(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2020 년 9 월 24 일 (24.09.2020)

WIPO | PCT

(10) 국제공개번호
WO 2020/190116 A1

(51) 국제특허분류:
H01L 51/00 (2006.01) *H01L 51/50* (2006.01)

(21) 국제출원번호: PCT/KR2020/095039

(22) 국제출원일: 2020 년 3 월 13 일 (13.03.2020)

(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
10-2019-0030168 2019 년 3 월 15 일 (15.03.2019) KR
10-2020-0030989 2020 년 3 월 12 일 (12.03.2020) KR

(71) 출원인: 주식회사 엘지화학 (**LG CHEM, LTD.**) [KR/KR]; 07336 서울시 영등포구 여의대로 128, Seoul (KR).

(72) 발명자: 김민준 (**KIM, Minjun**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 이동훈 (**LEE, Dong Hoon**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 서상덕 (**SUH, Sang Duk**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 김동희 (**KIM, Donghee**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 김서연 (**KIM, Seoyeon**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 이다정 (**LEE, Da Jung**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR). 최승원 (**CHOI, Seung Won**); 34122 대전시 유성구 문지로 188 LG화학 기술연구원, Daejeon (KR).

(74) 대리인: 유미특허법인 (**YOU ME PATENT AND LAW FIRM**); 06134 서울시 강남구 테헤란로 115, Seoul (KR).

(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

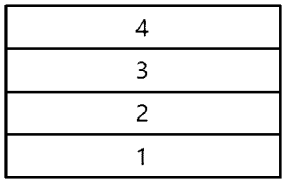
(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:
— 국제조사보고서와 함께 (조약 제21조(3))

WO 2020/190116 A1

(54) **Title:** ORGANIC LIGHT EMITTING DIODE

(54) 발명의 명칭: 유기 발광 소자



(57) **Abstract:** The present invention provides an organic light emitting diode.

(57) 요약서: 본 발명은 유기 발광 소자를 제공한다.

명세서

발명의 명칭: 유기 발광 소자

기술분야

[1] 본 출원은 2019년 3월 15일자 한국 특허 출원 제10-2019-0030168호 및 2020년 3월 12일자 한국 특허 출원 제10-2020-0030989호에 기초한 우선권의 이익을 주장하며, 해당 한국 특허 출원의 문헌들에 개시된 모든 내용은 본 명세서의 일부로서 포함된다.

[2]

[3] 본 발명은 구동 전압이 낮고, 발광 효율이 높으며, 수명이 우수한 유기 발광 소자에 관한 것이다.

배경기술

[4] 일반적으로 유기 발광 현상이란 유기 물질을 이용하여 전기에너지를 빛에너지로 전환시켜주는 현상을 말한다. 유기 발광 현상을 이용하는 유기 발광 소자는 넓은 시야각, 우수한 콘트라스트, 빠른 응답 시간을 가지며, 휘도, 구동 전압 및 응답 속도 특성이 우수하여 많은 연구가 진행되고 있다.

[5]

[6] 유기 발광 소자는 일반적으로 양극과 음극 및 상기 양극과 음극 사이에 유기물 층을 포함하는 구조를 가진다. 상기 유기물 층은 유기 발광 소자의 효율과 안정성을 높이기 위하여 각기 다른 물질로 구성된 다층의 구조로 이루어진 경우가 많으며, 예컨대 정공주입층, 정공수송층, 발광층, 전자수송층, 전자주입층 등으로 이루어질 수 있다. 이러한 유기 발광 소자의 구조에서 두 전극 사이에 전압을 걸어주게 되면 양극에서는 정공이, 음극에서는 전자가 유기물층에 주입되게 되고, 주입된 정공과 전자가 만났을 때 엑시톤(exciton)이 형성되며, 이 엑시톤이 다시 바닥상태로 떨어질 때 빛이 나게 된다.

[7]

[8] 상기와 같은 유기 발광 소자에 사용되는 유기물에 대하여 새로운 재료의 개발이 지속적으로 요구되고 있다.

[9]

[10] [선행기술문헌]

[11] [특허문헌]

[12] (특허문헌 0001) 한국특허 공개번호 제10-2000-0051826호

[13]

발명의 상세한 설명

기술적 과제

[14] 본 발명은 구동 전압이 낮고, 발광 효율이 높으며, 수명이 우수한 유기 발광 소자에 관한 것이다.

[15]

과제 해결 수단

[16] 상기 과제를 해결하기 위하여, 본 발명은 하기의 유기 발광 소자를 제공한다.

[17] 본 발명에 따른 유기 발광 소자는,

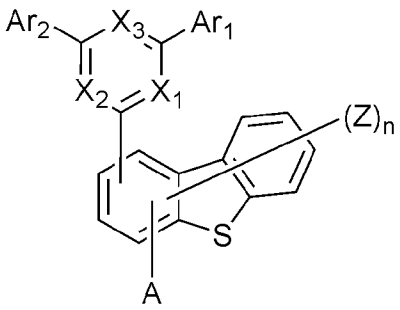
[18] 제1 전극;

[19] 상기 제1 전극과 대향하여 구비된 제2 전극; 및

[20] 상기 제1 전극과 상기 제2 전극 사이에 구비된 발광층을 포함하고,

[21] 상기 발광층은 하기 화학식 1로 표시되는 제1 화합물 및 하기 화학식 2로 표시되는 제2 화합물을 포함하고,

[22] [화학식 1]

[23] 

[24] 상기 화학식 1에서,

[25] X_1 내지 X_3는 각각 독립적으로, N 또는 CH이되, X_1 내지 X_3 중 적어도 둘은 N이고,

[26] Ar_1 및 Ar_2는 각각 독립적으로, 중수소; 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

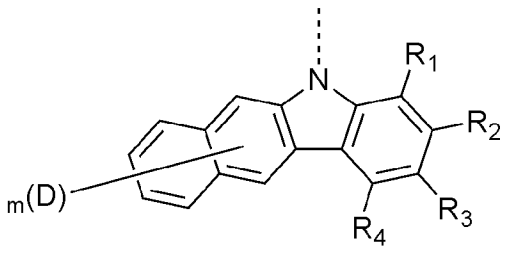
[27] Z는 각각 독립적으로, 수소, 또는 중수소이거나, 또는 Z 중 인접하는 둘은 서로 결합하여 C_{6-60} 방향족 고리 또는 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리를 형성할 수 있고,

[28] 여기서, 상기 C_{6-60} 방향족 고리 및 상기 C_{2-60} 헤테로방향족 고리는 비치환되거나, 또는 중수소로 치환되고,

[29] n은 0 내지 6의 정수이고,

[30] A는 하기 화학식 1-1로 표시되는 치환기이고,

[31] [화학식 1-1]

[32] 

[33] 상기 화학식 1-1에서,

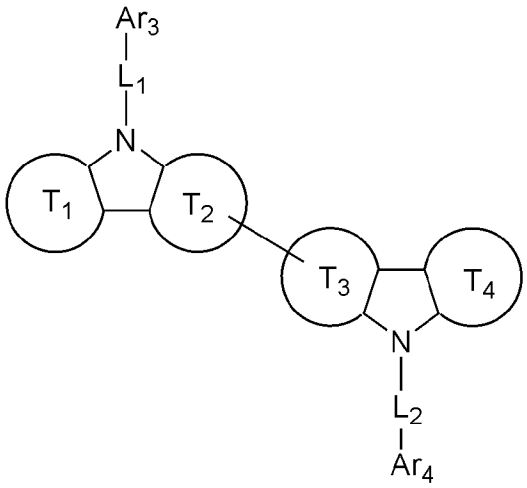
[34] R_1 내지 R_4는 각각 독립적으로, 수소 또는 중수소이거나, 또는 R_1 내지 R_4 중 인접하는 둘은 서로 결합하여 C_{6-60} 방향족 고리 또는 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리를 형성할 수 있고,

[35] 여기서, 상기 C_{6-60} 방향족 고리 및 상기 C_{2-60} 헤테로방향족 고리는 비치환되거나, 또는 중수소로 치환되고,

[36] D는 중수소를 의미하고,

[37] m은 0 내지 6의 정수이고,

[38] [화학식 2]

[39] 

[40] 상기 화학식 2에서,

[41] T_1 내지 T_4는 각각 독립적으로, 이웃하는 오각고리와 융합되는, 치환 또는 비치환된 C_{6-60} 방향족 고리; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리이고,

[42] L_1 및 L_2는 각각 독립적으로, 단일 결합; 치환 또는 비치환된 C_{6-60} 아릴렌; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴렌이고,

[43] Ar_3 및 Ar_4는 각각 독립적으로, 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이다.

[44]

발명의 효과

[45] 상술한 유기 발광 소자는 발광층에 호스트 물질로 제1 화합물 및 제2 화합물을 동시에 포함하여, 낮은 구동 전압, 높은 발광 효율 및 장수명 특성을 나타낼 수 있다.

[46]

도면의 간단한 설명

[47] 도 1은 기판(1), 양극(2), 발광층(3) 및 음극(4)으로 이루어진 유기 발광 소자의 예를 도시한 것이다.

[48] 도 2는 기판(1), 양극(2), 정공주입층(5), 정공수송층(6), 발광층(3), 전자억제층(7), 정공저지층(8), 전자주입 및 수송층(8) 및 음극(4)으로 이루어진 유기 발광 소자의 예를 도시한 것이다.

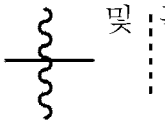
[49]

발명의 실시를 위한 형태

[50] 이하, 본 발명의 이해를 돕기 위하여 보다 상세히 설명한다.

[51]

[52] (용어의 정의)

[53] 본 명세서에서,  및 는 다른 치환기에 연결되는 결합을 의미한다.

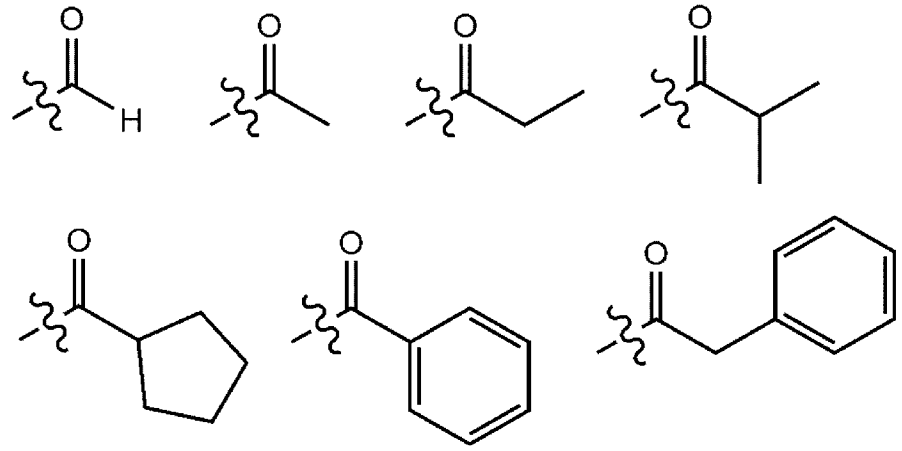
[54]

[55] 본 명세서에서 "치환 또는 비치환된" 이라는 용어는 중수소; 할로겐기; 시아노기; 니트로기; 히드록시기; 카보닐기; 에스테르기; 이미드기; 아미노기; 포스핀옥사이드기; 알콕시기; 아릴옥시기; 알킬티옥시기; 아릴티옥시기; 알킬술폭시기; 아릴술폭시기; 실릴기; 붕소기; 알킬기; 사이클로알킬기; 알케닐기; 아릴기; 아르알킬기; 아르알케닐기; 알킬아릴기; 알킬아민기; 아랄킬아민기; 헤테로아릴아민기; 아릴아민기; 아릴포스핀기; 또는 N, O 및 S 원자 중 1개 이상을 포함하는 헤테로아릴기로 이루어진 군에서 선택된 1개 이상의 치환기로 치환 또는 비치환되거나, 상기 예시된 치환기 중 2 이상의 치환기가 연결된 치환 또는 비치환된 것을 의미한다. 예컨대, "2 이상의 치환기가 연결된 치환기"는 비페닐기일 수 있다. 즉, 비페닐기는 아릴기일 수도 있고, 2개의 페닐기가 연결된 치환기로 해석될 수 있다.

[56]

[57] 본 명세서에서 카보닐기의 탄소수는 특별히 한정되지 않으나, 탄소수 1 내지 40인 것이 바람직하다. 구체적으로 하기와 같은 구조의 화합물이 될 수 있으나, 이에 한정되는 것은 아니다.

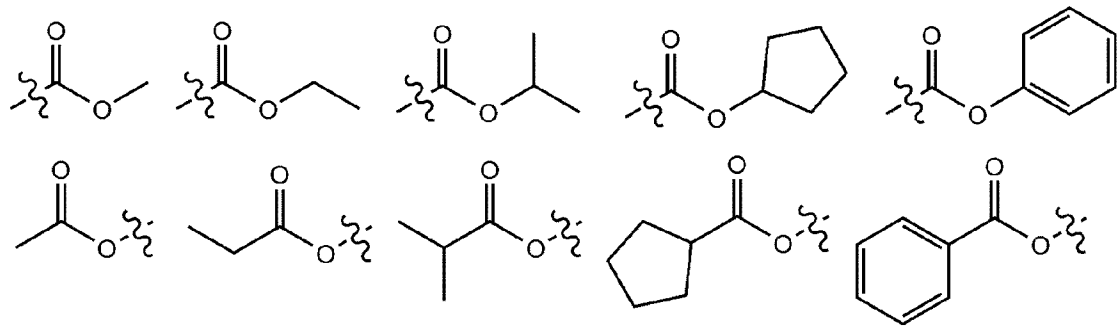
[58]



[59]

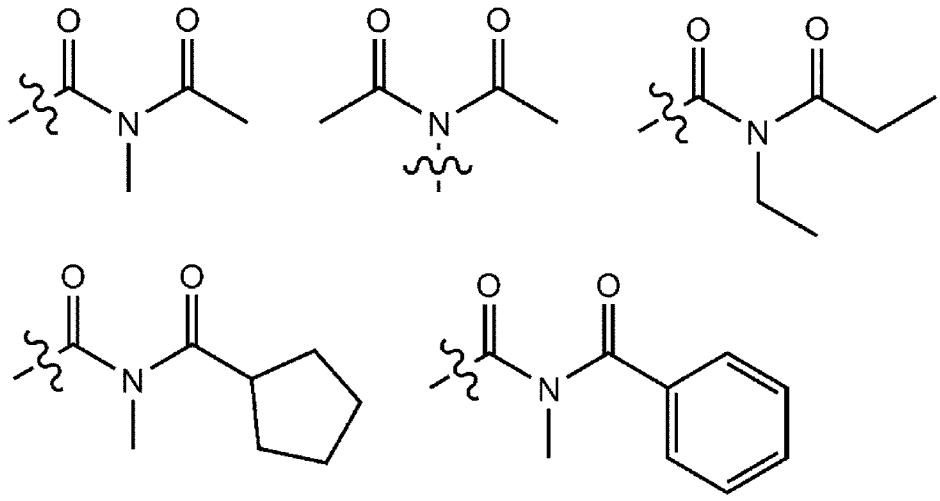
[60] 본 명세서에 있어서, 에스테르기는 에스테르기의 산소가 탄소수 1 내지 25의 직쇄, 분지쇄 또는 고리쇄 알킬기 또는 탄소수 6 내지 25의 아릴기로 치환될 수 있다. 구체적으로, 하기 구조식의 화합물이 될 수 있으나, 이에 한정되는 것은 아니다.

[61]



[62] 본 명세서에 있어서, 이미드기의 탄소수는 특별히 한정되지 않으나, 탄소수 1 내지 25인 것이 바람직하다. 구체적으로 하기와 같은 구조의 화합물이 될 수 있으나, 이에 한정되는 것은 아니다.

[63]



[64]

[65] 본 명세서에 있어서, 실릴기는 구체적으로 트리메틸실릴기, 트리에틸실릴기,

t-부틸디메틸실릴기, 비닐디메틸실릴기, 프로필디메틸실릴기, 트리페닐실릴기, 디페닐실릴기, 페닐실릴기 등이 있으나 이에 한정되지 않는다.

[66]

[67] 본 명세서에 있어서, 붕소기는 구체적으로 트리메틸붕소기, 트리에틸붕소기, t-부틸디메틸붕소기, 트리페닐붕소기, 페닐붕소기 등이 있으나 이에 한정되지 않는다.

[68]

[69] 본 명세서에 있어서, 할로겐기의 예로는 불소, 염소, 브롬 또는 요오드가 있다.

[70]

[71] 본 명세서에 있어서, 상기 알킬기는 직쇄 또는 분지쇄일 수 있고, 탄소수는 특별히 한정되지 않으나 1 내지 40인 것이 바람직하다. 일 실시상태에 따르면, 상기 알킬기의 탄소수는 1 내지 20이다. 또 하나의 실시상태에 따르면, 상기 알킬기의 탄소수는 1 내지 10이다. 또 하나의 실시상태에 따르면, 상기 알킬기의 탄소수는 1 내지 6이다. 알킬기의 구체적인 예로는 메틸, 에틸, 프로필, n-프로필, 이소프로필, 부틸, n-부틸, 이소부틸, tert-부틸, sec-부틸, 1-메틸-부틸, 1-에틸-부틸, 펜틸, n-펜틸, 이소펜틸, 네오펜틸, tert-펜틸, 헥실, n-헥실, 1-메틸펜틸, 2-메틸펜틸, 4-메틸-2-펜틸, 3,3-디메틸부틸, 2-에틸부틸, 헵틸, n-헵틸, 1-메틸헥실, 사이클로펜틸메틸,사이클로헥틸메틸, 옥틸, n-옥틸, tert-옥틸, 1-메틸헵틸, 2-에틸헥실, 2-프로필펜틸, n-노닐, 2,2-디메틸헵틸, 1-에틸-프로필, 1,1-디메틸-프로필, 이소헥실, 2-메틸펜틸, 4-메틸헥실, 5-메틸헥실 등이 있으나, 이들에 한정되지 않는다.

[72]

[73] 본 명세서에 있어서, 상기 알케닐기는 직쇄 또는 분지쇄일 수 있고, 탄소수는 특별히 한정되지 않으나, 2 내지 40인 것이 바람직하다. 일 실시상태에 따르면, 상기 알케닐기의 탄소수는 2 내지 20이다. 또 하나의 실시상태에 따르면, 상기 알케닐기의 탄소수는 2 내지 10이다. 또 하나의 실시상태에 따르면, 상기 알케닐기의 탄소수는 2 내지 6이다. 구체적인 예로는 비닐, 1-프로페닐, 이소프로페닐, 1-부테닐, 2-부테닐, 3-부테닐, 1-펜테닐, 2-펜테닐, 3-펜테닐, 3-메틸-1-부테닐, 1,3-부타디에닐, 알릴, 1-페닐비닐-1-일, 2-페닐비닐-1-일, 2,2-디페닐비닐-1-일, 2-페닐-2-(나프틸-1-일)비닐-1-일, 2,2-비스(디페닐-1-일)비닐-1-일, 스틸베닐기, 스티레닐기 등이 있으나 이들에 한정되지 않는다.

[74]

[75] 본 명세서에 있어서, 사이클로알킬기는 특별히 한정되지 않으나, 탄소수 3 내지 60인 것이 바람직하며, 일 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 30이다. 또 하나의 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 20이다. 또 하나의 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 6이다. 구체적으로 사이클로프로필, 사이클로부틸, 사이클로펜틸,

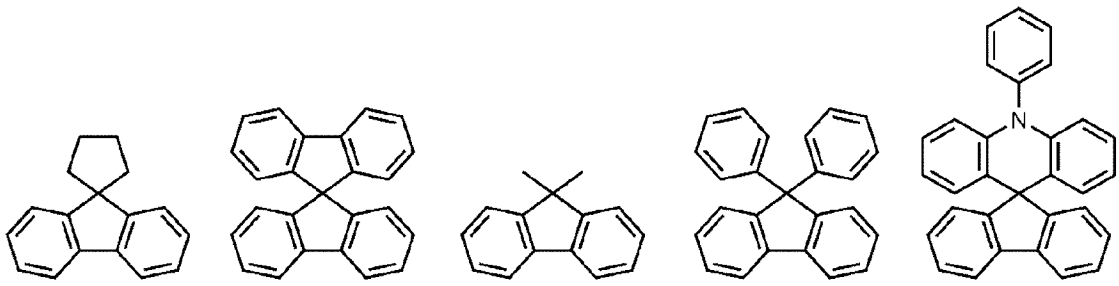
3-메틸사이클로펜틸, 2,3-디메틸사이클로펜틸, 사이클로헥실, 3-메틸사이클로헥실, 4-메틸사이클로헥실, 2,3-디메틸사이클로헥실, 3,4,5-트리메틸사이클로헥실, 4-tert-부틸사이클로헥실, 사이클로헵틸, 사이클로옥틸 등이 있으나, 이에 한정되지 않는다.

[76]

[77] 본 명세서에 있어서, 아릴기는 특별히 한정되지 않으나 탄소수 6 내지 60인 것이 바람직하며, 단환식 아릴기 또는 다환식 아릴기일 수 있다. 일 실시상태에 따르면, 상기 아릴기의 탄소수는 6 내지 30이다. 일 실시상태에 따르면, 상기 아릴기의 탄소수는 6 내지 20이다. 상기 아릴기가 단환식 아릴기로는 페닐기, 비페닐기, 터페닐기 등이 될 수 있으나, 이에 한정되는 것은 아니다. 상기 다환식 아릴기로는 나프틸기, 안트라세닐기, 페난쓰레닐기, 파이레닐기, 페릴레닐기, 크라이세닐기, 플루오레닐기 등이 될 수 있으나, 이에 한정되는 것은 아니다.

[78]

[79] 본 명세서에 있어서, 플루오레닐기는 치환될 수 있고, 치환기 2개가 서로 결합하여 스피로 구조를 형성할 수 있다. 상기 플루오레닐기가 치환되는 경우,



등이 될 수 있다. 다만, 이에 한정되는 것은 아니다.

[80]

[81] 본 본 명세서에 있어서, 헤테로아릴은 이종 원소로 O, N, Si 및 S 중 1개 이상을 포함하는 헤테로아릴로서, 탄소수는 특별히 한정되지 않으나, 탄소수 2 내지 60인 것이 바람직하다. 헤테로아릴의 예로는 티오펜기, 퓨란기, 피롤기, 이미다졸기, 티아졸기, 옥사졸기, 옥사디아졸기, 트리아졸기, 피리딜기, 비피리딜기, 피리미딜기, 트리아진기, 아크리딜기, 피리다진기, 피라지닐기, 퀴놀리닐기, 퀴나졸린기, 퀴녹살리닐기, 프탈라지닐기, 피리도 피리미디닐기, 피리도 피라지닐기, 피라지노 피라지닐기, 이소퀴놀린기, 인돌기, 카바졸기, 벤즈옥사졸기, 벤조이미다졸기, 벤조티아졸기, 벤조카바졸기, 벤조티오펜기, 디벤조티오펜기, 벤조퓨라닐기, 페난쓰롤린기(phenanthroline), 이소옥사졸릴기, 티아디아졸릴기, 페노티아지닐기 및 디벤조퓨라닐기 등이 있으나, 이들에만 한정되는 것은 아니다.

[82]

[83] 본 명세서에서 사용되는 용어 "방향족 고리"는 고리 형성 원자로서 탄소만을 포함하면서 분자 전체가 방향족성(aromaticity)을 갖는 축합단환 또는 축합다환

고리뿐 아니라, 플루오렌 고리와 같은 복수 개의 방향족성을 갖는 축합단환 고리가 인접한 치환기끼리 연결되어 형성된 축합다환 고리 또한 포함하는 것으로 이해된다. 이때, 상기 방향족 고리의 탄소수는 6 내지 60, 또는 6 내지 30, 또는 6 내지 20이나, 이에 한정되는 것은 아니다. 또한, 상기 방향족 고리로는 벤젠 고리, 나프탈렌 고리, 안트라센 고리, 페난쓰렌 고리, 파이렌 고리, 플루오렌 고리 등이 될 수 있으나, 이에 한정되는 것은 아니다.

[84]

[85] 본 명세서에서 사용되는 용어 "헤테로방향족 고리(heterocyclic ring)"는 고리 형성 원자로서 탄소 외 O, N, 및 S 중 1개 이상의 헤테로원자를 포함하면서 분자 전체가 방향족성을 갖는 헤테로축합단환 또는 헤테로축합다환 고리를 의미한다. 상기 헤테로 고리의 탄소수는 2 내지 60, 또는 2 내지 30, 또는 2 내지 20이나, 이에 한정되는 것은 아니다. 또한, 상기 헤테로 고리로는 벤조퓨란 고리, 벤조티오펜 고리, 디벤조퓨란 고리, 디벤조티오펜 고리 등이 될 수 있으나, 이에 한정되는 것은 아니다.

[86]

[87] 본 명세서에 있어서, 아르알킬기, 아르알케닐기, 알킬아릴기, 아릴아민기 중의 아릴기는 전술한 아릴기의 예시와 같다. 본 명세서에 있어서, 아르알킬기, 알킬아릴기, 알킬아민기 중 알킬기는 전술한 알킬기의 예시와 같다. 본 명세서에 있어서, 헤테로아릴아민 중 헤테로아릴은 전술한 헤테로아릴에 관한 설명이 적용될 수 있다. 본 명세서에 있어서, 아르알케닐기 중 알케닐기는 전술한 알케닐기의 예시와 같다. 본 명세서에 있어서, 아릴렌은 2가기인 것을 제외하고는 전술한 아릴기에 관한 설명이 적용될 수 있다. 본 명세서에 있어서, 헤테로아릴렌은 2가기인 것을 제외하고는 전술한 헤테로아릴에 관한 설명이 적용될 수 있다. 본 명세서에 있어서, 탄화수소 고리는 1가기가 아니고, 2개의 치환기가 결합하여 형성한 것을 제외하고는 전술한 아릴기 또는 사이클로알킬기에 관한 설명이 적용될 수 있다. 본 명세서에 있어서, 헤테로고리는 1가기가 아니고, 2개의 치환기가 결합하여 형성한 것을 제외하고는 전술한 헤테로아릴에 관한 설명이 적용될 수 있다.

[88]

[89] 이하, 각 구성 별로 본 발명을 상세히 설명한다.

[90]

[91] **제1 전극 및 제2 전극**

[92] 일 구현예에 따른 유기 발광 소자는, 기판 상에 제1 전극 및 상기 제1 전극과 대향하여 구비된 제2 전극을 포함하고, 이때, 상기 제1 전극이 양극인 경우 상기 제2 전극은 음극이고, 상기 제1 전극이 음극인 경우 상기 제2 전극은 양극이다.

[93] 구체적으로, 상기 유기 발광 소자는 기판 상에 양극, 발광층 및 음극이 순차적으로 적층된 정방향 구조(normal type)의 유기 발광 소자일 수 있다. 다르게는, 상기 유기 발광 소자는 기판 상에 음극, 발광층 및 양극이 순차적으로

적층된 역방향 구조(inverted type)의 유기 발광 소자일 수 있다.

[94]

[95] 상기 양극 물질로는 통상 유기물 층으로 정공 주입이 원활할 수 있도록 일함수가 큰 물질이 바람직하다. 상기 양극 물질의 구체적인 예로는 바나듐, 크롬, 구리, 아연, 금과 같은 금속 또는 이들의 합금; 아연 산화물, 인듐 산화물, 인듐주석 산화물(ITO), 인듐아연 산화물(IZO)과 같은 금속 산화물; ZnO:Al 또는 SNO_2:Sb와 같은 금속과 산화물의 조합; 폴리(3-메틸티오펜), 폴리[3,4-(에틸렌-1,2-디옥시)티오펜](PEDOT), 폴리피롤 및 폴리아닐린과 같은 전도성 고분자 등이 있으나, 이들에만 한정되는 것은 아니다.

[96]

[97] 상기 음극 물질로는 통상 유기물층으로 전자 주입이 용이하도록 일함수가 작은 물질인 것이 바람직하다. 상기 음극 물질의 구체적인 예로는 마그네슘, 칼슘, 나트륨, 칼륨, 티타늄, 인듐, 이트륨, 리튬, 가돌리늄, 알루미늄, 은, 주석 및 납과 같은 금속 또는 이들의 합금; LiF/Al 또는 LiO_2/Al과 같은 다층 구조 물질 등이 있으나, 이들에만 한정되는 것은 아니다.

[98]

[99] **발광층**

[100] 일 구현예에 따른 유기 발광 소자는 상기 제1 전극과 제2 전극 사이에 구비된, 정공 수송층과 전자 수송층으로부터 수송된 정공과 전자가 결합되어 가시광선 영역의 빛을 내는 층인 발광층을 포함하고, 상기 발광층은 상기 화학식 1로 표시되는 제1 화합물과 상기 화학식 2로 표시되는 제2 화합물을 포함한다.

[101]

[102] 이때, 상기 발광층 내에서 상기 제1 화합물과 상기 제2 화합물은 모두 호스트 재료로 사용된다. 구체적으로, 상기 제1 화합물은 N형 호스트 물질이고, 상기 제2 화합물은 P형 호스트 물질로, 유기 발광 소자의 발광층이 이러한 N형 호스트 물질과 P형 호스트 물질을 동시에 포함하는 경우 단일 물질 호스트를 사용하는 경우에 비하여, 효율 및 수명 측면에서 개선된 효과를 나타낼 수 있다.

[103]

[104] 특히, 상기 제1 화합물은 디벤조티오펜계 코어의 하나의 벤젠 고리에 N 함유 6원-헤테로고리기와 A 치환기(벤조카바졸일계 치환기)가 모두 결합된 구조를 갖는다. 이러한 구조를 갖는 제1 화합물은 N 함유 6원-헤테로고리기와 A 치환기(벤조카바졸일계 치환기)가 디벤조티오펜계 코어의 다른 벤젠 고리에 각각 결합되어 있는 구조를 갖는 화합물 및 상기 A 치환기(벤조카바졸일계 치환기) 대신 치환/비치환된 카바졸일 치환기가 결합된 화합물에 비하여, 전자와 정공에 대한 안정도가 높고, 전자와 정공의 균형을 안정적으로 유지할 수 있다. 따라서, 상기 제1 화합물을 채용한 유기 발광 소자는, (1) N 함유 6원-헤테로고리기와 A 치환기(벤조카바졸일계 치환기)가 디벤조티오펜계 코어의 다른 벤젠 고리에 각각 결합되어 있는 구조를 갖는 화합물 및 (2) 상기 A

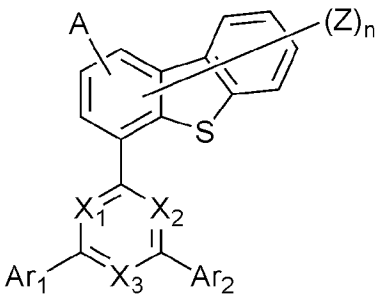
치환기(벤조카바졸일계 치환기) 대신 치환/비치환된 카바졸일 치환기가 결합된 화합물을 채용한 유기 발광 소자에 비하여, 저구동 전압, 고효율 및 장수명의 특성을 나타낸다.

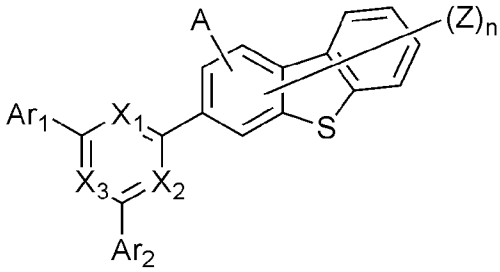
[105]

[106] 바람직하게는, 상기 제1 화합물은 상기 디벤조티오펜계 코어에서의 N 함유 6원-헤테로고리기의 결합 위치에 따라 하기 화학식 1A 내지 1D 중 어느 하나로 표시된다:

[107] [화학식 1A] [화학식 1B]

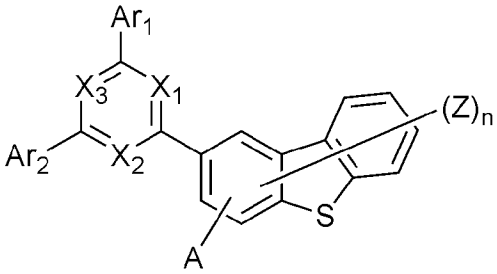
[108]

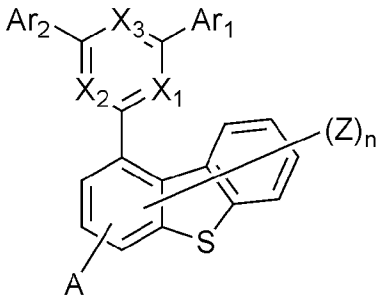




[109] [화학식 1C] [화학식 1D]

[110]





[111] 상기 화학식 1A 내지 1D에서,

[112] 각 치환기에 대한 설명은 상기 화학식 1에서 정의한 바와 같다.

[113]

[114] 바람직하게는, X_1 내지 X_3는 모두 N이다.

[115]

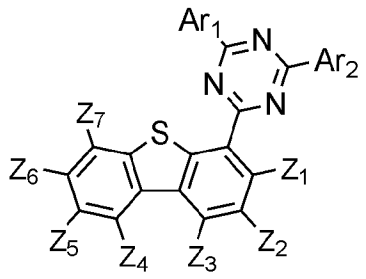
[116] 바람직하게는, Z는 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z 중 인접하는 둘은 서로 결합하여 비치환되거나 또는 중수소로 치환된 C_{6-20} 방향족 고리, 예를 들어 벤젠 고리를 형성할 수 있다.

[117] 이때, Z의 개수를 의미하는 n은 0, 1, 2, 3, 4, 5, 또는 6이다.

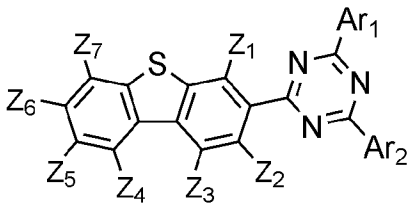
[118]

[119] 보다 구체적으로, 상기 제1 화합물은 하기 화학식 1A-1 내지 1D-1 중 어느 하나로 표시될 수 있다:

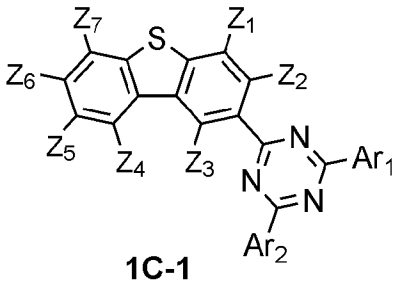
[120]



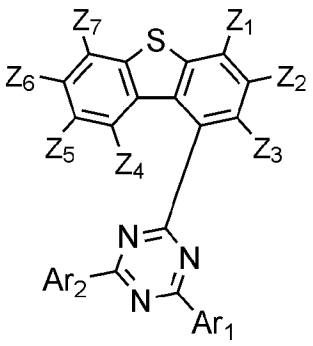
1A-1



1B-1



1C-1



1D-1

[121] 상기 화학식 1A-1 내지 1D-1에서,

[122] Z_1 내지 Z_3 중 하나는 상기 화학식 1-1로 표시되는 치환기 A이고, 나머지는 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_1 내지 Z_3 중 인접하는 둘은 서로 결합하여 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있고,

[123] Z_4 내지 Z_7은 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_4 내지 Z_7 중 인접하는 둘은 서로 결합하여 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있고,

[124] Ar_1 및 Ar_2는 상기 화학식 1에서 정의한 바와 같다.

[125]

[126] 구체적으로, 상기 화학식 1A-1에서는,

[127] Z_1이 A이고, Z_2 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_2 및 Z_3 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성하거나;

[128] Z_2가 A이고, Z_1 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나; 또는

[129] Z_3가 A이고, Z_1 및 Z_2가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_1 및 Z_2 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있다.

[130]

[131] 또한, 상기 화학식 1B-1에서는,

[132] Z_1이 A이고, Z_2 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_2 및 Z_3 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를

형성하거나;

[133] Z_2가 A이고, Z_1 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나; 또는

[134] Z_3가 A이고, Z_1 및 Z_2가 각각 독립적으로, 수소 또는 중수소일 수 있다.

[135]

[136] 또한, 상기 화학식 1C-1에서는,

[137] Z_1이 A이고, Z_2 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나;

[138] Z_2가 A이고, Z_1 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나; 또는

[139] Z_3가 A이고, Z_1 및 Z_2가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_1 및 Z_2 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있다.

[140]

[141] 구체적으로, 상기 화학식 1D-1에서는,

[142] Z_1이 A이고, Z_2 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_2 및 Z_3 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성하거나;

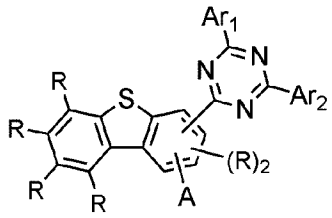
[143] Z_2가 A이고, Z_1 및 Z_3가 각각 독립적으로, 수소 또는 중수소이거나; 또는

[144] Z_3가 A이고, Z_1 및 Z_2가 각각 독립적으로, 수소 또는 중수소이거나, 또는 Z_1 및 Z_2 둘이 서로 결합하여, 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있다.

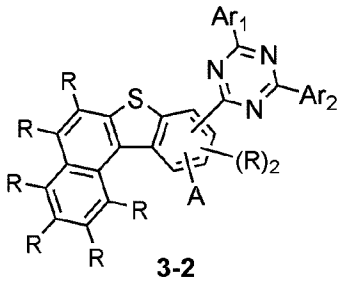
[145]

[146] 또는, 상기 제1 화합물은 하기 화학식 3-1 내지 3-7 중 어느 하나로 표시될 수 있다:

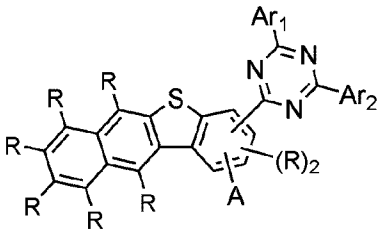
[147]



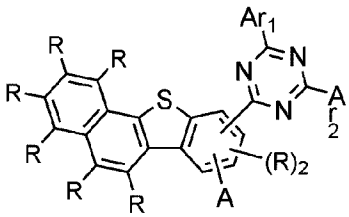
3-1



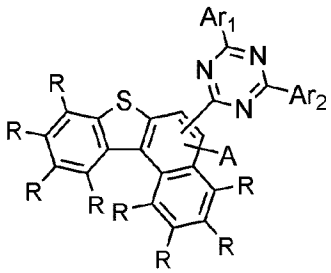
3-2



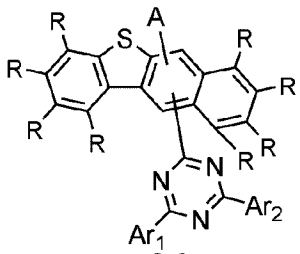
3-3



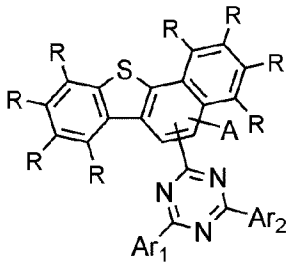
3-4



3-5



3-6



3-7

[148] 상기 화학식 3-1 내지 3-7에서,

[149] R은 각각 독립적으로, 수소, 또는 중수소이고,

[150] A, Ar_1 및 Ar_2는 상기 화학식 1에서 정의한 바와 같다.

[151]

[152] 바람직하게는, Ar_1 및 Ar_2는 각각 독립적으로, 비치환되거나, 또는 중수소 또는 C_{6-20} 아릴로 치환된 C_{6-20} 아릴이다.

[153]

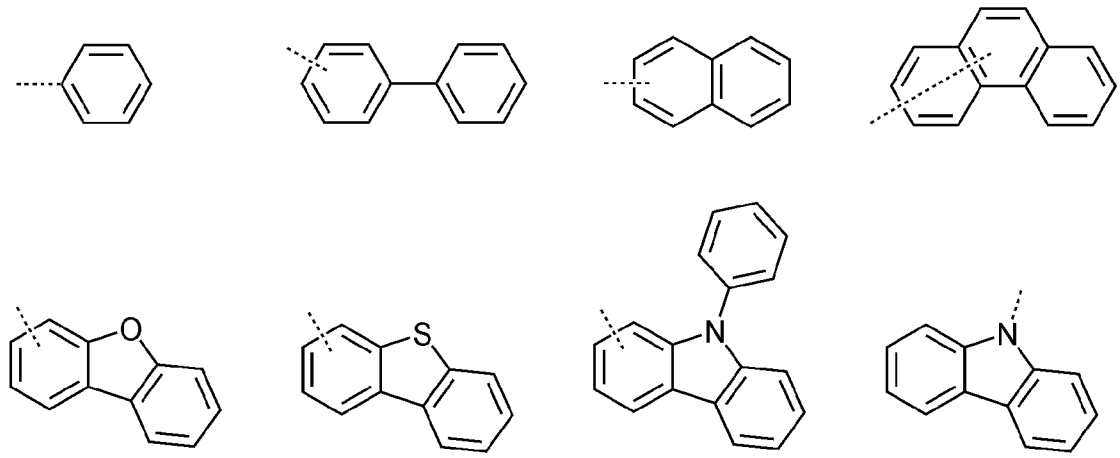
[154] 보다 바람직하게는, Ar_1 및 Ar_2는 각각 독립적으로, 페닐, 비페닐릴, 터페닐릴, 나프틸, 페난쓰레닐, 디벤조티오페닐, 디벤조퓨라닐, 또는 카바졸일이고,

[155] 여기서, Ar_1 및 Ar_2는 비치환되거나, 또는 중수소 및 C_{6-20} 아릴로 구성되는 군으로부터 각각 독립적으로 선택되는 1개 내지 5개의 치환기로 치환될 수 있다.

[156]

[157] 가장 바람직하게는, Ar_1 및 Ar_2는 각각 독립적으로, 하기로 구성되는 군으로부터 선택되는 어느 하나이다:

[158]



.

[159]

[160] 이때, Ar_1 및 Ar_2는 서로 동일할 수 있고, 또는, Ar_1 및 Ar_2는 상이할 수 있다.

[161]

[162] 또한, 상기 화학식 1-1로 표시되는 치환기인 A에서, R_1 내지 R_4는 각각 독립적으로, 수소 또는 중수소이거나, 또는 R_1 내지 R_4 중 인접하는 둘은 서로 결합하여 비치환되거나 또는 중수소로 치환된 벤젠 고리를 형성할 수 있다.

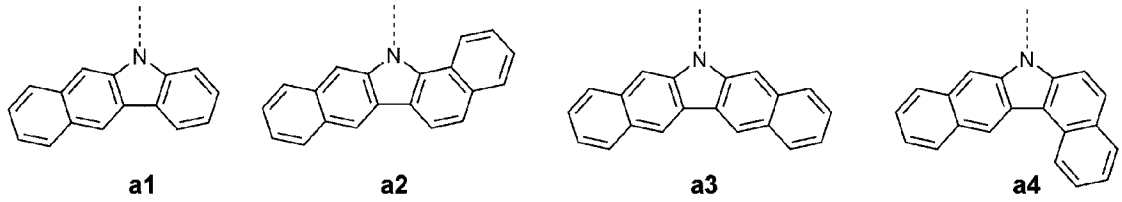
[163]

[164] 이때, 중수소(D)의 개수를 의미하는 m은 0, 1, 2, 3, 4, 5, 또는 6이다.

[165]

[166] 예를 들어, A는 하기 화학식 a1 내지 a4로 표시되는 치환기 중 어느 하나이다:

[167]



a1 a2 a3 a4

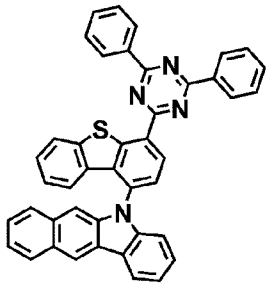
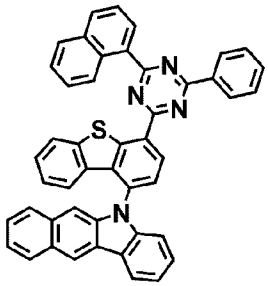
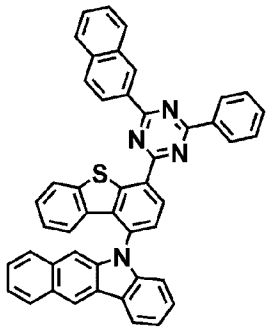
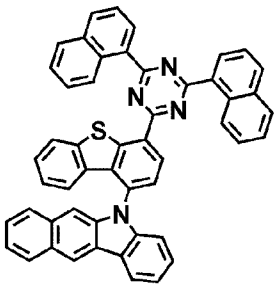
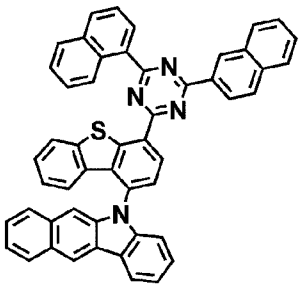
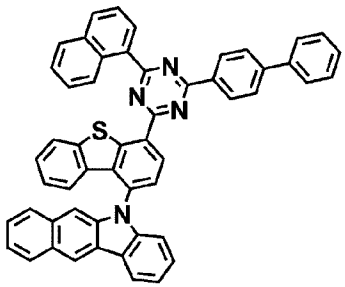
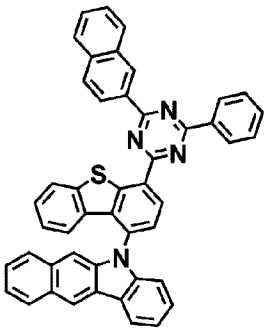
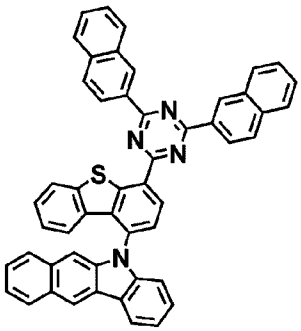
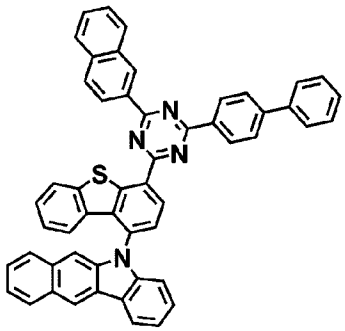
.

[168]

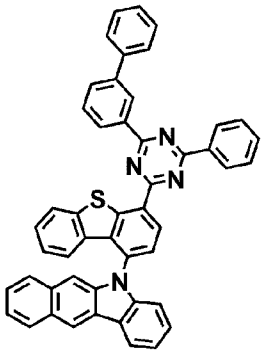
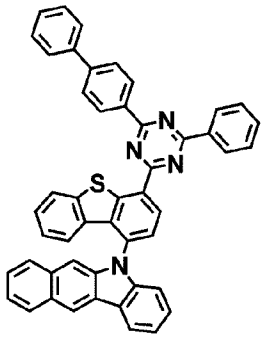
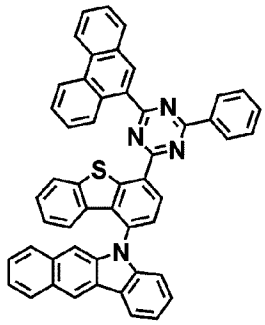
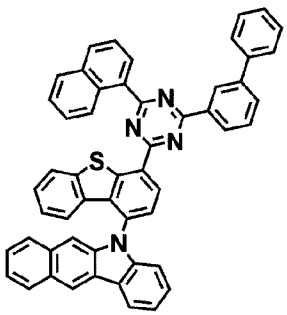
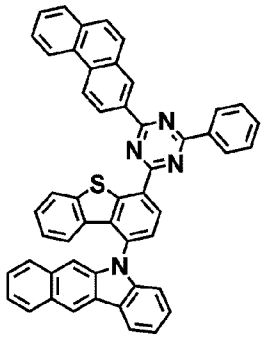
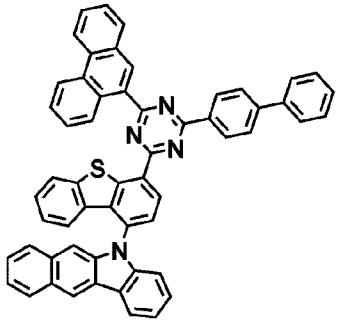
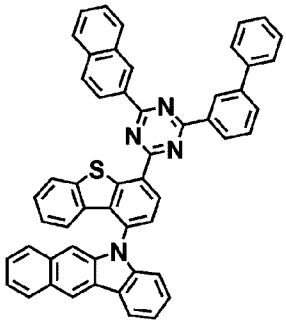
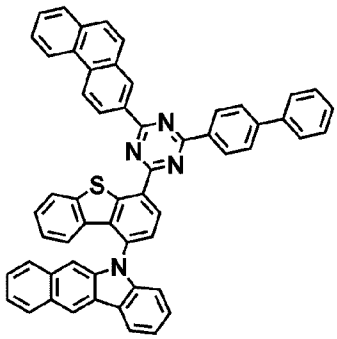
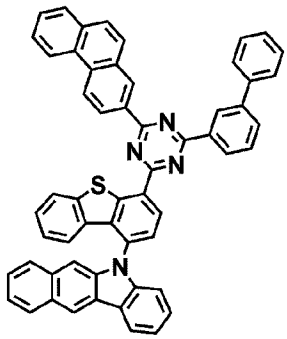
[169] 상기 제1 화합물의 구체적인 예는 다음과 같다:

[170]

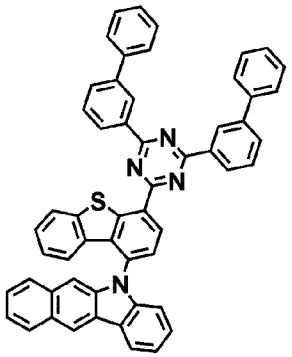
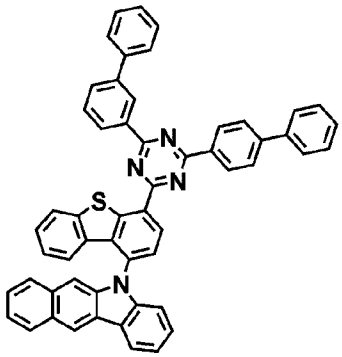
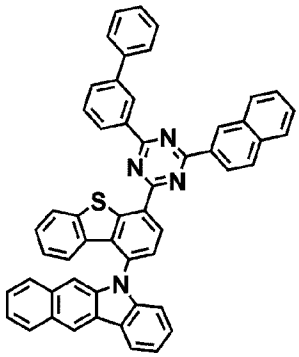
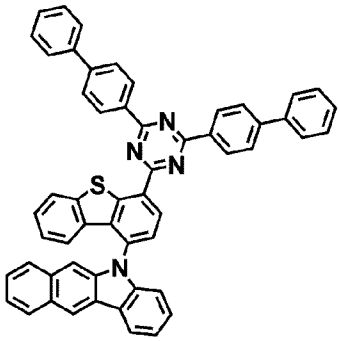
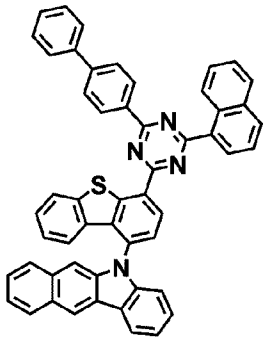
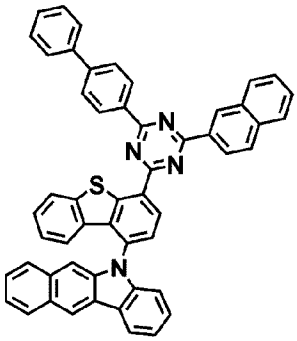
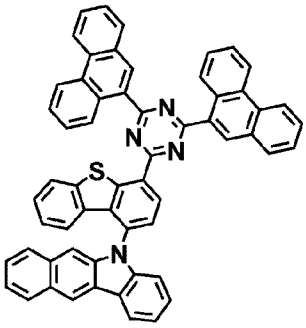
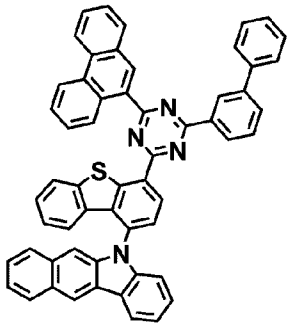
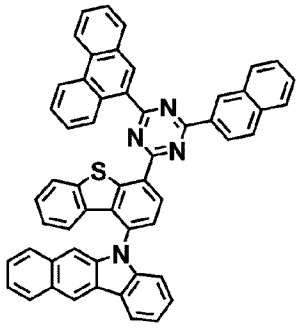
[171]

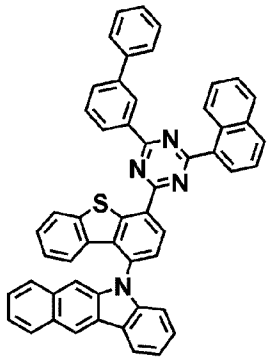
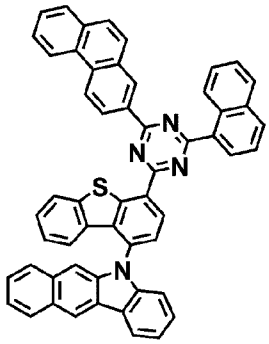
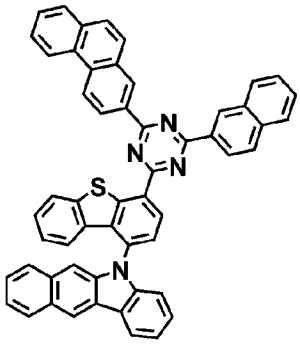
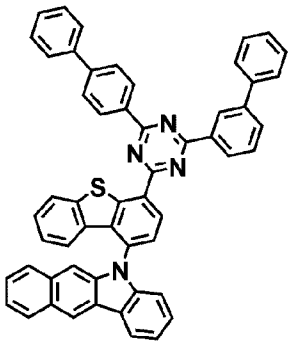
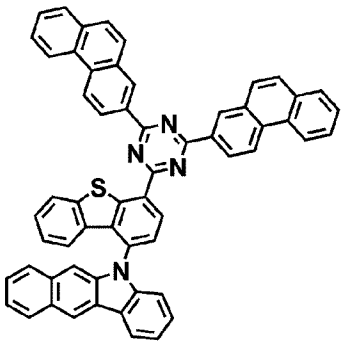
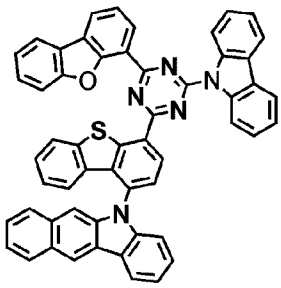
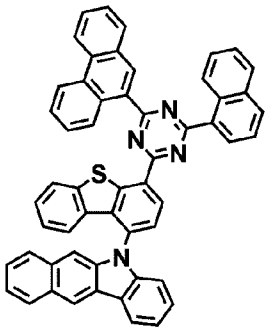
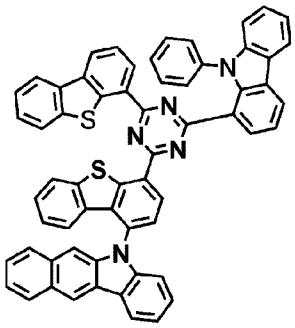
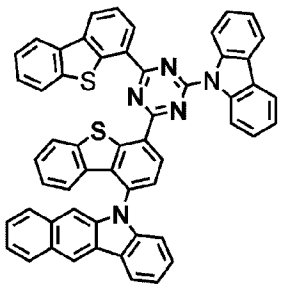
[172]

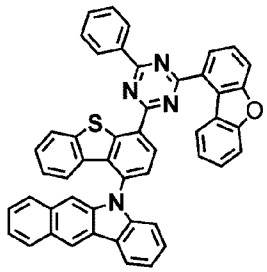
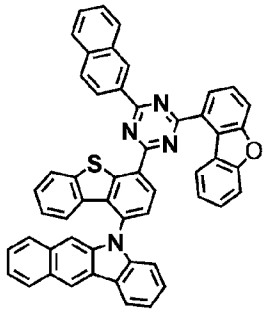
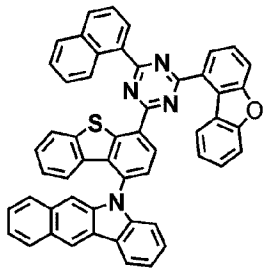
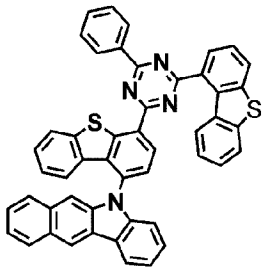
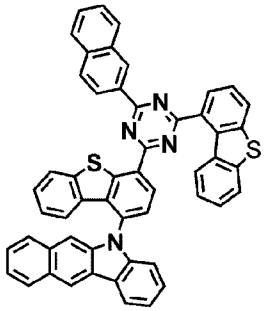
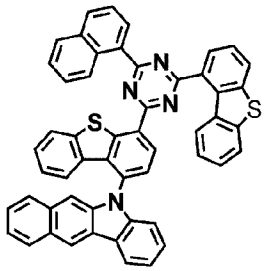
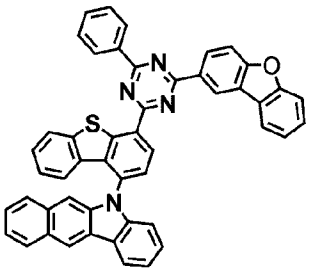
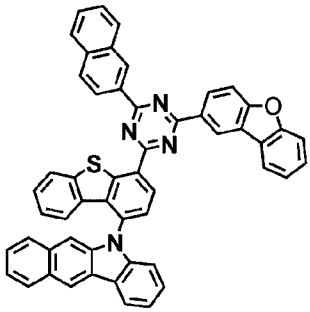
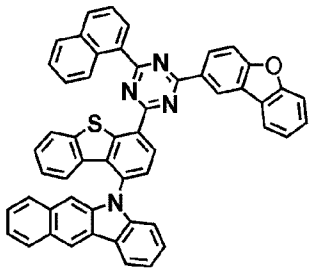
[173]

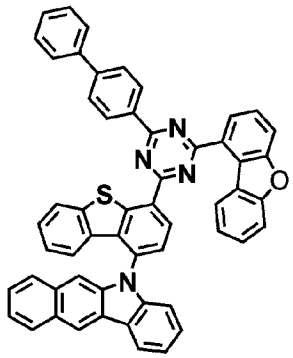
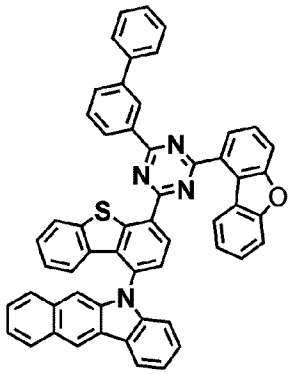
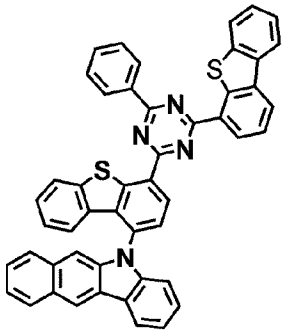
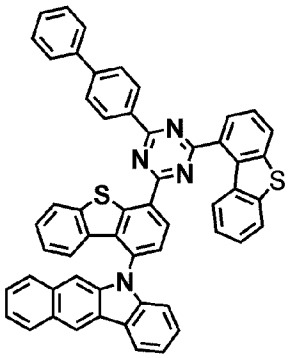
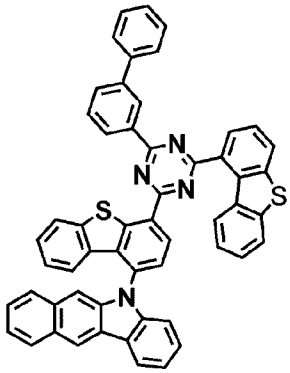
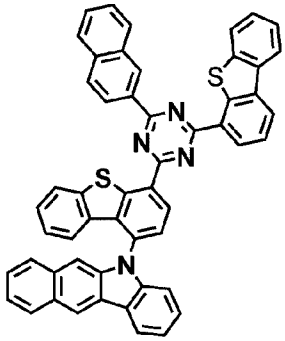
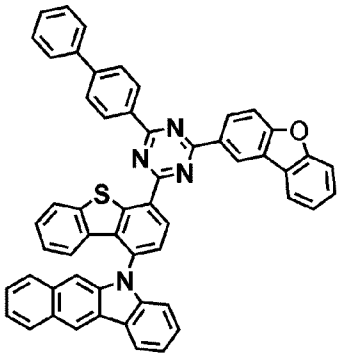
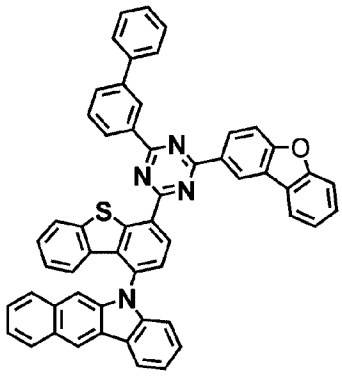
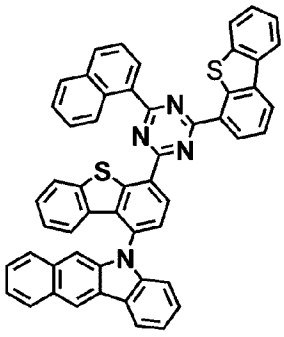
[174]

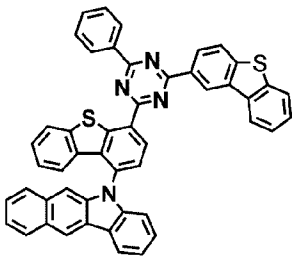
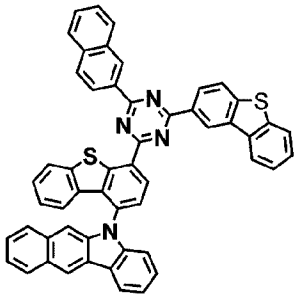
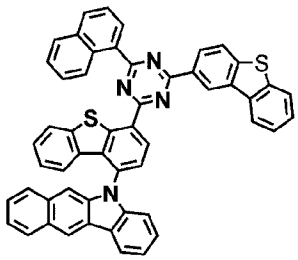
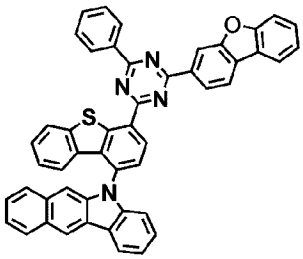
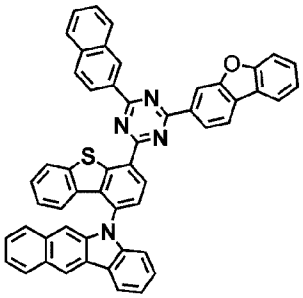
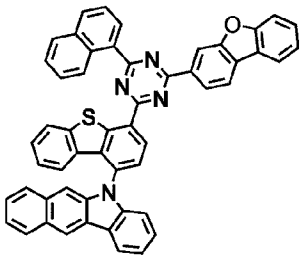
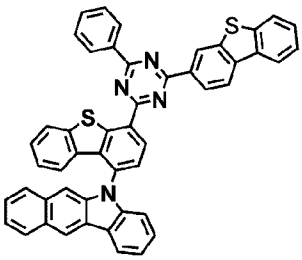
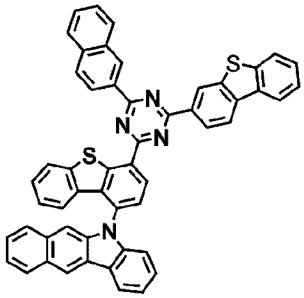
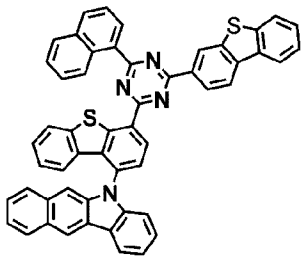
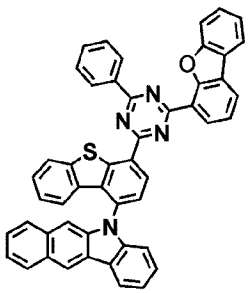
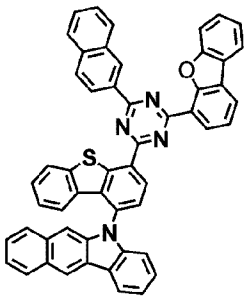
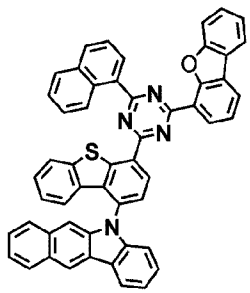
[175]

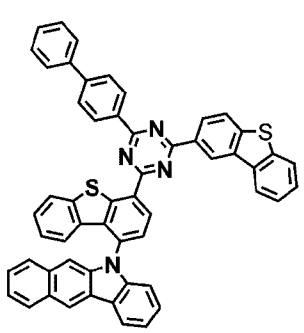
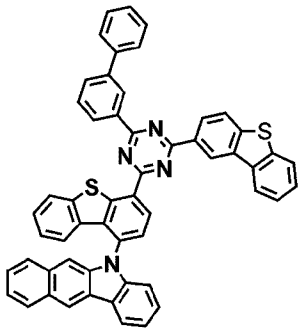
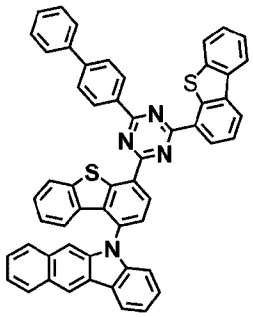
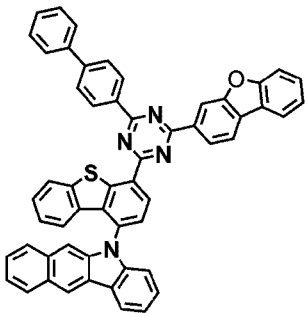
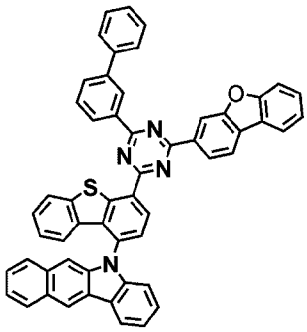
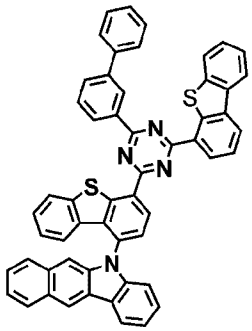
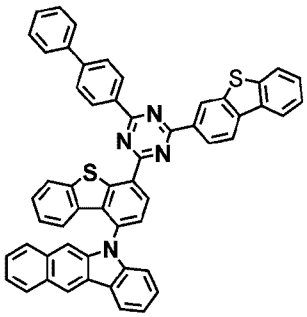
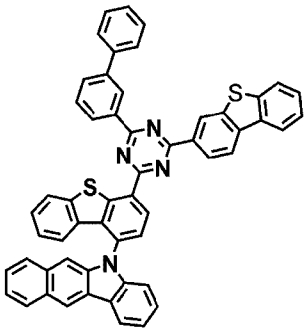
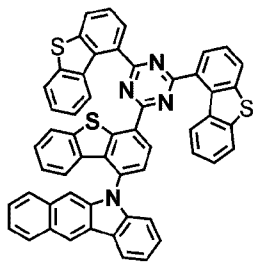
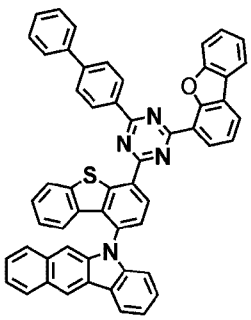
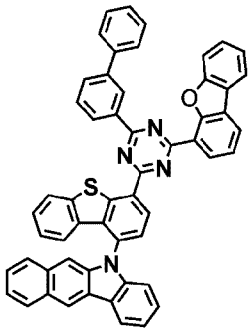
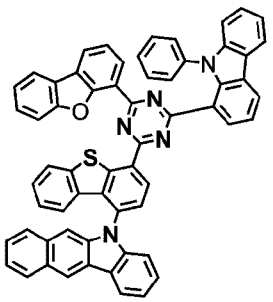
[176]

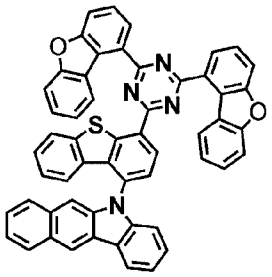
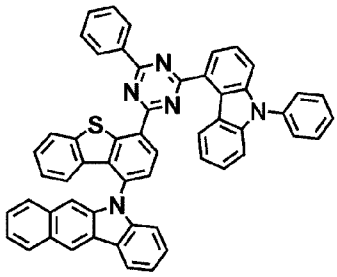
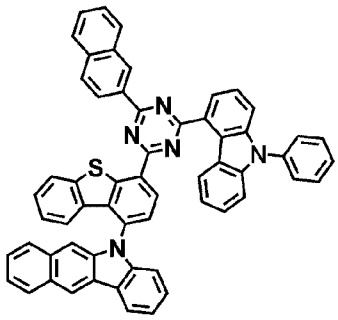
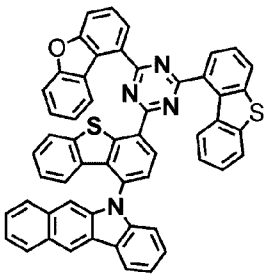
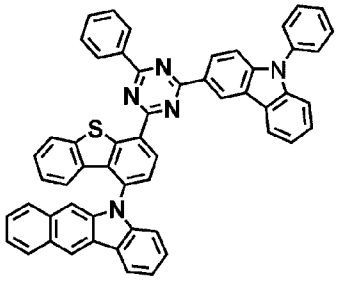
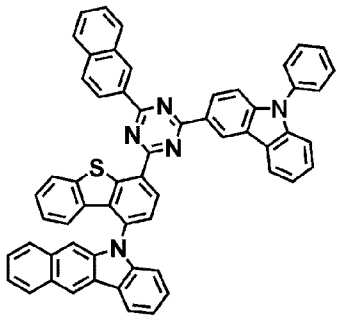
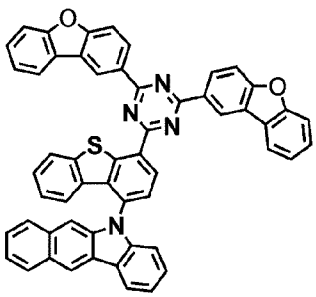
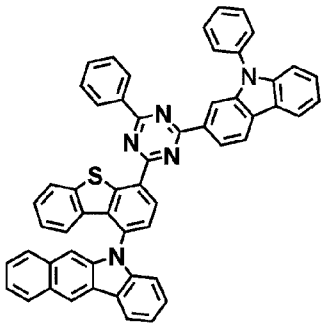
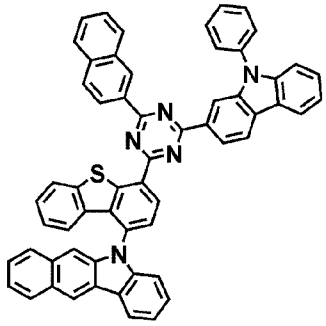
[177]

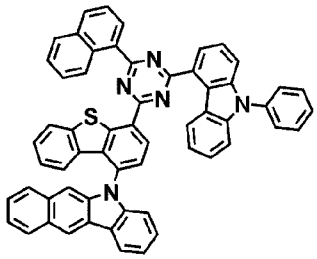
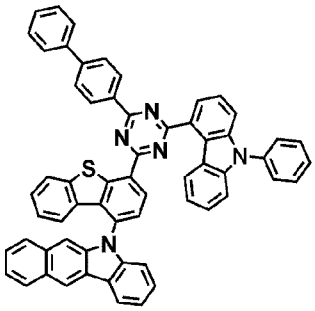
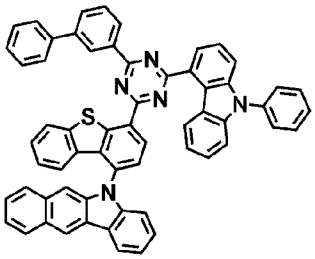
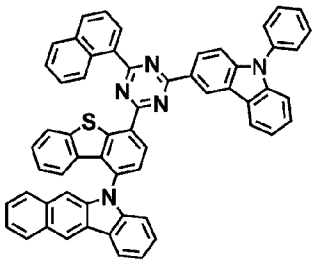
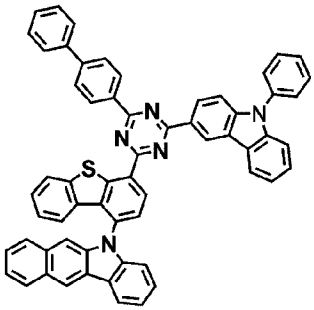
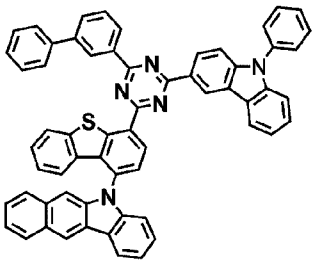
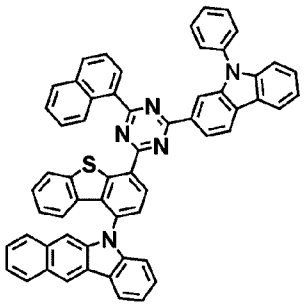
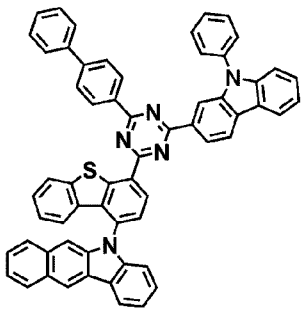
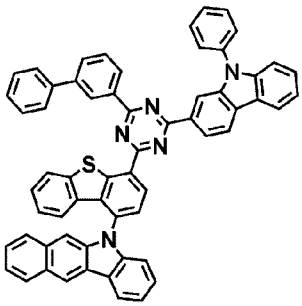
[178]

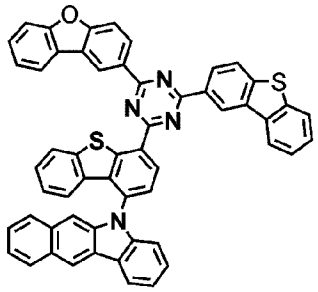
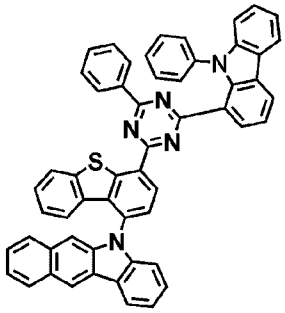
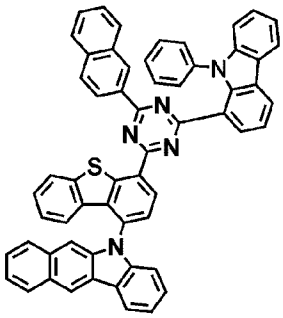
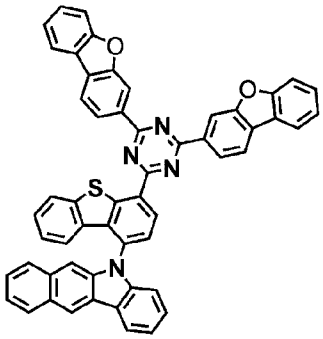
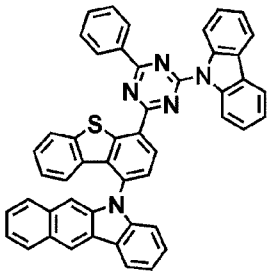
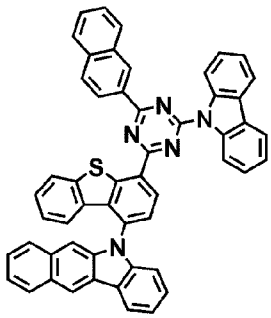
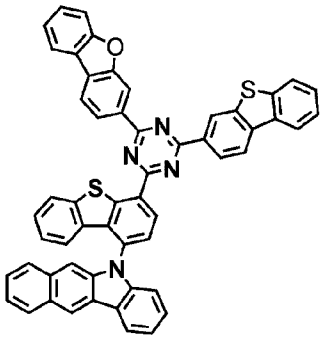
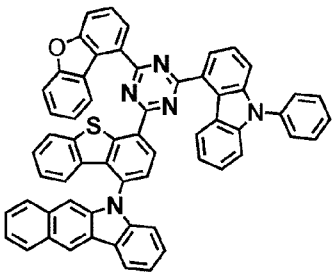
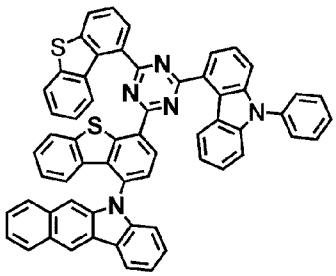
[179]

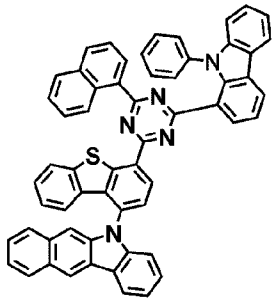
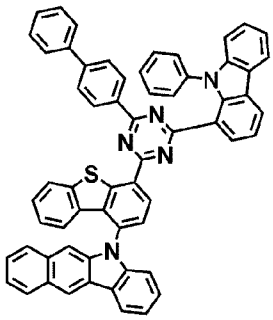
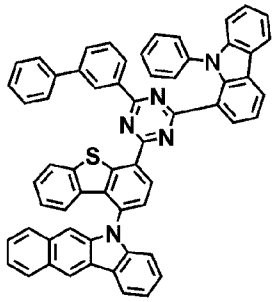
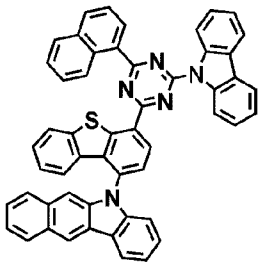
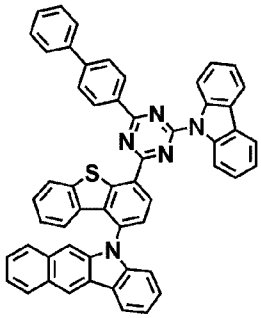
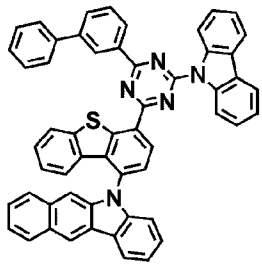
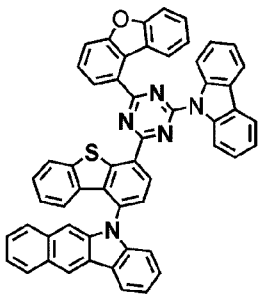
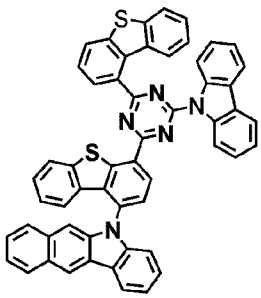
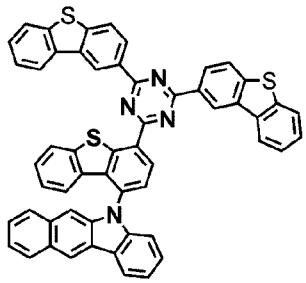
[180]

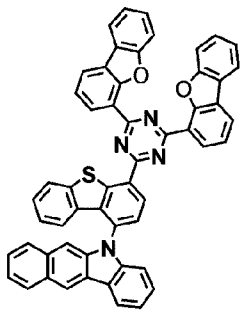
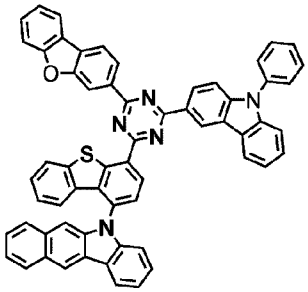
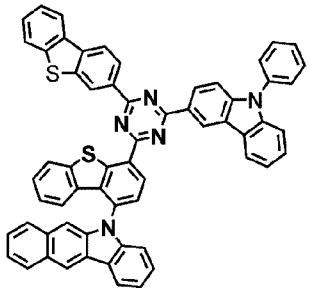
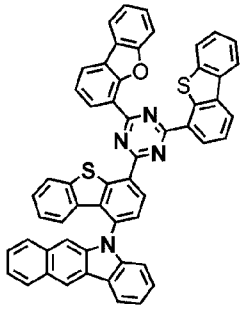
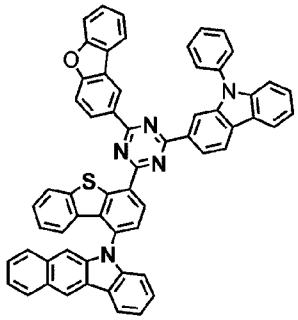
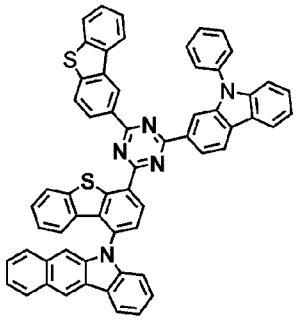
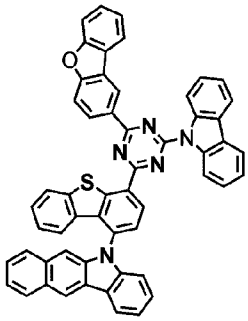
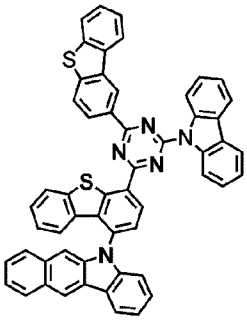
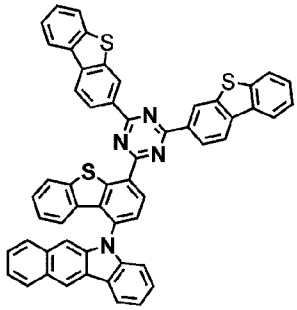
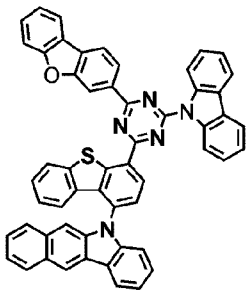
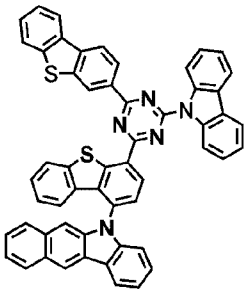
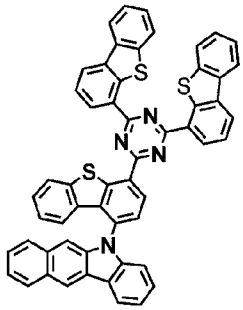
[181]

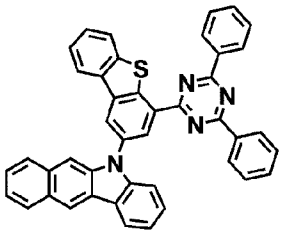
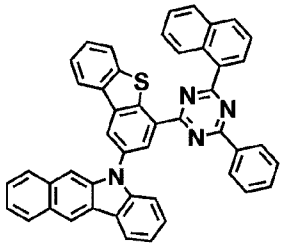
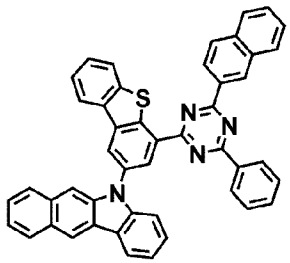
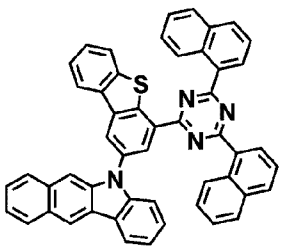
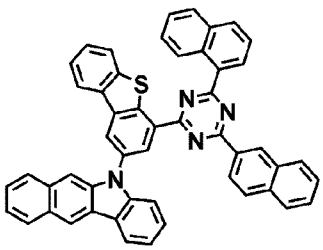
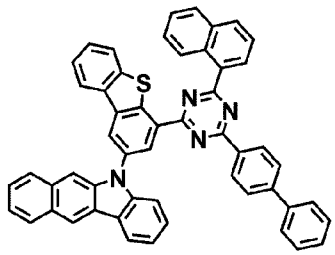
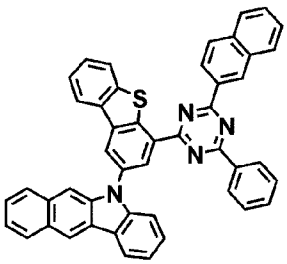
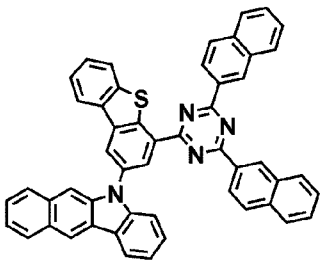
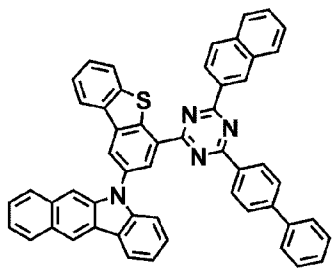
[182]

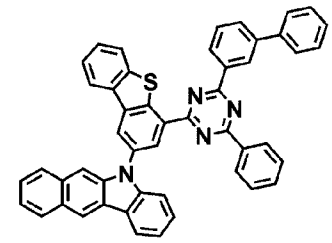
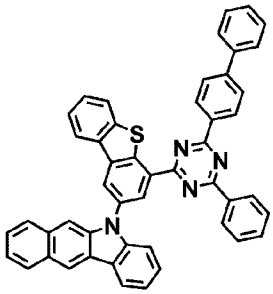
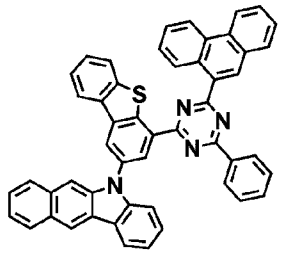
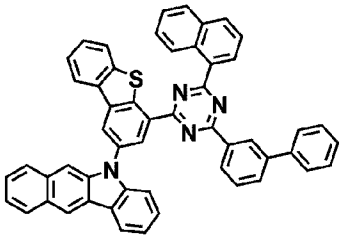
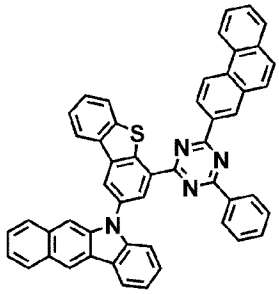
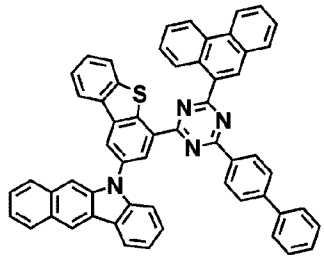
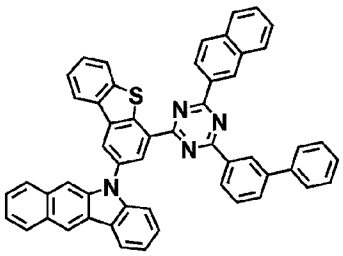
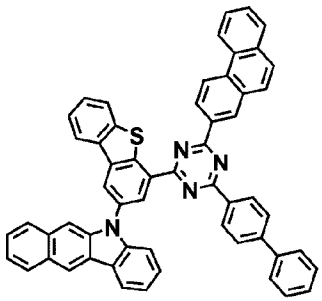
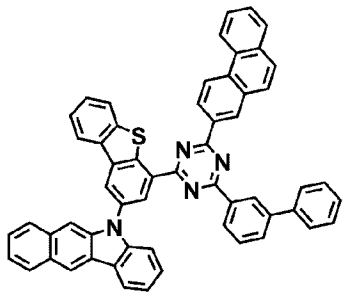
[183]

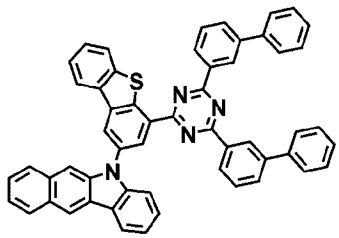
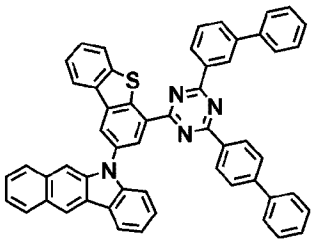
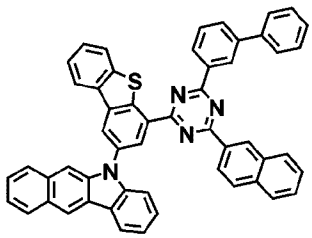
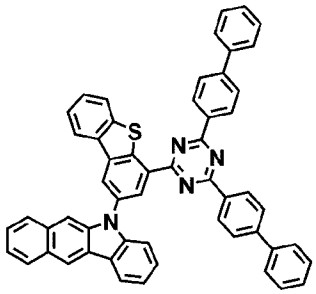
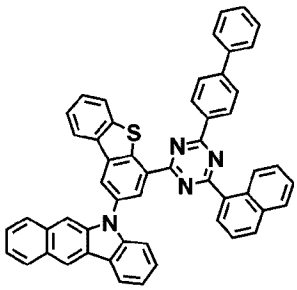
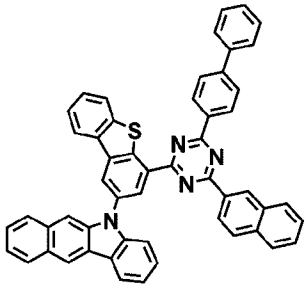
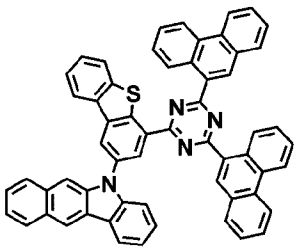
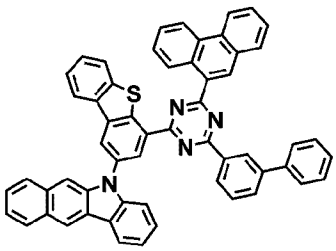
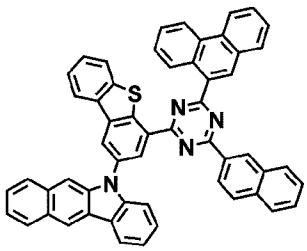
[184]

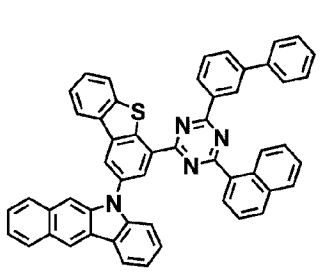
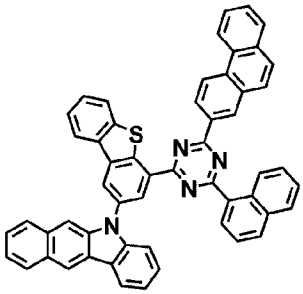
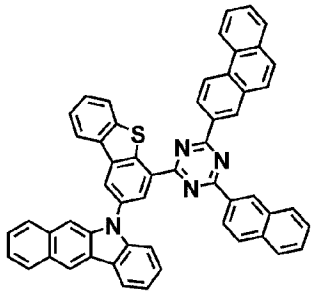
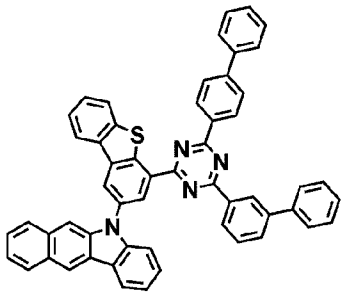
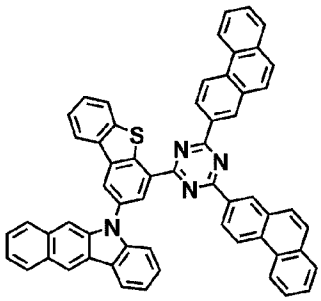
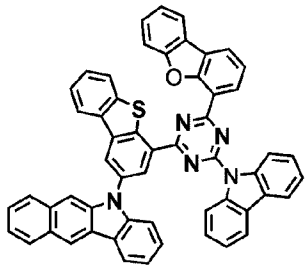
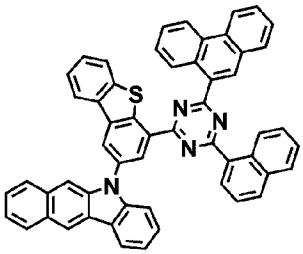
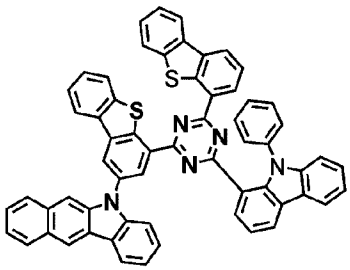
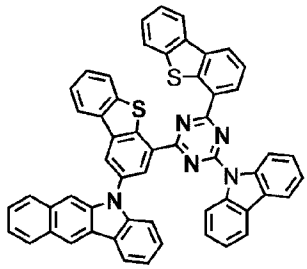
[185]

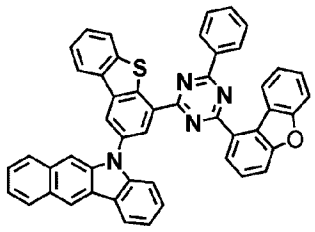
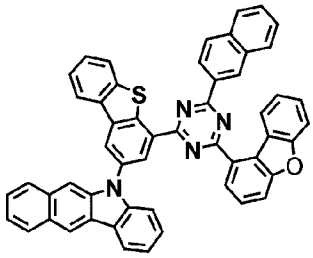
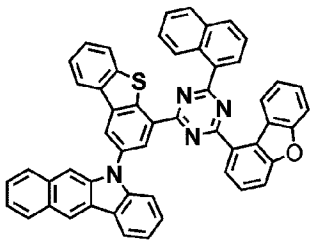
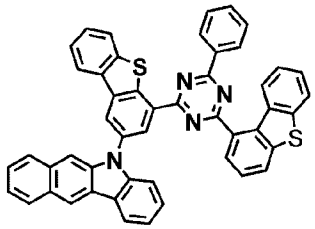
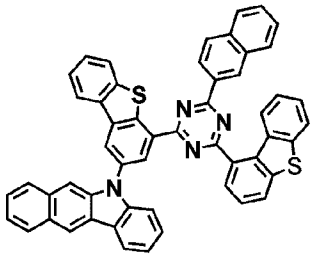
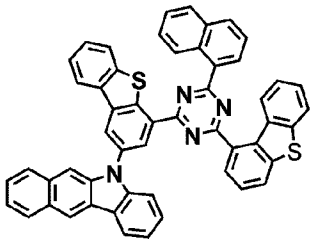
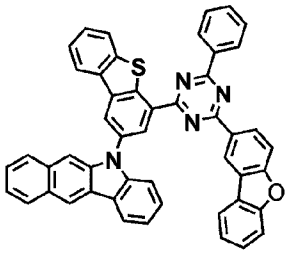
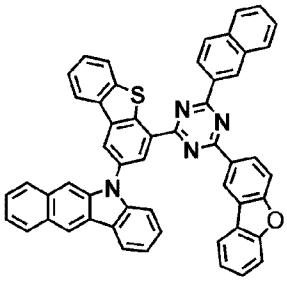
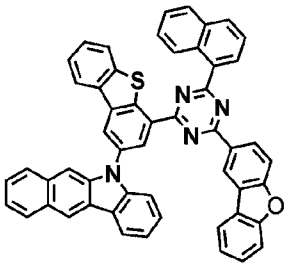
[186]

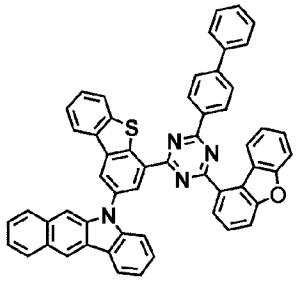
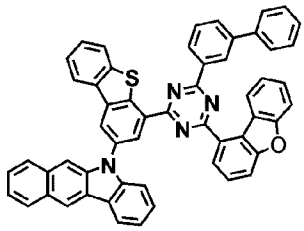
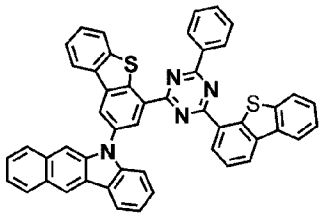
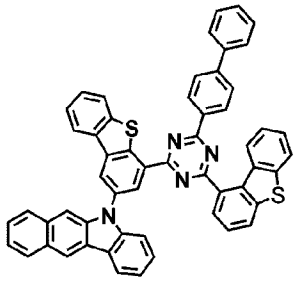
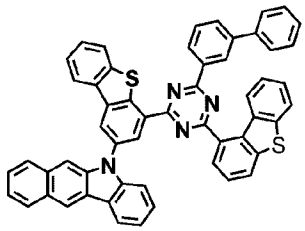
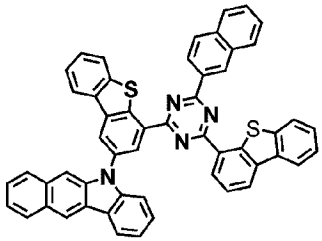
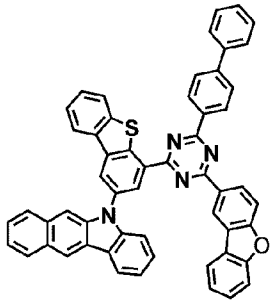
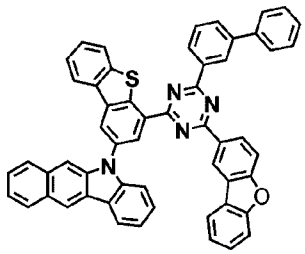
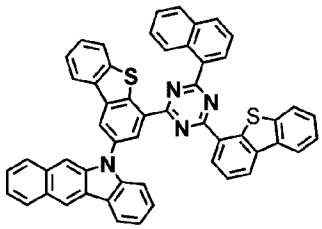
[187]

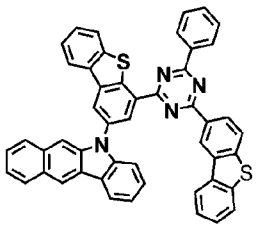
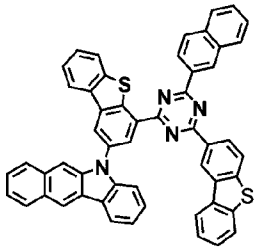
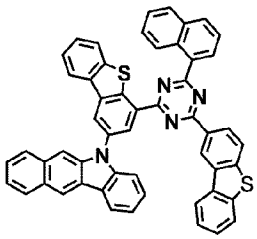
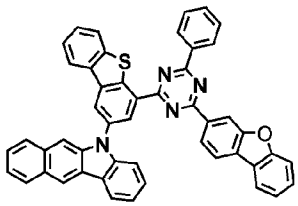
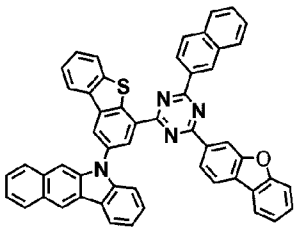
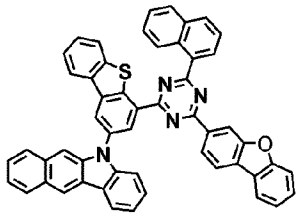
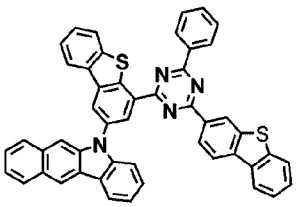
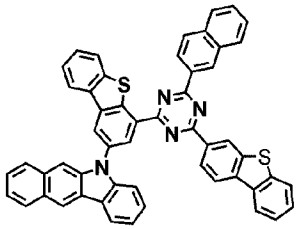
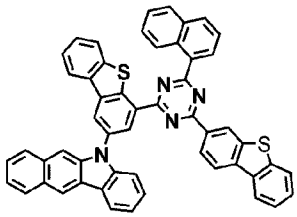
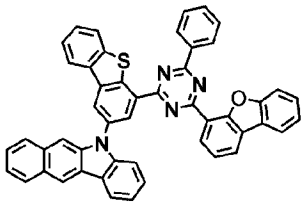
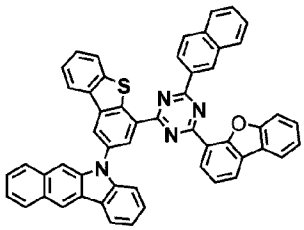
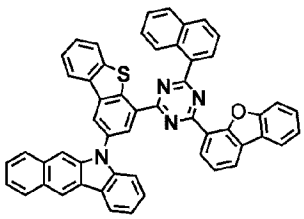
[188]

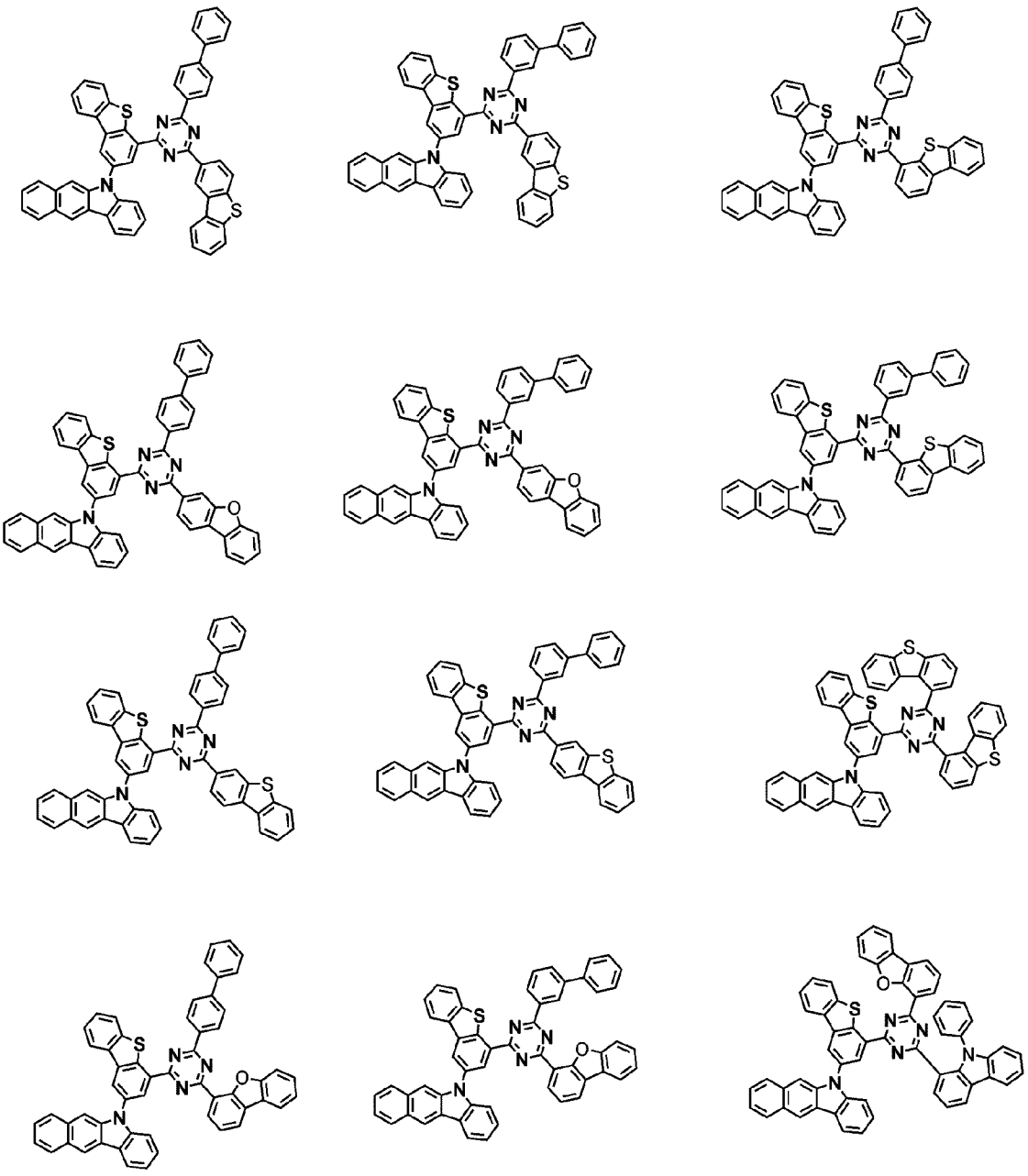
[189]

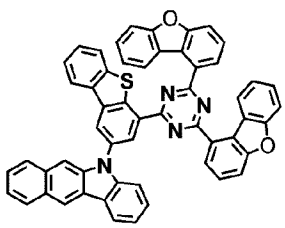
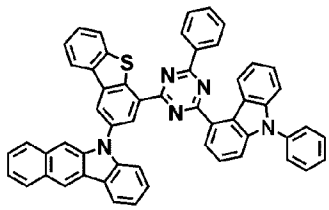
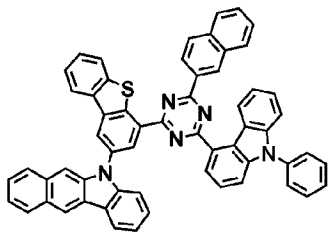
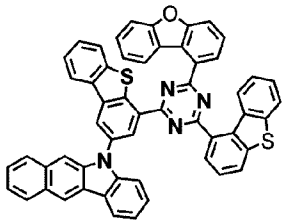
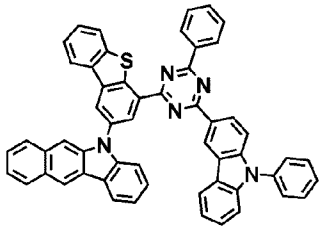
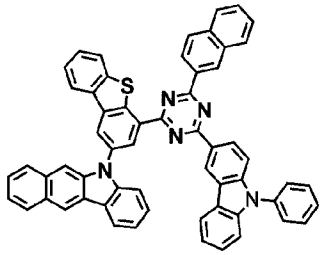
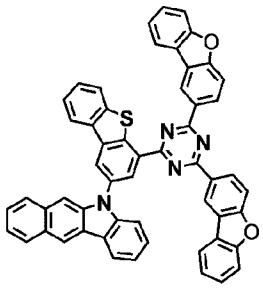
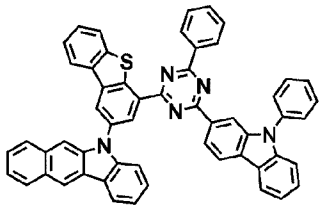
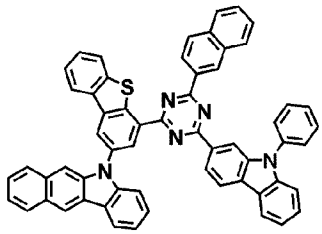
[190]

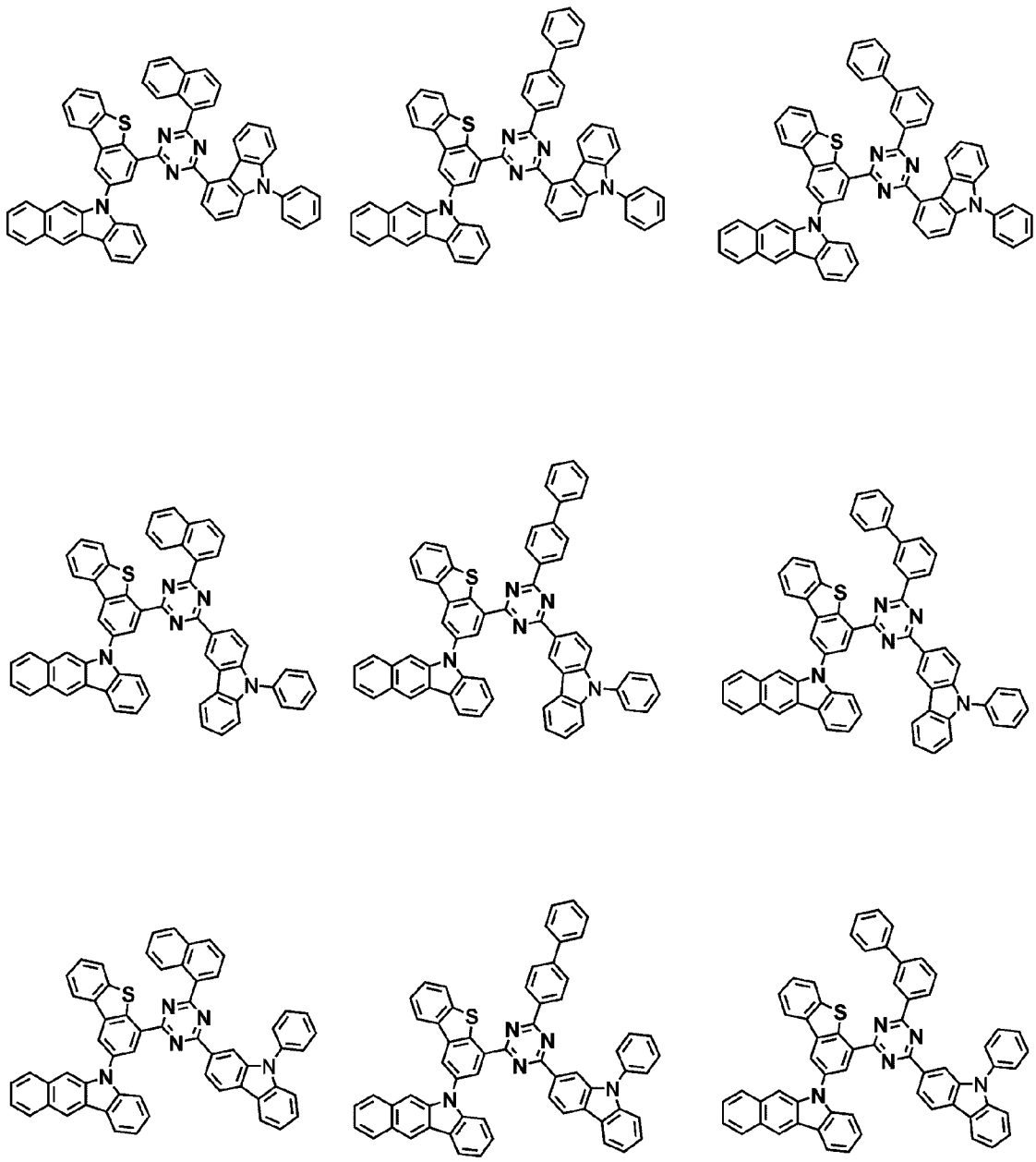
[191]



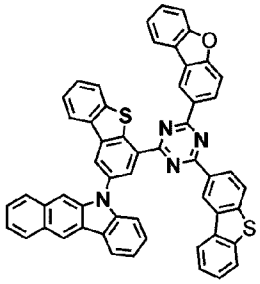
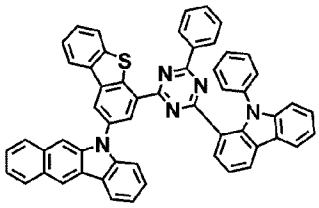
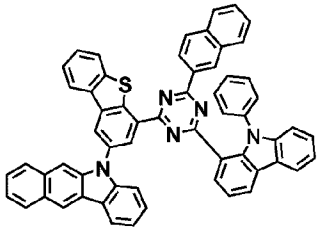
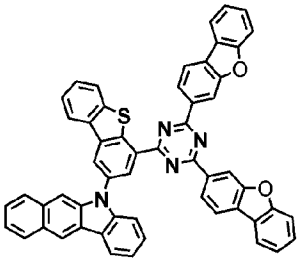
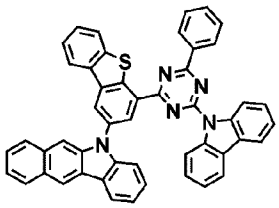
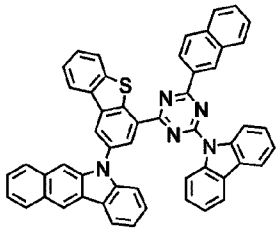
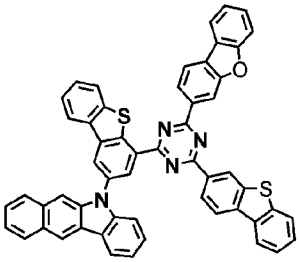
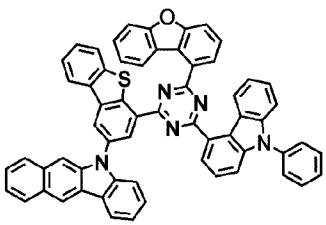
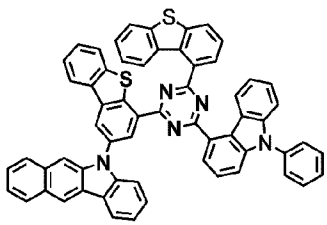
[192]

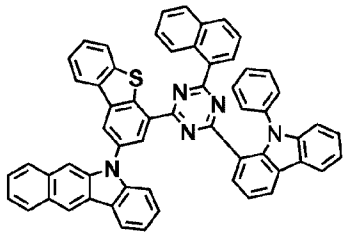
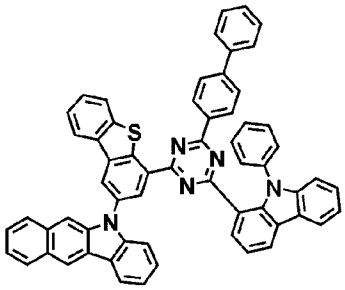
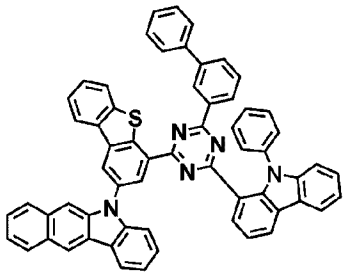
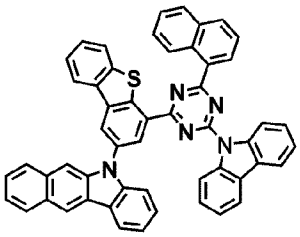
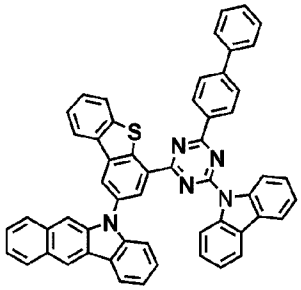
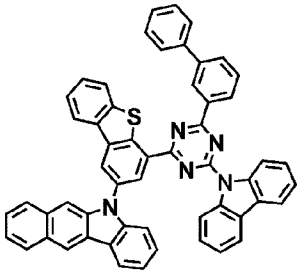
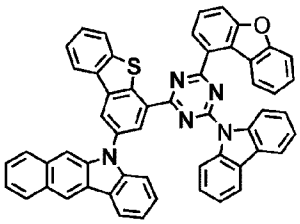
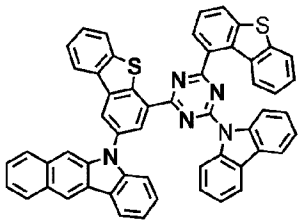
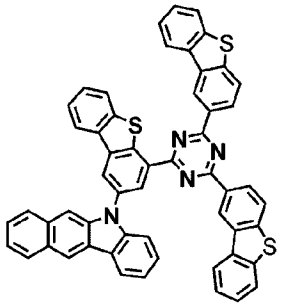
[193]



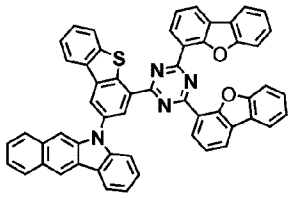
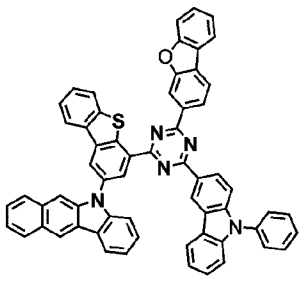
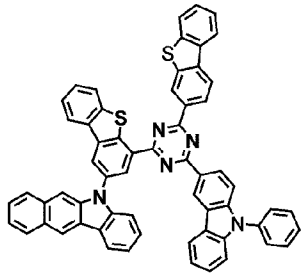
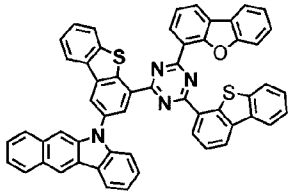
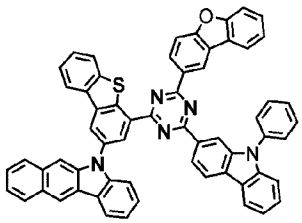
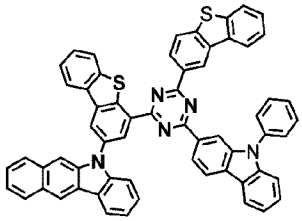
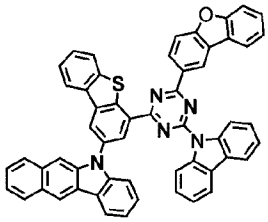
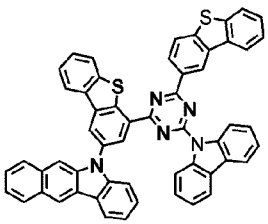
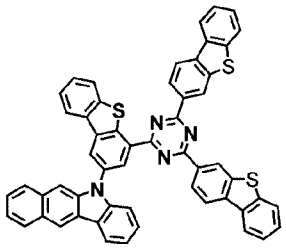
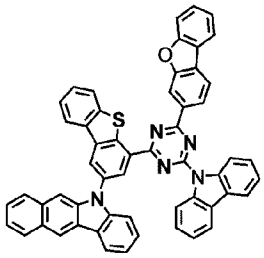
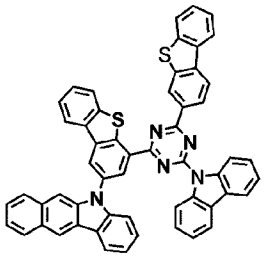
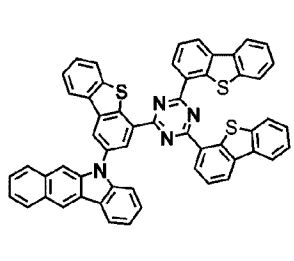
[194]

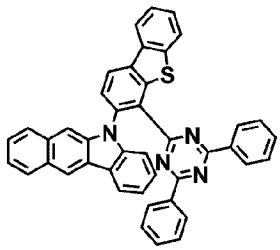
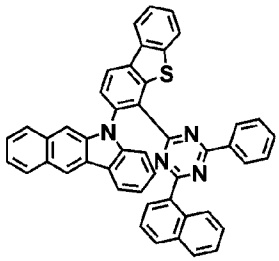
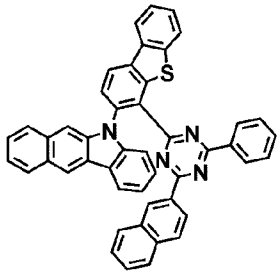
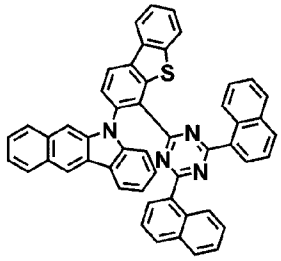
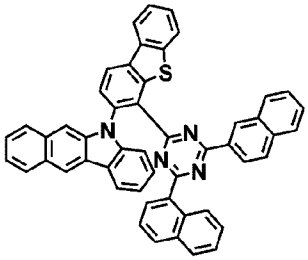
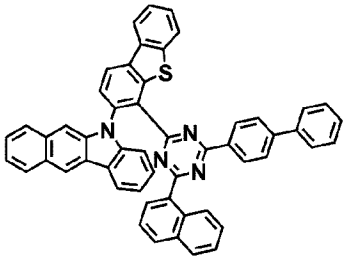
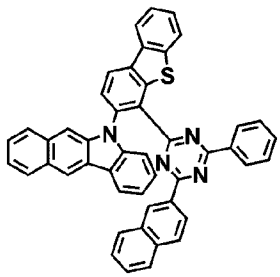
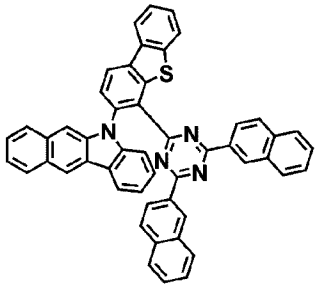
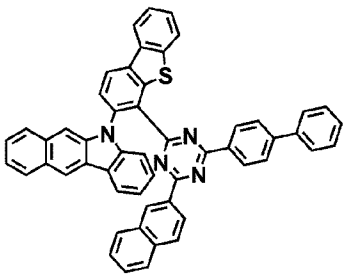
[195]

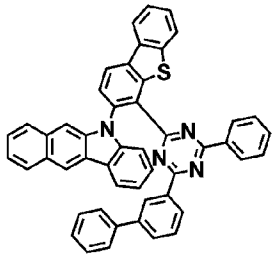
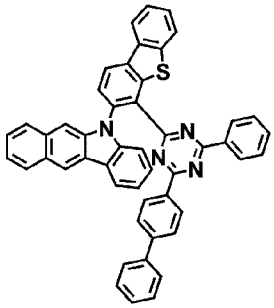
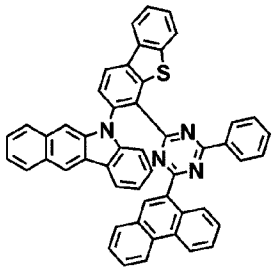
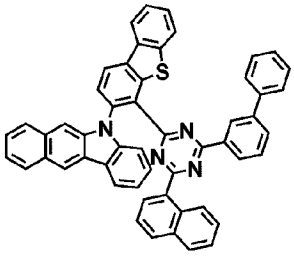
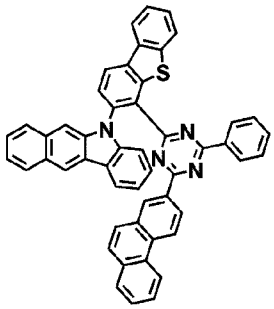
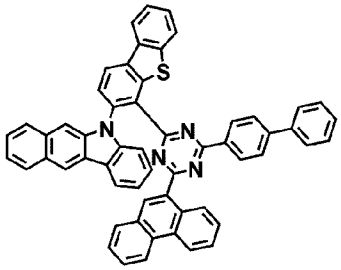
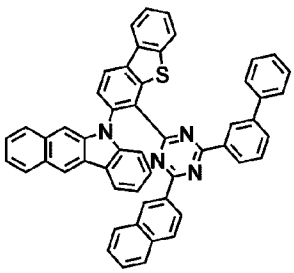
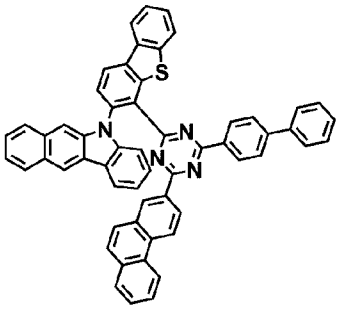
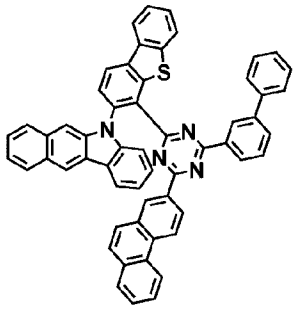
[196]

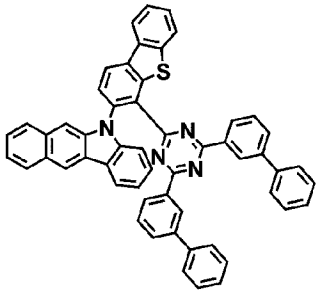
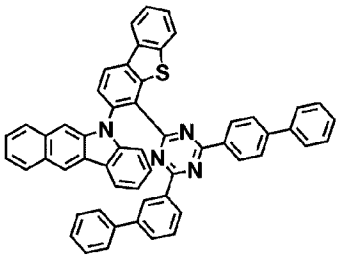
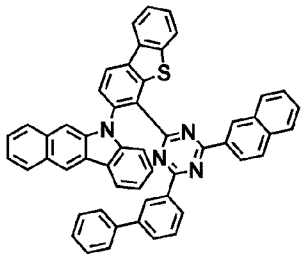
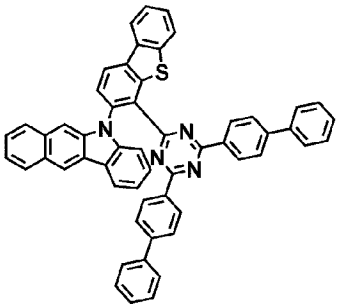
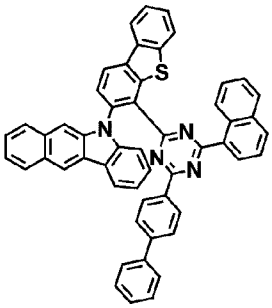
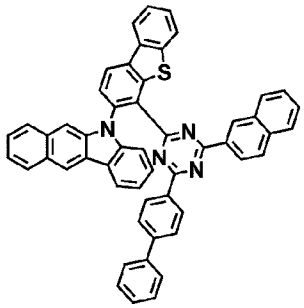
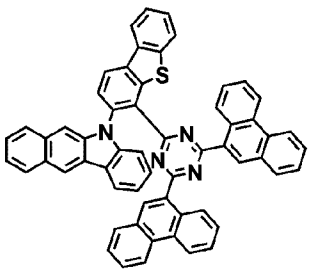
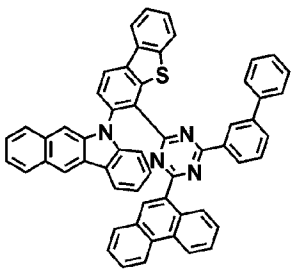
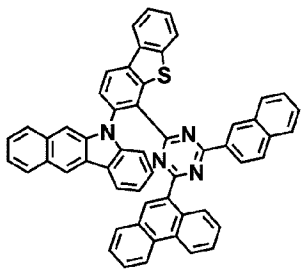
[197]

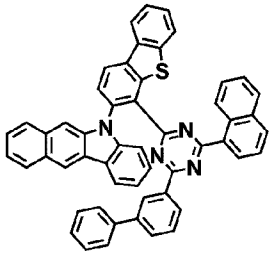
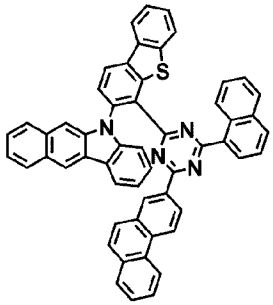
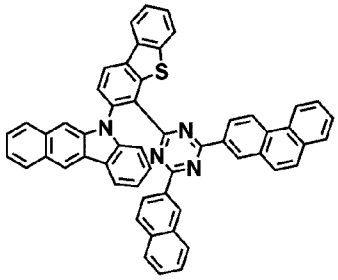
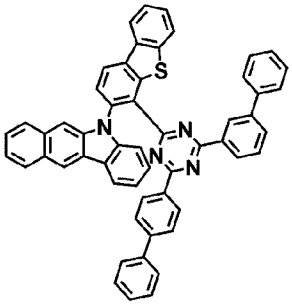
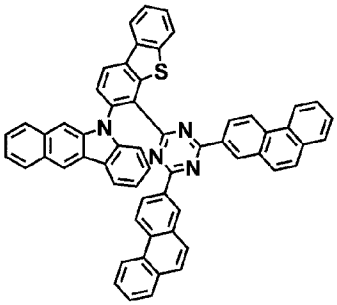
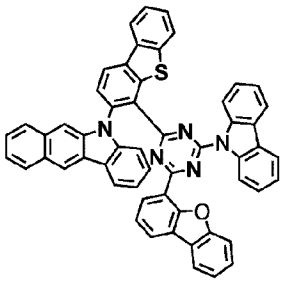
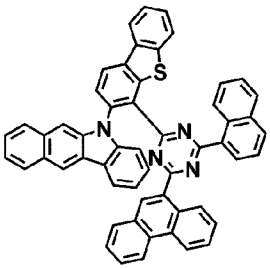
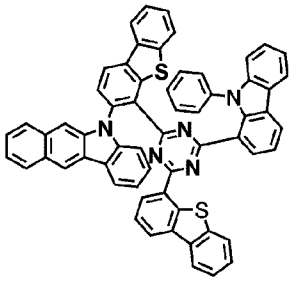
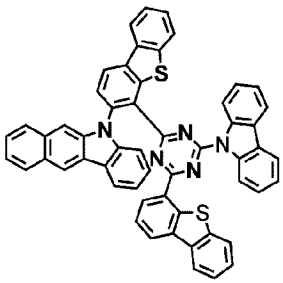
[198]

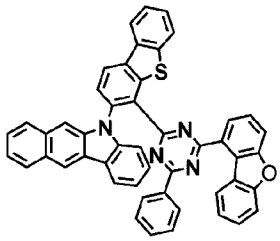
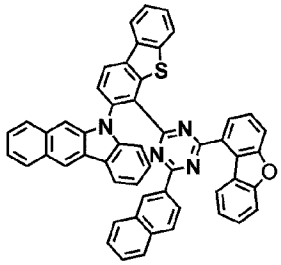
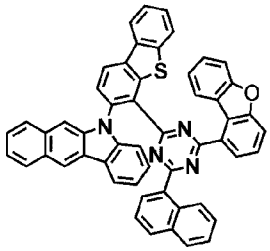
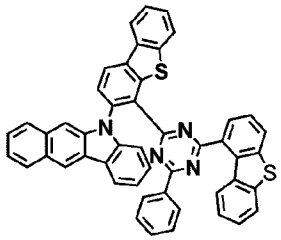
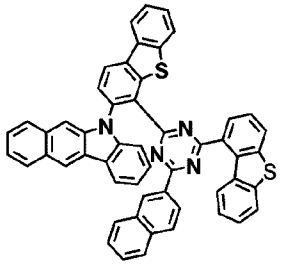
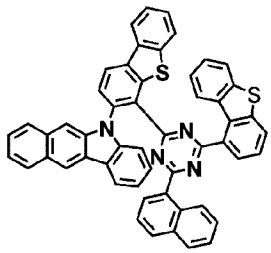
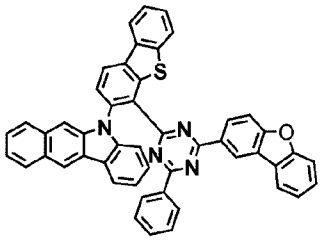
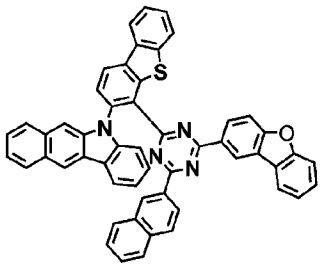
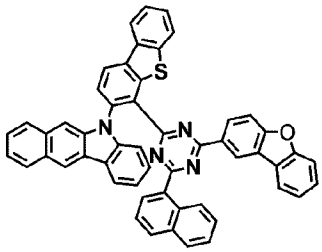
[199]

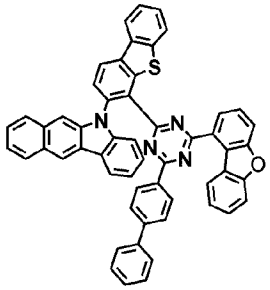
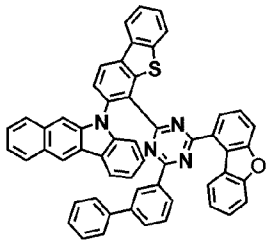
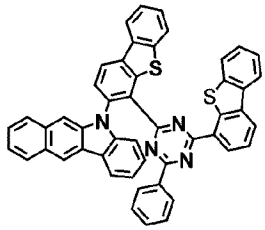
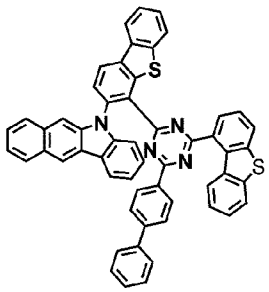
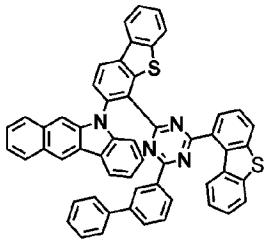
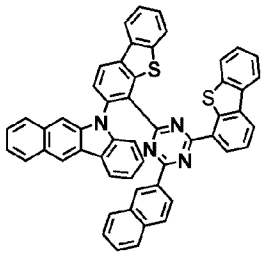
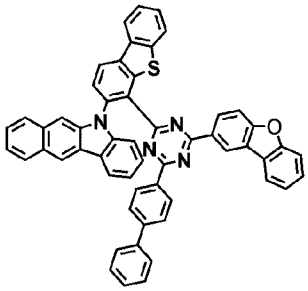
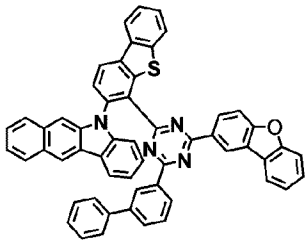
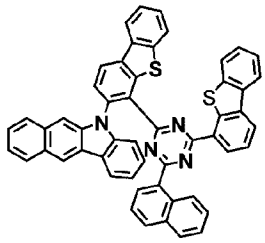
[200]

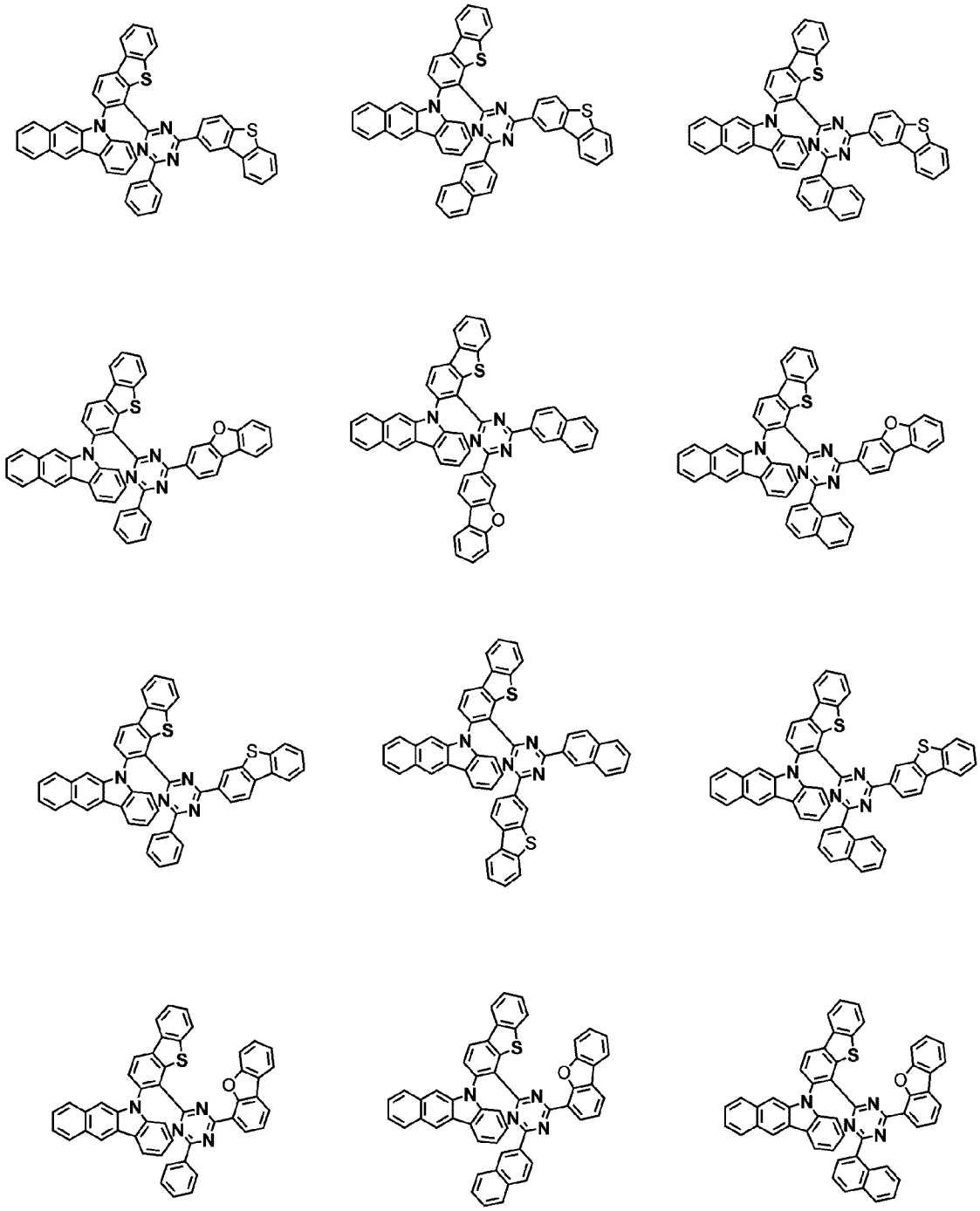
[201]

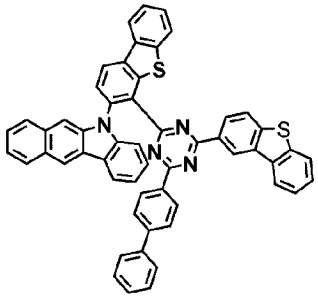
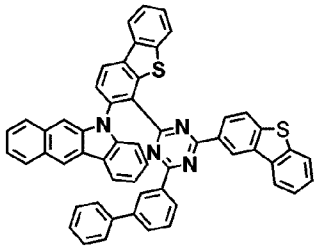
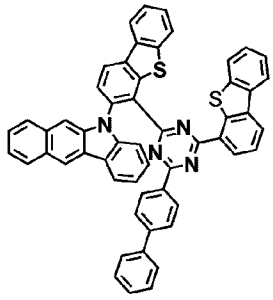
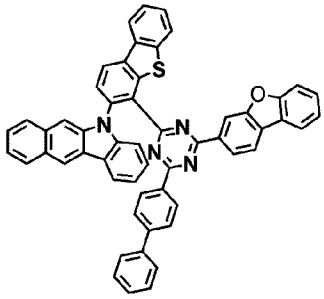
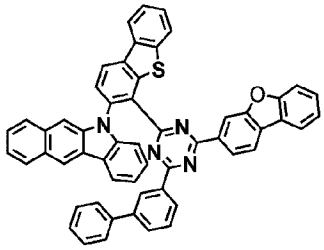
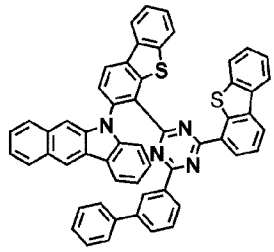
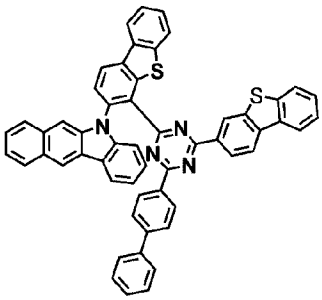
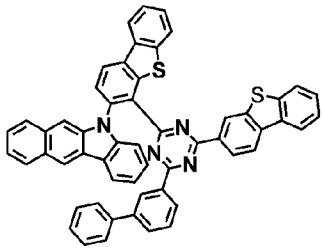
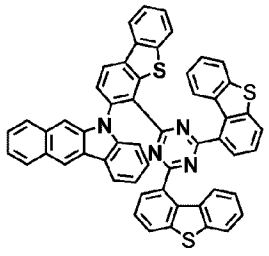
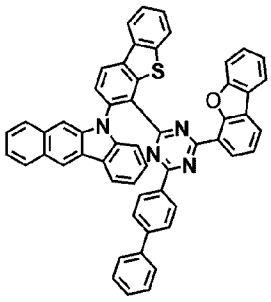
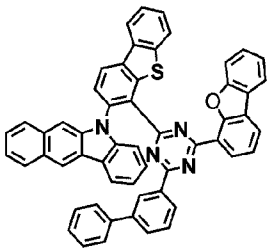
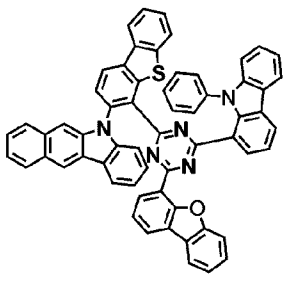
[202]

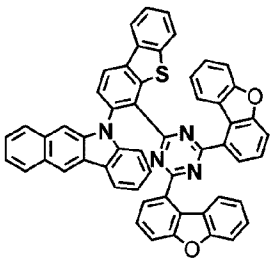
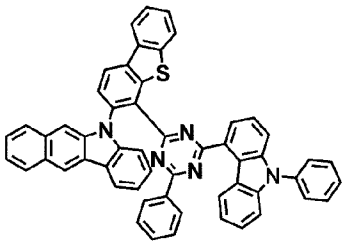
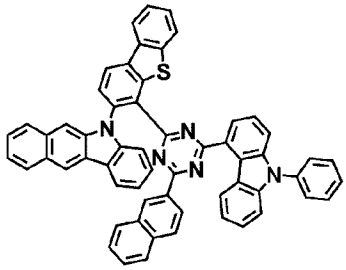
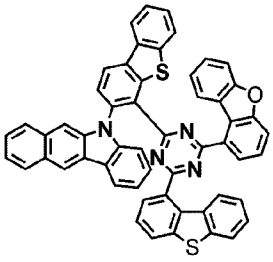
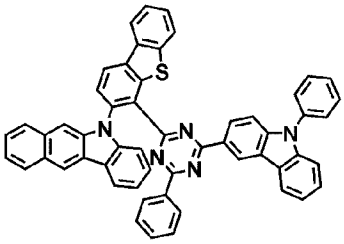
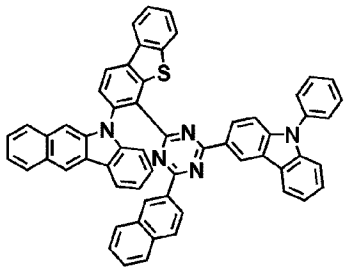
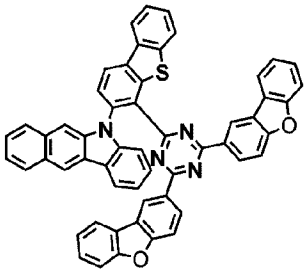
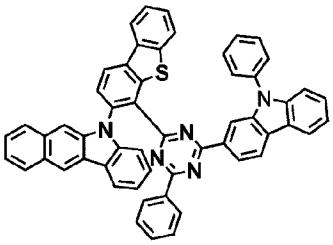
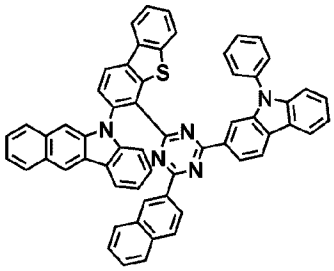
[203]



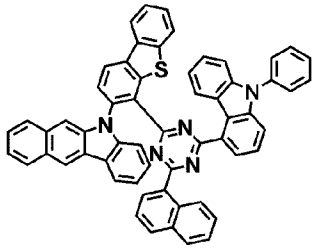
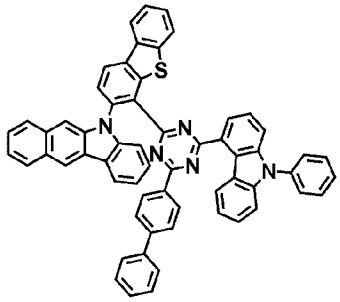
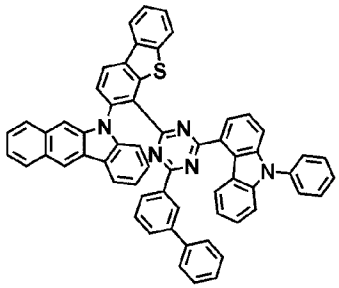
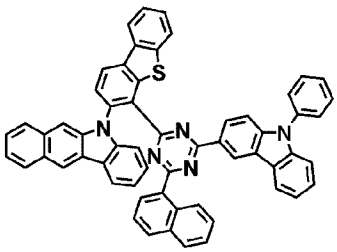
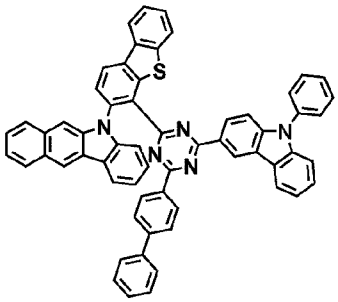
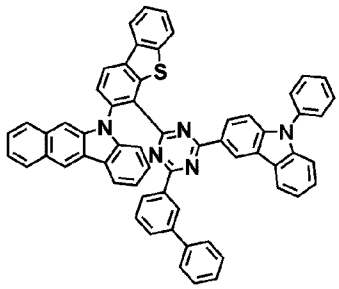
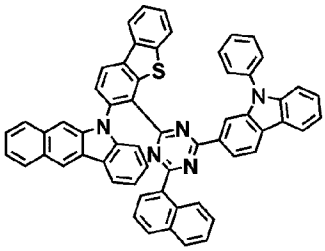
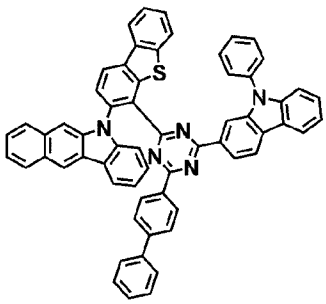
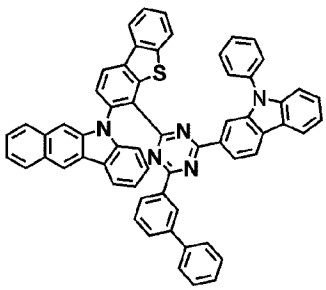
[204]

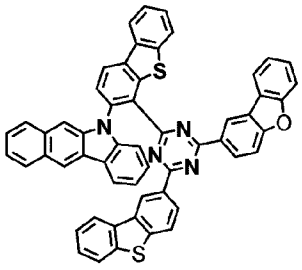
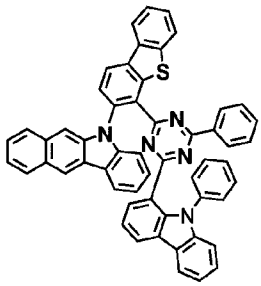
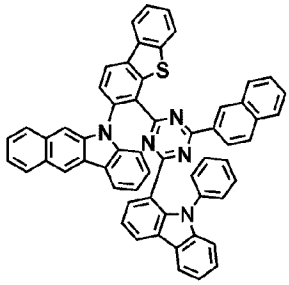
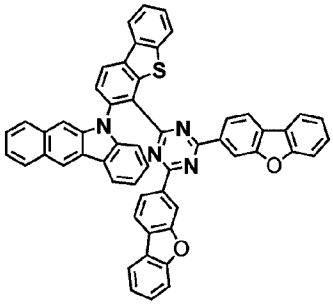
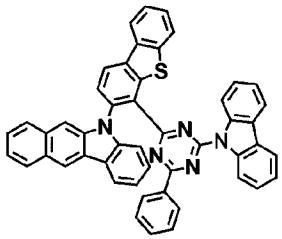
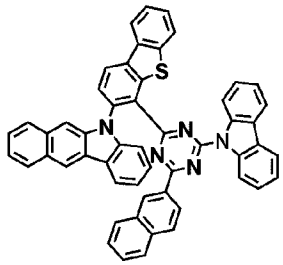
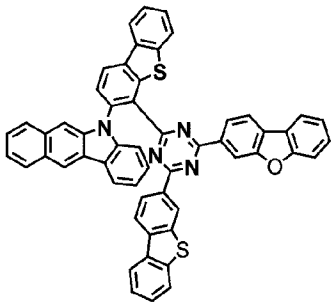
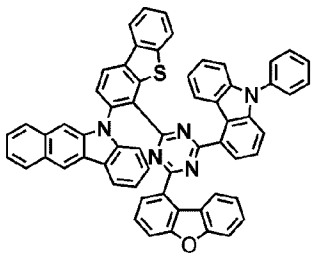
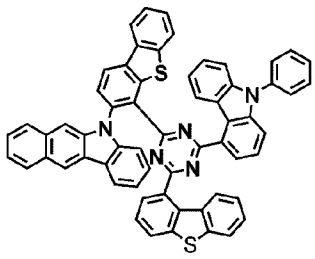
[205]

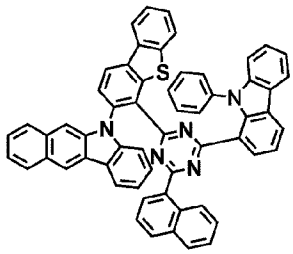
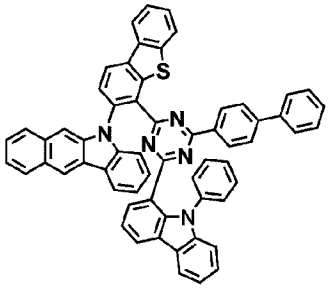
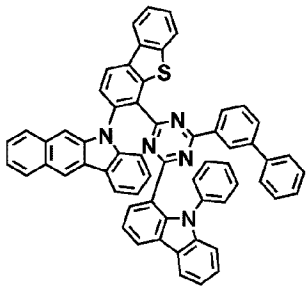
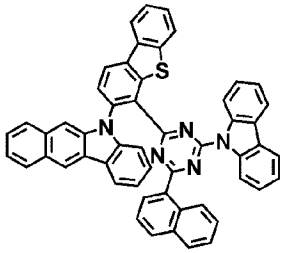
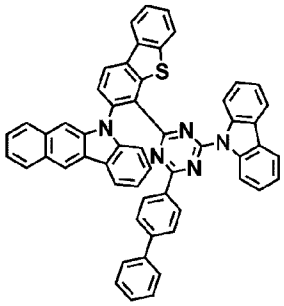
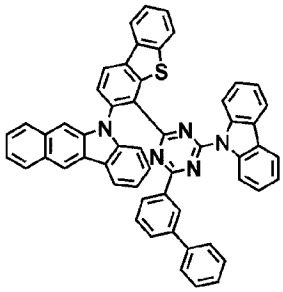
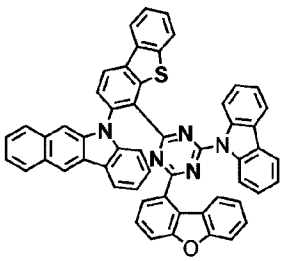
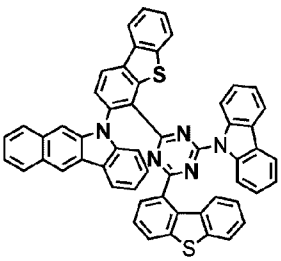
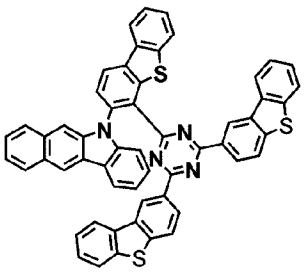
[206]

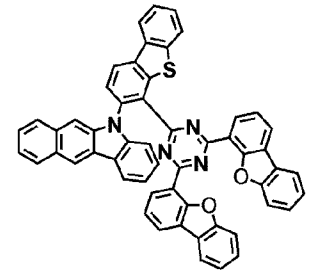
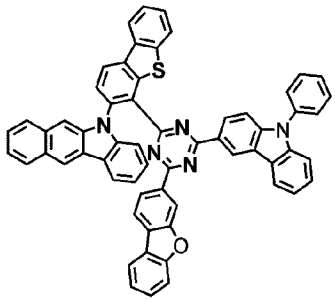
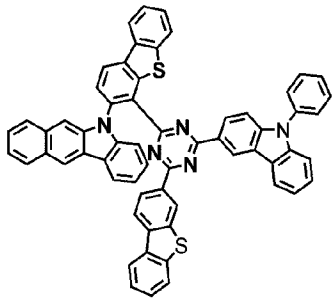
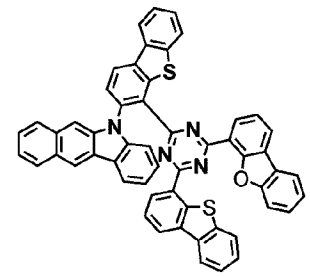
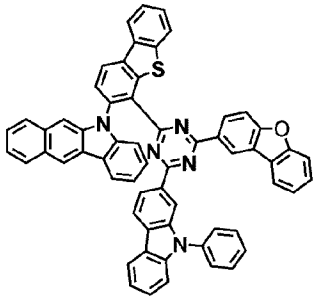
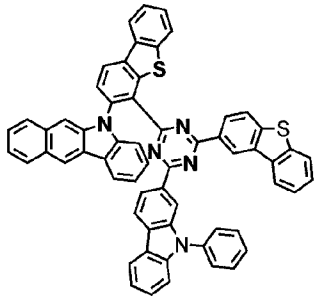
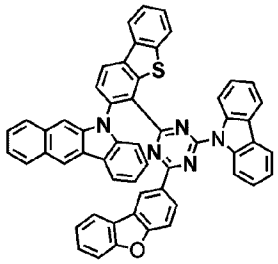
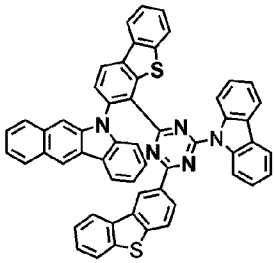
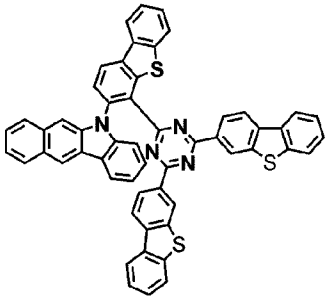
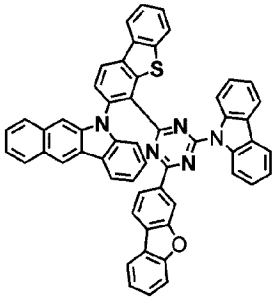
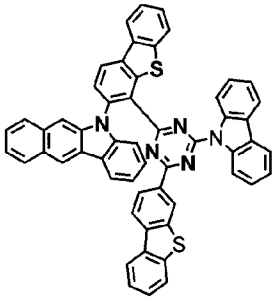
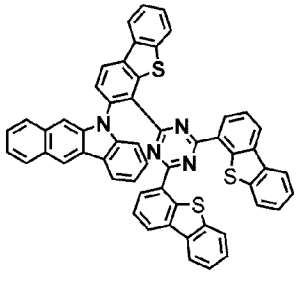
[207]

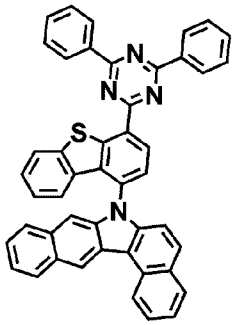
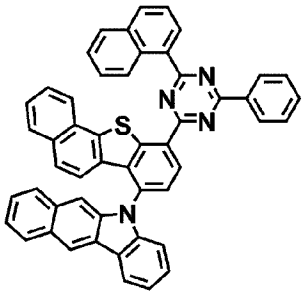
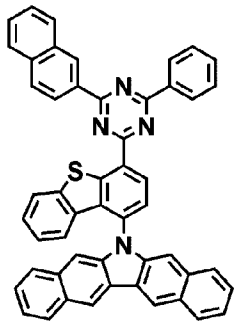
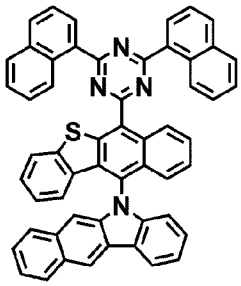
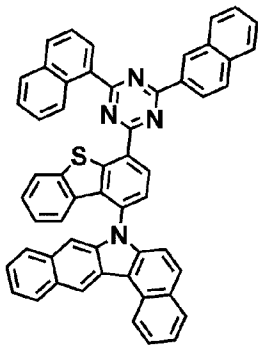
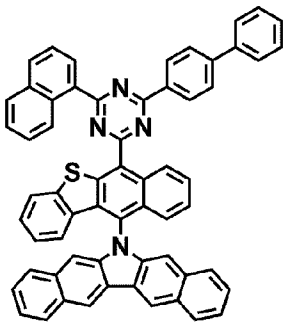
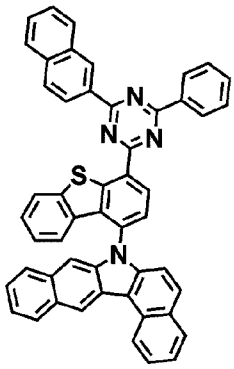
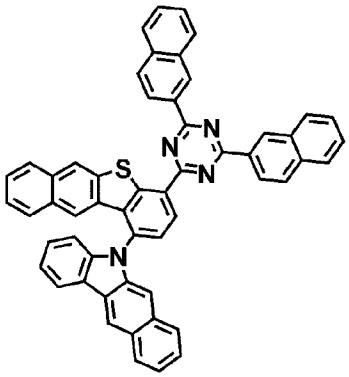
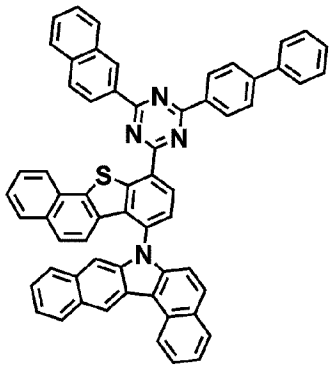
[208]

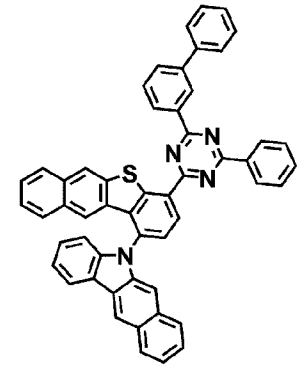
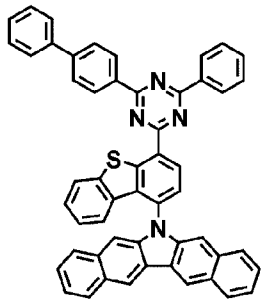
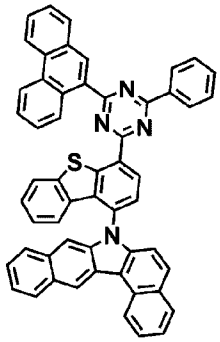
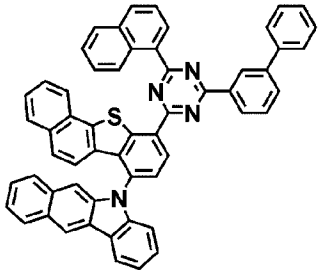
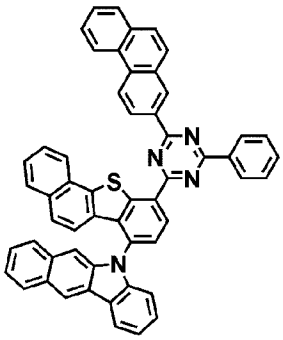
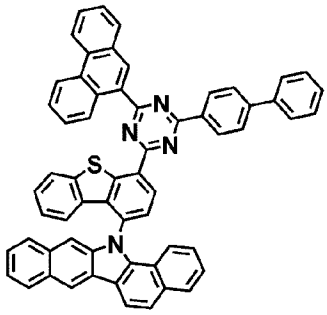
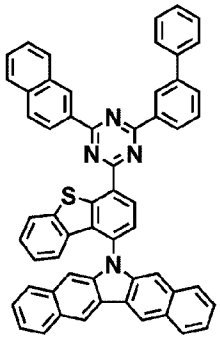
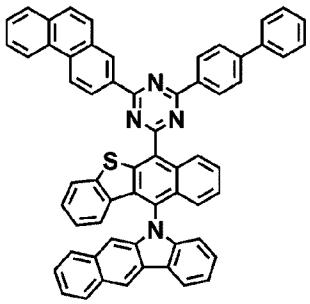
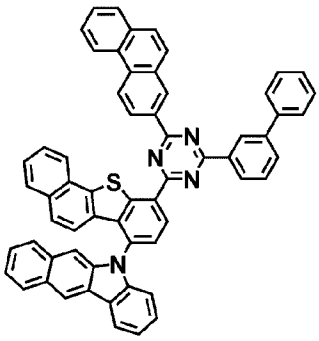
[209]

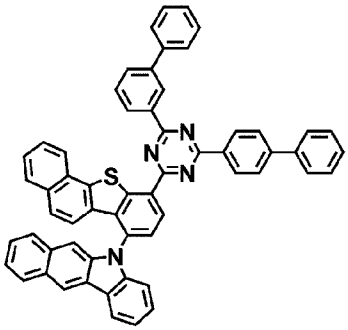
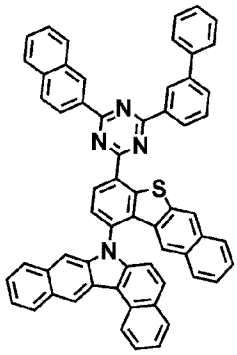
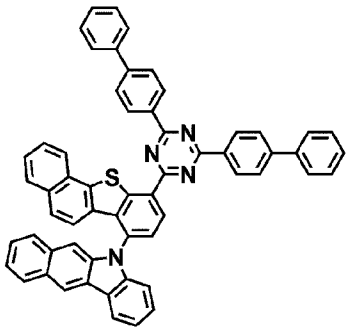
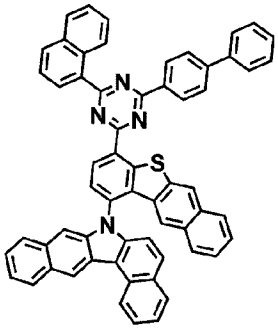
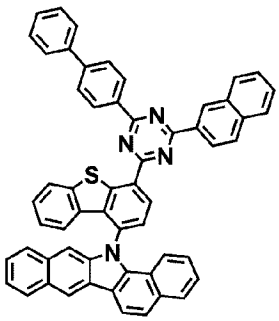
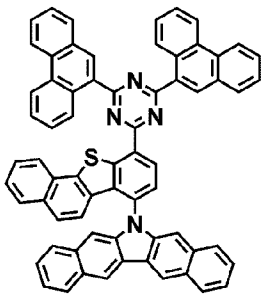
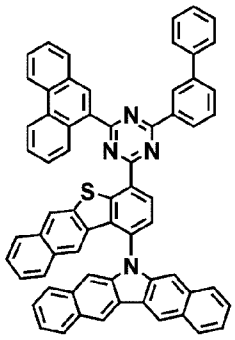
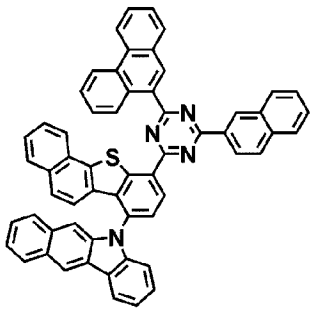
[210]

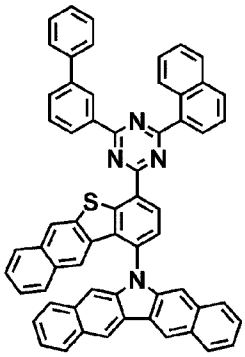
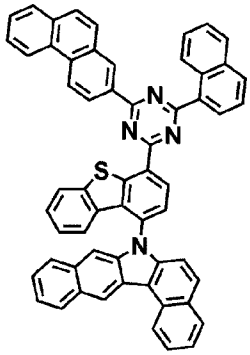
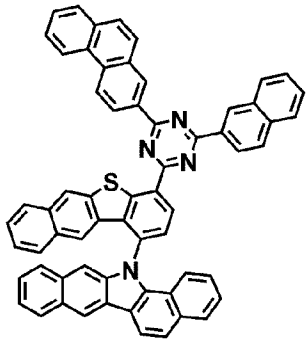
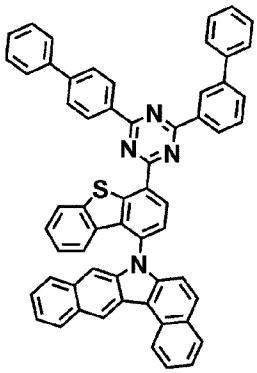
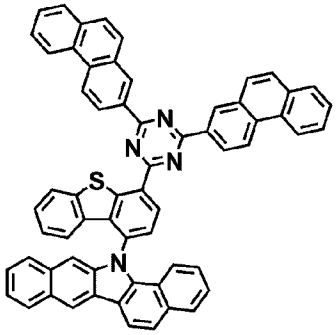
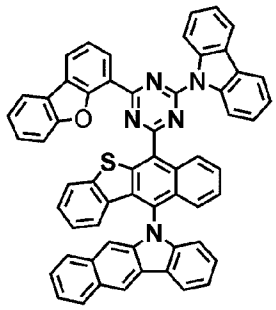
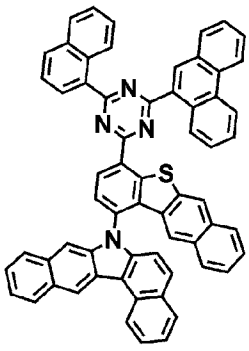
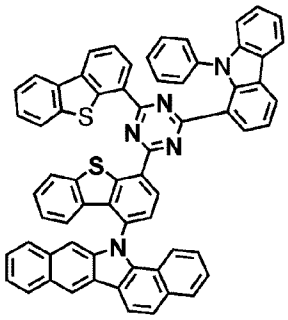
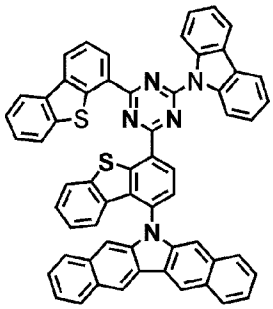
[211]

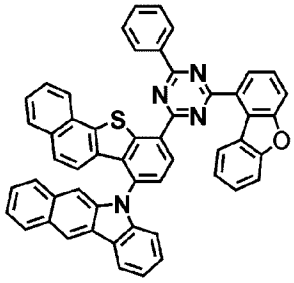
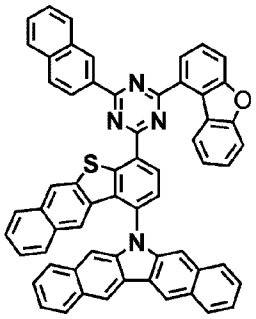
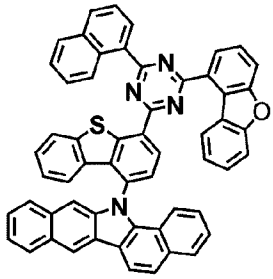
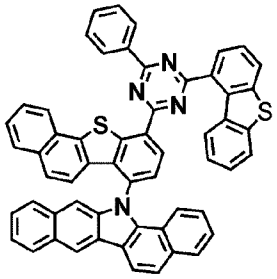
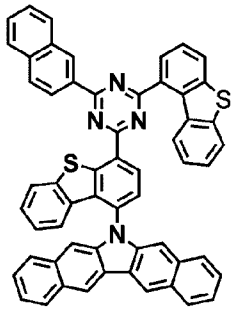
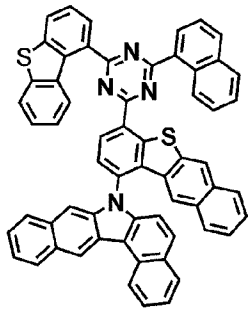
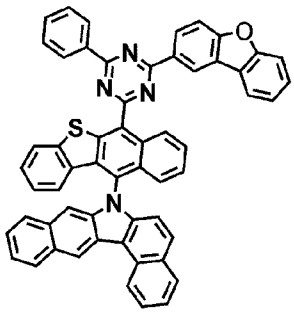
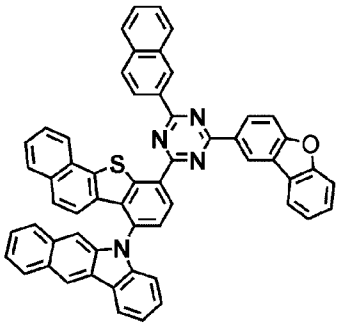
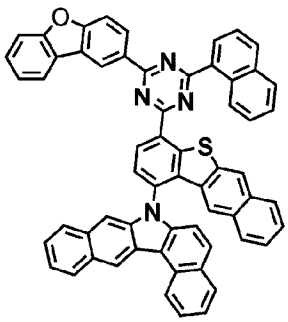
[212]

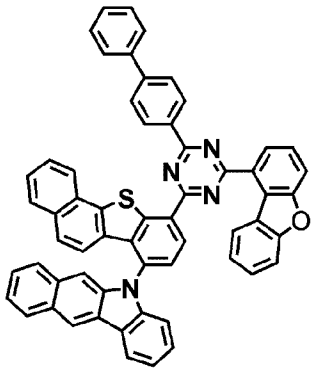
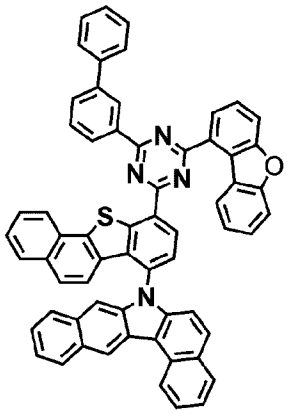
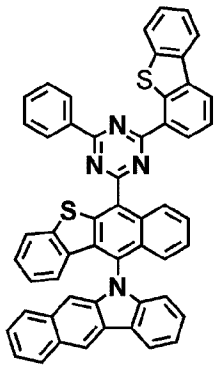
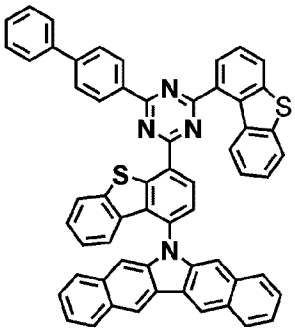
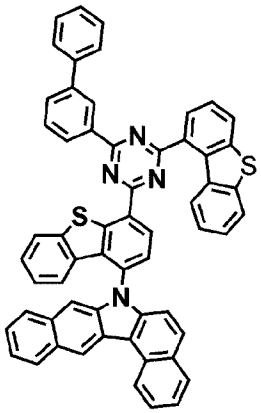
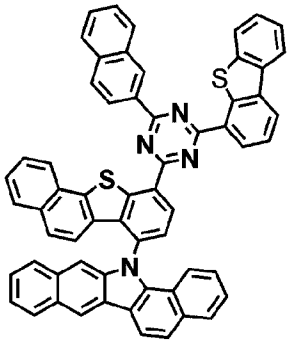
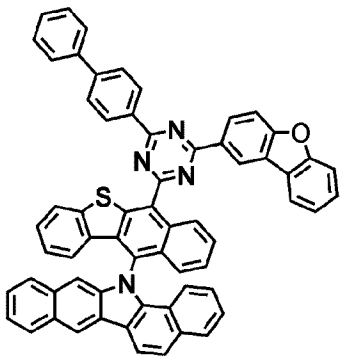
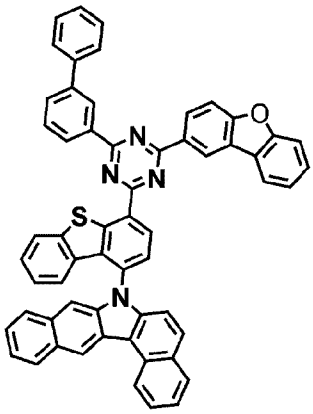
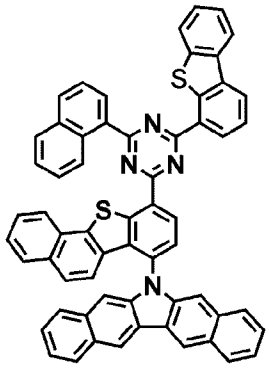
[213]

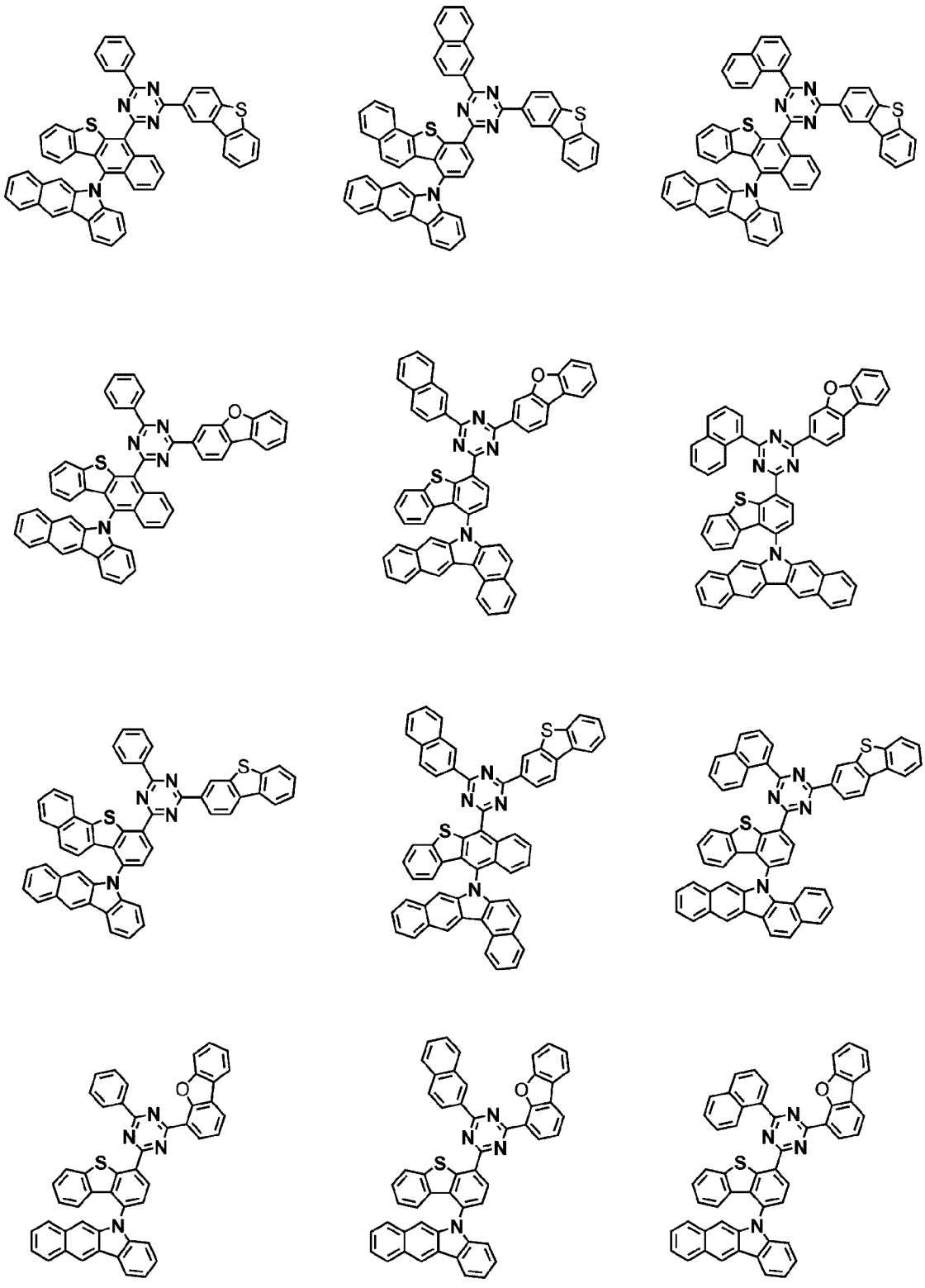
[214]

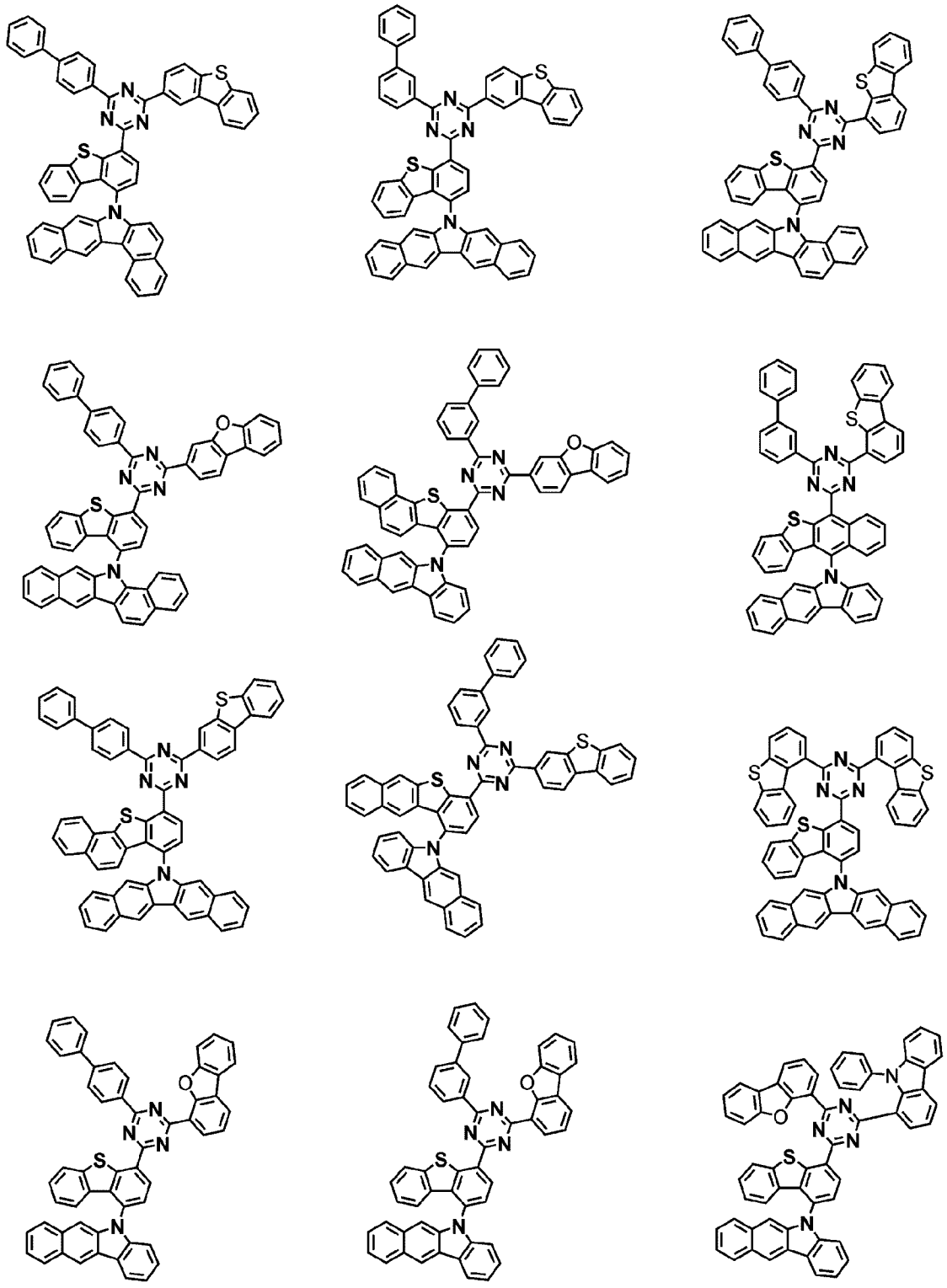
[215]

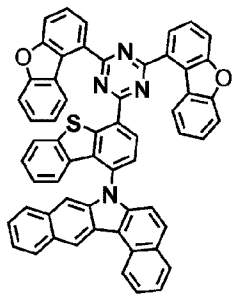
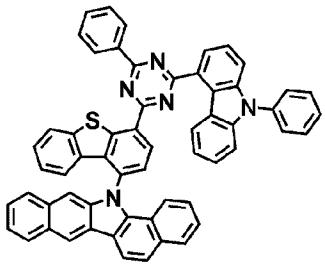
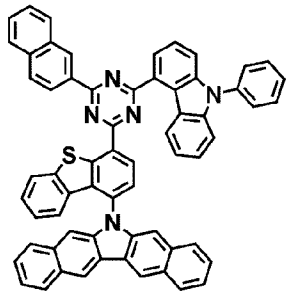
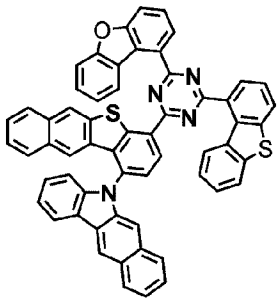
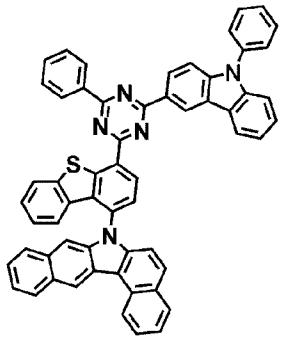
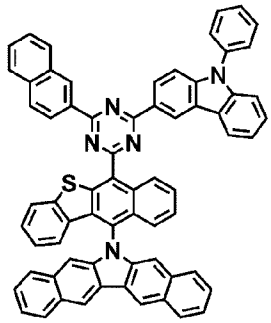
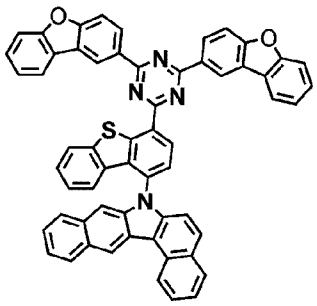
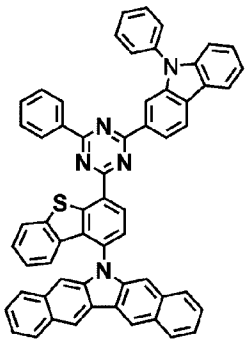
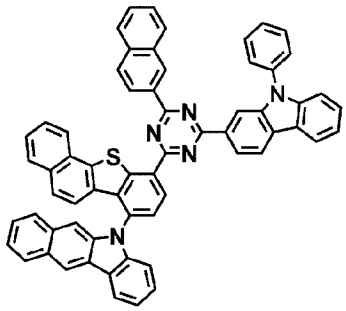
[216]



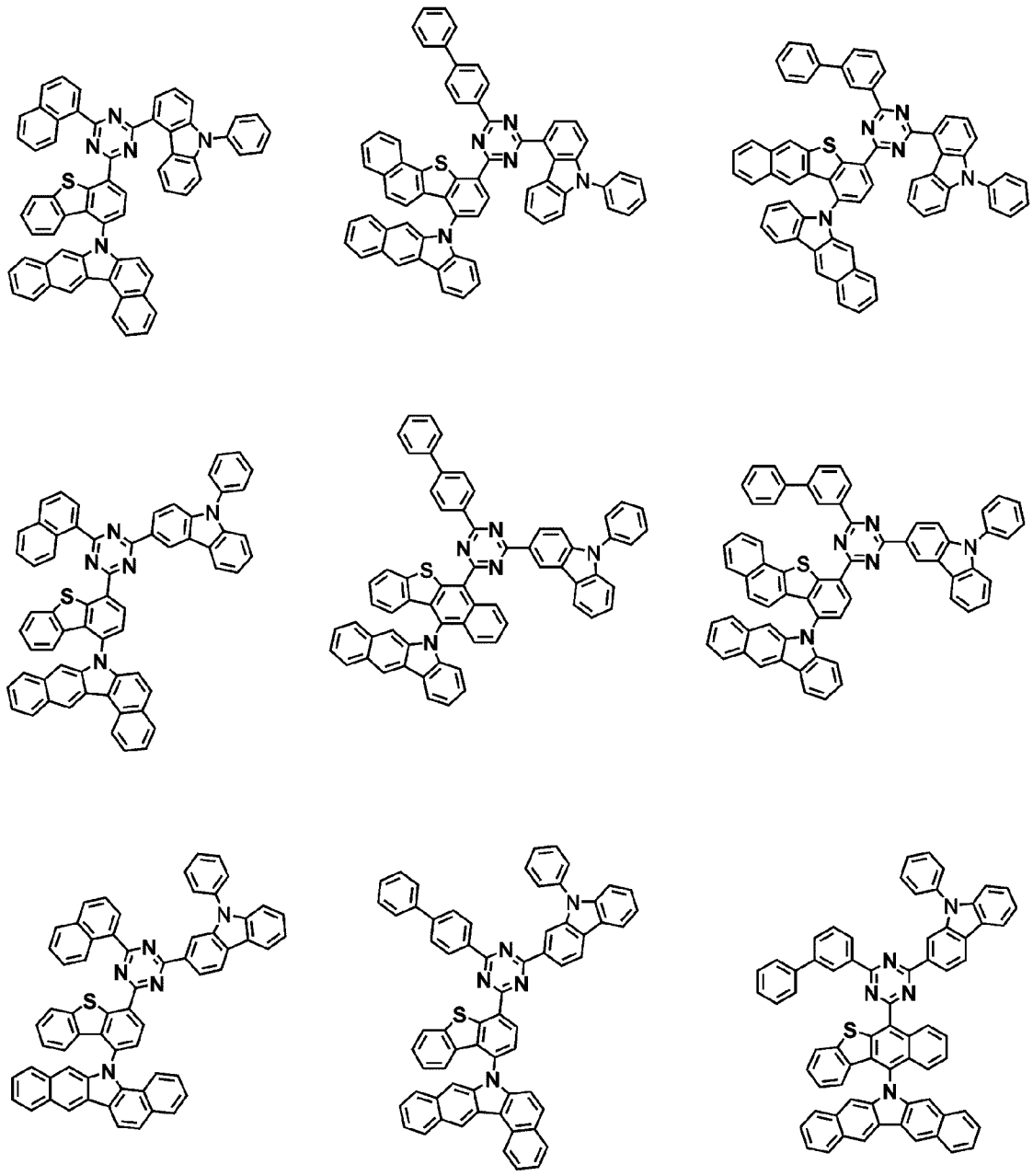
[217]



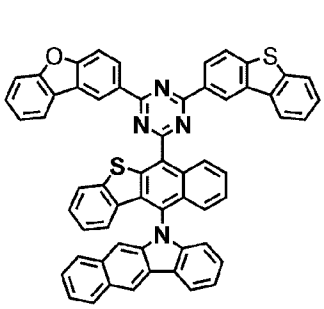
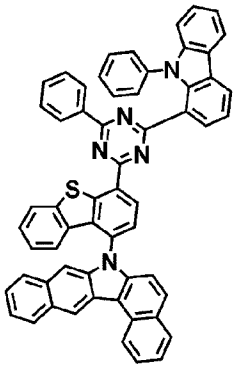
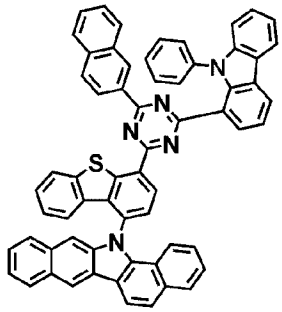
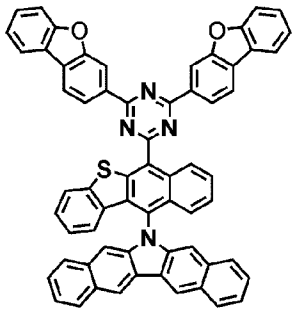
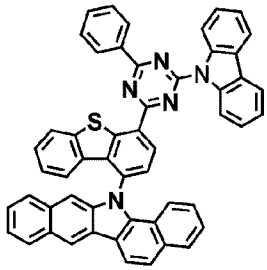
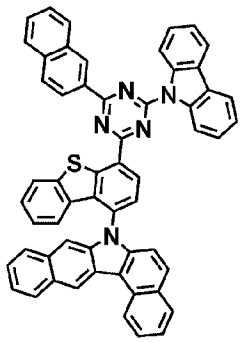
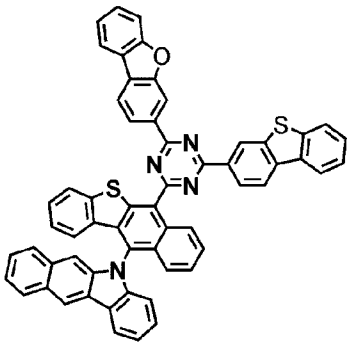
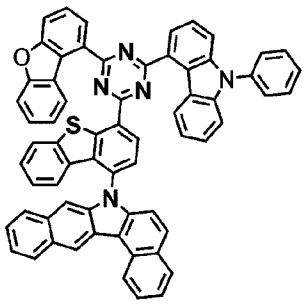
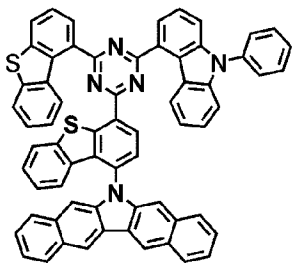
[218]

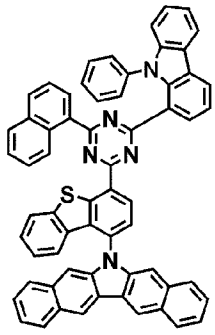
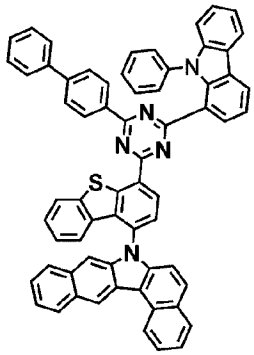
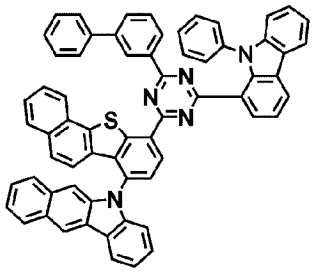
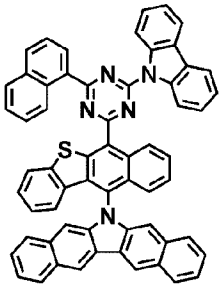
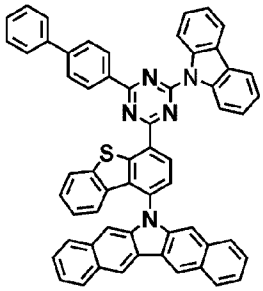
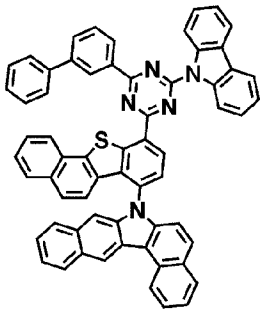
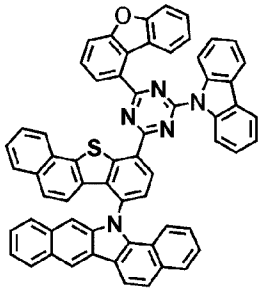
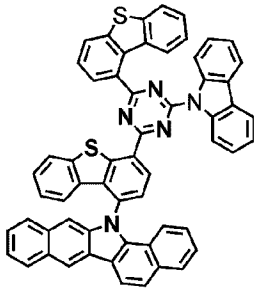
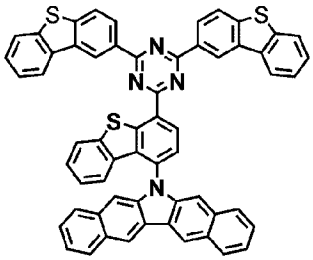
[219]



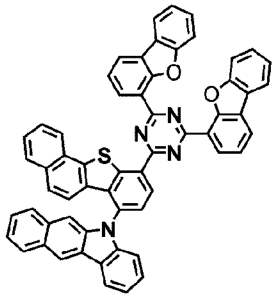
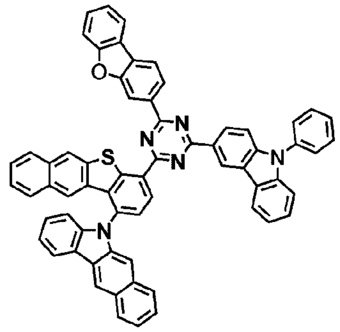
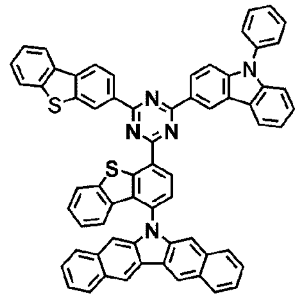
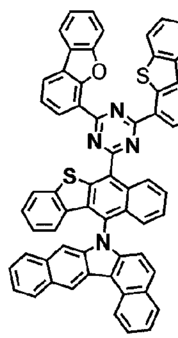
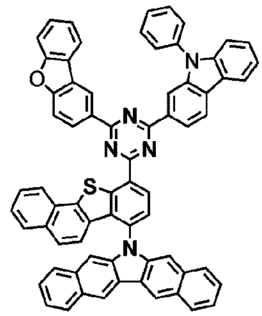
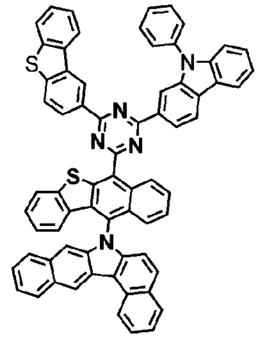
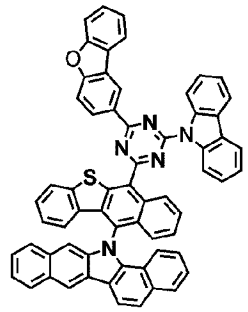
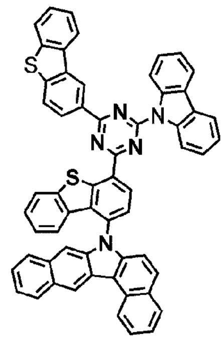
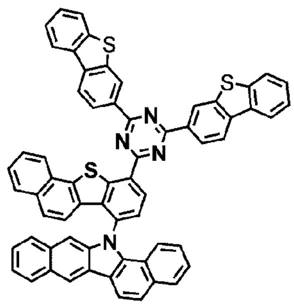
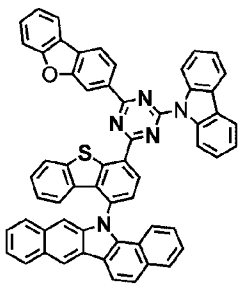
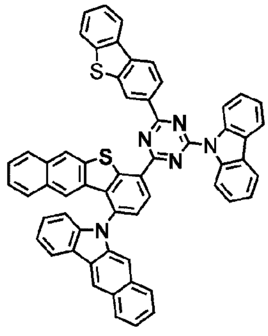
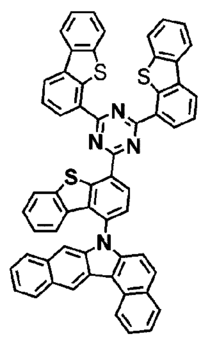
[220]

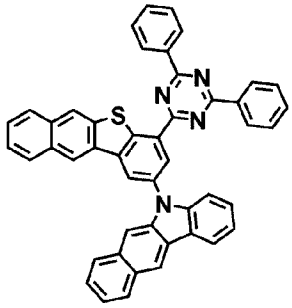
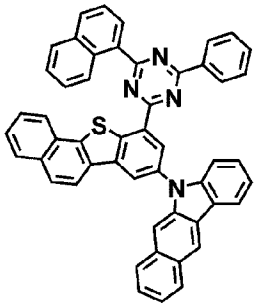
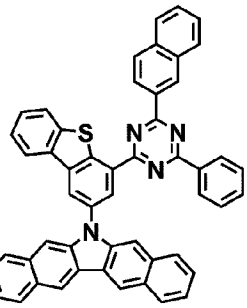
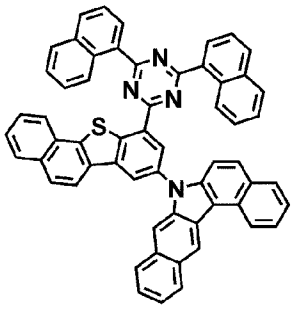
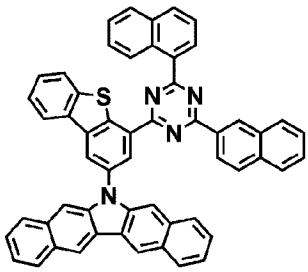
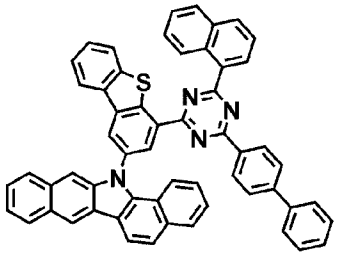
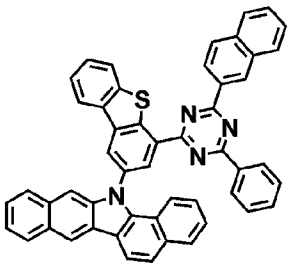
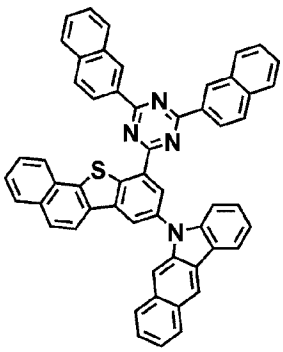
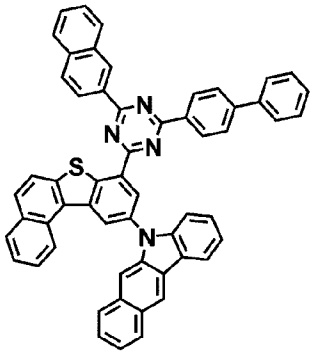
[221]

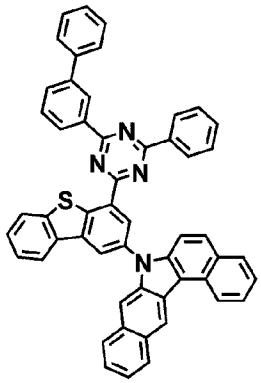
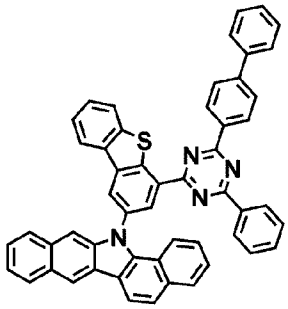
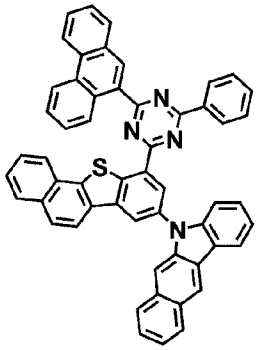
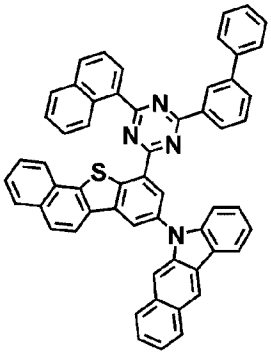
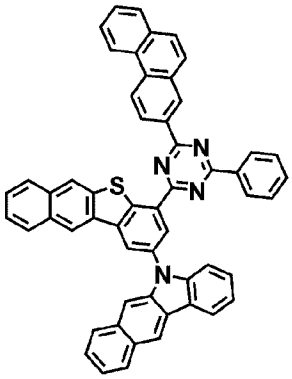
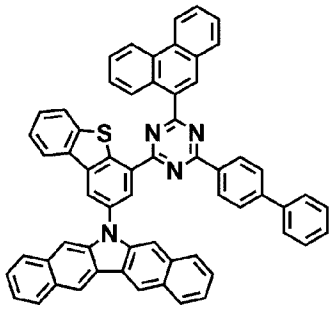
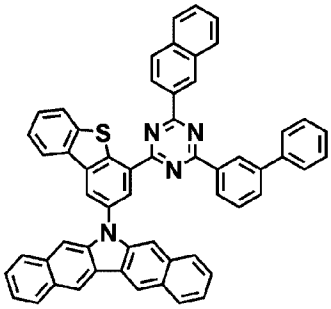
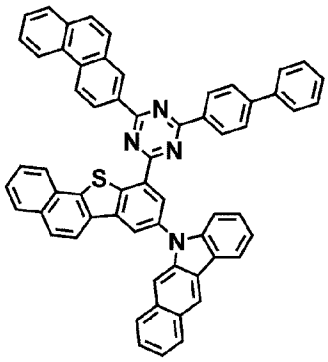
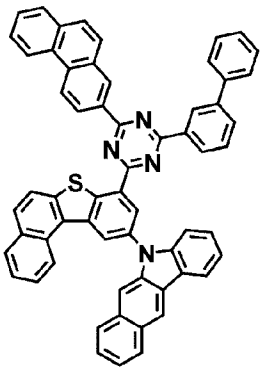
[222]

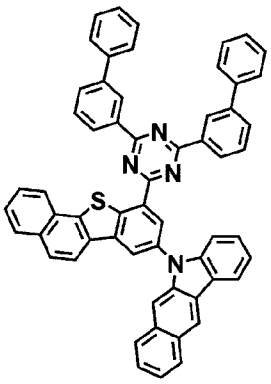
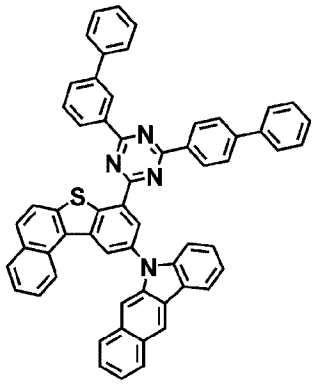
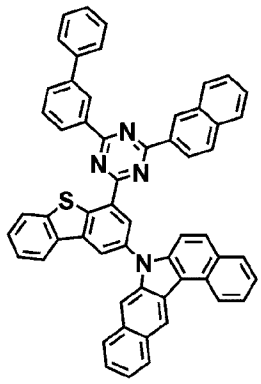
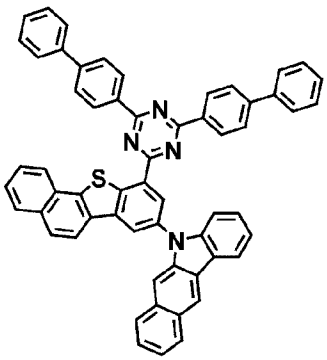
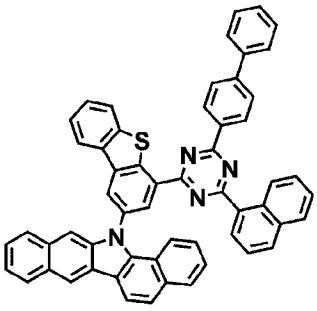
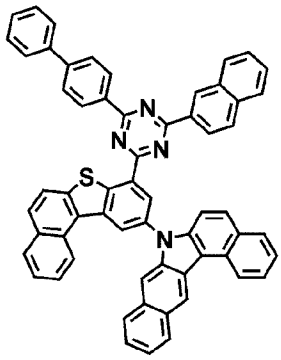
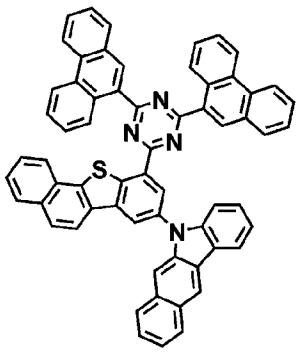
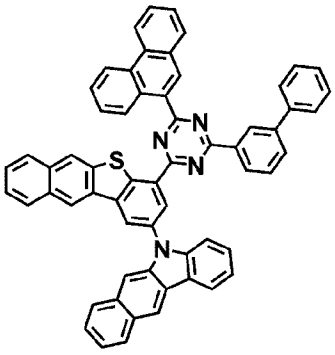
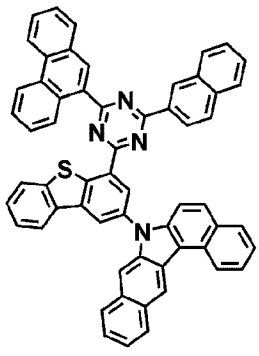
[223]

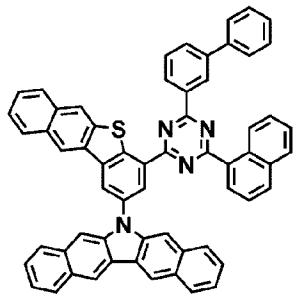
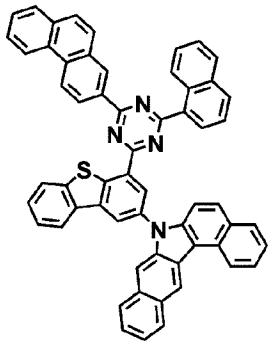
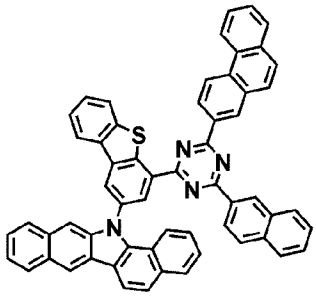
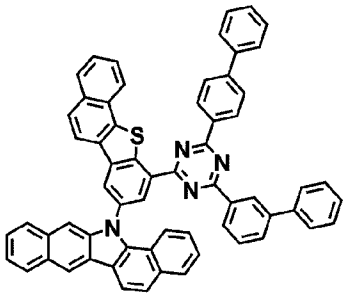
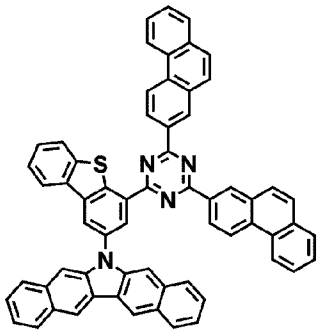
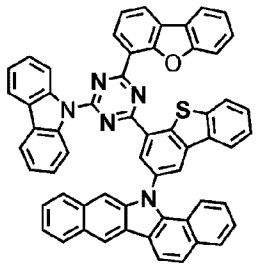
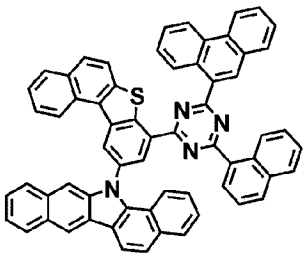
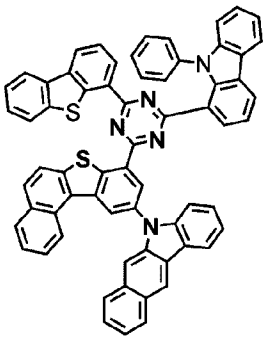
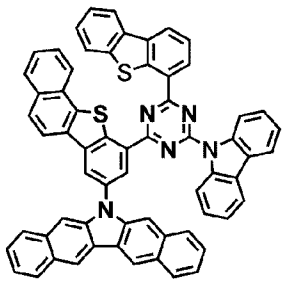
[224]

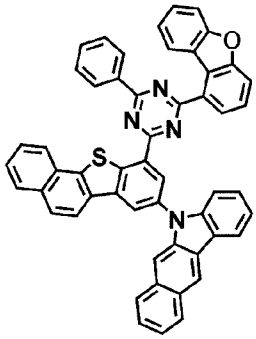
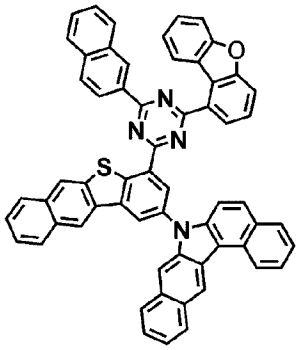
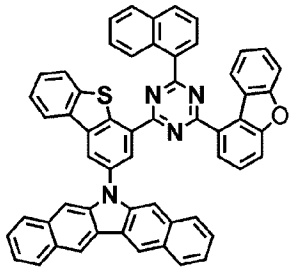
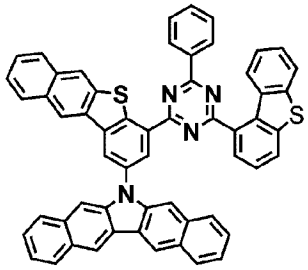
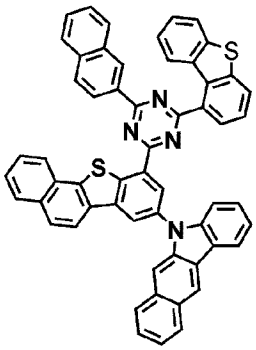
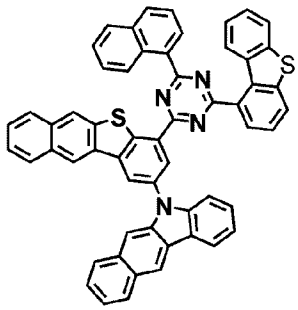
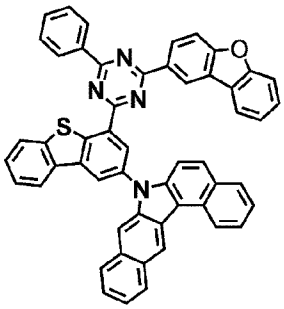
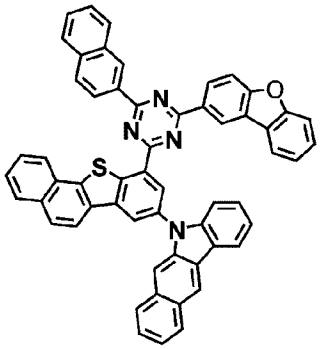
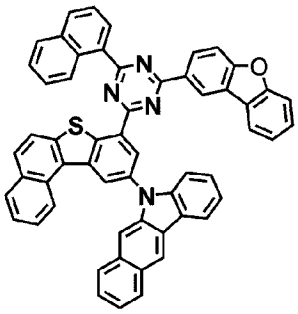
[225]

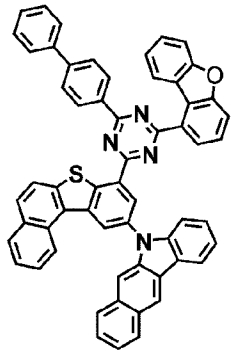
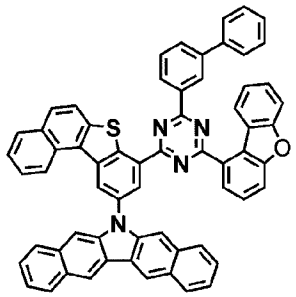
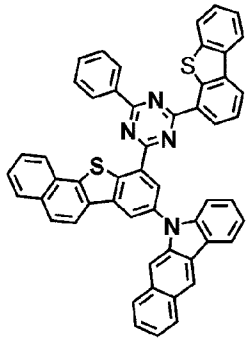
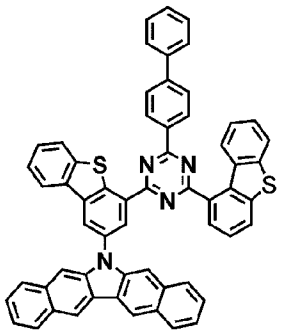
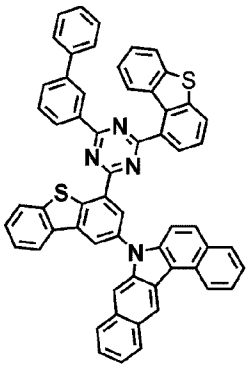
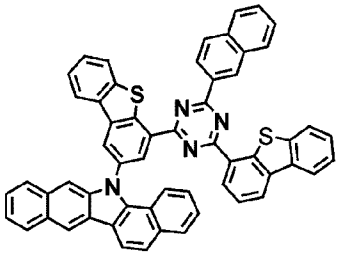
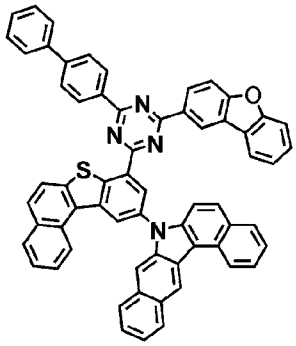
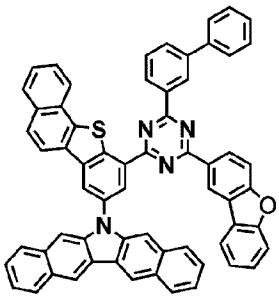
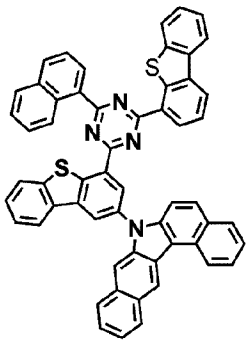
[226]

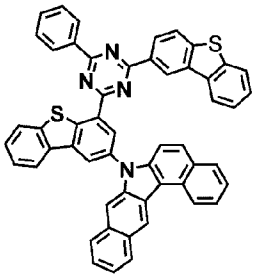
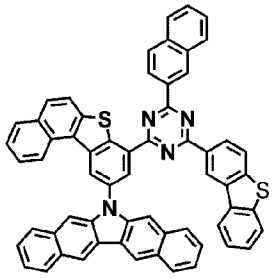
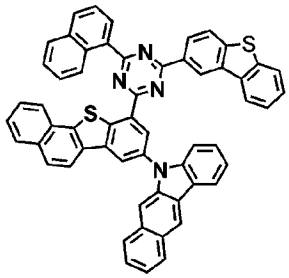
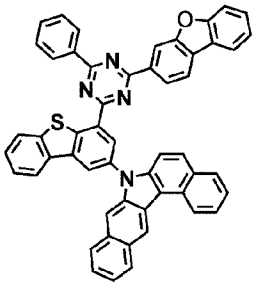
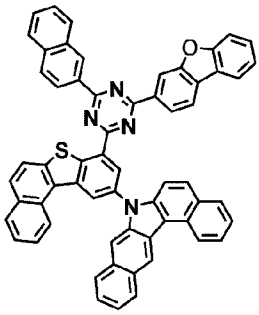
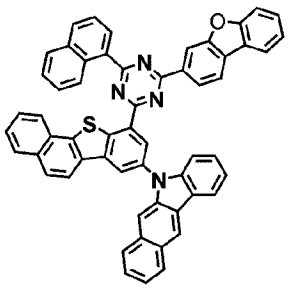
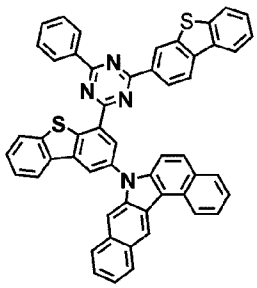
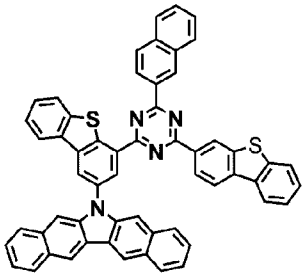
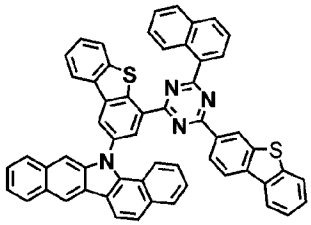
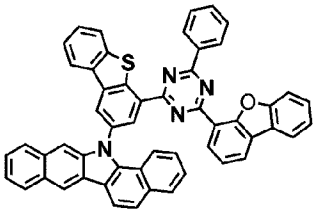
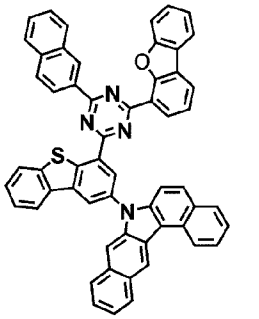
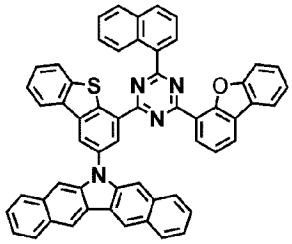
[227]

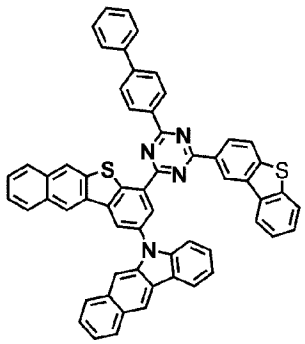
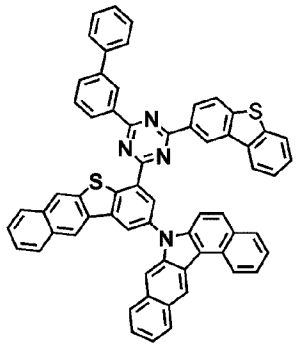
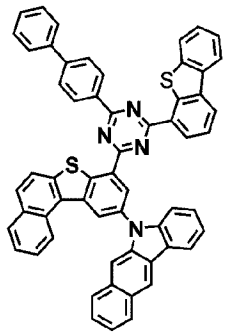
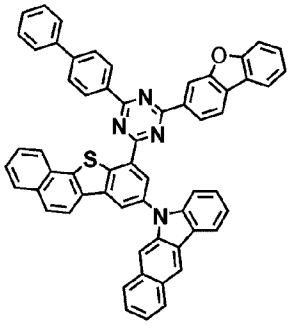
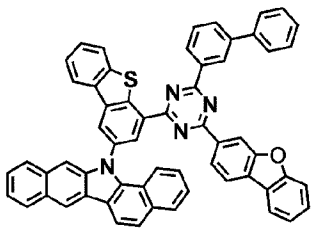
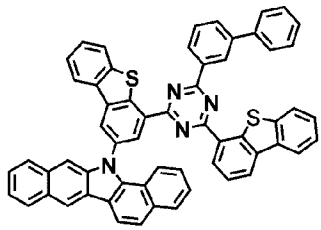
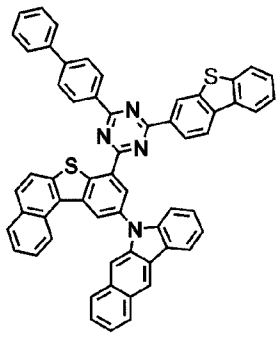
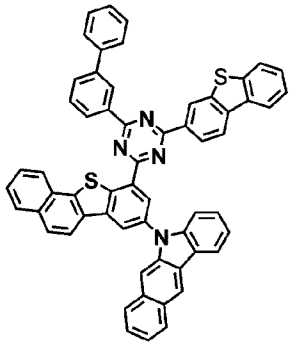
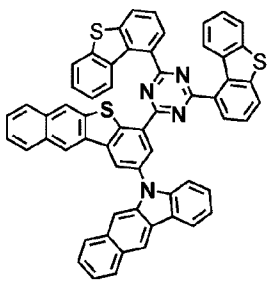
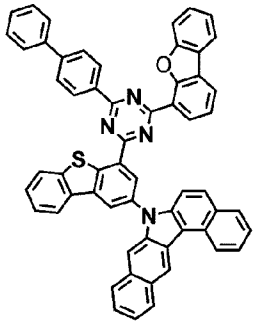
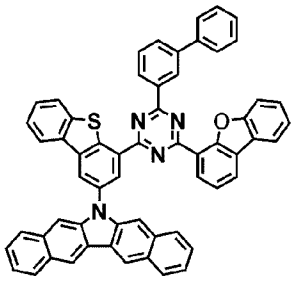
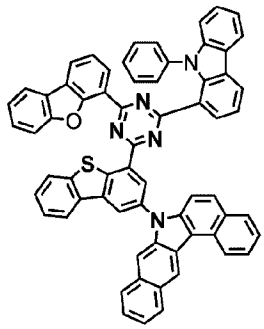
[228]

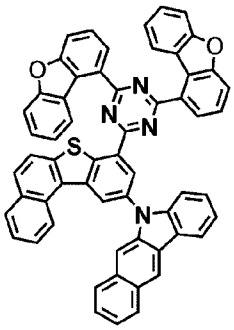
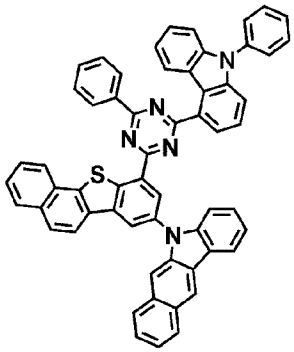
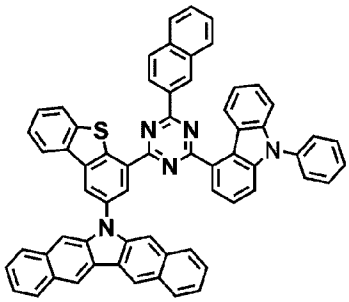
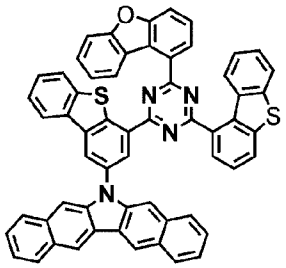
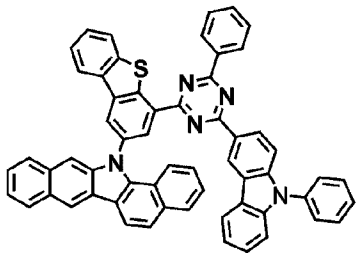
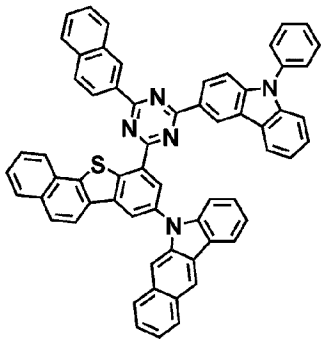
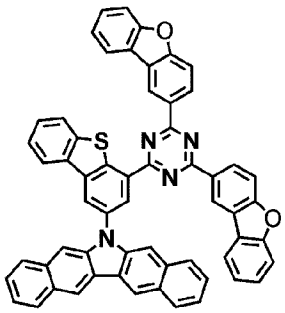
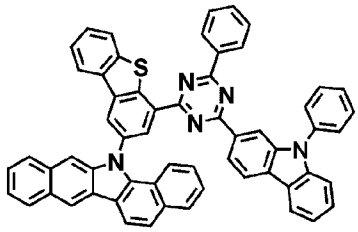
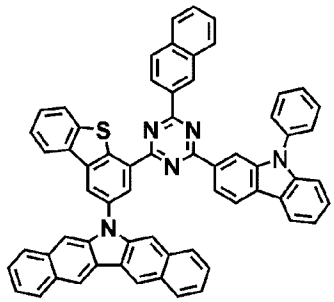
[229]

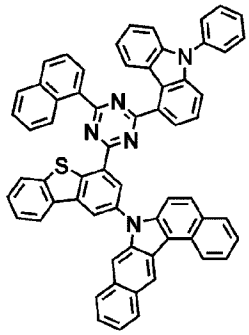
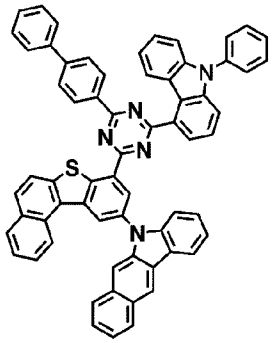
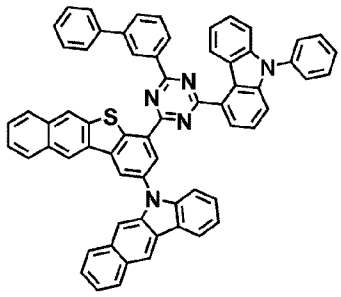
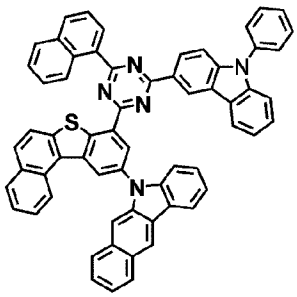
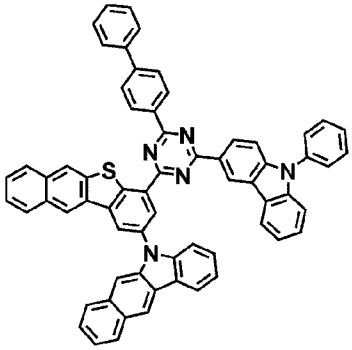
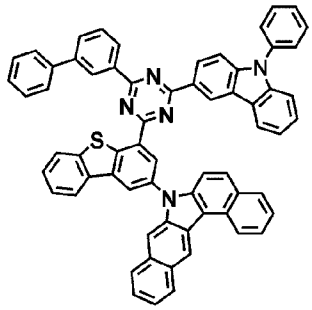
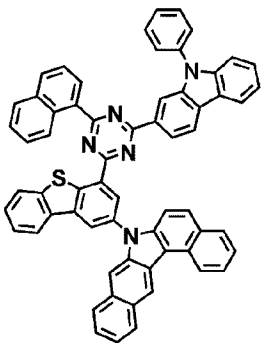
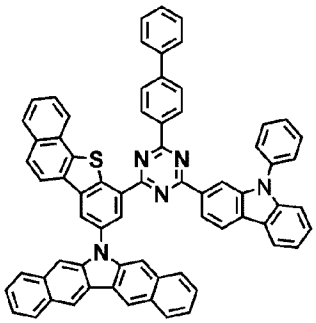
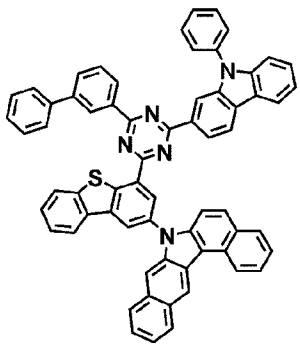
[230]

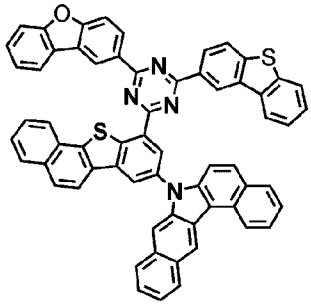
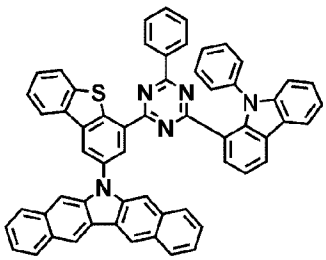
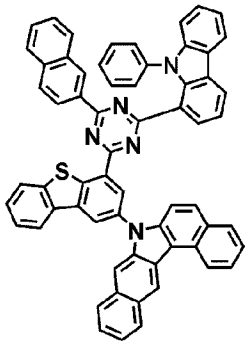
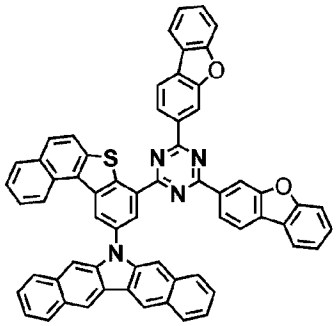
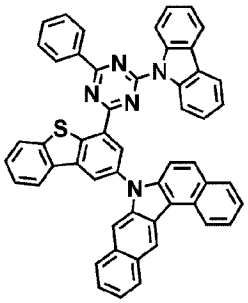
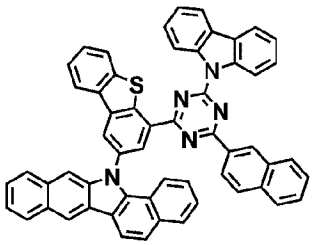
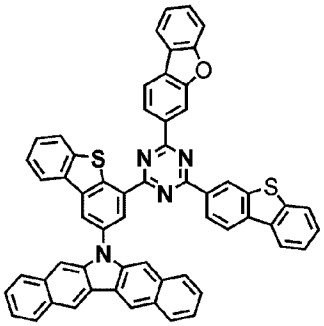
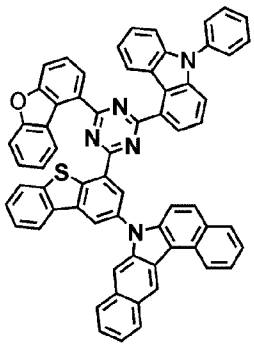
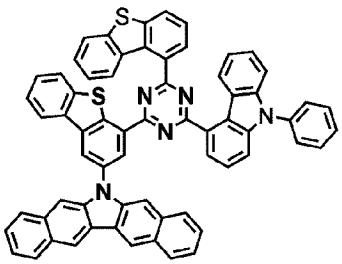
[231]

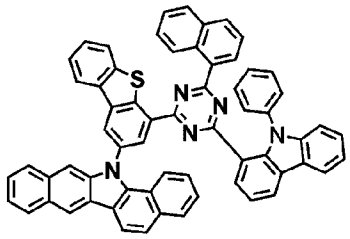
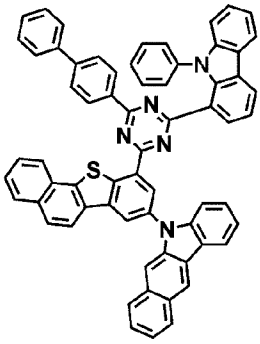
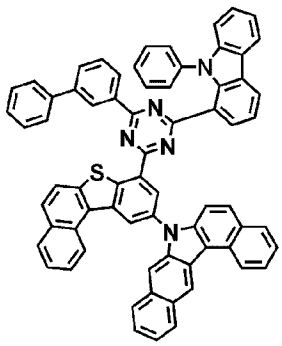
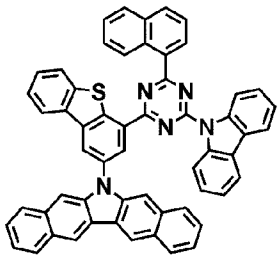
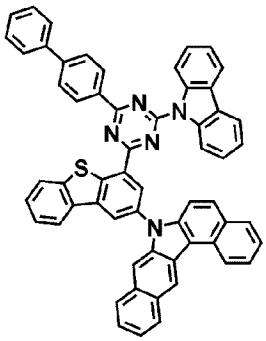
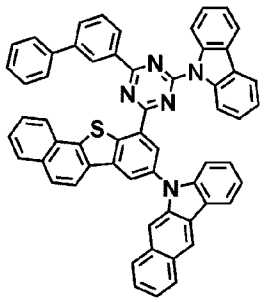
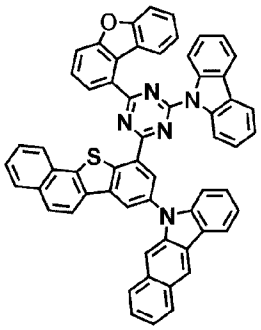
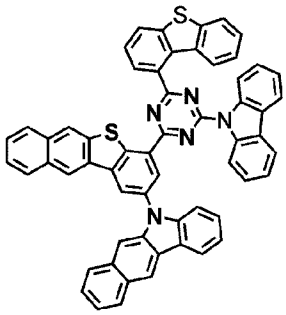
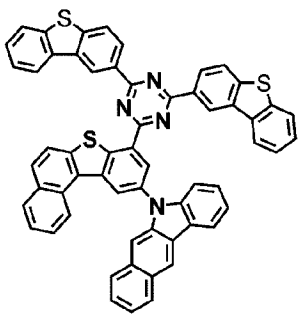
[232]

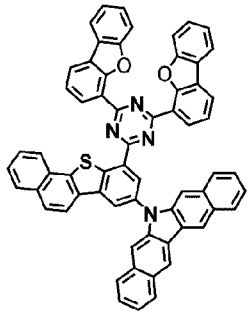
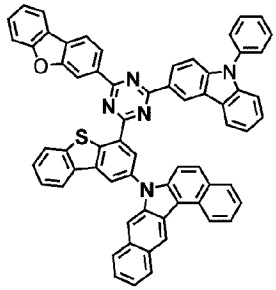
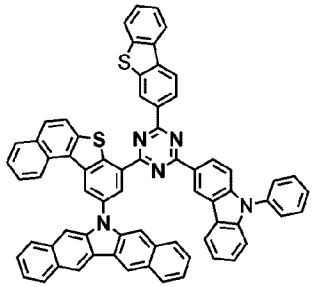
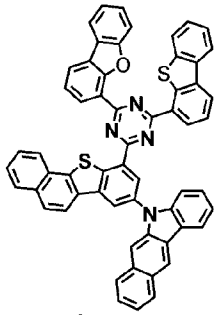
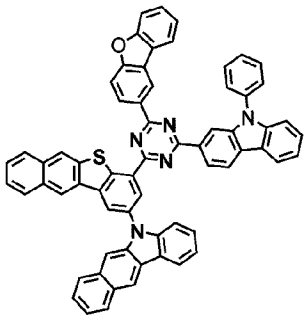
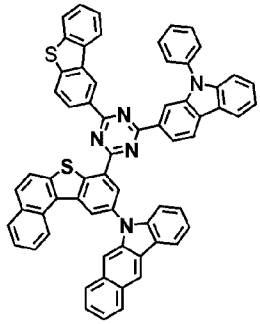
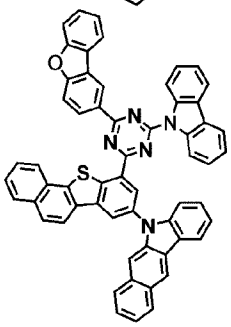
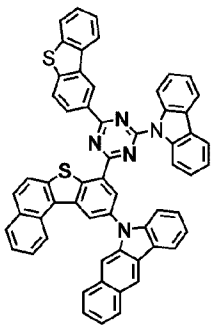
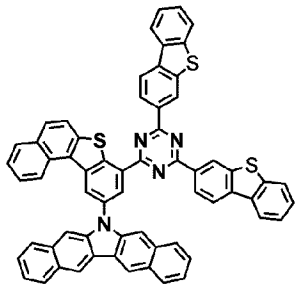
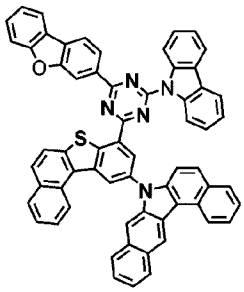
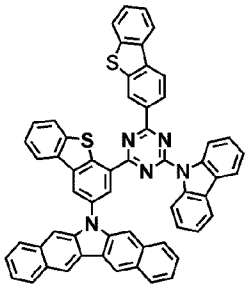
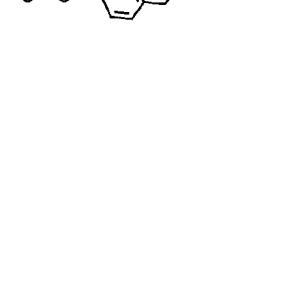
[233]

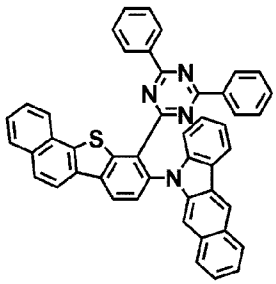
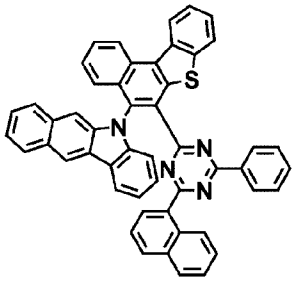
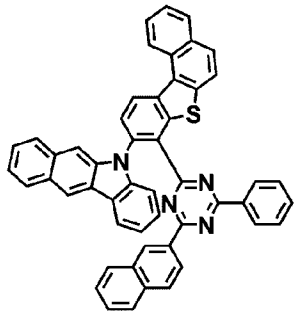
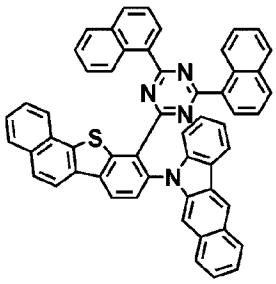
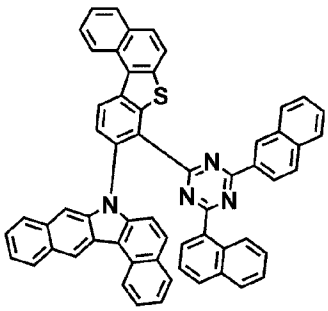
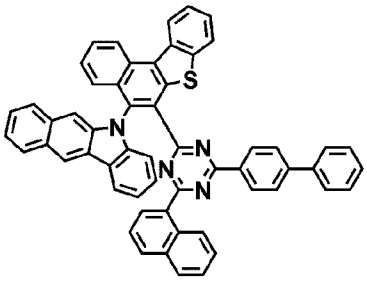
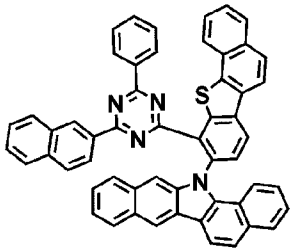
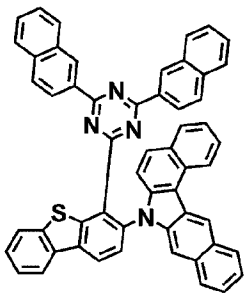
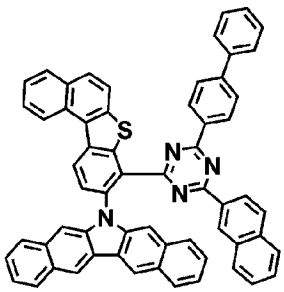
[234]

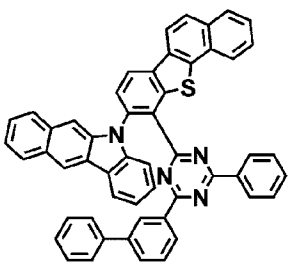
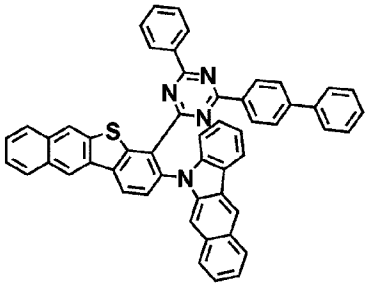
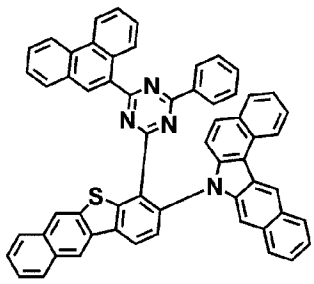
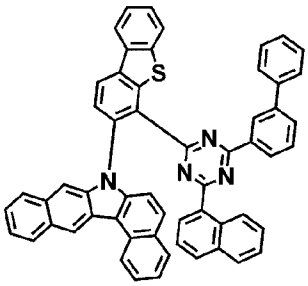
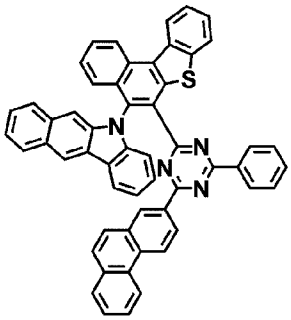
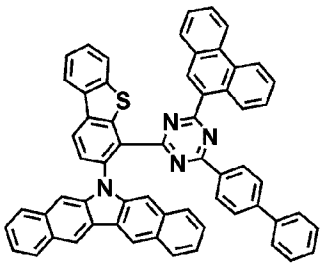
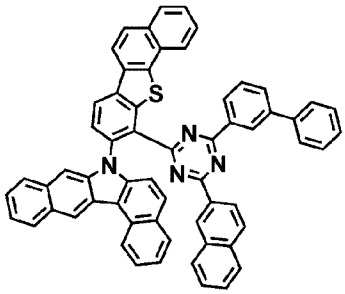
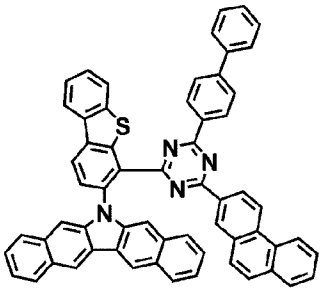
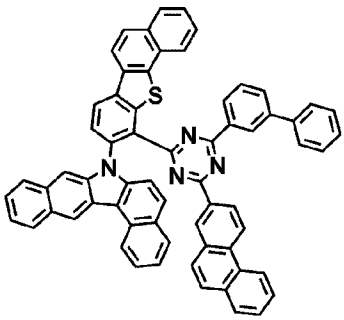
[235]

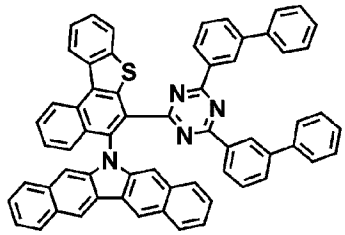
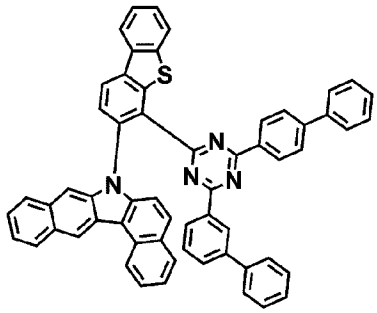
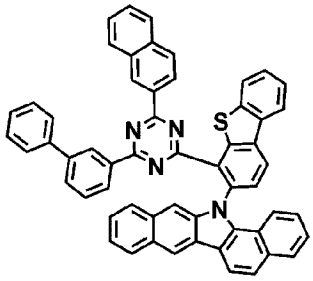
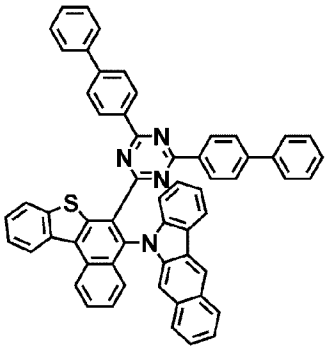
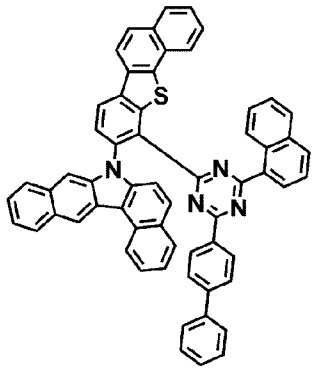
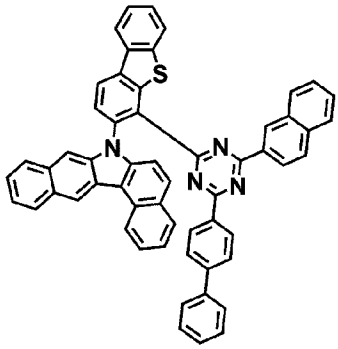
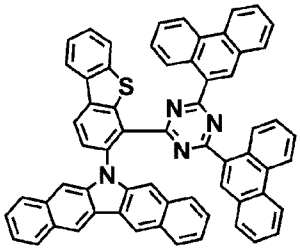
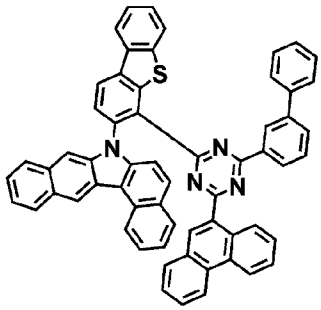
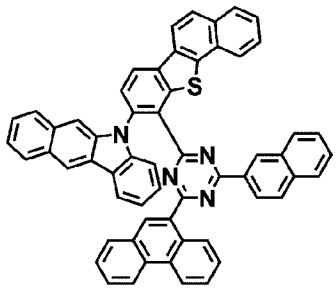
[236]

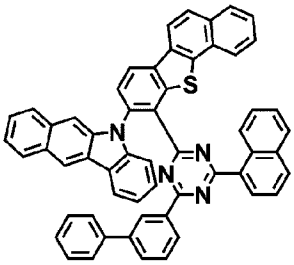
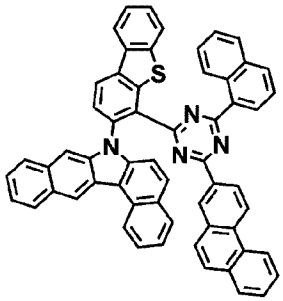
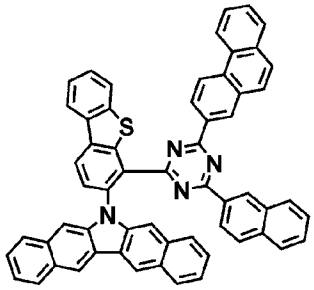
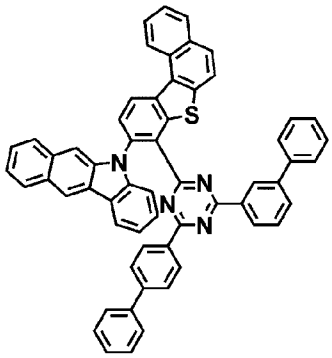
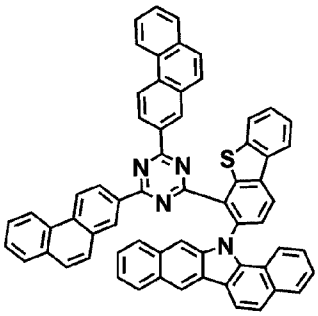
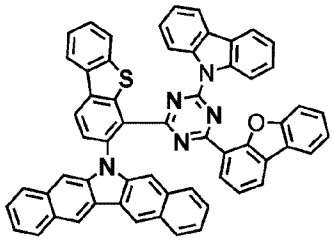
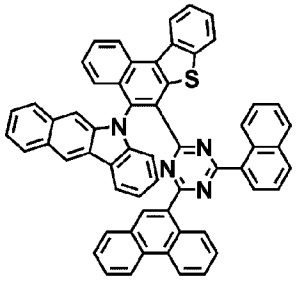
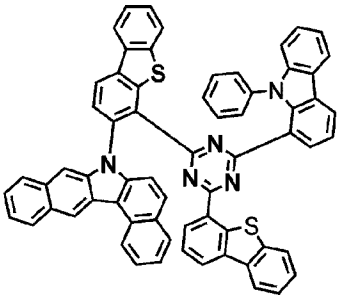
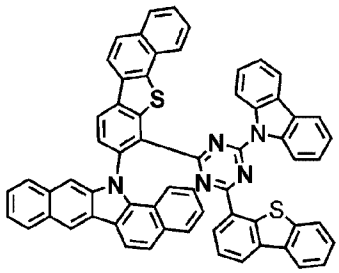
[237]

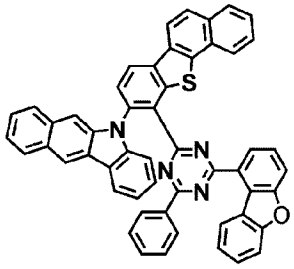
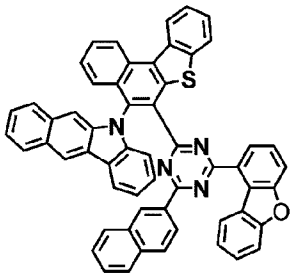
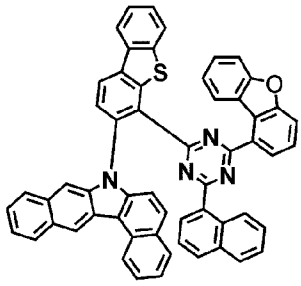
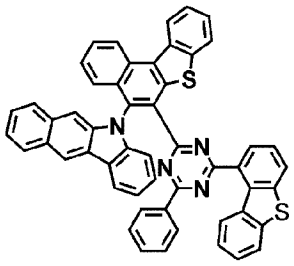
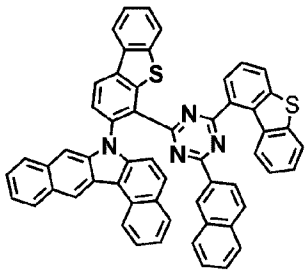
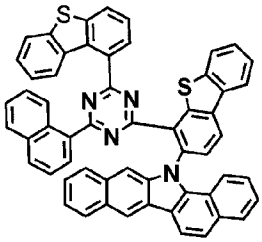
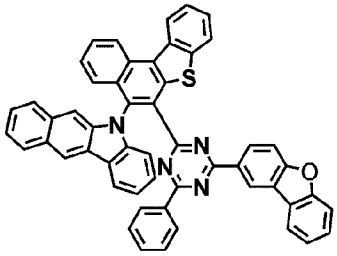
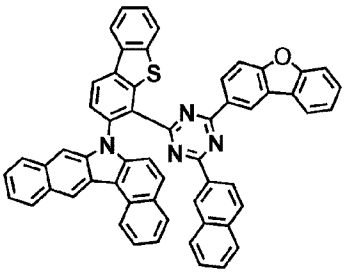
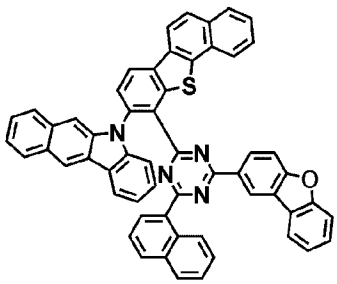
[238]

