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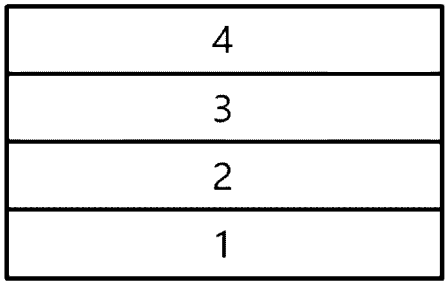
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(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, 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))

(54) **Title:** ORGANIC LIGHT-EMITTING DEVICE

(54) 발명의 명칭: 유기 발광 소자



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

(57) 요약서: 본 발명은 유기 발광 소자를 제공한다.

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명세서

발명의 명칭: 유기 발광 소자

기술분야

[1] 관련 출원(들)과의 상호 인용

[2] 본 출원은 2020년 7월 17일자 한국 특허 출원 제10-2020-0089021호 및 2021년 7월 15일자 한국 특허 출원 제10-2021-0093118호에 기초한 우선권의 이익을 주장하며, 해당 한국 특허 출원들의 문헌에 개시된 모든 내용은 본 명세서의 일부로서 포함된다.

[3] 본 발명은 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 유기물층을 포함하는 구조를 가진다. 상기 유기물층은 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 유기 발광 소자에 관한 것이다.

[15]

기술적 해결방법

[16] 본 발명은,

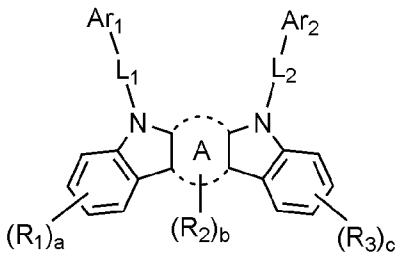
[17] 양극;

[18] 상기 양극과 대향하여 구비된 음극; 및

[19] 상기 양극과 음극 사이에 구비된 발광층을 포함하고,

[20] 상기 발광층은 하기 화학식 1로 표시되는 제1 화합물, 하기 화학식 2로 표시되는 제2 화합물 및 하기 화학식 3으로 표시되는 제3 화합물을 포함하는 유기 발광 소자를 제공한다:

[21] [화학식 1]

[22] 

[23] 상기 화학식 1에서,

[24] A는 이웃하는 2 개의 오각고리와 융합된 벤젠 고리이고,

[25] L_1 및 L_2는 각각 독립적으로 단일 결합; 또는 치환 또는 비치환된 C_{6-60} 아릴렌이고,

[26] Ar_1 및 Ar_2는 각각 독립적으로 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

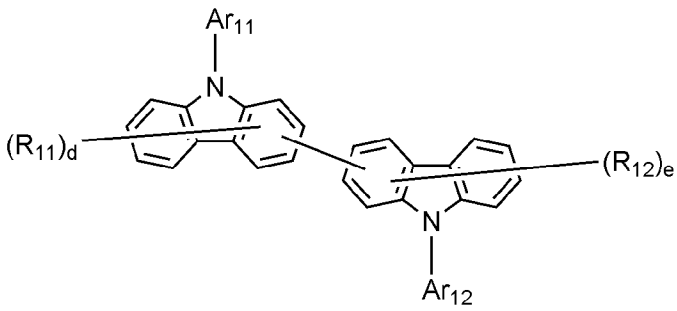
[27] R_1 내지 R_3는 각각 독립적으로 수소, 중수소, 또는 C_{6-12} 아릴이고,

[28] a는 0 내지 4의 정수이고,

[29] b는 0 내지 2의 정수이고,

[30] c는 0 내지 4의 정수이고,

[31] [화학식 2]

[32] 

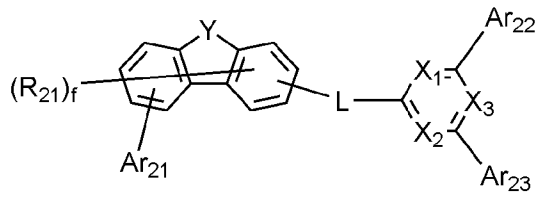
[33] 상기 화학식 2에서,

[34] Ar_{11} 및 Ar_{12}는 각각 독립적으로 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

[35] R_{11} 및 R_{12}는 각각 독립적으로 수소; 중수소; 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

[36] d 및 e는 각각 독립적으로 0 내지 7의 정수이고,

[37] [화학식 3]

[38] 

[39] 상기 화학식 3에서,

[40] X_1 내지 X_3는 각각 독립적으로 N 또는 CH이고, 단, X_1 내지 X_3 중 적어도 하나는 N이고,

[41] Y는 O 또는 S이고,

[42] L은 단일 결합; 치환 또는 비치환된 C_{6-60} 아릴렌; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴렌이고,

[43] Ar_{21} 내지 Ar_{23}은 각각 독립적으로 중수소, 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

[44] R_{21}은 수소, 중수소, 또는 C_{6-12} 아릴이고,

[45] f는 0 내지 6의 정수이다.

[46] 이때, a, b, c, d, e 및 f가 각각 2 이상인 경우, 괄호 안의 치환기는 서로 동일하거나 상이하다.

[47]

발명의 효과

[48] 상술한 유기 발광 소자는 발광층에 2종의 호스트 화합물을 포함하여, 유기 발광 소자에서 효율, 구동전압 및/또는 수명 특성을 향상시킬 수 있다.

[49]

도면의 간단한 설명

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

[51] 도 2는 기판 (1), 양극(2), 정공주입층(5), 정공수송층(6), 전자저지층(7), 발광층(3), 정공저지층(8), 전자수송층(9), 전자주입층(10) 및 음극(4)으로 이루어진 유기 발광 소자의 예를 도시한 것이다.

[52]

발명의 실시를 위한 형태

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

[54]

[55] 본 명세서에서,  , 또는  는 다른 치환기에 연결되는 결합을 의미하고, D는

중수소를 의미하고, Ph는 페닐기를 의미한다.

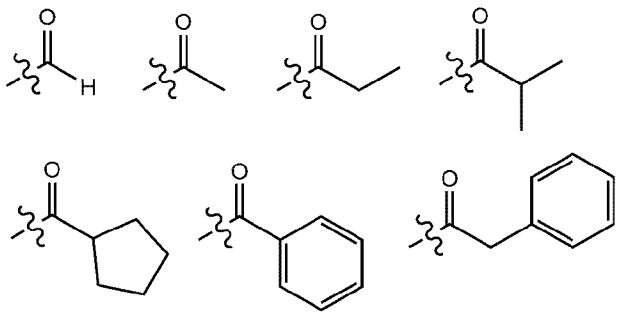
[56]

[57] 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 헤테로아릴로 이루어진 군에서 선택된 1개 이상의 치환기로 치환 또는 비치환되거나, 상기 예시된 치환기 중 2 이상의 치환기가 연결된 치환기로 치환 또는 비치환된 것을 의미한다. 예컨대, "2 이상의 치환기가 연결된 치환기"는 비페닐기일 수 있다. 즉, 비페닐이기는 아릴기일 수도 있고, 2개의 페닐기가 연결된 치환기로 해석될 수도 있다. 일례로, "치환 또는 비치환된" 이라는 용어는 "비치환되거나, 또는 중수소, 할로겐, 시아노, C_{1-10} 알킬, C_{1-10} 알콕시 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상, 예를 들어, 1개 내지 5개의 치환기로 치환된"이라는 의미로 이해될 수 있다. 또한, 본 명세서에서 "1개 이상의 치환기로 치환된"이라는 용어는 일례로 "1개 내지 10개의 치환기로 치환된"; "1개 내지 5개의 치환기로 치환된"; 또는 "1개 또는 2개의 치환기로 치환된"이라는 의미로 이해될 수 있다.

[58]

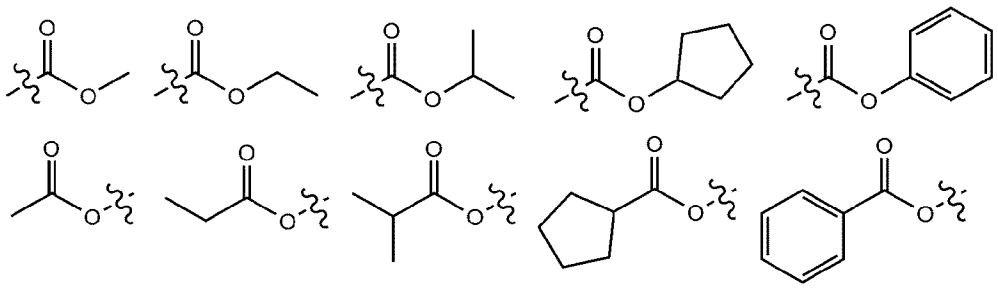
[59] 본 명세서에서 카보닐기의 탄소수는 특별히 한정되지 않으나, 탄소수 1 내지 40인 것이 바람직하다. 구체적으로 하기와 같은 구조의 치환기가 될 수 있으나, 이에 한정되는 것은 아니다.

[60]



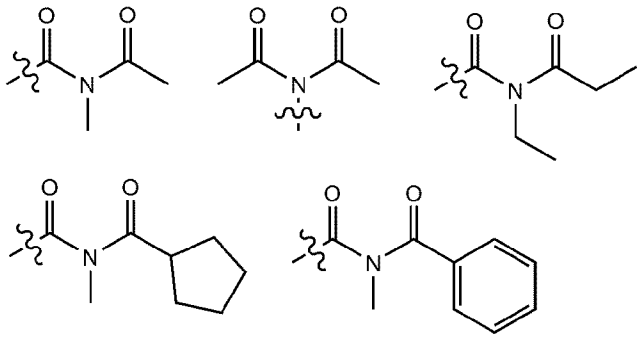
[61]

[62] 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 치환기가 될 수 있으나, 이에 한정되는 것은 아니다.

[63] 

[64]

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

[66] 

[67]

[68] 본 명세서에 있어서, 실릴기는 구체적으로 트리메틸실릴기, 트리에틸실릴기, t-부틸디메틸실릴기, 비닐디메틸실릴기, 프로필디메틸실릴기, 트리페닐실릴기, 디페닐실릴기, 페닐실릴기 등이 있으나 이에 한정되지 않는다.

[69]

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

[71]

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

[73]

[74] 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 구체적인 예로는 메틸, 에틸, 프로필, n-프로필, 이소프로필, 부틸, n-부틸, 이소부틸, tert-부틸, sec-부틸, 1-메틸-부틸, 1-에틸부틸, 펜틸, n-펜틸, 이소펜틸, 네오펜틸, tert-펜틸, 1-에틸-프로필, 1,1-디메틸프로필, 헥실, n-헥실, 1-메틸펜틸, 2-메틸펜틸, 4-메틸-2-펜틸, 3,3-디메틸부틸, 2-에틸부틸, 헵틸, n-헵틸, 이소헥실, 1-메틸헥실, 2-메틸헥실, 3-메틸헥실, 4-메틸헥실, 5-메틸헥실, 사이클로펜틸메틸,

사이클로헥실메틸, 옥틸, n-옥틸, tert-옥틸, 1-메틸헵틸, 2-에틸헥실, 2,4,4-트리메틸-1-펜틸, 2,4,4-트리메틸-2-펜틸, 2-프로필펜틸, n-노닐, 2,2-디메틸헵틸 등이 있으나, 이들에 한정되지 않는다.

[75]

[76] 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.

[77]

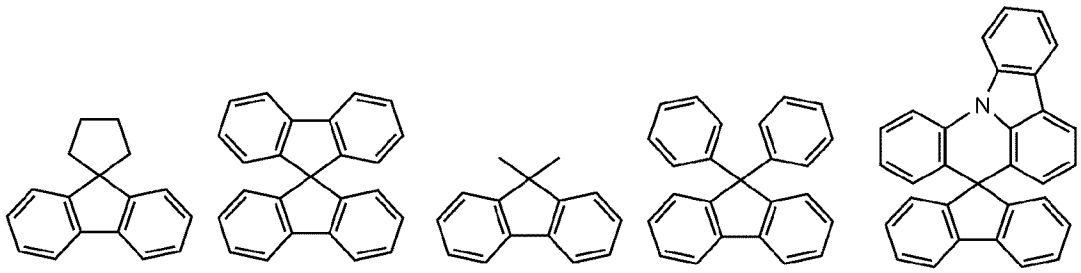
[78] 본 명세서에 있어서, 사이클로알킬기는 특별히 한정되지 않으나, 탄소수 3 내지 60인 것이 바람직하며, 일 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 30이다. 또 하나의 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 20이다. 또 하나의 실시상태에 따르면, 상기 사이클로알킬기의 탄소수는 3 내지 6이다. 구체적으로 사이클로프로필, 사이클로부틸, 사이클로펜틸, 3-메틸사이클로펜틸, 2,3-디메틸사이클로펜틸, 사이클로헥실, 3-메틸사이클로헥실, 4-메틸사이클로헥실, 2,3-디메틸사이클로헥실, 3,4,5-트리메틸사이클로헥실, 4-tert-부틸사이클로헥실, 사이클로헵틸, 사이클로옥틸, 아다만틸 등이 있으나, 이에 한정되지 않는다.

[79]

[80] 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, 비페닐이기, 터페닐기 등이 될 수 있으나, 이에 한정되는 것은 아니다. 상기 다환식 아릴기로는 나프틸기, 안트릴이기, 페난트릴기, 파이레닐기, 페릴레닐기, 크라이세닐기, 플루오레닐기 등이 될 수 있으나, 이에 한정되는 것은 아니다.

[81]

[82] 본 명세서에 있어서, 플루오레닐기는 치환될 수 있고, 치환기 2개가 서로



등이 될 수 있다. 다만, 이에 한정되는 것은 아니다.

[83]

[84] 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, 벤조옥사졸기, 벤조이미다졸기, 벤조티아졸기, 벤조카바졸기, 벤조티오펜기, 디벤조티오펜기, 벤조퓨라닐기, 페난쓰롤린기(phenanthroline), 이소옥사졸릴기, 티아디아졸릴기, 페노티아지닐기 및 디벤조퓨라닐기 등이 있으나, 이들에만 한정되는 것은 아니다.

[85]

[86] 본 명세서에 있어서, 아르알킬기, 아르알케닐기, 알킬아릴기, 아릴아민기, 아릴실릴기 중의 아릴기는 전술한 아릴기의 예시와 같다. 본 명세서에 있어서, 아르알킬기, 알킬아릴기, 알킬아민기 중 알킬기는 전술한 알킬기의 예시와 같다. 본 명세서에 있어서, 헤테로아릴아민기 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.

[87]

[88] 본 명세서 있어서, 용어 "중수소화된 또는 중수소로 치환된"의 의미는 각 화학식에서 적어도 하나의 이용가능한 수소가 중수소로 치환된 것을 의미한다. 구체적으로, 각 화학식 또는 치환기의 정의에서 중수로 치환된다는 것은, 분자 내 수소가 결합될 수 있는 위치 중 적어도 하나 이상이 중수소로 치환될 것을

의미하고, 보다 구체적으로, 이용가능한 수소의 적어도 10%가 중수소에 의해 치환된 것을 의미한다. 일례로, 각 화학식에서 적어도 20%, 적어도 30%, 적어도 40%, 적어도 50%, 적어도 60%, 적어도 70%, 적어도 80%, 적어도 90%, 또는 100% 중수소화된다.

[89]

[90] 한편, 일 구현예에 따른 유기 발광 소자는, 양극; 상기 양극과 대향하여 구비된 음극; 및 상기 양극과 음극 사이에 구비된 발광층을 포함하고, 상기 발광층은 상기 화학식 1로 표시되는 제1 화합물, 상기 화학식 2로 표시되는 제2 화합물 및 상기 화학식 3으로 표시되는 제3 화합물을 상기 발광층의 호스트 물질로 포함한다.

[91]

[92] 본 발명에 따른 유기 발광 소자는 발광층에 특정 구조를 갖는 3종의 화합물을 호스트 물질로 동시에 포함하여, 유기 발광 소자에서 효율, 구동전압 및/또는 수명 특성을 향상시킬 수 있다.

[93]

[94] 이하 각 구성 별로 본 발명을 상세히 설명한다.

[95]

[96] **양극 및 음극**

[97] 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, 이에 한정되는 것은 아니다.

[98]

[99] 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, 이에 한정되는 것은 아니다.

[100]

[101] **정공주입층**

[102] 본 발명에 따른 유기 발광 소자는 필요에 따라 양극과 후술하는 정공수송층 사이에 정공주입층을 포함할 수 있다.

[103]

[104] 상기 정공주입층은 상기 양극 상에 위치하여, 양극으로부터 정공을 주입하는 층으로, 정공 주입 물질을 포함한다. 이러한 정공 주입 물질로는 정공을

수송하는 능력을 가져 양극에서의 정공 주입효과, 발광층 또는 발광재료에 대하여 우수한 정공 주입 효과를 갖고, 발광층에서 생성된 엑시톤의 전자주입층 또는 전자주입재료에의 이동을 방지하며, 또한, 박막 형성 능력이 우수한 화합물이 바람직하다. 특히, 정공 주입 물질의 HOMO(highest occupied molecular orbital)가 양극 물질의 일함수와 주변 유기물층의 HOMO 사이인 것이 적합하다.

[105]

[106] 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 한정되는 것은 아니다.

[107]

[108] **정공수송층**

[109] 본 발명에 따른 유기 발광 소자는 양극과 발광층 사이에 정공수송층을 포함할 수 있다. 상기 정공수송층은 양극 또는 양극 상에 형성된 정공주입층으로부터 정공을 수취하여 발광층까지 정공을 수송하는 층으로, 정공 수송 물질을 포함한다. 상기 정공 수송 물질로는 양극이나 정공 주입층으로부터 정공을 수송받아 발광층으로 옮겨줄 수 있는 물질로 정공에 대한 이동성이 큰 물질이 적합하다. 구체적인 예로는 아릴아민 계열의 유기물, 전도성 고분자, 및 공액 부분과 비공액 부분이 함께 있는 블록 공중합체 등이 있으나, 이에 한정되는 것은 아니다.

[110]

[111] **전자저지층**

[112] 본 발명에 따른 유기 발광 소자는 필요에 따라 정공수송층과 발광층 사이에 전자저지층을 포함할 수 있다. 상기 전자저지층은 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 전자저지층은 전자저지물질을 포함하고, 이러한 전자저지물질의 예로 아릴아민 계열의 유기물 등을 사용할 수 있으나, 이에 한정되는 것은 아니다.

[113]

[114] **발광층**

[115] 본 발명에 따른 유기 발광 소자는 양극과 음극 사이에 발광층을 포함하고, 상기 발광층은 상기 제1 화합물, 상기 제2 화합물 및 상기 제3 화합물을 호스트 물질로 포함한다. 구체적으로, 상기 제1 화합물 및 상기 제2 화합물은 정공 수송 능력이 전자 수송 능력보다 우수한 P형 호스트 물질로 기능하고, 상기 제3 화합물은 전자 수송 능력이 정공 수송 능력보다 우수한 N형 호스트 물질로 기능하여, 발광층 내 정공과 전자의 비율을 적절하게 유지시킬 수 있다. 특히, 이와 같이

P형 호스트 물질로 상기 2종의 화합물을 조합하여 사용하는 경우 1종의 화합물만을 사용한 경우에 비하여 저전압 및 장수명 소자 특성을 나타낼 수 있다. 또한, 상기 3종의 호스트 물질을 채용한 소자는 다른 화합물간의 조합을 채용한 소자에 비하여, 고효율 및 장수명 특성을 나타낼 수 있다.

[116]

[117] 이하, 상기 제1 화합물, 상기 제2 화합물 및 상기 제3 화합물을 순차적으로 설명한다.

[118]

[119] **(제1 화합물)**

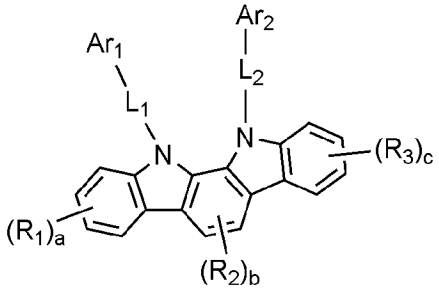
[120] 상기 제1 화합물은 상기 화학식 1로 표시된다. 구체적으로, 상기 제1 화합물은 인돌로카바졸 화합물로, 상기 화합물은 도펀트 물질로 정공을 수송하는 능력이 우수하여, 전자 수송 능력이 우수한 후술할 제3 화합물과 함께 발광층 내에서의 정공과 전자의 재결합 확률을 높일 수 있다.

[121]

[122] 상기 제1 화합물은, A의 융합 위치에 따라, 하기 화학식 1-1 내지 1-5 중 어느 하나로 표시될 수 있다:

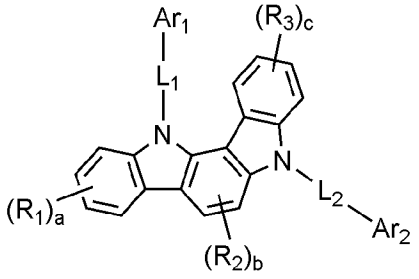
[123] [화학식 1-1]

[124]



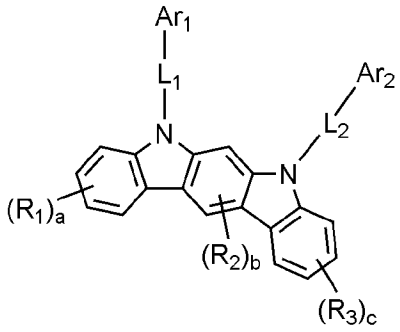
[125] [화학식 1-2]

[126]



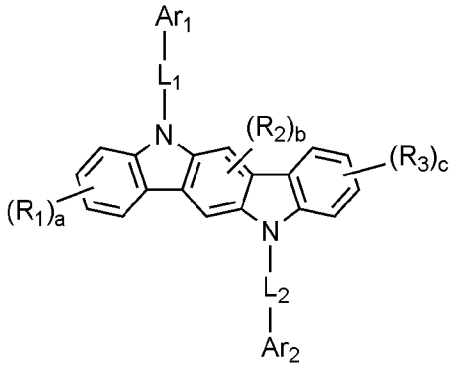
[127] [화학식 1-3]

[128]



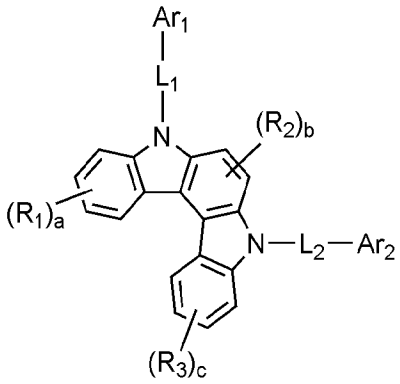
[129] [화학식 1-4]

[130]



[131] [화학식 1-5]

[132]



[133] 상기 1-1 내지 1-5에서,

[134] L_1, L_2, Ar_1, Ar_2, R_1 내지 R_3, a, b 및 c는 상기 화학식 1에서 정의한 바와 같다.

[135]

[136] 또한, 상기 화학식 1에서, L_1 및 L_2는 각각 독립적으로 단일 결합, 또는 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴렌일 수 있다.

[137]

[138] 구체적으로, L_1 및 L_2는 각각 독립적으로 단일 결합, 또는 페닐렌일 수 있다.

[139]

[140] 보다 구체적으로, L_1 및 L_2는 각각 독립적으로 단일결합, 1,2-페닐렌, 1,3-페닐렌, 또는 1,4-페닐렌일 수 있다. 예를 들어, L_1 및 L_2가 모두 단일결합이거나; 또는 L_1 및 L_2 중 하나는 단일결합이고, 다른 하나는 1,3-페닐렌, 또는 1,4-페닐렌일 수

있다.

[141]

[142] 또한, Ar_1 및 Ar_2는 각각 독립적으로 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 C_{6-20} 아릴; 또는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 N, O 및 S 중 1개의 헤테로원자를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[143]

[144] 구체적으로는, Ar_1 및 Ar_2는 모두 비치환되거나, 또는 중수소 및 C_{1-10} 알킬로 구성되는 군으로부터 선택되는 1개 또는 2개의 치환기로 치환된 C_{6-20} 아릴이거나; 또는 Ar_1 및 Ar_2 중 하나는 비치환되거나, 또는 중수소 및 C_{1-10} 알킬로 구성되는 군으로부터 선택되는 1개 또는 2개의 치환기로 치환된 C_{6-20} 아릴이고, 다른 하나는 비치환되거나, 또는 중수소로 치환된 N, O 및 S 중 1개 의 헤테로원자를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[145]

[146] 보다 구체적으로는, Ar_1 및 Ar_2는 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 또는 디벤조티오페닐이고,

[147] 여기서, Ar_1 및 Ar_2는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환될 수 있다.

[148]

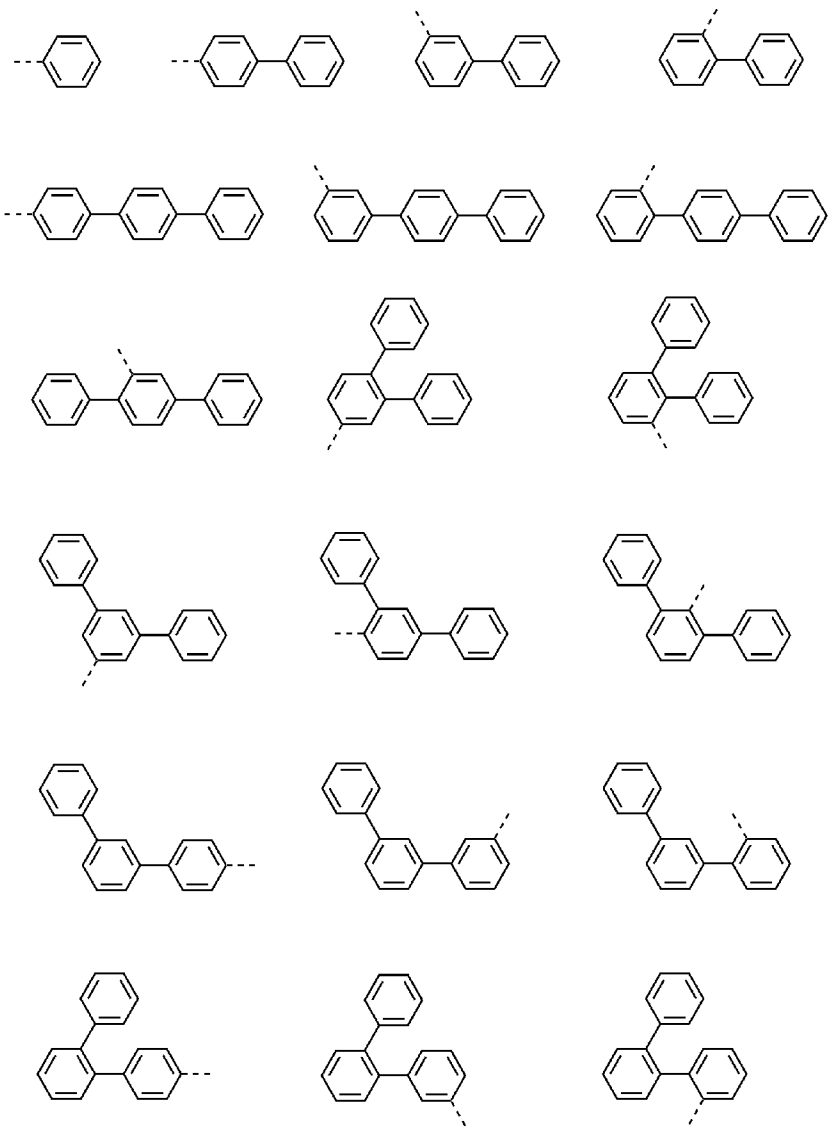
[149] 다시 말하여, Ar_1 및 Ar_2는 헤테로원자 N을 포함하는 6원-헤테로고리를 포함하지 않을 수 있다.

[150]

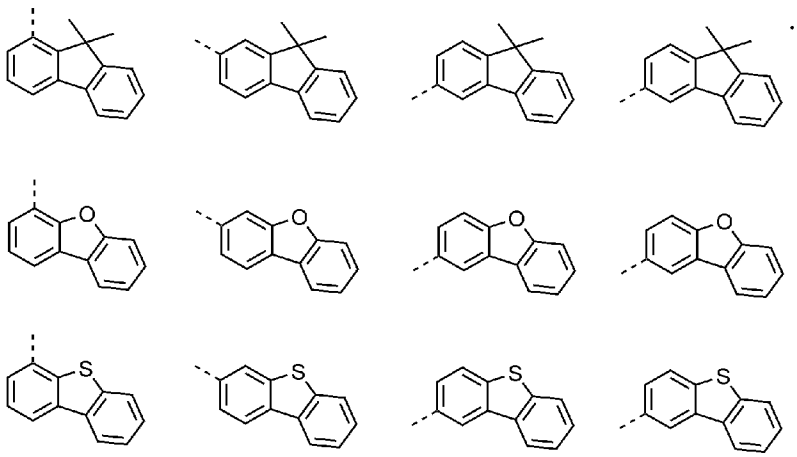
[151] 예를 들어, Ar_1 및 Ar_2는 하기로 구성되는 군으로부터 선택되는 어느 하나일 수 있으나, 이에 한정되는 것은 아니다:

[152]

[153]



[154]



[155]

[156] 이때, Ar_1 및 Ar_2는 서로 동일하거나 또는 상이할 수 있다.

[157]

[158] 또한, R_1 내지 R_3는 모두 수소이거나; 또는 모두 중수소일 수 있다.

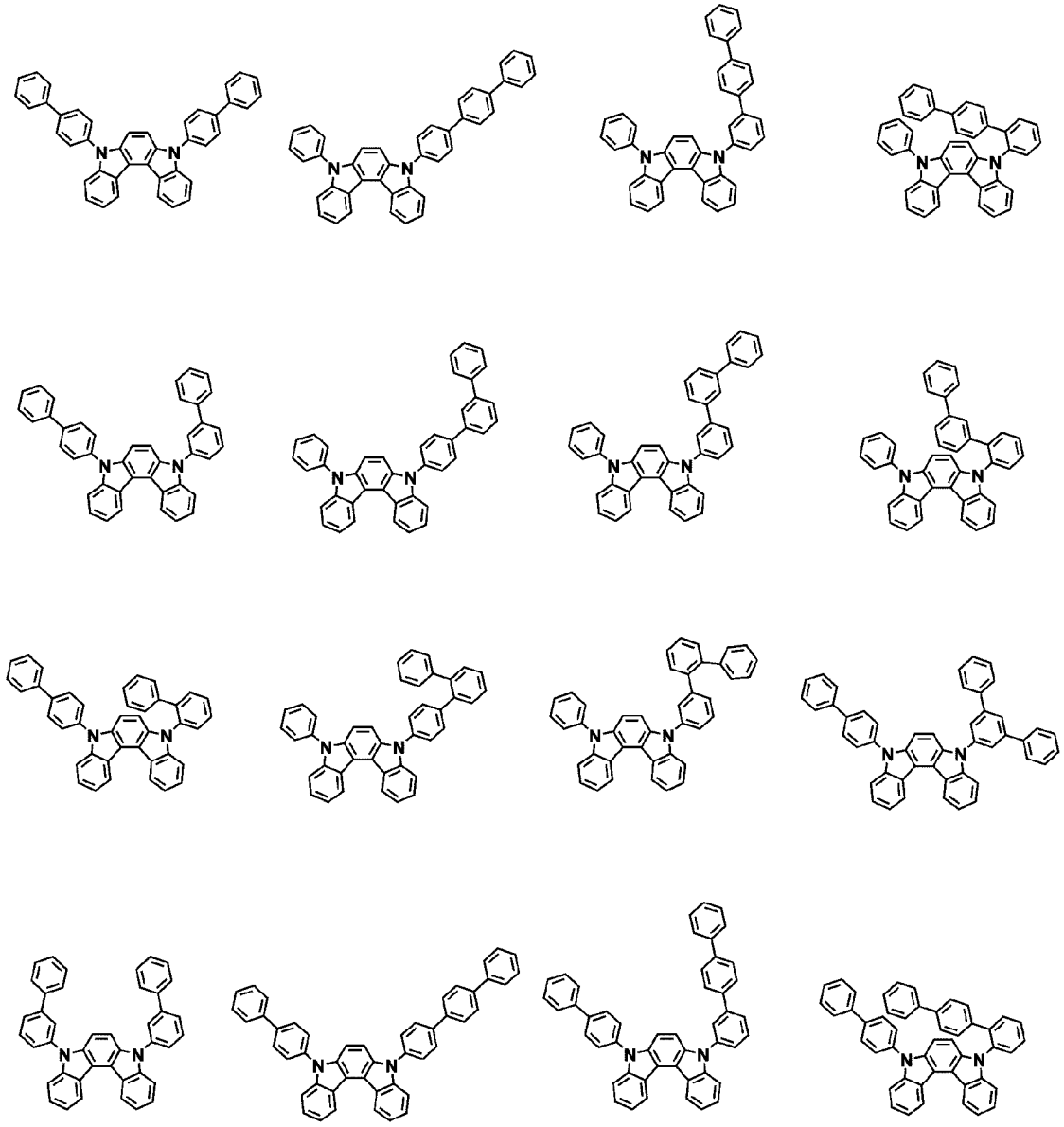
[159] 이때, R_1의 개수를 의미하는 a는 0, 1, 2, 3, 또는 4이고, R_2의 개수를 의미하는 b는 0, 1, 또는 2이고, R_3의 개수를 의미하는 c는 0, 1, 2, 3, 또는 4이다.

[160]

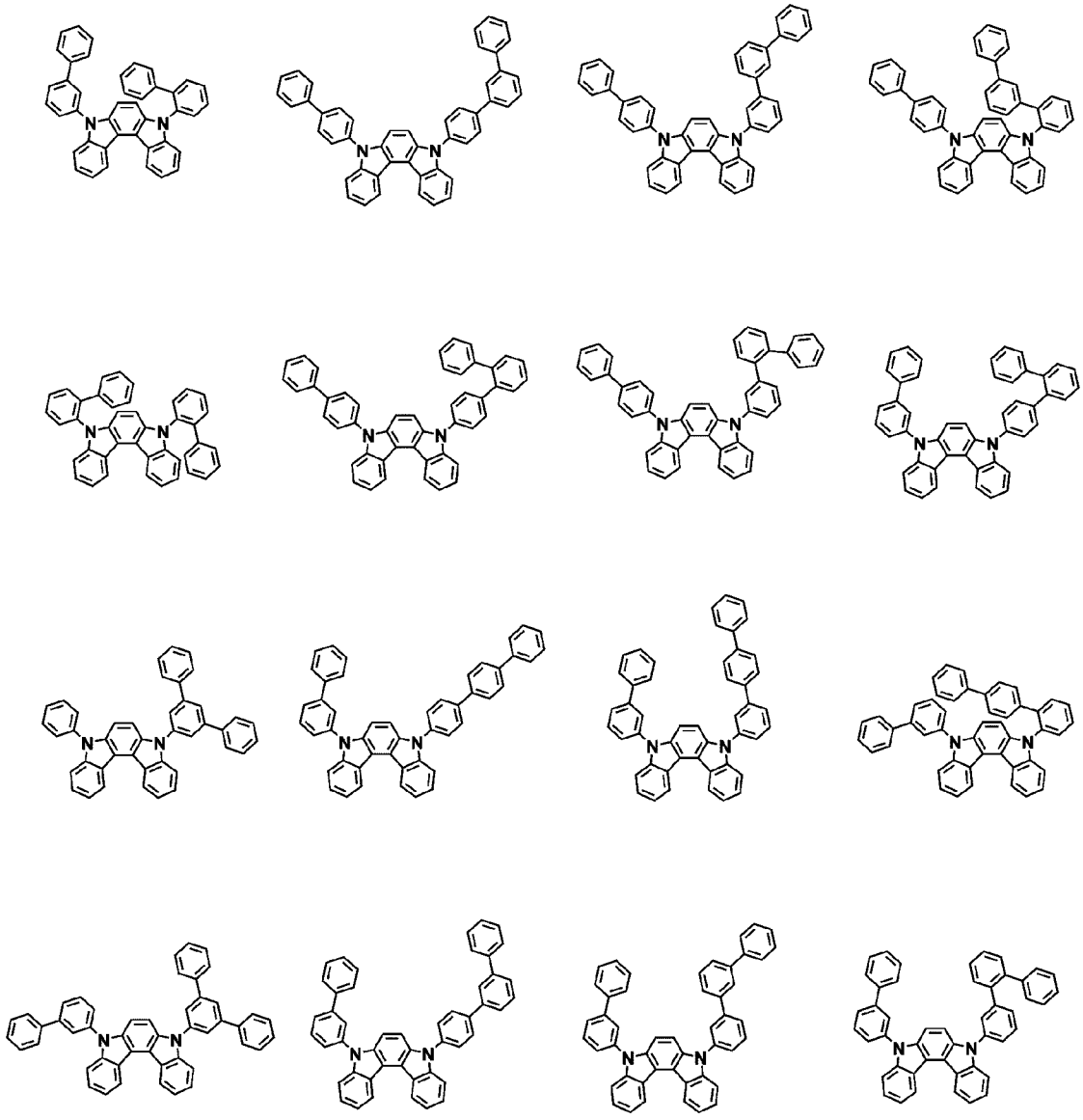
[161] 상기 화학식 1로 표시되는 제1 화합물의 대표적인 예는 하기와 같다:

[162]

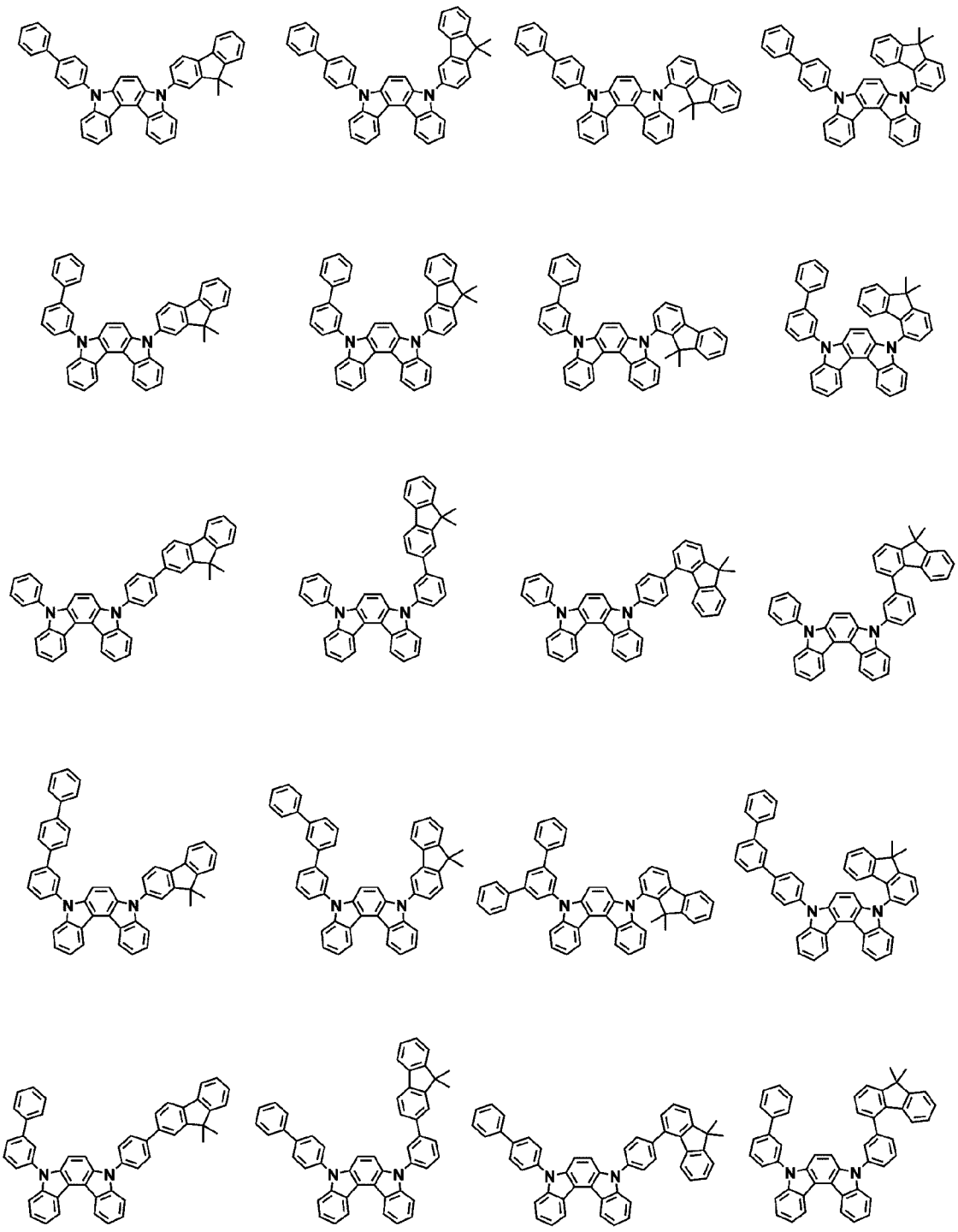
[163]



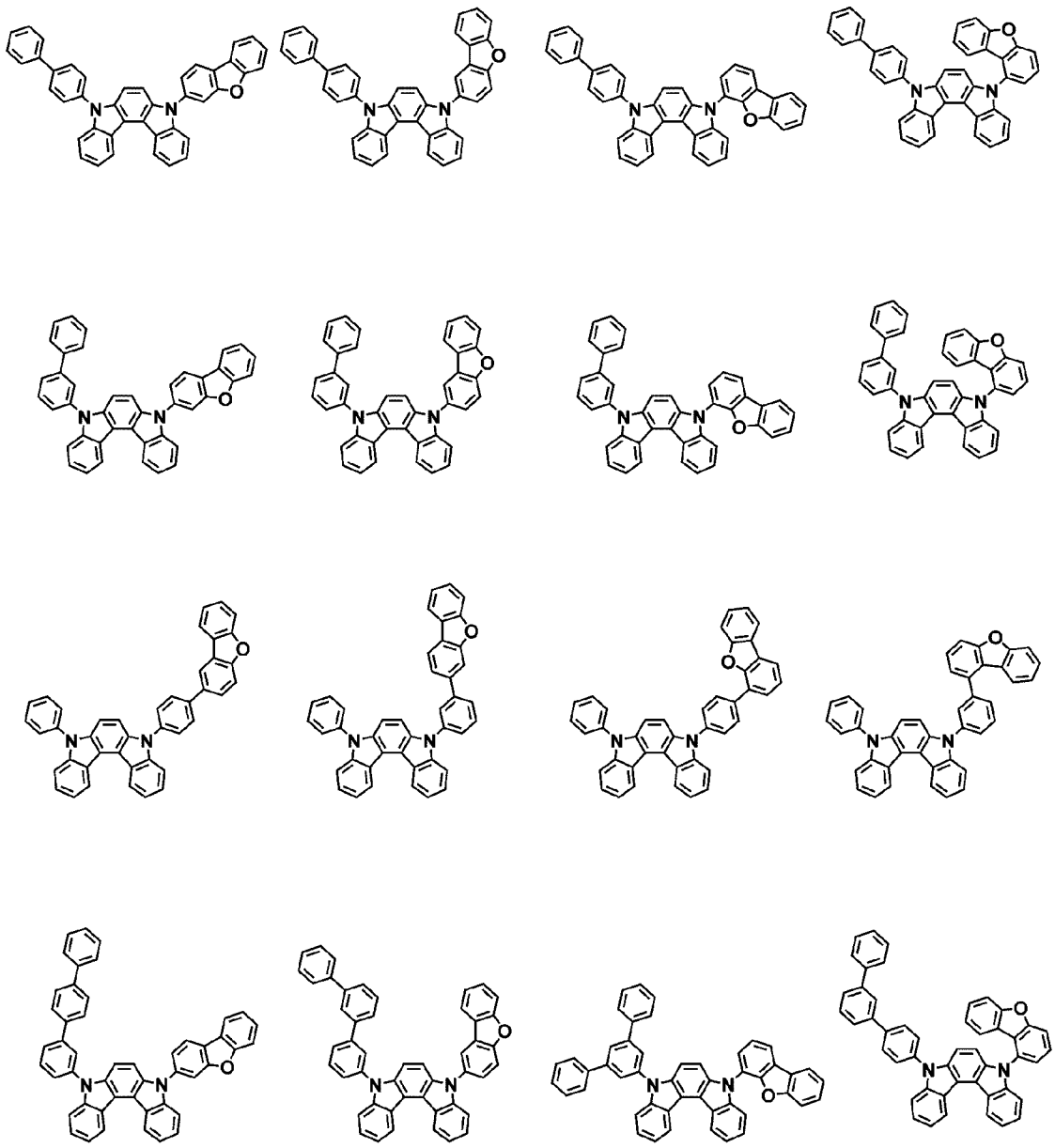
[164]



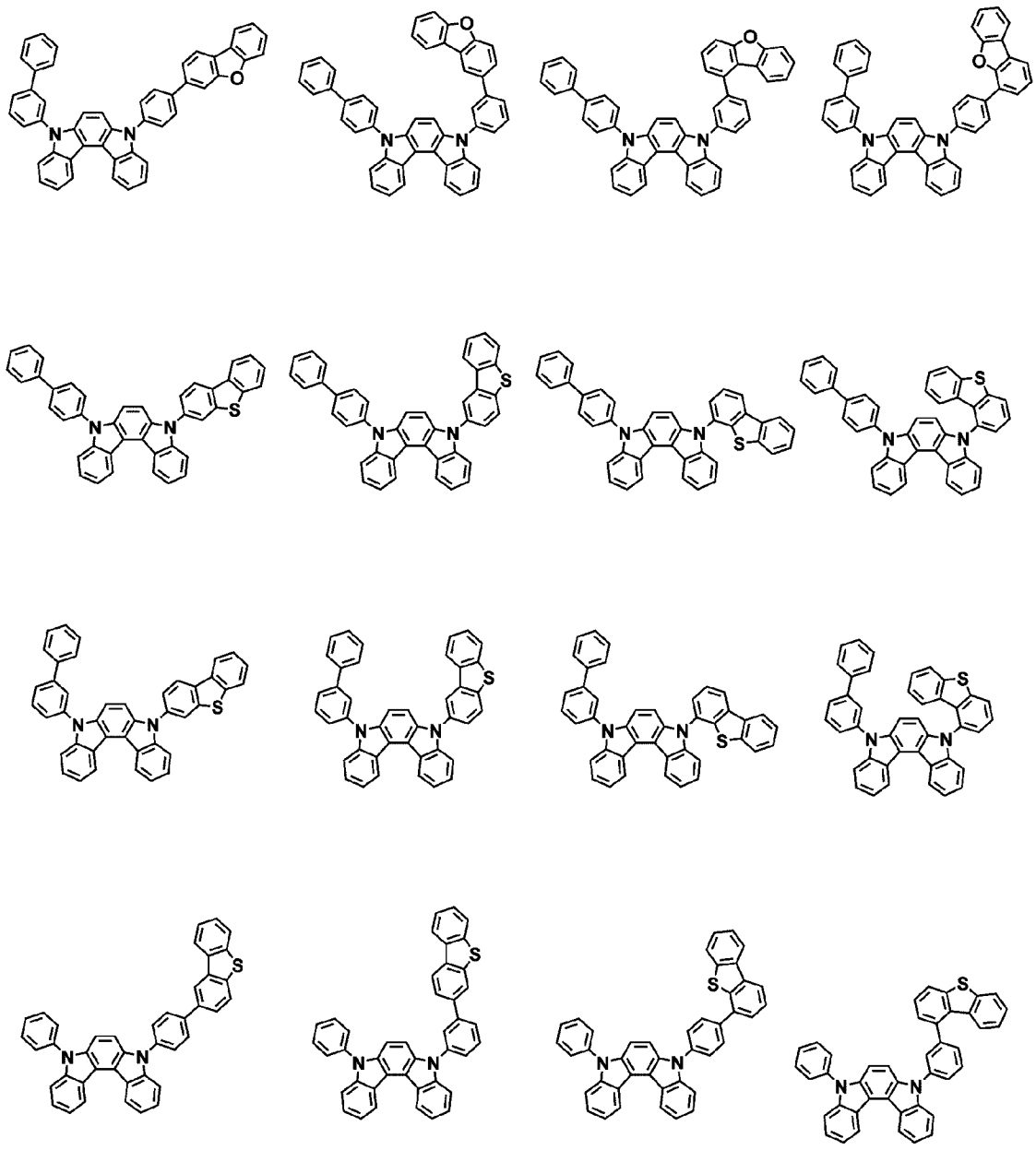
[165]



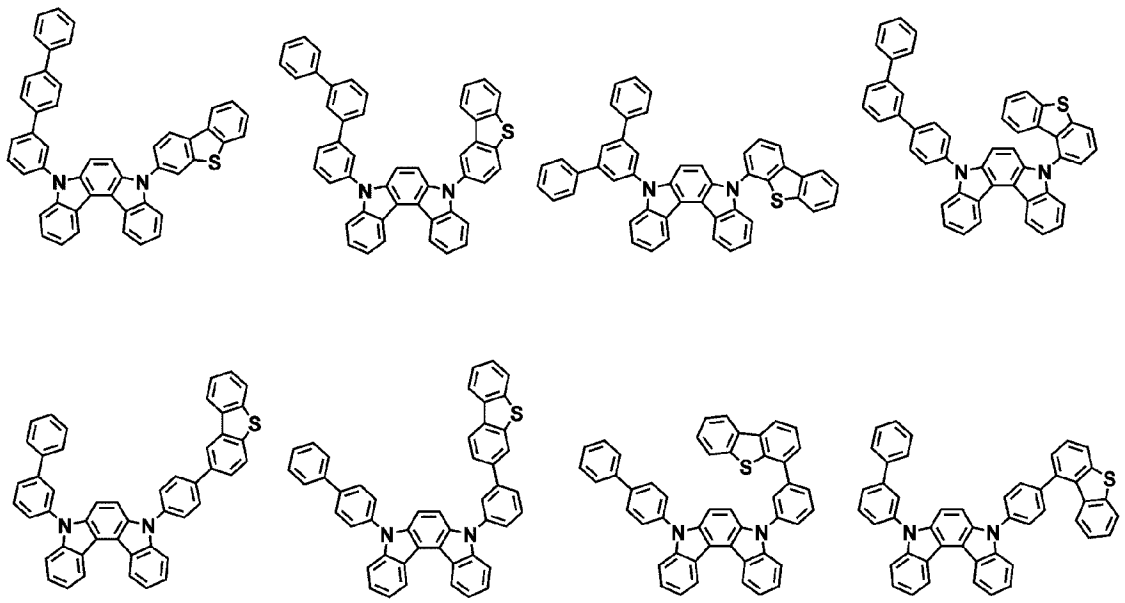
[166]



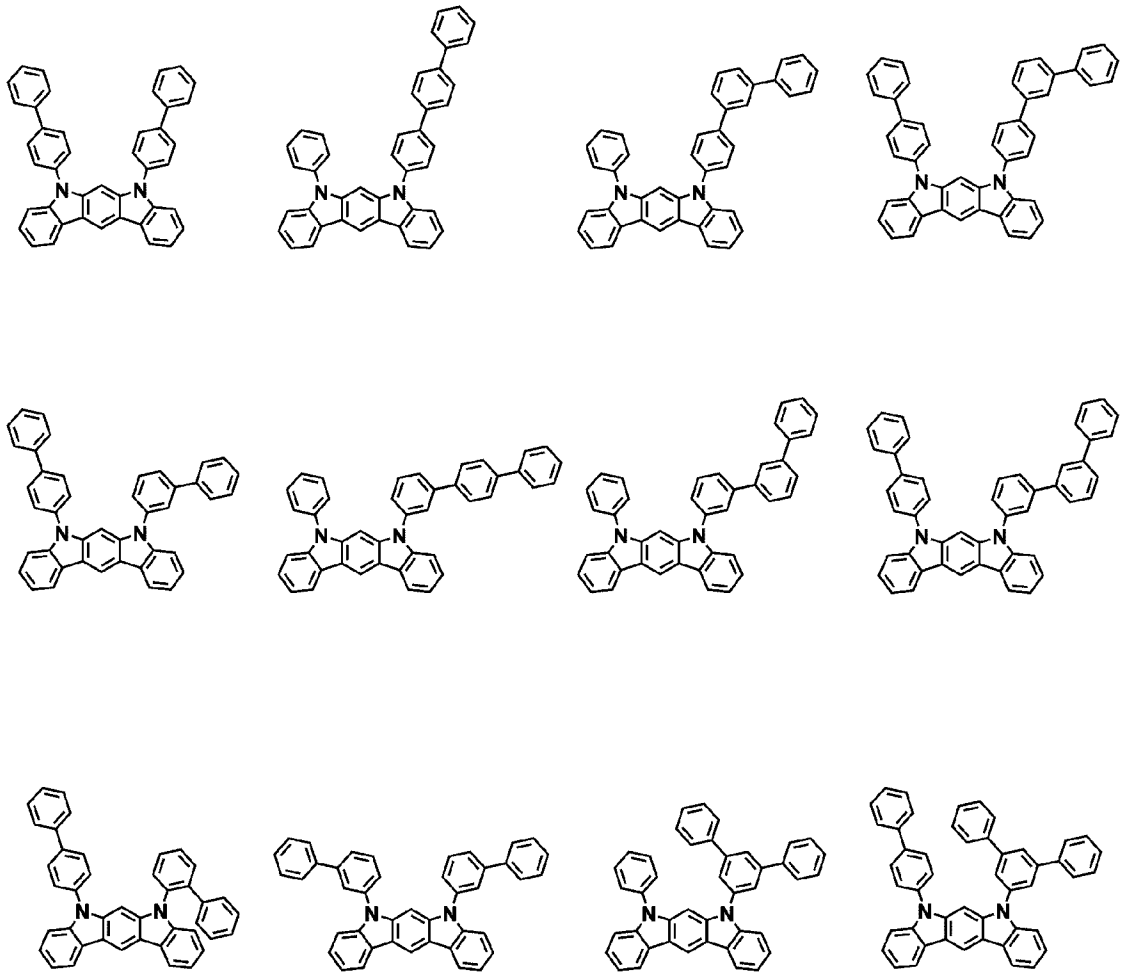
[167]



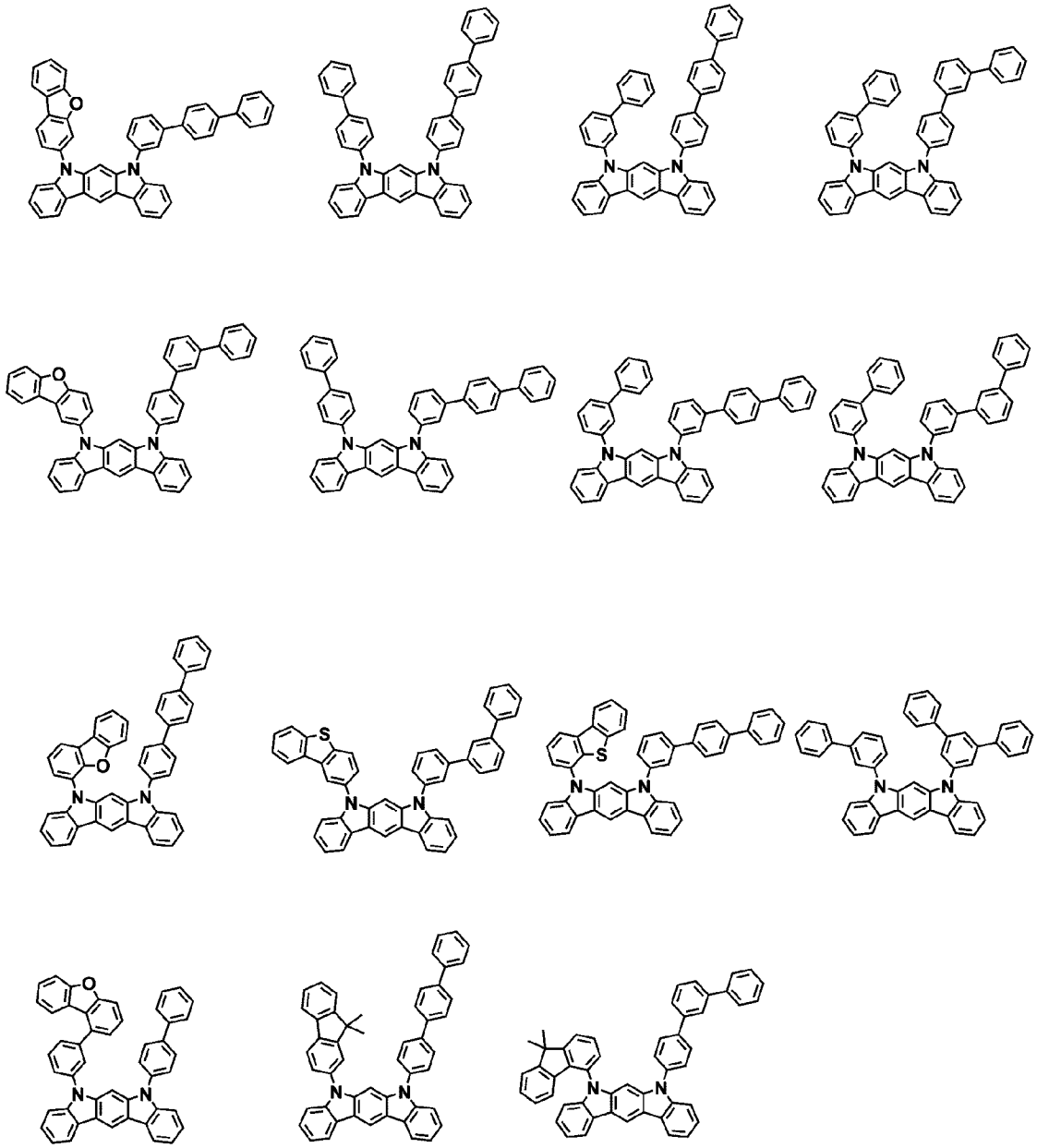
[168]



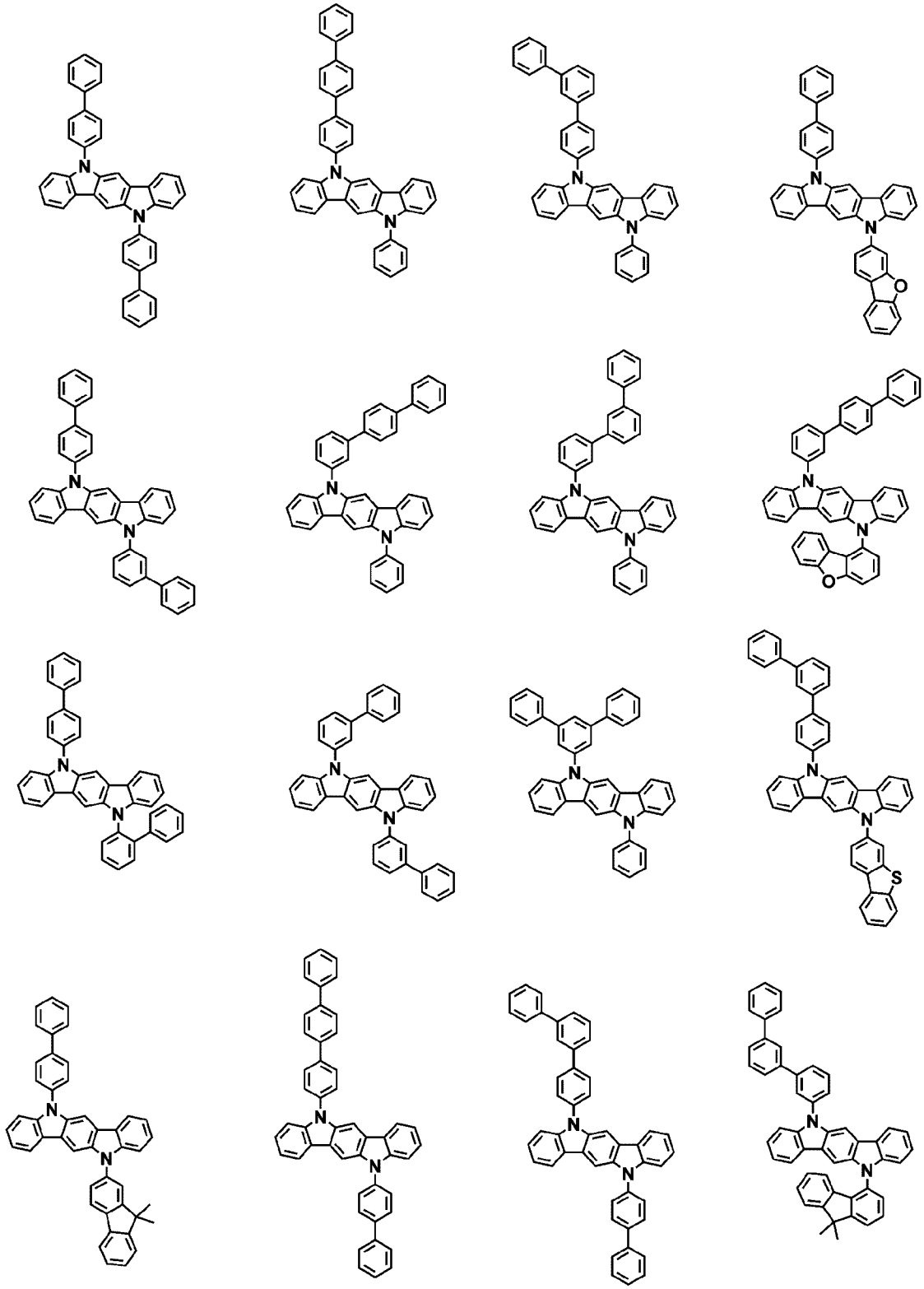
[169]



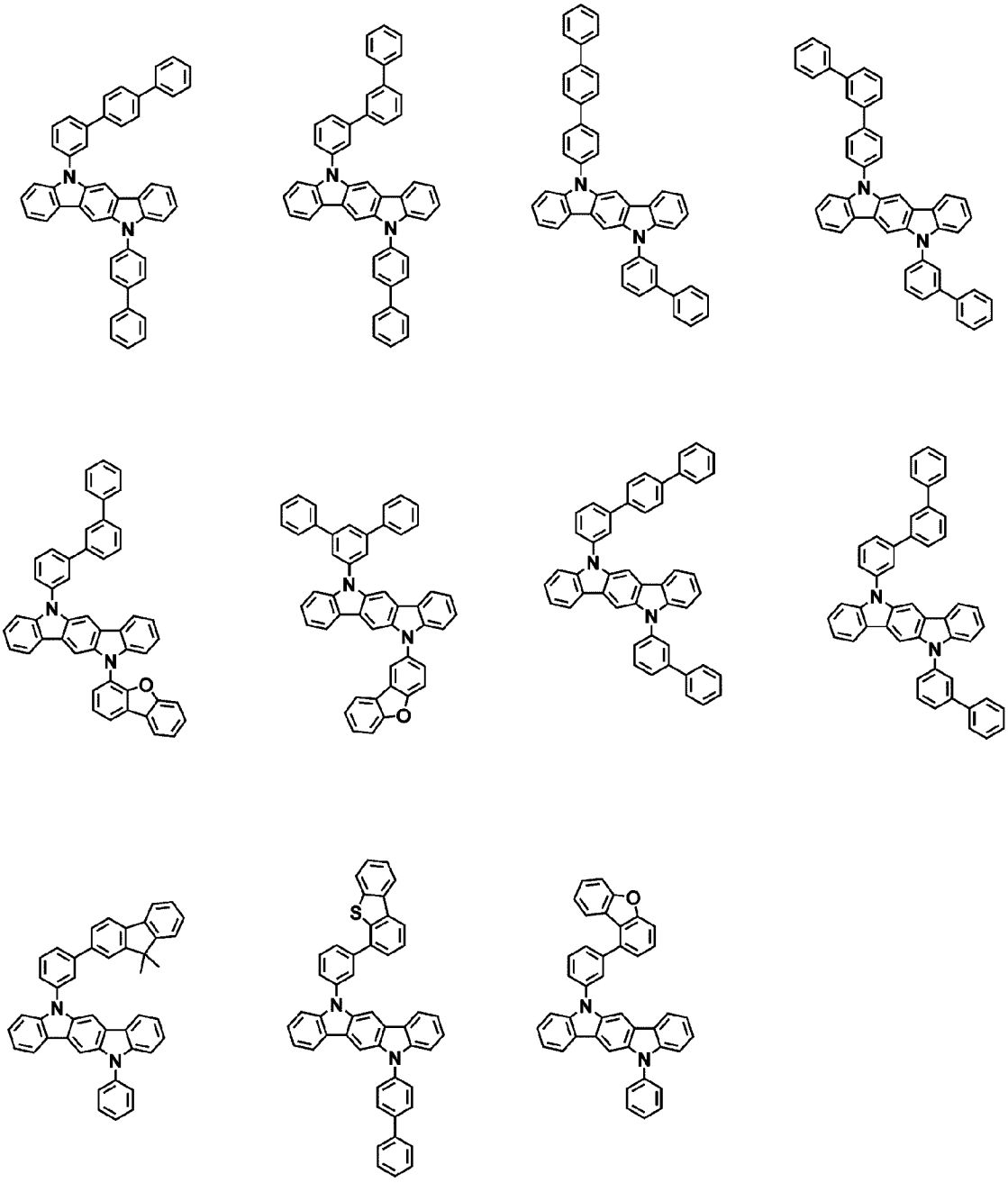
[170]



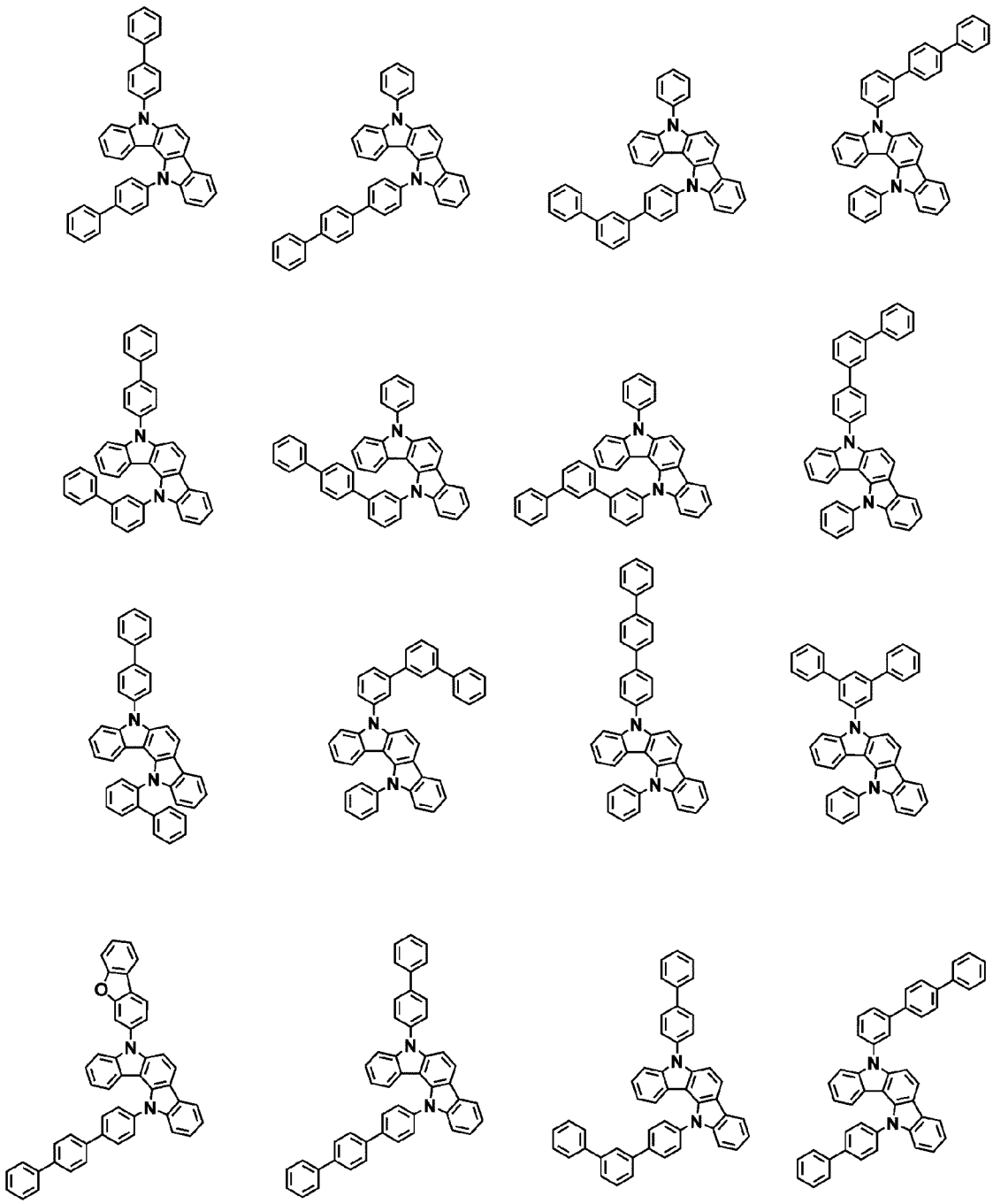
[171]



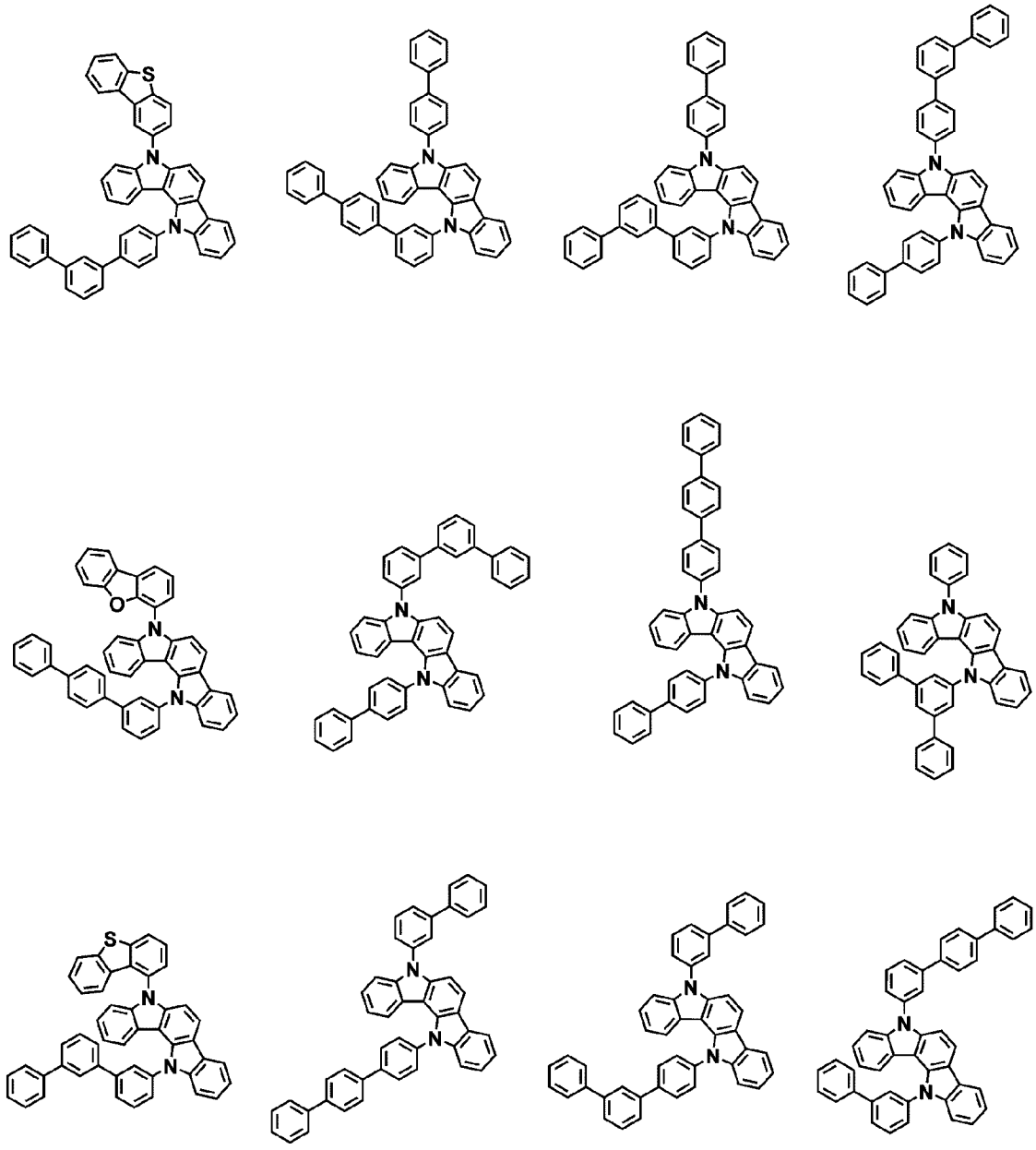
[172]



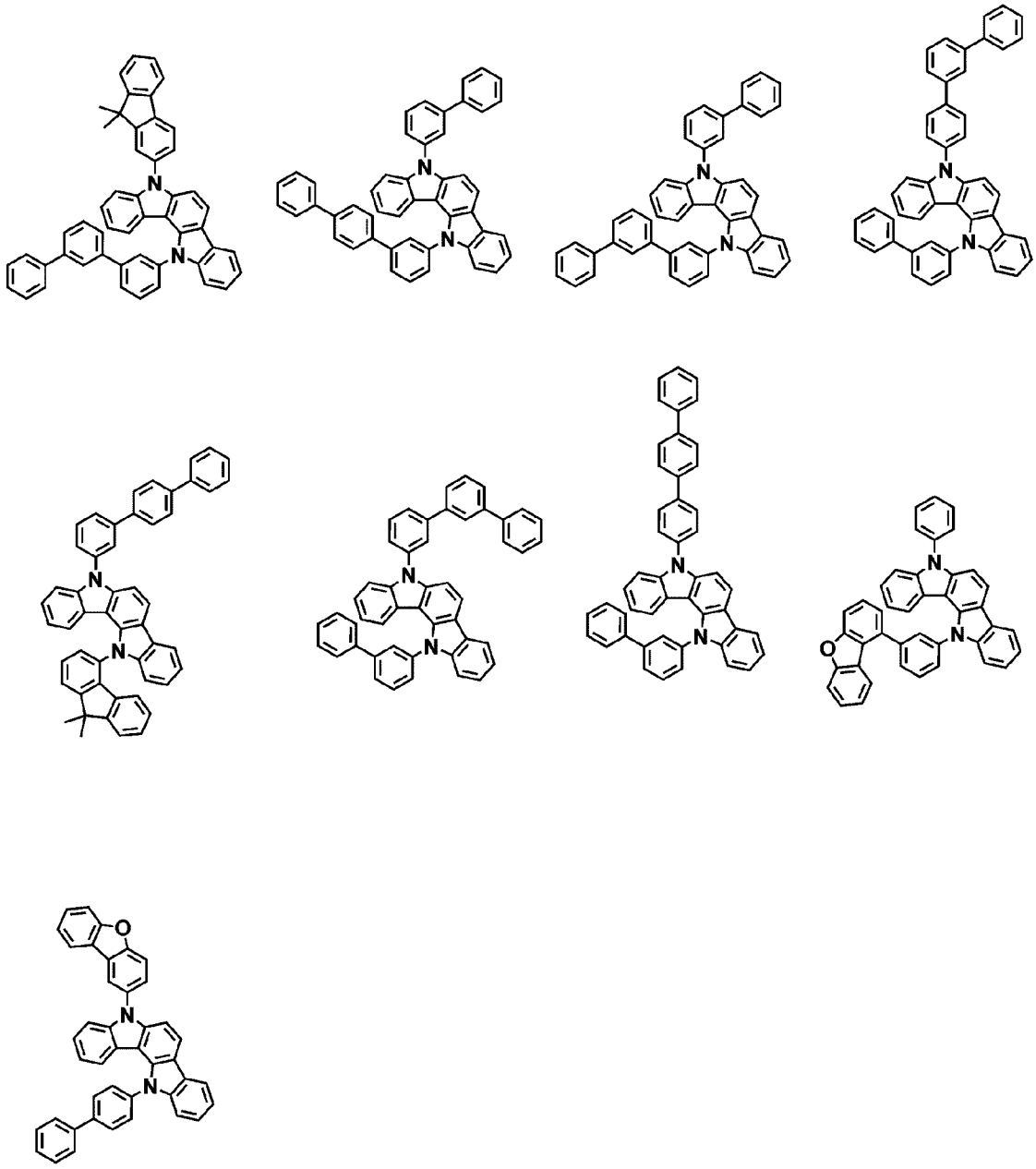
[173]



[174]



[175]



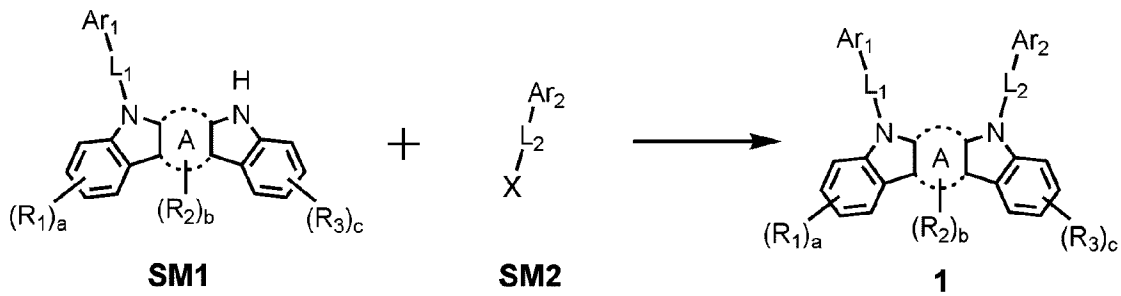
[176] .

[177]

[178] 한편, 상기 제1 화합물은 일례로 하기 반응식 1과 같은 제조 방법으로 제조할 수 있다.

[179] [반응식 1]

[180]



SM1 SM2 1

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

[182] 구체적으로, 상기 화학식 1로 표시되는 화합물은 아민 치환 반응을 통해 출발물질 SM1 및 SM2가 결합하여 제조된다. 이러한 아민 치환 반응은 각각 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.

[183]

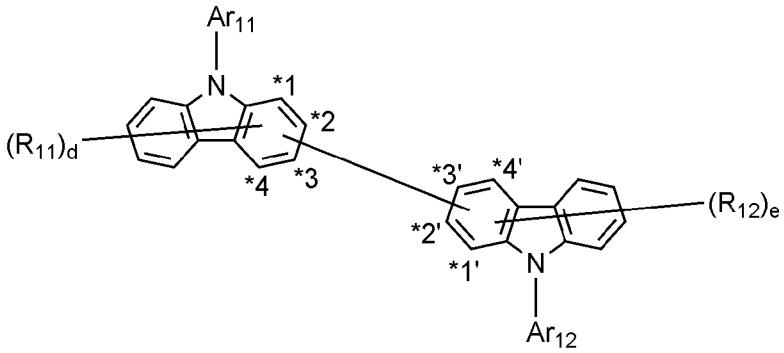
[184] **(제2 화합물)**

[185] 상기 제2 화합물은 상기 화학식 2로 표시되는 비스카바졸계 화합물로, 상기 제1 화합물과 마찬가지로 P형 호스트 역할을 하여 발광층 내에서 정공을 효율적으로 전달할 수 있고, 이에 따라 전자 수송 능력이 우수한 후술하는 제3 화합물과 함께 발광층 내에서의 정공과 전자의 재결합 확률을 높일 수 있다.

[186]

[187] 상기 화학식 2에서, 2개의 카바졸 구조의 결합 위치를 표시하면 하기와 같다:

[188] [화학식 2]

[189] 

[190] 상기 화학식 2에서,

[191] 각 치환기에 대한 설명은 상술한 바와 같고,

[192] 2개의 카바졸 구조를 연결하는 단일 결합은,

[193] 좌측 카바졸 구조의 *1번 위치의 탄소, 2번 위치의 탄소, *3번 위치의 탄소 및 *4번 위치의 탄소 중 어느 하나와,

[194] 우측 카바졸 구조의 *1'번 위치의 탄소, *2'번 위치의 탄소, *3'번 위치의 탄소 및 *4'번 위치의 탄소 중 어느 하나와 연결될 수 있다.

[195]

[196] 보다 구체적으로, 상기 제2 화합물은 좌측 카바졸 구조 및 우측 카바졸 구조에서, (*1번 위치의 탄소, *1'번 위치의 탄소), (*2번 위치의 탄소, *2'번 위치의 탄소), (*3번 위치의 탄소, *3'번 위치의 탄소), 또는 (*4번 위치의 탄소, *4'번 위치의 탄소)끼리 연결되어 결합될 수 있다.

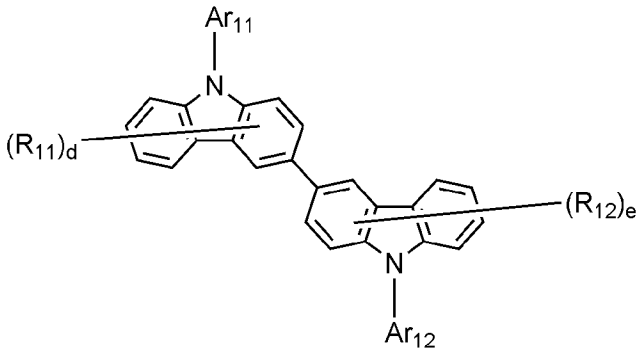
[197]

[198] 일 구현예에 따르면, 상기 제2 화합물은 (좌측 카바졸 구조의 *3번 위치의 탄소,

우측 카바졸 구조의 *3'번 위치의 탄소)가 결합된 구조인, 하기 화학식 2-1로 표시될 수 있다:

[199] [화학식 2-1]

[200]



[201] 상기 화학식 2'에서,

[202] Ar_{11}, Ar_{12}, R_{11} 및 R_{12}, d 및 e는 상기 화학식 2에서 정의한 바와 같다.

[203]

[204] 또한, Ar_{11} 및 Ar_{12}는 각각 독립적으로 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 C_{6-20} 아릴; 또는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 N, O 및 S 중 1개의 헤테로원자를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[205]

[206] 구체적으로는, Ar_{11} 및 Ar_{12}는 모두 비치환되거나, 또는 중수소 및 C_{1-10} 알킬로 구성되는 군으로부터 선택되는 1개 또는 2개의 치환기로 치환된 C_{6-20} 아릴이거나; 또는 Ar_{11} 및 Ar_{12} 중 하나는 비치환되거나, 또는 중수소 및 C_{1-10} 알킬로 구성되는 군으로부터 선택되는 1개 또는 2개의 치환기로 치환된 C_{6-20} 아릴이고, 다른 하나는 비치환되거나, 또는 중수소로 치환된 N, O 및 S 중 1개 의 헤테로원자를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[207]

[208] 보다 구체적으로는, Ar_{11} 및 Ar_{12}는 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 또는 디벤조티오페닐이고,

[209] 여기서, Ar_{11} 및 Ar_{12}는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환될 수 있다.

[210]

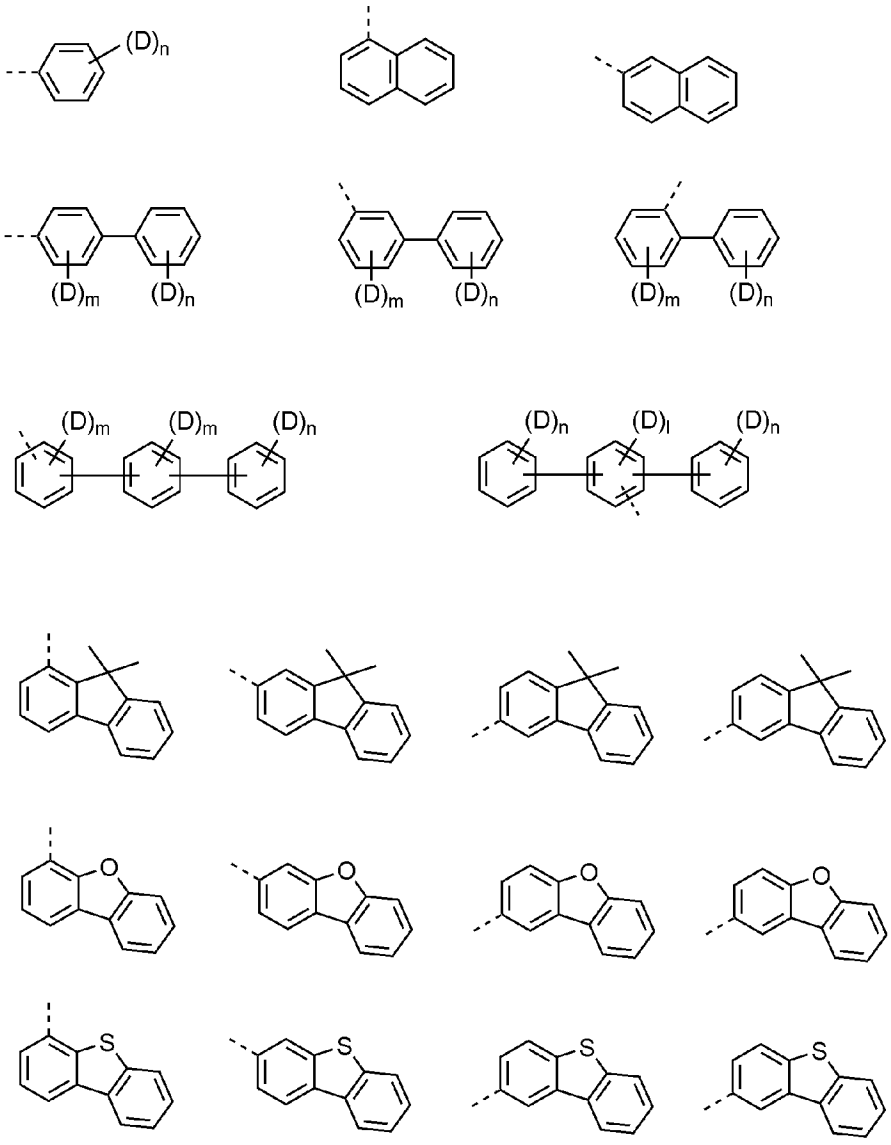
[211] 다시 말하여, Ar_{11} 및 Ar_{12}는 헤테로원자 N을 포함하는 6원-헤테로고리를 포함하지 않을 수 있다.

[212]

[213] 예를 들어, Ar_{11} 및 Ar_{12}는 하기로 구성되는 군으로부터 선택되는 어느 하나일 수 있으나, 이에 한정되는 것은 아니다:

[214]

[215]



[216] 상기에서,

[217] D는 중수소이고,

[218] n은 0 내지 5의 정수이고,

[219] m은 0 내지 4의 정수이고,

[220] l은 0 내지 3의 정수이다.

[221]

[222] 이때, Ar_{11} 및 Ar_{12} 중 적어도 하나는 페닐 또는 비페닐릴일 수 있다.

[223]

[224] 또한, Ar_{11} 및 Ar_{12}는 서로 동일하거나 또는 상이할 수 있다.

[225]

[226] 또한, 상기 화학식 2에서, R_{11} 및 R_{12}는 각각 독립적으로 수소, 중수소, 또는 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴일 수 있다.

[227]

[228] 예를 들어, R_{11} 및 R_{12}는 각각 독립적으로 수소, 중수소, 또는 페닐일 수 있으나,

이에 한정되는 것은 아니다.

[229]

[230] 또한, R_{11} 및 R_{12}의 개수를 각각 나타내는, d 및 e는 각각 독립적으로 0, 1, 2, 3, 4, 5, 6, 또는 7일 수 있다.

[231]

[232] 보다 구체적으로, d 및 e는 각각 독립적으로 0, 1, 또는 7일 수 있다.

[233]

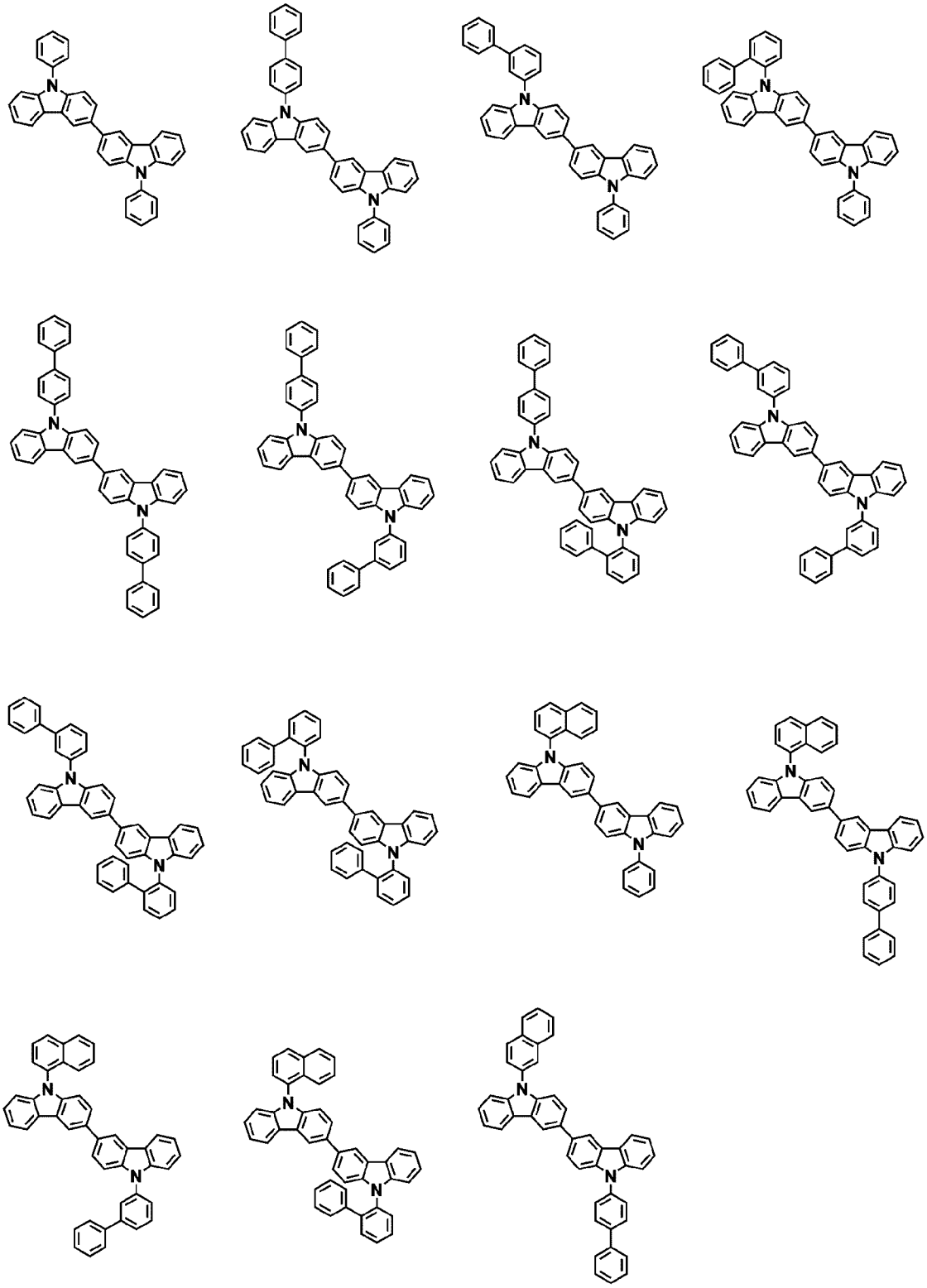
[234] 예를 들어, d+e는 0 또는 1일 수 있다.

[235]

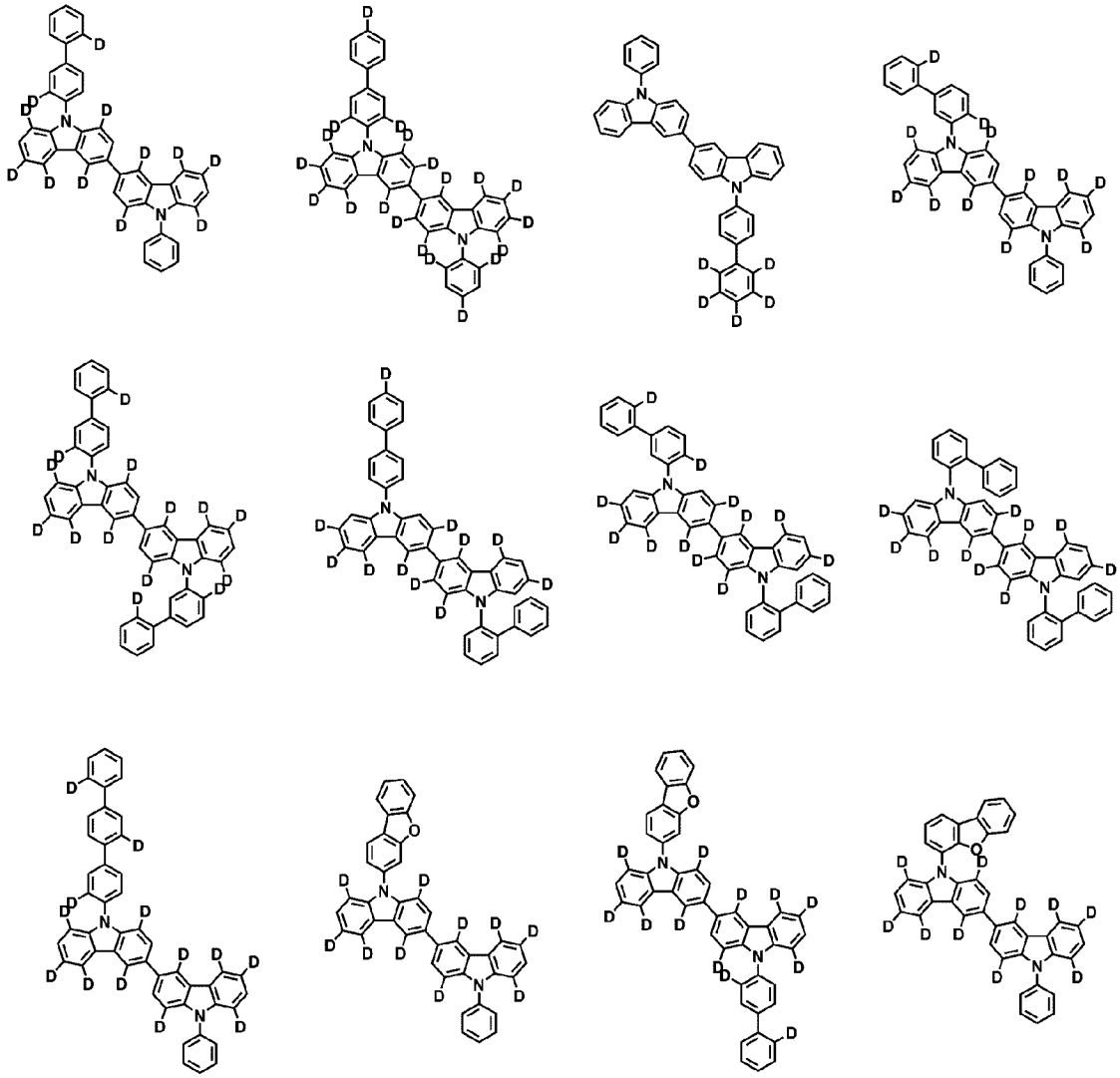
[236] 상기 화학식 2로 표시되는 제2 화합물의 대표적인 예는 하기와 같다:

[237]

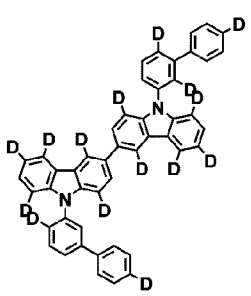
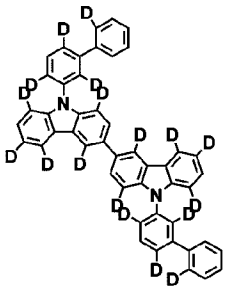
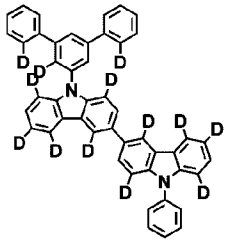
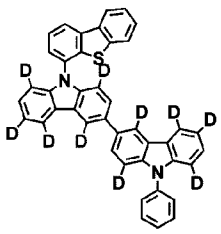
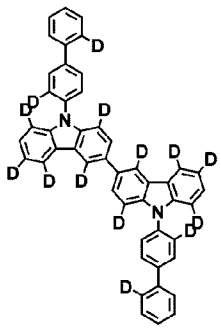
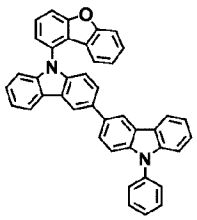
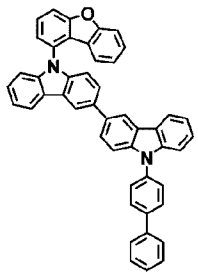
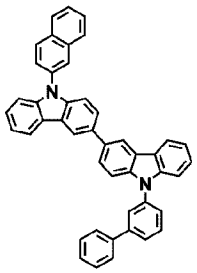
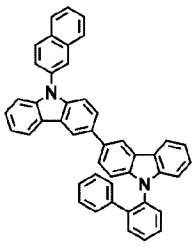
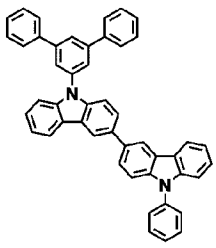
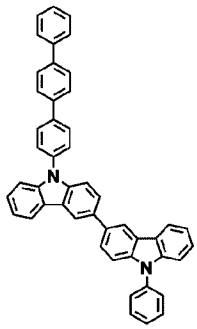
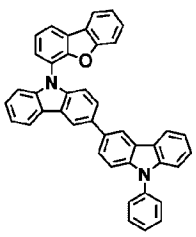
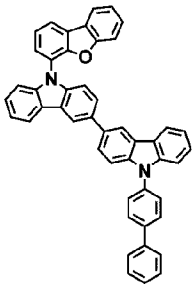
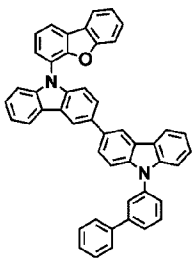
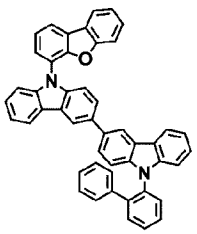
[238]



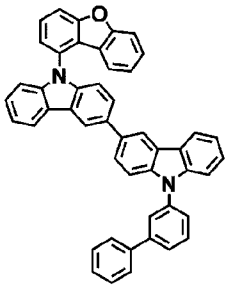
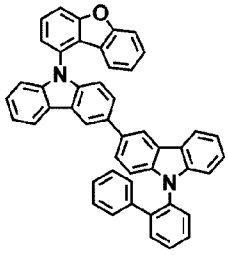
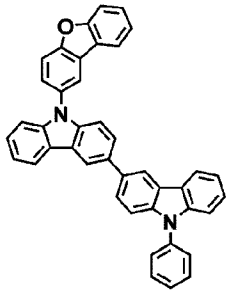
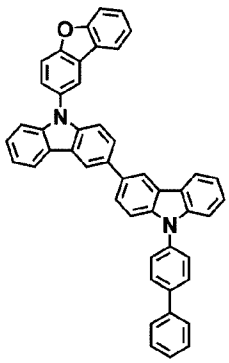
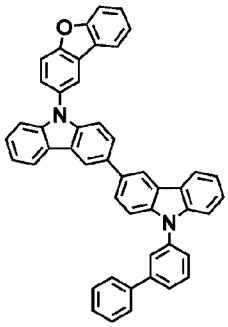
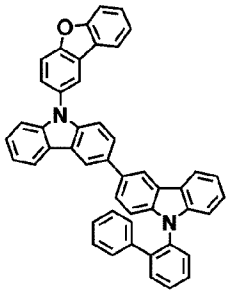
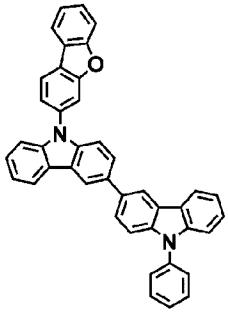
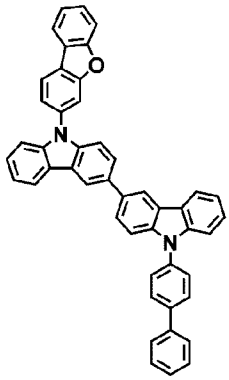
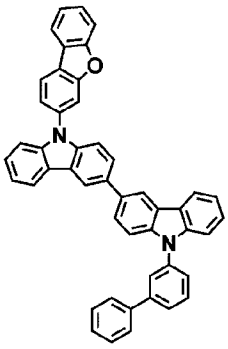
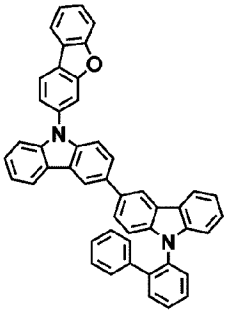
[239]



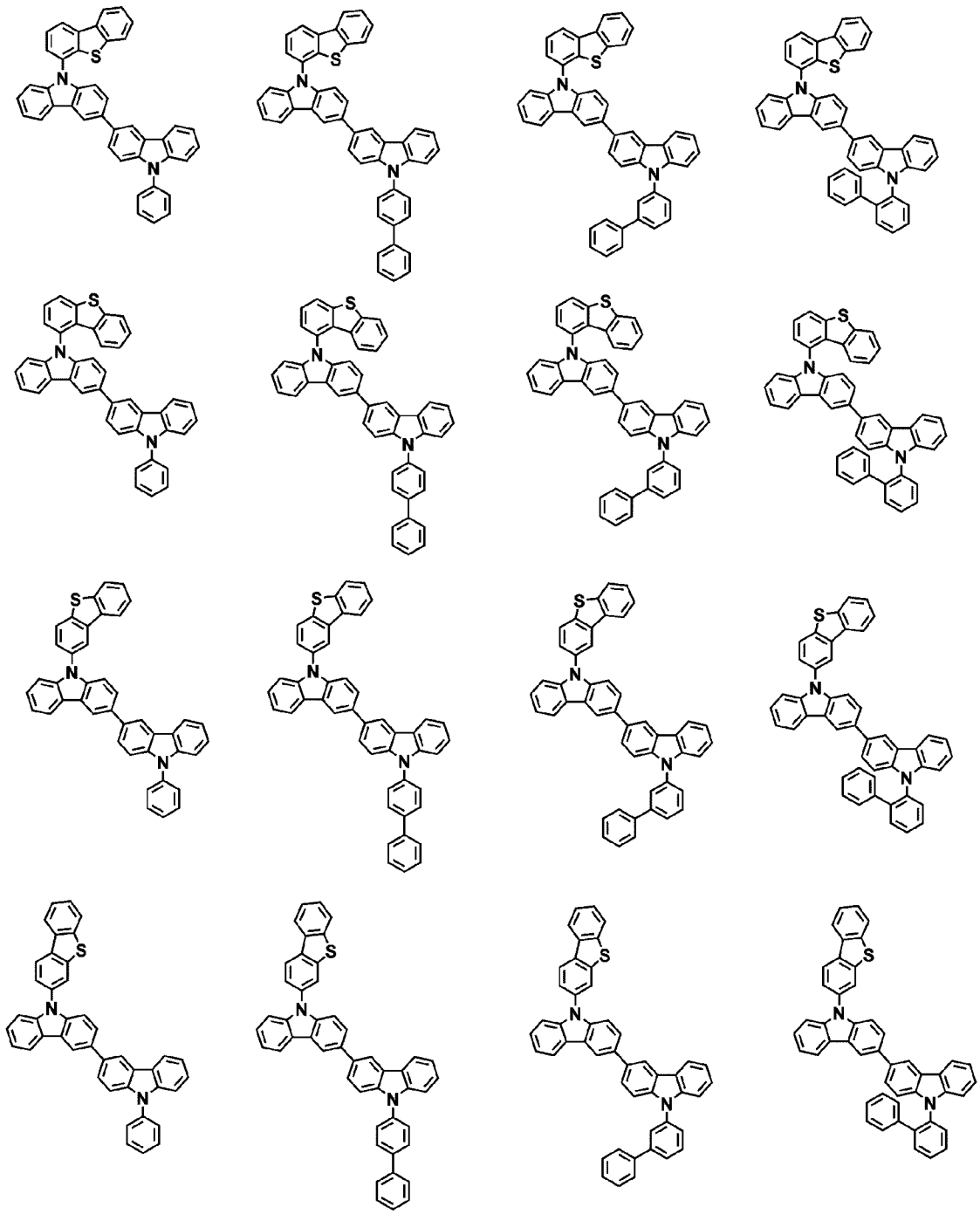
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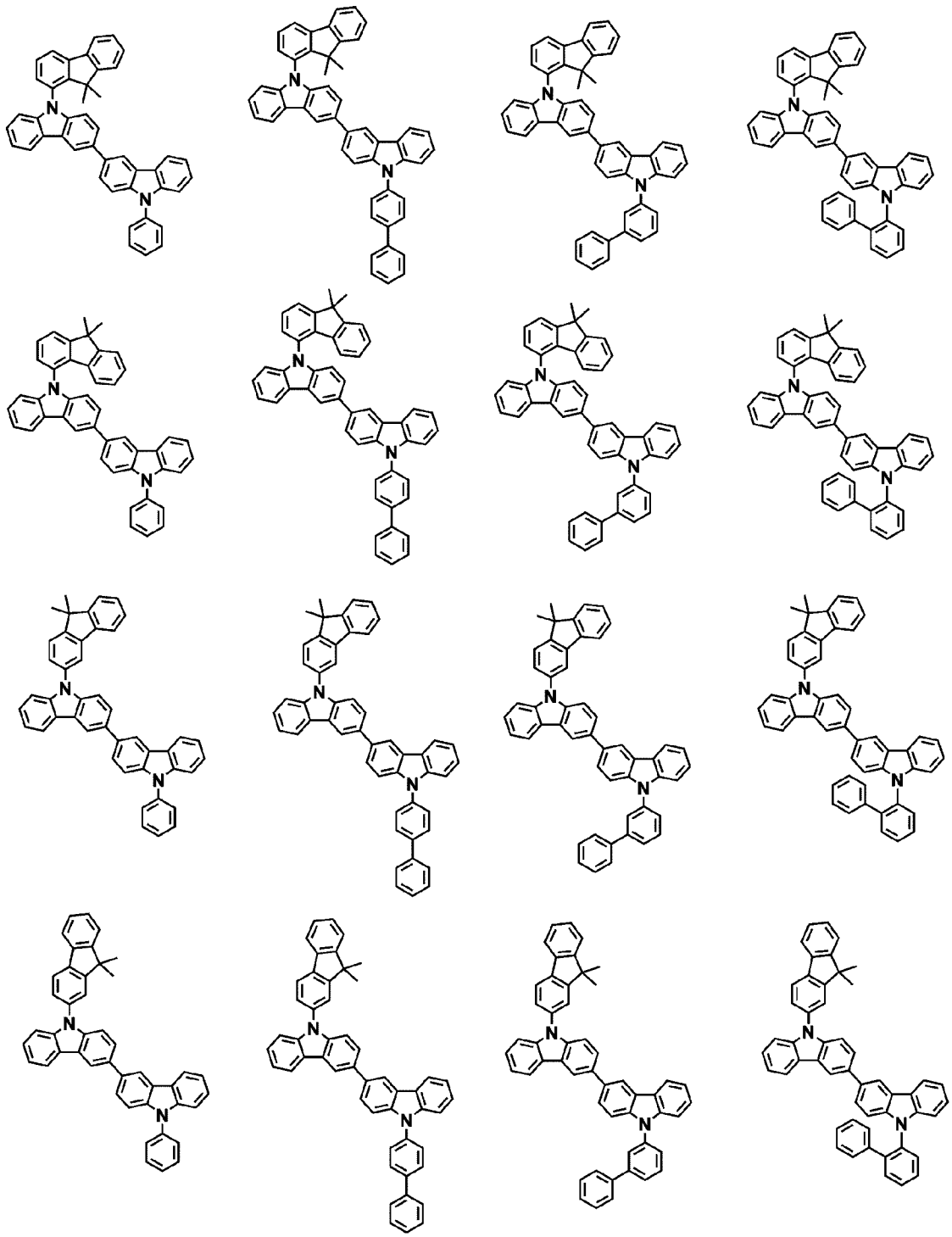
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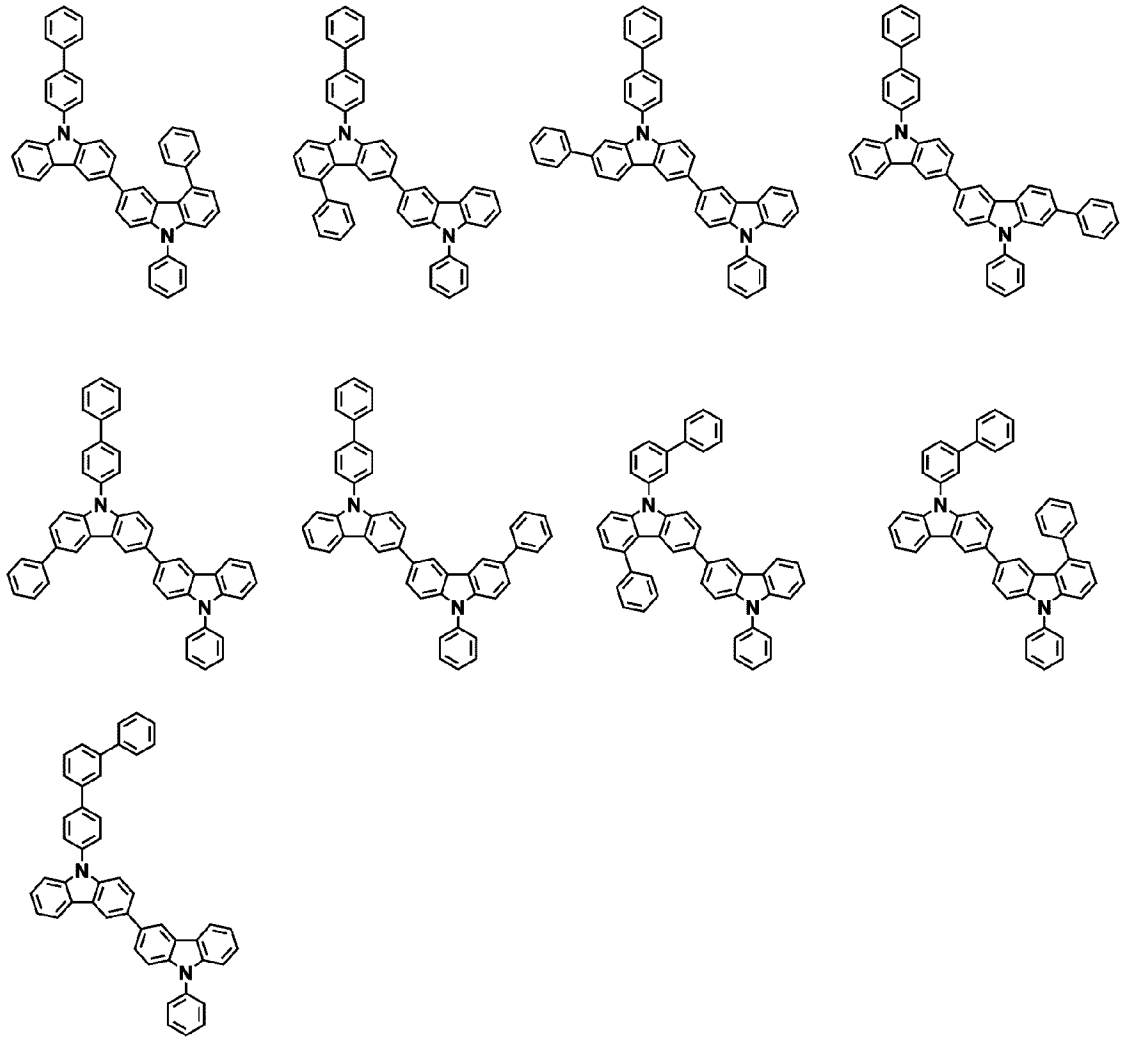











[242]



[243]



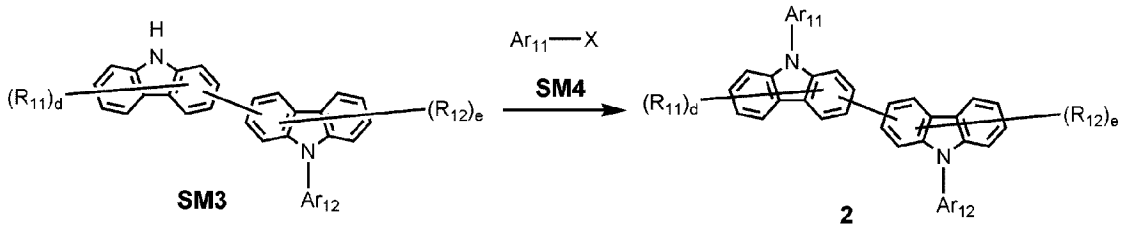
[244] 

[245] .

[246]

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

[248] [반응식 2]

[249] 

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

[251] 구체적으로, 상기 화학식 2로 표시되는 화합물은 아민 치환 반응을 통해 출발물질 SM3 및 SM4가 결합하여 제조된다. 이러한 아민 치환 반응은 각각 팔라듐 촉매와 염기의 존재 하에 수행하는 것이 바람직하다. 또한, 상기 아민

치환 반응을 위한 반응기는 적절히 변경될 수 있고, 화학식 2로 표시되는 화합물의 제조 방법은 후술할 제조예에서 보다 구체화될 수 있다.

[252]

[253] **(제3 화합물)**

[254] 상기 화합물은 디벤조퓨란/디벤조티오펜 코어의 한 쪽 벤젠 고리에는 N 함유 6-원 헤테로 고리가 치환되고, 다른 한 쪽 벤젠 고리에는 1개의 아릴/헤테로아릴기가 치환된 구조를 갖는다. 이러한 제3 화합물은 1) 디벤조퓨란/디벤조티오펜 코어의 한 쪽 벤젠 고리에는 N 함유 6-원 헤테로고리가 치환되었으나, 다른 한 쪽 벤젠 고리에는 중수소 외의 치환기를 갖지 않는 화합물 및 2) 디벤조퓨란/디벤조티오펜 코어의 한 쪽 벤젠 고리에 N 함유 6-원 헤테로고리와 아릴/ 헤테로아릴기가 동시에 치환된 화합물에 비하여, 전자 수송 능력이 우수하여, 도펀트 물질로 전자를 효율적으로 전달함에 따라 발광층에서의 전자-정공 재결합 확률을 높일 수 있다.

[255]

[256] 상기 화학식 3에서, X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH일 수 있다.

[257]

[258] 또한, L은 단일 결합일 수 있다.

[259]

[260] 또한, Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴일 수 있다.

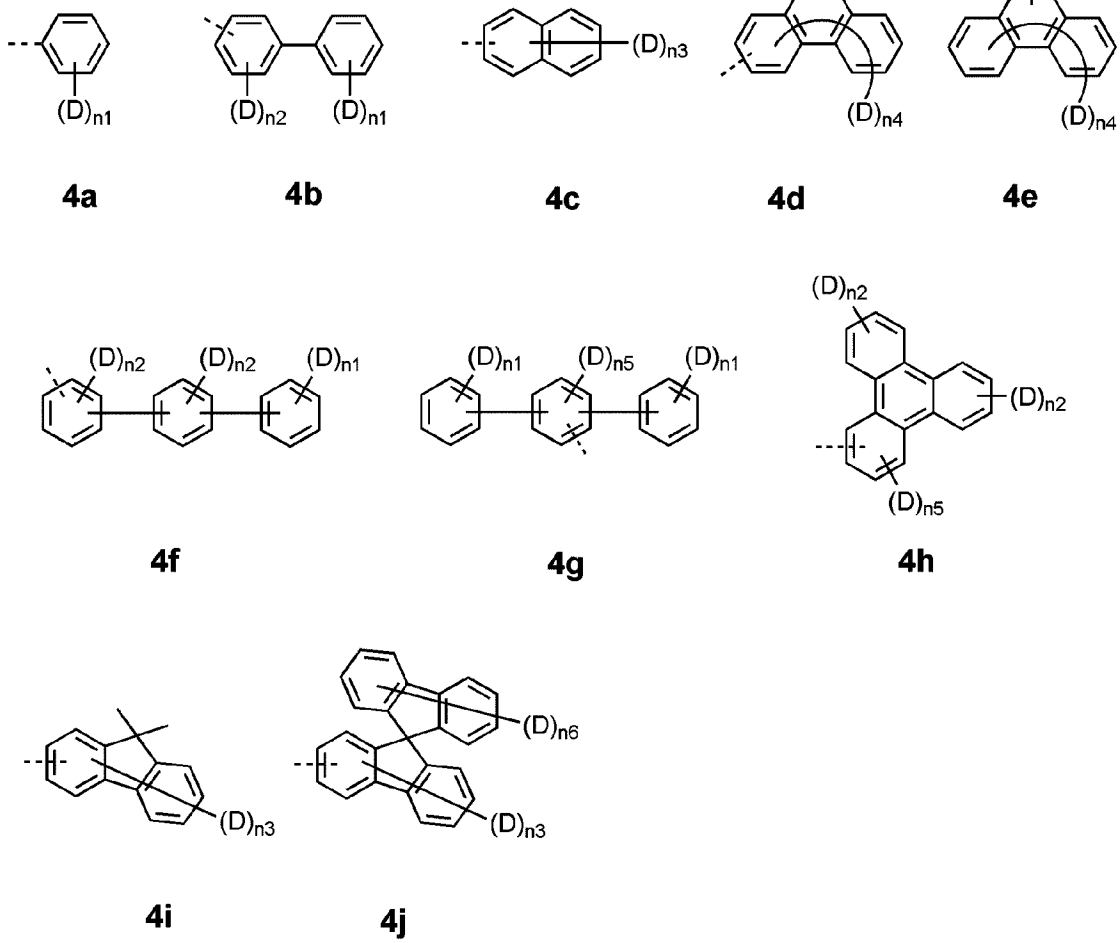
[261] 또는, Ar_{21}은 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[262] 또는, Ar_{21}은 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴일 수 있다.

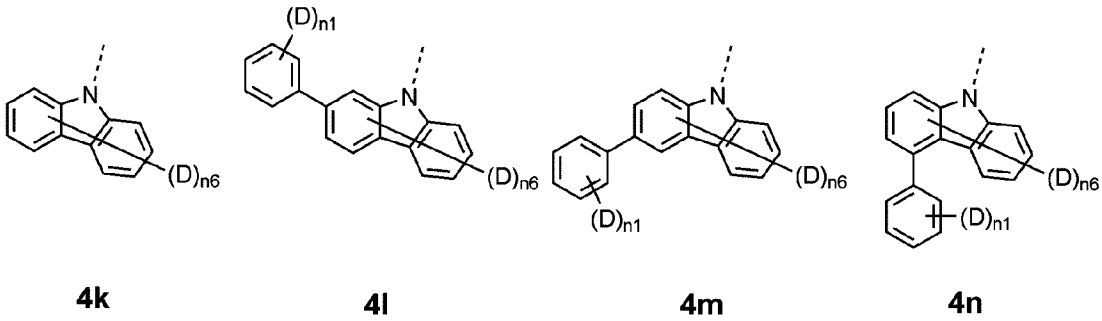
[263]

[264] 구체적으로, Ar_{21}은 하기 화학식 4a 내지 4t 중 어느 하나로 표시될 수 있다:

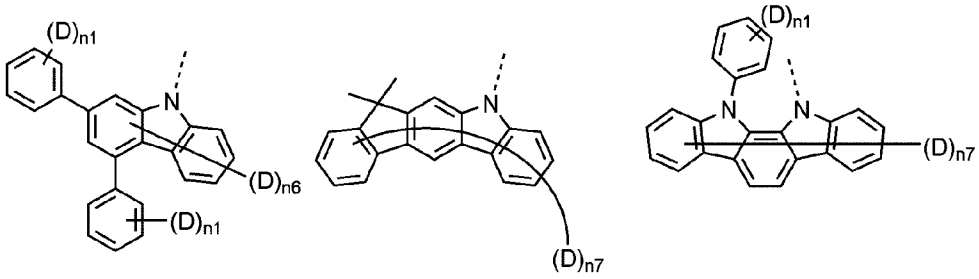
[265]


(D)n1
(D)n2
(D)n1
(D)n3
(D)n4
(D)n4
4a
4b
4c
4d
4e
(D)n2
(D)n2
(D)n1
(D)n1
(D)n5
(D)n1
(D)n2
(D)n2
(D)n5
4f
4g
4h
(D)n3
(D)n6
(D)n3
4i
4j

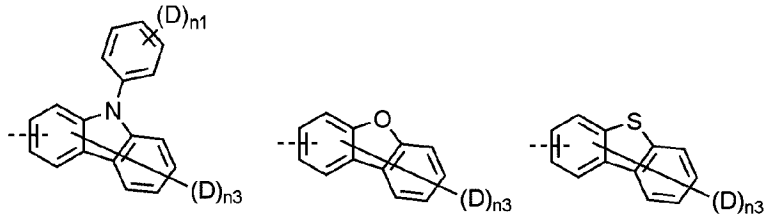
[266]



4k 4l 4m 4n



4o 4p 4q



4r 4s 4t

[267] 상기 화학식 4a 내지 4t에서,

[268] D는 중수소이고,

[269] n1은 각각 독립적으로 0 내지 5의 정수이고,

[270] n2는 각각 독립적으로 0 내지 4의 정수이고,

[271] n3는 각각 독립적으로 0 내지 7의 정수이고,

[272] n4는 각각 독립적으로 0 내지 9의 정수이고,

[273] n5는 각각 독립적으로 0 내지 3의 정수이고,

[274] n6은 각각 독립적으로 0 내지 8의 정수이고,

[275] n7은 각각 독립적으로 0 내지 10의 정수이다.

[276]

[277] 이때, n1은 0, 또는 5이고,

[278] n6은 0, 4, 6 또는 8이고,

[279] n7은 0 또는 6일 수 있다.

[280]

[281] 또한, Ar_{21}이 비치환되거나, 또는 중수소로 치환된 C_{6-20}아릴인 경우, Ar_{21}은 상기 화학식 4a 내지 4j 중 어느 하나일 수 있다.

[282]

[283] 또한, Ar_{21}이 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴인 경우, Ar_{21}은 상기 화학식 4s 또는 4t일 수 있다.

[284]

[285] 또한, Ar_{21}은 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴인 경우, , Ar_{21}은 상기 화학식 4k 내지 4r 중 어느 하나일 수 있다.

[286]

[287] 또한, Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 비치환되거나 또는 중수소로 치환된 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 C_{6-20}아릴; 또는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 비치환되거나 또는 중수소로 치환된 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 N, O 및 S 중 1개의 헤테로원자를 포함하는 C_{2-20} 헤테로아릴일 수 있다.

[288]

[289] 다만, Ar_{22} 및 Ar_{23} 중 하나가 디벤조퓨라닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아니고, Ar_{22} 및 Ar_{23} 중 하나가 디벤조티오페닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아닐 수 있다.

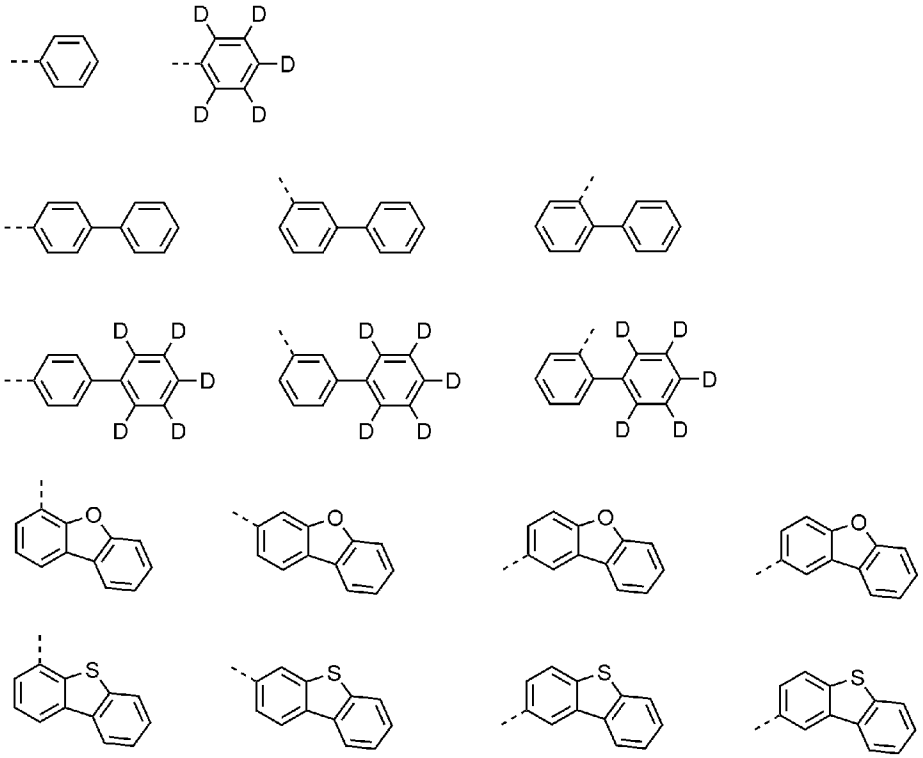
[290]

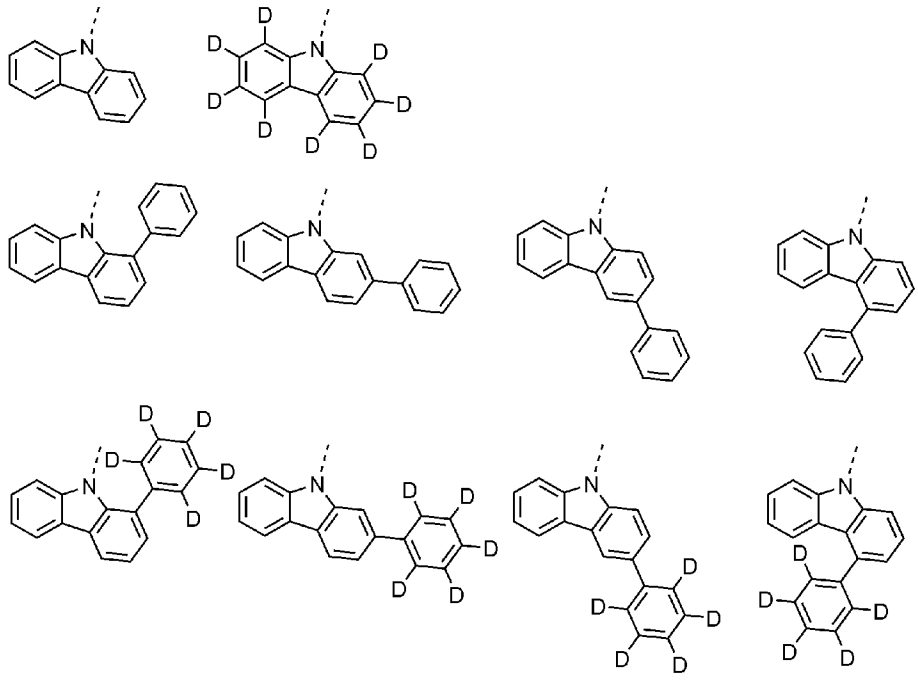
[291] 구체적으로는, Ar_{22} 및 Ar_{23}은 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 디벤조티오페닐, 또는 카바졸일이고,

[292] 여기서, Ar_1 및 Ar_2는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 비치환되거나 또는 중수소로 치환된 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기, 예를 들어, 중수소, 메틸, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환될 수 있다.

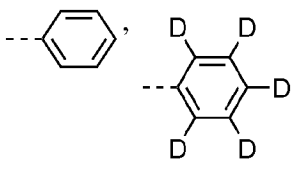
[293]

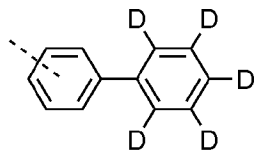
[294] 보다 구체적으로는, Ar_{22} 및 Ar_{23}은 각각 독립적으로 하기로 구성되는 군으로부터 선택되는 어느 하나일 수 있으나, 이에 한정되는 것은 아니다:

[295] 

[296] 

[297]

[298] 이때, Ar_{22} 및 Ar_{23} 중 적어도 하나는,  , 또는



일 수 있다.

[299]

[300] 또한, Ar_{22} 및 Ar_{23}는 서로 동일하거나 또는 상이할 수 있다.

[301]

[302] 또한, 상기 화학식 3에서, R_{21}의 개수를 각각 나타내는, f는 0, 1, 2, 3, 4, 5, 또는 6일 수 있다.

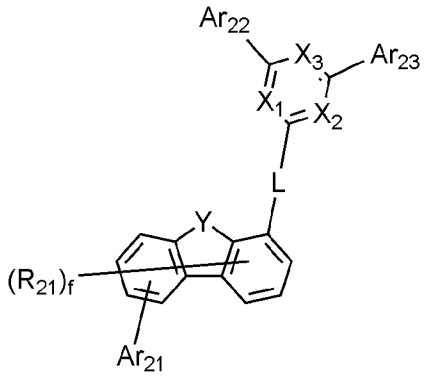
[303]

[304] 또한, R_{21}은 중수소일 수 있고, 이때, f가 0인 경우 Ar_{21} 내지 Ar_{23} 중 적어도 하나는 중수소로 치환될 수 있다.

[305]

[306] 한편, 상기 제3 화합물은 하기 화학식 3-1로 표시될 수 있다:

[307] [화학식 3-1]

[308] 

[309] 상기 화학식 3-1에서,

[310] X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

[311] Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

[312] Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

[313] R_{21}은 중수소이고,

[314] Y, L 및 f는 제1항에서 정의한 바와 같고,

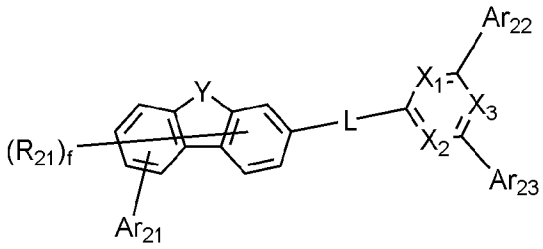
[315] 단, f가 0인 경우 Ar_{21} 내지 Ar_{23} 중 적어도 하나는 중수소로 치환된다.

[316]

[317] 또는, 상기 제3 화합물은 하기 화학식 3-2로 표시될 수 있다:

[318] [화학식 3-2]

[319]



[320] 상기 화학식 3-2에서,

[321] X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

[322] Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

[323] Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

[324] 단, Ar_{22} 및 Ar_{23} 중 하나가 디벤조퓨라닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아니고, Ar_{22} 및 Ar_{23} 중 하나가 디벤조티오페닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아니며,

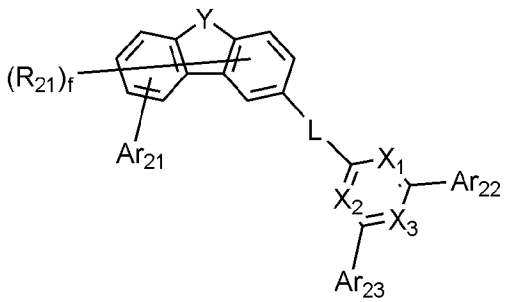
[325] Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

[326]

[327] 또는, 상기 제3 화합물은 하기 화학식 3-3으로 표시될 수 있다:

[328] [화학식 3-3]

[329]



[330] 상기 화학식 3-3에서,

[331] X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

[332] Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는

비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

[333] Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

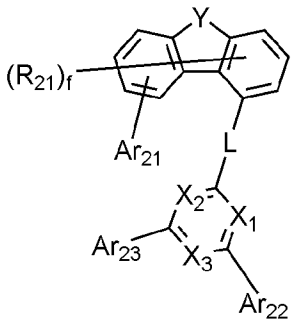
[334] Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

[335]

[336] 또는, 상기 제3 화합물은 하기 화학식 3-4로 표시될 수 있다:

[337] [화학식 3-4]

[338]



[339] 상기 화학식 3-4에서,

[340] X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

[341] Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

[342] A Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

[343] Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

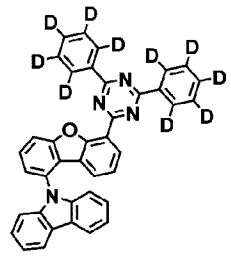
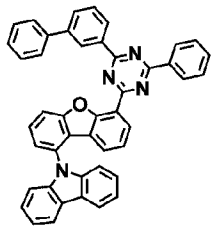
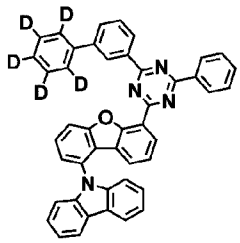
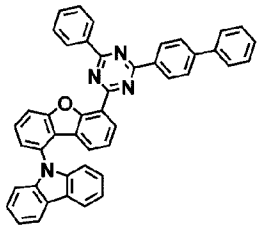
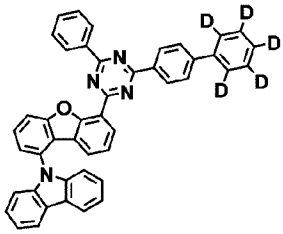
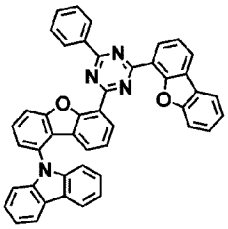
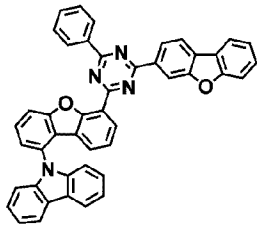
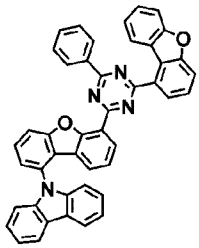
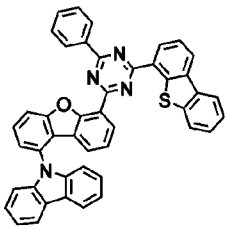
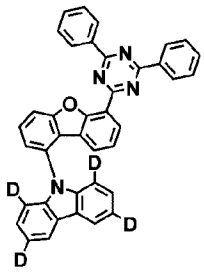
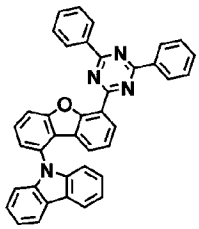
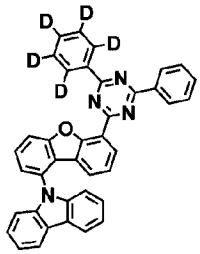
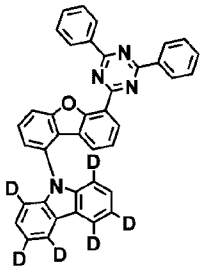
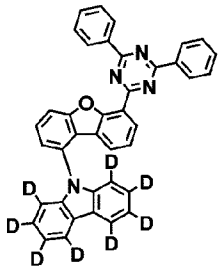
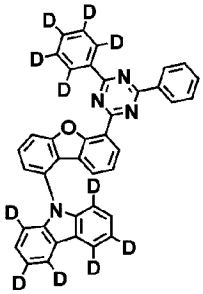
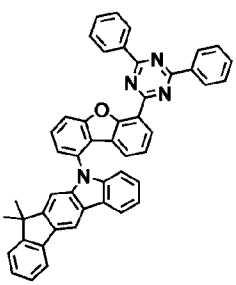
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[345] 상기 화학식 3으로 표시되는 제3 화합물의 대표적인 예는 하기와 같다:

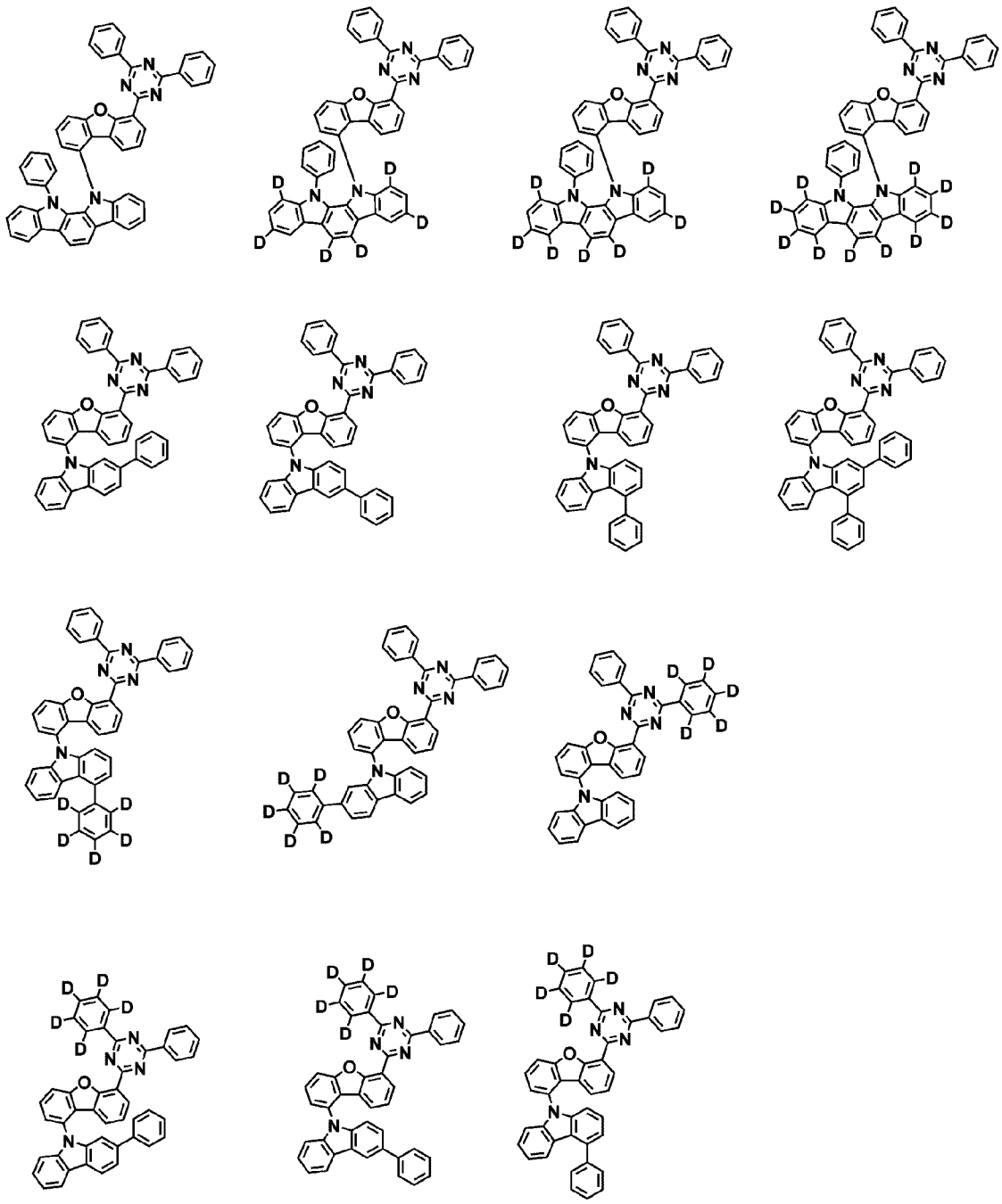
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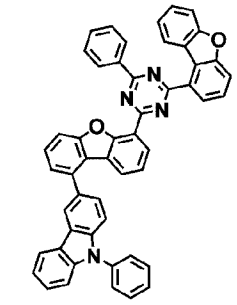
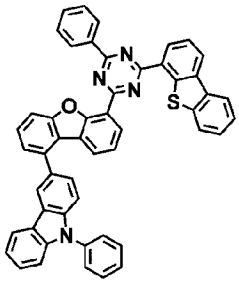
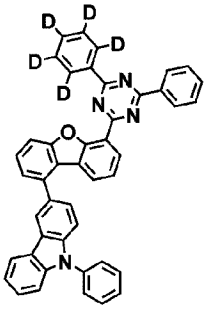
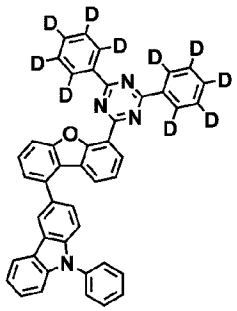
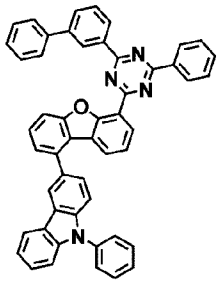
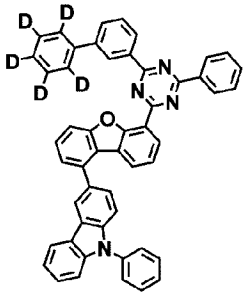
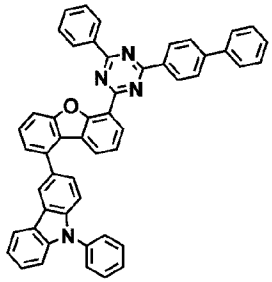
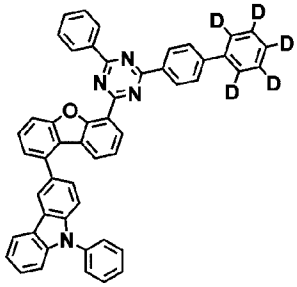
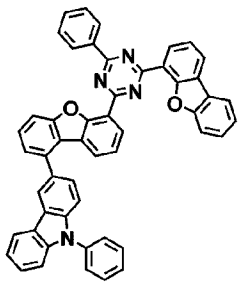
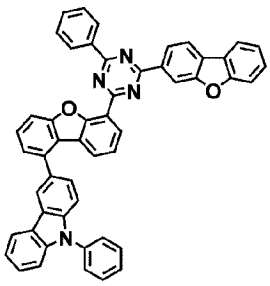
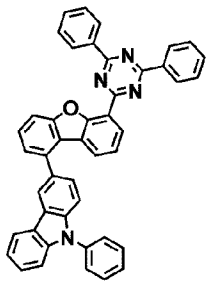
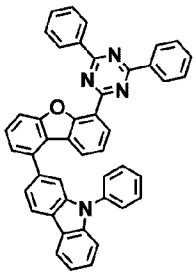
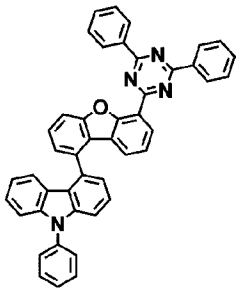
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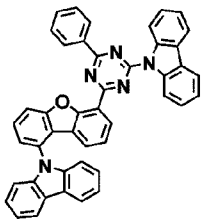
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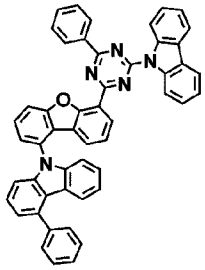


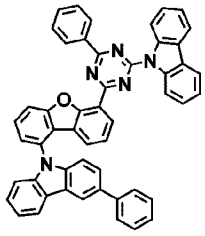
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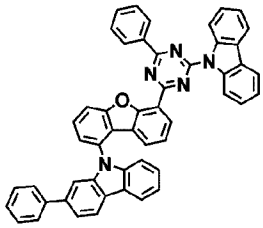














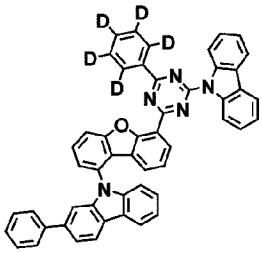
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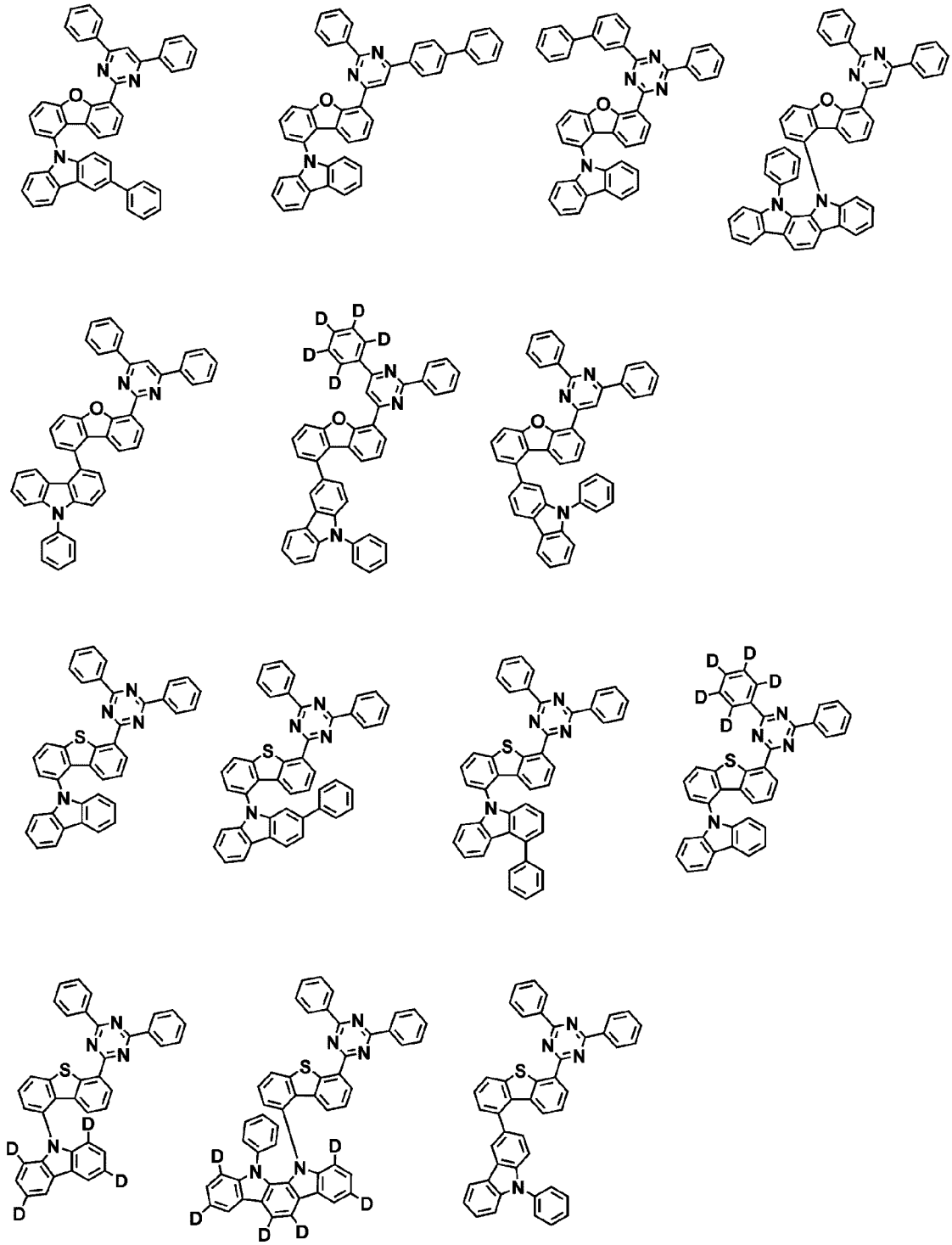




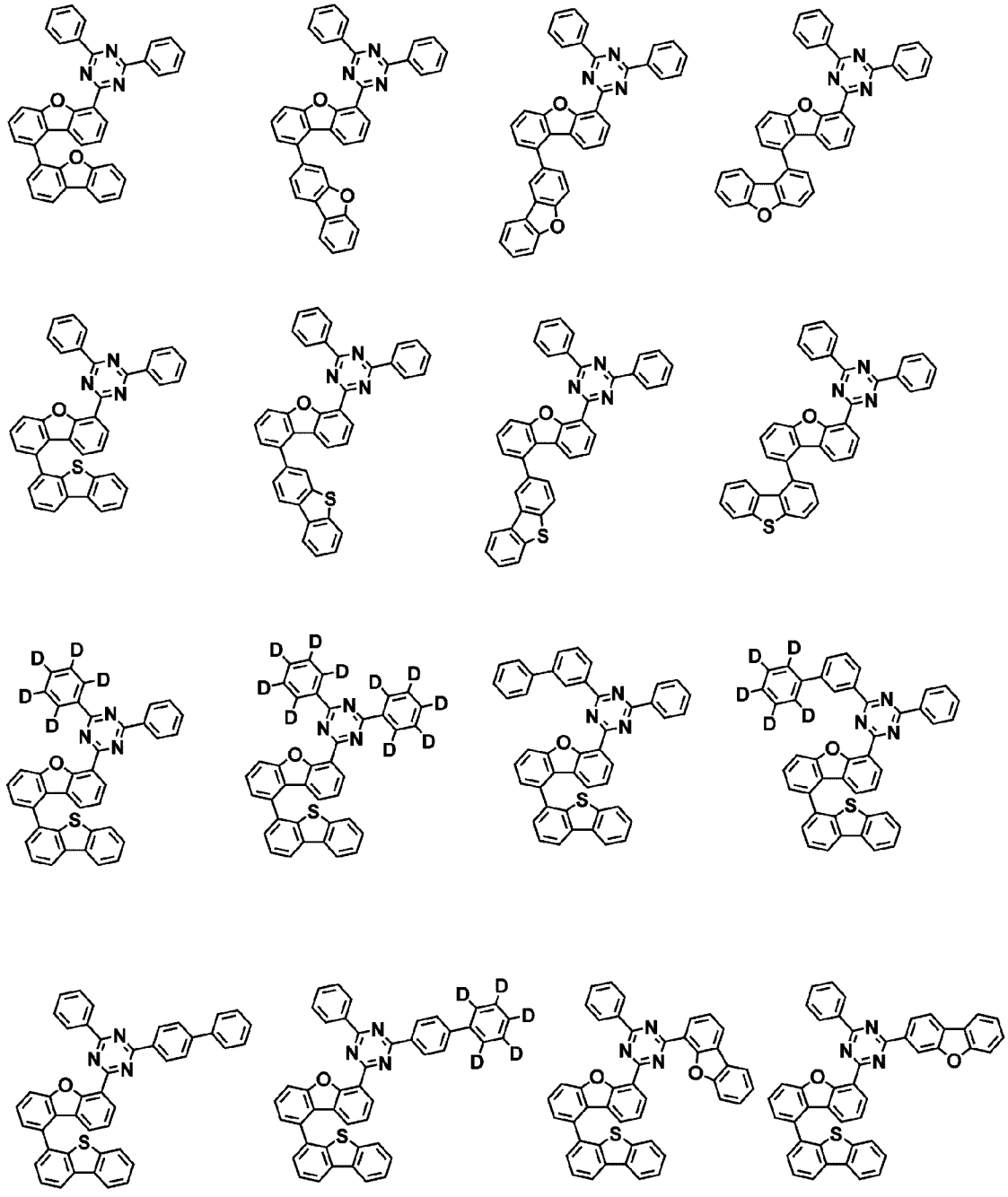




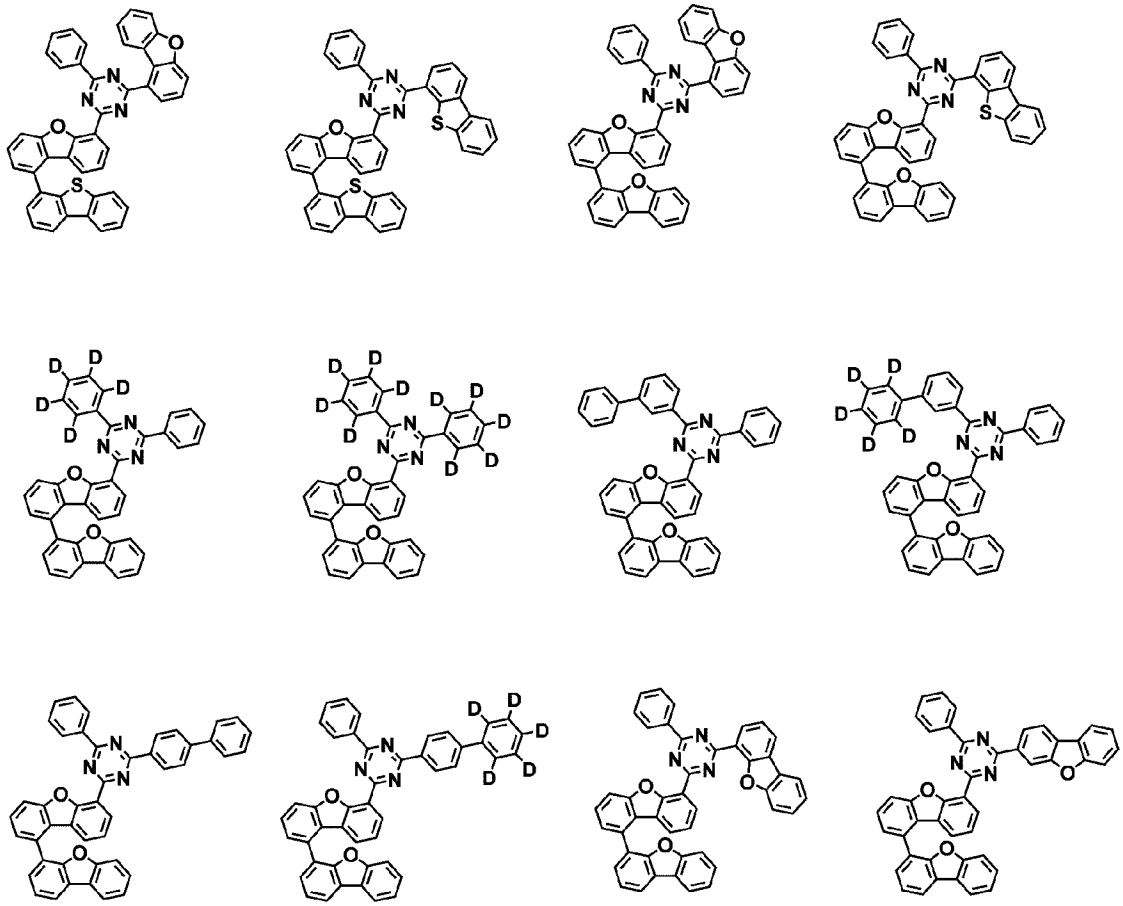
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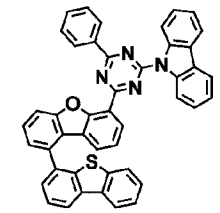
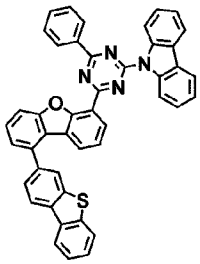
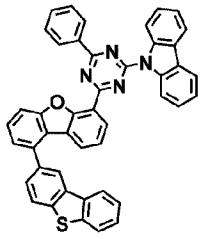
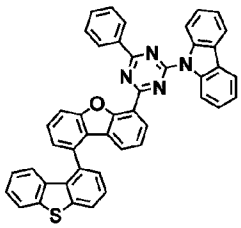
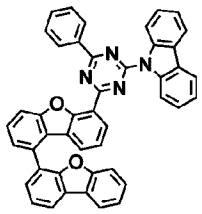
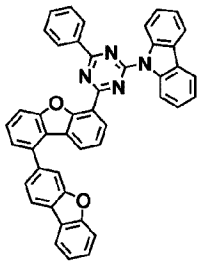
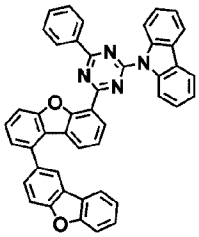
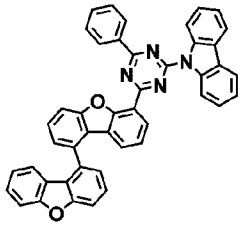
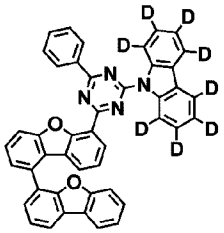
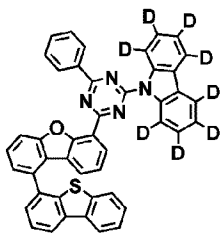
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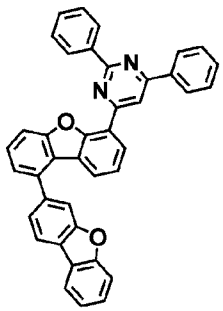
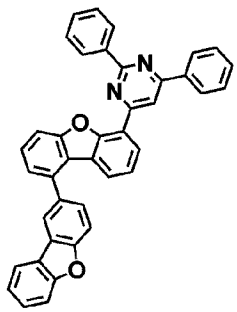
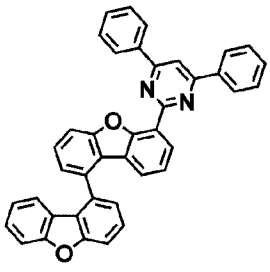
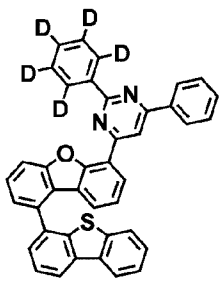
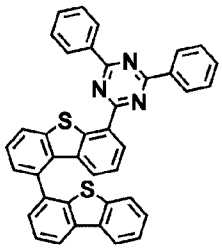
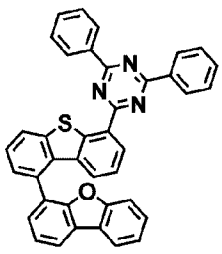
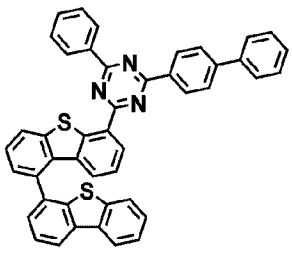
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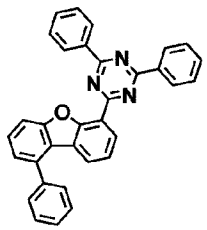
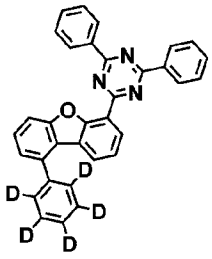
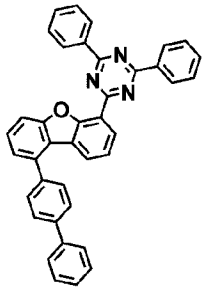
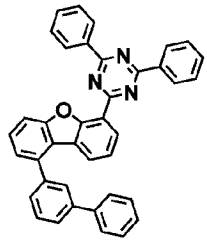
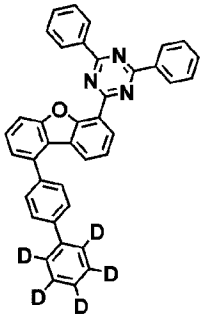
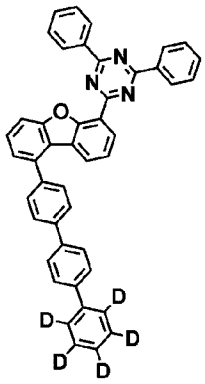
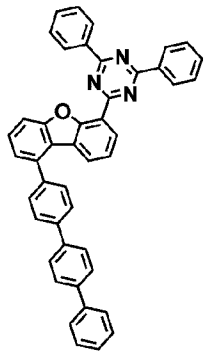
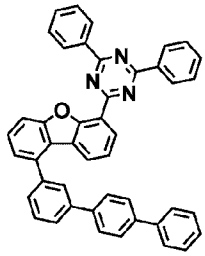
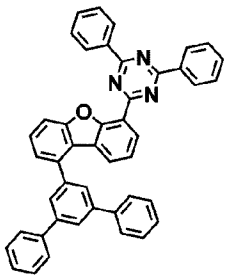
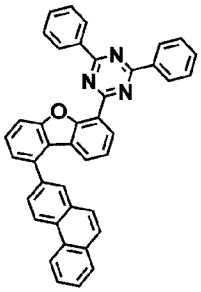
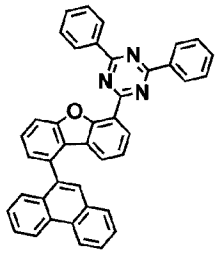
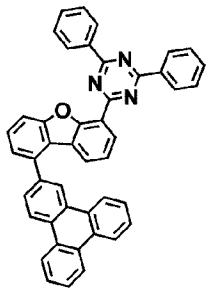
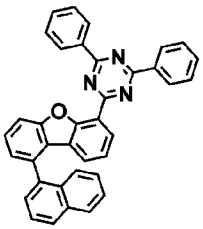
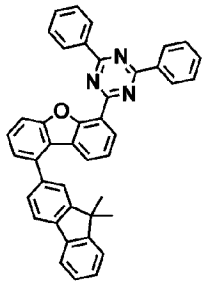
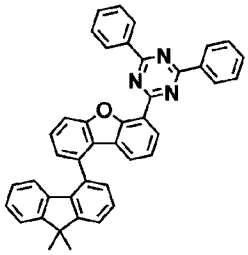
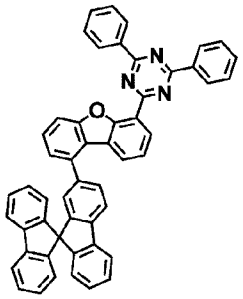
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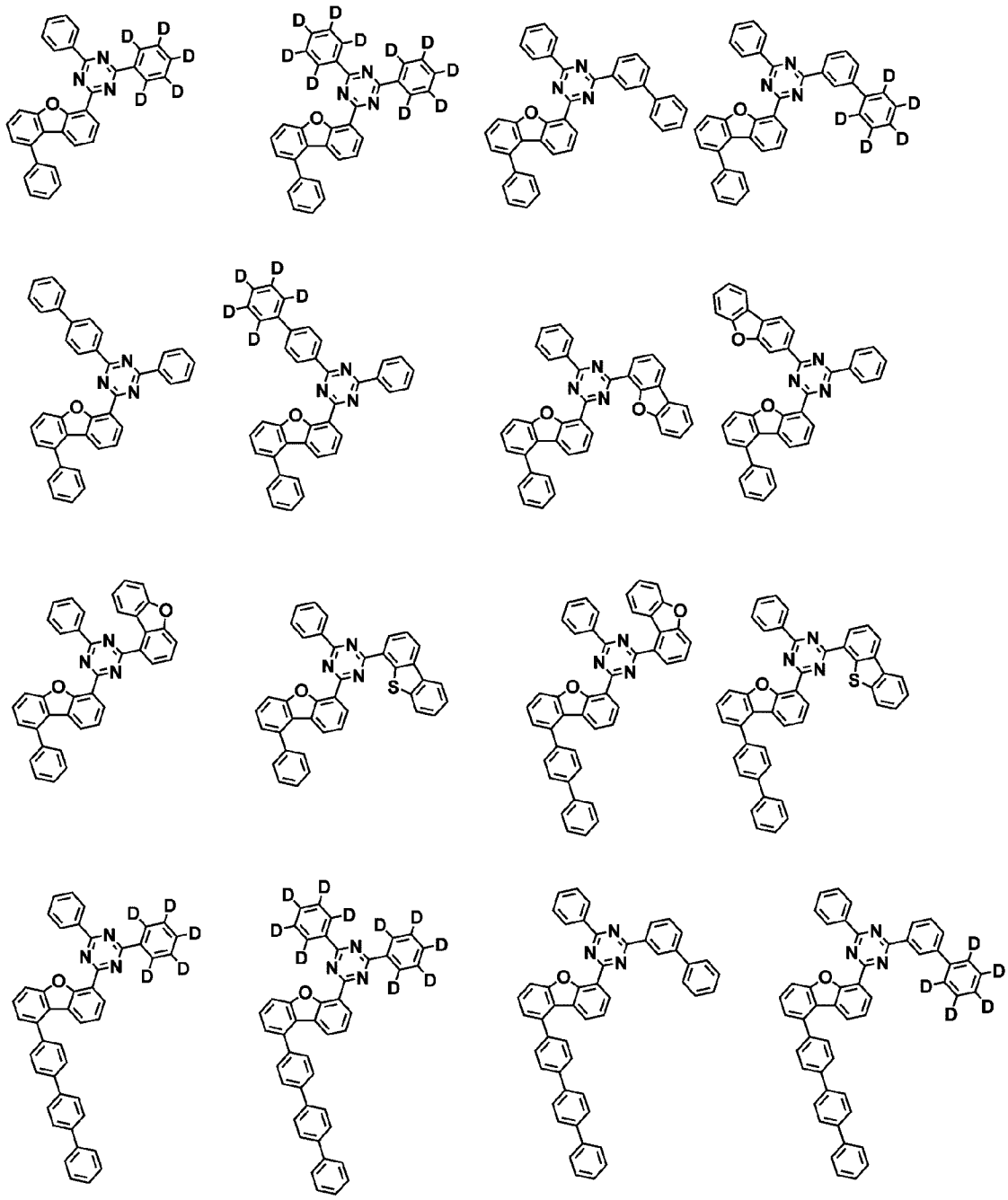
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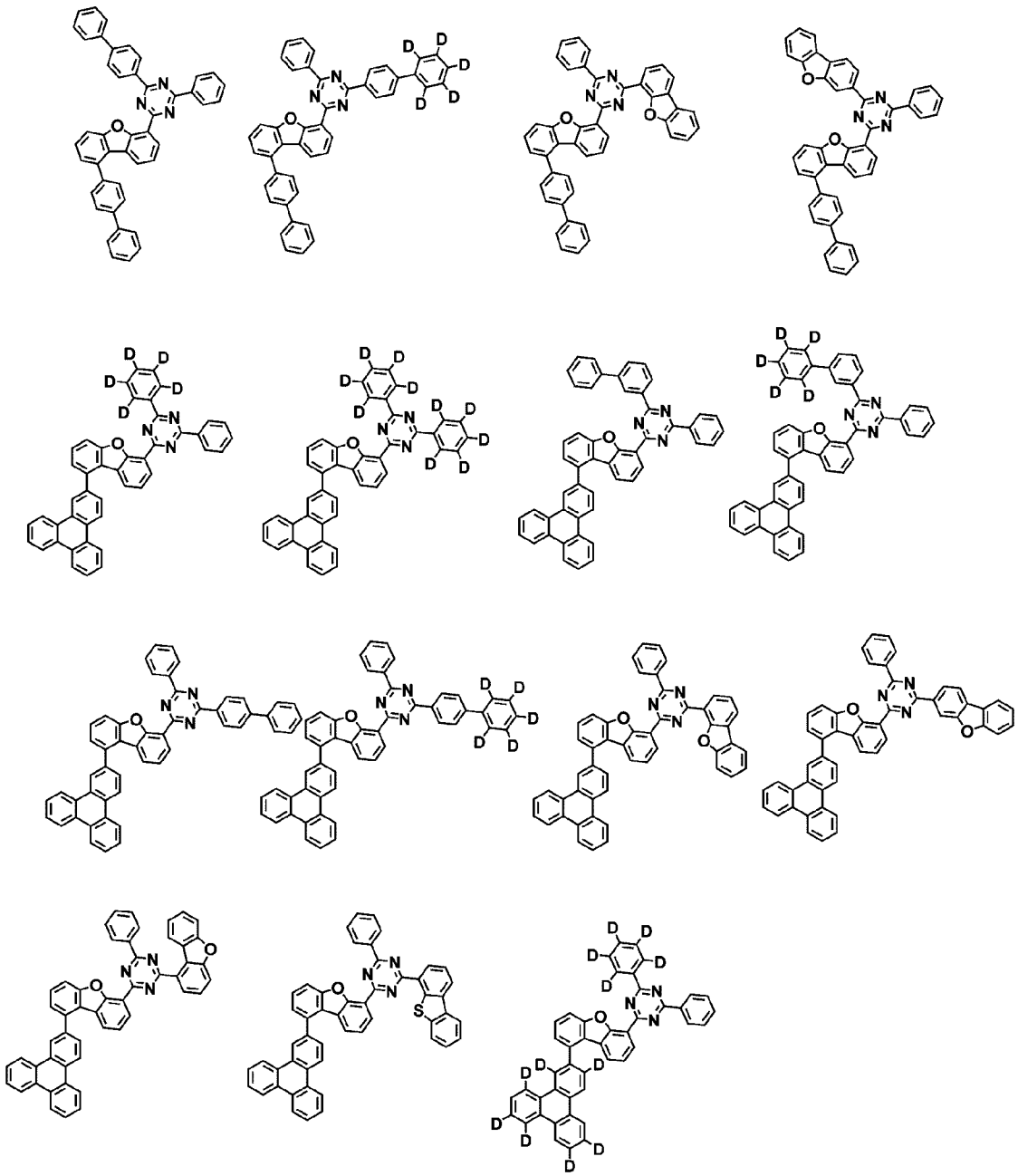
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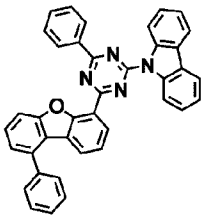
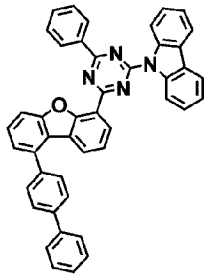
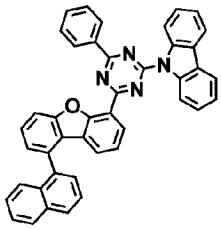
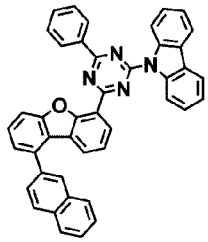
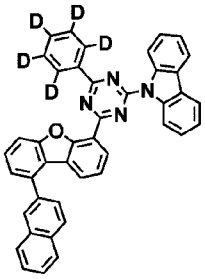
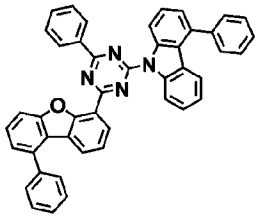
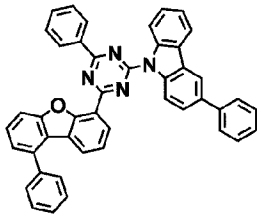
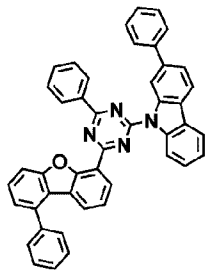
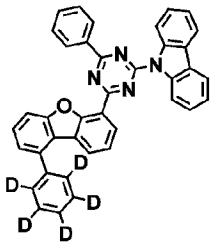
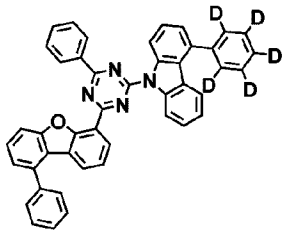
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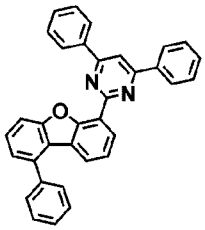
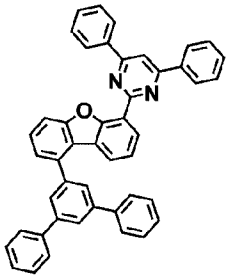
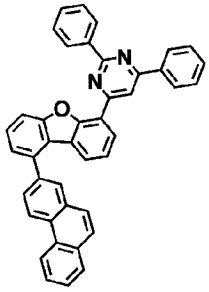
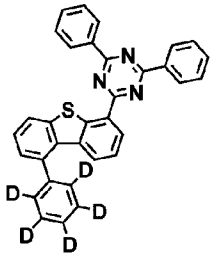
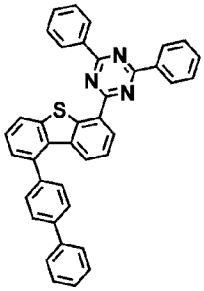
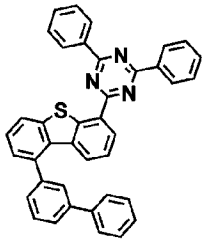
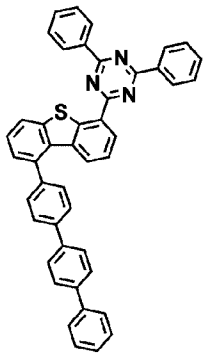
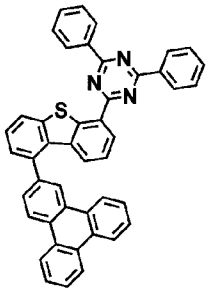
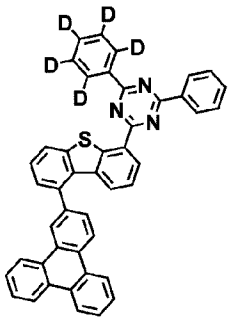
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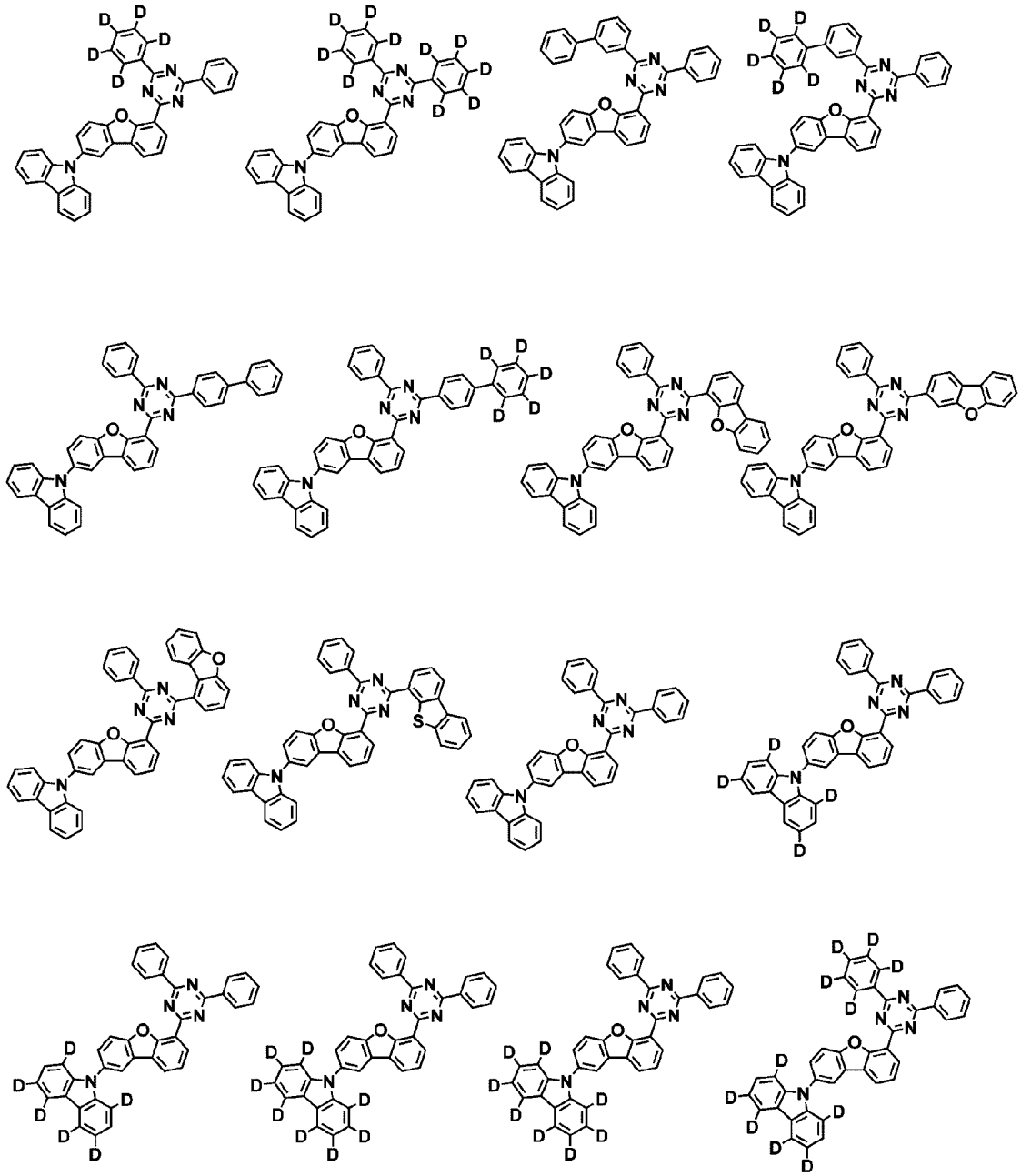
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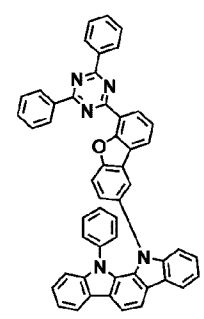
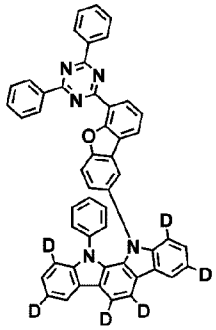
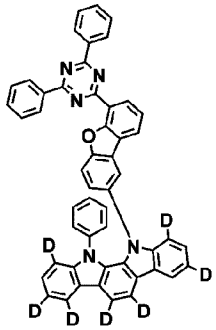
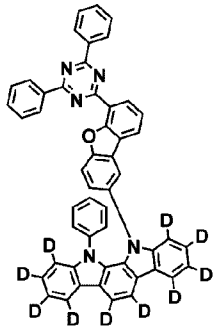
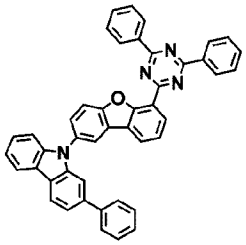
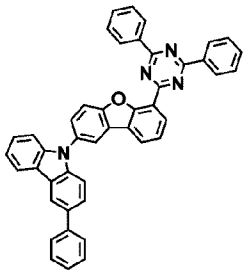
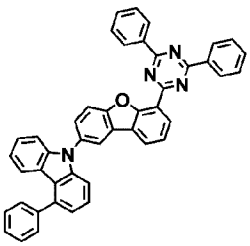
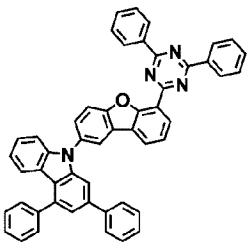
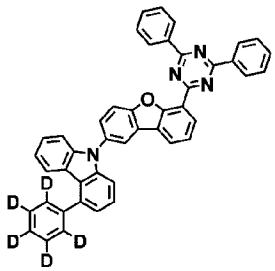
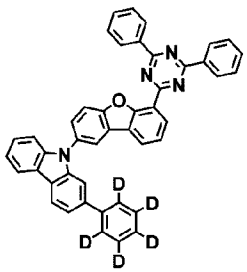
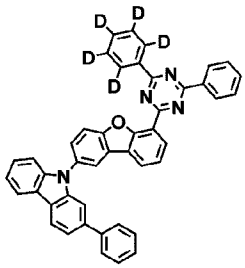
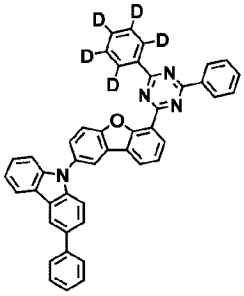
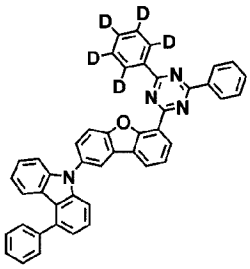
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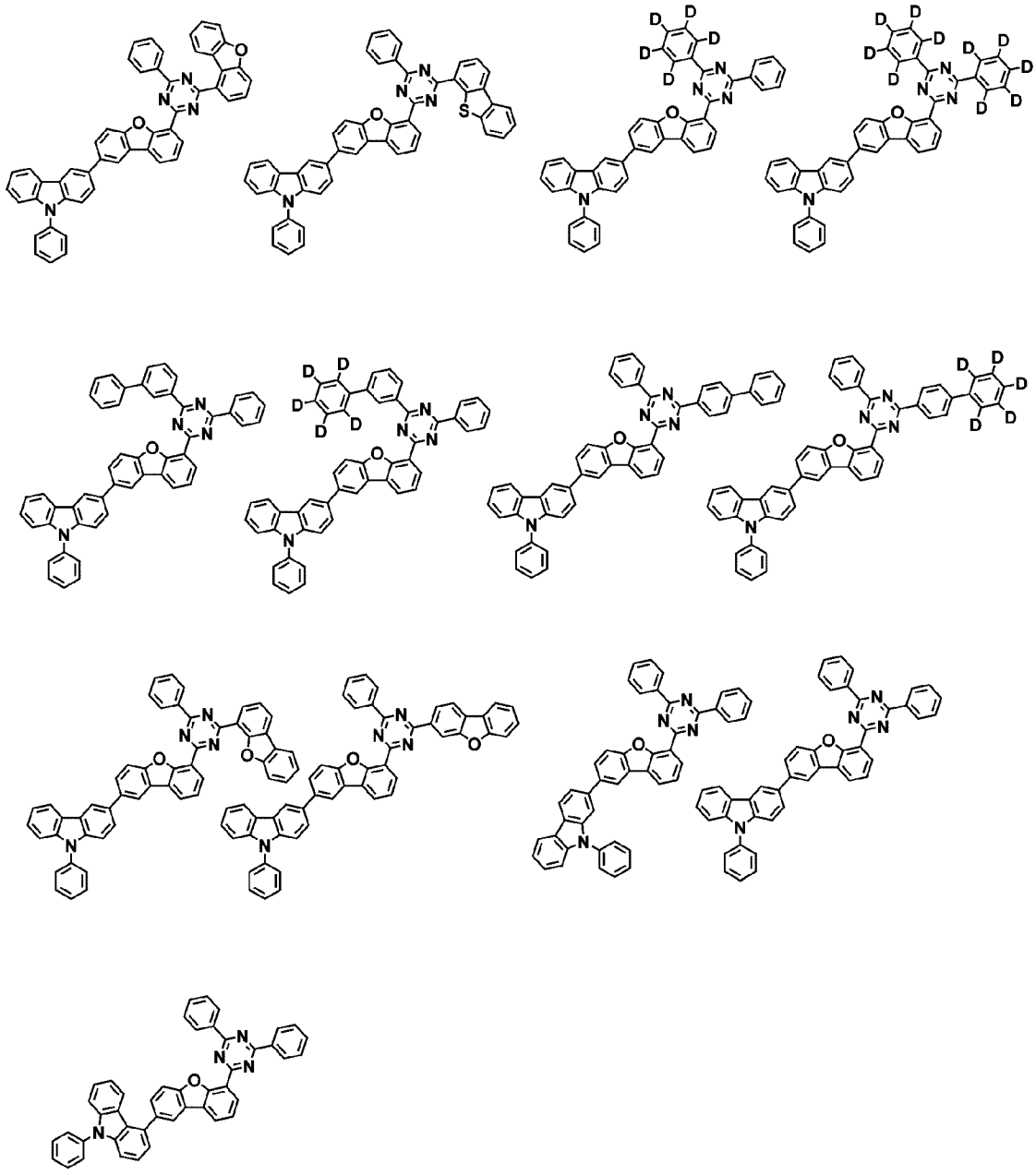
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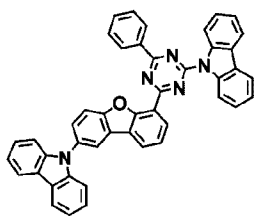
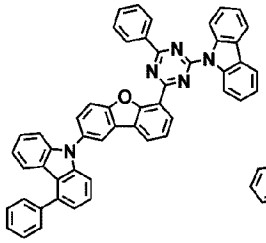
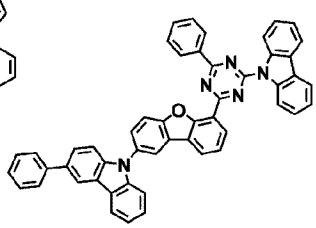
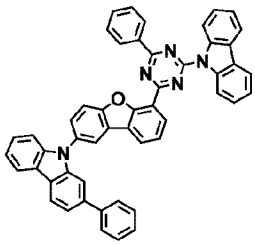
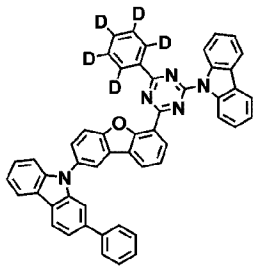
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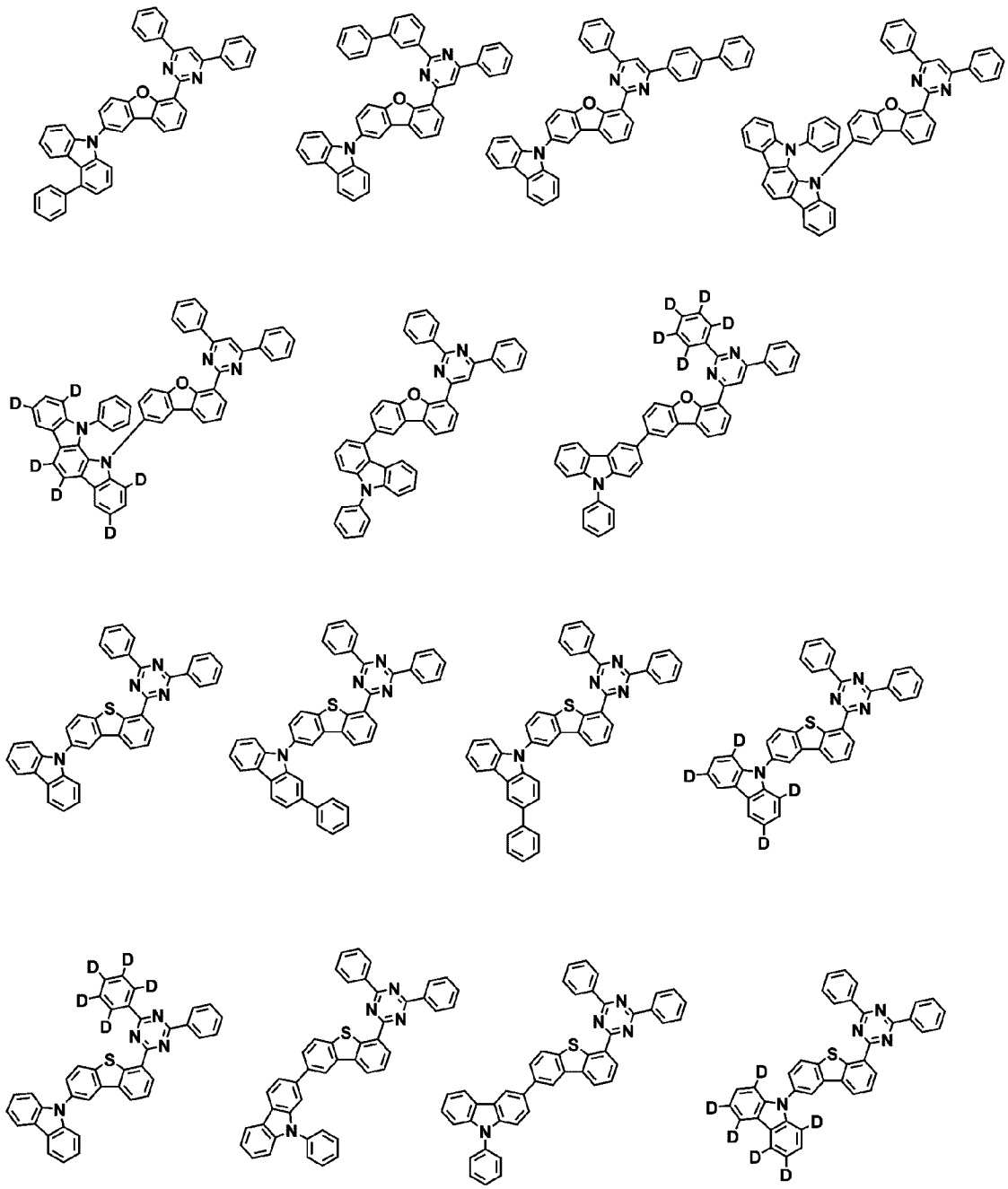
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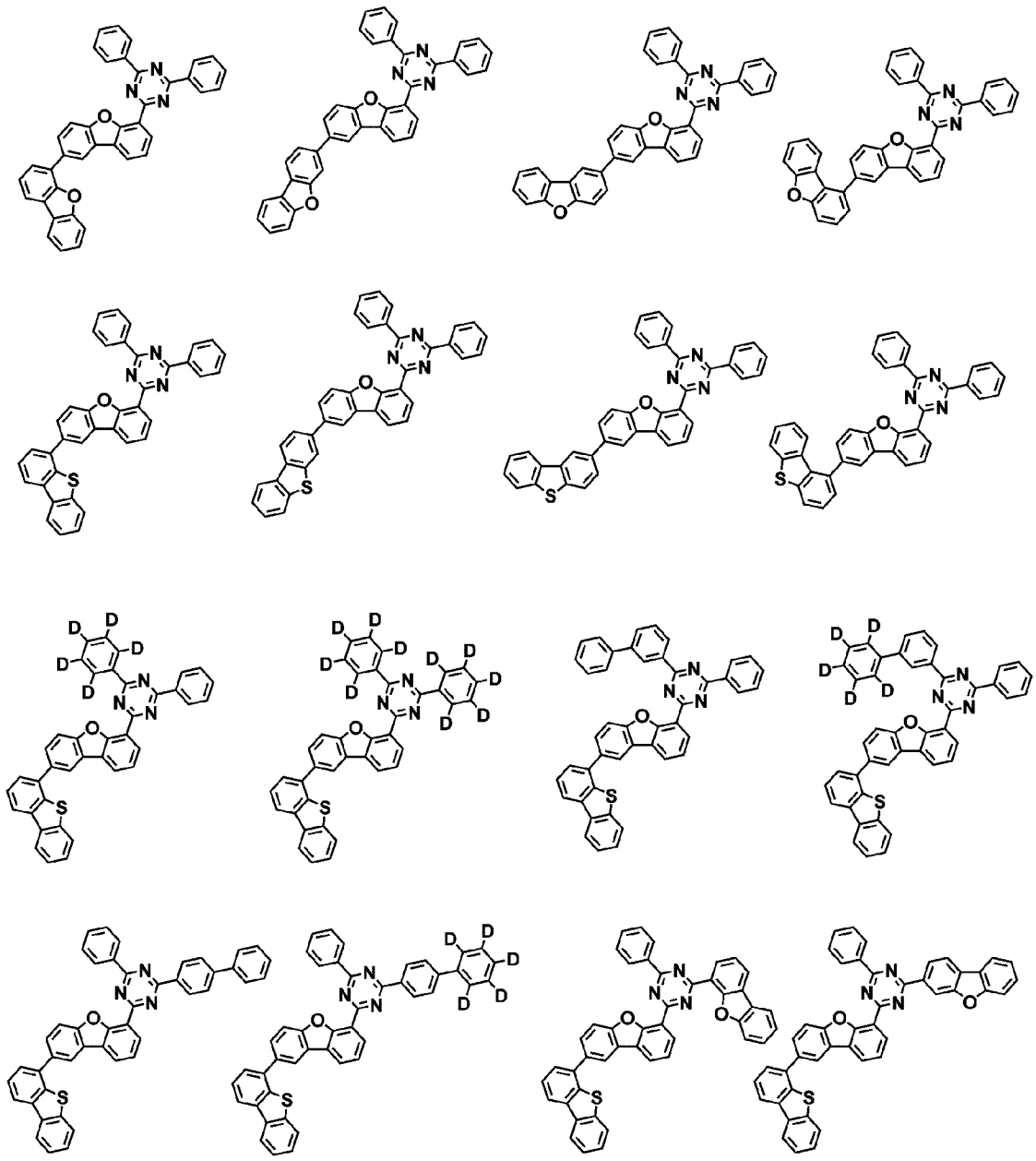
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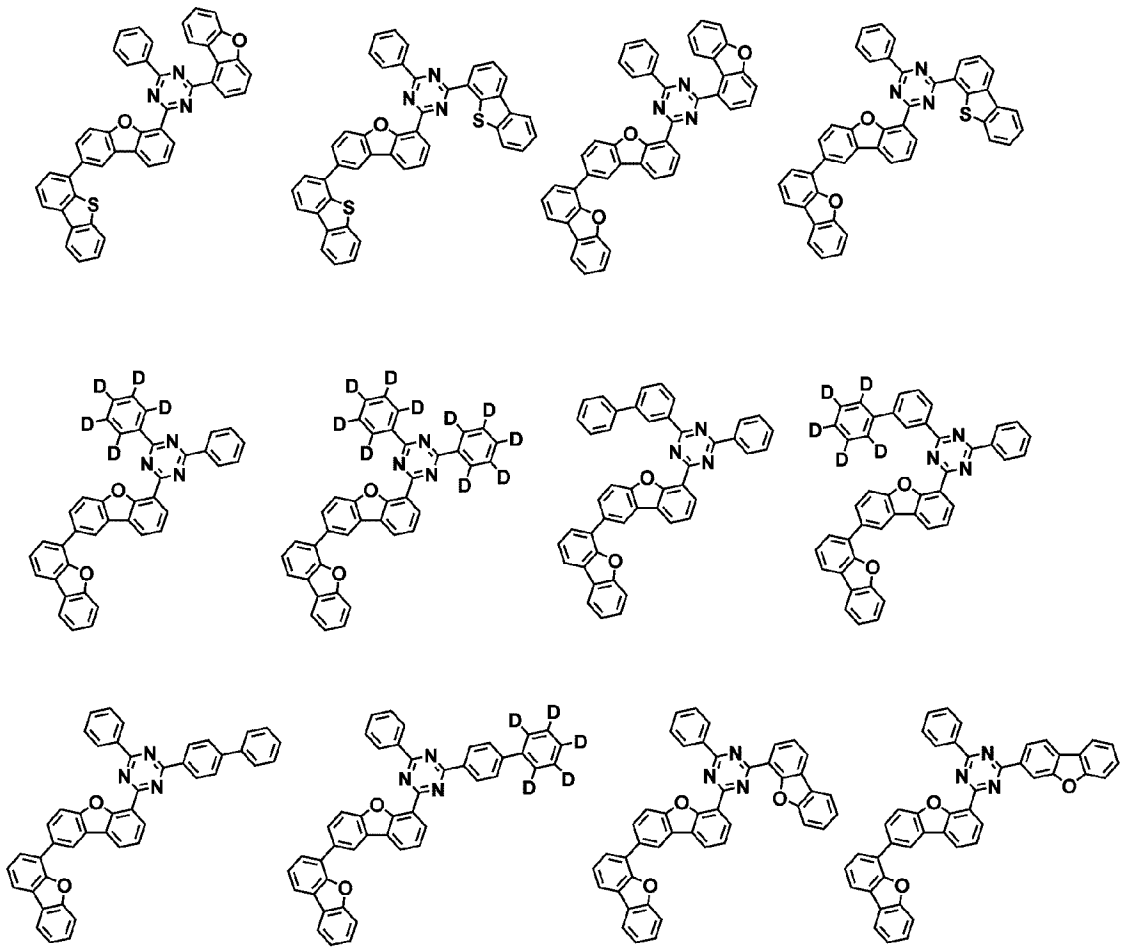
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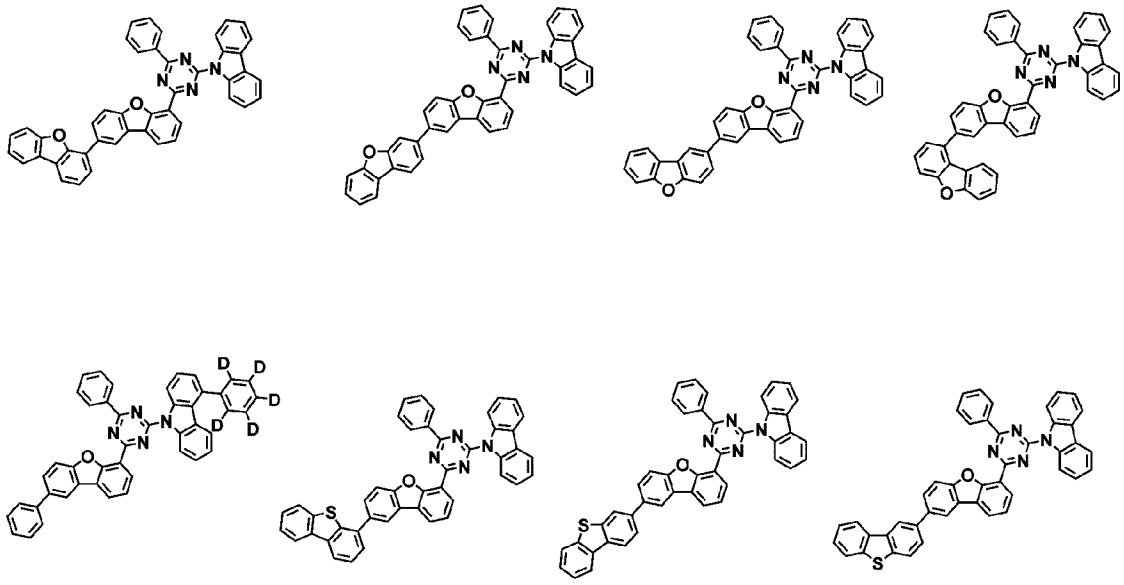
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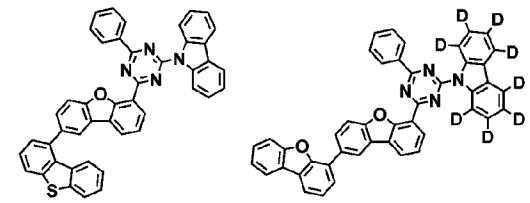