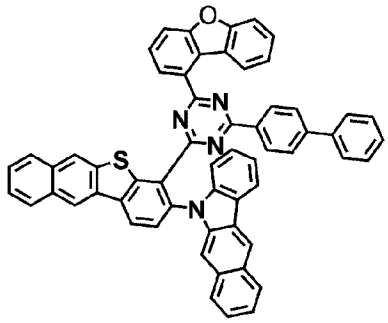
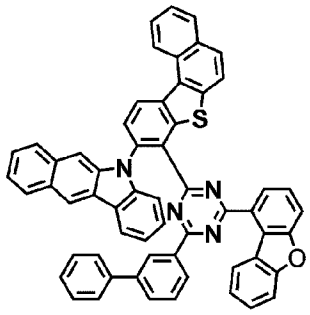
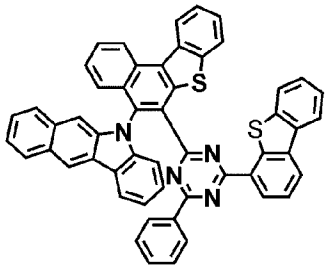
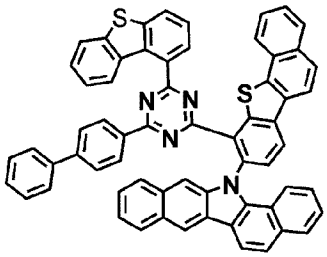
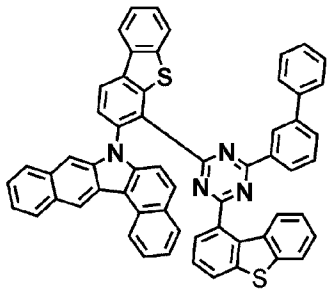
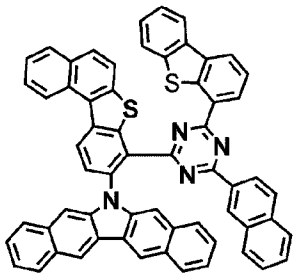
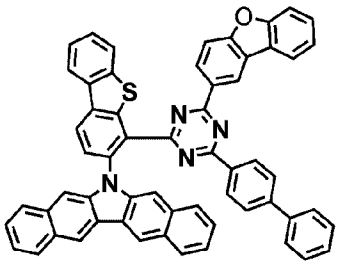
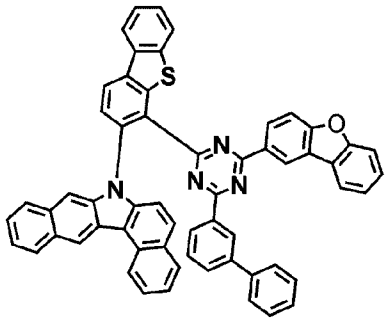
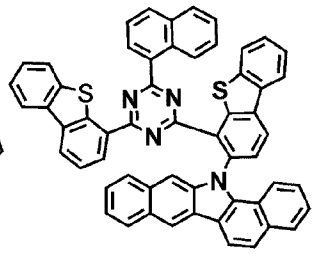
[239]

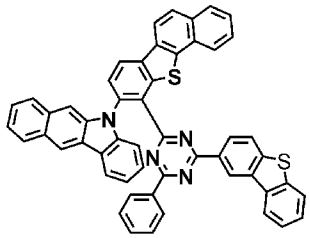
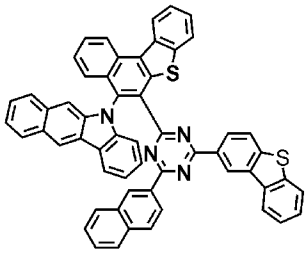
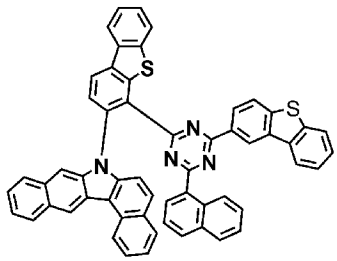
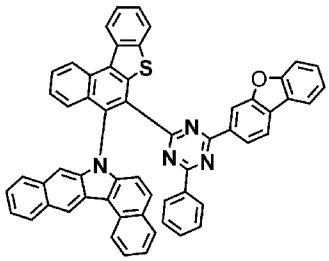
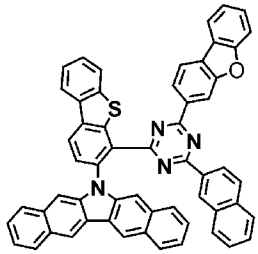
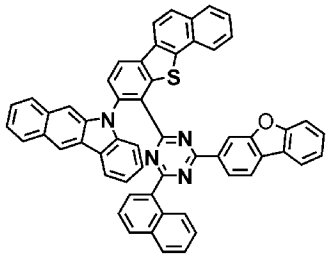
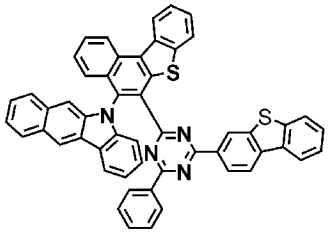
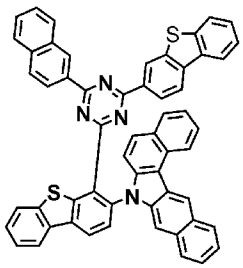
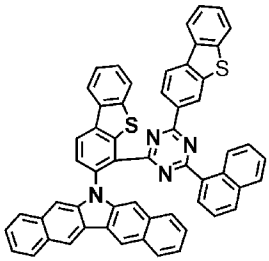
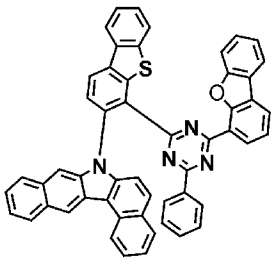
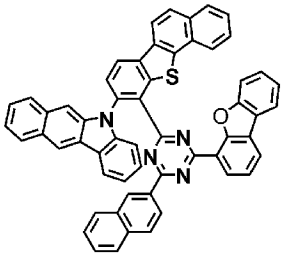
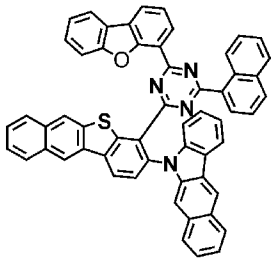
[240]

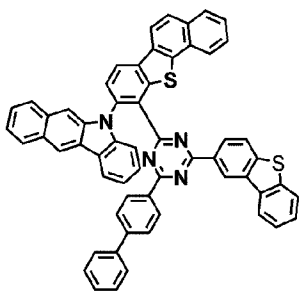
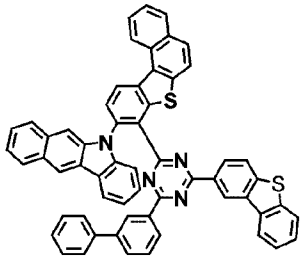
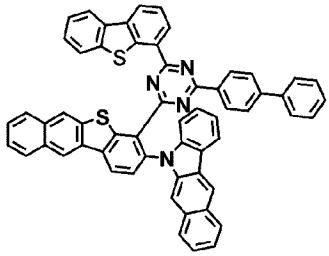
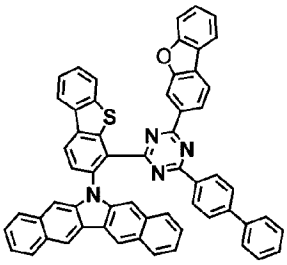
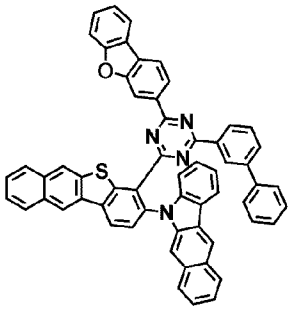
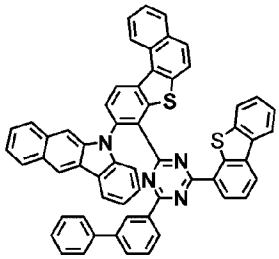
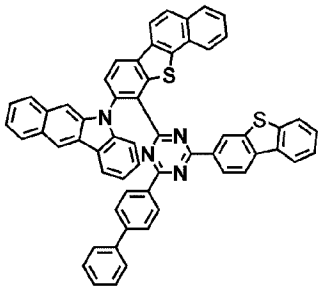
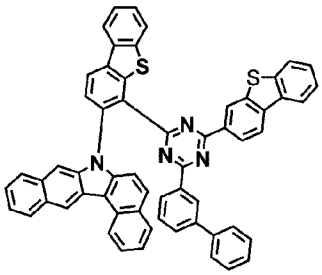
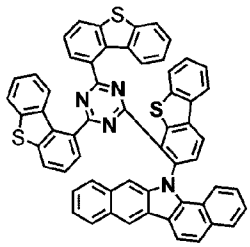
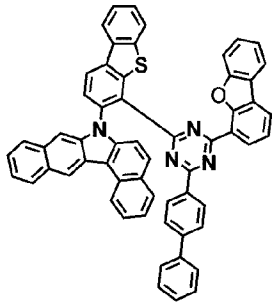
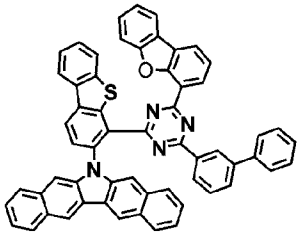
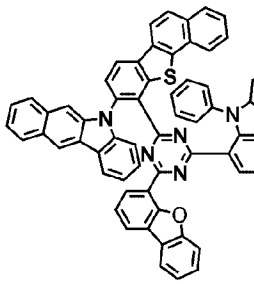
[241]

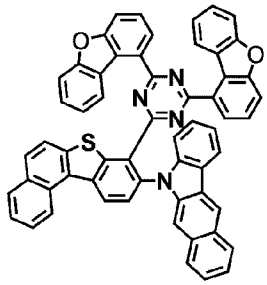
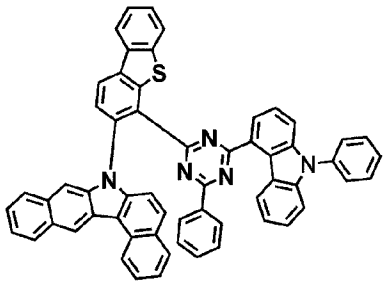
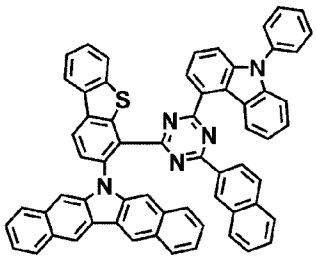
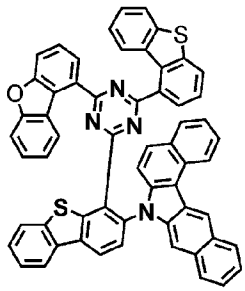
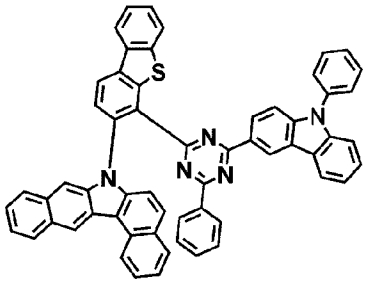
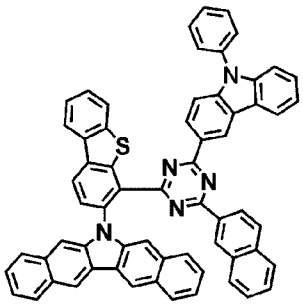
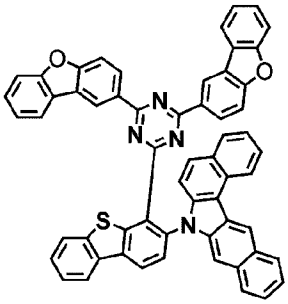
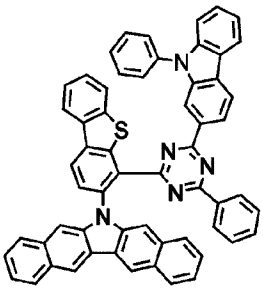
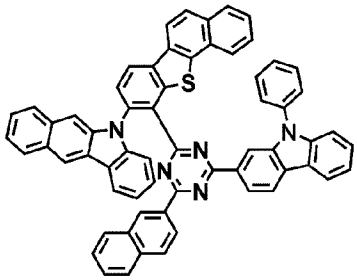
[242]

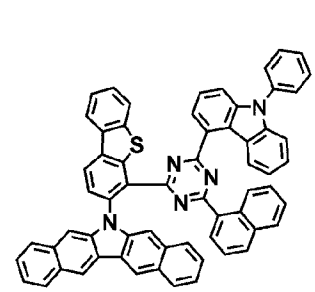
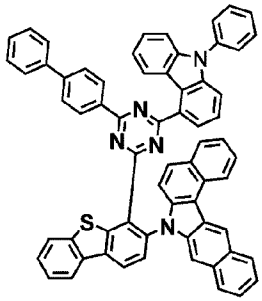
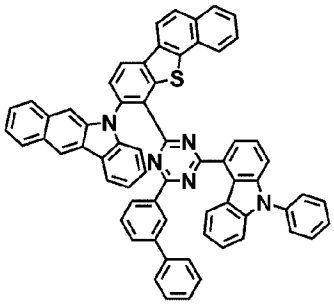
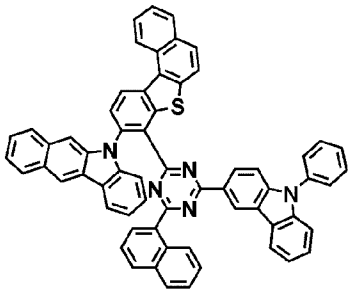
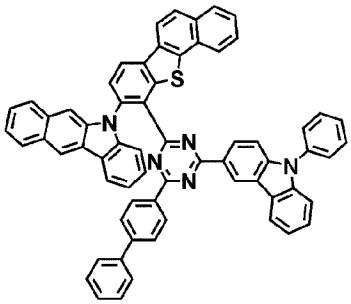
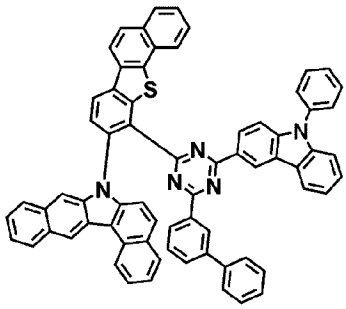
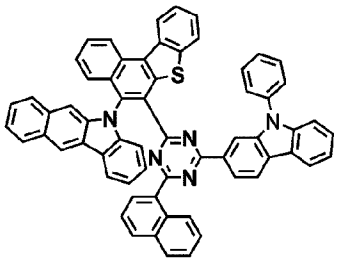
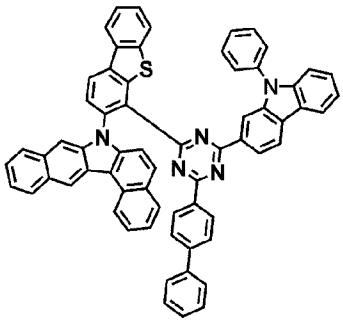
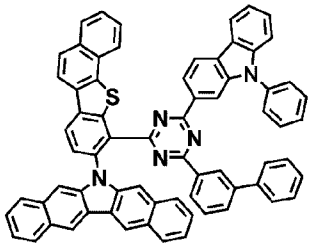
[243]

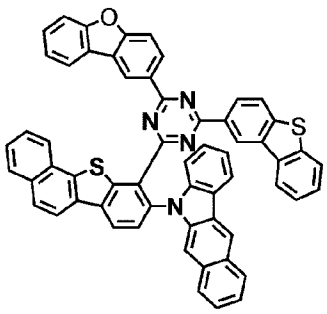
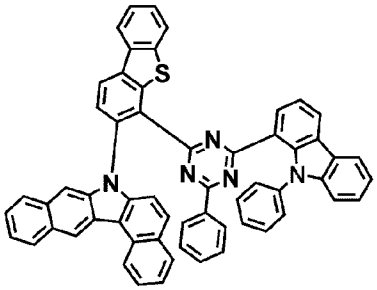
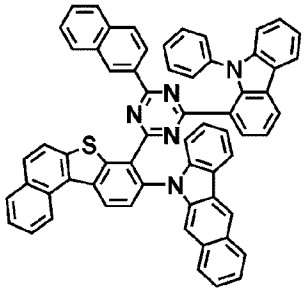
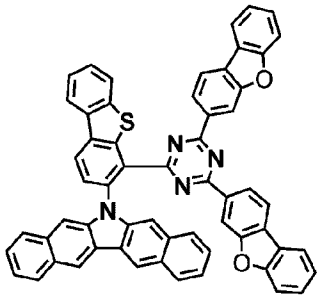
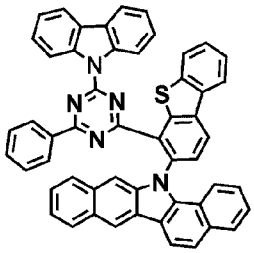
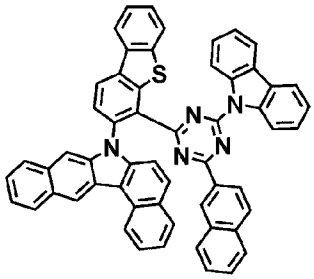
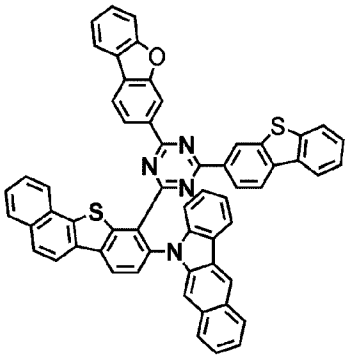
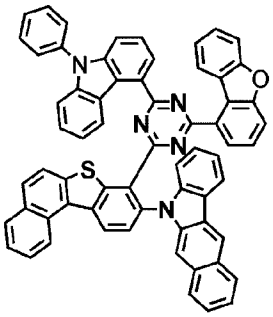
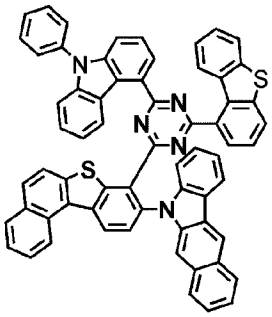
[244]

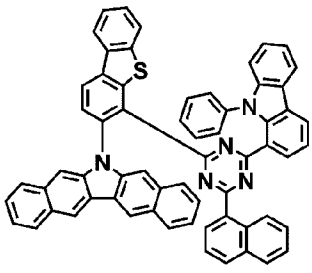
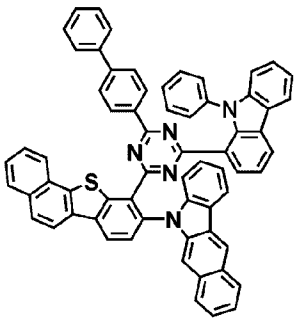
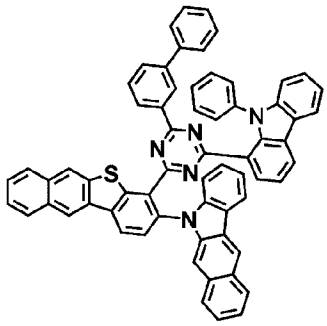
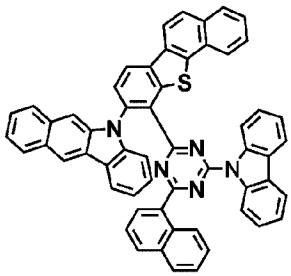
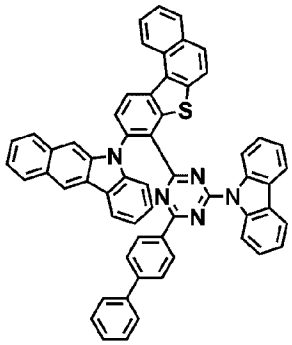
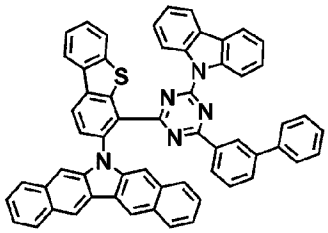
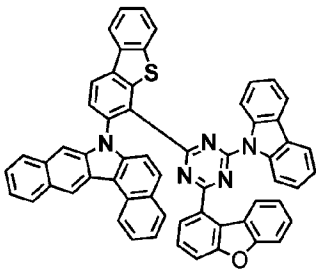
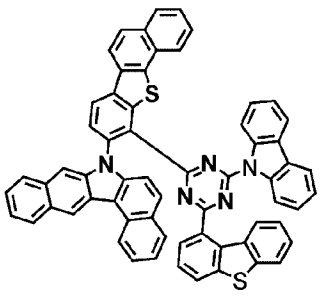
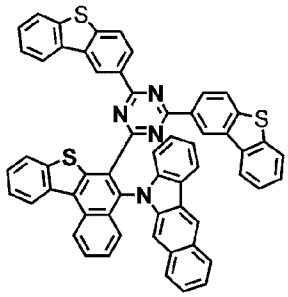
[245]

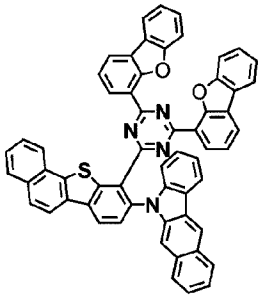
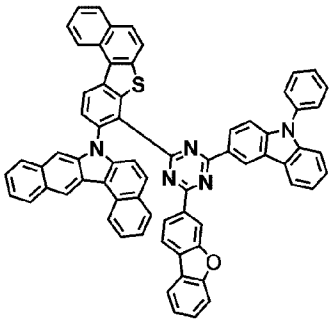
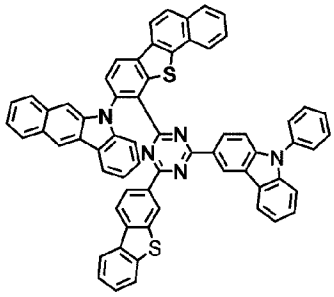
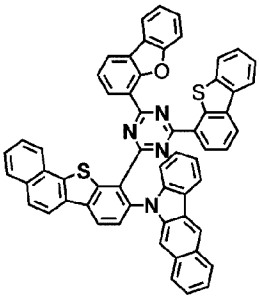
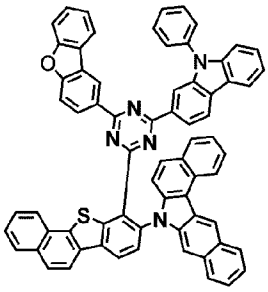
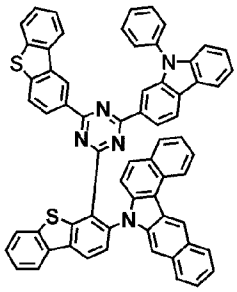
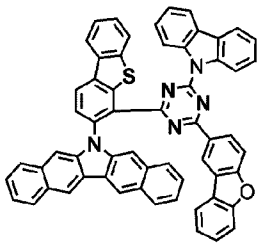
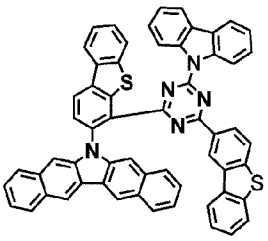
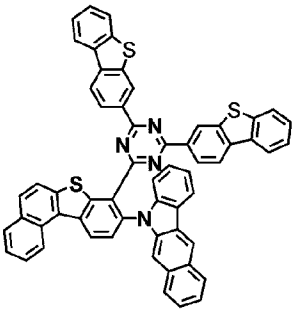
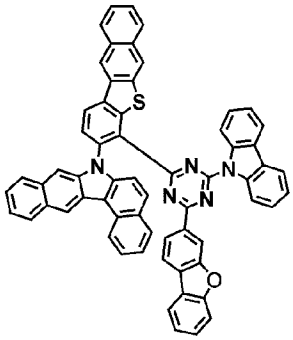
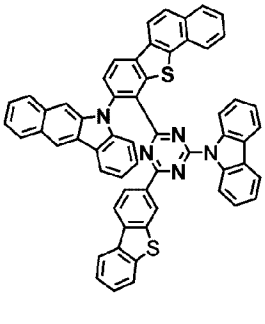
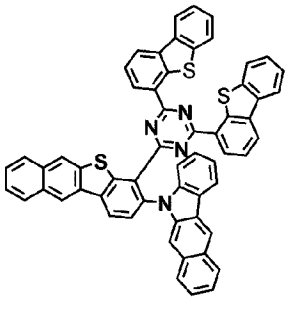
[246]

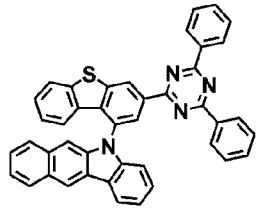
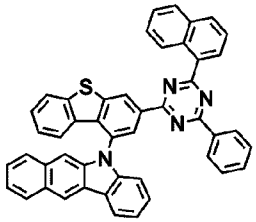
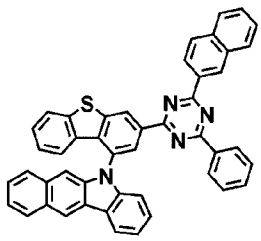
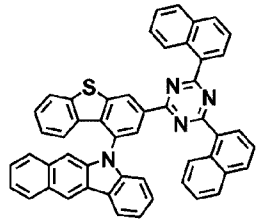
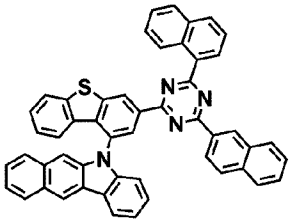
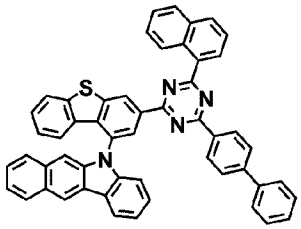
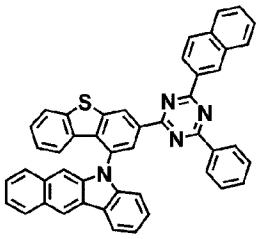
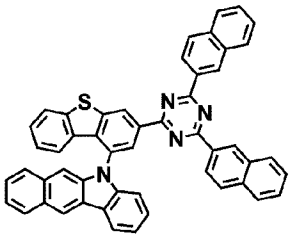
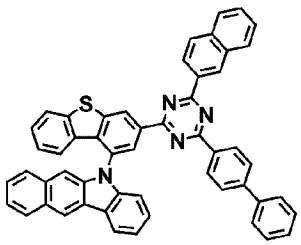
[247]

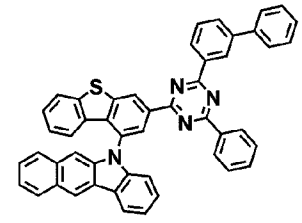
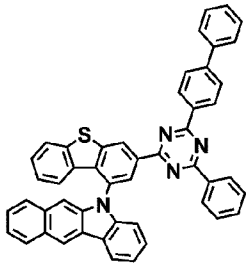
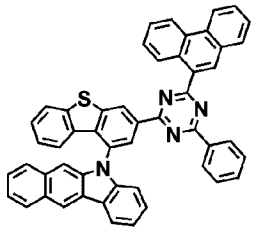
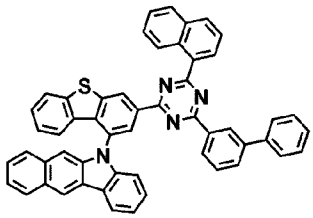
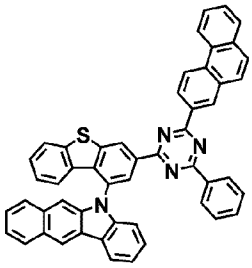
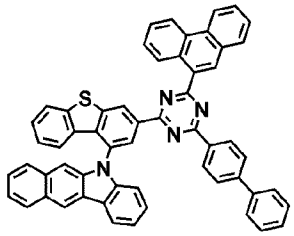
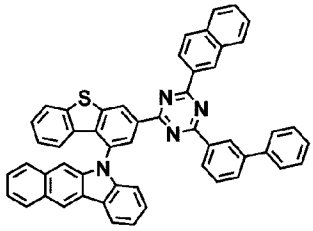
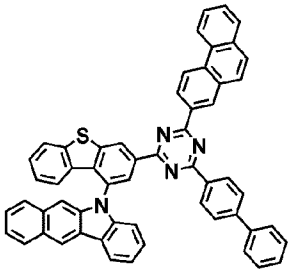
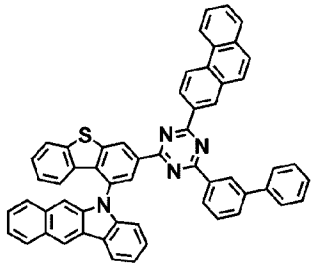
[248]

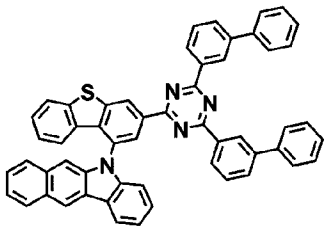
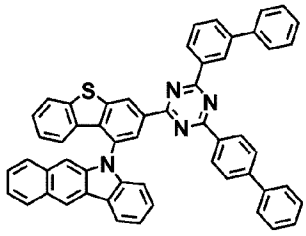
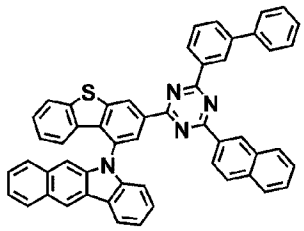
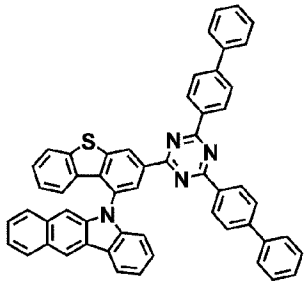
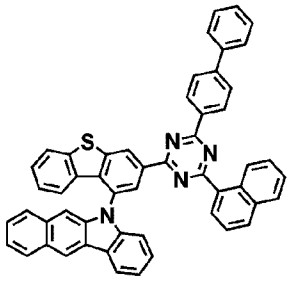
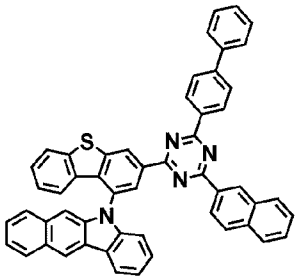
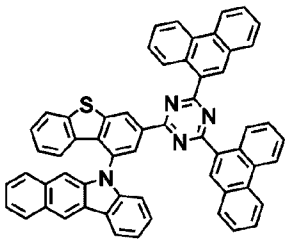
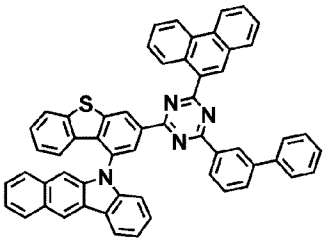
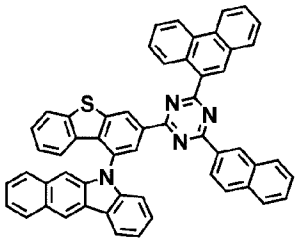
[249]

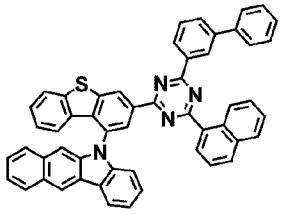
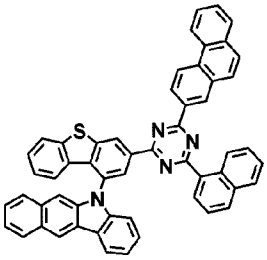
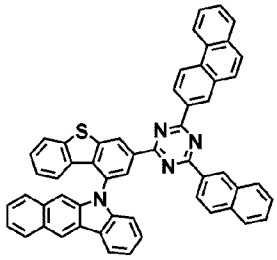
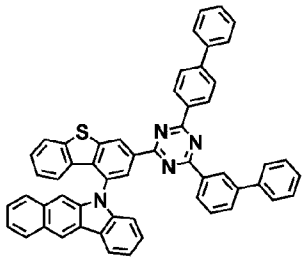
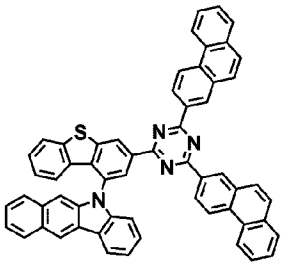
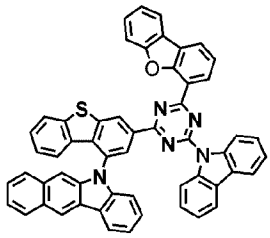
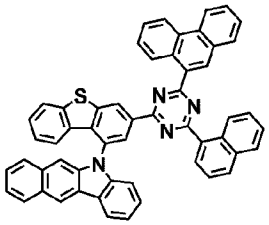
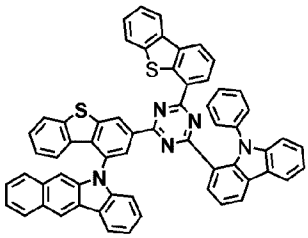
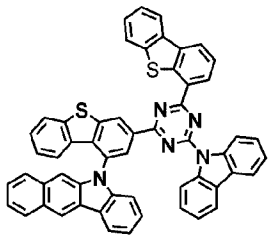
[250]

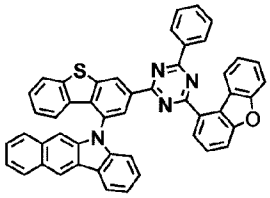
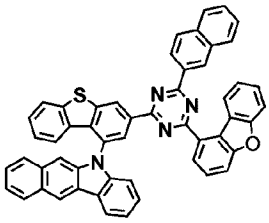
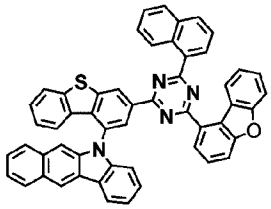
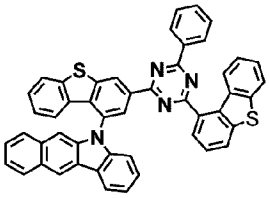
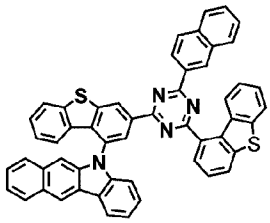
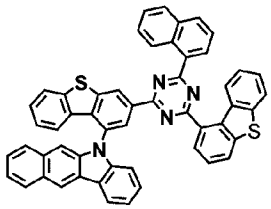
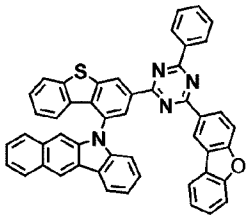
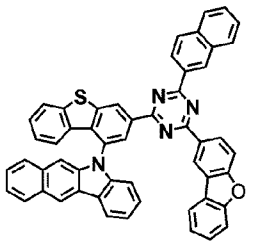
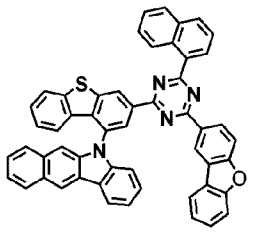
[251]

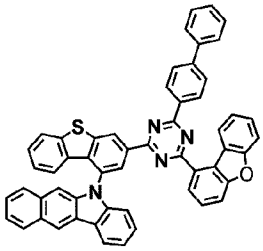
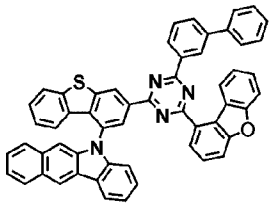
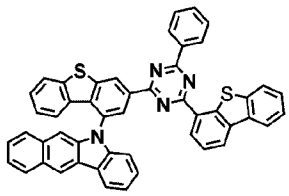
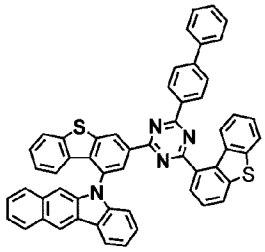
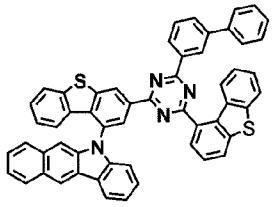
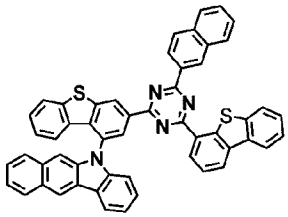
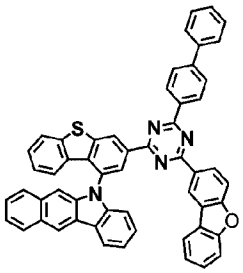
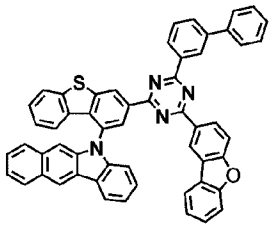
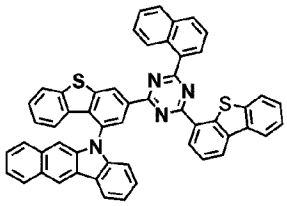
[252]

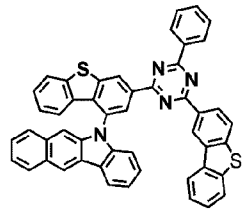
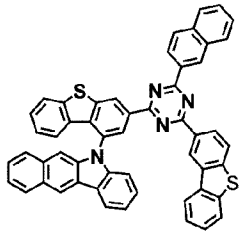
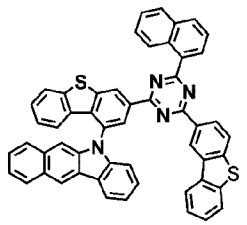
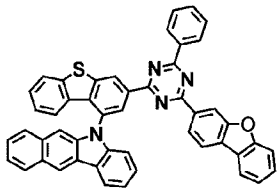
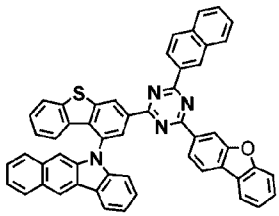
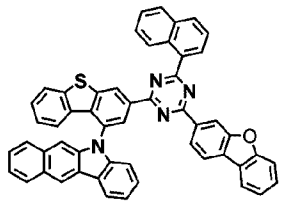
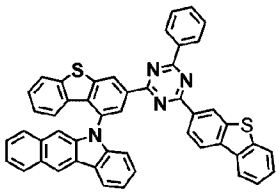
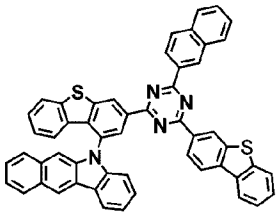
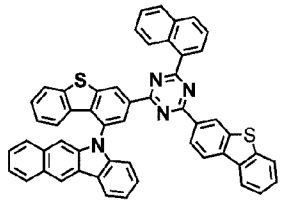
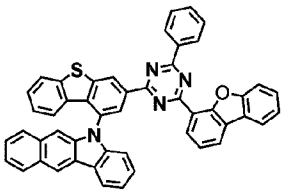
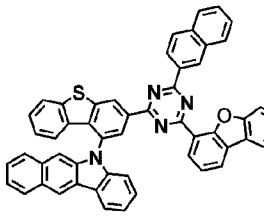
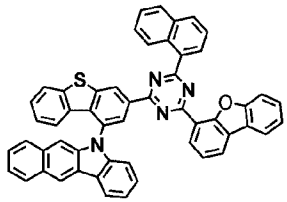
[253]

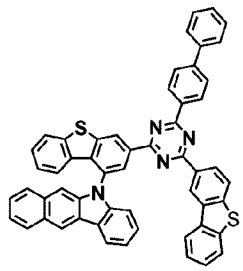
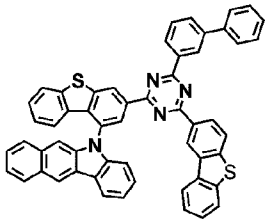
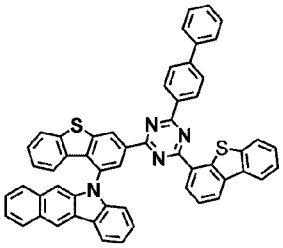
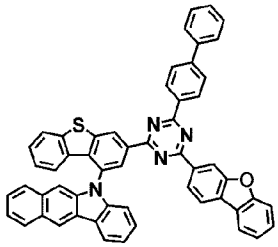
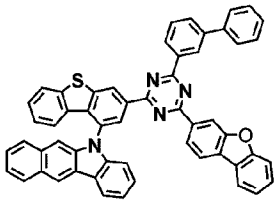
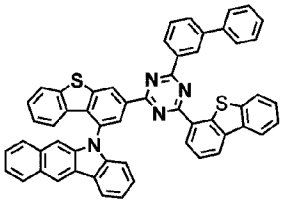
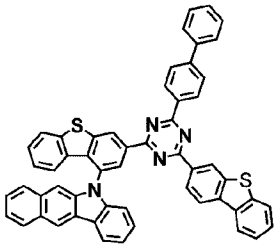
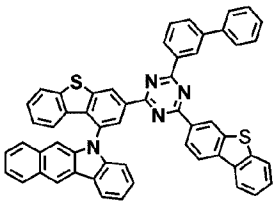
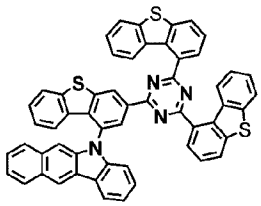
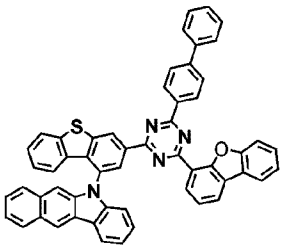
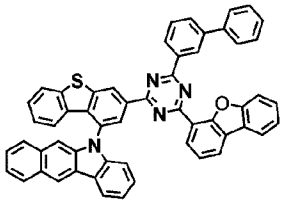
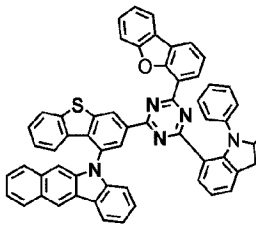
[254]

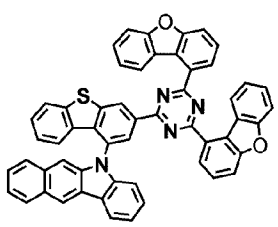
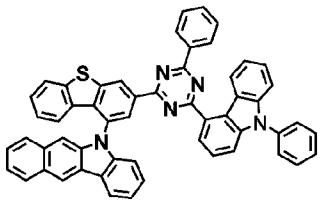
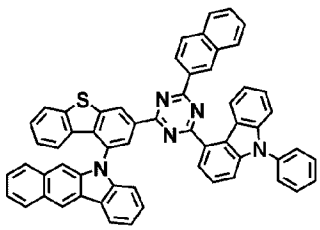
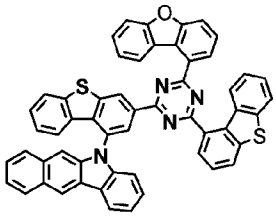
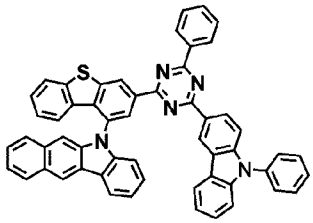
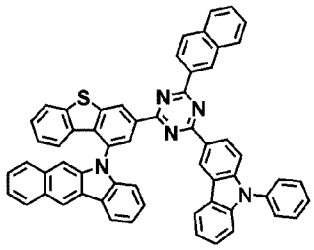
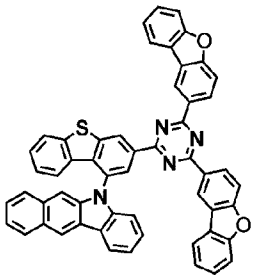
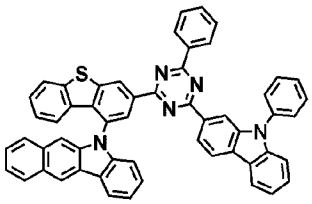
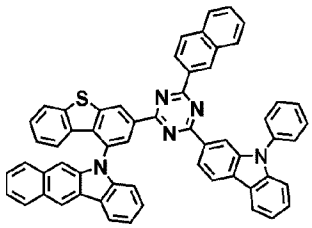
[255]

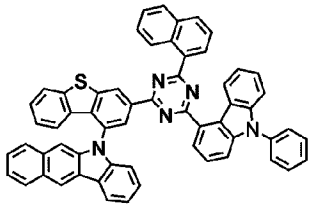
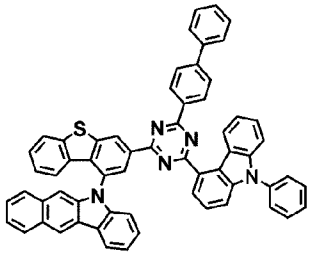
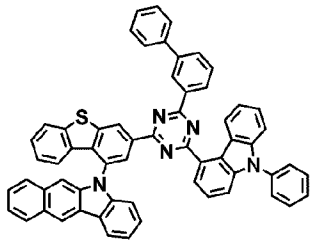
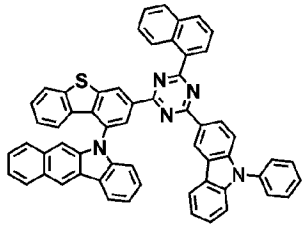
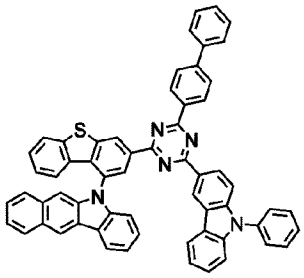
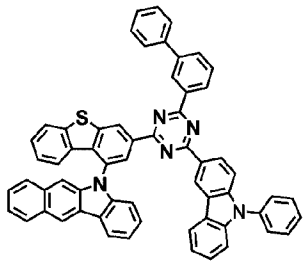
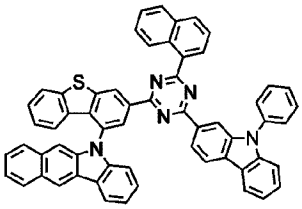
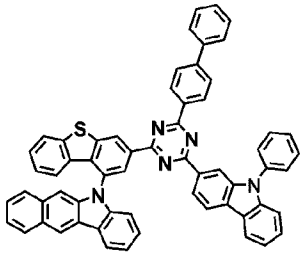
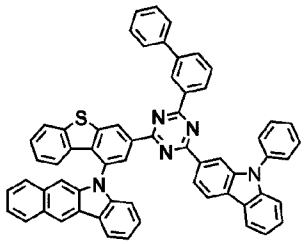
[256]

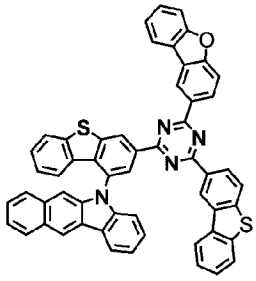
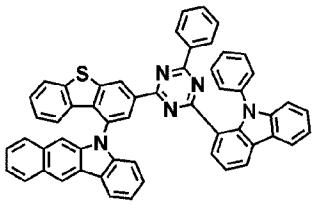
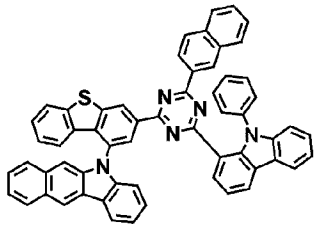
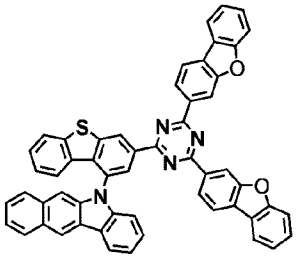
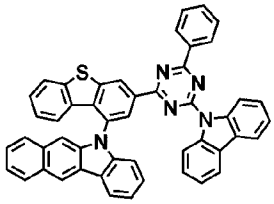
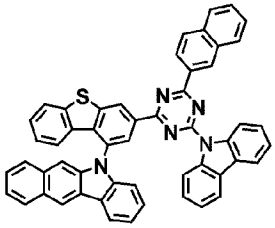
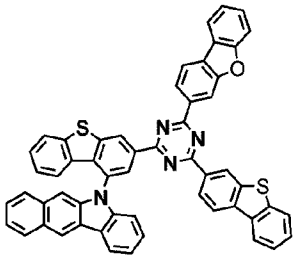
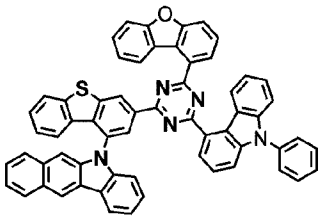
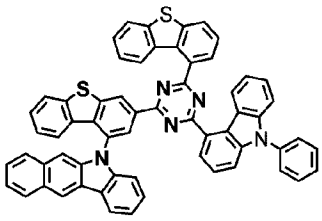
[257]

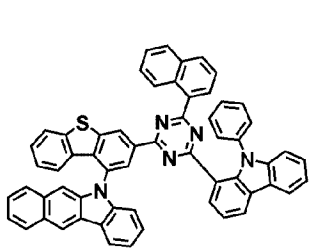
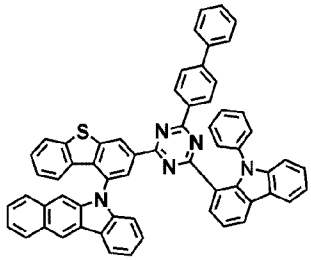
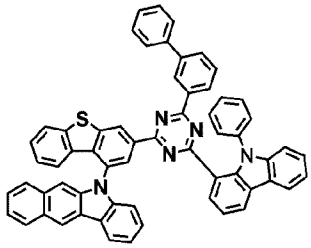
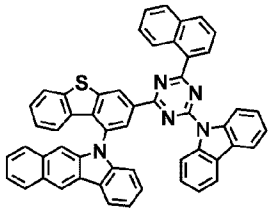
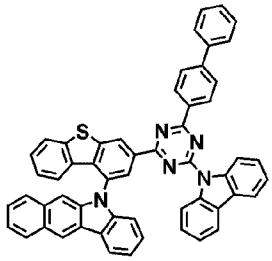
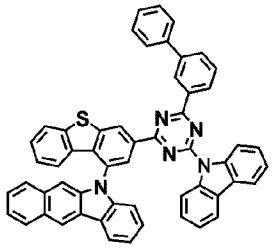
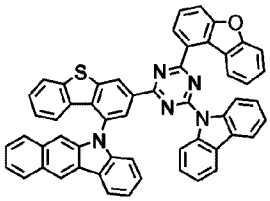
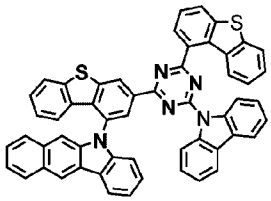
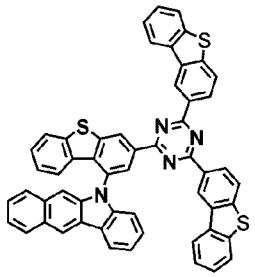
[258]

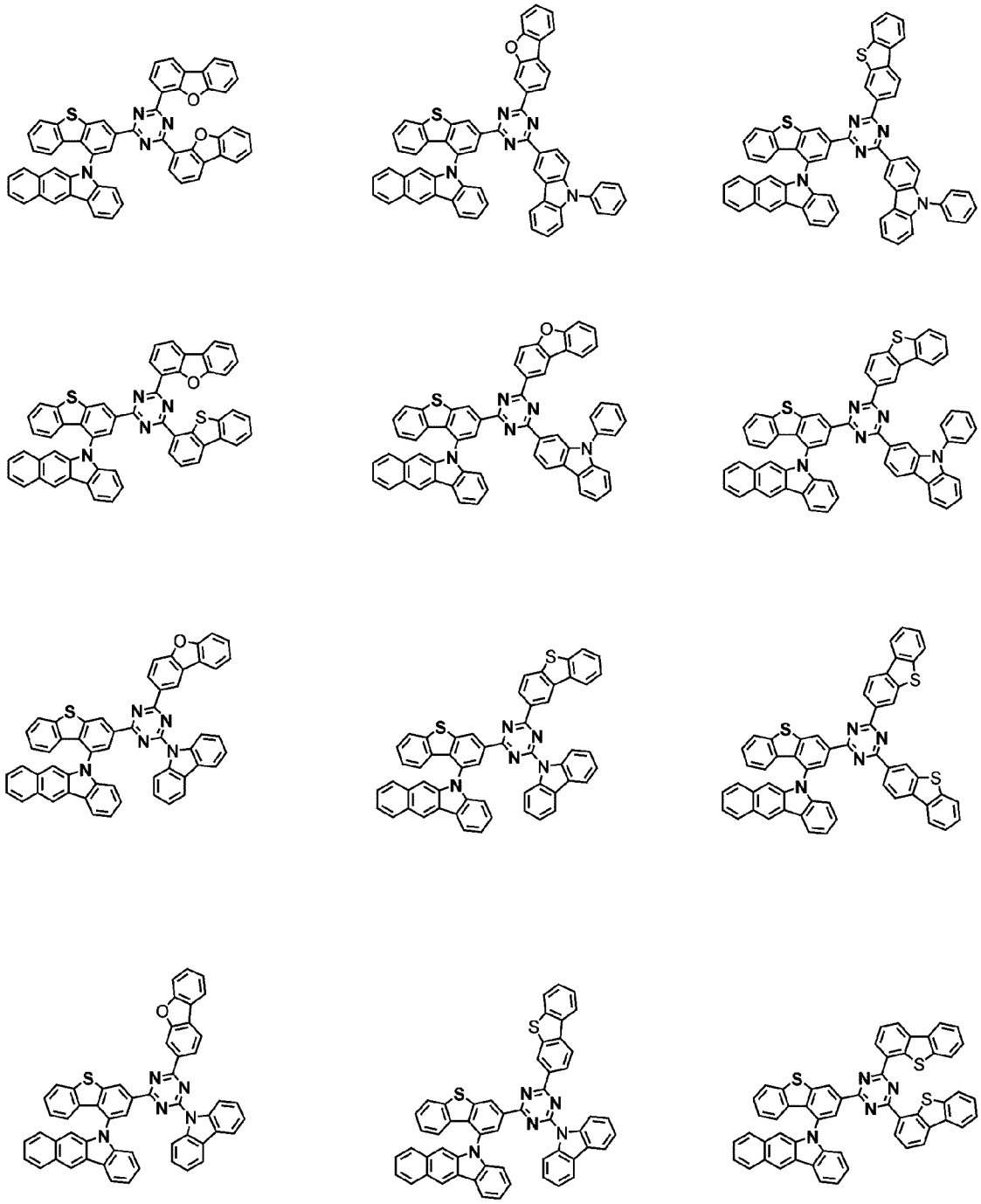
[259]

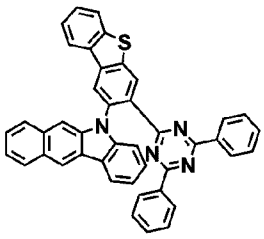
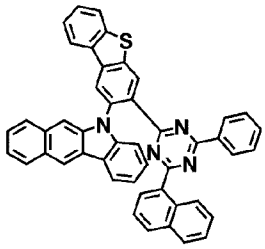
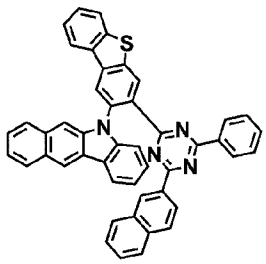
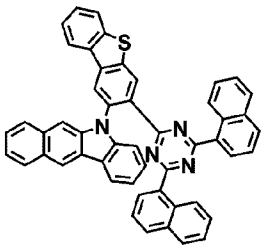
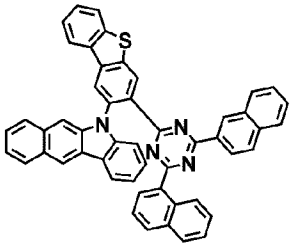
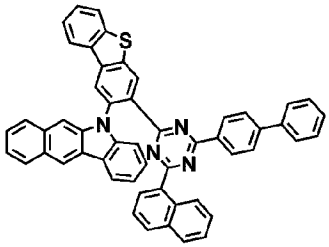
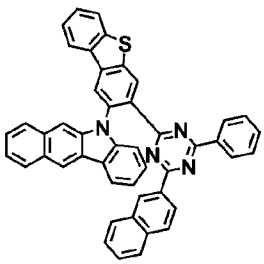
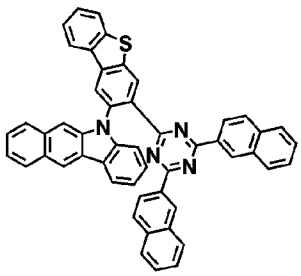
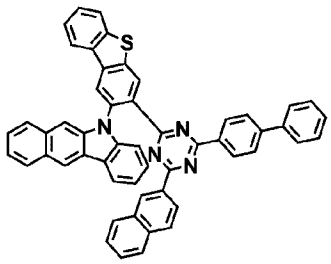
[260]

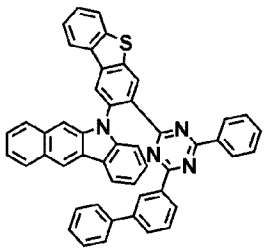
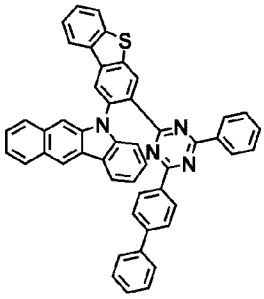
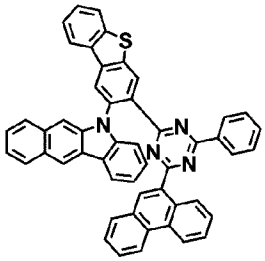
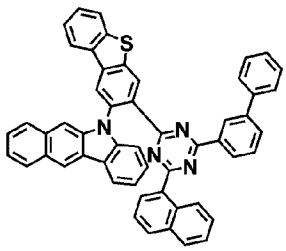
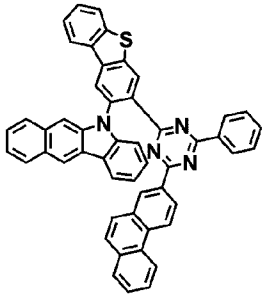
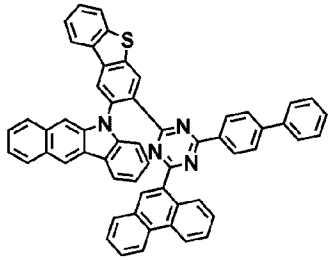
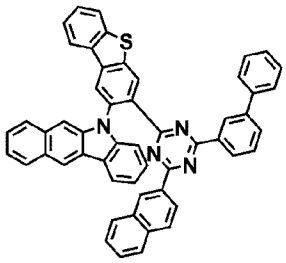
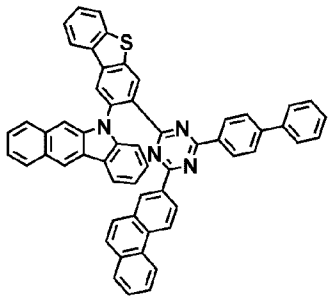
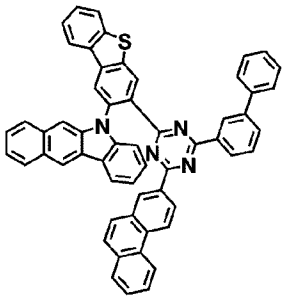
[261]



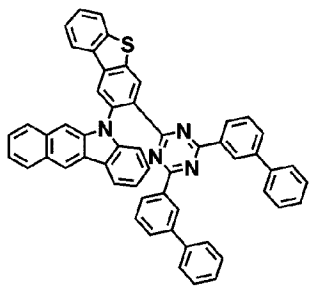
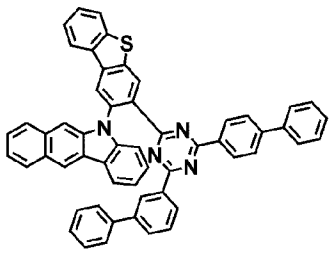
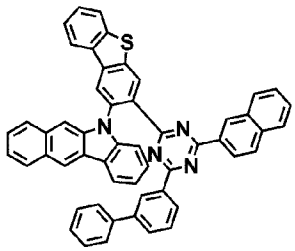
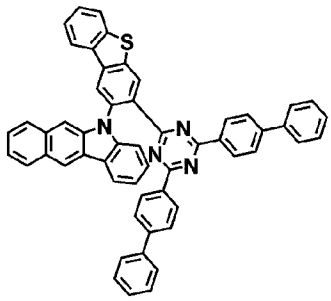
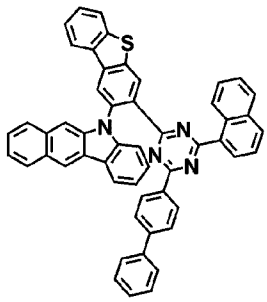
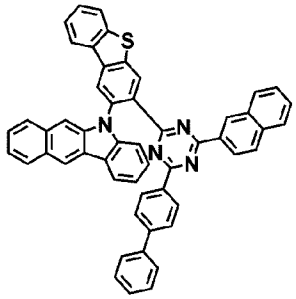
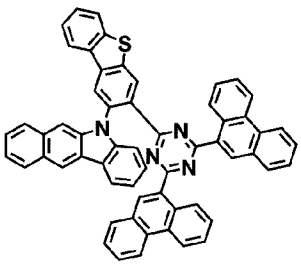
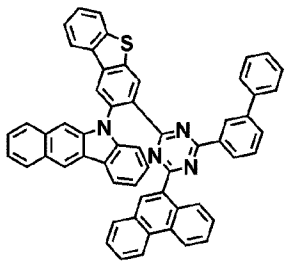
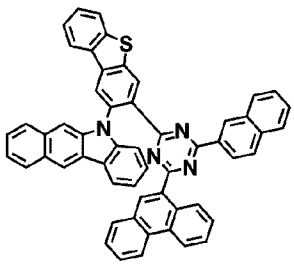
[262]

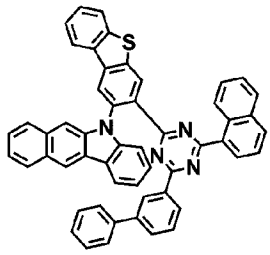
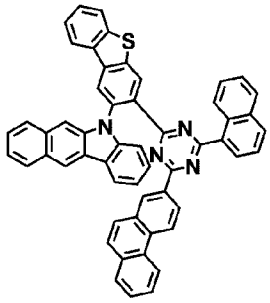
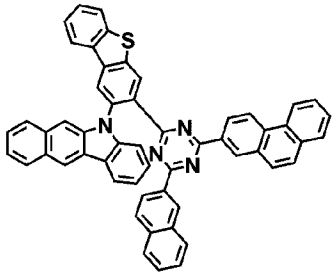
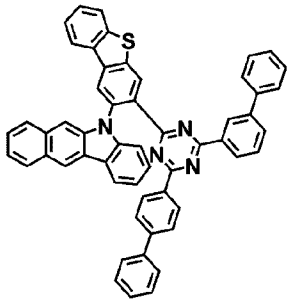
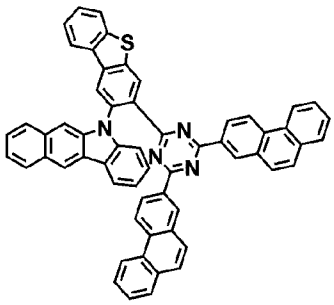
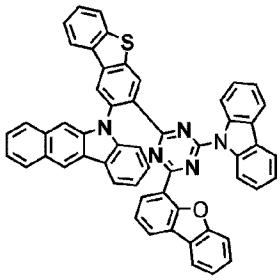
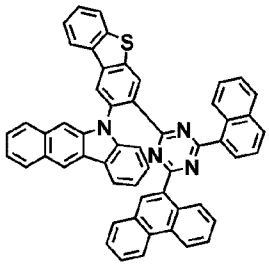
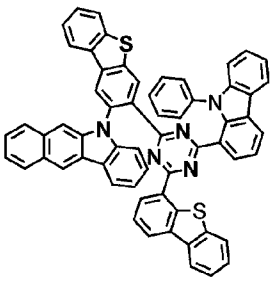
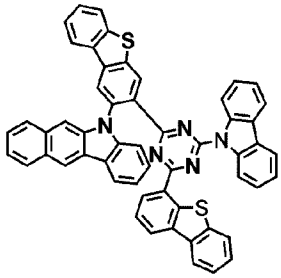
[263]

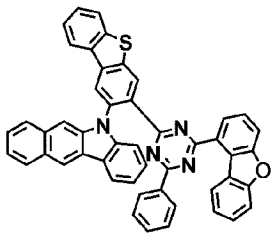
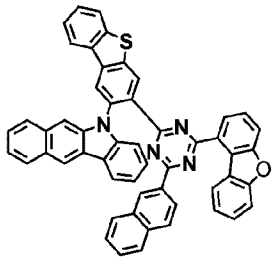
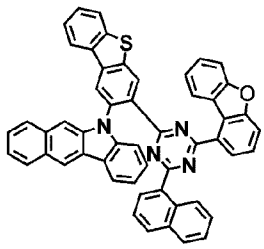
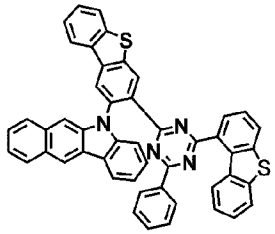
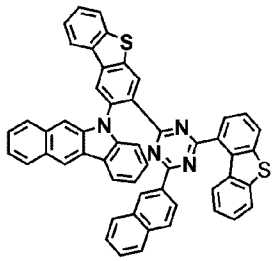
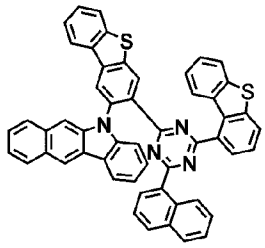
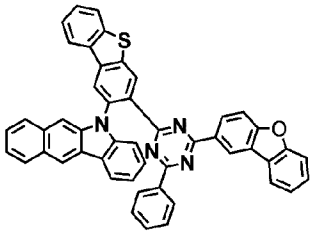
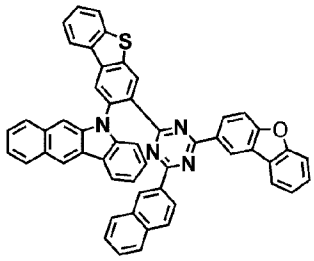
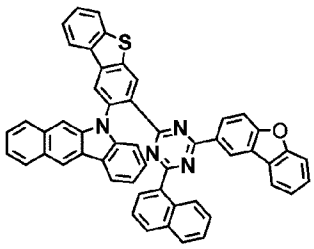
[264]

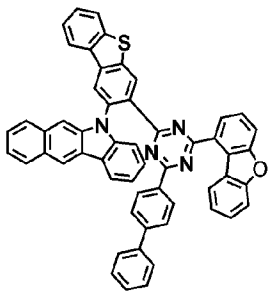
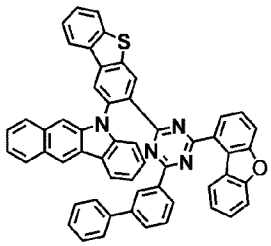
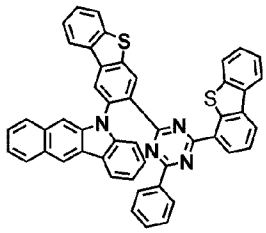
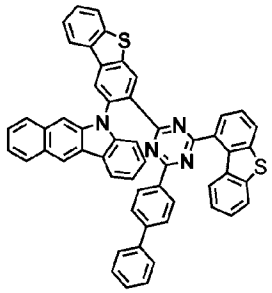
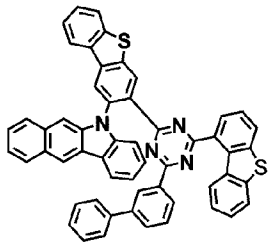
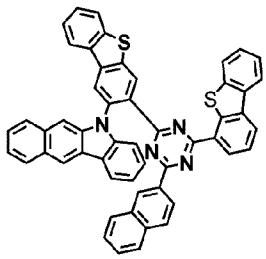
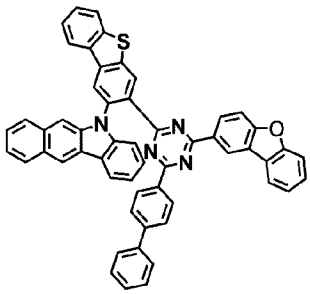
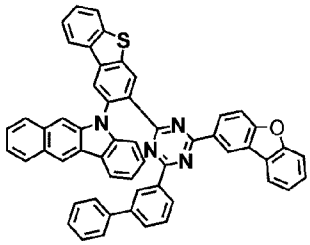
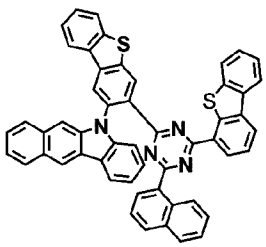
[265]

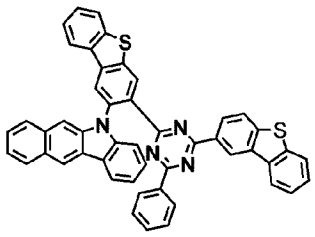
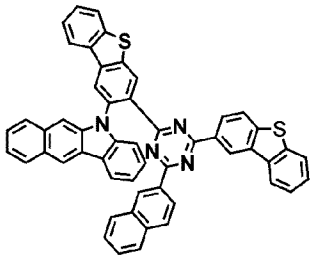
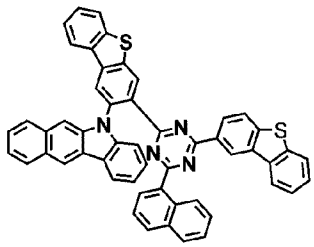
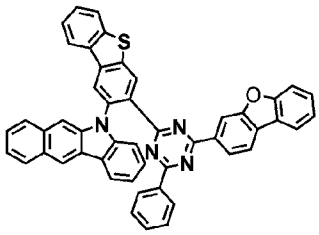
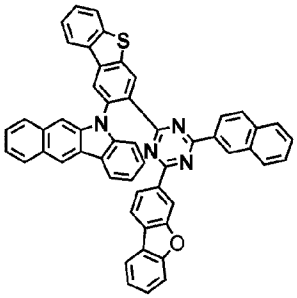
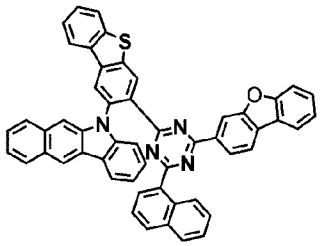
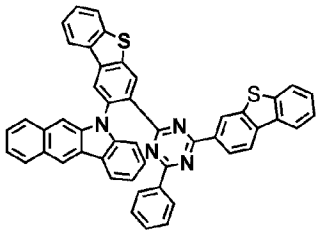
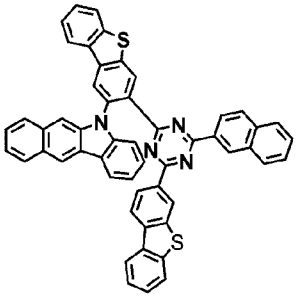
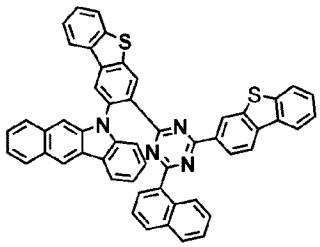
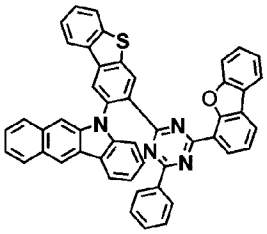
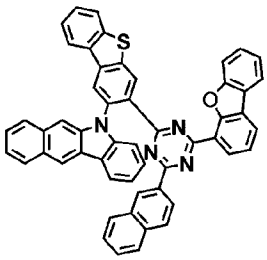
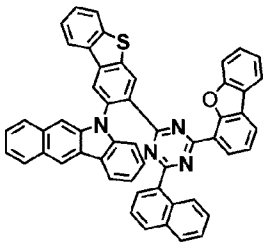
[266]

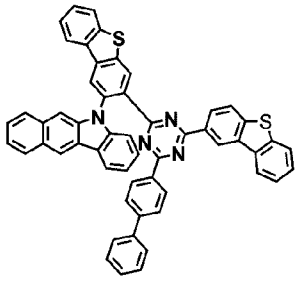
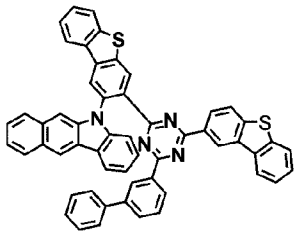
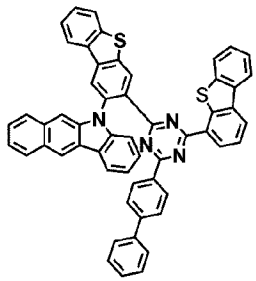
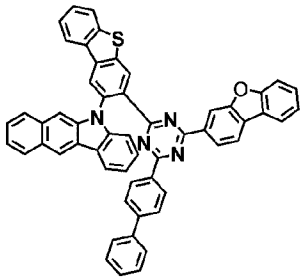
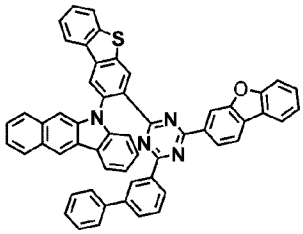
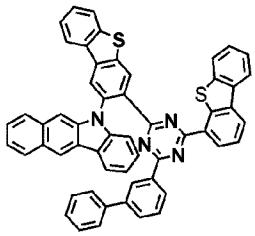
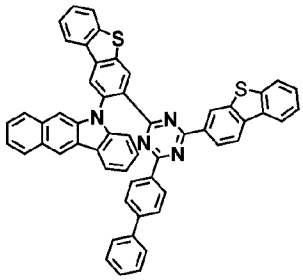
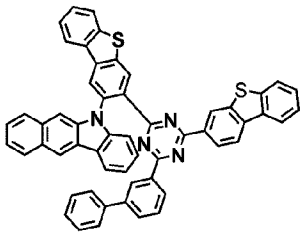
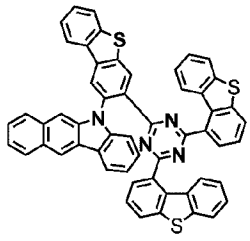
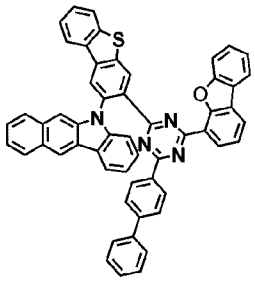
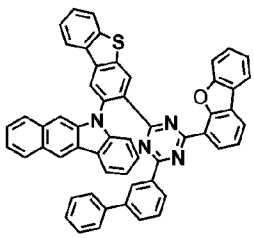
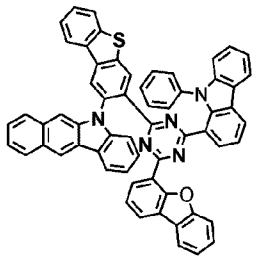
[267]

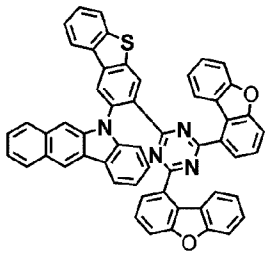
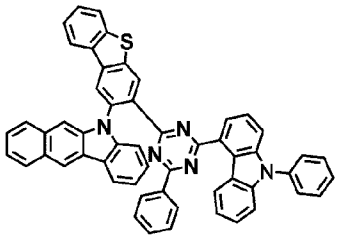
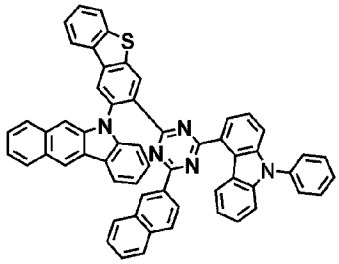
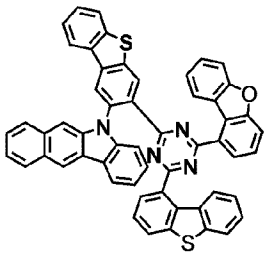
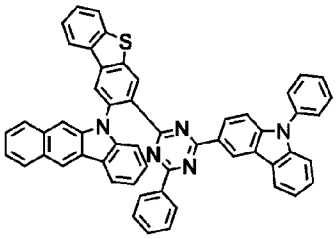
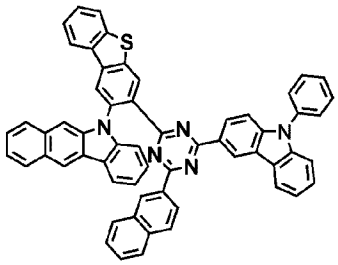
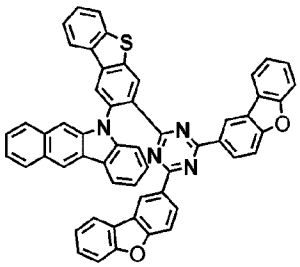
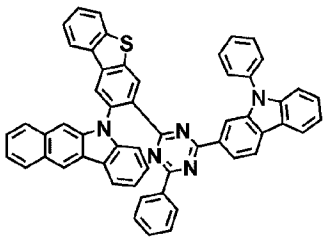
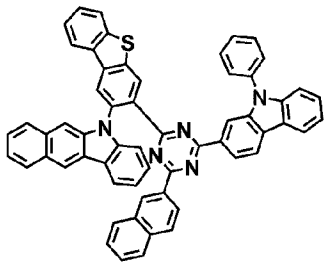
[268]

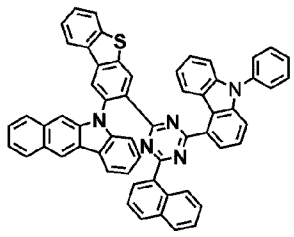
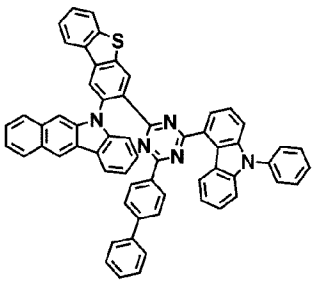
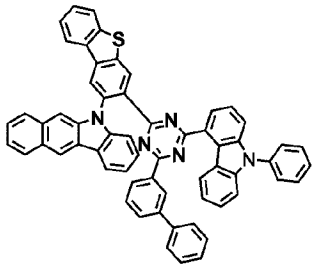
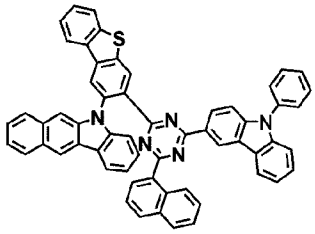
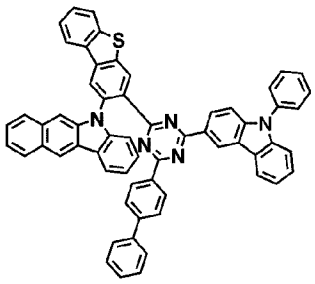
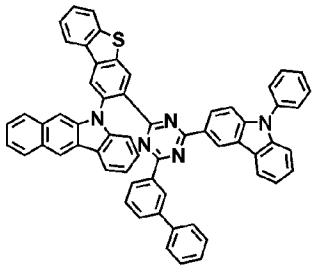
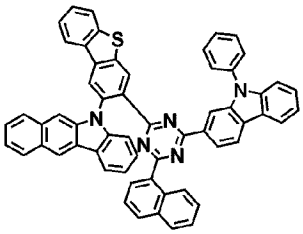
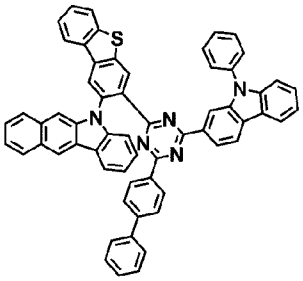
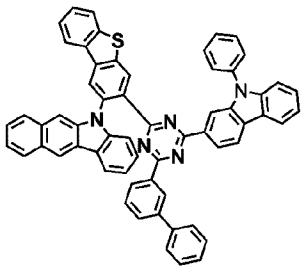
[269]

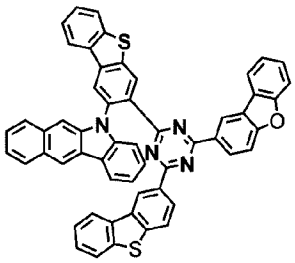
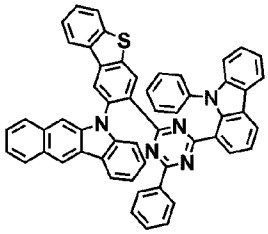
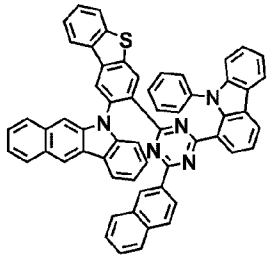
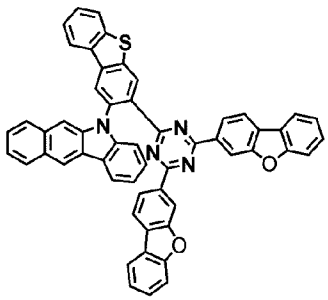
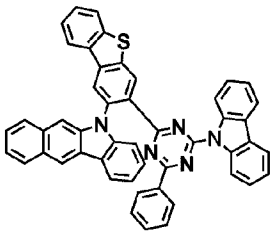
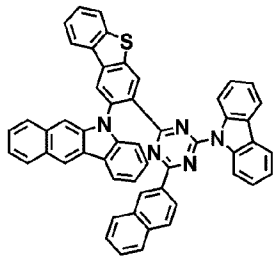
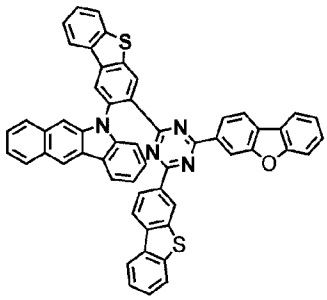
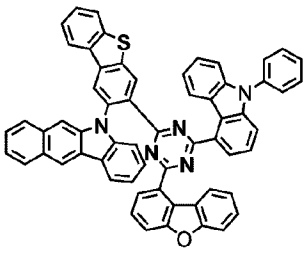
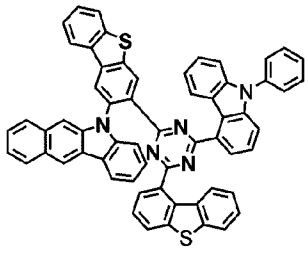
[270]

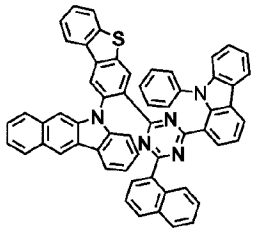
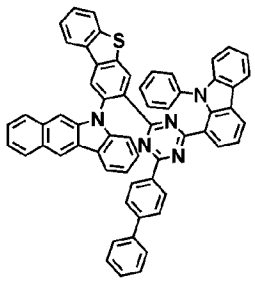
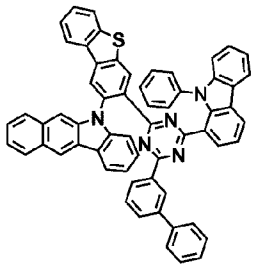
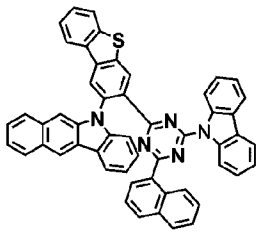
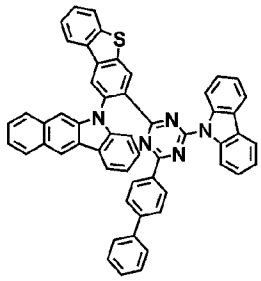
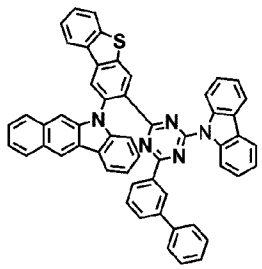
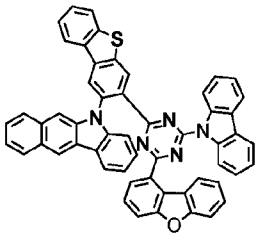
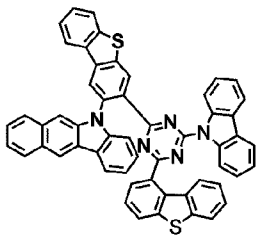
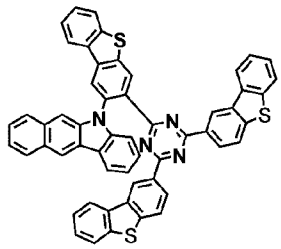
[271]

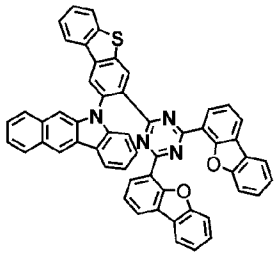
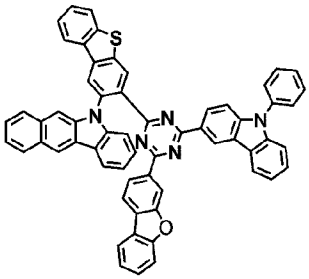
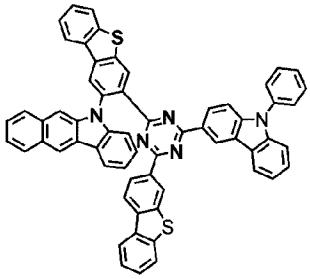
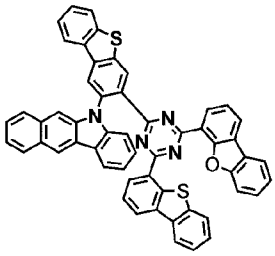
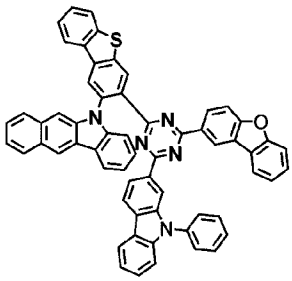
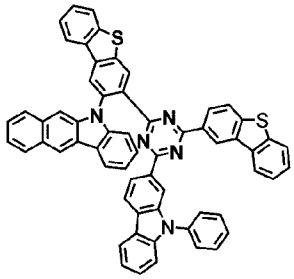
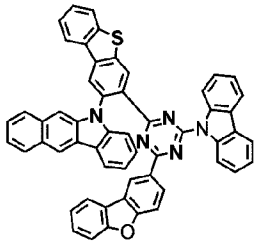
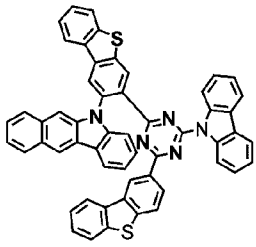
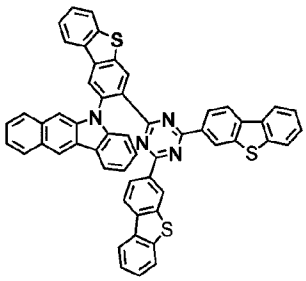
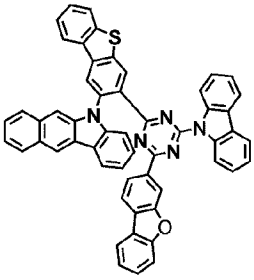
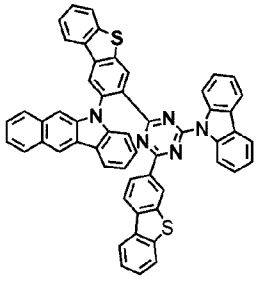
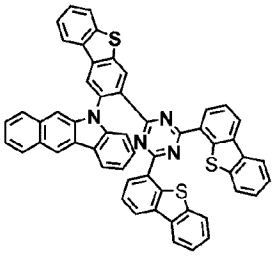
[272]

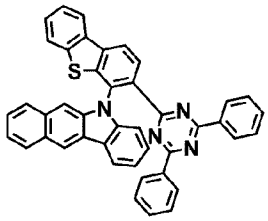
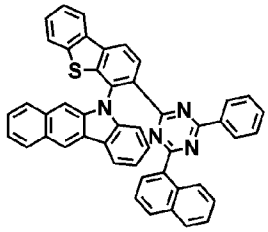
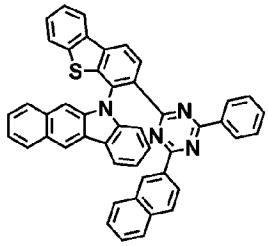
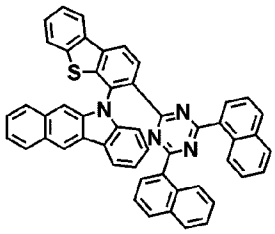
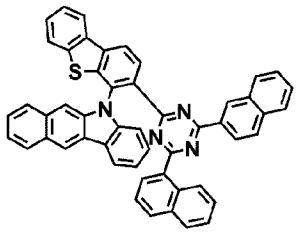
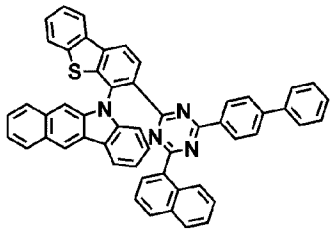
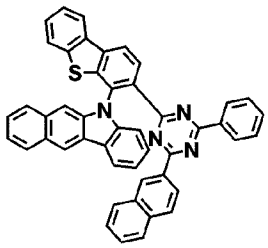
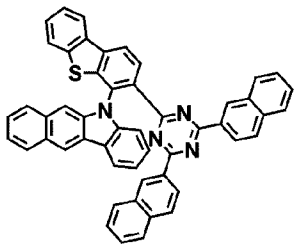
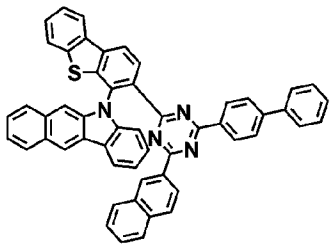
[273]

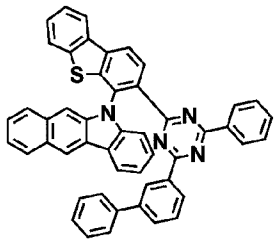
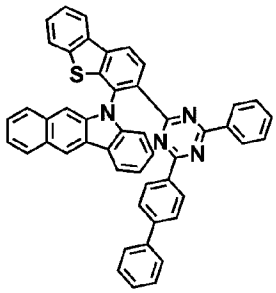
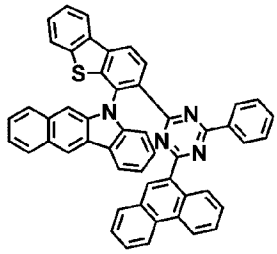
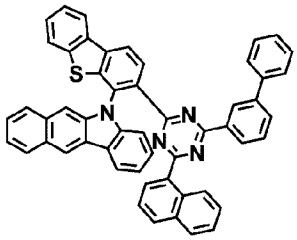
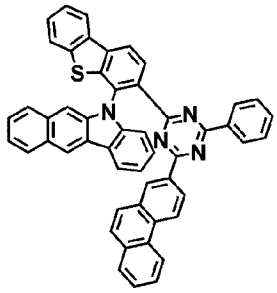
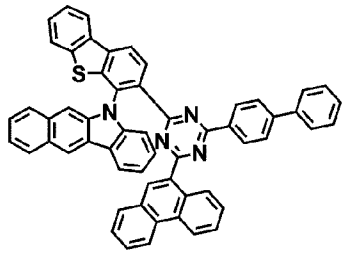
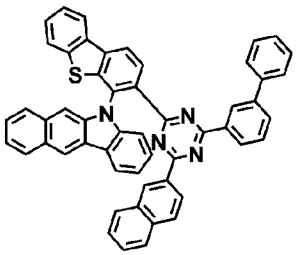
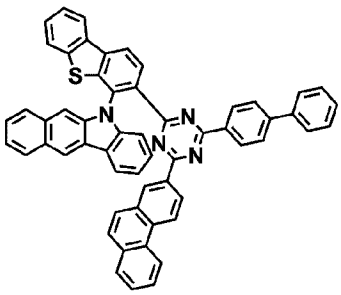
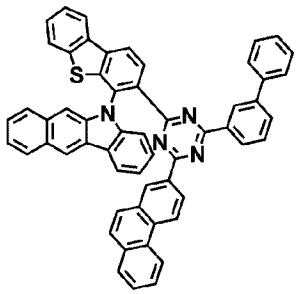
[274]

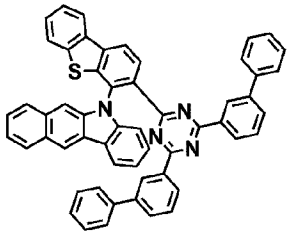
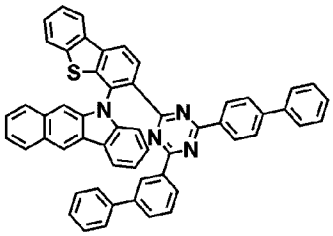
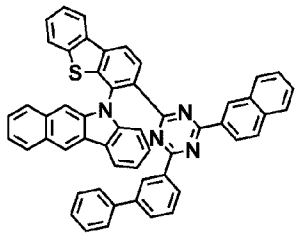
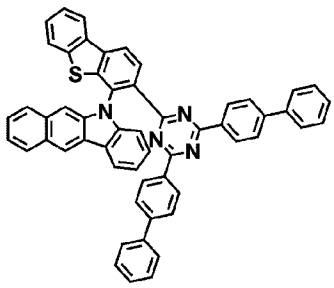
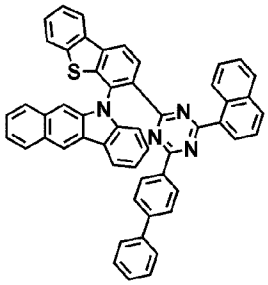
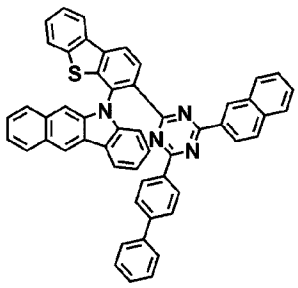
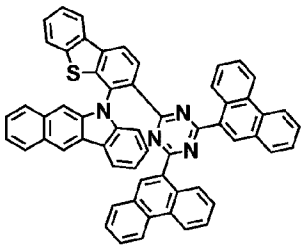
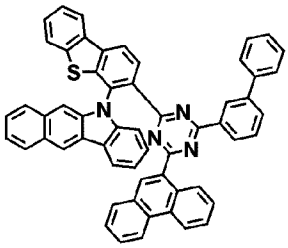
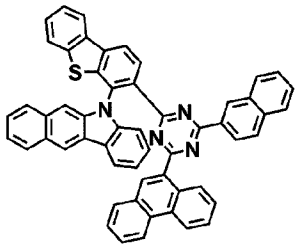
[275]

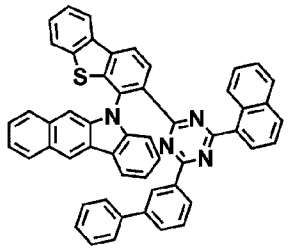
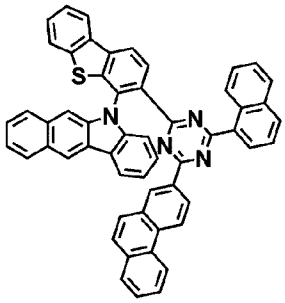
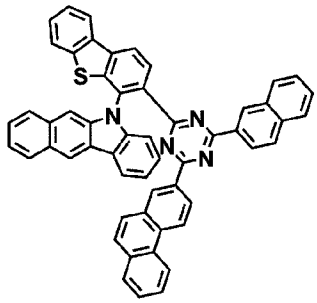
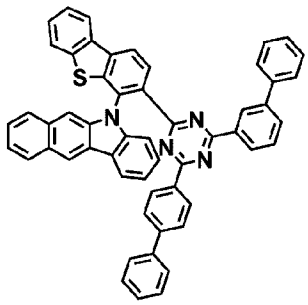
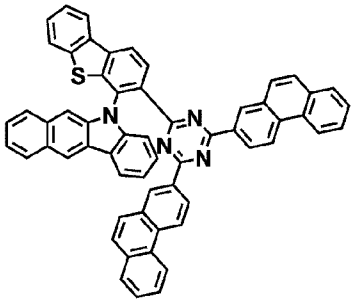
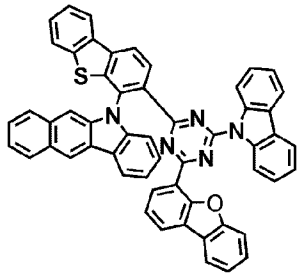
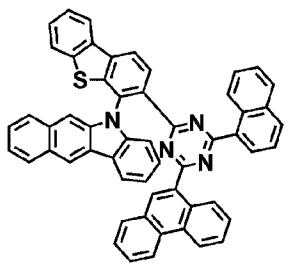
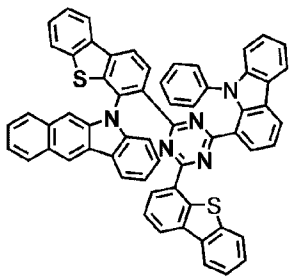
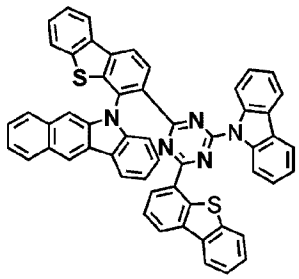
[276]

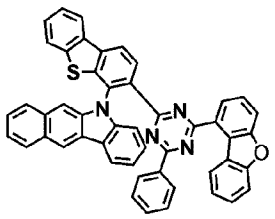
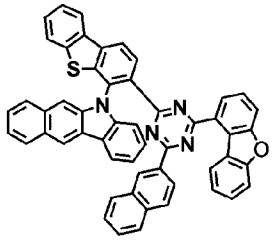
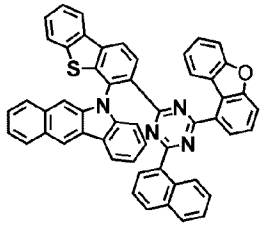
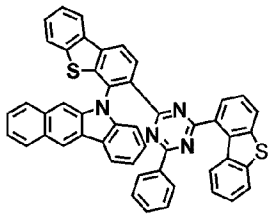
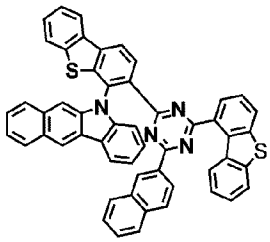
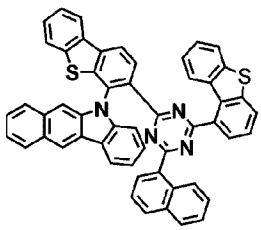
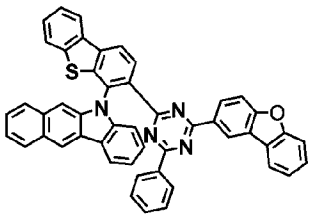
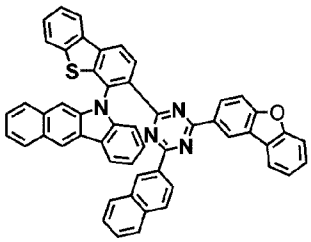
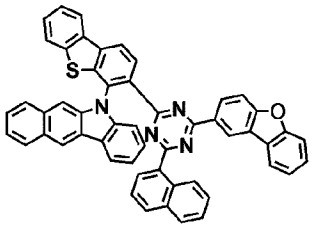
[277]

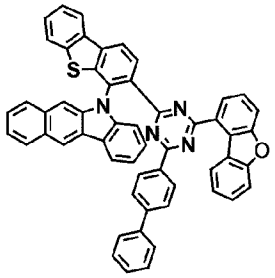
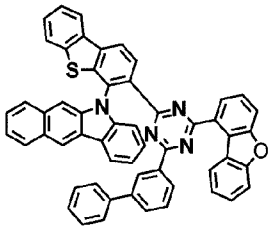
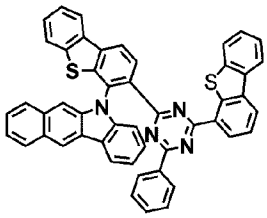
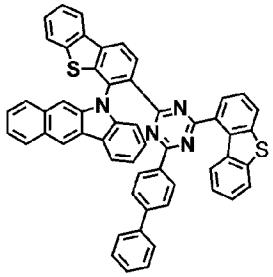
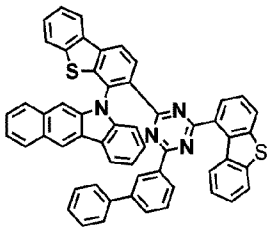
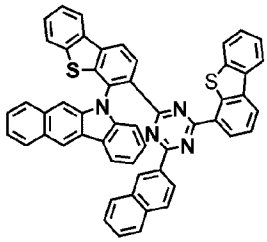
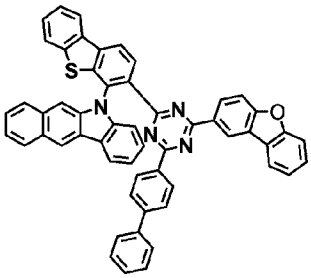
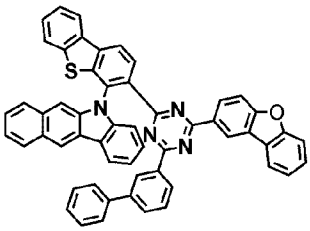
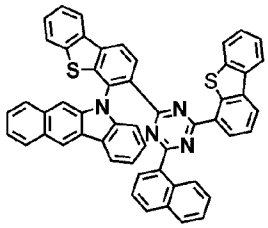
[278]

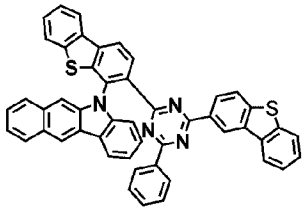
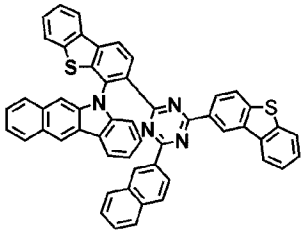
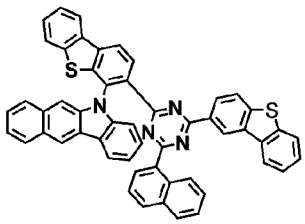
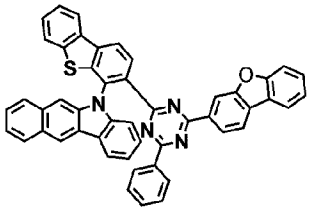
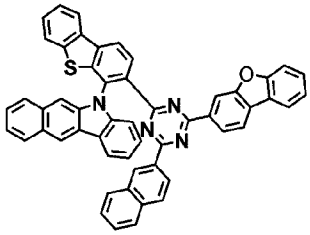
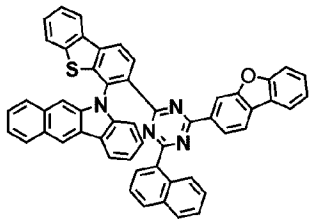
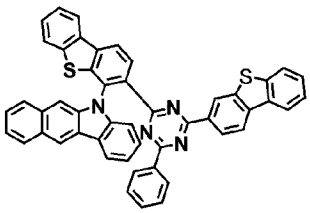
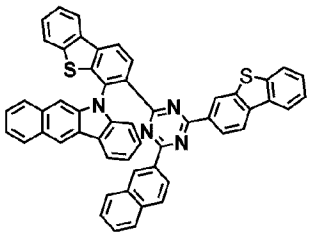
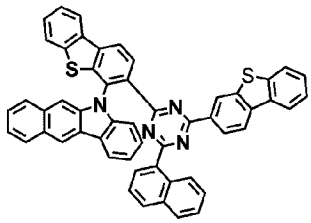
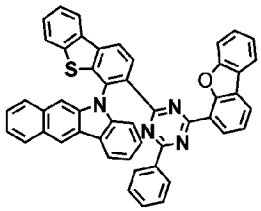
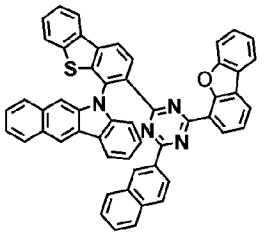
[279]

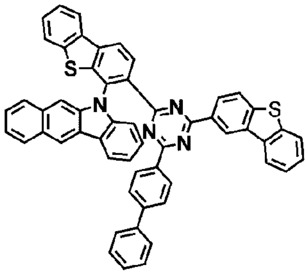
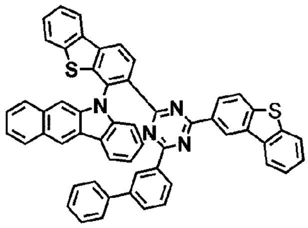
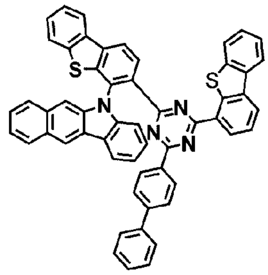
[280]

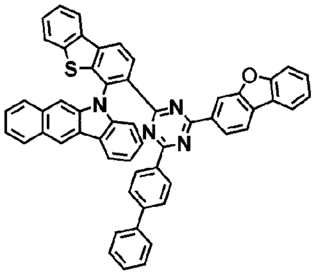
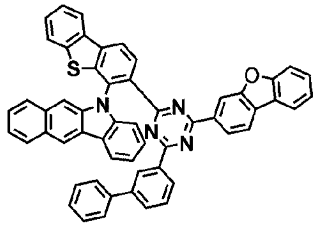
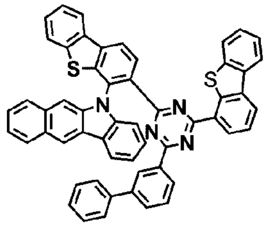










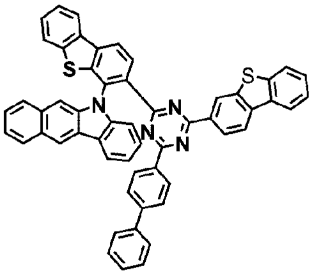
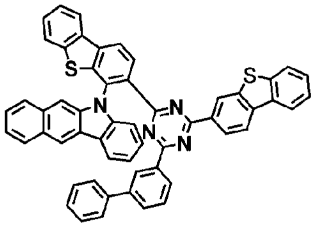
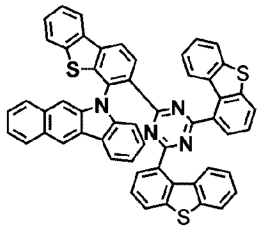
[281]

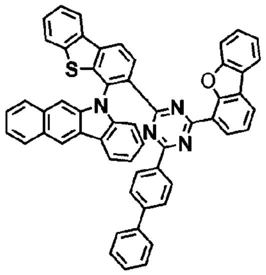
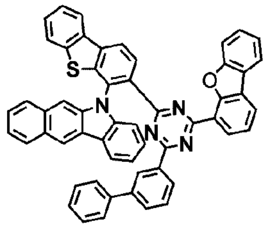
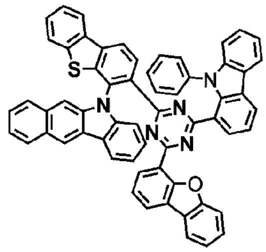












[282]

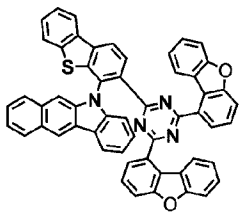
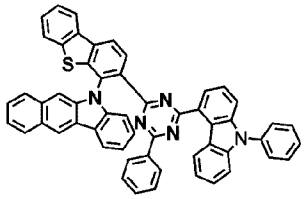
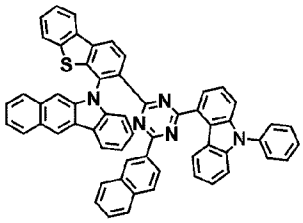
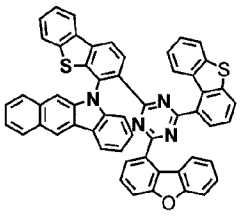
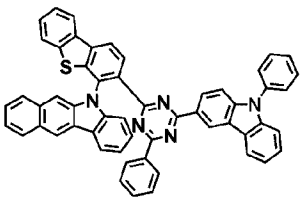
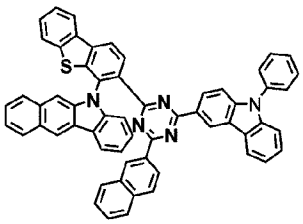
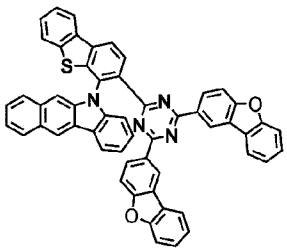
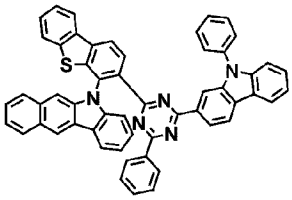
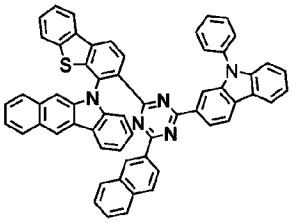
  

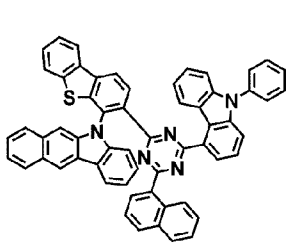
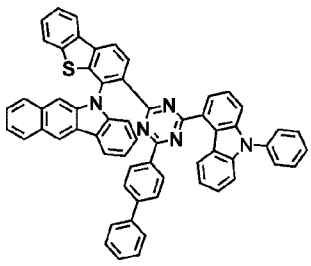
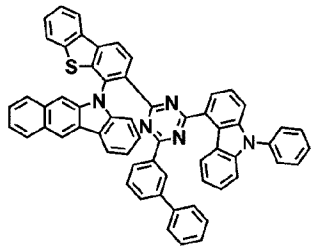
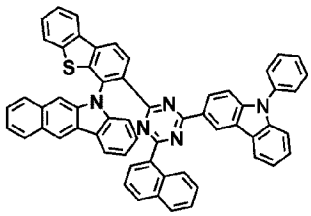
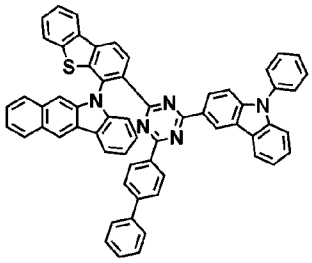
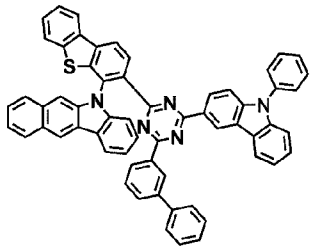
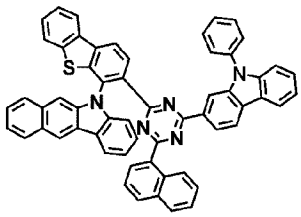
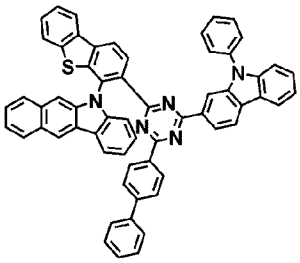
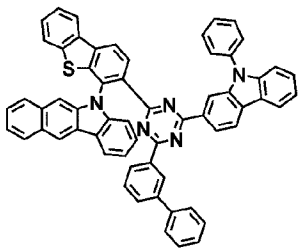
  

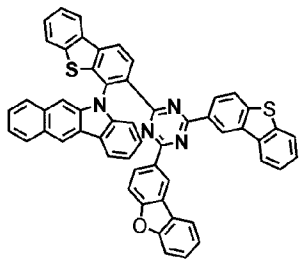
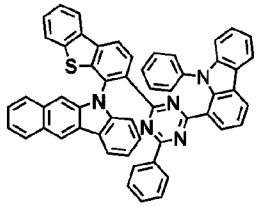
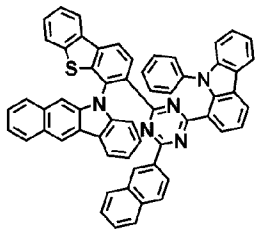
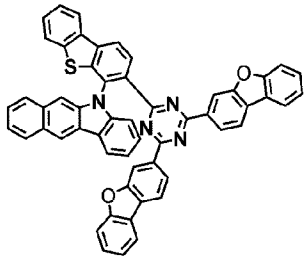
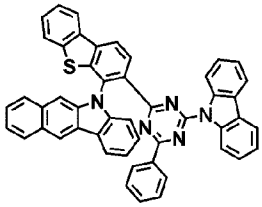
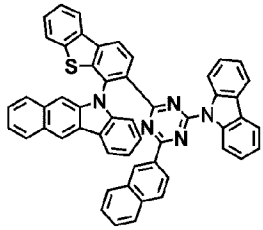
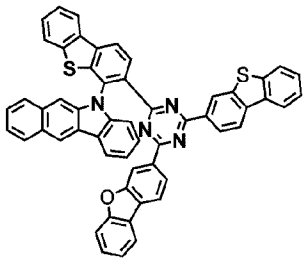
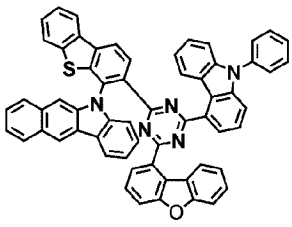
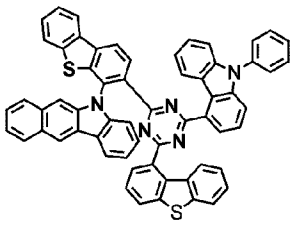
[283]

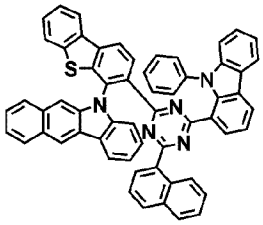
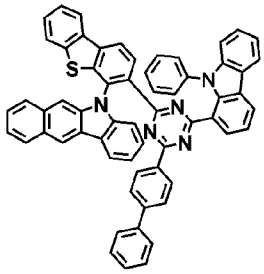
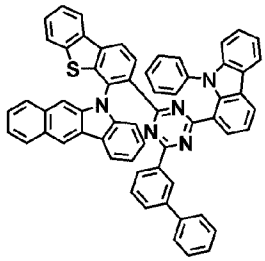
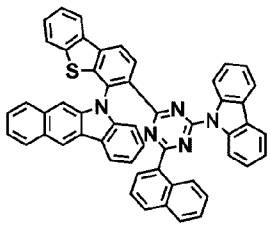
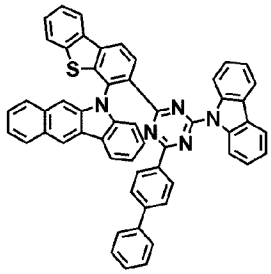
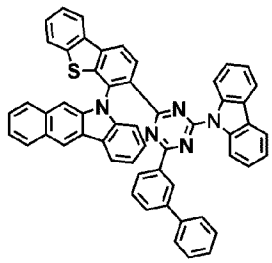
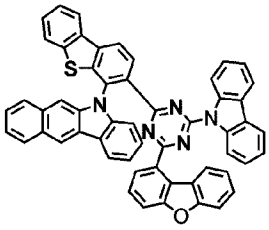
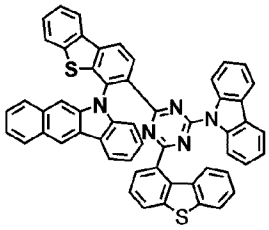
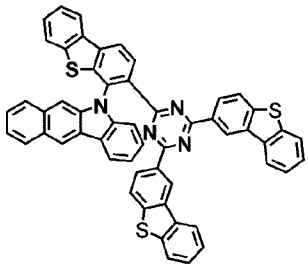
[284]

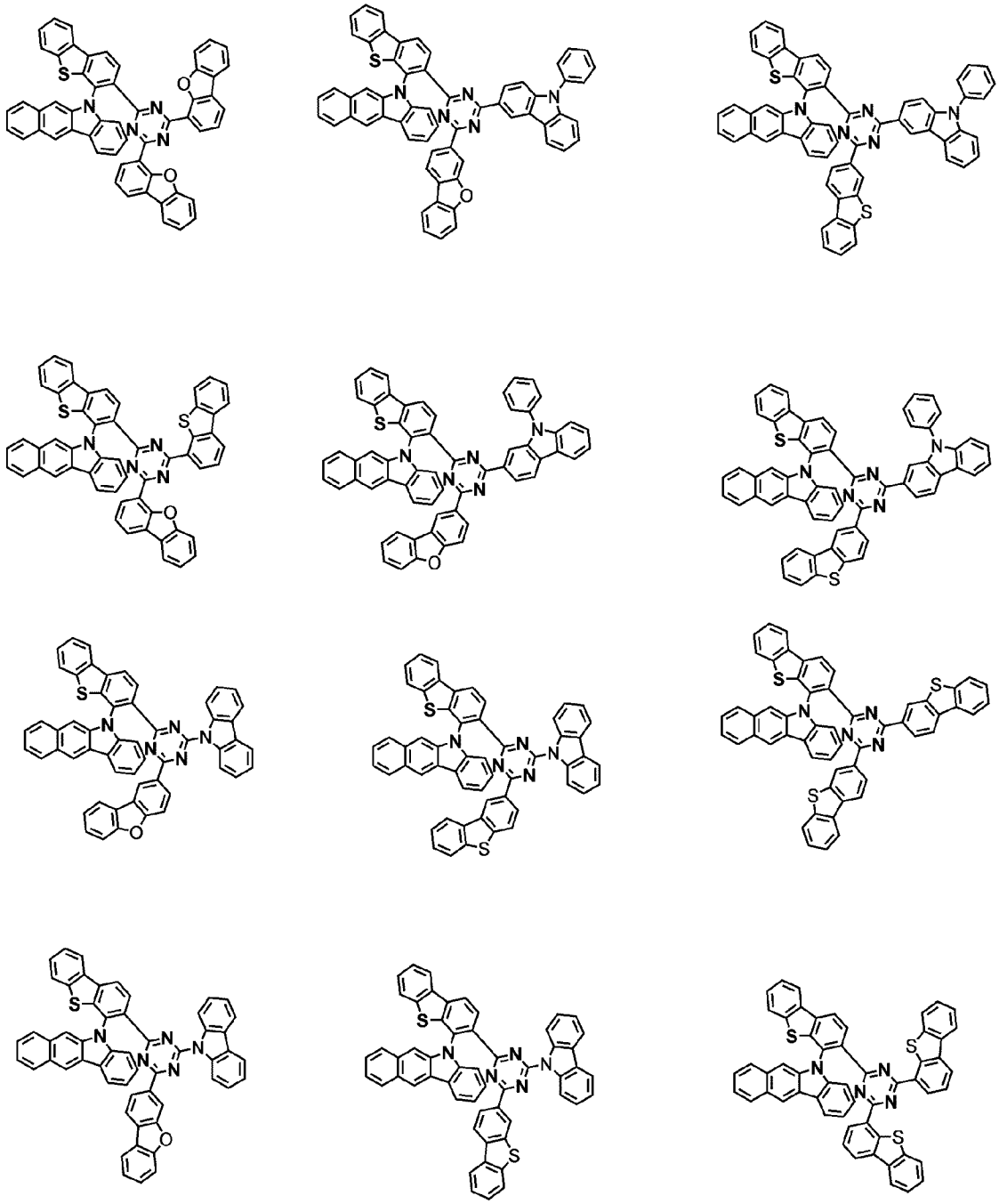
[285]

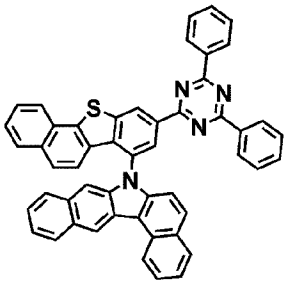
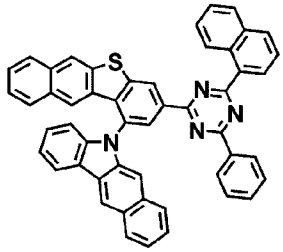
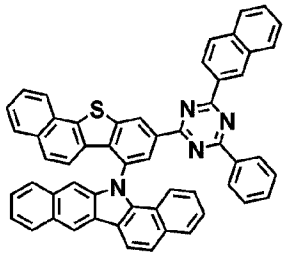
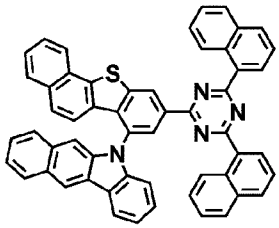
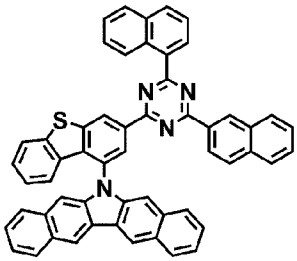
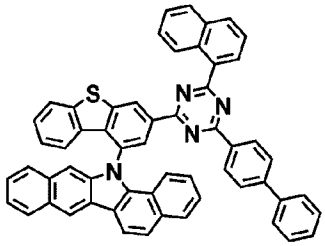
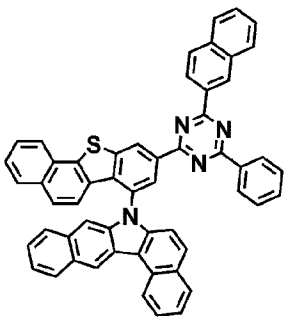
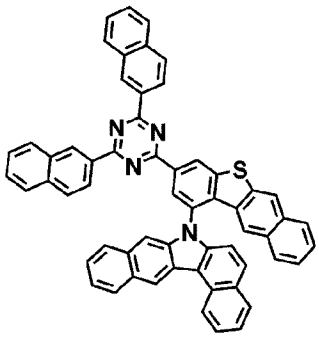
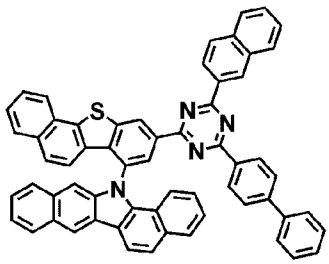
[286]

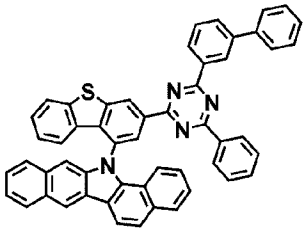
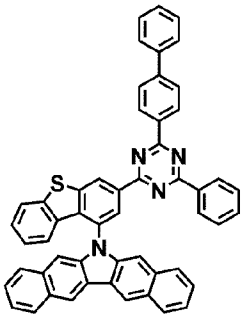
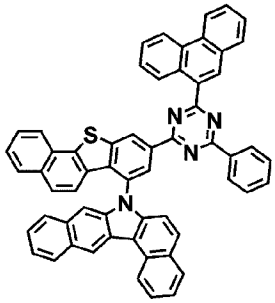
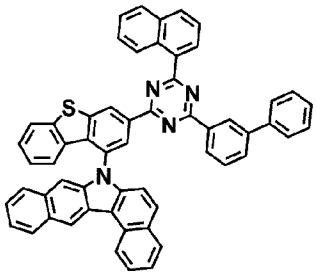
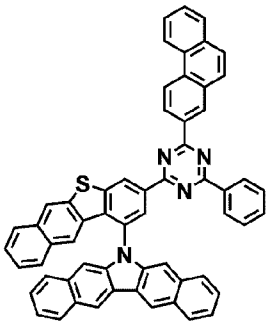
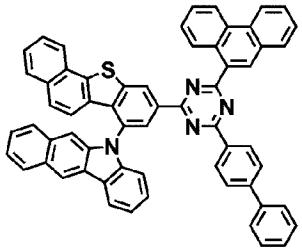
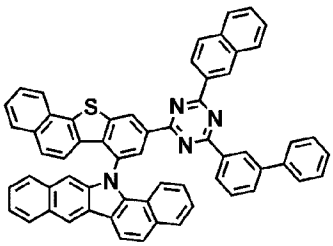
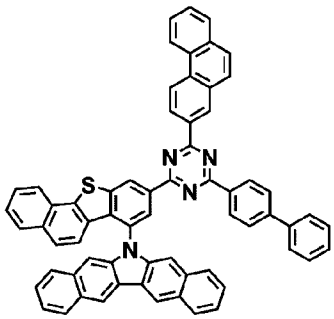
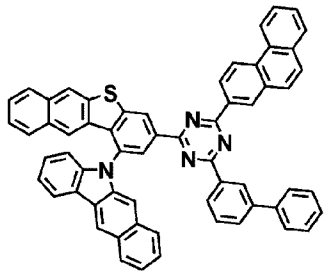
[287]



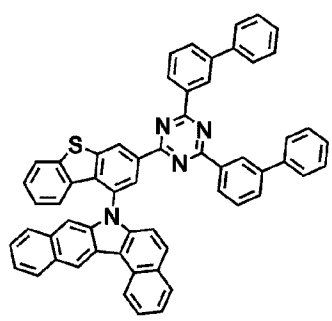
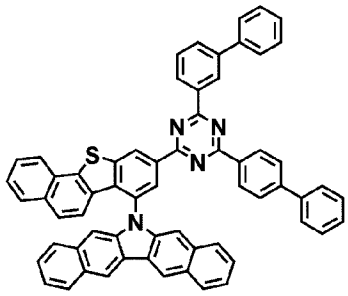
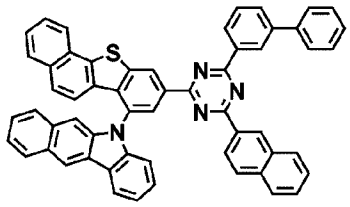
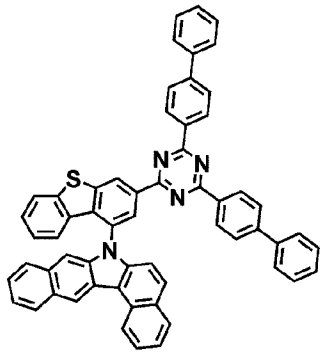
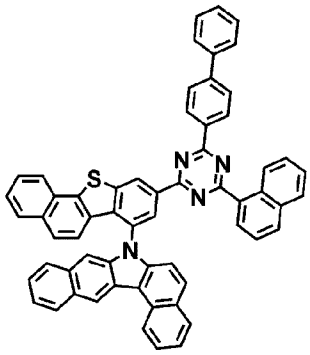
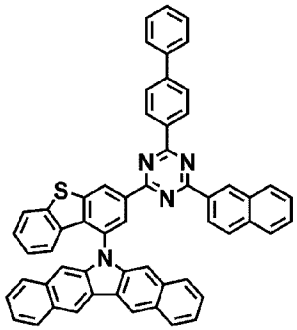
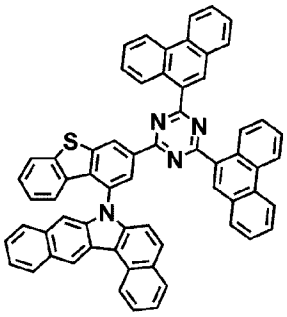
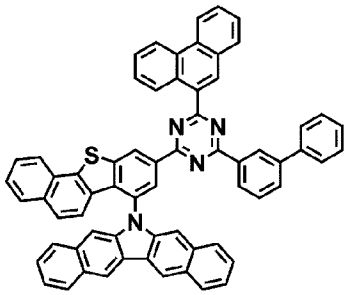
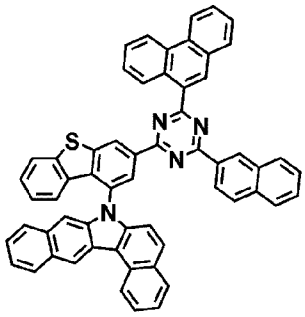
[288]

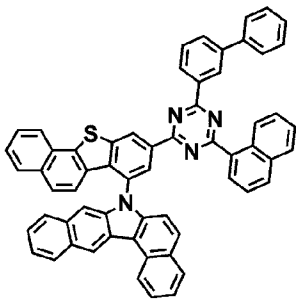
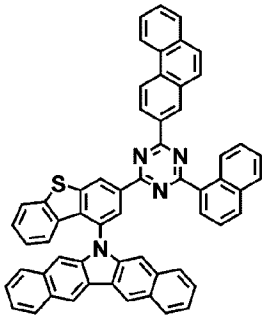
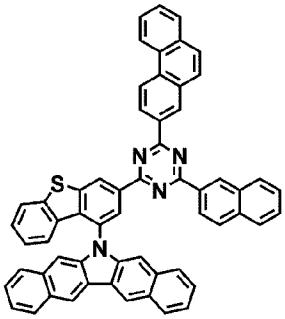
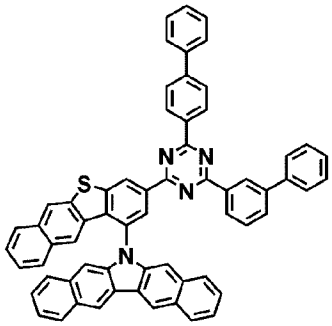
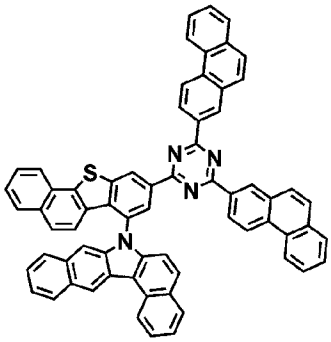
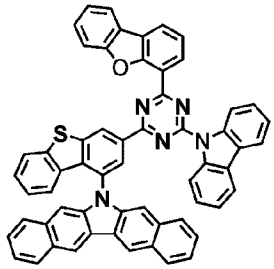
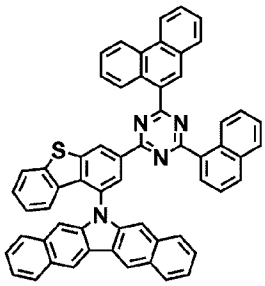
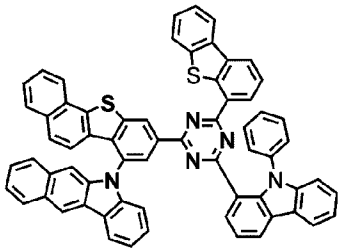
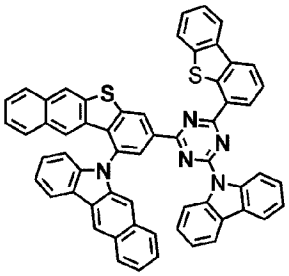
[289]

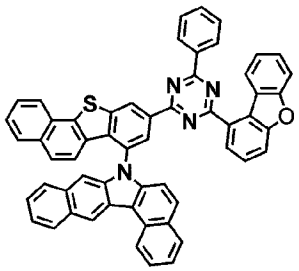
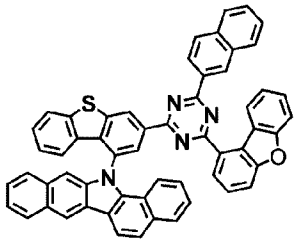
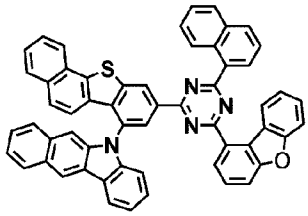
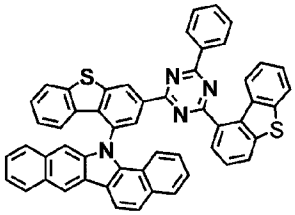
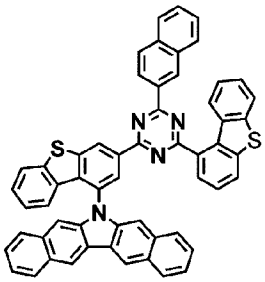
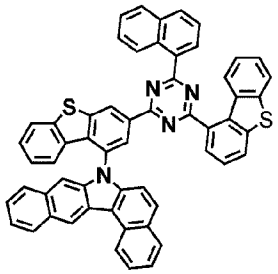
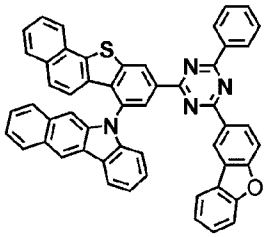
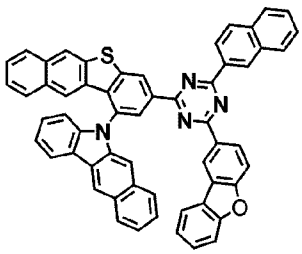
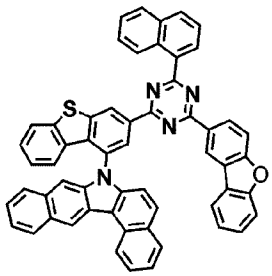
[290]

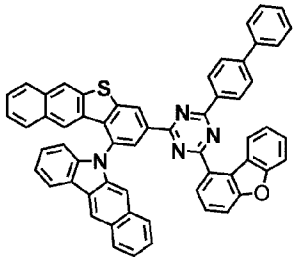
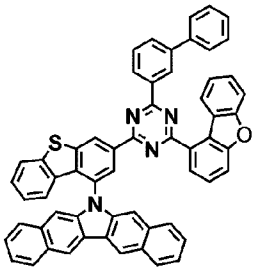
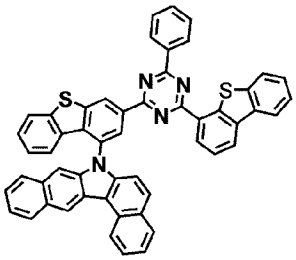
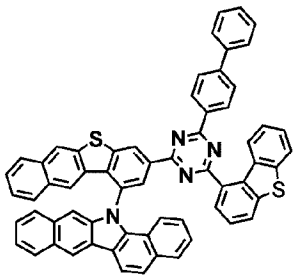
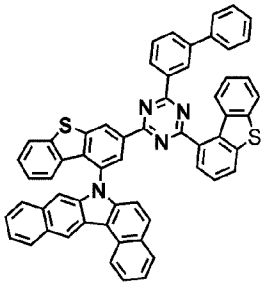
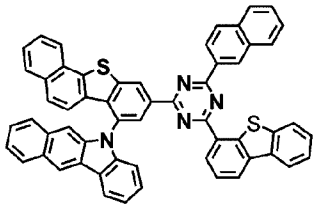
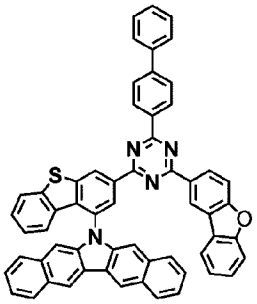
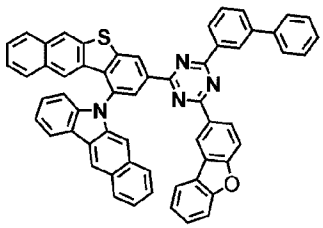
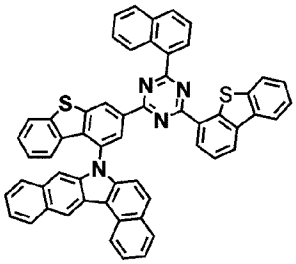
[291]

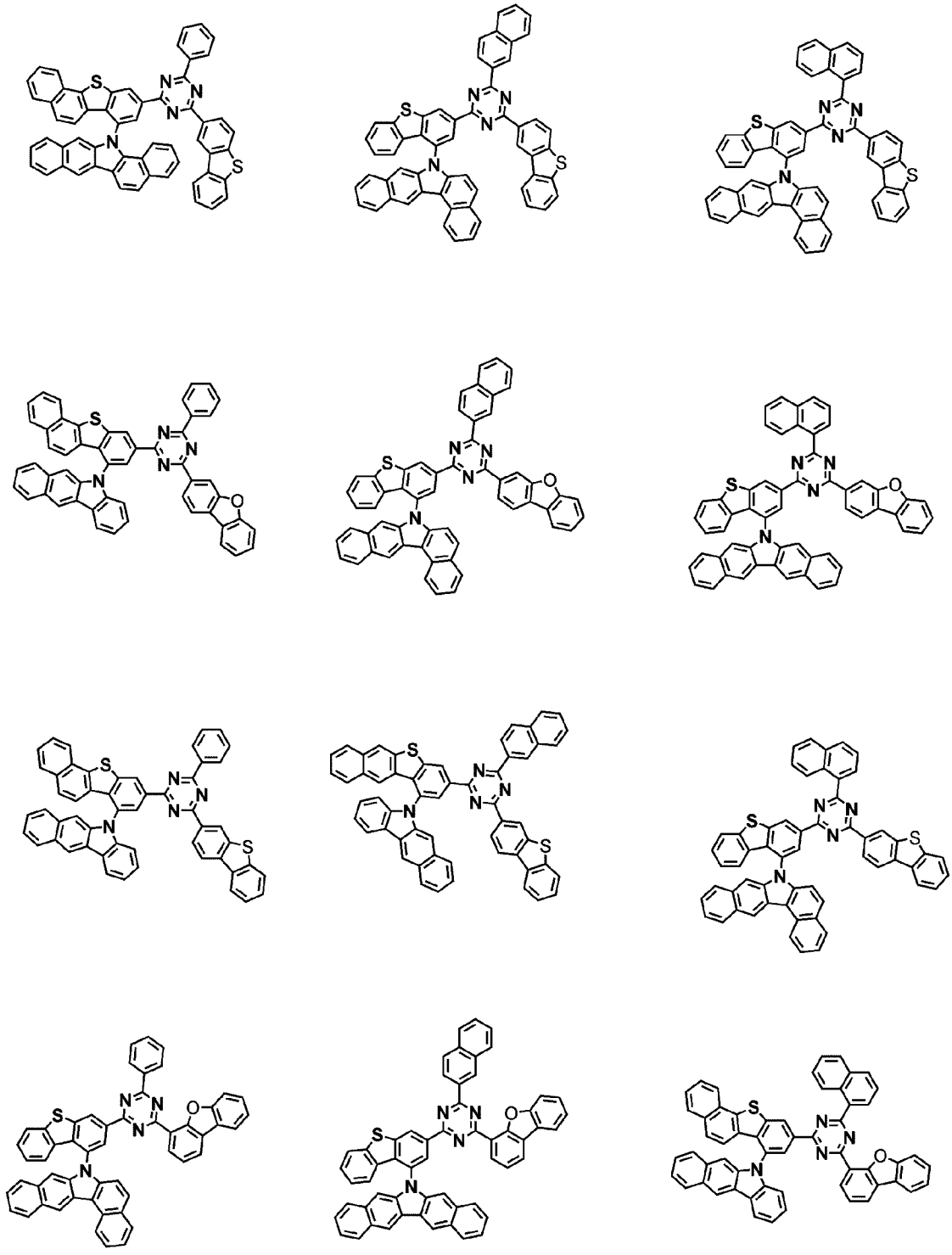
[292]

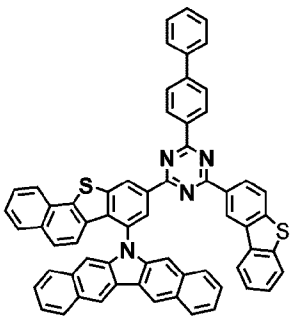
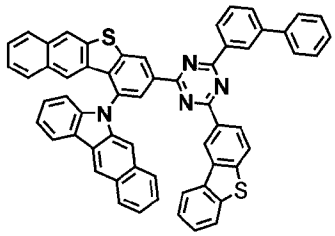
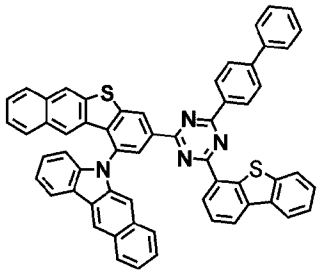
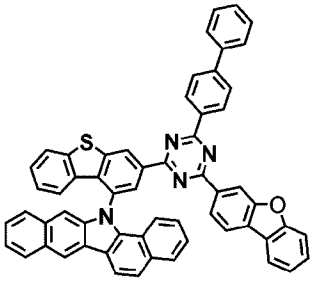
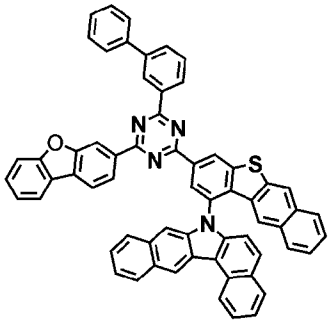
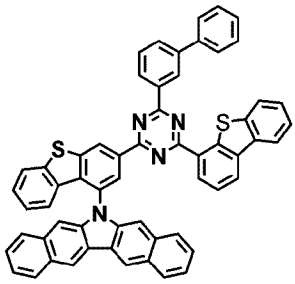
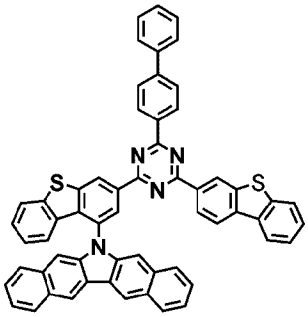
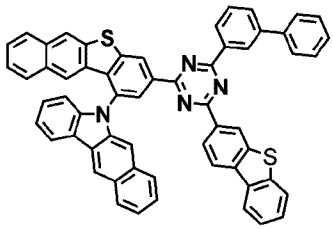
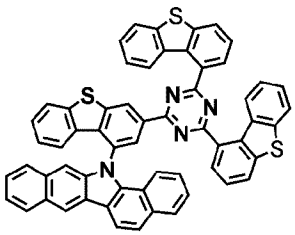
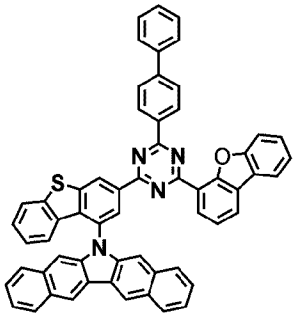
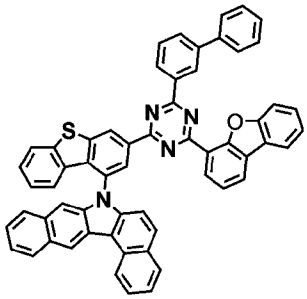
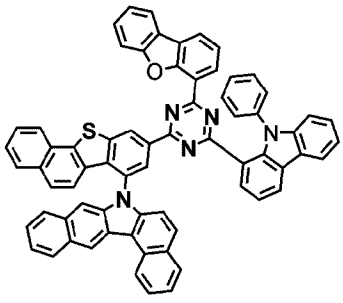
[293]

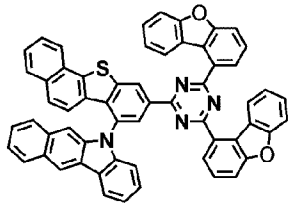
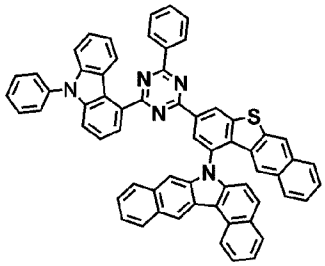
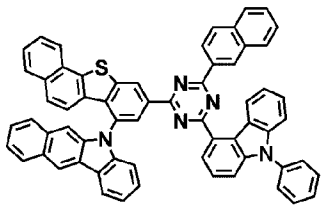
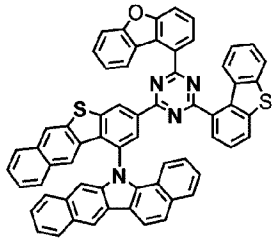
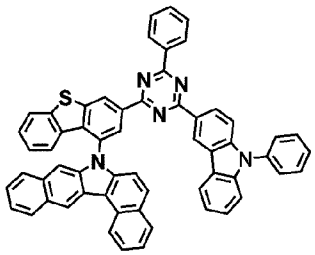
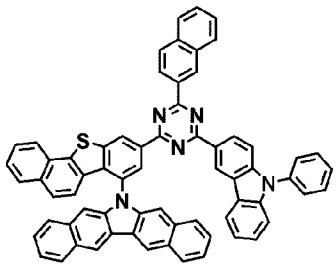
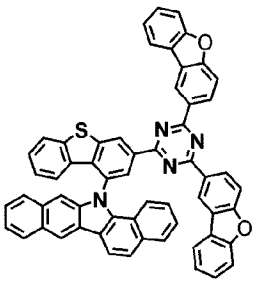
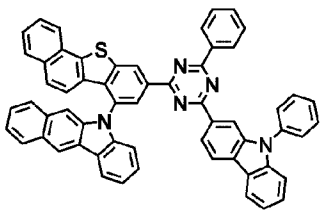
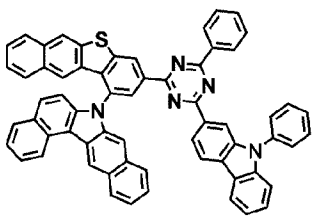
[294]



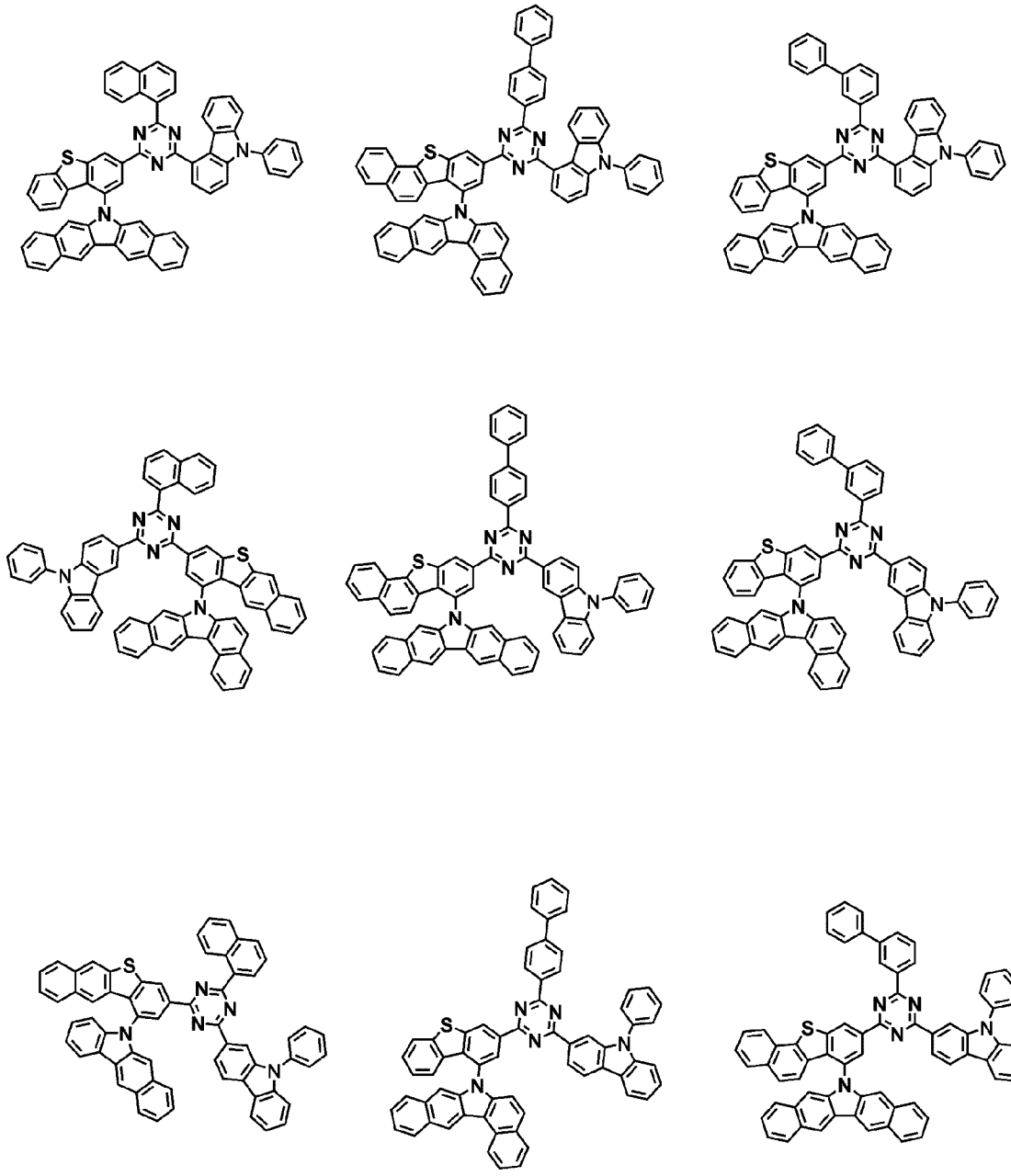
[295]

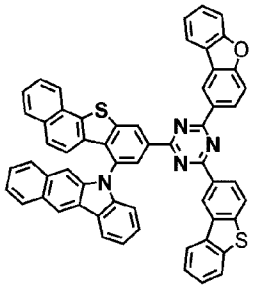
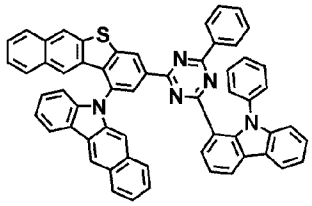
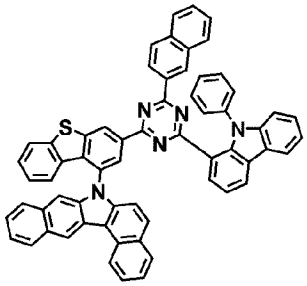
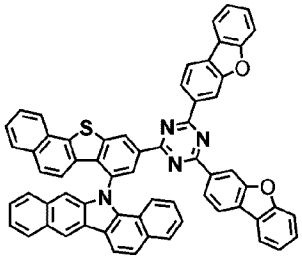
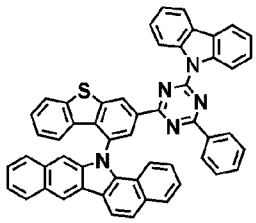
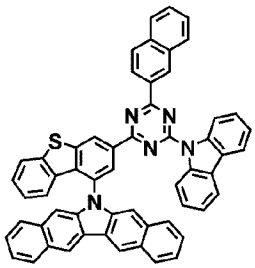
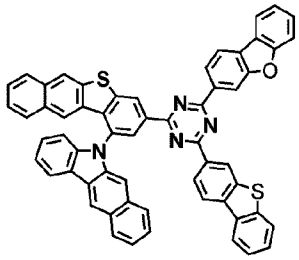
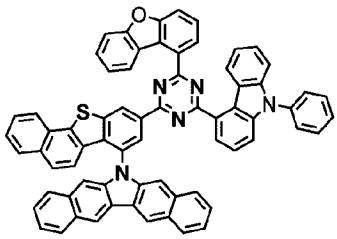
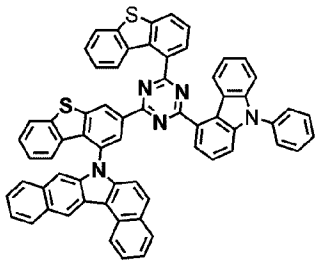
[296]

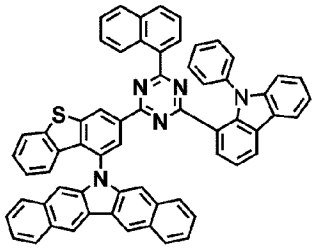
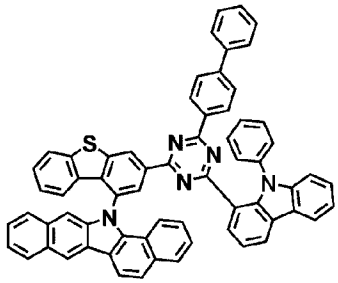
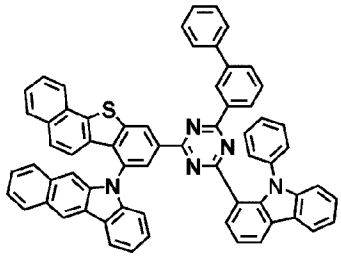
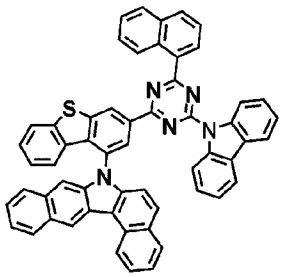
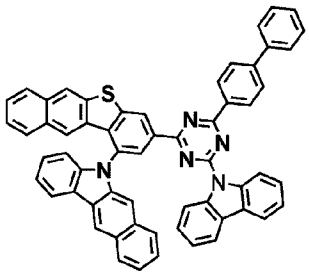
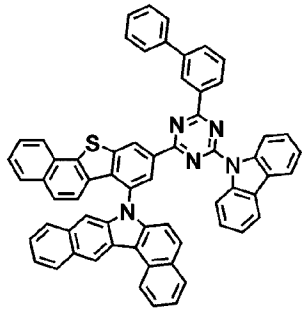
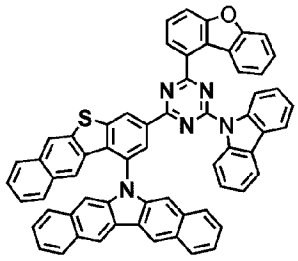
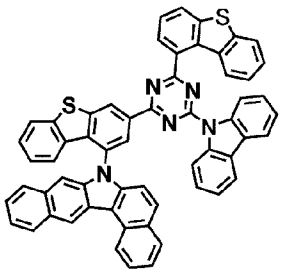
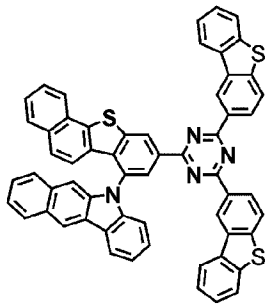
[297]



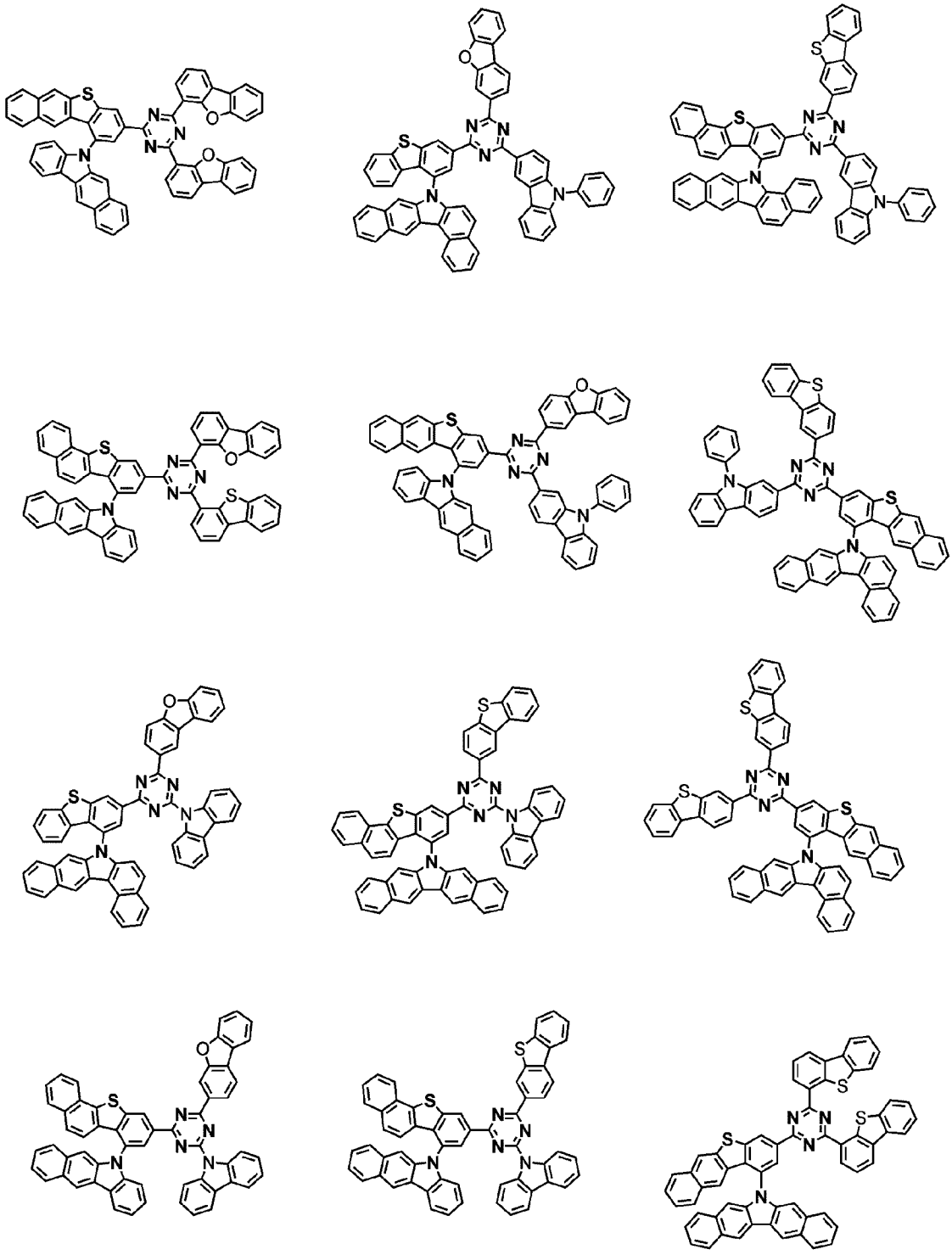
[298]

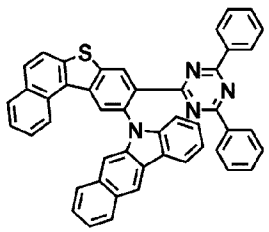
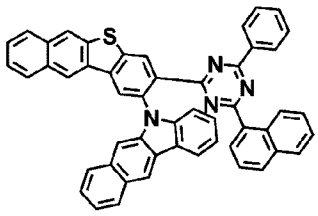
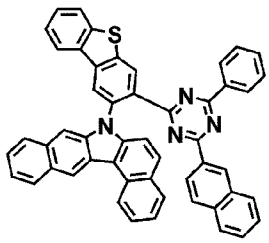
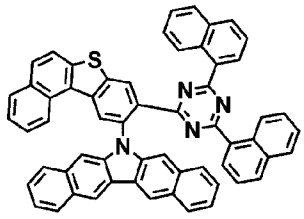
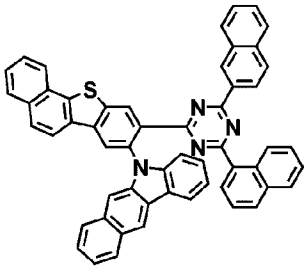
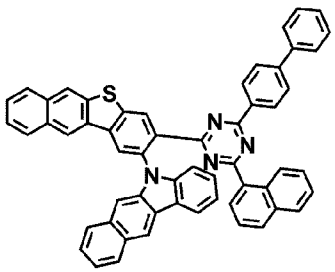
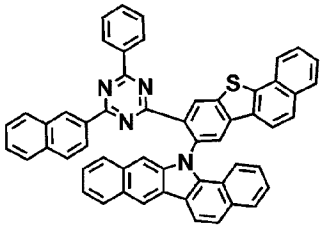
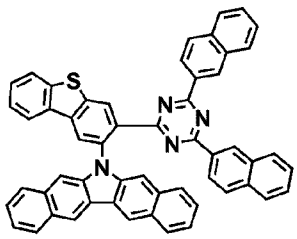
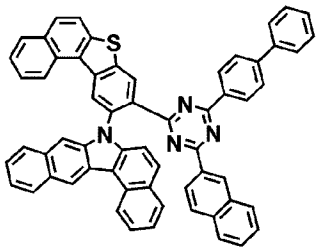
[299]

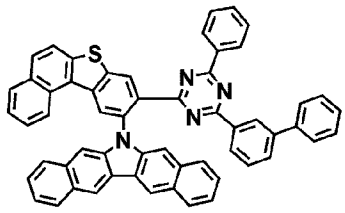
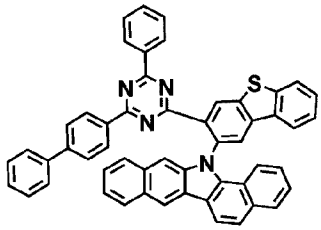
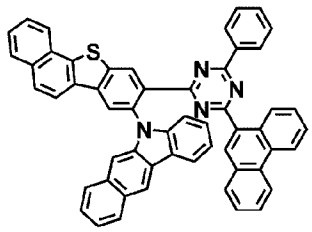
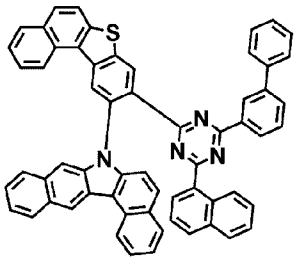
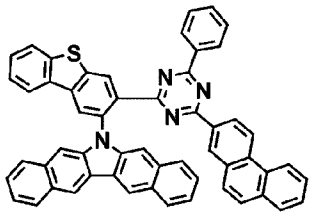
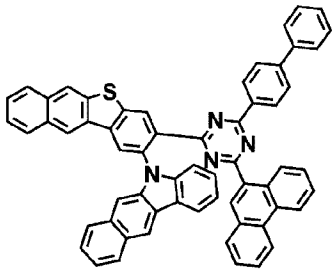
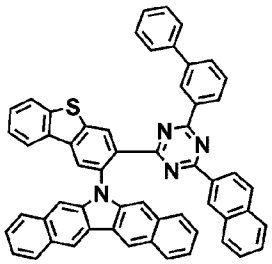
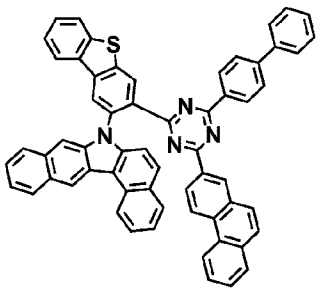
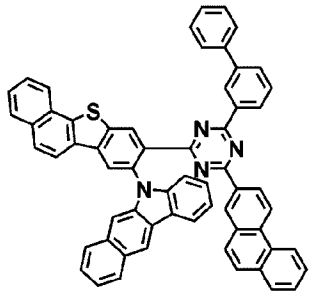
[300]



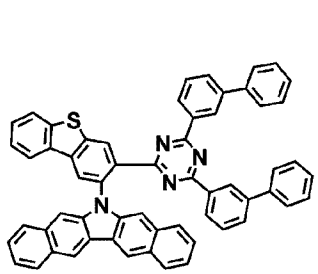
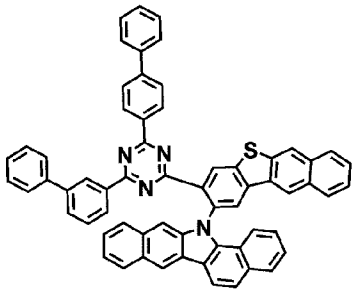
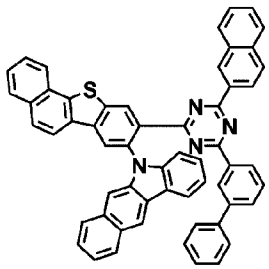
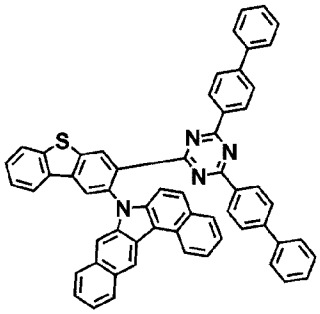
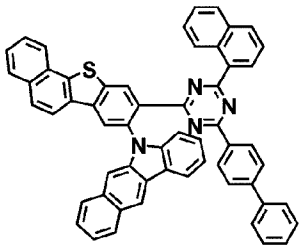
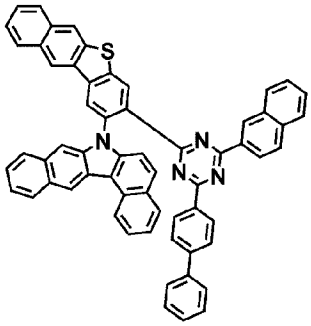
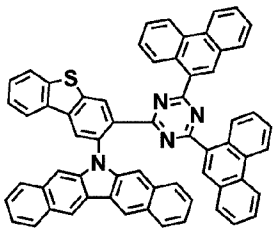
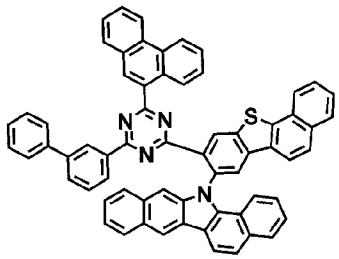
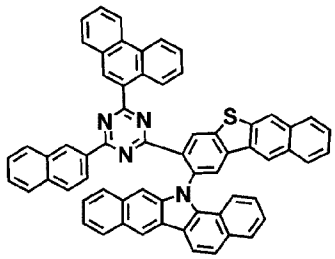
[301]

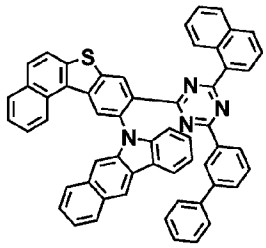
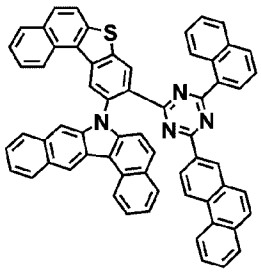
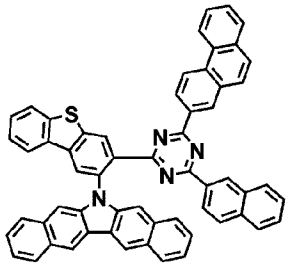
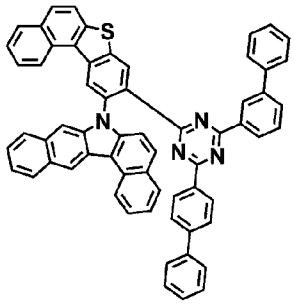
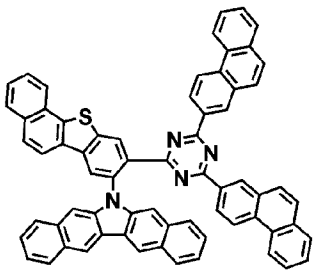
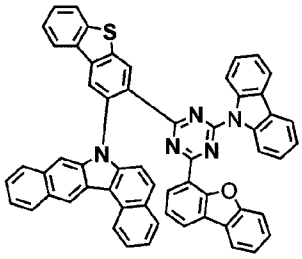
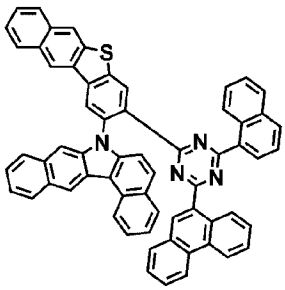
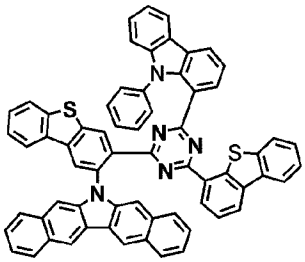
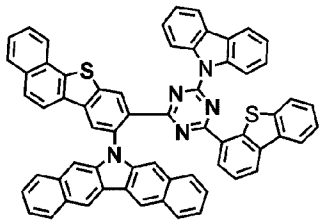
[302]

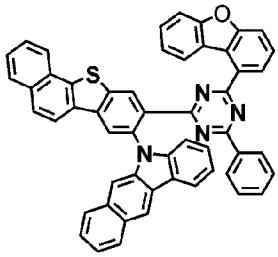
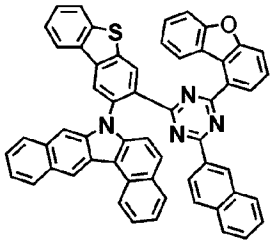
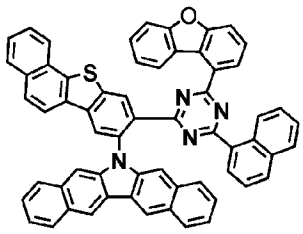
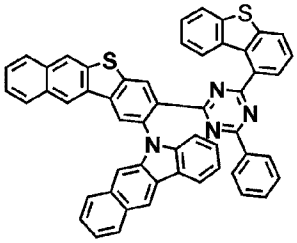
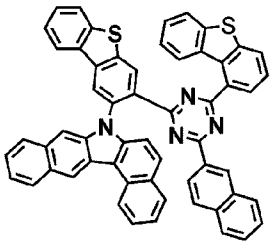
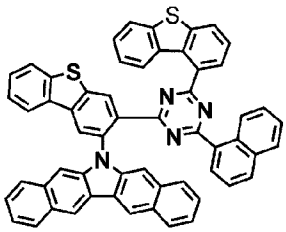
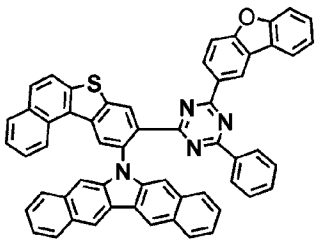
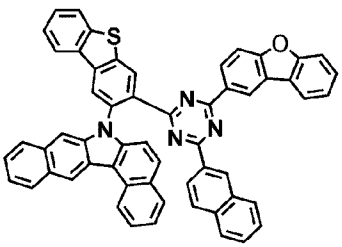
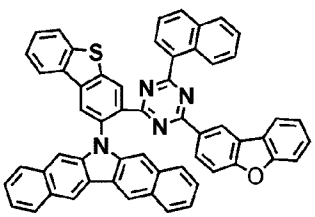
[303]

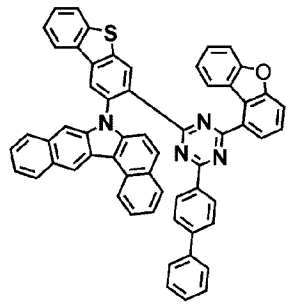
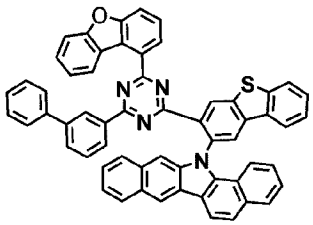
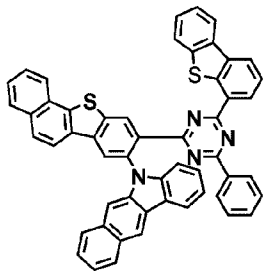
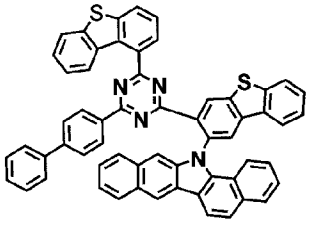
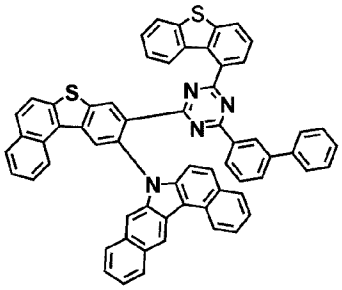
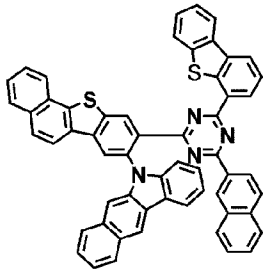
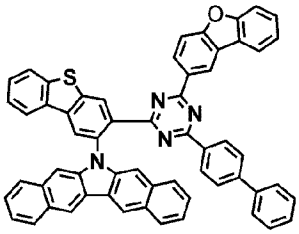
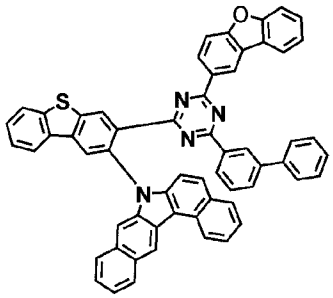
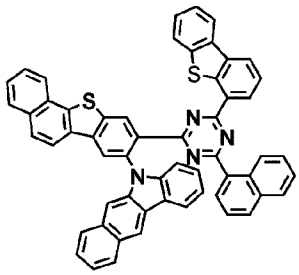
[304]

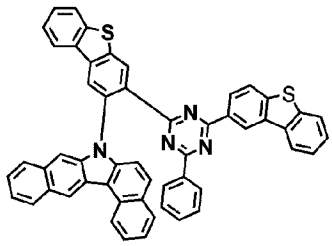
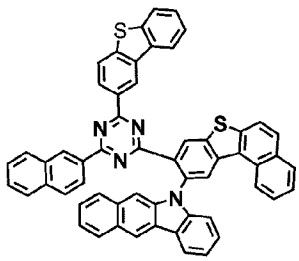
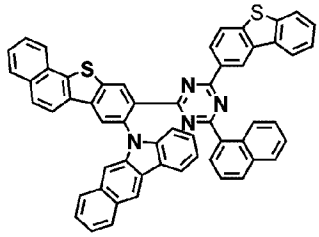
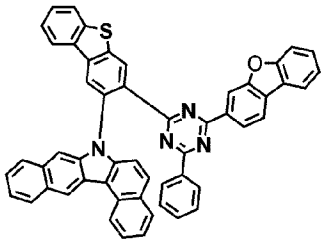
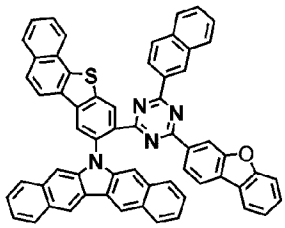
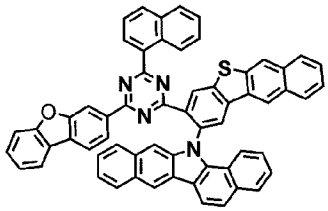
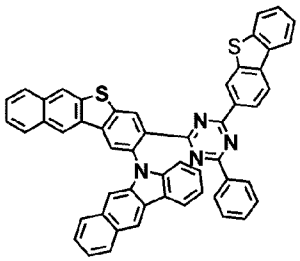
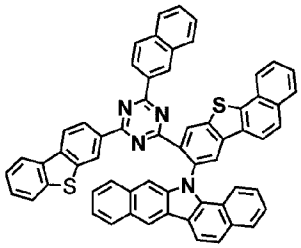
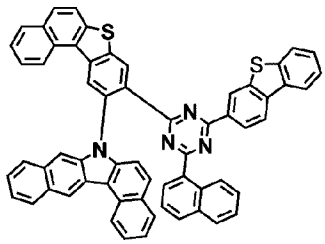
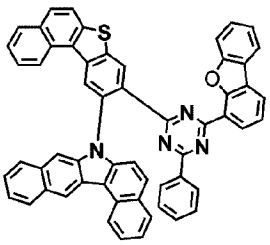
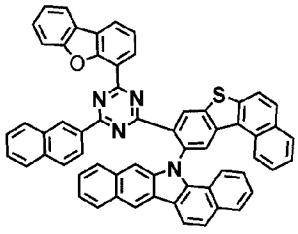
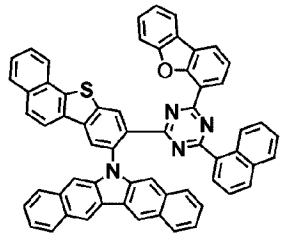
[305]

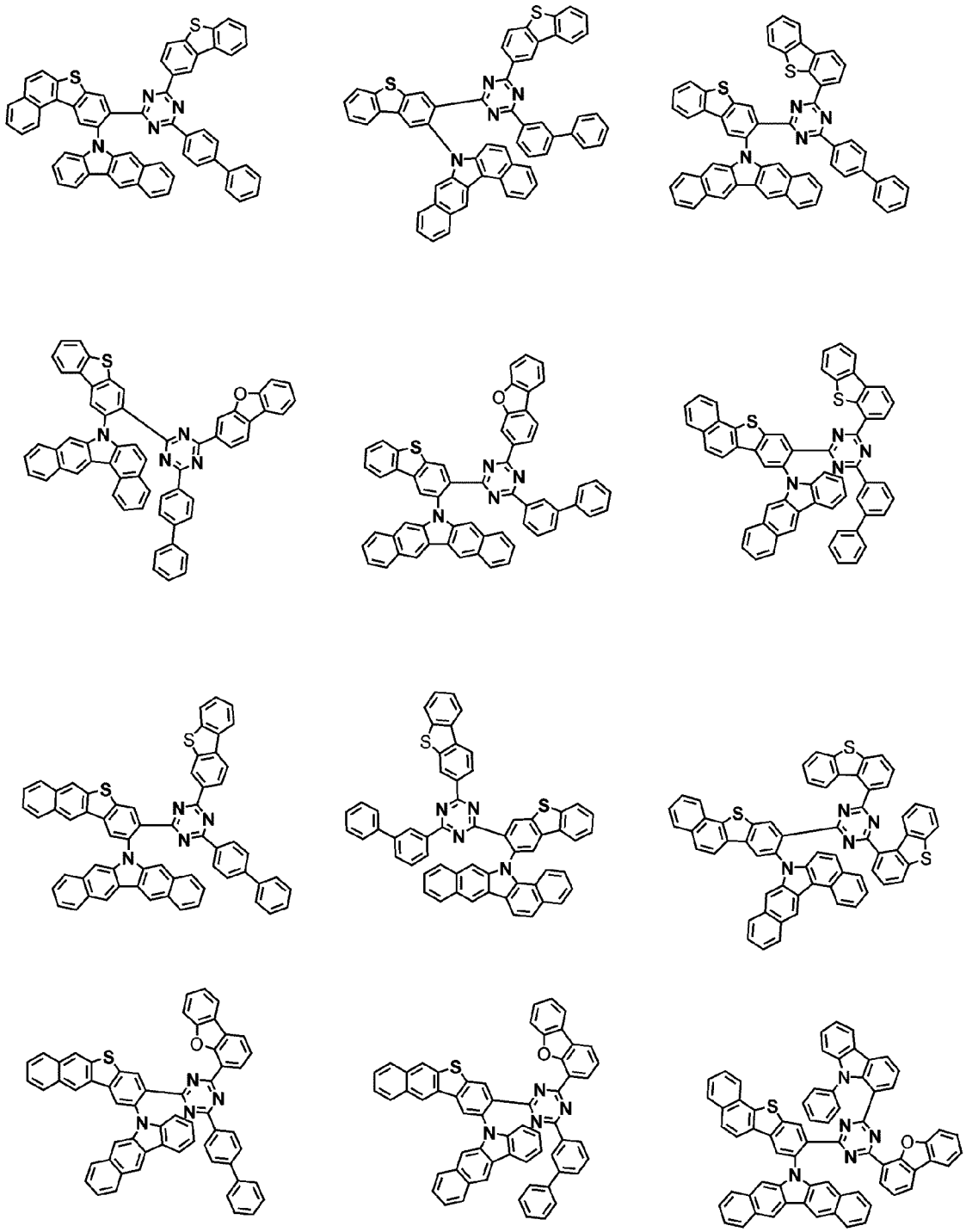
[306]

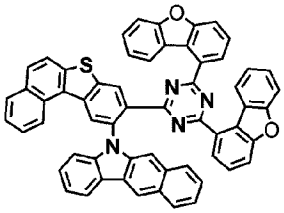
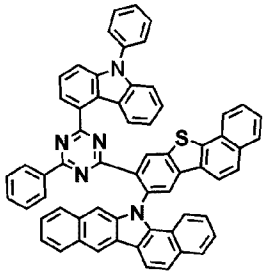
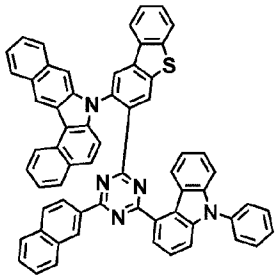
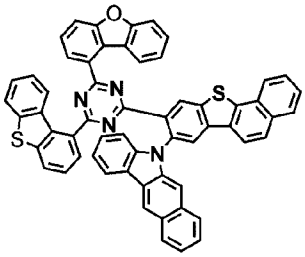
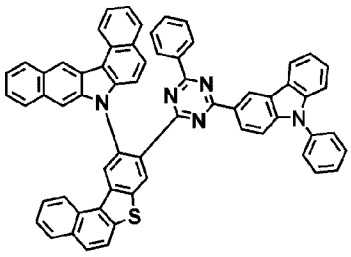
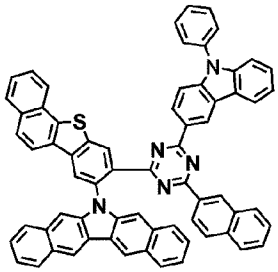
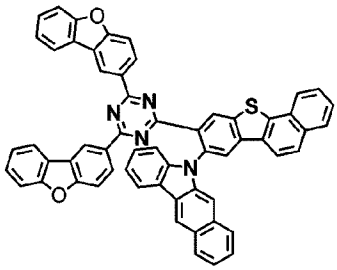
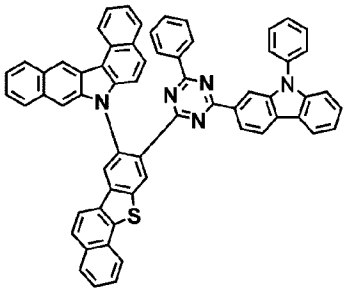
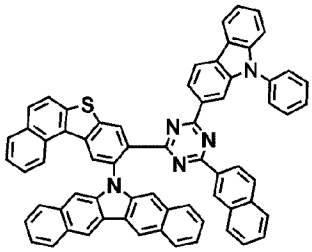
[307]

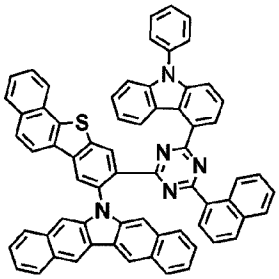
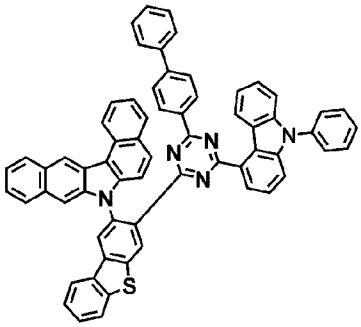
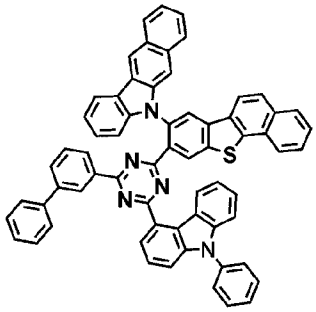
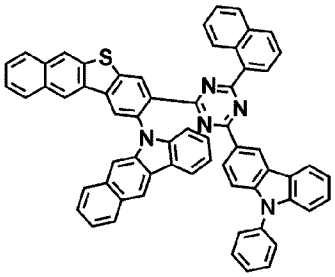
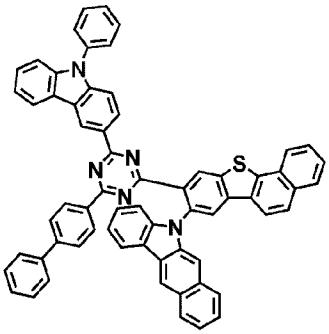
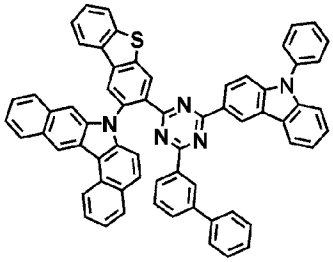
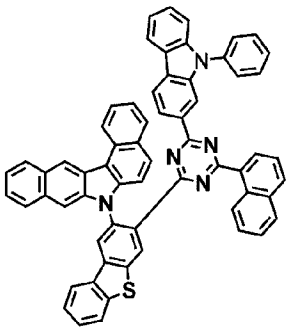
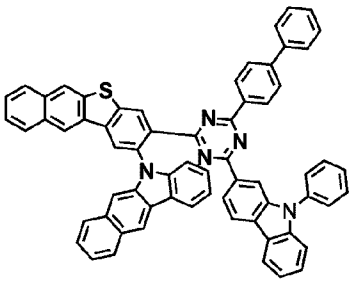
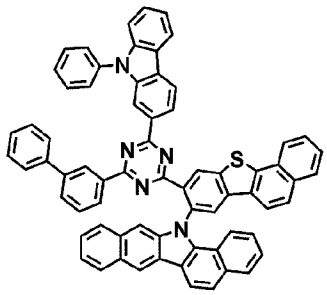
[308]



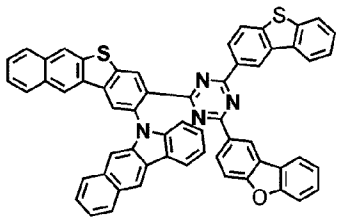
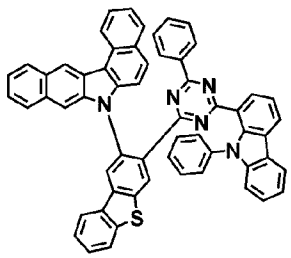
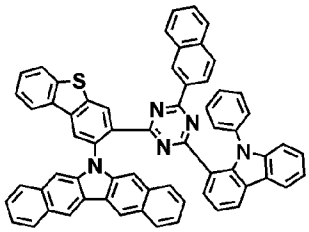
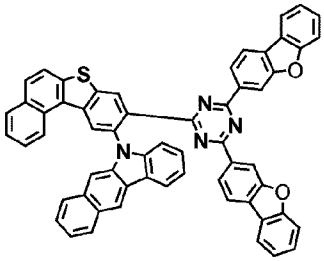
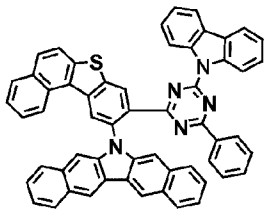
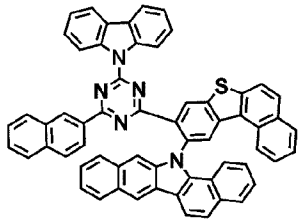
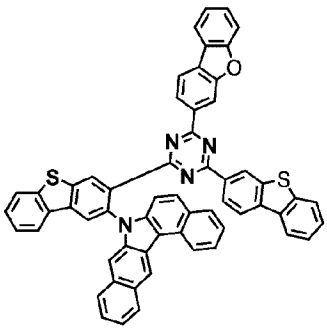
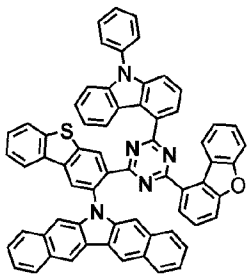
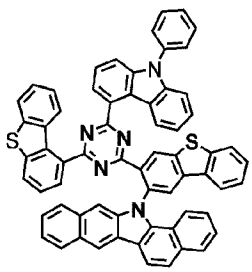
[309]

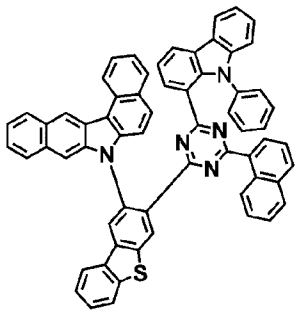
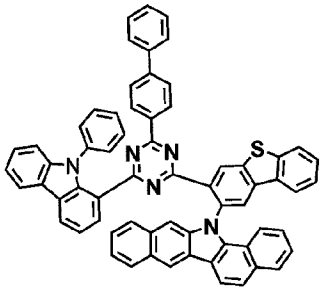
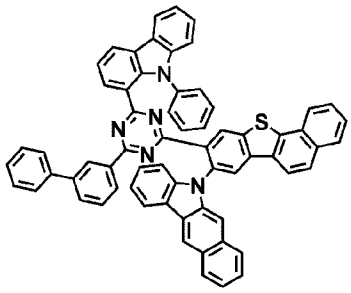
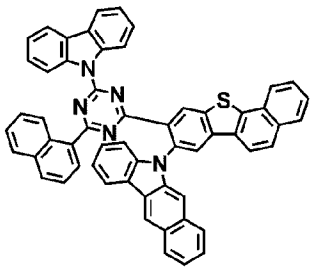
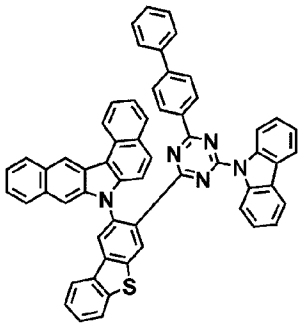
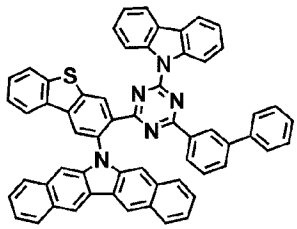
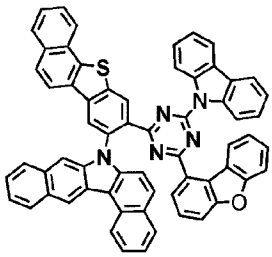
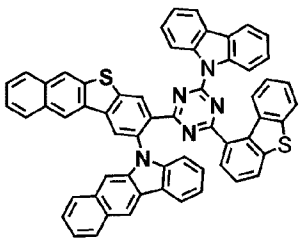
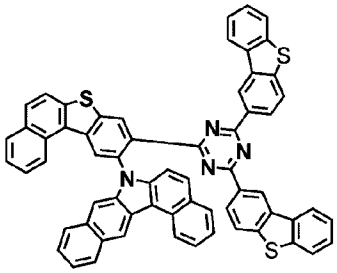
[310]

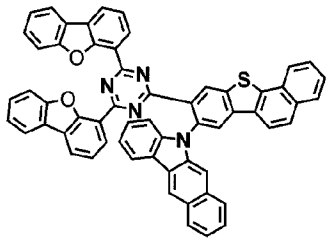
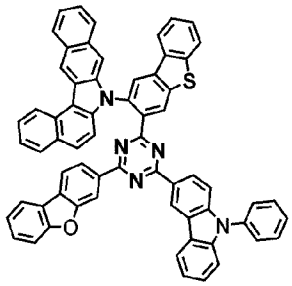
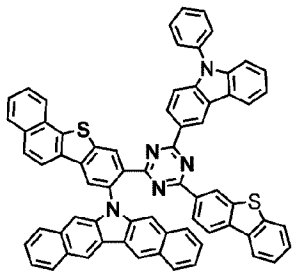
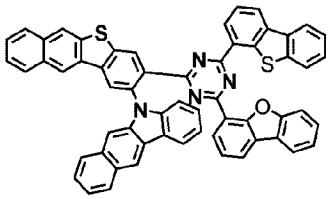
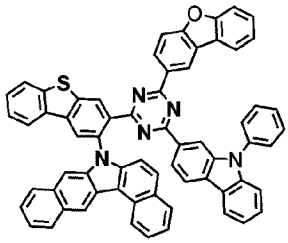
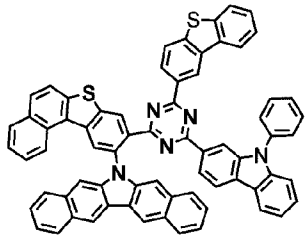
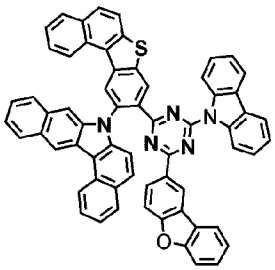
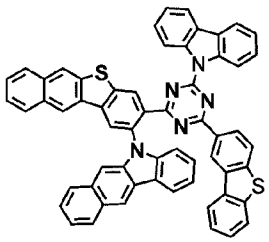
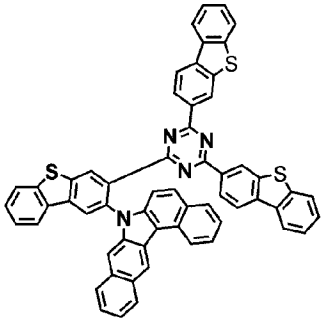
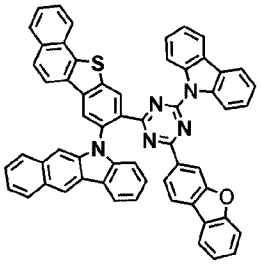
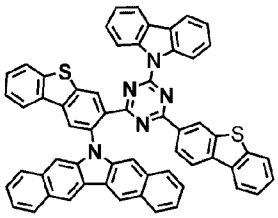
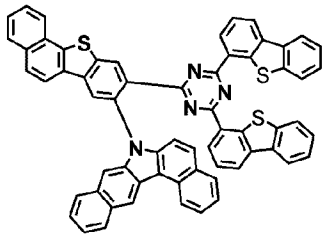
[311]

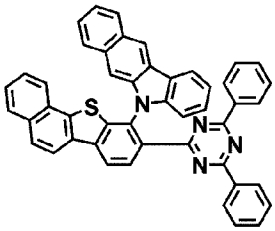
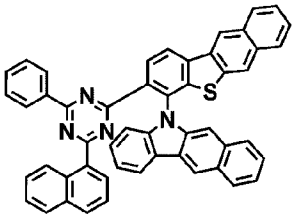
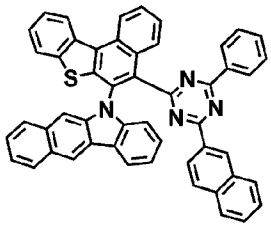
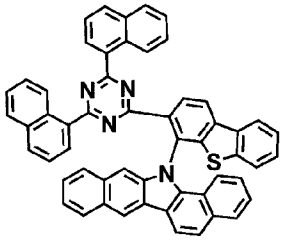
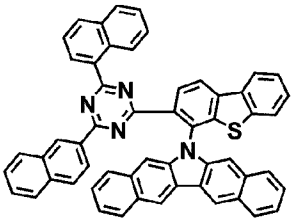
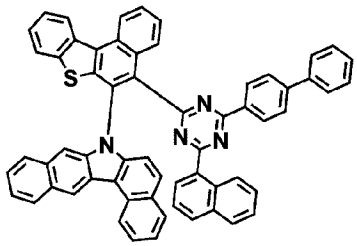
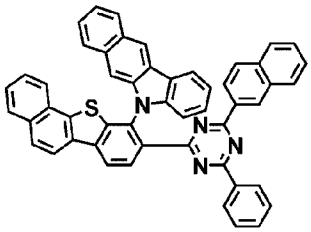
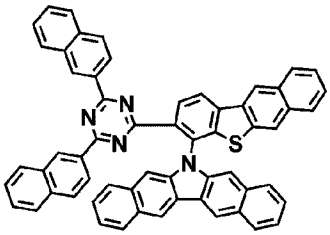
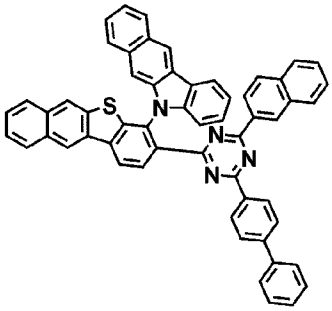
[312]

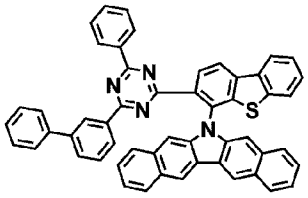
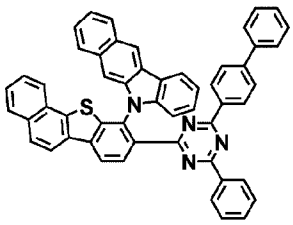
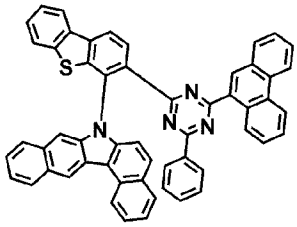
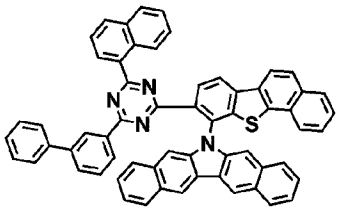
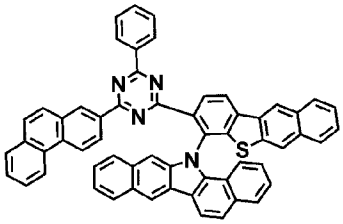
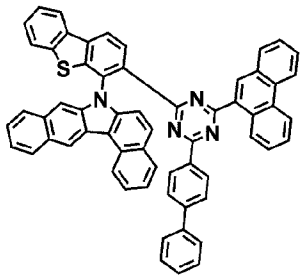
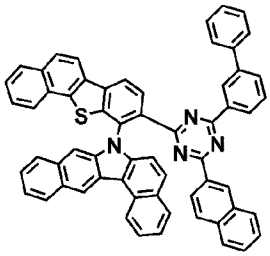
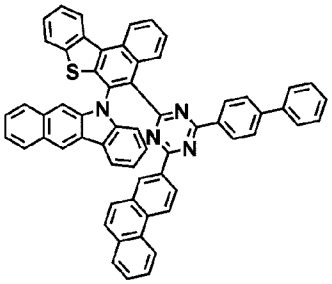
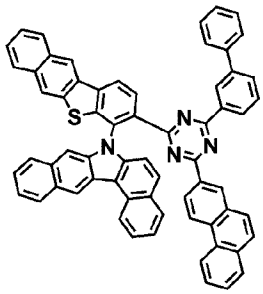
[313]

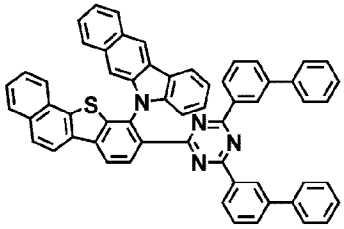
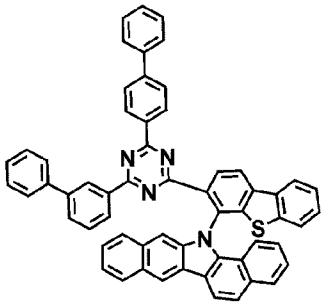
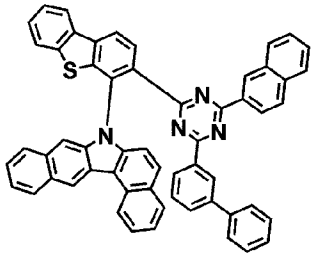
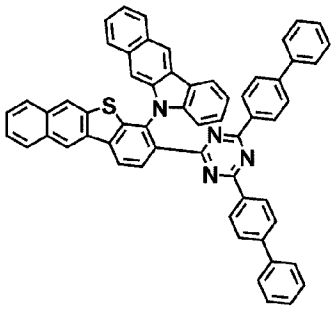
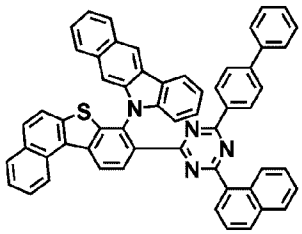
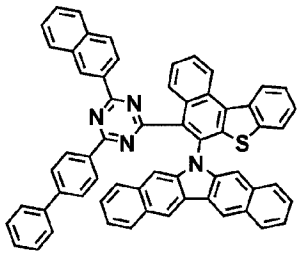
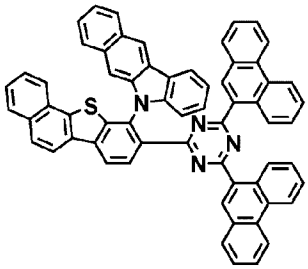
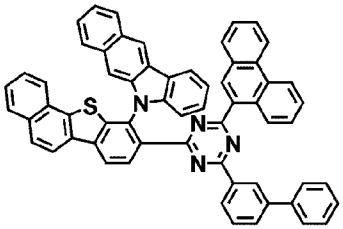
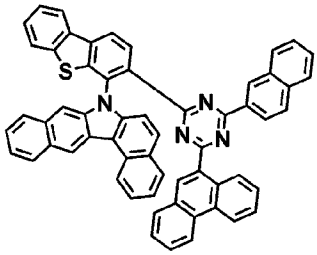
[314]

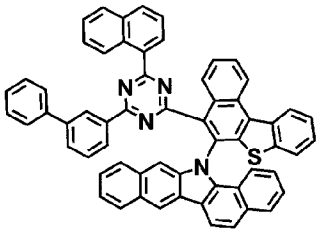
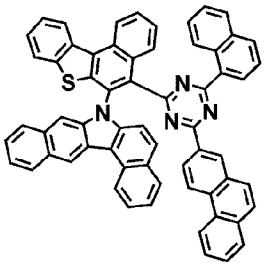
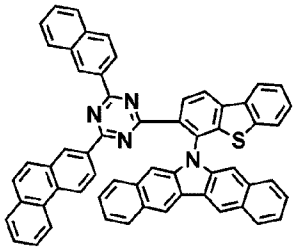
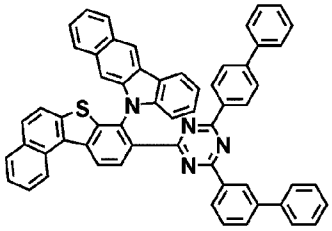
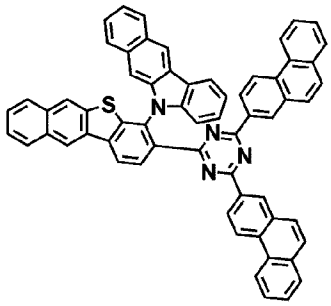
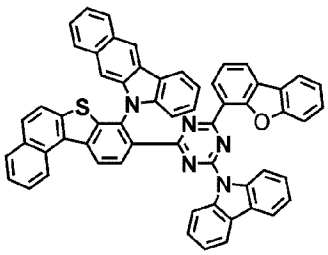
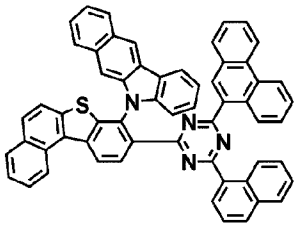
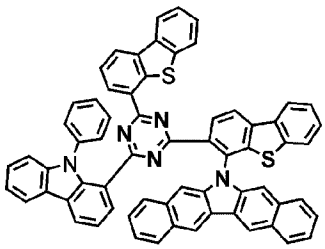
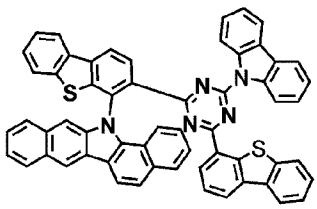
[315]

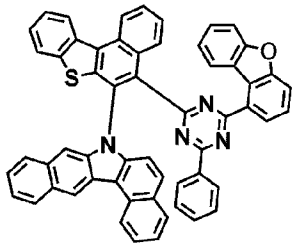
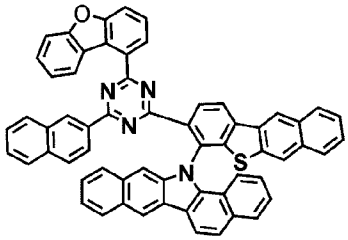
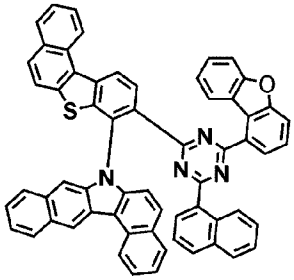
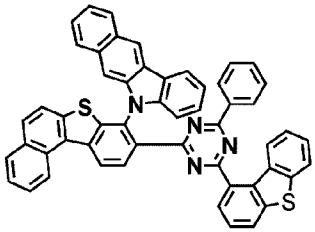
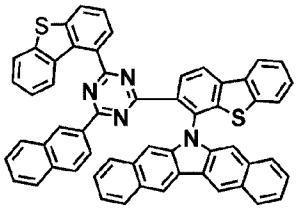
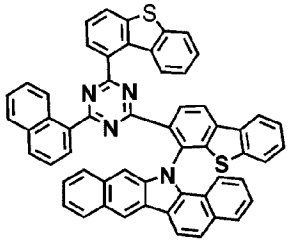
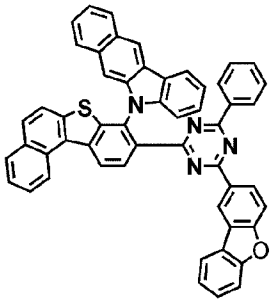
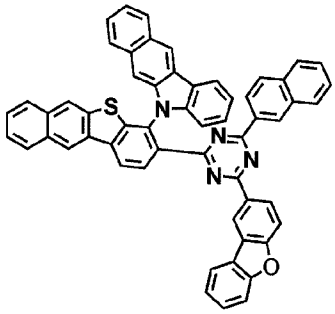
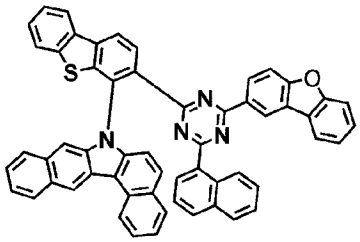
[316]

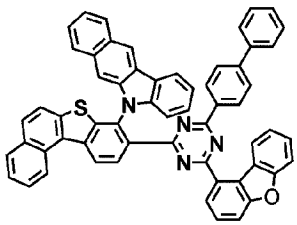
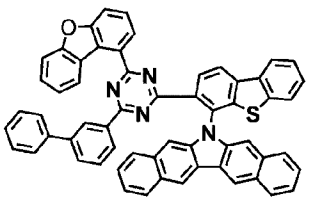
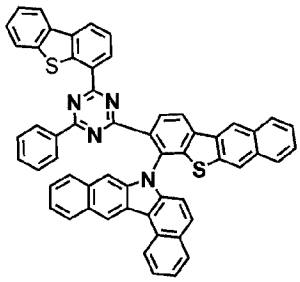
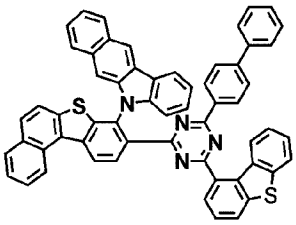
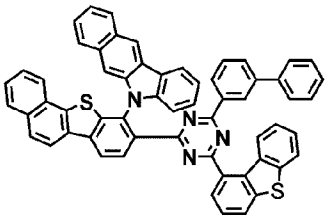
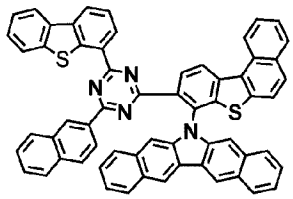
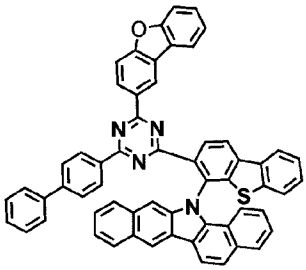
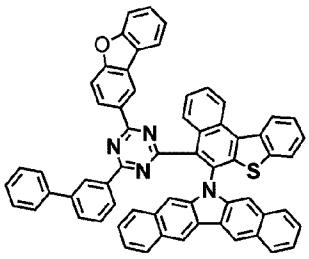
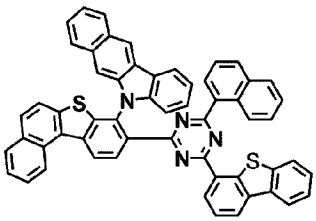
[317]

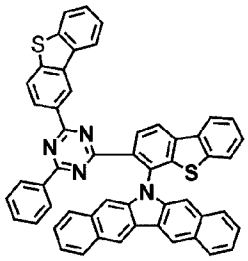
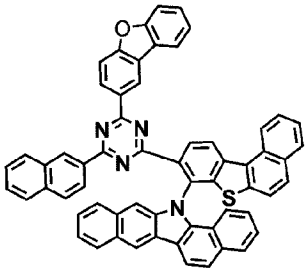
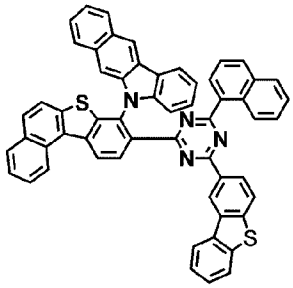
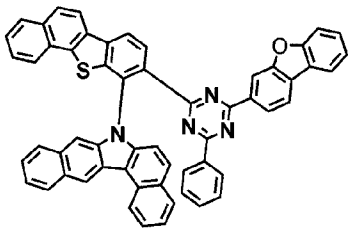
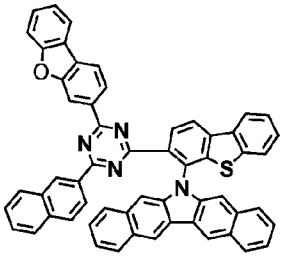
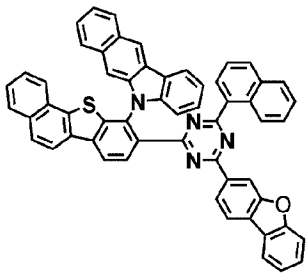
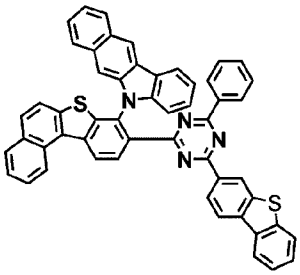
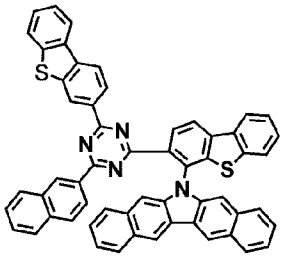
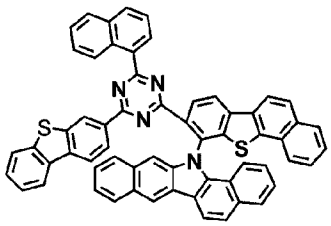
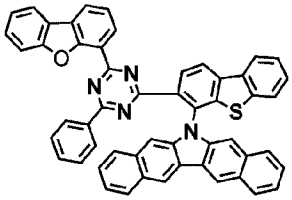
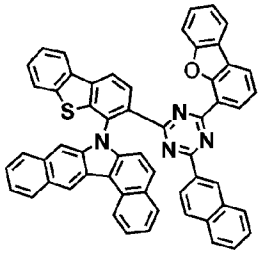
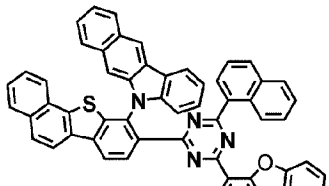
[318]

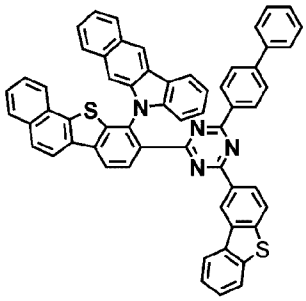
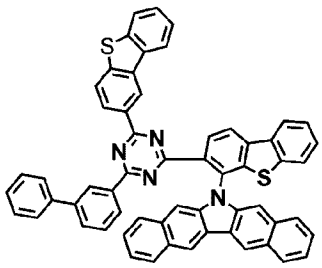
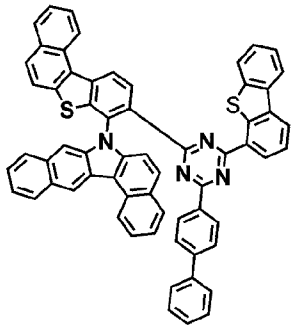
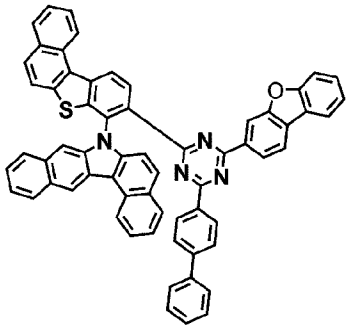
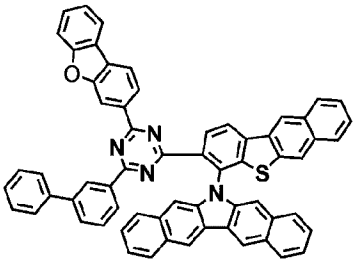
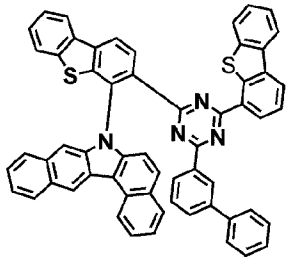
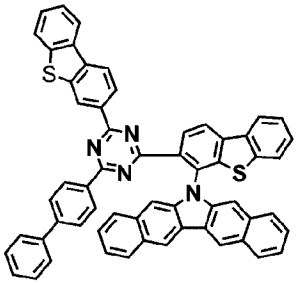
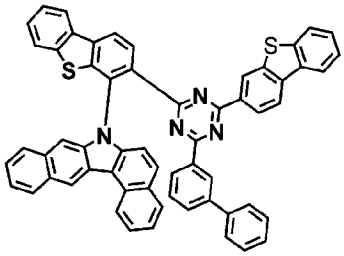
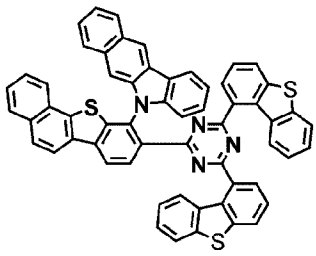
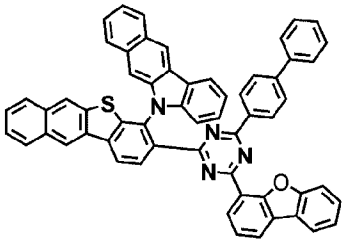
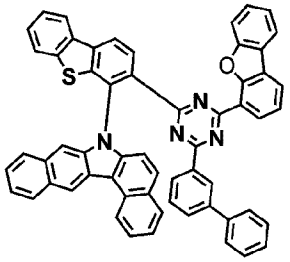
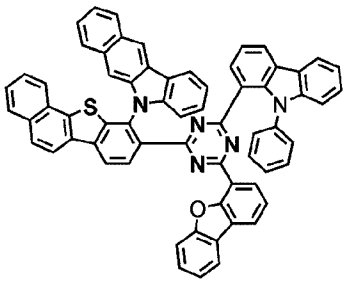
[319]

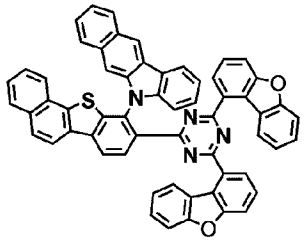
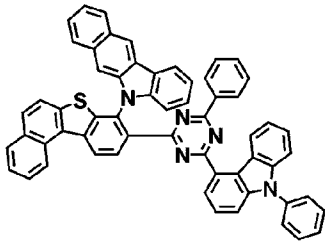
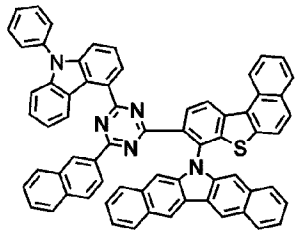
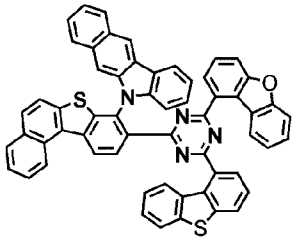
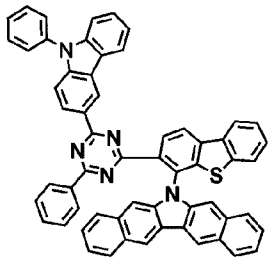
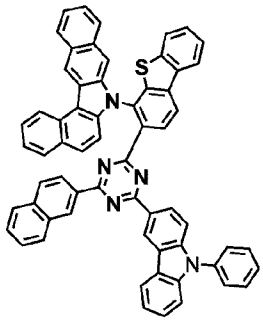
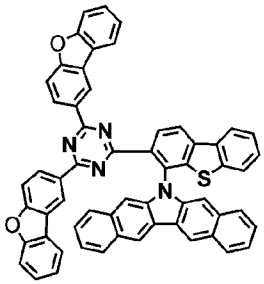
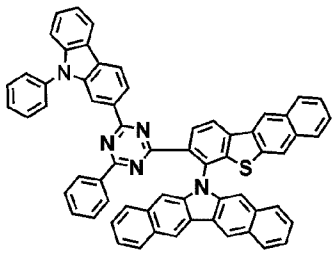
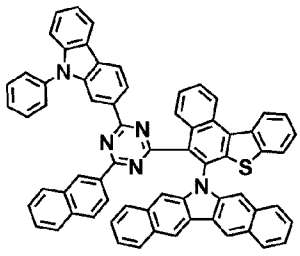
[320]

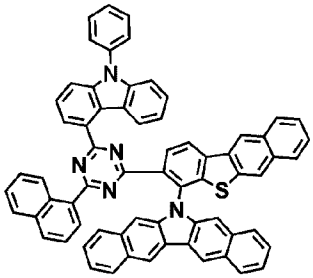
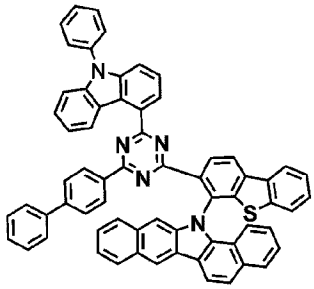
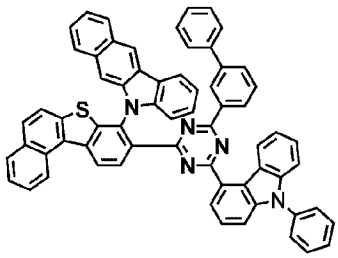
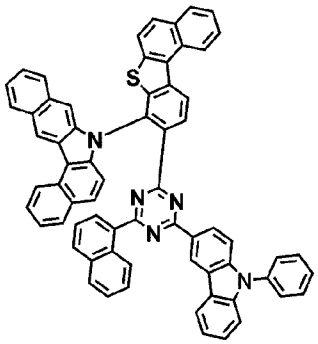
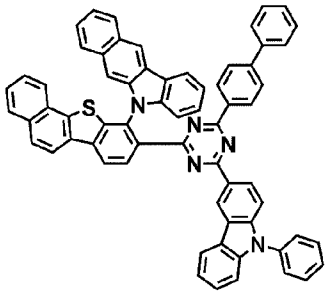
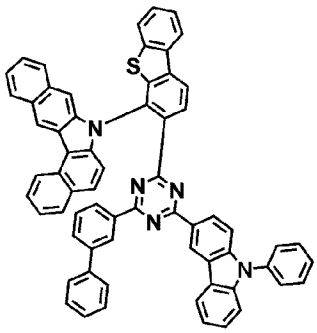
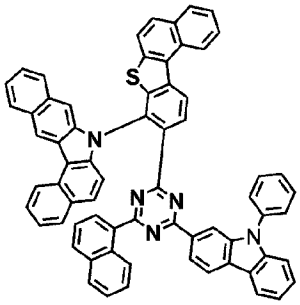
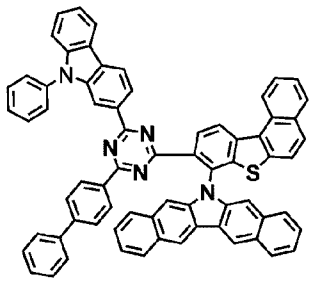
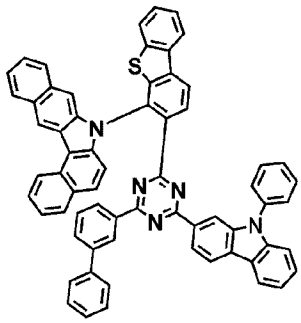
[321]

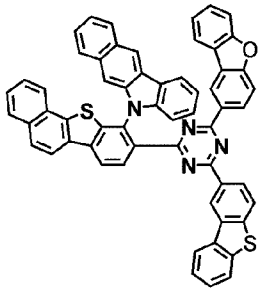
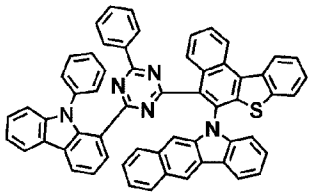
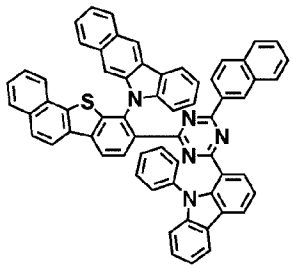
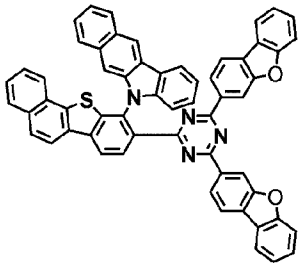
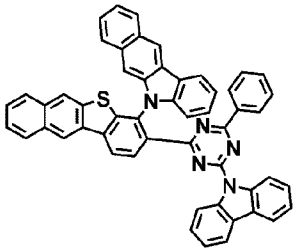
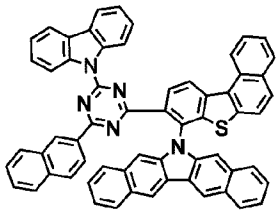
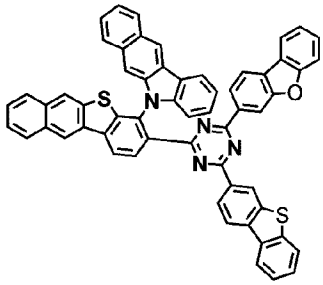
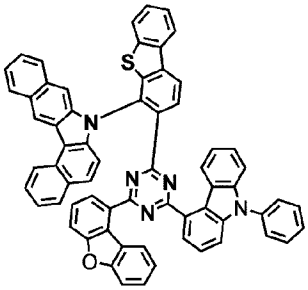
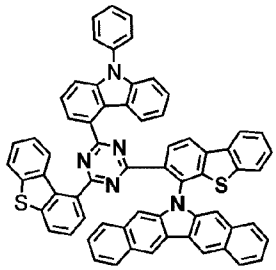
[322]

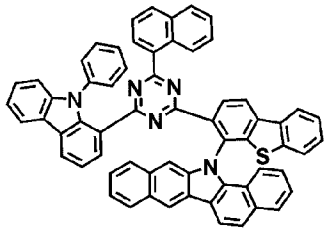
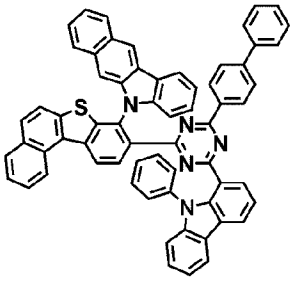
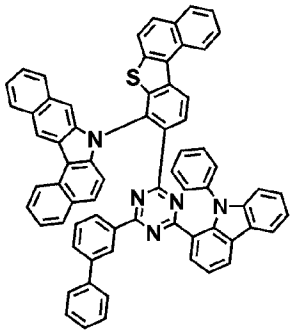
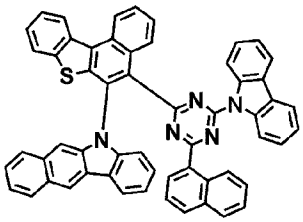
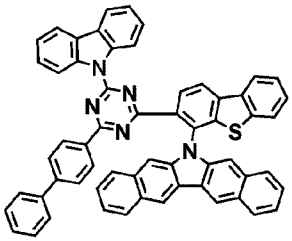
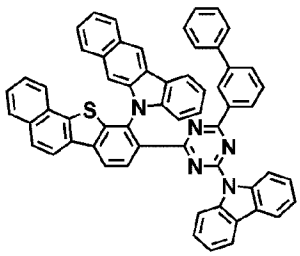
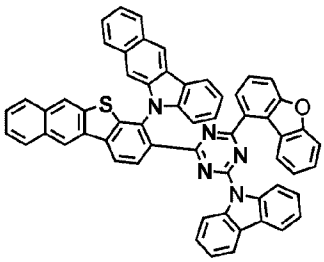
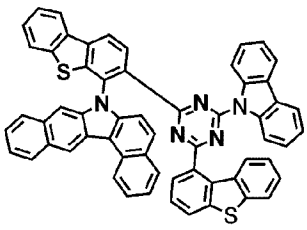
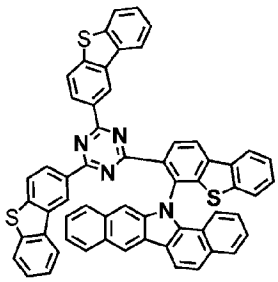
[323]

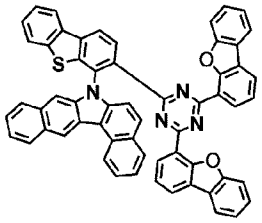
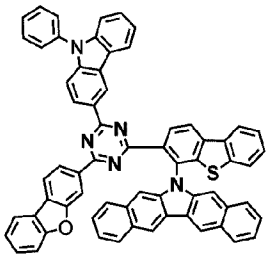
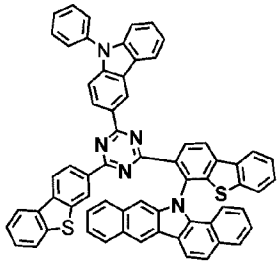
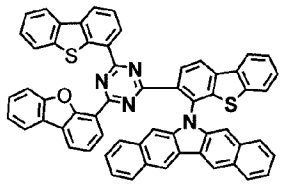
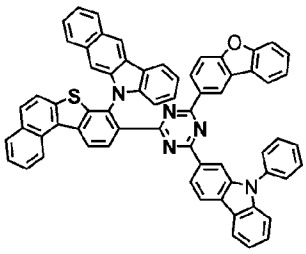
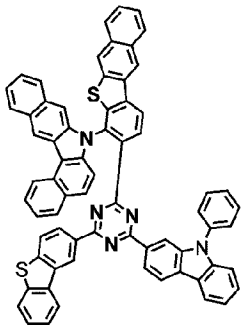
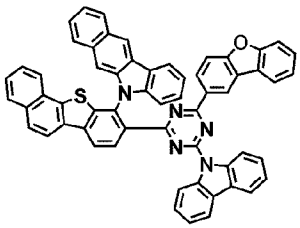
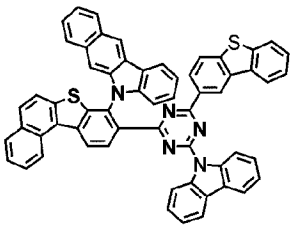
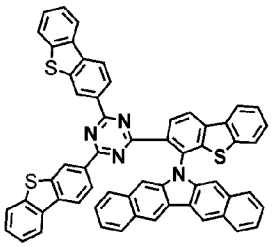
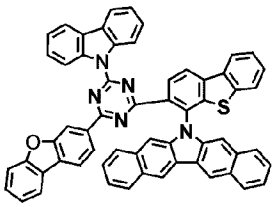
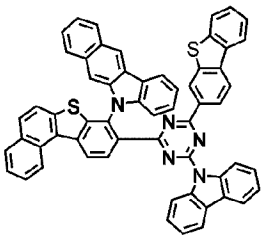
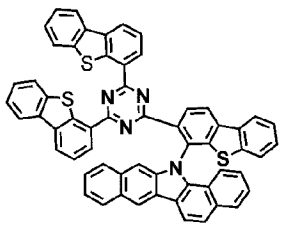
[324]

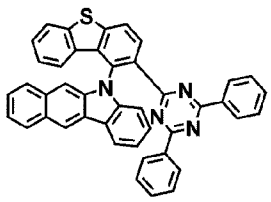
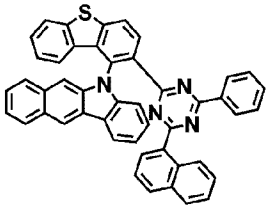
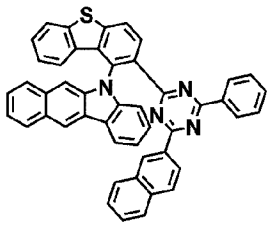
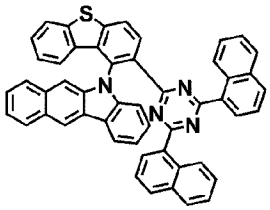
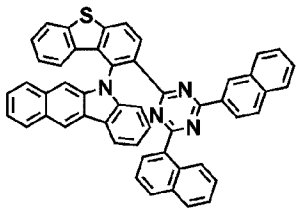
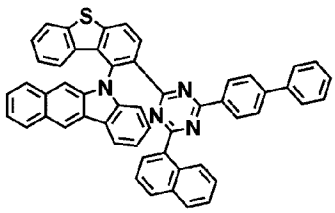
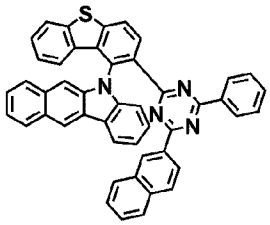
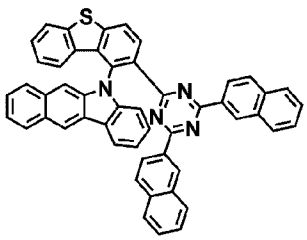
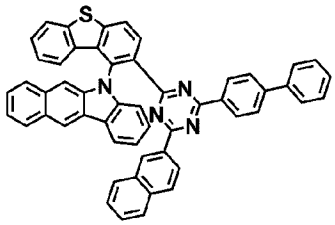
[325]

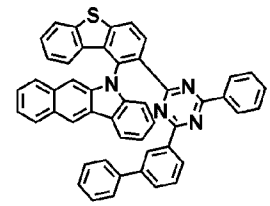
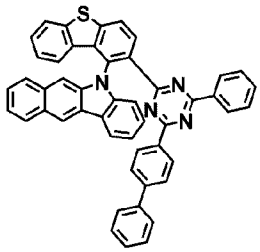
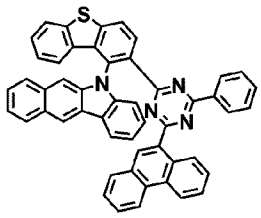
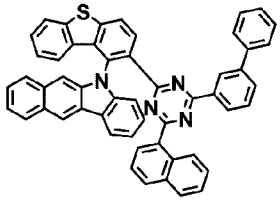
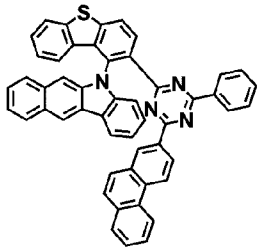
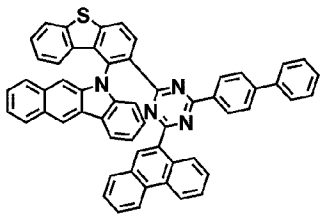
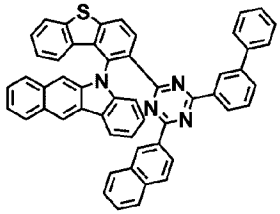
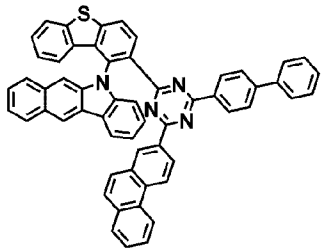
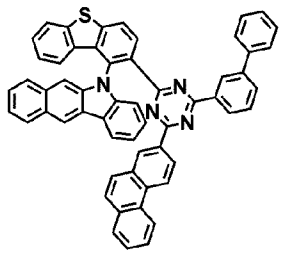
[326]

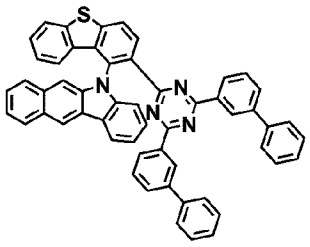
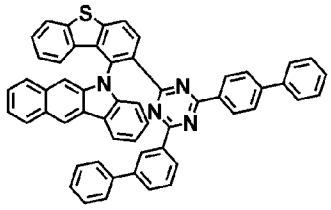
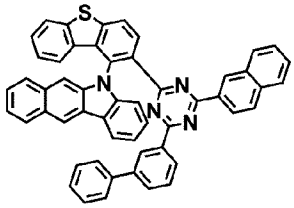
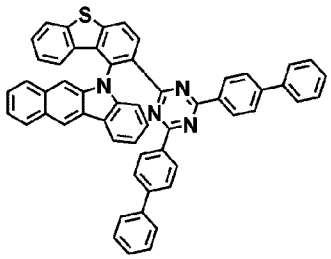
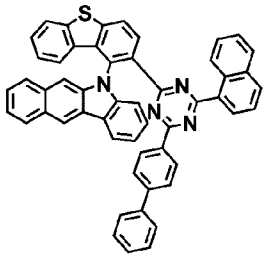
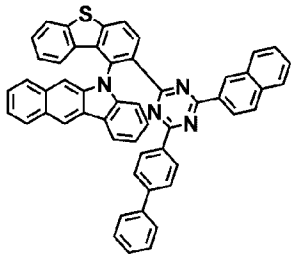
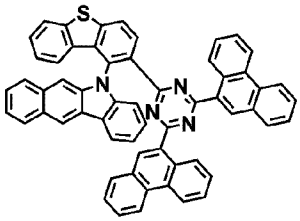
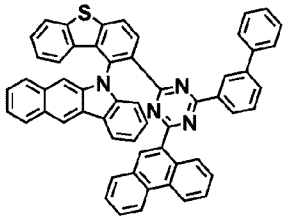
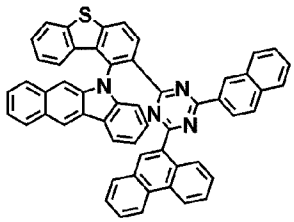
[327]

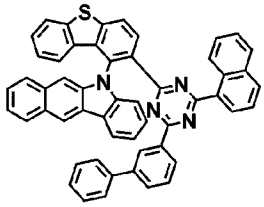
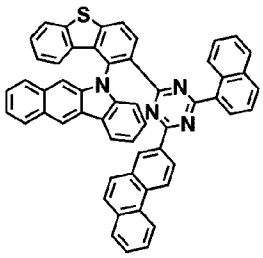
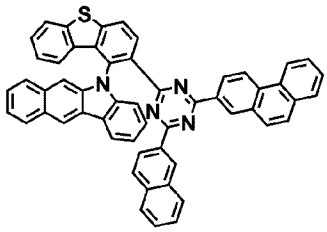
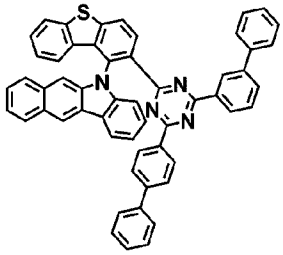
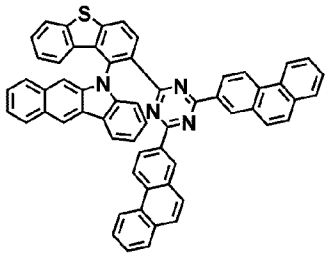
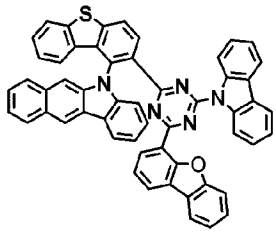
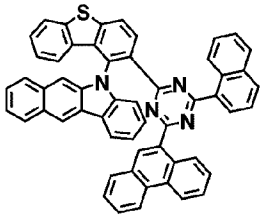
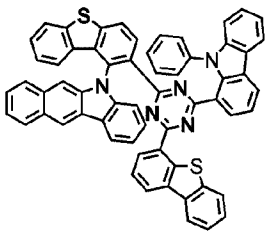
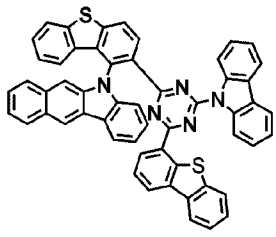
[328]

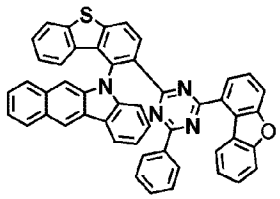
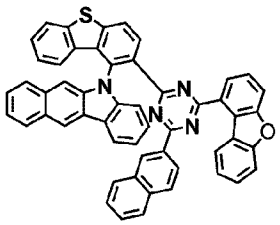
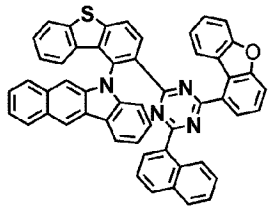
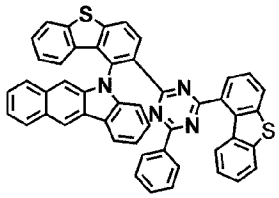
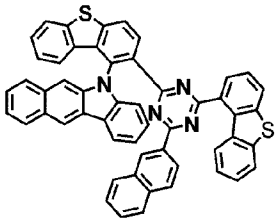
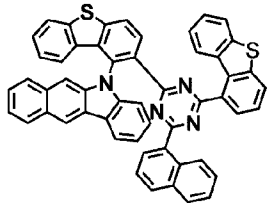
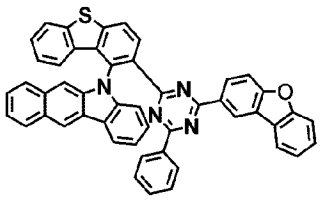
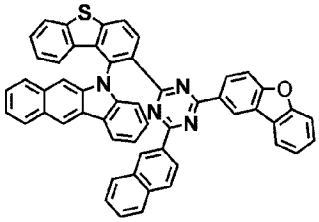
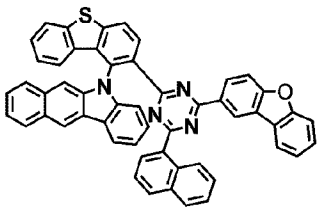
[329]

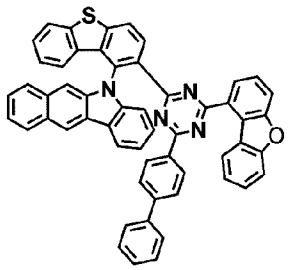
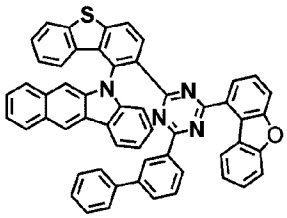
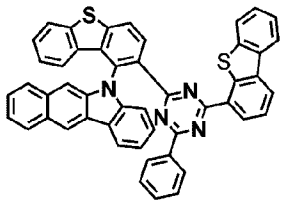
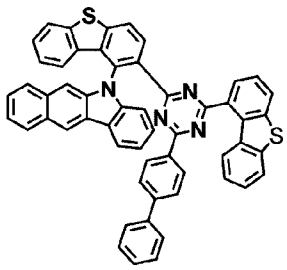
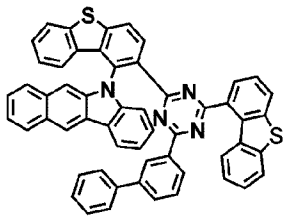
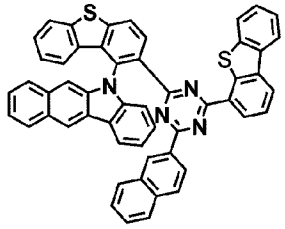
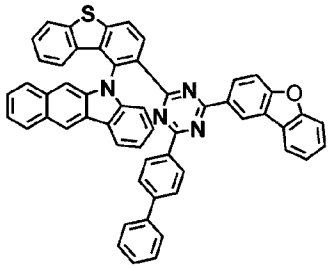
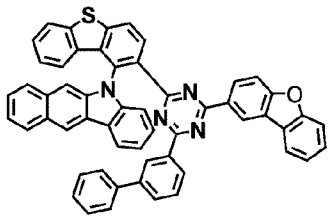
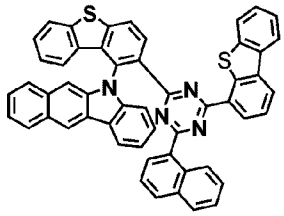
[330]

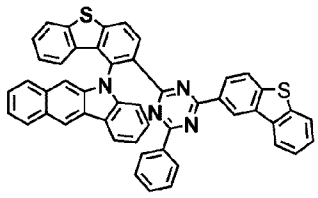
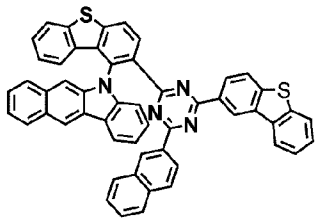
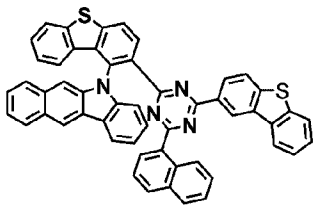
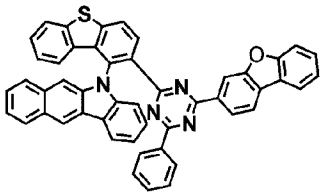
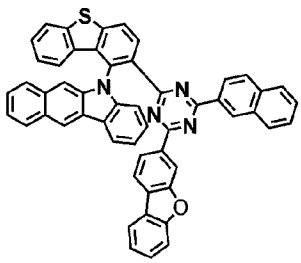
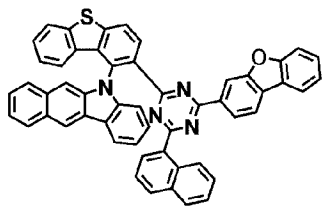
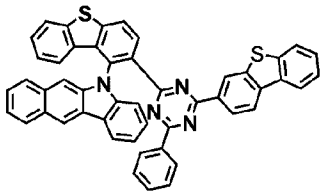
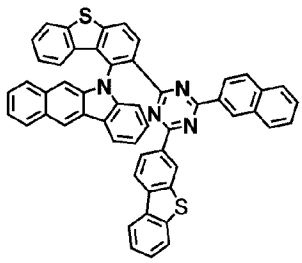
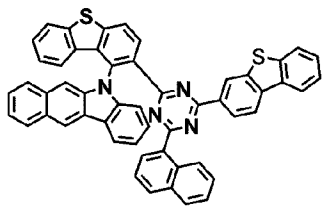
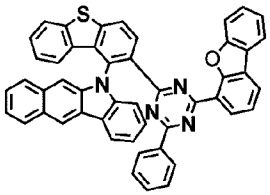
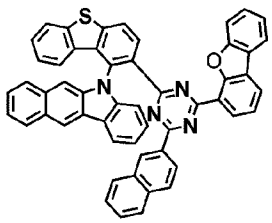
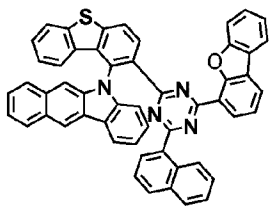
[331]

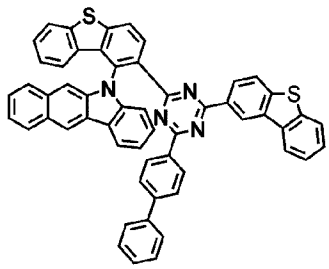
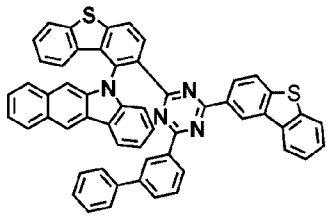
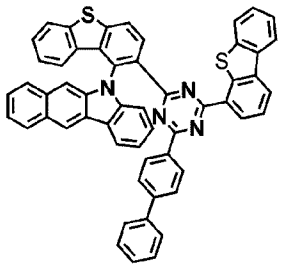
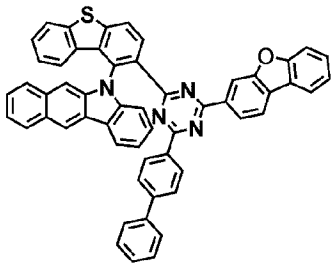
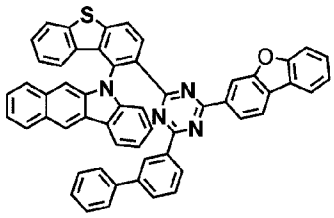
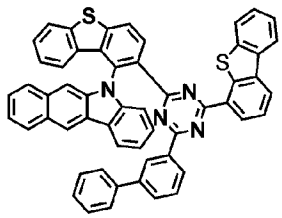
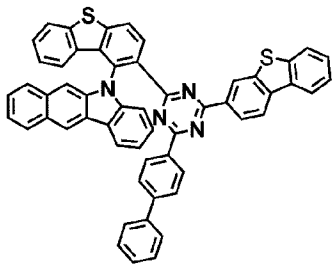
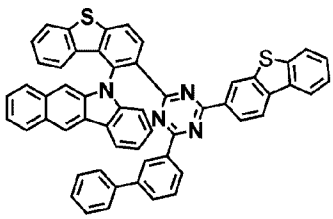
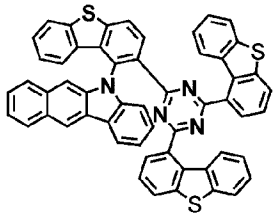
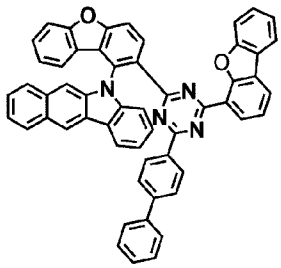
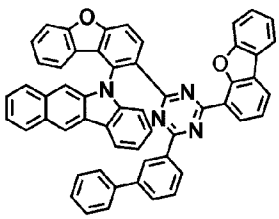
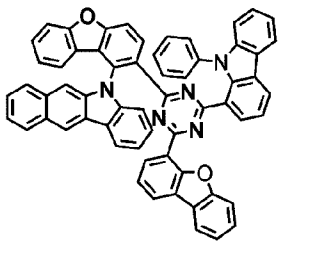
[332]

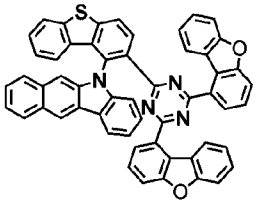
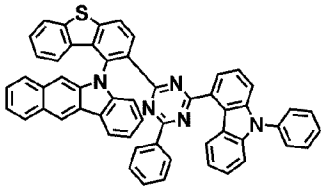
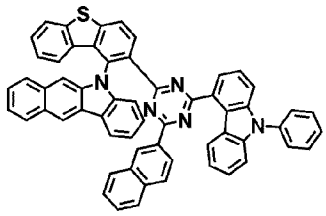
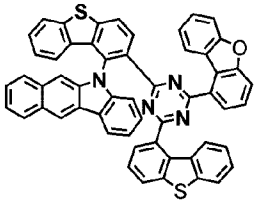
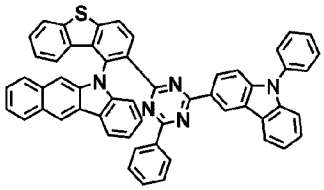
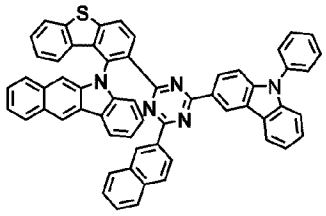
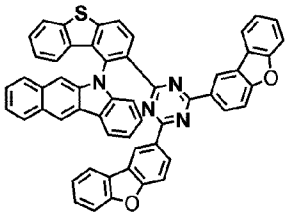
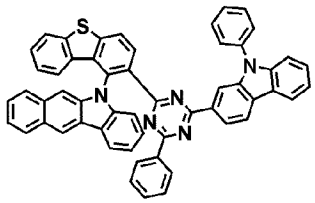
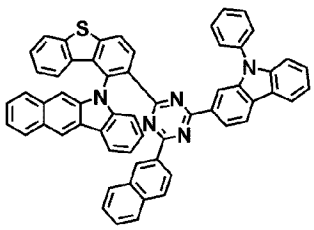
[333]