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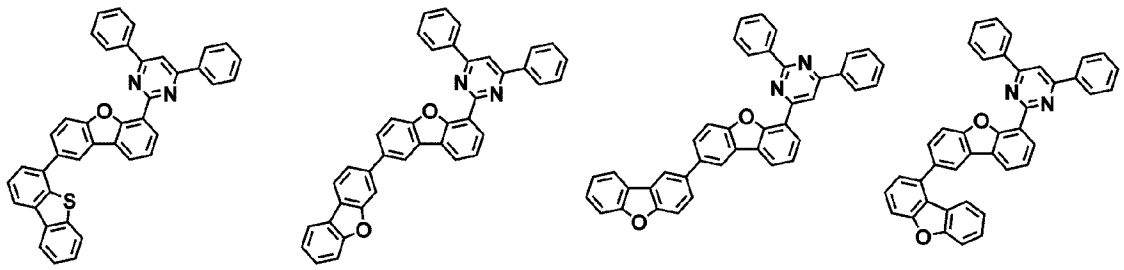


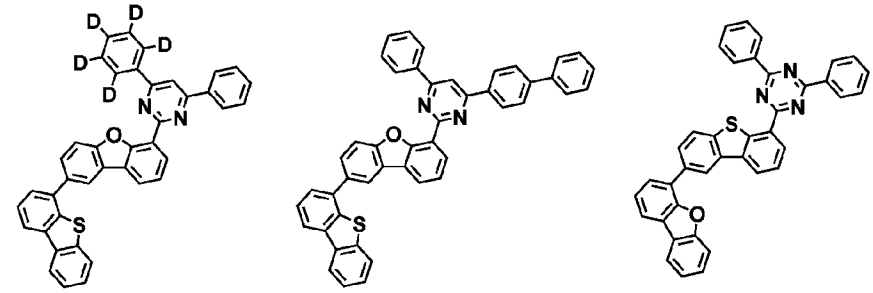
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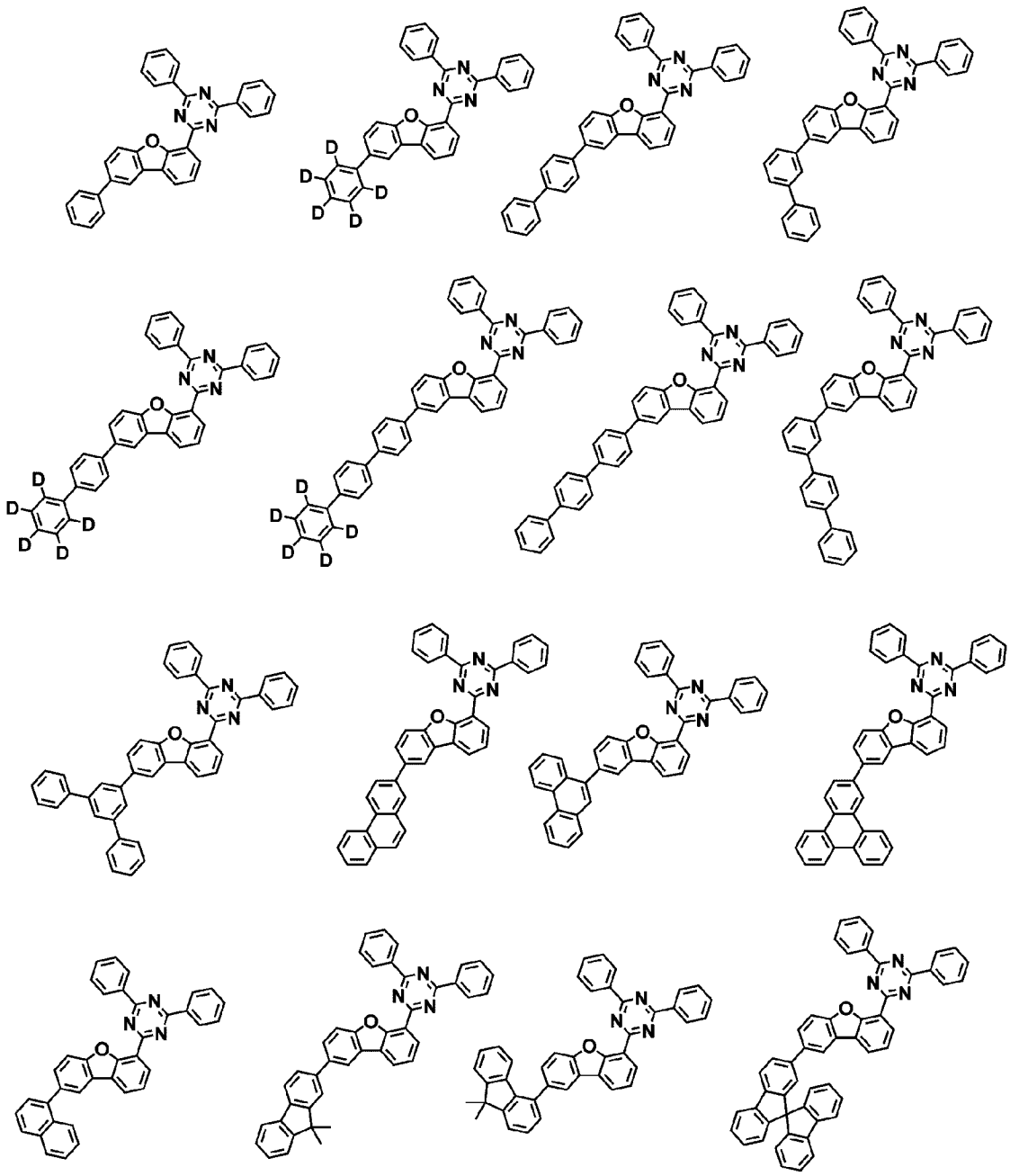


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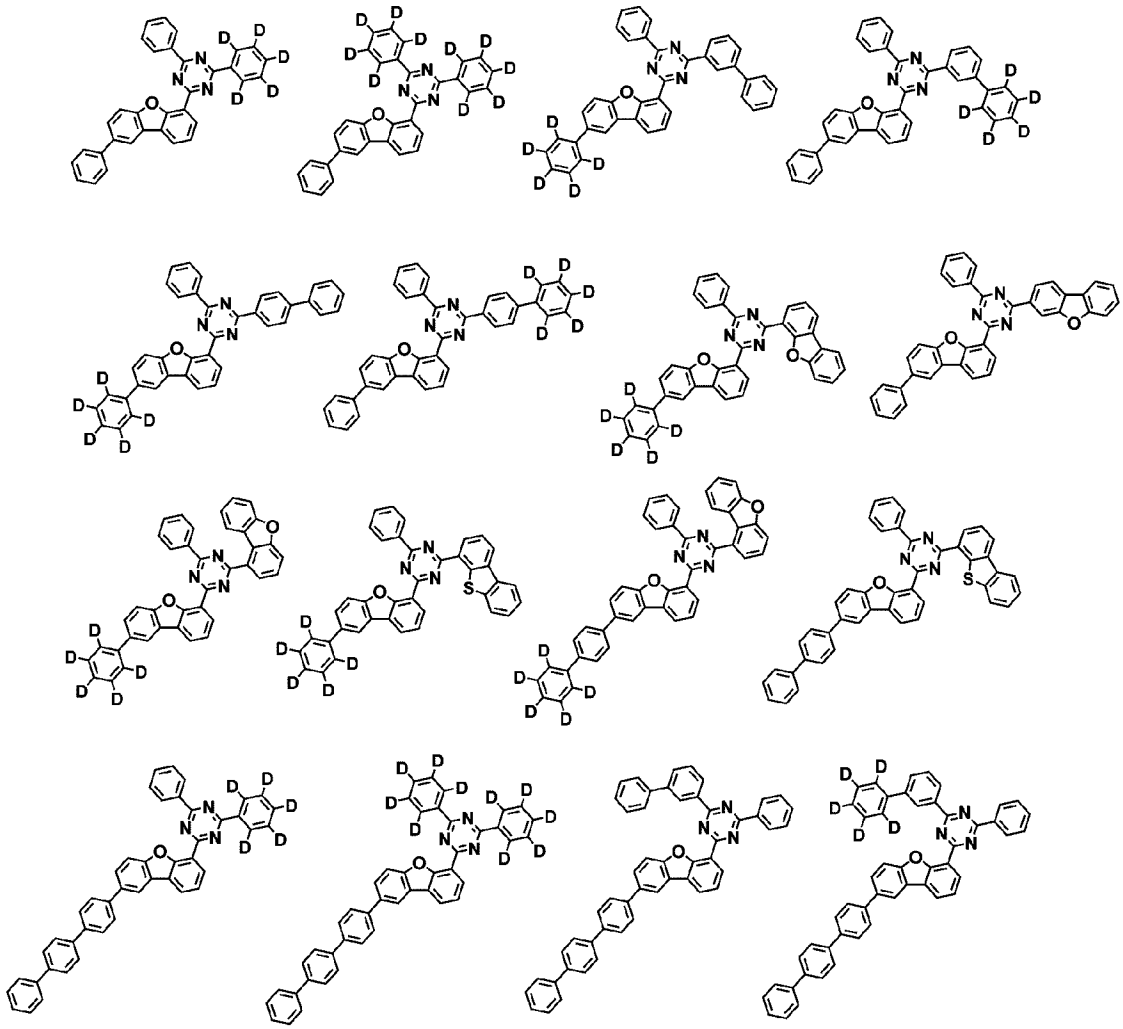




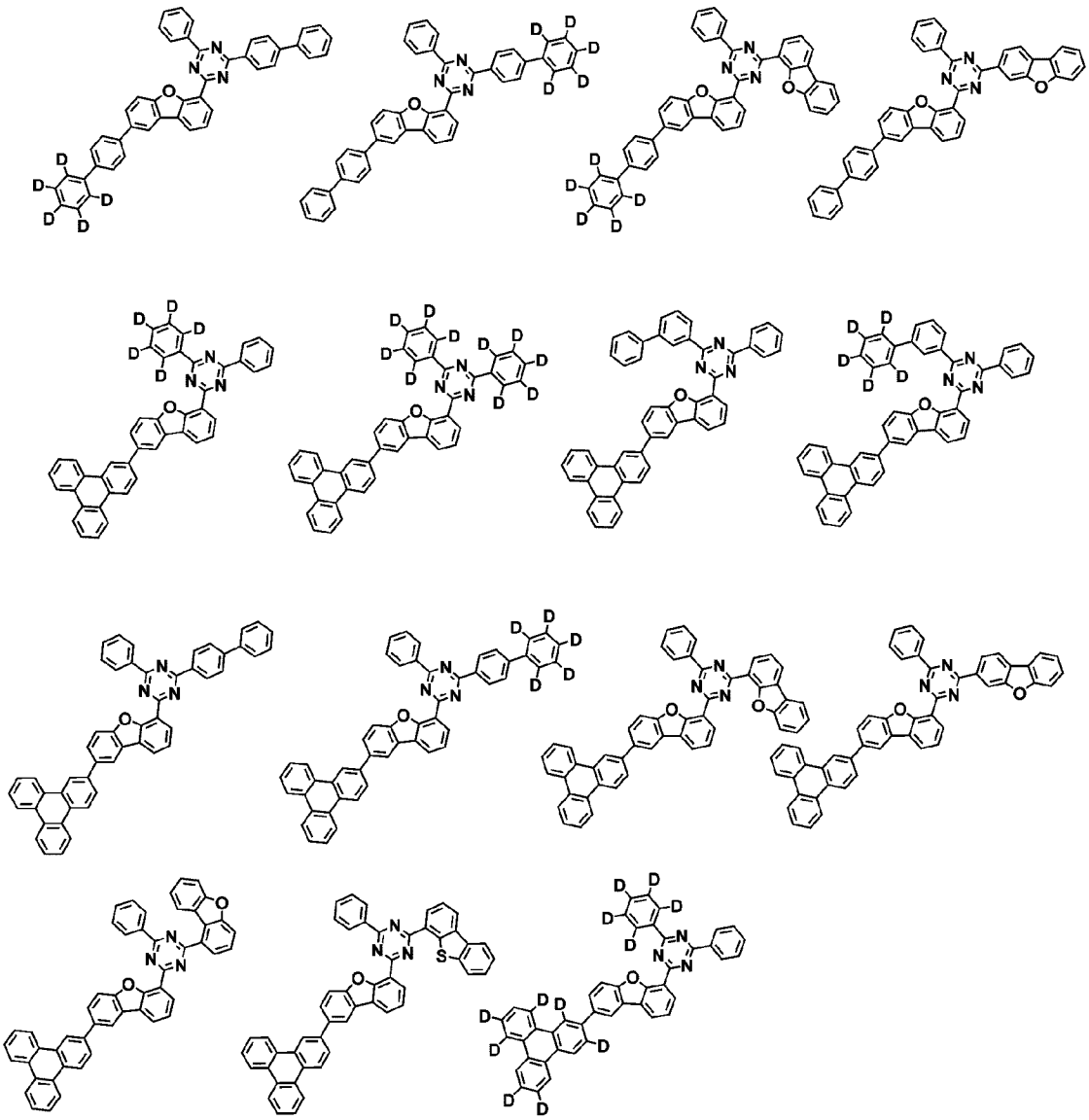
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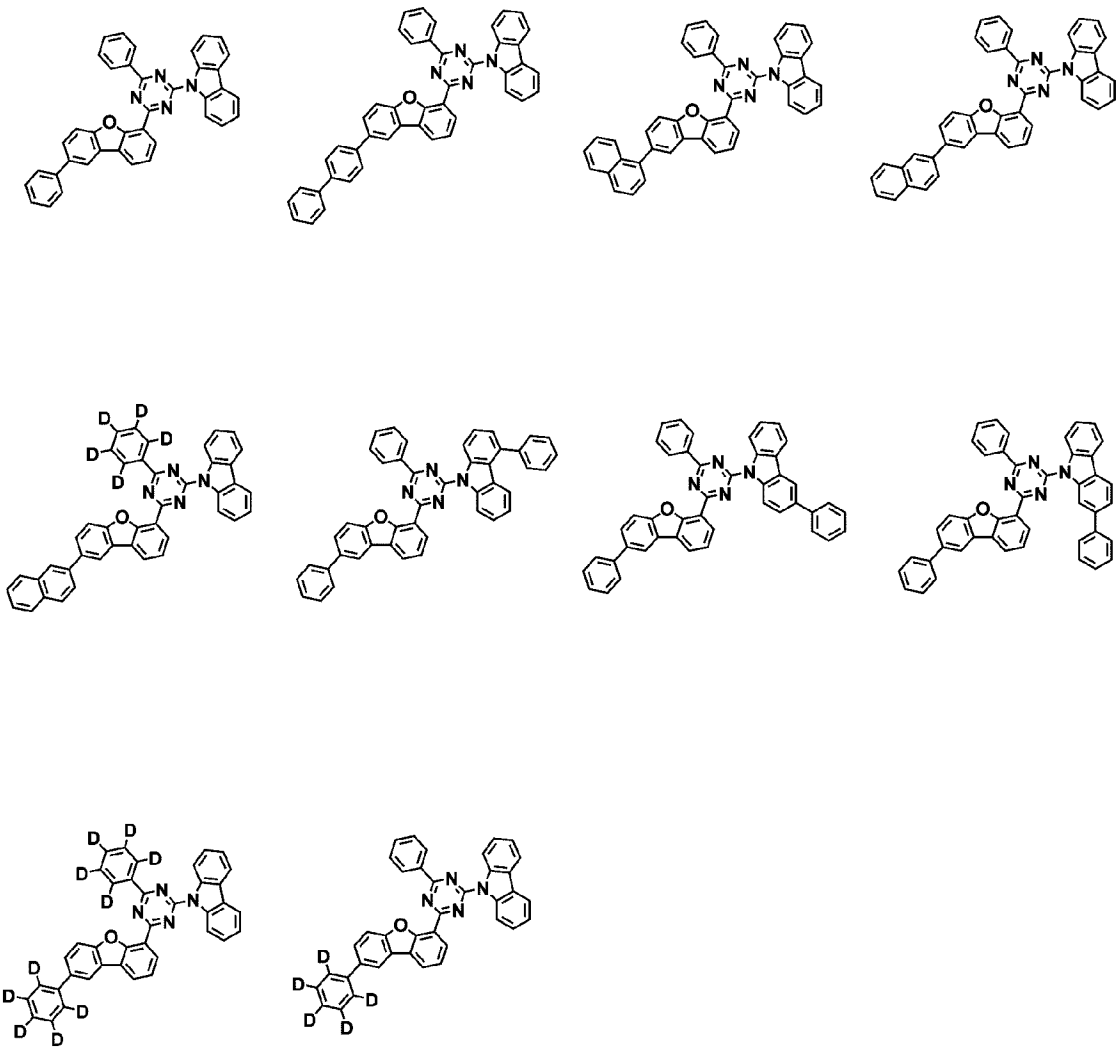
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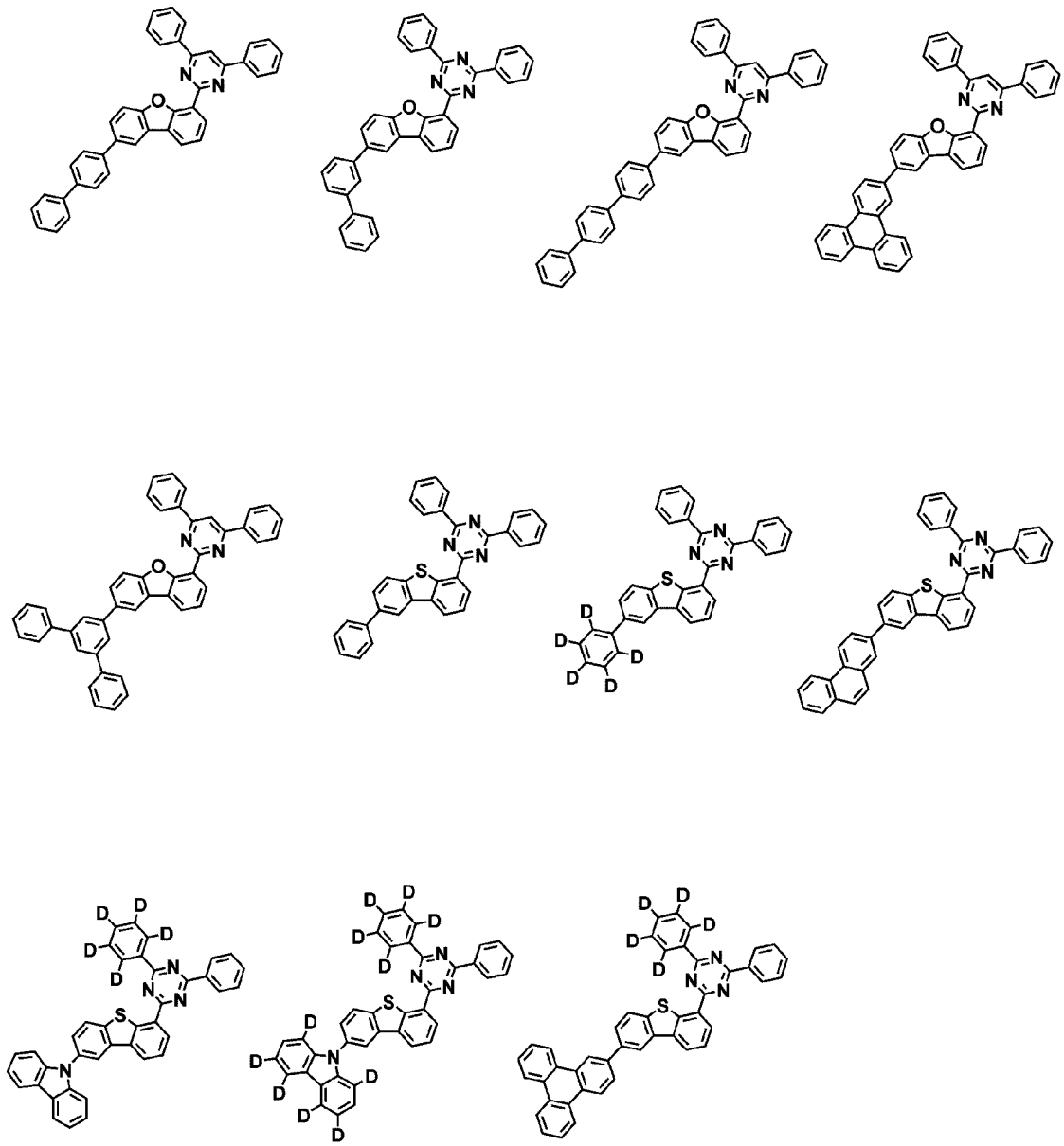
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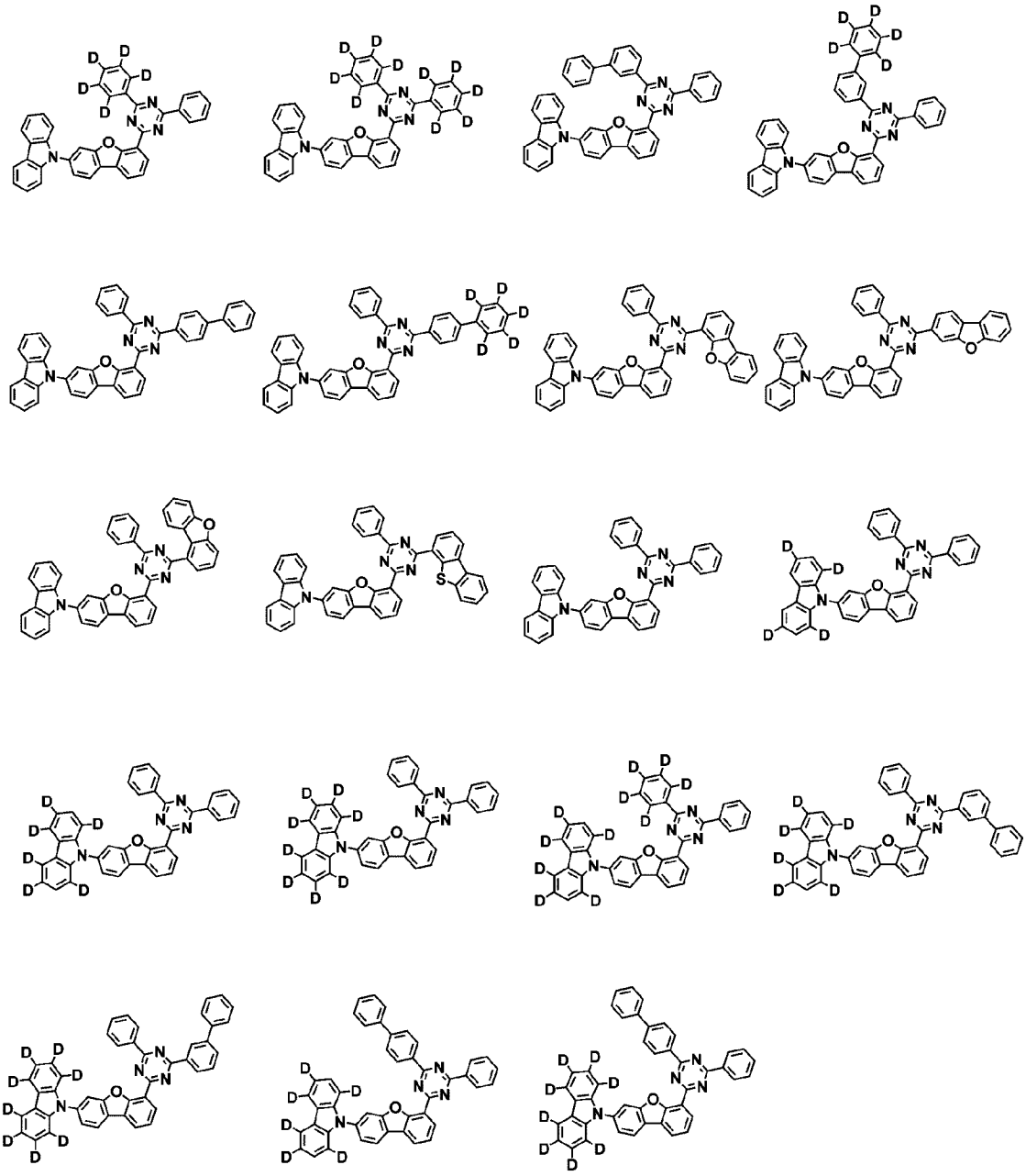
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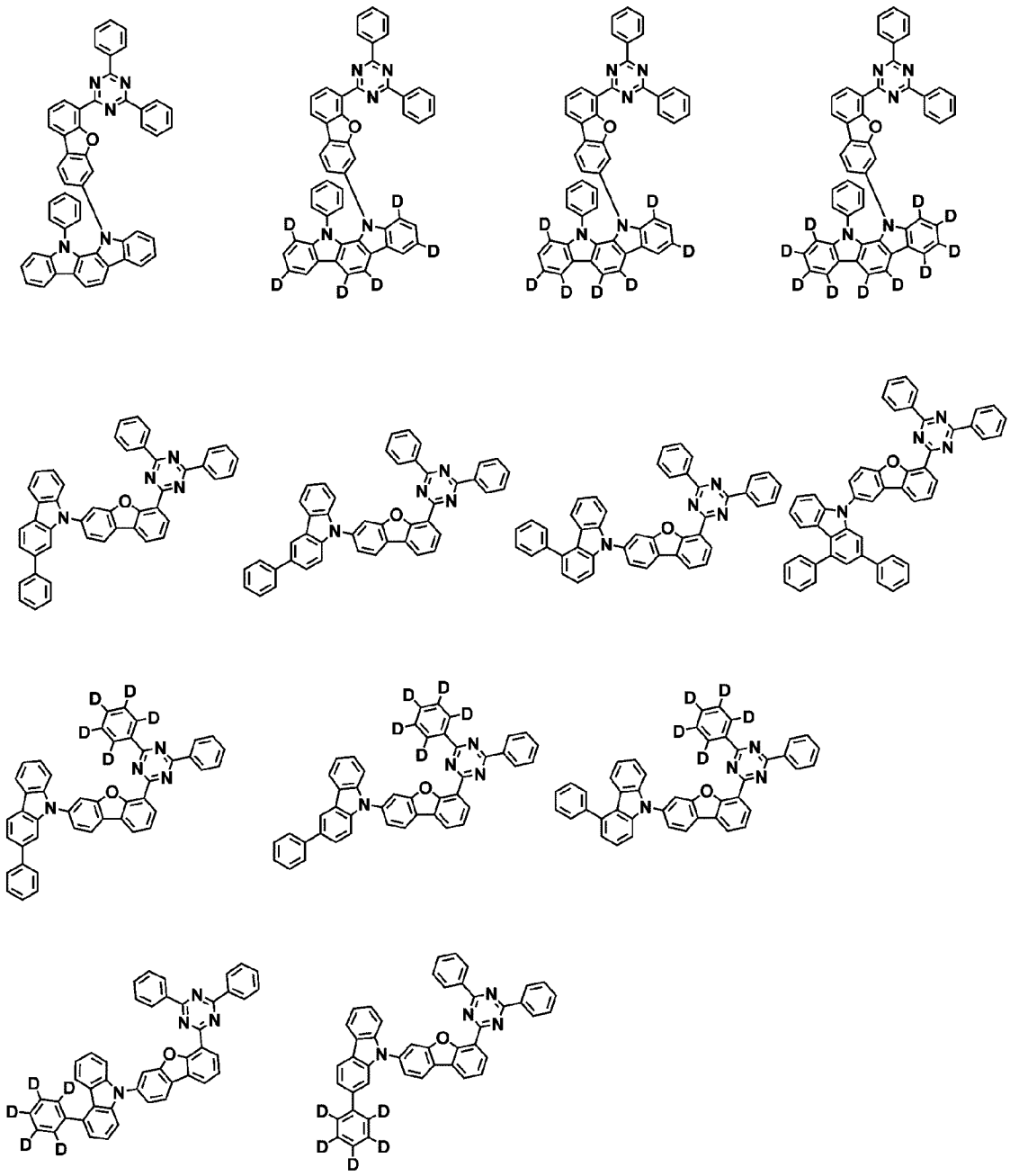
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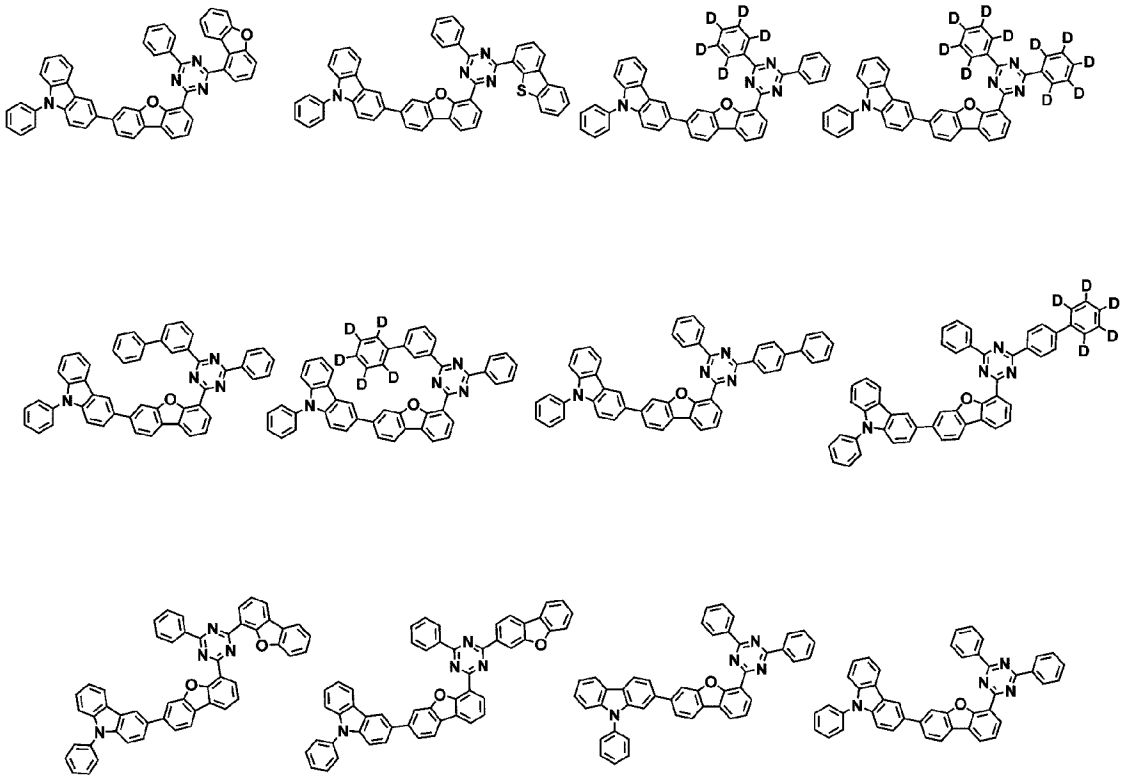
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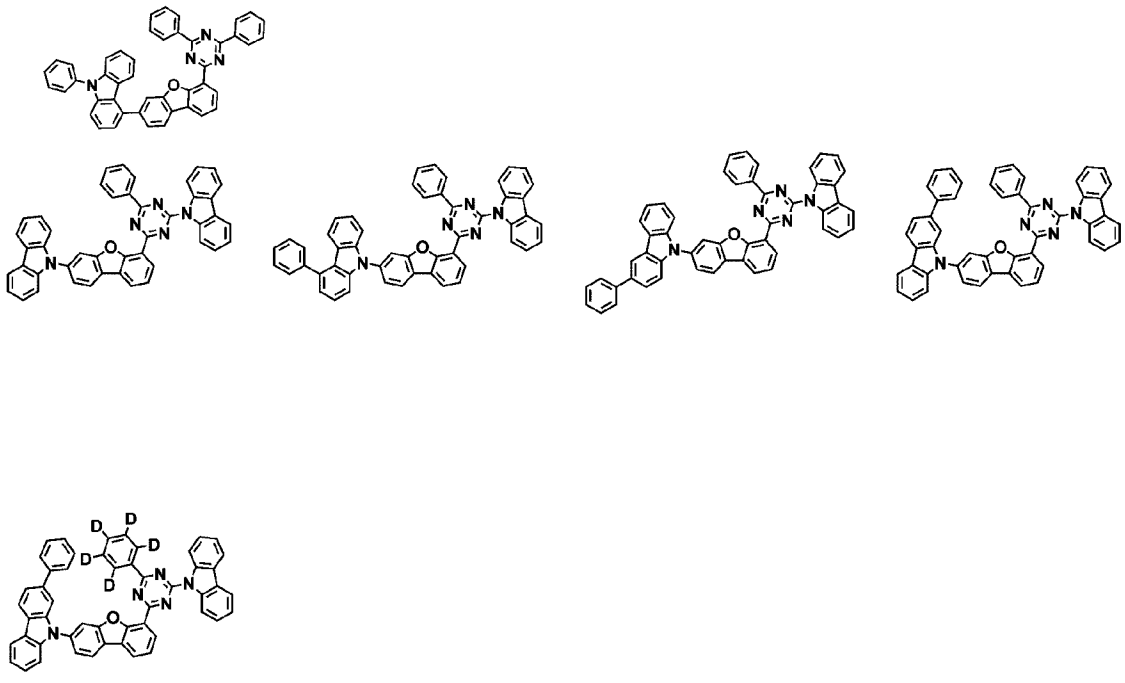
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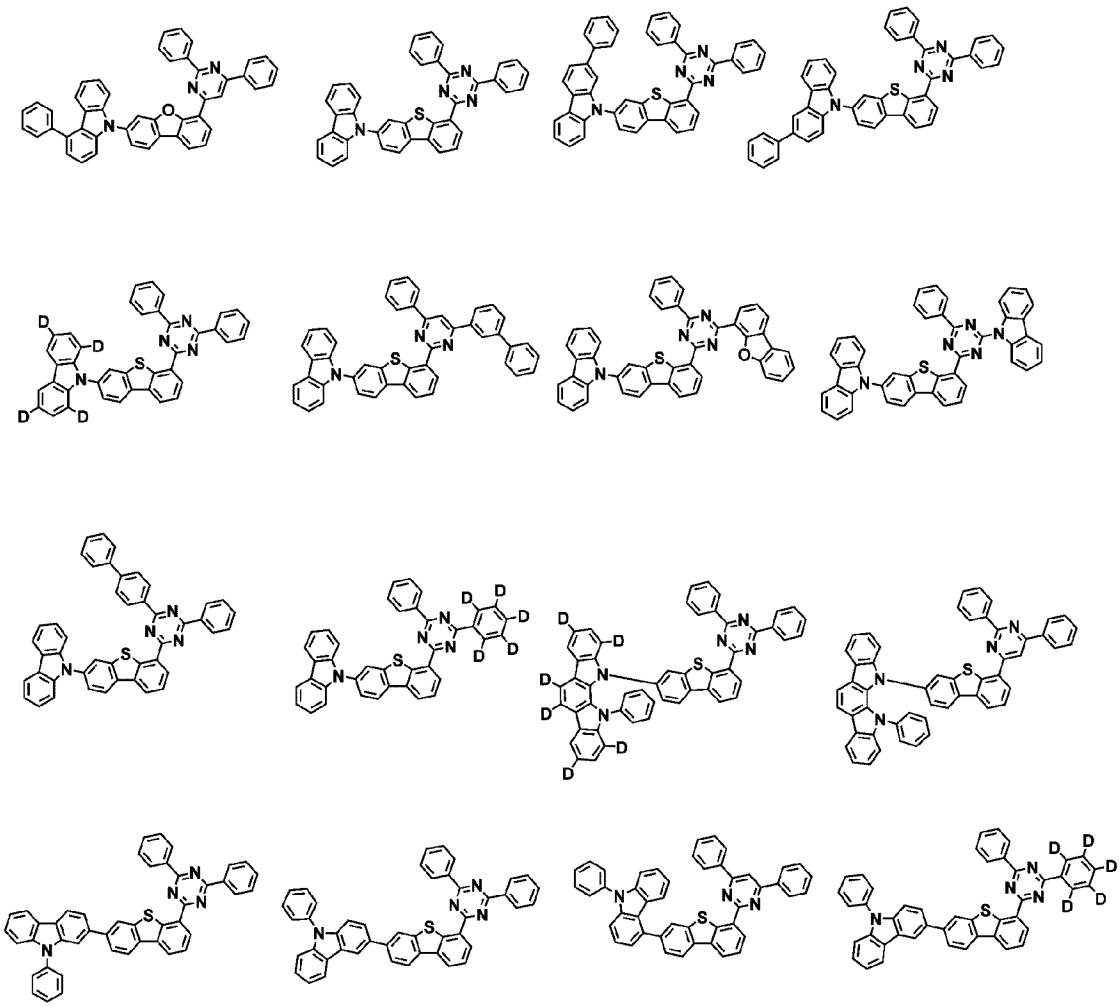
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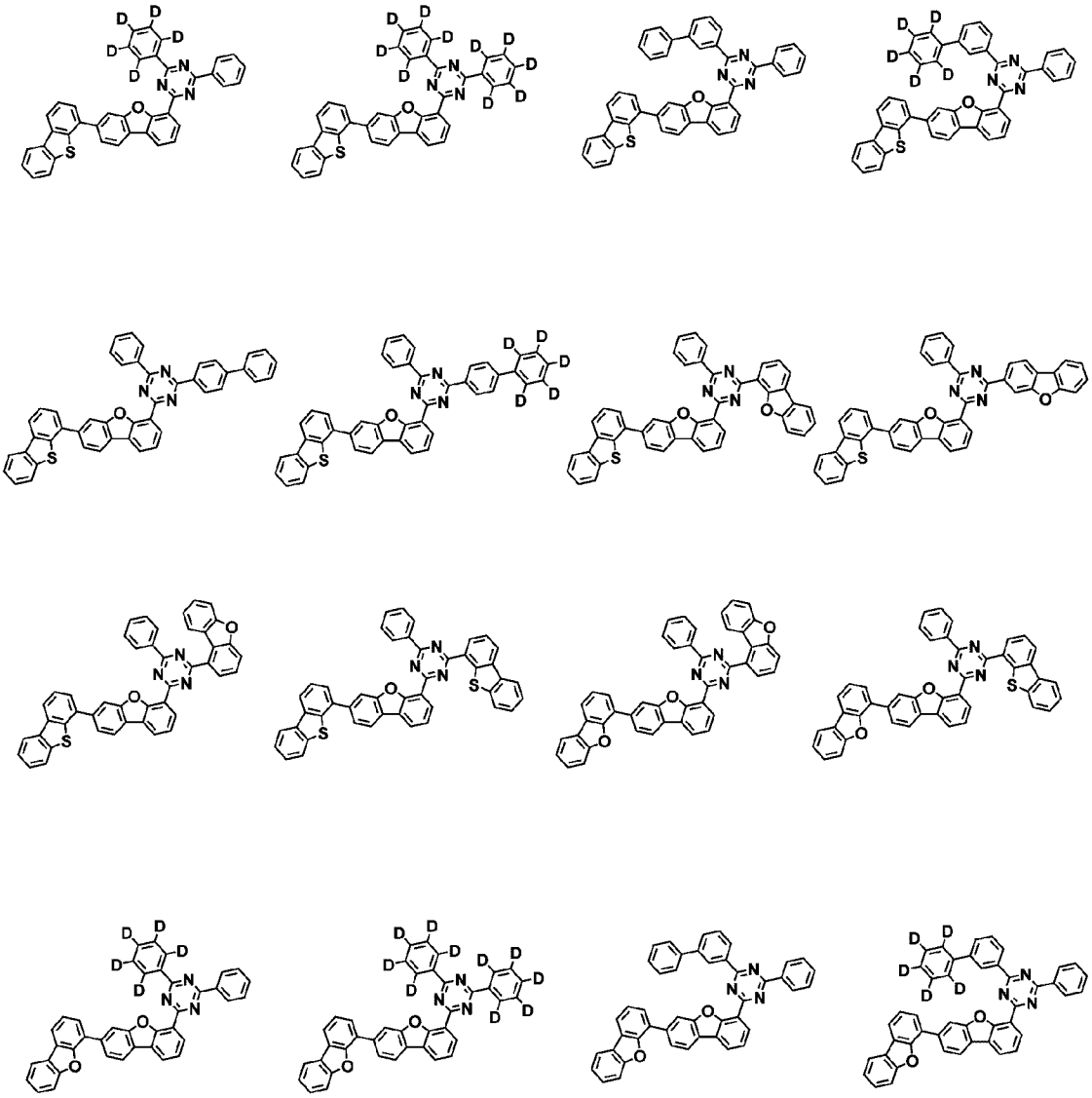
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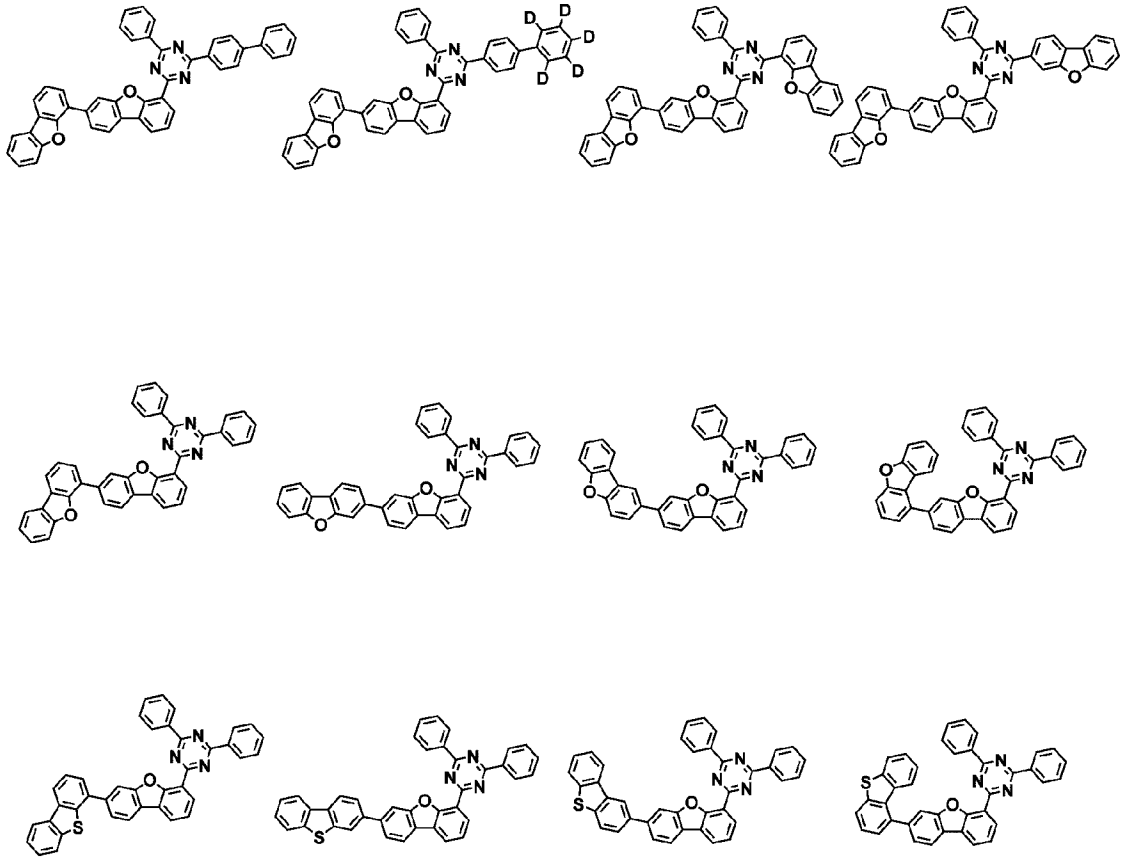
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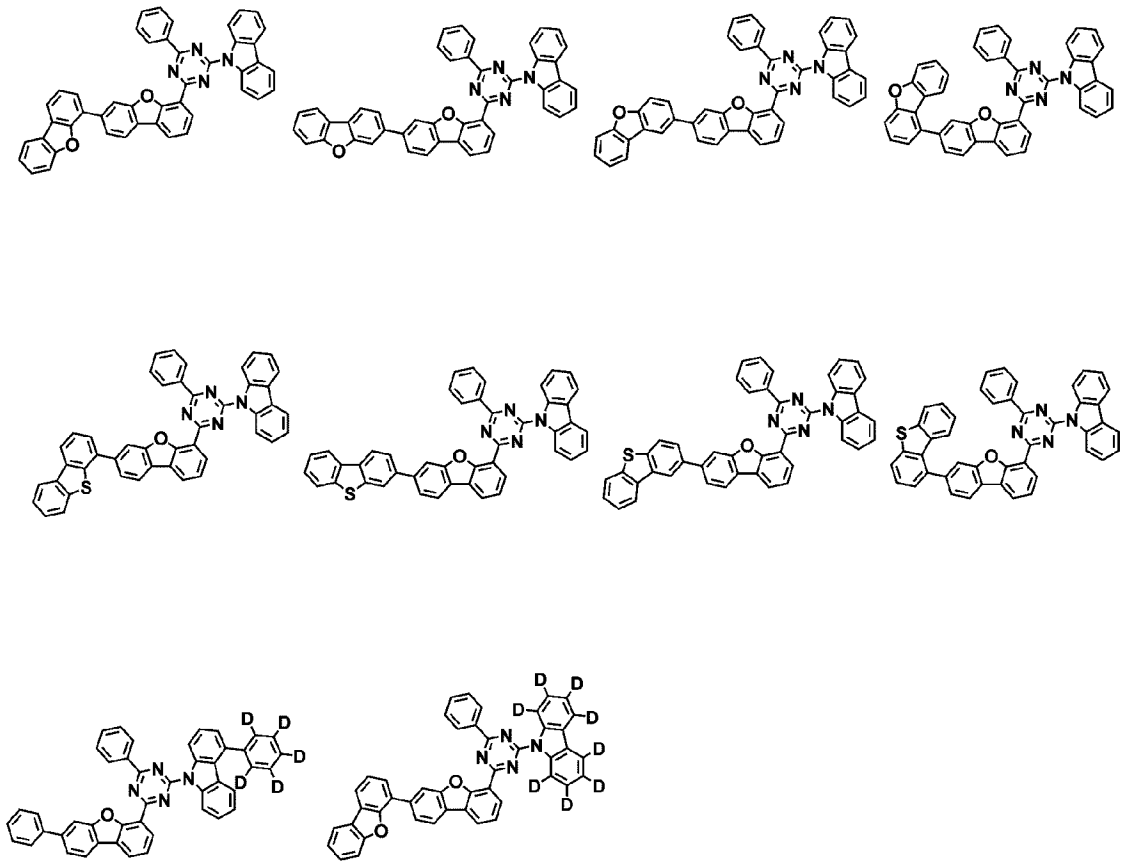
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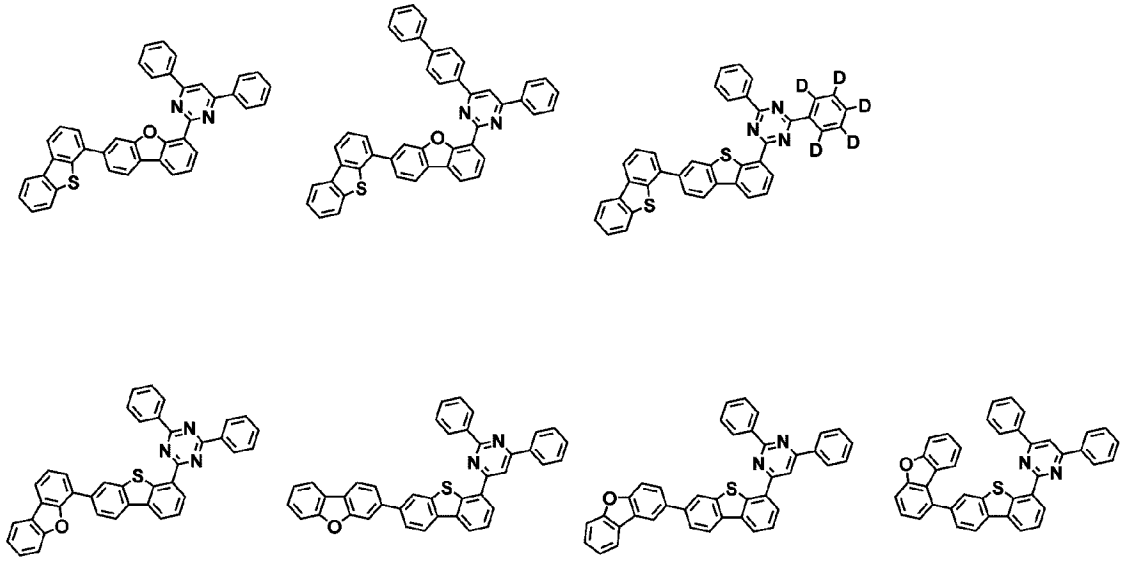
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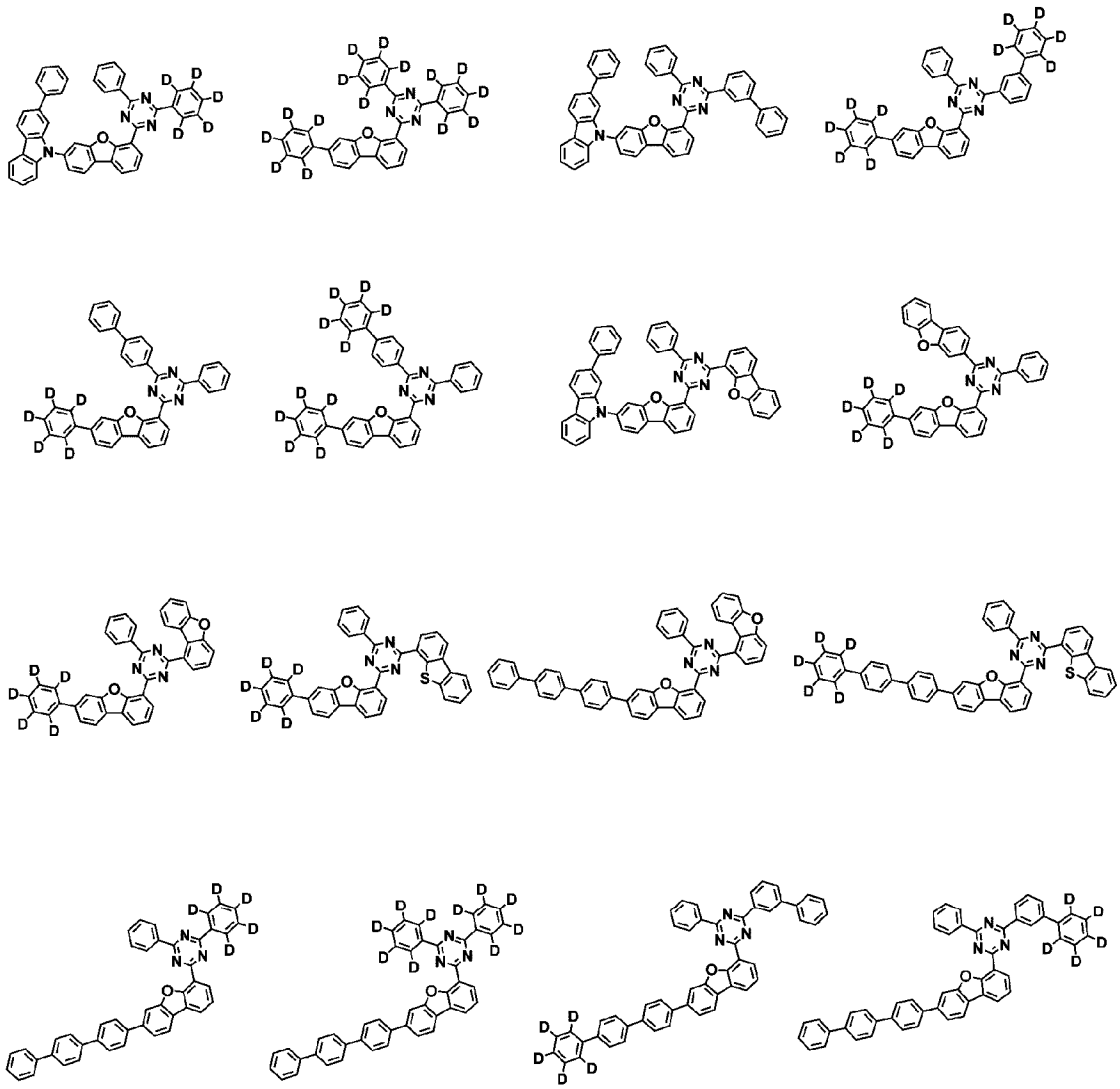
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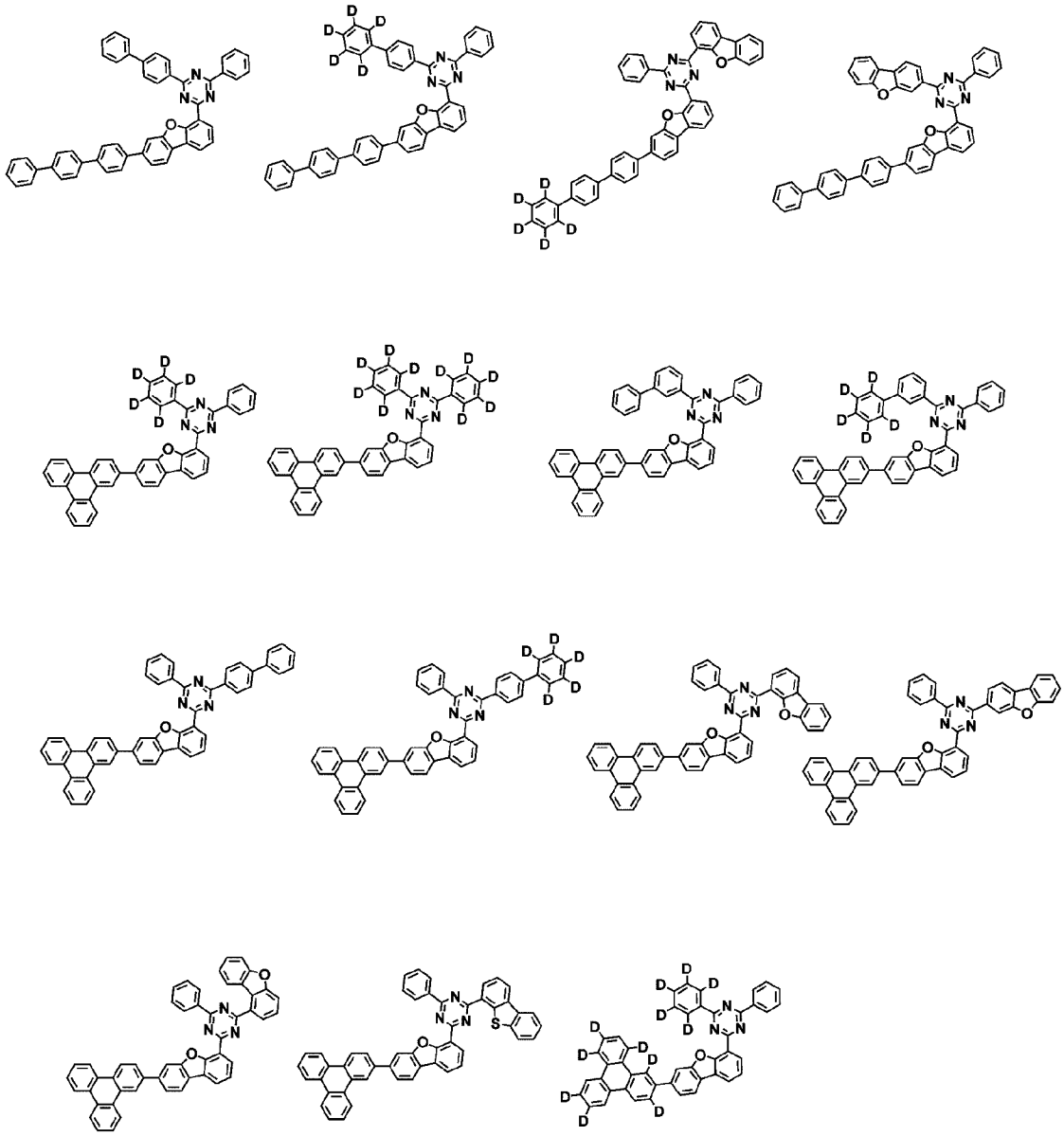
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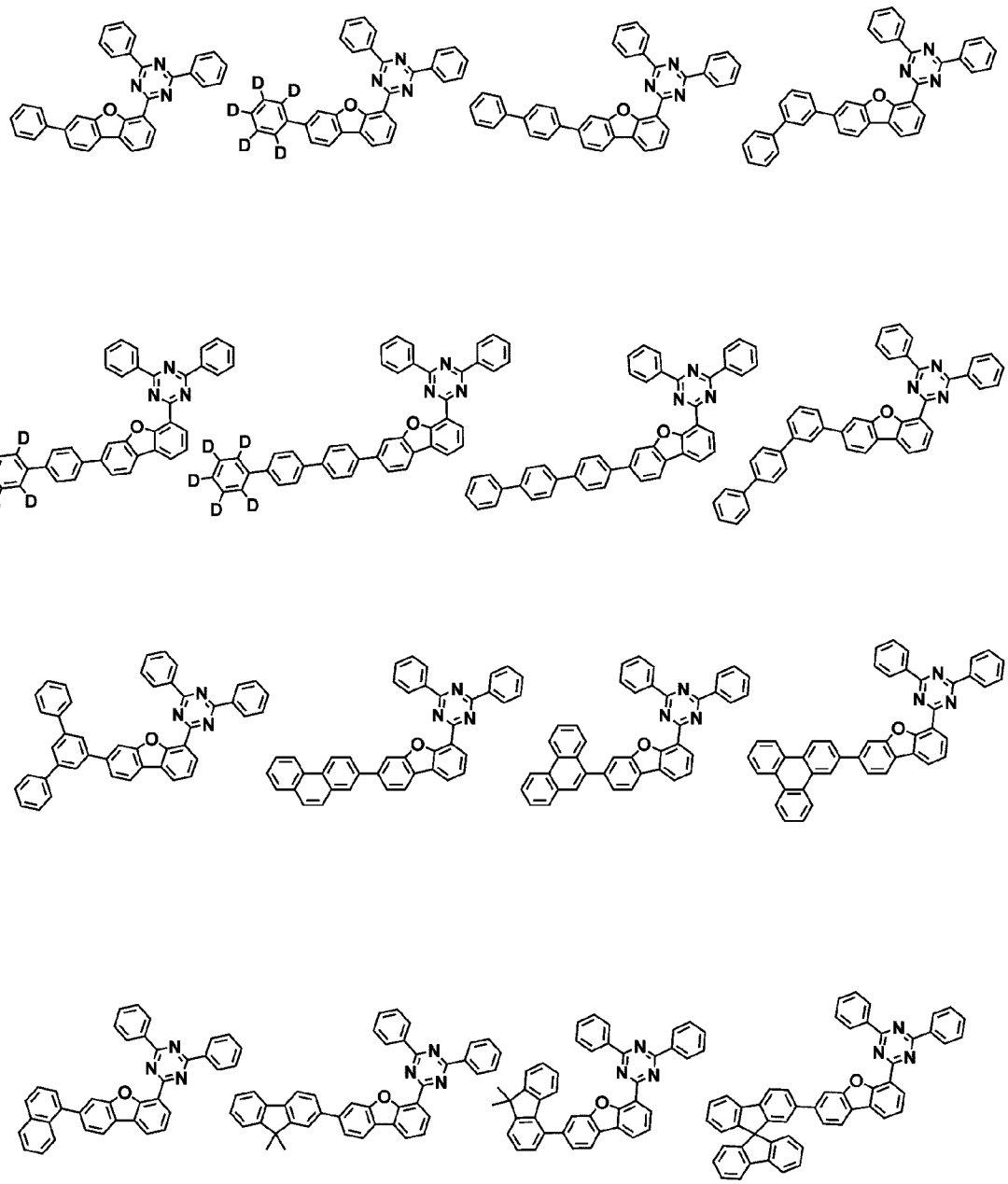
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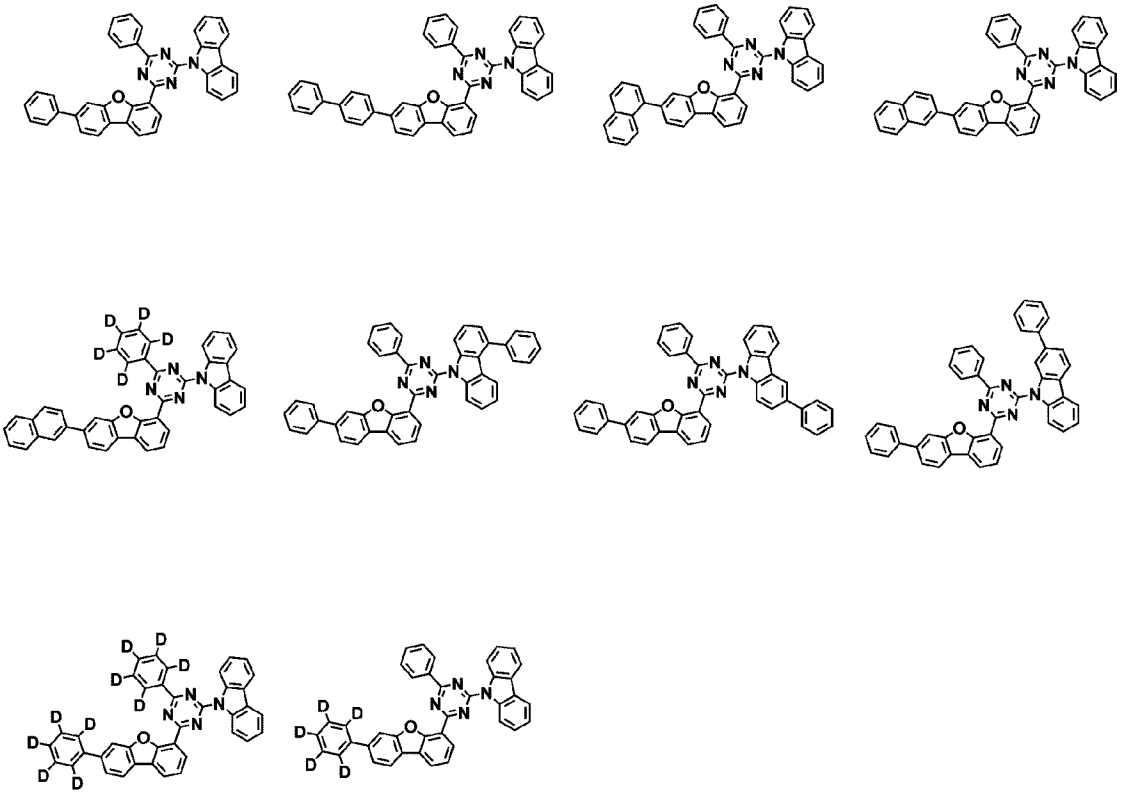
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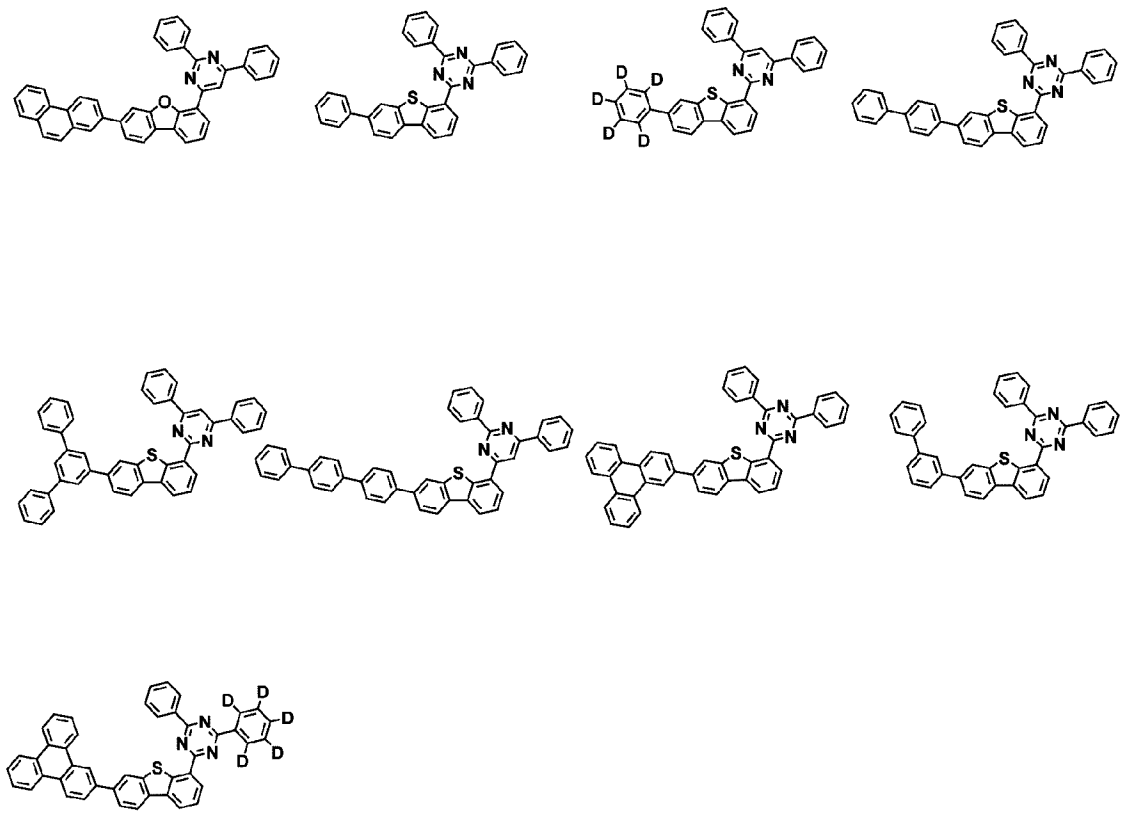
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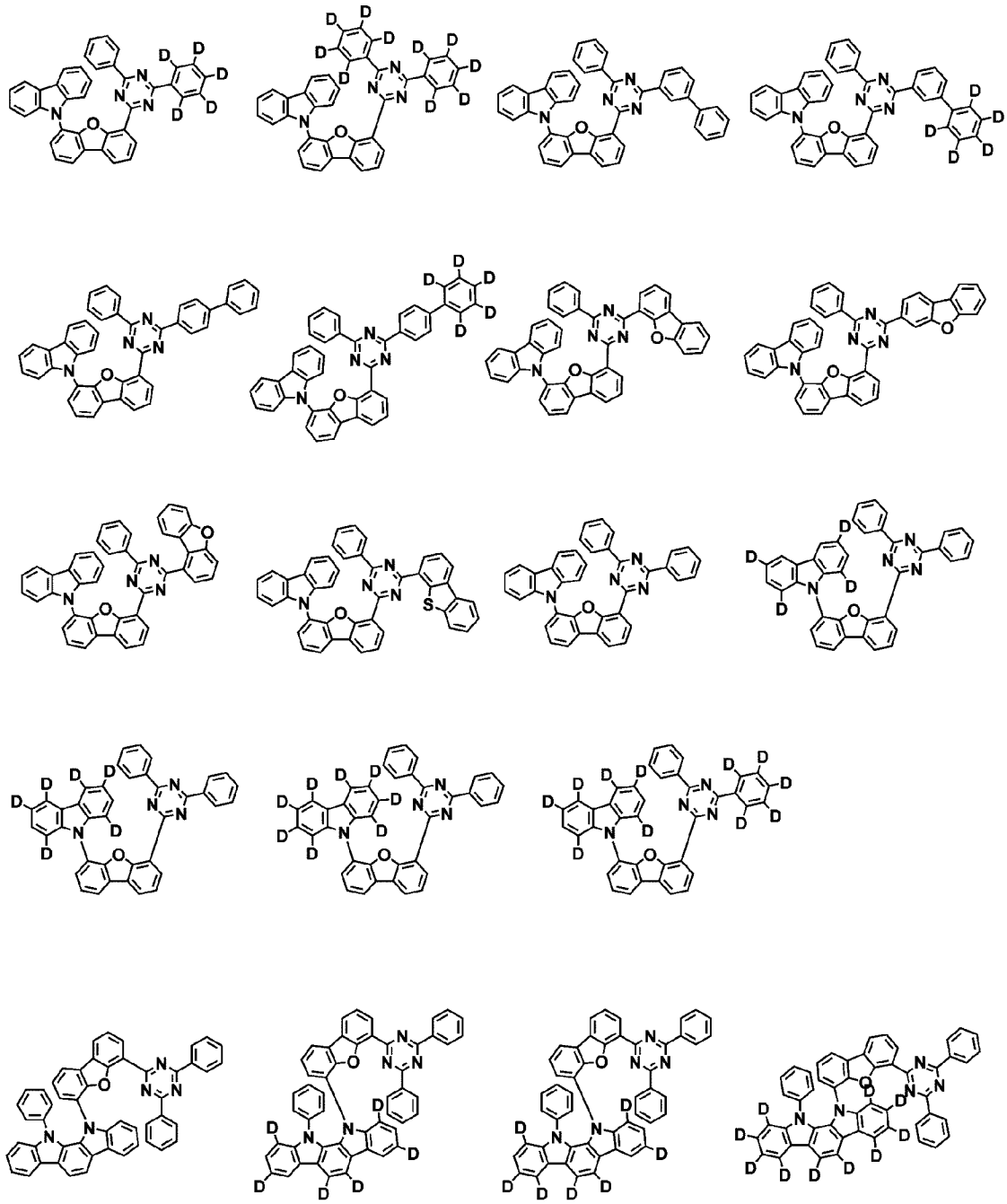
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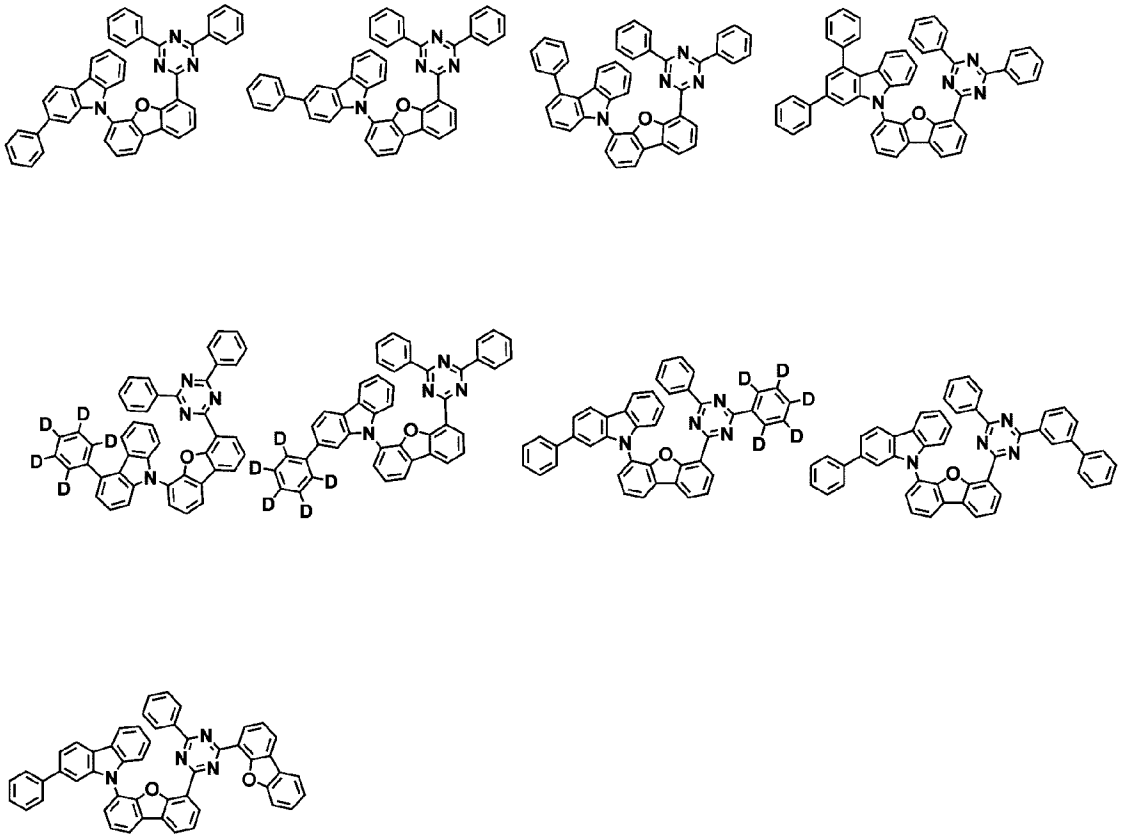
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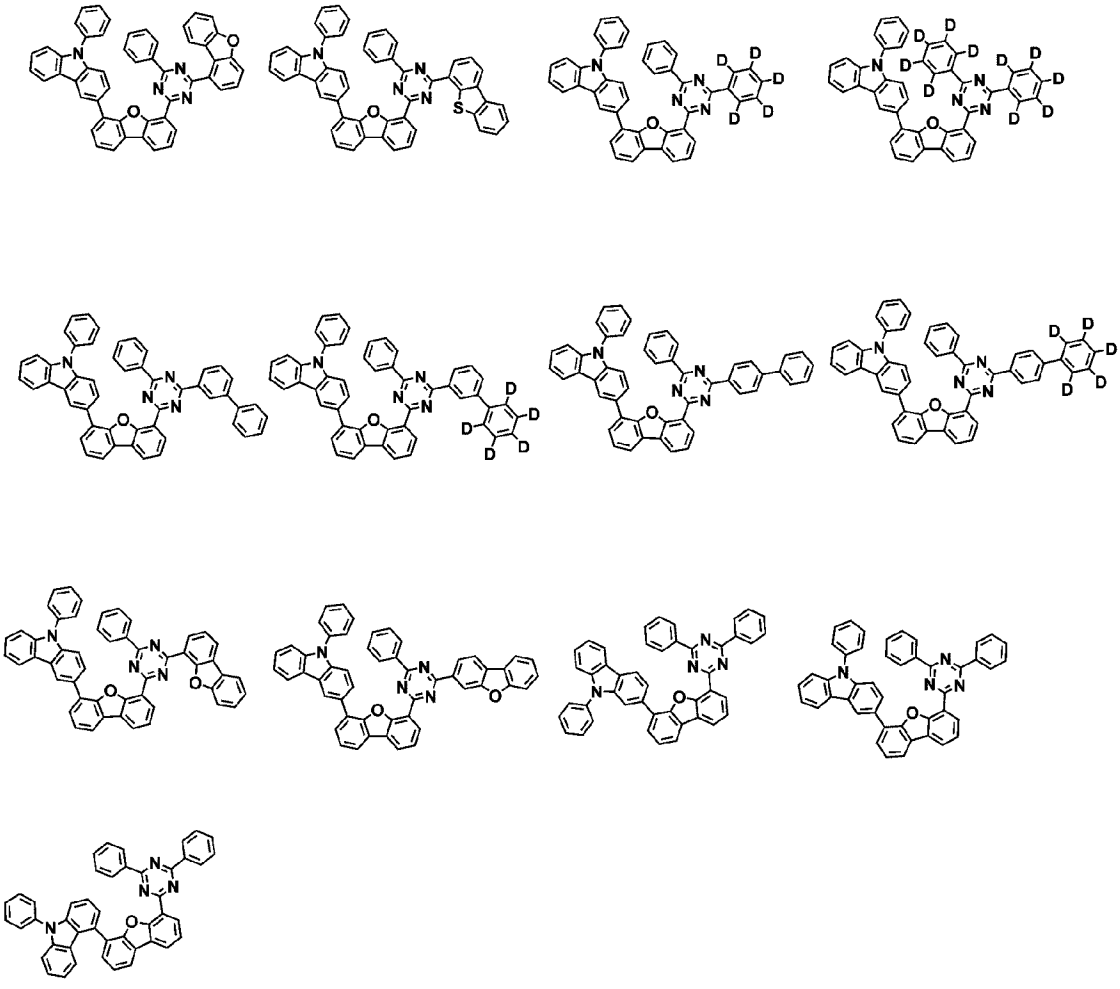
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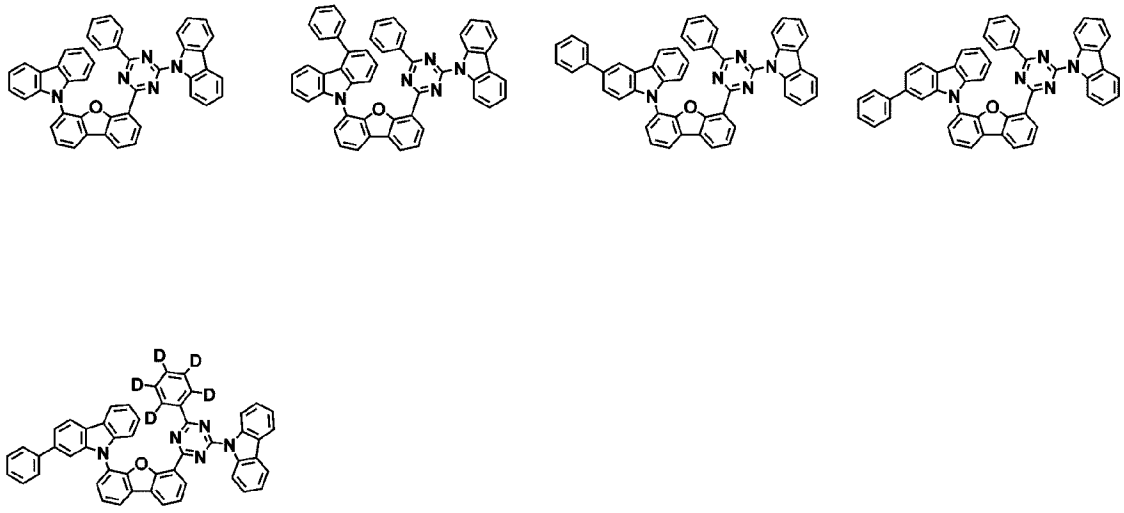
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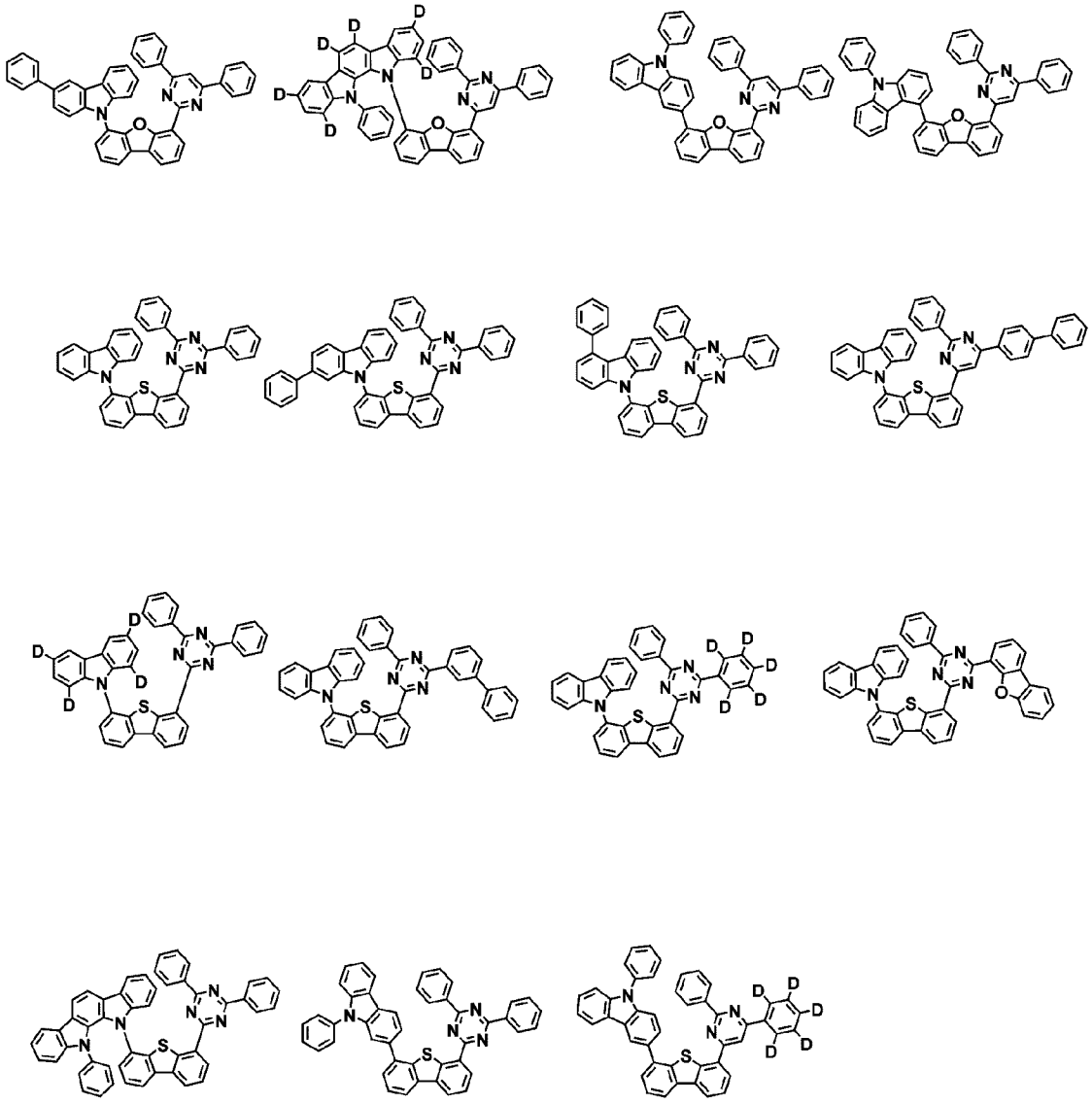
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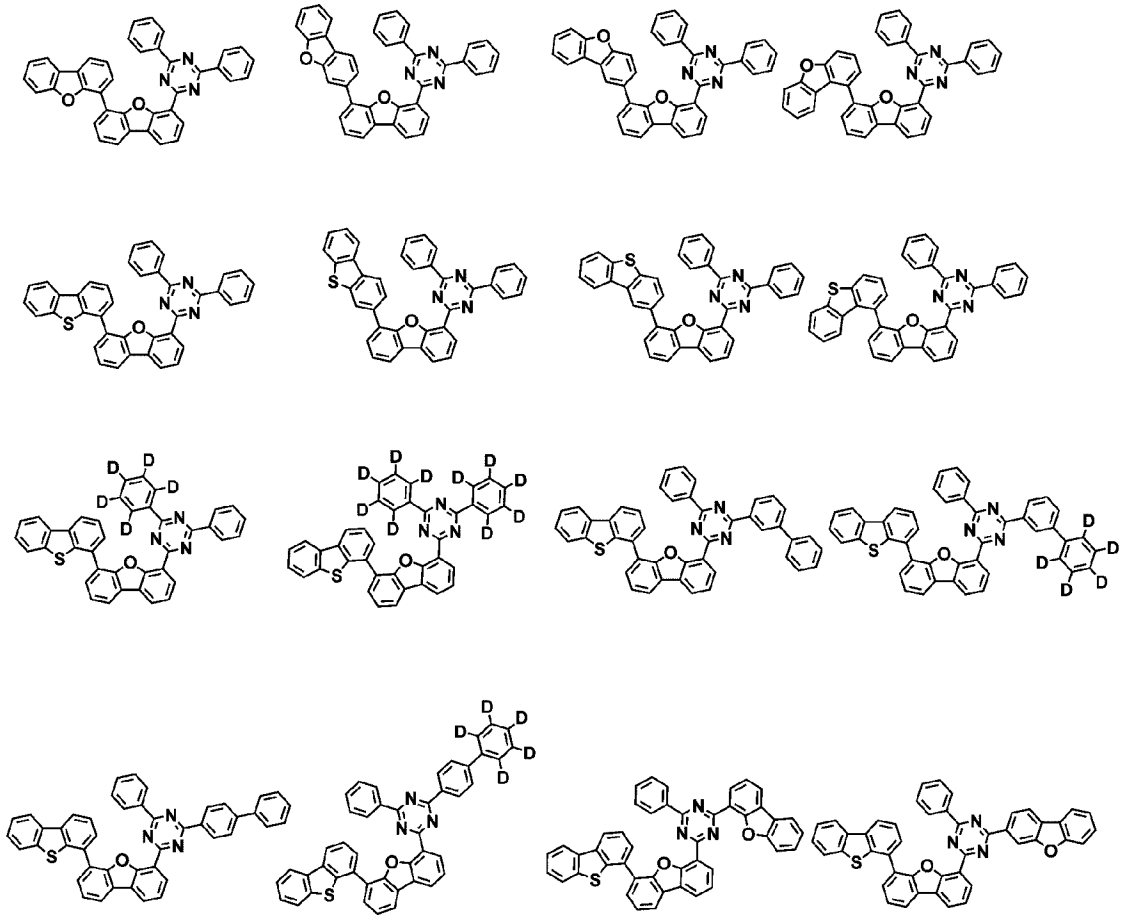
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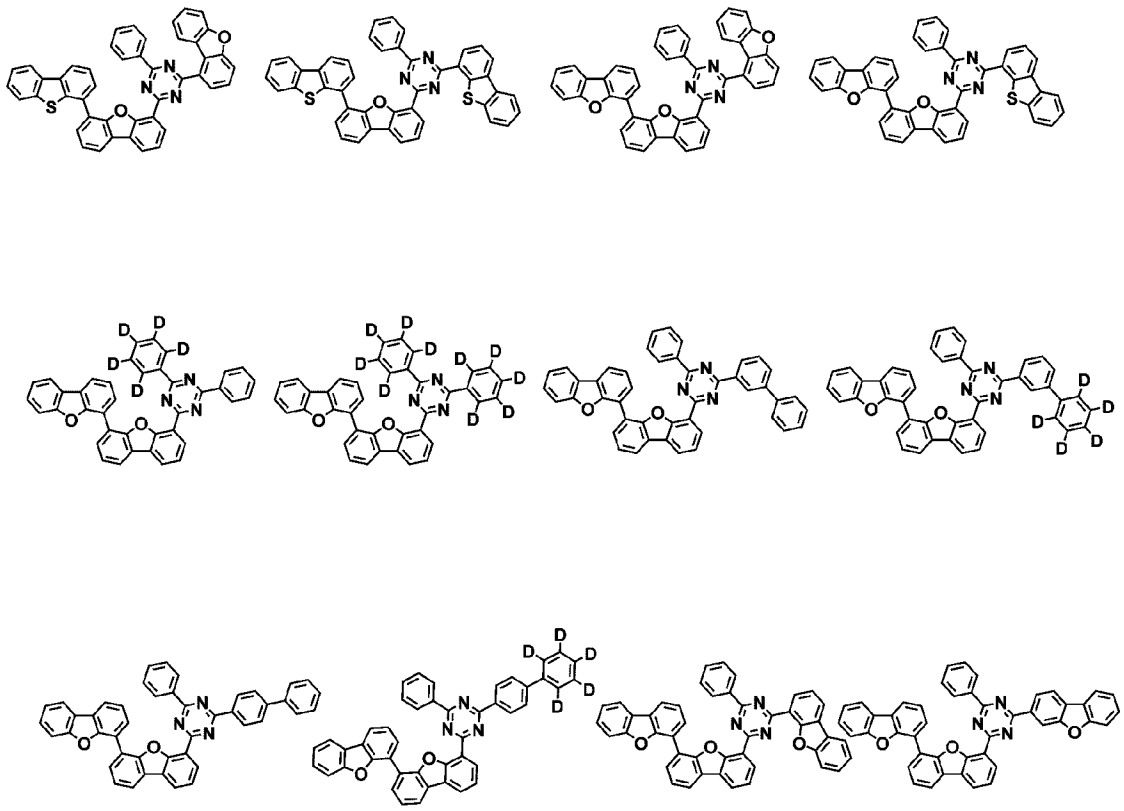
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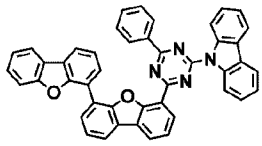
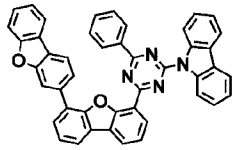
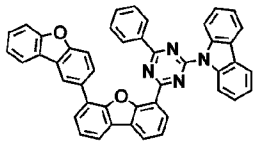
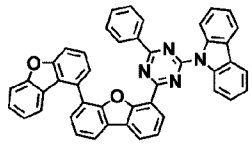
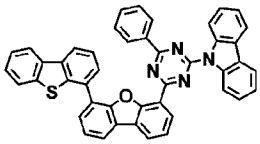
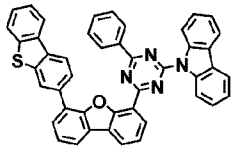
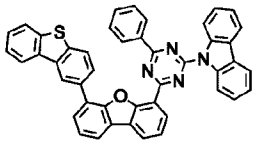
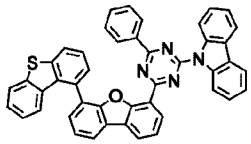
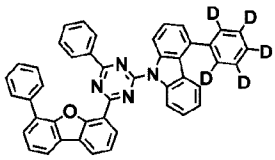
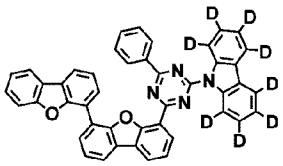
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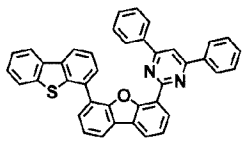
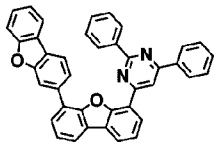
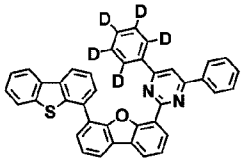
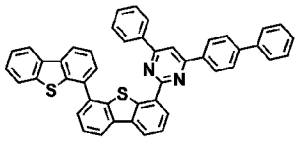
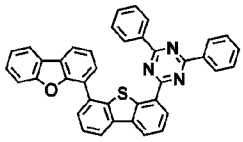
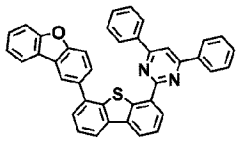
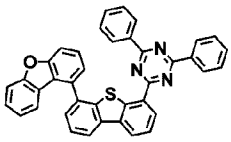
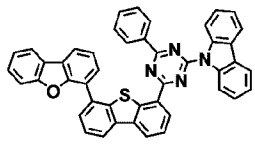
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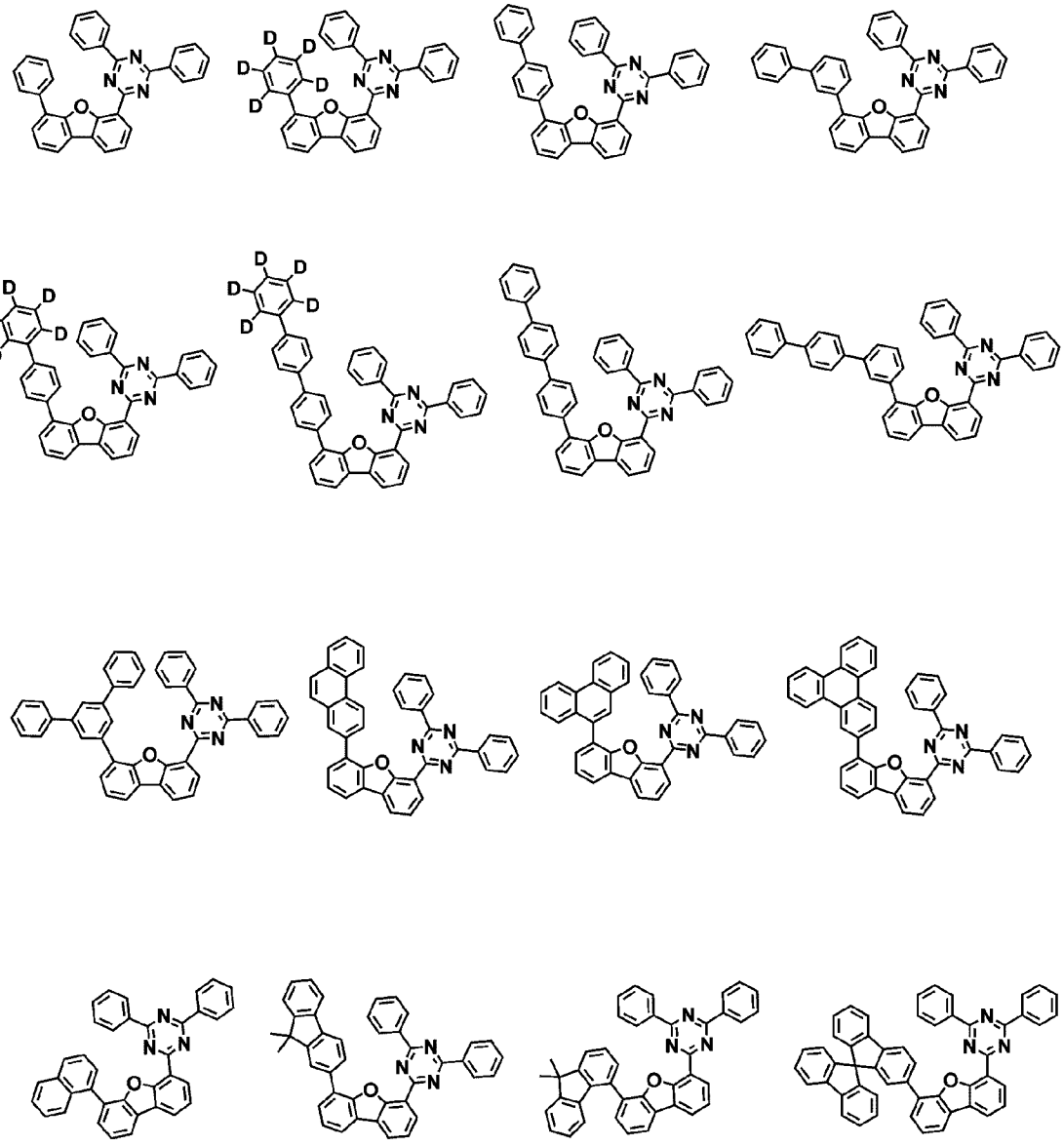
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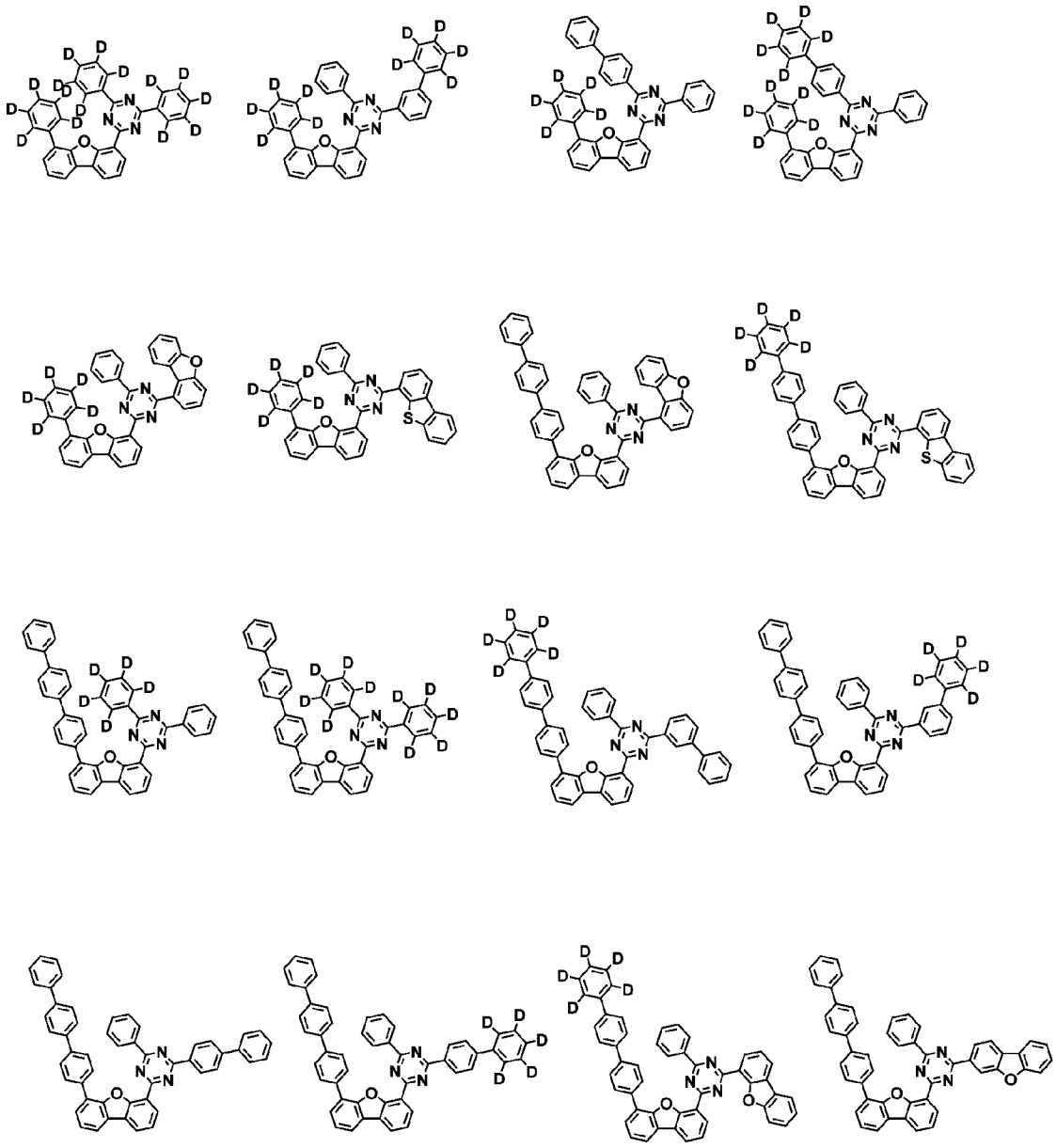
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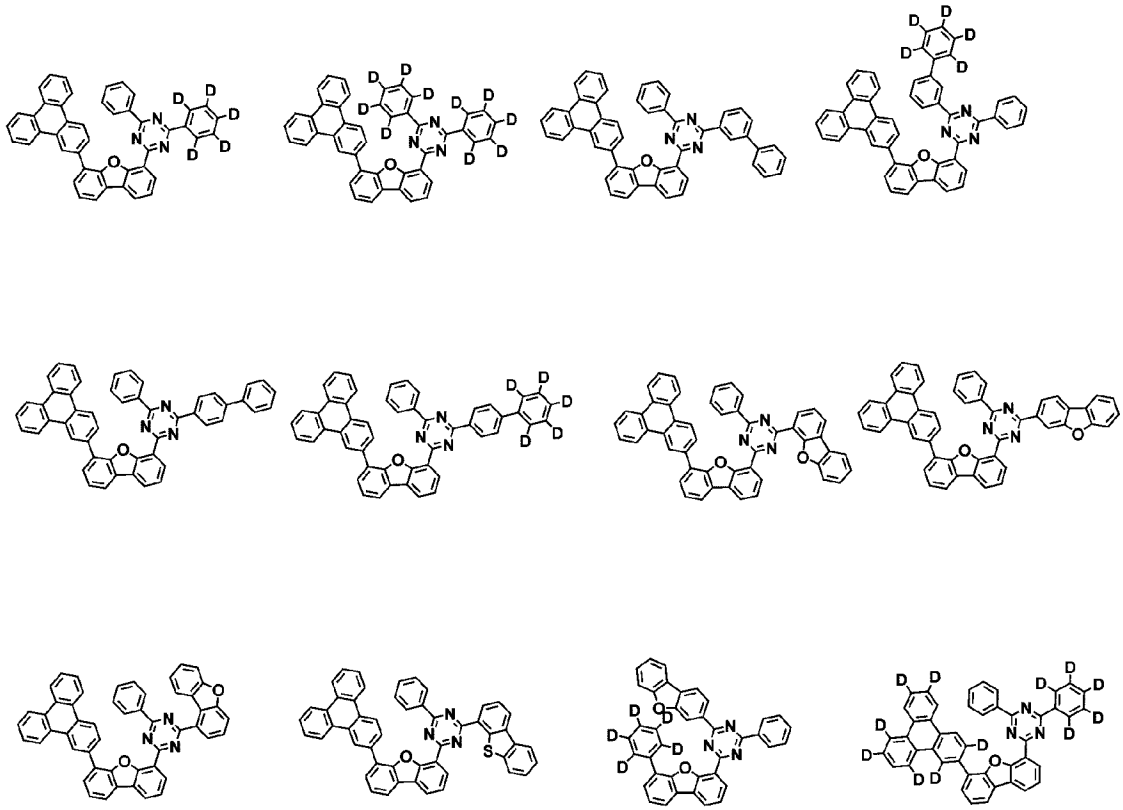
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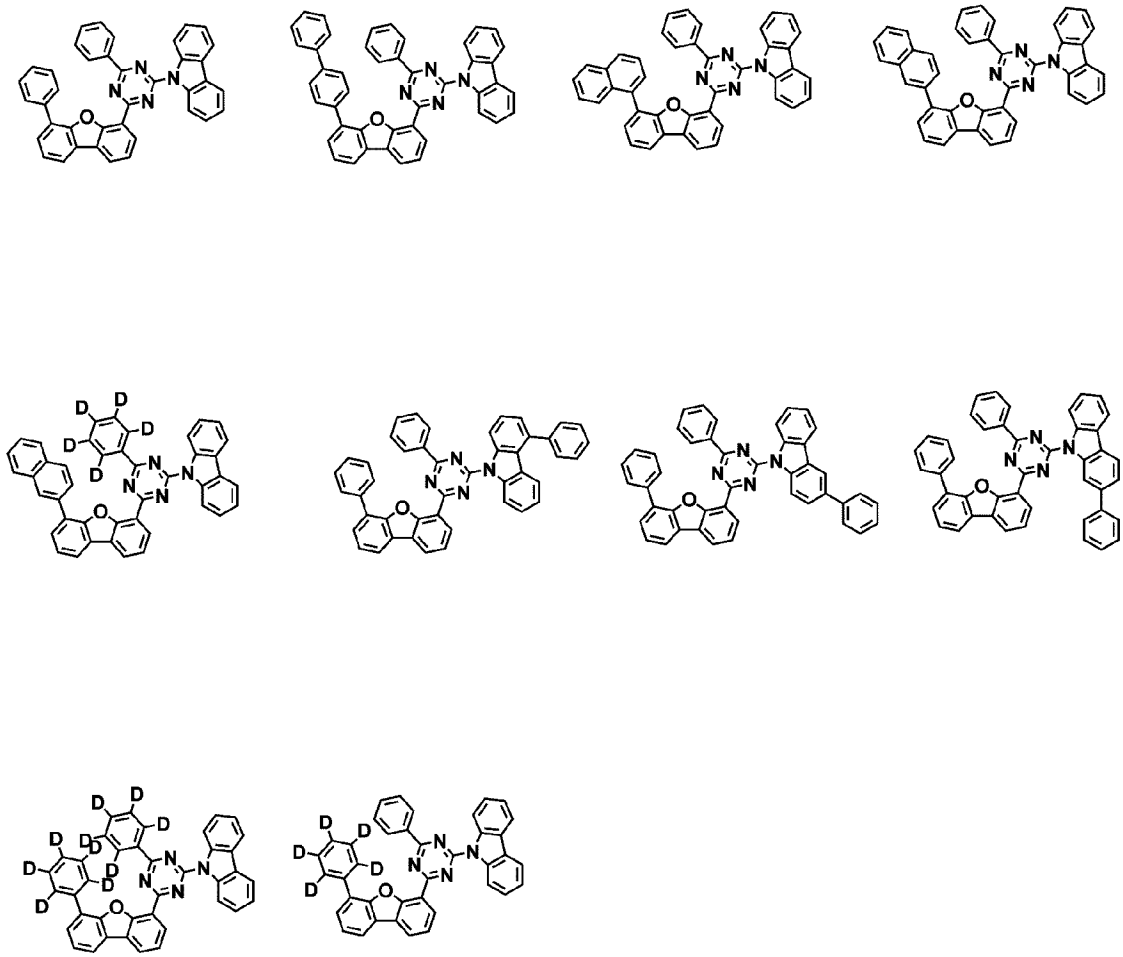
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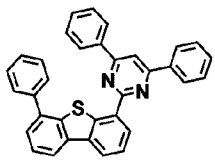
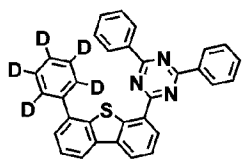
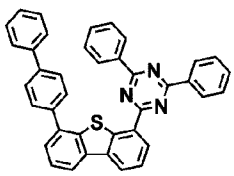
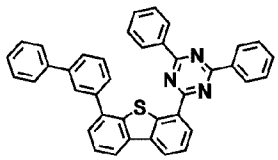
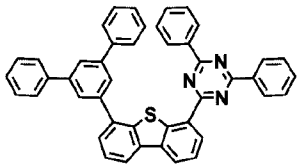
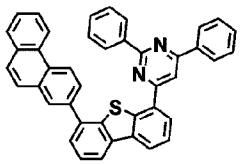
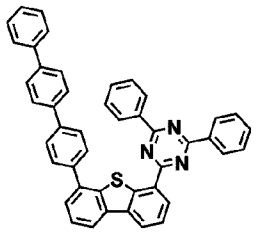
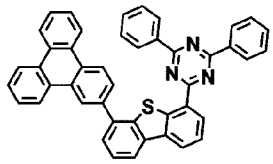
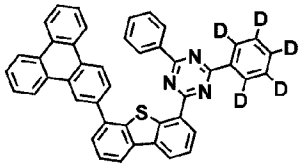
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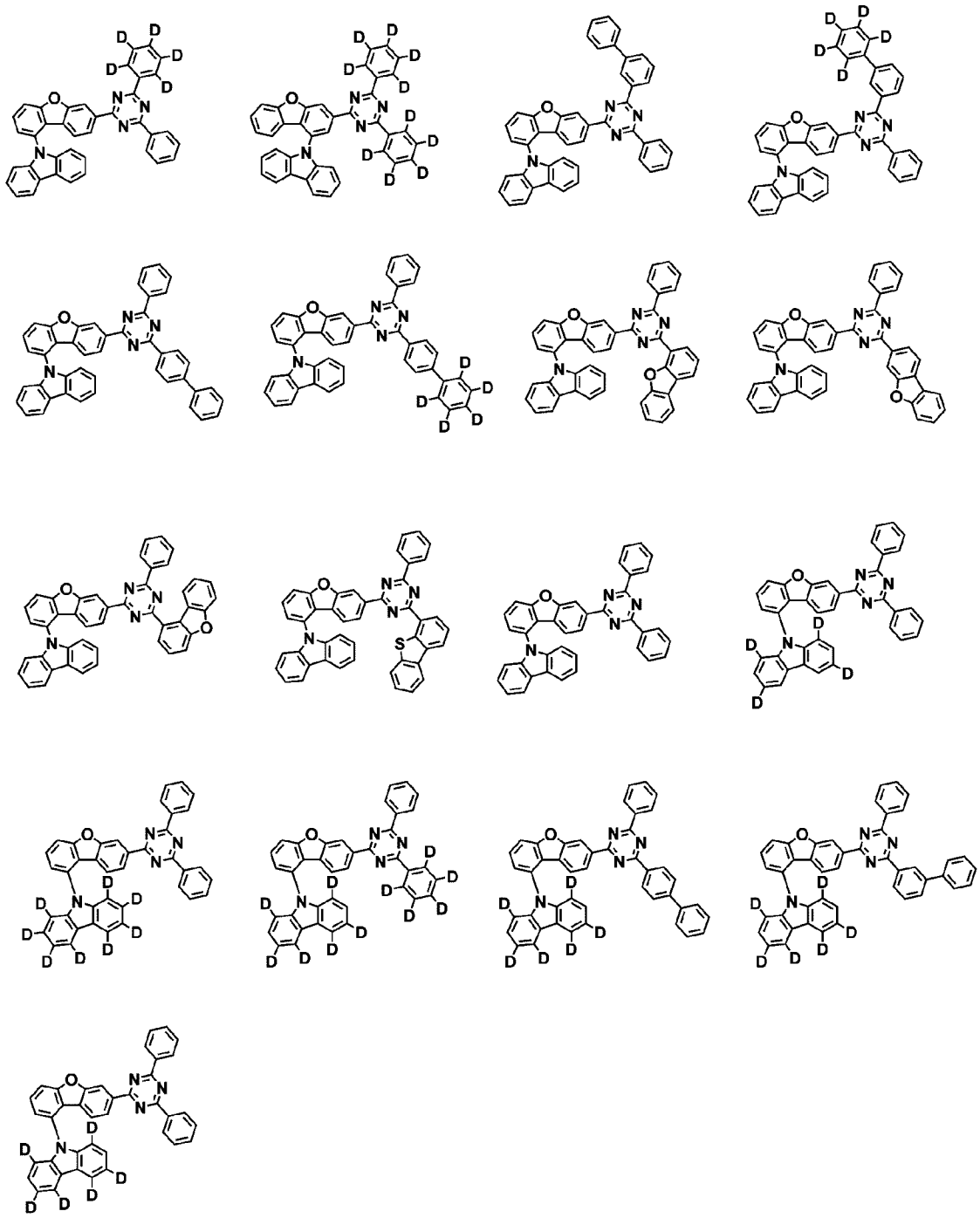
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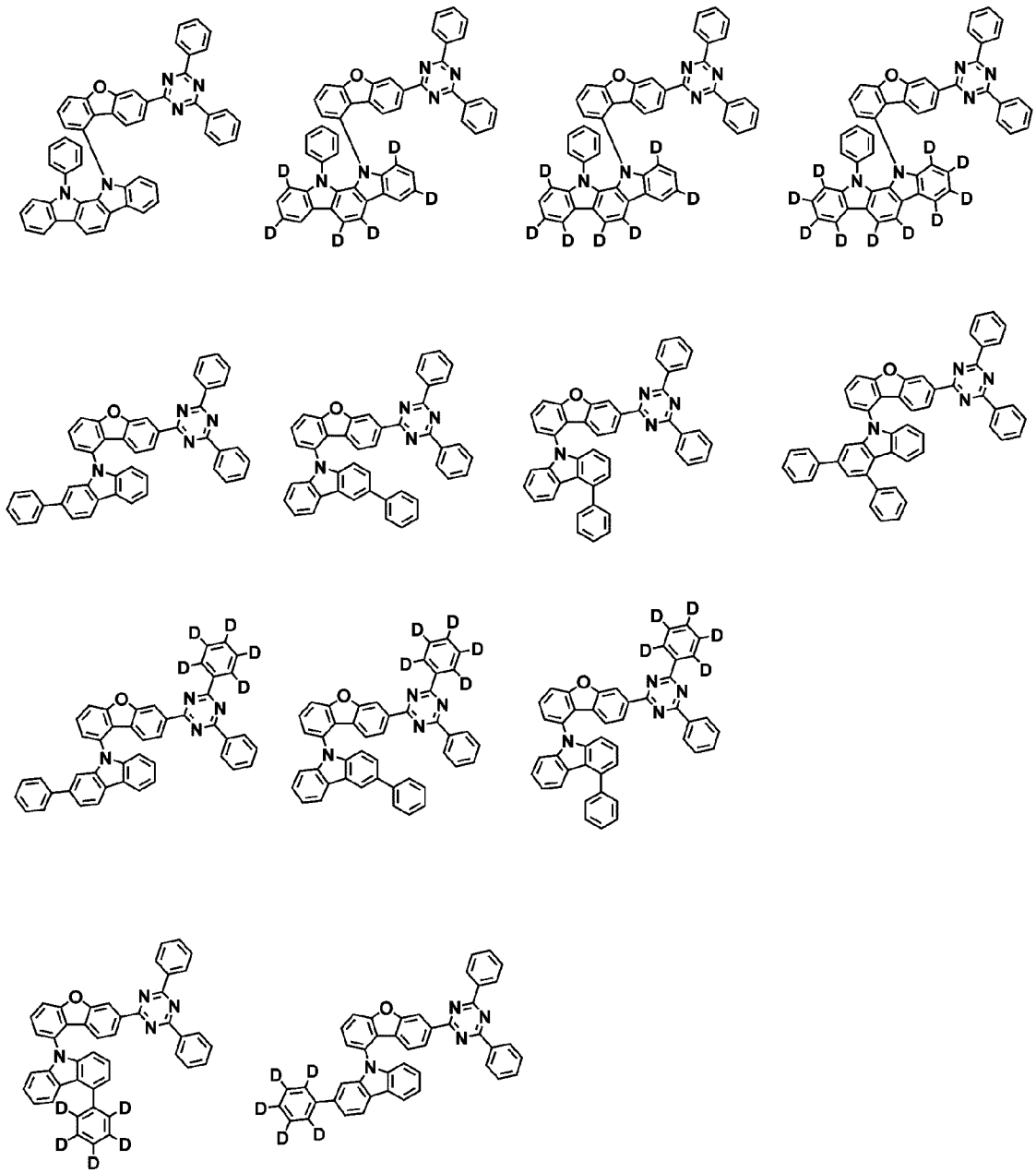
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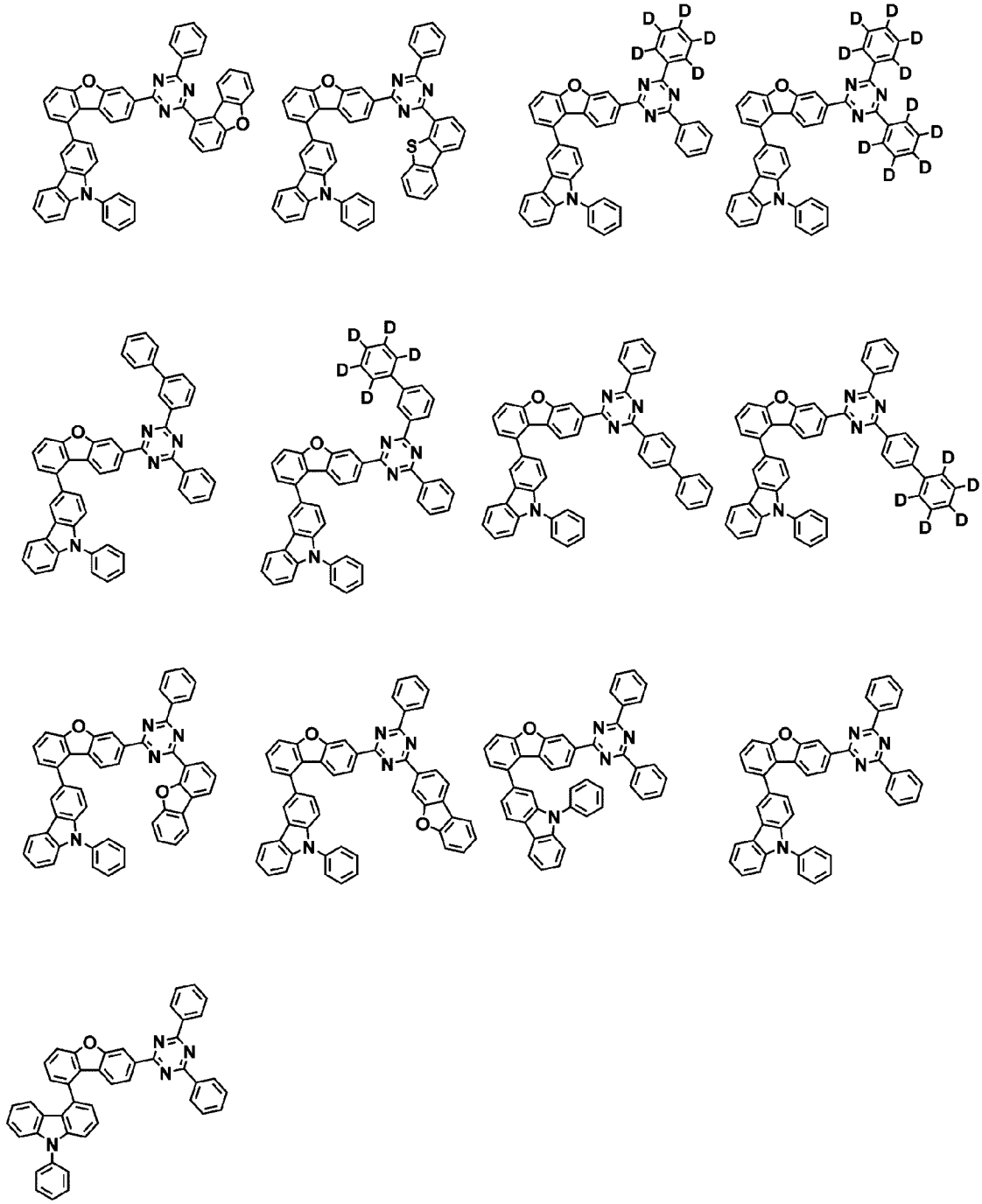
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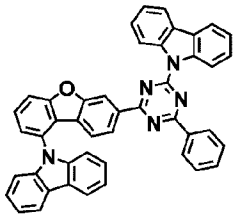
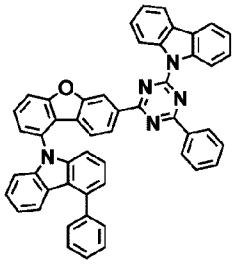
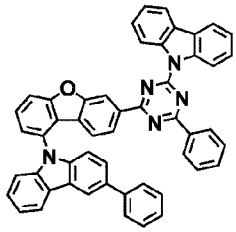
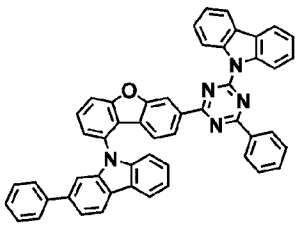
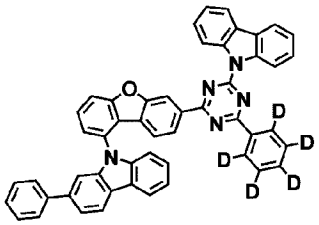
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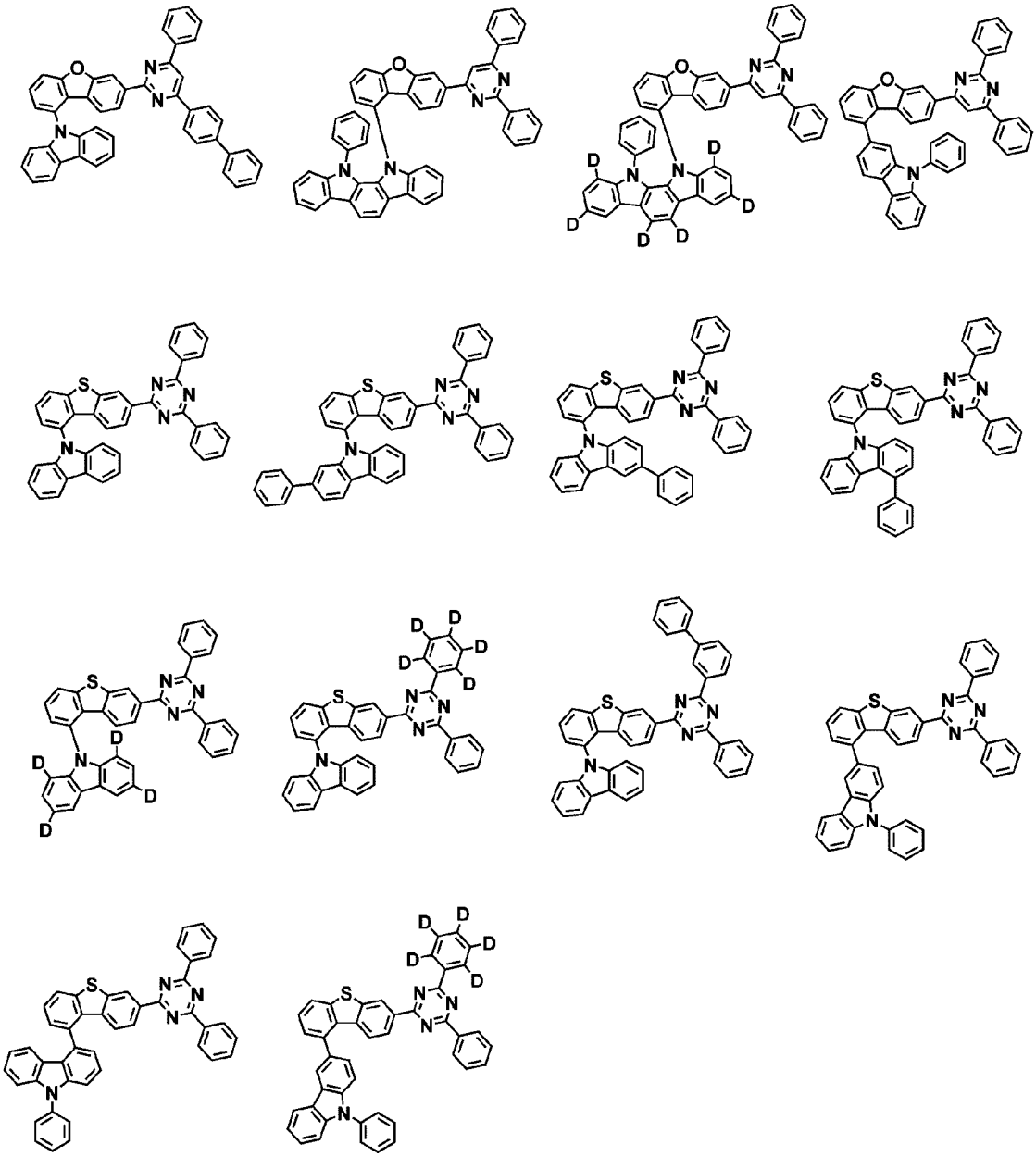
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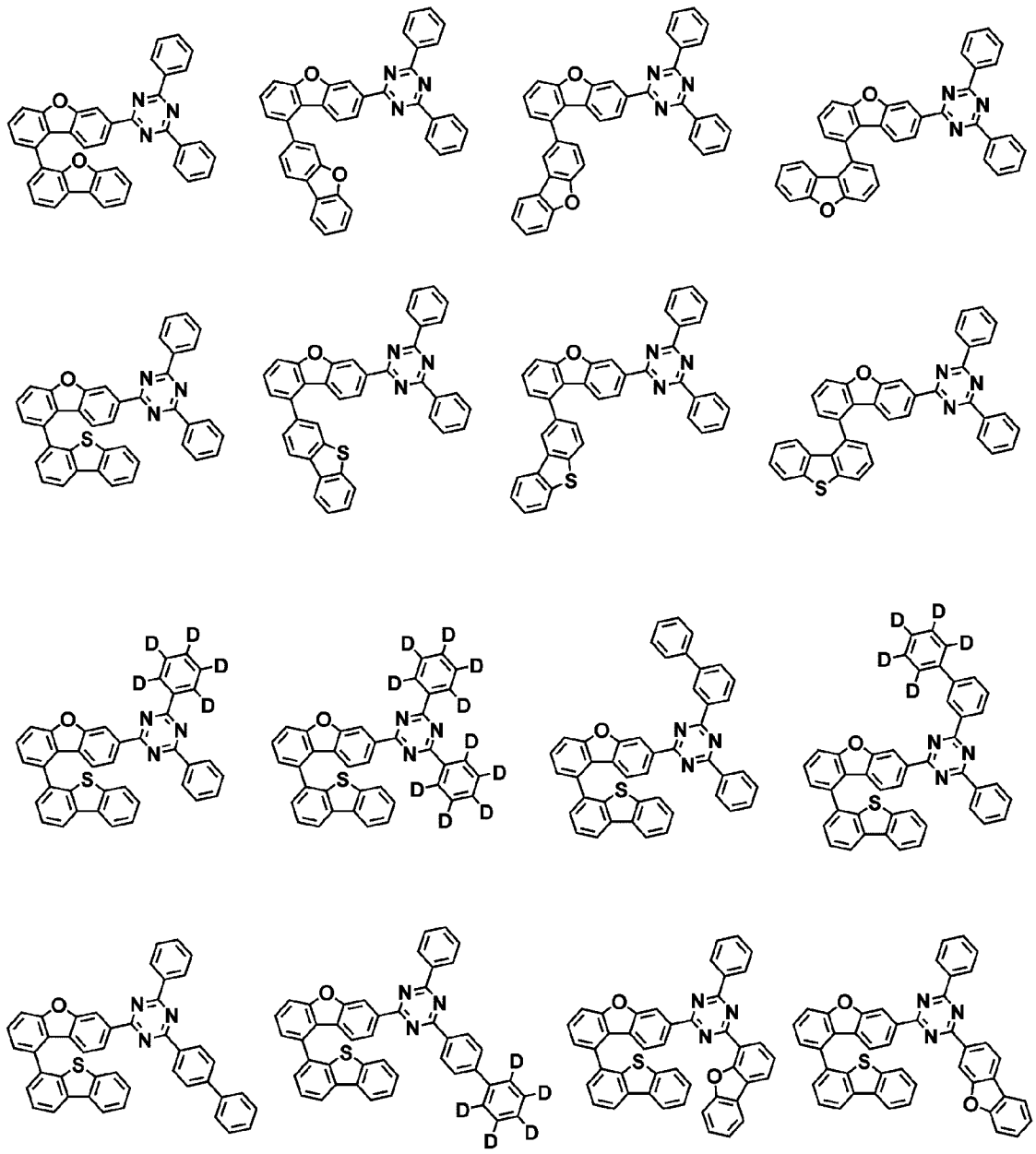
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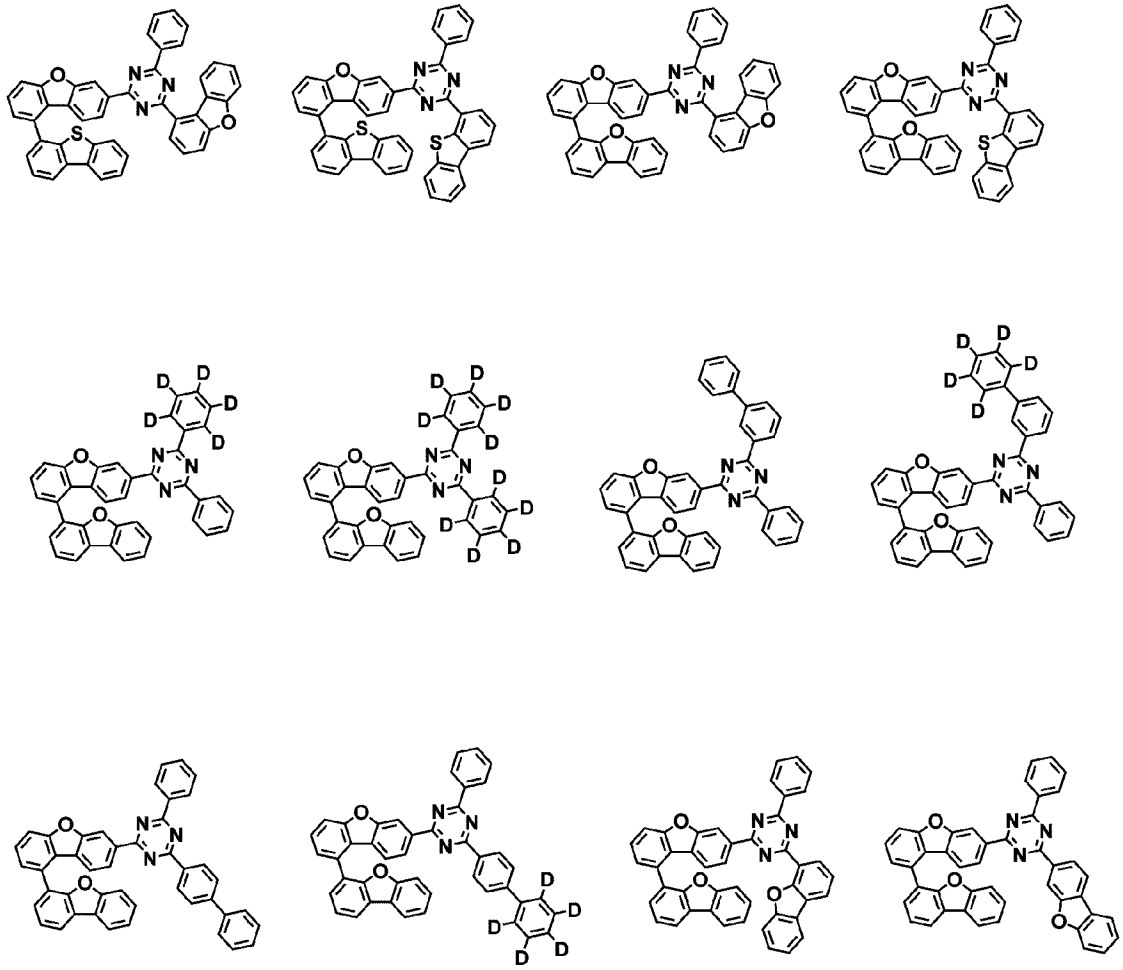
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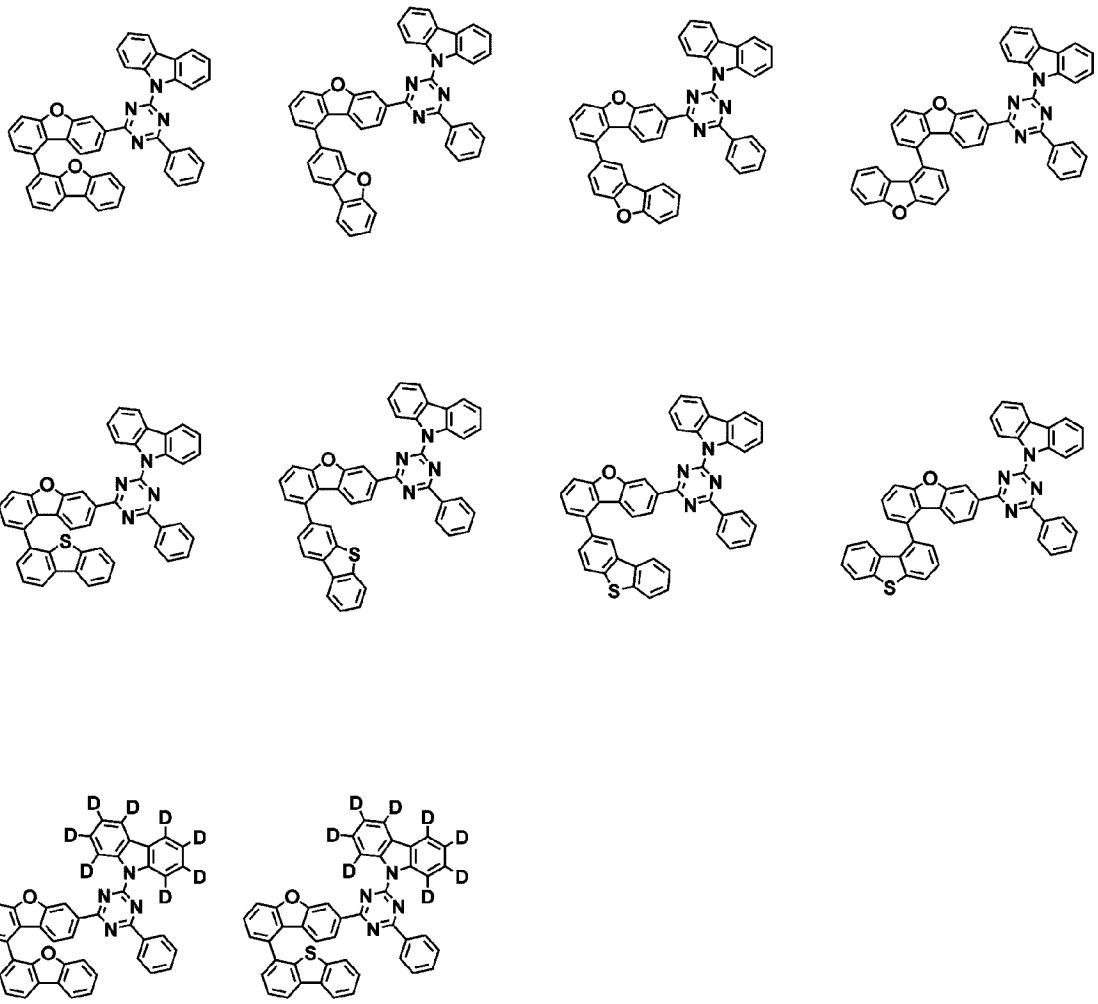
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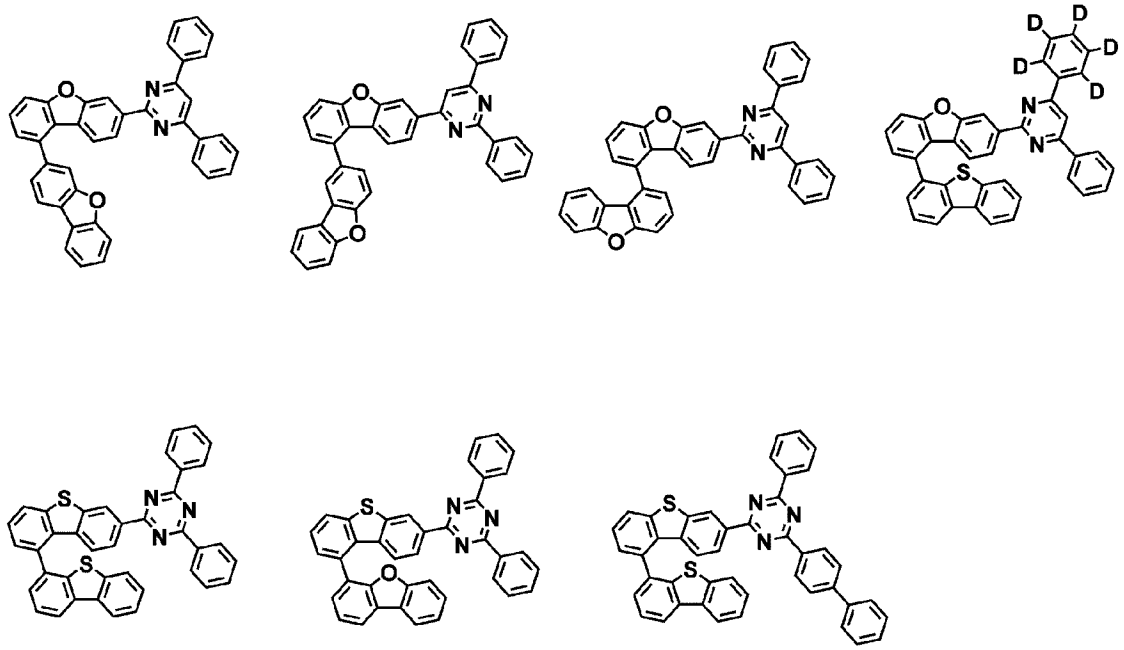
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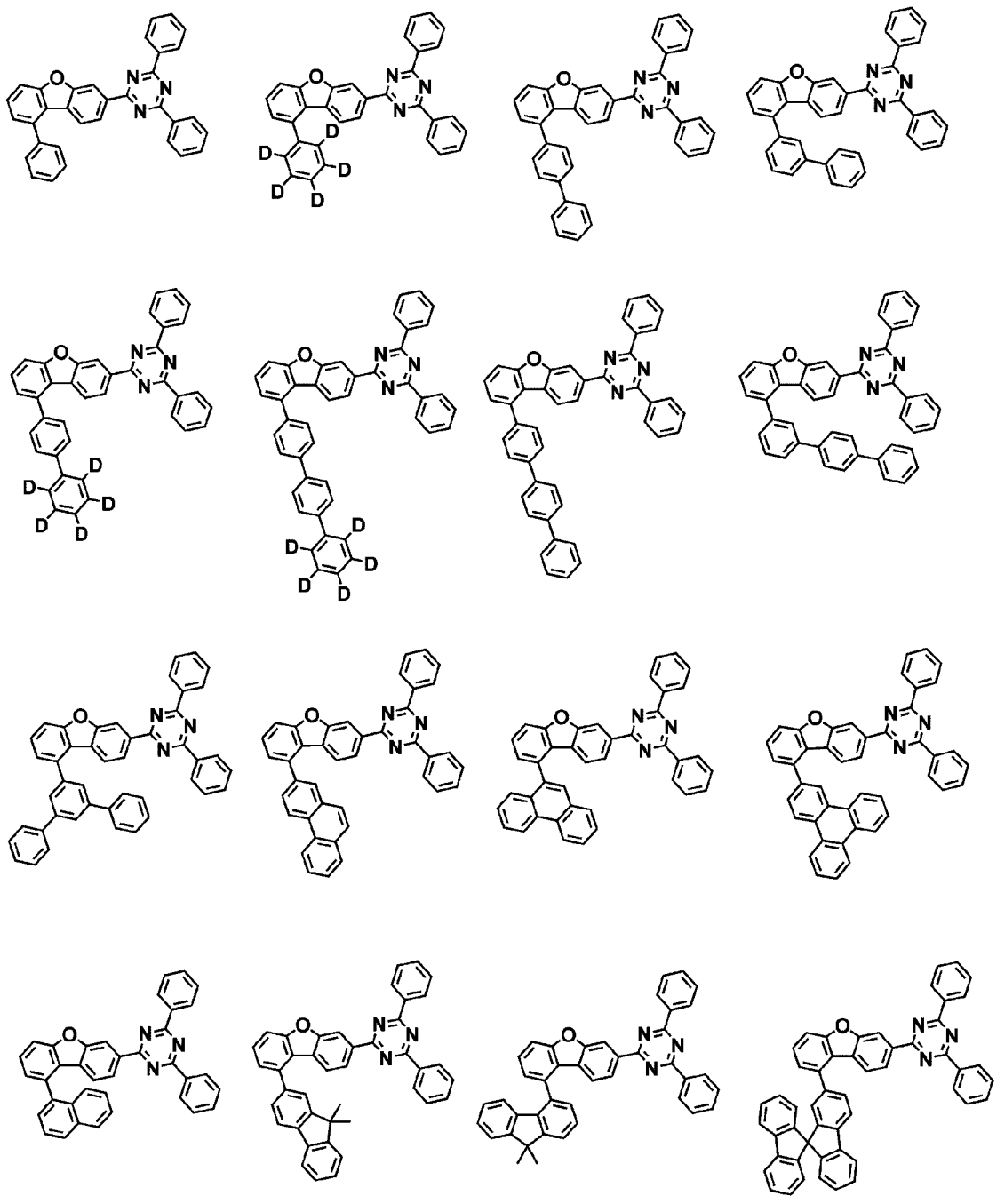
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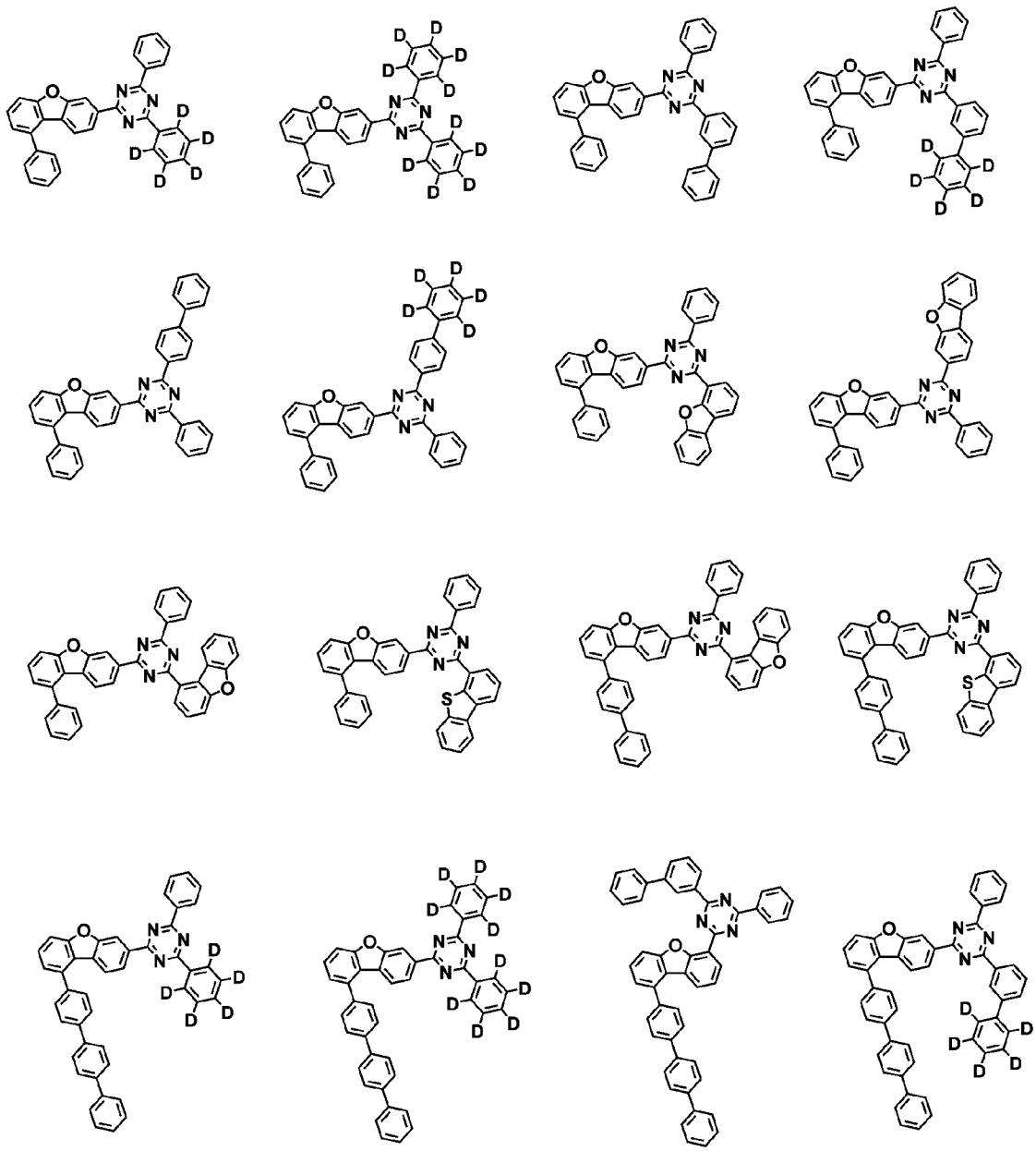
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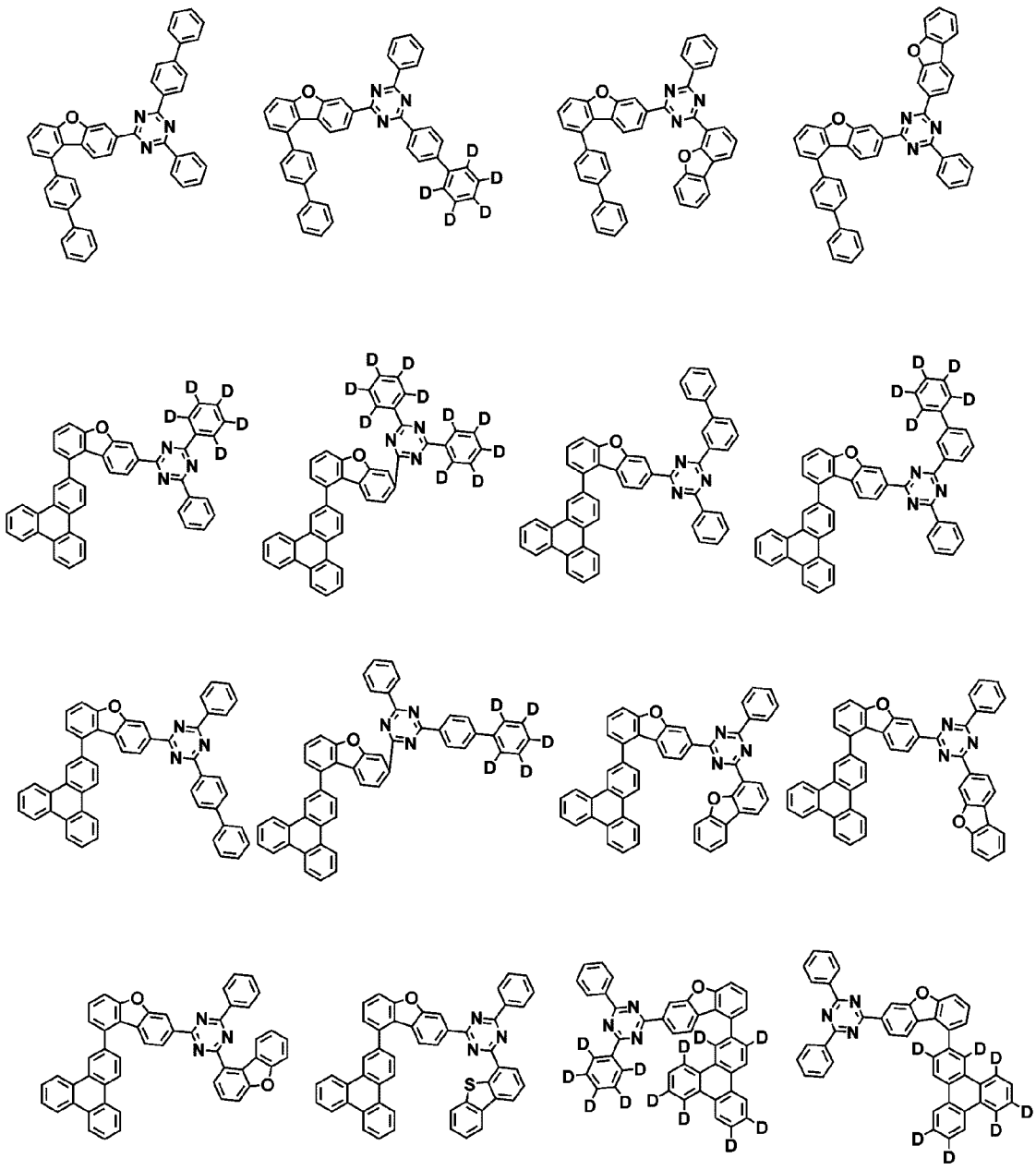
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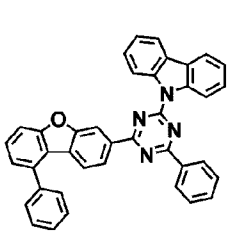
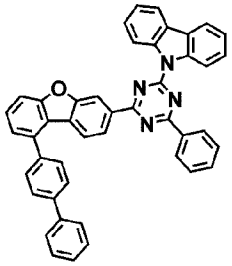
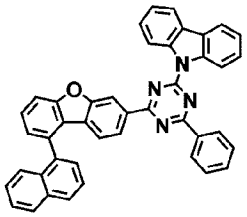
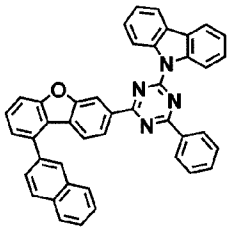
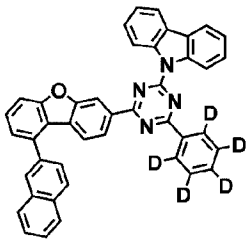
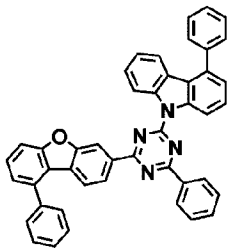
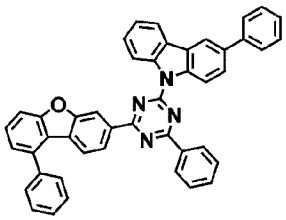
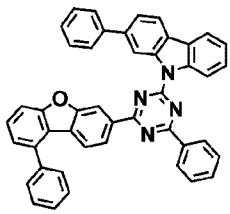
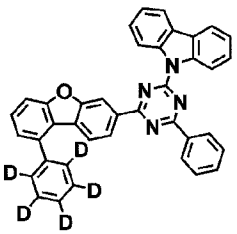
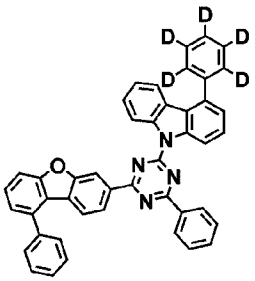
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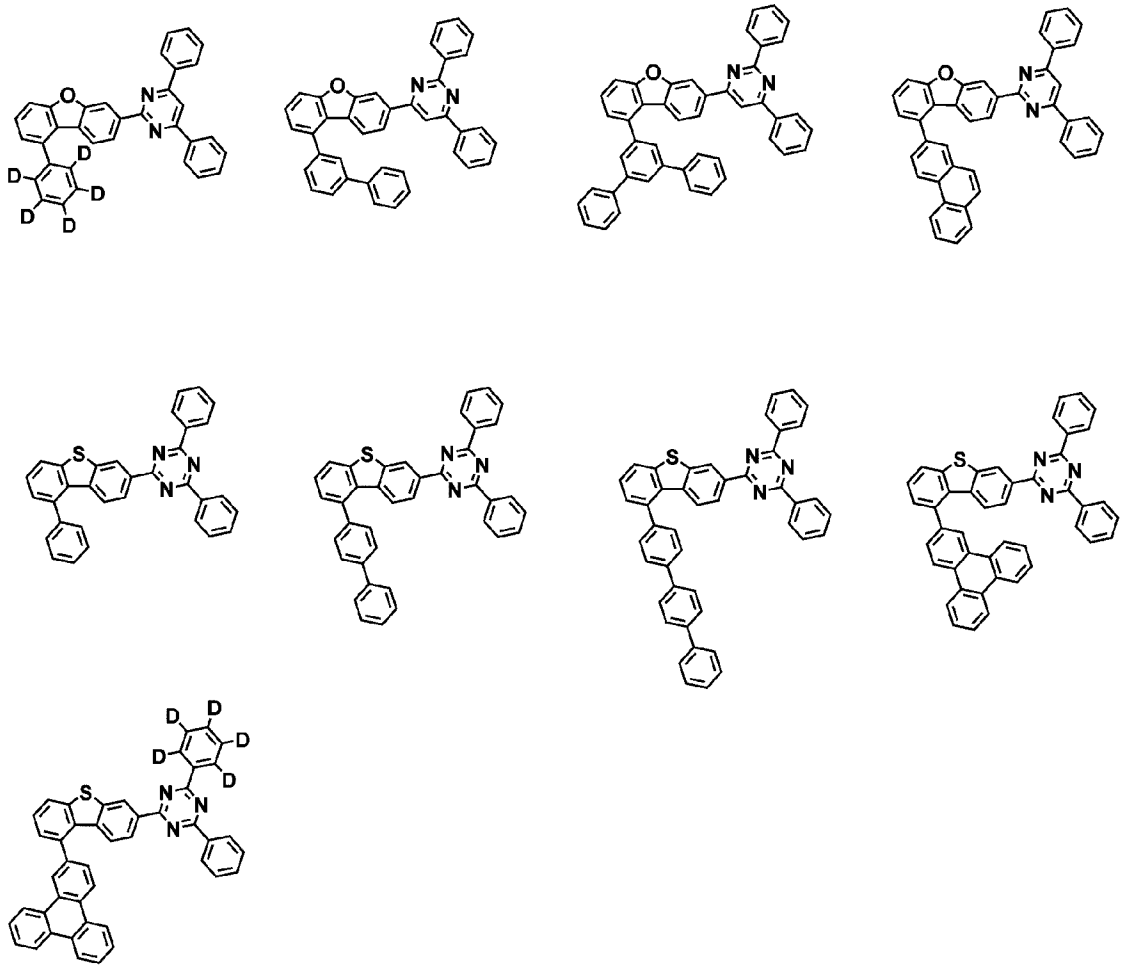
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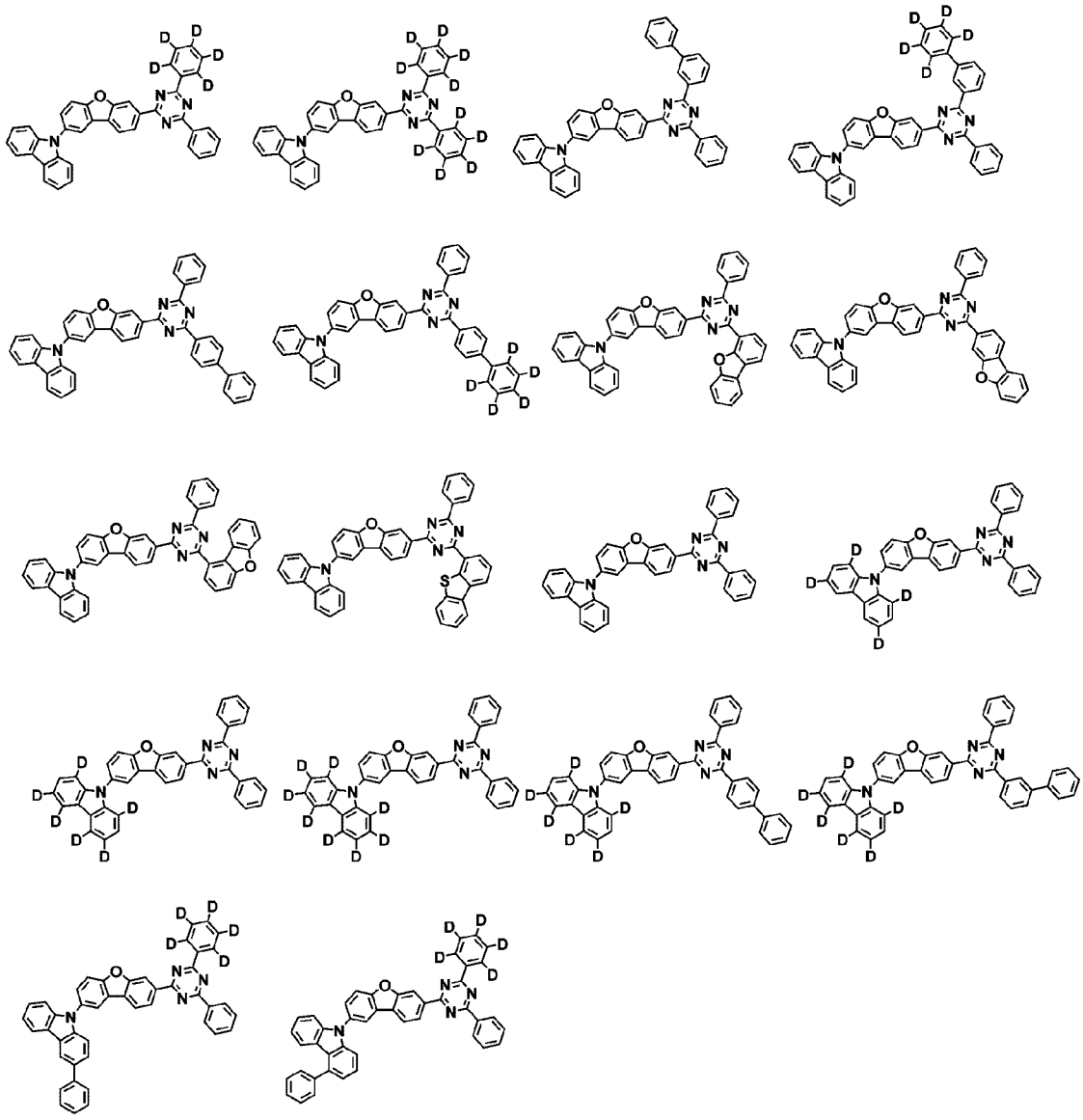
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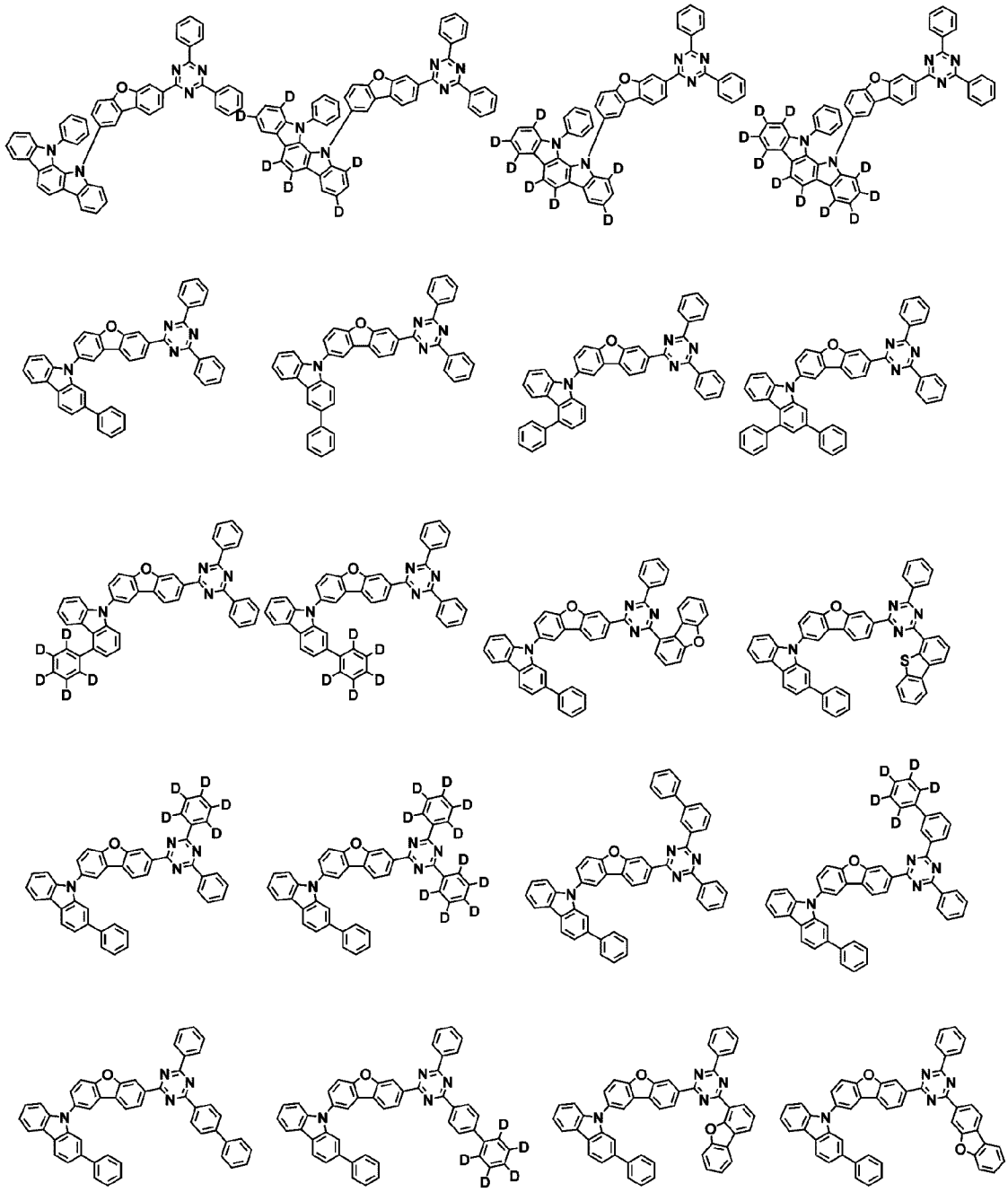
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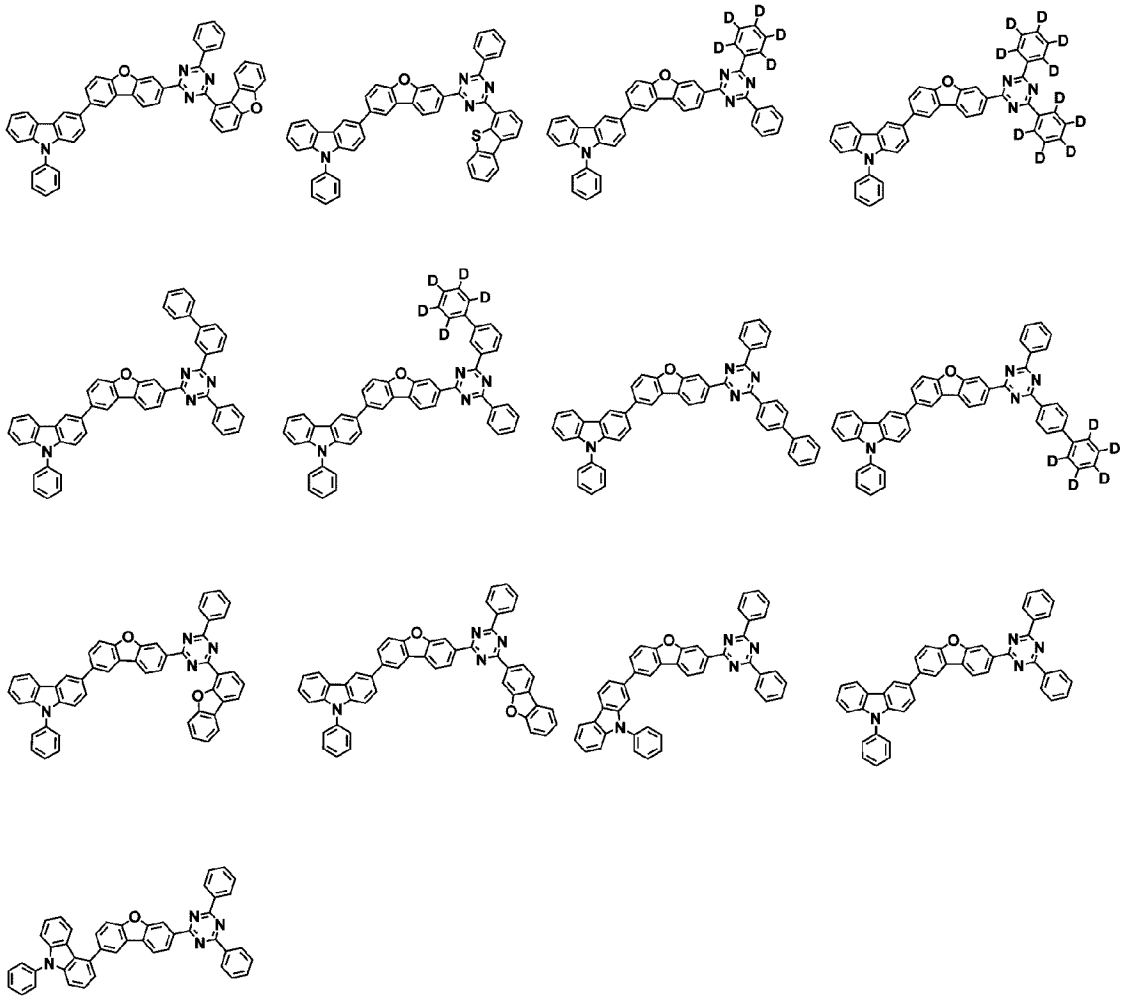
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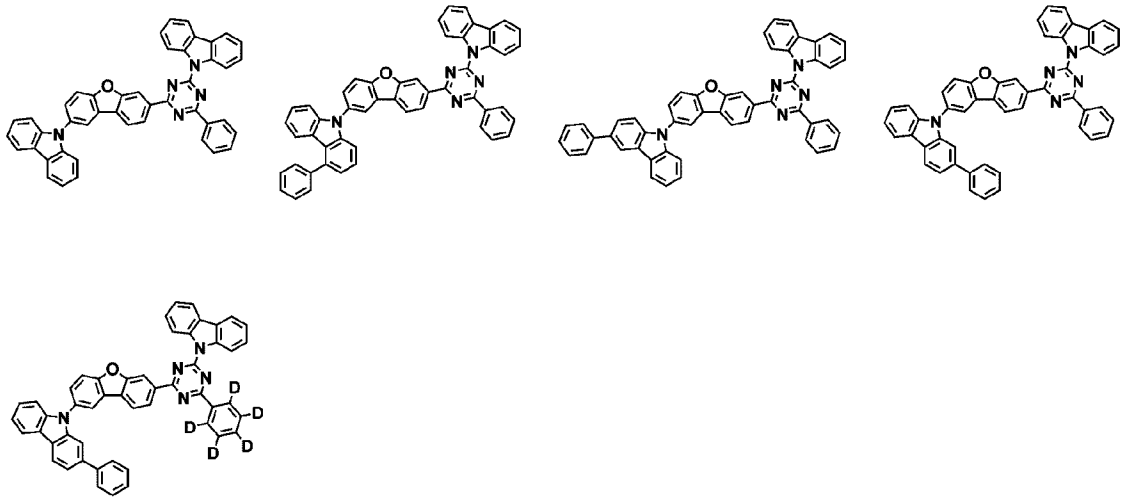
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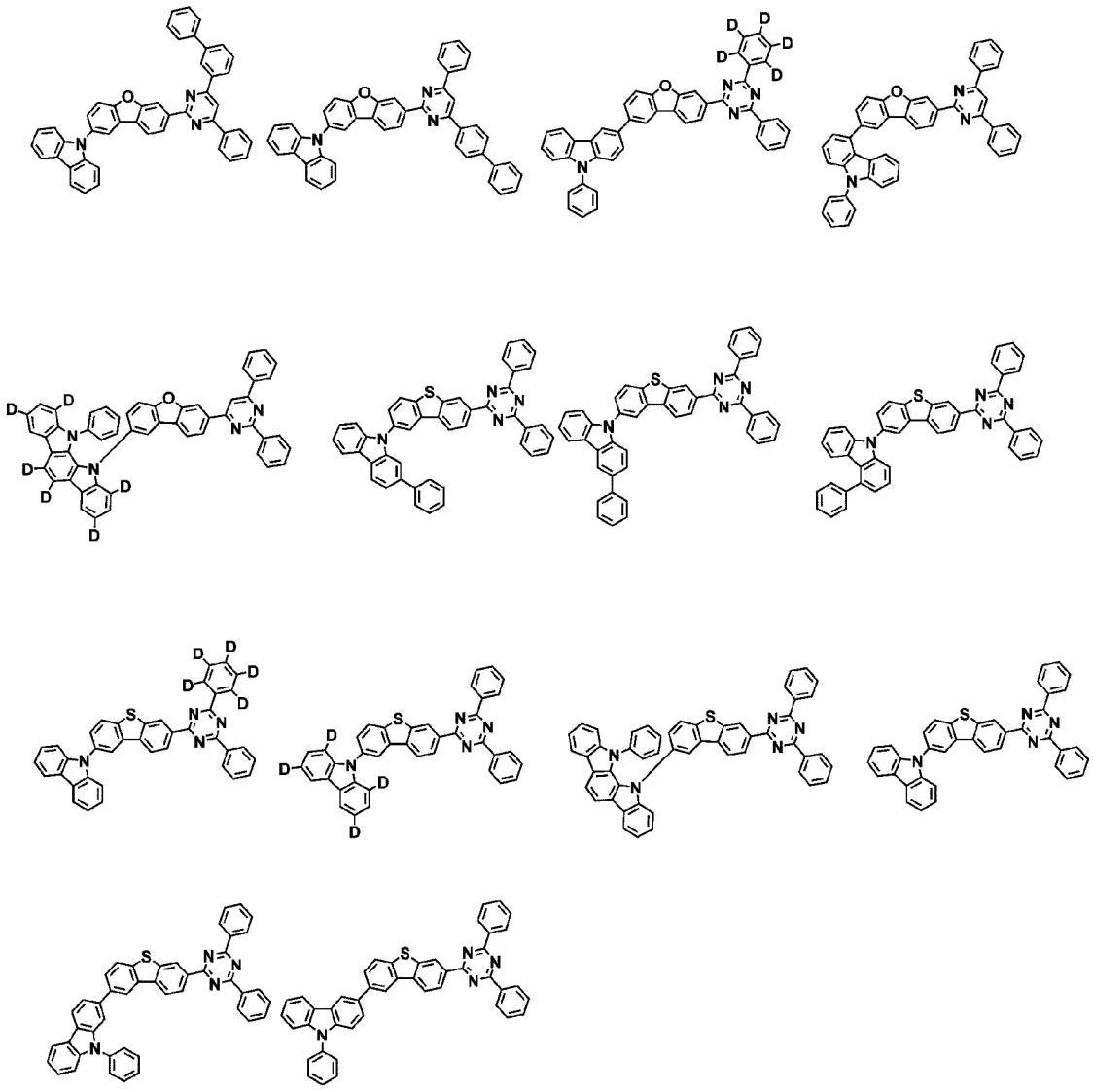
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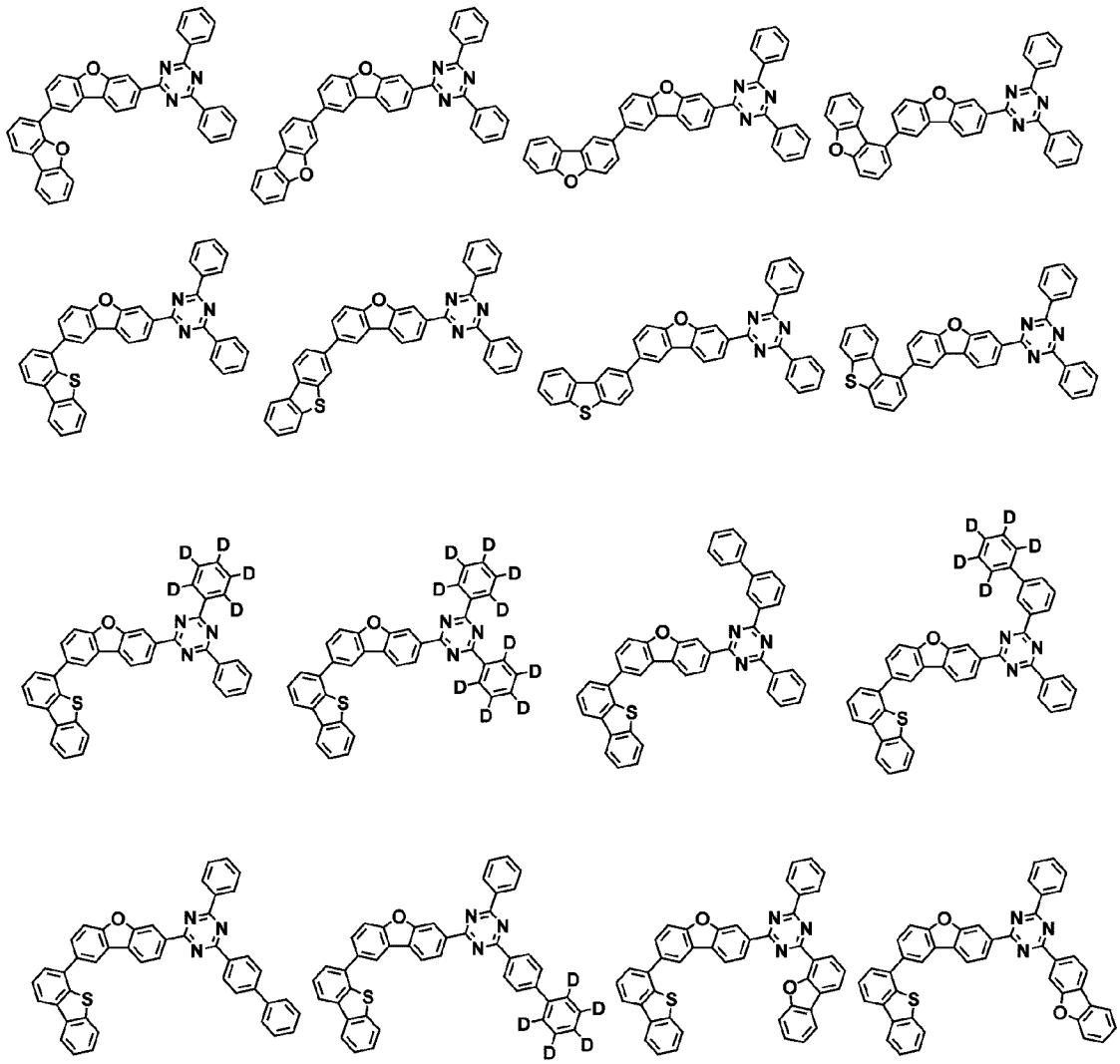
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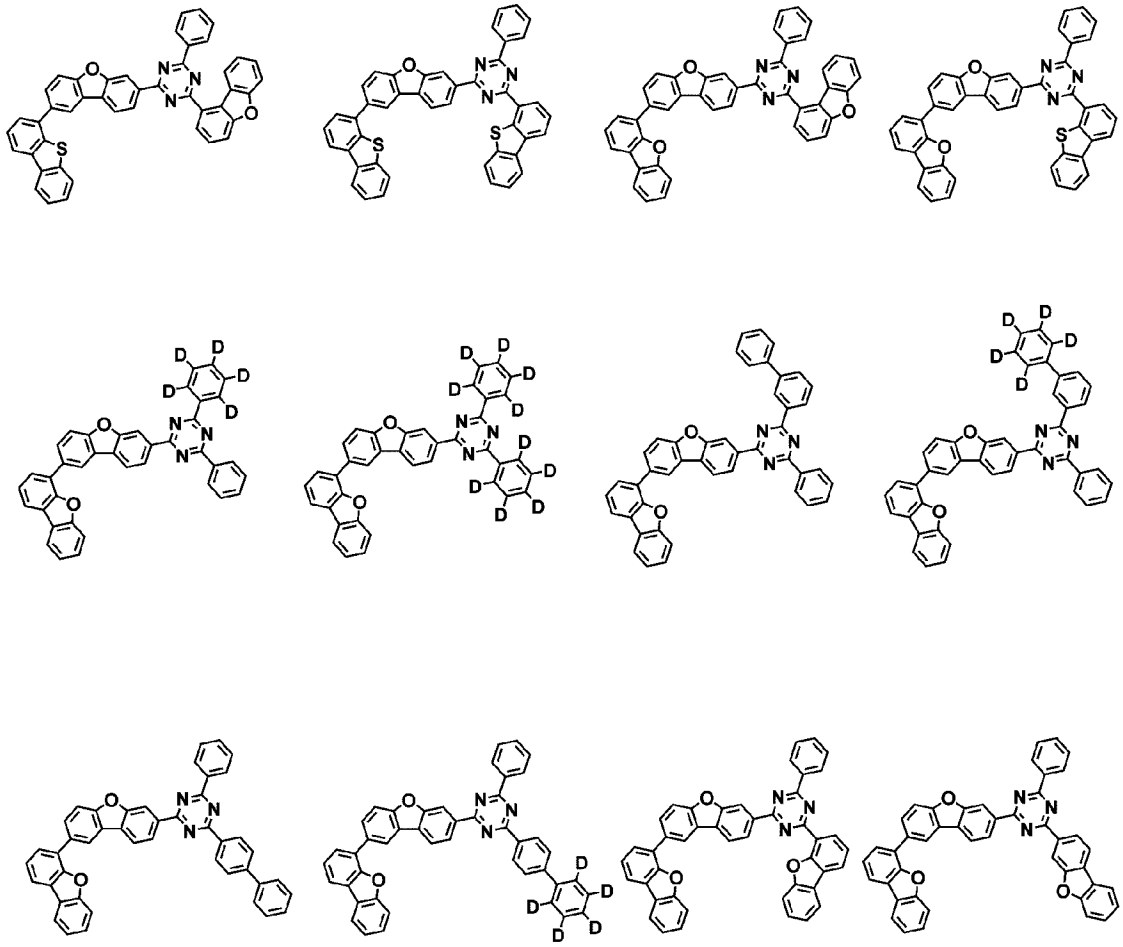
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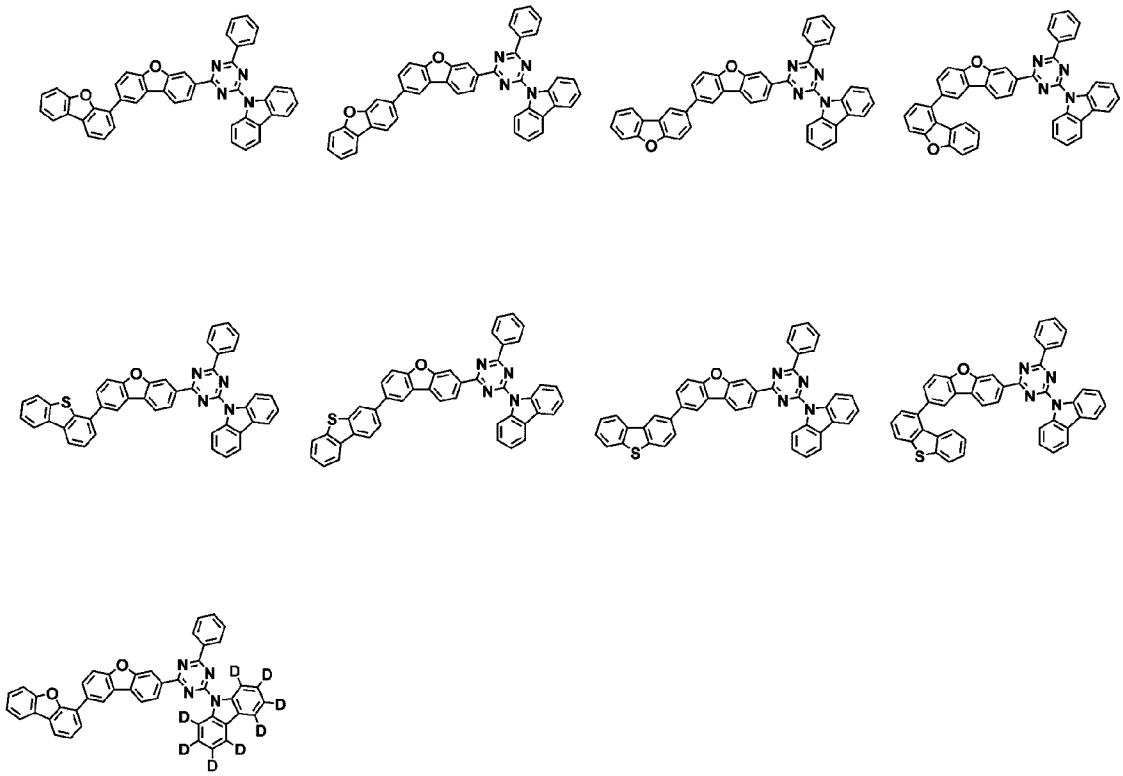
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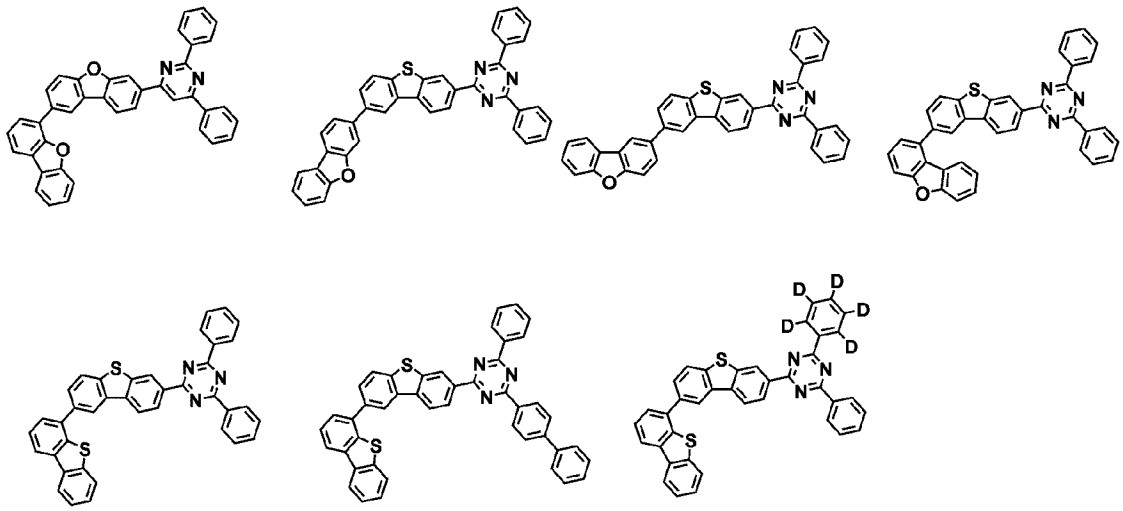
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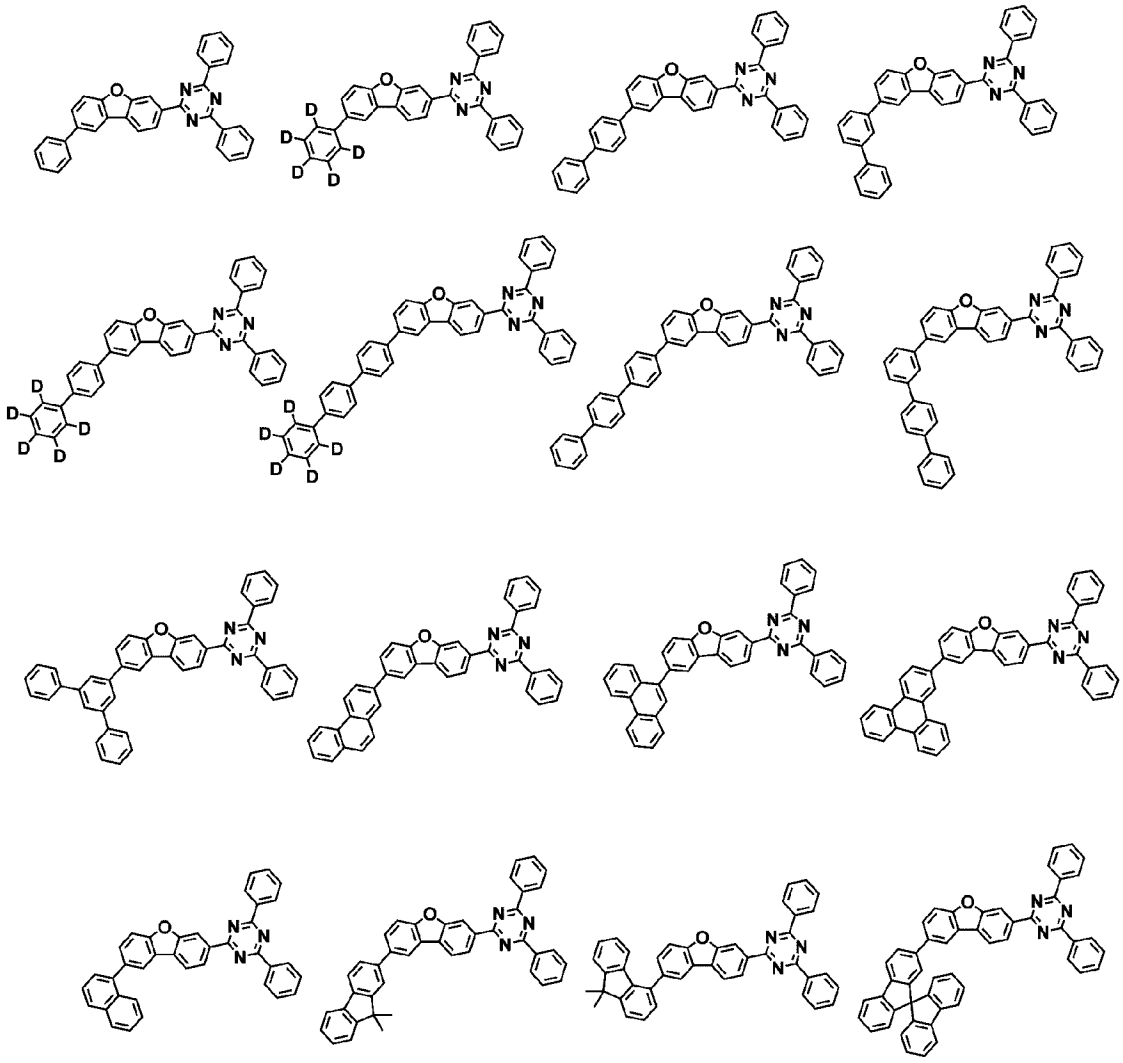
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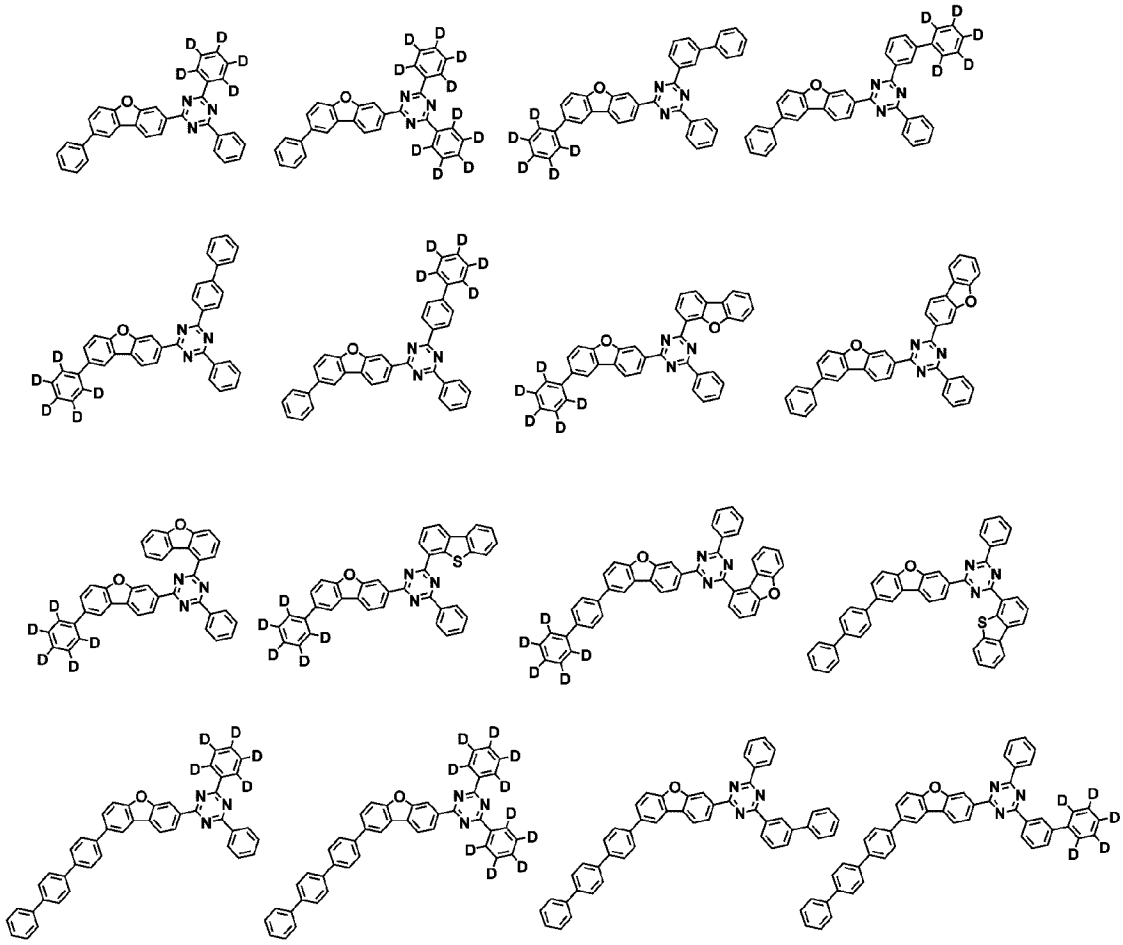
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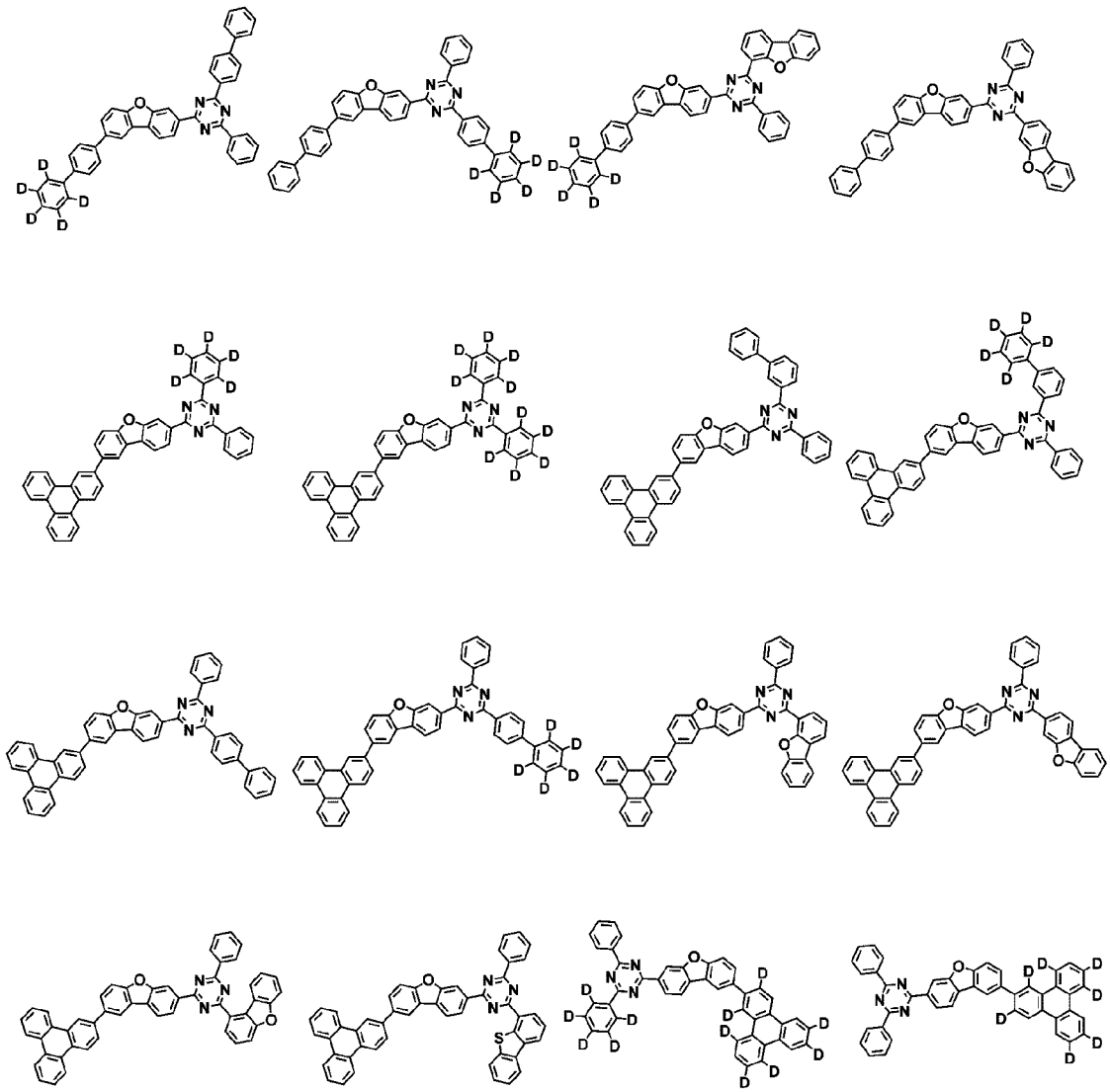
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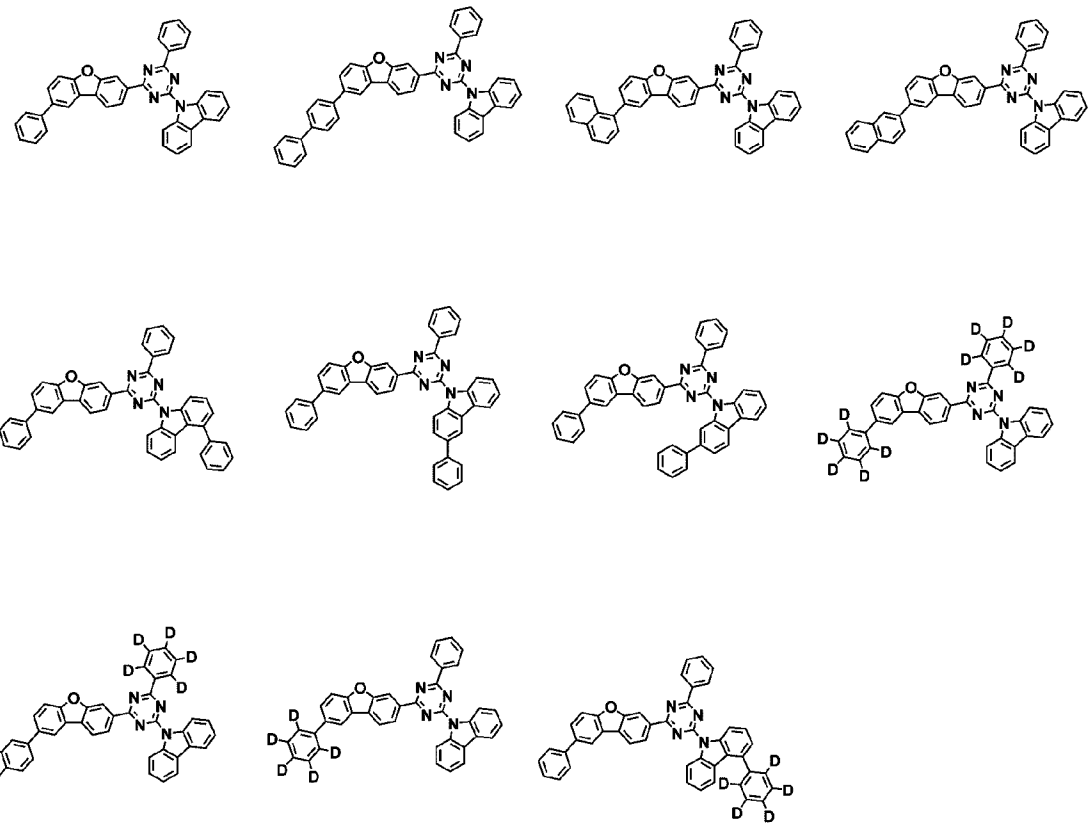
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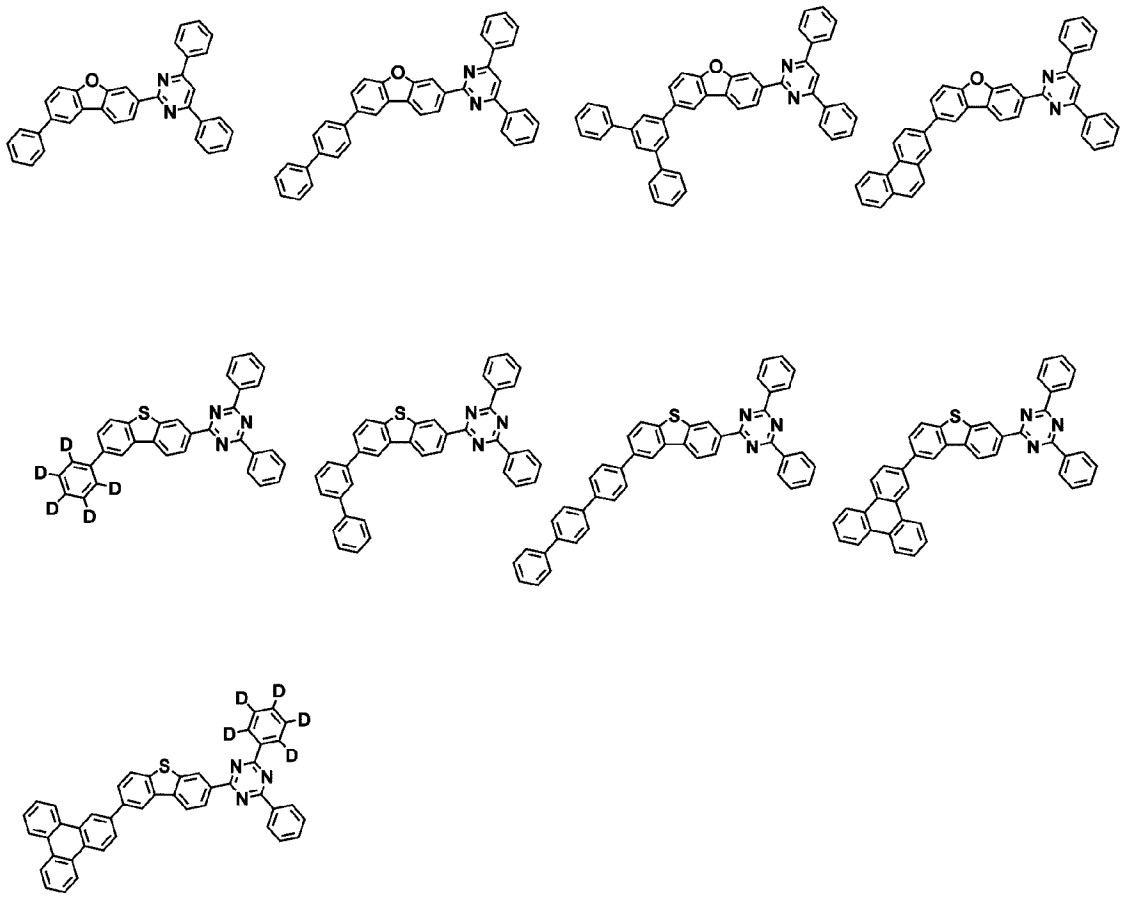
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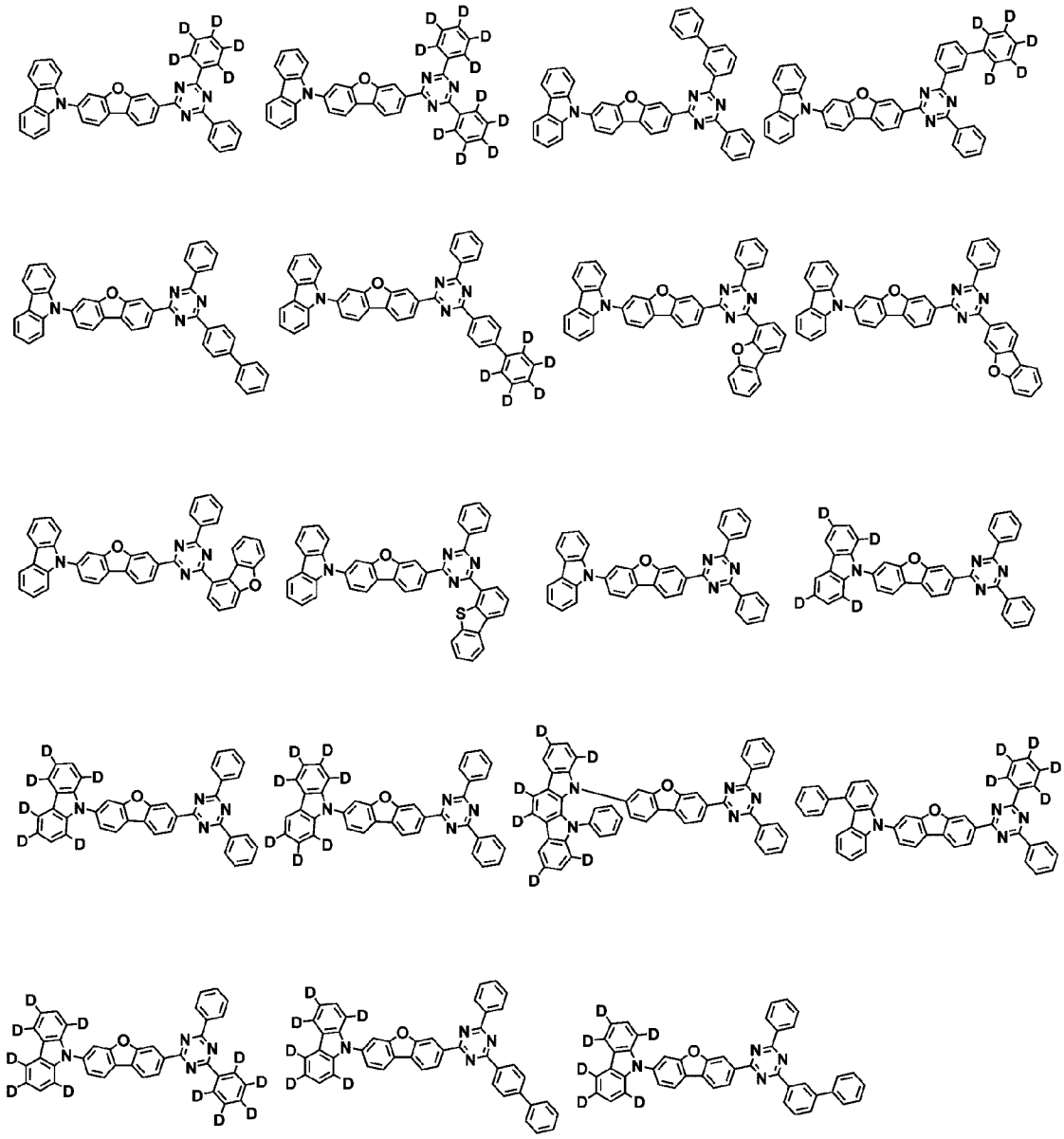
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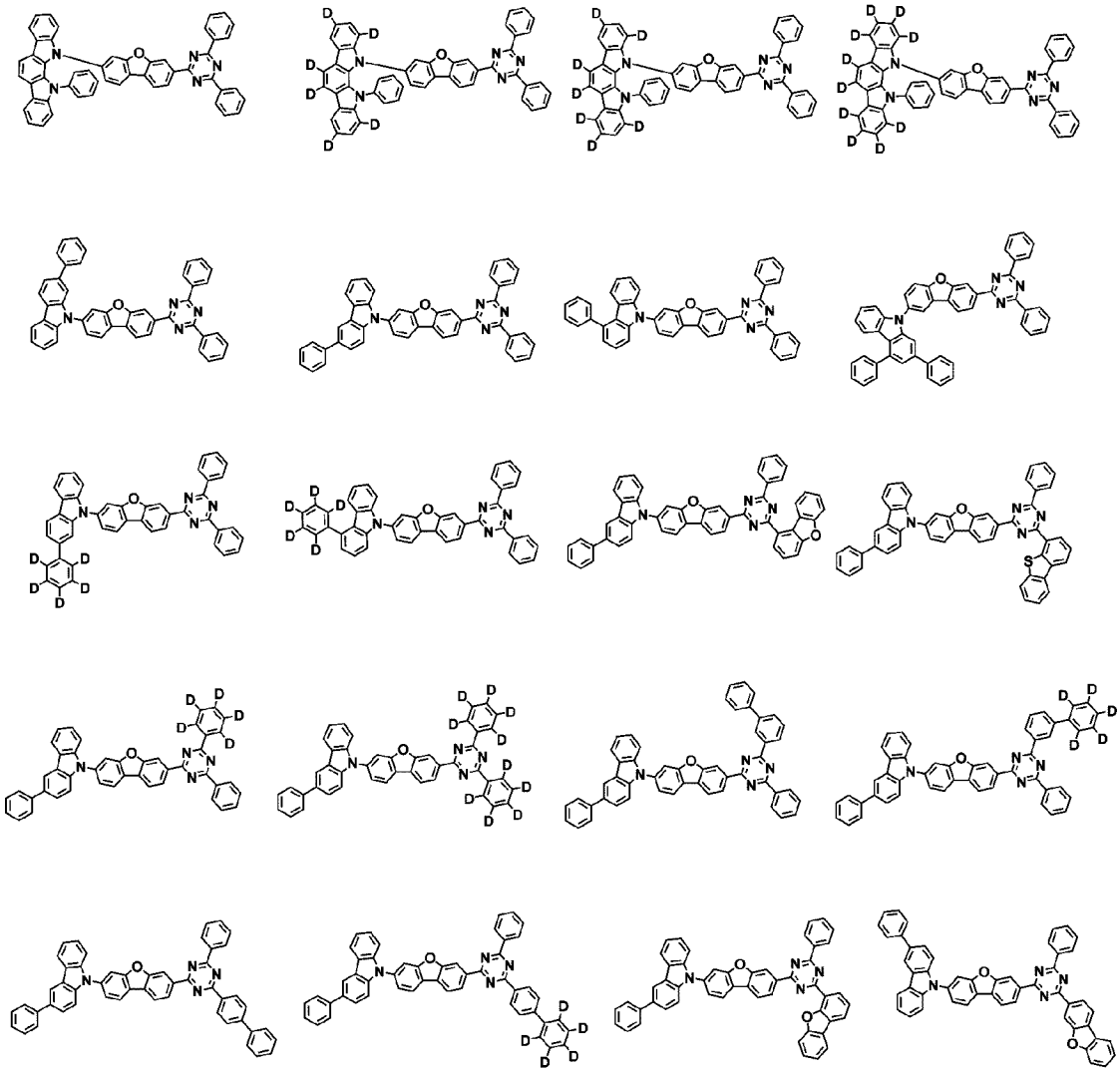
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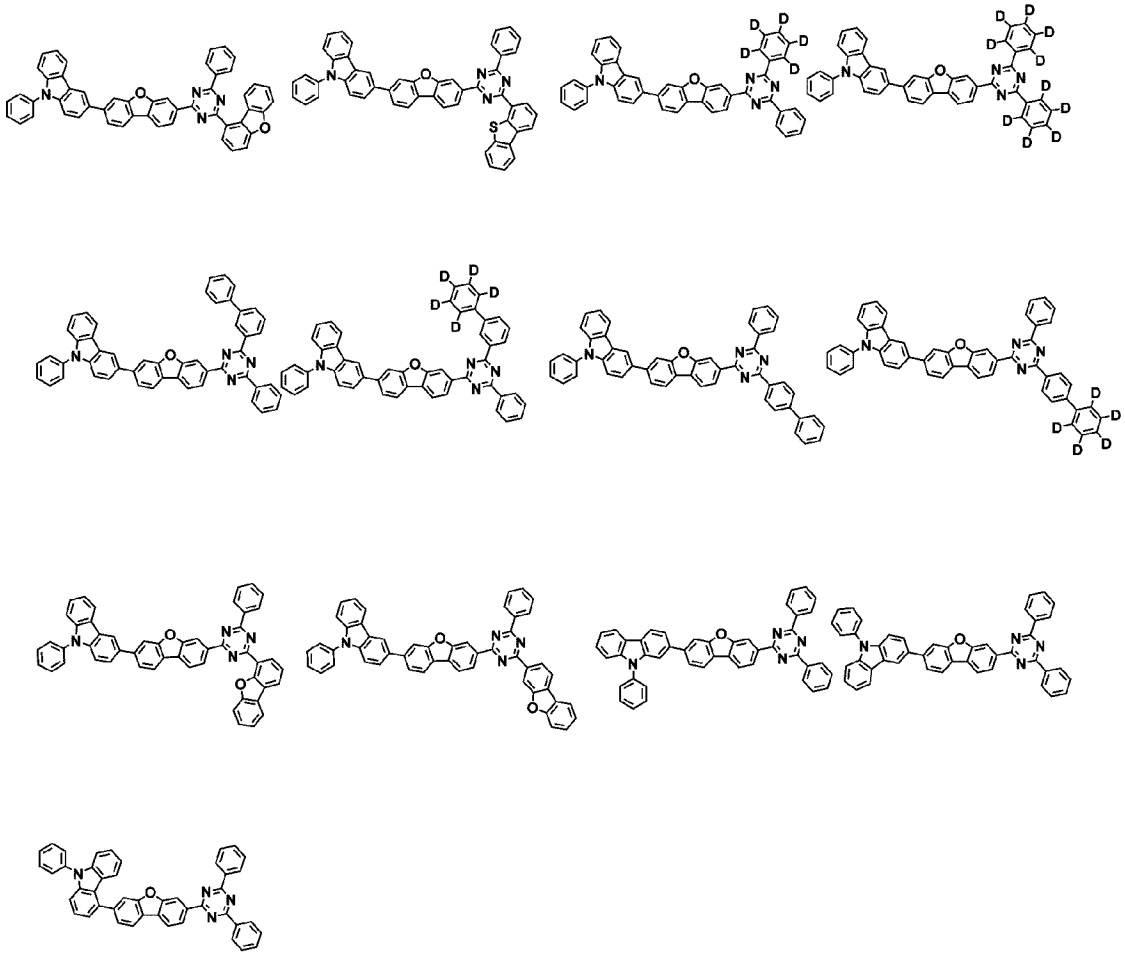
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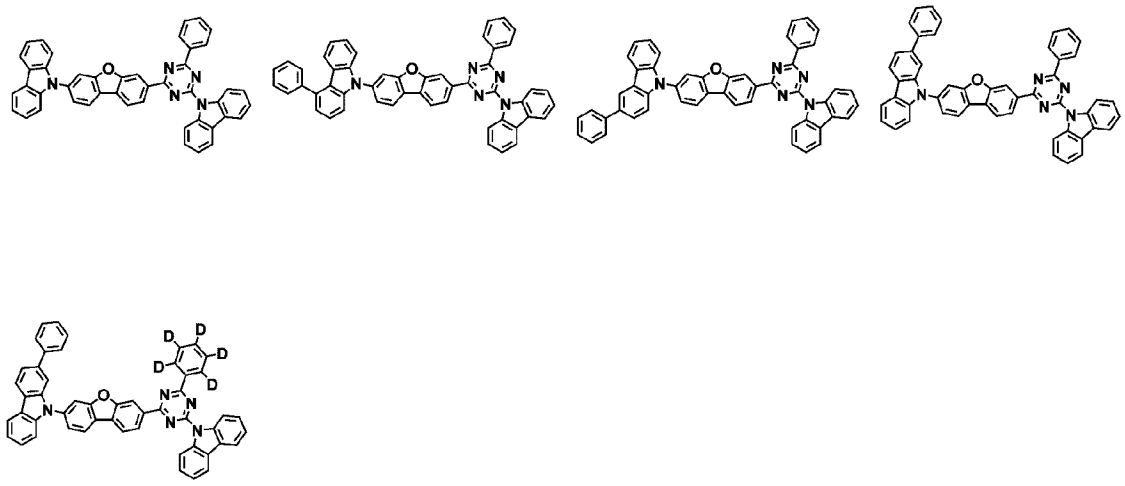
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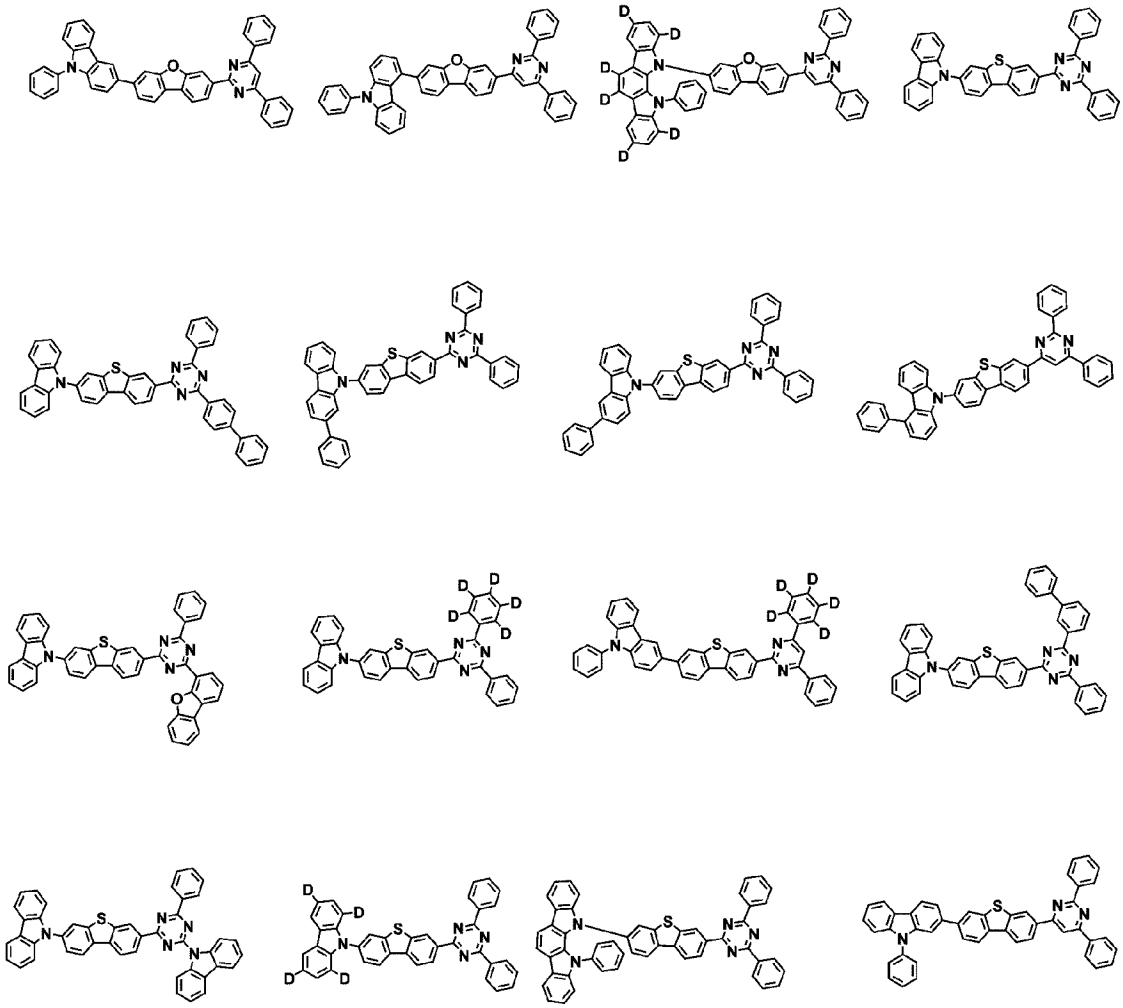
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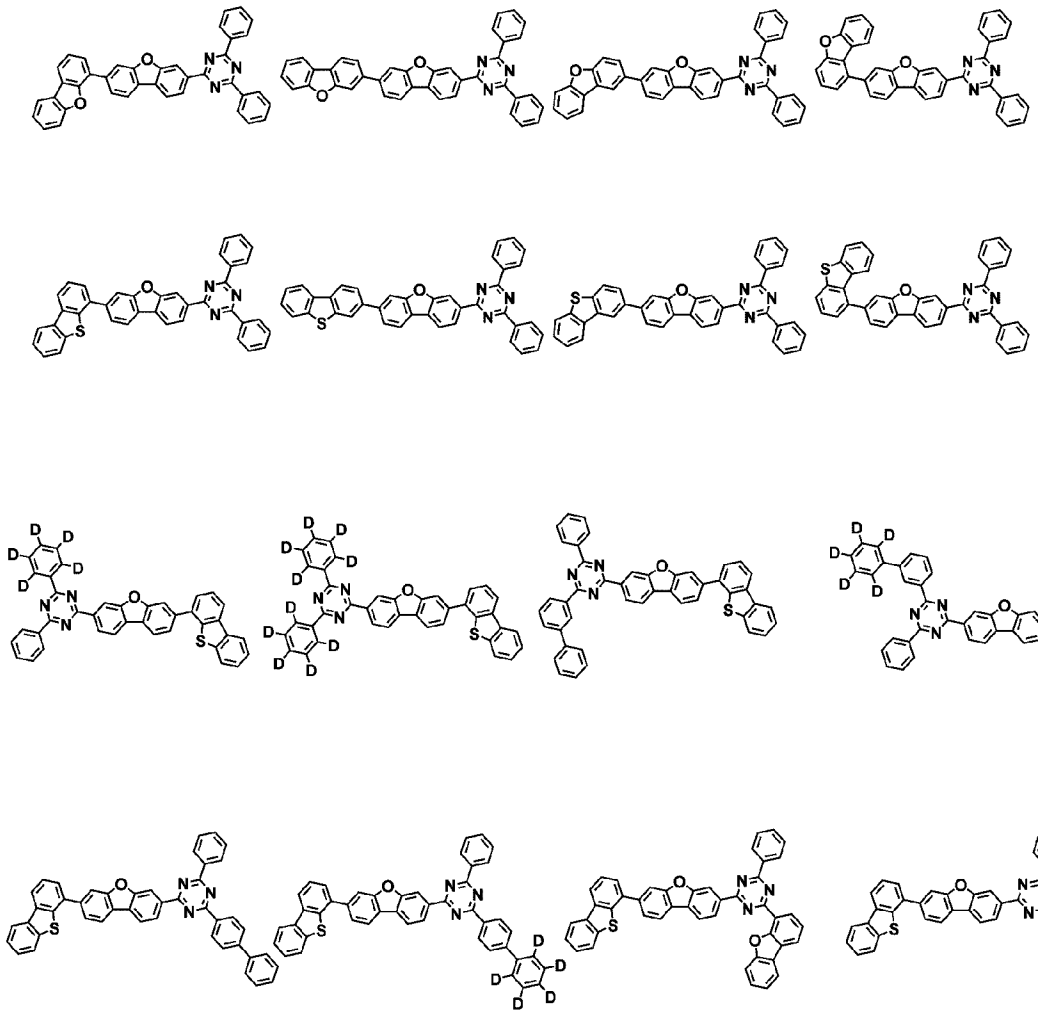
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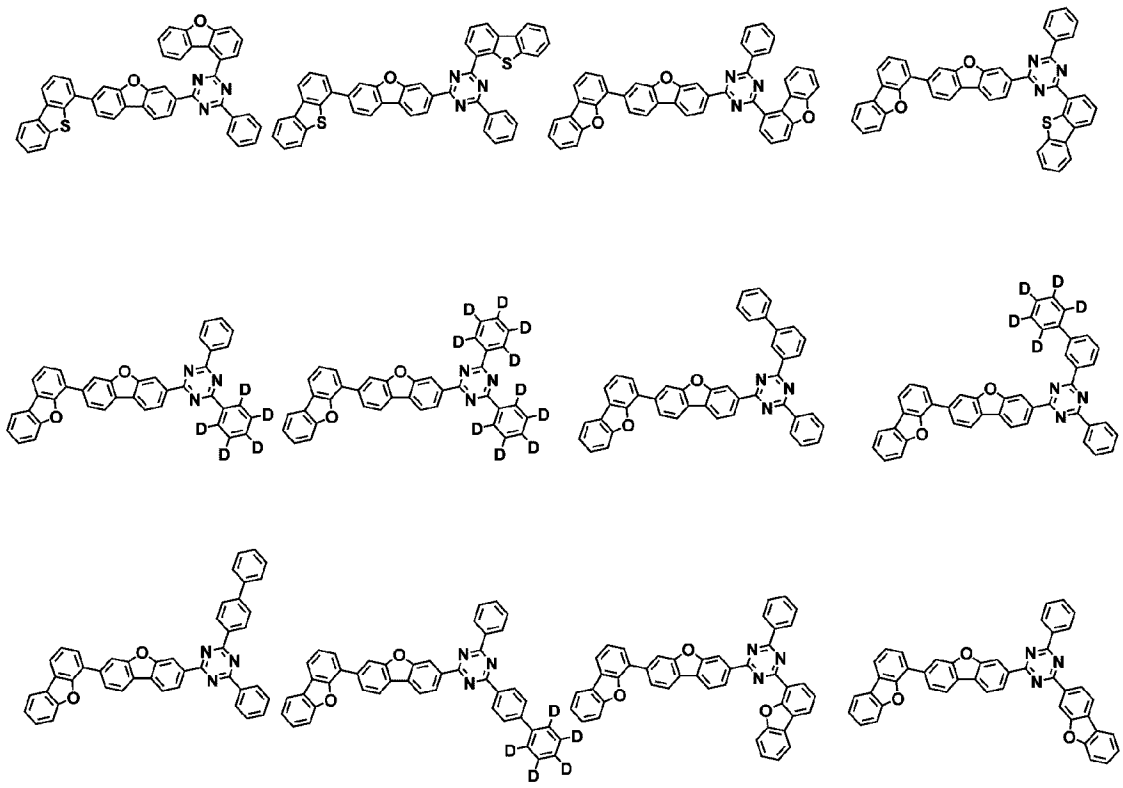
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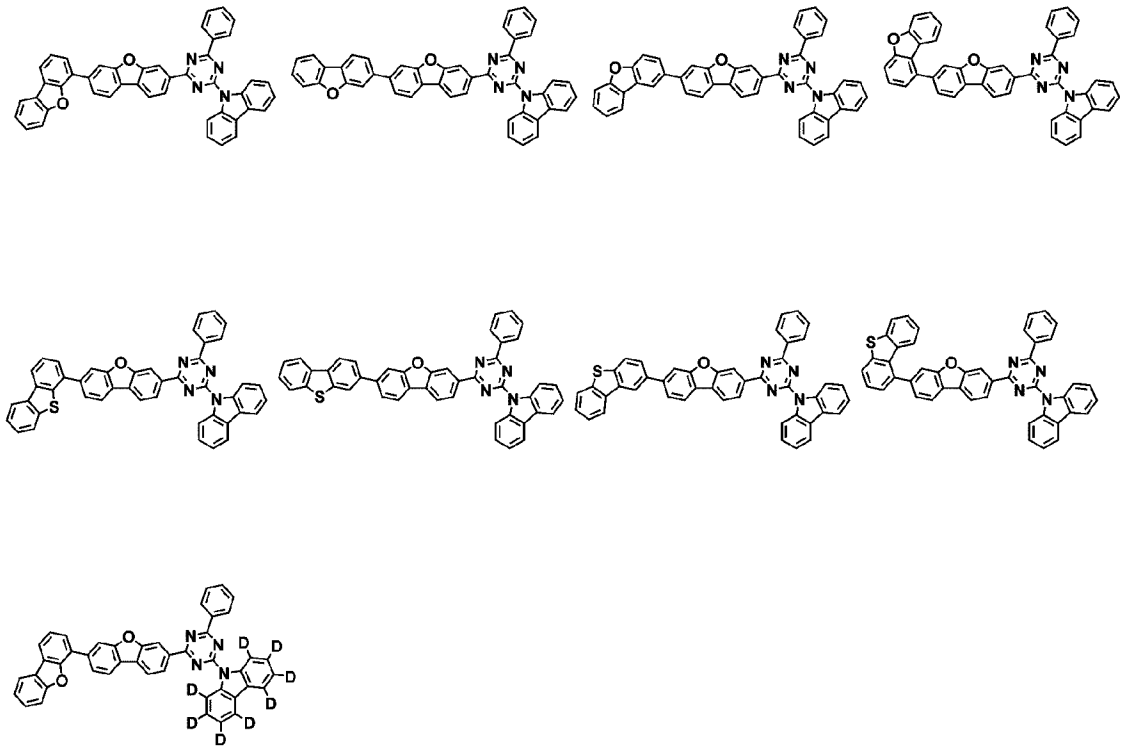
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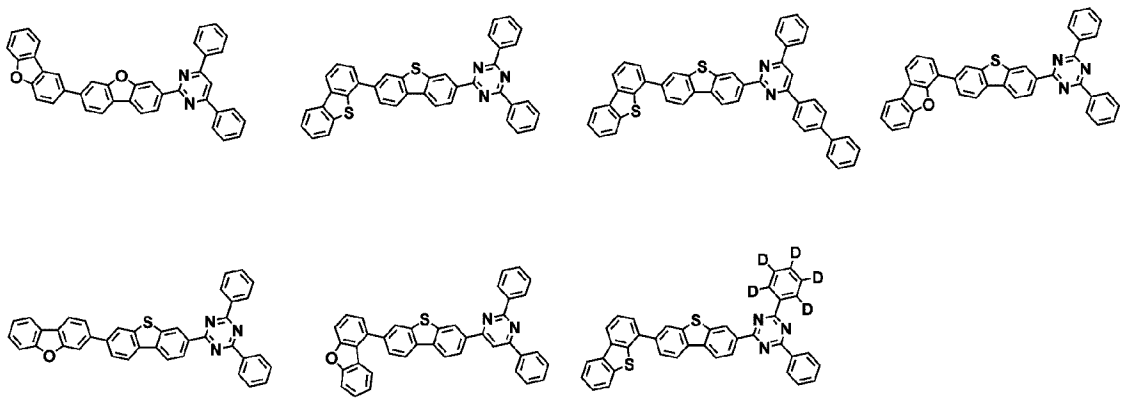
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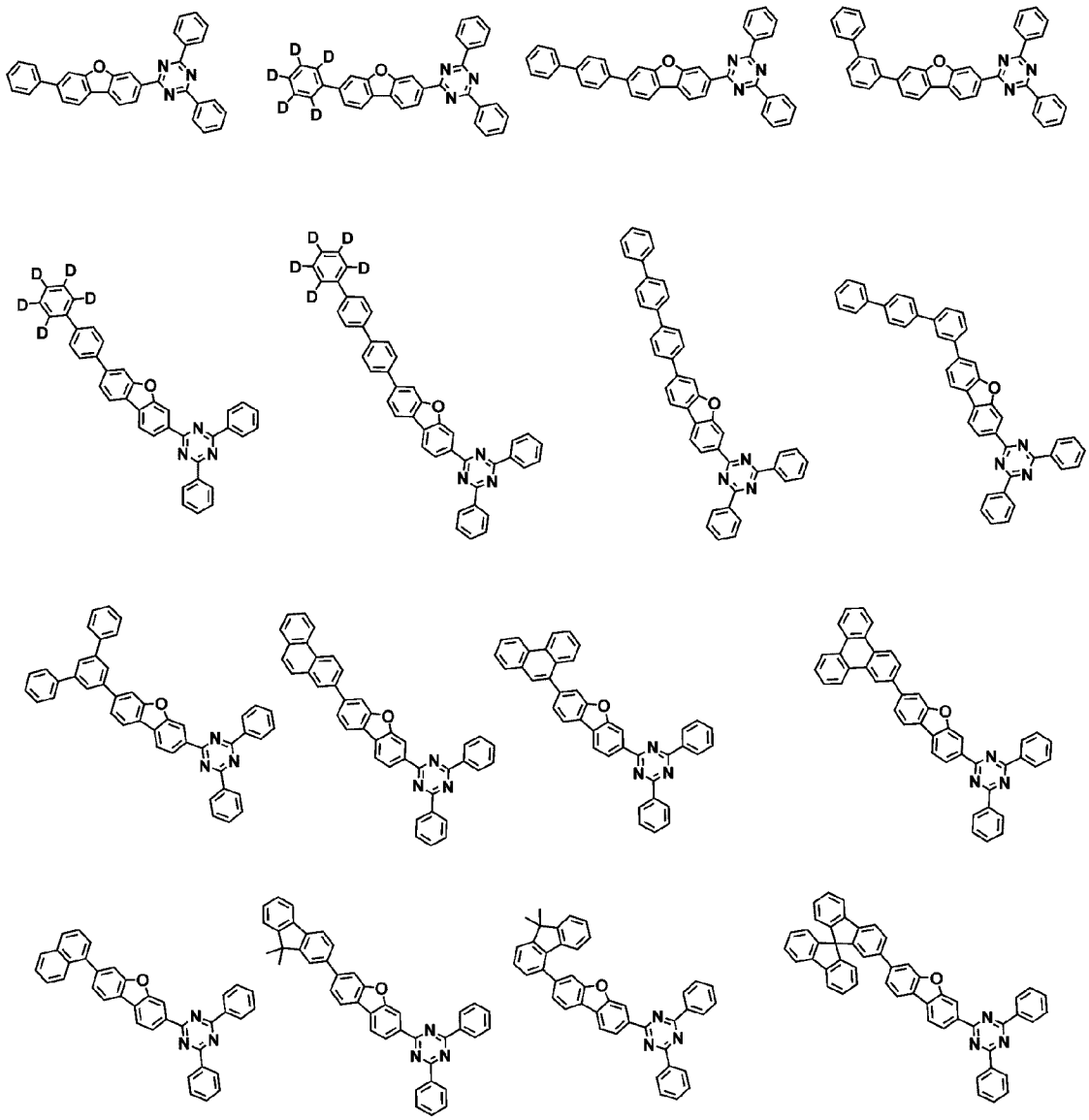
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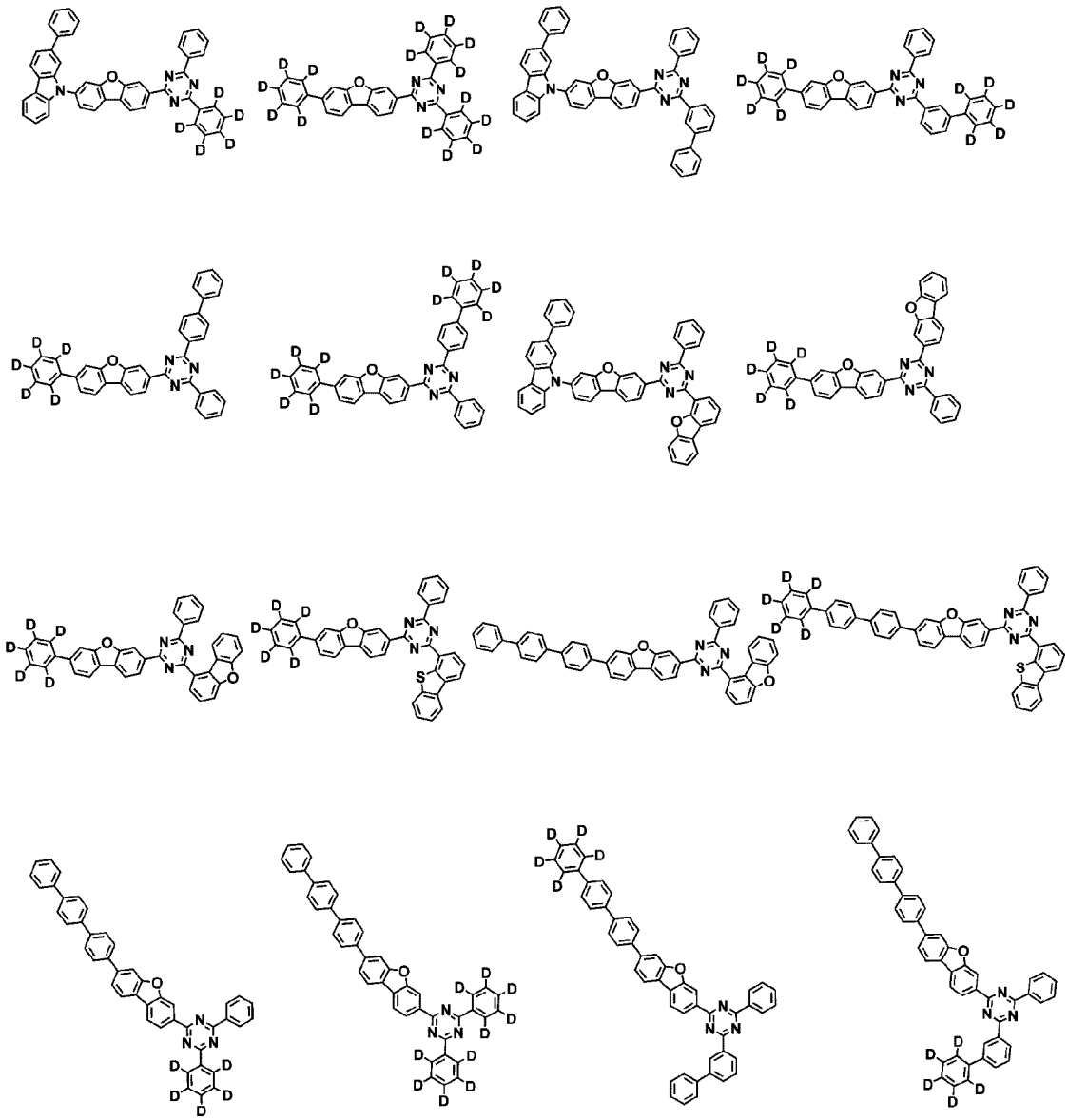
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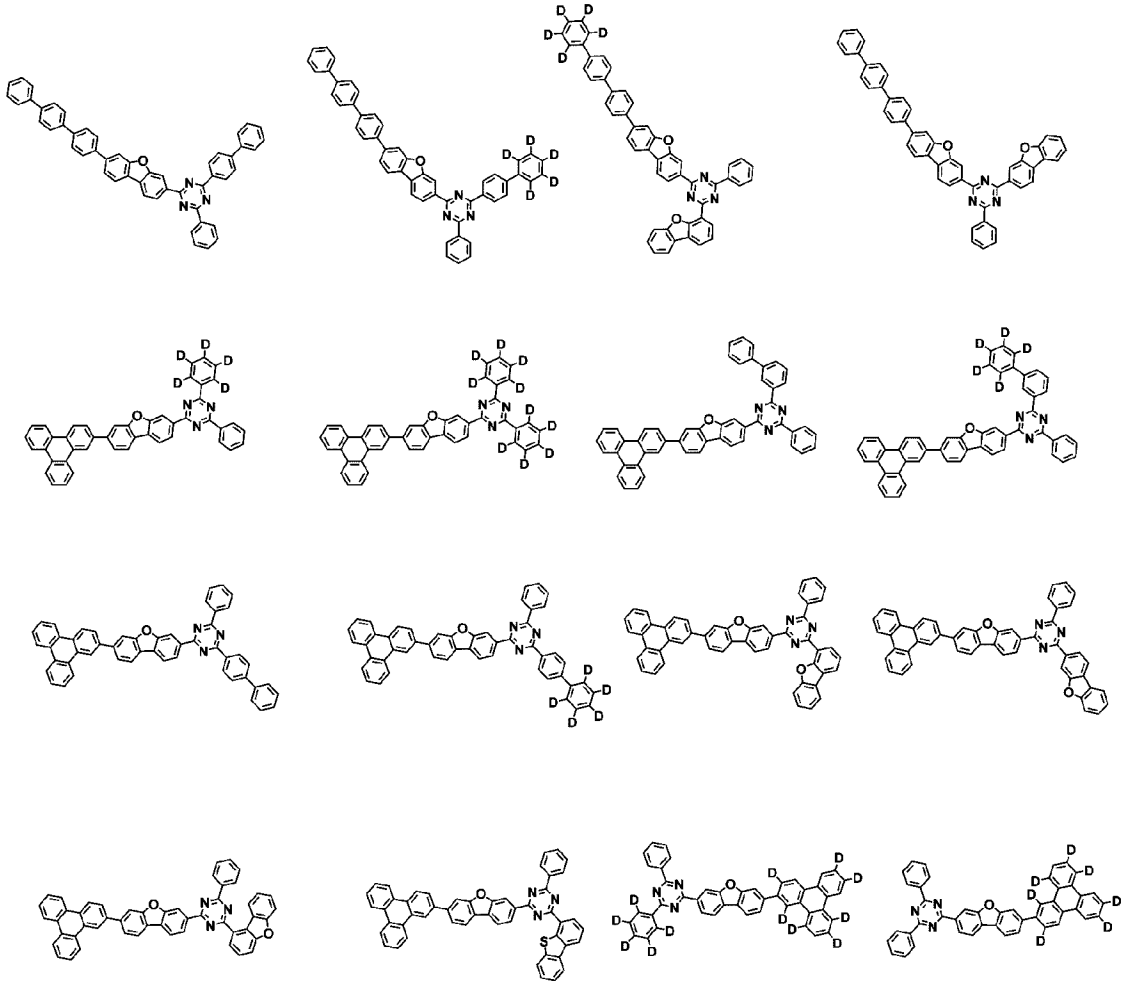
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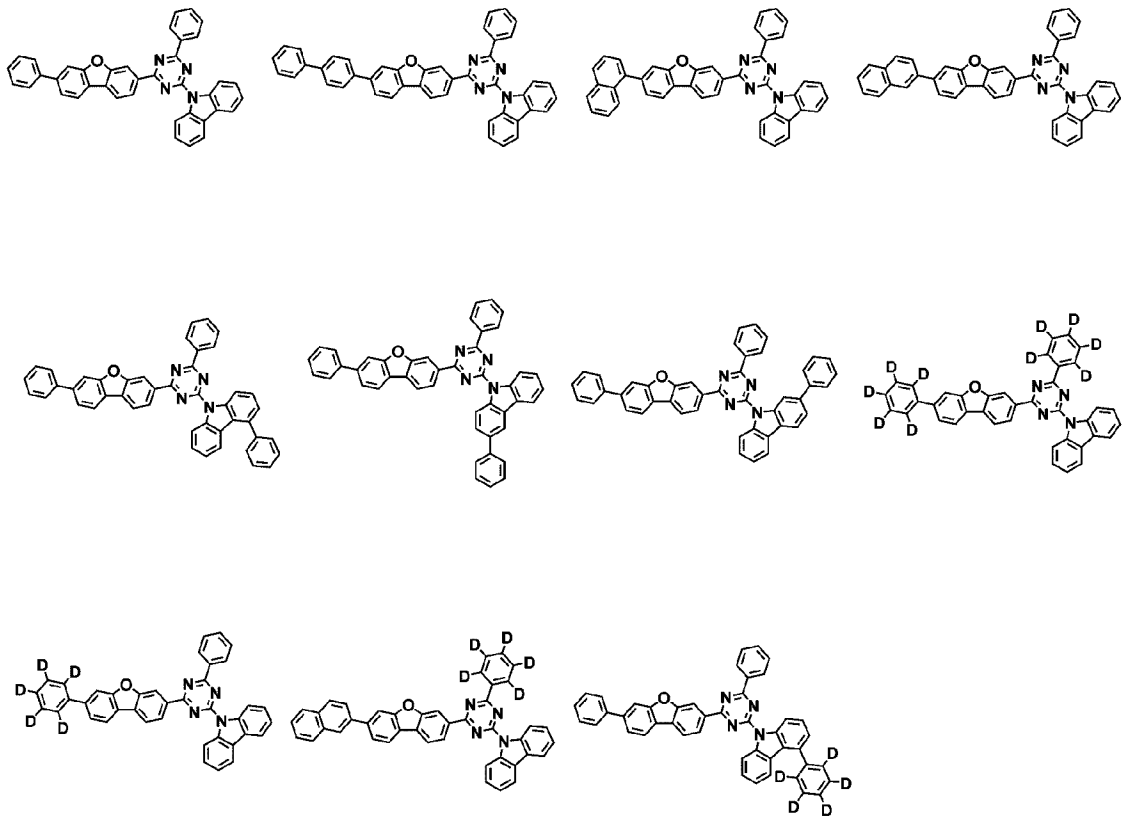
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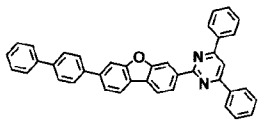
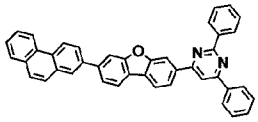
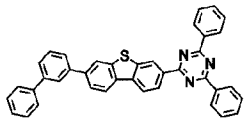
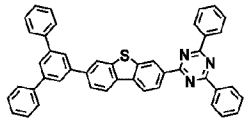
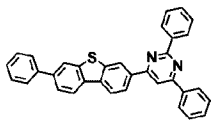
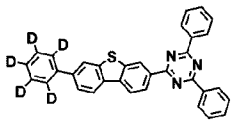
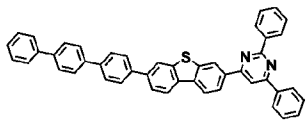
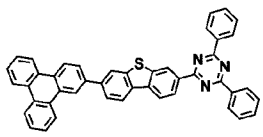
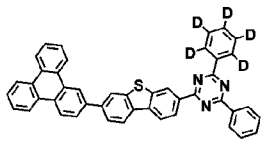
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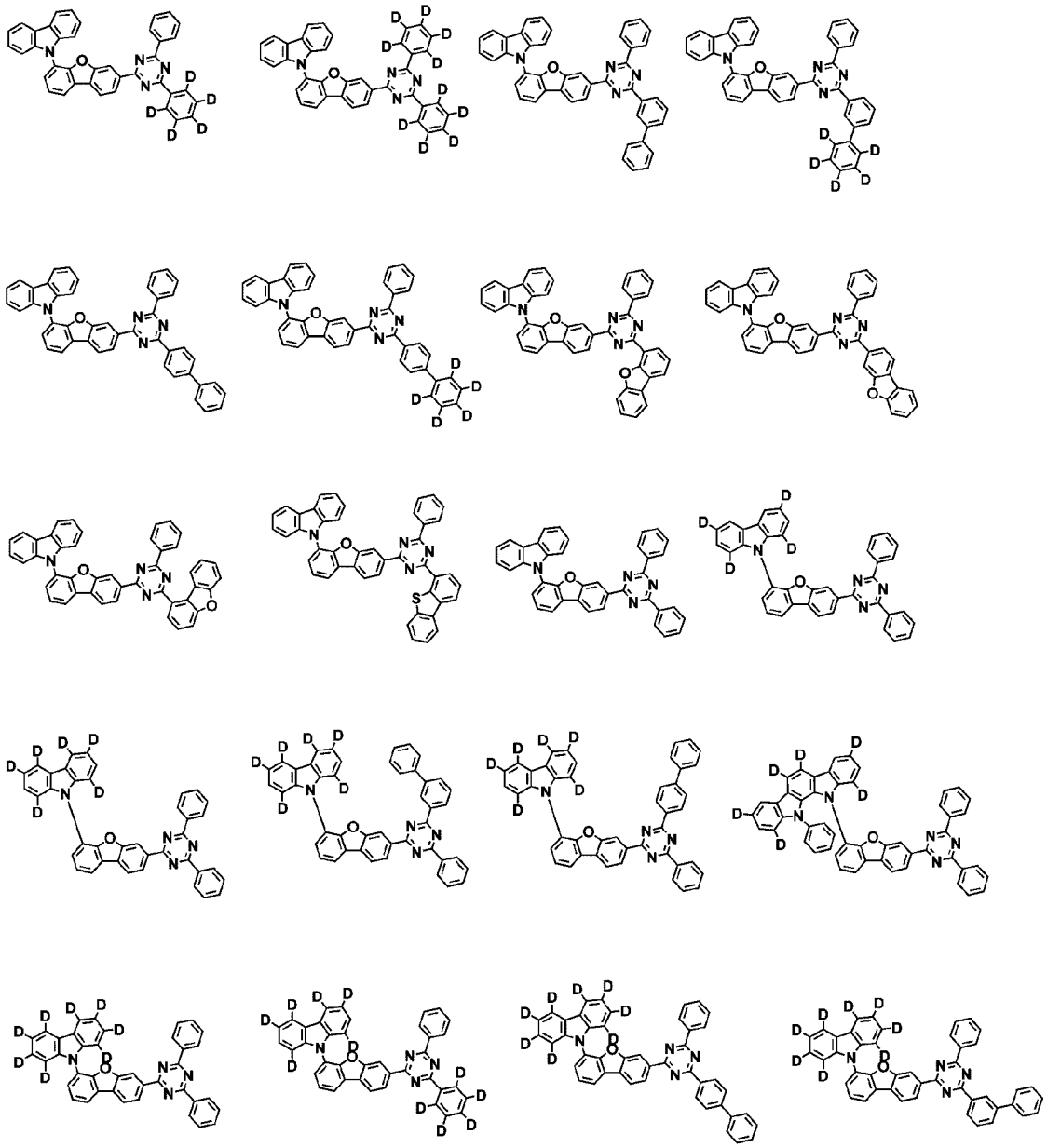
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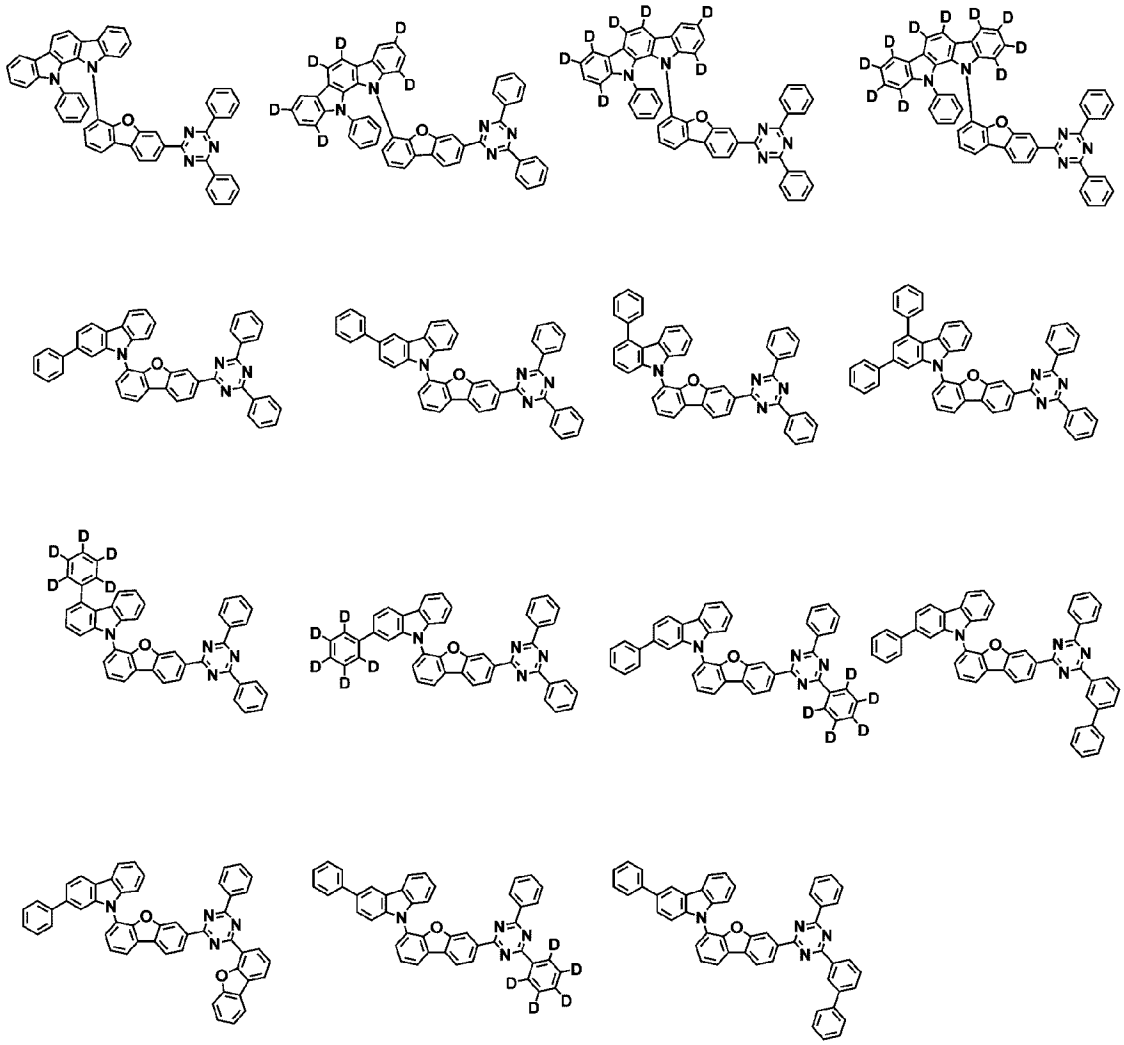
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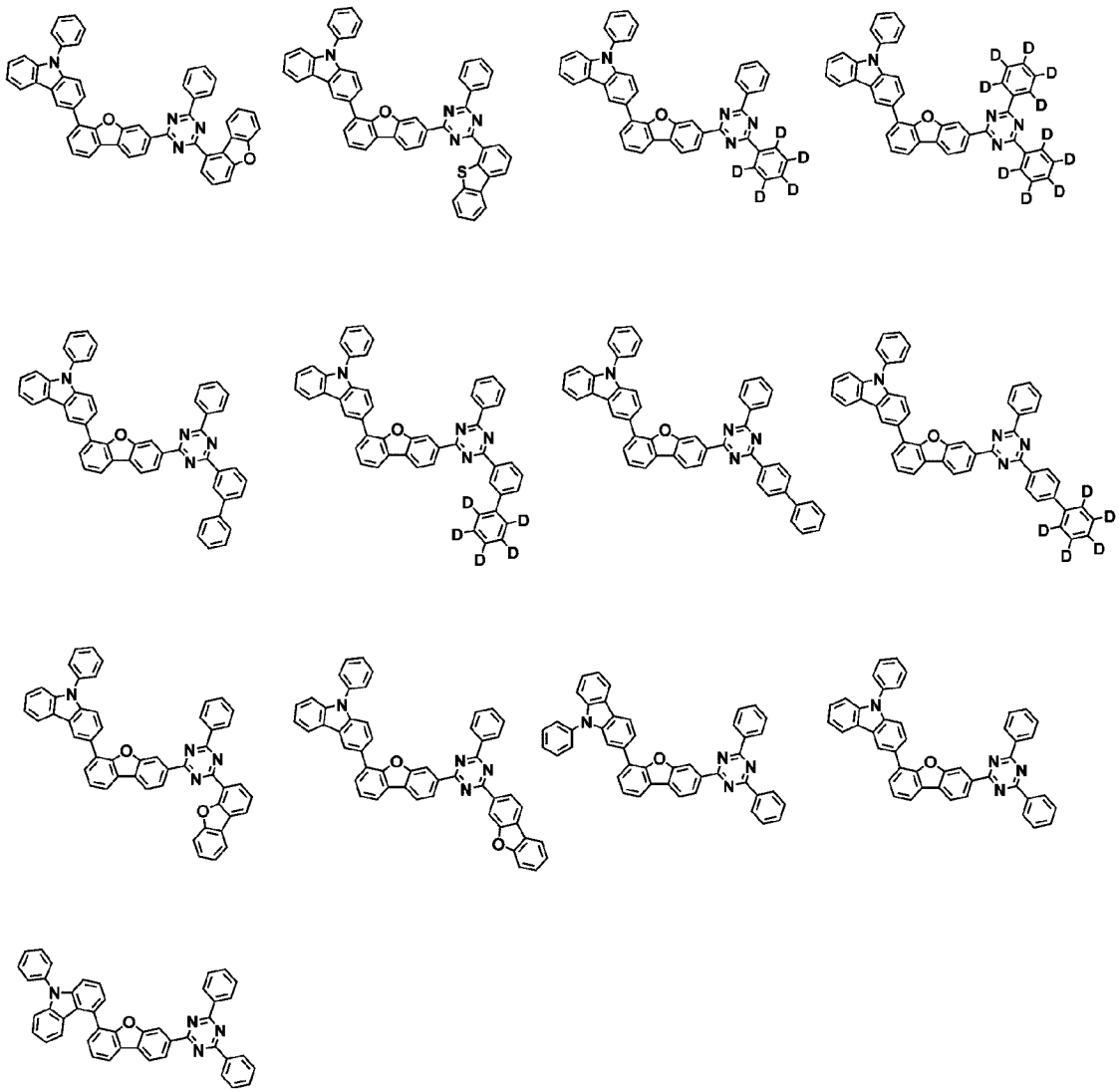
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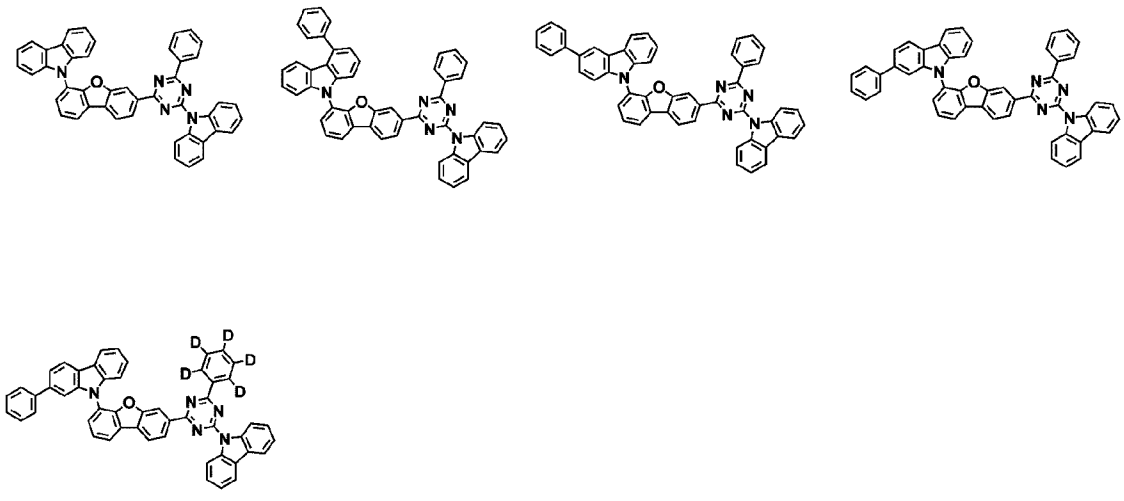
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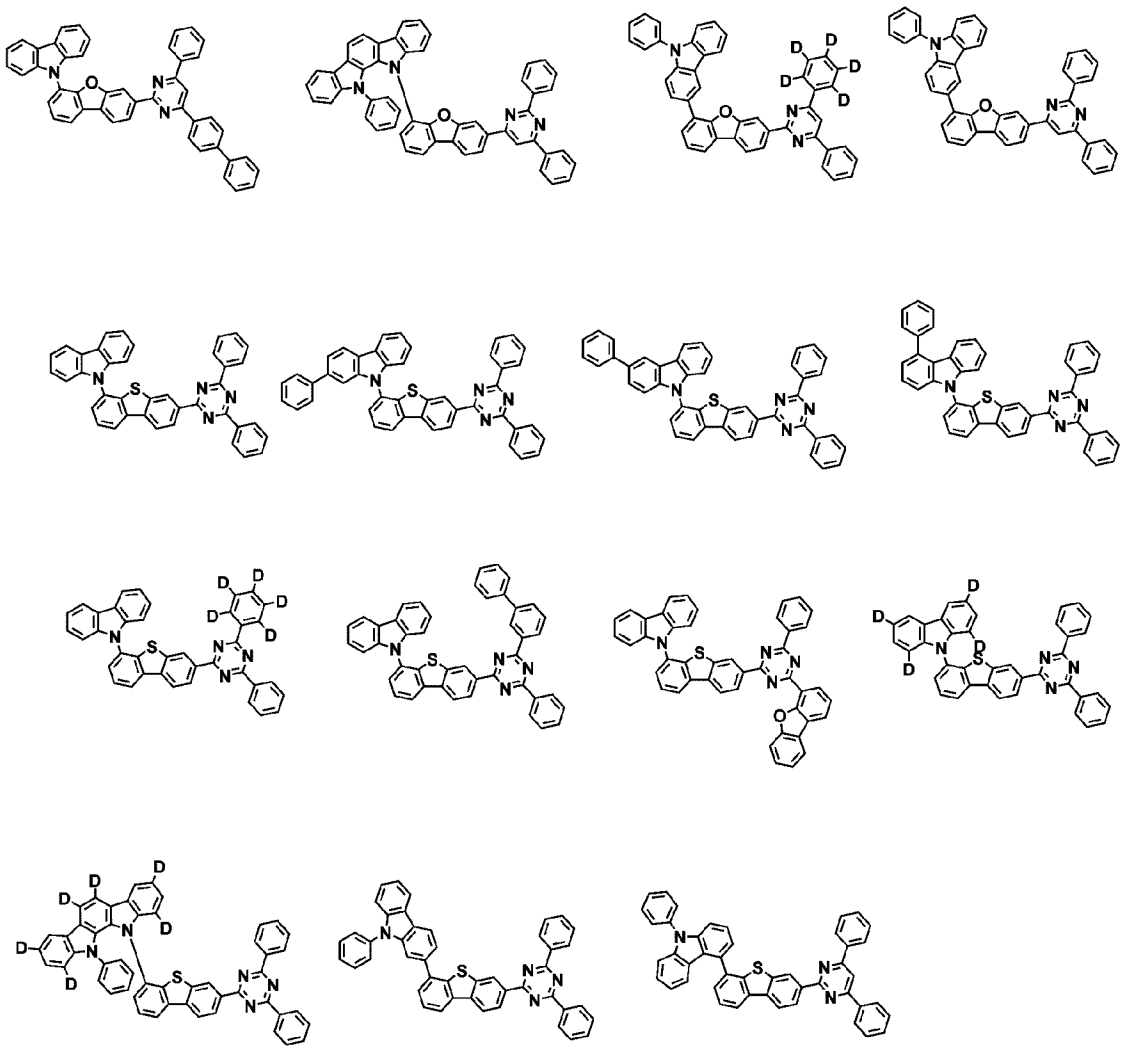
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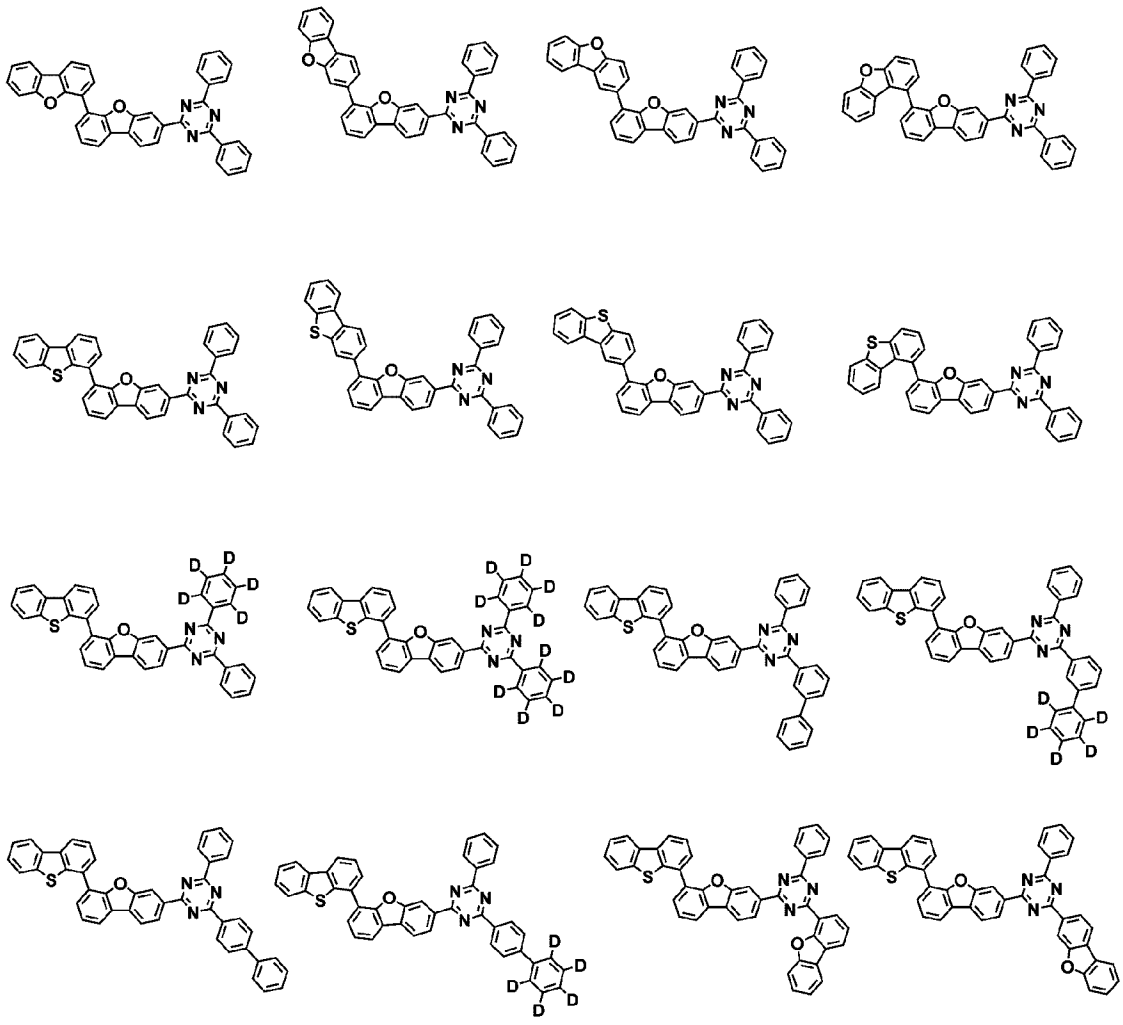
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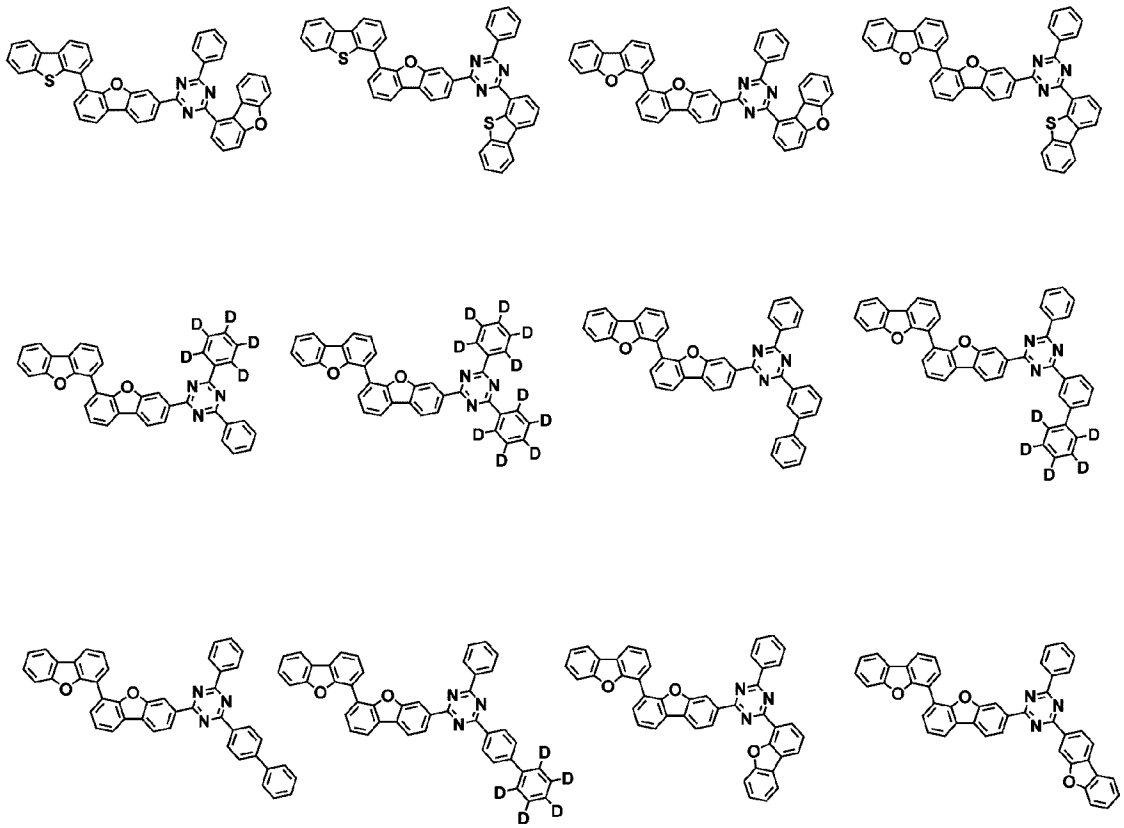
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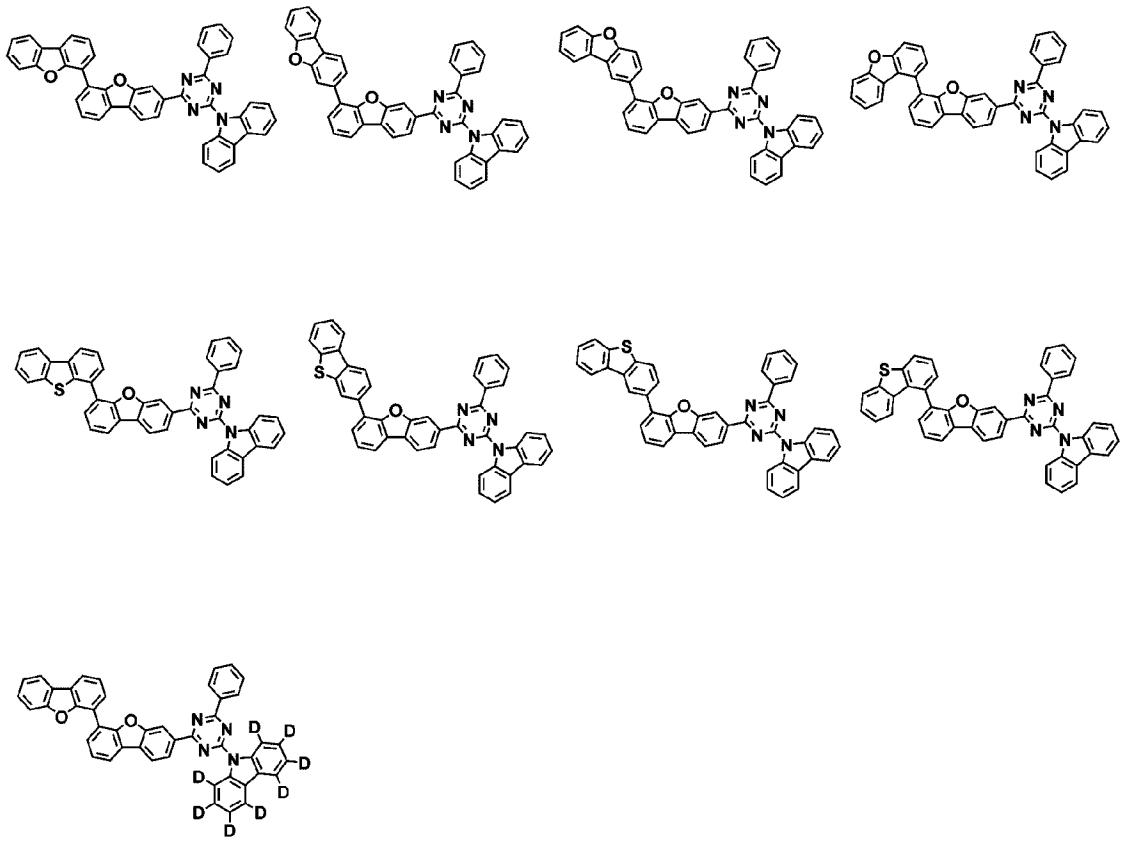
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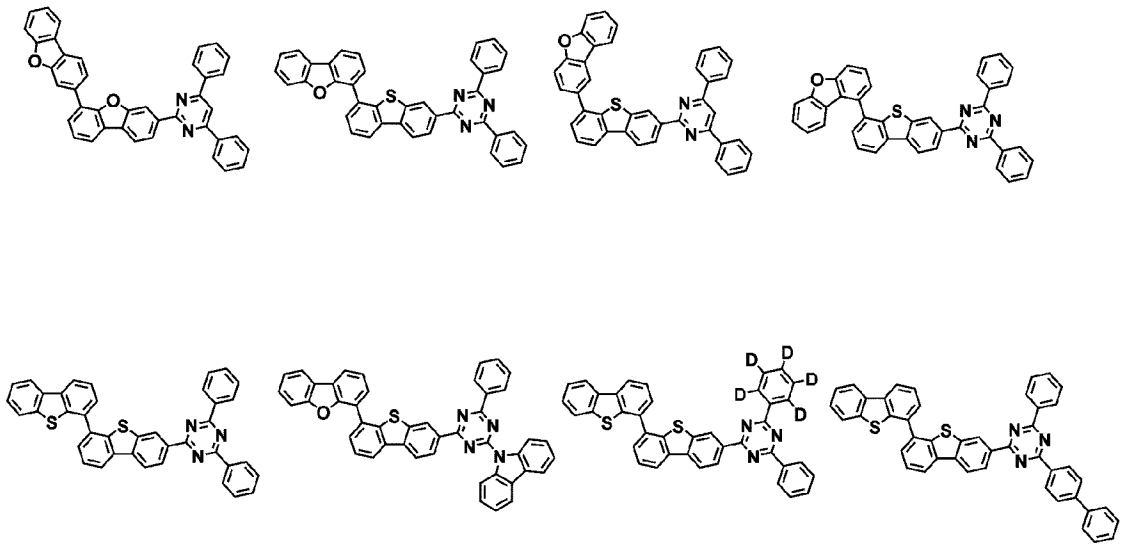
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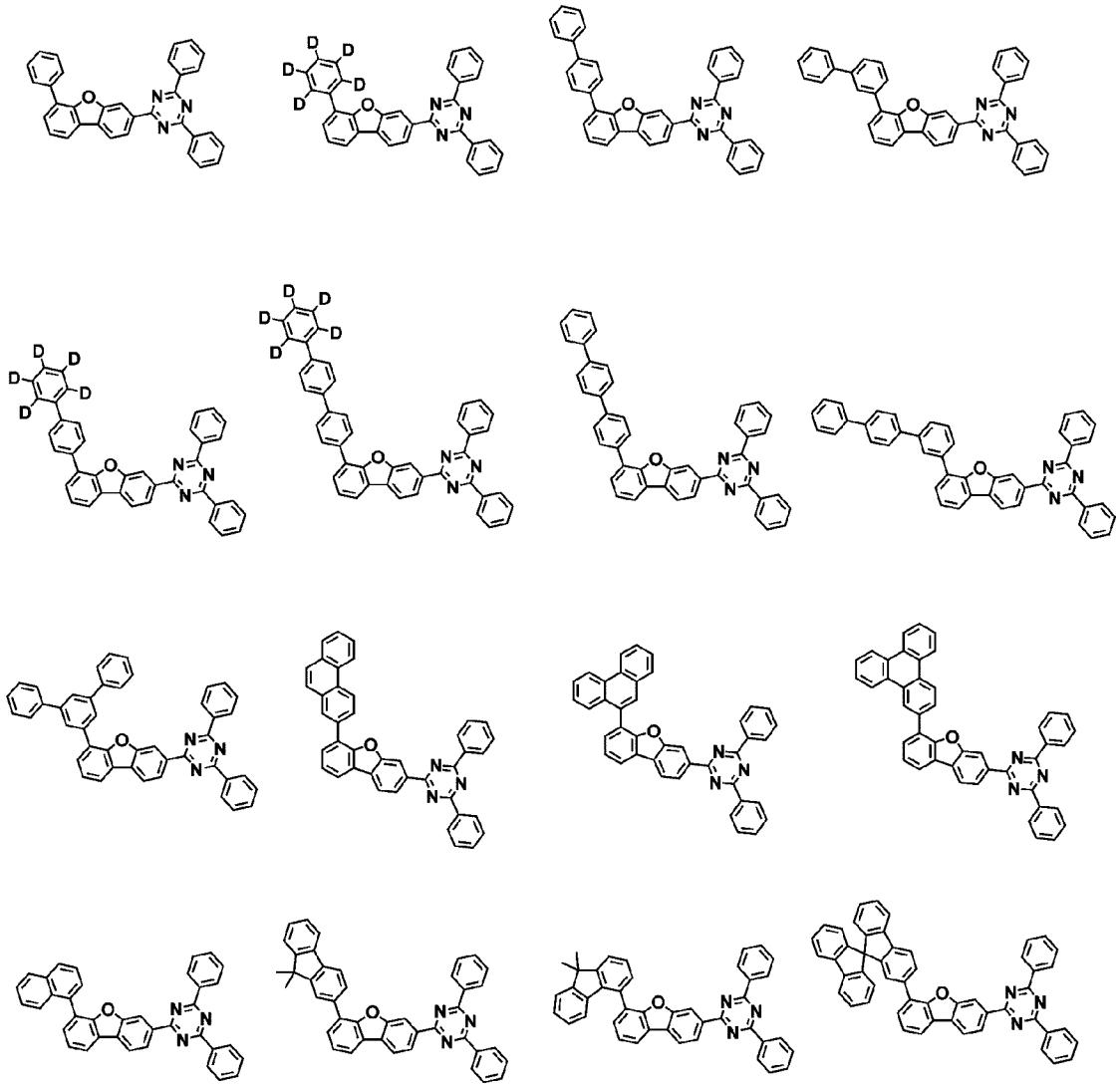
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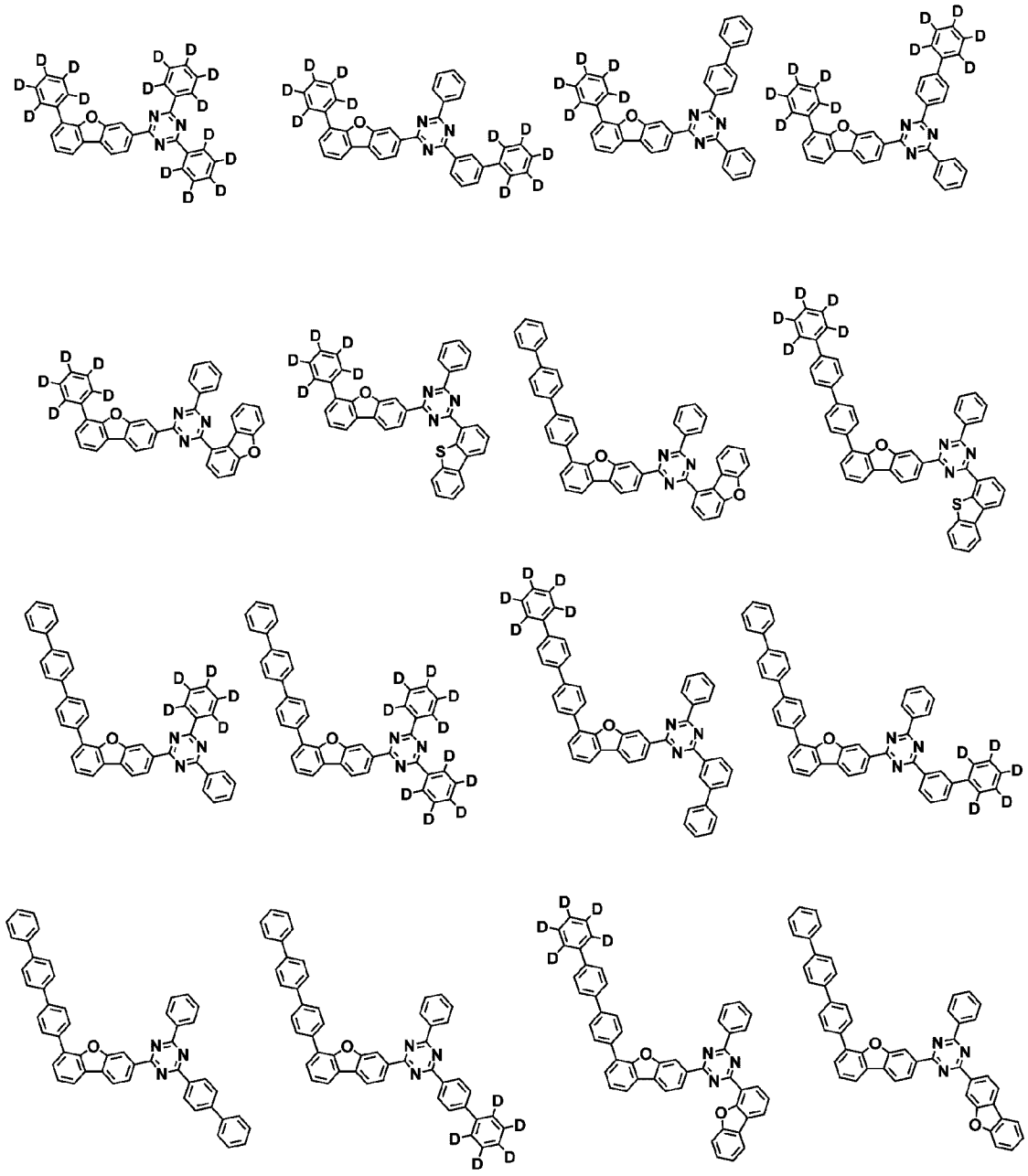
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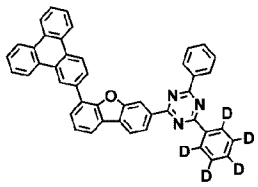
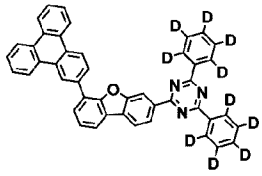
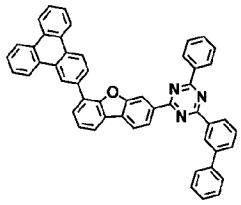
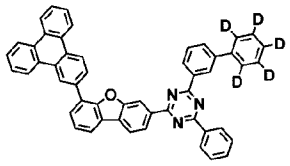
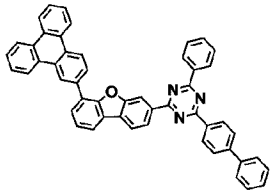
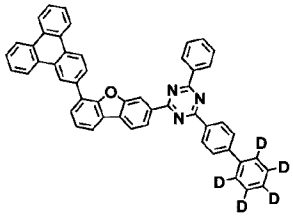
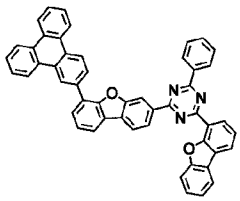
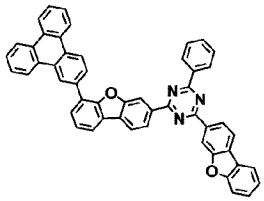
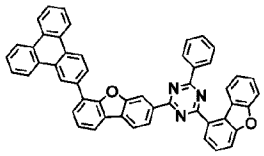
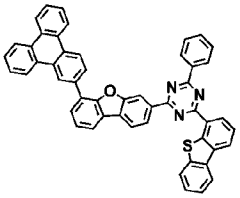
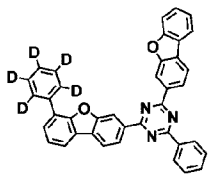
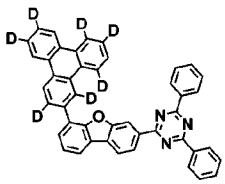
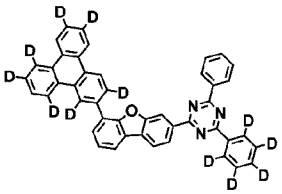
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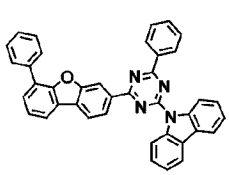
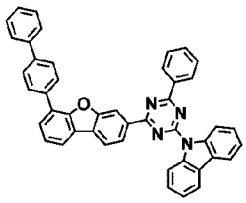
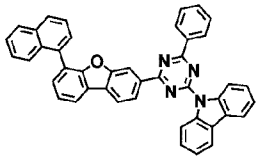
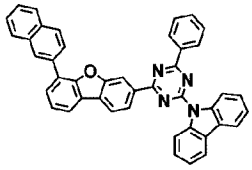
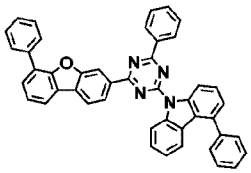
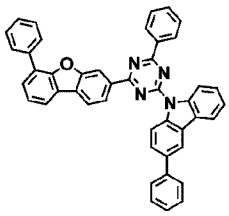
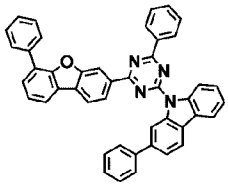
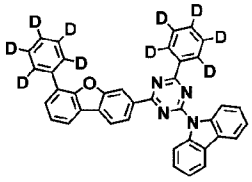
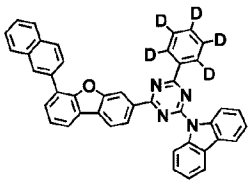
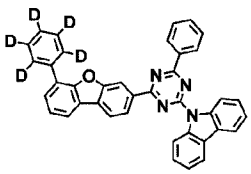
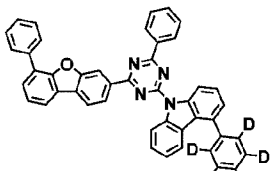
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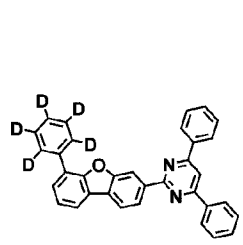
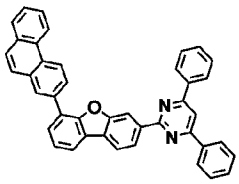
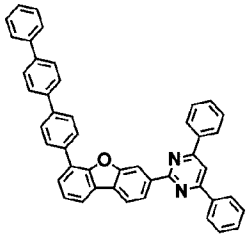
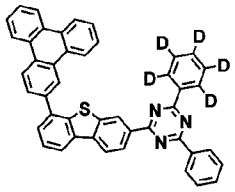
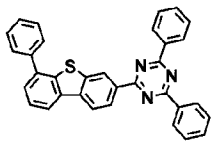
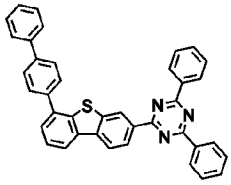
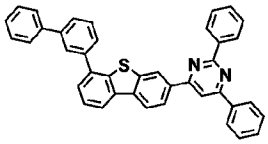
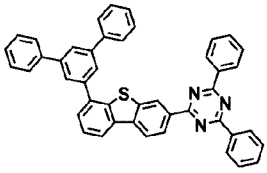
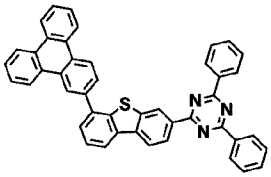
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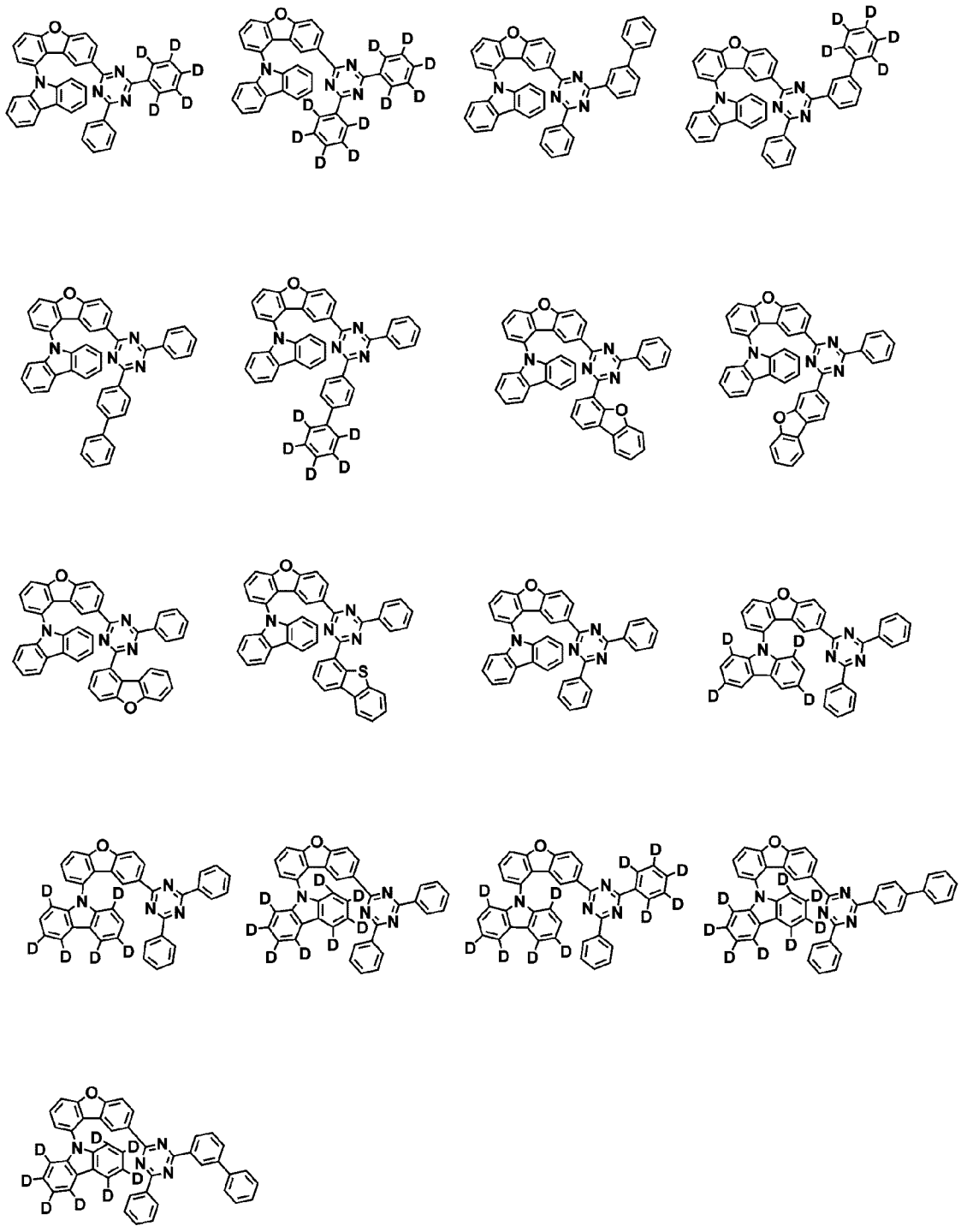
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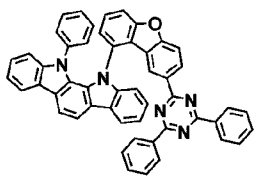
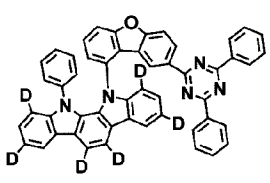
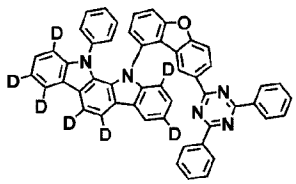
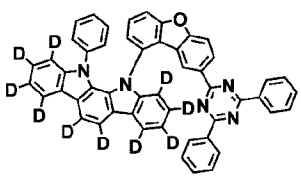
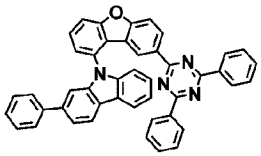
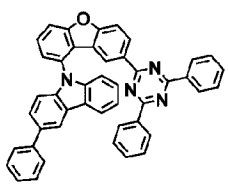
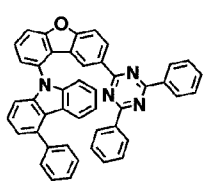
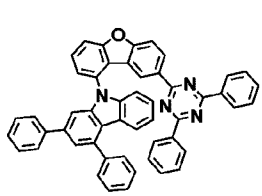
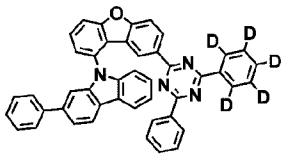
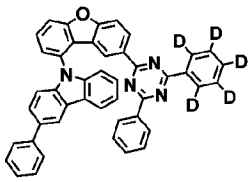
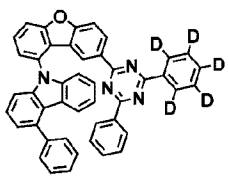
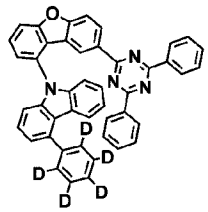
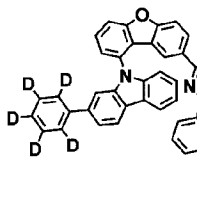
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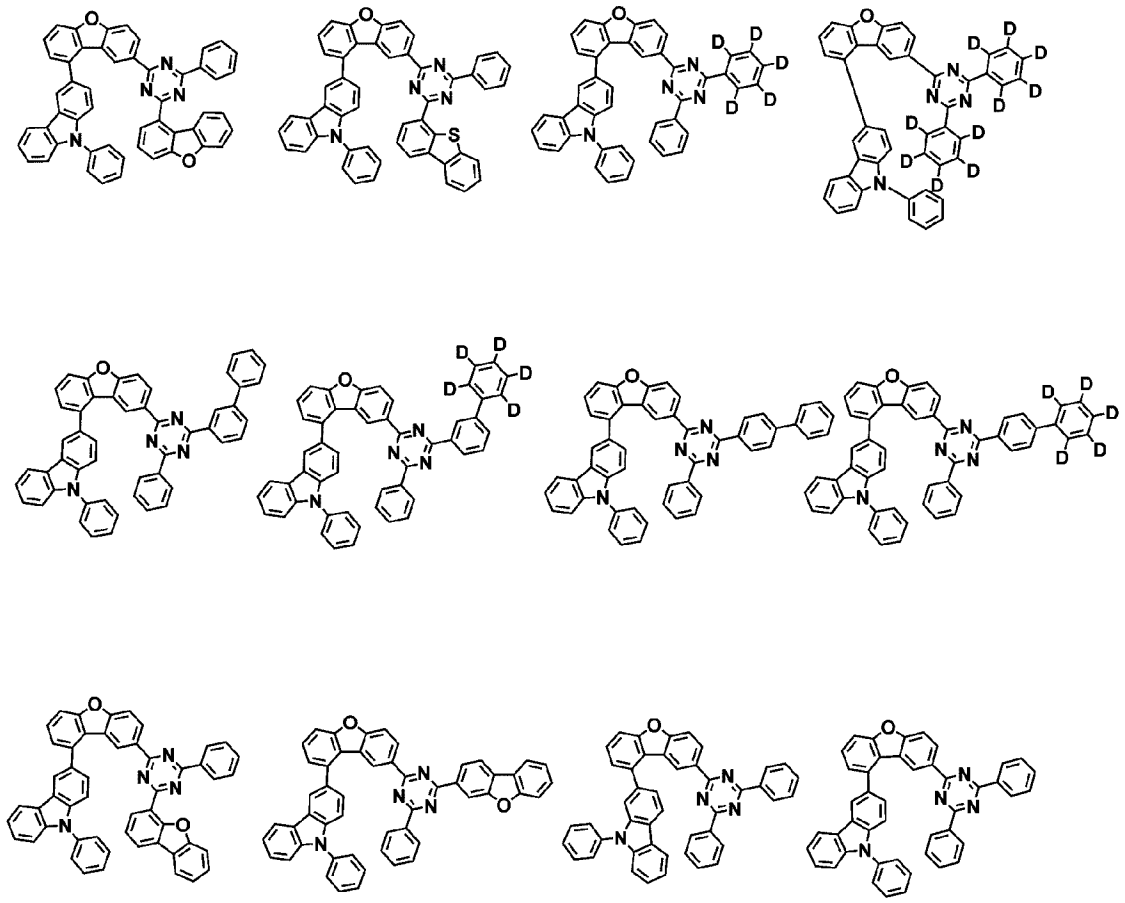
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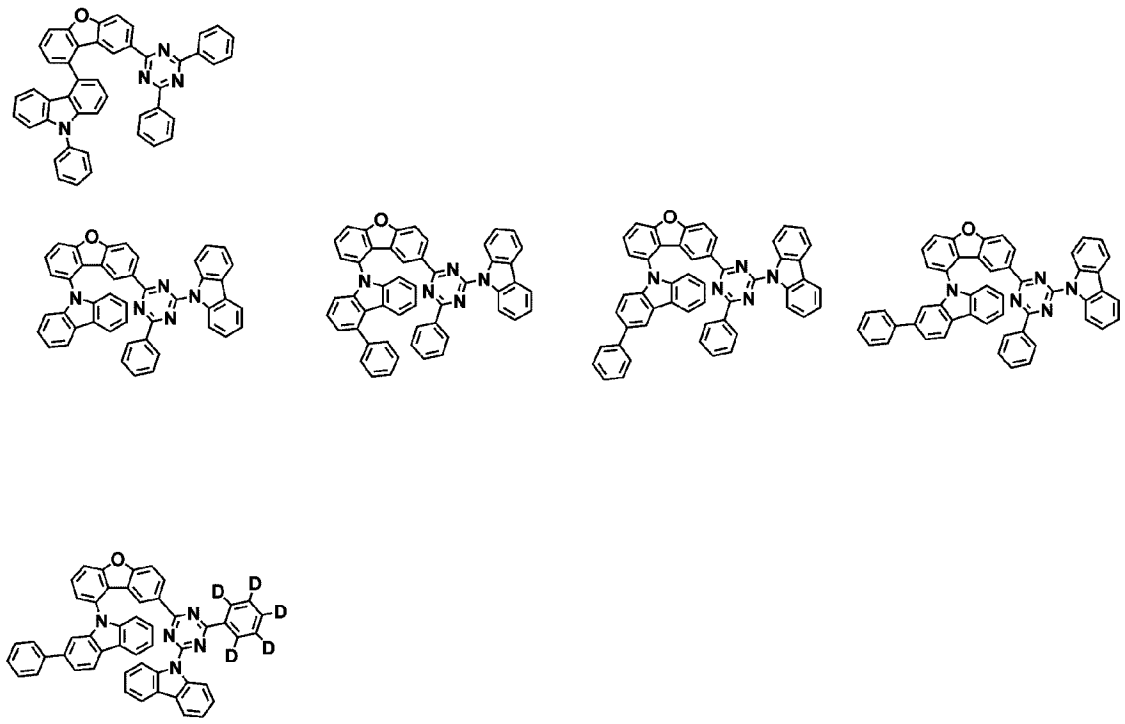
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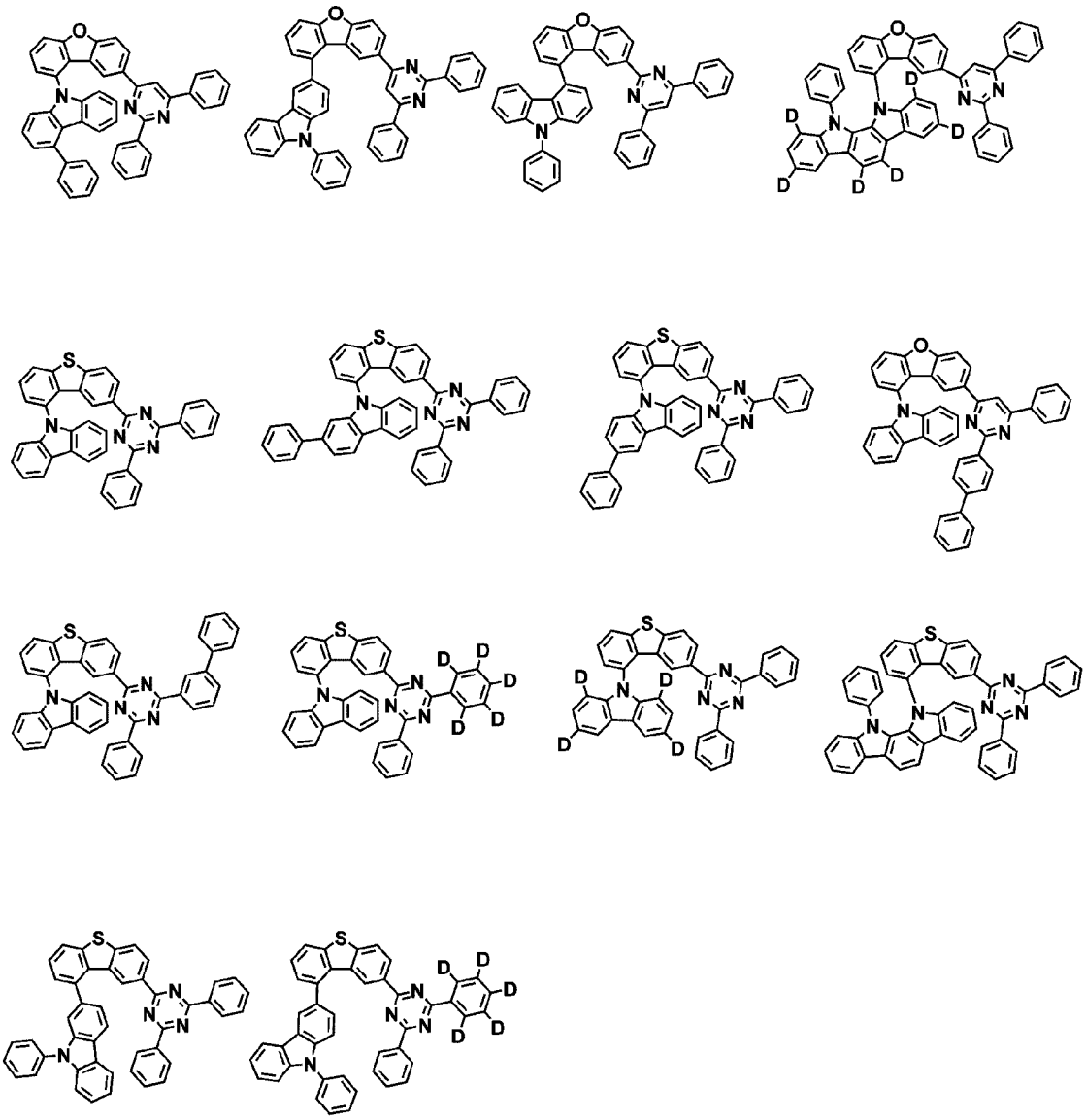
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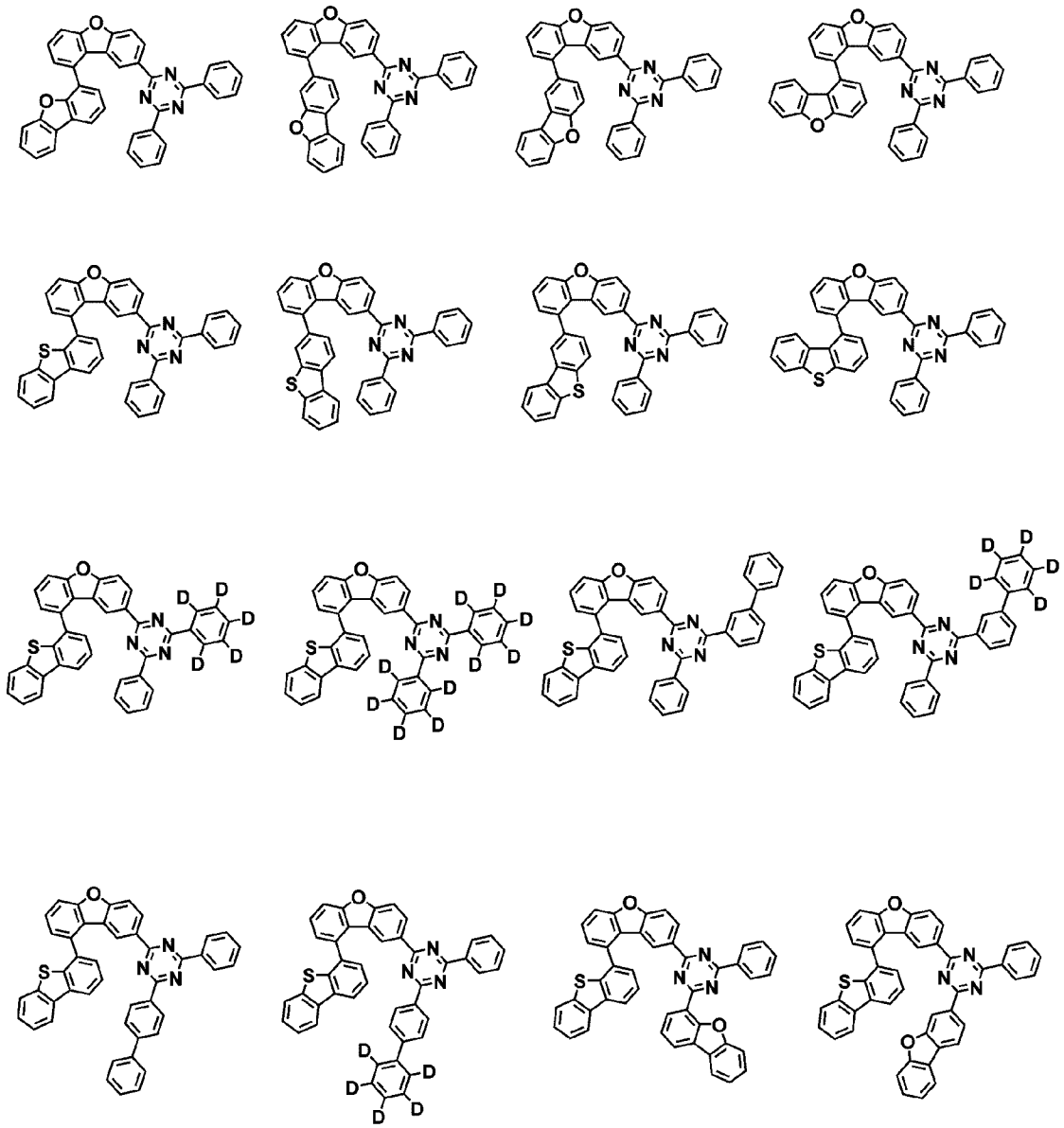
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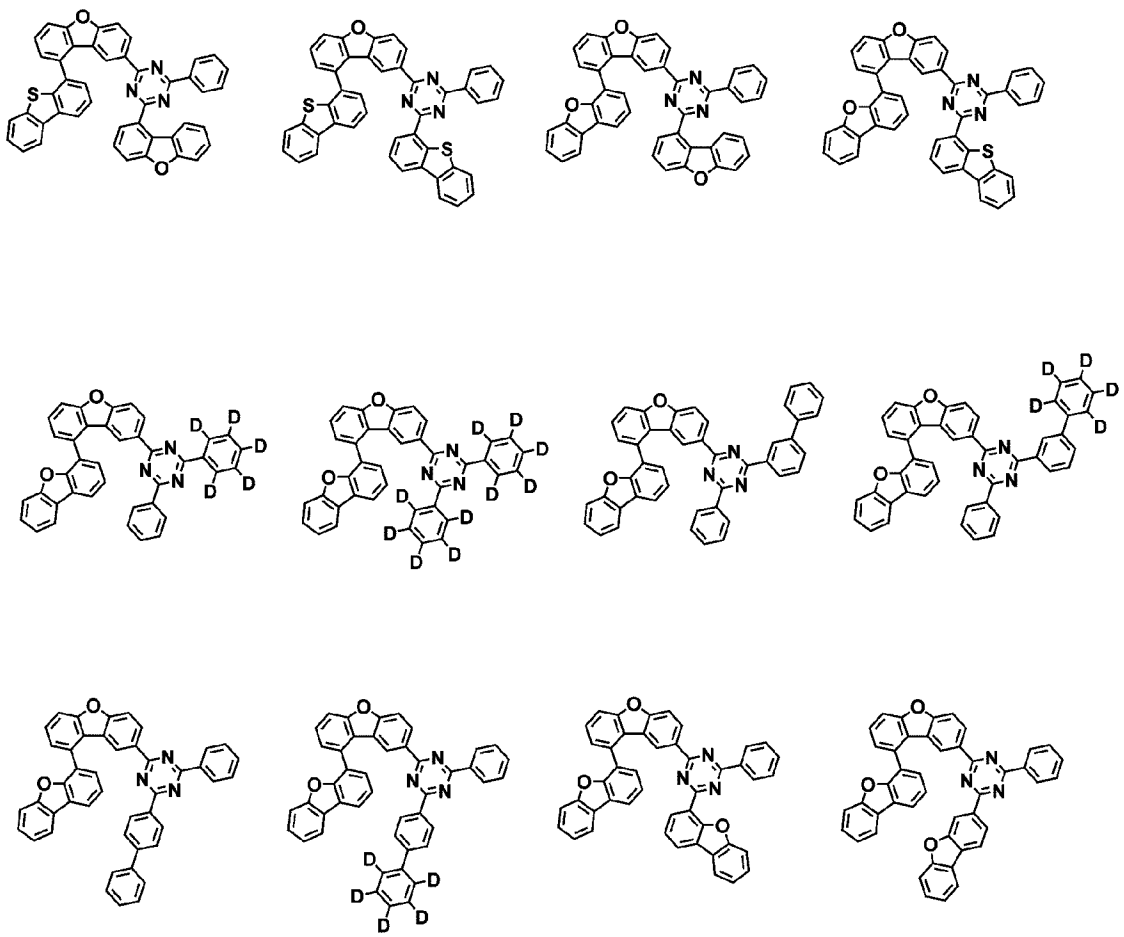
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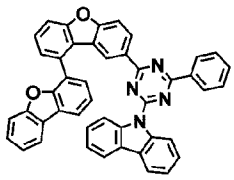
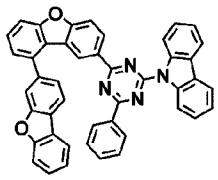
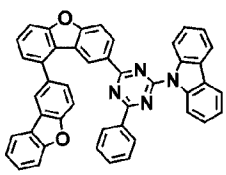
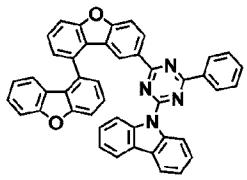
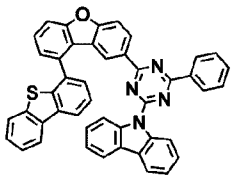
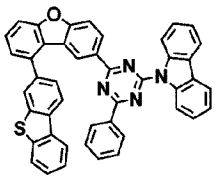
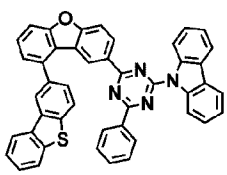
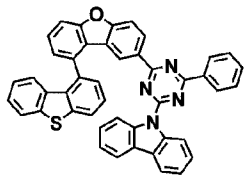
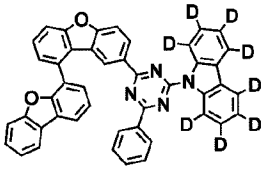
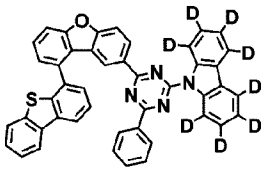
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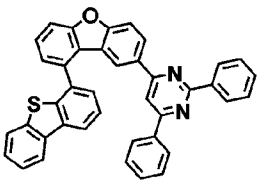
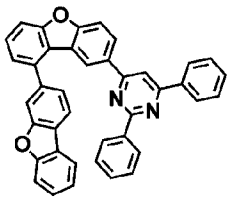
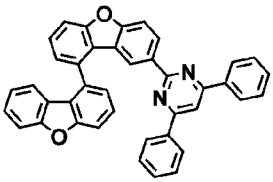
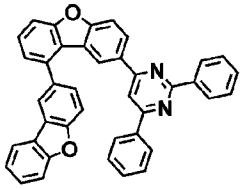
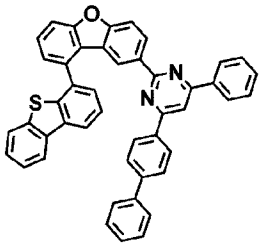
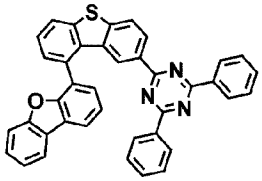
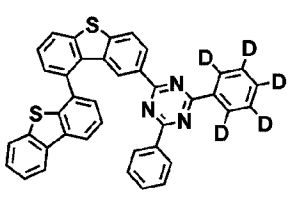
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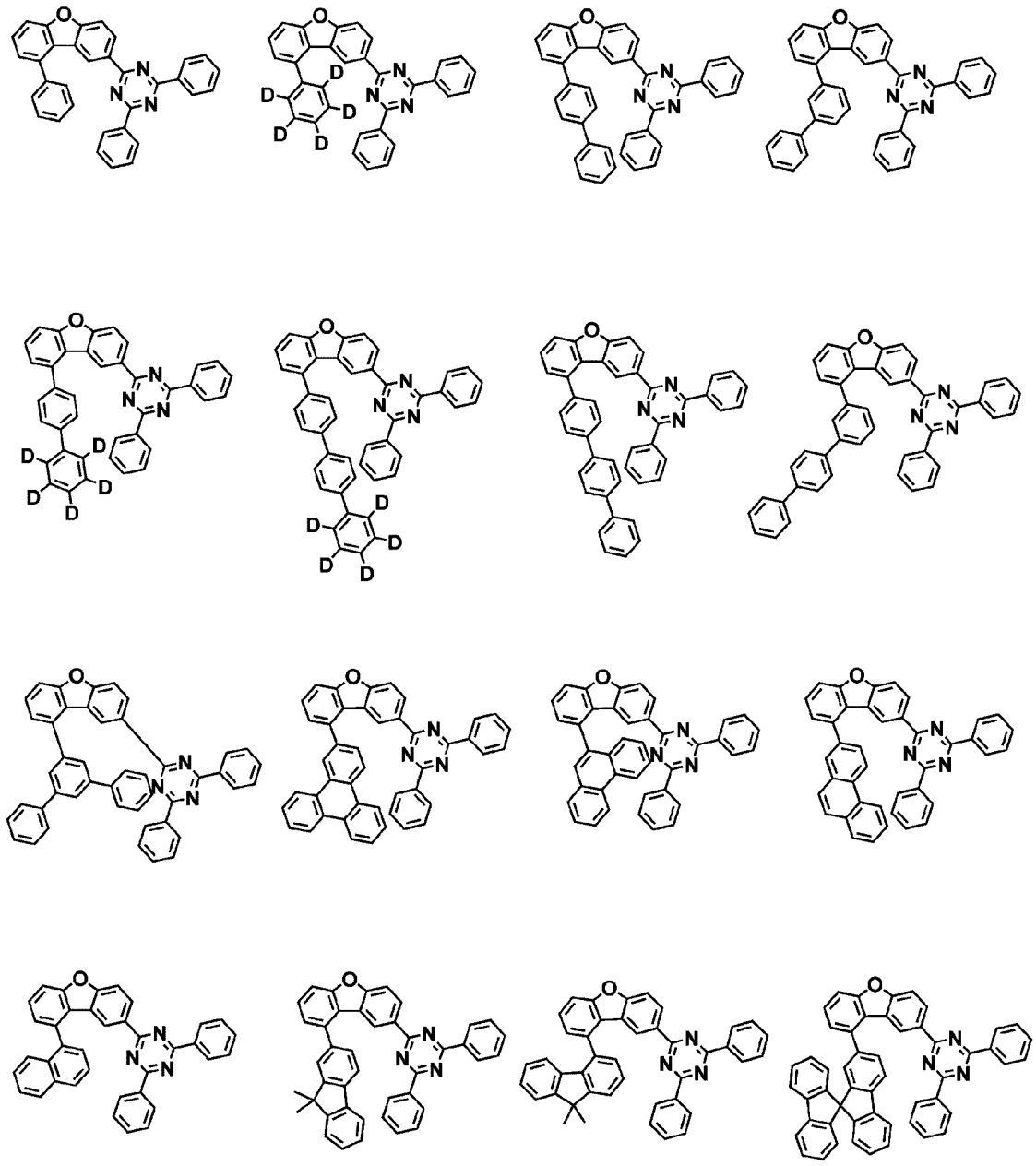
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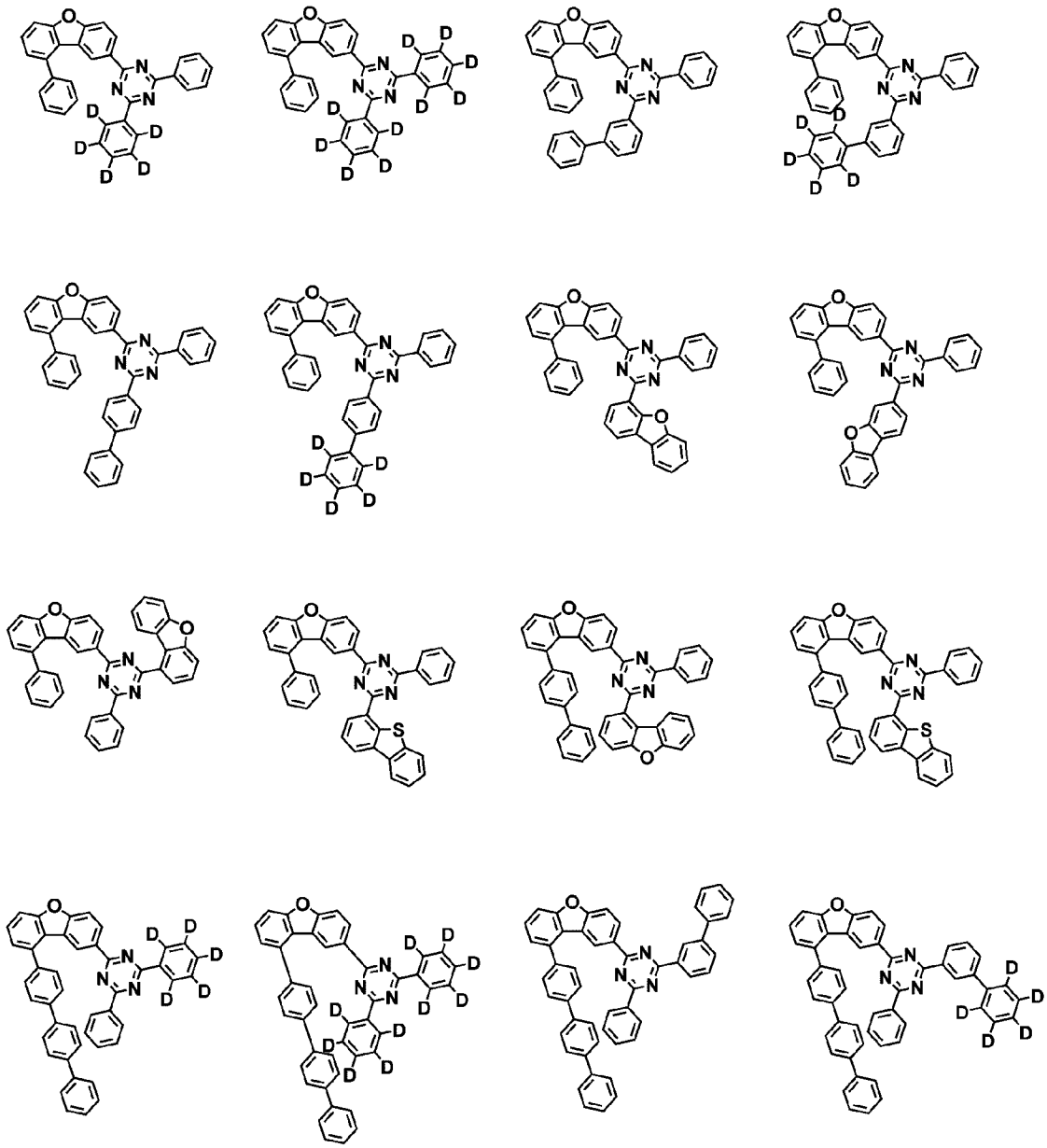
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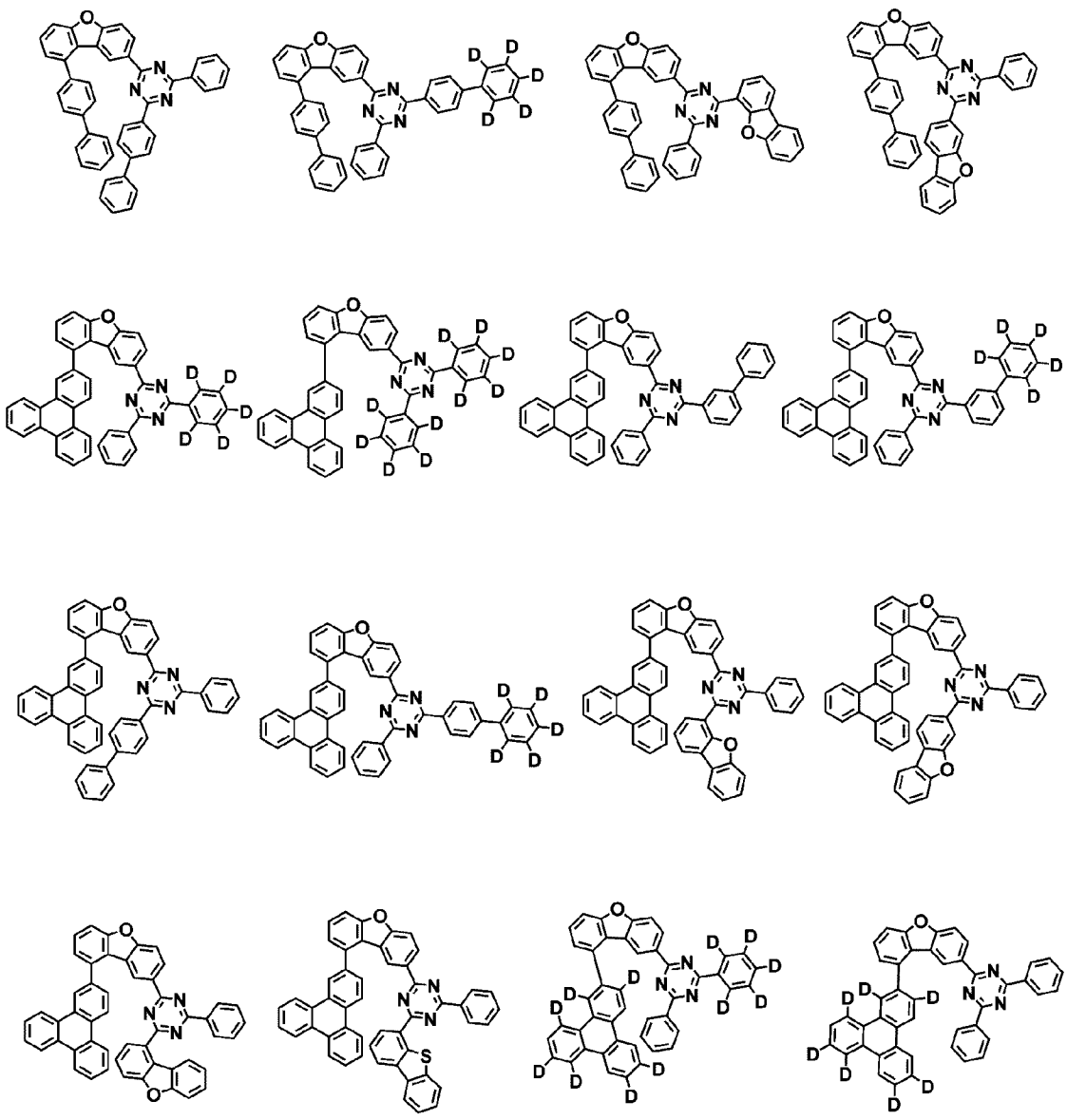
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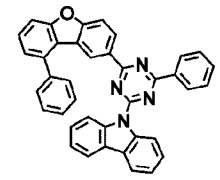
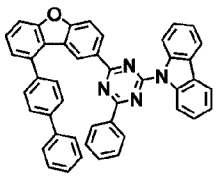
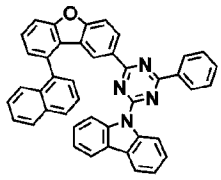
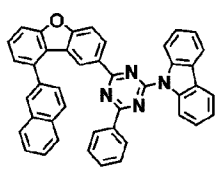
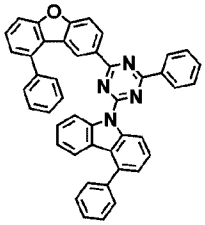
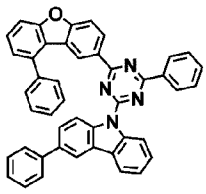
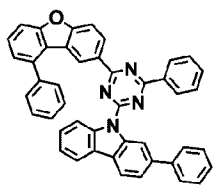
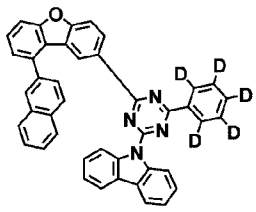
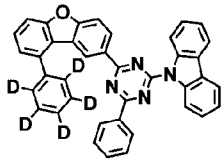
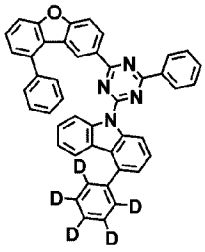
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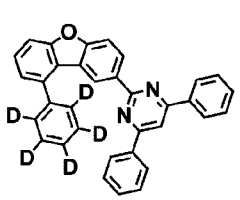
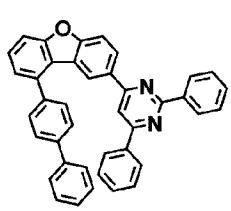
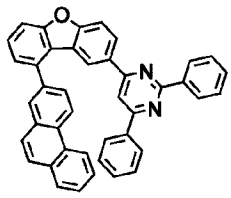
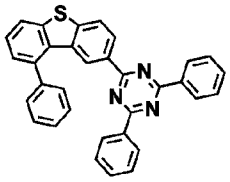
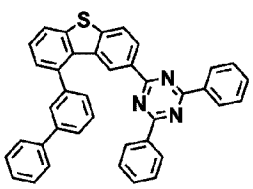
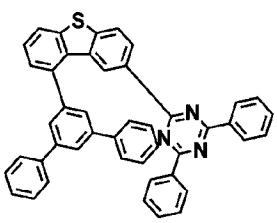
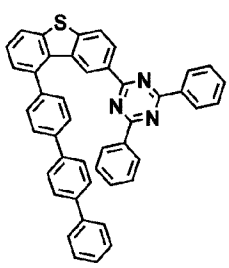
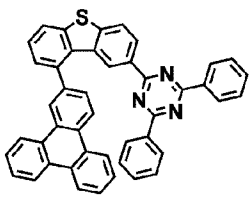
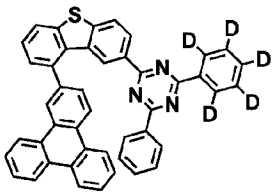
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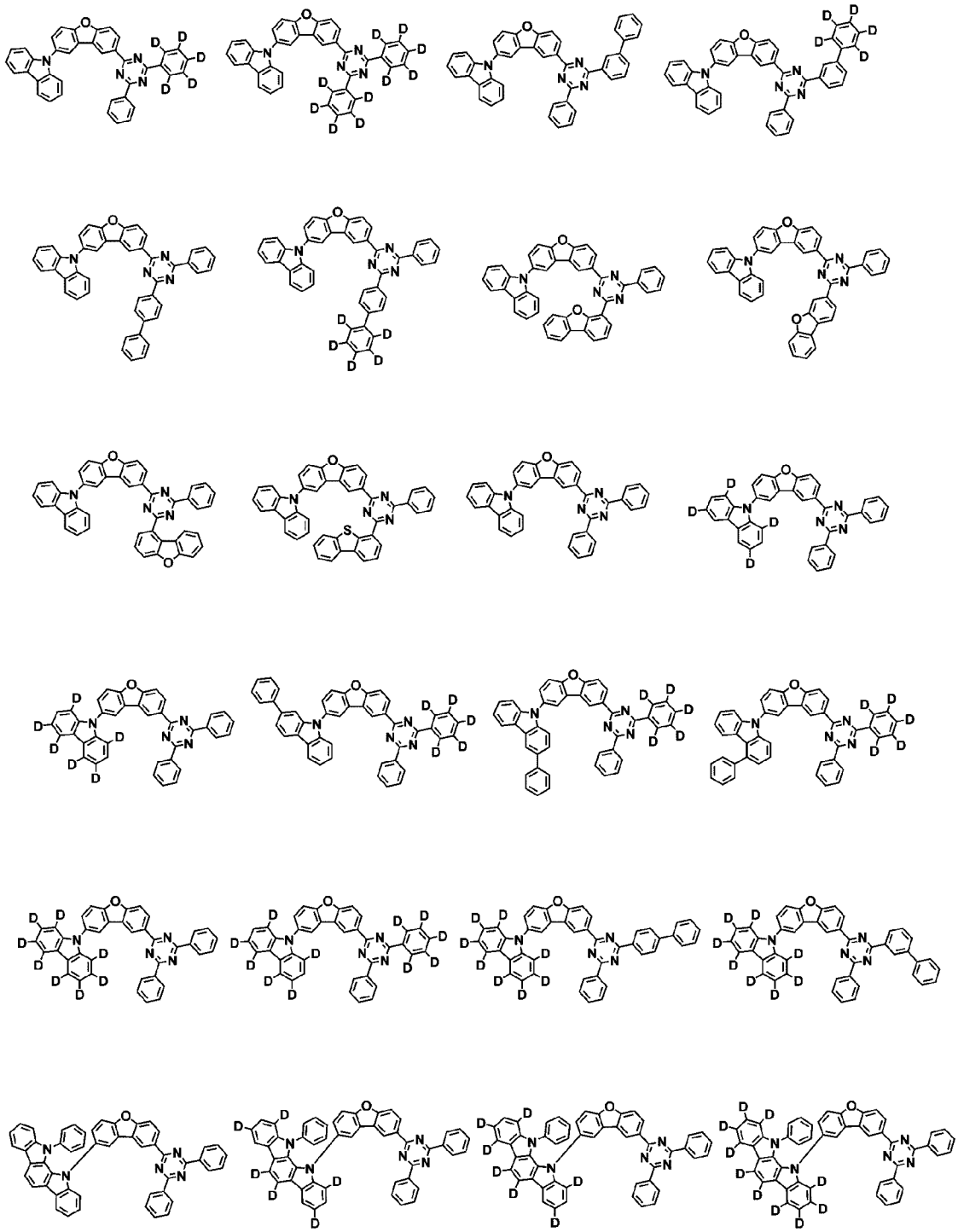
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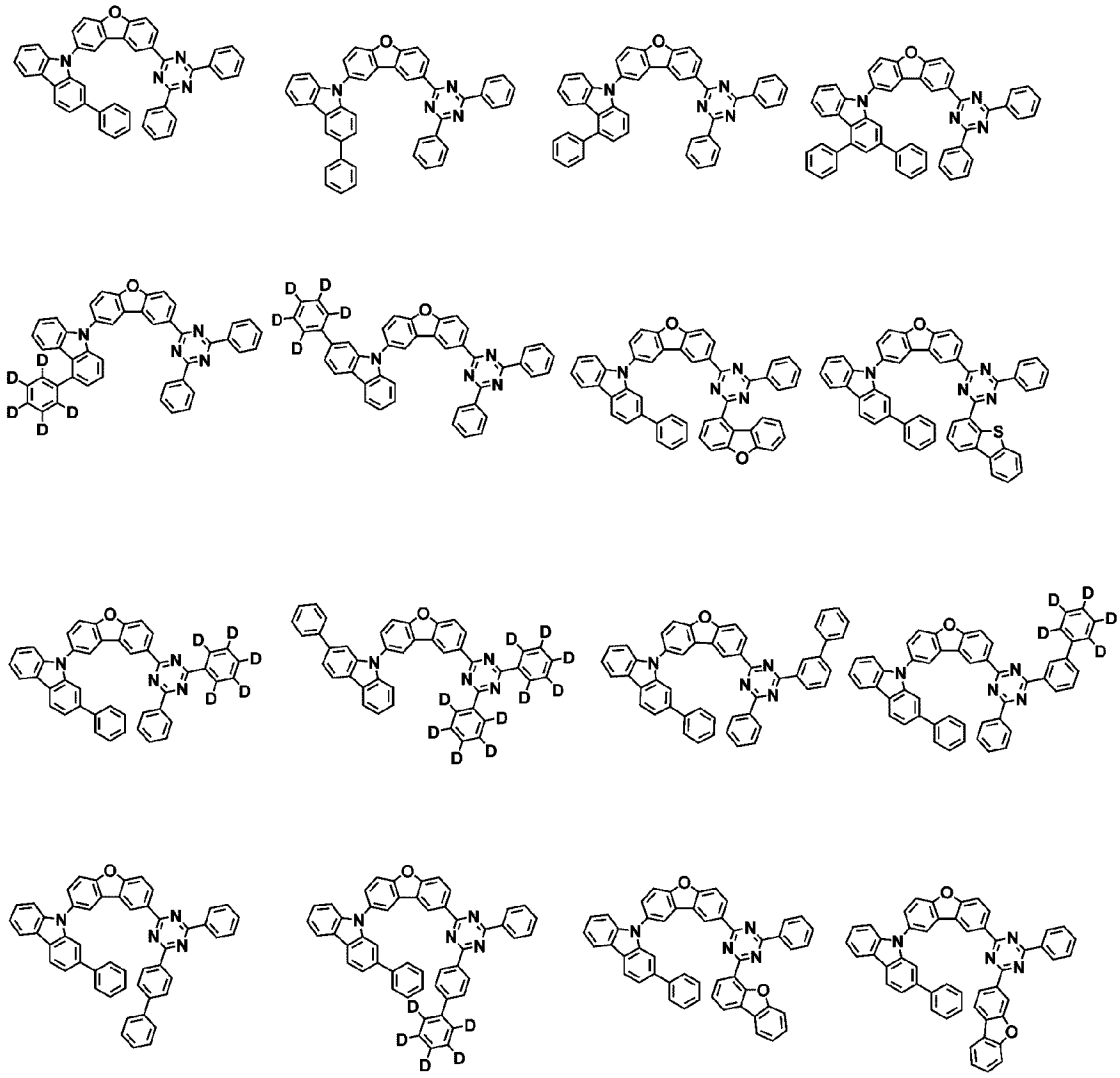