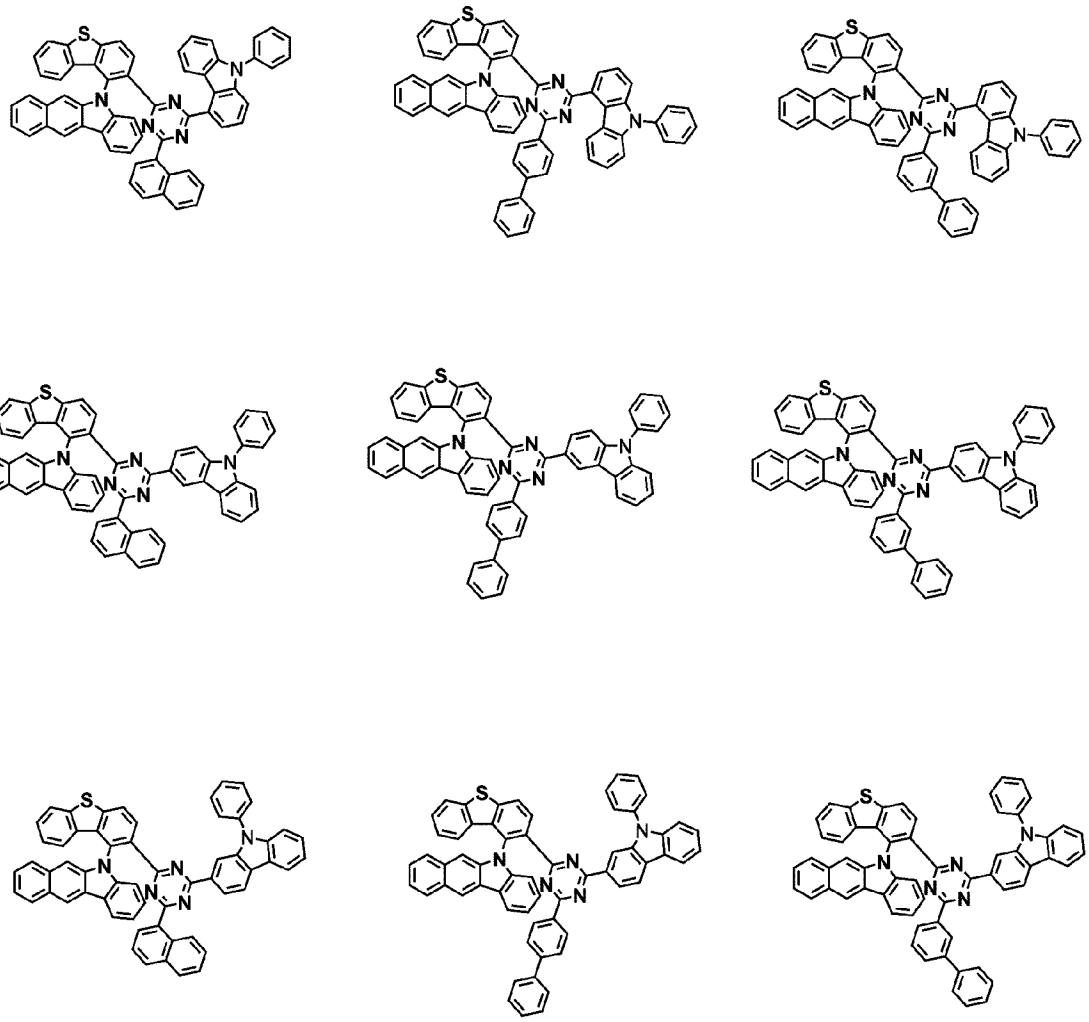
[334]

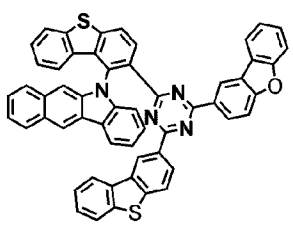
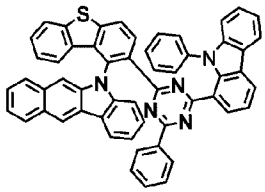
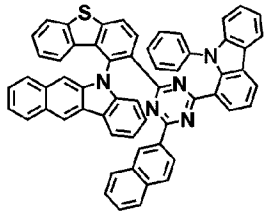
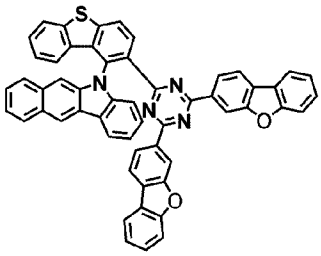
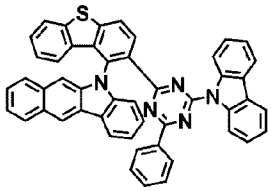
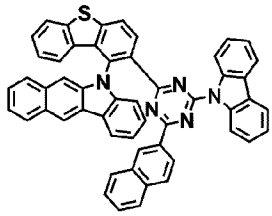
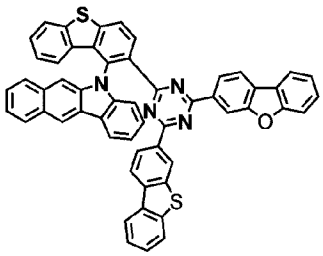
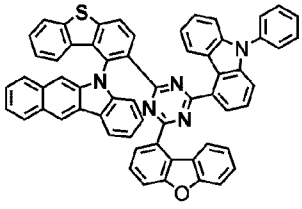
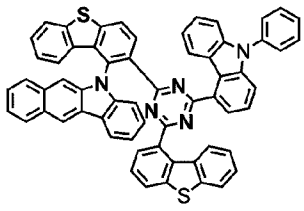
[335]

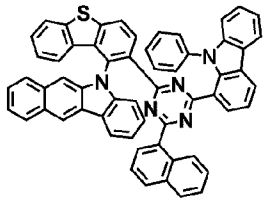
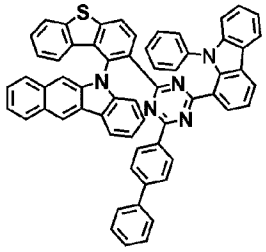
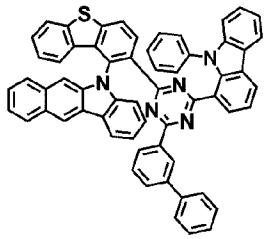
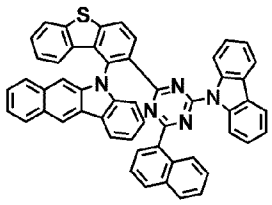
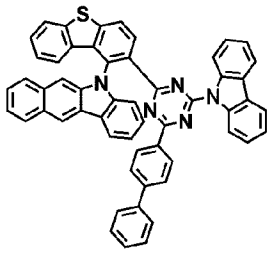
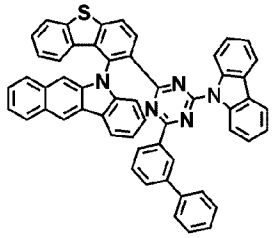
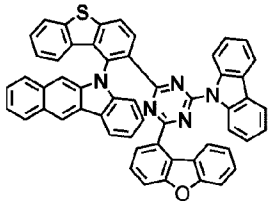
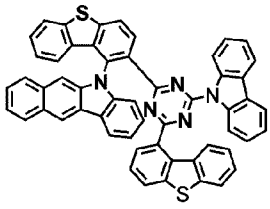
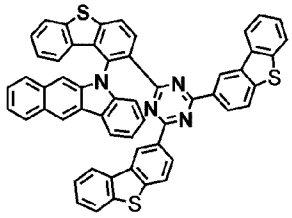
[336]



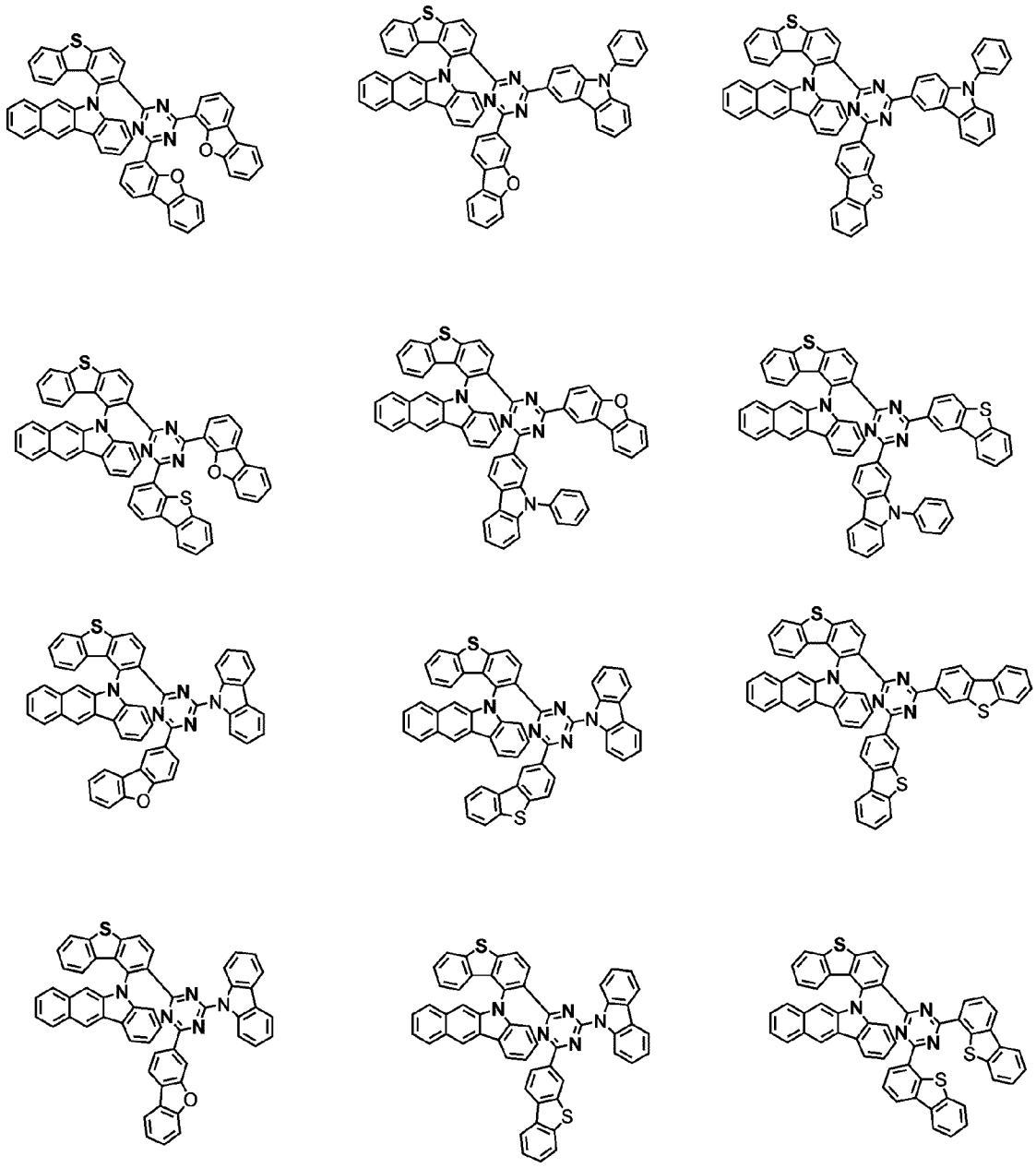
[337]

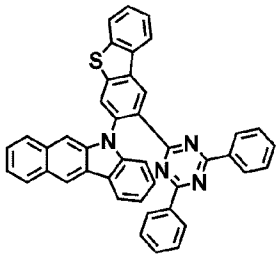
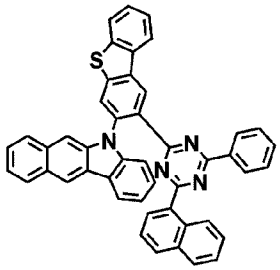
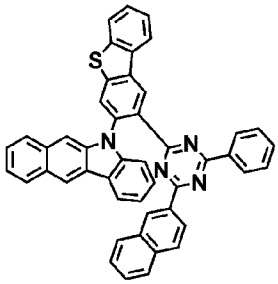
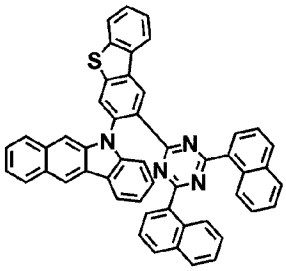
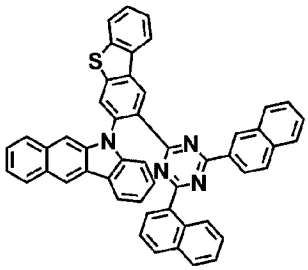
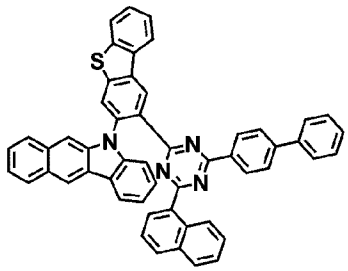
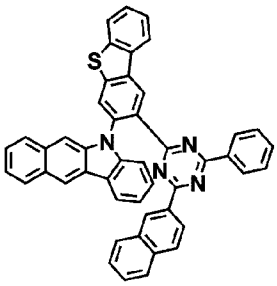
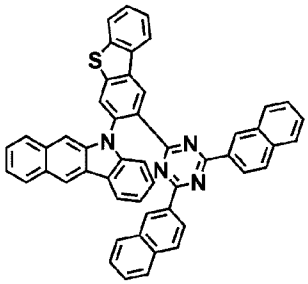
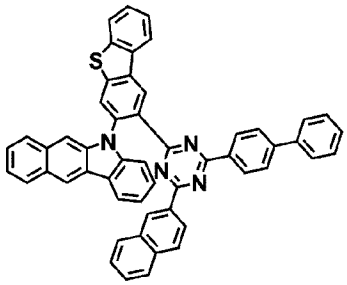
[338]

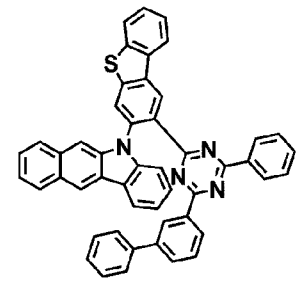
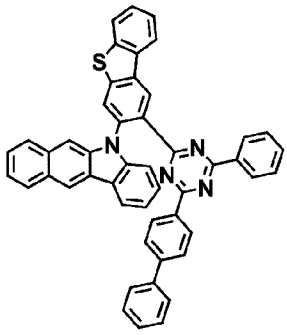
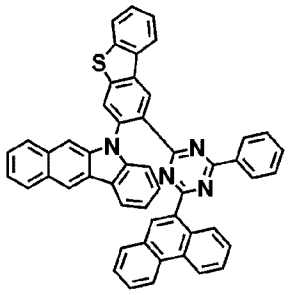
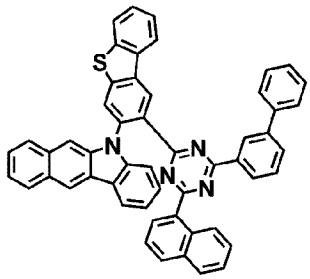
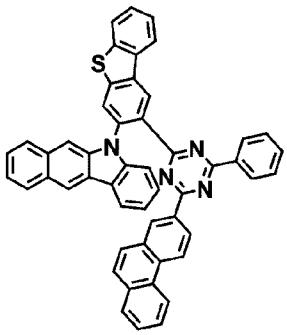
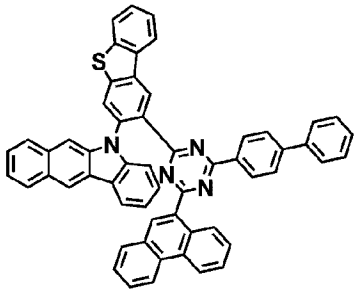
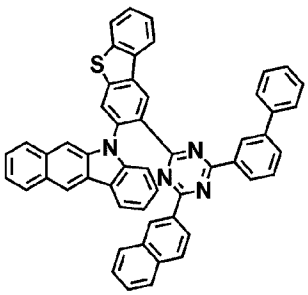
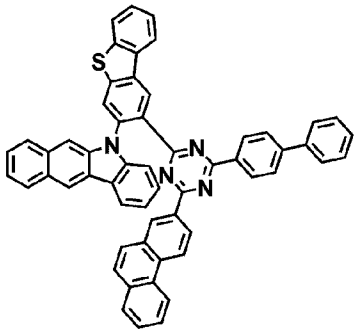
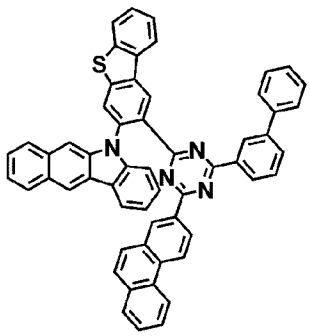
[339]



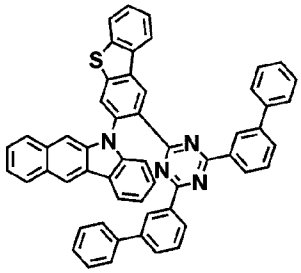
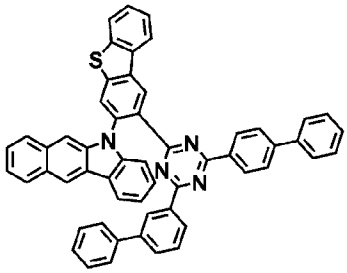
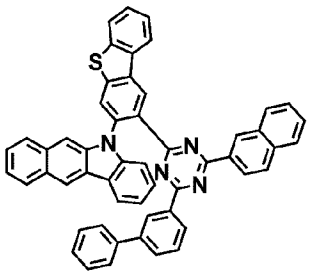
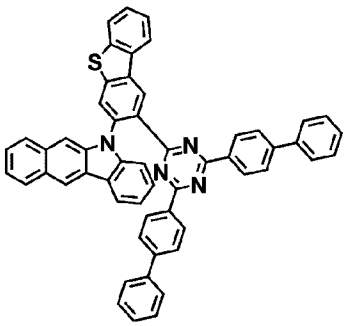
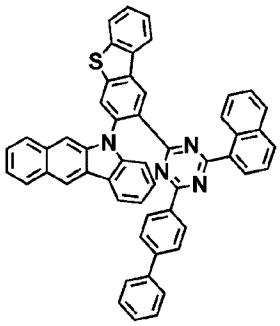
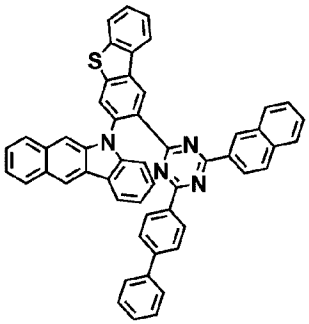
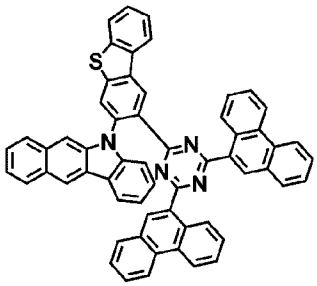
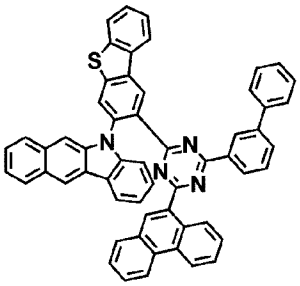
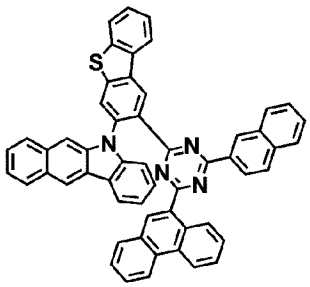
[340]

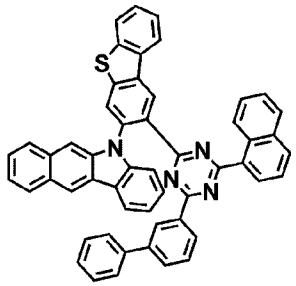
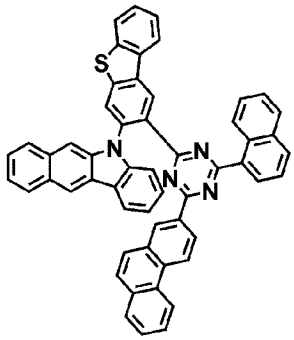
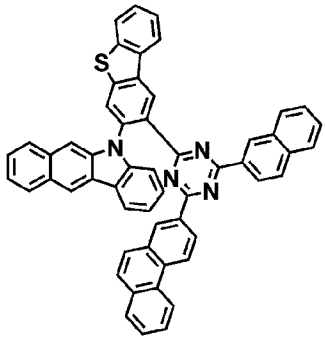
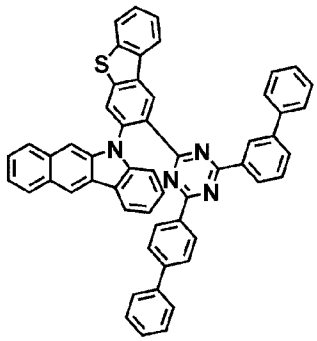
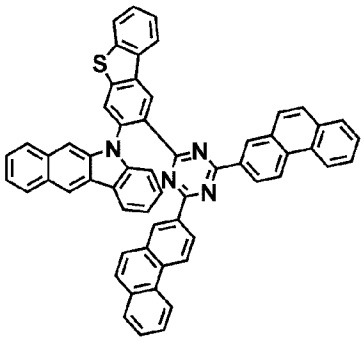
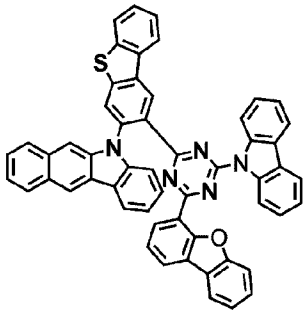
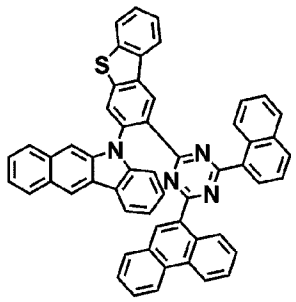
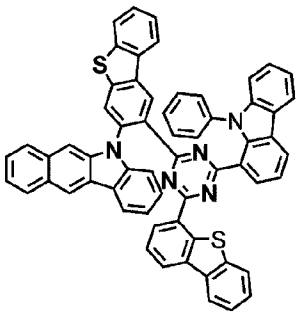
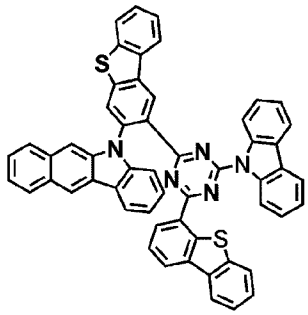
[341]

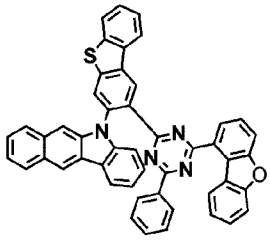
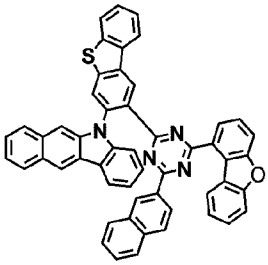
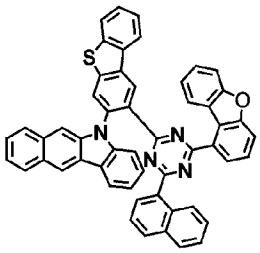
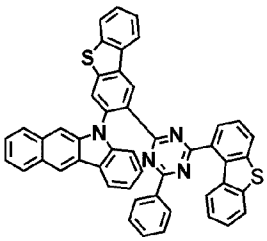
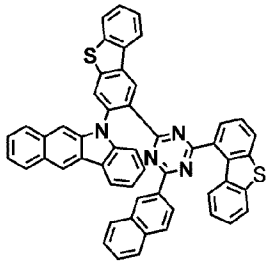
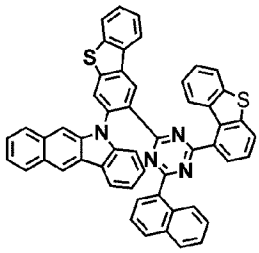
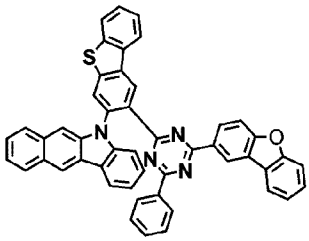
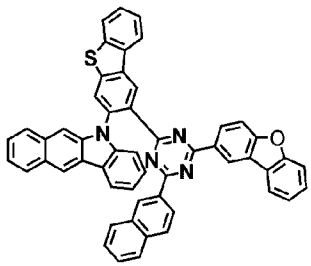
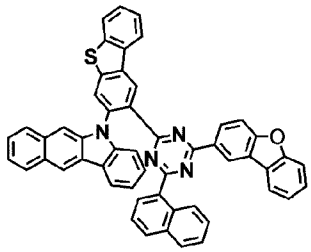
[342]

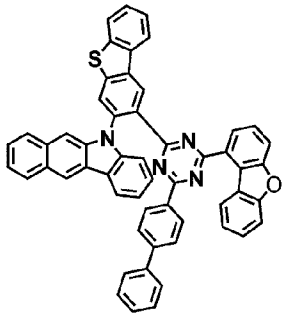
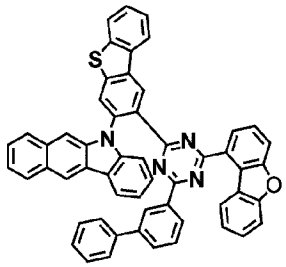
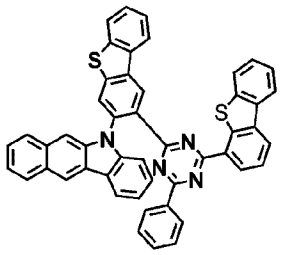
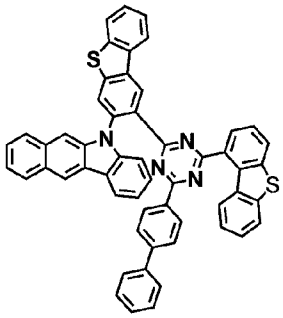
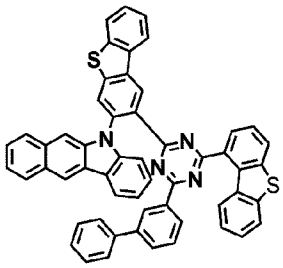
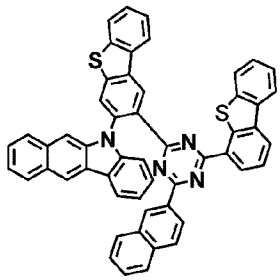
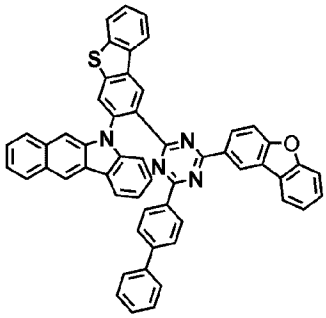
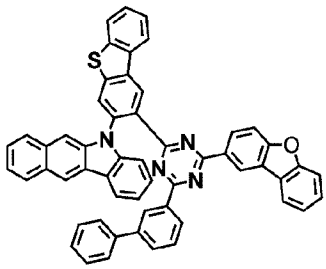
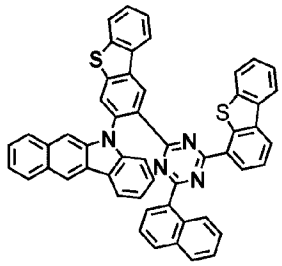
[343]

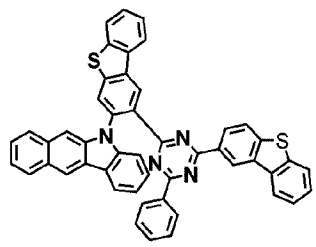
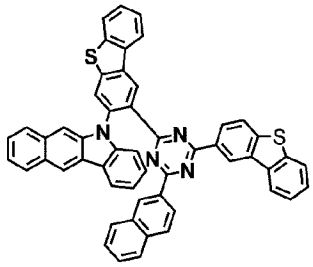
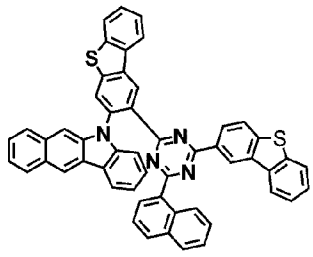
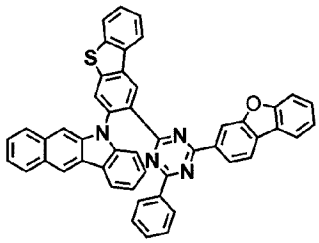
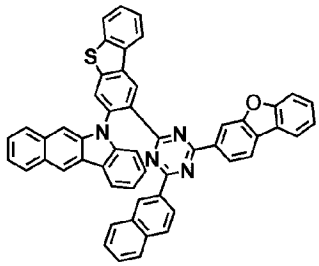
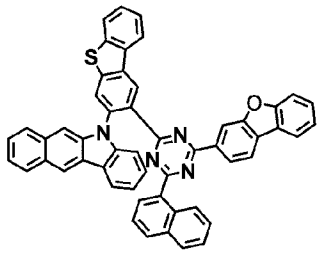
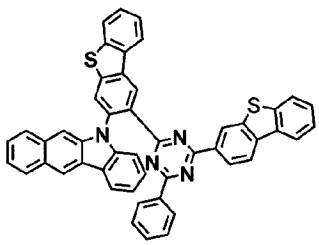
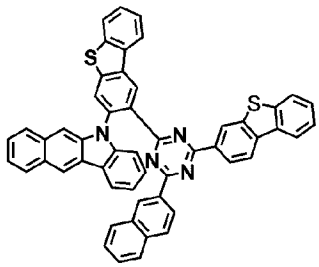
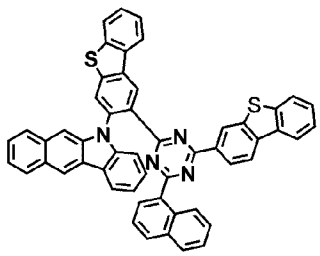
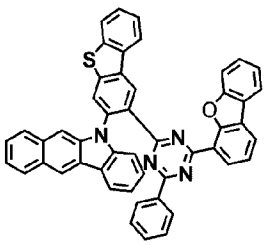
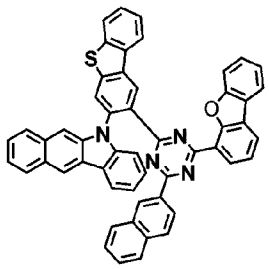
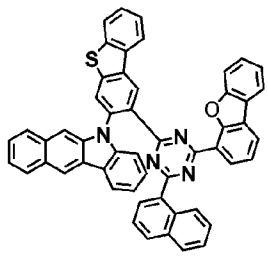
[344]

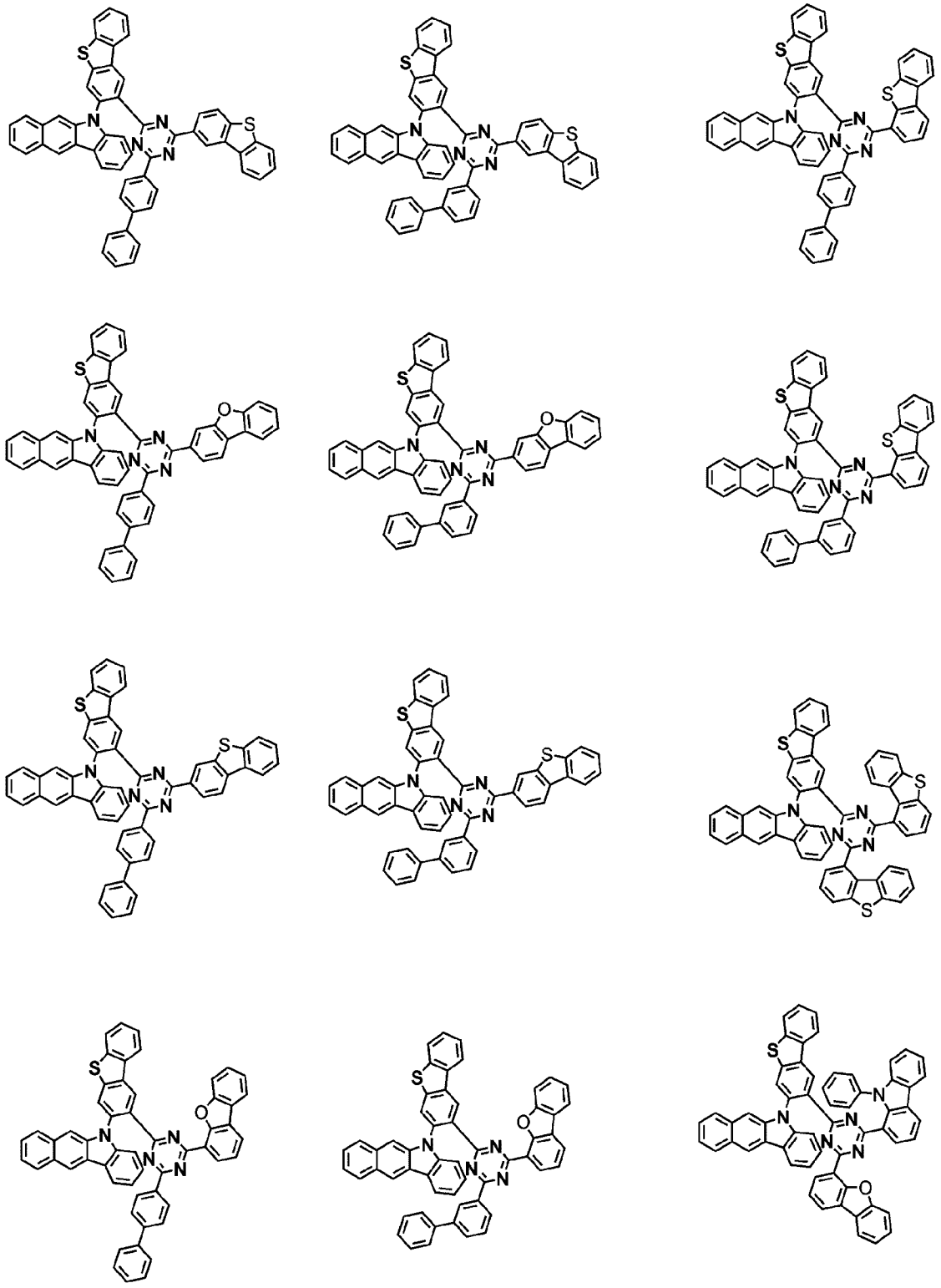
[345]

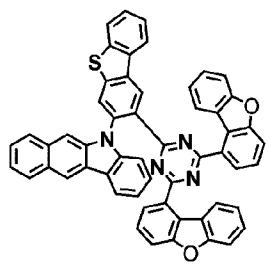
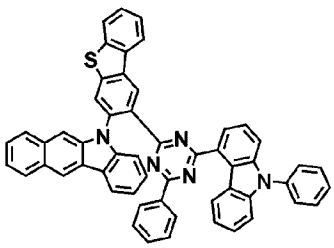
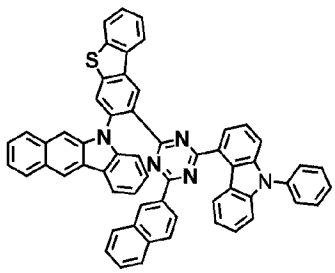
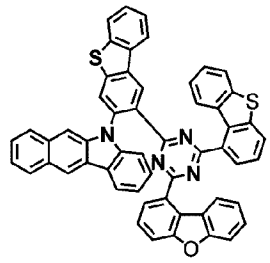
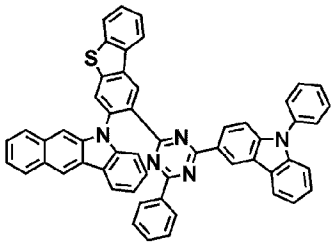
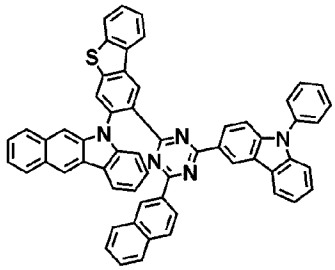
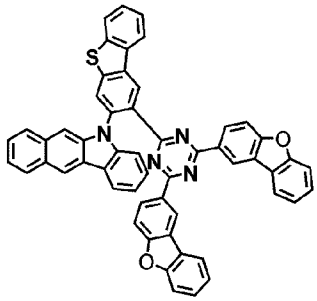
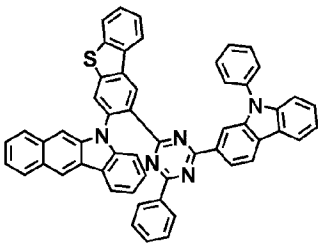
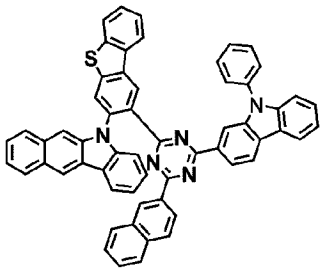
[346]

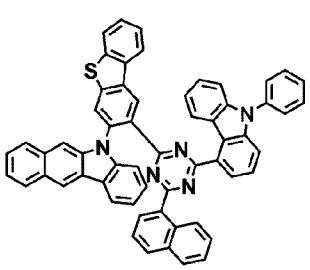
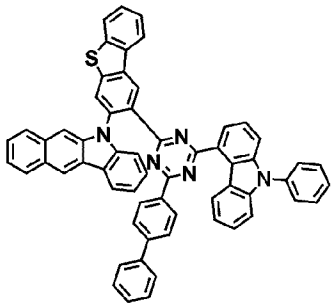
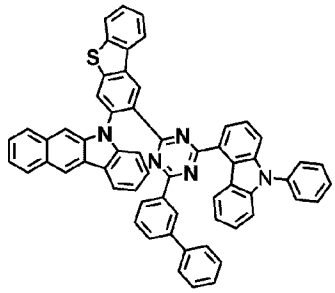
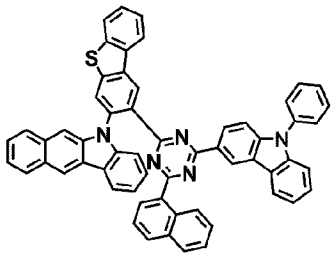
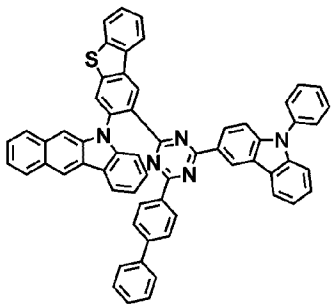
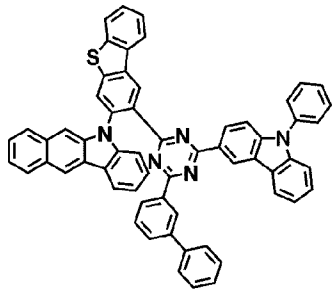
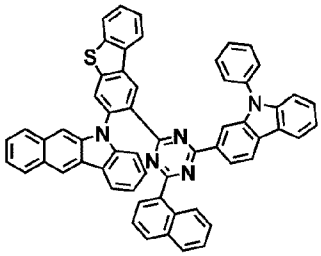
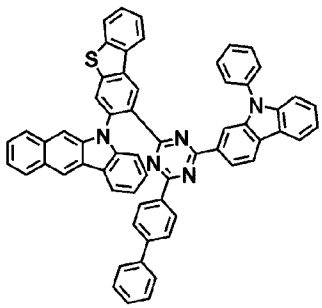
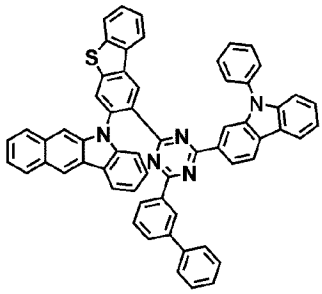
[347]



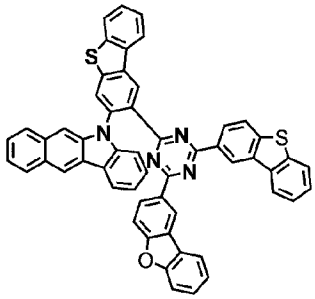
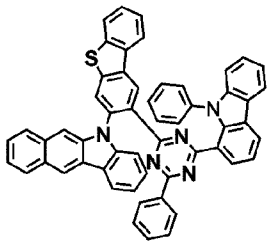
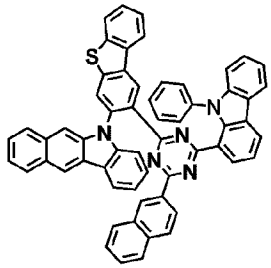
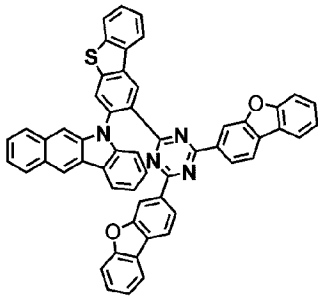
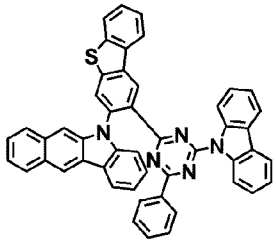
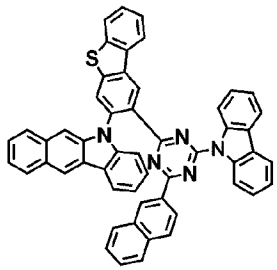
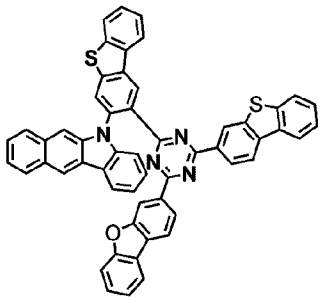
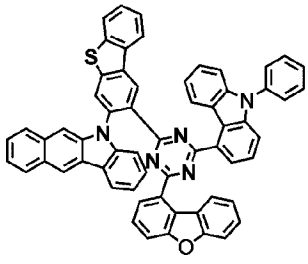
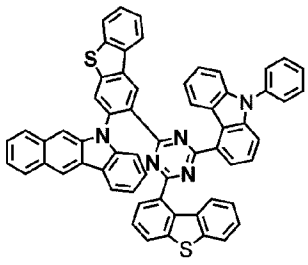
[348]

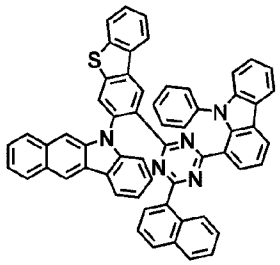
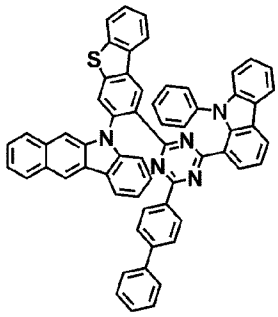
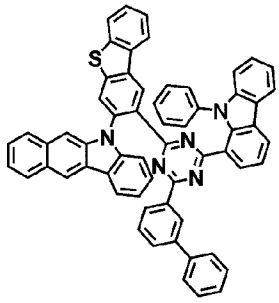
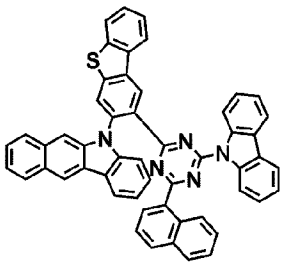
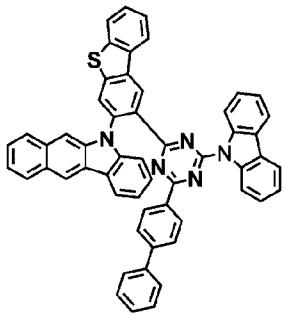
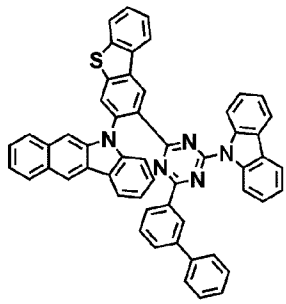
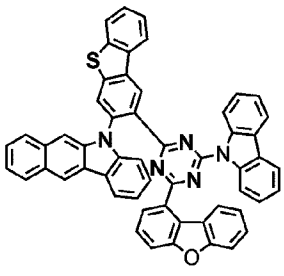
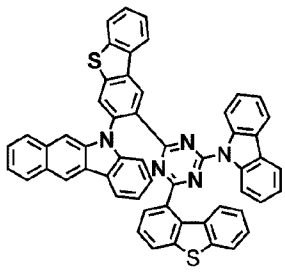
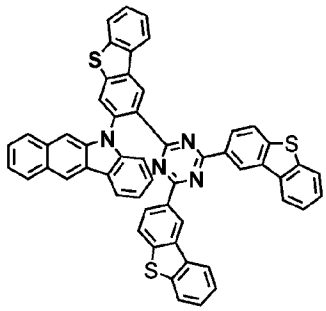
[349]

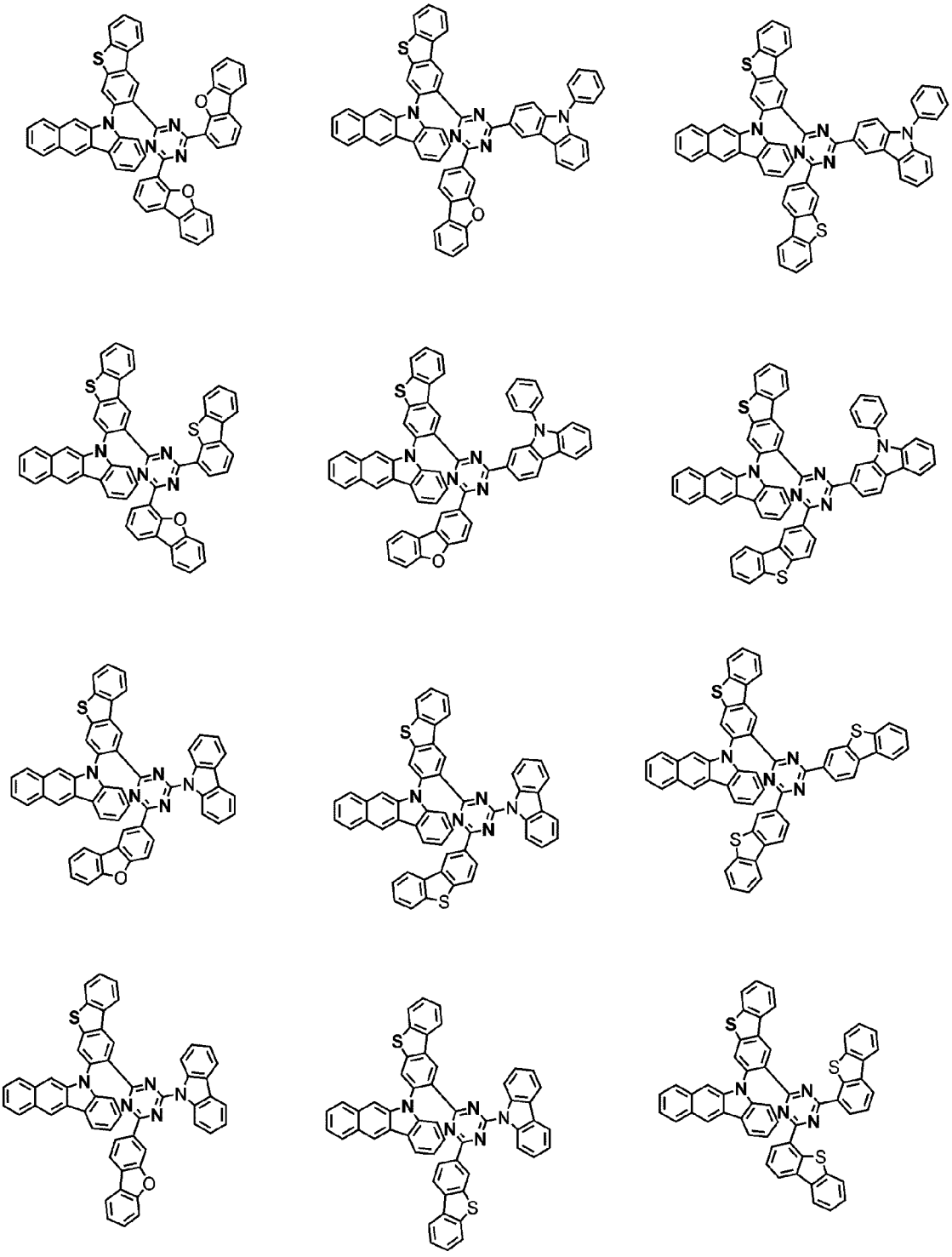
[350]

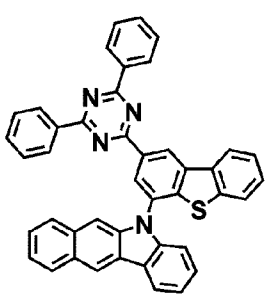
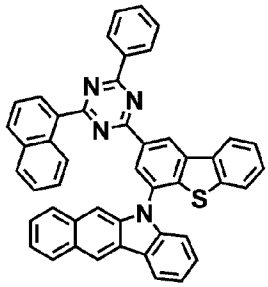
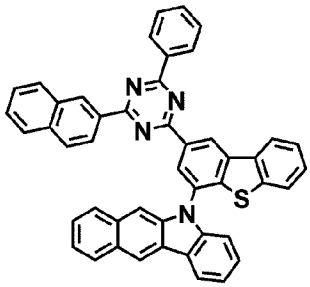
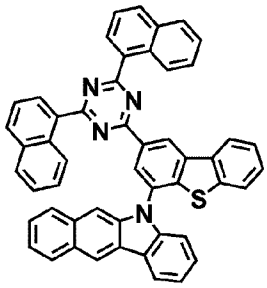
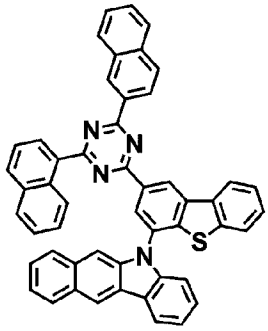
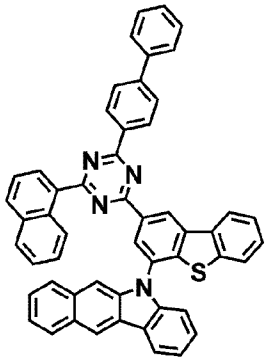
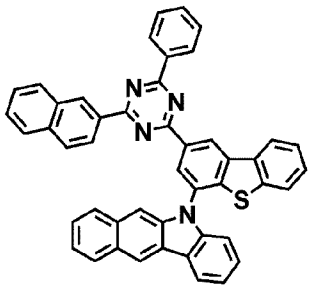
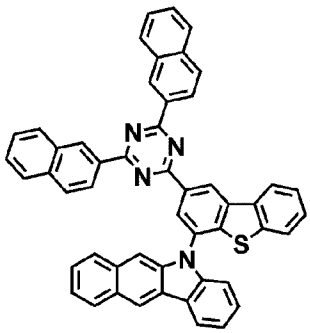
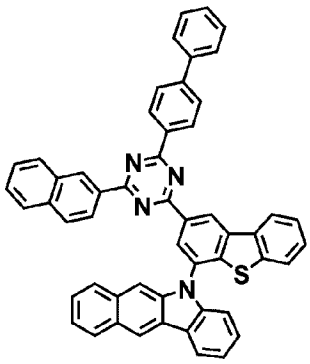
[351]

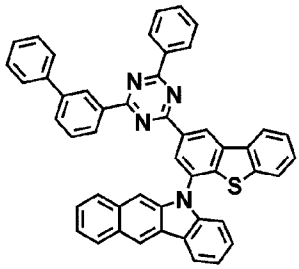
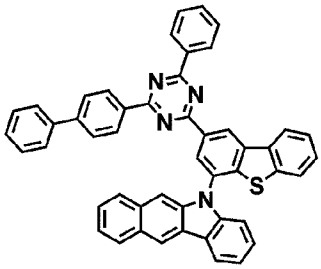
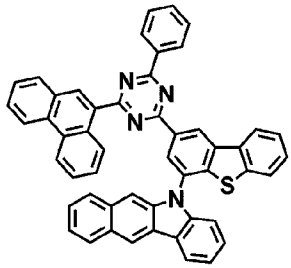
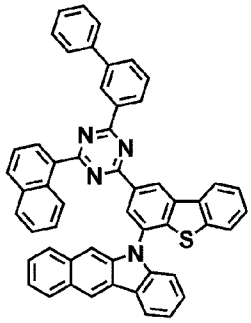
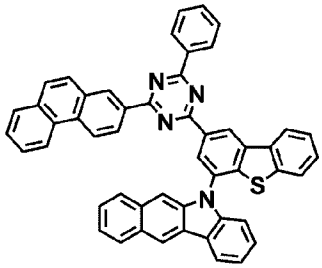
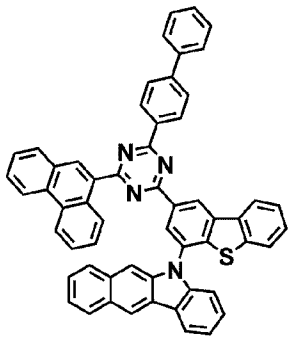
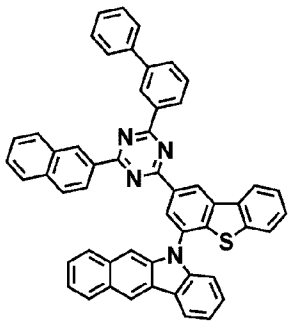
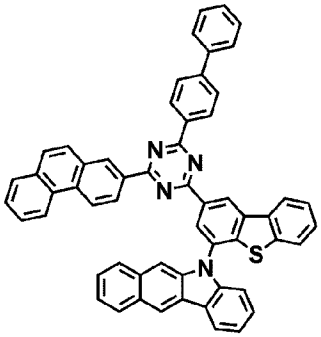
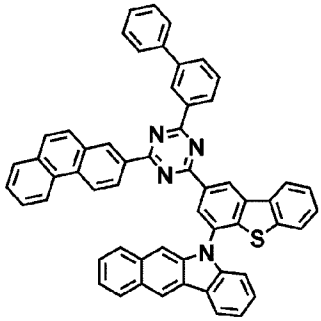
[352]



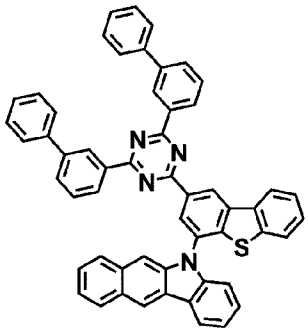
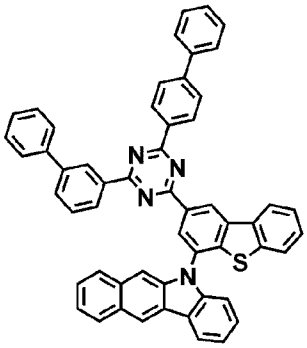
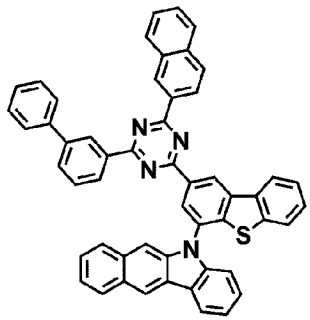
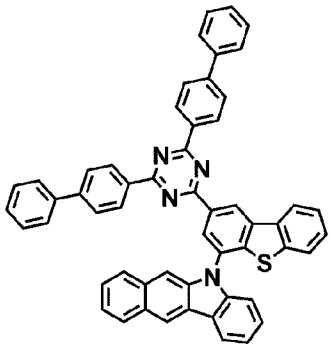
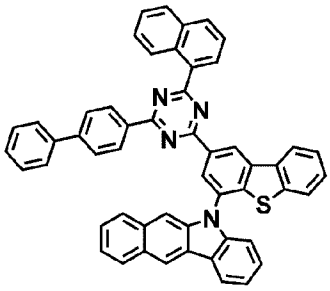
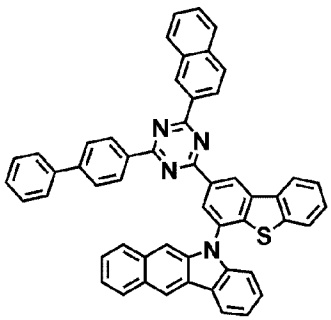
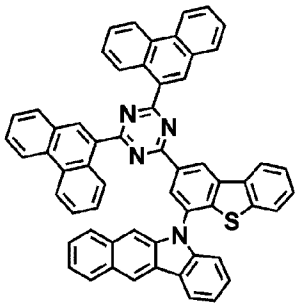
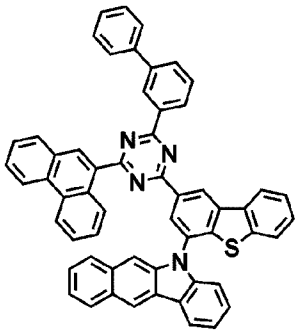
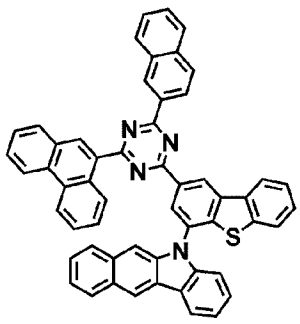
[353]

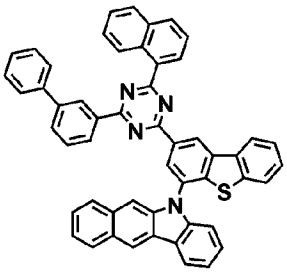
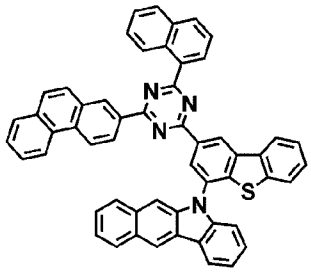
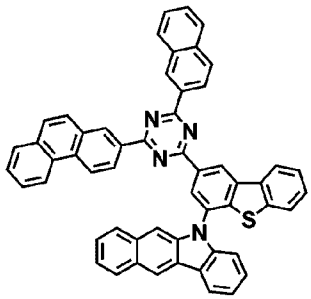
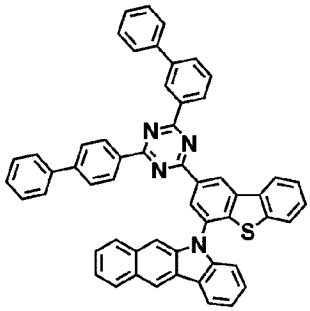
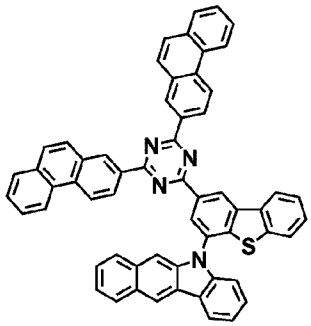
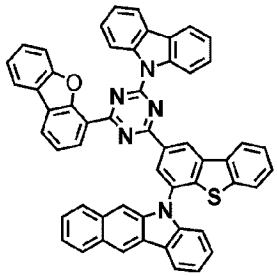
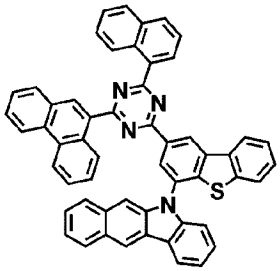
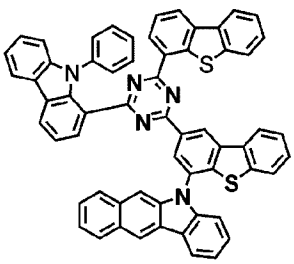
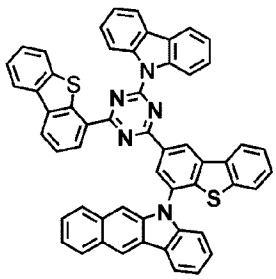
[354]

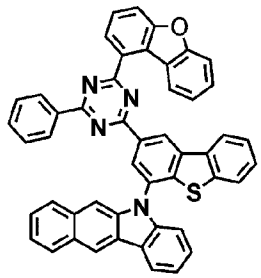
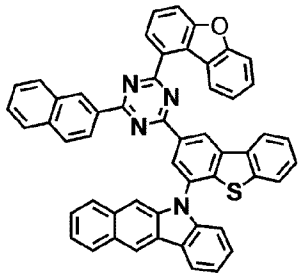
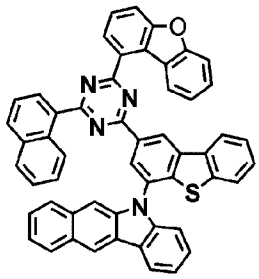
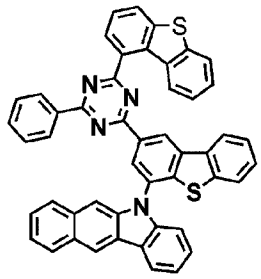
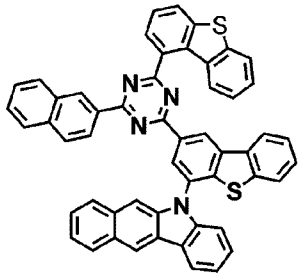
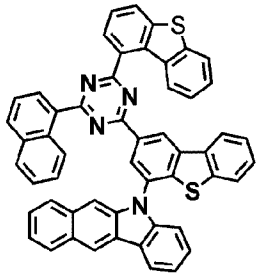
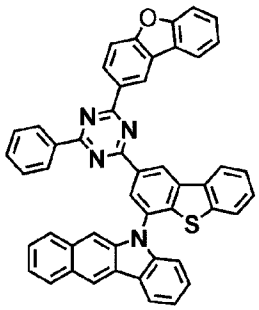
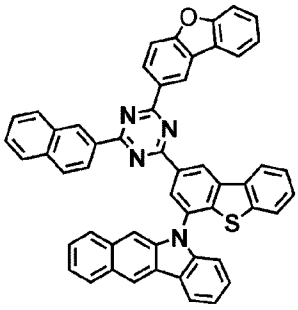
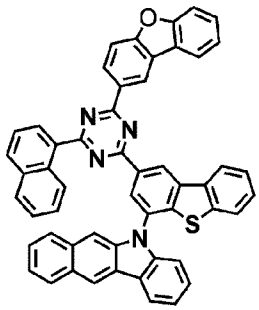
[355]

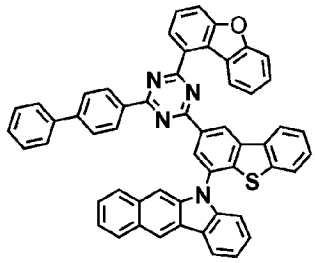
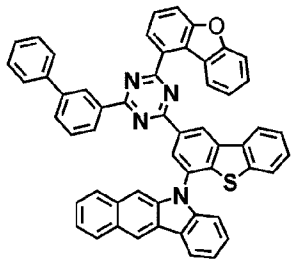
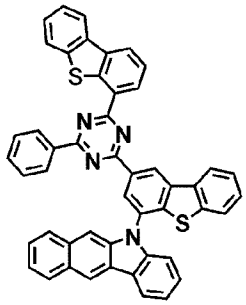
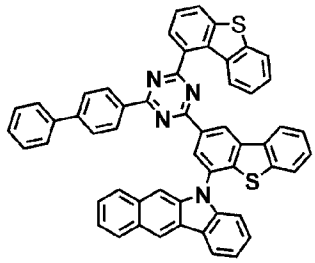
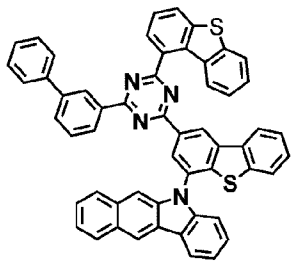
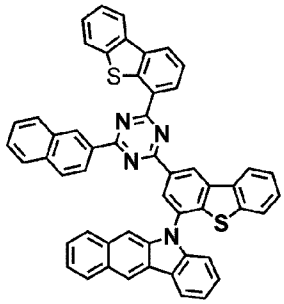
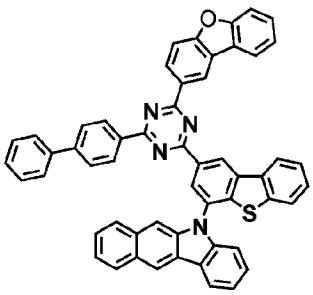
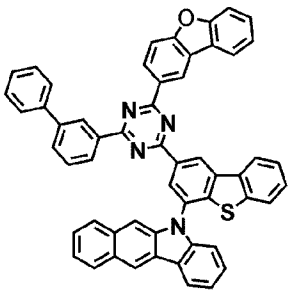
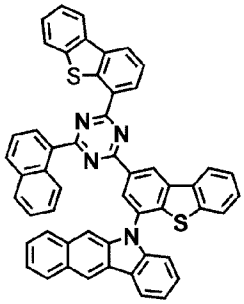
[356]

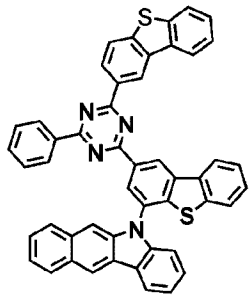
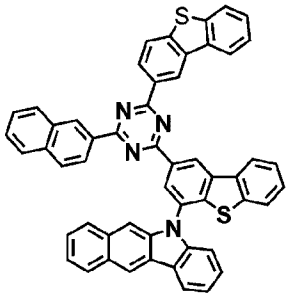
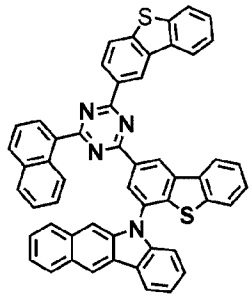
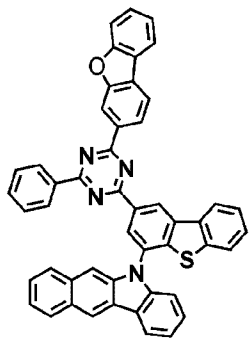
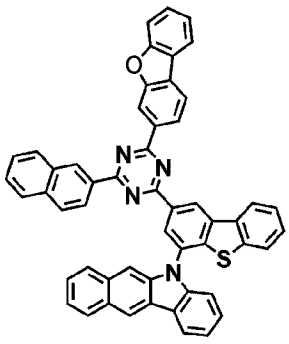
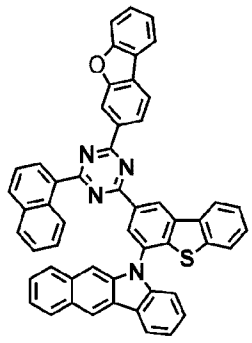
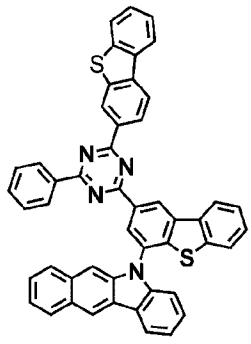
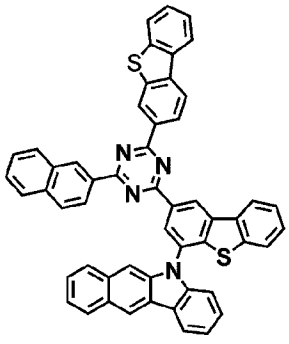
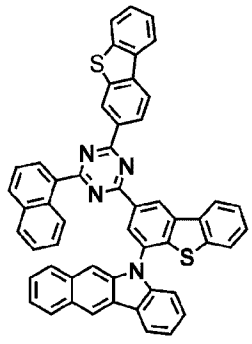
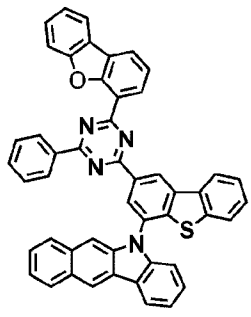
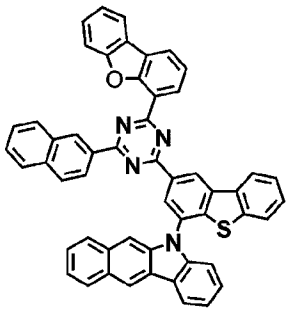
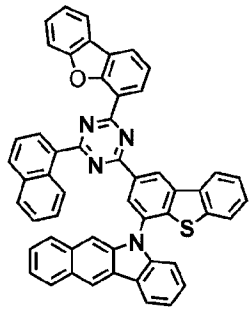
[357]

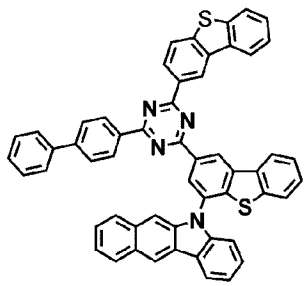
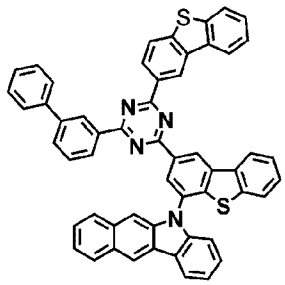
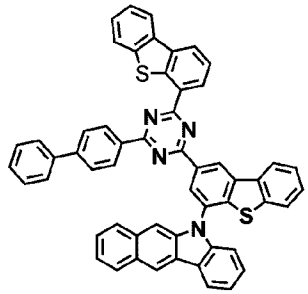
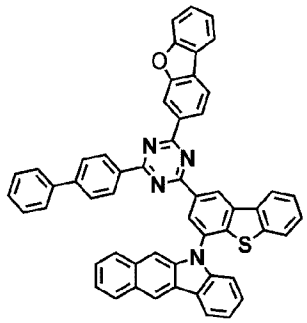
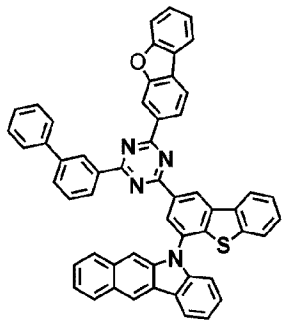
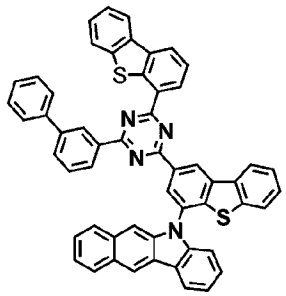
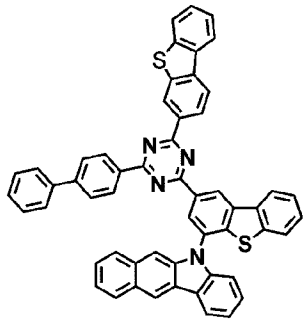
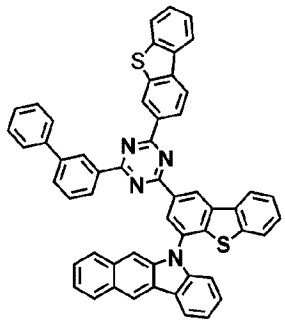
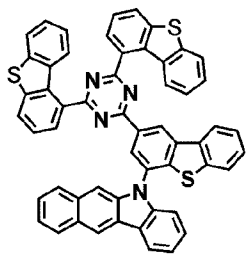
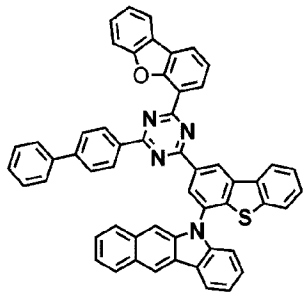
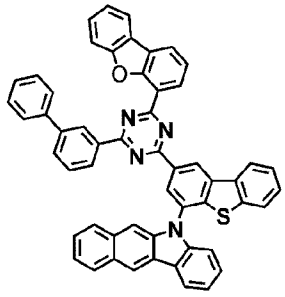
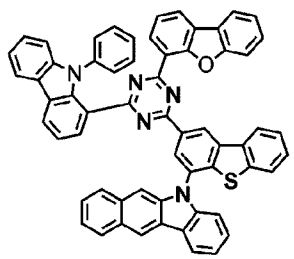
[358]

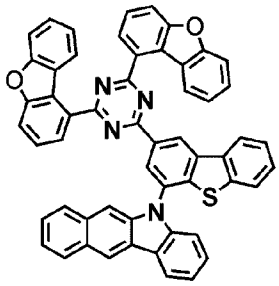
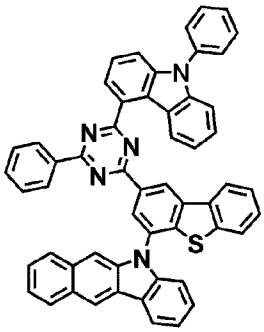
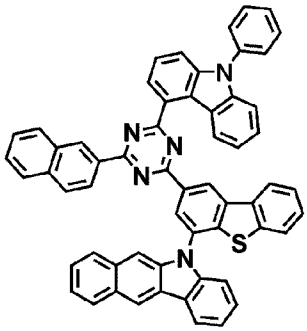
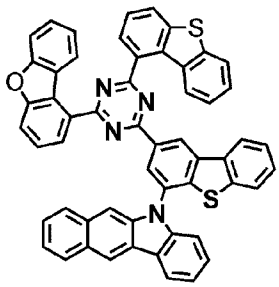
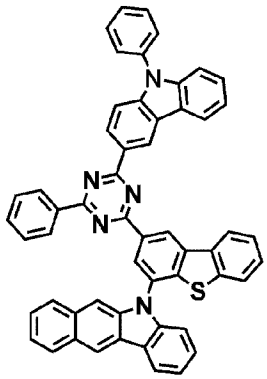
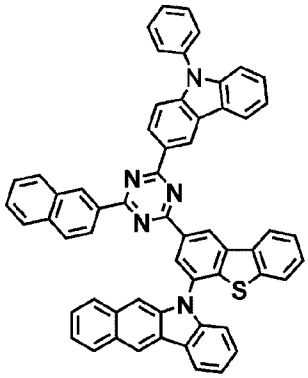
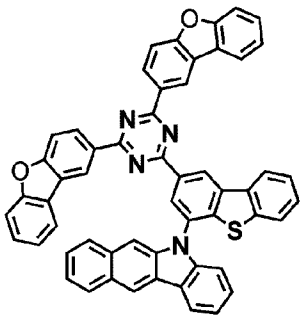
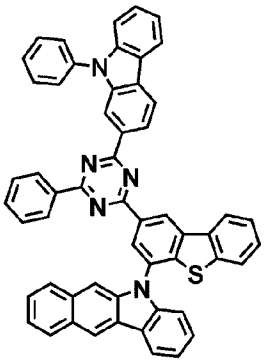
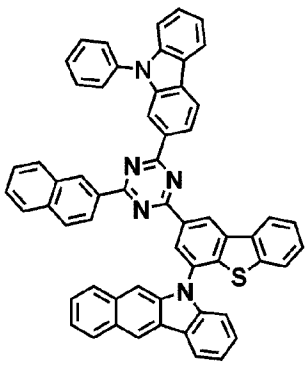
[359]

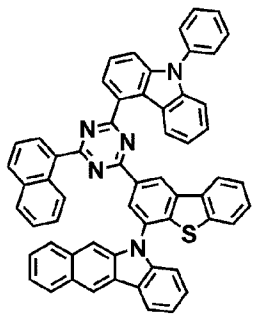
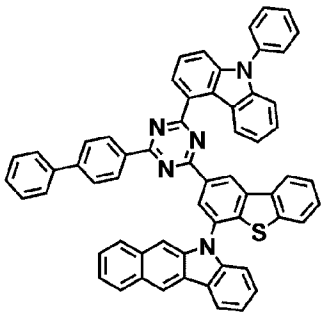
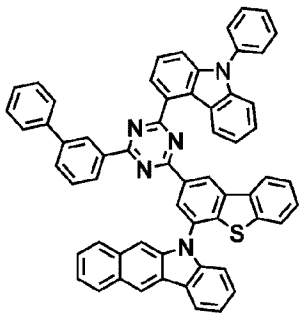
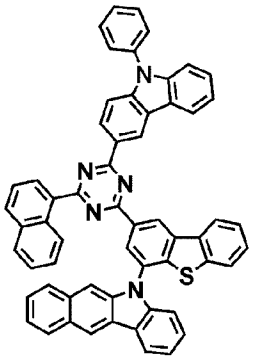
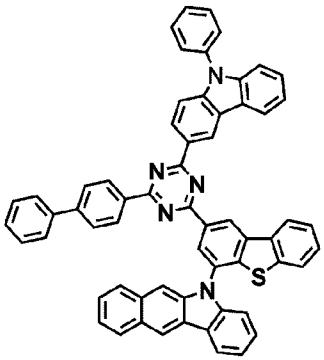
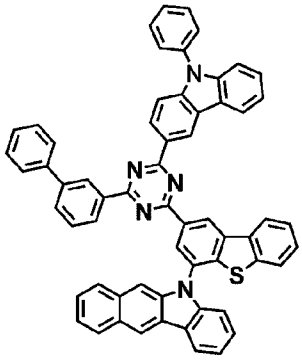
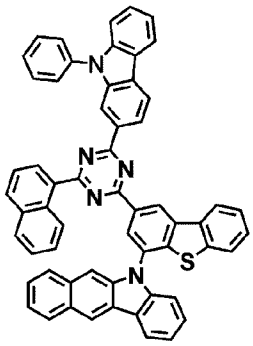
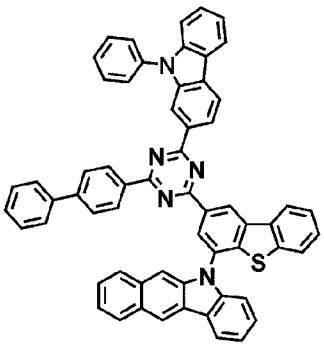
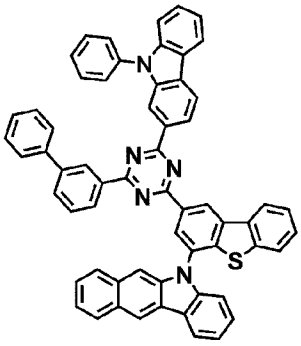
[360]

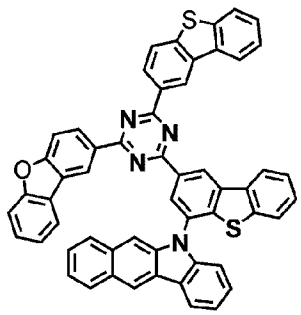
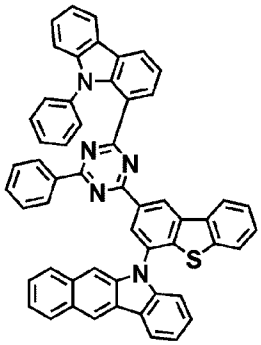
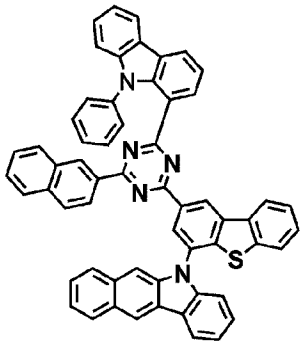
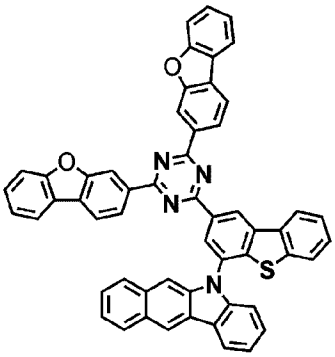
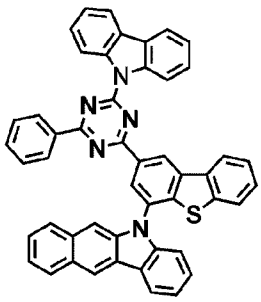
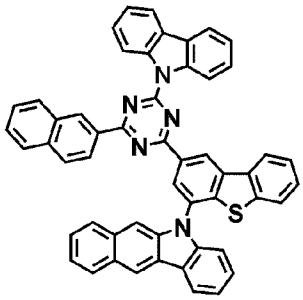
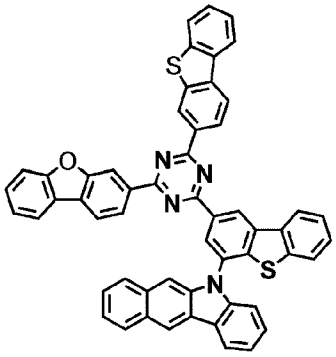
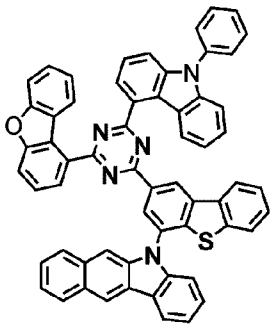
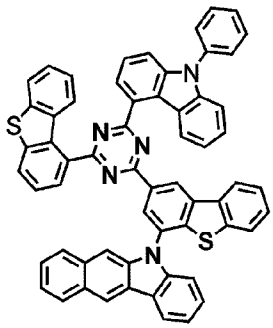
[361]

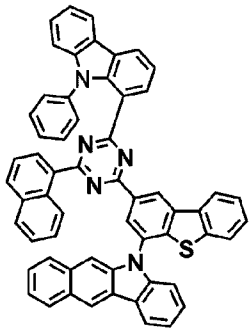
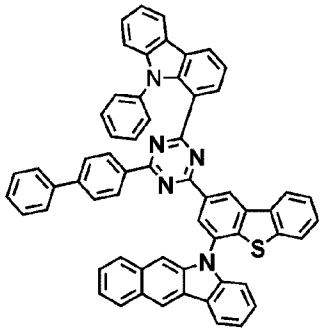
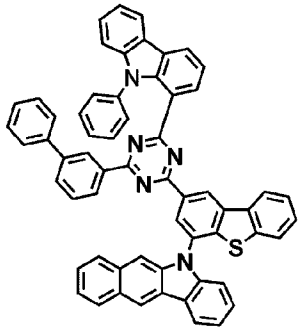
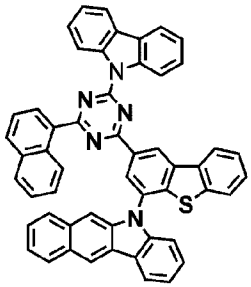
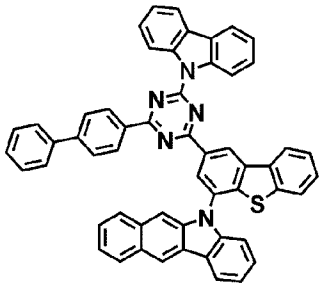
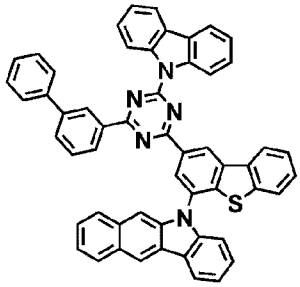
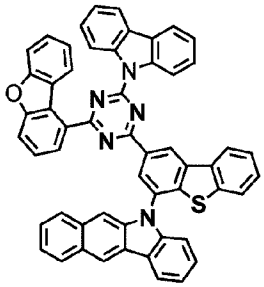
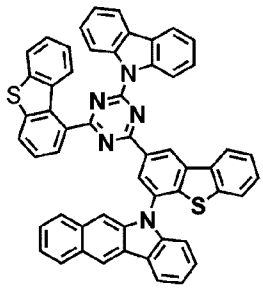
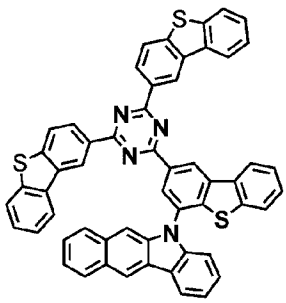
[362]

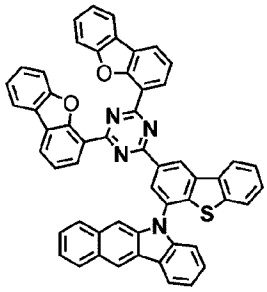
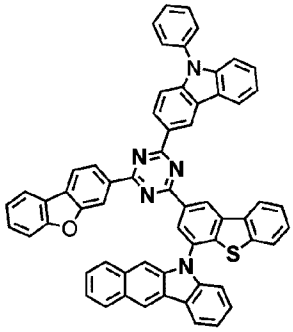
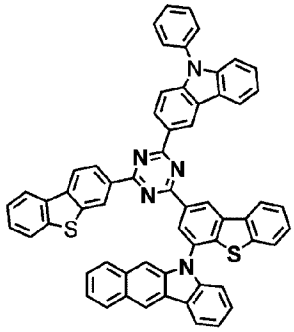
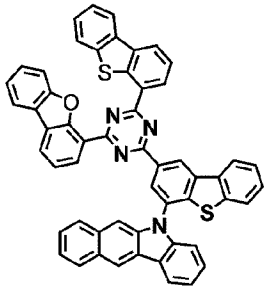
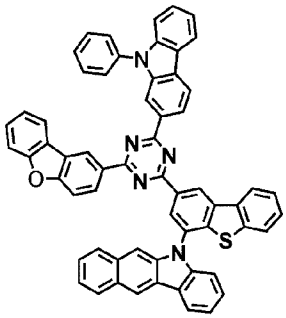
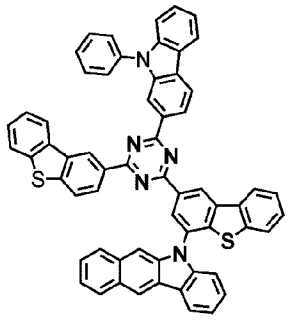
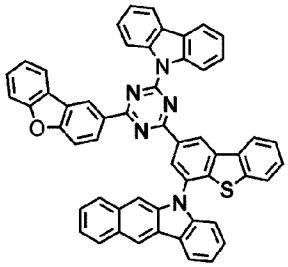
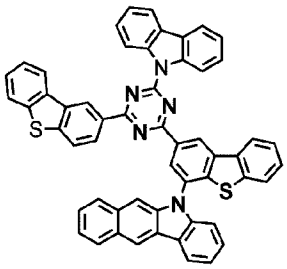
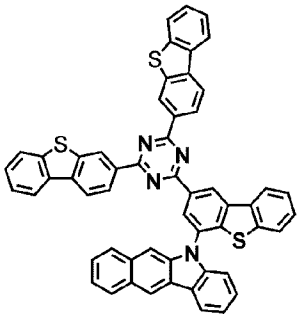
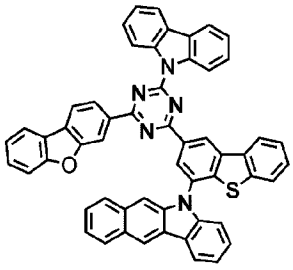
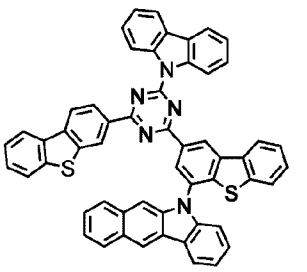
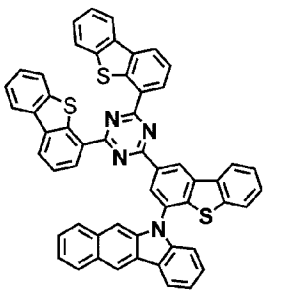
[363]

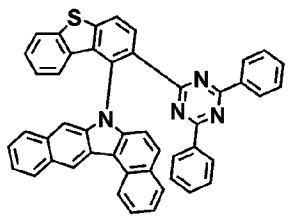
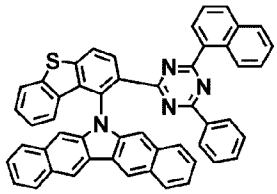
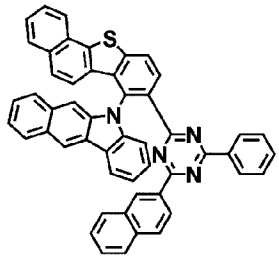
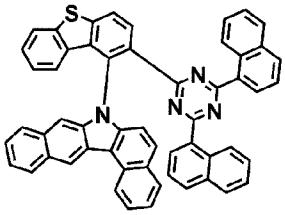
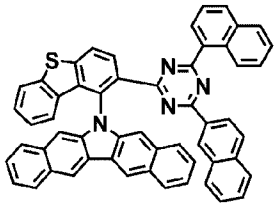
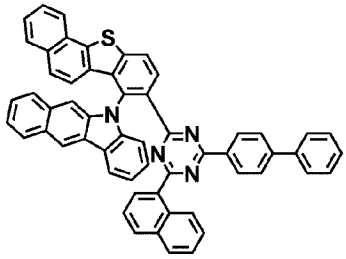
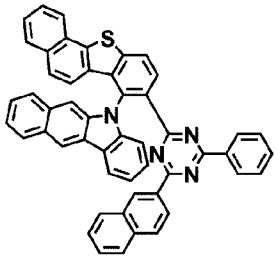
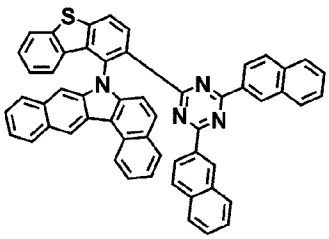
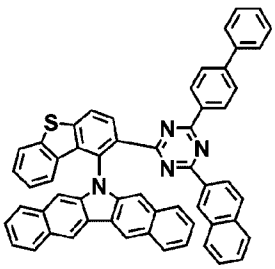
[364]

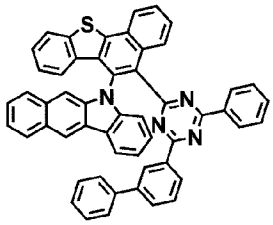
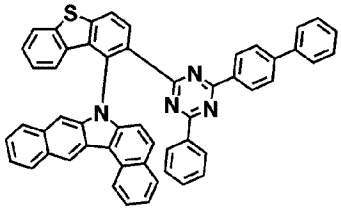
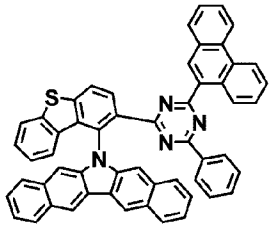
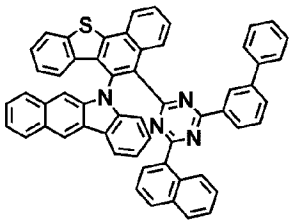
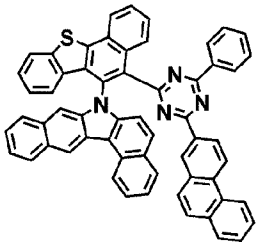
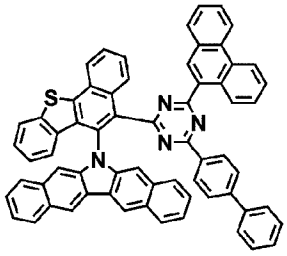
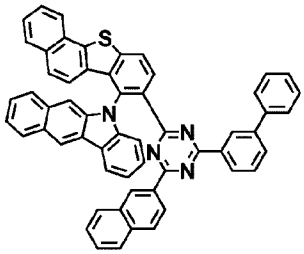
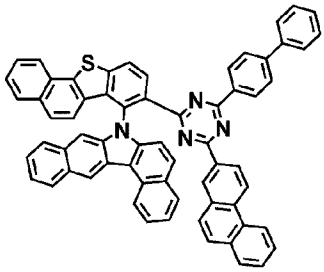
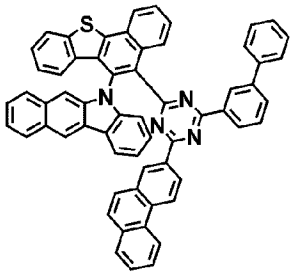
[365]

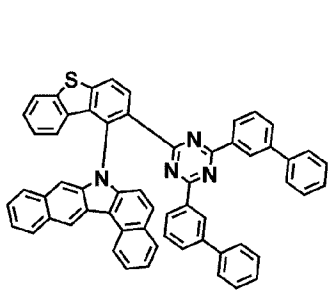
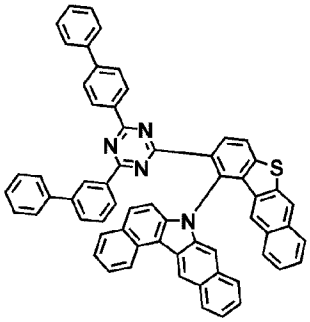
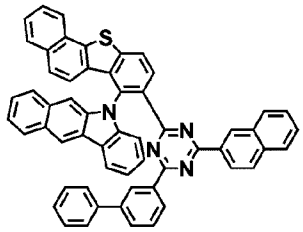
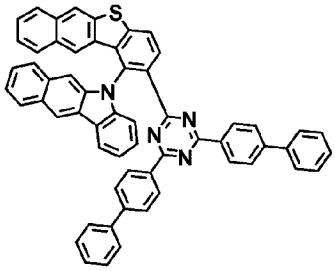
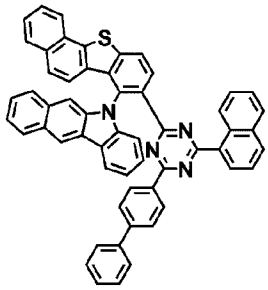
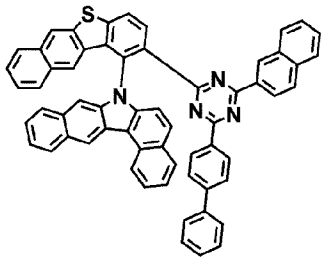
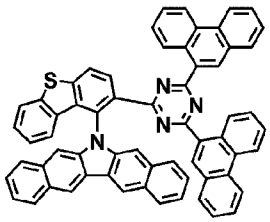
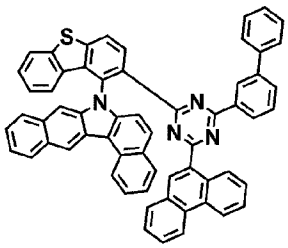
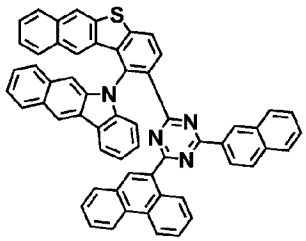
[366]

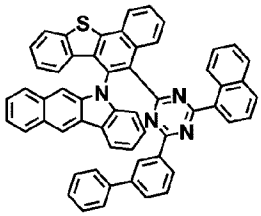
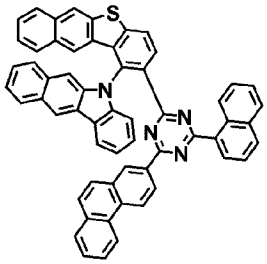
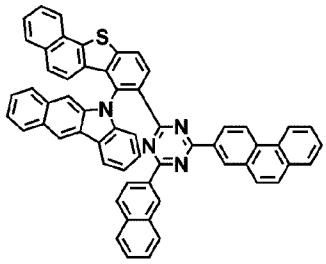
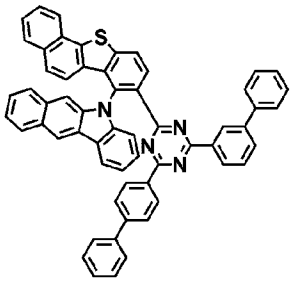
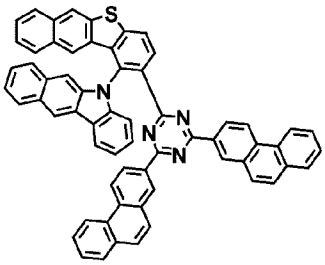
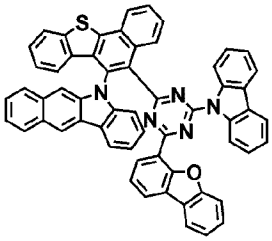
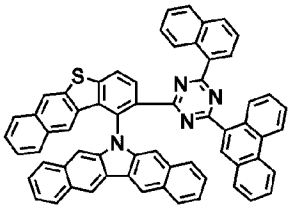
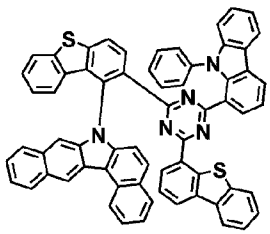
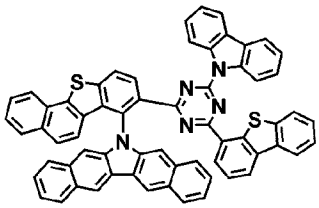
[367]

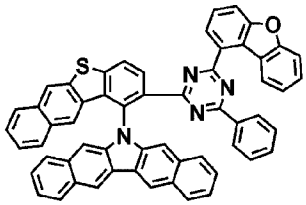
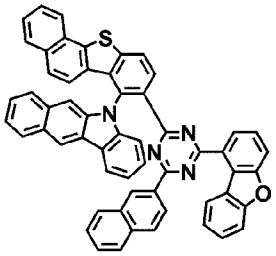
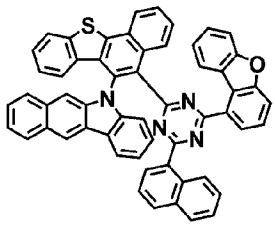
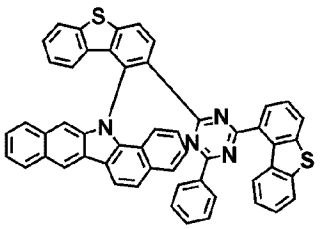
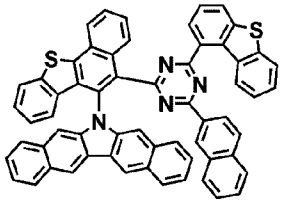
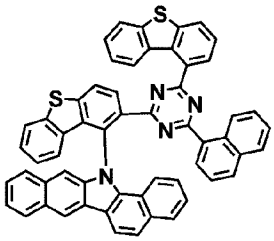
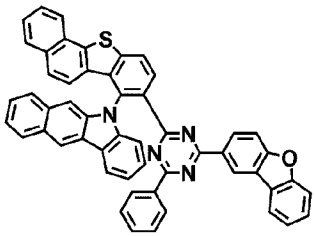
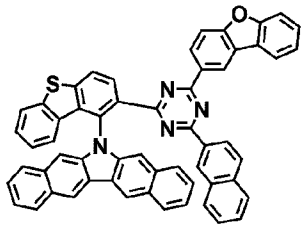
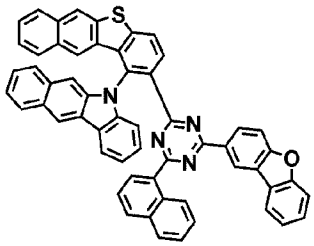
[368]

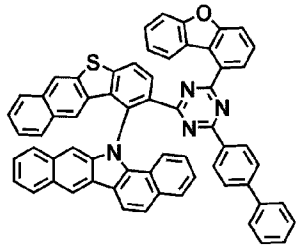
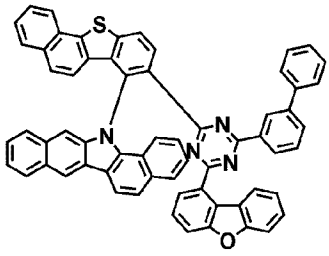
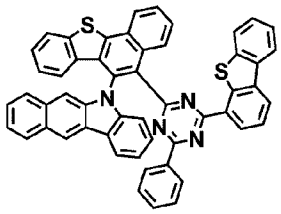
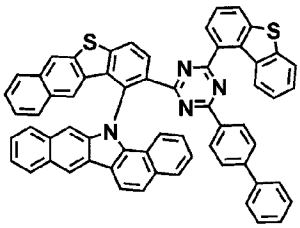
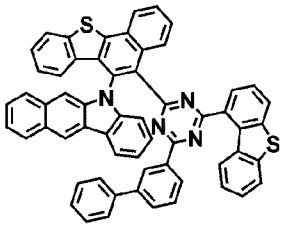
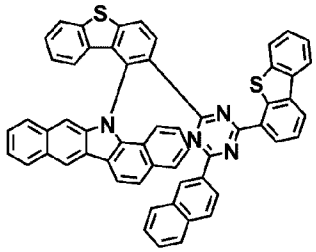
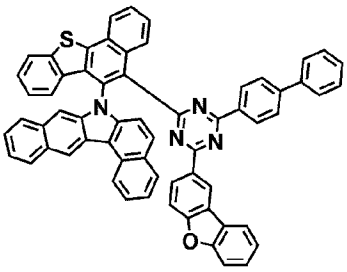
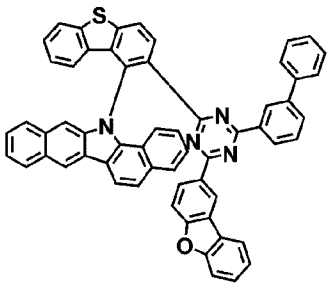
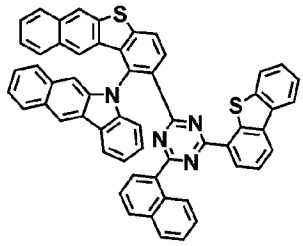
[369]

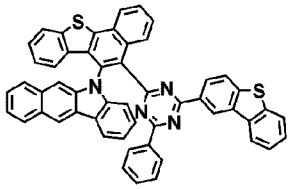
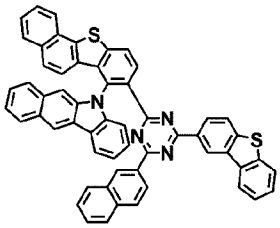
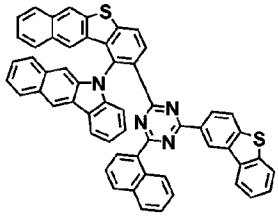
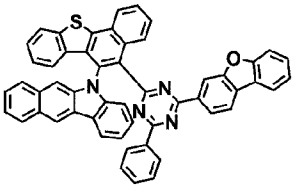
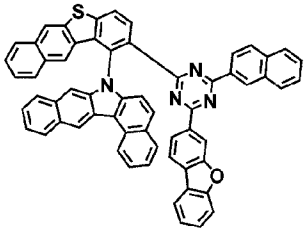
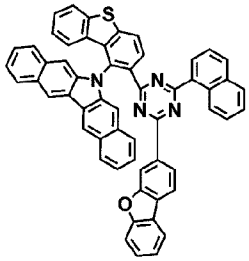
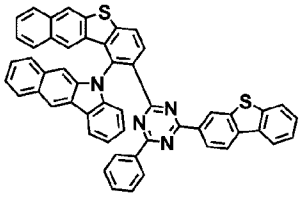
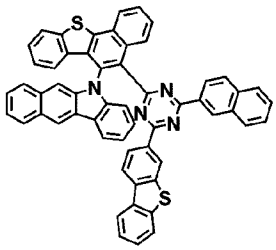
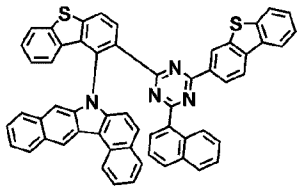
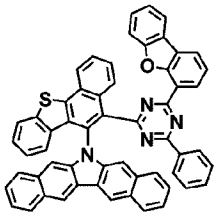
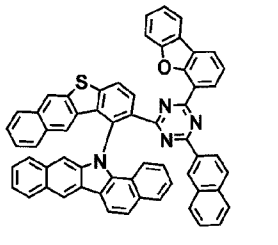
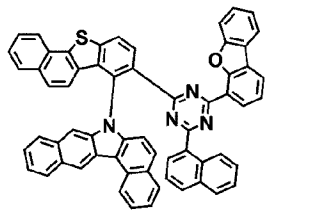
[370]

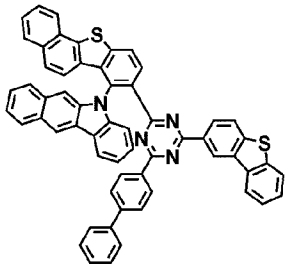
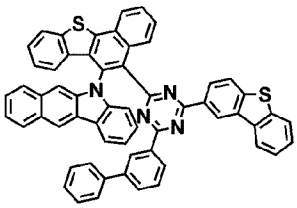
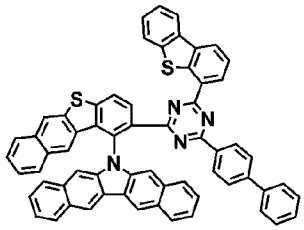
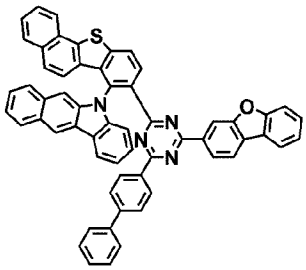
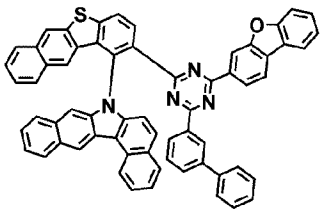
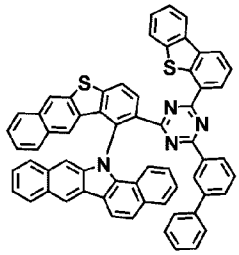
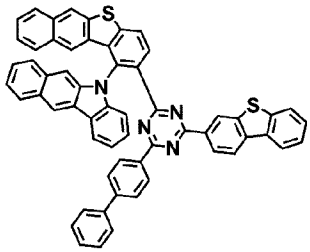
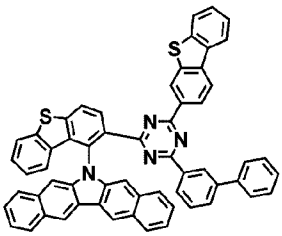
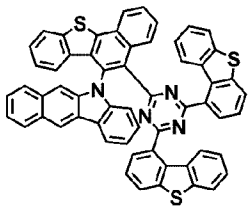
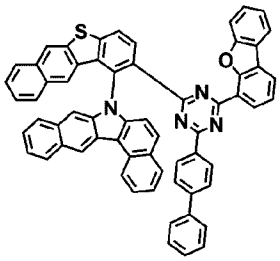
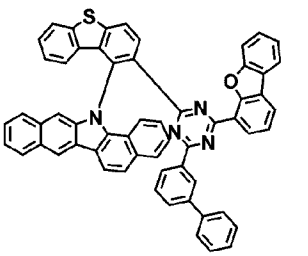
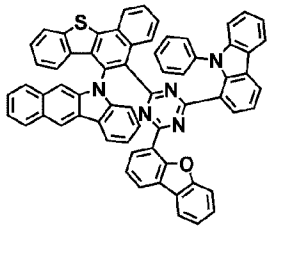
[371]

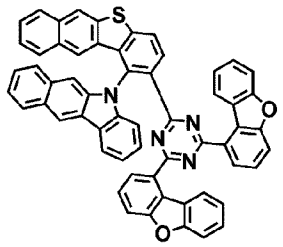
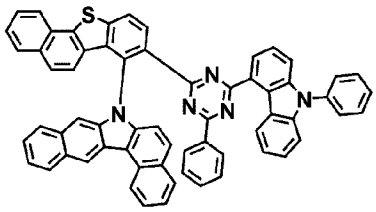
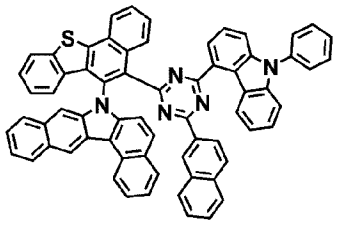
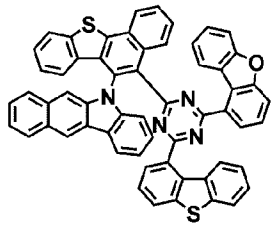
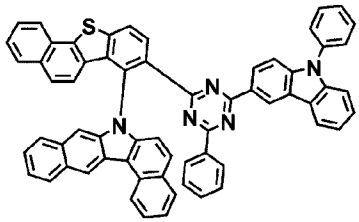
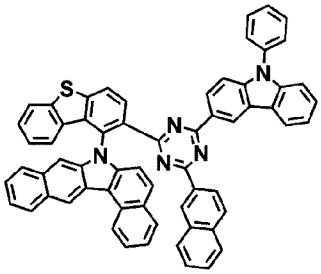
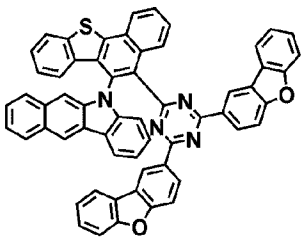
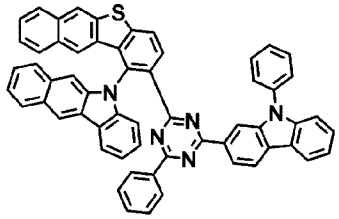
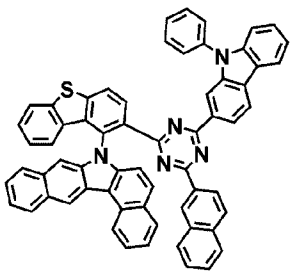
[372]

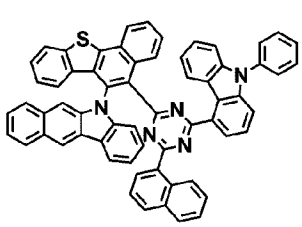
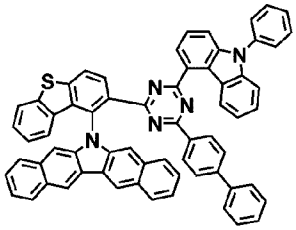
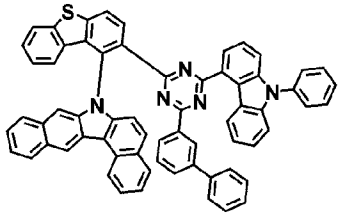
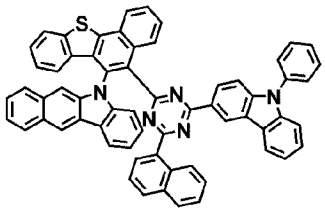
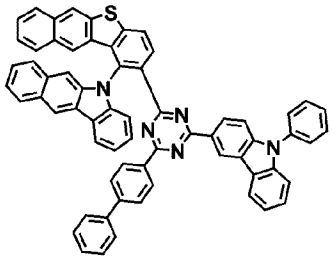
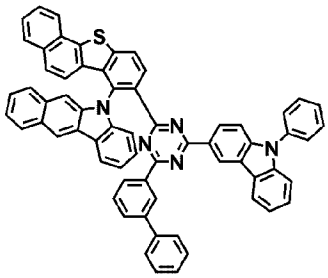
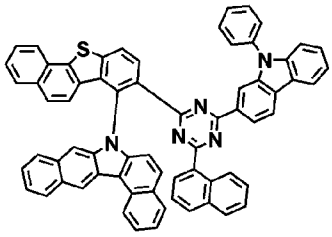
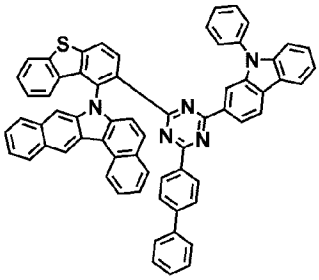
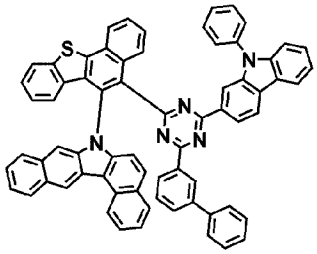
[373]

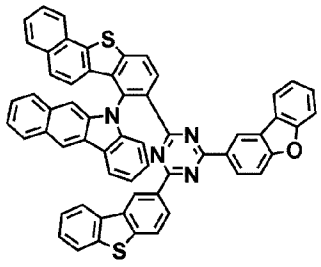
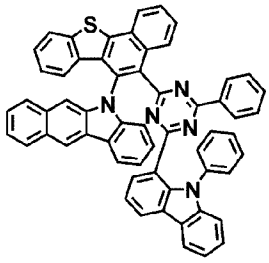
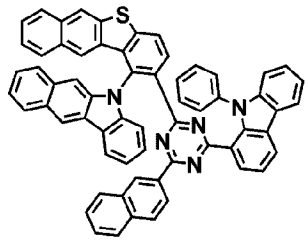
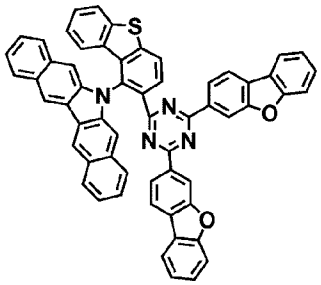
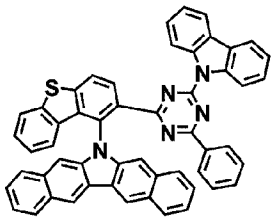
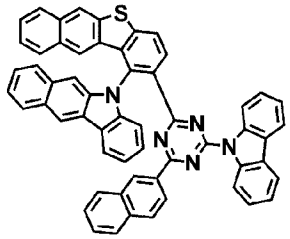
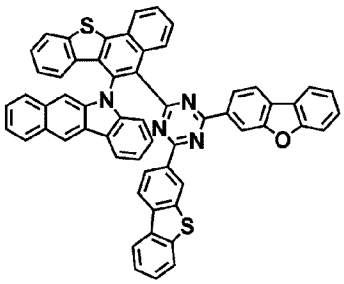
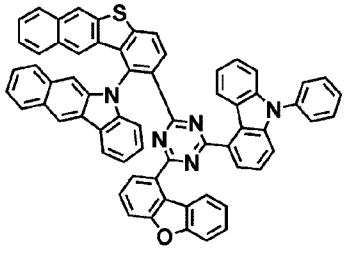
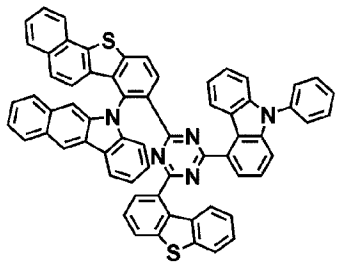
[374]

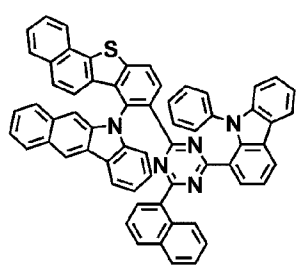
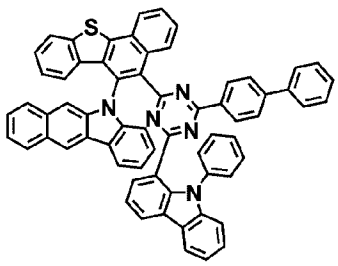
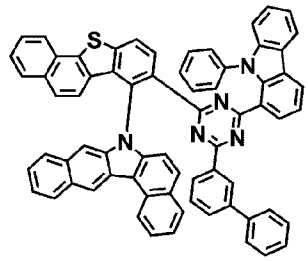
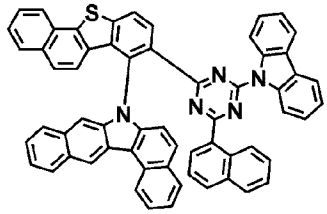
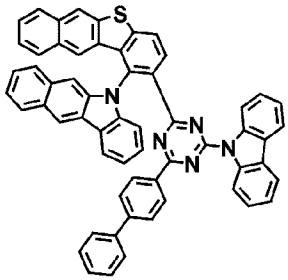
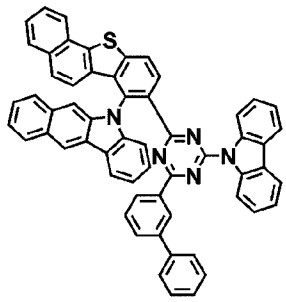
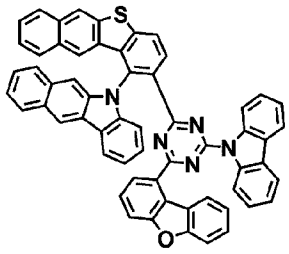
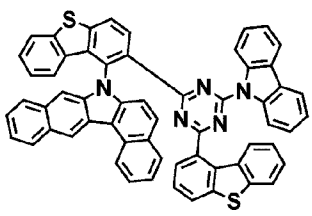
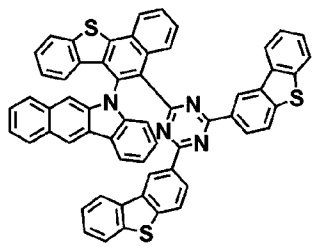
[375]

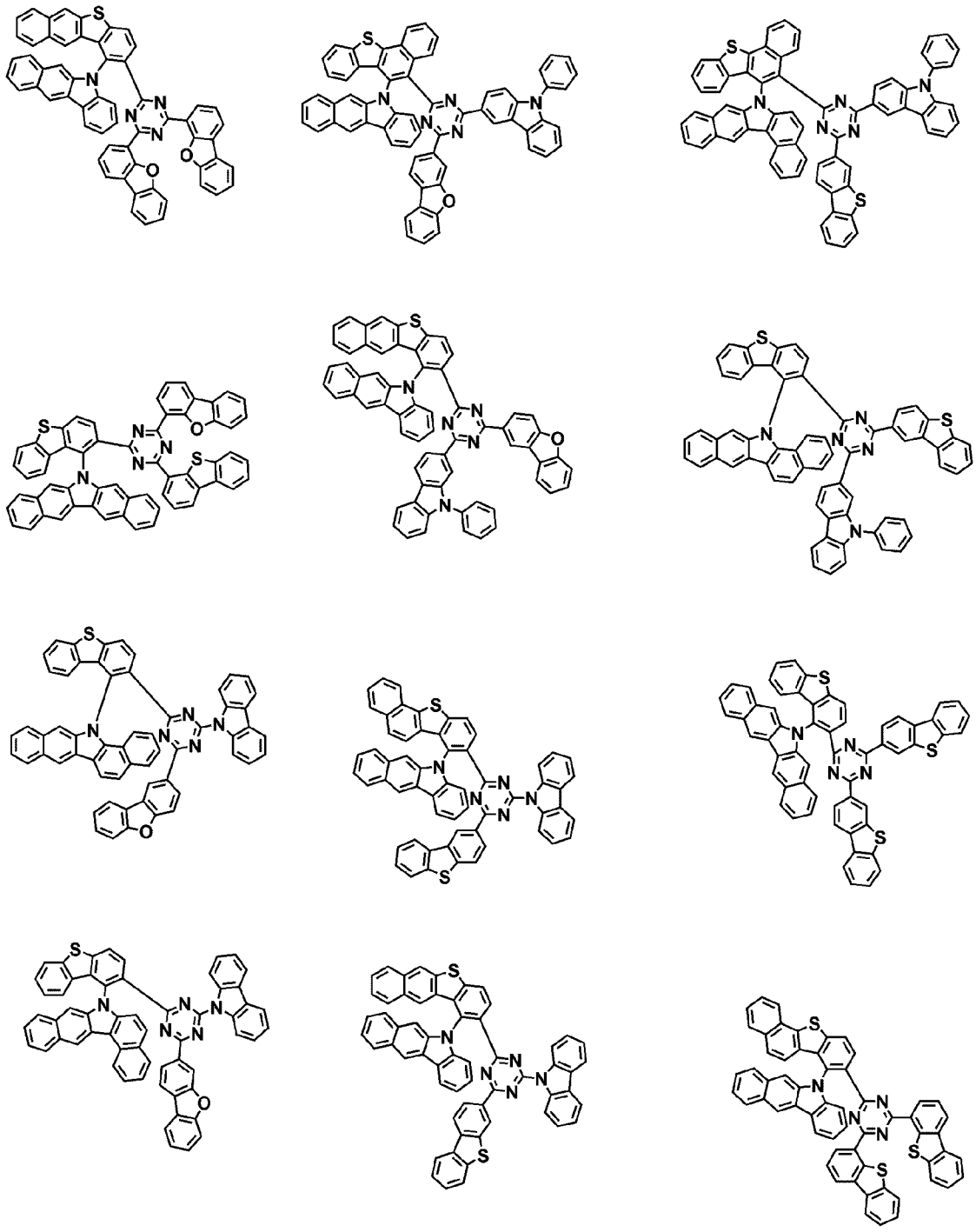
[376]

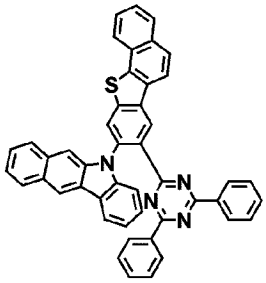
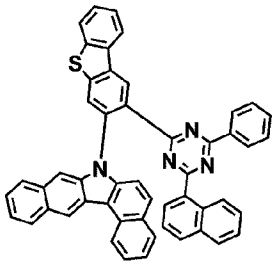
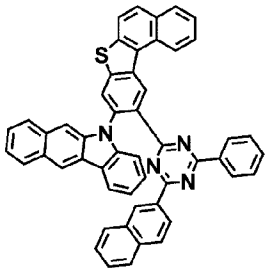
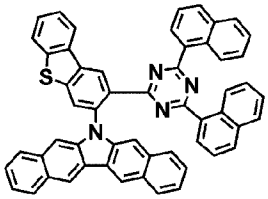
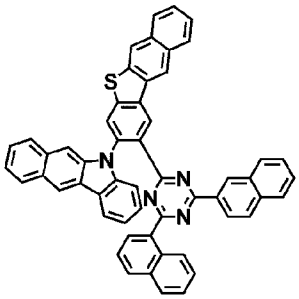
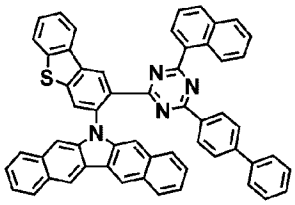
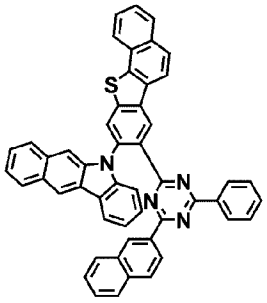
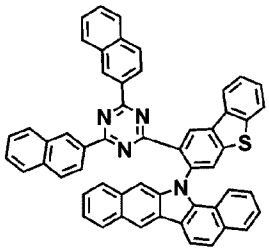
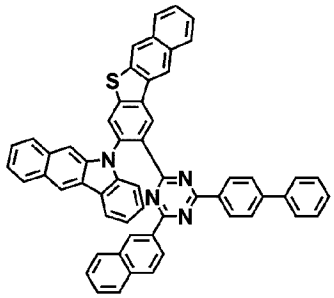
[377]

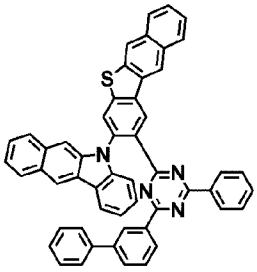
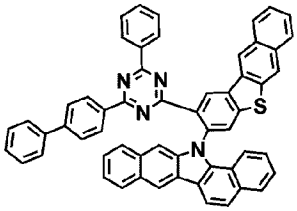
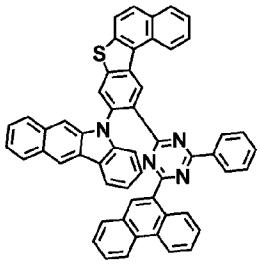
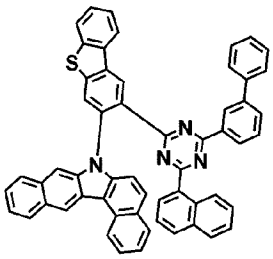
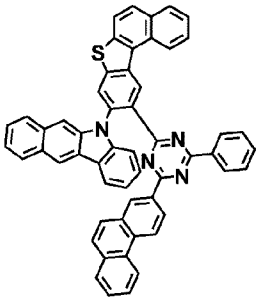
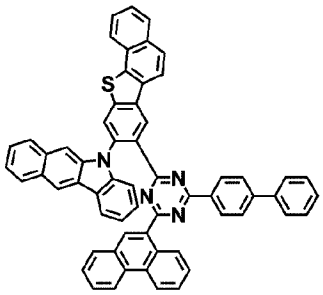
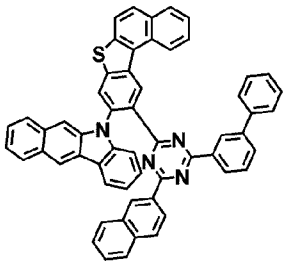
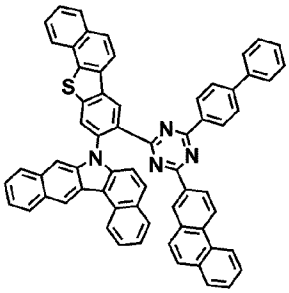
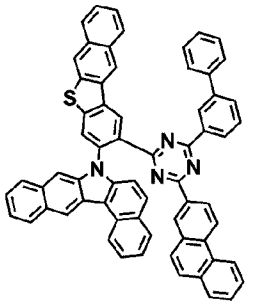
[378]



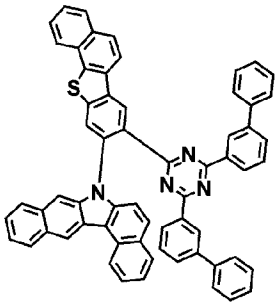
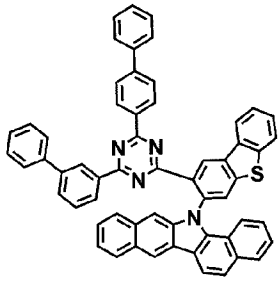
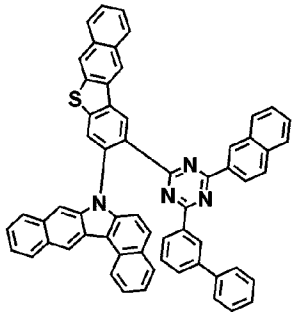
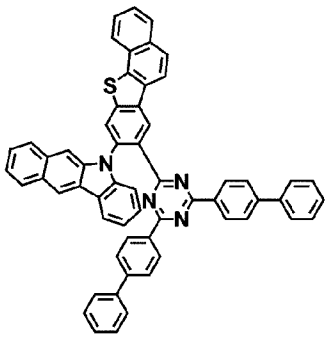
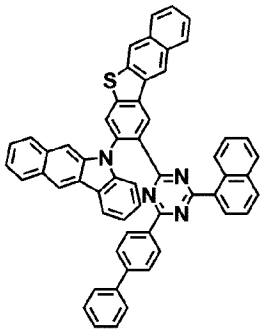
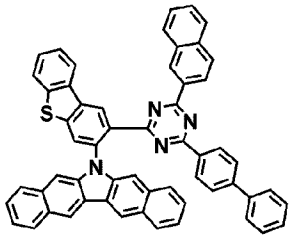
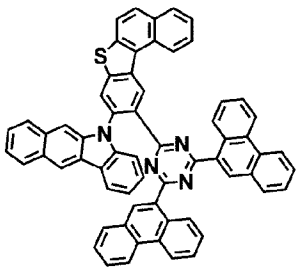
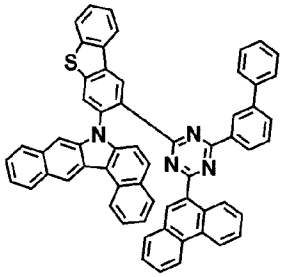
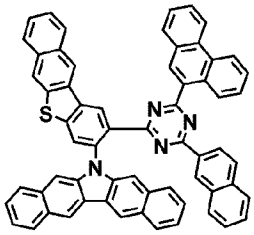
[379]

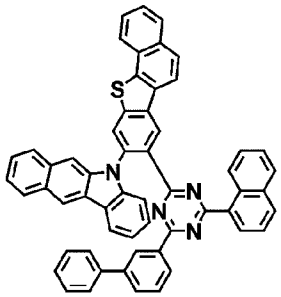
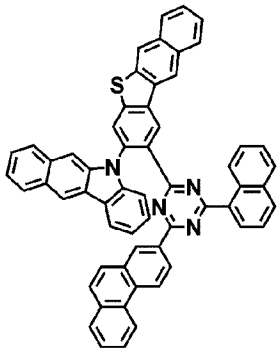
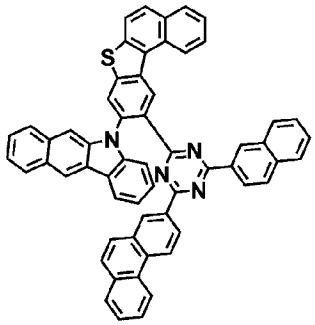
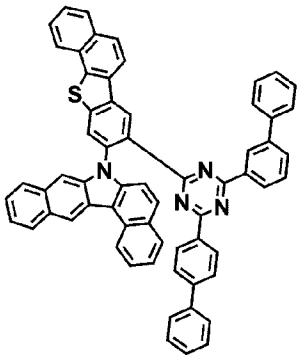
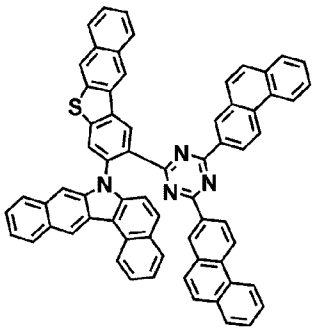
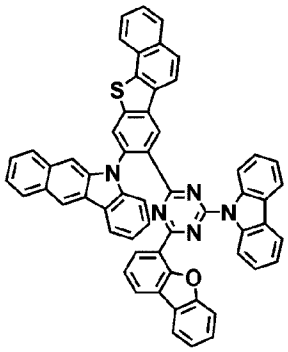
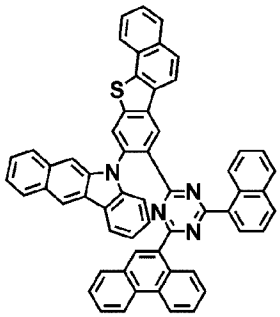
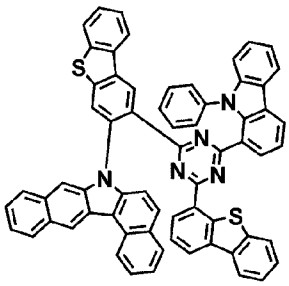
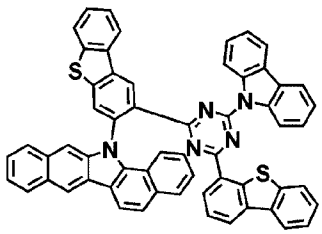
[380]

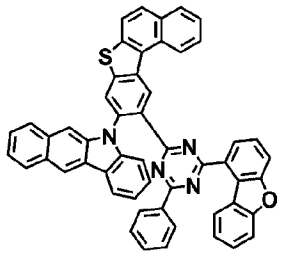
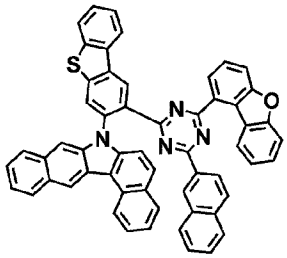
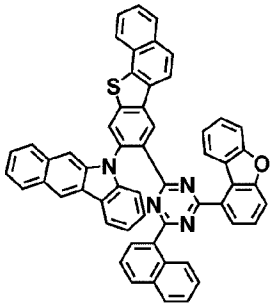
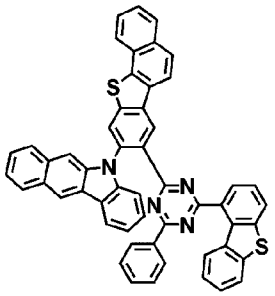
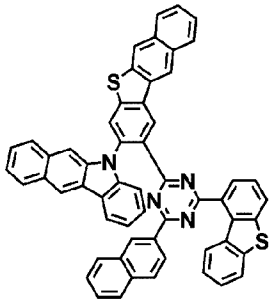
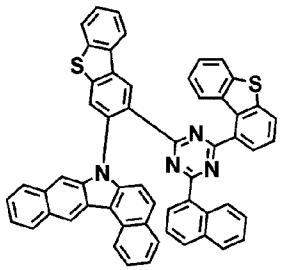
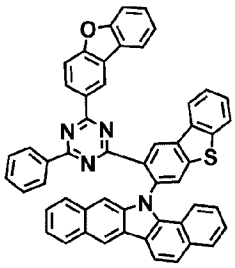
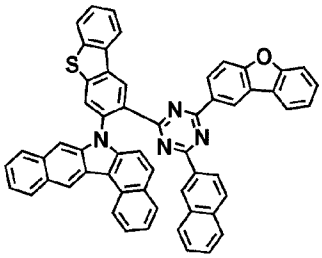
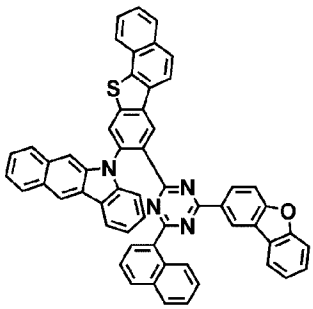
[381]

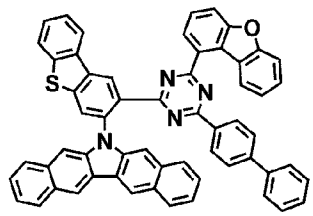
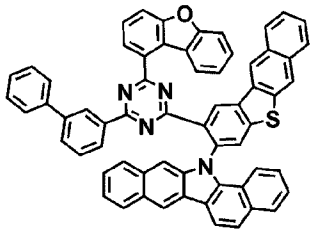
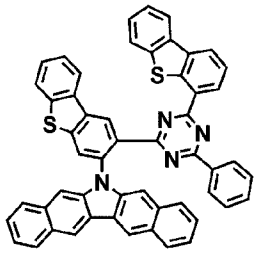
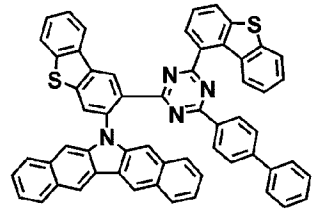
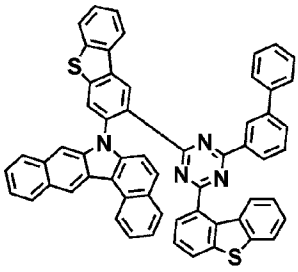
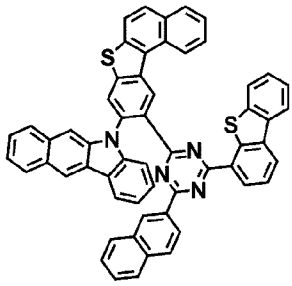
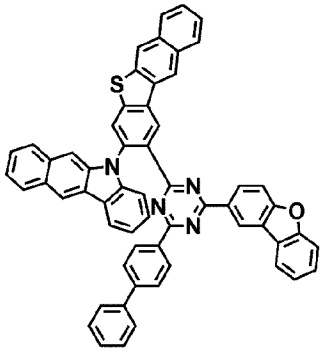
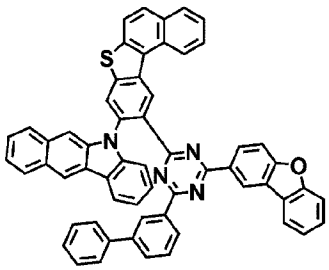
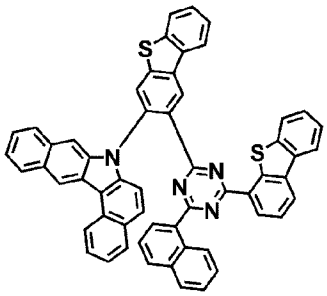
[382]

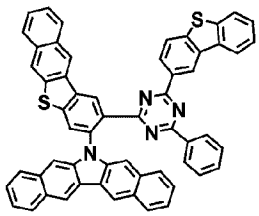
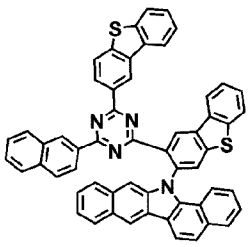
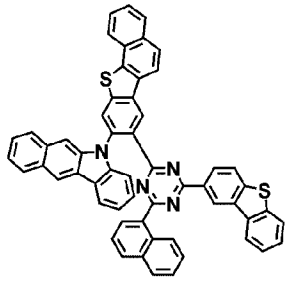
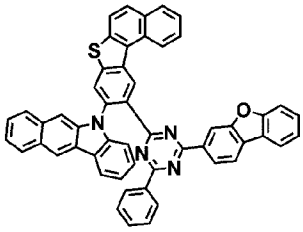
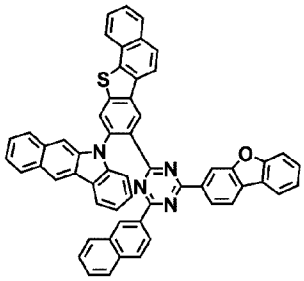
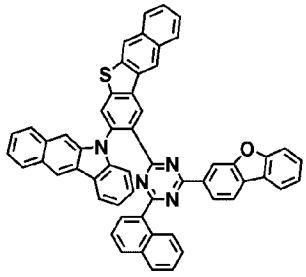
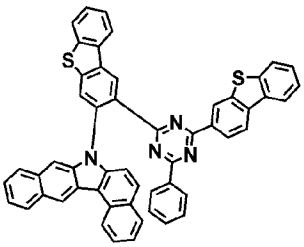
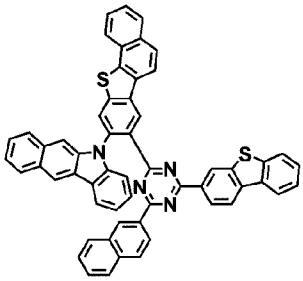
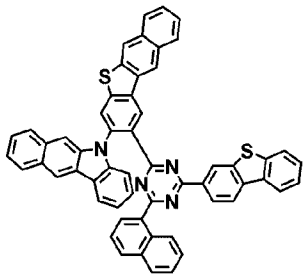
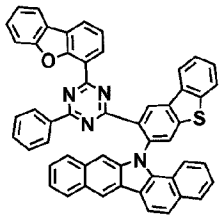
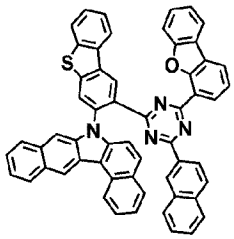
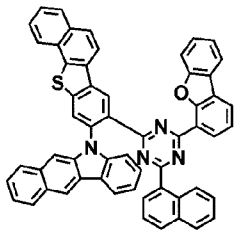
[383]

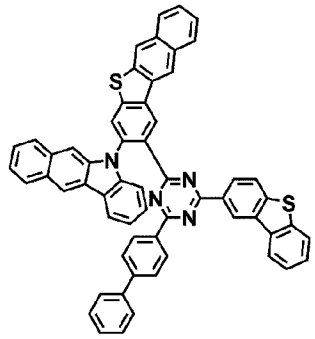
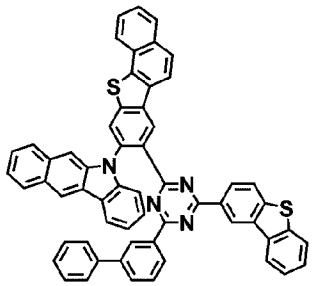
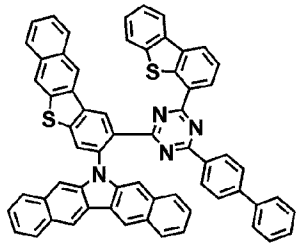
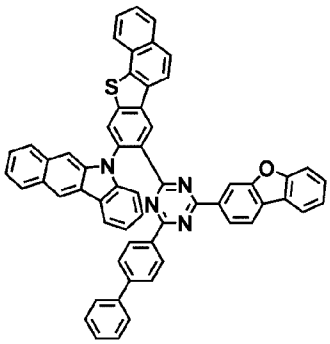
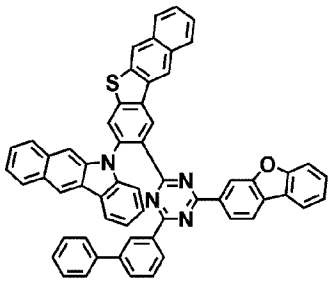
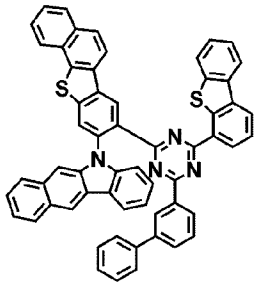
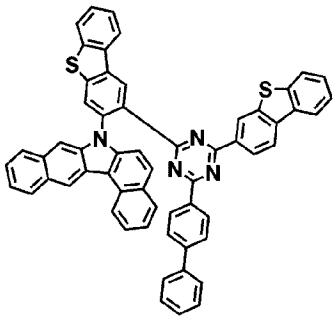
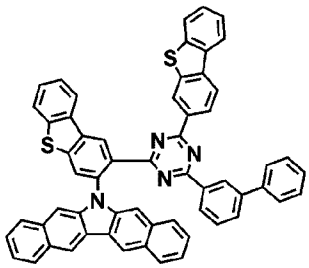
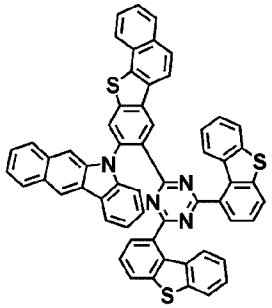
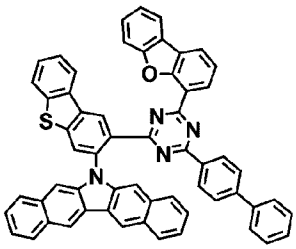
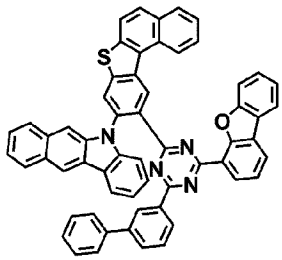
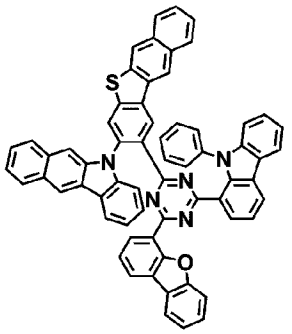
[384]

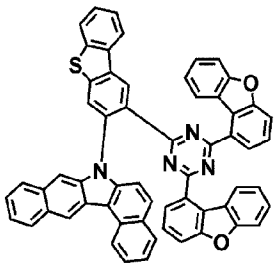
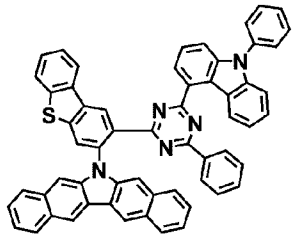
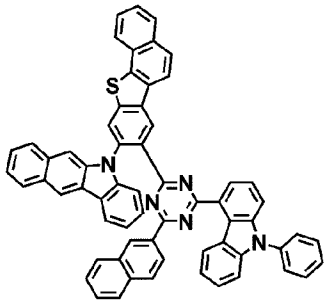
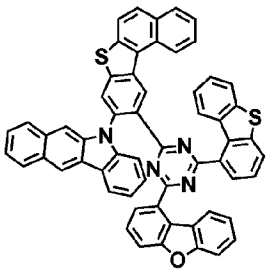
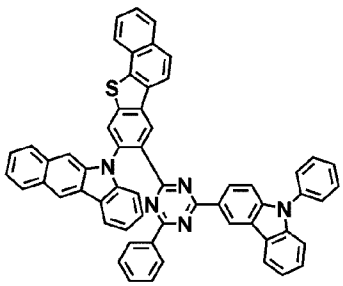
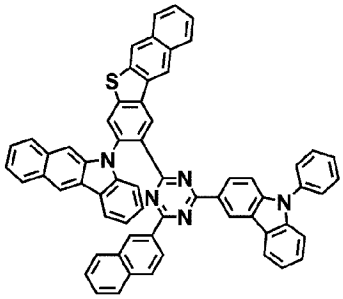
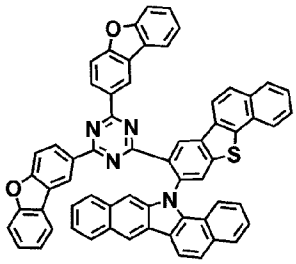
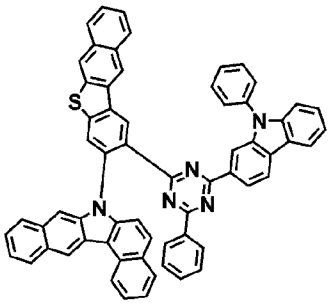
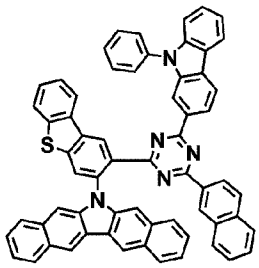
[385]

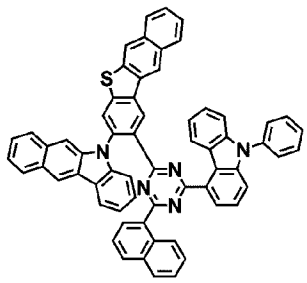
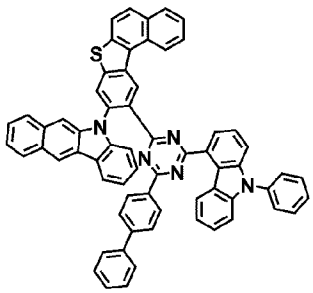
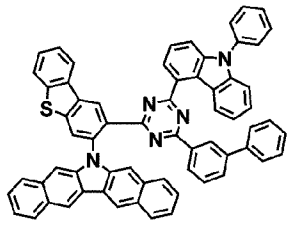
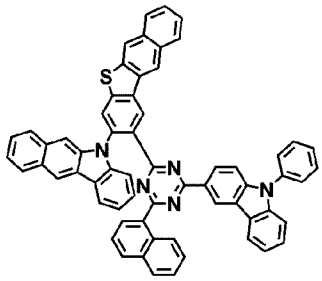
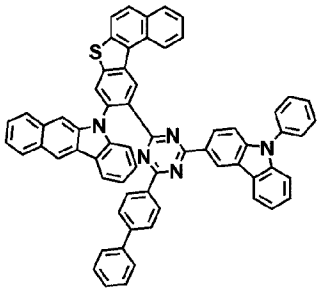
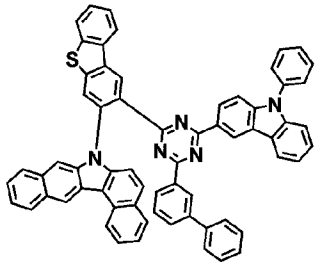
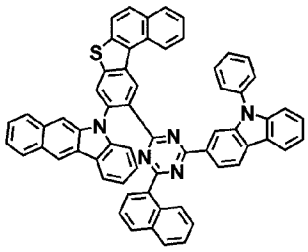
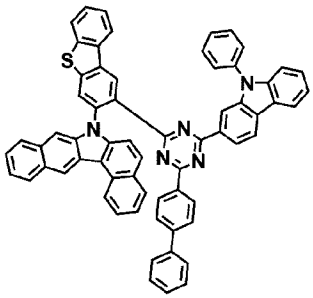
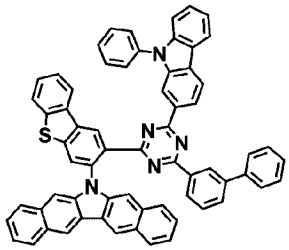
[386]

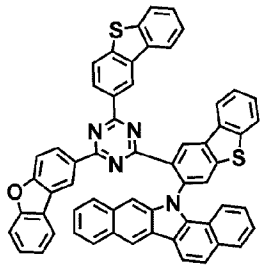
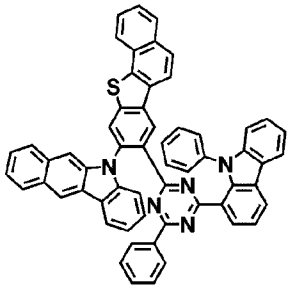
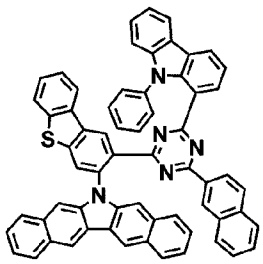
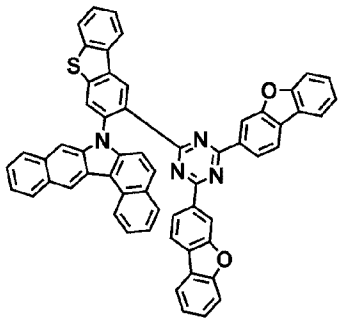
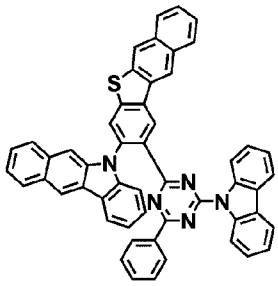
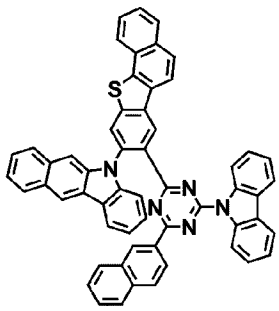
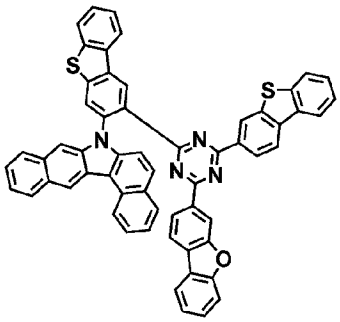
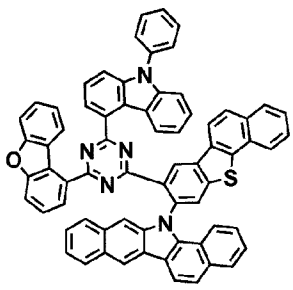
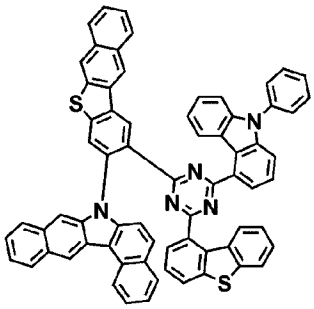
[387]

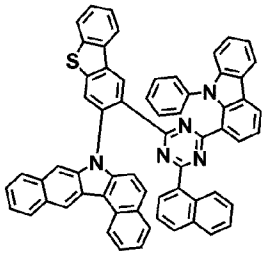
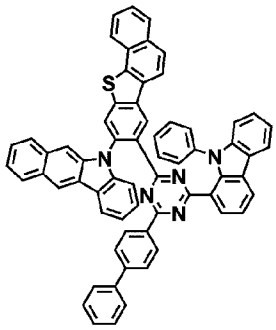
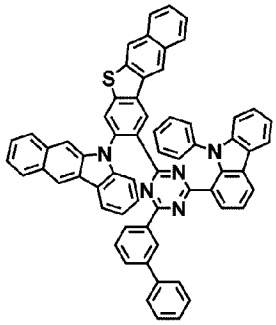
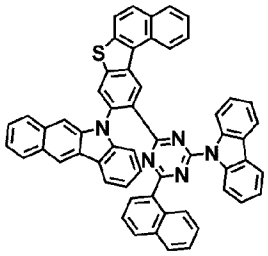
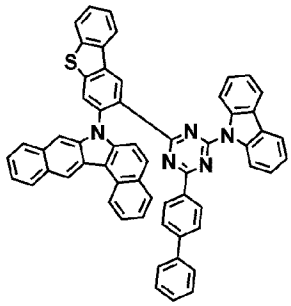
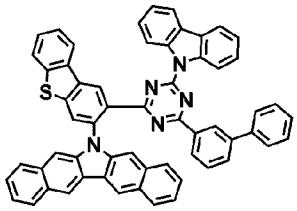
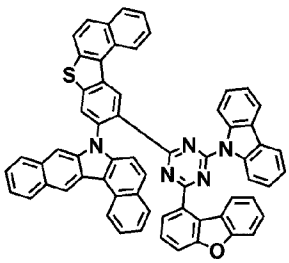
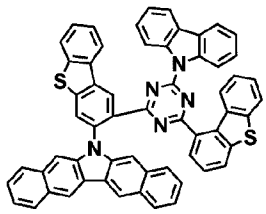
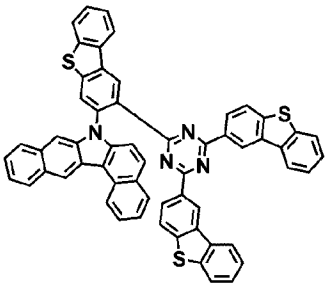
[388]

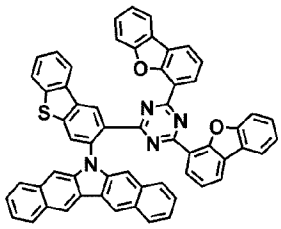
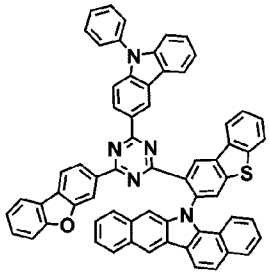
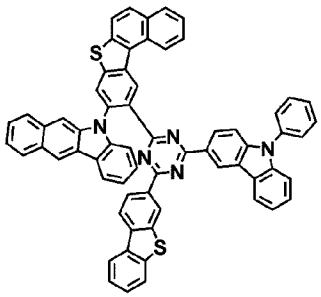
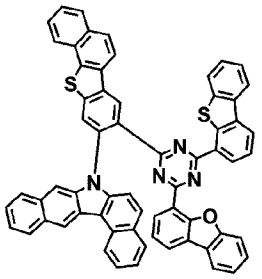
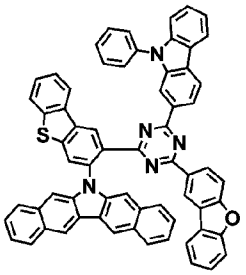
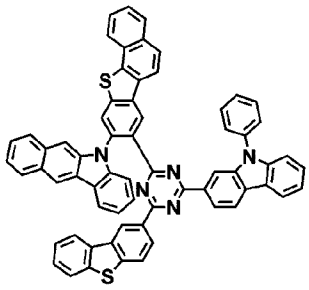
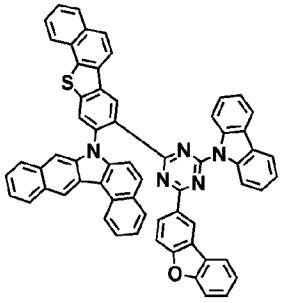
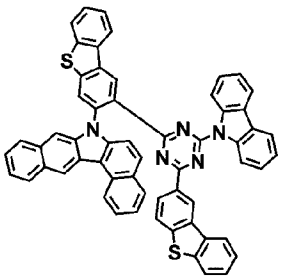
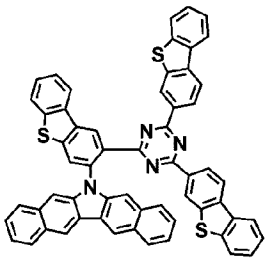
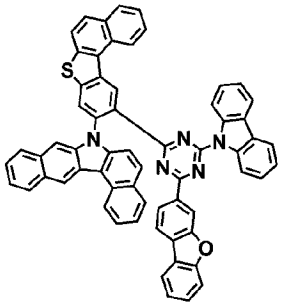
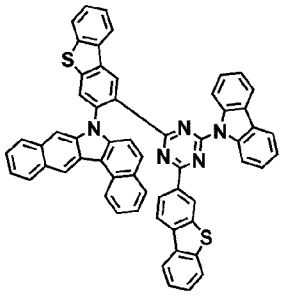
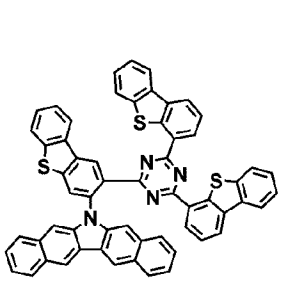
[389]

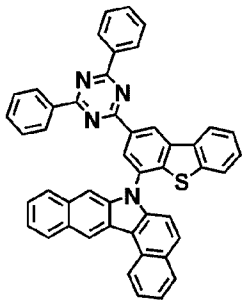
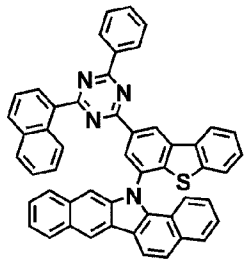
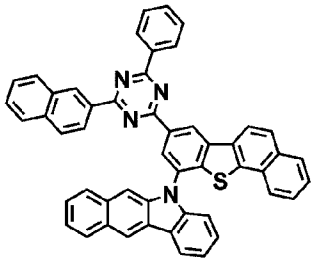
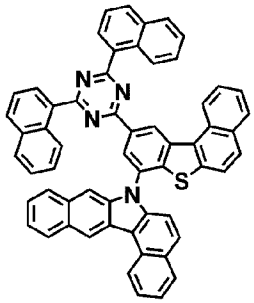
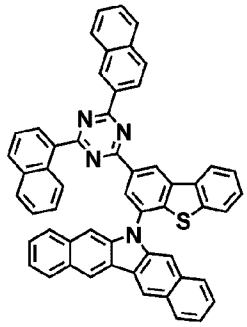
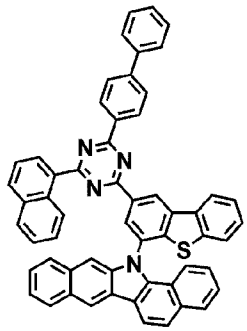
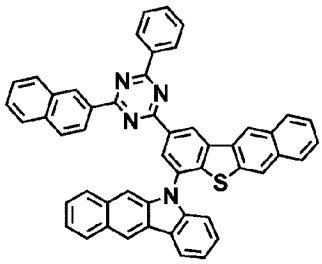
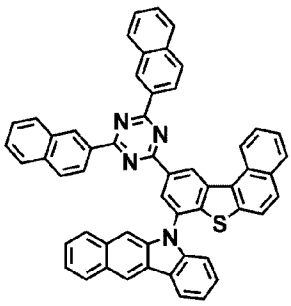
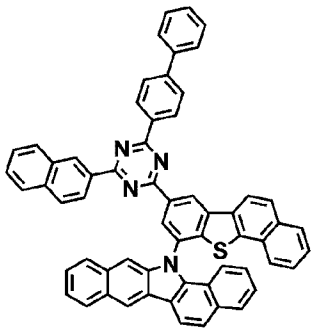
[390]

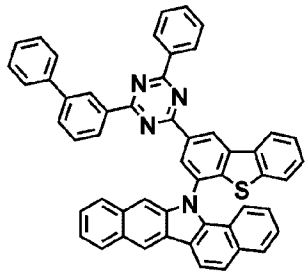
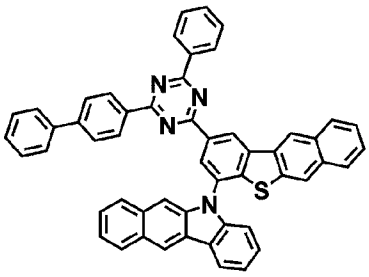
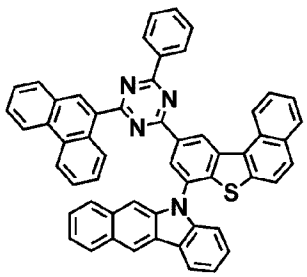
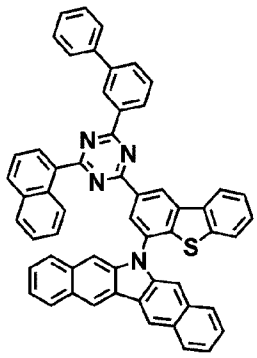
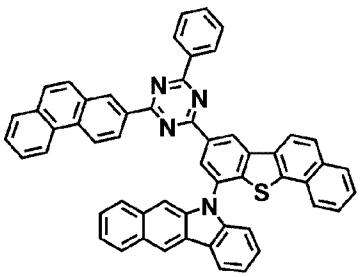
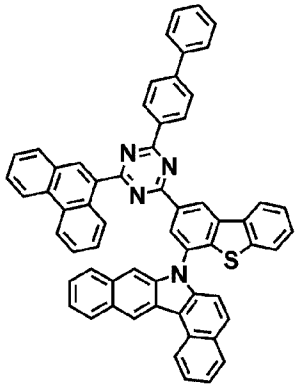
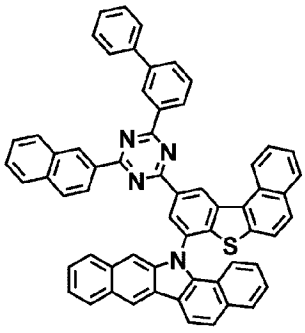
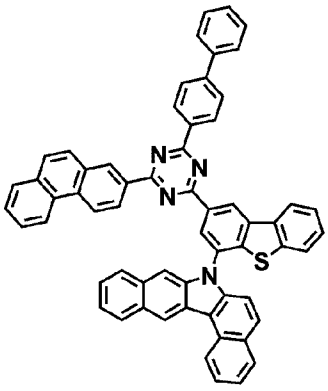
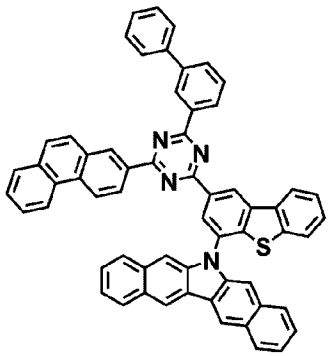
[391]

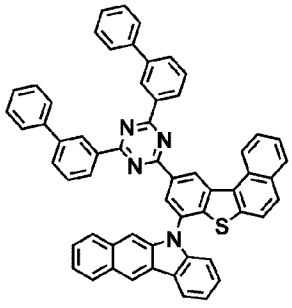
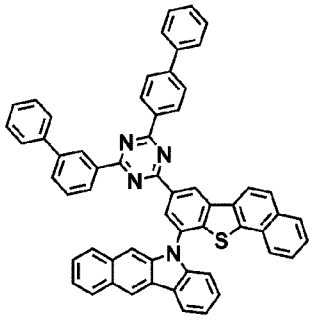
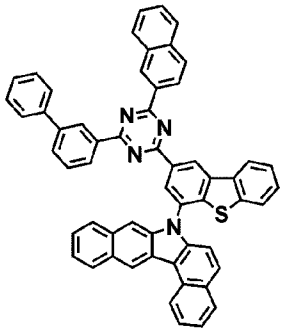
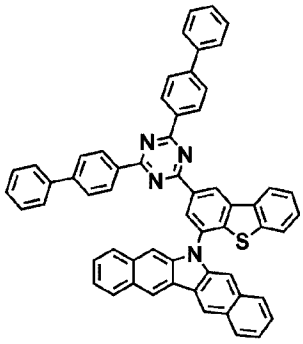
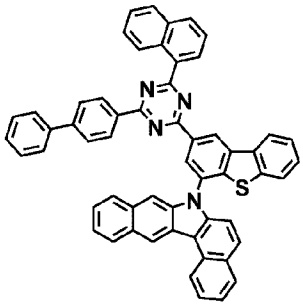
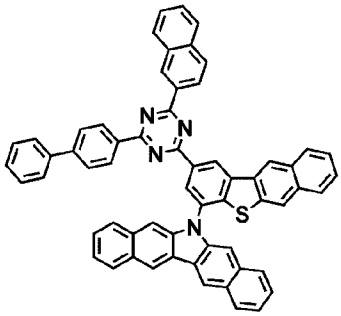
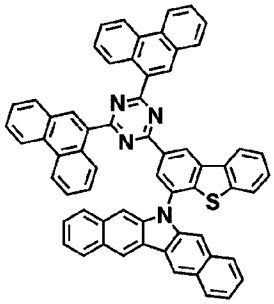
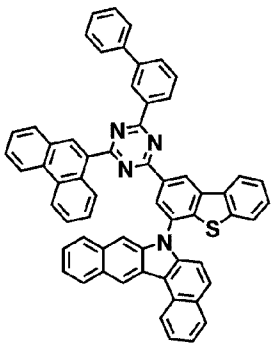
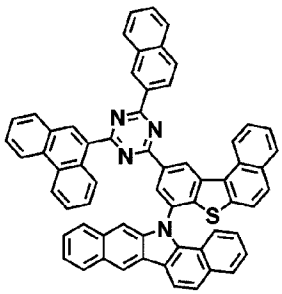
[392]

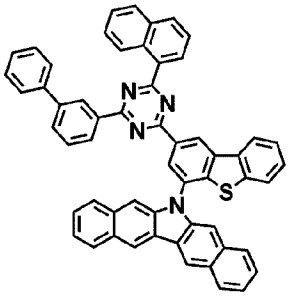
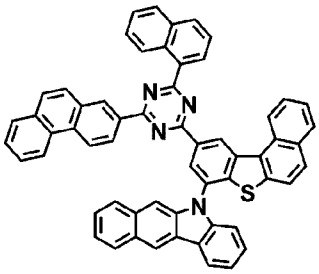
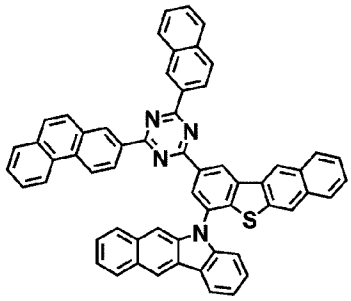
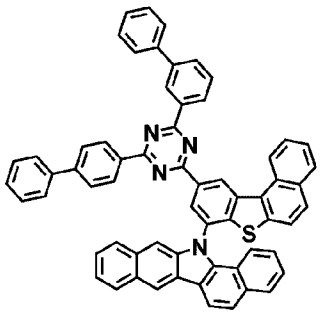
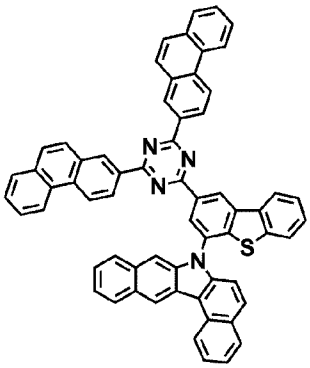
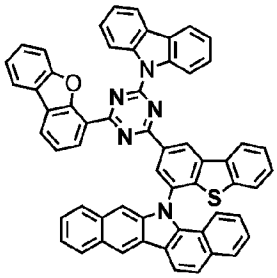
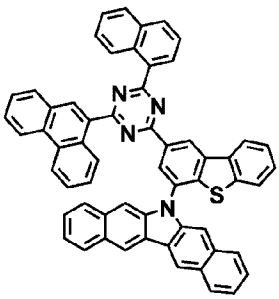
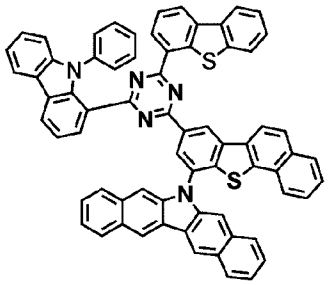
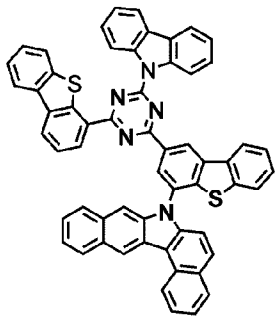
[393]

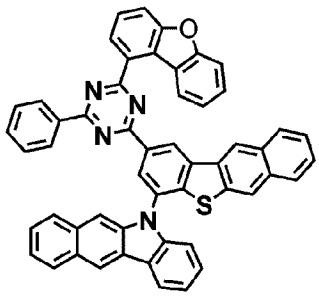
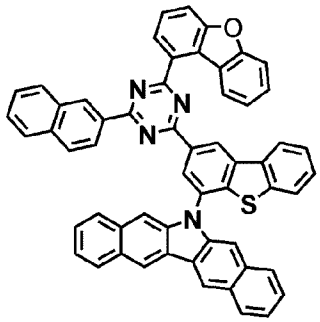
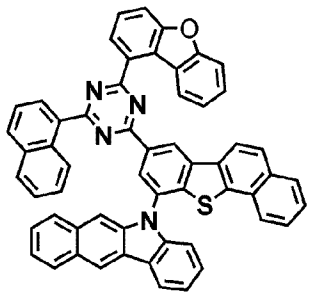
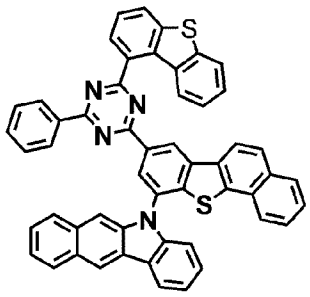
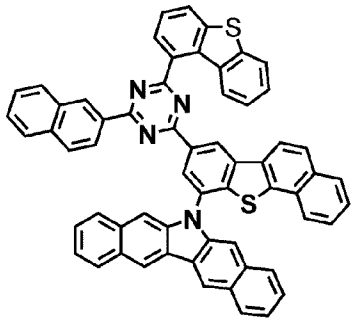
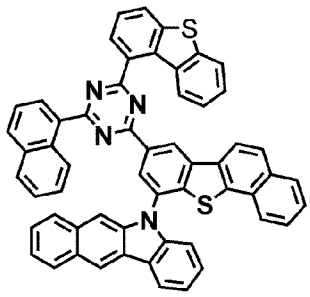
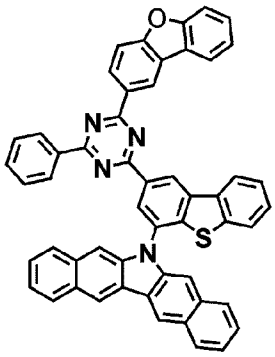
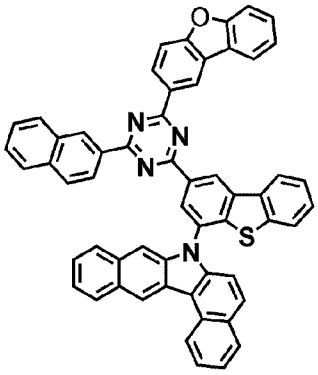
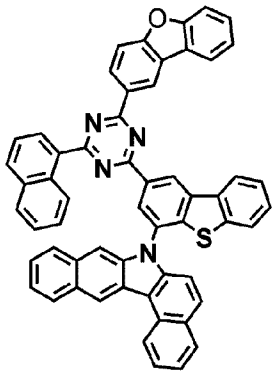
[394]

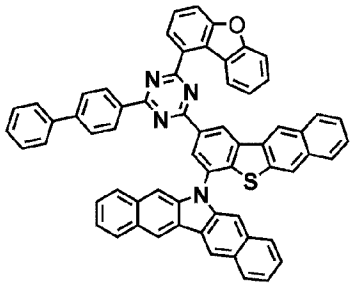
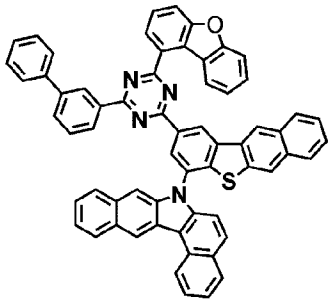
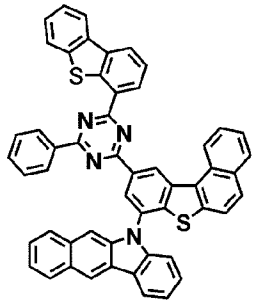
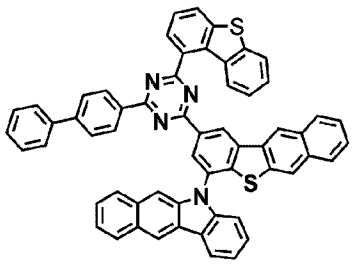
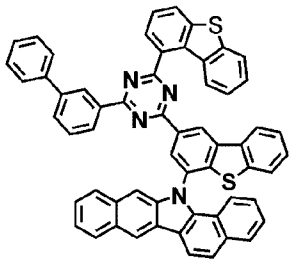
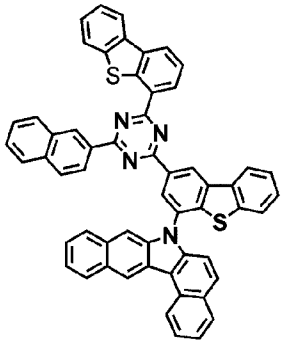
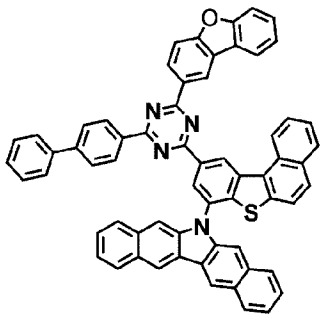
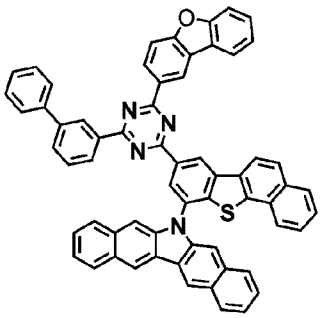
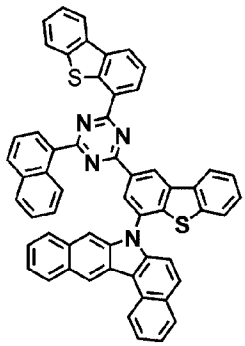
[395]

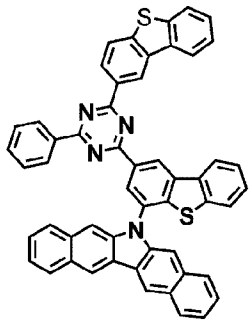
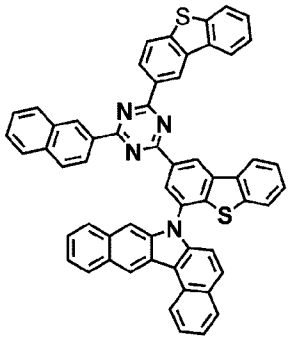
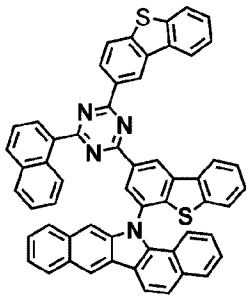
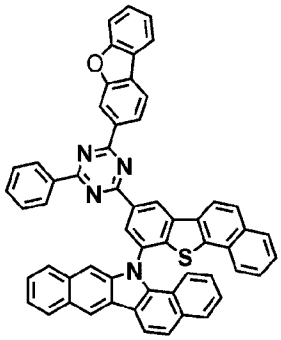
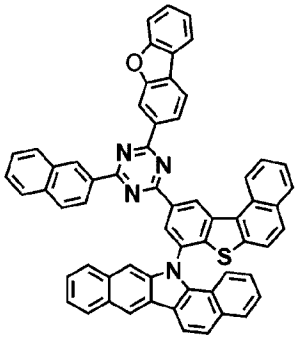
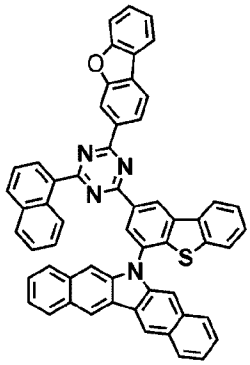
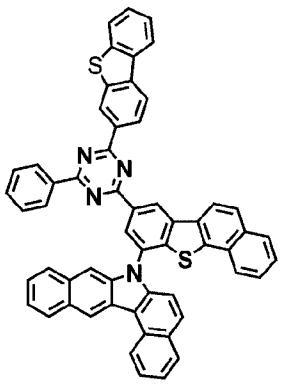
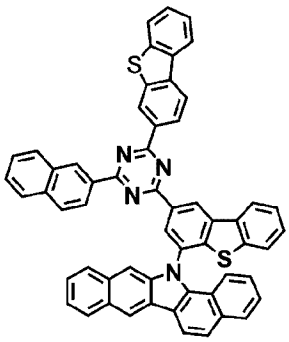
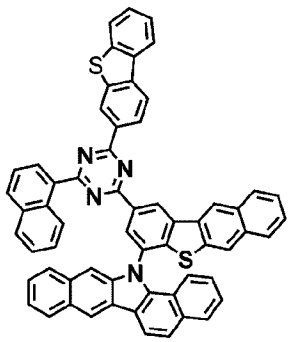
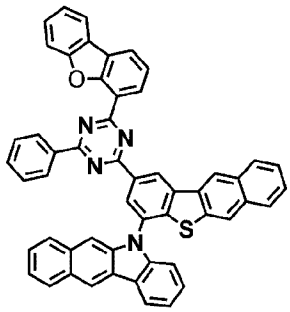
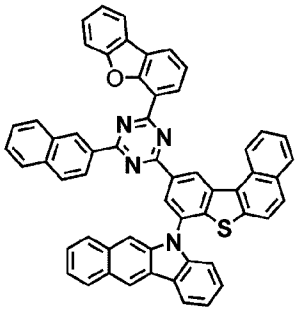
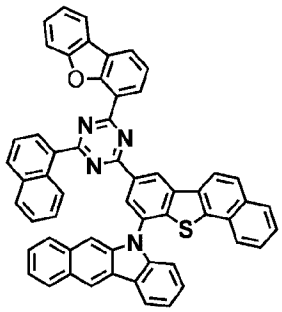
[396]

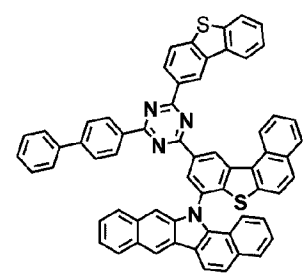
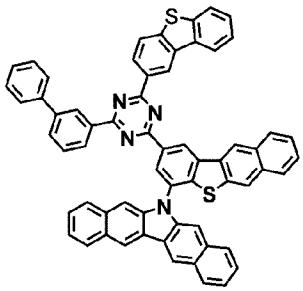
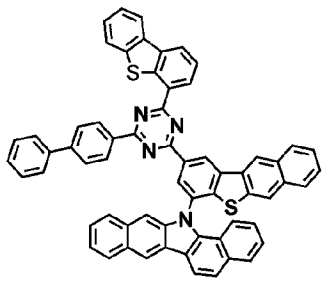
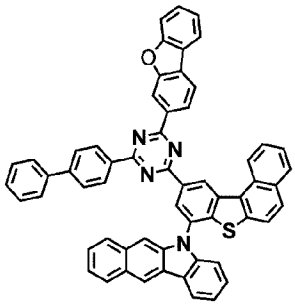
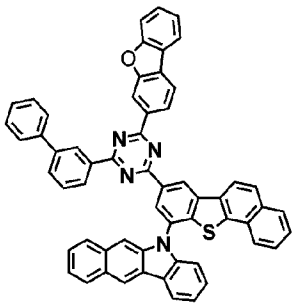
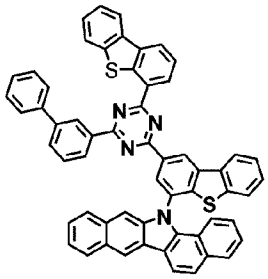
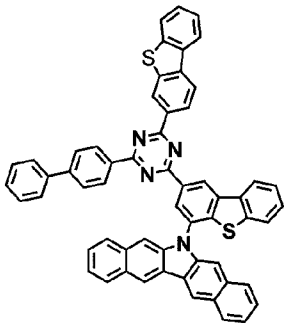
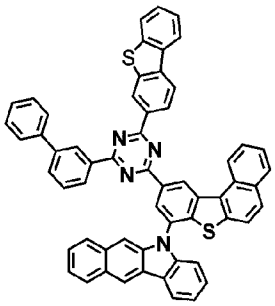
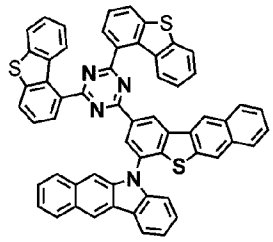
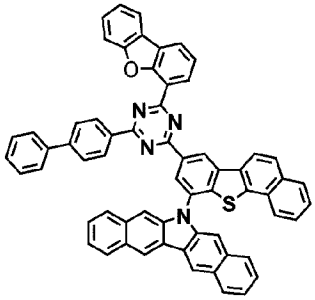
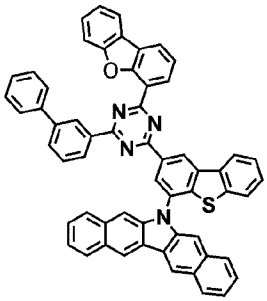
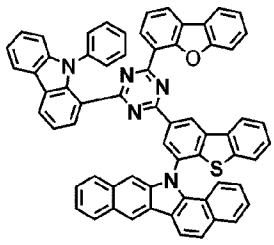
[397]

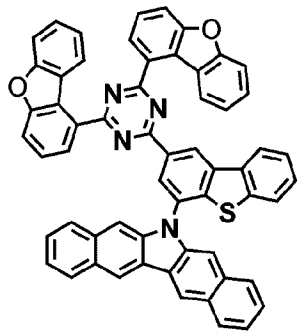
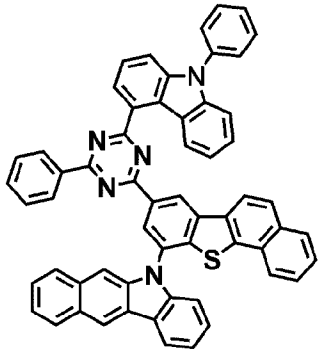
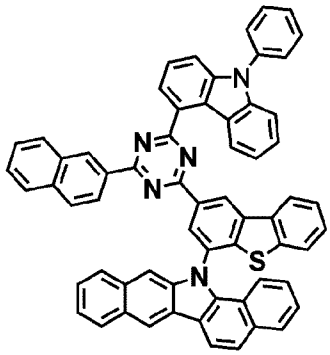
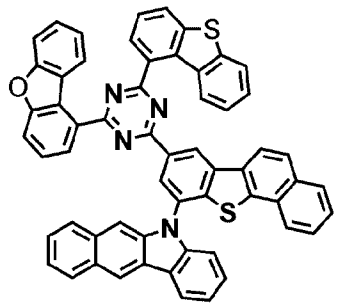
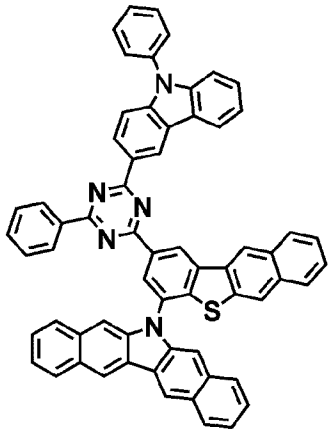
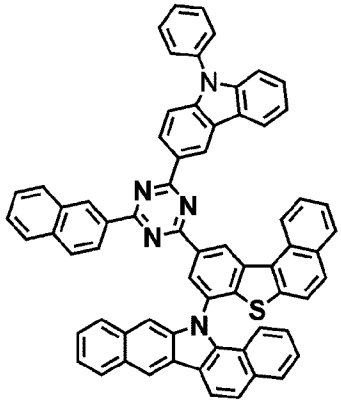
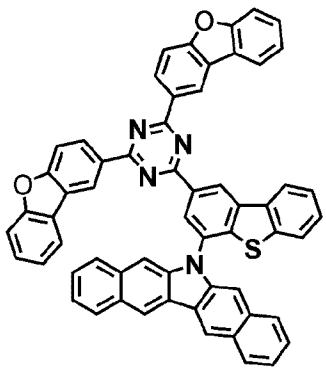
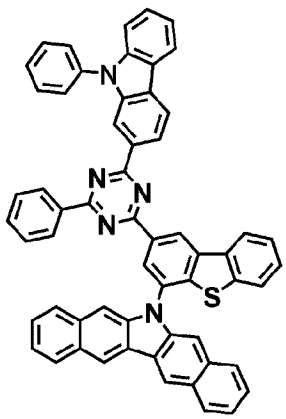
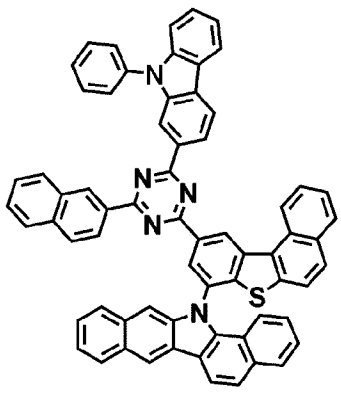
[398]

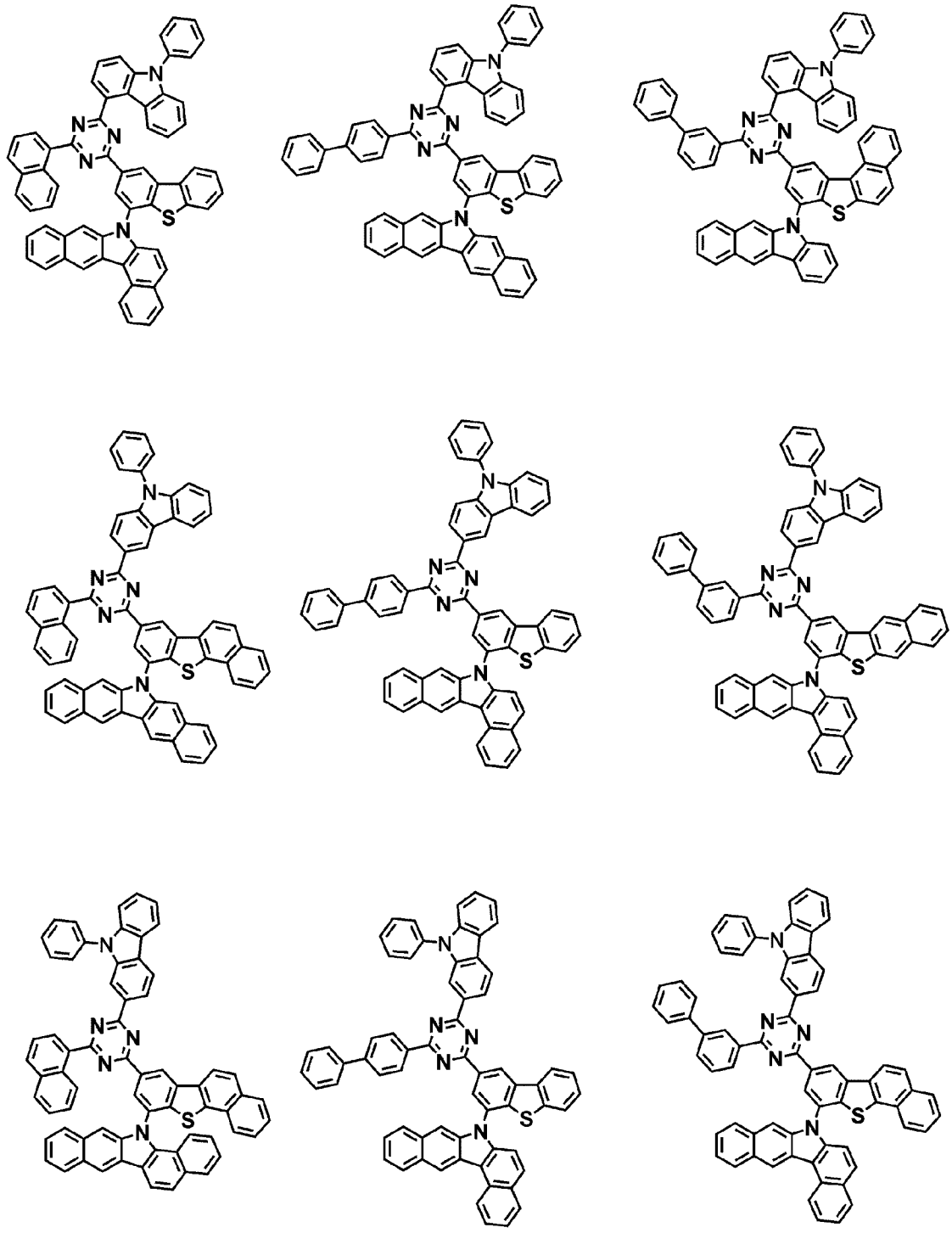
[399]

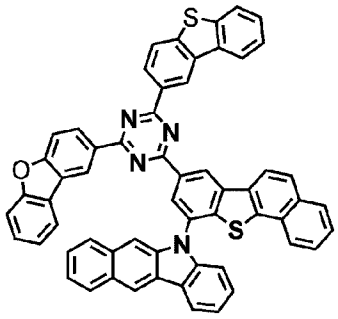
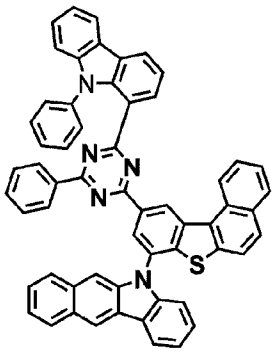
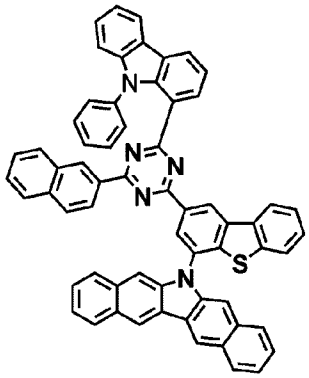
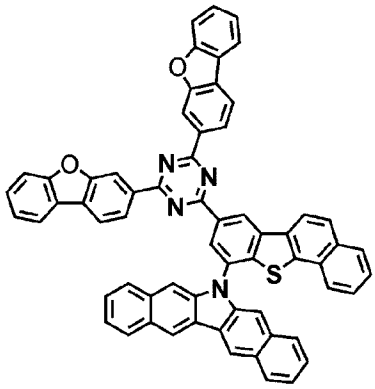
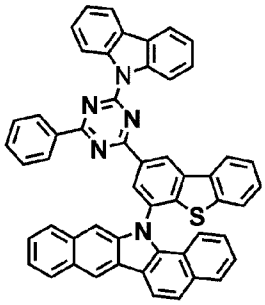
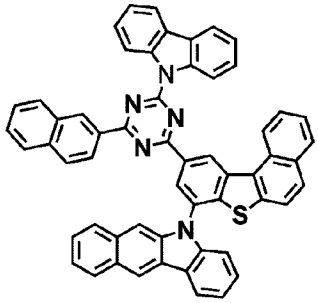
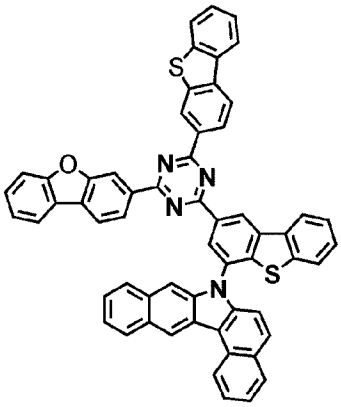
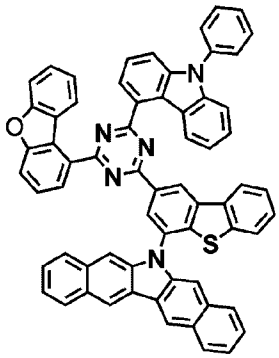
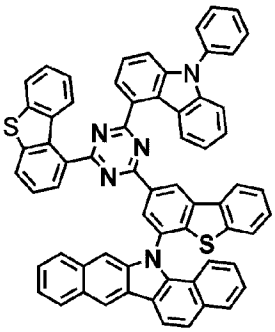
[400]

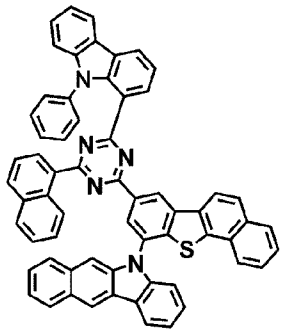
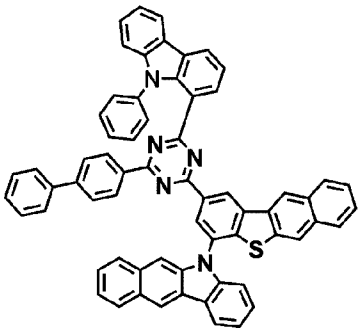
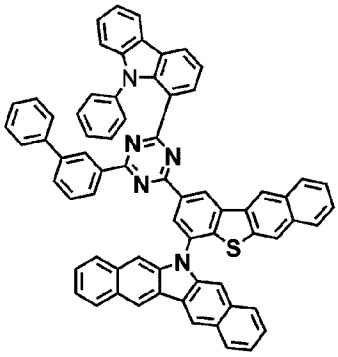
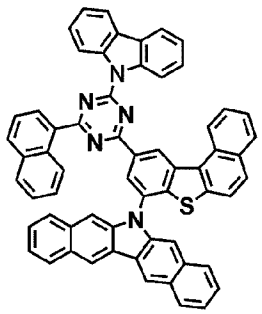
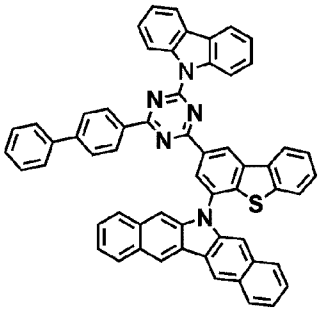
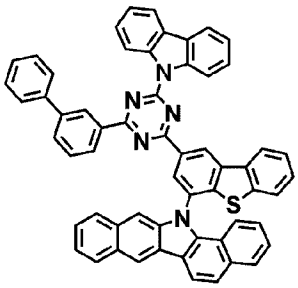
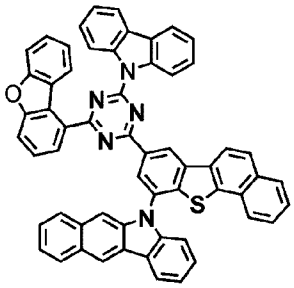
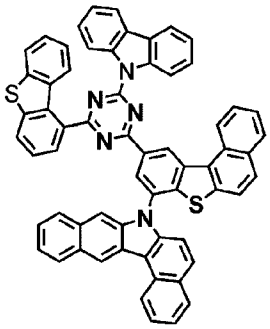
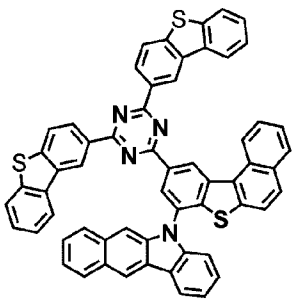
[401]



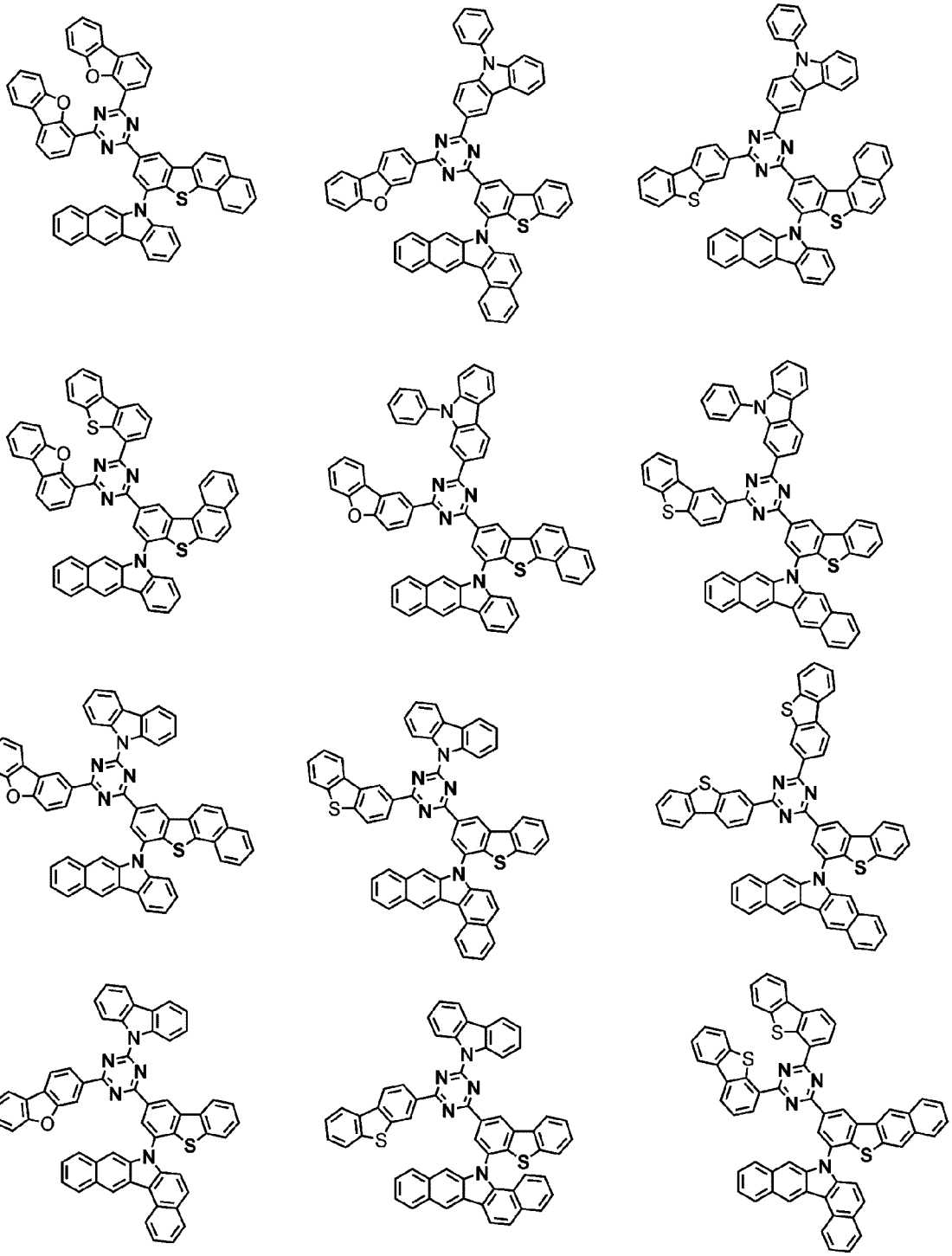
[402]

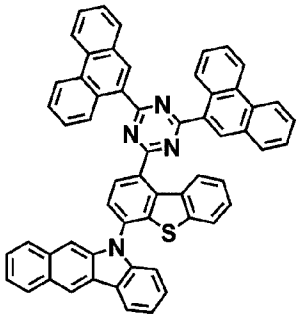
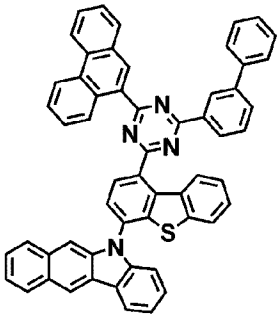
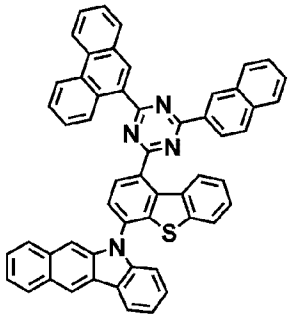
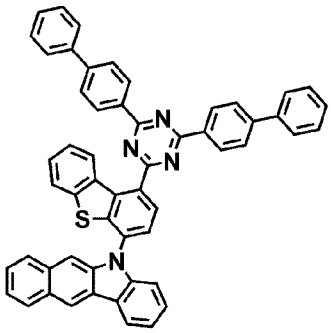
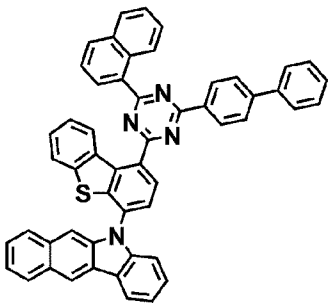
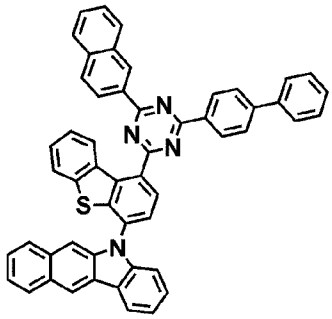
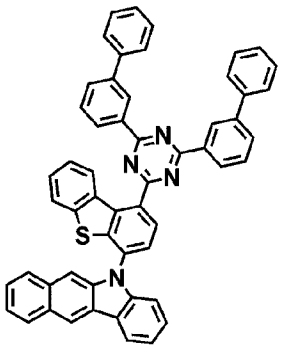
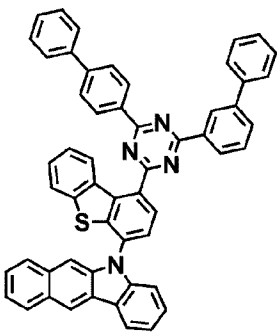
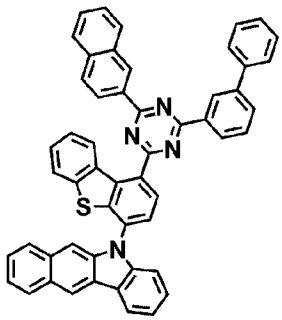
[403]

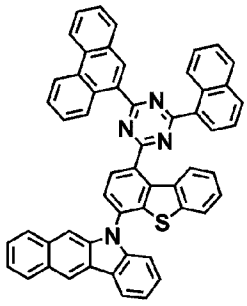
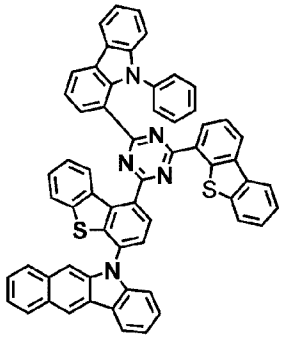
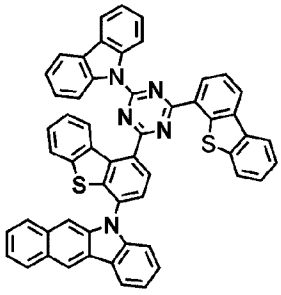
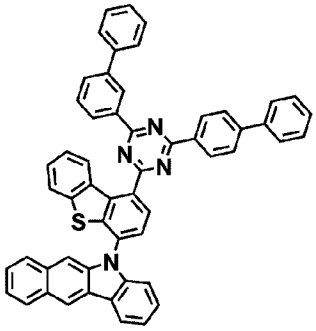
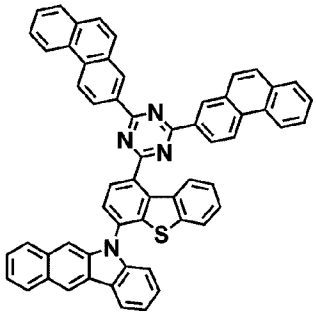
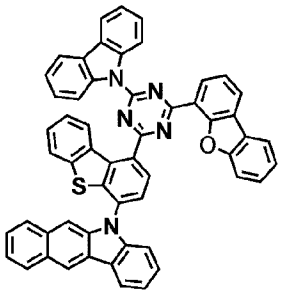
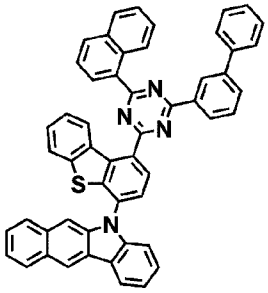
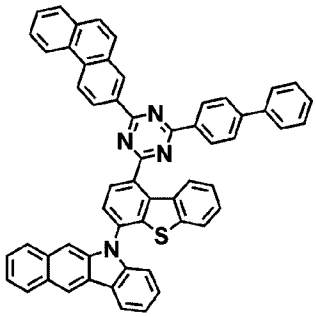
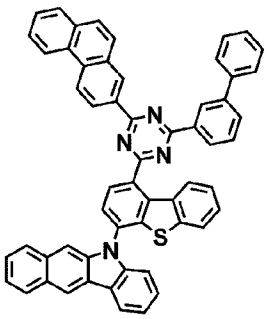
[404]



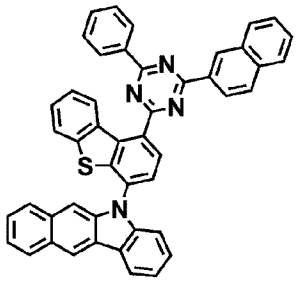
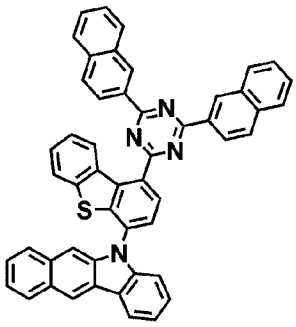
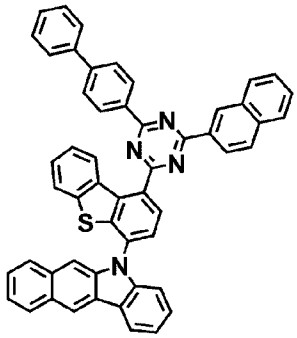
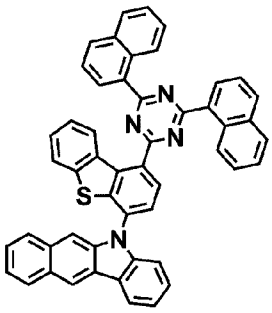
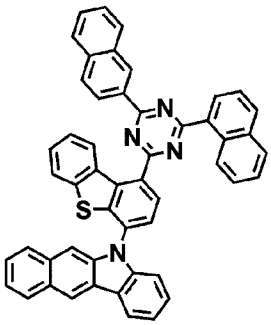
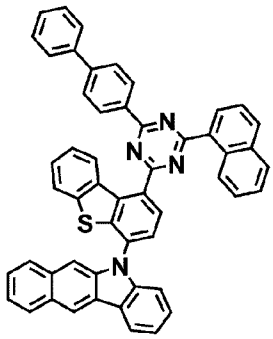
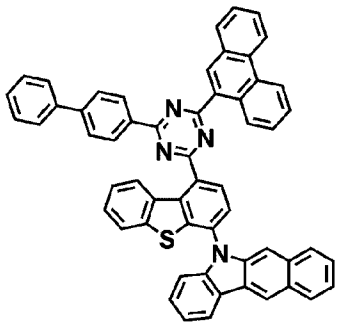
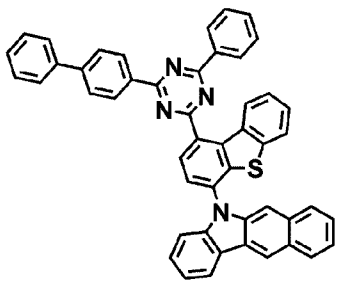
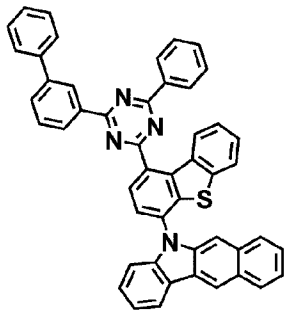
[405]

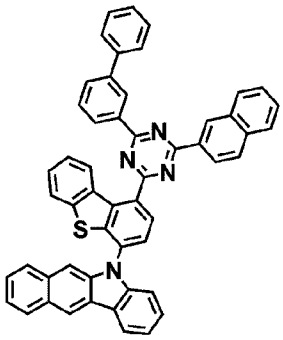
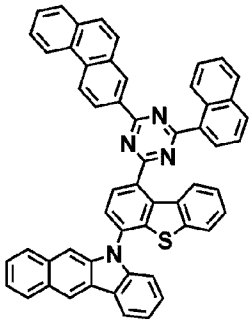
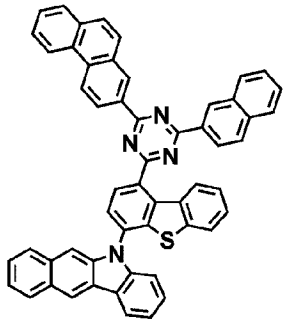
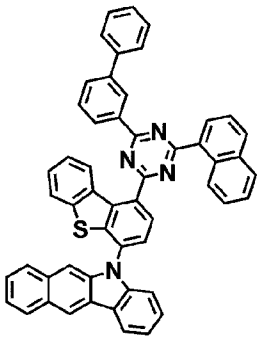
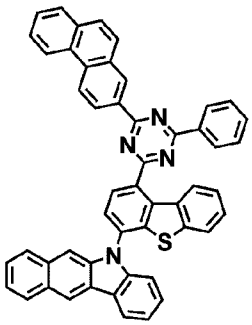
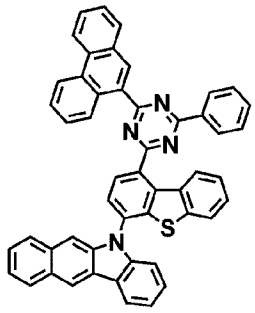
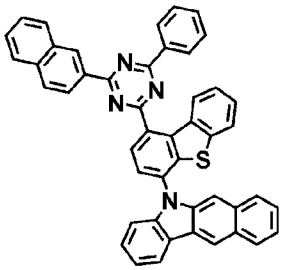
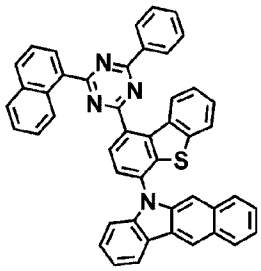
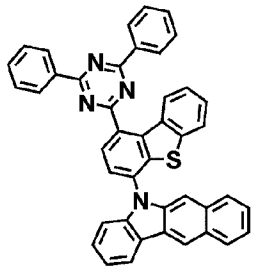
[406]

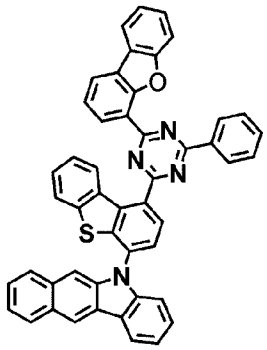
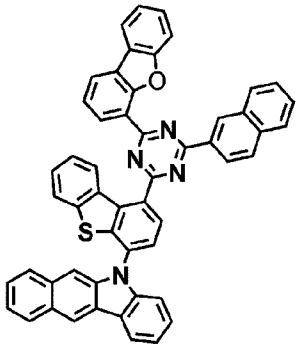
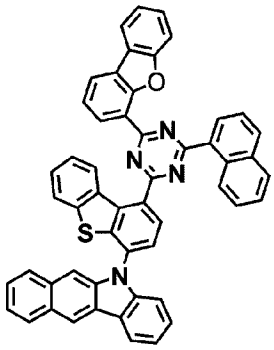
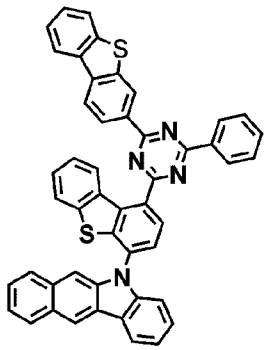
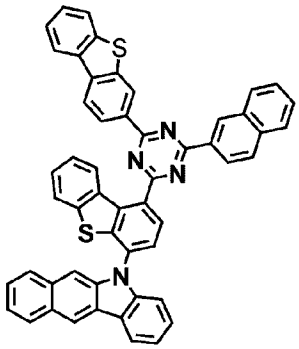
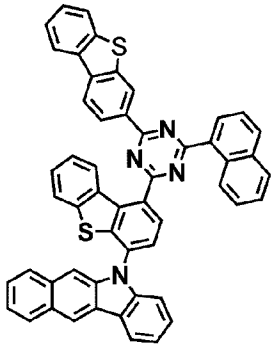
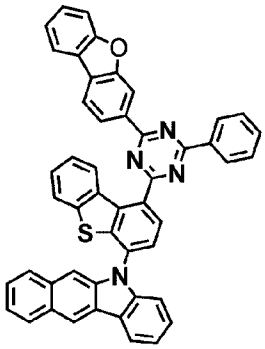
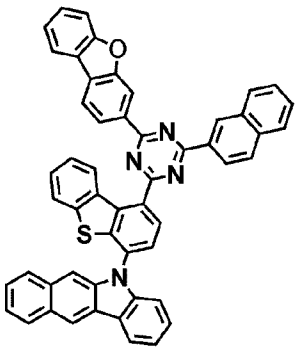
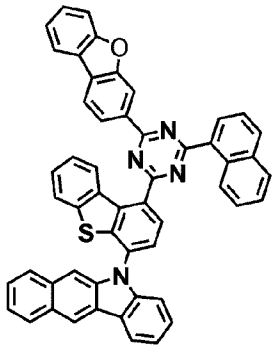
[407]

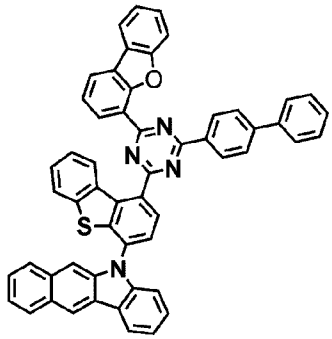
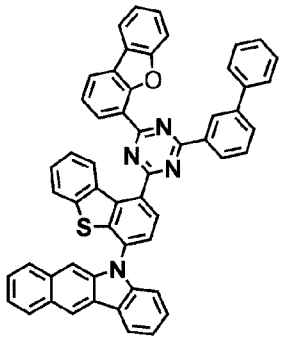
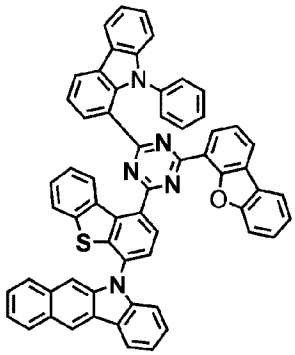
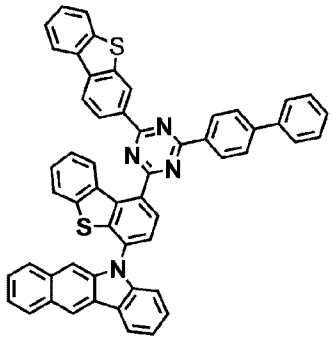
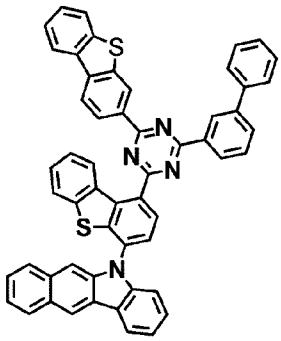
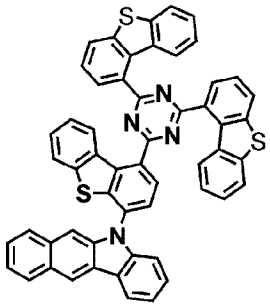
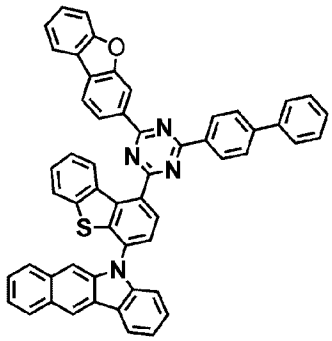
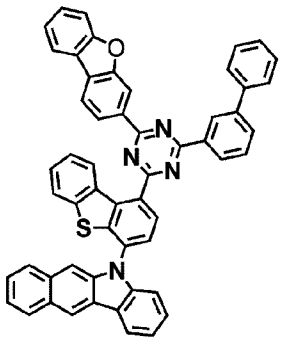
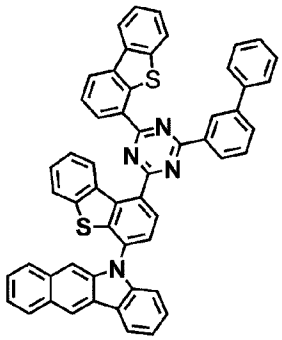
[408]

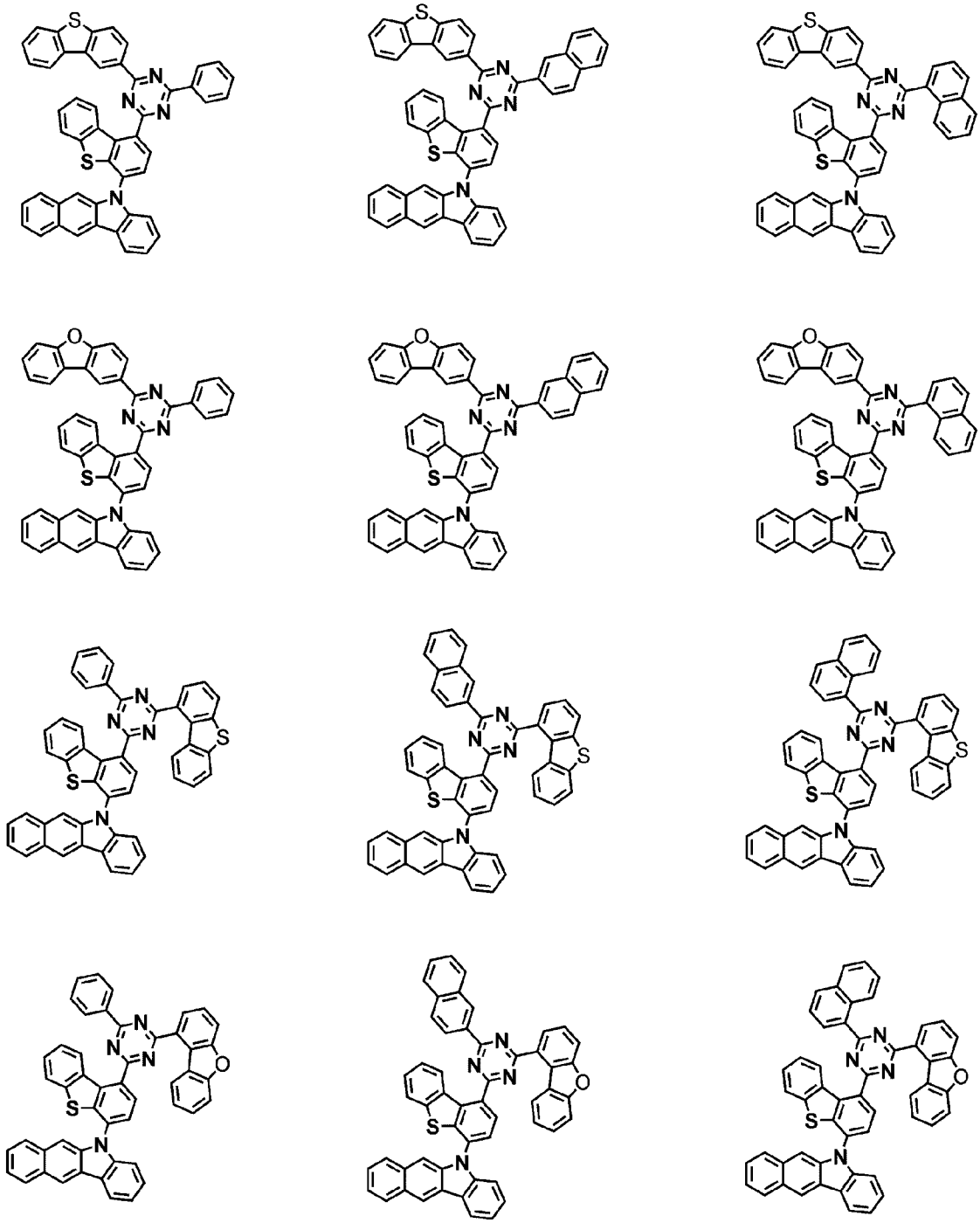
[409]

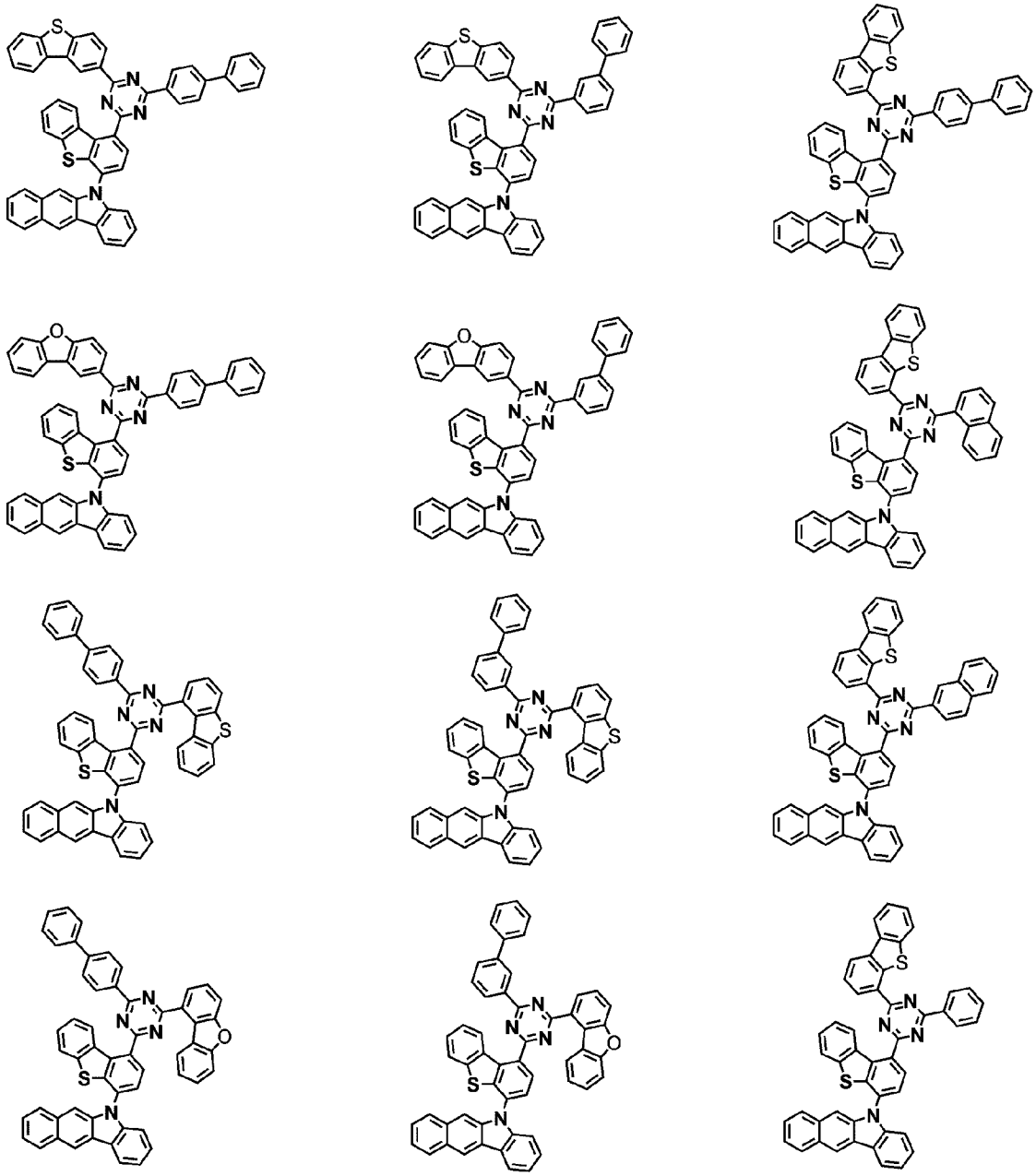
[410]

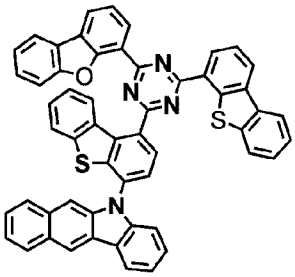
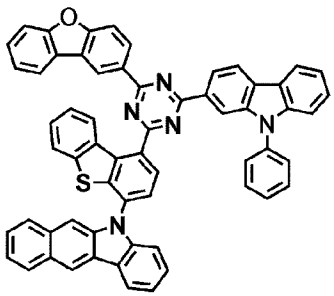
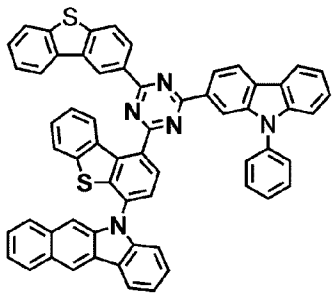
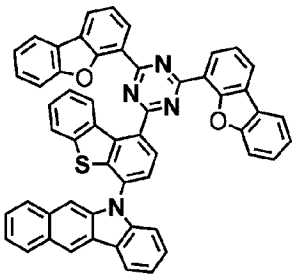
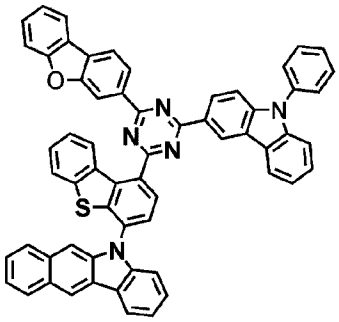
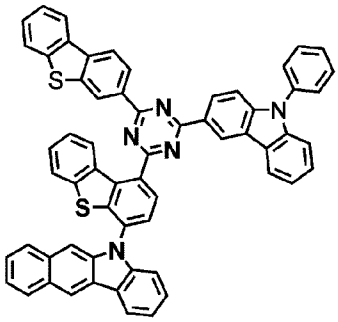
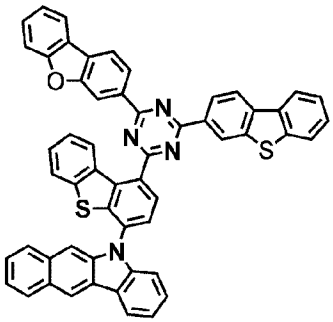
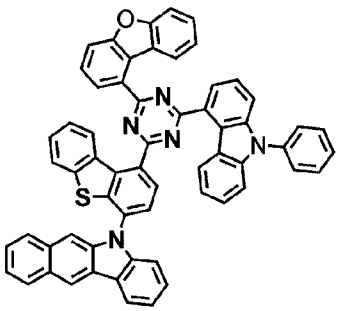
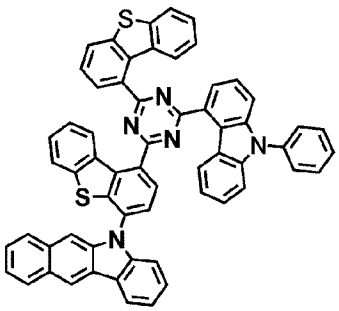
[411]



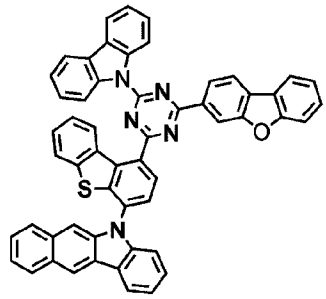
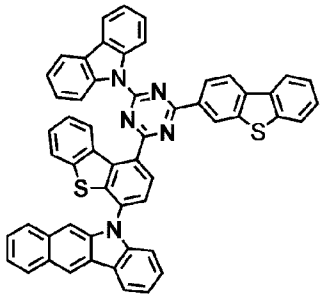
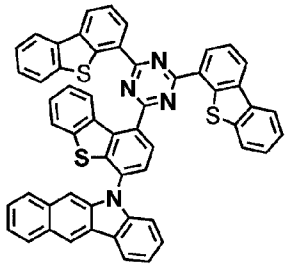
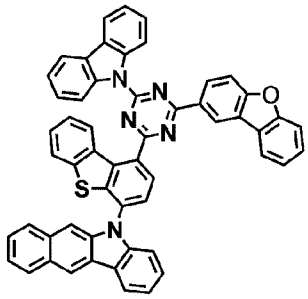
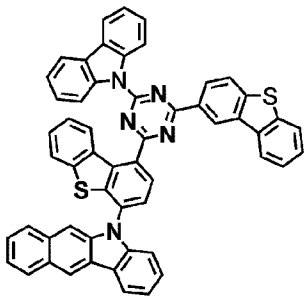
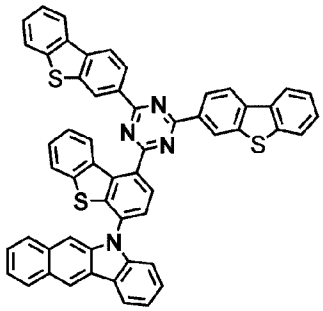
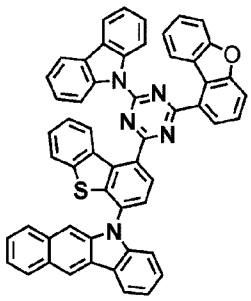
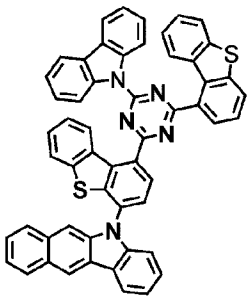
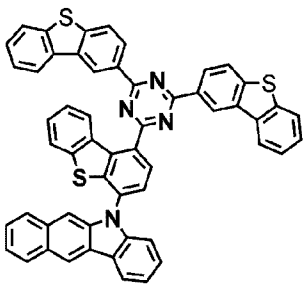
[412]



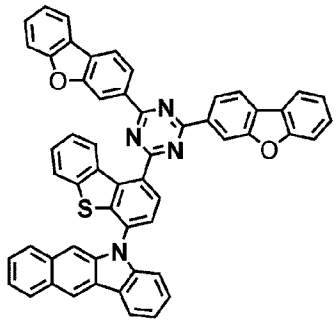
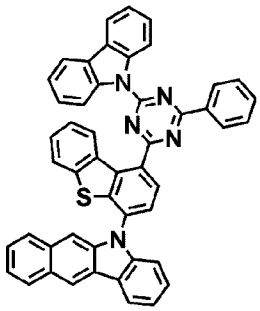
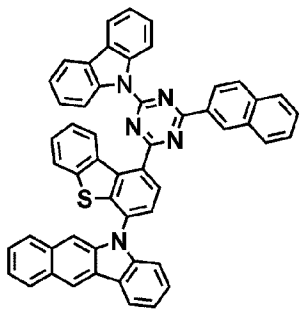
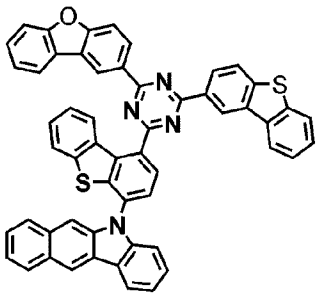
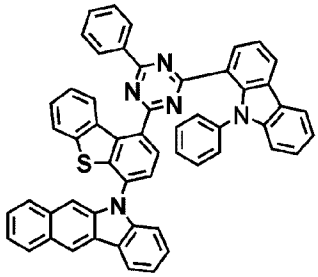
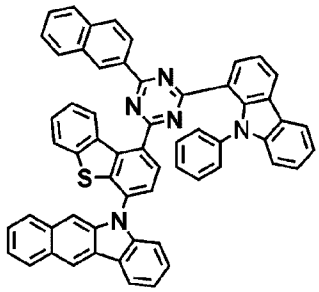
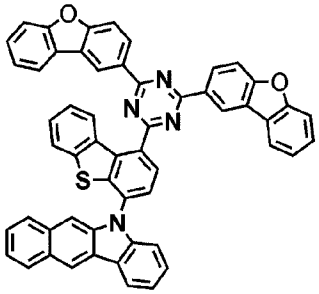
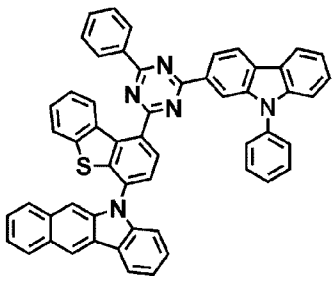
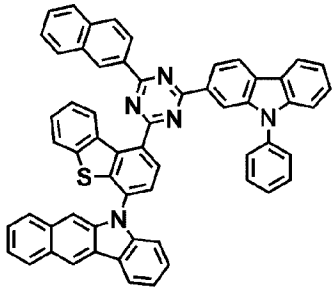
[413]

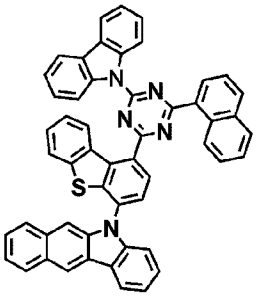
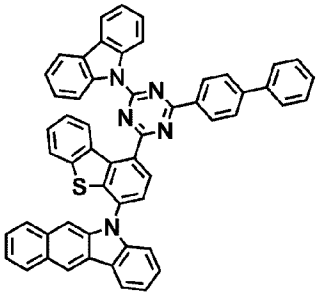
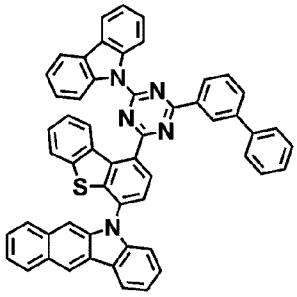
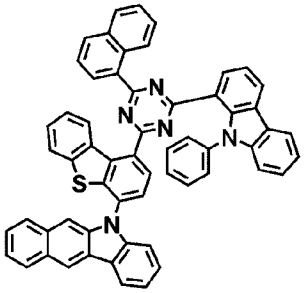
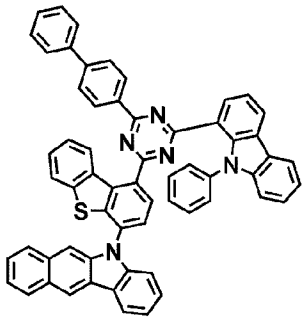
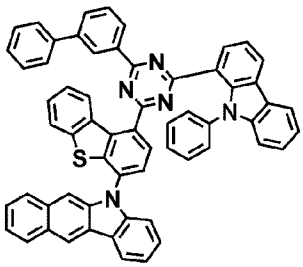
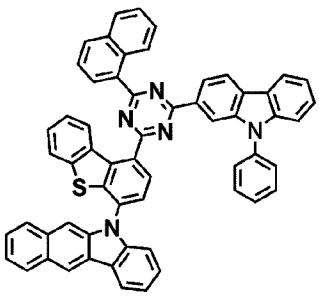
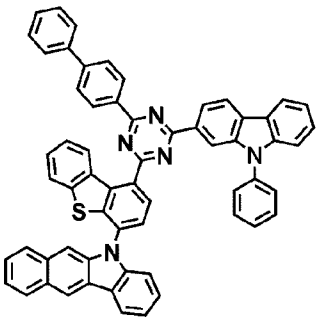
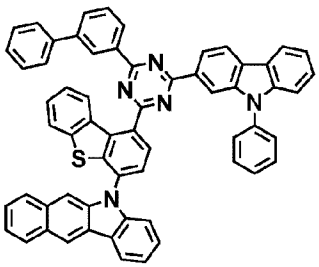
[414]

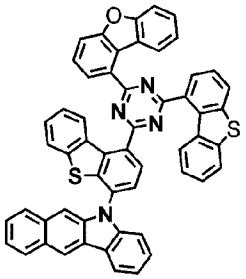
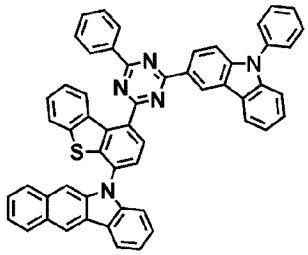
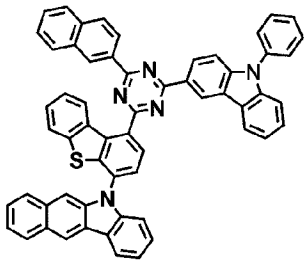
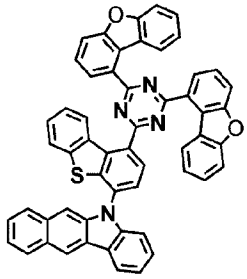
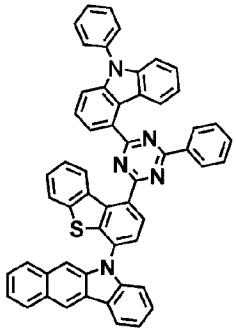
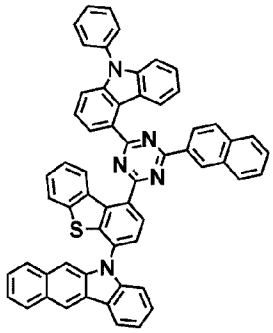
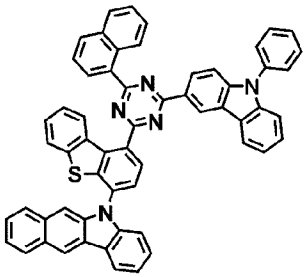
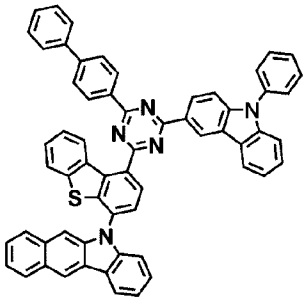
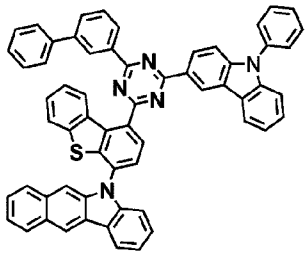
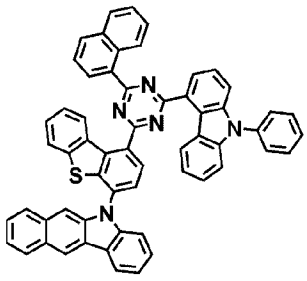
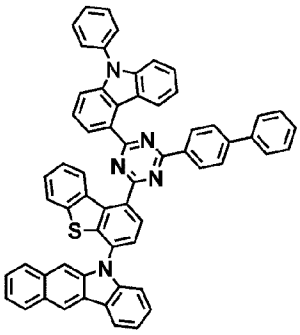
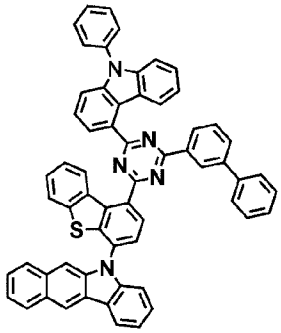
[415]

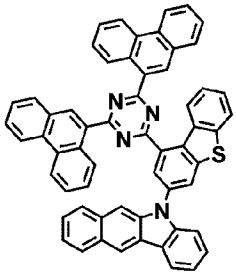
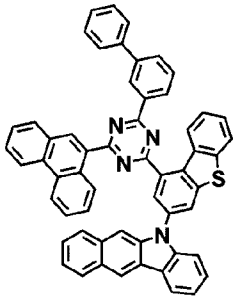
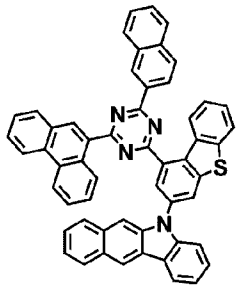
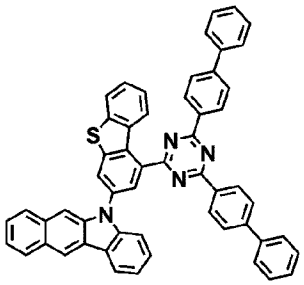
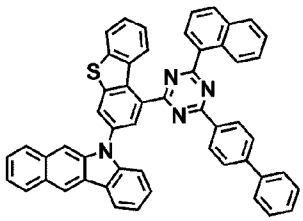
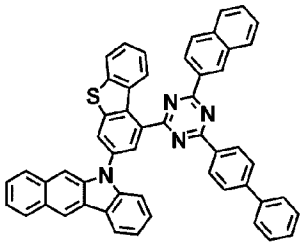
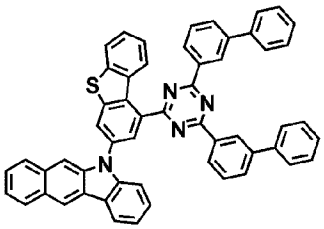
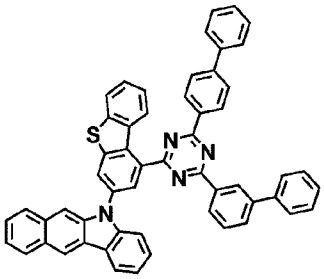
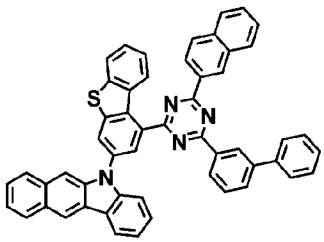
[416]

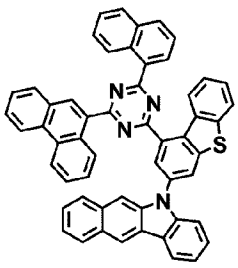
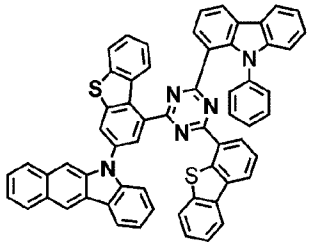
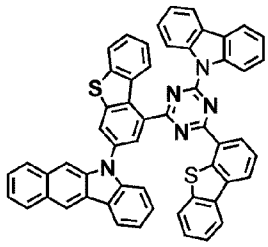
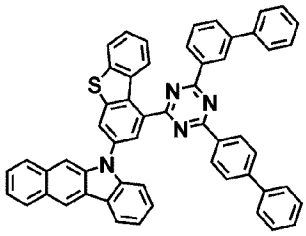
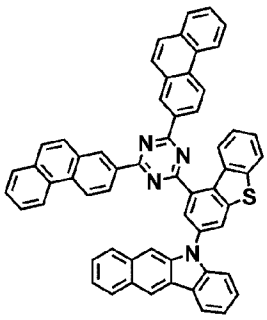
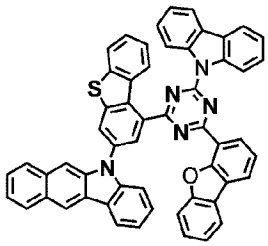
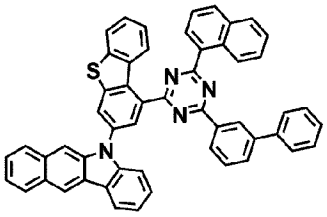
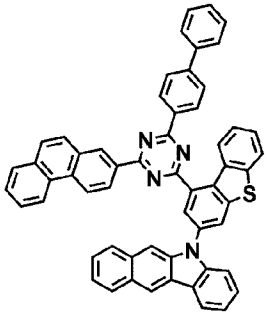
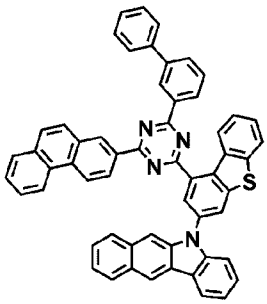
[417]

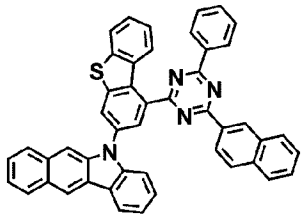
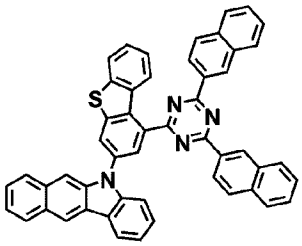
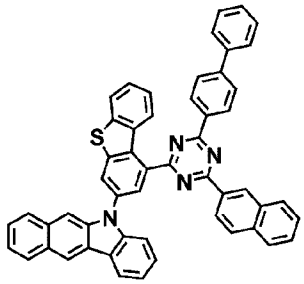
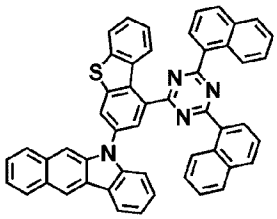
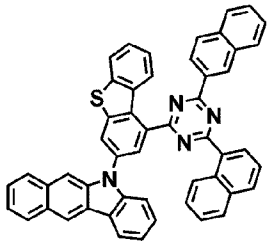
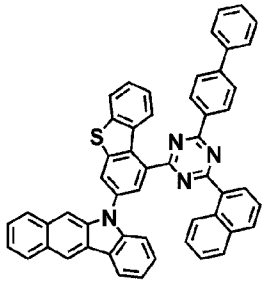
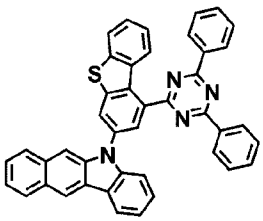
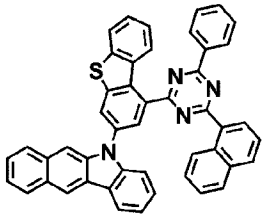
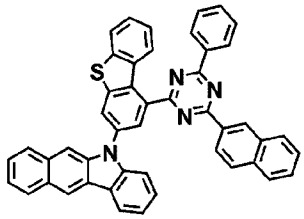
[418]

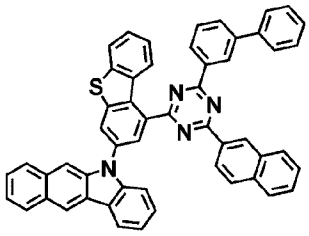
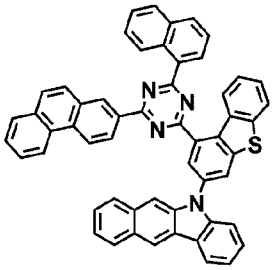
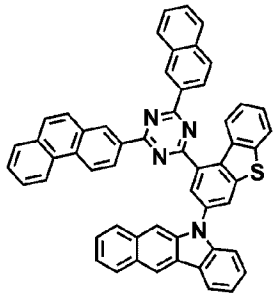
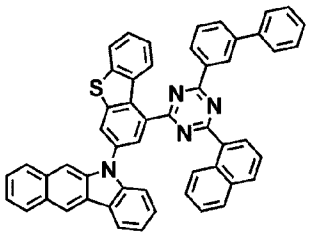
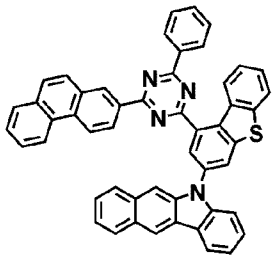
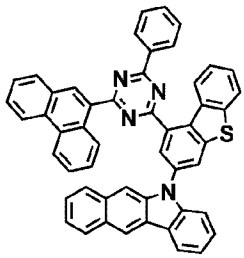
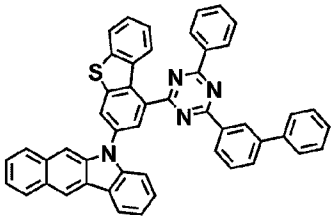
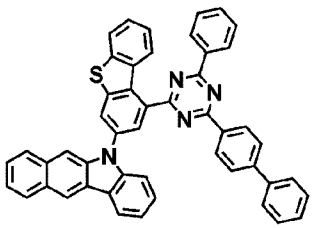
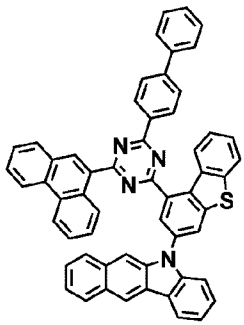
[419]