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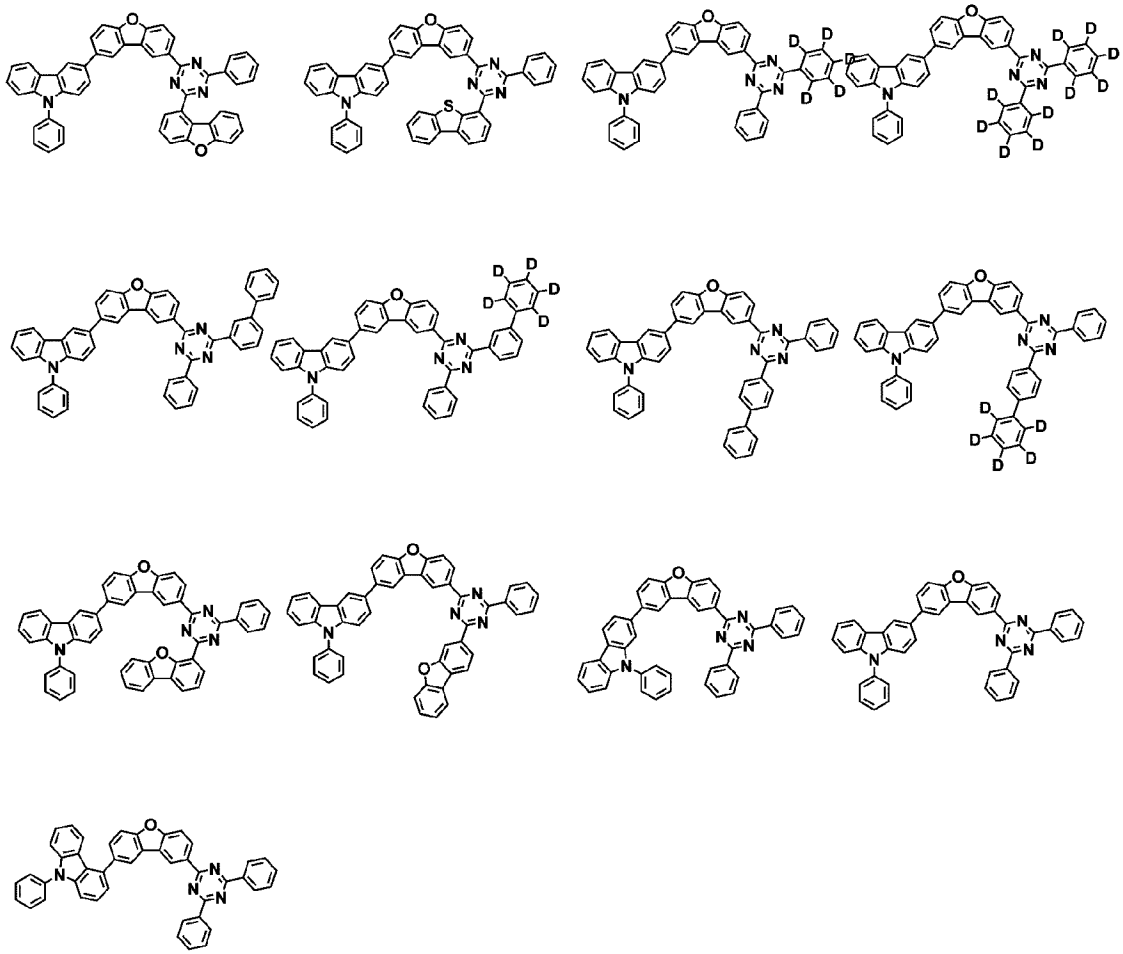


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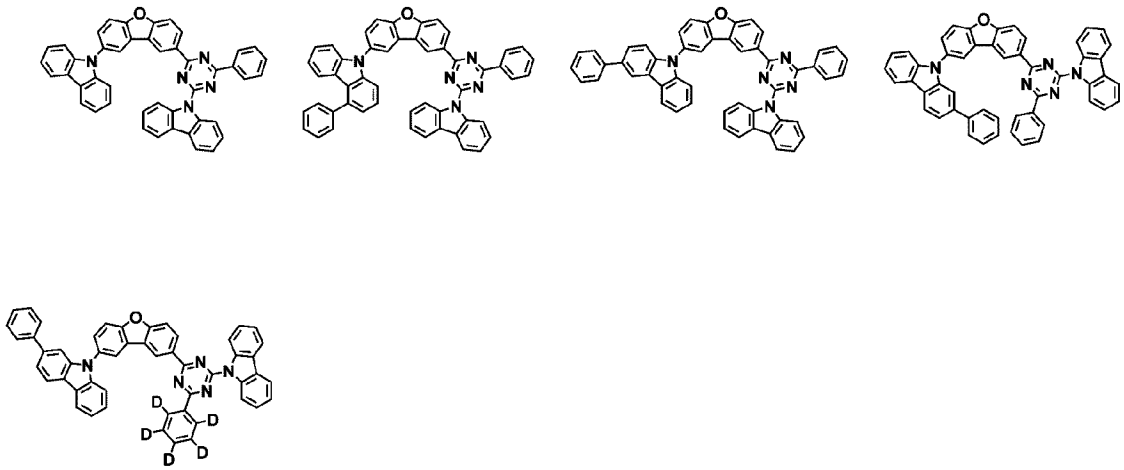
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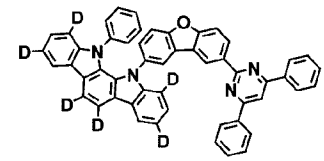
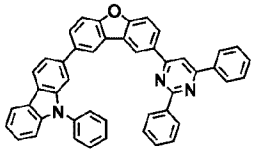
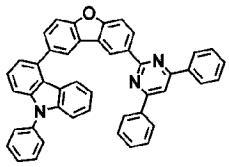
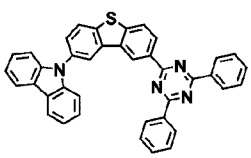
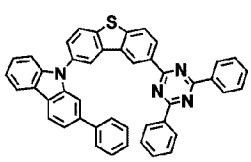
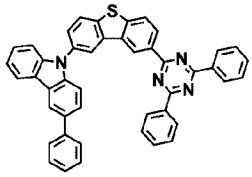
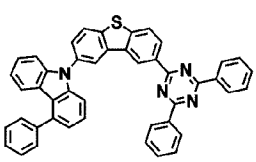
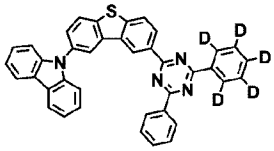
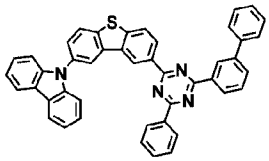
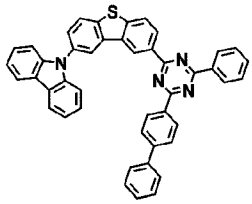
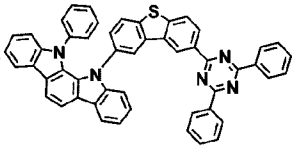
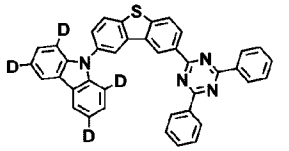
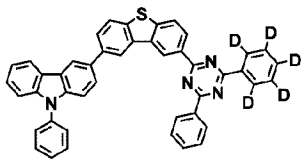
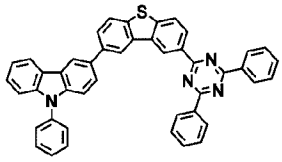
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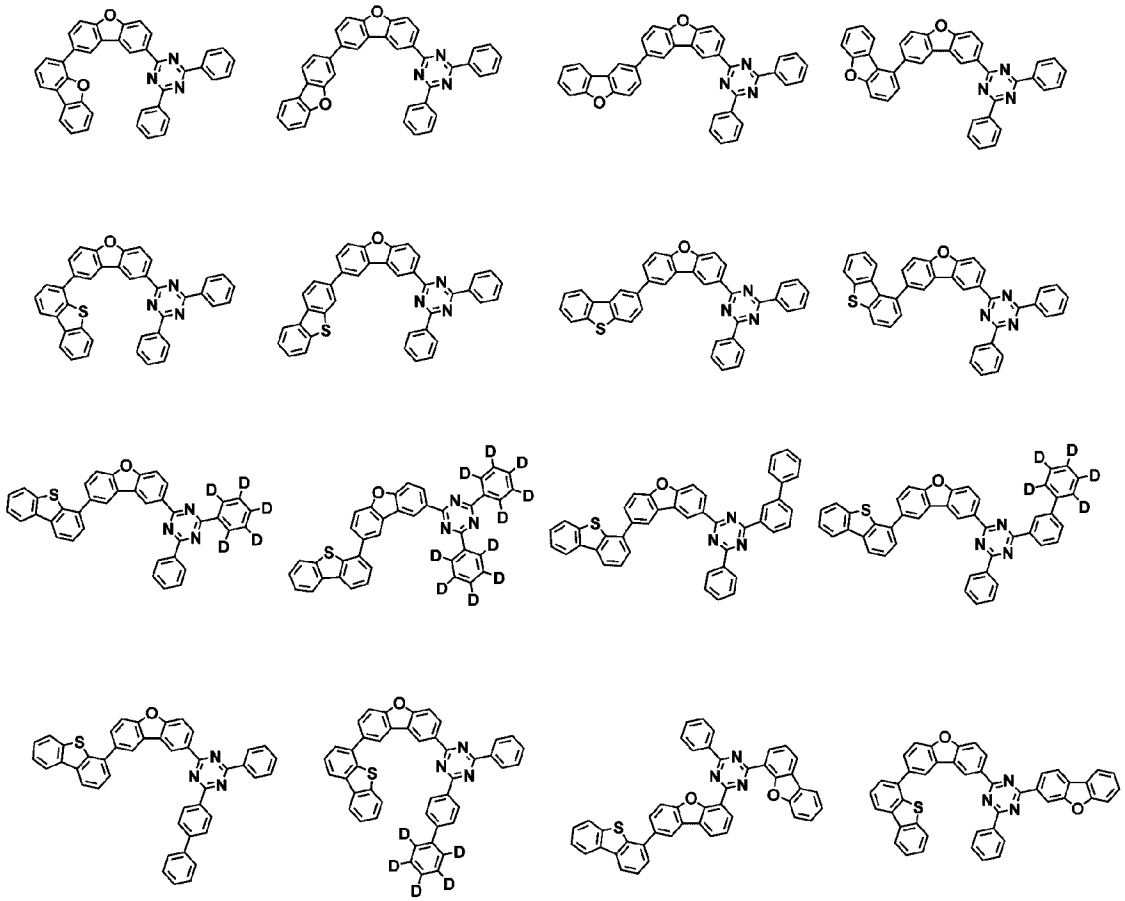
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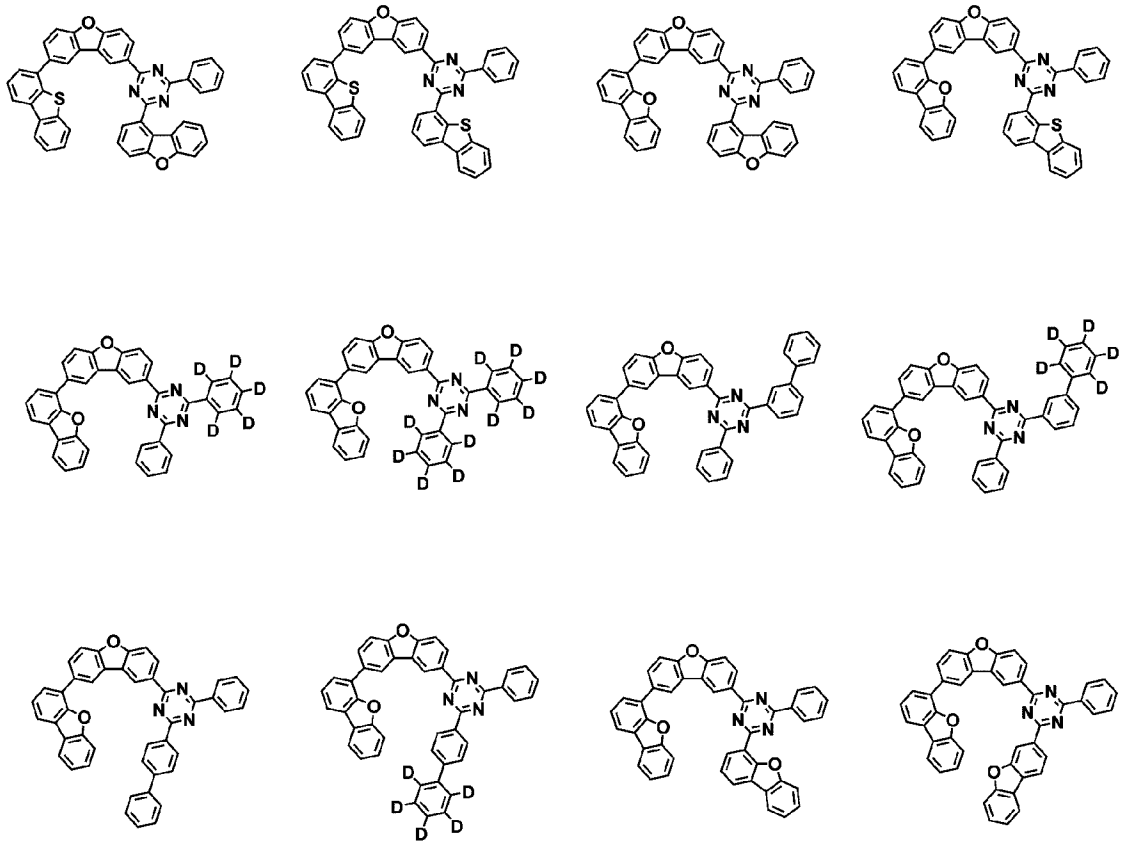
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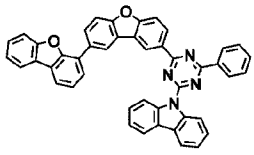
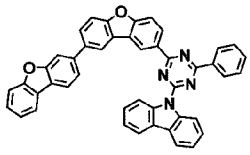
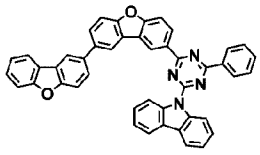
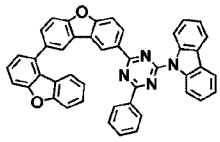
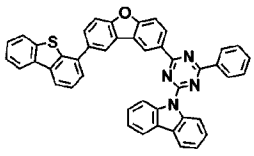
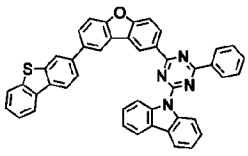
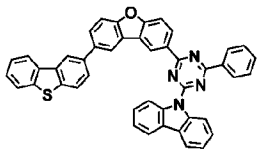
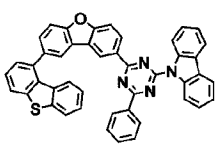
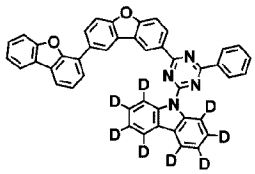
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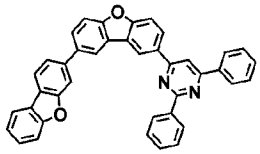
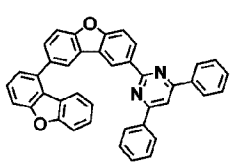
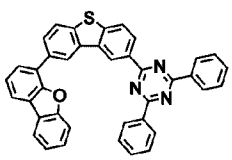
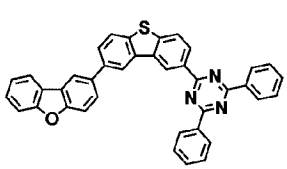
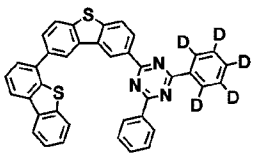
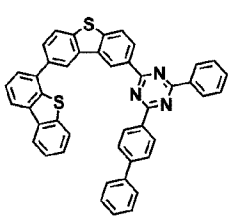
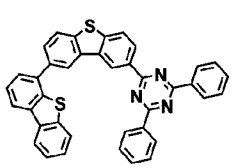
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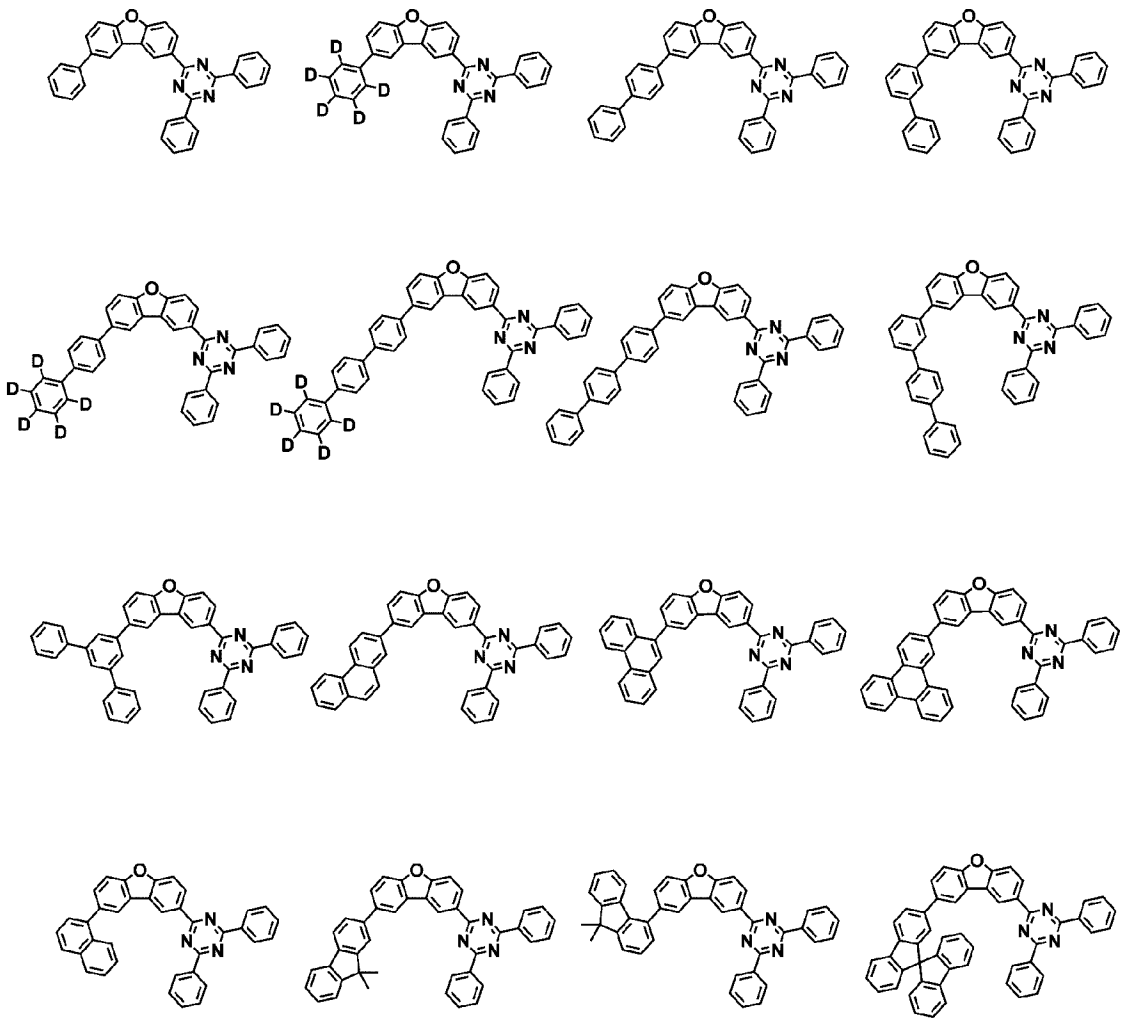
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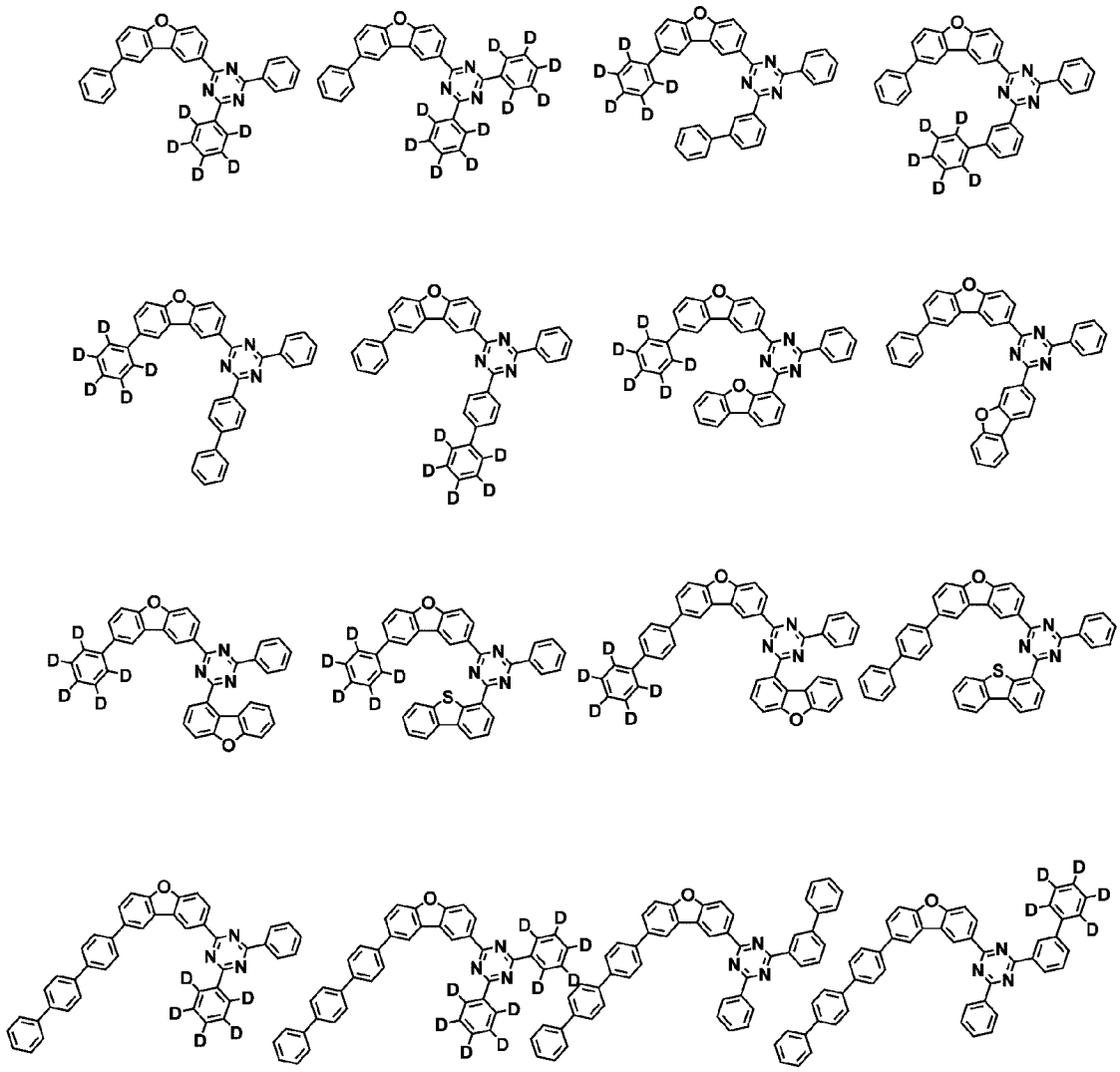
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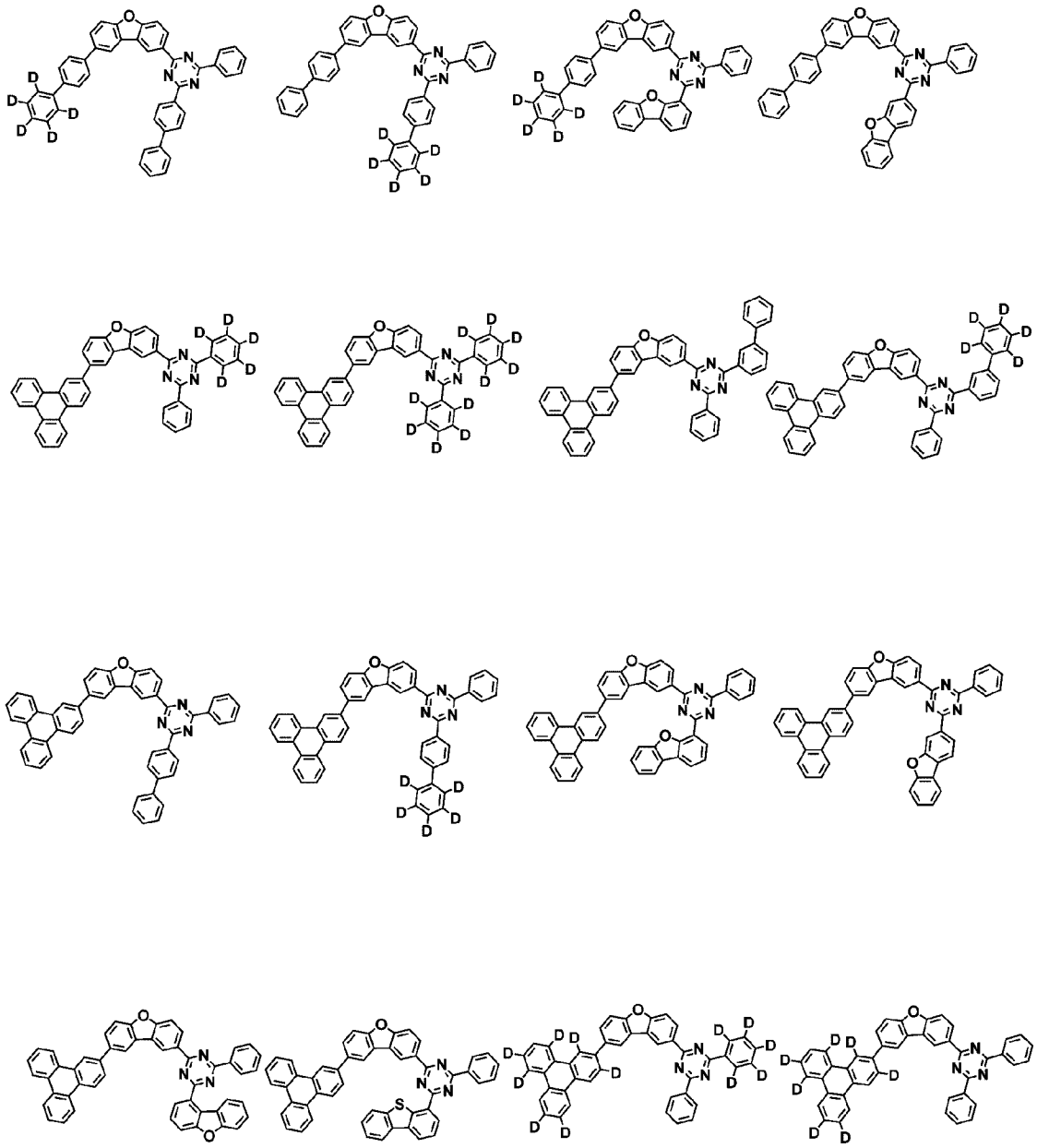
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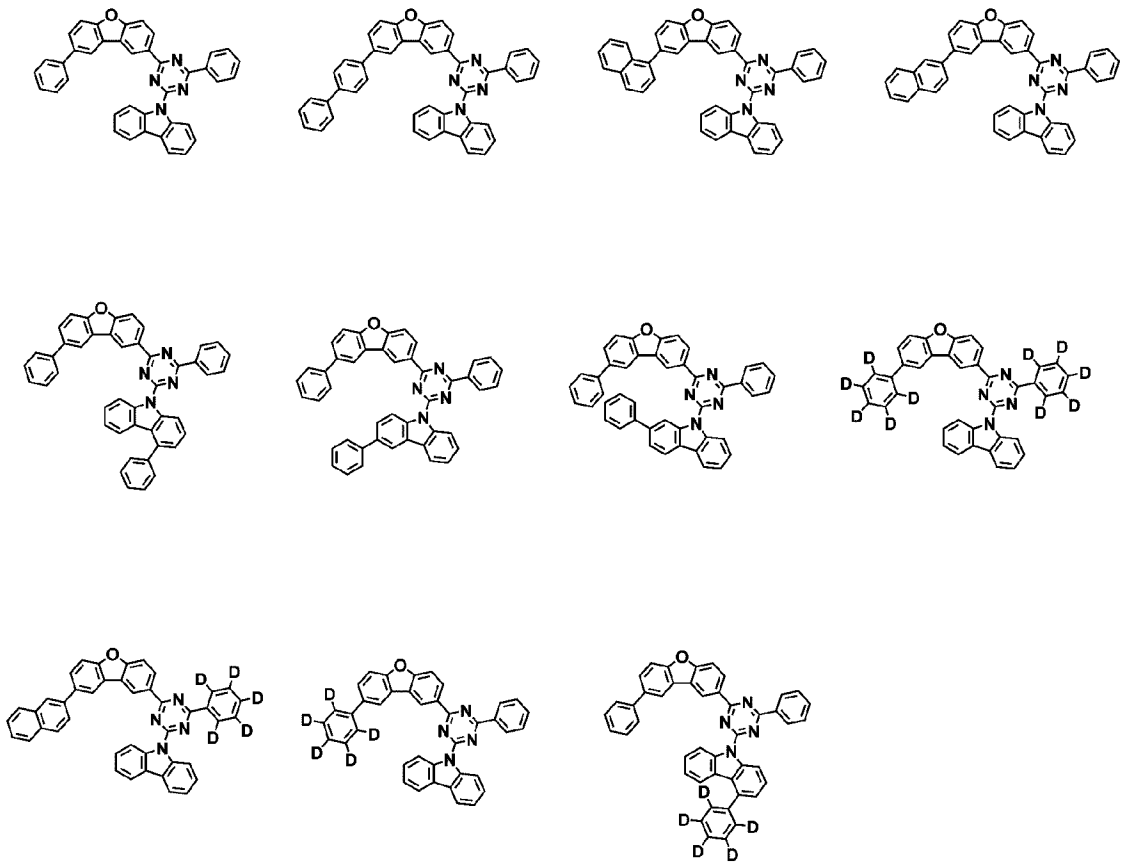
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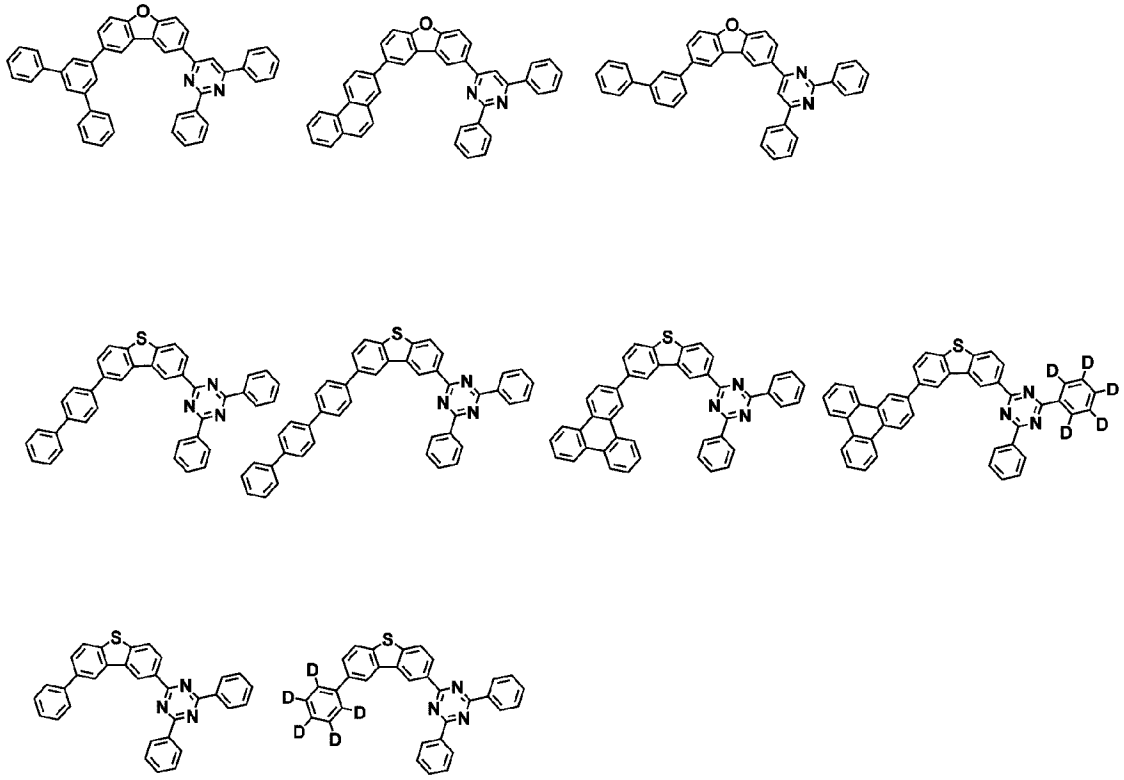
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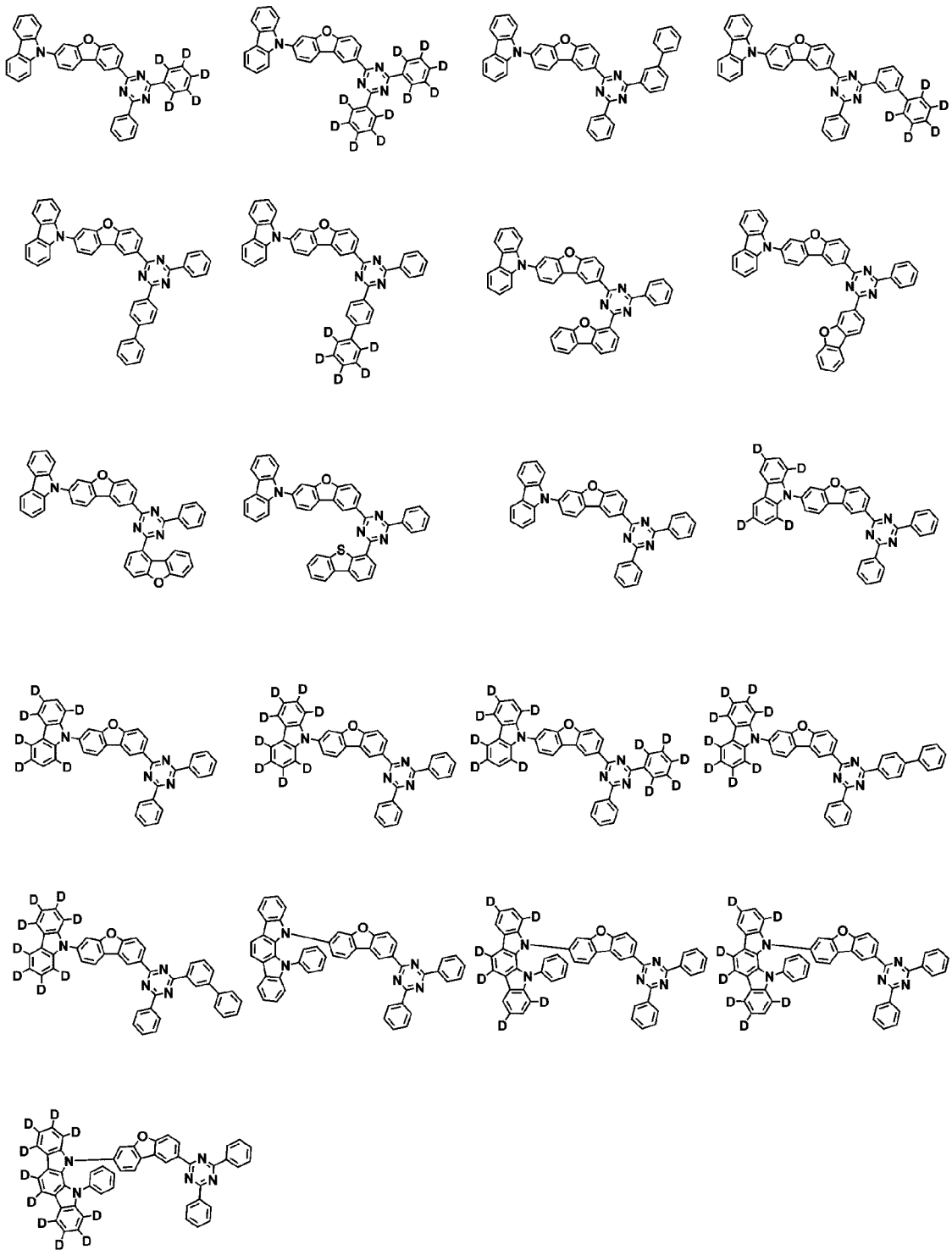
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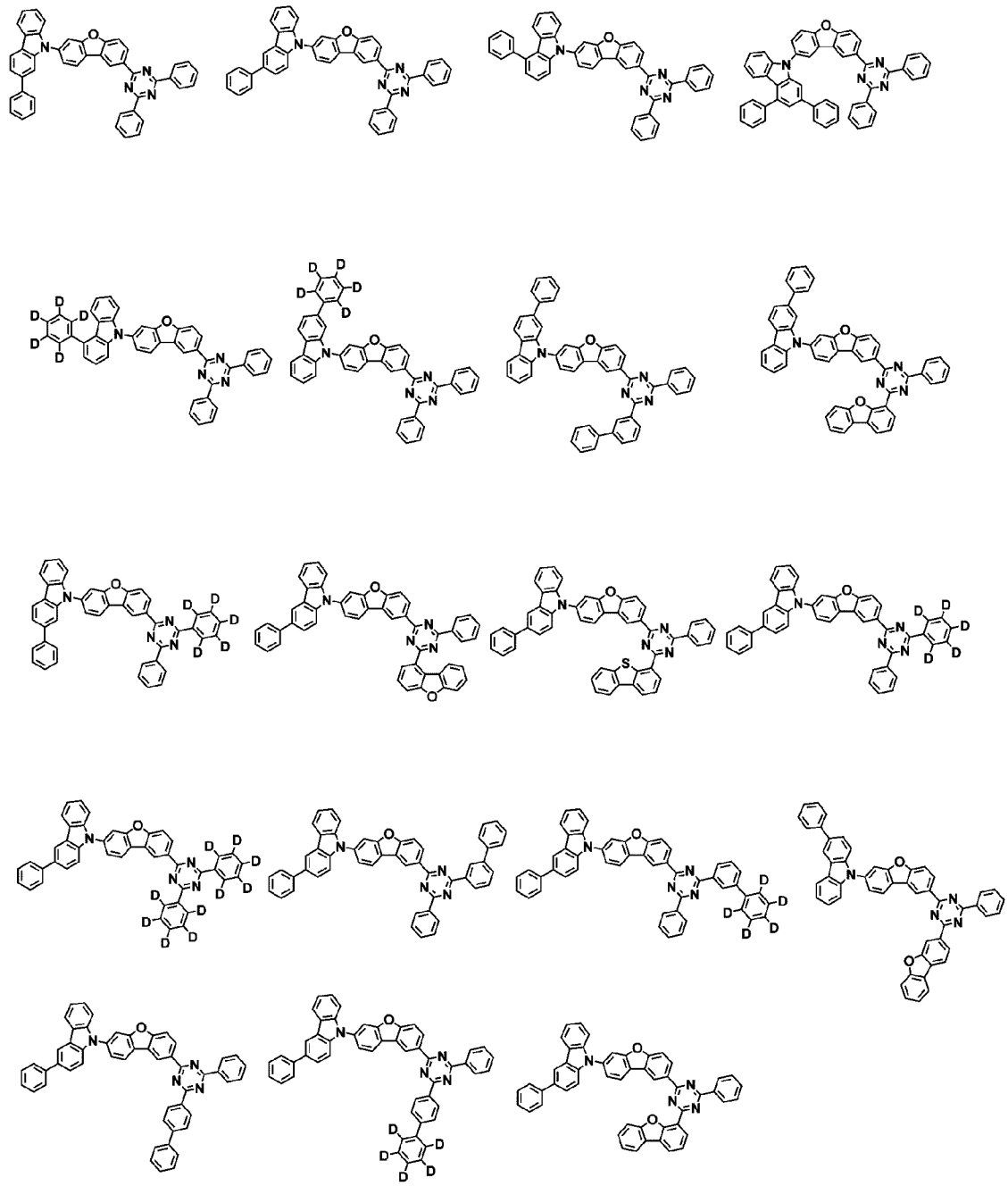
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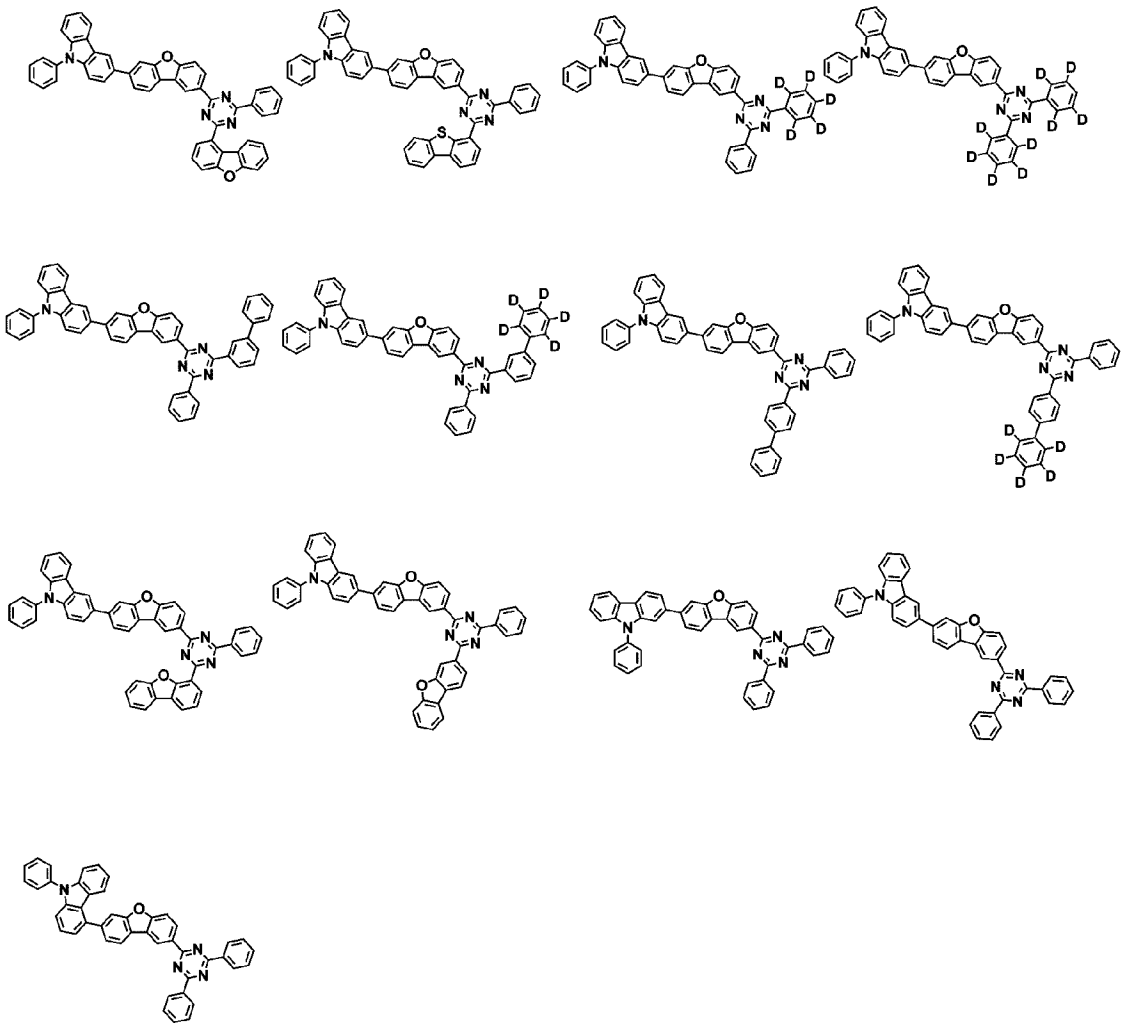
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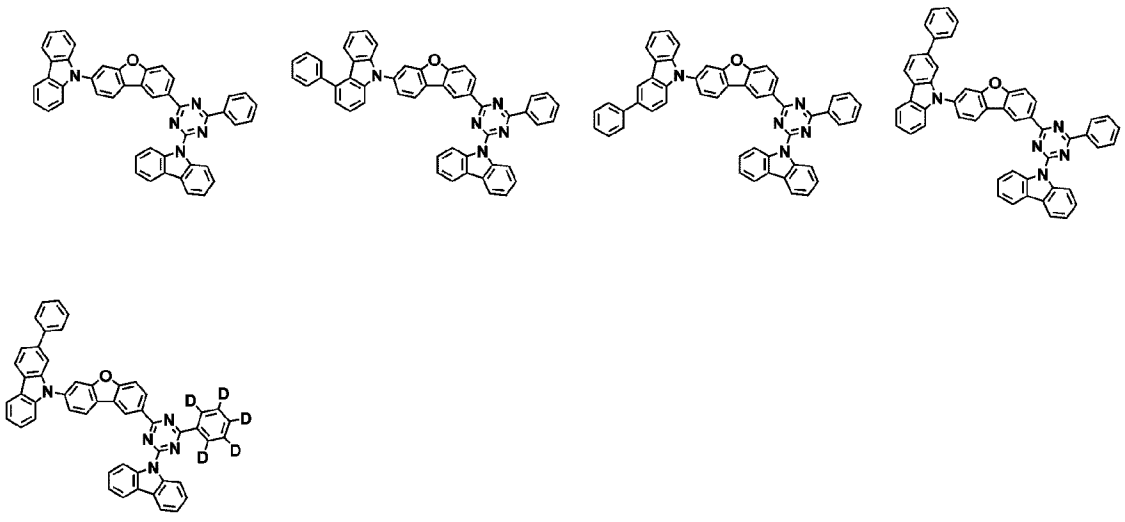
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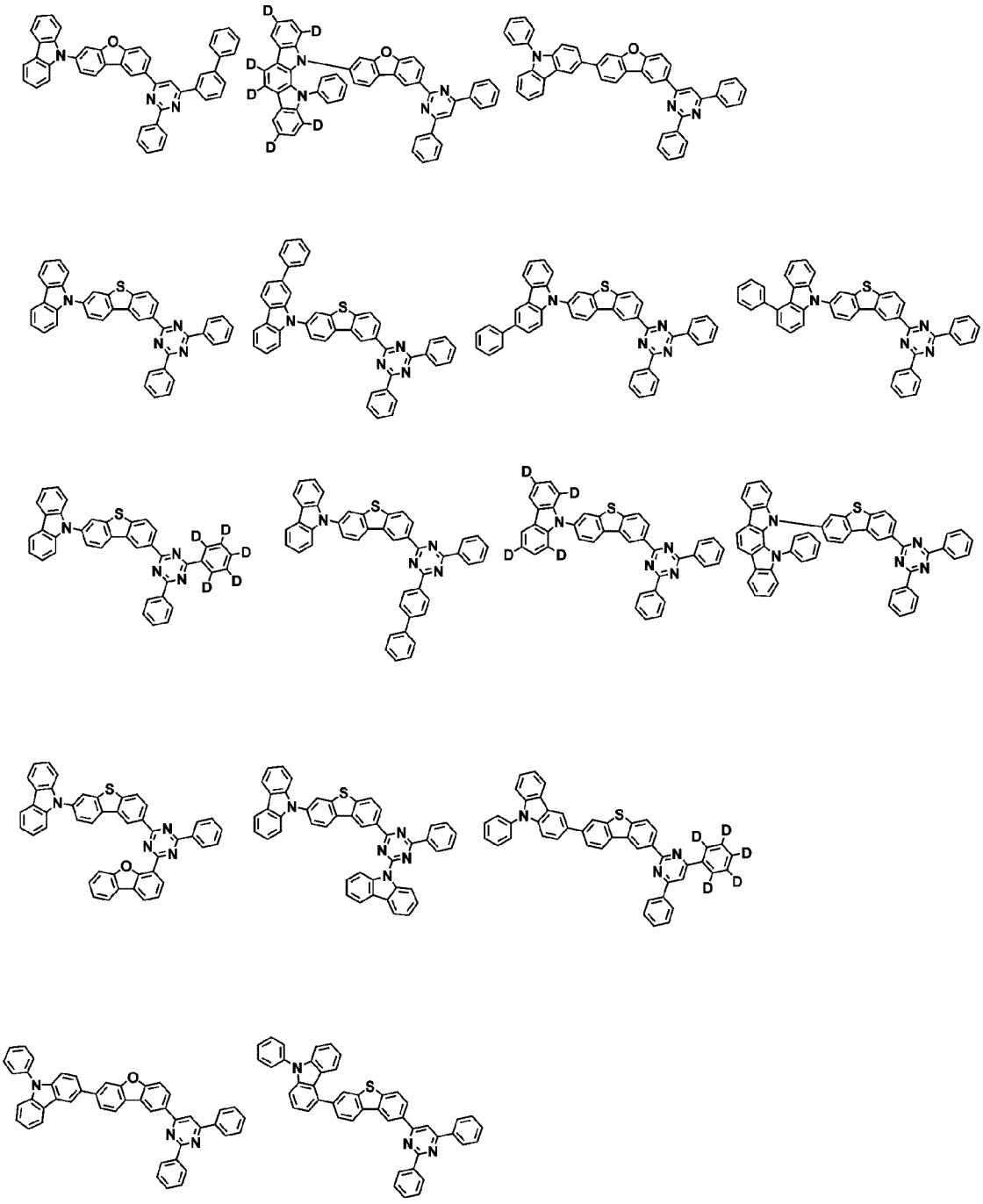
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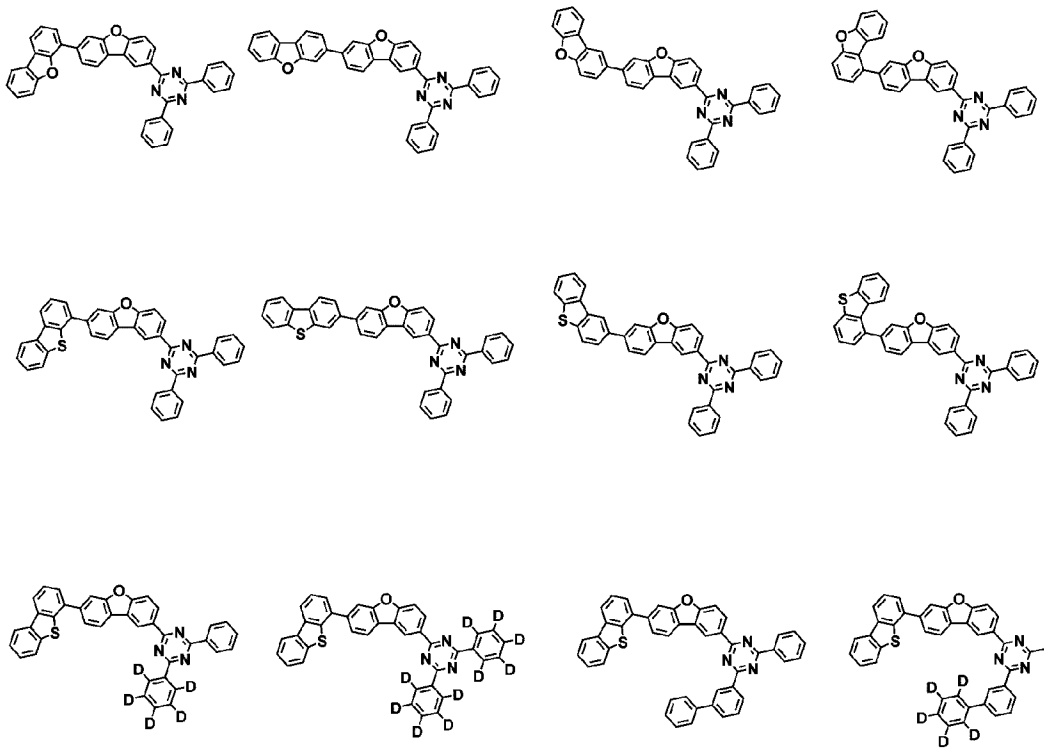
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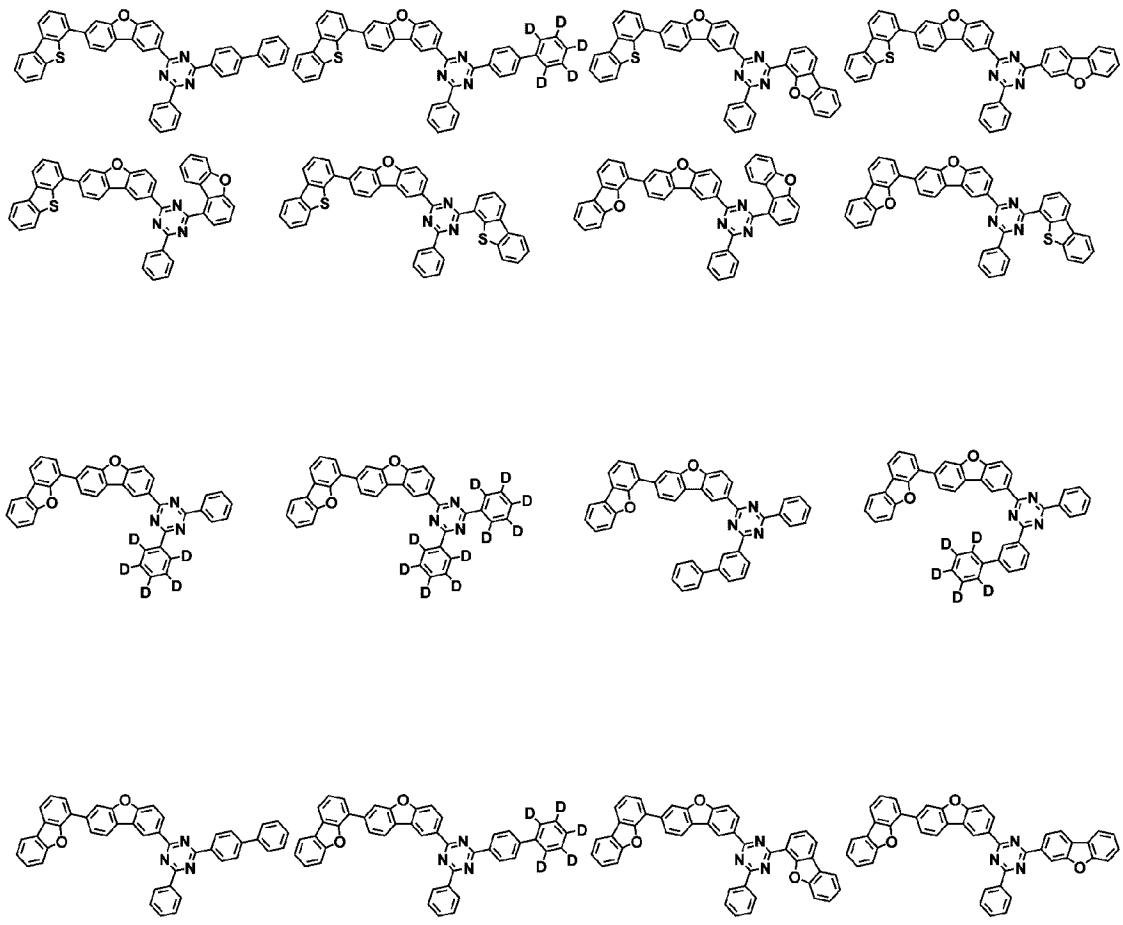
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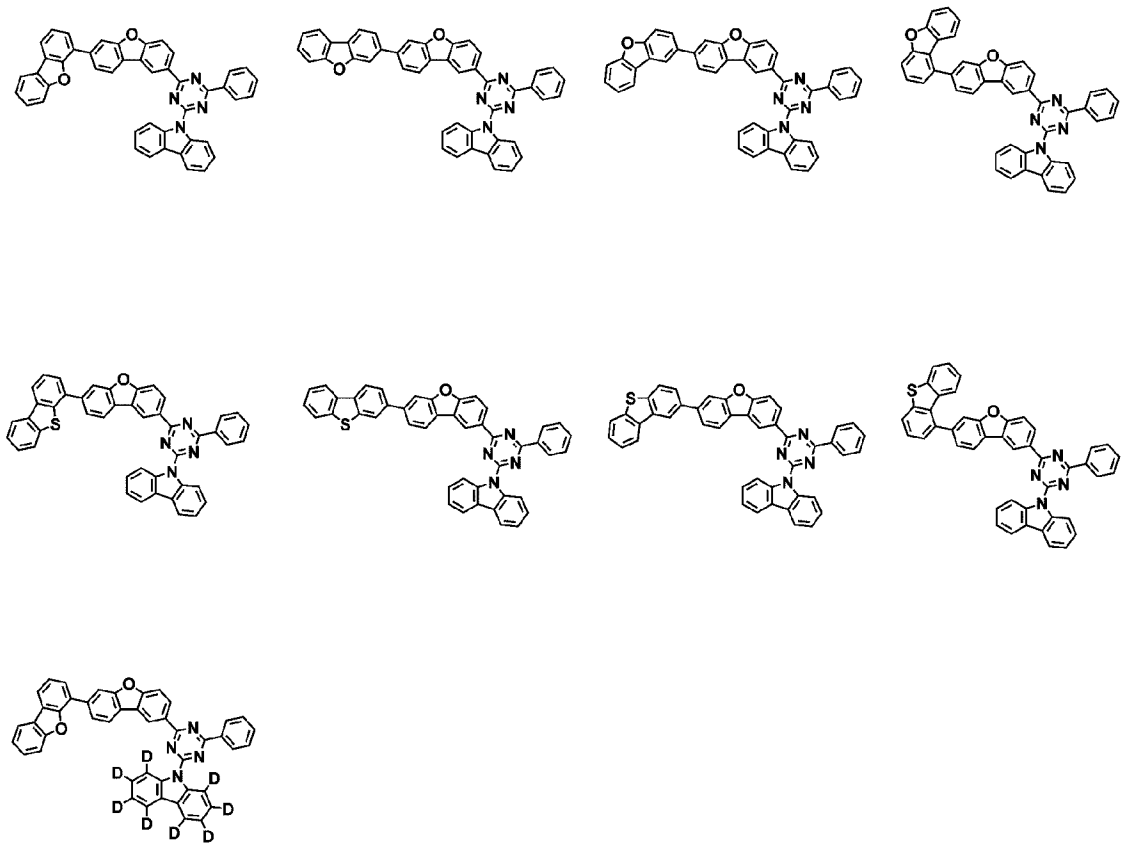
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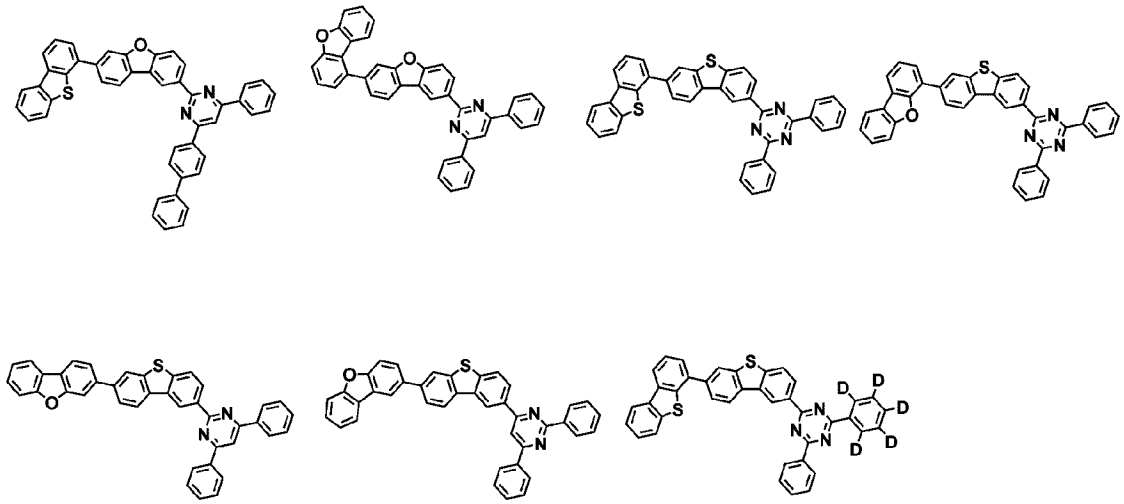
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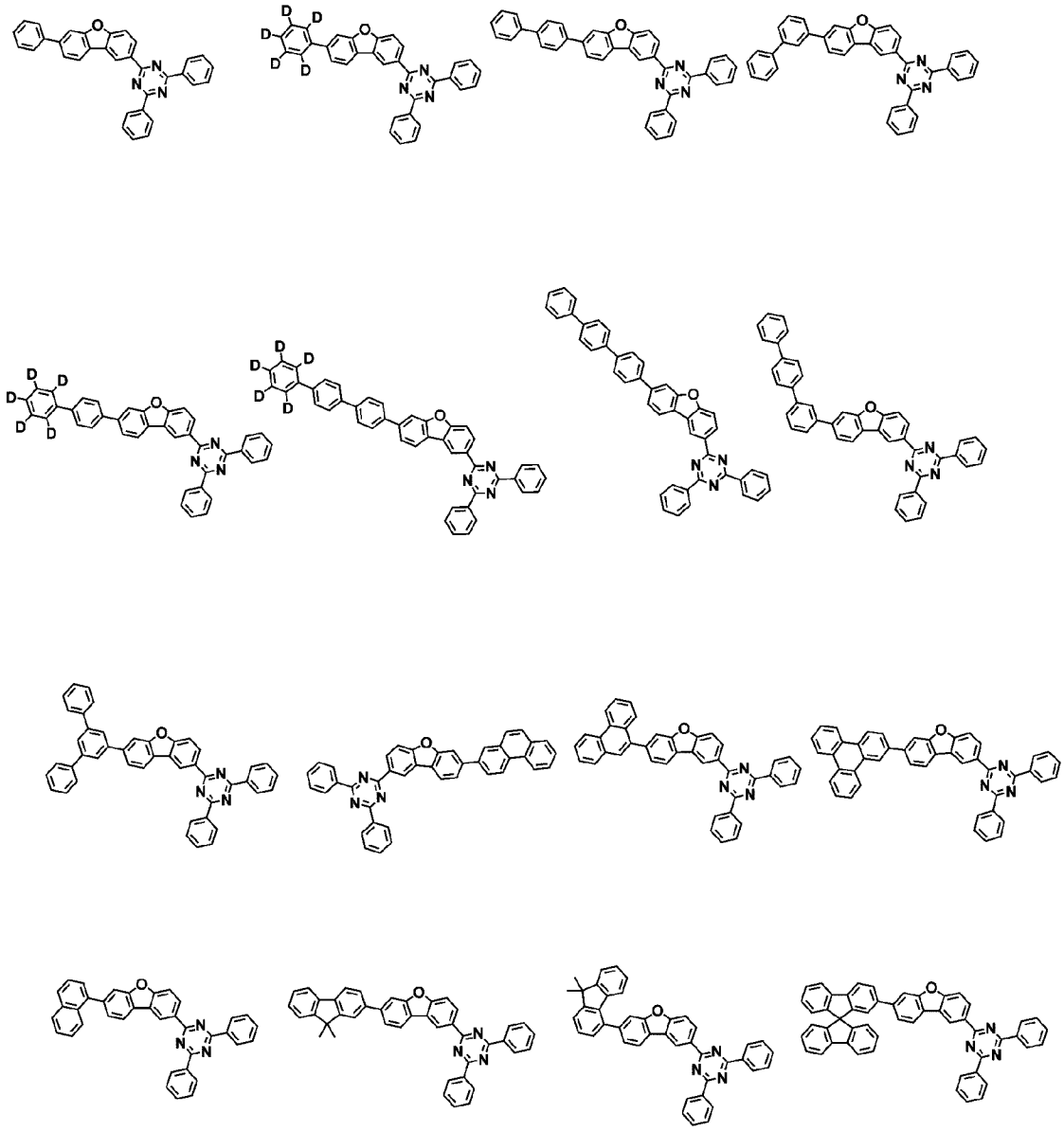
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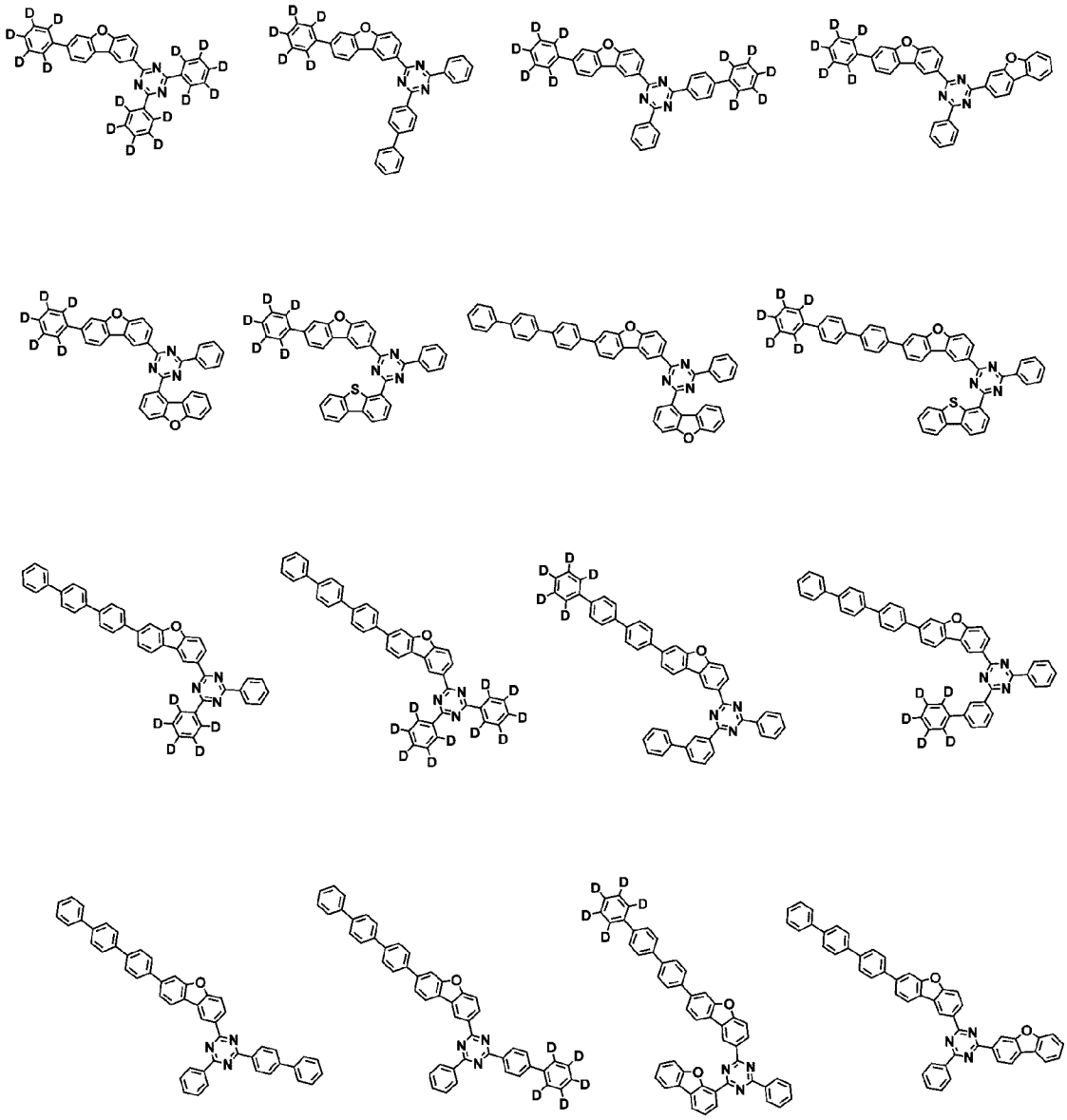
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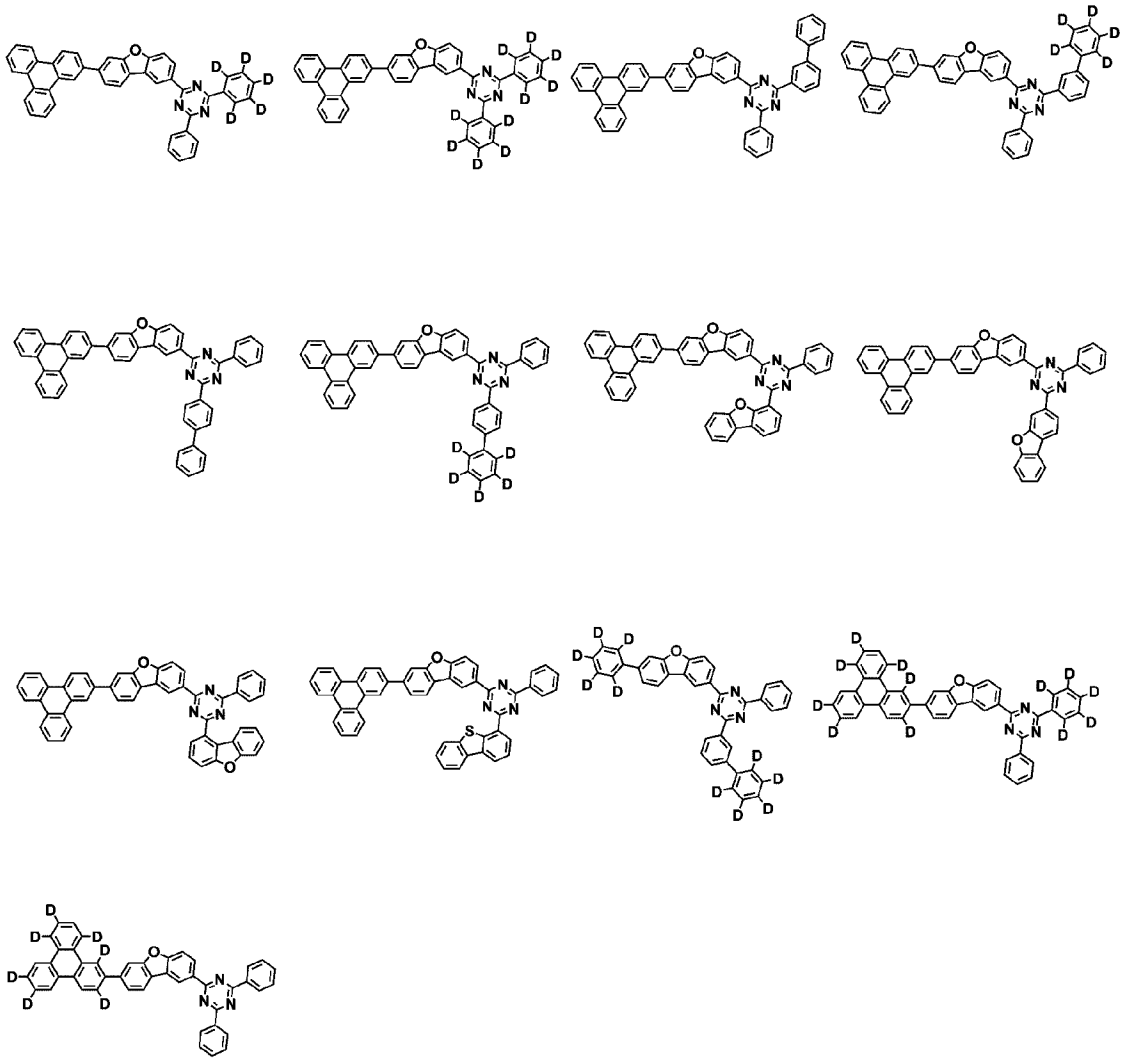
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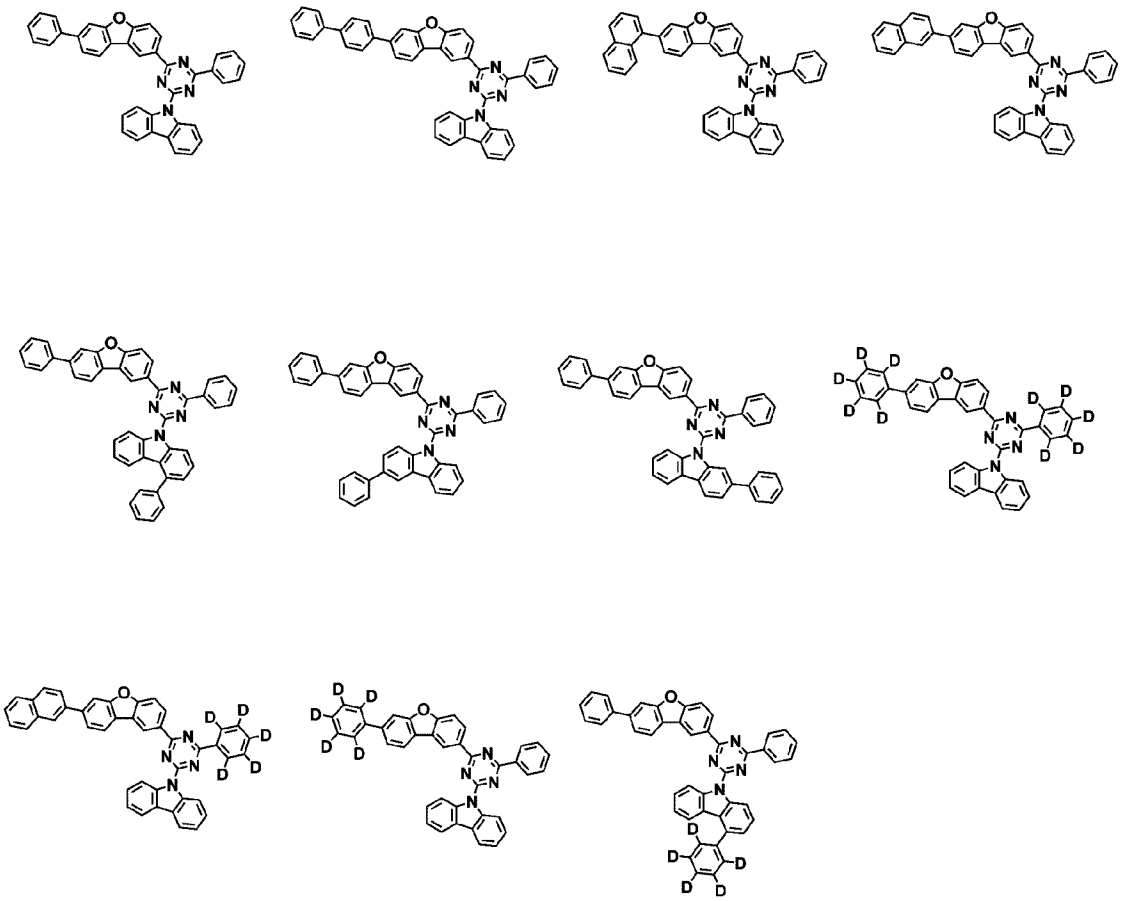
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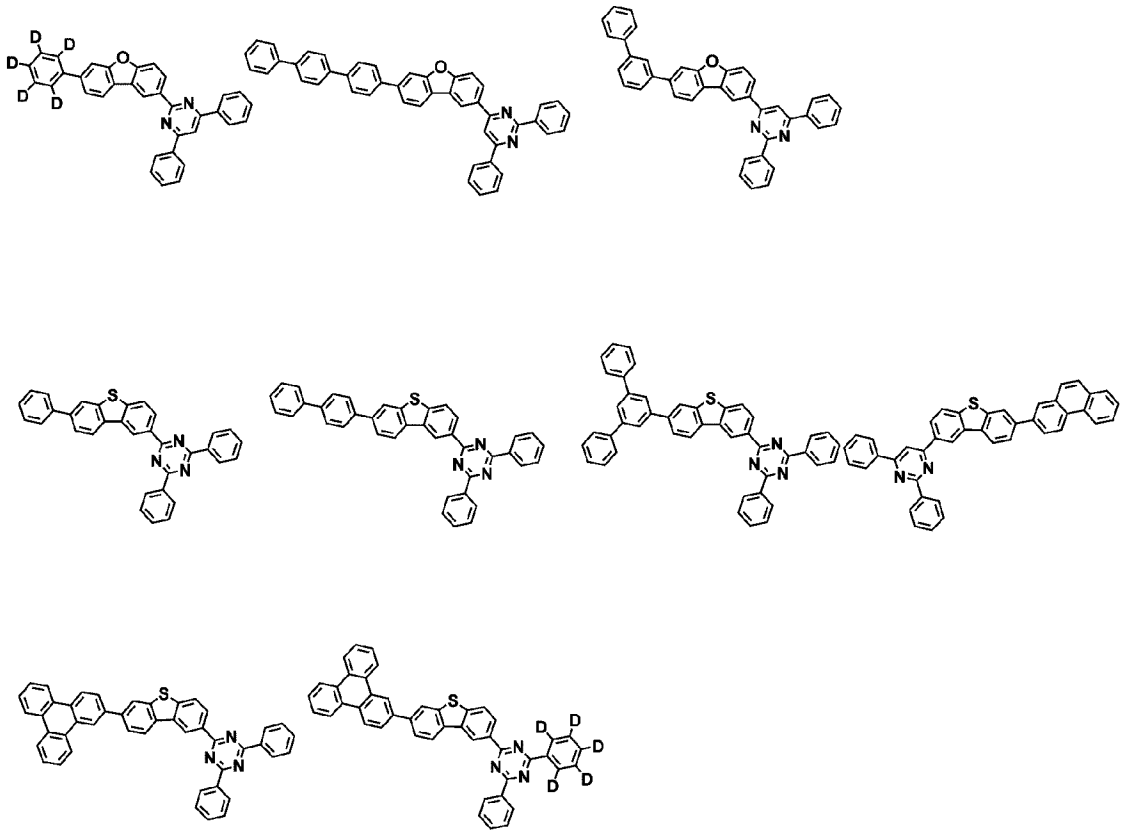
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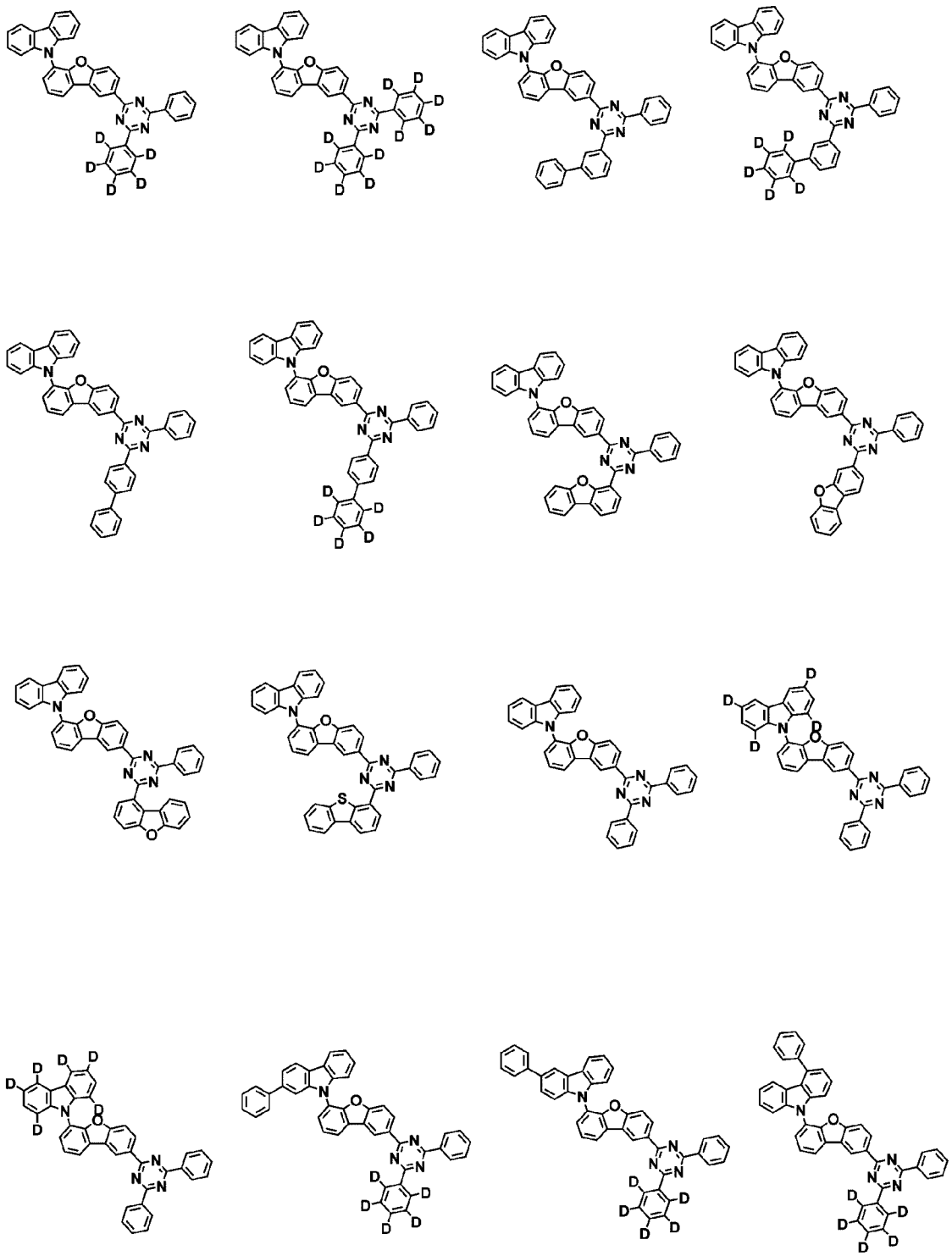
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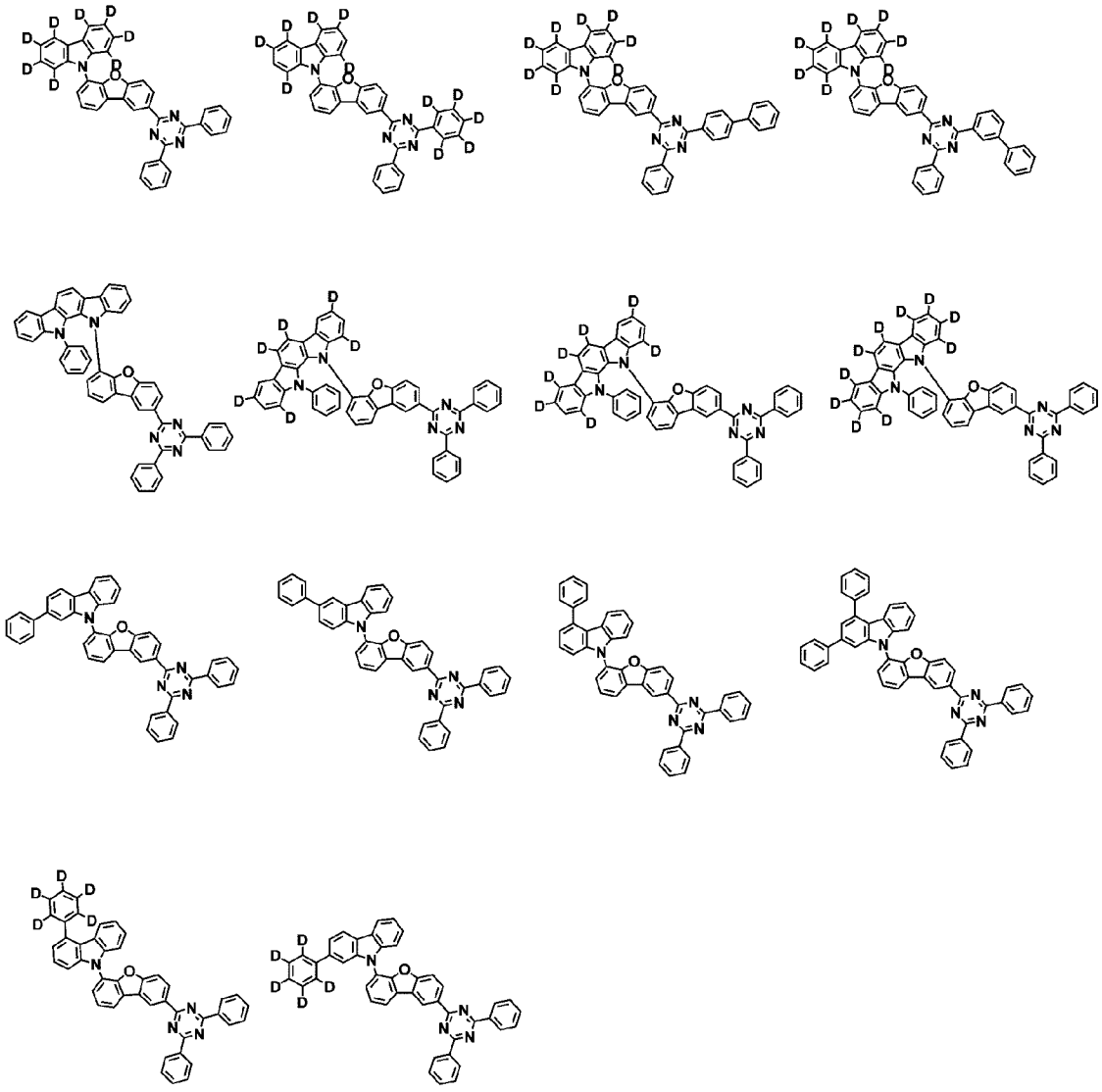
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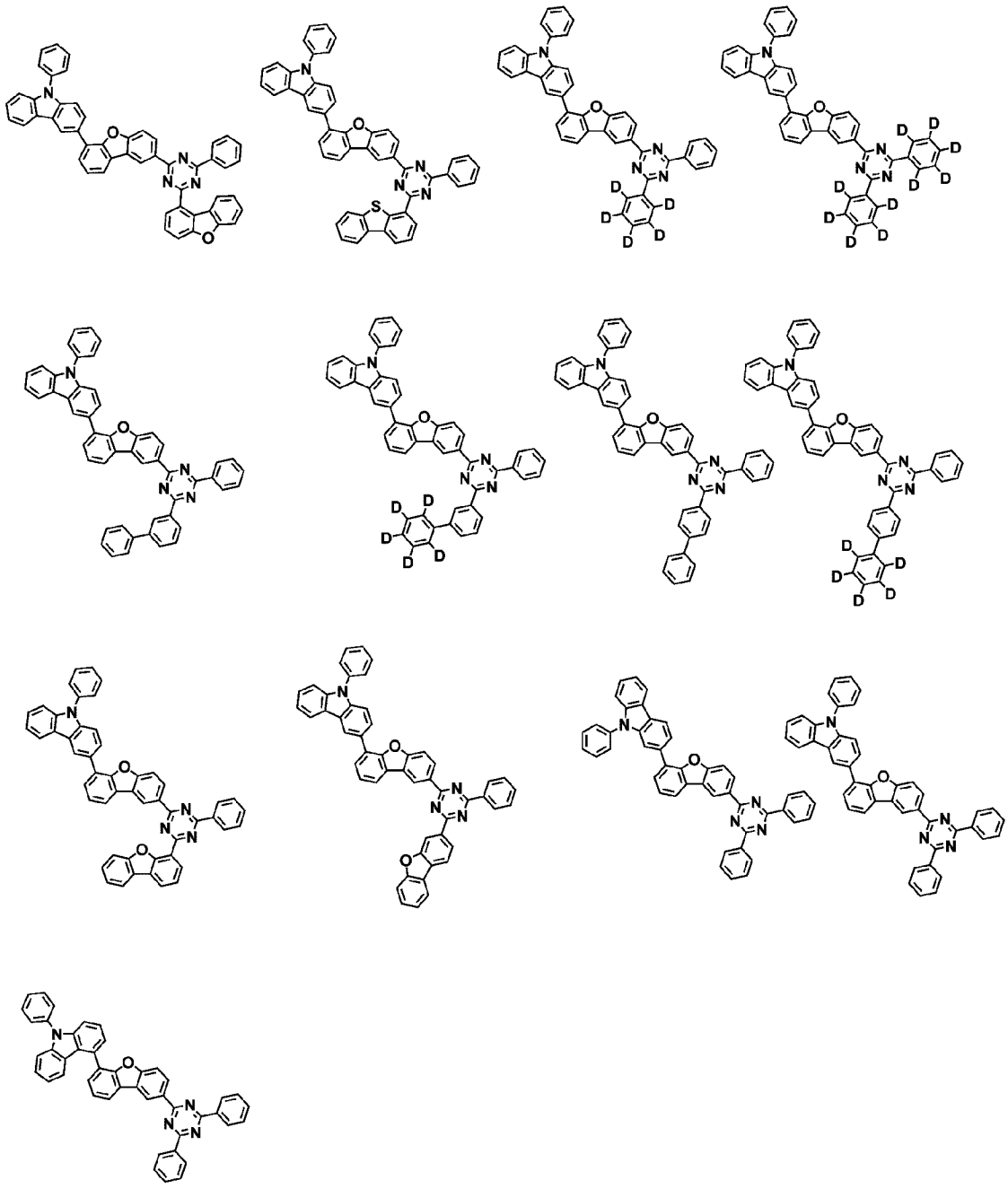
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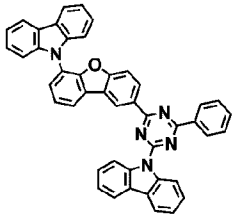
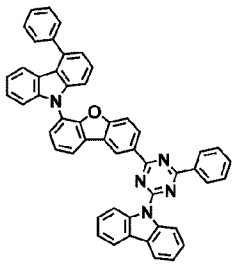
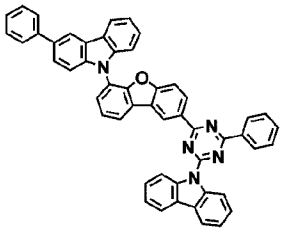
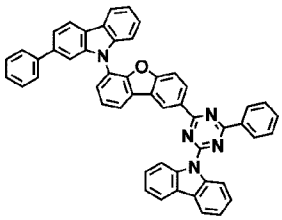
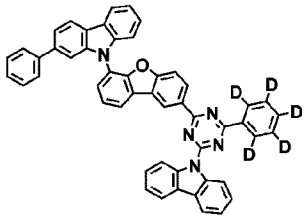
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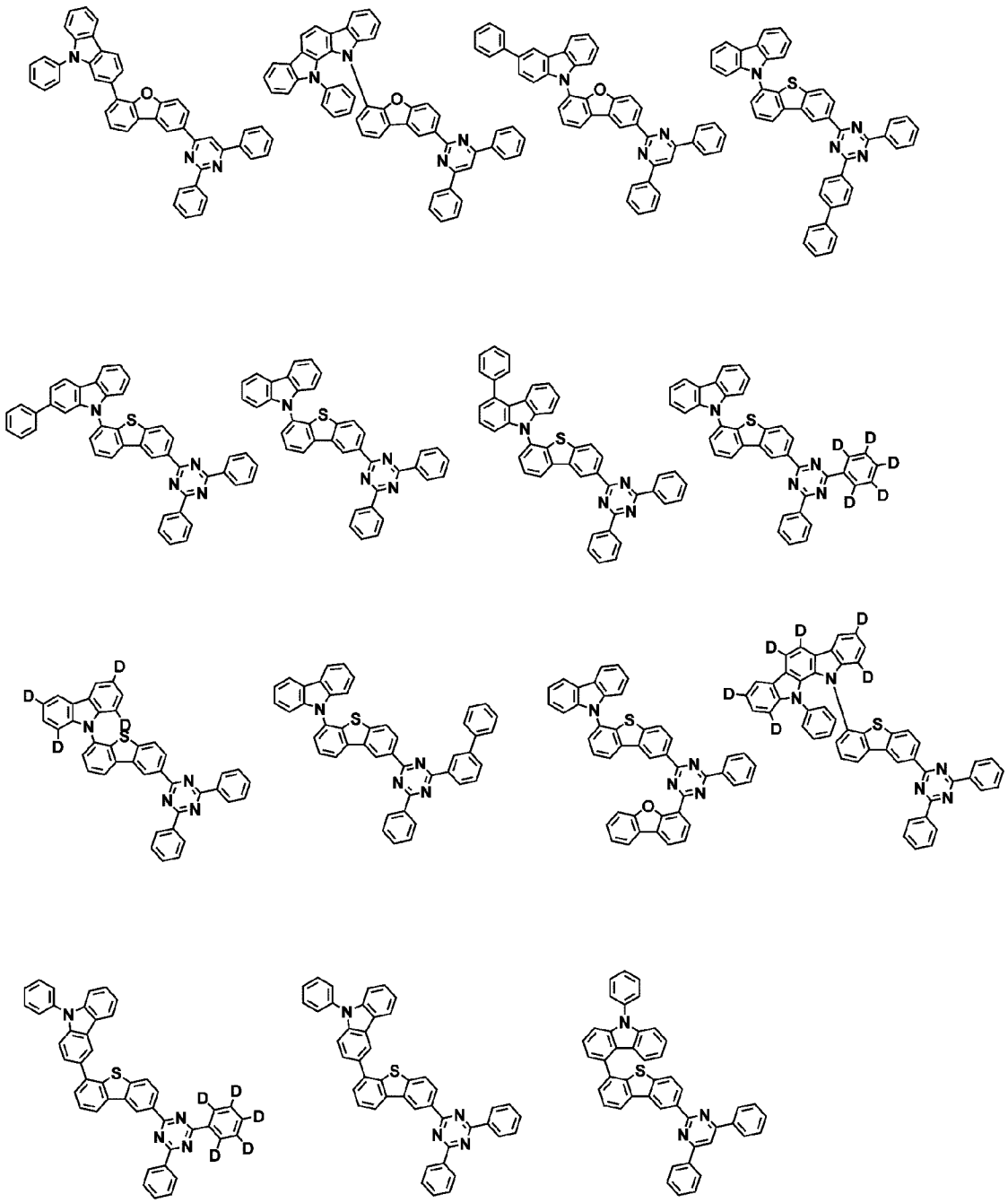
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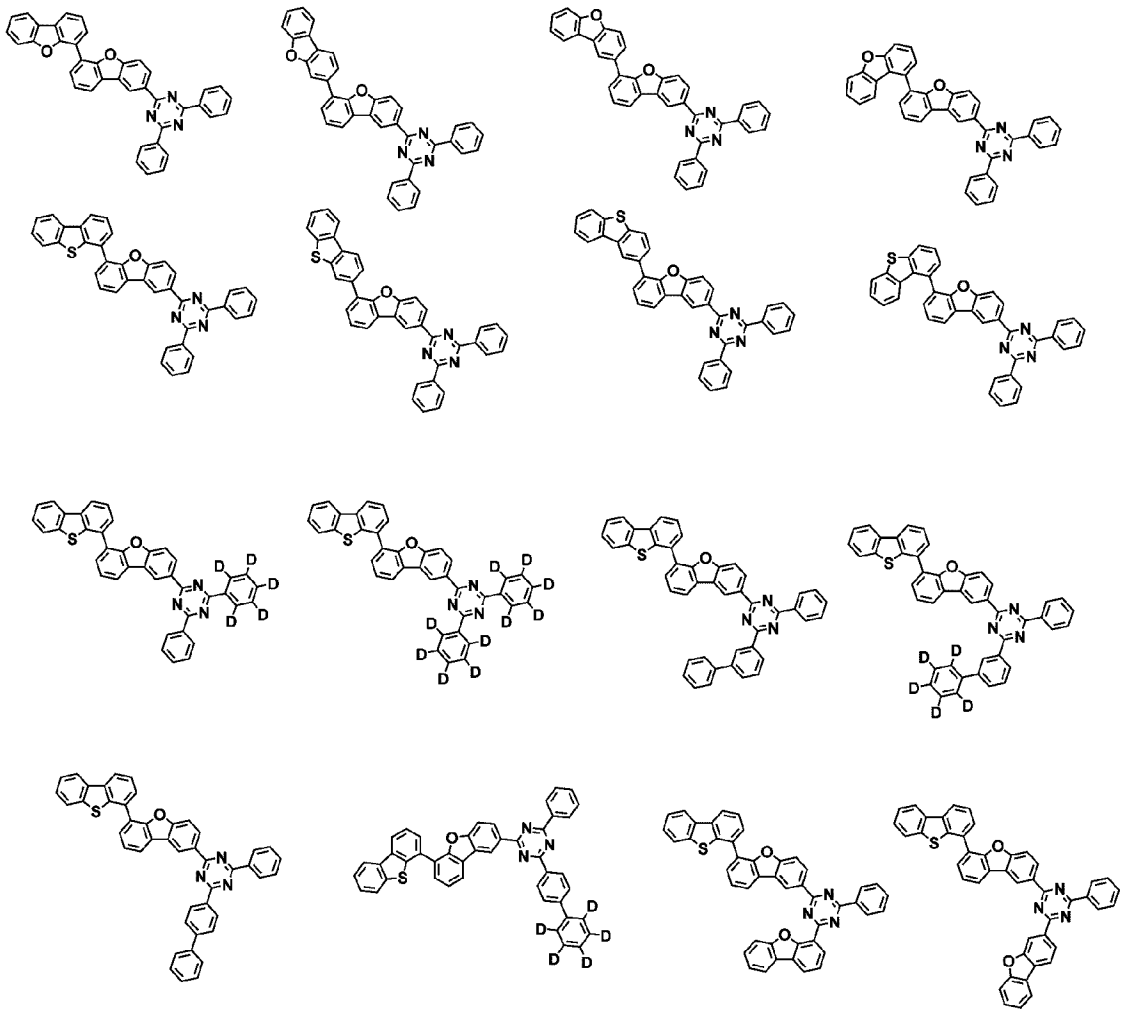
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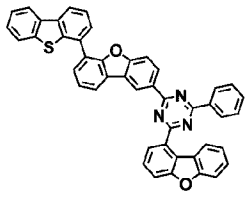
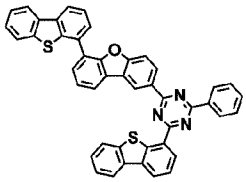
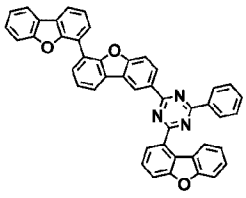
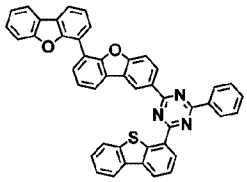
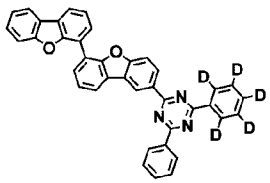
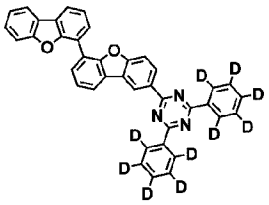
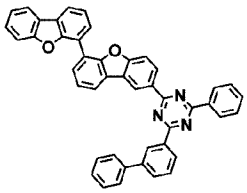
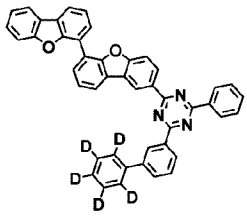
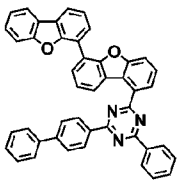
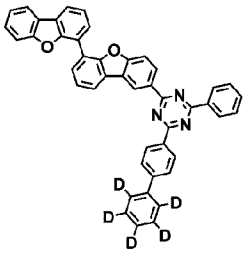
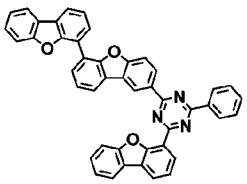
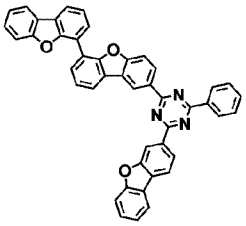
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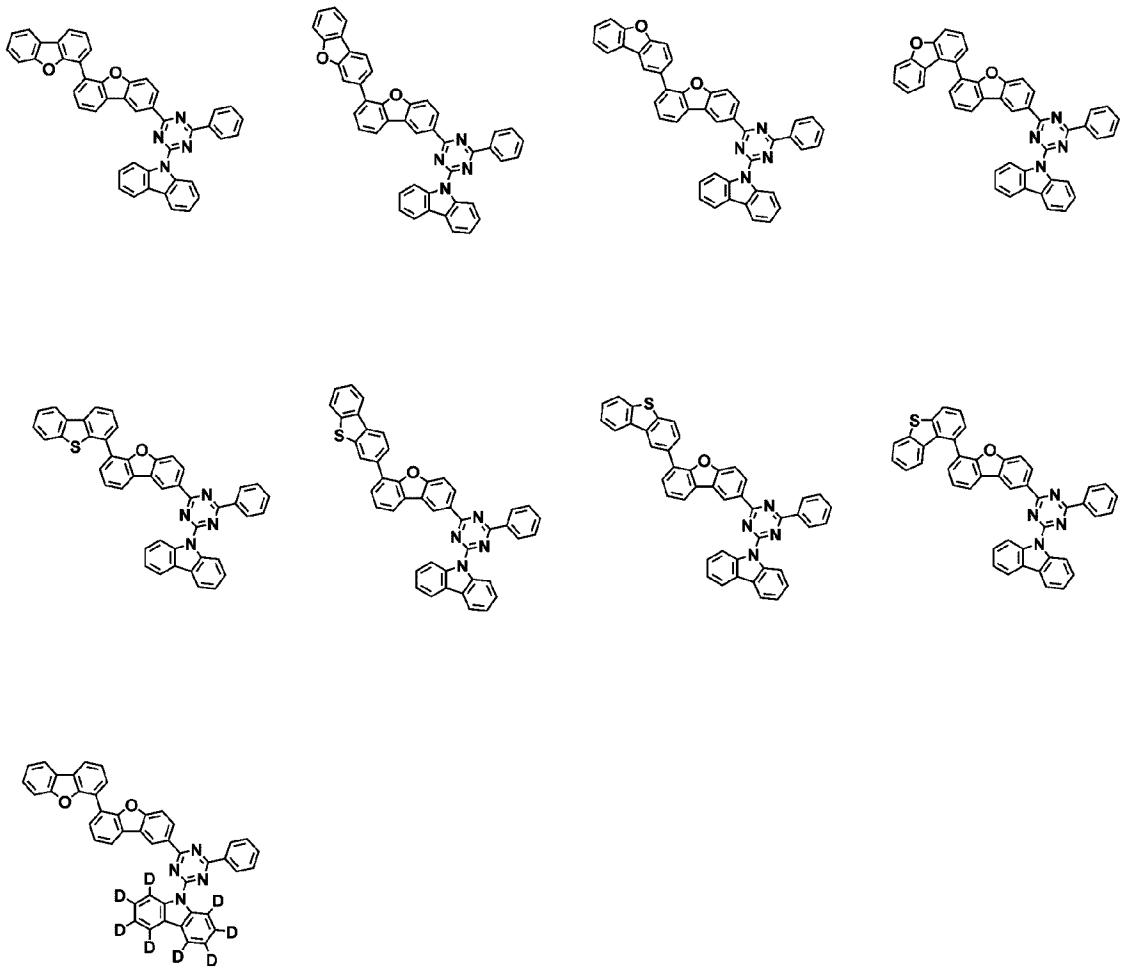
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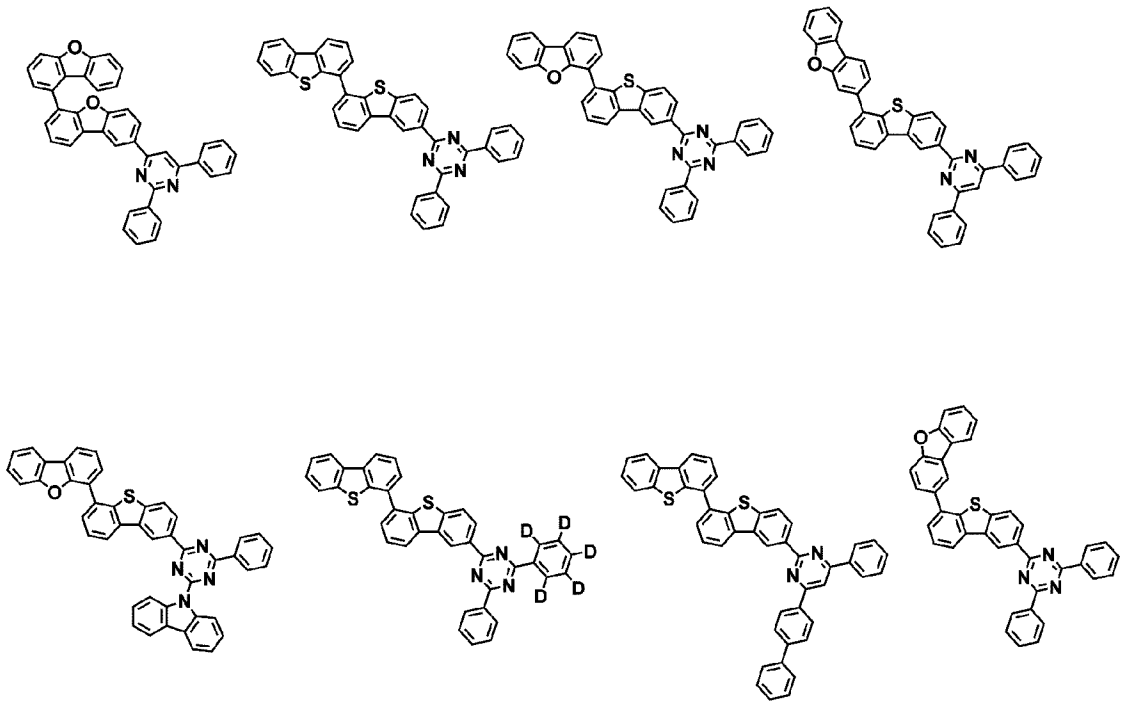
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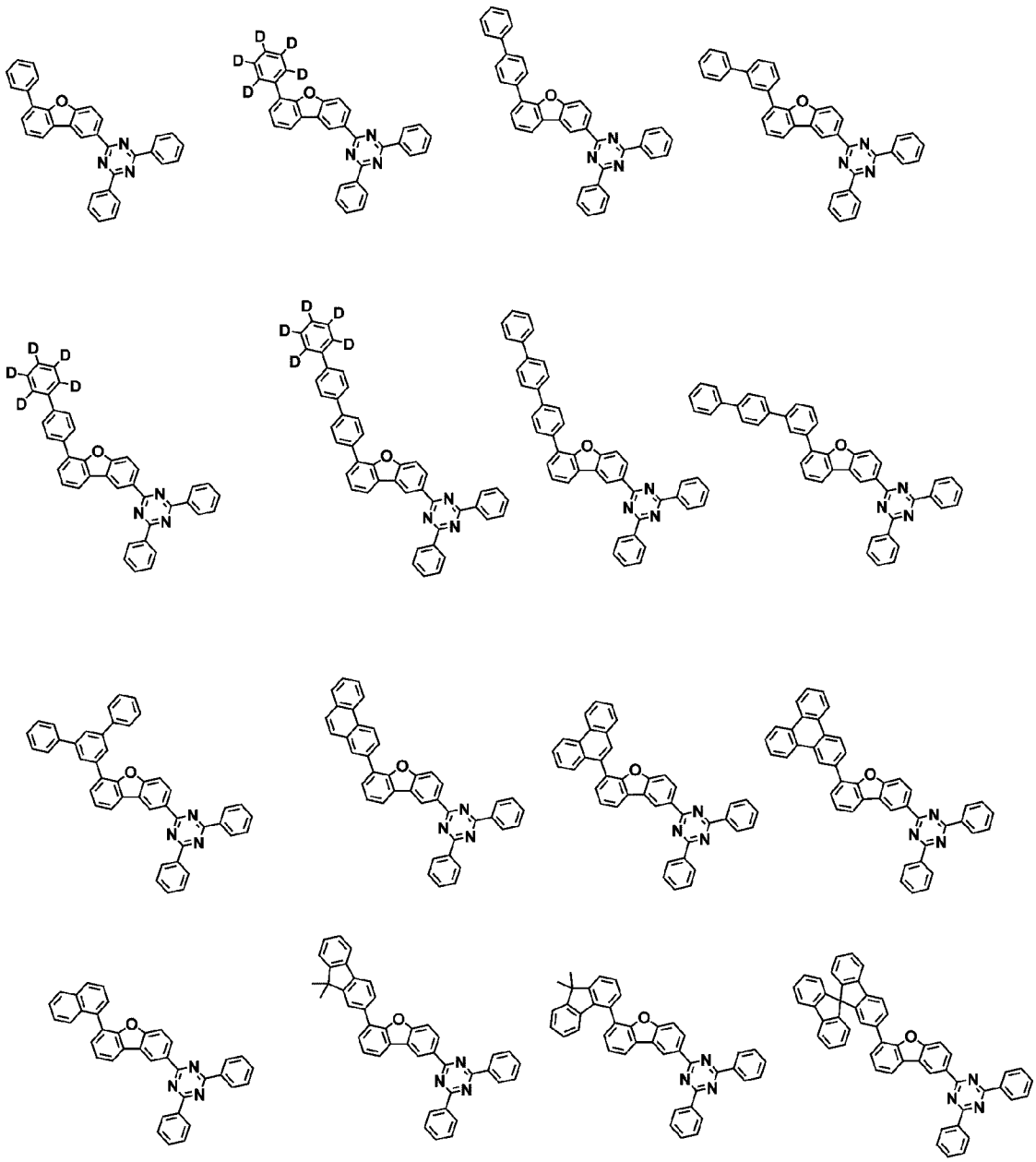
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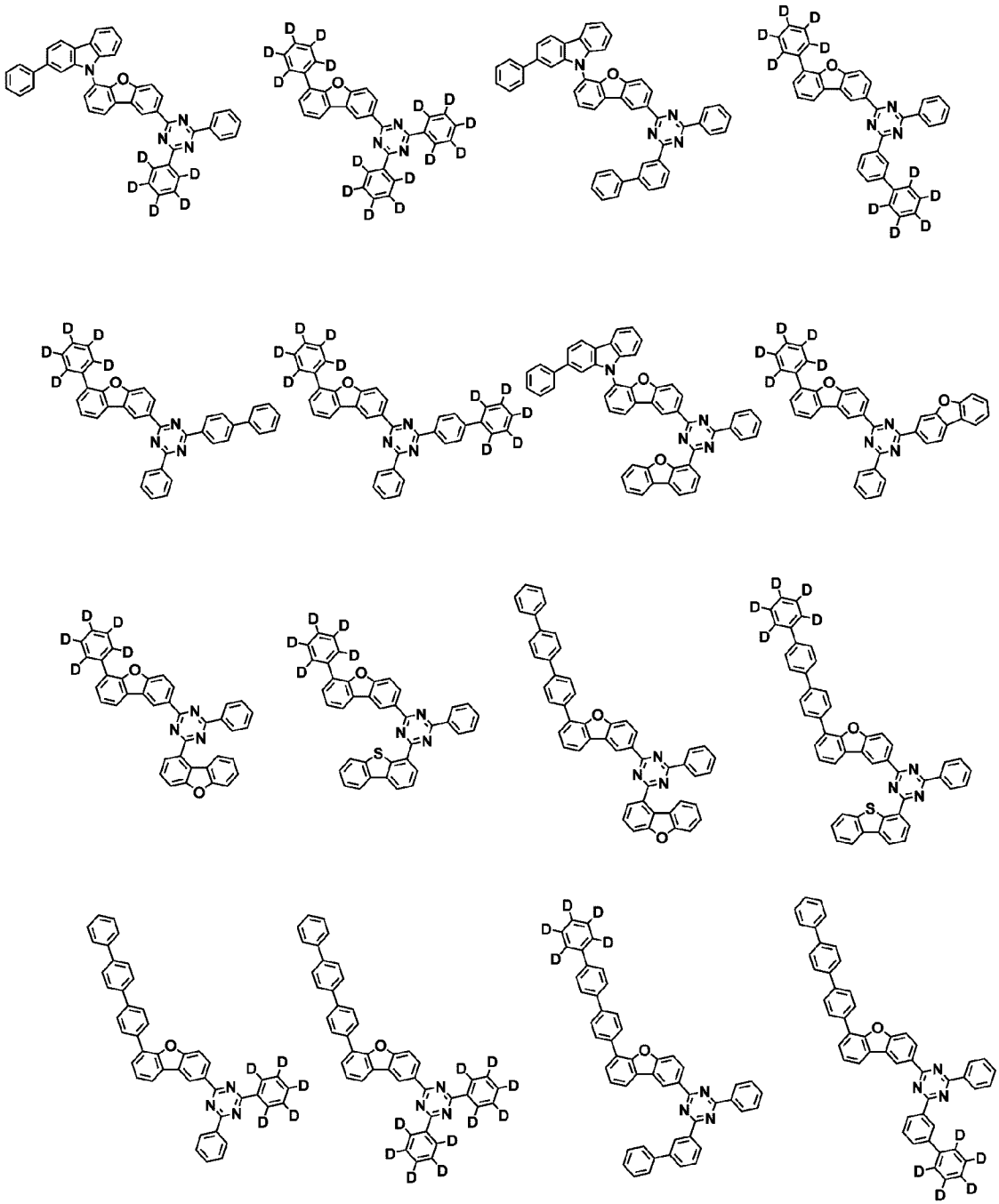


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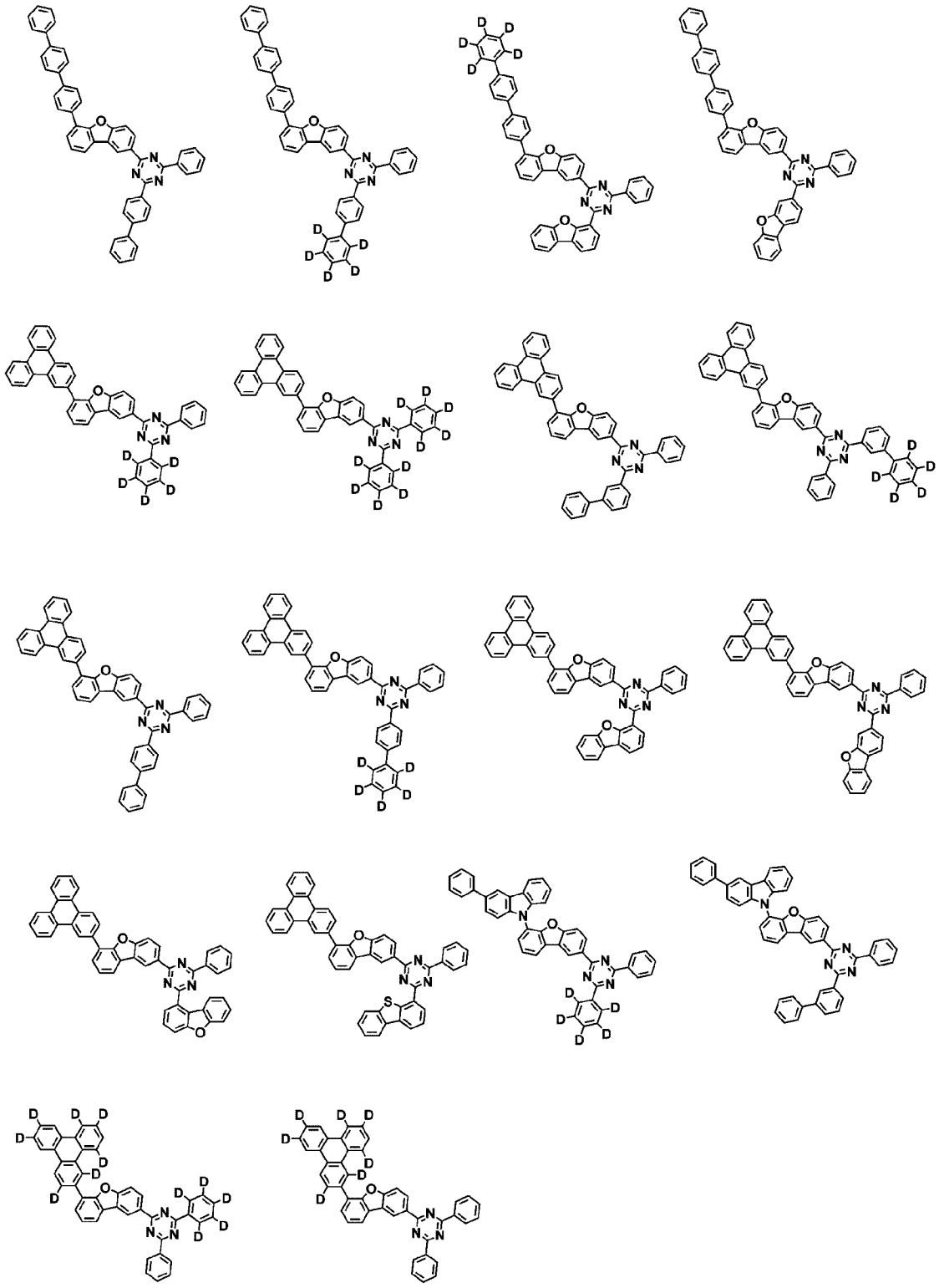


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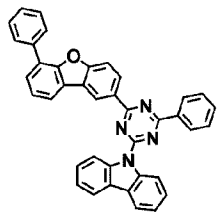
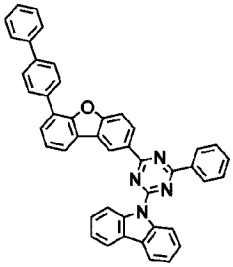
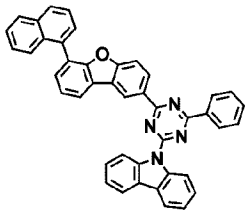
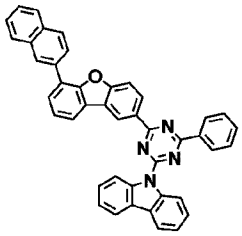
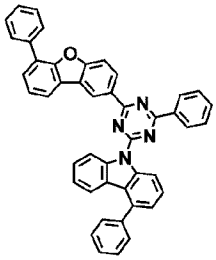
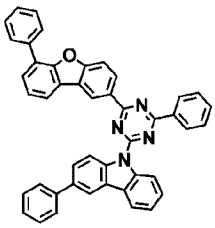
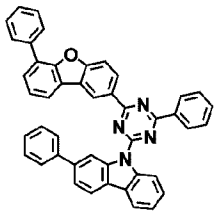
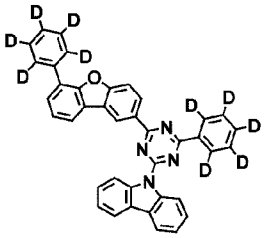
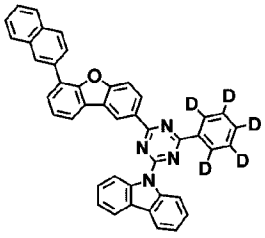
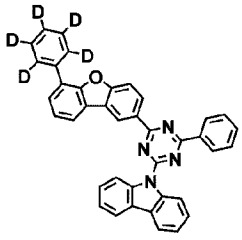
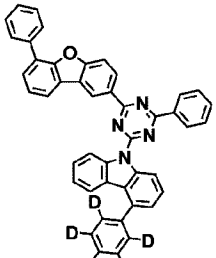


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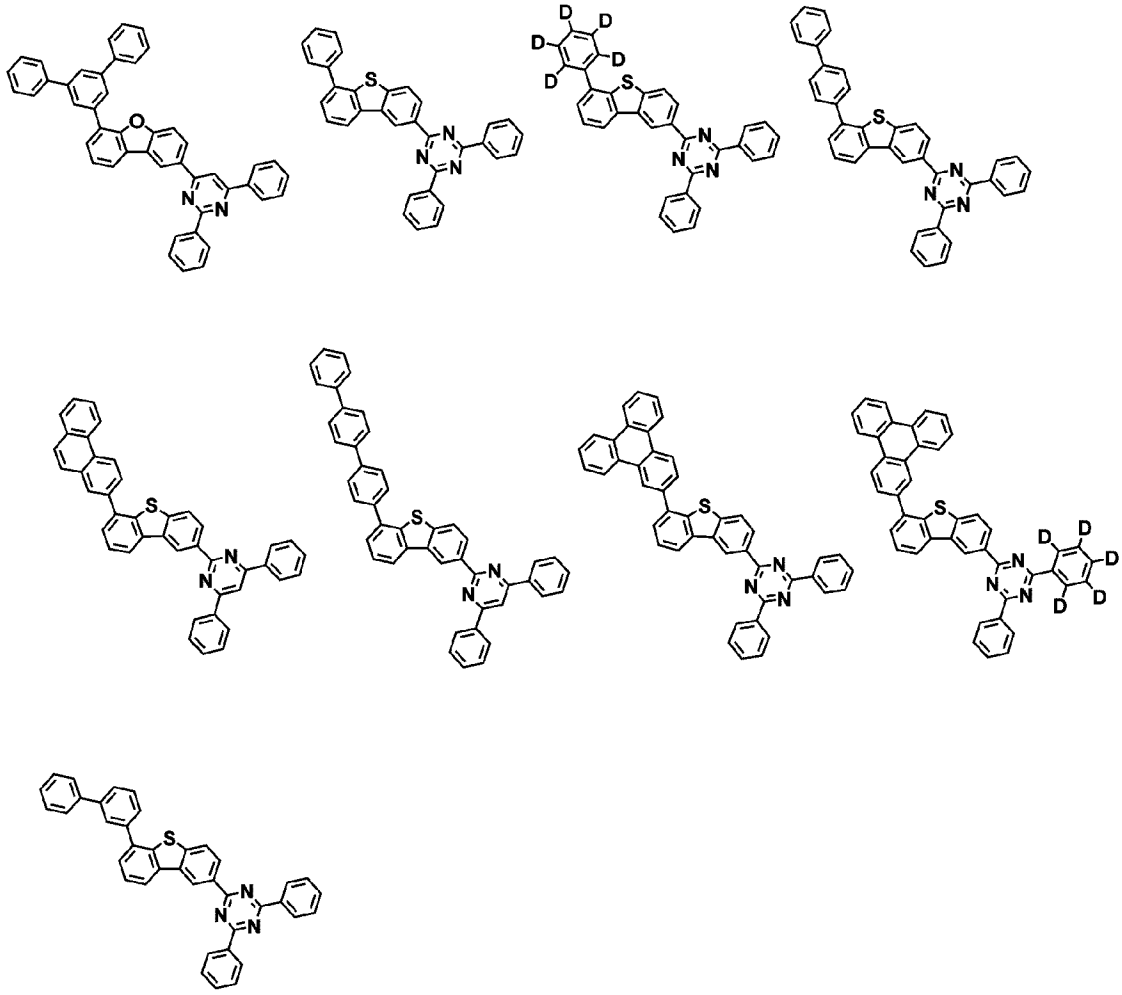


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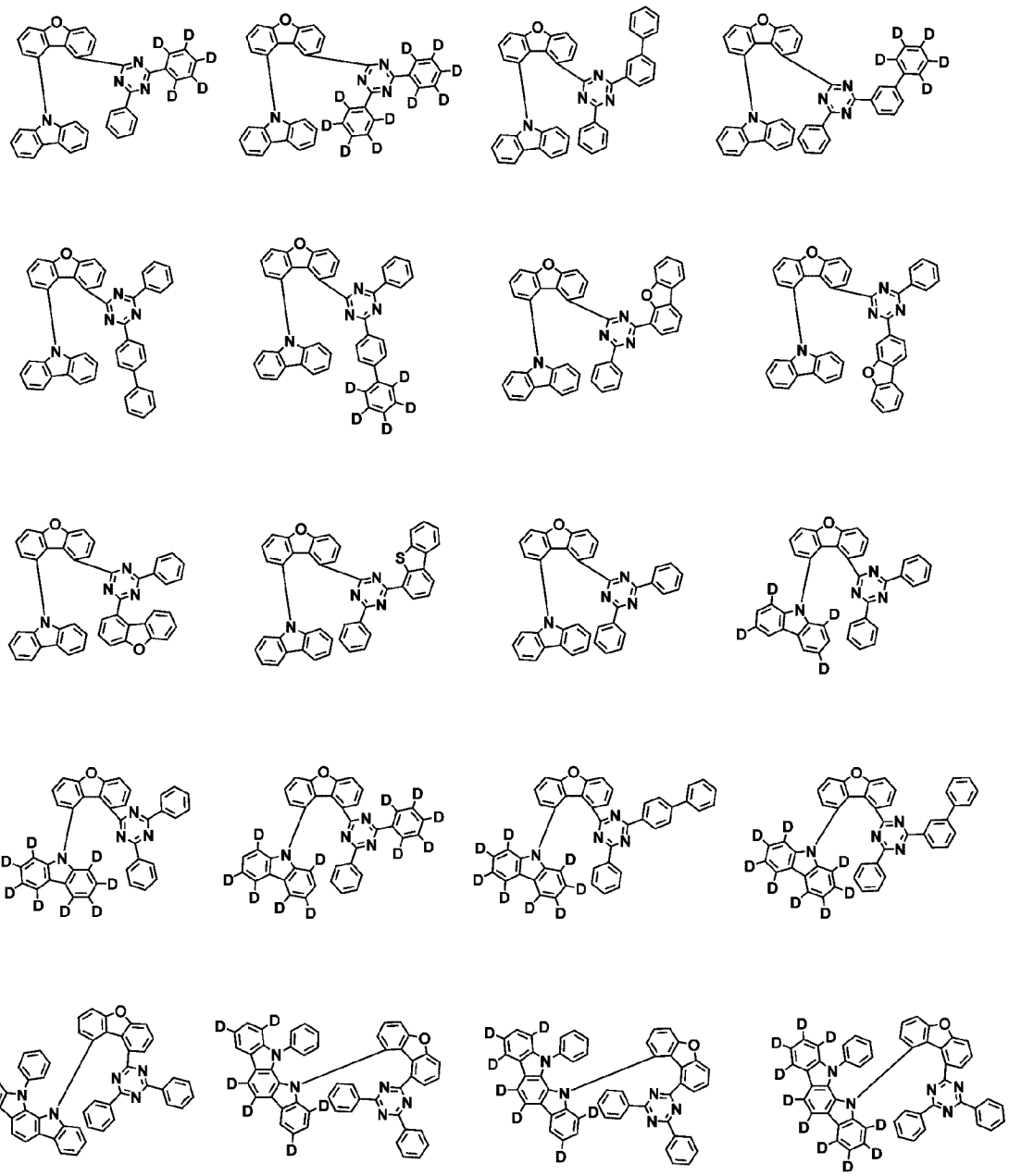
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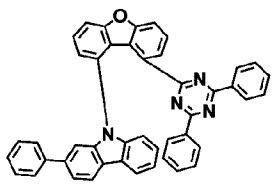
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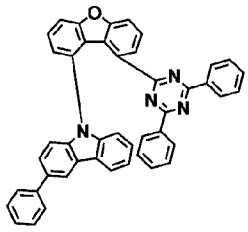


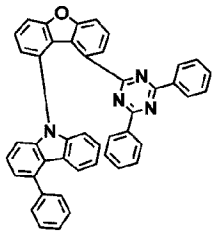
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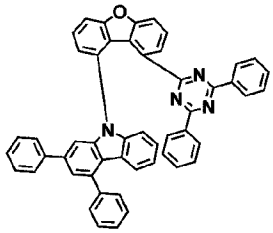


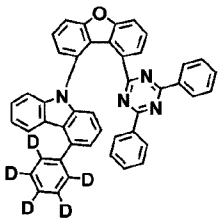
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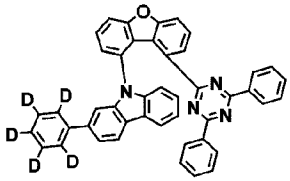




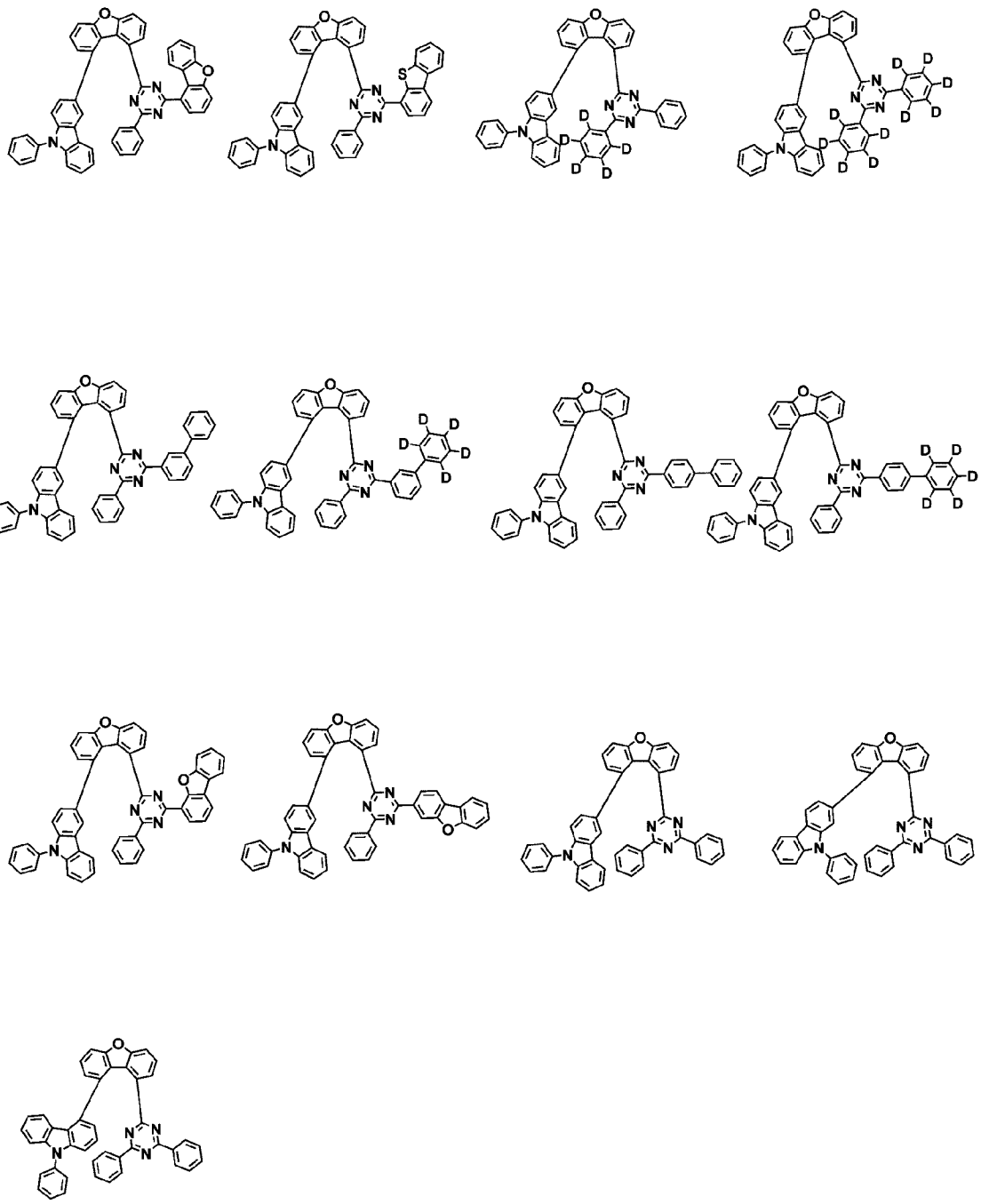




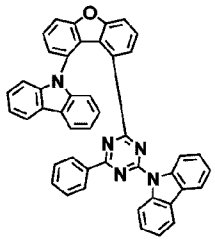
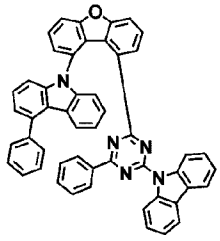
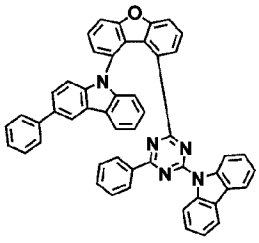
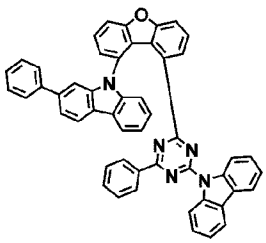
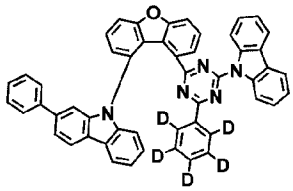




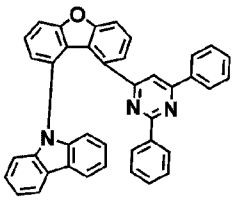
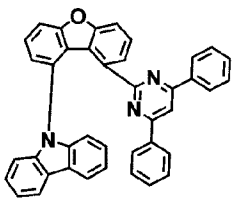
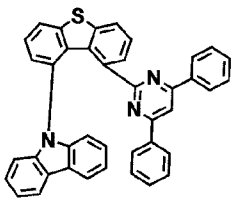
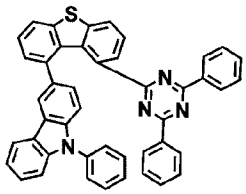
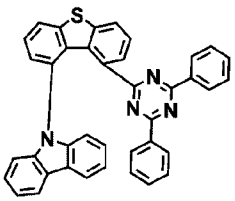
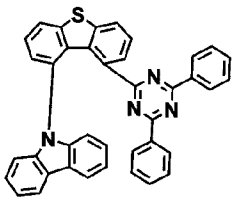
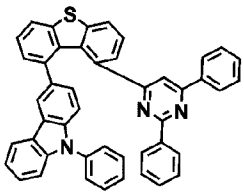
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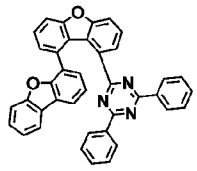
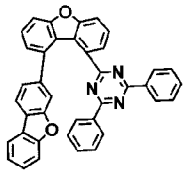
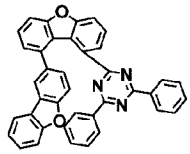
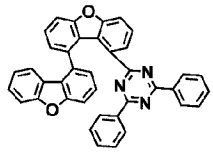
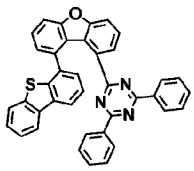
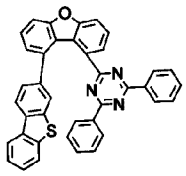
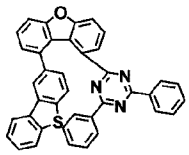
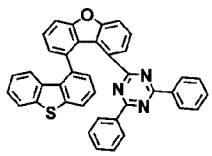
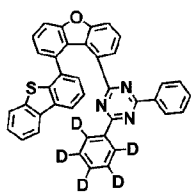
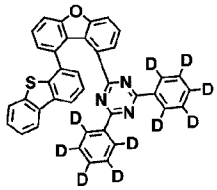
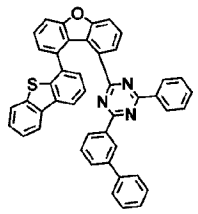
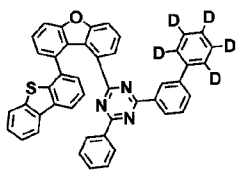
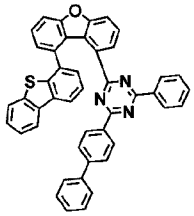
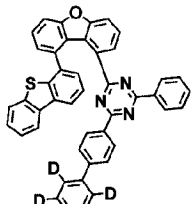
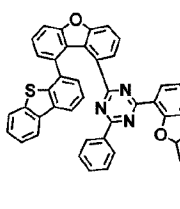
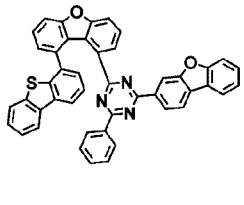
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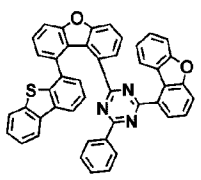
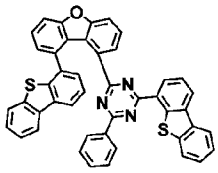
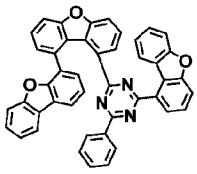
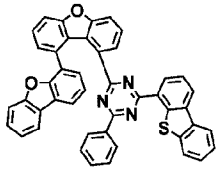
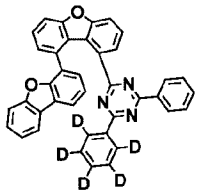
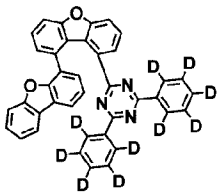
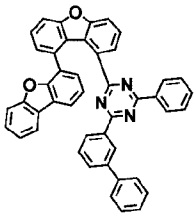
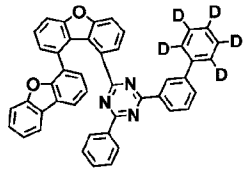
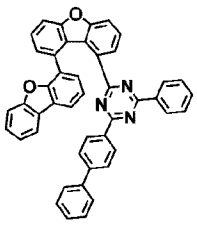
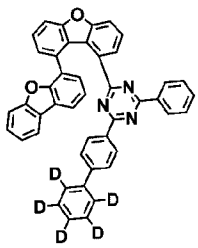
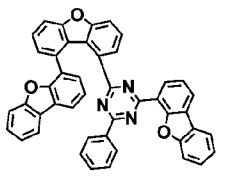
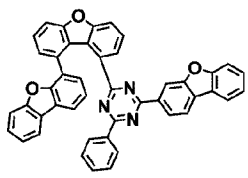
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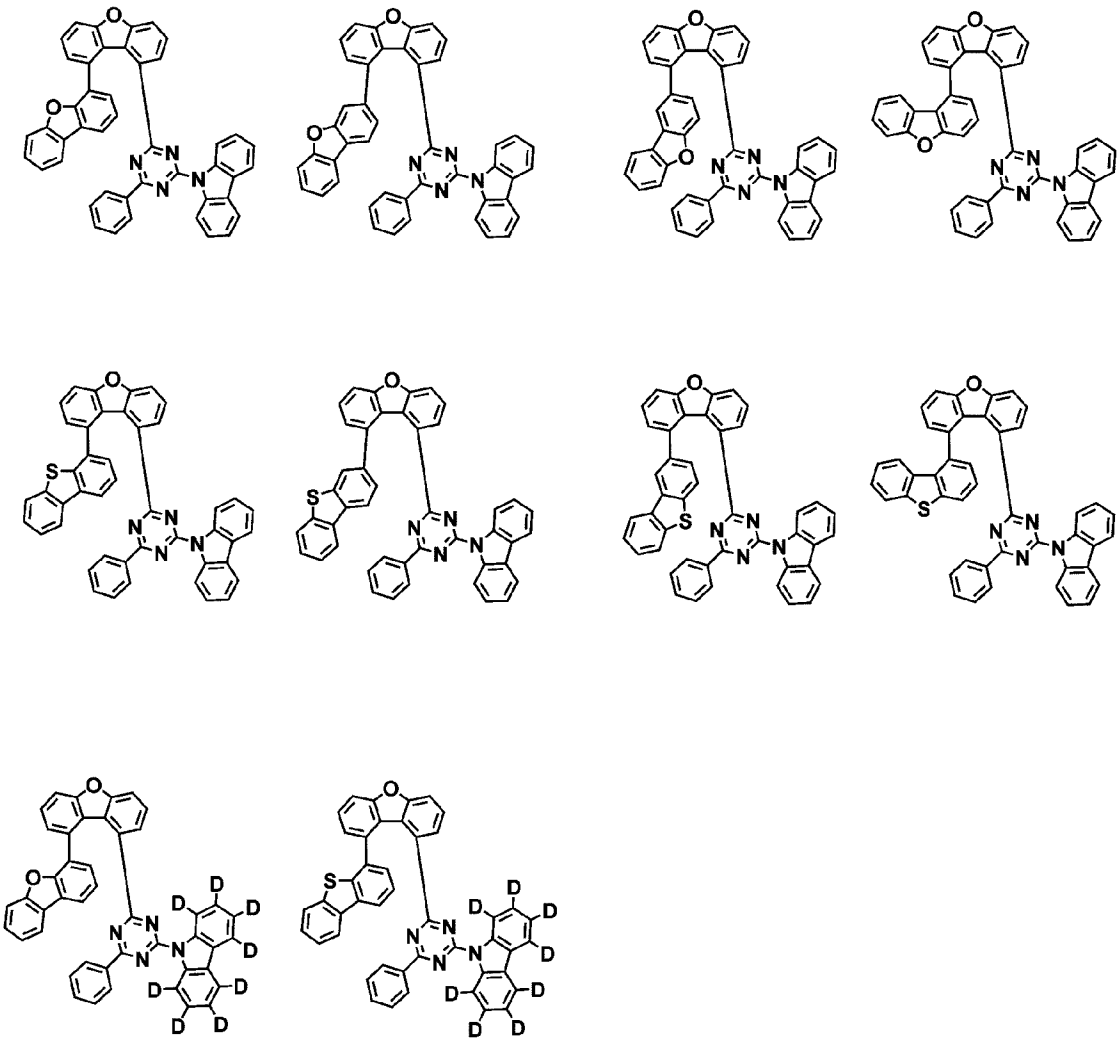
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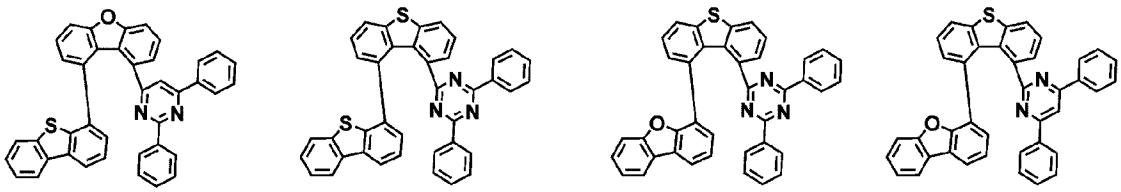
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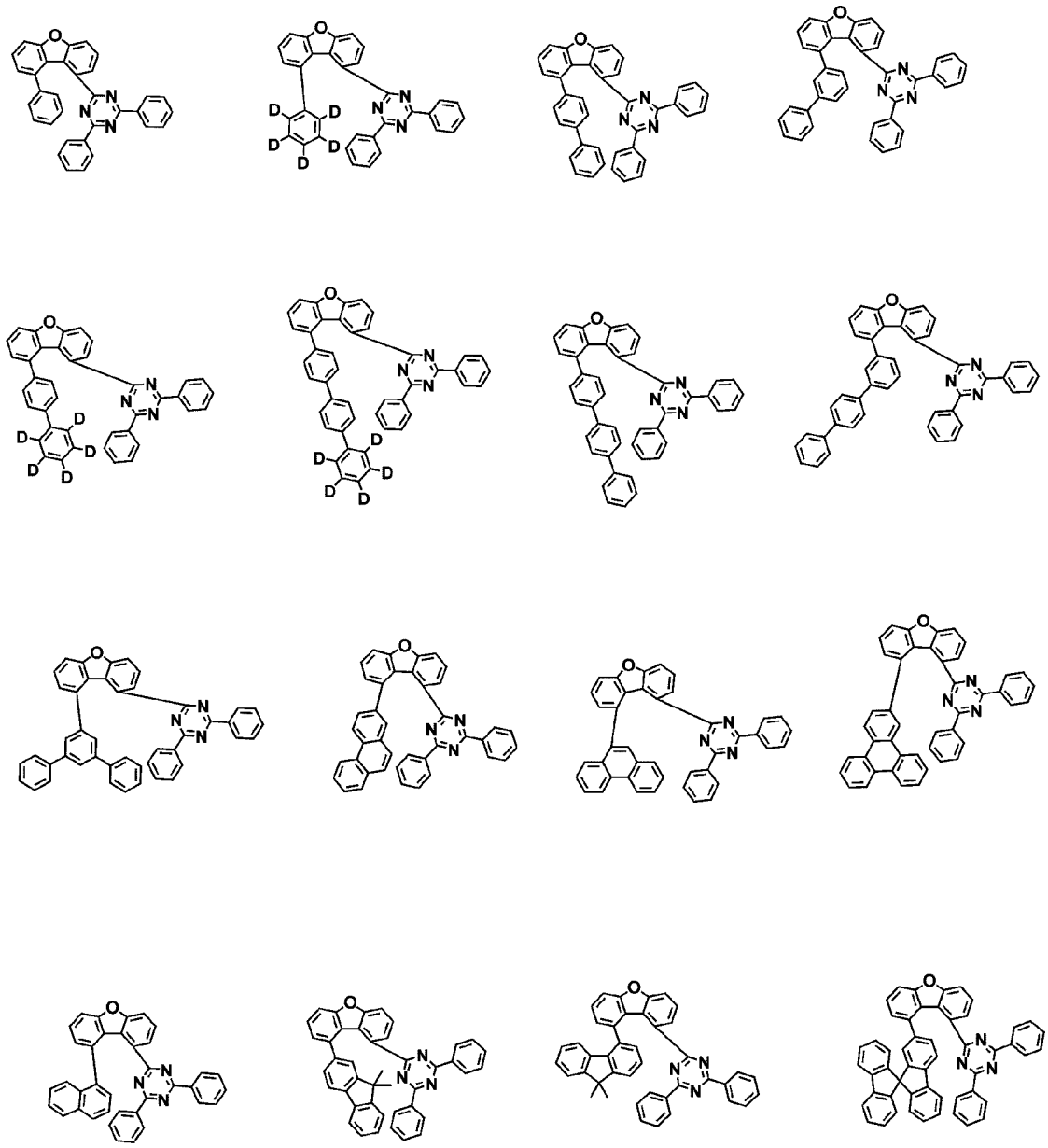
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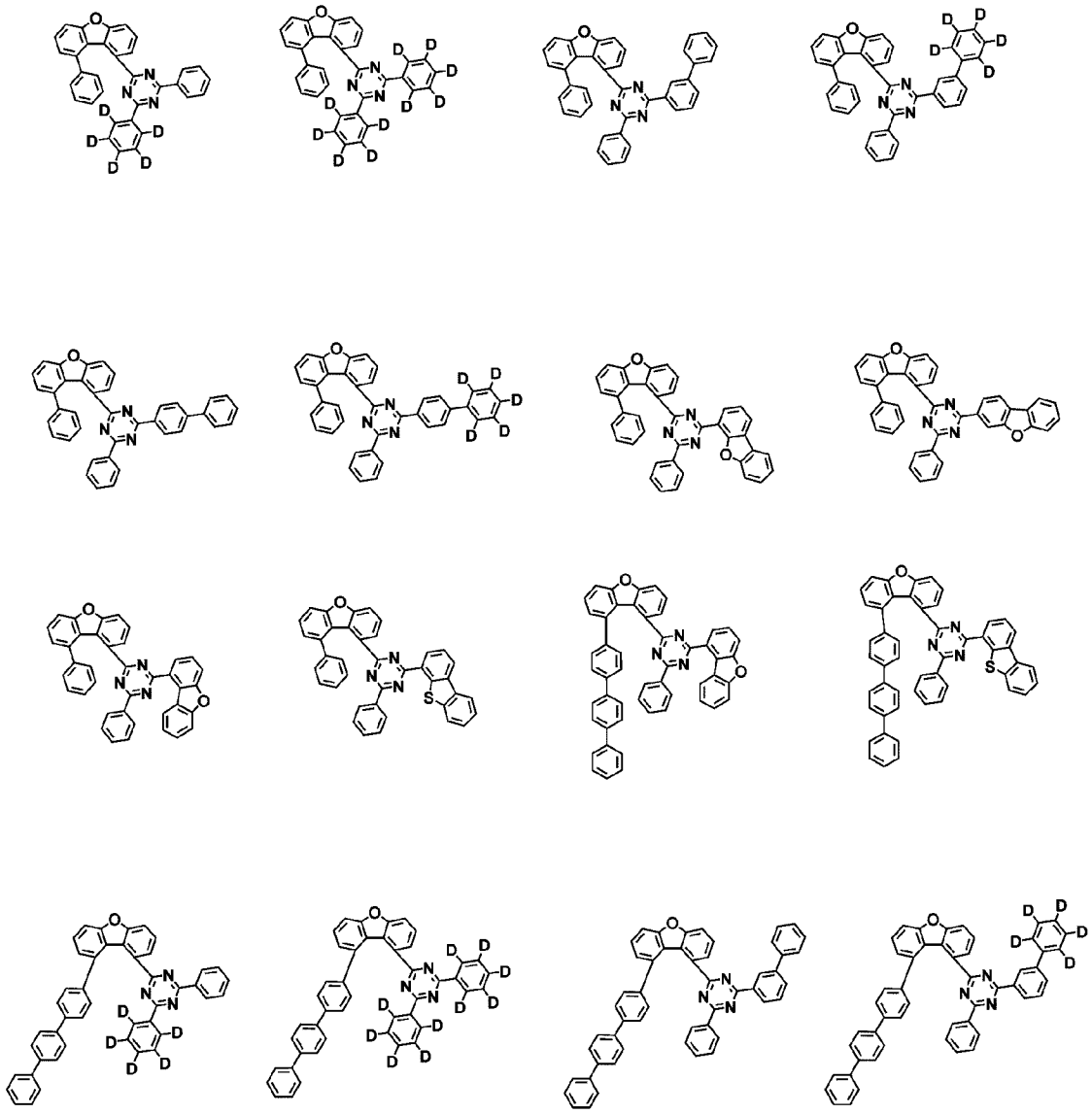
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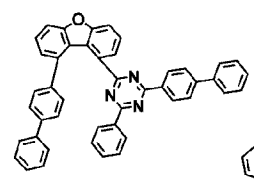
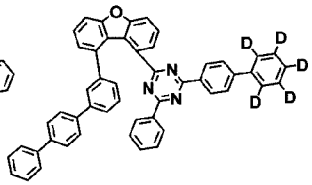
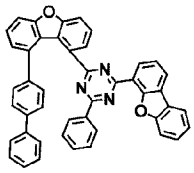
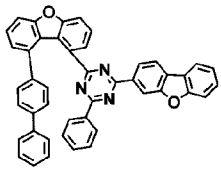
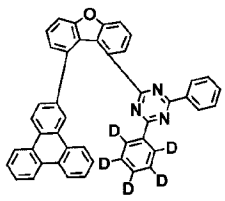
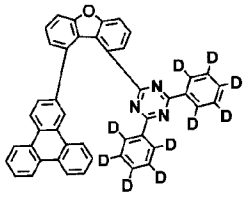
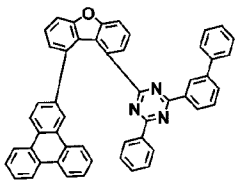
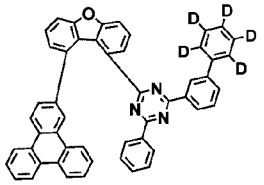
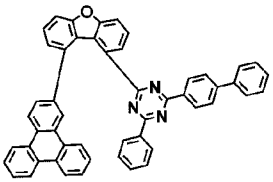
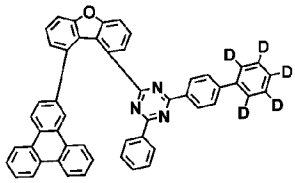
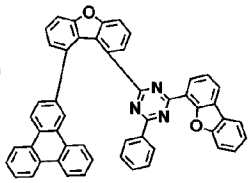
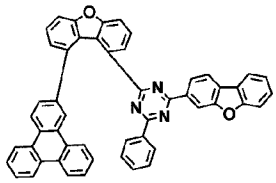
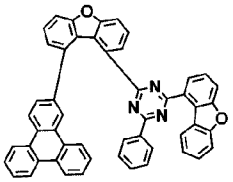
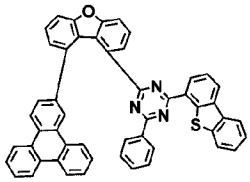
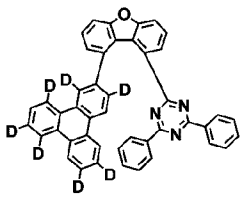
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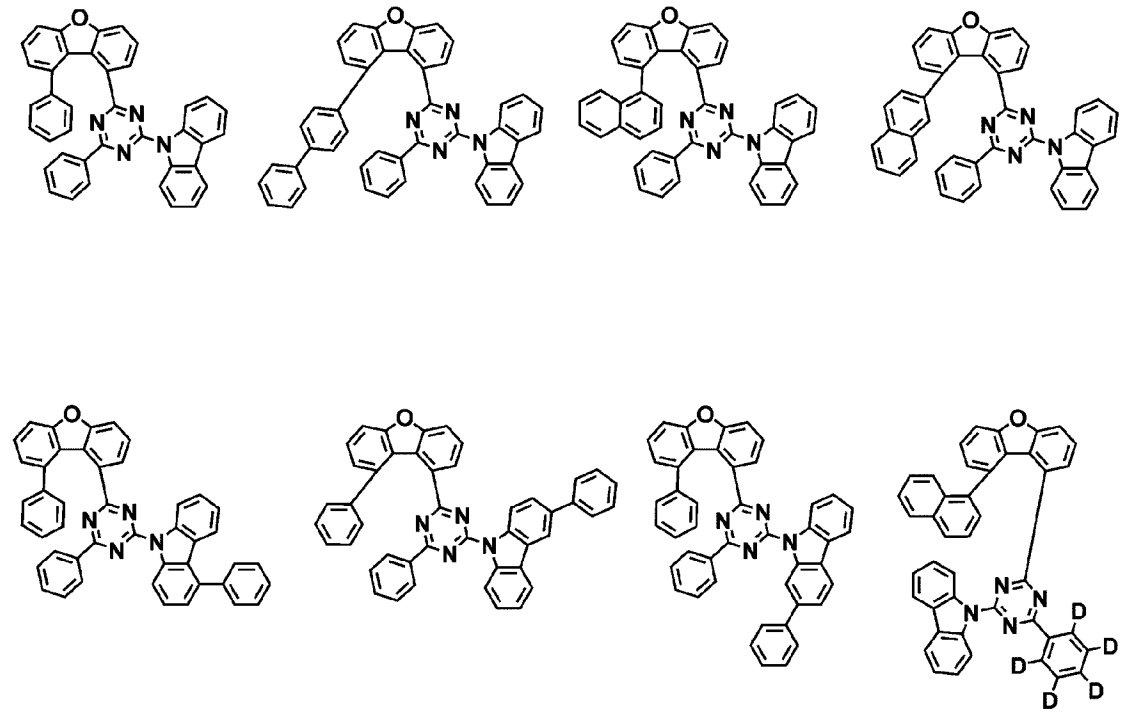
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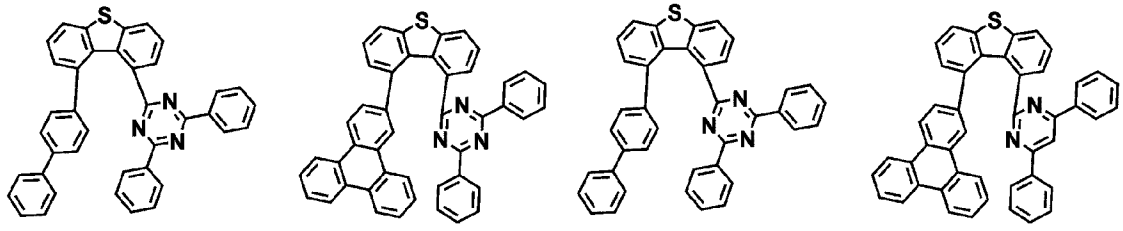
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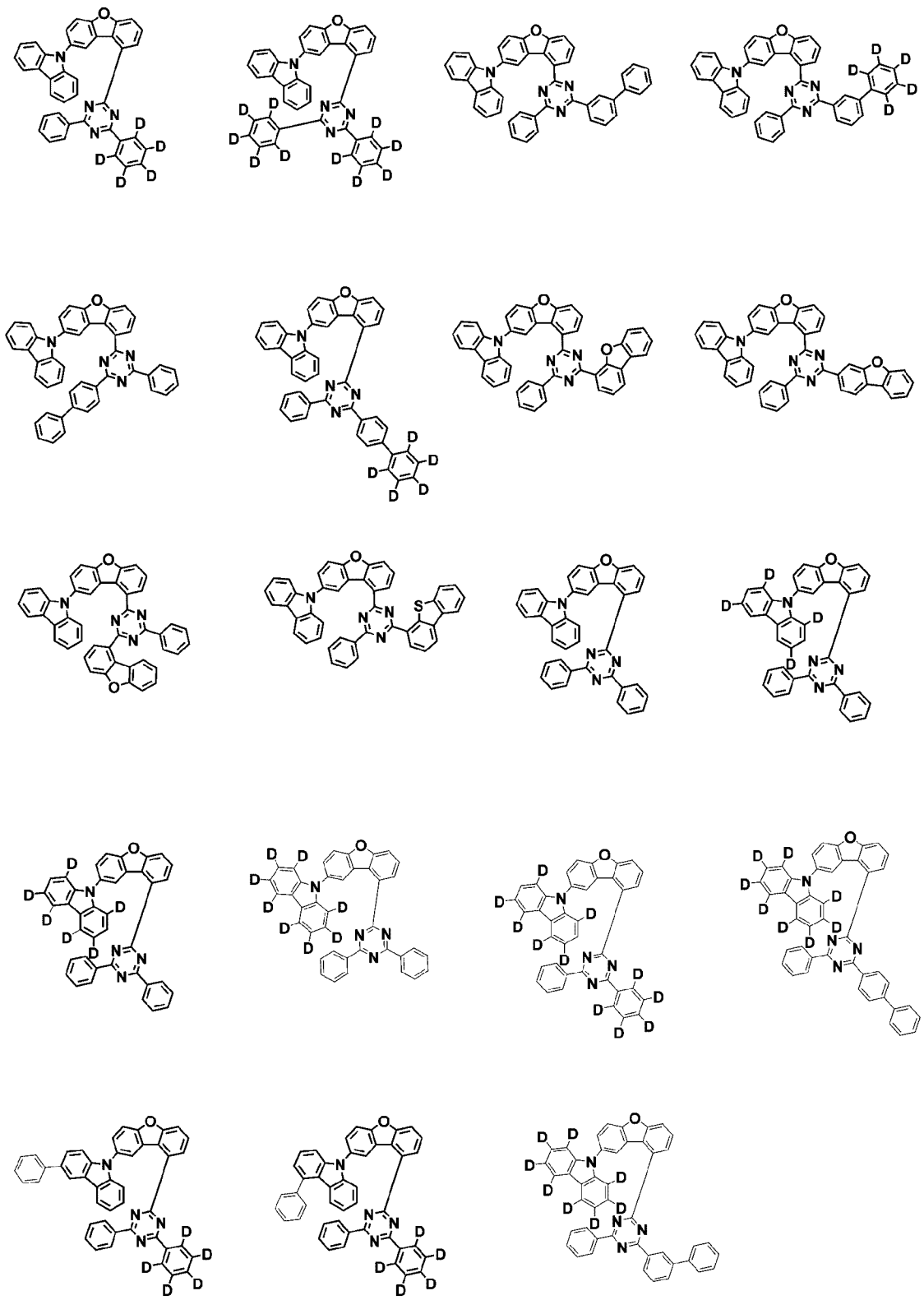
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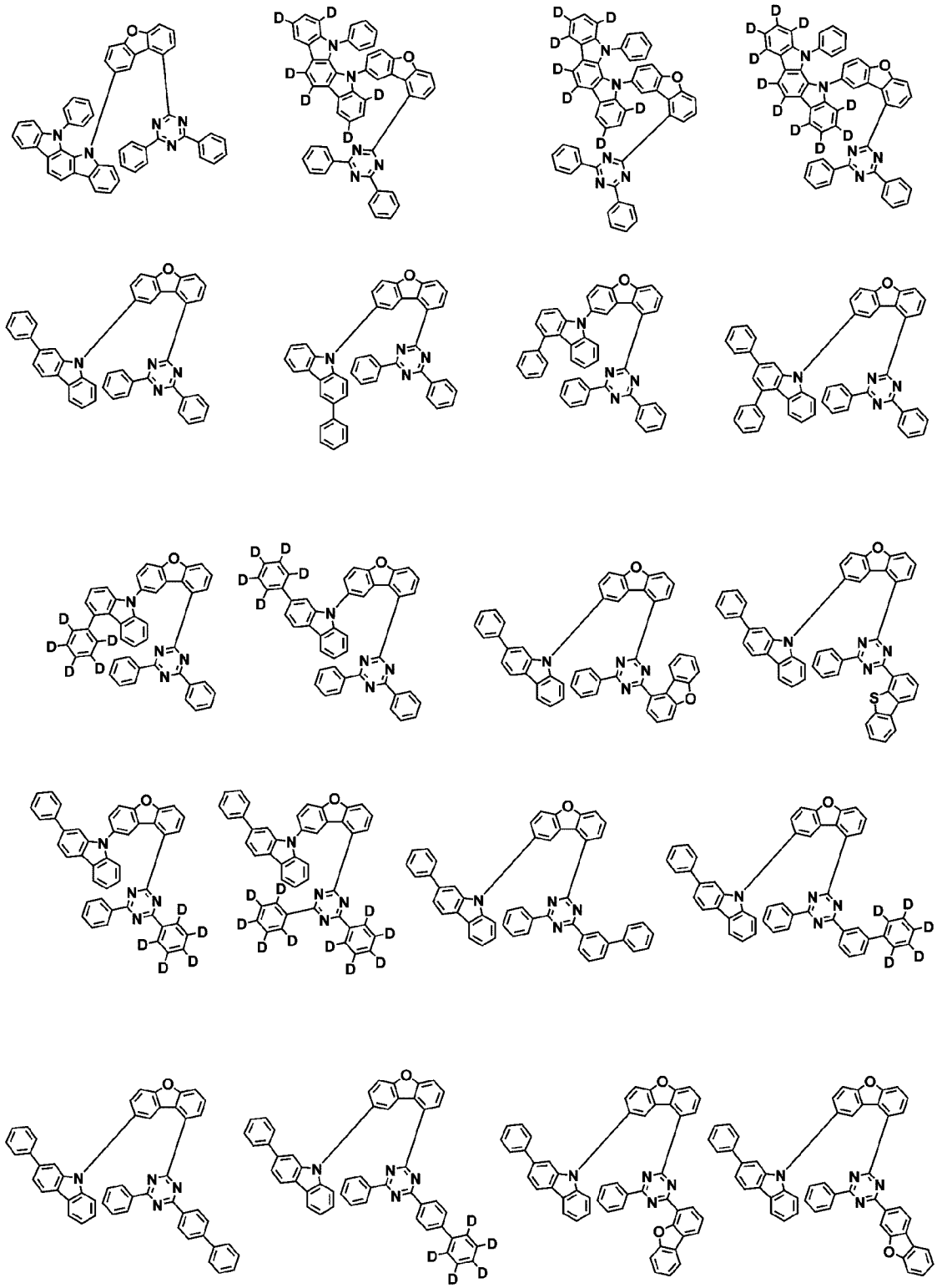
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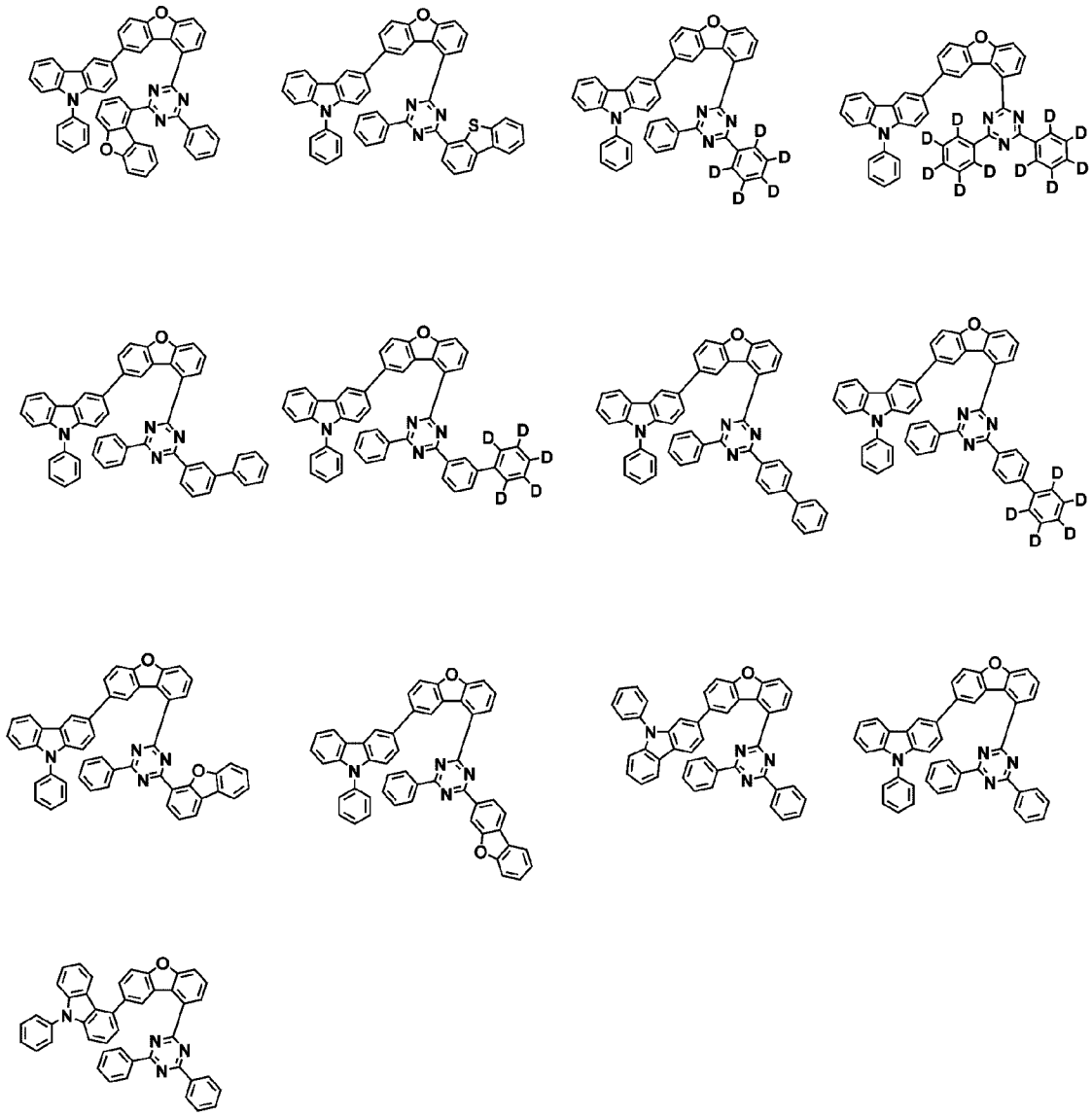
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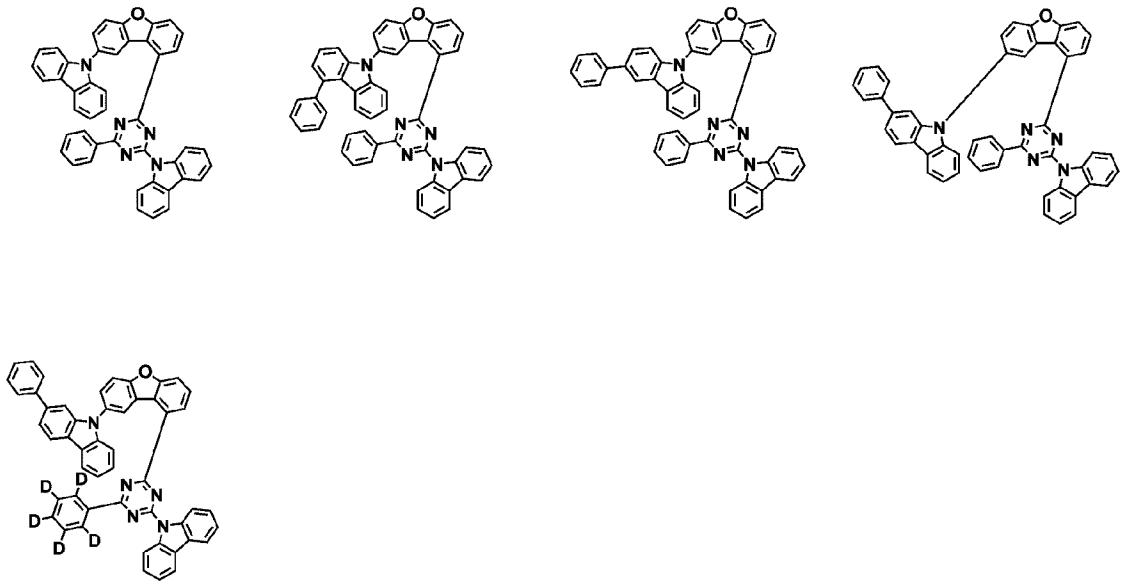
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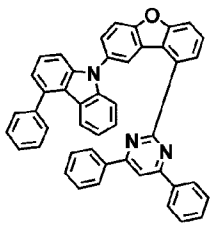
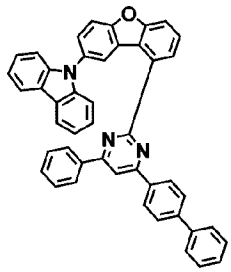
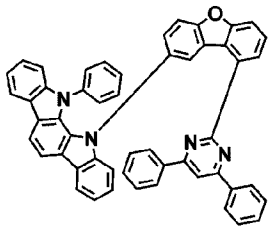
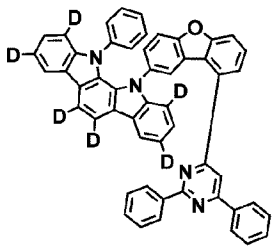
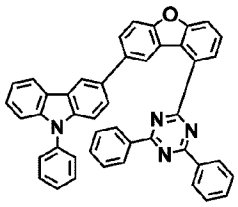
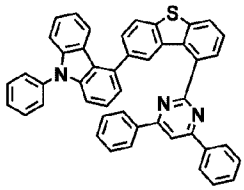
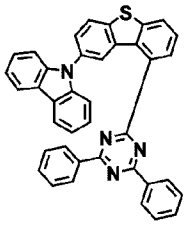
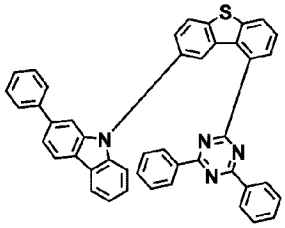
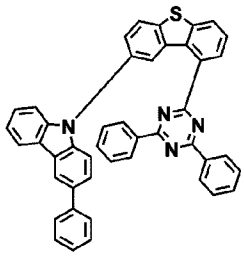
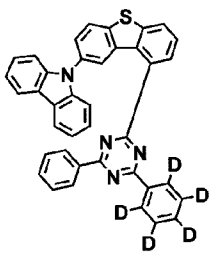
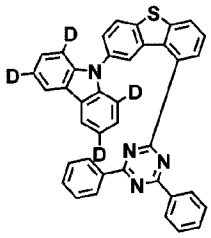
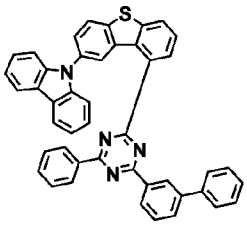
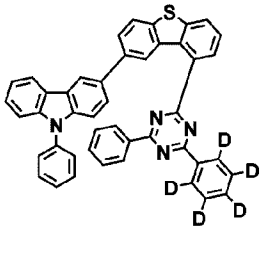
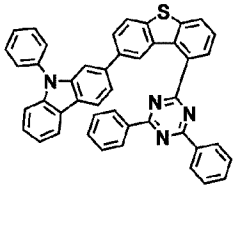
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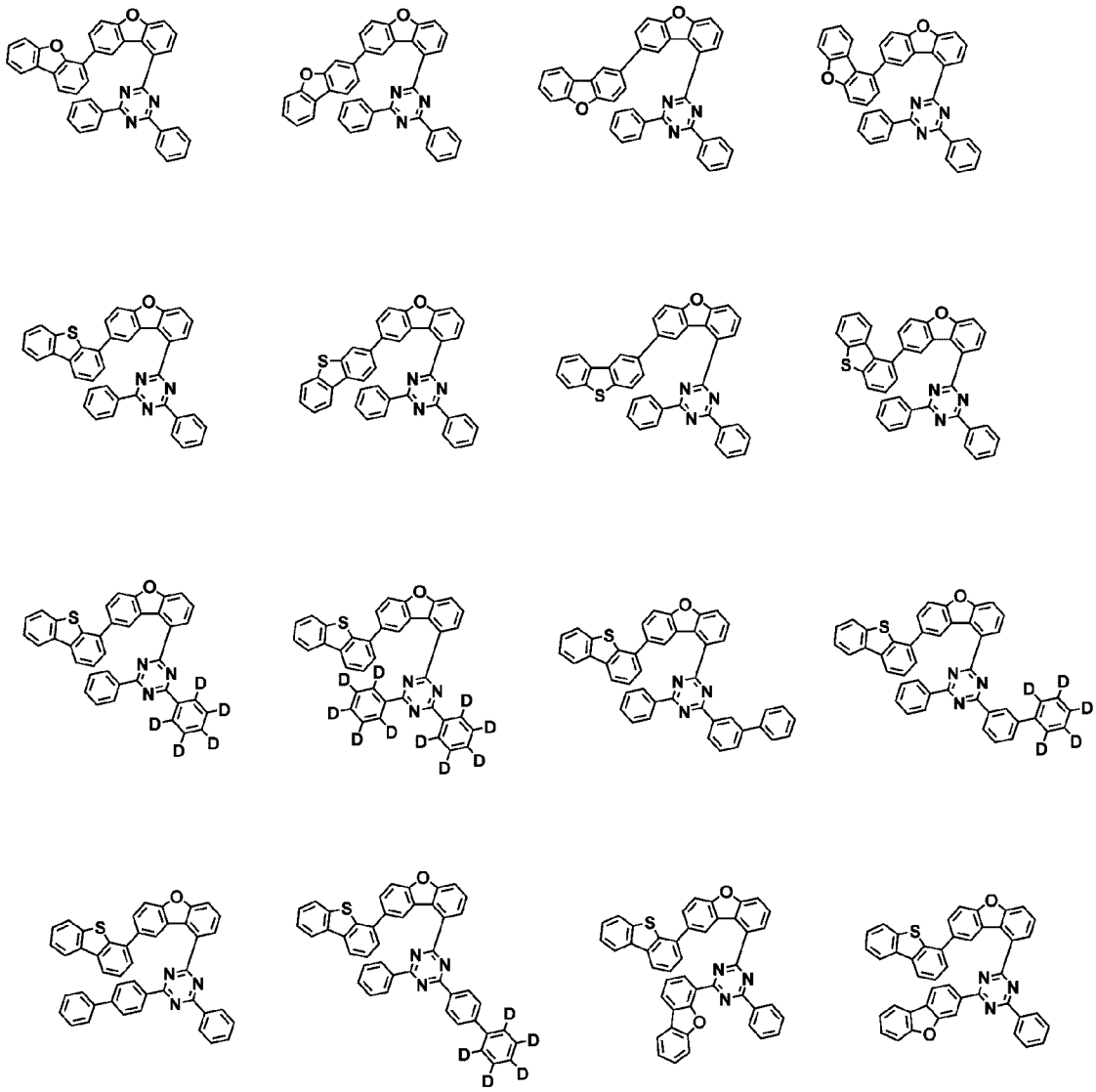
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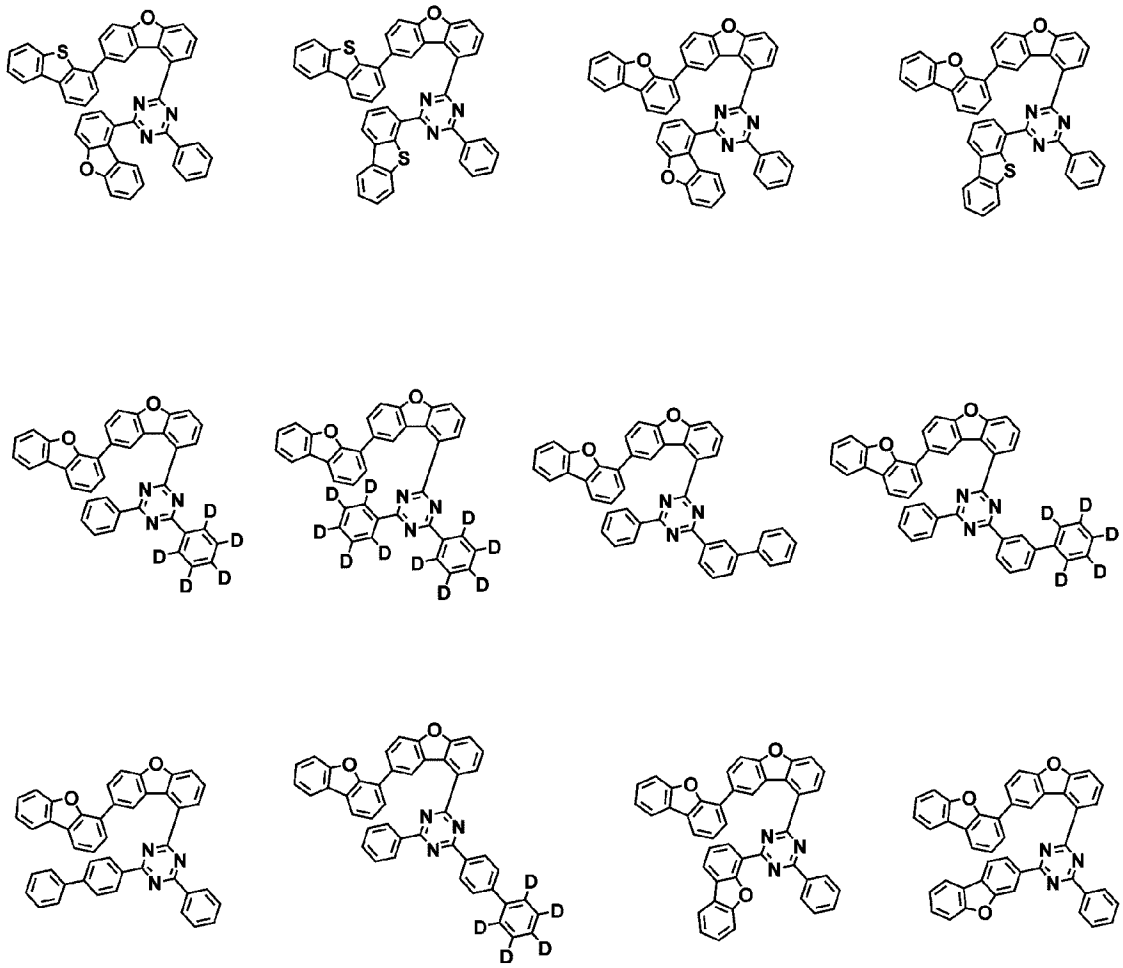
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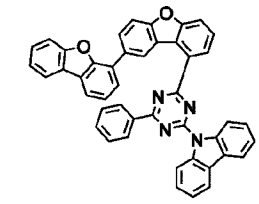
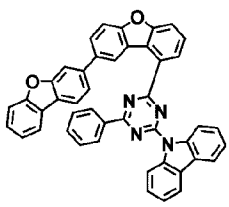
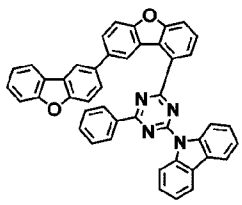
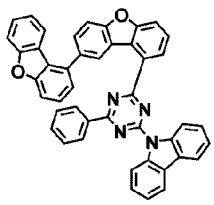
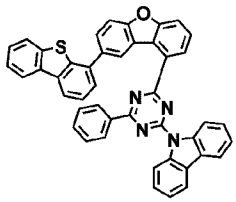
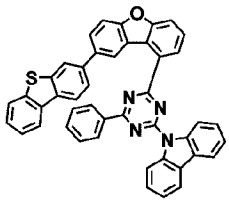
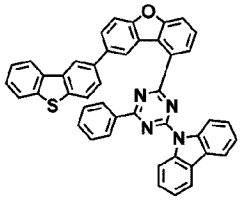
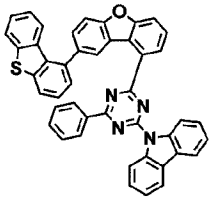
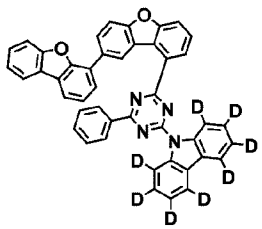
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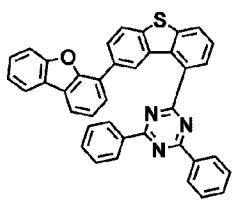
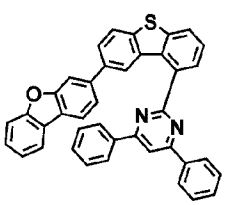
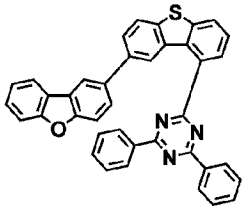
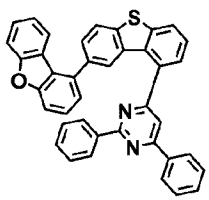
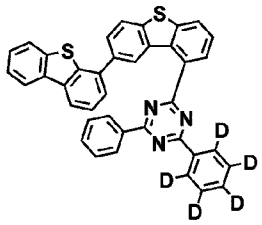
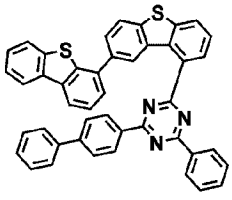
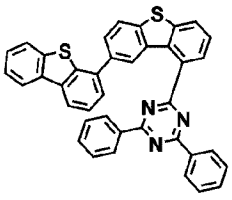
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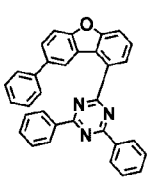
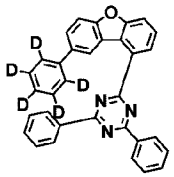
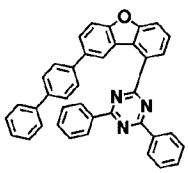
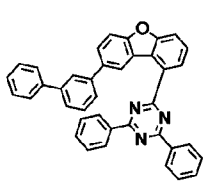
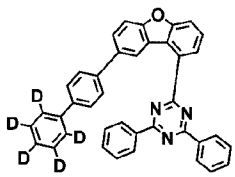
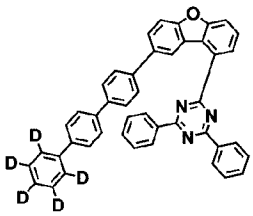
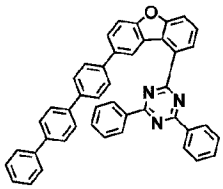
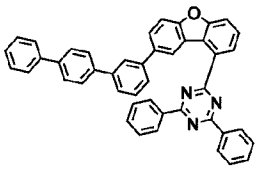
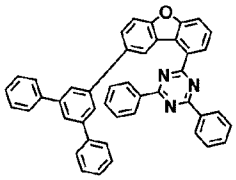
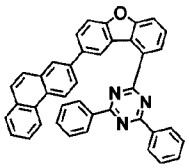
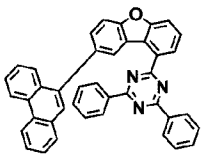
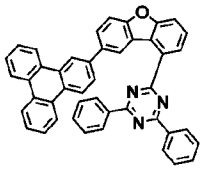
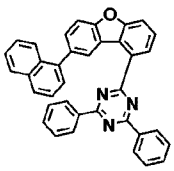
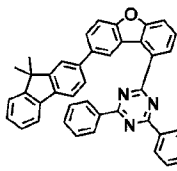
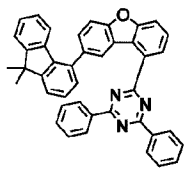
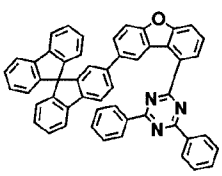
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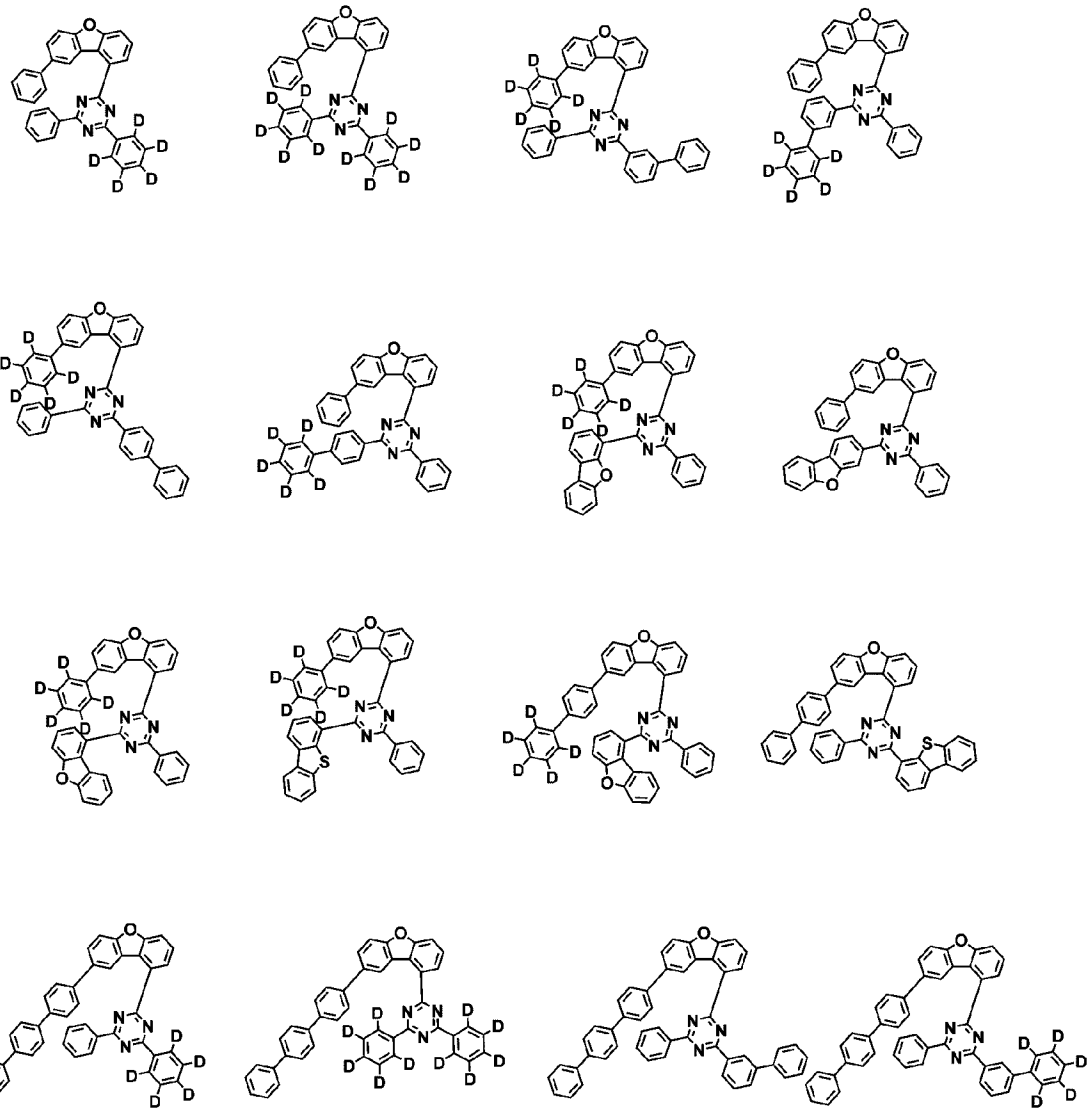
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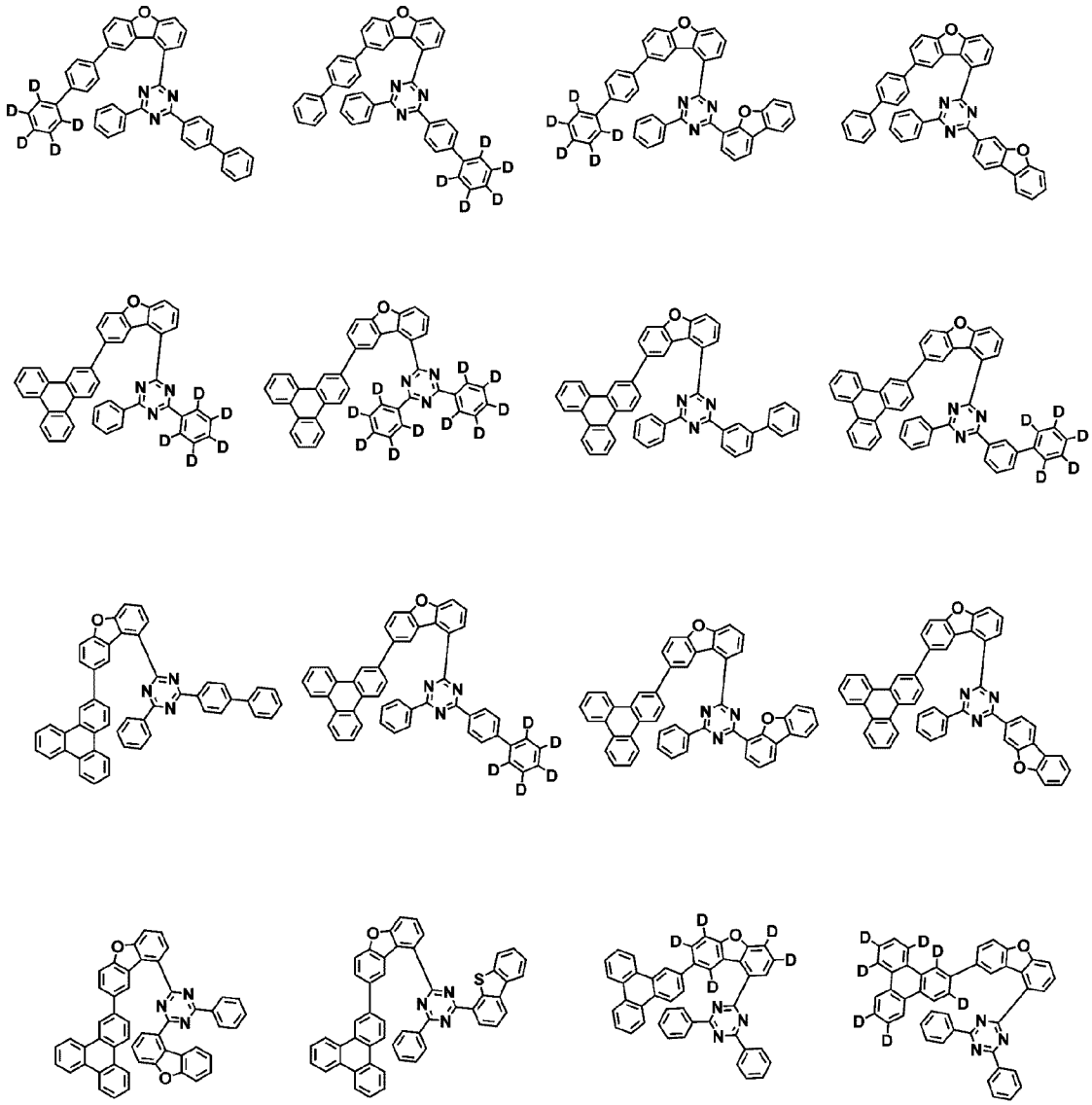
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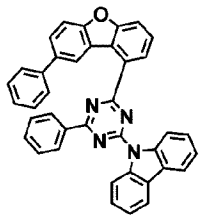
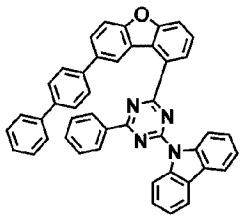
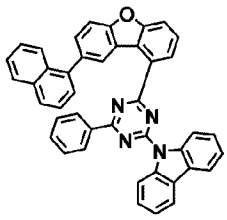
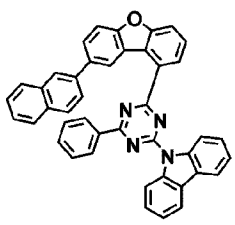
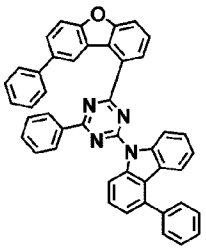
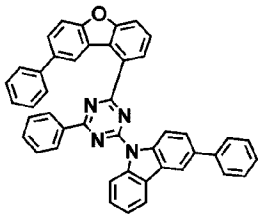
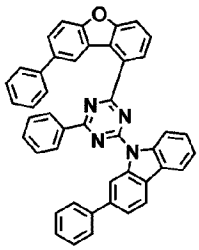
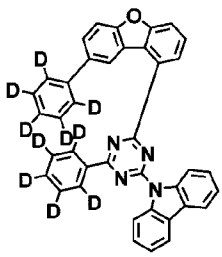
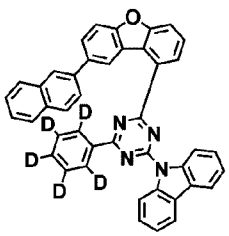
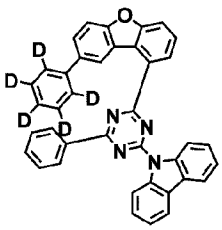
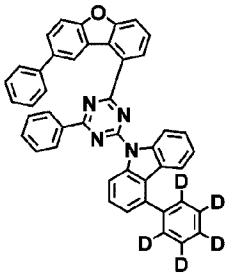
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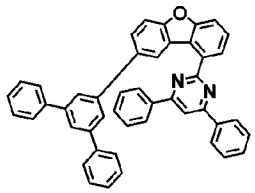
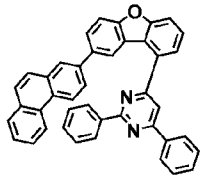
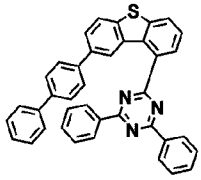
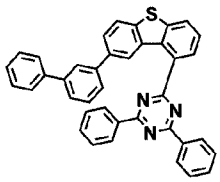
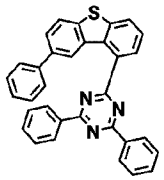
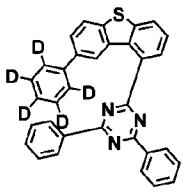
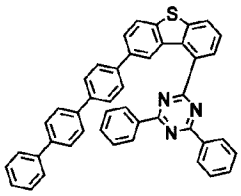
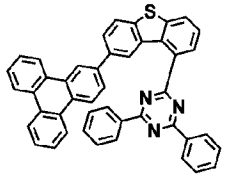
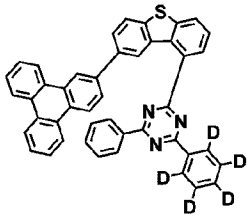
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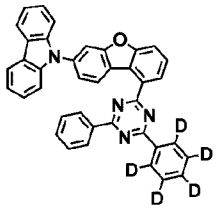
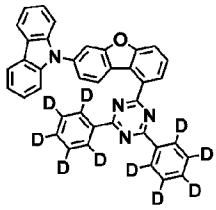
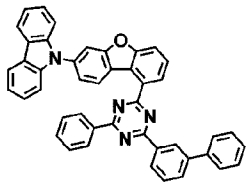
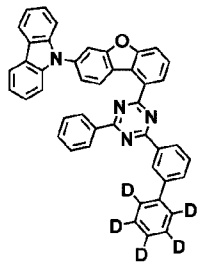
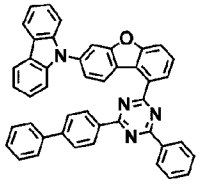
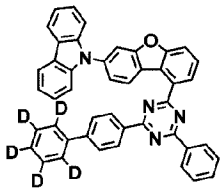
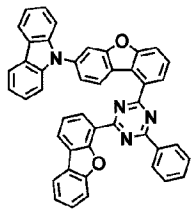
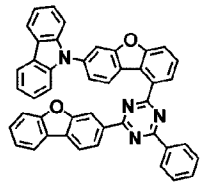
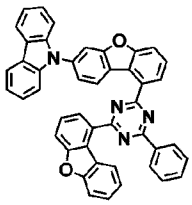
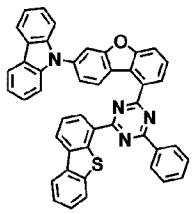
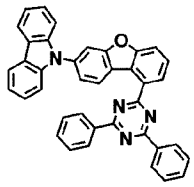
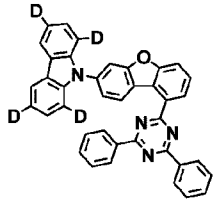
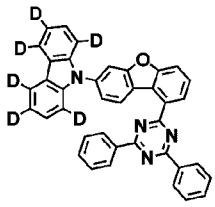
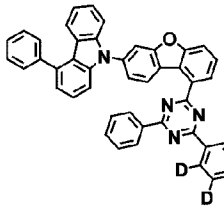
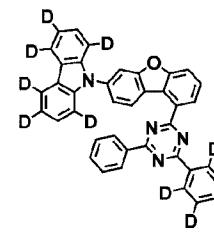
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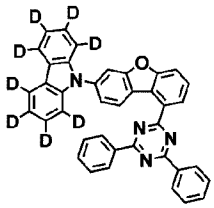












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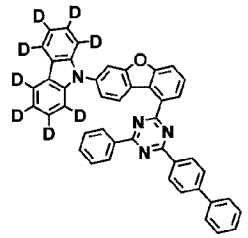
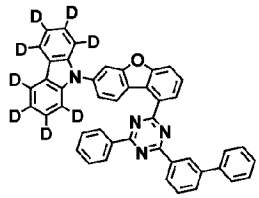
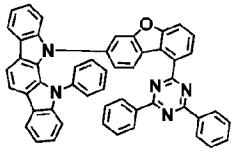
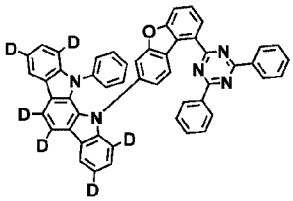
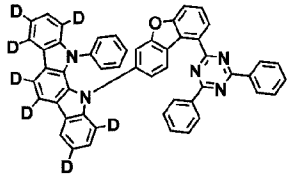
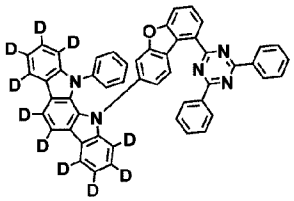










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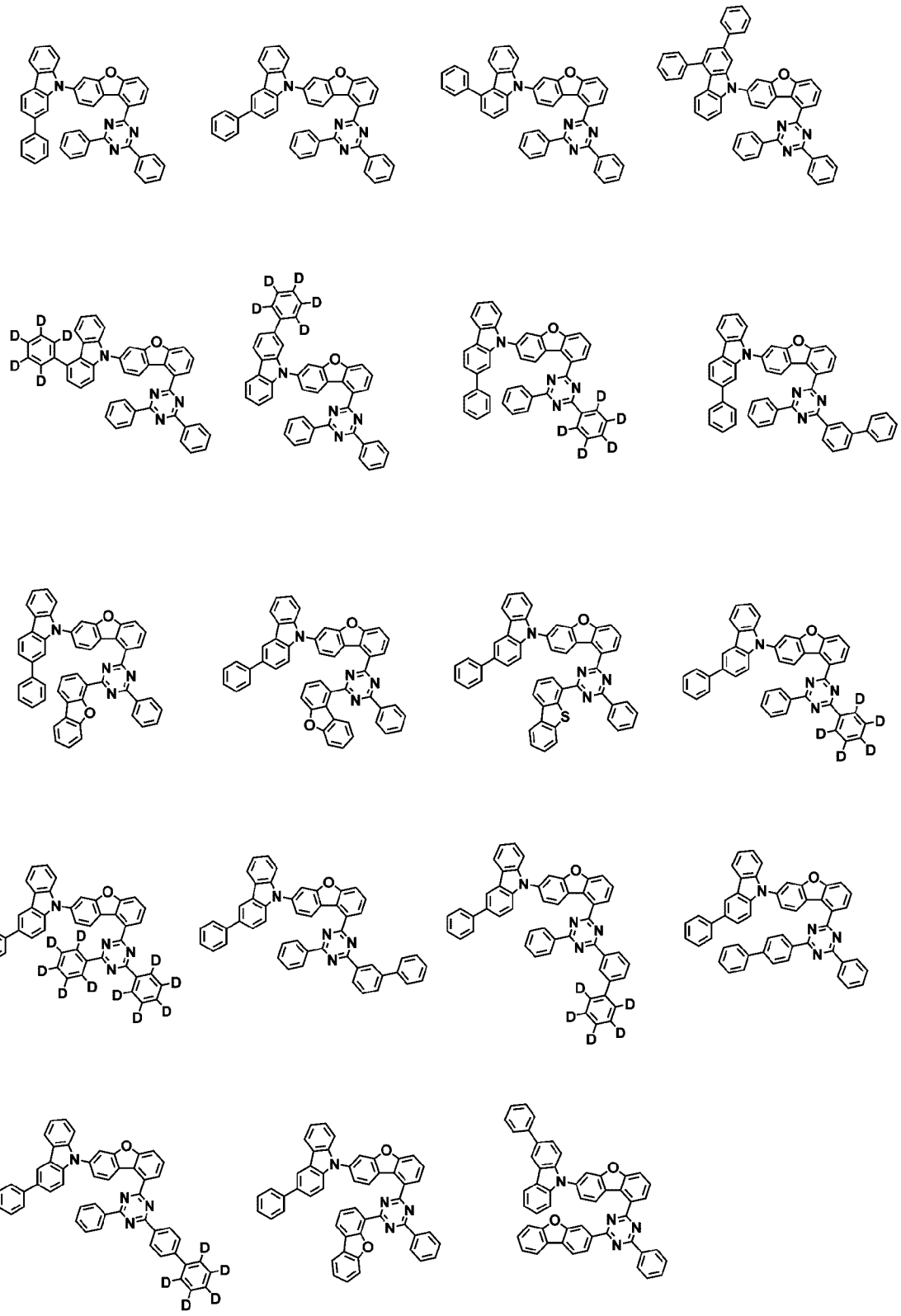


















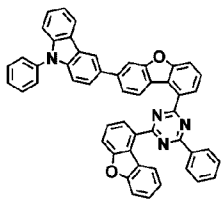
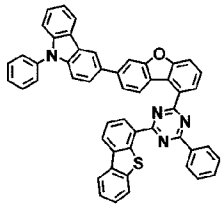
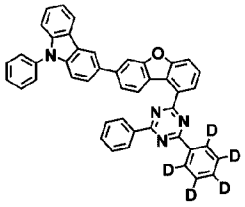
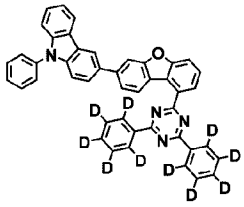
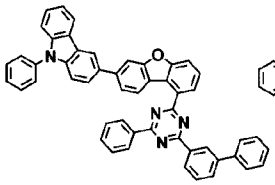
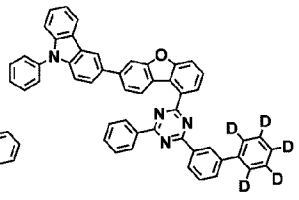
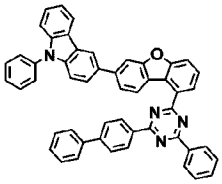
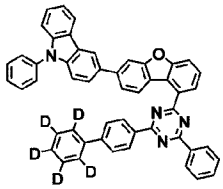
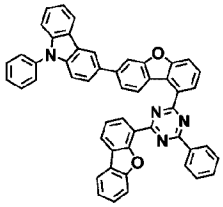
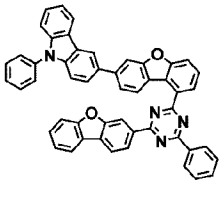
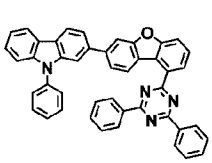
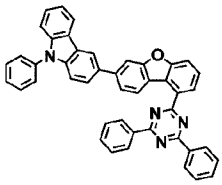
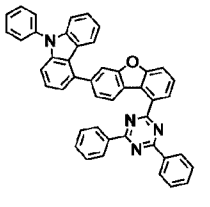
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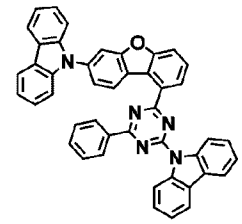
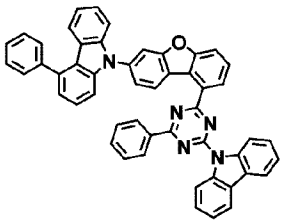
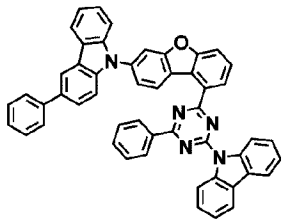
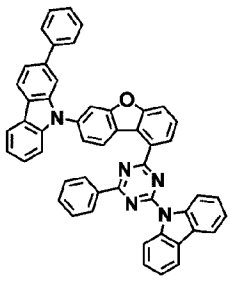
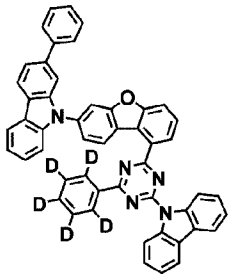
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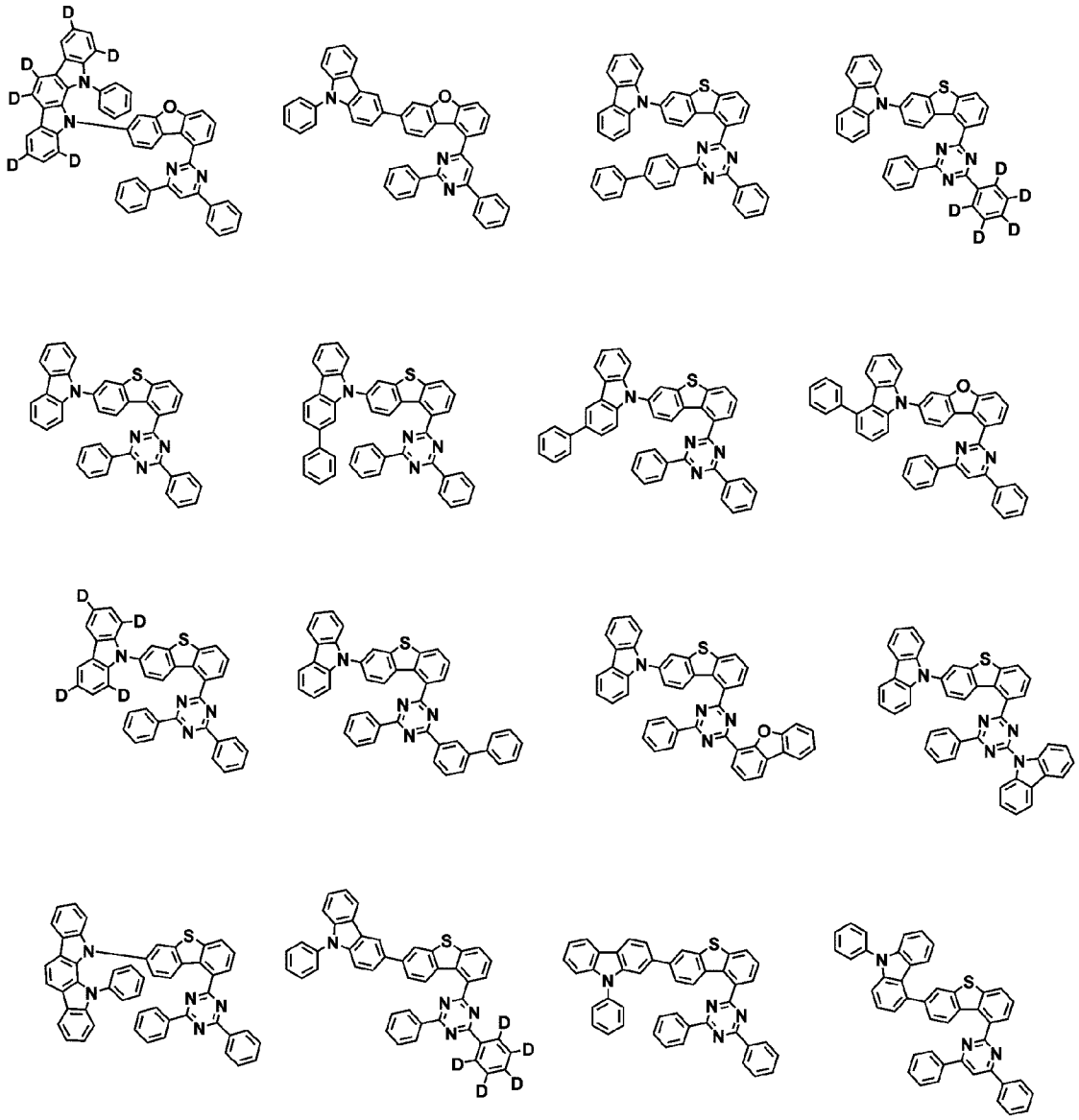
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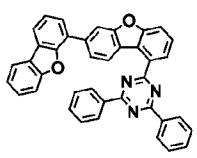
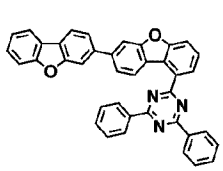
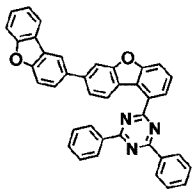
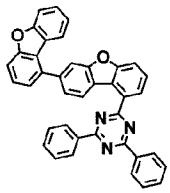
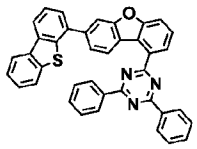
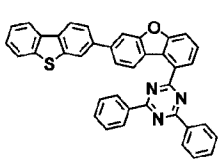
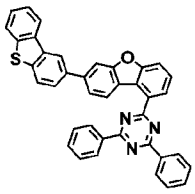
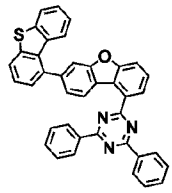
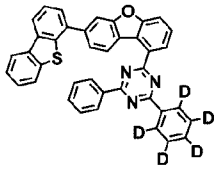
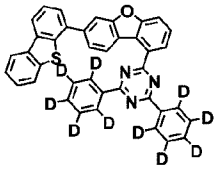
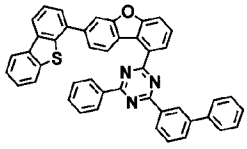
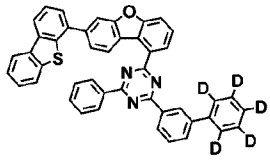
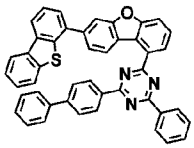
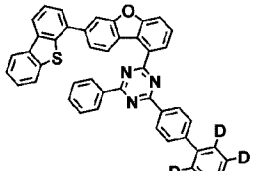
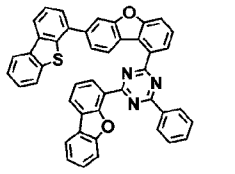
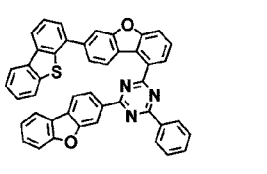
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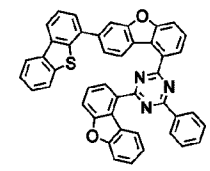
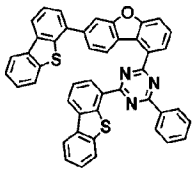
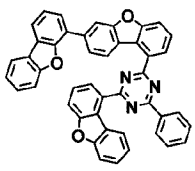
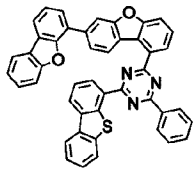
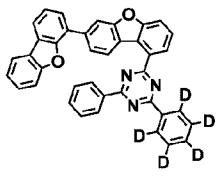
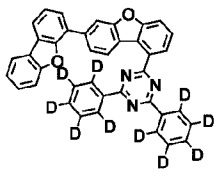
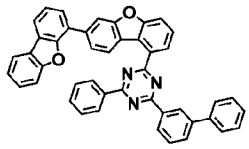
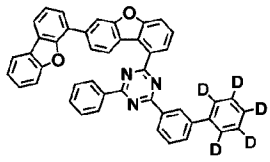
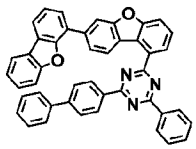
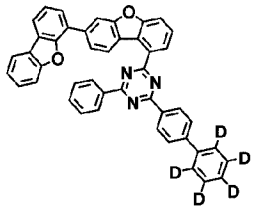
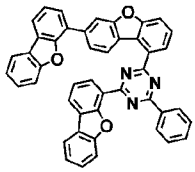
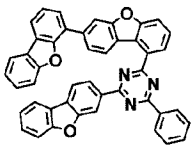
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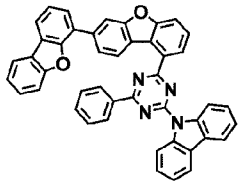
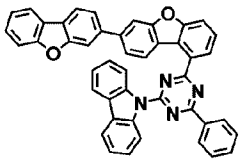
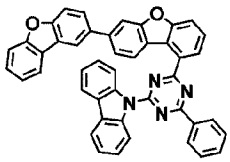
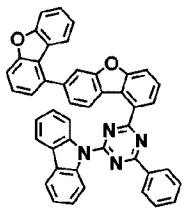
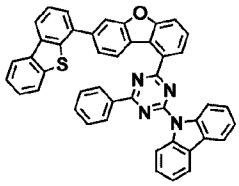
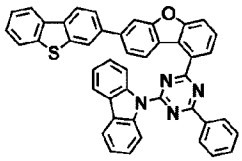
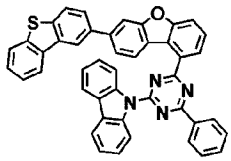
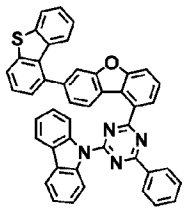
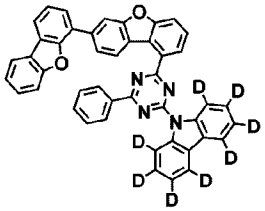
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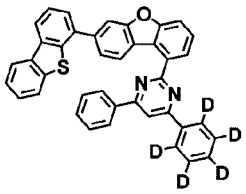
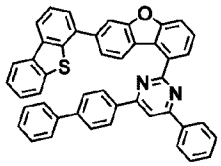
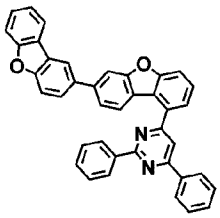
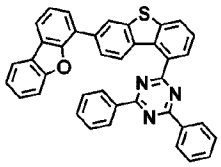
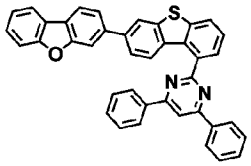
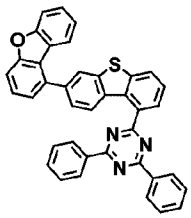
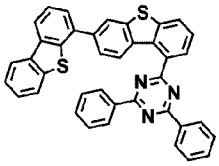
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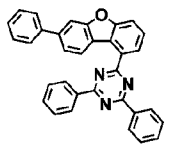
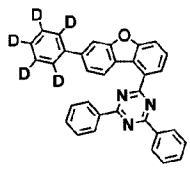
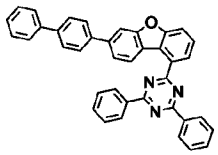
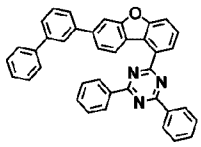
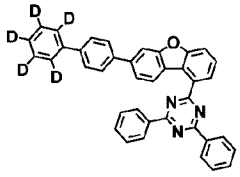
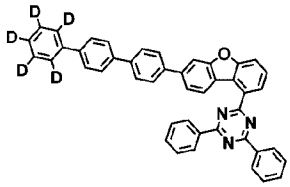
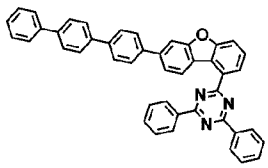
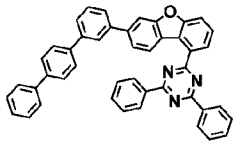
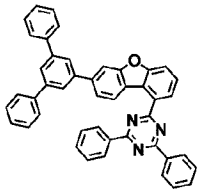
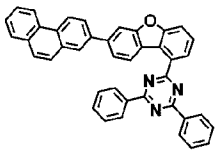
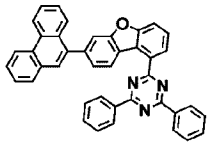
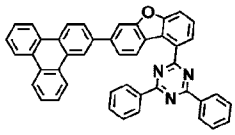
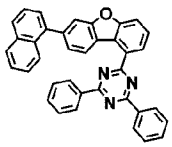
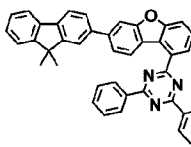
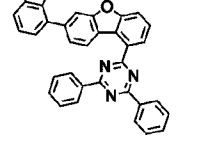
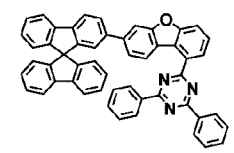
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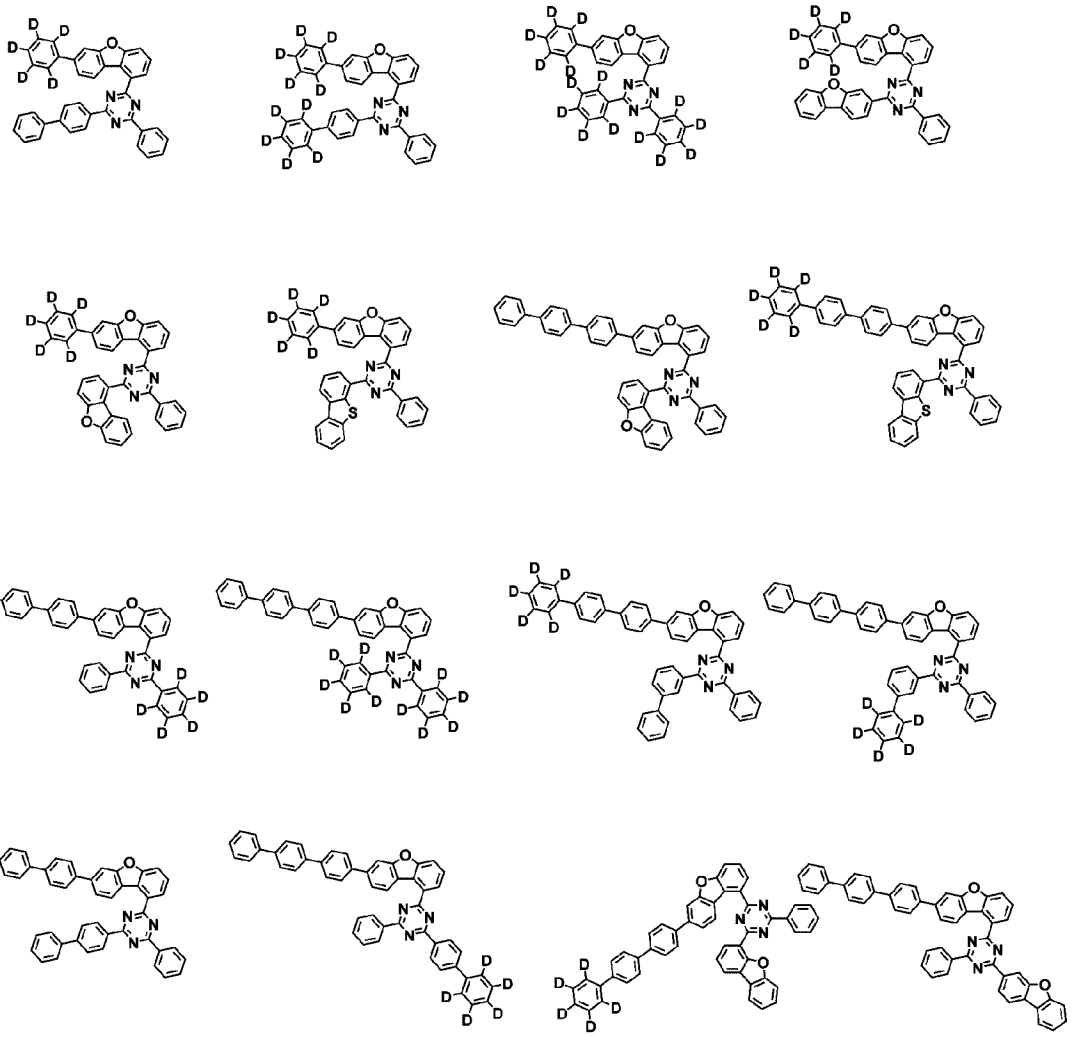
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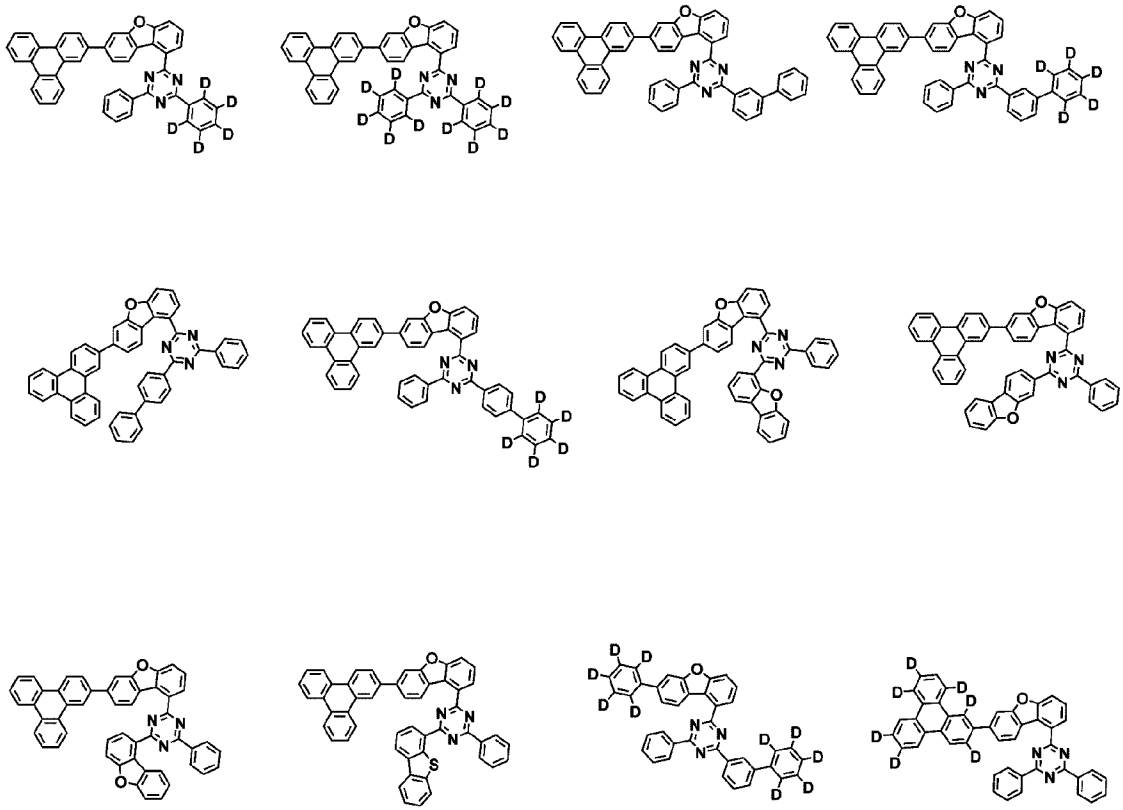
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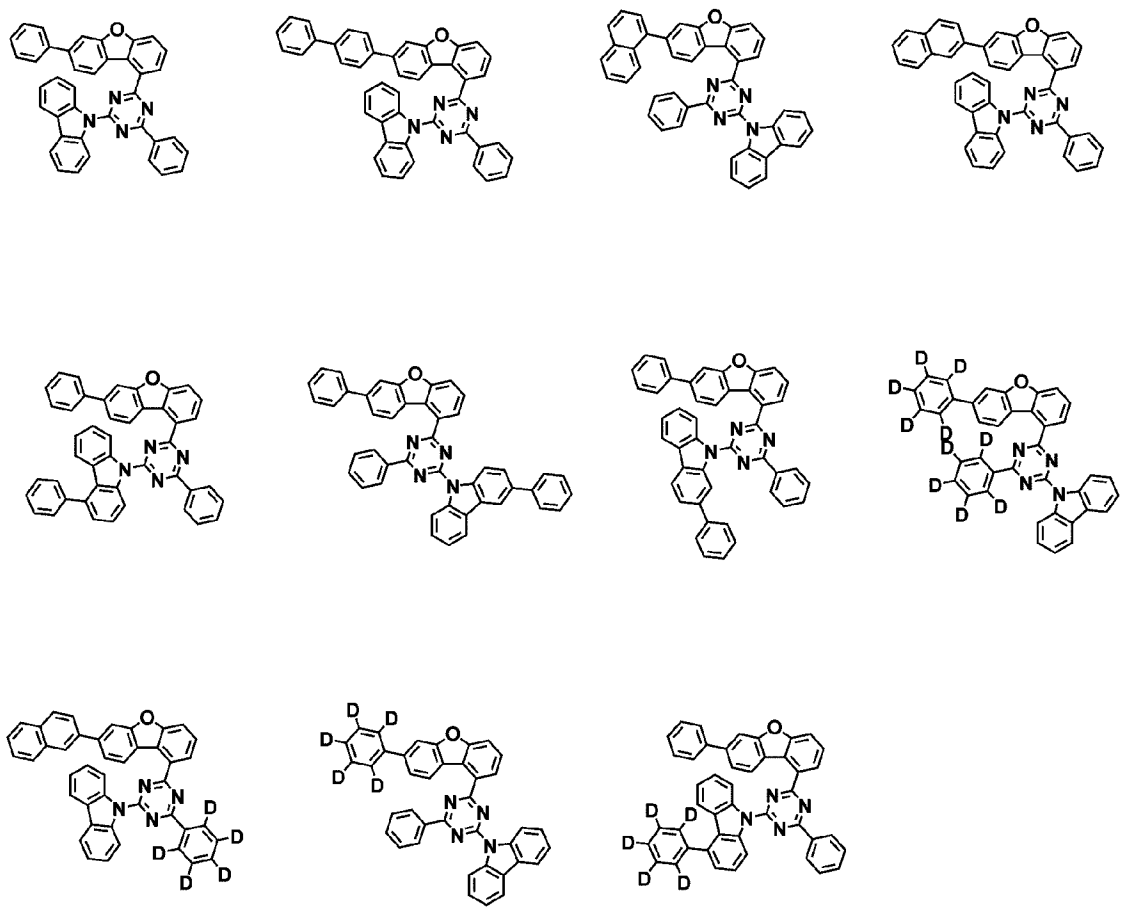
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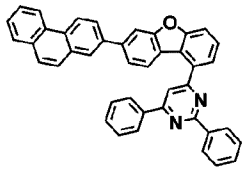
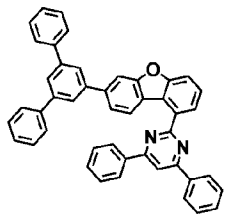
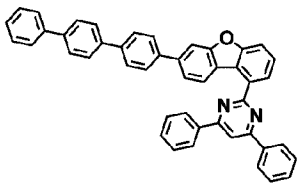
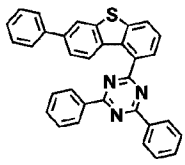
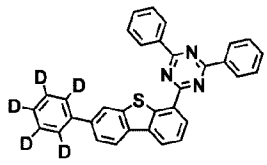
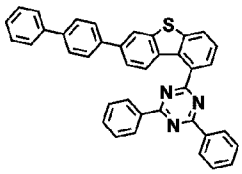
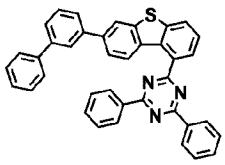
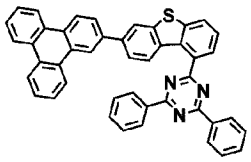
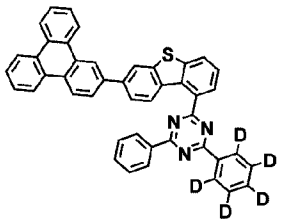
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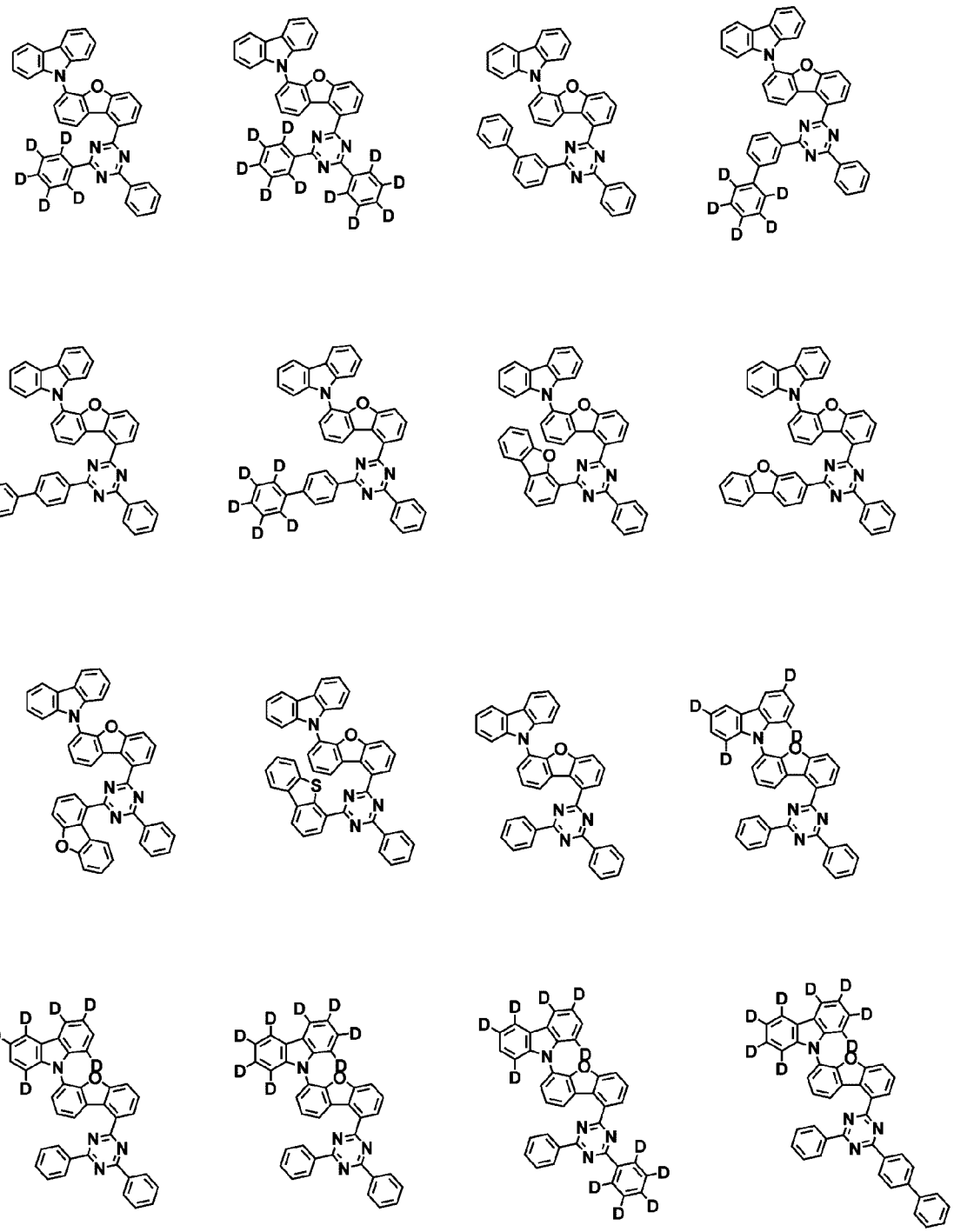
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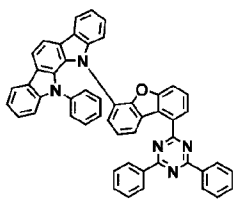
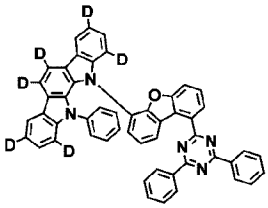
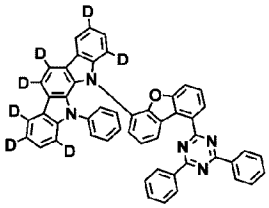
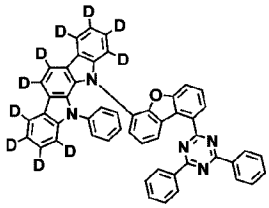
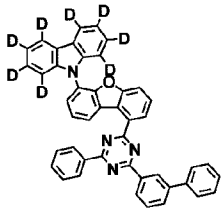
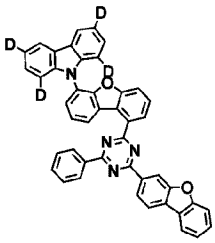
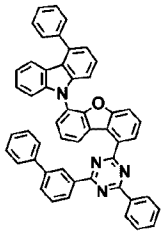
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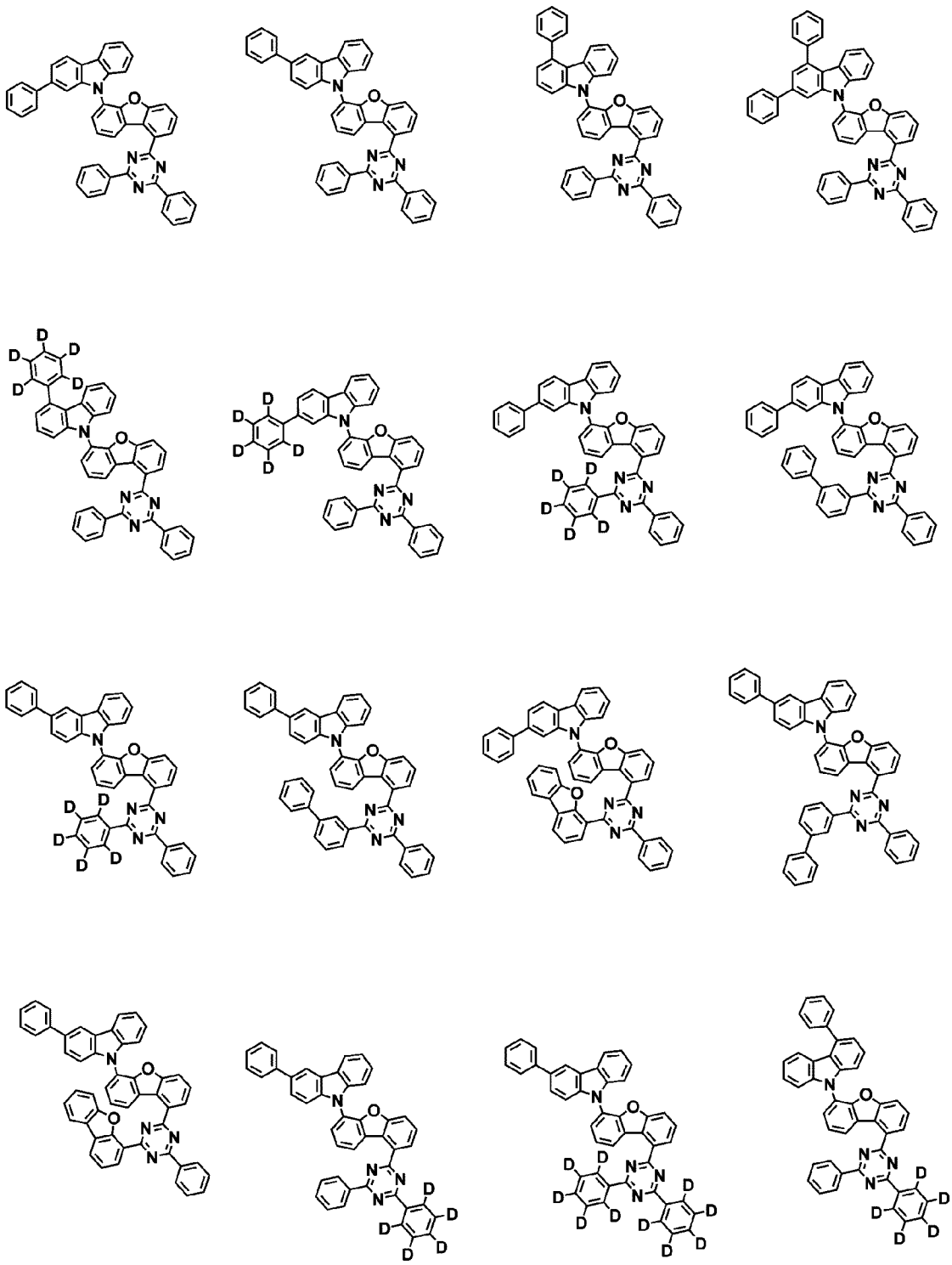
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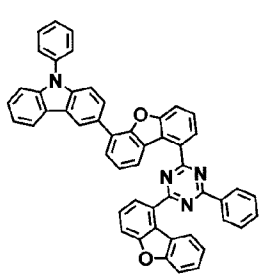
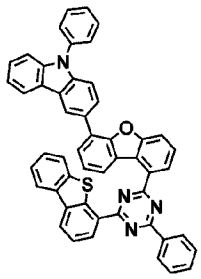
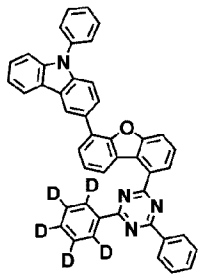
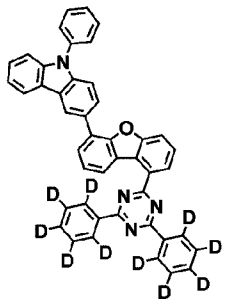
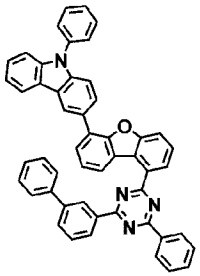
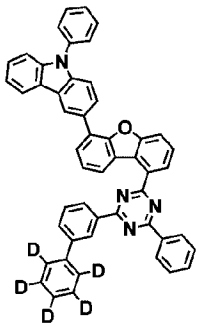
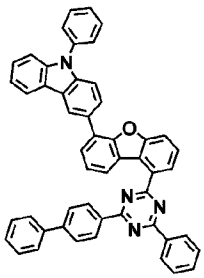
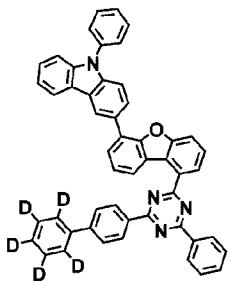
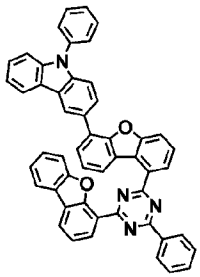
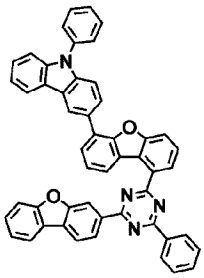
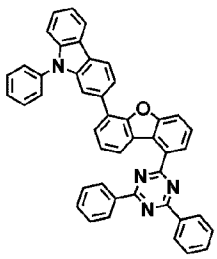
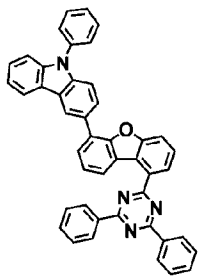
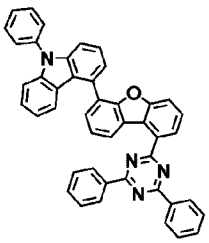
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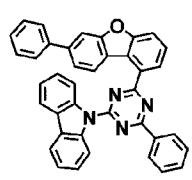
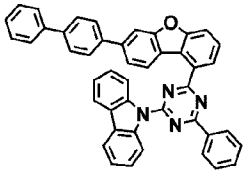
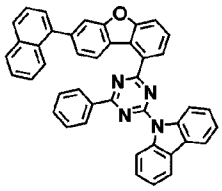
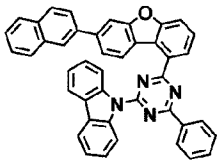
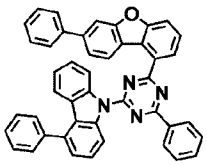
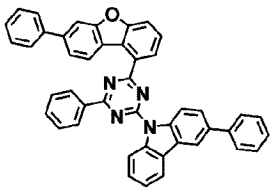
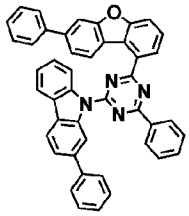
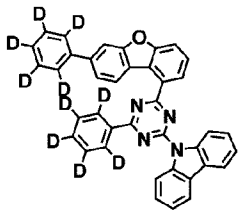
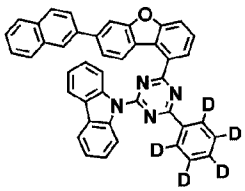
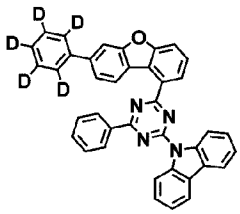
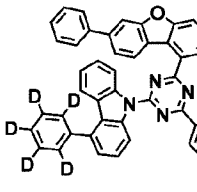
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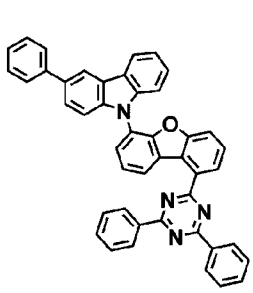
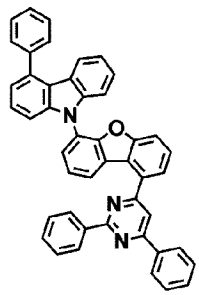
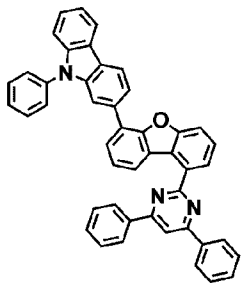
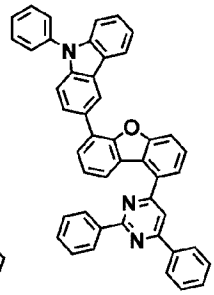
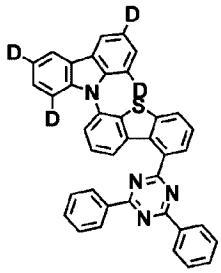
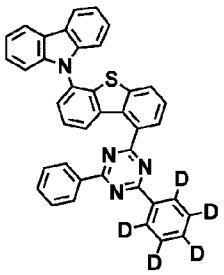
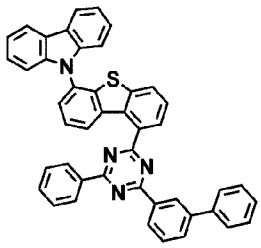
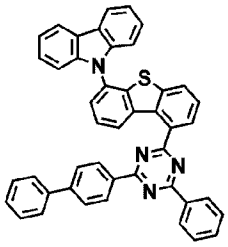
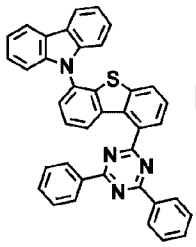
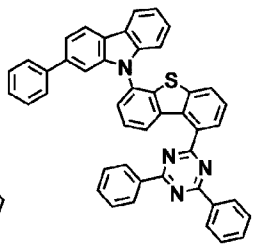
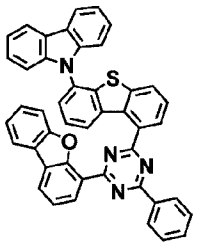
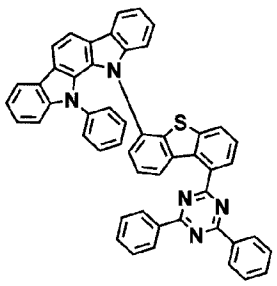
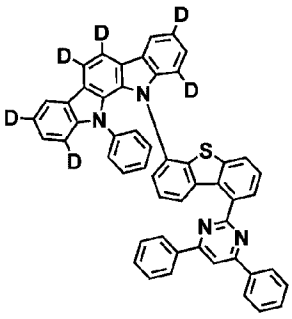
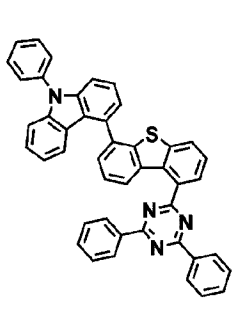
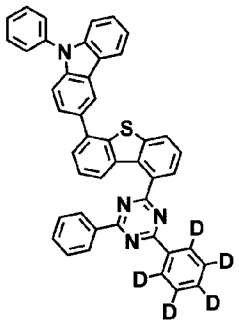
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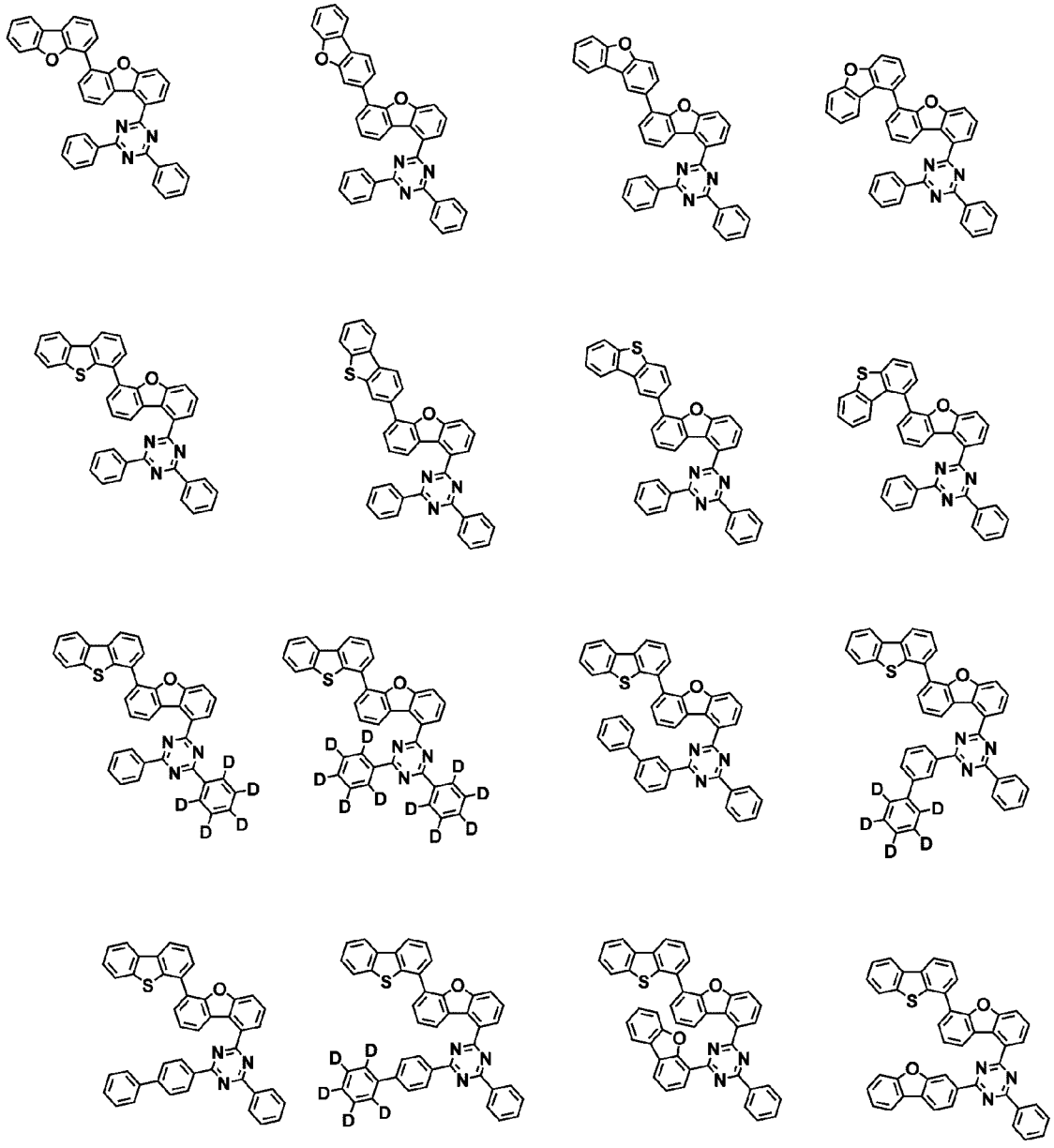
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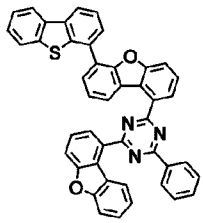
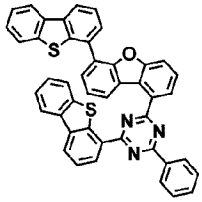
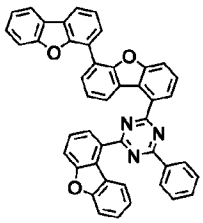
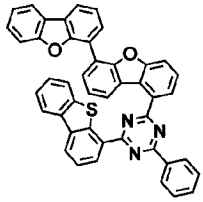
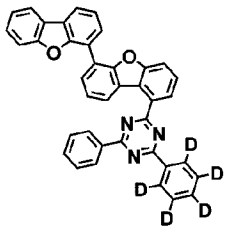
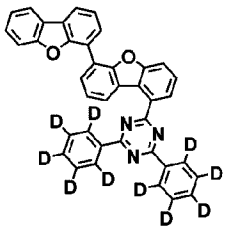
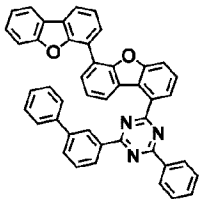
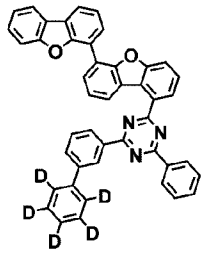
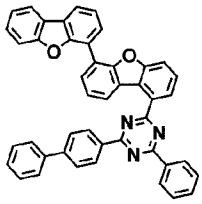
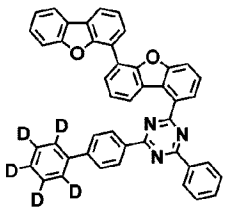
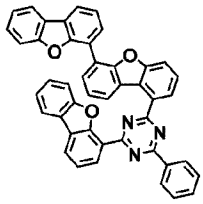
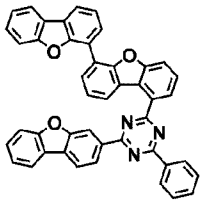
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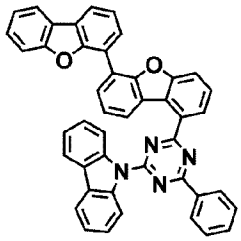
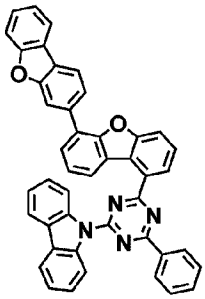
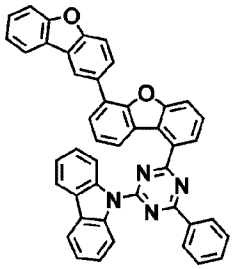
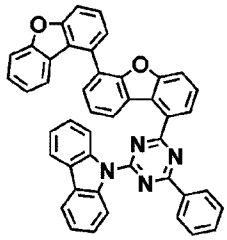
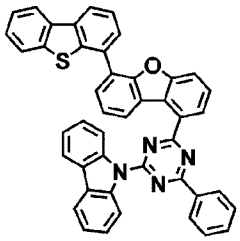
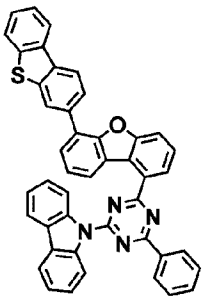
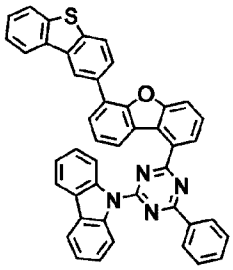
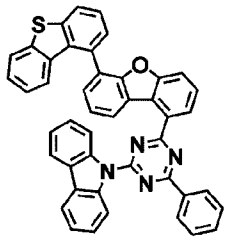
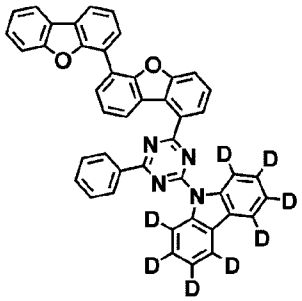
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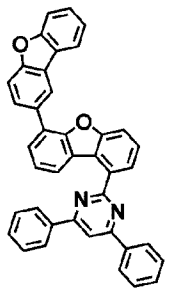
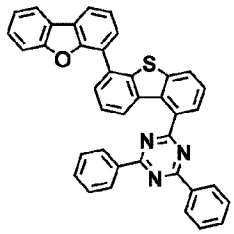
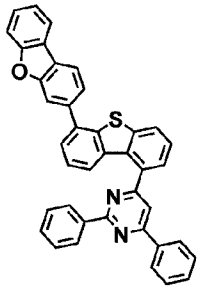
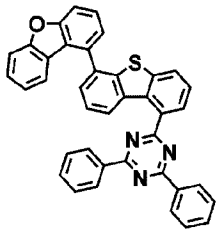
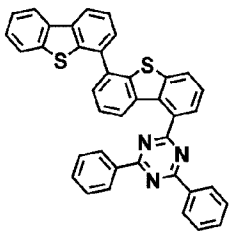
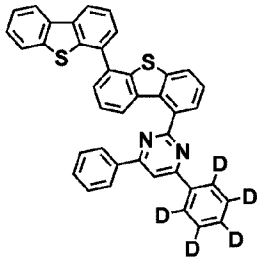
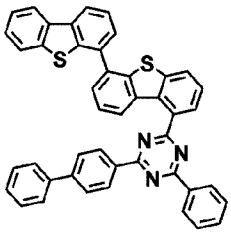
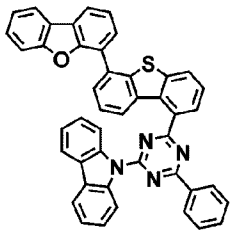
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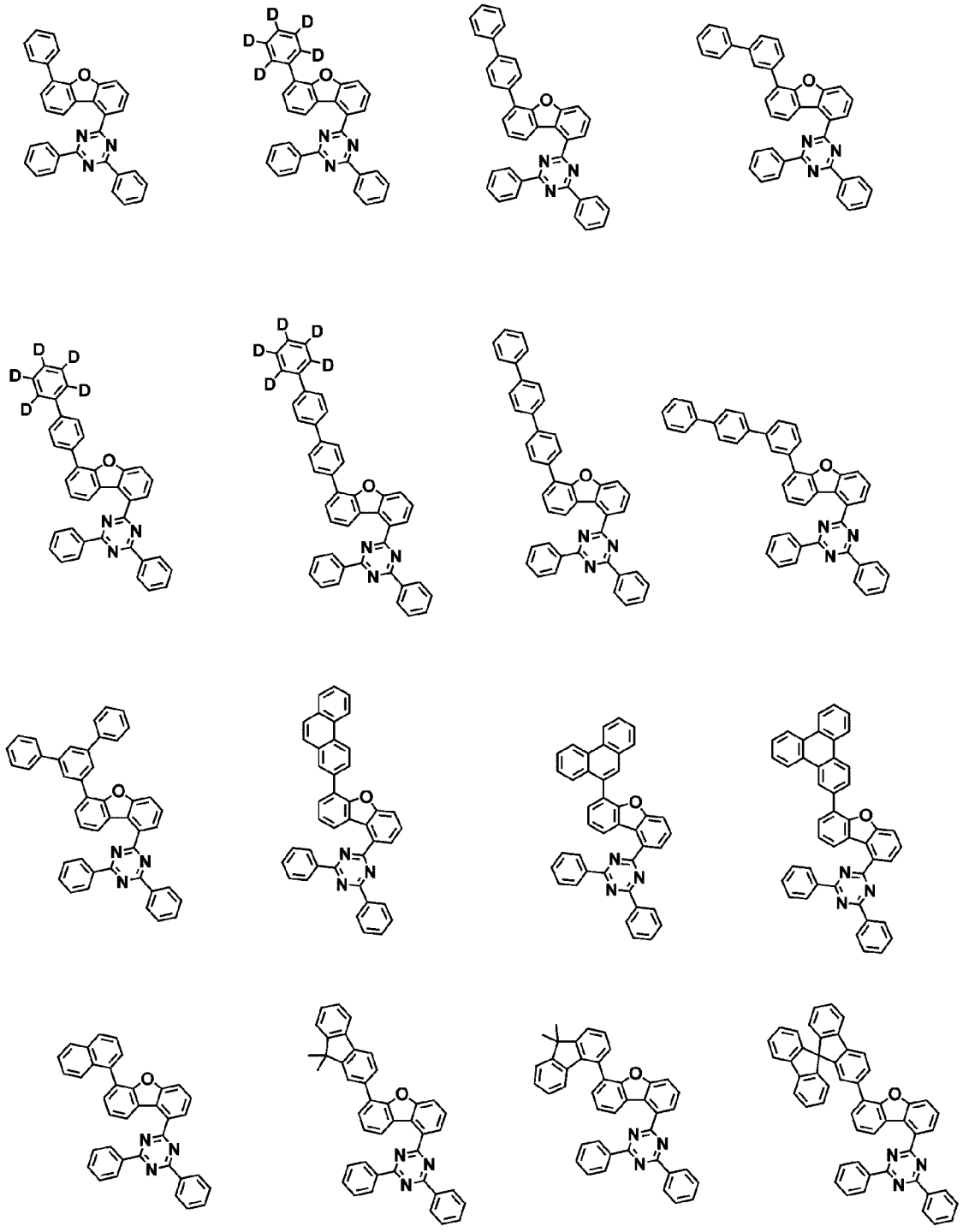
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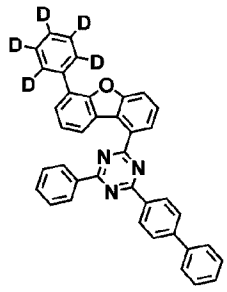
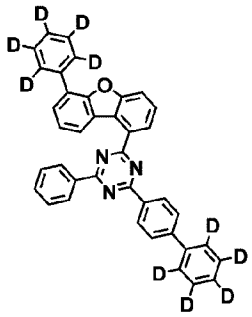
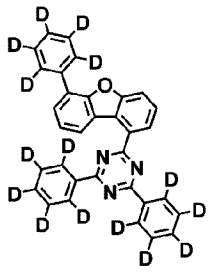
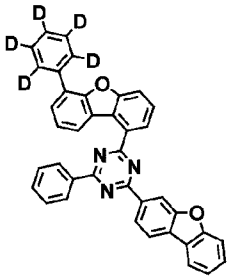
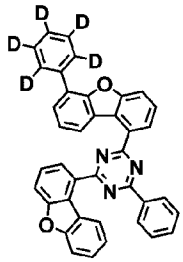
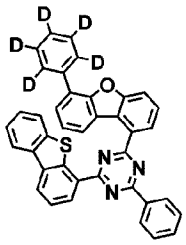
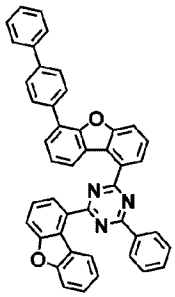
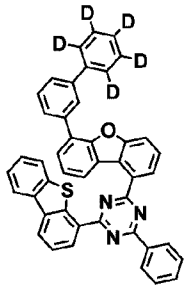
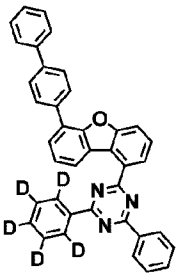
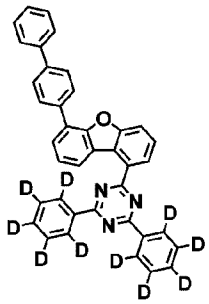
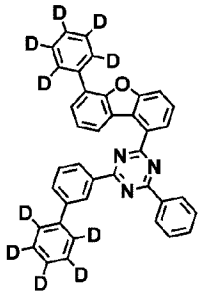
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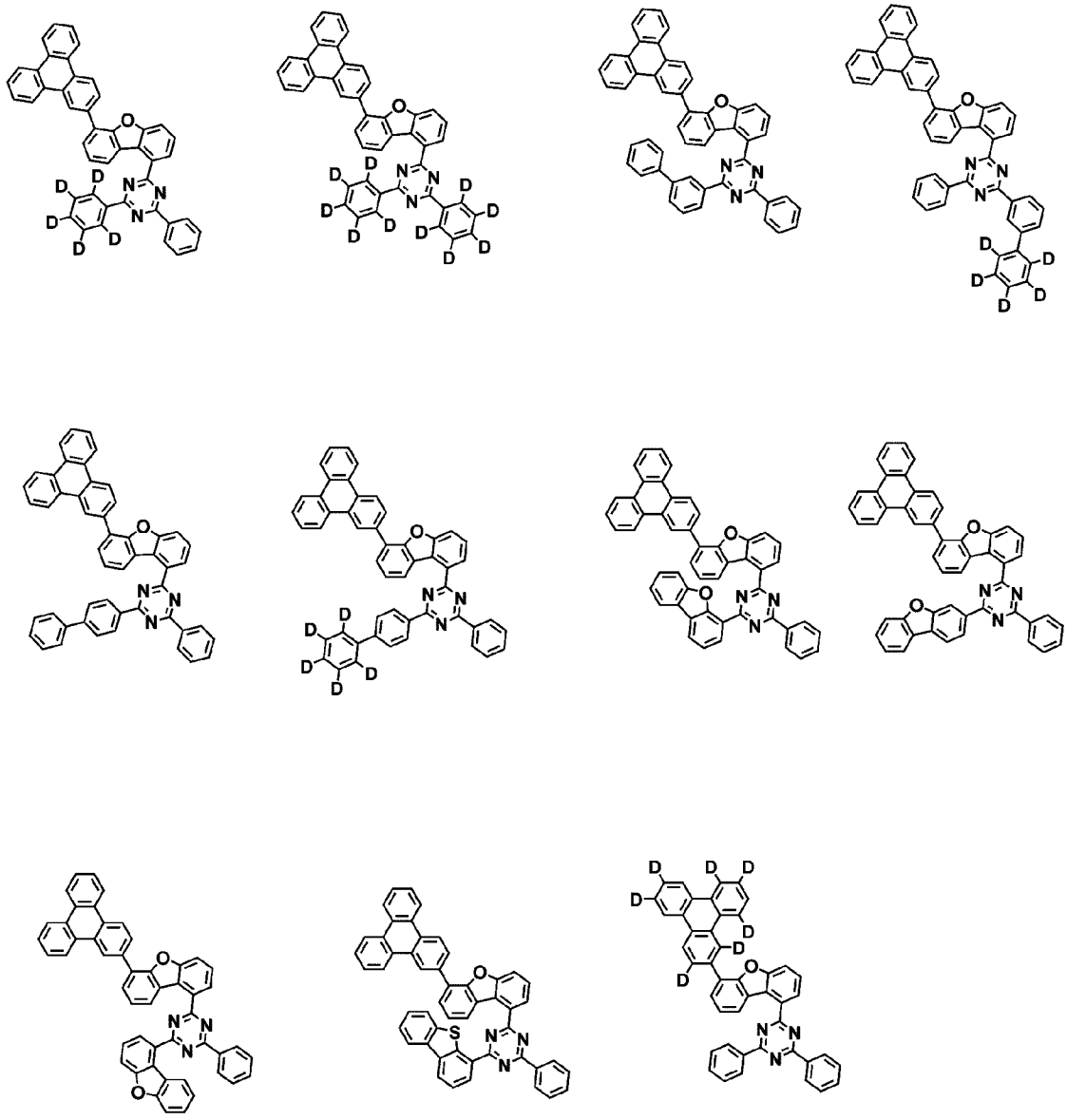
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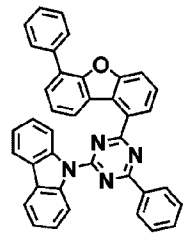
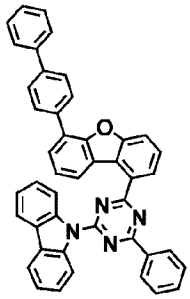
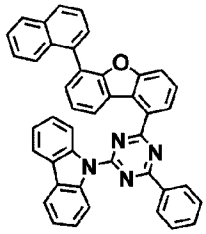
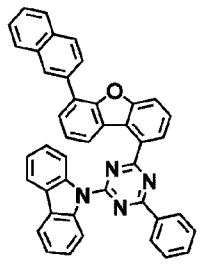
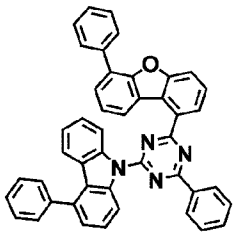
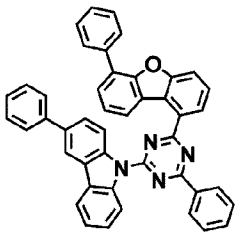
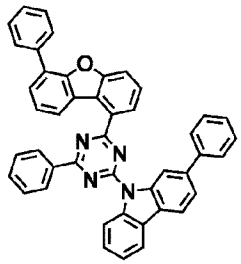
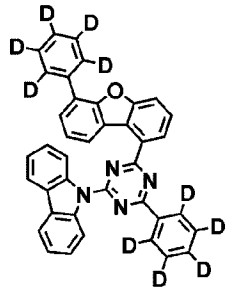
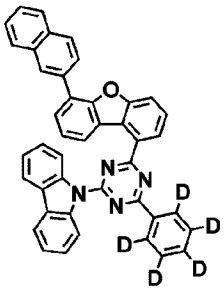
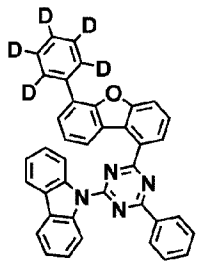
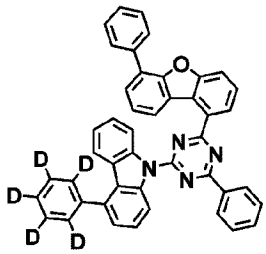
[573]

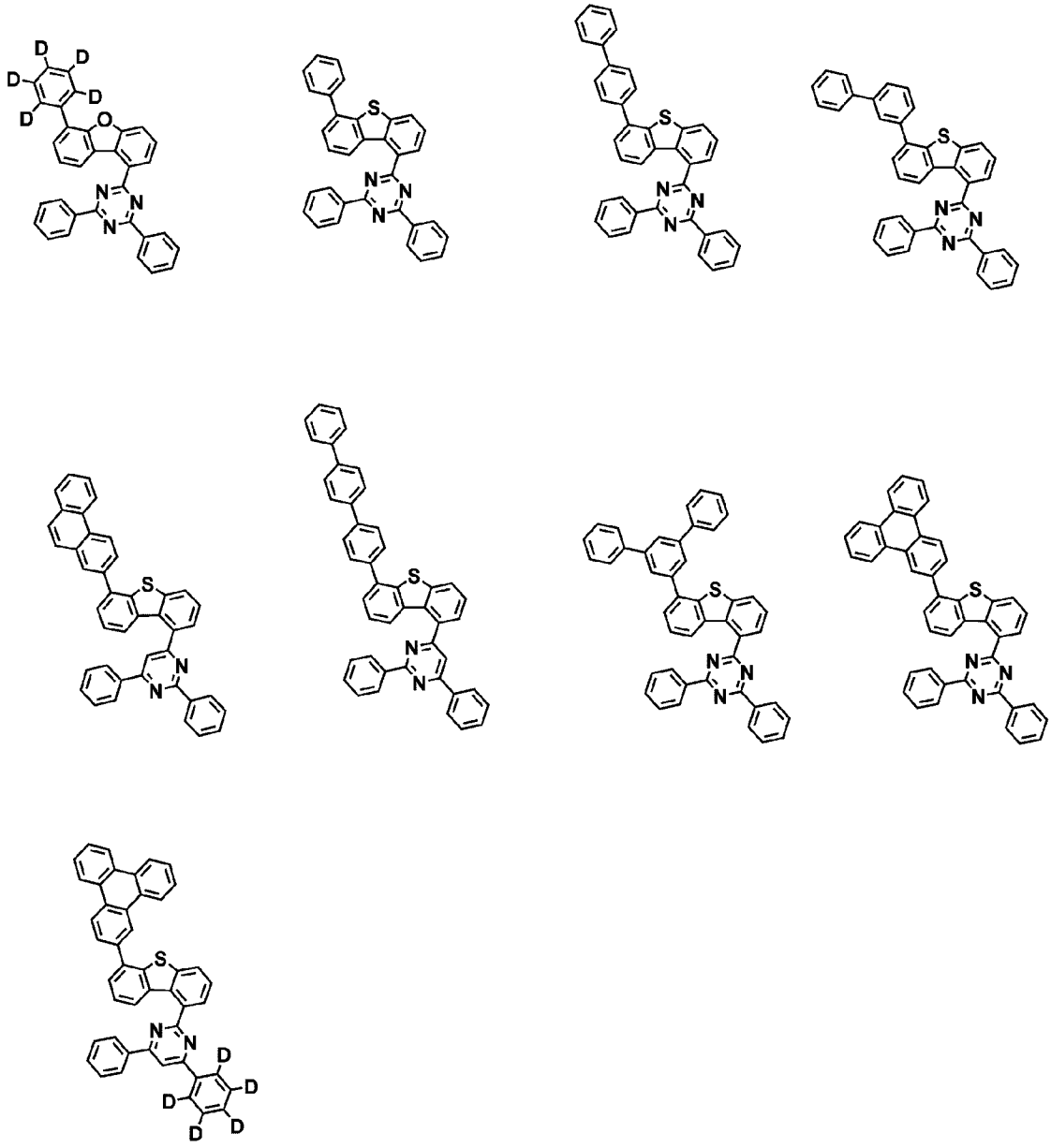
[574]



[575]

[576]



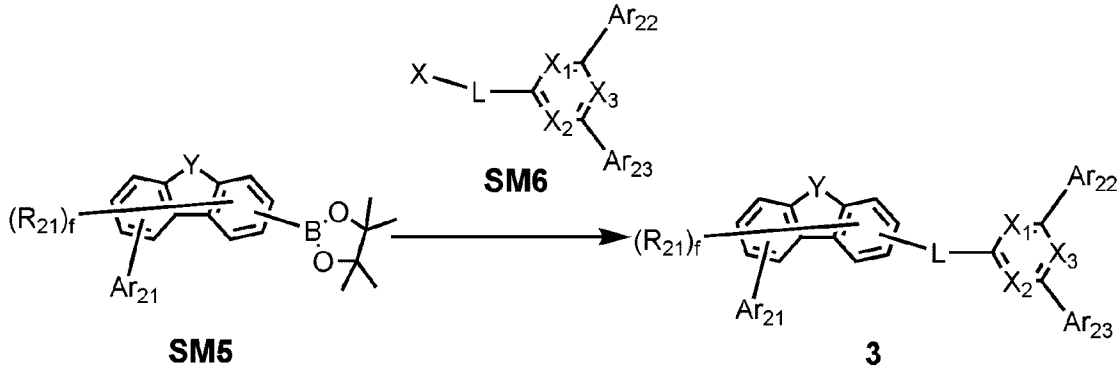
[577] .