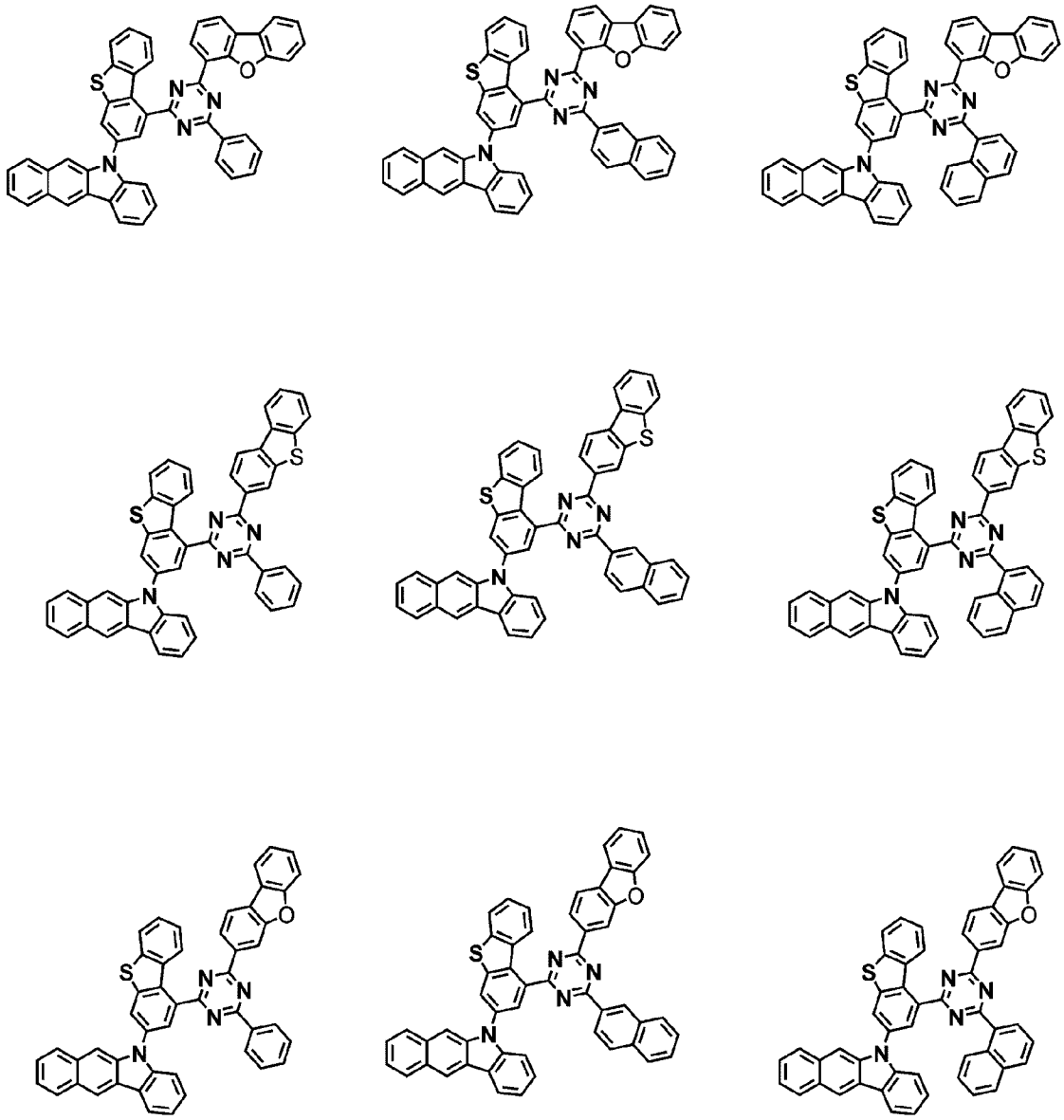
[420]

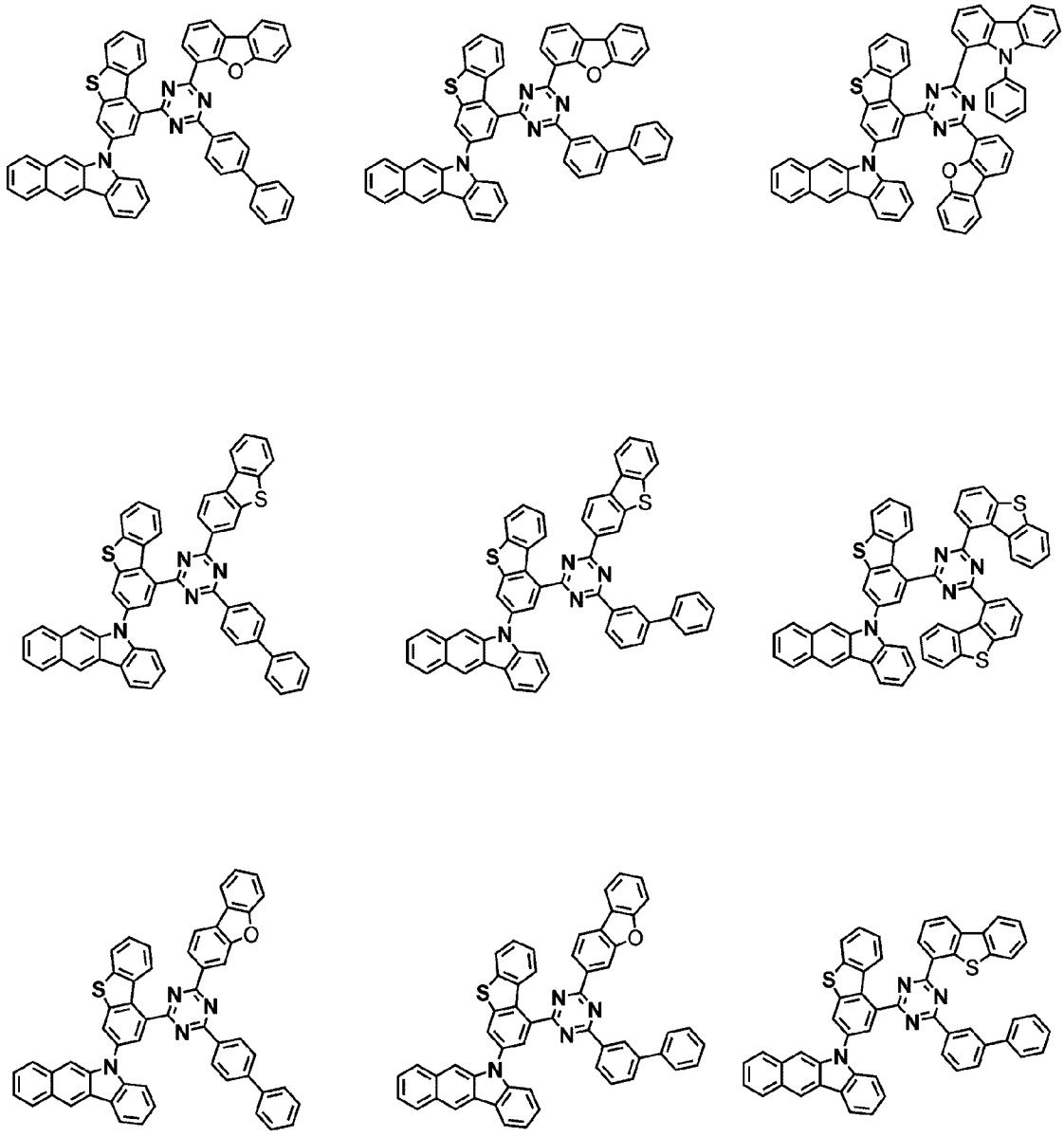
[421]

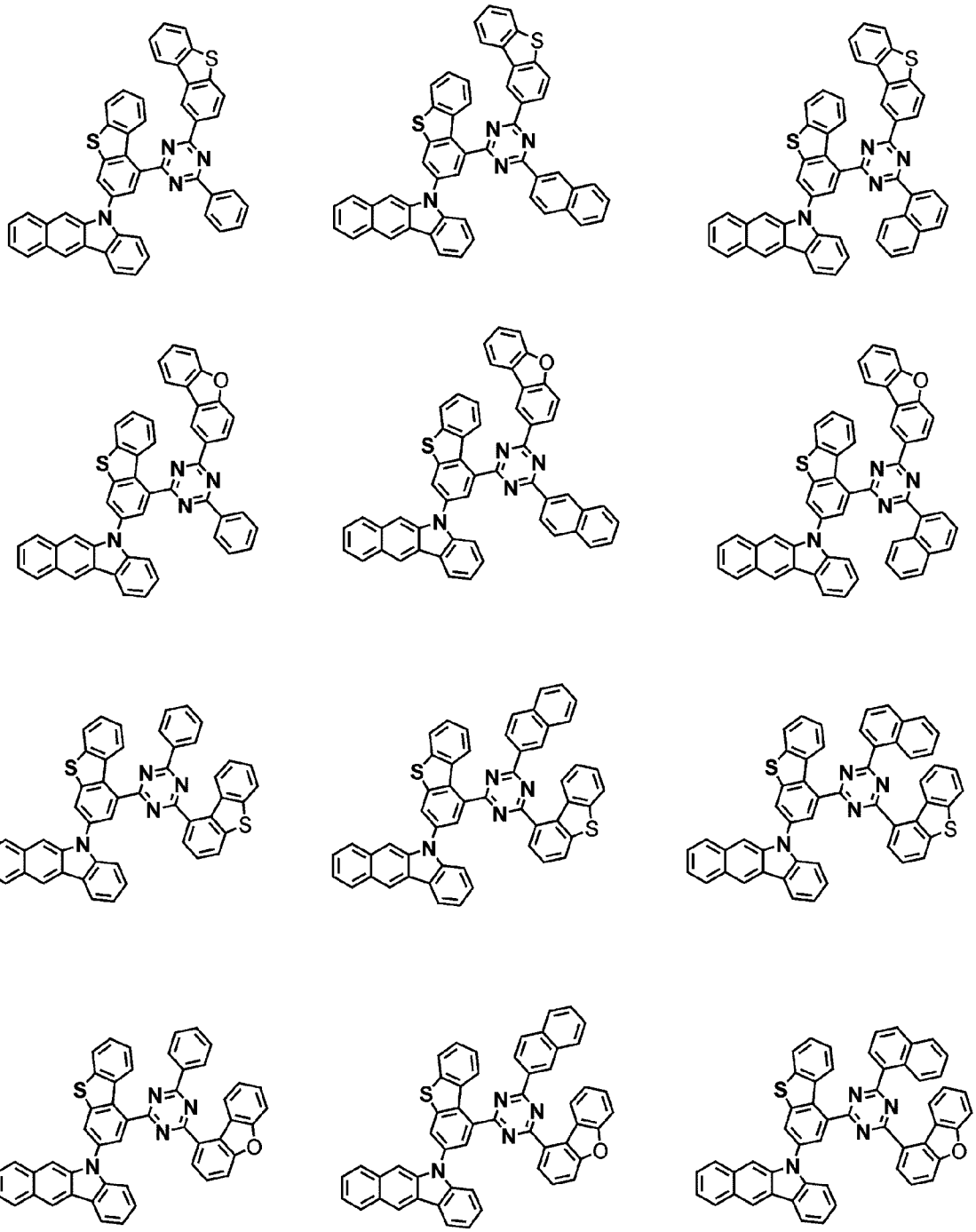
[422]



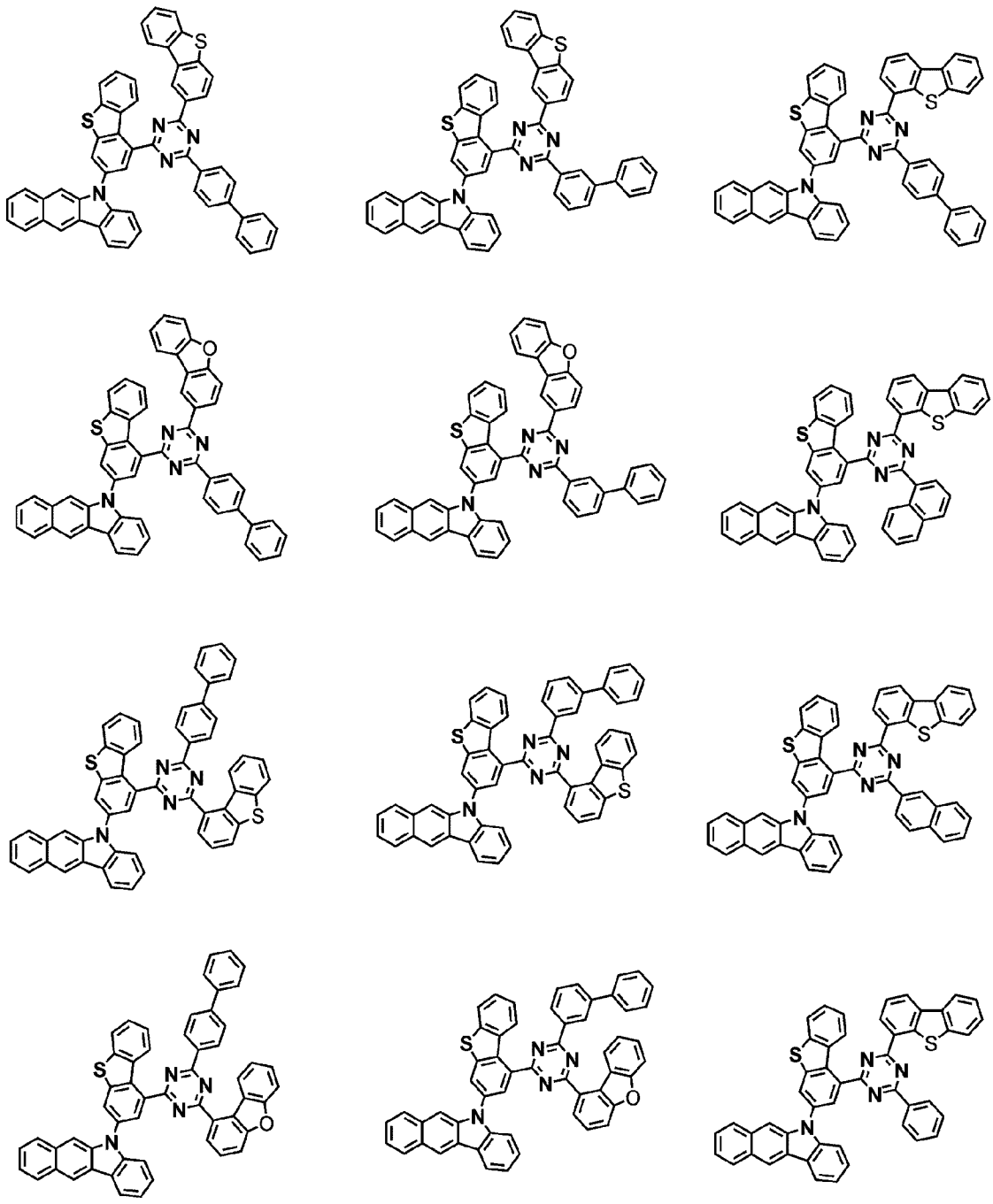
[423]



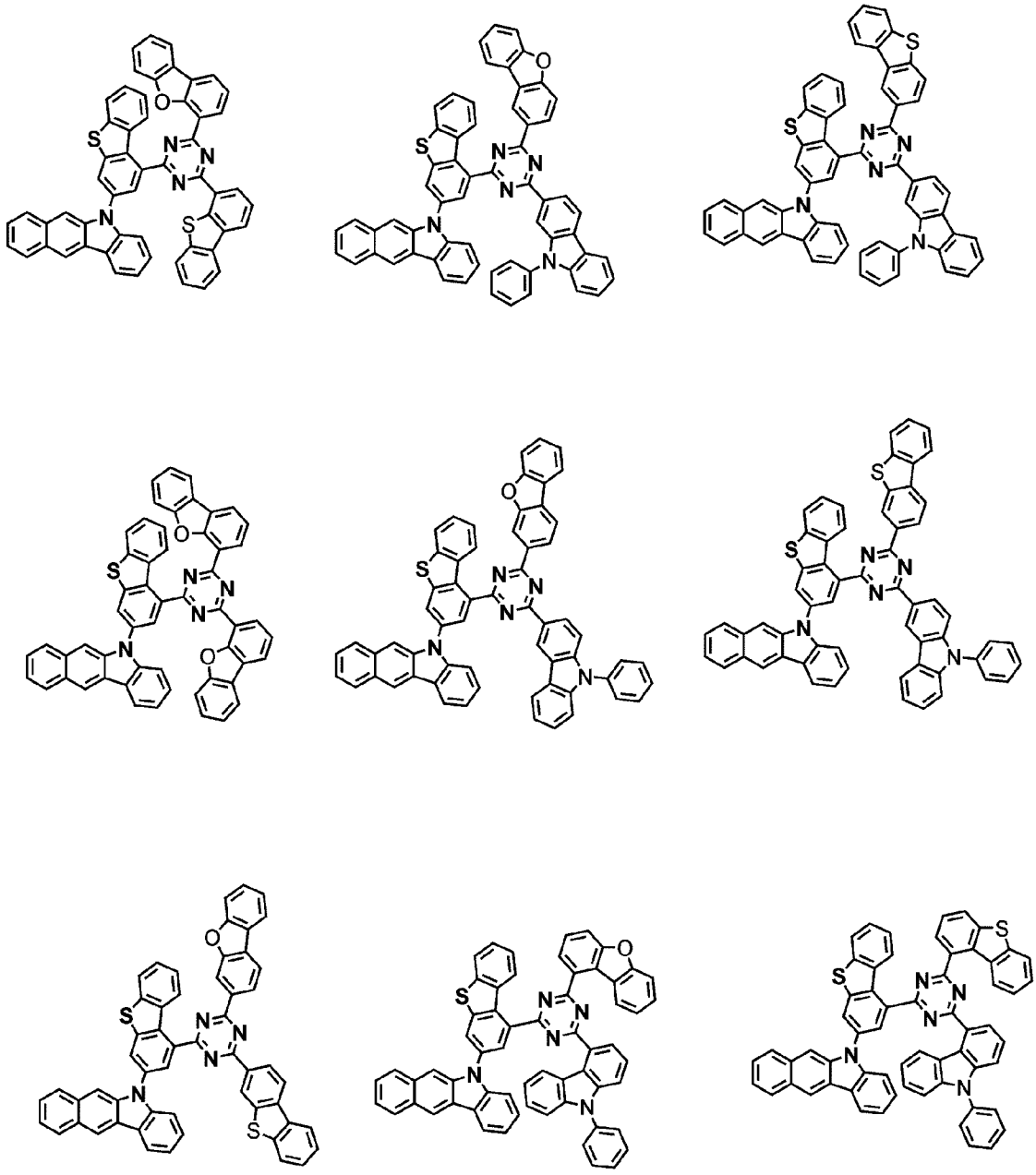
[424]



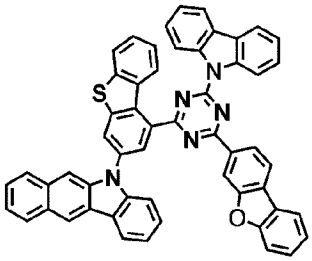
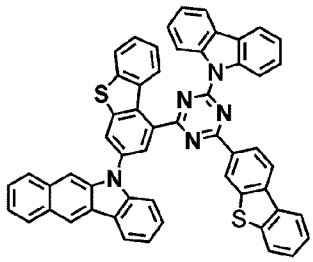
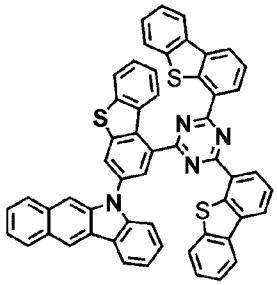
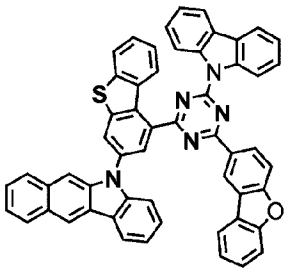
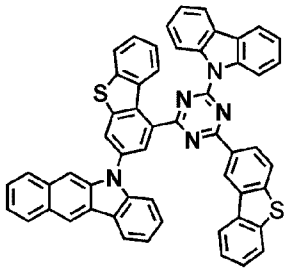
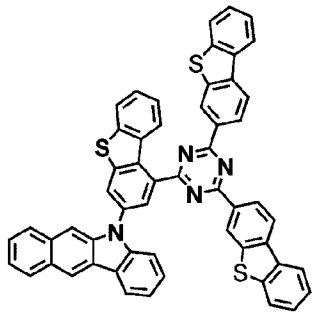
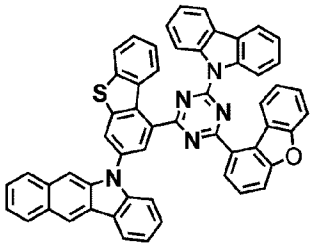
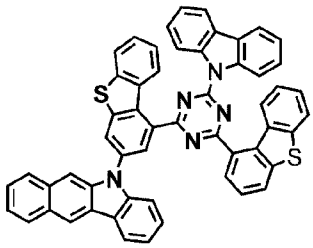
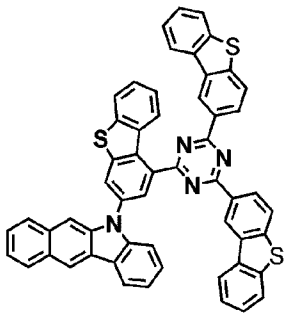
[425]



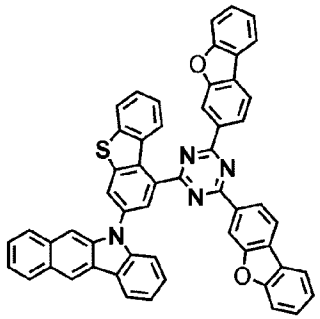
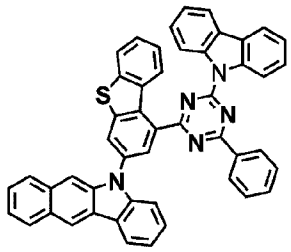
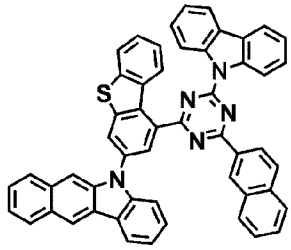
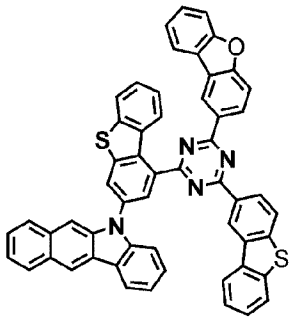
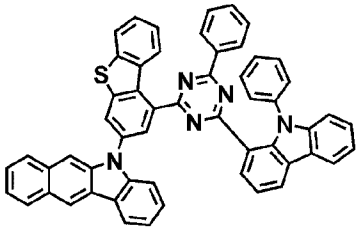
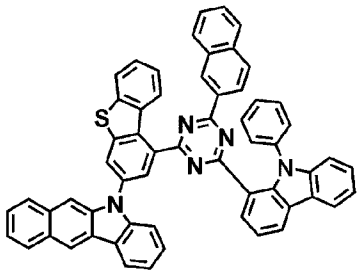
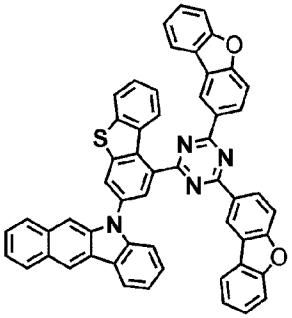
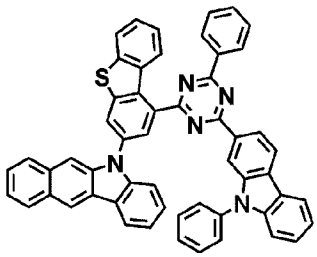
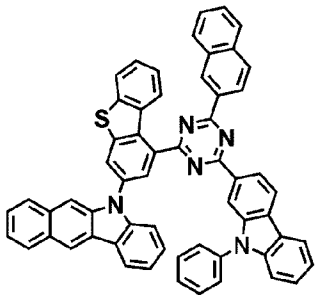
[426]



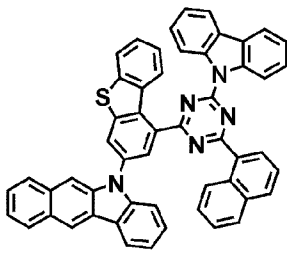
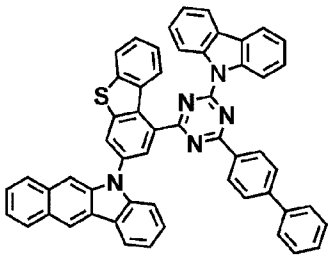
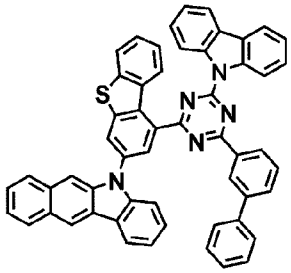
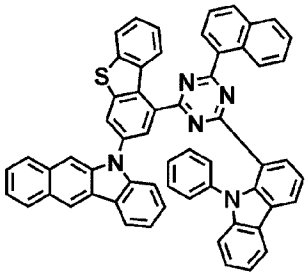
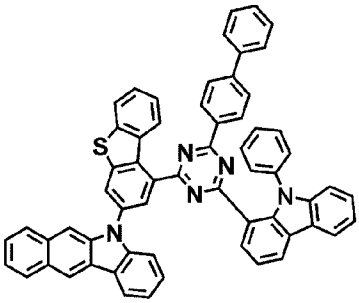
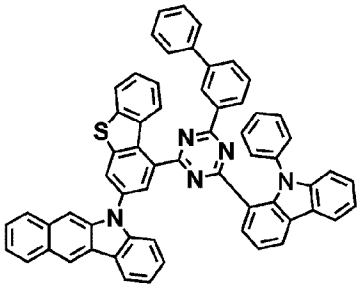
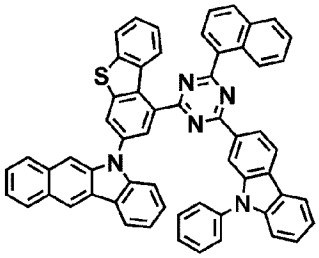
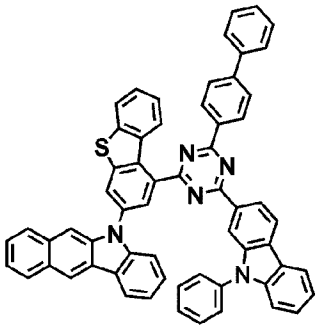
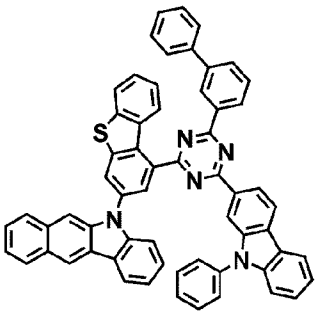
[427]

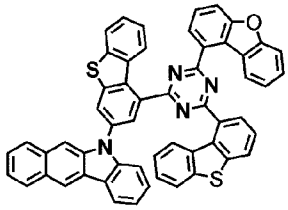
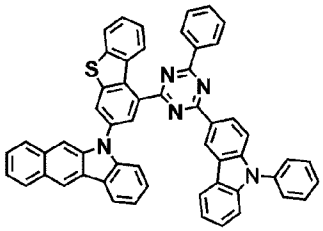
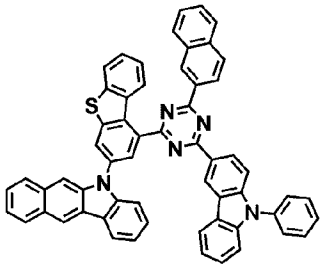
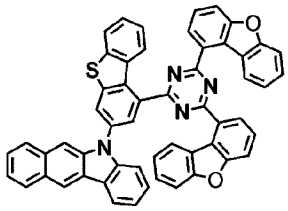
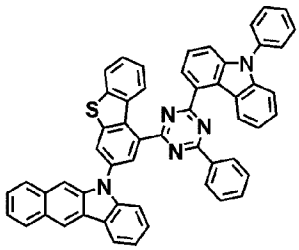
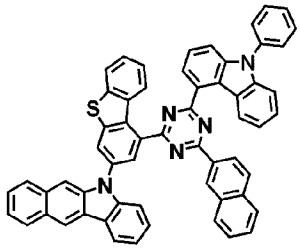
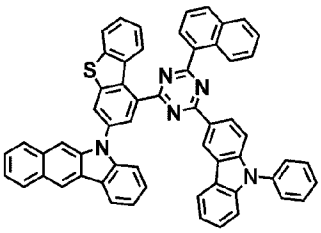
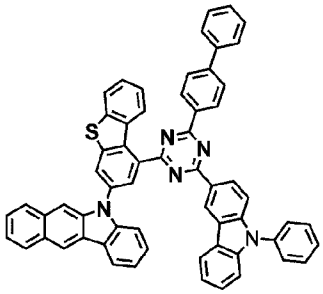
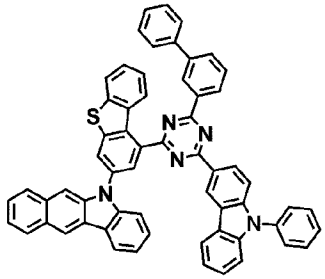
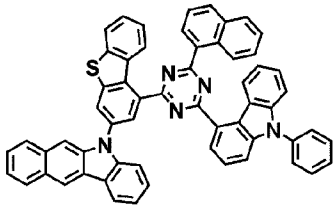
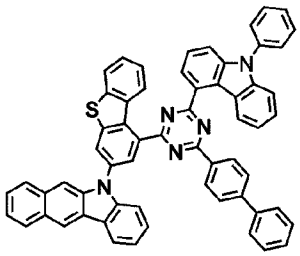
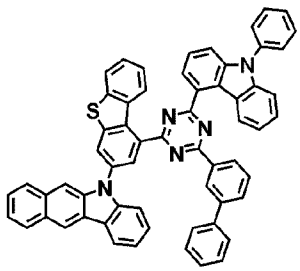
[428]

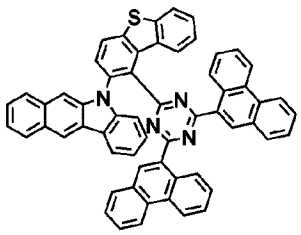
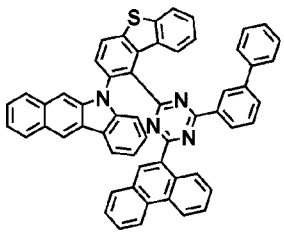
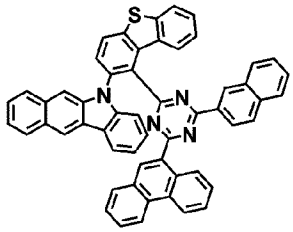
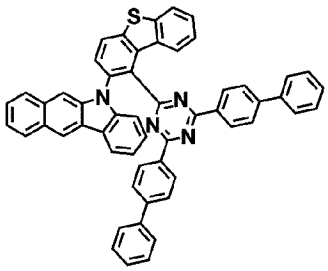
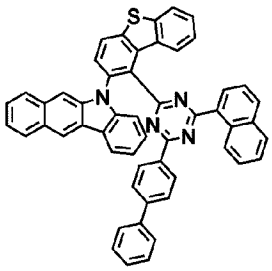
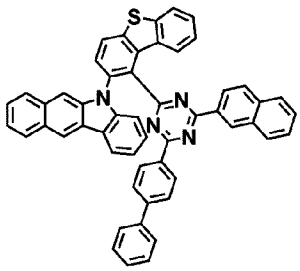
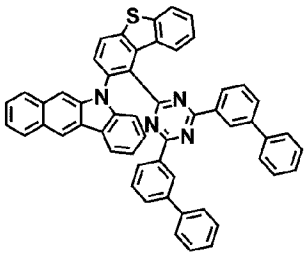
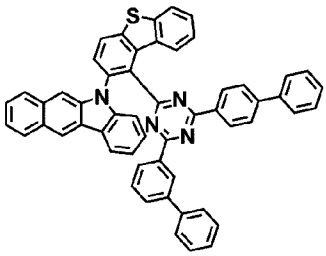
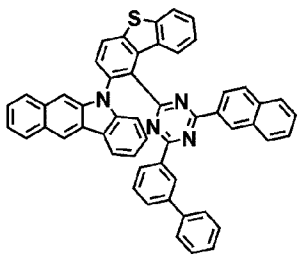
[429]

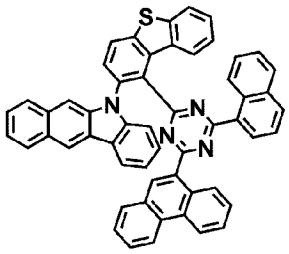
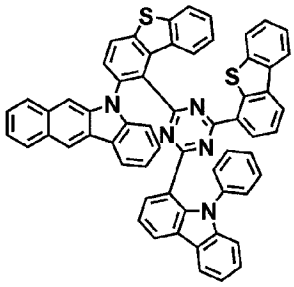
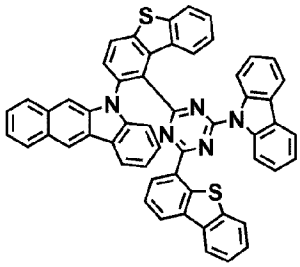
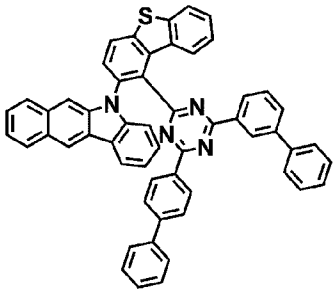
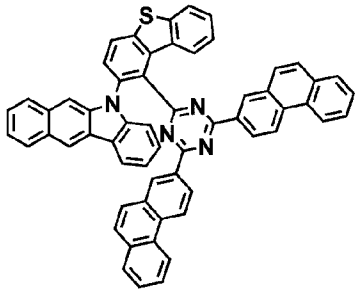
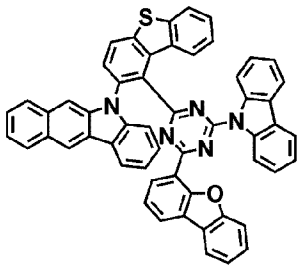
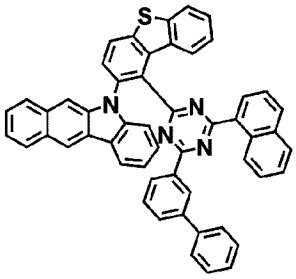
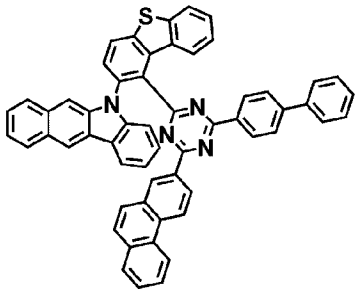
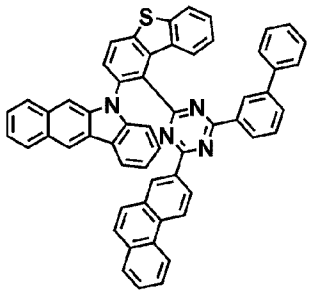
[430]

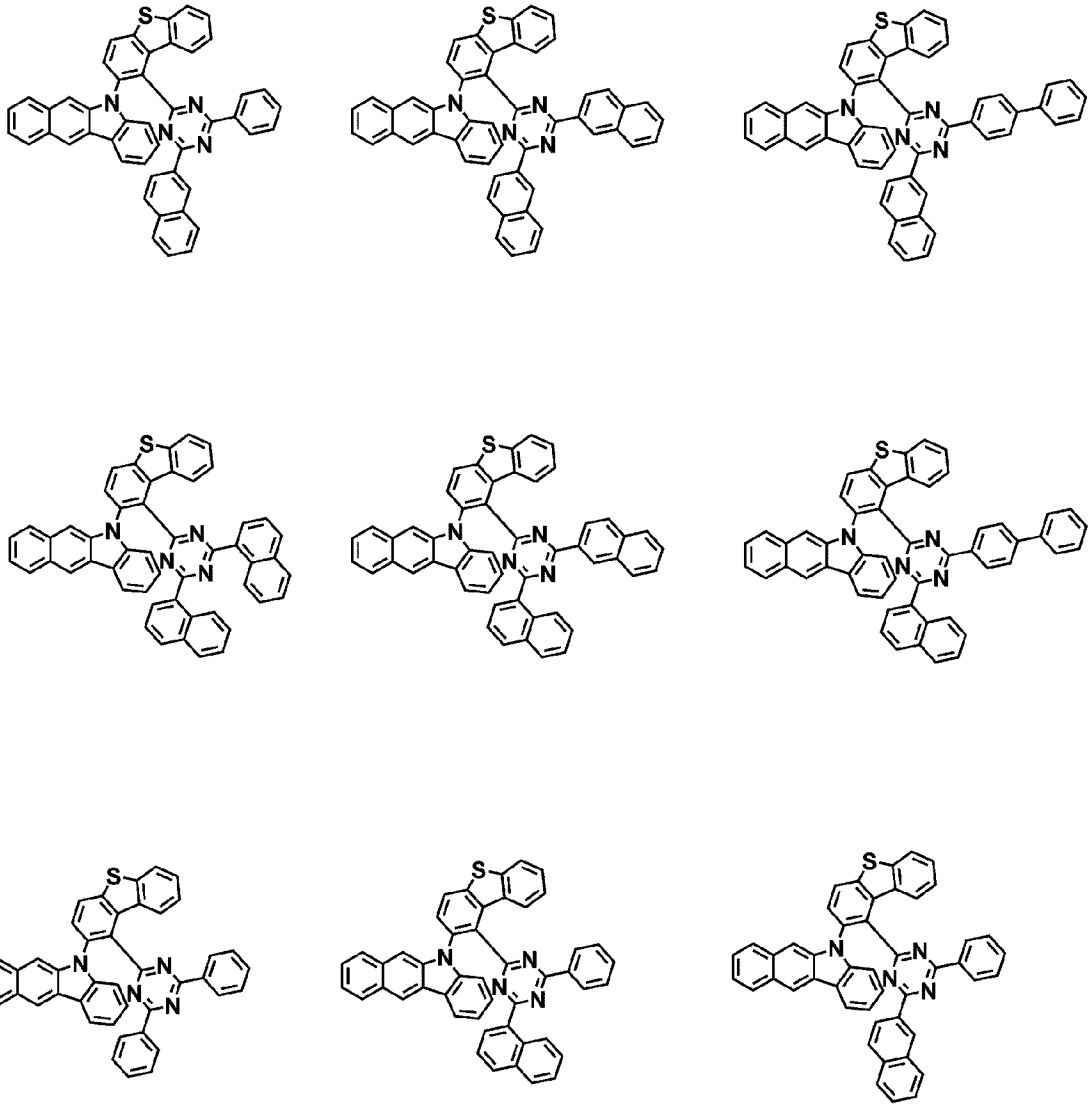
[431]

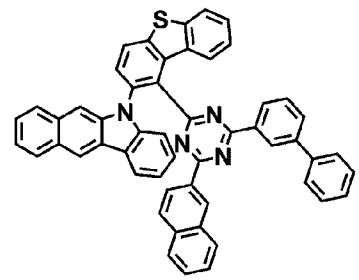
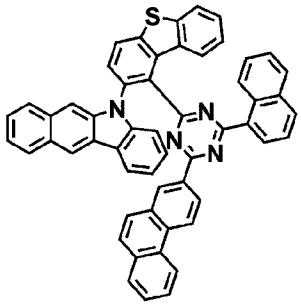
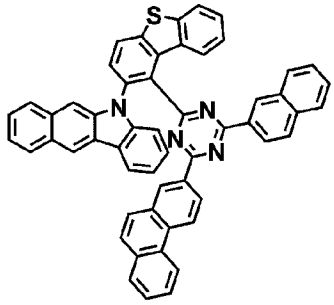
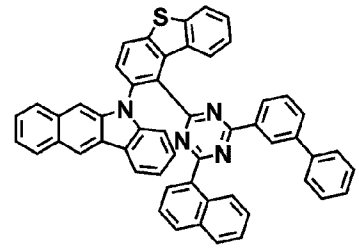
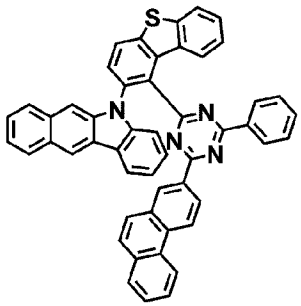
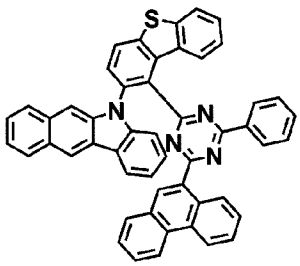
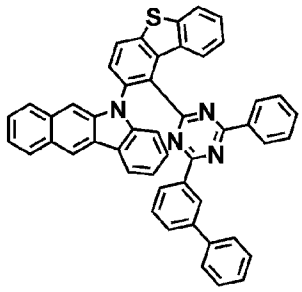
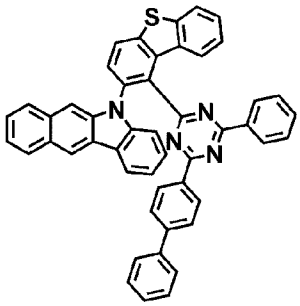
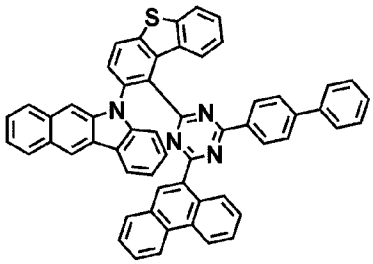
[432]

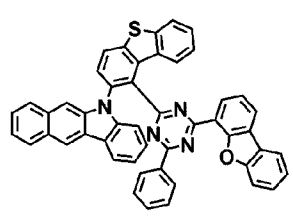
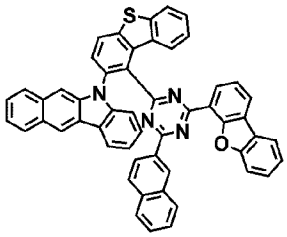
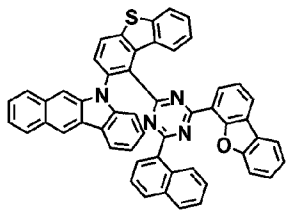
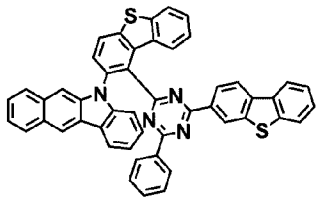
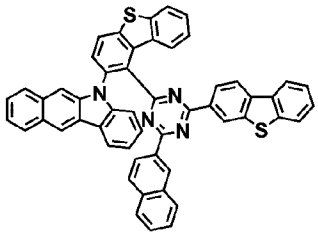
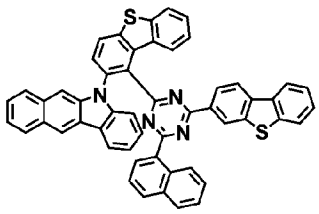
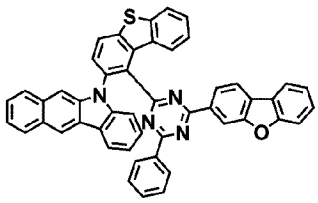
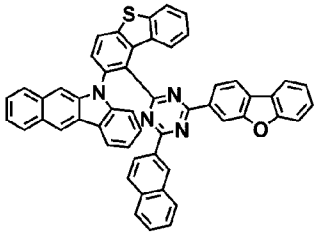
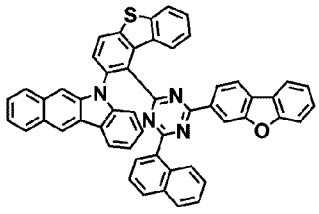
[433]



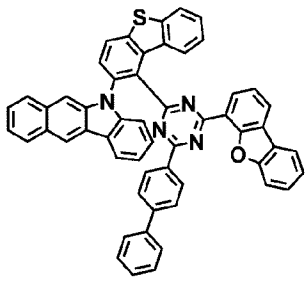
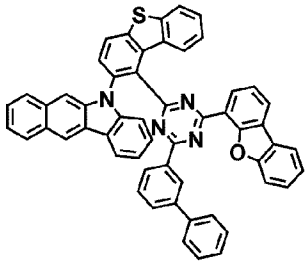
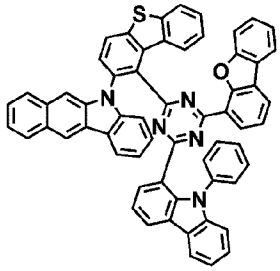
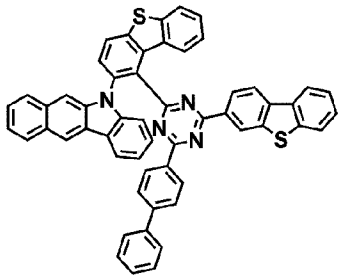
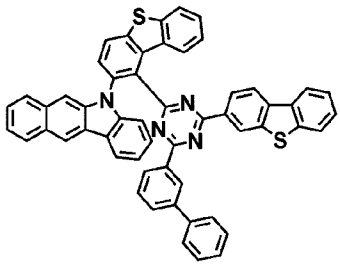
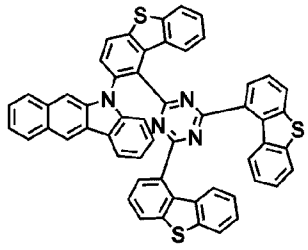
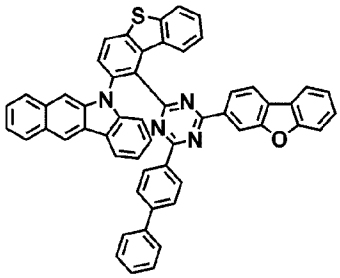
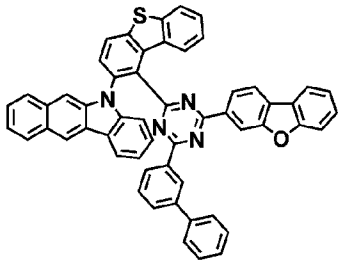
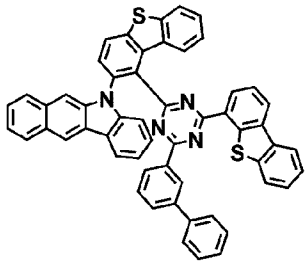
[434]

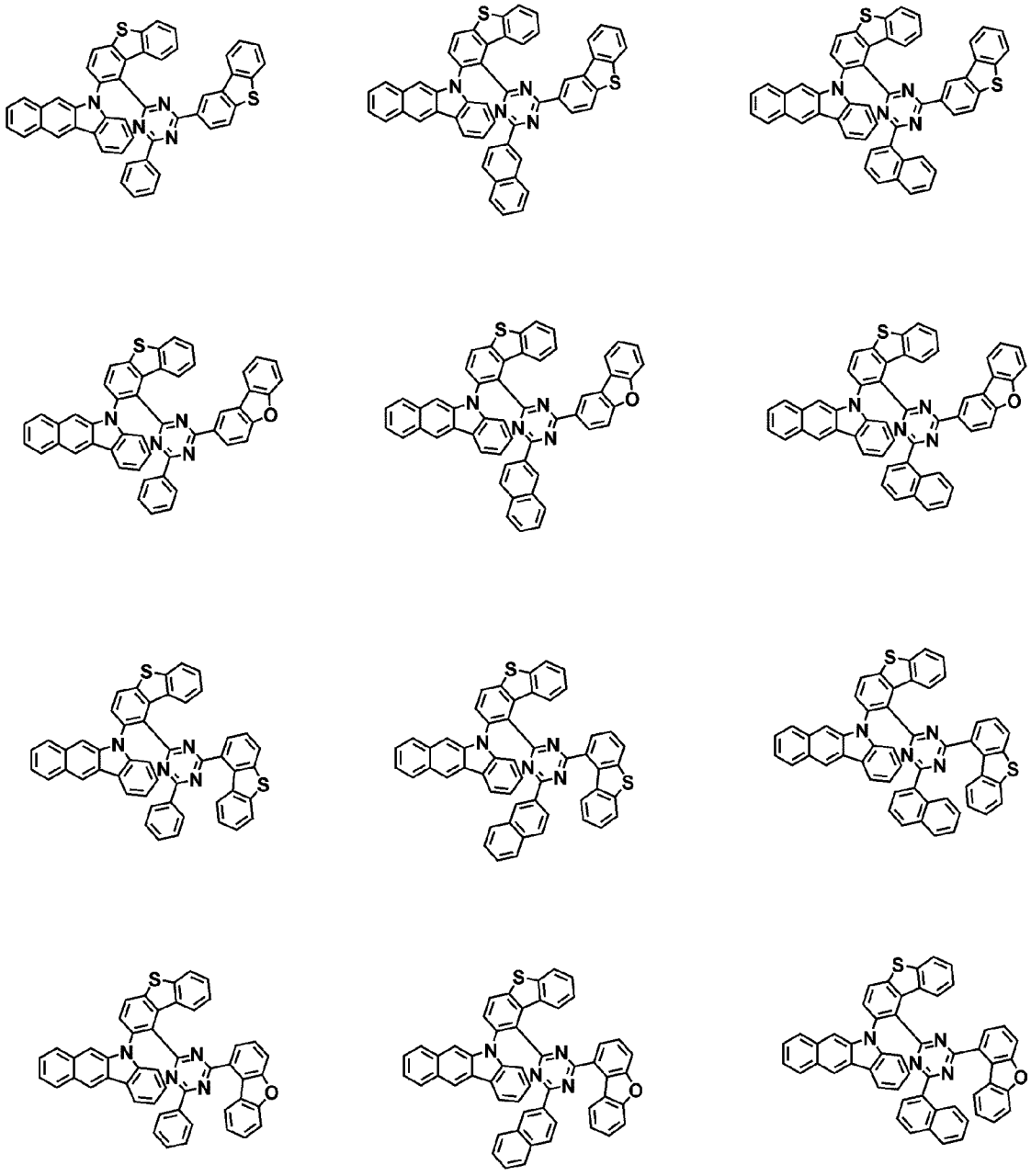
[435]

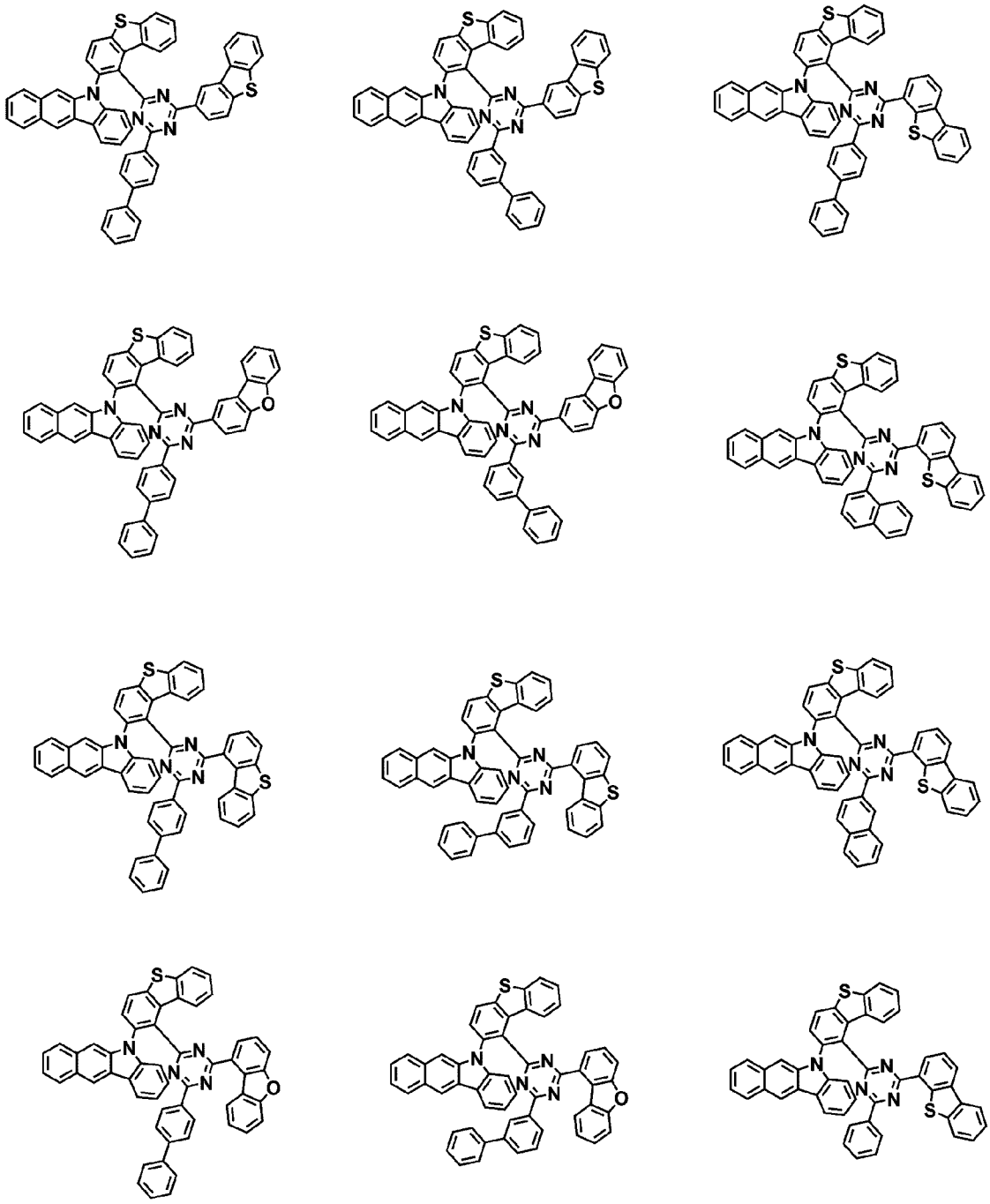
[436]

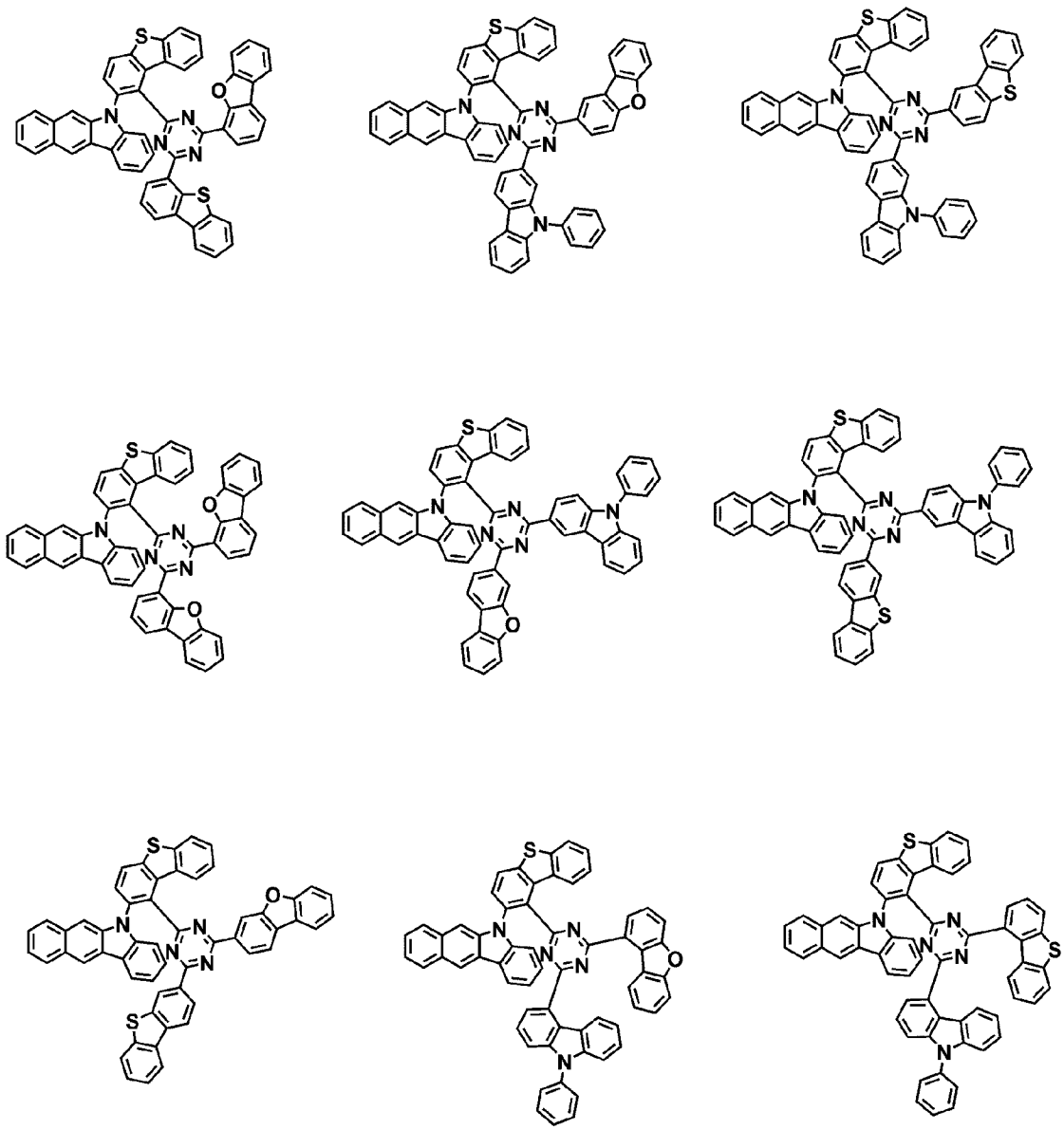
[437]



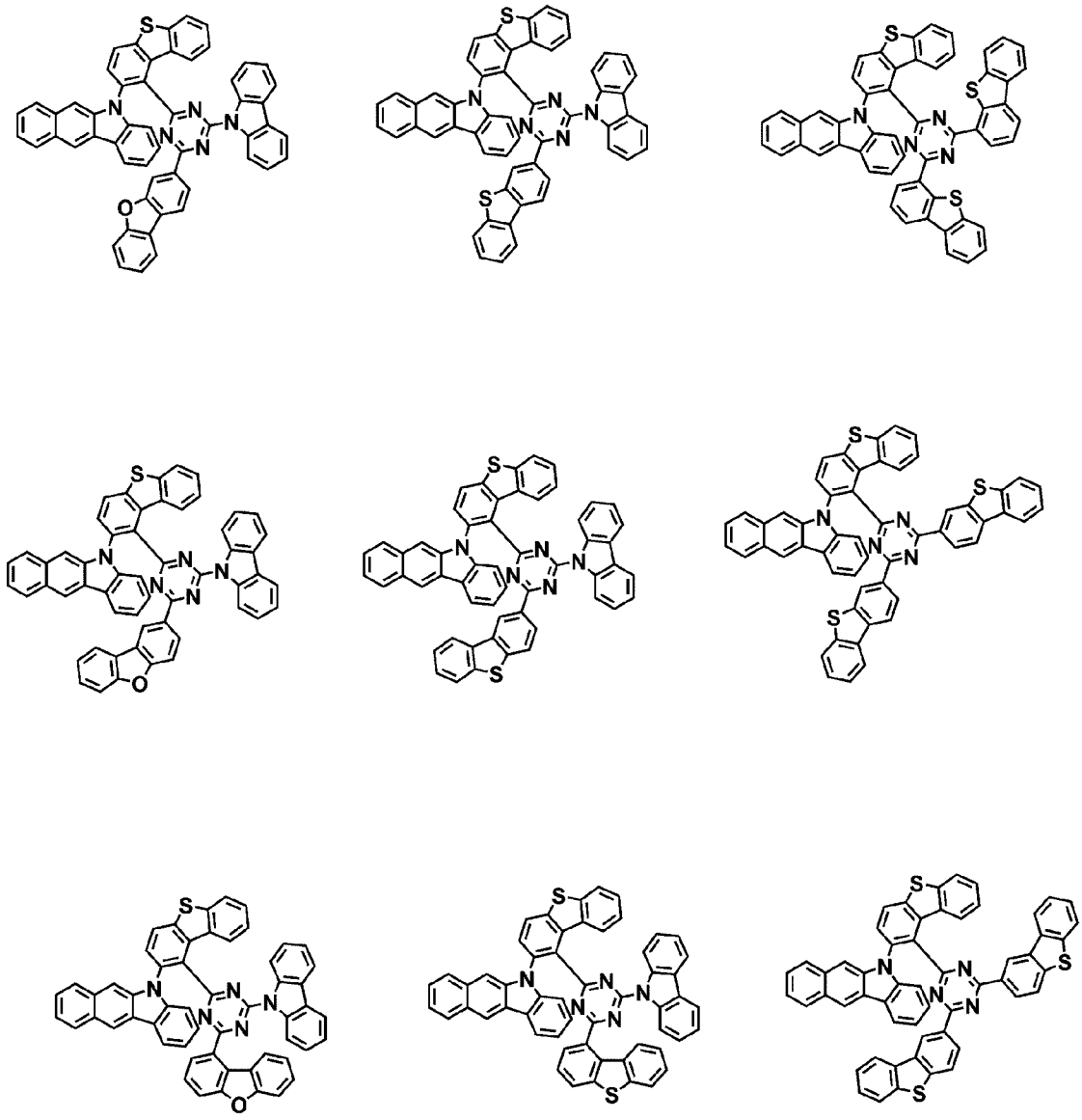
[438]



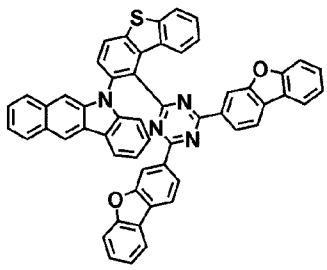
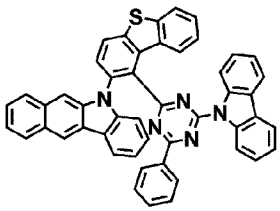
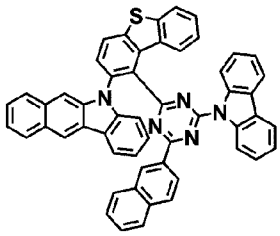
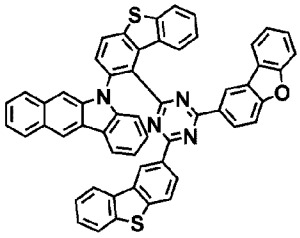
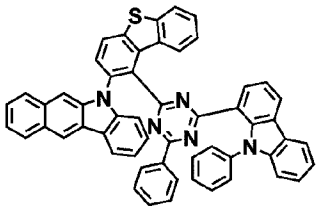
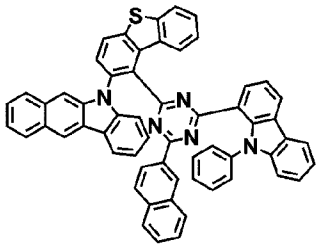
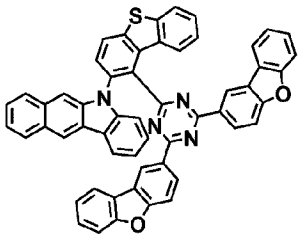
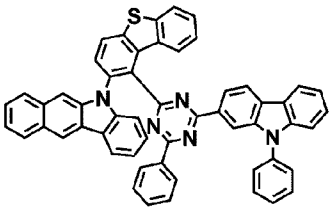
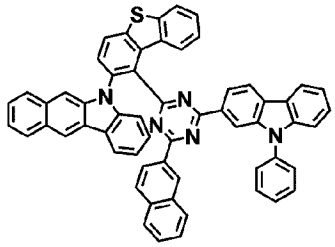
[439]



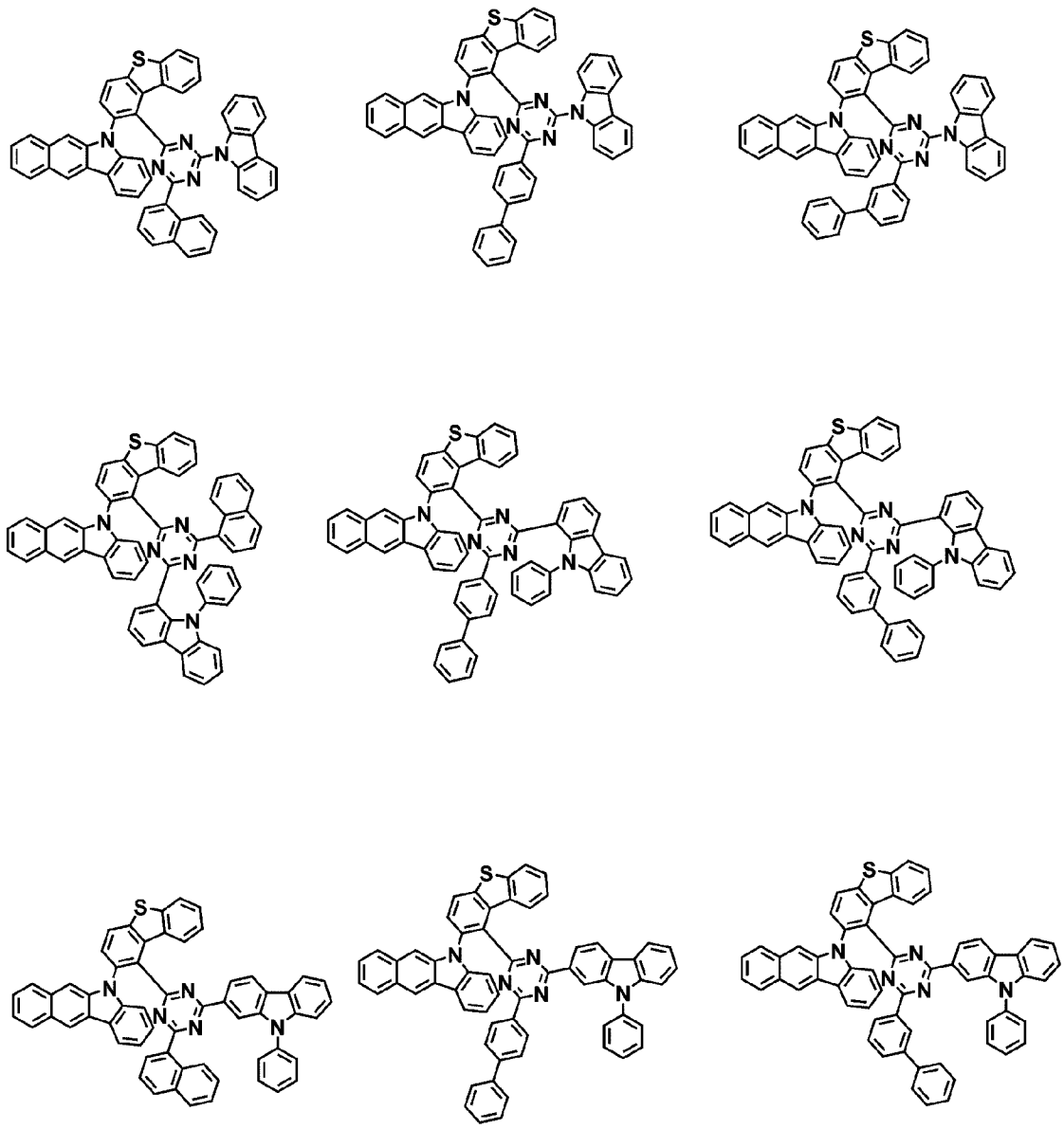
[440]



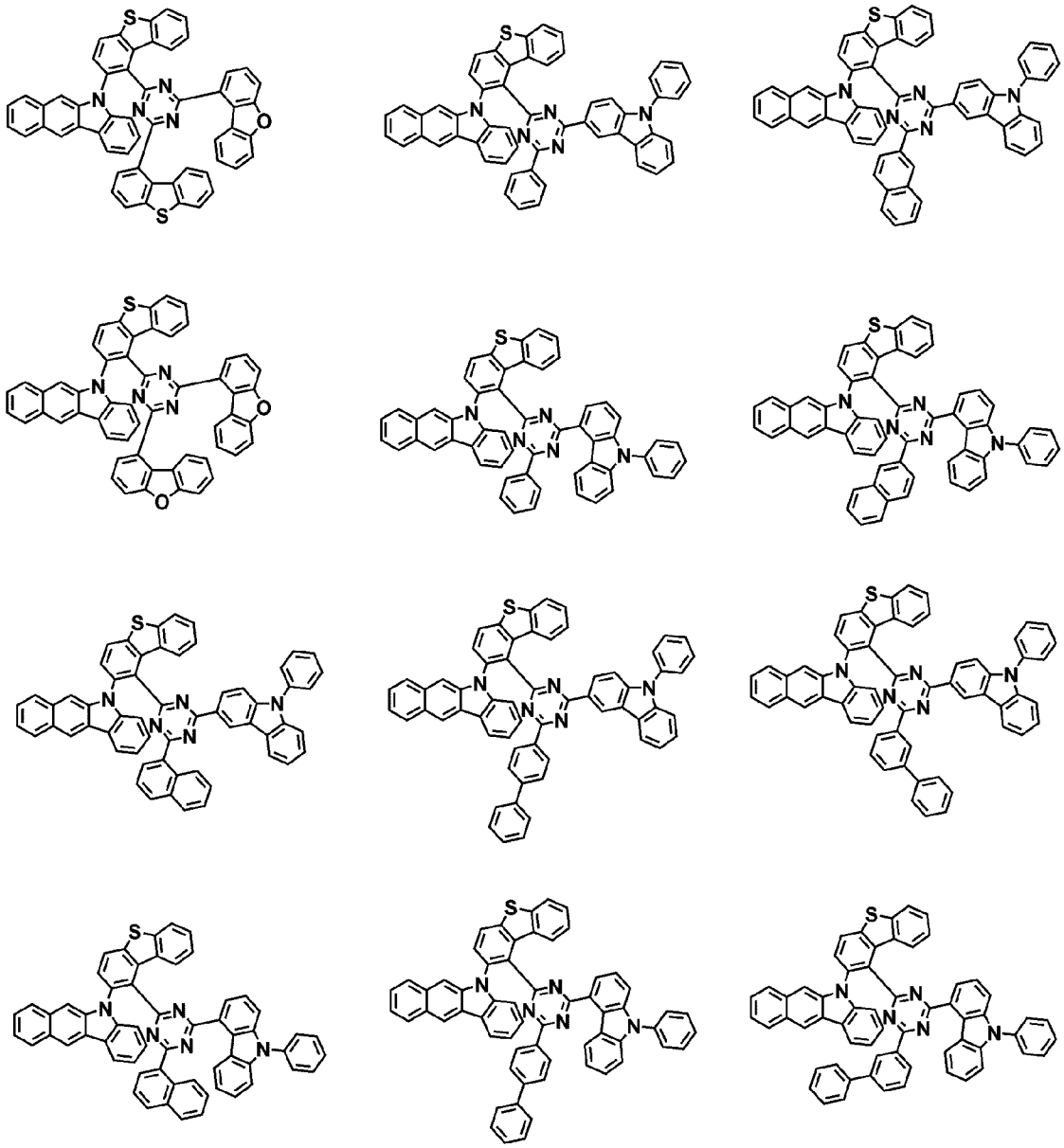
[441]

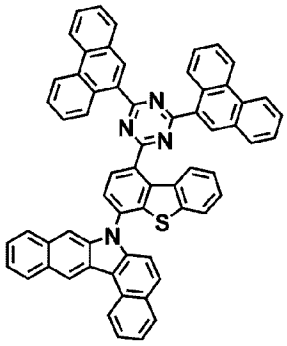
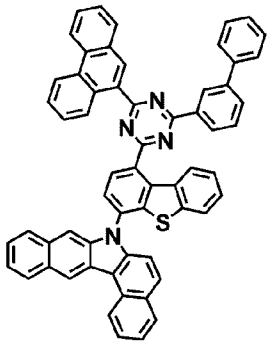
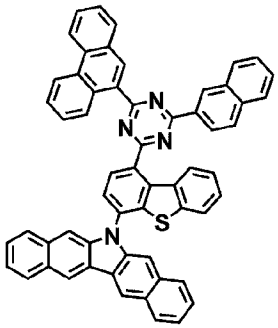
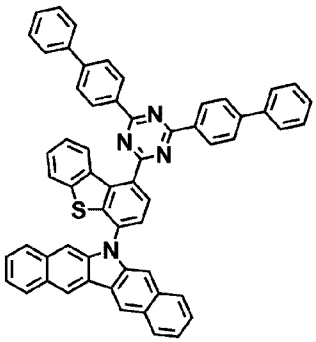
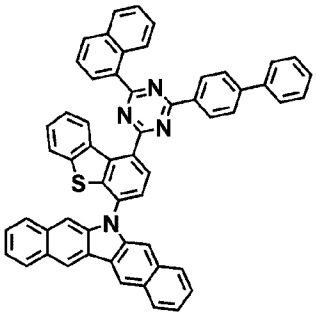
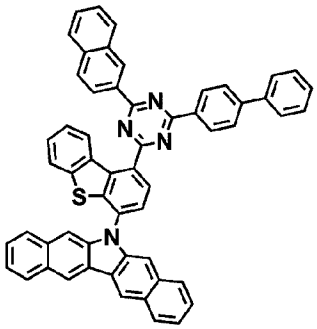
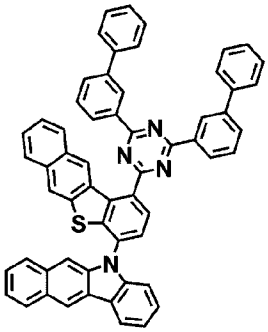
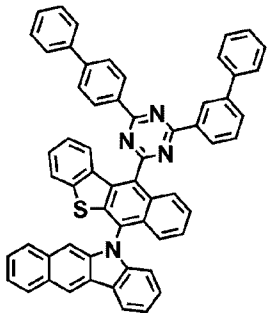
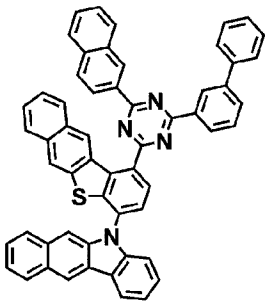
[442]



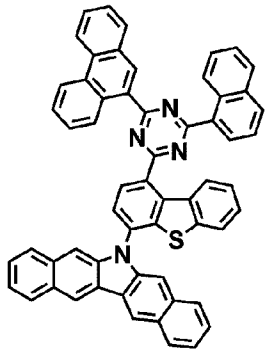
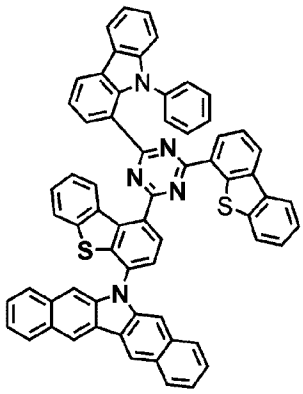
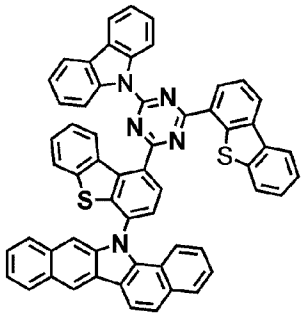
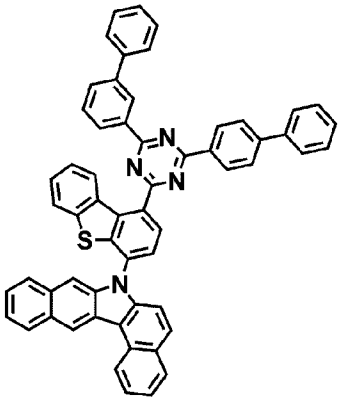
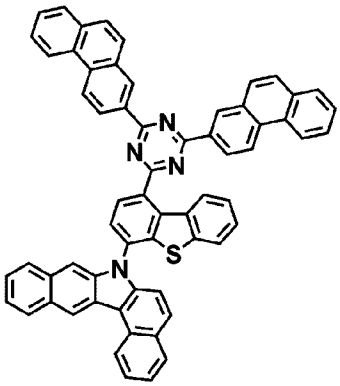
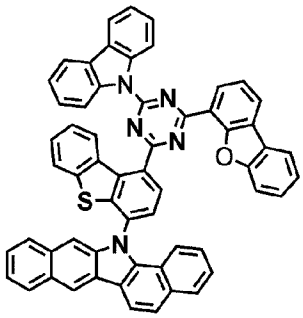
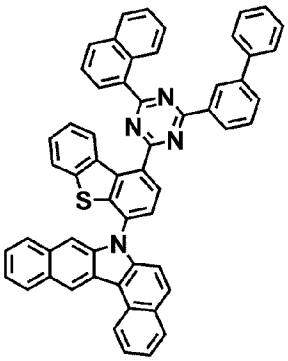
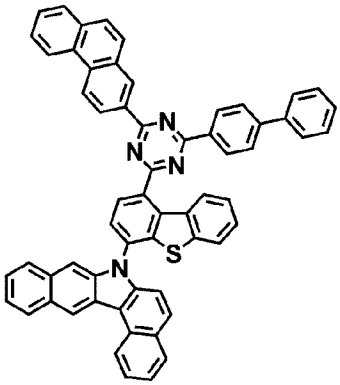
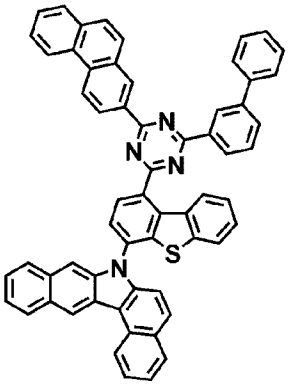
[443]



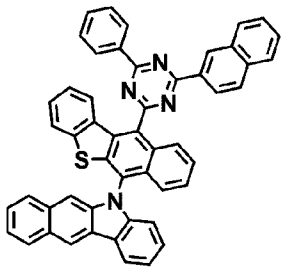
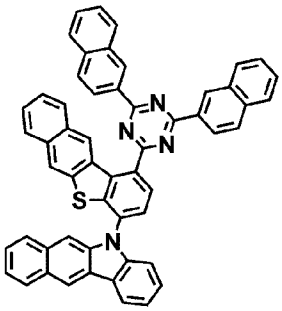
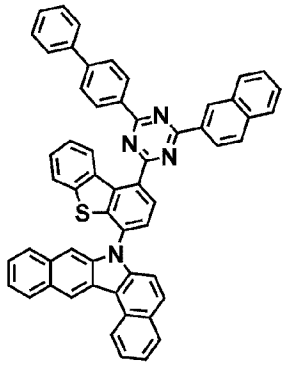
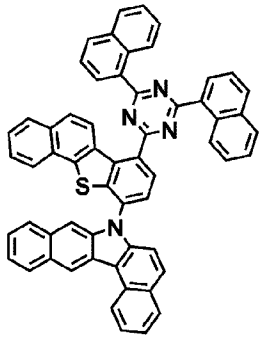
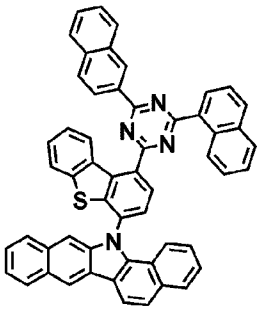
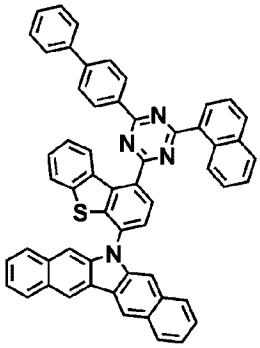
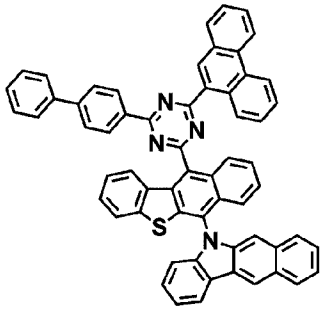
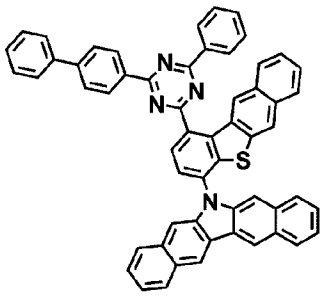
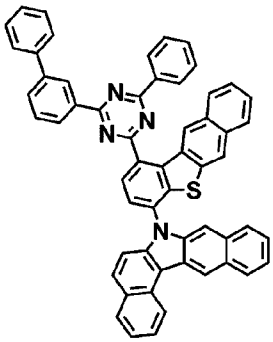
[444]

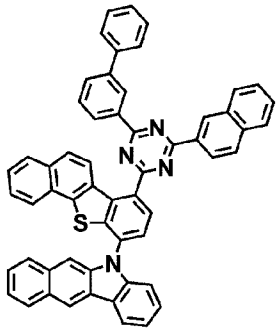
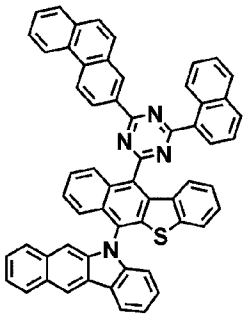
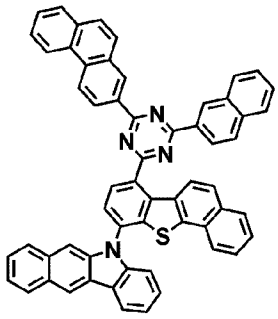
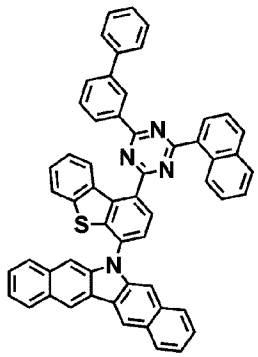
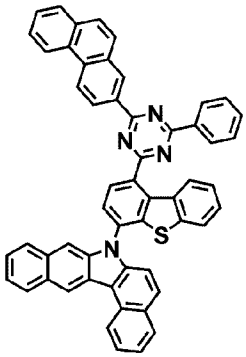
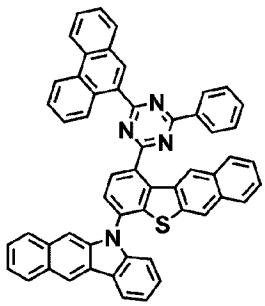
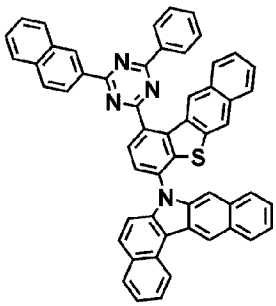
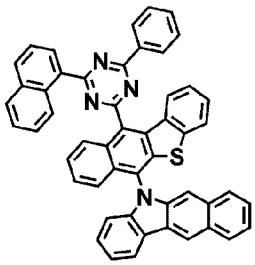
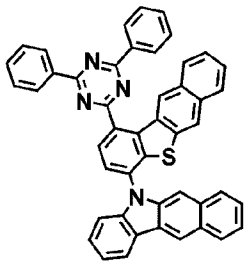
[445]

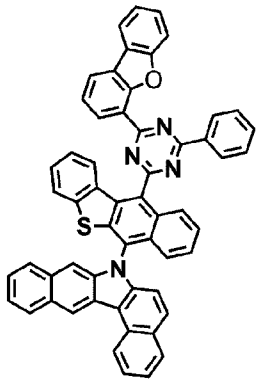
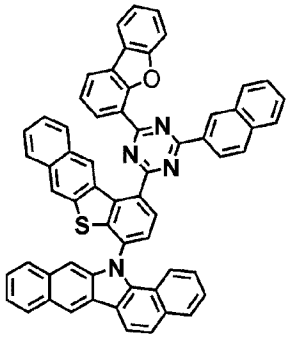
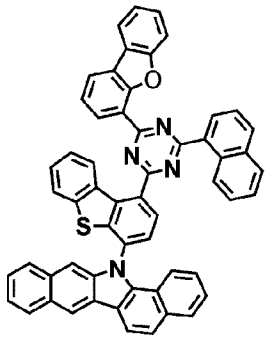
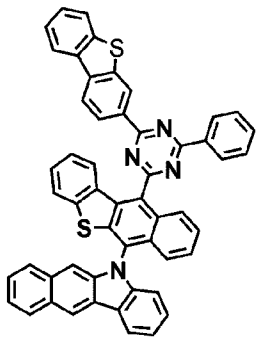
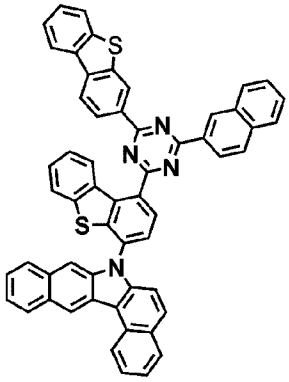
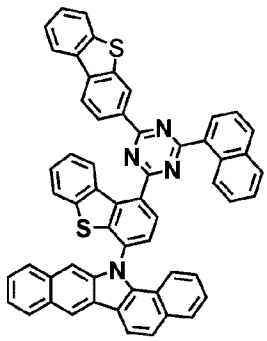
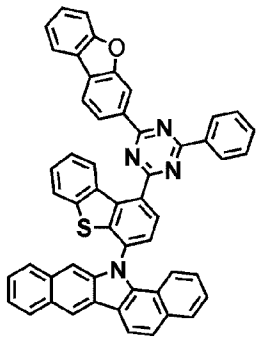
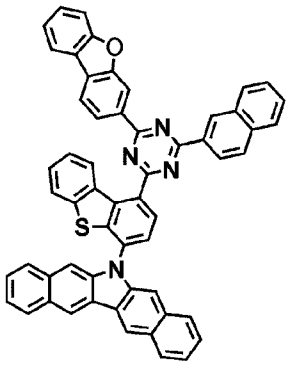
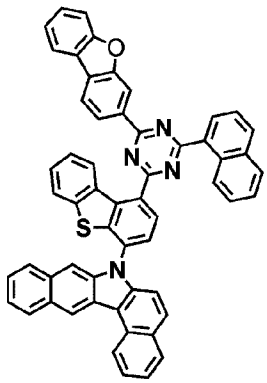
[446]

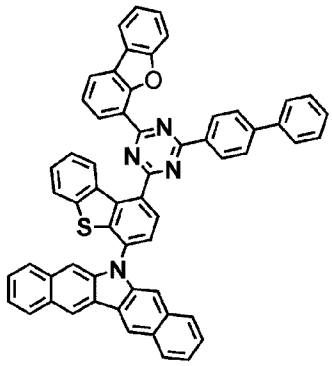
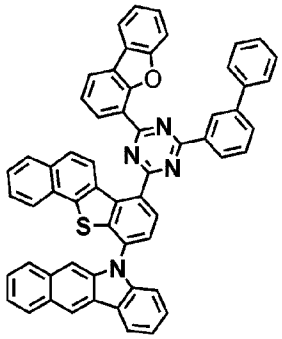
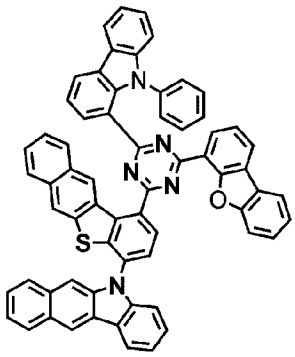
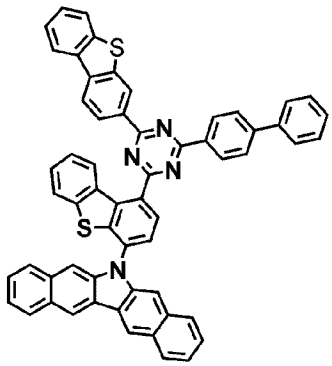
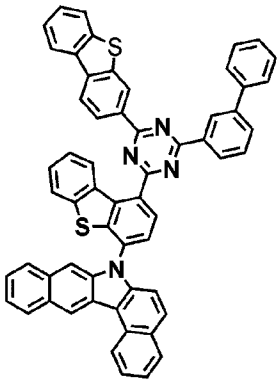
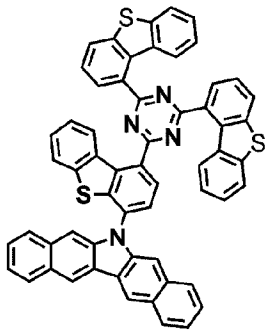
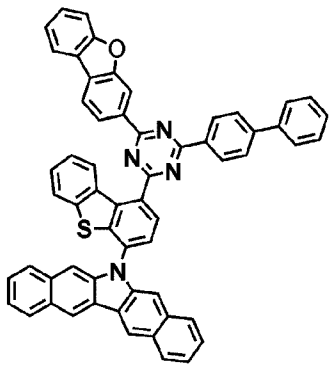
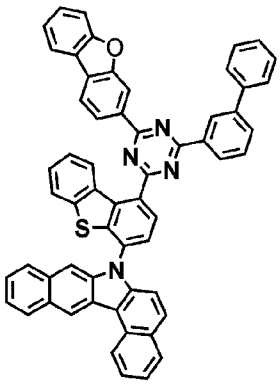
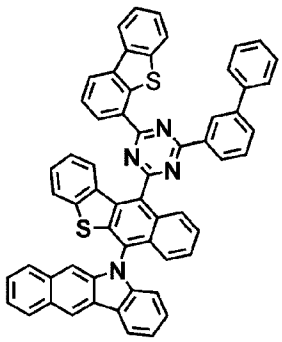
[447]

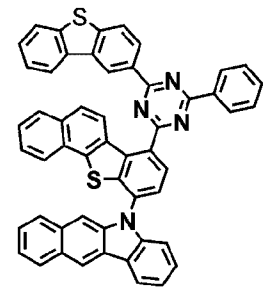
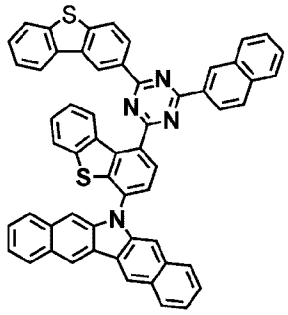
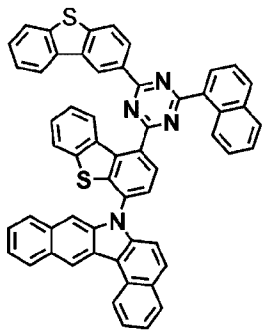
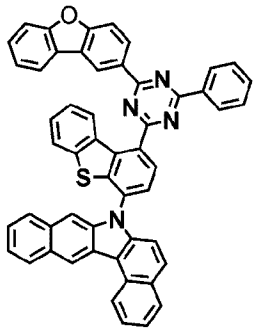
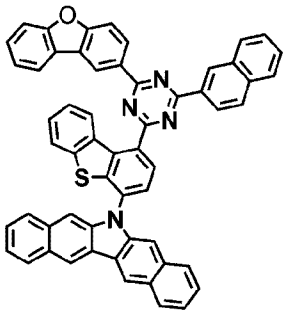
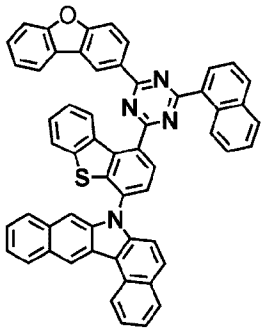
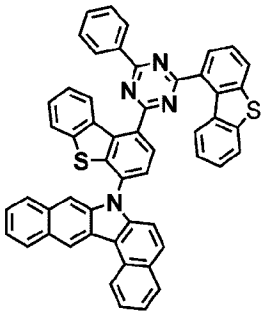
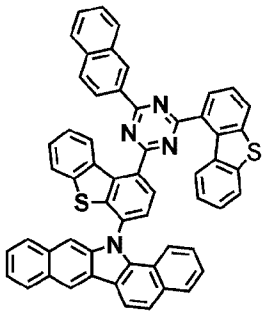
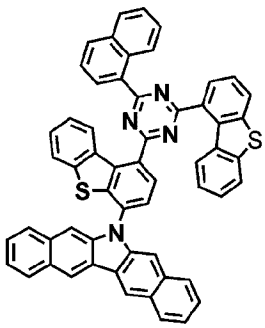
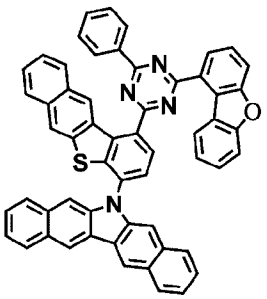
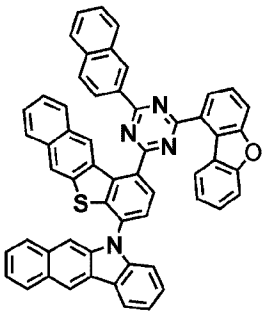
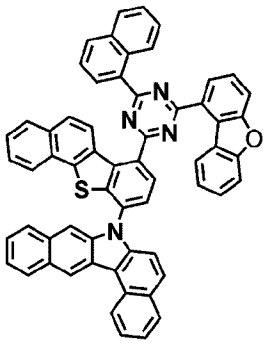
[448]

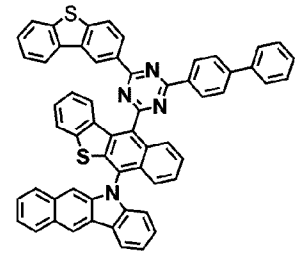
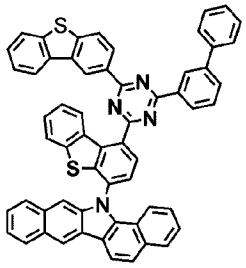
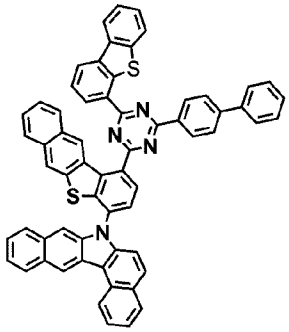
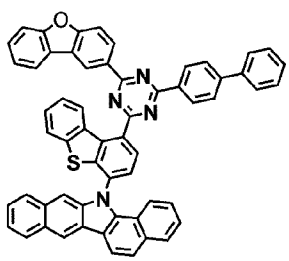
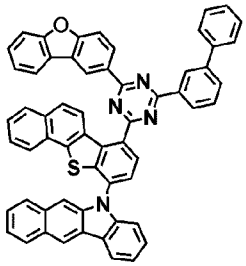
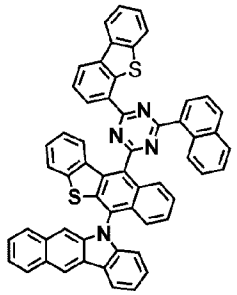
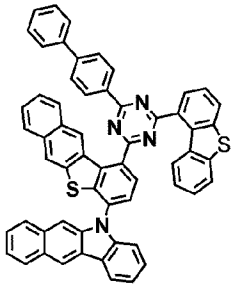
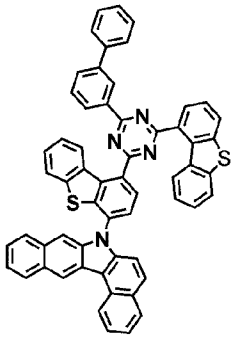
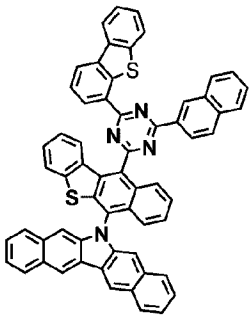
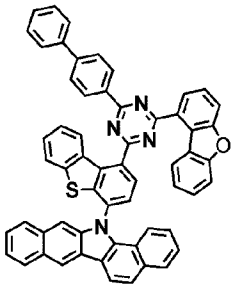
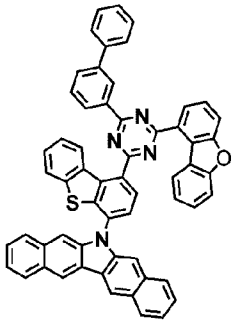
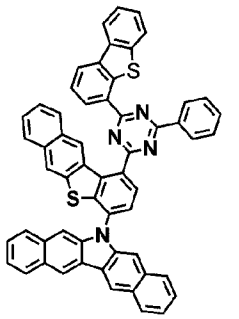
[449]

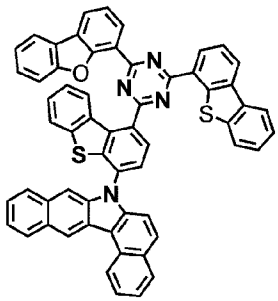
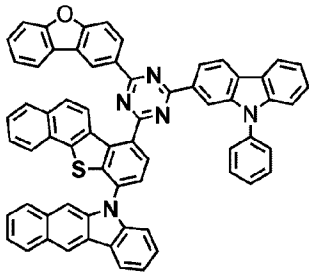
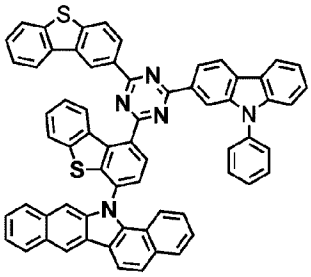
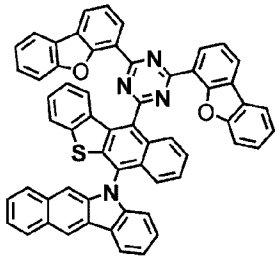
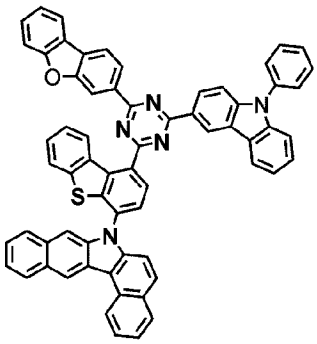
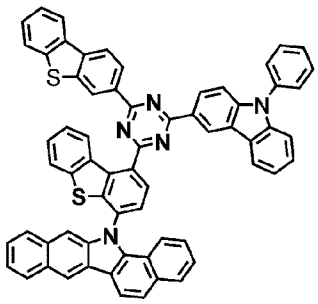
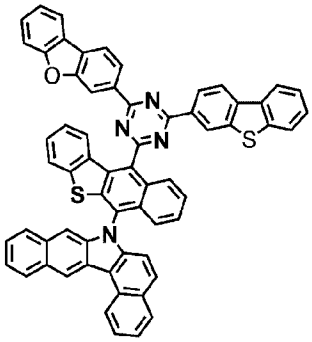
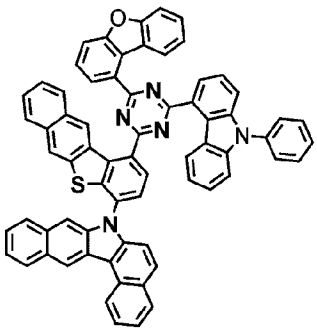
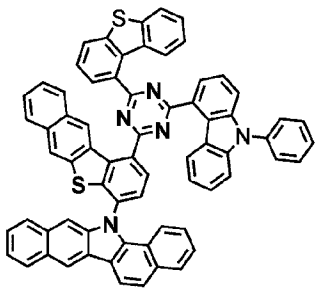
[450]

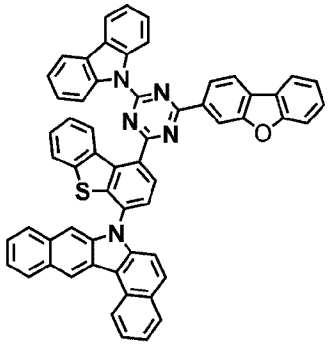
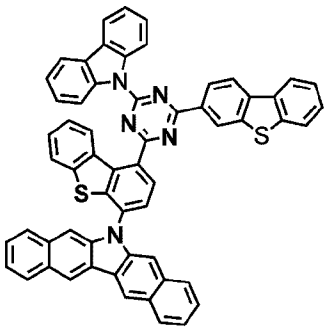
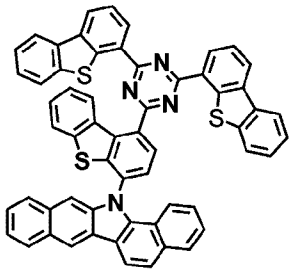
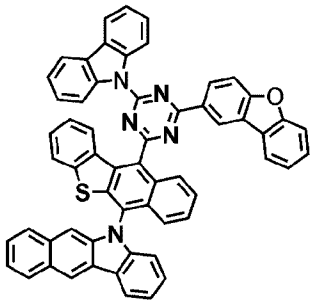
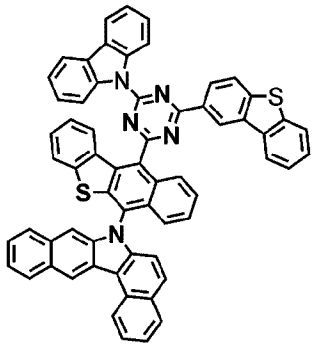
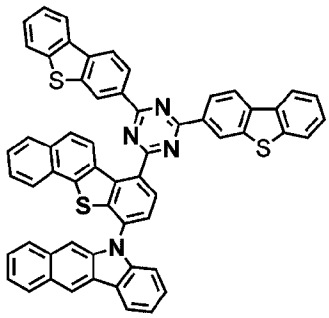
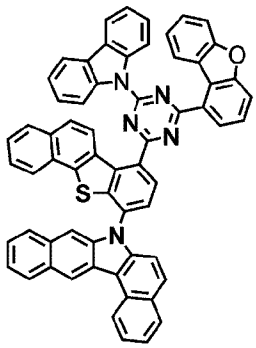
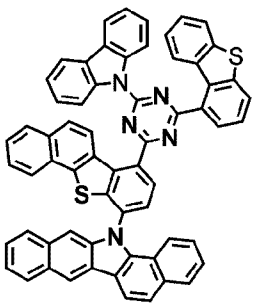
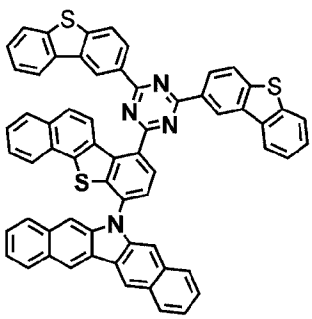
[451]

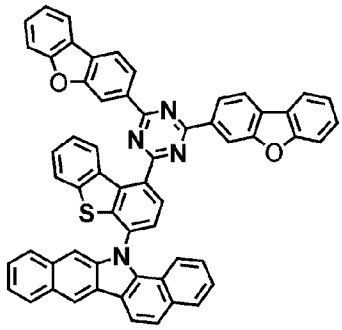
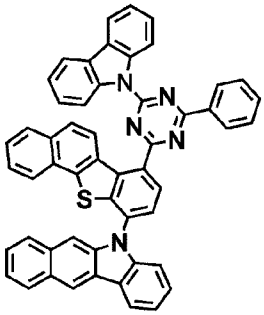
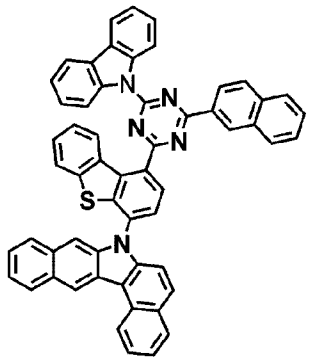
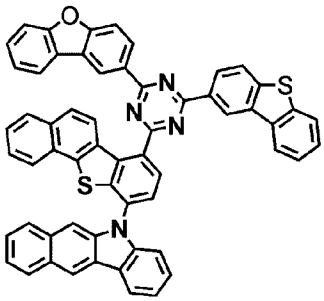
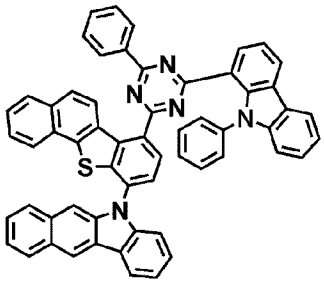
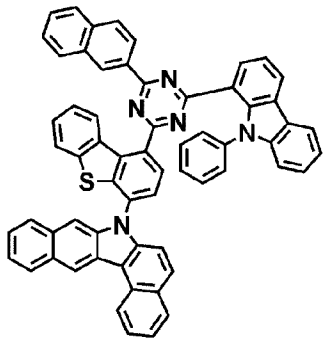
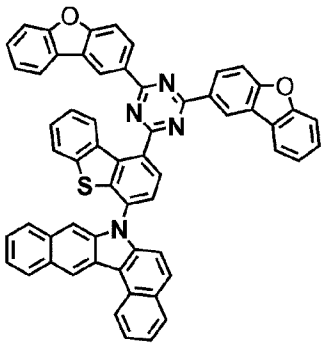
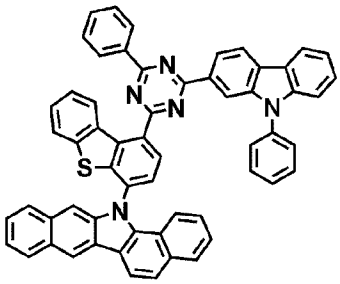
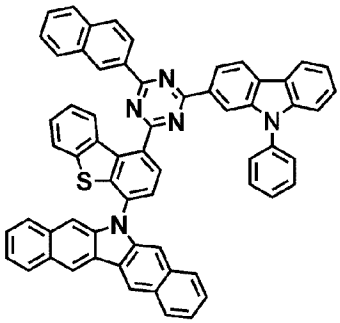
[452]

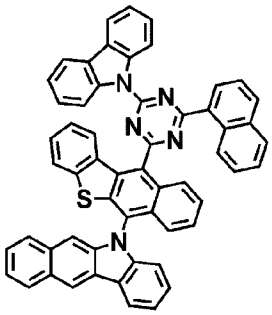
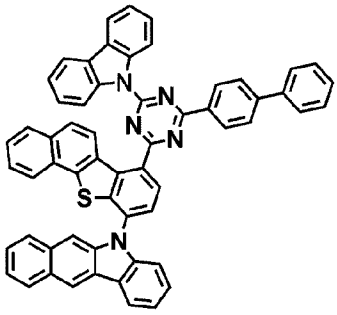
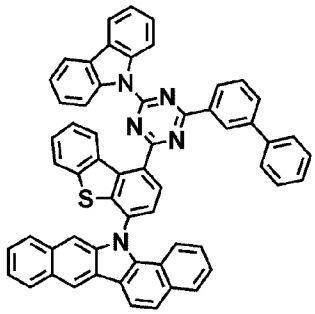
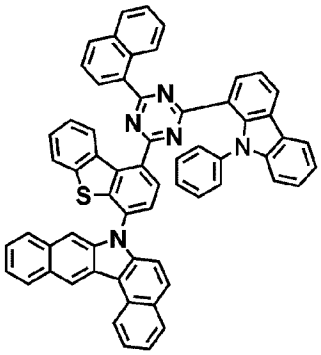
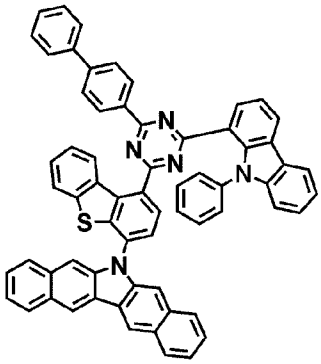
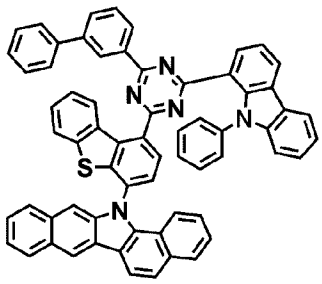
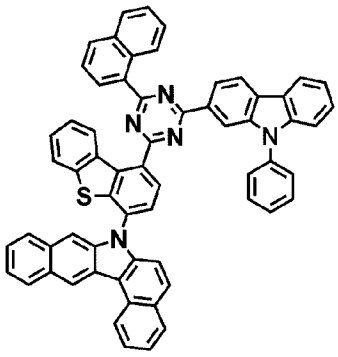
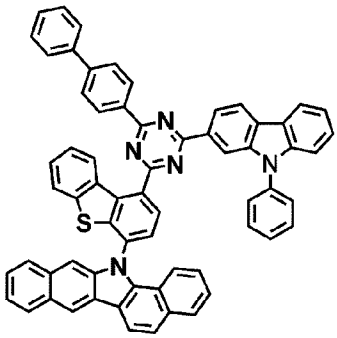
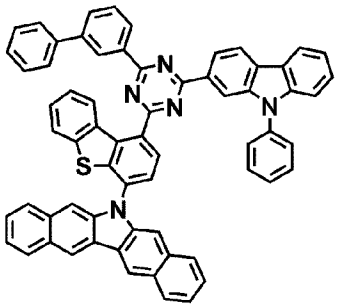
[453]

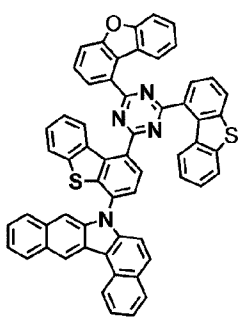
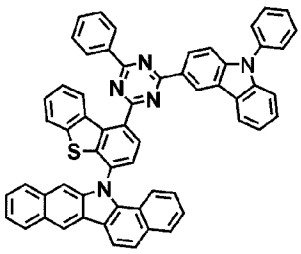
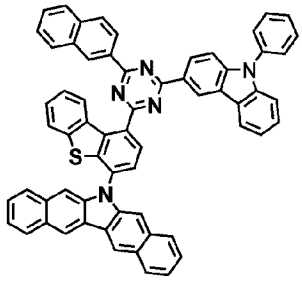
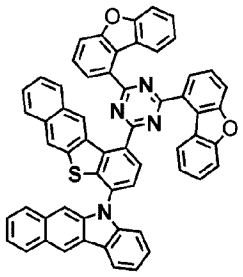
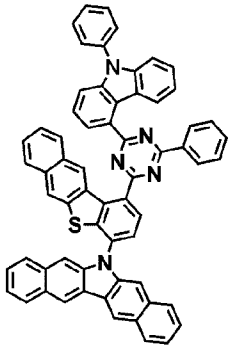
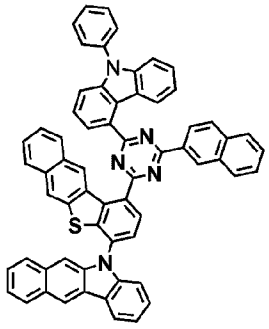
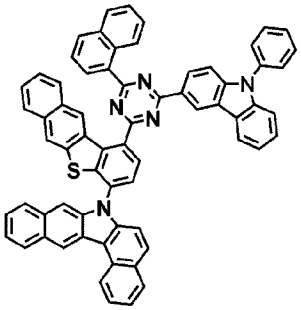
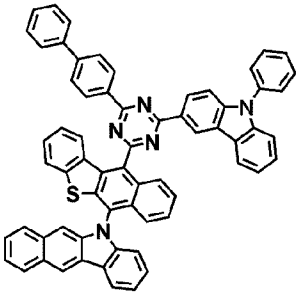
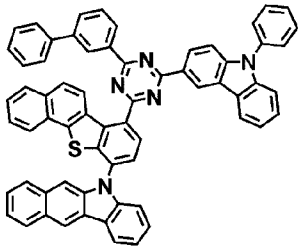
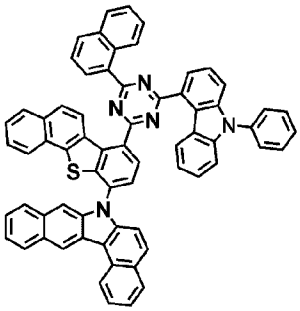
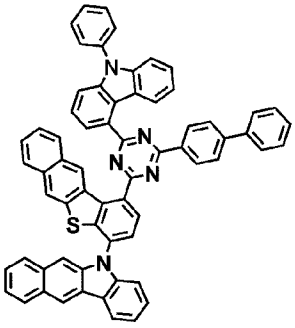
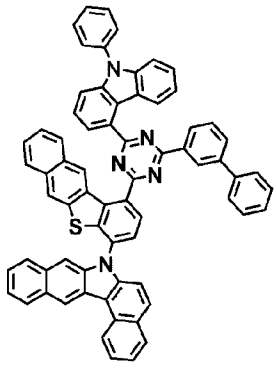
[454]

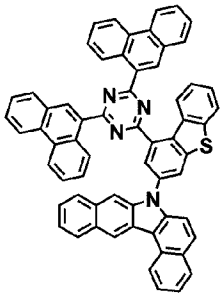
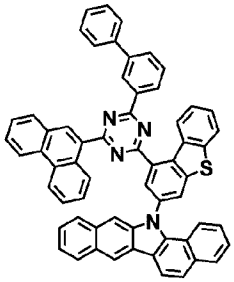
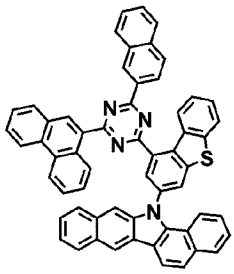
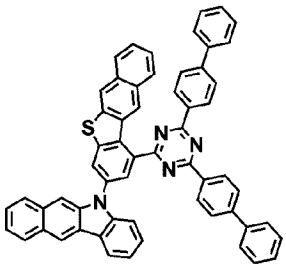
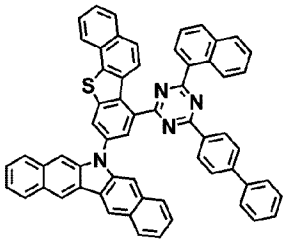
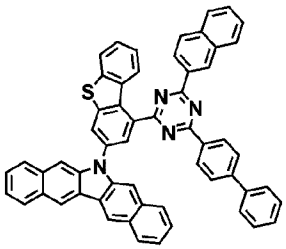
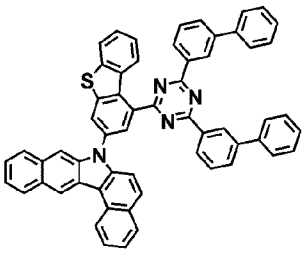
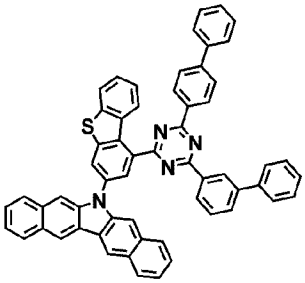
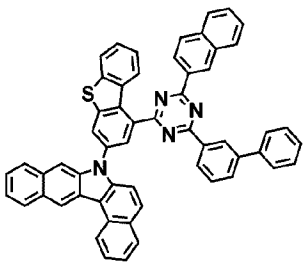
[455]

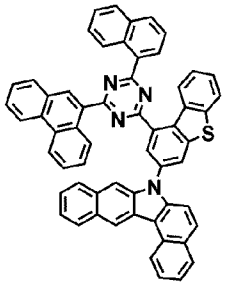
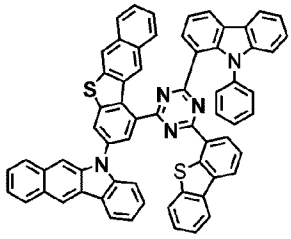
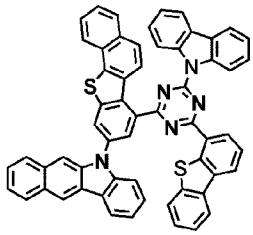
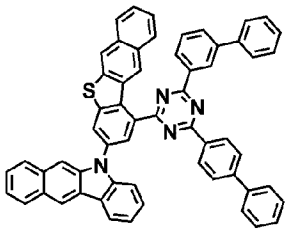
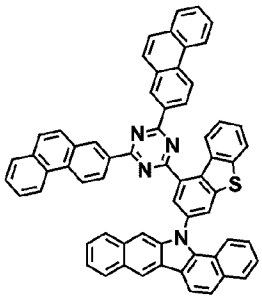
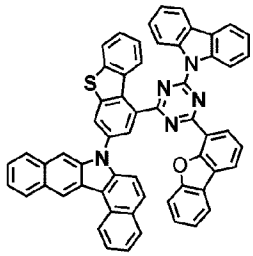
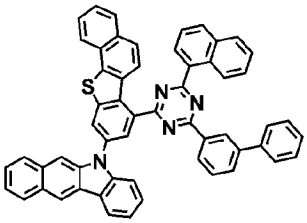
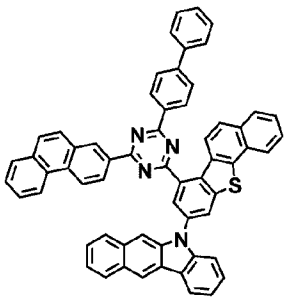
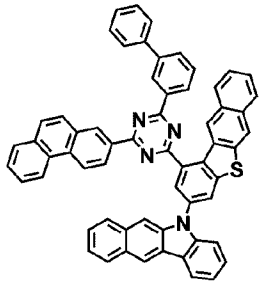
[456]

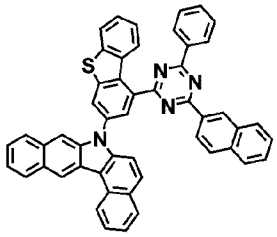
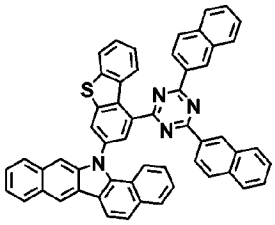
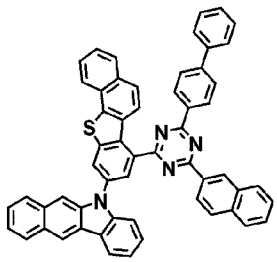
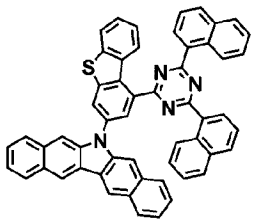
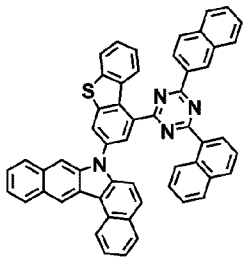
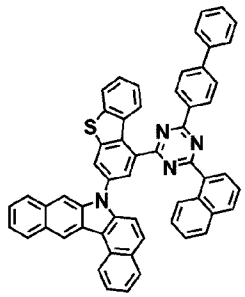
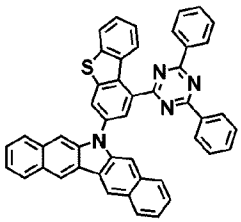
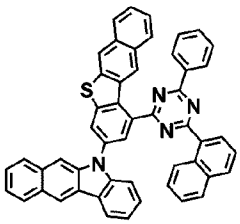
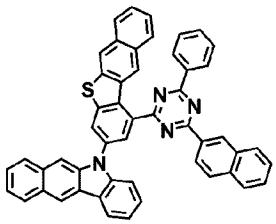
[457]

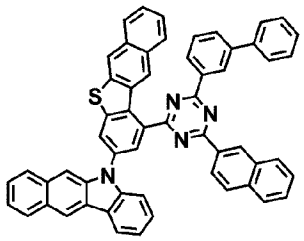
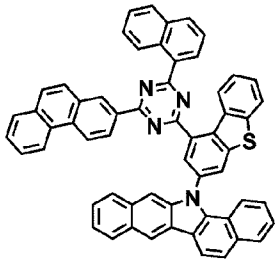
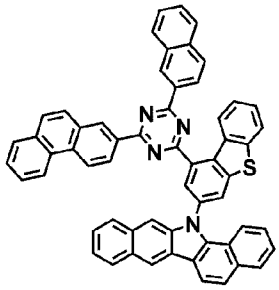
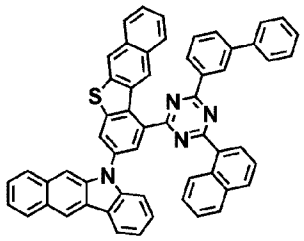
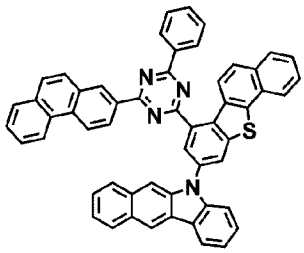
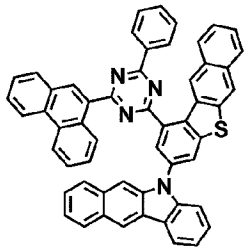
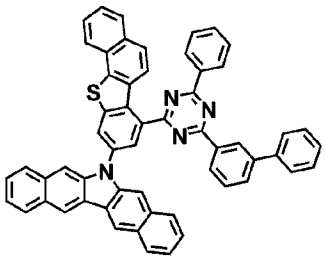
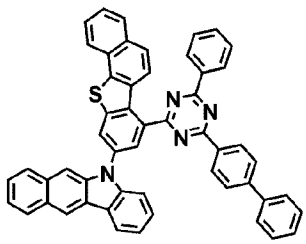
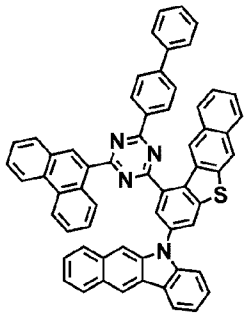
[458]

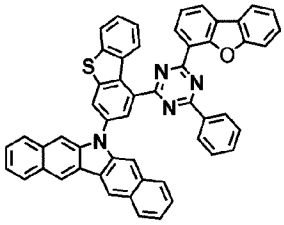
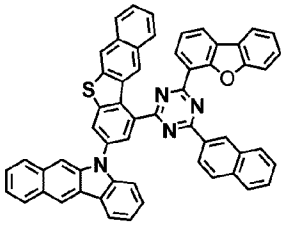
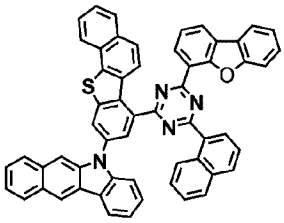
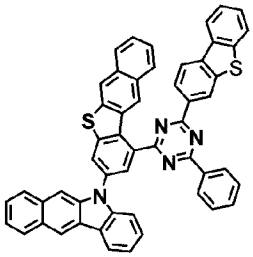
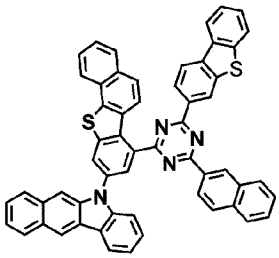
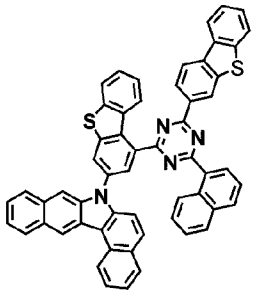
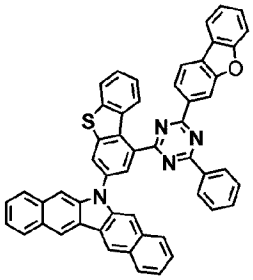
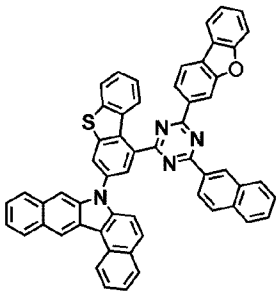
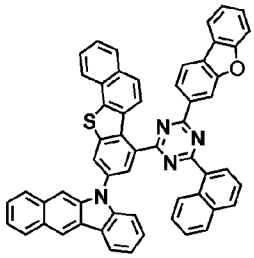
[459]

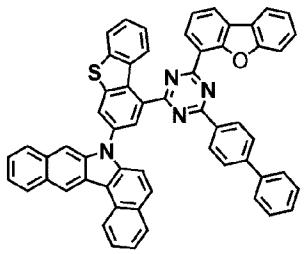
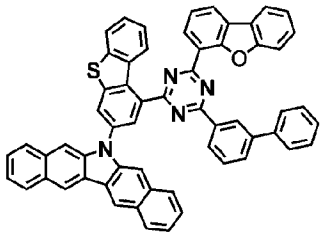
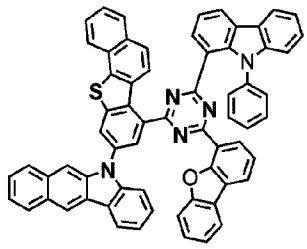
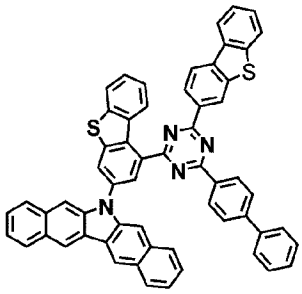
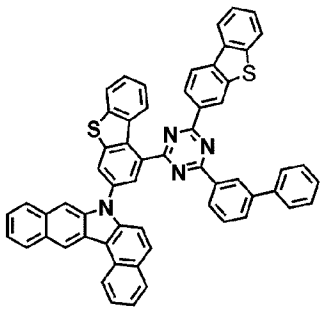
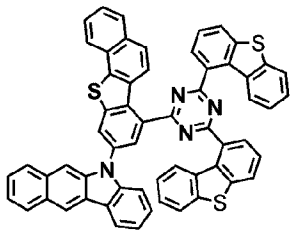
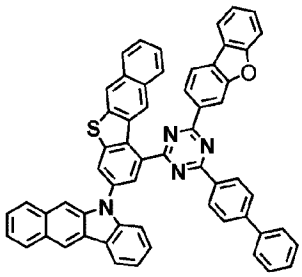
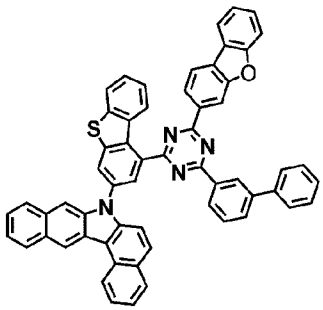
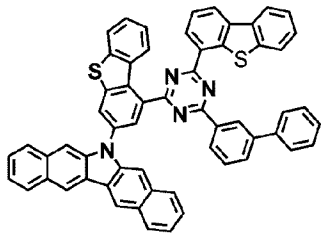
[460]

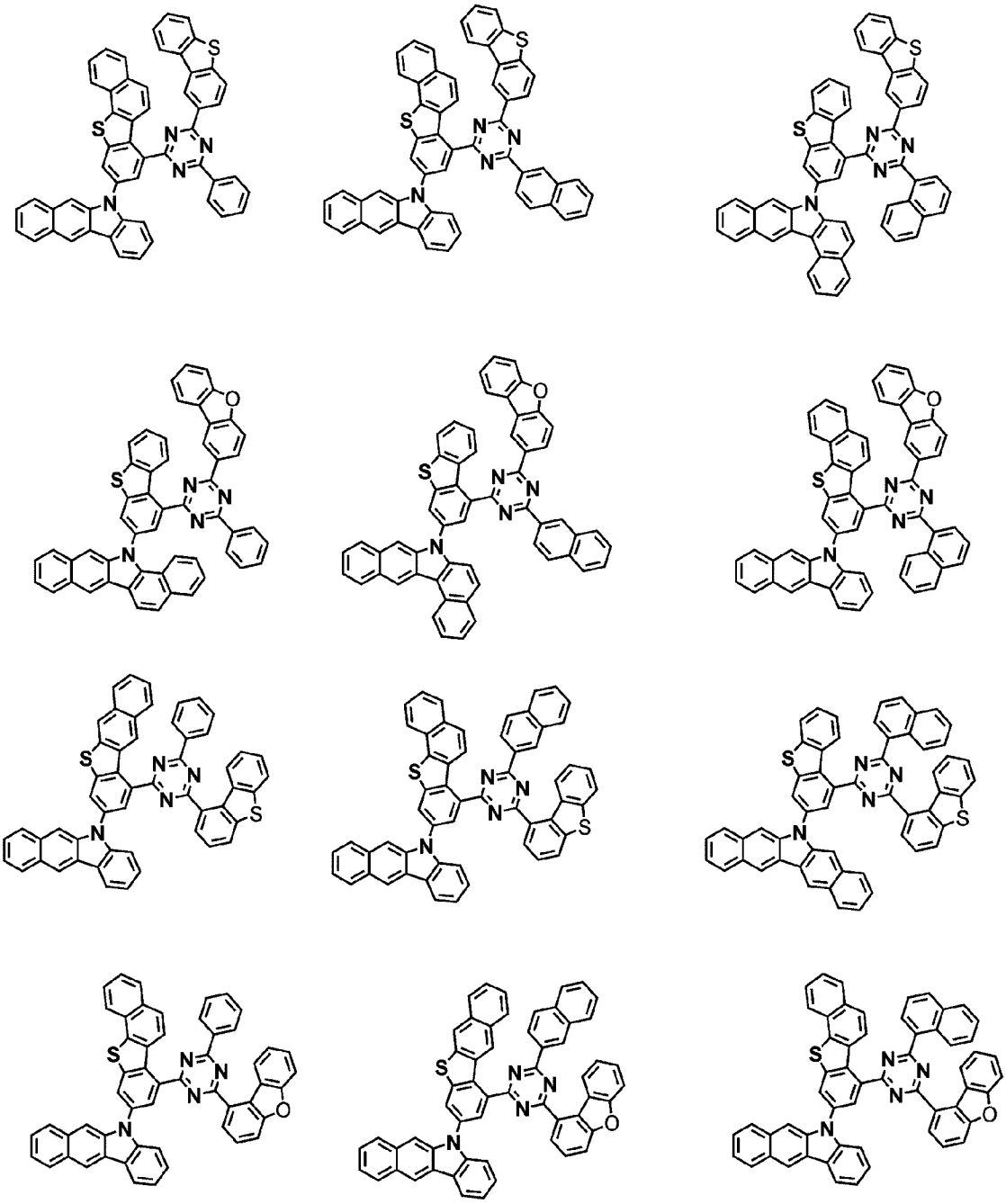
[461]

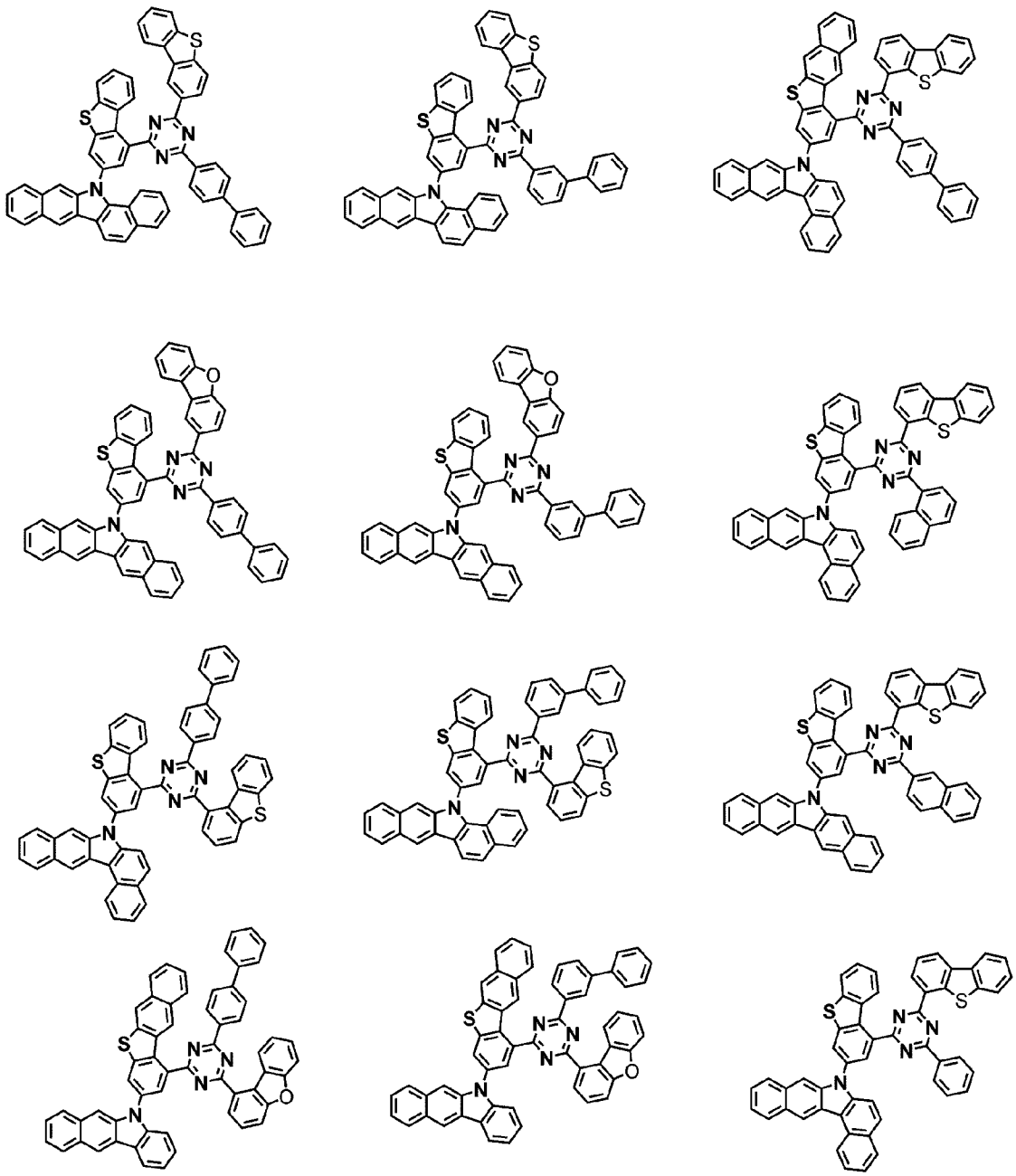
[462]

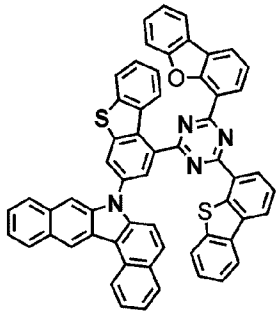
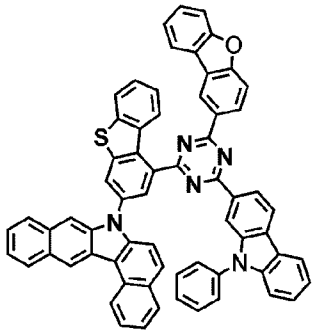
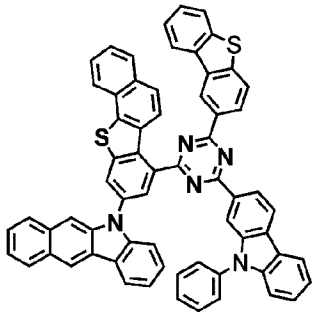
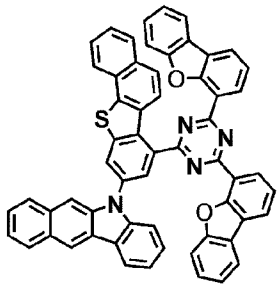
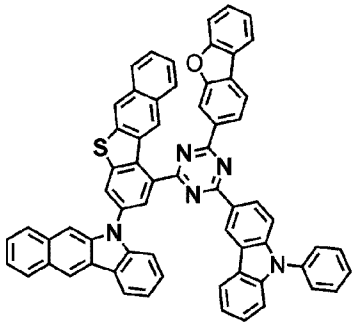
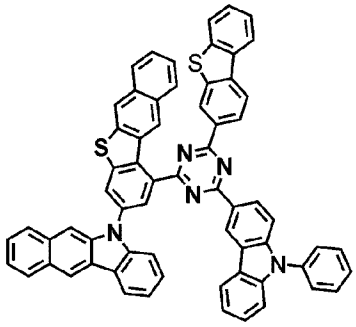
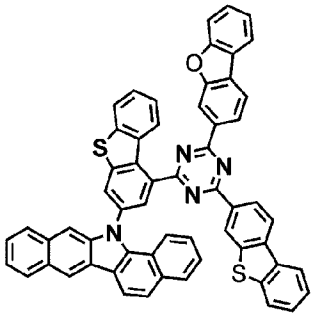
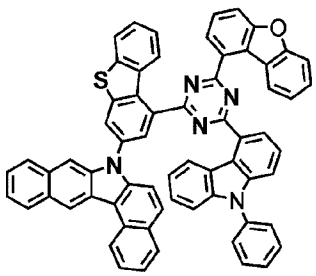
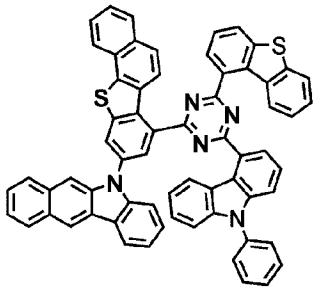
[463]



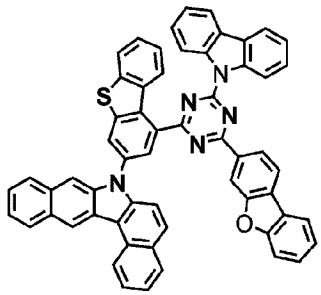
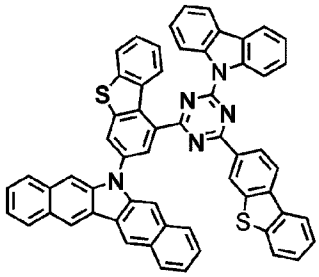
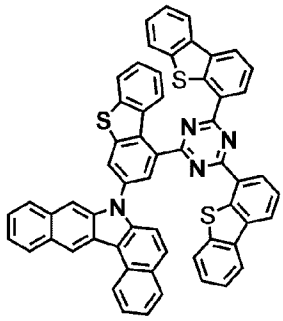
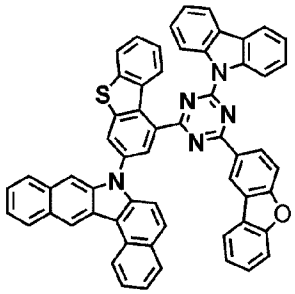
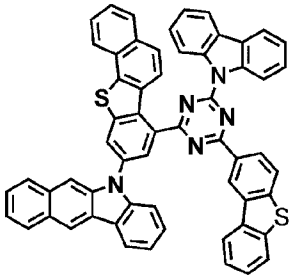
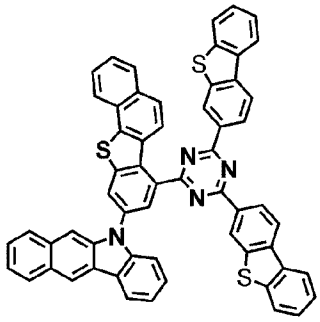
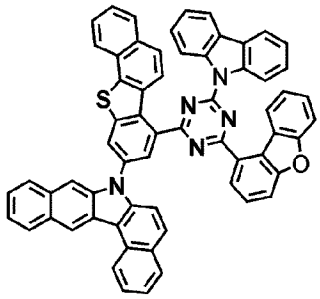
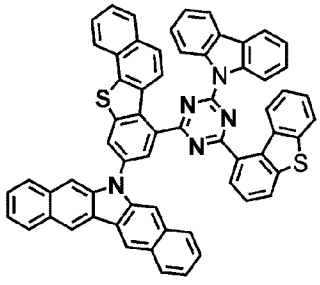
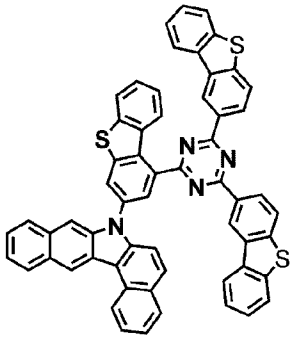
[464]



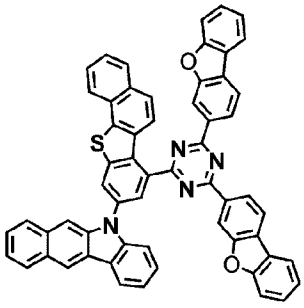
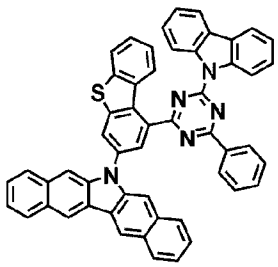
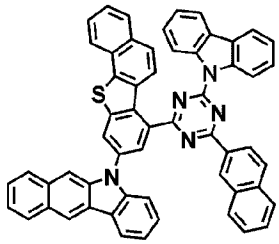
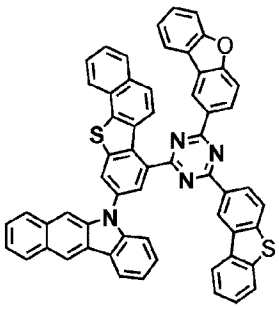
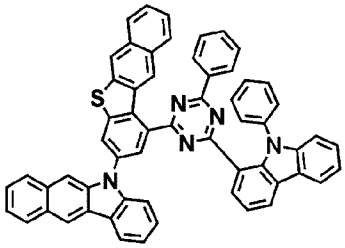
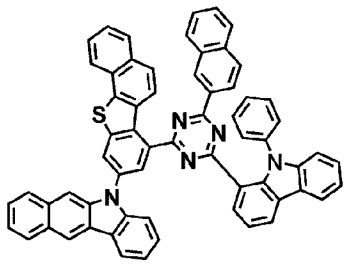
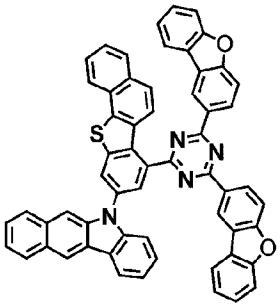
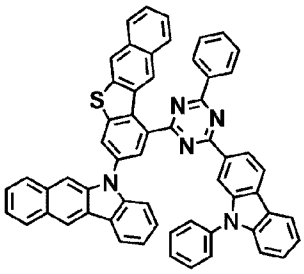
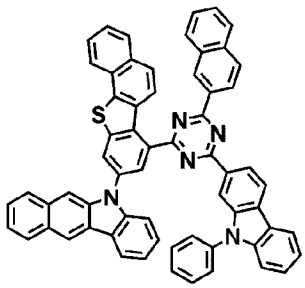
[465]

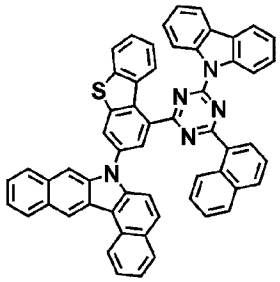
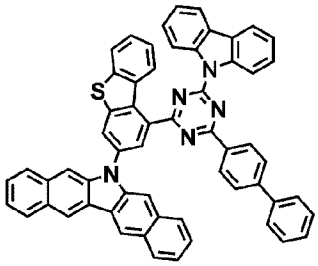
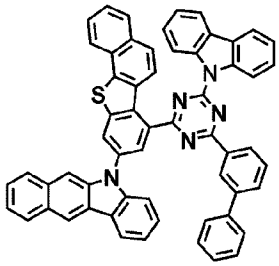
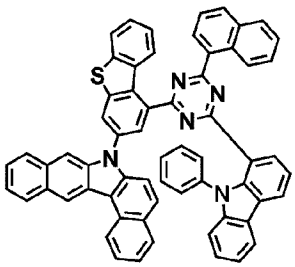
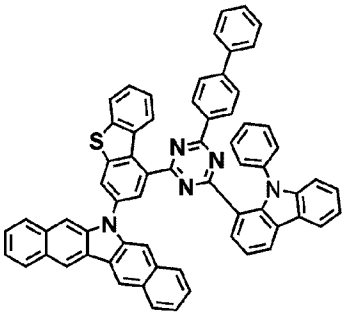
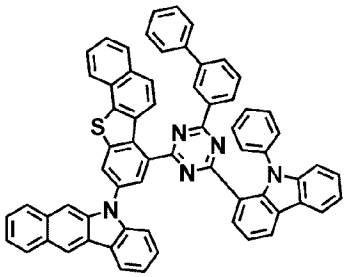
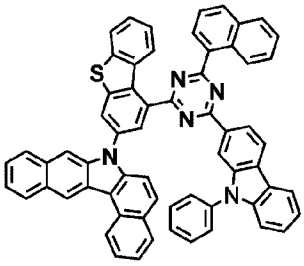
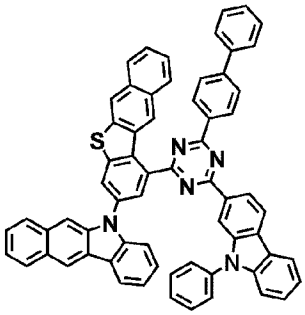
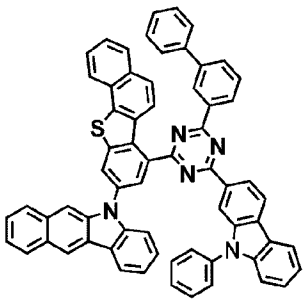
[466]

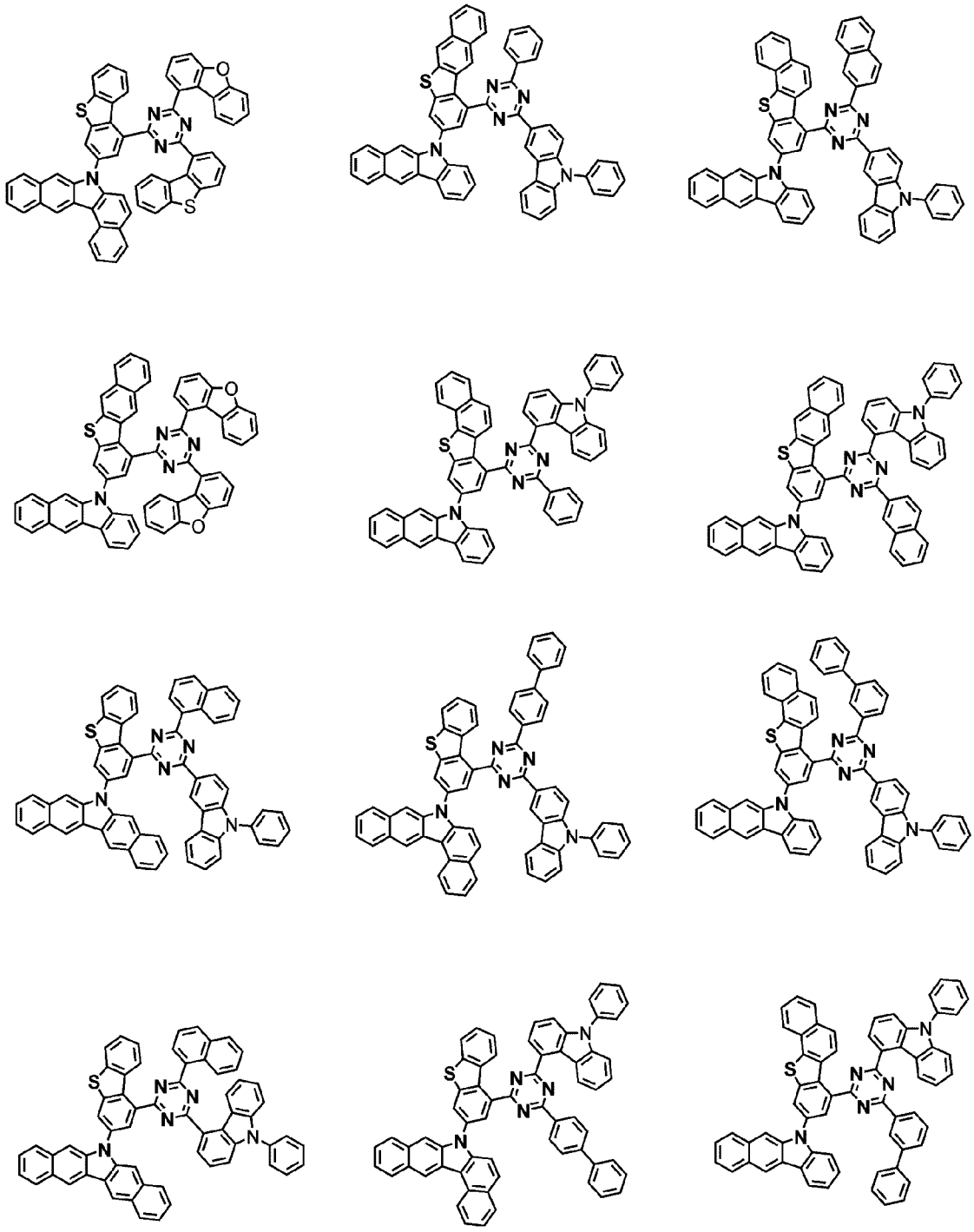
[467]

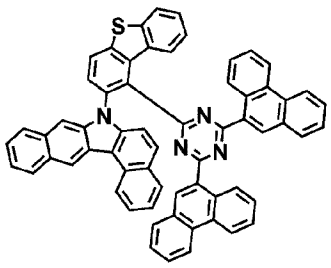
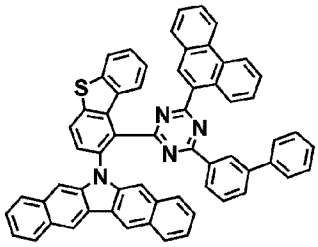
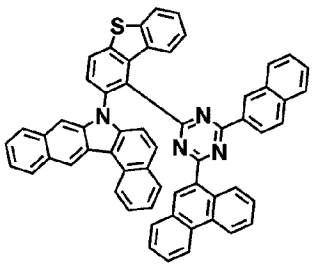
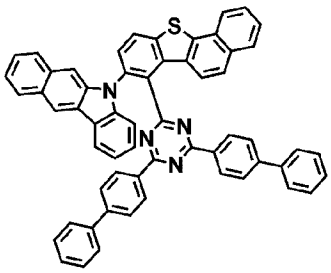
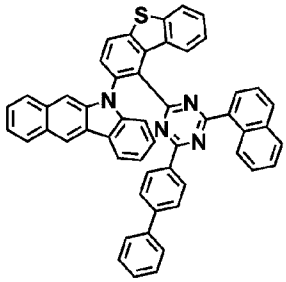
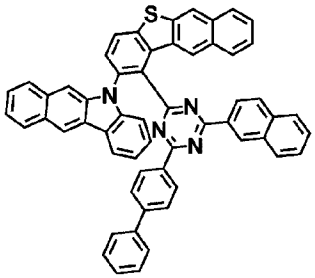
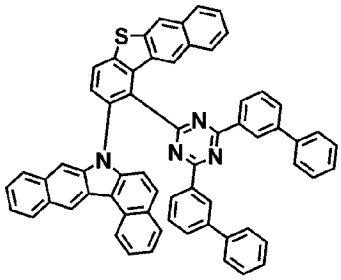
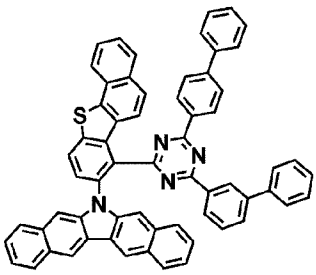
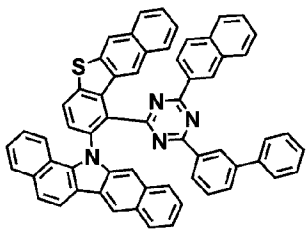
[468]

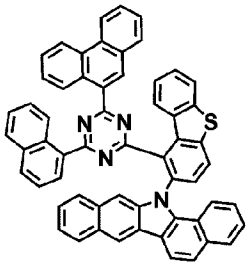
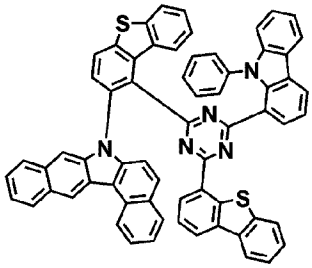
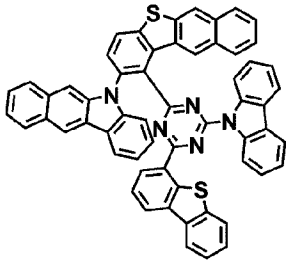
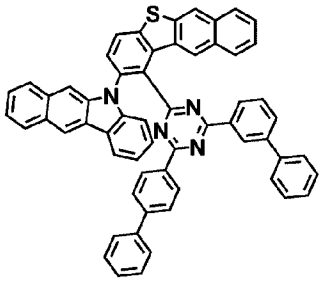
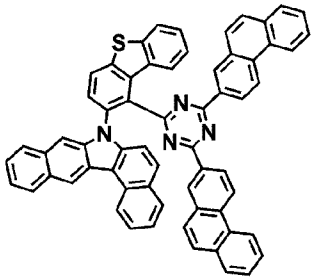
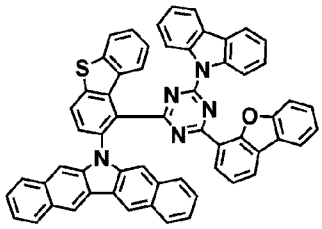
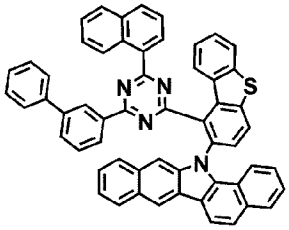
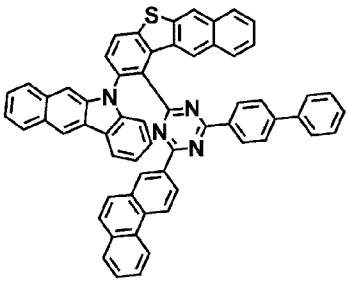
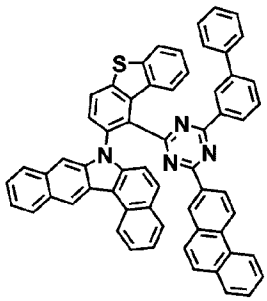
[469]



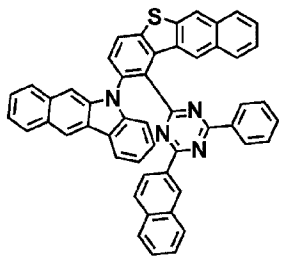
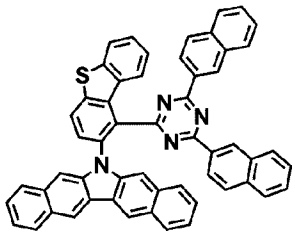
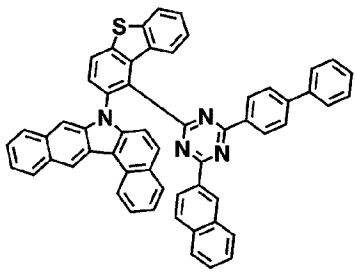
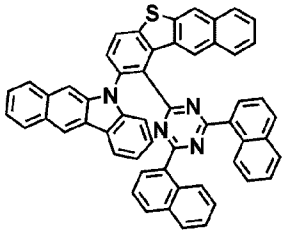
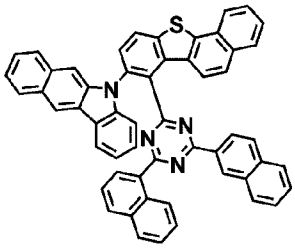
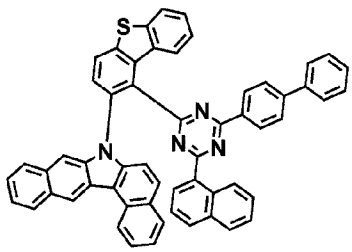
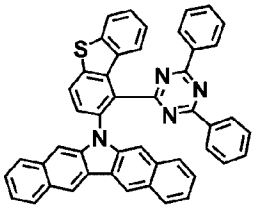
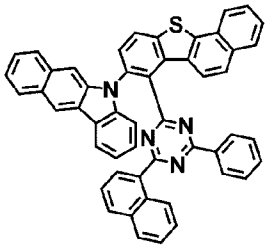
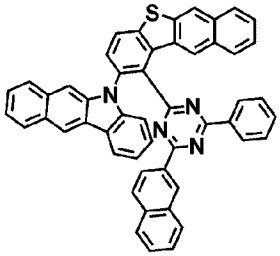
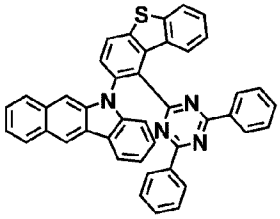
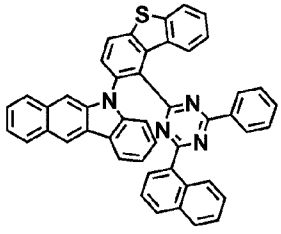
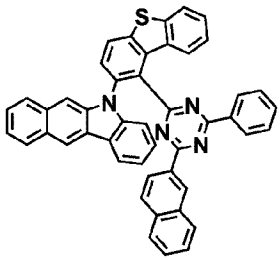
[470]

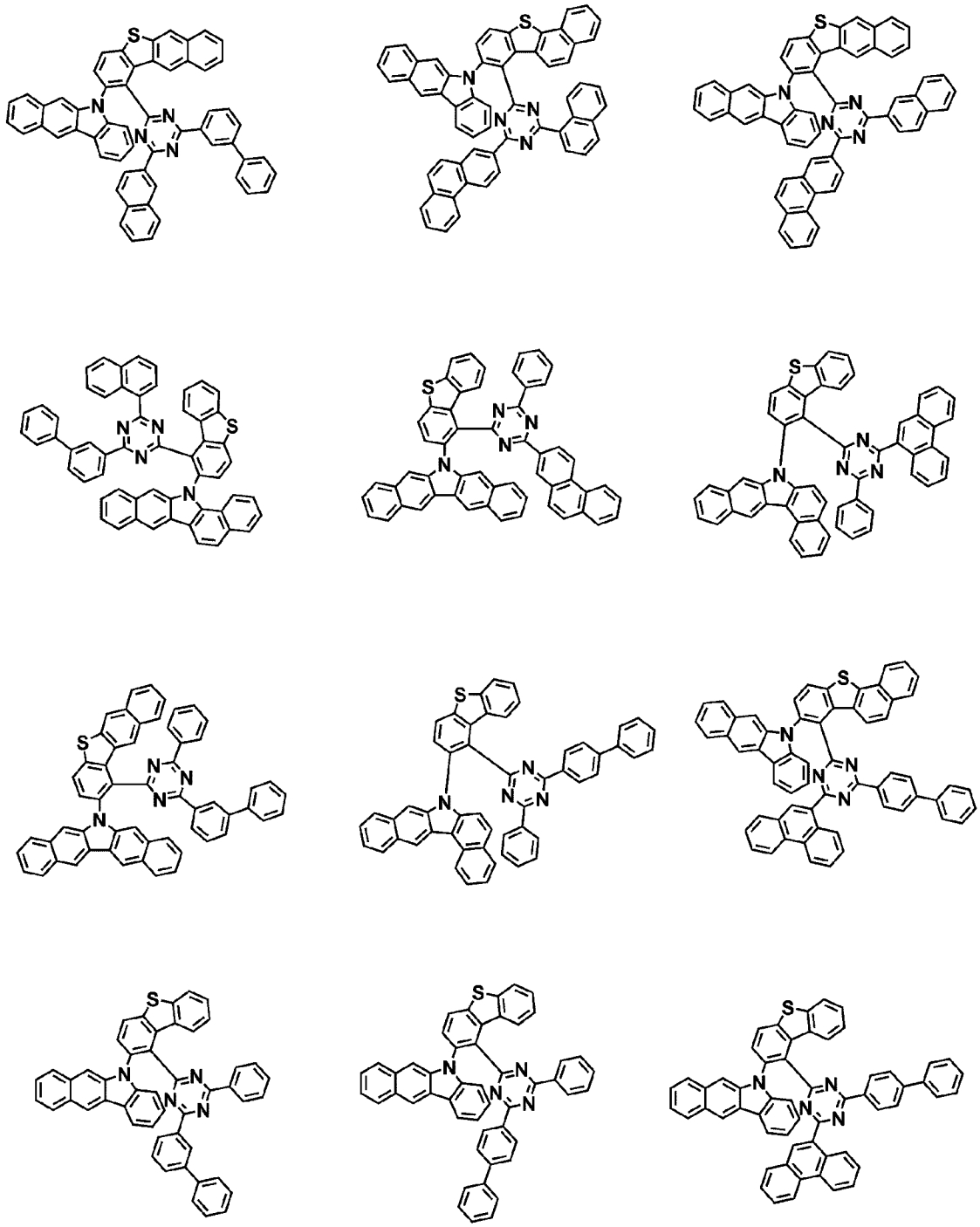
[471]

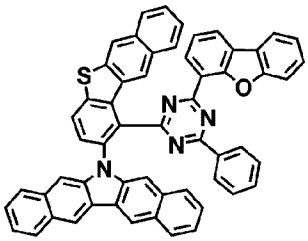
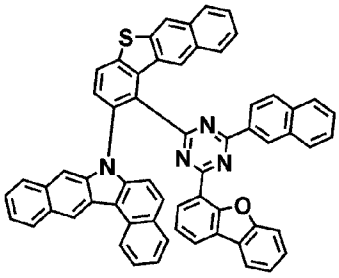
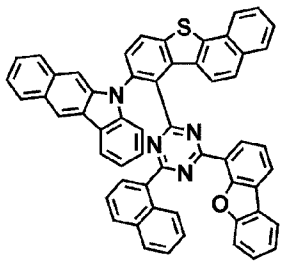
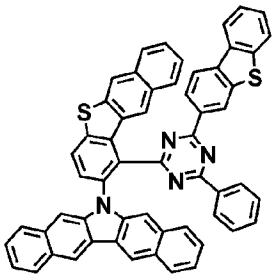
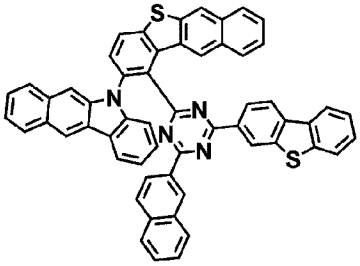
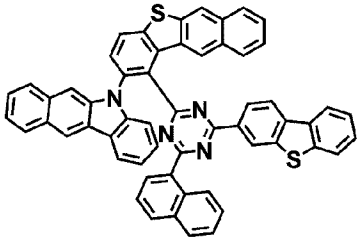
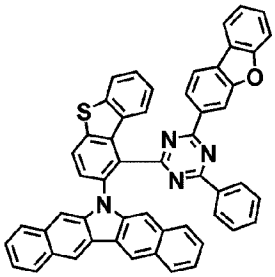
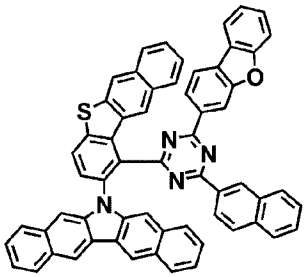
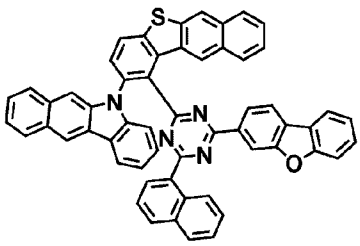
[472]

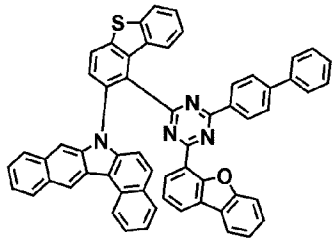
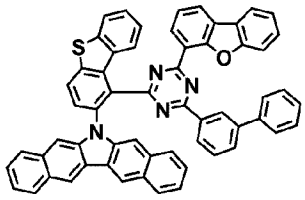
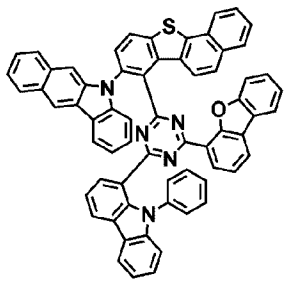
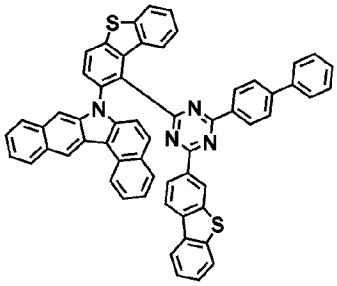
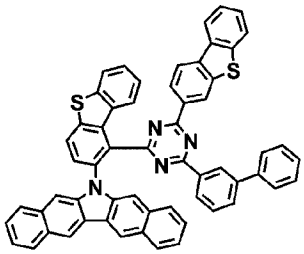
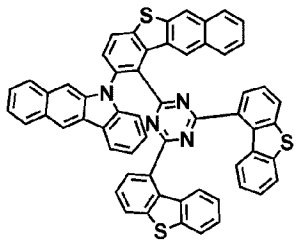
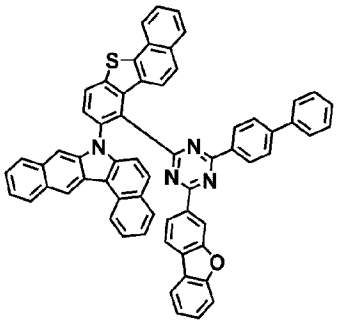
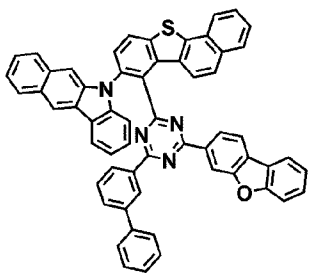
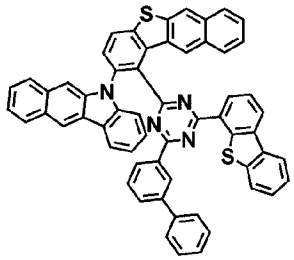
[473]



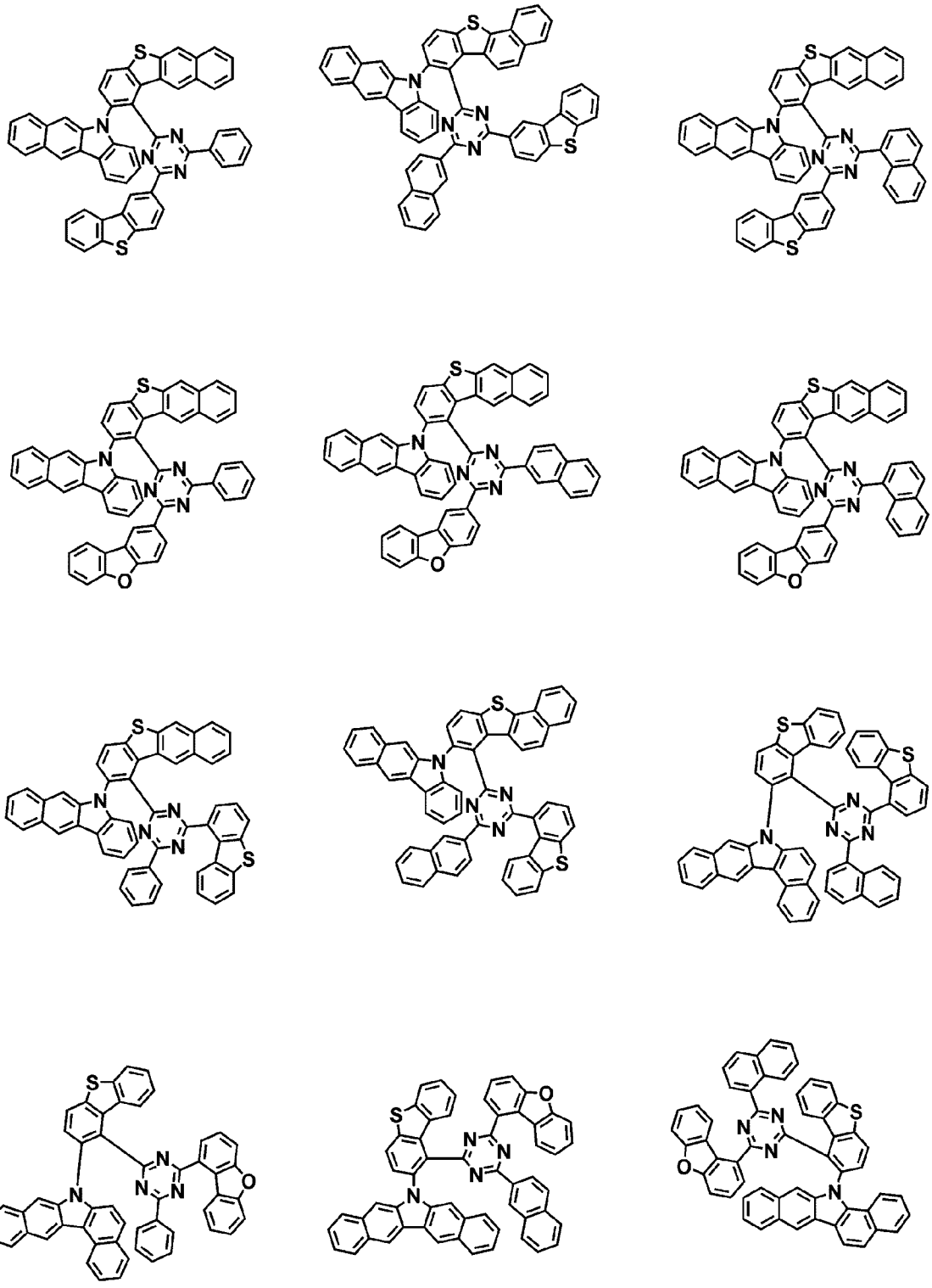
[474]

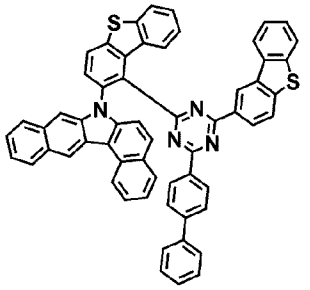
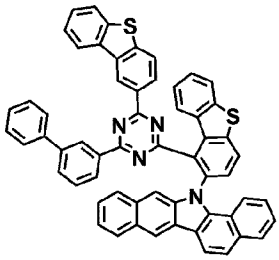
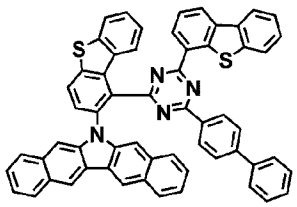
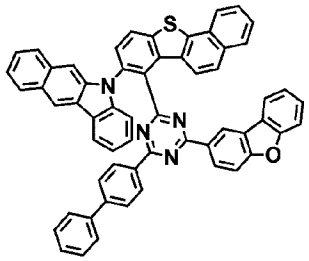
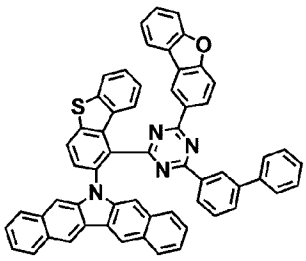
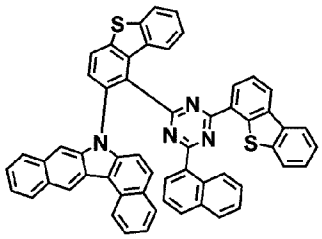
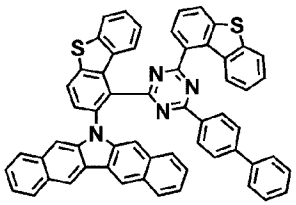
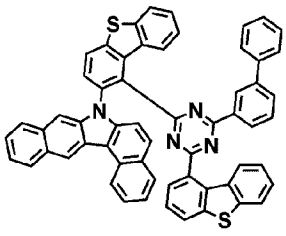
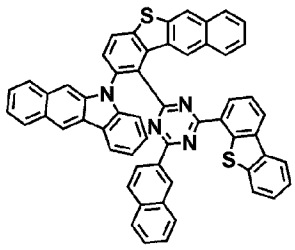
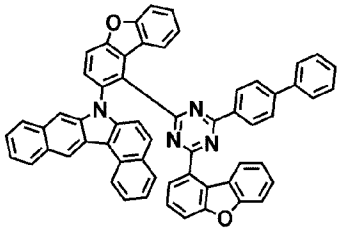
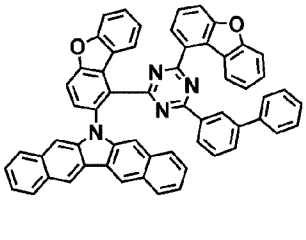
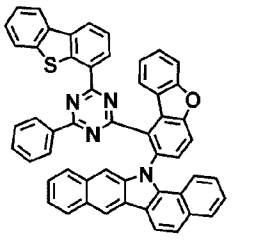
[475]

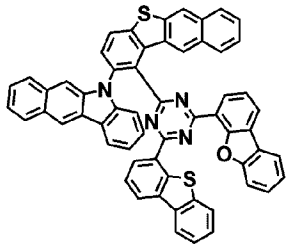
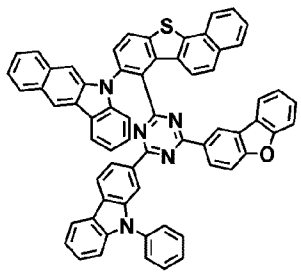
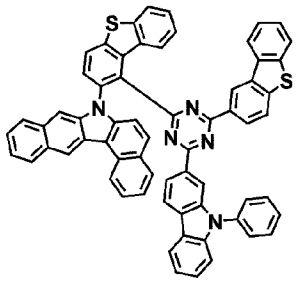
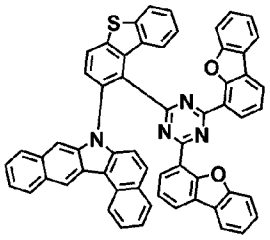
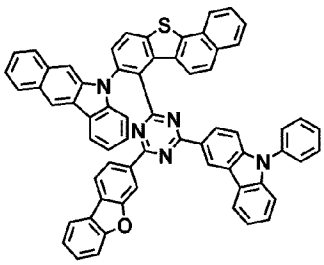
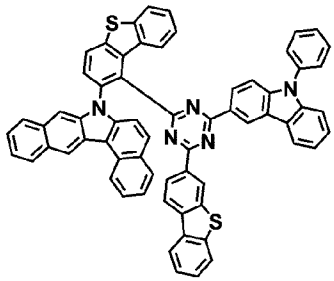
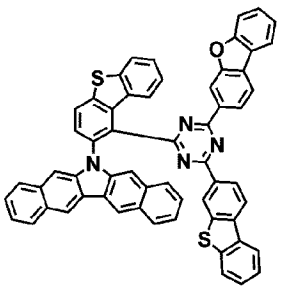
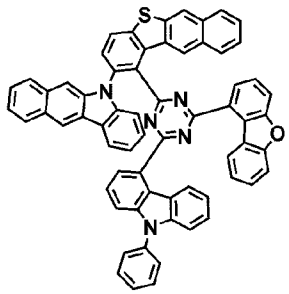
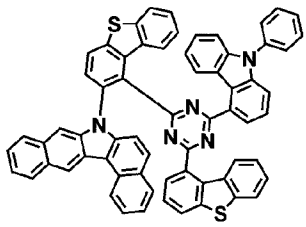
[476]



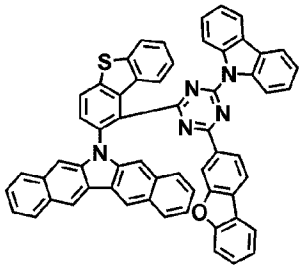
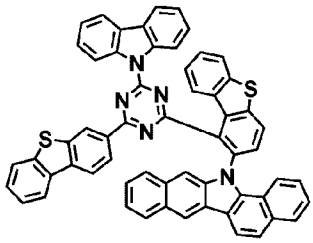
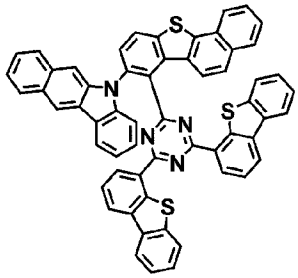
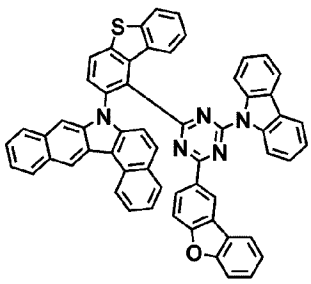
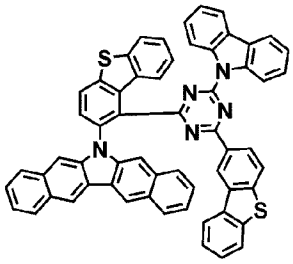
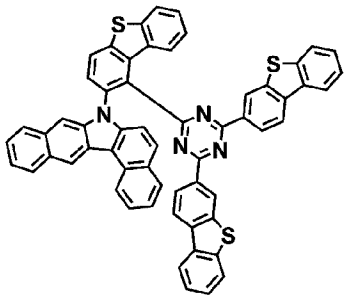
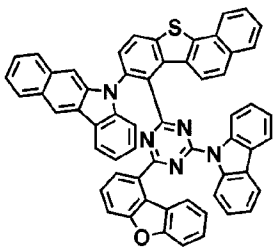
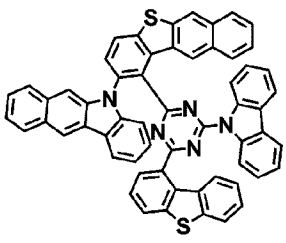
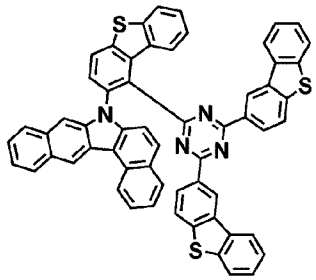
[477]

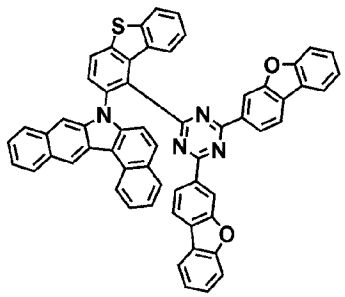
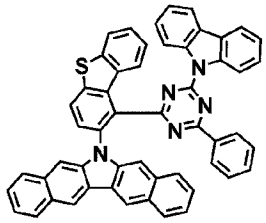
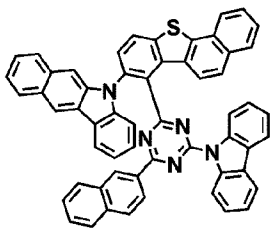
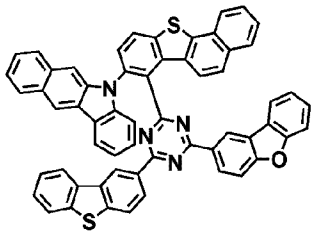
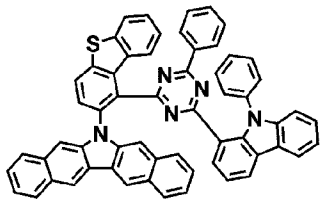
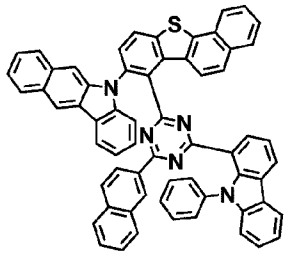
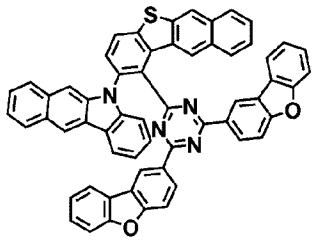
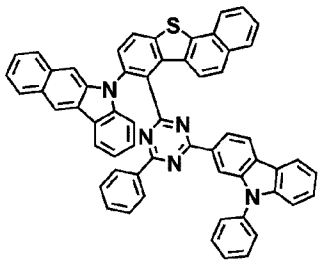
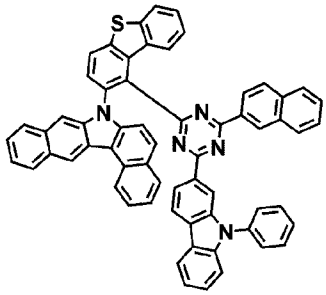
[478]

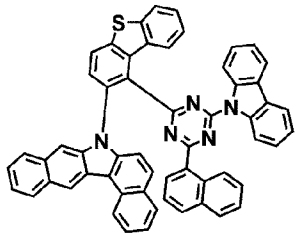
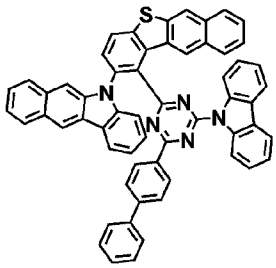
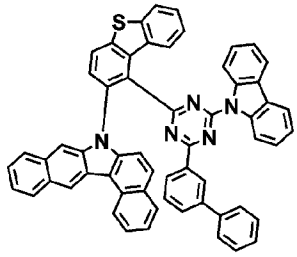
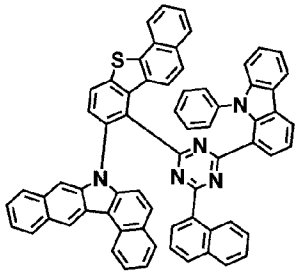
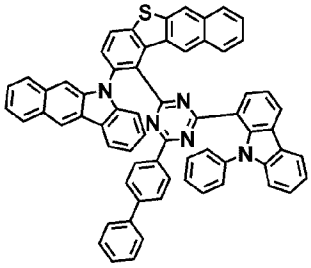
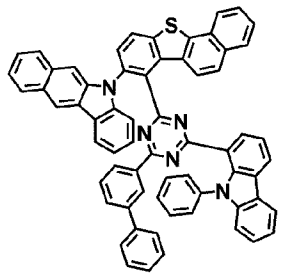
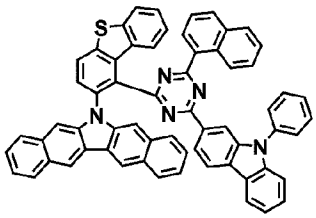
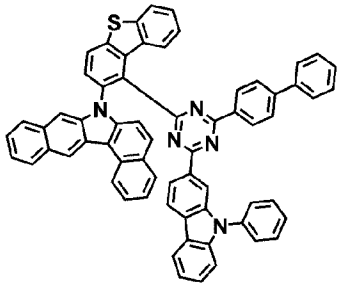
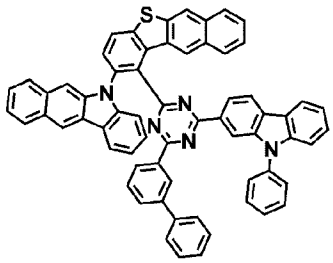
[479]

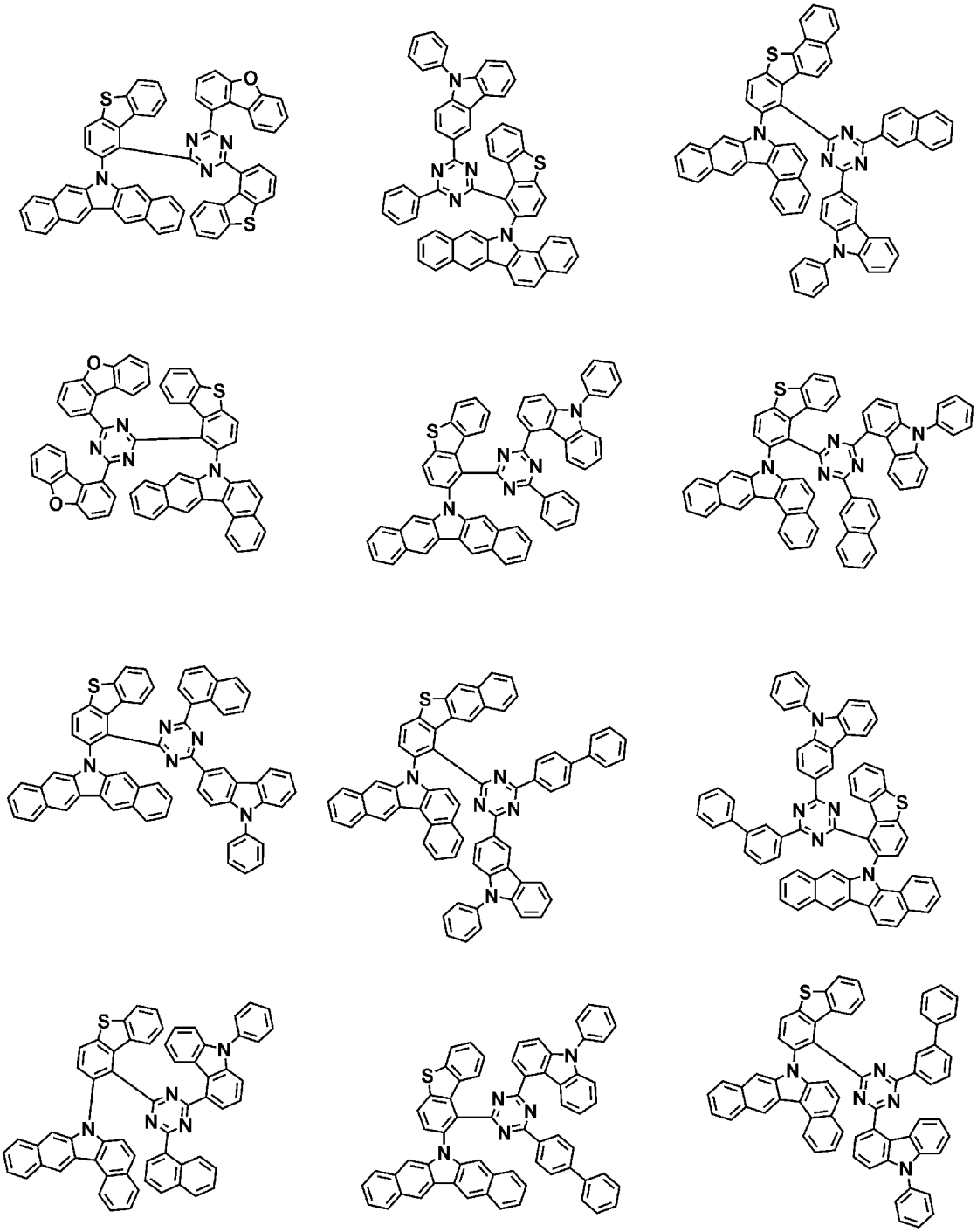
[480]

[481]

[482]



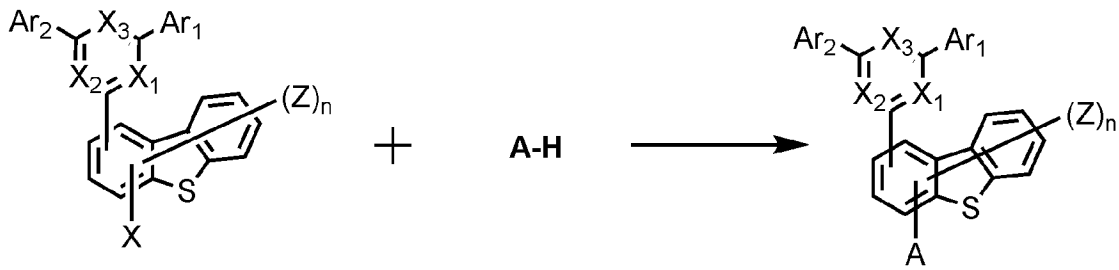
[483] .

[484]

[485] 한편, 상기 화학식 1로 표시되는 화합물은 일례로 하기 반응식 1과 같은 제조 방법으로 제조할 수 있다.

[486] [반응식 1]

[487]



SM1 SM2 1

[488] 상기 반응식 1에서, X는 각각 독립적으로, 할로겐이고, 바람직하게는 브로모, 또는 클로로이고, 다른 치환기에 대한 정의는 앞서 설명한 바와 같다.

[489] 구체적으로, 상기 화학식 1로 표시되는 화합물은 아민 치환 반응을 통해 출발물질 SM1 및 SM2가 결합하여 제조된다. 이러한 아민 치환 반응은 팔라듐 촉매와 염기의 존재 하에 수행하는 것이 바람직하다. 또한, 상기 아민 치환 반응을 위한 반응기는 적절히 변경될 수 있고, 화학식 1로 표시되는 화합물의 제조 방법은 후술할 제조예에서 보다 구체화될 수 있다.

[490]

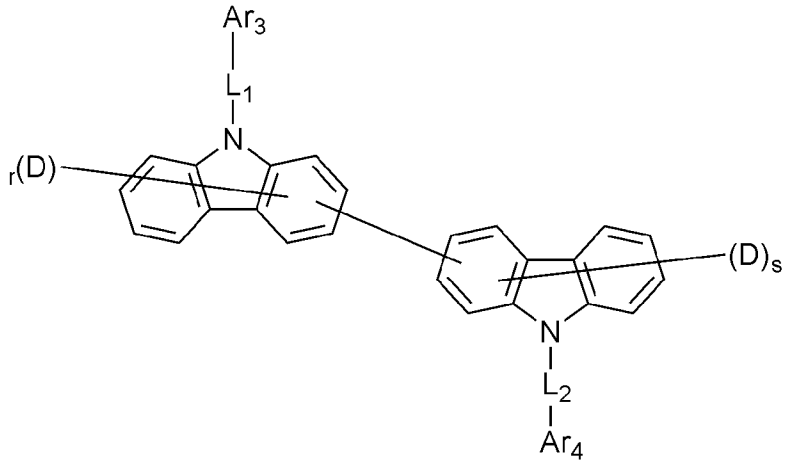
[491] 한편, 상기 제2 화합물은 비스카바졸계 화합물로, 바람직하게는, T_1 내지 T_4가 각각 독립적으로 C_{6-20} 방향족 고리인 구조를 갖는다. 보다 바람직하게는, T_1 내지 T_4는 비치환되거나 또는 중수소로 치환된 벤젠 고리, 또는 비치환되거나 또는 중수소로 치환된 나프탈렌 고리이다.

[492]

[493] 가장 바람직하게는, T_1 내지 T_4는 모두 벤젠 고리로, 이때 상기 제2 화합물은 하기 화학식 2-1로 표시된다:

[494] [화학식 2-1]

[495]



[496] 상기 화학식 2-1에서,

[497] D는 중수소를 의미하고,

[498] r 및 s는 각각 독립적으로, 0 내지 7의 정수이고,

[499] 각 치환기에 대한 설명은 상기 화학식 2에서 정의한 바와 같다.

[500]

[501] 바람직하게는, L_1 및 L_2는 각각 독립적으로, 단일결합, 또는 비치환된 C_{6-20} 아릴렌이다.

[502]

[503] 보다 바람직하게는, L_1 및 L_2는 각각 독립적으로, 단일 결합, 페닐렌, 또는 나프틸렌이다.

[504]

[505] 바람직하게는, Ar_3 및 Ar_4는 각각 독립적으로, 비치환되거나, 또는 C_{1-10} 알킬 또는 C_{6-20} 아릴로 치환된 C_{6-20} 아릴; 또는 O 또는 S를 포함하는 C_{2-20} 헤테로아릴이다.

[506]

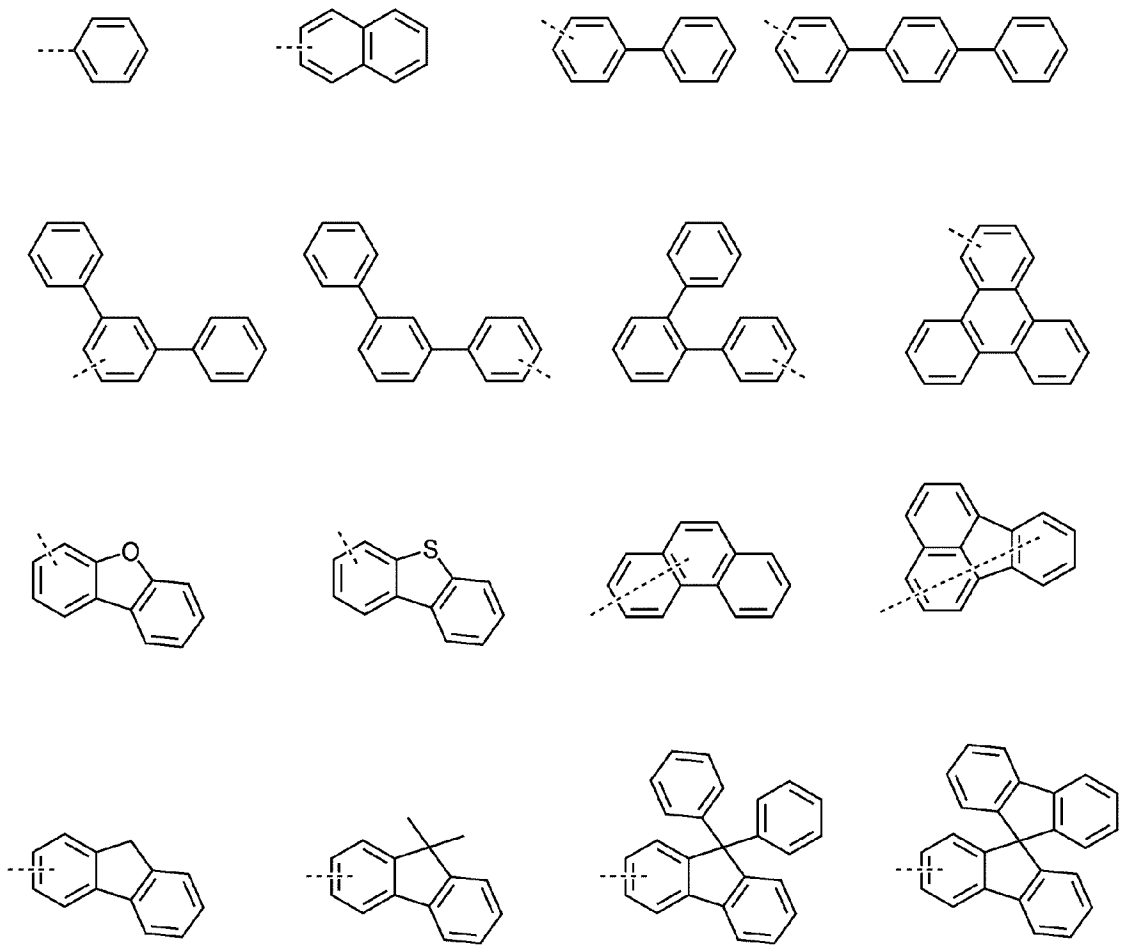
[507] 보다 바람직하게는, Ar_3 및 Ar_4는 각각 독립적으로, 페닐, 비페닐릴, 터페닐릴, 나프틸, 페난쓰레닐, 트리페닐레닐, 플루오레닐, 스피로비플루오레닐, 플루오란테닐, 디벤조티오페닐, 디벤조퓨라닐이고,

[508] 여기서, Ar_3 및 Ar_4는 비치환되거나, 또는 C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 각각 독립적으로 선택되는 1개 내지 4개의 치환기로 치환될 수 있다.

[509]

[510] 가장 바람직하게는, Ar_3 및 Ar_4는 각각 독립적으로, 하기로 구성되는 군으로부터 선택되는 어느 하나이다:

[511]



[512]

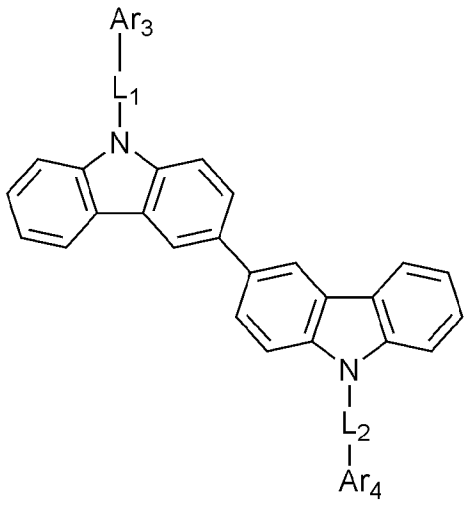
[513] 이때, Ar_3 및 Ar_4는 서로 동일할 수 있고, 또는, Ar_3 및 Ar_4는 상이할 수 있다.

[514]

[515] 바람직하게는, 상기 제2 화합물은 하기 화학식 2-2로 표시된다:

[516] [화학식 2-2]

[517]



[518] 상기 화학식 2-2에서,

[519] L_1 및 L_2는 각각 독립적으로, 단일 결합, 페닐렌, 또는 나프틸렌이고,

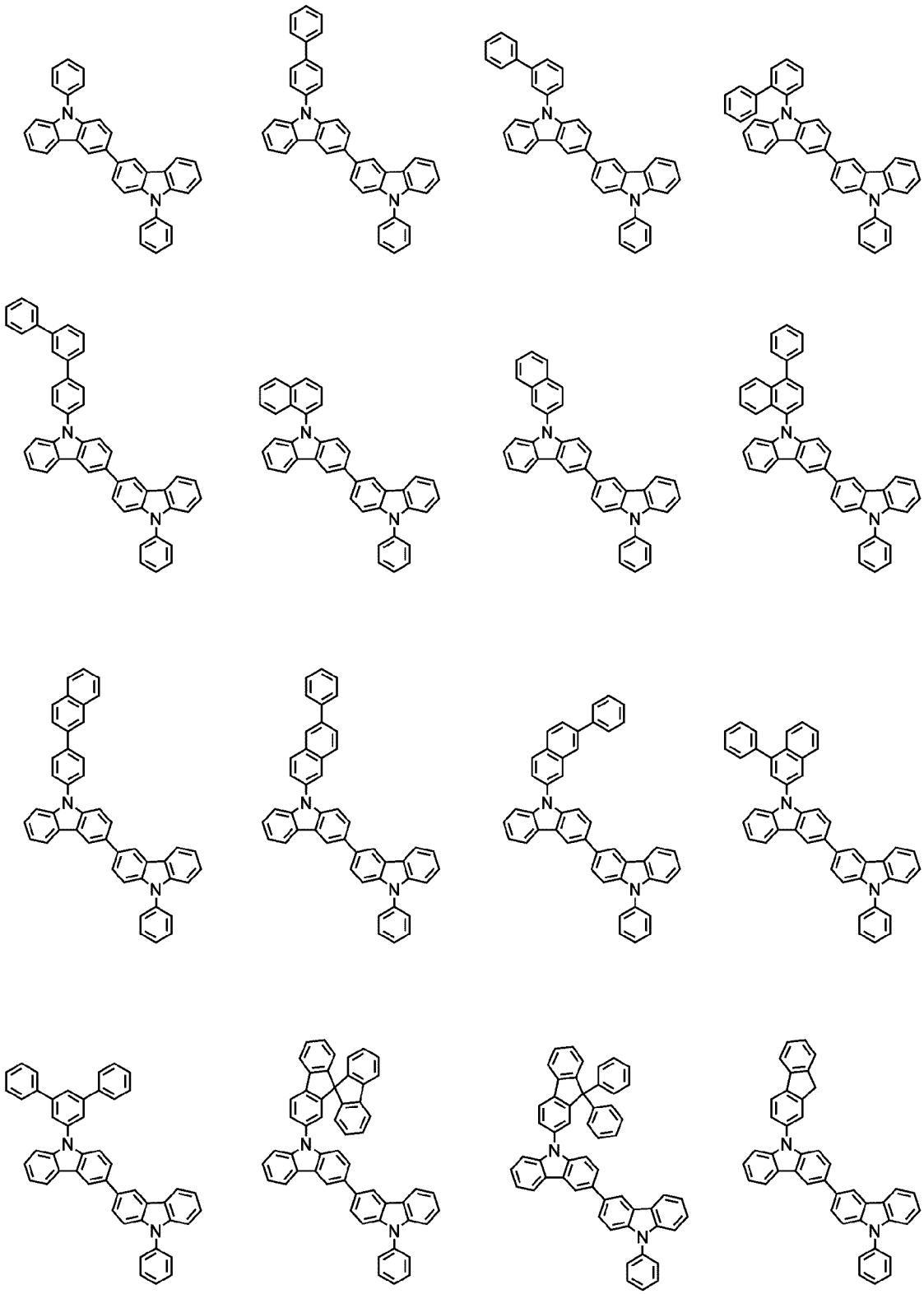
[520] Ar_3 및 Ar_4는 상기 화학식 2에서 정의한 바와 같다.

[521]

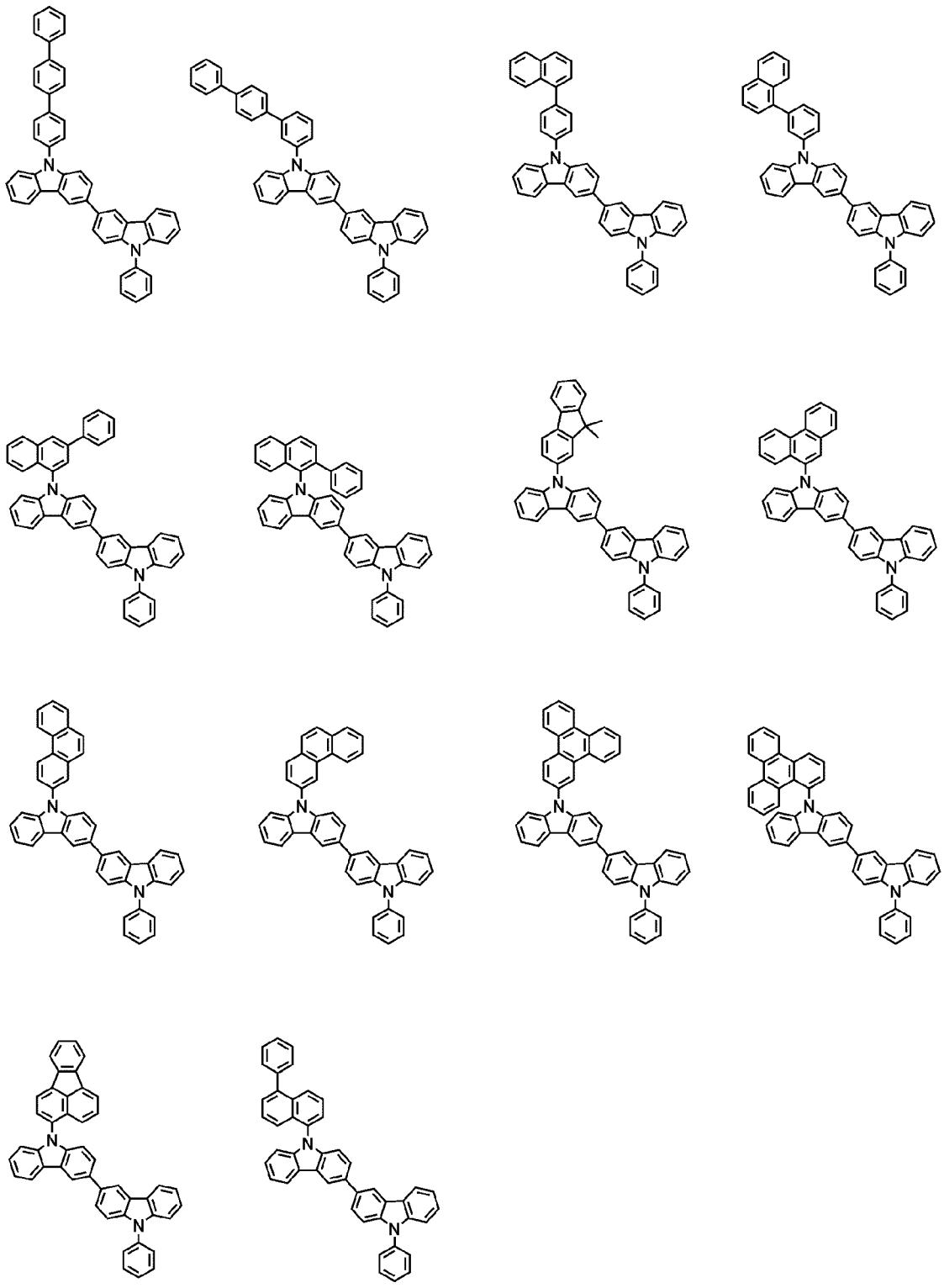
[522] 상기 제2 화합물의 구체적인 예는 다음과 같다:

[523]

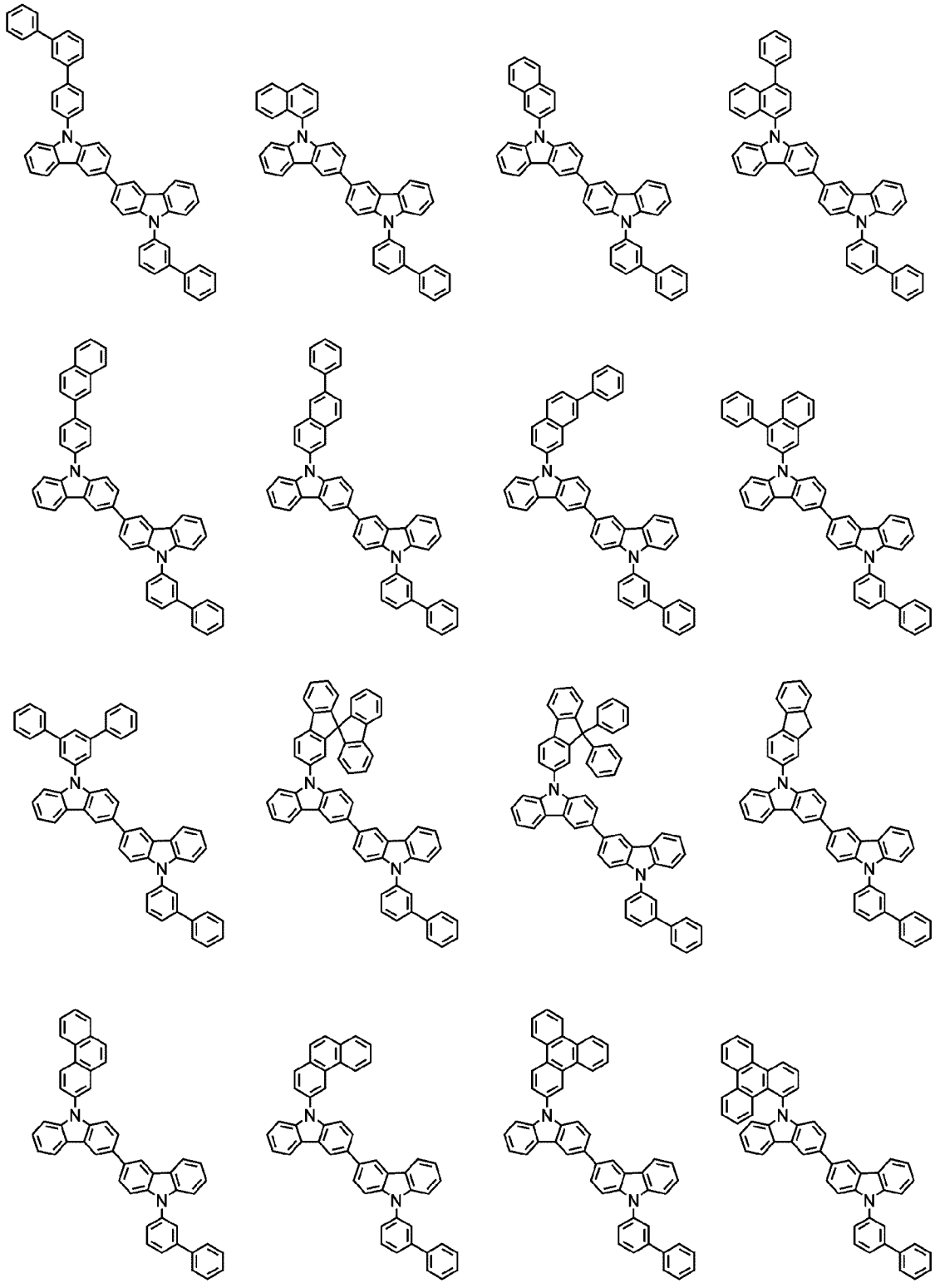
[524]



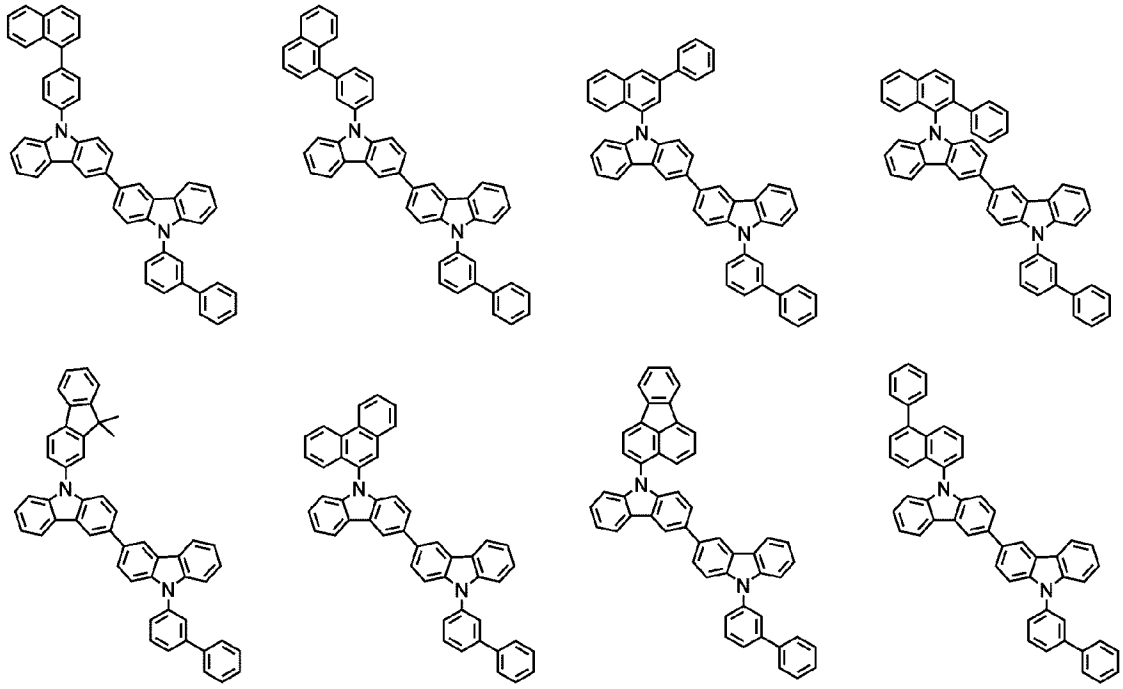
[525]



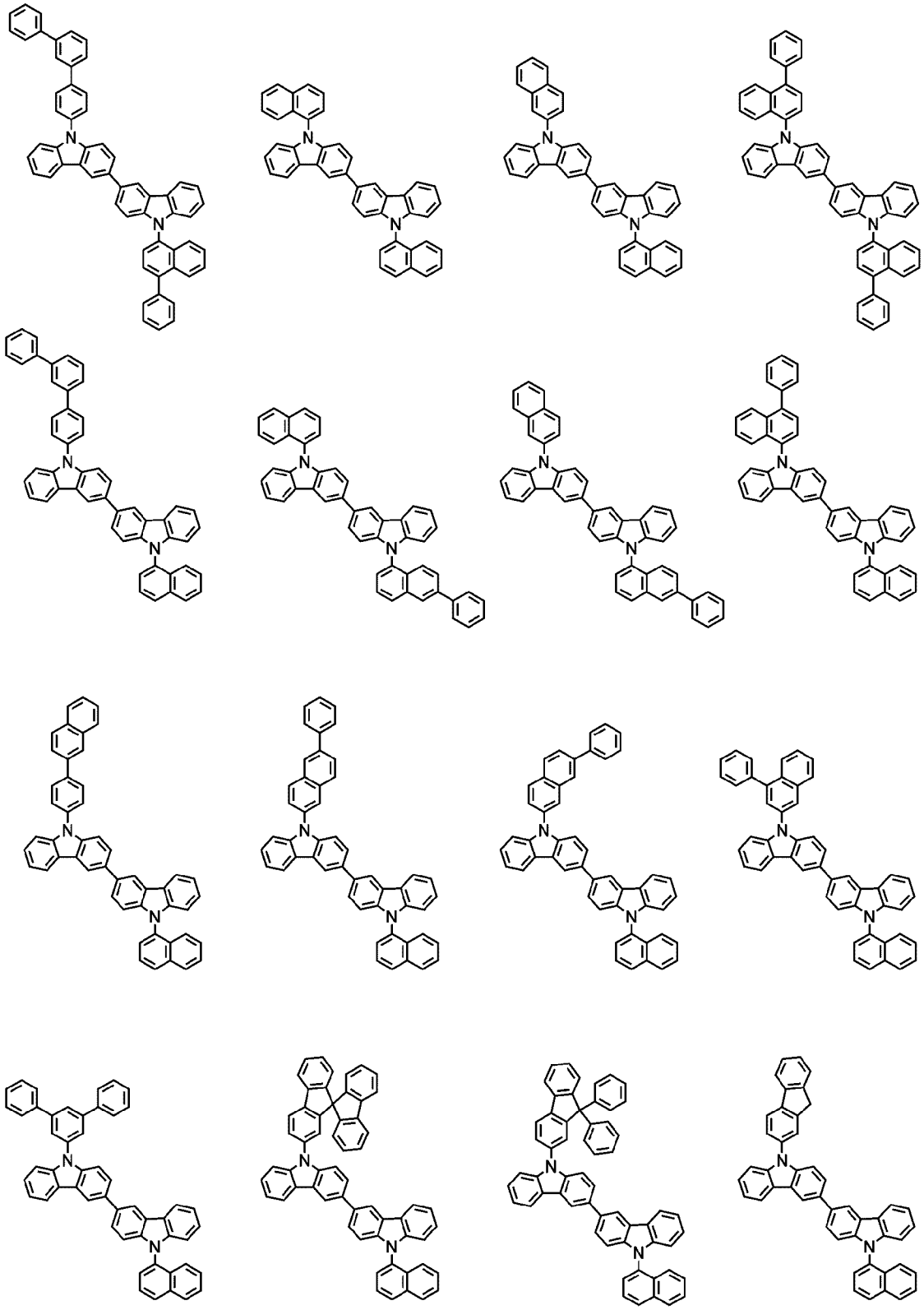
[526]



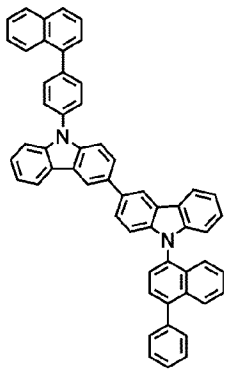
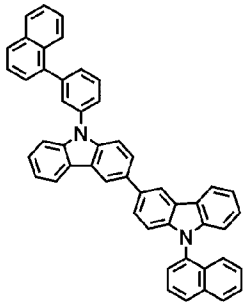
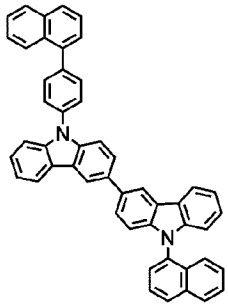
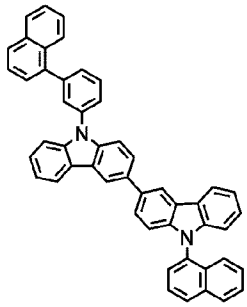
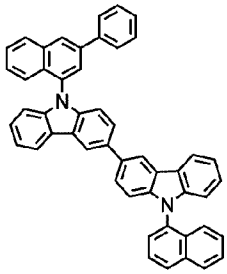
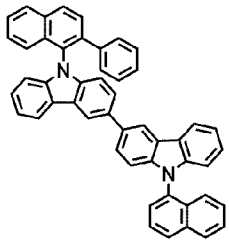
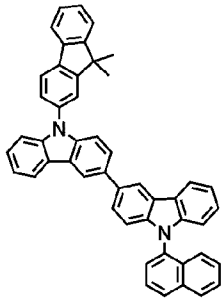
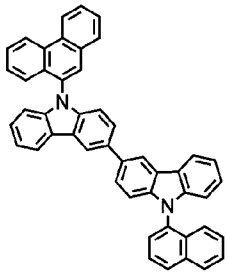
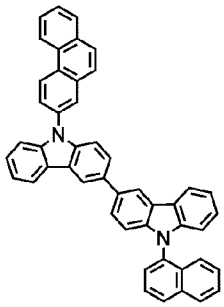
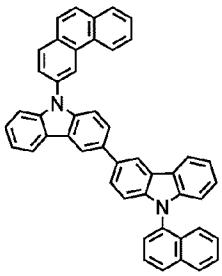
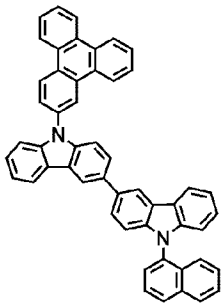
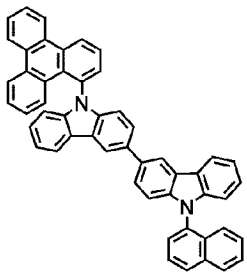
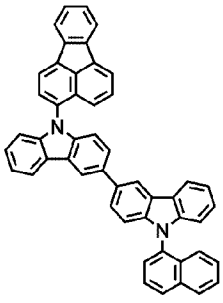
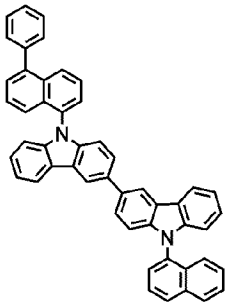
[527]



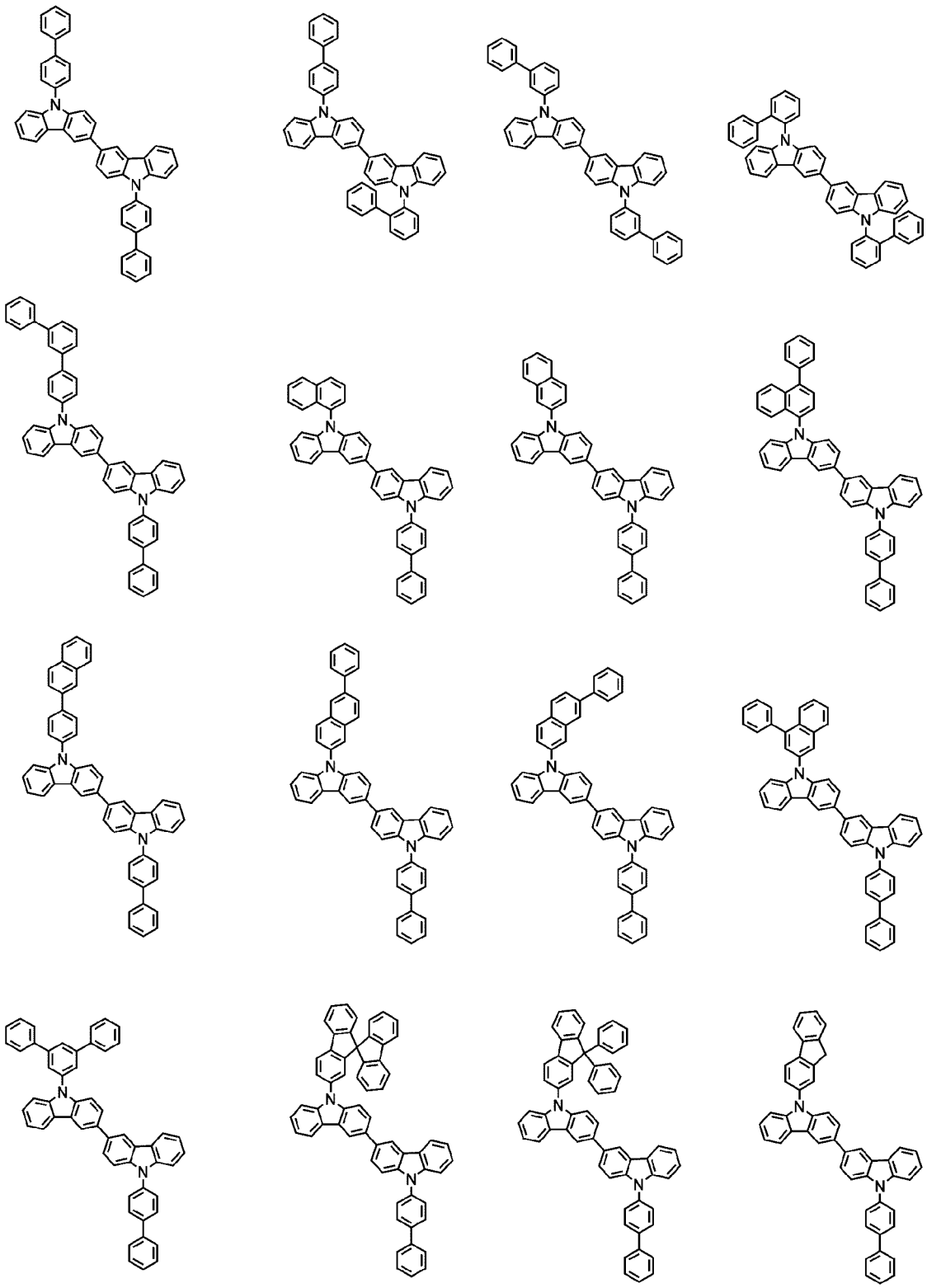
[528]



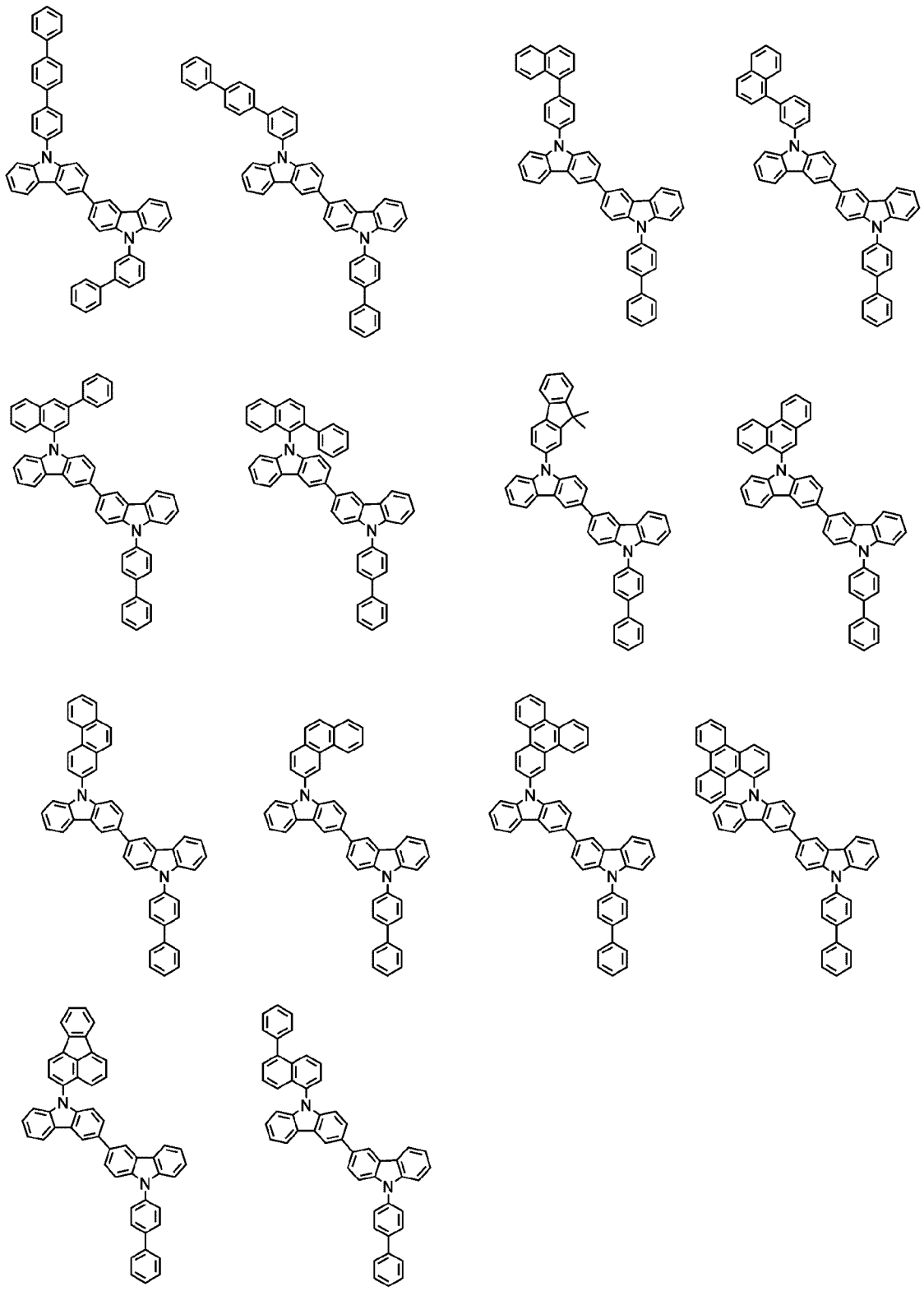
[529]

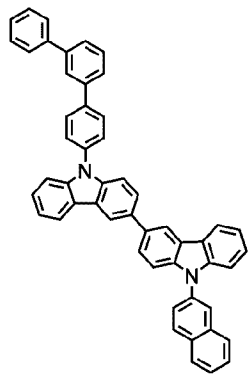
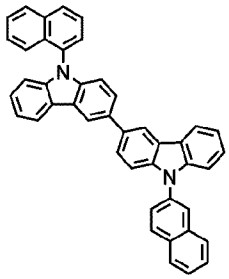
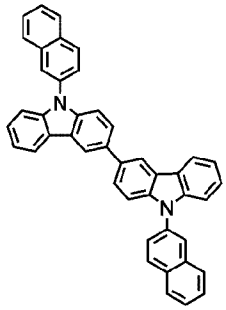
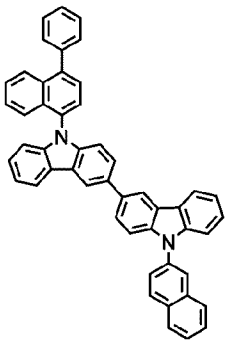
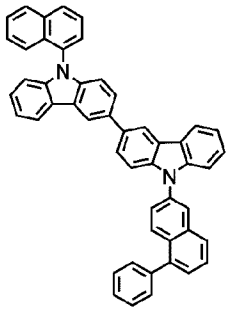
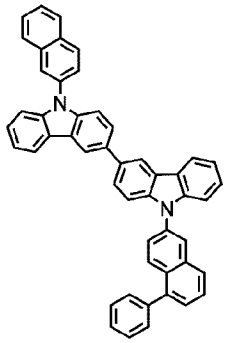
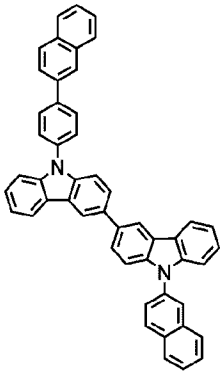
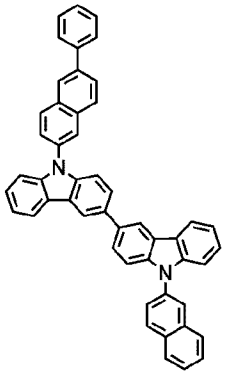
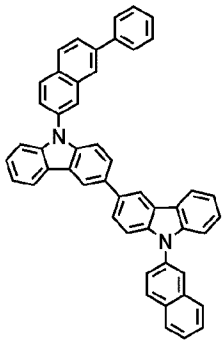
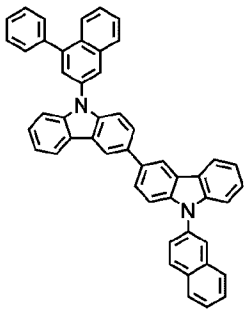
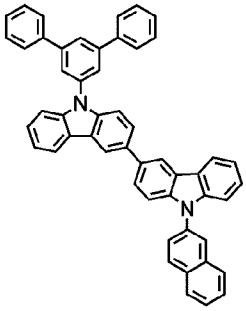
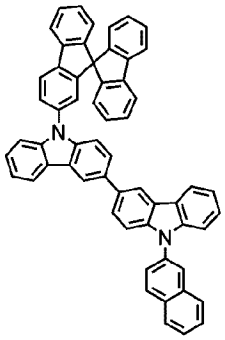
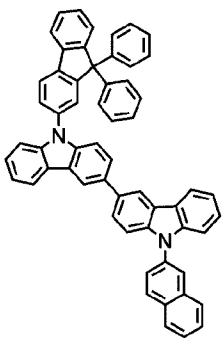
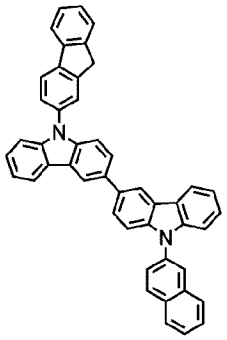
[530]



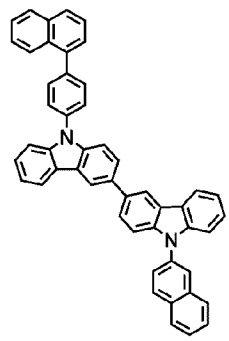
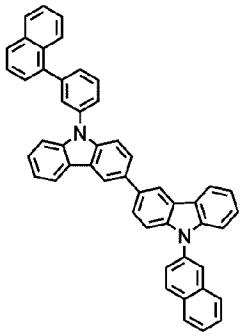
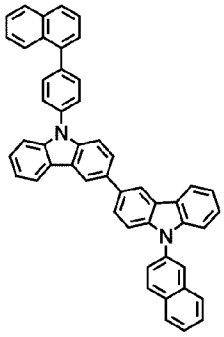
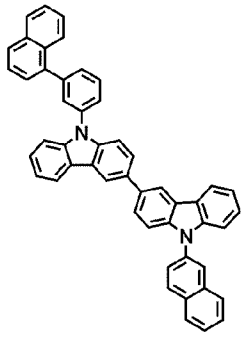
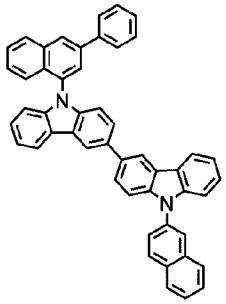
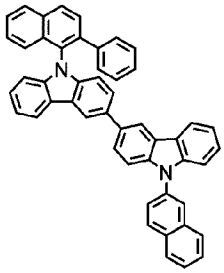
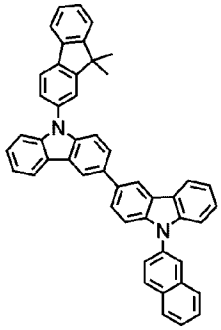
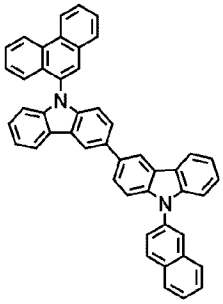
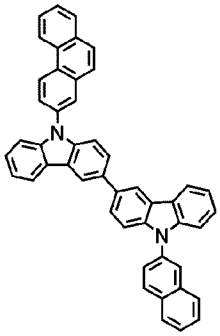
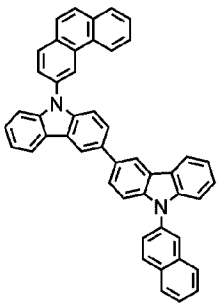
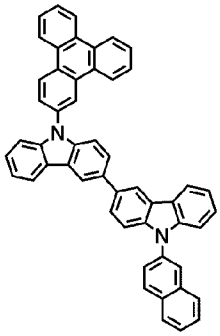
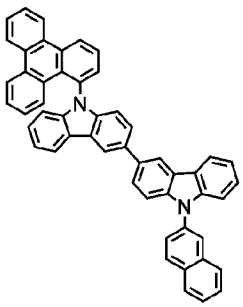
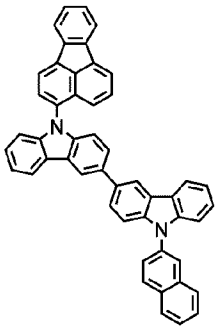
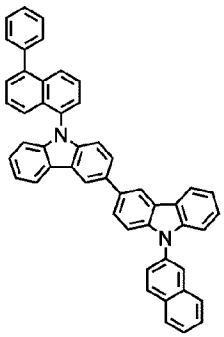
[531]



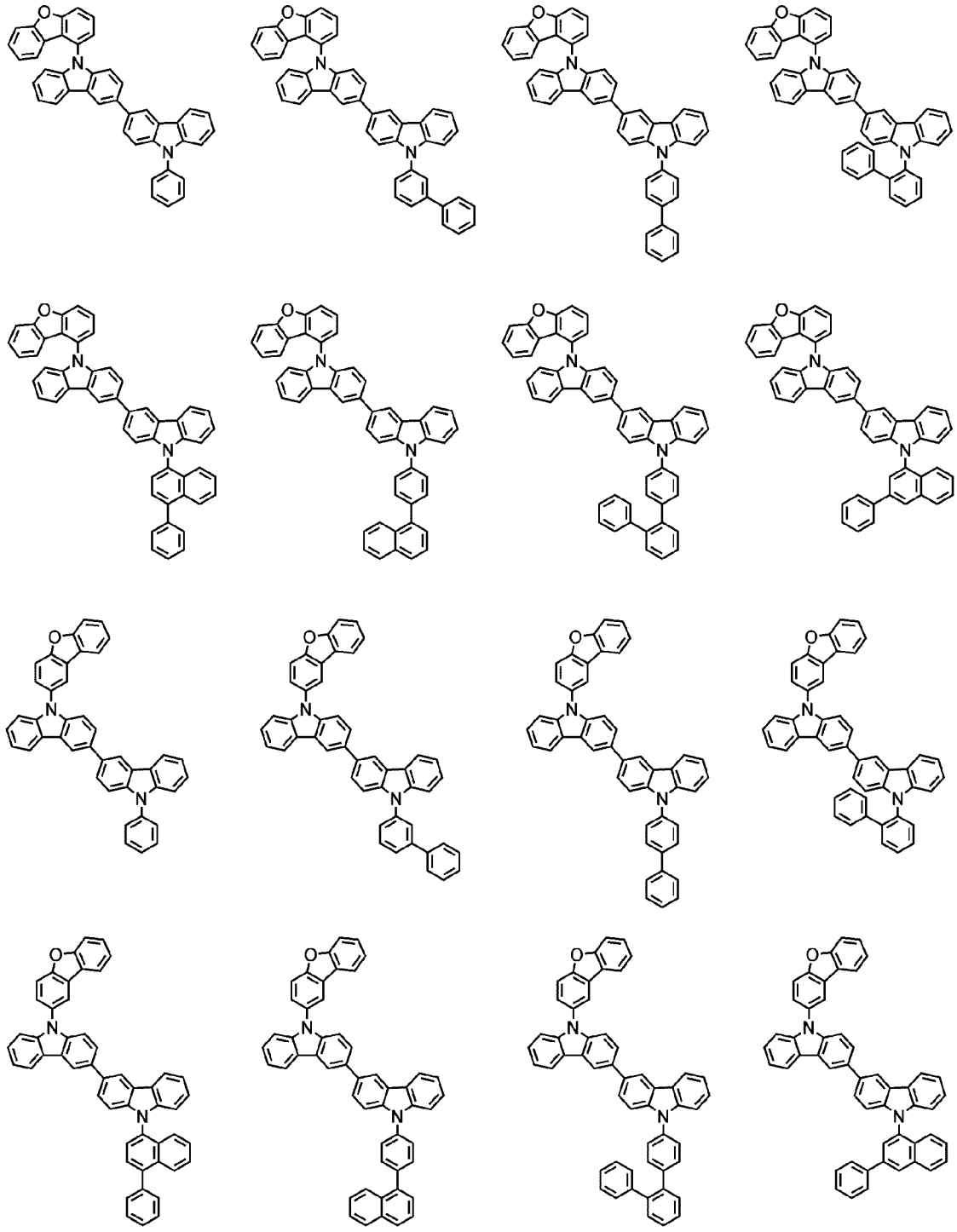
[532]

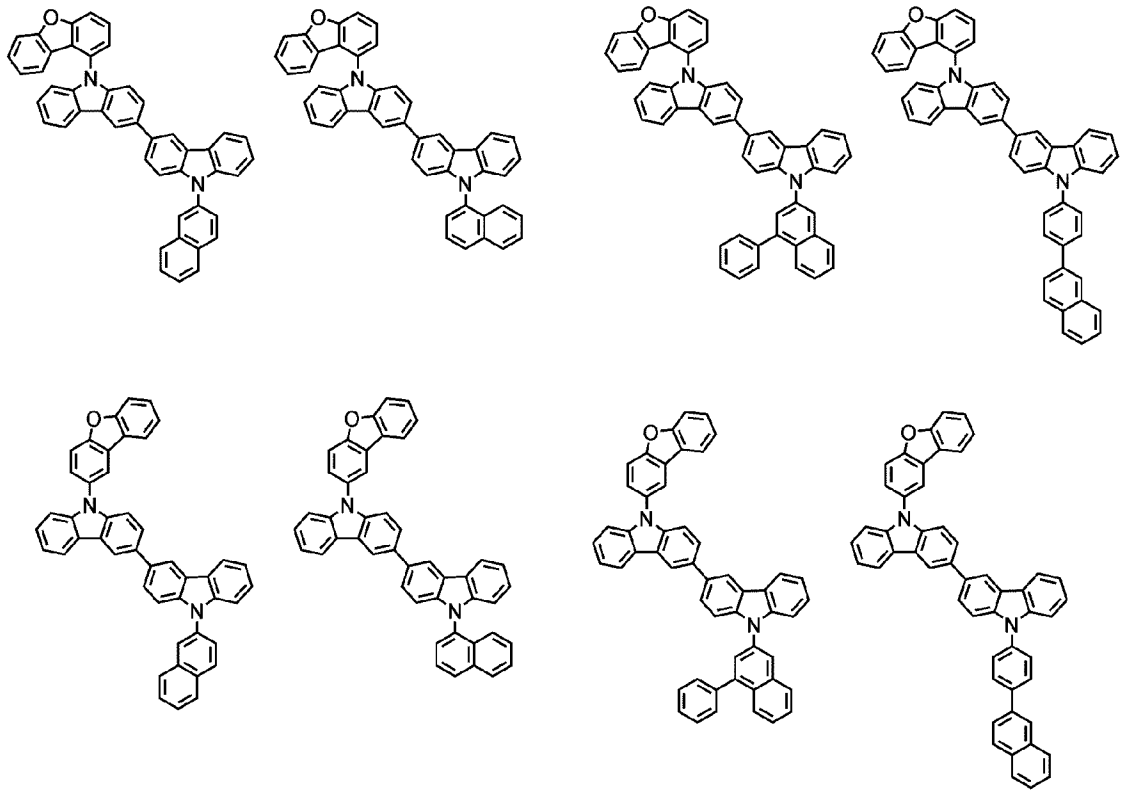
[533]

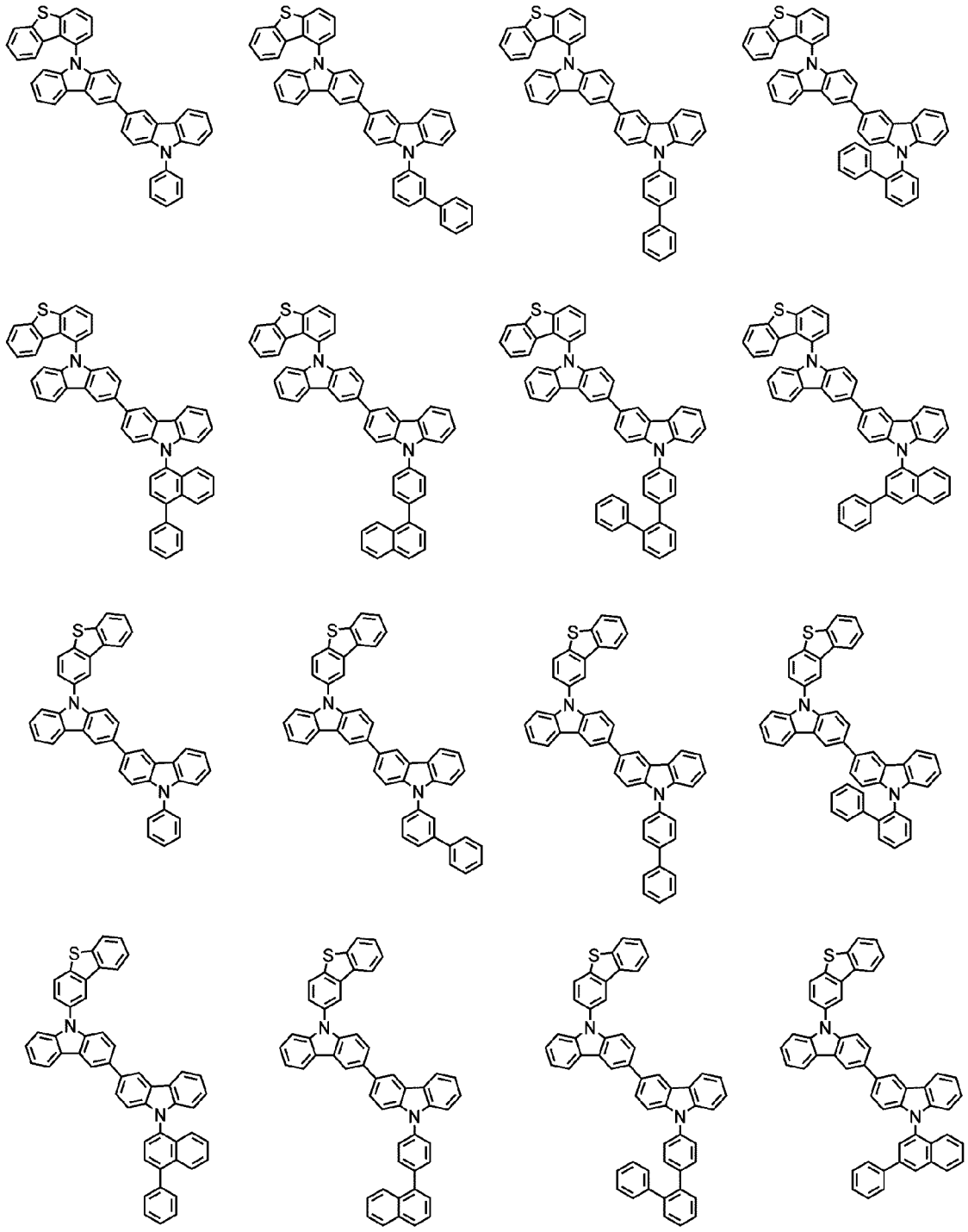
[534]



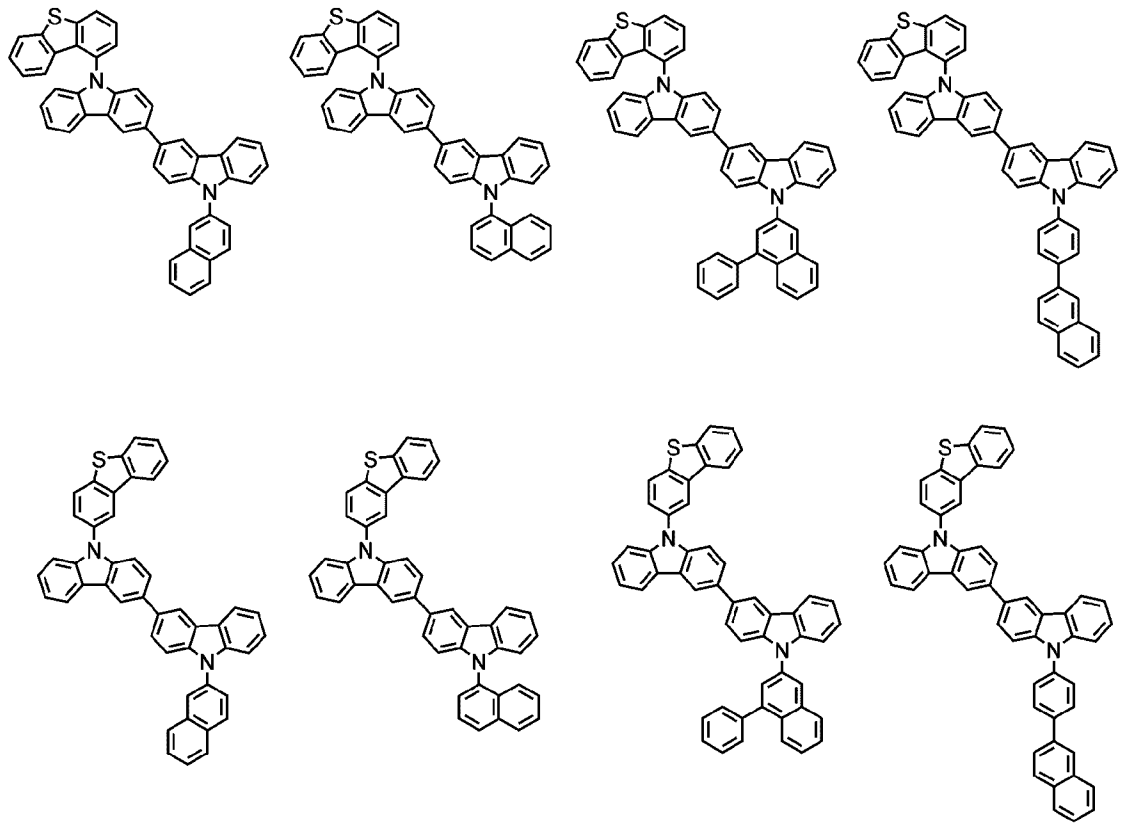
[535]



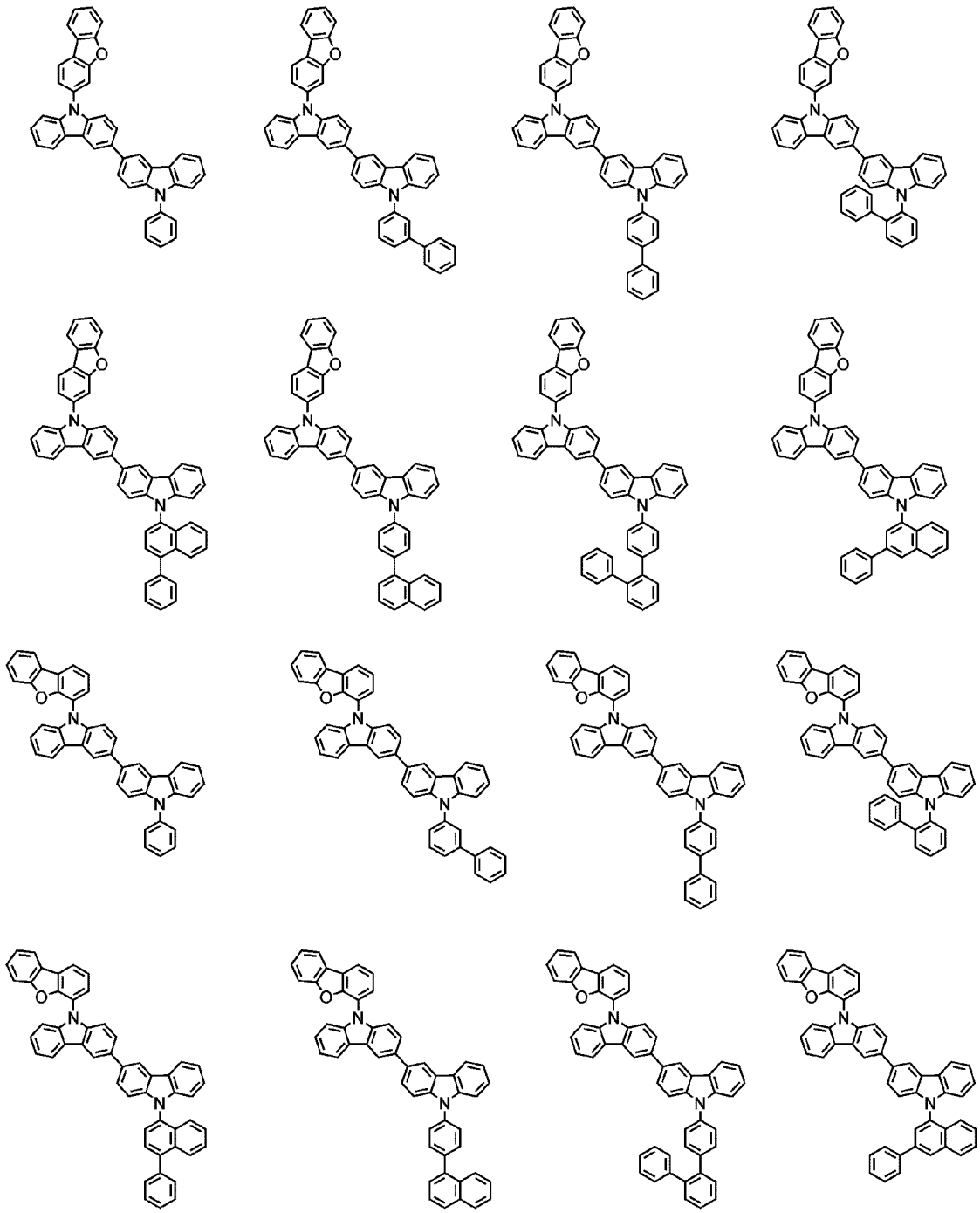
[536]



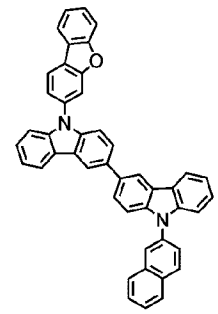
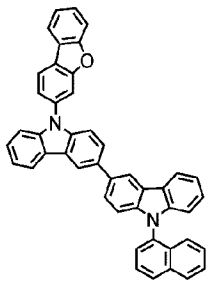
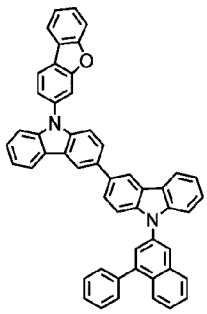
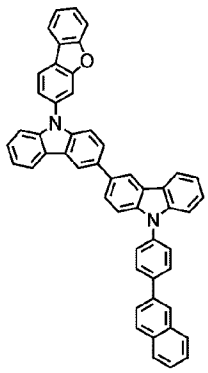
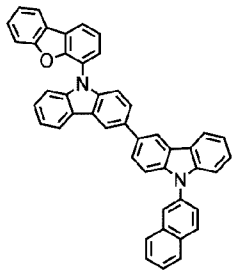
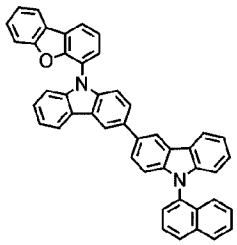
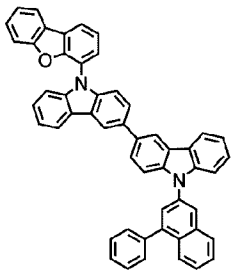
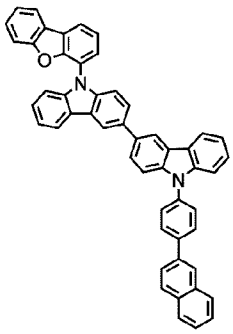
[537]



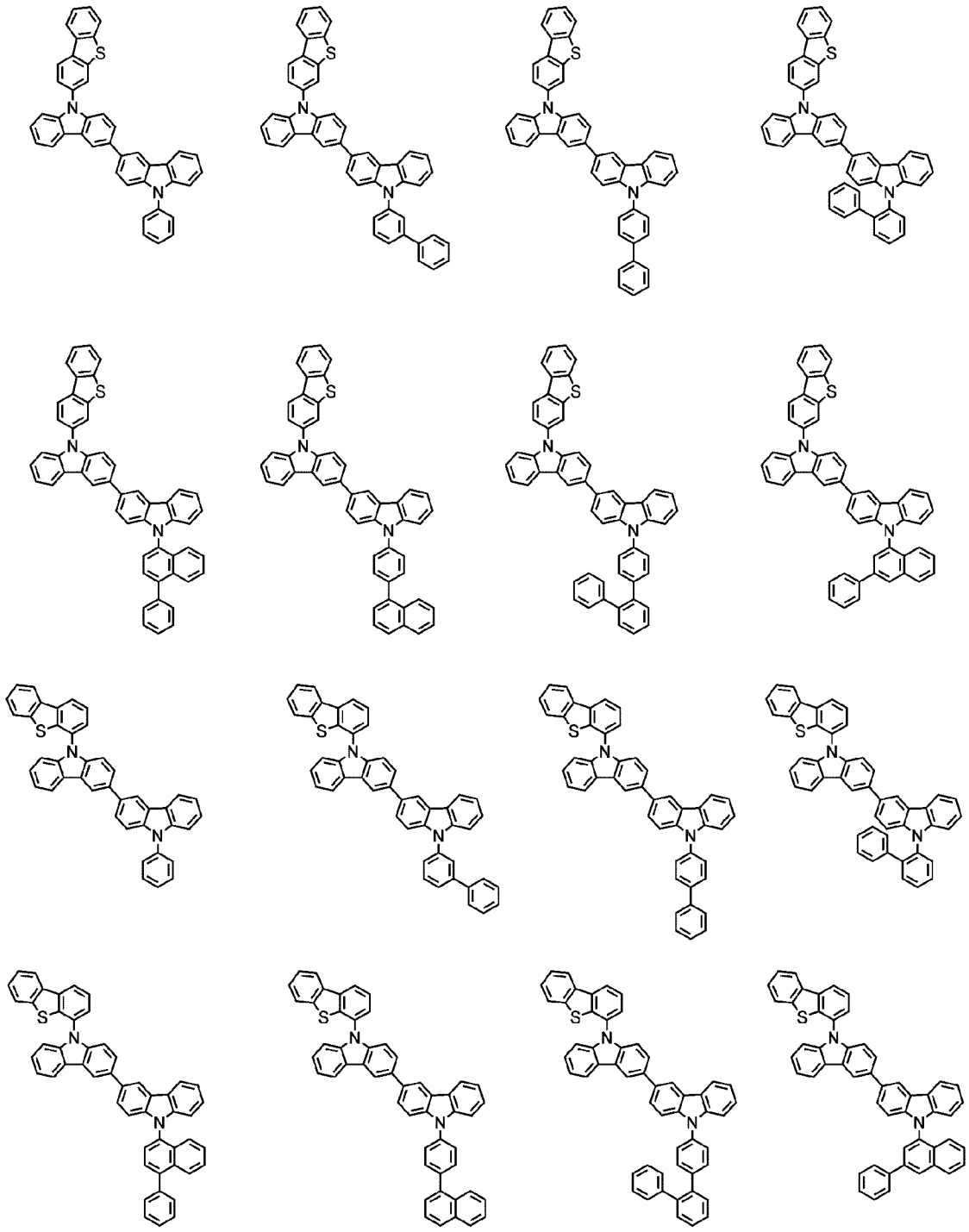
[538]



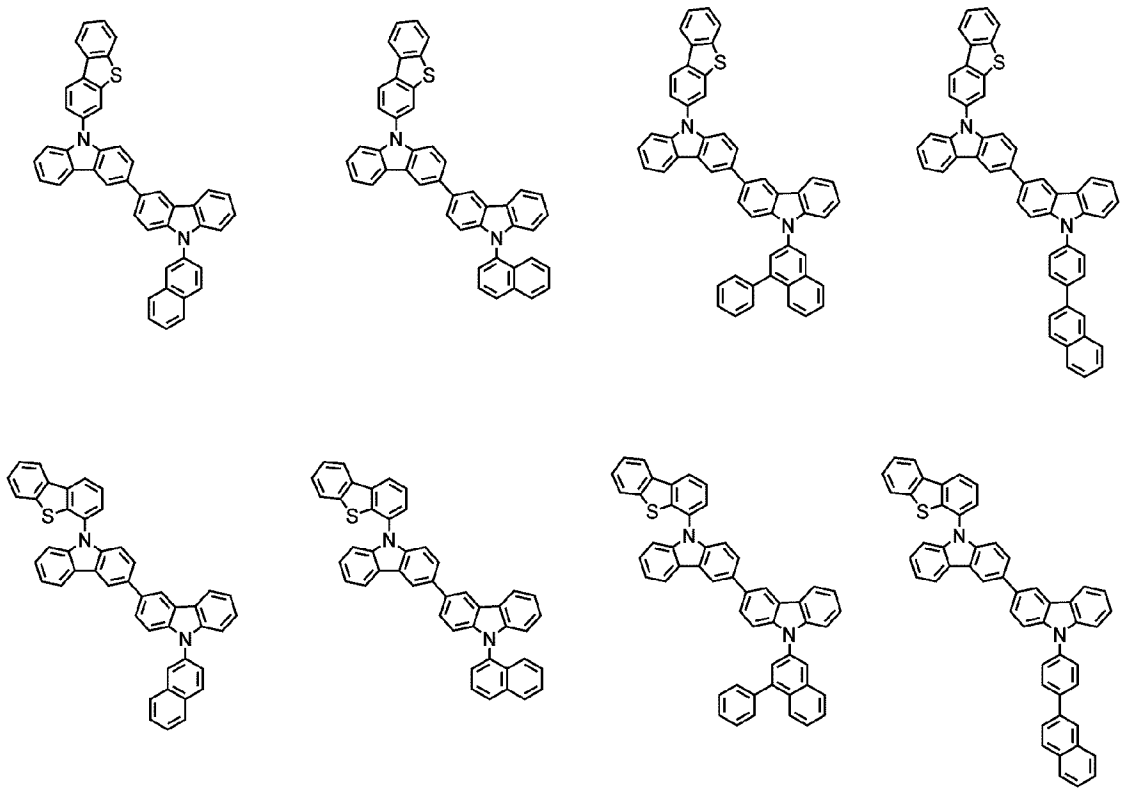
[539]

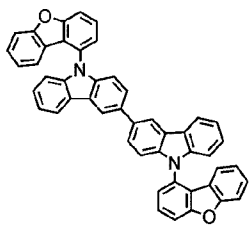
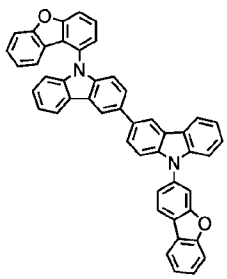
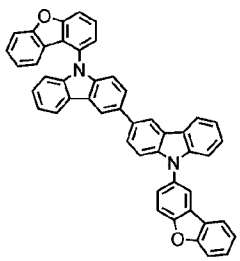
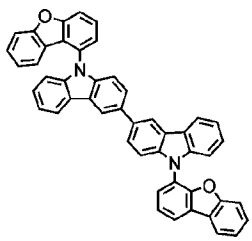
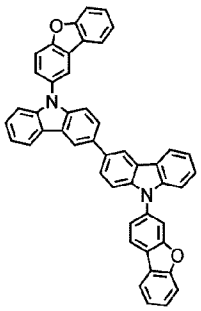
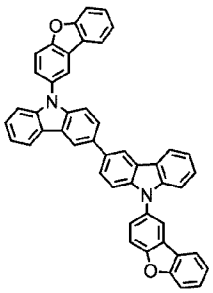
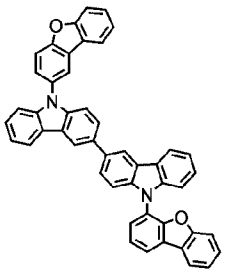
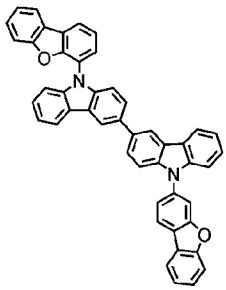
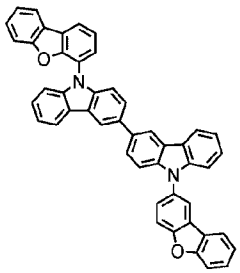
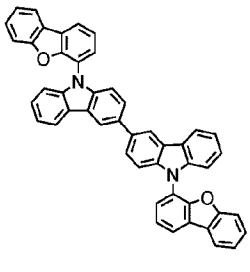
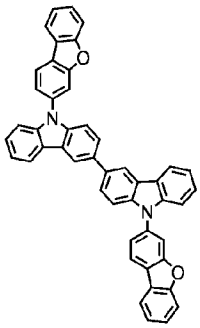
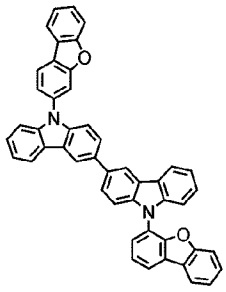
[540]



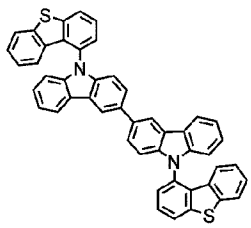
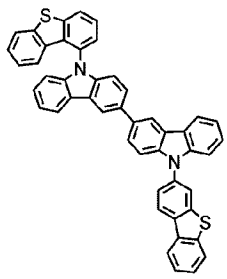
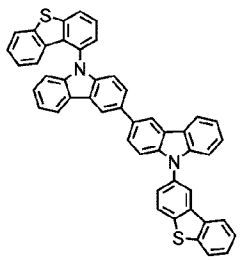
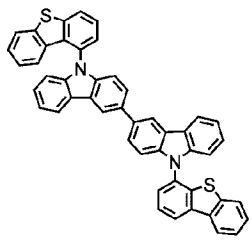
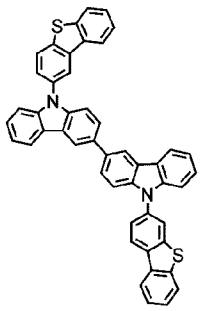
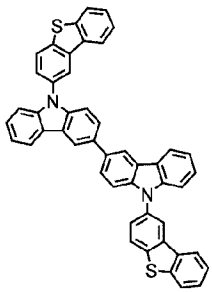
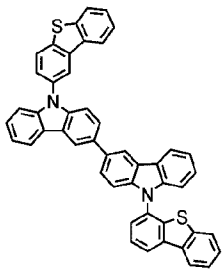
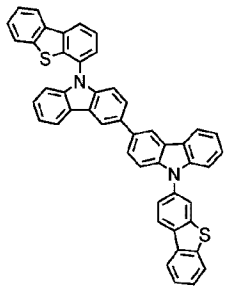
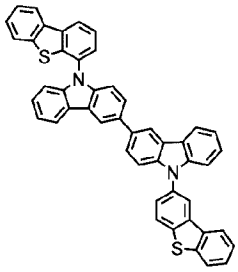
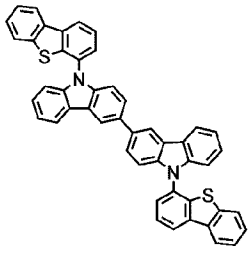
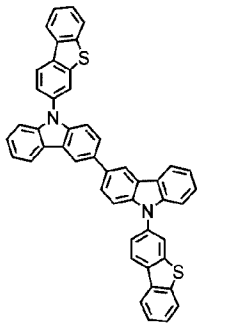
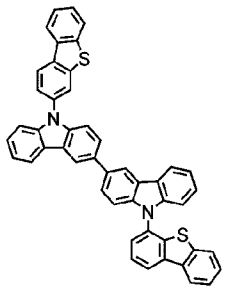
[541]



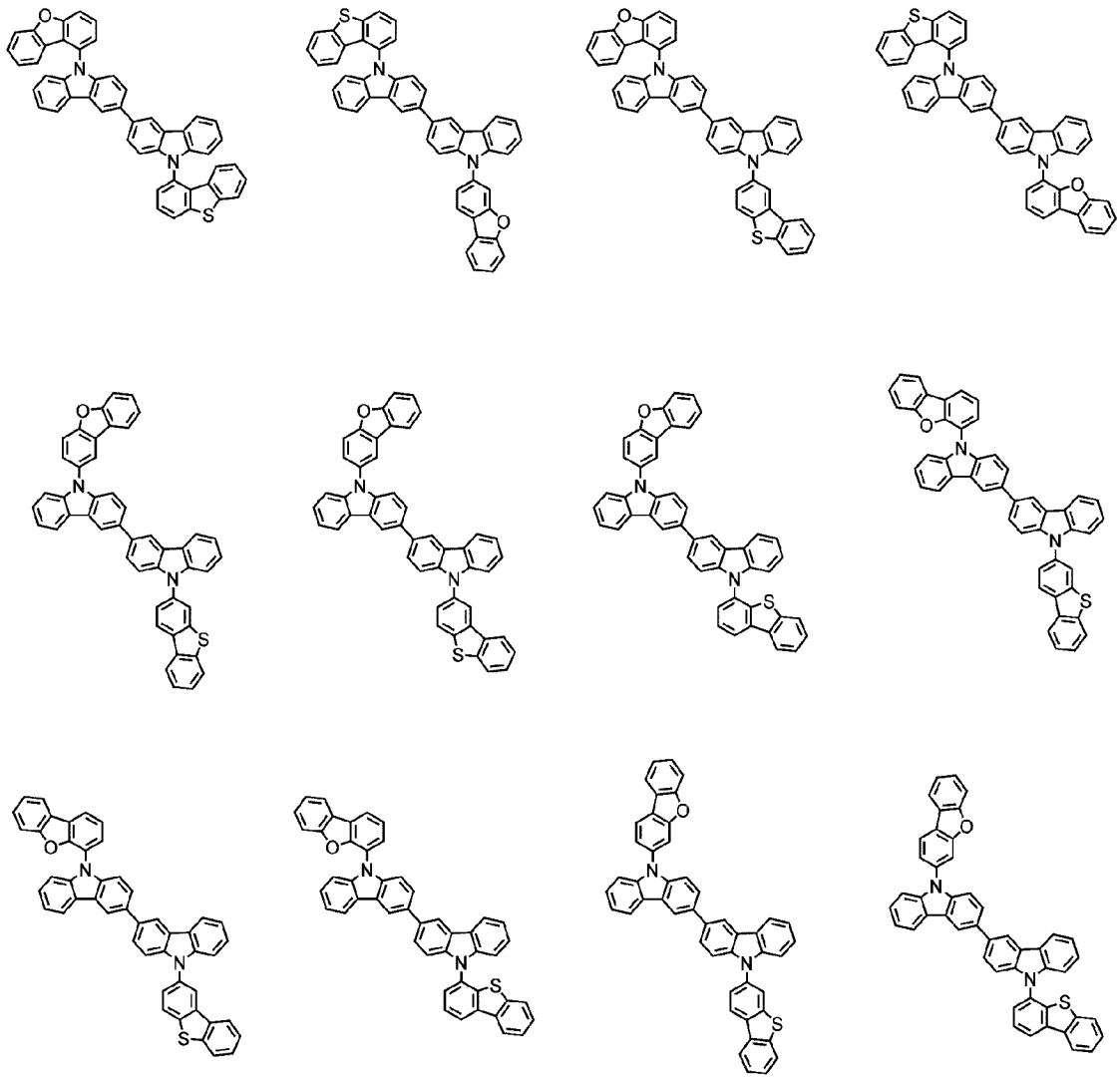
[542]

[543]

[544]



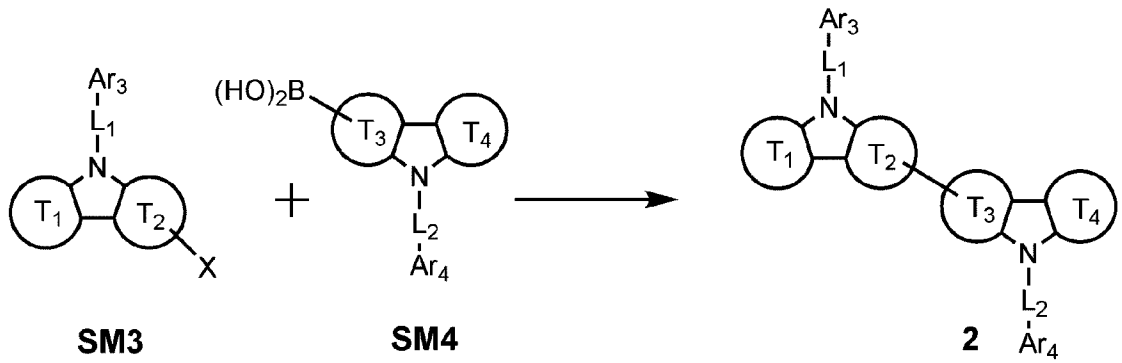
[545] .