[578]

[579] 한편, 상기 화학식 3으로 표시되는 화합물은 일례로 하기 반응식 3과 같은 제조 방법으로 제조할 수 있다.

[580] [반응식 3]

[581]



[582] 상기 반응식 3에서, X는 각각 독립적으로 할로겐이고, 바람직하게는 브로모, 또는 클로로이고, 다른 치환기에 대한 정의는 앞서 설명한 바와 같다.

[583] 구체적으로, 상기 화학식 3으로 표시되는 화합물은 Suzuki-coupling 반응을 통해 출발물질 SM5 및 SM6이 결합하여 제조된다. 이러한 Suzuki-coupling 반응은 각각 팔라듐 촉매와 염기의 존재 하에 수행하는 것이 바람직하다. 또한, 상기 Suzuki-coupling 반응을 위한 반응기는 적절히 변경될 수 있고, 화학식 3으로 표시되는 화합물의 제조 방법은 후술할 제조예에서 보다 구체화될 수 있다.

[584]

[585] 또한, 일 구현예에서, 상기 제1 화합물, 제2 화합물 및 제3 화합물 중 적어도 하나는 화합물 내에 중수소를 포함할 수 있다. 보다 구체적으로는, 상기 제2 화합물이 중수소를 포함하거나; 상기 제3 화합물이 중수소를 포함하거나; 또는 상기 제2 화합물 및 상기 제3 화합물이 동시에 중수소를 포함할 수 있다. 이와 같은 경우 발광층 내의 화합물에 포함된 중수소(D)로 인하여, 중수소 포함 화합물의 라디칼 음이온 상태의 진동에너지가 낮아져 안정된 에너지를 가질 수 있고, 이에 따라, 형성된 엑시플렉스도 보다 안정한 상태가 될 수 있다.

[586]

[587] 한편, 상기 발광층 내에 (상기 제1 화합물과 상기 제2 화합물의 중량의 합) 및 (상기 제3 화합물의 중량)의 비는 90:10 내지 10:90일 수 있다. 보다 구체적으로는, 상기 발광층 내에 (상기 제1 화합물과 상기 제2 화합물의 중량의 합) 및 (상기 제3 화합물의 중량)의 비는 90:10 내지 50:50, 또는 85:15 내지 75:25일 수 있다. 바람직하게는, 상기 발광층 내에 (상기 제1 화합물과 상기 제2 화합물의 중량의 합) 및 (상기 제3 화합물의 중량)의 비는 80:20 일 수 있다.

[588]

[589] 다시 말하여, 상기 발광층 내에 상기 제3 화합물은 상기 제1 화합물, 상기 제2 화합물 및 상기 제3 화합물의 총 중량 기준으로 10 중량% 내지 50 중량%로 포함될 수 있다. 상기 제3 화합물의 함량이 상기 제1 화합물, 상기 제2 화합물 및 상기 제3 화합물의 총 중량 기준으로 10 중량% 미만인 경우 발광층 내 전자전달이 원활하지 않아 소자 전반적으로 정공과 전자의 균형이 맞지 않게 되어, 제작된 소자의 전압, 효율 및 수명에 문제가 있을 수 있고, 50 중량%

초과하는 경우 소자의 수명이 낮아진다는 문제가 있을 수 있다.

[590]

[591] 예를 들어, 상기 발광층 내에 상기 제3 화합물은 상기 제1 화합물, 상기 제2 화합물 및 상기 제3 화합물의 총 중량 기준으로 10 중량% 이상, 15 중량% 이상이면서, 40 중량% 이하, 30 중량% 이하, 또는 25 중량% 이하일 수 있다.

[592]

[593] 또한, 상기 발광층 내에 상기 제1 화합물 및 상기 제2 화합물은 1:9 내지 9:1의 중량비로 포함될 수 있는데, 상기 발광층 내에 상기 제2 화합물이 상기 제1 화합물 대비 지나치게 적게 포함되는 경우 구동 전압이 높아지는 문제가 있을 수 있고, 지나치게 많이 포함되는 경우 효율이 낮아지는 문제가 있을 수 있다. 예를 들어, 상기 발광층 내에 상기 제1 화합물 및 상기 제2 화합물의 중량비는 2:8 내지 8:2, 2.5:7.5 내지 7:3, 2.5:7.5 내지 6:4, 또는 2.5:7.5 내지 5:5일 수 있다.
바람직하게는, 상기 제2 화합물은 상기 제1 화합물의 함량 이상으로 상기 발광층 내에 포함될 수 있다.

[594]

[595] 한편, 상기 발광층은 상기 3종의 호스트 물질 외에 도펀트 물질을 더 포함할 수 있다. 이러한 도펀트 물질로는 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 한정되는 것은 아니다. 또한, 금속 착체로는 이리듐 착체, 백금 착체 등이 있으나, 이에 한정되는 것은 아니다.

[596]

[597] 이때, 도펀트 물질은, 상기 발광층 내에 상기 호스트 물질과 상기 도펀트 물질의 총중량의 합을 기준으로 1 내지 25 중량%로 포함될 수 있다.

[598]

[599] **정공저지층**

[600] 본 발명에 따른 유기 발광 소자는 필요에 따라 발광층과 후술하는 전자수송층 사이에 정공저지층을 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.

[601]

[602] **전자수송층**

[603] 상기 전자수송층은 상기 발광층과 음극 사이에 형성되어 전자주입층으로부터 전자를 수취하여 발광층까지 전자를 수송하는 역할을 한다. 상기 전자수송층은 전자 수송 물질을 포함하고, 이러한 전자 수송 물질로는 음극으로부터 전자를 잘 주입 받아 발광층으로 옮겨줄 수 있는 물질로서, 전자에 대한 이동성이 큰 물질이 적합하다.

[604]

[605] 구체적인 전자 주입 및 수송물질의 예로는 8-히드록시퀴놀린의 Al 착물; Alq_3를 포함한 착물; 유기 라디칼 화합물; 히드록시플라본-금속 착물; 트리아진 유도체 등이 있으나, 이들에만 한정되는 것은 아니다. 또는 플루오레논, 안트라퀴노다이메탄, 다이페노퀴논, 티오피란 다이옥사이드, 옥사졸, 옥사다이아졸, 트리아졸, 이미다졸, 페릴렌테트라카복실산, 플루오레닐리덴 메탄, 안트론 등과 그들의 유도체, 금속 착체 화합물, 또는 질소 함유 5원환 유도체 등과 함께 사용할 수도 있으나, 이에 한정되는 것은 아니다.

[606]

[607] **전자주입층**

[608] 본 발명에 따른 유기 발광 소자는 필요에 따라 전자수송층과 음극 사이에 전자주입층을 포함할 수 있다.

[609]

[610] 상기 전자주입층은 상기 전자수송층과 음극 사이에 위치하여, 음극으로부터 전자를 주입하는 역할을 한다. 상기 전자주입층은 전자 주입 물질을 포함하고, 이러한 전자 주입 물질로는 전자를 수송하는 능력을 가지면서, 발광층 또는 발광 재료에 대하여 우수한 전자주입 효과를 가지며, 박막형성능력이 우수한 물질이 적합하다.

[611]

[612] 상기 전자 주입 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, 한정되는 것은 아니다.

[613]

[614] 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, 한정되는 것은 아니다.

[615]

[616] **유기 발광 소자**

[617] 본 발명에 따른 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.

[618]

[619] 도 2는 기판 (1), 양극(2), 정공주입층(5), 정공수송층(6), 전자저지층(7), 발광층(3), 정공저지층(8), 전자수송층(9), 전자주입층(10) 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.

[620]

[621] 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.

[622]

[623] 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.

[624]

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

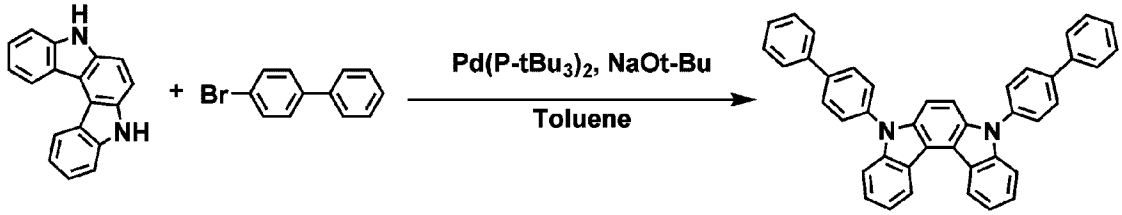
[626]

[627] 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.

[628]

[629] **제조예 1-1: 화합물 1-1의 합성**

[630]



1-1

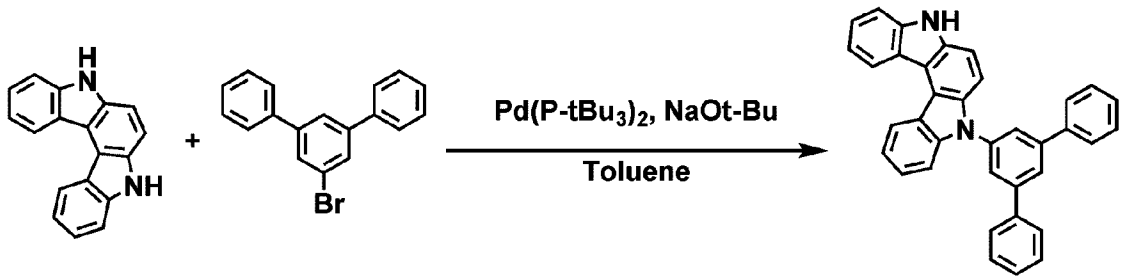
[631] 질소 분위기에서 11,12-디하이드로인돌로[2,3-a]카바졸(15.0 g, 58.5 mmol)와 4-브로모-1,1'-비페닐(30.0 g, 128.8 mmol)를 톨루엔(300 mL)에 넣고 교반 및 환류하였다. 이 후 소디움 터트-부톡사이드(16.9 g, 175.6 mmol), 비스(트리-터트-부틸포스핀)팔라듐(0)(0.9 g, 1.8 mmol)을 투입하였다. 12시간 반응 후 상온으로 식히고 클로로포름과 물을 이용하여 유기층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수 황산 마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제한 후, 승화정제를 통해 화합물 1-1을 9.8 g 제조하였다. (수율 30%, MS: $[M+H]^+$= 562)

[632]

[633] **제조예 1-2: 화합물 1-2의 합성**

[634] 단계 1) 중간체 1-2-1의 합성

[635]



1-2-1

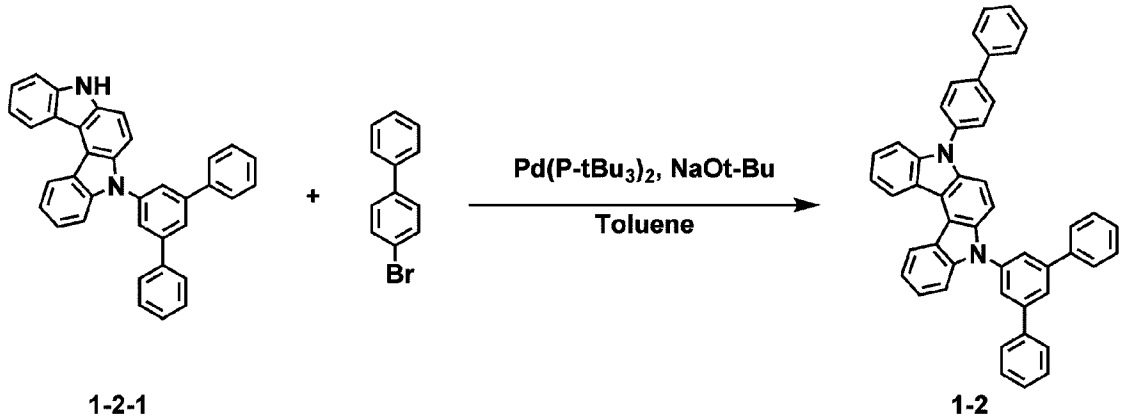
[636] 질소 분위기에서 11,12-디하이드로인돌로[2,3-a]카바졸(15.0 g, 58.5 mmol)와 5'-브로모-1,1':3',1''-터페닐(19.9 g, 64.4 mmol)를 톨루엔(300 mL)에 넣고 교반 및 환류하였다. 이 후 소디움 터트-부톡사이드(8.4 g, 87.8 mmol), 비스(트리-터트-부틸포스핀)팔라듐(0)(0.9 g, 1.8 mmol)을 투입하였다. 11시간 반응 후 상온으로 식히고 클로로포름과 물을 이용하여 유기층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에

유기층을 분리하여, 무수 황산 마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 중간체 1-2-1을 19.3 g 제조하였다. (수율 68%, MS: $[M+H]^+$= 486)

[637]

[638] 단계 2) 화합물 1-2의 합성

[639]



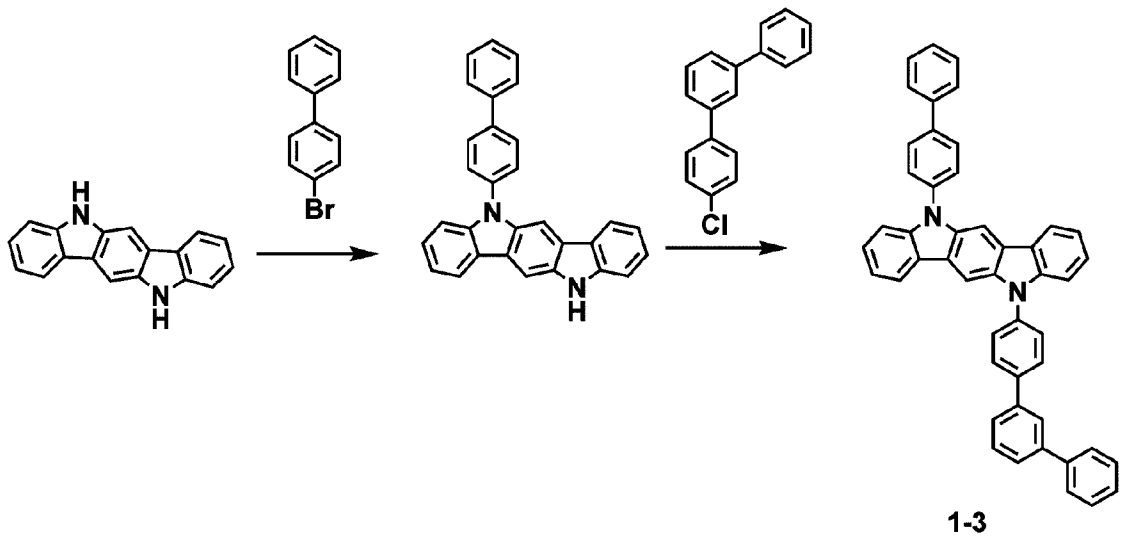
1-2-1 1-2

[640] 질소 분위기에서 중간체 1-2-1(15.0 g, 31.0 mmol)와 4-브로모-1,1'-비페닐(7.9 g, 34.0 mmol)를 톨루엔(300 mL)에 넣고 교반 및 환류하였다. 이 후 소디움 터트-부톡사이드(4.5 g, 46.4 mmol), 비스(트리-터트-부틸포스핀)팔라듐(0)(0.5 g, 0.9 mmol)을 투입하였다. 7시간 반응 후 상온으로 식히고 클로로포름과 물을 이용하여 유기층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수 황산 마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제한 후, 승화정제를 통해 화합물 1-2를 9.5 g 제조하였다. (수율 48%, MS: $[M+H]^+$= 638)

[641]

[642] **제조예 1-3: 화합물 1-3의 합성**

[643]



1-3

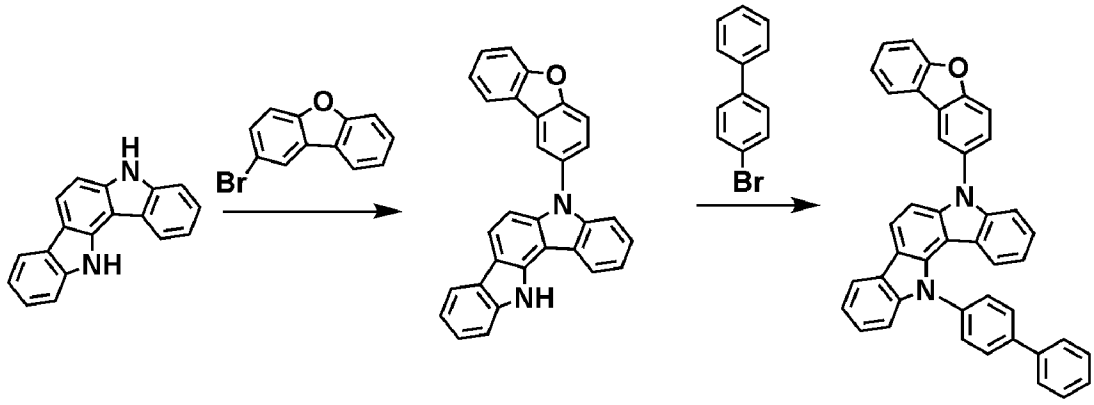
[644] 제조예 1-2에서, 5,8-디하이드로인돌로[2,3-c]카바졸을

5,11-디하이드로인돌로[3,2-b]카바졸로, 5'-브로모-1,1':3',1''-터페닐 을 4-브로모-1,1'-비페닐로, 4-브로모-1,1'-비페닐을 4-클로로-1,1':3',1''-터페닐로 변경하여 사용한 것을 제외하고는, 화합물 1-2의 제조 방법과 동일한 제조 방법으로 화합물 1-3을 제조하였다. (MS: $[M+H]^+$= 638)

[645]

[646] **제조예 1-4: 화합물 1-4의 합성**

[647]



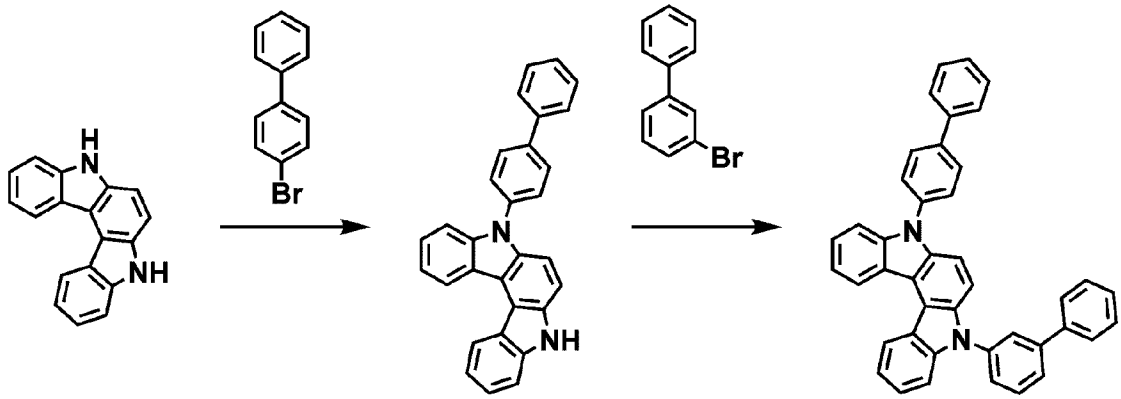
1-4

[648] 제조예 1-2에서, 5,8-디하이드로인돌로[2,3-c]카바졸을 5,12-디하이드로인돌로[3,2-a]카바졸로, 5'-브로모-1,1':3',1''-터페닐'을 2-브로모디벤조[b,d]퓨란으로 변경하여 사용한 것을 제외하고는, 화합물 1-2의 제조 방법과 동일한 제조 방법으로 화합물 1-4를 제조하였다. (MS: $[M+H]^+$= 576)

[649]

[650] **제조예 1-5: 화합물 1-5의 합성**

[651]



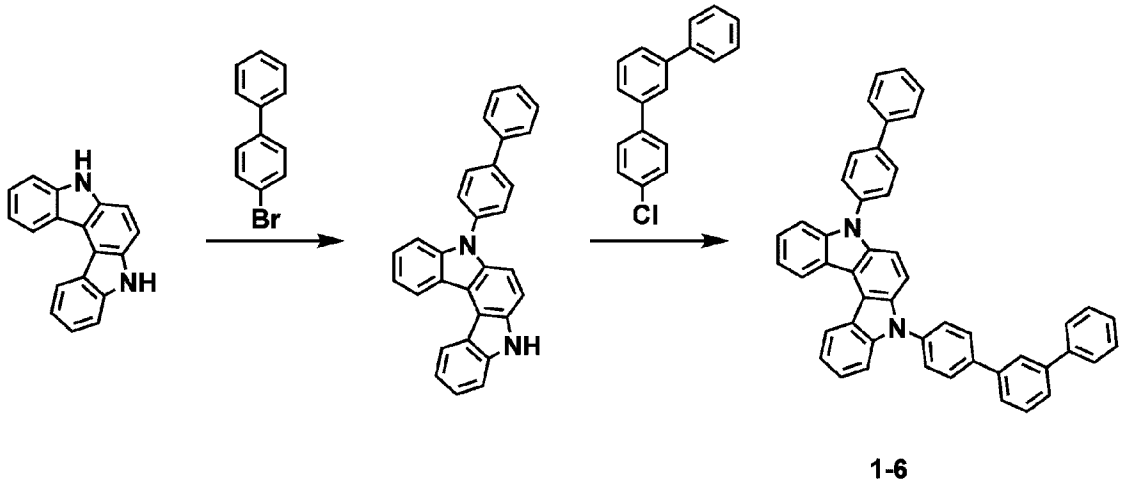
1-5

[652] 제조예 1-2에서, 5'-브로모-1,1':3',1''-터페닐'을 4-브로모-1,1'-비페닐로 4-브로모-1,1'-비페닐을 3-브로모-1,1'-비페닐로 변경하여 사용한 것을 제외하고는, 화합물 1-2의 제조 방법과 동일한 제조 방법으로 화합물 1-5를 제조하였다. (MS: $[M+H]^+$= 562)

[653]

[654] 제조예 **1-6:** 화합물 **1-6**의 합성

[655]



1-6

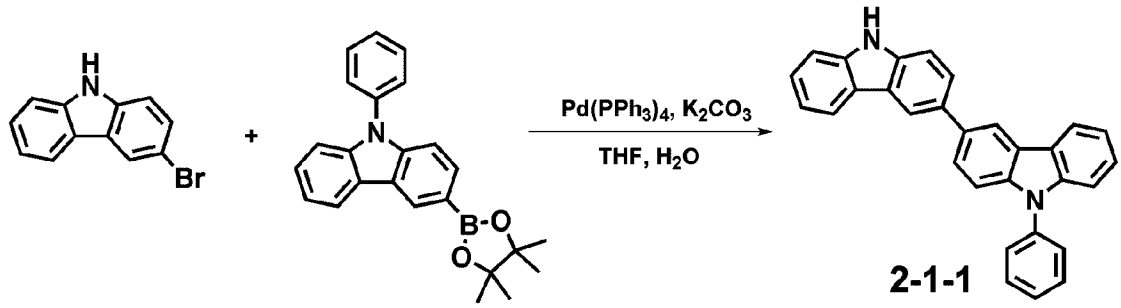
[656] 제조예 1-2에서, 5'-브로모-1,1':3',1''-터페닐'을 4-브로모-1,1'-비페닐로, 4-브로모-1,1'-비페닐을 4-클로로-1,1':3',1''-터페닐로 변경하여 사용한 것을 제외하고는, 화합물 1-2의 제조 방법과 동일한 제조 방법으로 화합물 1-6을 제조하였다. (MS: $[M+H]^+$= 638)

[657]

[658] 제조예 **2-1:** 화합물 **2-1**의 합성

[659] 단계 1) 화합물 2-1-1의 합성

[660]



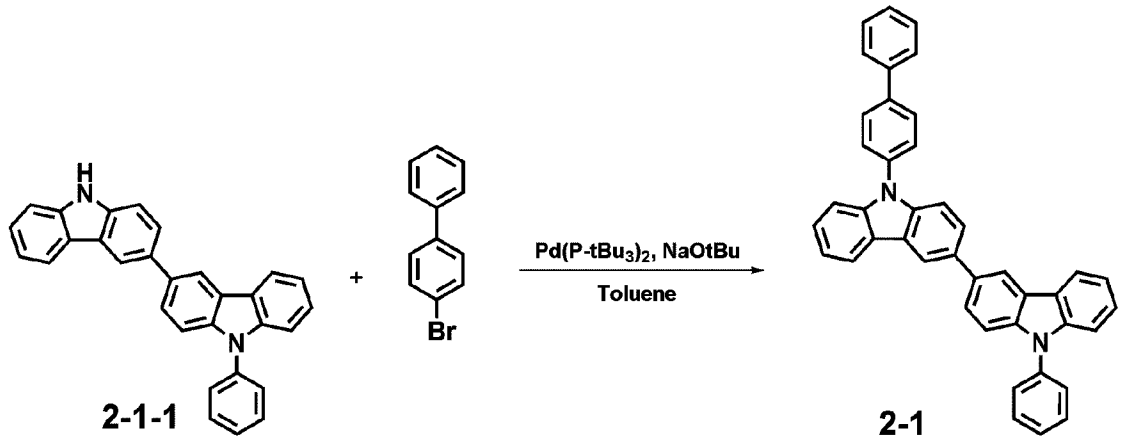
2-1-1

[661] 질소 분위기에서 3-브로모-9H-카바졸(15.0 g, 60.9 mmol)와 9-페닐-3-(4,4,5,5-테트라메틸-1,3,2-디옥사보롤란-2-일)-9H-카바졸(24.8 g, 67.0 mmol)를 THF 300mL에 넣고 교반 및 환류하였다. 이 후 포타슘 카보네이트(33.7 g, 243.8 mmol)를 물(101 mL)에 녹여 투입하고 충분히 교반한 후 테트라키스(트리페닐포스핀)팔라듐(0)(2.1 g, 1.8 mmol)을 투입하였다. 10시간 반응 후 상온으로 식히고 유기층과 물층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수 황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제하여 화합물 2-1-a를 15.2 g 제조하였다. (수율 61%, MS: $[M+H]^+$= 410)

[662]

[663] 단계 2) 화합물 2-1의 합성

[664]

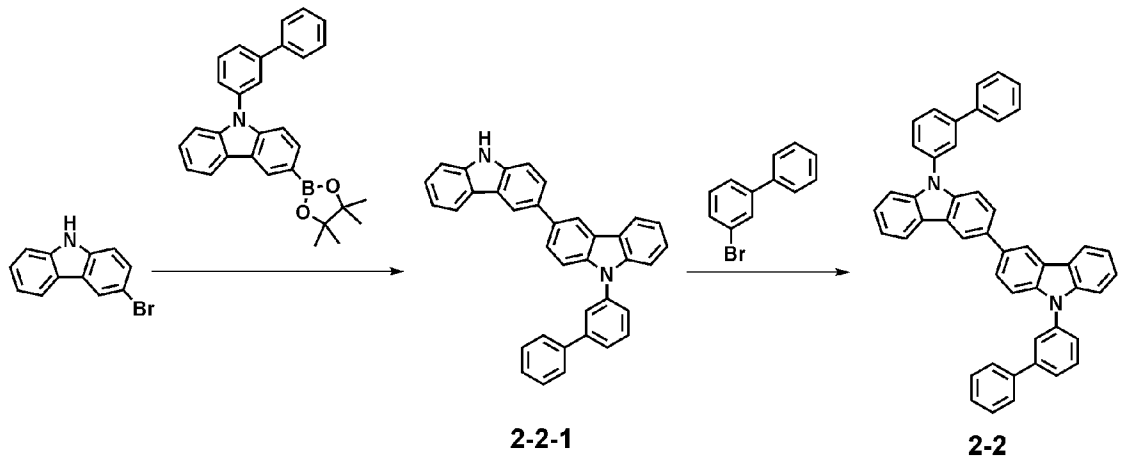


[665] 질소 분위기에서 화합물 2-1-1(15.0 g, 36.7 mmol)와 4-브로모-1,1'-비페닐(9.4 g, 40.4 mmol)를 톨루엔(300 mL)에 넣고 교반 및 환류하였다. 이 후 소디움 터트-부톡사이드(5.3 g, 55.1 mmol), 비스(트리-터트-부틸포스핀)팔라듐(0)(0.6 g, 1.1 mmol)을 투입하였다. 10시간 반응 후 상온으로 식히고 클로로포름과 물을 이용하여 유기층을 분리 후 유기층을 증류하였다. 이를 다시 클로로포름에 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수 황산 마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 실리카 겔 컬럼 크로마토그래피로 정제한 후, 승화정제를 통해 화합물 2-1을 9.7 g 제조하였다. (수율 47%, MS: $[M+H]^+$= 561)

[666]

[667] **제조예 2-2: 화합물 2-2의 합성**

[668]

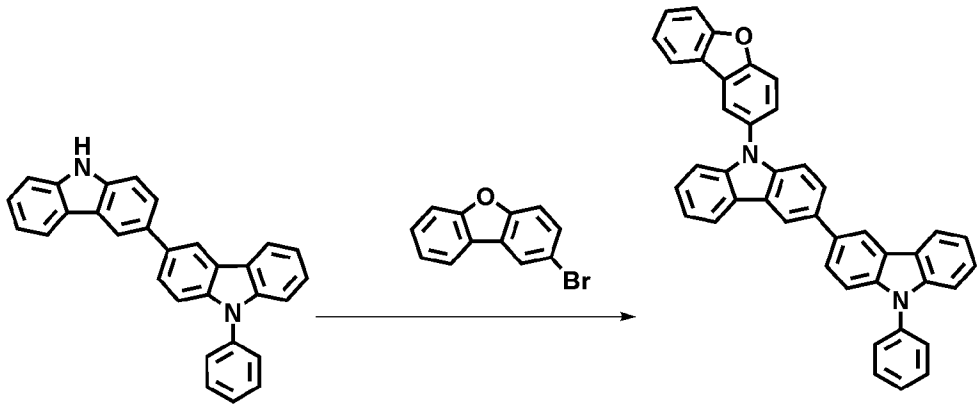


[669] 제조예 2-1에서,
9-페닐-3-(4,4,5,5-테트라메틸-1,3,2-디옥사보롤란-2-일)-9H-카바졸을 9-([1,1'-비페닐]-3-일)-3-(4,4,5,5-테트라메틸-1,3,2-디옥사보롤란-2-일)-9H-카바졸로, 4-브로모-1,1'-비페닐을 3-브로모-1,1'-비페닐로 변경하여 사용한 것을 제외하고는, 화합물 2-1의 제조 방법과 동일한 제조 방법으로 화합물 2-2를 제조하였다. (MS: $[M+H]^+$= 637)

[670]

[671] **제조예 2-3: 화합물 2-3의 합성**

[672]



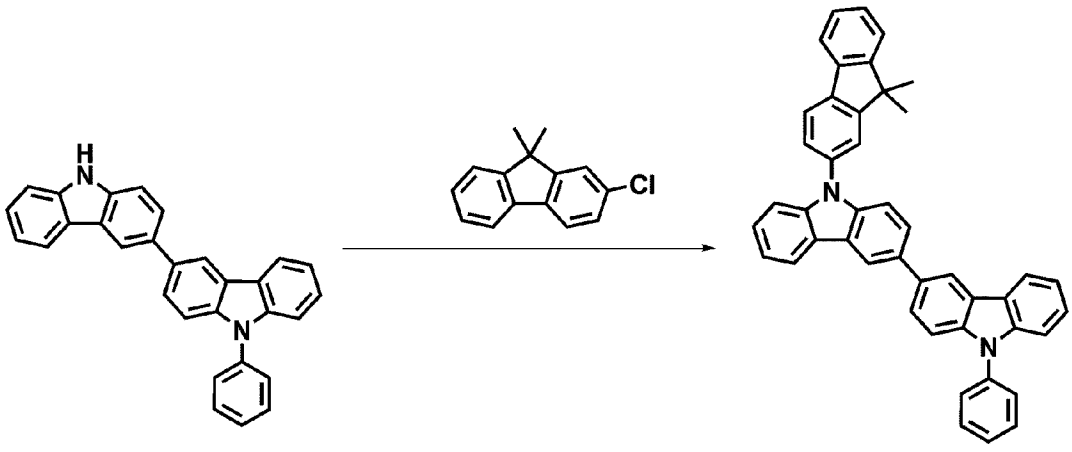
2-3

[673] 제조예 2-1의 단계 2에서, 4-브로모-1,1'-비페닐을 2-브로모디벤조[b,d]퓨란으로 변경하여 사용한 것을 제외하고는, 화합물 2-1의 제조 방법과 동일한 제조 방법으로 화합물 2-3을 제조하였다. (MS: $[M+H]^+$= 576)

[674]

[675] **제조예 2-4: 화합물 2-4의 합성**

[676]



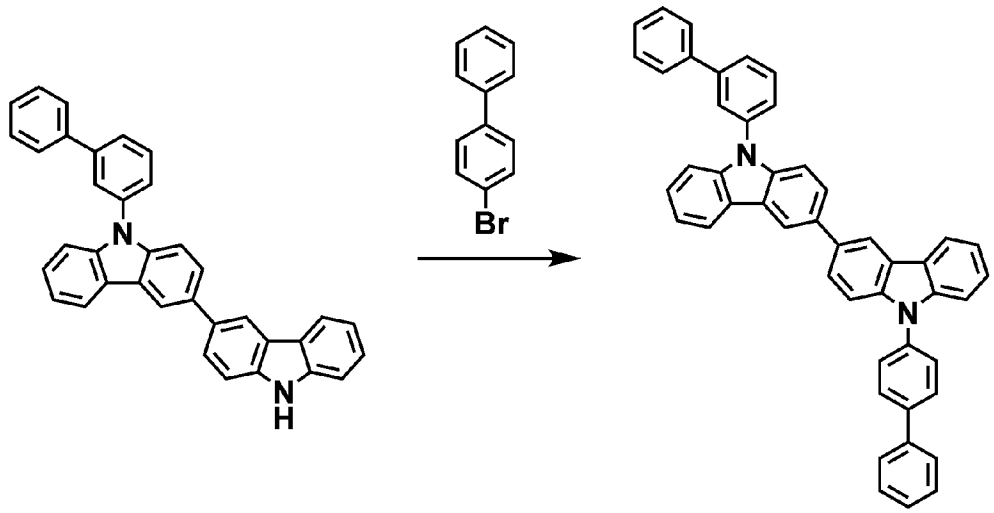
2-4

[677] 제조예 2-1에서, 4-브로모-1,1'-비페닐을 2-클로로-9,9-디메틸-9H-플루오렌으로 변경하여 사용한 것을 제외하고는, 화합물 2-1의 제조 방법과 동일한 제조 방법으로 화합물 2-4를 제조하였다. (MS: $[M+H]^+$= 602)

[678]

[679] **제조예 2-5: 화합물 2-5의 합성**

[680]



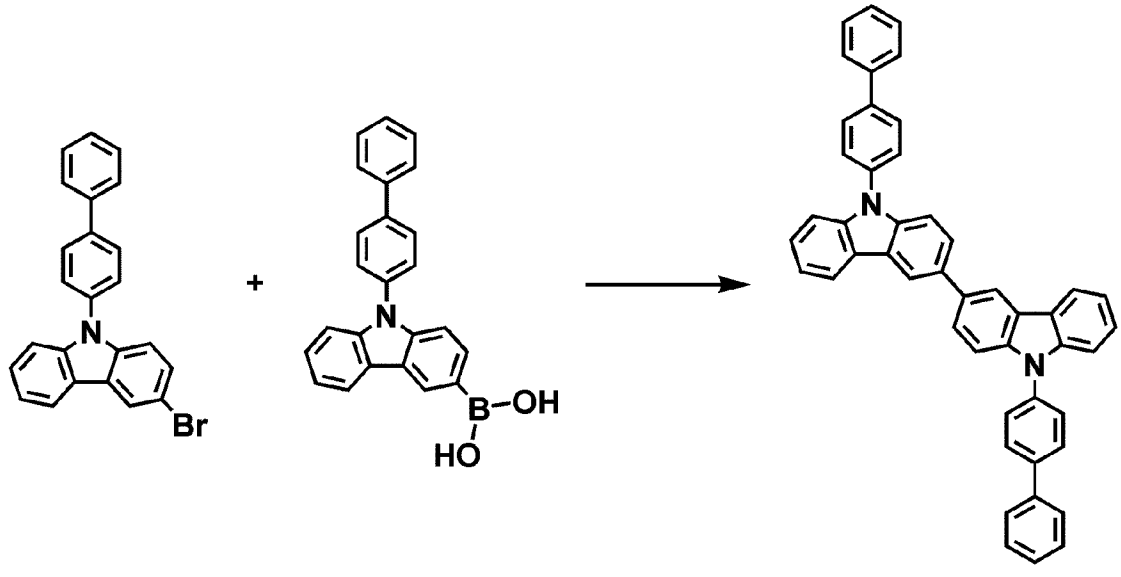
2-2-1 **2-5**

[681] 제조예 2-1의 단계 2에서, 화합물 2-1-1을 화합물 2-2-1로 변경하여 사용한 것을 제외하고는, 화합물 2-1의 제조 방법과 동일한 제조 방법으로 화합물 2-5를 제조하였다. (MS: $[M+H]^+$= 637)

[682]

[683] **제조예 2-6: 화합물 2-6의 합성**

[684]



2-6

[685] 화합물 9-(1,1'-비페닐)-4-일)-3-브로모-9H-카바졸(15 g, 37.7 mmol)과 화합물(9-([1,1'-비페닐]-4-일)-9H-카바졸-3-일)보론산(13.7 g, 37.7 mmol)을 테트라하이드로퓨란(300 mL)에 분산시킨 후, 2M 탄산칼륨수용액(aq. K_2CO_3)(100 mL, 75.3 mmol)을 첨가하고 테트라키스트리페닐포스피노팔라듐[$Pd(PPh_3)_4$](0.4 g, 1 mol%)을 넣은 후 3시간 동안 교반 환류하였다. 상온으로 온도를 낮추고 물층을 제거하여 감압 농축하고, 에틸아세테이트를 투입하여 1시간 동안 환류

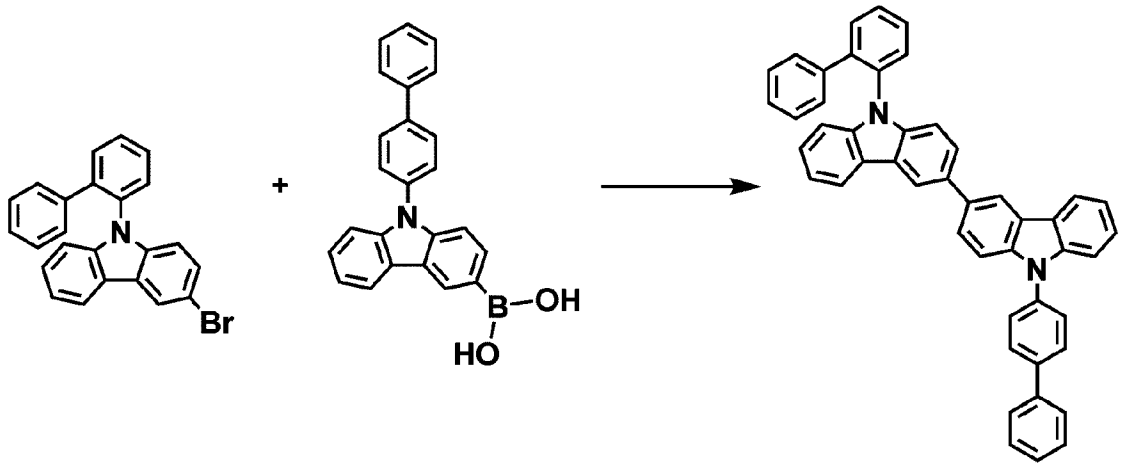
하에 교반 하여 실온으로 식힌 후 고체를 여과하였다. 얻어진 고체에 클로로포름을 넣고 환류하에 녹이고, 에틸아세테이트를 추가하여 재결정으로 화합물 2-6을 제조하였다. (13.5 g, 수율 56%, MS:[M+H]+=637)

[686]

[687]

[688] **제조예 2-7: 화합물 2-7의 합성**

[689]



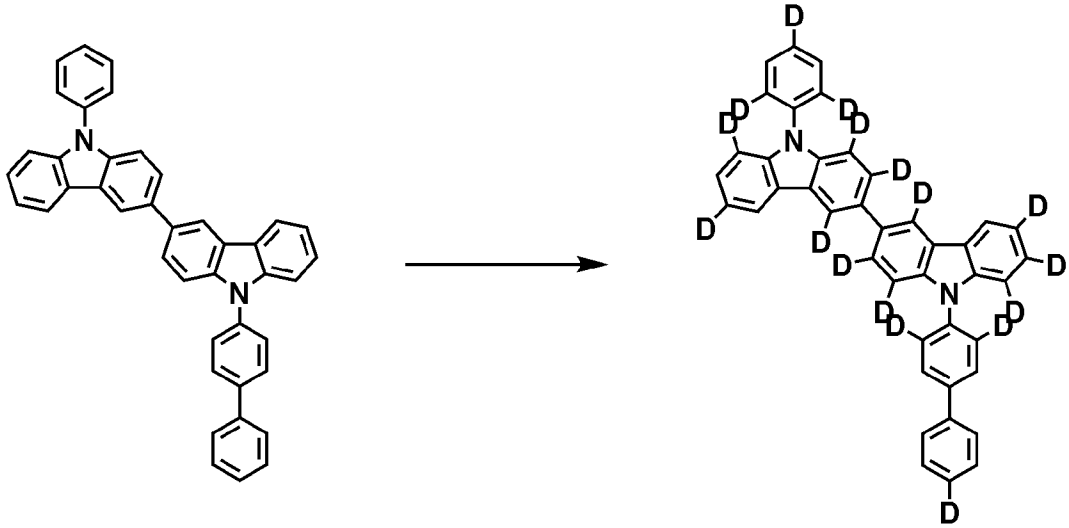
2-7

[690] 제조예 2-6에서, 화합물 9-(1,1'-비페닐)-4-일)-3-브로모-9H-카바졸을 화합물 9-([1,1'-비페닐]-2-일)-3-브로모-9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 2-6의 제조 방법과 동일한 제조 방법으로 화합물 2-7를 제조하였다. (MS: [M+H]+= 637)

[691]

[692] **제조예 2-8: 화합물 2-8의 합성**

[693]



2-1 **2-8**

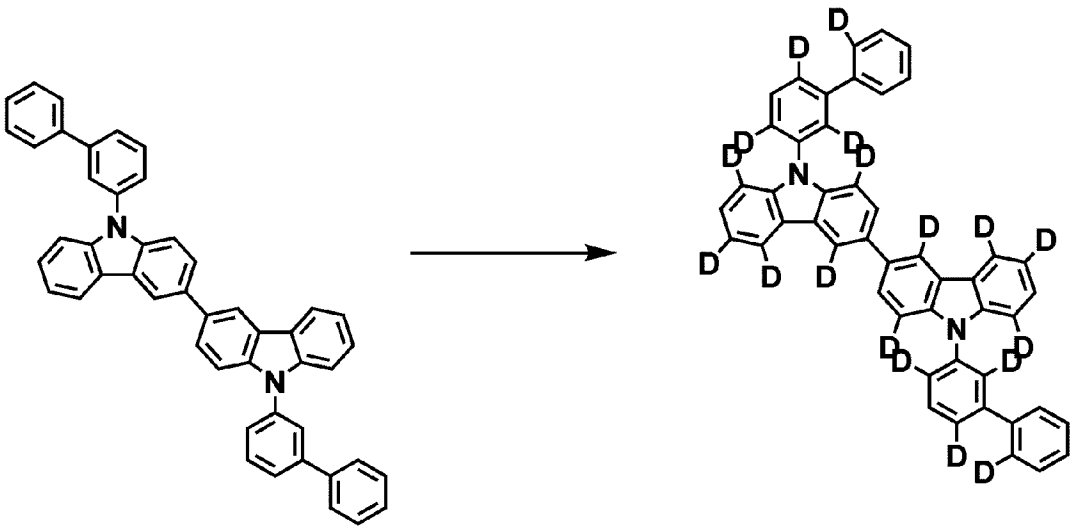
[694] 질소 분위기에서 화합물 2-1(20g, 31.41mmol)과 Benzen-D_6 200 mL에 넣고

교반하였다. 이 후 트리플릭산(3.4g, 22.65 mmol)을 넣고 가온 및 교반하였다. 4시간 반응 후 상온으로 식인 후 에탄올을 넣고 생성된 고체를 여과하였다. 고체를 클로로포름 30 배 886 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 클로로포름과 에틸아세테이트를 이용하여 실리카 컬럼을 통해 정제하여 흰색의 고체 화합물 2-8을 제조하였다. (13.2g, 64%, MS: [M+H]+ = 578.8)

[695]

[696] **제조예 2-9: 화합물 2-9의 합성**

[697]



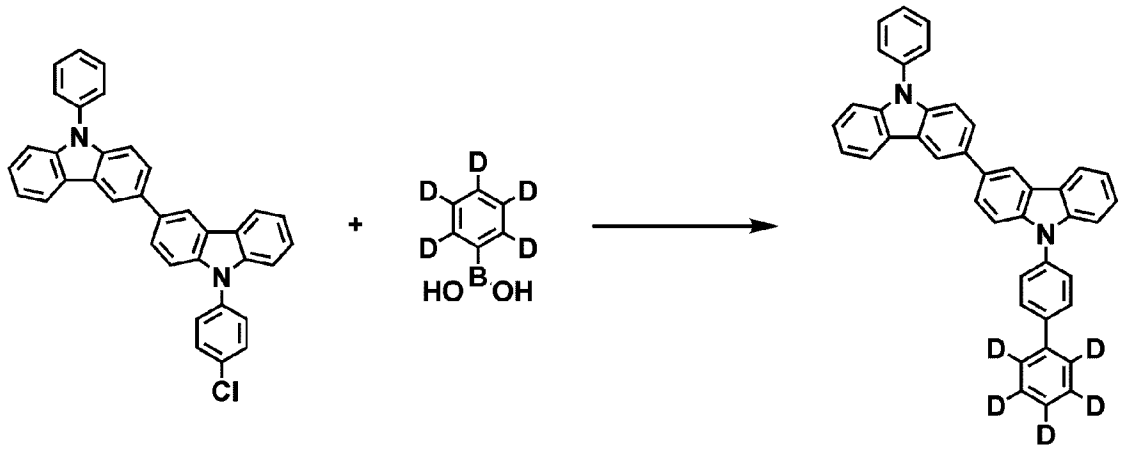
2-2 **2-9**

[698] 제조예 2-8 에서, 화합물 2-1을 화합물 2-2으로 변경하여 사용한 것을 제외하고는, 화합물 2-8의 제조 방법과 동일한 제조 방법으로 화합물 2-9를 제조하였다. (MS: $[M+H]^+$= 656)

[699]

[700] **제조예 2-10: 화합물 2-10의 합성**

[701]



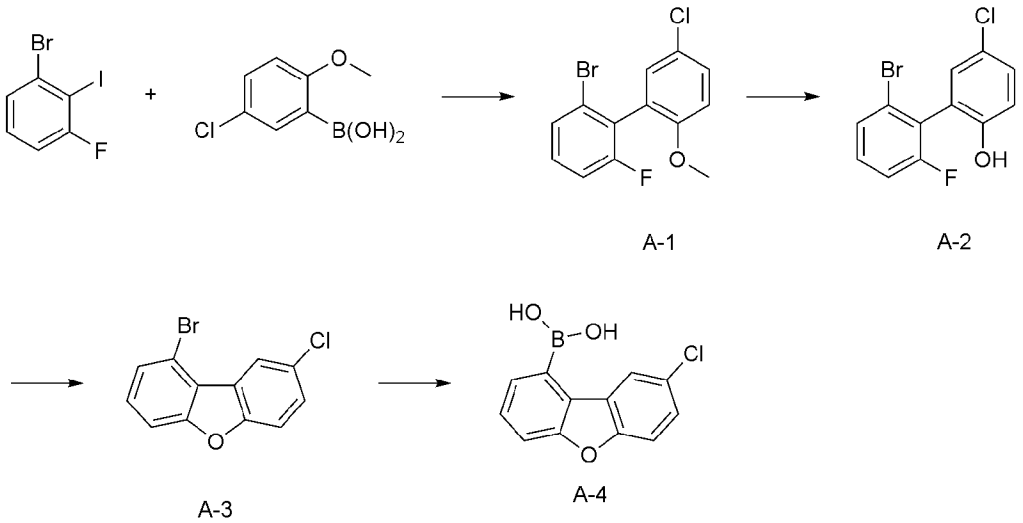
2-10

[702] 질소 분위기에서 9-([1,1'-비페닐]-3-일)-9'-(4-클로로페닐)-9H,9'H-3,3'-비카바졸(15 g, 25.2 mmol)와(페닐-d5)보론산(3.2 g, 25.2 mmol)을 다이옥신 300 mL에 넣고 교반 및 환류하였다. 이 후 제3인산칼륨(16.1 g, 75.6mmol)를 물 16 mL에 녹여 투입하고 충분히 교반한 후 디벤질리덴아세톤팔라듐(0.4 g, 0.8mmol) 및 트리사이클로헥실포스핀(0.4 g, 1.5 mmol)을 투입하였다. 9 시간 반응 후 상온으로 식인 후 생성된 고체를 여과하였다. 고체를 디클로로벤젠(DCB) 30 배 485 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 DCB과 에틸아세테이트재결정을 통해 흰색의 고체 화합물 2-10을 제조하였다. (9.9g, 61%, MS: [M+H]+ = 642.8)

[703]

[704] **제조예 3-1: 중간체 A-4의 화합물 합성**

[705]



A-1 A-2 A-3 A-4

[706] 1) 화합물 A-1의 제조

[707] 1-브로모-3-플루오로-2-아이오도벤젠(75 g, 249.3 mmol),

(5-클로로-2-메톡시페닐)보론산(51.1 g, 249.3 mmol)을 테트라하이드로퓨란 550 mL에 녹였다. 여기에 탄산나트륨(Na_2CO_3) 2 M 용액(350 mL), 테트라키스(트리페닐포스핀)팔라듐(0)(2.88 g, 2.49 mmol)을 넣고 11시간 환류시켰다. 반응이 끝난 후 상온으로 냉각시키고, 물 층을 분리하여 제거하고 무수황산마그네슘으로 건조한 후 감압농축 시킨 혼합물을 클로로포름과 에탄올을 이용하여 재결정화시켜 화합물 A-1(63.2 g, 수율 80 %; MS:$[M+H]^+$ =314)을 얻었다.

[708]

[709] 2) 화합물 A-2의 제조

[710] 화합물 A-1(63.2 g, 200.3 mmol)을 디클로로메탄 750 mL에 녹인 뒤 0℃로 냉각시켰다. 보론 트리브로마이드(20.0 mL, 210.3 mmol)를 천천히 적가한 뒤 12시간 동안 교반하였다. 반응이 종료된 후 물로 3회 세척하고, 황산 마그네슘으로 건조하여 여과한 여액을 감압 증류하고 컬럼크로마토크래피로 정제하여 화합물 A-2(57.9 g, 수율 96 %; MS:$[M+H]^+$=300)을 얻었다.

[711]

[712] 3) 화합물 A-3의 제조

[713] 화합물 A-2(57.9 g, 192.0 mmol)와 탄산칼슘(79.6 g, 576.0 mol)을 N-methyl-2-pyrrolidone 350 mL에 녹인 후 2 시간 동안 가열 교반하였다. 상온으로 온도를 낮추고 물에 역침전시켜 필터한다. 디클로로멘탄에 완전히 녹인 후 물로 씻어주고 무수황산마그네슘으로 건조한 후 감압농축 시키고 에탄올을 이용하여 재결정화시켜 건조하여 화합물 A-3(42.1 g, 수율 78 %; MS:$[M+H]^+$=280)을 얻었다.

[714]

[715] 4) 화합물 A-4의 제조

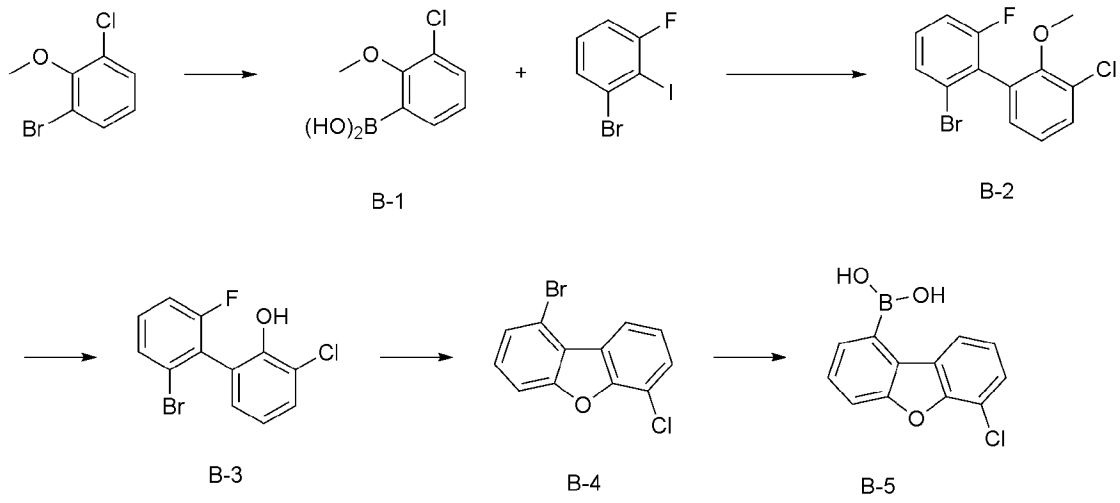
[716] 화합물 A-3(42.1 g, 149.5 mmol)을 테트라하이드로퓨란(330 mL)에 녹인 후, -78℃로 온도를 낮추고 2.5 M 터트-부틸리튬(t-BuLi)(60.4 mL, 151.0 mmol)을 천천히 가하였다. 동일 온도에서 1시간 동안 교반한 후 트리아이소프로필보레이트(51.8 mL, 224.3 mmol)을 가하고, 상온으로 온도를 서서히 올리면서 3시간동안 교반하였다. 반응 혼합물에 2 N 염산수용액(300 mL)을 가하고 1.5시간 동안 상온에서 교반하였다. 생성된 침전물을 거르고 물과 에틸에테르(ethyl ether)로 차례로 씻은 후 진공 건조하여 중간체 A-4(34.3 g, 수율 93 %; MS:$[M+H]^+$=247)을 제조하였다.

[717]

[718] **제조예 3-2: 중간체 B-5의 화합물 합성**

[719]

[720]



[721] 1) 화합물 B-1의 제조

[722] 1-브로모-3-클로로-2-메톡시벤젠(100.0 g, 451.5 mmol)을 테트라하이드로퓨란(1000 mL)에 녹인 후, -78℃로 온도를 낮추고 2.5 M 터셔리-부틸리튬(t-BuLi)(182.4 mL, 456.0 mmol)을 천천히 적가하였다. 동일 온도에서 1시간 동안 교반한 후 트리아이소프로필보레이트($B(OiPr)_3$)(156.3 mL, 677.3 mmol)을 가하고, 상온으로 온도를 서서히 올리면서 3시간 동안 교반하였다. 반응 혼합물에 2 N 염산 수용액(150 mL)을 가하고 1.5시간 동안 상온에서 교반하였다. 생성된 침전물을 거르고 물과 에틸에테르(ethyl ether)로 차례로 씻은 후 진공 건조하였다. 건조 후 클로로포름과 에틸아세테이트로 재결정하고 건조하여 화합물 B-1(84.2 g, 수율 90%; MS:$[M+H]^+$=230)을 제조하였다.

[723]

[724] 2) 화합물 B-2의 제조

[725] (5-클로로-2-메톡시페닐)보론산 대신 화합물 B-1(84.2 g, 451.7 mmol)을 사용한 것을 제외하고는, 제조예 3-1의 화합물 A-1 을 제조하는 방법과 동일한 방법으로 화합물 B-2(74.6 g, 수율 52%; MS:$[M+H]^+$=314)을 제조하였다.

[726]

[727] 3) 화합물 B-3의 제조

[728] 화합물 A-1 대신 화합물 B-2(74.6g, 236.4 mmol) 를 사용한 것을 제외하고 화합물 A-2 를 제조하는 방법과 동일한 방법으로 화합물 B-3(60.3 g, 수율 85%; MS:$[M+H]^+$=300)을 제조하였다.

[729]

[730] 4) 화합물 B-4의 제조

[731] 화합물 A-2 대신 화합물 B-3(60.3g, 199.9 mmol) 를 사용한 것을 제외하고 화합물 A-3 를 제조하는 방법과 동일한 방법으로 화합물 B-4(48.1 g, 수율 85%; MS:$[M+H]^+$=280)을 제조하였다.

[732]

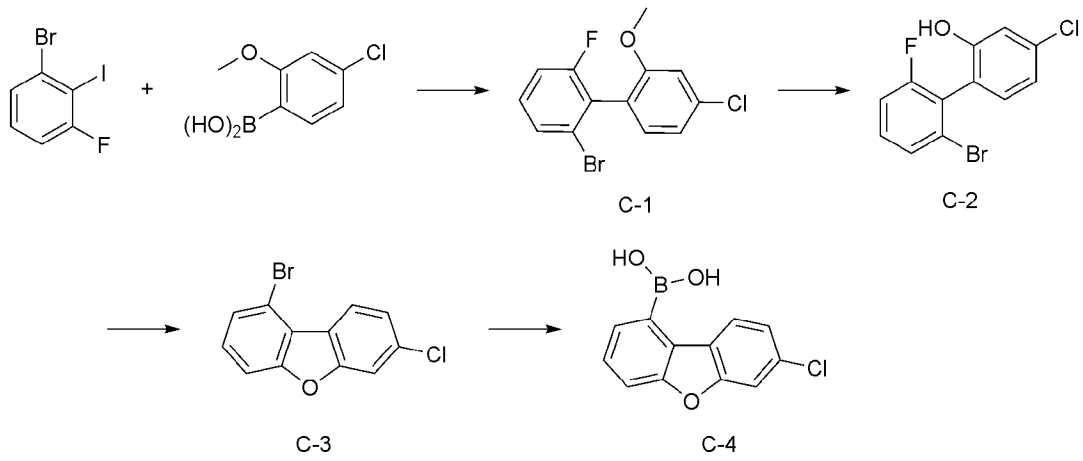
[733] 5) 화합물 B-5의 제조

[734] 화합물 A-3 대신 화합물 B-3(48.1g, 170.9 mmol) 를 사용한 것을 제외하고 화합물 A-4 를 제조하는 방법과 동일한 방법으로 화합물 B-5(40.1 g, 수율 95%; MS:[M+H]$^+$=247)을 제조하였다.

[735]

[736] **제조예 3-3: 중간체 C-4의 화합물 합성**

[737]



[738] 1) 화합물 C-1의 제조

[739] (5-클로로-2-메톡시페닐)보론산 대신(4-클로로-2-메톡시페닐)보론산(51.1 g, 249.3 mmol)을 사용한 것을 제외하고는, 제조예 1의 화합물 A-1 을 제조하는 방법과 동일한 방법으로 화합물 C-1(60.1 g, 수율 76%; MS:[M+H]$^+$=314)을 제조하였다.

[740]

[741] 2) 화합물 C-2의 제조

[742] 화합물 A-1 대신 화합물 C-1(60.1 g, 190.4 mmol) 를 사용한 것을 제외하고 화합물 A-2 를 제조하는 방법과 동일한 방법으로 화합물 C-2(54.0 g, 수율 94%; MS:[M+H]$^+$=300)을 제조하였다.

[743]

[744] 3) 화합물 C-3의 제조

[745] 화합물 A-2 대신 화합물 C-2(54.0g, 179.1 mmol) 를 사용한 것을 제외하고 화합물 A-3 를 제조하는 방법과 동일한 방법으로 화합물 C-4(42.2 g, 수율 83%; MS:[M+H]$^+$=280)을 제조하였다.

[746]

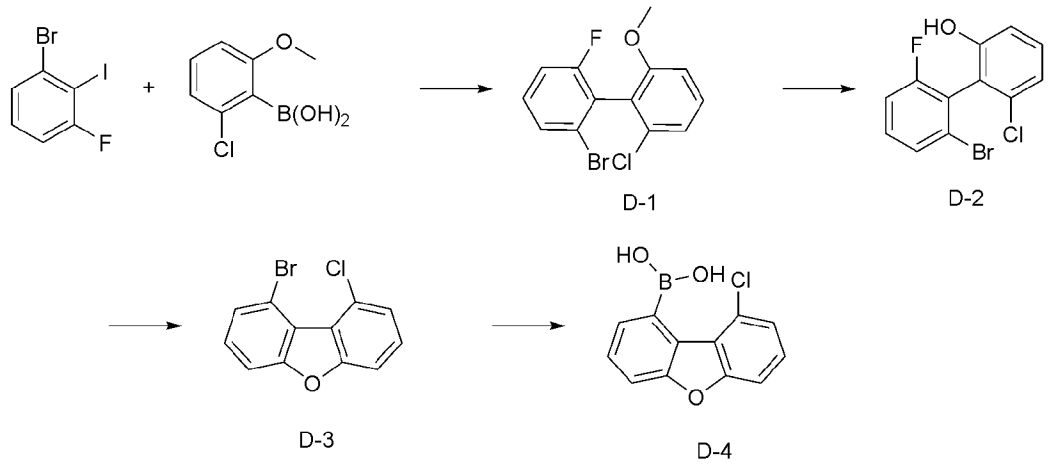
[747] 4) 화합물 C-4의 제조

[748] 화합물 A-3 대신 화합물 C-3(42.2g, 170.9 mmol) 를 사용한 것을 제외하고 화합물 A-4 를 제조하는 방법과 동일한 방법으로 화합물 C-4(34.1 g, 수율 92%; MS:[M+H]$^+$=247)을 제조하였다.

[749]

[750] **제조예 3-4: 중간체 D-4의 화합물 합성**

[751]



[752] 1) 화합물 D-1의 제조

[753] (5-클로로-2-메톡시페닐)보론산 대신(2-클로로-6-메톡시페닐)보론산(51.1 g, 249.3 mmol)을 사용한 것을 제외하고는, 제조예 1의 화합물 A-1 을 제조하는 방법과 동일한 방법으로 화합물 D-1(63.5 g, 수율 81%; MS:$[M+H]^+$=314)을 제조하였다.

[754]

[755] 2) 화합물 D-2의 제조

[756] 화합물 A-1 대신 화합물 D-1(63.5 g, 201.2 mmol) 를 사용한 것을 제외하고 화합물 A-2 를 제조하는 방법과 동일한 방법으로 화합물 D-2(55.1 g, 수율 91%; MS:$[M+H]^+$=300)을 제조하였다.

[757]

[758] 3) 화합물 D-3의 제조

[759] 화합물 A-2 대신 화합물 C-2(55.1g, 182.7 mmol) 를 사용한 것을 제외하고 화합물 A-3 를 제조하는 방법과 동일한 방법으로 화합물 C-3(42.0 g, 수율 82%; MS:$[M+H]^+$=280)을 제조하였다.

[760]

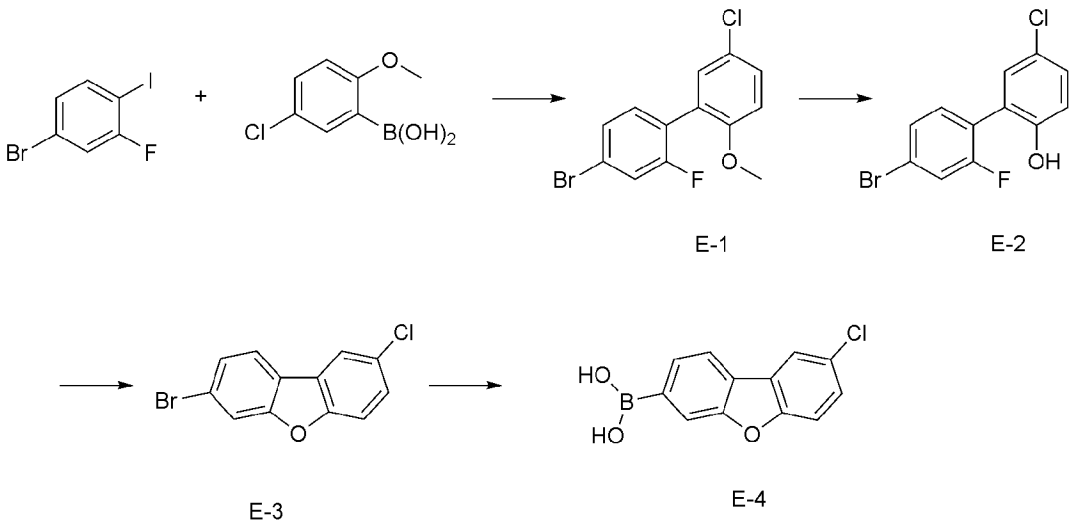
[761] 4) 화합물 D-4의 제조

[762] 화합물 A-3 대신 화합물 C-3(42.0g, 149.2 mmol) 를 사용한 것을 제외하고 화합물 A-4 를 제조하는 방법과 동일한 방법으로 화합물 C-4(35.7 g, 수율 85%; MS:$[M+H]^+$=247)을 제조하였다.

[763]

[764] **제조예 3-5: 중간체 E-4의 화합물 합성**

[765]

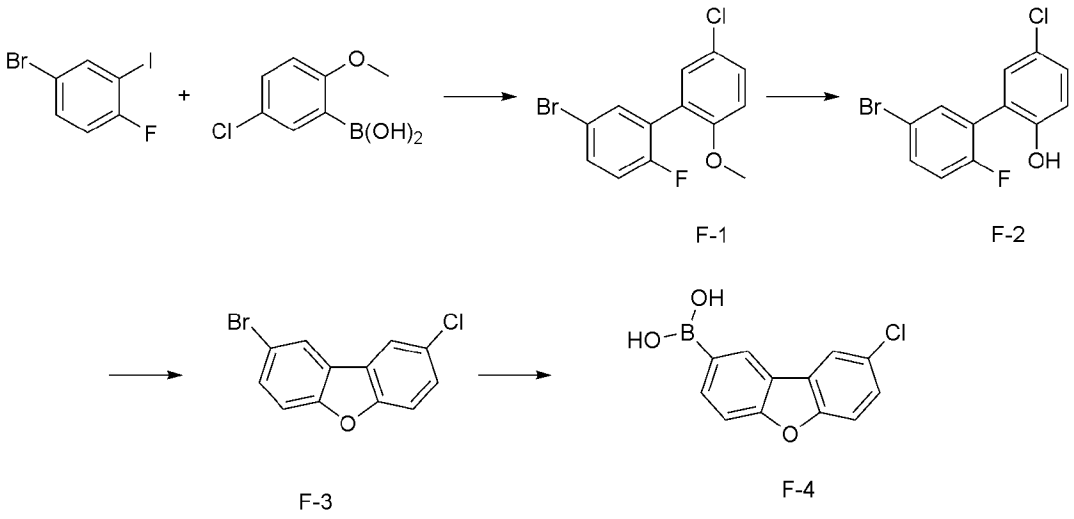


[766] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 4-브로모-2-플루오로-1-아이오도벤젠으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 E-4를 제조하였다. (MS: $[M+H]^+$= 247)

[767]

[768] **제조예 3-6: 중간체 F-4의 화합물 합성**

[769]

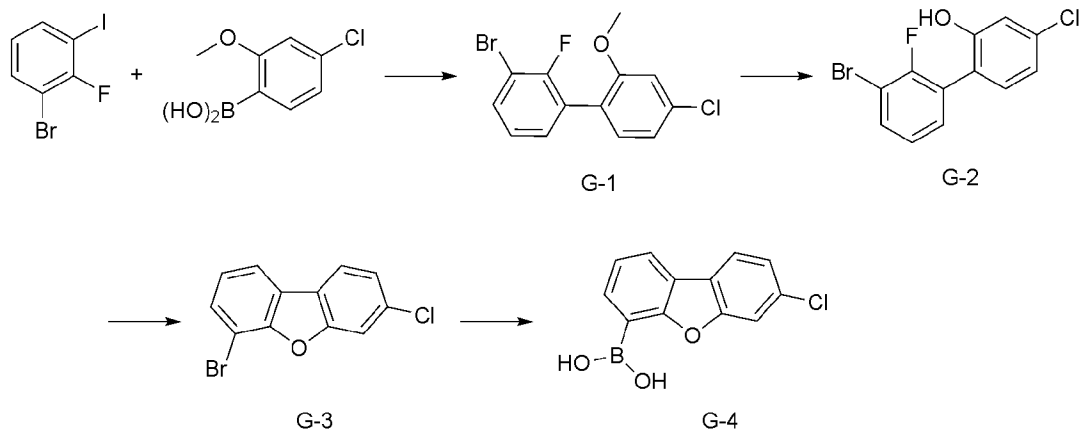


[770]

[771] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 4-브로모-1-플루오로-2-아이오도벤젠으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 F-4를 제조하였다. (MS: $[M+H]^+$= 247)

[772]

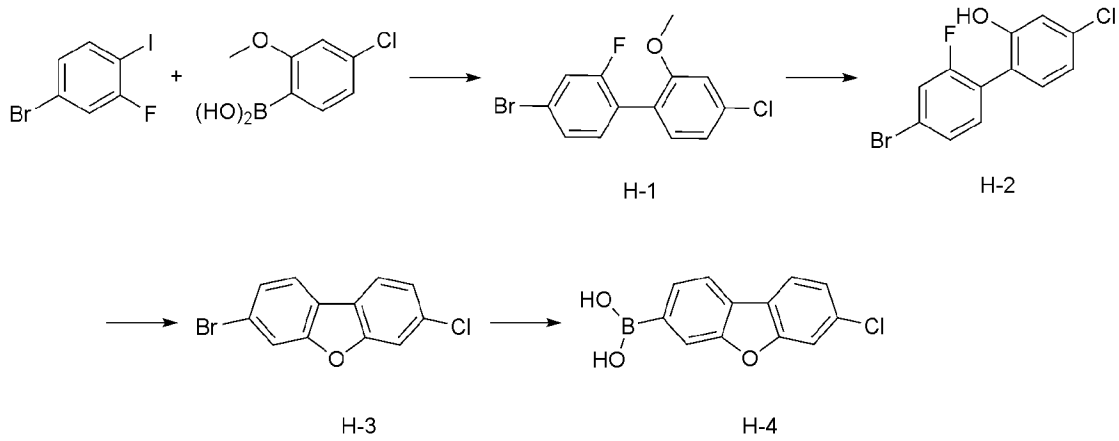
[773] **제조예 3-7: 중간체 G-4의 화합물 합성**

[774] 

[775] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 1-브로모-2-플루오로-3-아이오도벤젠으로, (5-클로로-2-메톡시페닐)보론산을(4-클로로-2-메톡시페닐)보론산으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 G-4를 제조하였다. (MS: $[M+H]^+$= 247)

[776]

[777] **제조예 3-8: 중간체 H-4의 화합물 합성**

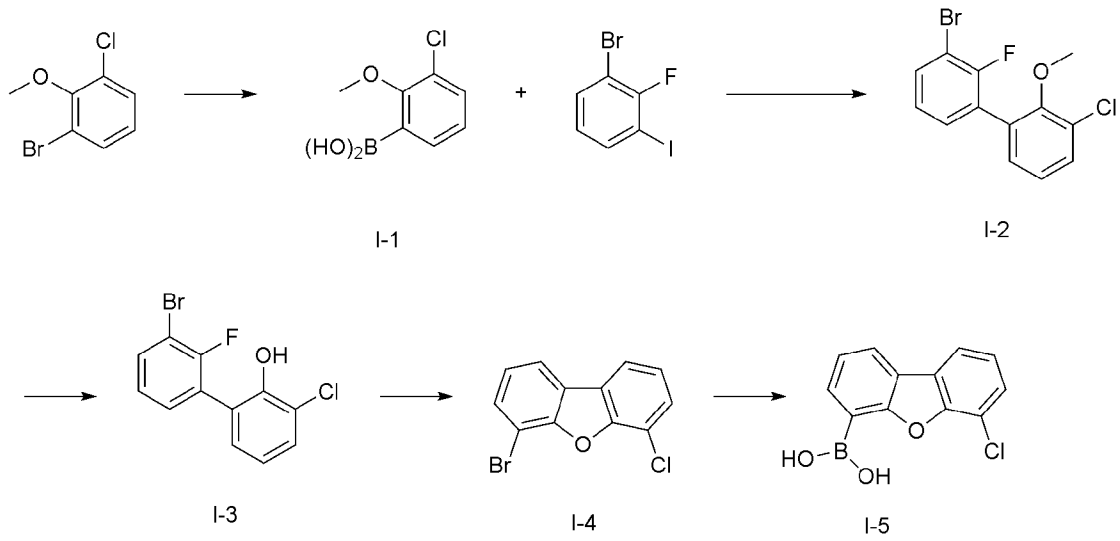
[778] 

[779] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 4-브로모-2-플루오로-1-아이오도벤젠으로, (5-클로로-2-메톡시페닐)보론산을 (4-클로로-2-메톡시페닐)보론산으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 H-4를 제조하였다. (MS: $[M+H]^+$ = 247)

[780]

[781] **제조예 3-9: 중간체 I-5의 화합물 합성**

[782]

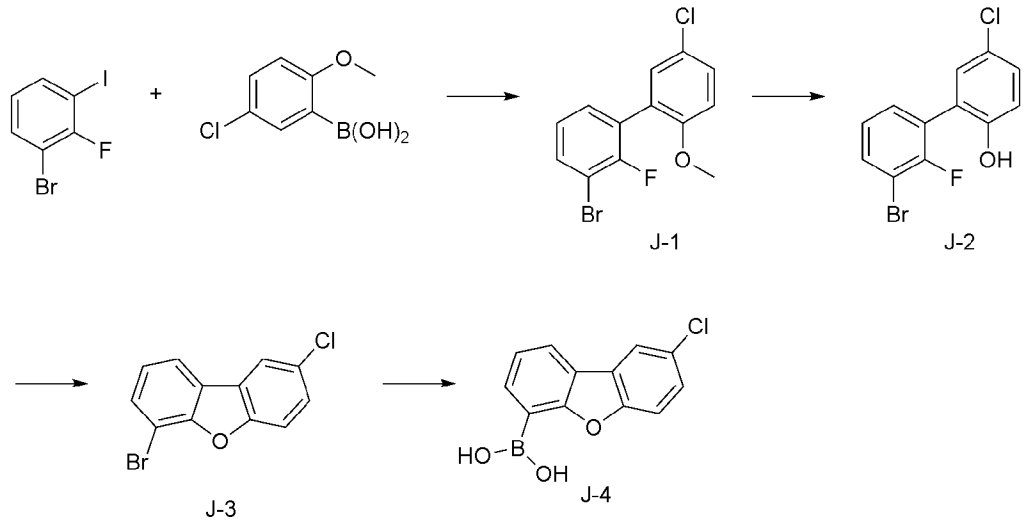


[783] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 1-브로모-2-플루오로-3-아이오도벤젠으로, (5-클로로-2-메톡시페닐)보론산을 화합물 3-2의 제조 방법으로 동일하게 만든 화합물 I-1로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 I-5를 제조하였다. (MS: $[M+H]^+$= 247)

[784]

[785] **제조예 3-10: 중간체 J-4의 화합물 합성**

[786]



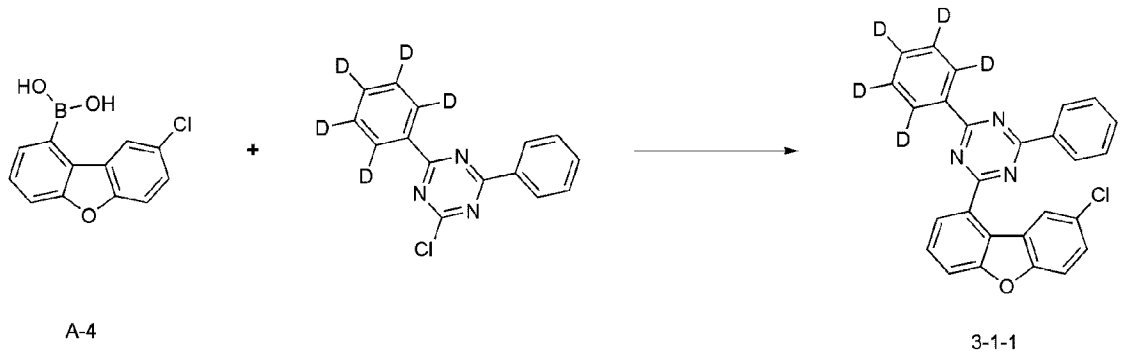
[787] 제조예 3-1에서, 1-브로모-3-플루오로-2-아이오도벤젠을 1-브로모-2-플루오로-3-아이오도벤젠으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 제조 방법과 동일한 제조 방법으로 화합물 J-4를 제조하였다. (MS: $[M+H]^+$= 247)

[788]

[789] **제조예 3-11: 화합물 3-1의 합성**

[790] 단계 1) 중간체 3-1-1의 합성

[791]



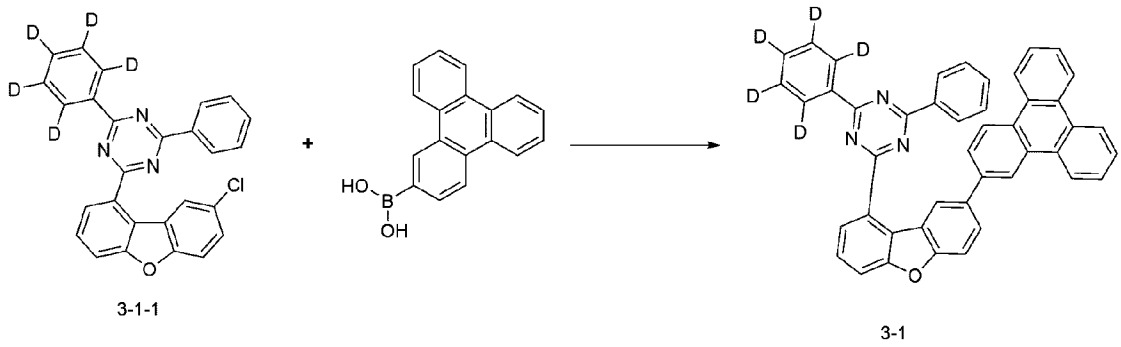
A-4 3-1-1

[792] 질소 분위기에서 A-4(20 g, 81.2 mmol)와 2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진(22.1 g, 81.2 mmol)를 테트라하이드로퓨란 500 mL에 넣고 교반 및 환류하였다. 이 후 포타슘카보네이트(33.6 g, 243.5 mmol)를 물34 mL에 녹여 투입하고 충분히 교반한 후 비스(트리 터셔리-부틸포스핀)팔라듐(1.2 g, 2.4 mmol)을 투입하였다. 7시간 반응 후 상온으로 식인 후 생성된 고체를 여과하였다. 고체를 테트라하이드로퓨란 1781 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 테트라하이드로퓨란과 에틸아세테이트 재결정을 통해 흰색의 고체 화합물 3-1-1(27.4g, 77%, MS: [M+H]+ = 439.9)을 제조하였다.

[793]

[794] 단계 2) 화합물 3-1의 합성

[795]



3-1-1 3-1

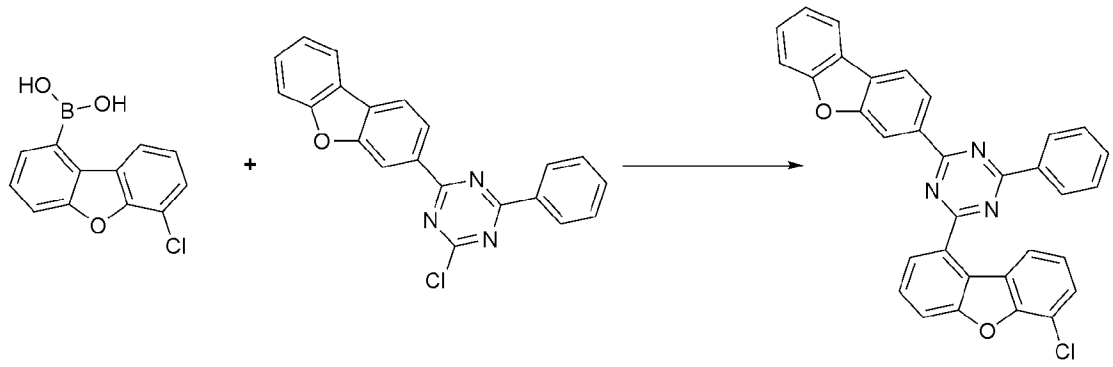
[796] 질소 분위기에서 3-1-1(10 g, 22.8 mmol)와 트라이페닐렌-2-일보론산(6.2 g, 22.8 mmol)를 Diox 200 mL에 넣고 교반 및 환류하였다. 이 후 제3인산칼륨(14.5 g, 68.3 mmol)를 물 15 mL에 녹여 투입하고 충분히 교반한 후 디벤질리덴아세톤팔라듐(0.4 g, 0.7 mmol) 및 트리사이클로헥실포스핀(0.4 g, 1.4 mmol)을 투입하였다. 7 시간 반응 후 상온으로 식인 후 생성된 고체를 여과하였다. 고체를 디클로로벤젠 431 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 디클로로벤젠과 에틸아세테이트 재결정을 통해 고체 화합물 3-1(10.5g, 73%, MS: [M+H]+ = 631.8)을 제조하였다.

[797]

[798] **제조예 3-12: 화합물 3-2의 합성**

[799] 단계 1) 중간체 3-2-1의 합성

[800]



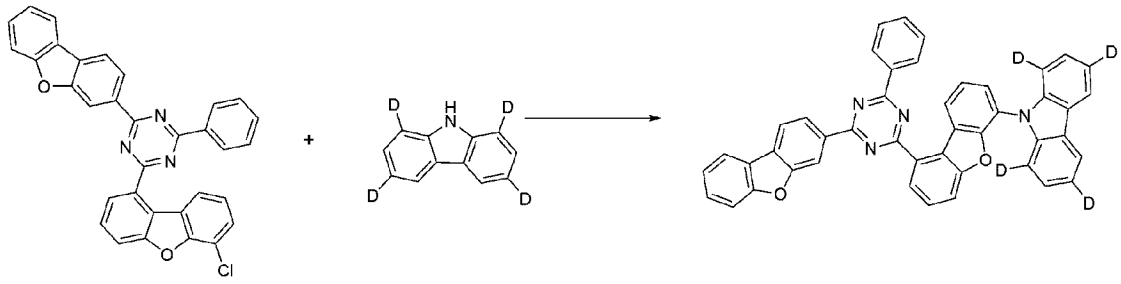
B-5 **3-2-1**

[801] 제조예 3-11 단계 1에서, A-4을 B-5로,
2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진을
2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 단계1의 제조 방법과 동일한 제조 방법으로 화합물 3-2-1를 제조하였다. (MS: $[M+H]^+$= 524)

[802]

[803] 단계 2) 화합물 3-2의 합성

[804]



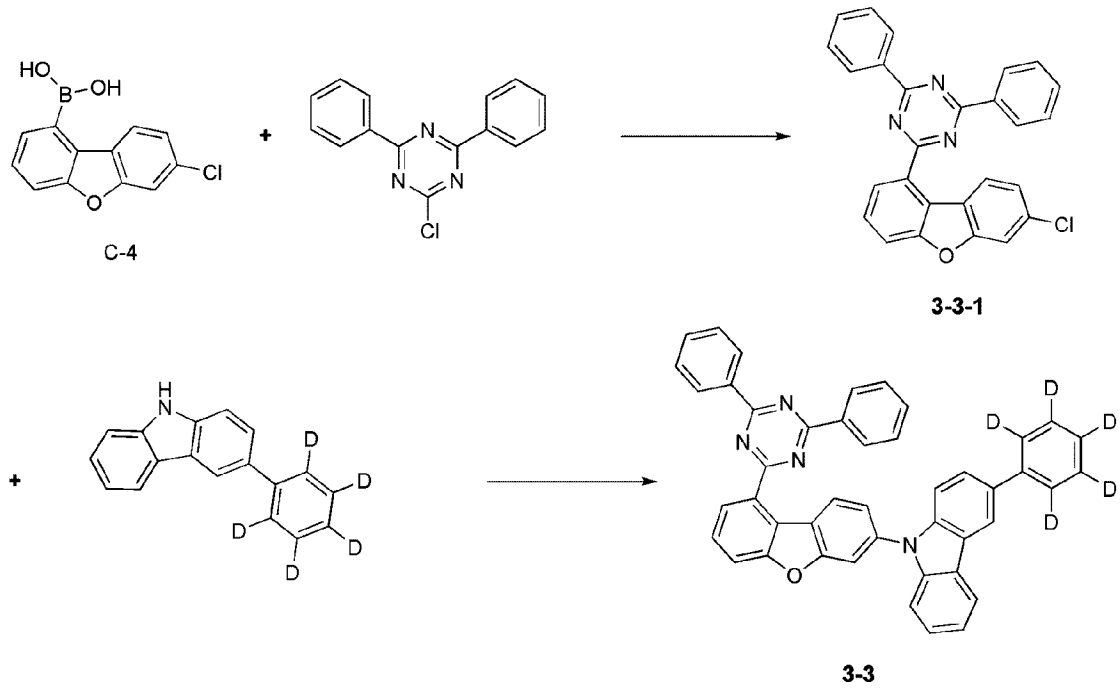
3-2-1 **3-2**

[805] 질소 분위기에서 3-2-1(10 g, 19.1 mmol)와 9H-카바졸-1,3,6,8-d4(4.7 g, 19.1mmol)를 자일렌 200mL에 넣고 교반 및 환류하였다. 이 후 나트륨 터셔리-부톡사이드(5.5 g, 57.3mmol)를 투입하고 충분히 교반한 후 비스(트리 터셔리-부틸포스핀)팔라듐(0.3 g, 0.6mmol)을 투입하였다. 4시간 반응 후 상온으로 식인 후 생성된 고체를 여과하였다. 고체를 디클로로벤젠 377 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한 화합물을 디클로로벤젠과 에틸아세테이트를 이용하여 실리카 컬럼을 통해 정제하여 고체 화합물 3-2(12g, 95%, MS: [M+H]+ = 659.2)를 제조하였다.

[806]

[807] **제조예 3-13: 화합물 3-3의 합성**

[808]

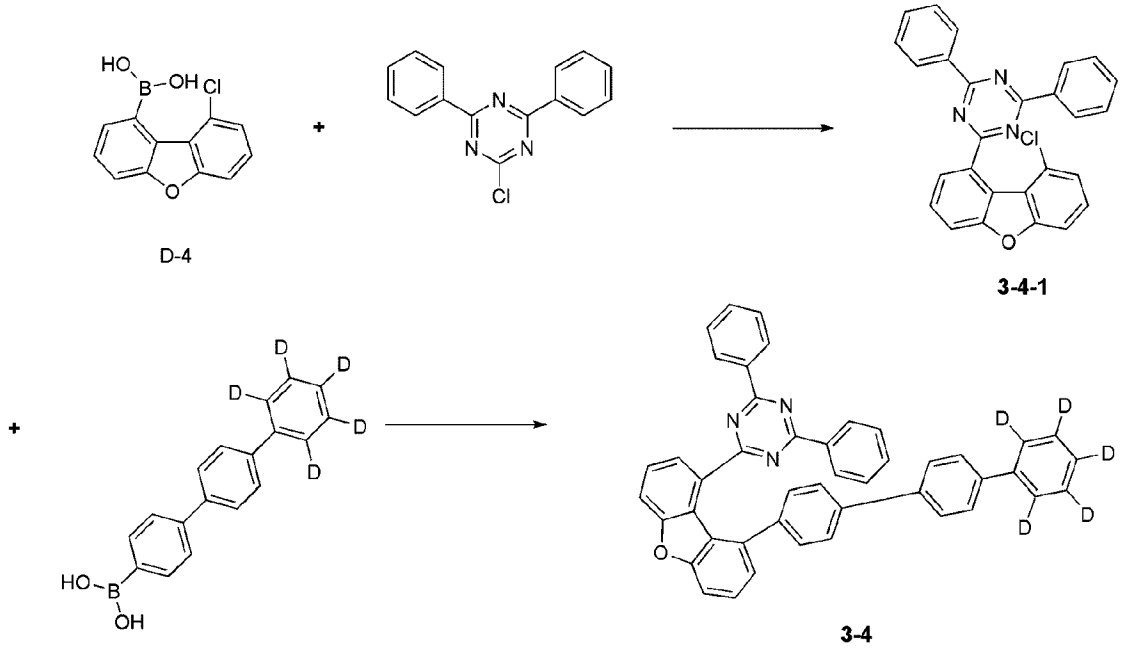


[809] 제조예 3-12 에서, 화합물 B-5를 화합물 C-4로, 2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을 2-클로로-4, 6-디페닐-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을 3-(페닐-d5)-9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 3-12의 제조 방법과 동일한 제조 방법으로 화합물 3-3을 제조하였다. (MS: $[M+H]^+$= 646)

[810]

[811] **제조예 3-14: 화합물 3-4의 합성**

[812]



[813] 제조예 3-11에서, 화합물 A-4를 화합물 D-4로, 2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진을

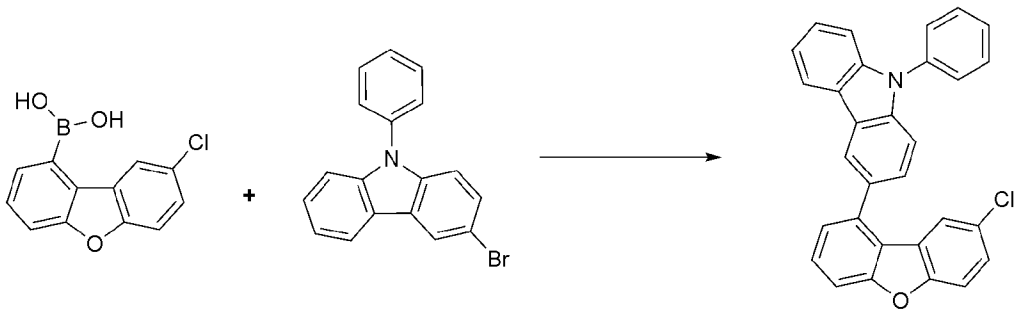
2-클로로-4,6-디페닐-1,3,5-트리아진으로,
트라이페닐렌-2-일보론산을([1,1':4',1"-터페닐]-4-일-2",3",4",5",6"-d5)보론산으로 변경하여 사용한 것을 제외하고는, 화합물 3-11의 제조 방법과 동일한 제조 방법으로 화합물 3-4을 제조하였다. (MS: $[M+H]^+$= 633)

[814]

[815] **제조예 3-15: 화합물 3-5의 합성**

[816] 단계 1) 중간체 3-5-1의 합성

[817]



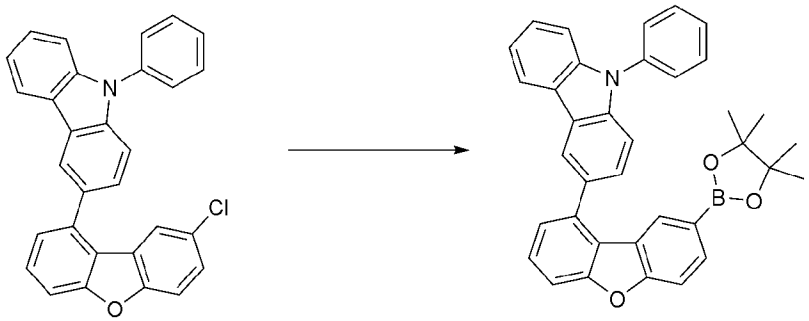
A-4 **3-5-1**

[818] 제조예 3-11 단계 1에서, 2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진을 3-브로모-9-페닐-9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 단계1의 제조 방법과 동일한 제조 방법으로 화합물 3-5-1를 제조하였다. (MS: $[M+H]^+$= 444)

[819]

[820] 단계 2) 중간체 3-5-2의 합성

[821]



3-5-1 **3-5-2**

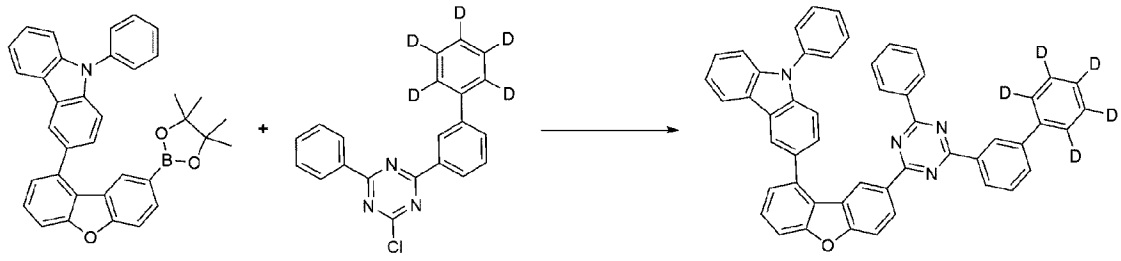
[822] 질소 분위기에서 화합물3-5-1(21.7 g, 49 mmol)와 비스(피나콜라토)디보론(14.9 g, 58.8mmol)를 Diox 434mL에 넣고 교반 및 환류하였다. 이 후 포타슘아세테이트(14.1 g, 146.9mmol)를투입하고 충분히 교반한 후 팔라듐디벤질리덴아세톤팔라듐(0.8 g, 1.5mmol) 및 트리사이클로헥실포스핀(0.8 g, 2.9mmol)을 투입하였다. 3시간 반응 후 상온으로 식인 후 유기층을 필터처리하여 염을 제거한 후 걸러진 유기층을 증류하였다. 이를 다시 클로로포름 786 mL에 투입하여 녹이고, 물로 2회 세척 후에 유기층을 분리하여, 무수황산마그네슘을 넣고 교반한 후 여과하여 여액을 감압 증류하였다. 농축한

화합물을 클로로포름과 에탄올재결정을 통해 고체 화합물 3-5-2(20.2g, 77%, MS: [M+H]+ = 536.2)을 제조하였다.

[823]

[824] 단계 3) 화합물 3-5의 합성

[825]



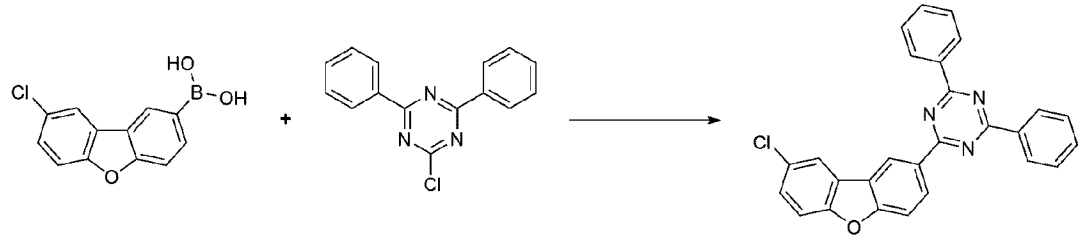
3-5-2 3-5

[826] 제조예 3-11 단계 2에서, 화합물 3-1-1을 화합물 3-5-2로, 트라이페닐렌-2-일보론산을 2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-1의 단계2의 제조 방법과 동일한 제조 방법으로 화합물 3-5를 제조하였다. (MS: $[M+H]^+$= 722)

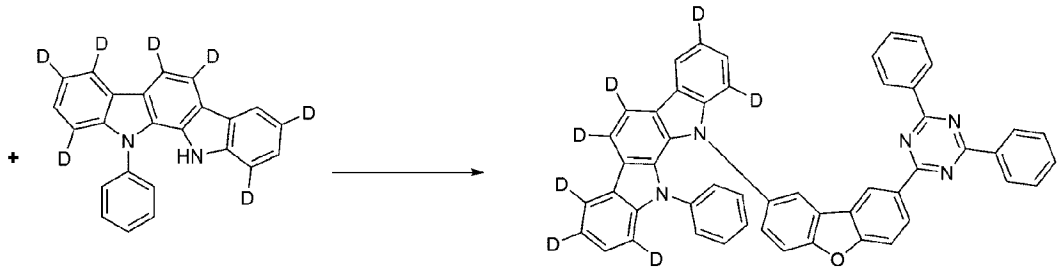
[827]

[828] **제조예 3-16: 화합물 3-6의 합성**

[829]



F-4 3-6-1



3-6

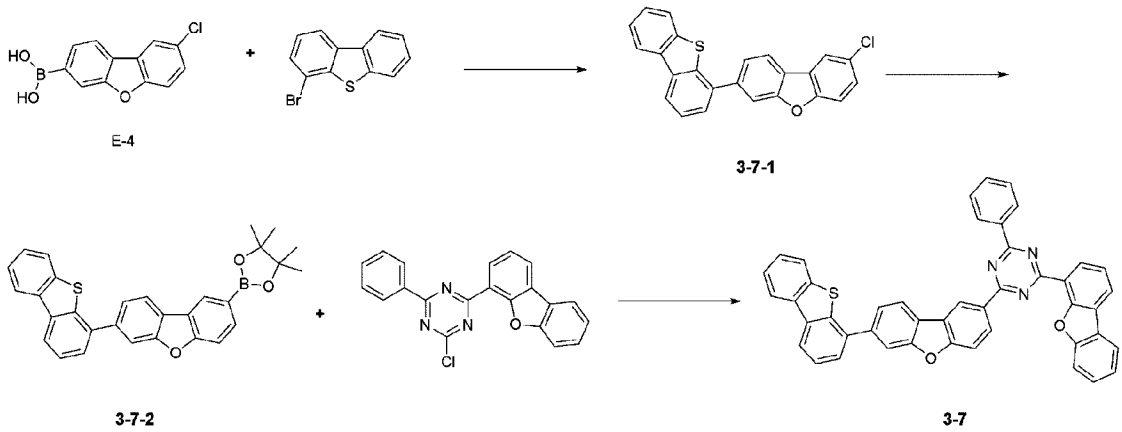
[830] 제조예 3-12 에서, 화합물 B-5를 화합물 F-4로, 2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을 2-클로로-4, 6-디페닐-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을 11-페닐-11,12-디하이드로인돌로[2,3-a]카바졸-1,3,5,6,7,8,10-d7으로 변경하여

사용한 것을 제외하고는, 화합물 3-12의 제조 방법과 동일한 제조 방법으로 화합물 3-4을 제조하였다. (MS: $[M+H]^+$= 737)

[831]

[832] **제조예 3-17: 화합물 3-7의 합성**

[833]

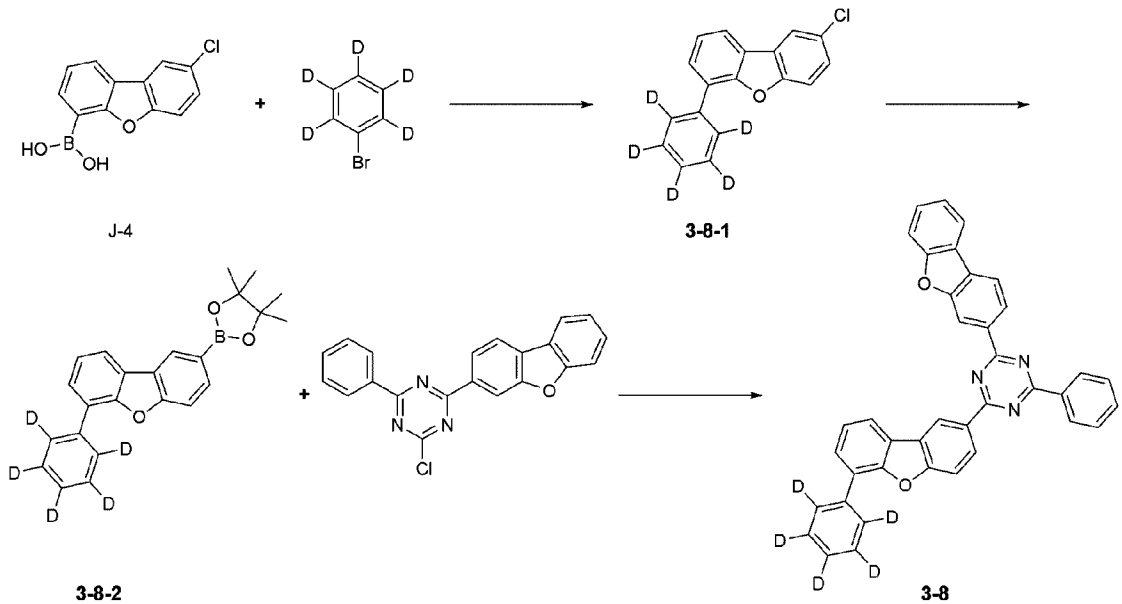


[834] 제조예 3-15에서, 화합물 A-4을 화합물 E-4로, 3-브로모-9-페닐-9H-카바졸을 4-브로모디벤조[b,d]싸이오펜으로,
2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을 2-클로로-4-(디벤조[b,d]퓨란-4-일)-6-페닐-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-7를 제조하였다. (MS: $[M+H]^+$= 672)

[835]

[836] **제조예 3-18: 화합물 3-8의 합성**

[837]



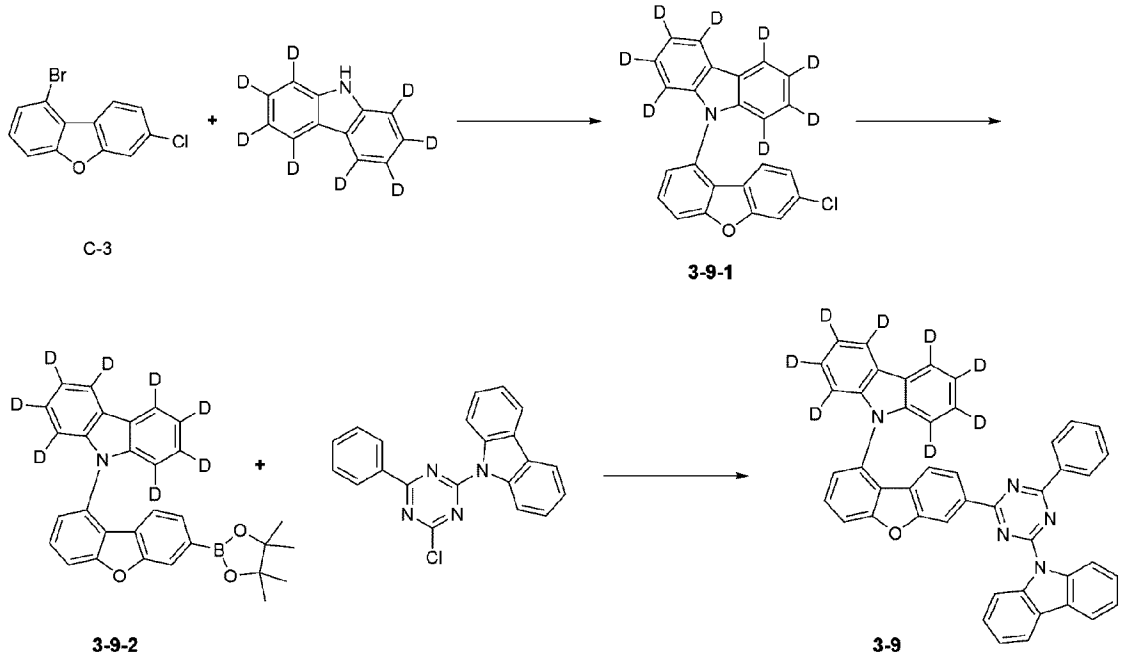
[838] 제조예 3-15에서, 화합물 A-4을 화합물 J-4로, 3-브로모-9-페닐-9H-카바졸을 1-브로로벤젠-2,3,4,5,6-d5으로,
2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을

2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-8를 제조하였다. (MS: $[M+H]^+$= 571)

[839]

[840] **제조예 3-19: 화합물 3-9의 합성**

[841]

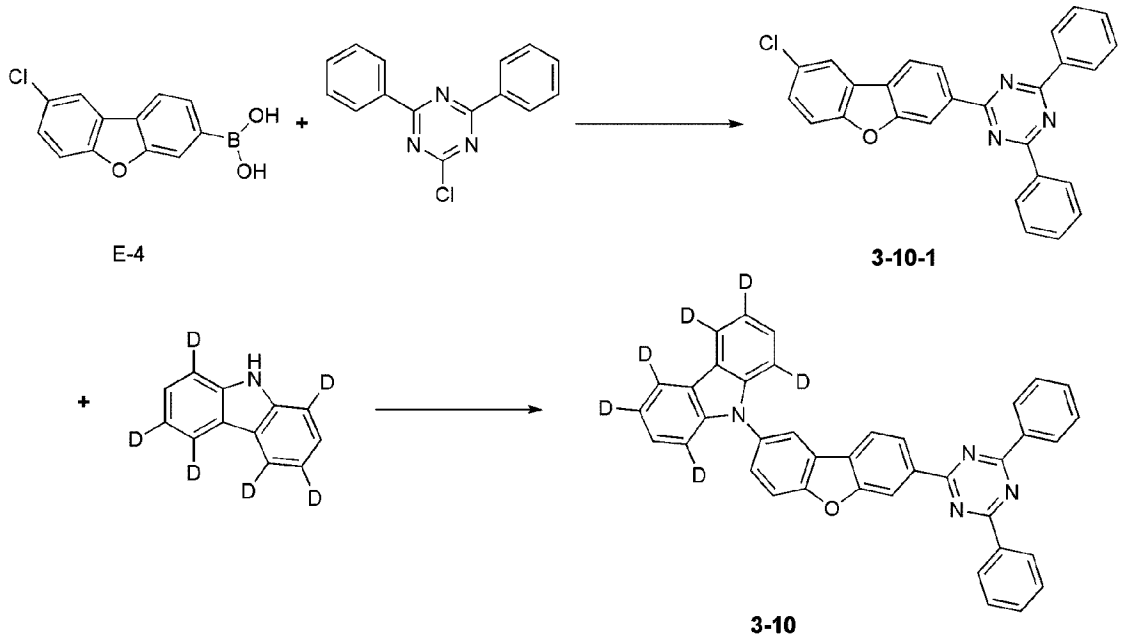


[842] 제조예 3-12 단계 2에서, 화합물 3-2-1을 화합물 C-3으로, 9H-카바졸-1,3,6,8-d4을 9H-카바졸-1,2,3,4,5,6,7,8-d8으로 변경하여 사용한 것을 제외하고는 화합물 3-12의 단계 2의 제조 방법과 동일한 제조 방법으로 화합물 3-9-1을 제조한뒤, 제조예 3-15 단계 2-3에서, 화합물3-5-1을 화합물 3-9-1로, 2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을 9-(4-클로로-6-페닐-1,3,5-트리아진-2-일)-9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-8를 제조하였다. (MS: $[M+H]^+$= 662)

[843]

[844] **제조예 3-20: 화합물 3-10의 합성**

[845]

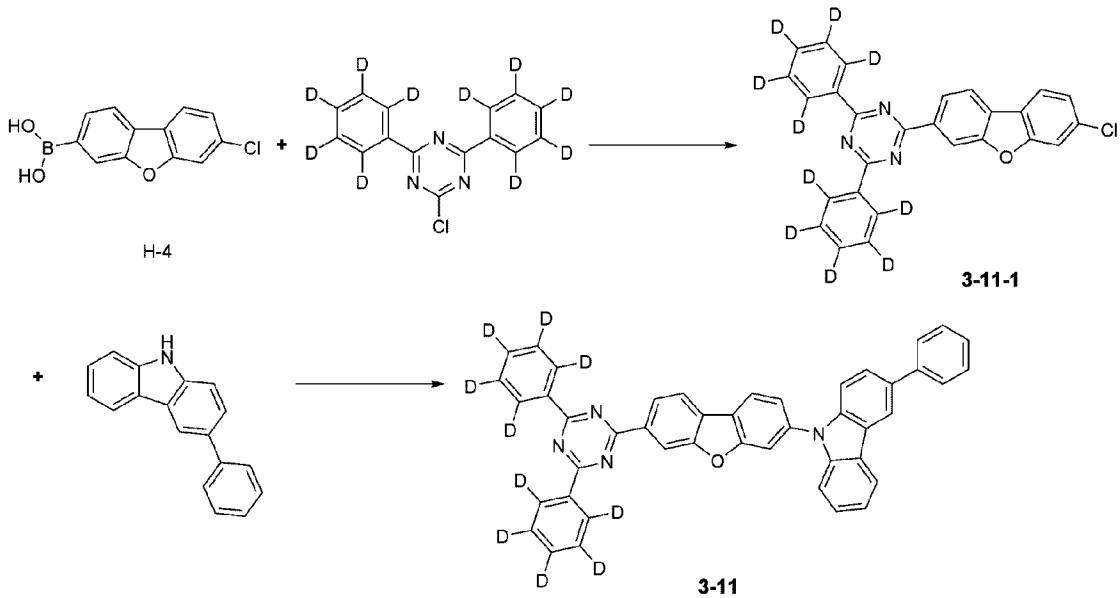


[846] 제조예 3-12 에서, 화합물 B-5를 화합물 E-4로, 2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을 2-클로로-4, 6-디페닐-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을 9H-카바졸-1,3,4,5,6,8-d6로 변경하여 사용한 것을 제외하고는, 화합물 3-12의 제조 방법과 동일한 제조 방법으로 화합물 3-10을 제조하였다. (MS: $[M+H]^+$= 571)

[847]

[848] **제조예 3-21: 화합물 3-11의 합성**

[849]



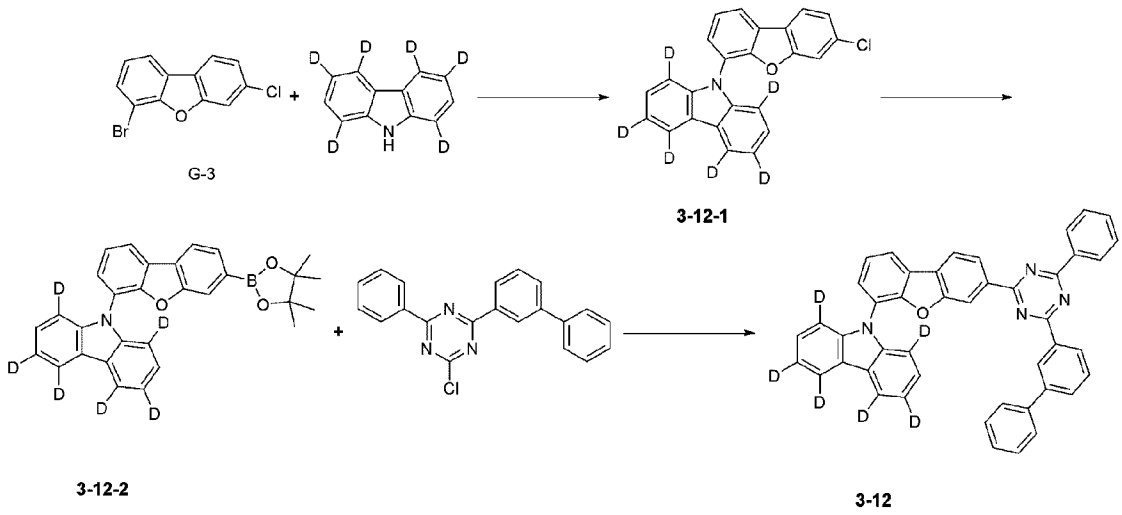
[850] 제조예 3-12 에서, 화합물 B-5를 화합물 H-4로, 2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을 2-클로로-4,6-비스(페닐-d5)-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을 3-페닐-9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 3-12의 제조

방법과 동일한 제조 방법으로 화합물 3-11를 제조하였다. (MS: $[M+H]^+$= 651)

[851]

[852] **제조예 3-22: 화합물 3-12의 합성**

[853]

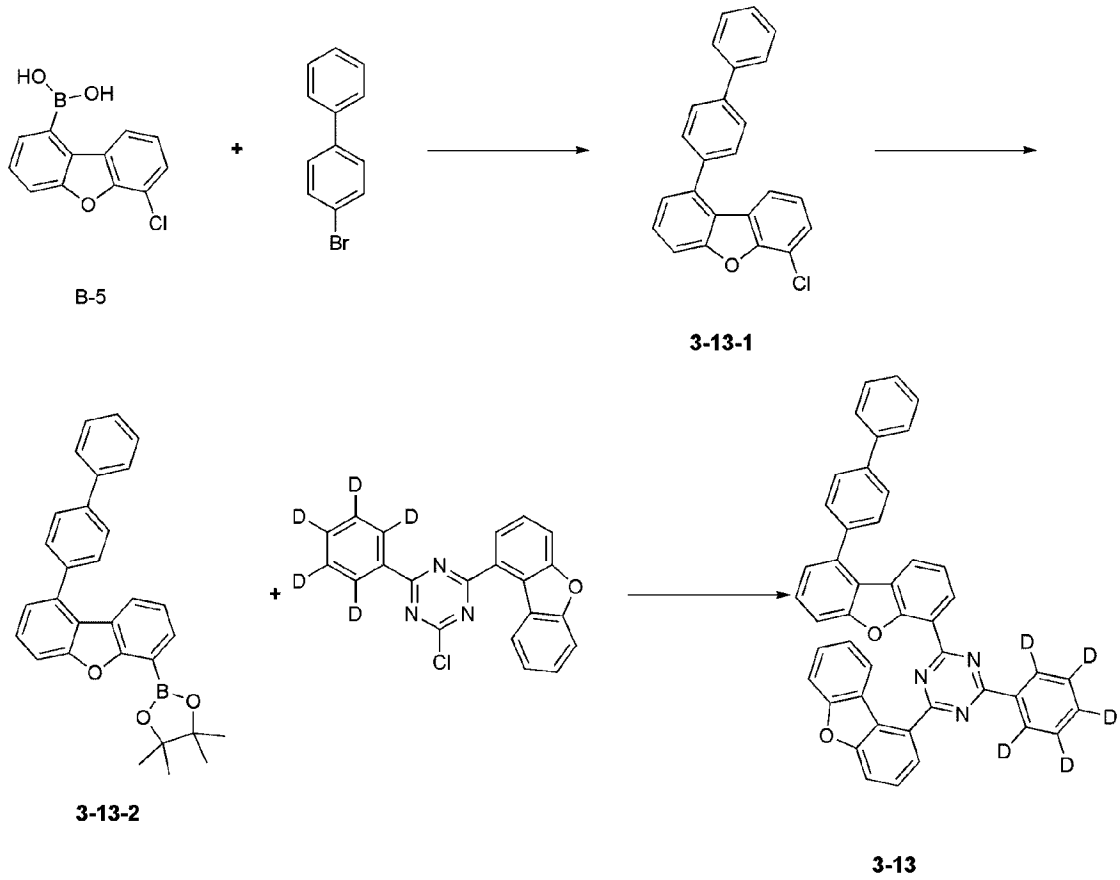


[854] 제조예 3-12 단계 2에서, 화합물 3-2-1을 화합물 G-3으로, 9H-카바졸-1,3,6,8-d4을 9H-카바졸-1,3,4,5,6,8-d6으로 변경하여 사용한 것을 제외하고는 화합물 3-12의 단계 2의 제조 방법과 동일한 제조 방법으로 화합물 3-12-1을 제조한뒤, 제조예 3-15 단계 2-3에서, 화합물3-5-1을 화합물 3-12-1로, 2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을 2-([1,1'-비페닐]-3-일)-4-클로로-6-페닐-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-12를 제조하였다. (MS: $[M+H]^+$= 647)

[855]

[856] **제조예 3-23: 화합물 3-13의 합성**

[857]

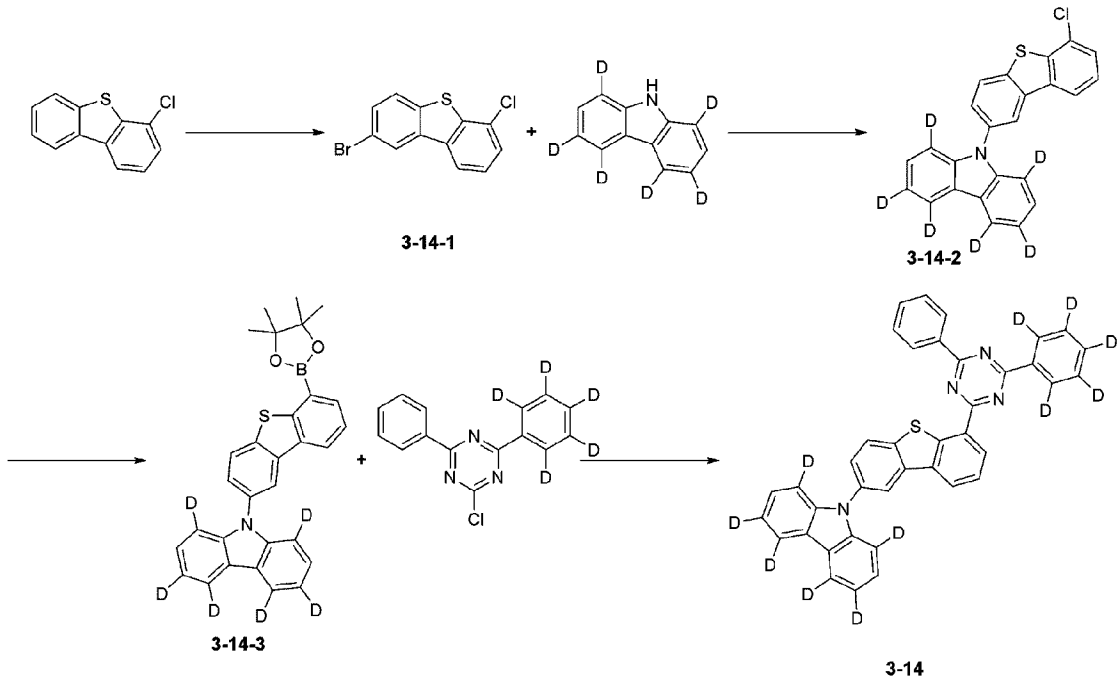


[858] 제조예 3-15에서, 화합물 A-4을 화합물 B-5으로, 3-브로모-9-페닐-9H-카바졸을 4-브로모-1,1'-비페닐으로,
2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을 2-chloro-4-(디벤조[b,d]퓨란-1-일)-6-(페닐-d5)-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-13을 제조하였다. (MS: $[M+H]^+$= 647)

[859]

[860] **제조예 3-24: 화합물 3-14의 합성**

[861]



[862] 단계 1) 중간체 3-14-1의 합성

[863] 질소 분위기에서 500mL 둥근 바닥 플라스크에 4-클로로 다이벤조싸이오펜(20 g, 0.09 mol)을 DMF 200 mL에 녹인 후, 0℃에서 NBS(16.5 g, 0.09 mol)를 5회 나누어 첨가해준 뒤, 실온에서 6시간 교반하였다. 이 후, 용액을 감압한 뒤, 에틸아세테이트에 녹여 물로 물로 씻어준 뒤, 유기층을 분리해 내고 감압하여 용매를 모두 제거하였다. 이를 컬럼크로마토그래피를 이용하여 중간체 3-14-1를 얻었다(20.6 g, 수율 76%, MS:$[M+H]^+$= 297).

[864]

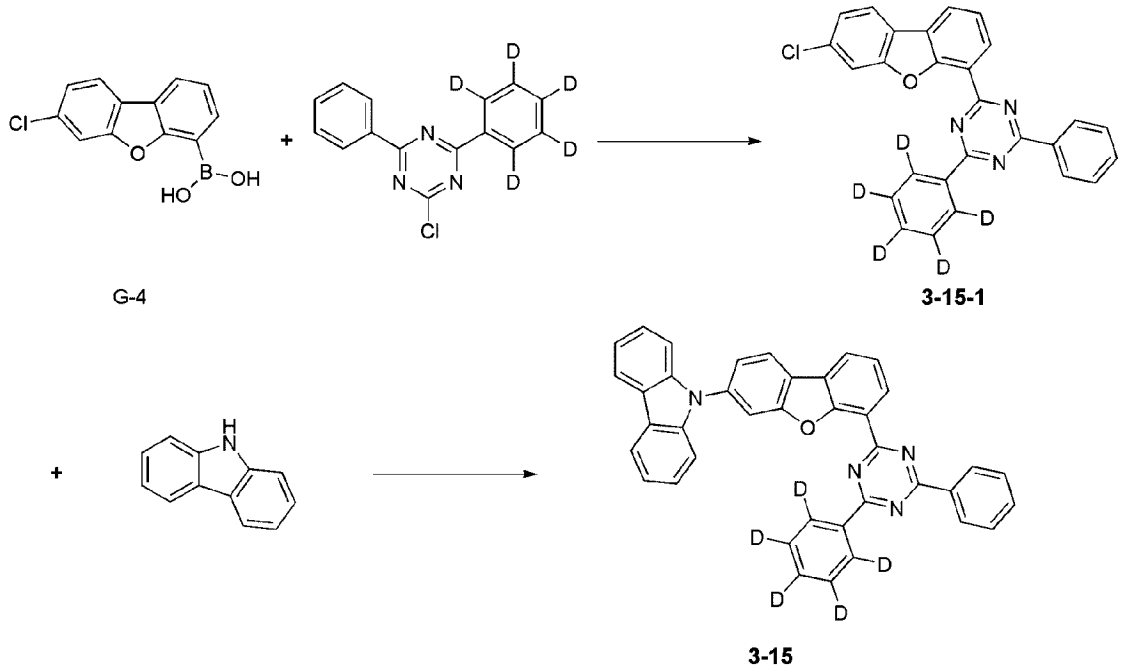
[865] 단계 2) 화합물 3-14의 합성

[866] 제조예 3-12 단계 2에서, 화합물 3-2-1을 화합물 3-14-1로, 9H-카바졸-1,3,6,8-d4을 9H-카바졸-1,3,4,5,6,8-d6으로 변경하여 사용한 것을 제외하고는 화합물 3-12의 단계 2의 제조 방법과 동일한 제조 방법으로 화합물 3-14-2를 제조한뒤, 제조예 3-15 단계 2-3에서, 화합물3-5-1을 화합물 3-14-2로, 2-([1,1'-비페닐]-3-일-2',3',4',5',6'-d5)-4-클로로-6-페닐-1,3,5-트리아진을 2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진으로 변경하여 사용한 것을 제외하고는, 화합물 3-15의 제조 방법과 동일한 제조 방법으로 화합물 3-14를 제조하였다. (MS: $[M+H]^+$= 592)

[867]

[868] **제조예 3-25: 화합물 3-15의 합성**

[869]

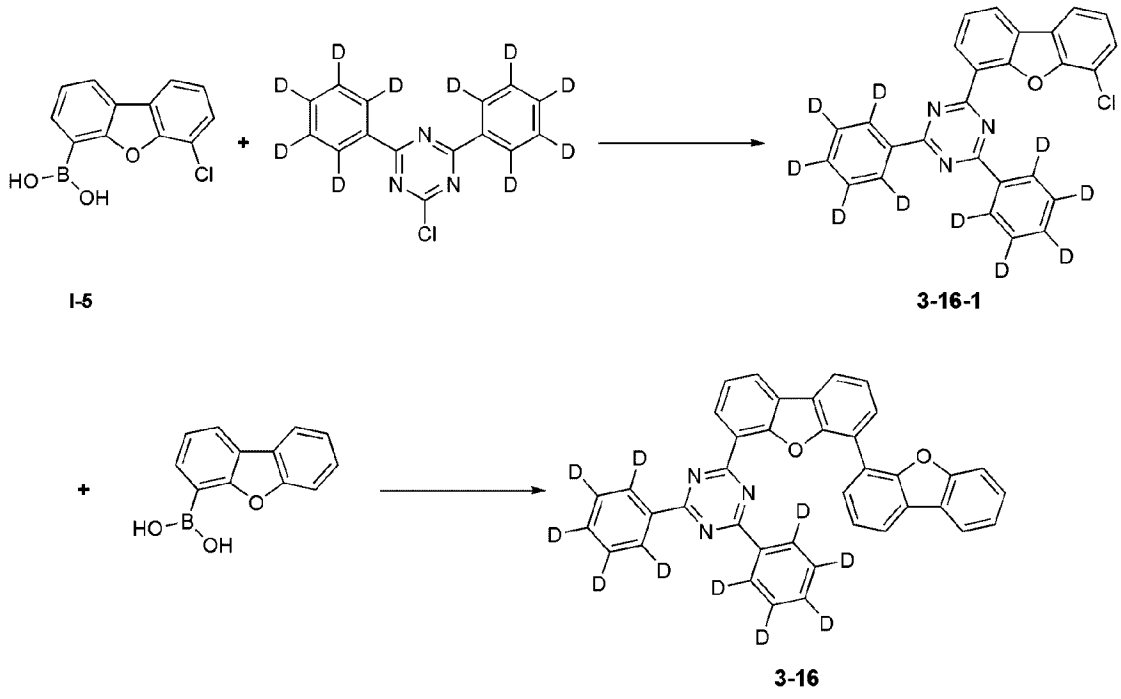


[870] 제조예 3-12 에서, 화합물 B-5를 화합물 G-4로,
2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을
2-클로로-4-페닐-6-(페닐-d5)-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을
9H-카바졸로 변경하여 사용한 것을 제외하고는, 화합물 3-12의 제조 방법과 동일한 제조 방법으로 화합물 3-15를 제조하였다. (MS: $[M+H]^+$= 570)

[871]

[872] **제조예 3-26: 화합물 3-16의 합성**

[873]



[874] 제조예 3-12 에서, 화합물 B-5를 화합물 I-5로,

2-클로로-4-(디벤조[b,d]퓨란-3-일)-6-페닐-1,3,5-트리아진을 2-클로로-4,6-비스(페닐-d5)-1,3,5-트리아진으로, 9H-카바졸-1,3,6,8-d4을 디벤조[b,d]퓨란-4-일보론산으로 변경하여 사용한 것을 제외하고는, 화합물 3-12의 제조 방법과 동일한 제조 방법으로 화합물 3-16을 제조하였다. (MS: $[M+H]^+$= 576)

[875]

[876] **실시예 1: 유기 발광 소자의 제조**

[877] ITO(Indium Tin Oxide)가 1400 Å의 두께로 박막 코팅된 유리 기판을 세제를 녹인 증류수에 넣고 초음파로 세척하였다. 이때, 세제로는 피셔사(Fischer Co.) 제품을 사용하였으며, 증류수로는 밀러포어사(Millipore Co.) 제품의 필터(Filter)로 2차로 걸러진 증류수를 사용하였다. ITO를 30분간 세척한 후 증류수로 2회 반복하여 초음파 세척을 10분간 진행하였다. 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.

[878]

[879] 이렇게 준비된 ITO 투명 전극 위에 하기 95 중량%의 HT-A과 5 중량%의 PD를 100 Å의 두께로 열 진공 증착하여 정공주입층을 형성하고, 이어서 HT-A 물질만 1150 Å의 두께로 증착하여 정공수송층을 형성하였다. 그 위에 전자 저지층으로 하기 HT-B를 450 Å 두께로 열 진공 증착하였다.

[880]

[881] 이어서, 상기 전자저지층 위에 제1 호스트로 화합물 1-1과 제2 호스트로 화합물 2-1과 제3 호스트로 화합물 3-10을 35:35:30의 중량비로 혼합한 92 중량%의 호스트와 8 중량%의 GD를 350 Å의 두께로 진공 증착하여, 발광층을 형성하였다.

[882]

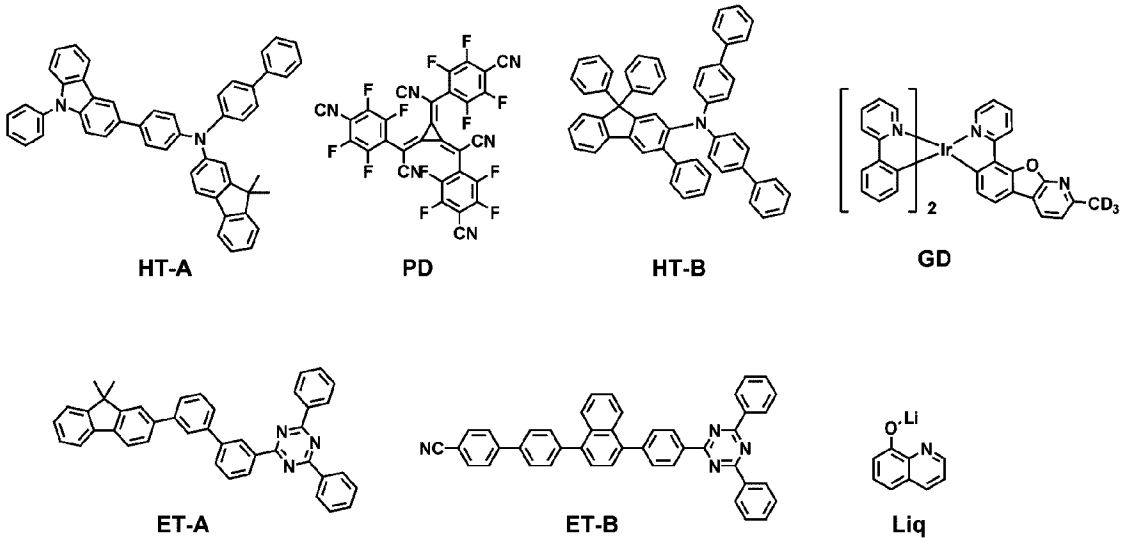
[883] 이어서, 정공저지층으로 하기 ET-A를 50 Å의 두께로 진공 증착하였다. 이어서 전자수송층으로 하기 ET-B와 Liq를 1:1의 비율로 300 Å의 두께로 열 진공 증착하고, 이어서 전자주입층으로 Yb를 10Å의 두께로 진공 증착하였다.

[884]

[885] 상기 전자주입층 위에 마그네슘과 은을 1:4의 비율로 150 Å의 두께로 증착하여 음극을 형성하여, 유기 발광 소자를 제조하였다.

[886]

[887]



[888]

[889]

[890] 상기의 과정에서 유기물의 증착속도는 0.4 ~ 0.7 Å/sec를 유지하였고, 마그네슘과 은의 증착 속도는 2 Å/sec를 유지하였으며, 증착시 진공도는 $2x10^{-7}$ ~ $5x10^{-6}$ torr를 유지하여, 유기 발광 소자를 제작하였다.

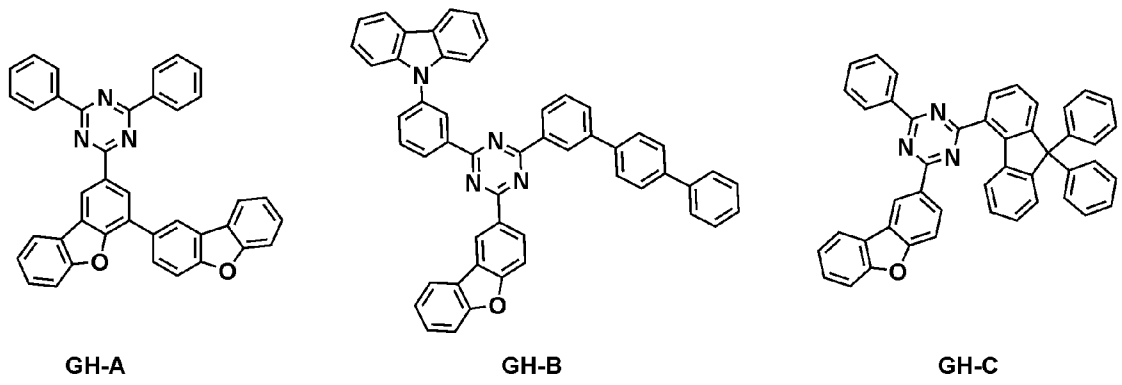
[891]

[892] **실시예 2 내지 38 및 비교예 1 내지 10**

[893] 호스트 물질을 하기 표 1 내지 3과 같이 변경하였다는 점을 제외하고는, 상기 실시예 1과 동일한 방법을 이용하여 실시예 2 내지 38 및 비교예 1 내지 10의 유기 발광 소자를 각각 제작하였다. 이때, 비율은 제1 호스트, 제2 호스트 및 제3 호스트의 중량비를 의미한다. 또한, 하기 표 1에 기재된 GH-A, GH-B, 및 GH-C 화합물은 각각 하기와 같다.

[894]

[895]



[896]

[897] **실험예 1: 소자 특성 평가**

[898] 상기 실시예 1 내지 38 및 비교예 1 내지 10에서 제작된 유기 발광 소자를 120℃ 오븐에서 30분간 열처리한 후 꺼내어, 전류를 인가하여 전압, 효율, 수명(T95)을 측정하고 그 결과를 하기 표 1 내지 3에 나타내었다. 이때, 전압 및 효율은 10

mA/cm^2의 전류 밀도를 인가하여 측정되었으며, T95은 전류 밀도 20 mA/cm^2에서 초기 휘도가 95%로 저하할 때까지의 시간(hr)을 의미한다.

[899] [표1]

	제1 호스트	제2 호스트	제3 호스트	비율	@10 mA/cm^2		@20 mA/cm^2
					전압 (V)	효율 (cd/A)	수명 (T95, hr)
실시예 1	화합물 1-1	화합물 2-1	화합물 3-10	40:40:20	3.93	77.8	155
실시예 2	화합물 1-1	화합물 2-1	화합물 3-12	40:40:20	3.89	76.3	163
실시예 3	화합물 1-1	화합물 2-1	화합물 3-15	40:40:20	3.89	77.2	149
실시예 4	화합물 1-1	화합물 2-8	화합물 3-10	40:40:20	3.94	77.6	183
실시예 5	화합물 1-1	화합물 2-8	화합물 3-12	40:40:20	3.89	76.5	193
실시예 6	화합물 1-1	화합물 2-8	화합물 3-15	40:40:20	3.91	77.5	173
실시예 7	화합물 1-1	화합물 2-1	화합물 3-10	20:60:20	3.96	79.0	164
실시예 8	화합물 1-1	화합물 2-1	화합물 3-12	20:60:20	3.93	77.7	172
실시예 9	화합물 1-1	화합물 2-1	화합물 3-15	20:60:20	3.91	78.1	168
실시예 10	화합물 1-2	화합물 2-7	화합물 3-1	40:40:20	3.90	77.8	212
실시예 11	화합물 1-2	화합물 2-7	화합물 3-3	40:40:20	3.88	78.9	227
실시예 12	화합물 1-2	화합물 2-7	화합물 3-8	40:40:20	3.87	77.3	200
실시예 13	화합물 1-2	화합물 2-8	화합물 3-1	40:40:20	3.85	78.2	220
실시예 14	화합물 1-2	화합물 2-8	화합물 3-3	40:40:20	3.81	79.3	231

실시예 15	화합물 1-2	화합물 2-8	화합물 3-8	40:40:20	3.80	78.1	209
실시예 16	화합물 1-3	화합물 2-2	화합물 3-4	40:40:20	3.72	73.5	152
실시예 17	화합물 1-3	화합물 2-2	화합물 3-7	40:40:20	3.69	73.9	147
실시예 18	화합물 1-3	화합물 2-2	화합물 3-16	40:40:20	3.73	74.3	148
실시예 19	화합물 1-3	화합물 2-3	화합물 3-4	40:40:20	3.78	73.9	149
실시예 20	화합물 1-3	화합물 2-3	화합물 3-7	40:40:20	3.73	74.2	140
실시예 21	화합물 1-3	화합물 2-3	화합물 3-16	40:40:20	3.79	74.6	141

[900] [표2]

	제1 호스트	제2 호스트	제3 호스트	비율	@10 mA/cm^2		@20 mA/cm^2
					전압 (V)	효율 (cd/A)	수명 (T95, hr)
실시예 22	화합물 1-4	화합물 2-4	화합물 3-5	40:40:20	4.05	74.0	150
실시예 23	화합물 1-4	화합물 2-4	화합물 3-6	40:40:20	4.01	73.9	147
실시예 24	화합물 1-5	화합물 2-1	화합물 3-9	40:40:20	3.83	77.0	193
실시예 25	화합물 1-5	화합물 2-1	화합물 3-12	40:40:20	3.76	78.8	206
실시예 26	화합물 1-5	화합물 2-1	화합물 3-13	40:40:20	3.84	77.3	189
실시예 27	화합물 1-5	화합물 2-9	화합물 3-9	40:40:20	3.86	77.9	188
실시예 28	화합물 1-5	화합물 2-9	화합물 3-12	40:40:20	3.80	79.0	199
실시예 29	화합물 1-5	화합물 2-9	화합물 3-13	40:40:20	3.88	77.4	180
실시예 30	화합물 1-6	화합물 2-2	화합물 3-2	40:40:20	3.89	77.6	193
실시예 31	화합물 1-6	화합물 2-2	화합물 3-11	40:40:20	3.88	79.5	187
실시예 32	화합물 1-6	화합물 2-2	화합물 3-14	40:40:20	4.01	83.8	233
실시예 33	화합물 1-6	화합물 2-5	화합물 3-2	40:40:20	3.87	77.9	190
실시예 34	화합물 1-6	화합물 2-5	화합물 3-11	40:40:20	3.85	79.9	189
실시예 35	화합물 1-6	화합물 2-5	화합물 3-14	40:40:20	3.99	83.0	238
실시예	화합물	화합물	화합물	40:40:20	3.85	78.0	195

36	1-6	2-6	3-2				
실시예 37	화합물 1-6	화합물 2-6	화합물 3-11	40:40:20	3.82	80.3	190
실시예 38	화합물 1-6	화합물 2-6	화합물 3-14	40:40:20	3.96	84.6	245

[901] [표3]

	제1 호스트	제2 호스트	제3 호스트	비율	@10 mA/cm^2		@20 mA/cm^2
					전압 (V)	효율 (cd/A)	수명 (T95, hr)
비교예 1	화합물 1-1	-	-	100:0:0	6.93	13.9	16
비교예 2	-	화합물 2-1	-	0:100:0	7.83	8.5	23
비교예 3	-	-	화합물 3-1	0:0:100	6.44	46.9	47
비교예 4	화합물 1-1	화합물 2-1	-	50:50:0	7.26	15.3	41
비교예 5	화합물 1-1	-	화합물 3-1	80:0:20	4.62	67.8	119
비교예 6	-	화합물 2-1	화합물 3-1	0:80:20	4.88	73.2	136
비교예 7	화합물 1-1	-	GH-A	80:0:20	5.08	55.9	105
비교예 8	화합물 1-1	화합물 2-2	GH-A	40:40:20	4.40	60.3	136
비교예 9	화합물 1-2	-	GH-B	80:0:20	5.99	57.9	55
비교예 10	화합물 1-3	-	GH-C	80:0:20	6.06	59.8	67

[902]

[903] 상기 표 1 내지 3에서, 실시예 1 내지 38의 유기 발광 소자는 비교예 1 내지 10의 유기 발광 소자 대비 구동 전압이 현저히 낮고, 효율 및 수명이 현저히 개선된

것으로 확인된다

[904]

[905] 상기 인돌로카바졸 계열의 화합물(제1 화합물) 및 상기 비스카바졸 계열의 화합물(제2 화합물)은 각각 정공 수송 능력이 뛰어나 P형 호스트의 역할을 하고, 피리딘, 피리미딘, 또는 트리아진이 디벤조퓨란/디벤조티오펜의 N과 결합된 화합물(제3 화합물)은 N형 호스트의 역할을 한다.

[906]

[907] 이러한 P형 호스트와 N형 호스트를 혼합하여 발광층의 호스트로 적용하면 exciplex를 형성하므로, P형 호스트와 N형 호스트 중 어느 하나만을 적용할 경우에 대비하여, 소자의 특성이 개선될 수 있다. 이는, P형 호스트와 N형 호스트를 혼합하여 발광층의 호스트로 적용한 실시예 1 내지 38의 유기 발광 소자가 P형 호스트와 N형 호스트 중 어느 하나만을 적용한 비교예 1 내지 4의 유기 발광 소자 대비 현저히 낮은 구동 전압 및 현저히 개선된 효율 및 수명 특성을 나타내는 것에서 확인할 수 있다.

[908]

[909] 나아가, 상기 제1 화합물 및 2의 P형 호스트 2종과 상기 제3 화합물의 N 형 호스트를 혼합한 실시예의 유기 발광 소자(제1 화합물+제2 화합물+제3 화합물)가, P형 호스트 1종만을 상기 제3 화합물의 N형 호스트와 혼합한 비교예 5 또는 6의 유기 발광 소자(제1 화합물+제3 화합물; 또는 제2 화합물+제3 화합물)에 대비해서도 소자의 특성이 개선됨이 확인된다.

[910]

[911] 이는 상기 제1 화합물의 P형 호스트는 인돌로카바졸을 포함하는 구조 상 저전압의 특성을 나타내며, 상기 제2 화합물의 P형 호스트는 비스카바졸을 포함하는 구조 상 고효율, 장수명의 특성을 나타내기 때문에, 이들을 혼합하여 사용하는 것이 소자의 전압, 효율, 및 수명 특성이 고르게 개선하는 데 유리하였을 것으로 판단된다.

[912]

[913] 또한, 상기 제1 화합물 및 제2 화합물의 P형 호스트 2종과 상기 제3 화합물의 N 형 호스트의 혼합비율을 달리하였을 때 전압, 효율 및 수명 특성이 달라지는 것을 볼 수 있다. 구체적으로, 실시예 1 내지 3의 유기 발광 소자와 비교하여 상기 제2 화합물의 P형 호스트(비스카바졸을 포함하는 구조) 비율이 높아진 실시예 7 내지 9의 유기 발광 소자가 상기 제2 화합물의 P형 호스트의 특성인 고효율 장수명 특성이 반영되어, 실시예 1 내지 3의 유기 발광 소자 대비 효율 및 수명 특성이 동시에 향상됨을 확인할 수 있다.

[914]

[915] 또한, 실시예의 유기 발광 소자는 상기 제3 화합물과 전혀 다른 구조를 갖는 화합물을 N형 호스트로 사용한 비교예 8의 유기 발광 소자에 대비해서도 전압, 효율 및 수명 특성이 전반적으로 향상됨을 알 수 있다. 이는 상기 제1 및 제2

화합물의 P형 호스트 조합은 상기 제3 화합물인 N형 호스트와 혼합하여 사용되었을 때에 전압, 효율 및 수명 특성 모두에서 시너지 효과를 나타낸다는 것을 의미한다.

[916]

[917] [부호의 설명]

[918] 1: 기판 2: 양극

[919] 3: 발광층 4: 음극

[920] 5: 정공주입층 6: 정공수송층

[921] 7: 전자저지층 8: 정공저지층

[922] 9: 전자수송층 10: 전자주입층

청구범위

[청구항 1] 양극;

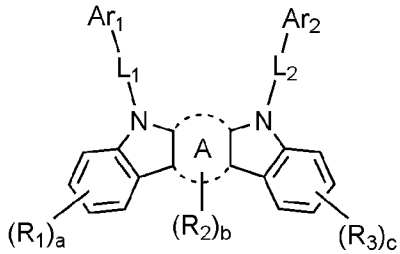
상기 양극과 대향하여 구비된 음극; 및

상기 양극과 음극 사이에 구비된 발광층을 포함하고,

상기 발광층은 하기 화학식 1로 표시되는 제1 화합물, 하기 화학식 2로 표시되는 제2 화합물 및 하기 화학식 3으로 표시되는 제3 화합물을 포함하는,

유기 발광 소자:

[화학식 1]



상기 화학식 1에서,

A는 이웃하는 2 개의 오각고리와 융합된 벤젠 고리이고,

L_1 및 L_2는 각각 독립적으로 단일 결합; 또는 치환 또는 비치환된 C_{6-60} 아릴렌이고,

Ar_1 및 Ar_2는 각각 독립적으로 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

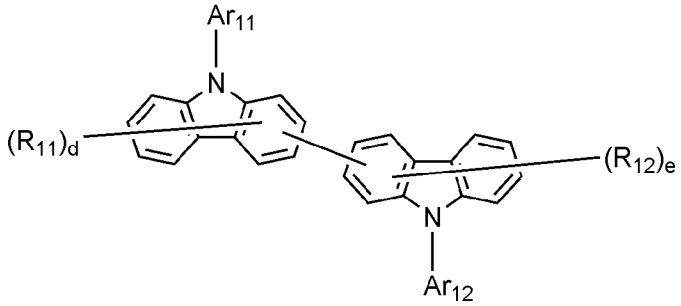
R_1 내지 R_3는 각각 독립적으로 수소, 중수소, 또는 C_{6-12} 아릴이고,

a는 0 내지 4의 정수이고,

b는 0 내지 2의 정수이고,

c는 0 내지 4의 정수이고,

[화학식 2]



상기 화학식 2에서,

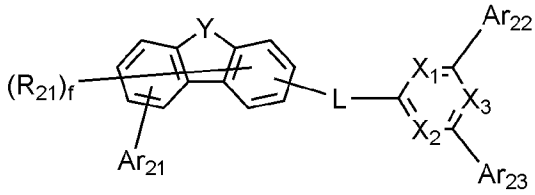
Ar_{11} 및 Ar_{12}는 각각 독립적으로 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60}

헤테로아릴이고,

R_{11} 및 R_{12}는 각각 독립적으로 수소; 중수소; 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

d 및 e는 각각 독립적으로 0 내지 7의 정수이고,

[화학식 3]



상기 화학식 3에서,

X_1 내지 X_3는 각각 독립적으로 N 또는 CH이고, 단, X_1 내지 X_3 중 적어도 하나는 N이고,

Y는 O 또는 S이고,

L은 단일 결합; 치환 또는 비치환된 C_{6-60} 아릴렌; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴렌이고,

Ar_{21} 내지 Ar_{23}은 각각 독립적으로 중수소, 치환 또는 비치환된 C_{6-60} 아릴; 또는 치환 또는 비치환된 N, O 및 S 중 1개 이상의 헤테로원자를 포함하는 C_{2-60} 헤테로아릴이고,

R_{21}은 수소, 중수소, 또는 C_{6-12} 아릴이고,

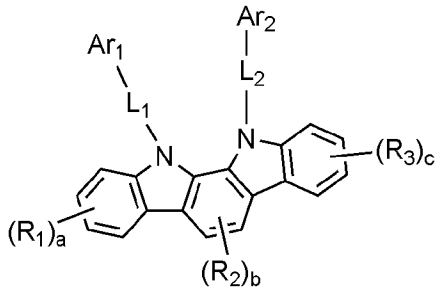
f는 0 내지 6의 정수이다.

[청구항 2] 제1항에 있어서,

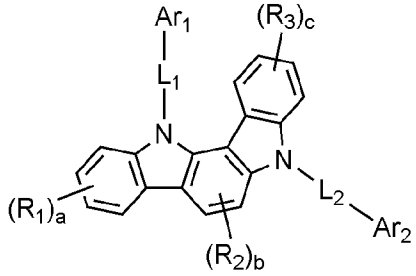
상기 제1 화합물은 하기 화학식 1-1 내지 1-5 중 어느 하나로 표시되는,

유기 발광 소자:

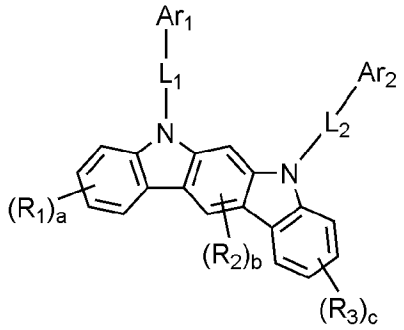
[화학식 1-1]



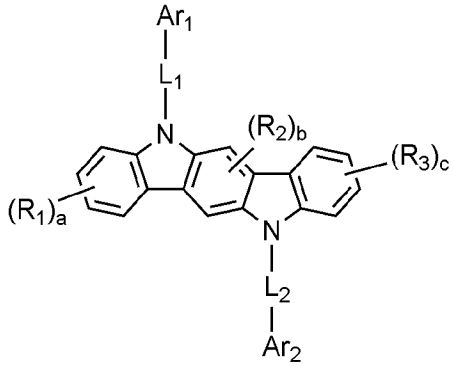
[화학식 1-2]



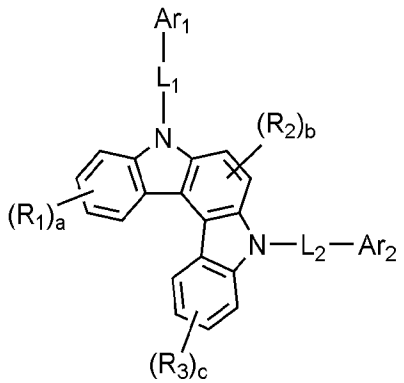
[화학식 1-3]



[화학식 1-4]



[화학식 1-5]



상기 1-1 내지 1-5에서,

L_1, L_2, Ar_1, Ar_2, R_1 내지 R_3, a, b 및 c는 제1항에서 정의한 바와 같다.

[청구항 3] 제1항에 있어서,

L_1 및 L_2는 각각 독립적으로 단일 결합, 또는 페닐렌인,

유기 발광 소자.

[청구항 4] 제1항에 있어서,

Ar_1 및 Ar_2는 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 또는 디벤조티오페닐이고,

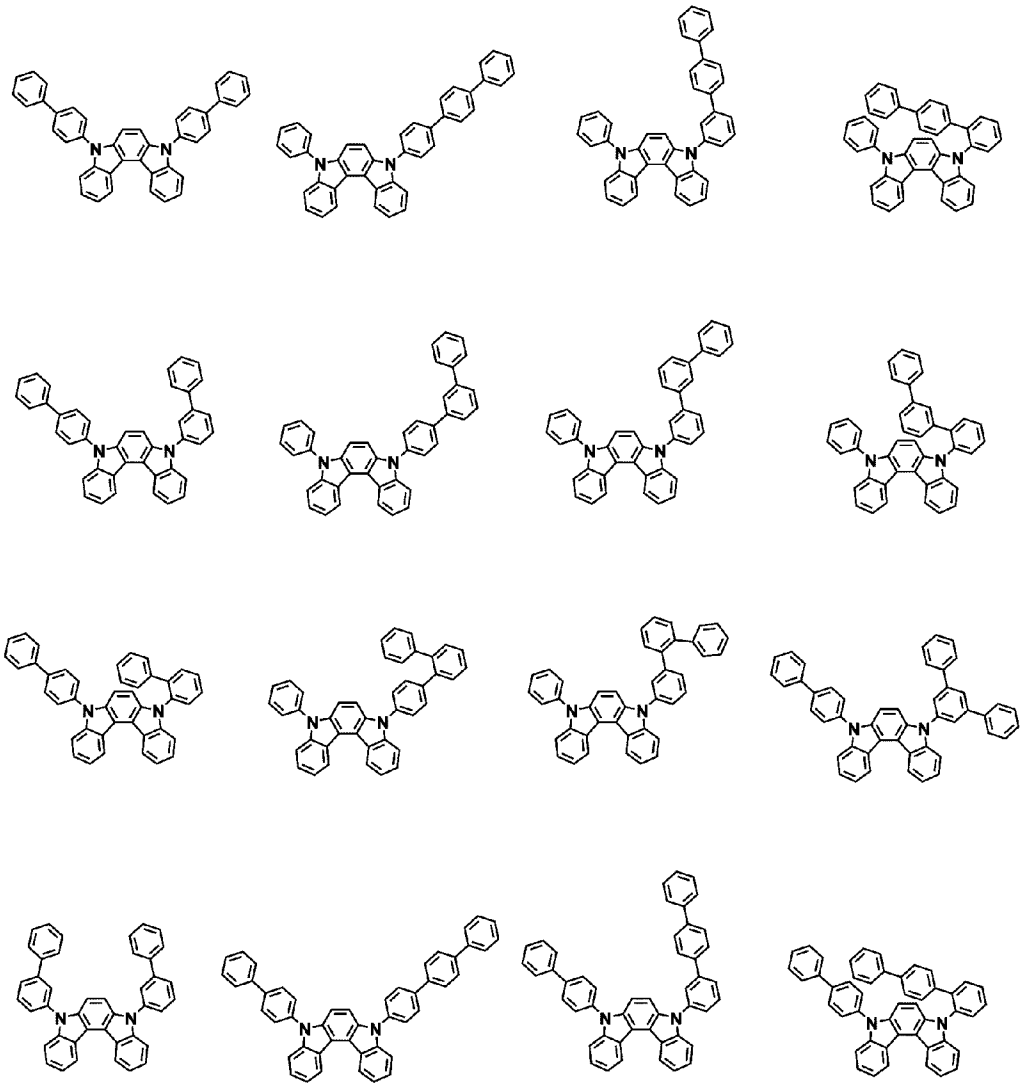
여기서, Ar_1 및 Ar_2는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환되는,

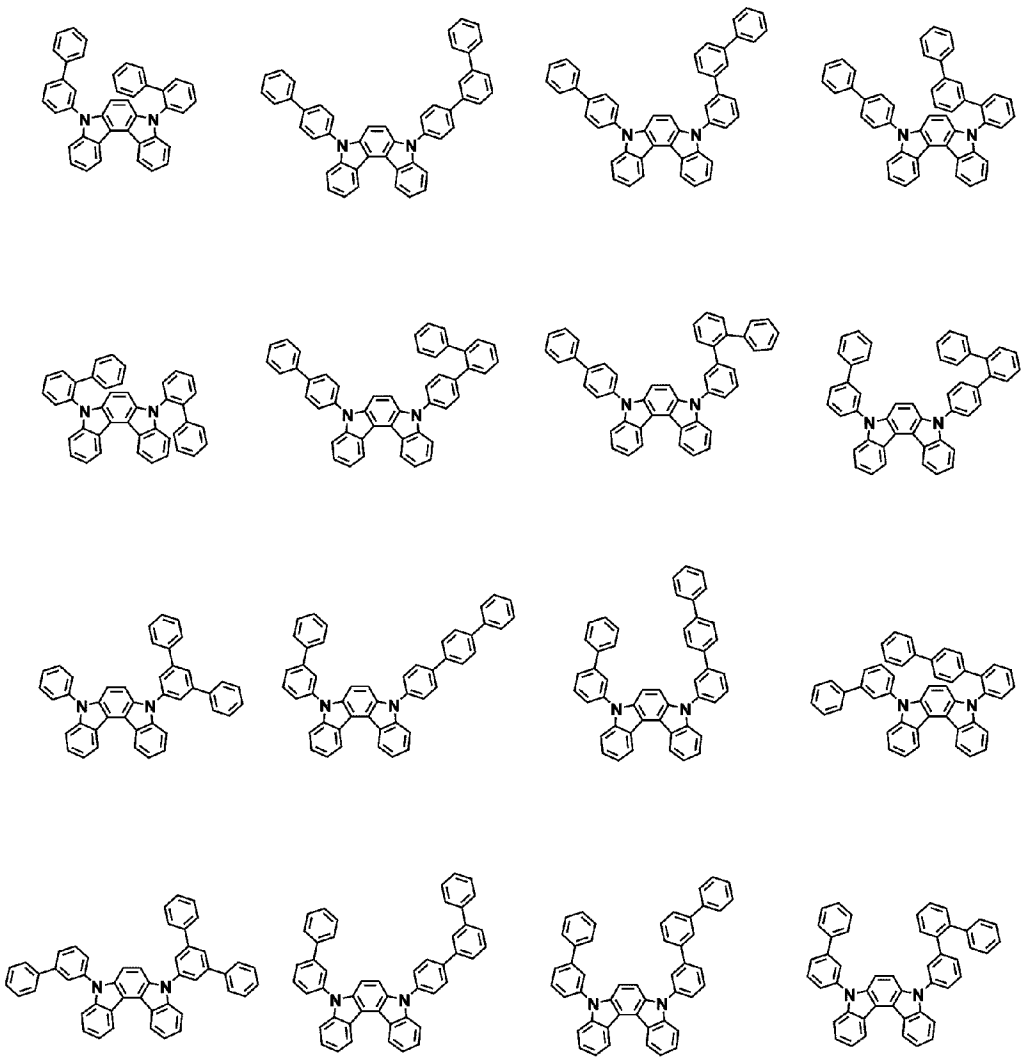
유기 발광 소자.

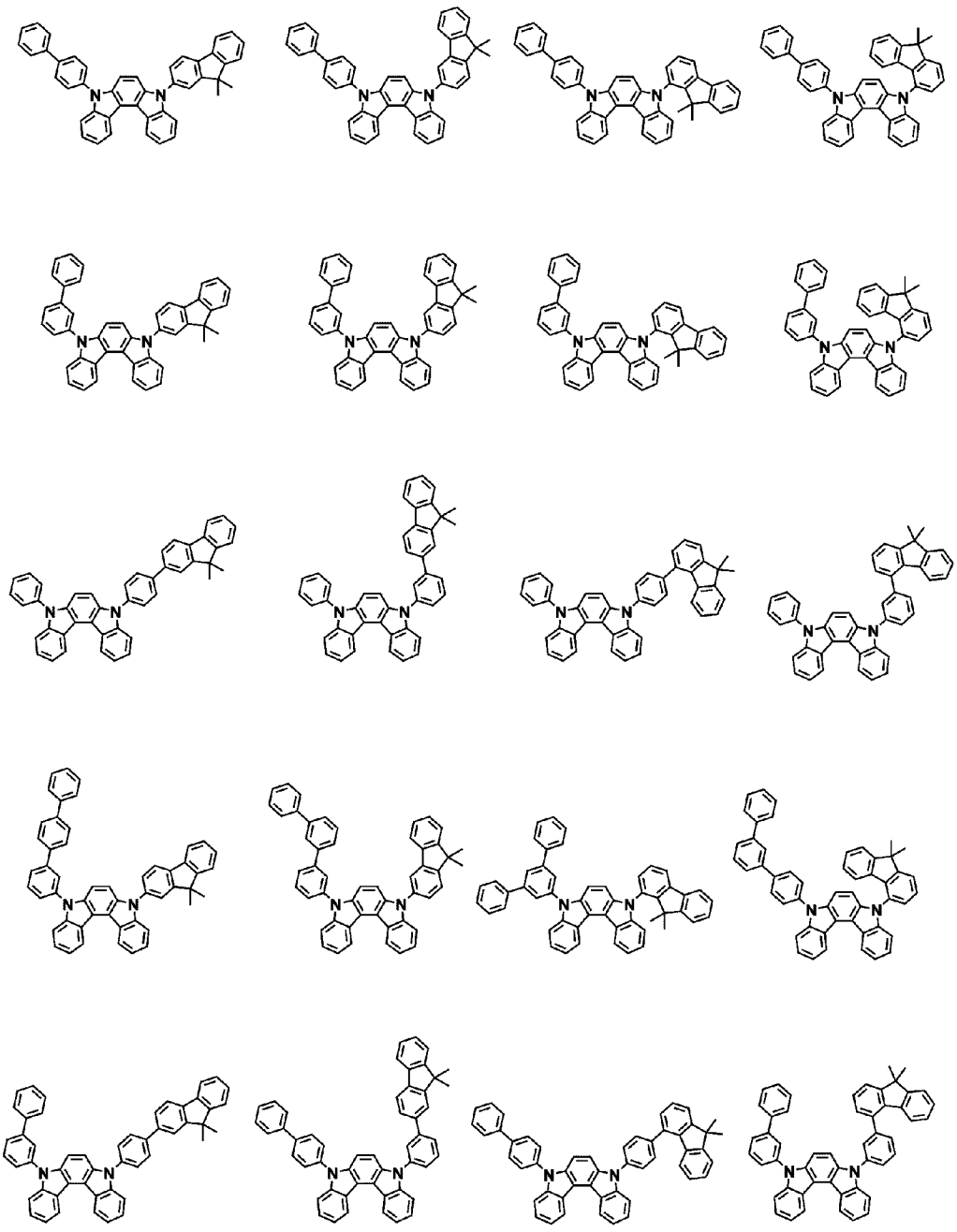
[청구항 5] 제1항에 있어서,

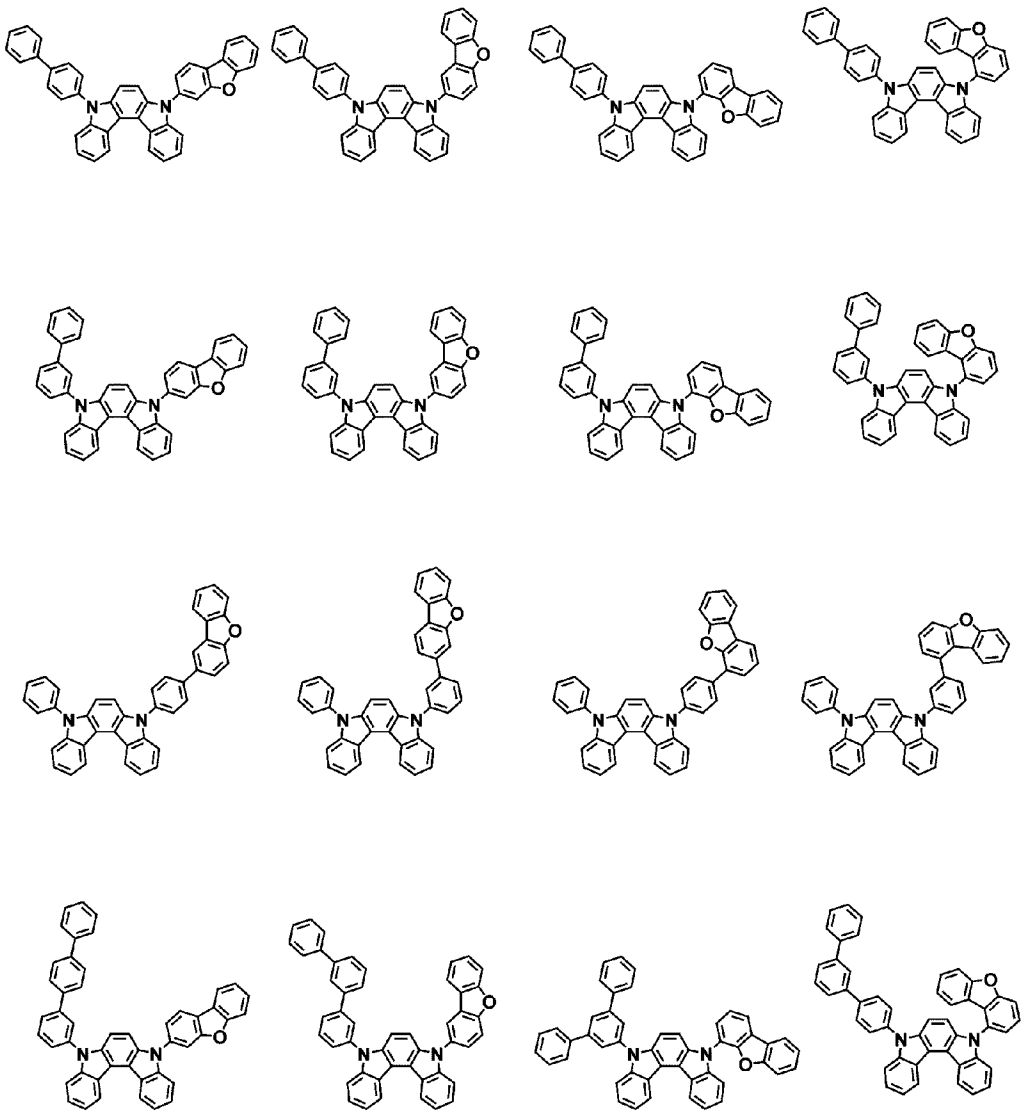
상기 제1 화합물은 하기로 구성되는 군으로부터 선택되는 어느 하나인,

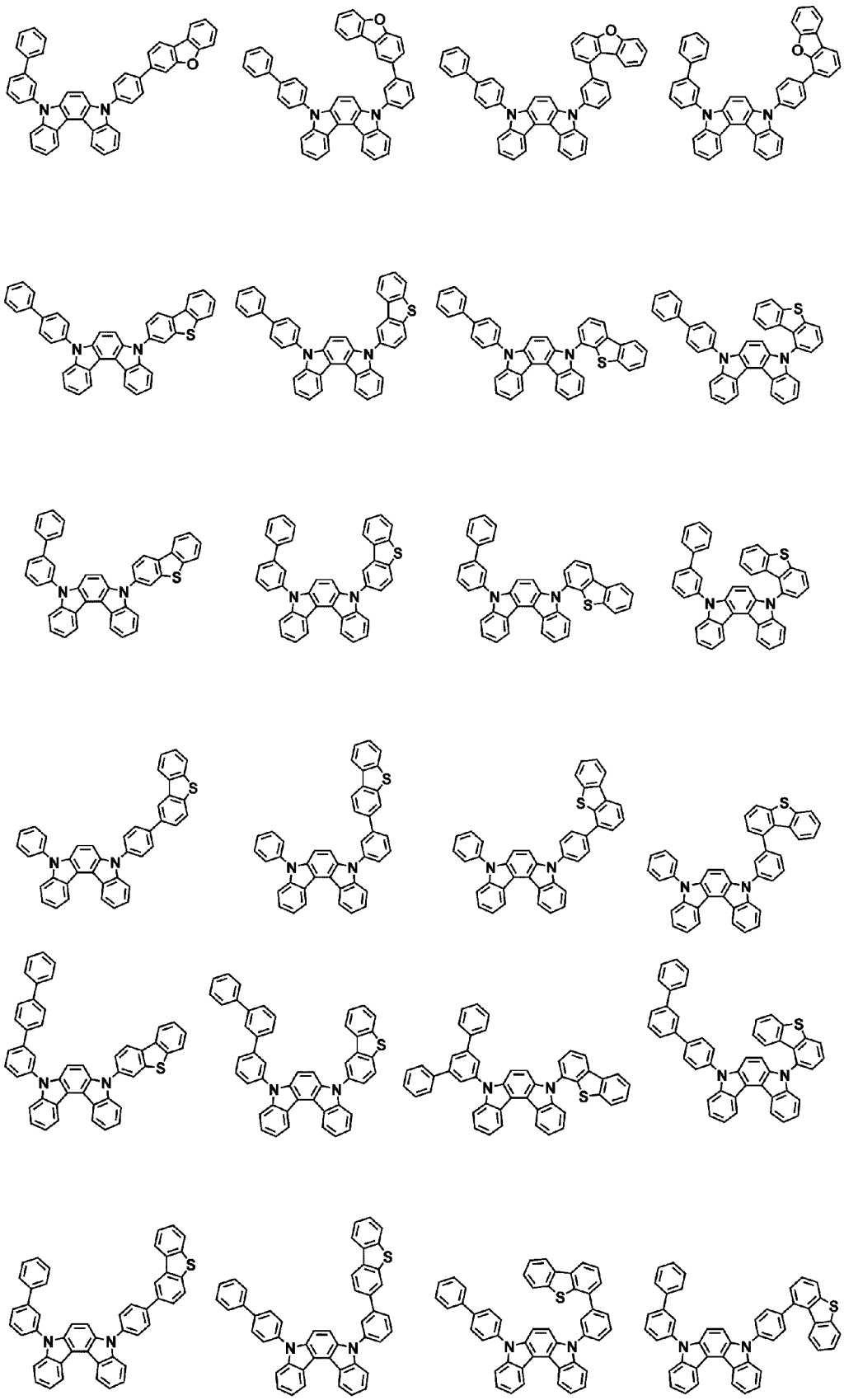
유기 발광 소자:

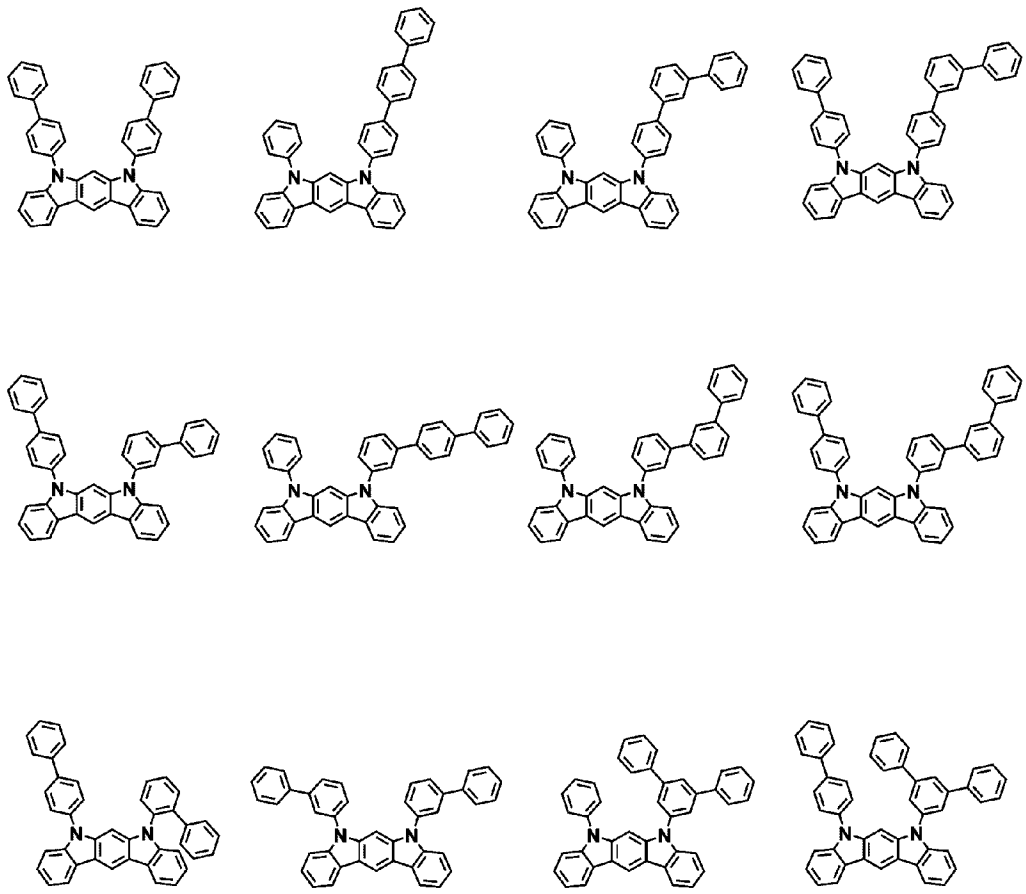


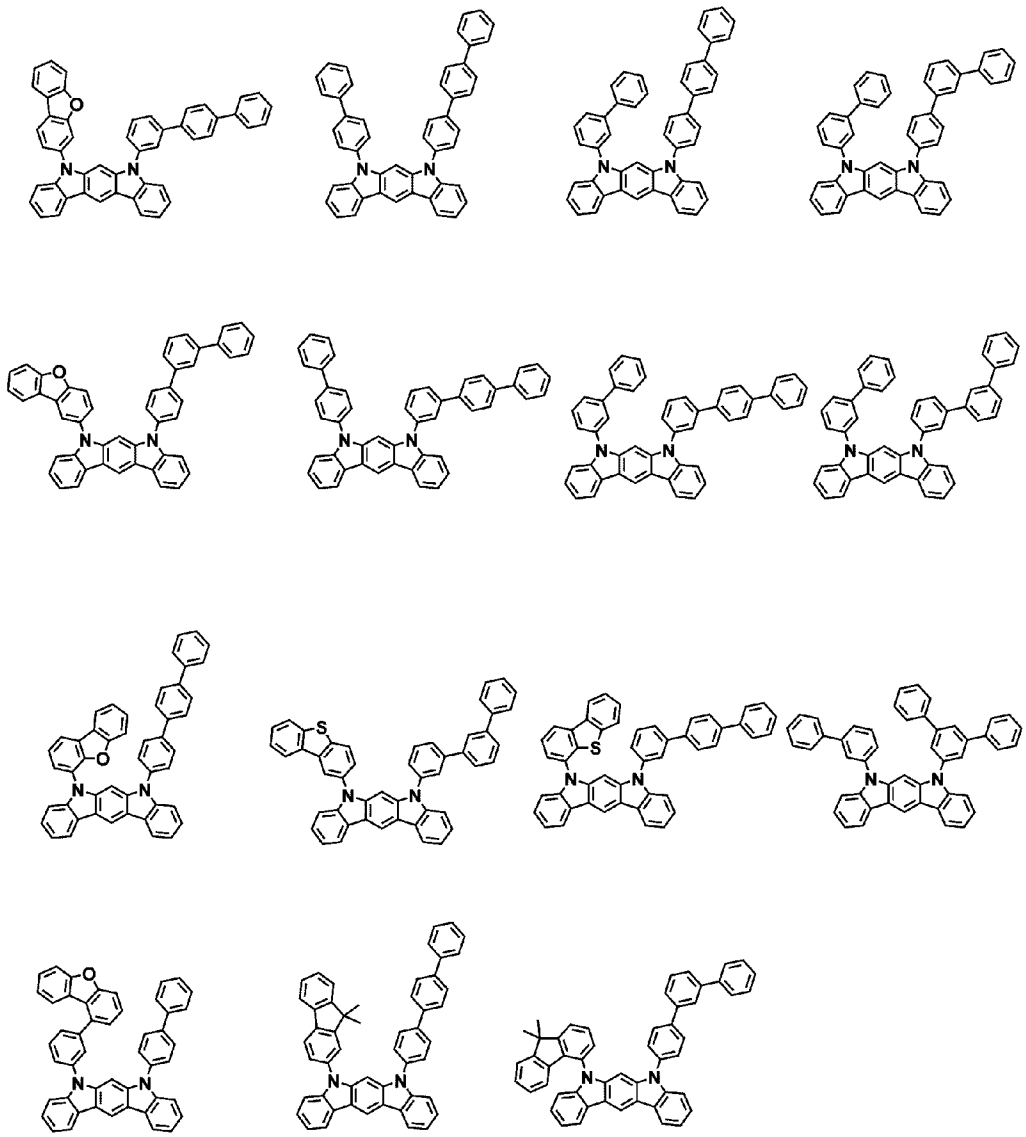


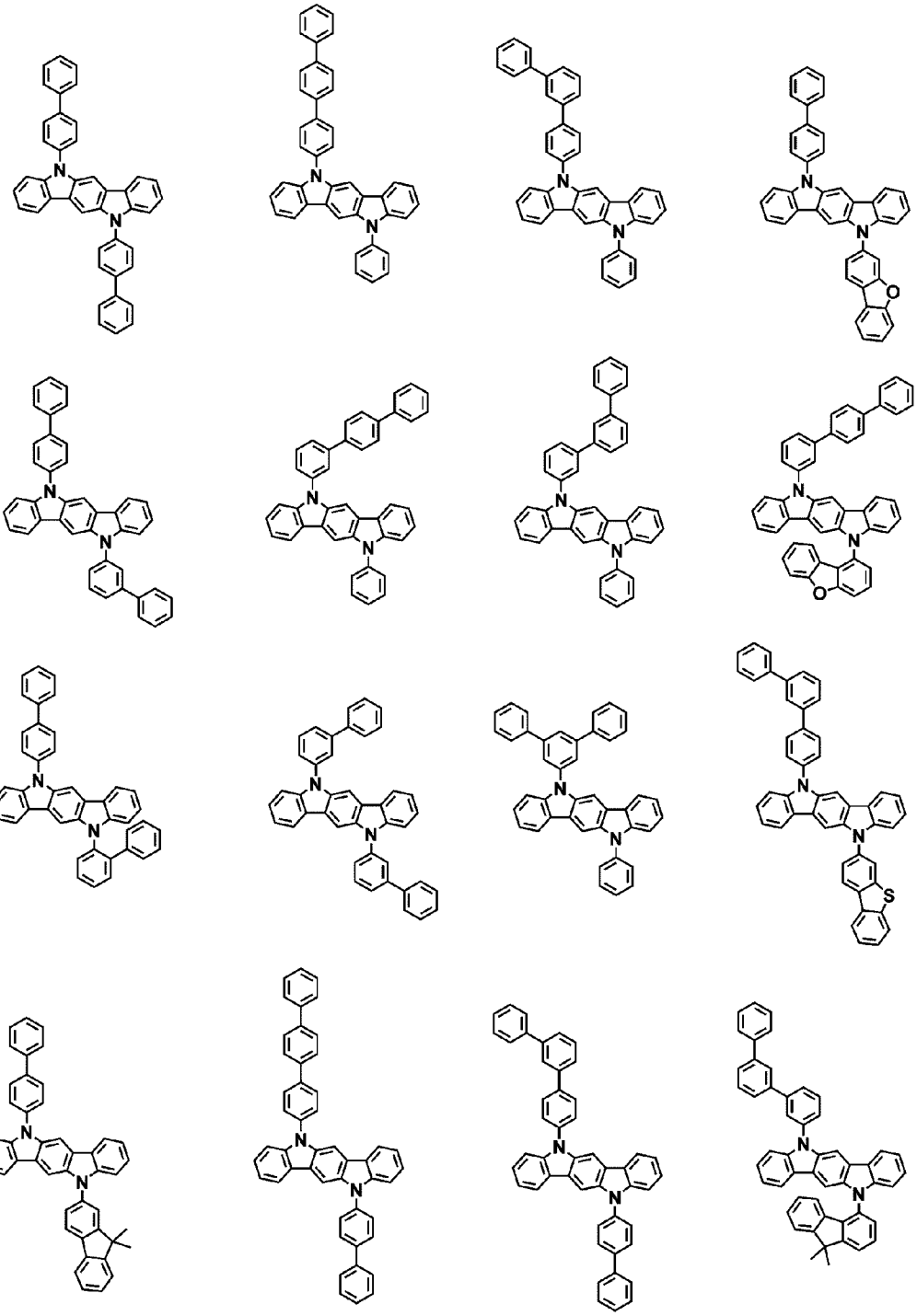


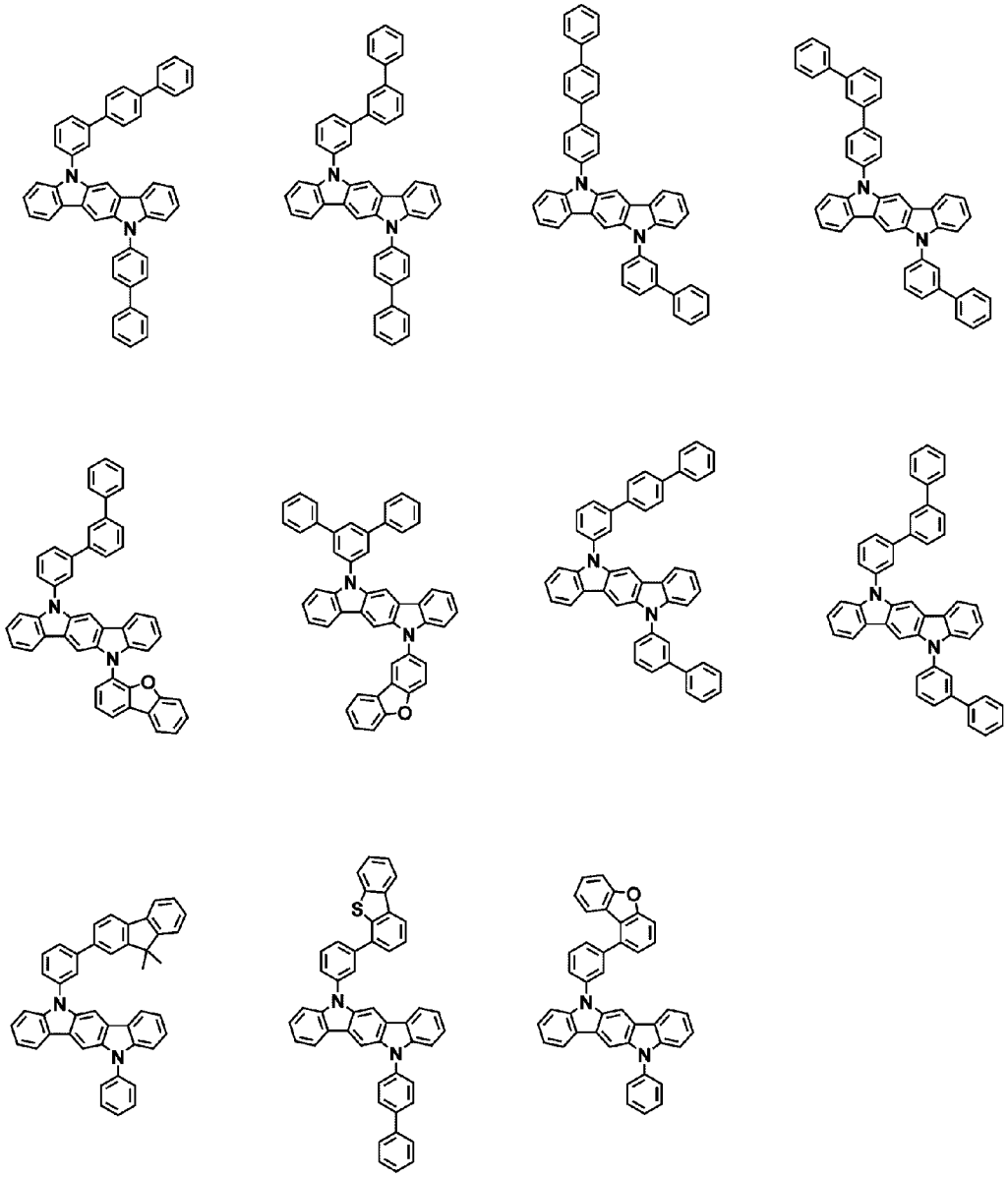


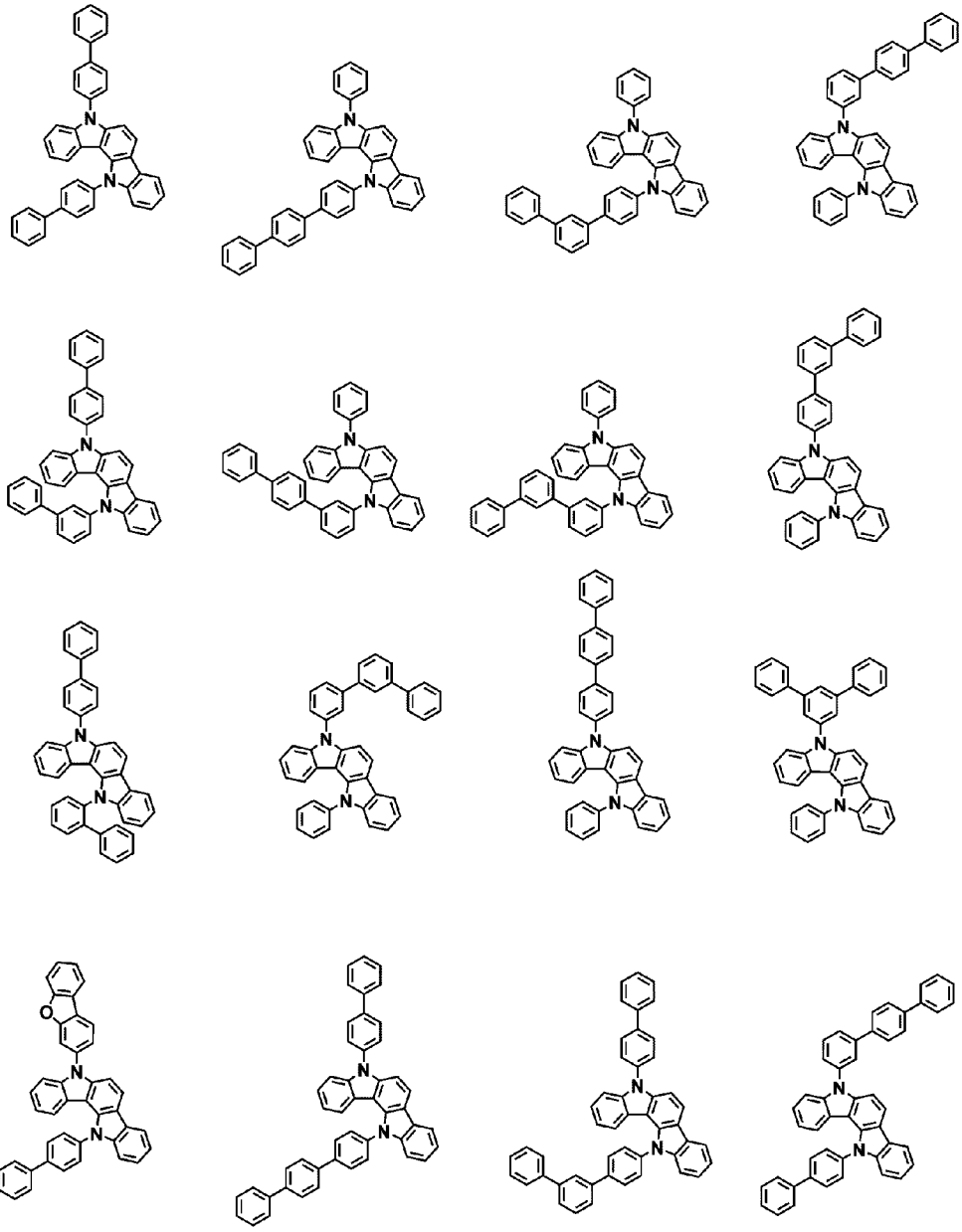


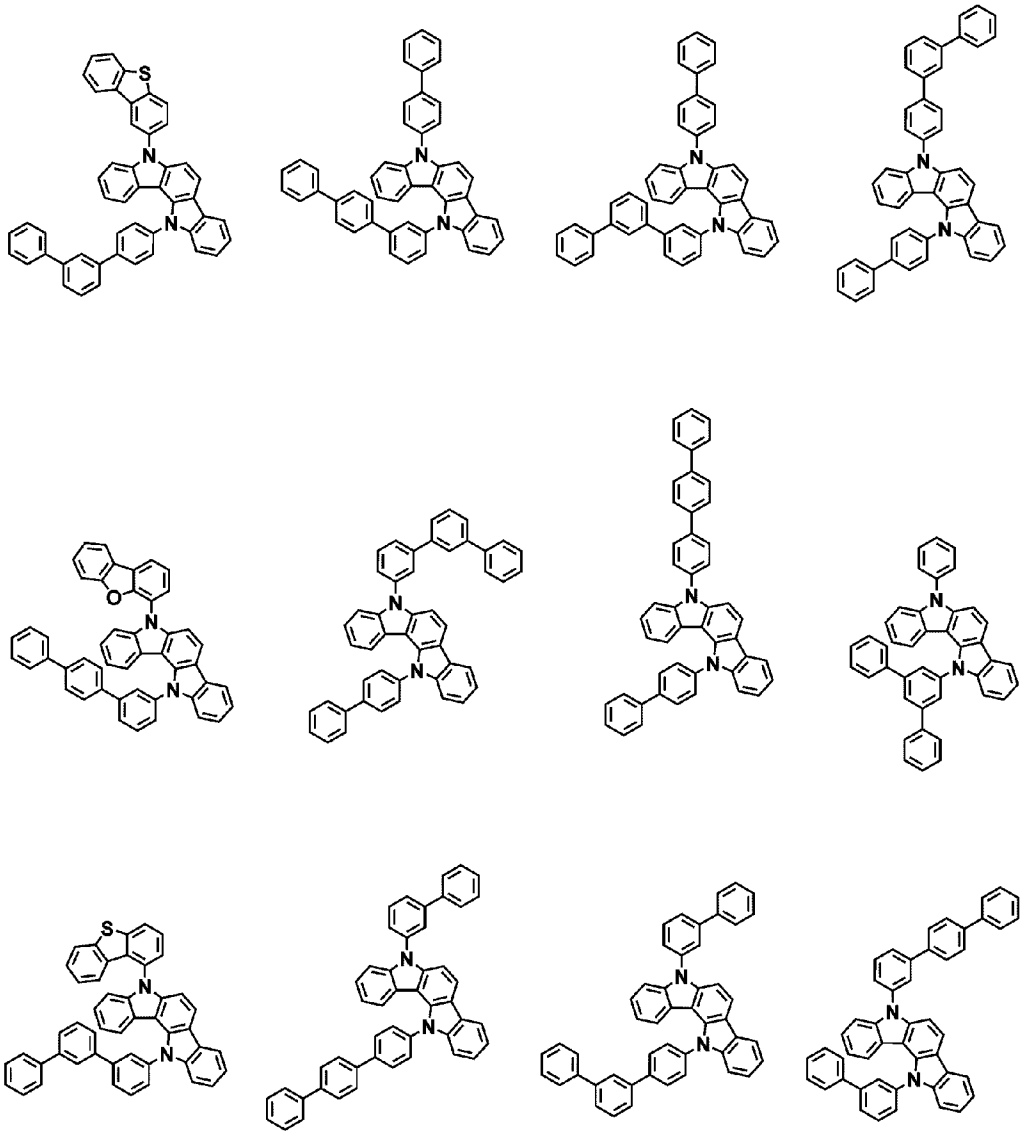


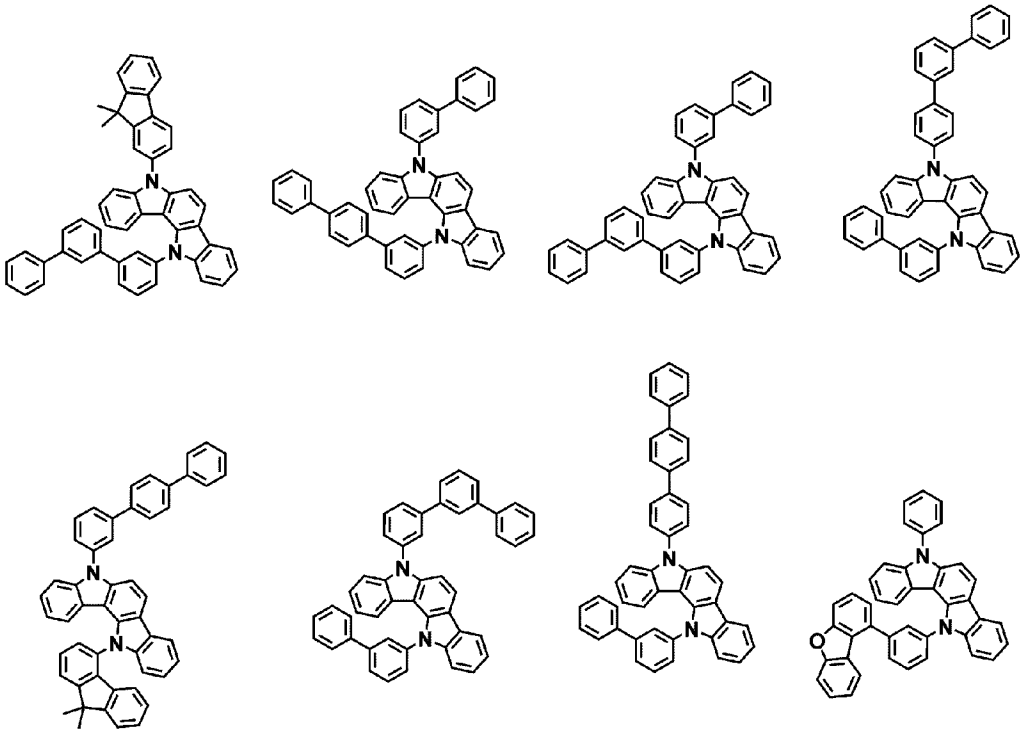


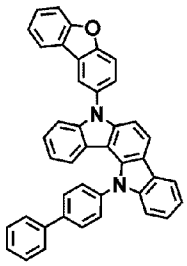












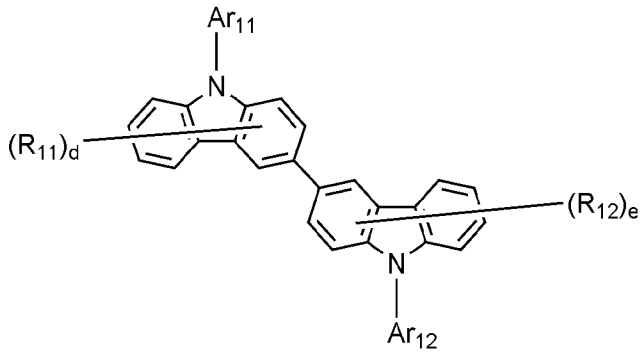
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[청구항 6] 제1항에 있어서,

상기 제2 화합물은 하기 화학식 2-1로 표시되는,

유기 발광 소자:

[화학식 2-1]



상기 화학식 2-1에서,

Ar_{11}, Ar_{12}, R_{11} 및 R_{12}, d 및 e는 제1항에서 정의한 바와 같다.

[청구항 7] 제1항에 있어서,

Ar_{11} 및 Ar_{12}는 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 또는 디벤조티오페닐이고,

여기서, Ar_{11} 및 Ar_{12}는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환되는,

유기 발광 소자.

[청구항 8] 제1항에 있어서,

Ar_{11} 및 Ar_{12} 중 적어도 하나는 페닐 또는 비페닐릴인,

유기 발광 소자.

[청구항 9] 제1항에 있어서,

R_{11} 및 R_{12}는 각각 독립적으로 수소, 중수소, 또는 페닐인,

유기 발광 소자.

[청구항 10] 제1항에 있어서,

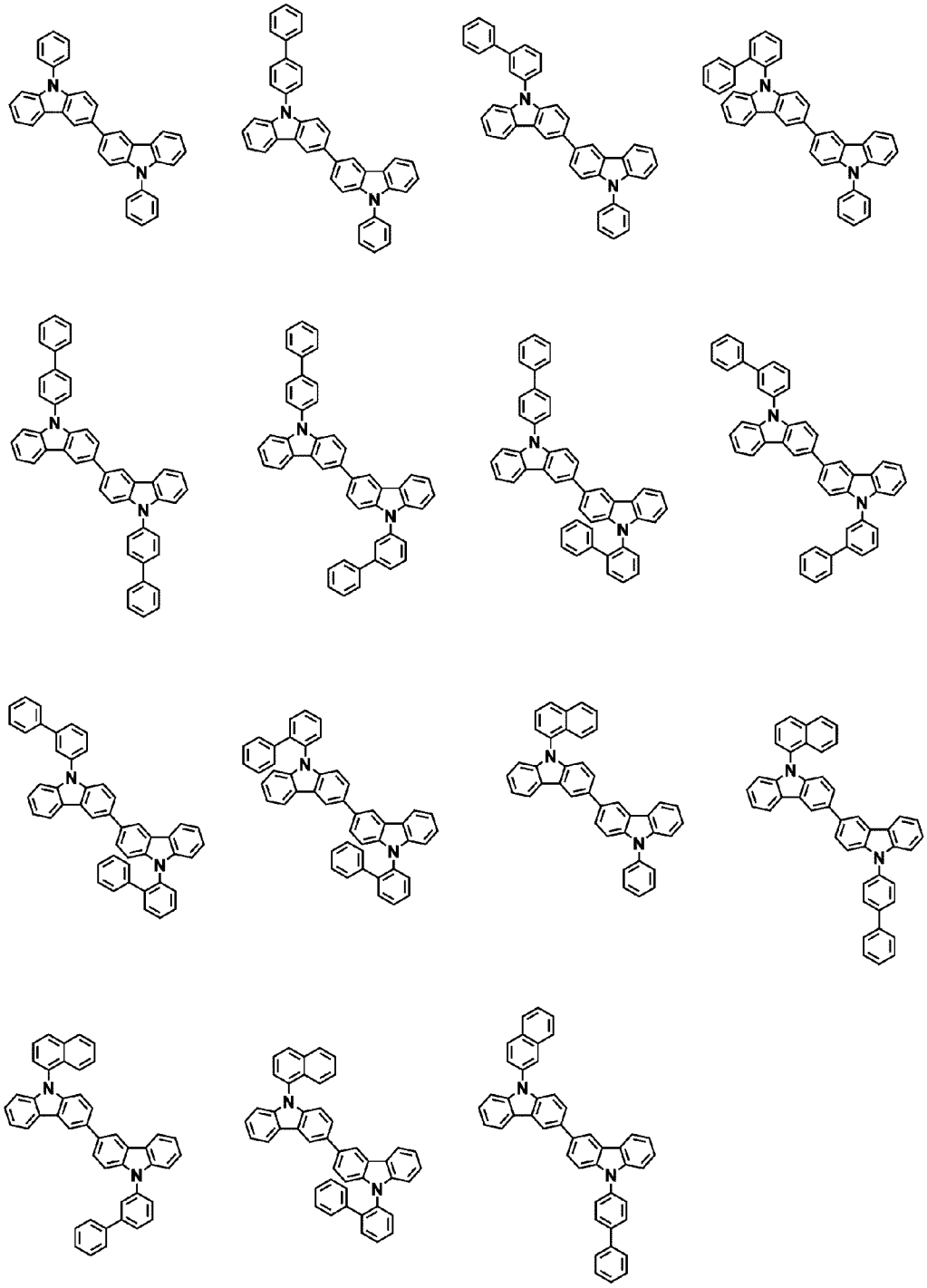
d+e는 0 또는 1인,

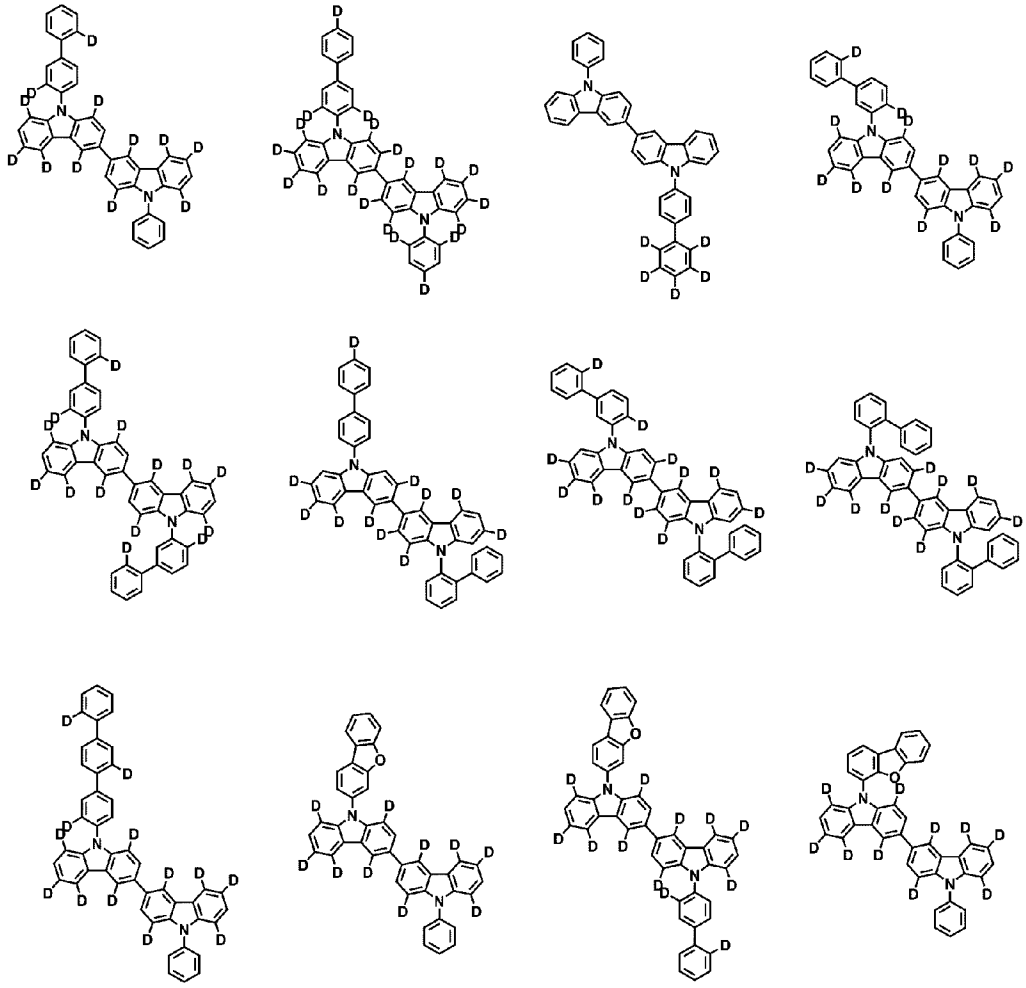
유기 발광 소자.

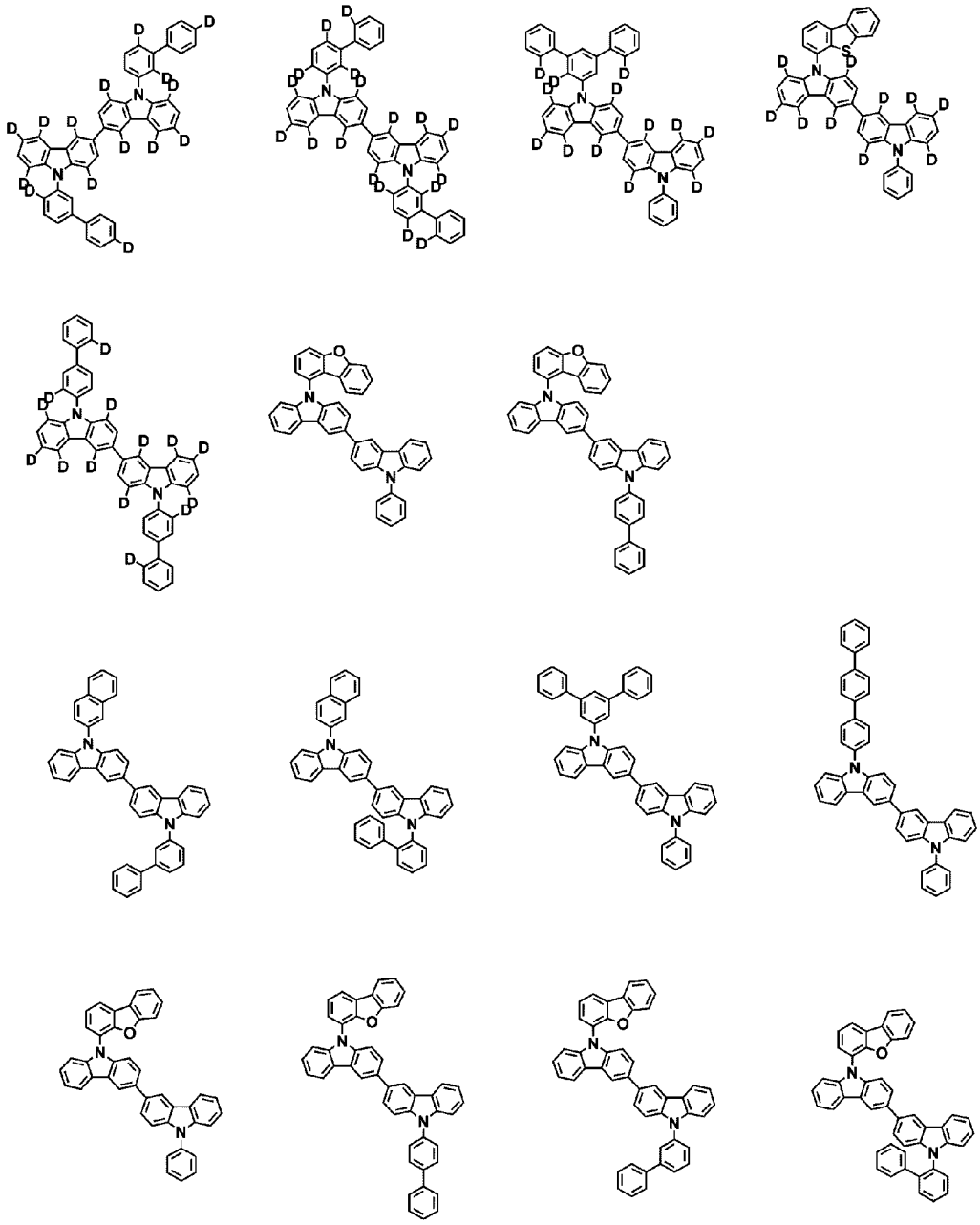
[청구항 11] 제1항에 있어서,

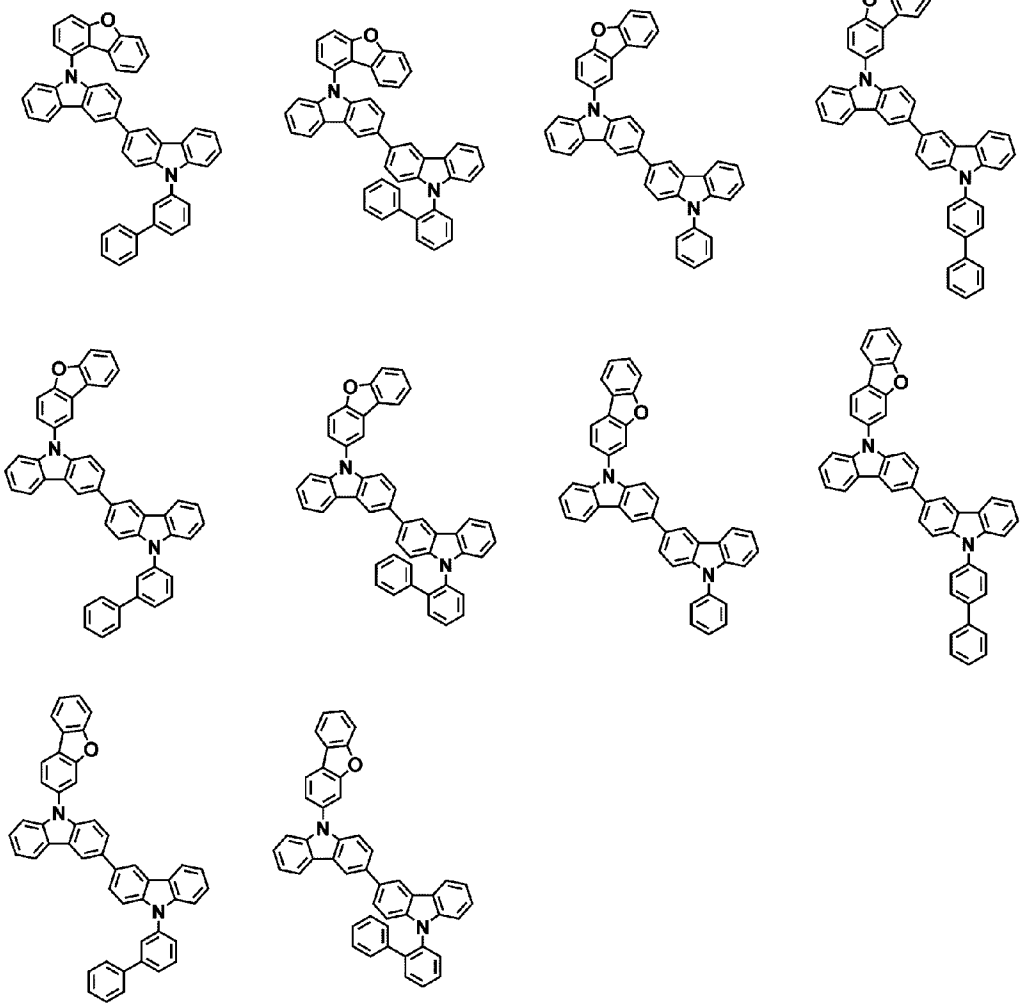
상기 제2 화합물은 하기로 구성되는 군으로부터 선택되는 어느 하나인,

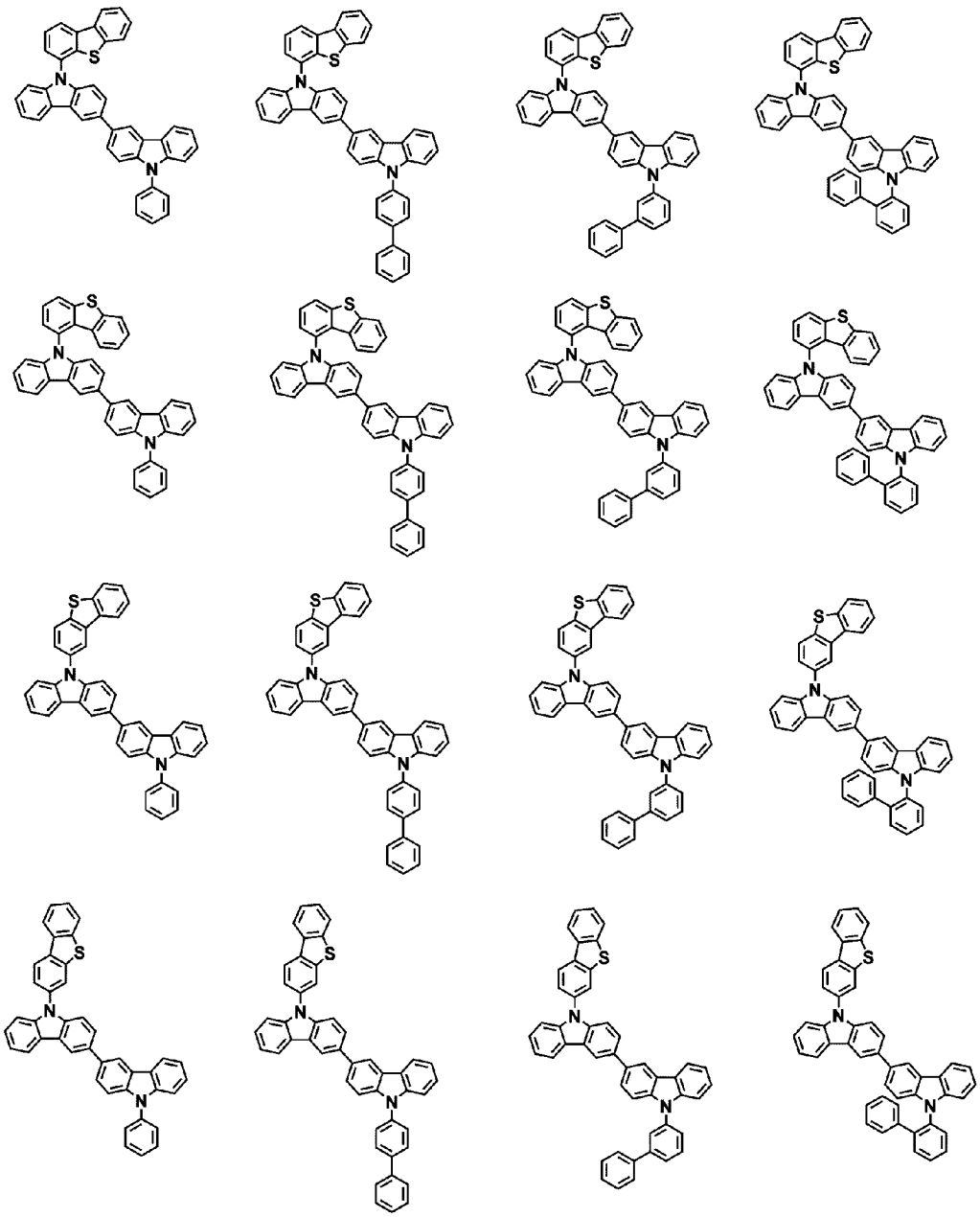
유기 발광 소자:

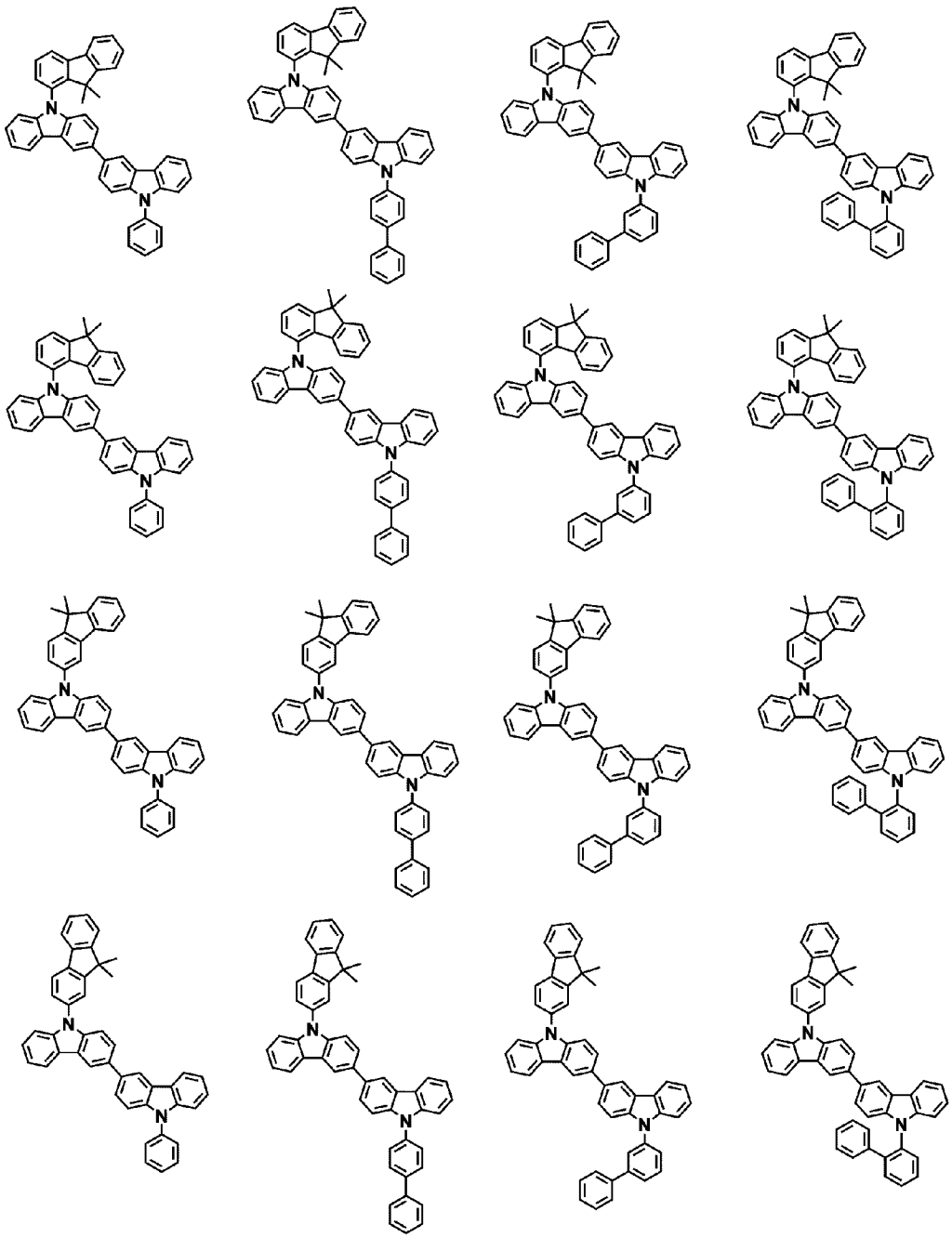


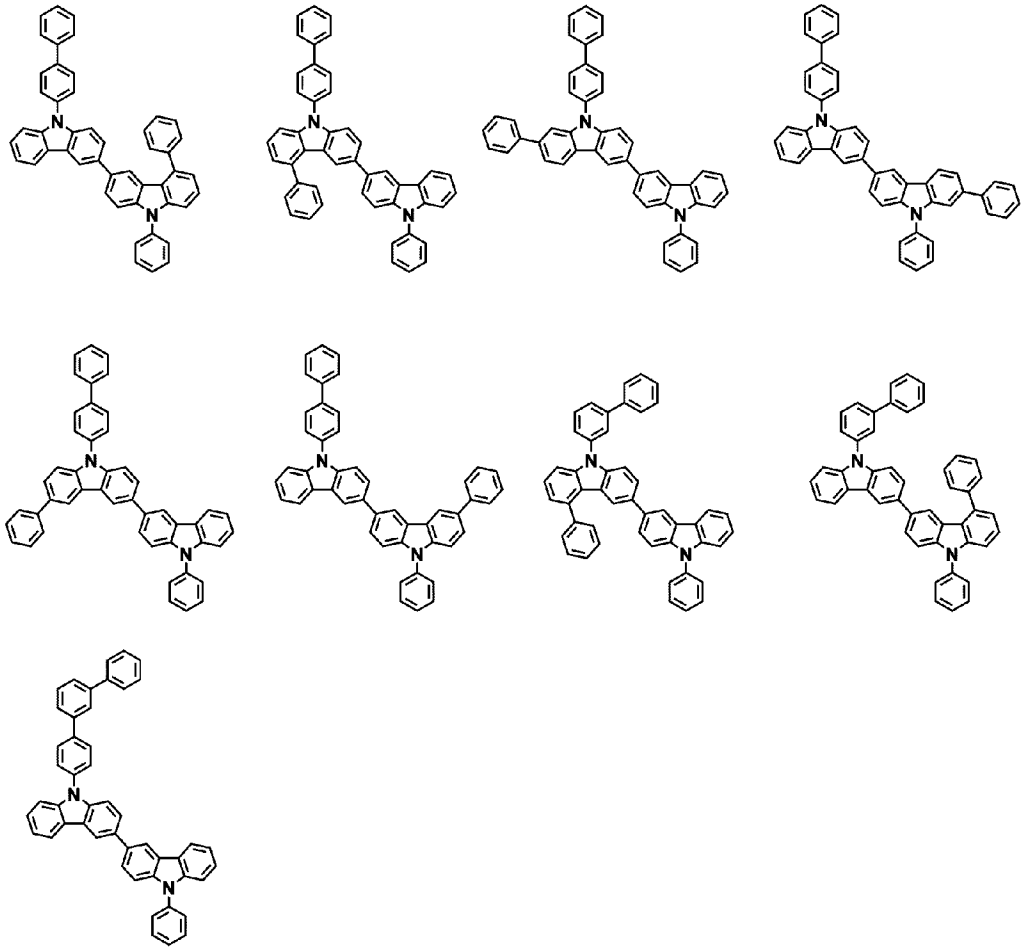












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[청구항 12] 제1항에 있어서,
X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH인,
유기 발광 소자.

[청구항 13] 제1항에 있어서,
L은 단일 결합인,
유기 발광 소자.

[청구항 14] 제1항에 있어서,
Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴인,
유기 발광 소자.

[청구항 15] 제1항에 있어서,
Ar_{21}은 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴인,
유기 발광 소자.

[청구항 16] 제1항에 있어서,
Ar_{21}은 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자

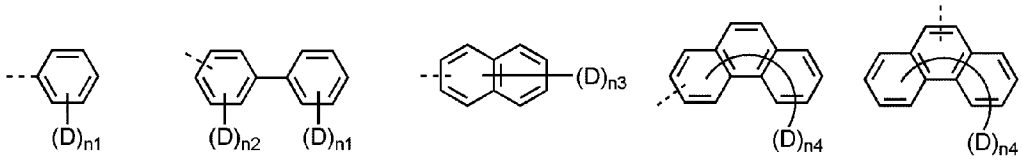
N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴인,

유기 발광 소자.

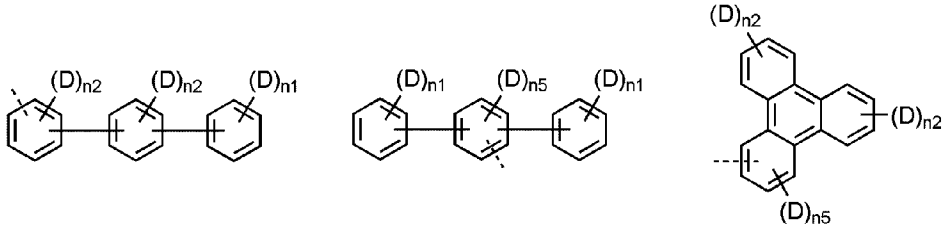
[청구항 17] 제1항에 있어서,

Ar_{21}은 하기 화학식 4a 내지 4t 중 어느 하나로 표시되는,

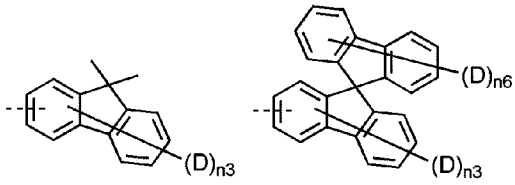
유기 발광 소자:



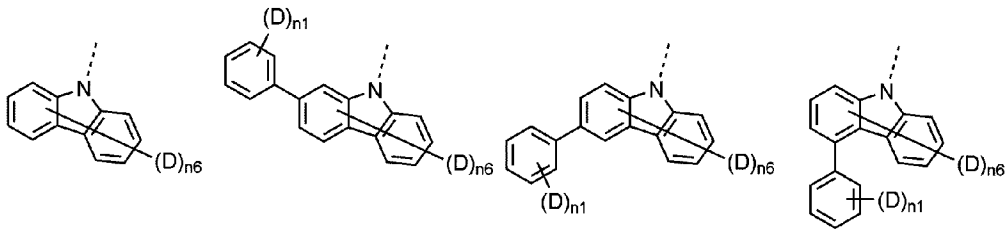
4a 4b 4c 4d 4e



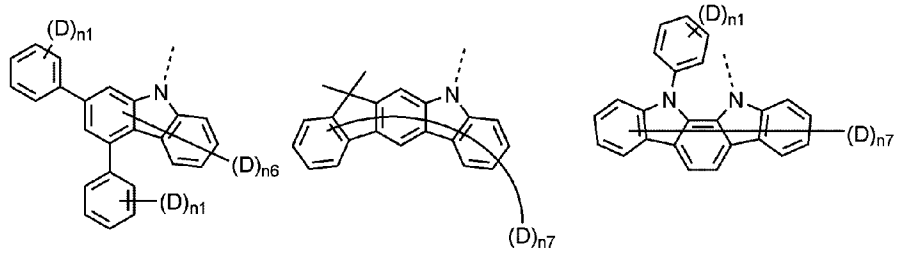
4f 4g 4h



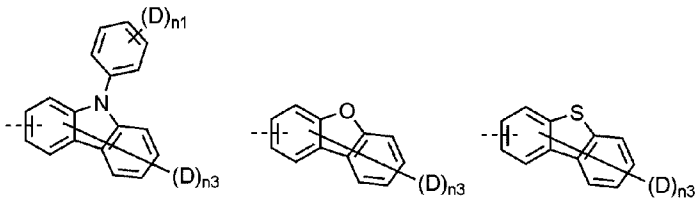
4i 4j



4k 4l 4m 4n



4o 4p 4q



4r 4s 4t

상기 화학식 4a 내지 4t에서,

D는 중수소이고,

n1은 각각 독립적으로 0 내지 5의 정수이고,

n2는 각각 독립적으로 0 내지 4의 정수이고,

n3는 각각 독립적으로 0 내지 7의 정수이고,

n4는 각각 독립적으로 0 내지 9의 정수이고,

n5는 각각 독립적으로 0 내지 3의 정수이고,

n6은 각각 독립적으로 0 내지 8의 정수이고,

n7은 각각 독립적으로 0 내지 10의 정수이다.

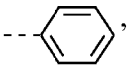
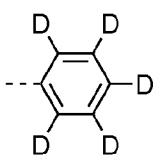
[청구항 18] 제1항에 있어서,

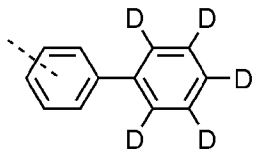
Ar_{22} 및 Ar_{23}은 각각 독립적으로 페닐, 비페닐릴, 터페닐릴, 나프틸, 플루오레닐, 디벤조퓨라닐, 디벤조티오페닐, 또는 카바졸일이고,

여기서, Ar_1 및 Ar_2는 비치환되거나, 또는 중수소, C_{1-10} 알킬 및 C_{6-20} 아릴로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환되는,

유기 발광 소자.

[청구항 19] 제1항에 있어서,

Ar_{22} 및 Ar_{23} 중 적어도 하나는,  ,  , 또는



인,

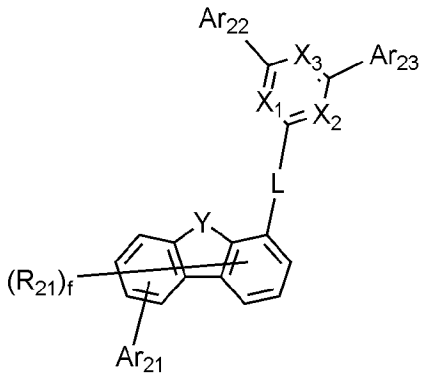
유기 발광 소자.

[청구항 20] 제1항에 있어서,

상기 제3 화합물은 하기 화학식 3-1로 표시되는,

유기 발광 소자:

[화학식 3-1]



상기 화학식 3-1에서,

X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

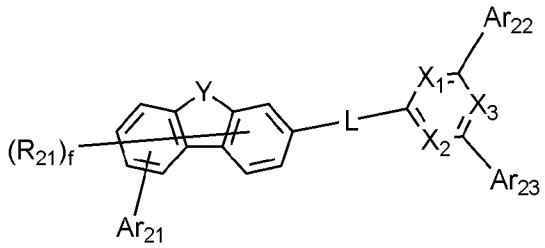
R_{21}은 중수소이고,

Y, L 및 f는 제1항에서 정의한 바와 같고,

단, f가 0인 경우 Ar_{21} 내지 Ar_{23} 중 적어도 하나는 중수소로 치환된다.

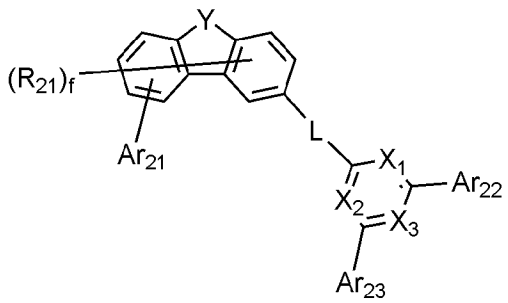
[청구항 21] 제1항에 있어서,

상기 제3 화합물은 하기 화학식 3-2로 표시되는,
유기 발광 소자:
[화학식 3-2]



상기 화학식 3-2에서,
X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,
Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,
Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,
단, Ar_{22} 및 Ar_{23} 중 하나가 디벤조퓨라닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아니고, Ar_{22} 및 Ar_{23} 중 하나가 디벤조티오페닐인 경우, 다른 하나는 디벤조퓨라닐 및 디벤조티오페닐이 아니며,
Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

[청구항 22] 제1항에 있어서,
상기 제3 화합물은 하기 화학식 3-3으로 표시되는,
유기 발광 소자:
[화학식 3-3]



상기 화학식 3-3에서,

X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

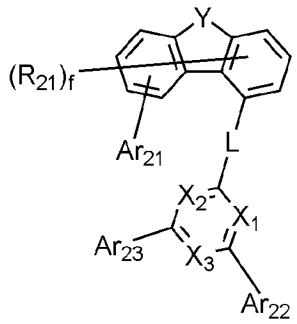
Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

[청구항 23] 제1항에 있어서,

상기 제3 화합물은 하기 화학식 3-4로 표시되는,

유기 발광 소자:

[화학식 3-4]



상기 화학식 3-4에서,

X_1 내지 X_3는 모두 N이거나; 또는 X_1 내지 X_3 중 둘은 N이고, 나머지 하나는 CH이고,

Ar_{21}은 비치환되거나, 또는 중수소로 치환된 C_{6-20} 아릴; 비치환되거나, 또는 중수소로 치환된 헤테로원자 O 또는 S를 포함하는 C_{2-20} 헤테로아릴; 또는 비치환되거나, 또는 중수소, 페닐 및 중수소로 치환된 페닐로 구성되는 군으로부터 선택되는 1개 이상의 치환기로 치환된 헤테로원자 N을 1개 또는 2개 포함하는 C_{2-20} 헤테로아릴이고,

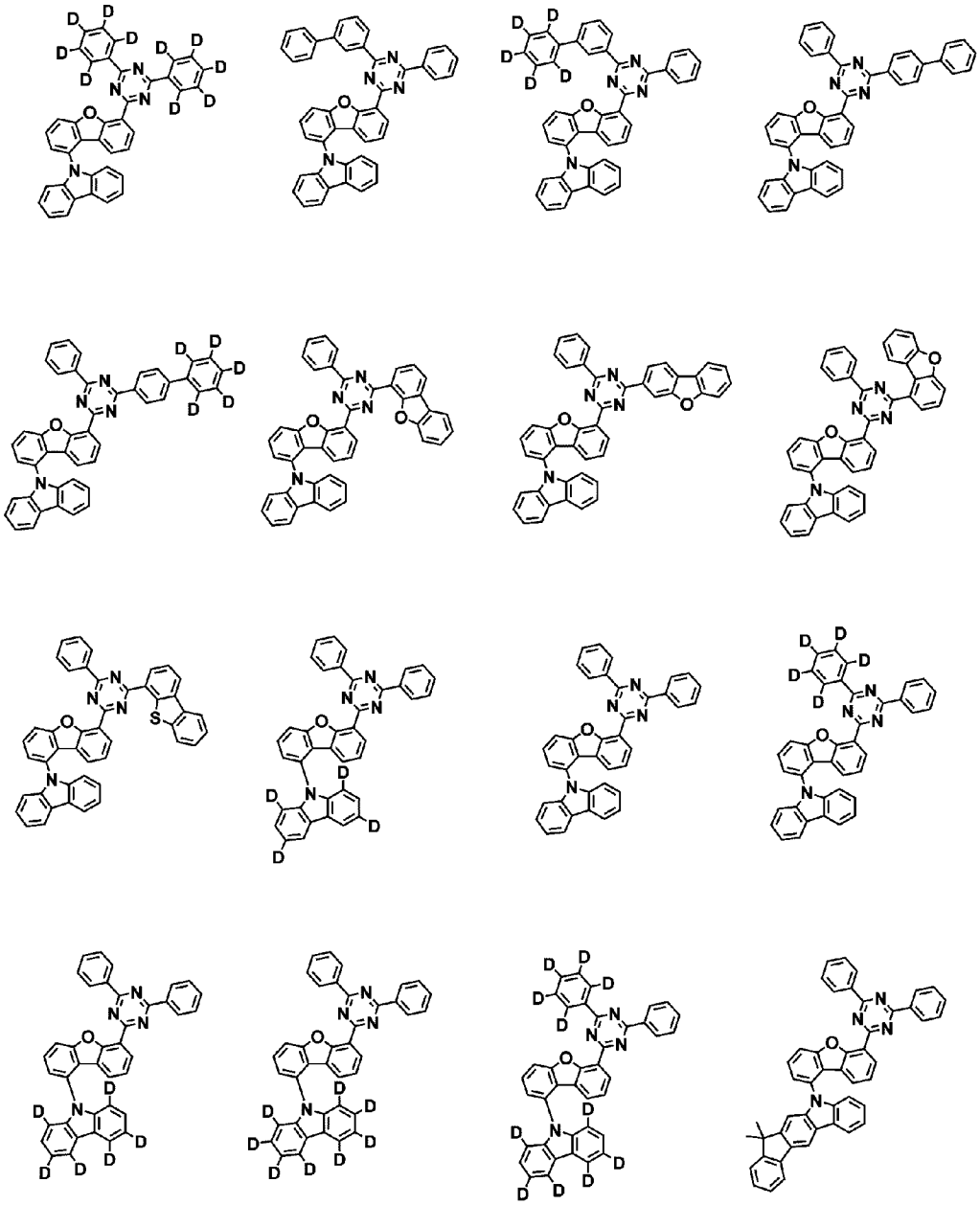
Ar_{22} 및 Ar_{23}은 각각 독립적으로 비치환되거나, 또는 중수소로 치환된 페닐; 비치환되거나, 또는 중수소로 치환된 비페닐릴; 비치환되거나, 또는 중수소로 치환된 디벤조퓨라닐; 비치환되거나, 또는 중수소로 치환된 디벤조티오페닐; 또는 비치환되거나, 또는 중수소, 페닐 또는 중수소로 치환된 페닐로 치환된 카바졸일이고,

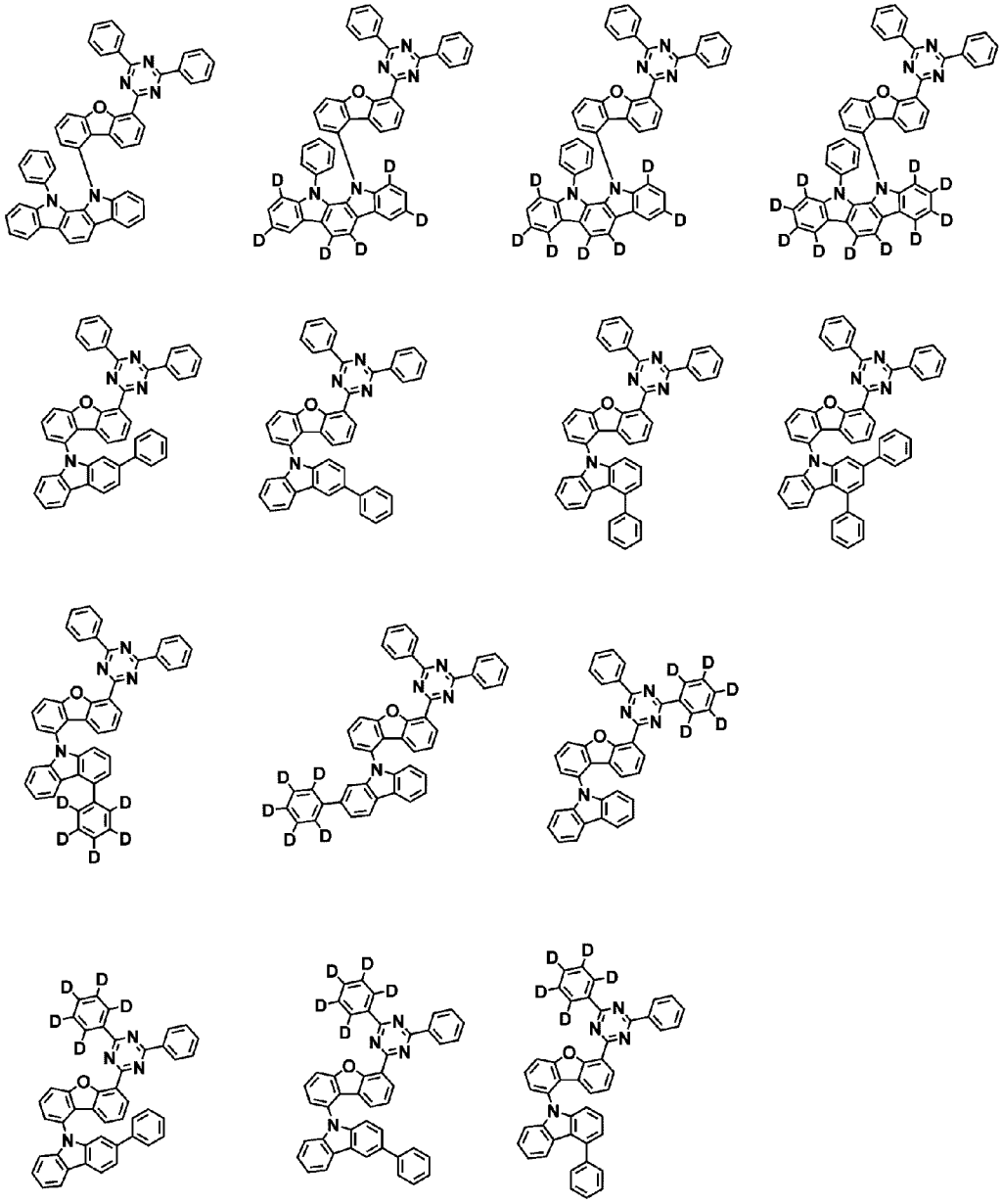
Y, L, R_{21} 및 f는 제1항에서 정의한 바와 같다.

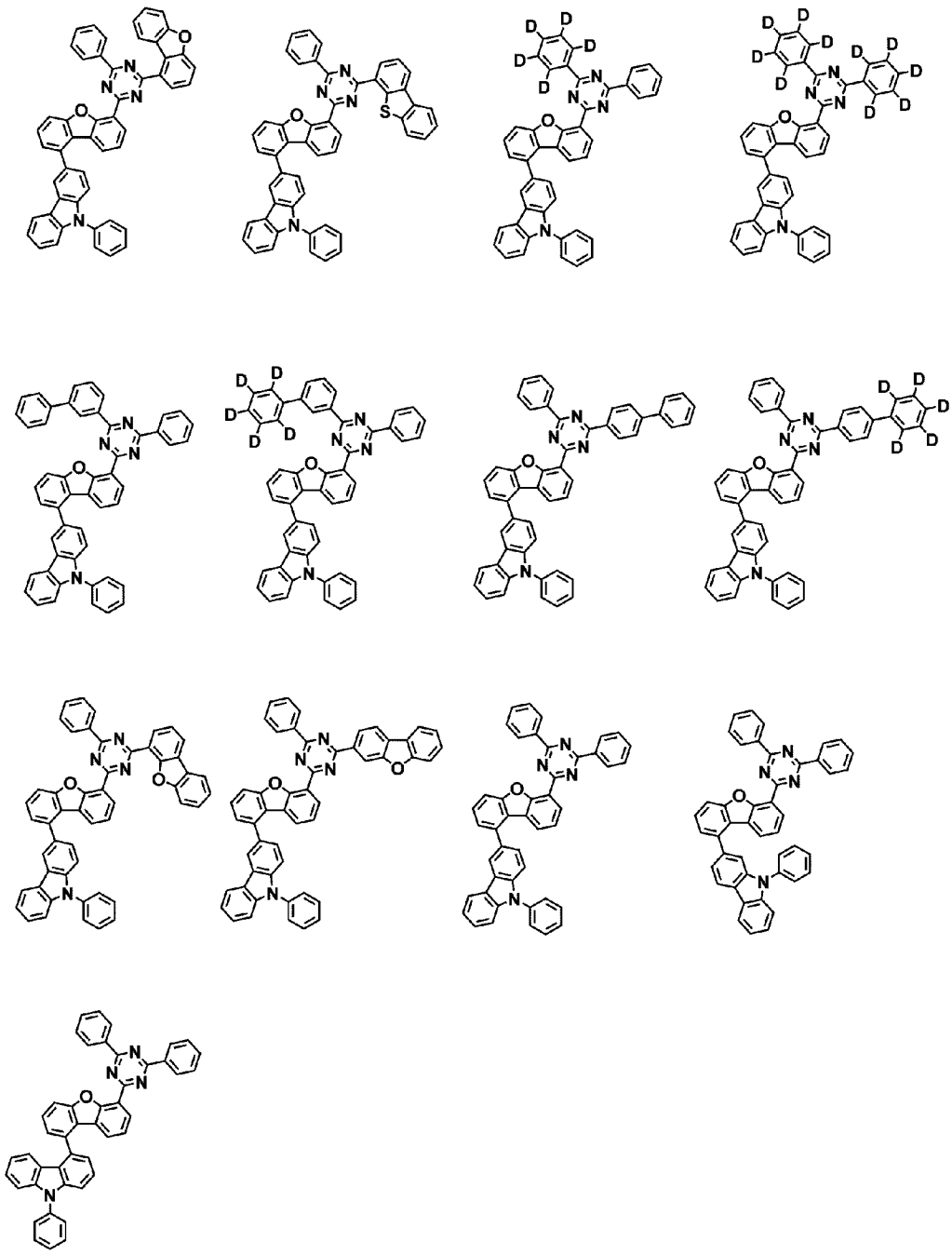
[청구항 24] 제1항에 있어서,

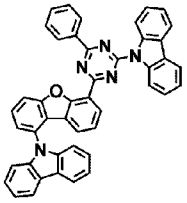
상기 제3 화합물은 하기로 구성되는 군으로부터 선택되는 어느 하나인,

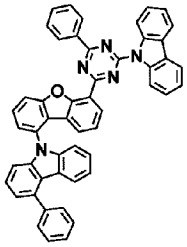
유기 발광 소자:

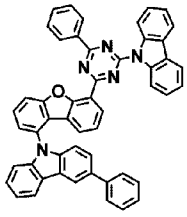


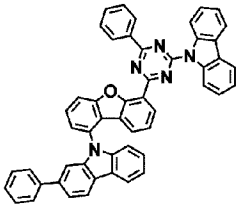


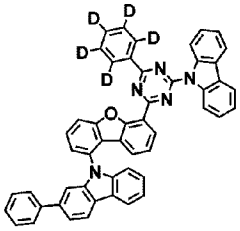


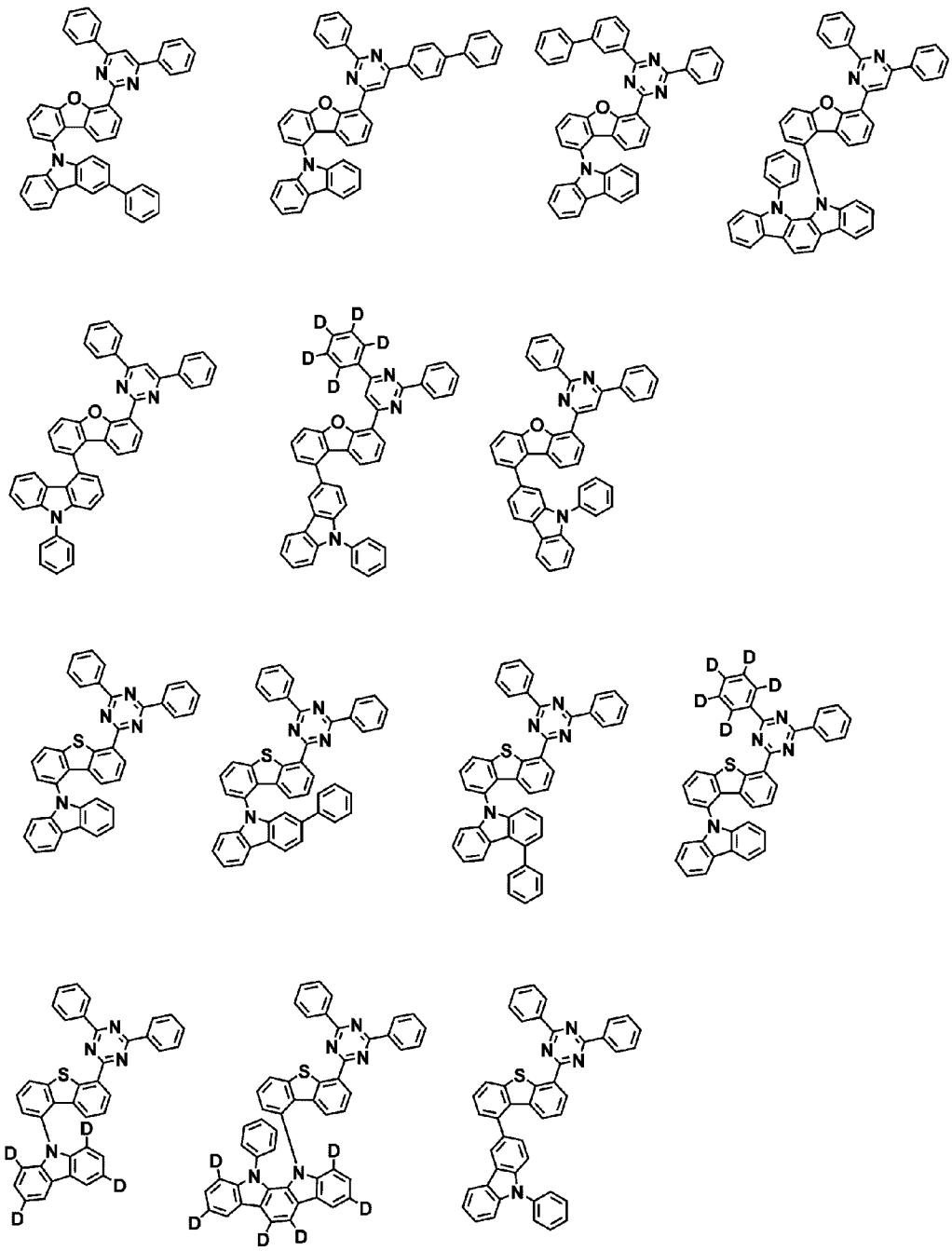


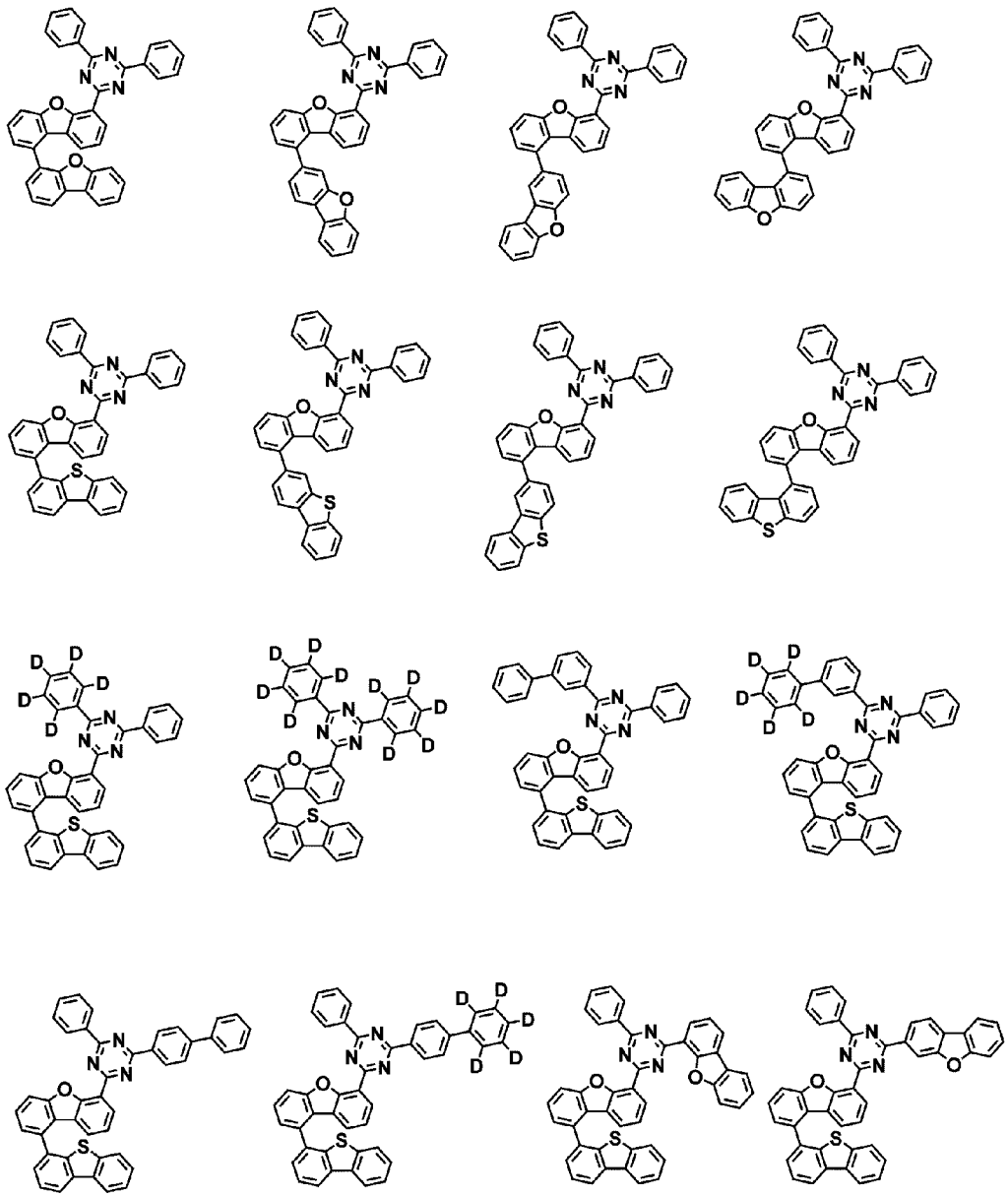


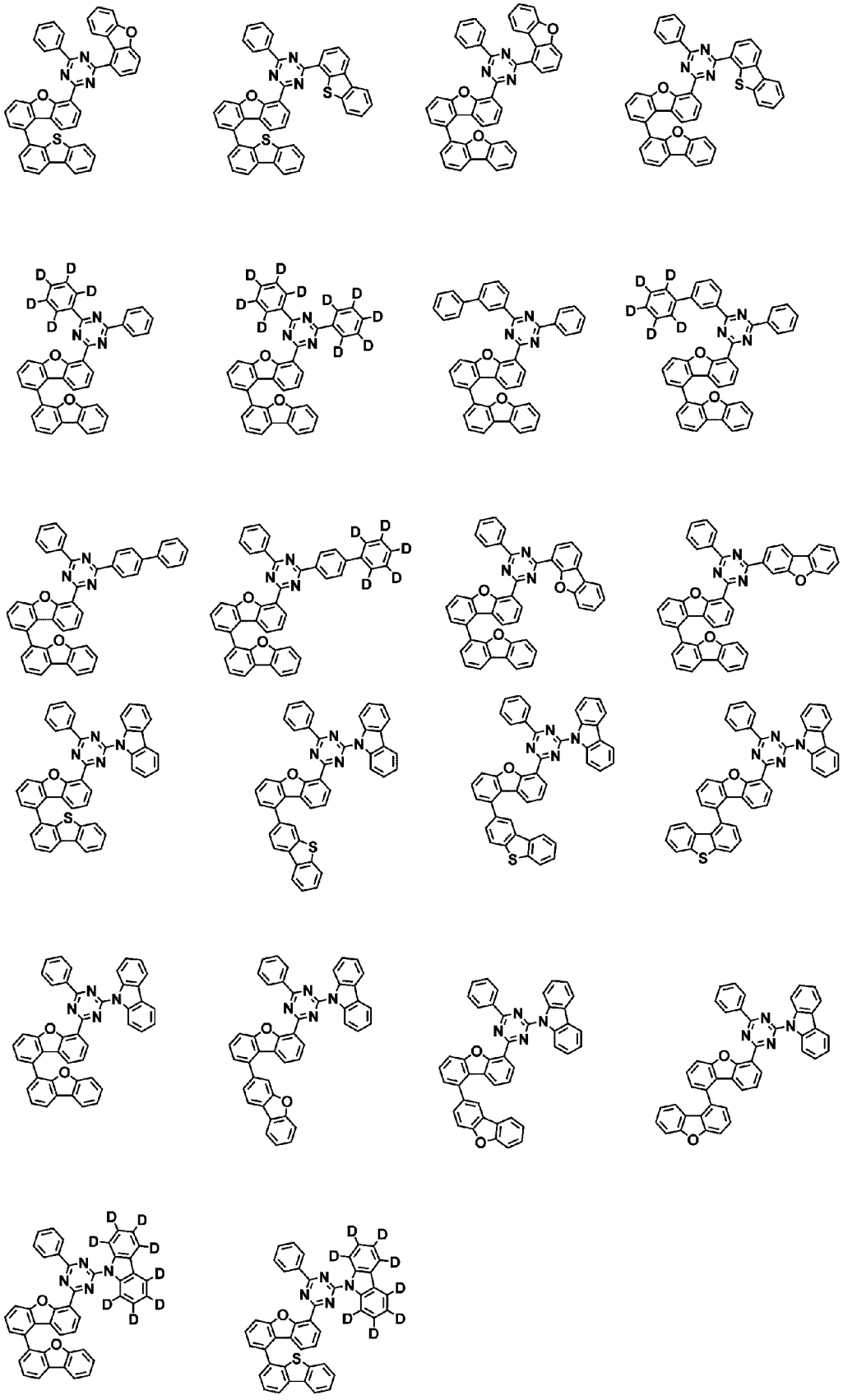


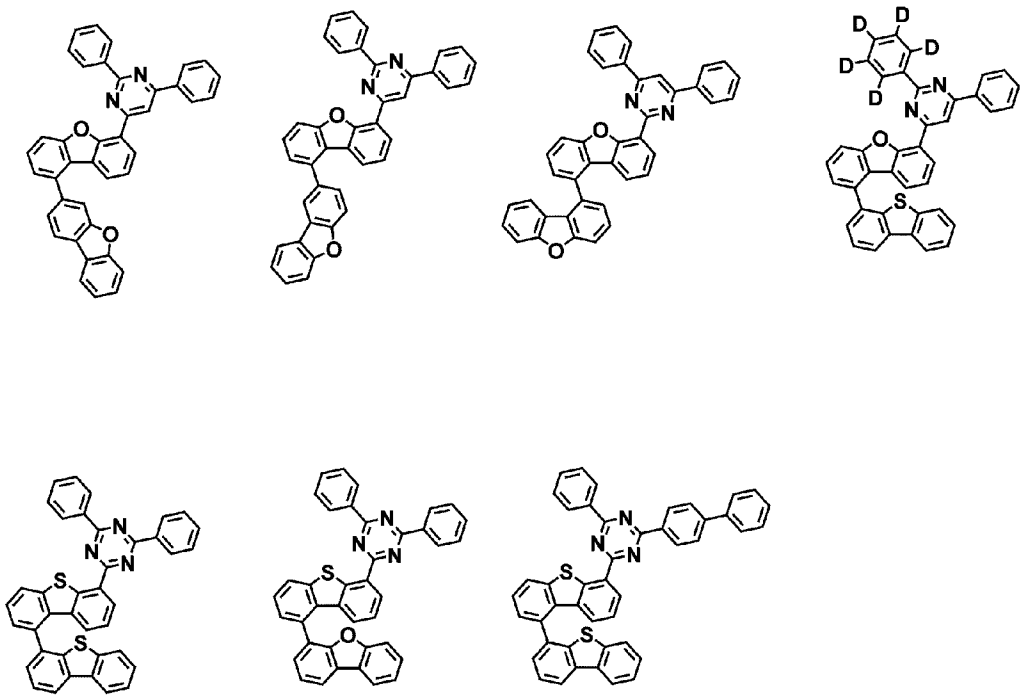


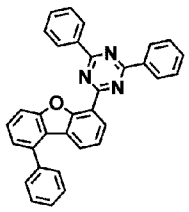
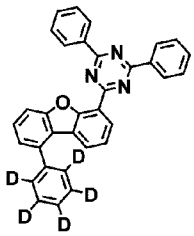
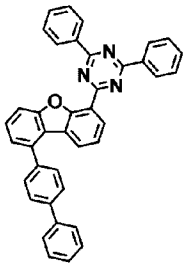
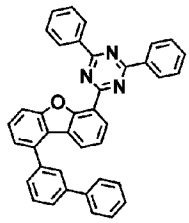
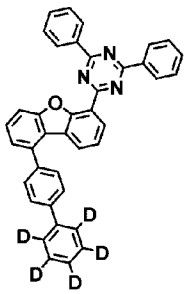
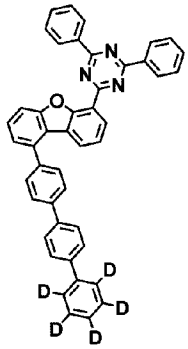
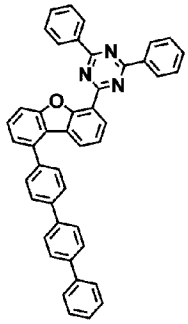
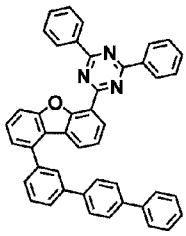
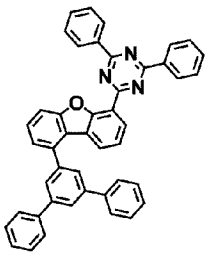
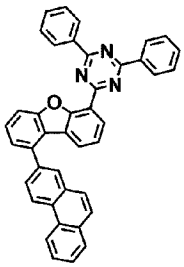
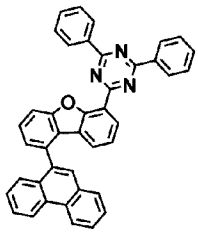
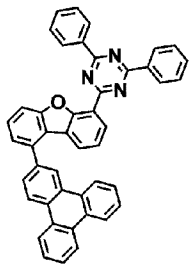
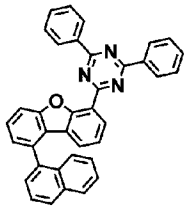
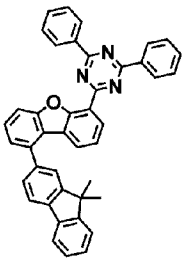
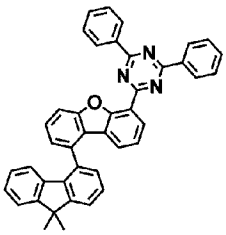
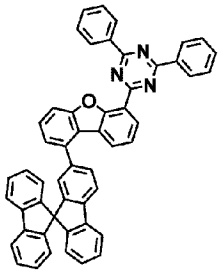


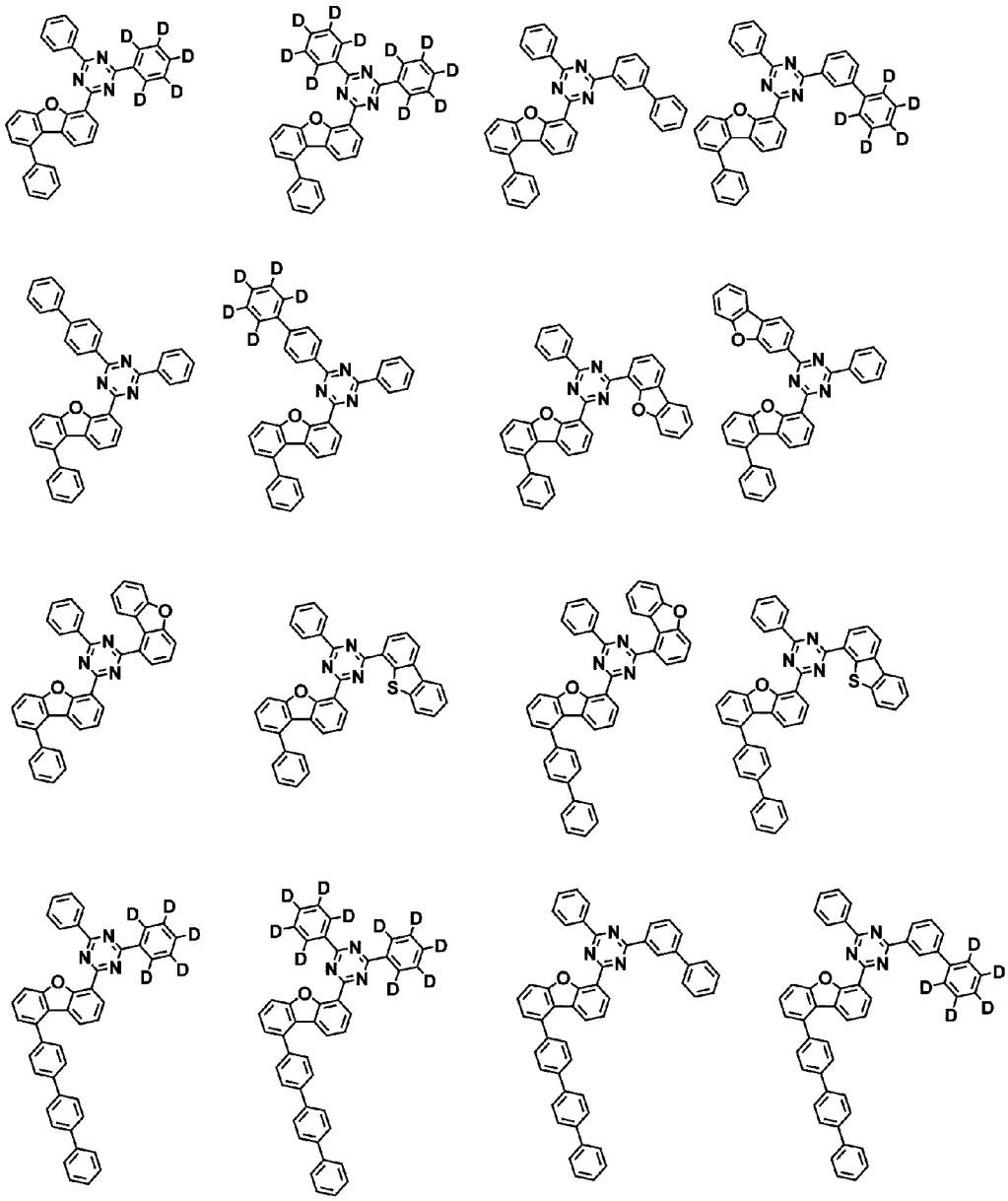


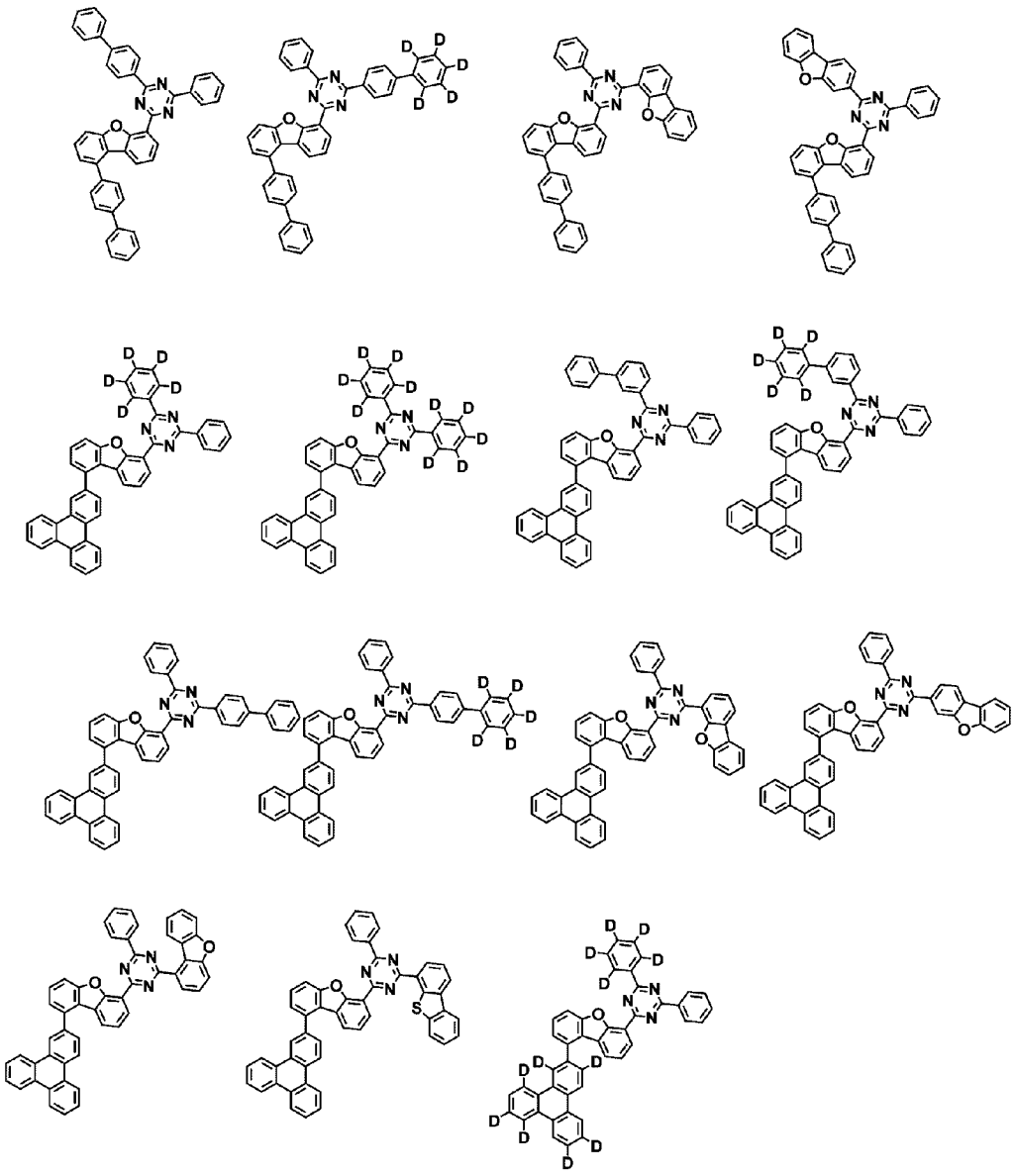


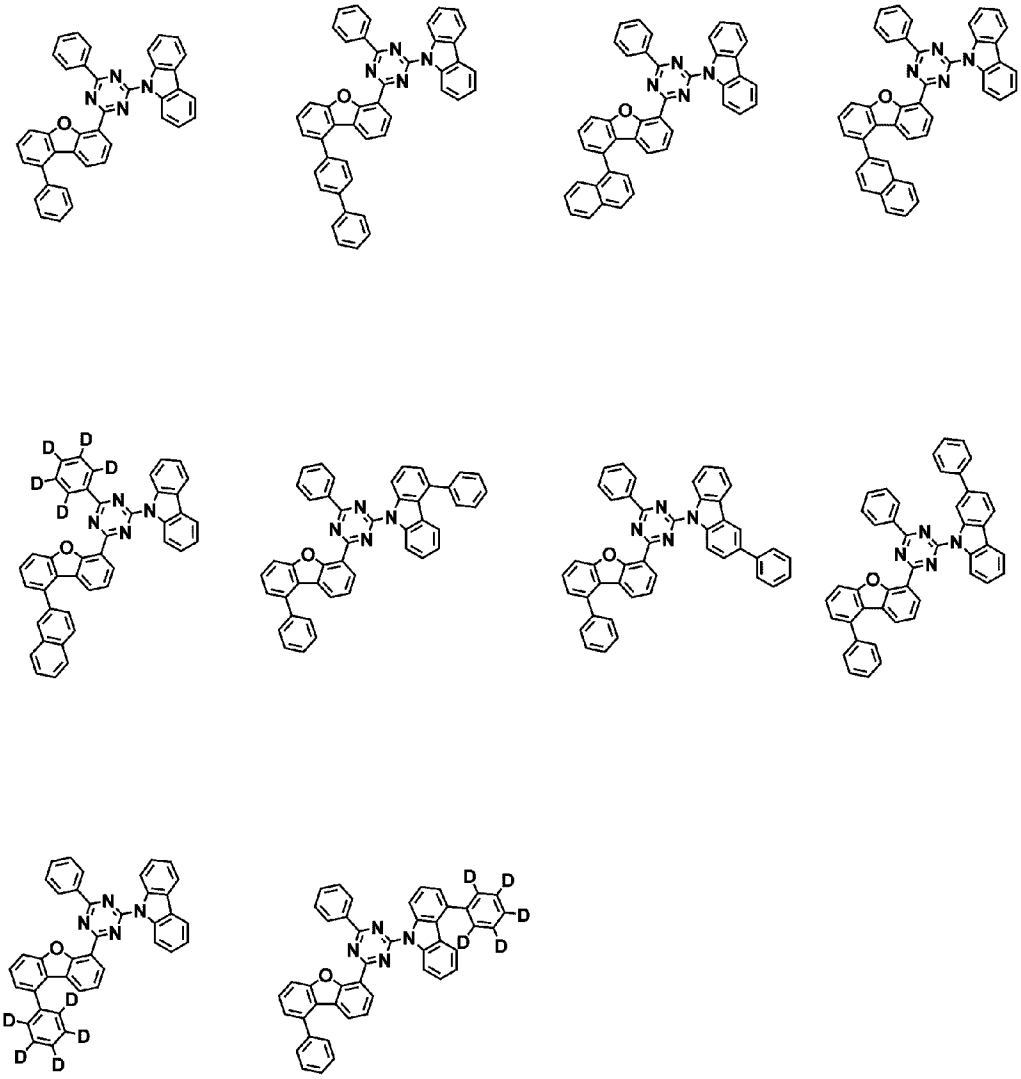


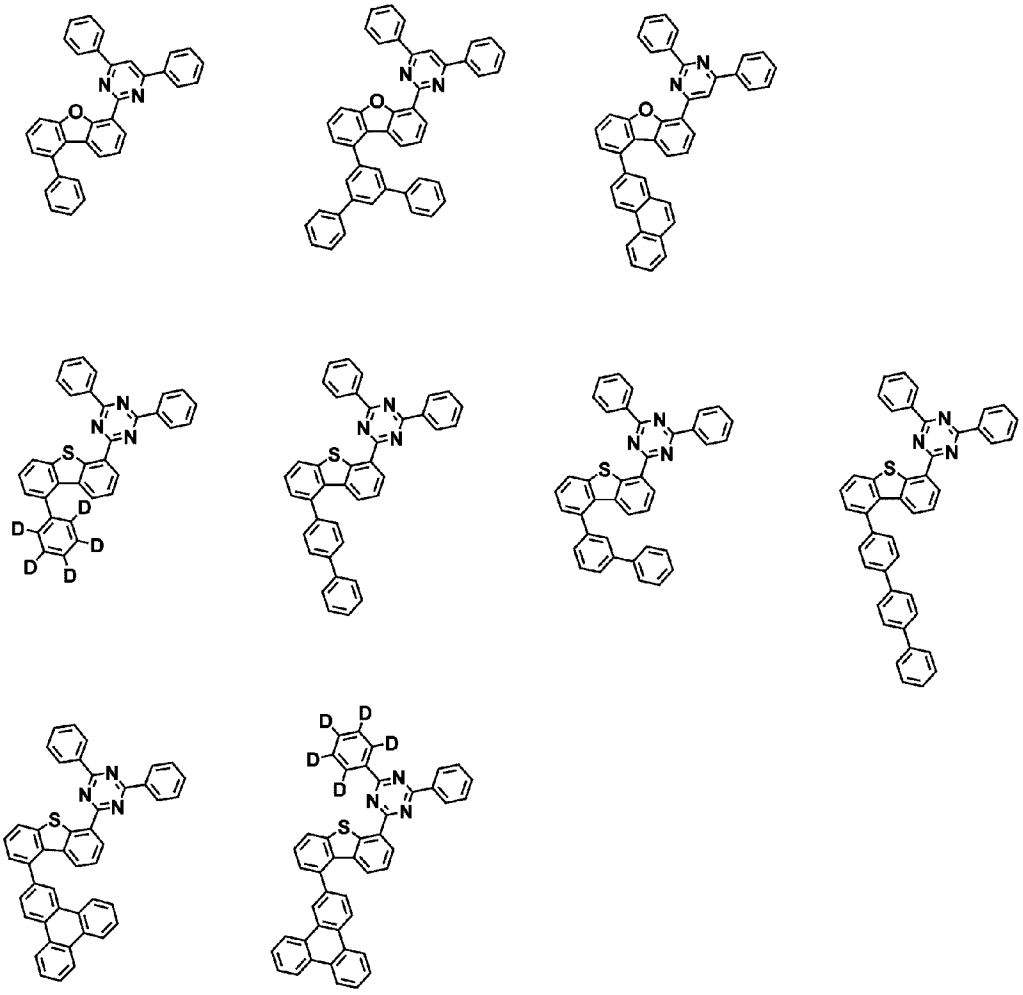


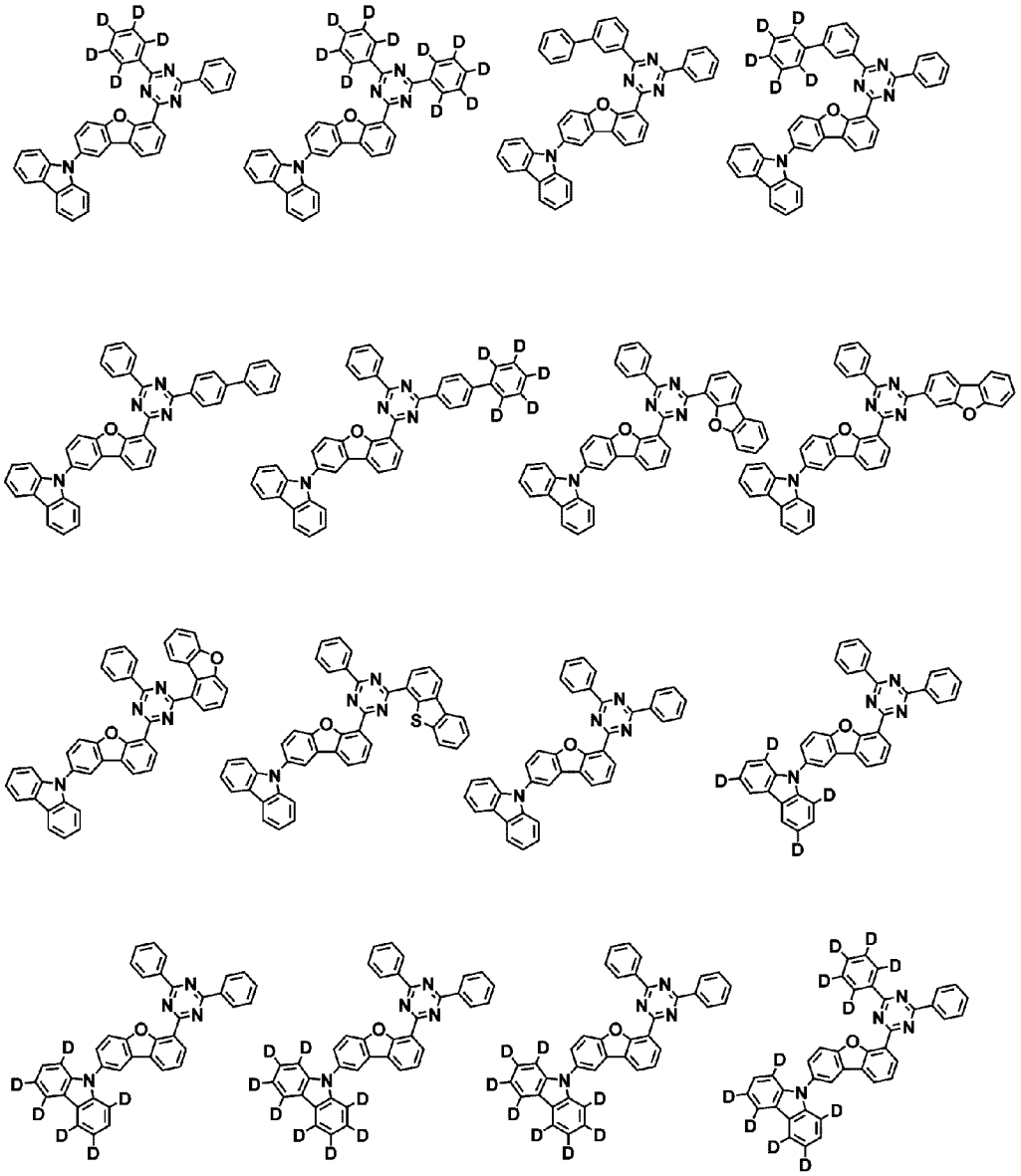

















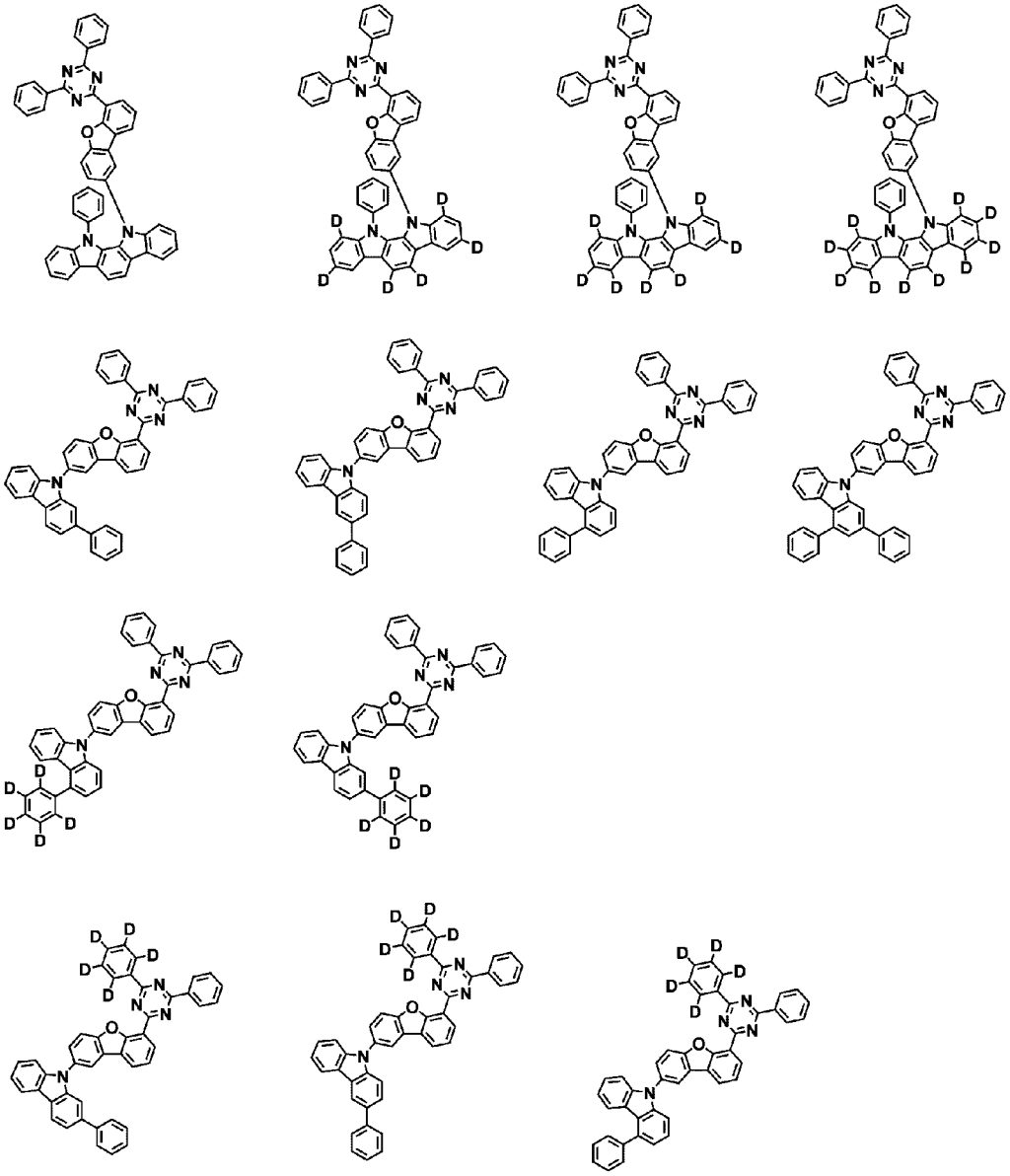


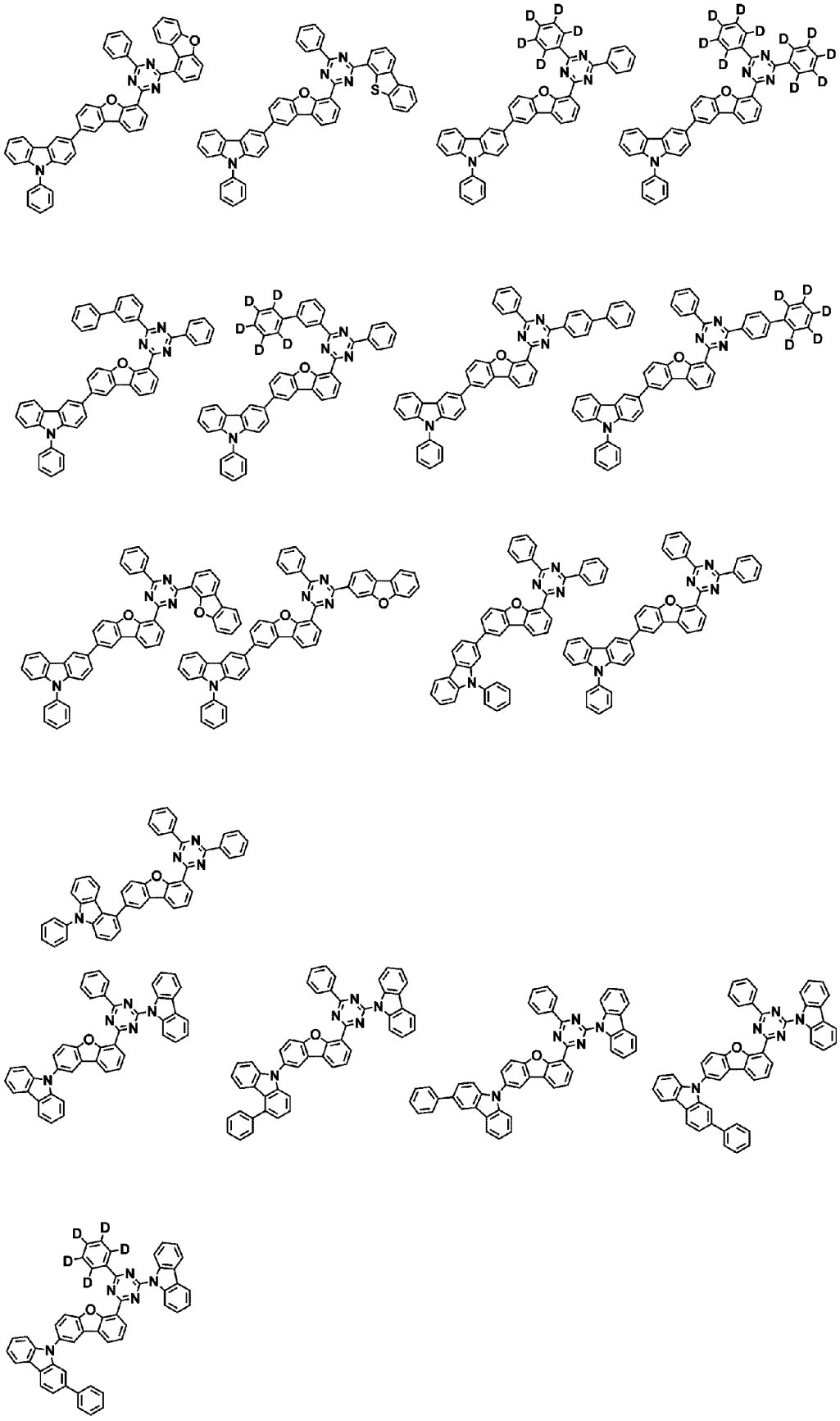


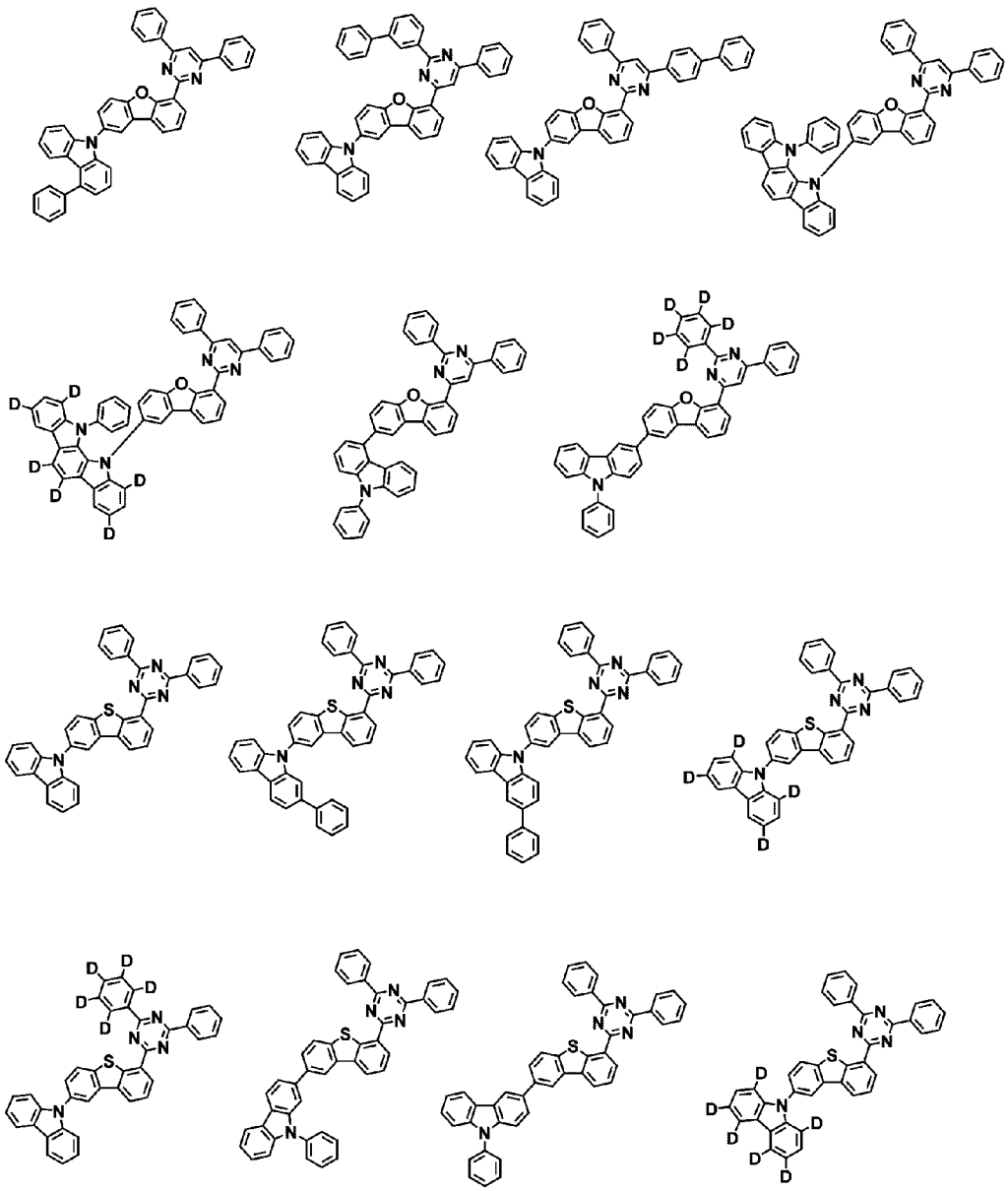


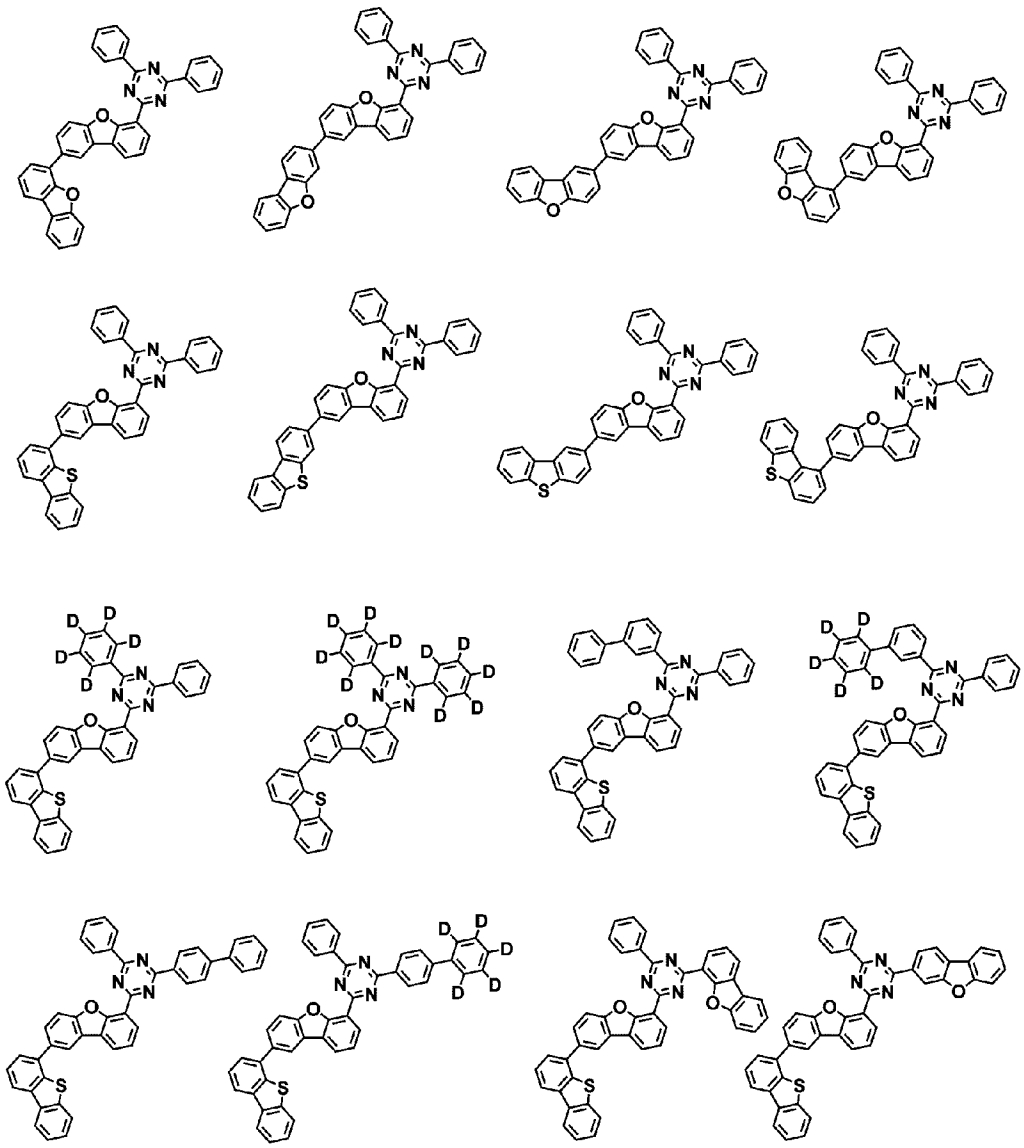


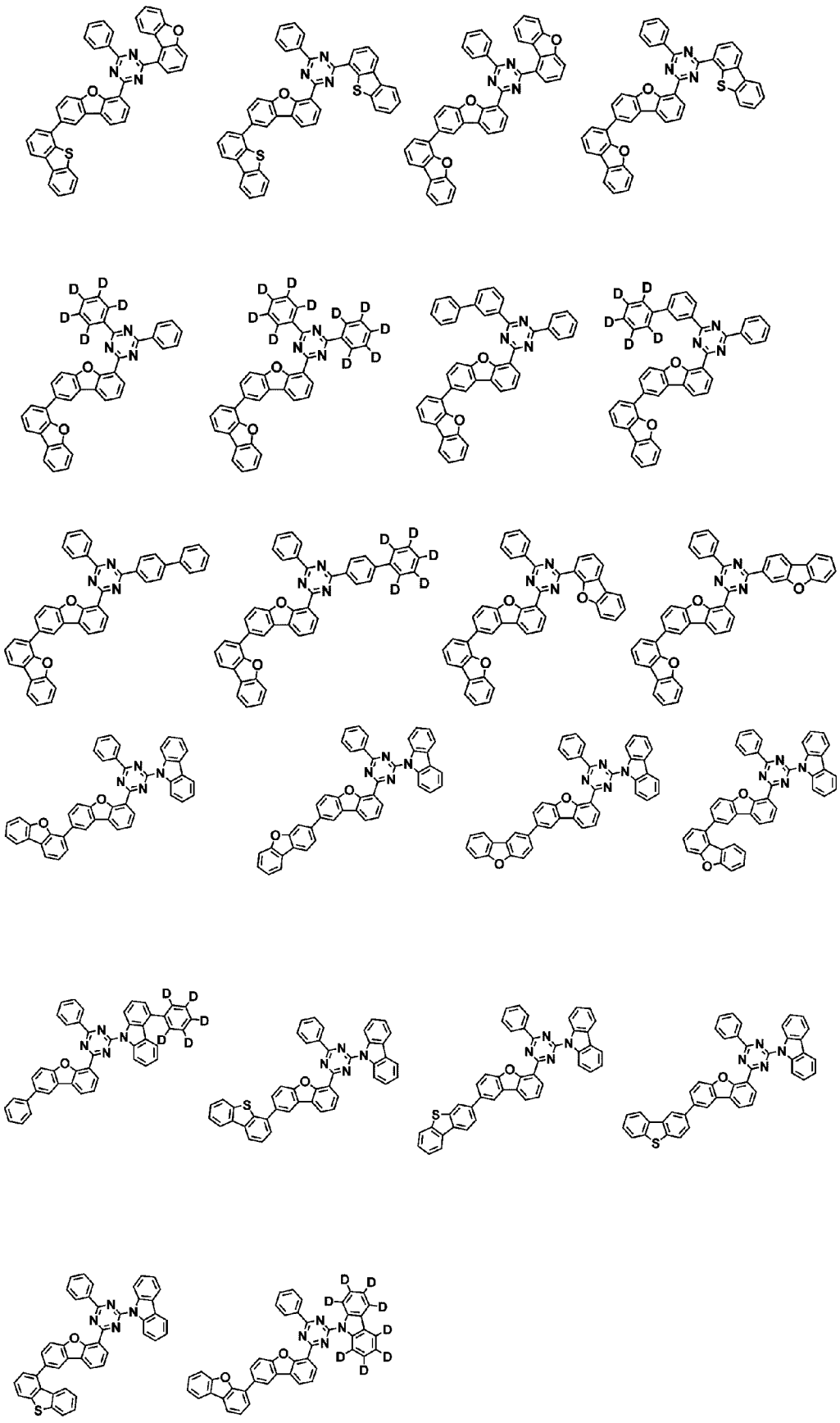


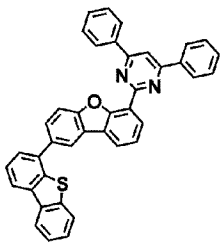
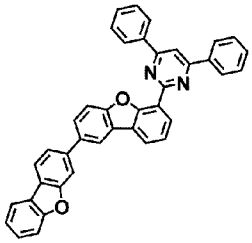
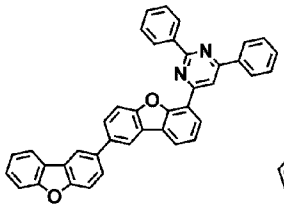
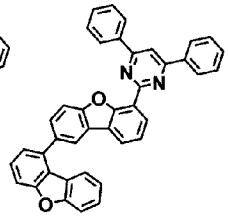
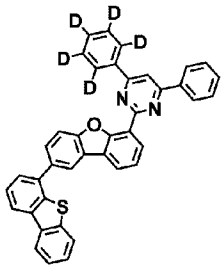
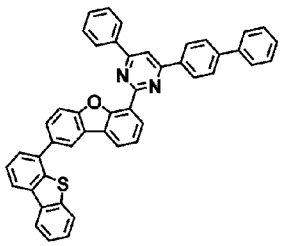
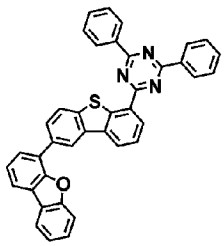


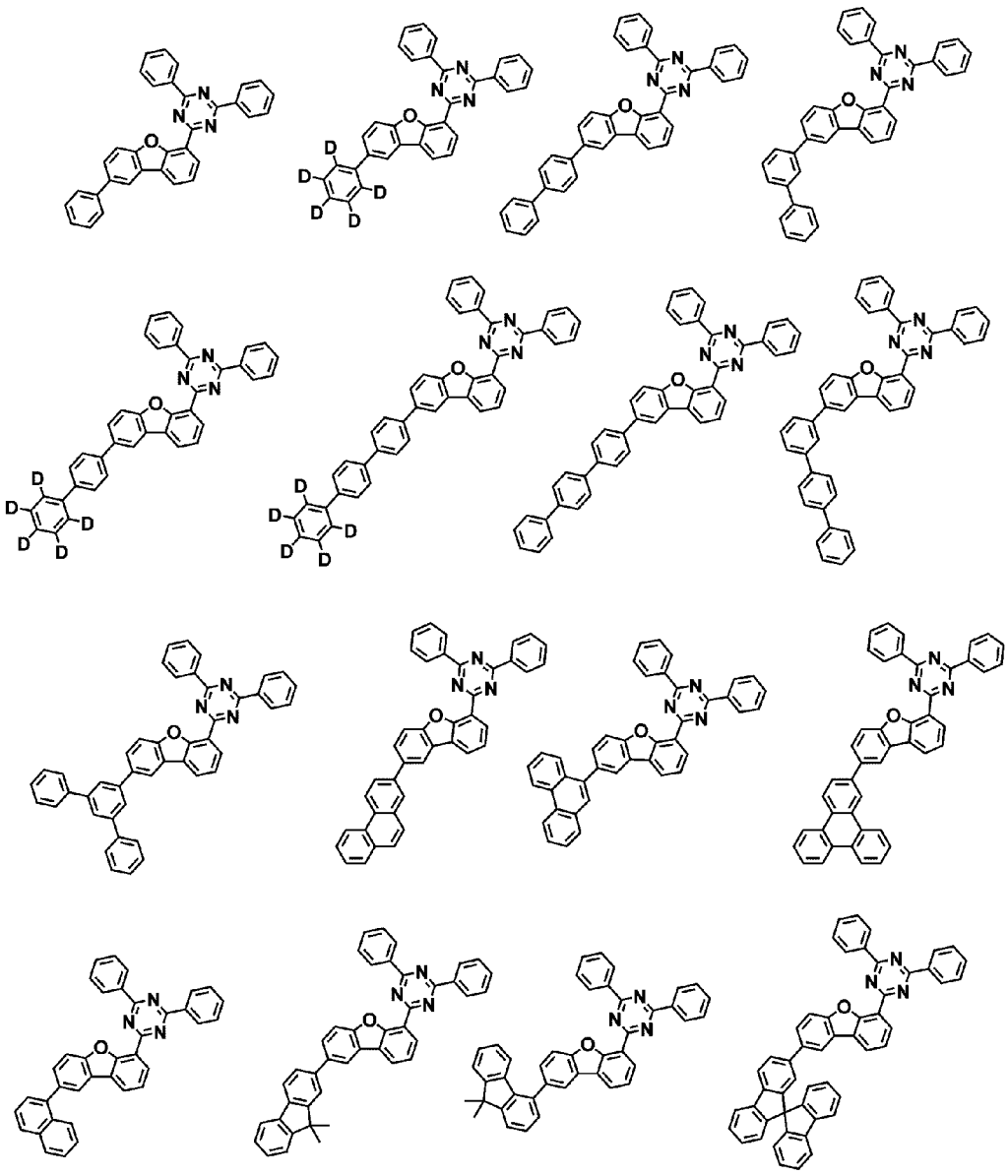


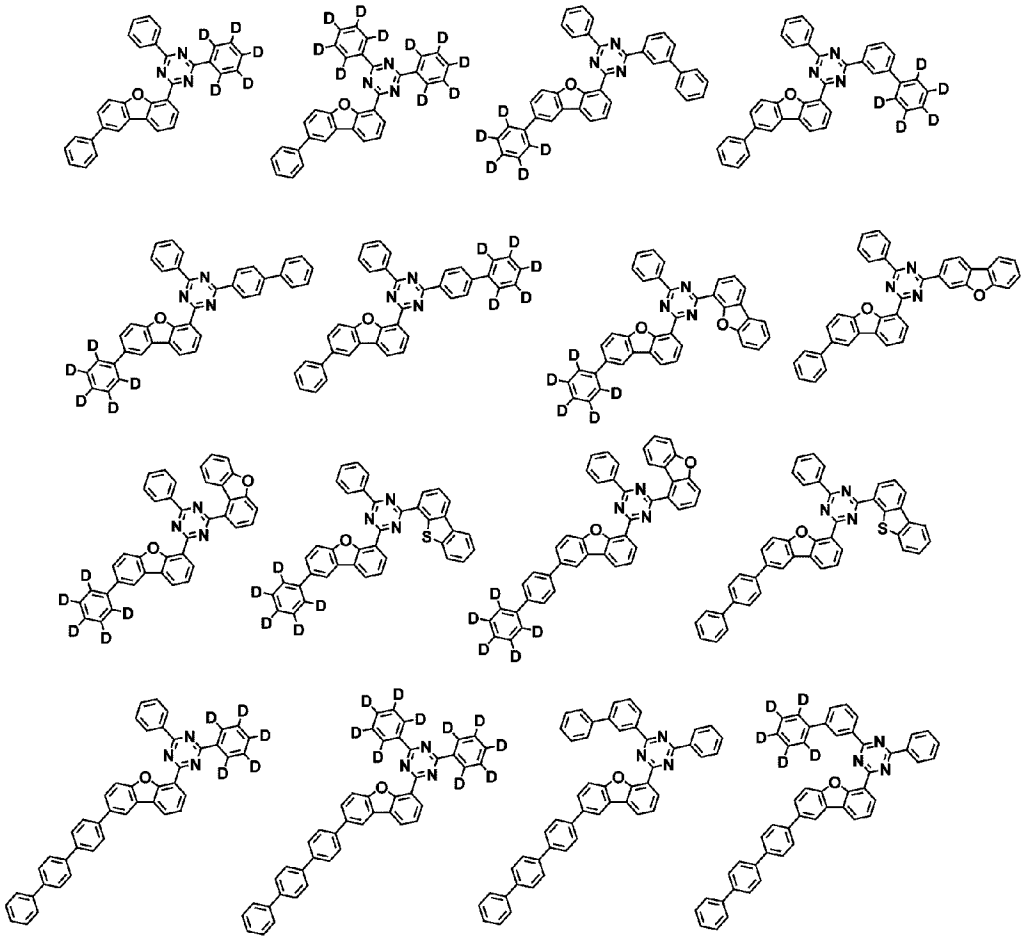


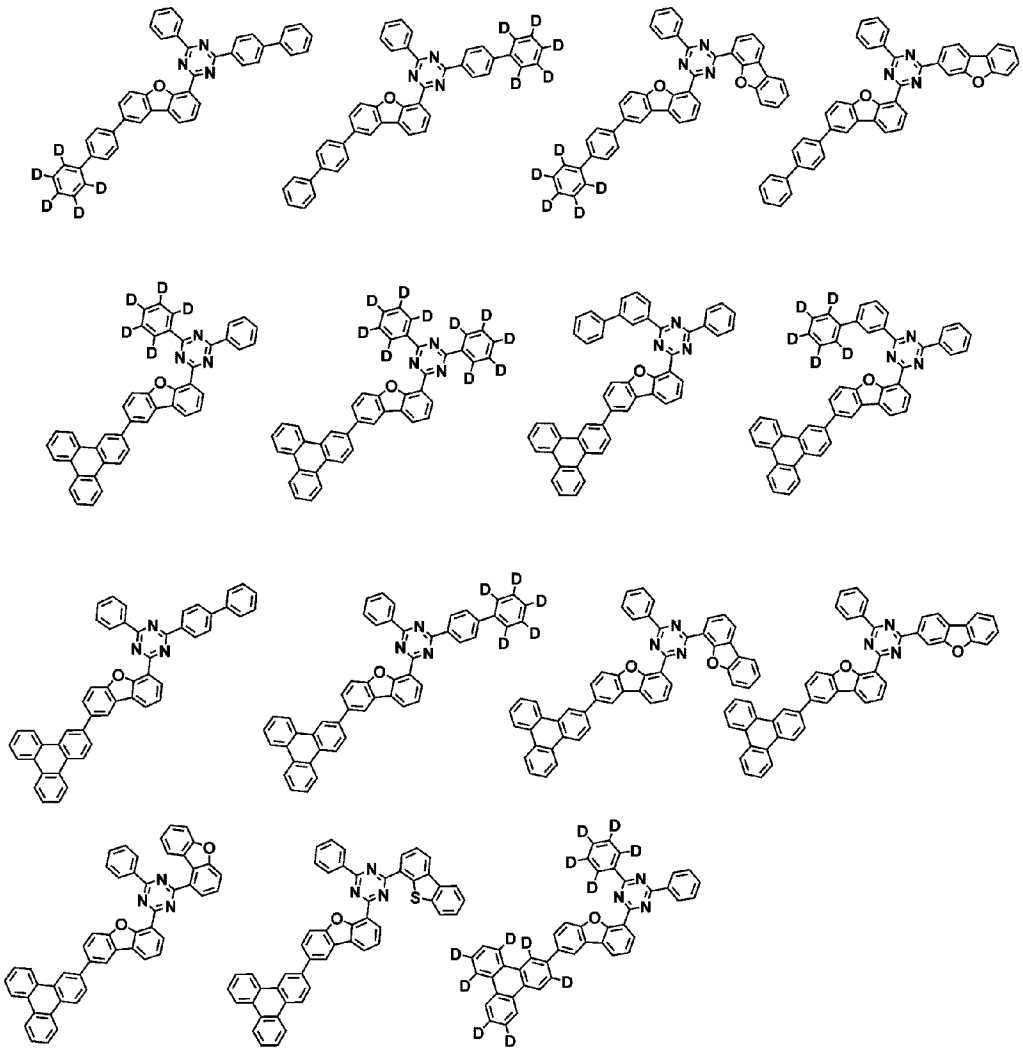


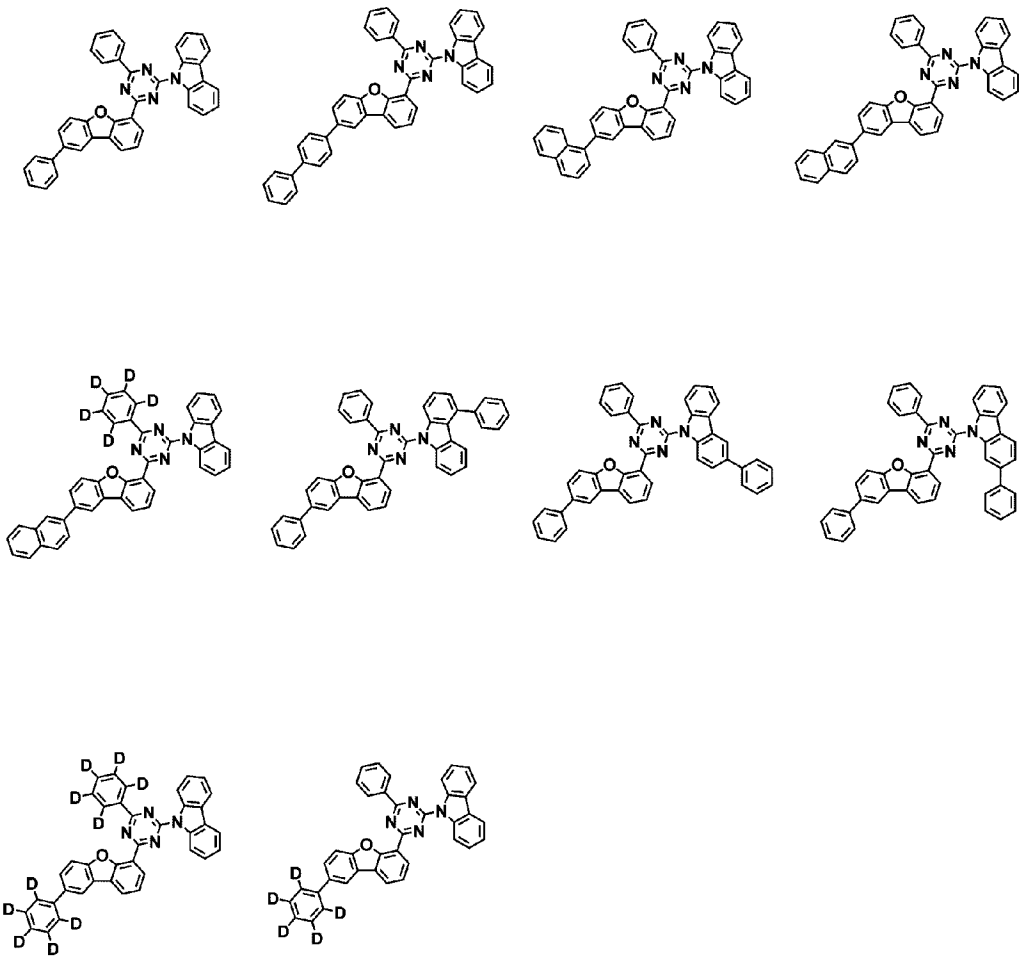


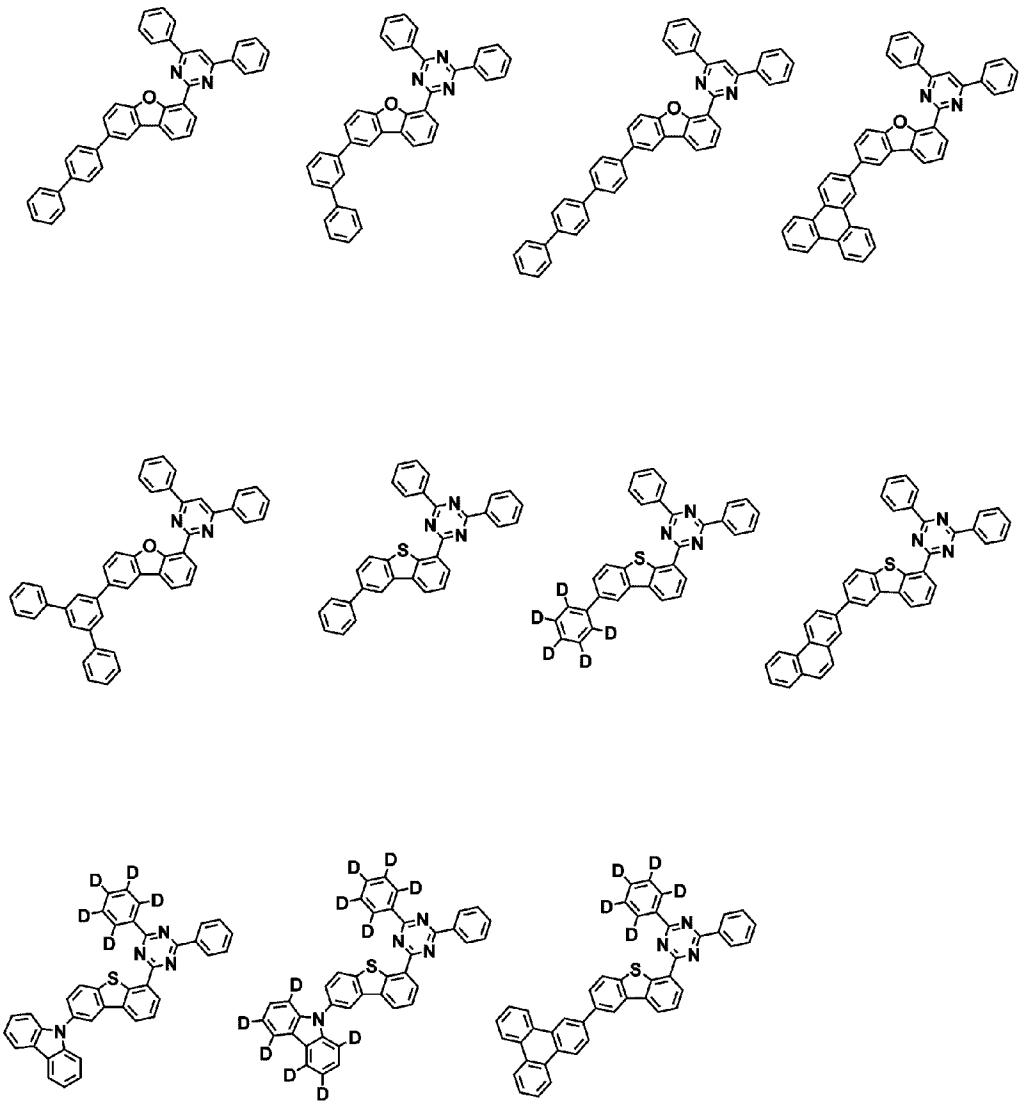








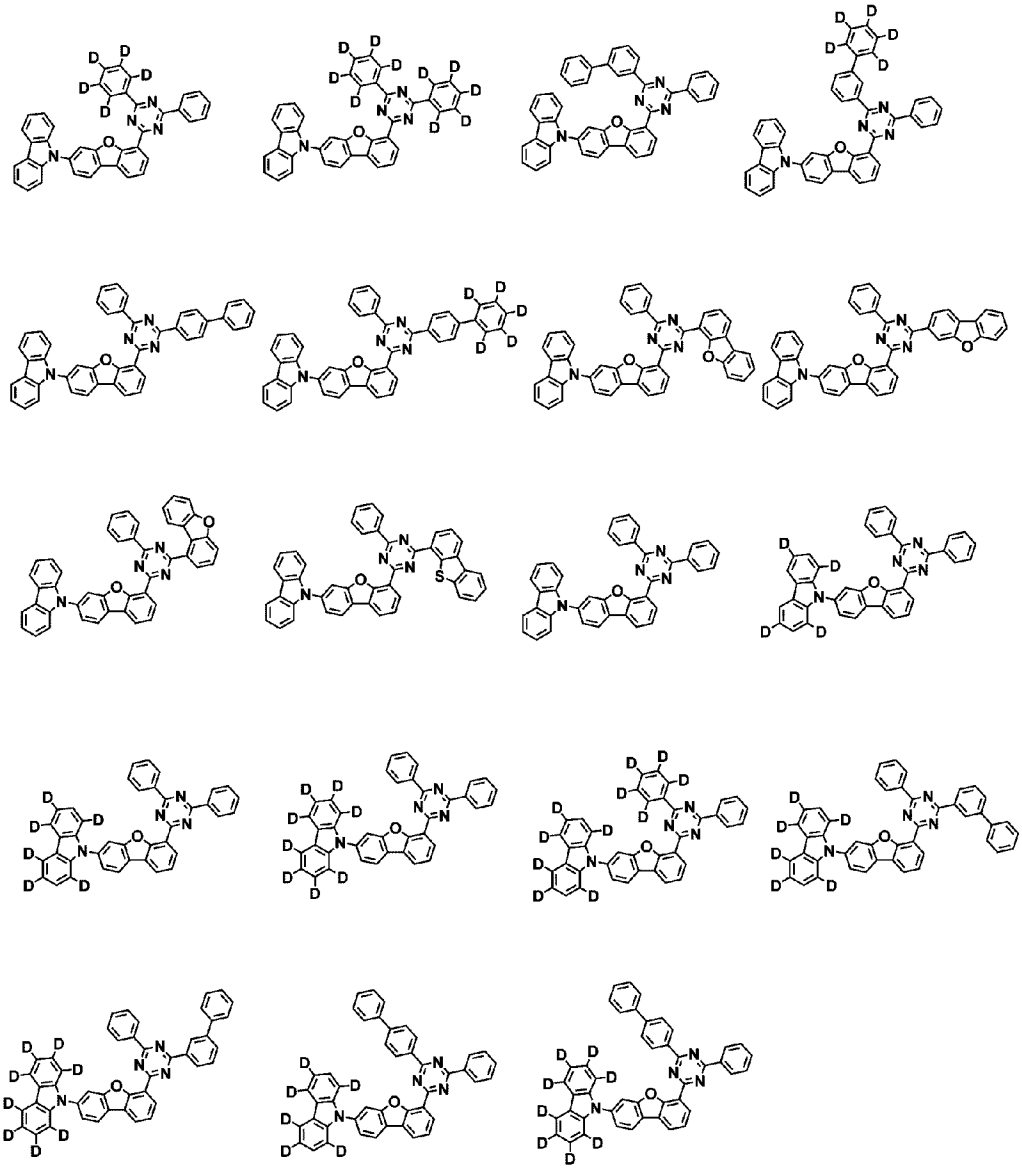


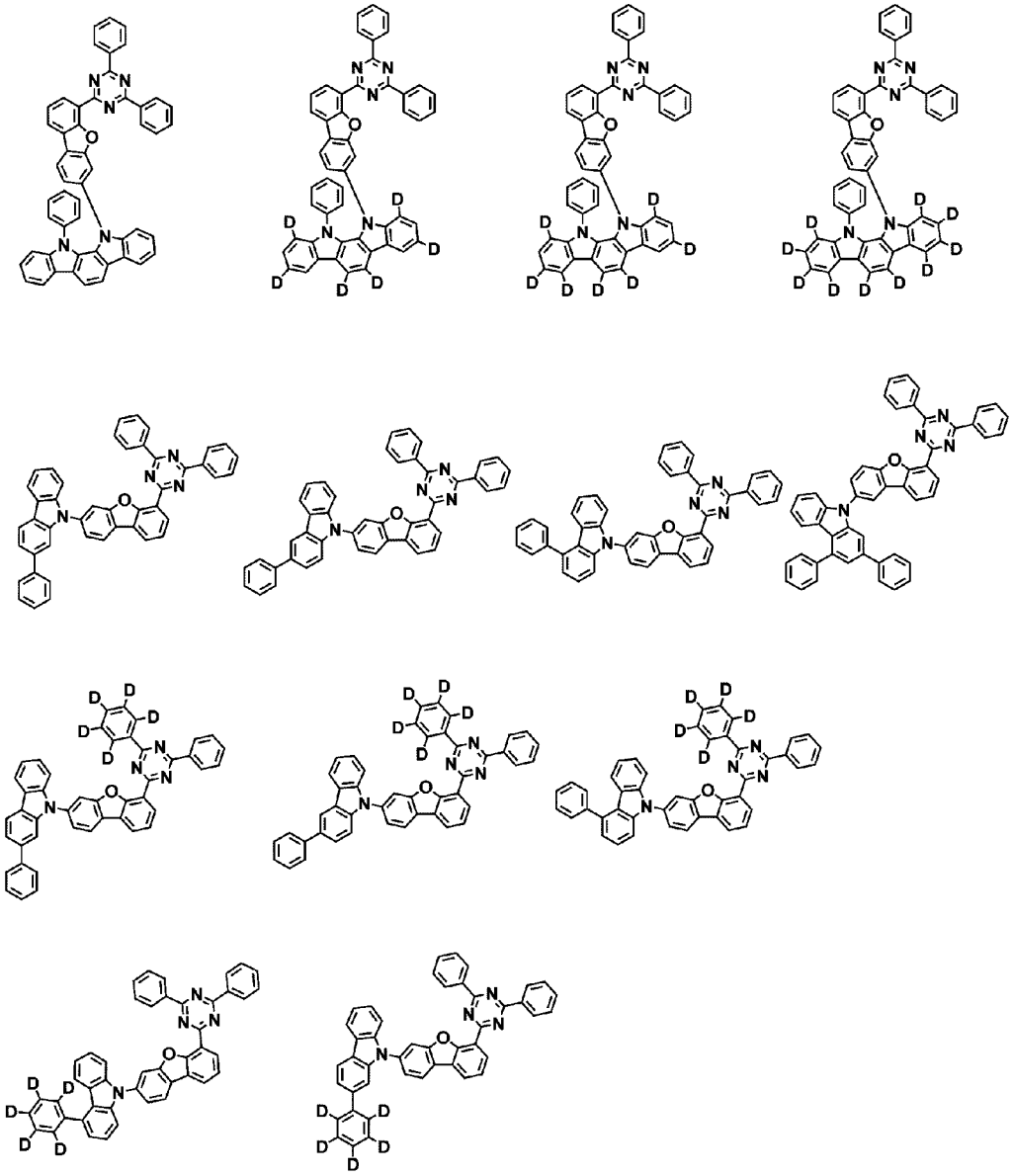


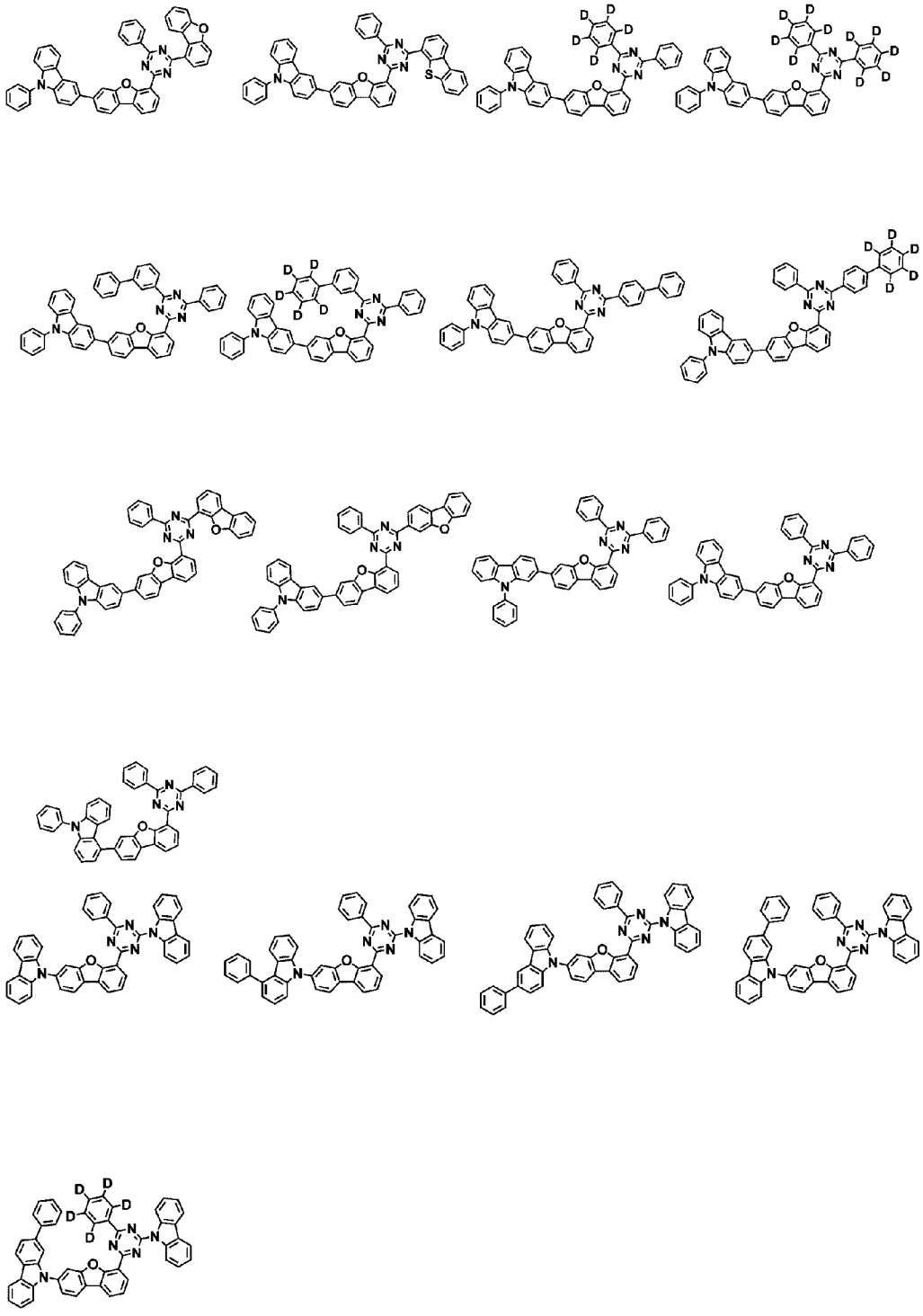


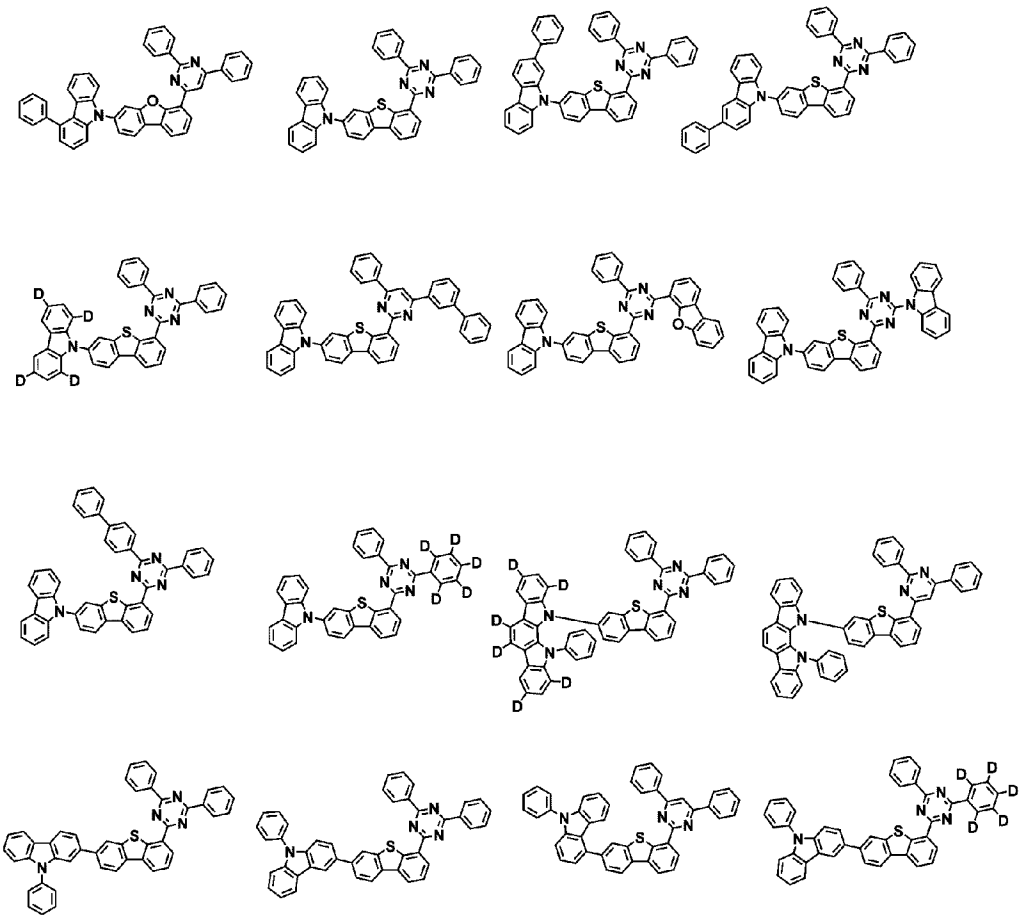


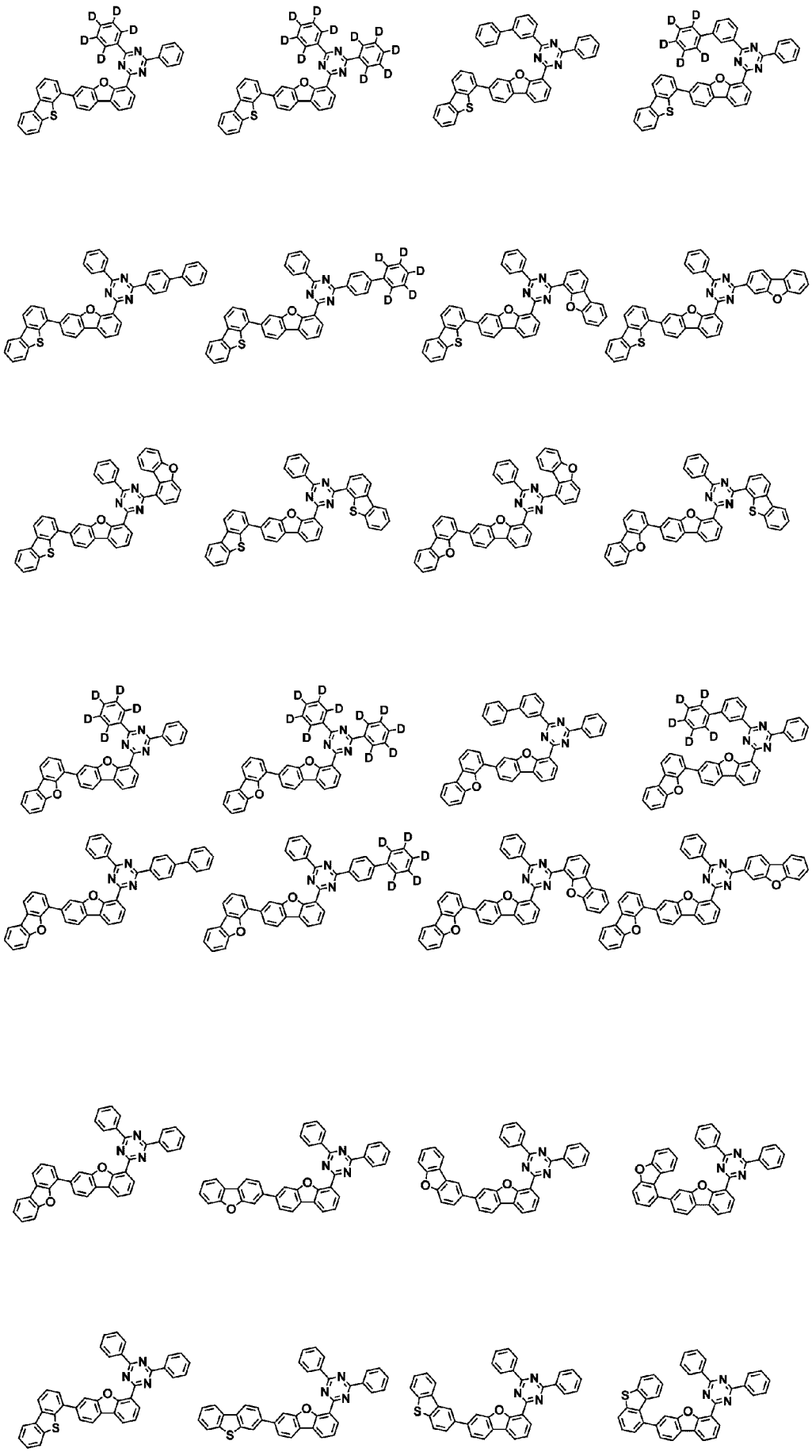


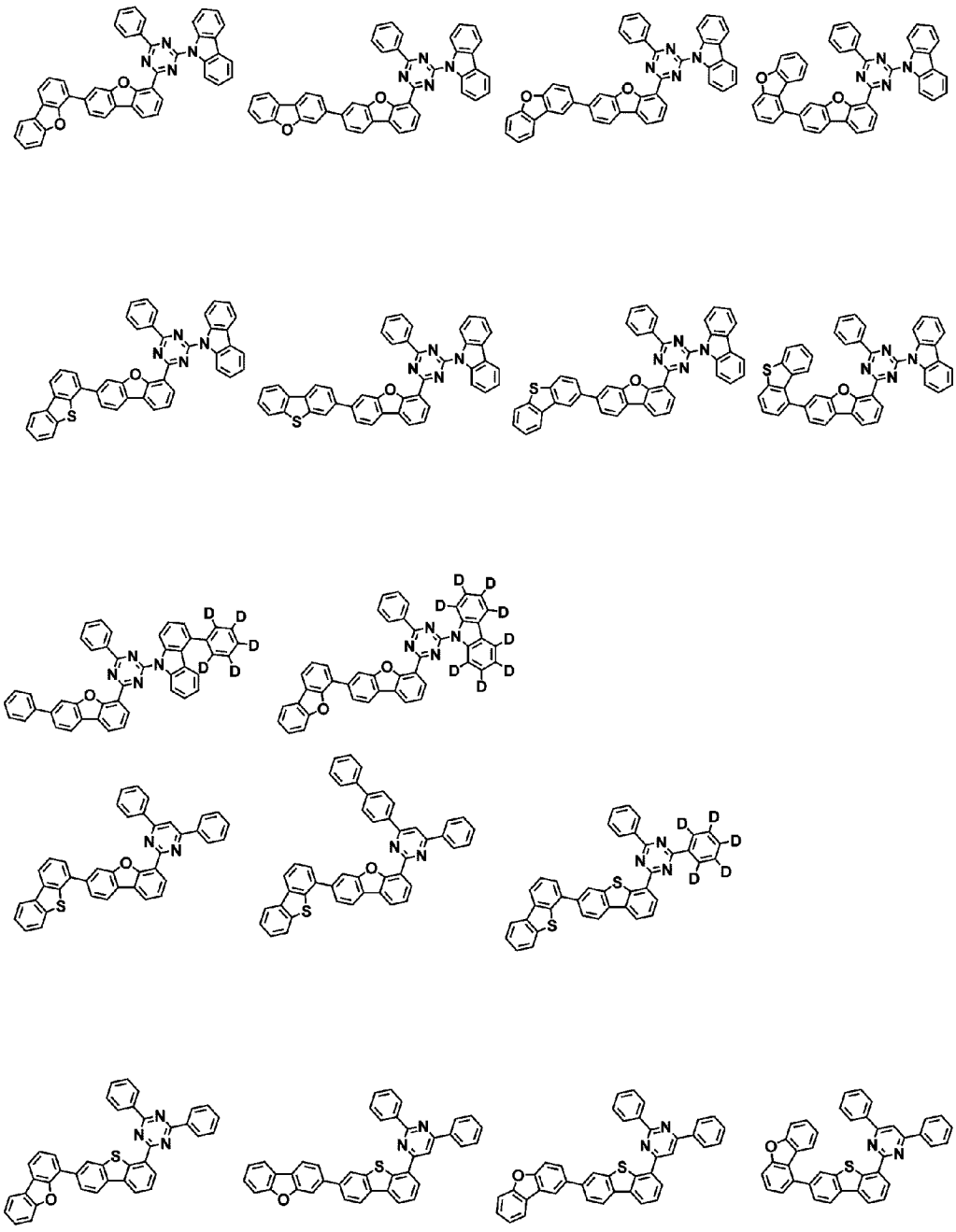


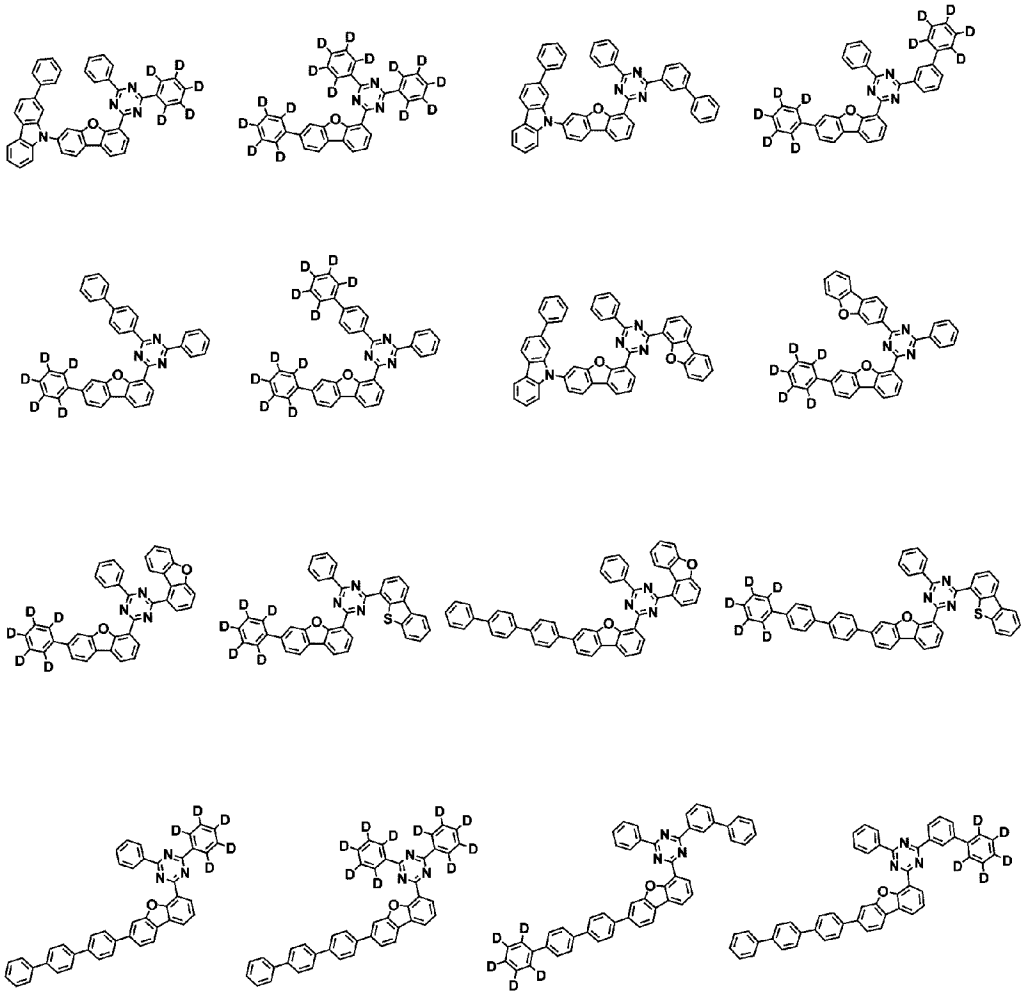


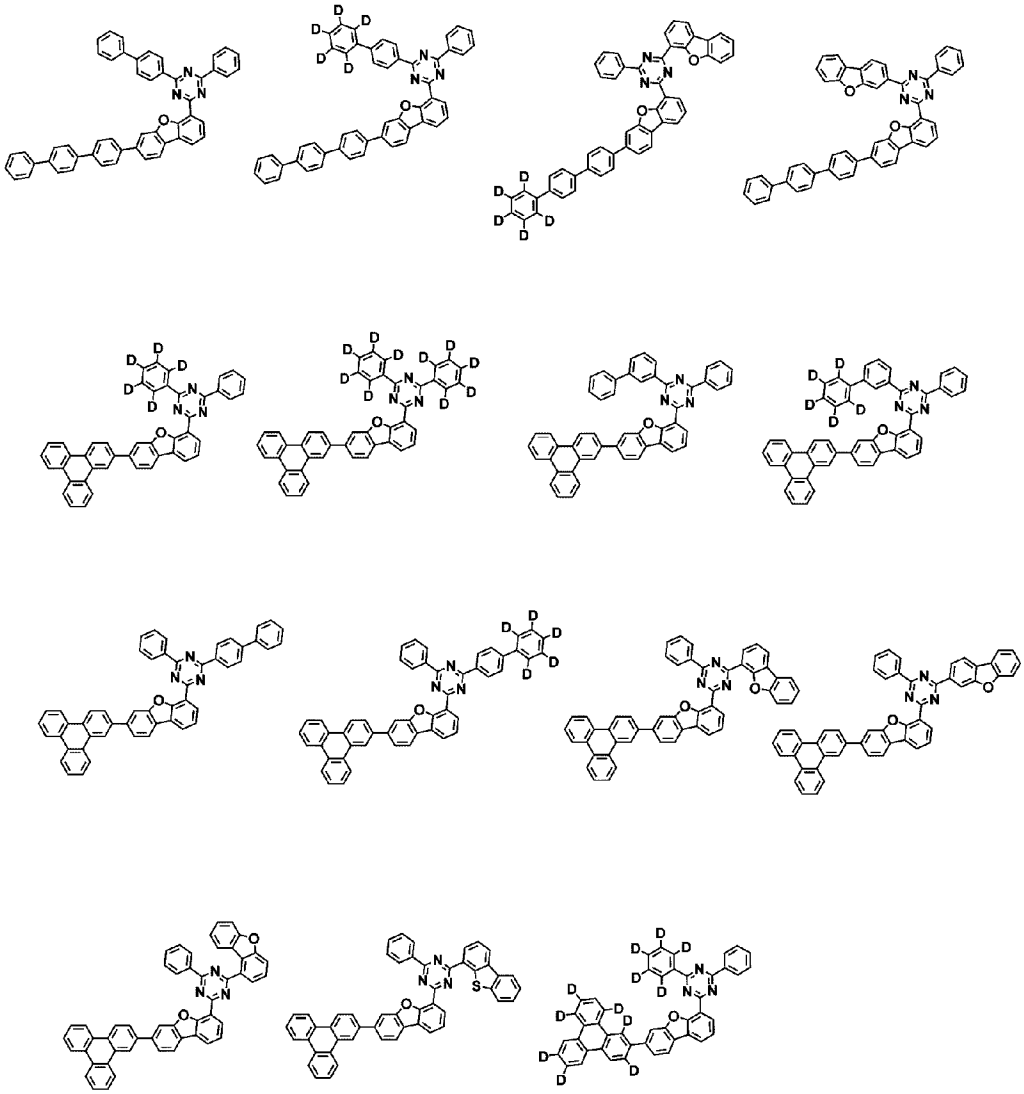


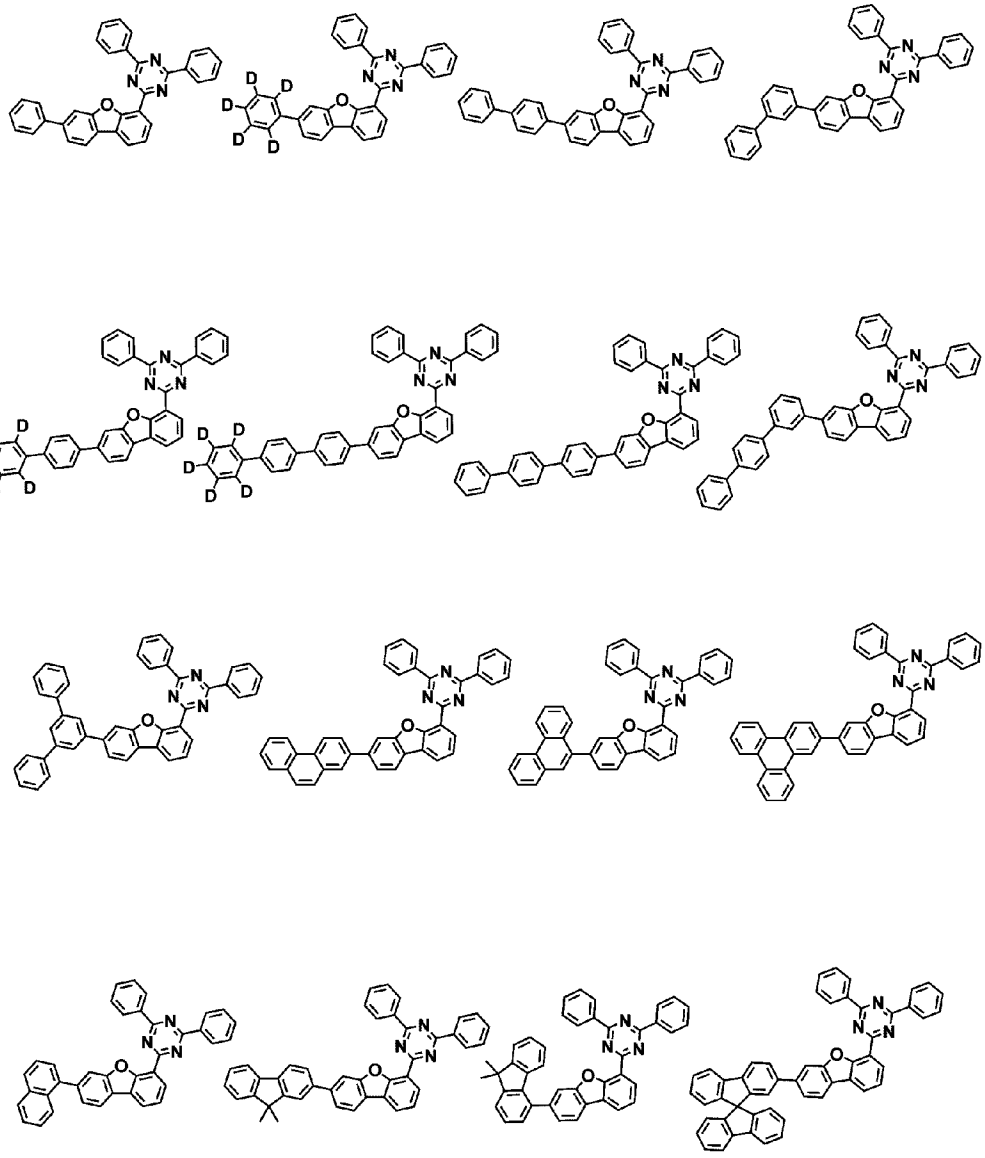


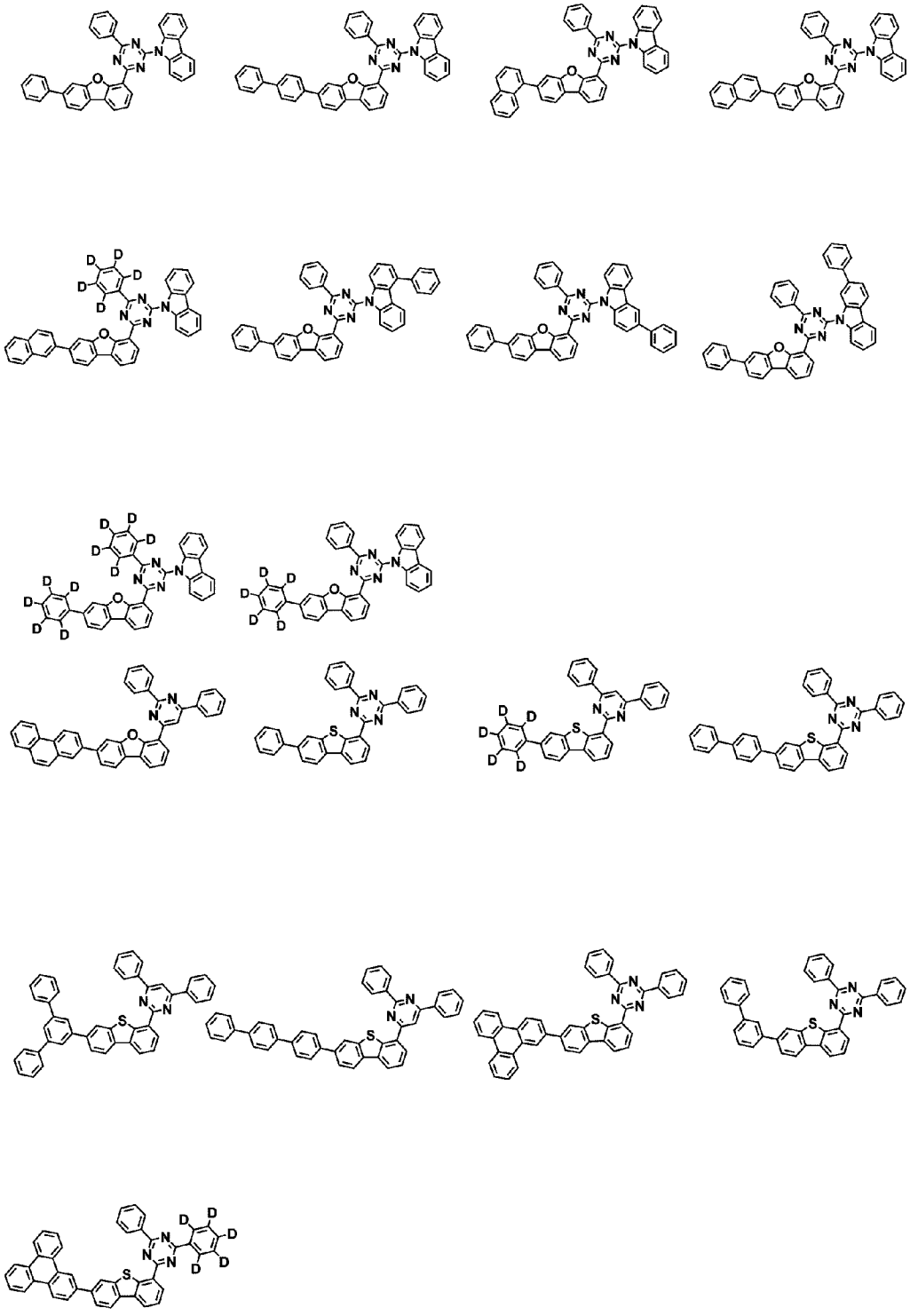


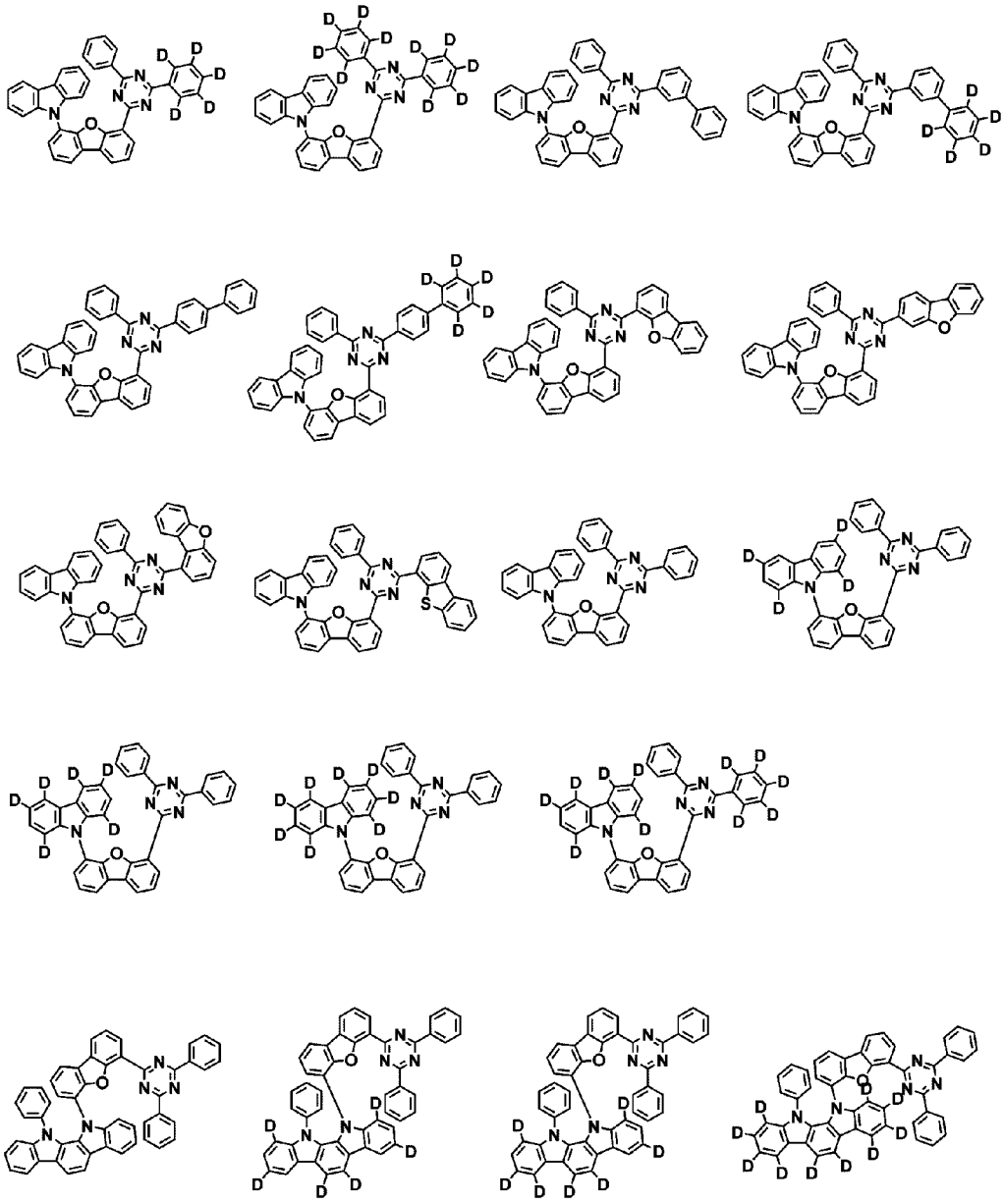


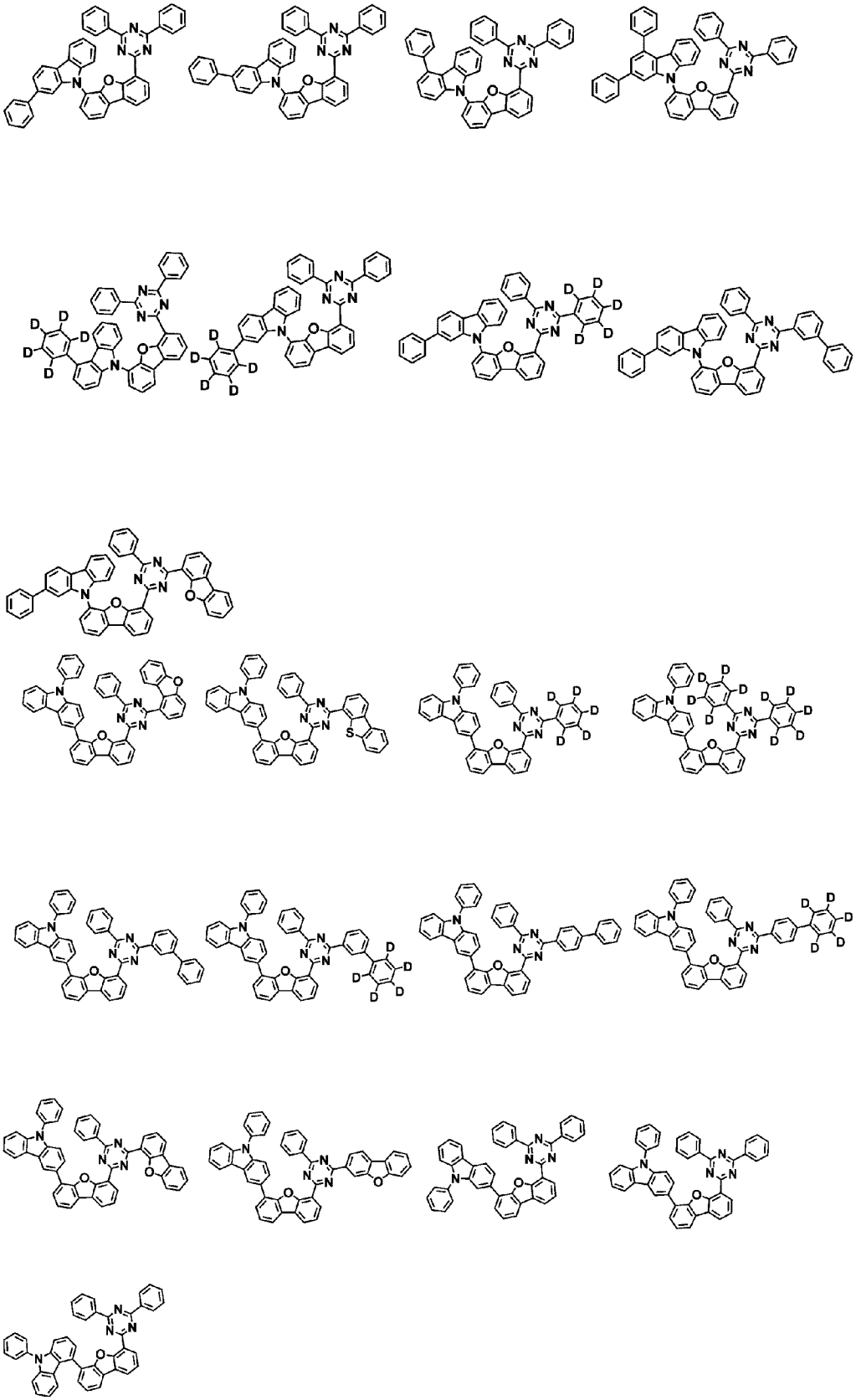


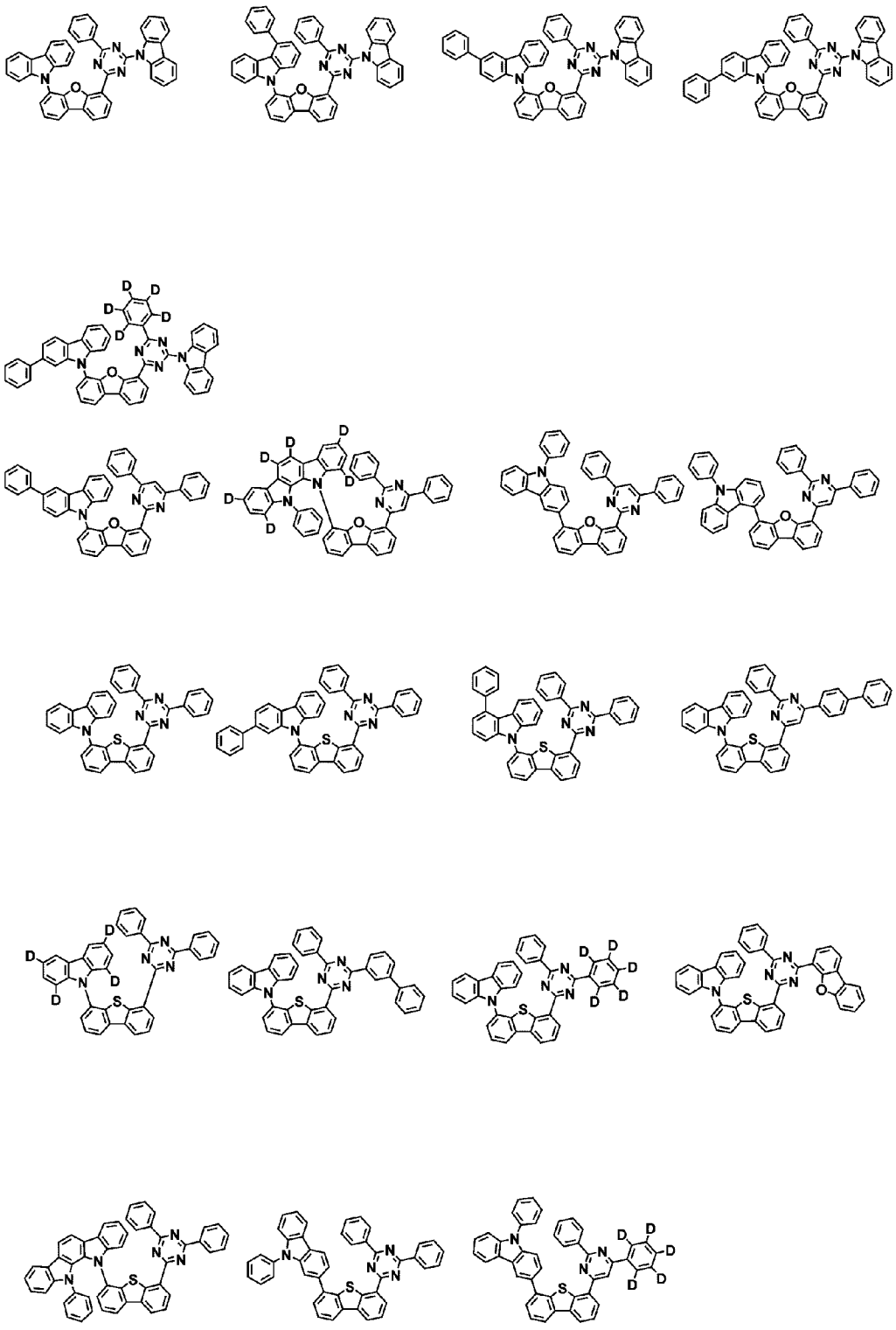


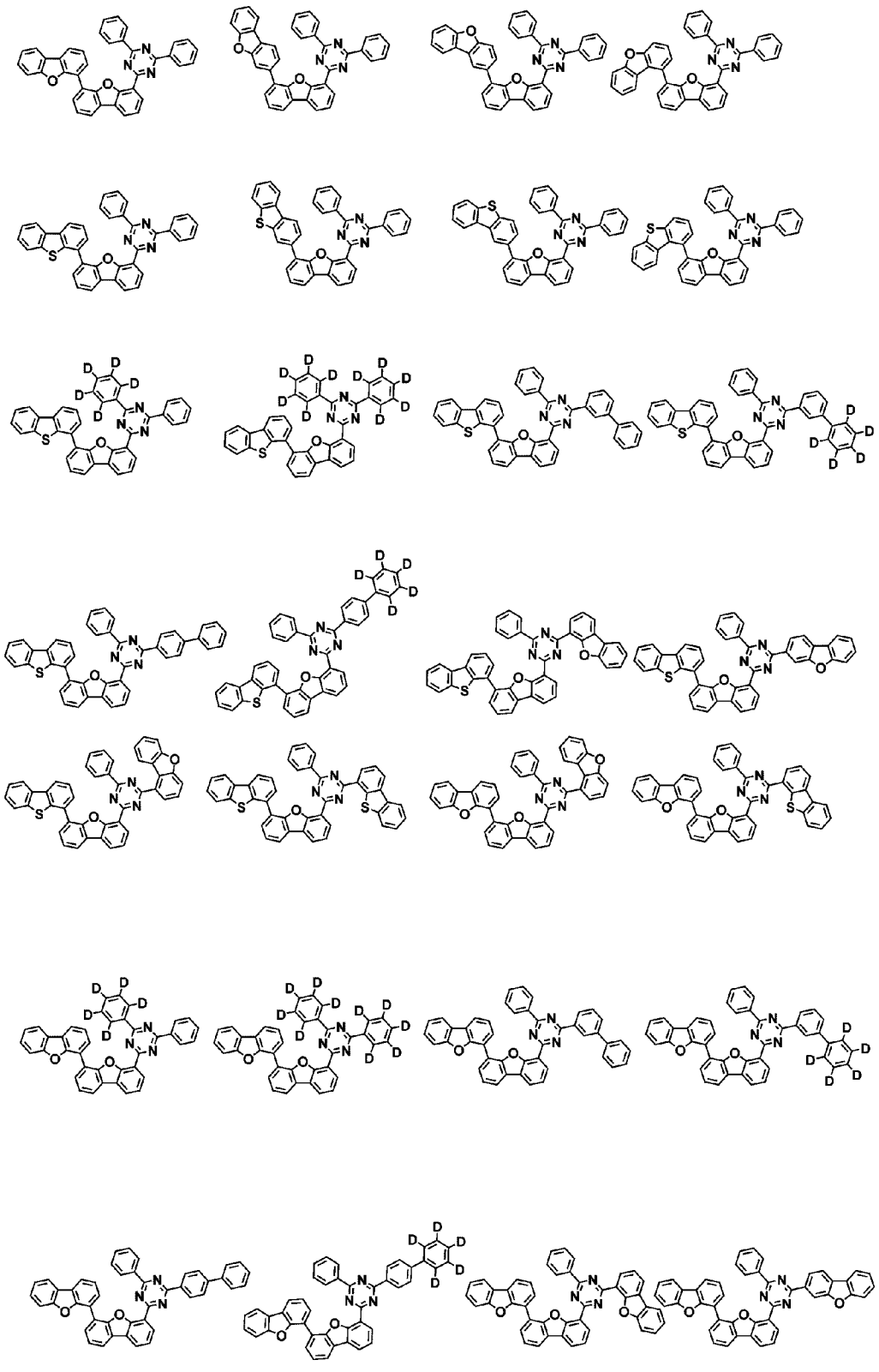


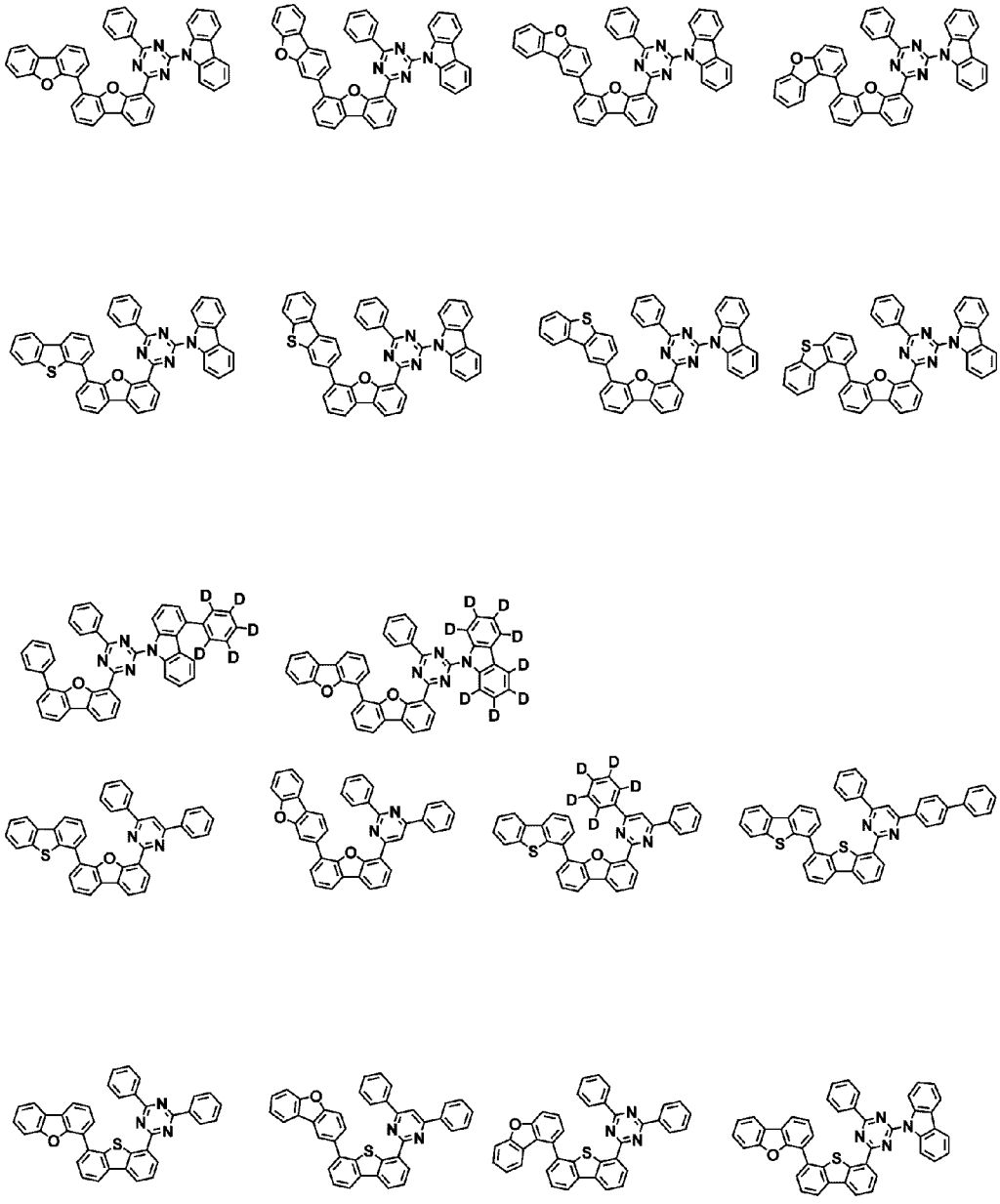


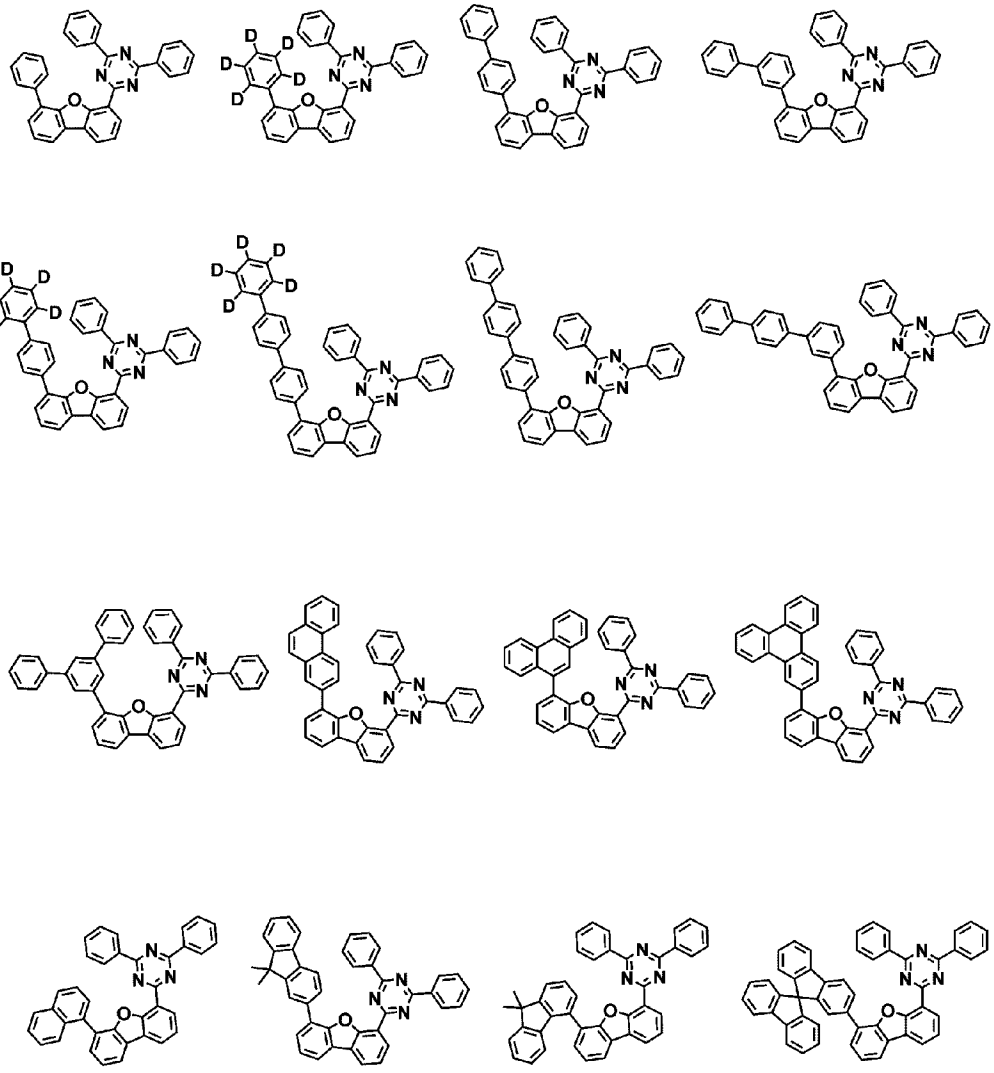


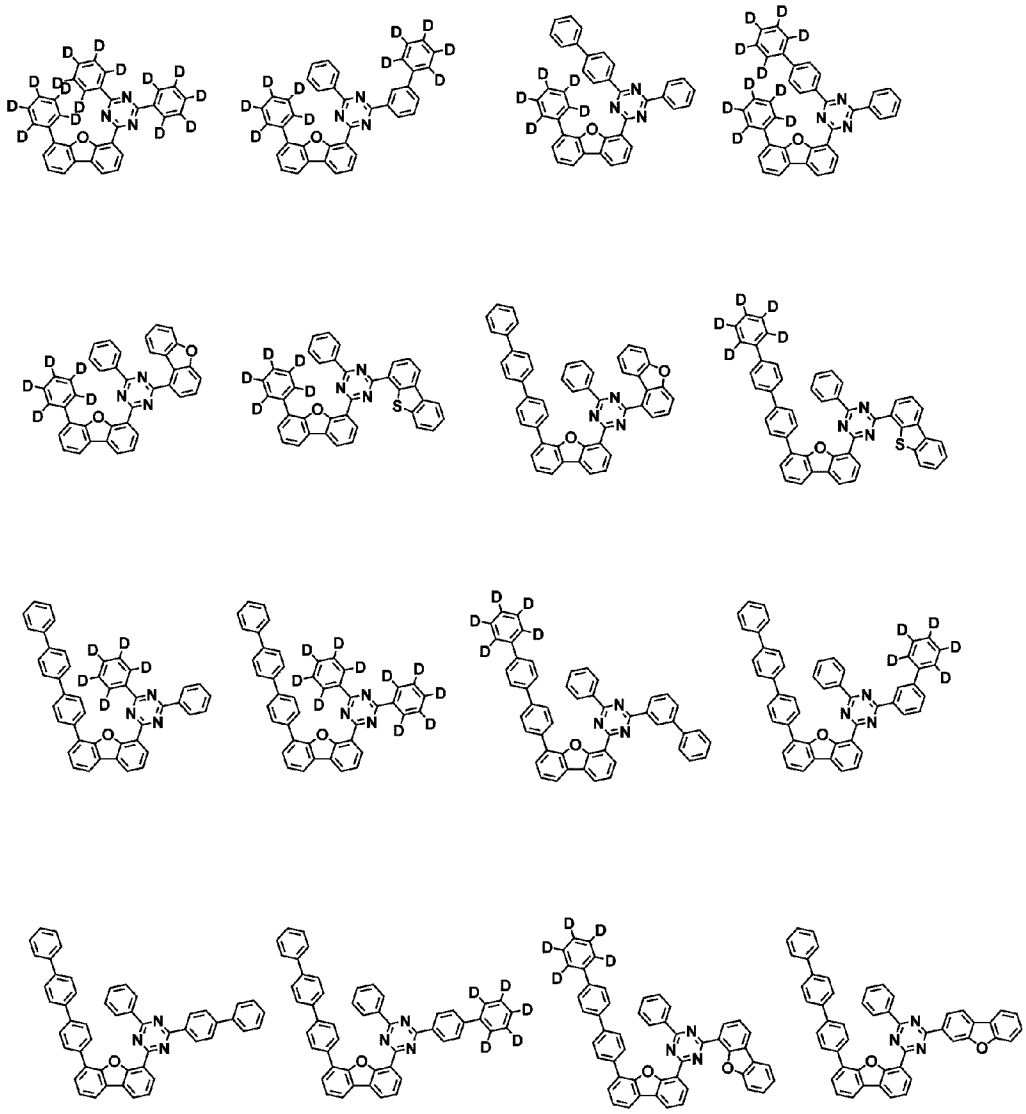


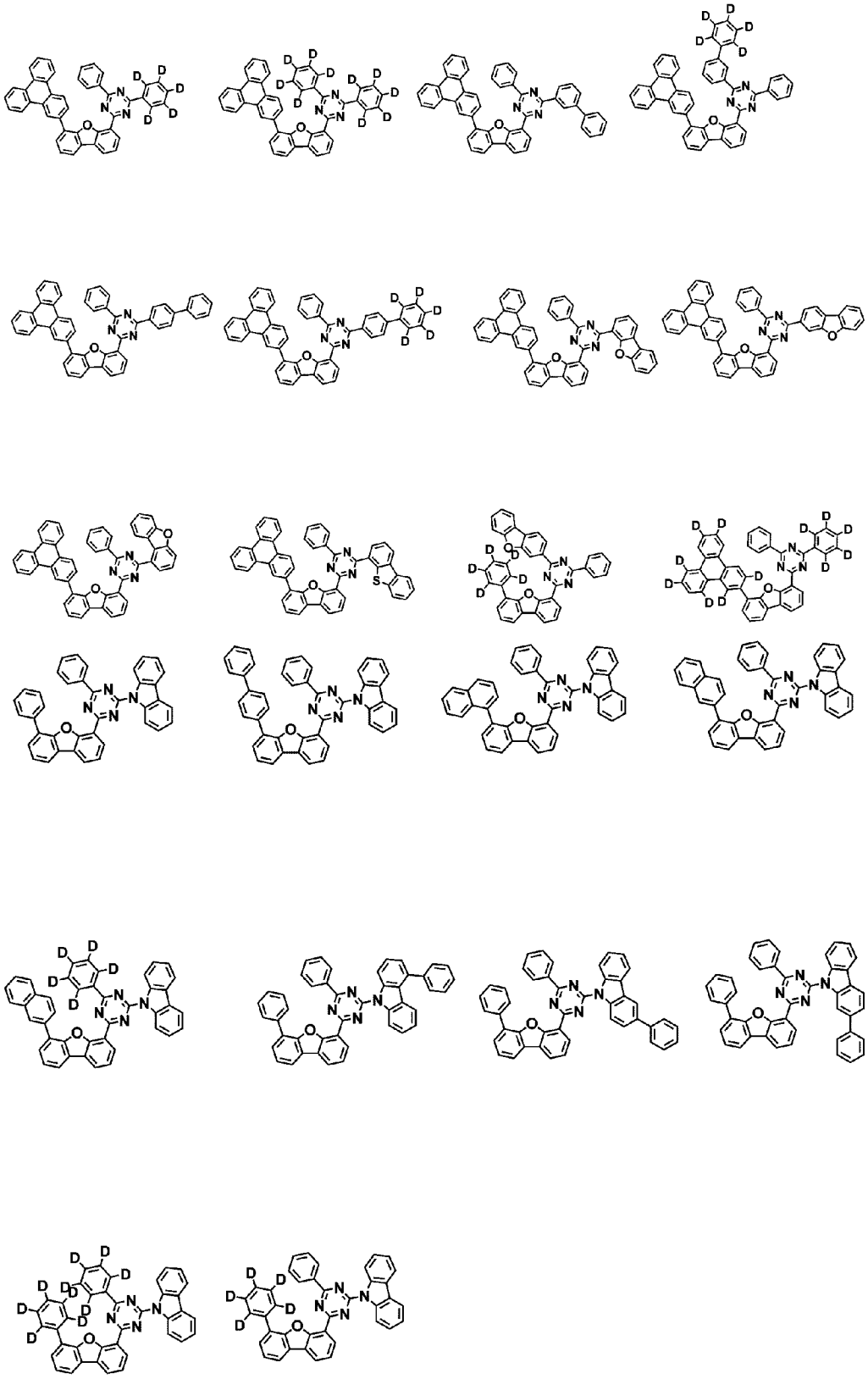


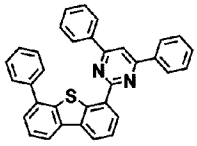
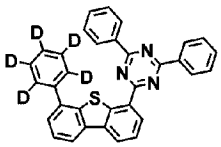
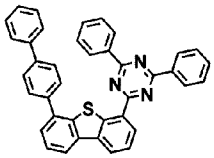
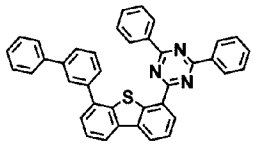
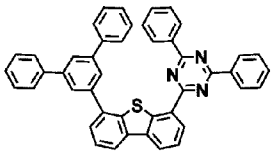
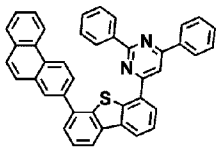
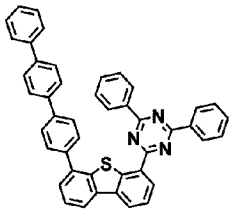
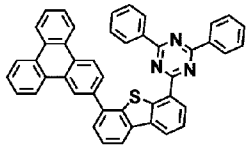
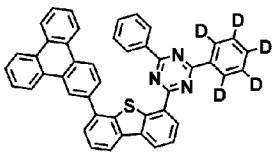