[546]

[547] 한편, 상기 화학식 2로 표시되는 화합물은 일례로 하기 반응식 2와 같은 제조 방법으로 제조할 수 있다.

[548] [반응식 2]

[549]



SM3 SM4 2

[550] 상기 반응식 2에서, X는 각각 독립적으로, 할로겐이고, 바람직하게는 브로모, 또는 클로로이고, 다른 치환기에 대한 정의는 앞서 설명한 바와 같다.

[551] 구체적으로, 상기 화학식 2로 표시되는 화합물은 Suzuki-coupling 반응을 통해 출발물질 SM3 및 SM4가 결합하여 제조된다. 이러한 Suzuki-coupling 반응은 팔라듐 촉매와 염기의 존재 하에 수행하는 것이 바람직하다. 또한, 상기 Suzuki-coupling 반응을 위한 반응기는 적절히 변경될 수 있고, 화학식 2로 표시되는 화합물의 제조 방법은 후술할 제조예에서 보다 구체화될 수 있다.

[552]

[553] 이러한 제1 화합물 및 상기 제2 화합물은 상기 발광층 내에 99:1 내지 1:99의 중량비, 보다 바람직하게는 50:50의 중량비로 포함되는 것이 고효율 및 장수명의 소자 구현에 바람직하다.

[554]

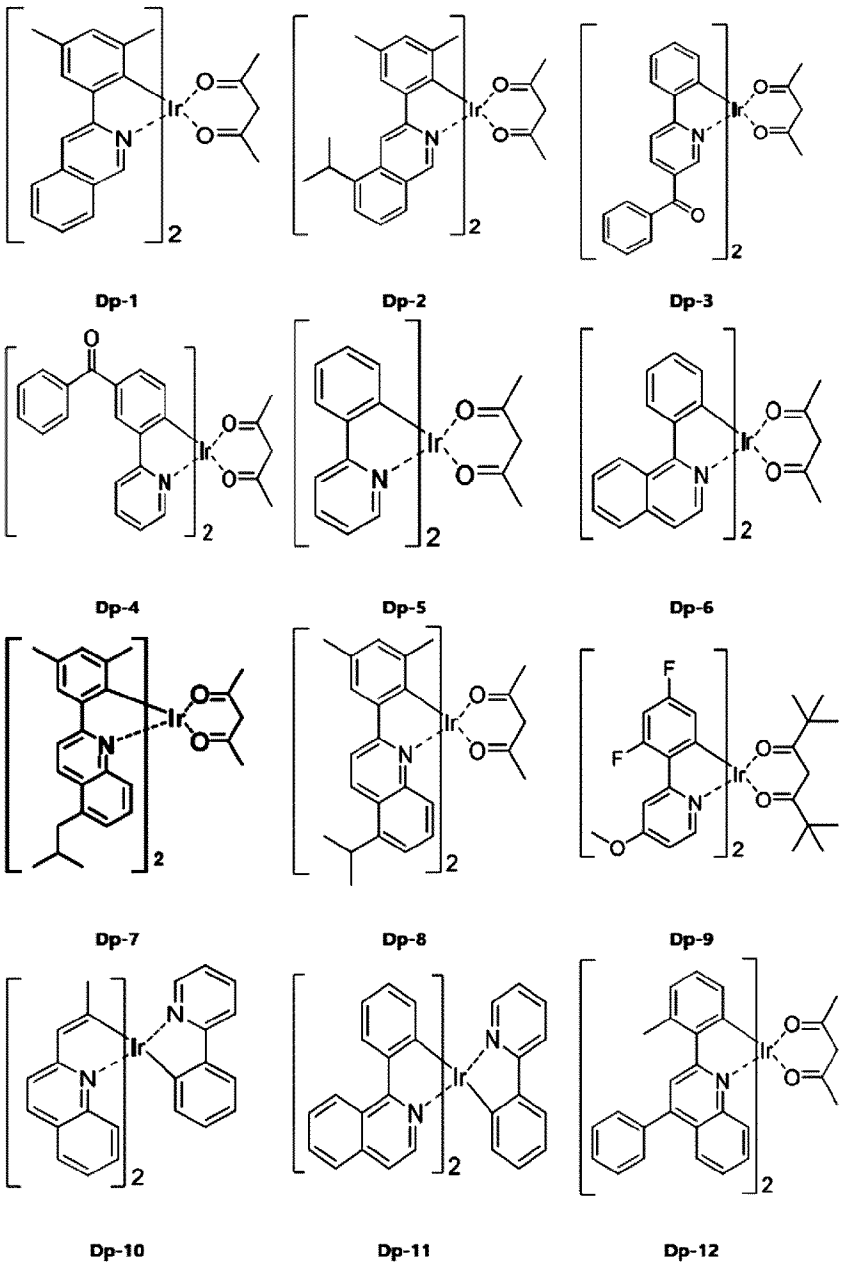
[555] 한편, 상기 발광층은 상기 호스트 재료 외 도펀트 재료를 더 포함한다. 이러한 도펀트 재료로는 방향족 아민 유도체, 스트릴아민 화합물, 붕소 착체, 플루오란텐 화합물, 금속 착체 등이 있다. 구체적으로 방향족 아민 유도체로는 치환 또는 비치환된 아릴아미노기를 갖는 축합 방향족환 유도체로서, 아릴아미노기를 갖는 피렌, 안트라센, 크리센, 페리플란텐 등이 있으며, 스티릴아민 화합물로는 치환 또는 비치환된 아릴아민에 적어도 1개의 아릴비닐기가 치환되어 있는 화합물로, 아릴기, 실릴기, 알킬기, 사이클로알킬기 및 아릴아미노기로 이루어진 군에서 1 또는 2 이상 선택되는 치환기가 치환 또는 비치환된다. 구체적으로 스티릴아민, 스티릴디아민, 스티릴트리아민, 스티릴테트라아민 등이 있으나, 이에 한정되지 않는다. 또한, 금속 착체로는 이리듐 착체, 백금 착체 등이 있으나, 이에 한정되지 않는다.

[556]

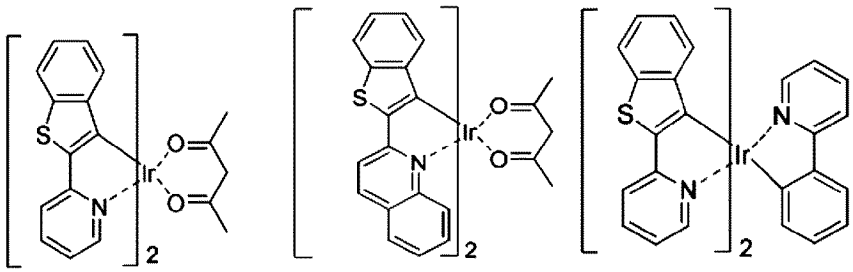
[557] 바람직하게는, 상기 발광층은 하기와 같은 이리듐 착체 화합물을 도펀트 재료로 포함할 수 있으나, 이에 한정되는 것은 아니다.

[558]

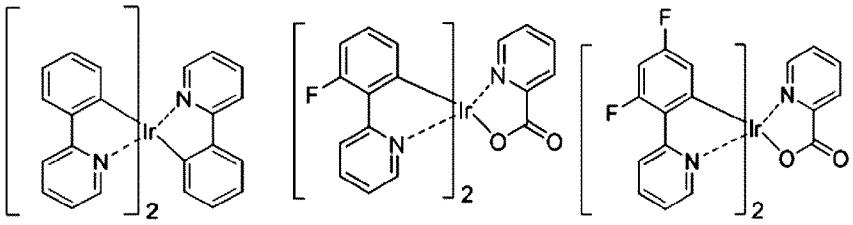
[559]



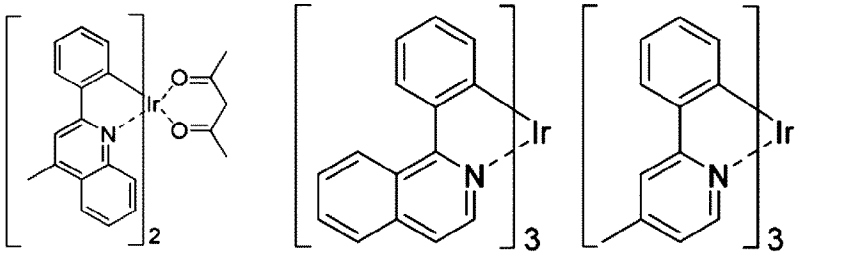
[560]



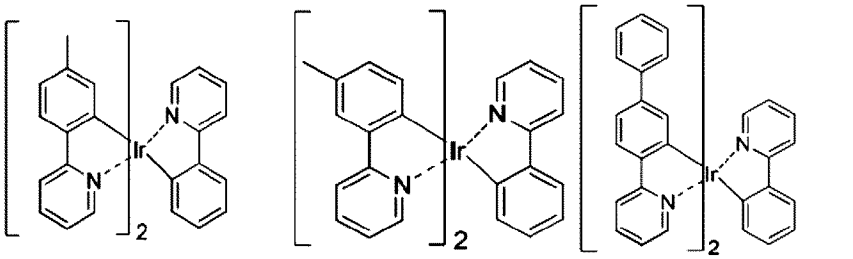
DP-13 Dp-14 Dp-15



Dp-16 Dp-17 Dp-18

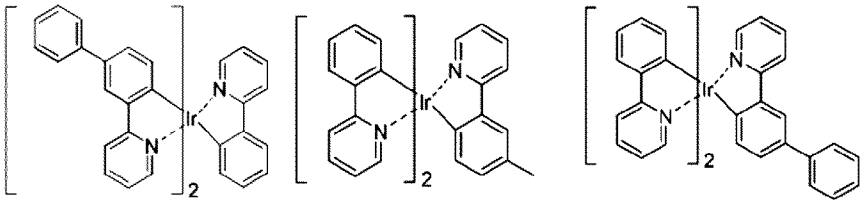


Dp-19 Dp-20 Dp-21



Dp-22 Dp-23 Dp-24

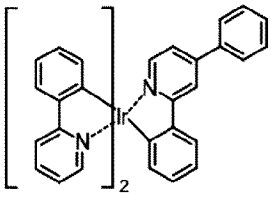
[561]



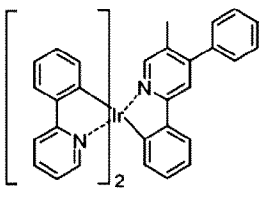
Dp-25

Dp-26

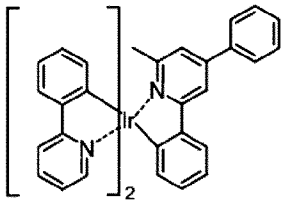
Dp-27



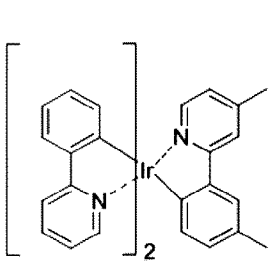
Dp-28



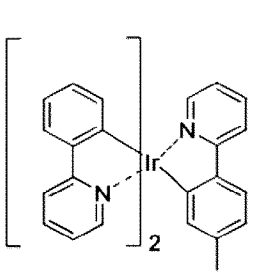
Dp-29



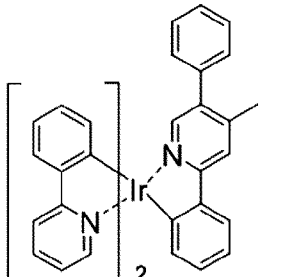
Dp-30



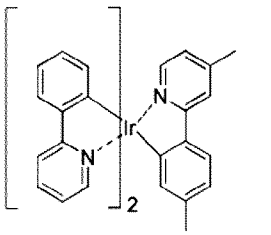
Dp-31



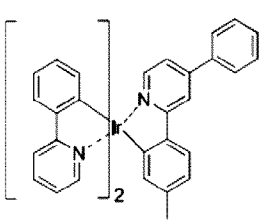
Dp-32



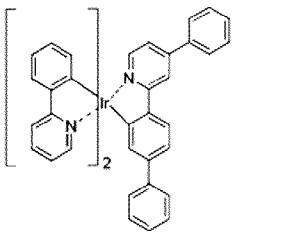
Dp-33



Dp-34

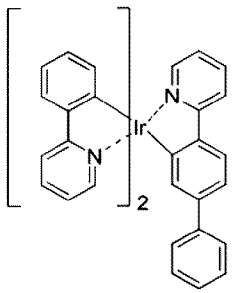


Dp-35

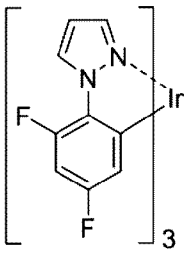


Dp-36

[562]



Dp-37



Dp-38

[563]

[564] 정공주입층

[565] 일 구현예에 따른 유기 발광 소자는 상기 양극 상에 정공 주입층을 추가로 포함할 수 있다. 상기 정공 주입층은 정공 주입 물질로 이루어져 있으며, 정공

주입 물질로는 정공을 수송하는 능력을 가져 양극에서의 정공 주입효과, 발광층 또는 발광재료에 대하여 우수한 정공 주입 효과를 갖고, 발광층에서 생성된 여기자의 전자주입층 또는 전자주입재료에의 이동을 방지하며, 또한, 박막 형성 능력이 우수한 화합물이 바람직하다.

[566]

[567] 상기 정공 주입 물질의 구체적인 예로는, 금속 포피린(porphyrin), 올리고티오펜, 아릴아민 계열의 유기물, 헥사니트릴헥사아자트리페닐렌 계열의 유기물, 퀴나크리돈(quinacridone)계열의 유기물, 페릴렌(perylene) 계열의 유기물, 안트라퀴논 및 폴리아닐린과 폴리티오펜 계열의 전도성 고분자 등이 있으나, 이에 한정되지 않는다.

[568]

[569] **정공수송층**

[570] 일 구현예에 따른 유기 발광 소자는 상기 양극 상에, 또는 상기 양극 상에 형성된 정공주입층 상에 정공수송층을 더 포함할 수 있다. 상기 정공수송층은 양극 또는 양극 상에 형성된 정공주입층으로부터 정공을 수취하여 발광층까지 정공을 수송하는 층으로, 상기 정공수송층에 포함되는 정공 수송 물질로는 양극이나 정공 주입층으로부터 정공을 수송받아 발광층으로 옮겨줄 수 있는 물질로 정공에 대한 이동성이 큰 물질이 적합하다.

[571]

[572] 상기 정공 수송 물질의 구체적인 예로는 아릴아민 계열의 유기물, 전도성 고분자, 및 공액 부분과 비공액 부분이 함께 있는 블록 공중합체 등이 있으나, 이에 한정되지 않는다.

[573]

[574] **전자억제층**

[575] 일 구현예에 따른 유기 발광 소자는 상기 정공수송층 상에 전자억제층을 더 포함할 수 있다. 상기 전자억제층은 상기 정공수송층 상에 형성되어, 바람직하게는 발광층에 접하여 구비되어, 정공이동도를 조절하고, 전자의 과다한 이동을 방지하여 정공-전자간 결합 확률을 높여줌으로써 유기 발광 소자의 효율을 개선하는 역할을 하는 층을 의미한다. 상기 전자억제층은 전자저지물질을 포함하고, 이러한 전자저지물질의 예로 상기 화학식 1로 표시되는 화합물을 사용하거나, 또는 아릴아민 계열의 유기물 등을 사용할 수 있으나, 이에 한정되는 것은 아니다.

[576]

[577] **정공저지층**

[578] 일 구현예에 따른 유기 발쇵 소자는 상기 발광층 상에 정공저지층을 더 포함할 수 있다. 상기 정공저지층은 발광층 상에 형성되어, 바람직하게는 발광층에 접하여 구비되어, 전자이동도를 조절하고 정공의 과다한 이동을 방지하여 정공-전자간 결합 확률을 높여줌으로써 유기 발광 소자의 효율을 개선하는

역할을 하는 층을 의미한다. 상기 정공저지층은 정공저지물질을 포함하고, 이러한 정공저지물질의 예로 트리아진을 포함한 아진류유도체; 트리아졸 유도체; 옥사디아졸 유도체; 페난트롤린 유도체; 포스핀옥사이드 유도체 등의 전자흡인기가 도입된 화합물을 사용할 수 있으나, 이에 한정되는 것은 아니다.

[579]

[580] **전자수송층**

[581] 일 구현예에 따른 유기 발광 소자는 상기 발광층 상에, 또는 상기 정공저지층 상에 전자수송층을 포함할 수 있다. 상기 전자수송층은 음극 또는 후술하는 전자주입층으로부터 전자를 수취하여 발광층까지 전자를 수송하는 층으로, 상기 전자수송층에 포함되는 전자 수송 물질로는 음극으로부터 전자를 잘 주입받아 발광층으로 옮겨줄 수 있는 전자에 대한 이동성이 큰 물질이 적합하다.

[582]

[583] 상기 전자 수송 물질의 구체적인 예로는 피리딘 유도체; 피리미딘 유도체; 트리아졸 유도체; 8-히드록시퀴놀린의 Al 착물; Alq_3를 포함한 착물; 유기 라디칼 화합물; 히드록시플라본-금속 착물 등이 있으나, 이들에만 한정되는 것은 아니다. 전자 수송층은 종래기술에 따라 사용된 바와 같이 임의의 원하는 캐소드 물질과 함께 사용할 수 있다. 특히, 적절한 캐소드 물질의 예는 낮은 일함수를 가지고 알루미늄층 또는 실버층이 뒤따르는 통상적인 물질이다. 구체적으로 세슘, 바륨, 칼슘, 이테르븀 및 사마륨이고, 각 경우 알루미늄 층 또는 실버층이 뒤따른다.

[584]

[585] **전자주입층**

[586] 일 구현예에 따른 유기 발광 소자는 상기 전자수송층과 음극 사이에 전자주입층을 추가로 포함할 수 있다. 상기 전자주입층은 음극으로부터 전자를 주입하는 층으로, 상기 전자주입층에 포함되는 전자 주입 물질로는 전자를 수송하는 능력을 갖고, 음극으로부터의 전자 주입 효과, 발광층 또는 발광 재료에 대하여 우수한 전자주입 효과를 가지며, 발광층에서 생성된 여기자의 정공주입층에의 이동을 방지하고, 또한, 박막형성능력이 우수한 화합물이 바람직하다.

[587]

[588] 상기 전자주입층으로 사용될 수 있는 물질의 구체적인 예로는, LiF, NaCl, CsF, Li_2O, BaO, 플루오레논, 안트라퀴노다이메탄, 다이페노퀴논, 티오피란 다이옥사이드, 옥사졸, 옥사다이아졸, 트리아졸, 이미다졸, 페릴렌테트라카복실산, 프레오레닐리덴 메탄, 안트론 등과 그들의 유도체, 금속 착체 화합물 및 질소 함유 5원환 유도체 등이 있으나, 이에 한정되지 않는다.

[589]

[590] 상기 금속 착체 화합물로서는 8-하이드록시퀴놀리나토 리튬, 비스(8-하이드록시퀴놀리나토)아연, 비스(8-하이드록시퀴놀리나토)구리,

비스(8-하이드록시퀴놀리나토)망간, 트리스(8-하이드록시퀴놀리나토)알루미늄,
트리스(2-메틸-8-하이드록시퀴놀리나토)알루미늄,
트리스(8-하이드록시퀴놀리나토)갈륨,
비스(10-하이드록시벤조[h]퀴놀리나토)베릴륨,
비스(10-하이드록시벤조[h]퀴놀리나토)아연,
비스(2-메틸-8-퀴놀리나토)클로로갈륨,
비스(2-메틸-8-퀴놀리나토)(o-크레졸라토)갈륨,
비스(2-메틸-8-퀴놀리나토)(1-나프톨라토)알루미늄,
비스(2-메틸-8-퀴놀리나토)(2-나프톨라토)갈륨 등이 있으나, 이에 한정되지 않는다.

[591]

[592] 한편, 상기의 전자수송층 및 전자주입층은 수취된 전자를 발광층까지 수송하는 전자수송층 및 전자주입층의 역할을 동시에 수행하는 전자 주입 및 수송층의 형태로도 구비 가능하다.

[593]

[594] **유기 발광 소자**

[595] 일 구현예에 따라 상기 제1 전극이 양극이고, 상기 제2 전극이 음극인 유기 발광 소자의 구조를 도 1에 예시하였다. 도 1은 기판(1), 양극(2), 발광층(3) 및 음극(4)으로 이루어진 유기 발광 소자의 예를 도시한 것이다. 이와 같은 구조에 있어서, 상기 제1 화합물 및 상기 제2 화합물은 상기 발광층에 포함될 수 있다.

[596]

[597] 다른 구현예에 따라 상기 제1 전극이 양극이고, 상기 제2 전극이 음극인 유기 발광 소자의 구조를 도 2에 예시하였다. 도 2는 기판(1), 양극(2), 정공주입층(5), 정공수송층(6), 발광층(3), 전자억제층(7), 정공저지층(8), 전자주입 및 수송층(8) 및 음극(4)으로 이루어진 유기 발광 소자의 예를 도시한 것이다. 이와 같은 구조에 있어서, 상기 제1 화합물 및 상기 제2 화합물은 상기 발광층에 포함될 수 있다.

[598]

[599] 본 발명에 따른 유기 발광 소자는 상술한 구성을 순차적으로 적층시켜 제조할 수 있다. 이때, 스퍼터링법(sputtering)이나 전자빔 증발법(e-beam evaporation)과 같은 PVD(physical Vapor Deposition)방법을 이용하여, 기판 상에 금속 또는 전도성을 가지는 금속 산화물 또는 이들의 합금을 증착시켜 양극을 형성하고, 그 위에 상술한 각 층을 형성한 후, 그 위에 음극으로 사용할 수 있는 물질을 증착시켜 제조할 수 있다. 이와 같은 방법 외에도, 기판 상에 음극 물질부터 유기물층, 양극 물질을 차례로 증착시켜 유기 발광 소자를 만들 수 있다. 또한, 발광층은 호스트 및 도펀트를 진공 증착법 뿐만 아니라 용액 도포법에 의하여 형성될 수 있다. 여기서, 용액 도포법이라 함은 스핀 코팅, 딥코팅, 닥터 블레이딩, 잉크젯 프린팅, 스크린 프린팅, 스프레이법, 롤 코팅 등을 의미하지만,

이들만으로 한정되는 것은 아니다.

[600]

[601] 이와 같은 방법 외에도, 기판 상에 음극 물질로부터 유기물층, 양극 물질을 차례로 증착시켜 유기 발광 소자를 제조할 수 있다(WO 2003/012890). 다만, 제조 방법이 이에 한정되는 것은 아니다.

[602]

[603] 한편, 본 발명에 따른 유기 발광 소자는 사용되는 재료에 따라 전면 발광형, 후면 발광형 또는 양면 발광형일 수 있다.

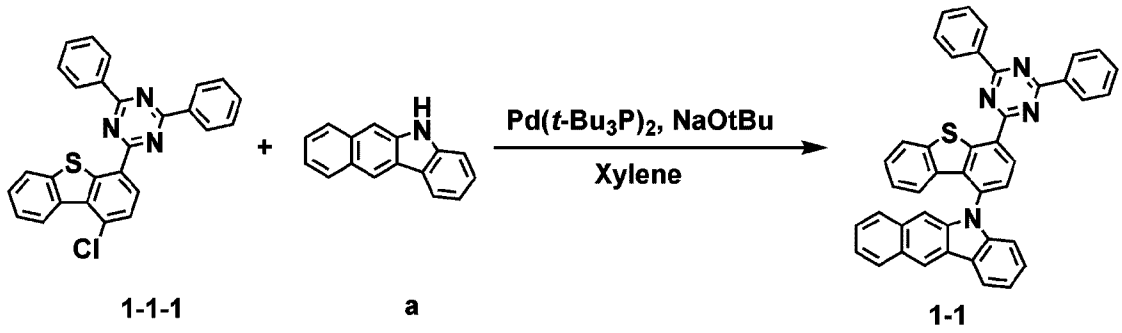
[604]

[605] 상기 유기 발광 소자의 제조는 이하 실시예에서 구체적으로 설명한다. 그러나 하기 실시예는 본 발명을 예시하기 위한 것이며, 본 발명의 범위가 이들에 의하여 한정되는 것은 아니다.

[606]

[607] **합성예 1-1: 화합물 1-1의 제조**

[608]



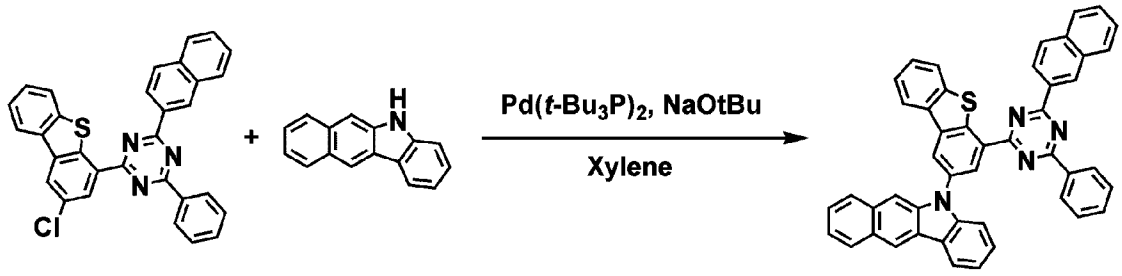
1-1-1 a 1-1

[609] 질소 분위기에서 중간체 1-1-1(10 g, 22.2mmol), 화합물 a(5.3g, 24.4 mmol), sodium tert-butoxide(4.3 g, 44.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-1을 7.3 g 제조하였다. (수율: 52%, MS: [M+H]+= 631)

[610]

[611] **합성예 1-2: 화합물 1-2의 제조**

[612]



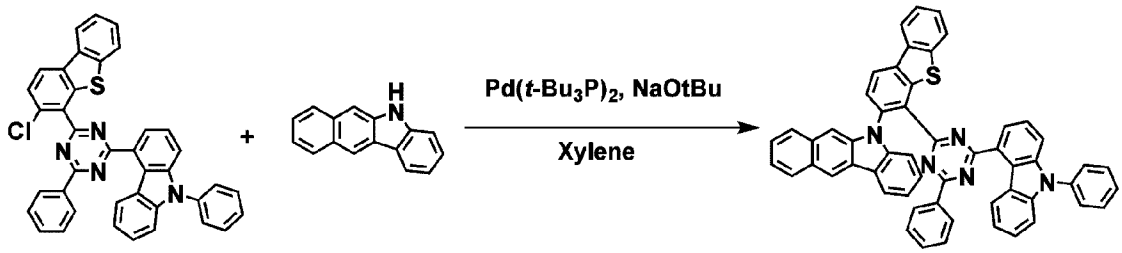
1-2-1 a 1-2

[613] 질소 분위기에서 중간체 1-2-1(10 g, 20mmol), 화합물 a(4.8g, 22 mmol), sodium tert-butoxide(3.8 g, 40 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-2를 6.9 g 제조하였다. (수율: 51%, MS: [M+H]+= 681)

[614]

[615] **합성예 1-3: 화합물 1-3의 제조**

[616]



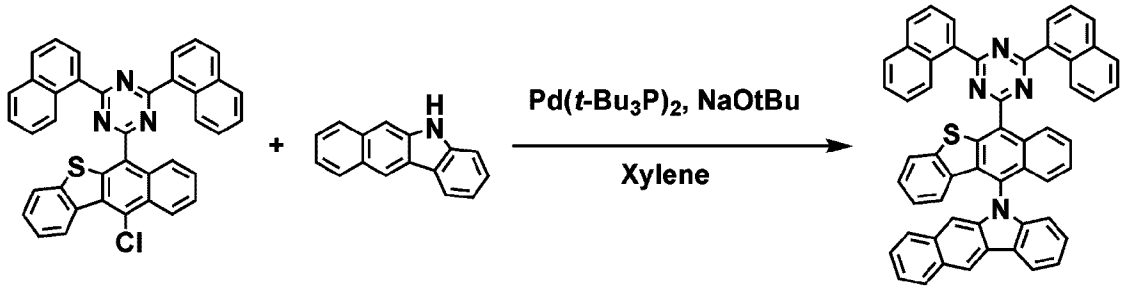
1-3-1 a 1-3

[617] 질소 분위기에서 중간체 1-3-1(10 g, 16.3mmol), 화합물 a(3.9g, 17.9 mmol), sodium tert-butoxide(3.1 g, 32.5 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-3을 8.9 g 제조하였다. (수율: 69%, MS: [M+H]+= 796)

[618]

[619] **합성예 1-4: 화합물 1-4의 제조**

[620]



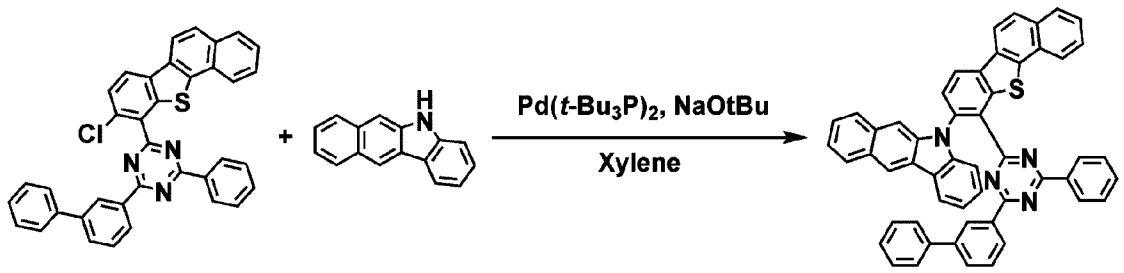
1-4-1 a 1-4

[621] 질소 분위기에서 중간체 1-4-1(10 g, 17.1mmol), 화합물 a(4.1g, 18.8 mmol), sodium tert-butoxide(3.3 g, 34.2 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-4를 7.1 g 제조하였다. (수율: 54%, MS: [M+H]+= 765)

[622]

[623] **합성예 1-5: 화합물 1-5의 제조**

[624]



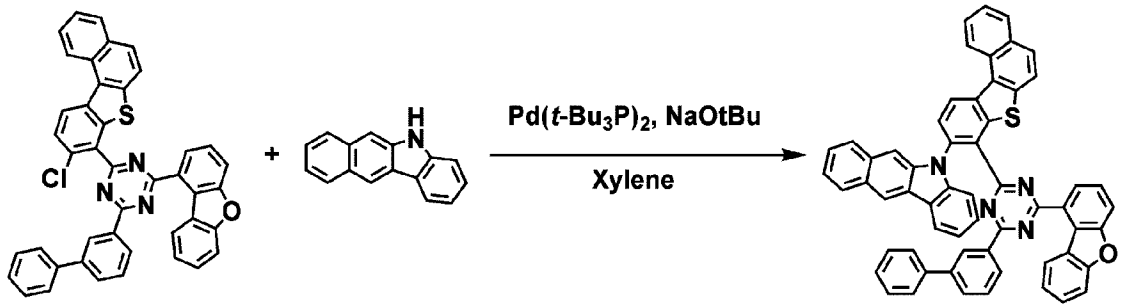
1-5-1 a 1-5

[625] 질소 분위기에서 중간체 1-5-1(10 g, 17.9mmol), 화합물 a(4.3g, 19.6 mmol), sodium tert-butoxide(3.4 g, 35.7 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-5를 8.9 g 제조하였다. (수율: 67%, MS: [M+H]+= 741)

[626]

[627] **합성예 1-6: 화합물 1-6의 제조**

[628]



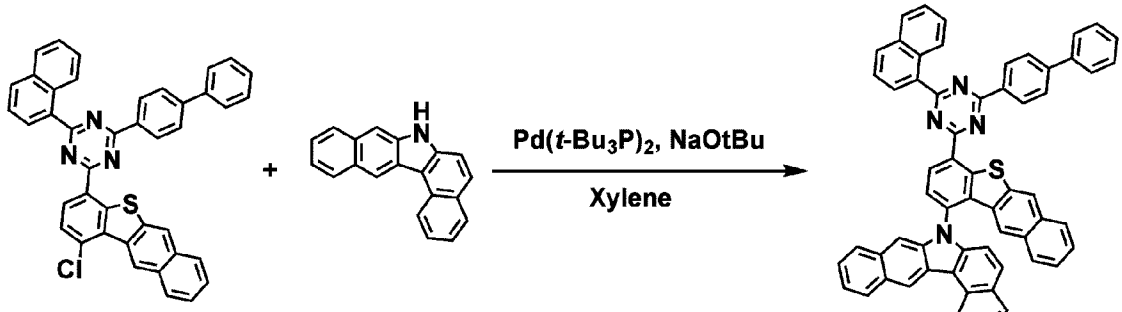
1-6-1 a 1-6

[629] 질소 분위기에서 중간체 1-6-1(10 g, 15.4mmol), 화합물 a(3.7g, 16.9 mmol), sodium tert-butoxide(3 g, 30.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-6을 7.4 g 제조하였다. (수율: 58%, MS: [M+H]+= 831)

[630]

[631] **합성예 1-7: 화합물 1-7의 제조**

[632]



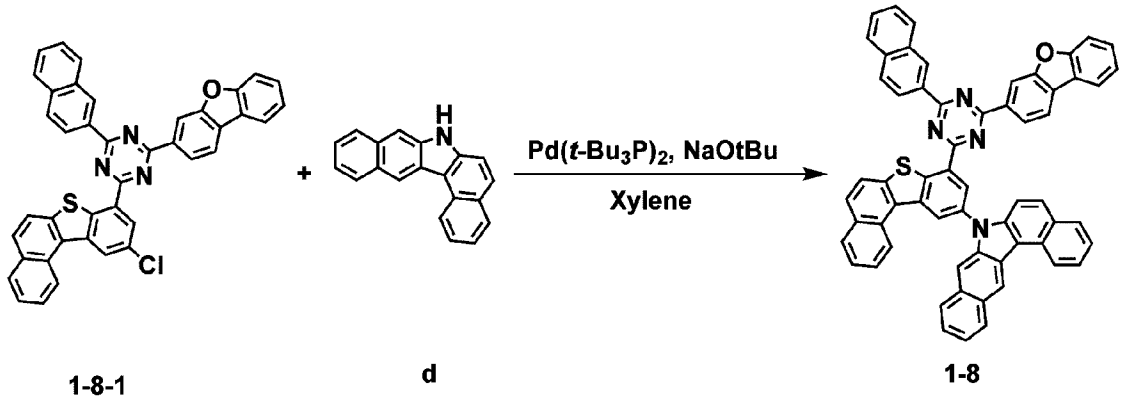
1-7-1 d 1-7

[633] 질소 분위기에서 중간체 1-7-1(10 g, 16.4mmol), 화합물 d(4.8g, 18 mmol), sodium tert-butoxide(3.2 g, 32.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-7을 7 g 제조하였다. (수율: 51%, MS: [M+H]+= 841)

[634]

[635] **합성예 1-8: 화합물 1-8의 제조**

[636]



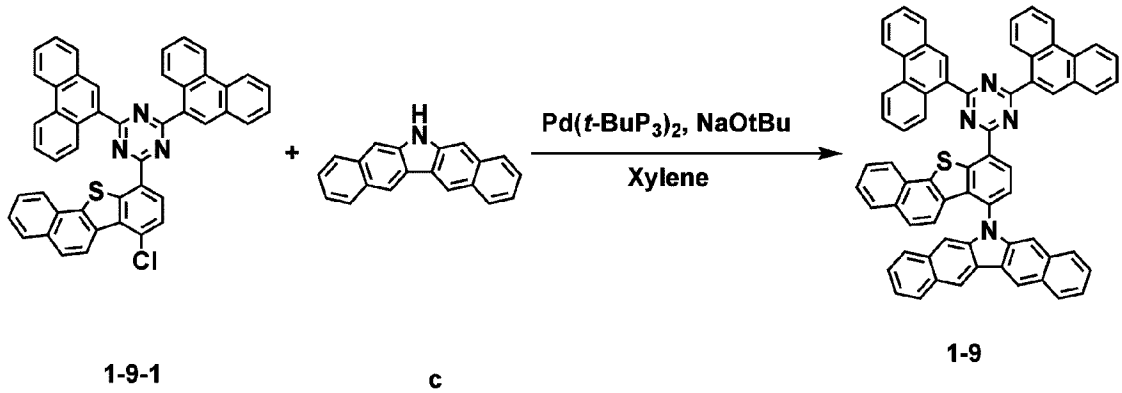
1-8-1 d 1-8

[637] 질소 분위기에서 중간체 1-8-1(10 g, 16mmol), 화합물 d(4.7g, 17.6 mmol), sodium tert-butoxide(3.1 g, 32 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-8을 6.8 g 제조하였다. (수율: 50%, MS: [M+H]+= 855)

[638]

[639] **합성예 1-9: 화합물 1-9의 제조**

[640]



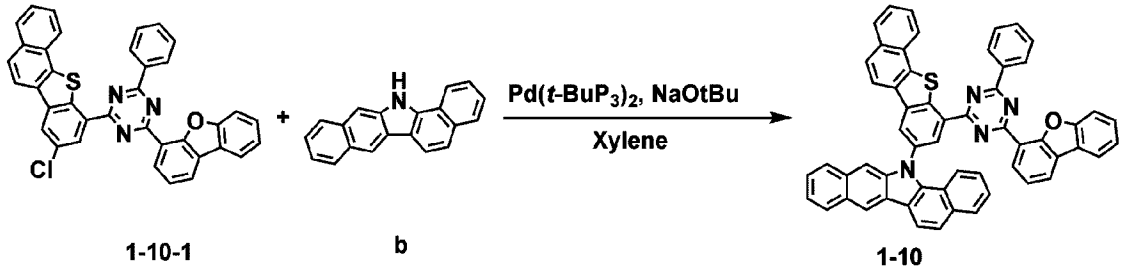
1-9-1 c 1-9

[641] 질소 분위기에서 중간체 1-9-1(10 g, 14.6mmol), 화합물 c(4.3g, 16.1 mmol), sodium tert-butoxide(2.8 g, 29.2 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.1 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-9를 6.7 g 제조하였다. (수율: 50%, MS: [M+H]+= 915)

[642]

[643] **합성예 1-10: 화합물 1-10의 제조**

[644]



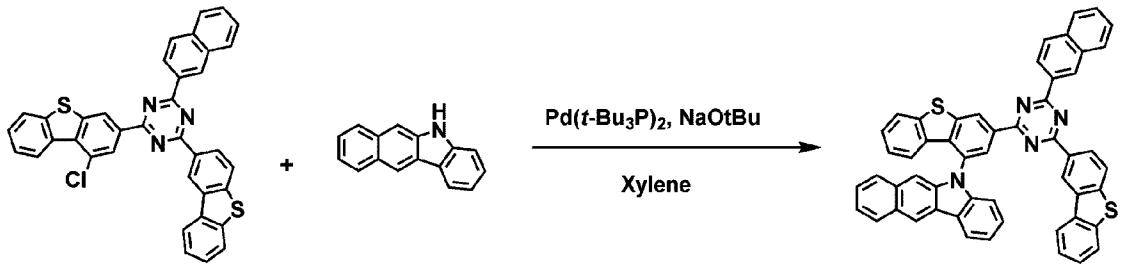
1-10-1 b 1-10

[645] 질소 분위기에서 중간체 1-10-1(10 g, 17.4mmol), 화합물 b(5.1g, 19.2 mmol), sodium tert-butoxide(3.3 g, 34.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-10을 8.8 g 제조하였다. (수율: 63%, MS: [M+H]+= 805)

[646]

[647] **합성예 1-11: 화합물 1-11의 제조**

[648]



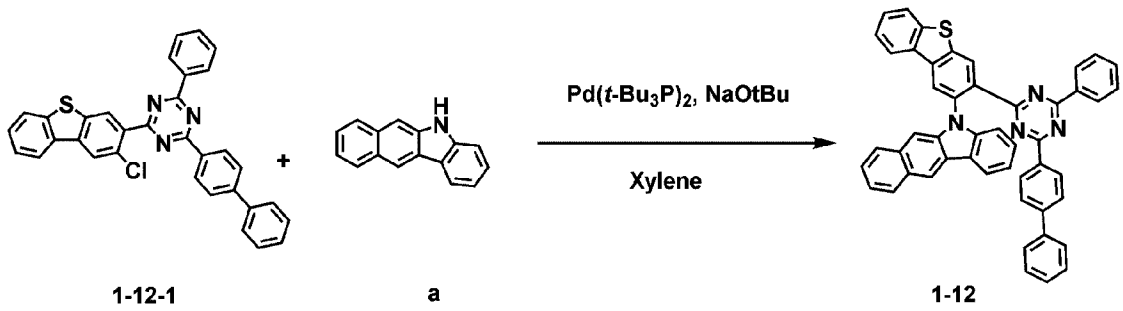
1-11-1 a 1-11

[649] 질소 분위기에서 중간체 1-11-1(10 g, 16.5mmol), 화합물 a(3.9g, 18.1 mmol), sodium tert-butoxide(3.2 g, 33 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-11을 8.4 g 제조하였다. (수율: 65%, MS: [M+H]+= 787)

[650]

[651] **합성예 1-12: 화합물 1-12의 제조**

[652]



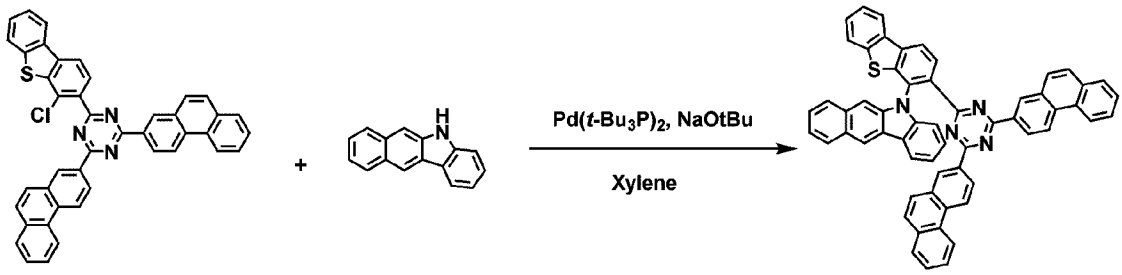
1-12-1 a 1-12

[653] 질소 분위기에서 중간체 1-12-1(10 g, 19mmol), 화합물 a(4.5g, 20.9 mmol), sodium tert-butoxide(3.7 g, 38 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-12를 7.1 g 제조하였다. (수율: 53%, MS: [M+H]+= 707)

[654]

[655] **합성예 1-13: 화합물 1-13의 제조**

[656]



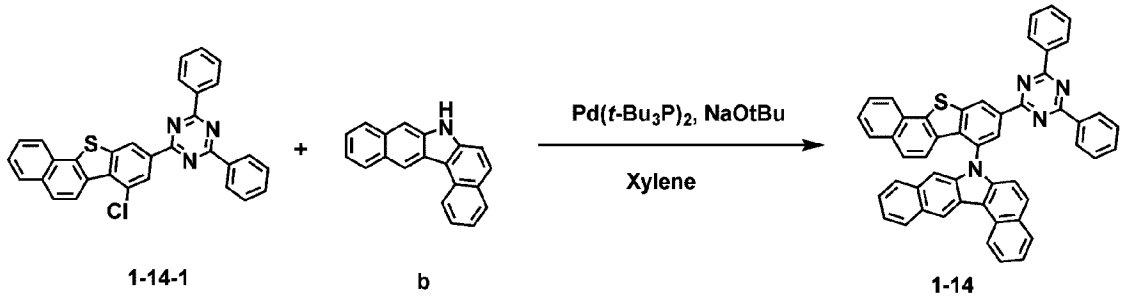
1-13-1 a 1-13

[657] 질소 분위기에서 중간체 1-13-1(10 g, 15.4mmol), 화합물 a(3.7g, 16.9 mmol), sodium tert-butoxide(3 g, 30.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-13을 6.8 g 제조하였다. (수율: 53%, MS: [M+H]+= 831)

[658]

[659] **합성예 1-14: 화합물 1-14의 제조**

[660]



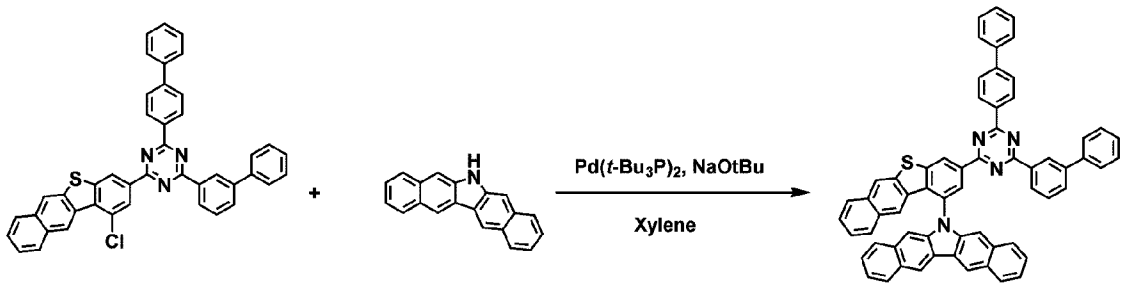
1-14-1 b 1-14

[661] 질소 분위기에서 중간체 1-14-1(10 g, 20mmol), 화합물 b(5.9g, 22 mmol), sodium tert-butoxide(3.8 g, 40 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-14를 7.9 g 제조하였다. (수율: 54%, MS: [M+H]+= 731)

[662]

[663] **합성예 1-15: 화합물 1-15의 제조**

[664]



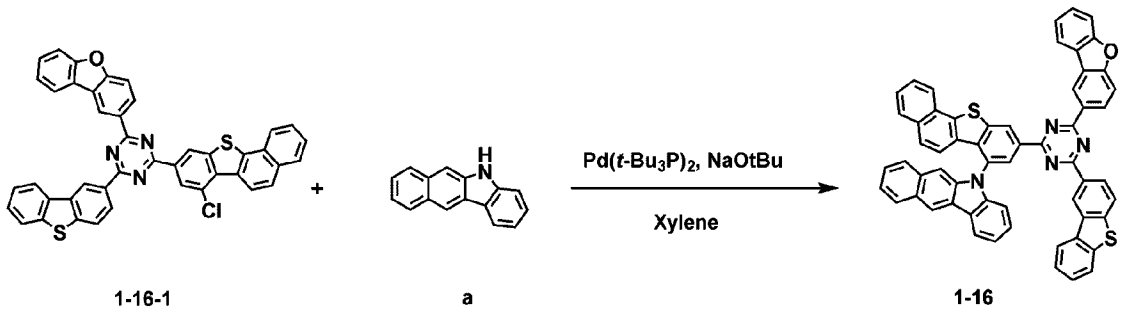
1-15-1 c 1-15

[665] 질소 분위기에서 중간체 1-15-1(10 g, 15.3mmol), 화합물 c(4.5g, 16.9 mmol), sodium tert-butoxide(2.9 g, 30.7 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-15를 9.3 g 제조하였다. (수율: 69%, MS: [M+H]+= 883)

[666]

[667] **합성예 1-16: 화합물 1-16의 제조**

[668]



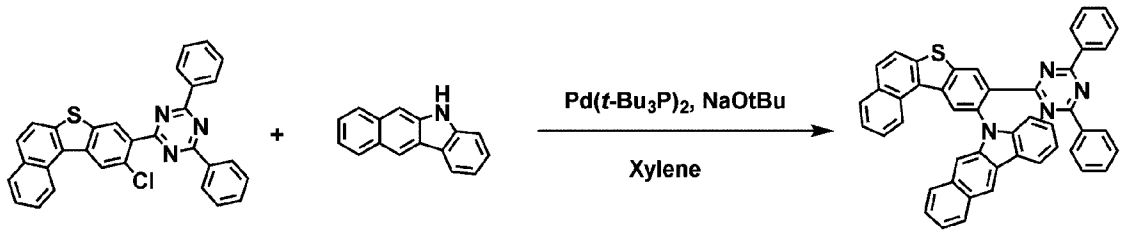
1-16-1 a 1-16

[669] 질소 분위기에서 중간체 1-16-1(10 g, 14.4mmol), 화합물 a(3.4g, 15.8 mmol), sodium tert-butoxide(2.8 g, 28.7 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.1 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-16을 6.4 g 제조하였다. (수율: 51%, MS: [M+H]+= 877)

[670]

[671] **합성예 1-17: 화합물 1-17의 제조**

[672]



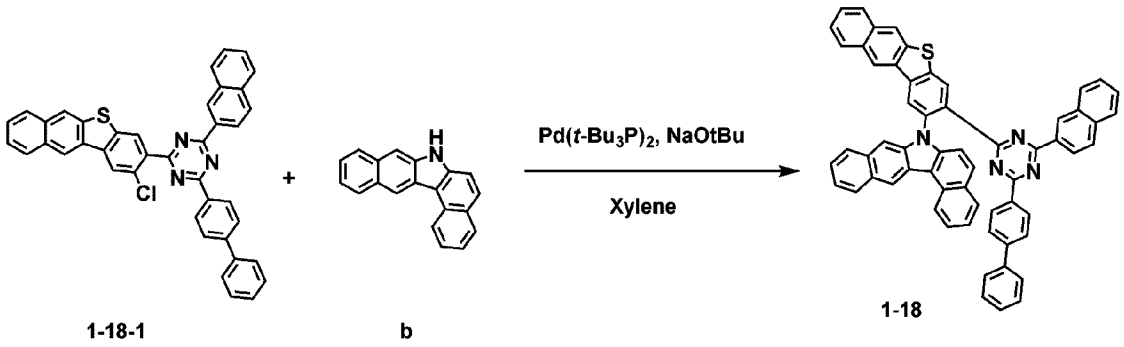
1-17-1 a 1-17

[673] 질소 분위기에서 중간체 1-17-1(10 g, 20mmol), 화합물 a(4.8g, 22 mmol), sodium tert-butoxide(3.8 g, 40 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-17을 7.9 g 제조하였다. (수율: 58%, MS: [M+H]+= 681)

[674]

[675] **합성예 1-18: 화합물 1-18의 제조**

[676]



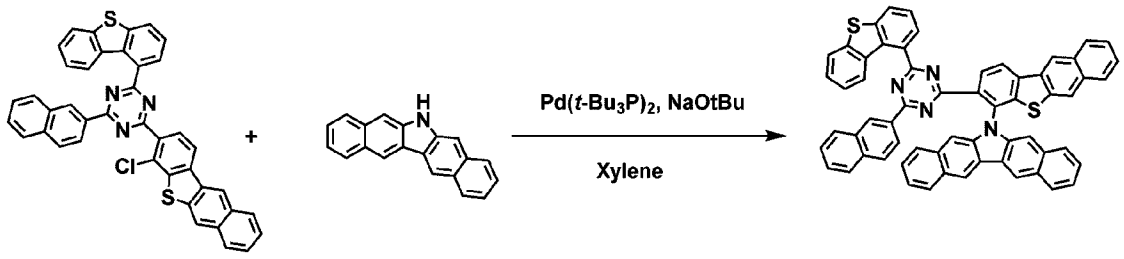
1-18-1 b 1-18

[677] 질소 분위기에서 중간체 1-18-1(10 g, 16mmol), 화합물 b(4.7g, 17.6 mmol), sodium tert-butoxide(3.1 g, 31.9 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-18을 7.2 g 제조하였다. (수율: 53%, MS: [M+H]+= 857)

[678]

[679] **합성예 1-19: 화합물 1-19의 제조**

[680]



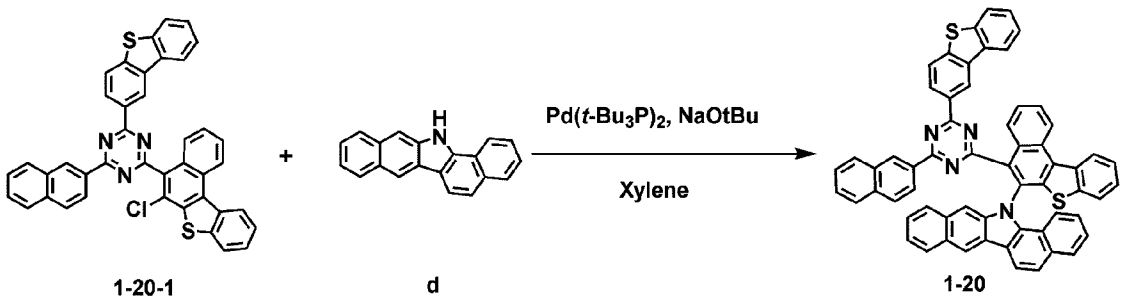
1-19-1 c 1-19

[681] 질소 분위기에서 중간체 1-19-1(10 g, 15.2mmol), 화합물 c(4.5g, 16.8 mmol), sodium tert-butoxide(2.9 g, 30.5 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-19를 8.5 g 제조하였다. (수율: 63%, MS: [M+H]+= 887)

[682]

[683] **합성예 1-20: 화합물 1-20의 제조**

[684]



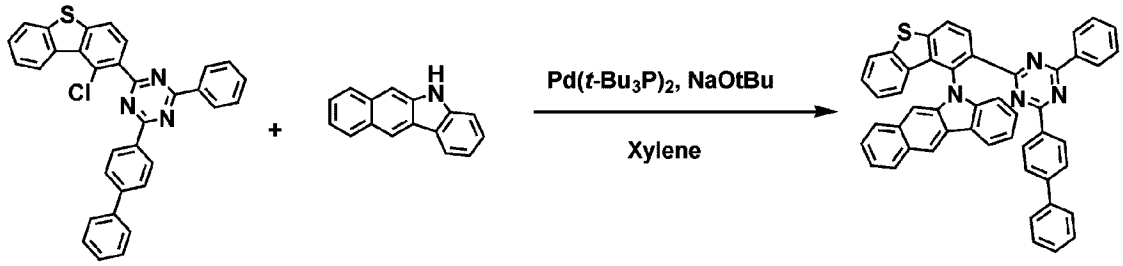
1-20-1 d 1-20

[685] 질소 분위기에서 중간체 1-20-1(10 g, 15.2mmol), 화합물 d(4.5g, 16.8 mmol), sodium tert-butoxide(2.9 g, 30.5 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-20을 7.4 g 제조하였다. (수율: 55%, MS: [M+H]+= 887)

[686]

[687] **합성예 1-21: 화합물 1-21의 제조**

[688]



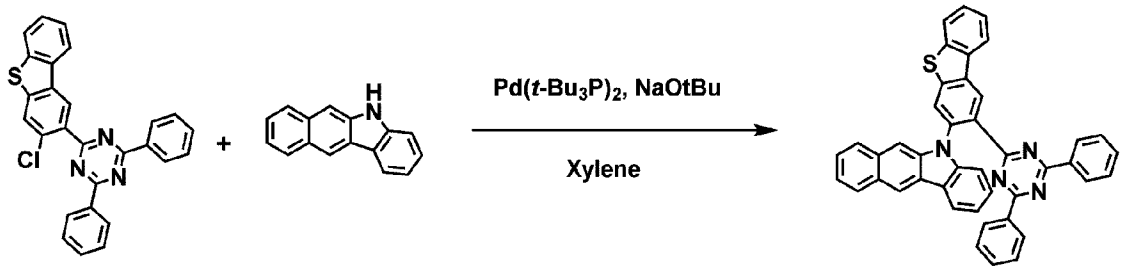
1-21-1 a 1-21

[689] 질소 분위기에서 중간체 1-21-1(10 g, 19mmol), 화합물 a(4.5g, 20.9 mmol), sodium tert-butoxide(3.7 g, 38 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-21을 9.4 g 제조하였다. (수율: 70%, MS: [M+H]+= 707)

[690]

[691] **합성예 1-22: 화합물 1-22의 제조**

[692]



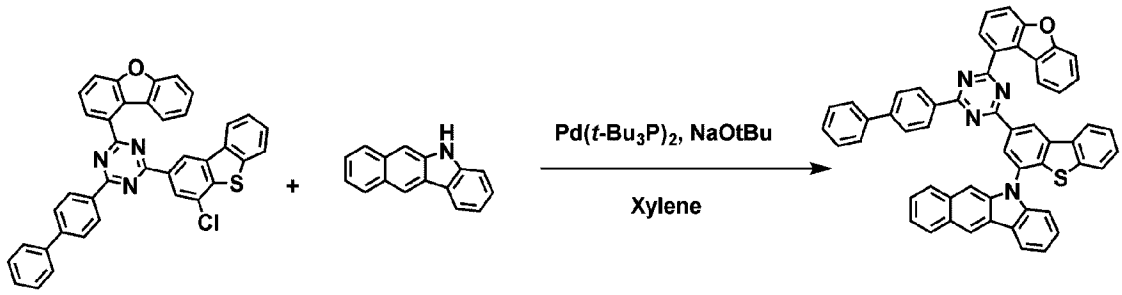
1-22-1 a 1-22

[693] 질소 분위기에서 중간체 1-22-1(10 g, 22.2mmol), 화합물 a(5.3g, 24.4 mmol), sodium tert-butoxide(4.3 g, 44.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-22를 7.1 g 제조하였다. (수율: 51%, MS: [M+H]+= 631)

[694]

[695] **합성예 1-23: 화합물 1-23의 제조**

[696]



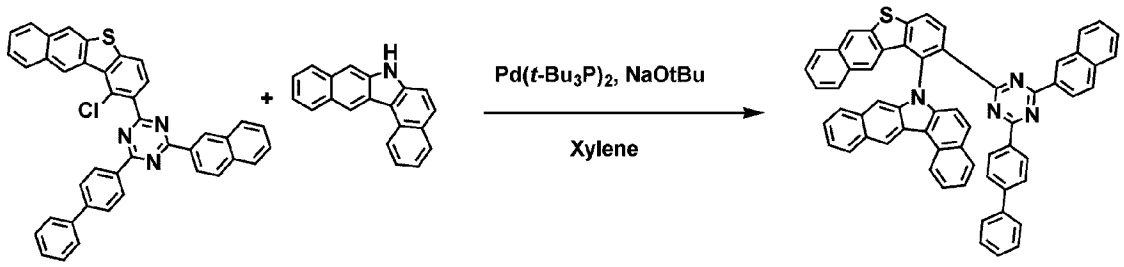
1-23-1 a 1-23

[697] 질소 분위기에서 중간체 1-23-1(10 g, 16.2mmol), 화합물 a(3.9g, 17.9 mmol), sodium tert-butoxide(3.1 g, 32.5 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-23을 6.8 g 제조하였다. (수율: 53%, MS: [M+H]+= 797)

[698]

[699] **합성예 1-24: 화합물 1-24의 제조**

[700]



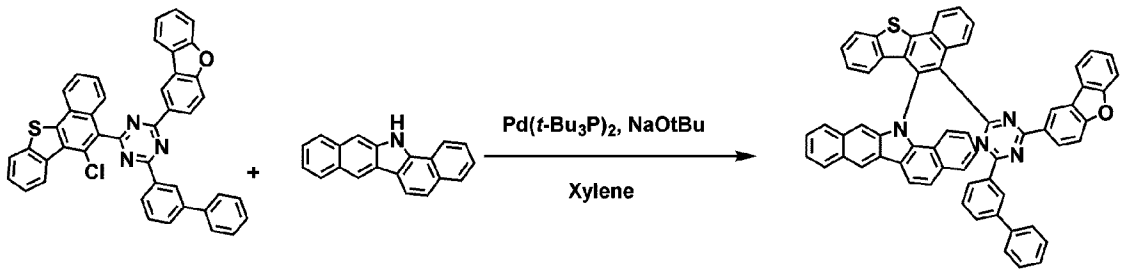
1-24-1 b 1-24

[701] 질소 분위기에서 중간체 1-24-1(10 g, 16mmol), 화합물 b(4.7g, 17.6 mmol), sodium tert-butoxide(3.1 g, 31.9 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-24를 8.3 g 제조하였다. (수율: 61%, MS: [M+H]+= 857)

[702]

[703] **합성예 1-25: 화합물 1-25의 제조**

[704]



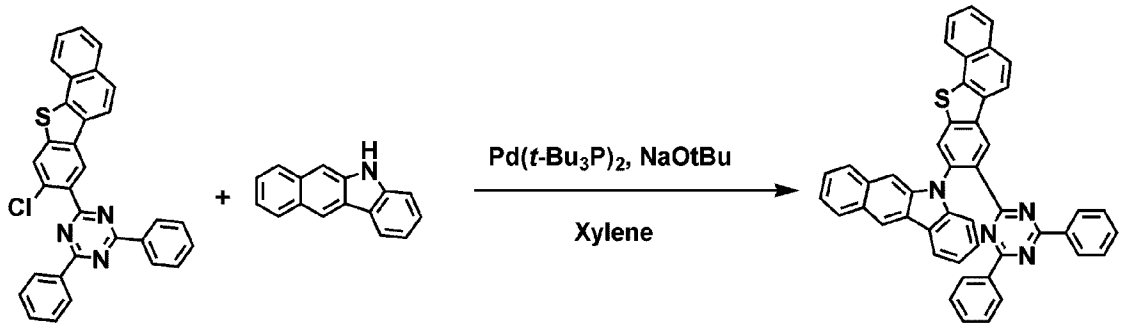
1-25-1 d 1-25

[705] 질소 분위기에서 중간체 1-25-1(10 g, 15mmol), 화합물 d(4.4g, 16.5 mmol), sodium tert-butoxide(2.9 g, 30 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-25을 8.7 g 제조하였다. (수율: 65%, MS: [M+H]+= 897)

[706]

[707] **합성예 1-26: 화합물 1-26의 제조**

[708]



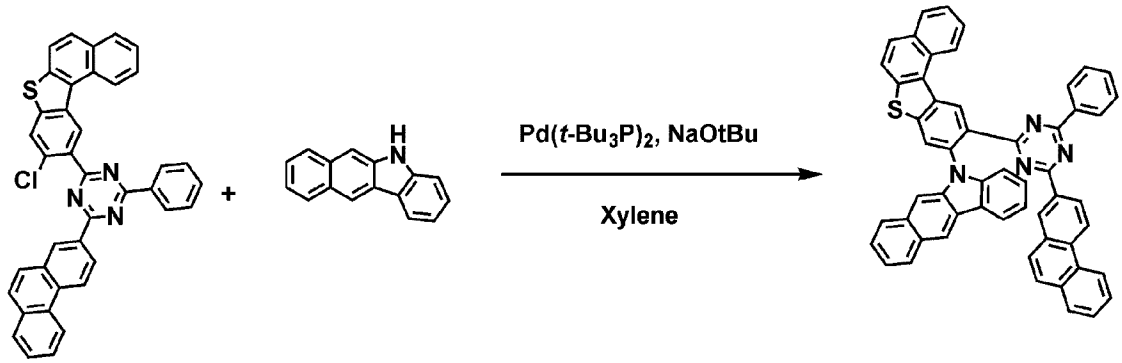
1-26-1 a 1-26

[709] 질소 분위기에서 중간체 1-26-1(10 g, 20mmol), 화합물 a(4.8g, 22 mmol), sodium tert-butoxide(3.8 g, 40 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-26을 6.9 g 제조하였다. (수율: 51%, MS: [M+H]+= 681)

[710]

[711] **합성예 1-27: 화합물 1-27의 제조**

[712]



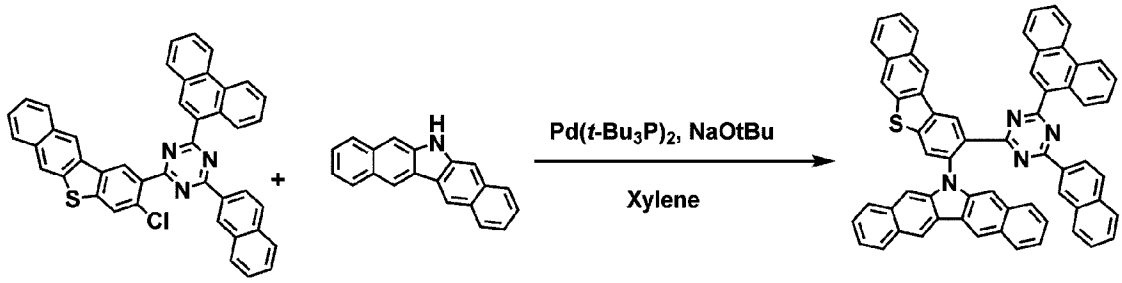
1-27-1 a 1-27

[713] 질소 분위기에서 중간체 1-27-1(10 g, 16.7mmol), 화합물 a(4g, 18.3 mmol), sodium tert-butoxide(3.2 g, 33.3 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-27을 6.6 g 제조하였다. (수율: 51%, MS: [M+H]+= 781)

[714]

[715] **합성예 1-28: 화합물 1-28의 제조**

[716]



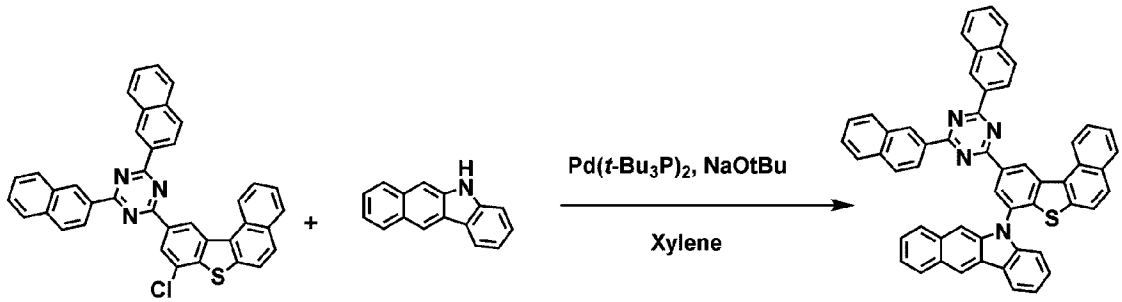
1-28-1 c 1-28

[717] 질소 분위기에서 중간체 1-28-1(10 g, 15.4mmol), 화합물 c(4.5g, 16.9 mmol), sodium tert-butoxide(3 g, 30.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-28을 7 g 제조하였다. (수율: 52%, MS: [M+H]+= 881)

[718]

[719] **합성예 1-29: 화합물 1-29의 제조**

[720]



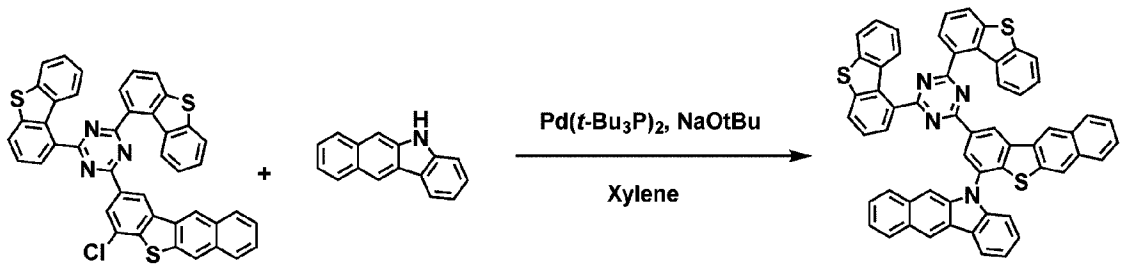
1-29-1 a 1-29

[721] 질소 분위기에서 중간체 1-29-1(10 g, 16.7mmol), 화합물 a(4g, 18.3 mmol), sodium tert-butoxide(3.2 g, 33.3 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-29를 6.9 g 제조하였다. (수율: 53%, MS: [M+H]+= 781)

[722]

[723] **합성예 1-30: 화합물 1-30의 제조**

[724]



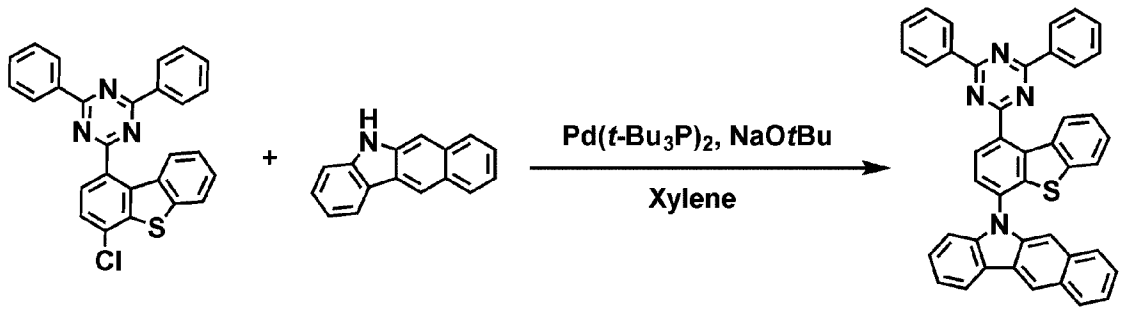
1-30-1 a 1-30

[725] 질소 분위기에서 중간체 1-30-1(10 g, 14mmol), 화합물 a(3.4g, 15.4 mmol), sodium tert-butoxide(2.7 g, 28.1 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.1 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-30을 7.1 g 제조하였다. (수율: 57%, MS: [M+H]+= 893)

[726]

[727] **합성예 1-31: 화합물 1-31의 제조**

[728]



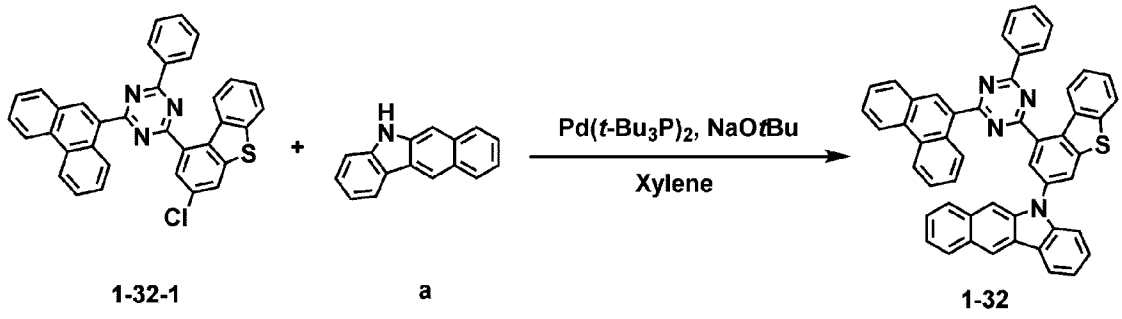
1-31-1 a 1-31

[729] 질소 분위기에서 중간체 1-31-1(10 g, 22.2mmol), 화합물 a(5.3g, 24.4 mmol), sodium tert-butoxide(4.3 g, 44.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-31을 7.8 g 제조하였다. (수율: 56%, MS: [M+H]+= 631)

[730]

[731] **합성예 1-32: 화합물 1-32의 제조**

[732]



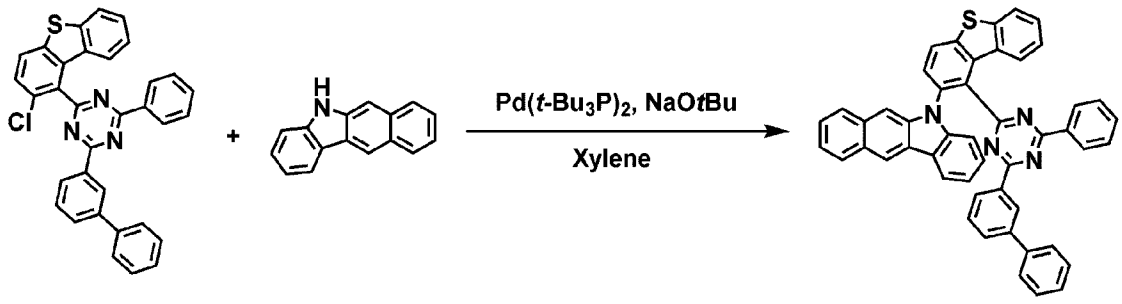
1-32-1 a 1-32

[733] 질소 분위기에서 중간체 1-32-1(10 g, 16.6mmol), 화합물 a(4g, 18.3 mmol), sodium tert-butoxide(3.2 g, 33.3 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-32를 8.1 g 제조하였다. (수율: 62%, MS: [M+H]+= 783)

[734]

[735] **합성예 1-33: 화합물 1-33의 제조**

[736]



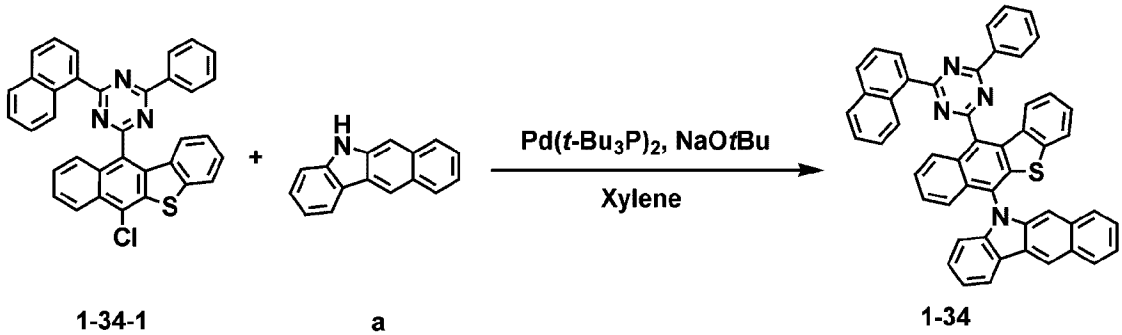
1-33-1 a 1-33

[737] 질소 분위기에서 중간체 1-33-1(10 g, 19mmol), 화합물 a(4.6g, 20.9 mmol), sodium tert-butoxide(3.7 g, 38.1 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-33을 7 g 제조하였다. (수율: 52%, MS: [M+H]+= 707)

[738]

[739] **합성예 1-34: 화합물 1-34의 제조**

[740]



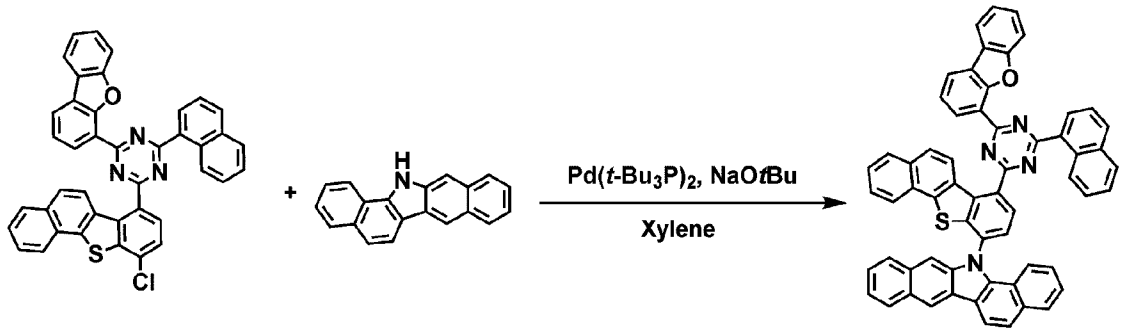
1-34-1 a 1-34

[741] 질소 분위기에서 중간체 1-34-1(10 g, 18.2mmol), 화합물 a(4.4g, 20 mmol), sodium tert-butoxide(3.5 g, 36.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-34를 8.2 g 제조하였다. (수율: 62%, MS: [M+H]+= 731)

[742]

[743] **합성예 1-35: 화합물 1-35의 제조**

[744]



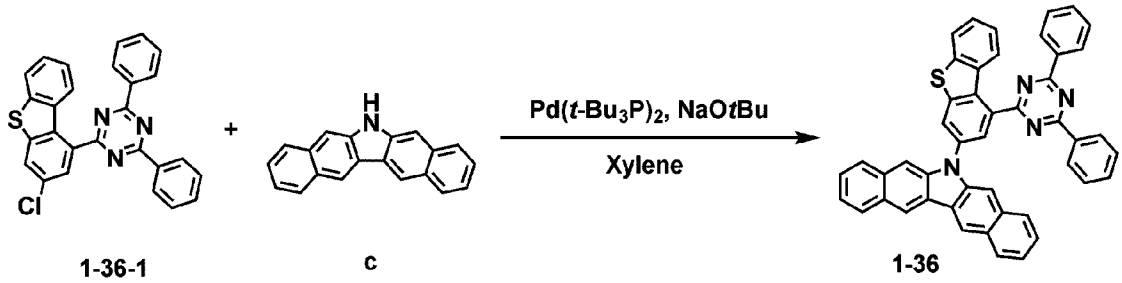
1-35-1 d 1-35

[745] 질소 분위기에서 중간체 1-35-1(10 g, 15.6mmol), 화합물 d(4.6g, 17.2 mmol), sodium tert-butoxide(3 g, 31.3 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-35을 9.4 g 제조하였다. (수율: 69%, MS: [M+H]+= 871)

[746]

[747] **합성예 1-36: 화합물 1-36의 제조**

[748]



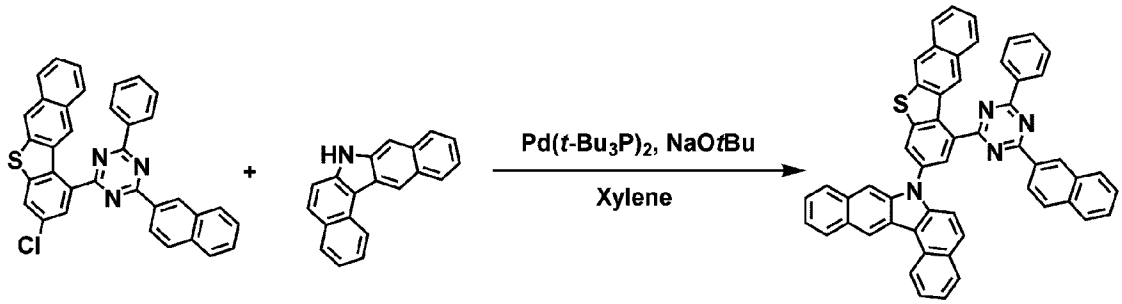
1-36-1 c 1-36

[749] 질소 분위기에서 중간체 1-36-1(10 g, 22.3mmol), 화합물 c(6.5g, 24.5 mmol), sodium tert-butoxide(4.3 g, 44.5 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-36을 8 g 제조하였다. (수율: 53%, MS: [M+H]+= 681)

[750]

[751] **합성예 1-37: 화합물 1-37의 제조**

[752]



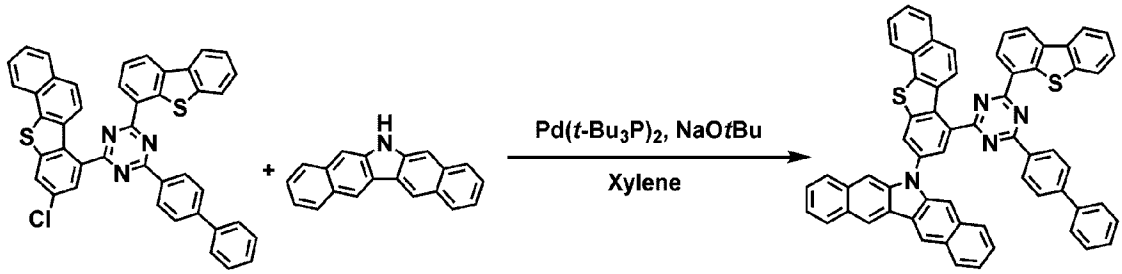
1-37-1 b 1-37

[753] 질소 분위기에서 중간체 1-37-1(10 g, 18.2mmol), 화합물 b(5.4g, 20 mmol), sodium tert-butoxide(3.5 g, 36.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-37을 37 9 g 제조하였다. (수율: 63%, MS: [M+H]+= 781)

[754]

[755] **합성예 1-38: 화합물 1-38의 제조**

[756]



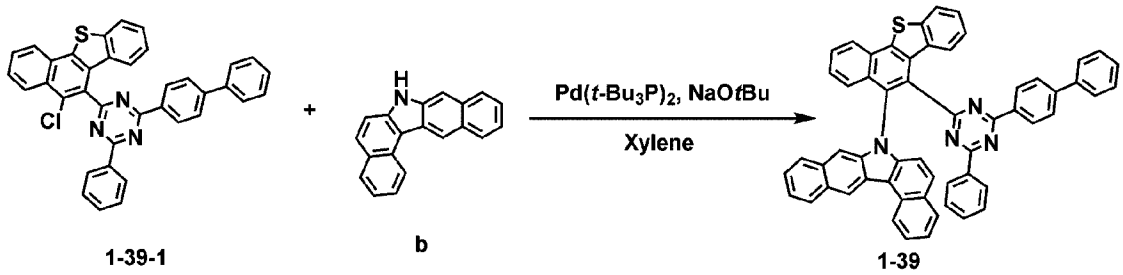
1-38-1 c 1-38

[757] 질소 분위기에서 중간체 1-38-1(10 g, 14.7mmol), 화합물 c(4.3g, 16.2 mmol), sodium tert-butoxide(2.8 g, 29.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-38을 8.6 g 제조하였다. (수율: 64%, MS: [M+H]+= 913)

[758]

[759] **합성예 1-39: 화합물 1-39의 제조**

[760]



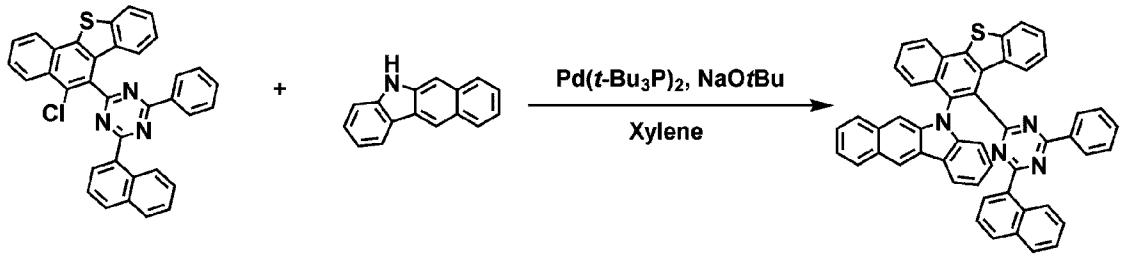
1-39-1 b 1-39

[761] 질소 분위기에서 중간체 1-39-1(10 g, 16mmol), 화합물 b(4.7g, 17.6 mmol), sodium tert-butoxide(3.1 g, 32 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-39를 9.3 g 제조하였다. (수율: 68%, MS: [M+H]+= 857)

[762]

[763] **합성예 1-40: 화합물 1-40의 제조**

[764]



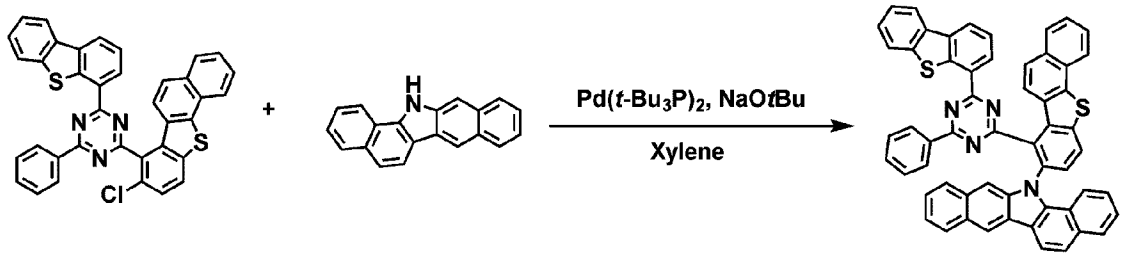
1-40-1 a 1-40

[765] 질소 분위기에서 중간체 1-40-1(10 g, 18.2mmol), 화합물 a(4.4g, 20 mmol), sodium tert-butoxide(3.5 g, 36.4 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.4 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-40을 8 g 제조하였다. (수율: 60%, MS: [M+H]+= 731)

[766]

[767] **합성예 1-41: 화합물 1-41의 제조**

[768]



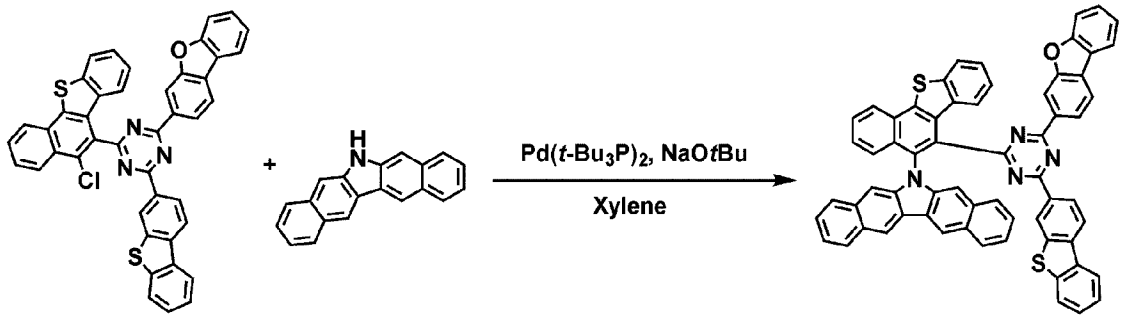
1-41-1 d 1-41

[769] 질소 분위기에서 중간체 1-41-1(10 g, 16.5mmol), 화합물 d(4.9g, 18.2 mmol), sodium tert-butoxide(3.2 g, 33.1 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.2 g, 0.3 mmol)을 투입하였다. 2시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-41을 8.2 g 제조하였다. (수율: 59%, MS: [M+H]+= 837)

[770]

[771] **합성예 1-42: 화합물 1-42의 제조**

[772]



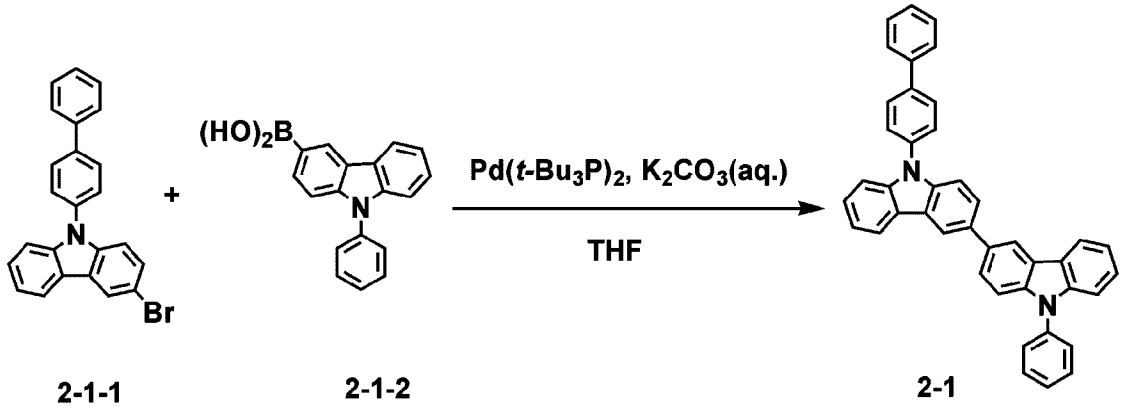
1-42-1 a 1-42

[773] 질소 분위기에서 중간체 1-42-1(10 g, 14.4mmol), 화합물 c(4.2g, 15.8 mmol), sodium tert-butoxide(2.8 g, 28.8 mmol)을 Xylene 200 ml에 넣고 교반 및 환류하였다. 이 후 bis(tri-tert-butylphosphine)palladium(0) (0.1 g, 0.3 mmol)을 투입하였다. 3시간 후 반응이 종결되면 상온으로 식히고 감압하여 용매를 제거하였다. 이 후 화합물을 다시 클로로포름에 완전히 녹이고 물로 2회 세척 후에 유기층을 분리하여 무수황산마그네슘 처리 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제해서 화합물 1-42를 7.1 g 제조하였다. (수율: 53%, MS: [M+H]+= 927)

[774]

[775] **합성예 2-1: 화합물 2-1의 제조**

[776]



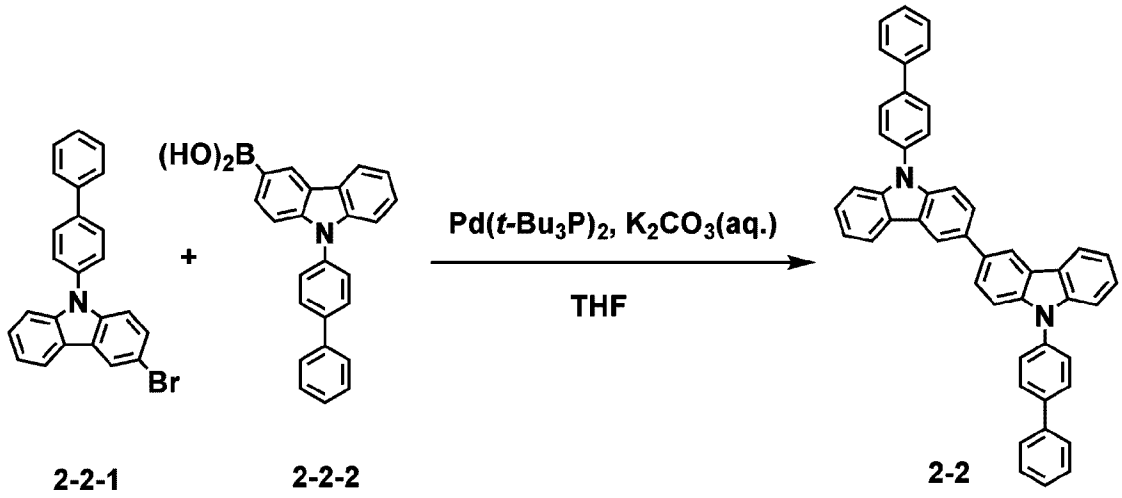
2-1-1 2-1-2 2-1

[777] 질소 분위기에서 중간체 2-1-1(10g, 25.2mmol)와 중간체 2-1-2(8g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-1를 9g 제조하였다. (수율: 64%, MS: [M+H]+= 561)

[778]

[779] **합성예 2-2: 화합물 2-2의 제조**

[780]



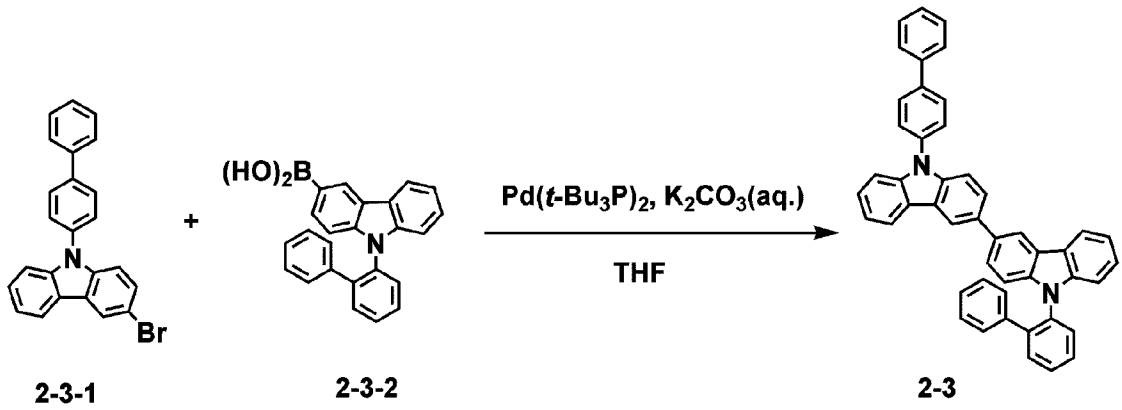
[781]

[782] 질소 분위기에서 중간체 2-2-1(10g, 25.2mmol)와 중간체 2-2-2(8g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-2를 10.6g 제조하였다. (수율: 66%, MS: [M+H]+= 637)

[783]

[784] **합성예 2-3: 화합물 2-3의 제조**

[785]



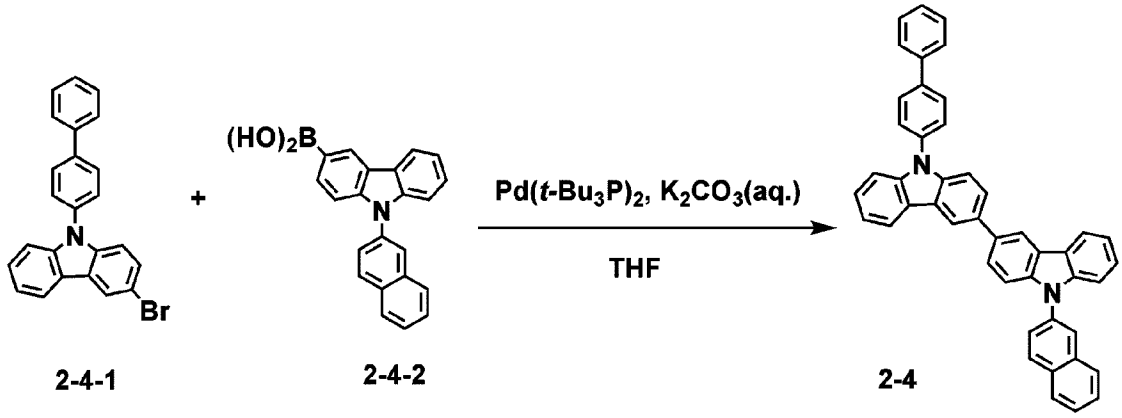
[786] 질소 분위기에서 중간체 2-3-1(10g, 25.2mmol)와 중간체 2-3-2(10.1g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한

화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-3을 9g 제조하였다. (수율: 56%, MS: [M+H]+= 637)

[787]

[788] **합성예 2-4: 화합물 2-4의 제조**

[789]

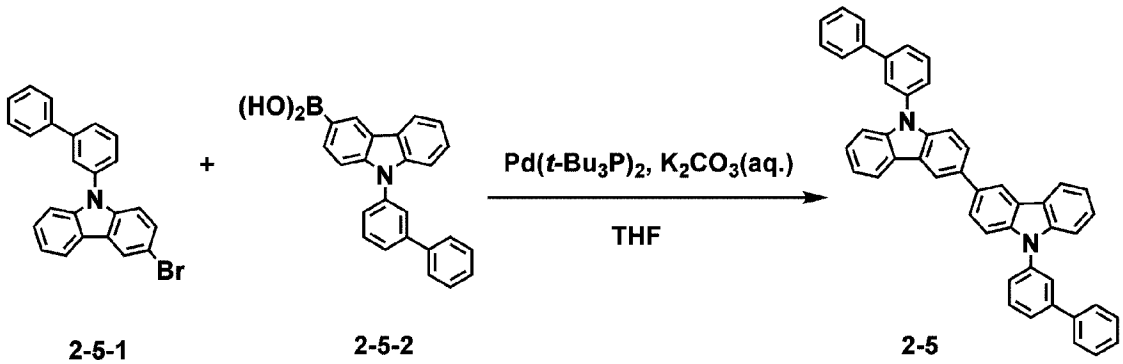


[790] 질소 분위기에서 중간체 2-4-1(10g, 25.2mmol)와 중간체 2-4-2(9.3g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-4를 7.8g 제조하였다. (수율: 51%, MS: [M+H]+= 611)

[791]

[792] **합성예 2-5: 화합물 2-5의 제조**

[793]



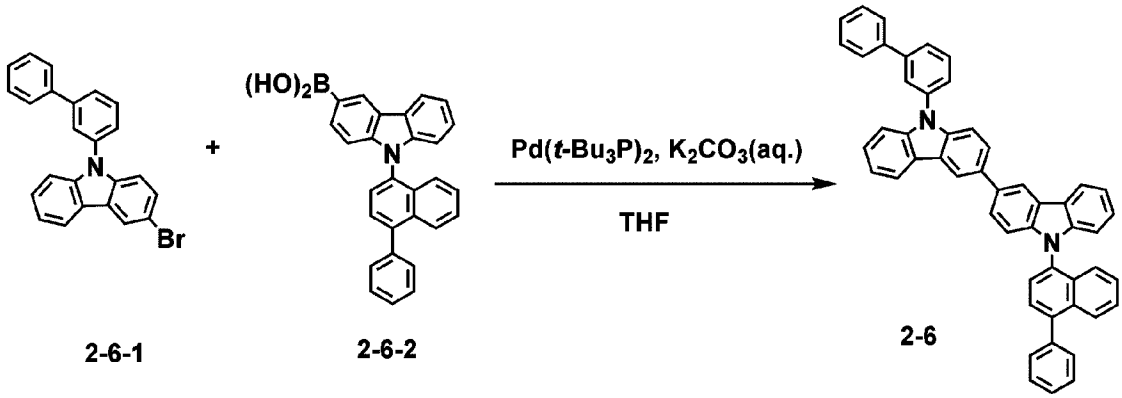
[794] 질소 분위기에서 중간체 2-5-1(10g, 25.2mmol)와 중간체 2-5-2(10.1g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여,

무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-5를 10.4g 제조하였다. (수율: 65%, MS: [M+H]+= 637)

[795]

[796] **합성예 2-6: 화합물 2-6의 제조**

[797]



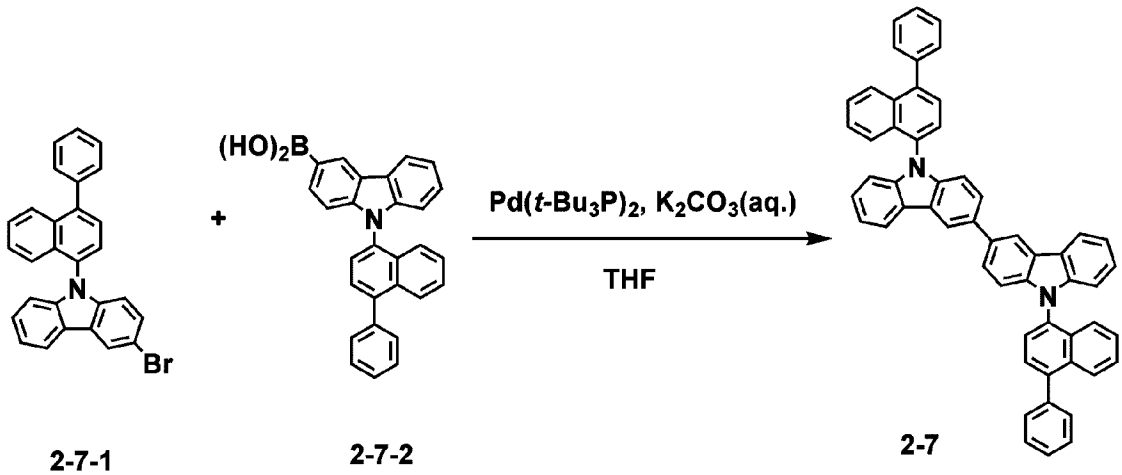
2-6-1 2-6-2 2-6

[798] 질소 분위기에서 중간체 2-6-1(10g, 25.2mmol)와 중간체 2-6-2(11.4g, 27.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.9g, 100.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-6을 10.5g 제조하였다. (수율: 61%, MS: [M+H]+= 687)

[799]

[800] **합성예 2-7: 화합물 2-7의 제조**

[801]



2-7-1 2-7-2 2-7

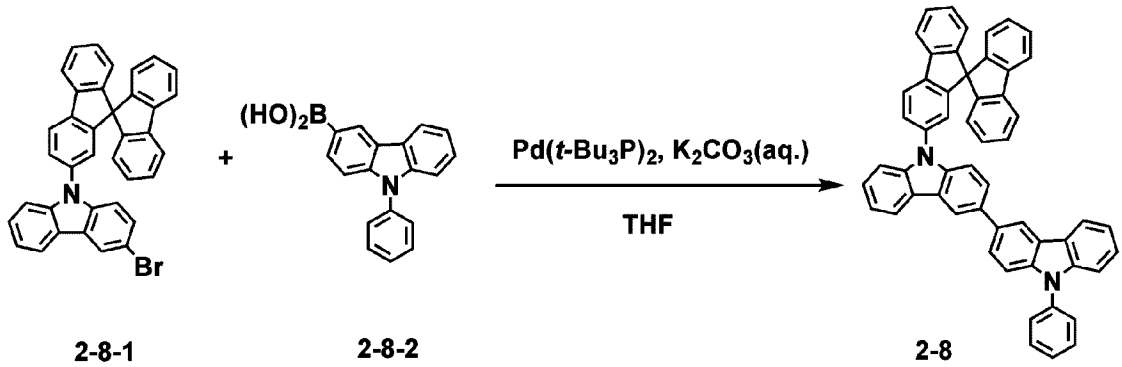
[802] 질소 분위기에서 중간체 2-7-1(10g, 22.4mmol)와 중간체 2-7-2(10.2g, 24.6mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(12.4g, 89.5mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음

bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-7을 11g 제조하였다. (수율: 67%, MS: [M+H]+= 737)

[803]

[804] **합성예 2-8: 화합물 2-8의 제조**

[805]



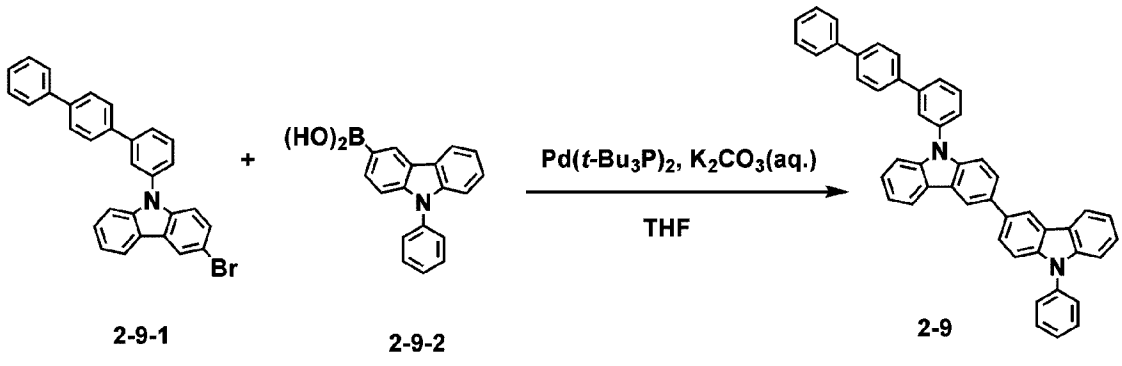
2-8-1 2-8-2 2-8

[806] 질소 분위기에서 중간체 2-8-1(10g, 17.9mmol)와 중간체 2-8-2(5.6g, 19.7mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(9.9g, 71.5mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-8를 7.8g 제조하였다. (수율: 60%, MS: [M+H]+= 723)

[807]

[808] **합성예 2-9: 화합물 2-9의 제조**

[809]



2-9-1 2-9-2 2-9

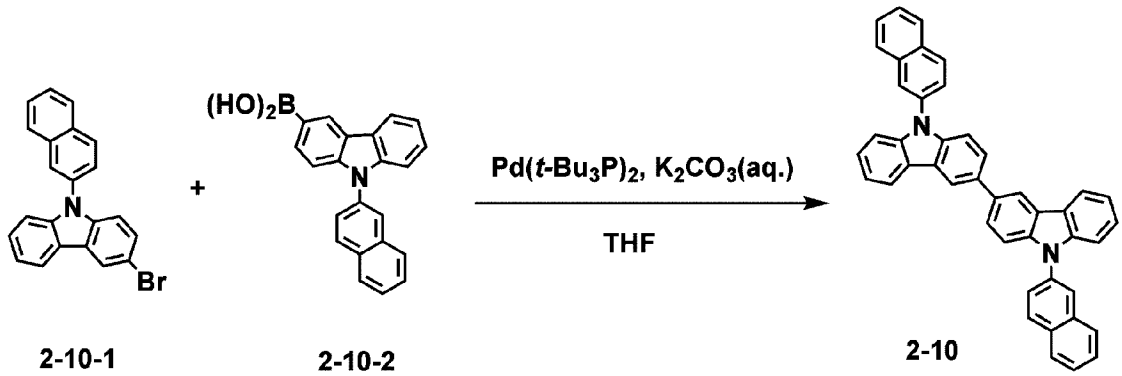
[810] 질소 분위기에서 중간체 2-9-1(10g, 21.1mmol)와 중간체 2-9-2(6.7g, 23.3mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(11.7g, 84.6mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음

bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-9를 7.4g 제조하였다. (수율: 55%, MS: [M+H]+= 637)

[811]

[812] **합성예 2-10: 화합물 2-10의 제조**

[813]



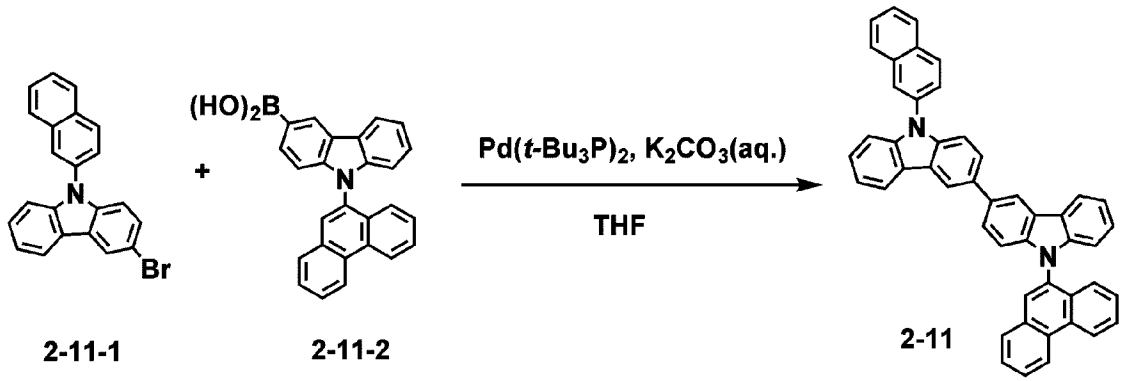
2-10-1 2-10-2 2-10

[814] 질소 분위기에서 중간체 2-10-1(10g, 27mmol)와 중간체 2-10-2(10g, 29.6mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(14.9g, 107.8mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-10을 11g 제조하였다. (수율: 70%, MS: [M+H]+= 585)

[815]

[816] **합성예 2-11: 화합물 2-11의 제조**

[817]



2-11-1 2-11-2 2-11

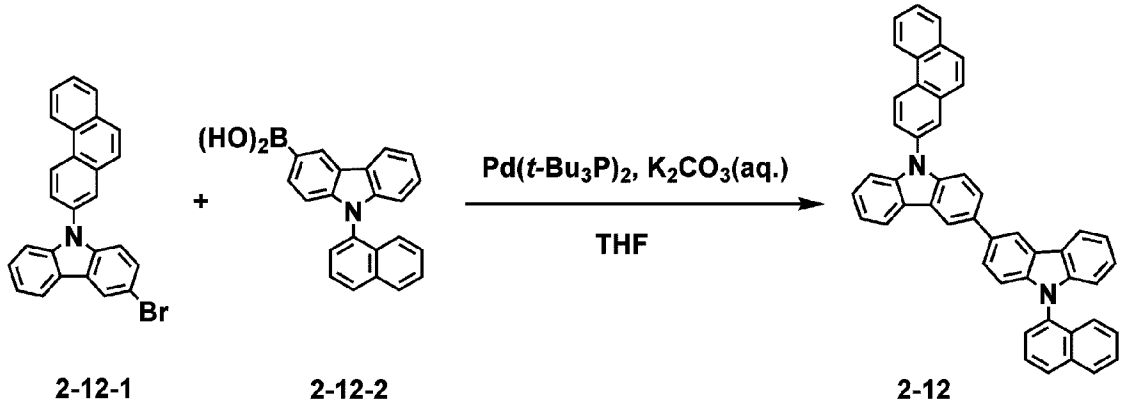
[818] 질소 분위기에서 중간체 2-11-1(10g, 27mmol)와 중간체 2-11-2(11.5g, 29.6mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(14.9g,

107.8mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.3mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-11을 11.5g 제조하였다. (수율: 67%, MS: [M+H]+= 635)

[819]

[820] **합성예 2-12: 화합물 2-12의 제조**

[821]



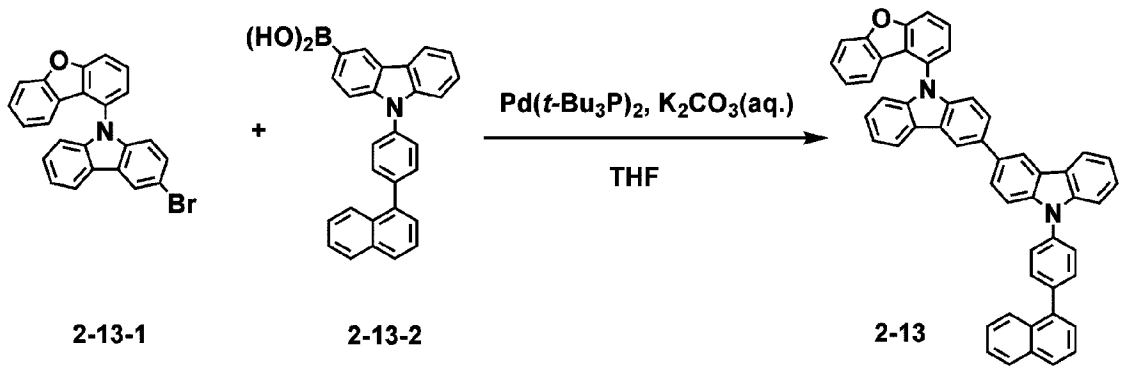
2-12-1 **2-12-2** **2-12**

[822] 질소 분위기에서 중간체 2-12-1(10g, 23.8mmol)와 중간체 2-12-2(8.8g, 26.1mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.1g, 95mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-12를 10.4g 제조하였다. (수율: 69%, MS: [M+H]+= 635)

[823]

[824] **합성예 2-13: 화합물 2-13의 제조**

[825]



2-13-1 **2-13-2** **2-13**

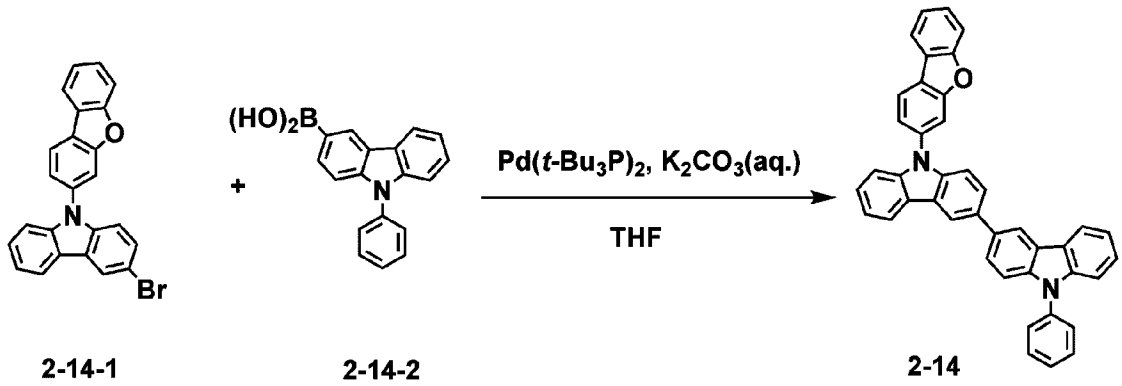
[826] 질소 분위기에서 중간체 2-13-1(10g, 24.3mmol)와 중간체 2-13-2(11.1g,

26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-13을 9g 제조하였다. (수율: 53%, MS: [M+H]+= 701)

[827]

[828] **합성예 2-14: 화합물 2-14의 제조**

[829]



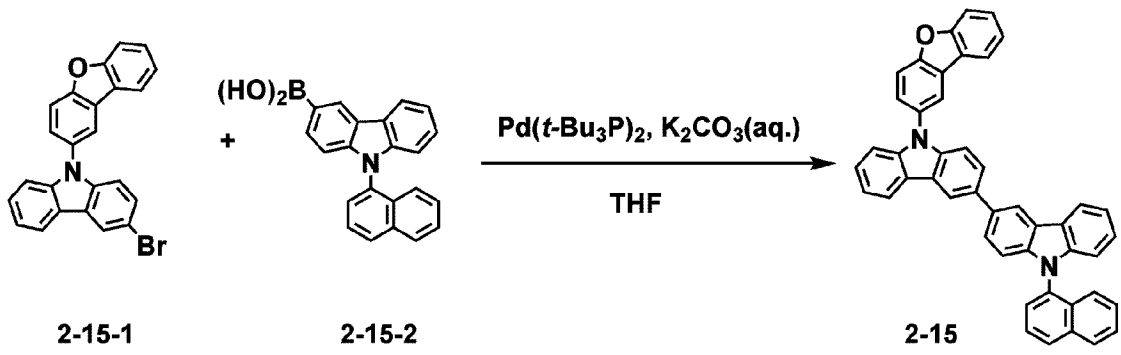
2-14-1 **2-14-2** **2-14**

[830] 질소 분위기에서 중간체 2-14-1(10g, 24.3mmol)와 중간체 2-14-2(7.7g, 26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-14를 8.9g 제조하였다. (수율: 64%, MS: [M+H]+= 575)

[831]

[832] **합성예 2-15: 화합물 2-15의 제조**

[833]



2-15-1 **2-15-2** **2-15**

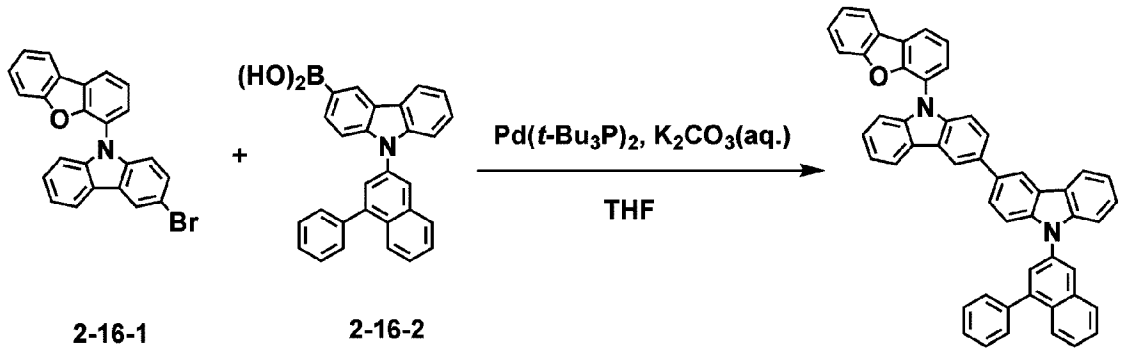
[834] 질소 분위기에서 중간체 2-15-1(10g, 24.3mmol)와 중간체 2-15-2(9g,

26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-15를 8.4g 제조하였다. (수율: 55%, MS: [M+H]+= 625)

[835]

[836] **합성예 2-16: 화합물 2-16의 제조**

[837]



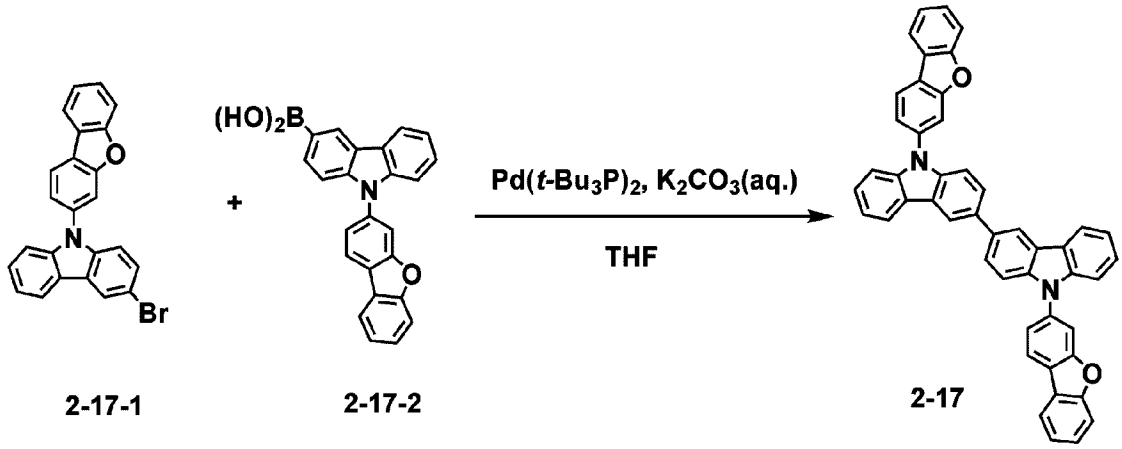
2-16-1 2-16-2 2-16

[838] 질소 분위기에서 중간체 2-16-1(10g, 24.3mmol)와 중간체 2-16-2(11.1g, 26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-16을 11.2g 제조하였다. (수율: 66%, MS: [M+H]+= 701)

[839]

[840] **합성예 2-17: 화합물 2-17의 제조**

[841]

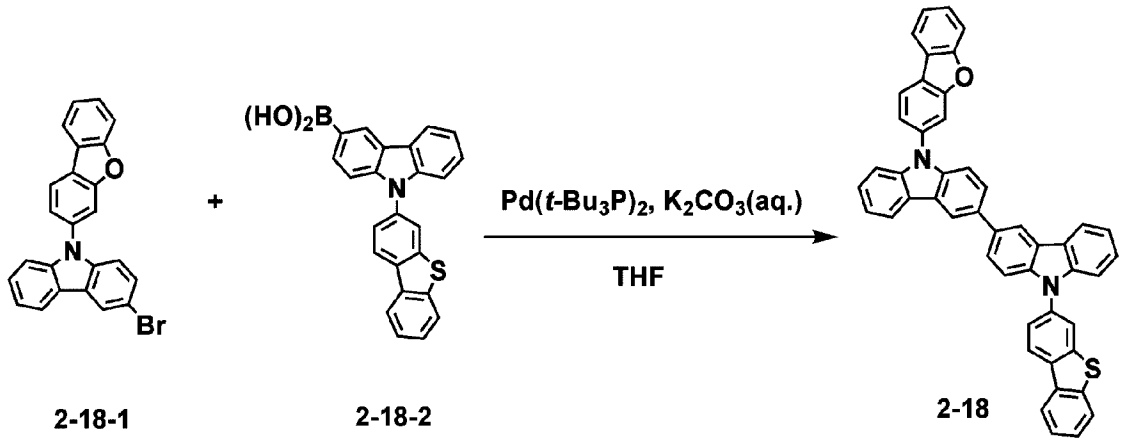


[842] 질소 분위기에서 중간체 2-17-1(10g, 24.3mmol)와 중간체 2-17-2(10.1g, 26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-17을 10g 제조하였다. (수율: 62%, MS: [M+H]+= 665)

[843]

[844] **합성예 2-18: 화합물 2-18의 제조**

[845]



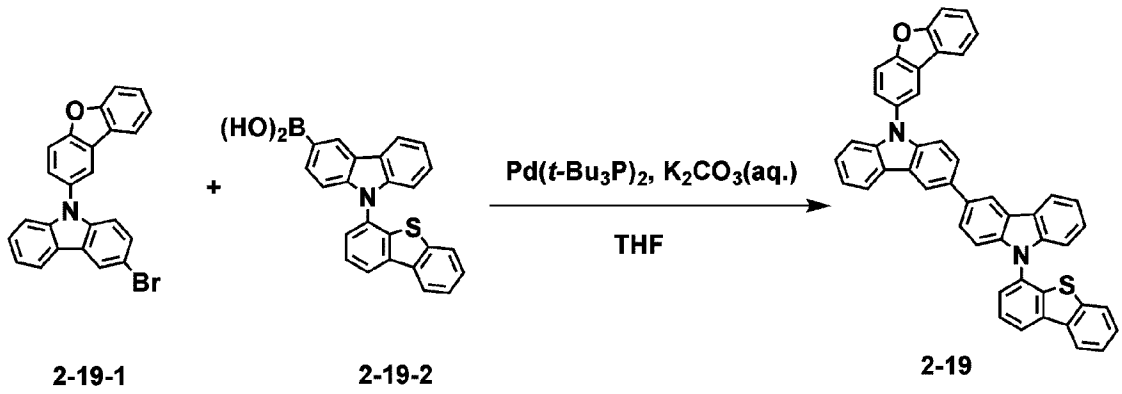
[846] 질소 분위기에서 중간체 2-18-1(10g, 24.3mmol)와 중간체 2-18-2(10.5g, 26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한

화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-18을 9.8g 제조하였다. (수율: 59%, MS: [M+H]+= 681)

[847]

[848] **합성예 2-19: 화합물 2-19의 제조**

[849]



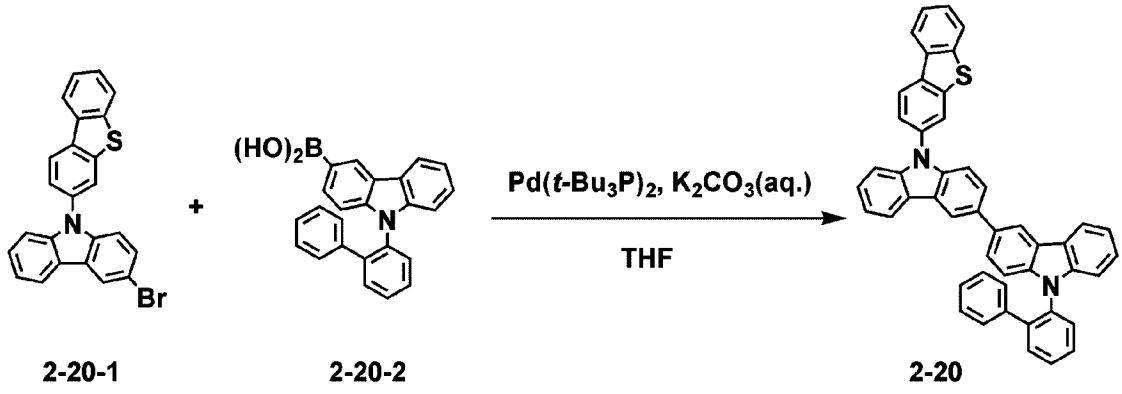
2-19-1 2-19-2 2-19

[850] 질소 분위기에서 중간체 2-19-1(10g, 24.3mmol)와 중간체 2-19-2(10.5g, 26.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(13.5g, 97.3mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-19를 11.4g 제조하였다. (수율: 69%, MS: [M+H]+= 681)

[851]

[852] **합성예 2-20: 화합물 2-20의 제조**

[853]



2-20-1 2-20-2 2-20

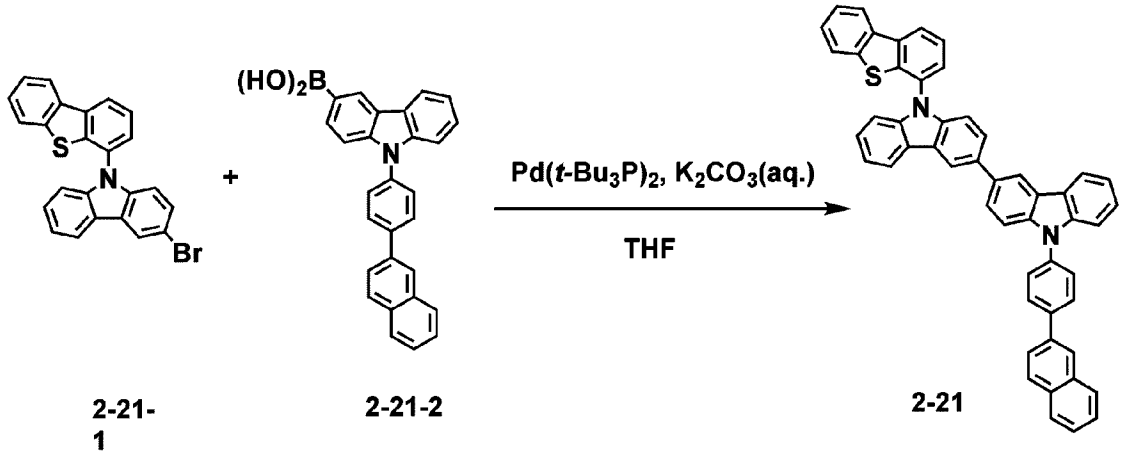
[854] 질소 분위기에서 중간체 2-20-1(10g, 23.4mmol)와 중간체 2-20-2(9.4g, 25.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(12.9g, 93.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 2시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여,

무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-20을 9g 제조하였다. (수율: 58%, MS: [M+H]+= 667)

[855]

[856] **합성예 2-21: 화합물 2-21의 제조**

[857]



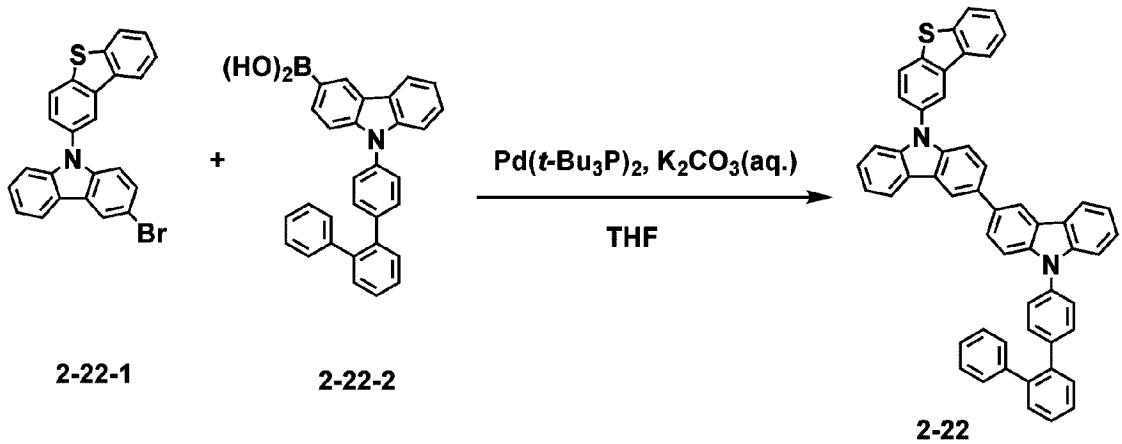
2-21-1 2-21-2 2-21

[858] 질소 분위기에서 중간체 2-21-1(10g, 23.4mmol)와 중간체 2-21-2(10.6g, 25.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(12.9g, 93.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-21을 10.7g 제조하였다. (수율: 64%, MS: [M+H]+= 717)

[859]

[860] **합성예 2-22: 화합물 2-22의 제조**

[861]



2-22-1 2-22-2 2-22

[862] 질소 분위기에서 중간체 2-22-1(10g, 23.4mmol)와 중간체 2-22-2(11.3g, 25.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(12.9g,

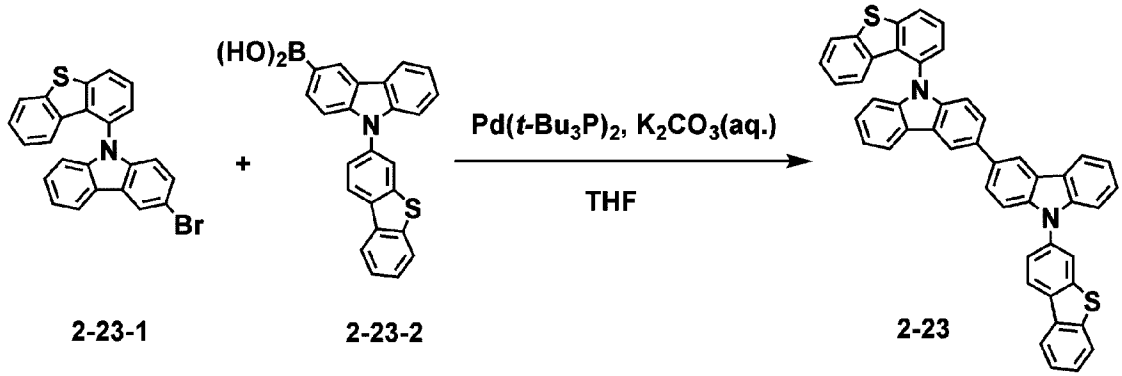
93.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 3시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-22를 9g 제조하였다. (수율: 52%, MS: [M+H]+= 743)

[863]

[864]

[865] **합성예 2-23: 화합물 2-23의 제조**

[866]



[867] 질소 분위기에서 중간체 2-23-1(10g, 23.4mmol)와 중간체 2-23-2(10.1g, 25.8mmol)를 THF 200 ml에 넣고 교반하고 potassium carbonate(12.9g, 93.7mmol)를 물에 녹여 투입하고 충분히 교반한 후 환류한 다음 bis(tri-tert-butylphosphine)palladium(0) (0.1g, 0.2mmol)을 투입하였다. 4시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-23을 9.1g 제조하였다. (수율: 56%, MS: [M+H]+= 697)

[868]

[869] **비교예 1: 유기 발광 소자의 제조**

[870] ITO(indium tin oxide)가 1,000Å의 두께로 박막 코팅된 유리 기판을 세제를 녹인 증류수에 넣고 초음파로 세척했다. 이때, 세제로는 피셔사(Fischer Co.) 제품을 사용하였으며, 증류수로는 밀러포어사(Millipore Co.) 제품의 필터(Filter)로 2차로 걸러진 증류수를 사용했다. ITO를 30분간 세척한 후 증류수로 2회 반복하여 초음파 세척을 10분간 진행했다. 증류수 세척이 끝난 후, 이소프로필알콜, 아세톤, 메탄올의 용제로 초음파 세척을 하고 건조시킨 후 플라즈마 세정기로 수송시켰다. 또한, 산소 플라즈마를 이용하여 상기 기판을 5분간 세정한 후 진공 증착기로 기판을 수송시켰다.

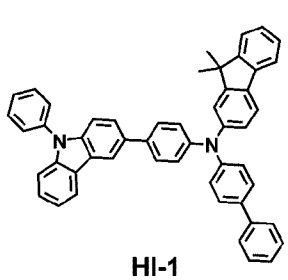
[871] 이렇게 준비된 ITO 투명 전극 위에 정공주입층으로 하기 HI-1 화합물을 1150Å의 두께로 형성하되 하기 A-1 화합물을 1.5% 농도로 p-doping 했다. 상기 정공주입층 위에 하기 HT-1 화합물을 진공 증착하여 막 두께 800Å 의 정공수송층을 형성하였다. 이어서, 상기 정공수송층 위에 막 두께 150Å으로 하기 EB-1 화합물을 진공 증착하여 전자억제층을 형성하였다.

[872] 이어서, 상기 EB-1 증착막 위에 상기 제조예 1-1에서 제조한 화합물 1-1 과 하기 Dp-7 화합물을 98:2의 중량비로 진공 증착하여 400Å 두께의 적색 발광층을 형성하였다.

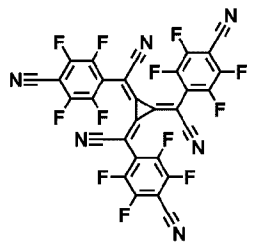
[873] 상기 발광층 위에 막 두께 30Å으로 하기 HB-1 화합물을 진공 증착하여 정공저지층을 형성하였다. 이어서, 상기 정공저지층 위에 하기 ET-1 화합물과 하기 LiQ 화합물을 2:1의 중량비로 진공 증착하여 300Å의 두께로 전자 주입 및 수송층을 형성하였다. 상기 전자 주입 및 수송층 위에 순차적으로 12Å 두께로 리튬플로라이드(LiF)와 1,000Å 두께로 알루미늄을 증착하여 음극을 형성하였다.

[874]

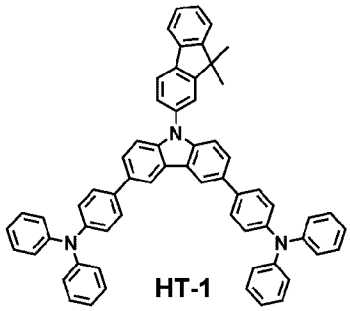
[875]



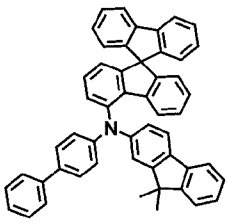
HI-1



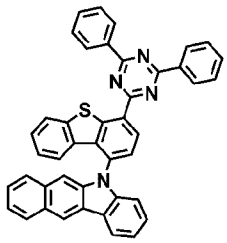
A-1



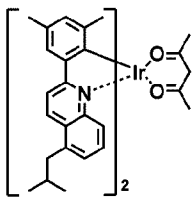
HT-1



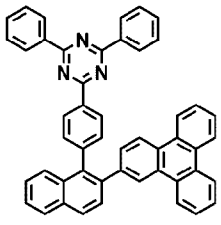
EB-1



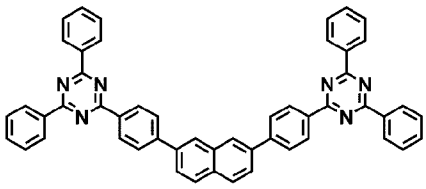
1-1



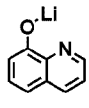
Dp-7



HB-1



ET-1



LiQ

[876] 상기의 과정에서 유기물의 증착속도는 0.4~0.7Å/sec를 유지하였고, 음극의 리튬플로라이드는 0.3Å/sec, 알루미늄은 2Å/sec의 증착 속도를 유지하였으며, 증착시 진공도는 $2 \times 10^{-7} \sim 5 \times 10^{-6}$ torr를 유지하여, 유기 발광 소자를 제작했다.

[877]

[878] **비교예 2 내지 비교예 15**

[879] 비교예 1의 유기 발광 소자에서 화합물 1-1 대신 하기 표 1에 기재된 화합물을 사용하는 것을 제외하고는, 상기 비교예 1과 동일한 방법으로 유기 발광 소자를 제조하였다.

[880]

[881] **실시예 1 내지 실시예 120**

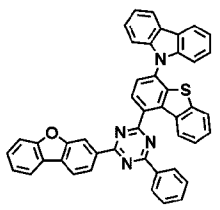
[882] 비교예 1의 유기 발광 소자에서 화합물 1-1 대신 표 2 내지 4에 기재된 제1 호스트로 화학식 1의 화합물과 제2호스트로 화학식 2의 화합물을 1:1의 중량비로 공증착하여 사용하는 것을 제외하고는, 상기 비교예 1과 동일한 방법으로 유기 발광 소자를 제조하였다.

[883]

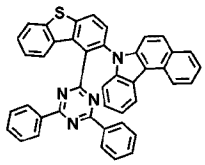
[884] **비교예 16 내지 비교예 63**

[885] 비교예 1의 유기 발광 소자에서 화합물 1-1 대신 하기 표 5 및 6에 기재된 제1 호스트로 비교 화합물 C-1 내지 C-12 화합물과 제2 호스트로 화학식2의 화합물을 1:1로 공증착하여 사용하는 것을 제외하고는, 상기 비교예 1과 동일한 방법으로 유기 발광 소자를 제조하였다.

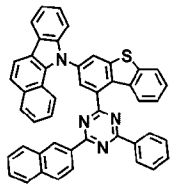
[886]



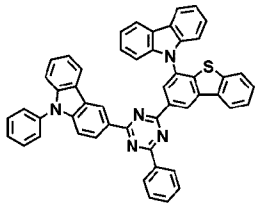
C-1



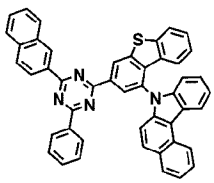
C-2



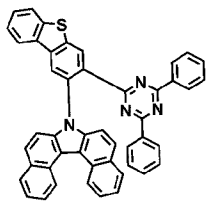
C-3



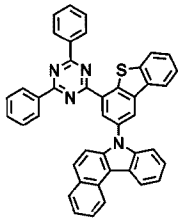
C-4



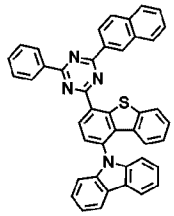
C-5



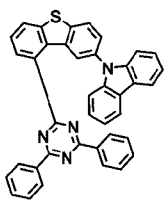
C-6



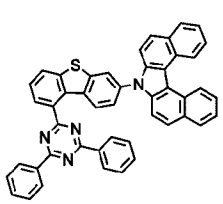
C-7



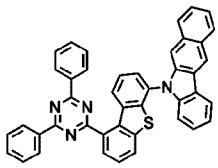
C-8



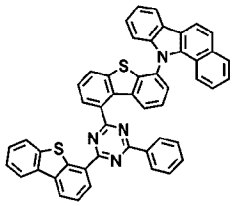
C-9



C-10



C-11



C-12

[887]

[888] **실험예 1: 소자 특성 평가**

[889] 상기 실시예 1 내지 실시예 120 및 비교예 1 내지 비교예 63에서 제작된 유기 발광 소자에 전류를 인가하였을 때, 전압, 효율, 수명을 측정(15mA/cm ^{2} 기준)하고 그 결과를 하기 표 1 내지 6에 나타냈다. 수명 T95는 휘도가 초기 휘도(10,000 nit)에서 95%로 감소되는데 소요되는 시간을 의미한다.

[890]

[891]

[892]

[893]

[894] [표1]

구분	호스트	구동전압(V)	효율(cd/A)	수명 T95(hr)	발광색
비교예 1	화합물 1-1	3.91	16.0	141	적색
비교예 2	화합물 1-2	3.84	16.1	143	적색
비교예 3	화합물 1-3	3.76	17.5	141	적색
비교예 4	화합물 1-12	3.97	16.3	144	적색
비교예 5	화합물 1-13	3.93	16.1	147	적색
비교예 6	화합물 1-14	3.94	16.1	140	적색
비교예 7	화합물 1-22	4.02	16.5	141	적색
비교예 8	화합물 1-23	3.98	15.3	145	적색
비교예 9	화합물 1-24	4.04	16.1	137	적색
비교예 10	화합물 1-32	3.82	16.3	134	적색
비교예 11	화합물 1-33	3.98	17.4	153	적색
비교예 12	화합물 1-34	3.91	17.2	151	적색
비교예 13	화합물 1-36	3.94	18.4	157	적색
비교예 14	화합물 1-37	3.92	17.7	157	적색
비교예 15	화합물 1-40	3.93	18.7	160	적색

[895]

[896]

[표2]

구분	제1호스트	제2호스트	구동전압(V)	효율(cd/A)	수명 T95(hr)	발광색
실시예 1	화합물 1-1	화합물 2-1	3.99	21.3	241	적색
실시예 2		화합물 2-2	3.97	20.4	234	적색
실시예 3		화합물 2-8	3.98	20.4	230	적색
실시예 4		화합물 2-19	3.99	21.7	227	적색
실시예 5	화합물 1-2	화합물 2-1	3.88	20.7	225	적색
실시예 6		화합물 2-2	3.91	20.6	206	적색
실시예 7		화합물 2-8	3.94	20.4	209	적색
실시예 8		화합물 2-19	3.92	20.3	212	적색
실시예 8	화합물 1-3	화합물 2-1	3.88	21.4	218	적색
실시예 10		화합물 2-2	3.85	19.4	220	적색
실시예 11		화합물 2-8	3.86	19.5	212	적색
실시예 12		화합물 2-19	3.90	20.1	215	적색
실시예 13	화합물 1-5	화합물 2-1	3.84	20.0	210	적색
실시예 14		화합물 2-2	3.82	21.1	219	적색
실시예 15		화합물 2-8	3.91	19.9	227	적색
실시예 16		화합물 2-19	3.90	20.8	203	적색
실시예 17	화합물 1-7	화합물 2-1	3.92	21.0	200	적색
실시예 18		화합물 2-2	3.90	20.1	218	적색
실시예 19		화합물 2-8	3.94	19.7	221	적색
실시예 20		화합물 2-19	3.99	20.6	220	적색
실시예 21	화합물 1-8	화합물 2-1	3.90	19.4	203	적색
실시예 22		화합물 2-2	3.91	19.3	200	적색
실시예 23		화합물 2-8	3.94	20.5	202	적색
실시예 24		화합물 2-19	3.95	20.7	199	적색
실시예 25	화합물 1-12	화합물 2-1	4.01	20.3	186	적색
실시예 26		화합물 2-2	4.05	20.2	203	적색
실시예 27		화합물 2-8	4.03	20.7	200	적색
실시예 28		화합물 2-19	4.05	20.4	209	적색

실시예 29	화합물 1-13	화합물 2-1	4.03	18.8	204	적색
실시예 30		화합물 2-2	4.07	19.1	210	적색
실시예 31		화합물 2-8	4.04	19.6	201	적색
실시예 32		화합물 2-19	4.03	20.1	212	적색
실시예 33	화합물 1-14	화합물 2-1	4.05	19.3	205	적색
실시예 34		화합물 2-2	4.10	19.5	198	적색
실시예 35		화합물 2-8	4.12	19.0	199	적색
실시예 36		화합물 2-19	4.09	19.7	203	적색
실시예 37	화합물 1-15	화합물 2-1	4.08	19.3	210	적색
실시예 38		화합물 2-2	4.06	19.0	216	적색
실시예 39		화합물 2-8	4.10	18.4	204	적색
실시예 40		화합물 2-19	4.12	19.0	201	적색

[897]

[898]

[표3]

구분	제1호스트	제2호스트	구동전압(V)	효율(cd/A)	수명 T95(hr)	발광색
실시예 41	화합물 1-16	화합물 2-1	4.11	18.1	197	적색
실시예 42		화합물 2-2	4.08	19.3	199	적색
실시예 43		화합물 2-8	4.10	19.6	203	적색
실시예 44		화합물 2-19	4.12	19.1	201	적색
실시예 45	화합물 1-22	화합물 2-9	4.13	18.6	205	적색
실시예 46		화합물 2-10	4.09	19.0	199	적색
실시예 47		화합물 2-12	4.12	19.2	198	적색
실시예 48		화합물 2-16	4.14	19.0	210	적색
실시예 49	화합물 1-23	화합물 2-9	4.07	17.8	197	적색
실시예 50		화합물 2-10	4.10	17.9	204	적색
실시예 51		화합물 2-12	4.05	18.0	207	적색
실시예 52		화합물 2-16	4.08	18.2	206	적색
실시예 53	화합물 1-24	화합물 2-9	4.13	18.3	208	적색
실시예 54		화합물 2-10	4.11	18.9	207	적색
실시예 55		화합물 2-12	4.15	19.1	203	적색
실시예 56		화합물 2-16	4.14	19.2	194	적색
실시예 57	화합물 1-25	화합물 2-9	4.15	18.1	191	적색
실시예 58		화합물 2-10	4.13	18.0	201	적색
실시예 59		화합물 2-12	4.14	18.7	203	적색
실시예 60		화합물 2-16	4.17	19.0	208	적색
실시예 61	화합물 1-26	화합물 2-9	4.18	18.7	205	적색
실시예 62		화합물 2-10	4.19	18.6	204	적색
실시예 63		화합물 2-12	4.14	18.9	203	적색
실시예 64		화합물 2-16	4.15	18.0	211	적색
실시예 65	화합물 1-27	화합물 2-9	4.11	18.7	216	적색
실시예 66		화합물 2-10	4.13	18.6	214	적색
실시예 67		화합물 2-12	4.15	18.9	210	적색
실시예 68		화합물 2-16	4.17	18.0	208	적색

실시예 69	화합물 1-29	화합물 2-9	4.18	18.0	207	적색
실시예 70		화합물 2-10	4.21	18.7	206	적색
실시예 71		화합물 2-12	4.19	18.4	201	적색
실시예 72		화합물 2-16	4.18	18.9	197	적색
실시예 73	화합물 1-30	화합물 2-9	4.20	18.5	191	적색
실시예 74		화합물 2-10	4.17	18.3	198	적색
실시예 75		화합물 2-12	4.15	19.1	204	적색
실시예 76		화합물 2-16	4.16	19.4	206	적색
실시예 77	화합물 1-31	화합물 2-9	4.19	19.3	190	적색
실시예 78		화합물 2-10	4.21	19.2	196	적색
실시예 79		화합물 2-12	4.15	19.3	194	적색
실시예 80		화합물 2-16	4.13	18.8	208	적색

[899]

[900]

[표4]

구분	제1호스트	제2호스트	구동전압(V)	효율(cd/A)	수명 T95(hr)	발광색
실시예 81	화합물 1-32	화합물 2-3	3.94	20.3	226	적색
실시예 82		화합물 2-4	3.97	21.3	211	적색
실시예 83		화합물 2-14	3.92	23.3	234	적색
실시예 84		화합물 2-21	3.96	22.7	227	적색
실시예 85	화합물 1-33	화합물 2-3	3.93	22.4	256	적색
실시예 86		화합물 2-4	3.95	23.6	267	적색
실시예 87		화합물 2-14	3.97	22.9	248	적색
실시예 88		화합물 2-21	3.96	22.5	272	적색
실시예 89	화합물 1-34	화합물 2-3	3.90	24.7	238	적색
실시예 90		화합물 2-4	3.91	24.6	222	적색
실시예 91		화합물 2-14	3.95	24.6	218	적색
실시예 92		화합물 2-21	3.97	24.3	231	적색
실시예 93	화합물 1-35	화합물 2-3	3.93	22.9	225	적색
실시예 94		화합물 2-4	3.97	22.4	219	적색
실시예 95		화합물 2-14	4.01	23.6	224	적색
실시예 96		화합물 2-21	3.98	22.7	216	적색
실시예 97	화합물 1-36	화합물 2-3	3.99	22.8	217	적색
실시예 98		화합물 2-4	3.97	23.0	205	적색
실시예 99		화합물 2-14	3.99	24.1	215	적색
실시예 100		화합물 2-21	3.95	22.8	224	적색
실시예 101	화합물 1-37	화합물 2-3	4.03	22.0	231	적색
실시예 102		화합물 2-4	3.99	21.7	244	적색
실시예 103		화합물 2-14	4.05	21.6	249	적색
실시예 104		화합물 2-21	4.02	22.0	271	적색
실시예 105	화합물 1-38	화합물 2-3	3.90	25.3	268	적색
실시예 106		화합물 2-4	3.95	25.4	248	적색
실시예 107		화합물 2-14	3.93	25.7	251	적색
실시예 108		화합물 2-21	3.97	25.0	255	적색

실시예 109	화합물 1-39	화합물 2-3	3.95	22.8	203	적색
실시예 110		화합물 2-4	3.98	21.9	201	적색
실시예 111		화합물 2-14	3.96	21.7	197	적색
실시예 112		화합물 2-21	3.99	21.3	205	적색
실시예 113	화합물 1-40	화합물 2-3	3.81	22.7	277	적색
실시예 114		화합물 2-4	3.85	22.9	285	적색
실시예 115		화합물 2-14	3.84	23.6	279	적색
실시예 116		화합물 2-21	3.80	23.8	288	적색
실시예 117	화합물 1-42	화합물 2-3	3.90	25.0	271	적색
실시예 118		화합물 2-4	3.87	24.9	265	적색
실시예 119		화합물 2-14	3.84	25.0	269	적색
실시예 120		화합물 2-21	3.89	24.5	258	적색

[901]

[902]

[표5]

구분	제1호스트	제2호스트	구동전압 (V)	효율(cd /A)	수명 T95(hr)	발광색
비교예 16	화합물 C-1	화합물 2-1	4.02	12.7	128	적색
비교예 17		화합물 2-2	4.03	12.3	123	적색
비교예 18		화합물 2-8	3.99	12.4	120	적색
비교예 19		화합물 2-19	4.01	12.5	111	적색
비교예 20	화합물 C-2	화합물 2-1	4.05	13.6	116	적색
비교예 21		화합물 2-2	3.99	13.8	120	적색
비교예 22		화합물 2-8	4.10	13.7	127	적색
비교예 23		화합물 2-19	3.97	13.2	104	적색
비교예 24	화합물 C-3	화합물 2-1	4.02	14.1	119	적색
비교예 25		화합물 2-2	4.00	14.5	121	적색
비교예 26		화합물 2-8	4.07	13.4	121	적색
비교예 27		화합물 2-19	3.99	14.3	134	적색
비교예 28	화합물 C-4	화합물 2-1	4.01	13.7	115	적색
비교예 29		화합물 2-2	4.11	14.6	103	적색
비교예 30		화합물 2-8	4.13	13.4	101	적색
비교예 31		화합물 2-19	4.08	12.8	109	적색
비교예 32	화합물 C-5	화합물 2-9	4.12	14.0	108	적색
비교예 33		화합물 2-10	4.13	13.3	103	적색
비교예 34		화합물 2-12	4.15	14.1	110	적색
비교예 35		화합물 2-16	4.10	14.4	111	적색
비교예 36	화합물 C-6	화합물 2-9	4.02	15.9	104	적색
비교예 37		화합물 2-10	4.00	14.8	105	적색
비교예 38		화합물 2-12	4.10	14.9	107	적색
비교예 39		화합물 2-16	4.04	14.5	114	적색
비교예 40	화합물 C-7	화합물 2-9	3.97	14.0	111	적색
비교예 41		화합물 2-10	3.95	14.1	113	적색
비교예 42		화합물 2-12	4.98	15.5	108	적색
비교예 43		화합물 2-16	3.99	14.3	111	적색

비교예 44	화합물 C-8	화합물 2-9	4.01	16.5	108	적색
비교예 45		화합물 2-10	4.05	15.2	106	적색
비교예 46		화합물 2-12	4.11	15.5	105	적색
비교예 47		화합물 2-16	4.13	15.3	104	적색
비교예 48	화합물 C-9	화합물 2-3	4.05	15.7	107	적색
비교예 49		화합물 2-4	4.07	14.5	106	적색
비교예 50		화합물 2-14	4.06	14.9	104	적색
비교예 51		화합물 2-21	4.05	14.0	108	적색
비교예 52	화합물 C-10	화합물 2-3	4.10	13.9	115	적색
비교예 53		화합물 2-4	4.12	13.3	113	적색
비교예 54		화합물 2-14	4.11	13.7	104	적색
비교예 55		화합물 2-21	4.15	14.5	107	적색

[903]

[904] [표6]

구분	제1호스트	제2호스트	구동전압(V)	효율(cd/A)	수명 T95(hr)	발광색
비교예 56	화합물 C-11	화합물 2-3	4.07	14.3	110	적색
비교예 57		화합물 2-4	4.11	14.0	114	적색
비교예 58		화합물 2-14	4.08	14.1	110	적색
비교예 59		화합물 2-21	4.09	15.8	118	적색
비교예 60	화합물 C-12	화합물 2-9	4.17	13.2	111	적색
비교예 61		화합물 2-10	4.15	13.0	115	적색
비교예 62		화합물 2-12	4.18	14.2	122	적색
비교예 63		화합물 2-16	4.11	14.3	118	적색

[905]

[906] 상기 표에 나타난 바와 같이, 발광층의 호스트 물질로 상기 화학식 1로 표시되는 제1 화합물 및 상기 화학식 2로 표시되는 제2 화합물을 동시에 사용한 실시예의 유기 발광 소자는, 상기 화학식 1 및 2로 표시되는 화합물 중 하나만을 채용하거나, 둘 다 채용하지 않는 비교예의 유기 발광 소자에 비하여, 동등 또는 우수한 발광 효율, 낮은 구동 전압 및 현저히 향상된 수명 특성을 나타내었다.

[907]

[908] 구체적으로, 실시예에 따른 소자는, 상기 화학식 1로 표시되는 화합물을 단일

호스트로 채용한 비교예의 소자에 비하여, 높은 효율 및 긴 수명을 나타내었다. 또한, 실시예에 따른 소자는, 비교예 화합물 C-1 내지 C-12를 제1 호스트로, 상기 화학식 2로 표시되는 화합물을 제2 호스트로 채용한 비교예의 소자에 비해서도 효율 및 수명 특성이 개선되었다. 이를 통해, 상기 화학식 1로 표시되는 제1 화합물 및 상기 화학식 2로 표시되는 제2 화합물의 조합을 코호스트로 사용 시에, 적색 발광층 내에서 적색 도펀트로의 에너지 전달이 효과적으로 이루어졌음이 확인된다. 이는, 제1 화합물이 전자와 정공에 대한 안정도가 높기 때문이라 판단 할 수 있으며, 또한 제2 화합물을 동시에 사용함에 따라 정공의 양이 많아지면서 적색 발광층내에 전자와 정공이 더 안정적인 균형을 유지하였기 때문으로 판단된다.

[909]

[910] 따라서, 유기 발광 소자의 호스트 물질로 상기 제1 화합물과 상기 제2 화합물을 동시에 채용하는 경우, 유기 발광 소자의 구동 전압, 발광 효율 및/또는 수명 특성이 향상시킬 수 있음을 확인할 수 있었다. 이는 일반적으로 유기 발광 소자의 발광 효율 및 수명 특성은 서로 트레이드-오프(Trade-off) 관계를 갖는 점을 고려할 때 본 발명의 화합물간의 조합을 채용한 유기 발광 소자는 비교예 소자 대비 현저히 향상된 소자 특성을 나타낸다고 볼 수 있다.

[911]

[912] [부호의 설명]

[913] 1: 기판 2: 양극

[914] 3: 발광층 4: 음극

[915] 5: 정공주입층 6: 정공수송층

[916] 7: 전자억제층 8: 정공저지층

[917] 9: 전자 주입 및 수송층

[918]

청구범위

[청구항 1] 제1 전극;

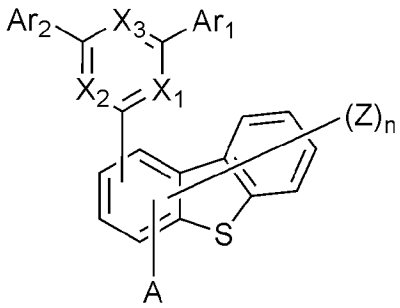
상기 제1 전극과 대향하여 구비된 제2 전극; 및

상기 제1 전극과 제2 전극 사이에 구비된 발광층을 포함하고,

상기 발광층은 하기 화학식 1로 표시되는 제1 화합물 및 하기 화학식 2로 표시되는 제2 화합물을 포함하는,

유기 발광 소자:

[화학식 1]



상기 화학식 1에서,

X_1 내지 X_3는 각각 독립적으로, N 또는 CH이되, X_1 내지 X_3 중 적어도 둘은 N이고,

Ar_1 및 Ar_2는 각각 독립적으로, 중수소; 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

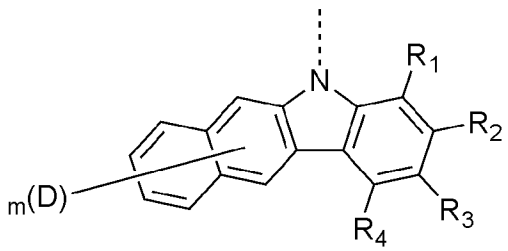
Z는 각각 독립적으로, 수소, 또는 중수소이거나, 또는 Z 중 인접하는 둘은 서로 결합하여 C_{6-60} 방향족 고리 또는 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리를 형성할 수 있고,

여기서, 상기 C_{6-60} 방향족 고리 및 상기 C_{2-60} 헤테로방향족 고리는 비치환되거나, 또는 중수소로 치환되고,

n은 0 내지 6의 정수이고,

A는 하기 화학식 1-1로 표시되는 치환기이고,

[화학식 1-1]



상기 화학식 1-1에서,

R_1 내지 R_4는 각각 독립적으로, 수소 또는 중수소이거나, 또는 R_1 내지 R

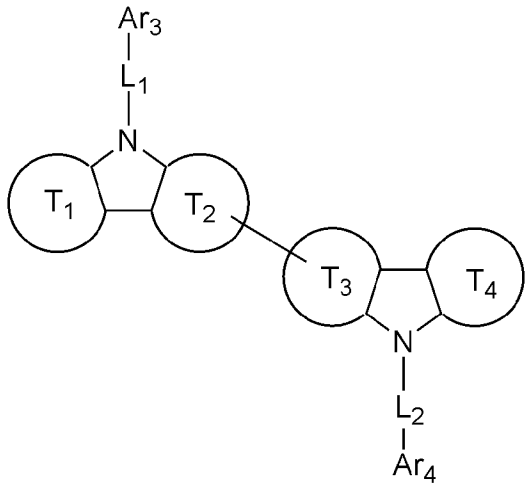
$_4$ 중 인접하는 둘은 서로 결합하여 C_{6-60} 방향족 고리 또는 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리를 형성할 수 있고,

여기서, 상기 C_{6-60} 방향족 고리 및 상기 C_{2-60} 헤테로방향족 고리는 비치환되거나, 또는 중수소로 치환되고,

D는 중수소를 의미하고,

m은 0 내지 6의 정수이고,

[화학식 2]



상기 화학식 2에서,

T_1 내지 T_4는 각각 독립적으로, 치환 또는 비치환된 C_{6-60} 방향족 고리; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로방향족 고리이고,

L_1 및 L_2는 각각 독립적으로, 단일 결합; 치환 또는 비치환된 C_{6-60} 아릴렌; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴렌이고,

Ar_3 및 Ar_4는 각각 독립적으로, 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S로 구성되는 군으로부터 선택되는 어느 하나 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이다.

[청구항 2] 제1항에 있어서,

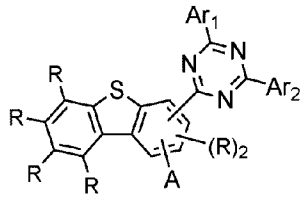
X_1 내지 X_3는 모두 N인,

유기 발광 소자.

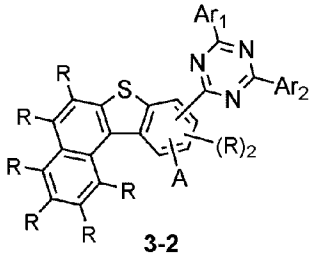
[청구항 3] 제1항에 있어서,

상기 제1 화합물은 하기 화학식 3-1 내지 3-7 중 어느 하나로 표시되는,

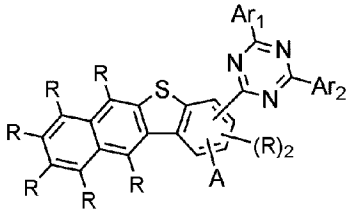
유기 발광 소자:



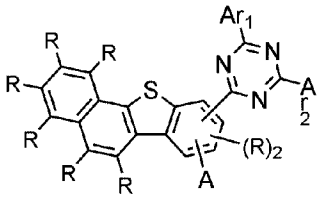
3-1



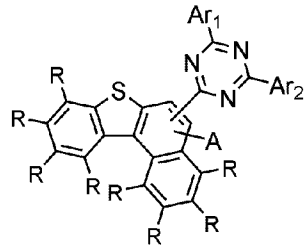
3-2



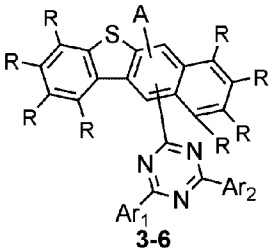
3-3



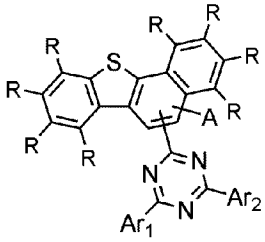
3-4



3-5



3-6



3-7

상기 화학식 3-1 내지 3-7에서,

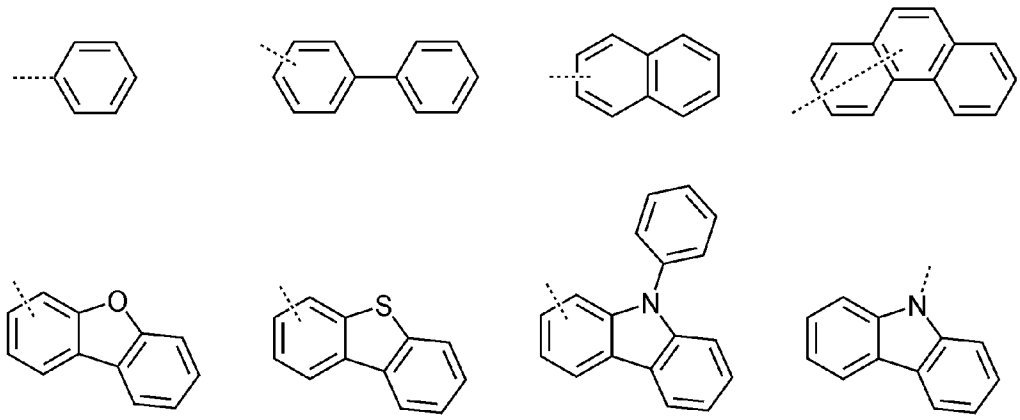
R은 각각 독립적으로, 수소, 또는 중수소이고,

A, Ar_1 및 Ar_2는 제1항에서 정의한 바와 같다.

[청구항 4] 제1항에 있어서,

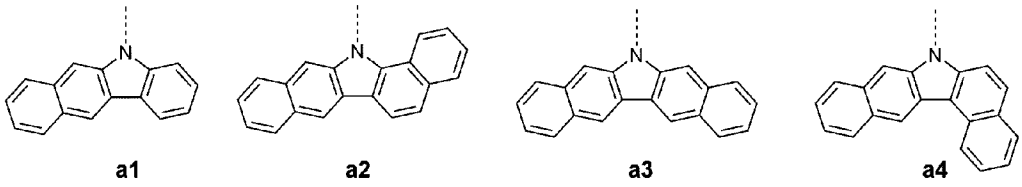
Ar_1 및 Ar_2는 각각 독립적으로, 하기로 구성되는 군으로부터 선택되는 어느 하나인,

유기 발광 소자:



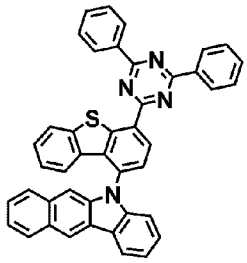
.

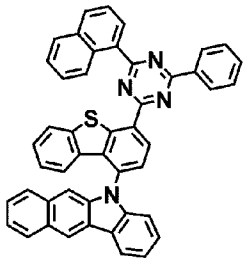
[청구항 5] 제1항에 있어서,
A는 하기 화학식 a1 내지 a4로 표시되는 치환기 중 어느 하나인,
유기 발광 소자:

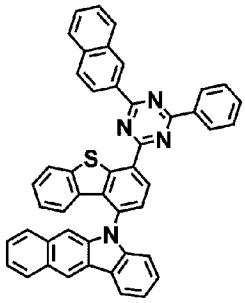


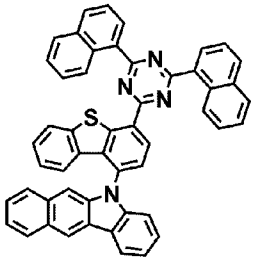
.

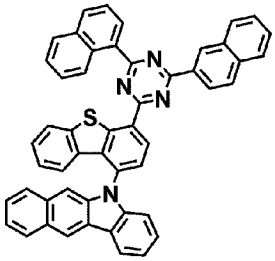
[청구항 6] 제1항에 있어서,
상기 제1 화합물은 하기로 구성되는 군으로부터 선택되는 어느 하나인,
유기 발광 소자:

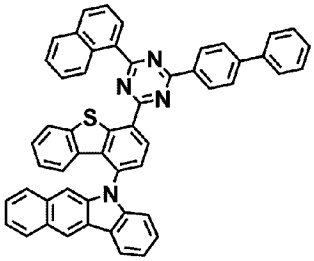


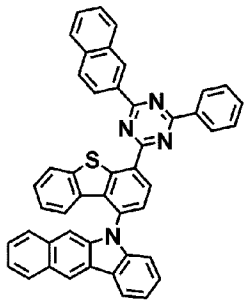


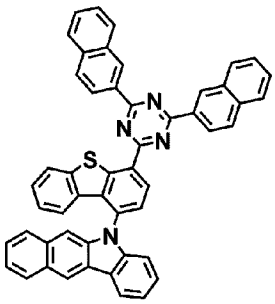


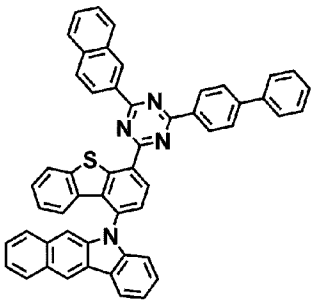


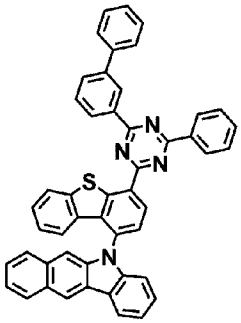
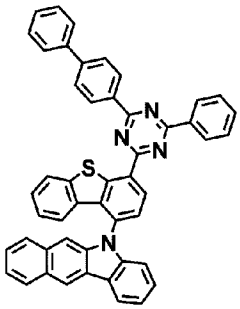
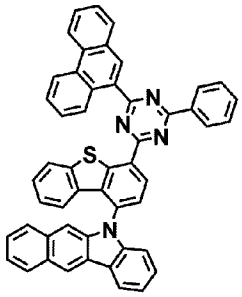
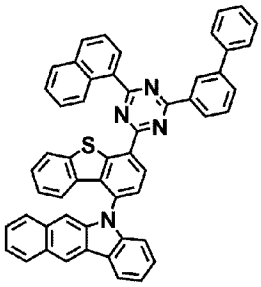
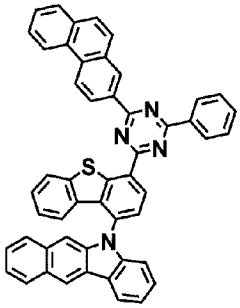
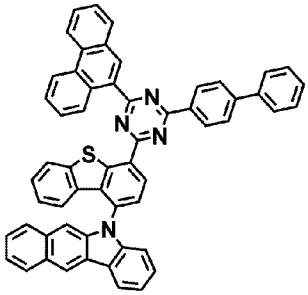
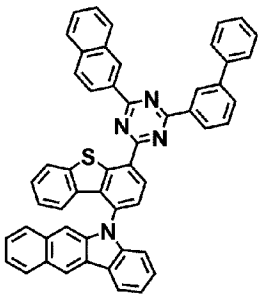
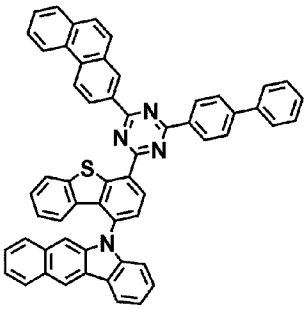
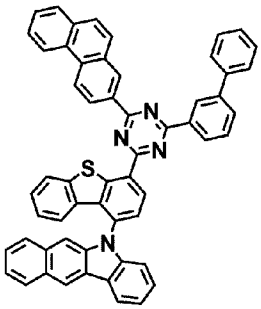


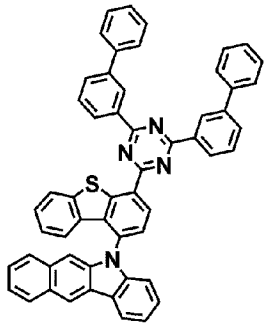


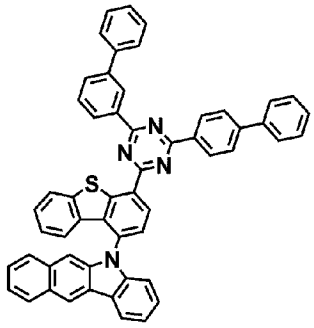


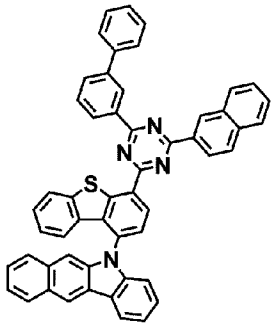


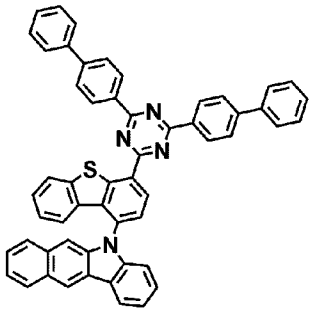


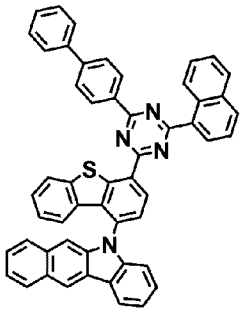










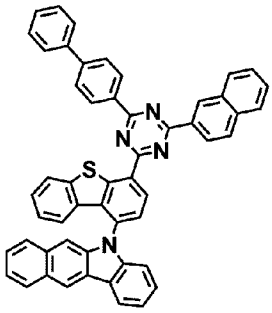


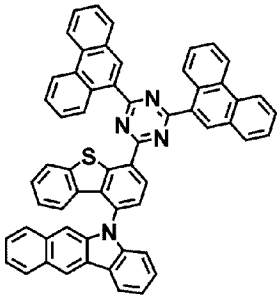


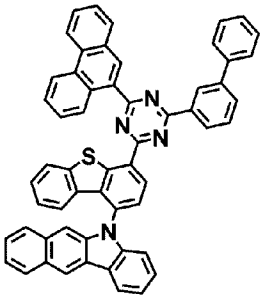


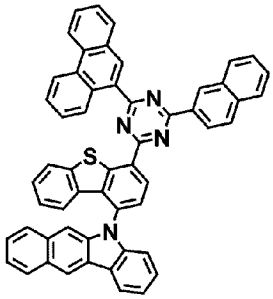


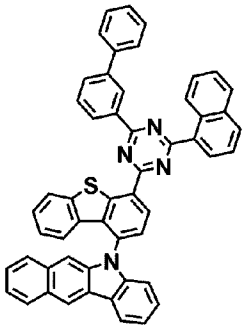


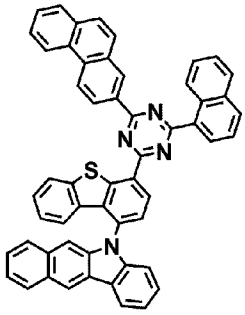


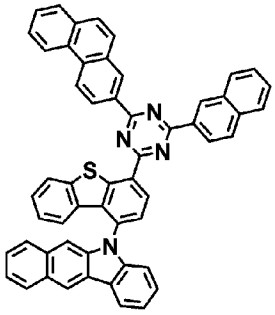


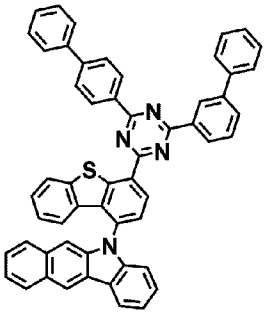


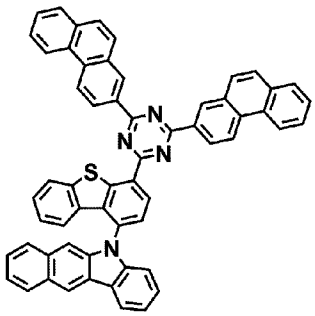


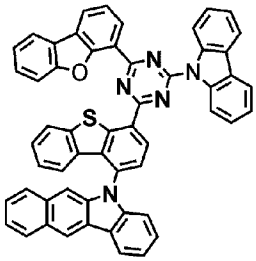


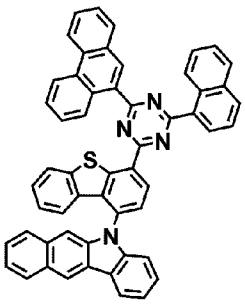


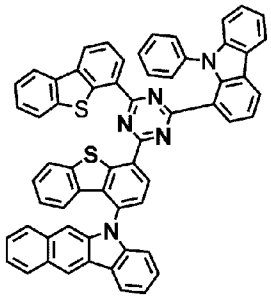


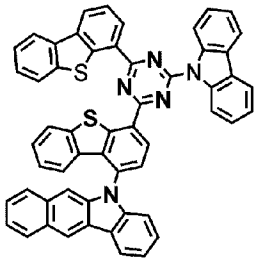


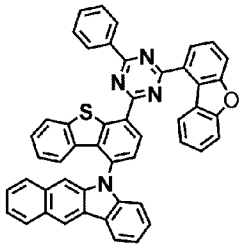
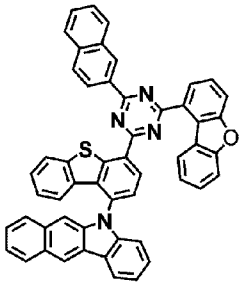
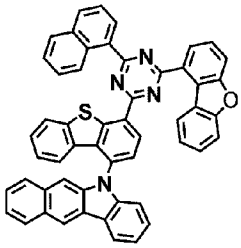
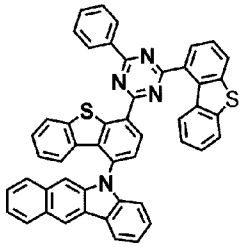
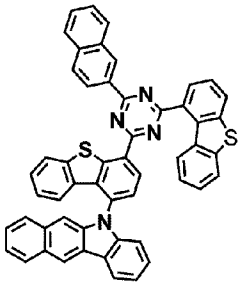
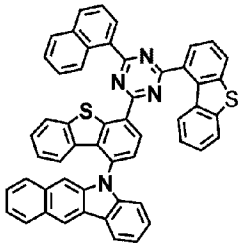
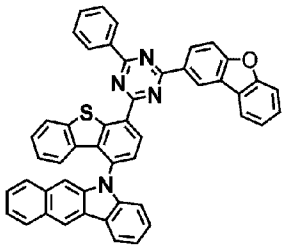
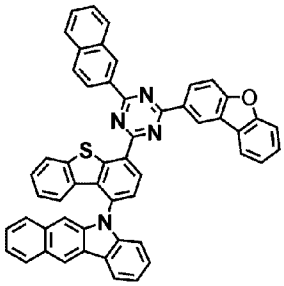
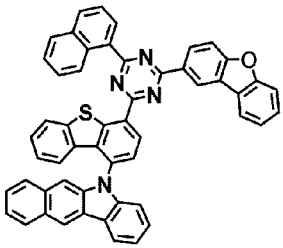


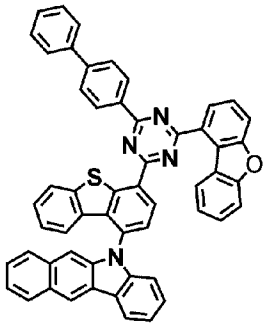
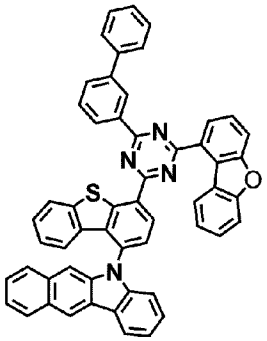
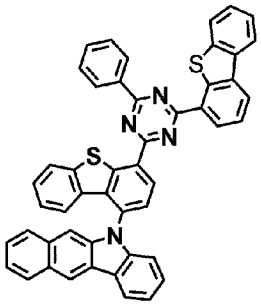
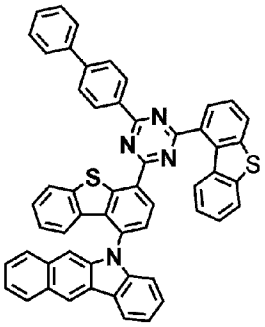
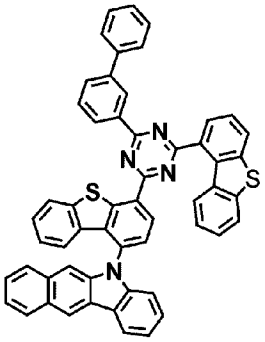
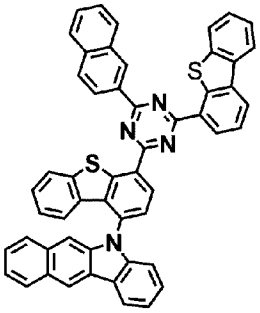
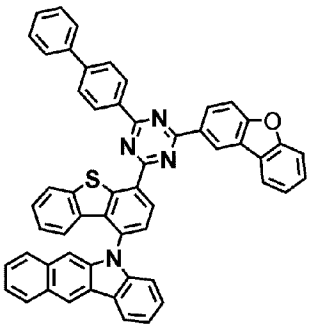
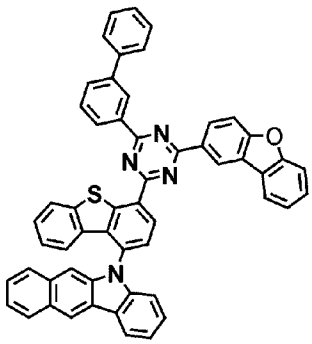
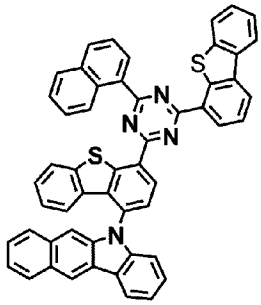


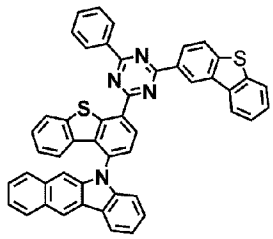
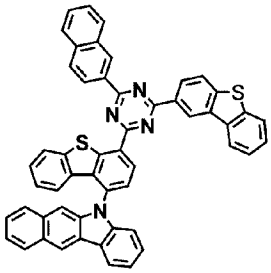
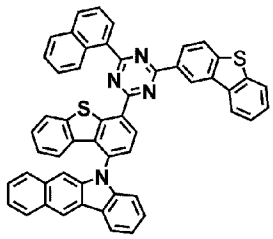
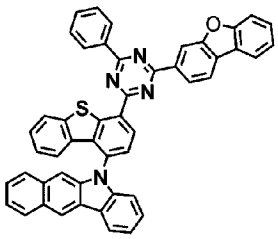
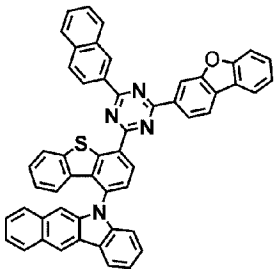
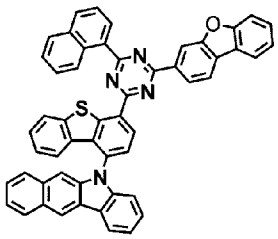
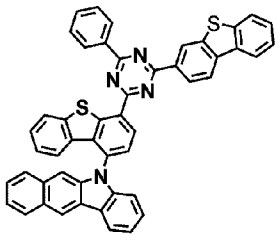
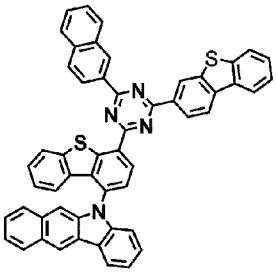
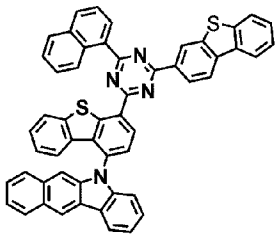
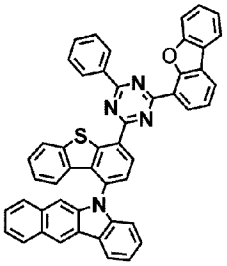
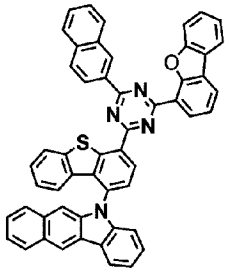
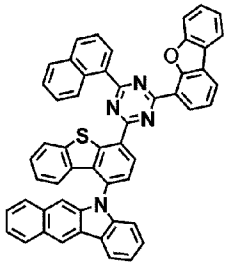


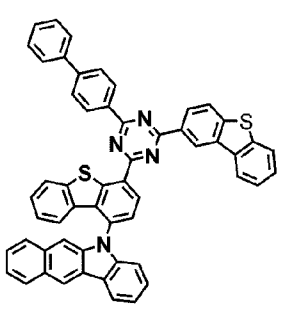
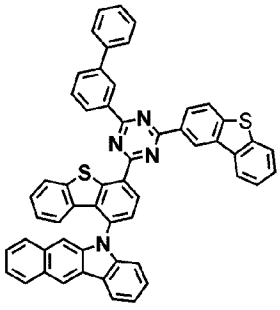
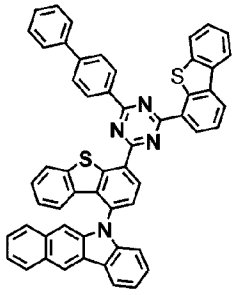
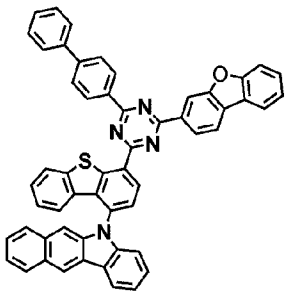
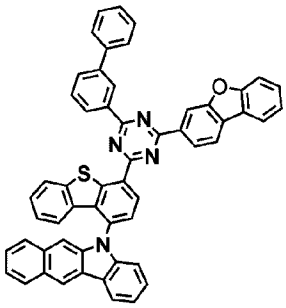
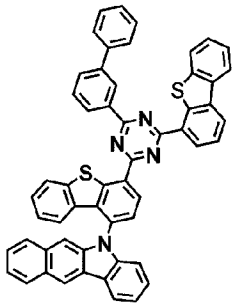
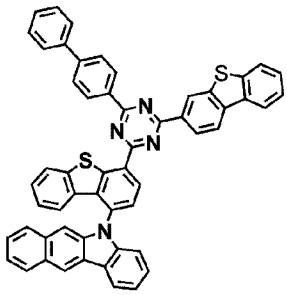
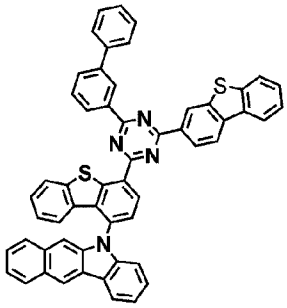
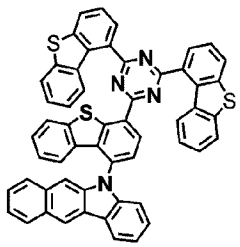
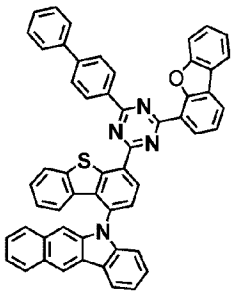
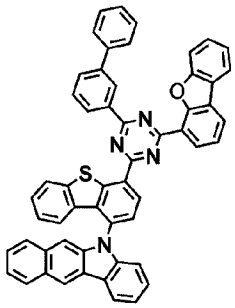


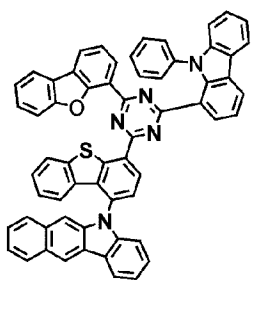


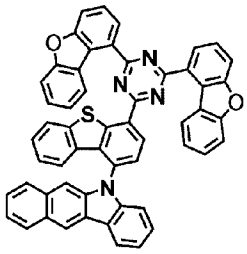
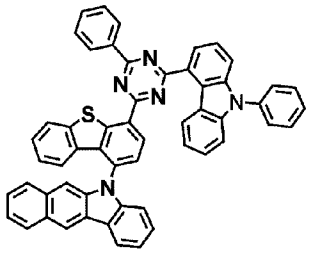
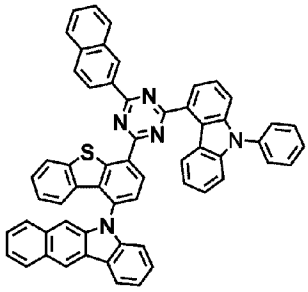
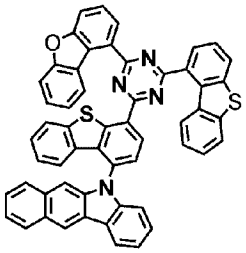
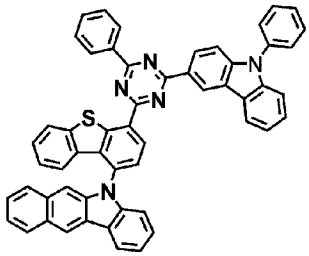
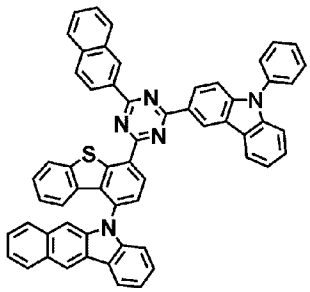
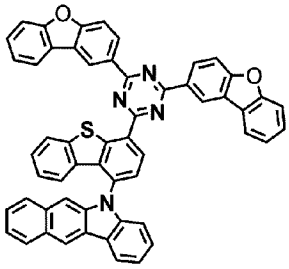
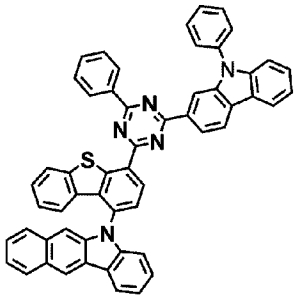
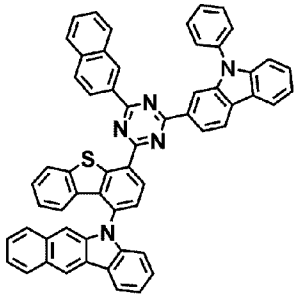










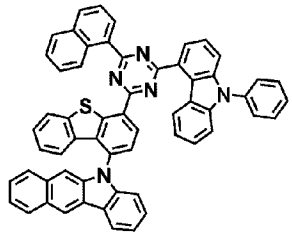
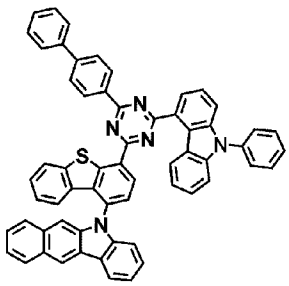
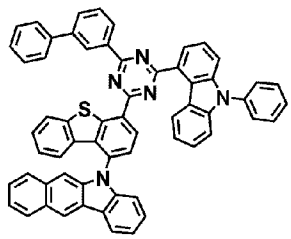
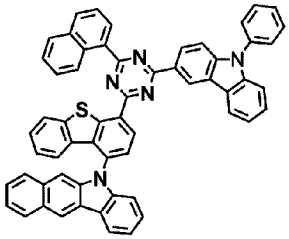
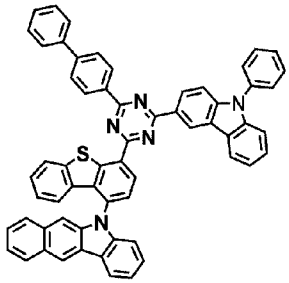
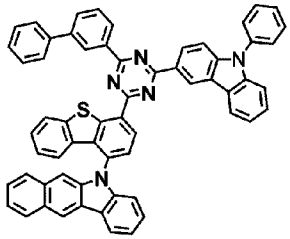
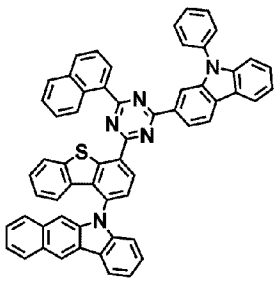
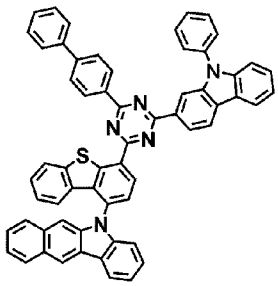
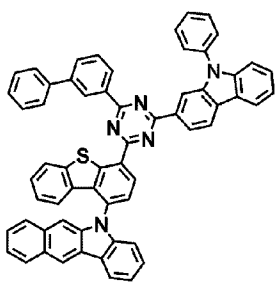










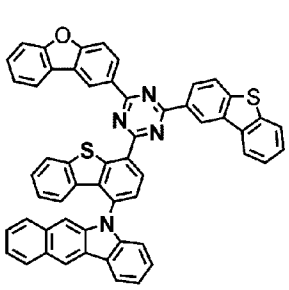
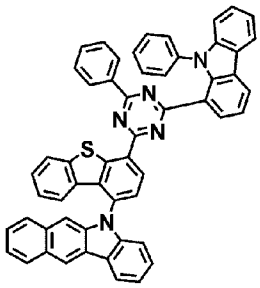
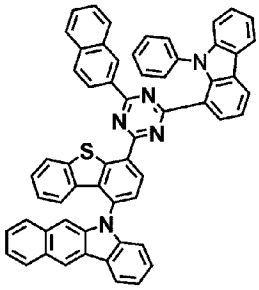
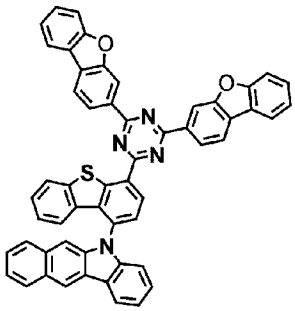
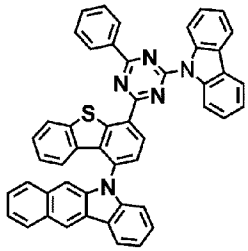
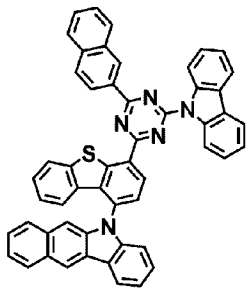
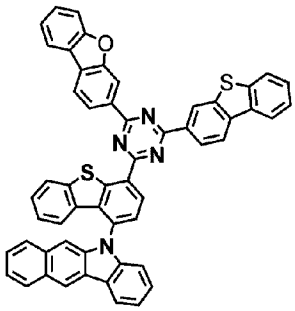
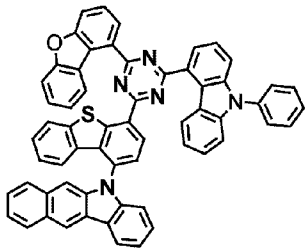
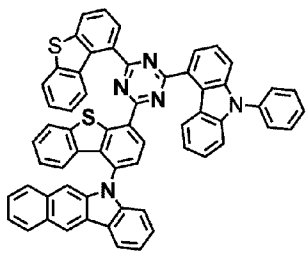













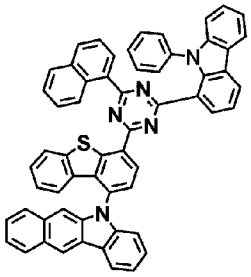












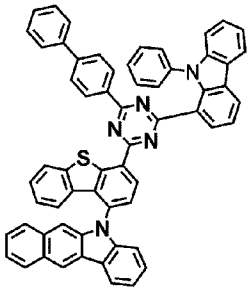


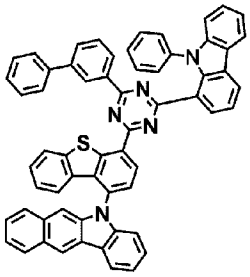










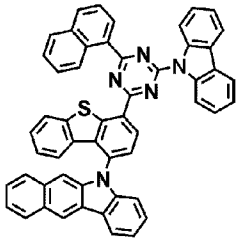










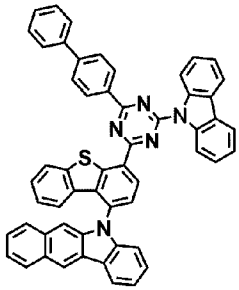










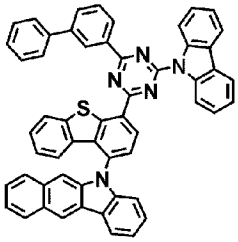


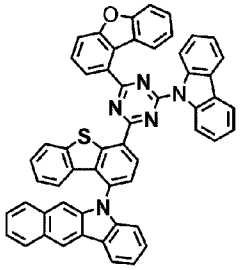


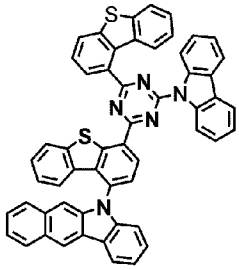


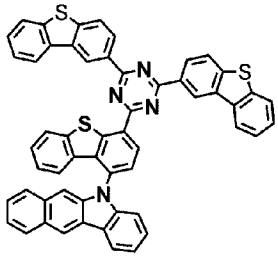


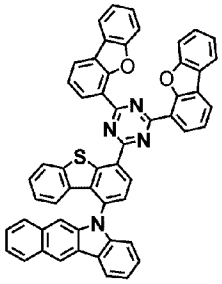
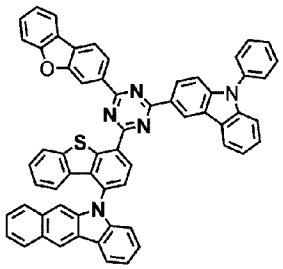
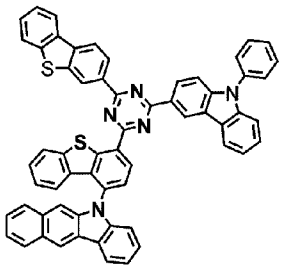
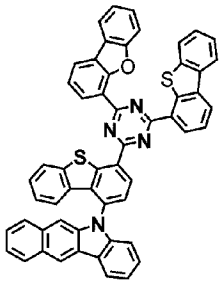
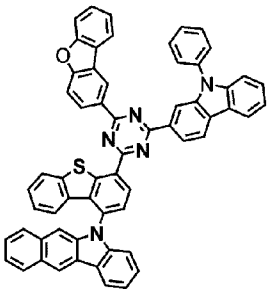
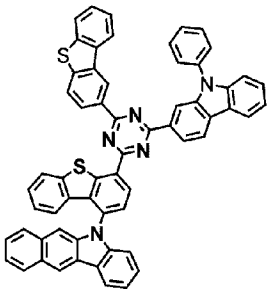
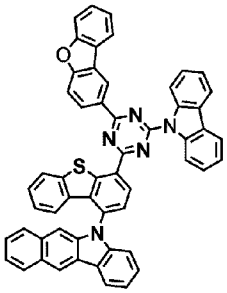
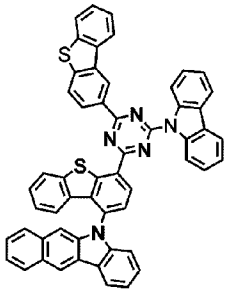
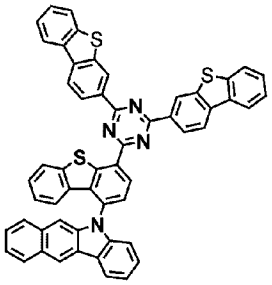
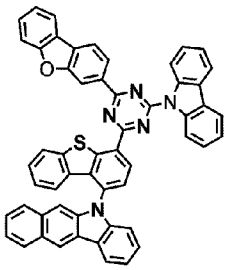
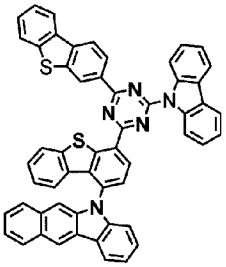
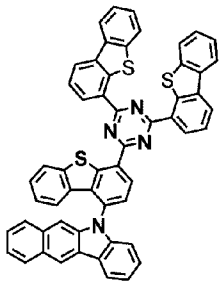


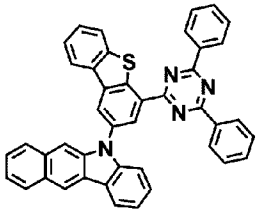


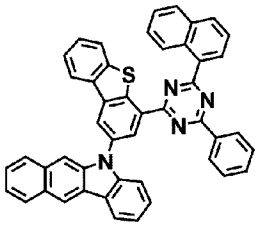


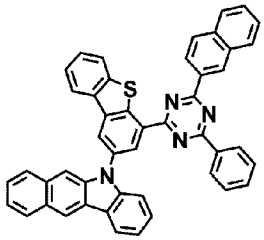


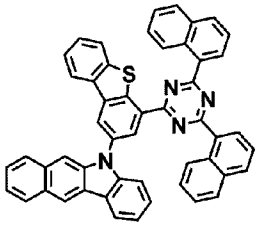


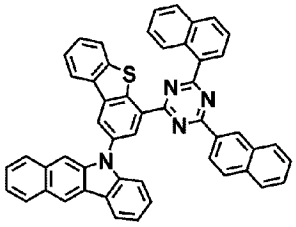













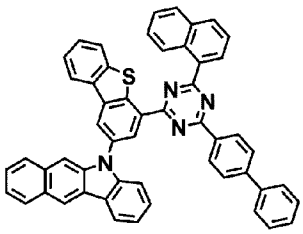


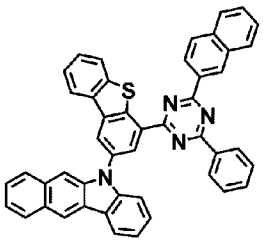


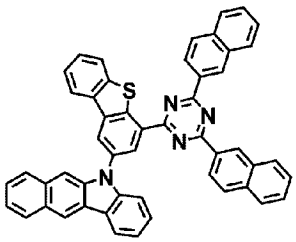


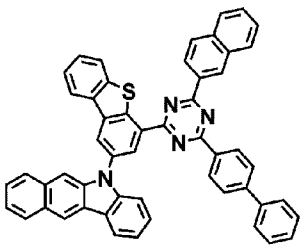


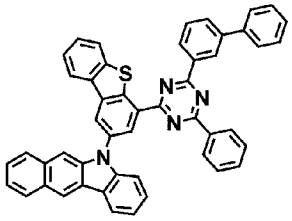
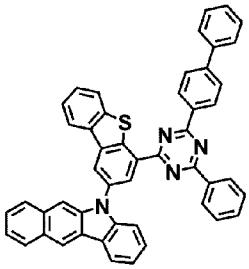
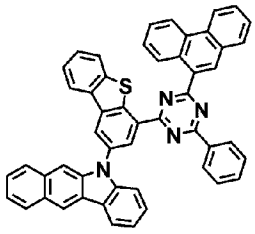
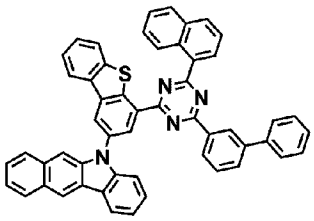
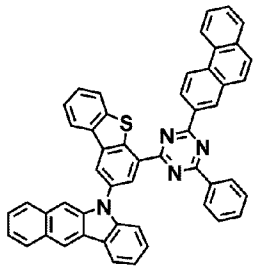
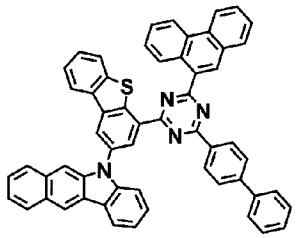
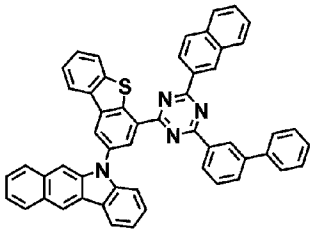
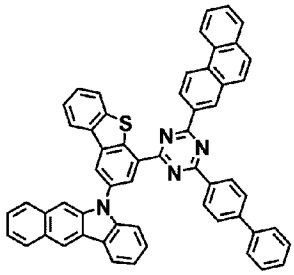
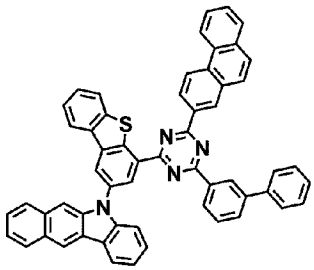


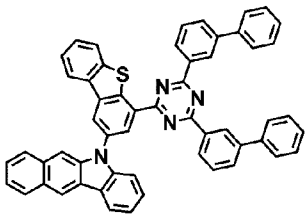
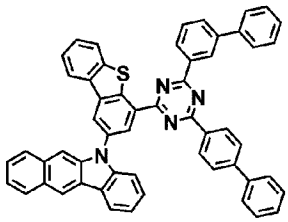
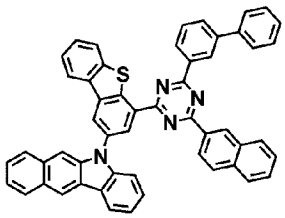
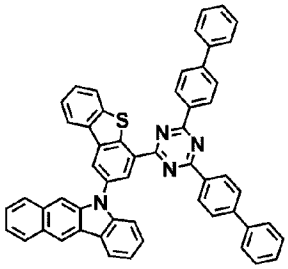
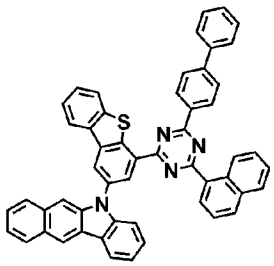
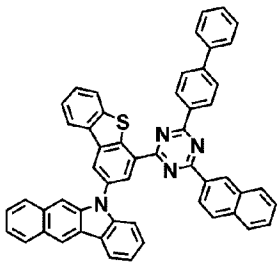
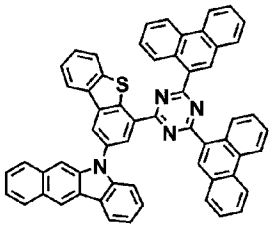
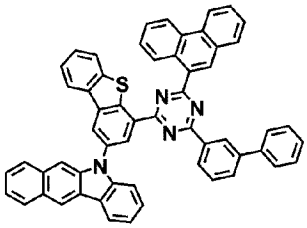
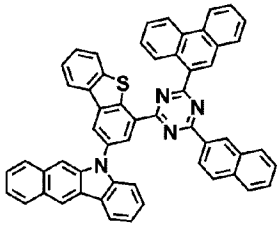


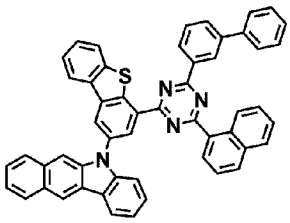
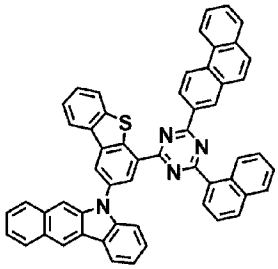
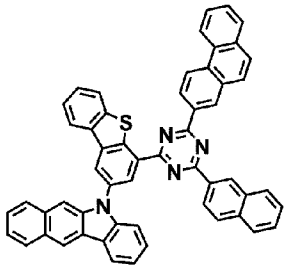
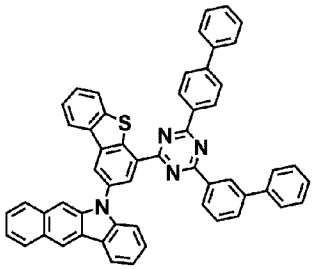
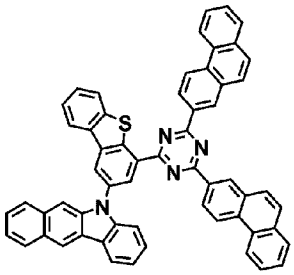
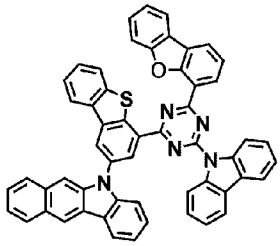
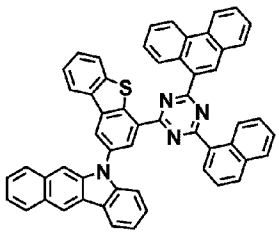
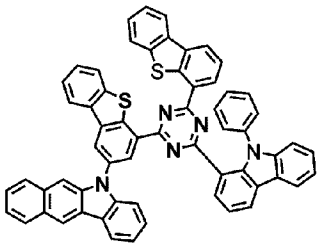
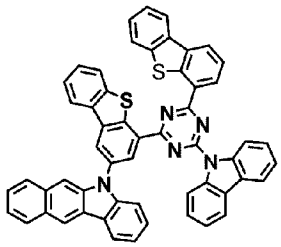


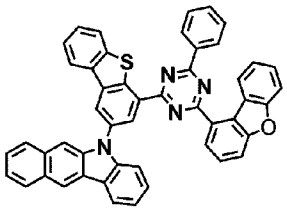
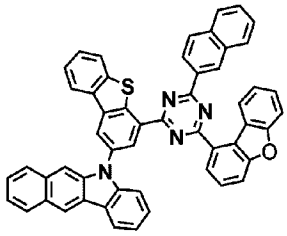
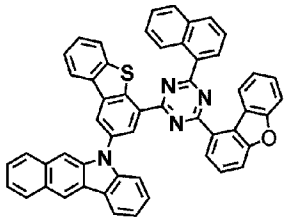
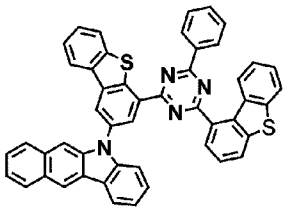
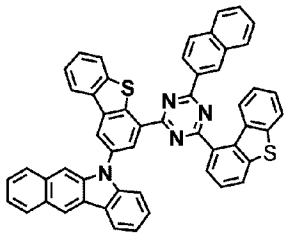
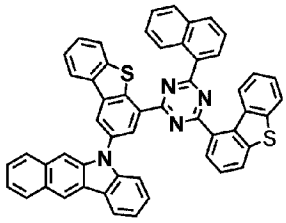
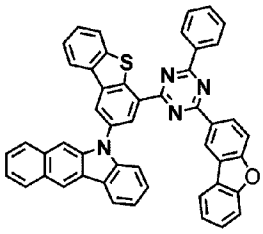
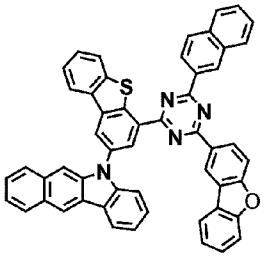
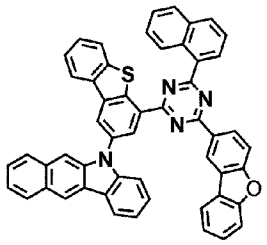


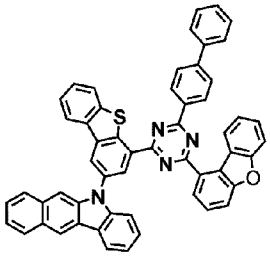


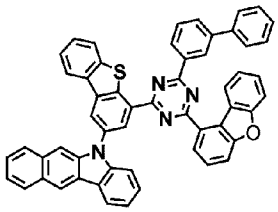










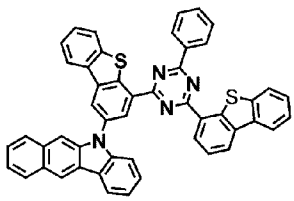










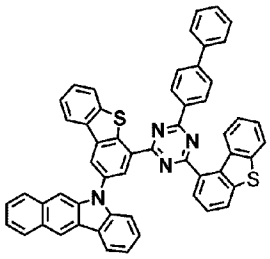










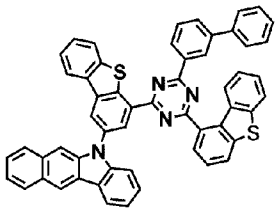










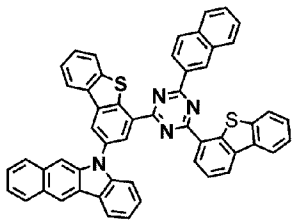


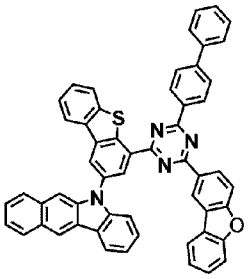


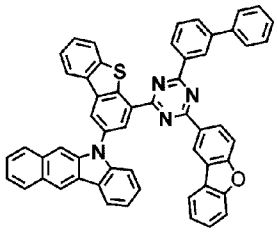


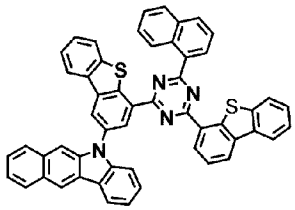


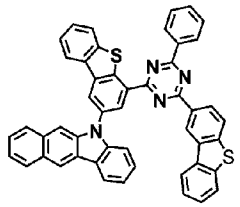
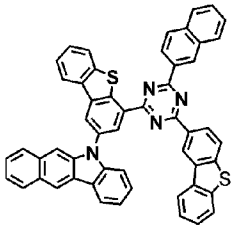
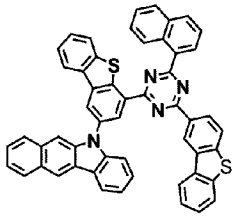
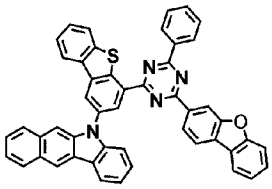
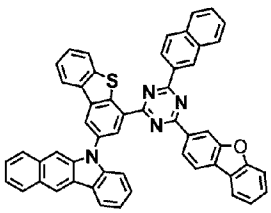
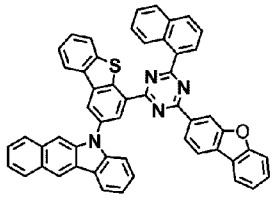
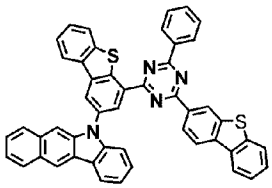
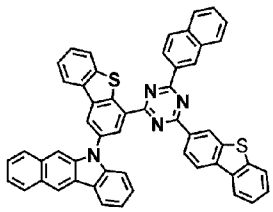
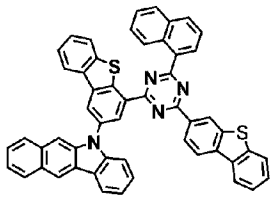
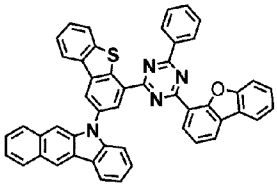
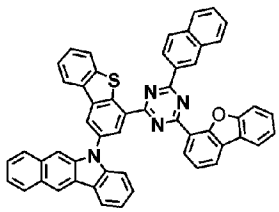
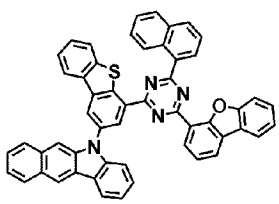


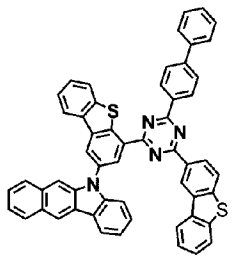
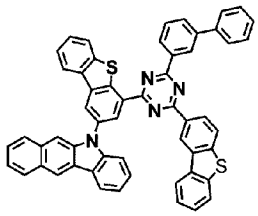
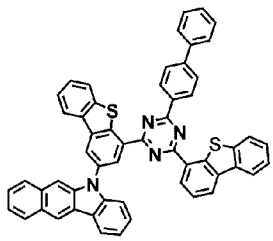
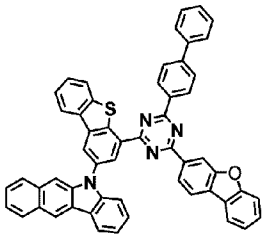
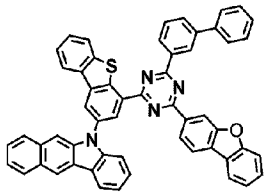
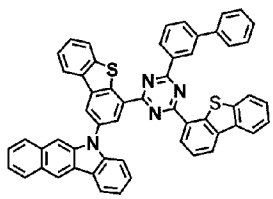
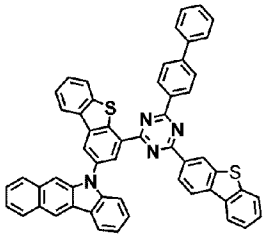
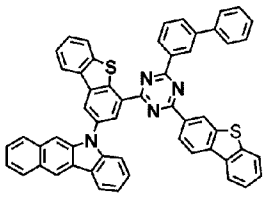
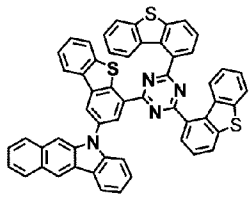
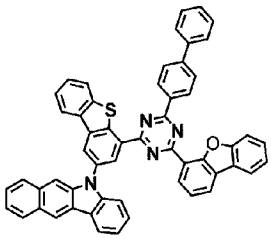
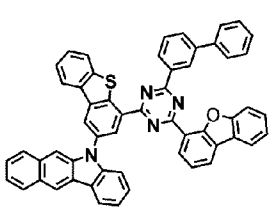
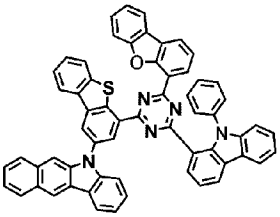


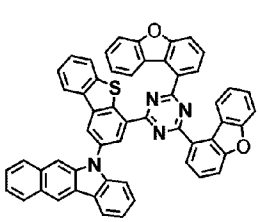


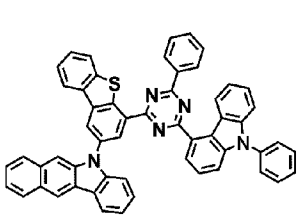


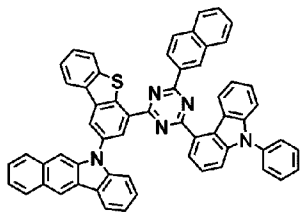


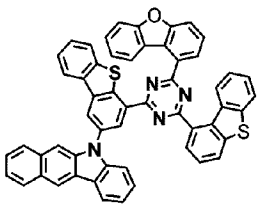













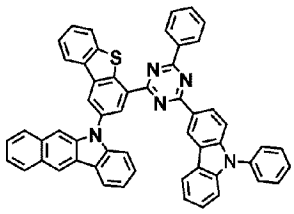













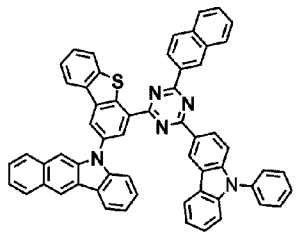


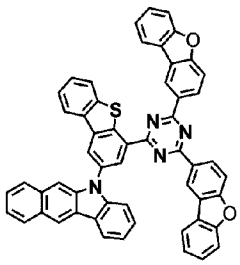


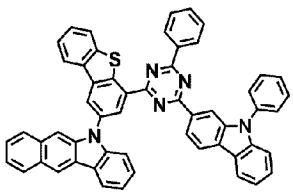


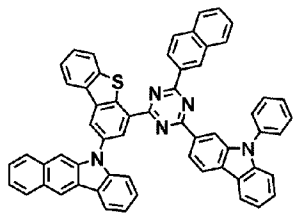


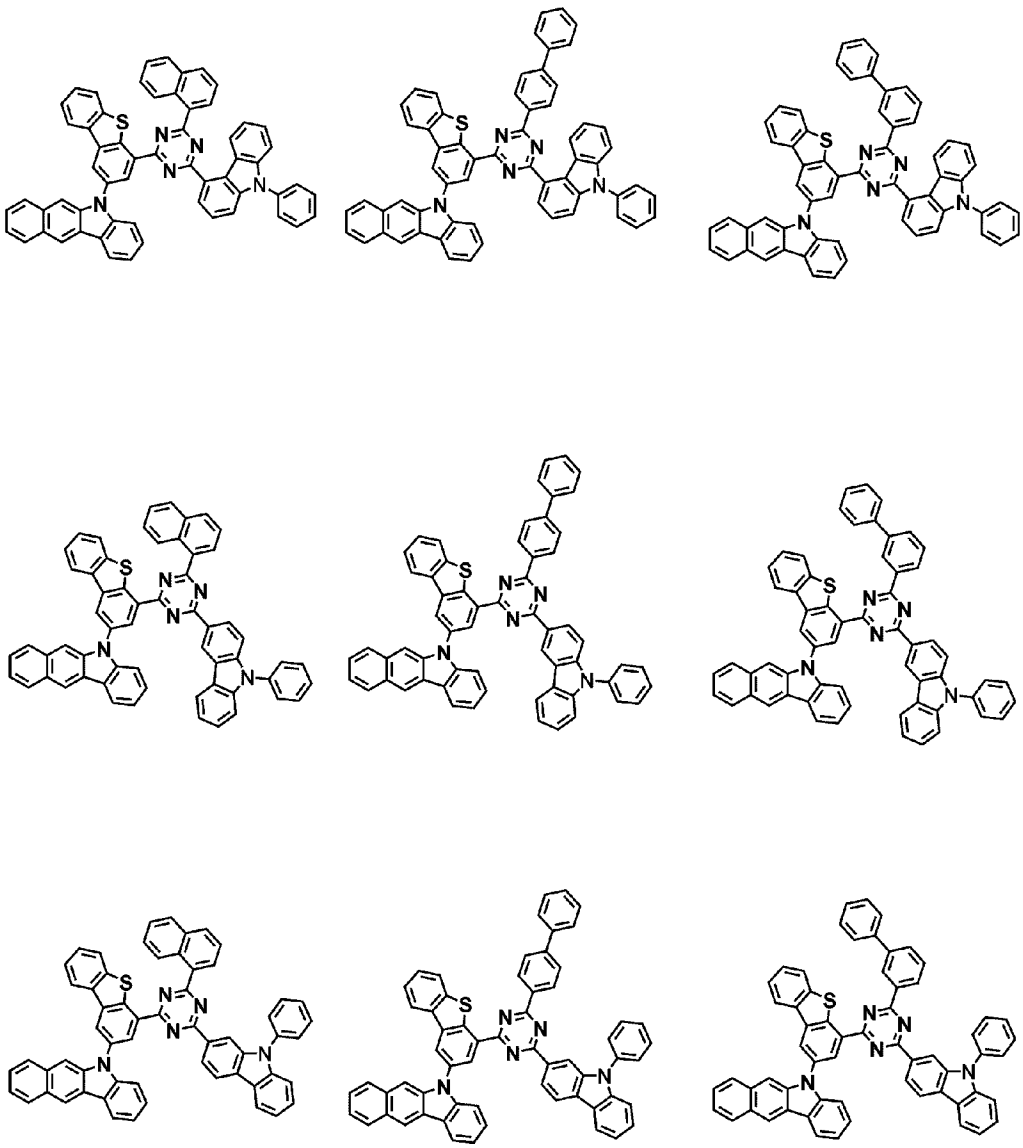


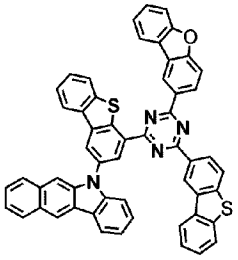


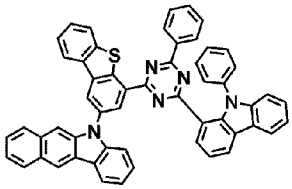


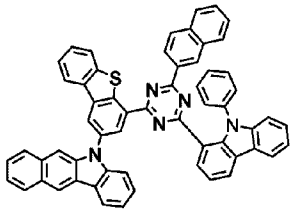


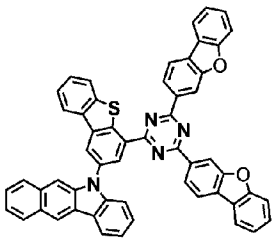


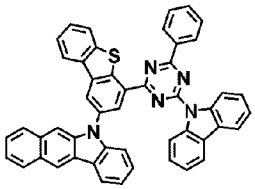


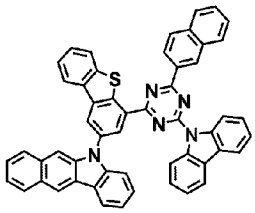


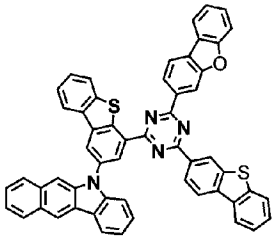


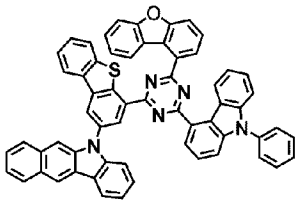


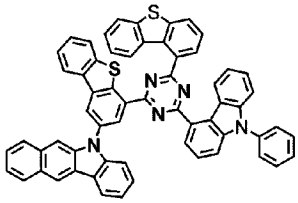


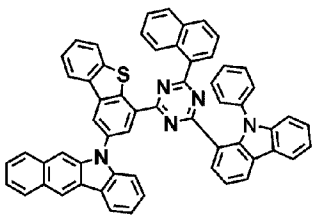
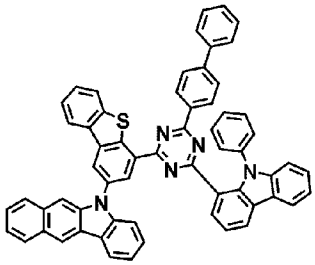
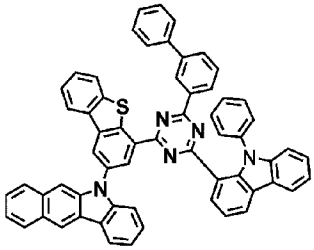
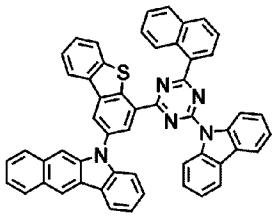
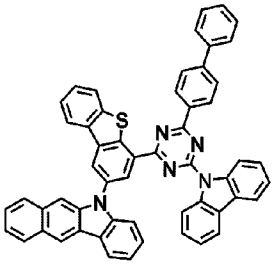
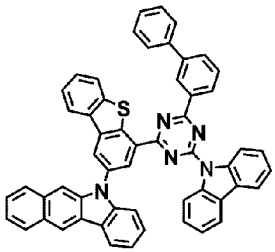
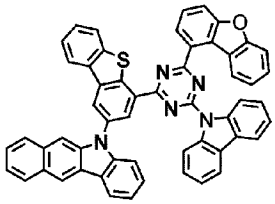
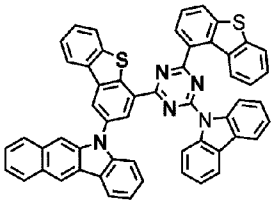
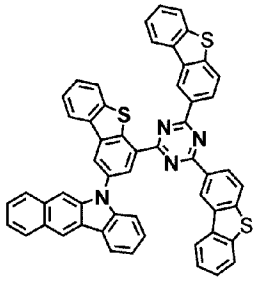


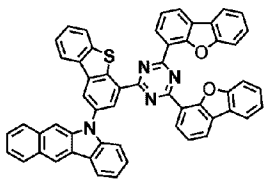
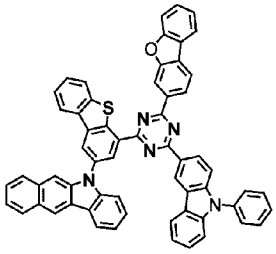
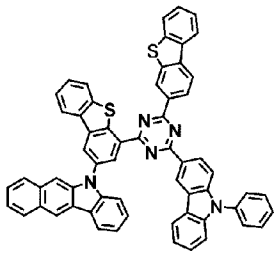
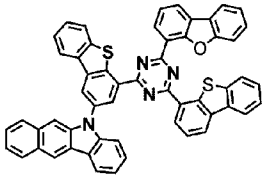
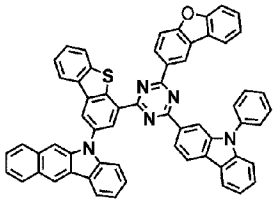
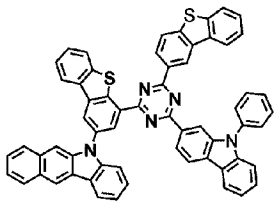
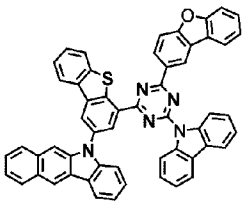
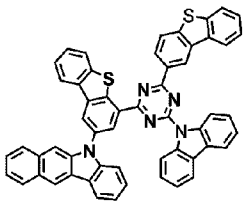
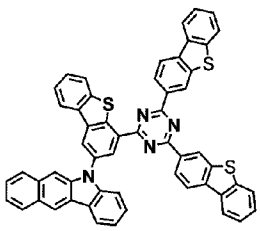
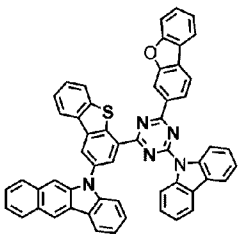
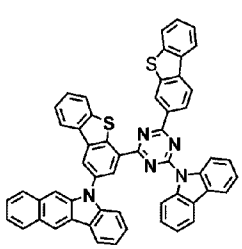
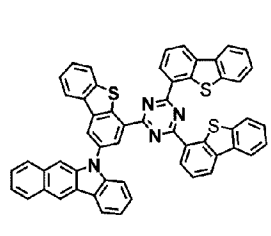