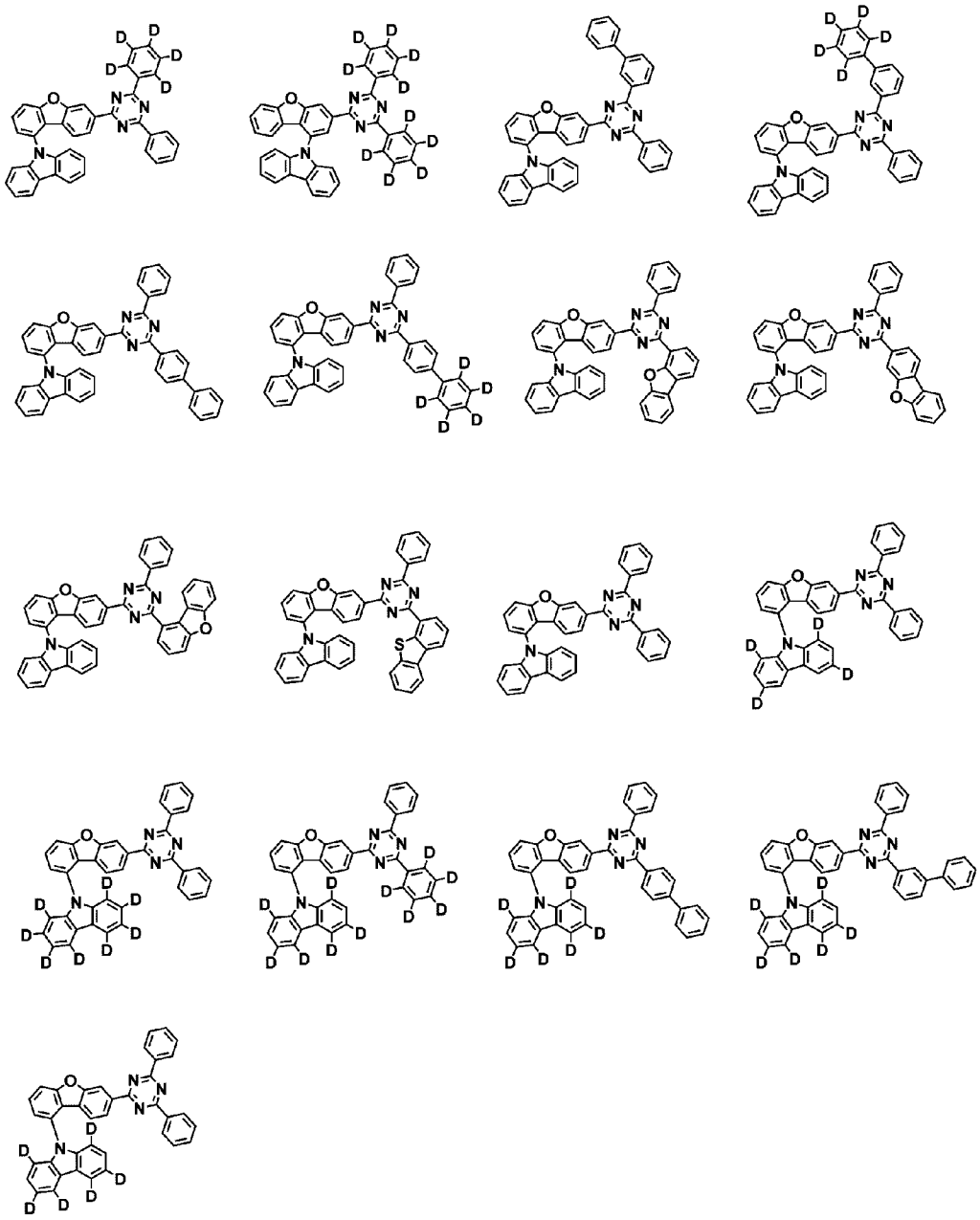


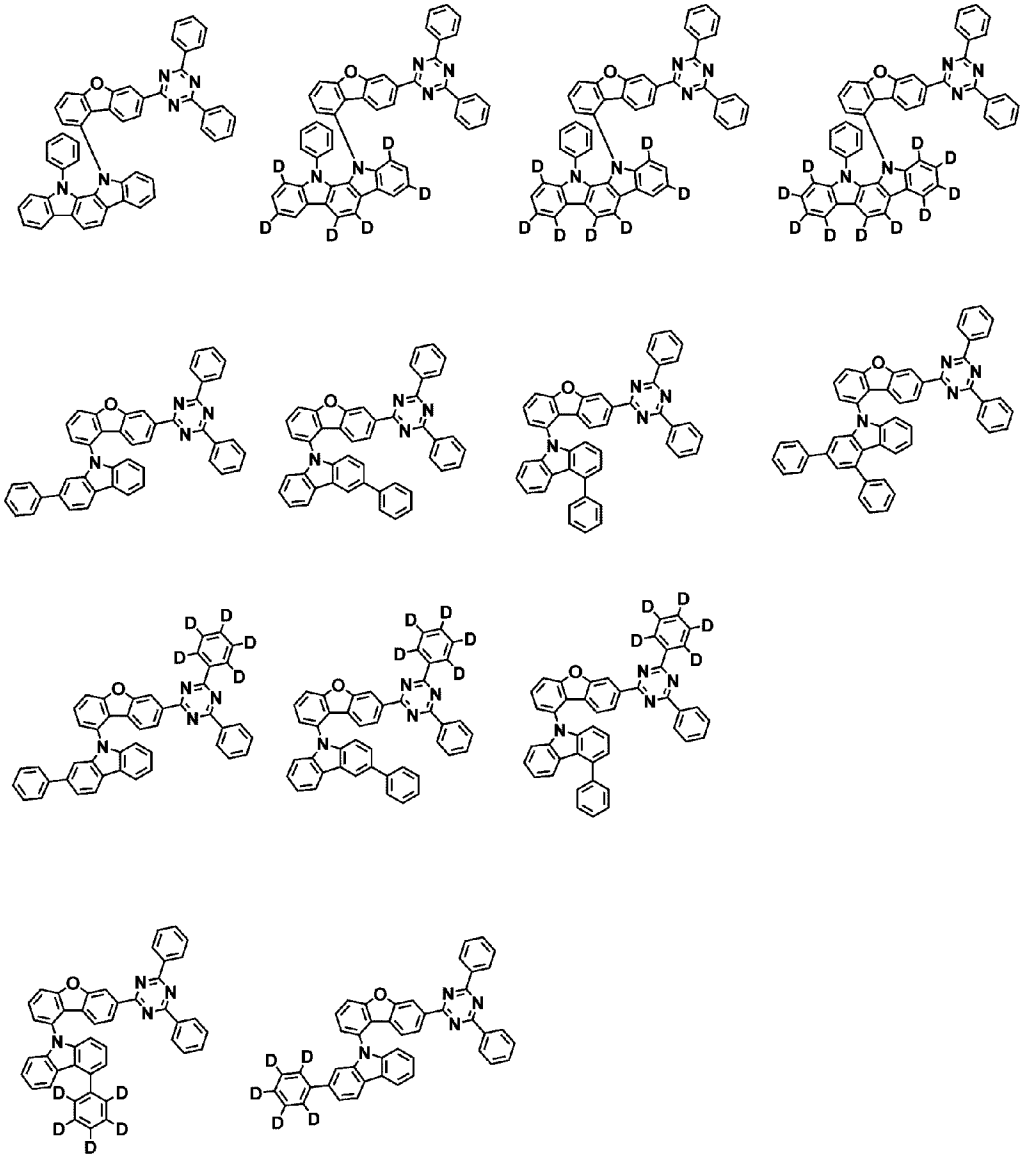


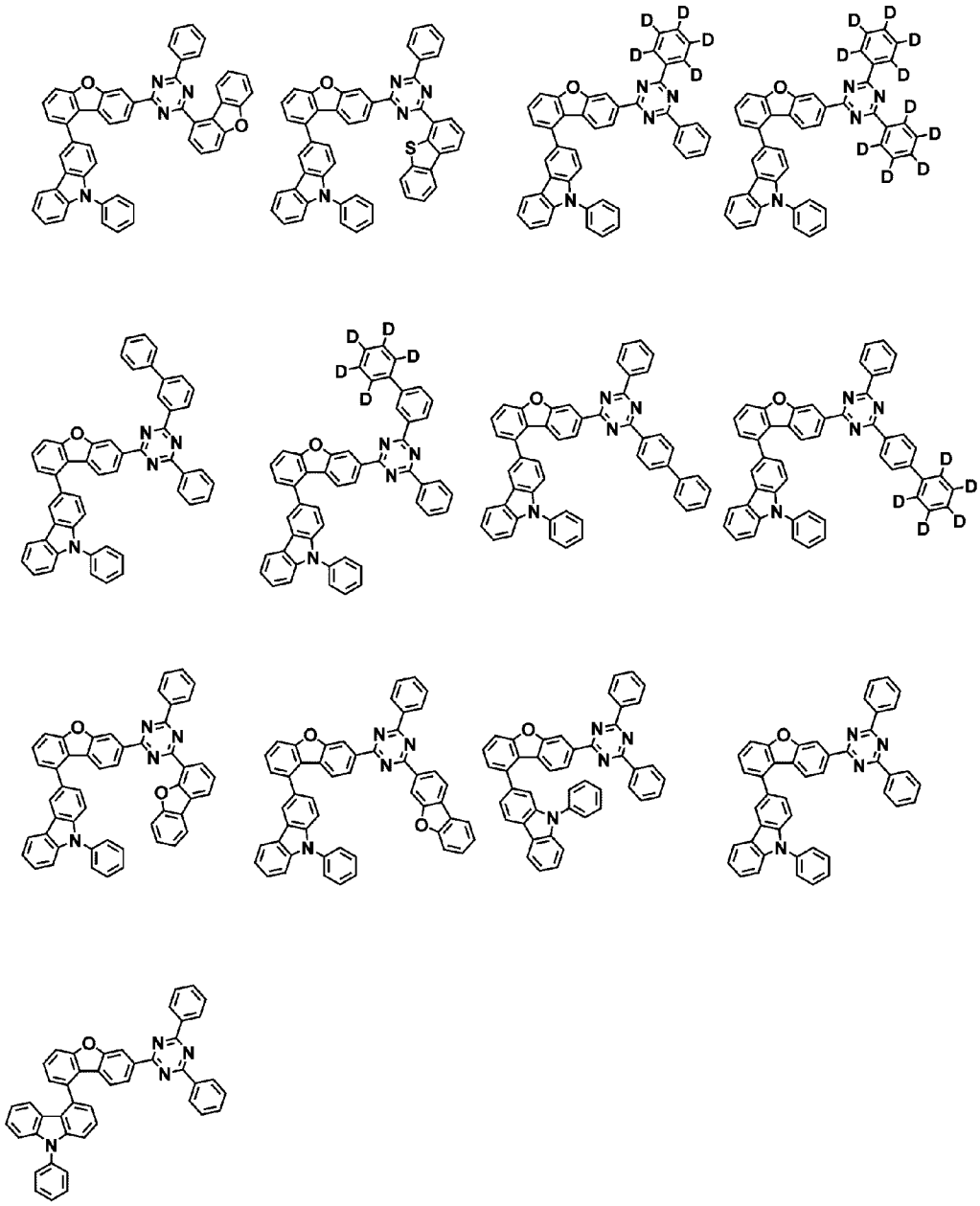


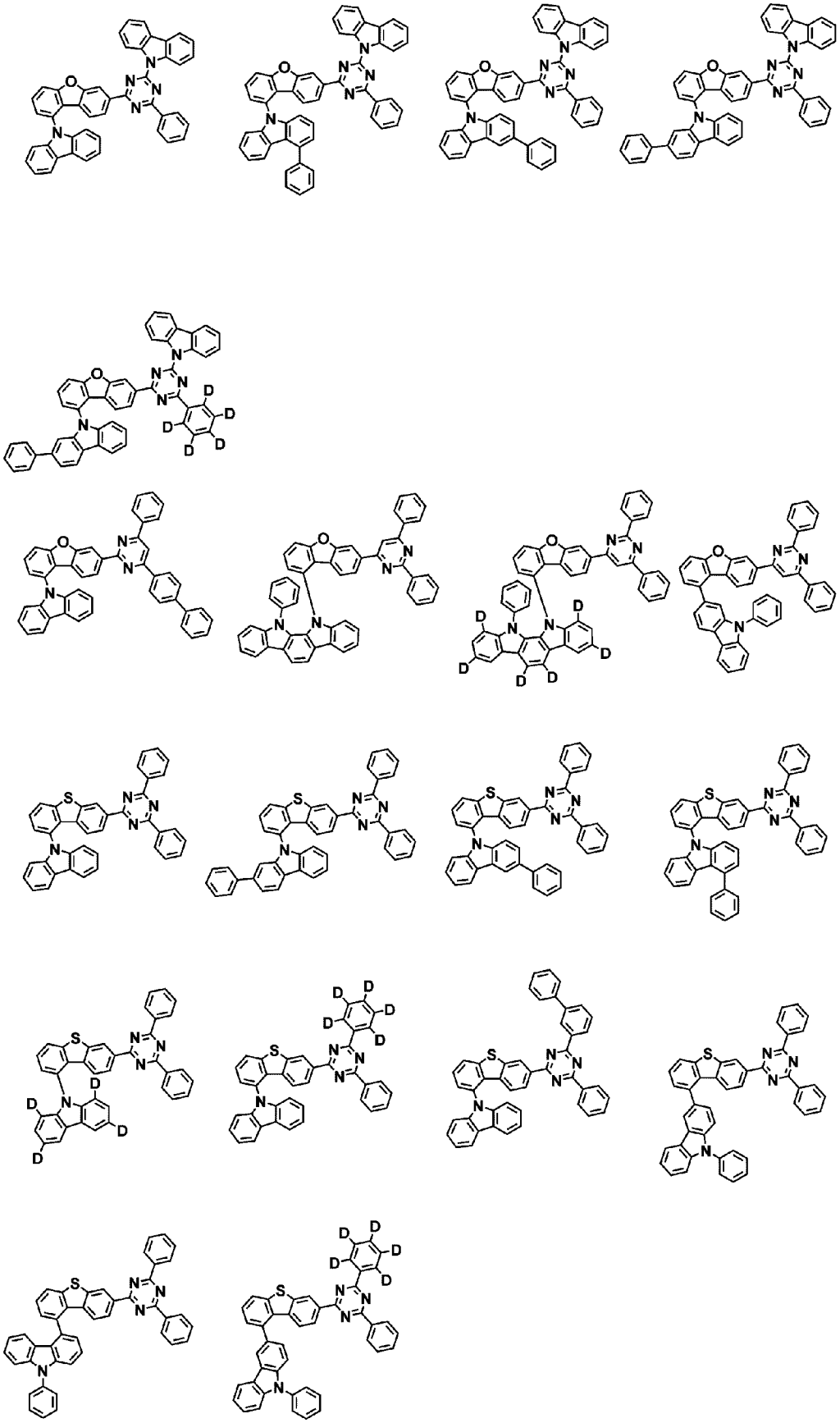


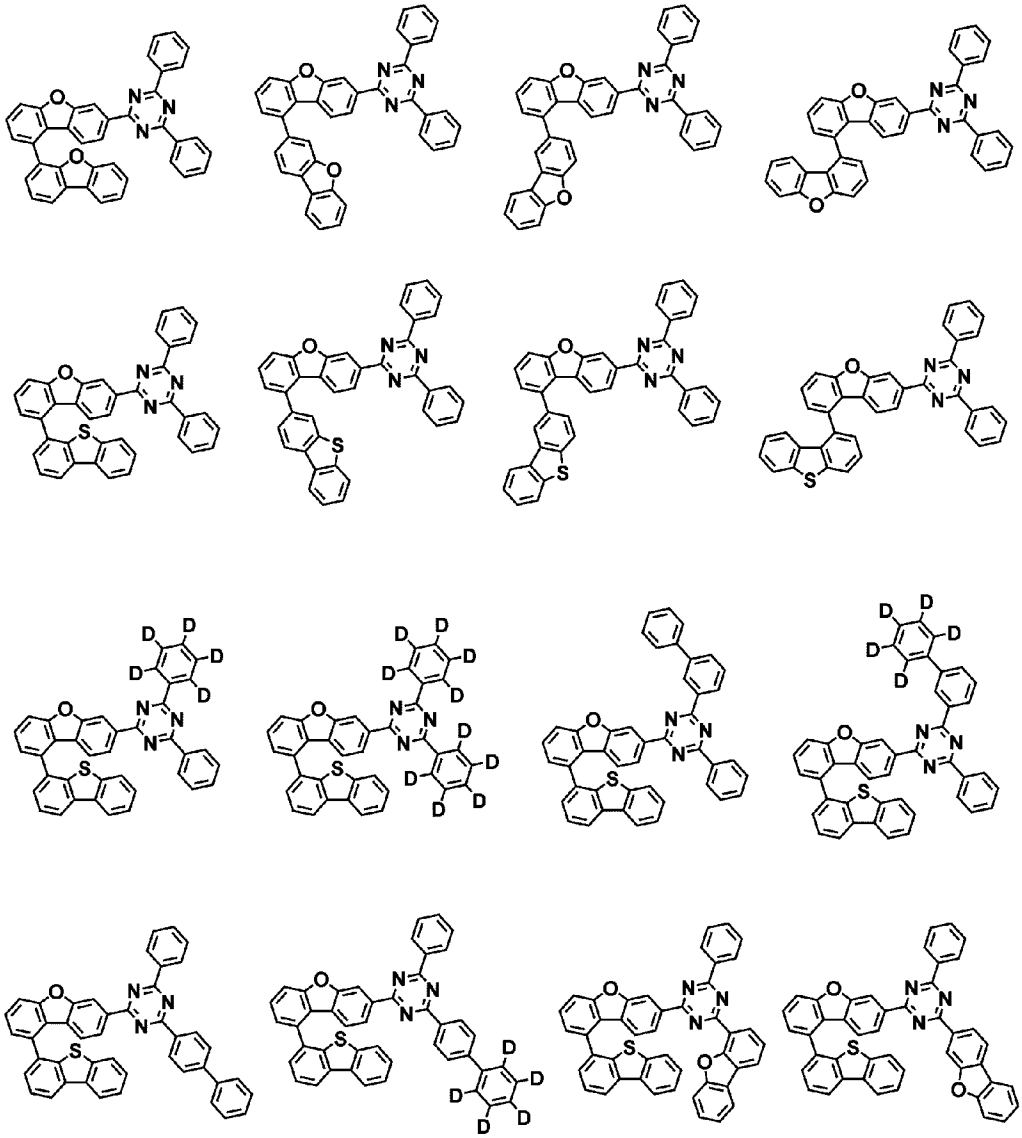










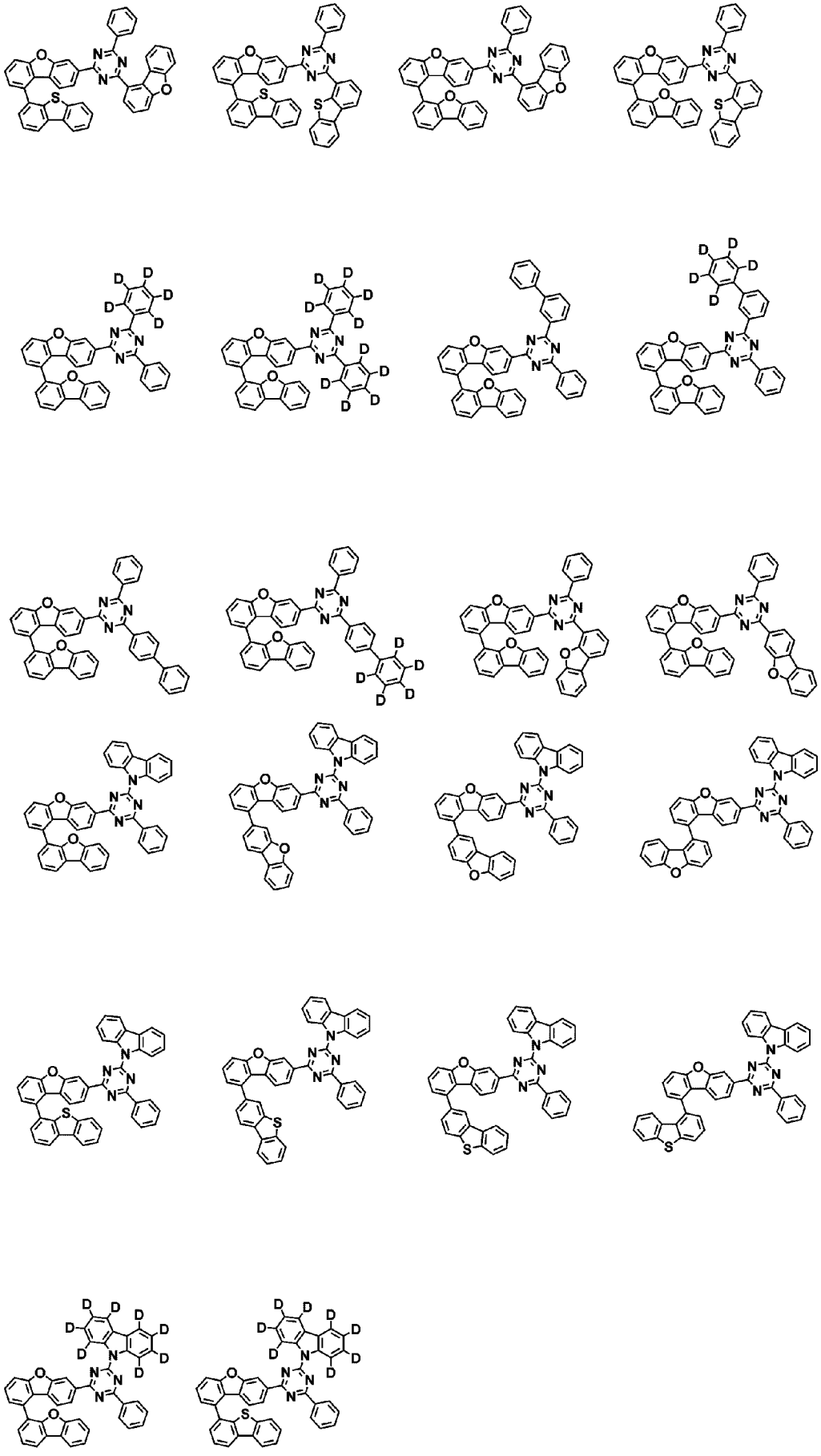


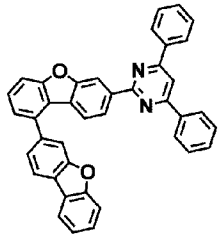


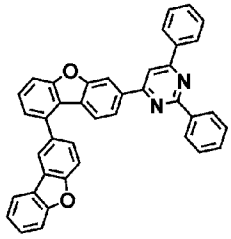


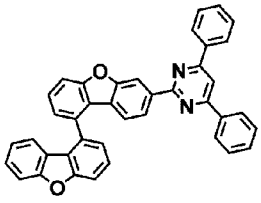


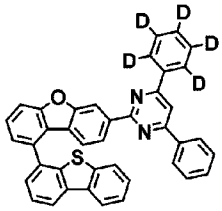


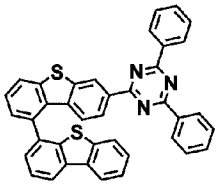


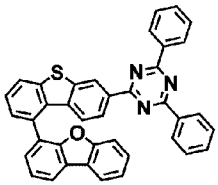


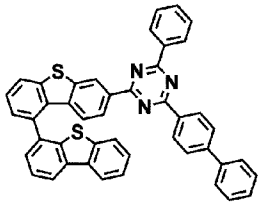


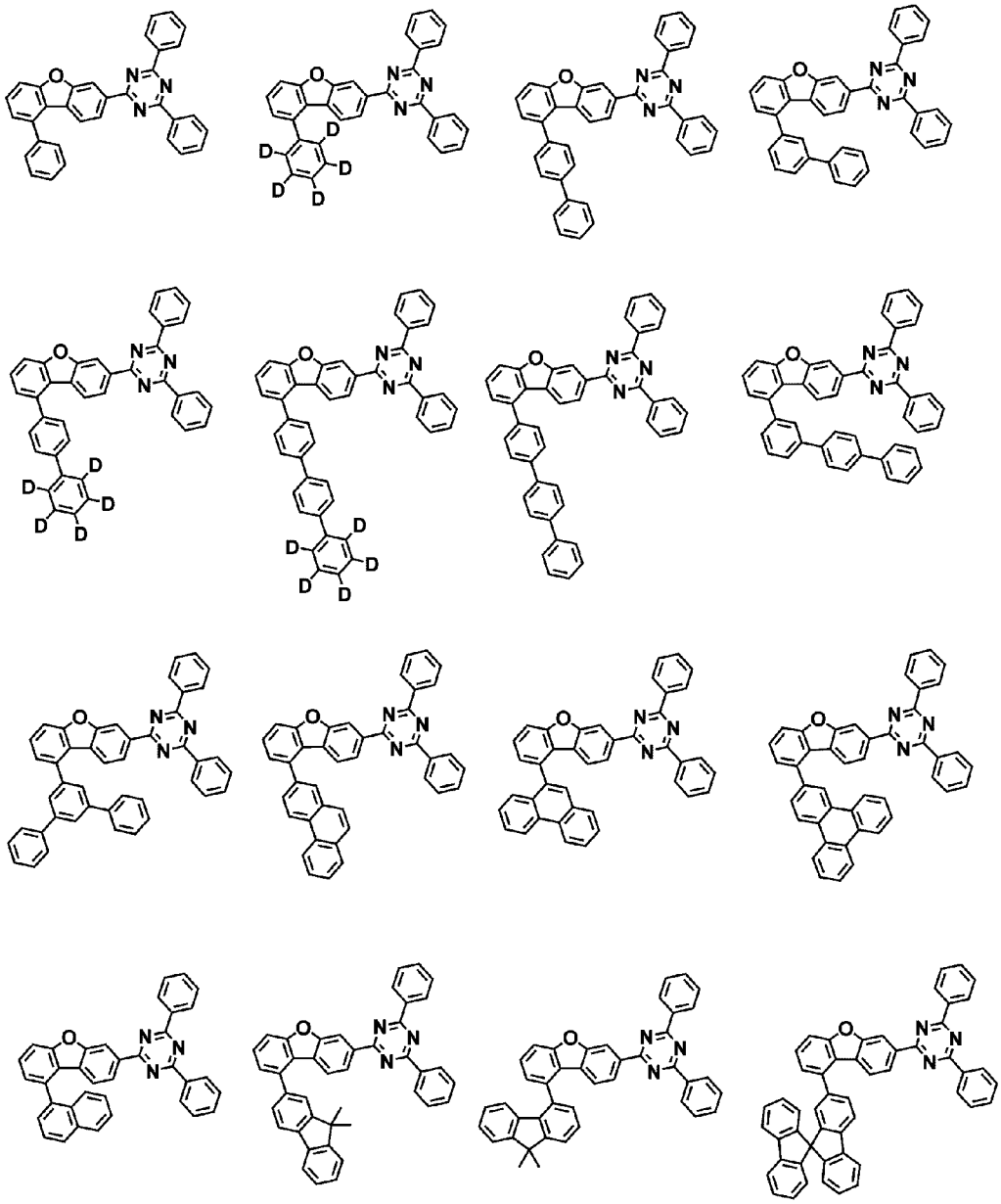


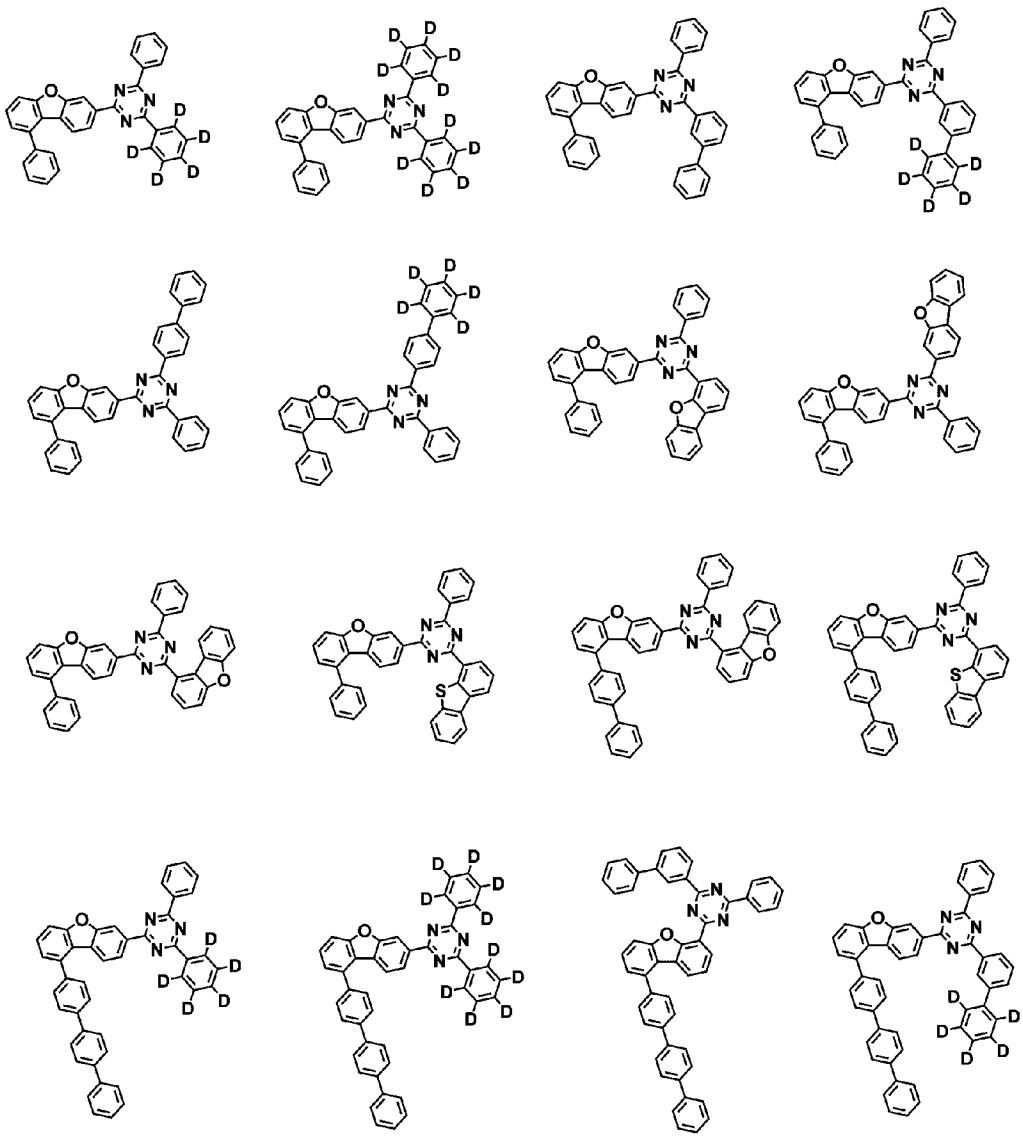


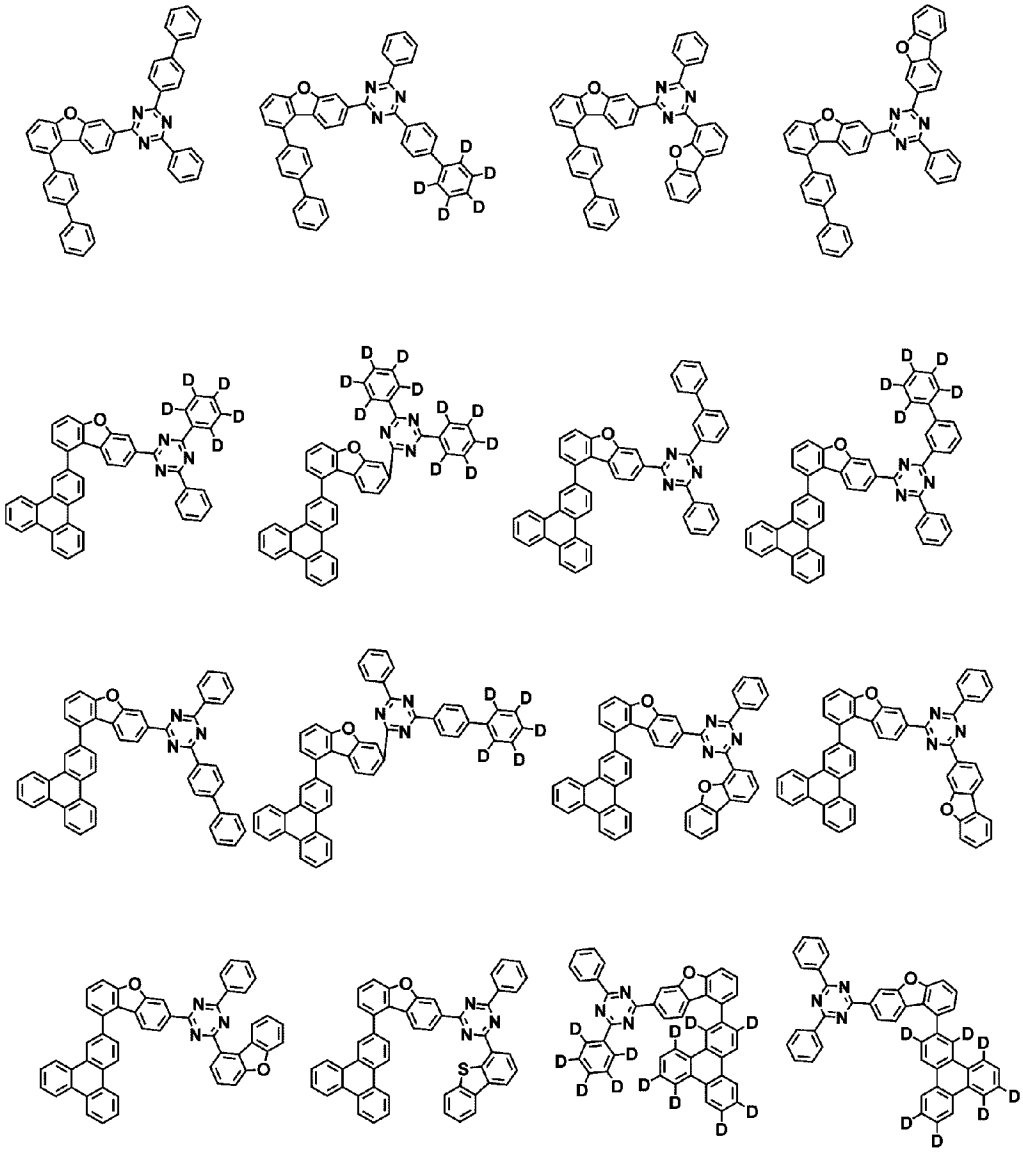


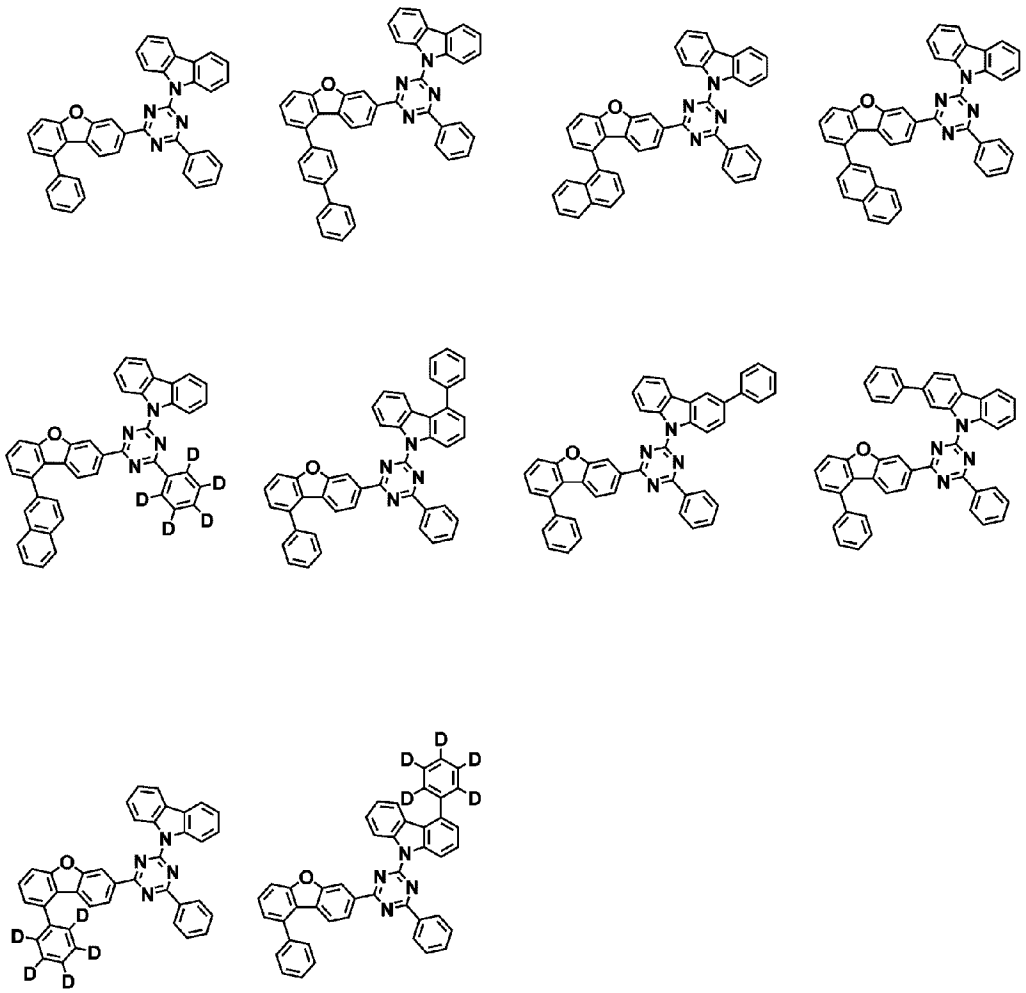


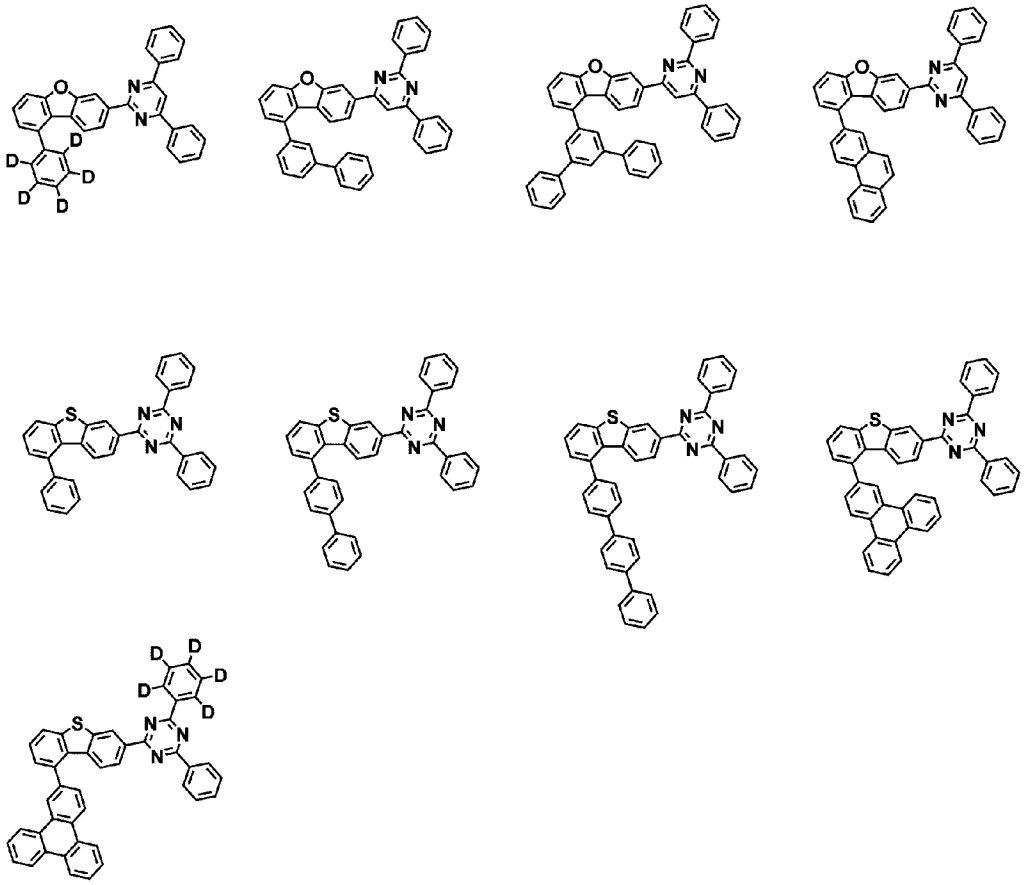


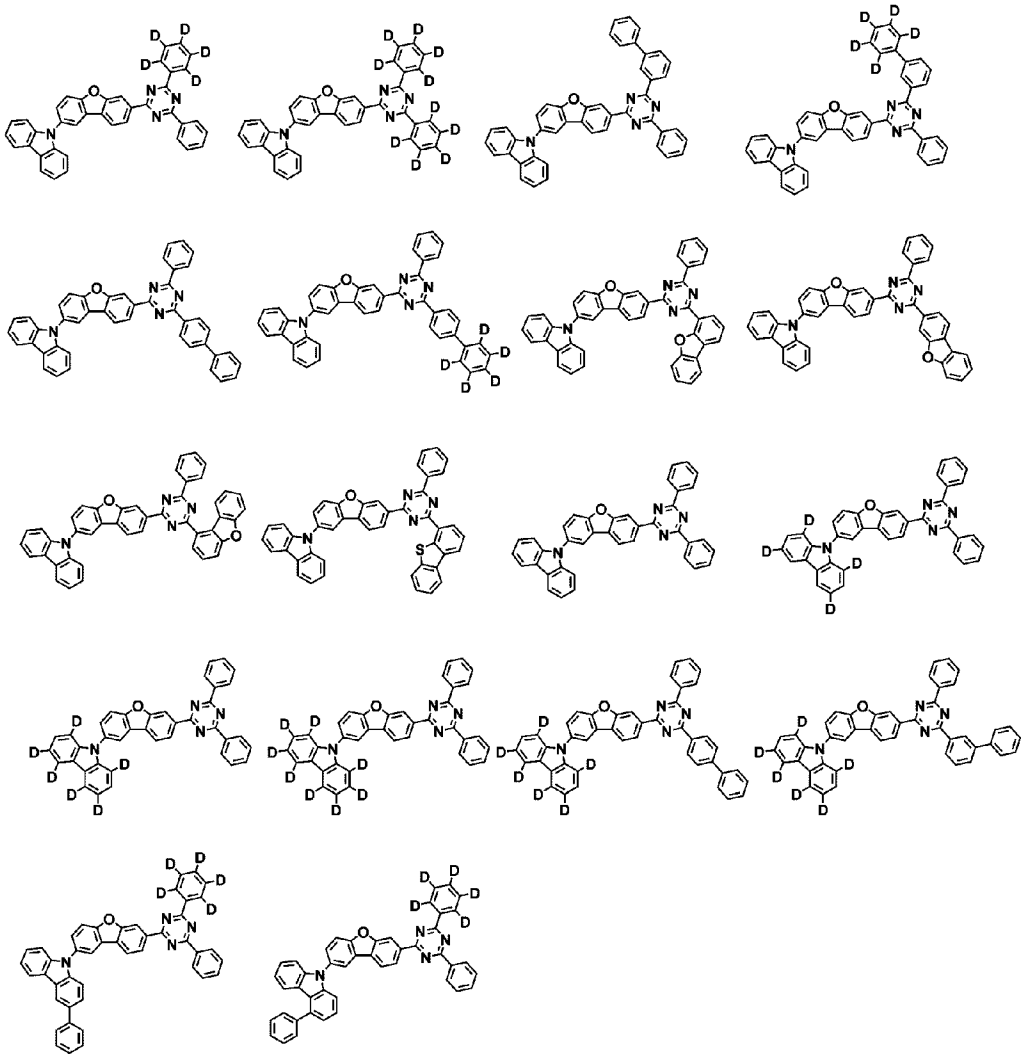


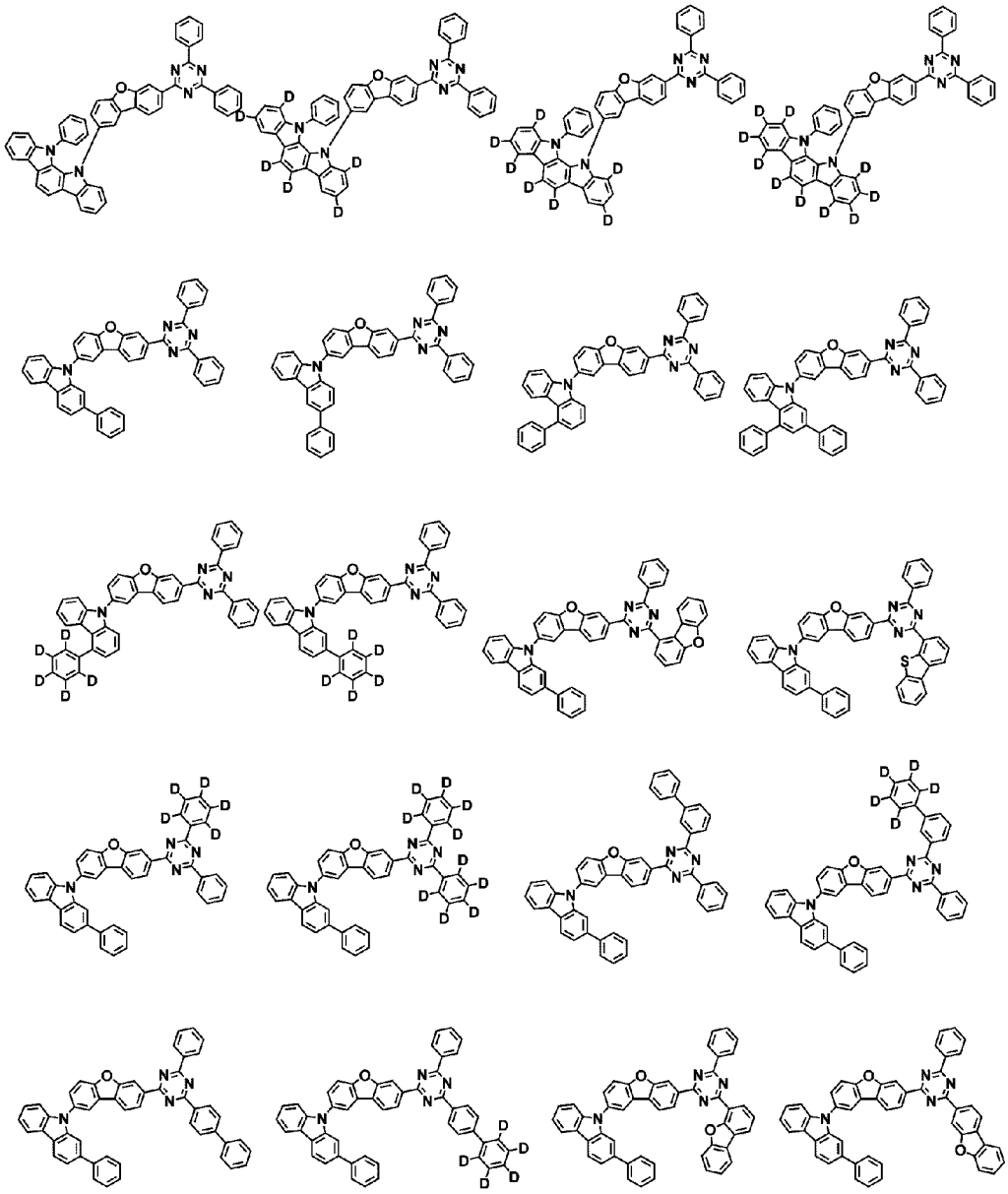


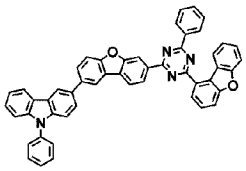
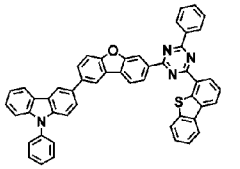
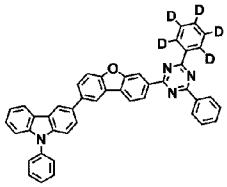
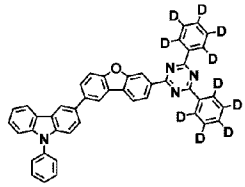
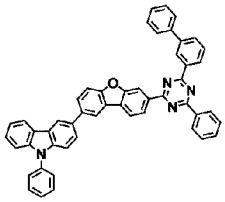
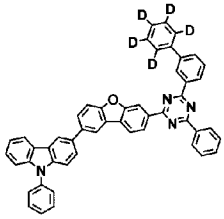
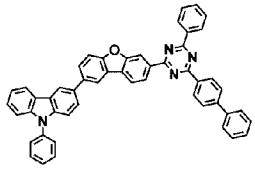
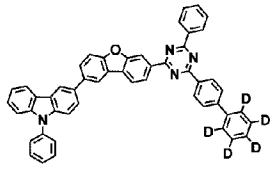
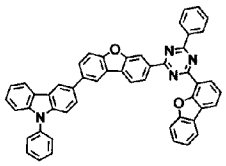
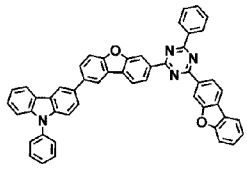
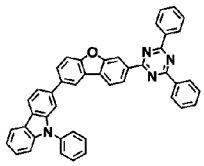
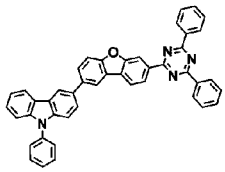
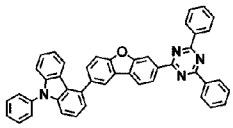
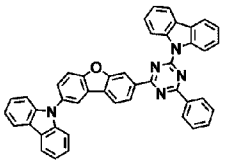
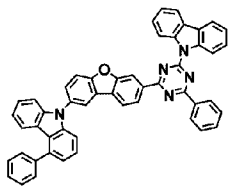
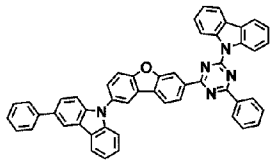
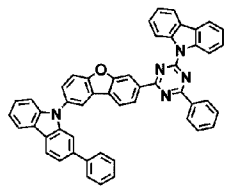
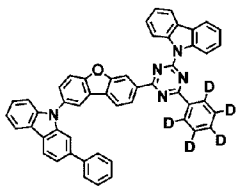


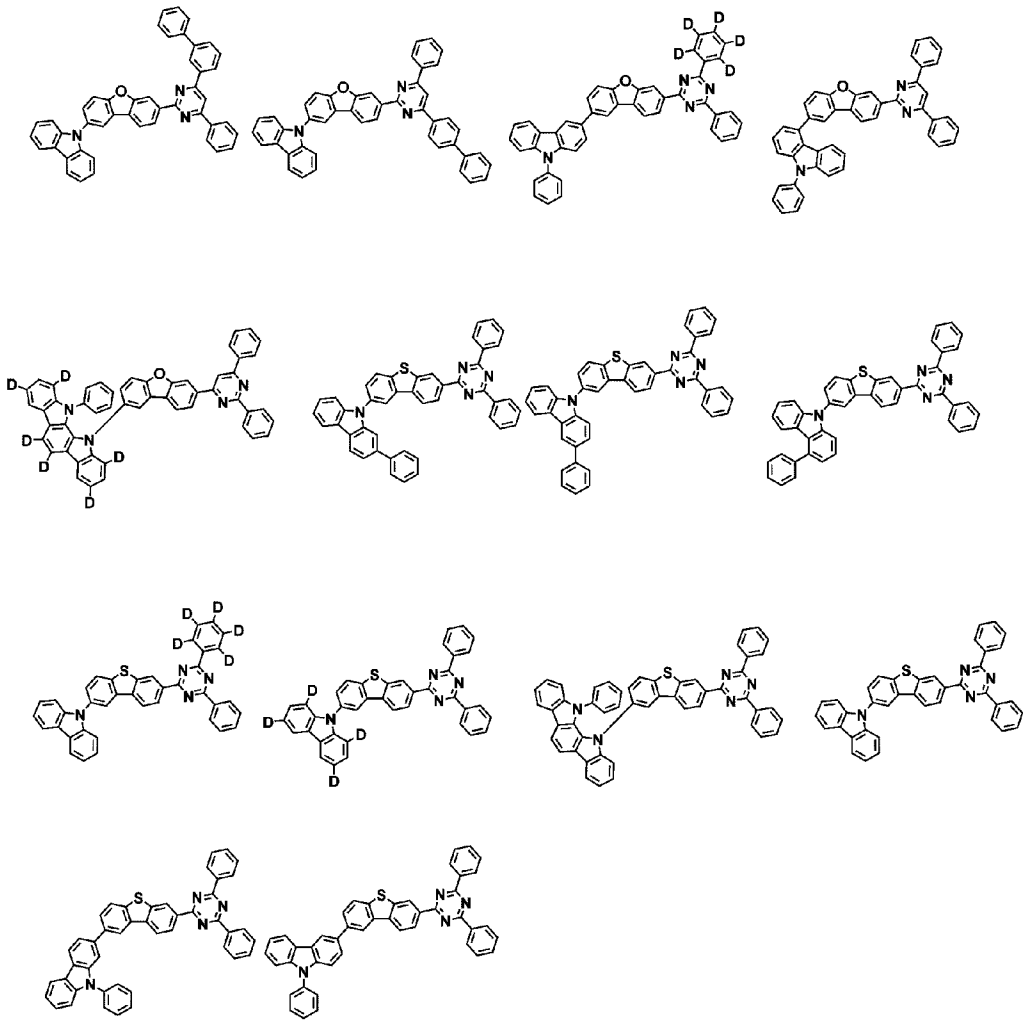


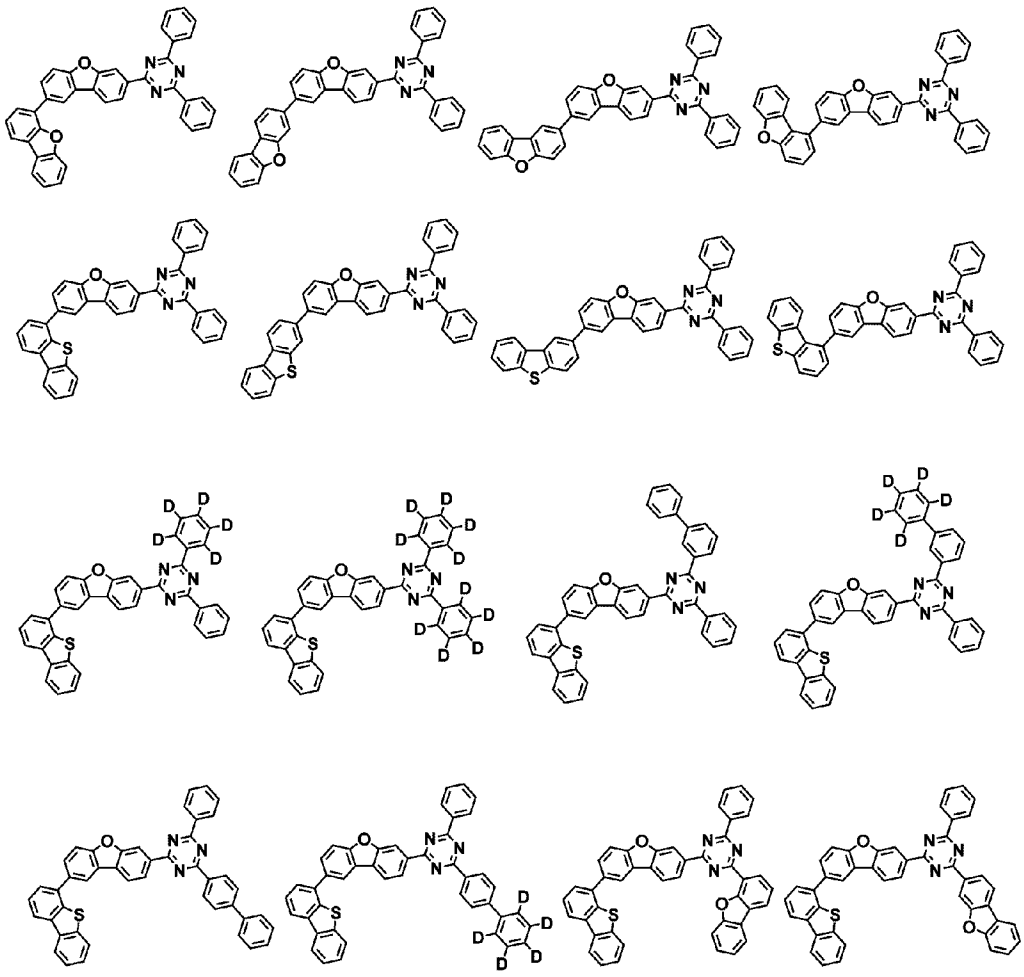


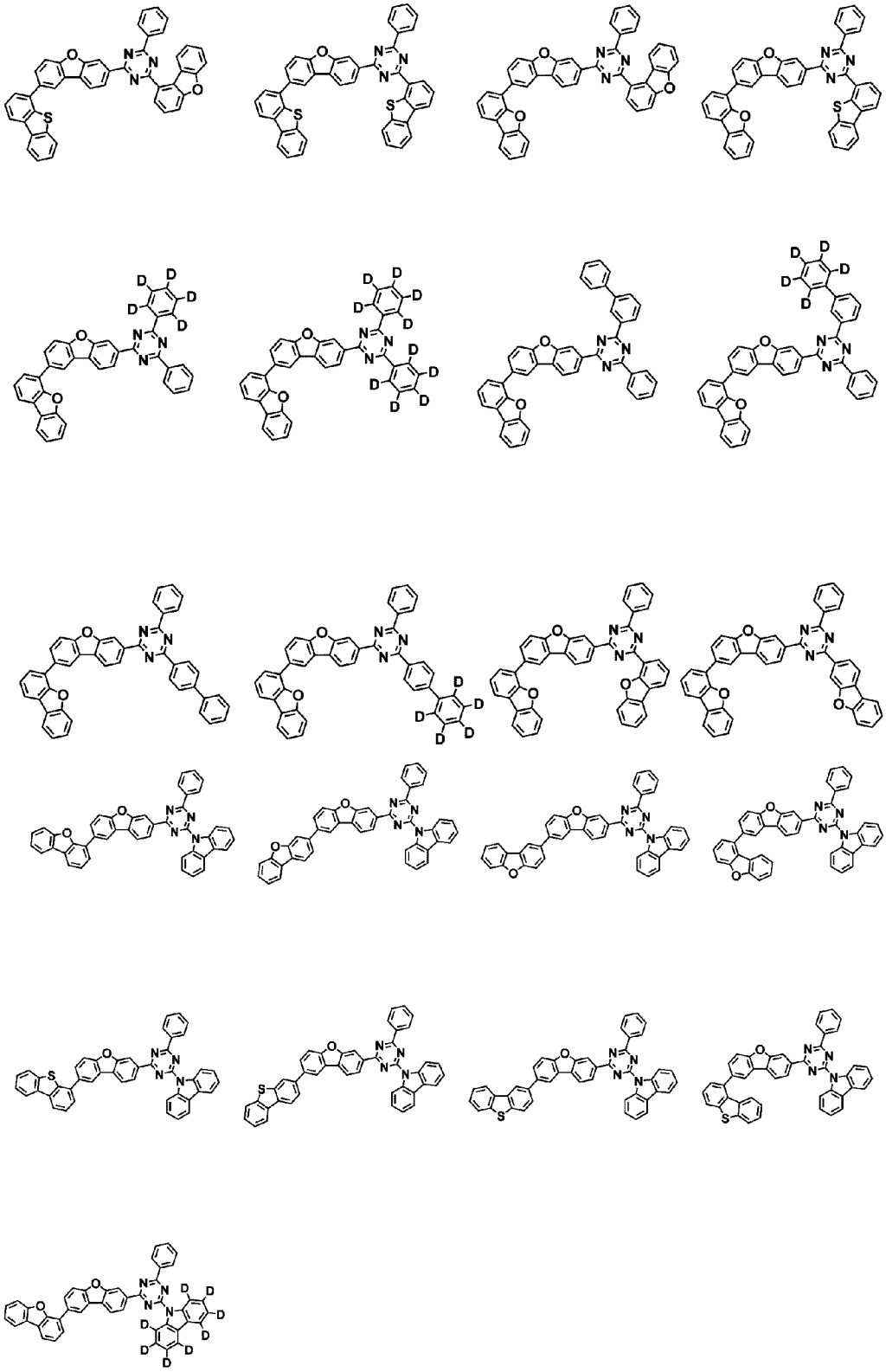


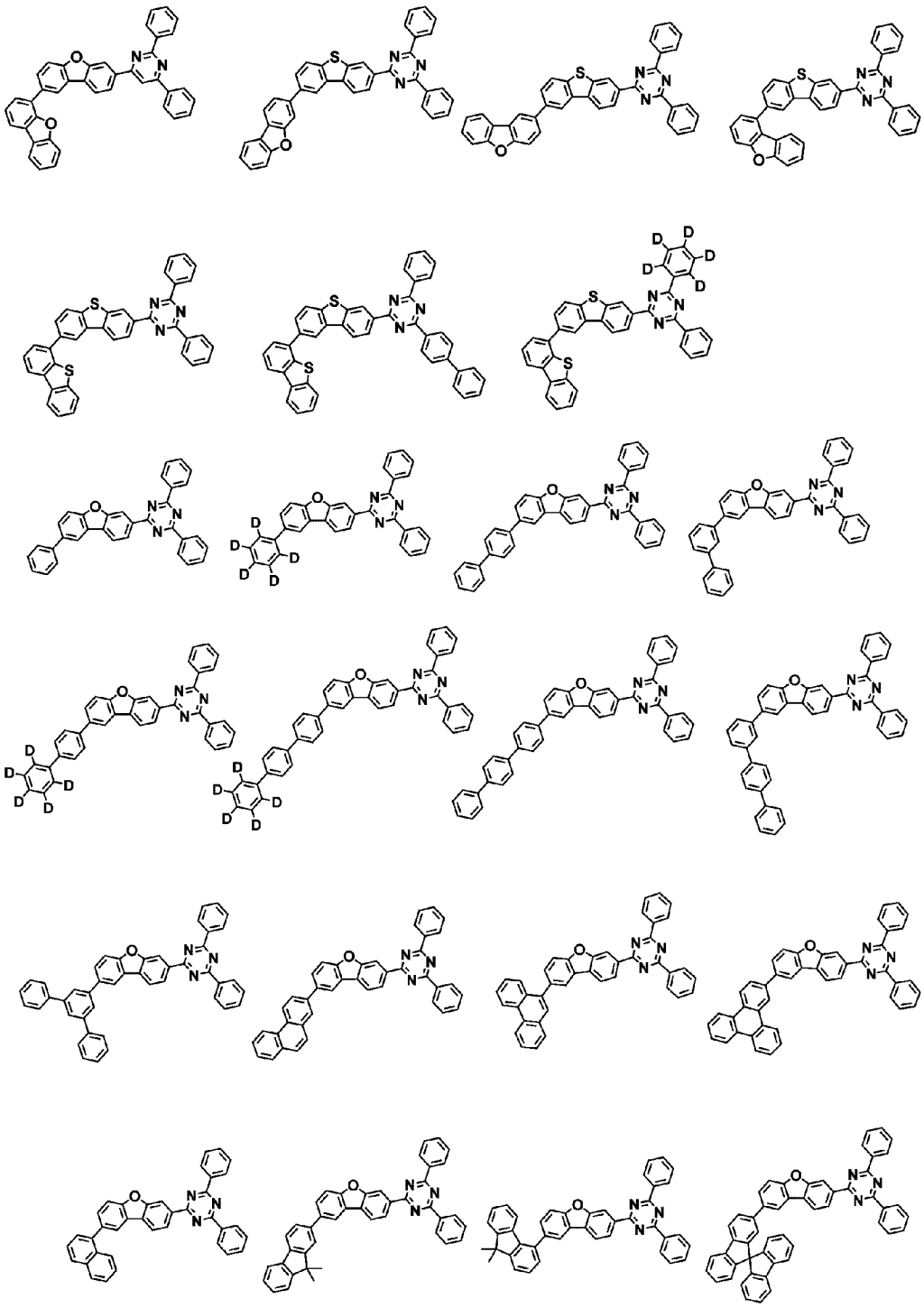


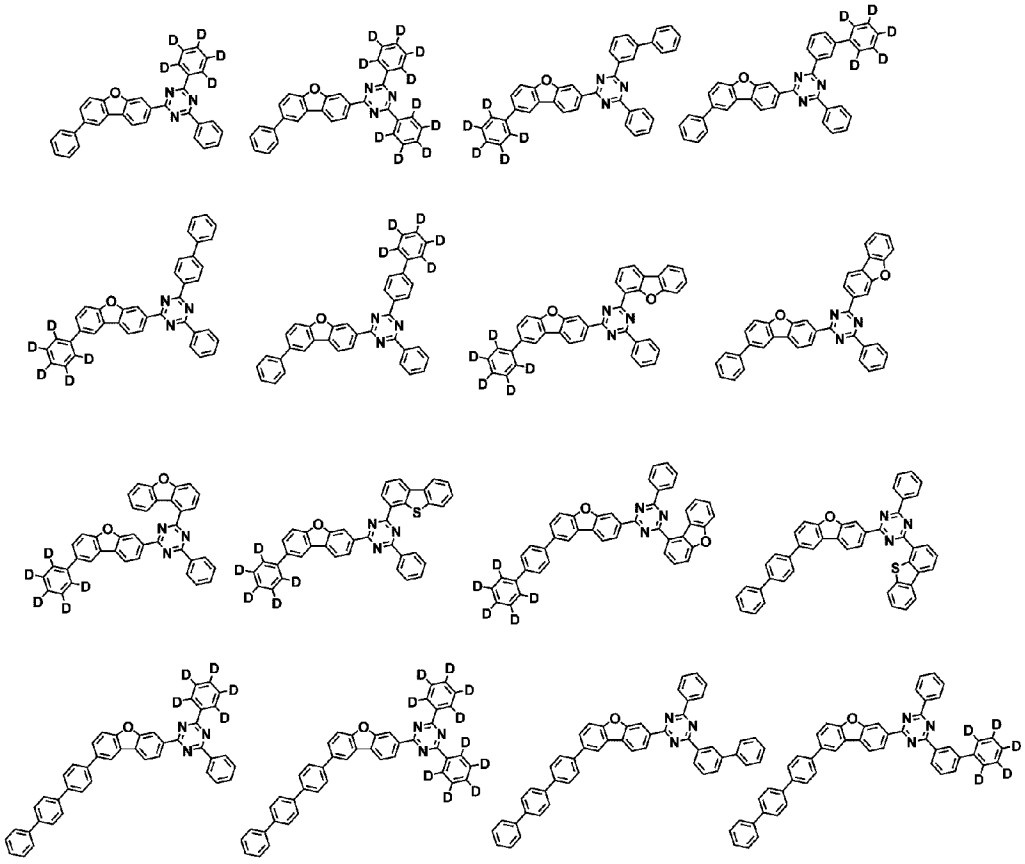



















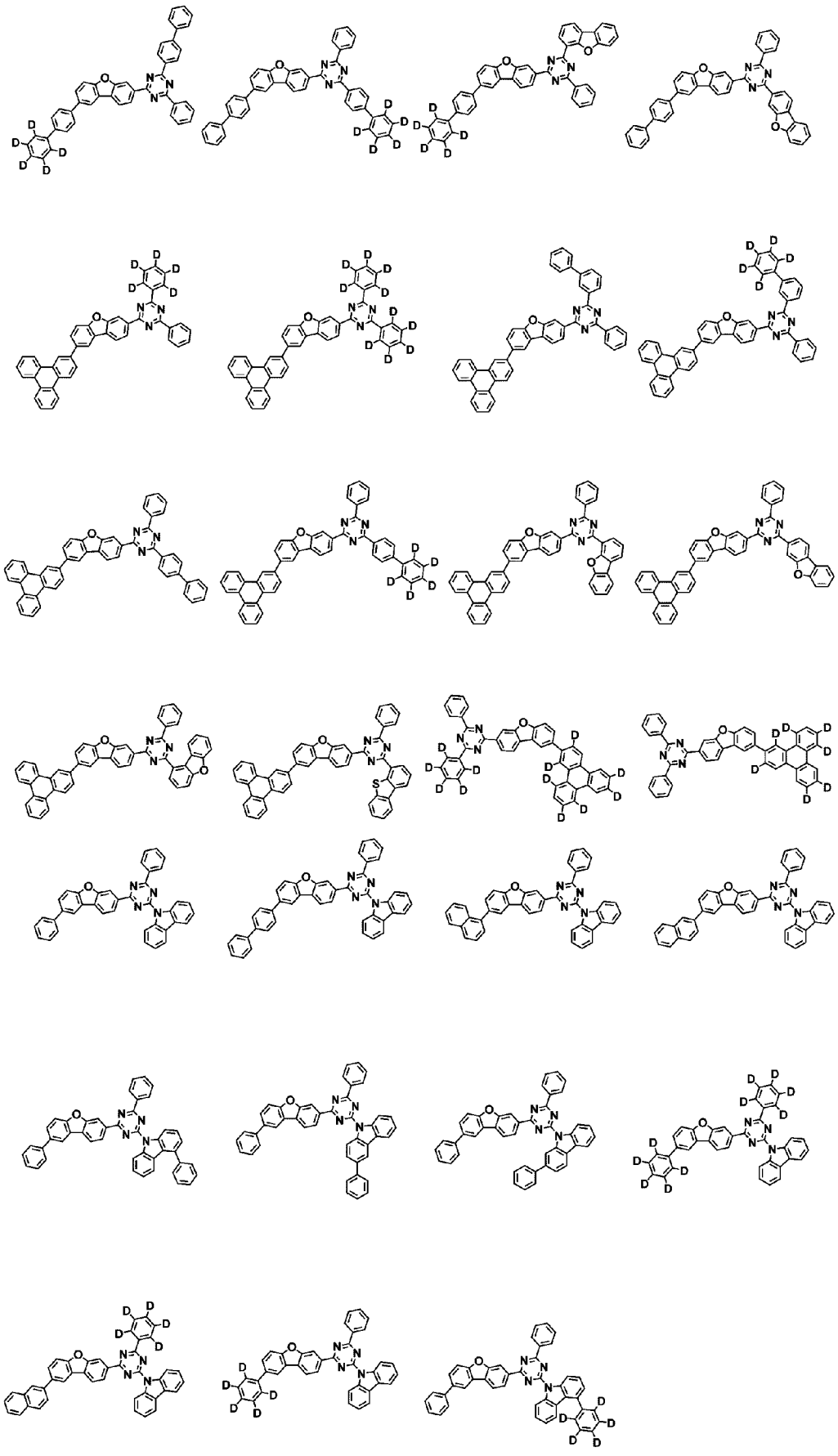


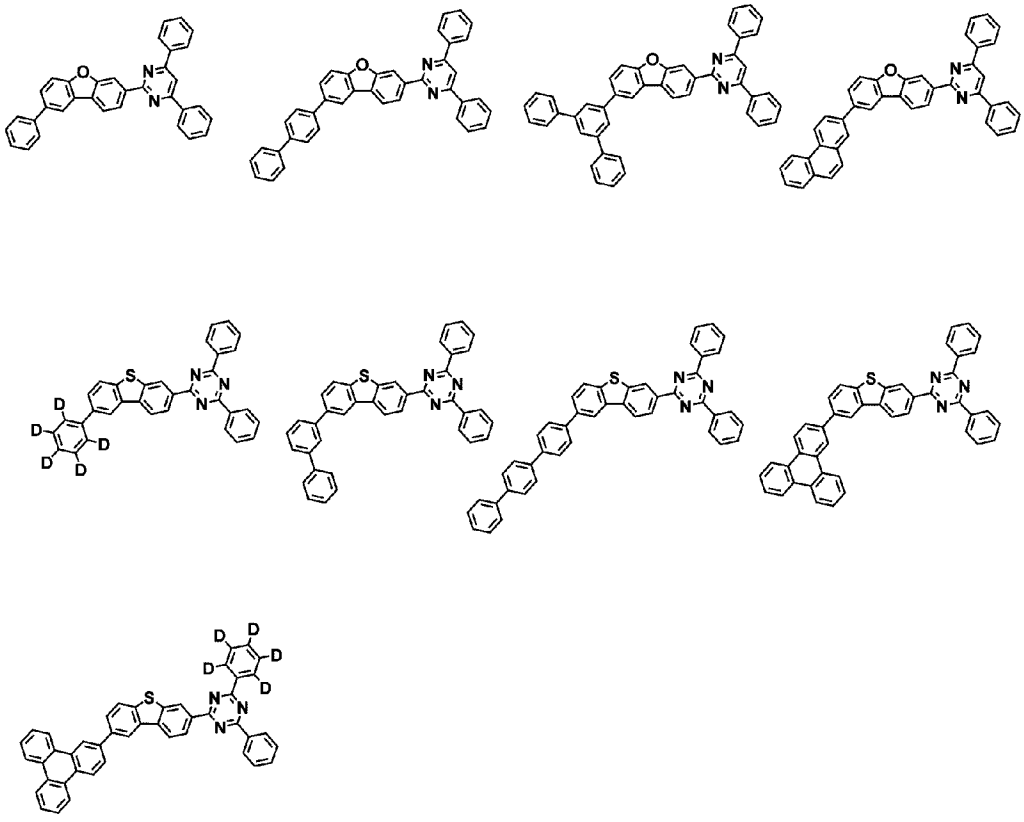


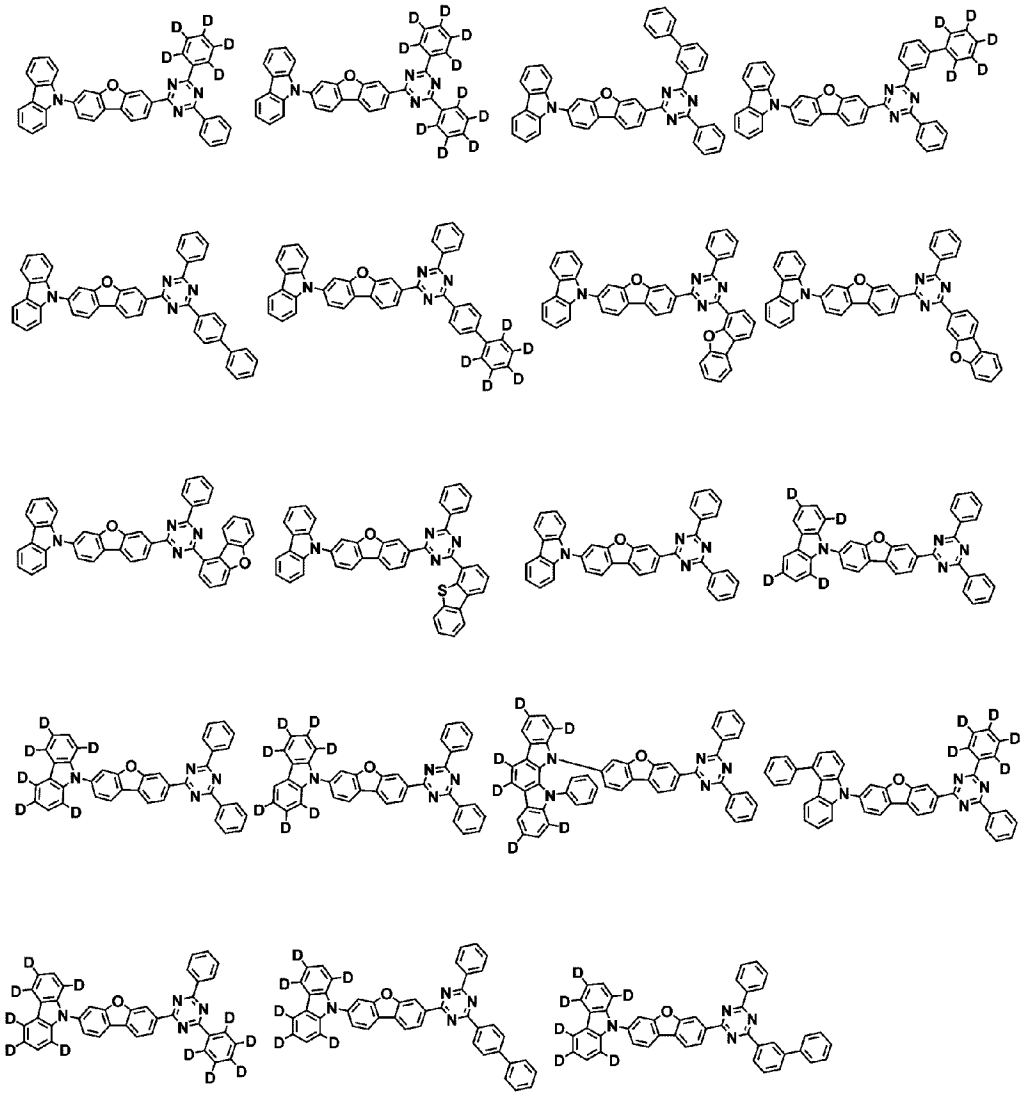


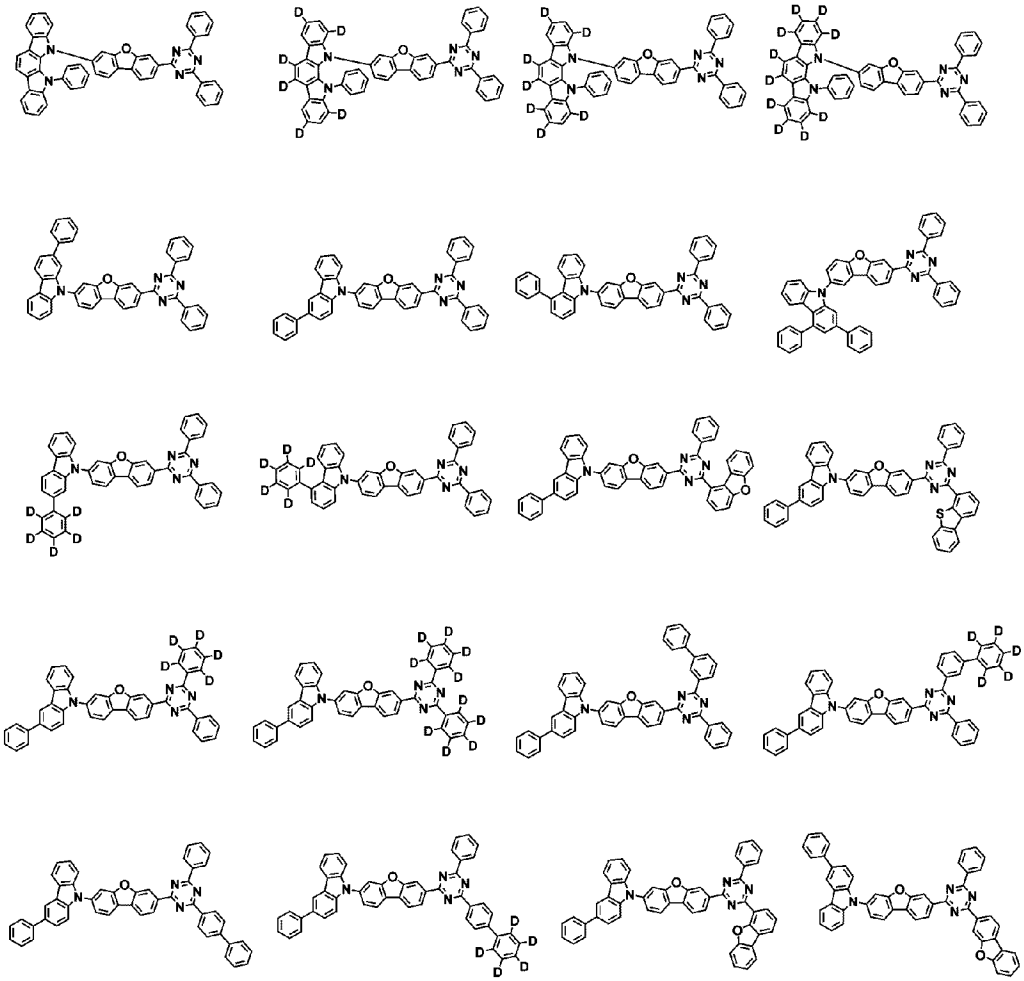


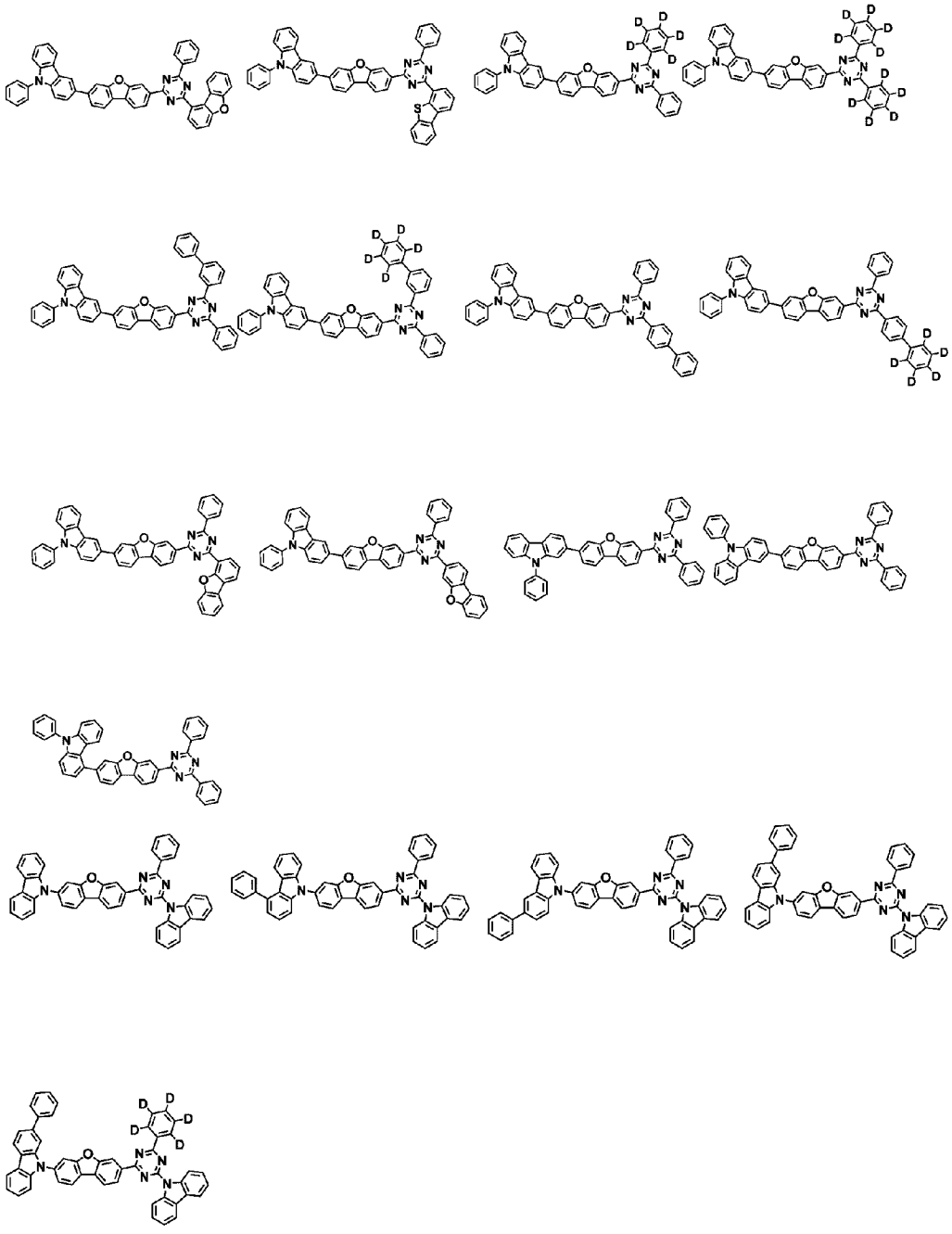


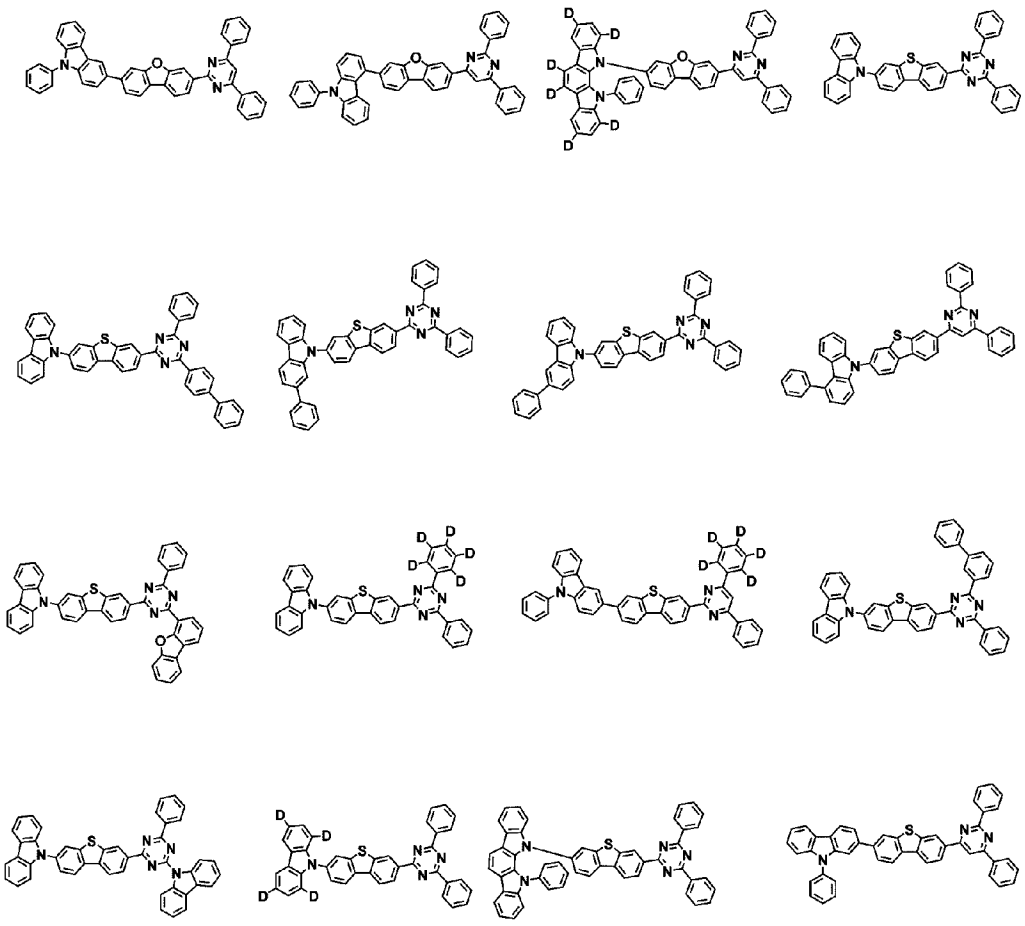


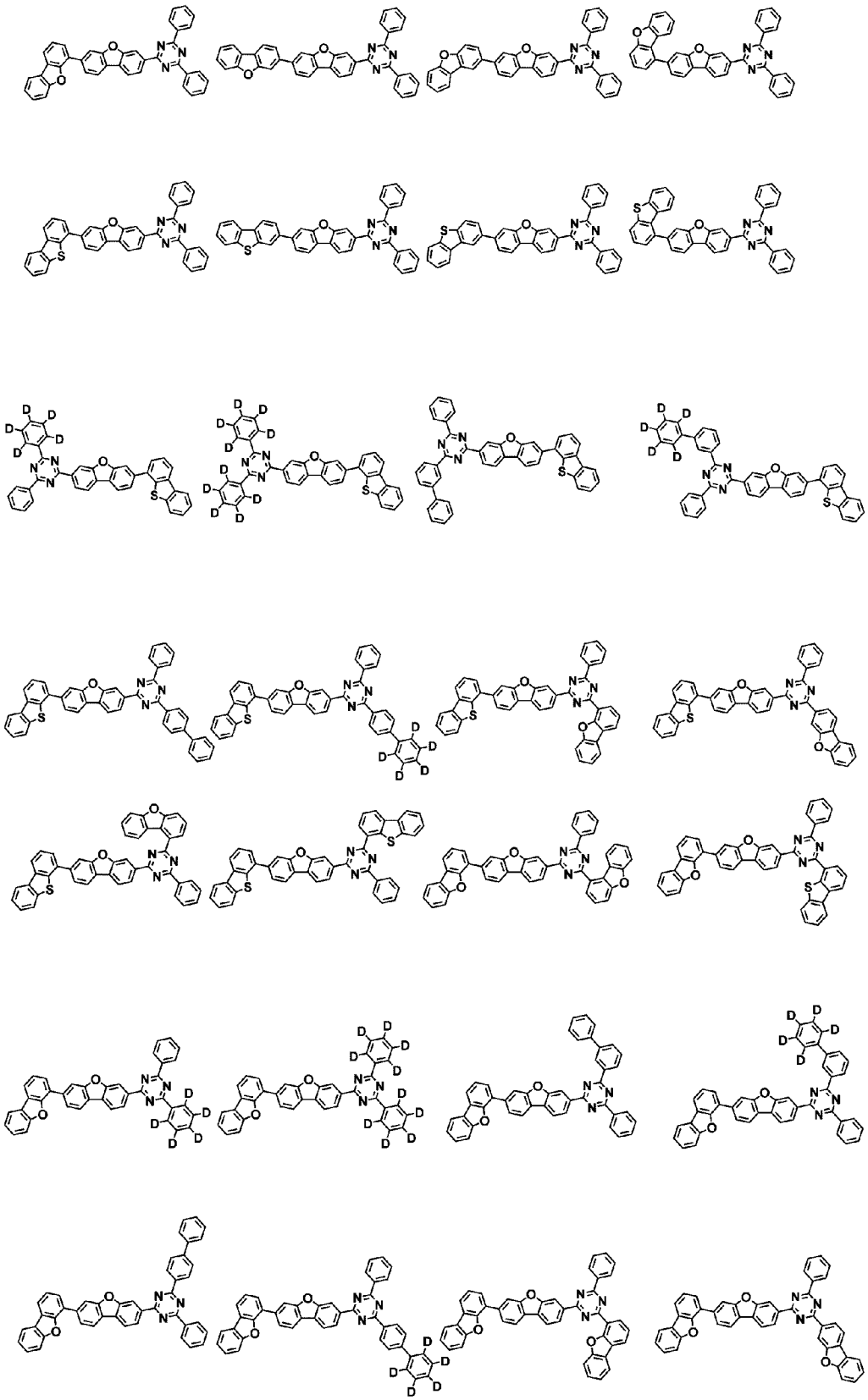


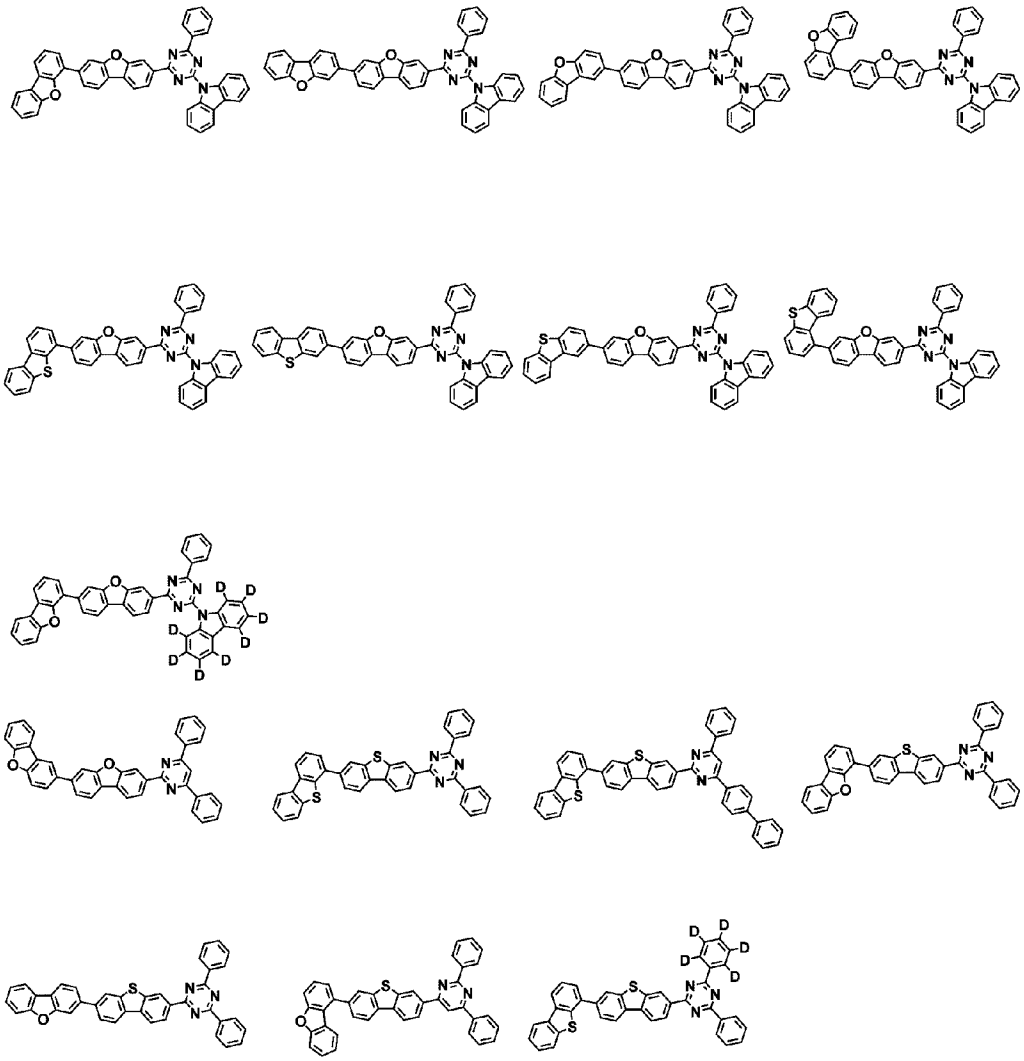


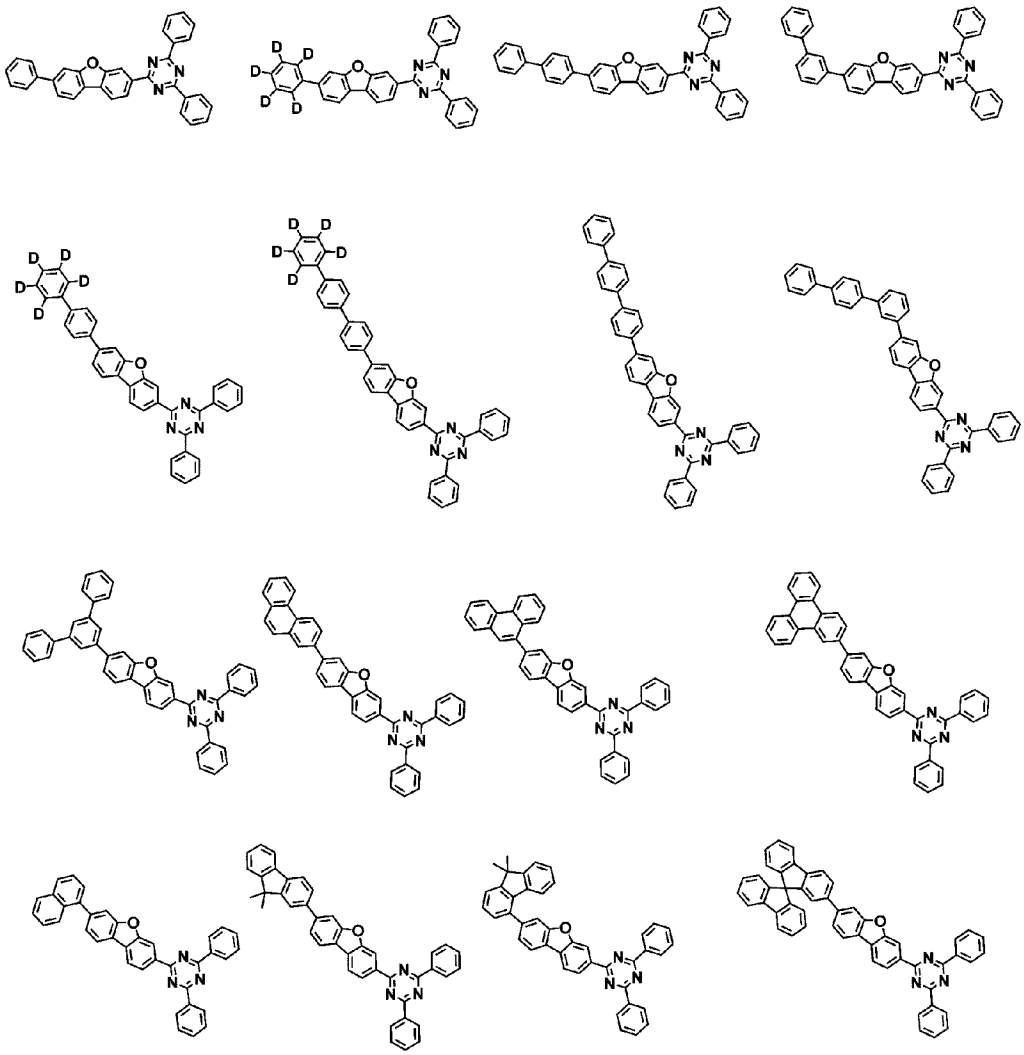


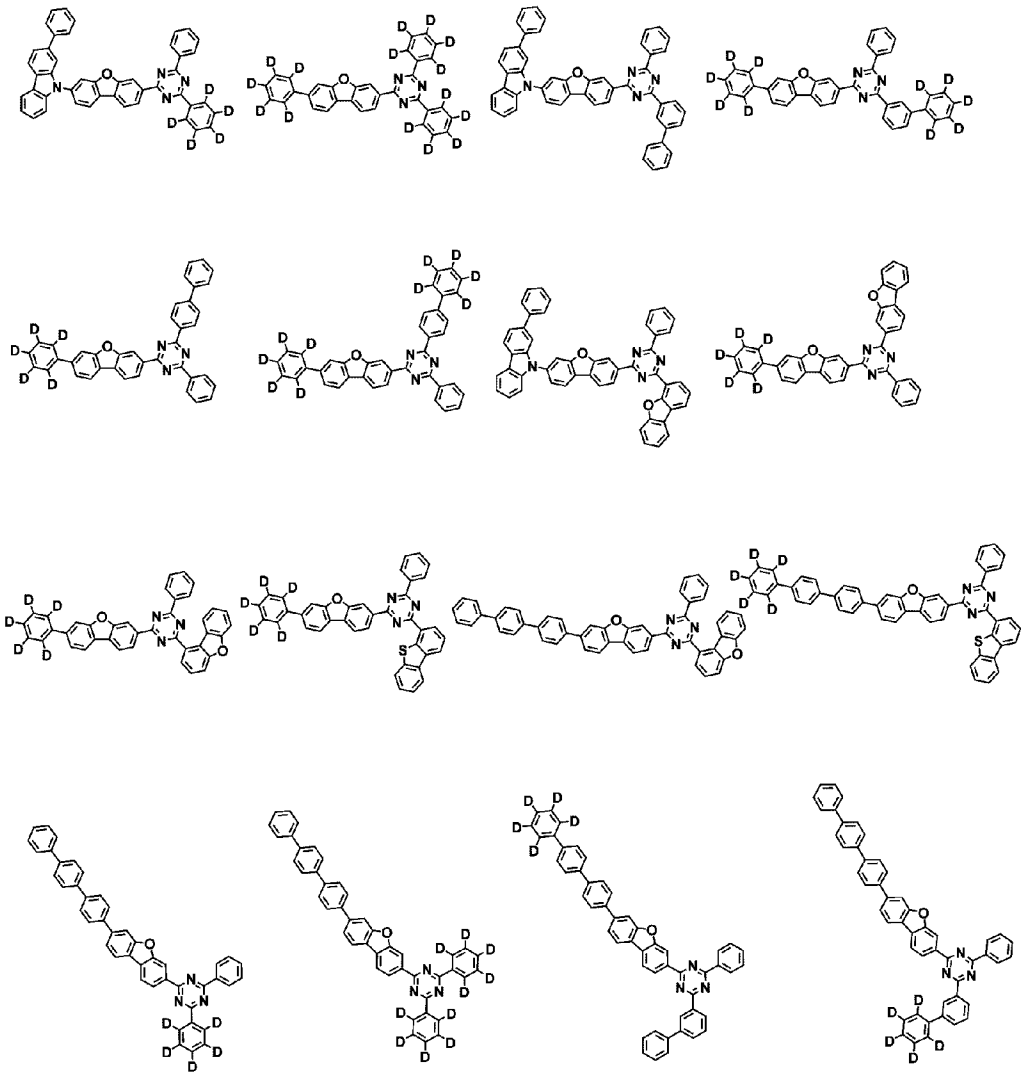


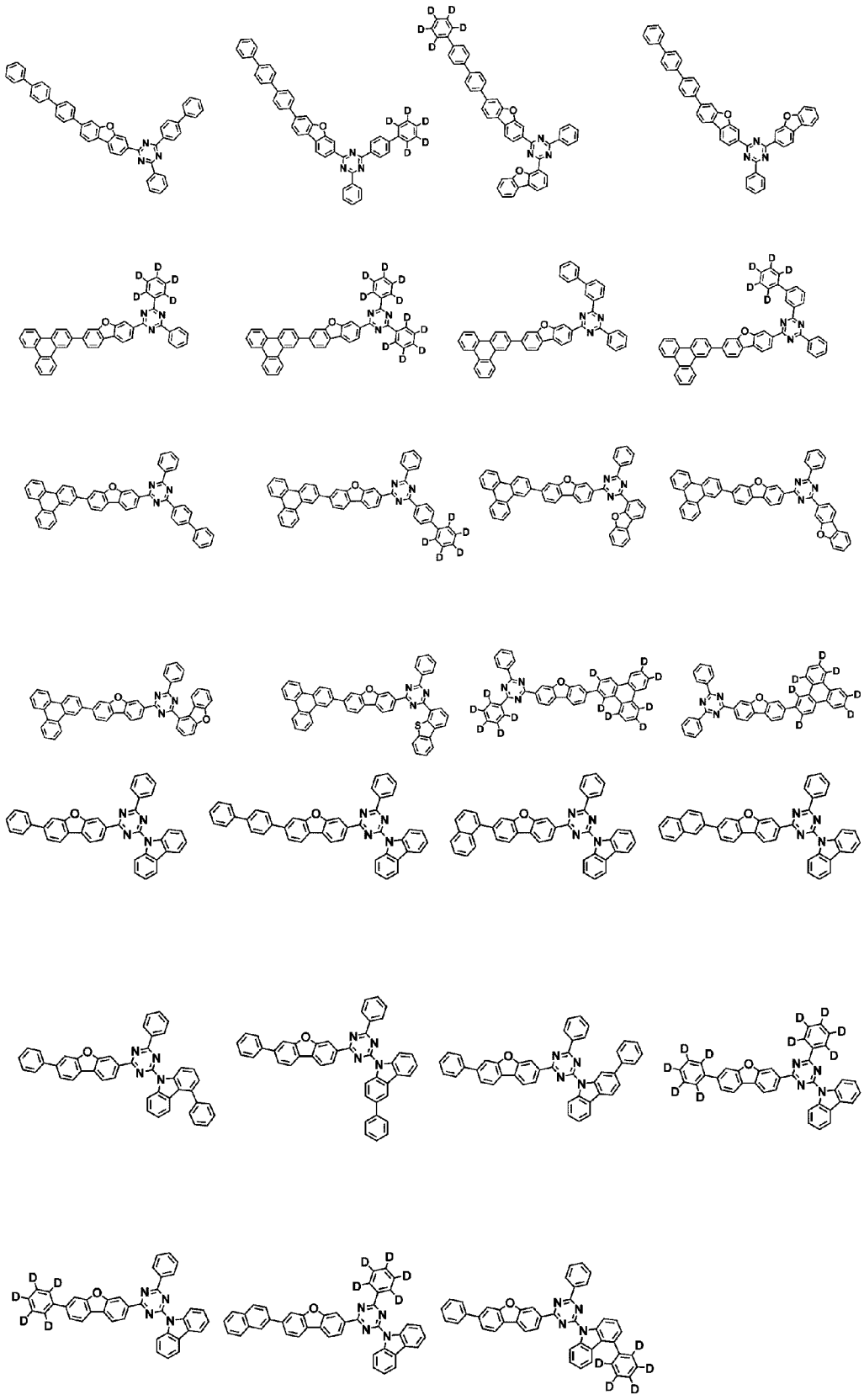


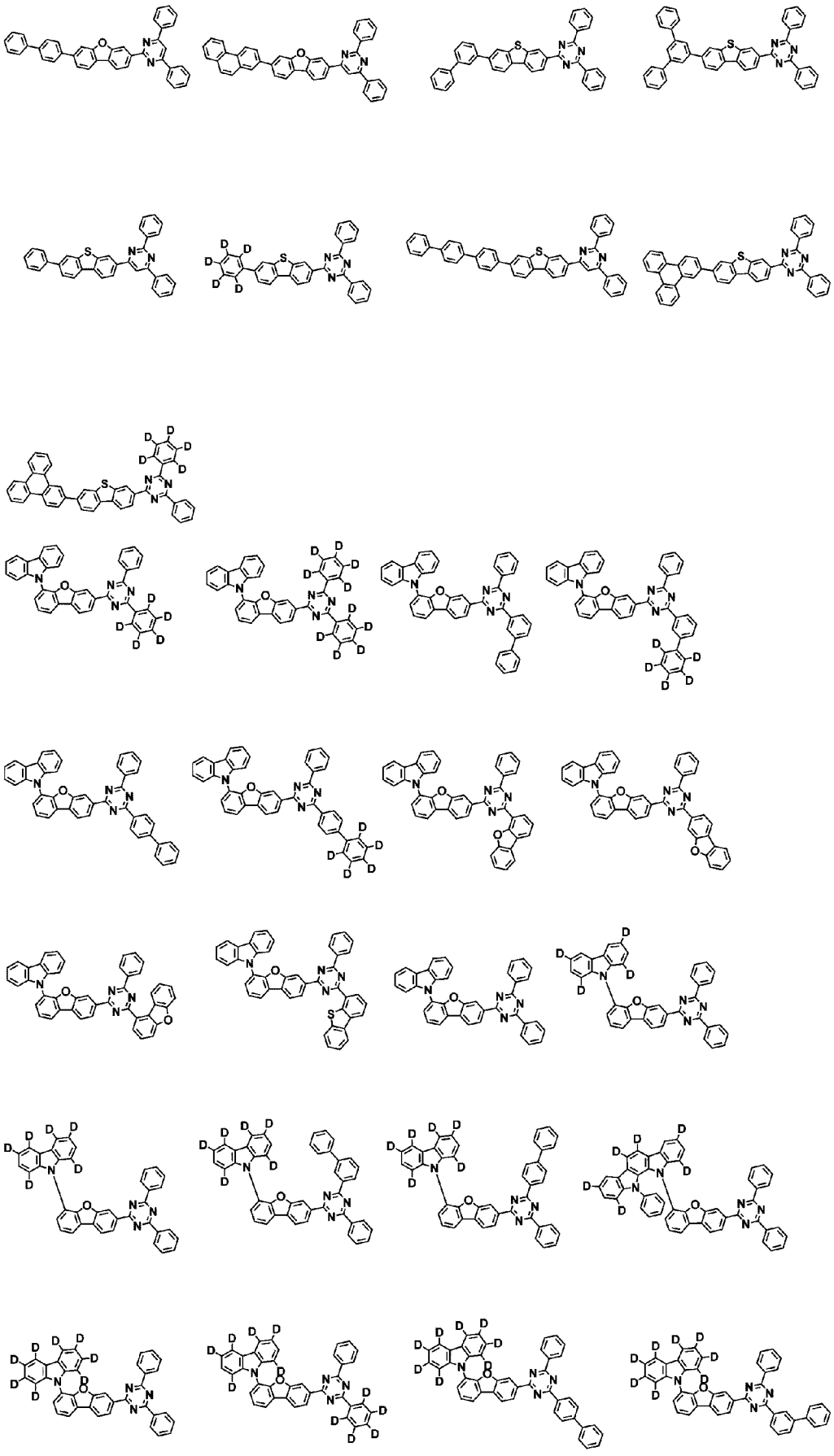


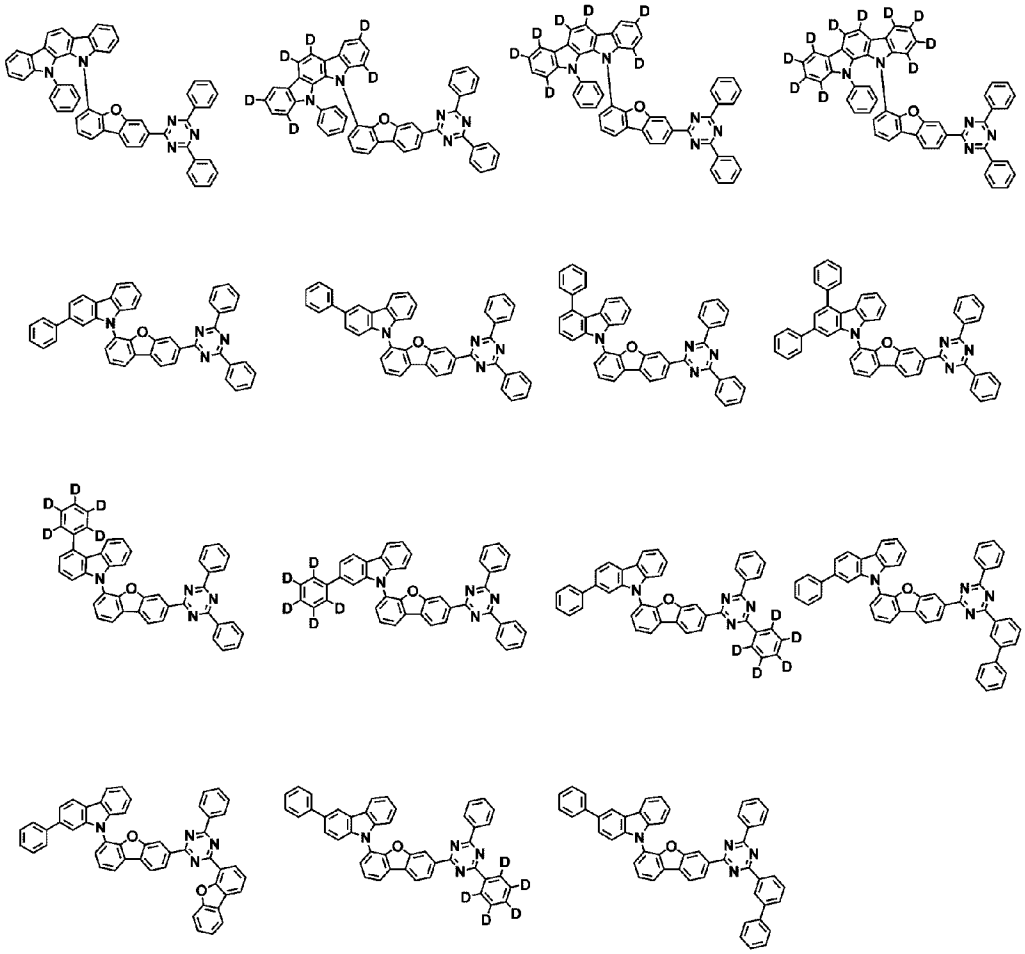


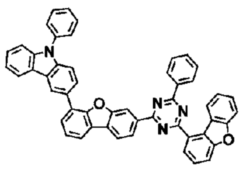


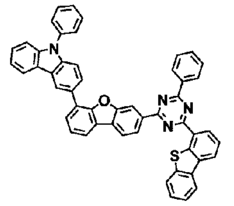


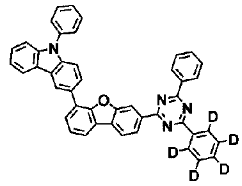


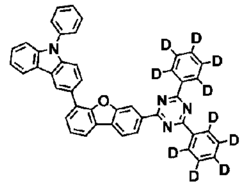


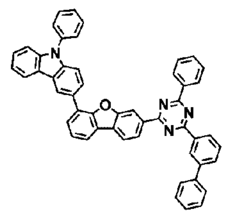


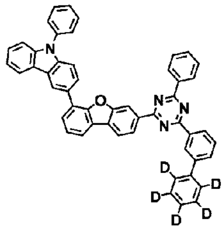

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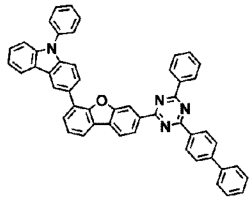

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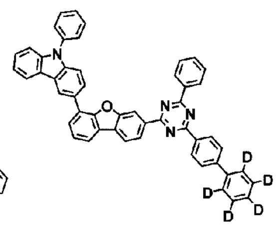

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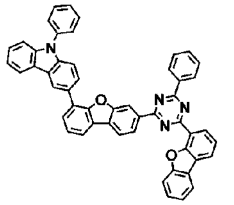

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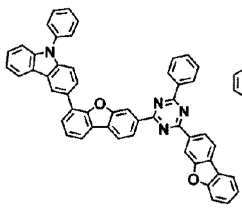

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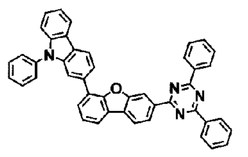

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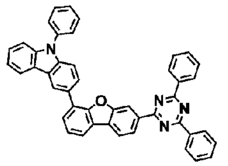

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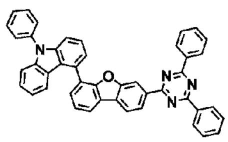

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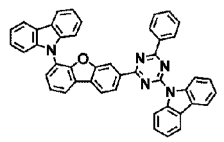

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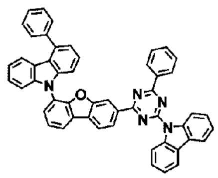

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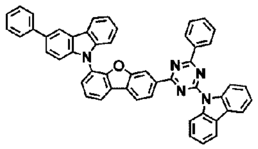

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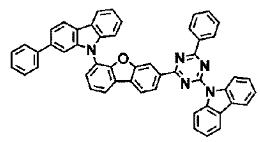

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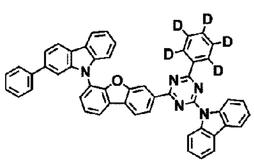

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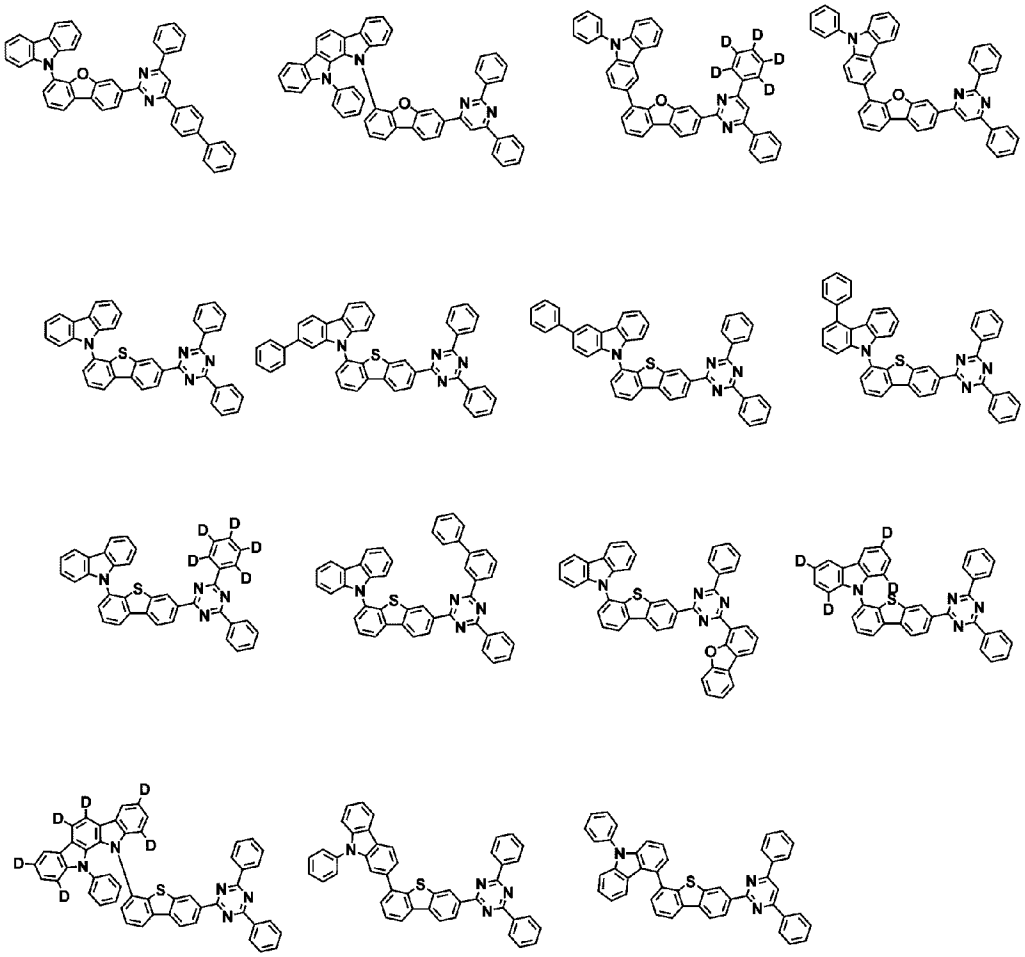

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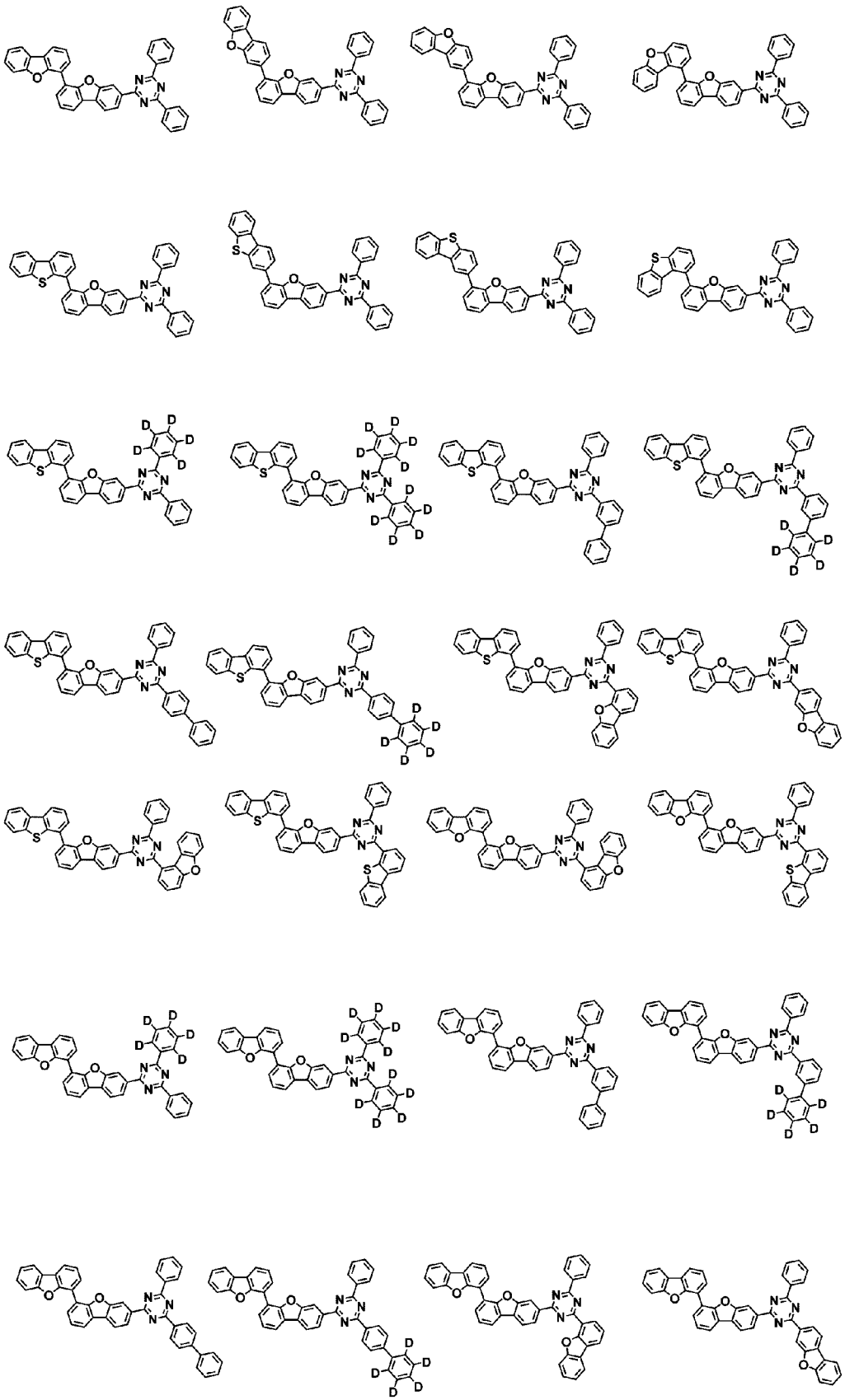

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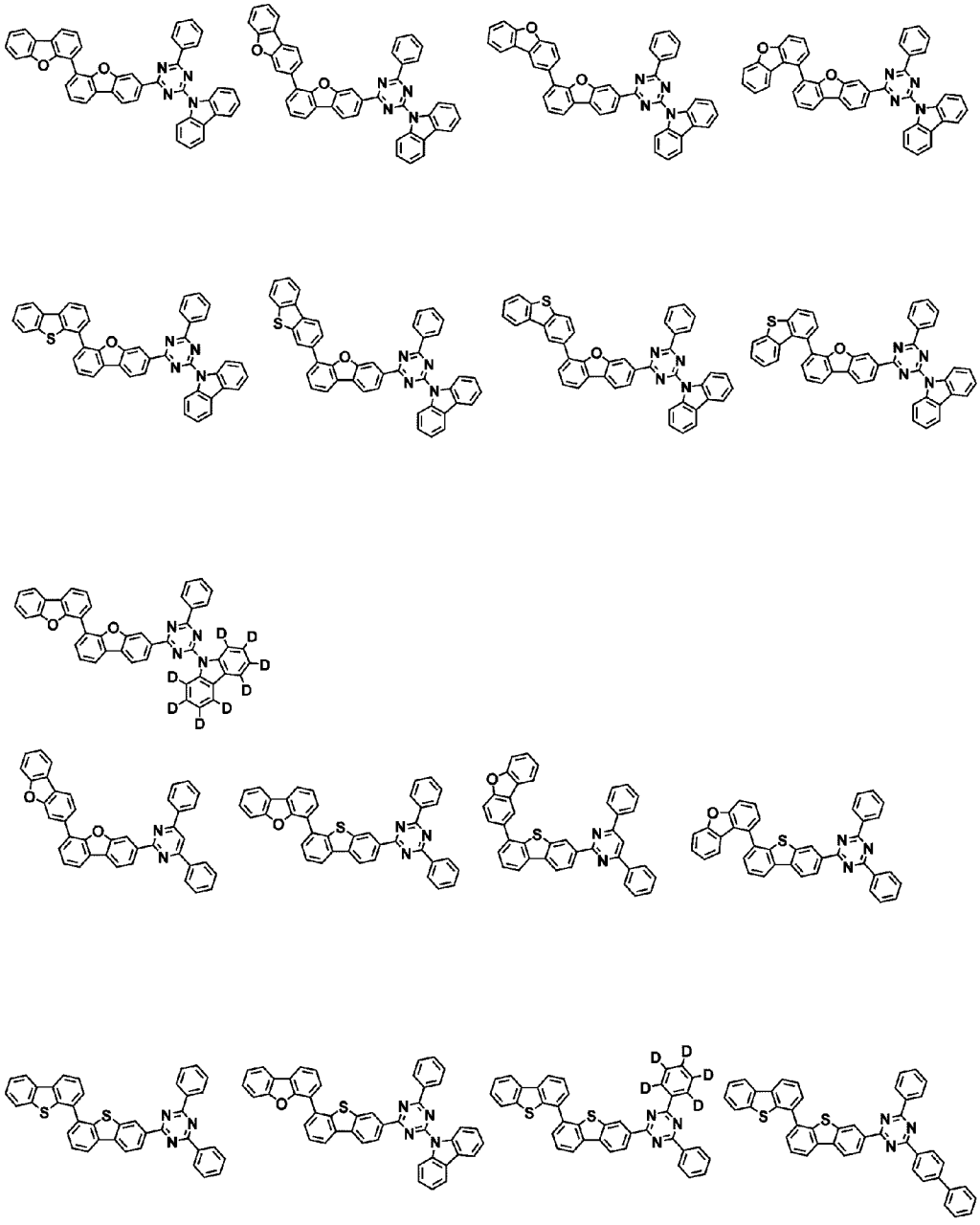

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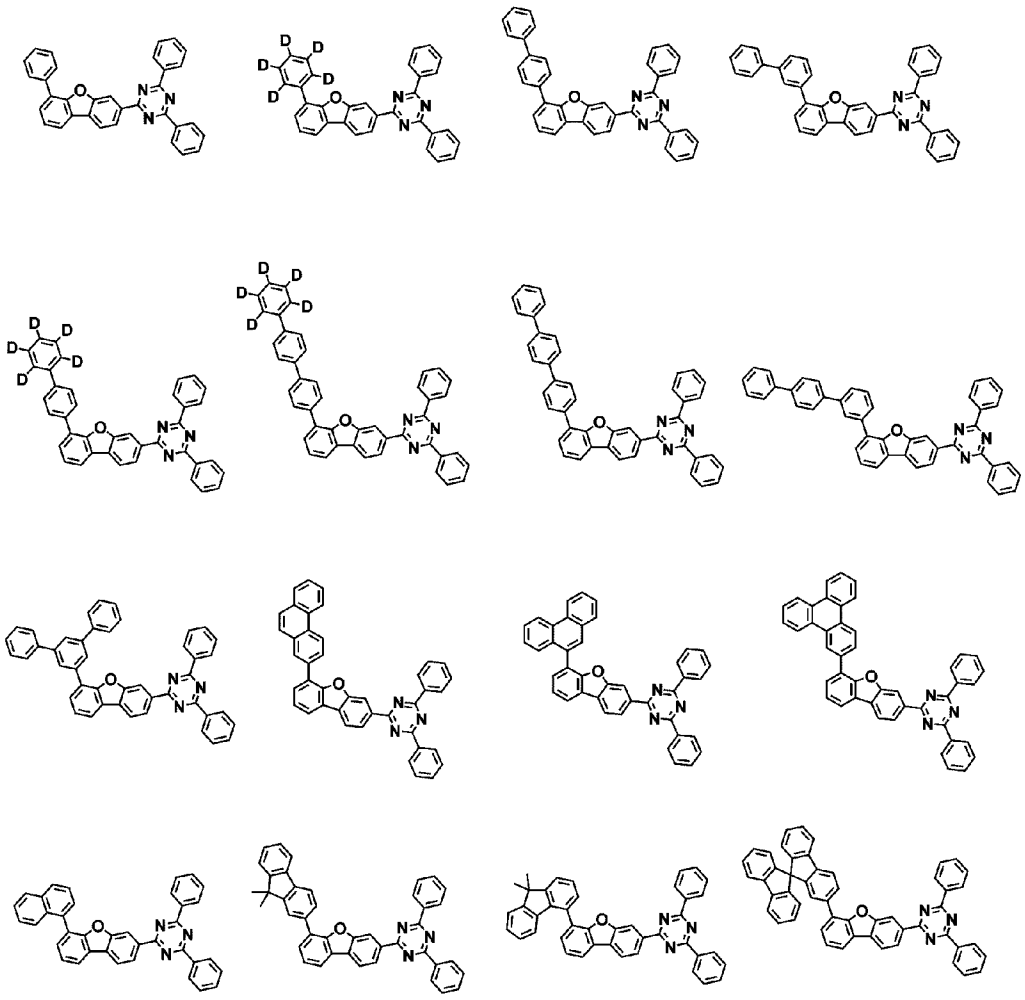

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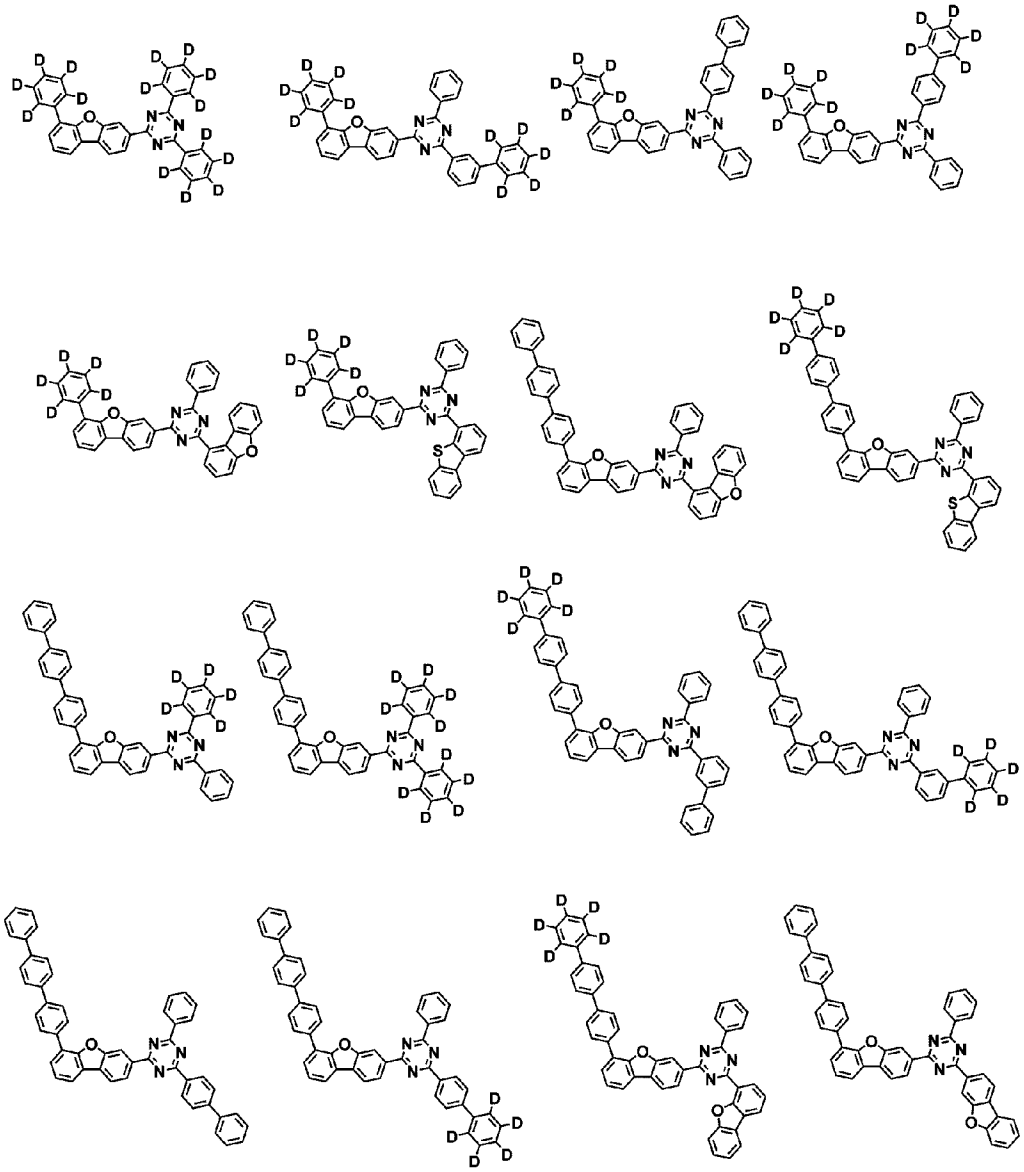

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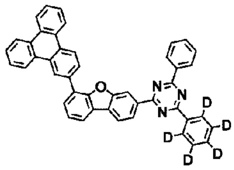


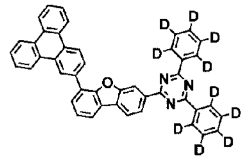


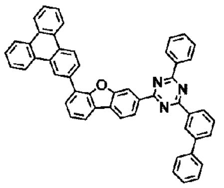


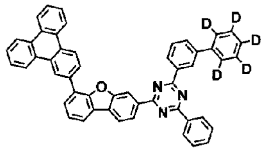


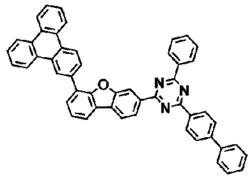


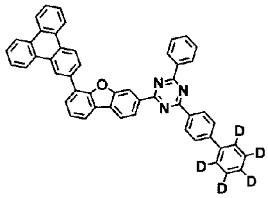

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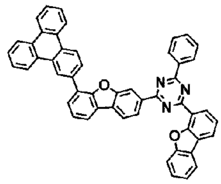

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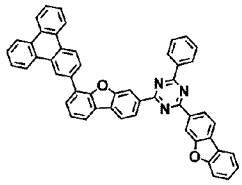

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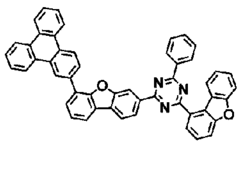

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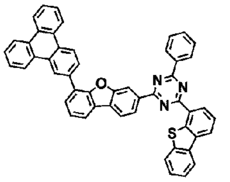

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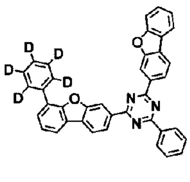

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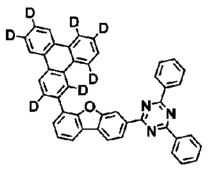

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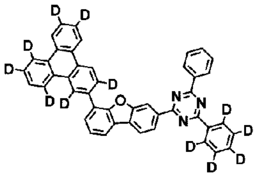

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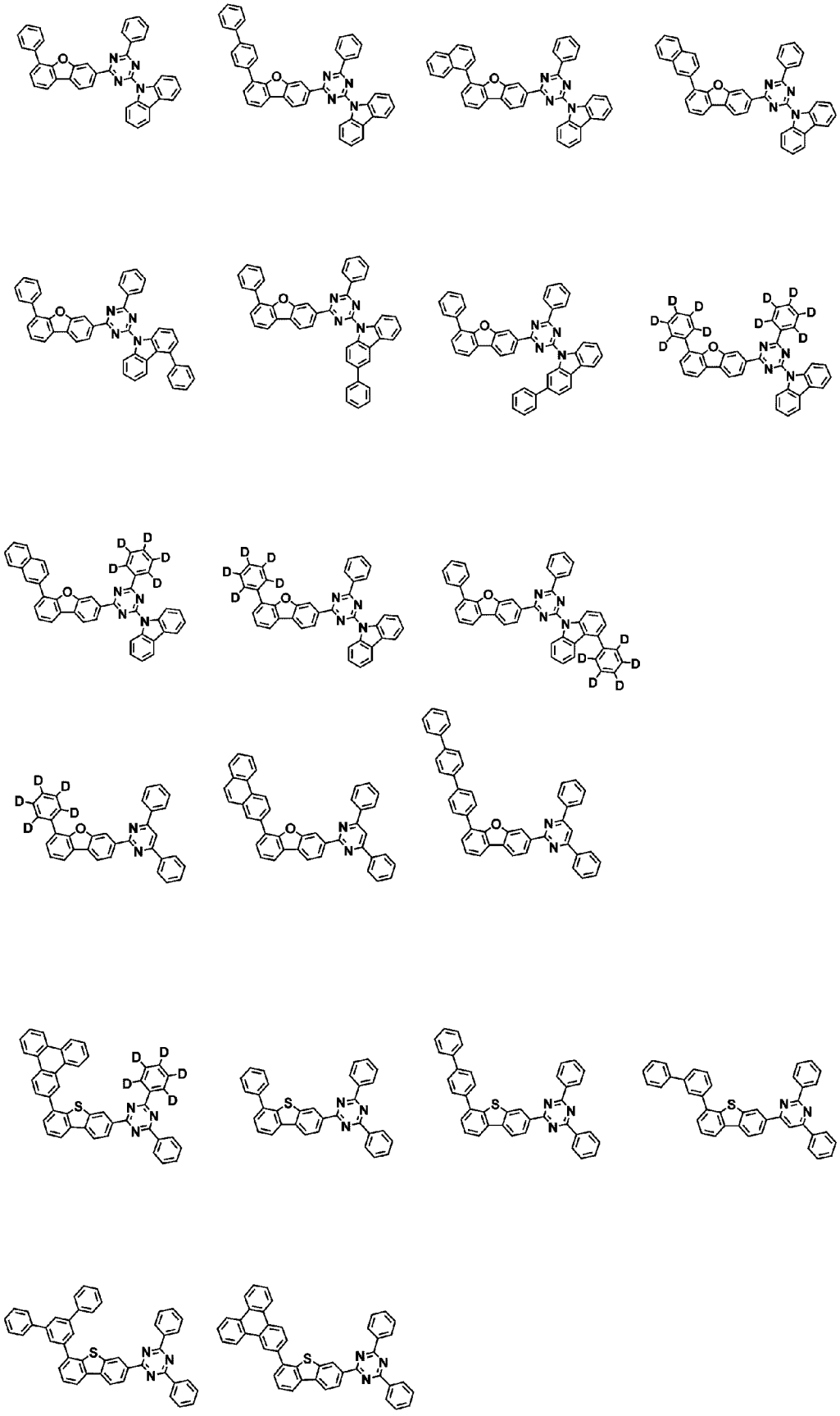

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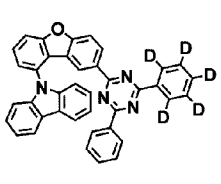
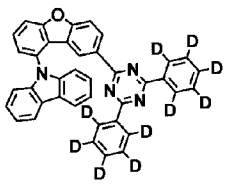
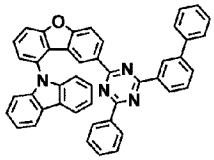
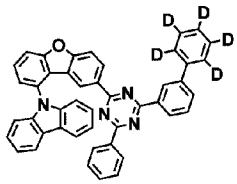
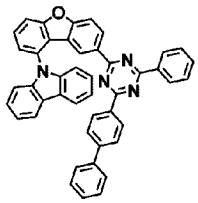
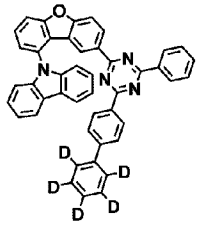
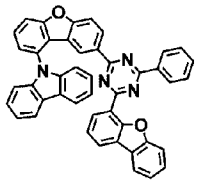
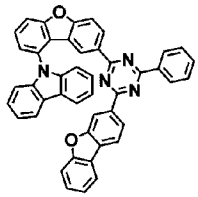
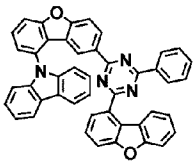
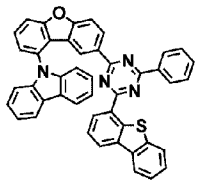
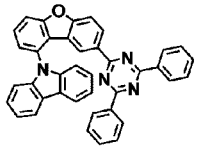
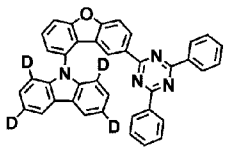
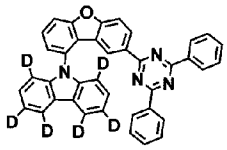
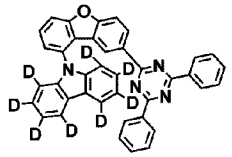
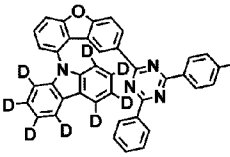
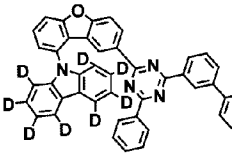

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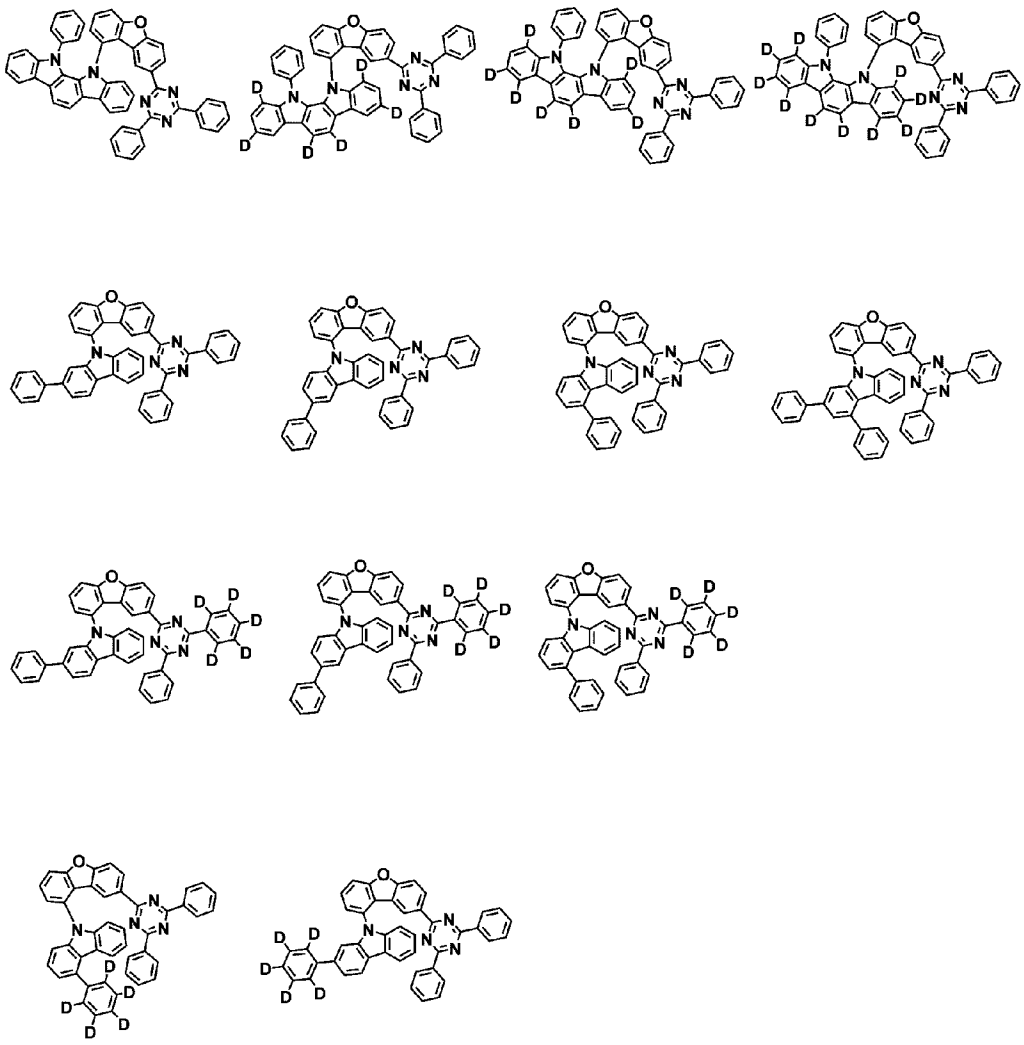

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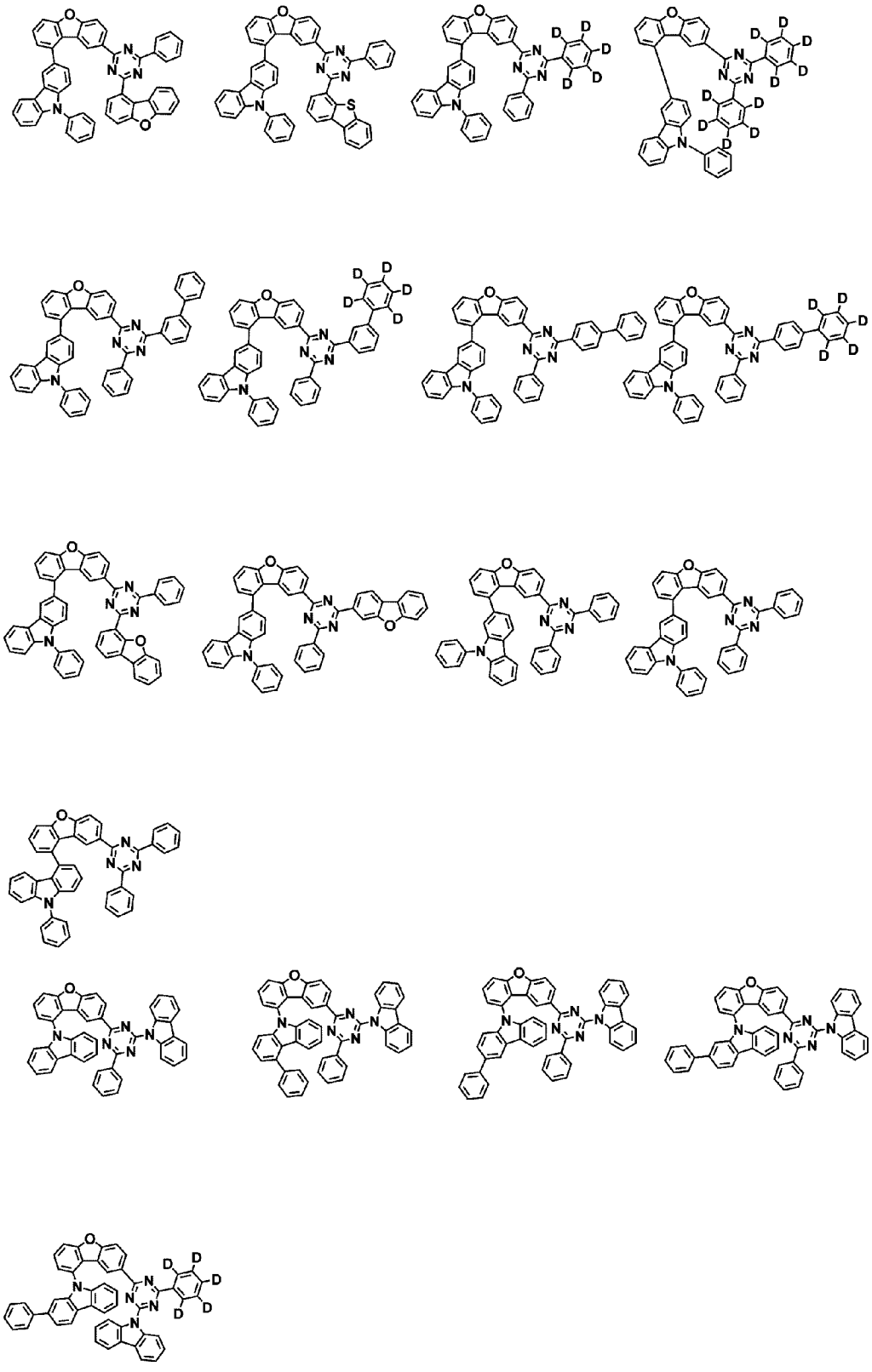

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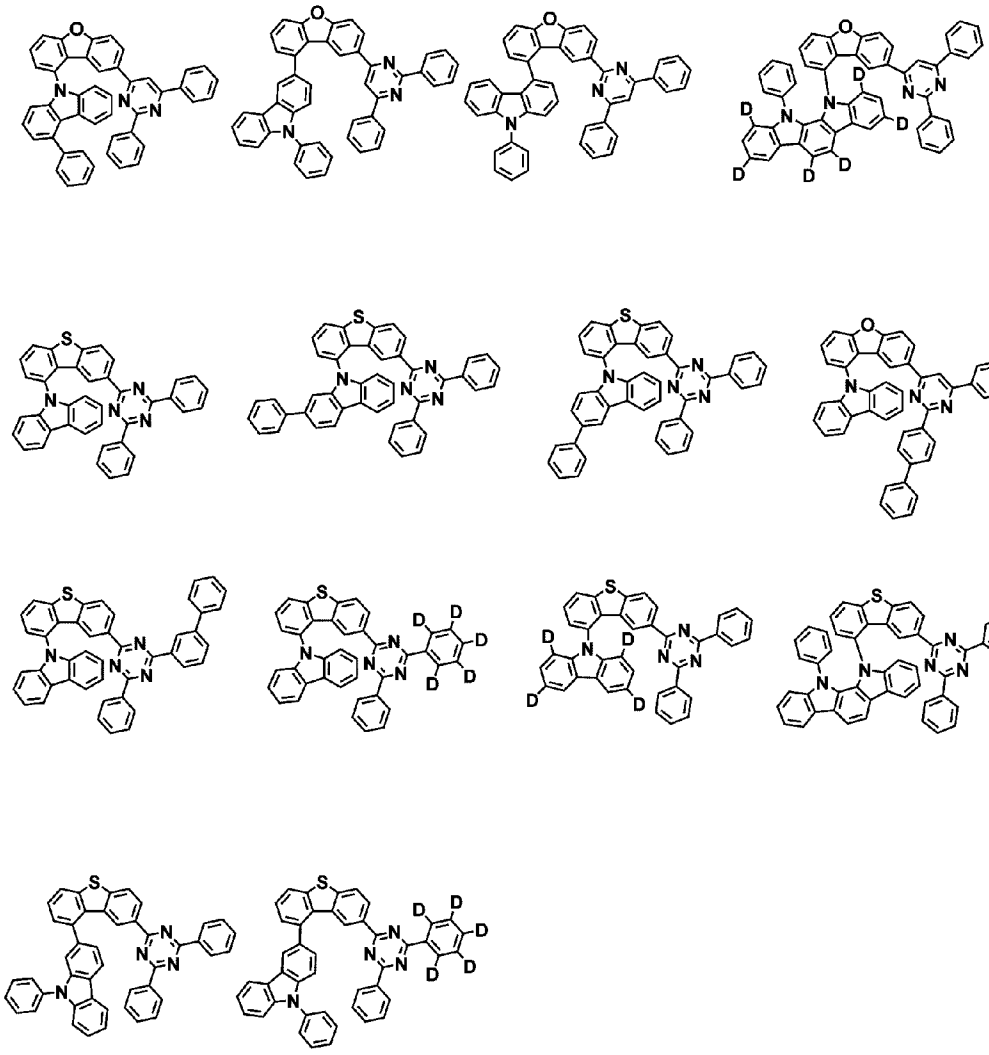

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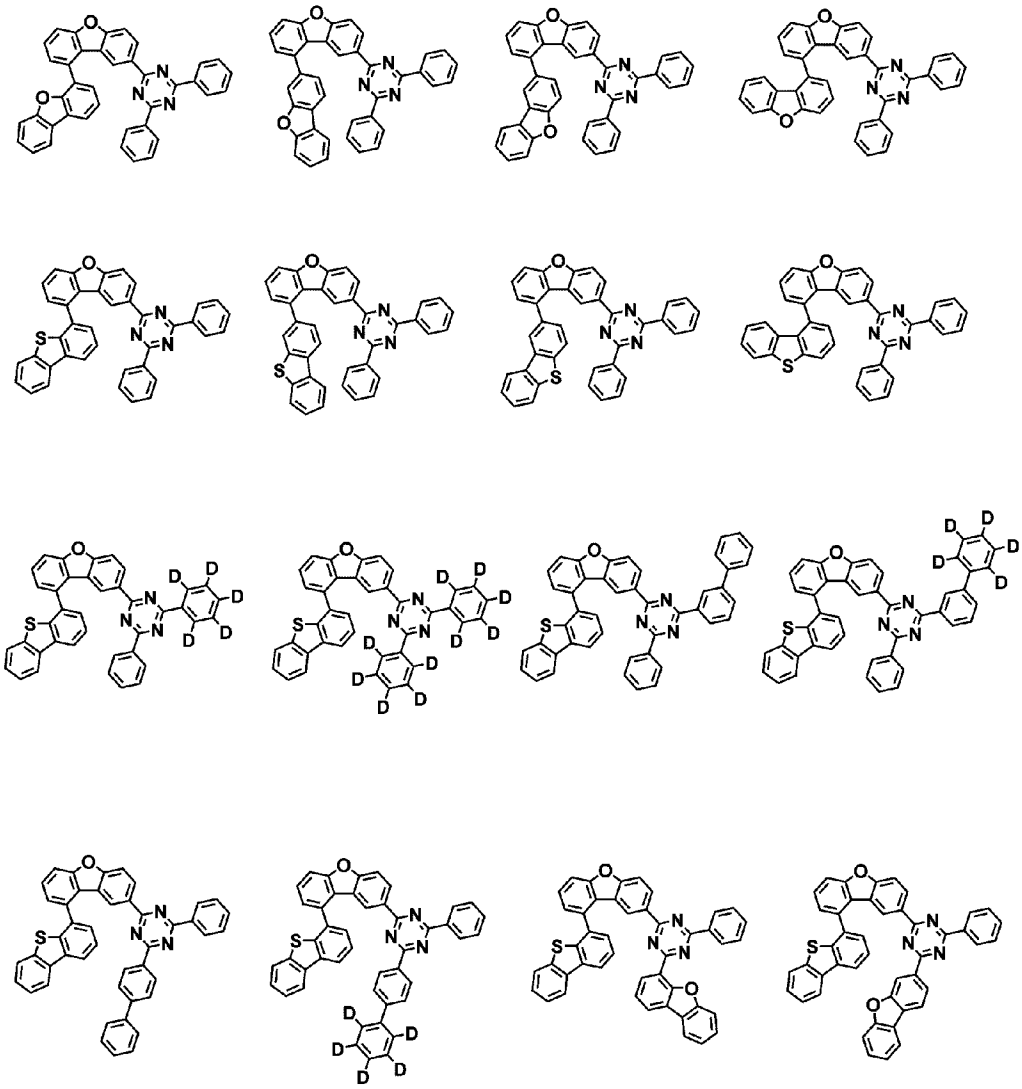


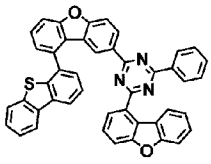
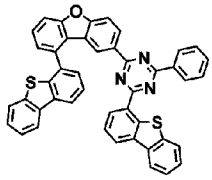
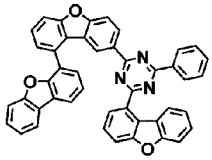
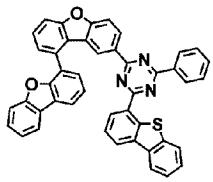
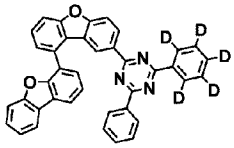
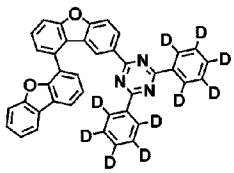
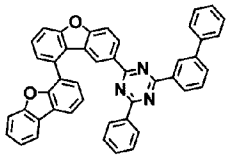
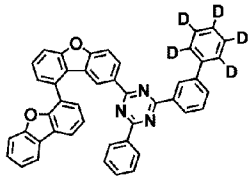
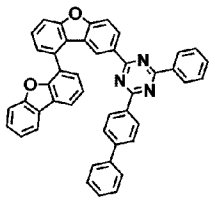
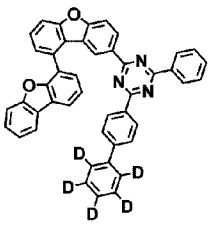
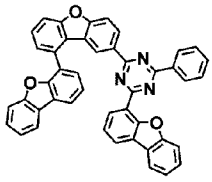
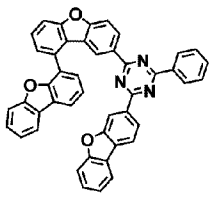
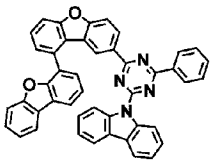
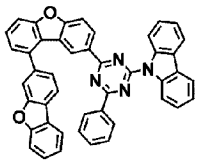
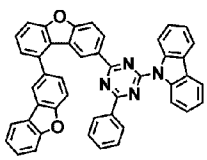
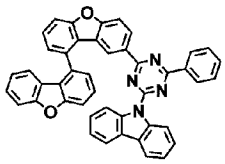
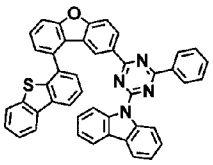
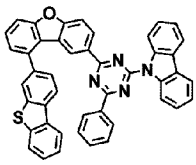
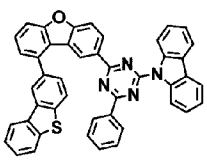
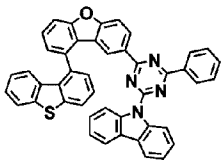
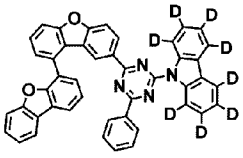
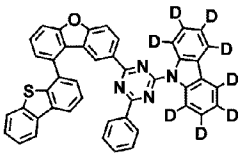

















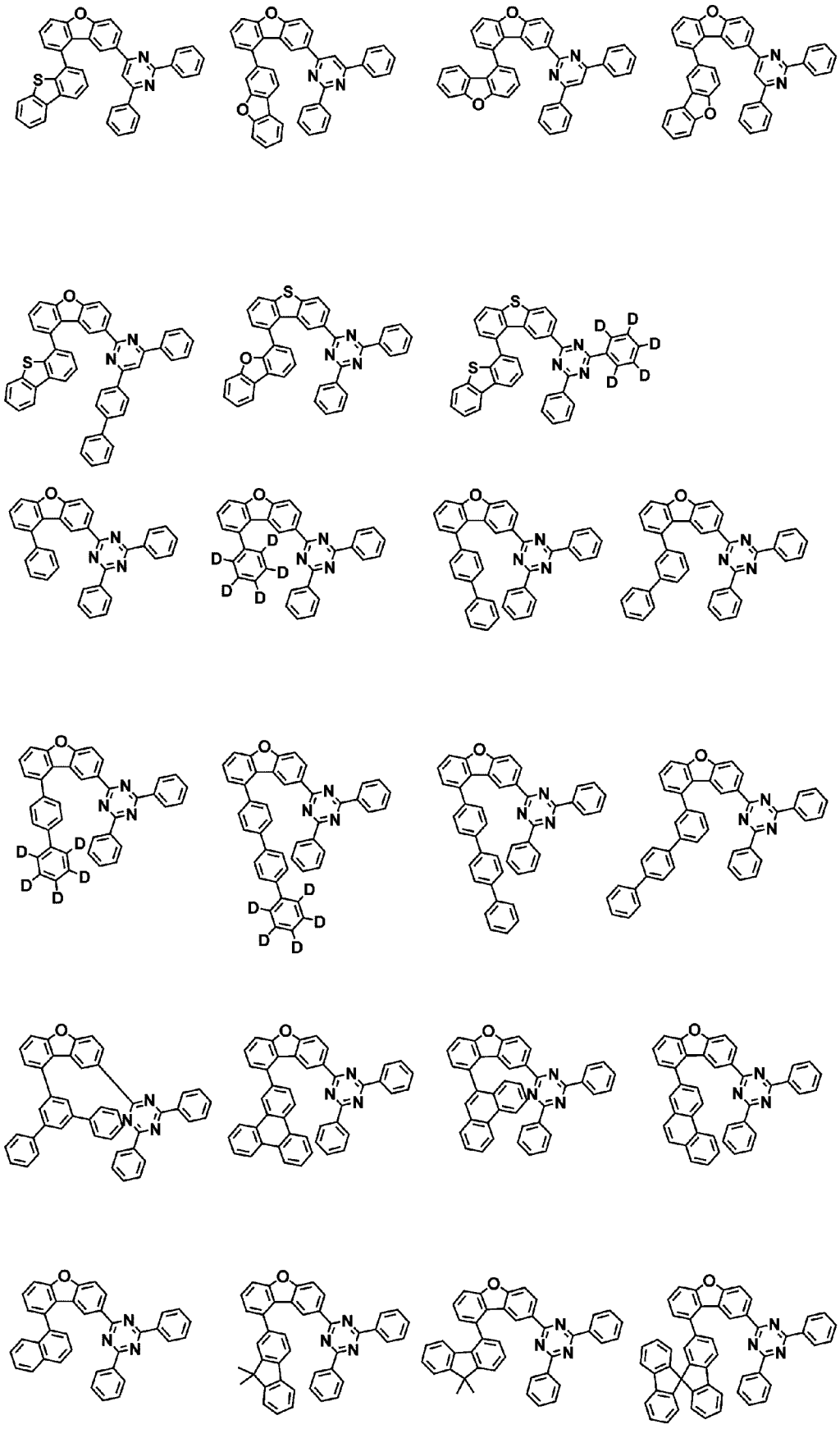



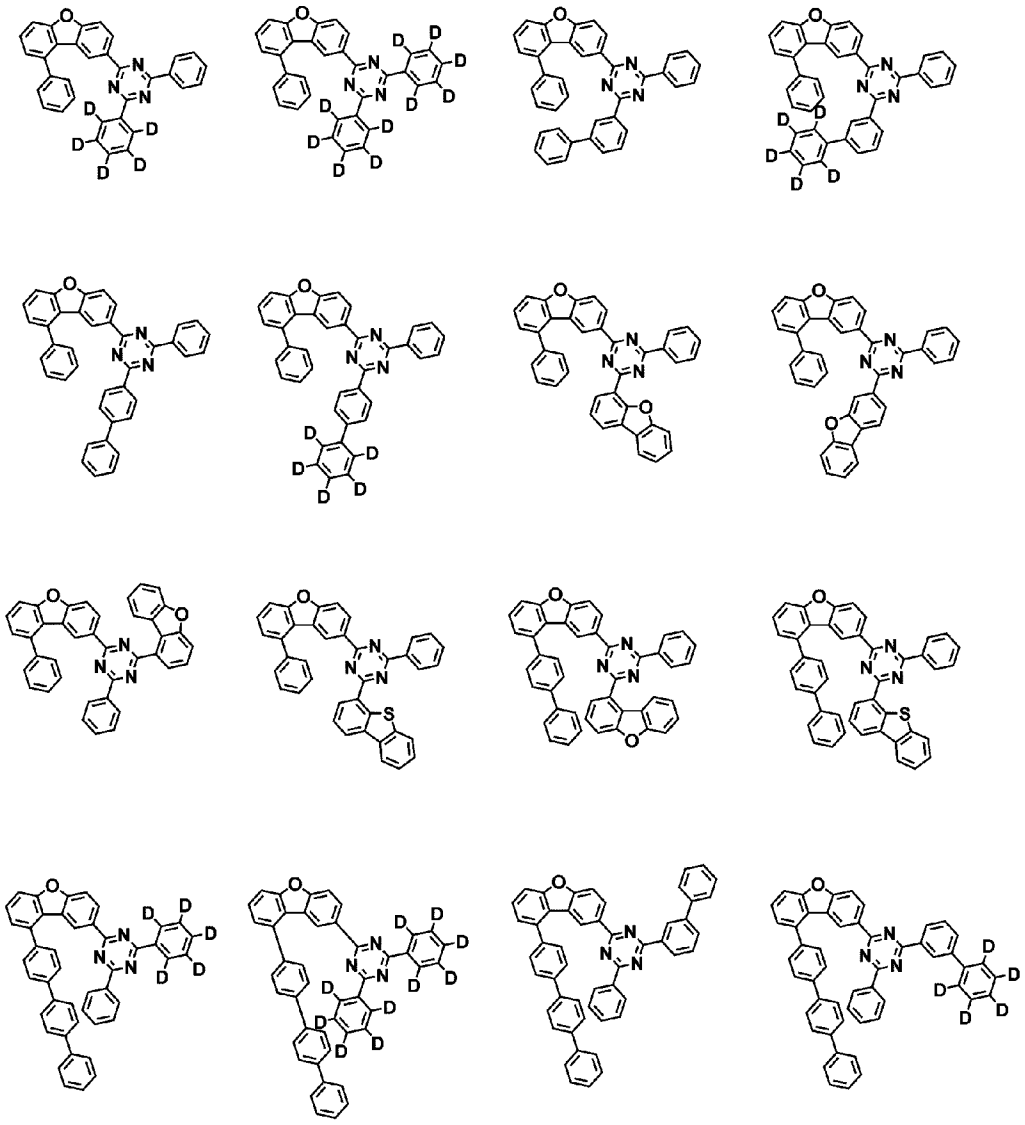


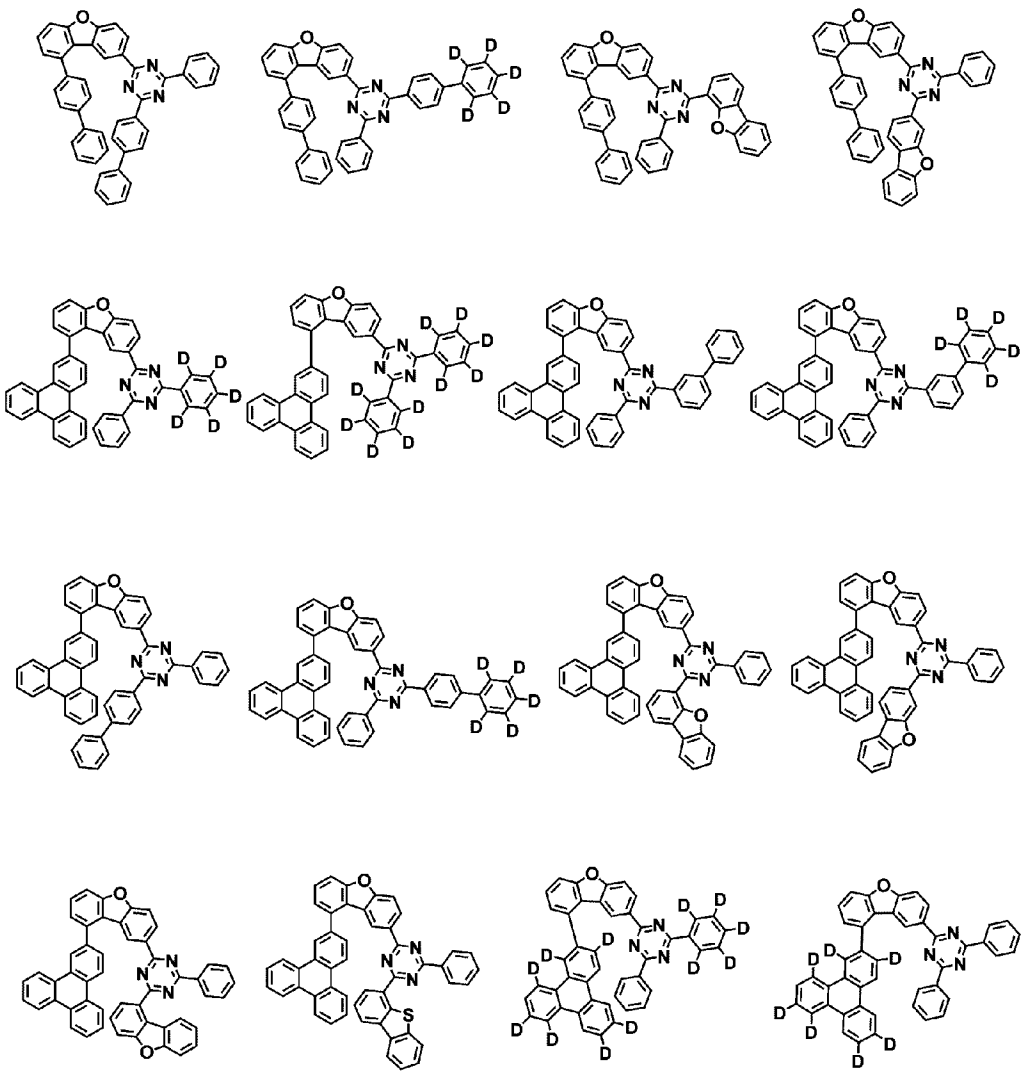


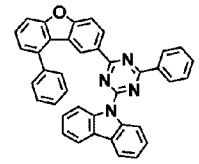
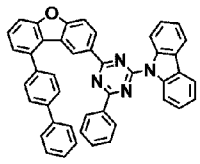
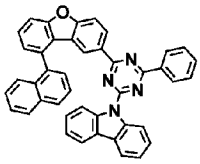
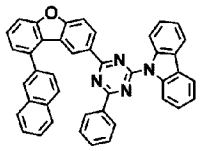
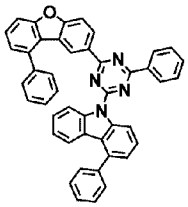
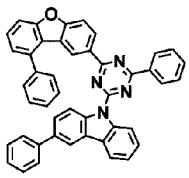
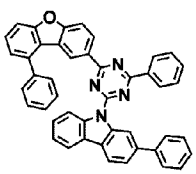
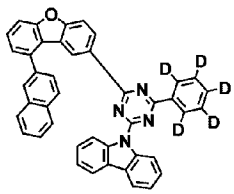
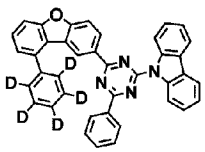
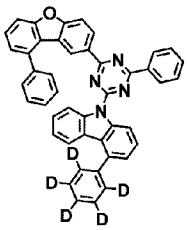
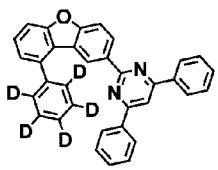
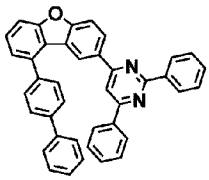
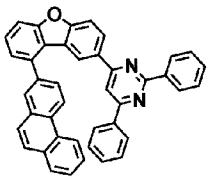
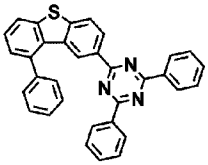
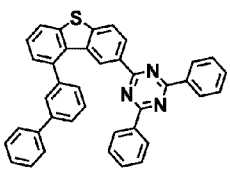
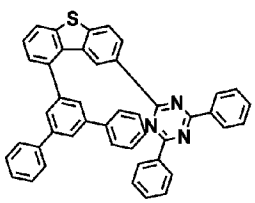
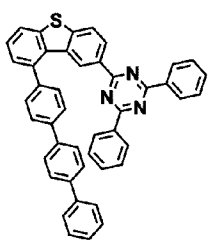
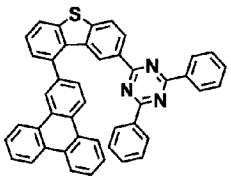
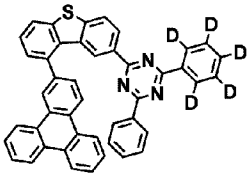


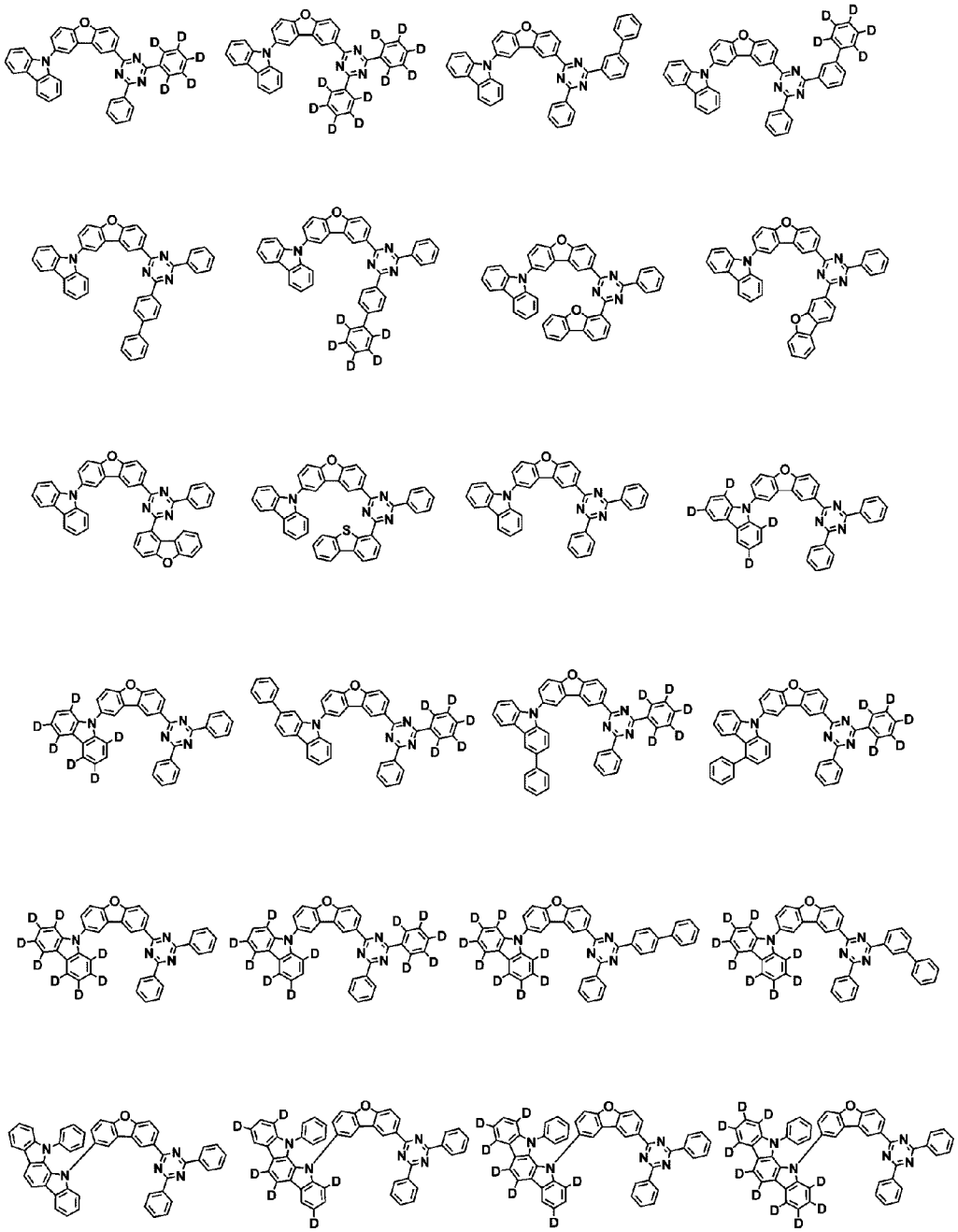























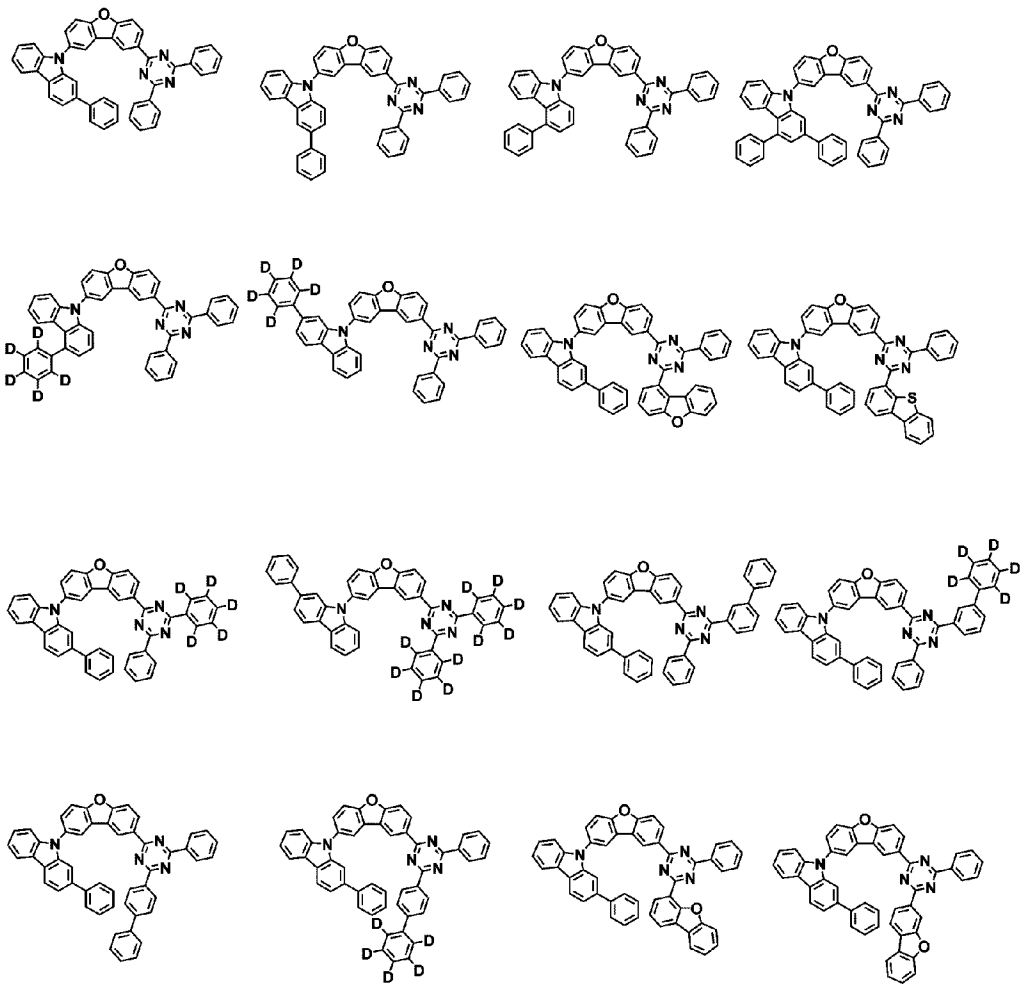


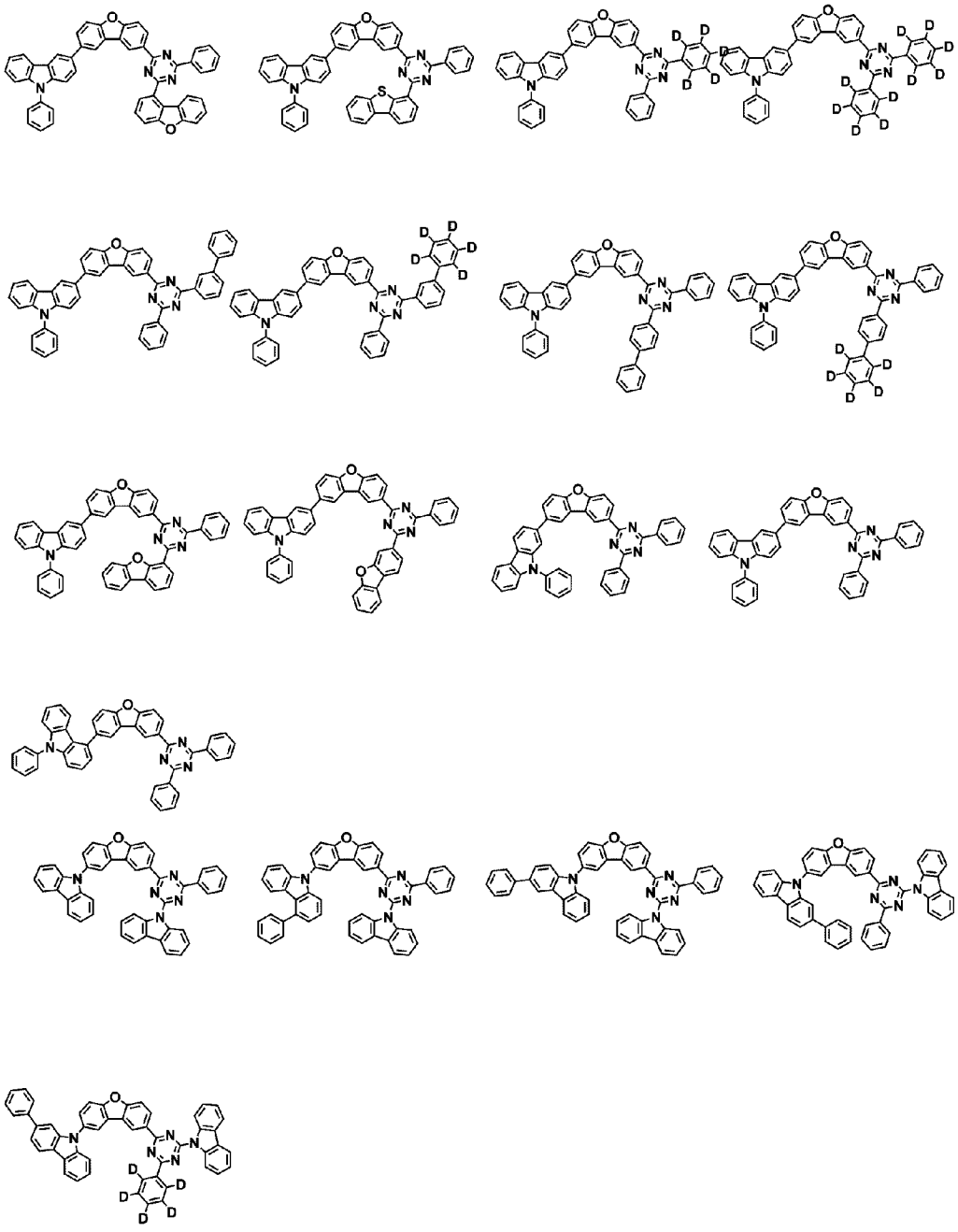


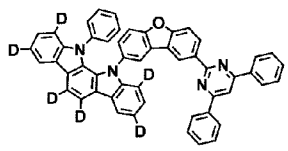
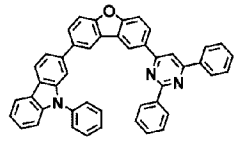
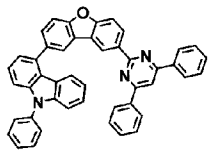
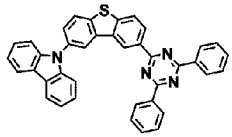
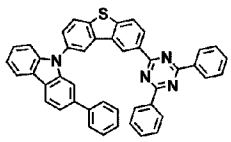
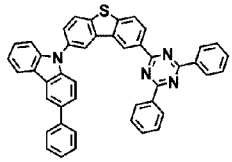
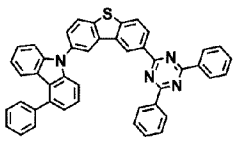
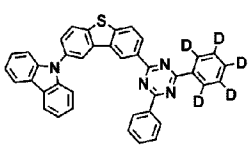
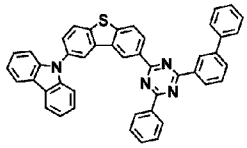
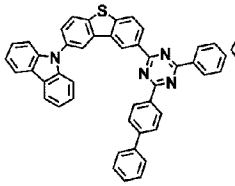
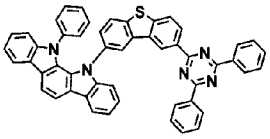
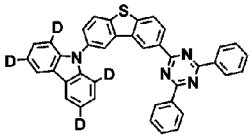
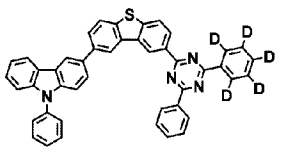
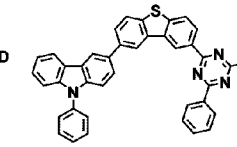


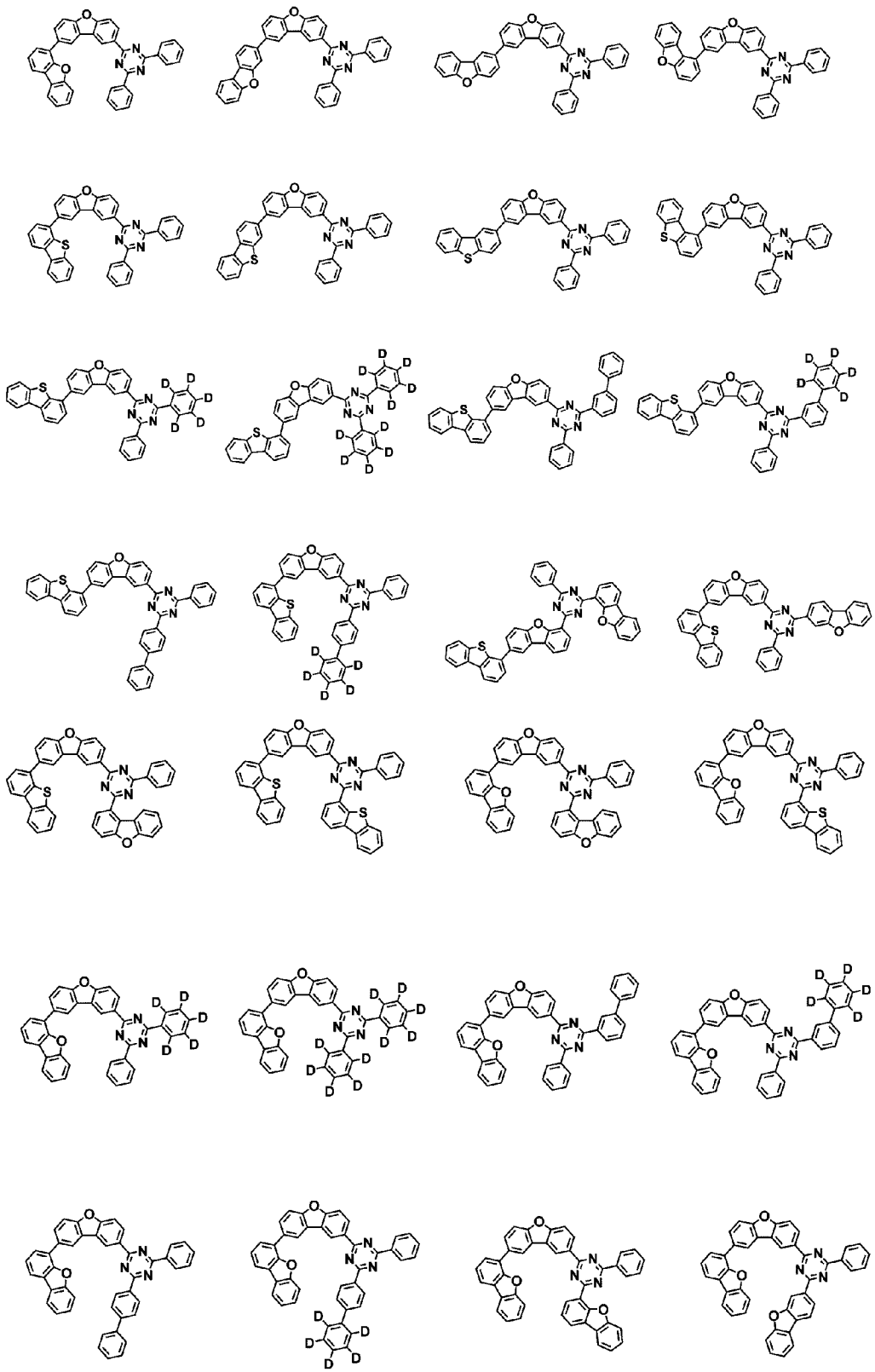




















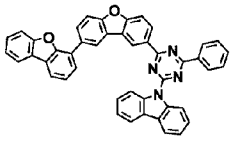
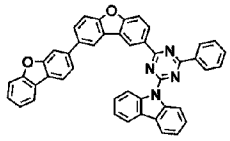
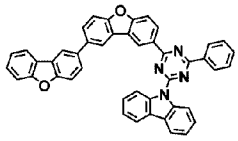
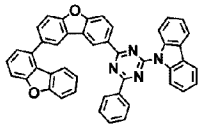
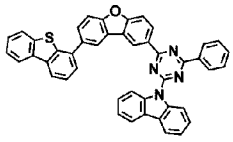
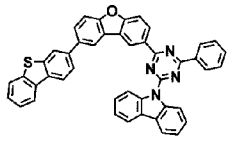
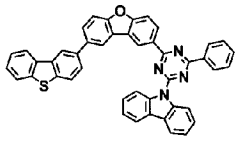
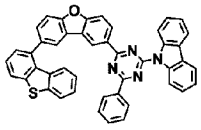
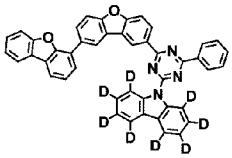
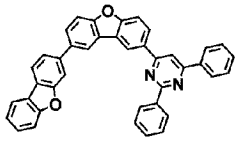
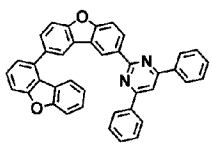
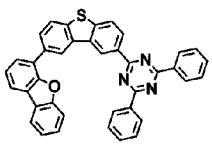
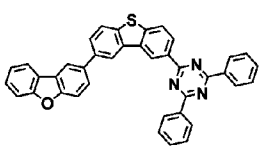
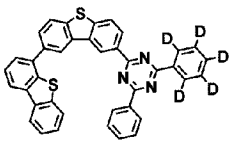
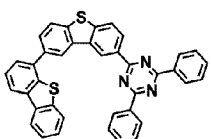
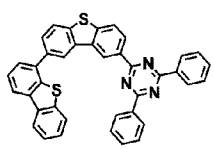