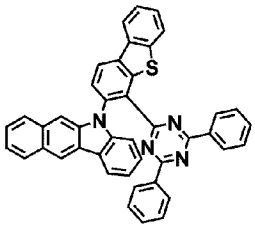


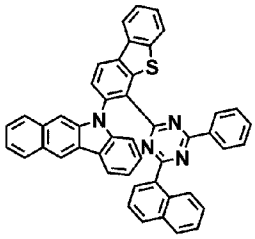


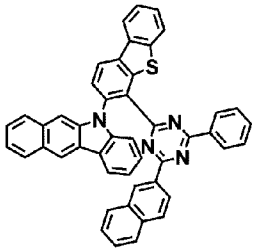


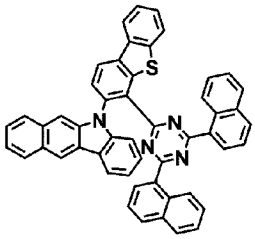










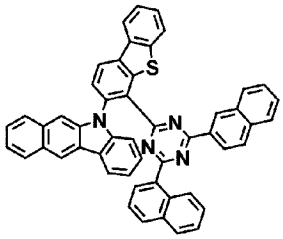













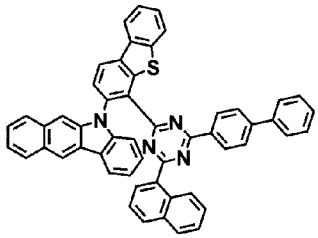


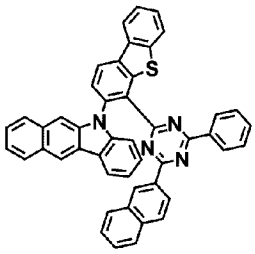


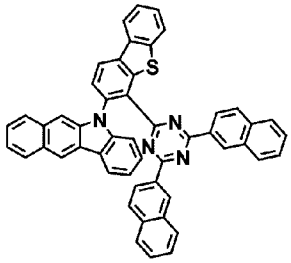


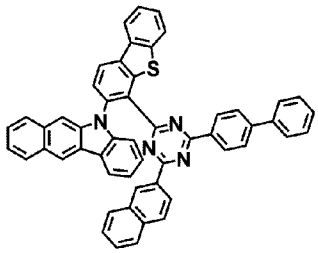


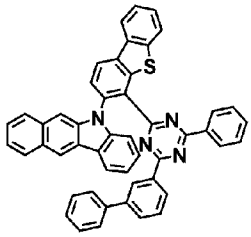


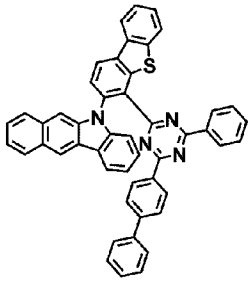


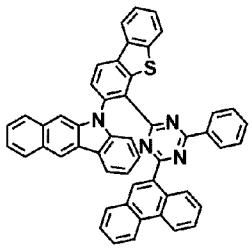


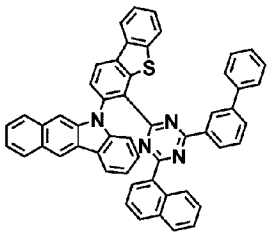


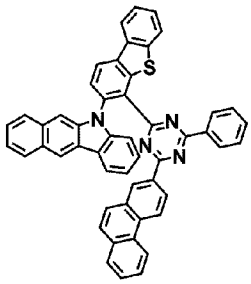


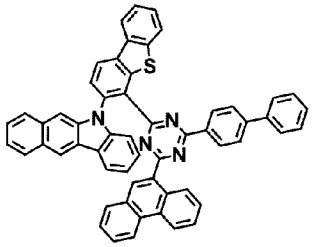


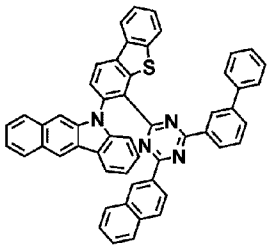


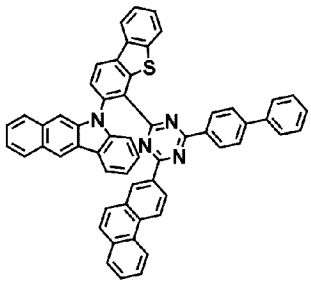


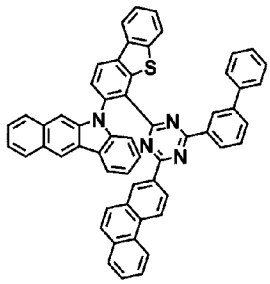


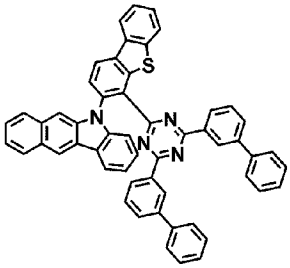


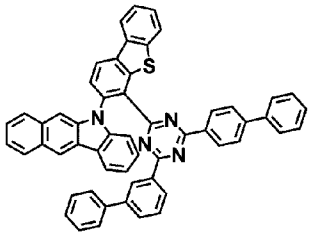


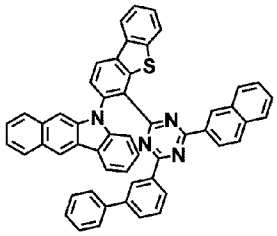


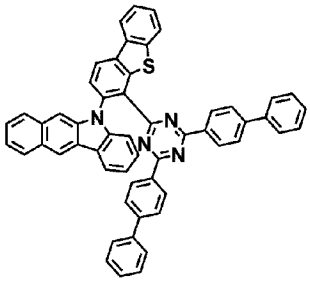


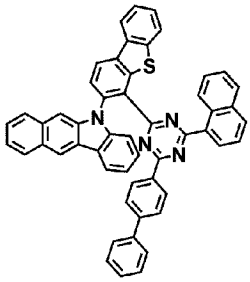


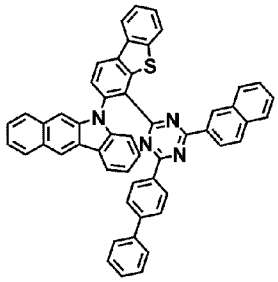


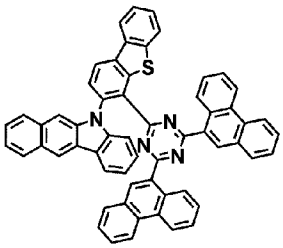


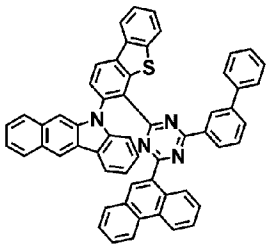


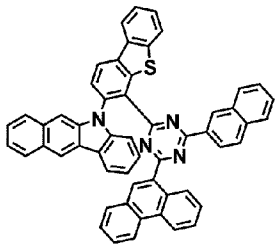


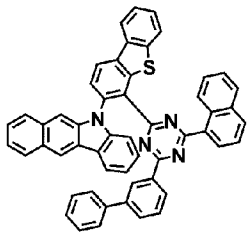


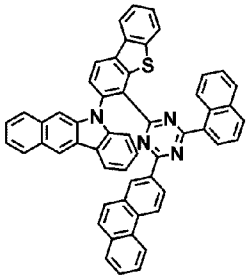


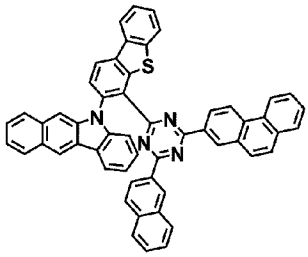


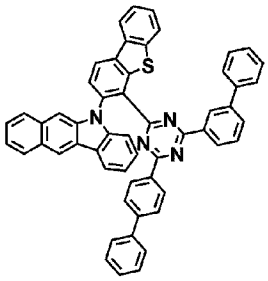


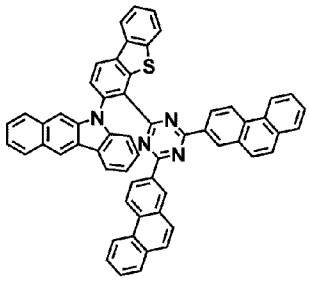


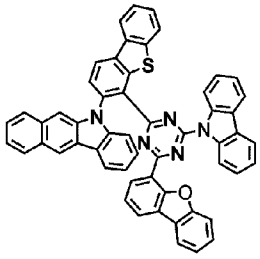


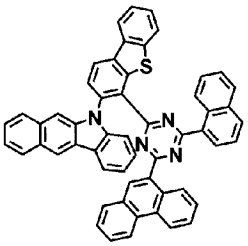


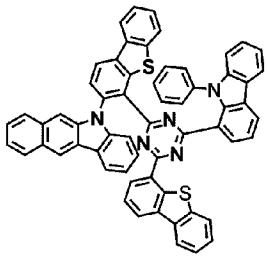


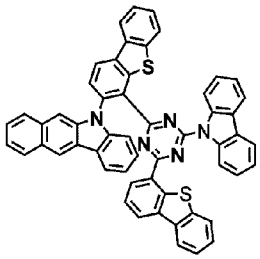


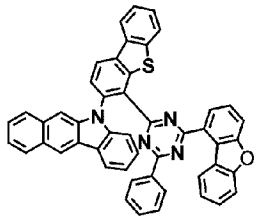
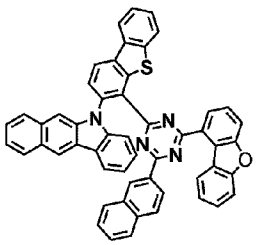
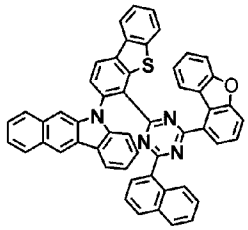
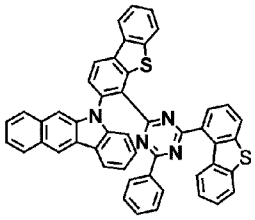
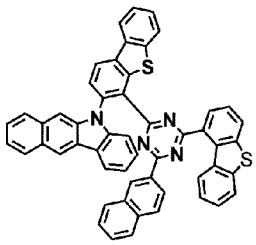
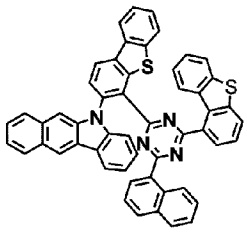
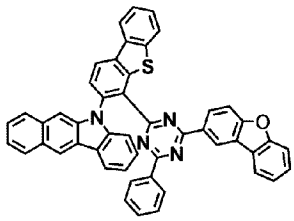
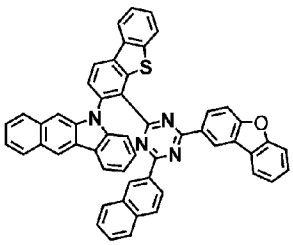
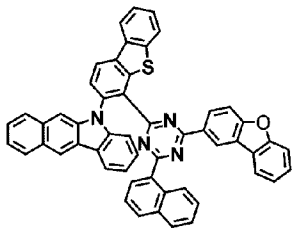


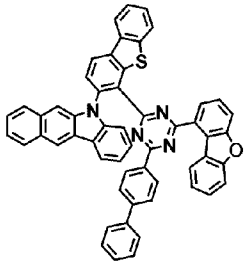


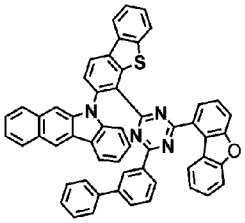


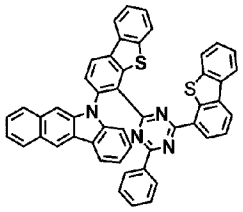


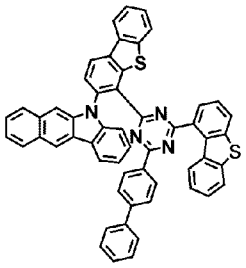


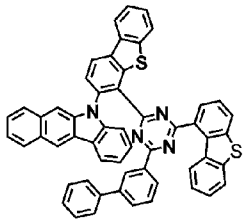










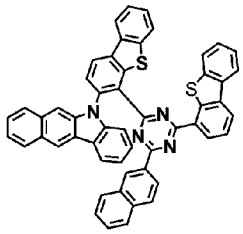


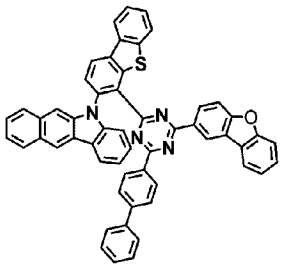


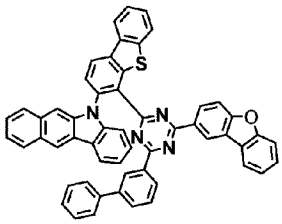


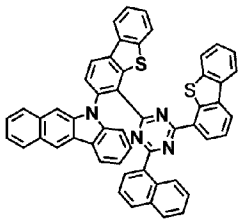


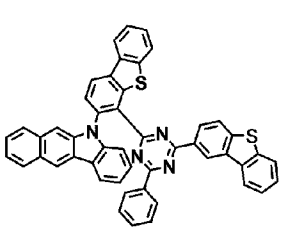
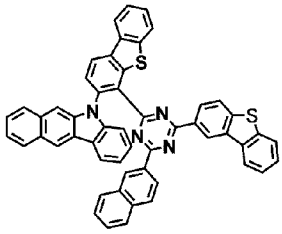
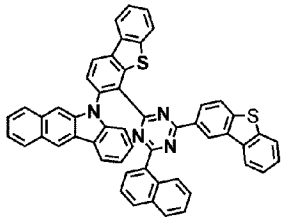
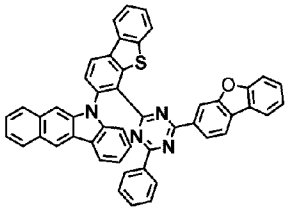
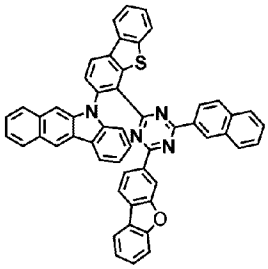
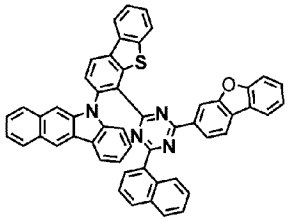
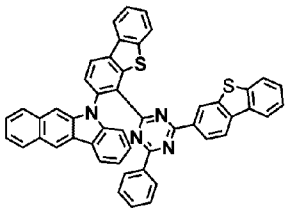
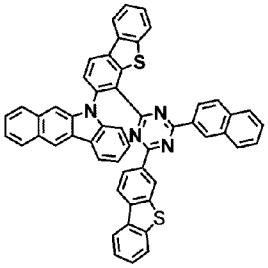
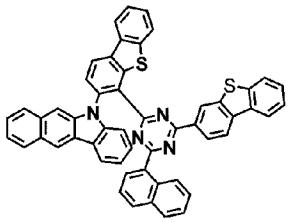
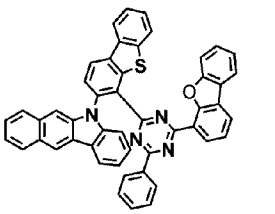
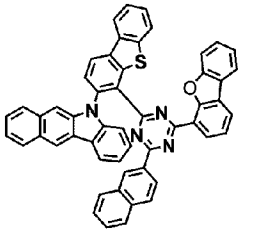
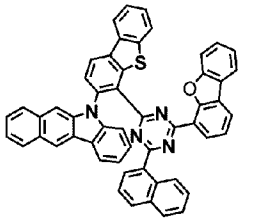


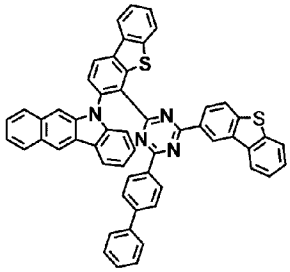
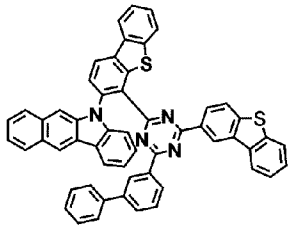
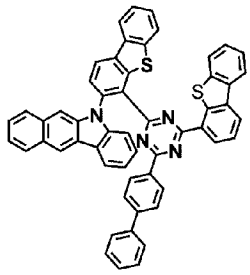
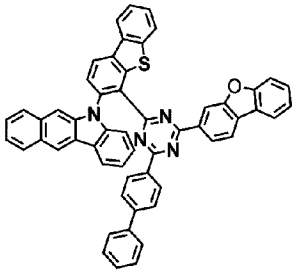
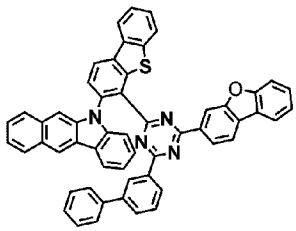
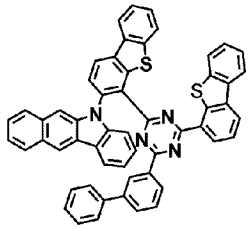
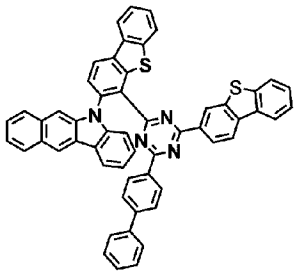
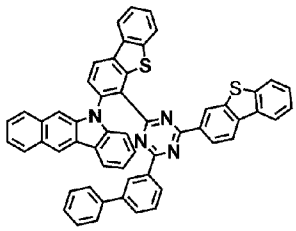
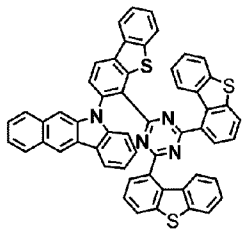
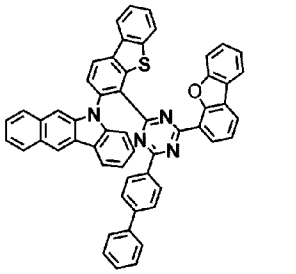
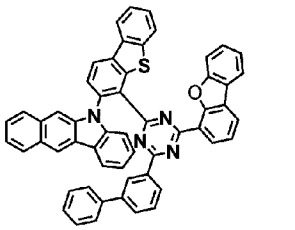
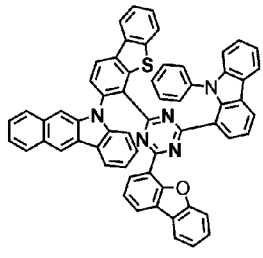


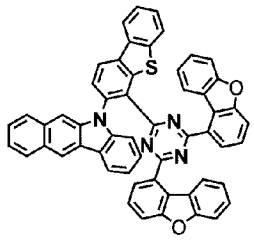
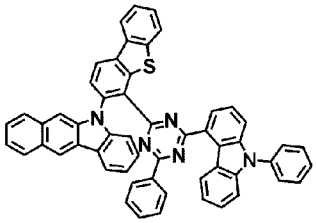
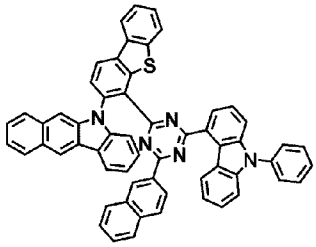
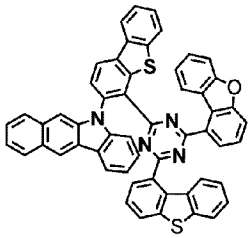
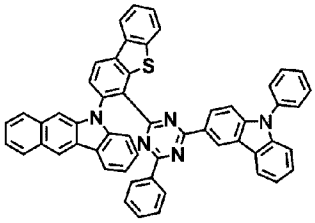
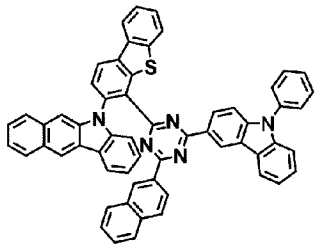
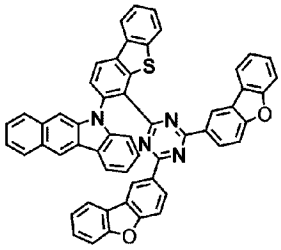
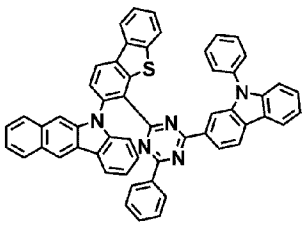
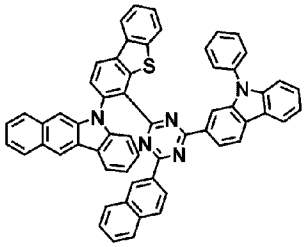


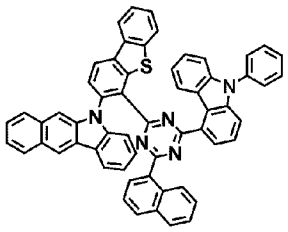
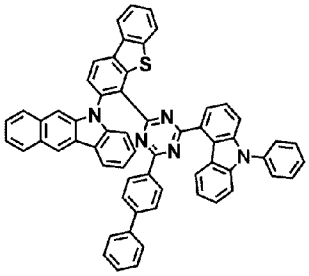
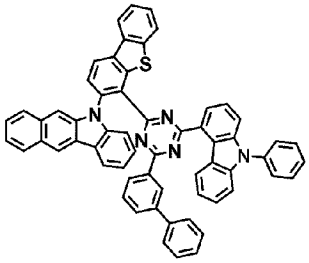
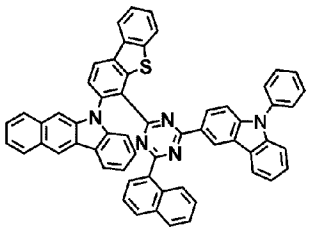
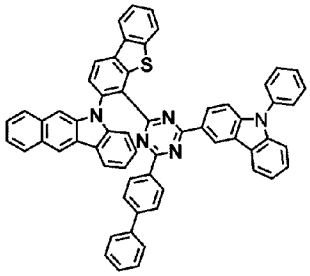
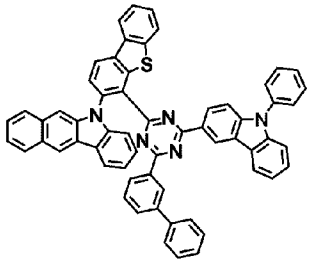
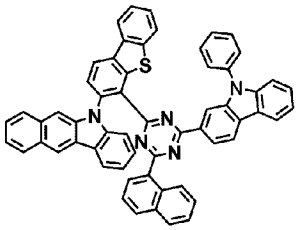
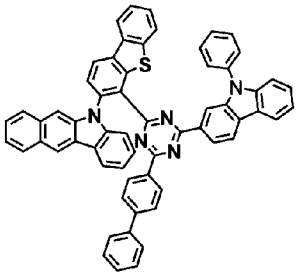
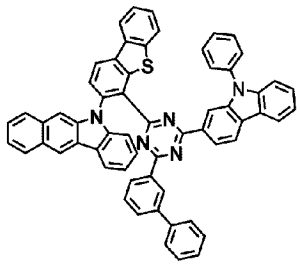


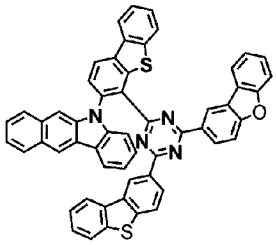


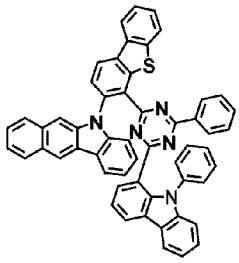













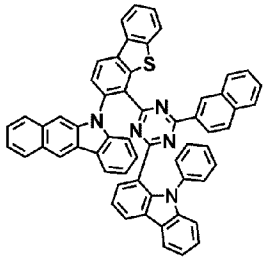













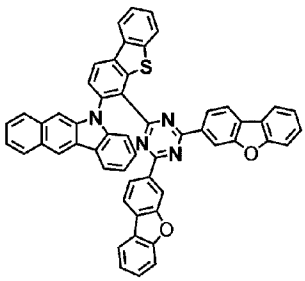










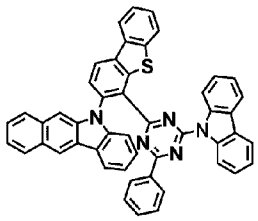










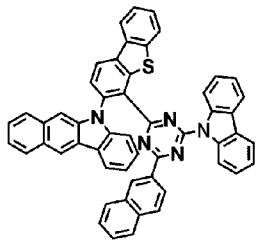


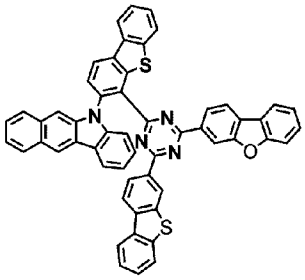


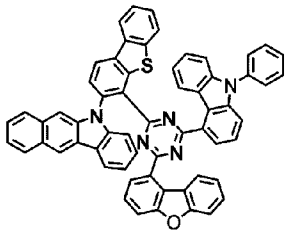


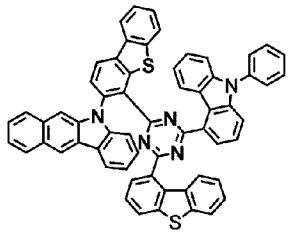


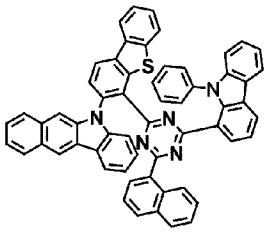


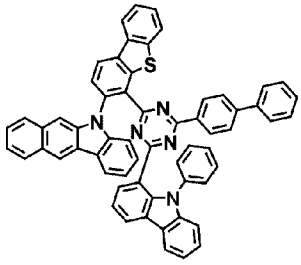


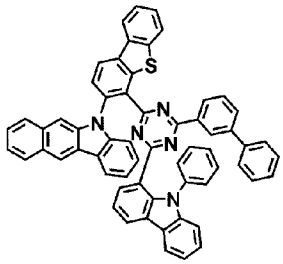


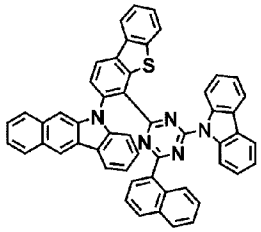


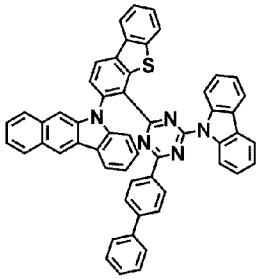


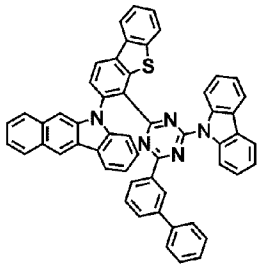


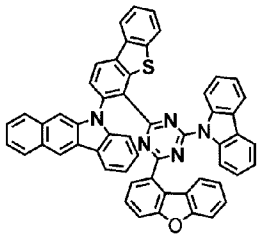


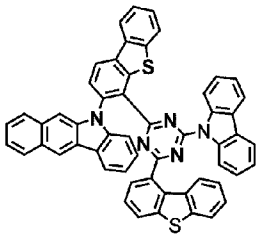


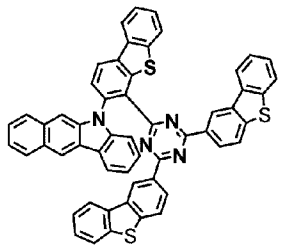


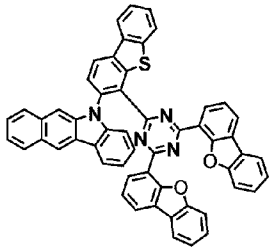
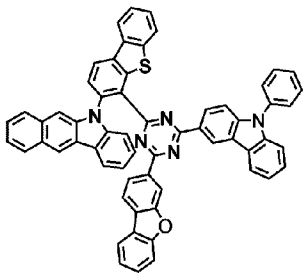
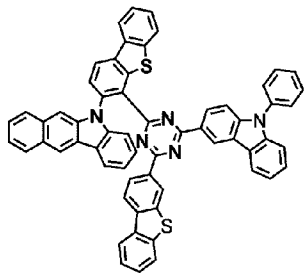
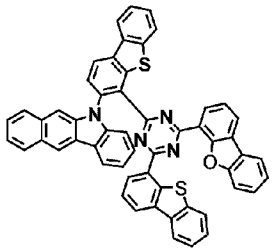
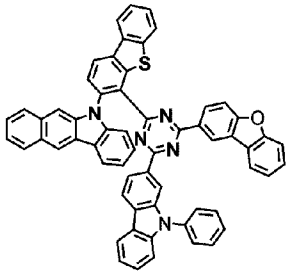
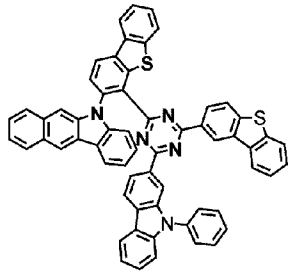
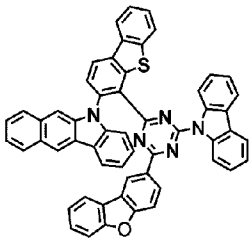
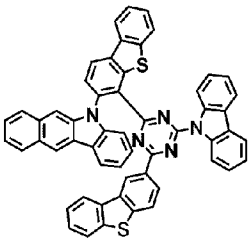
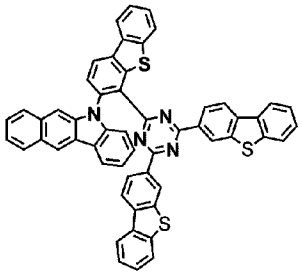
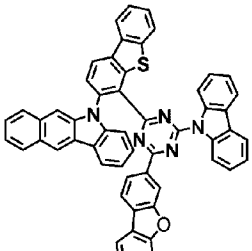
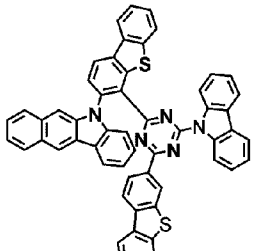
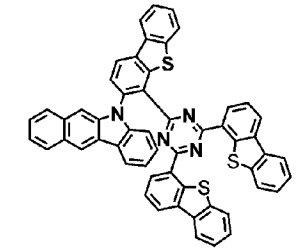


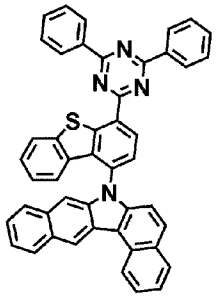


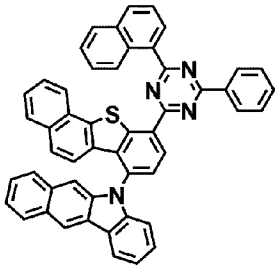


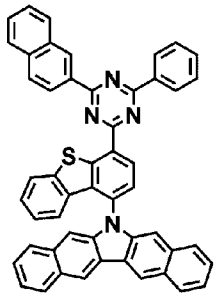


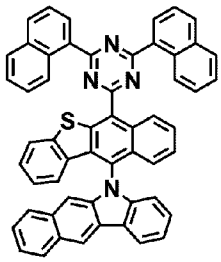


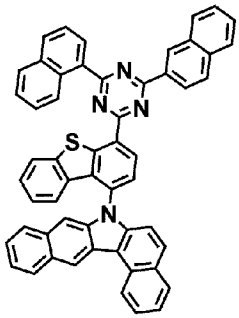













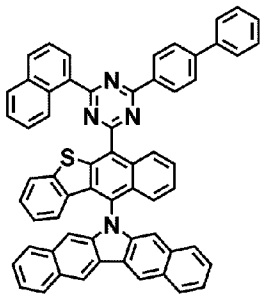


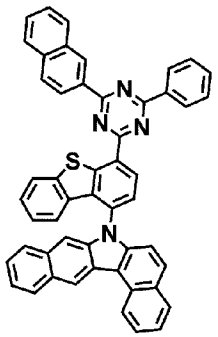


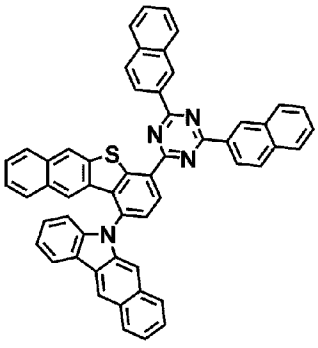


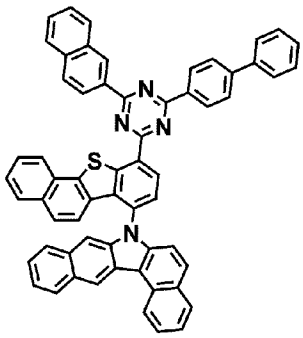


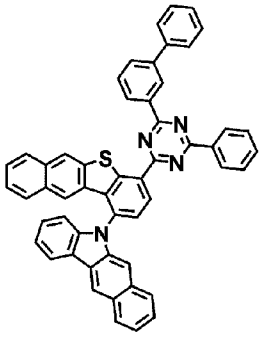


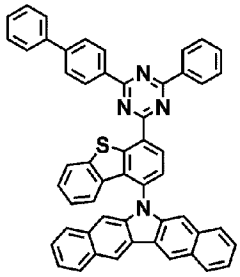


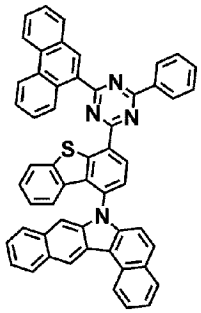


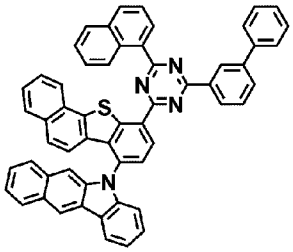


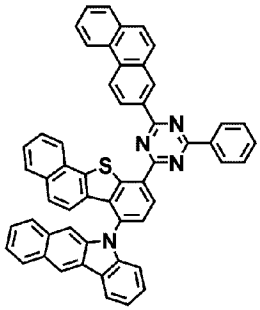


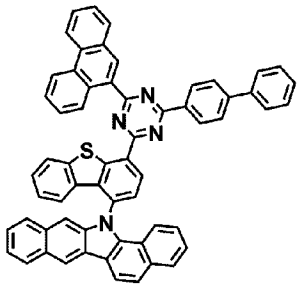


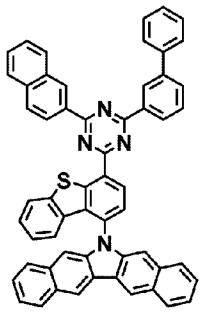


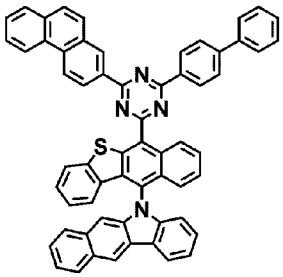


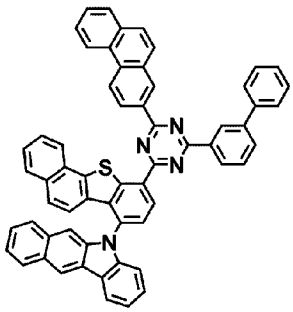


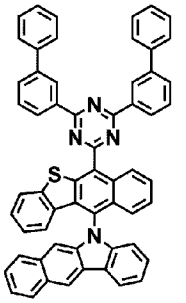


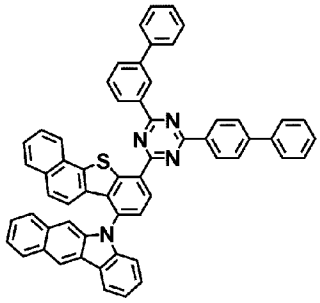


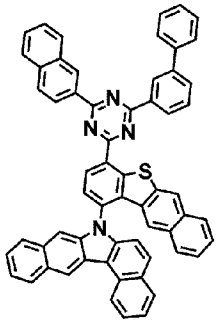


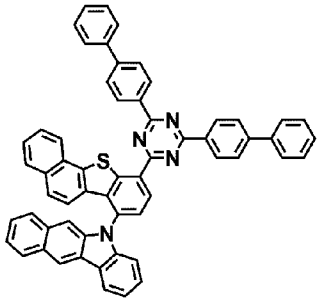


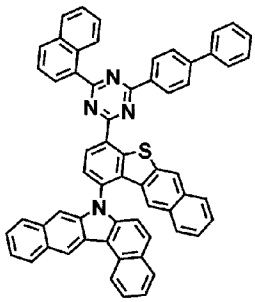


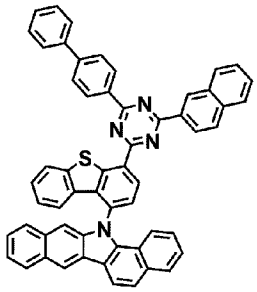


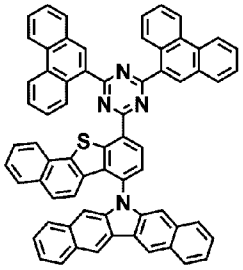


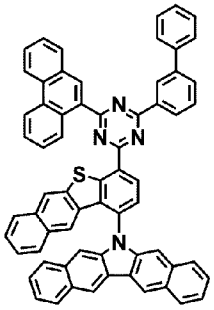


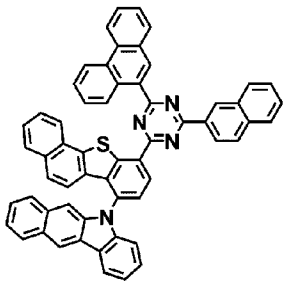


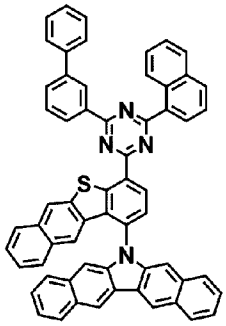


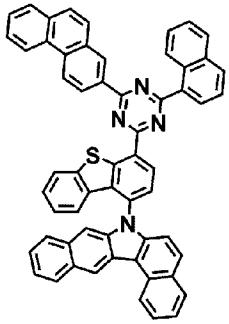


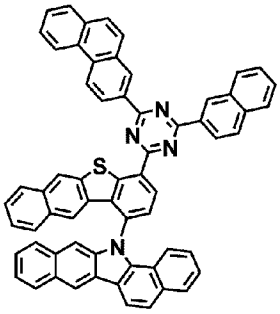


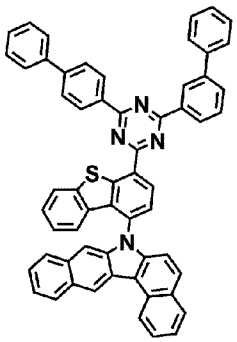


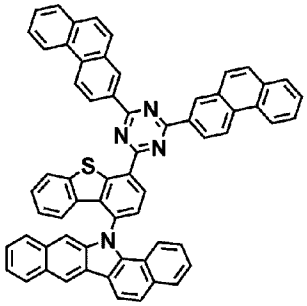


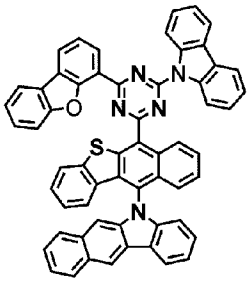


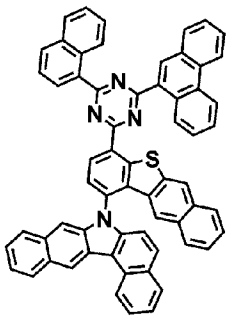


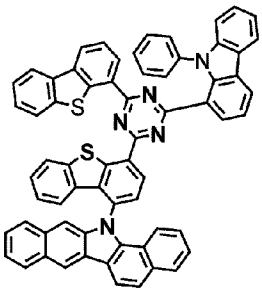


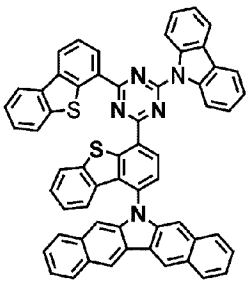


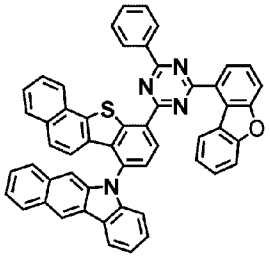


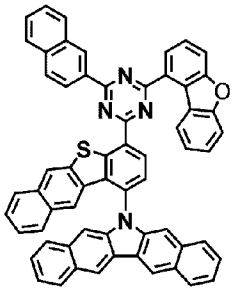


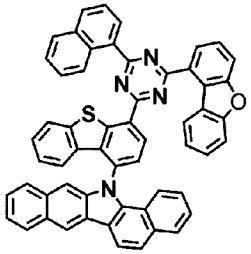


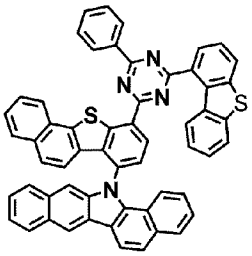


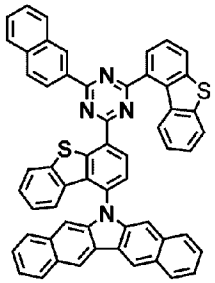


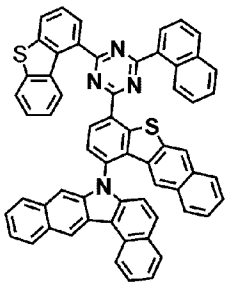


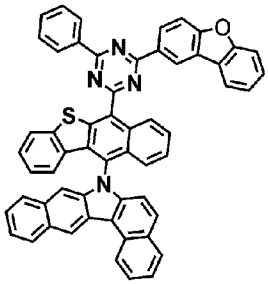


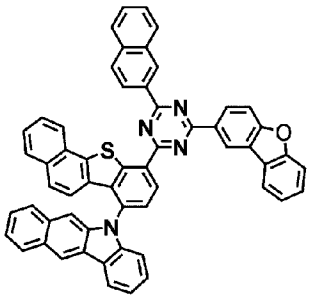


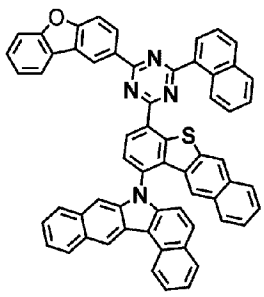


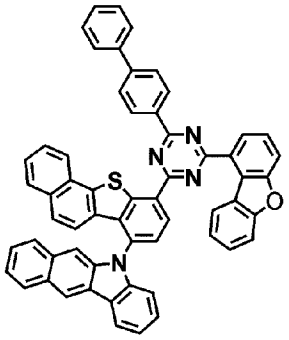


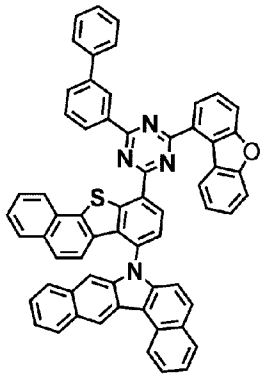


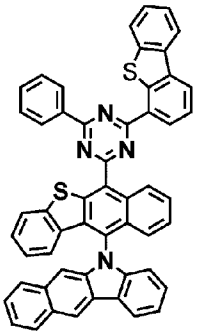


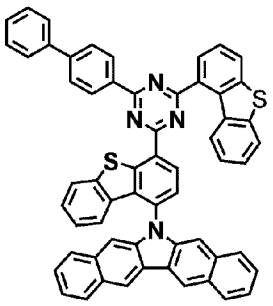


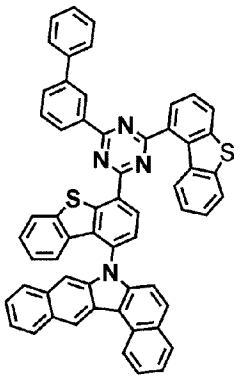


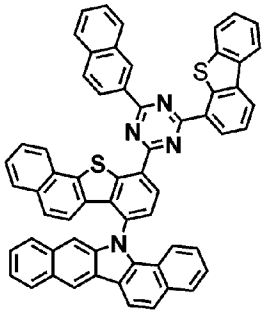


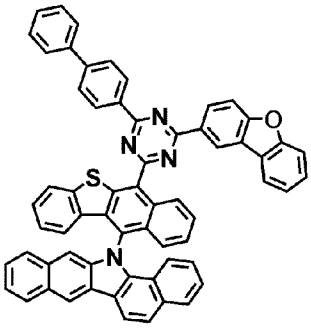


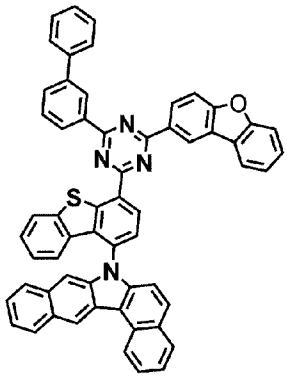


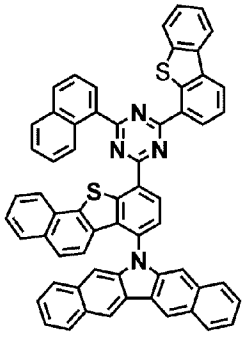


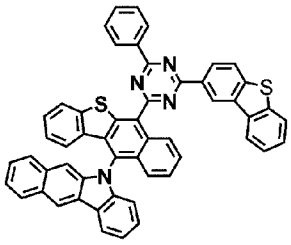
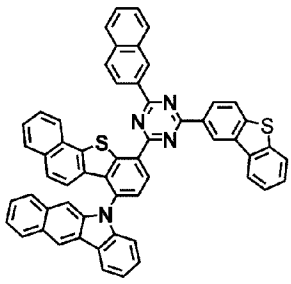
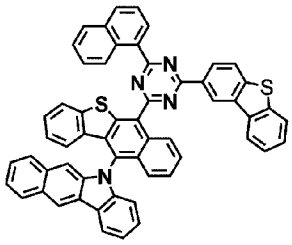
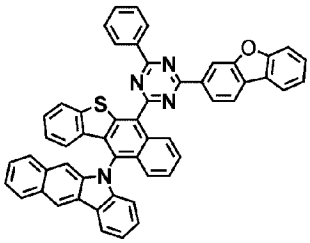
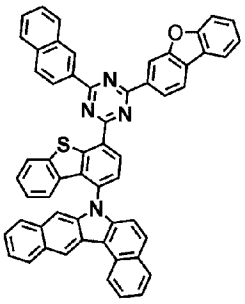
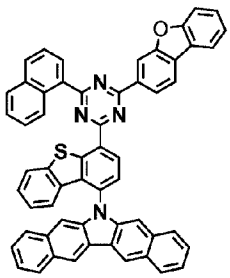
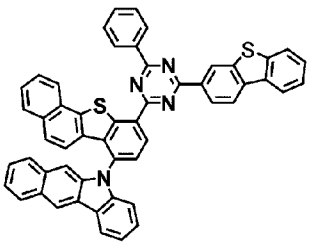
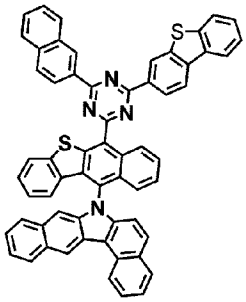
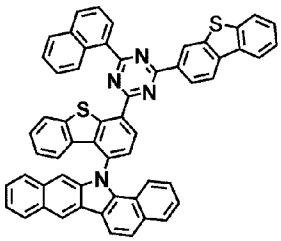
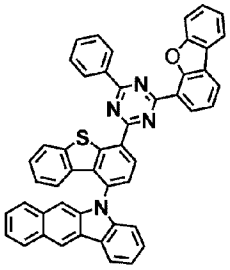
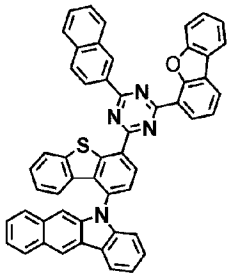
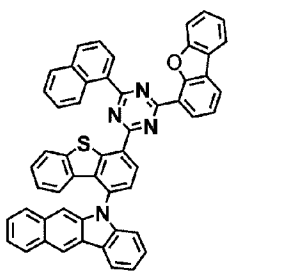


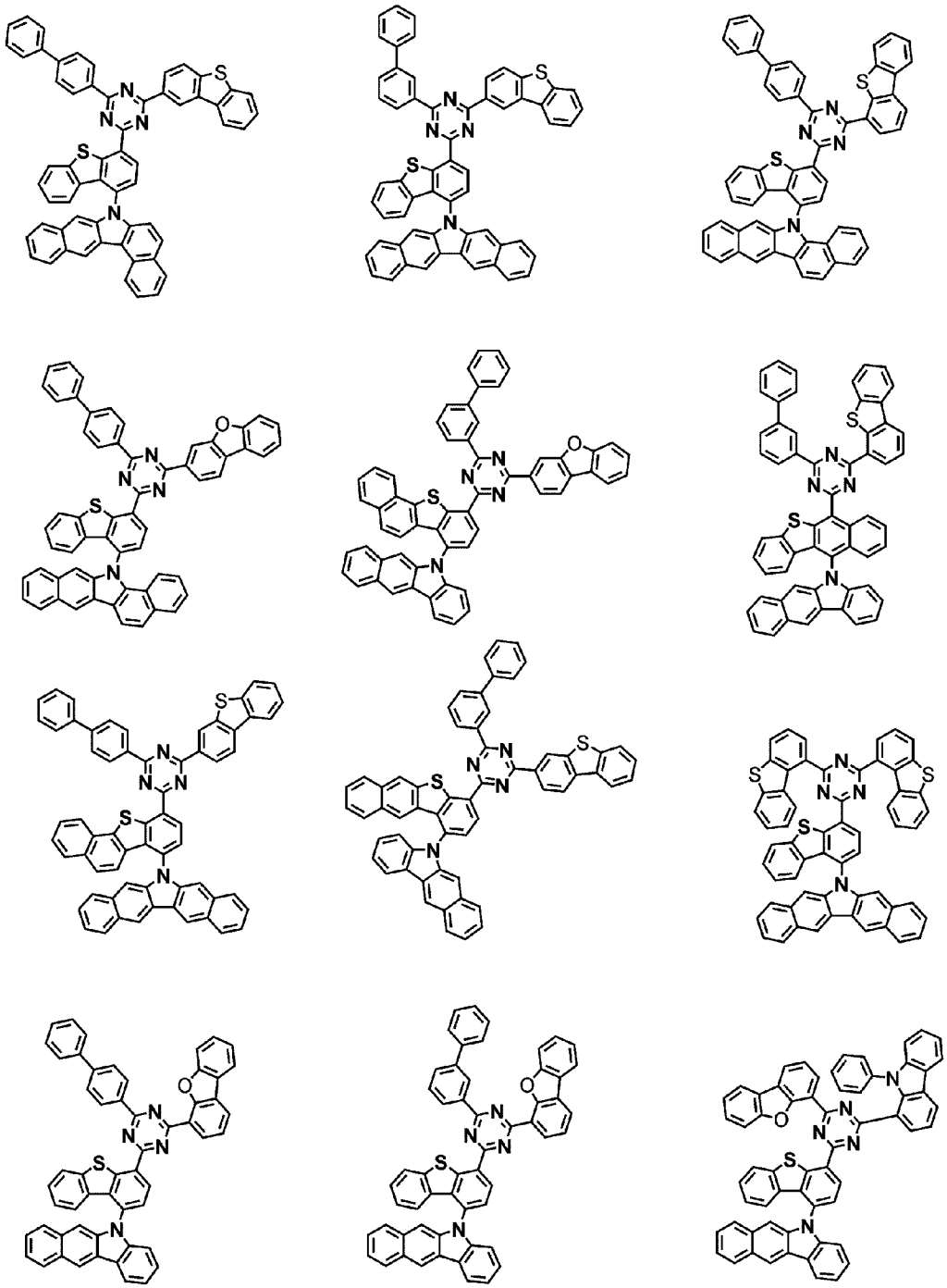


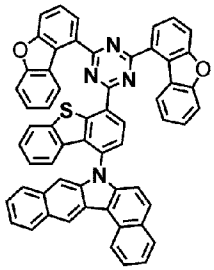
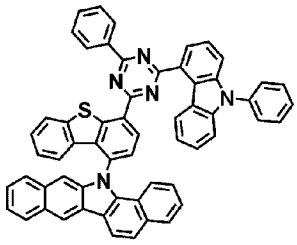
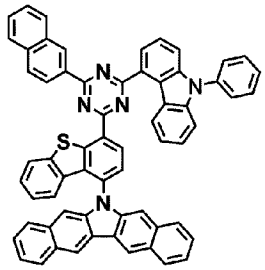
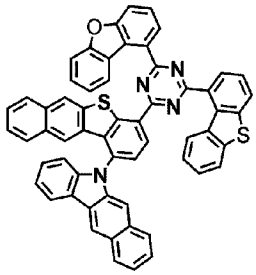
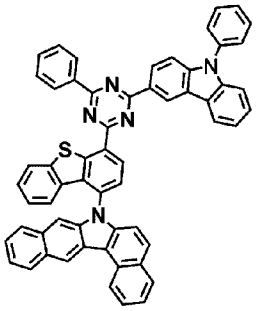
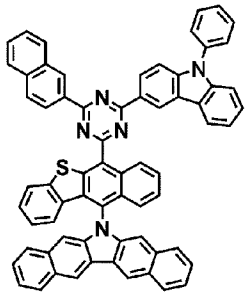
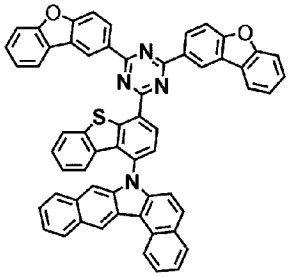
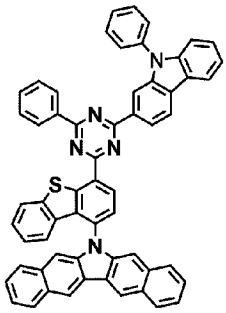
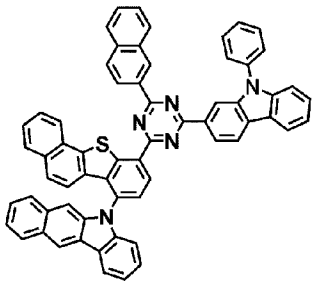


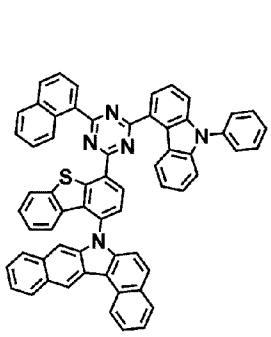
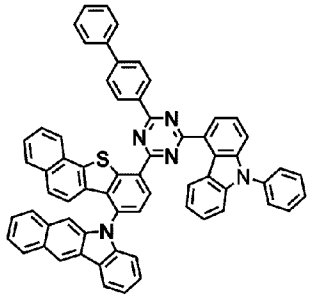
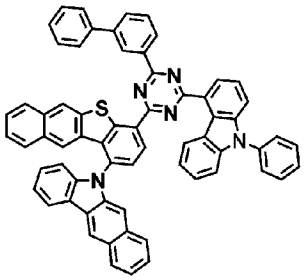
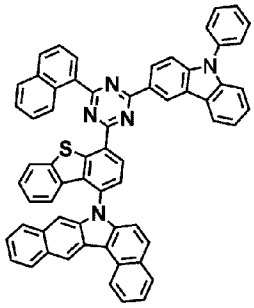
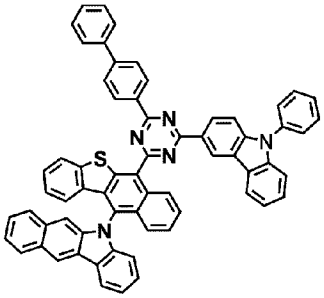
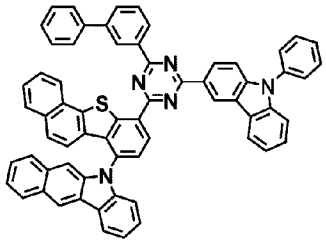
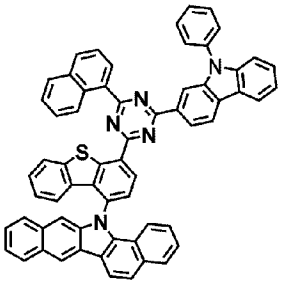
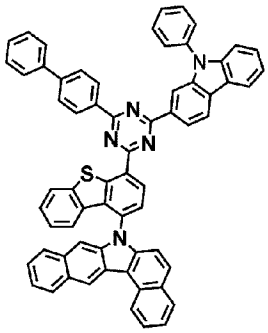
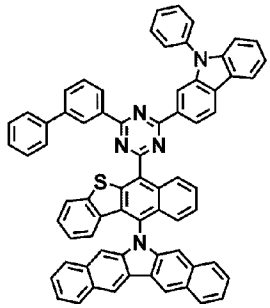


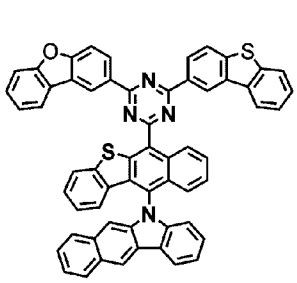
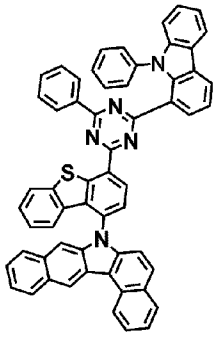
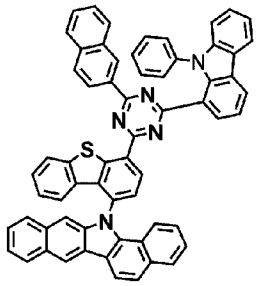
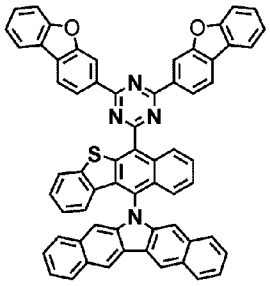
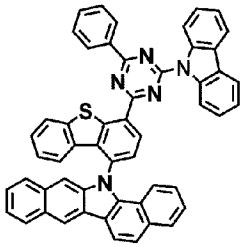
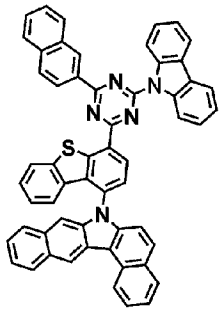
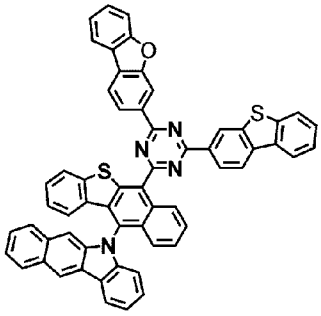
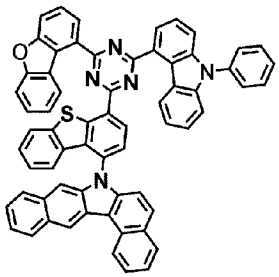
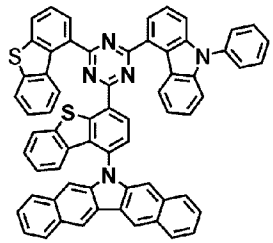


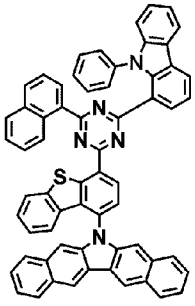













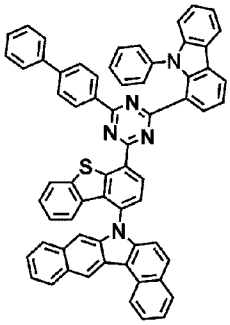


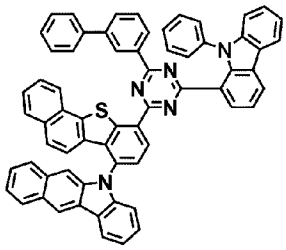










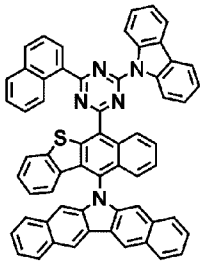










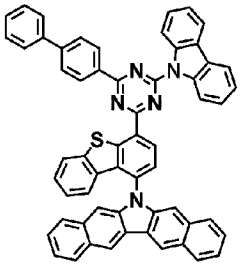










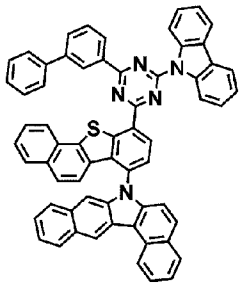


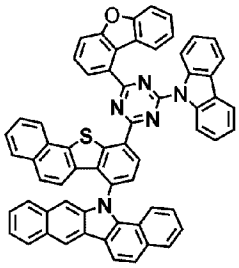


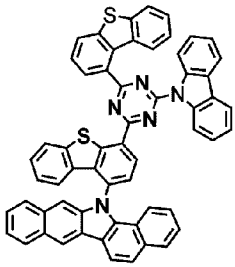


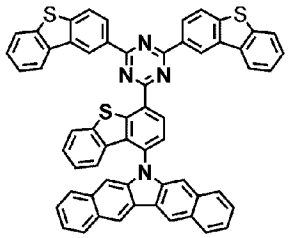


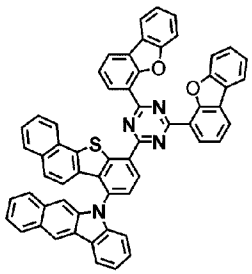
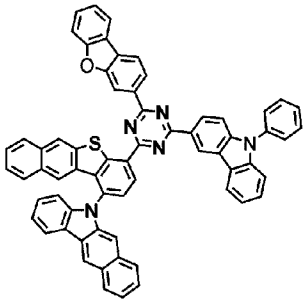
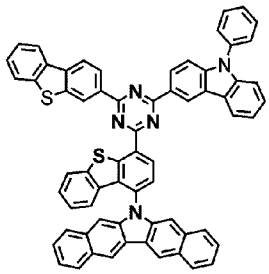
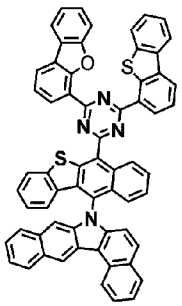
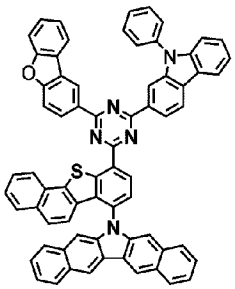
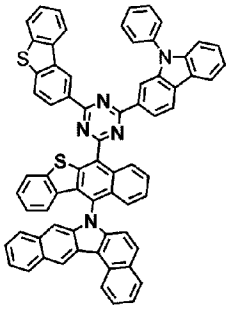
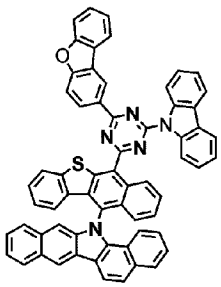
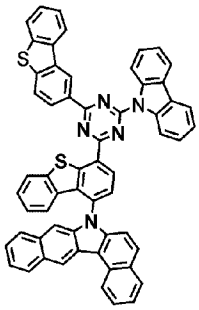
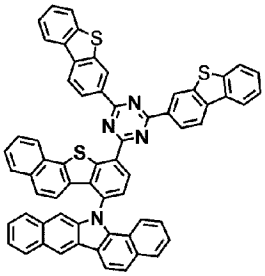
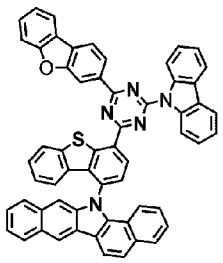
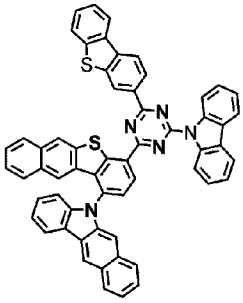
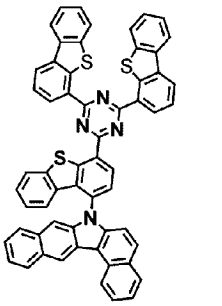


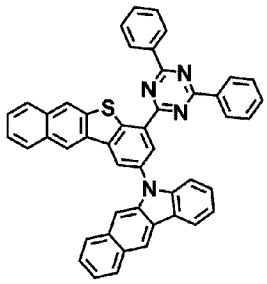
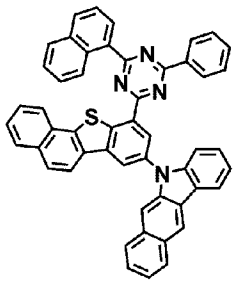
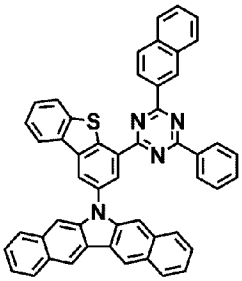
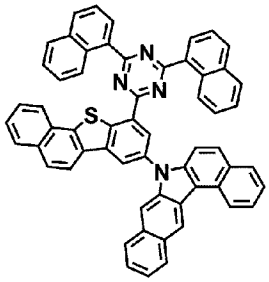
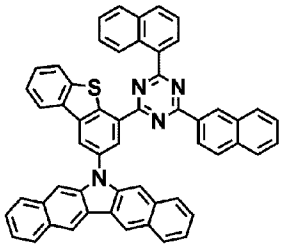
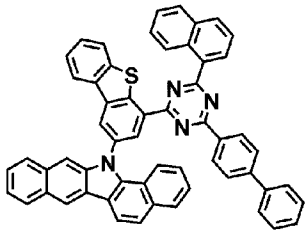
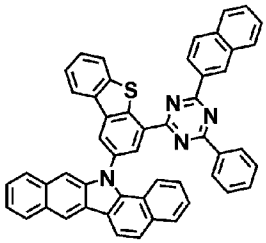
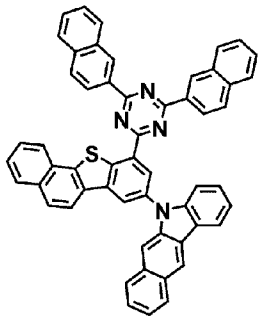
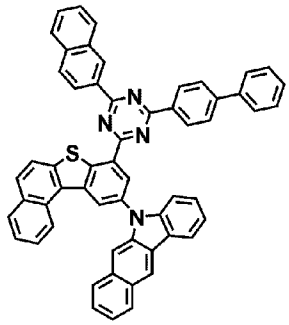


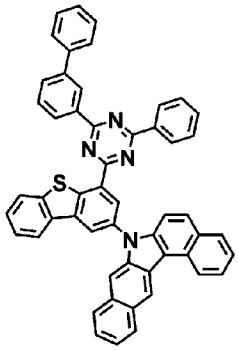
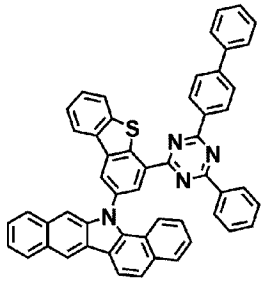
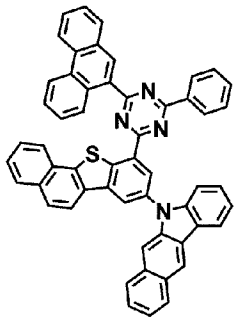
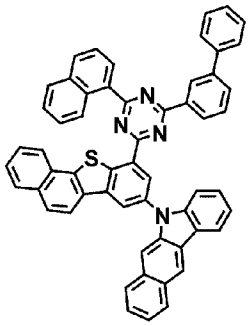
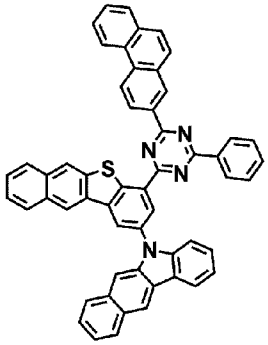
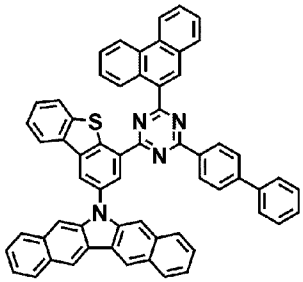
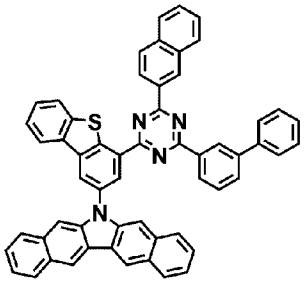
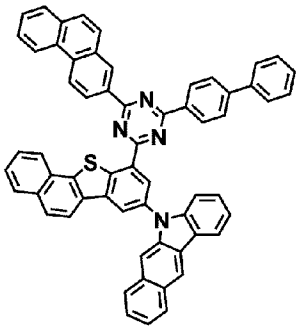
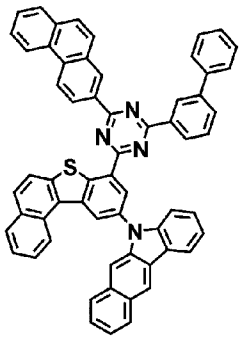


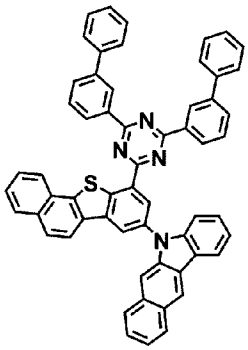
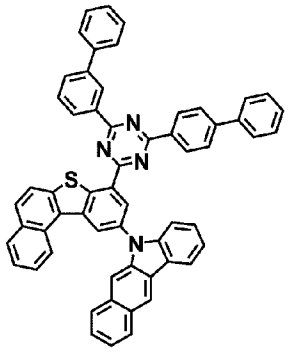
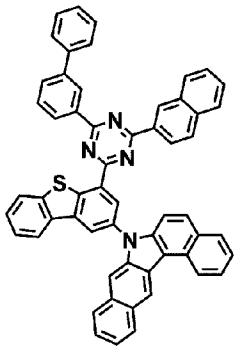
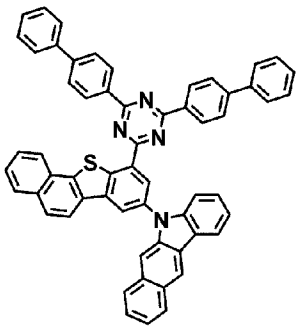
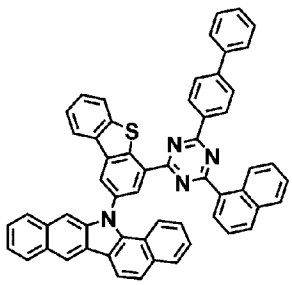
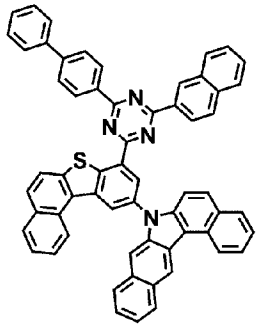
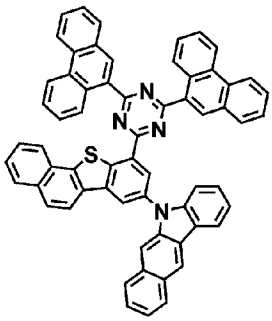
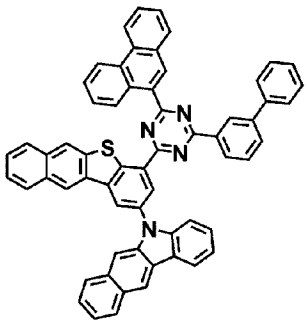
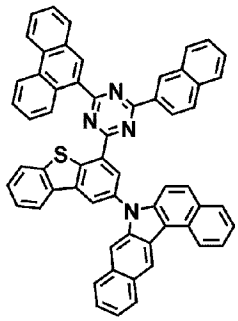


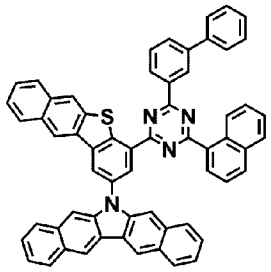


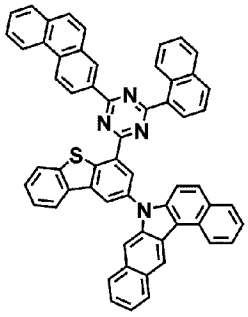













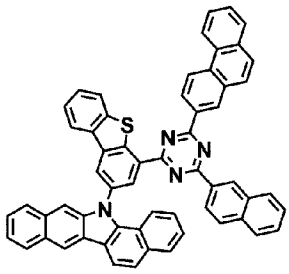










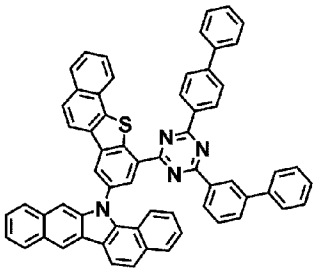










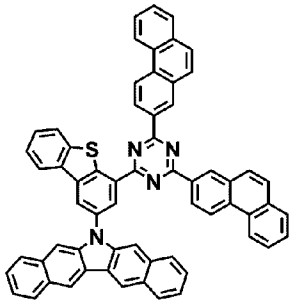










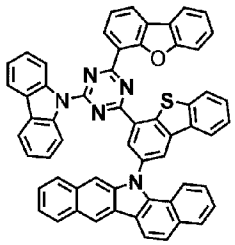


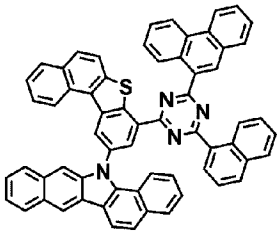


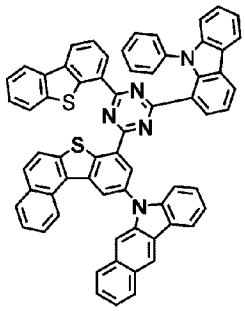


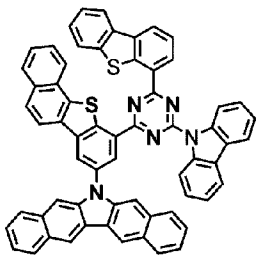


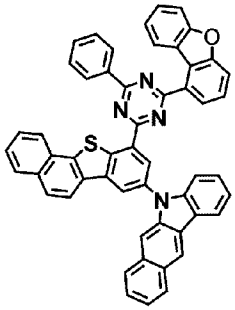


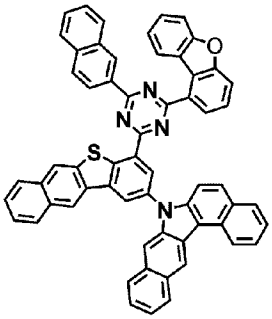


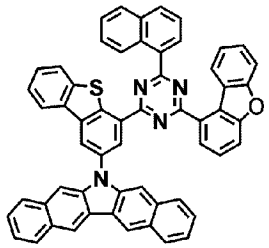


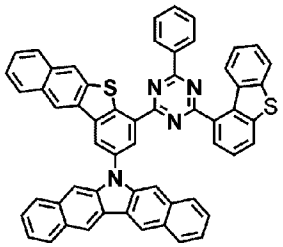


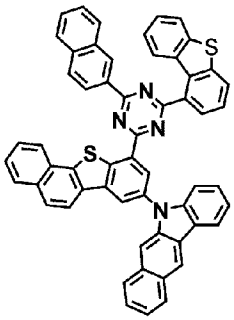


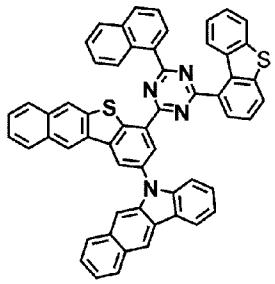


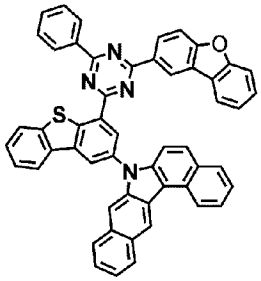


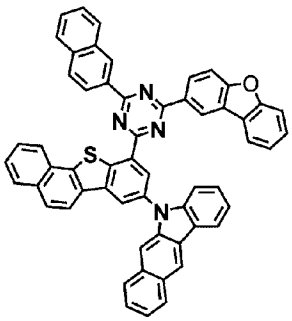


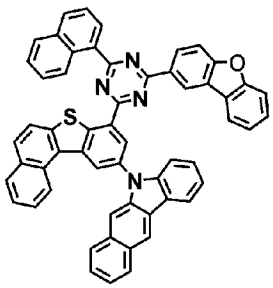


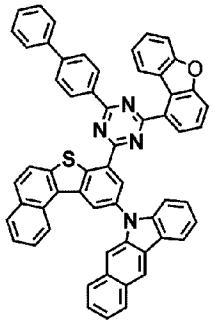


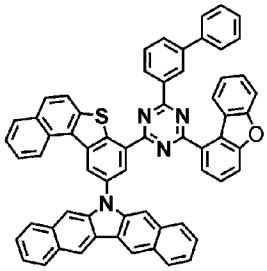


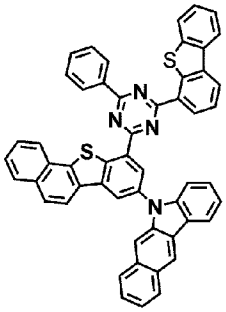


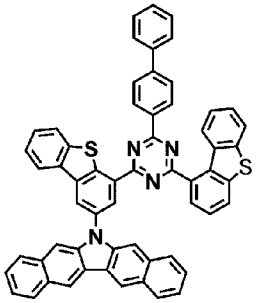


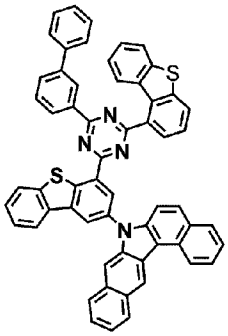


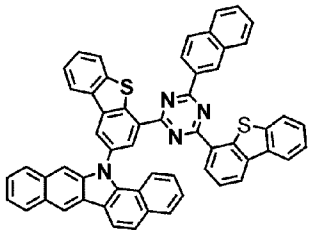


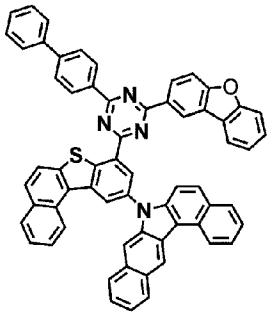


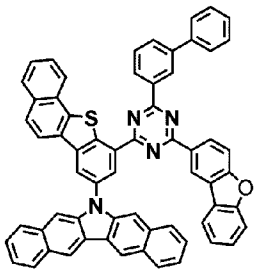


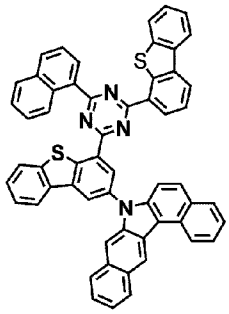


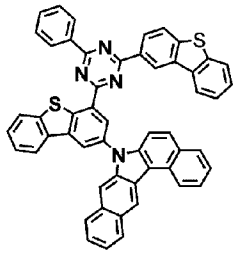
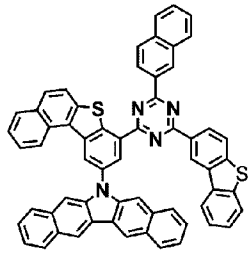
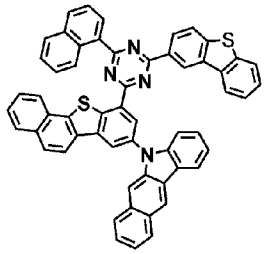
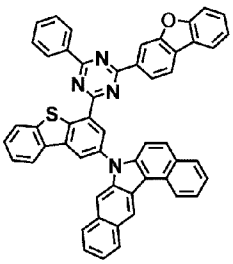
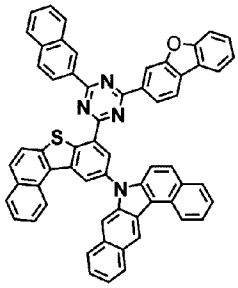
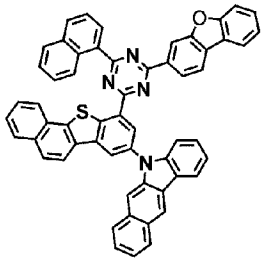
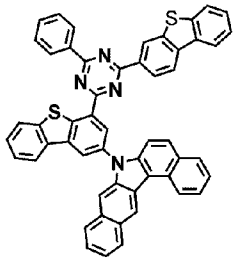
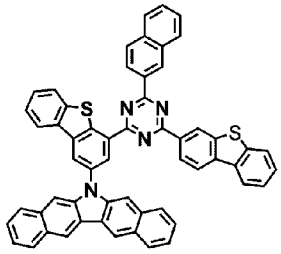
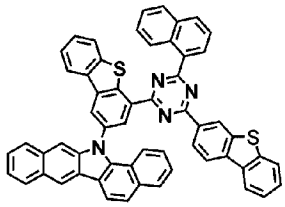
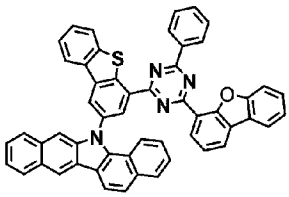
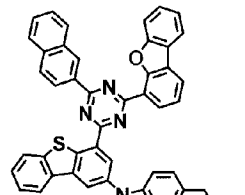
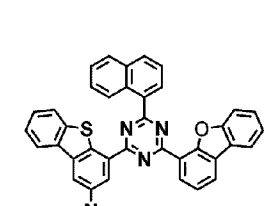


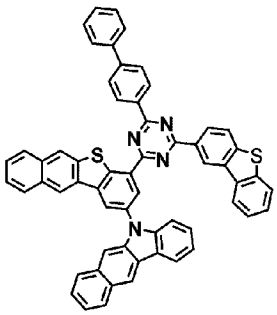
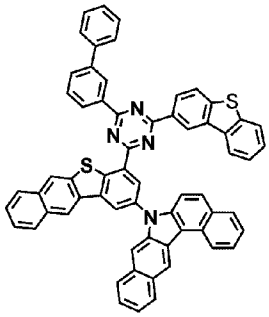
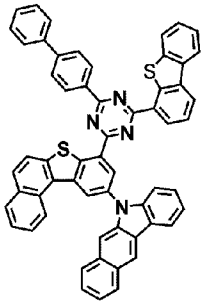
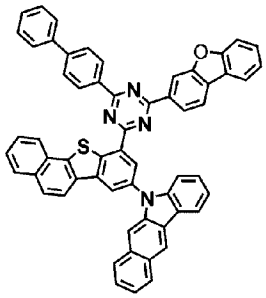
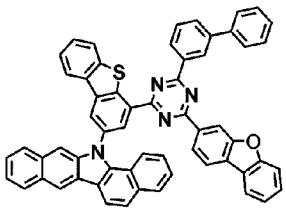
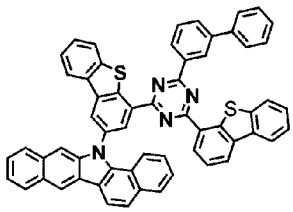
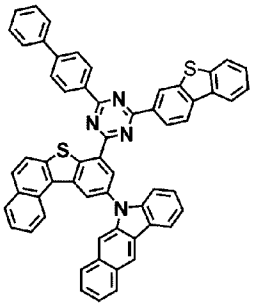
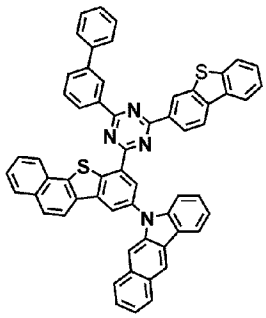
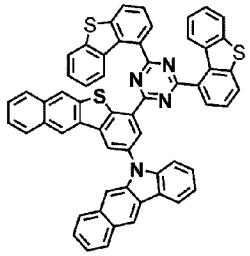
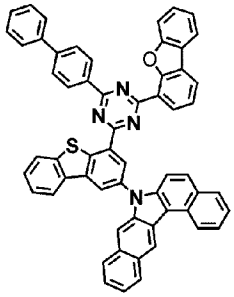
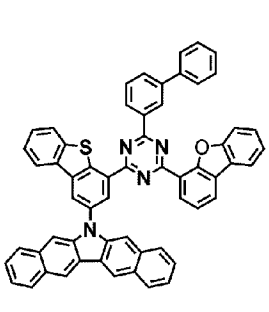
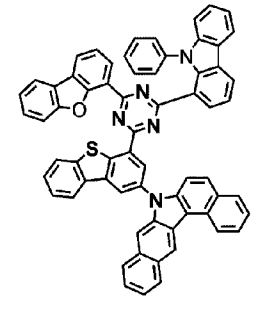


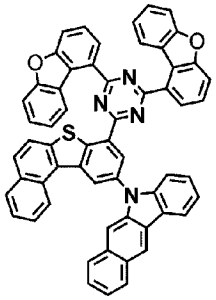
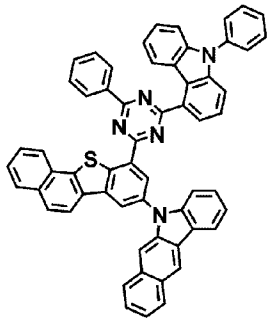
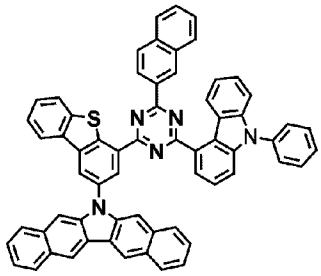
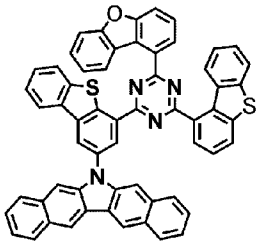
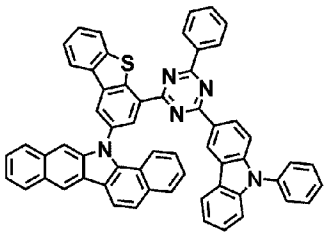
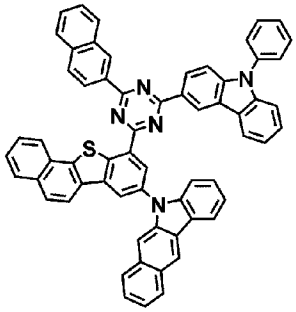
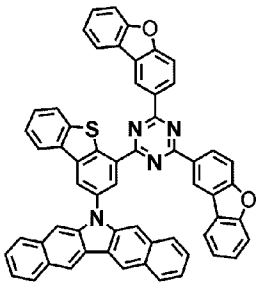
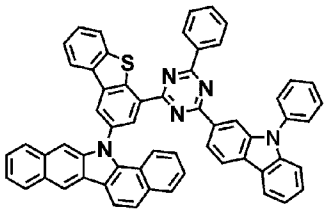
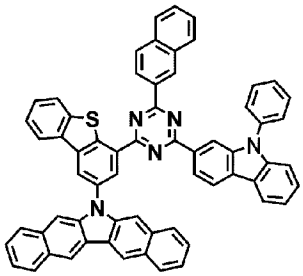


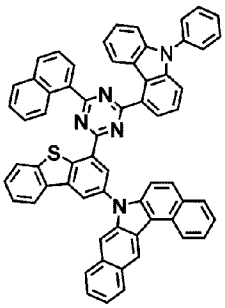
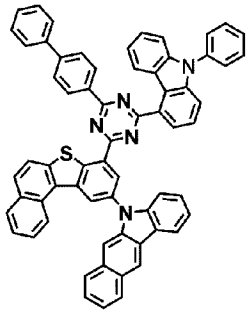
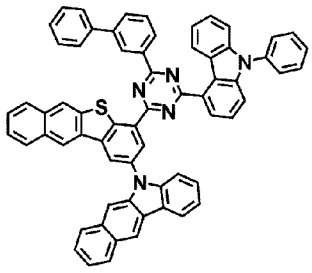
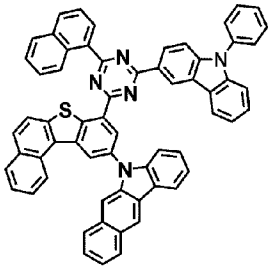
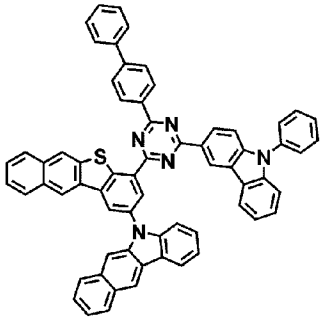
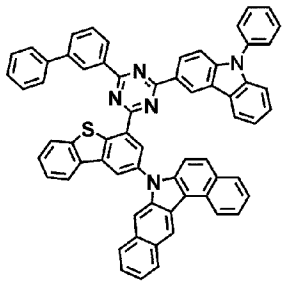
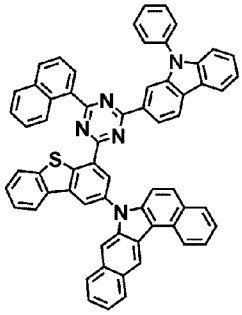
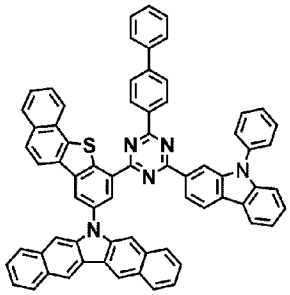
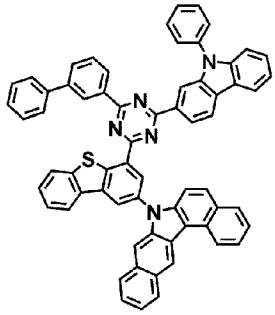


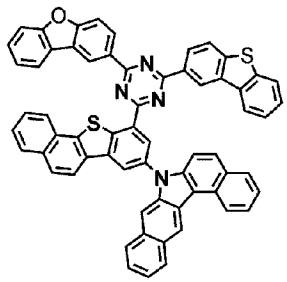


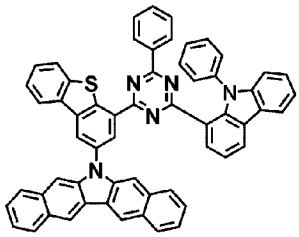













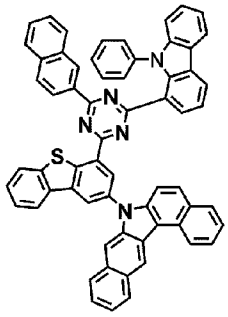













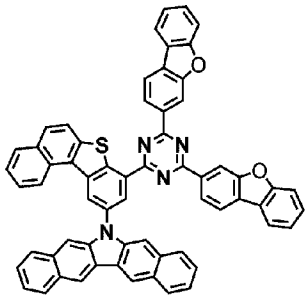










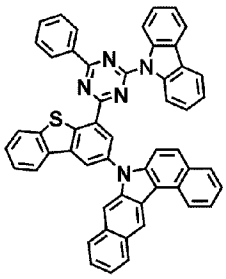










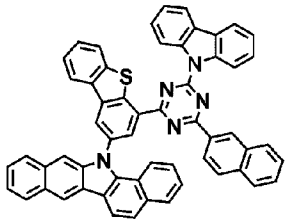


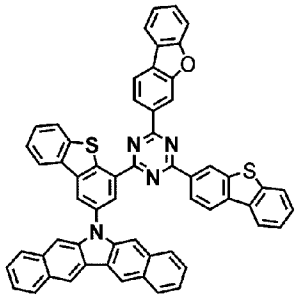


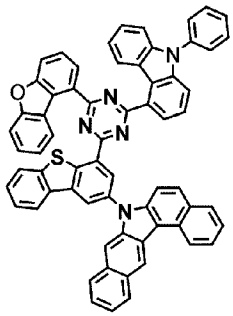


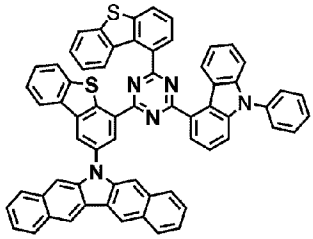


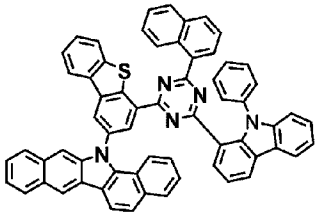


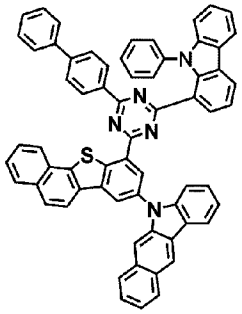


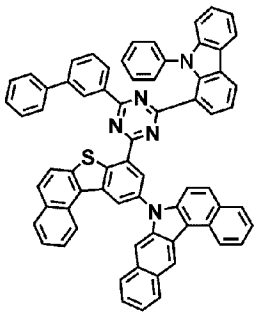


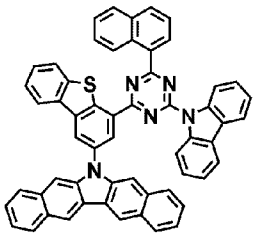


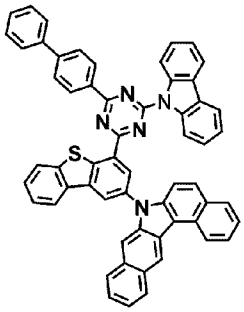


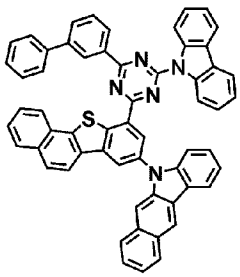


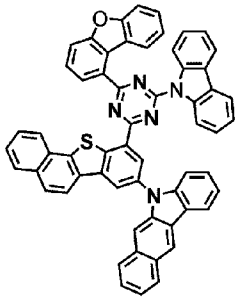


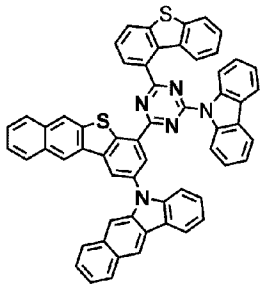


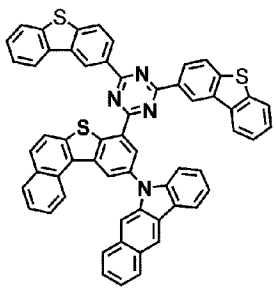


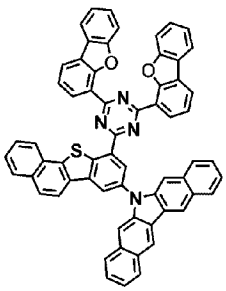
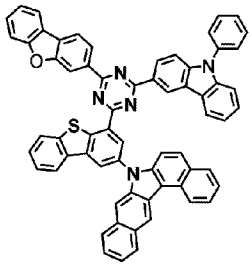
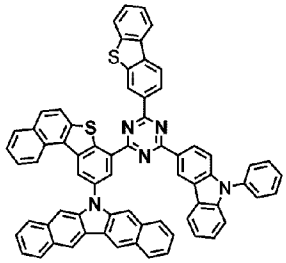
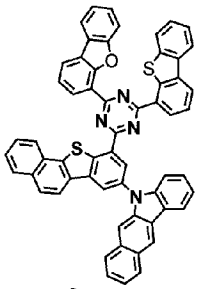
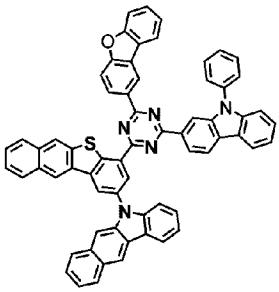
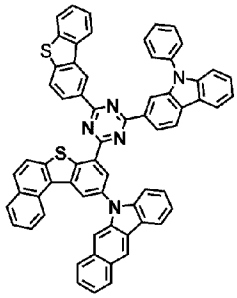
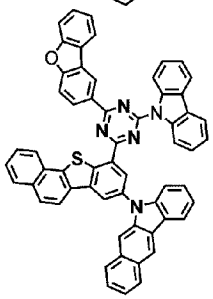
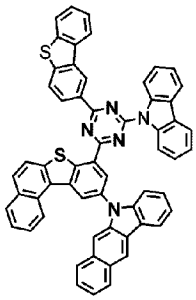
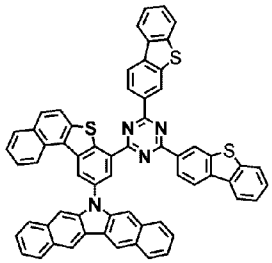
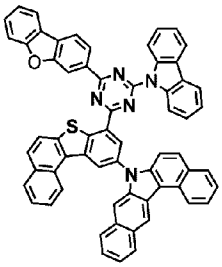
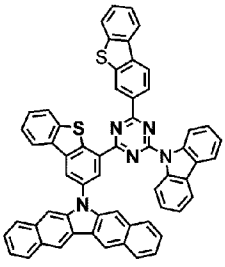
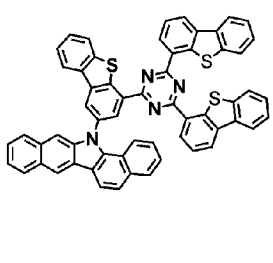


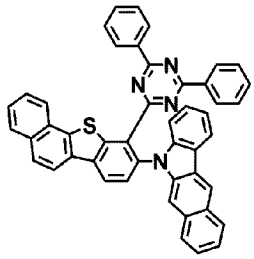


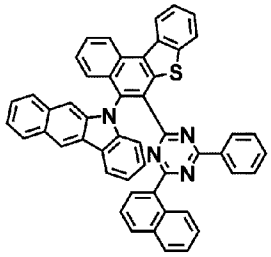


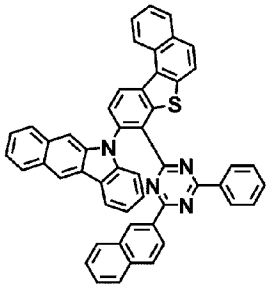


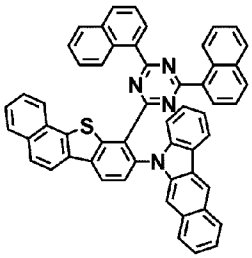


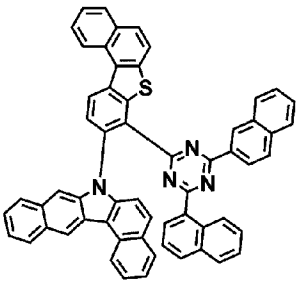













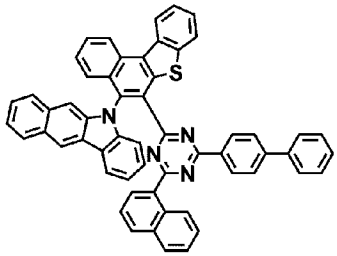


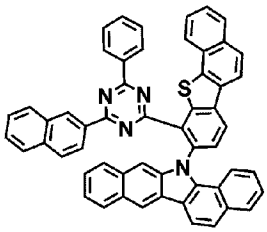


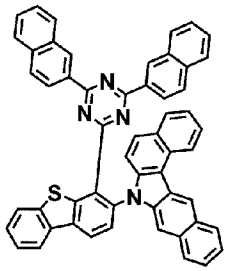


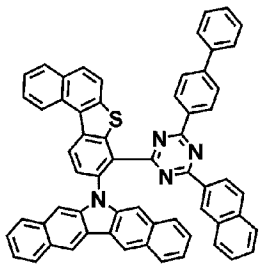


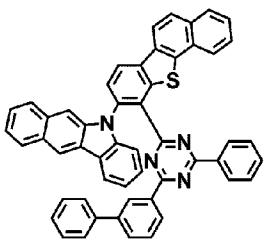
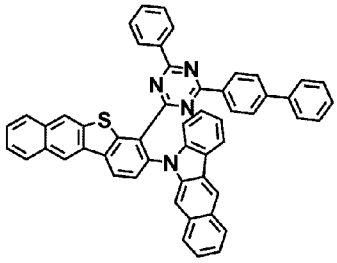
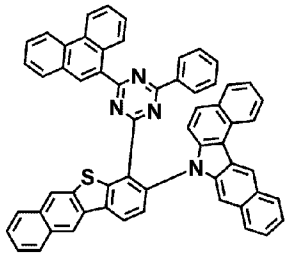
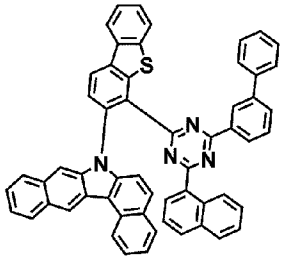
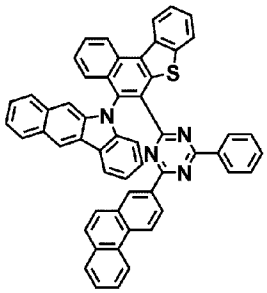
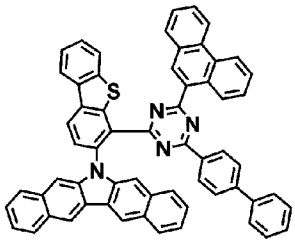
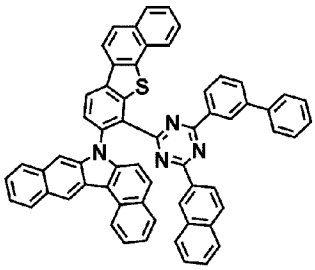
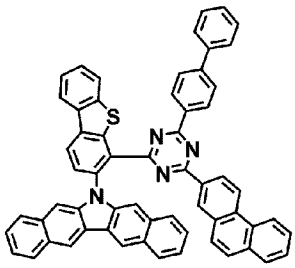
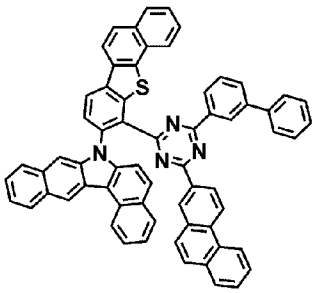


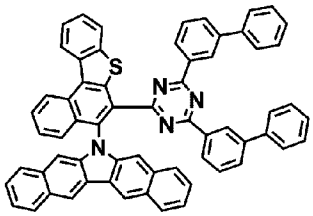
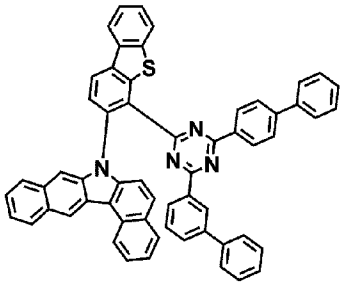
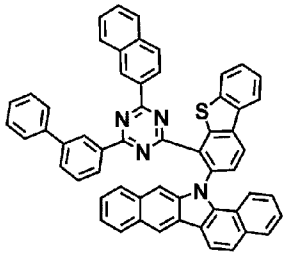
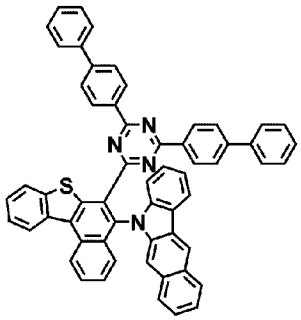
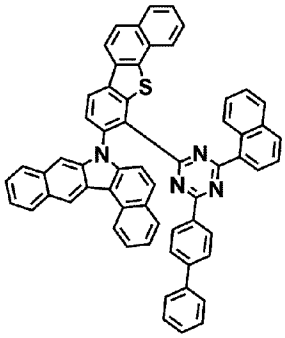
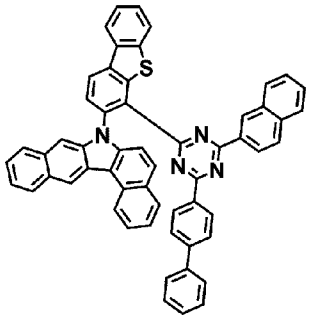
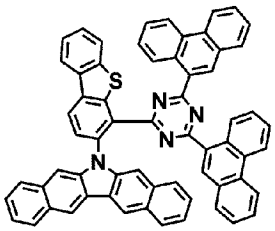
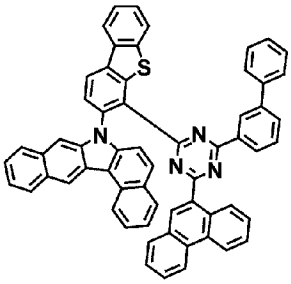
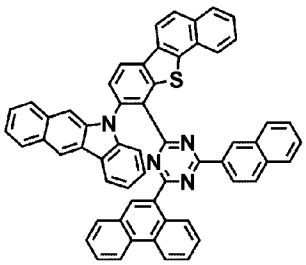


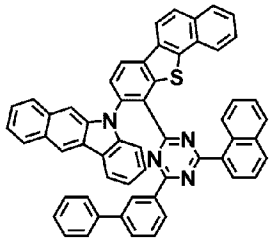
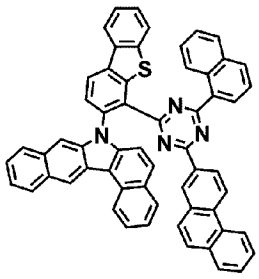
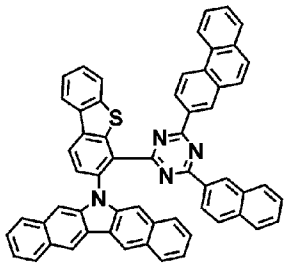
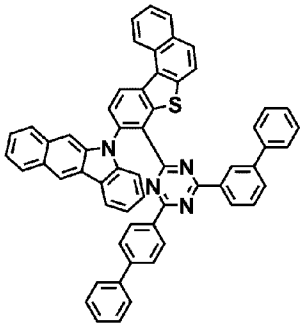
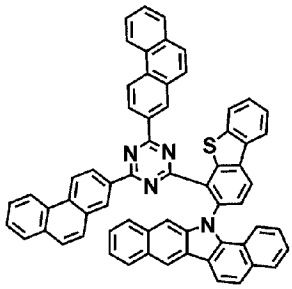
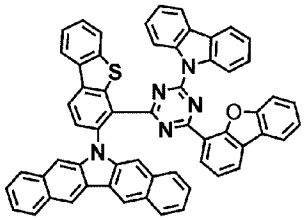
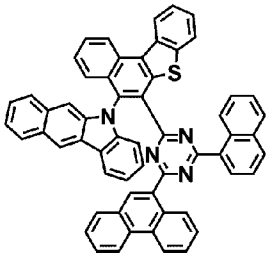
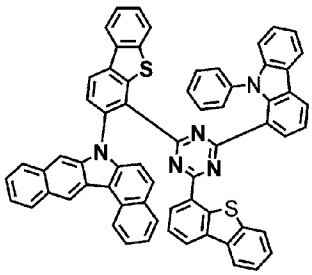
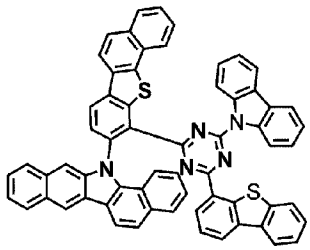


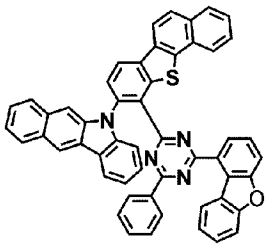


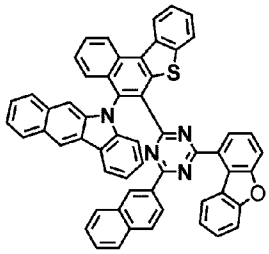


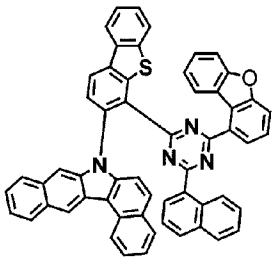










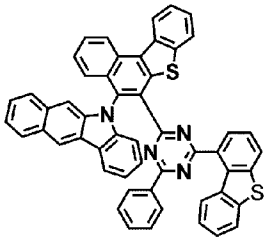










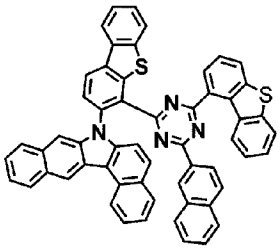










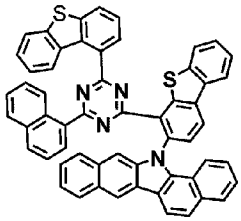


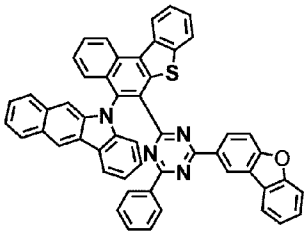


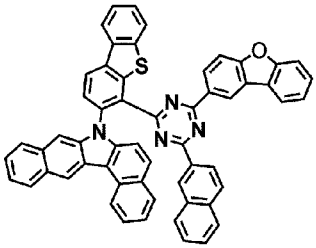


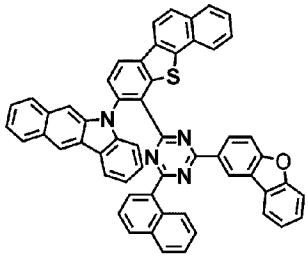


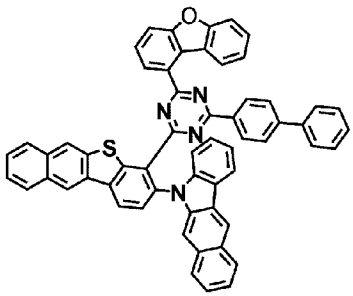


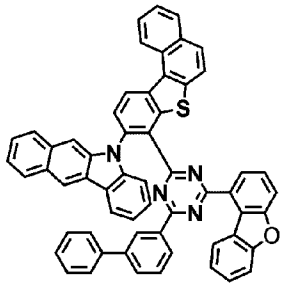


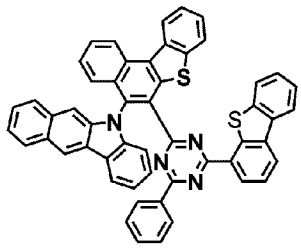


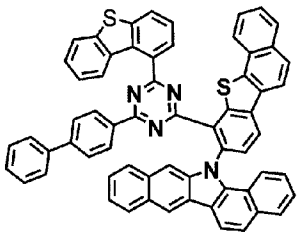


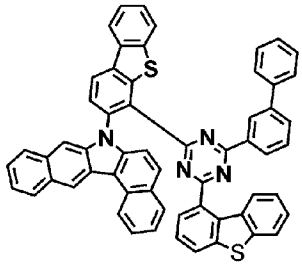


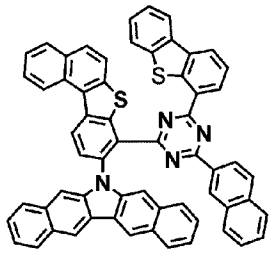


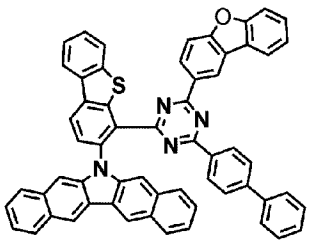


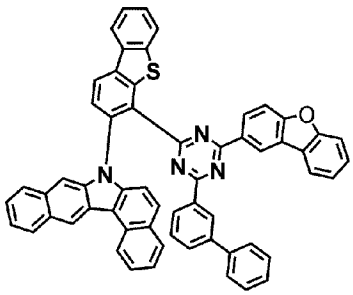


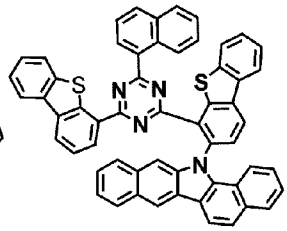


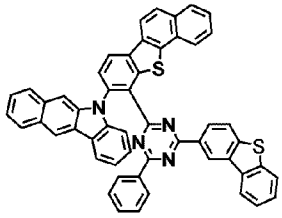
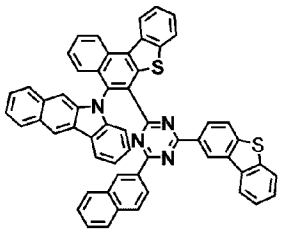
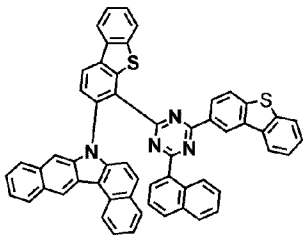
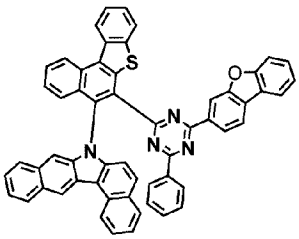
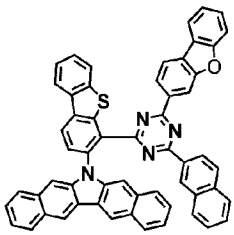
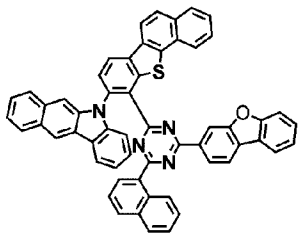
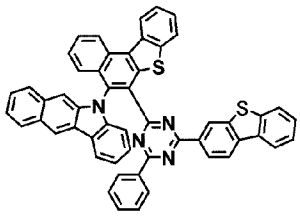
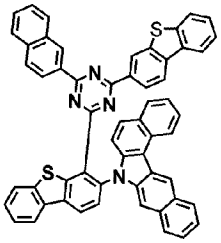
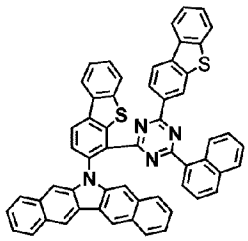
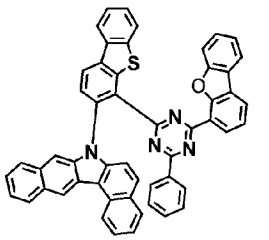
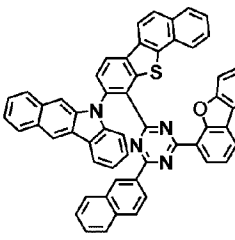
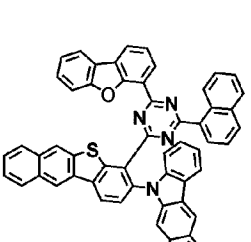


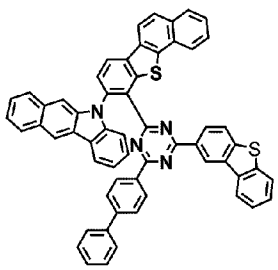
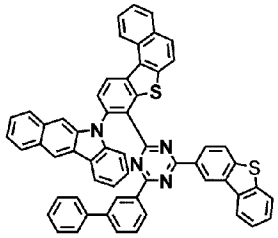
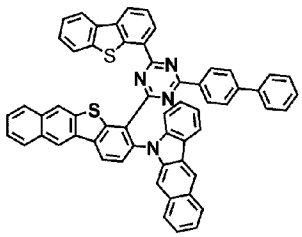
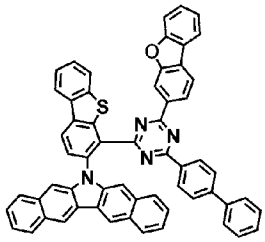
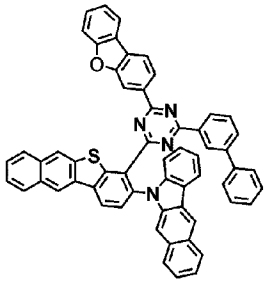
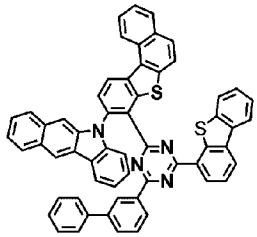
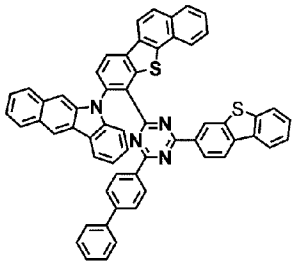
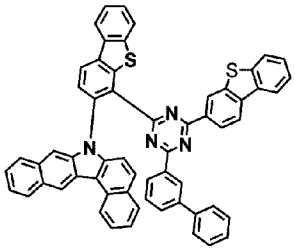
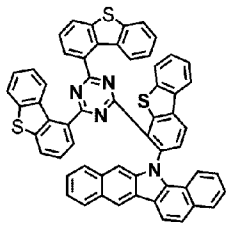
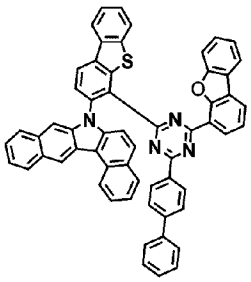
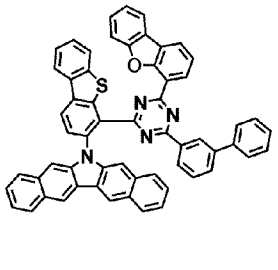
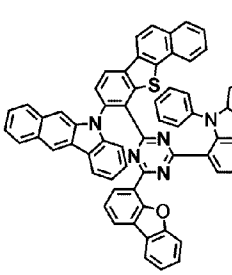


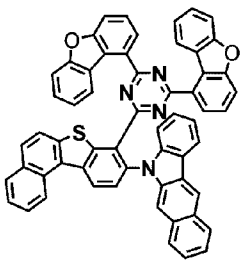
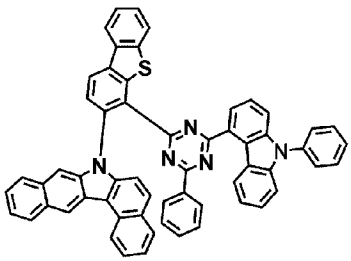
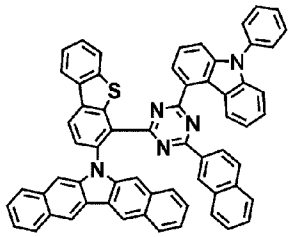
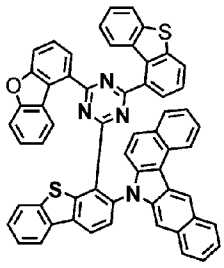
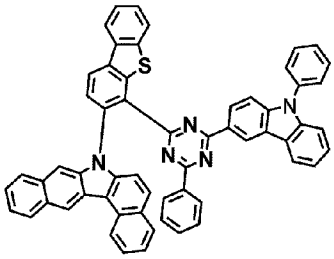
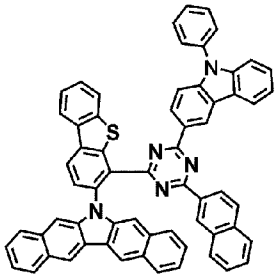
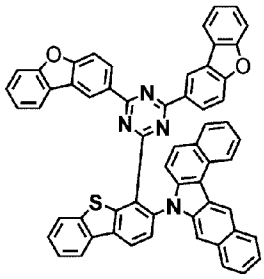
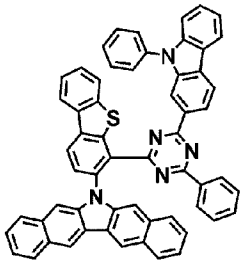
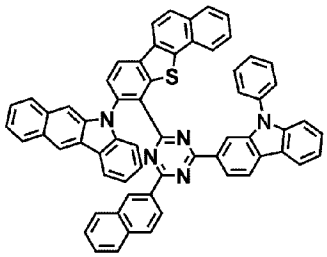


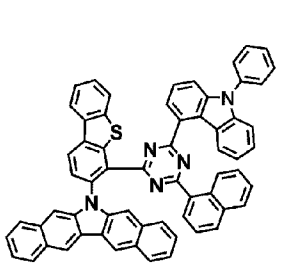
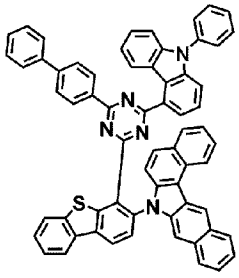
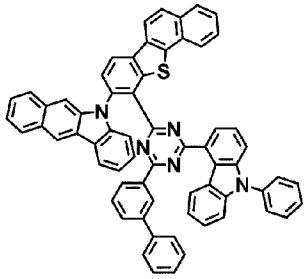
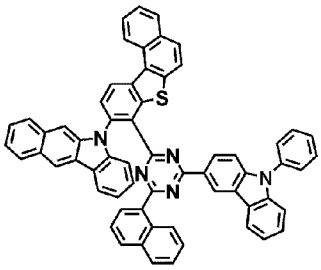
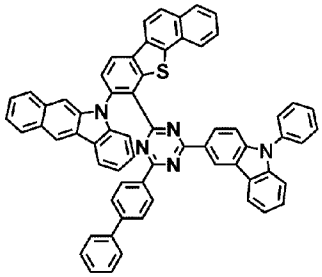
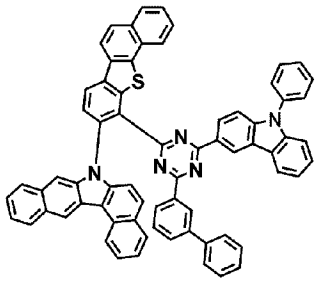
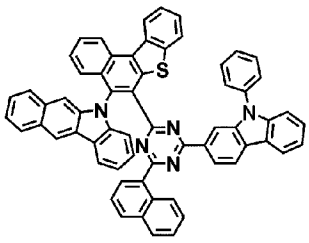
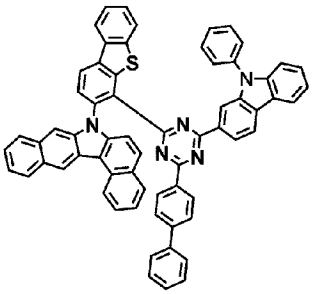
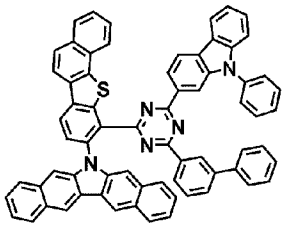


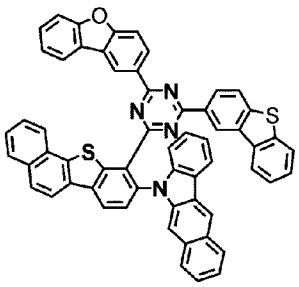


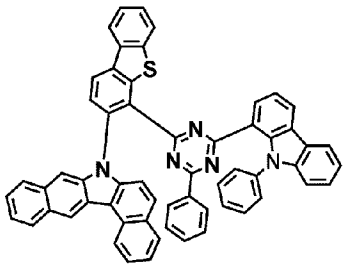













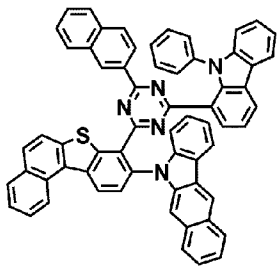













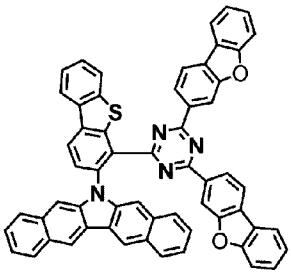










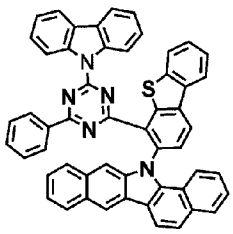










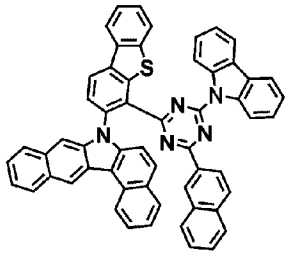


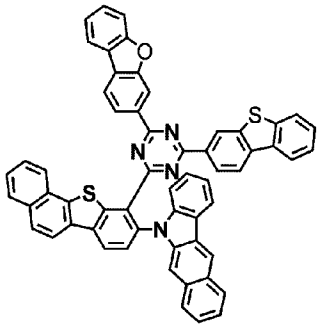


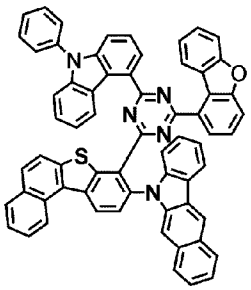


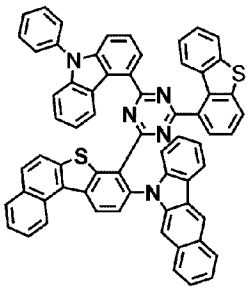


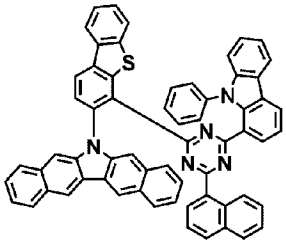


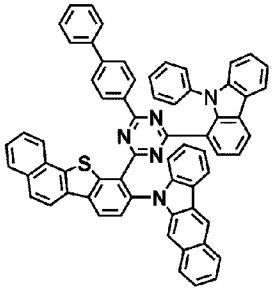


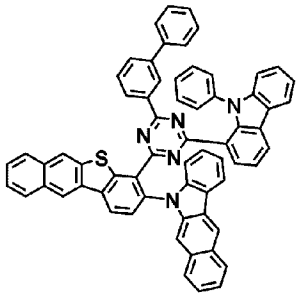


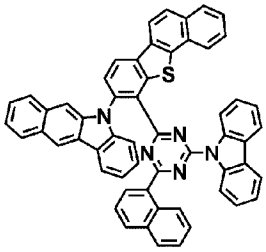


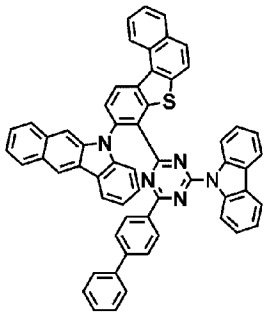


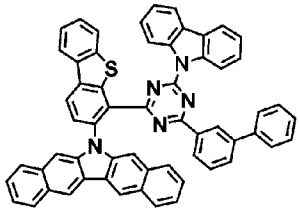


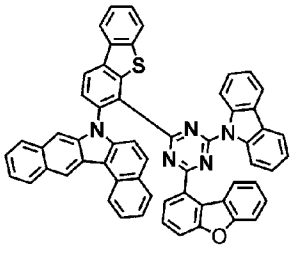


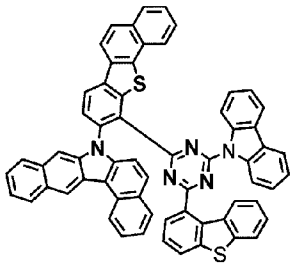


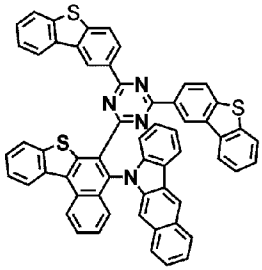


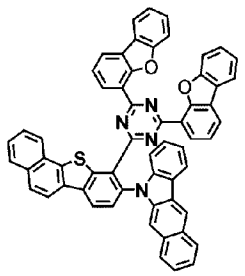
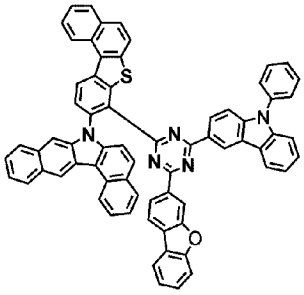
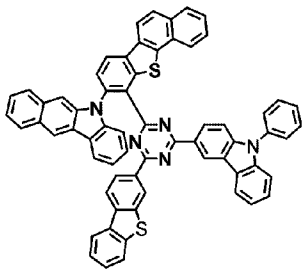
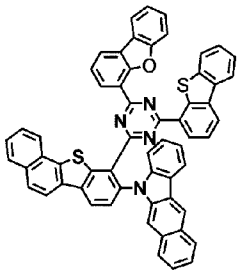
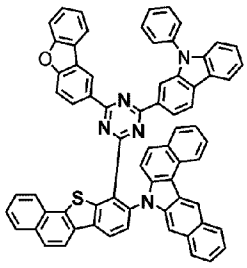
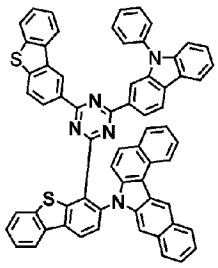
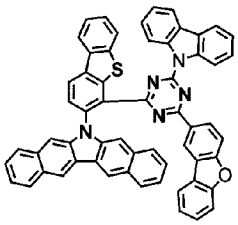
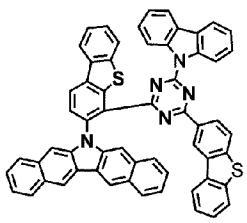
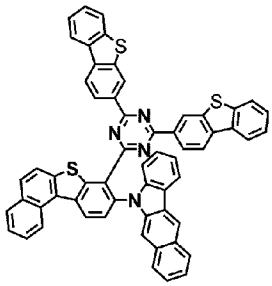
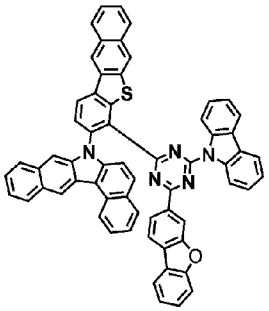
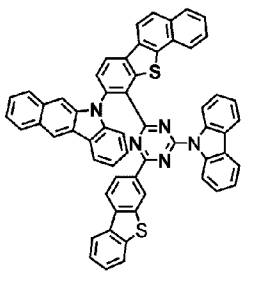
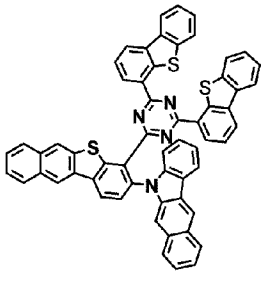


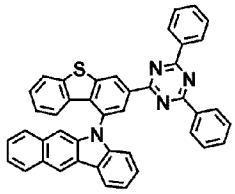


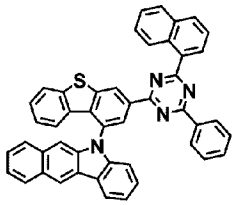


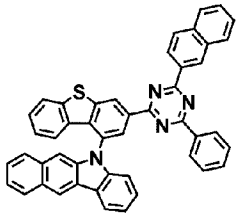


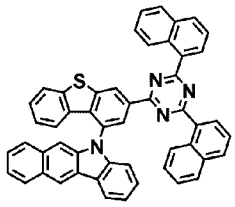


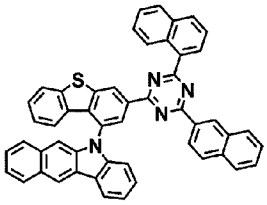













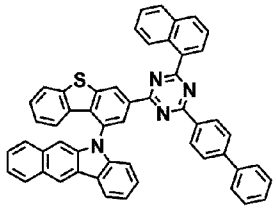


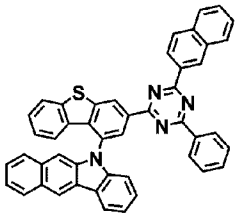


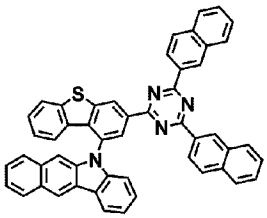


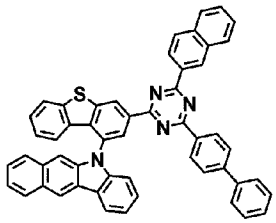


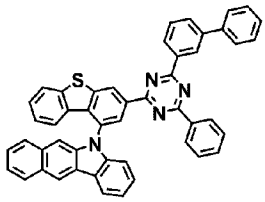


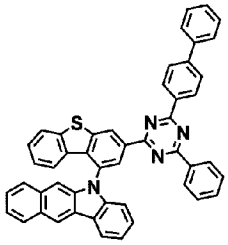


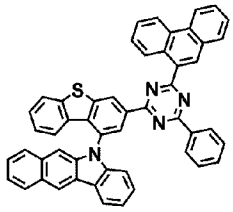


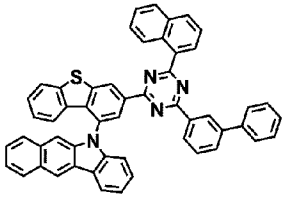


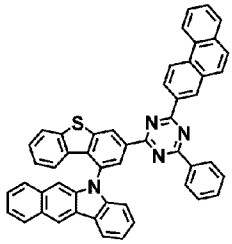


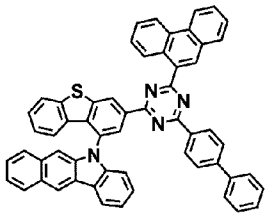


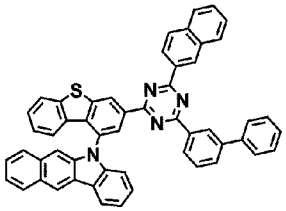


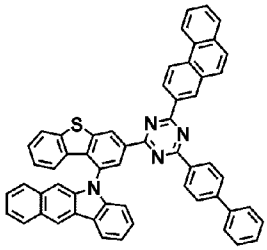


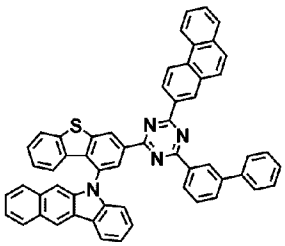


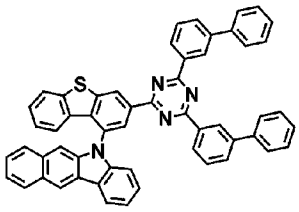
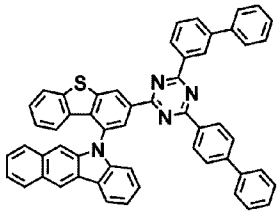
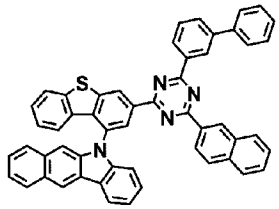
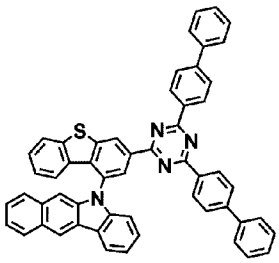
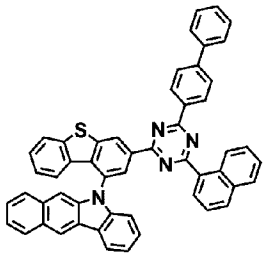
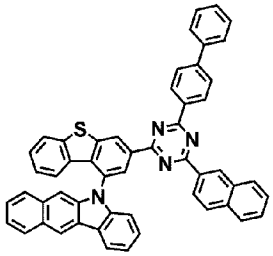
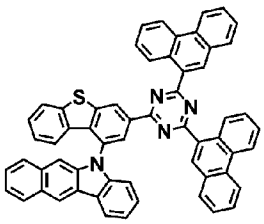
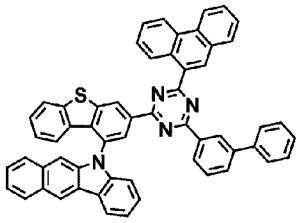
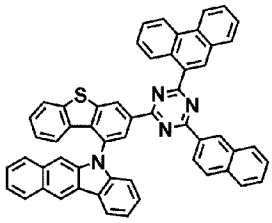


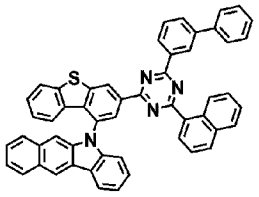
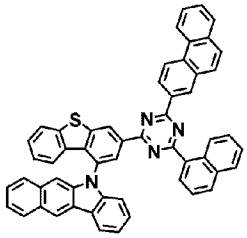
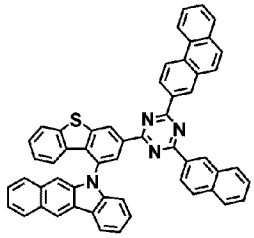
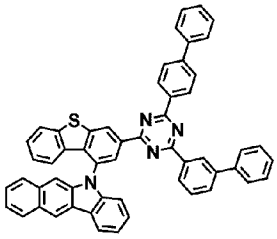
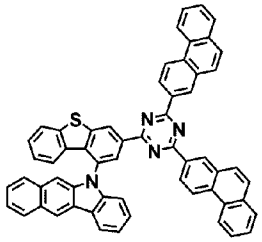
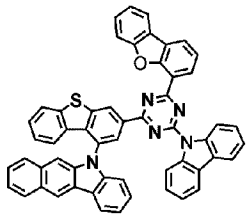
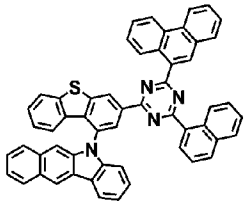
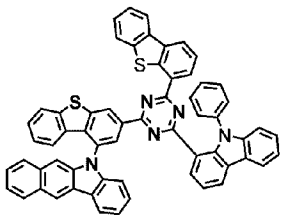
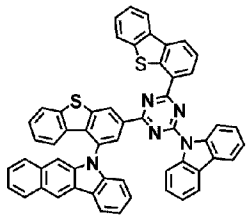


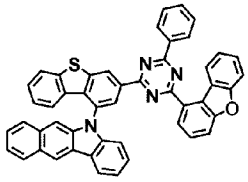


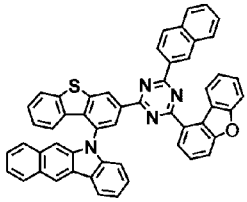


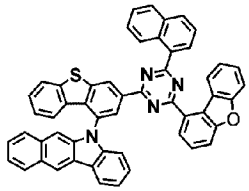


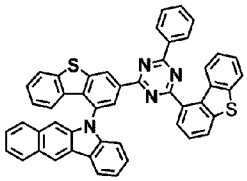










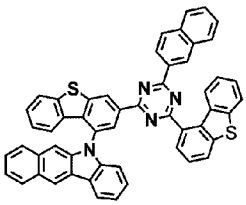










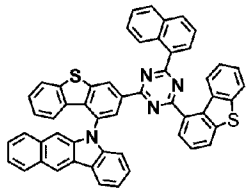


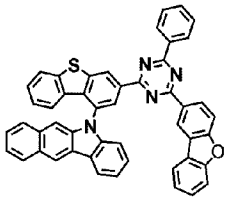


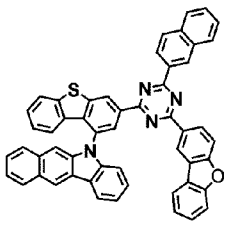


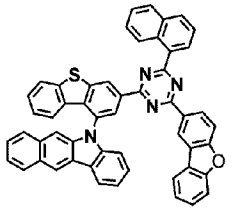


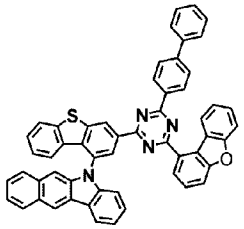
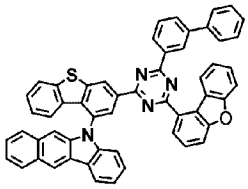
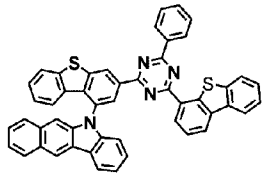
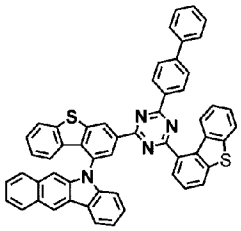
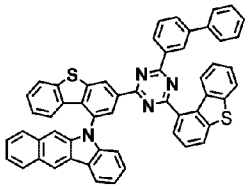
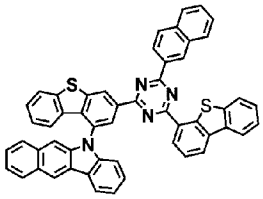
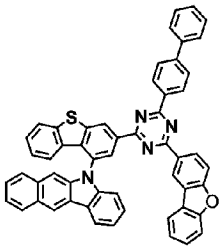
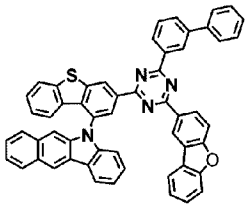
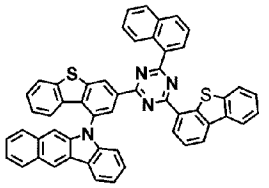


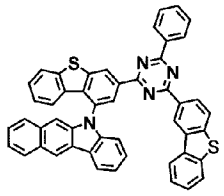
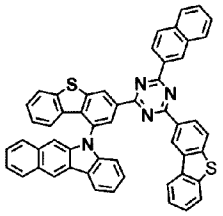
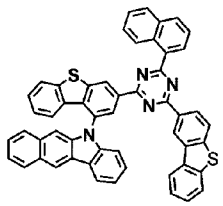
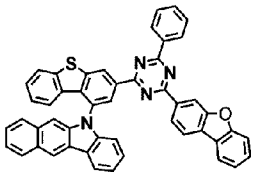
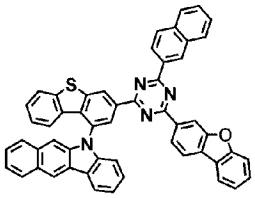
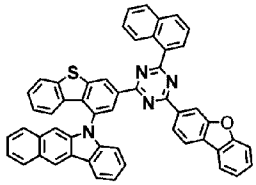
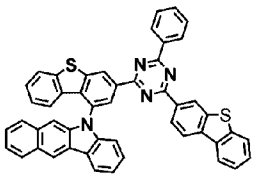
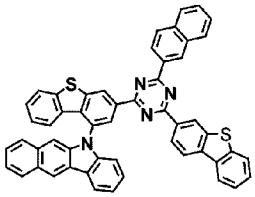
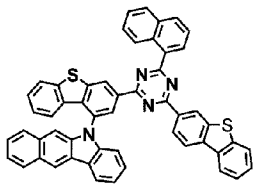
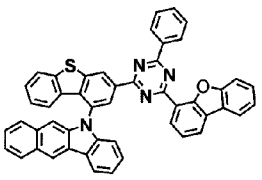
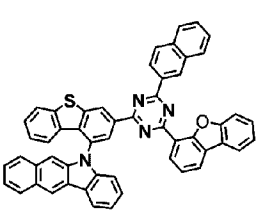
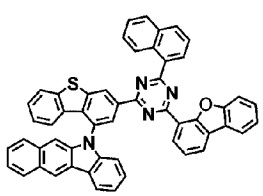


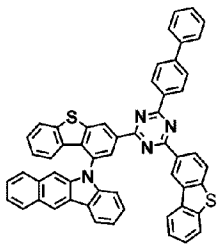
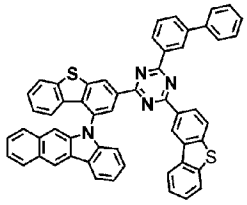
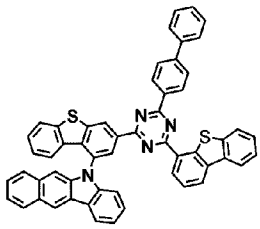
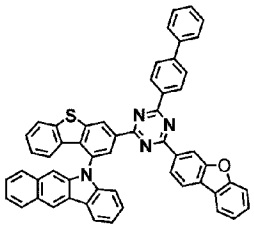
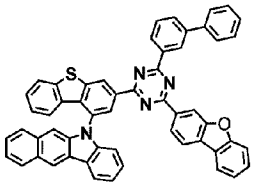
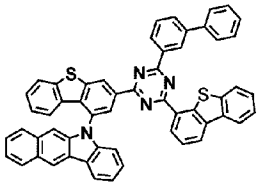
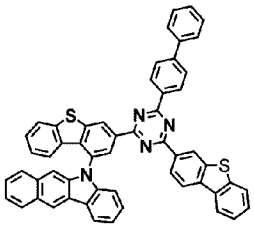
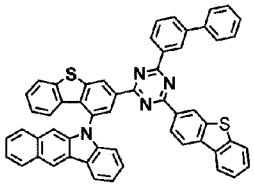
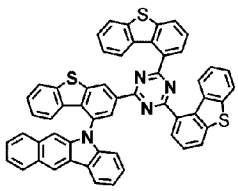
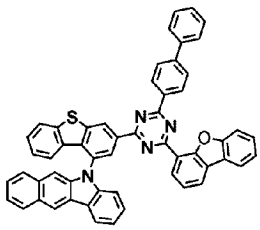
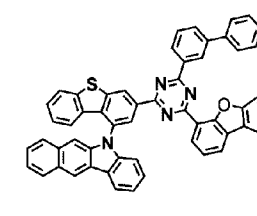
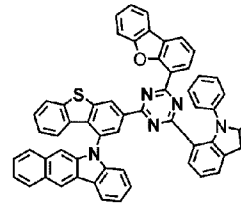


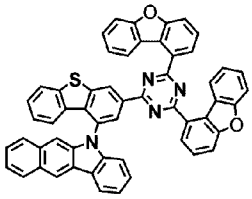


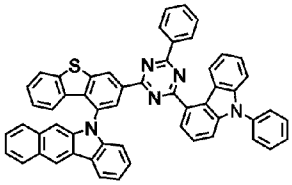


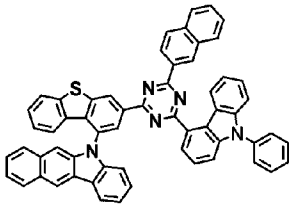










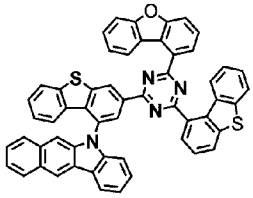













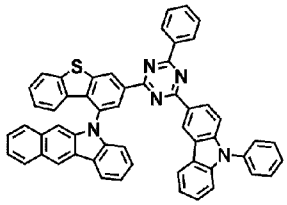













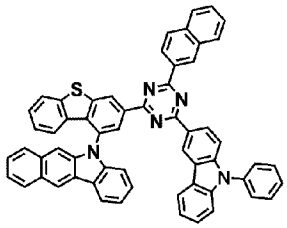


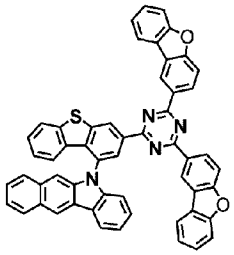


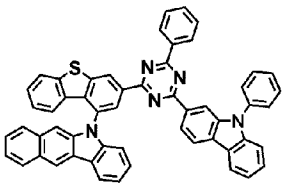


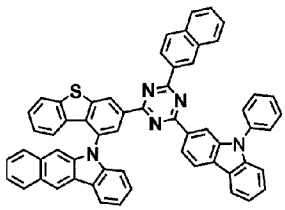


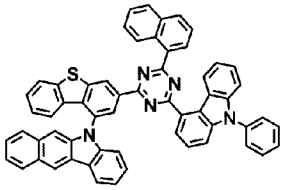
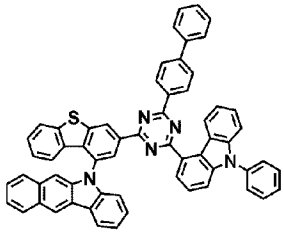
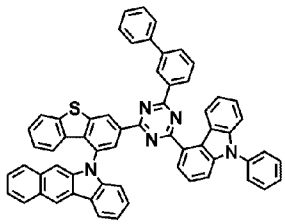
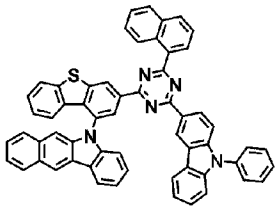
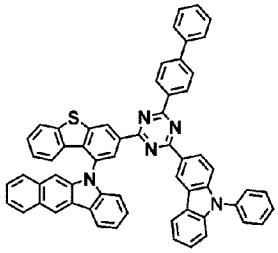
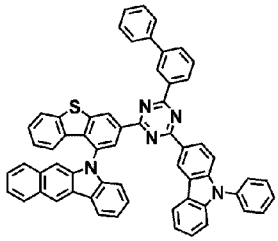
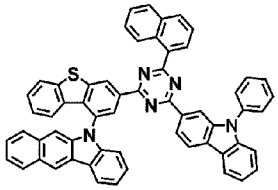
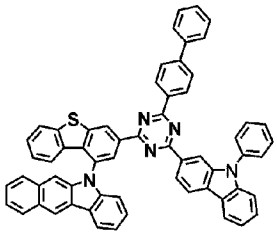
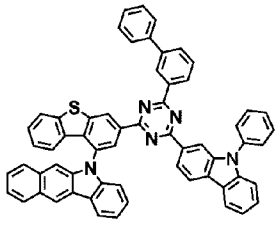


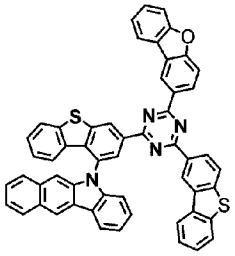


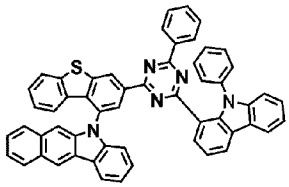


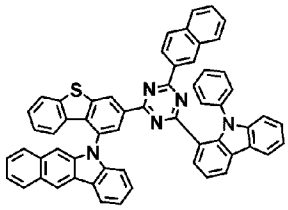


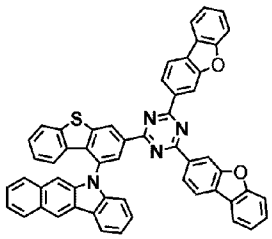


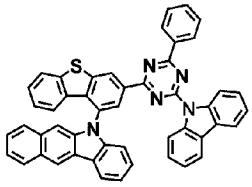










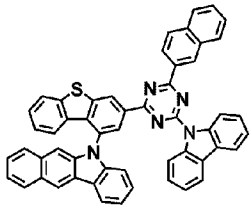


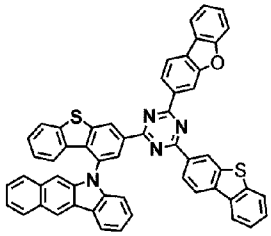


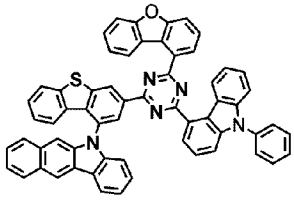


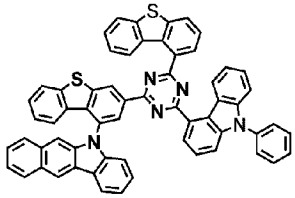


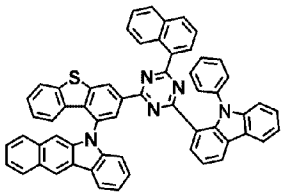
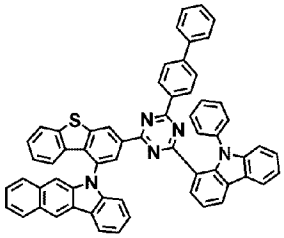
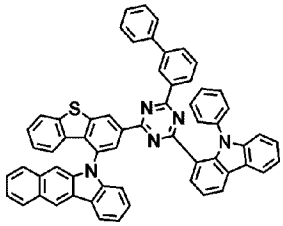
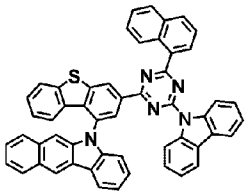
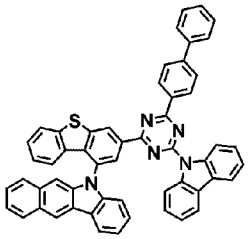
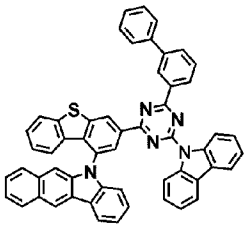
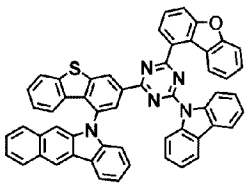
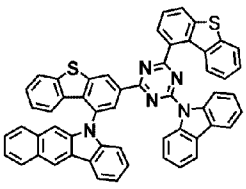
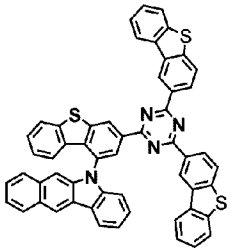


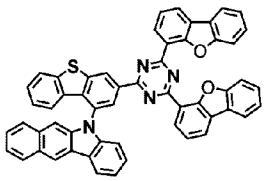
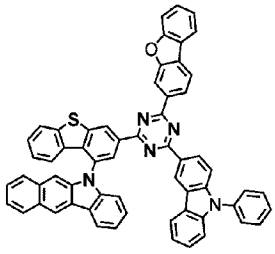
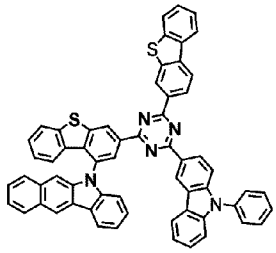
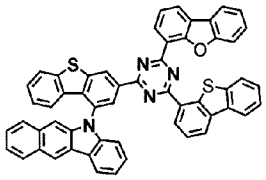
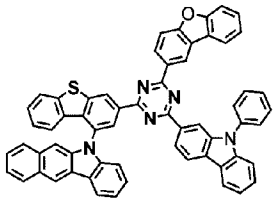
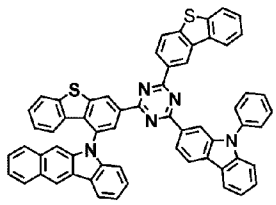
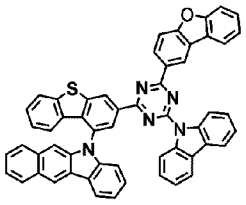
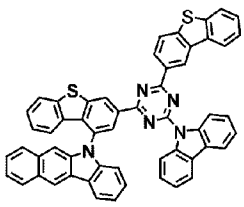
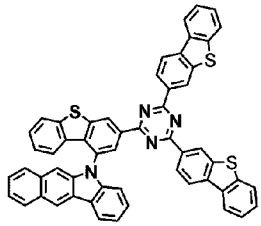
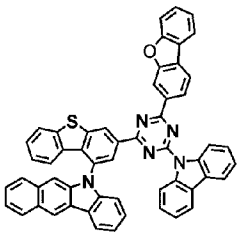
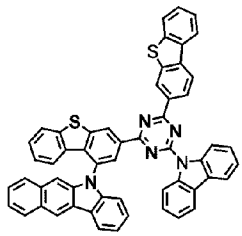
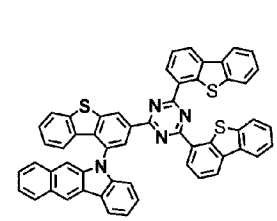


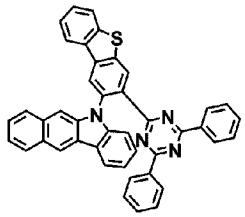


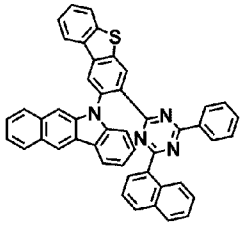


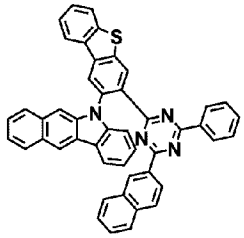


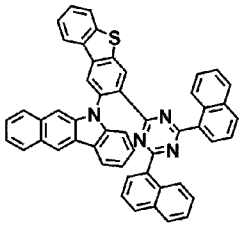










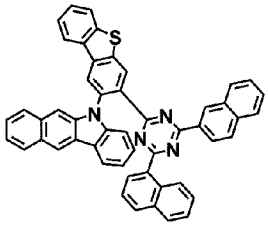













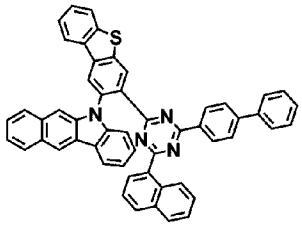


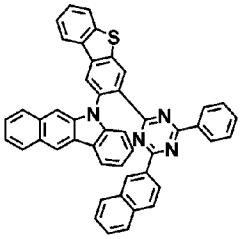


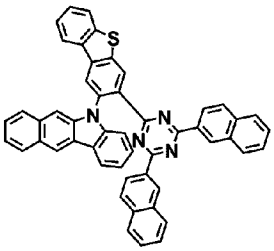


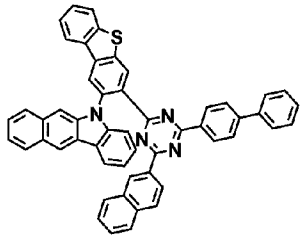


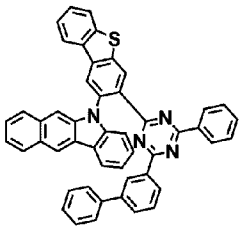
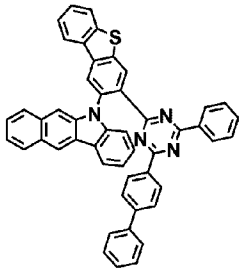
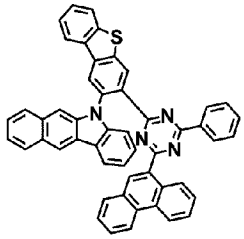
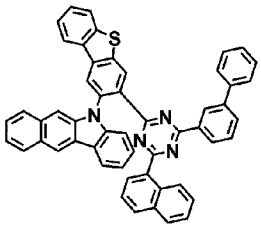
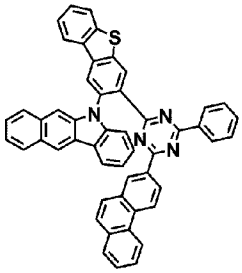
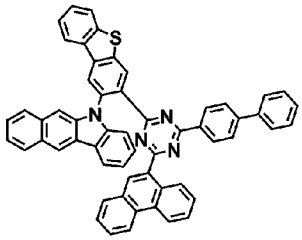
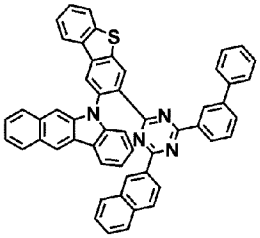
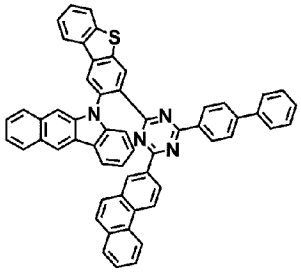
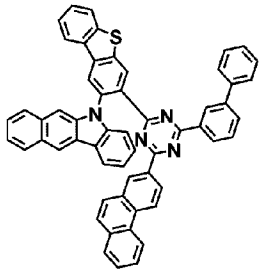


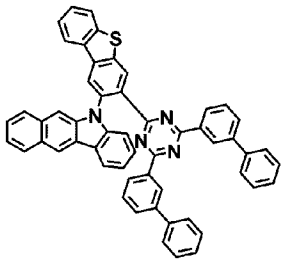


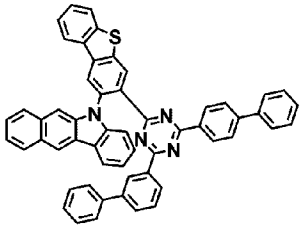


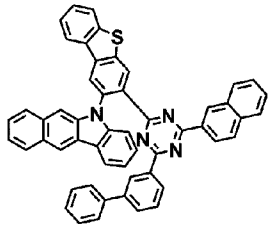


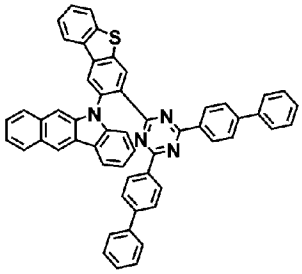


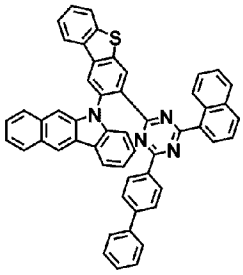










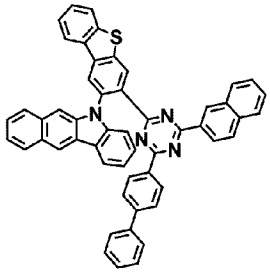


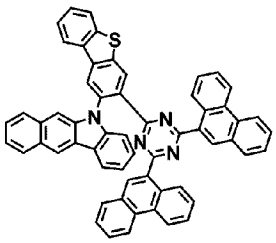


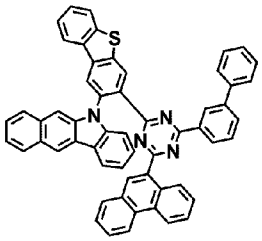


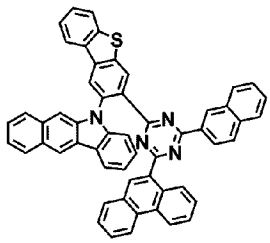


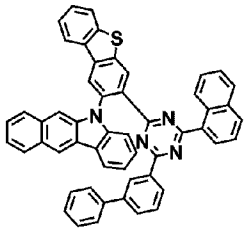


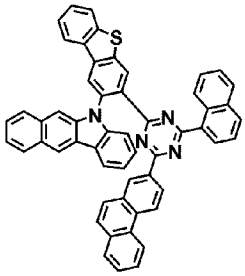


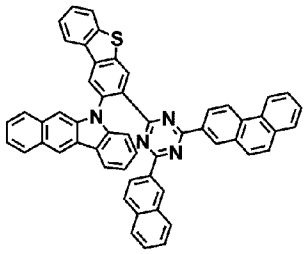


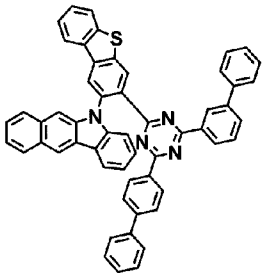


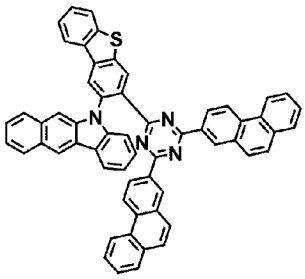


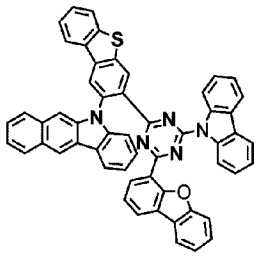


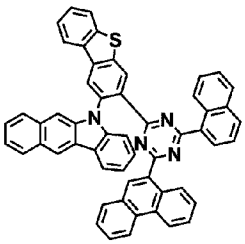


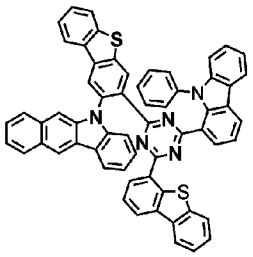


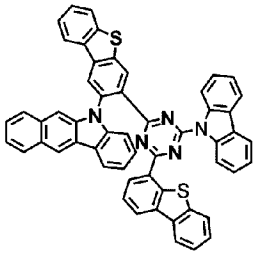


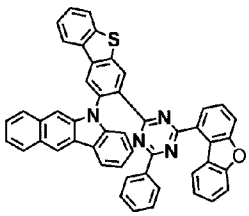


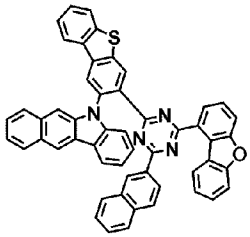


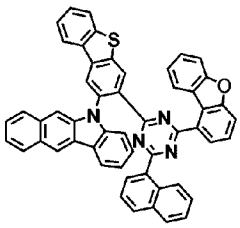


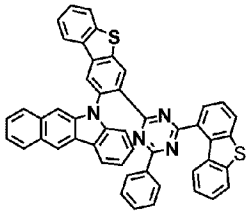


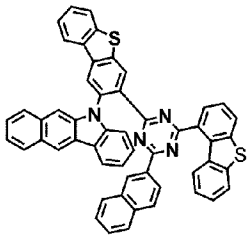


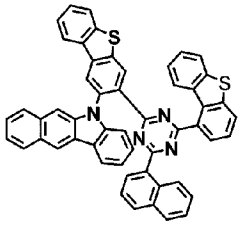


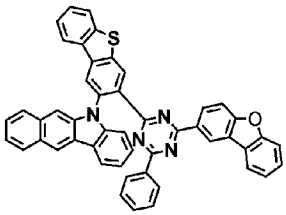


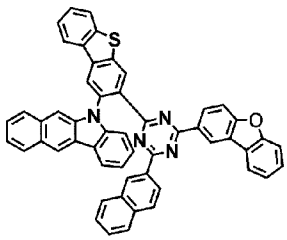


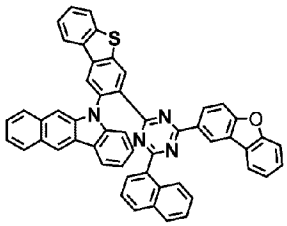


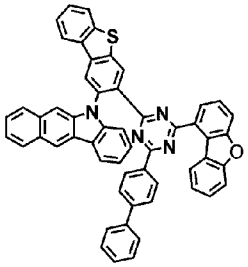


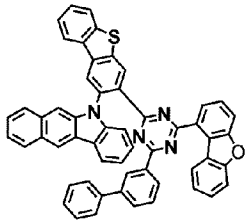


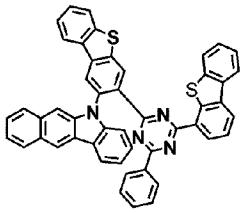


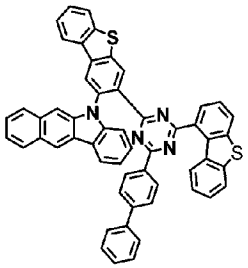


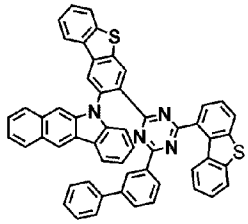


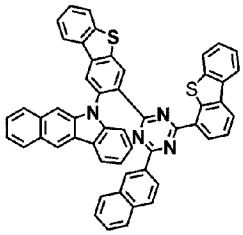


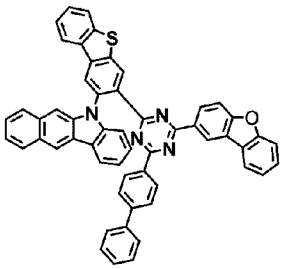


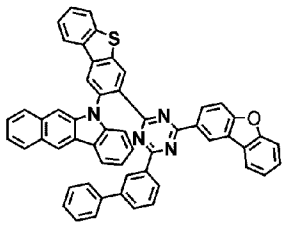


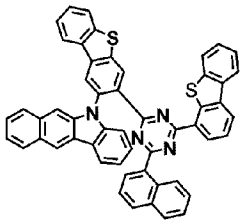


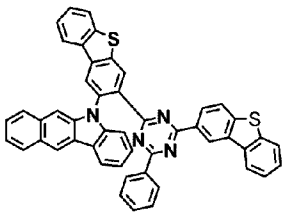
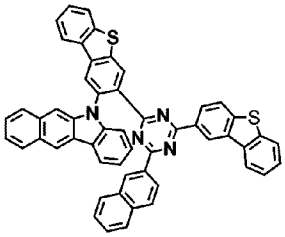
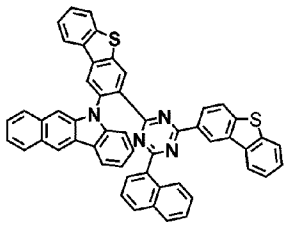
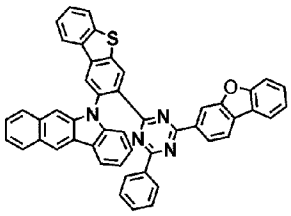
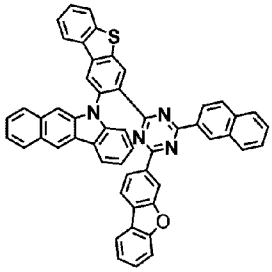
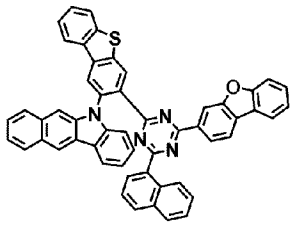
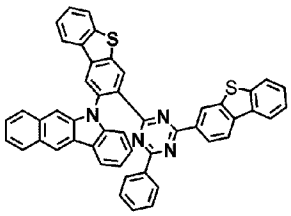
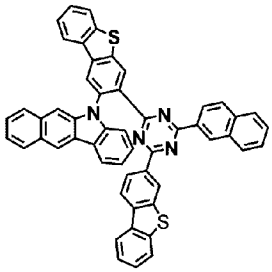
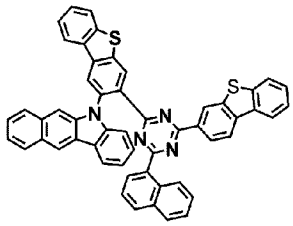
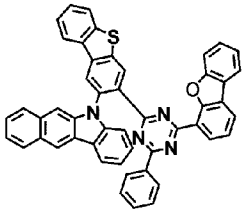
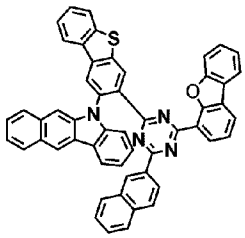
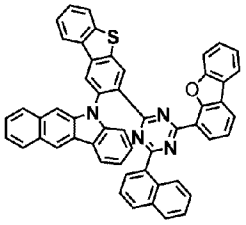


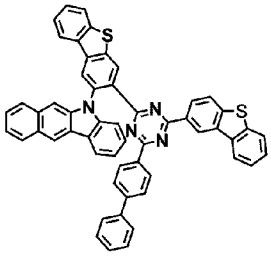
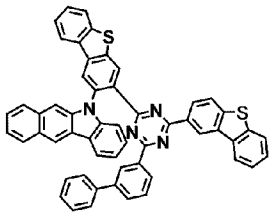
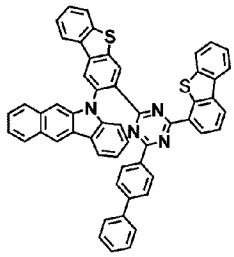
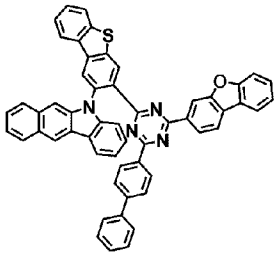
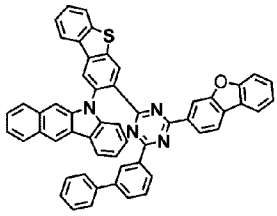
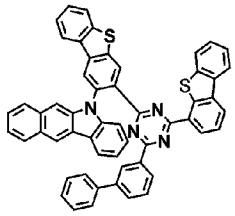
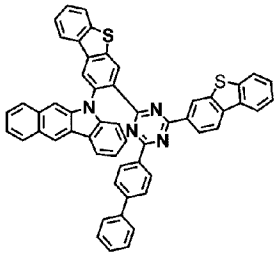
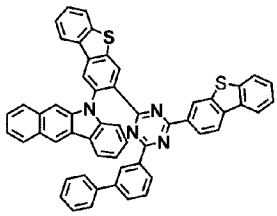
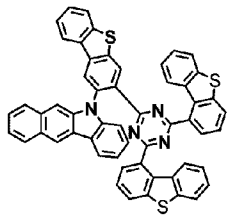
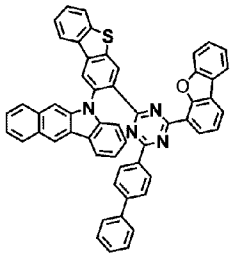
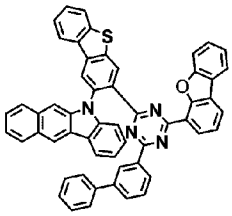
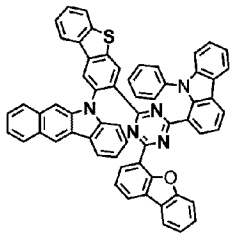


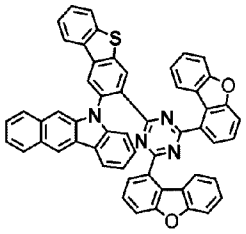
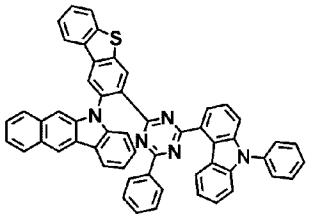
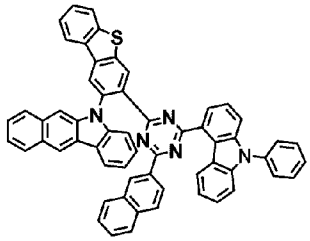
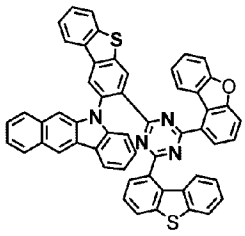
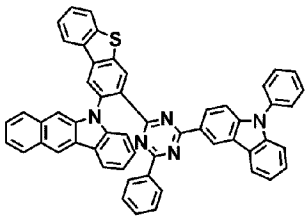
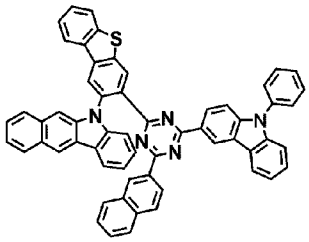
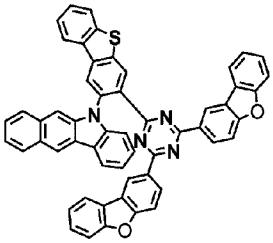
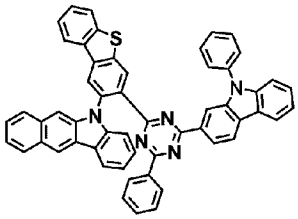
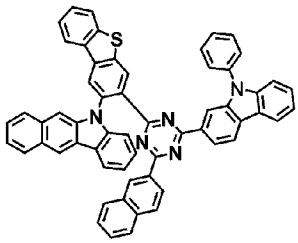


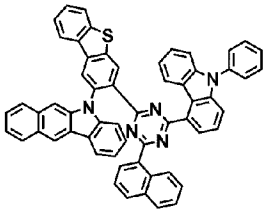
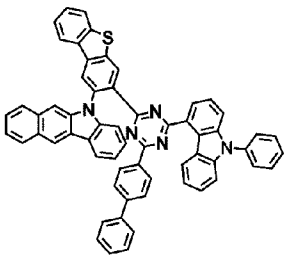
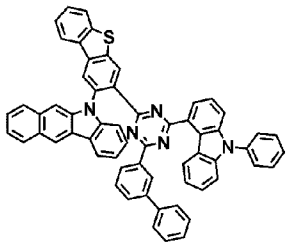
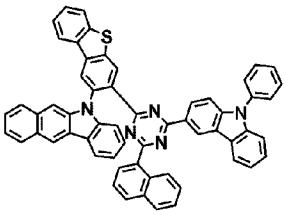
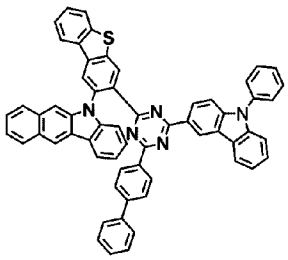
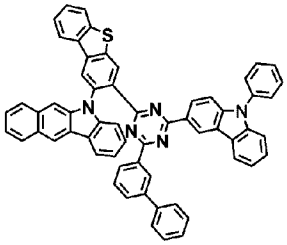
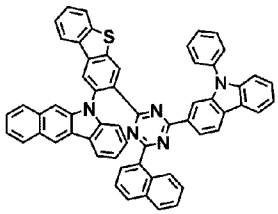
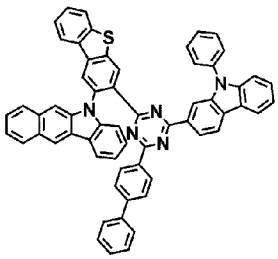
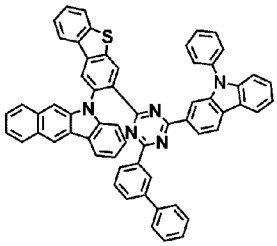


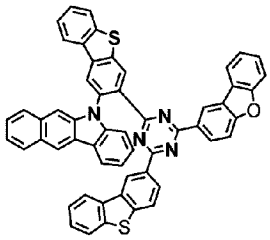


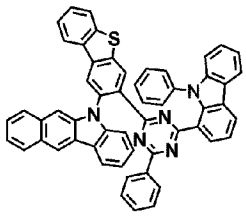













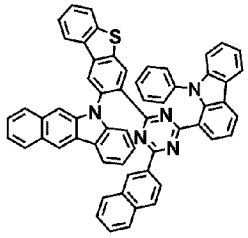













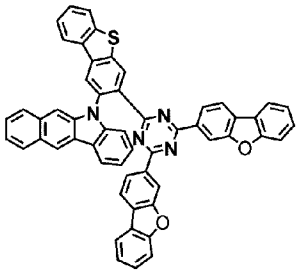










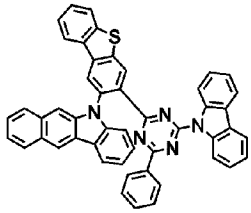










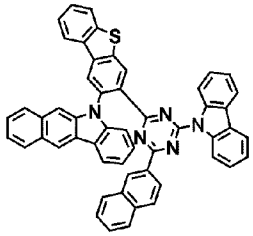


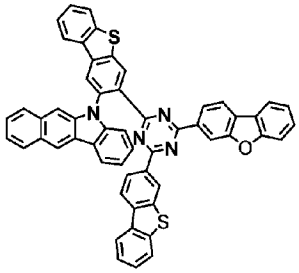


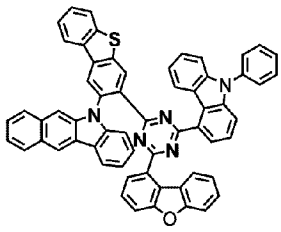


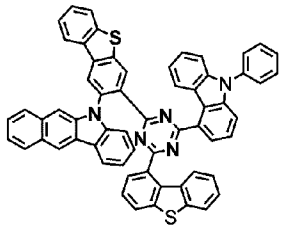


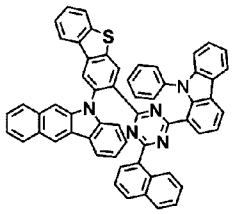
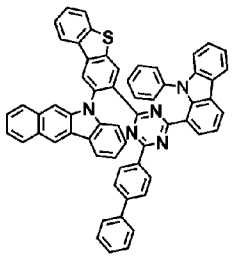
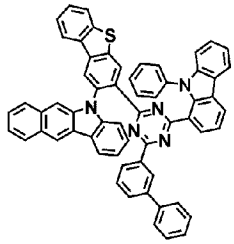
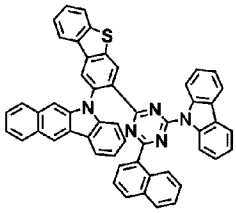
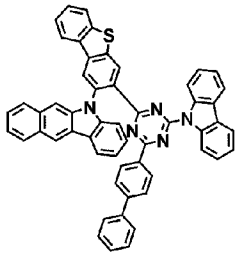
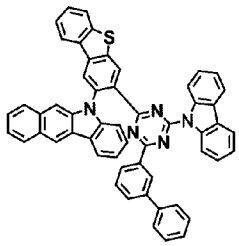
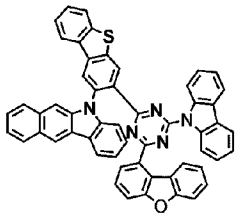
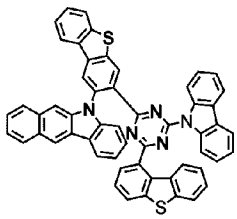
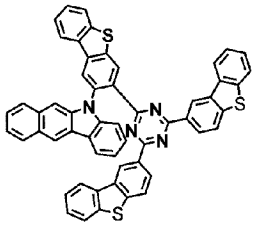


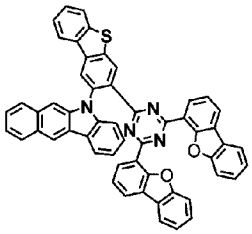
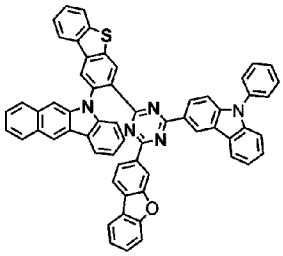
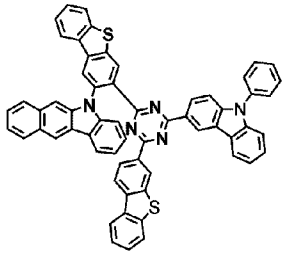
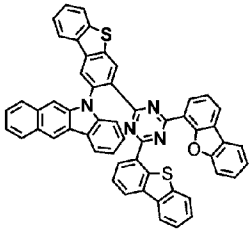
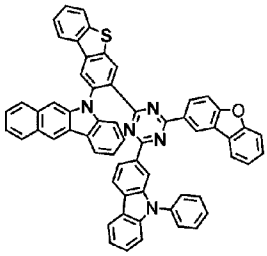
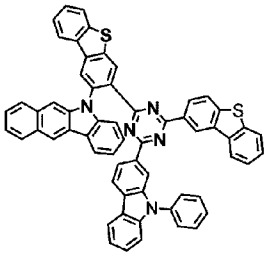
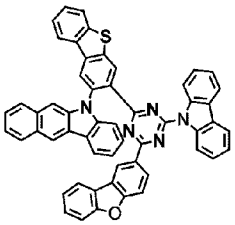
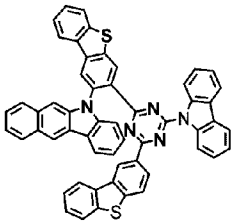
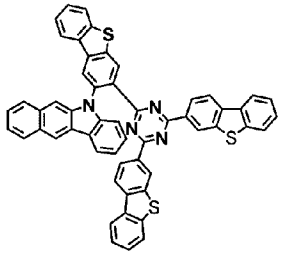
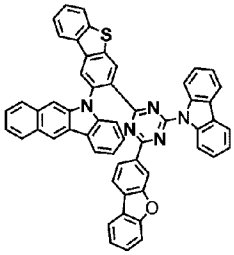
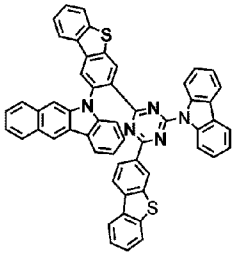
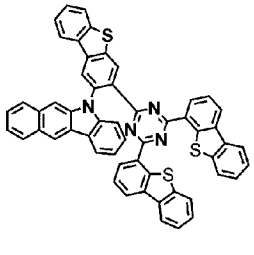


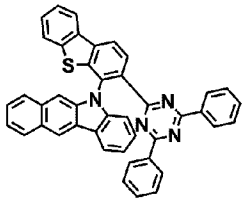
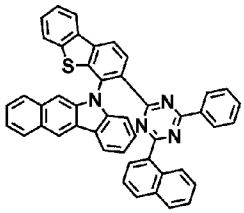
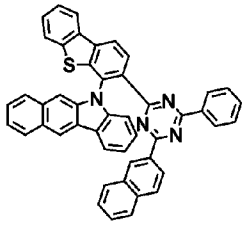
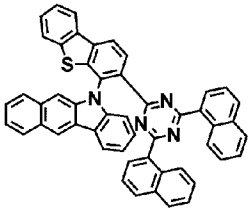
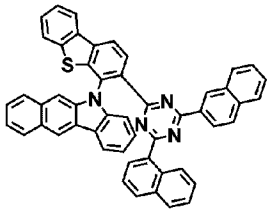
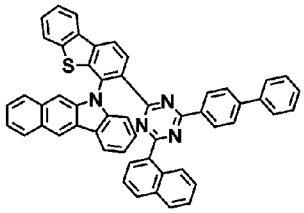
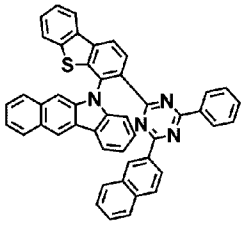
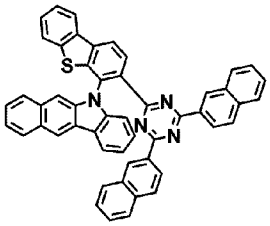
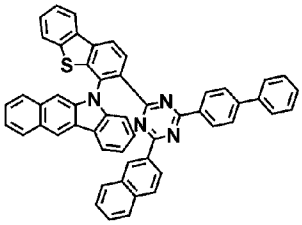


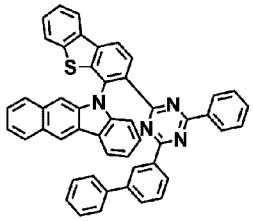


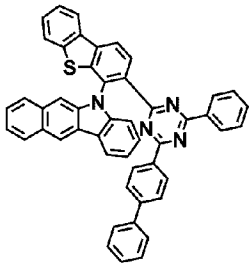


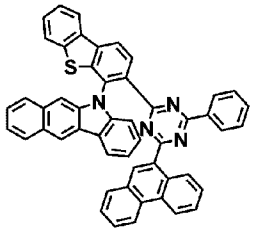










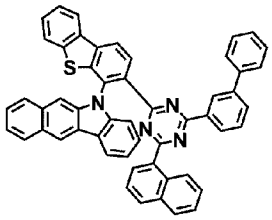













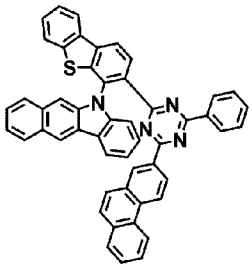










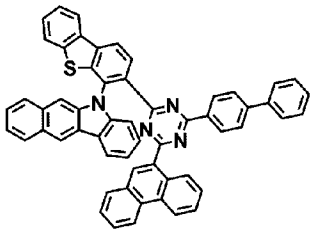


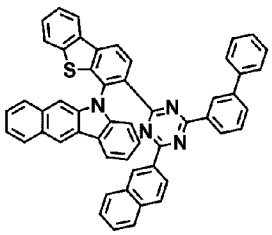


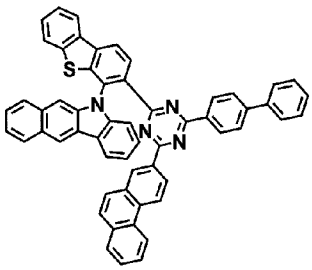


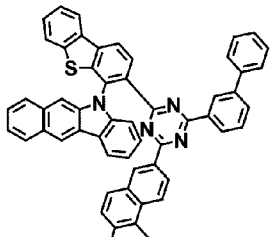


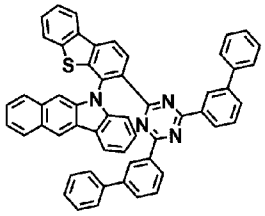


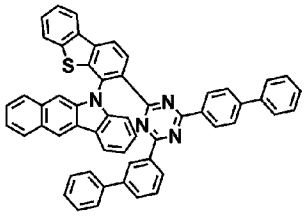


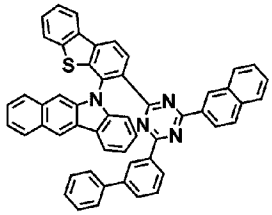


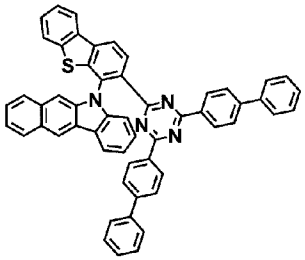


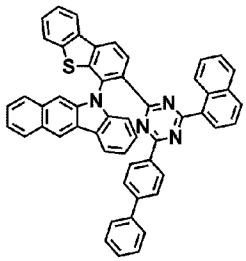


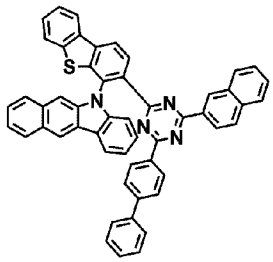


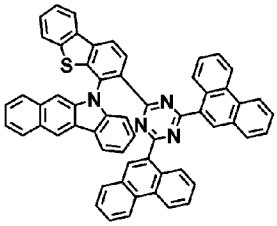


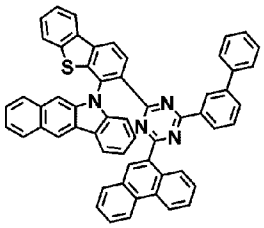


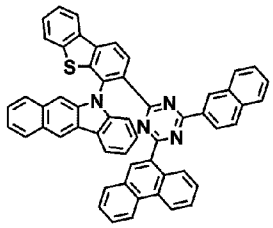


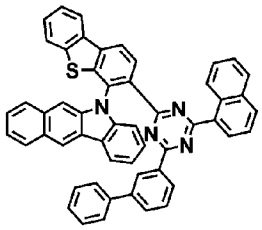


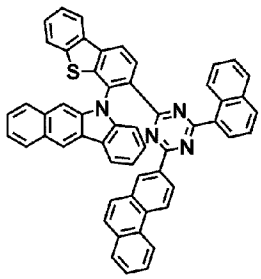


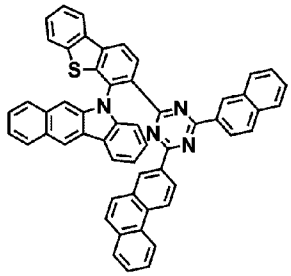


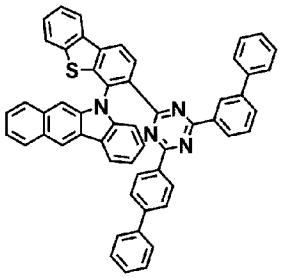


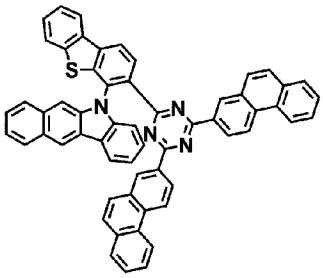


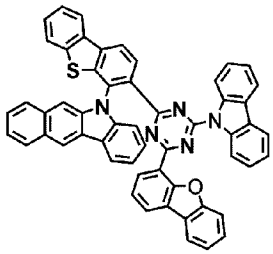


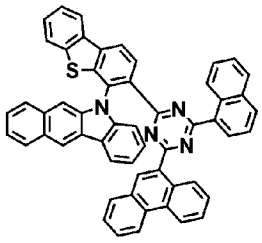


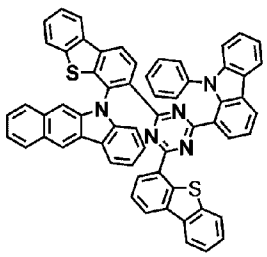


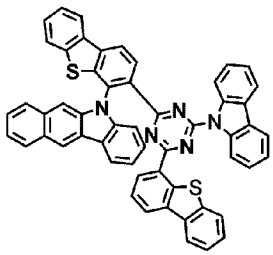


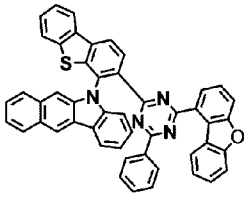


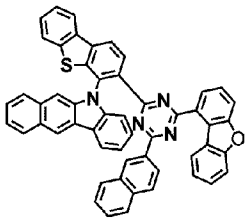


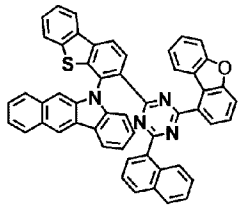


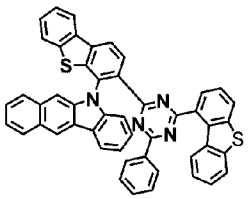


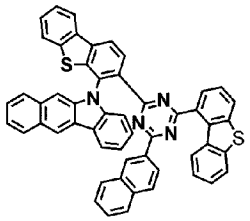


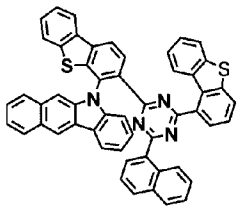


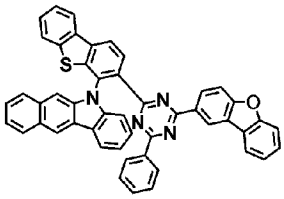


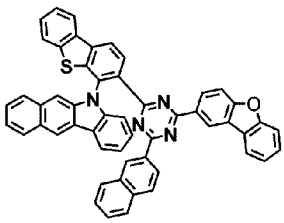


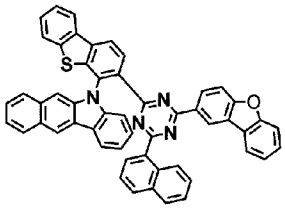


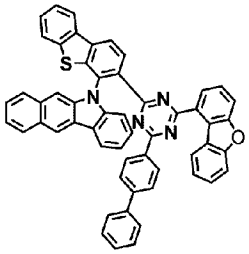


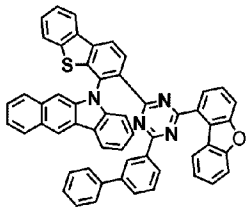


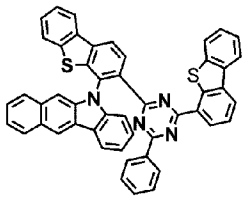


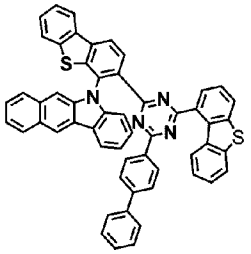


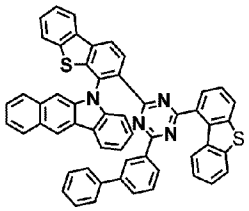


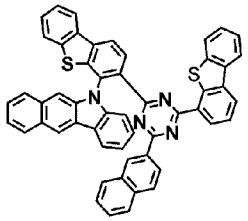


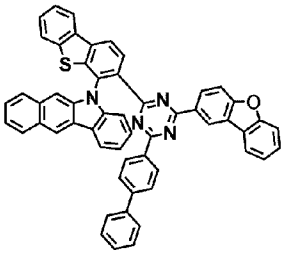


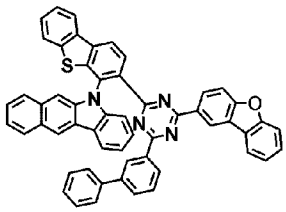


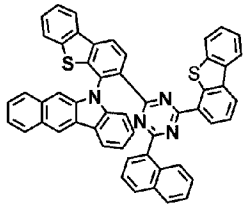


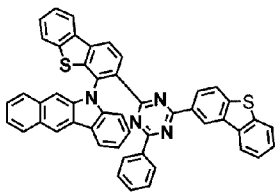
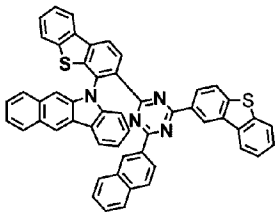
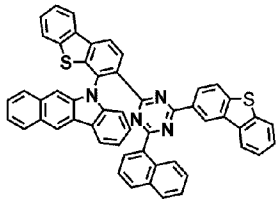
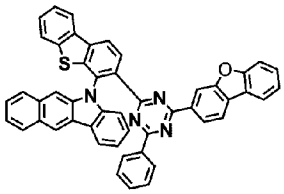
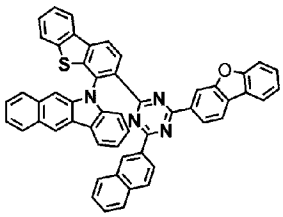
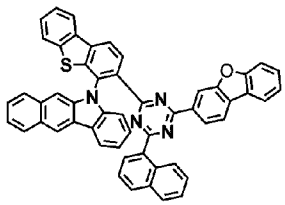
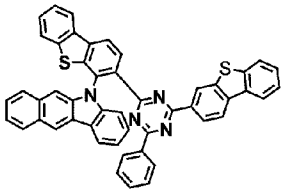
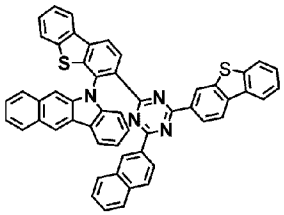
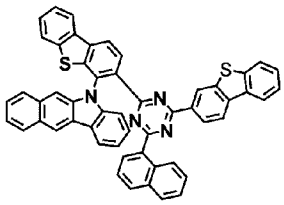
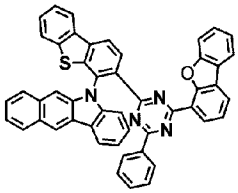
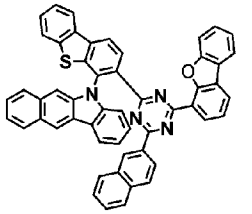
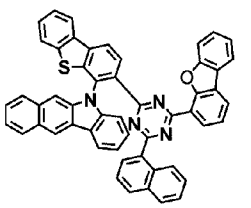


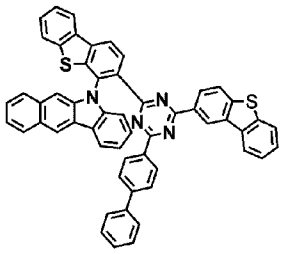
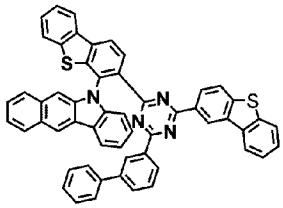
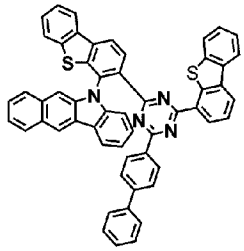
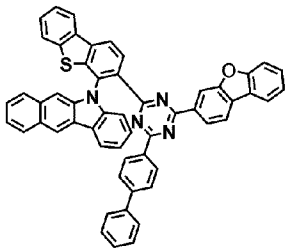
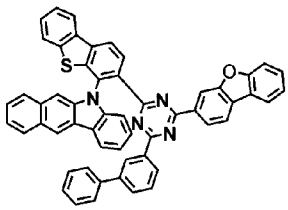
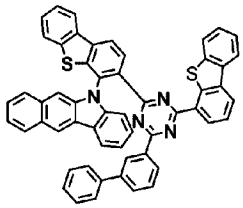
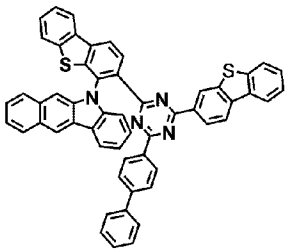
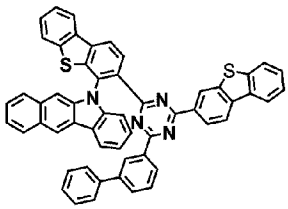
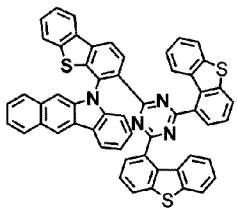
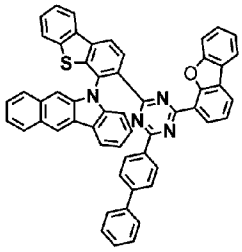
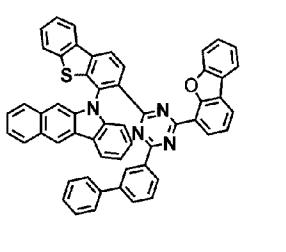
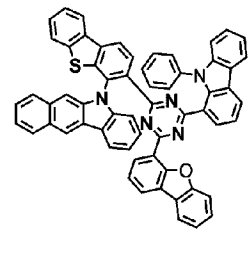


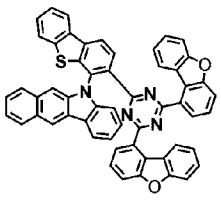


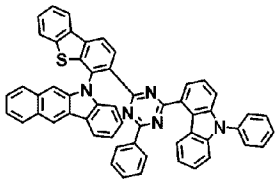


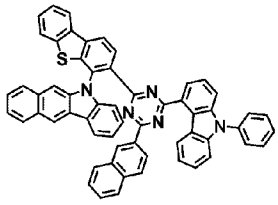


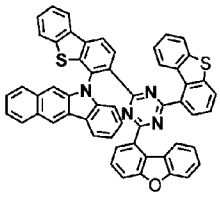













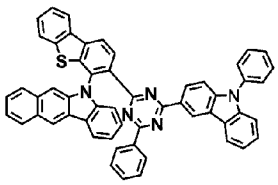













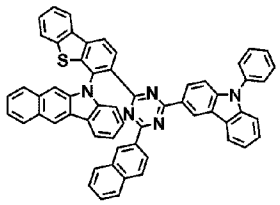


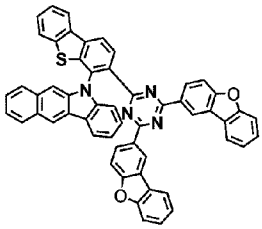


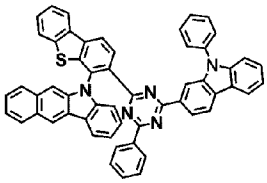


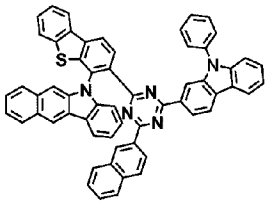


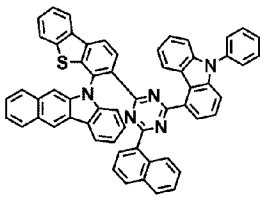
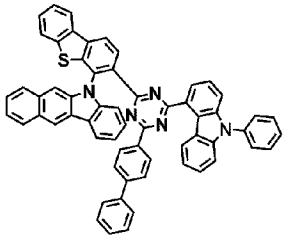
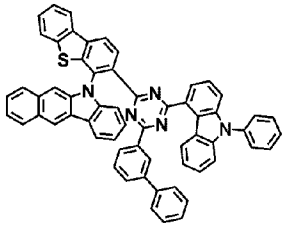
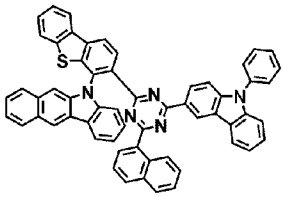
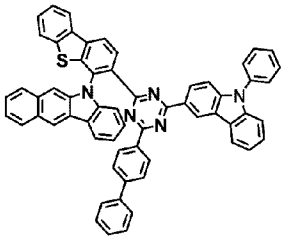
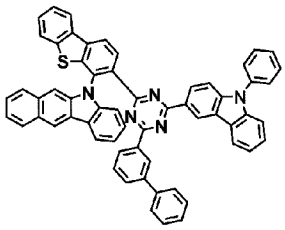
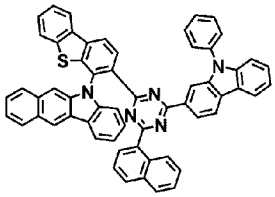
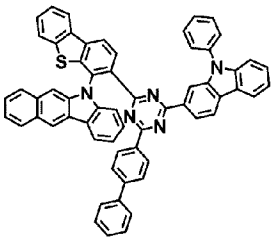
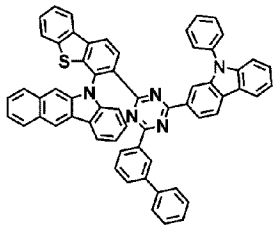


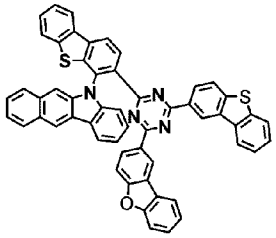


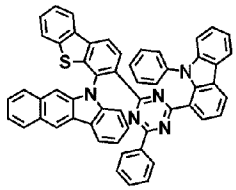


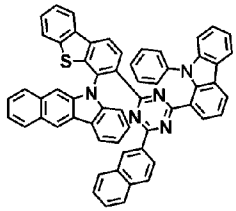


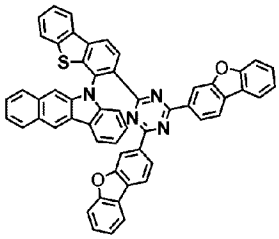


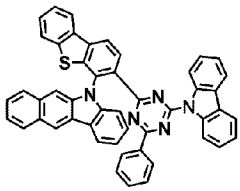










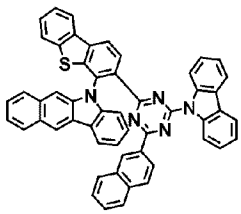


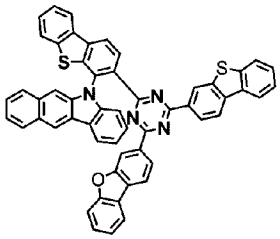


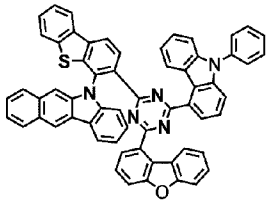


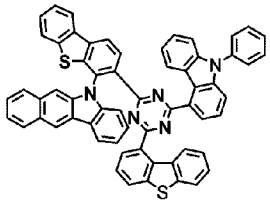


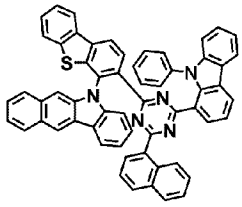
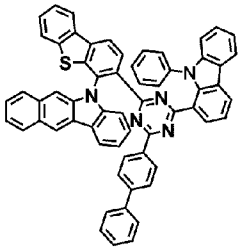
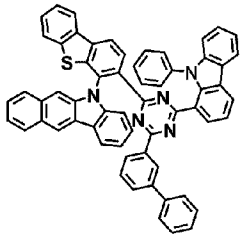
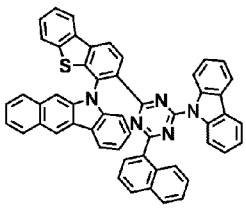
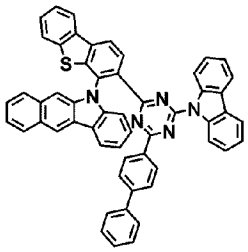
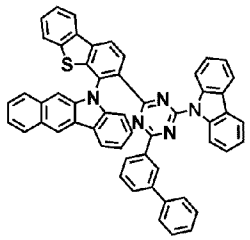
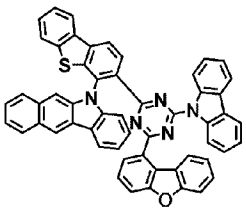
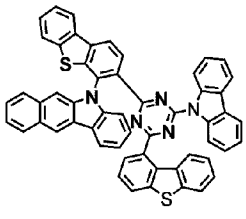
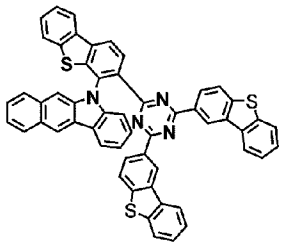


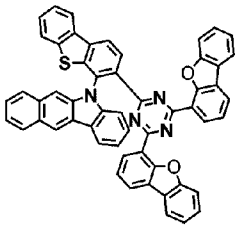
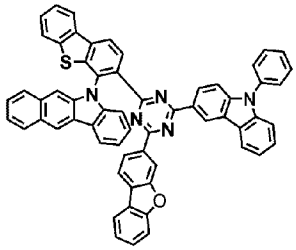
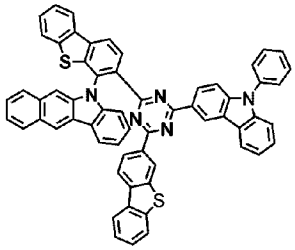
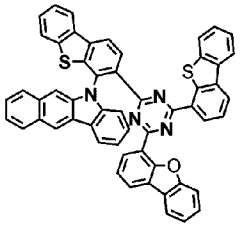
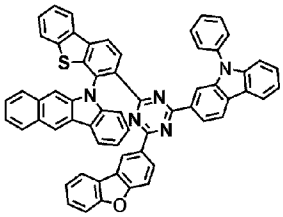
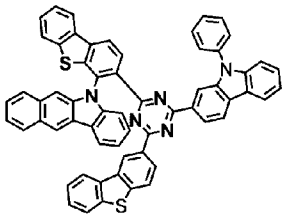
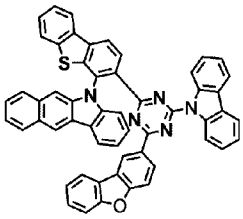
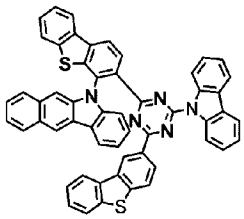
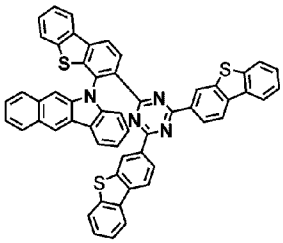
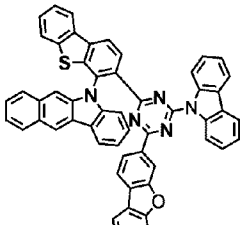
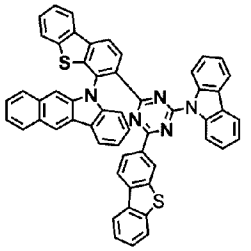
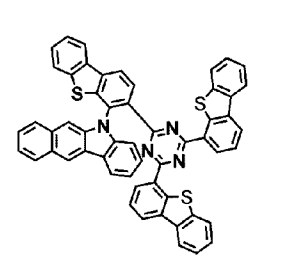


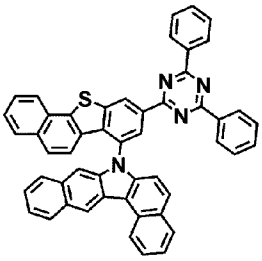
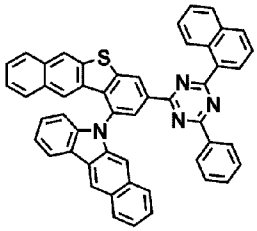
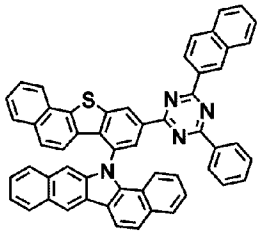
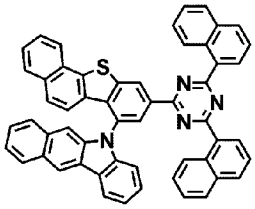
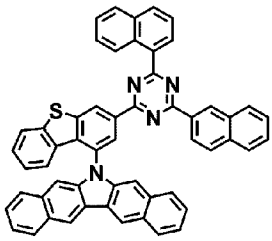
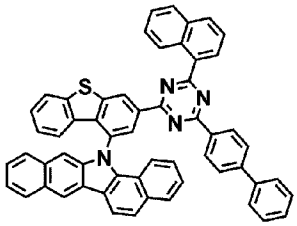
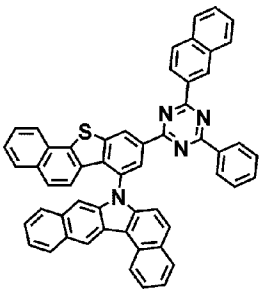
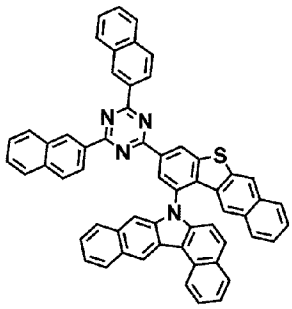
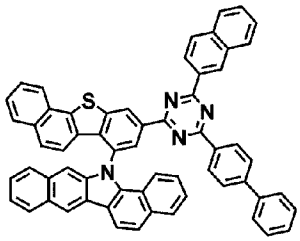


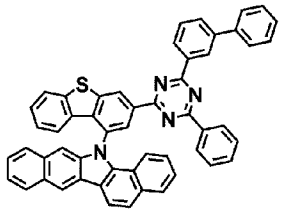
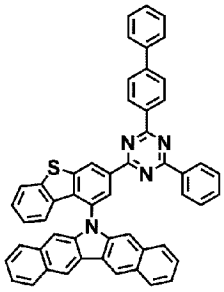
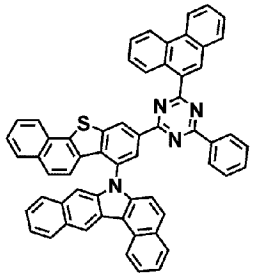
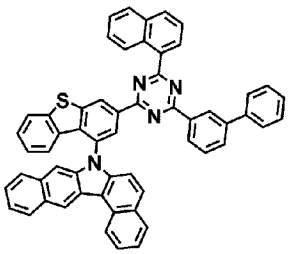
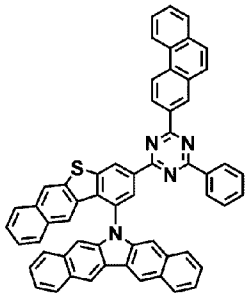
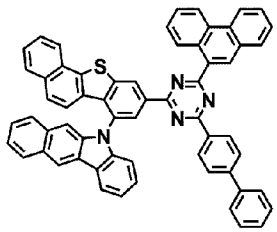
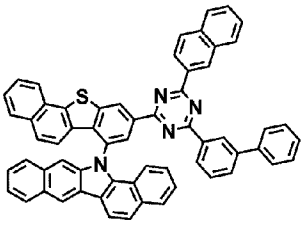
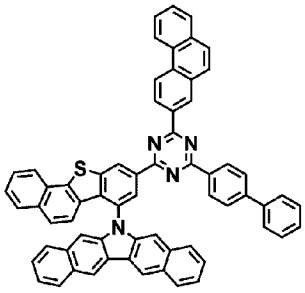
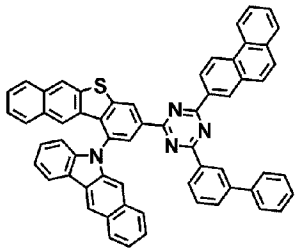


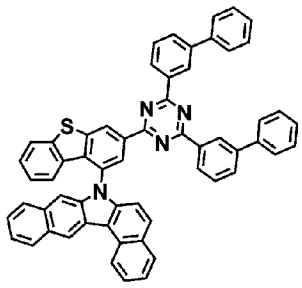
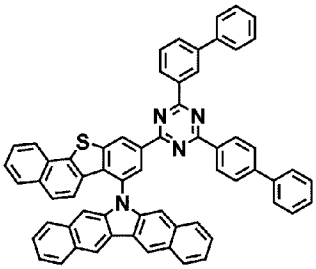
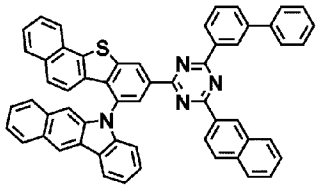
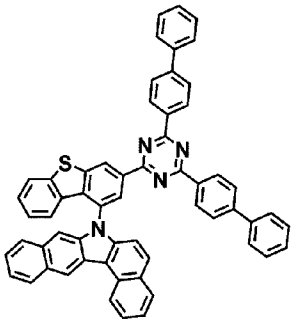
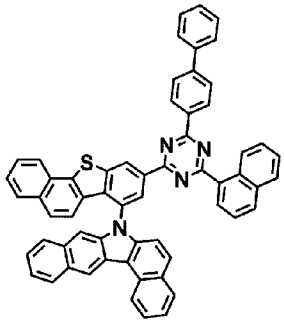
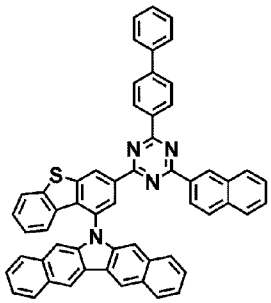
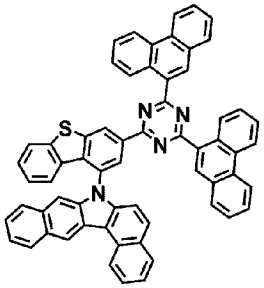
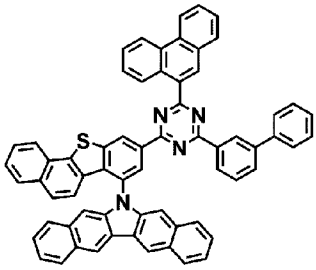
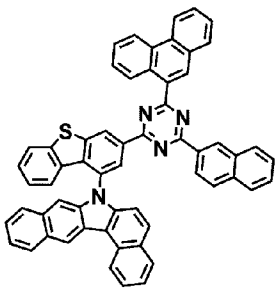


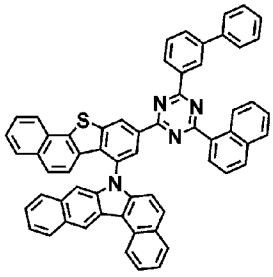










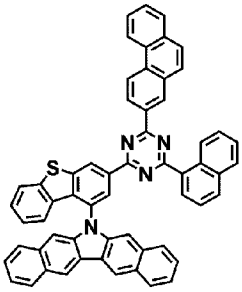













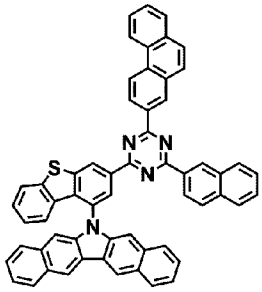










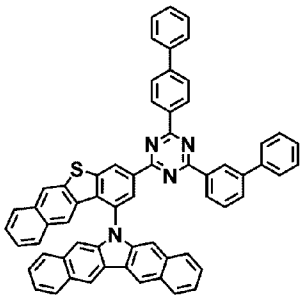










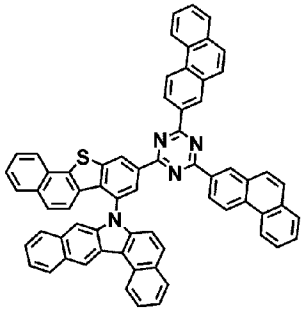










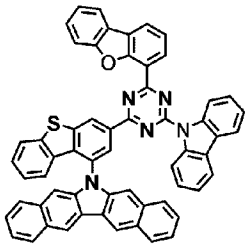


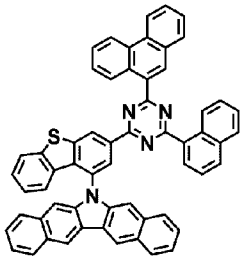


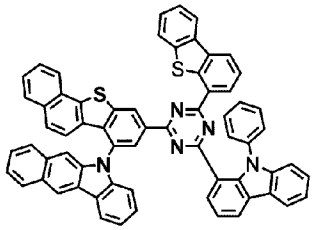


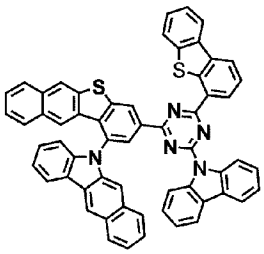


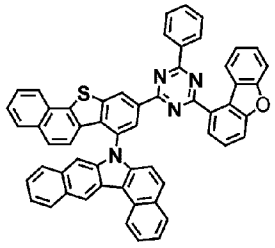
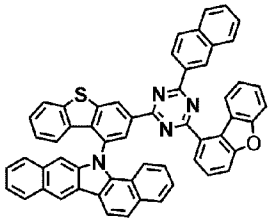
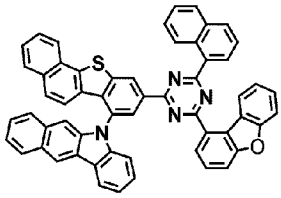
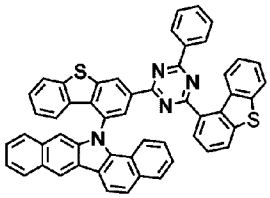
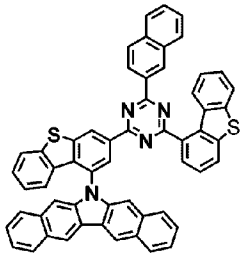
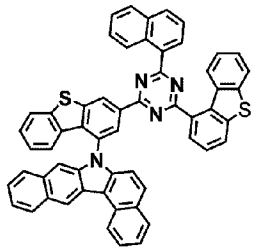
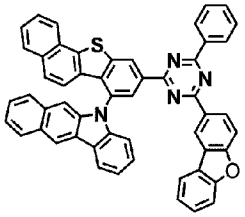
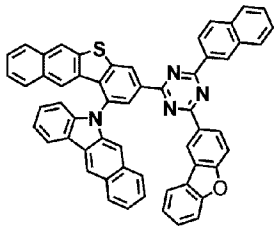
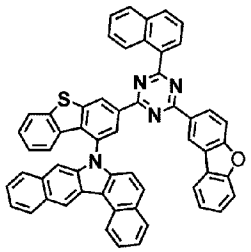


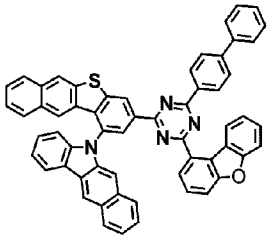
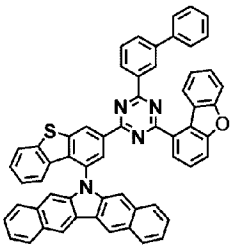
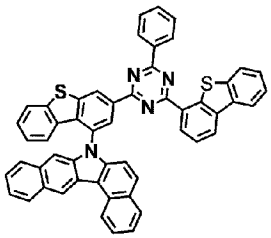
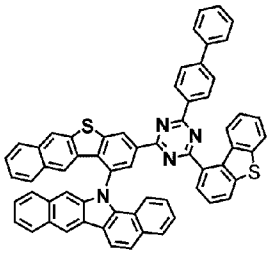
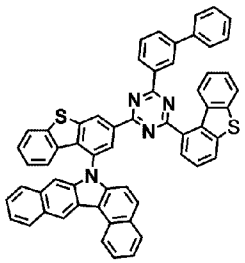
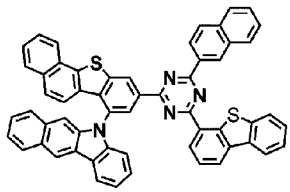
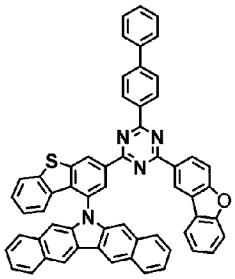
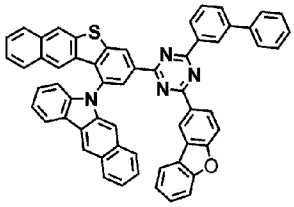
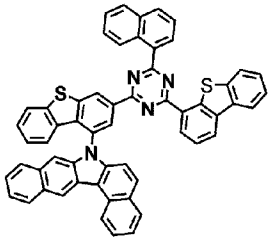


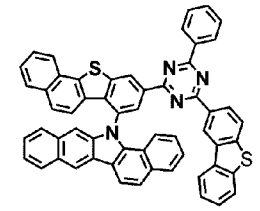
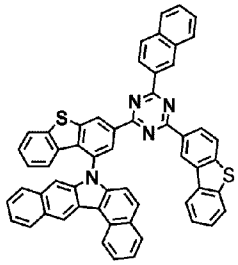
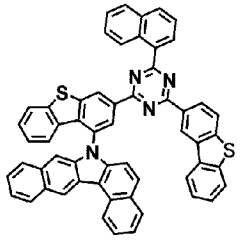
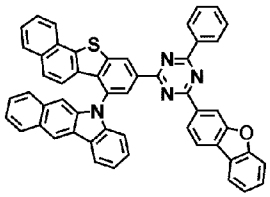
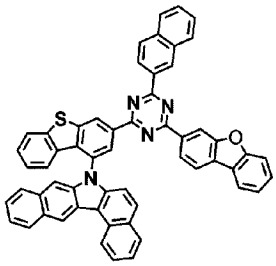
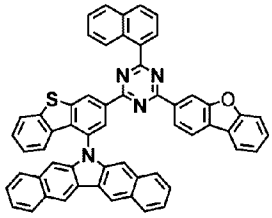
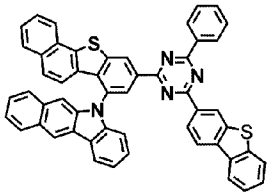
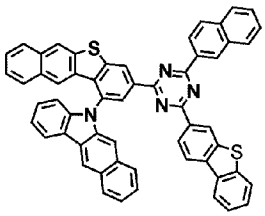
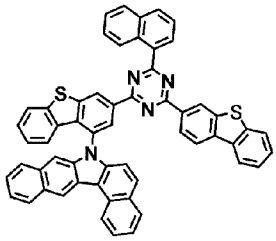
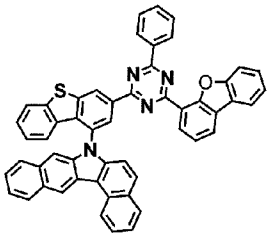
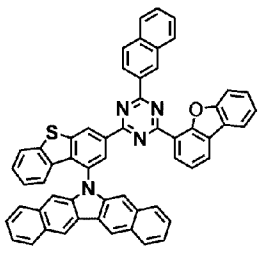
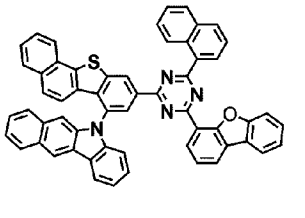


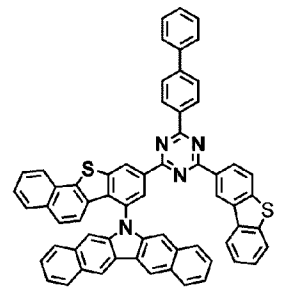
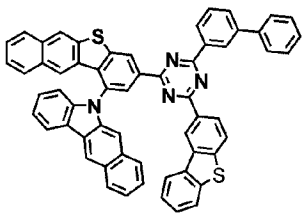
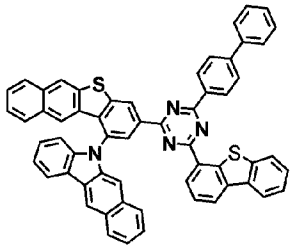
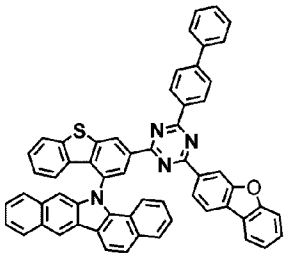
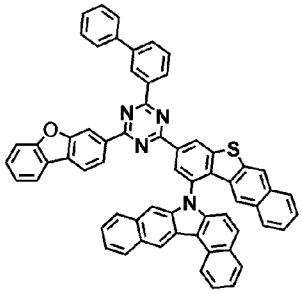
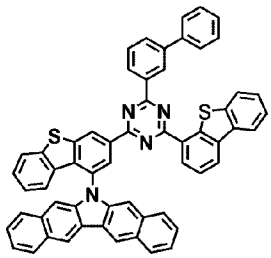
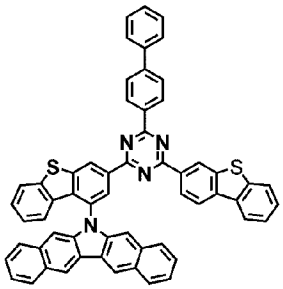
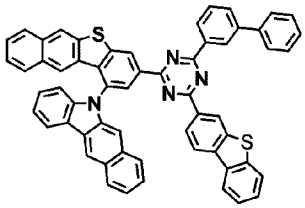
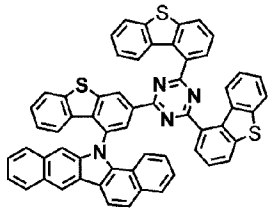
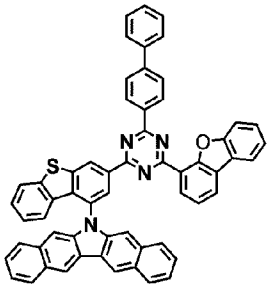
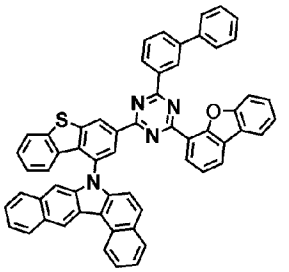
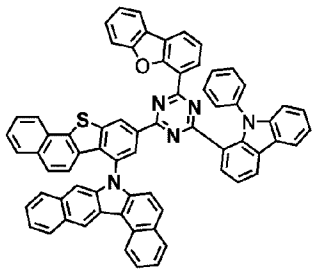


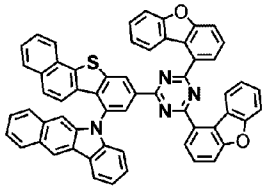


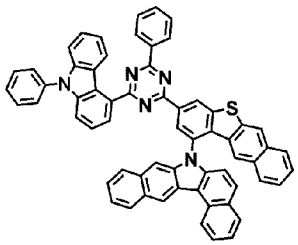










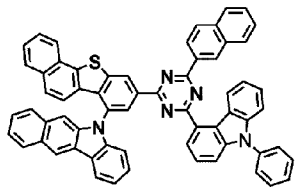










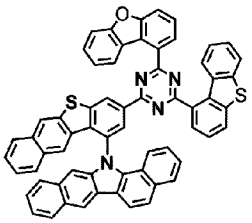













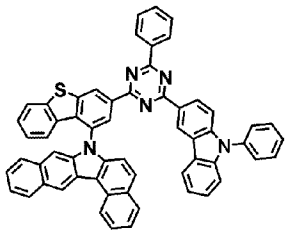













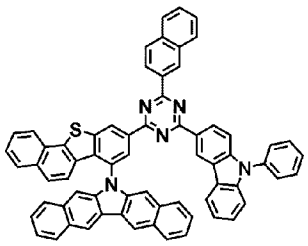


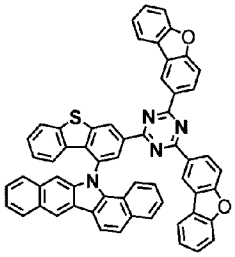


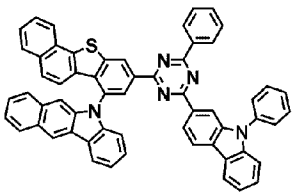


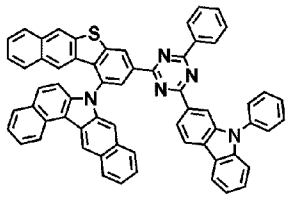


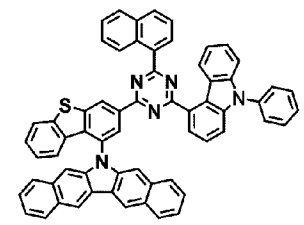
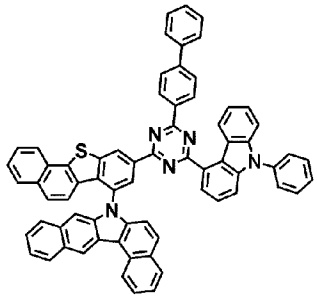
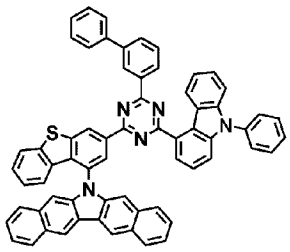
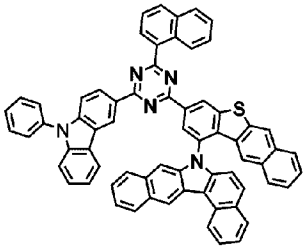
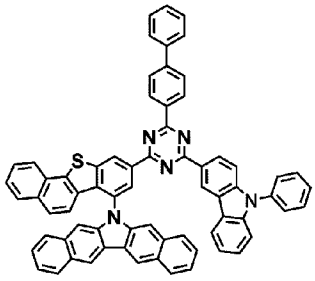
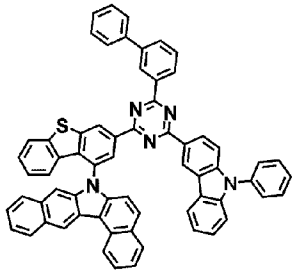
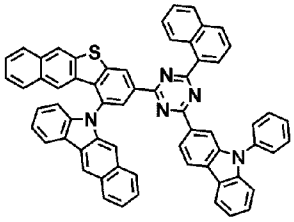
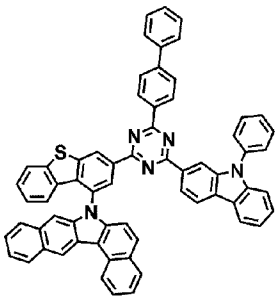
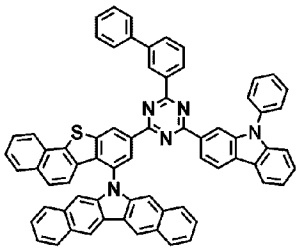


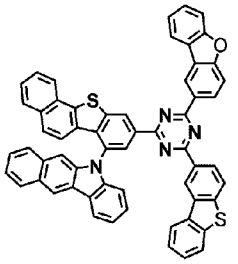


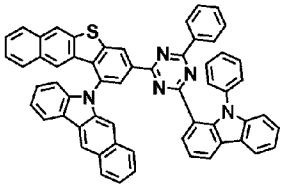


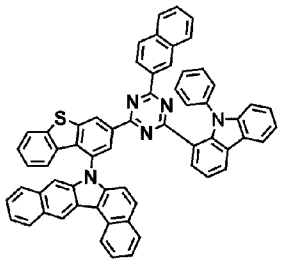


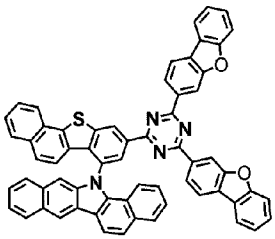


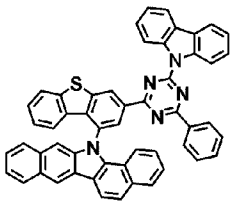










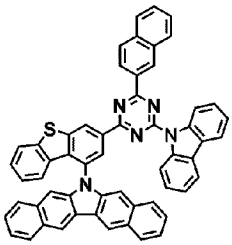


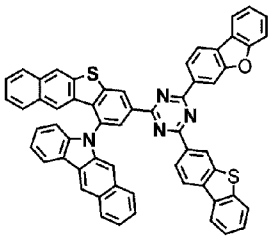


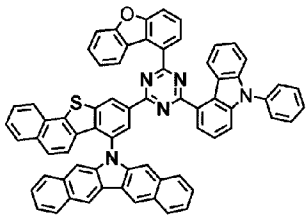


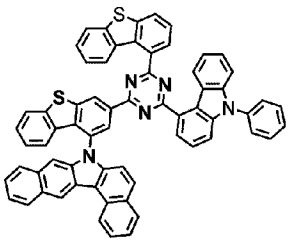


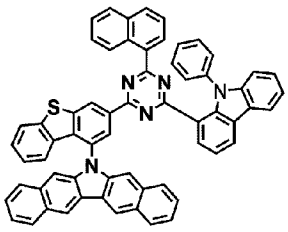


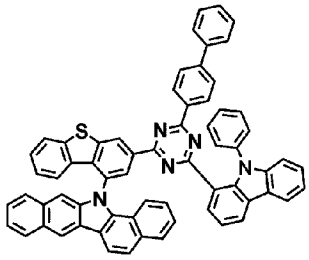


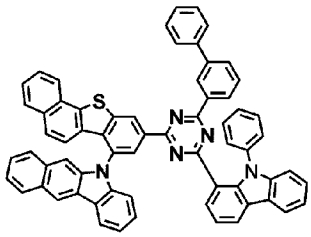


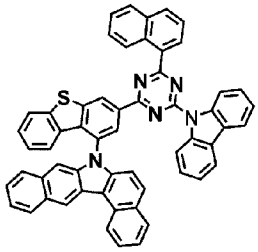


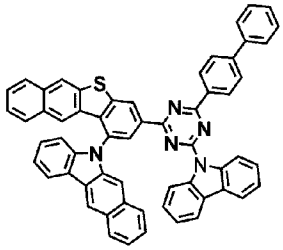


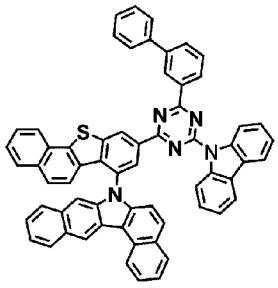


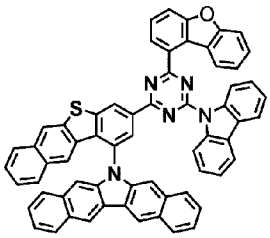


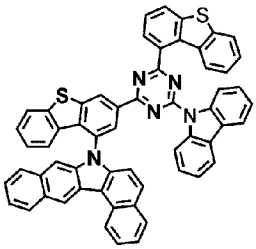


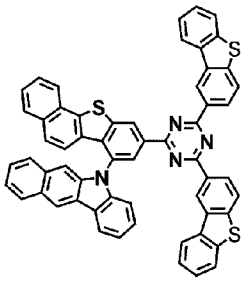


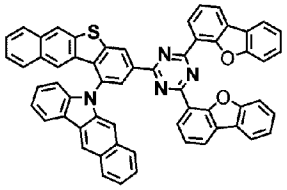
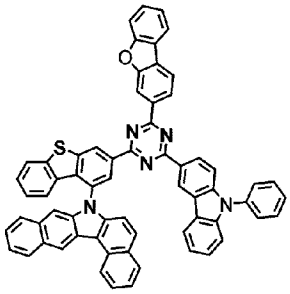
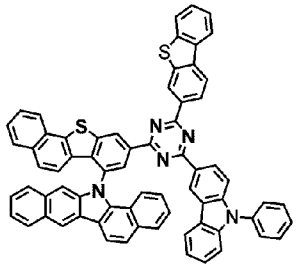
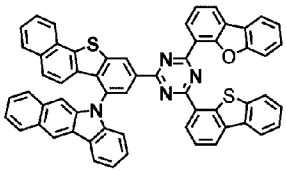
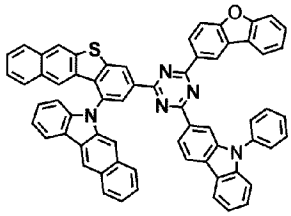
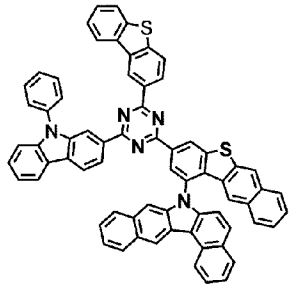
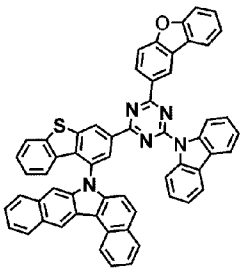
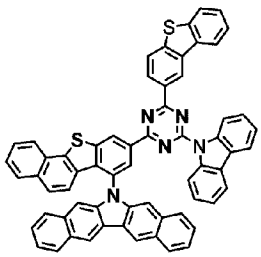
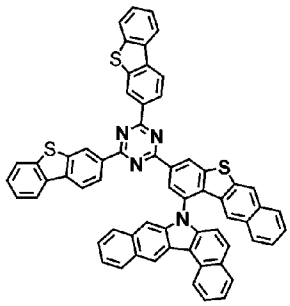
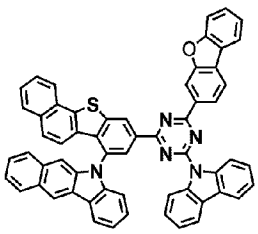
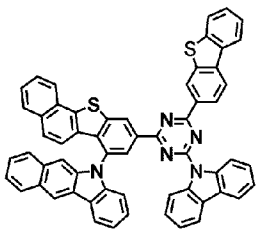
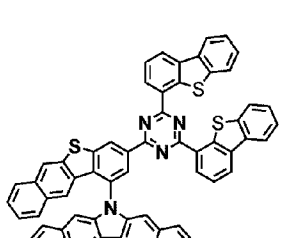


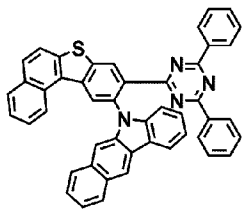
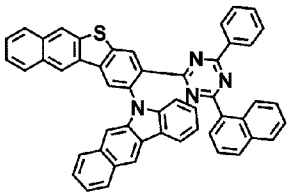
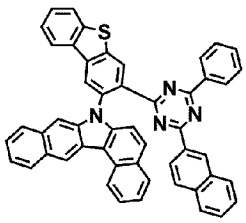
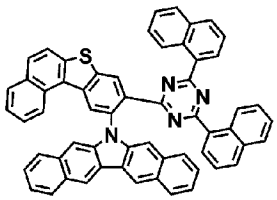
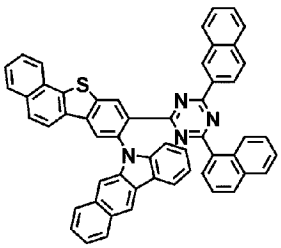
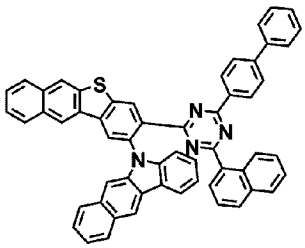
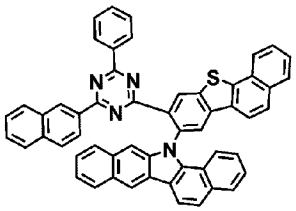
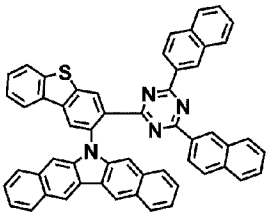
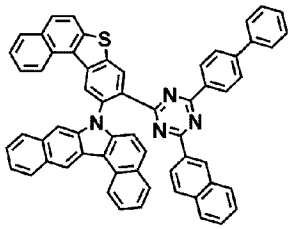


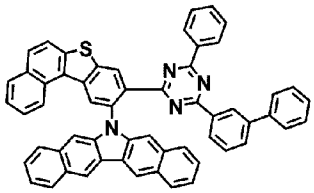


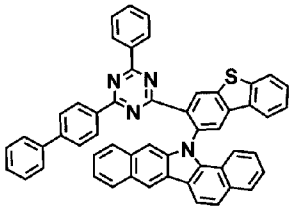


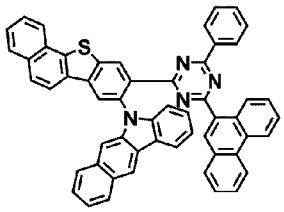


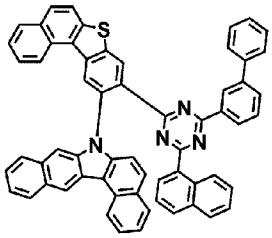













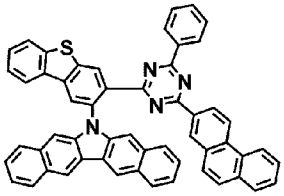










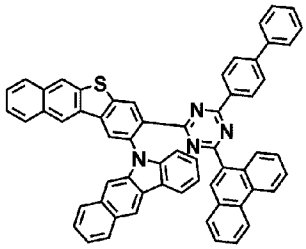


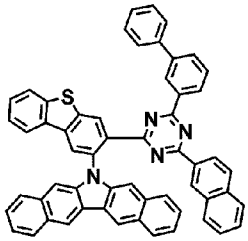


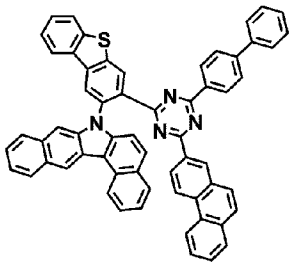


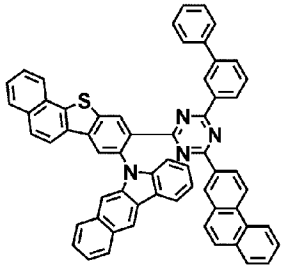


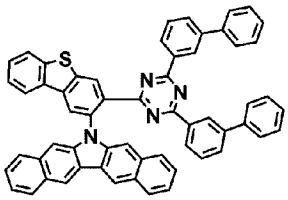
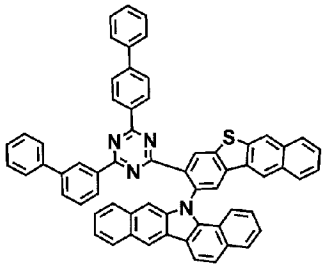
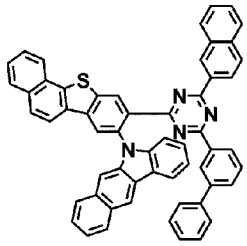
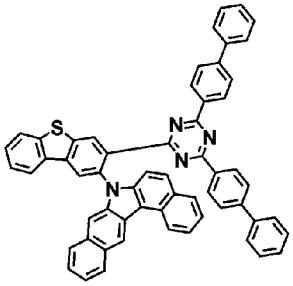
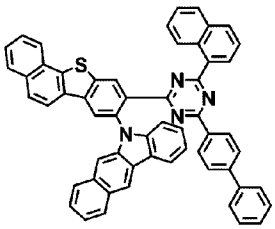
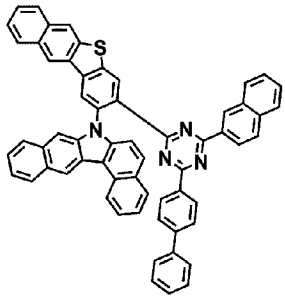
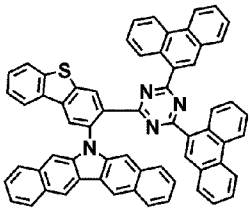
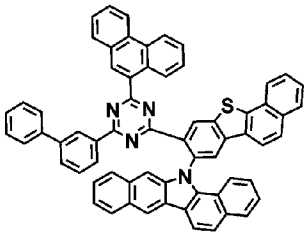
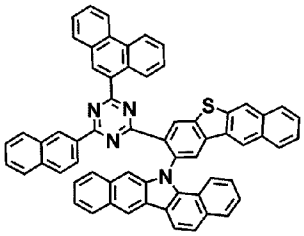


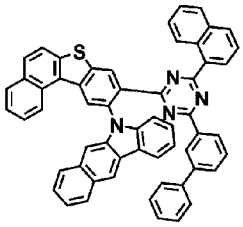


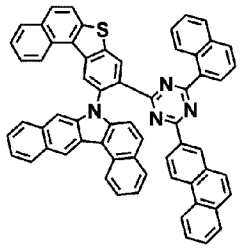


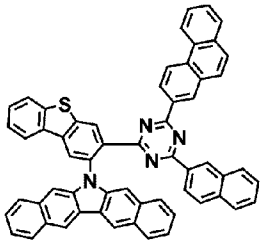


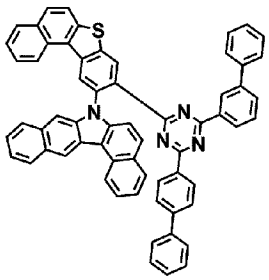


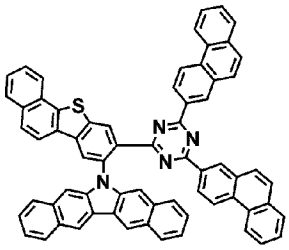










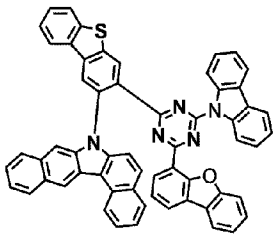


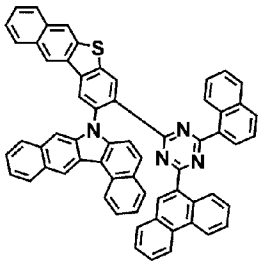


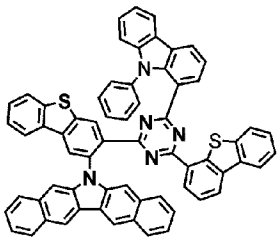


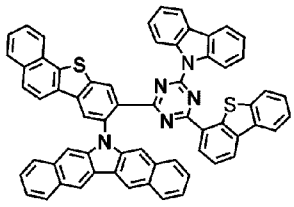


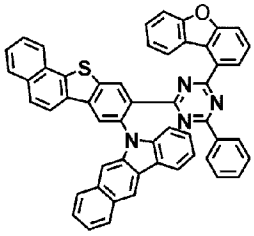
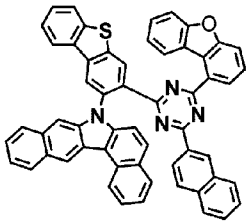
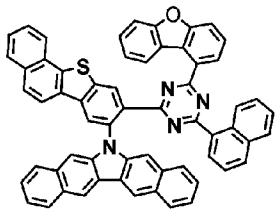
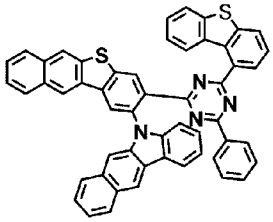
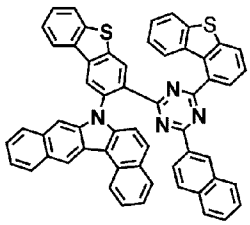
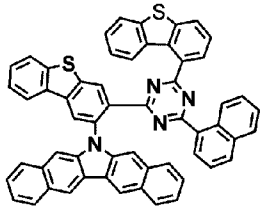
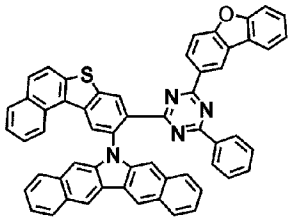
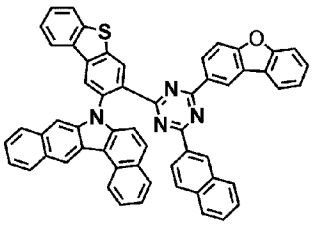
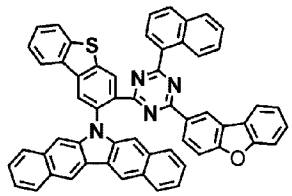


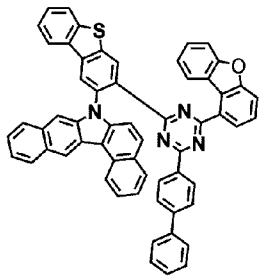


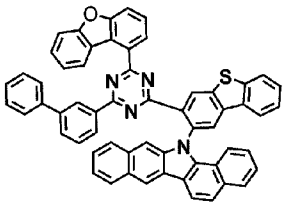


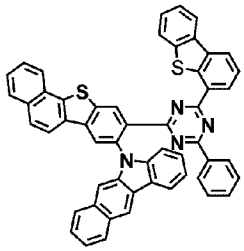


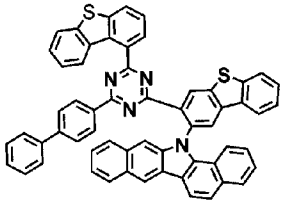


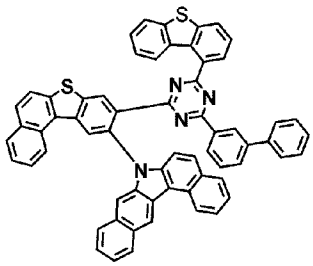










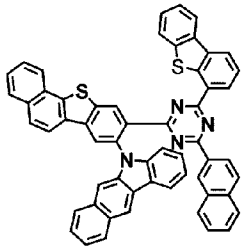


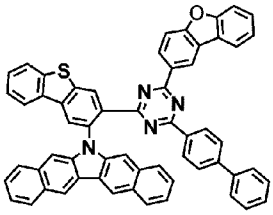


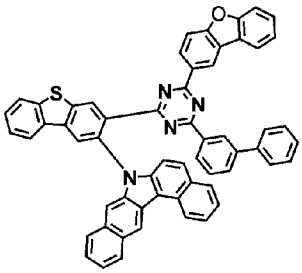


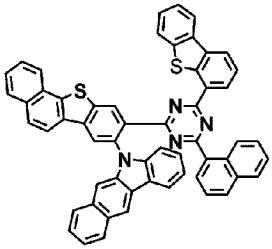


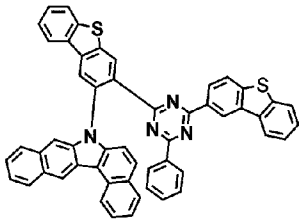
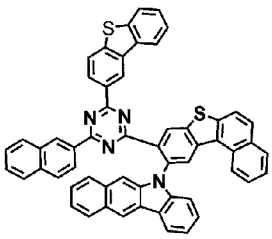
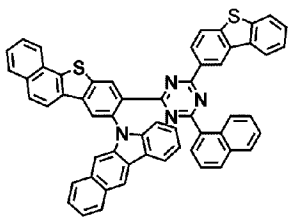
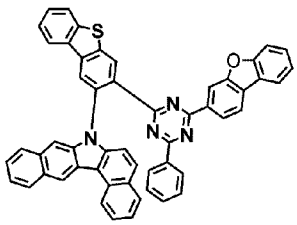
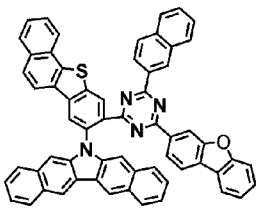
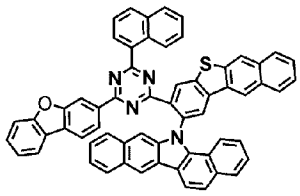
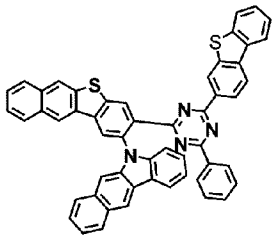
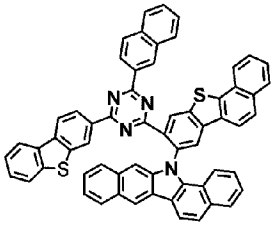
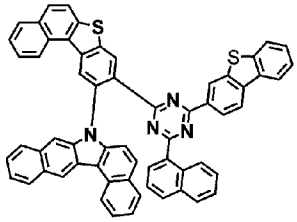
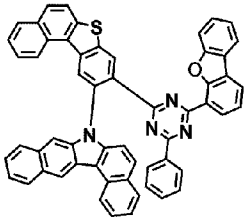
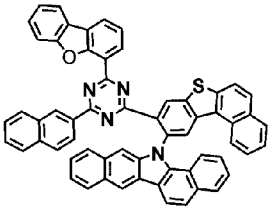
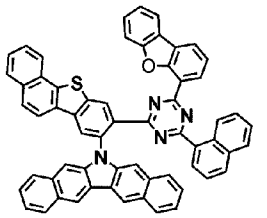


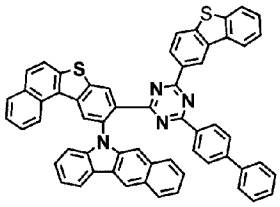
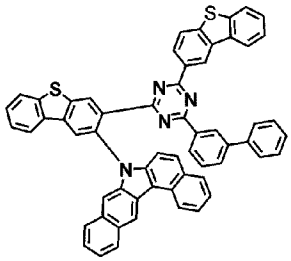
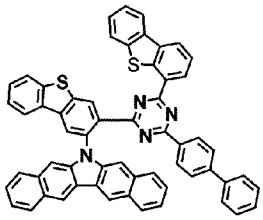
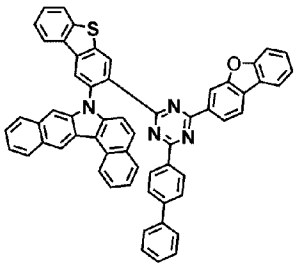
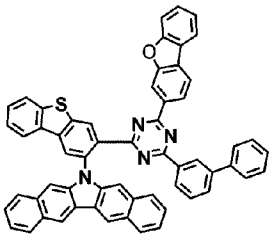
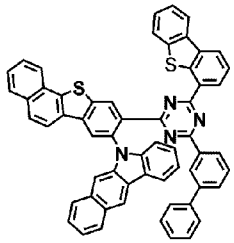
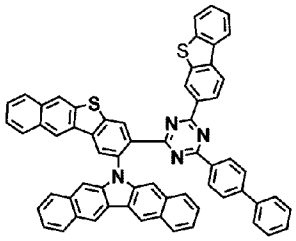
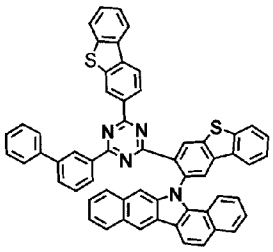
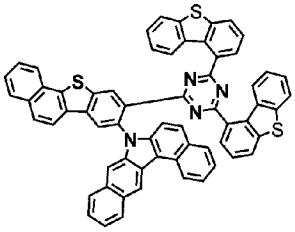
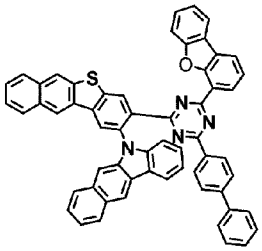
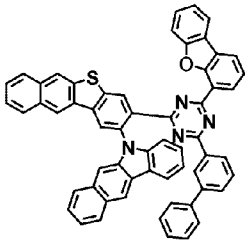
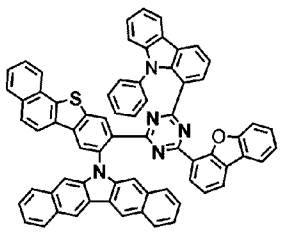


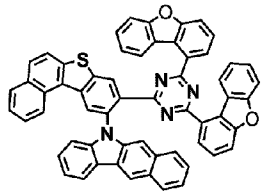
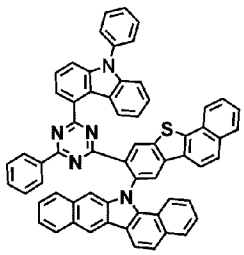
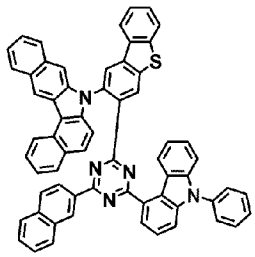
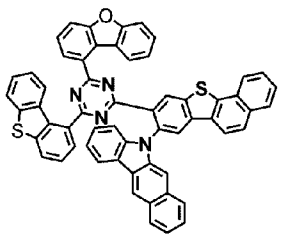
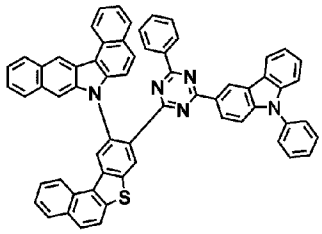
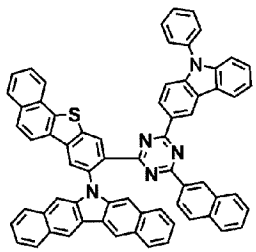
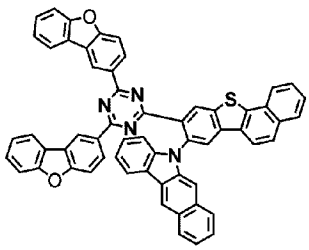
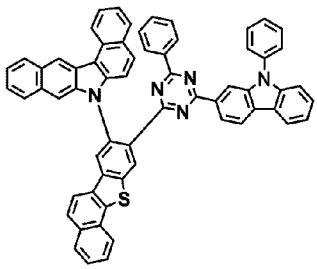
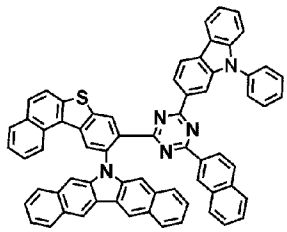


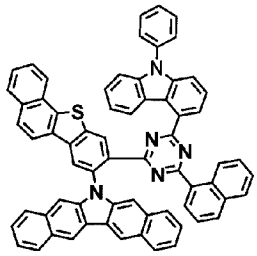
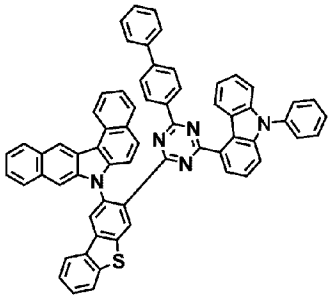
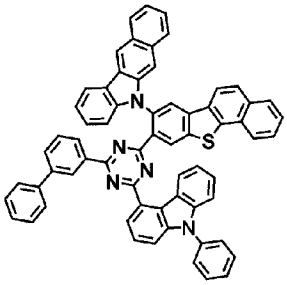
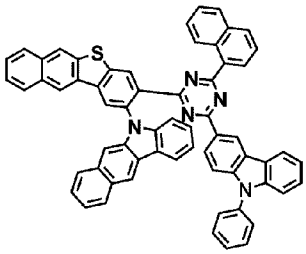
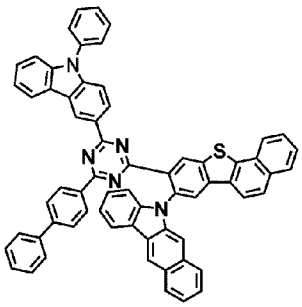
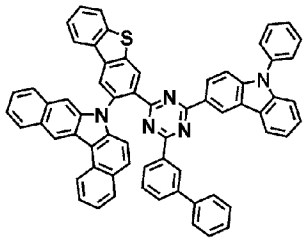
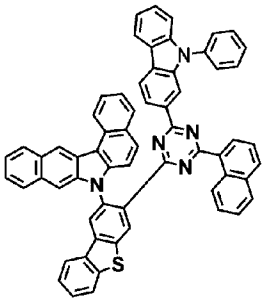
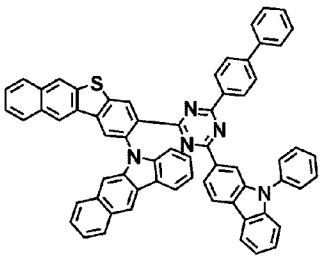
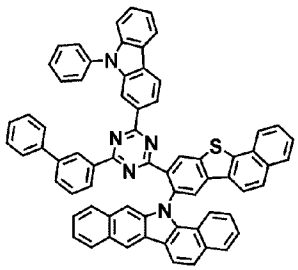


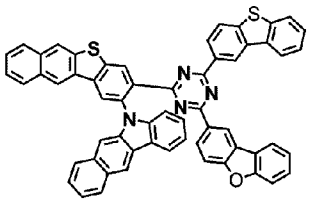


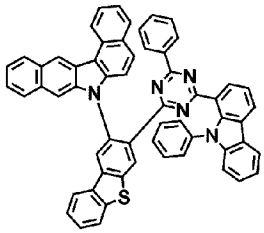













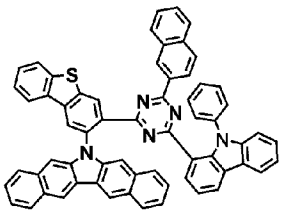













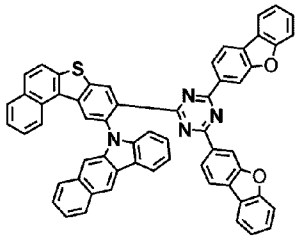










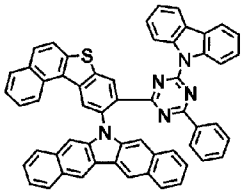










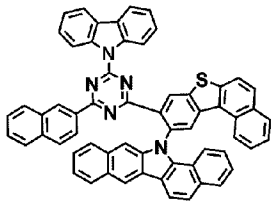


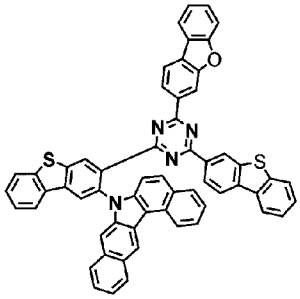


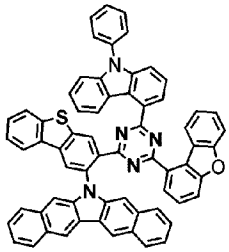


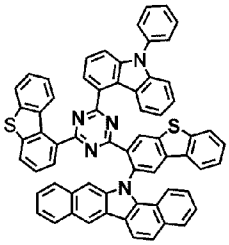


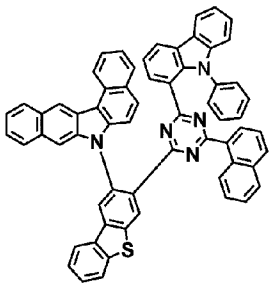


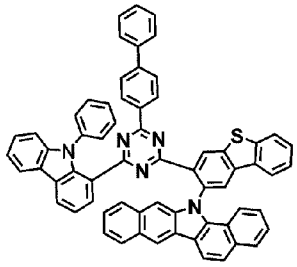


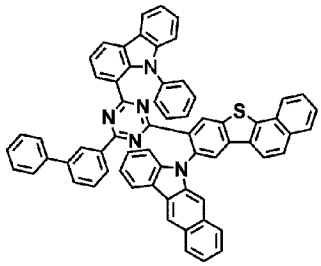


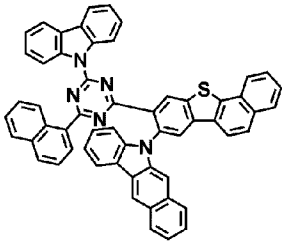


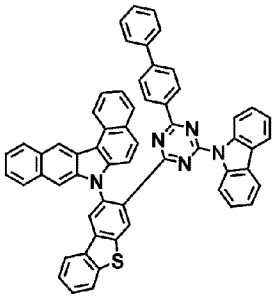


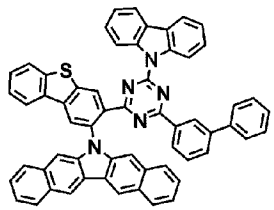


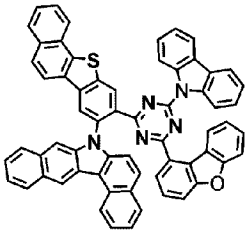


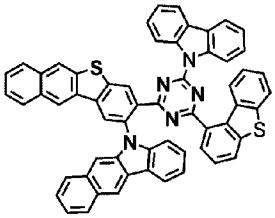


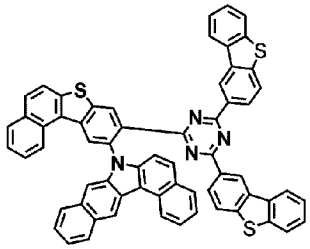


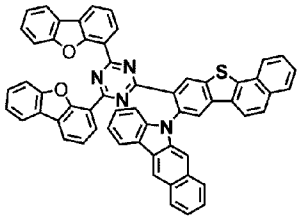
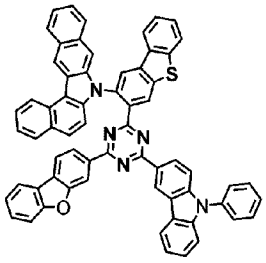
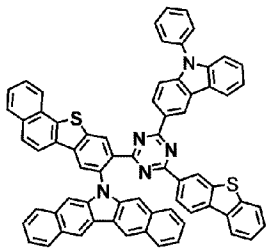
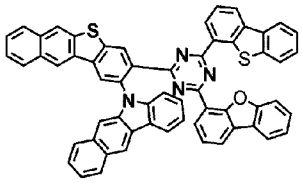
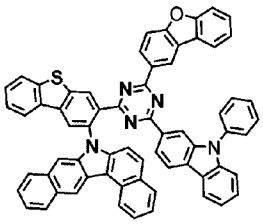
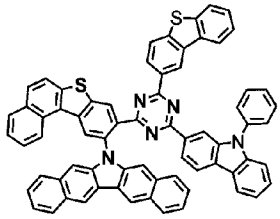
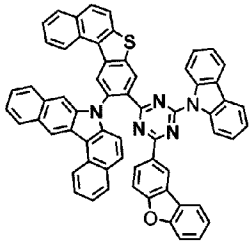
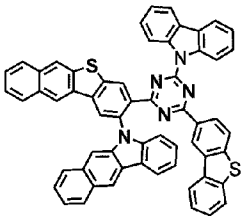
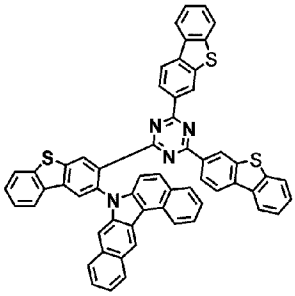
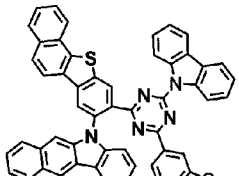
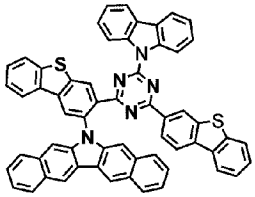
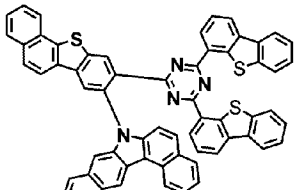


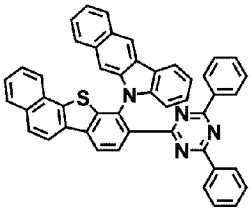
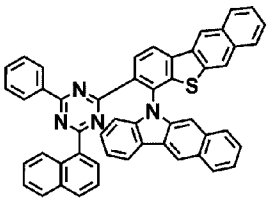
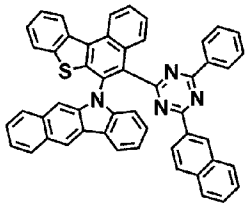
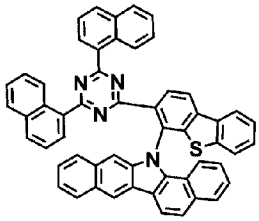
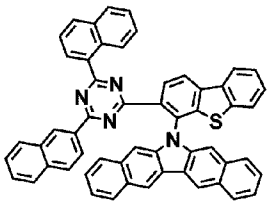
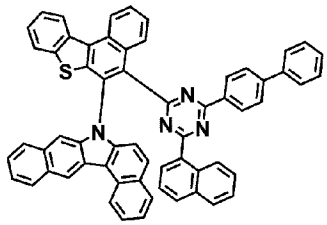
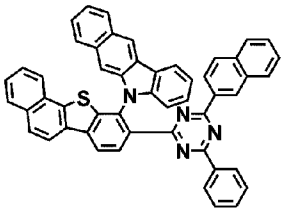
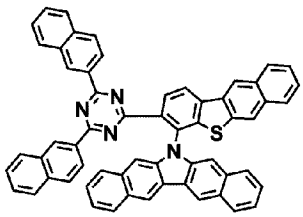
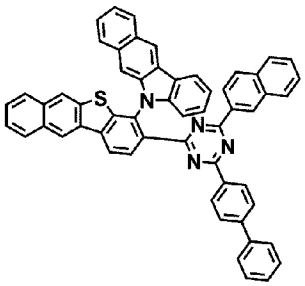


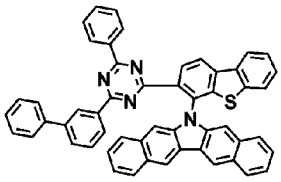
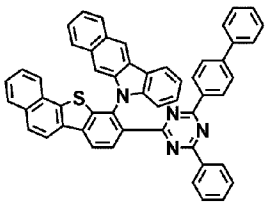
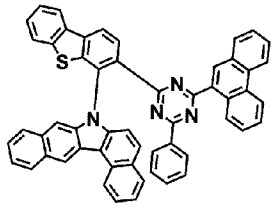
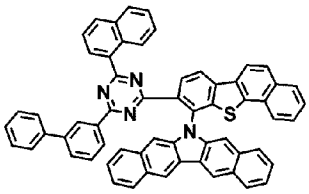
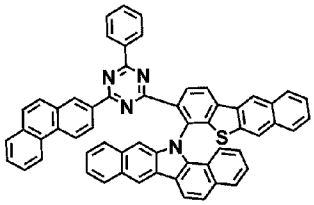
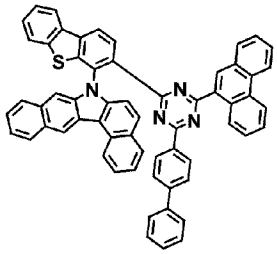
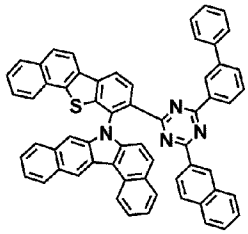
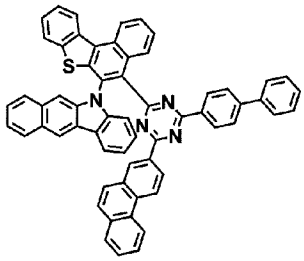
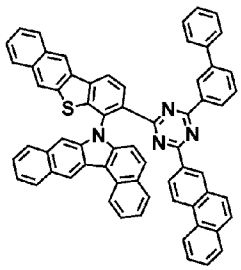


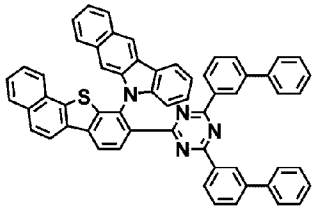
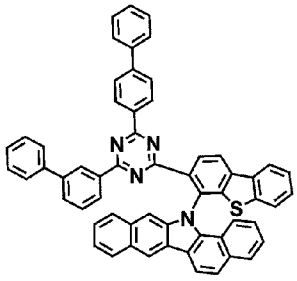
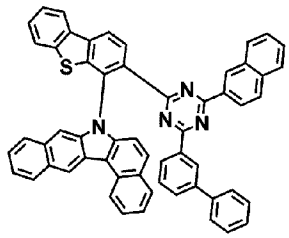
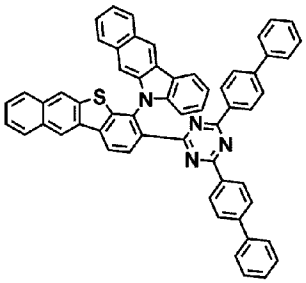
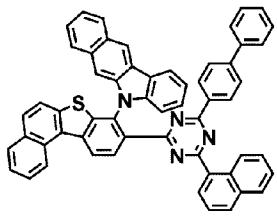
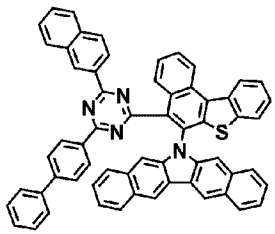
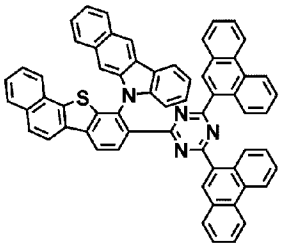
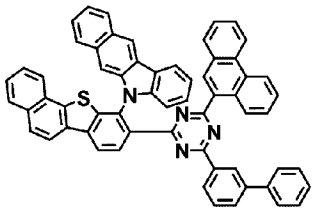
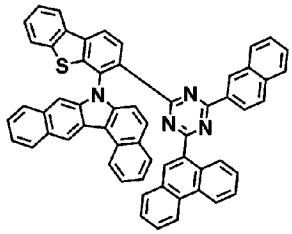


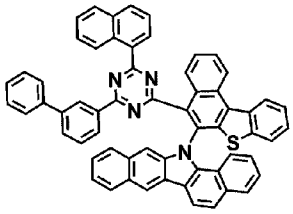


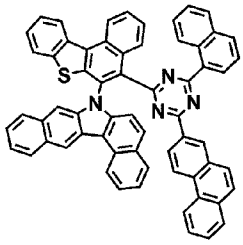













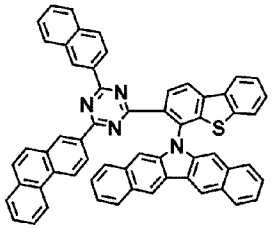










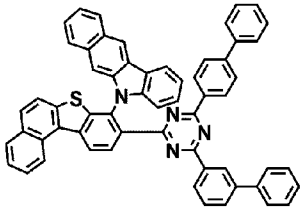










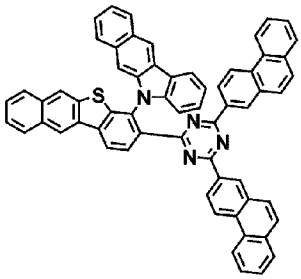










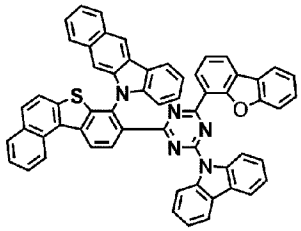


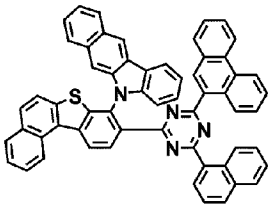


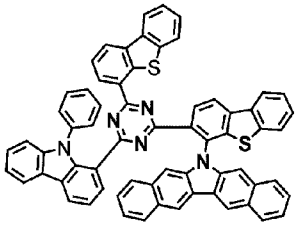


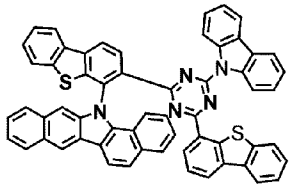


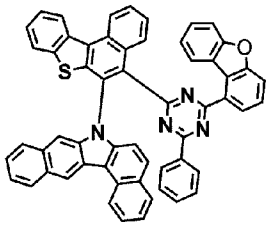
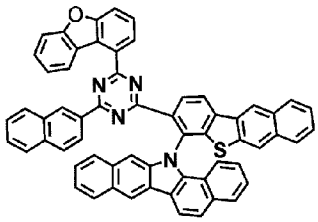
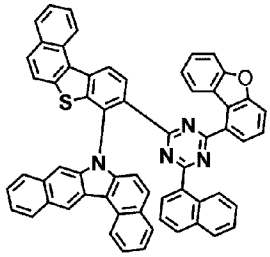
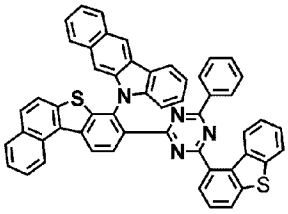
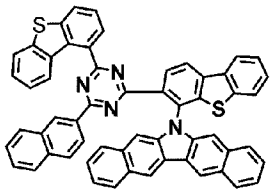
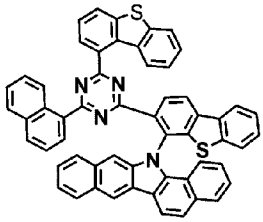
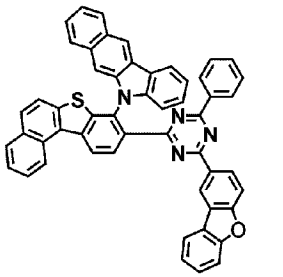
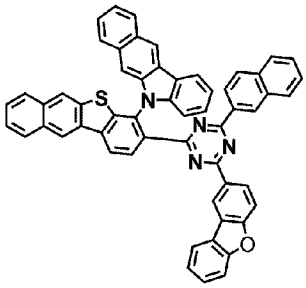
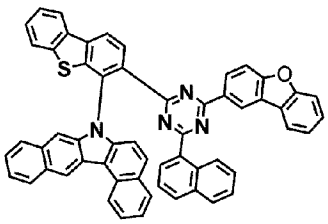


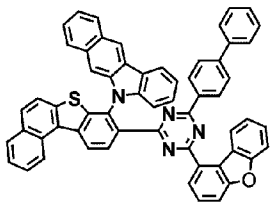


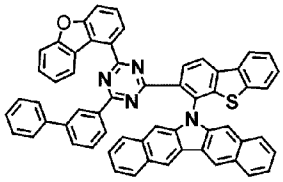


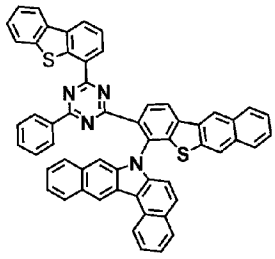


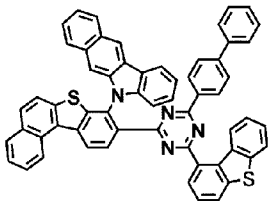


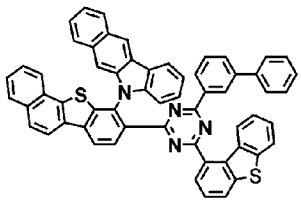










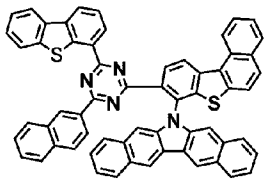


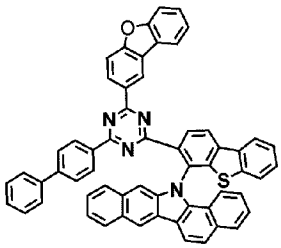


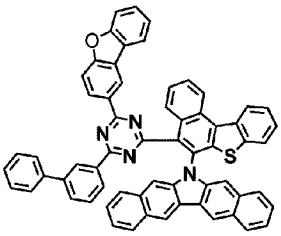


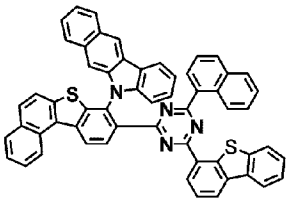


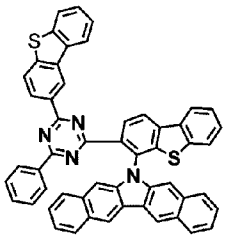
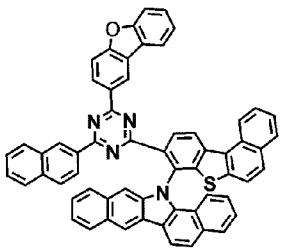
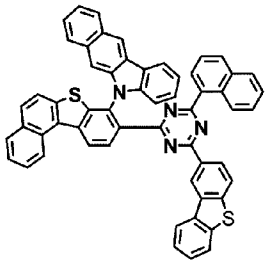
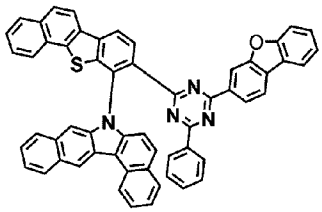
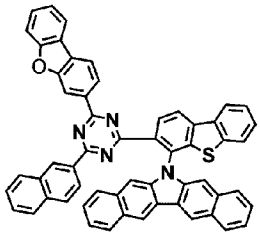
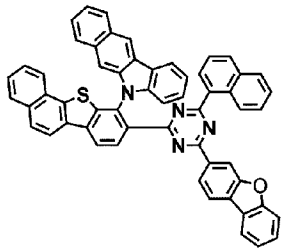
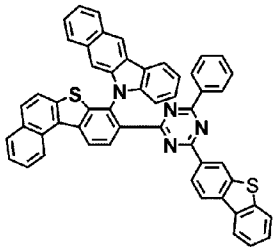
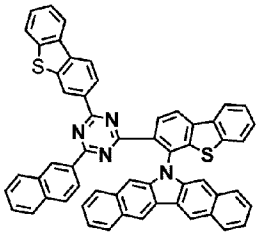
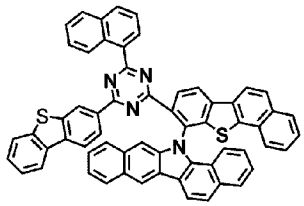
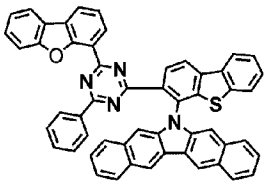
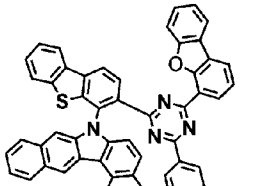
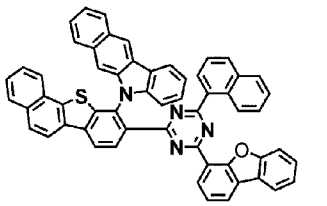


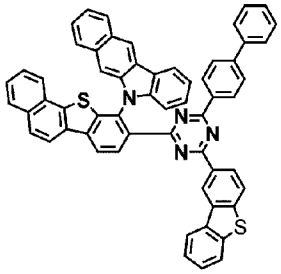
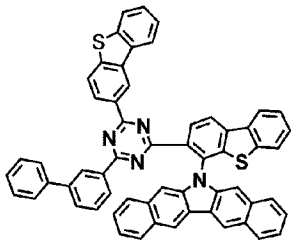
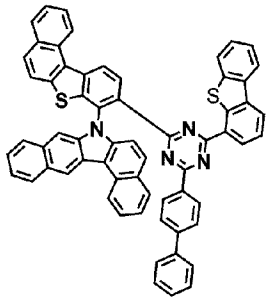
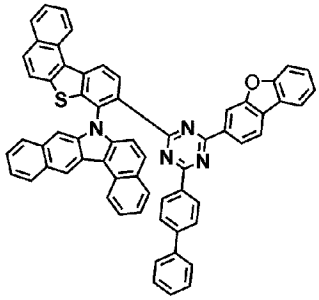
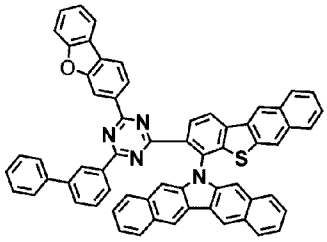
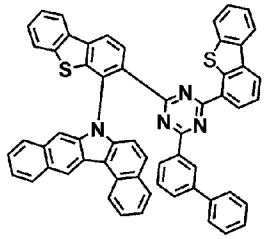
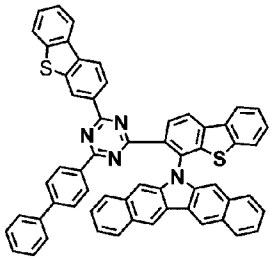
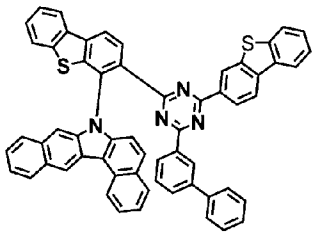
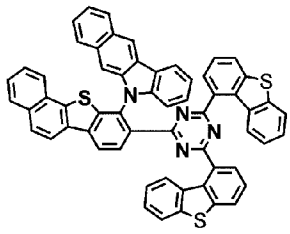
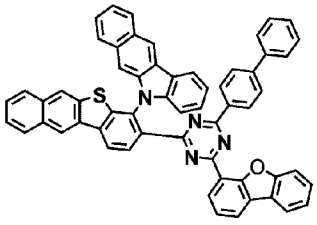
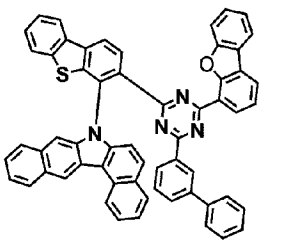
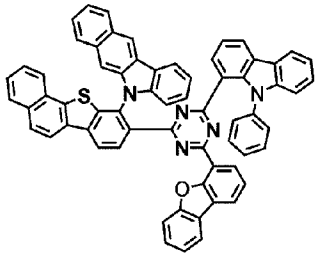


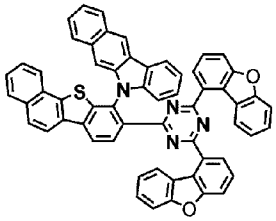


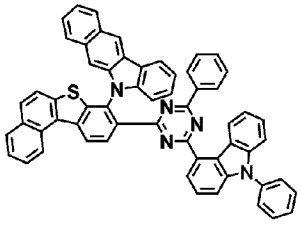


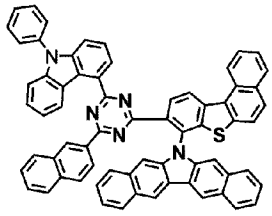


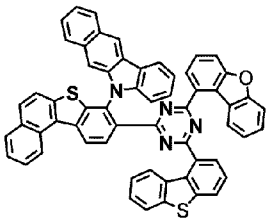













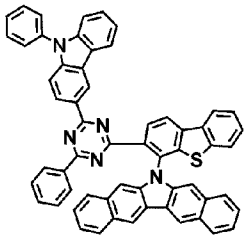













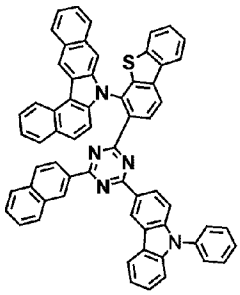


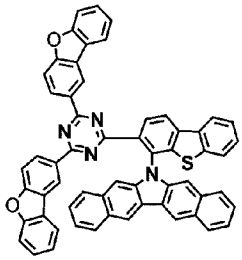


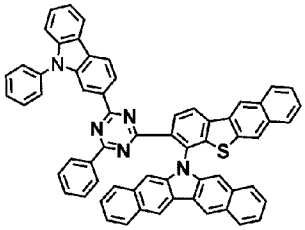


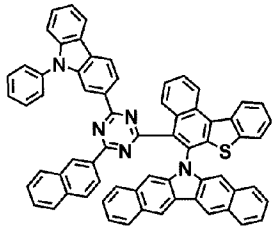


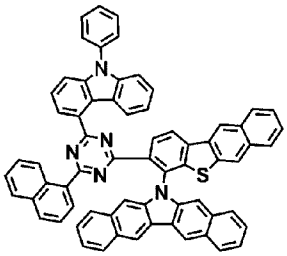
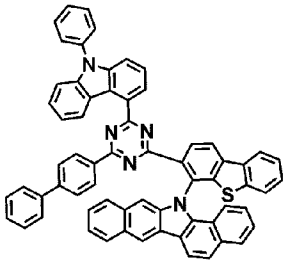
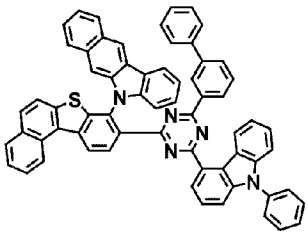
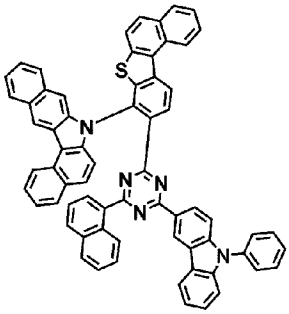
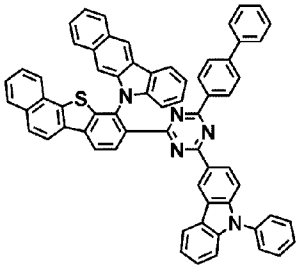
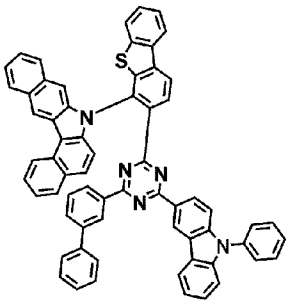
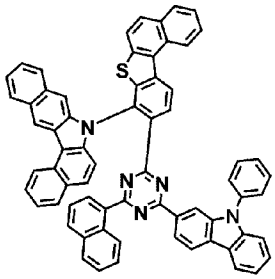
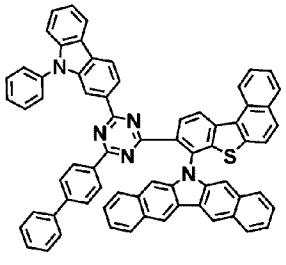
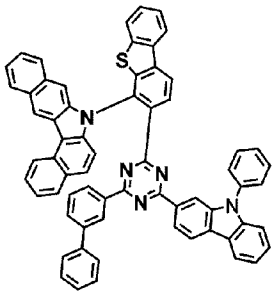


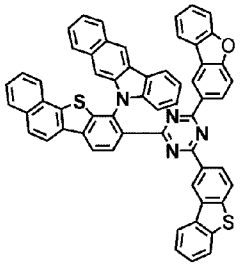


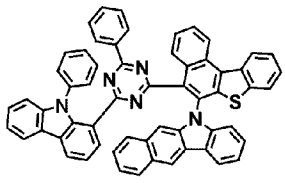


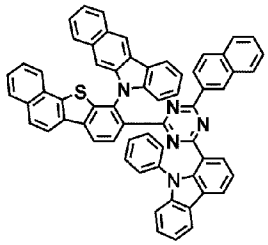


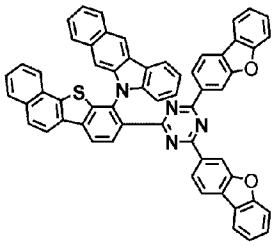


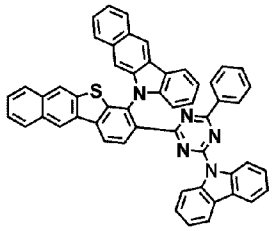










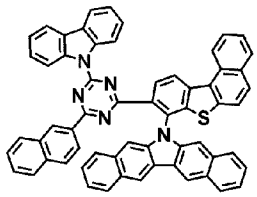


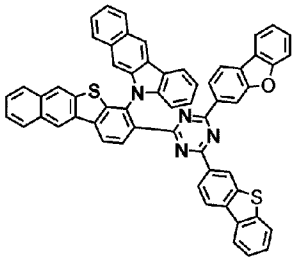


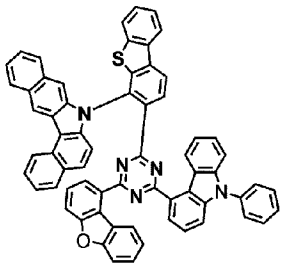


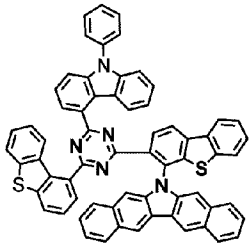


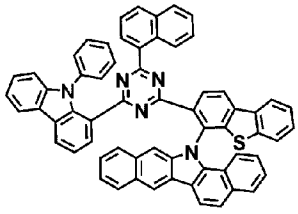


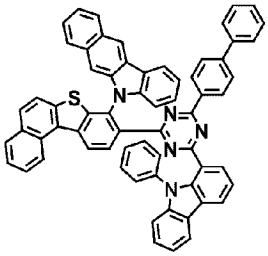


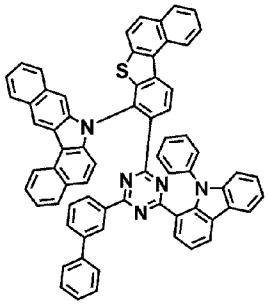


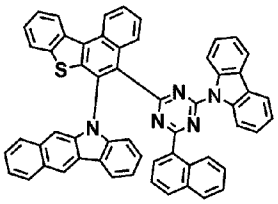


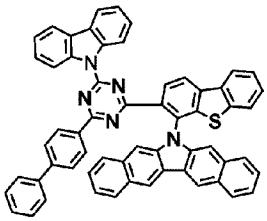


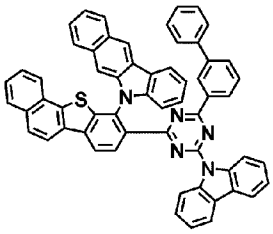


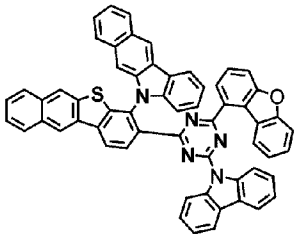


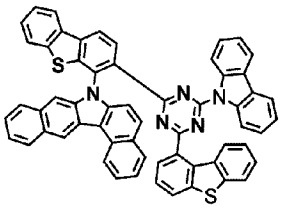


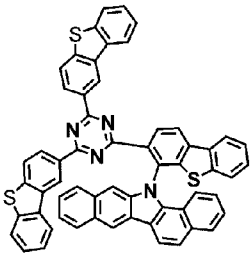


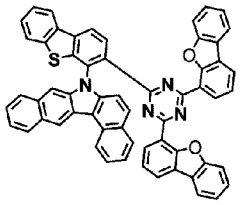
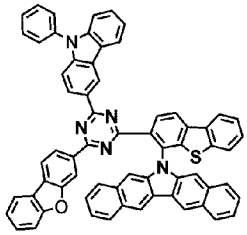
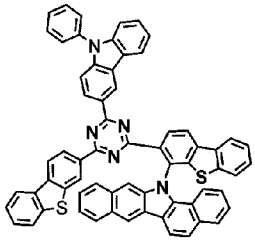
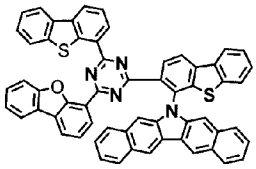
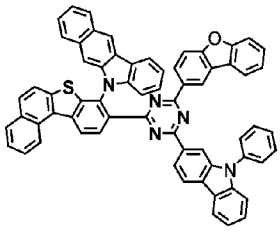
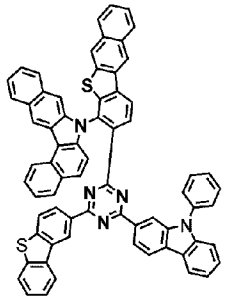
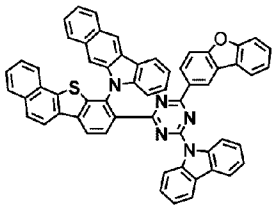
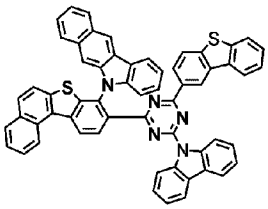
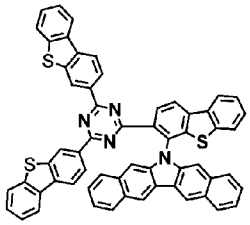
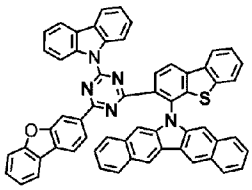
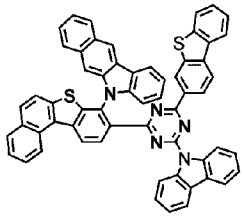
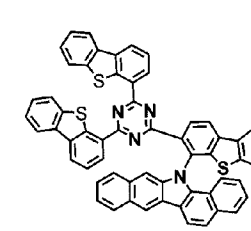


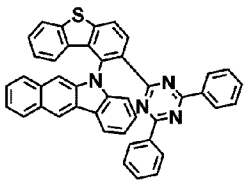
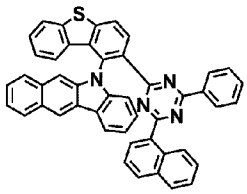
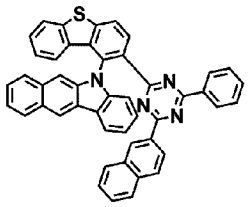
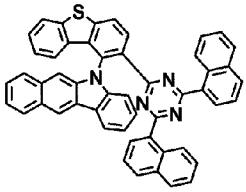
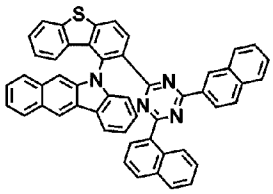
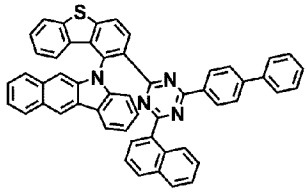
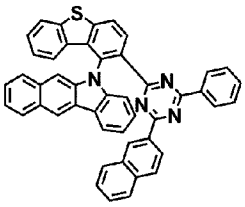
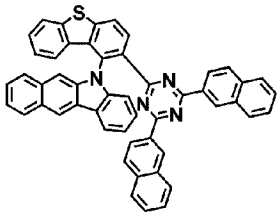
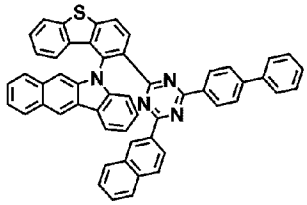


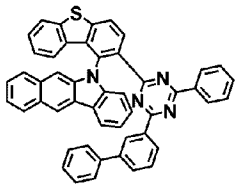
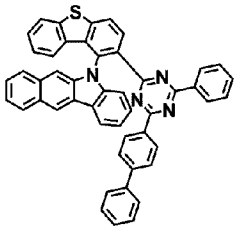
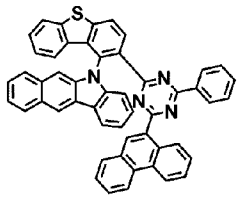
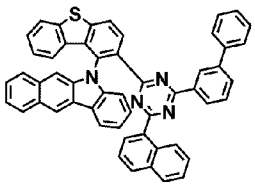
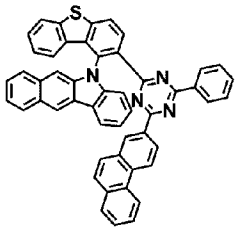
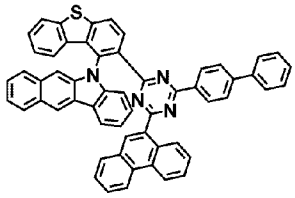
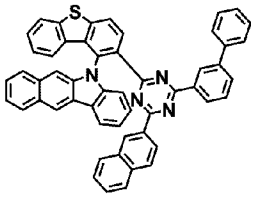
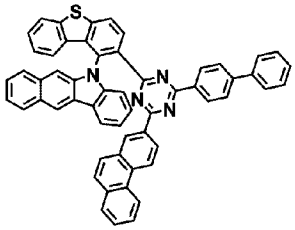
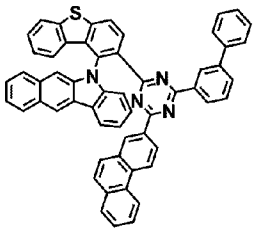


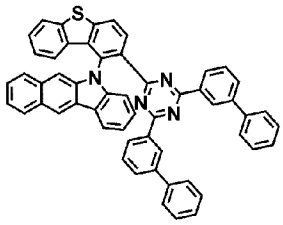


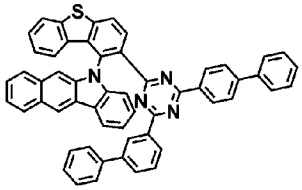


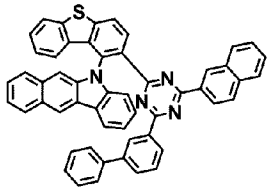













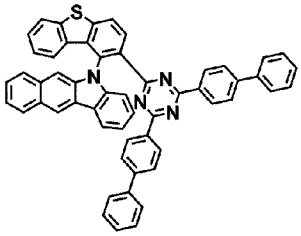










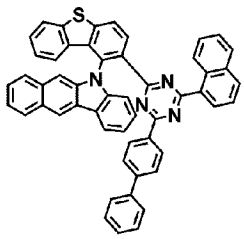










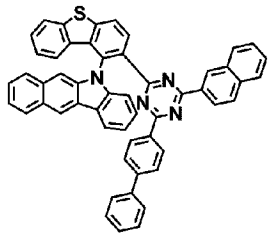


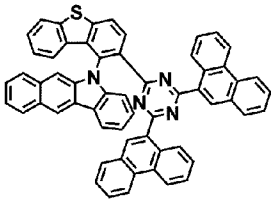


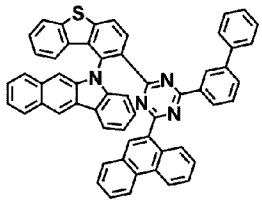


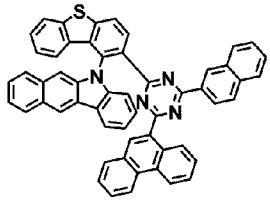


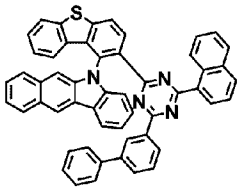


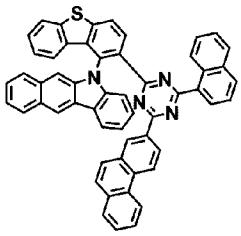


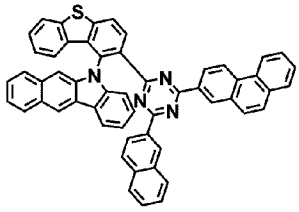


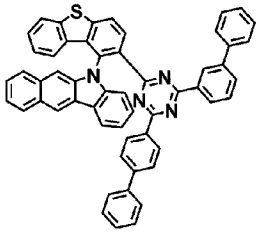


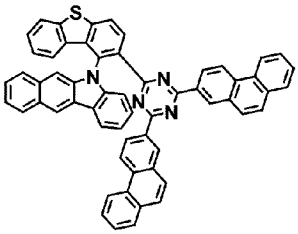


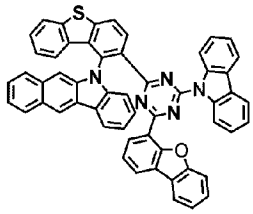


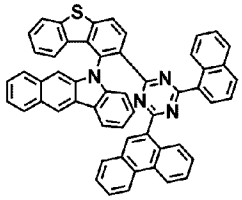


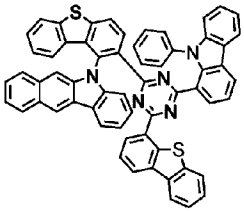


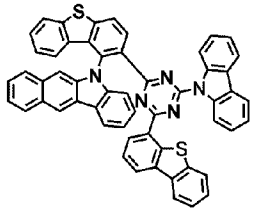


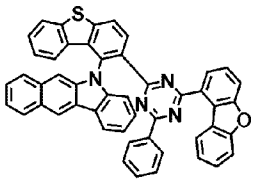
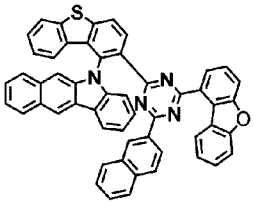
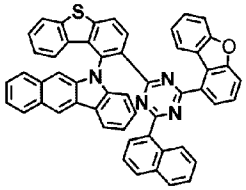
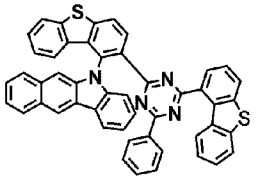
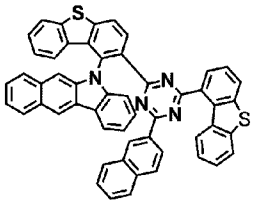
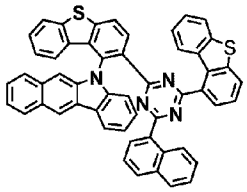
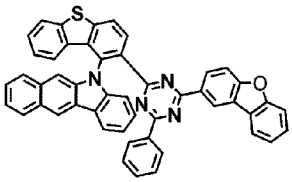
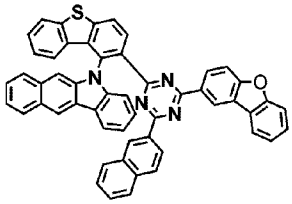
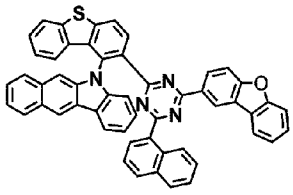


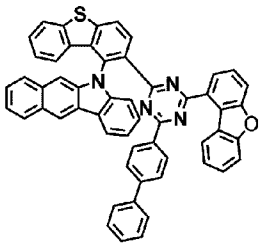


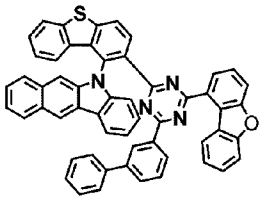


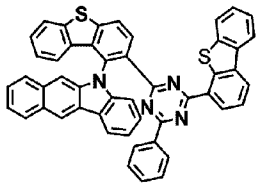


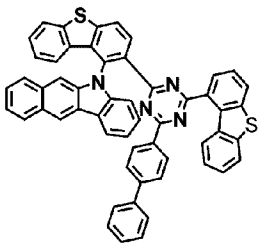


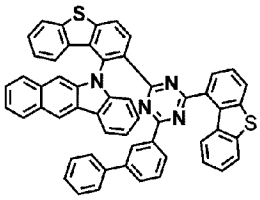










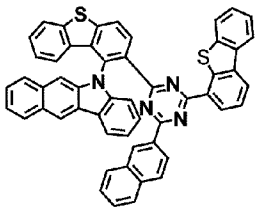


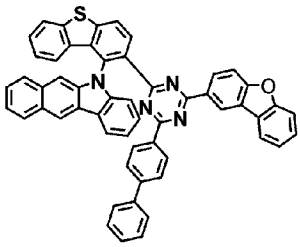


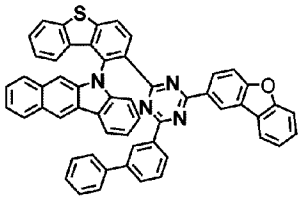


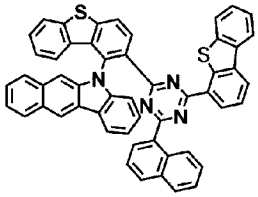


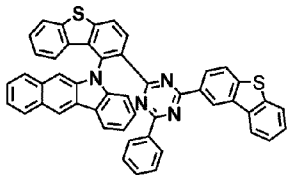
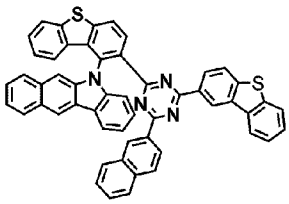
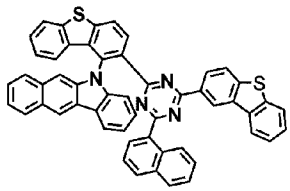
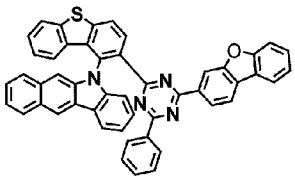
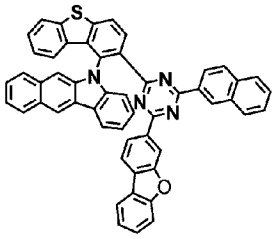
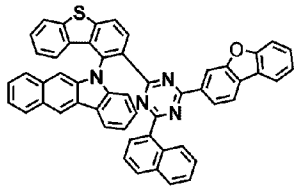
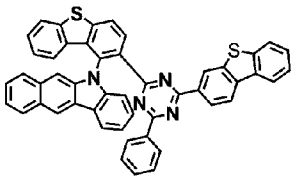
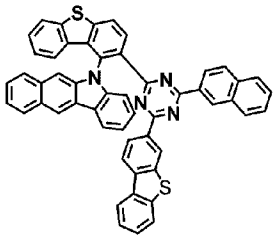
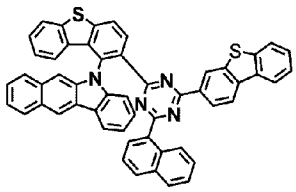
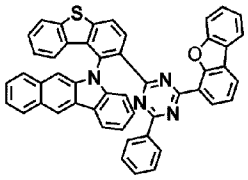
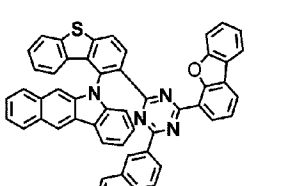
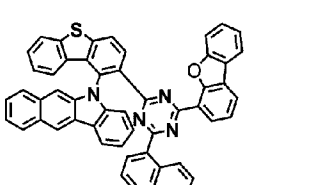


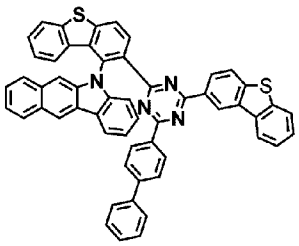
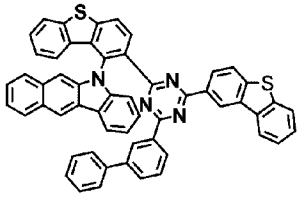
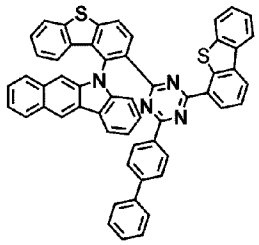
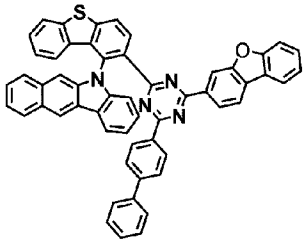
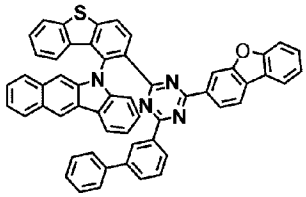
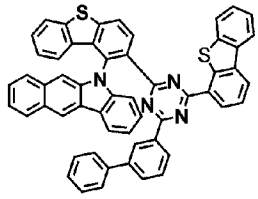
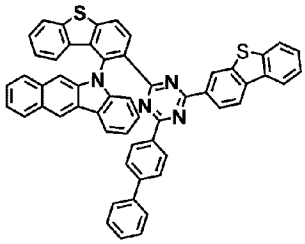
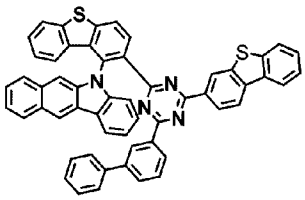
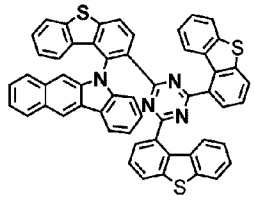
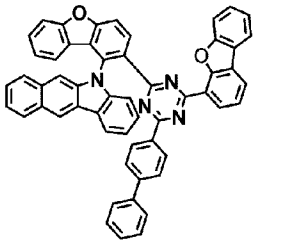
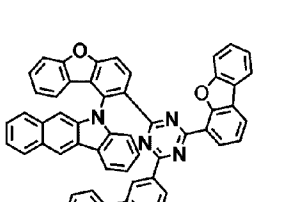
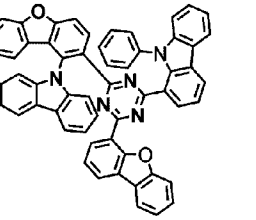


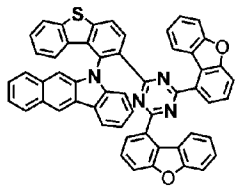
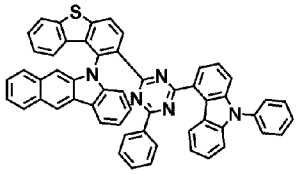
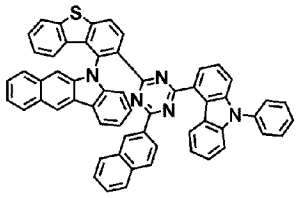
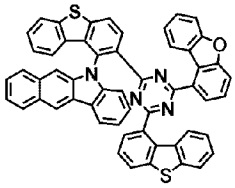
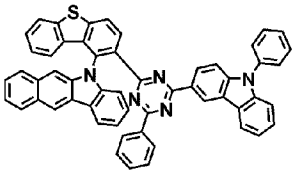
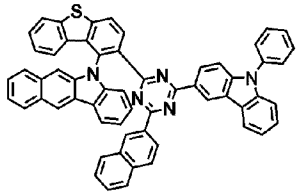
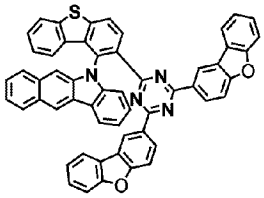
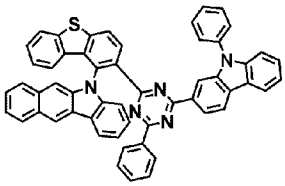
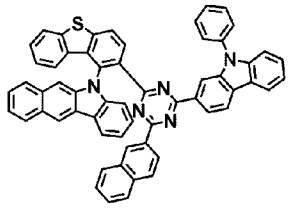


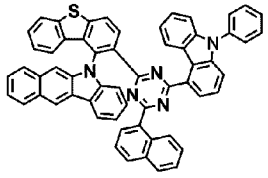
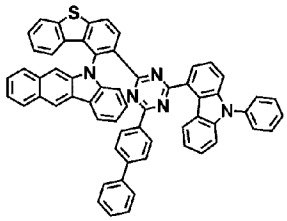
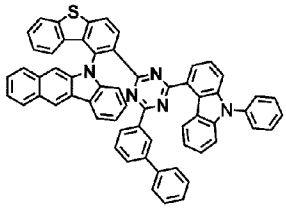
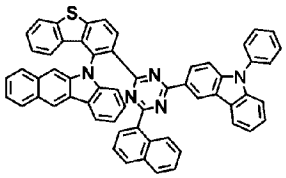
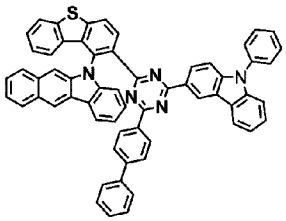
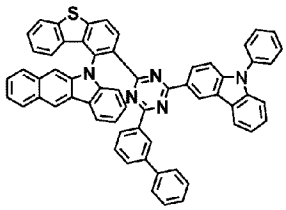
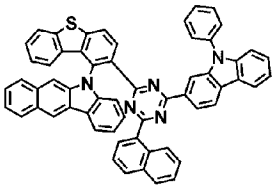
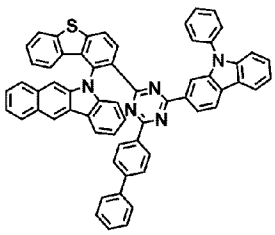
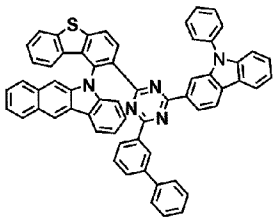


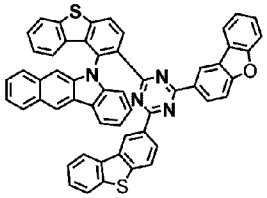


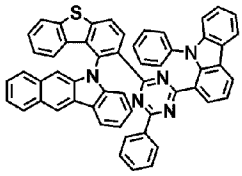













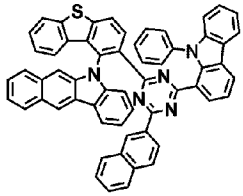













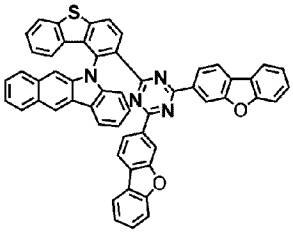










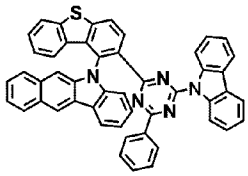










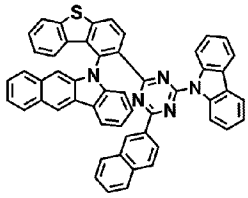


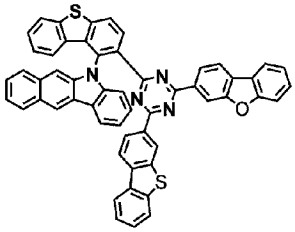


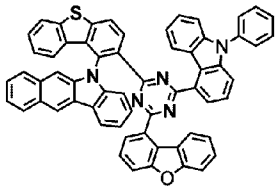


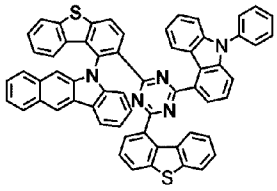


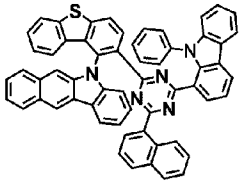
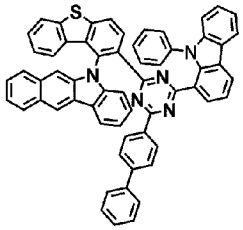
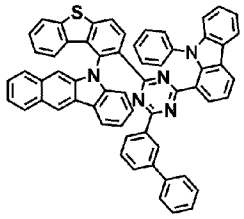
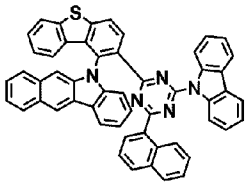
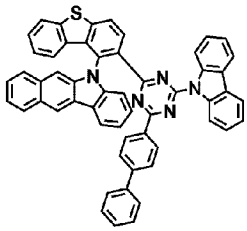
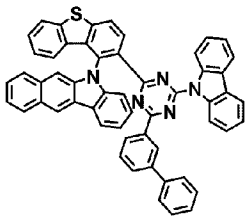
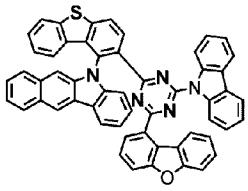
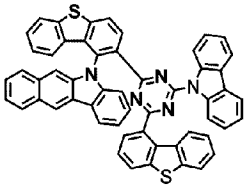
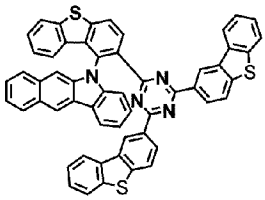


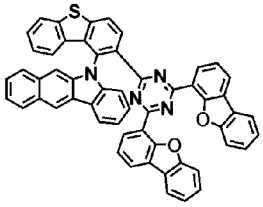
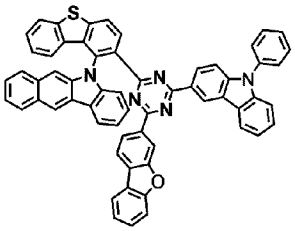
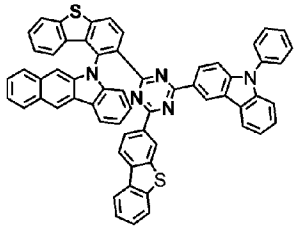
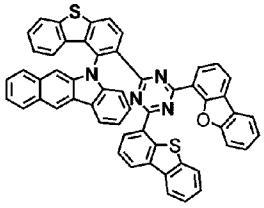
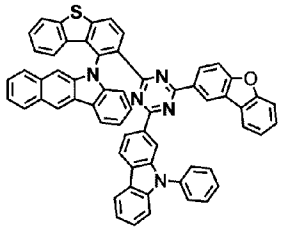
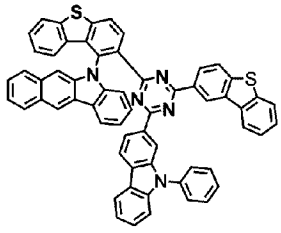
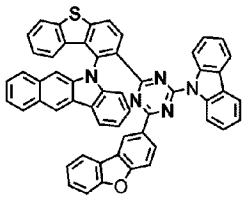
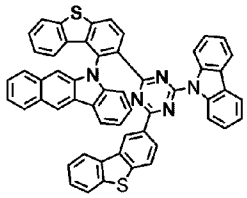
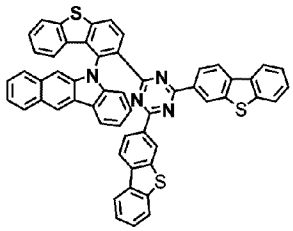
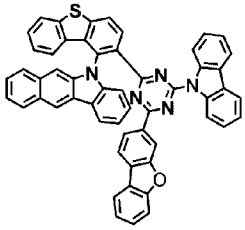
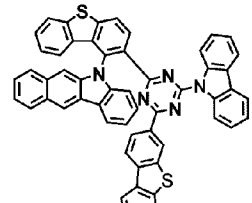


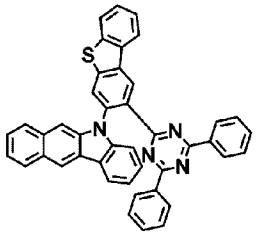


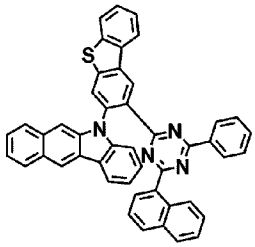


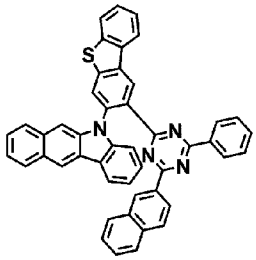


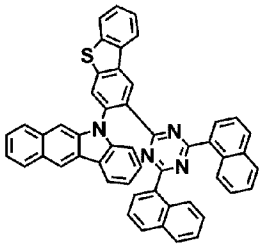










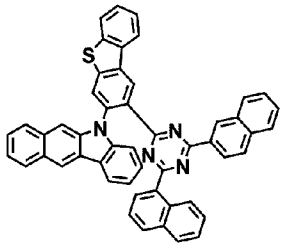












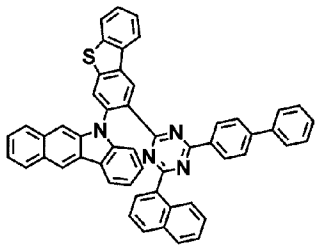


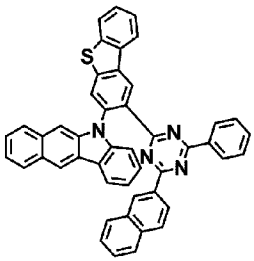


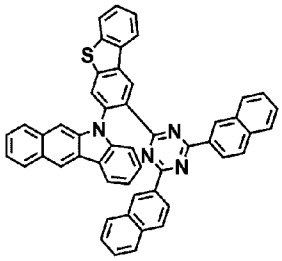


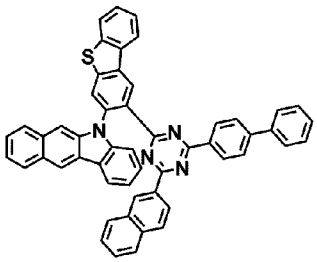


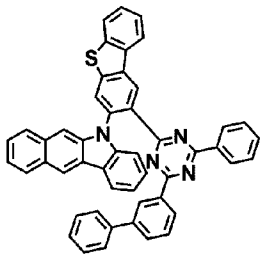


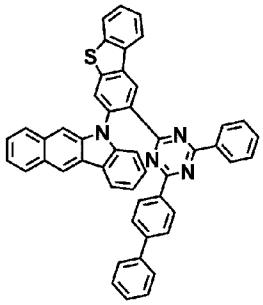


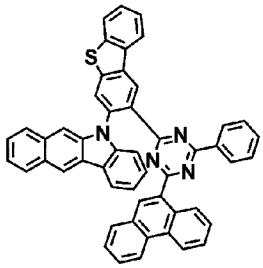


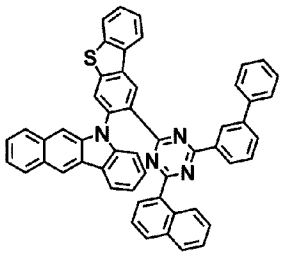


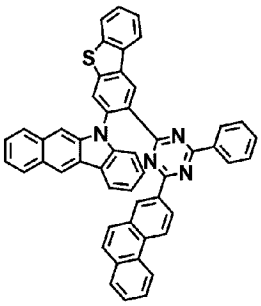


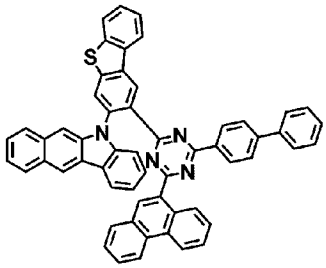


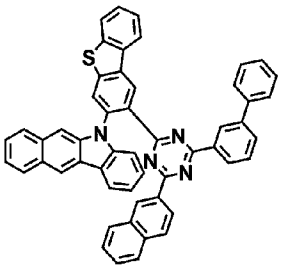


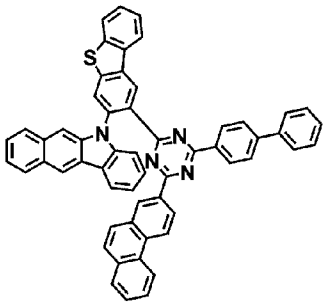


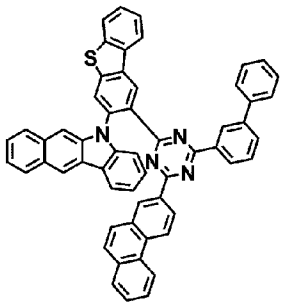


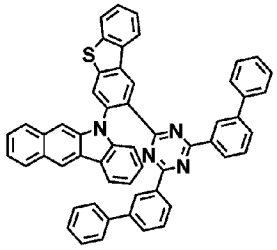


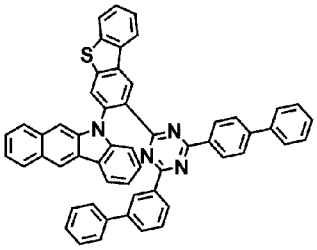


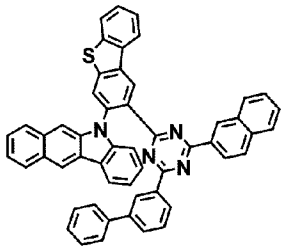


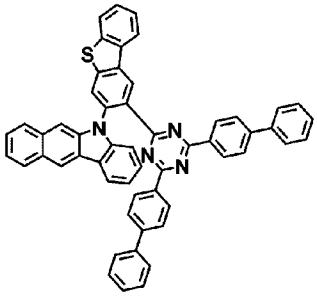


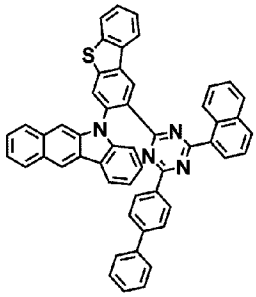


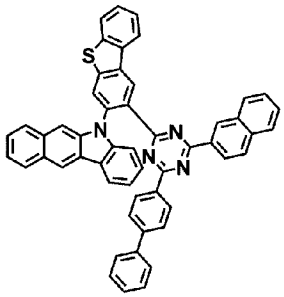


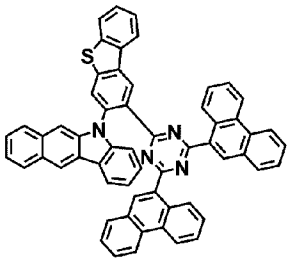


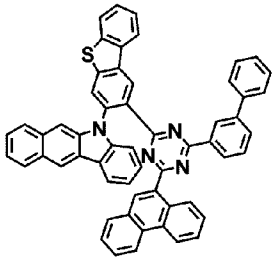


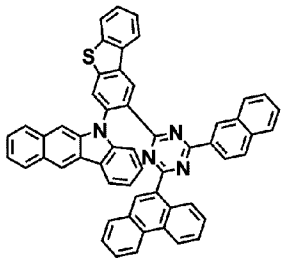


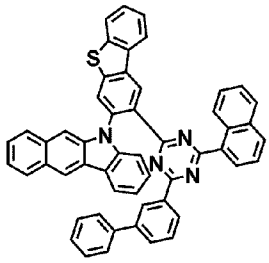


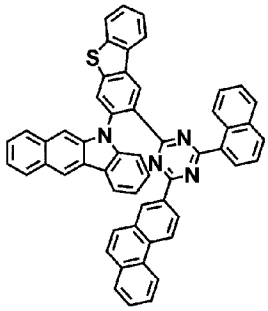


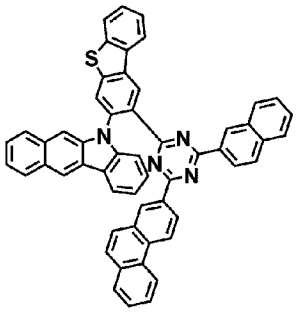


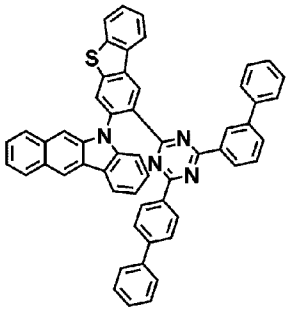


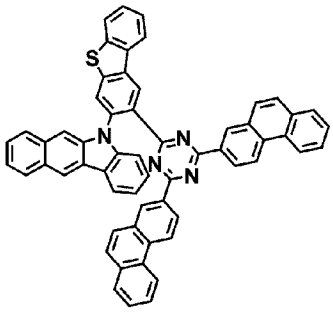


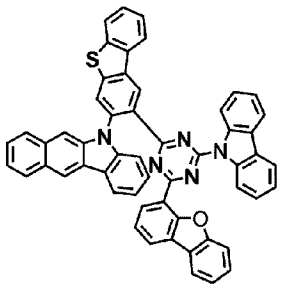


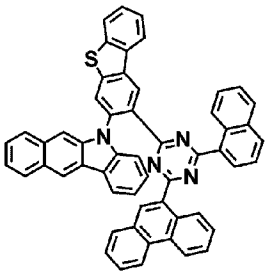


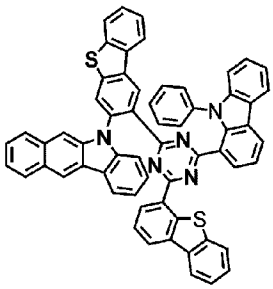


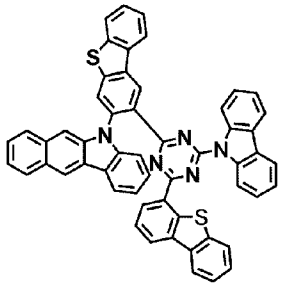


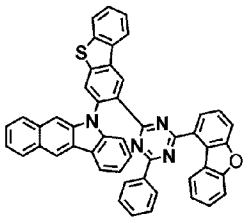
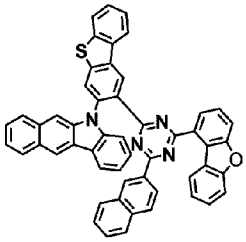
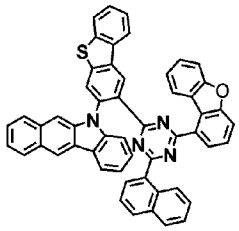
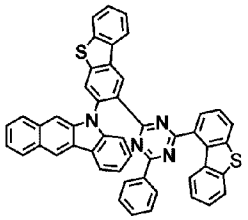
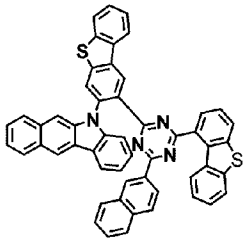
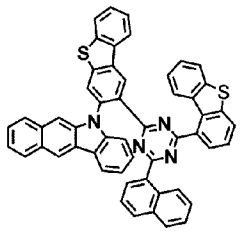
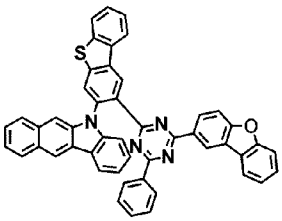
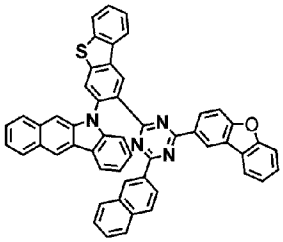
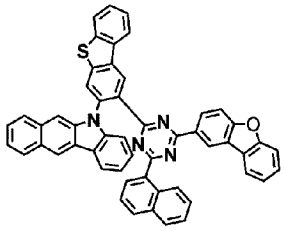


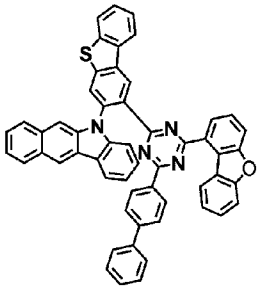


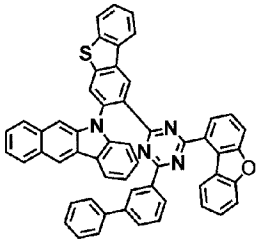


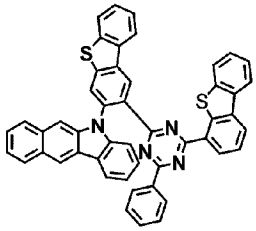


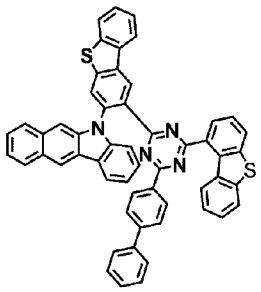


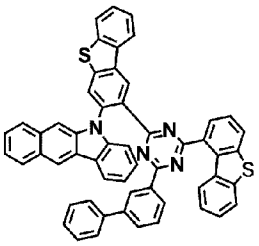










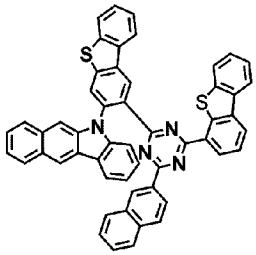


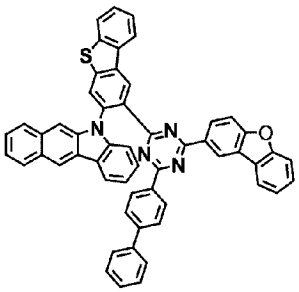


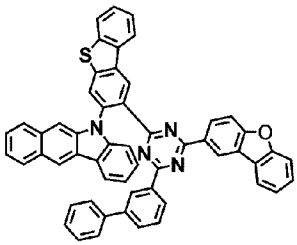


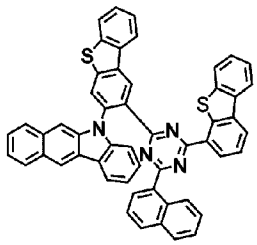


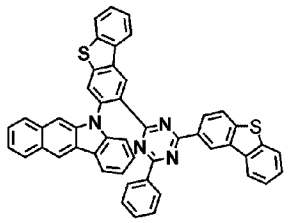
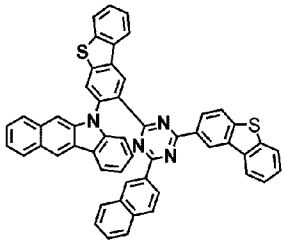
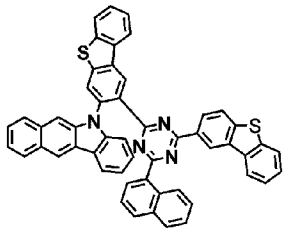
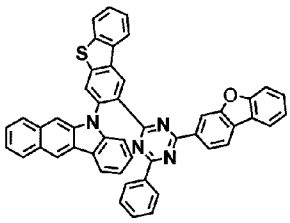
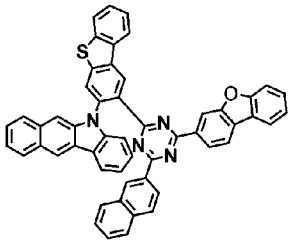
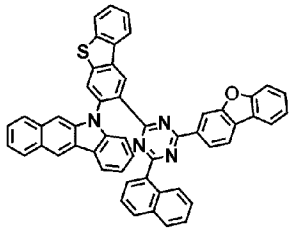
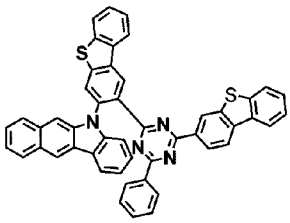
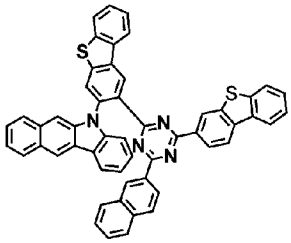
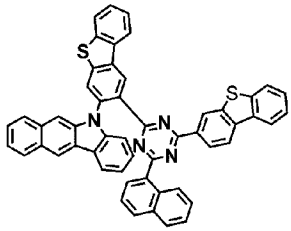
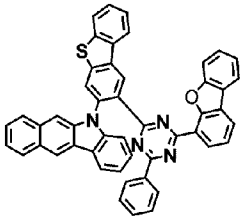
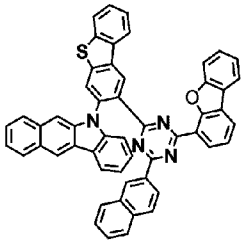
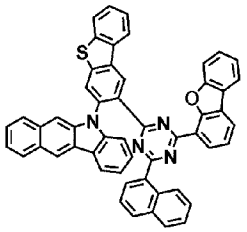


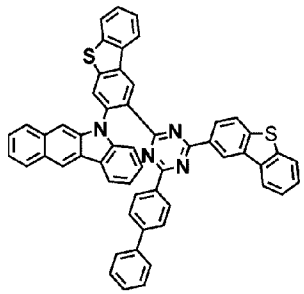
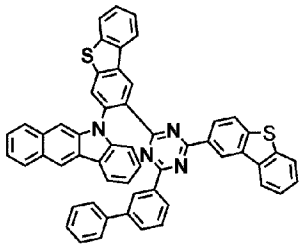
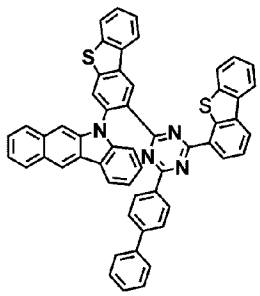
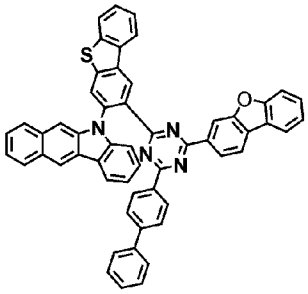
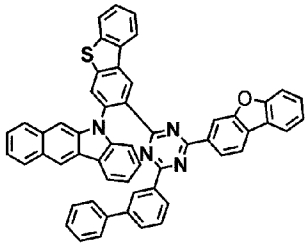
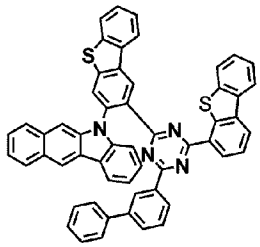
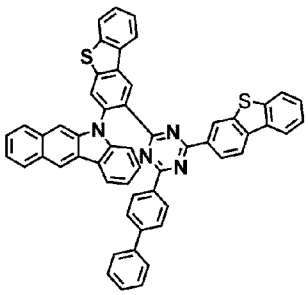
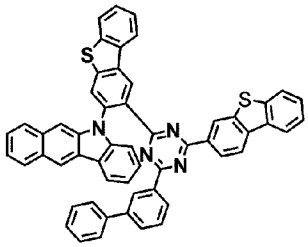
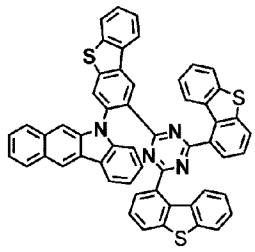
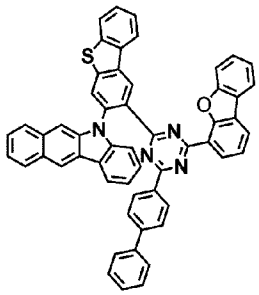
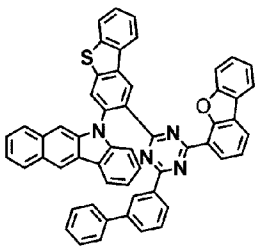
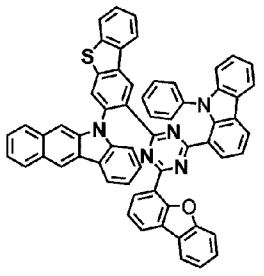


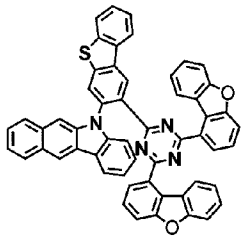


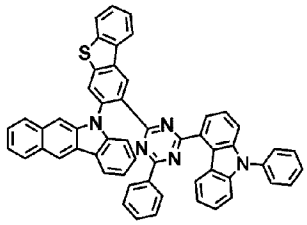


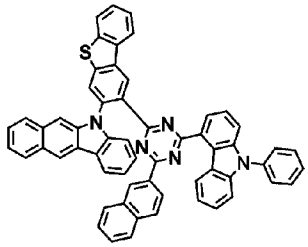


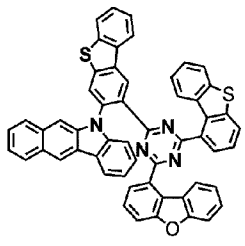













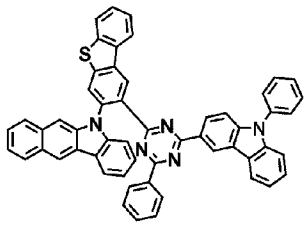













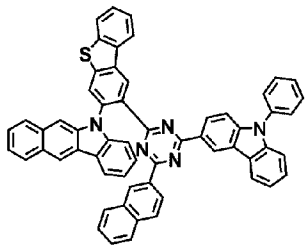


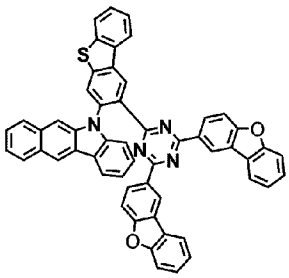


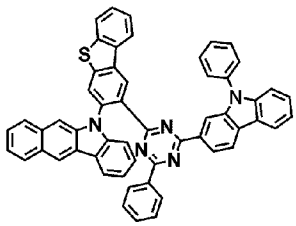


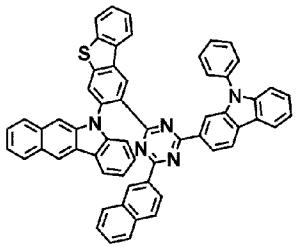


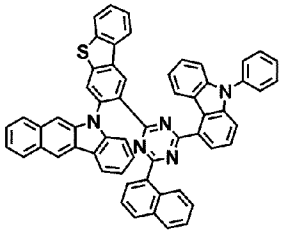
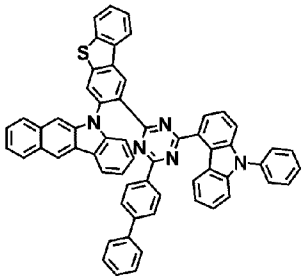
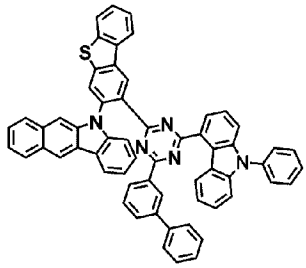
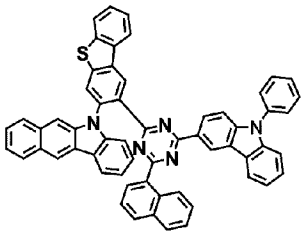
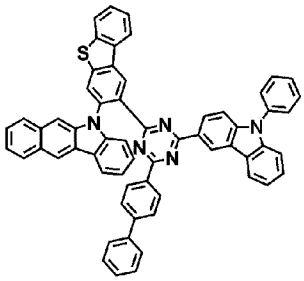
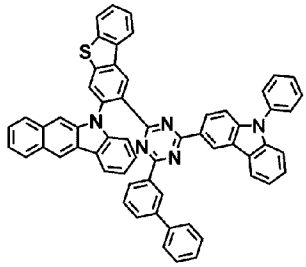
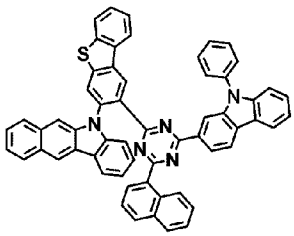
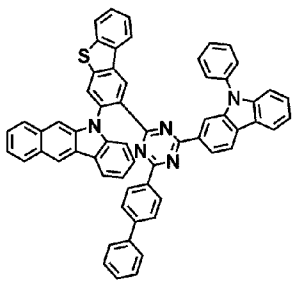
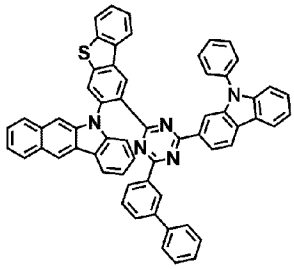


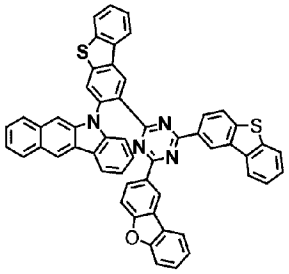
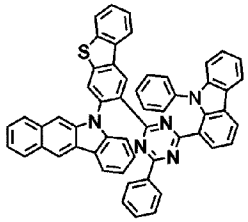
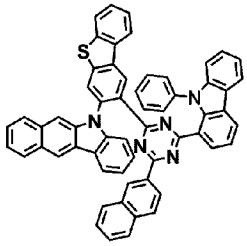
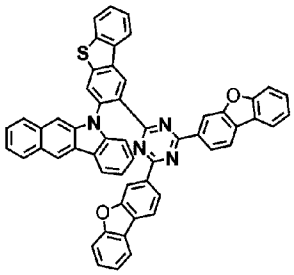
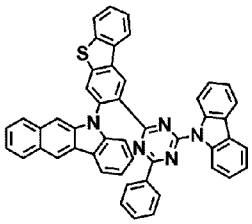
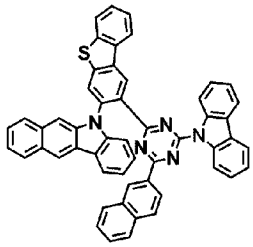
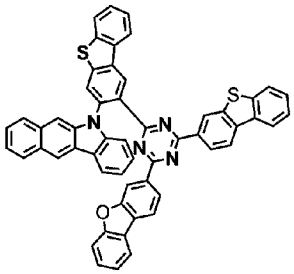
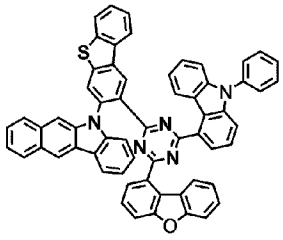
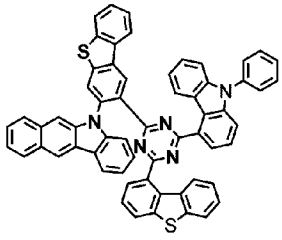


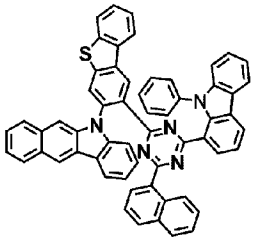


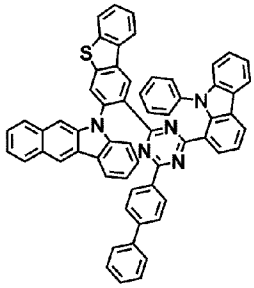


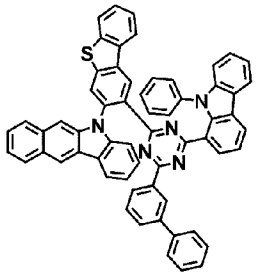


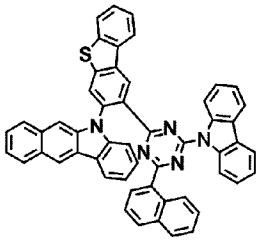










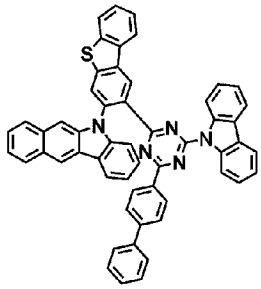










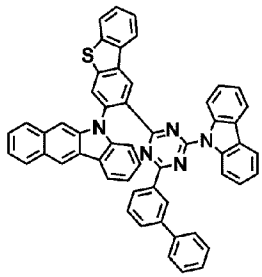


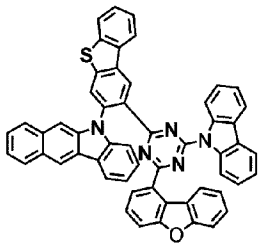


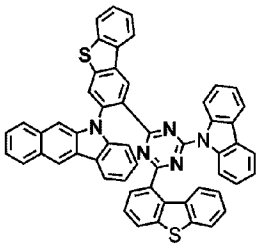


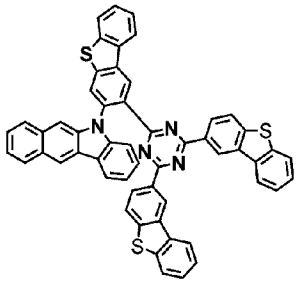


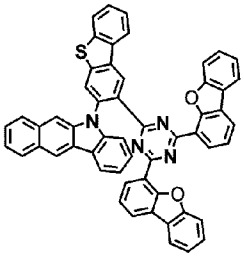
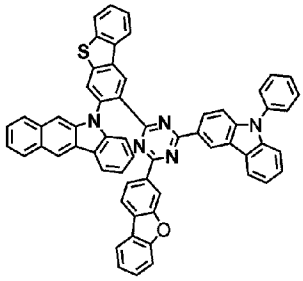
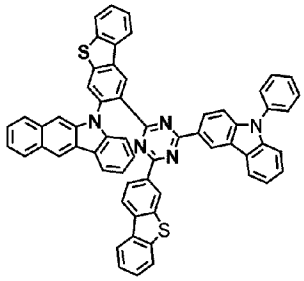
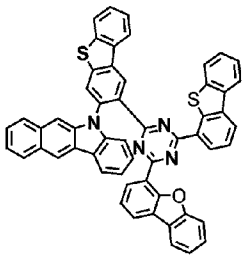
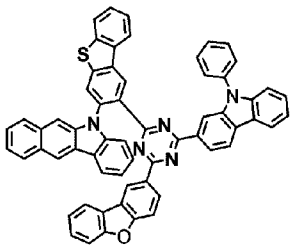
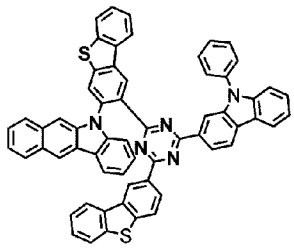
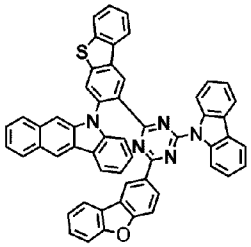
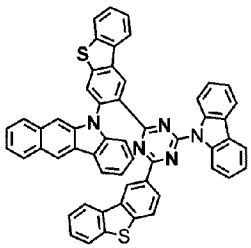
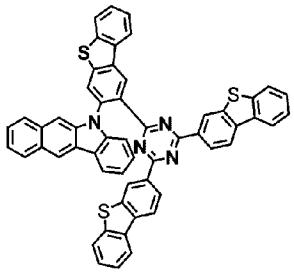
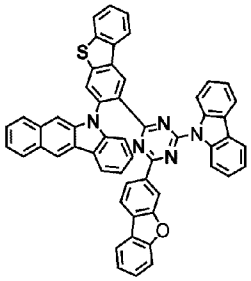
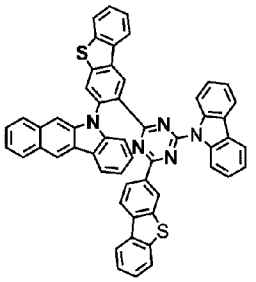
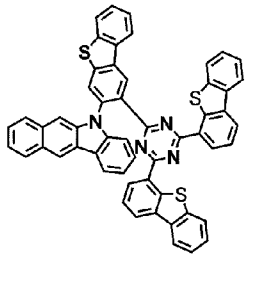


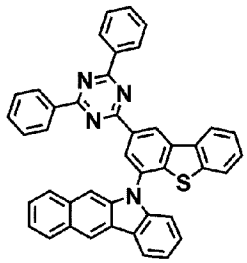
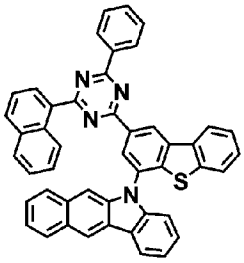
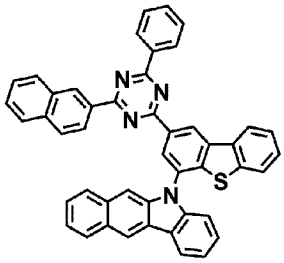
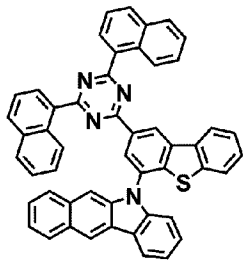
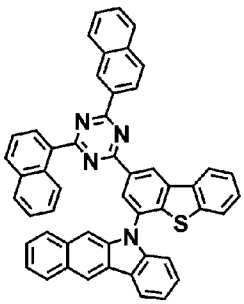
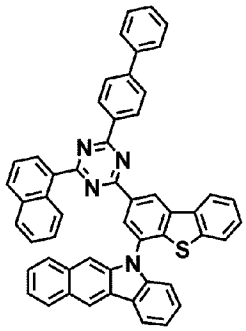
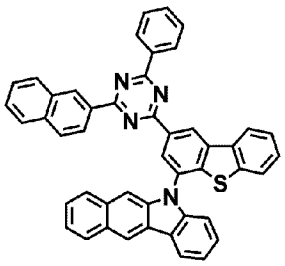
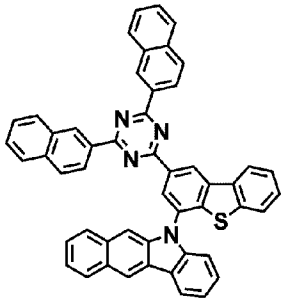
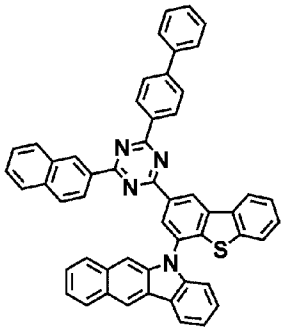


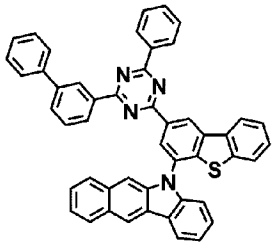


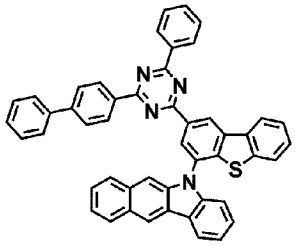


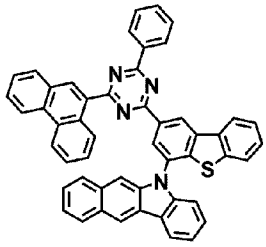


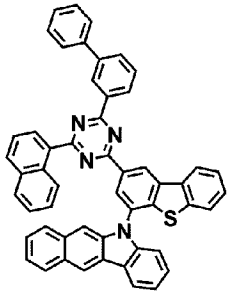













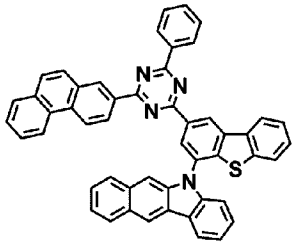










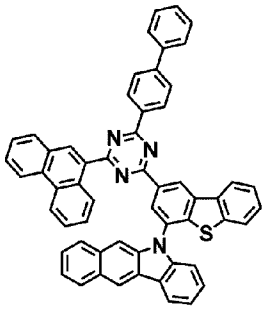


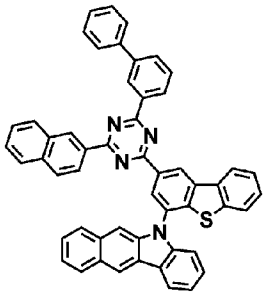


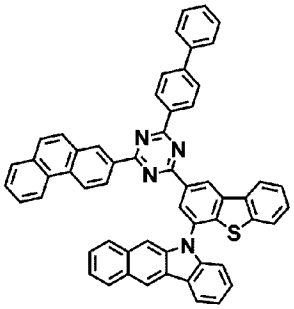


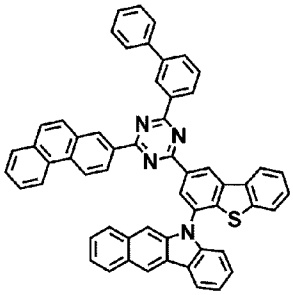


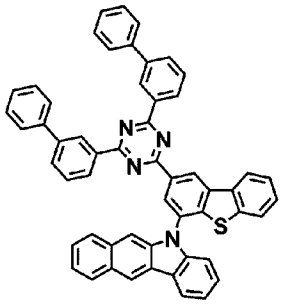
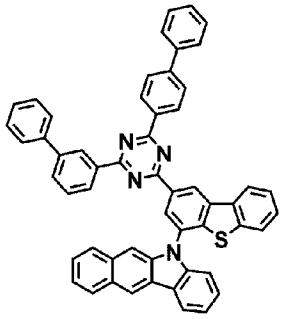
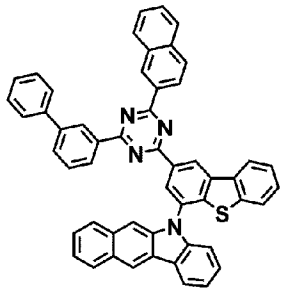
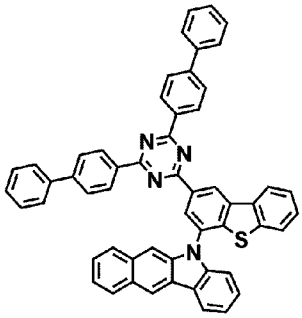
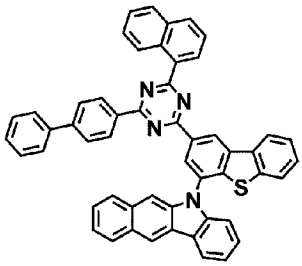
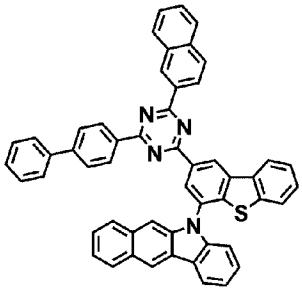
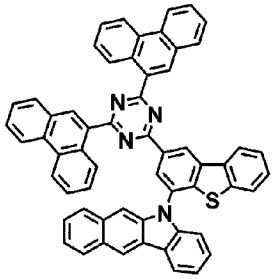
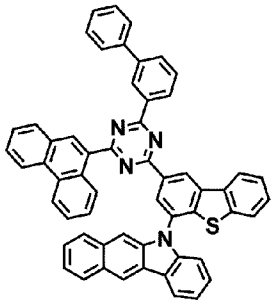
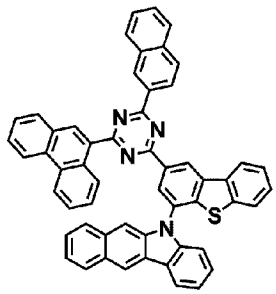


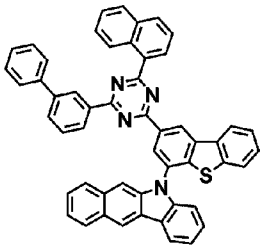


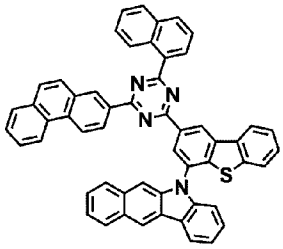


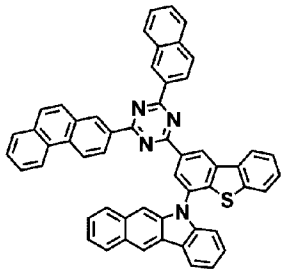


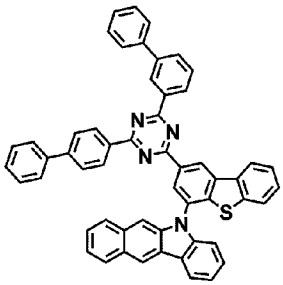


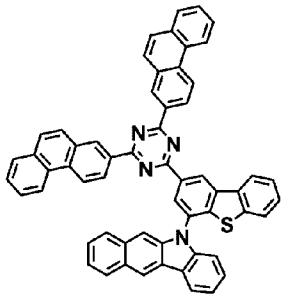










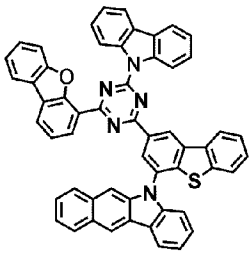


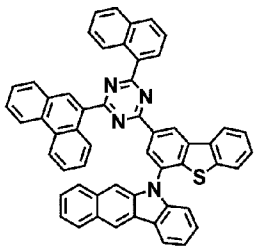


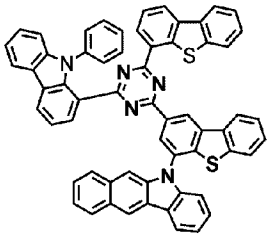


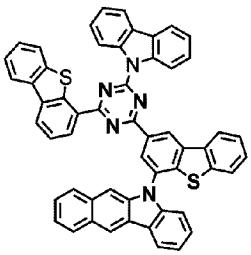


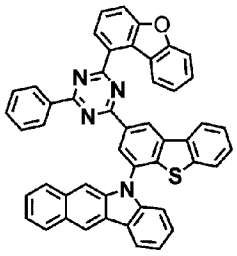
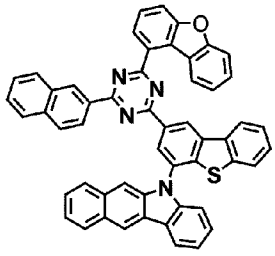
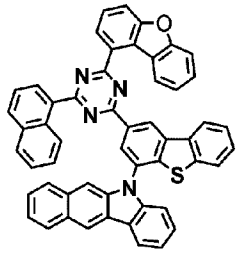
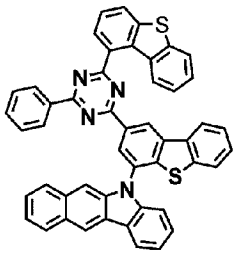
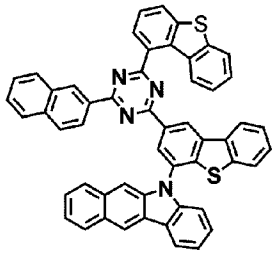
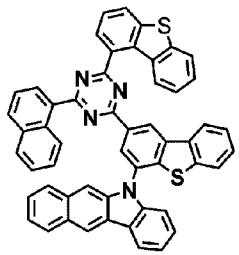
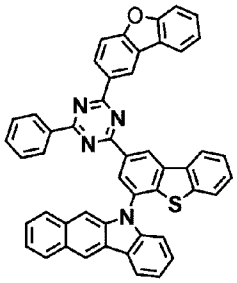
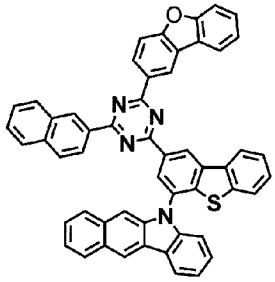
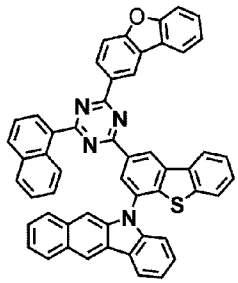


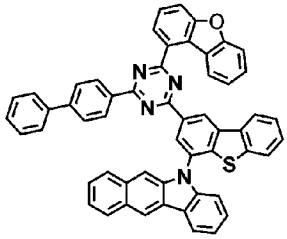


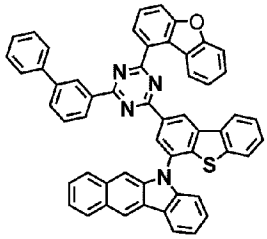


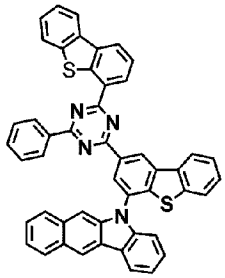


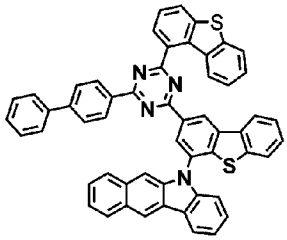


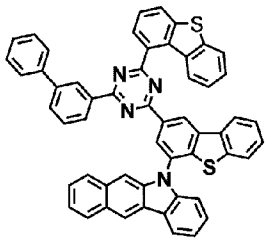










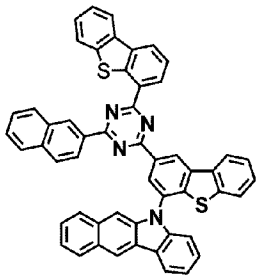


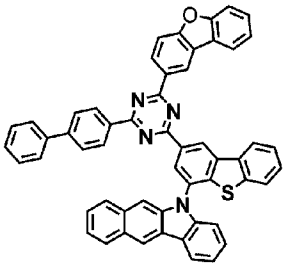


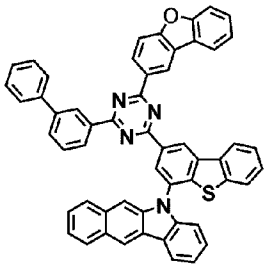


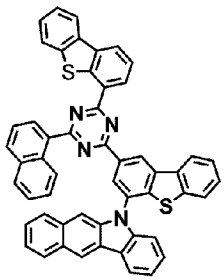


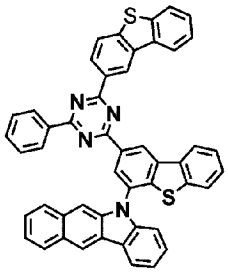
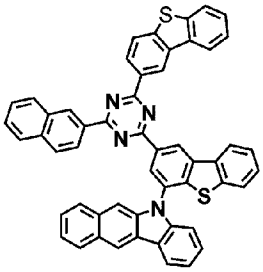
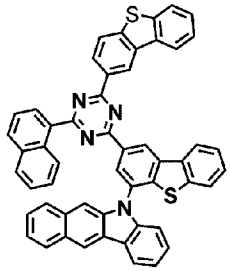
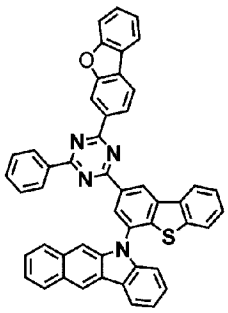
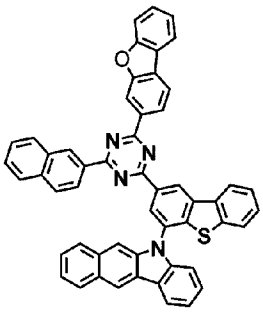
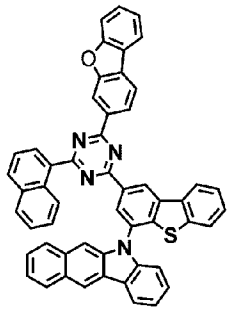
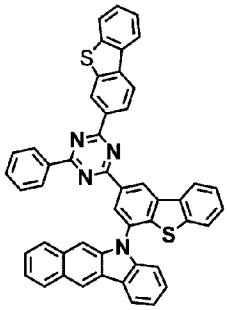
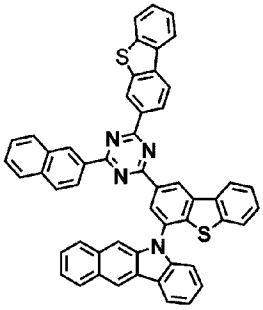
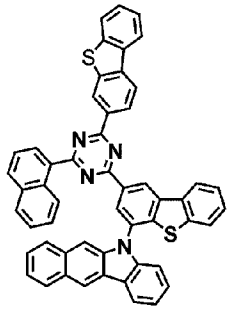
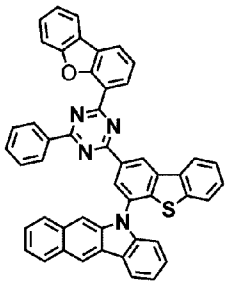
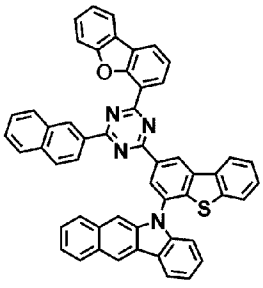
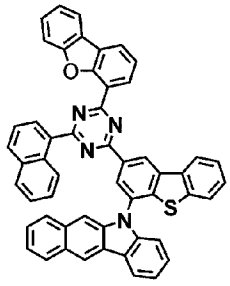


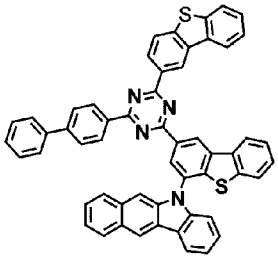
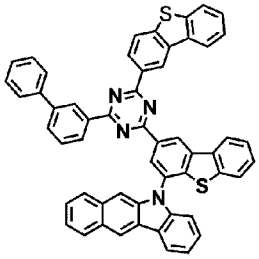
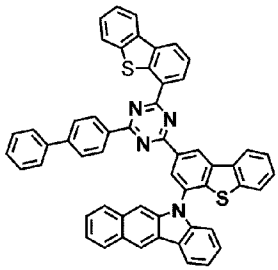
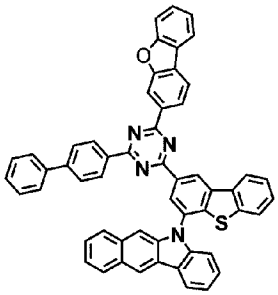
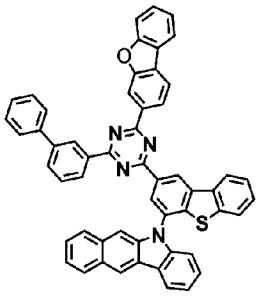
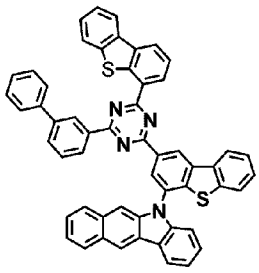
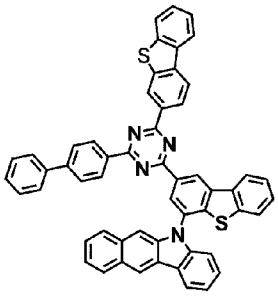
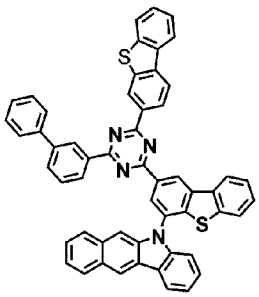
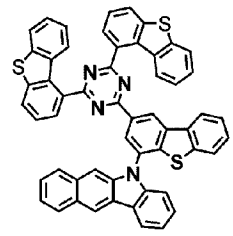
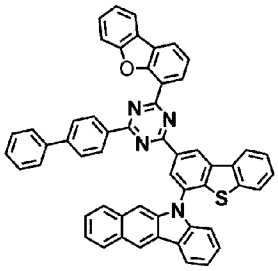
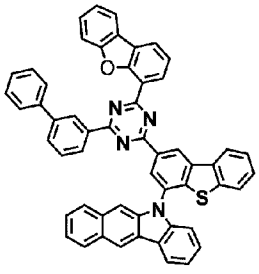
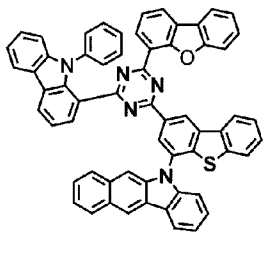


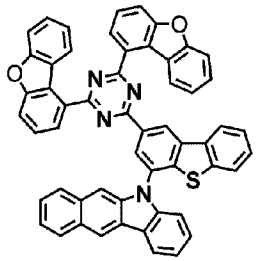


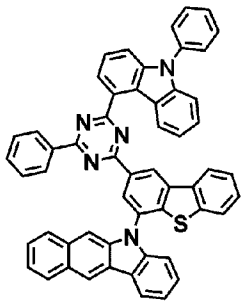


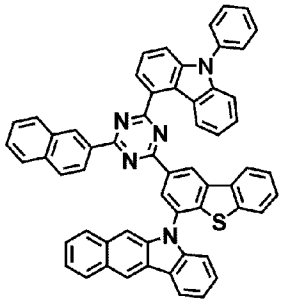


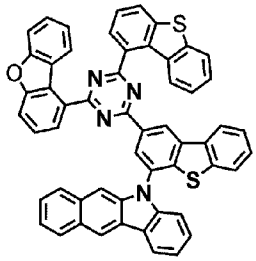













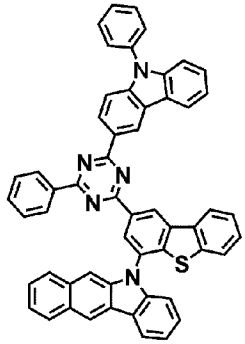













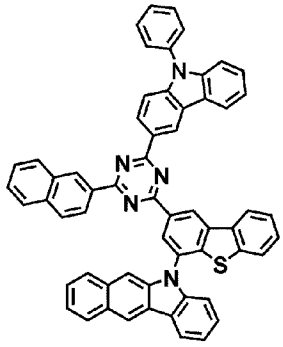


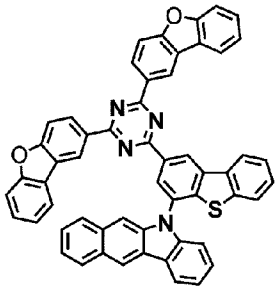


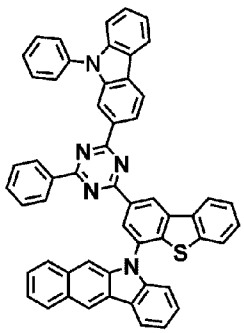


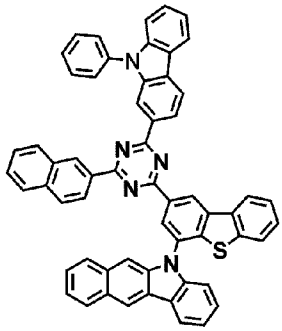


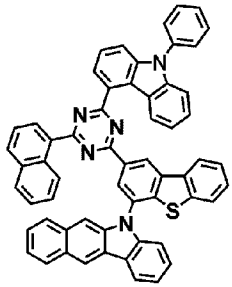
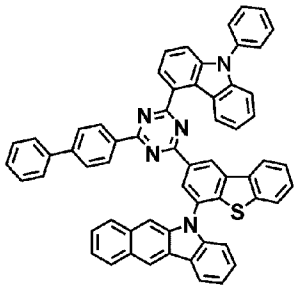
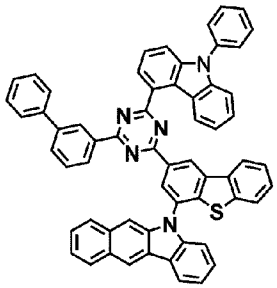
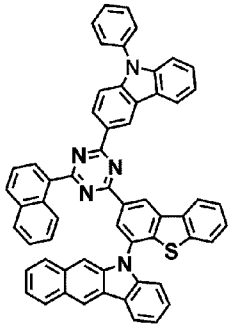
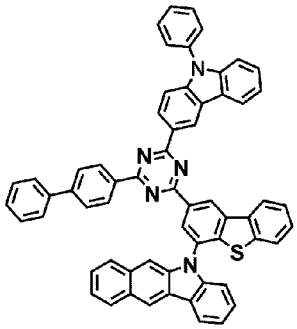
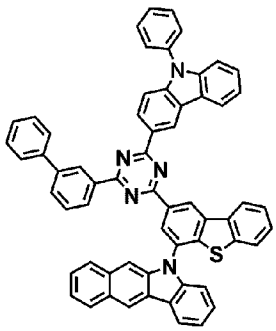
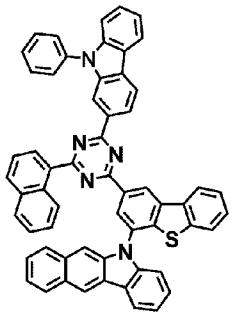
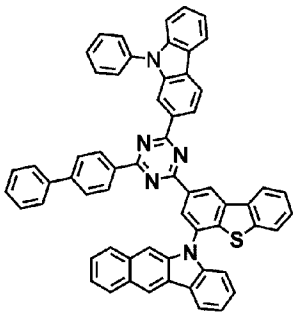
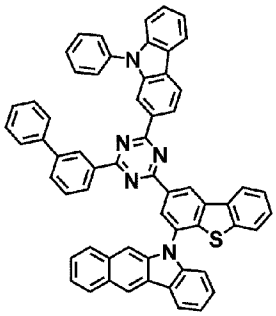


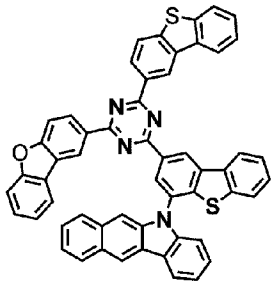
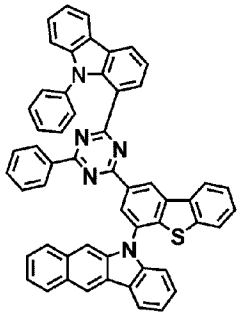
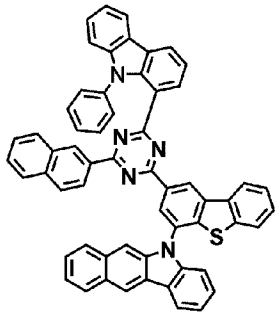
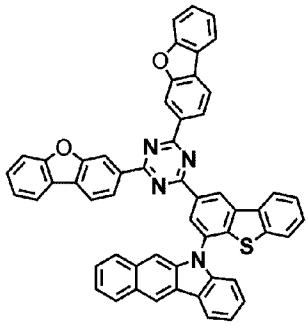
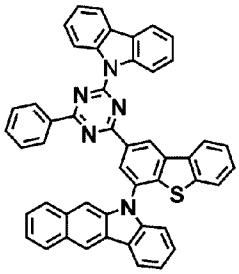
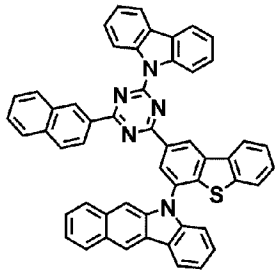
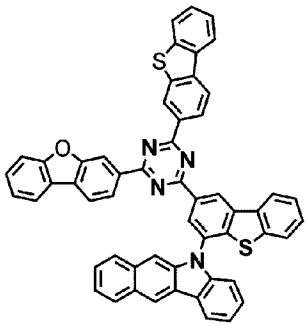
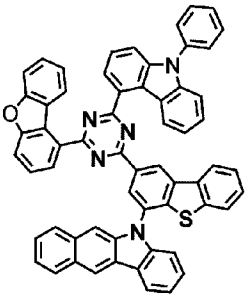
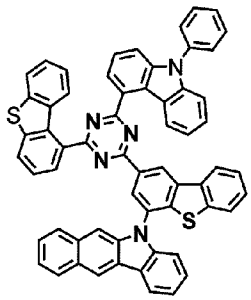


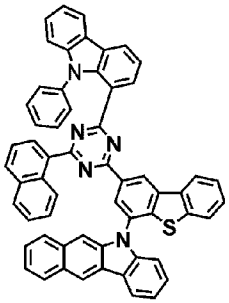


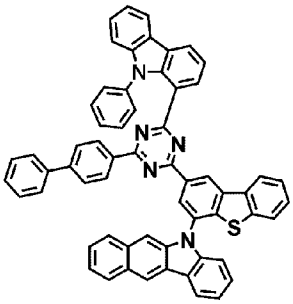


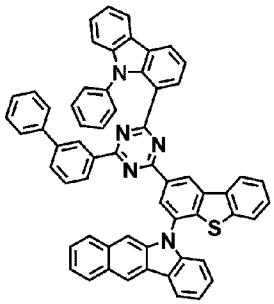


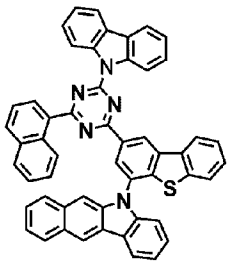










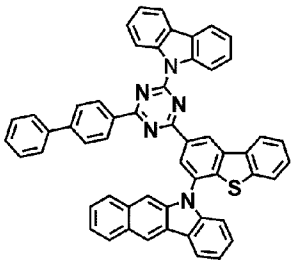










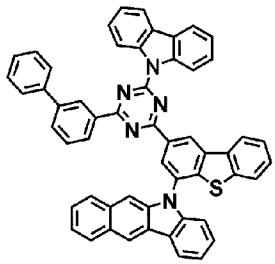


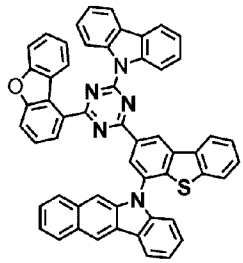


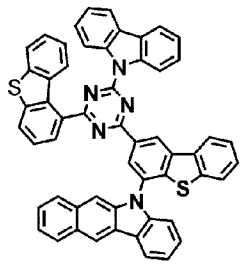


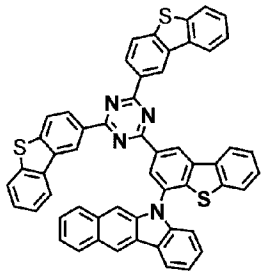


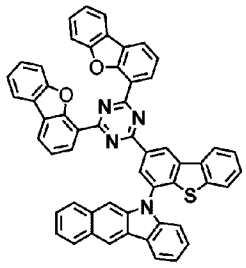
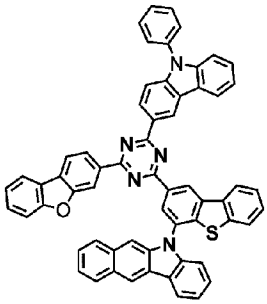
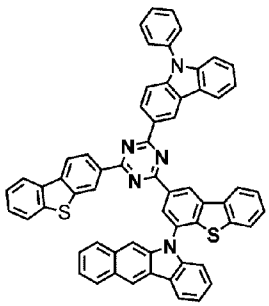
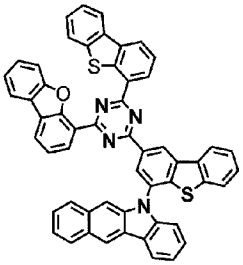
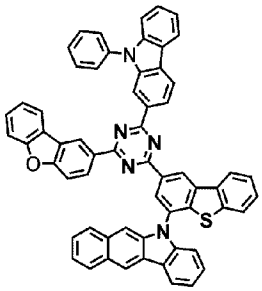
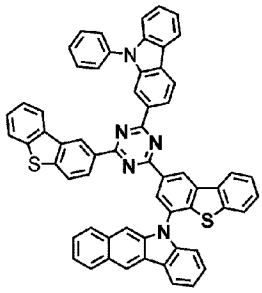
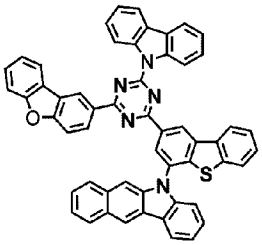
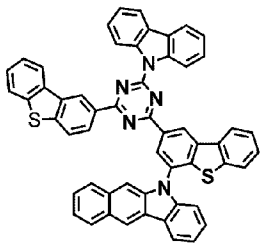
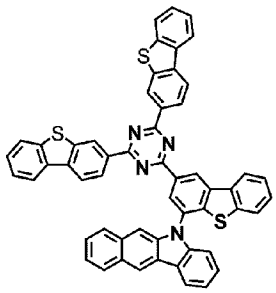
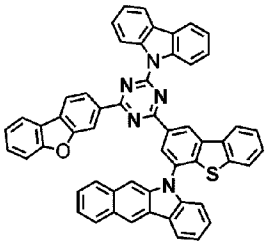
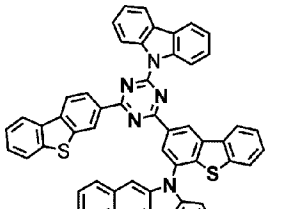
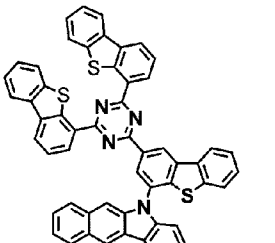


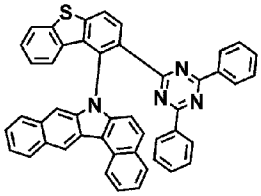


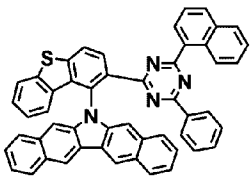


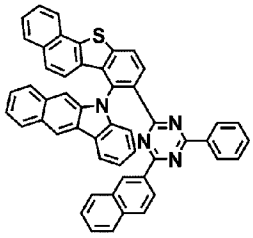


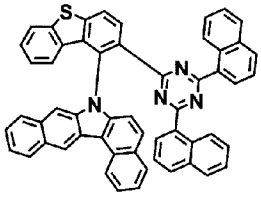


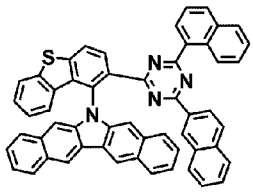













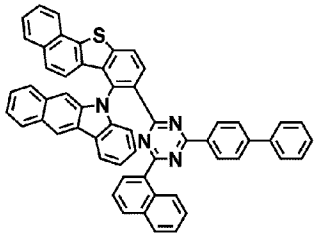


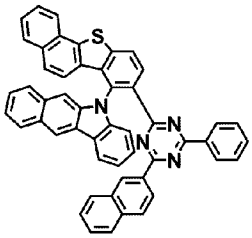


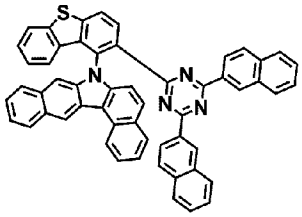


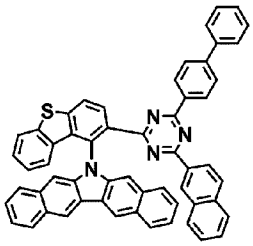


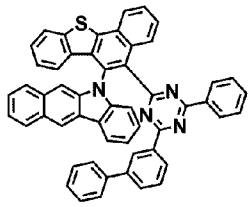
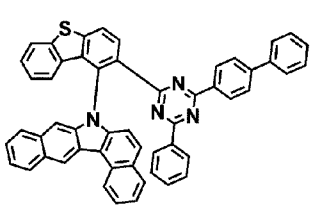
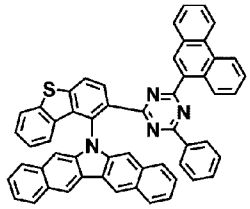
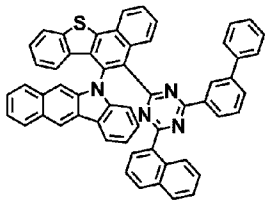
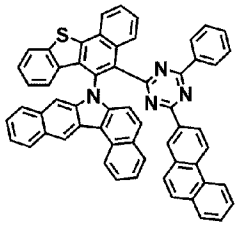
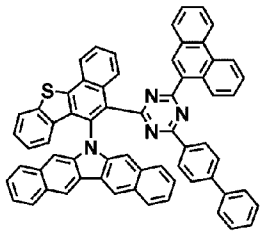
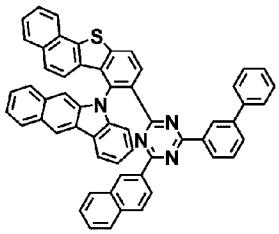
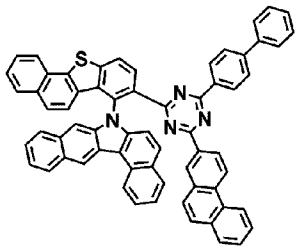
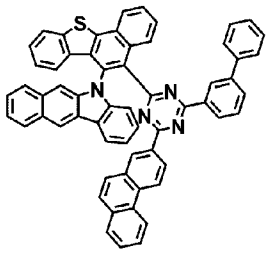


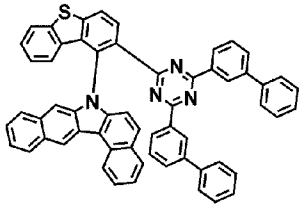
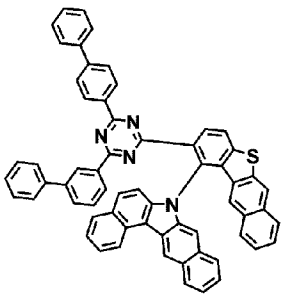
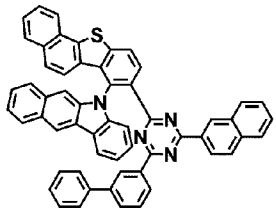
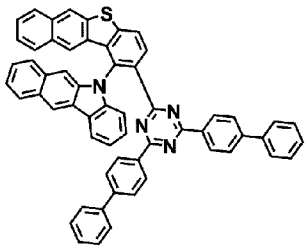
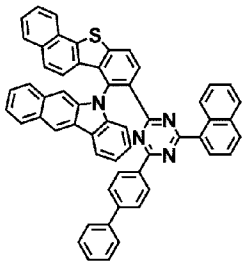
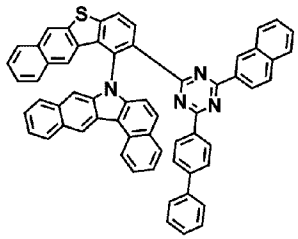
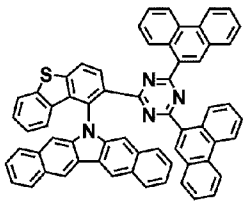
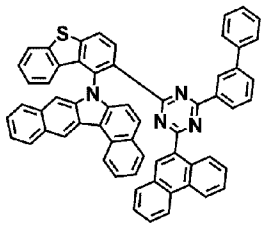
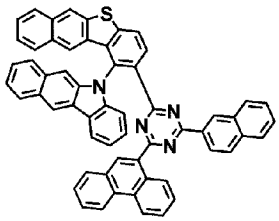


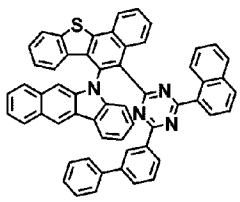


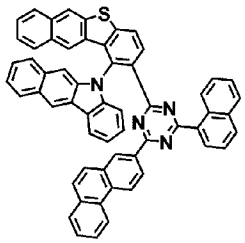


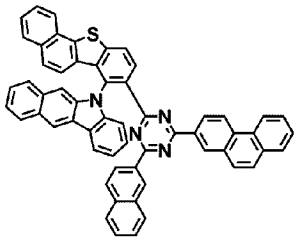


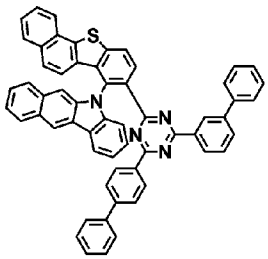










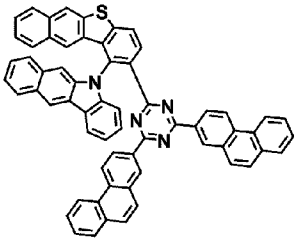










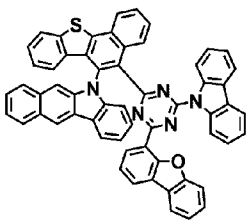


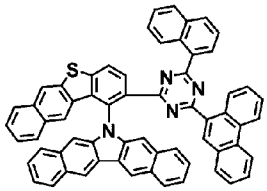


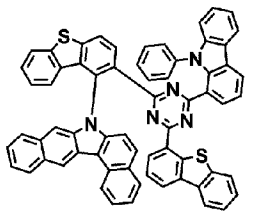


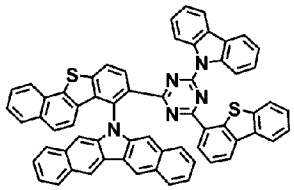


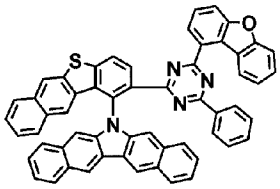
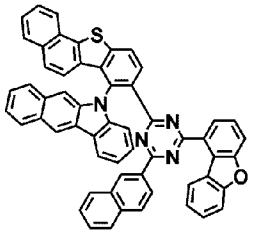
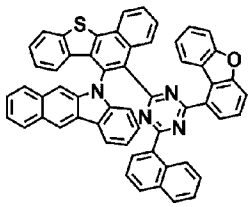
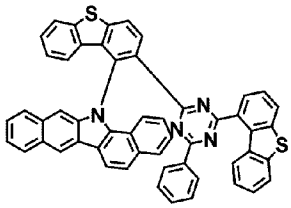
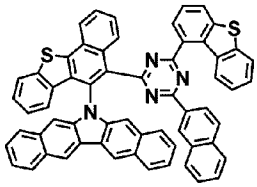
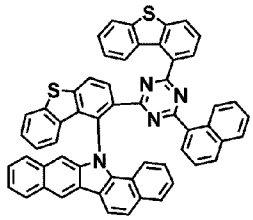
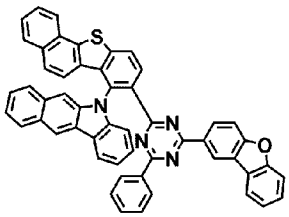
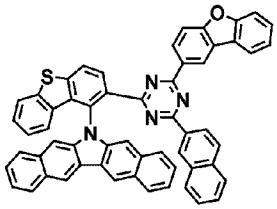
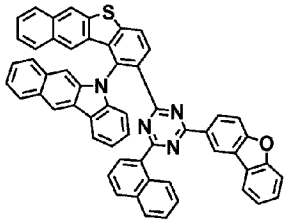


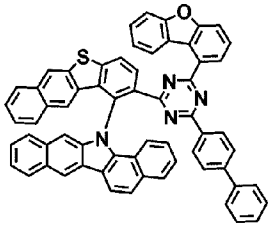


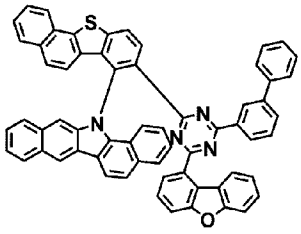


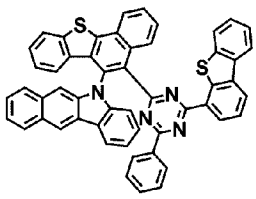


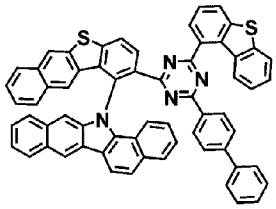


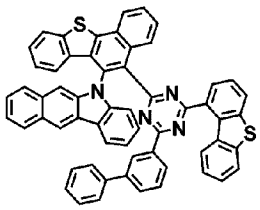










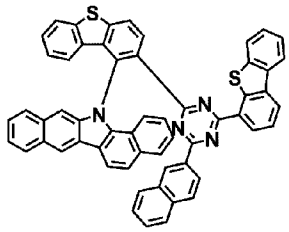


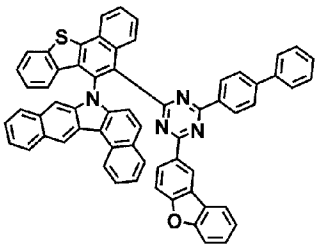


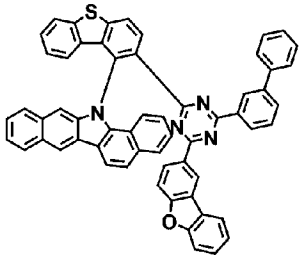


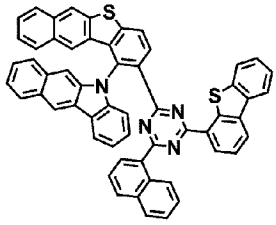


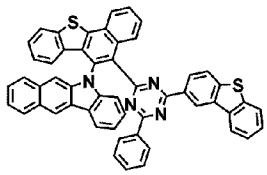
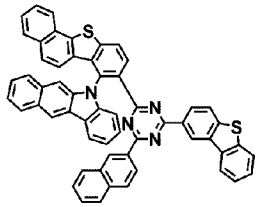
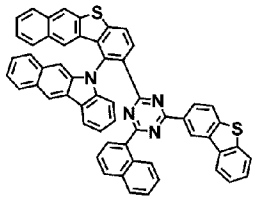
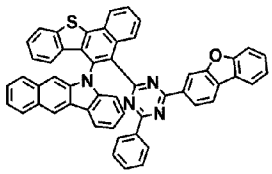
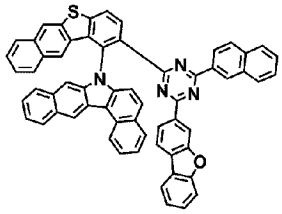
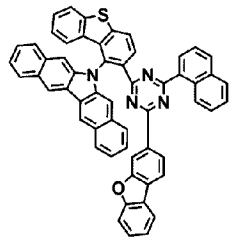
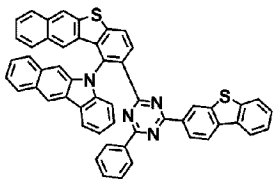
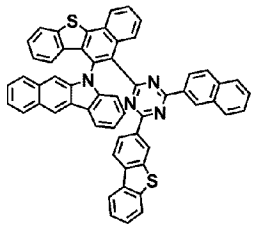
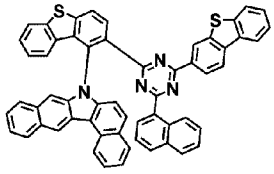
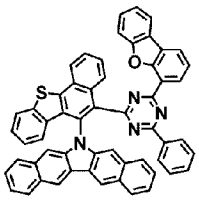
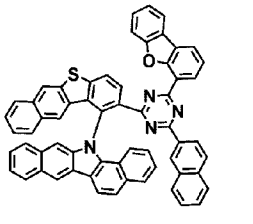
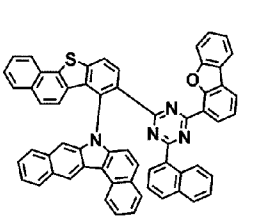


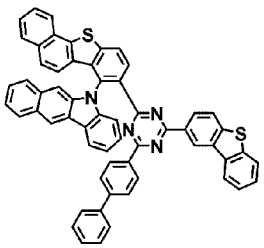
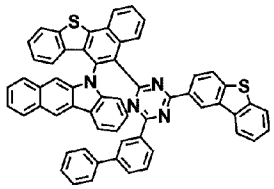
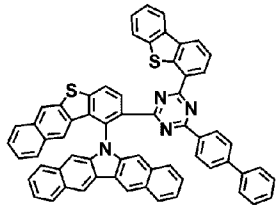
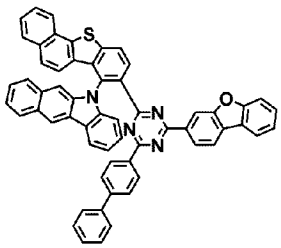
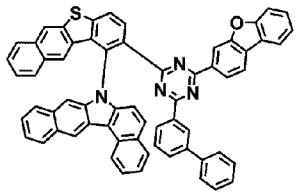
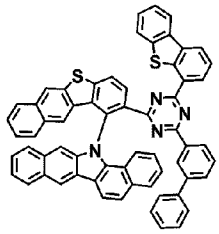
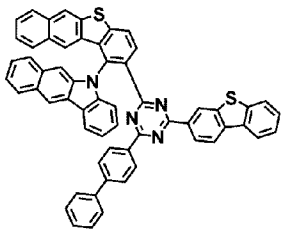
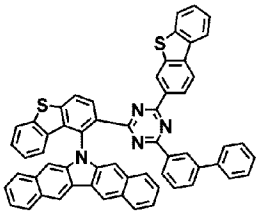
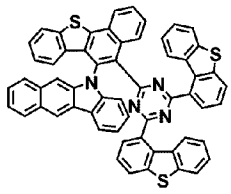
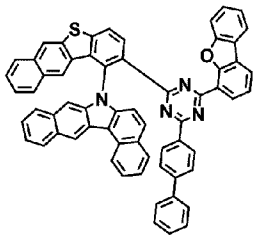
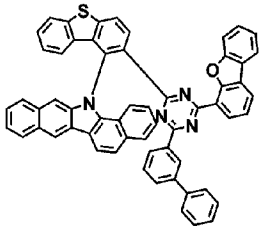
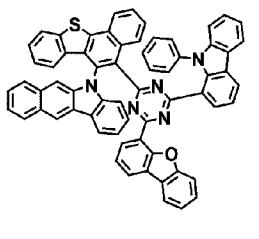


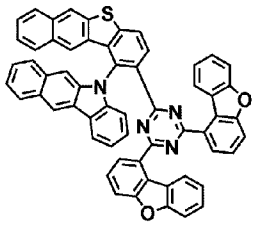


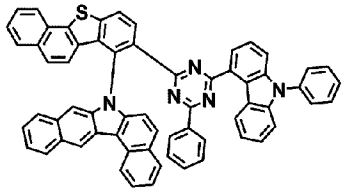


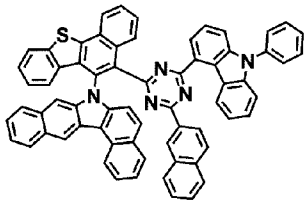


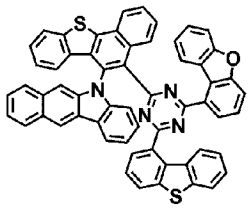













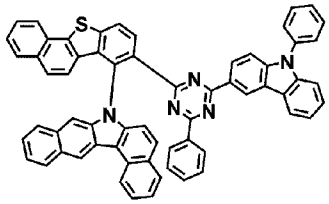













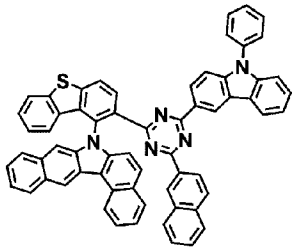


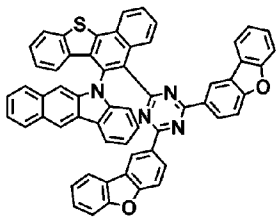


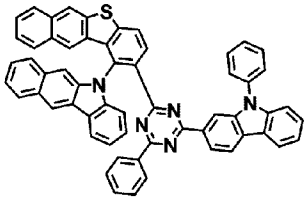


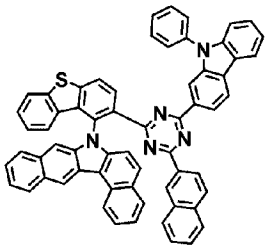


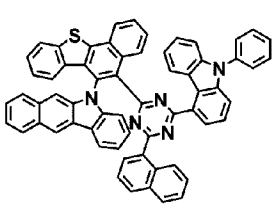


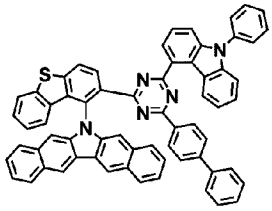


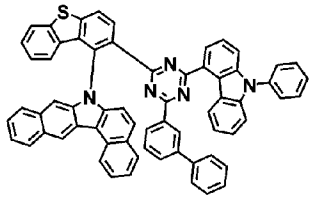


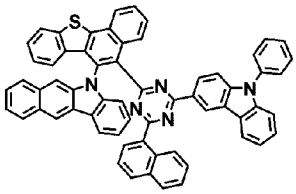


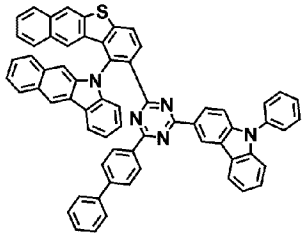


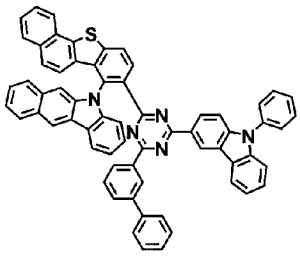


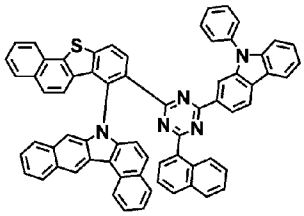


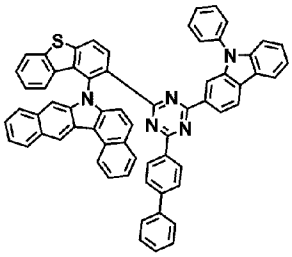


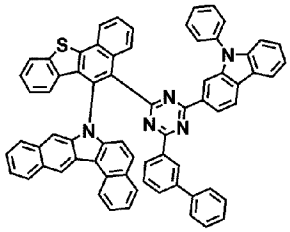


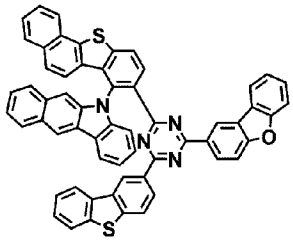


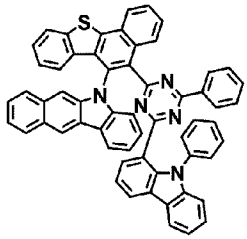


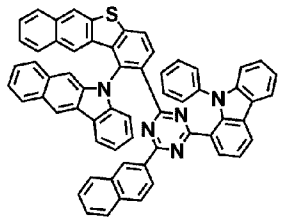


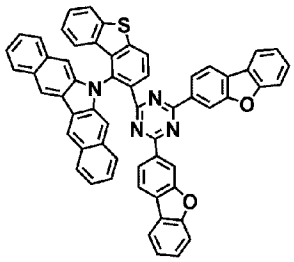


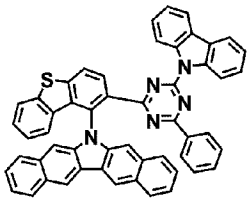


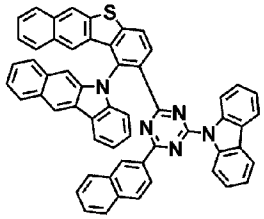


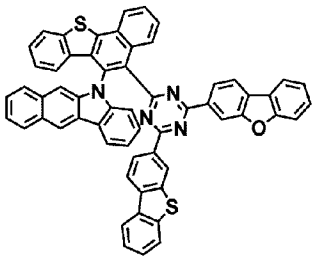


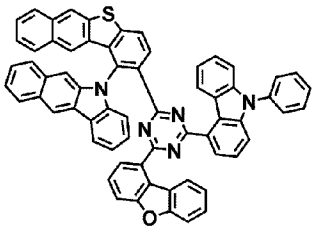


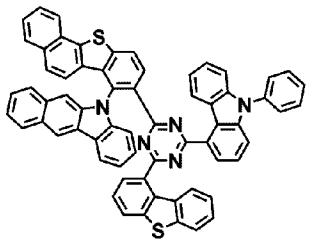


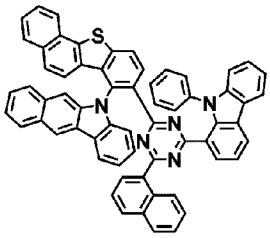


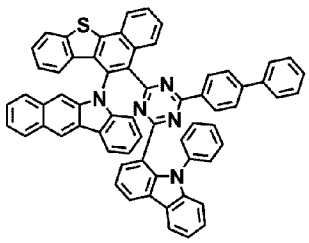


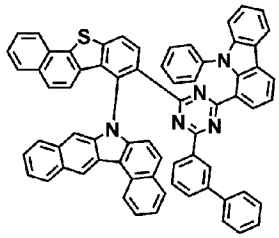


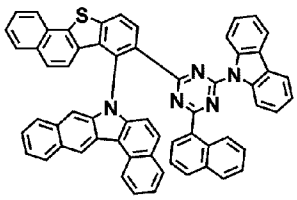


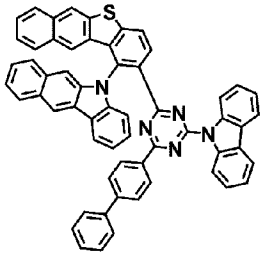


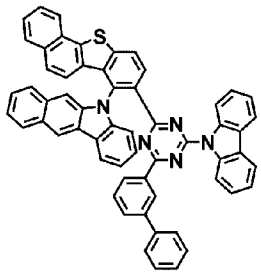


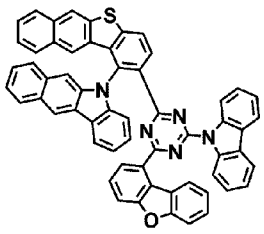


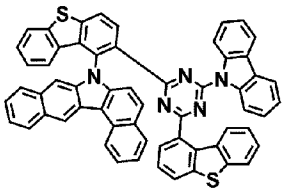


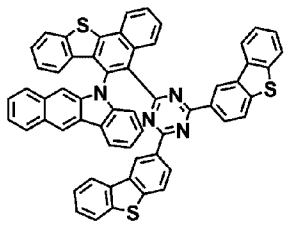


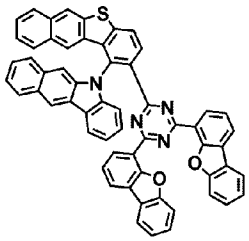
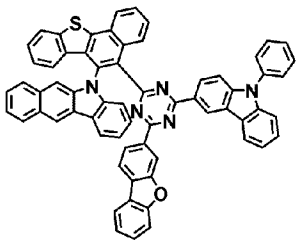
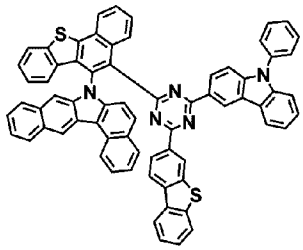
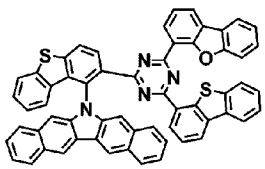
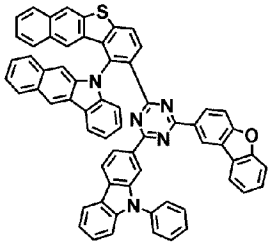
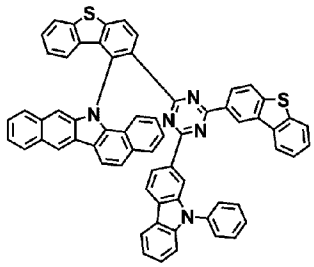
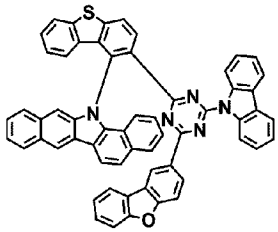
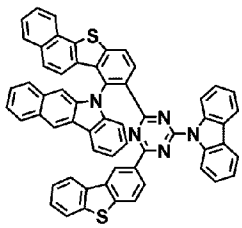
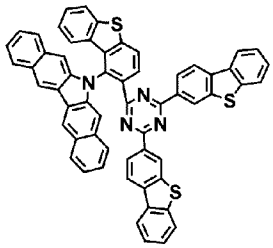
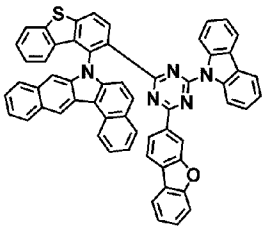
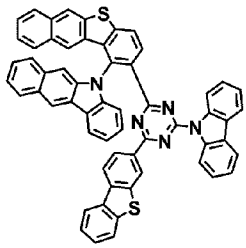
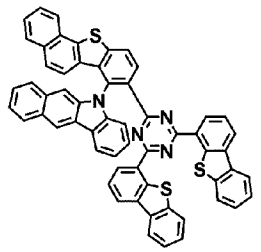


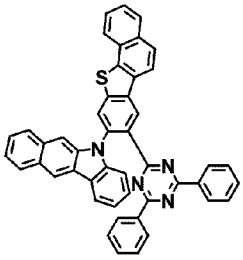


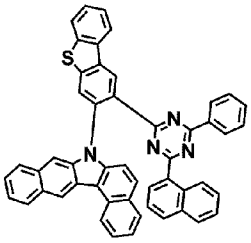


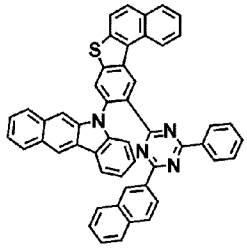


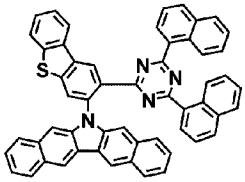


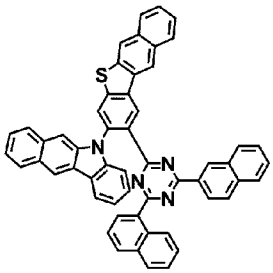













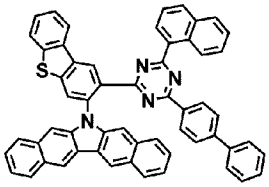


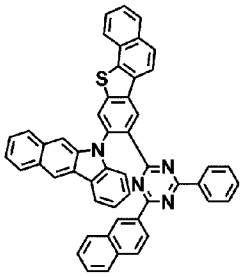


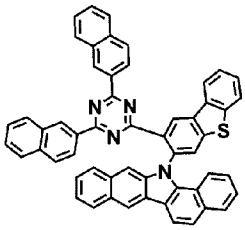


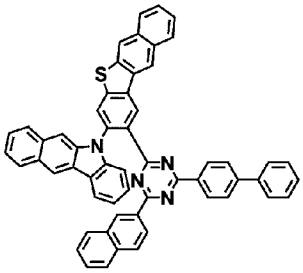


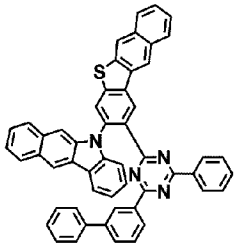
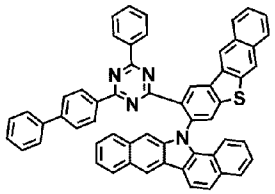
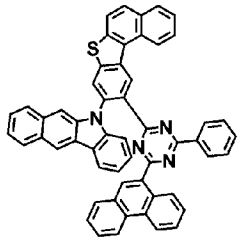
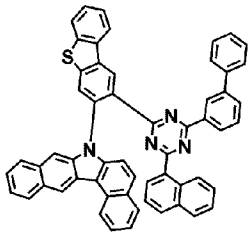
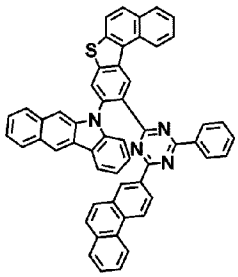
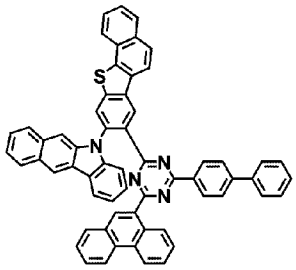
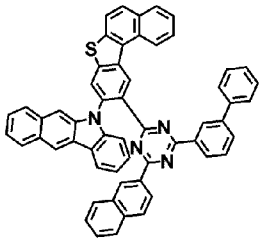
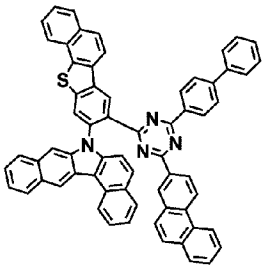
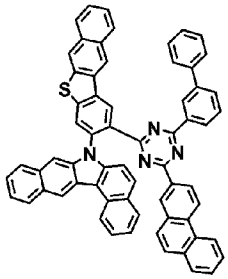


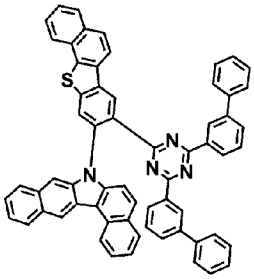
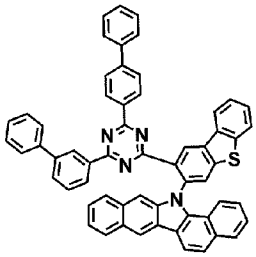
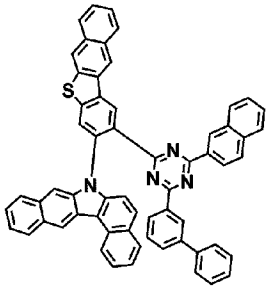
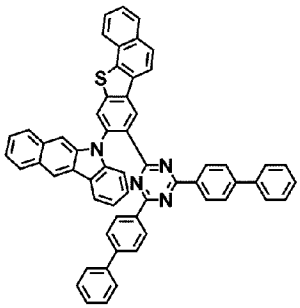
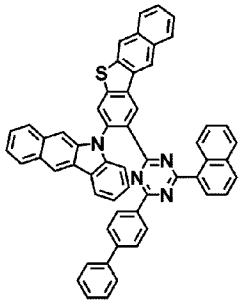
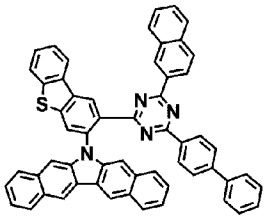
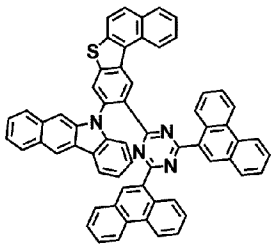
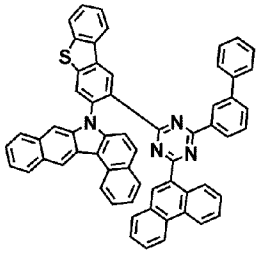
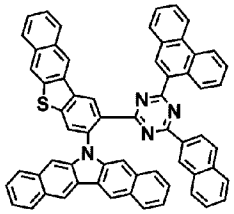


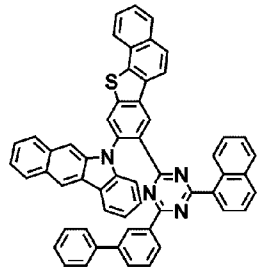
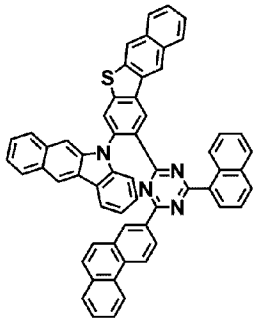
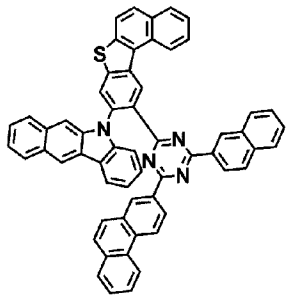
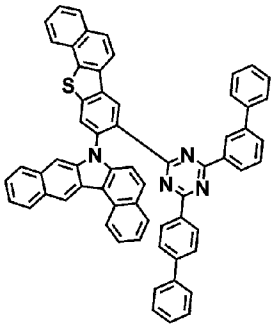
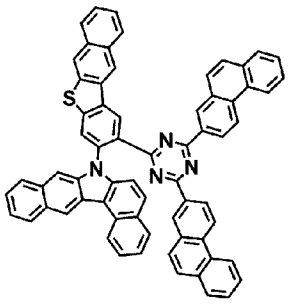
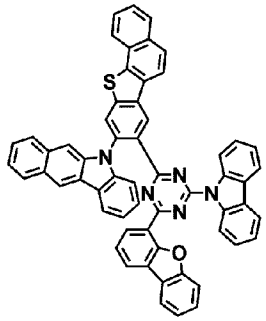
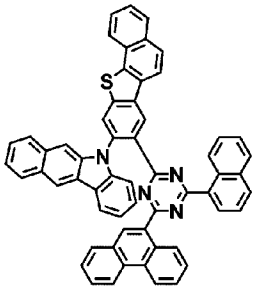
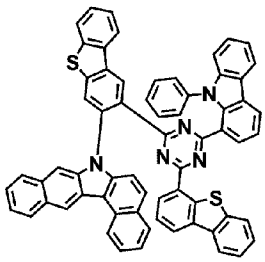
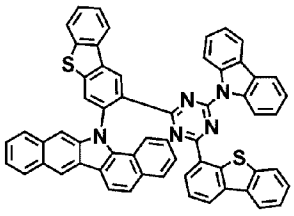


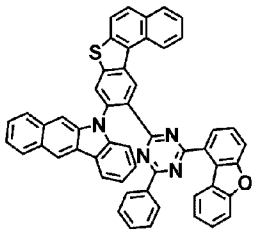


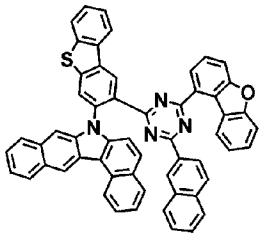


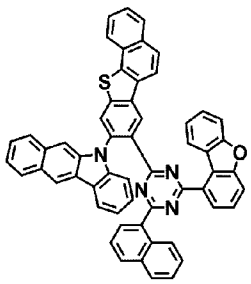










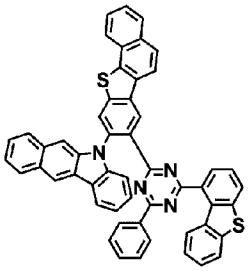










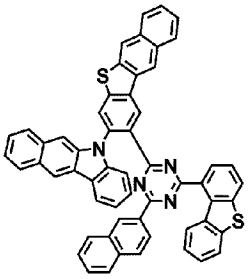










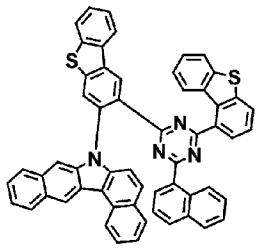


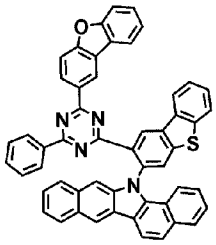


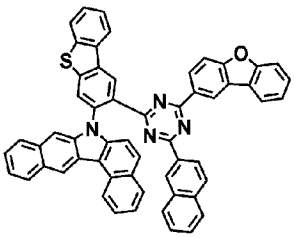


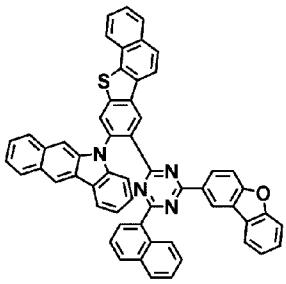


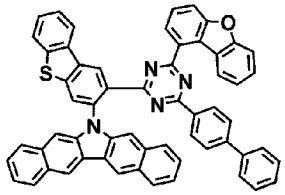
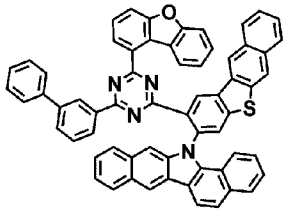
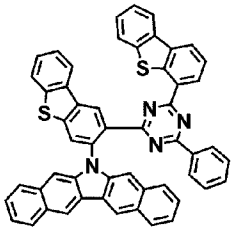
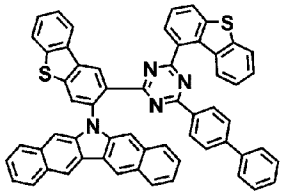
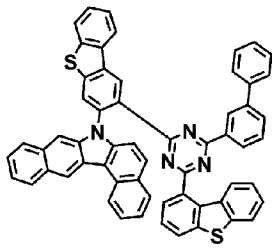
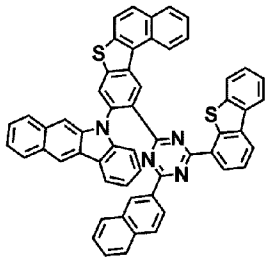
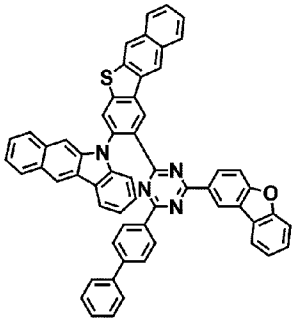
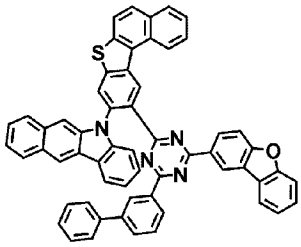
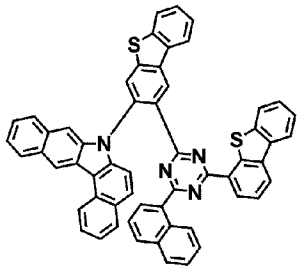


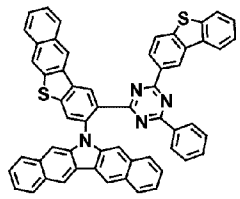
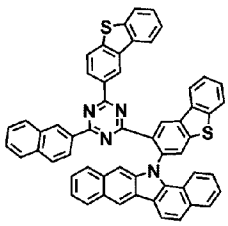
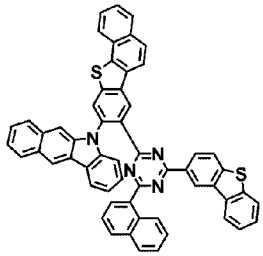
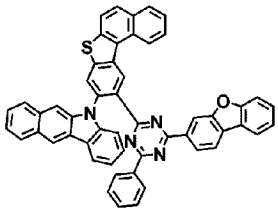
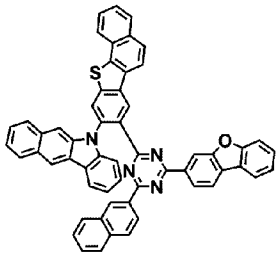
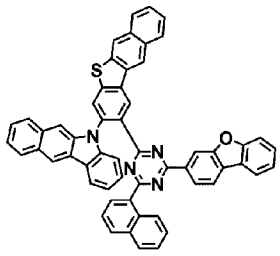
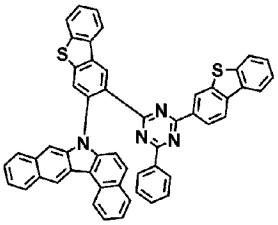
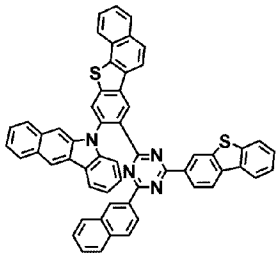
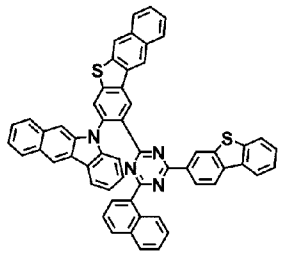
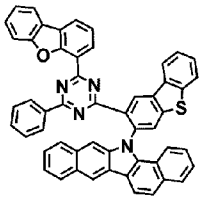
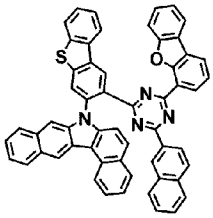
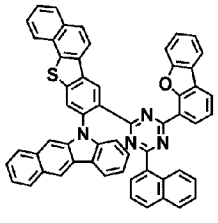


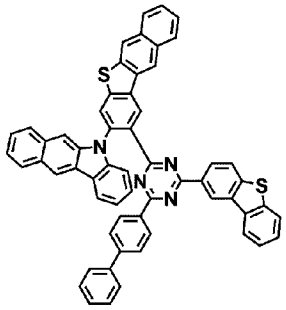
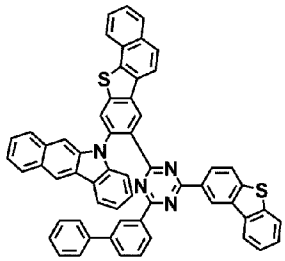
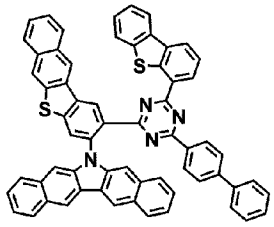
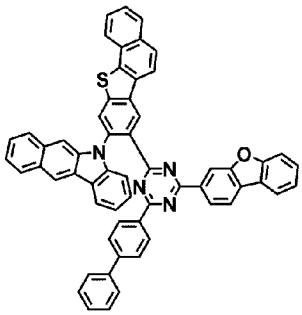
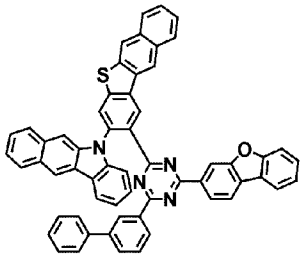
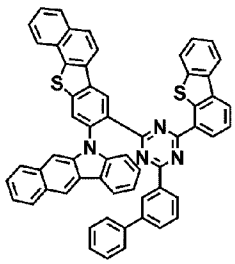
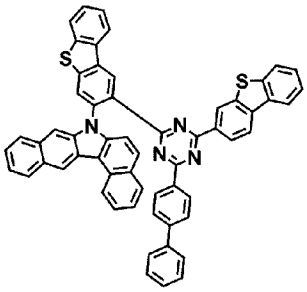
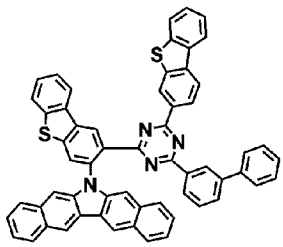
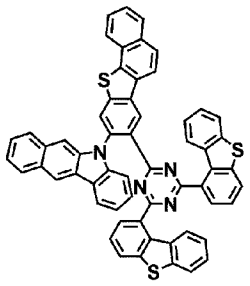
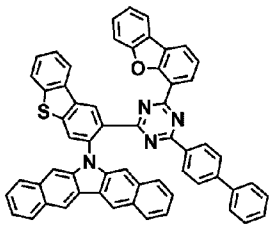
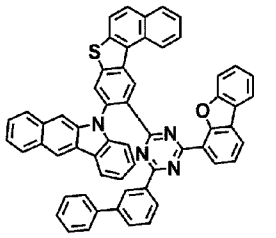
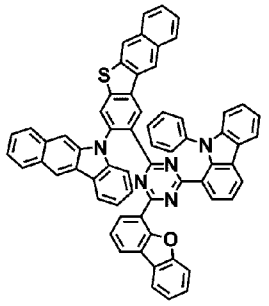


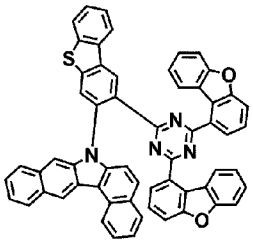


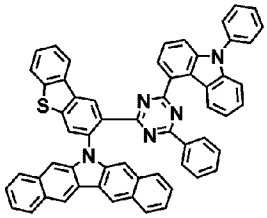


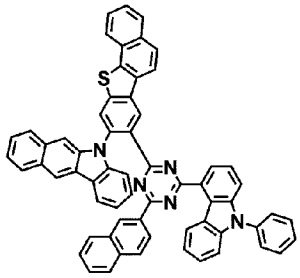










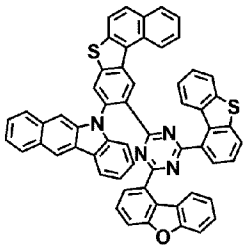













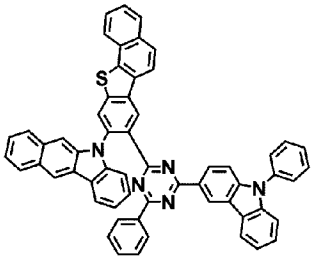













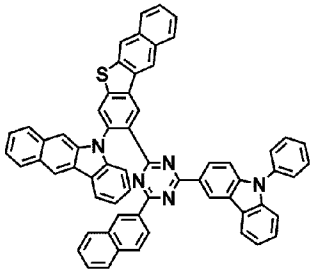


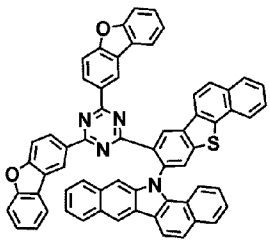


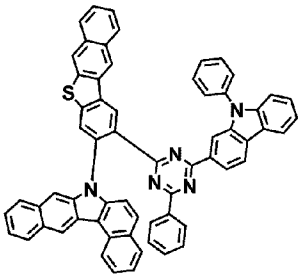


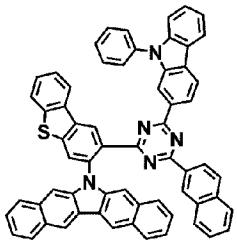


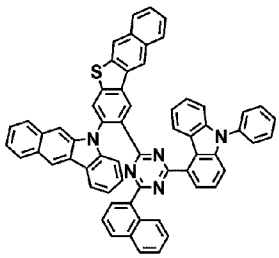


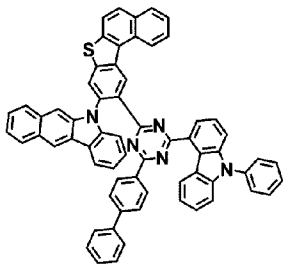


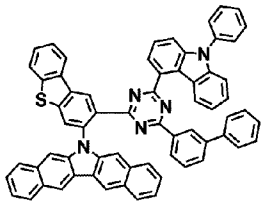


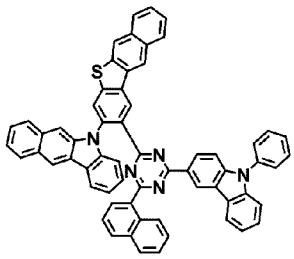


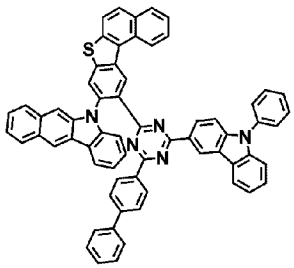


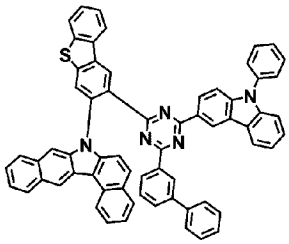


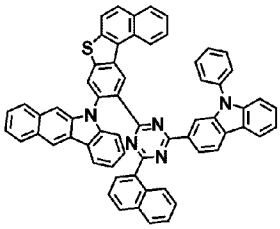


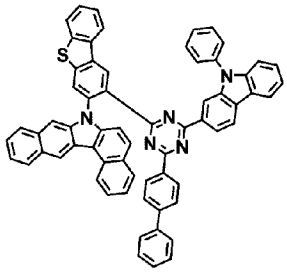


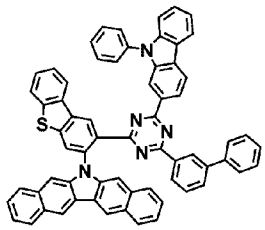


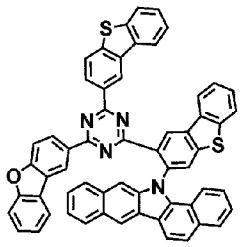


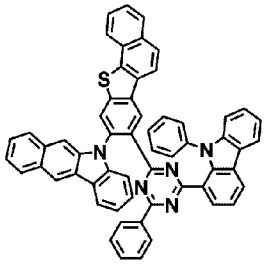


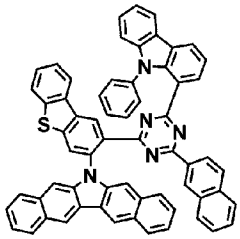


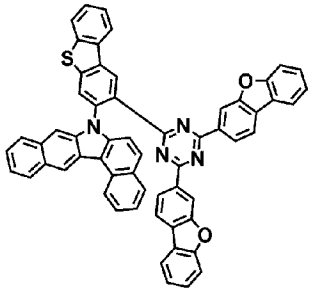


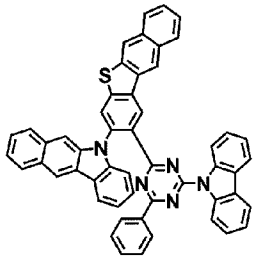


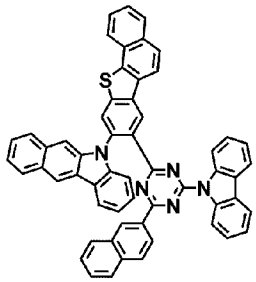


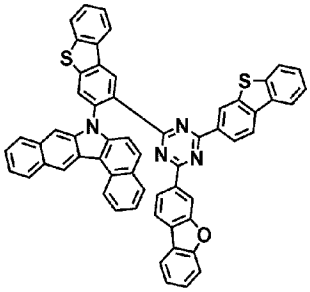


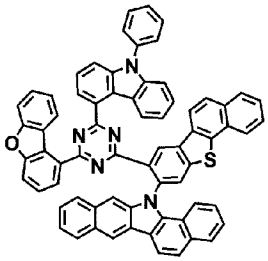


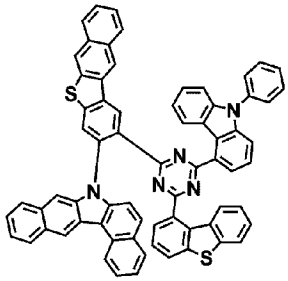


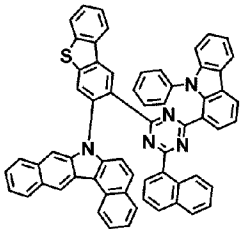


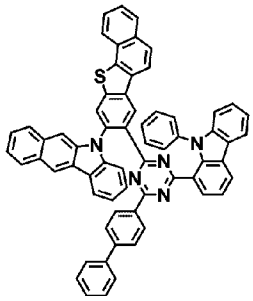


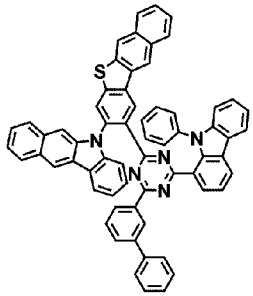


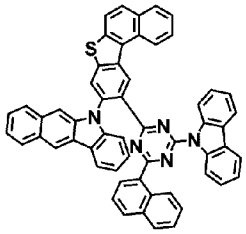


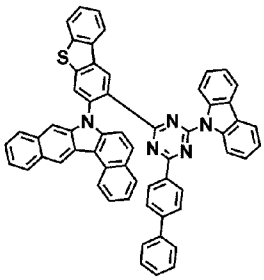


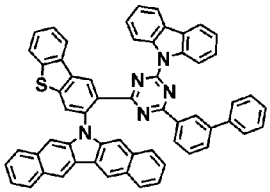


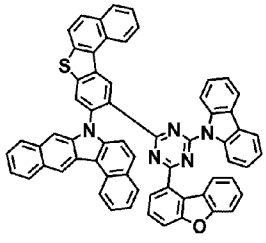


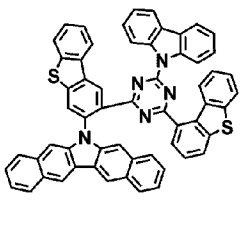


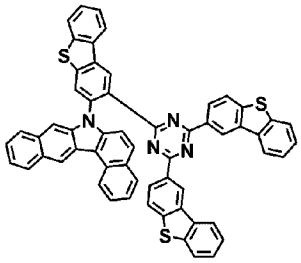


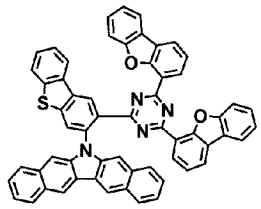
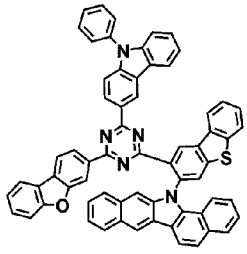
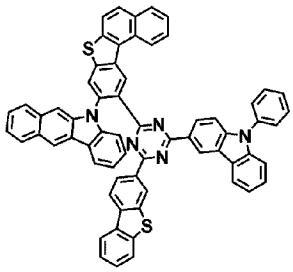
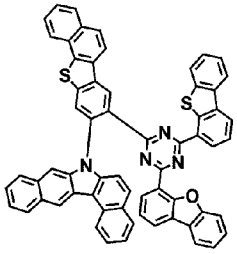
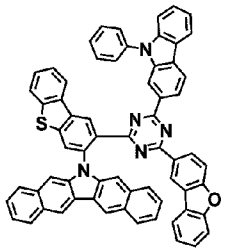
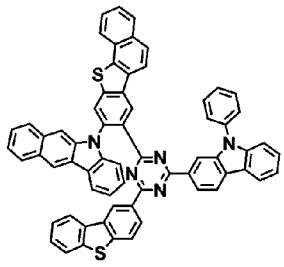
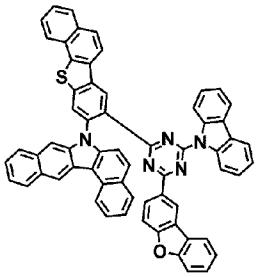
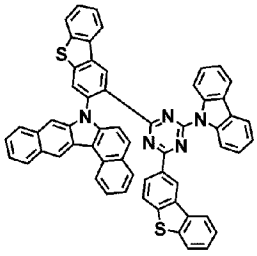
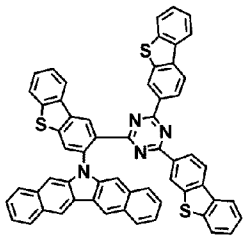
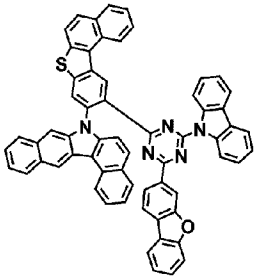
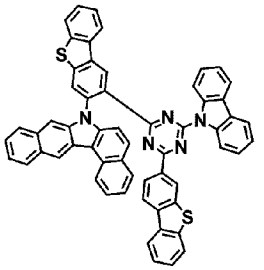
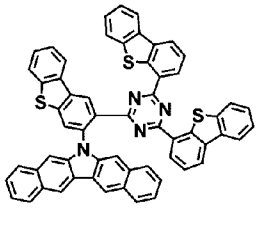


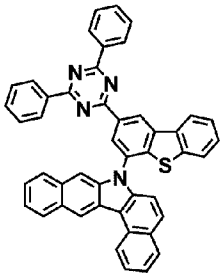


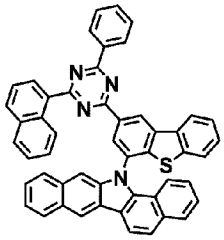


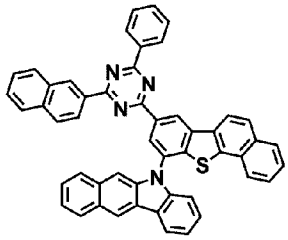


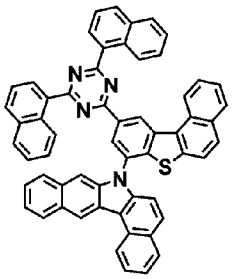


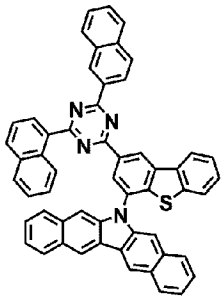













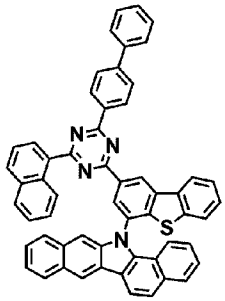


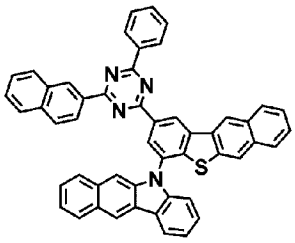


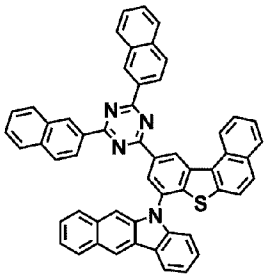


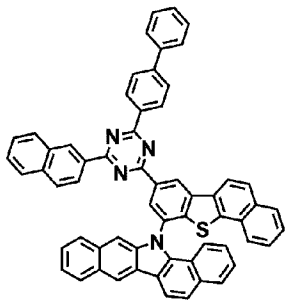


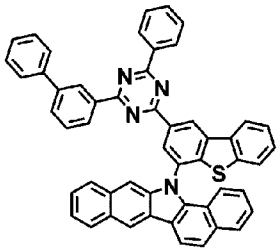
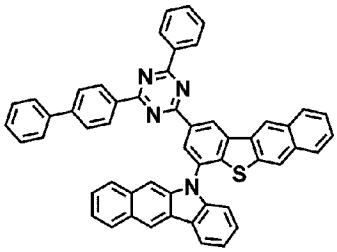
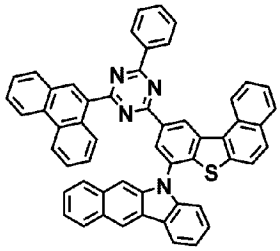
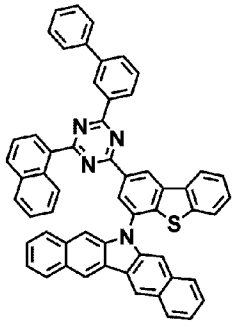
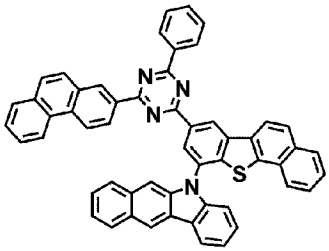
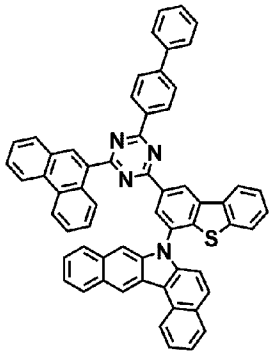
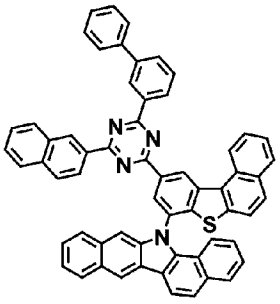
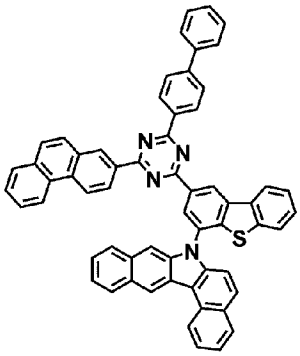
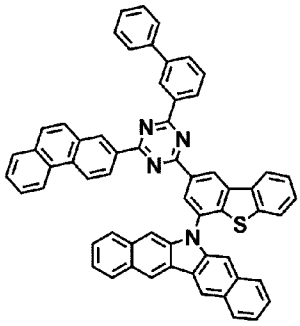


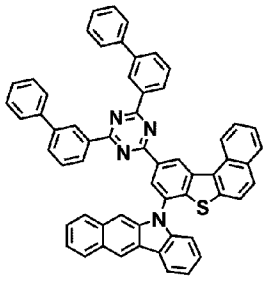


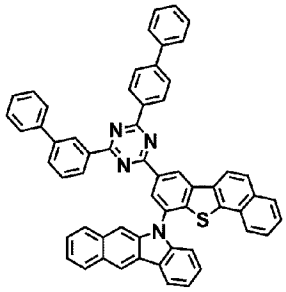


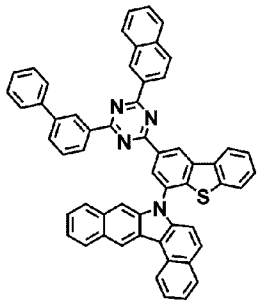


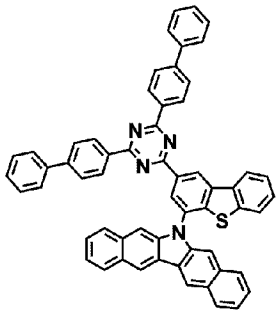


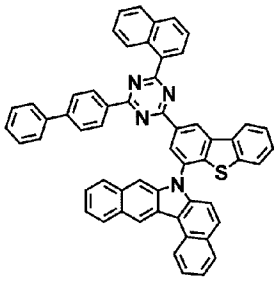










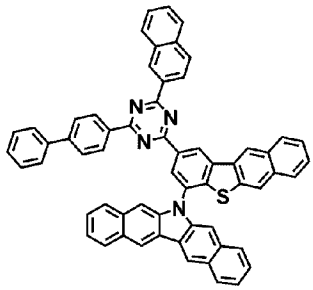


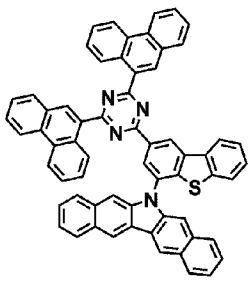


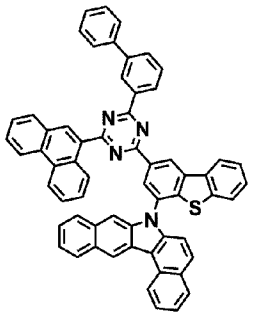


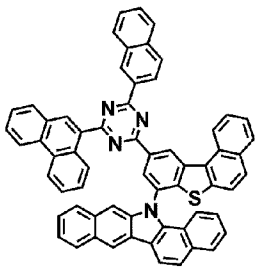


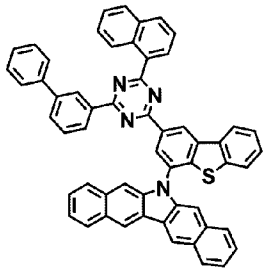
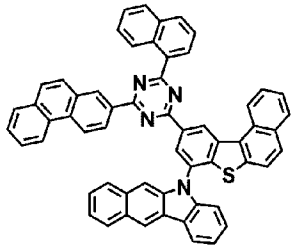
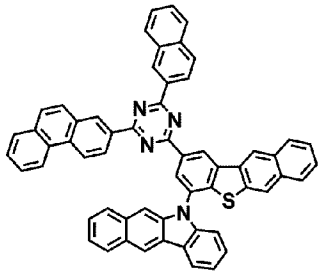
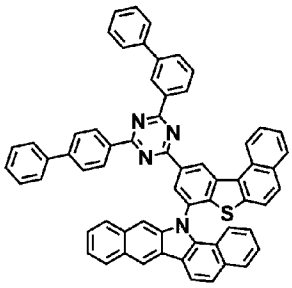
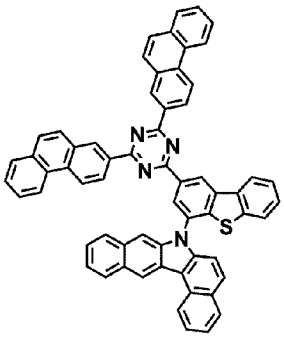
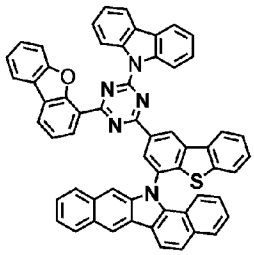
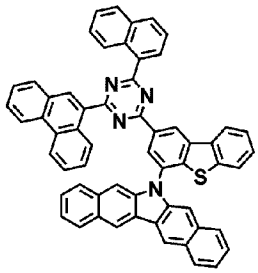
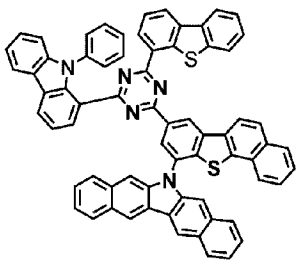
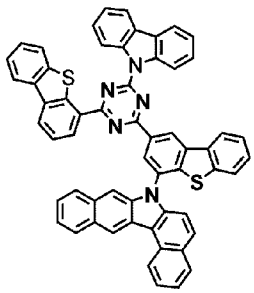


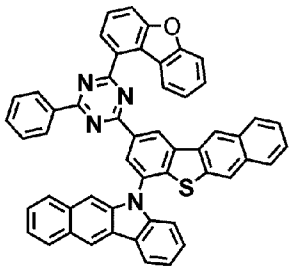
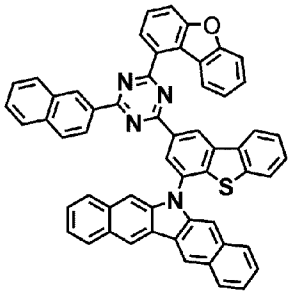
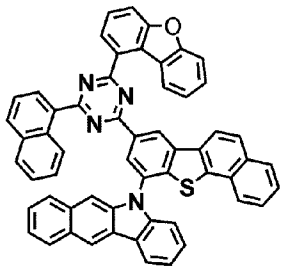
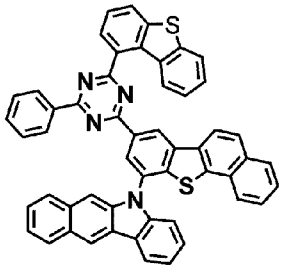
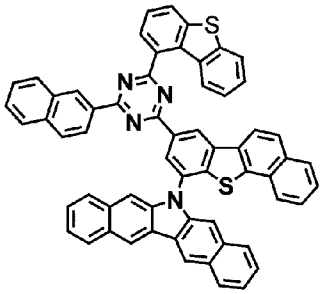
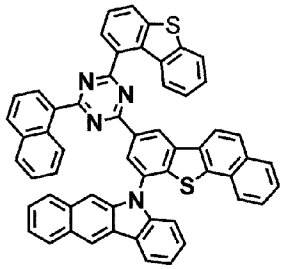
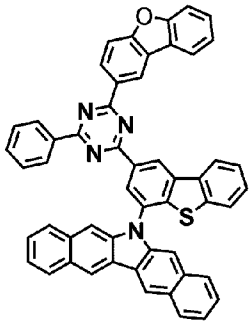
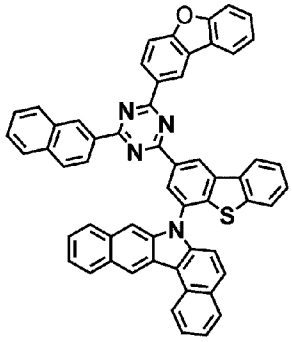
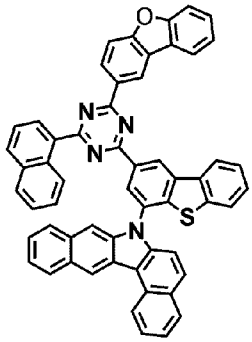


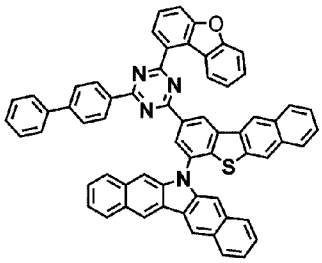


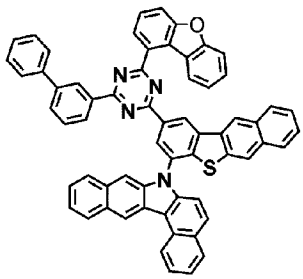


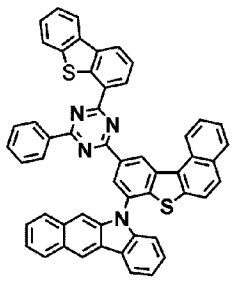


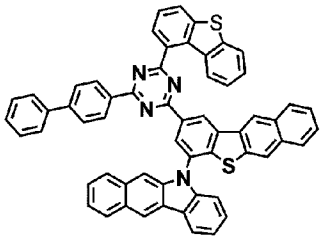










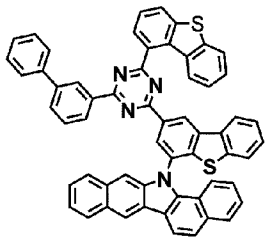










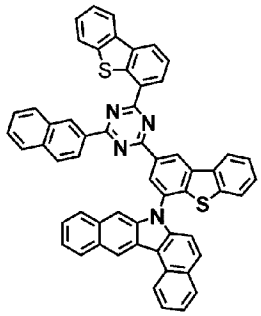


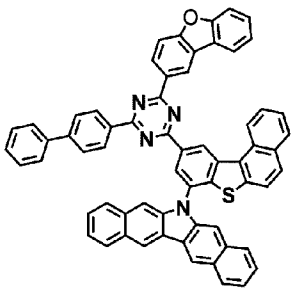


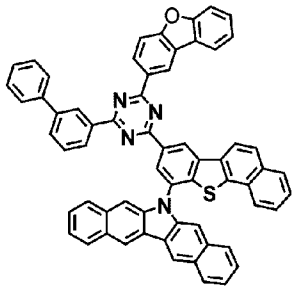


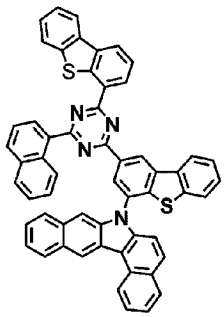


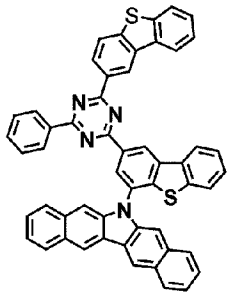
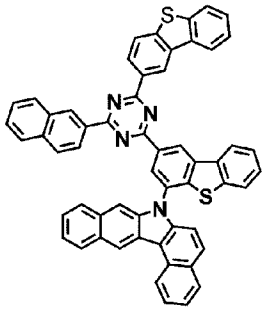
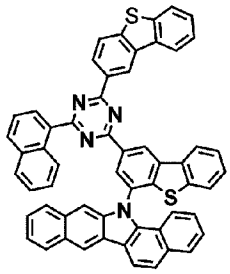
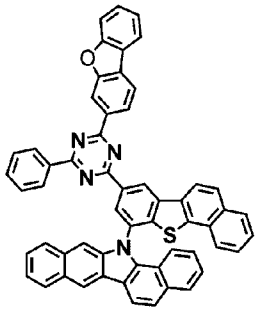
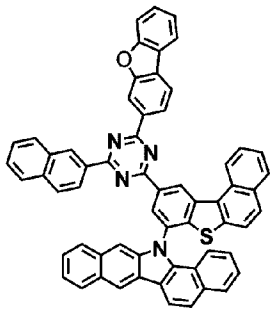
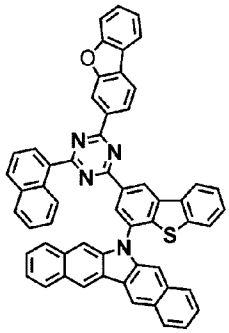
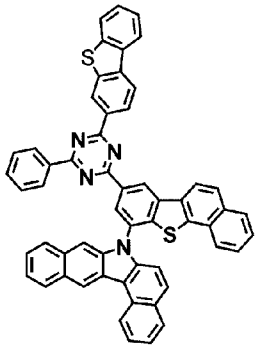
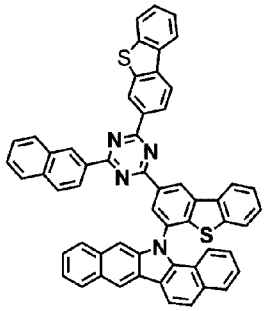
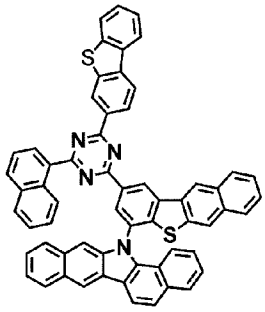
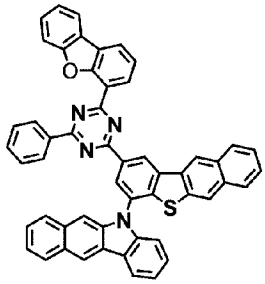
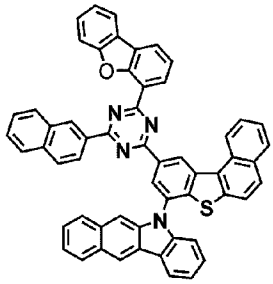
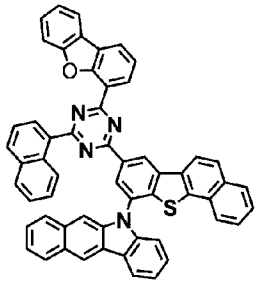


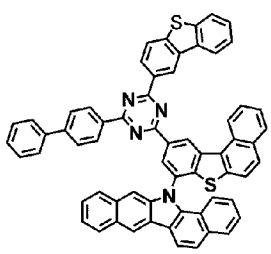
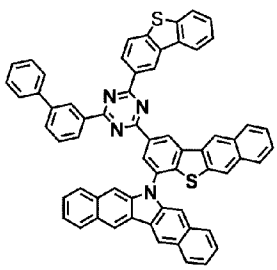
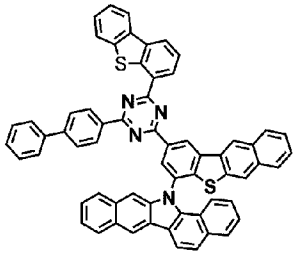
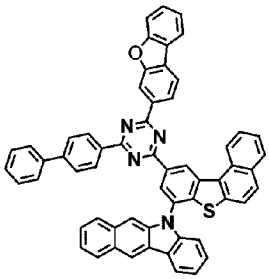
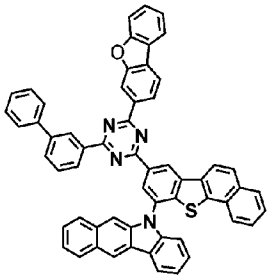
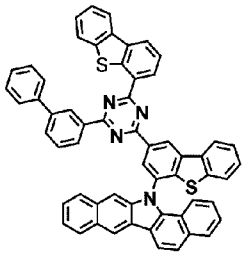
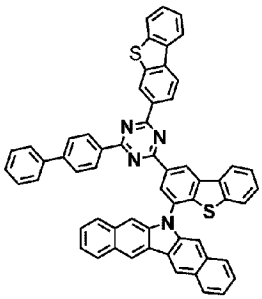
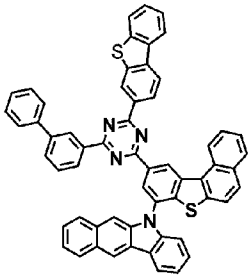
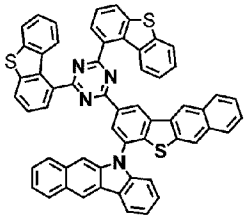
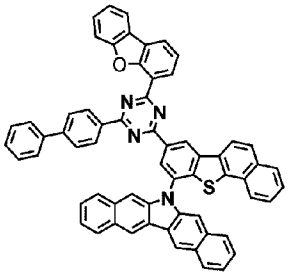
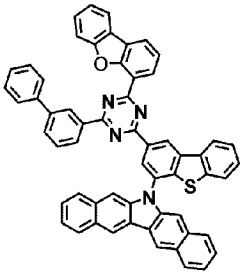
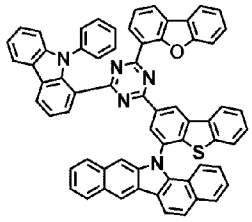


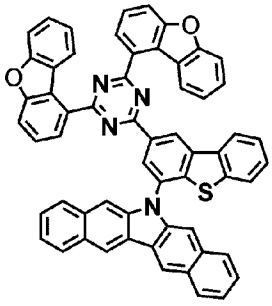


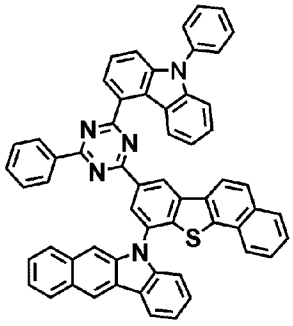


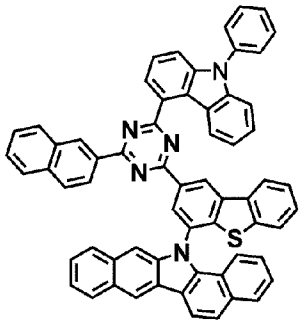


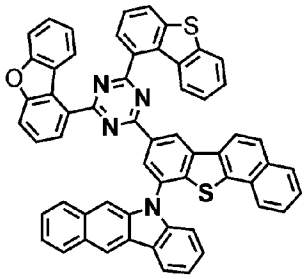













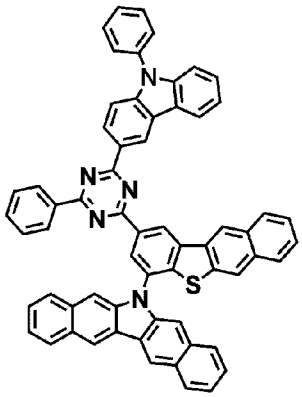













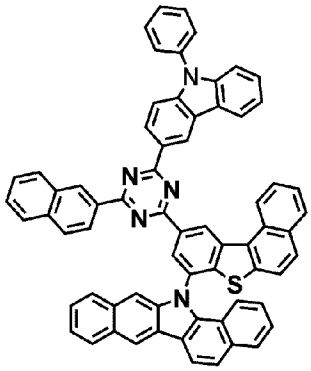


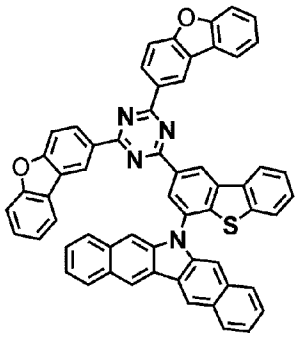


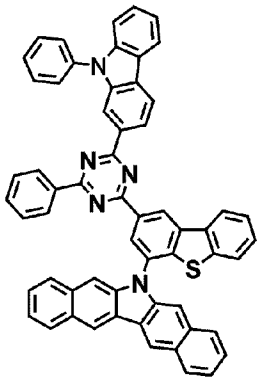


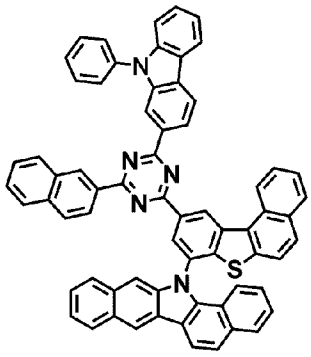


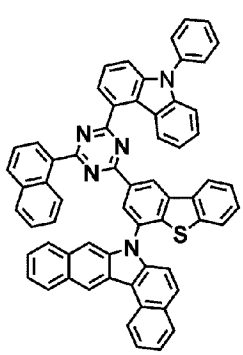


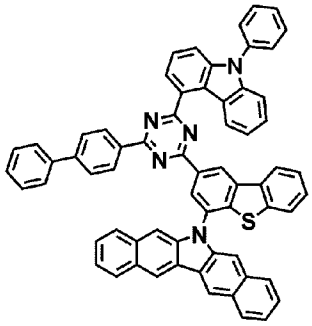


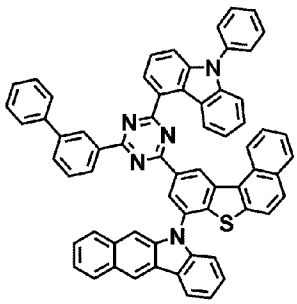


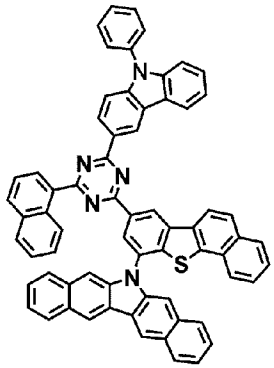


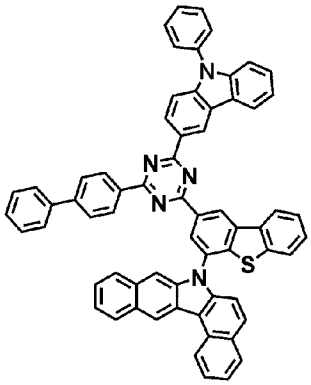


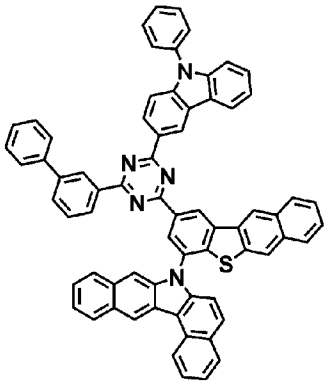


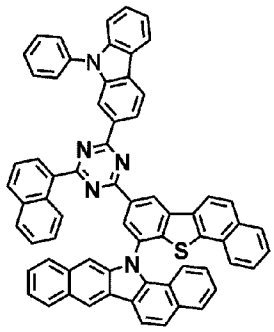


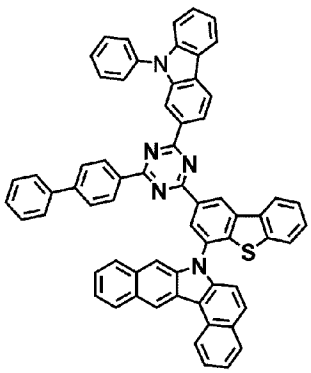


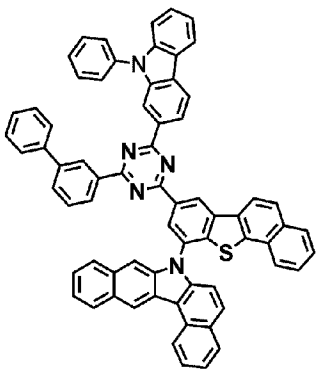


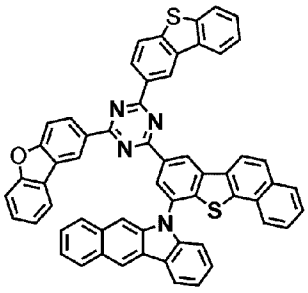


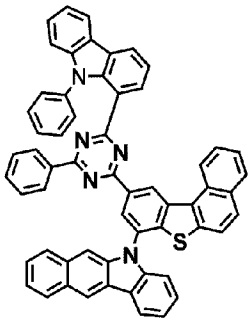


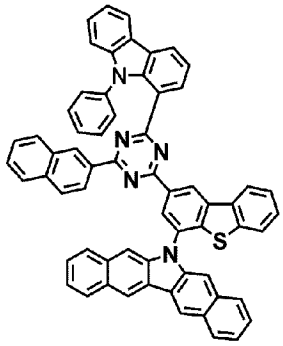


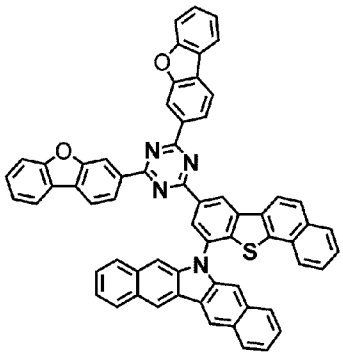


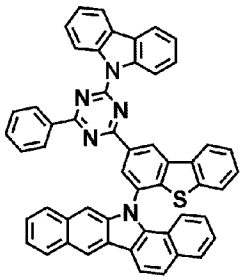


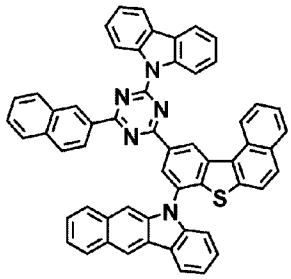


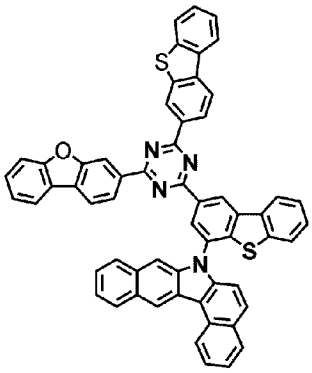


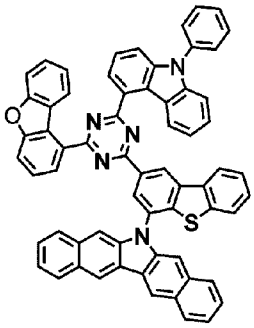


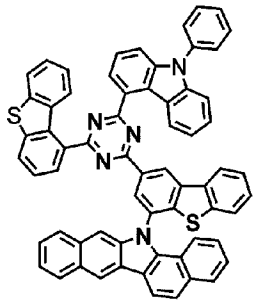


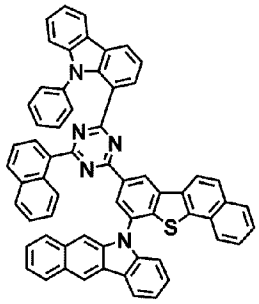
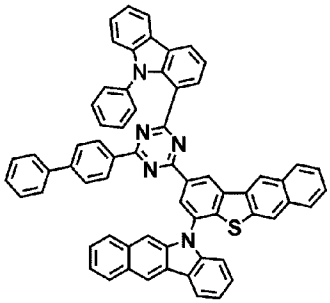
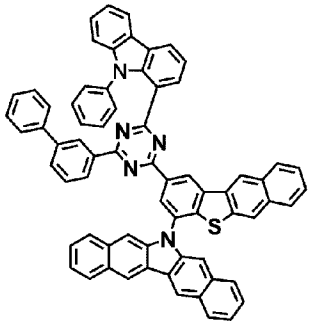
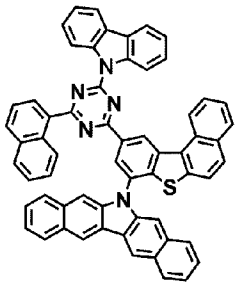
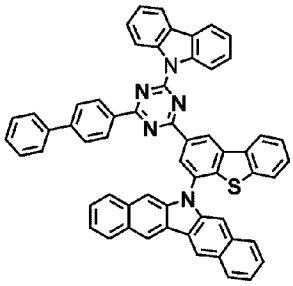
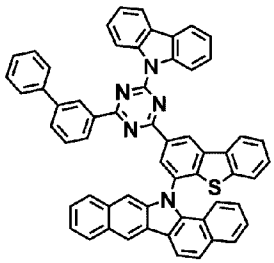
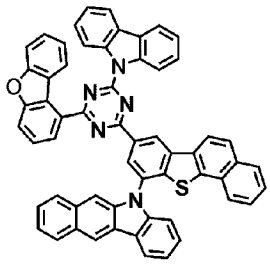
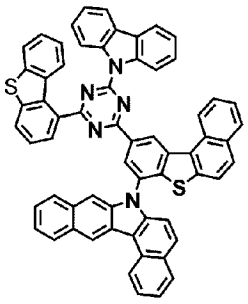
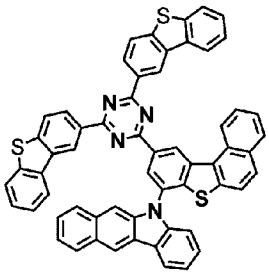


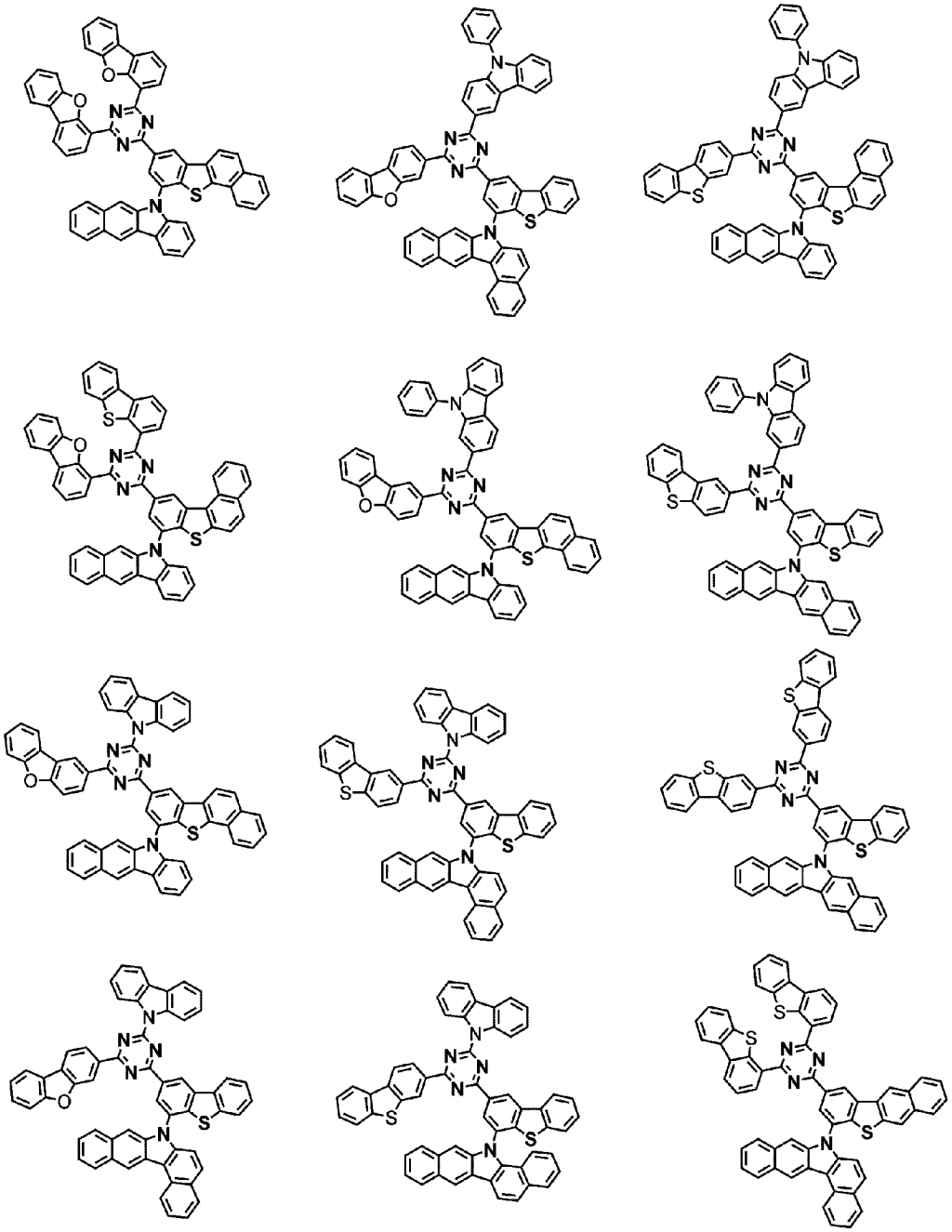


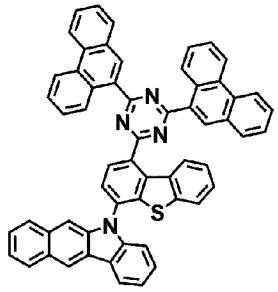
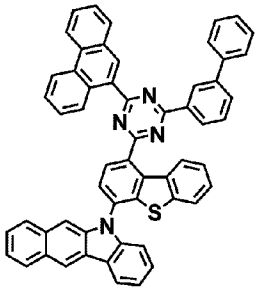
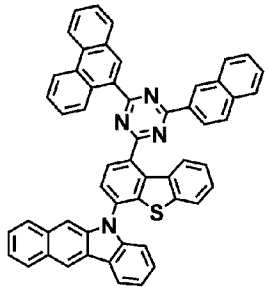
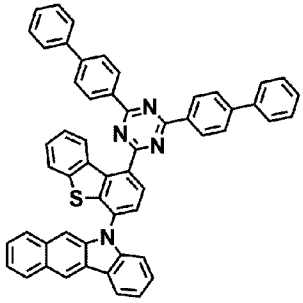
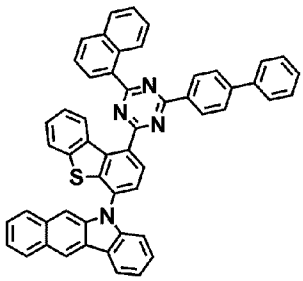
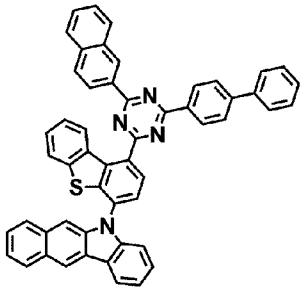
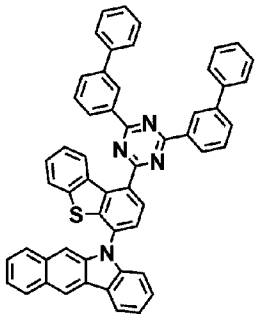
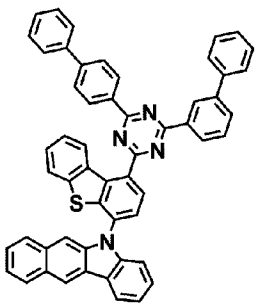
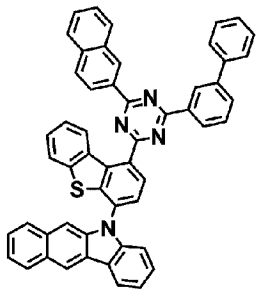


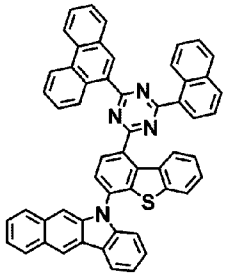


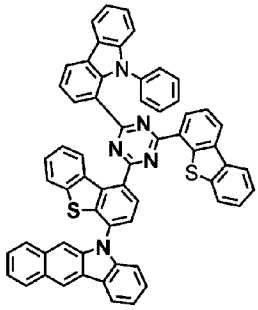


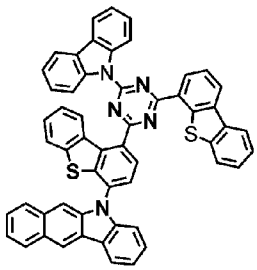










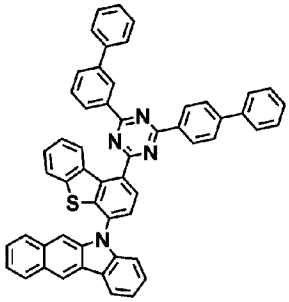


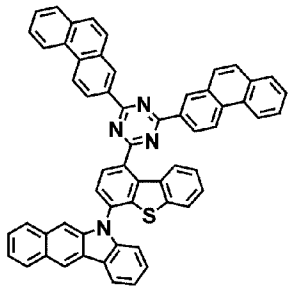










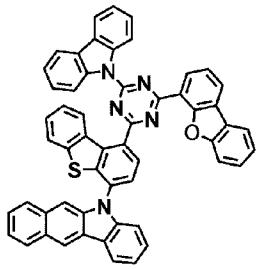


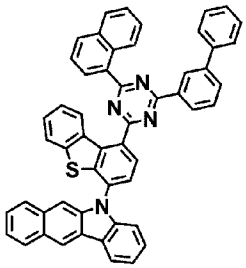


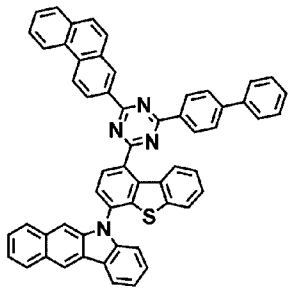


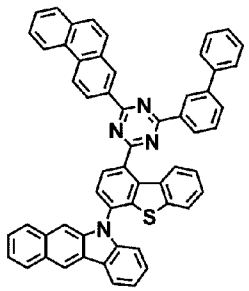


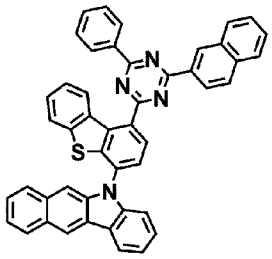


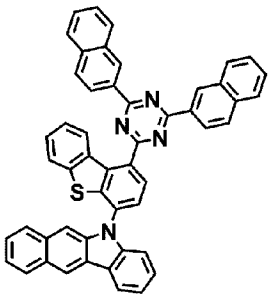


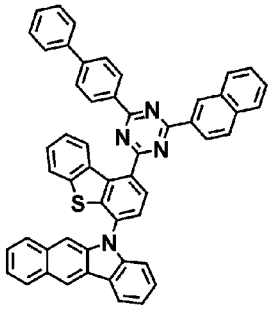


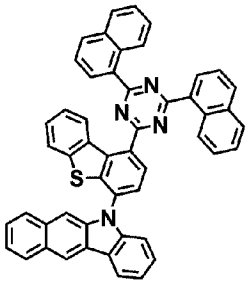


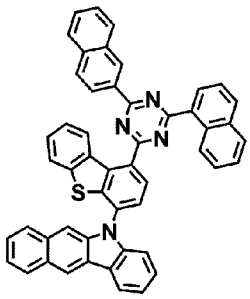


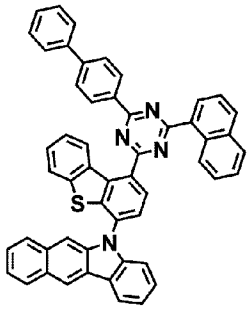


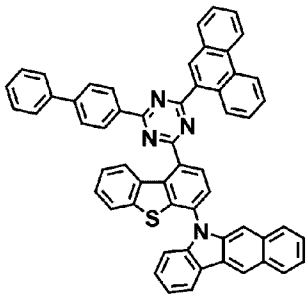


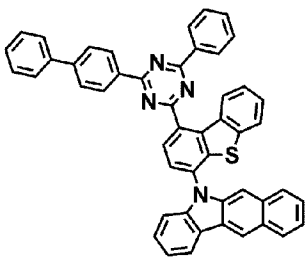


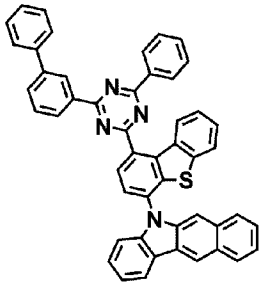


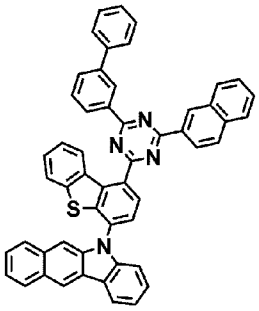


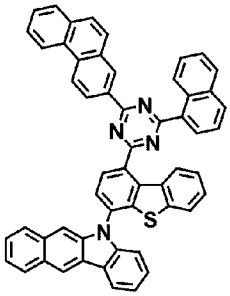


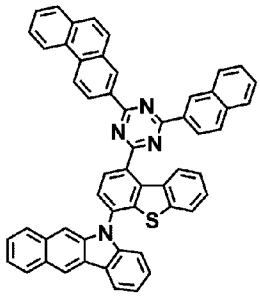


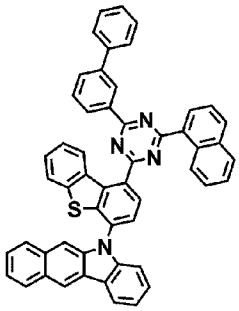


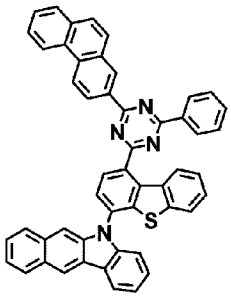


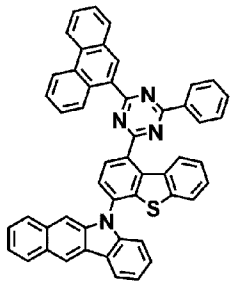


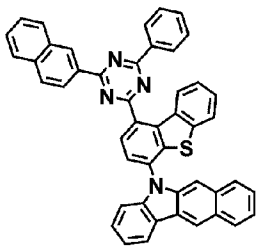


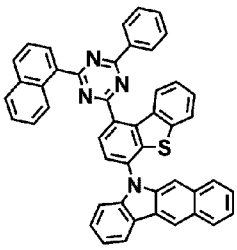


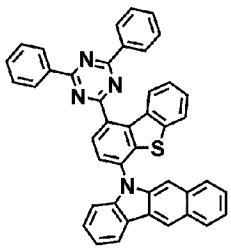


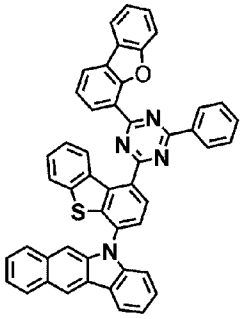


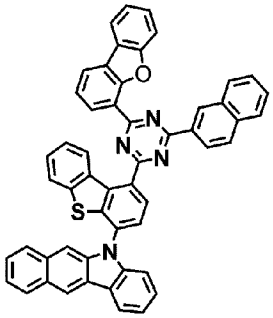


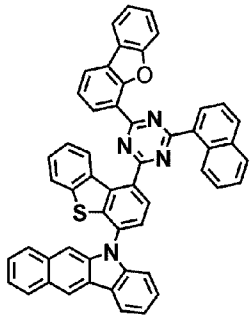


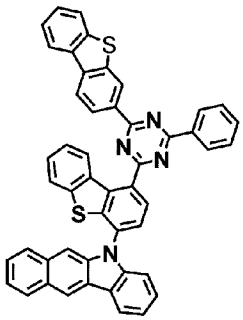


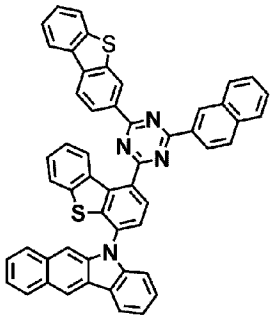


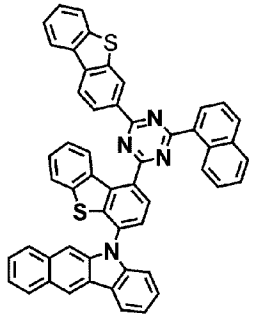


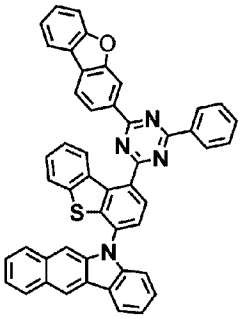


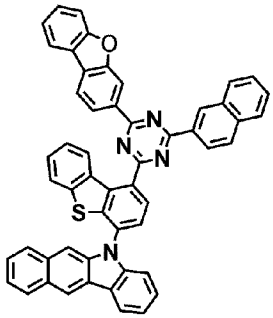


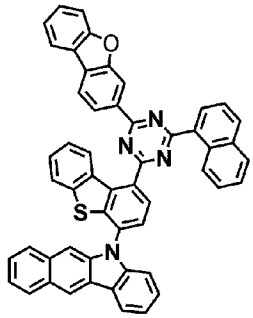


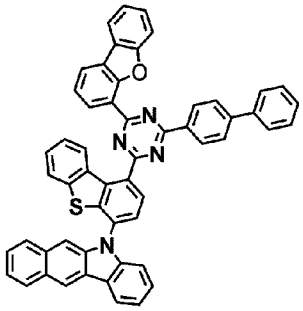


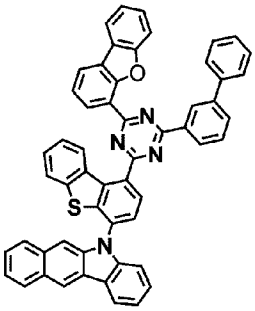


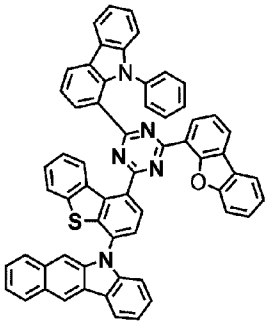


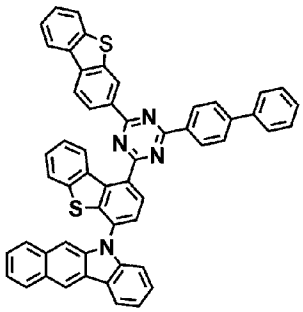


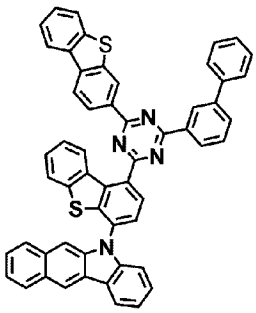


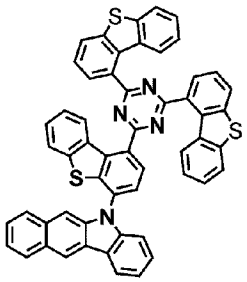


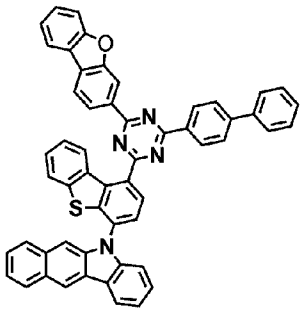


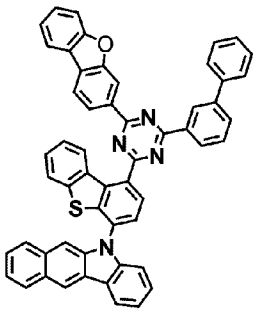


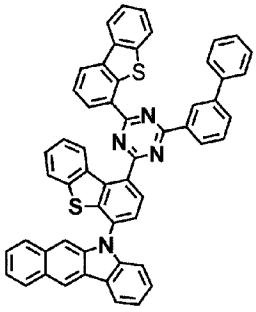


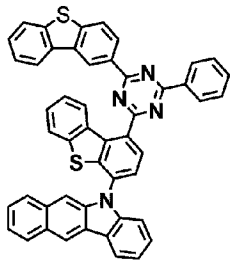
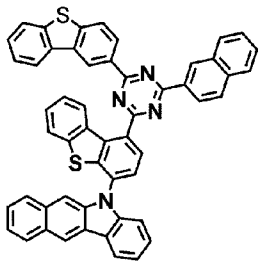
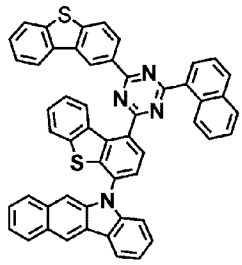
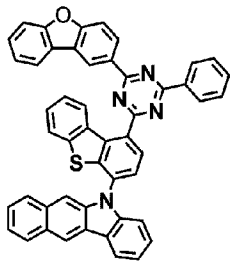
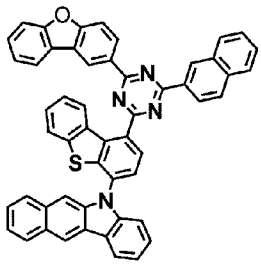
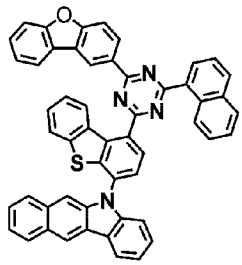
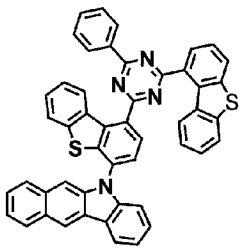
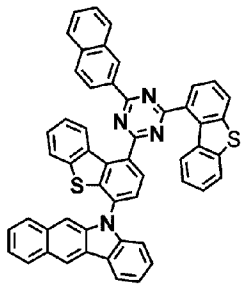
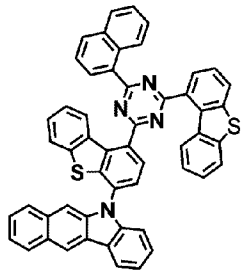
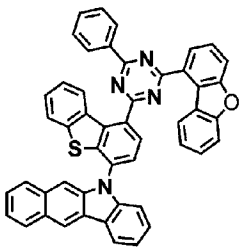
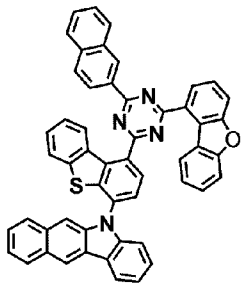
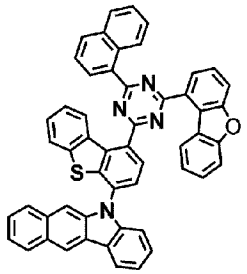


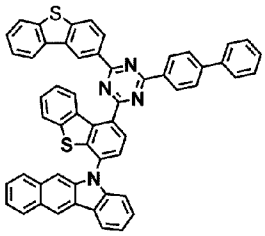
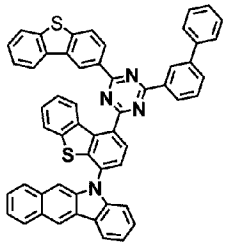
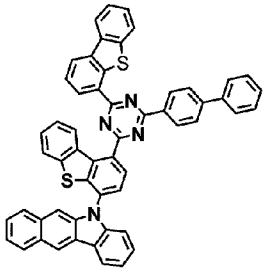
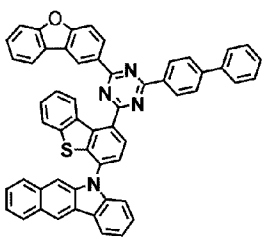
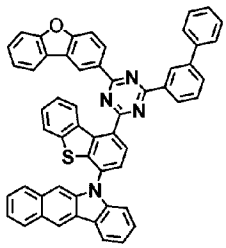
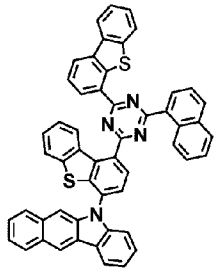
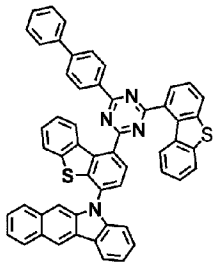
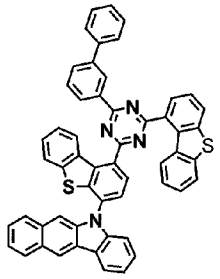
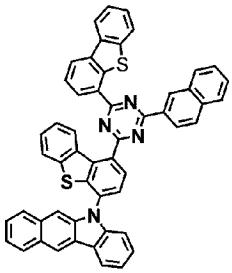
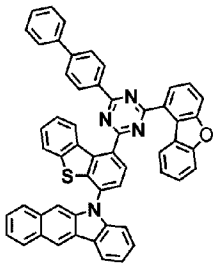
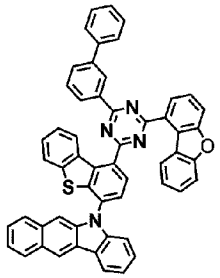
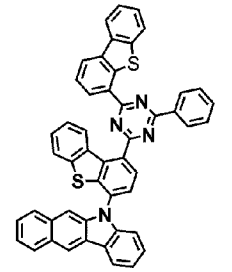


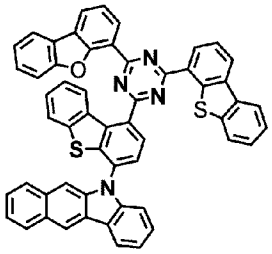


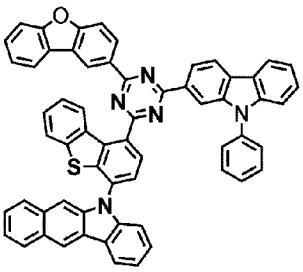


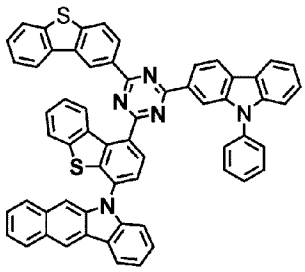


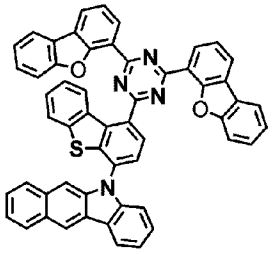













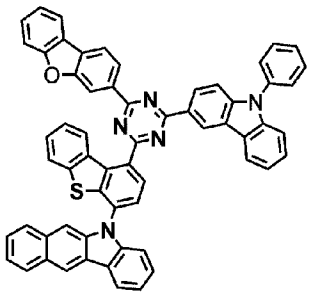













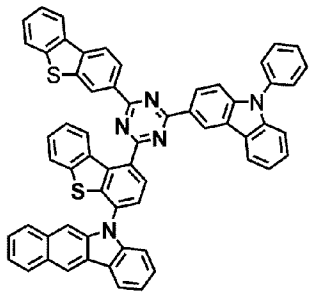


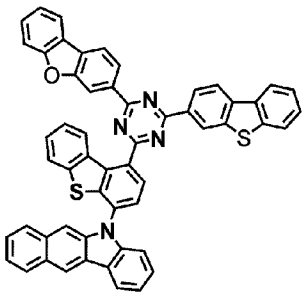


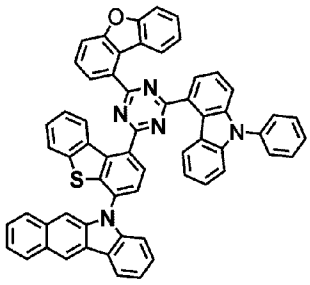


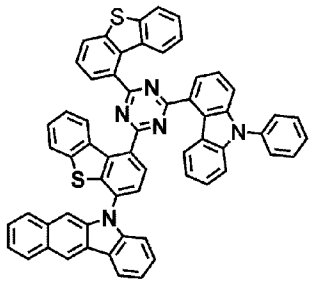


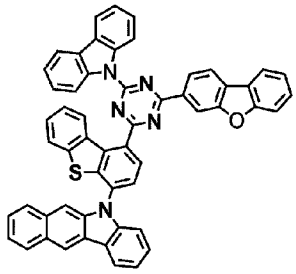


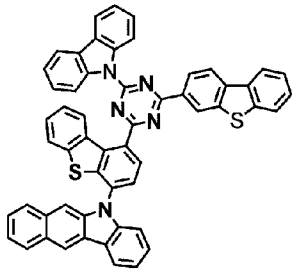


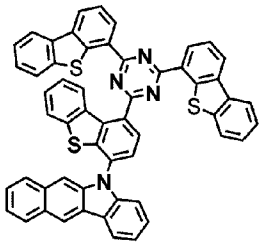


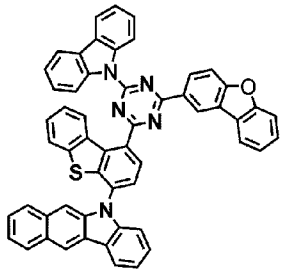


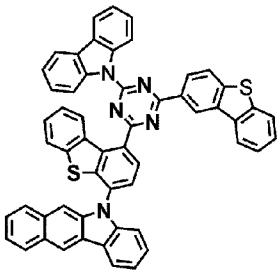


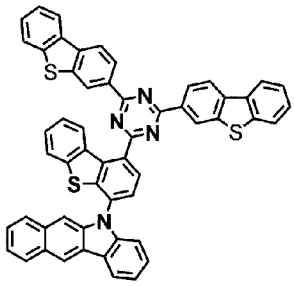


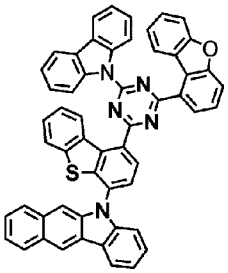


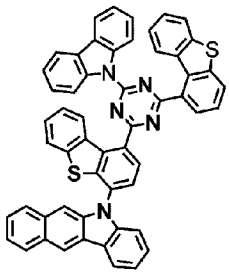


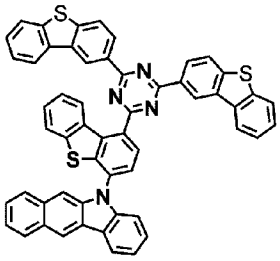


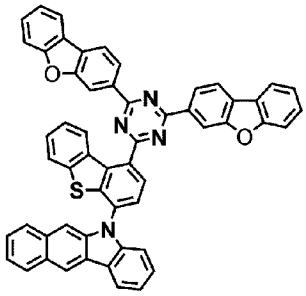


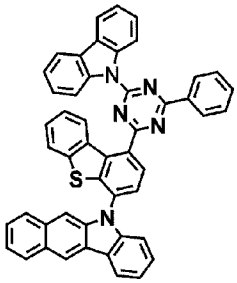


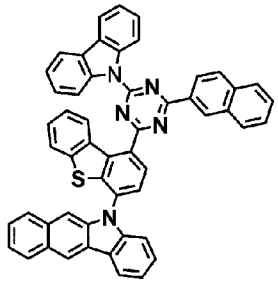


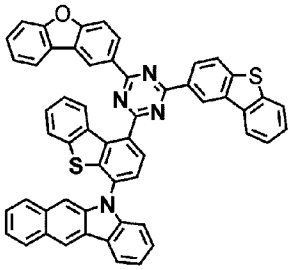


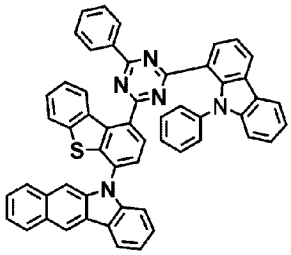


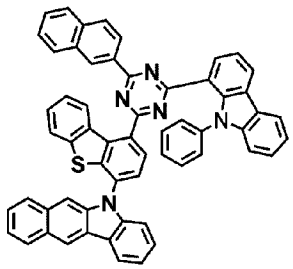


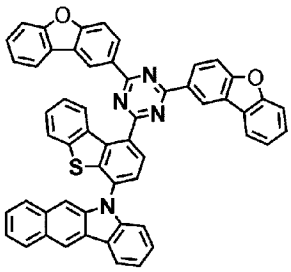


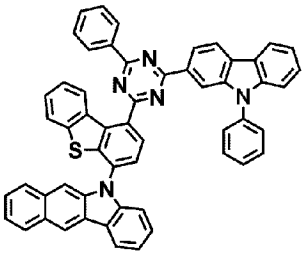


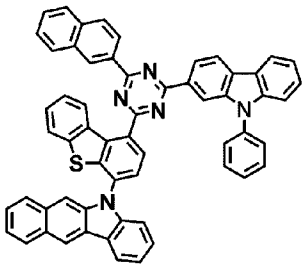


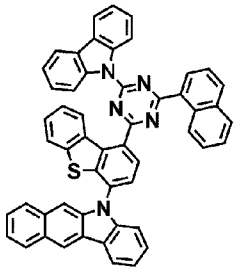


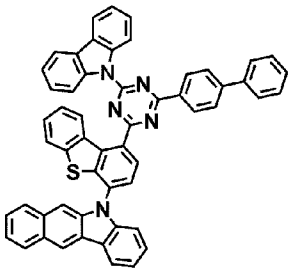


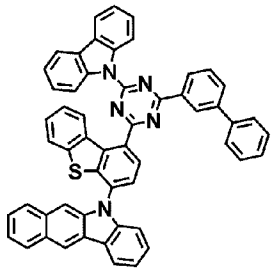


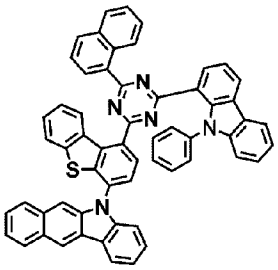


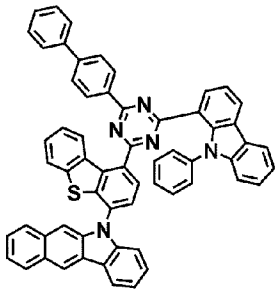


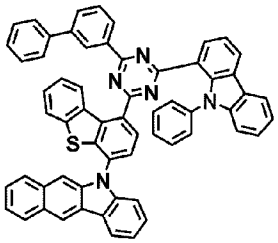


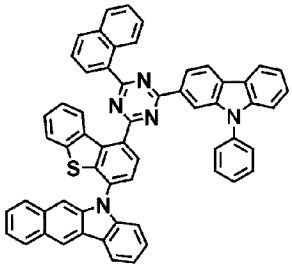


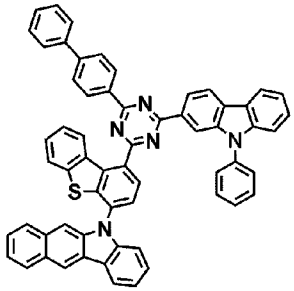


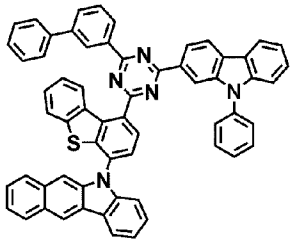


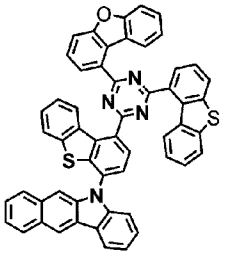
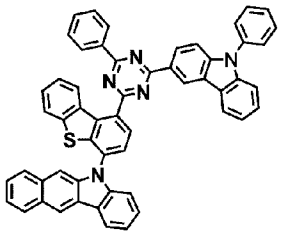
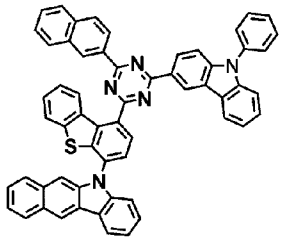
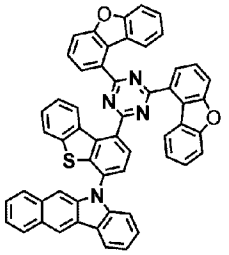
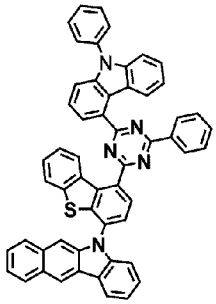
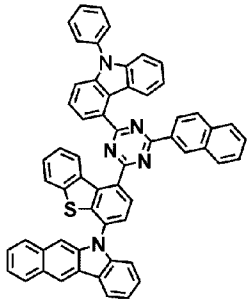
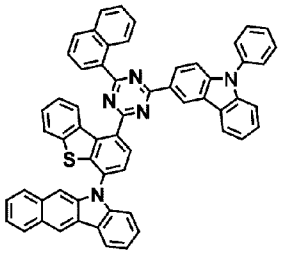
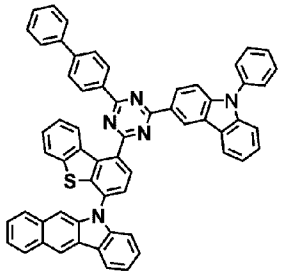
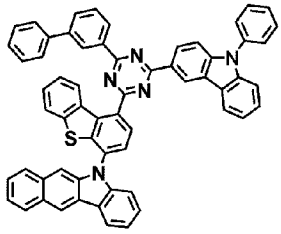
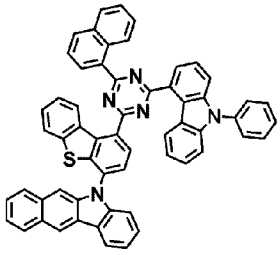
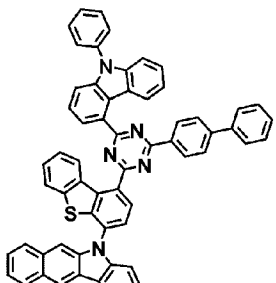
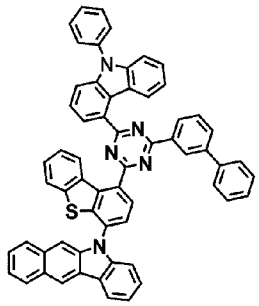


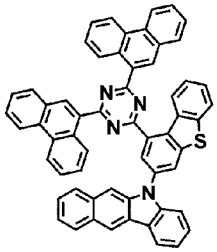
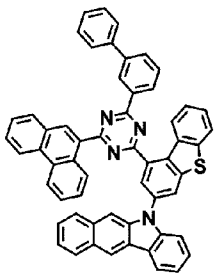
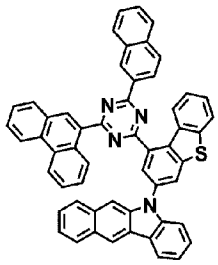
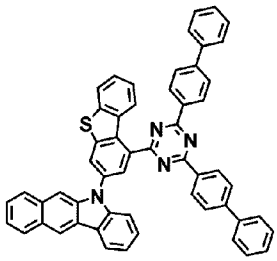
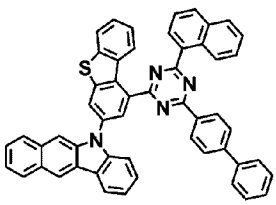
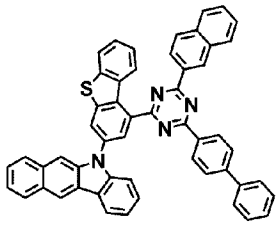
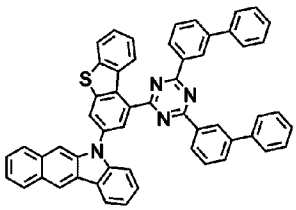
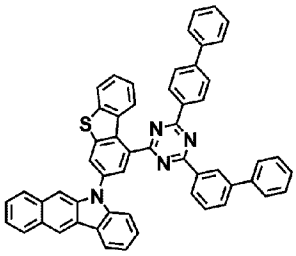
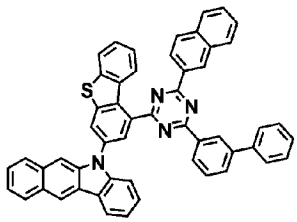


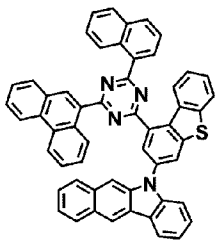
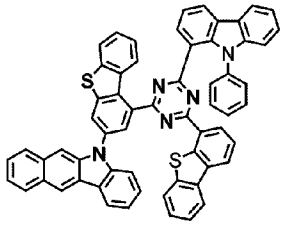
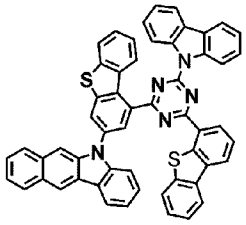
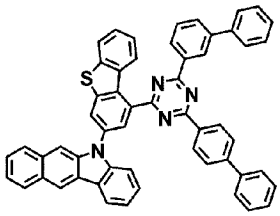
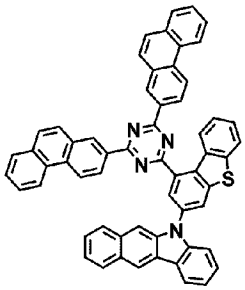
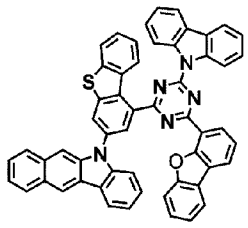
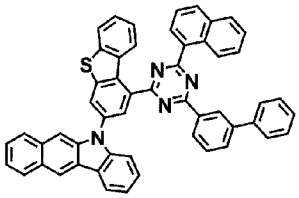
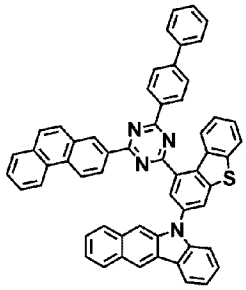
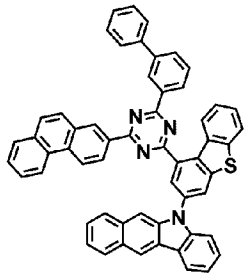


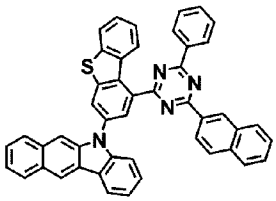


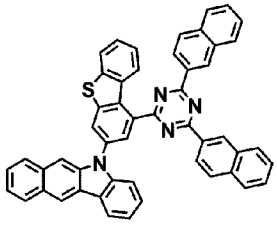


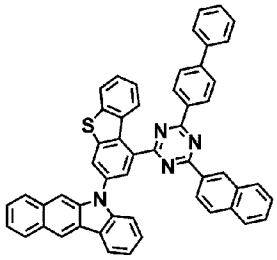













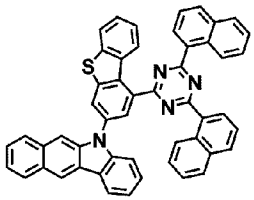










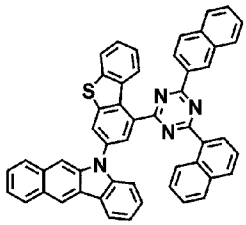










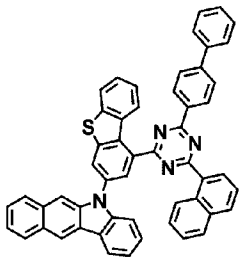


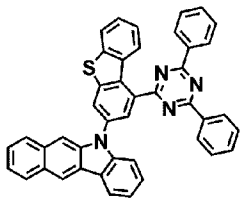


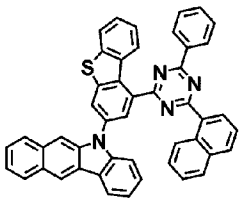


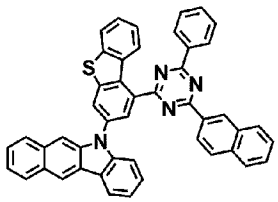


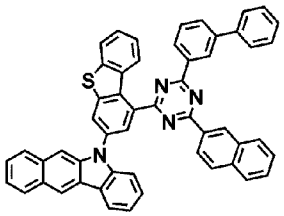


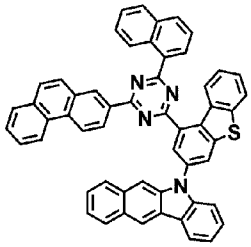


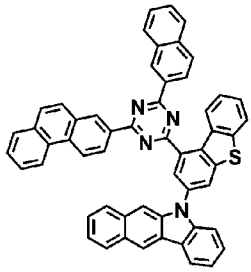


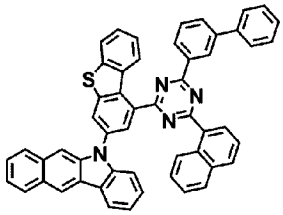


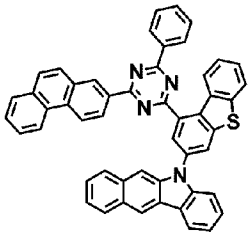


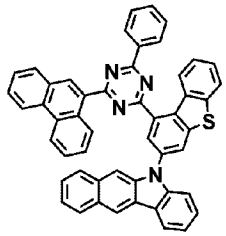


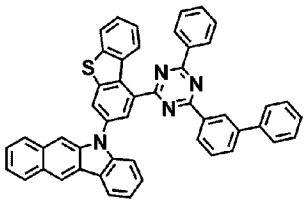


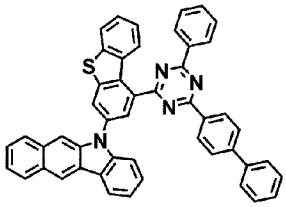


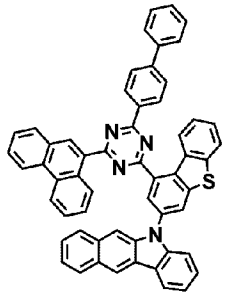


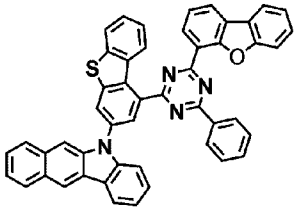


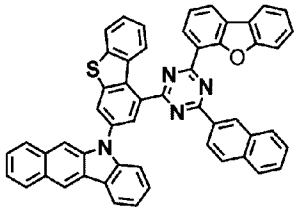


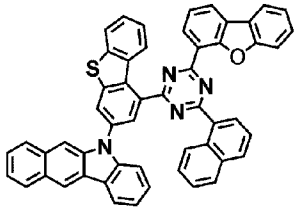


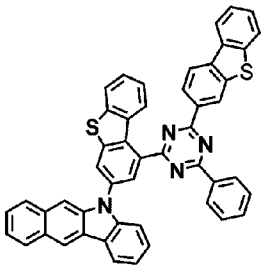


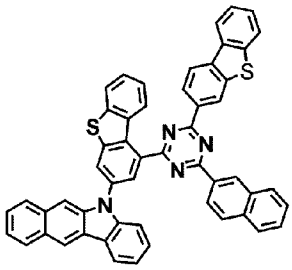


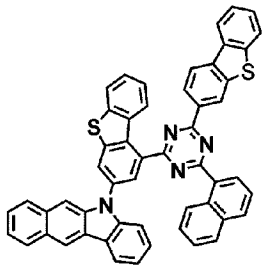


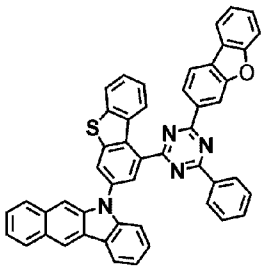


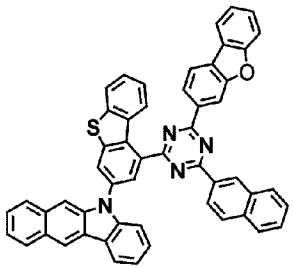


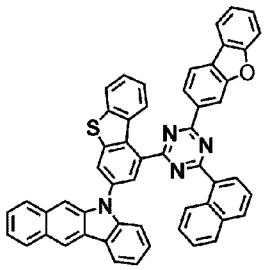


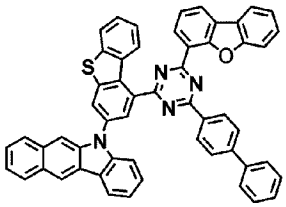


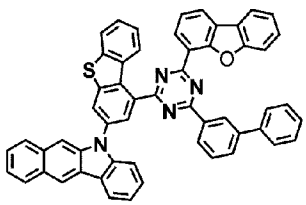


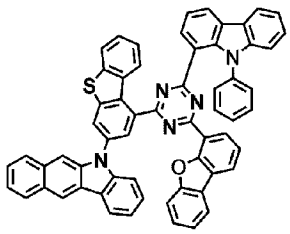


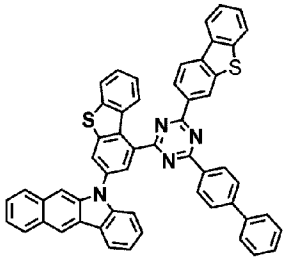


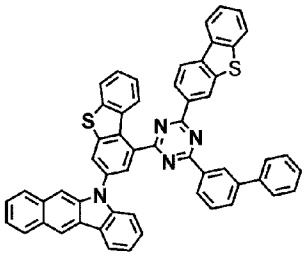


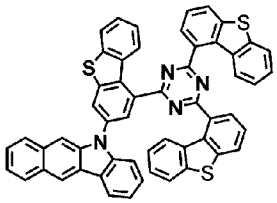


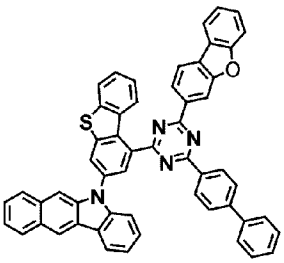


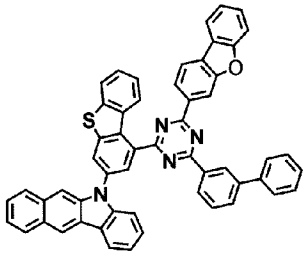


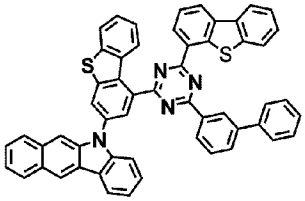


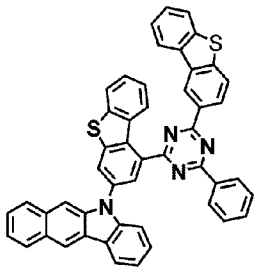
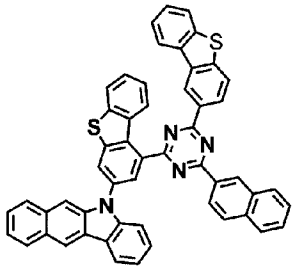
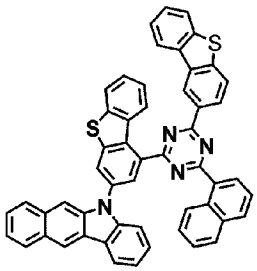
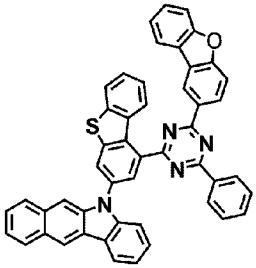
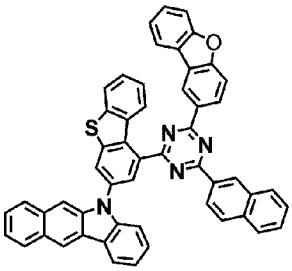
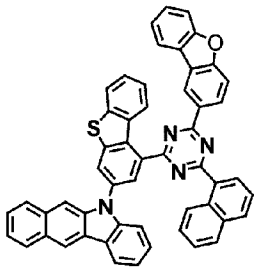
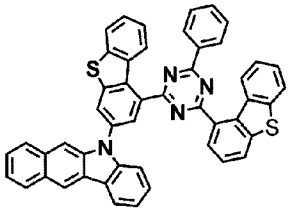
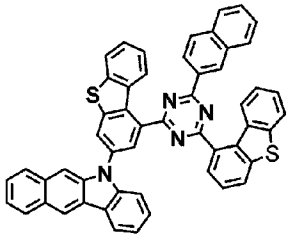
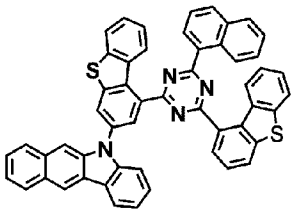
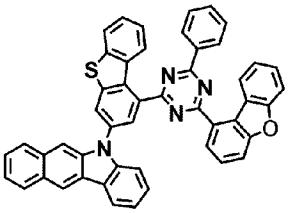
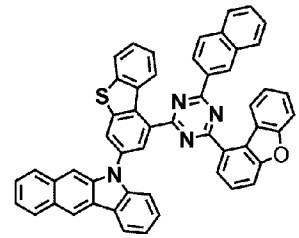
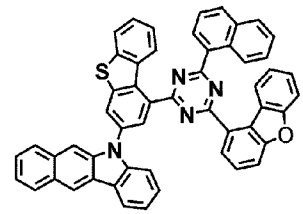


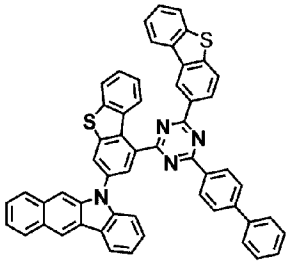
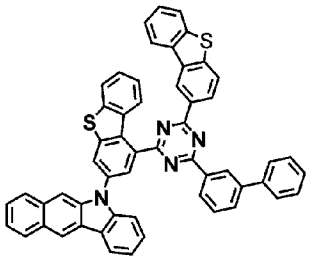
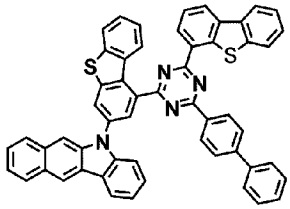
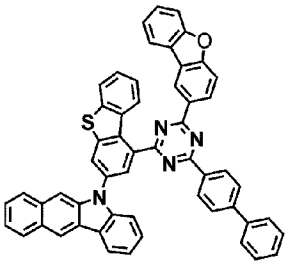
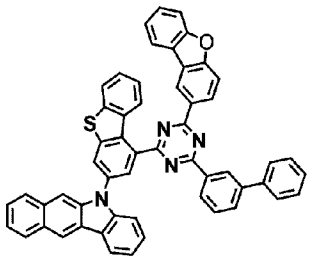
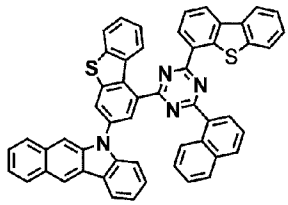
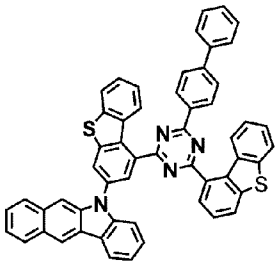
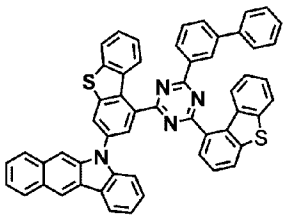
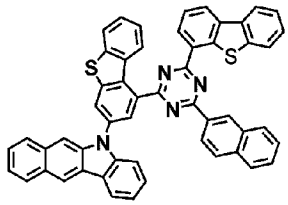
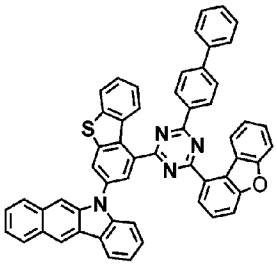
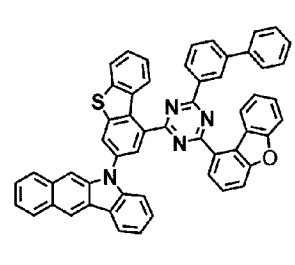
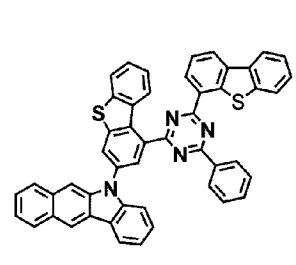


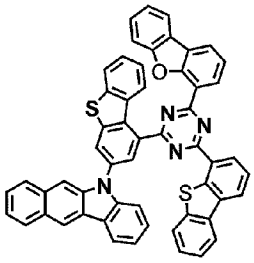


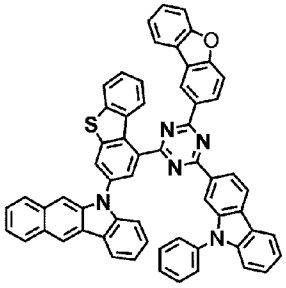


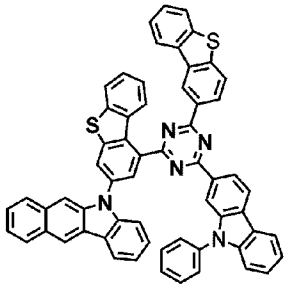


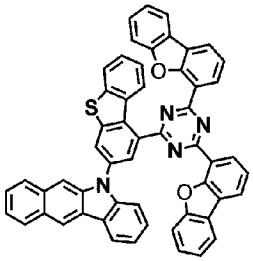













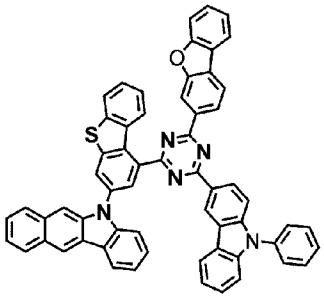













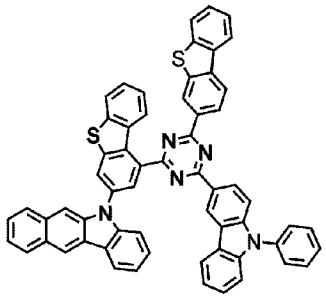


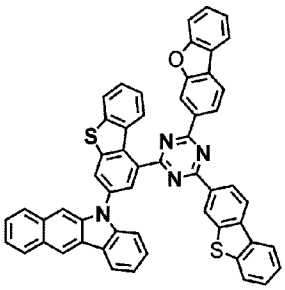


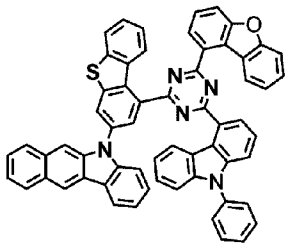


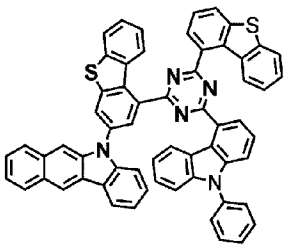


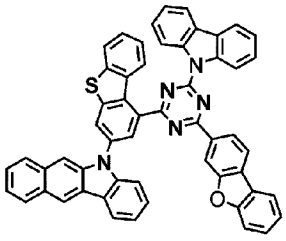


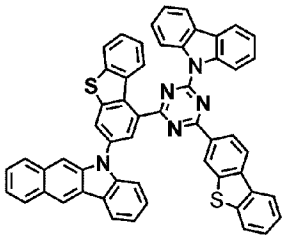


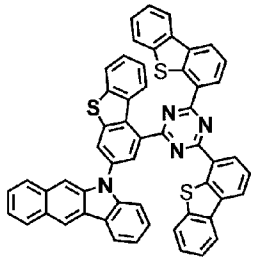


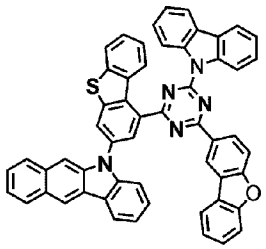


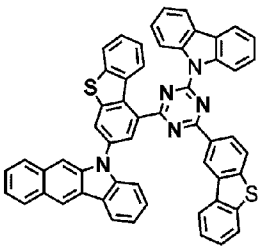


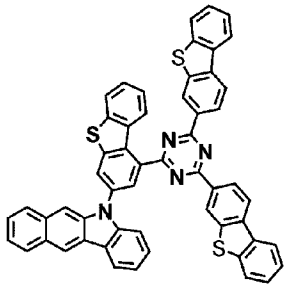


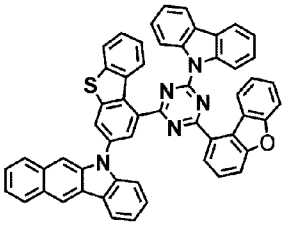


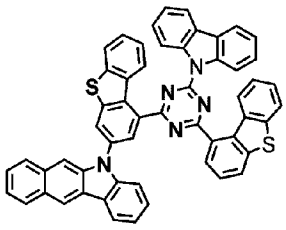


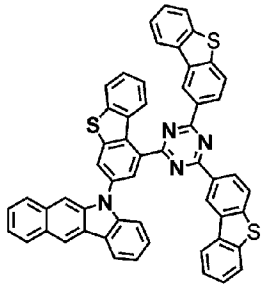


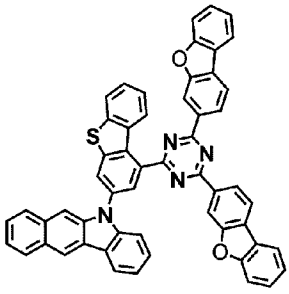
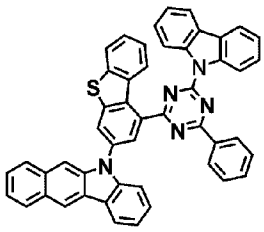
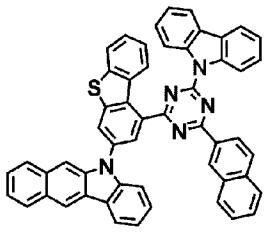
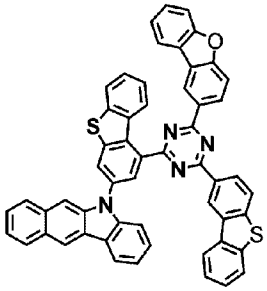
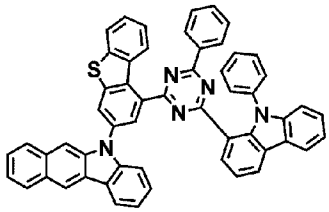
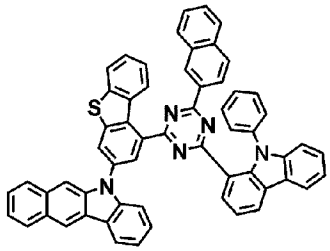
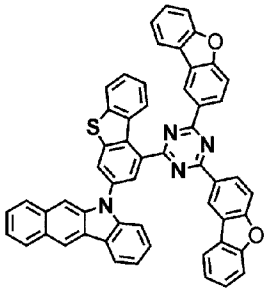
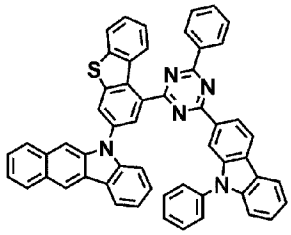
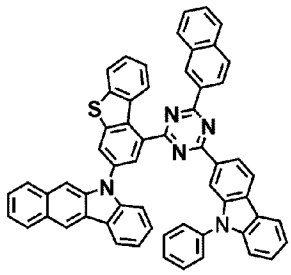


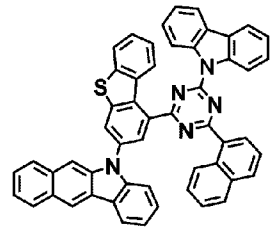
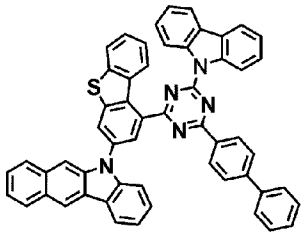
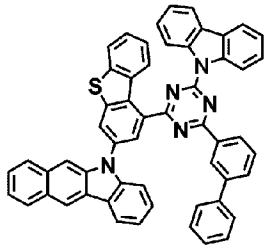
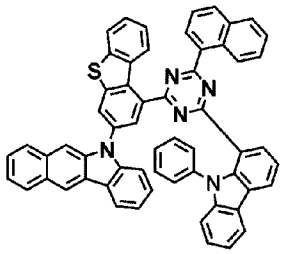
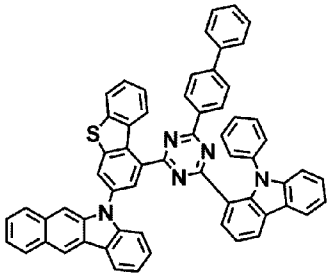
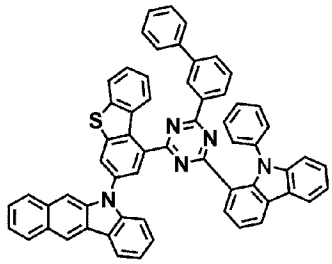
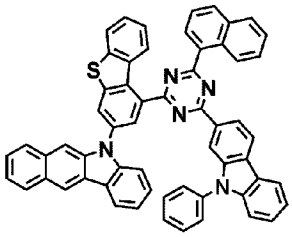
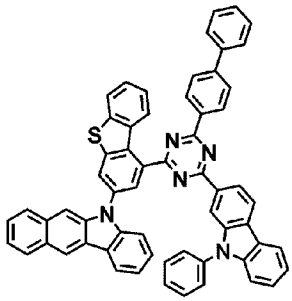
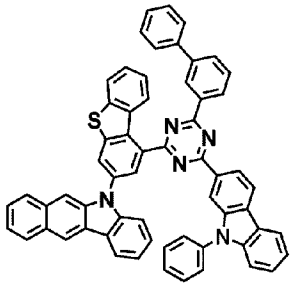


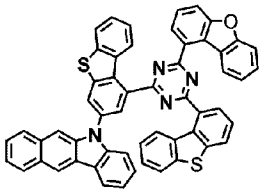
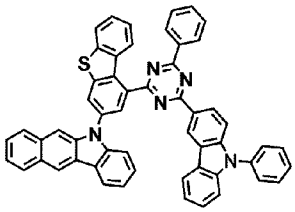
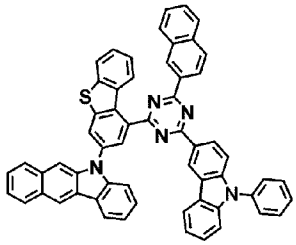
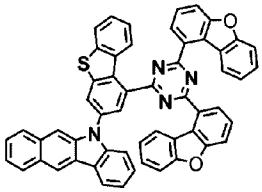
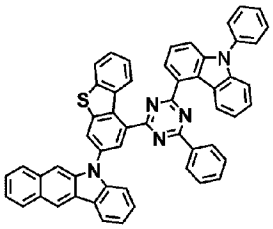
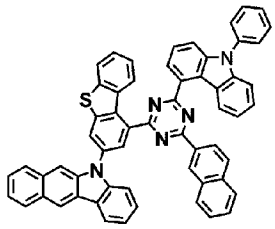
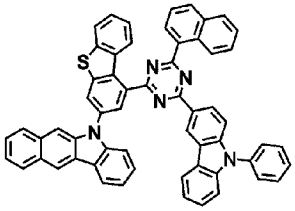
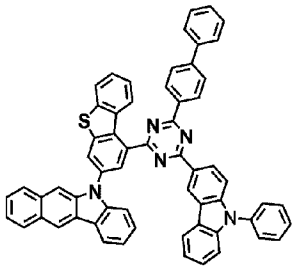
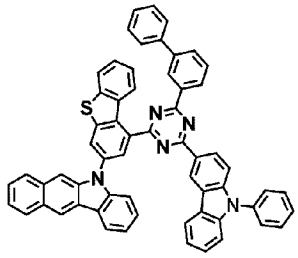
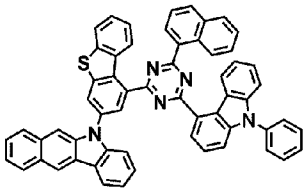
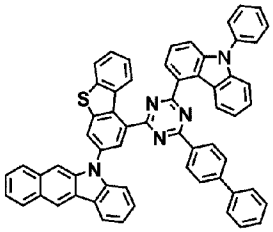
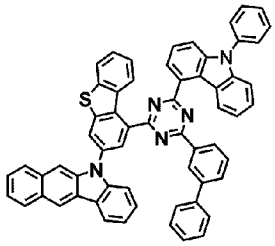


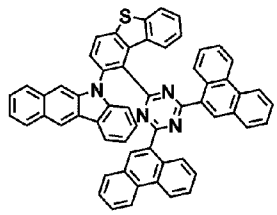
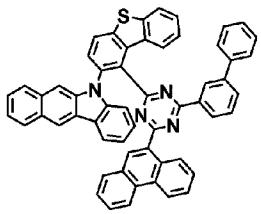
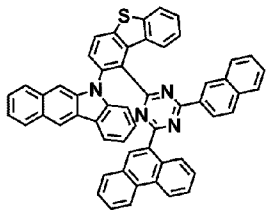
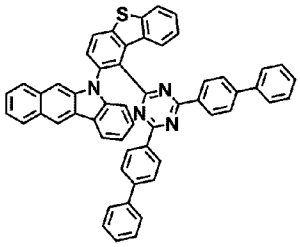
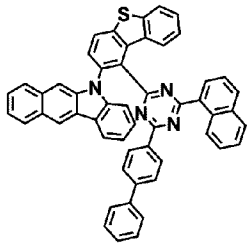
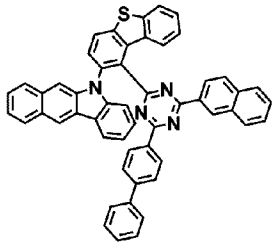
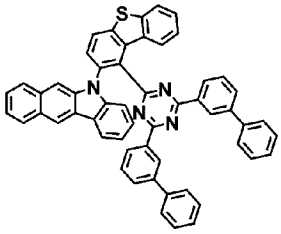
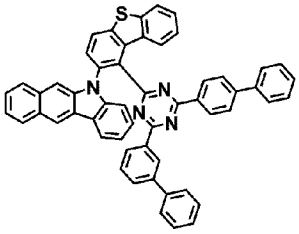
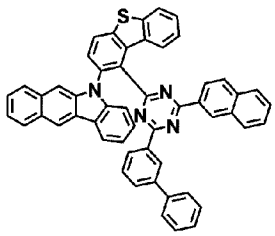


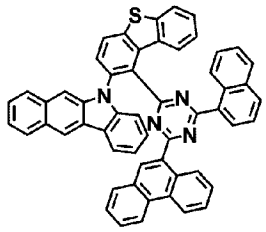


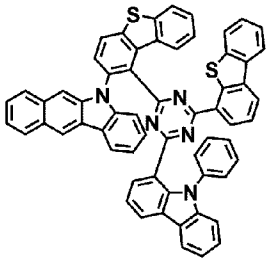










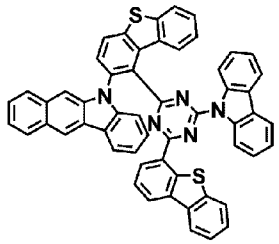










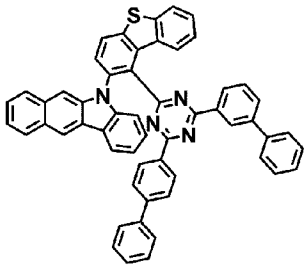













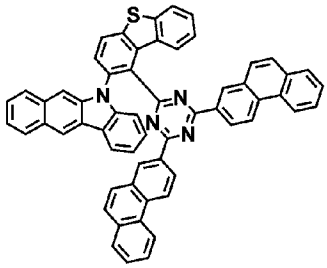










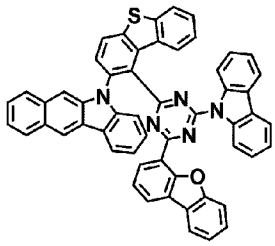


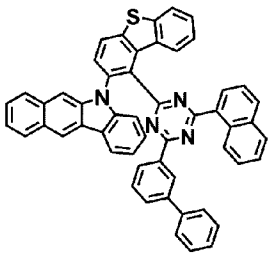


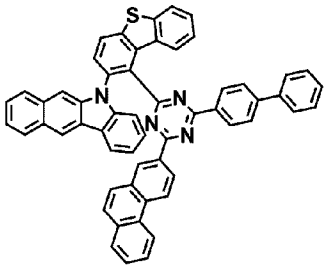


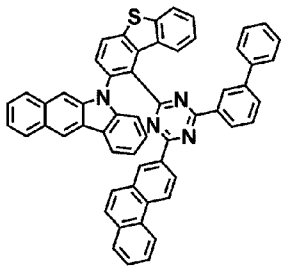


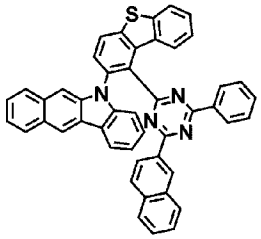
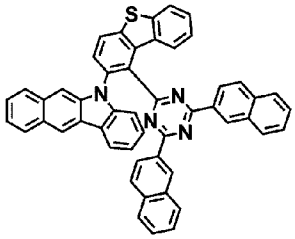
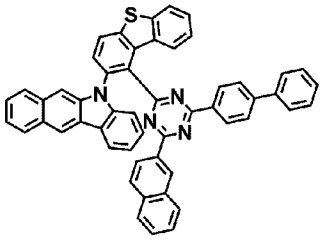
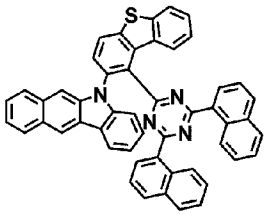
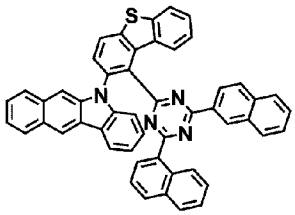
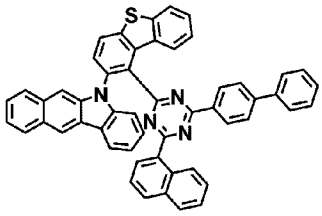
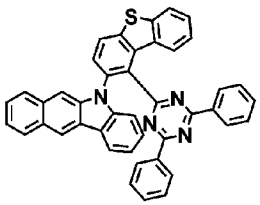
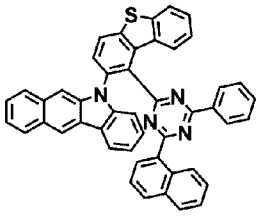
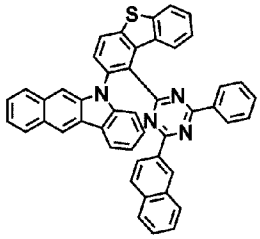


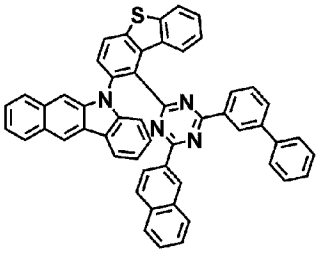


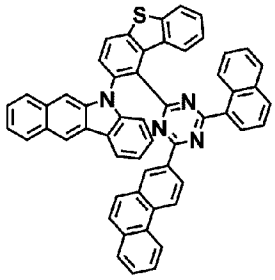


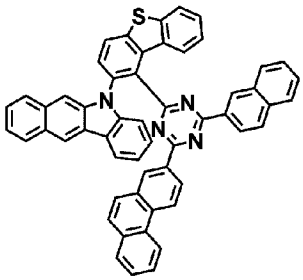


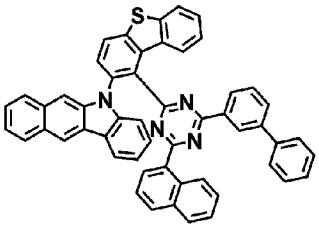


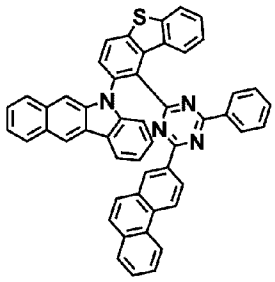










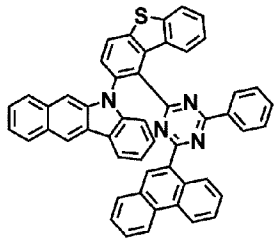


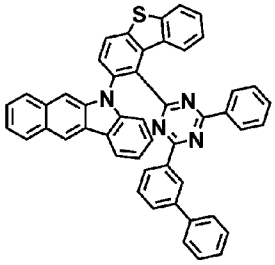


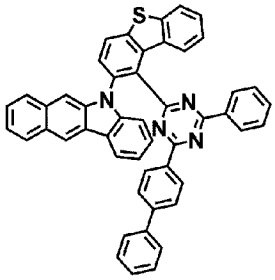


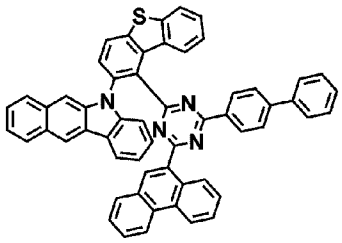


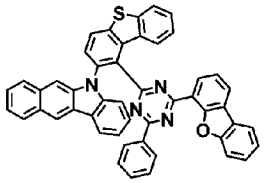
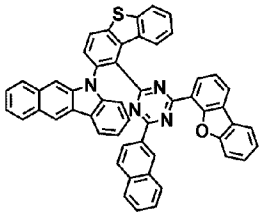
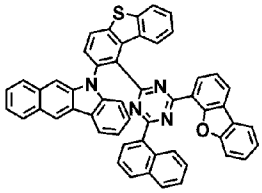
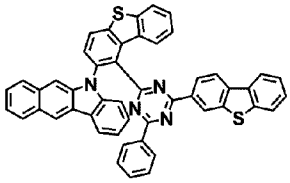
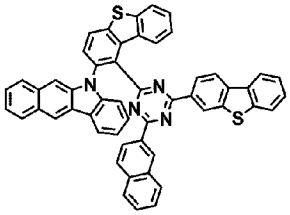
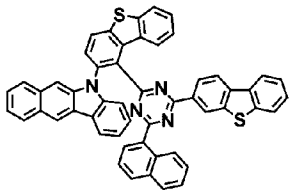
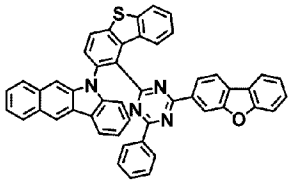
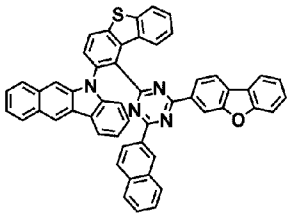
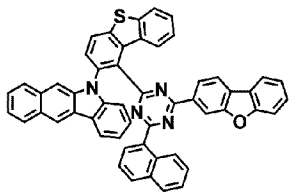


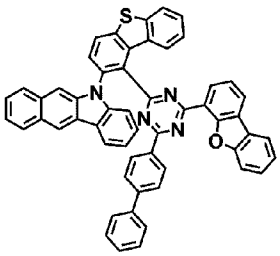


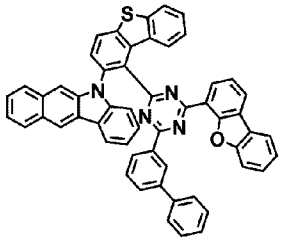


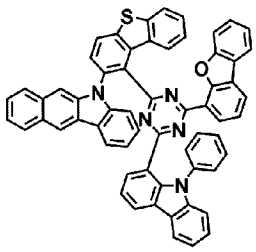


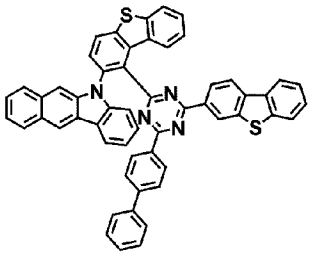


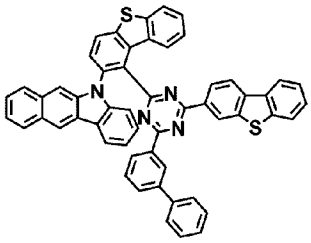










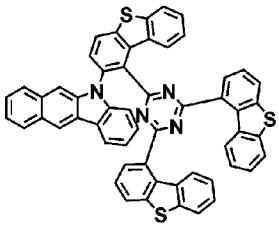


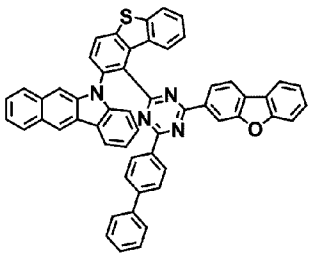


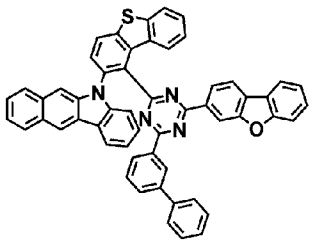


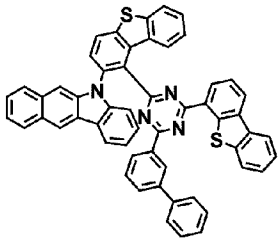


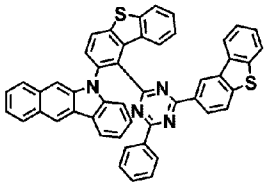
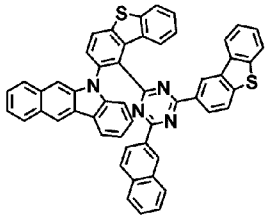
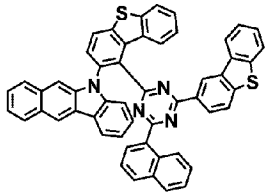
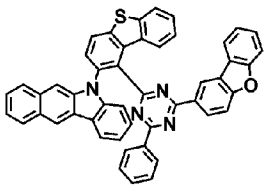
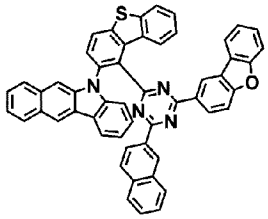
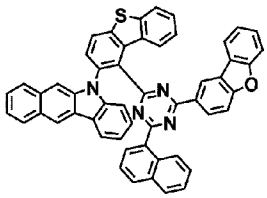
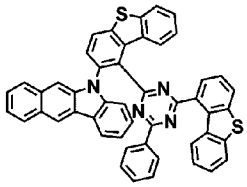
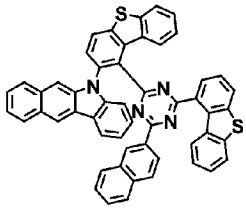
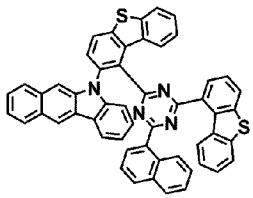
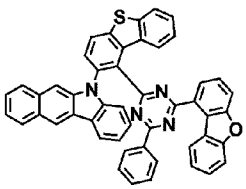
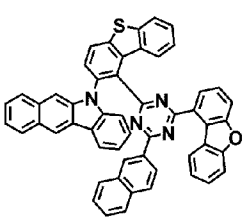
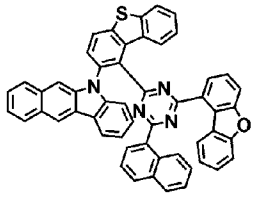


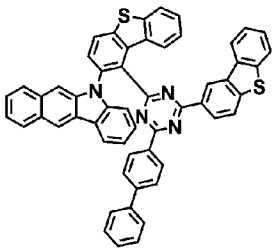
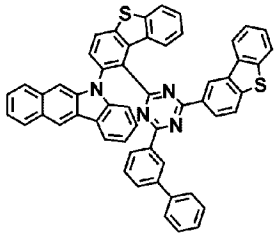
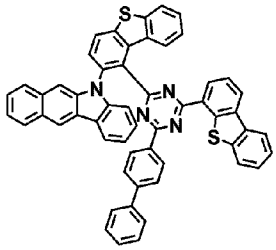
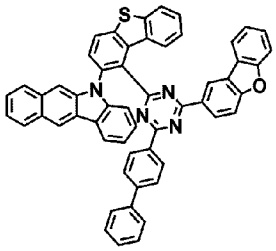
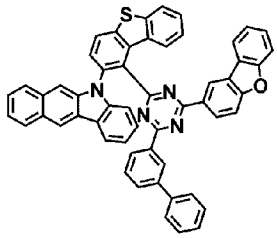
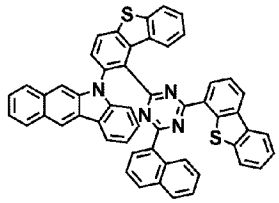
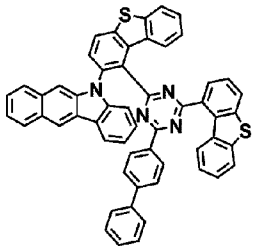
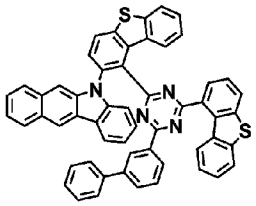
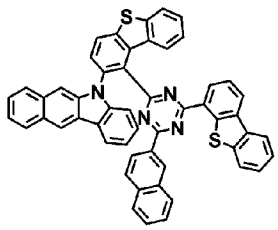
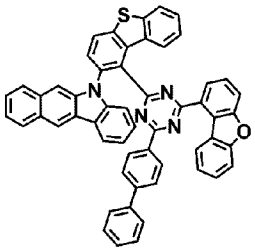
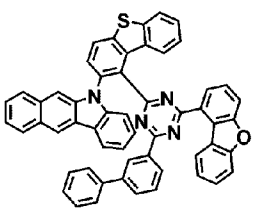
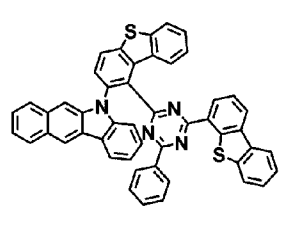


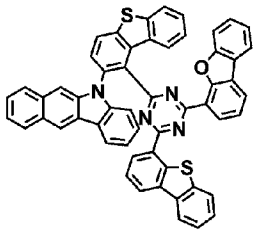
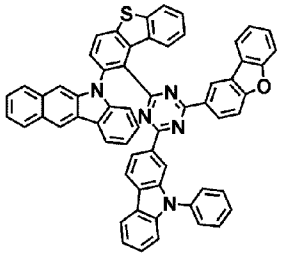
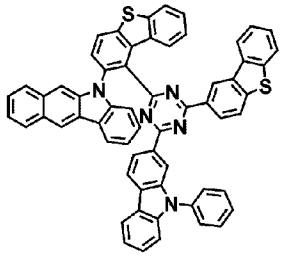
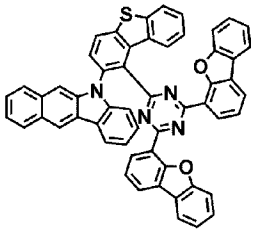
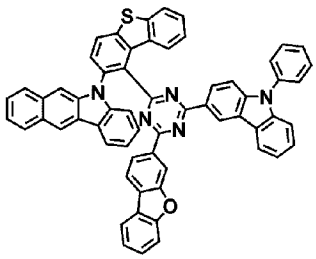
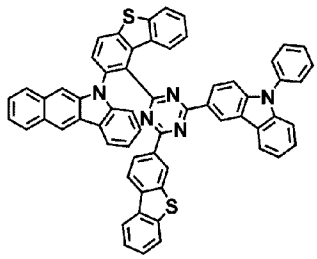
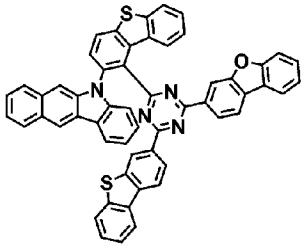
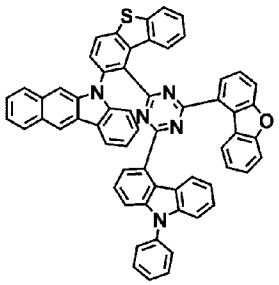
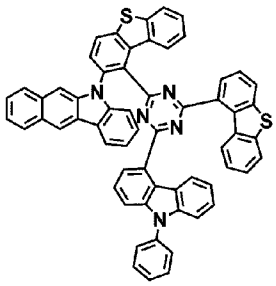


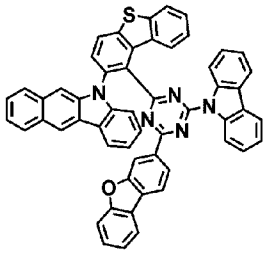


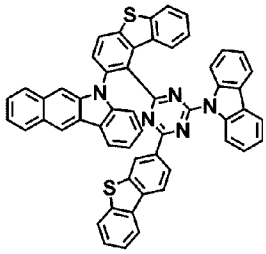


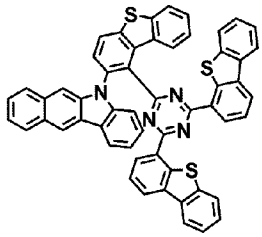













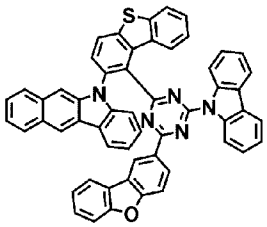













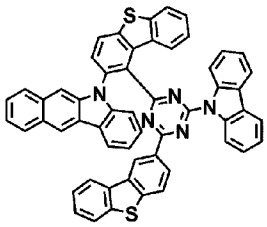










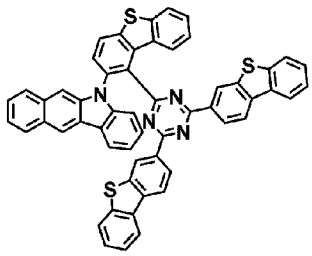


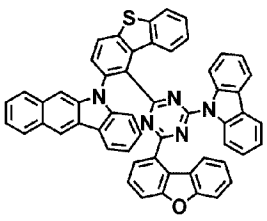


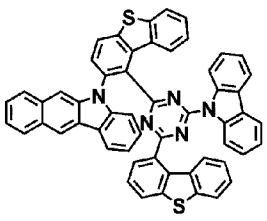


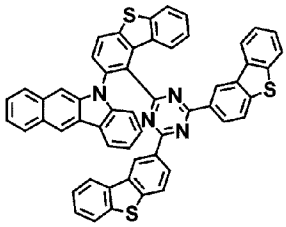


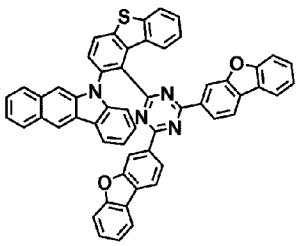
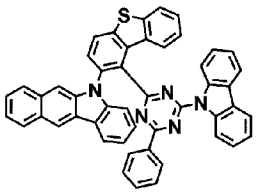
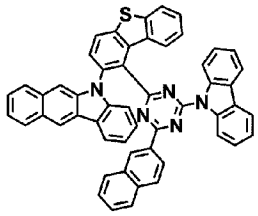
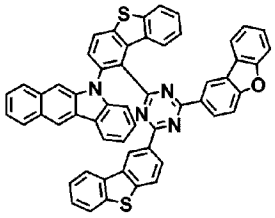
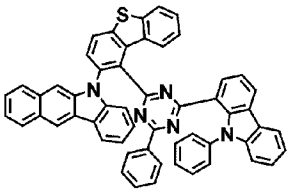
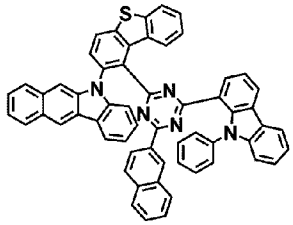
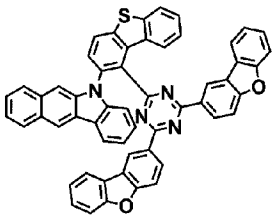
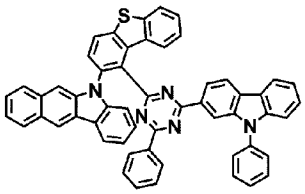
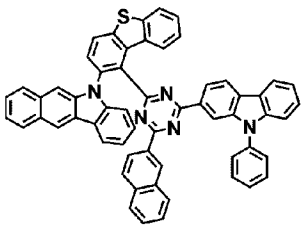


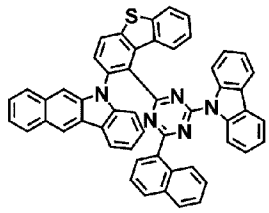
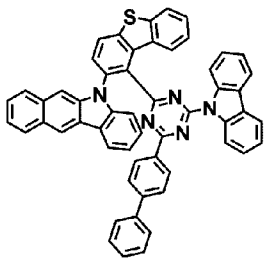
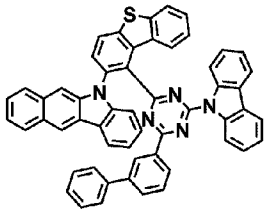
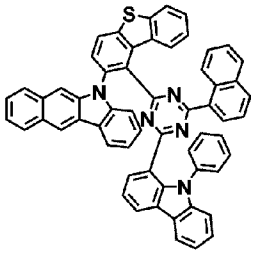
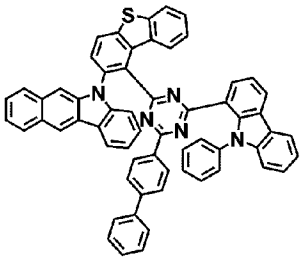
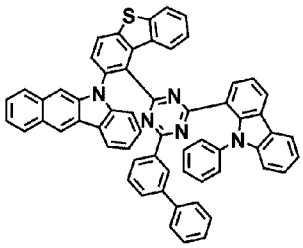
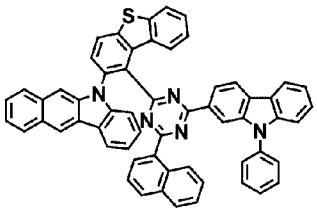
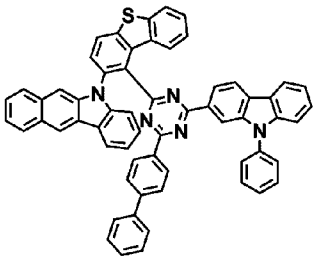
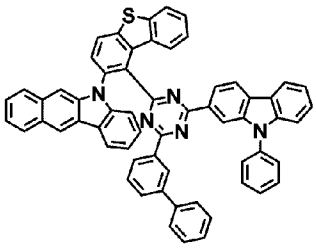


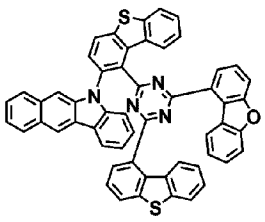
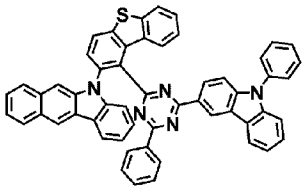
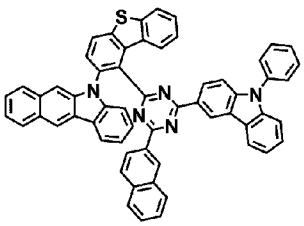
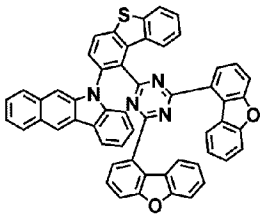
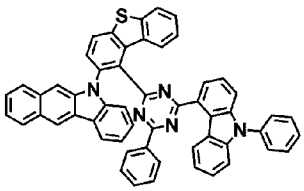
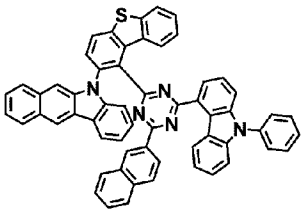
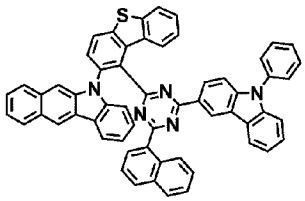
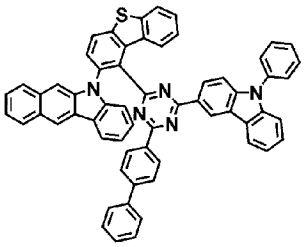
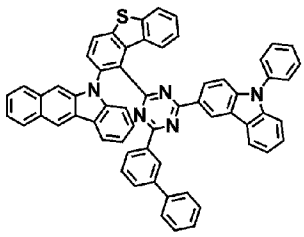
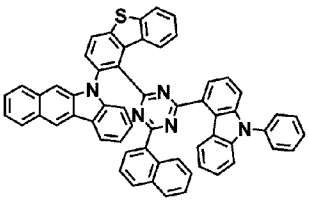
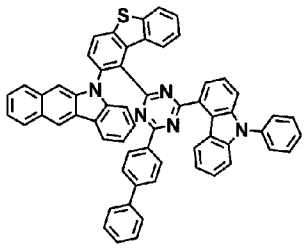
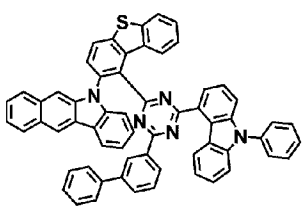


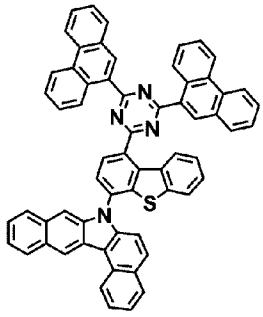


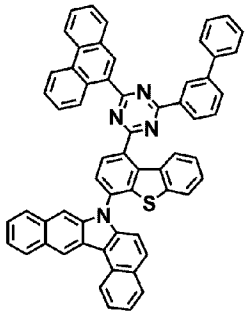


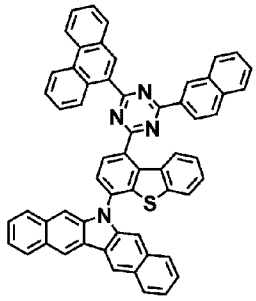










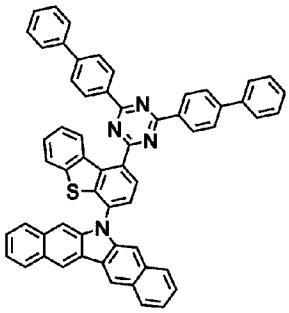










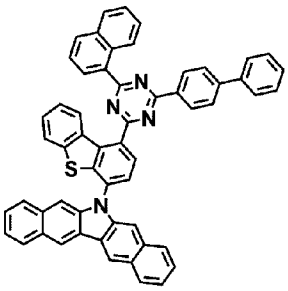













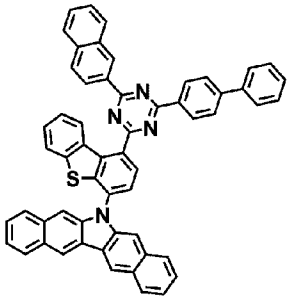


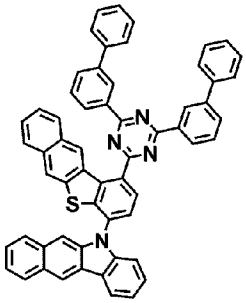


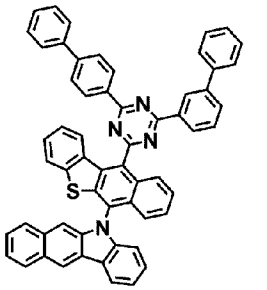


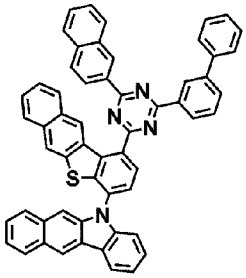


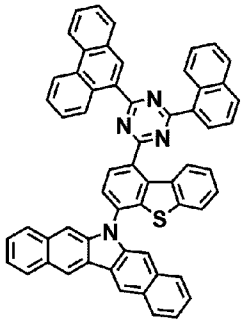


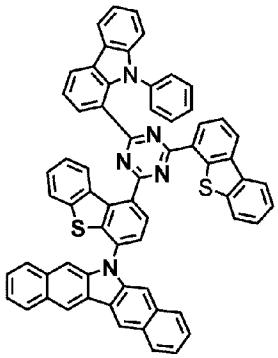


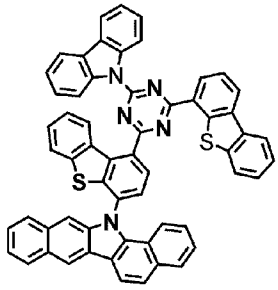


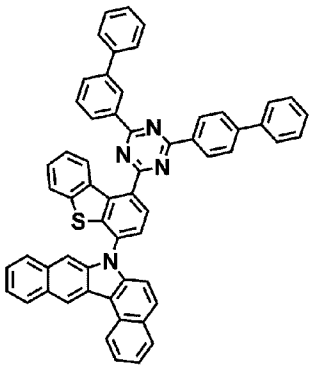


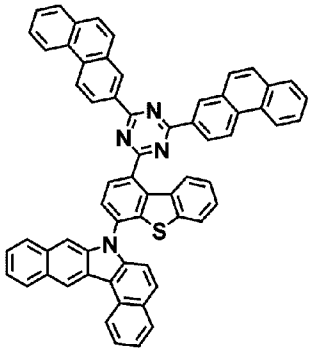


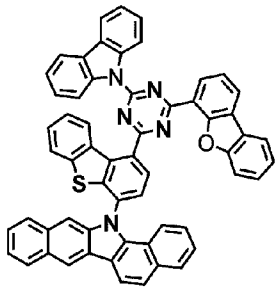


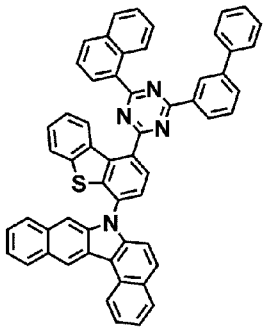


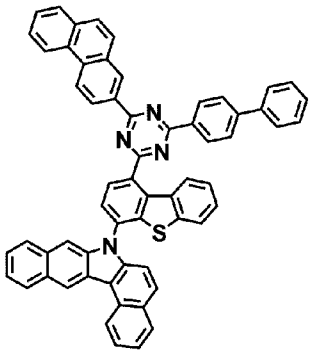


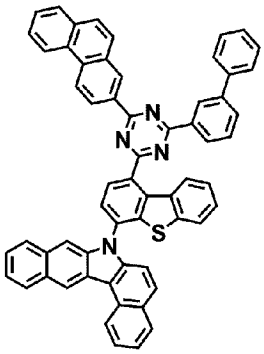


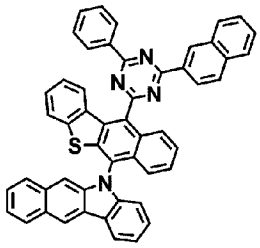


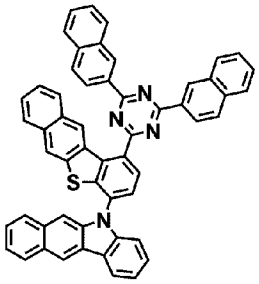


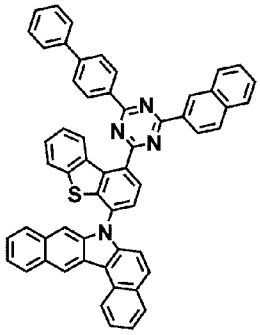


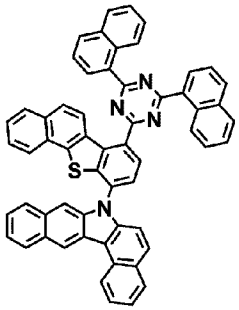


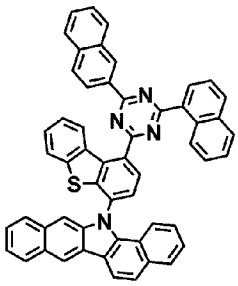


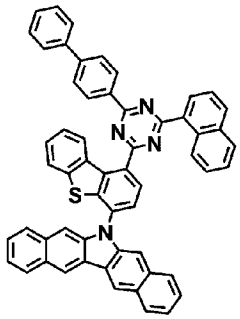


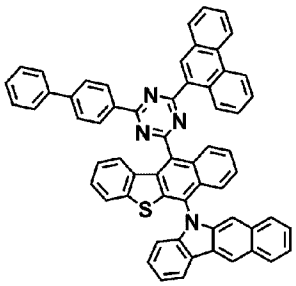


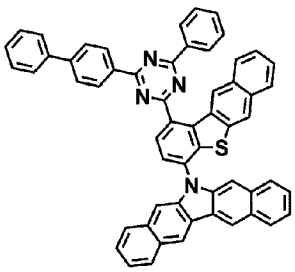


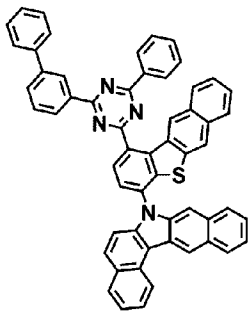


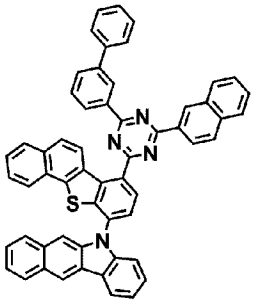


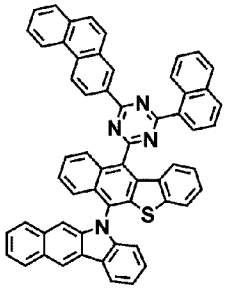


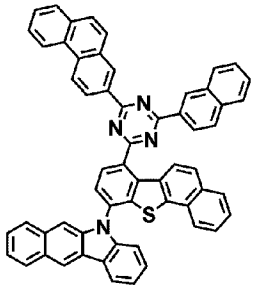


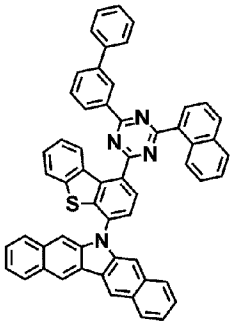


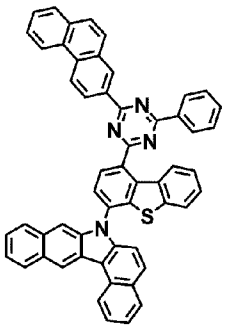


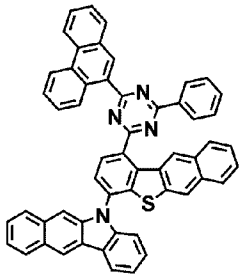


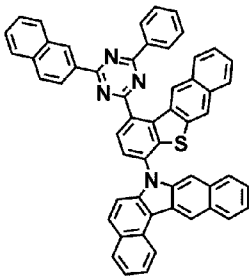


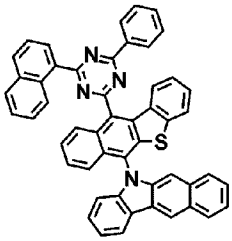


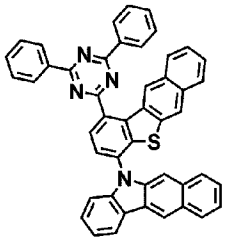


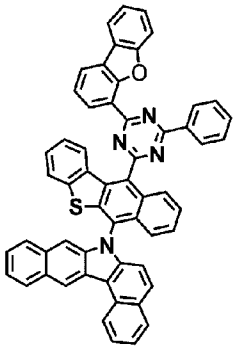


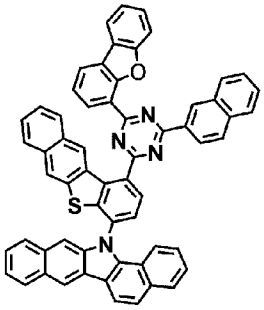


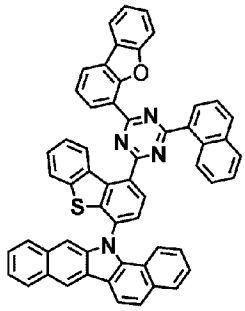


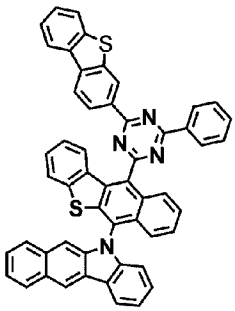


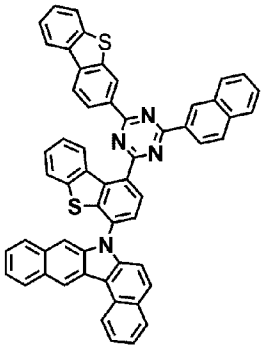


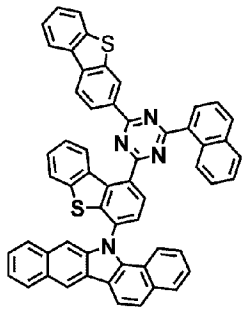


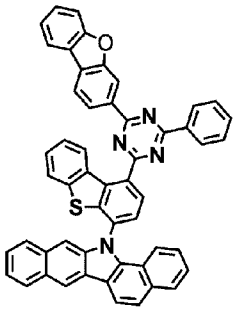


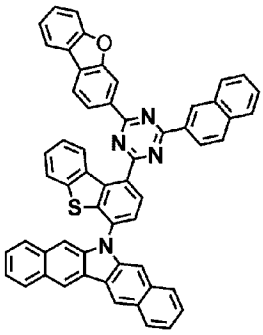


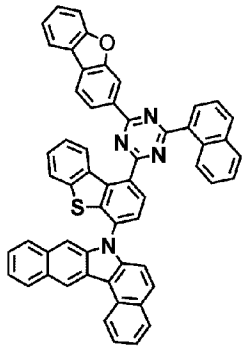


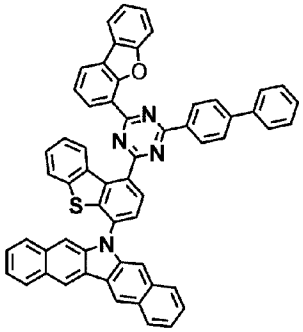


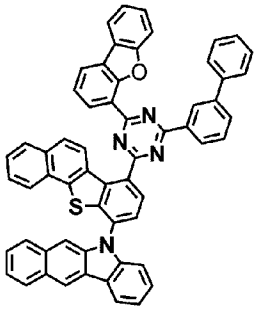


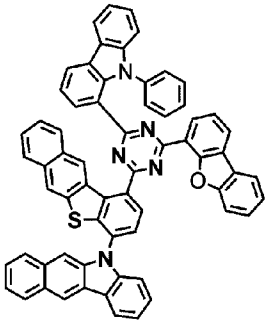


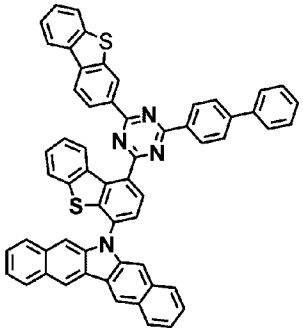


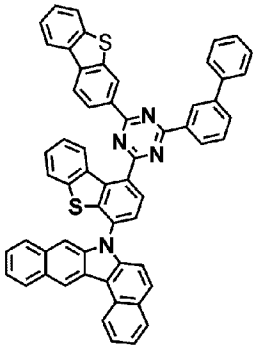


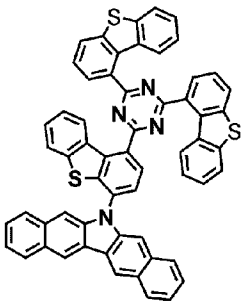


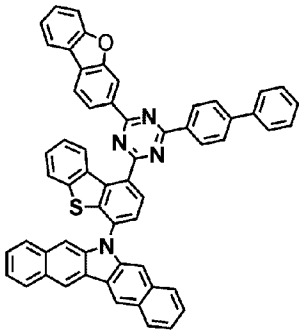


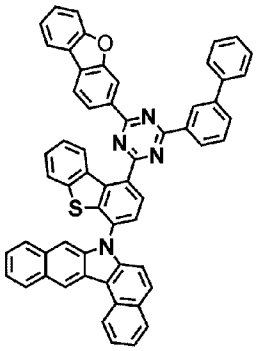


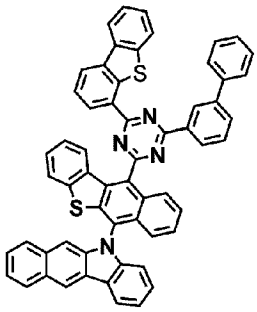


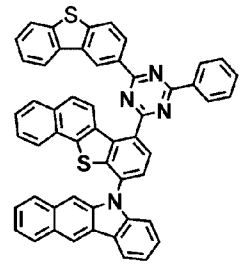
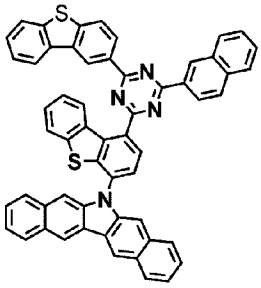
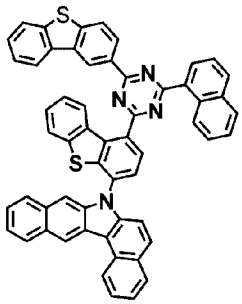
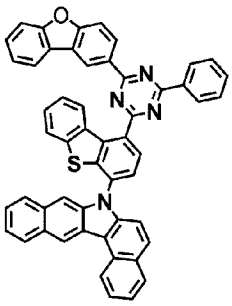
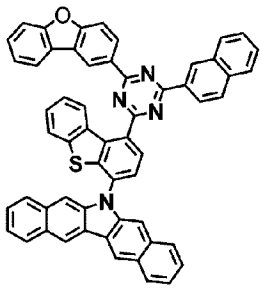
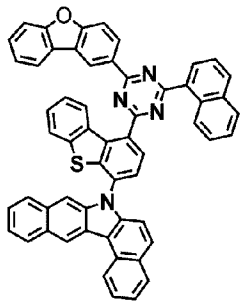
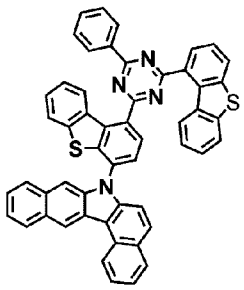
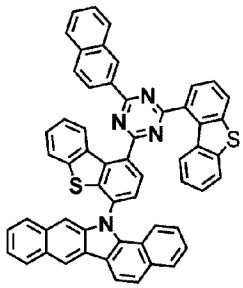
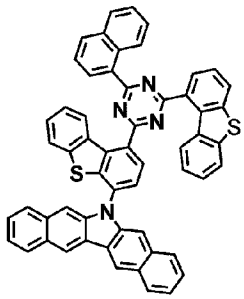
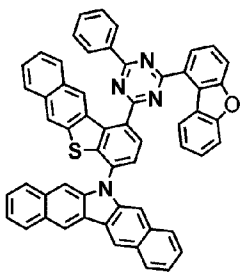
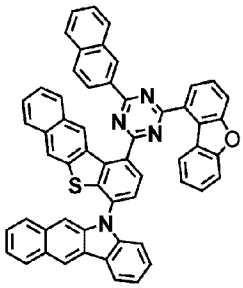
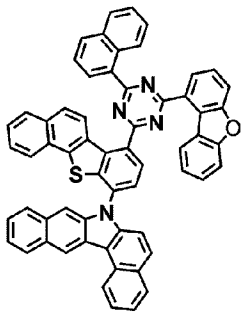


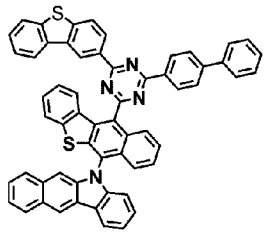
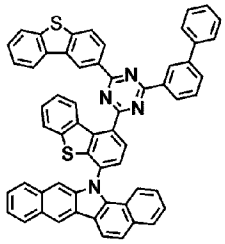
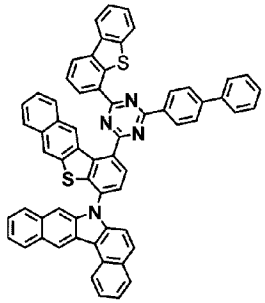
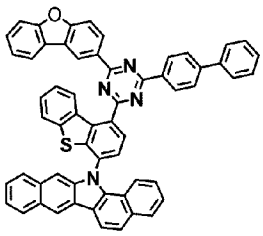
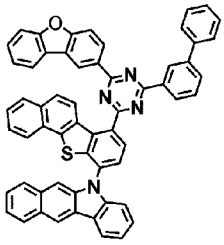
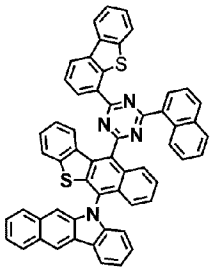
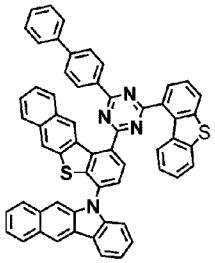
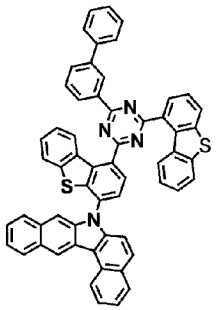
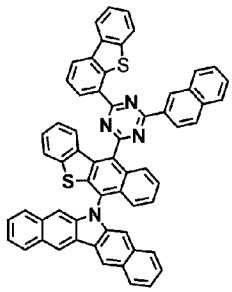
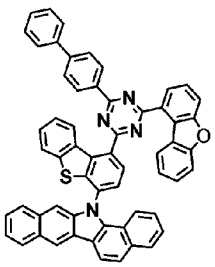
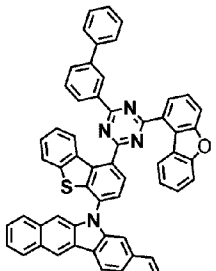
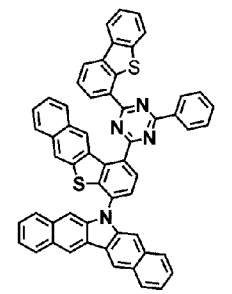


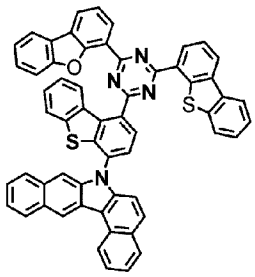


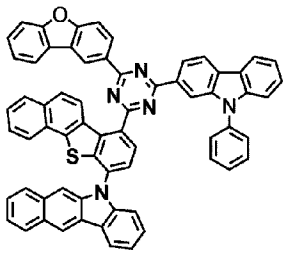


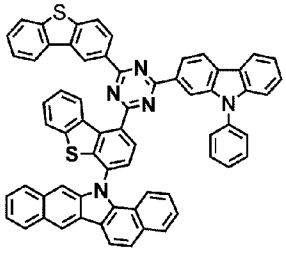


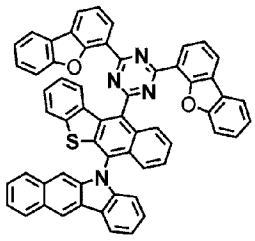













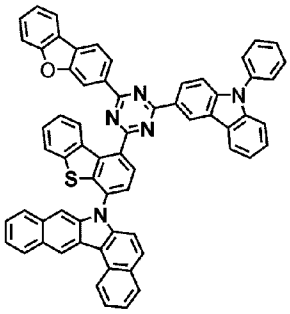













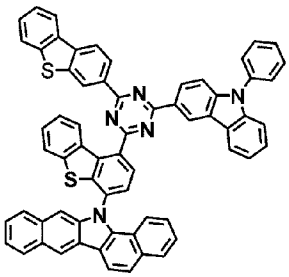


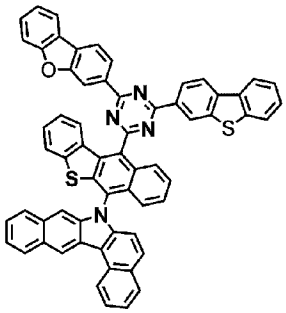


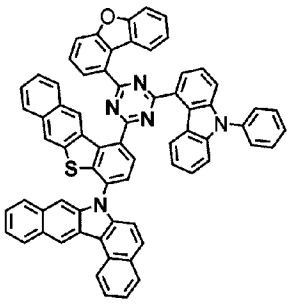


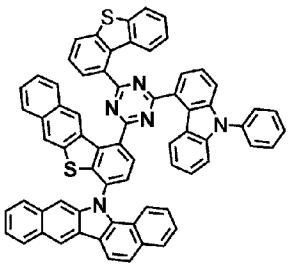


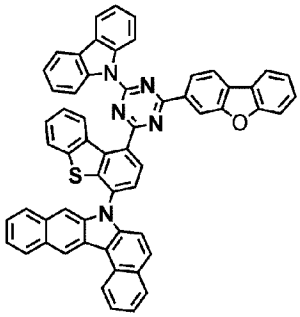


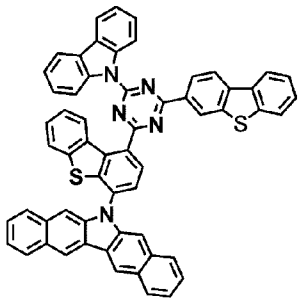


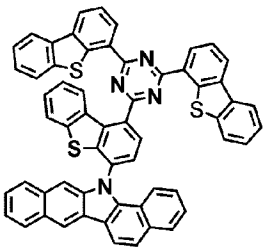


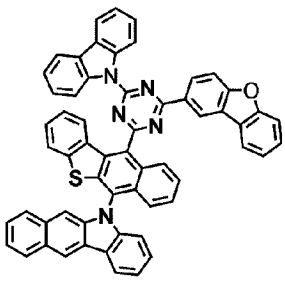


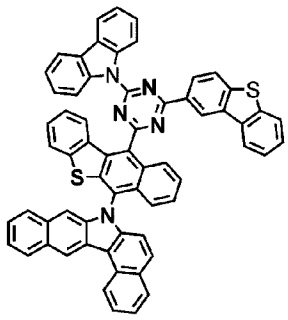


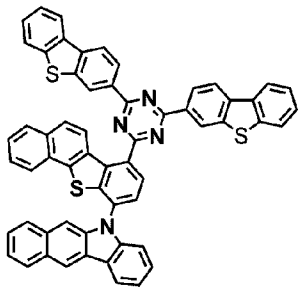


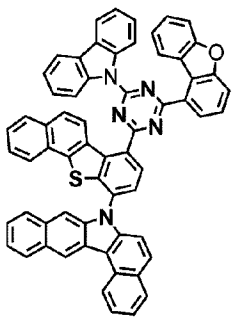


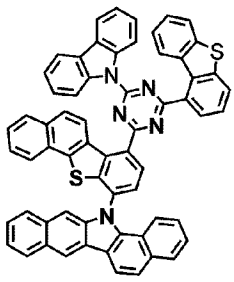


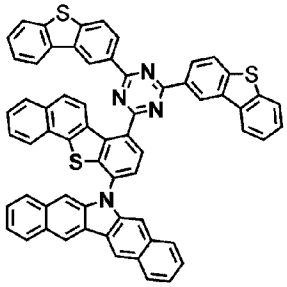


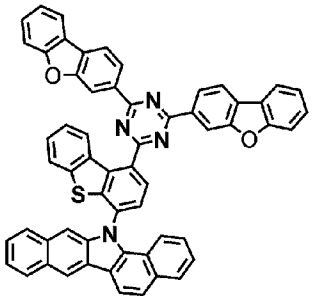


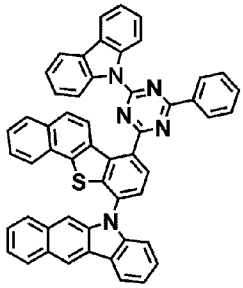


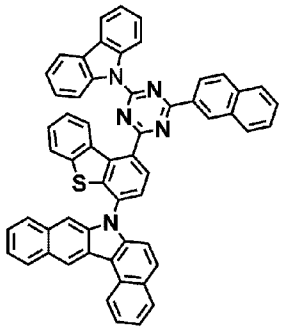


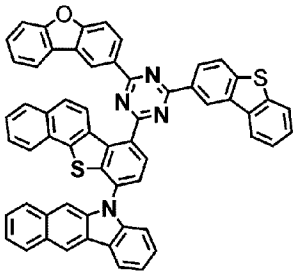


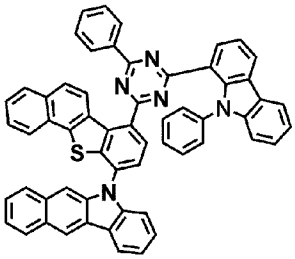


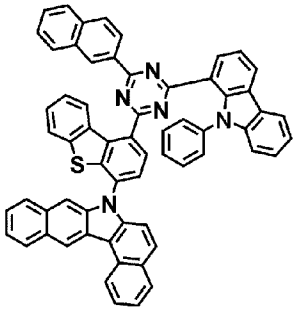


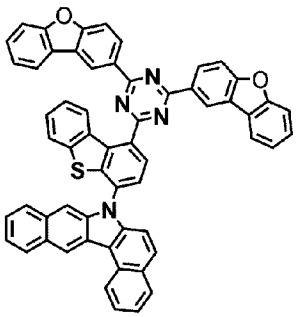


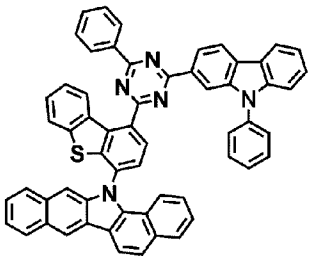


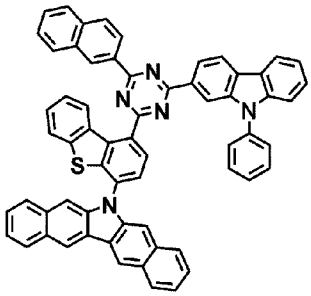


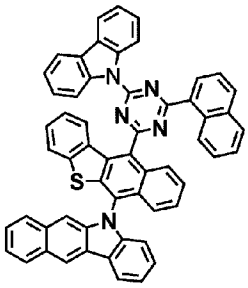
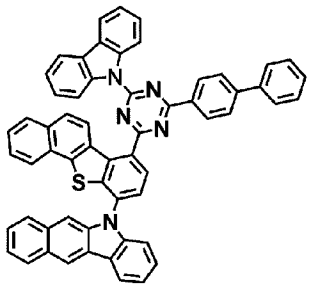
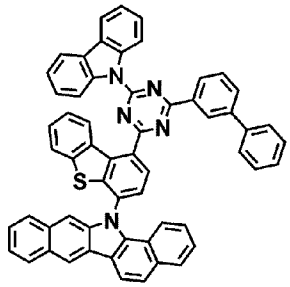
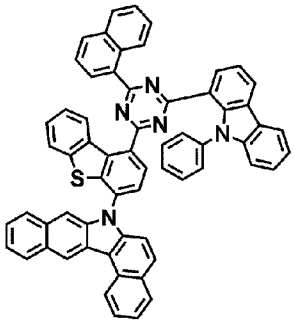
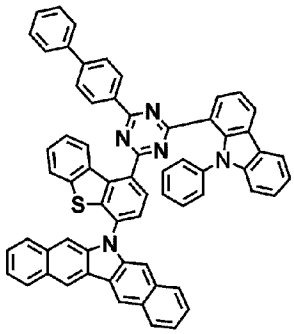
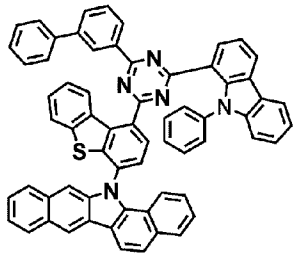
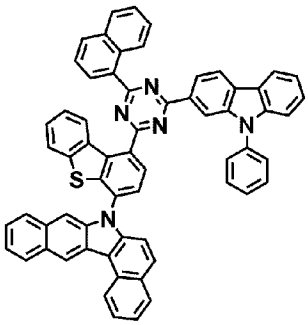
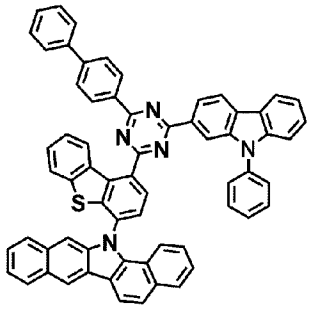
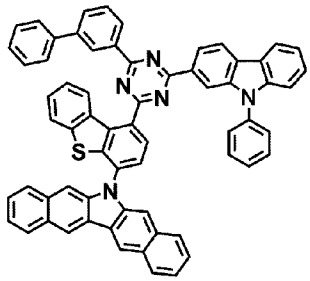


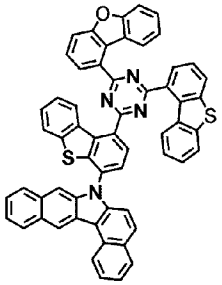
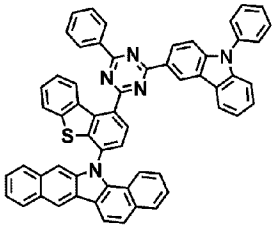
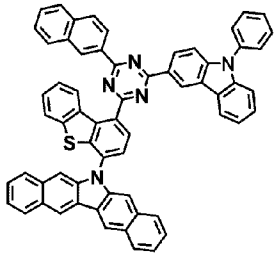
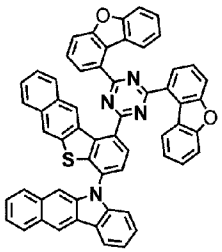
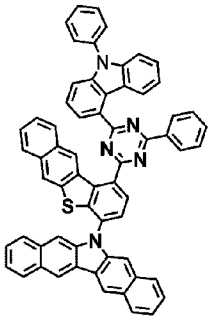
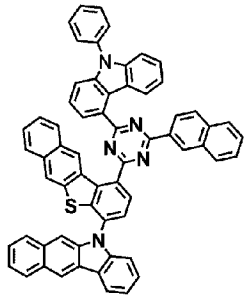
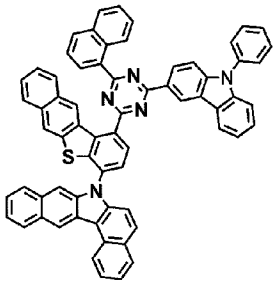
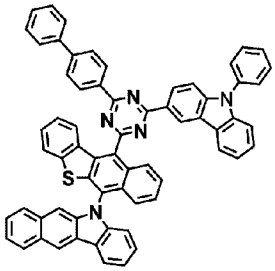
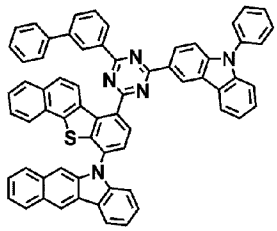
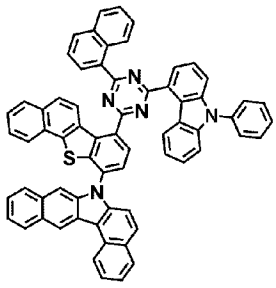
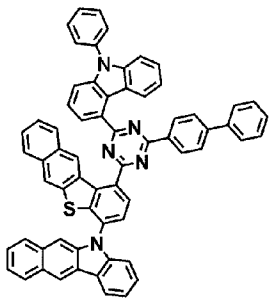
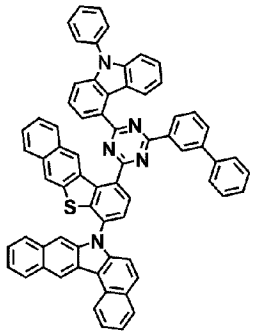


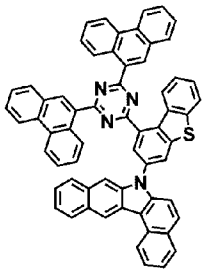
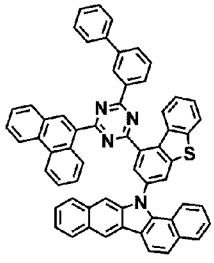
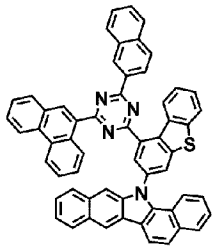
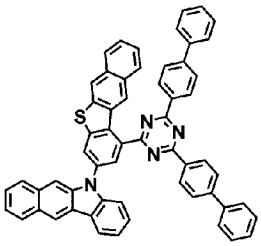
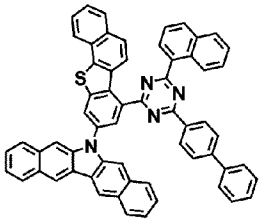
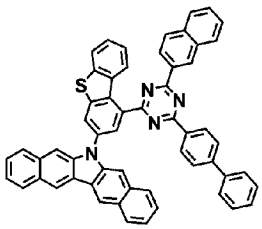
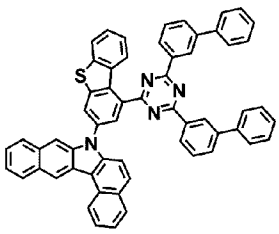
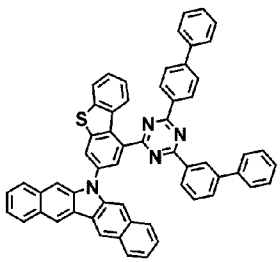
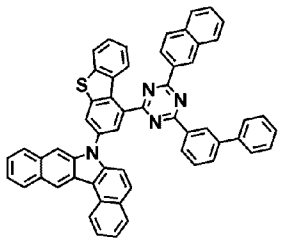


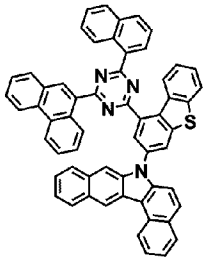


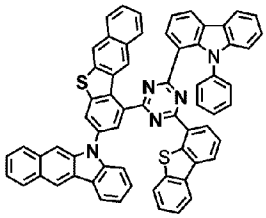


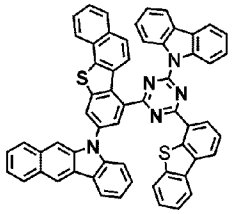










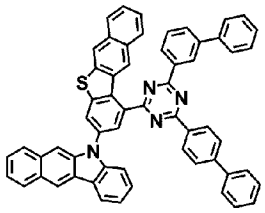













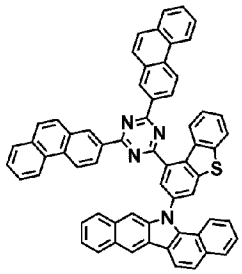










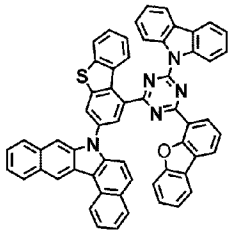


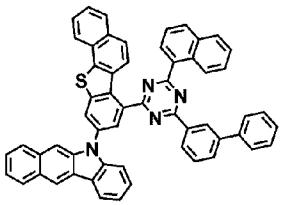


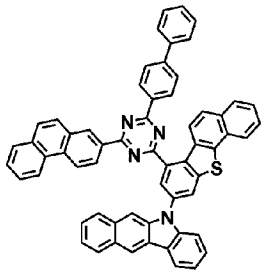


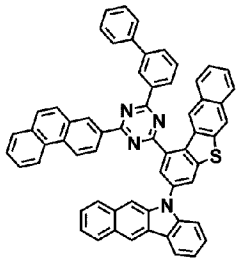


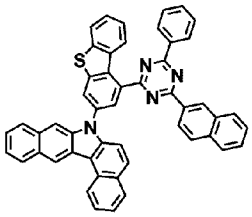
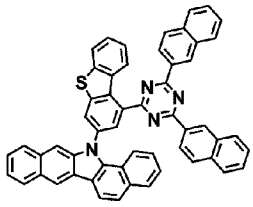
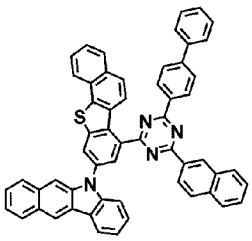
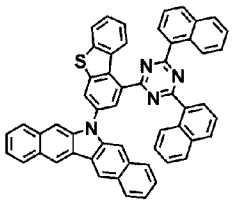
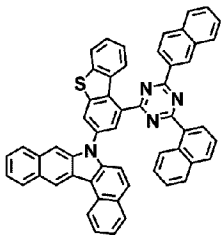
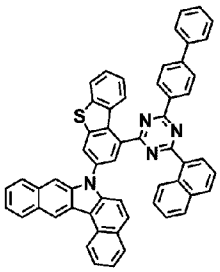
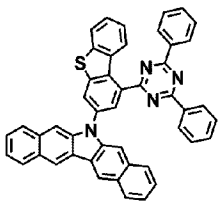
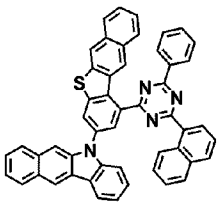
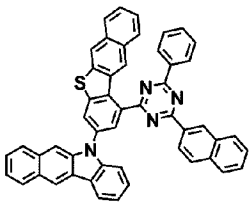


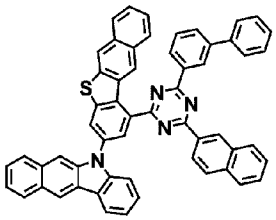


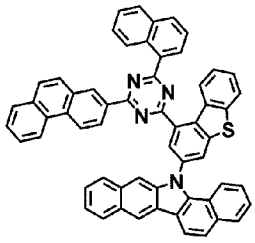


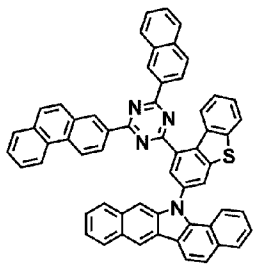


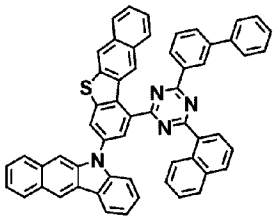


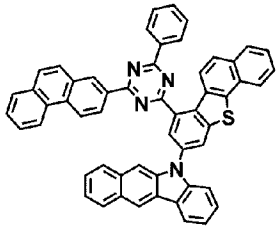










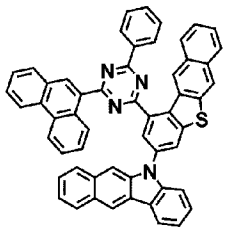


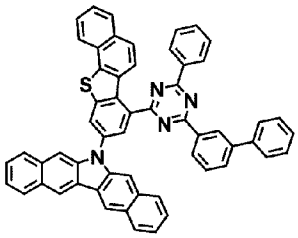


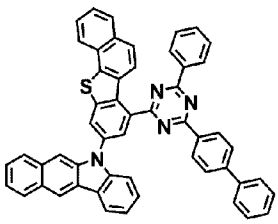


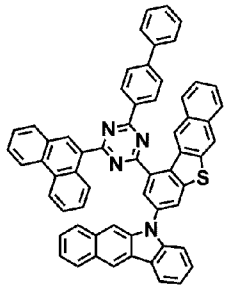


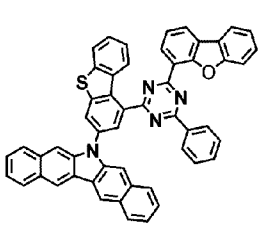
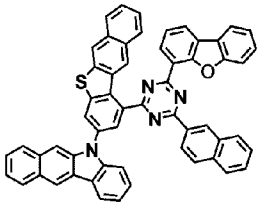
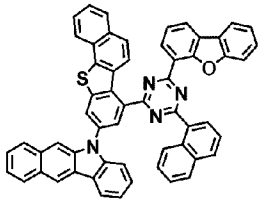
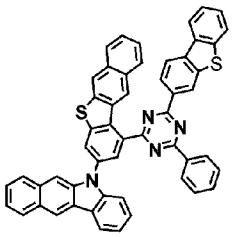
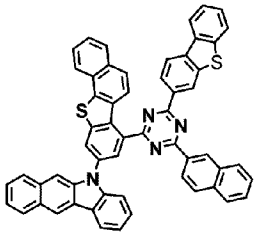
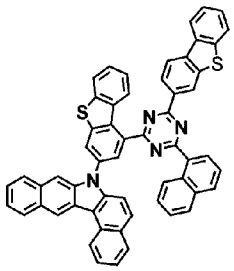
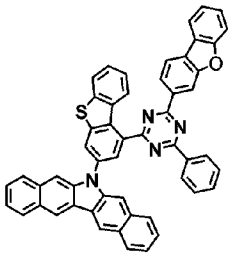
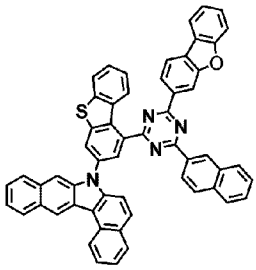
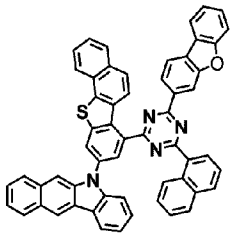


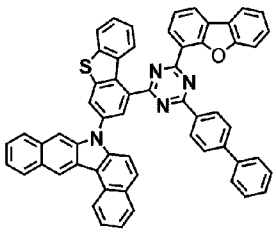


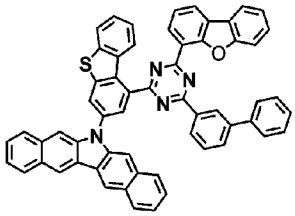


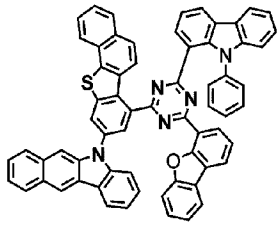


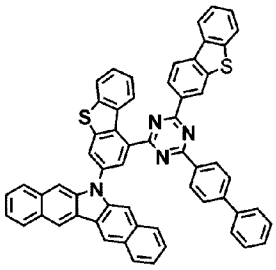


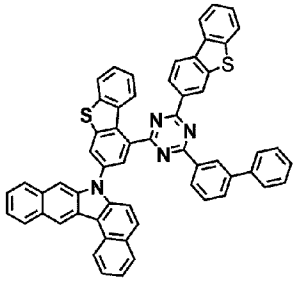










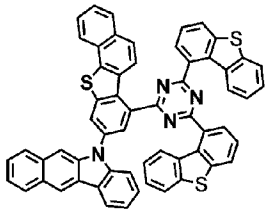


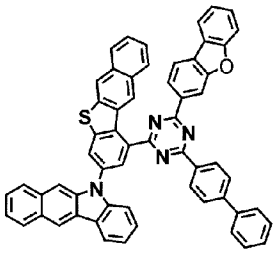


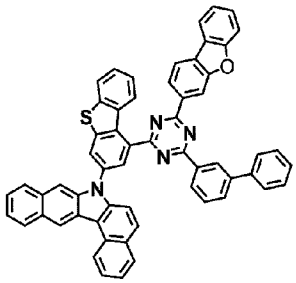


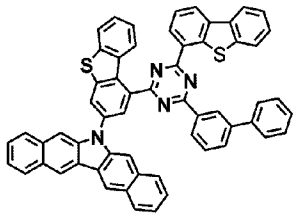


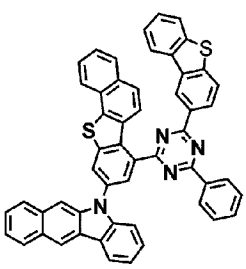
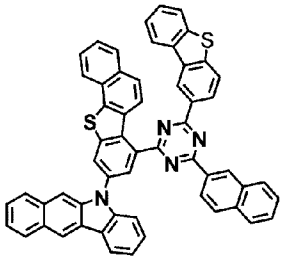
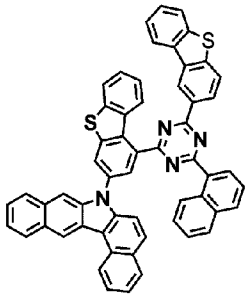
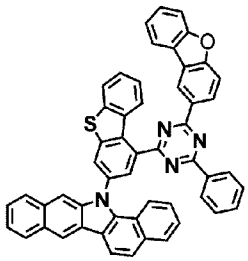
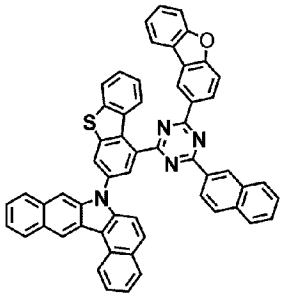
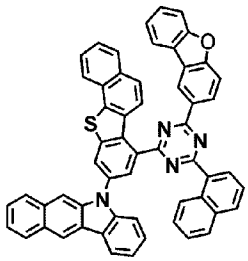
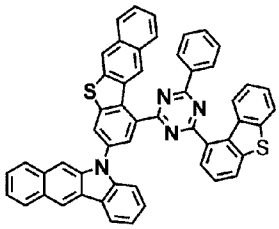
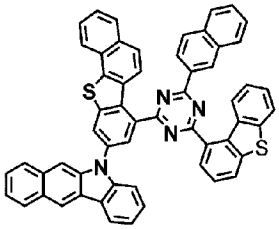
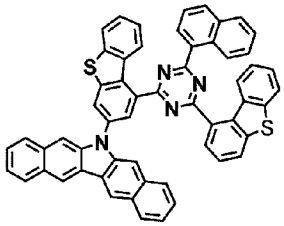
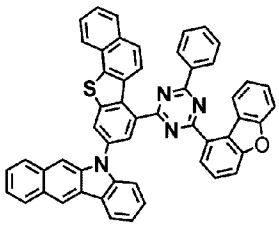
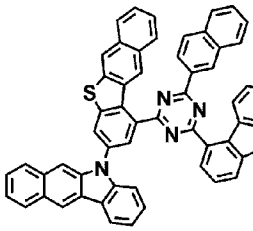
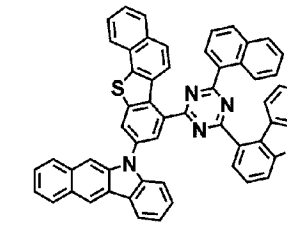


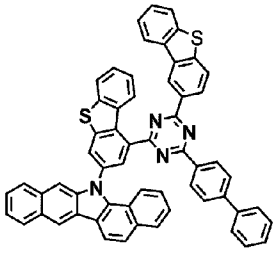
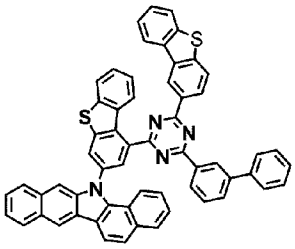
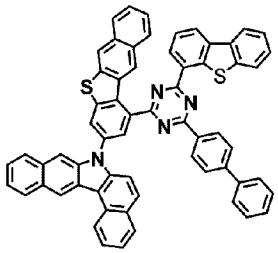
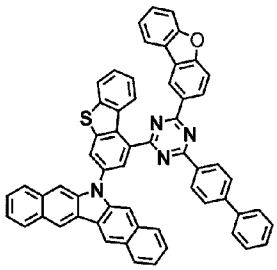
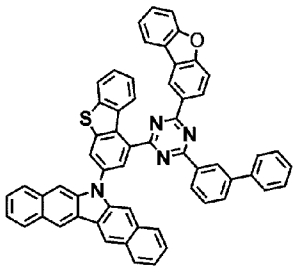
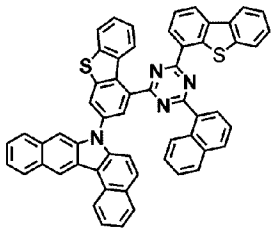
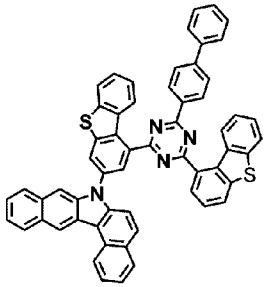
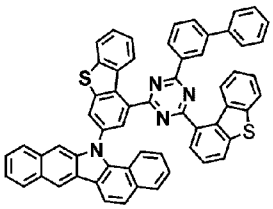
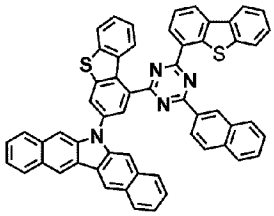
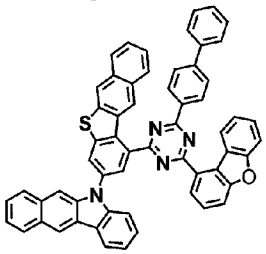
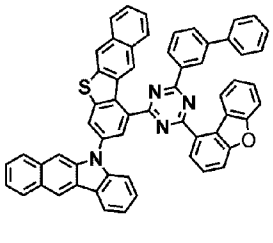
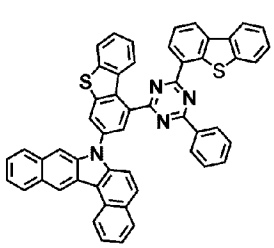


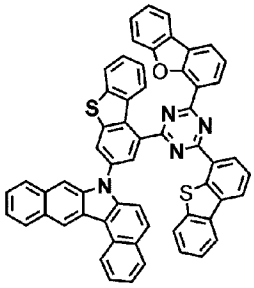


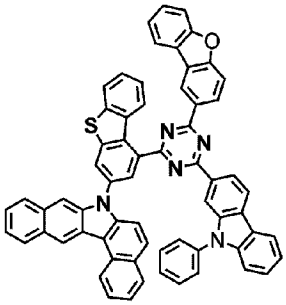


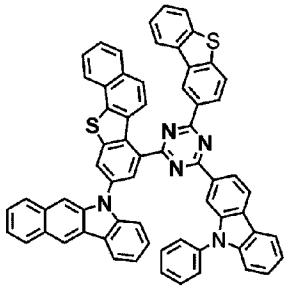


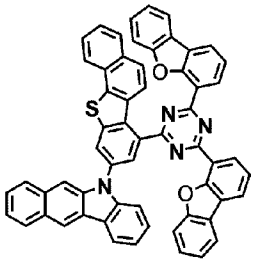













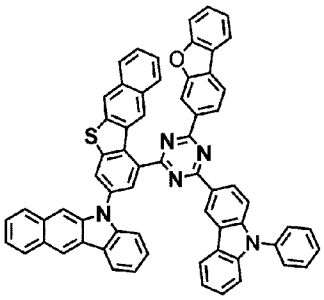













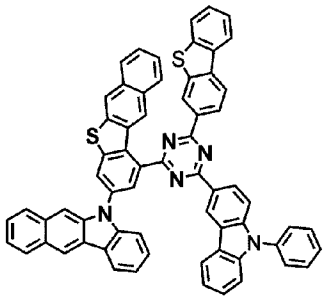


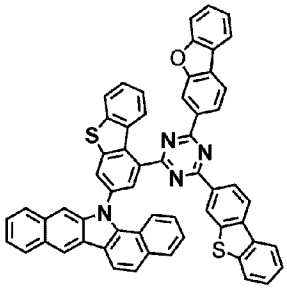


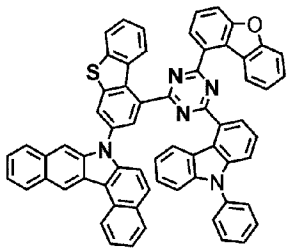


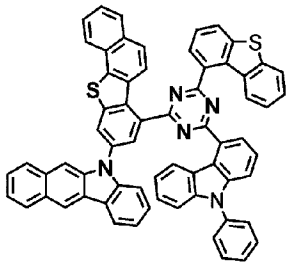


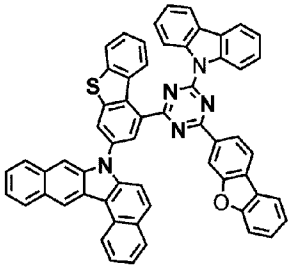


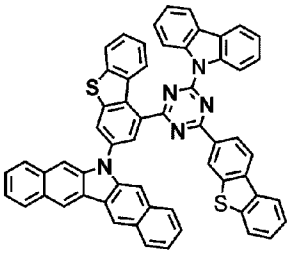


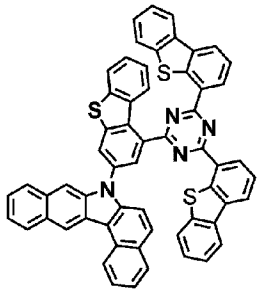


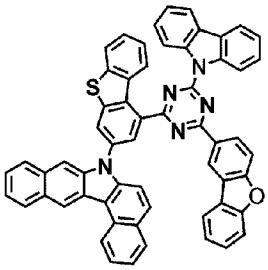


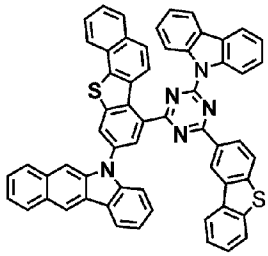


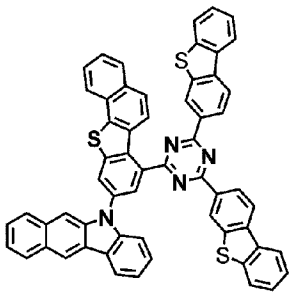


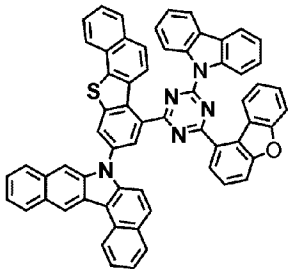


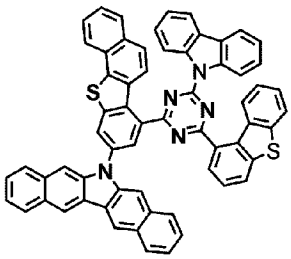


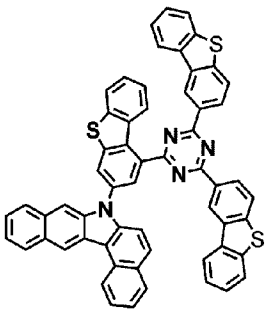


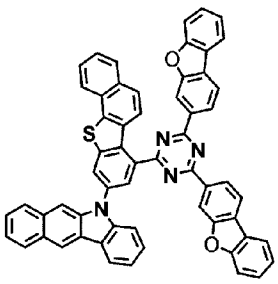
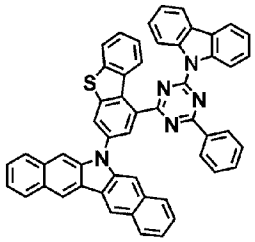
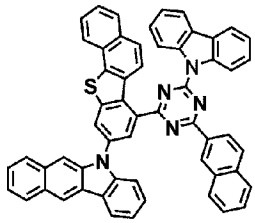
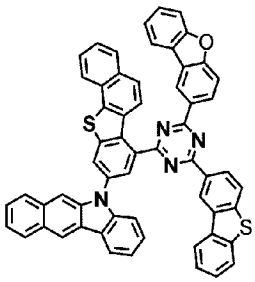
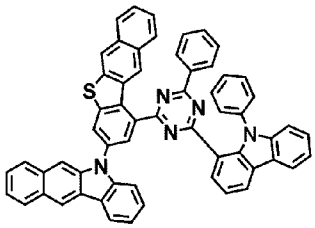
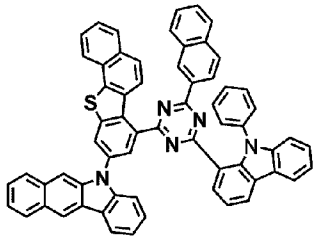
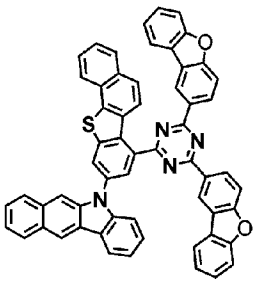
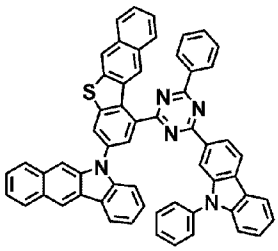
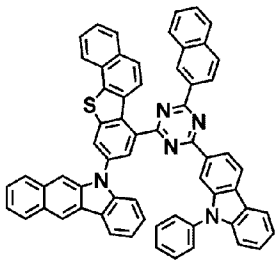


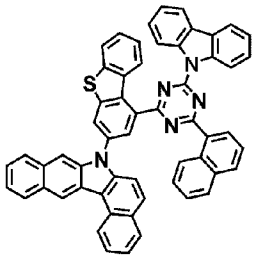
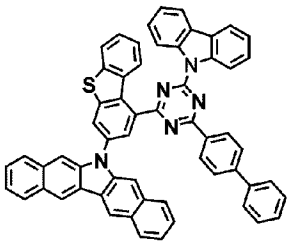
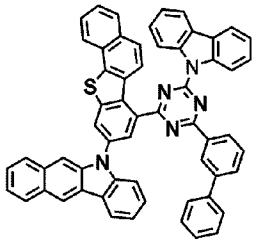
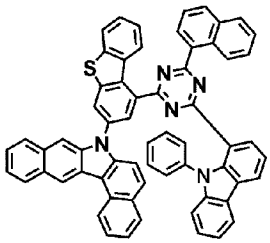
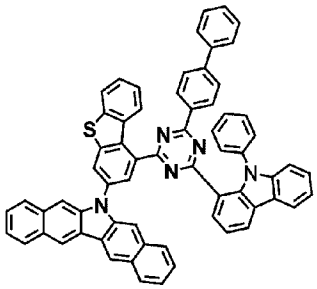
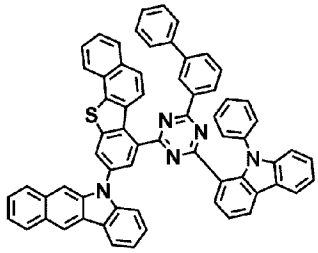
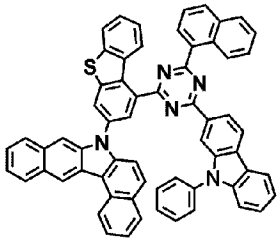
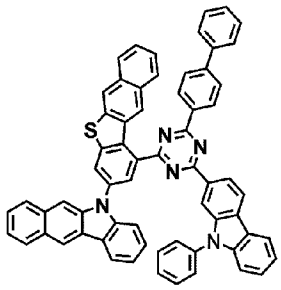
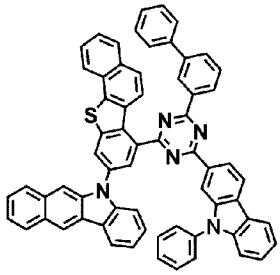


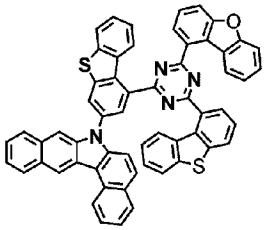
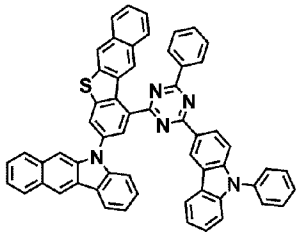
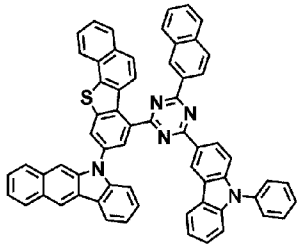
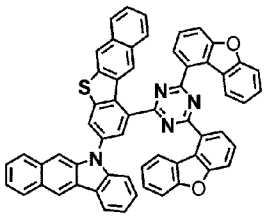
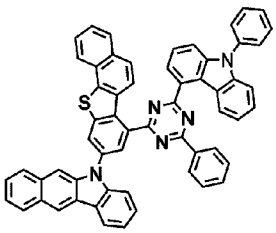
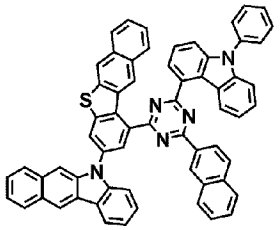
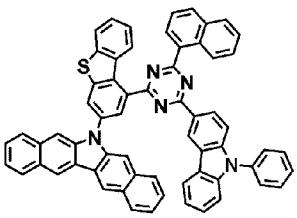
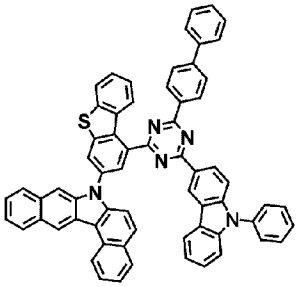
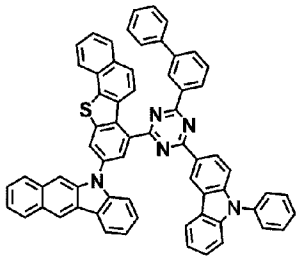
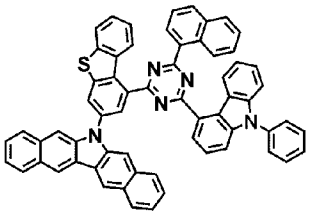
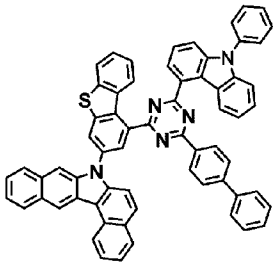
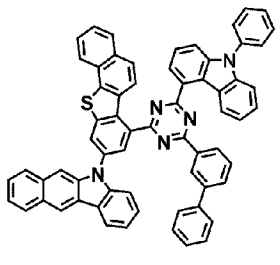


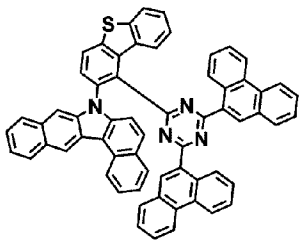


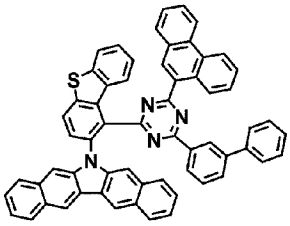


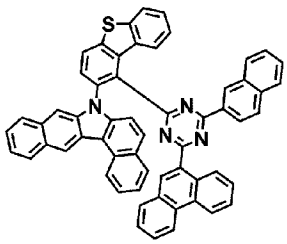










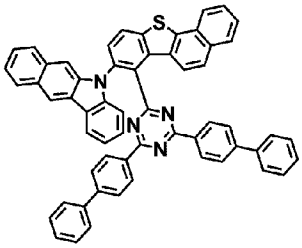










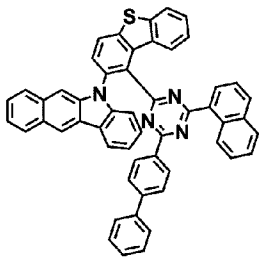













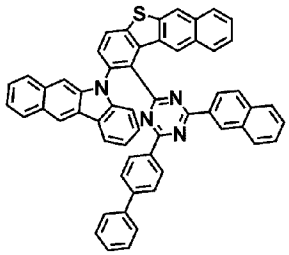


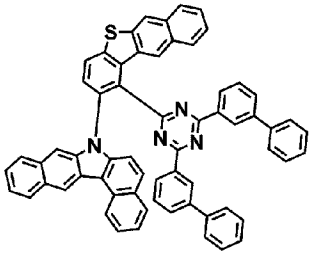


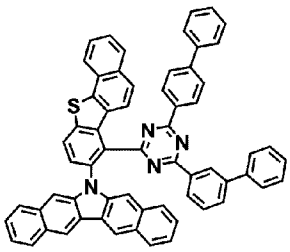


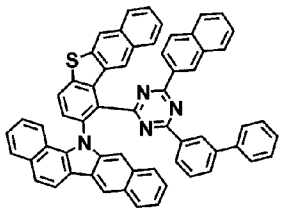


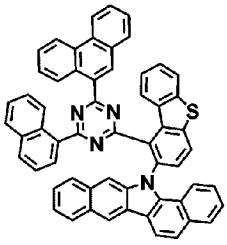
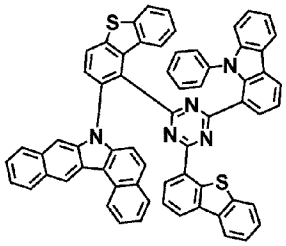
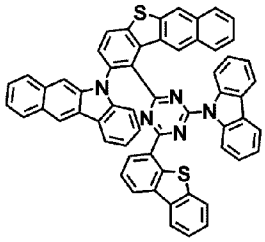
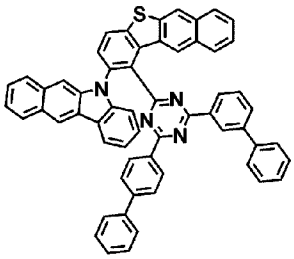
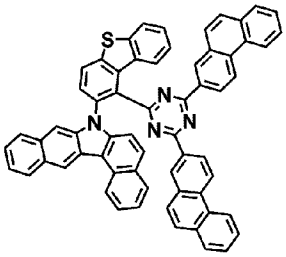
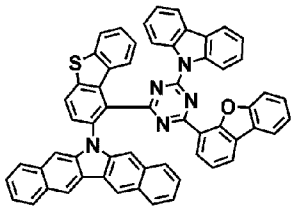
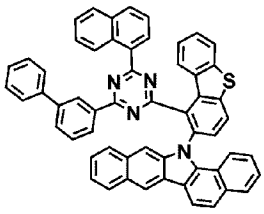
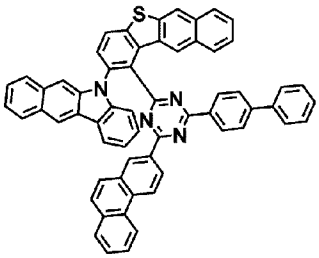
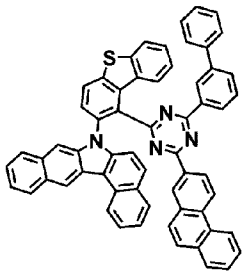


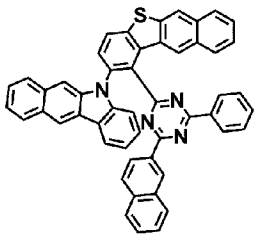
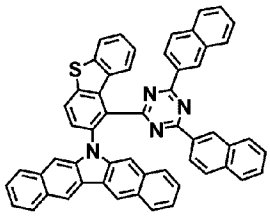
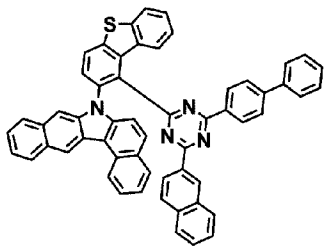
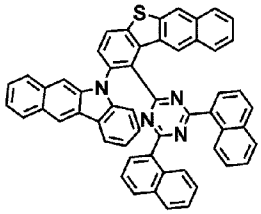
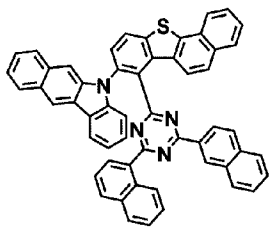
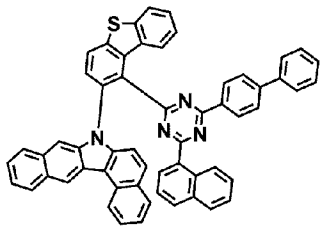
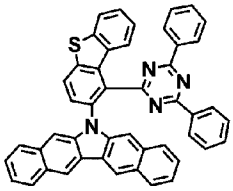
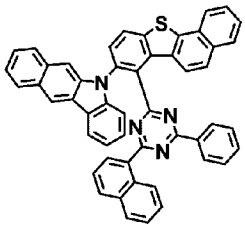
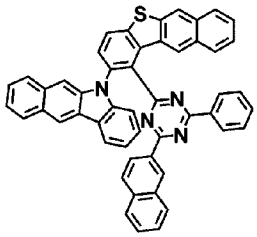
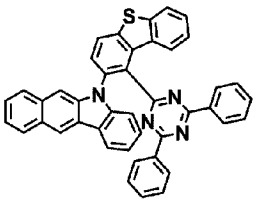
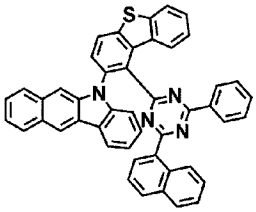
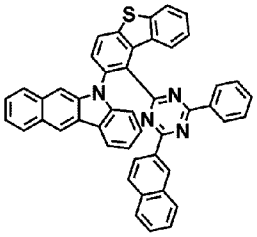


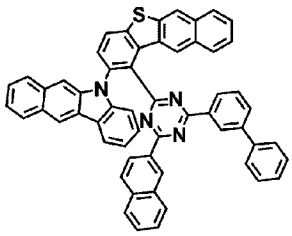
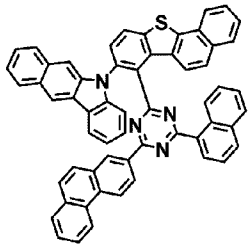
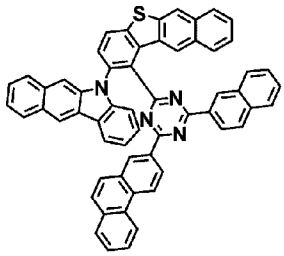
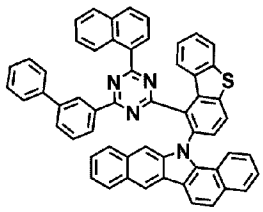
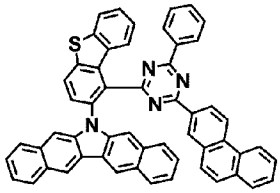
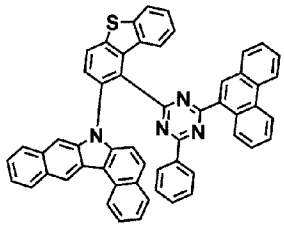
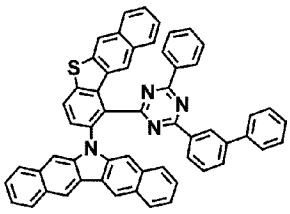
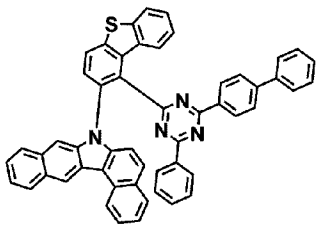
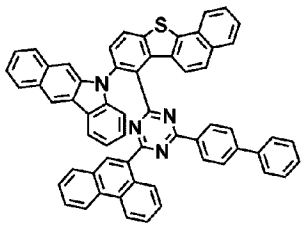
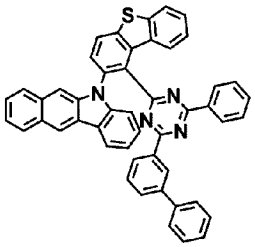
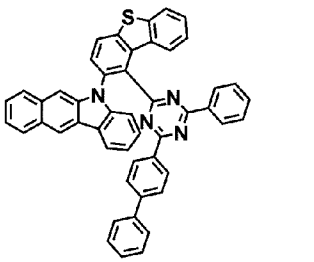
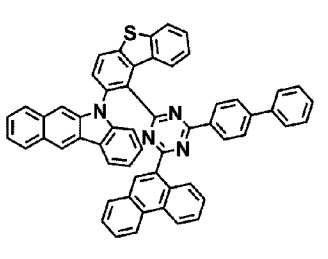


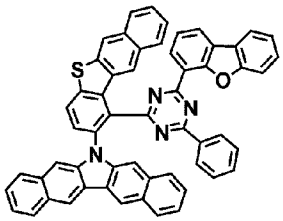


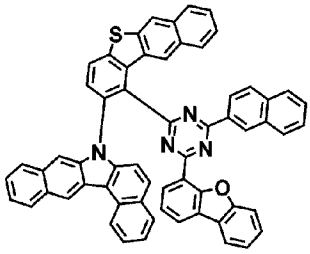


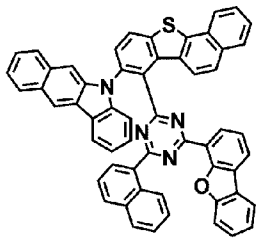










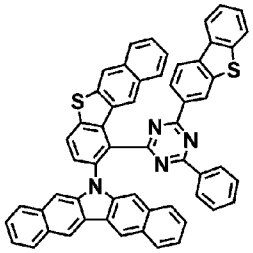













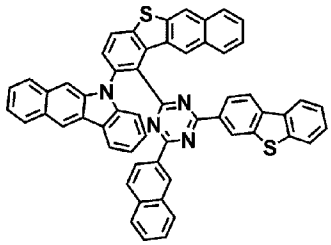













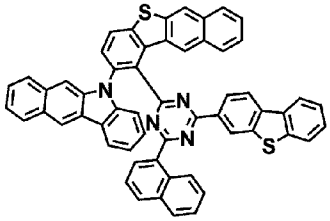


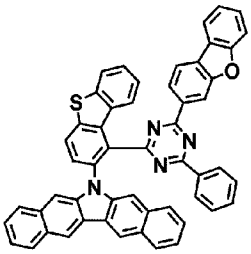


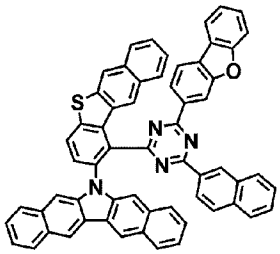


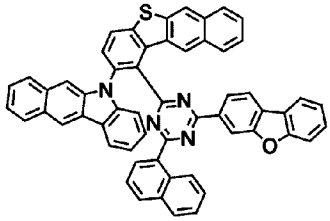


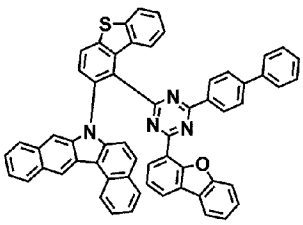


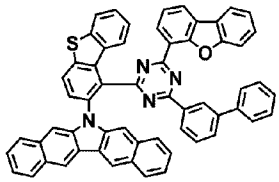


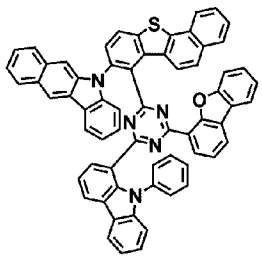


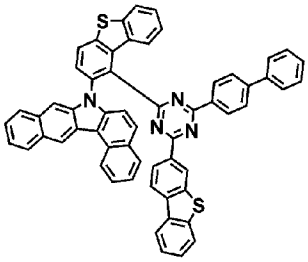


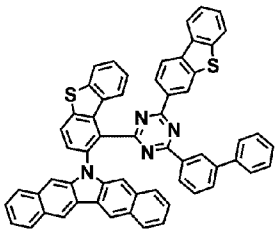


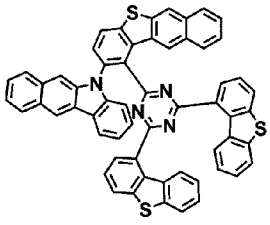


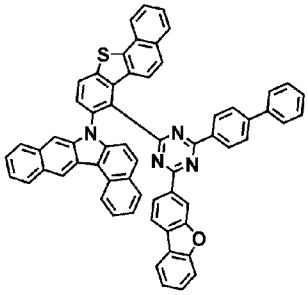


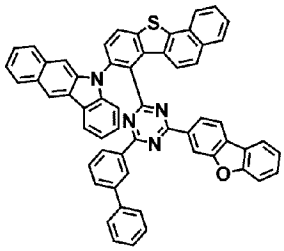


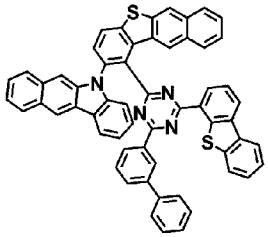


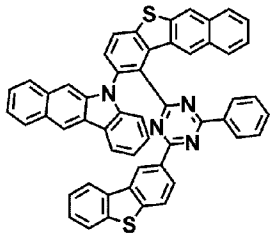
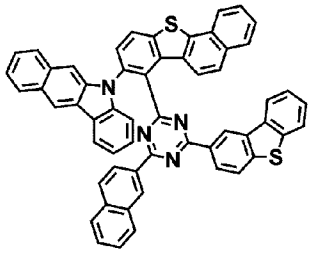
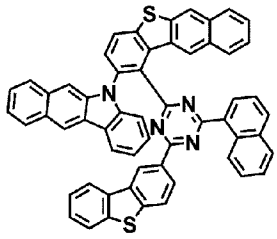
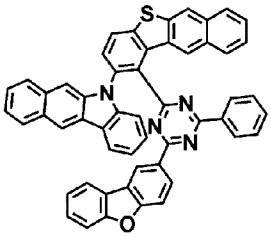
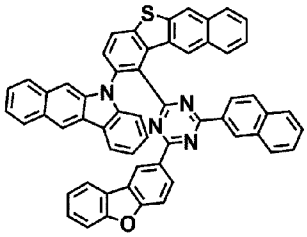
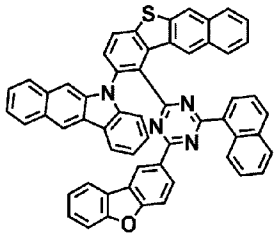
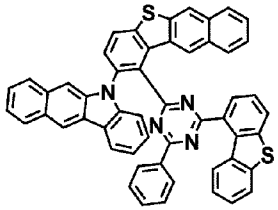
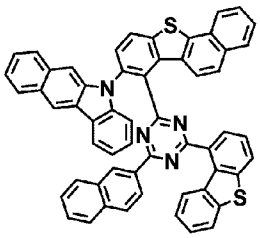
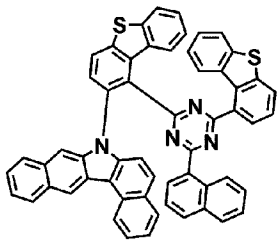
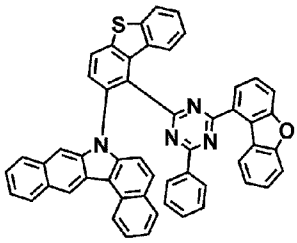
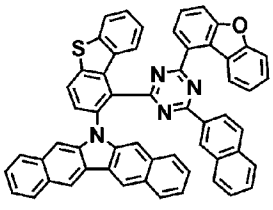
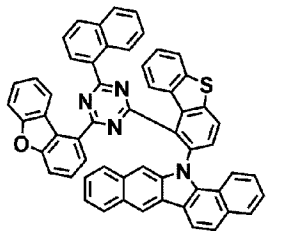


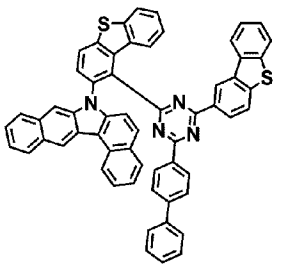
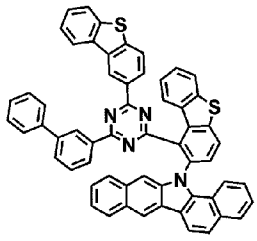
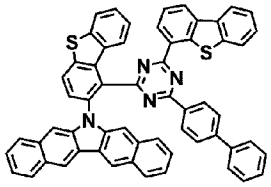
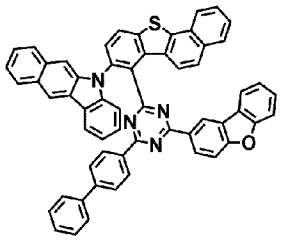
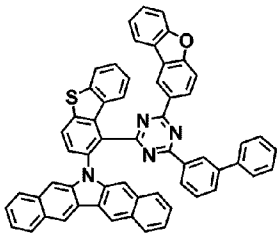
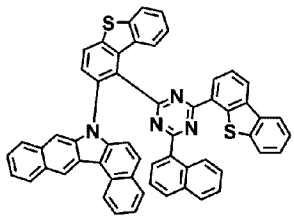
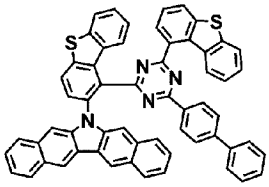
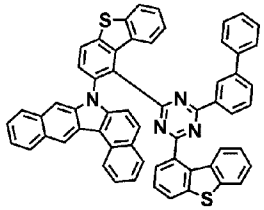
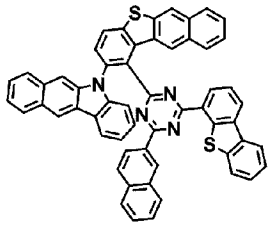
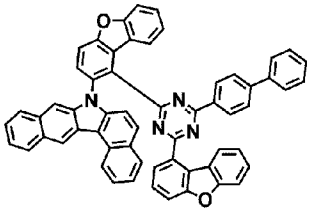
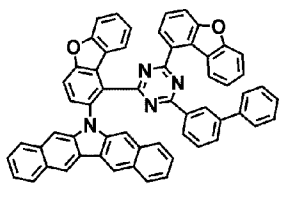
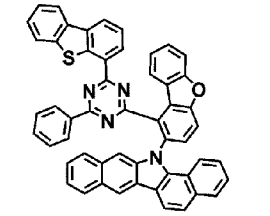


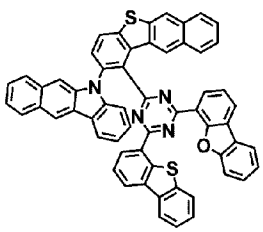


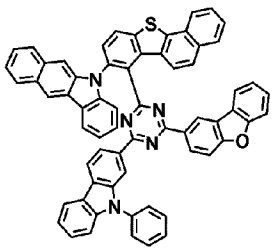


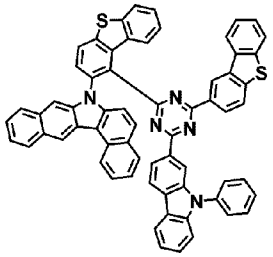


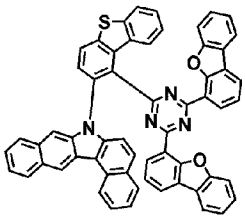













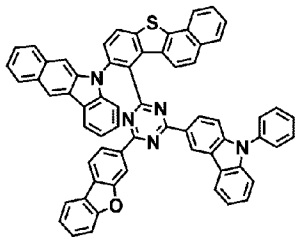













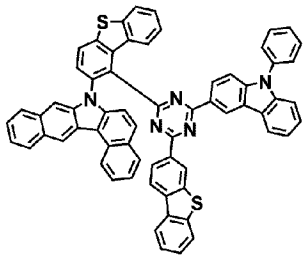


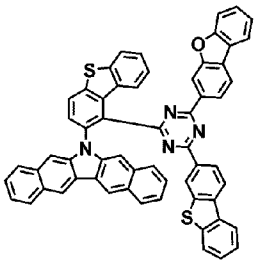


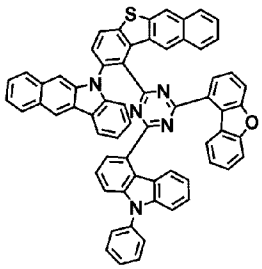


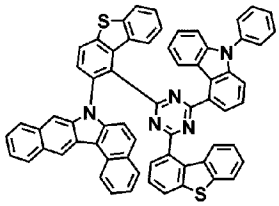


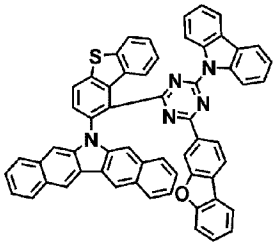


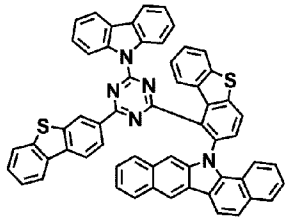


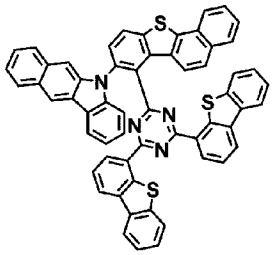


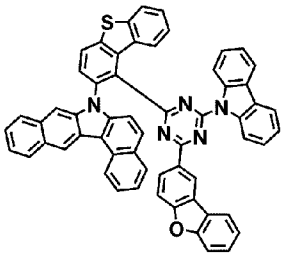


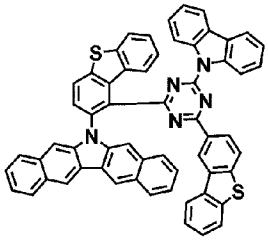


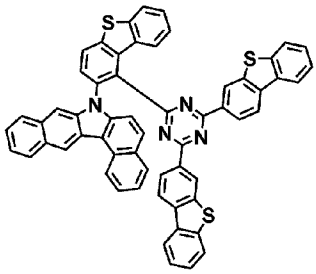


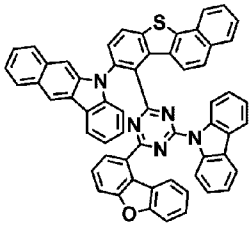


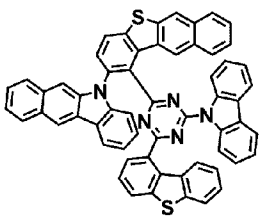


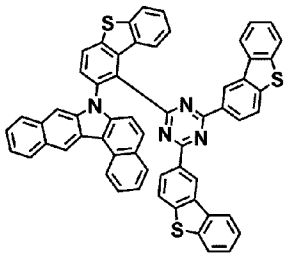


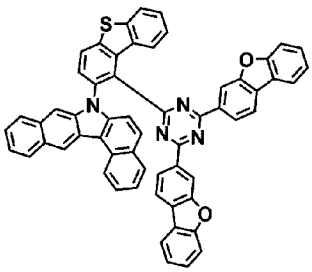


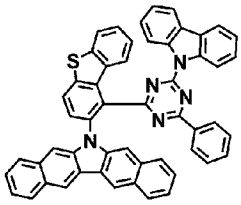


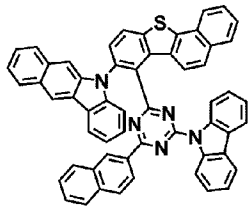


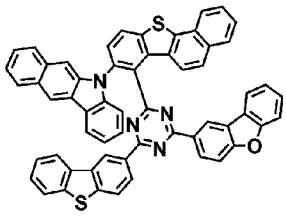


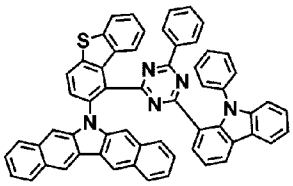


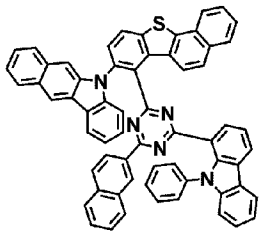


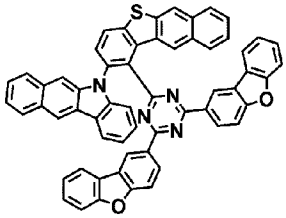


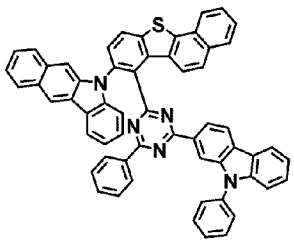


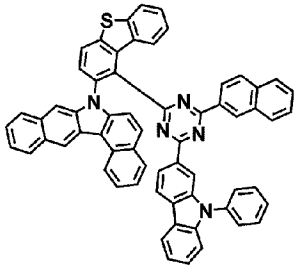


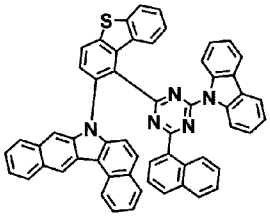
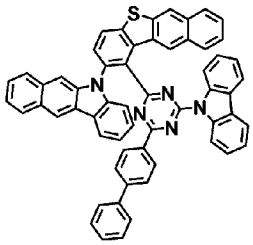
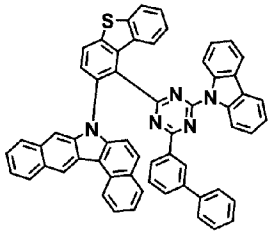
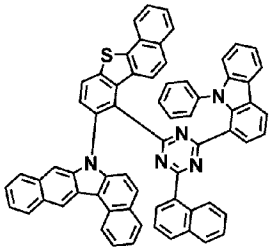
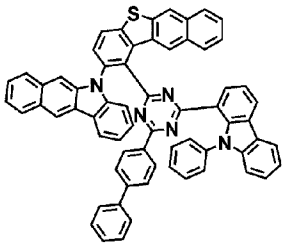
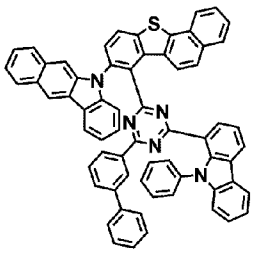
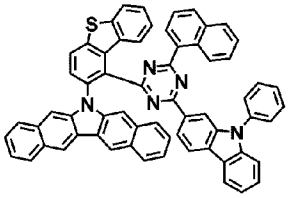
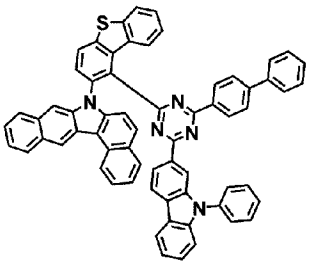
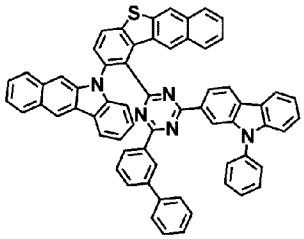


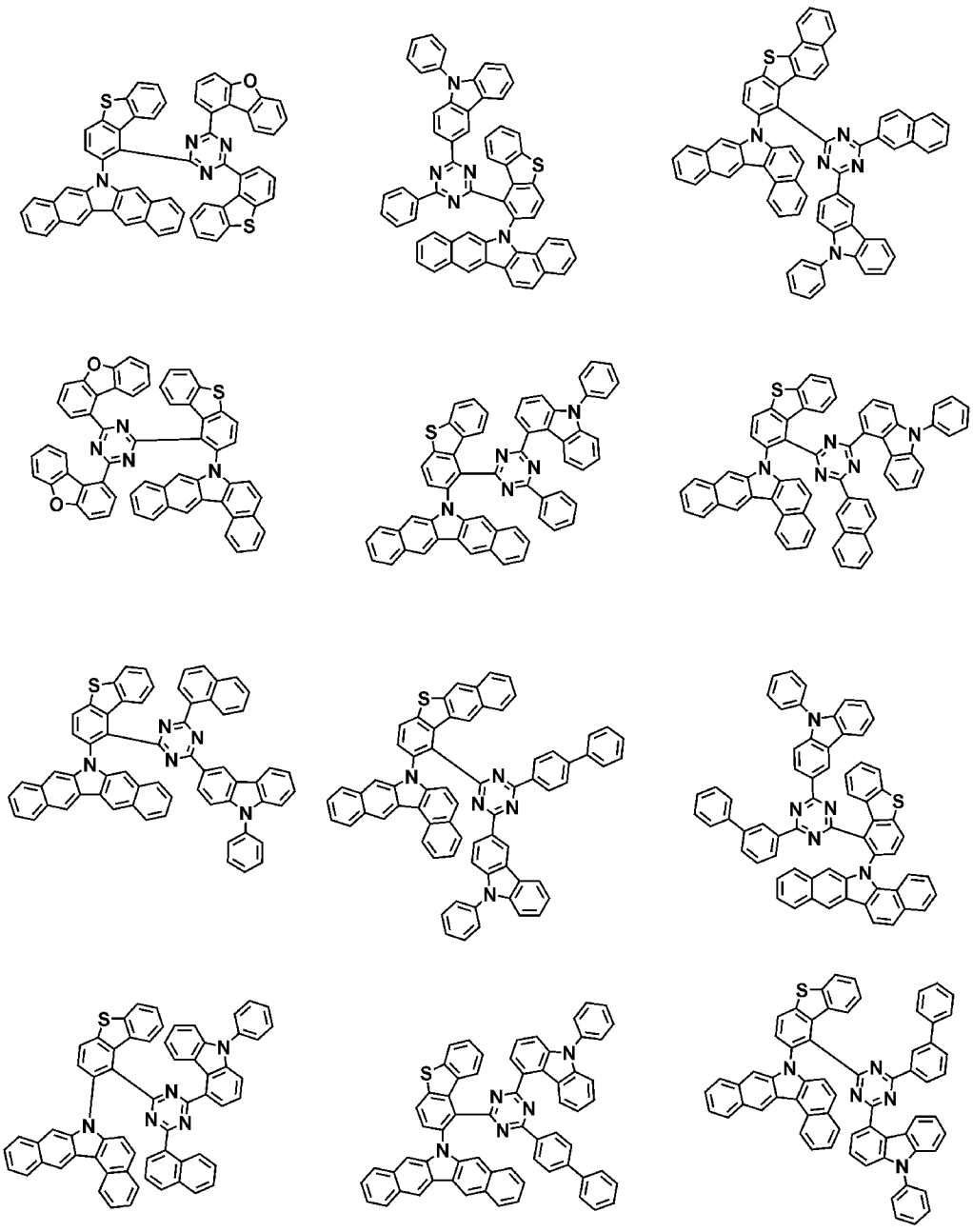






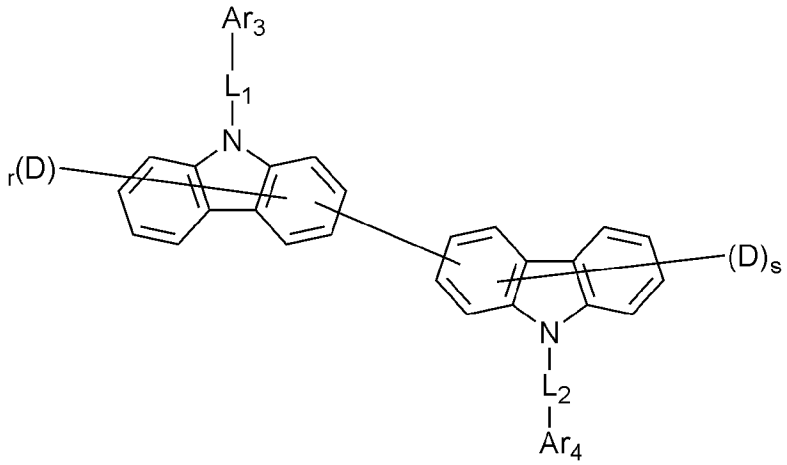




.

[청구항 7] 제1항에 있어서,
상기 제2 화합물은 하기 화학식 2-1로 표시되는,
유기 발광 소자:
[화학식 2-1]



상기 화학식 2-1에서,

D는 중수소를 의미하고,

r 및 s는 각각 독립적으로, 0 내지 7의 정수이고,

L_1, L_2, Ar_3 및 Ar_4에 대한 설명은 제1항에서 정의한 바와 같다.

[청구항 8] 제1항에 있어서,

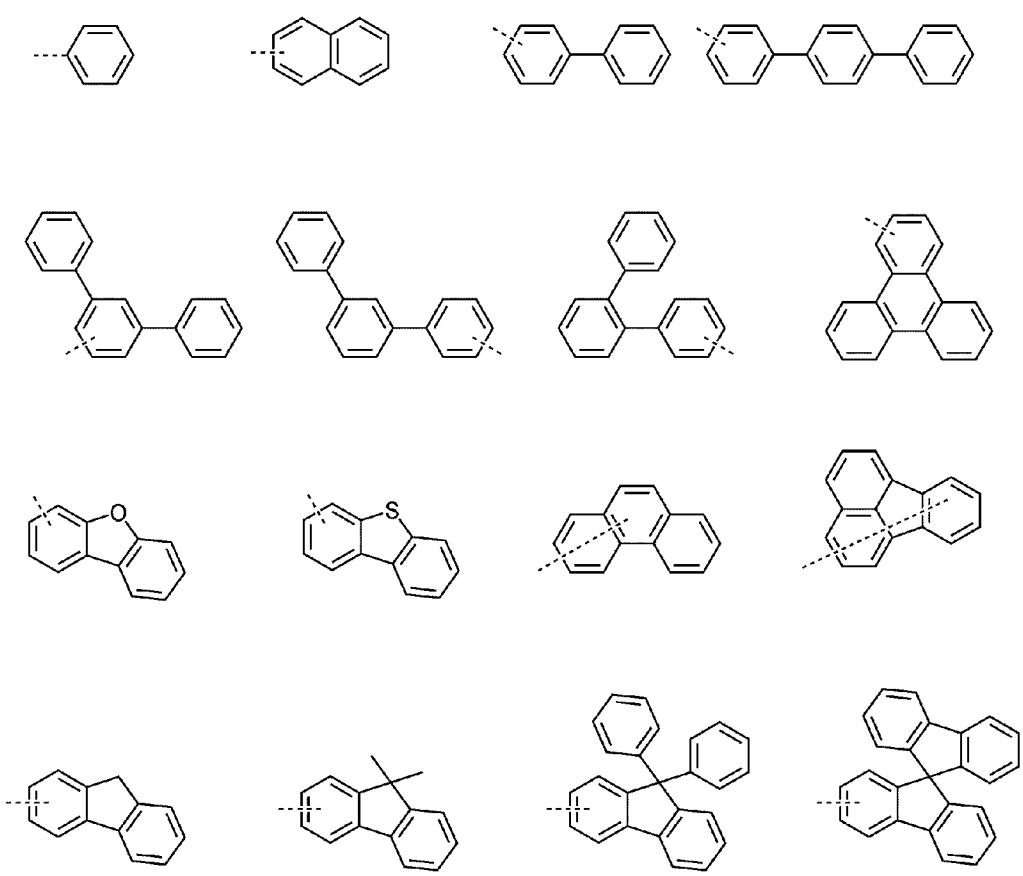
L_1 및 L_2는 각각 독립적으로, 단일 결합, 페닐렌, 또는 나프틸렌인,

유기 발광 소자.

[청구항 9] 제1항에 있어서,

Ar_3 및 Ar_4는 각각 독립적으로, 하기로 구성되는 군으로부터 선택되는 어느 하나인,

유기 발광 소자:



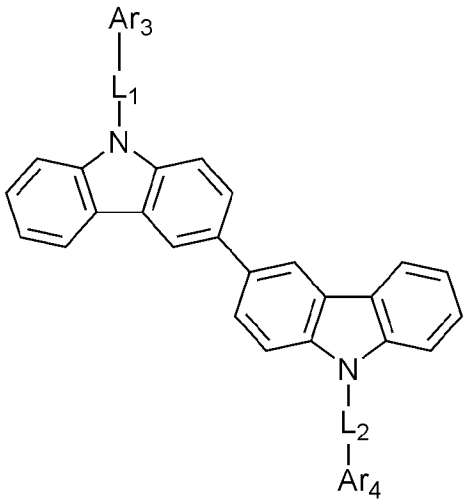
.

[청구항 10] 제1항에 있어서,

상기 제2 화합물은 하기 화학식 2-2로 표시되는,

유기 발광 소자:

[화학식 2-2]

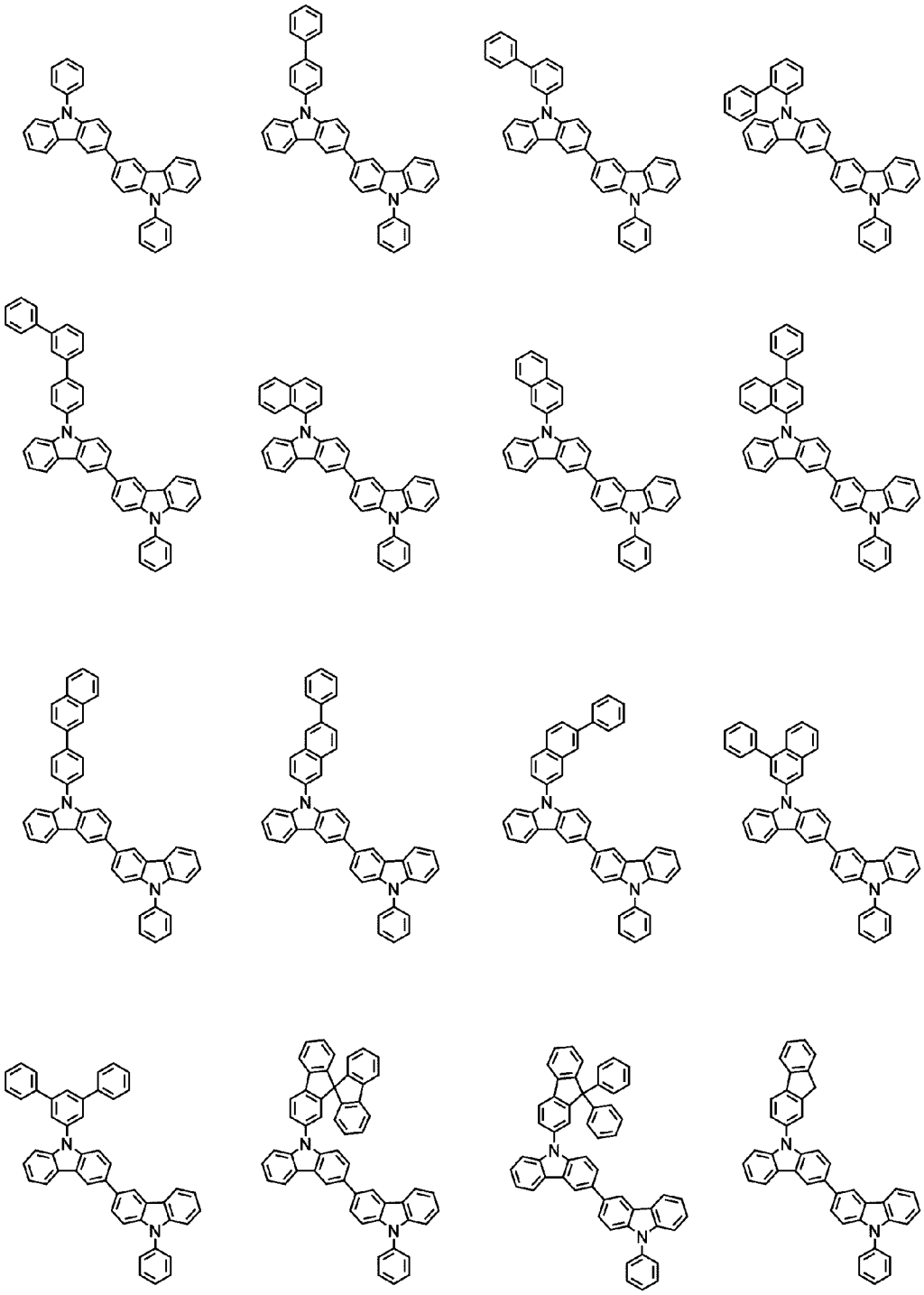


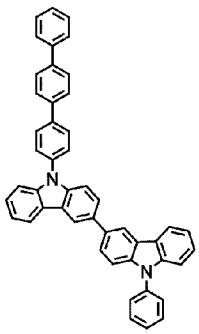
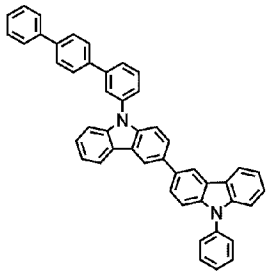
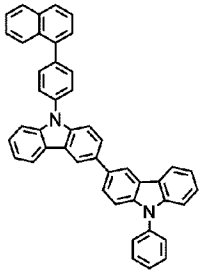
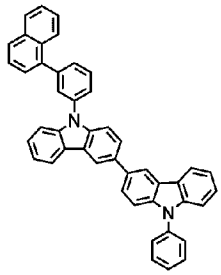
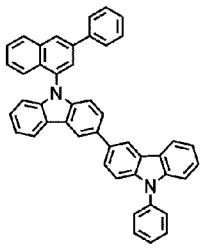
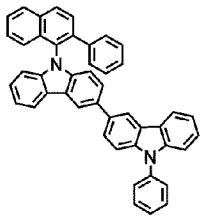
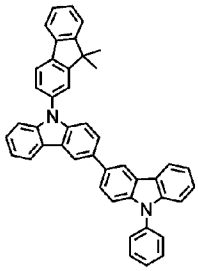
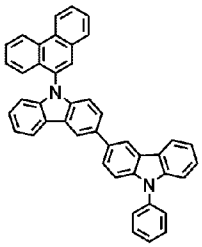
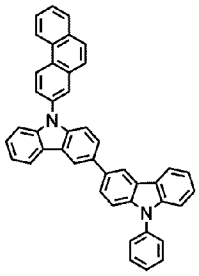
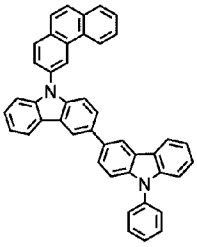
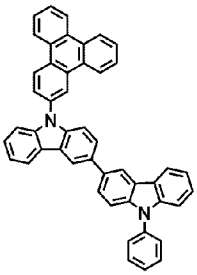
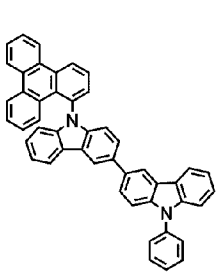
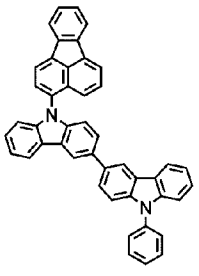
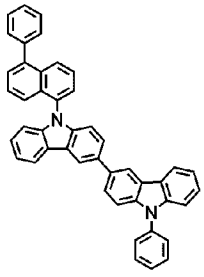
상기 화학식 2-2에서,

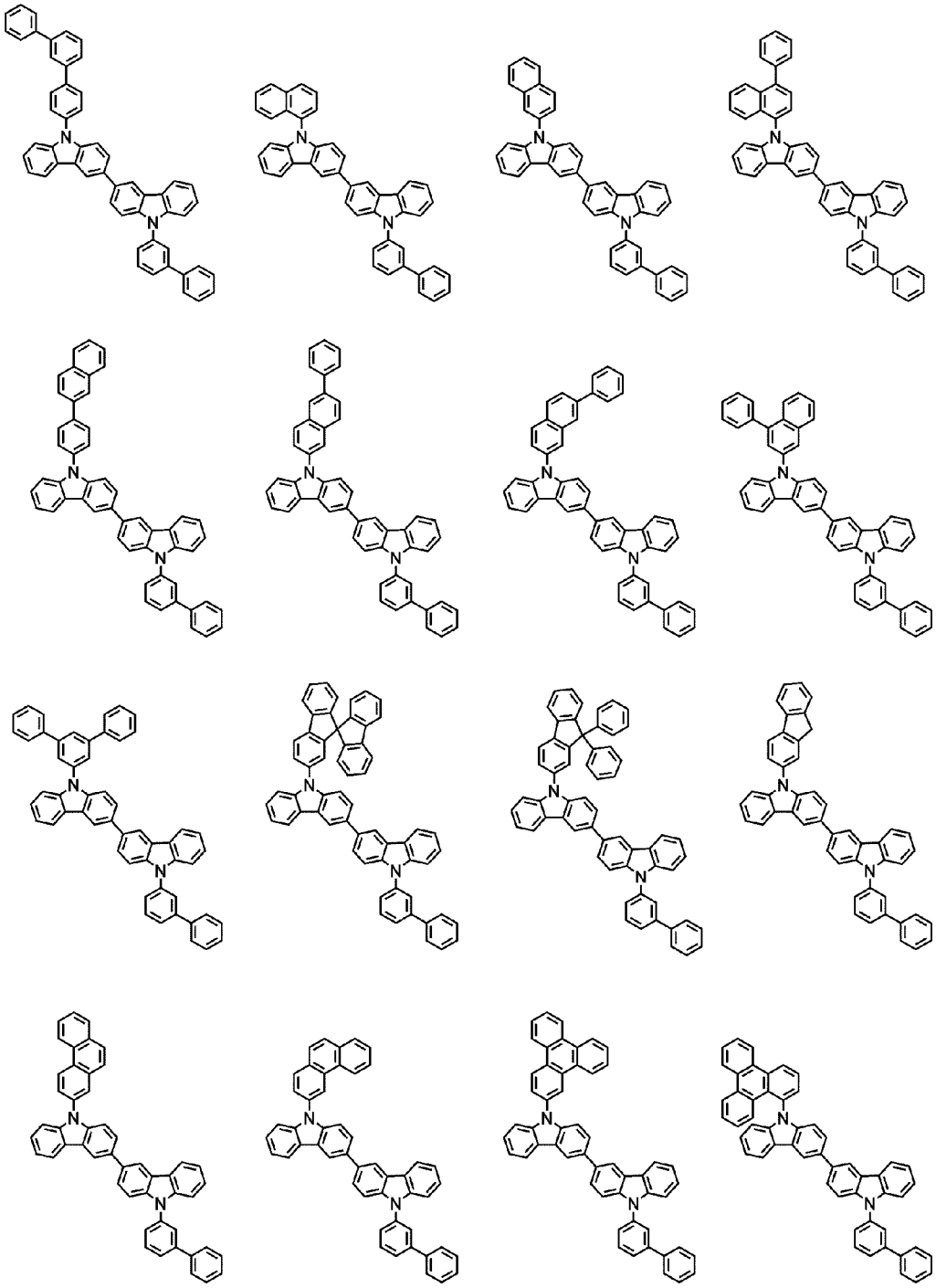
L_1 및 L_2는 각각 독립적으로, 단일 결합, 페닐렌, 또는 나프틸렌이고,

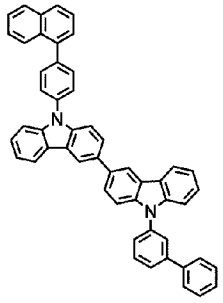
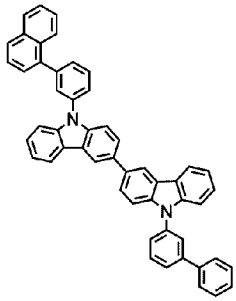
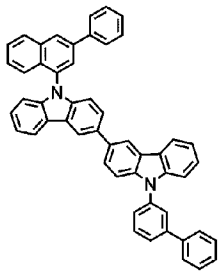
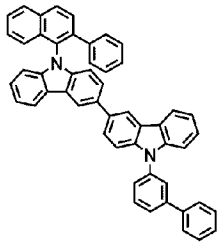
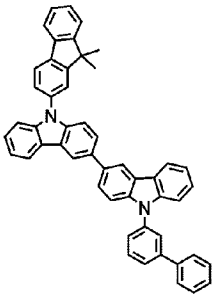
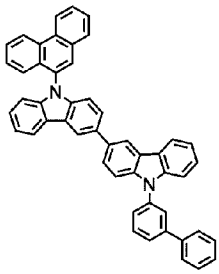
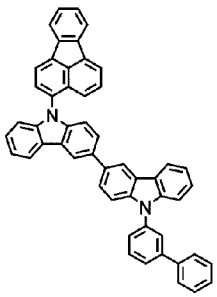
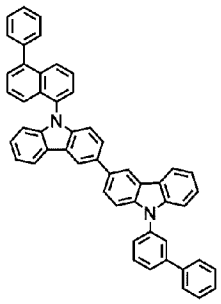
Ar_3 및 Ar_4는 제1항에서 정의한 바와 같다.

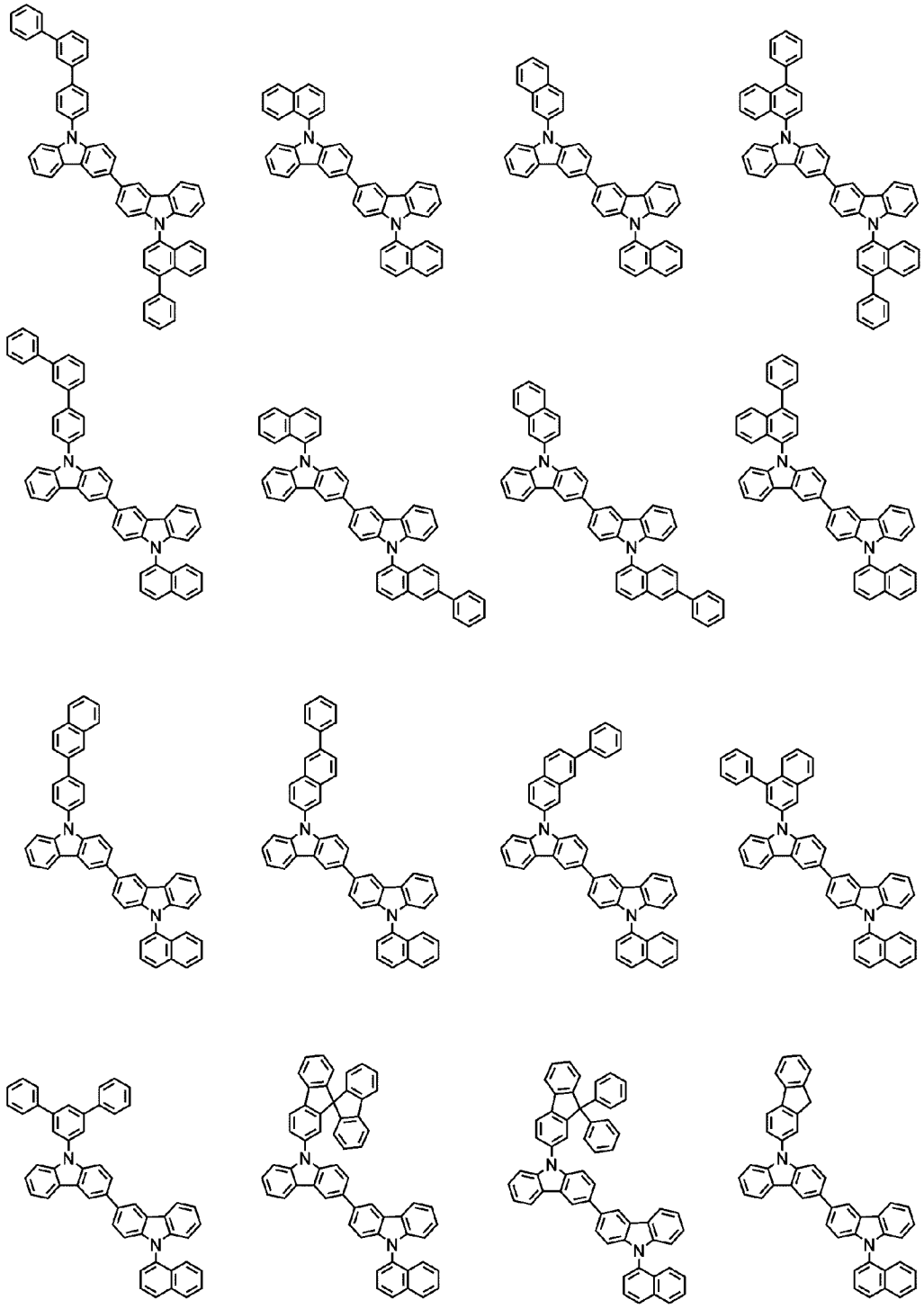
[청구항 11] 제1항에 있어서,
상기 제2 화합물은 하기로 구성되는 군으로부터 선택되는 어느 하나인,
유기 발광 소자:

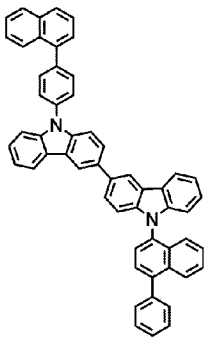
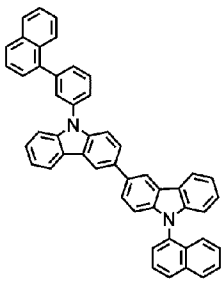
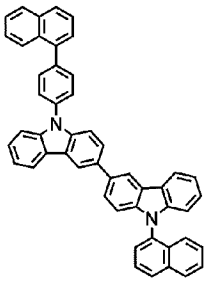
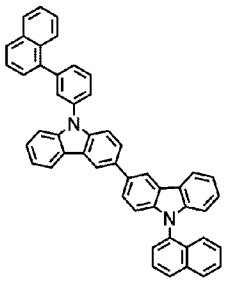
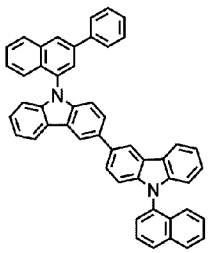
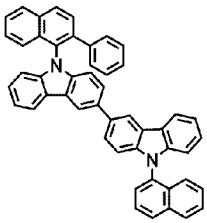
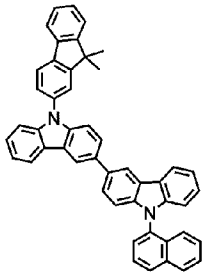
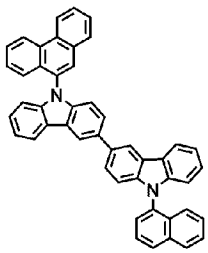
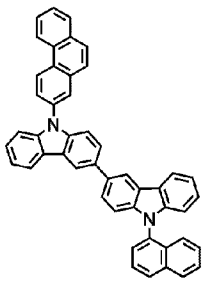
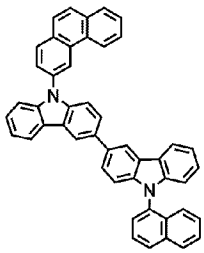
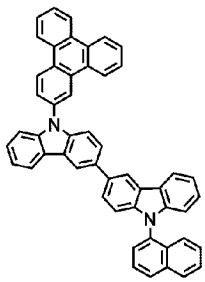
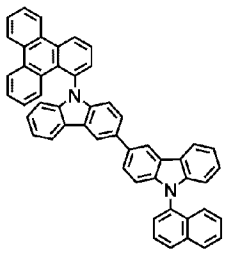
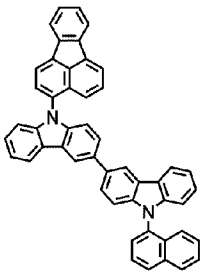
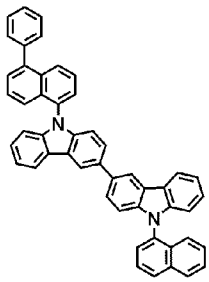


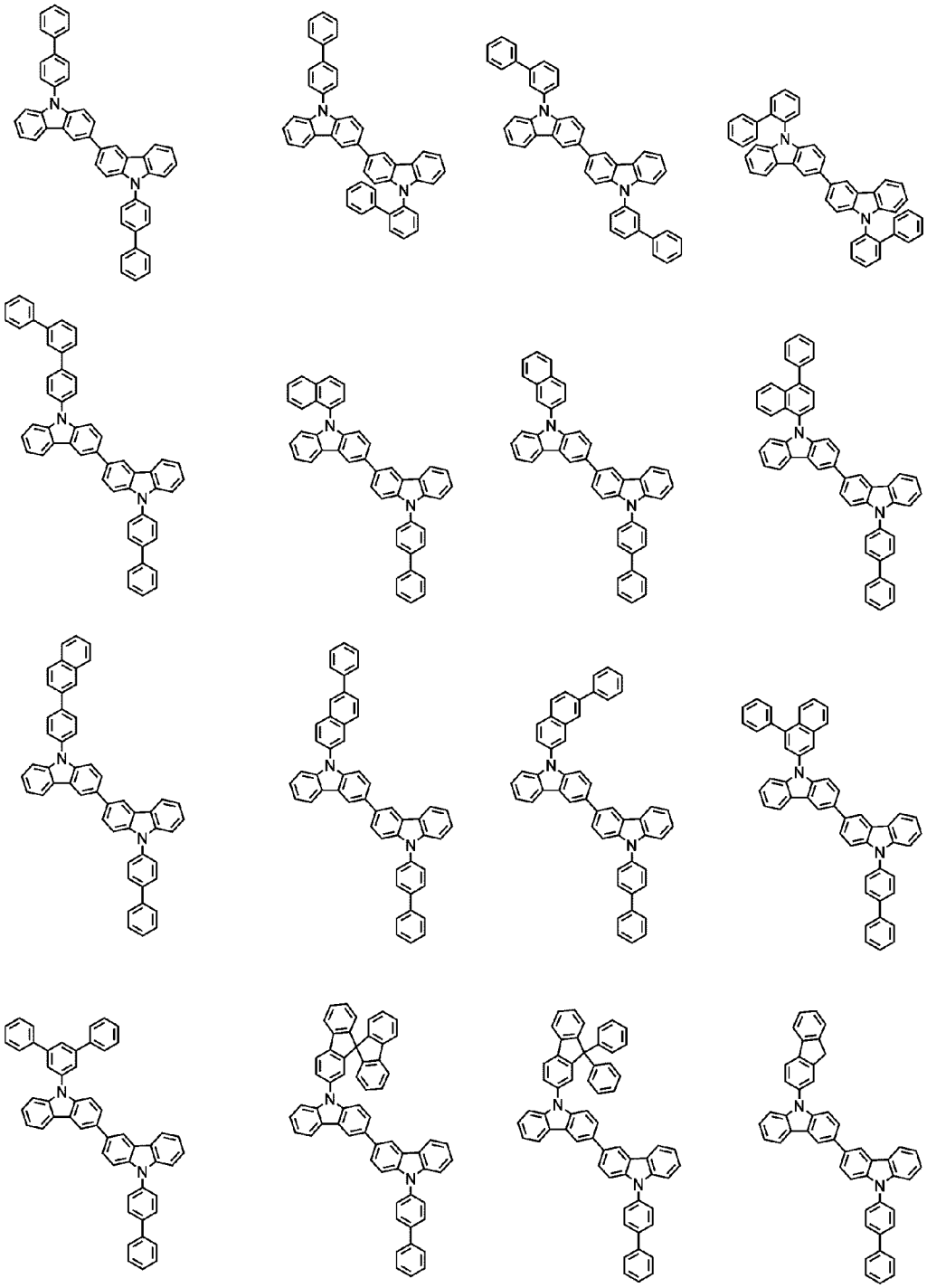















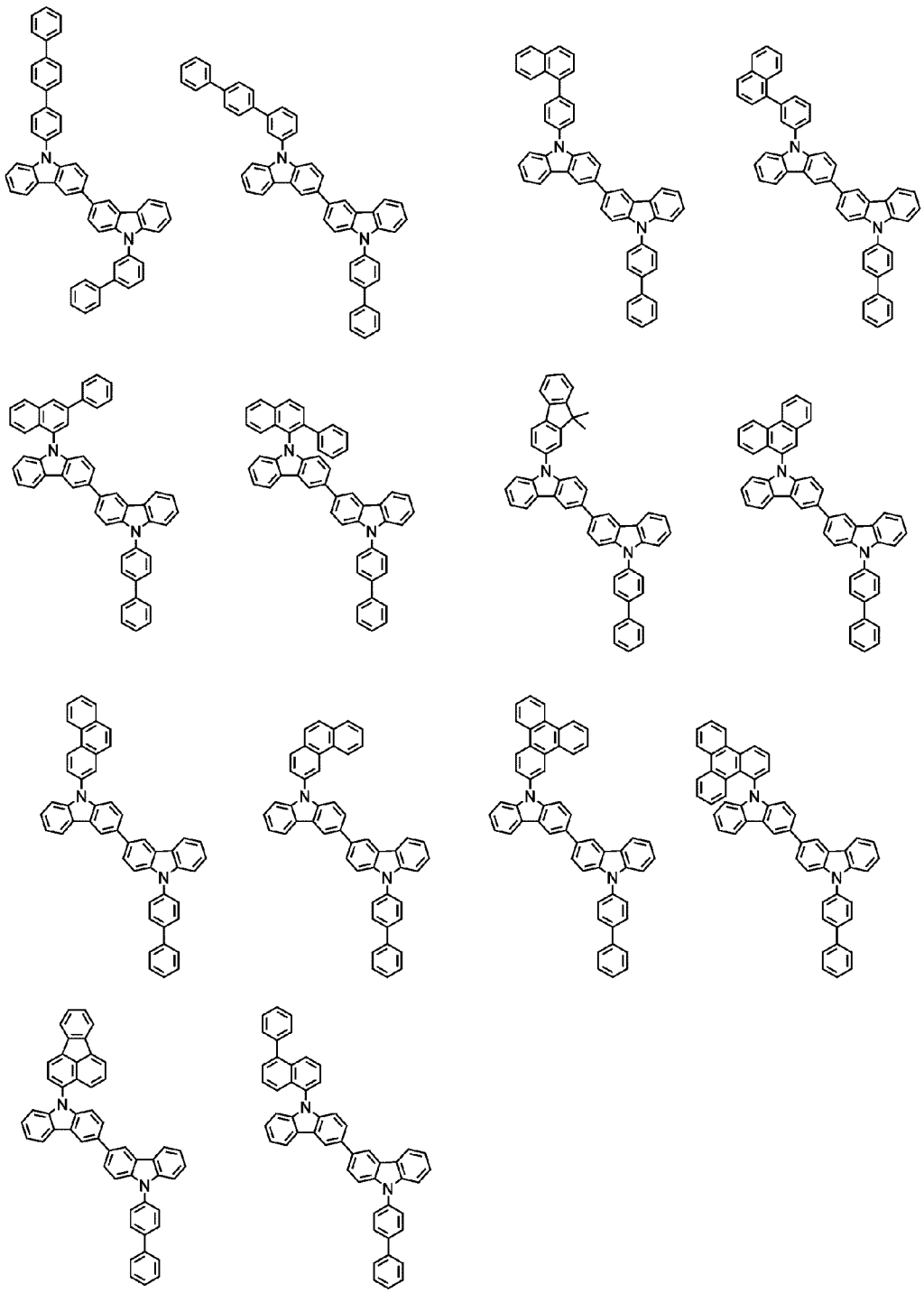


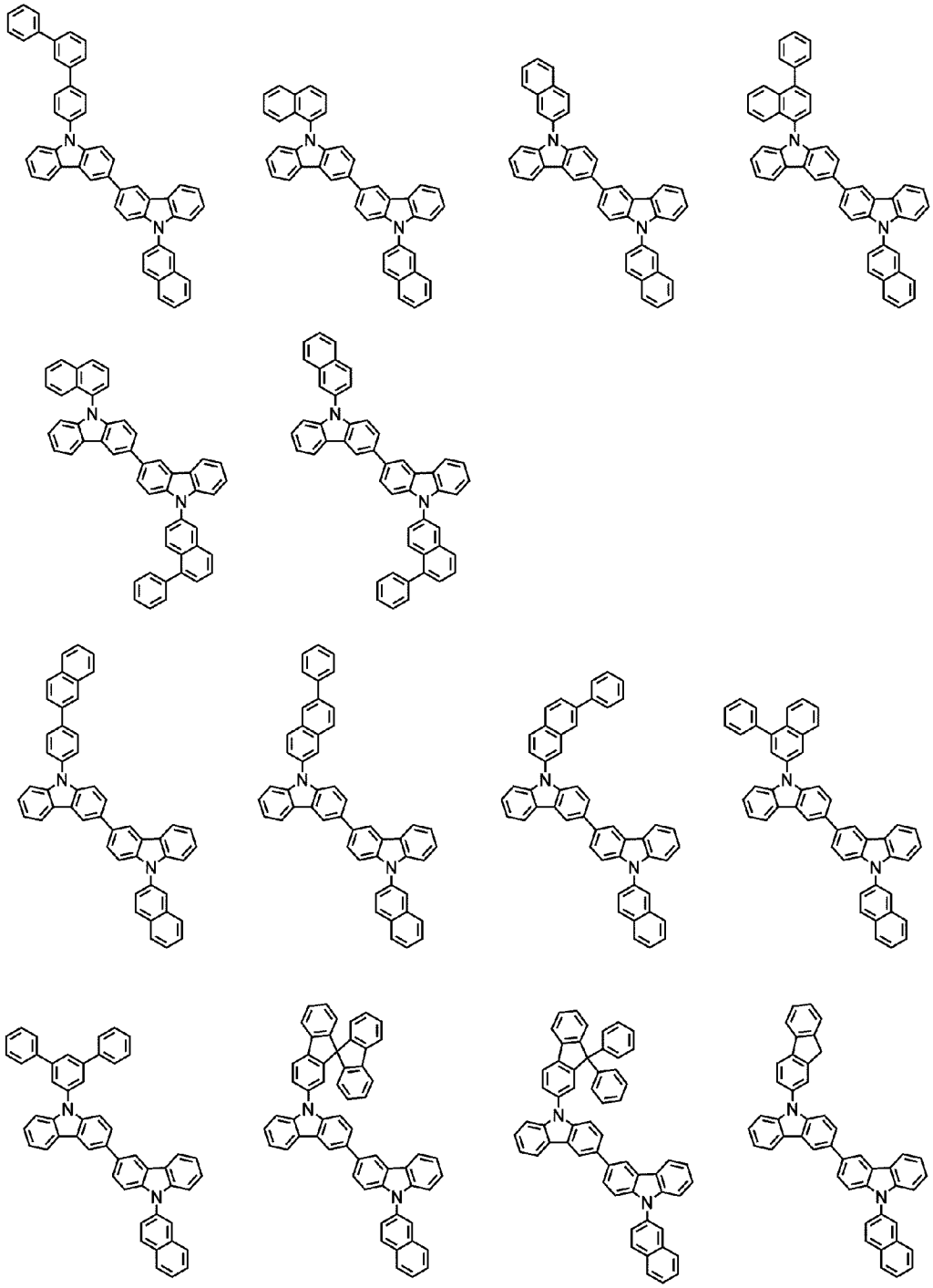









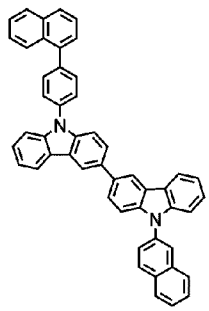
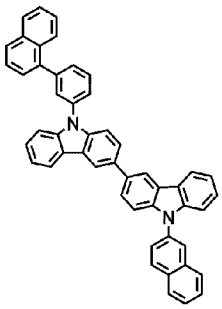
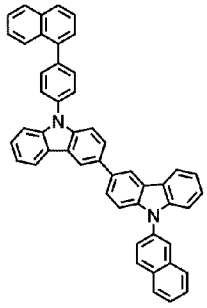
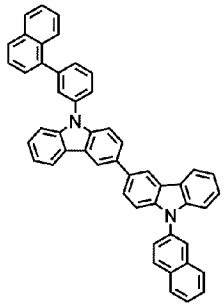
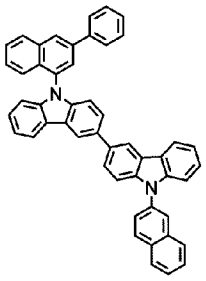
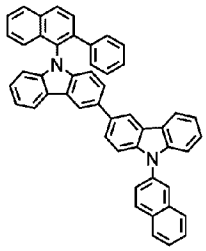
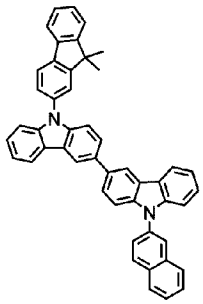
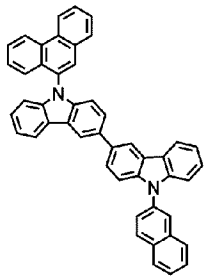
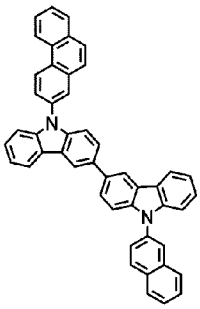
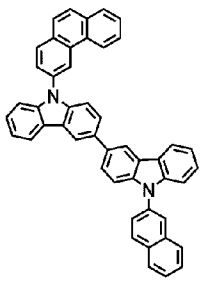
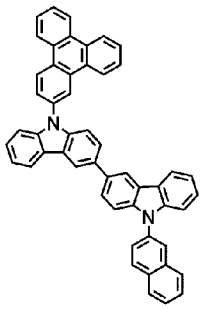
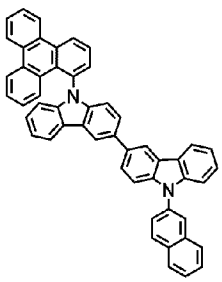
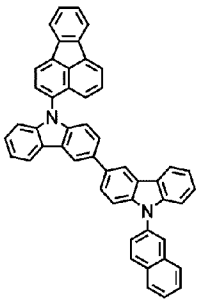
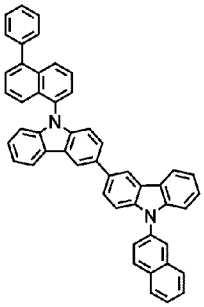


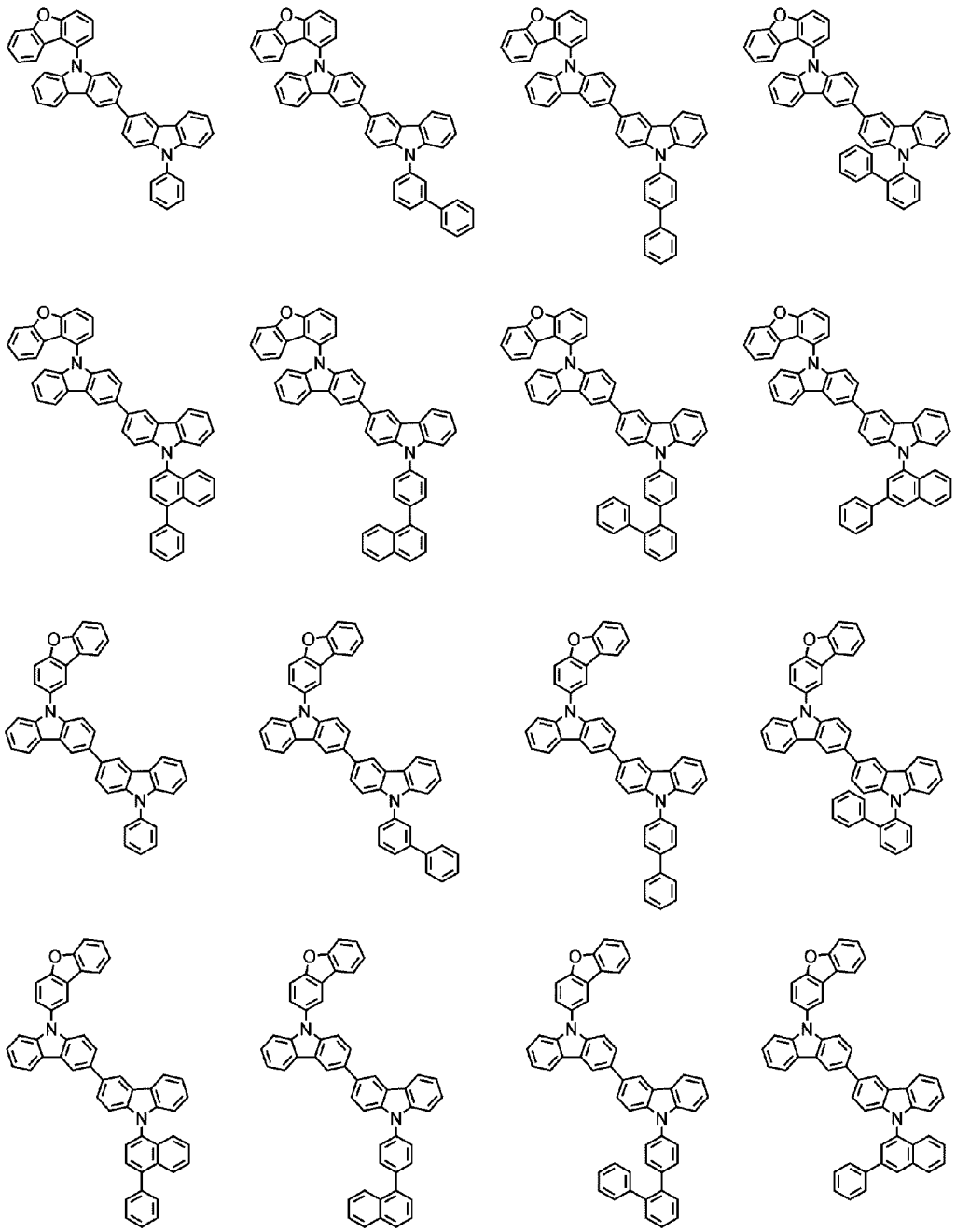















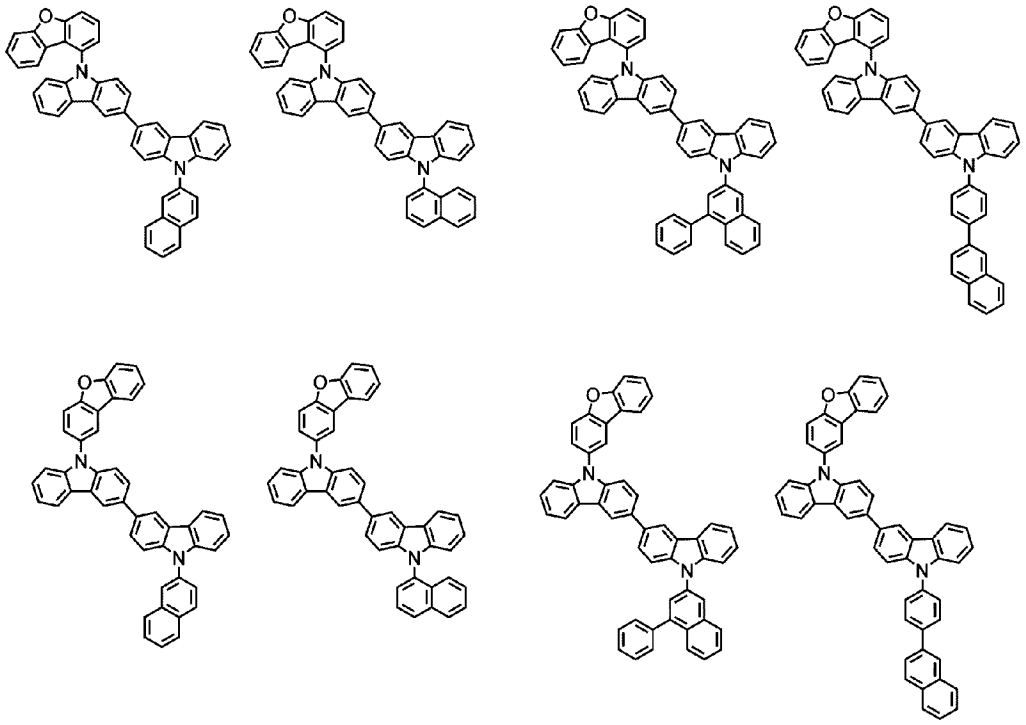


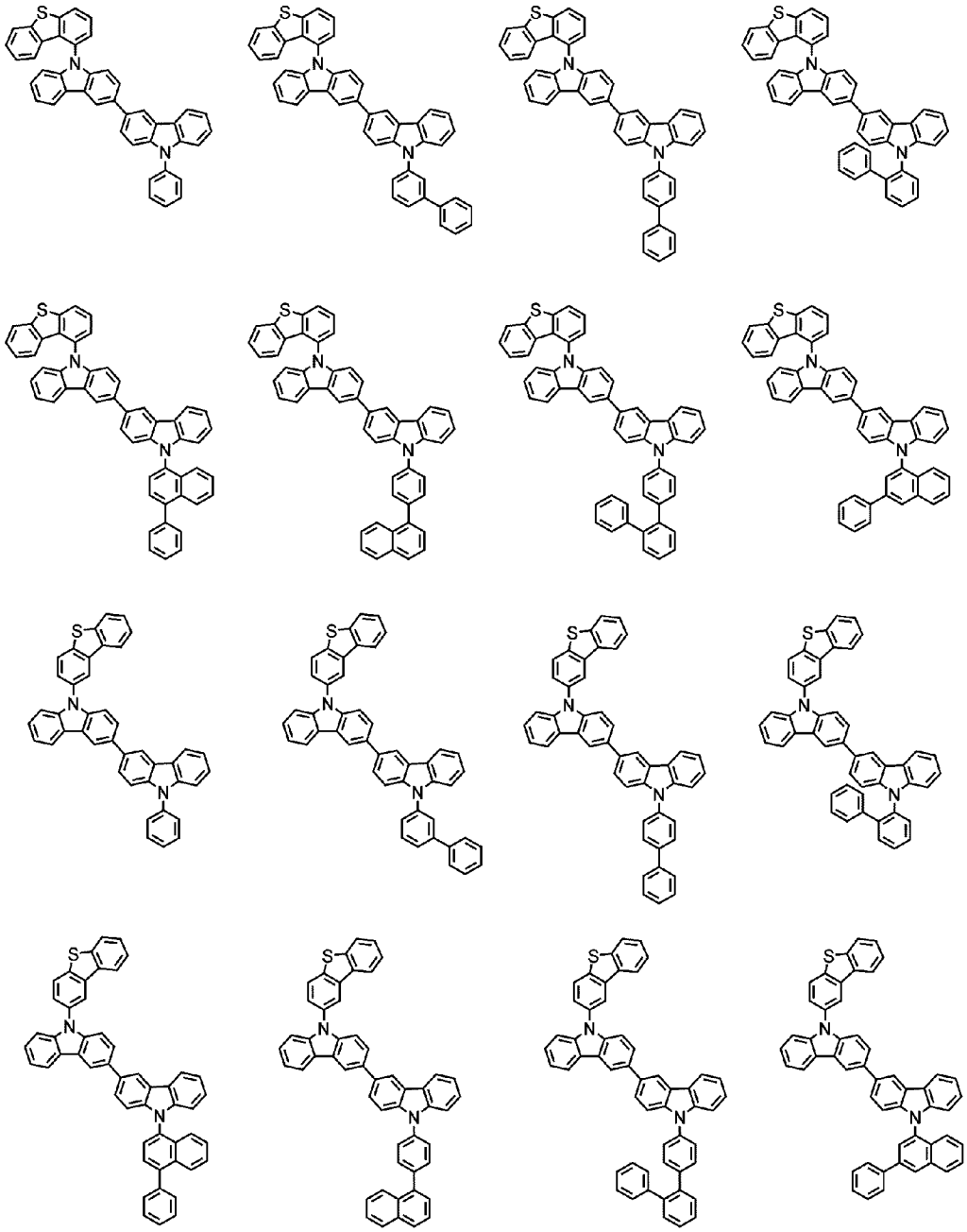


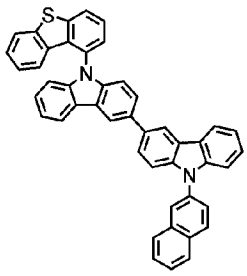
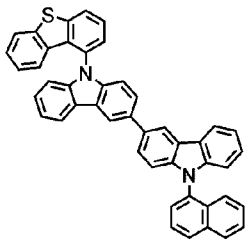
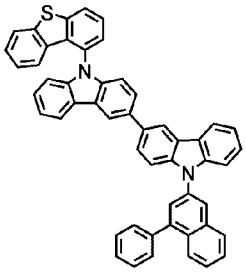
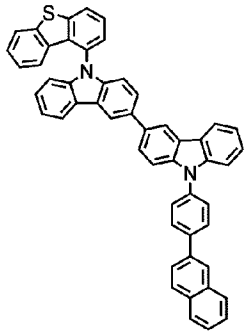
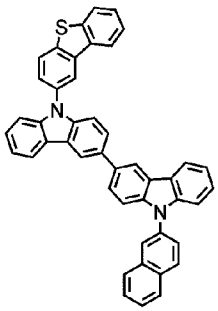
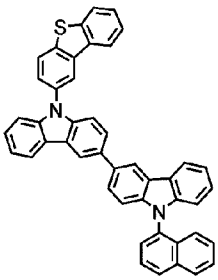
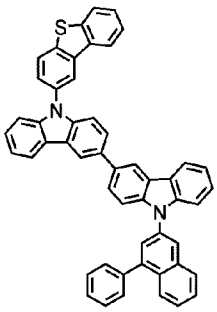
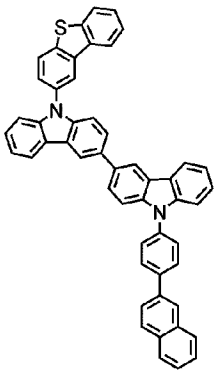


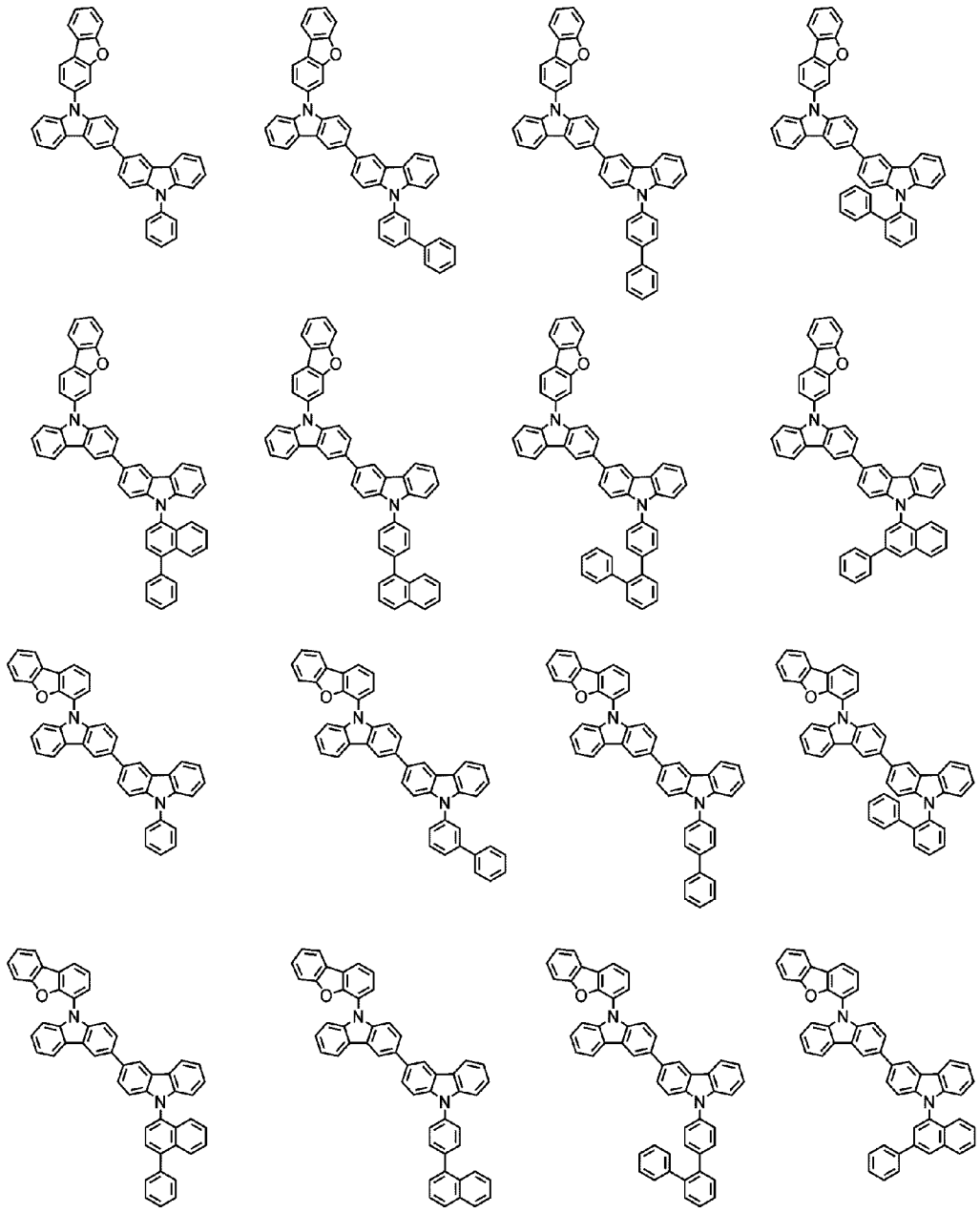















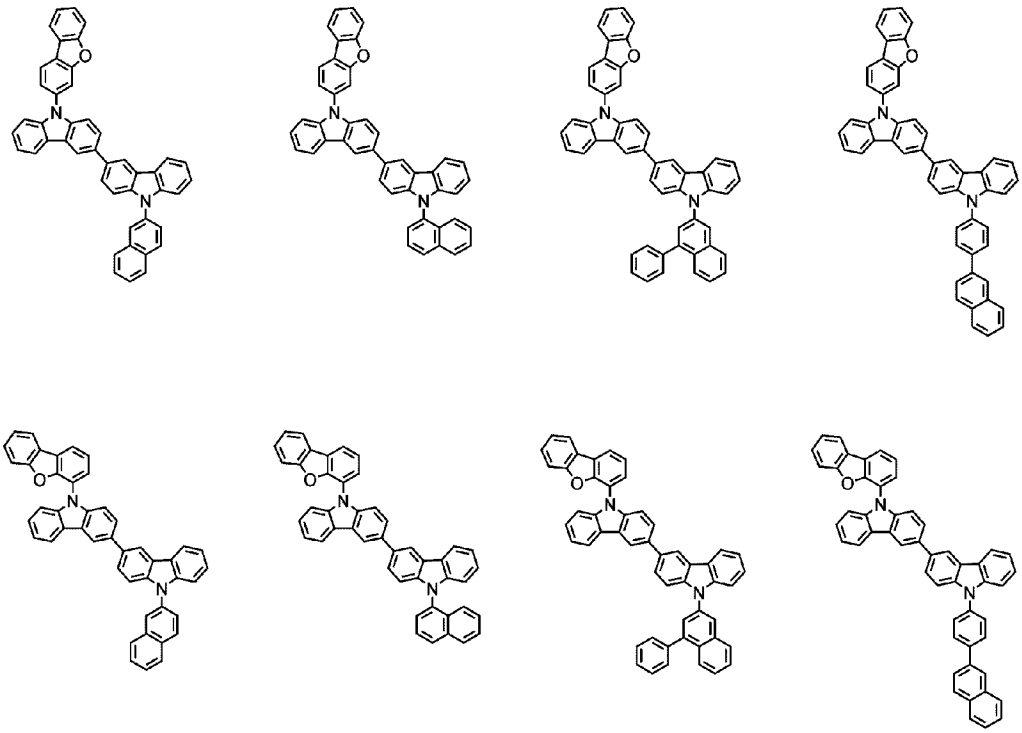


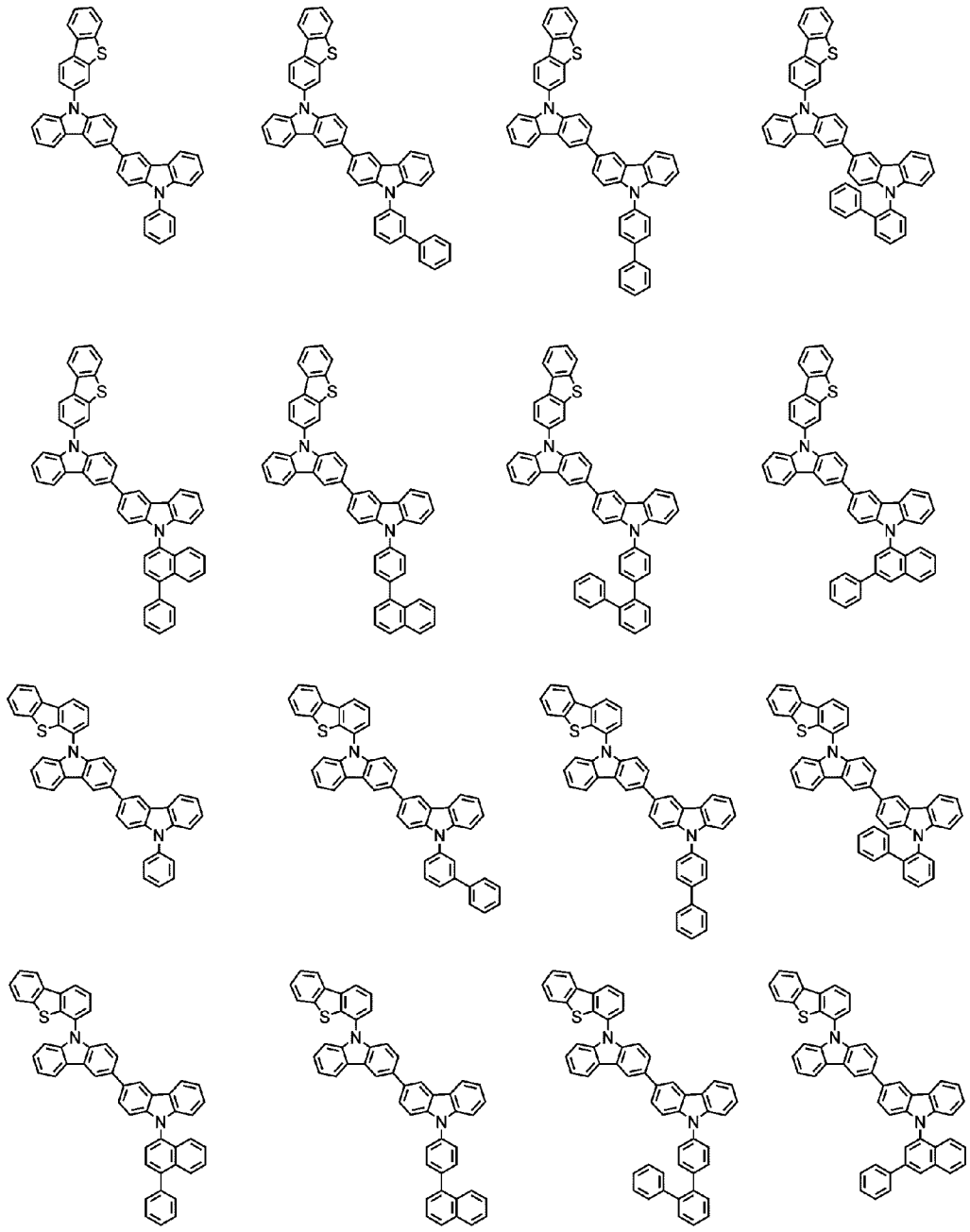


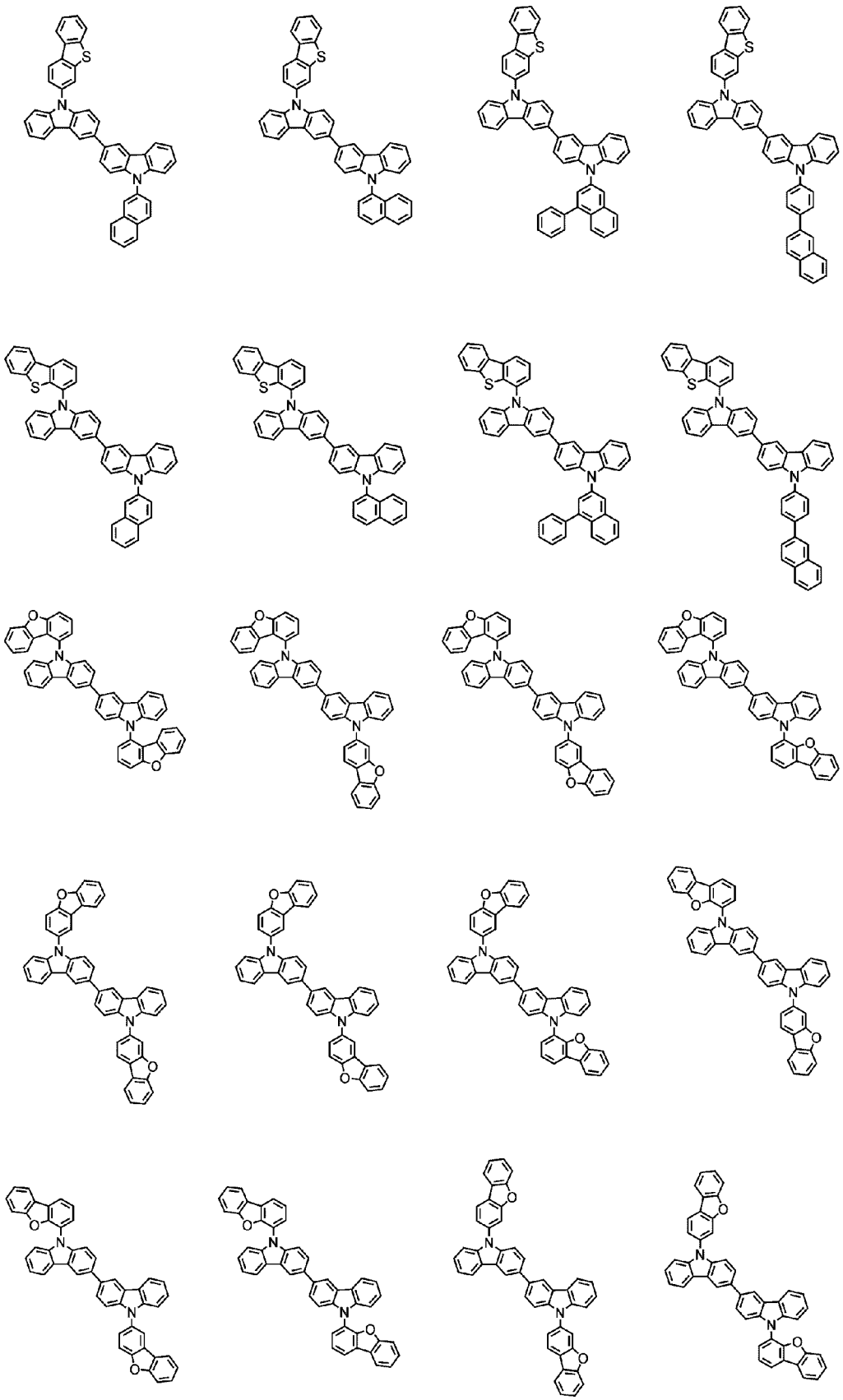


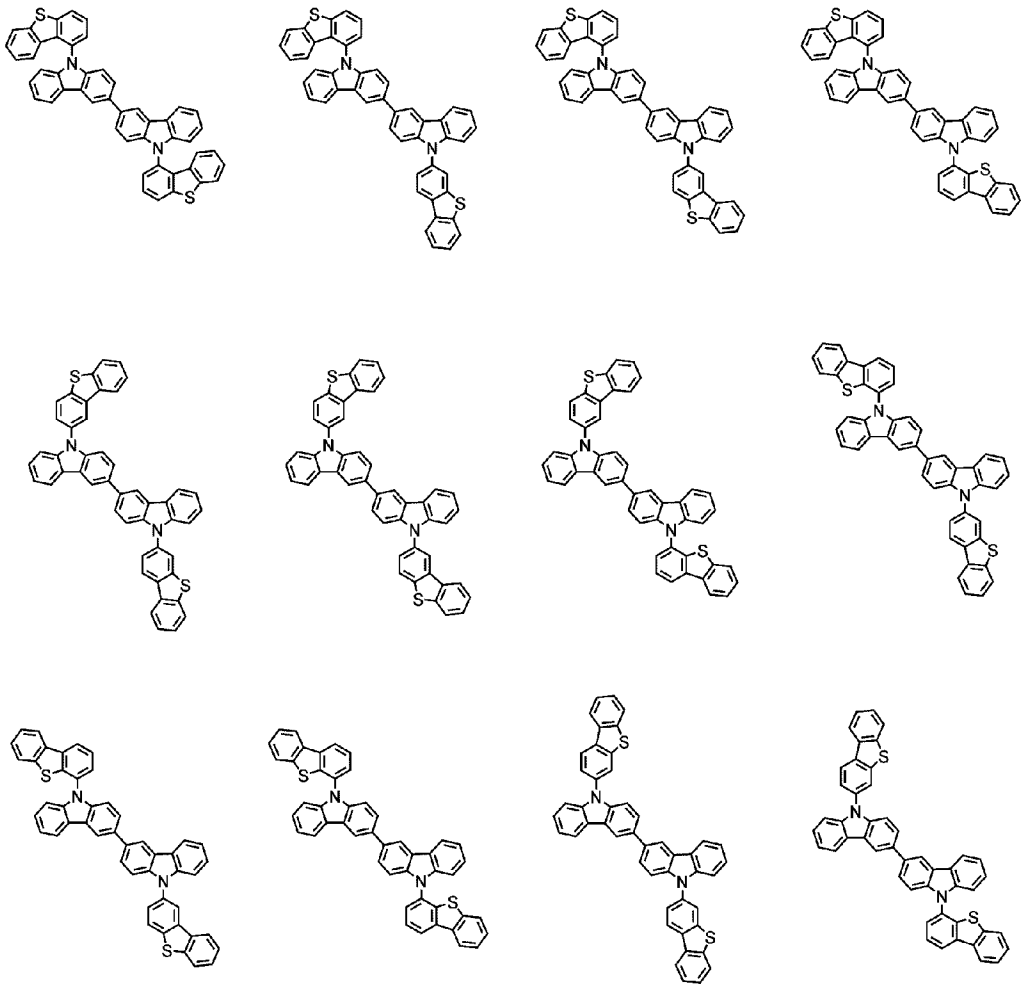









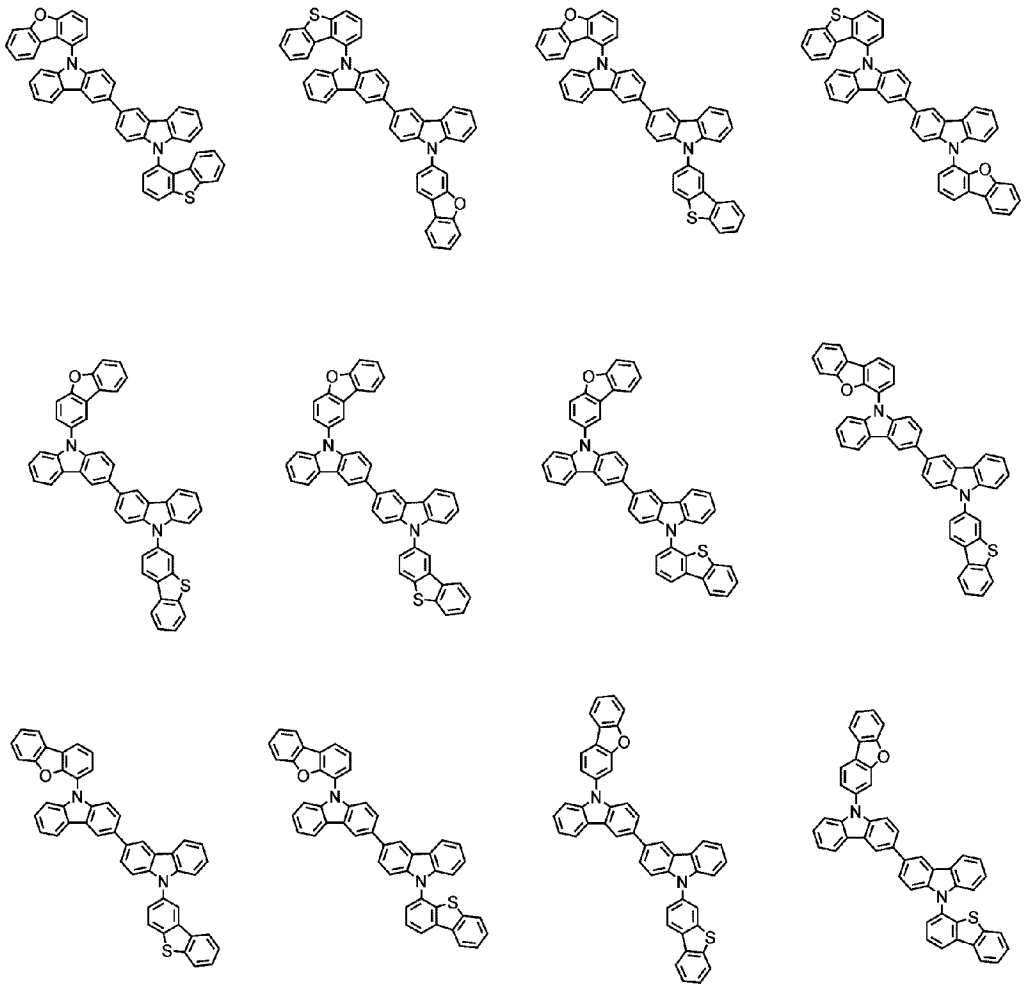








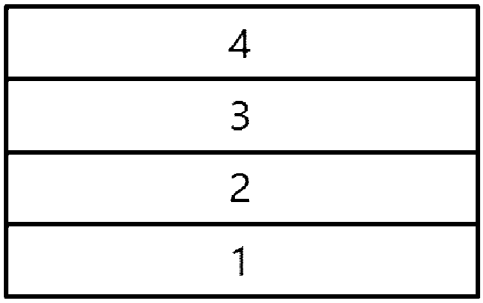




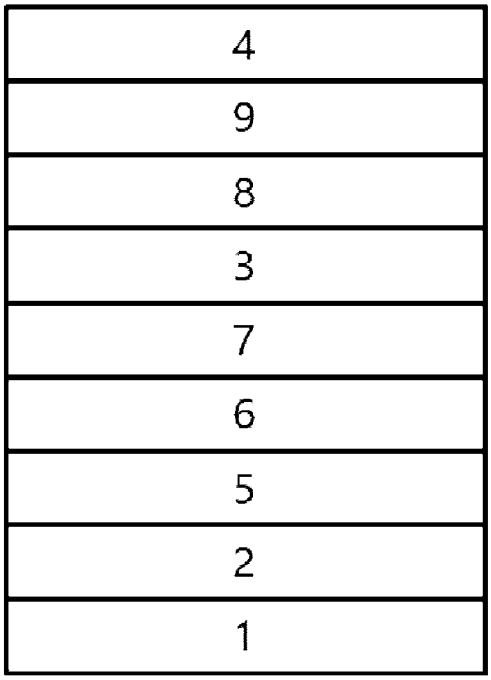
.

[청구항 12] 제1항에 있어서,
상기 제1 화합물 및 상기 제2 화합물은 99:1 내지 1:99의 중량비로 포함되는,
유기 발광 소자.

[도1]



[도2]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2020/095039

A. CLASSIFICATION OF SUBJECT MATTER

H01L 51/00(2006.01)i, H01L 51/50(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L 51/00; C07D 209/56; C07D 209/82; C07D 403/04; C07D 405/10; C07D 405/14; C09K 11/06; H01L 51/50

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal), STN (Registry, Caplus), Google & Keywords: organic light emitting diode(OLED), lifetime, driving voltage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2019-0024772 A (LG CHEM, LTD.) 08 March 2019 See claims 1, 7-10.	1-12
Y	KR 10-2015-0126756 A (SAMSUNG DISPLAY CO., LTD.) 13 November 2015 See claims 1, 15.	1-12
A	KR 10-2017-0111387 A (SFC CO., LTD.) 12 October 2017 See the entire document.	1-12
A	KR 10-2019-0013139 A (LT MATERIALS CO., LTD.) 11 February 2019 See the entire document.	1-12
A	KR 10-2019-0007789 A (SFC CO., LTD.) 23 January 2019 See the entire document.	1-12

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 JUNE 2020 (30.06.2020)	**30 JUNE 2020 (30.06.2020)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2020/095039

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2019-0024772 A	08/03/2019	CN 110520417 A	29/11/2019
		KR 10-2119954 B1	08/06/2020
		WO 2019-045405 A1	07/03/2019
KR 10-2015-0126756 A	13/11/2015	US 10431766 B2	01/10/2019
		US 2015-0318487 A1	05/11/2015
		US 2019-0372049 A1	05/12/2019
KR 10-2017-0111387 A	12/10/2017	None	
KR 10-2019-0013139 A	11/02/2019	None	
KR 10-2019-0007789 A	23/01/2019	None	

국 제 조 사 보 고 서

국제출원번호
PCT/KR2020/095039

A. 발명이 속하는 기술분류(국제특허분류(IPC))

H01L 51/00(2006.01)i, H01L 51/50(2006.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)

H01L 51/00; C07D 209/56; C07D 209/82; C07D 403/04; C07D 405/10; C07D 405/14; C09K 11/06; H01L 51/50

조사된 기술분야에 속하는 최소문헌 이외의 문헌

한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))

eKOMPASS(특허청 내부 검색시스템), STN(Registry, Caplus), 구글 & 키워드: 유기발광소자(OLED, Organic Light Emitting Diode), 수명(lifetime), 구동전압(driving voltage)

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
Y	KR 10-2019-0024772 A (주식회사 엘지화학) 2019.03.08 청구항 1, 7-10	1-12
Y	KR 10-2015-0126756 A (삼성디스플레이 주식회사) 2015.11.13 청구항 1, 15	1-12
A	KR 10-2017-0111387 A (에스에프씨 주식회사) 2017.10.12 전체 문헌	1-12
A	KR 10-2019-0013139 A (엘티소재주식회사) 2019.02.11 전체 문헌	1-12
A	KR 10-2019-0007789 A (에스에프씨 주식회사) 2019.01.23 전체 문헌	1-12

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"D" 본 국제출원에서 출원인이 인용한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2020년 06월 30일 (30.06.2020)	2020년 06월 30일 (30.06.2020)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(35208) 대전광역시 서구 청사로 189,
4동 (둔산동, 정부대전청사)
팩스 번호 +82-42-481-8578

심사관
허주형
전화번호 +82-42-481-8150

국제조사보고서
대응특허에 관한 정보

국제출원번호
PCT/KR2020/095039

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2019-0024772 A	2019/03/08	CN 110520417 A	2019/11/29
		KR 10-2119954 B1	2020/06/08
		WO 2019-045405 A1	2019/03/07
KR 10-2015-0126756 A	2015/11/13	US 10431766 B2	2019/10/01
		US 2015-0318487 A1	2015/11/05
		US 2019-0372049 A1	2019/12/05
KR 10-2017-0111387 A	2017/10/12	없음	
KR 10-2019-0013139 A	2019/02/11	없음	
KR 10-2019-0007789 A	2019/01/23	없음	