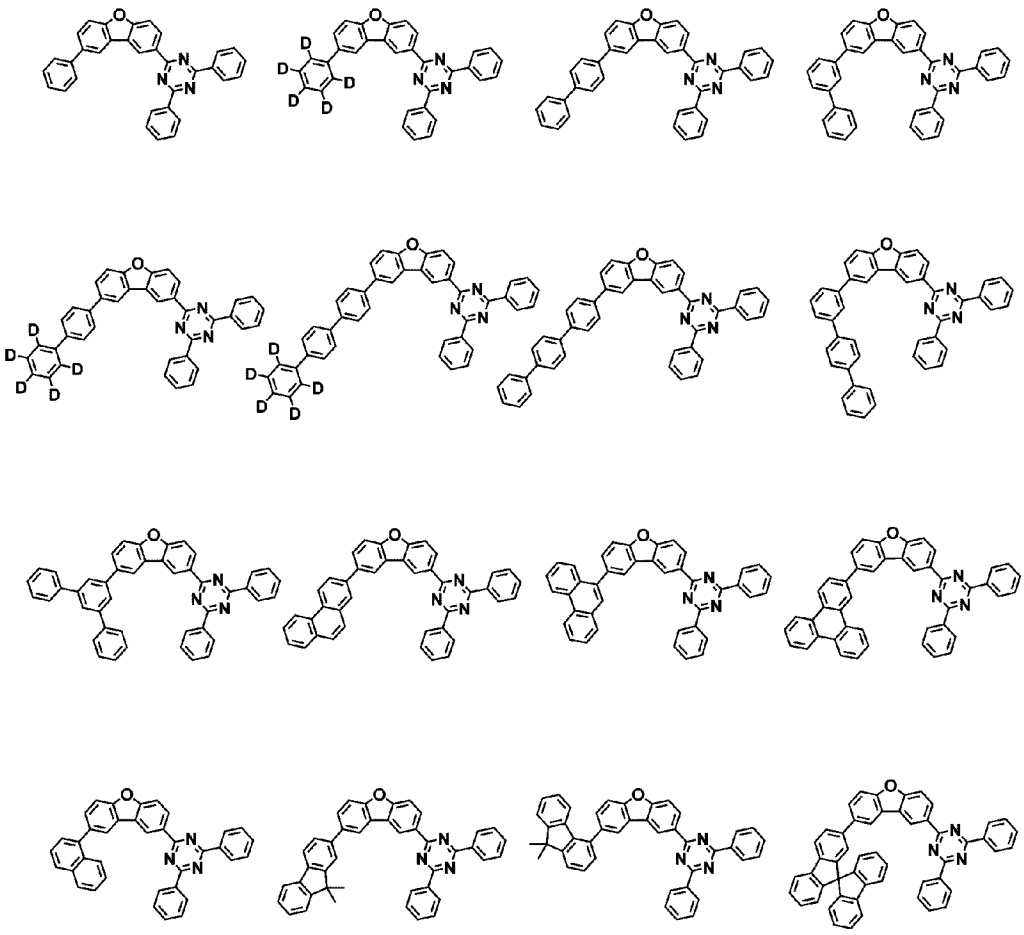


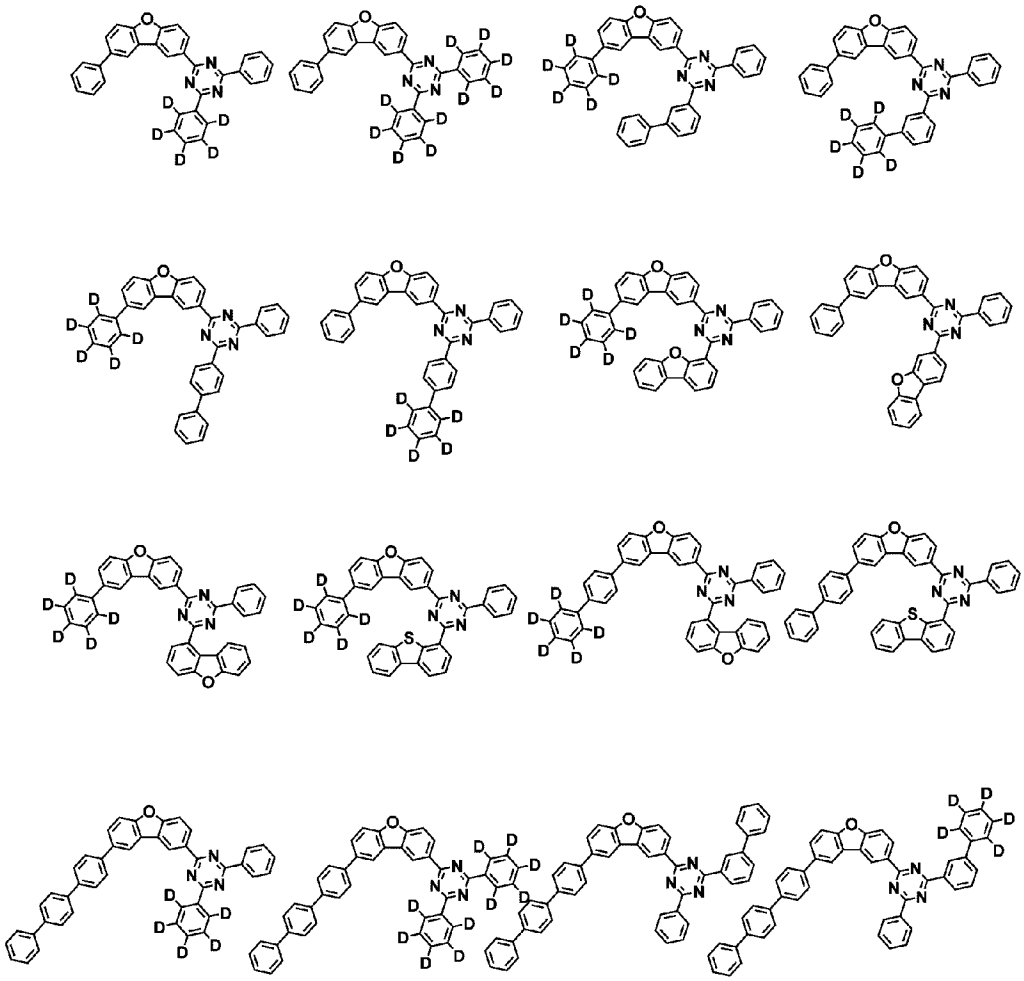


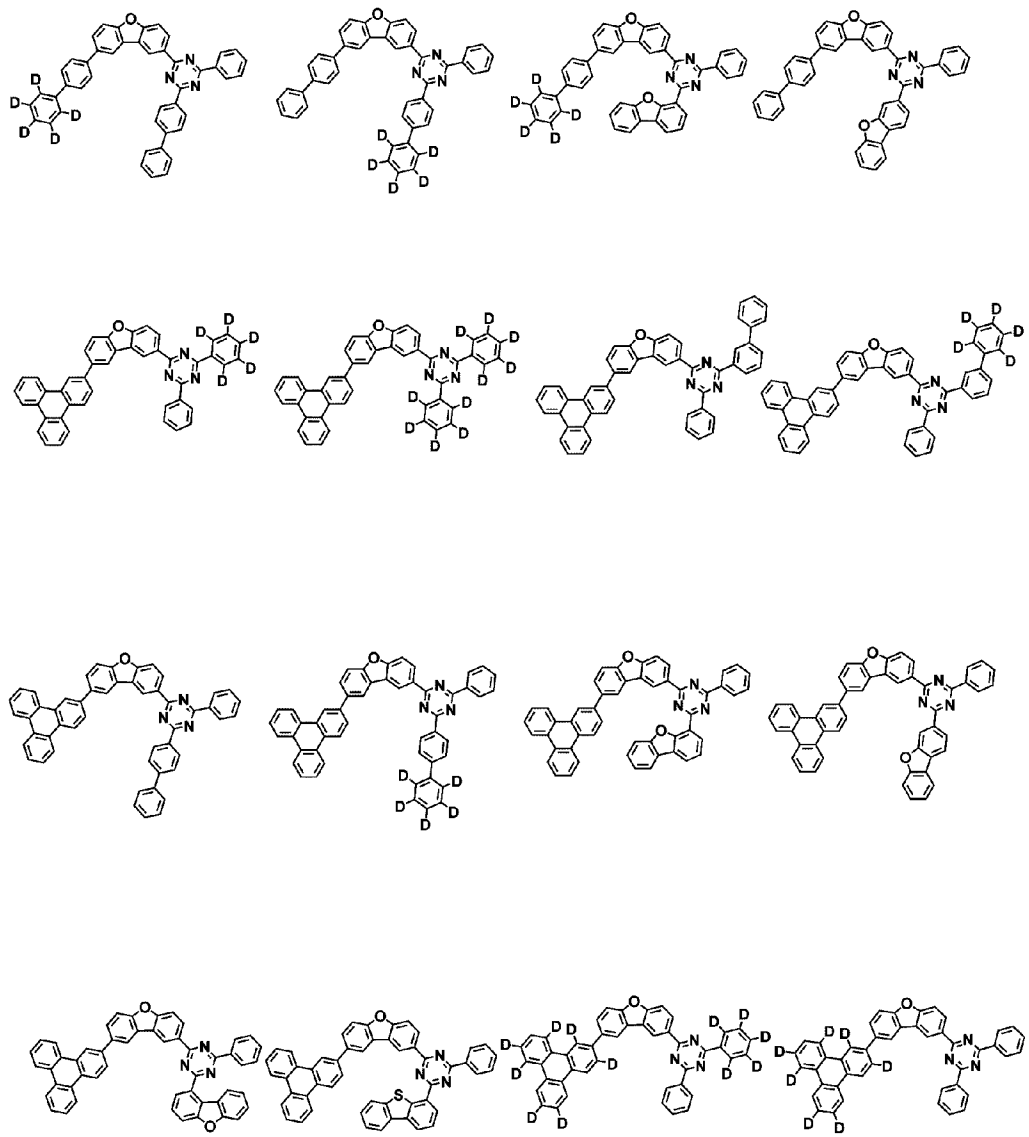















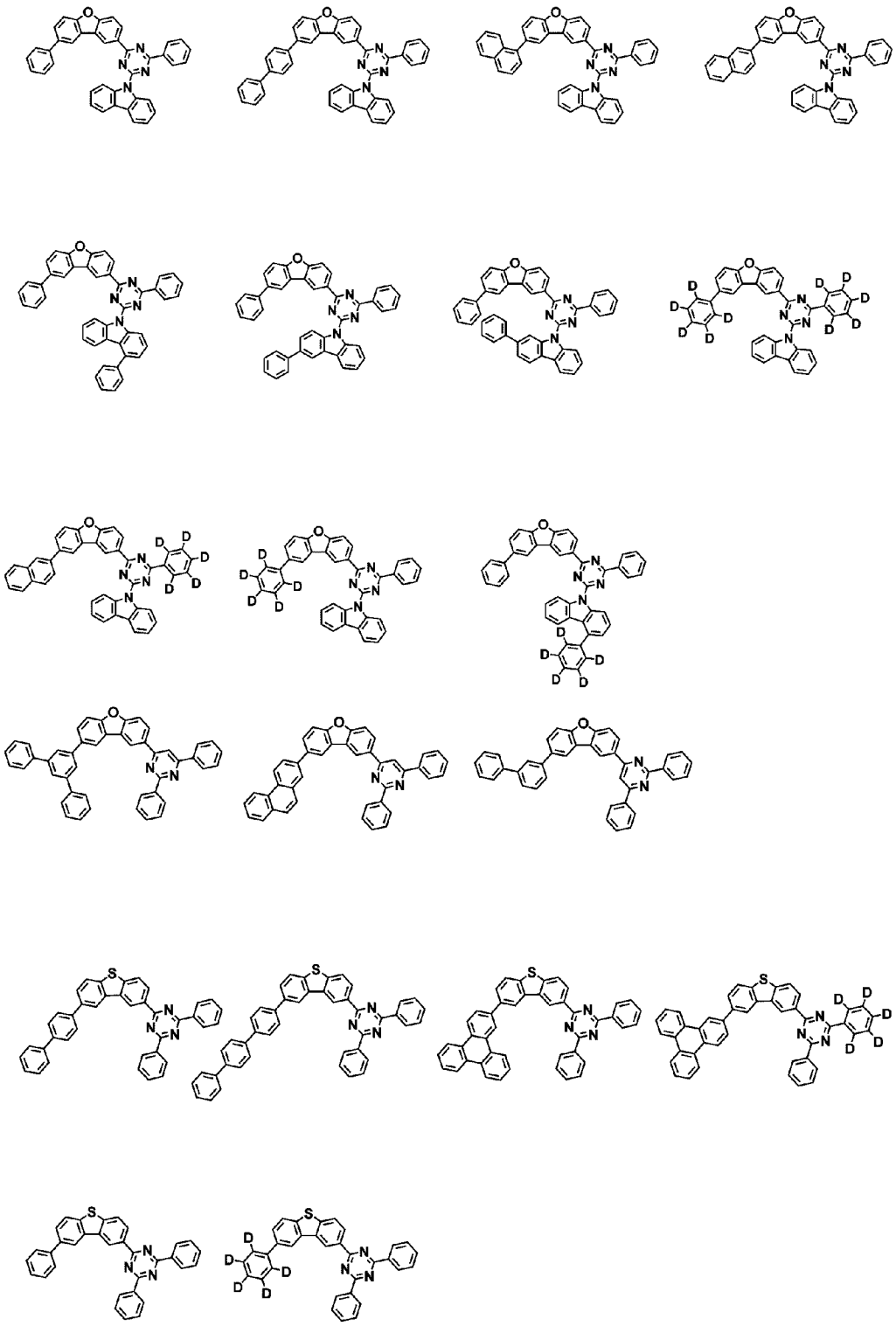


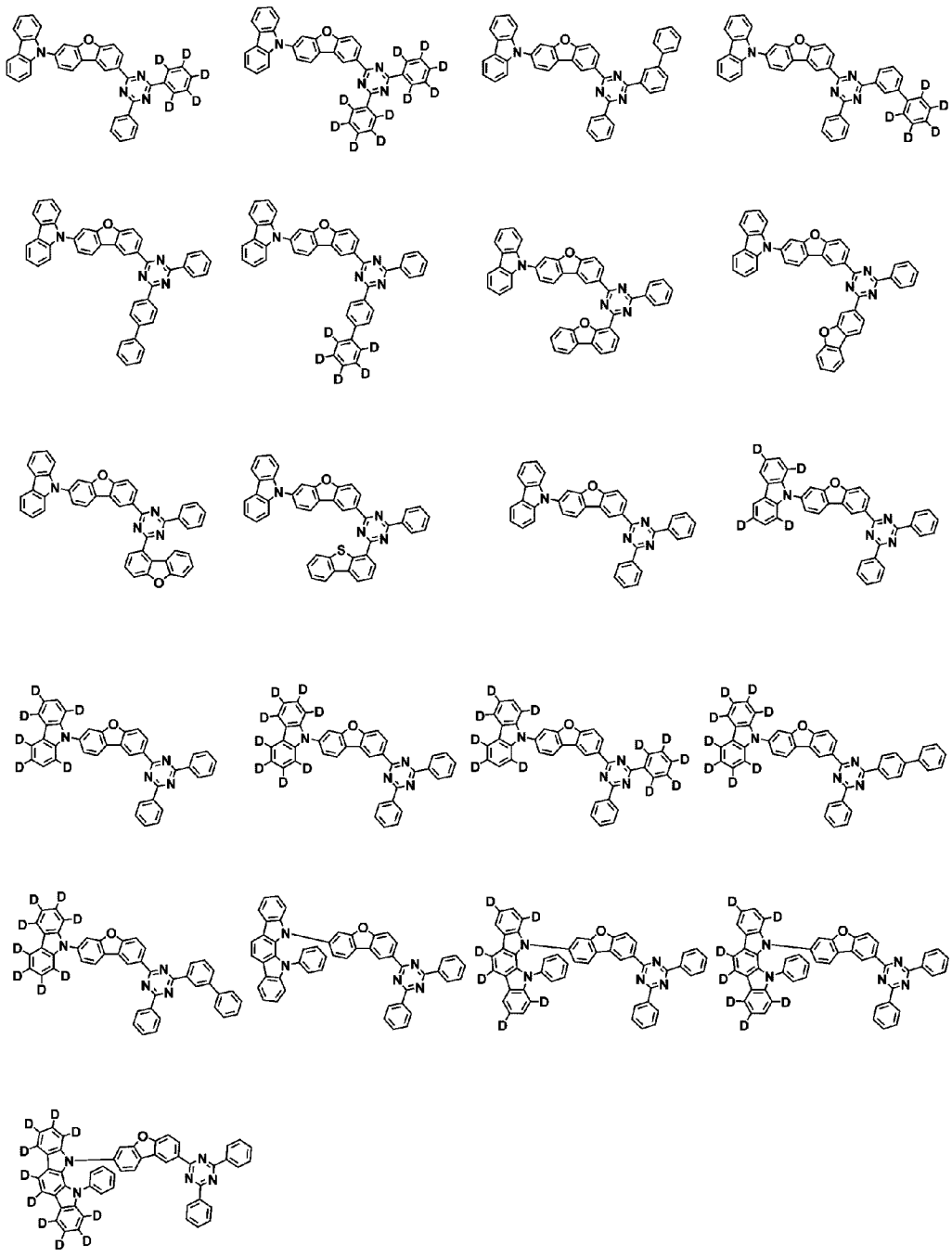

















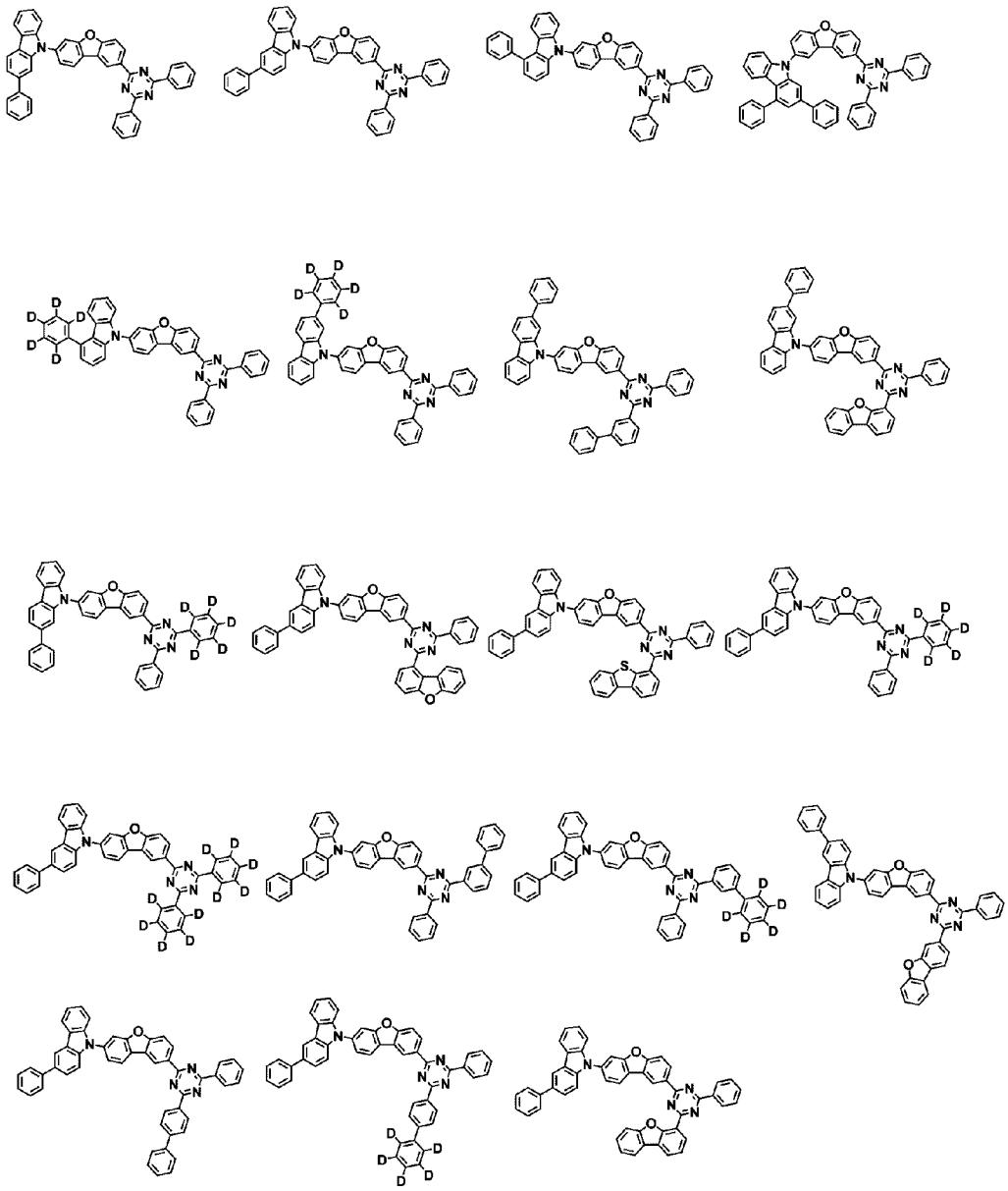


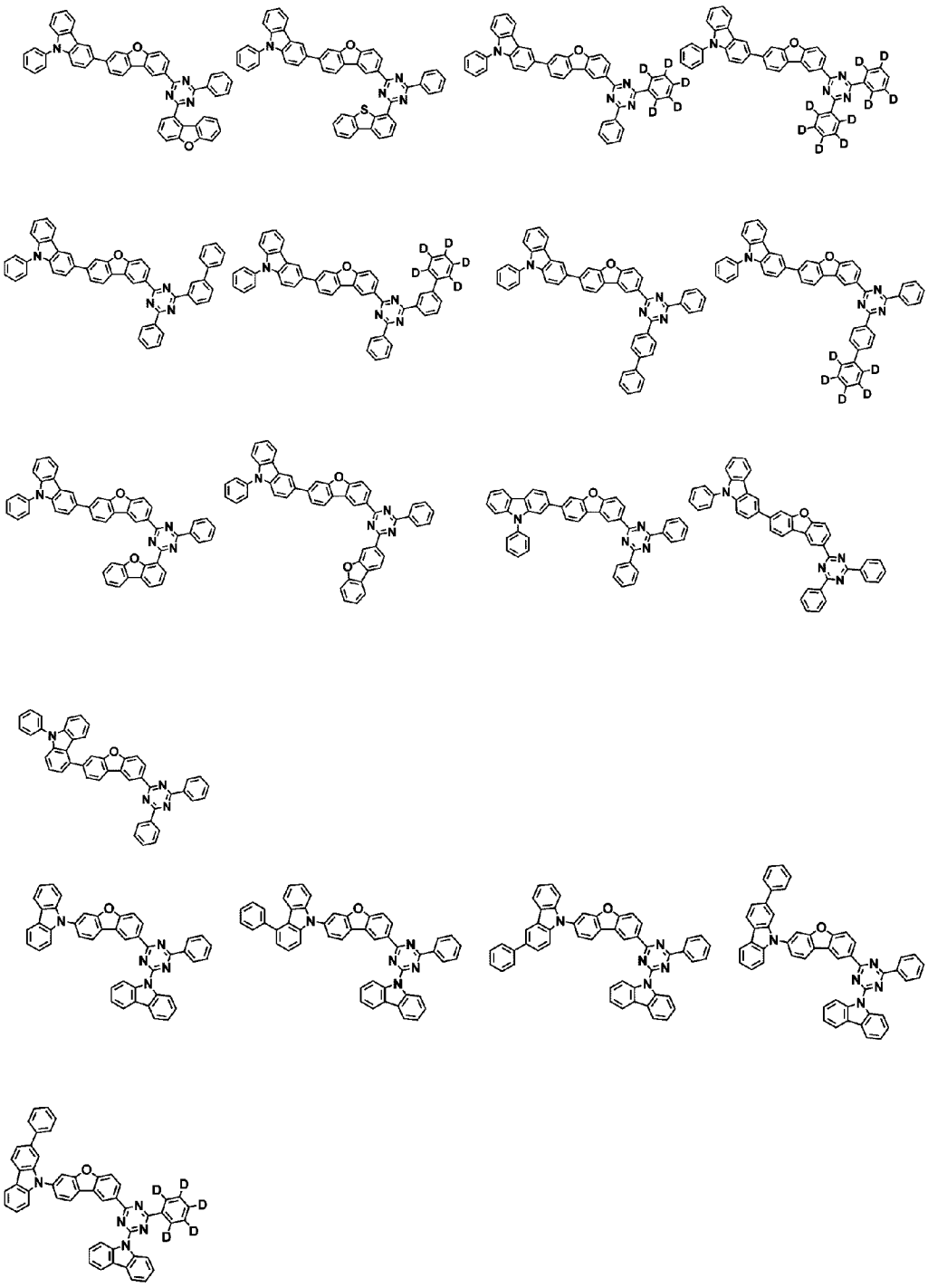


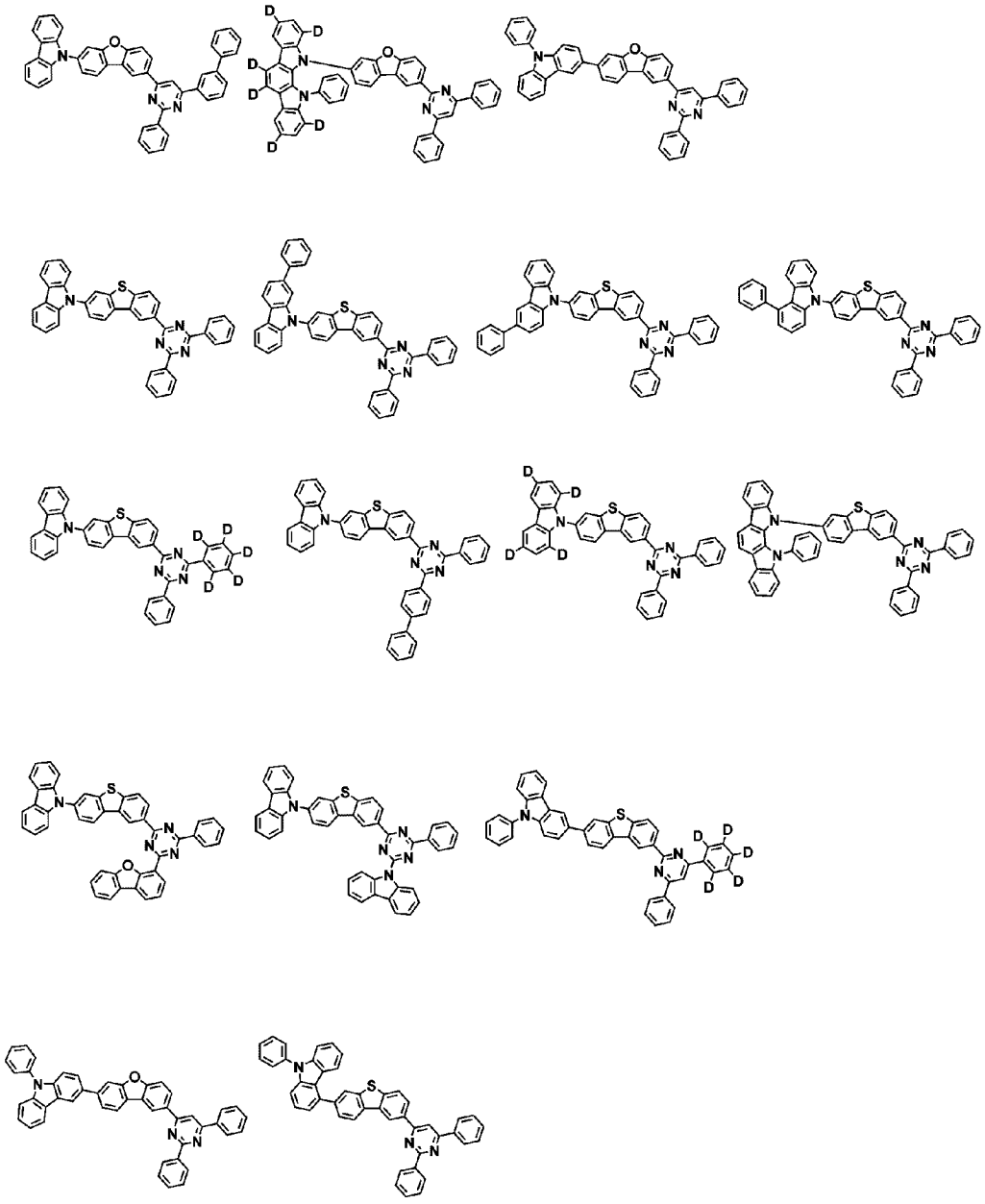


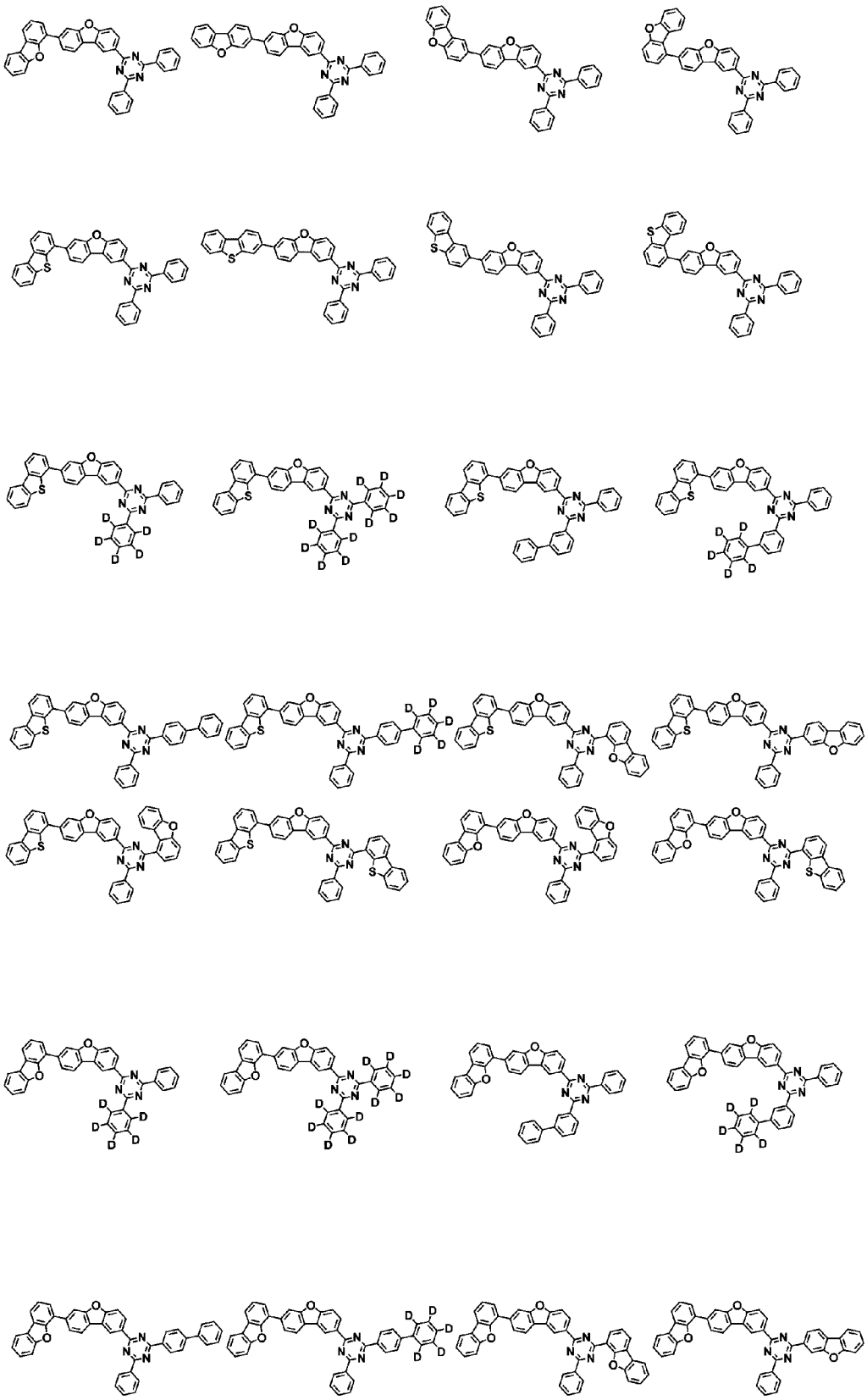


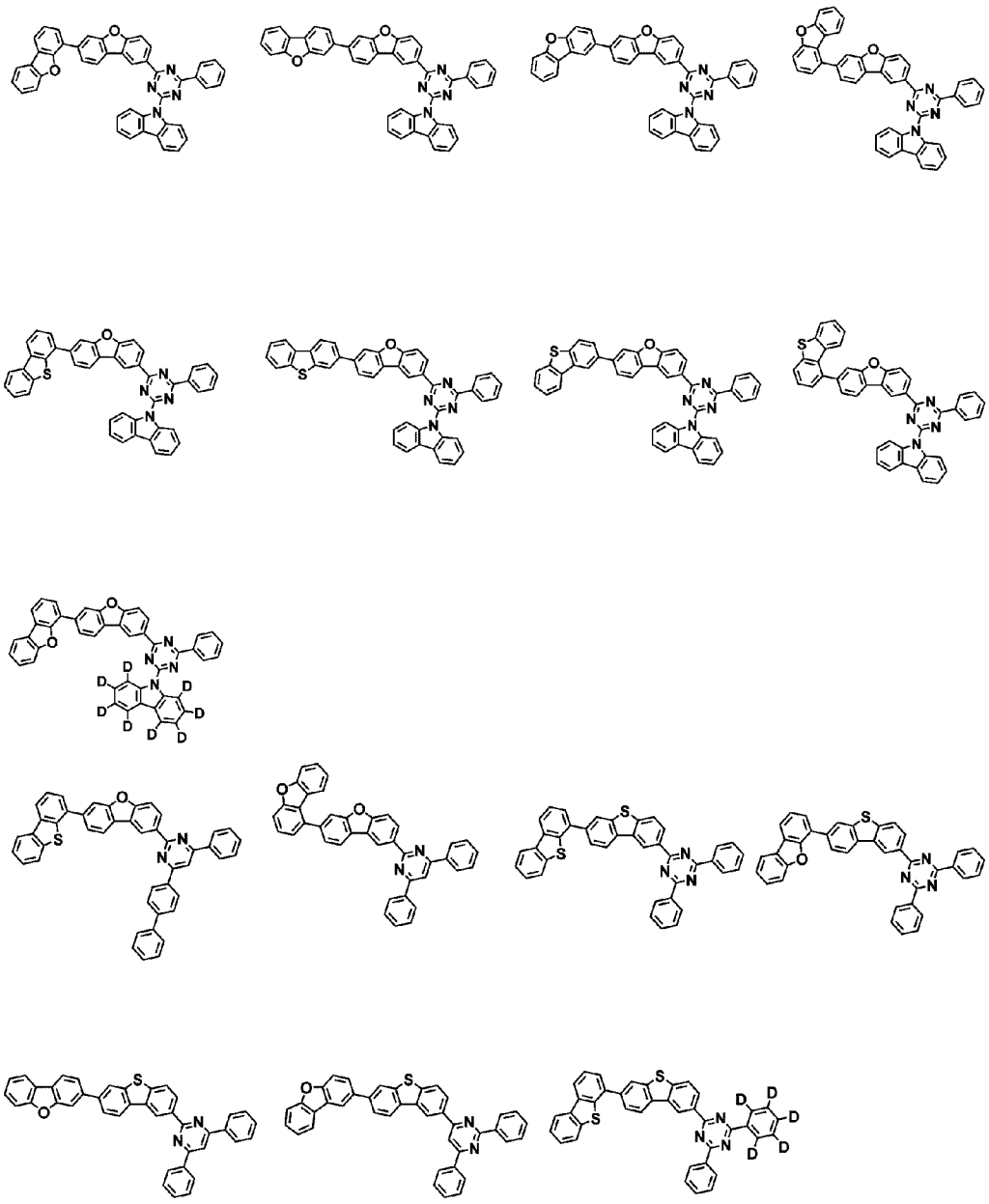


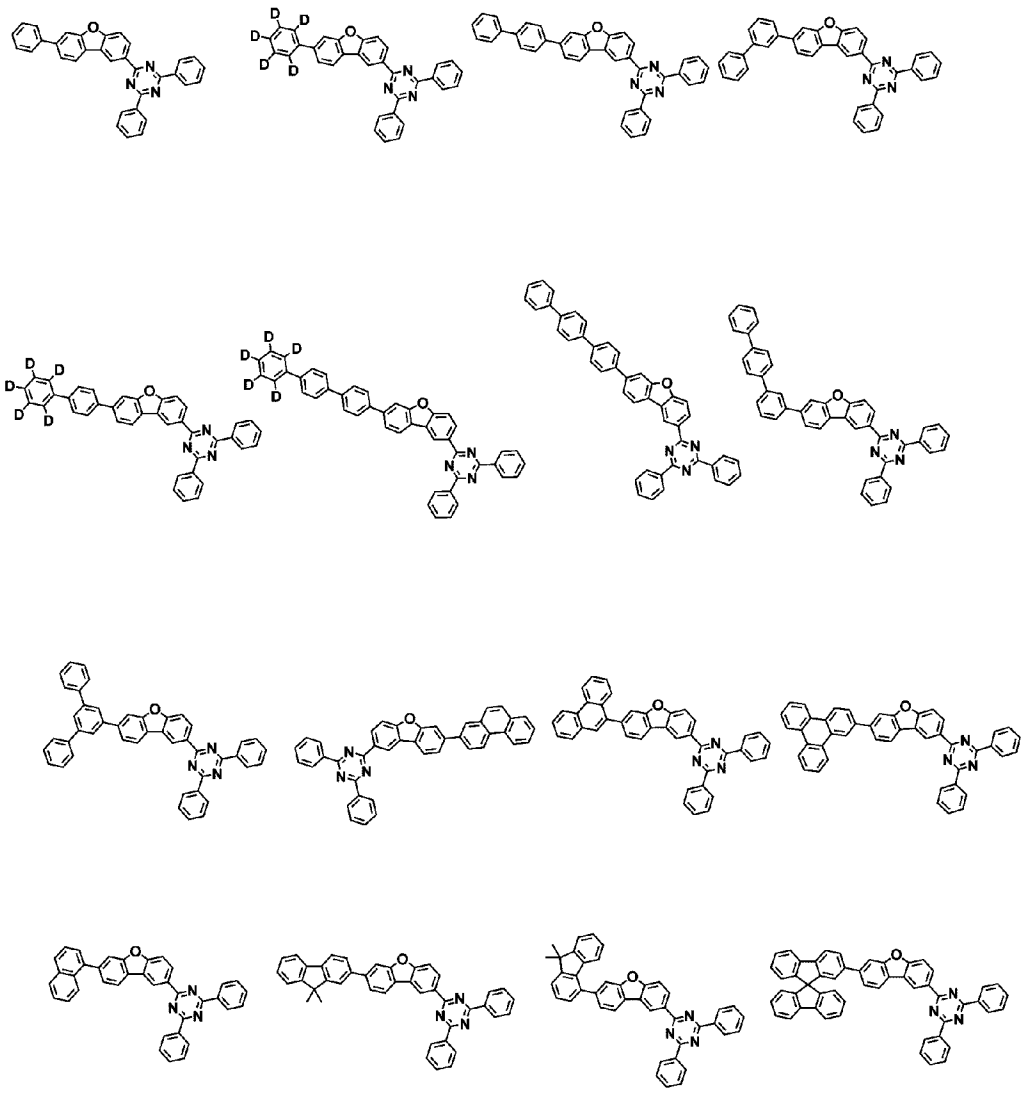


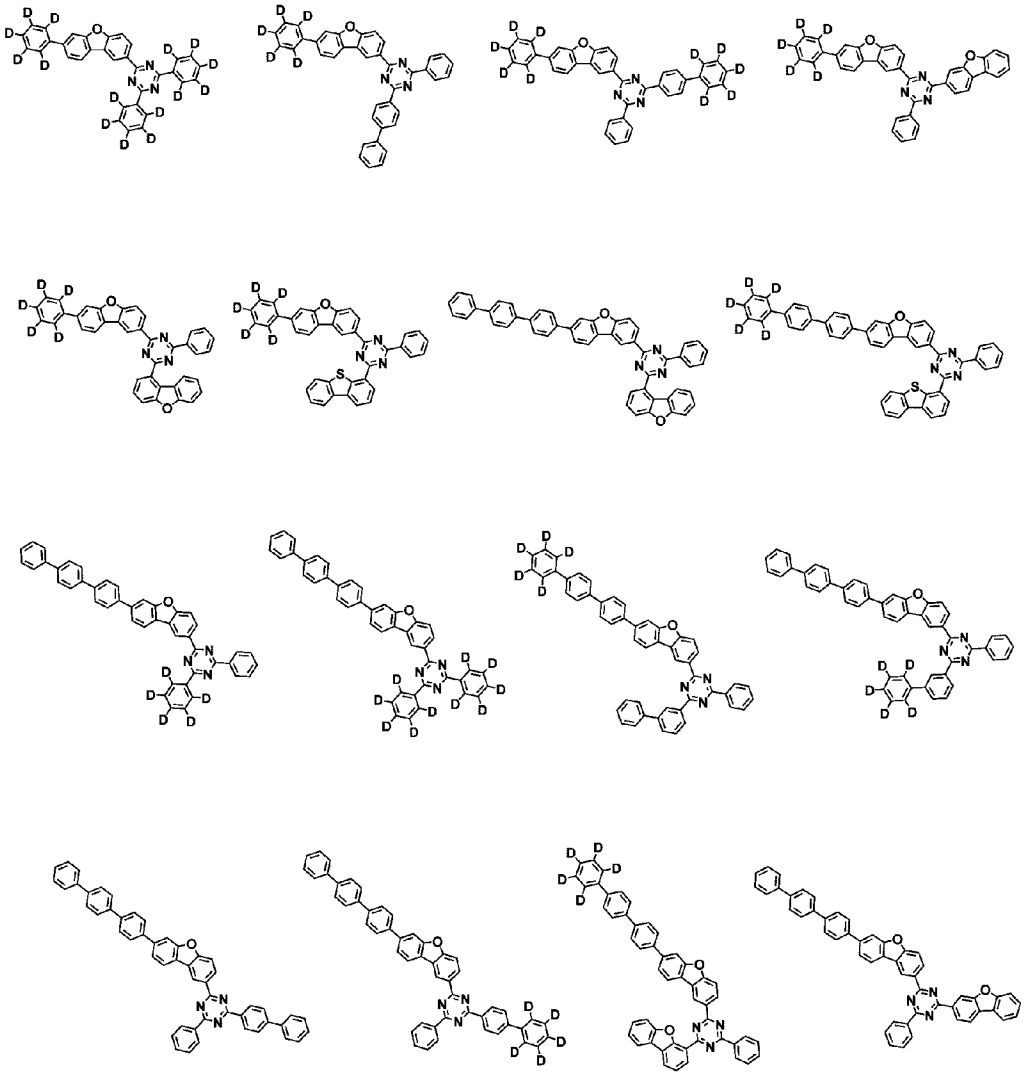


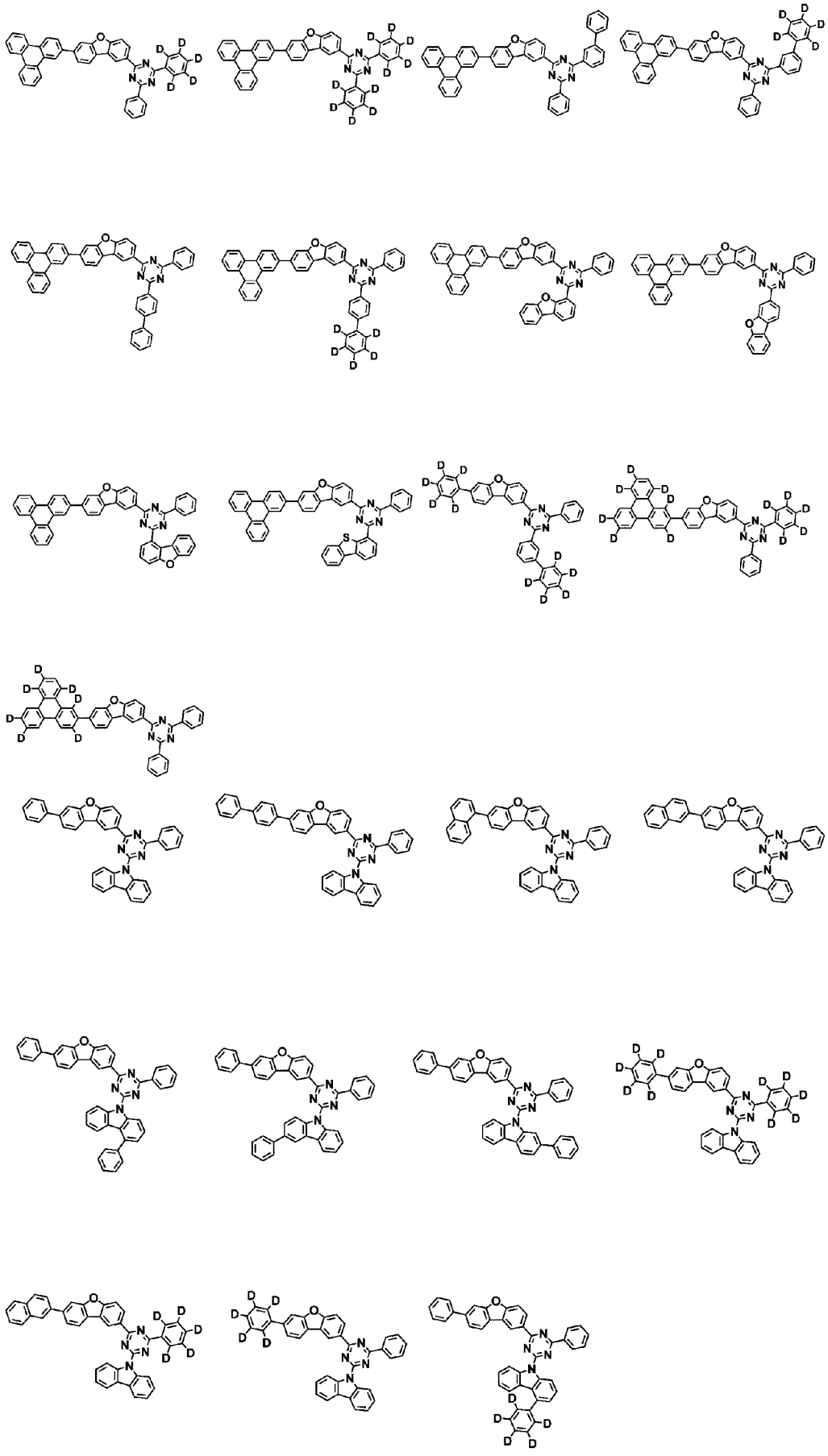


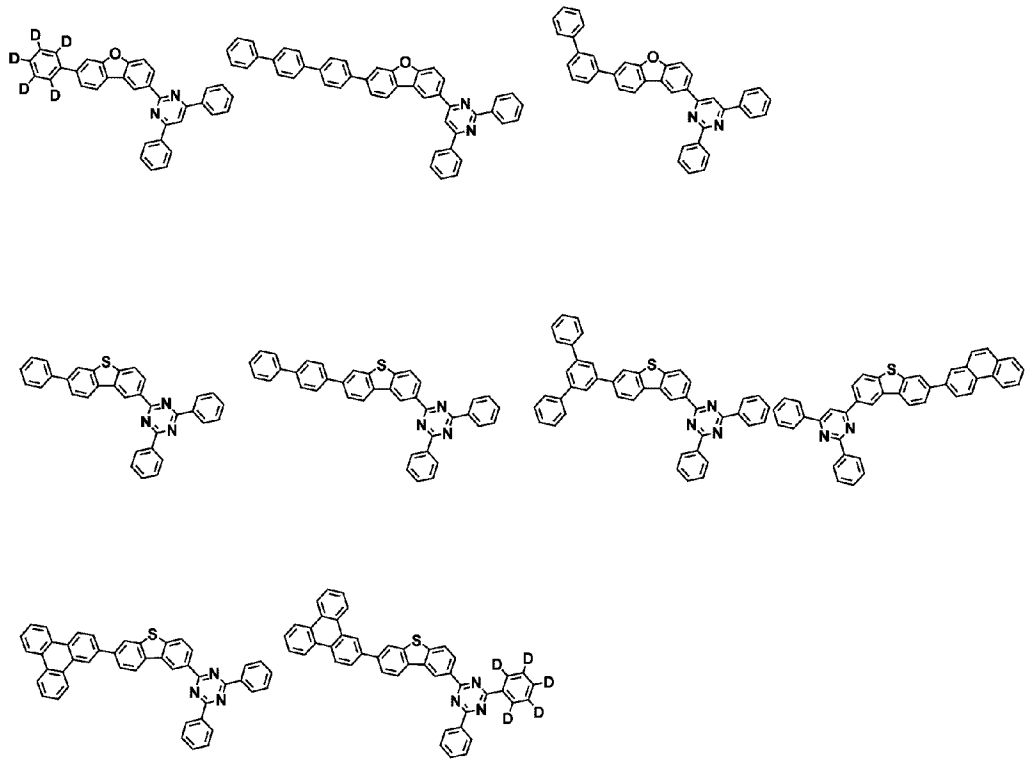


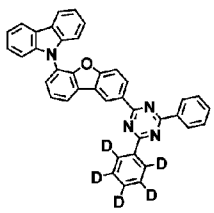
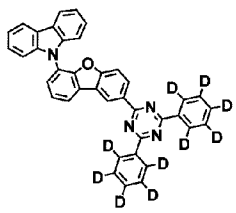
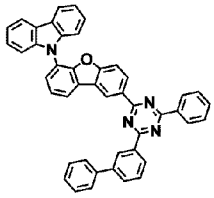
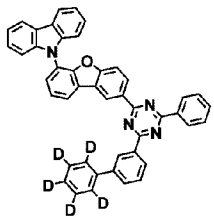
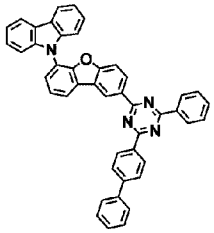
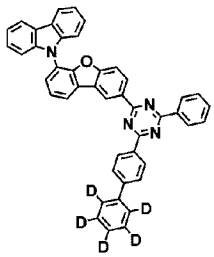
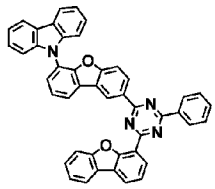
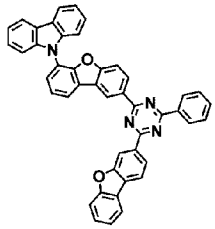
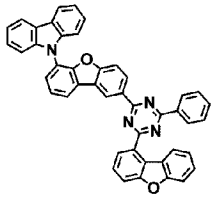
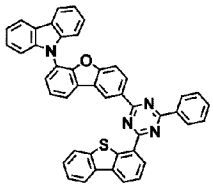
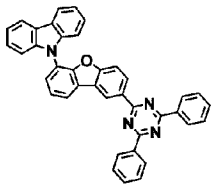
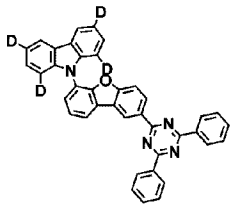
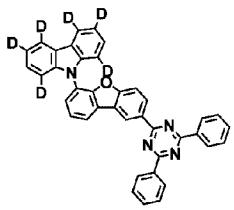
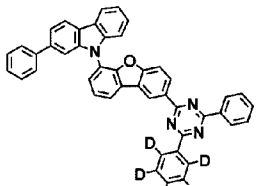
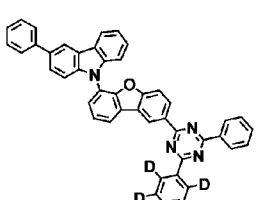
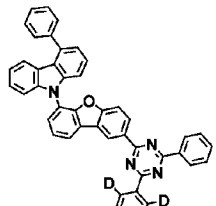


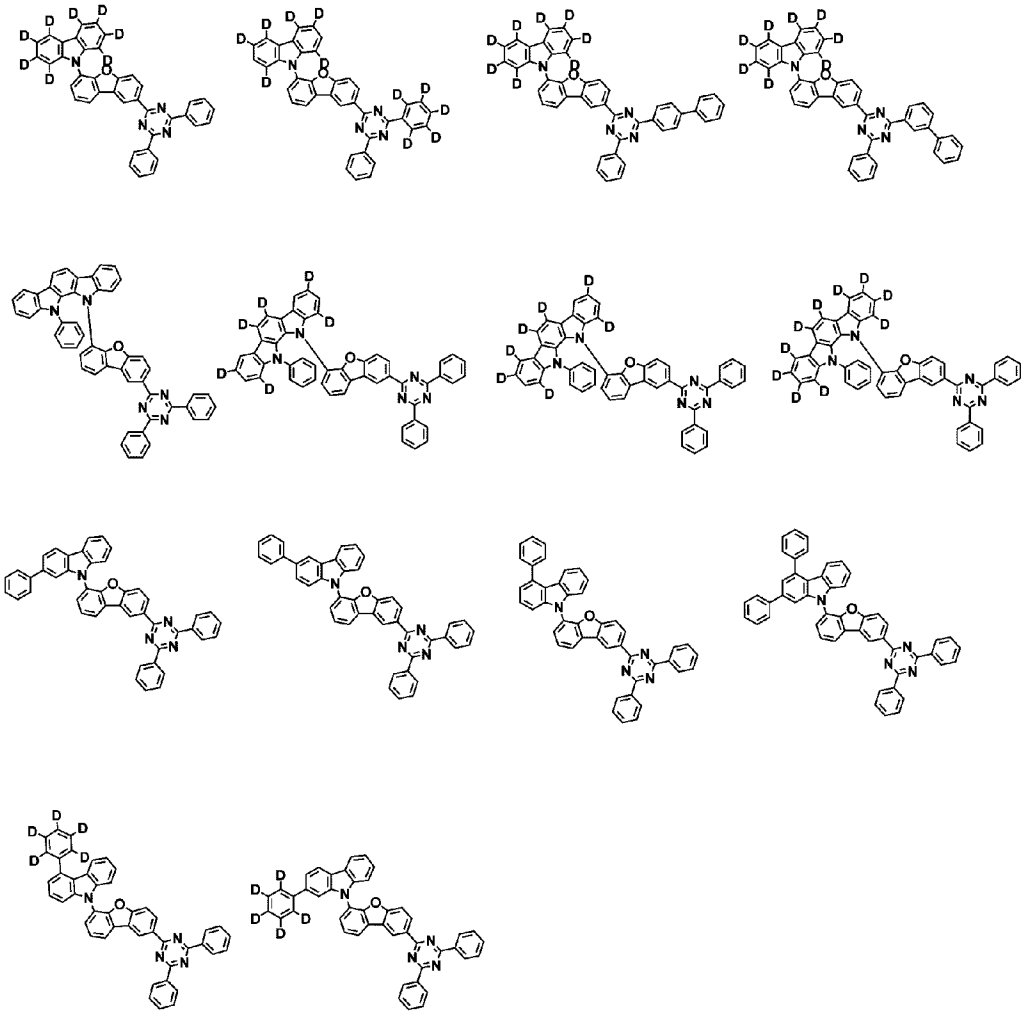


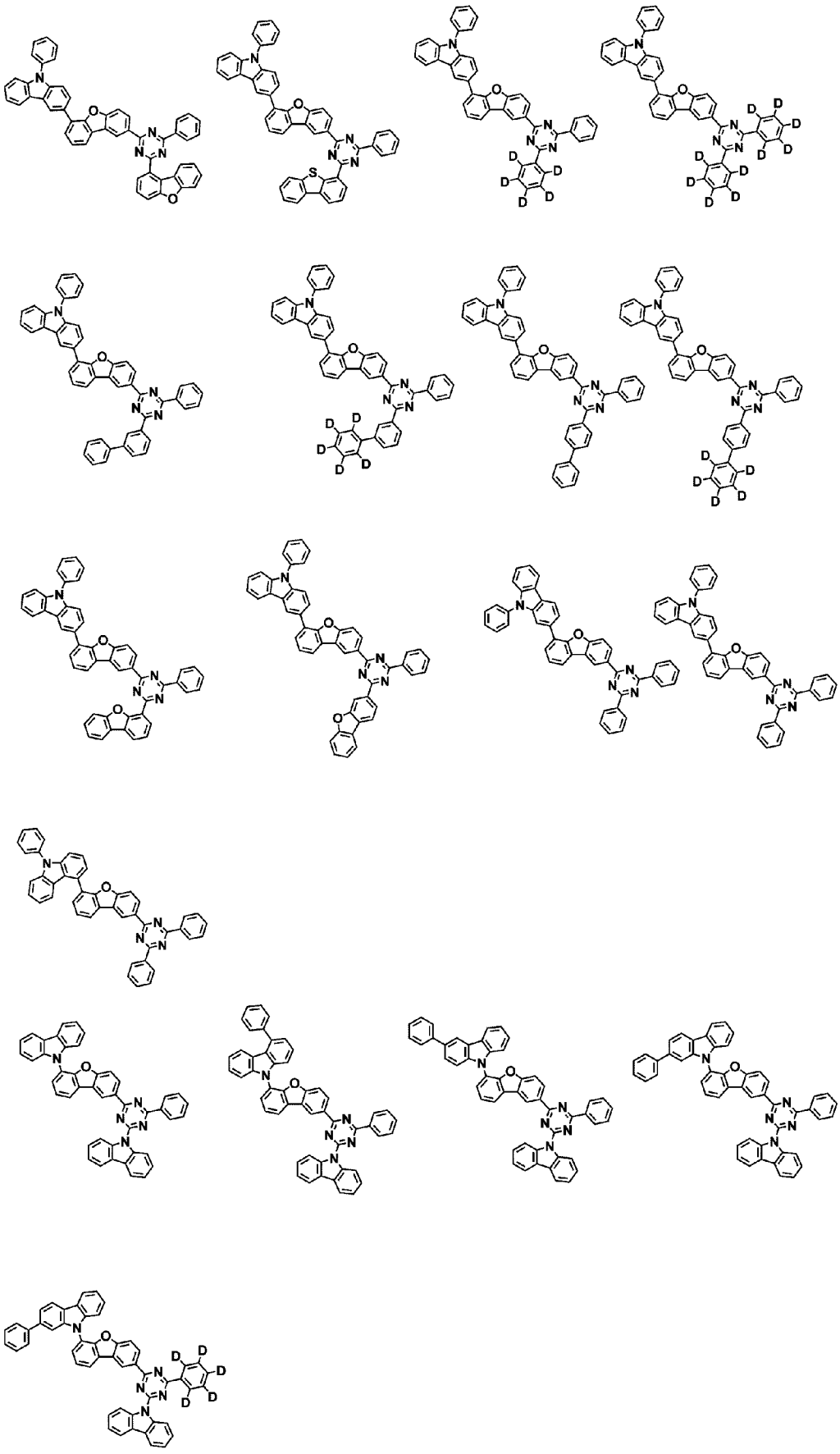


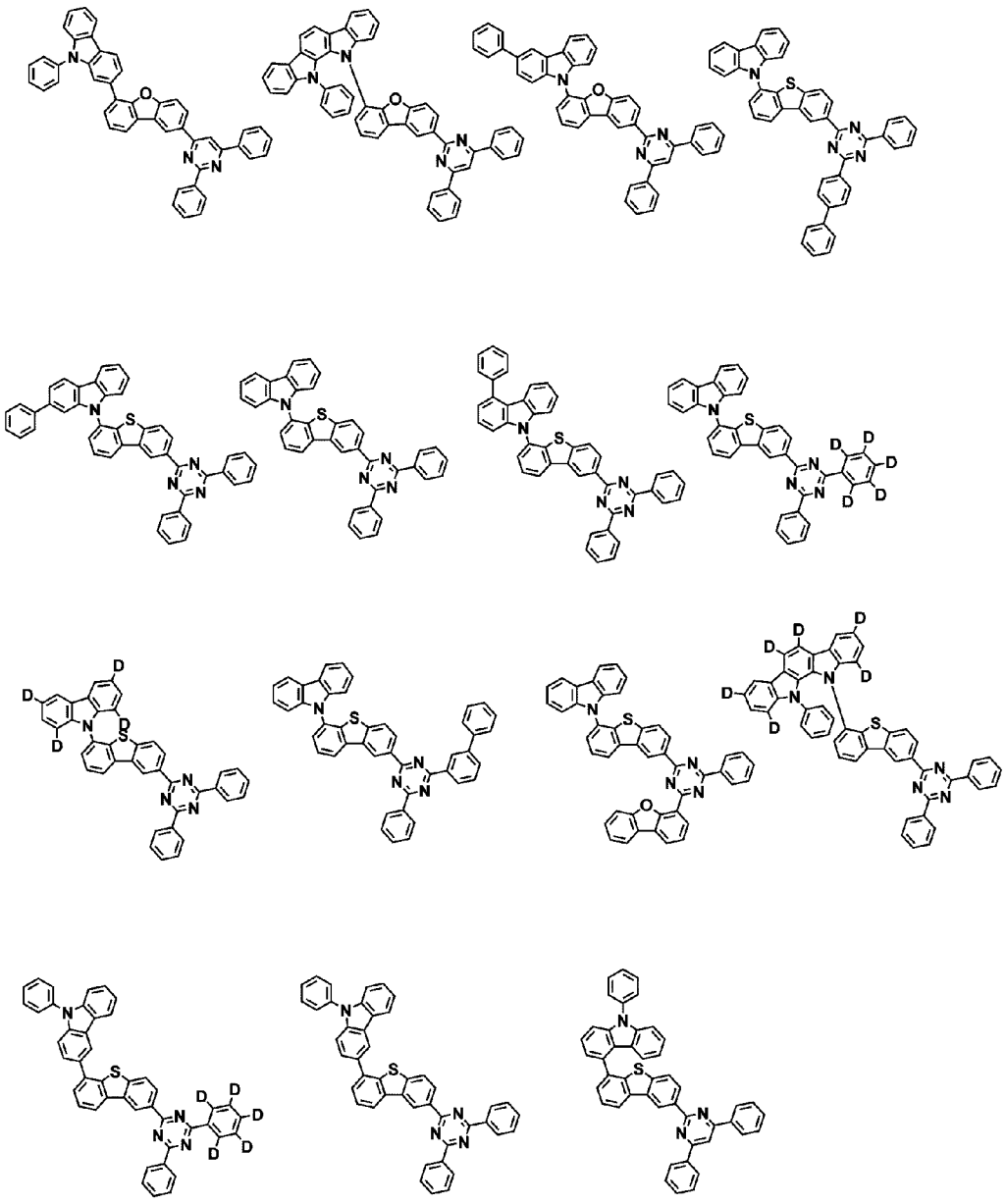


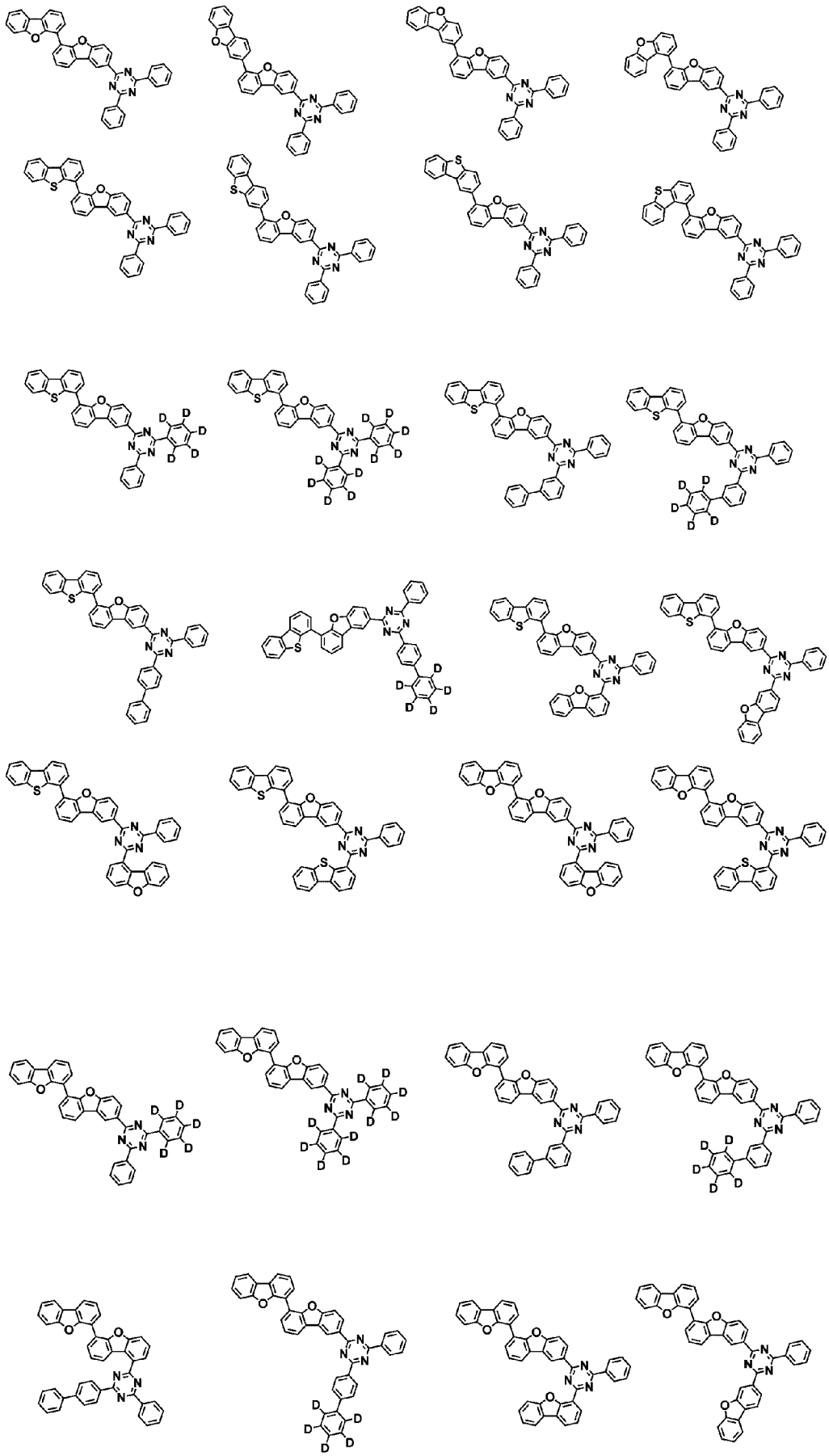


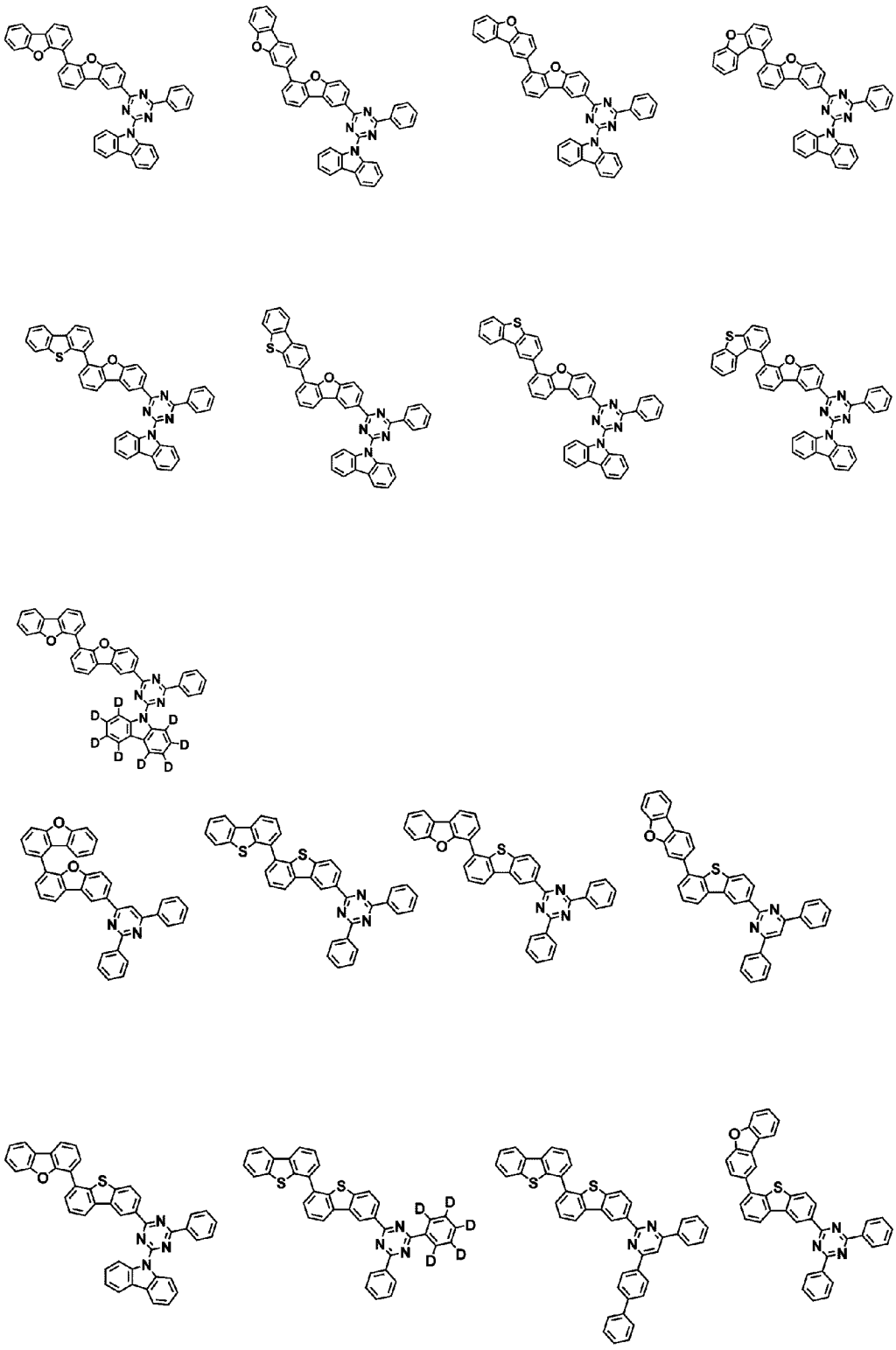

















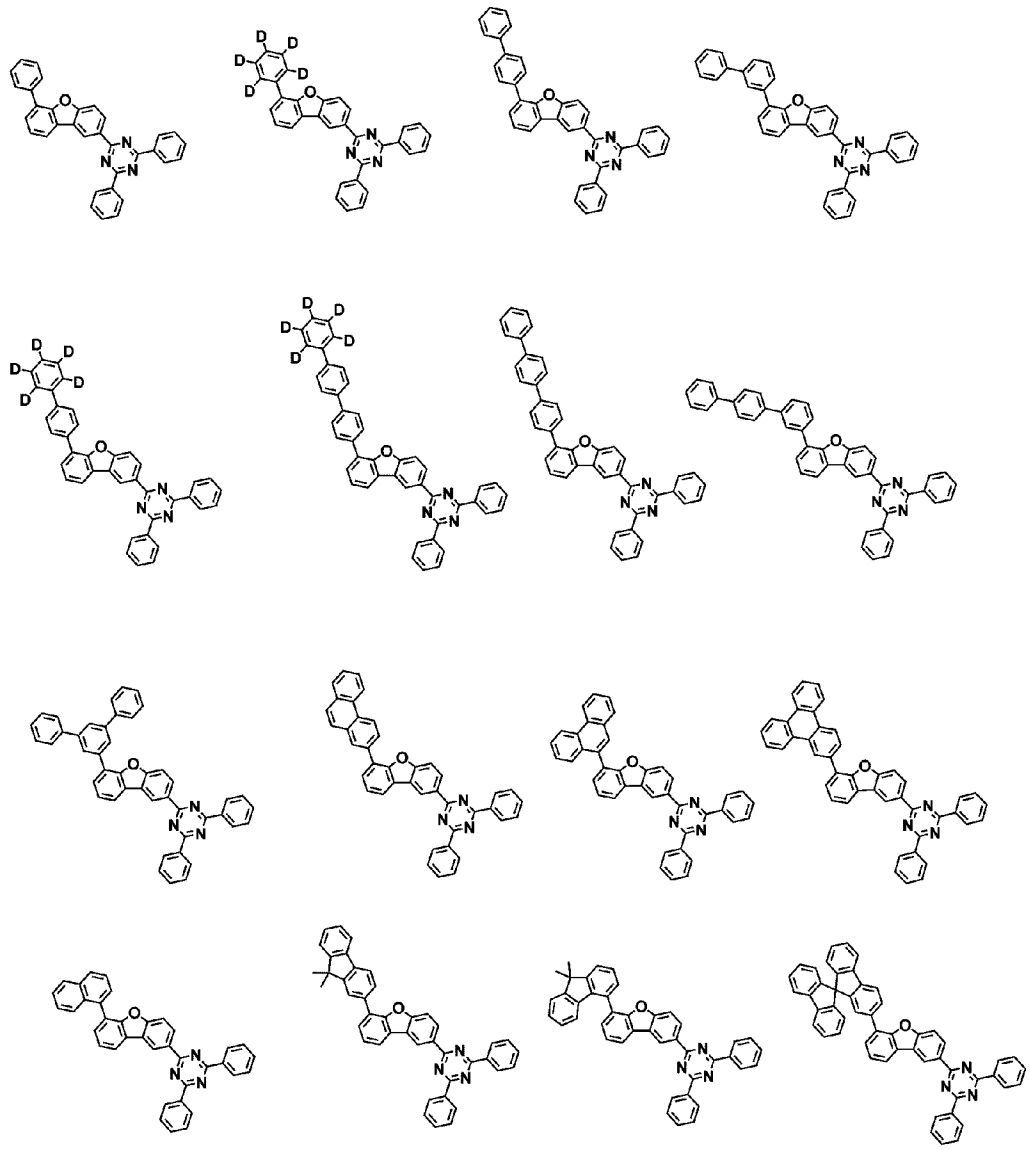


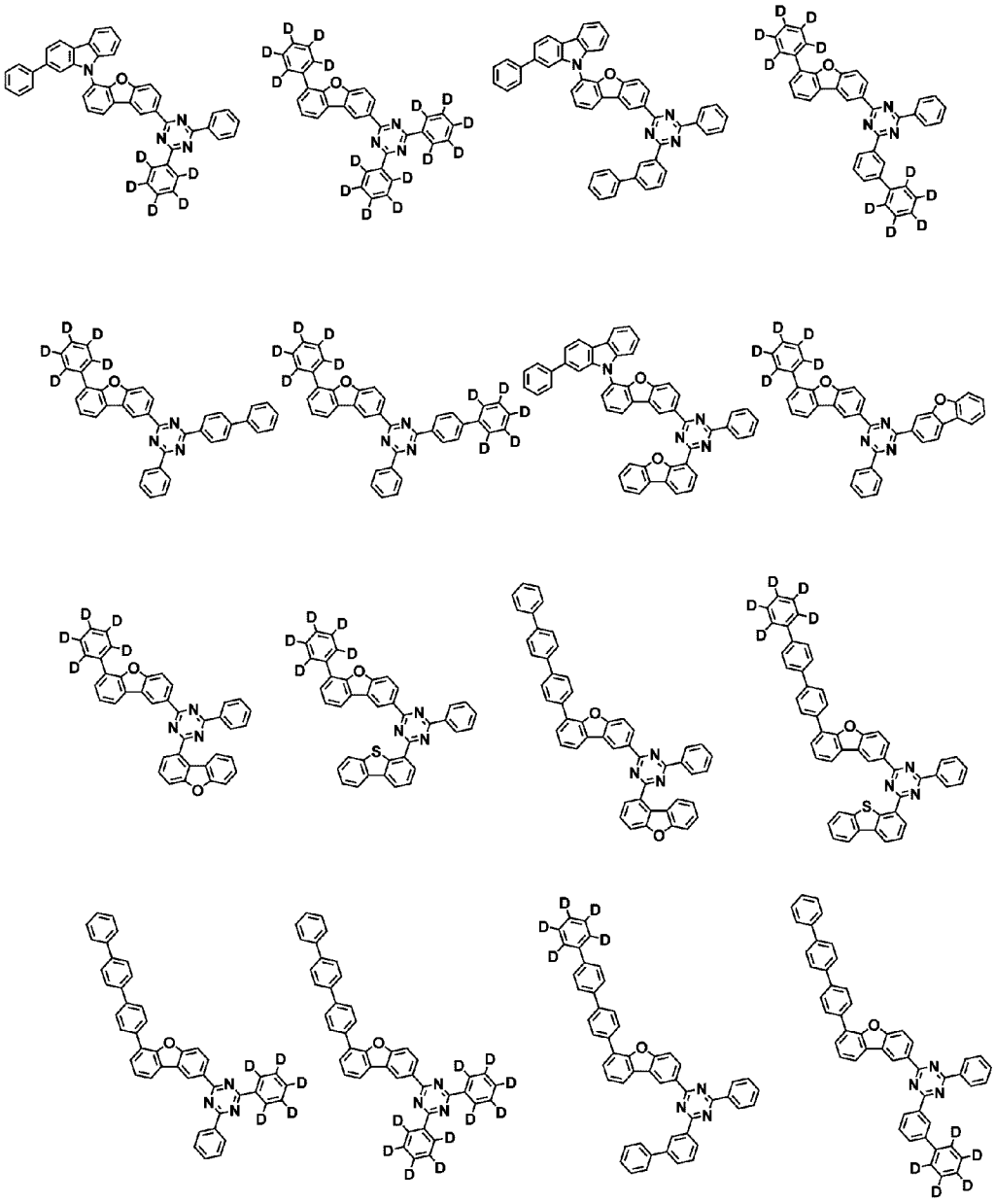


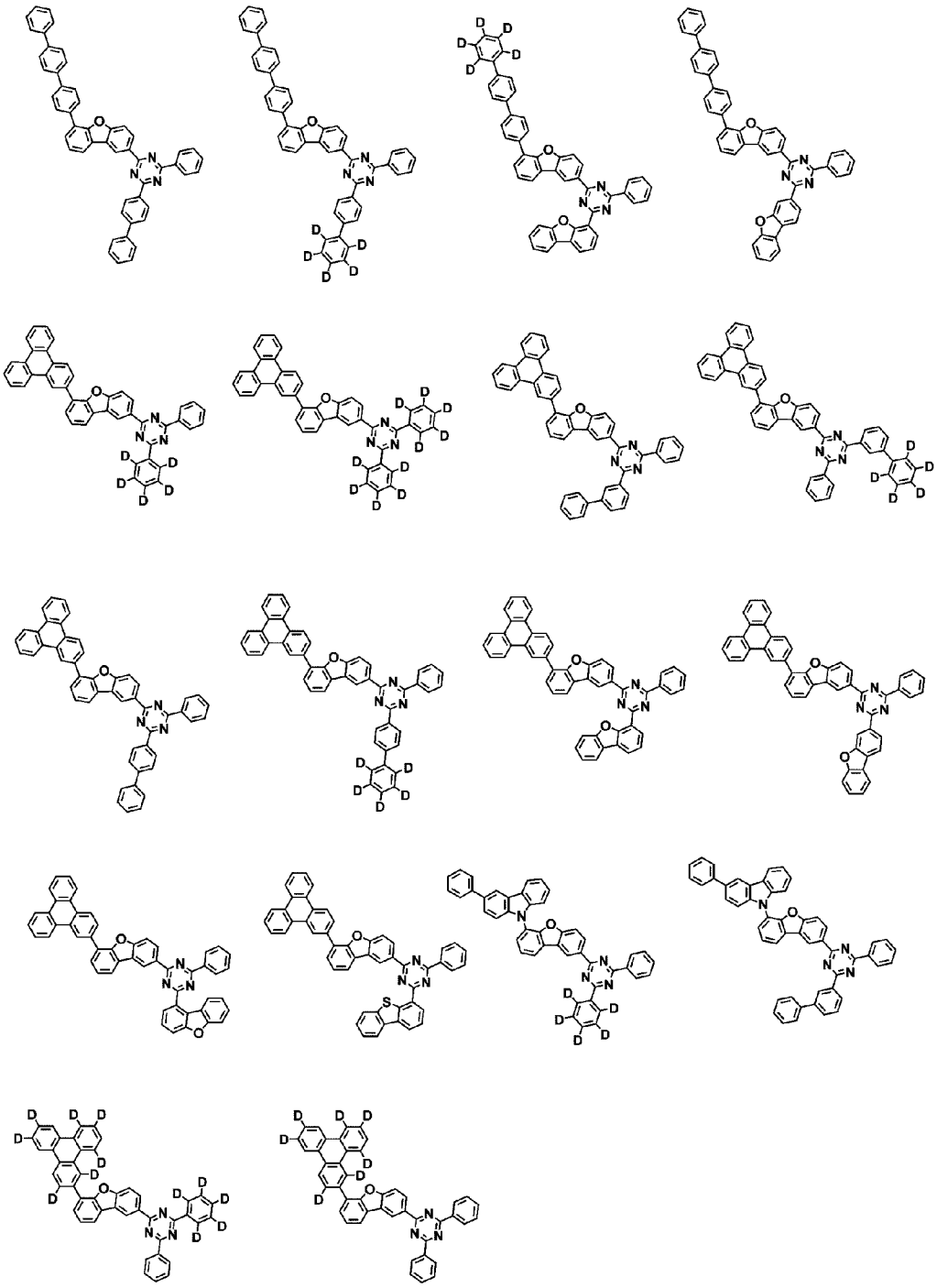


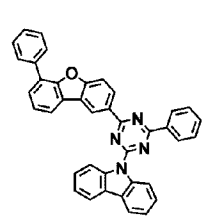
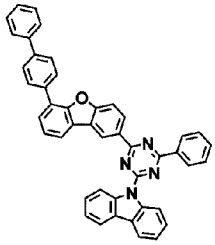
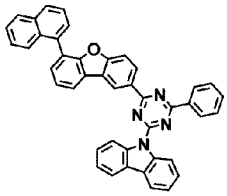
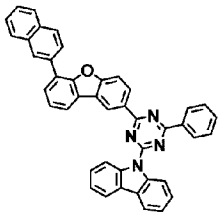
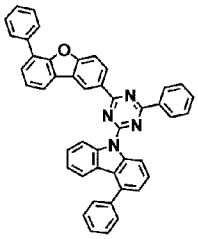
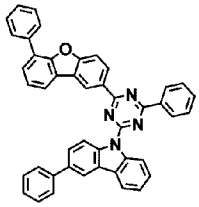
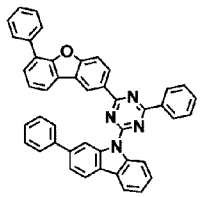
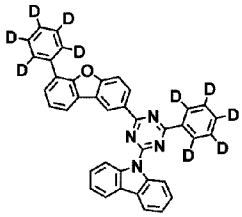
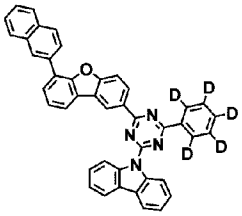
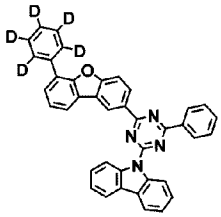
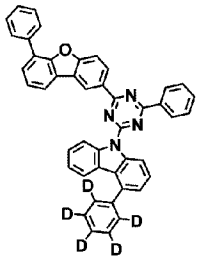


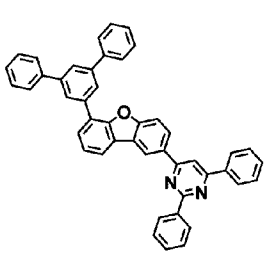


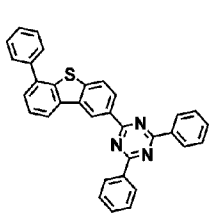


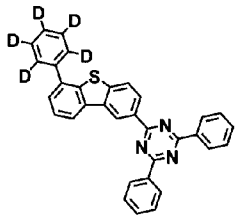


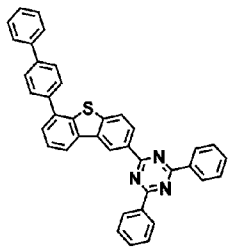


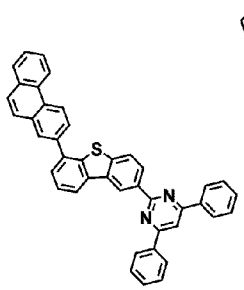












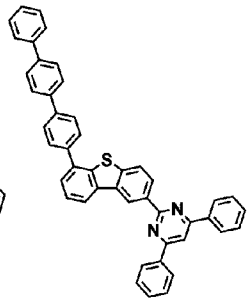


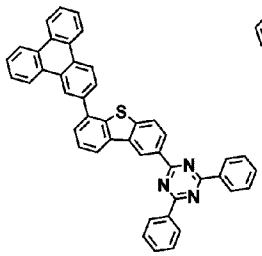


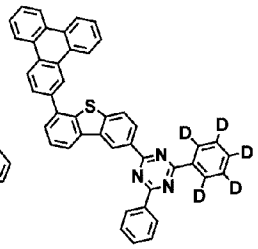


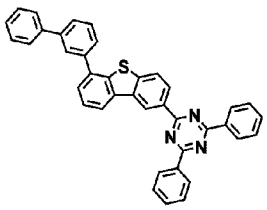


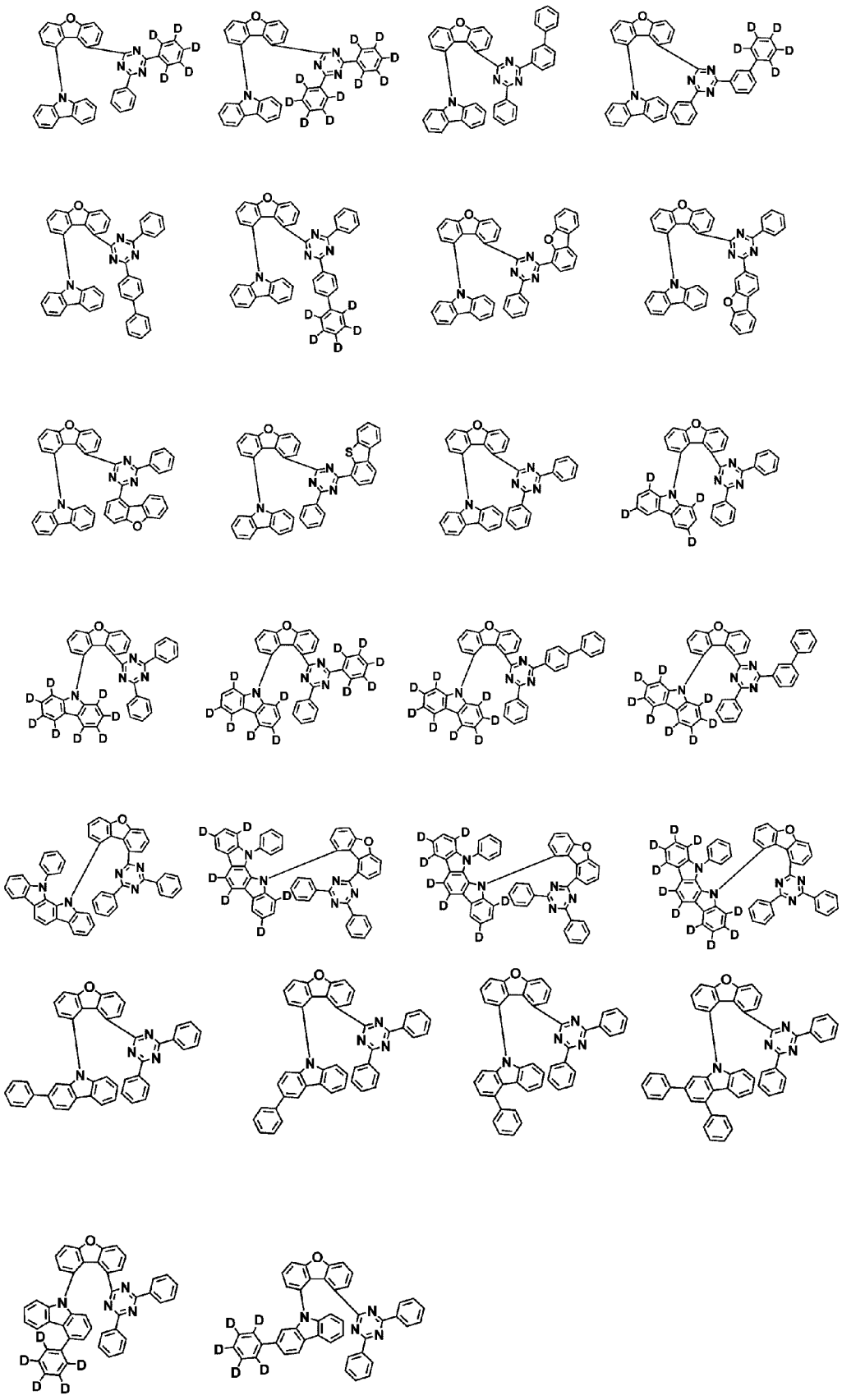


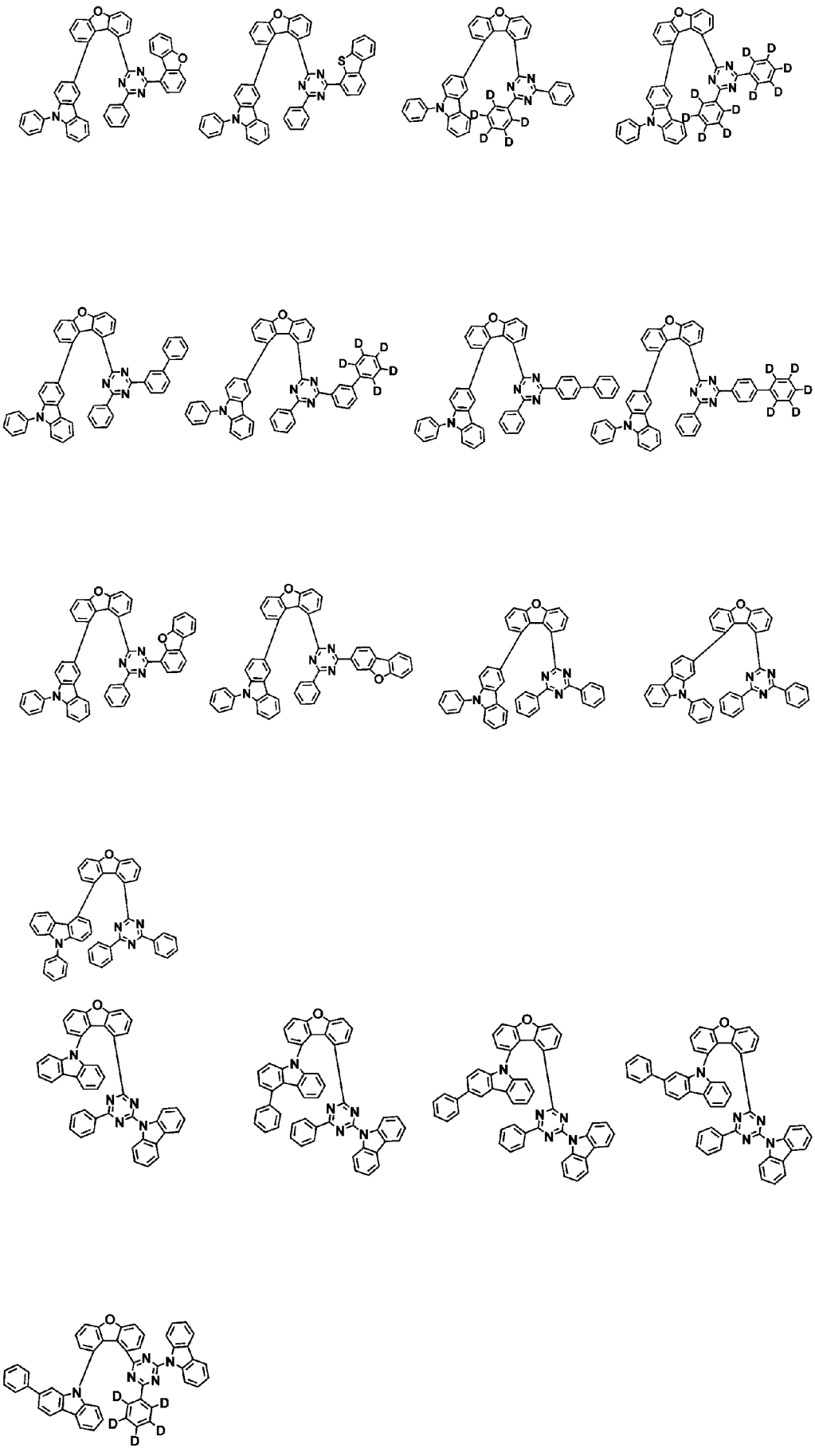


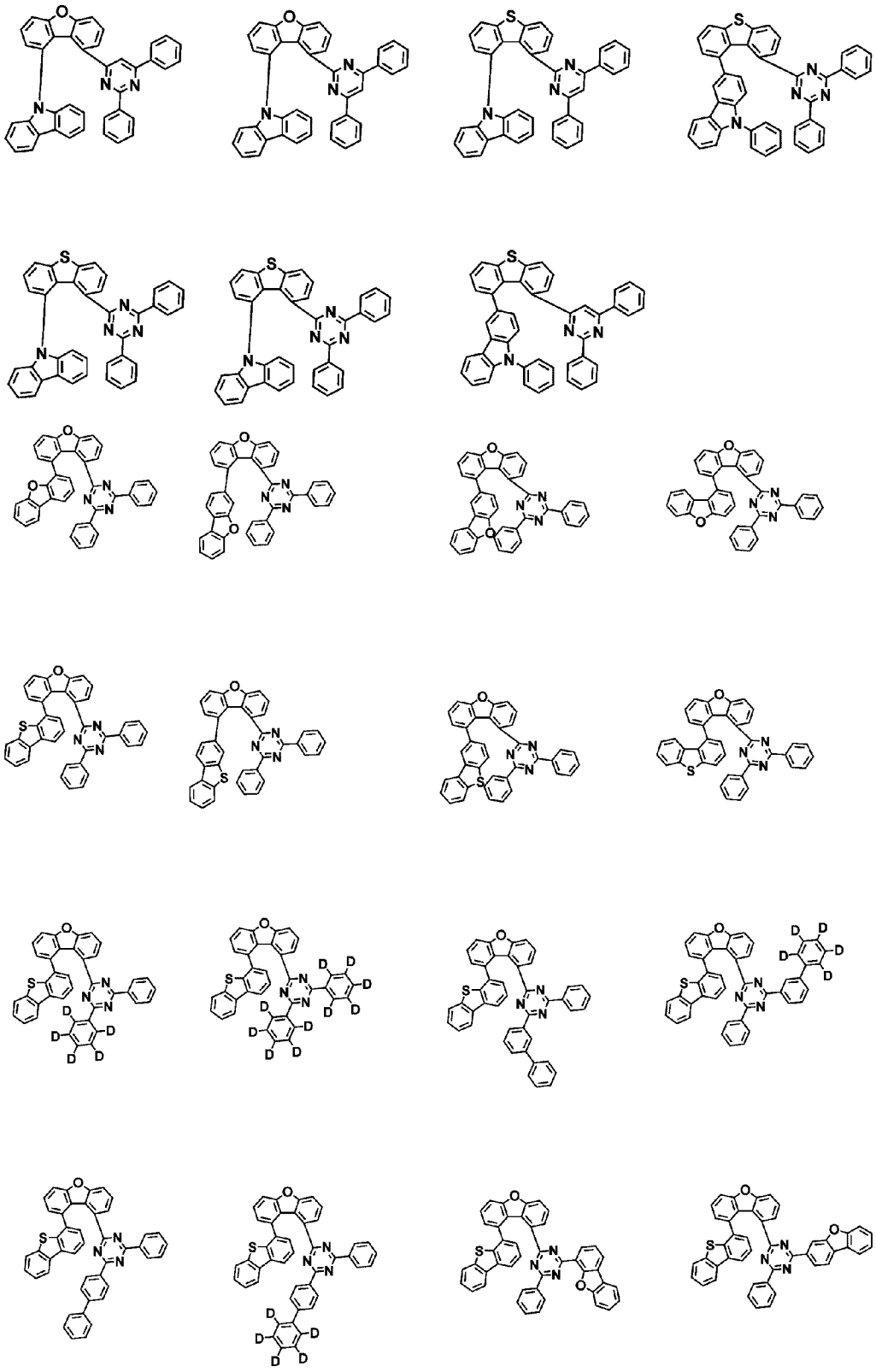


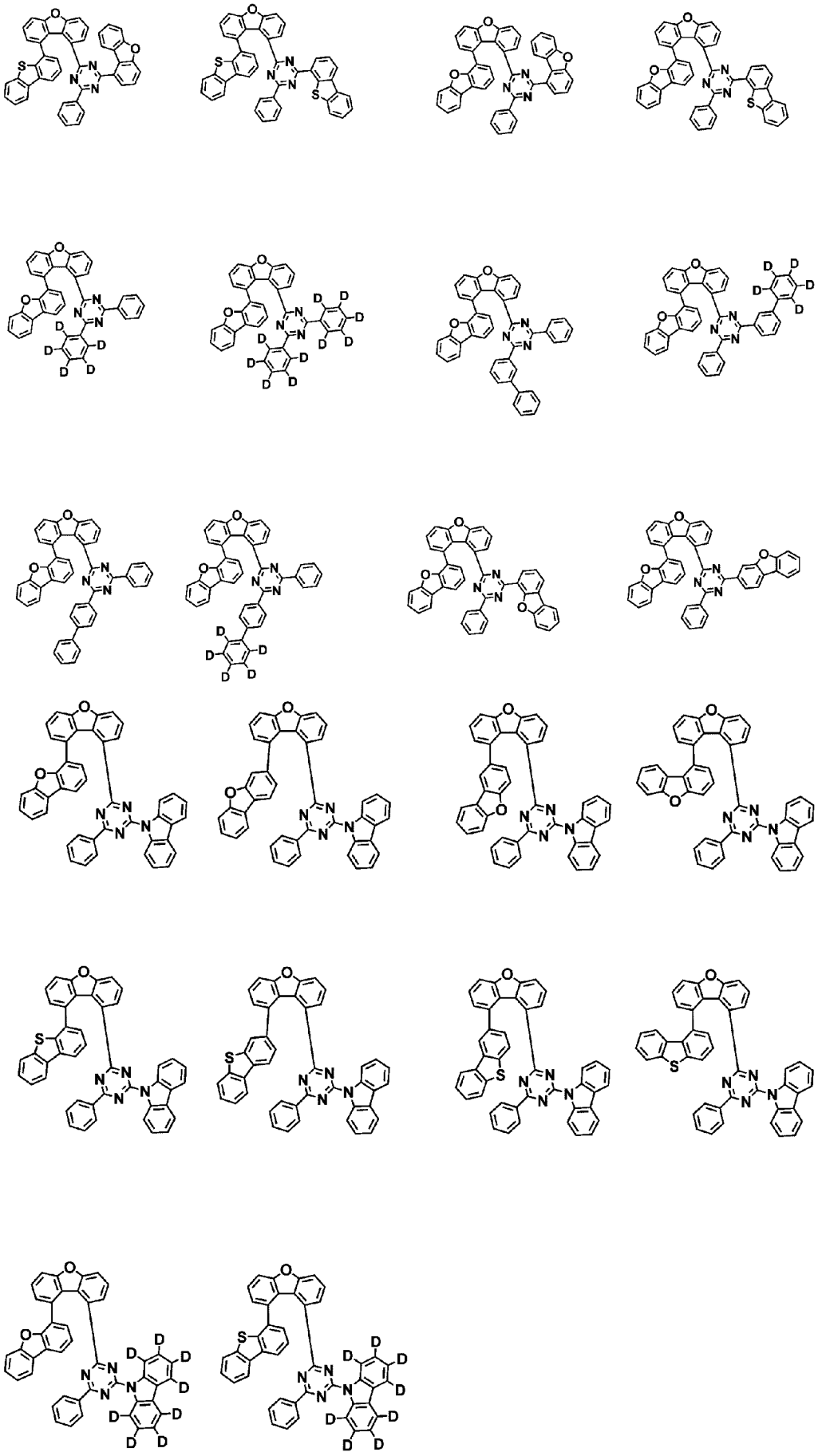


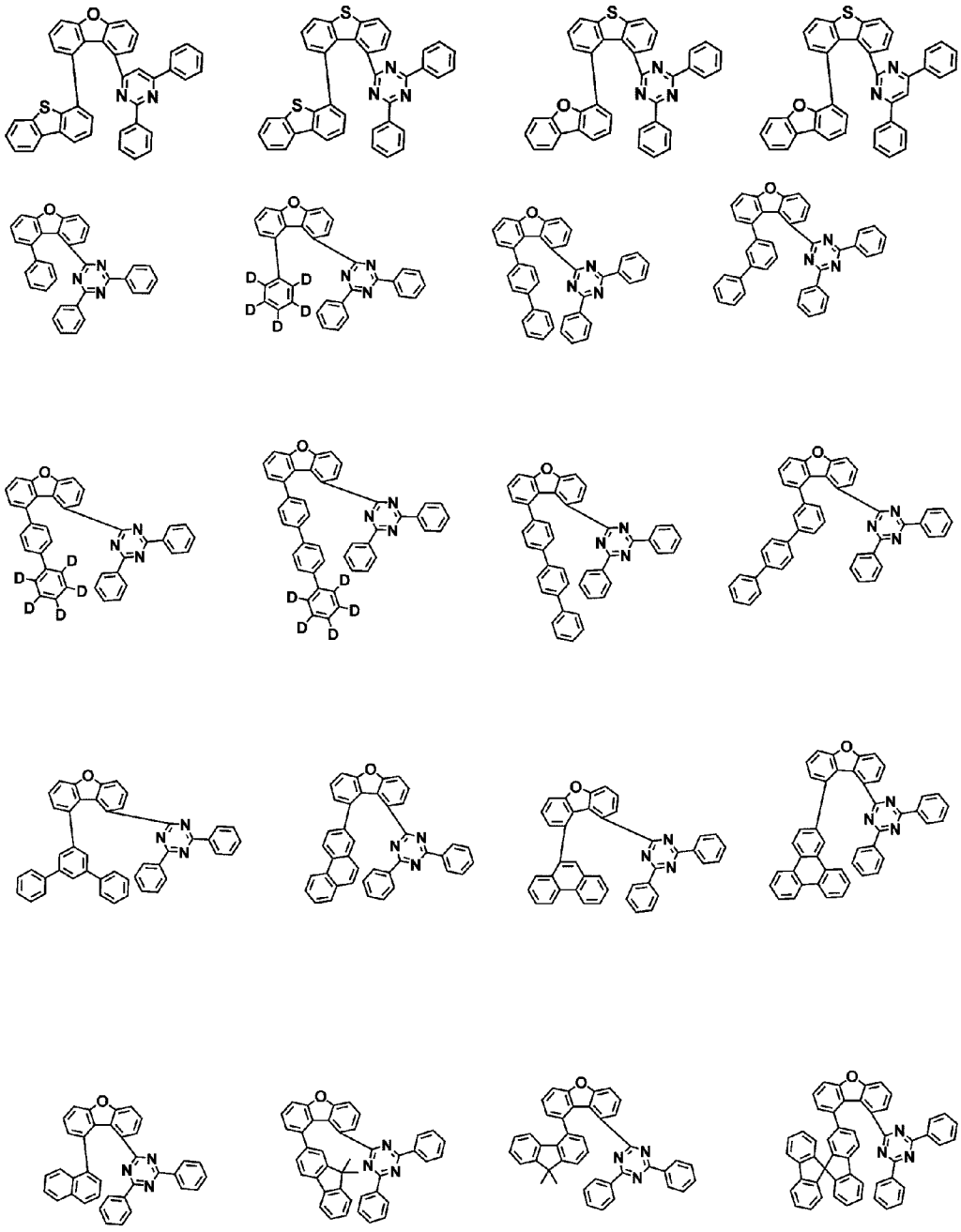


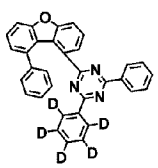
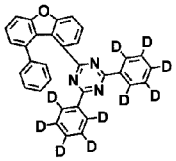
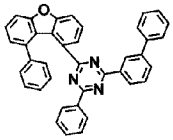
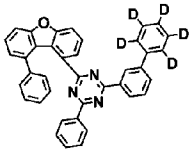
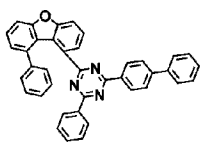
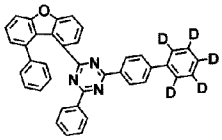
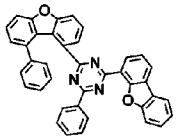
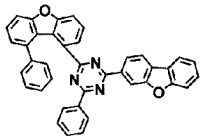
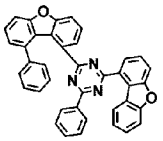
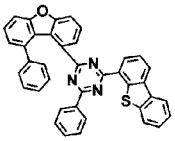
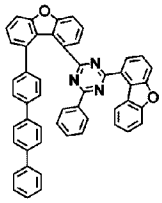
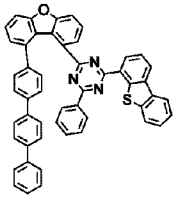
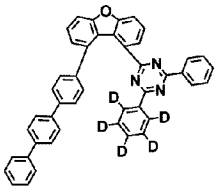
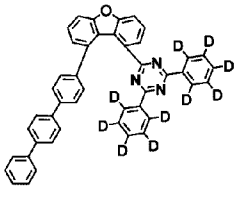
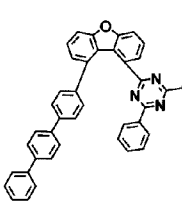
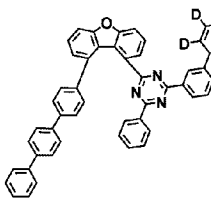


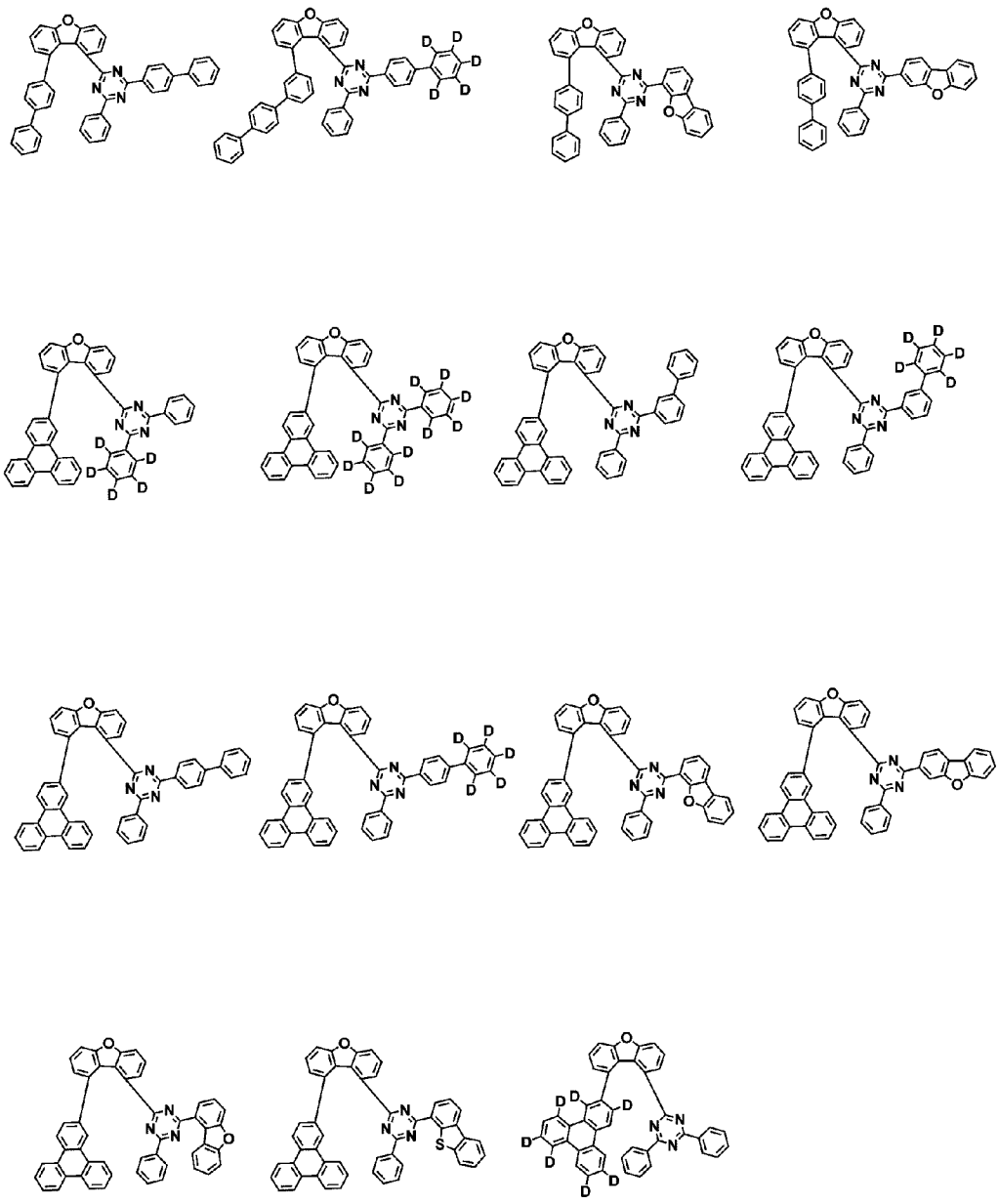


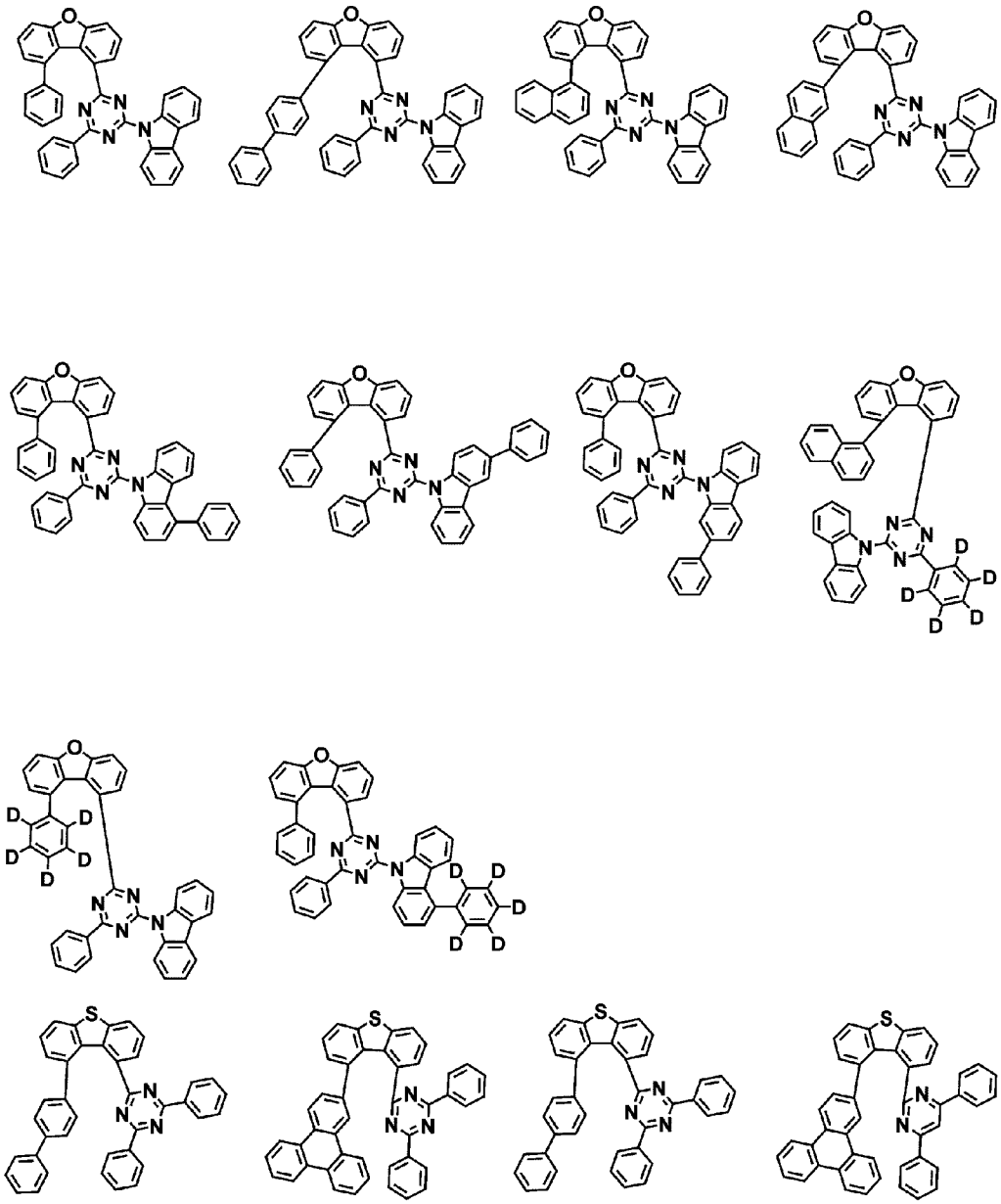


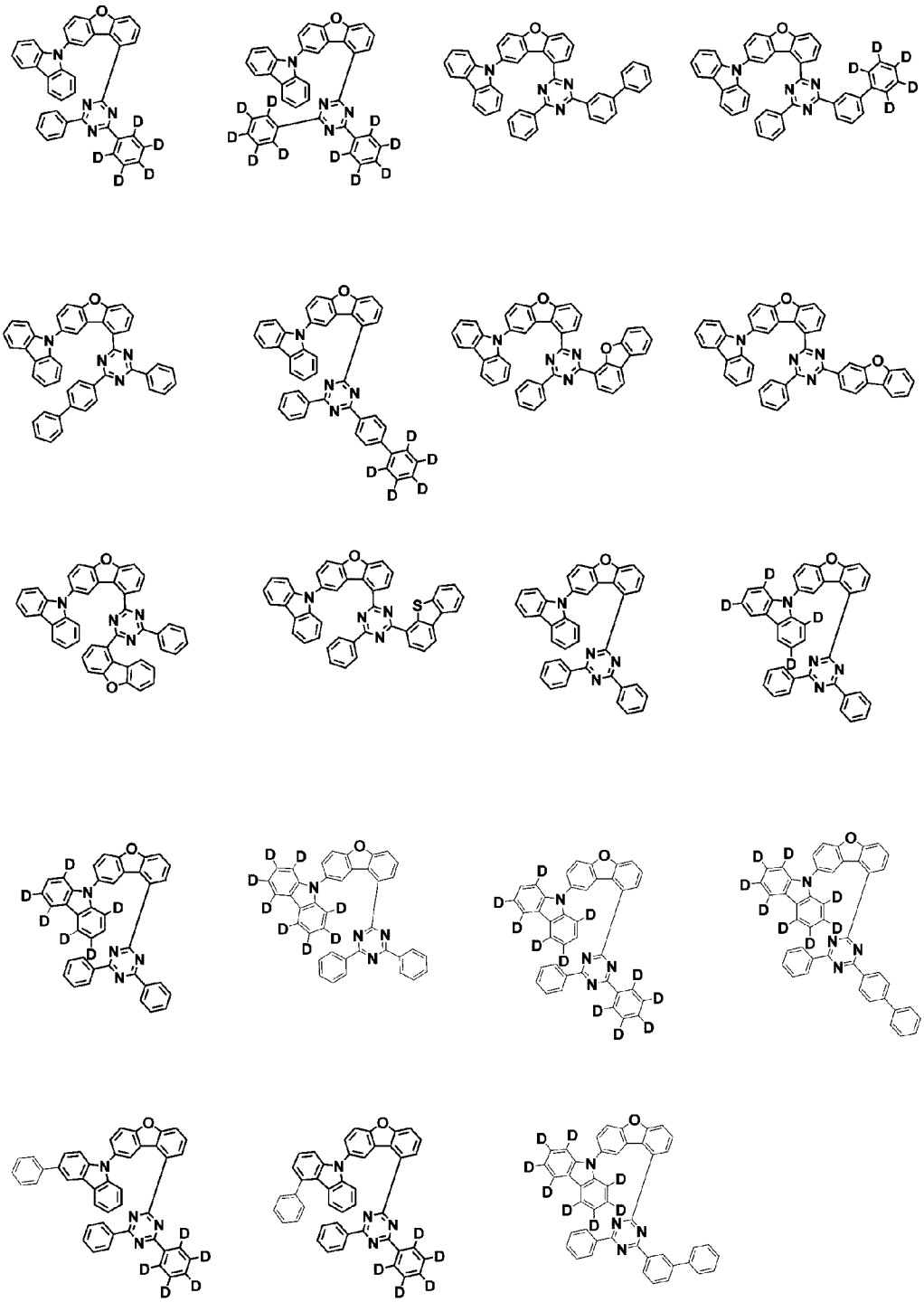


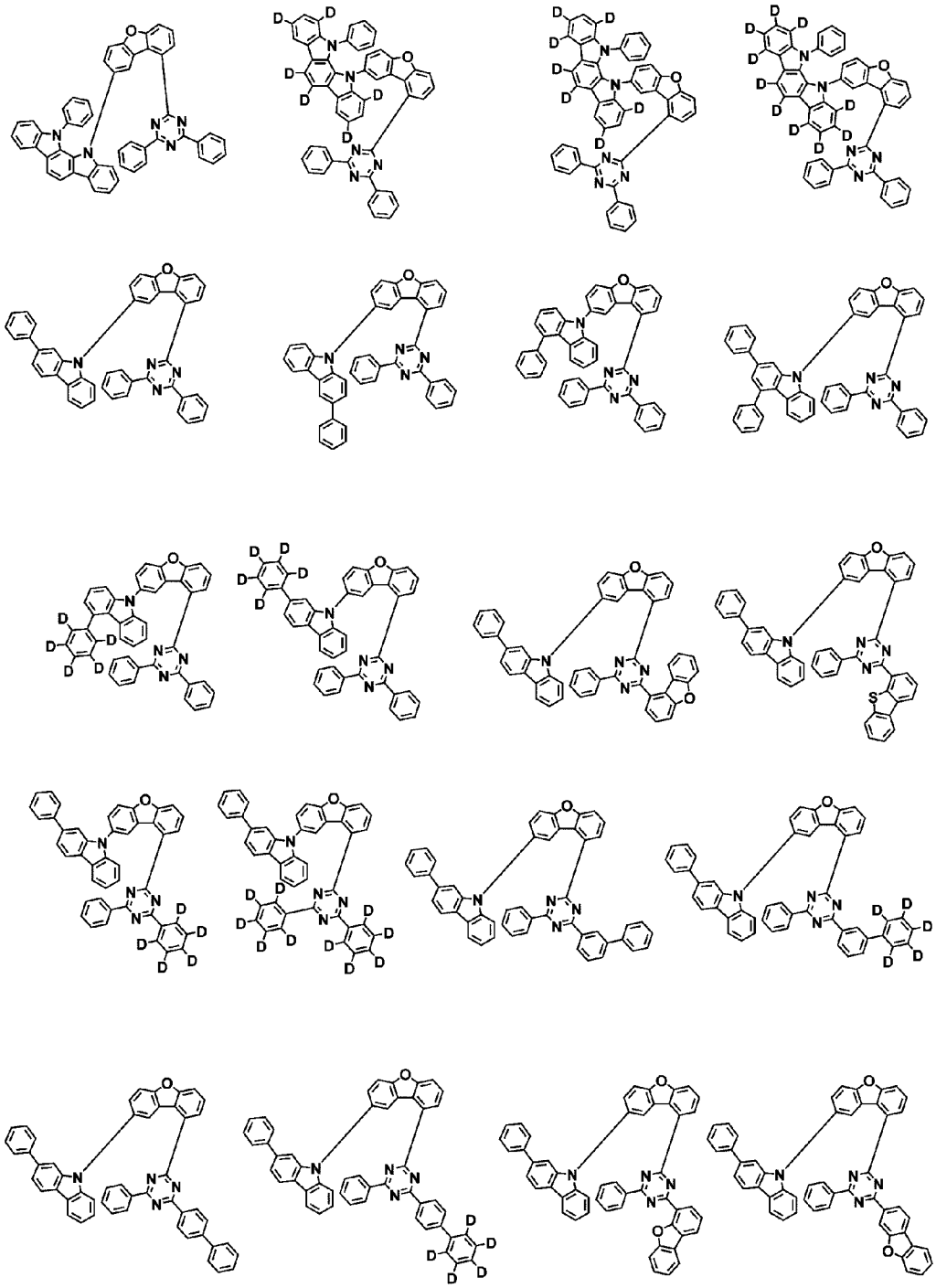


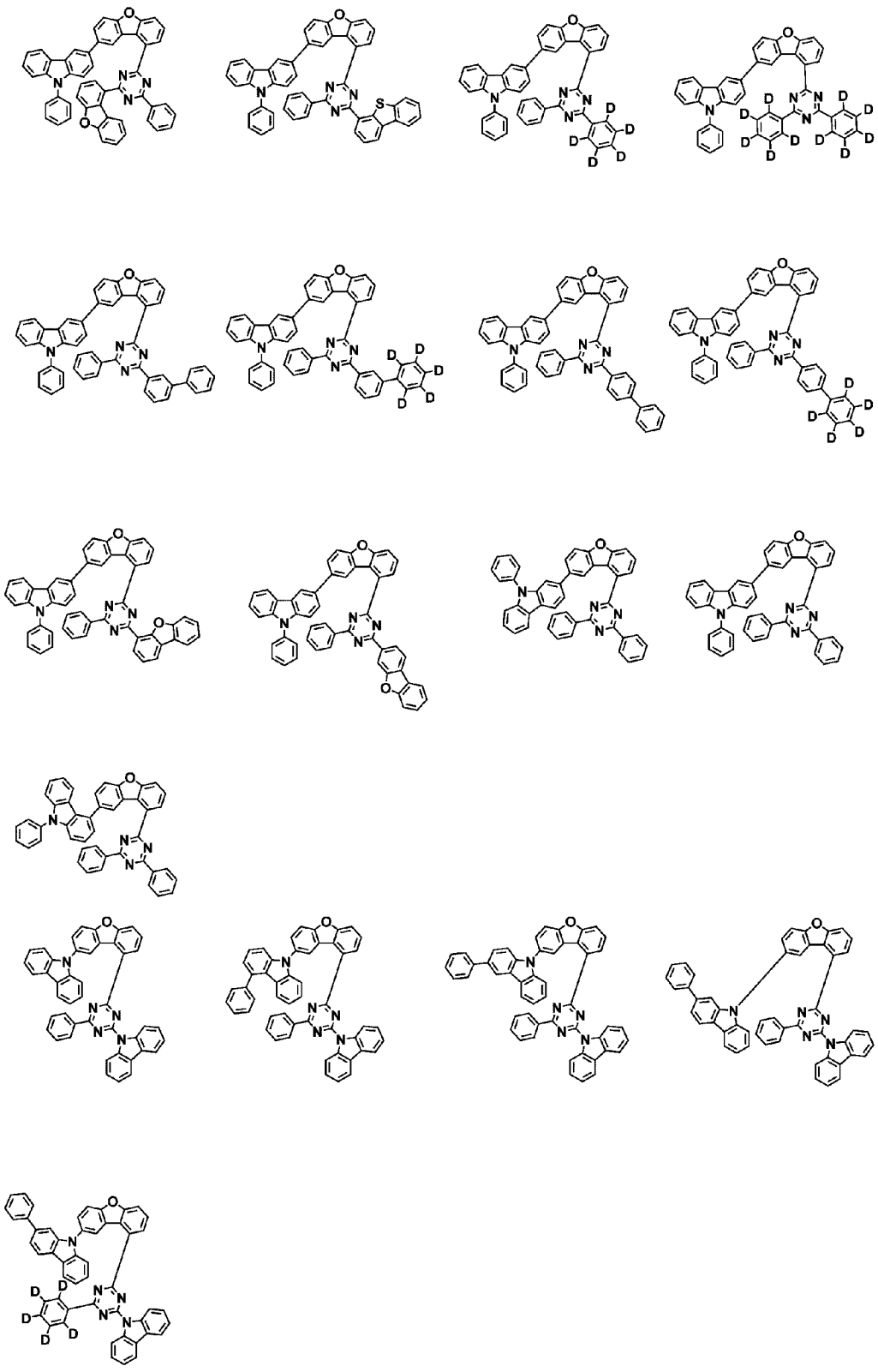

















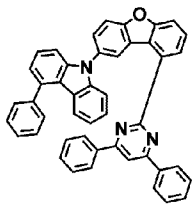
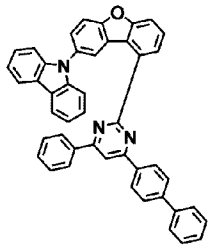
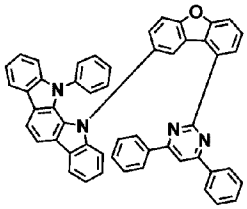
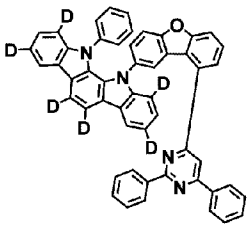
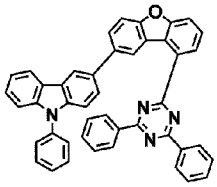
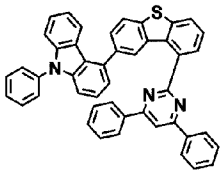
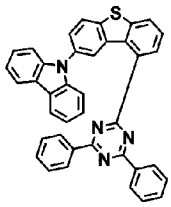
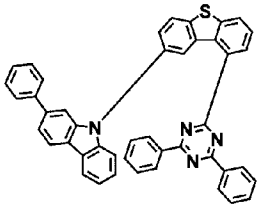
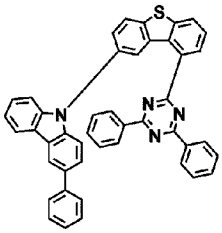
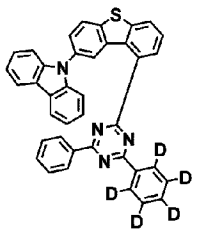
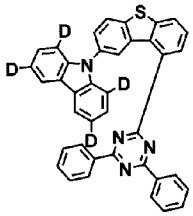
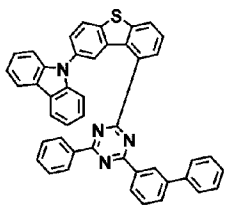
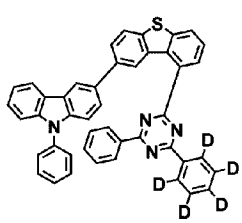
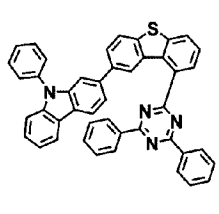


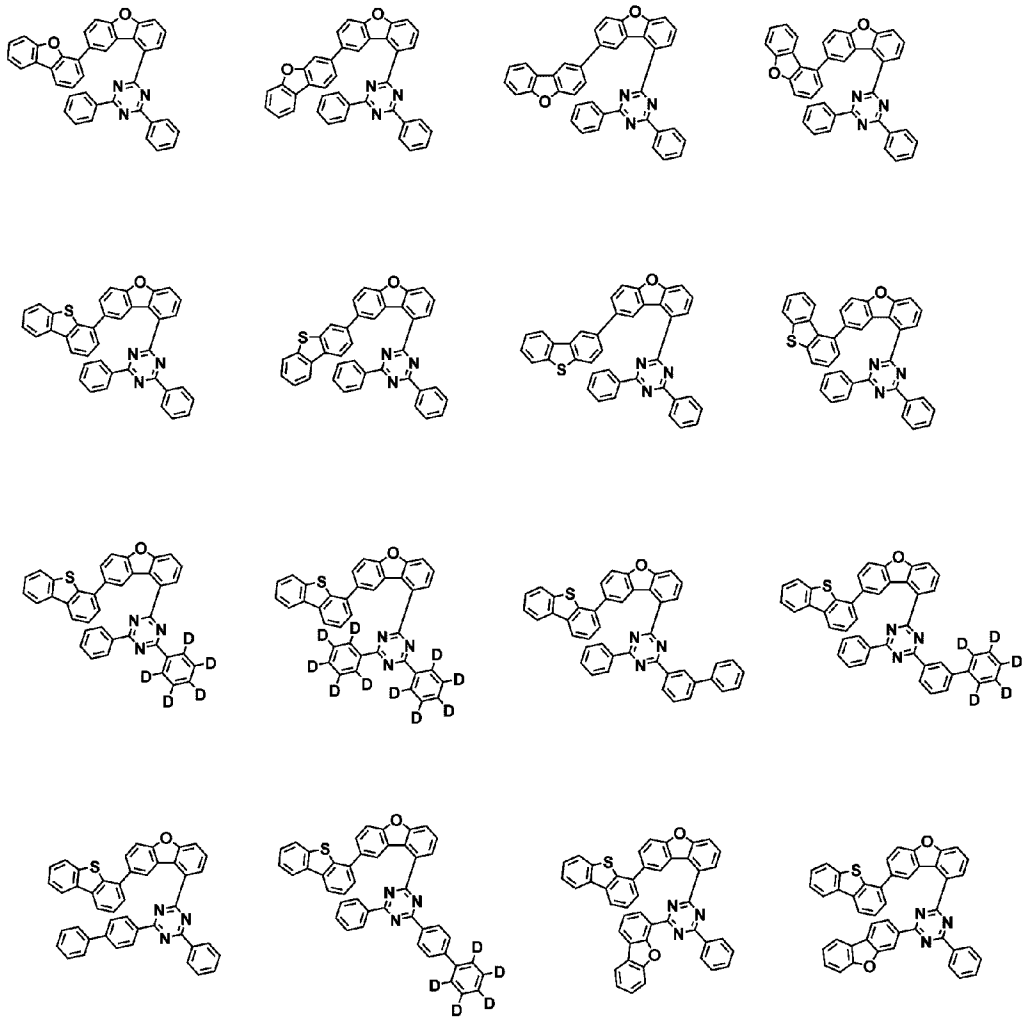


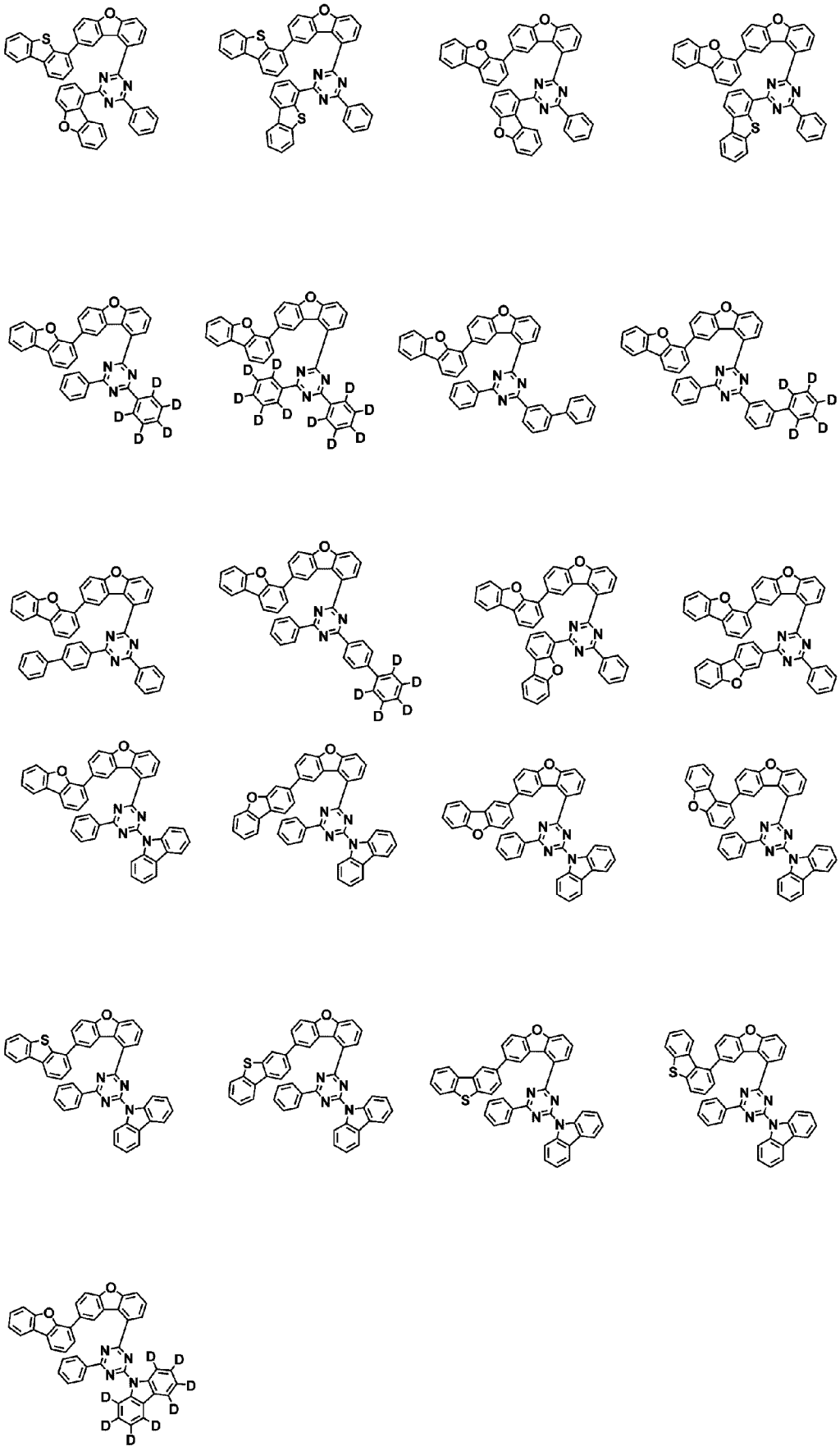


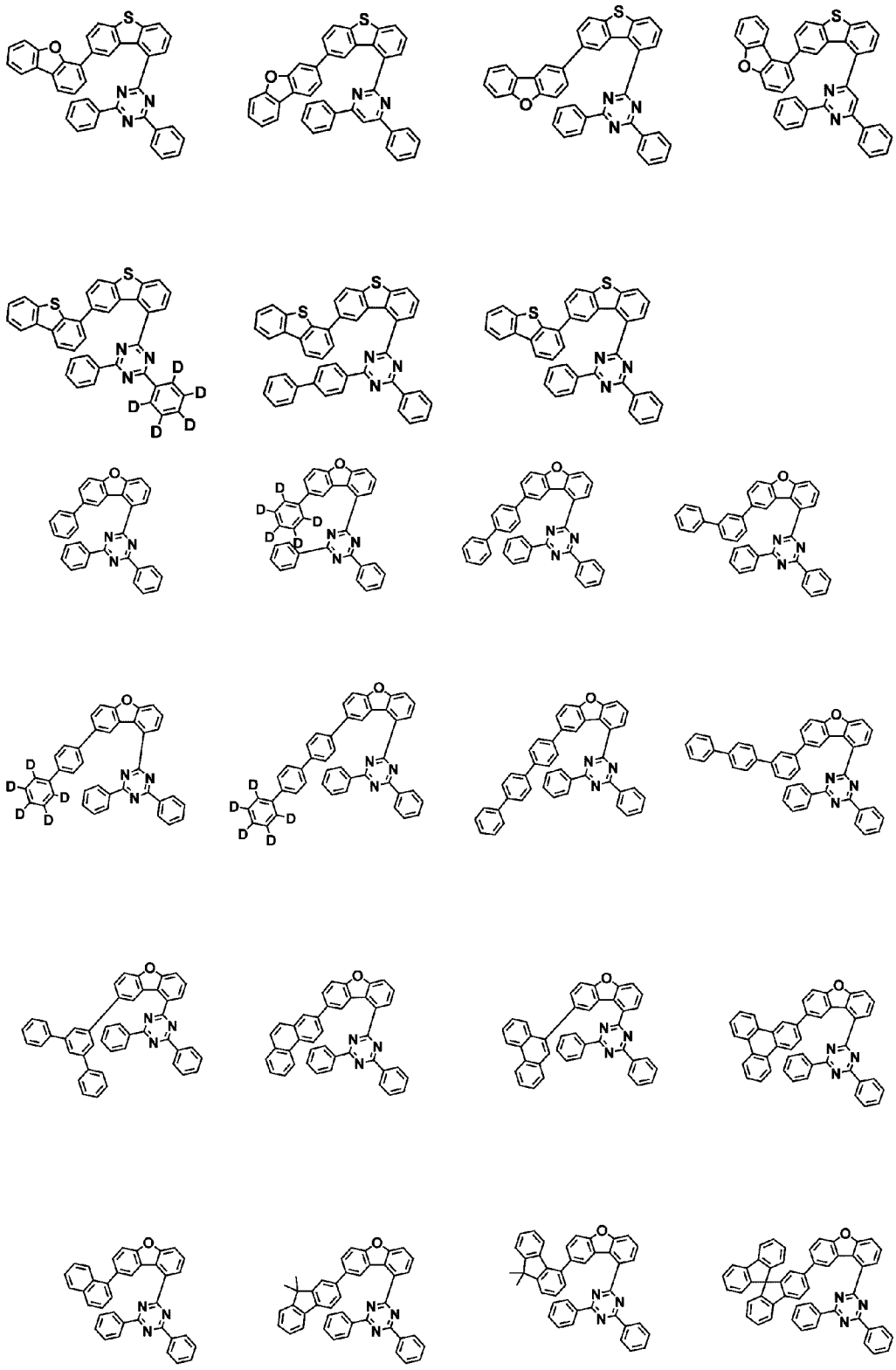


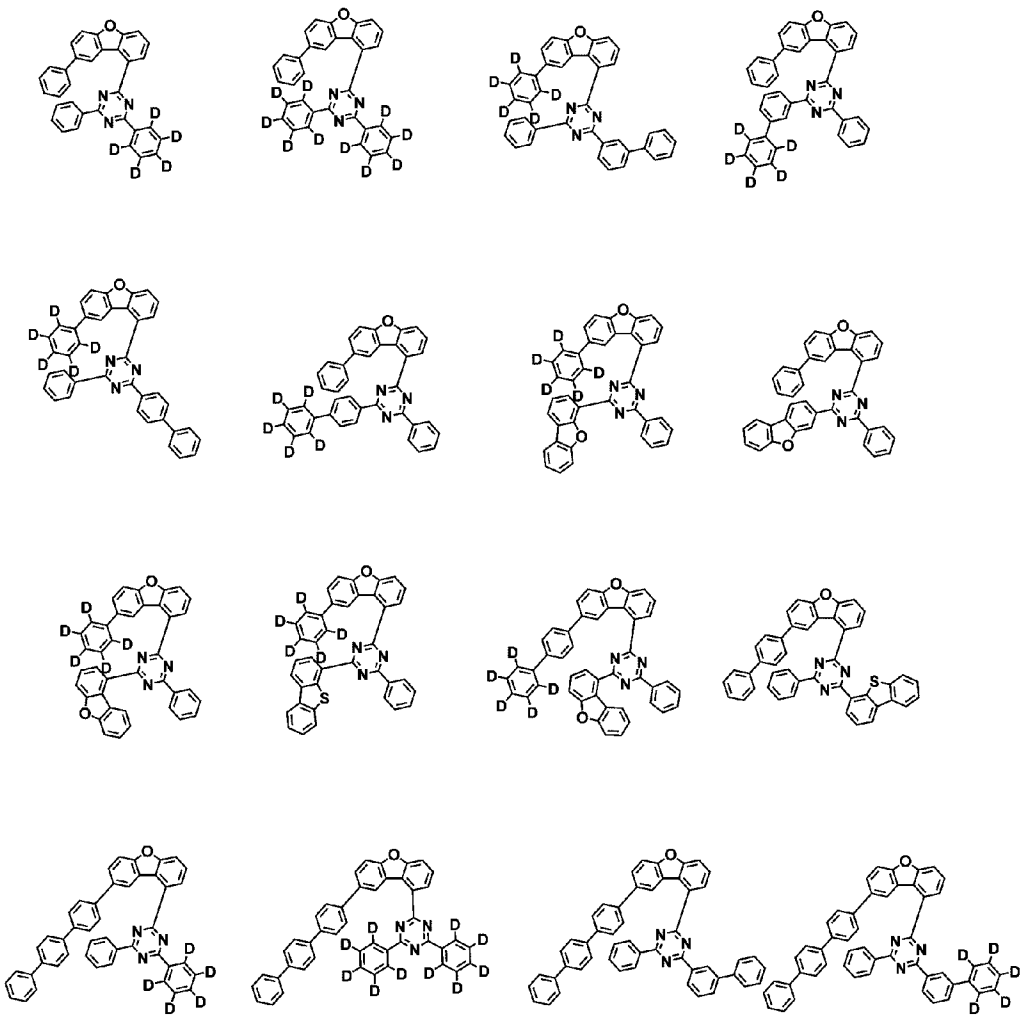


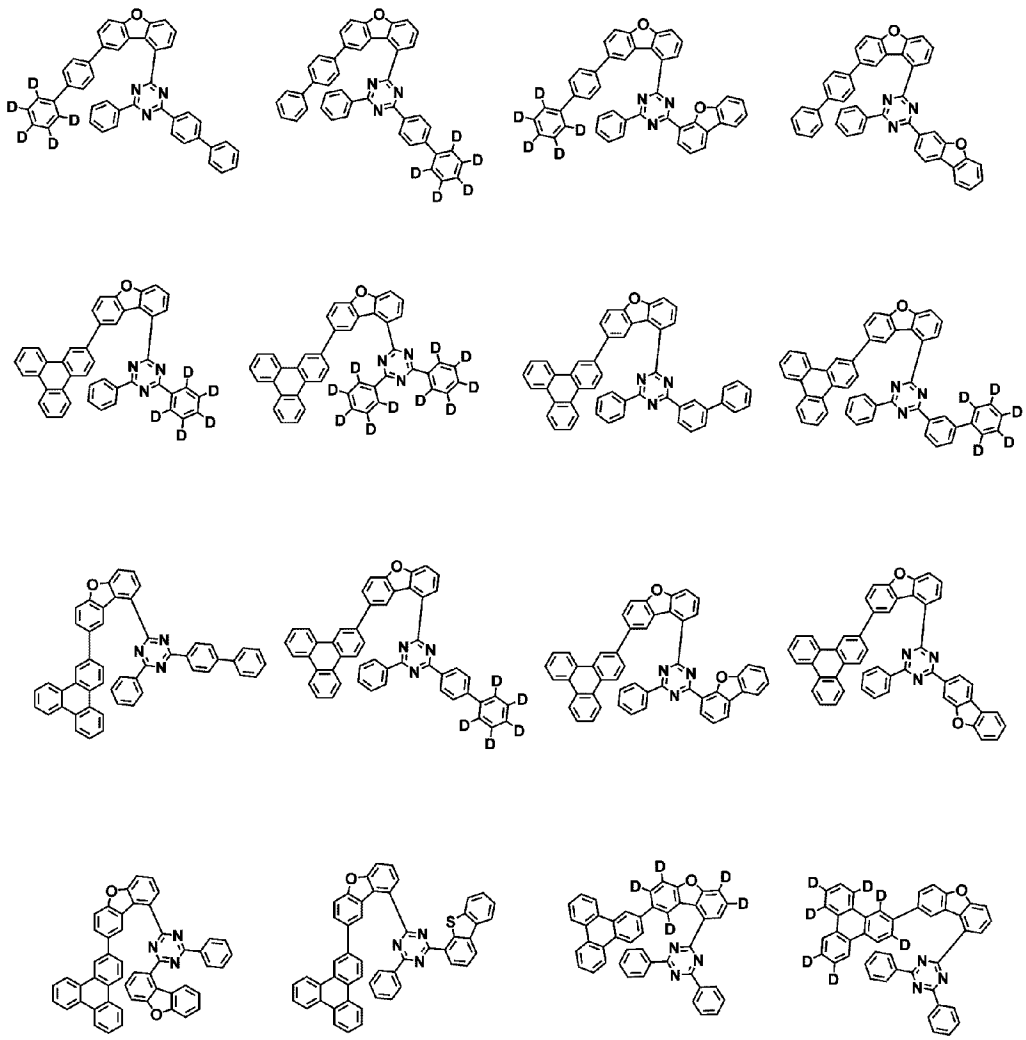















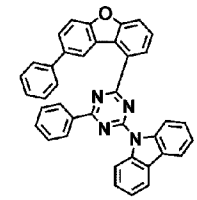
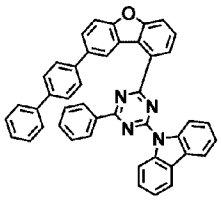
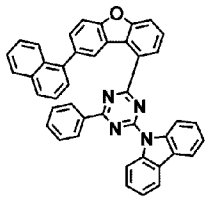
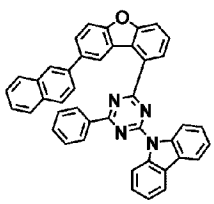
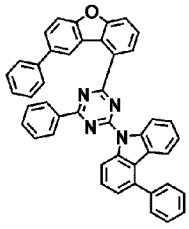
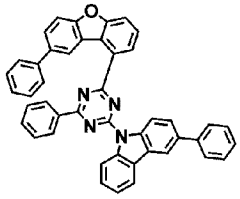
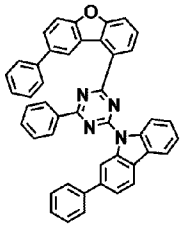
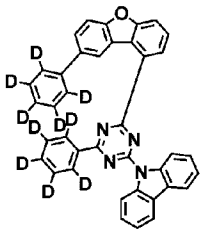
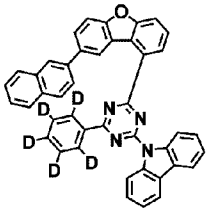
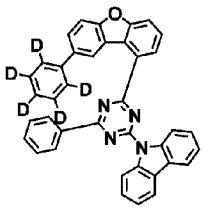
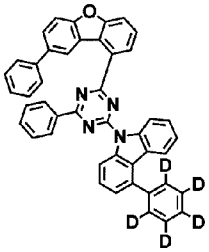


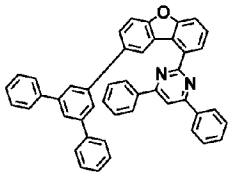
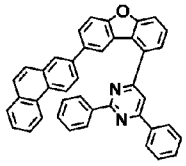
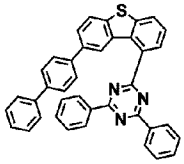
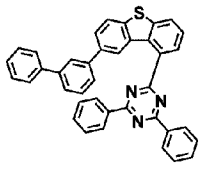
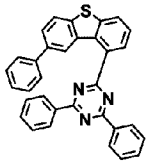
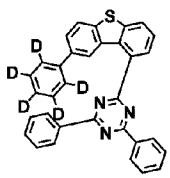
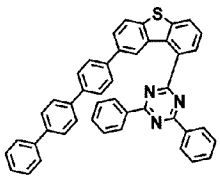
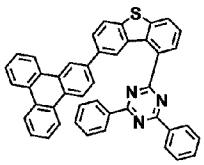
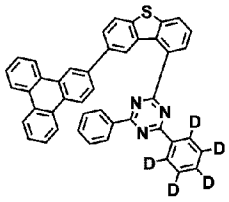


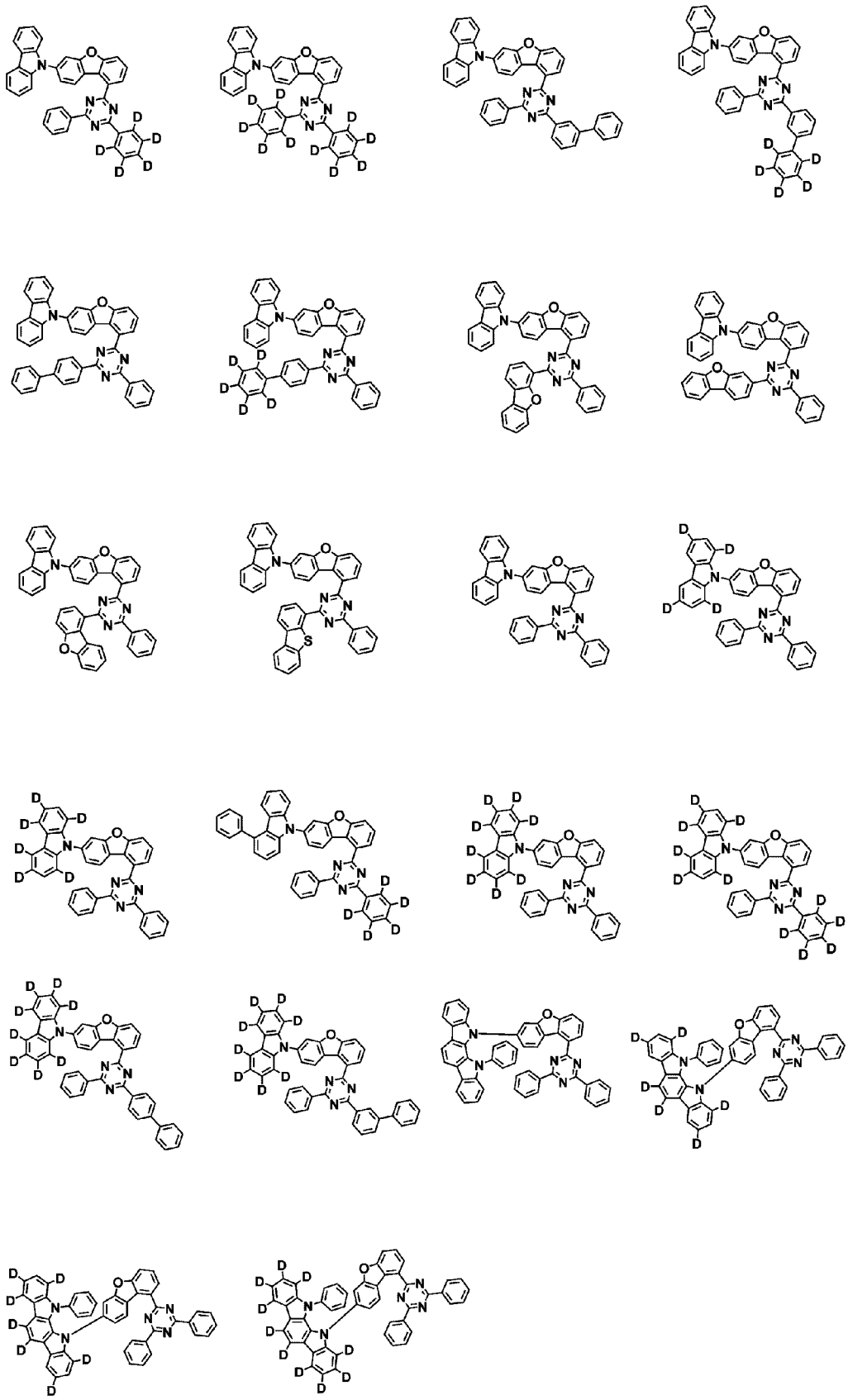


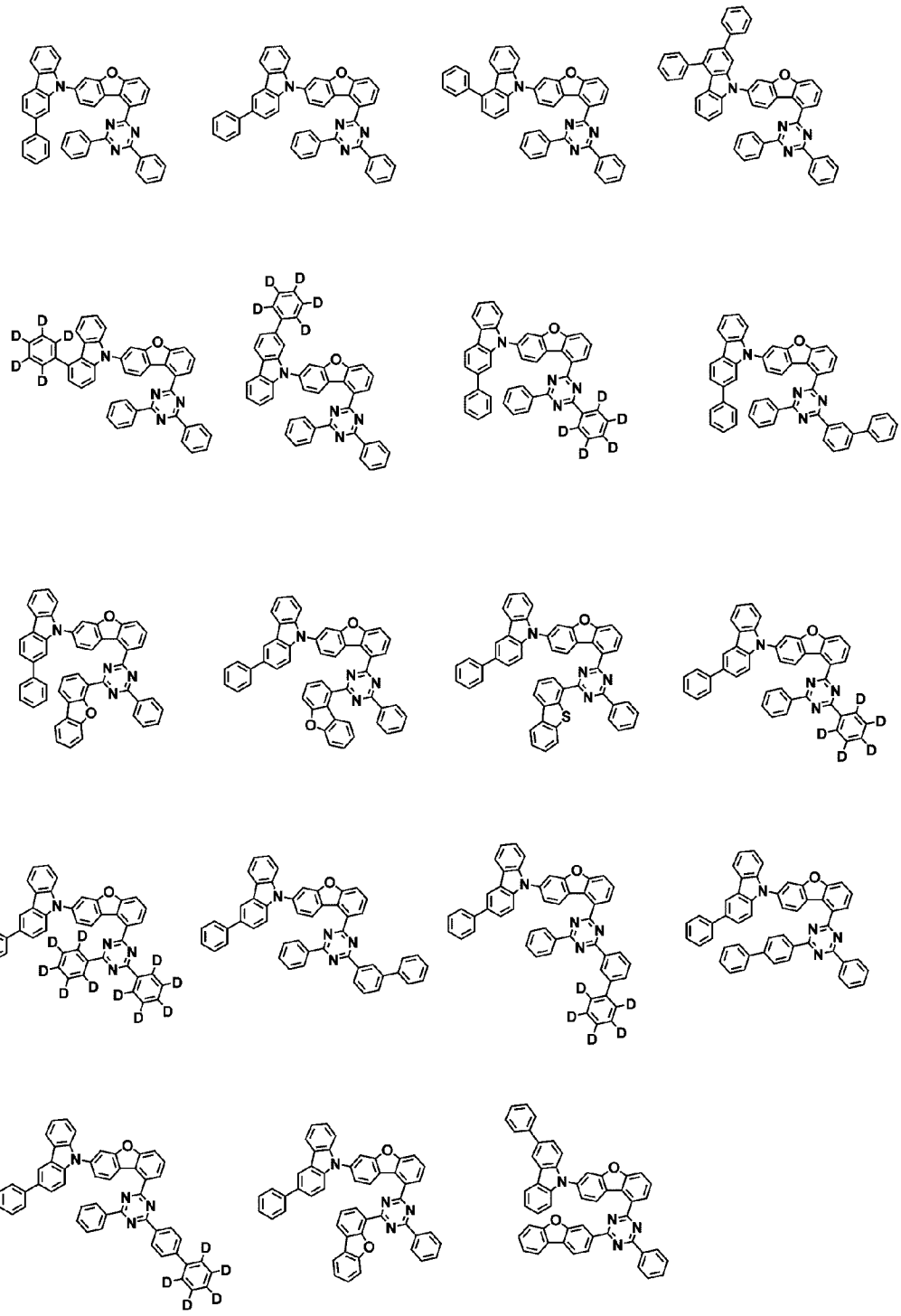


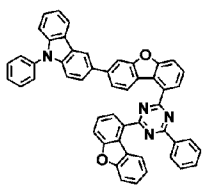
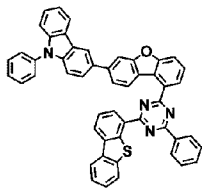
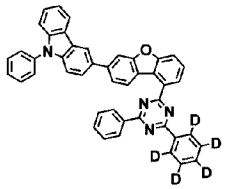
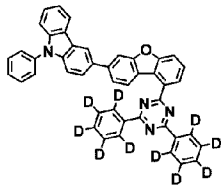
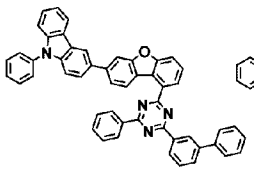
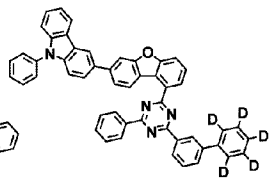
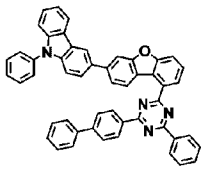
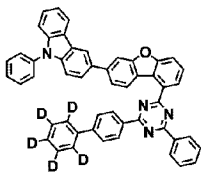
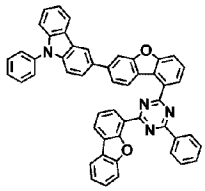
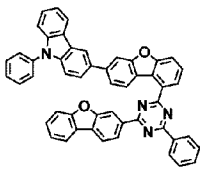
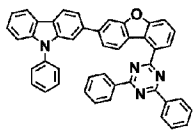
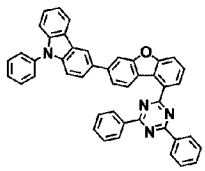
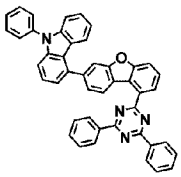
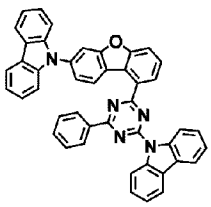
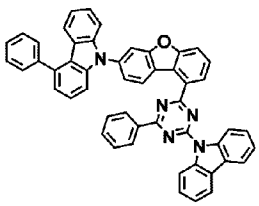
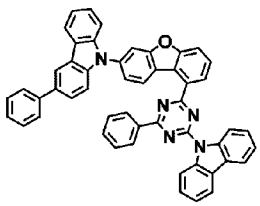
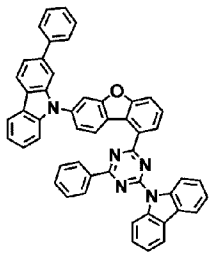
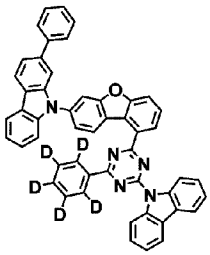


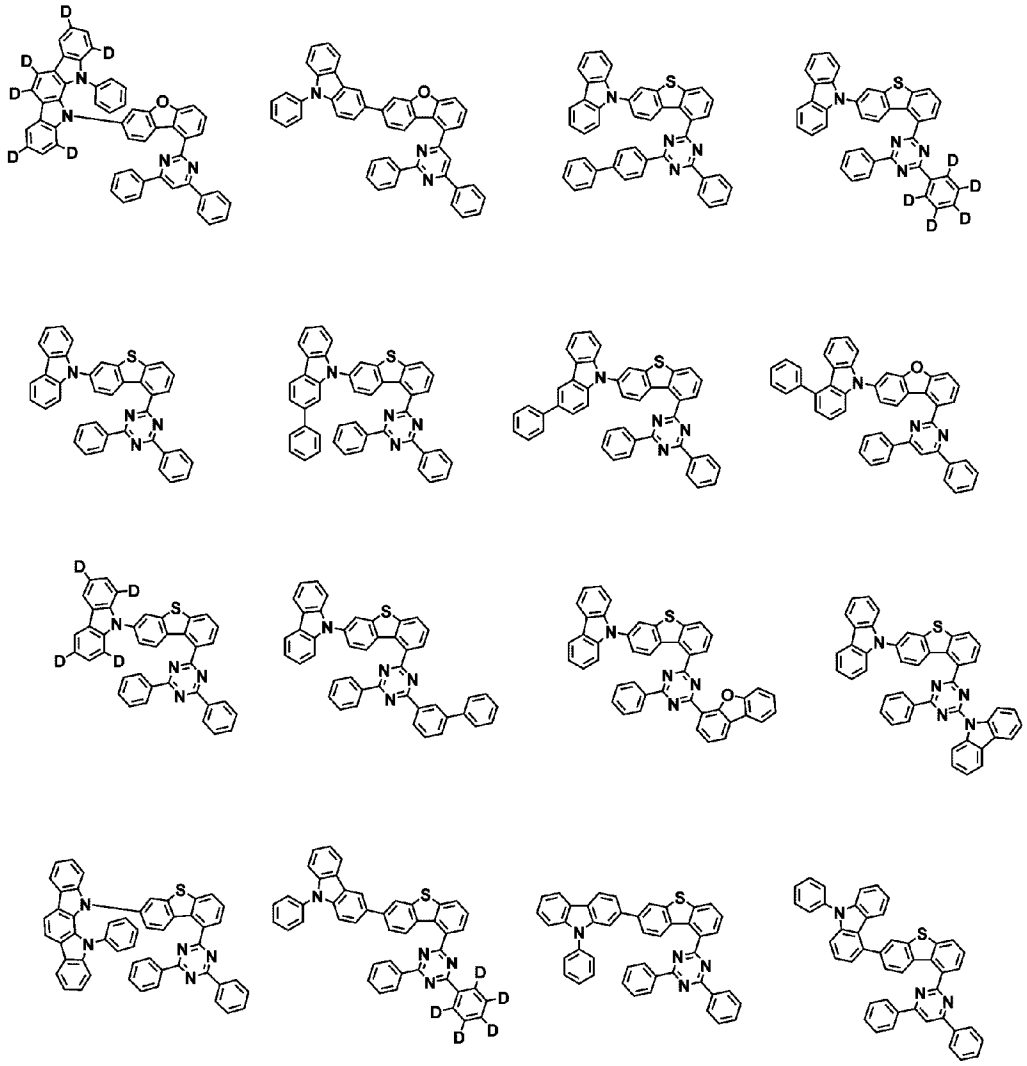












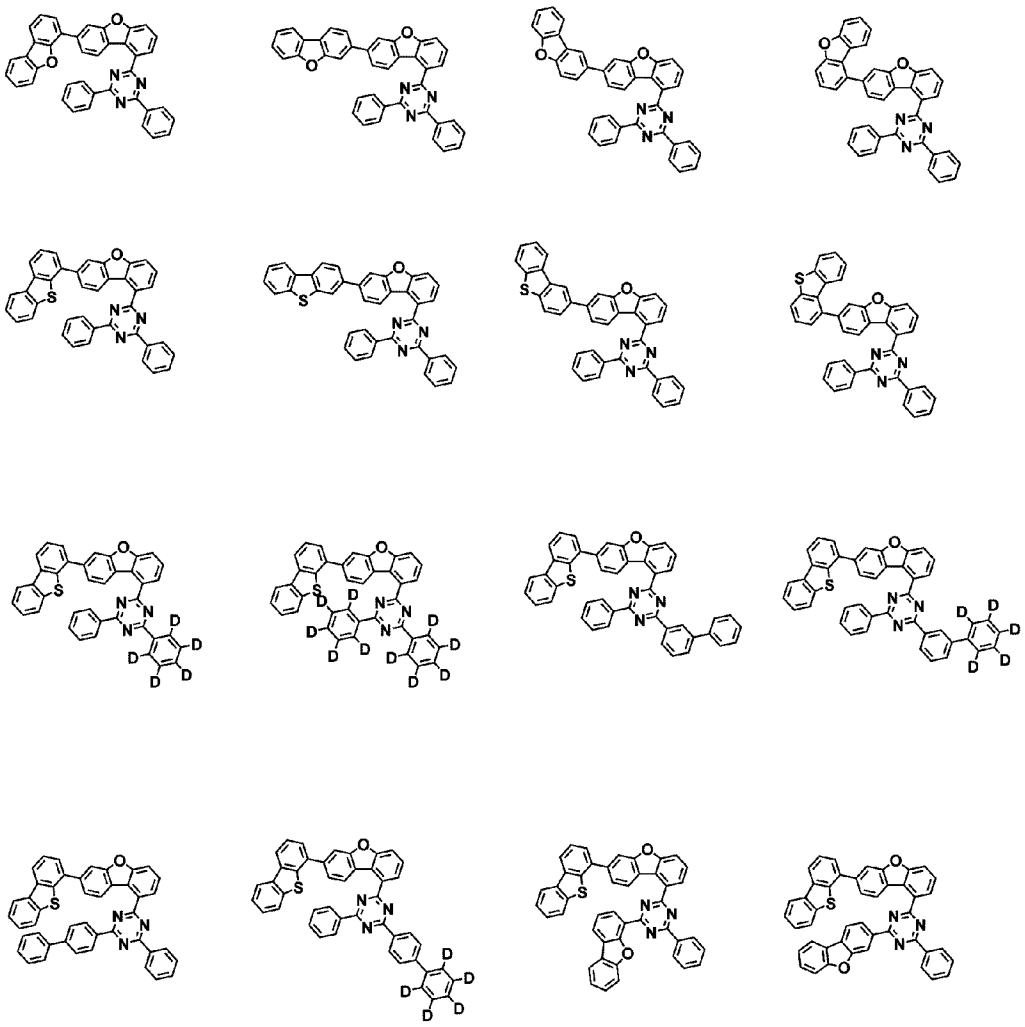










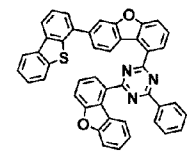
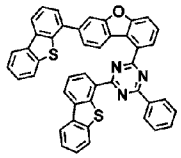
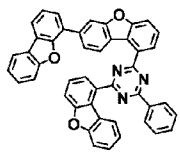
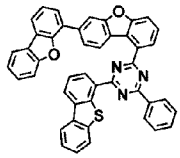
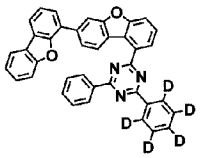
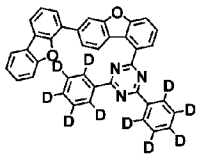
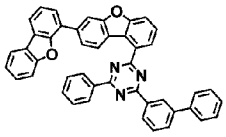
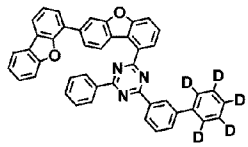
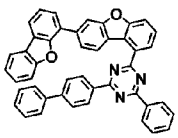
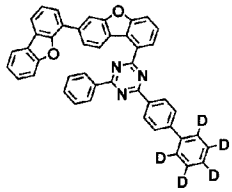
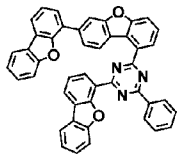
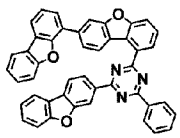
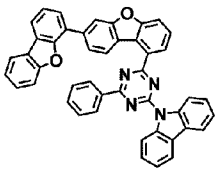
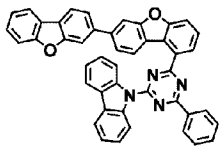
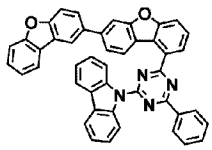
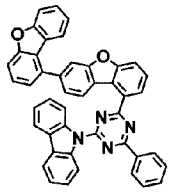
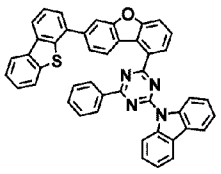
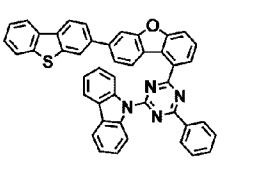
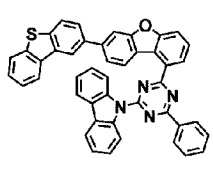
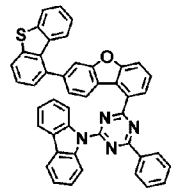
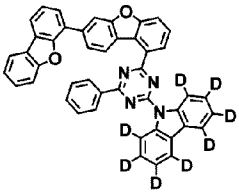


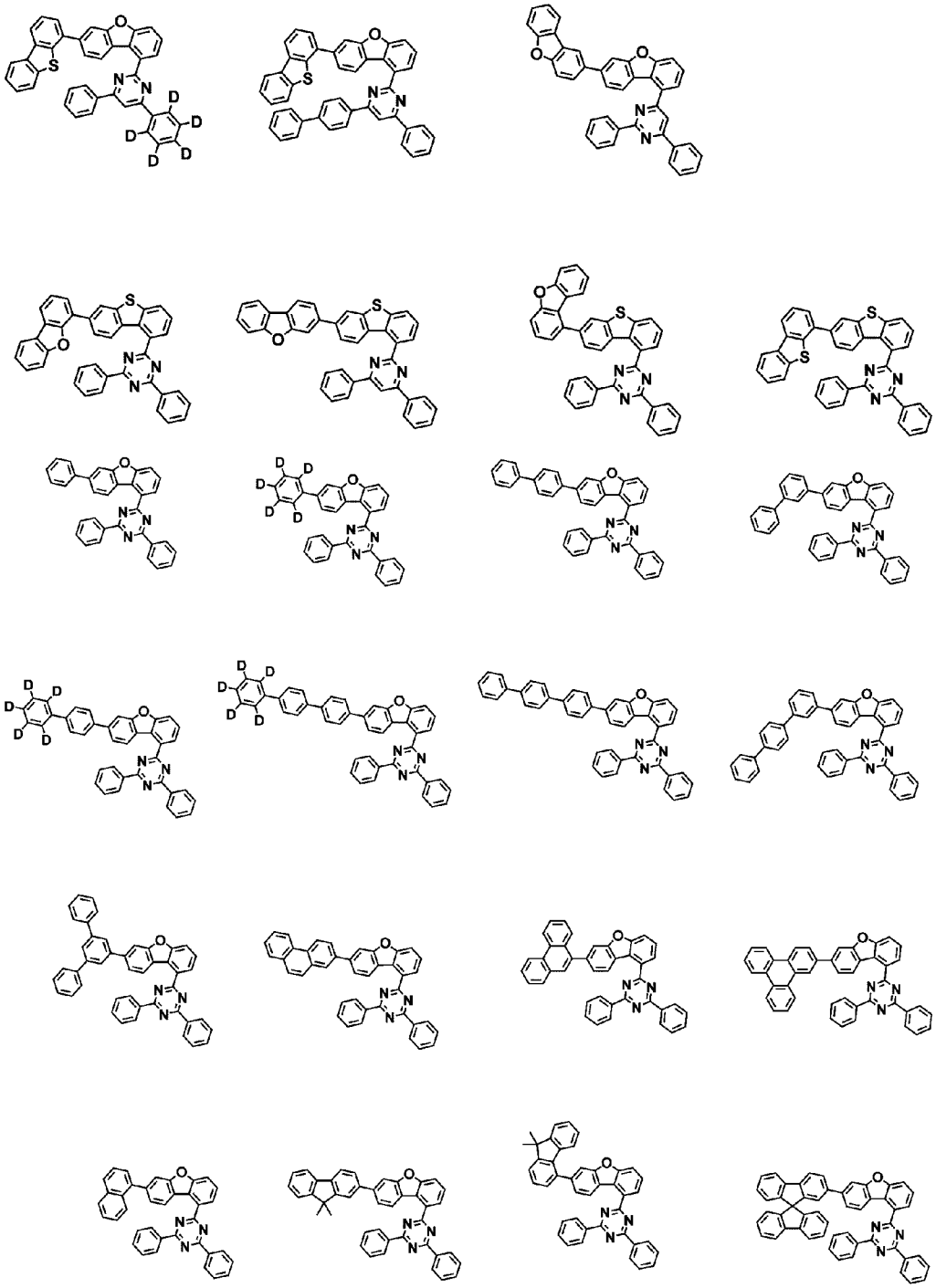


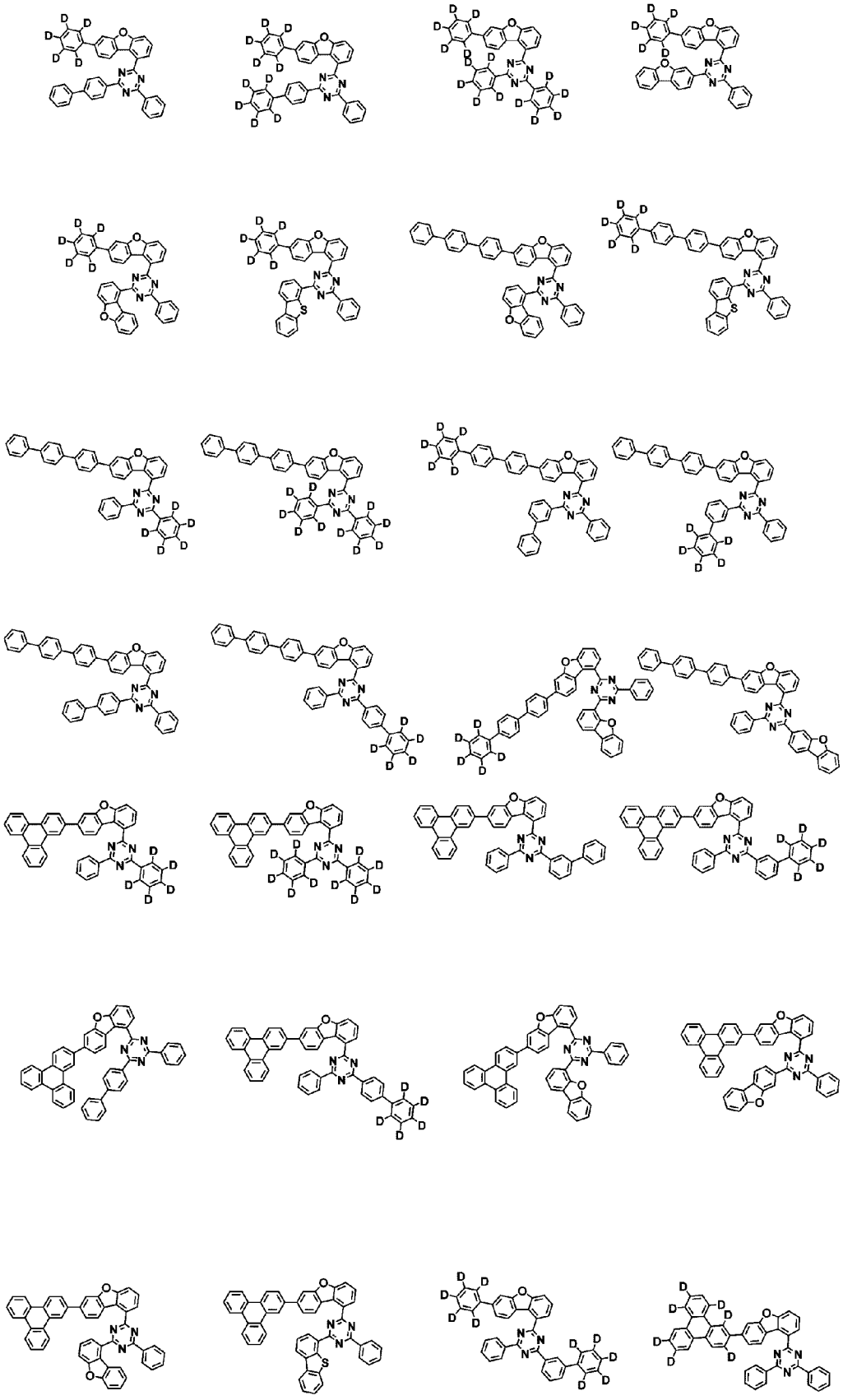



















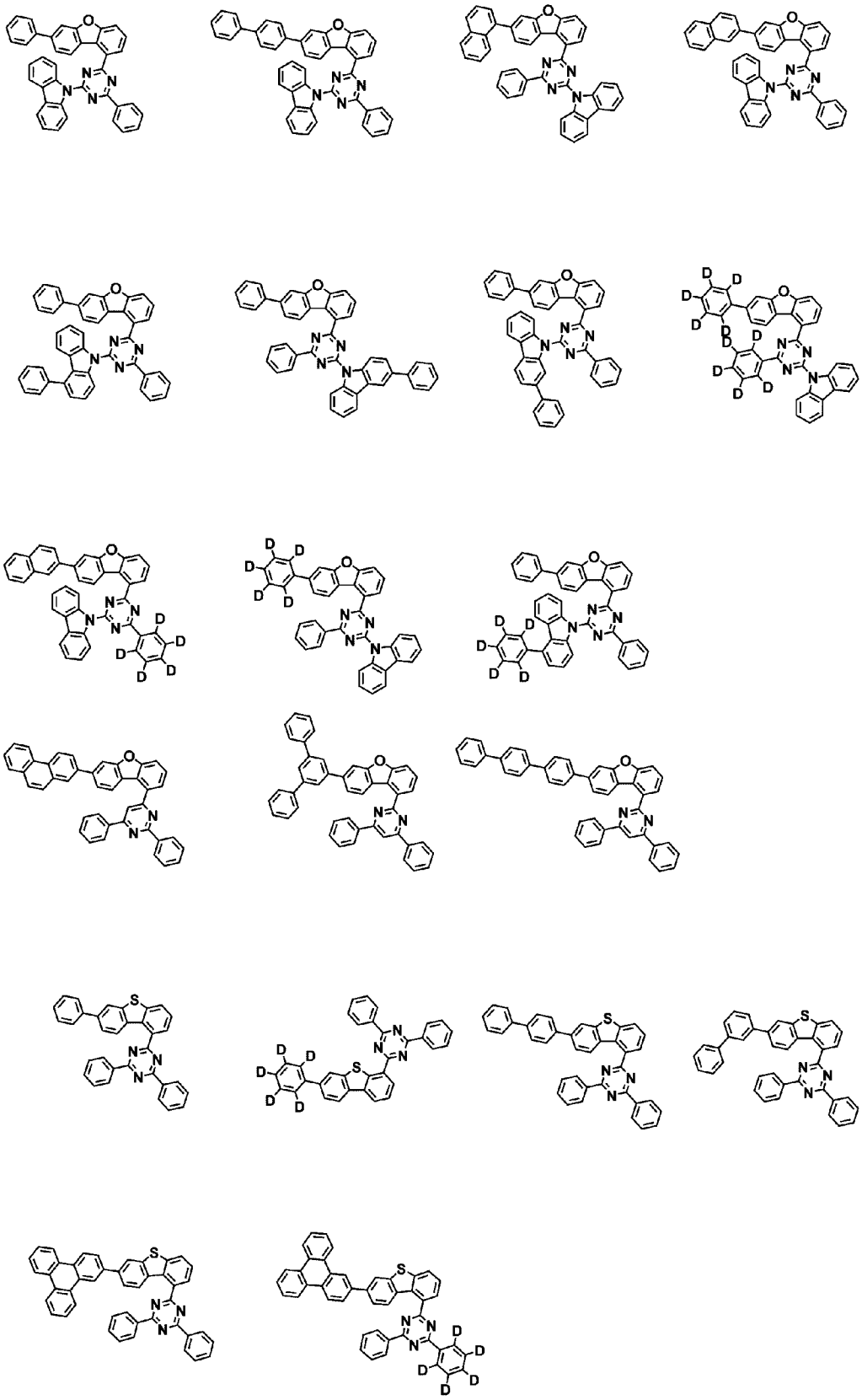


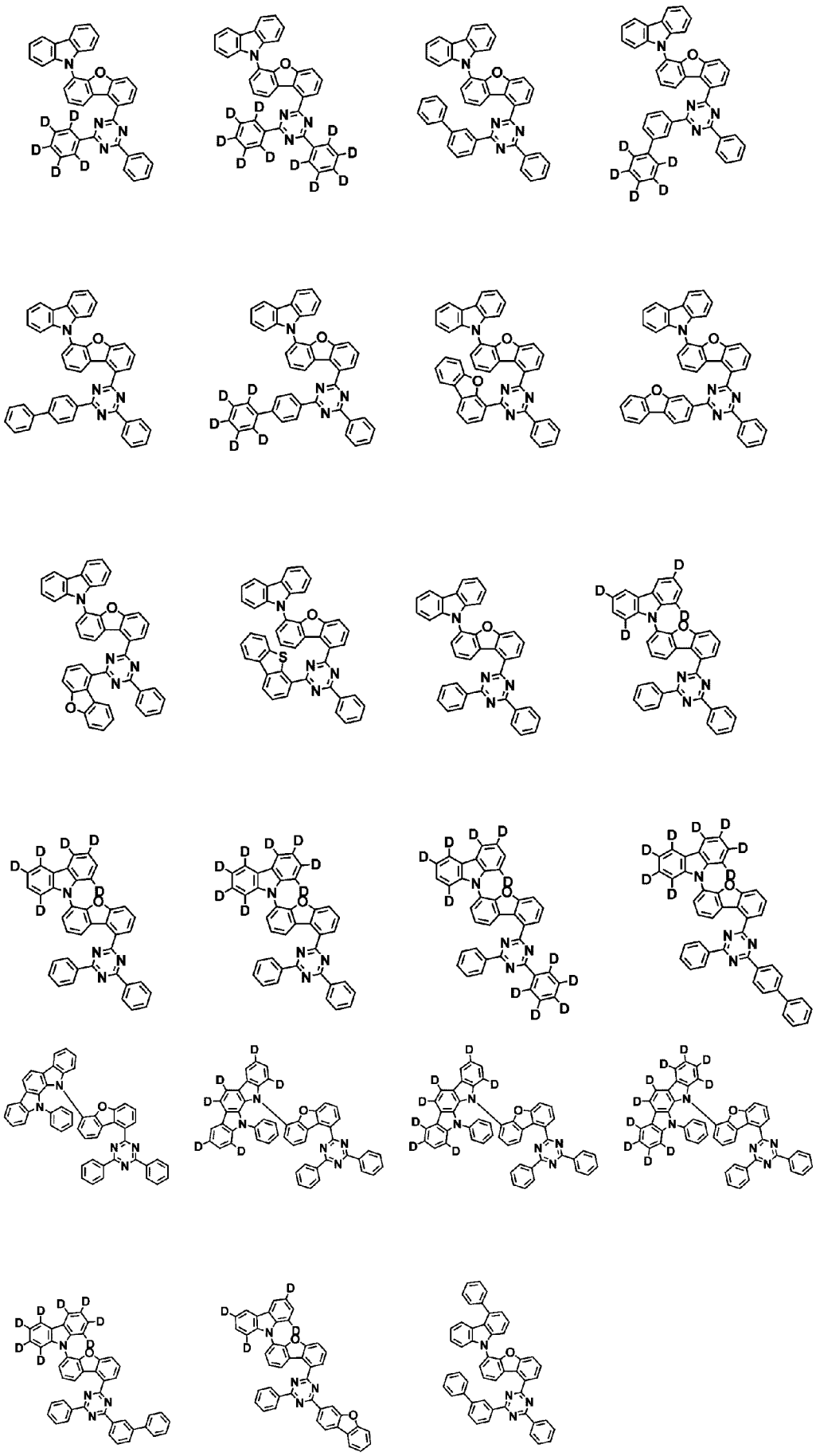


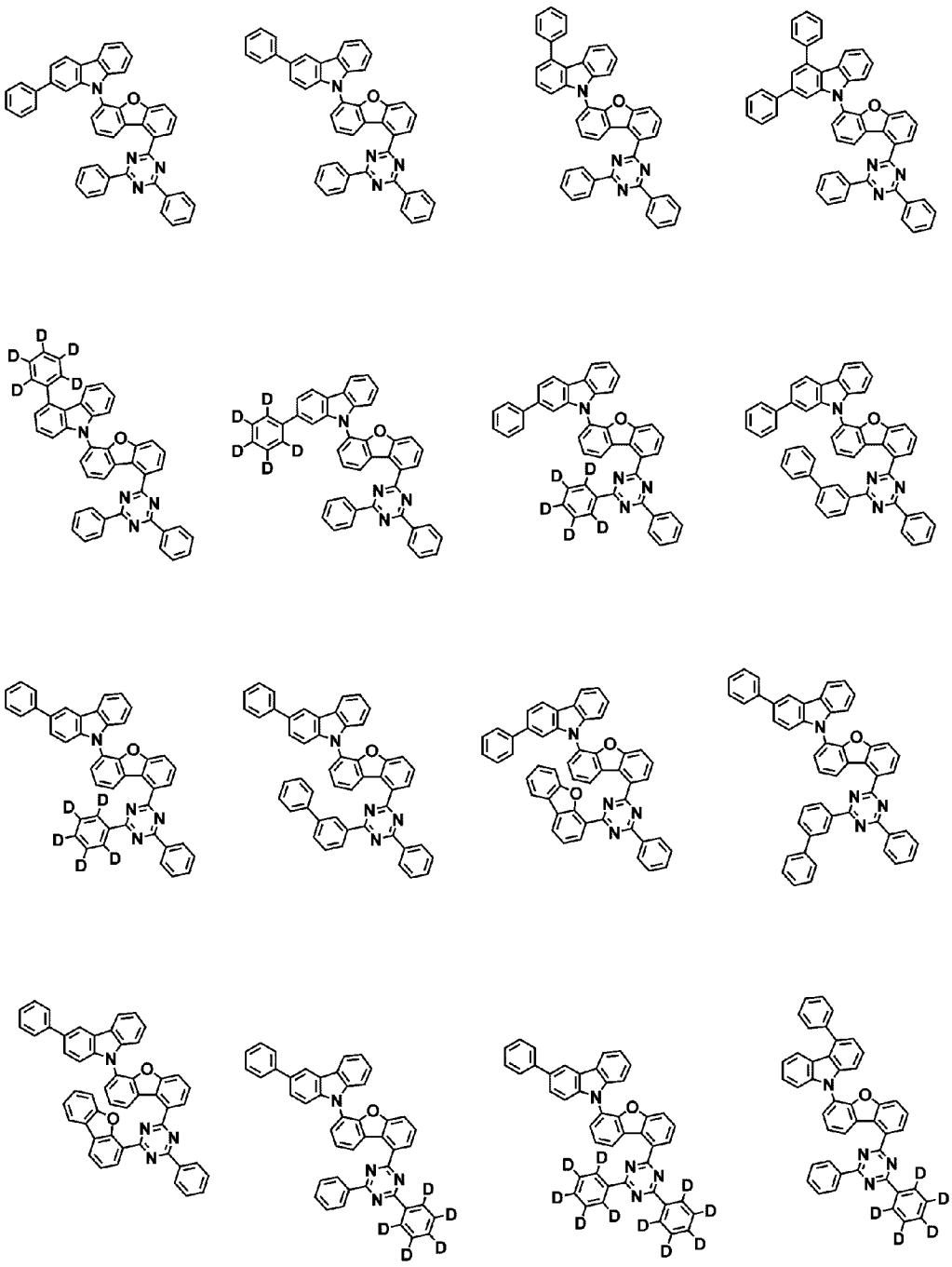






















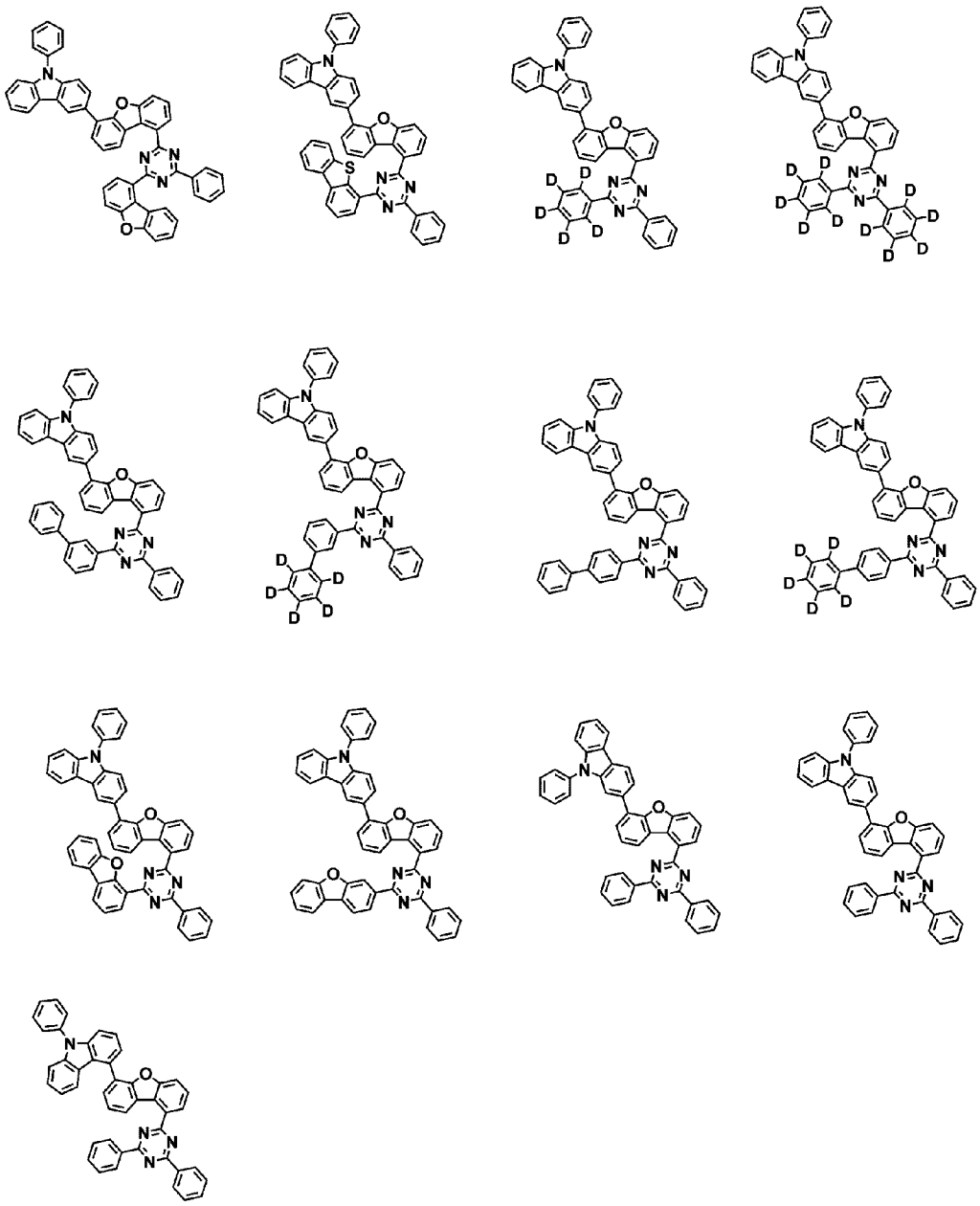


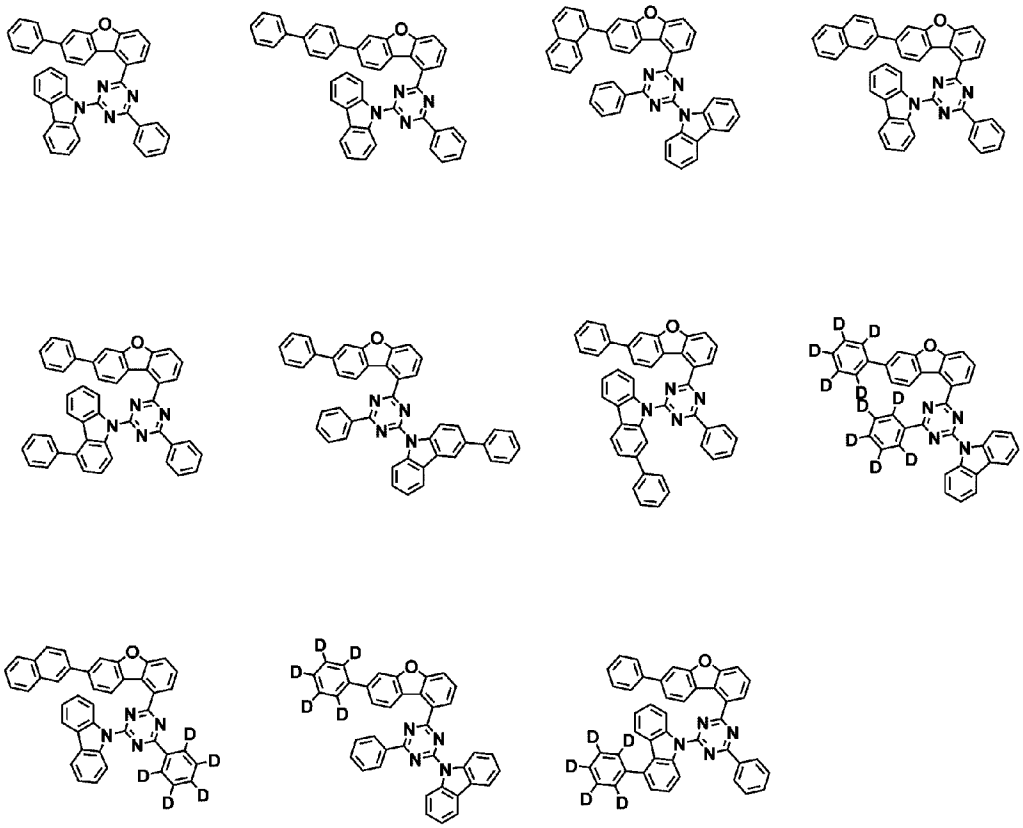


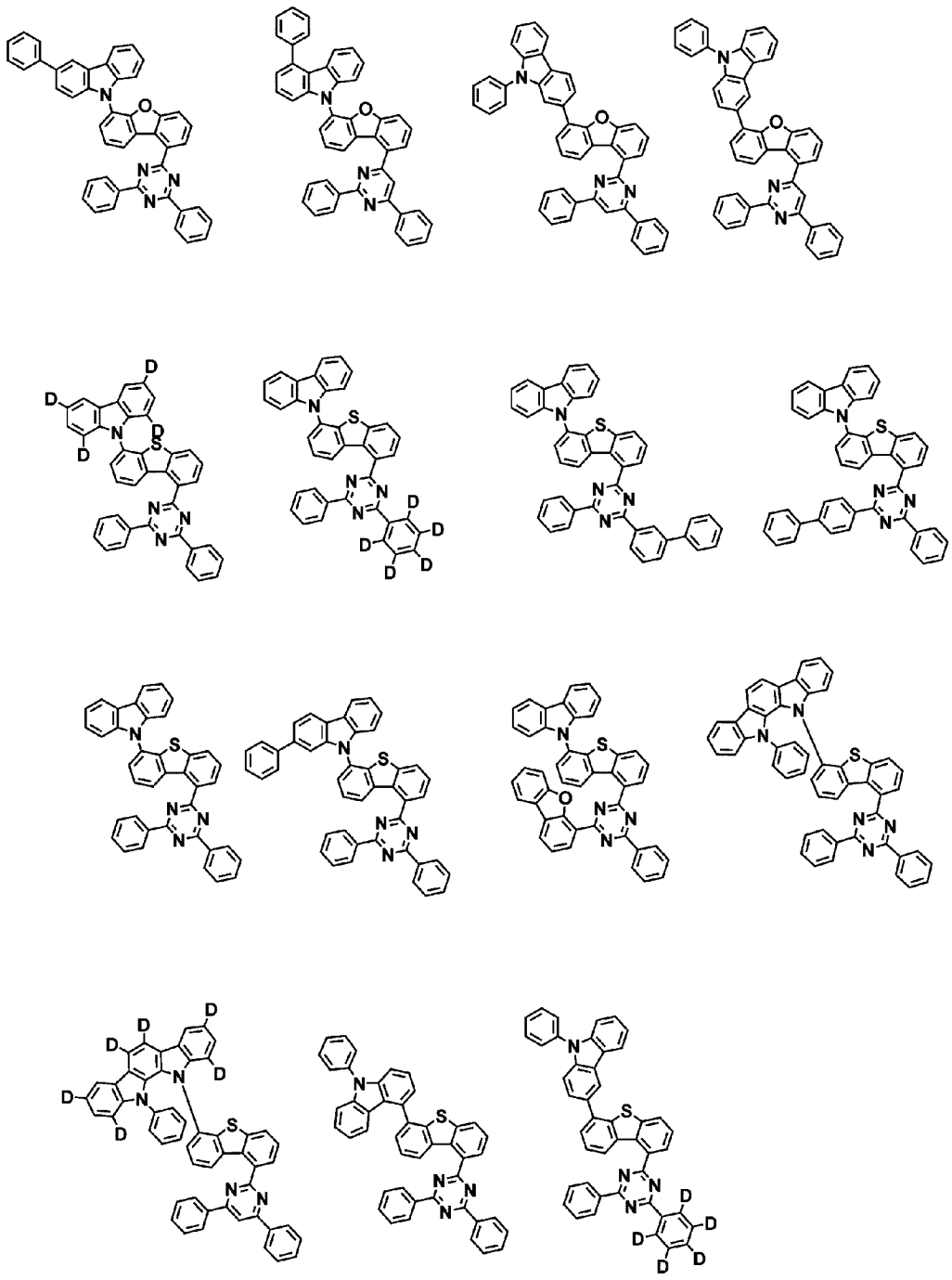


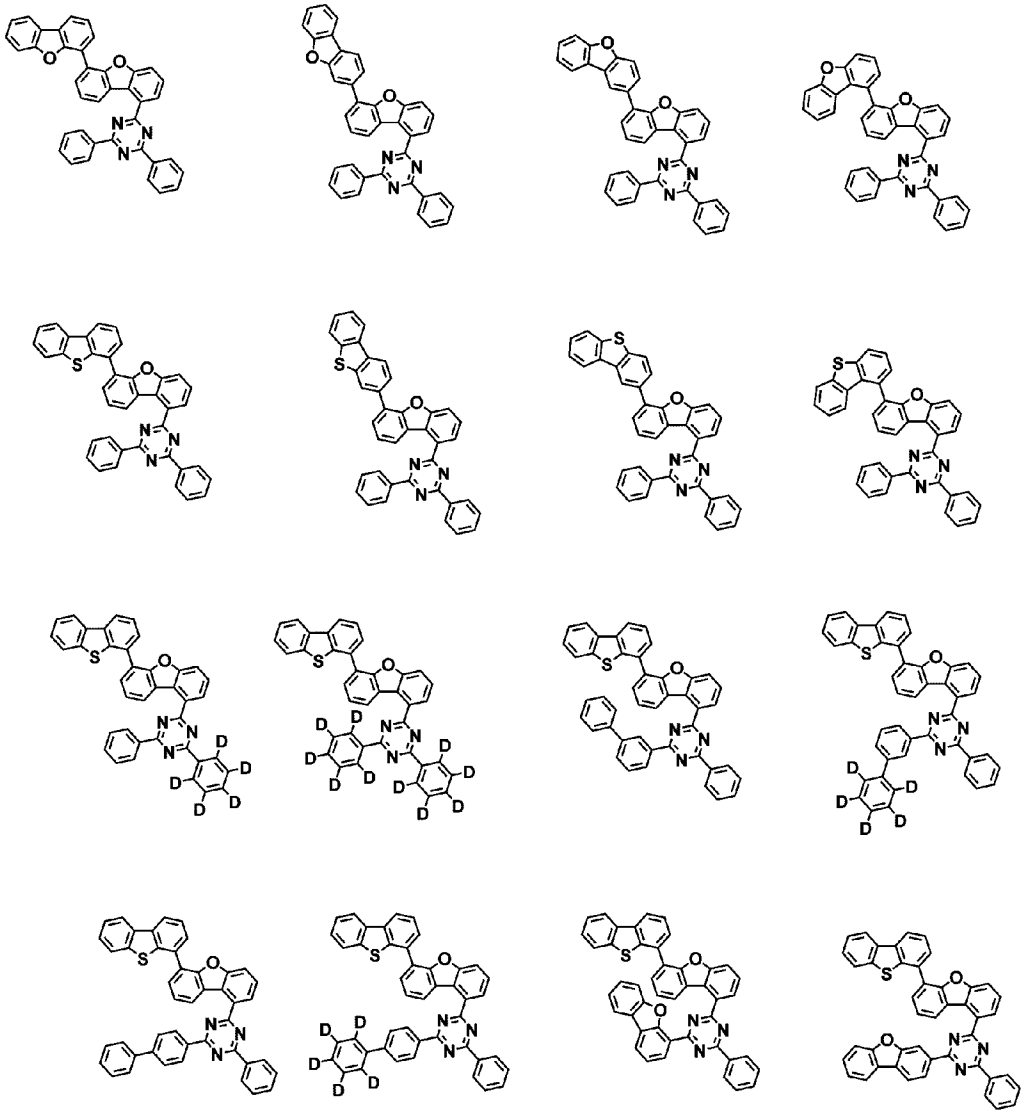


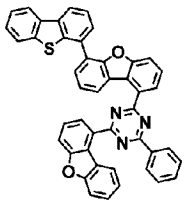
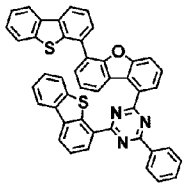
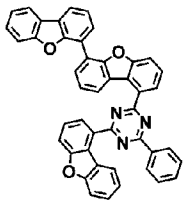
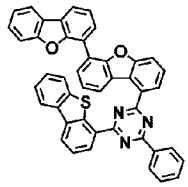
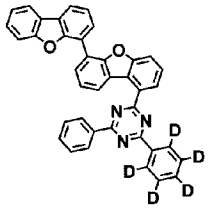
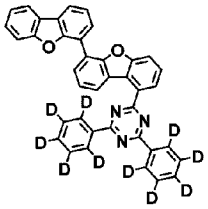
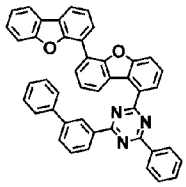
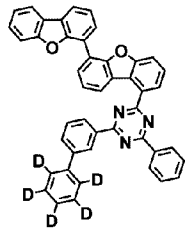
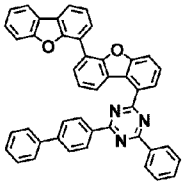
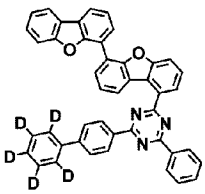
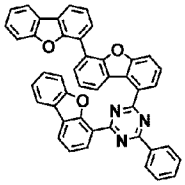
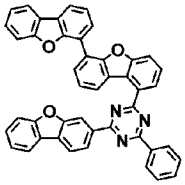


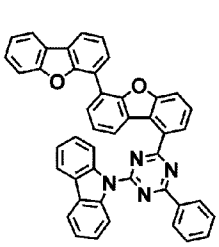
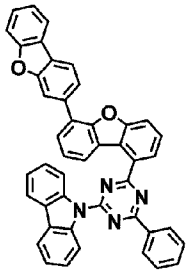
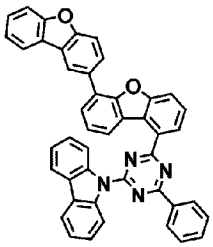
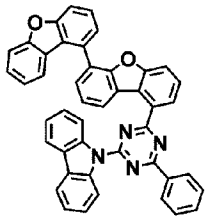
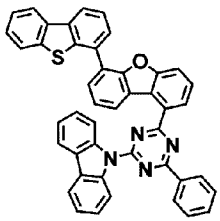
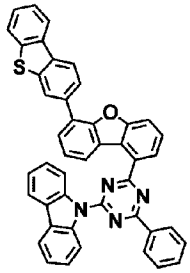
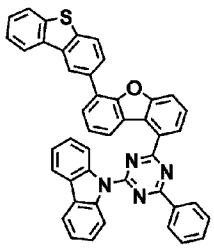
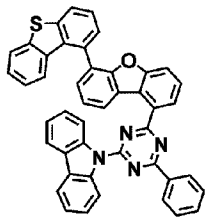
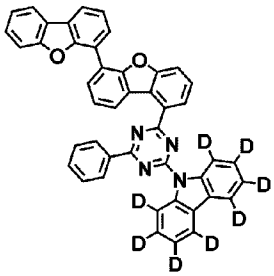


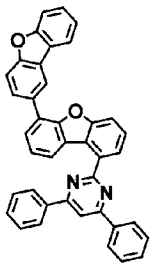
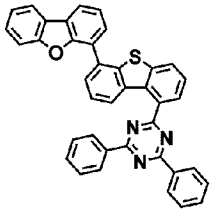
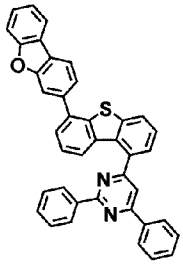
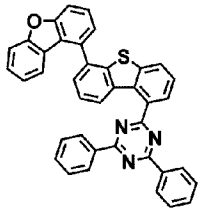
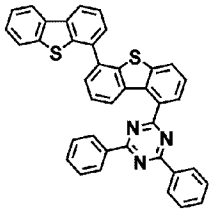
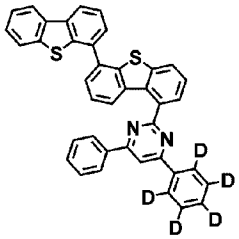
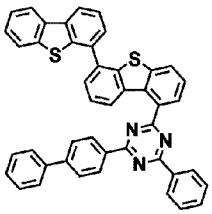
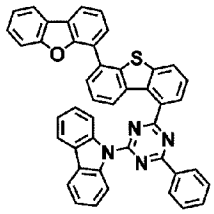


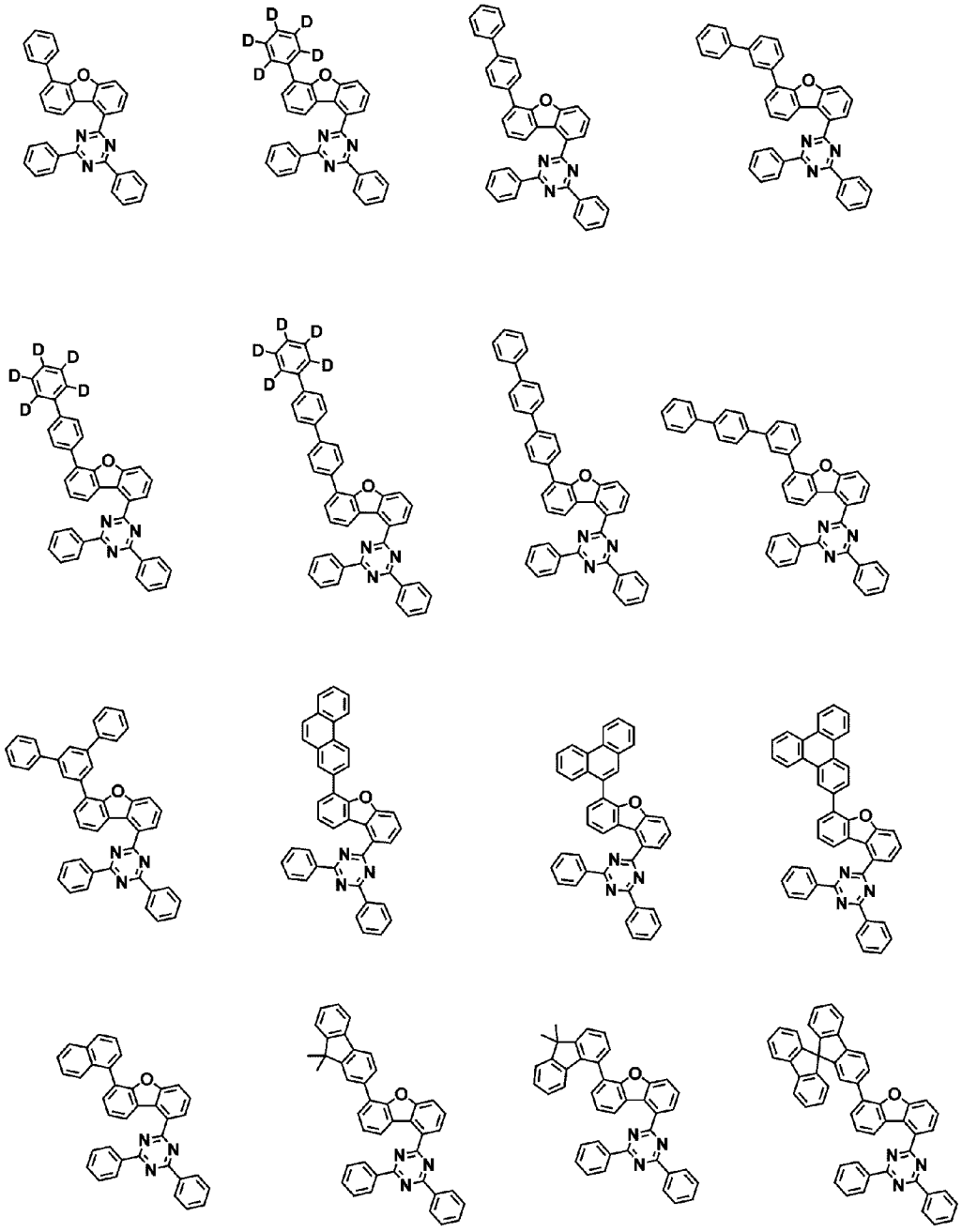


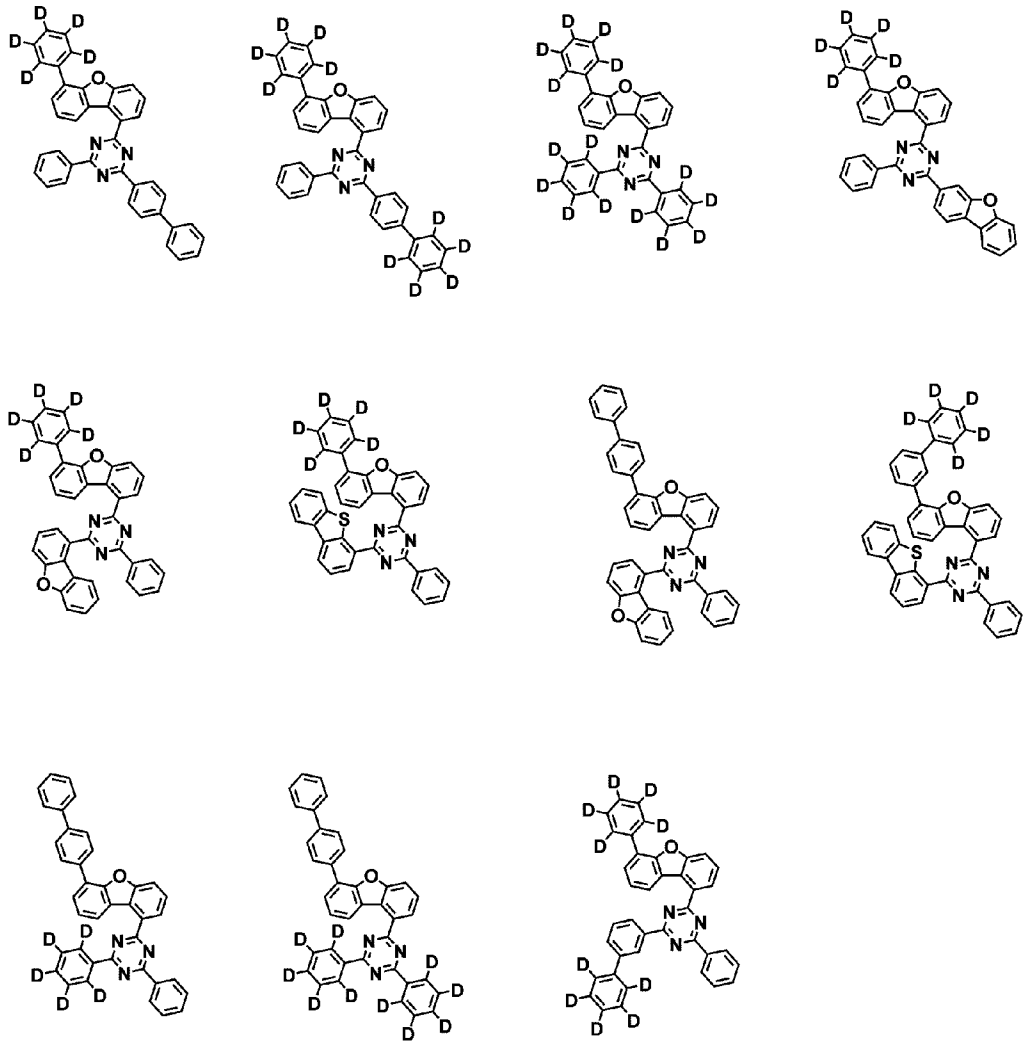


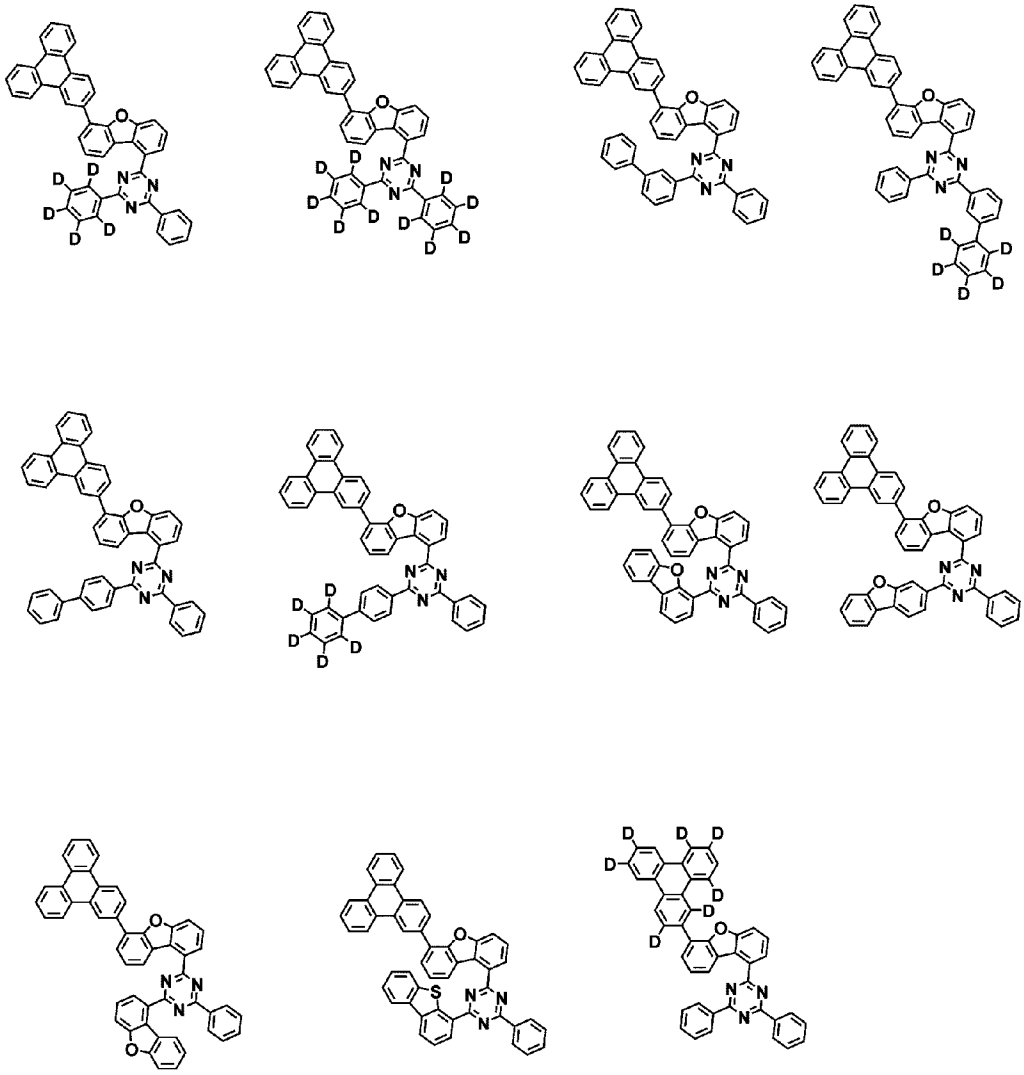













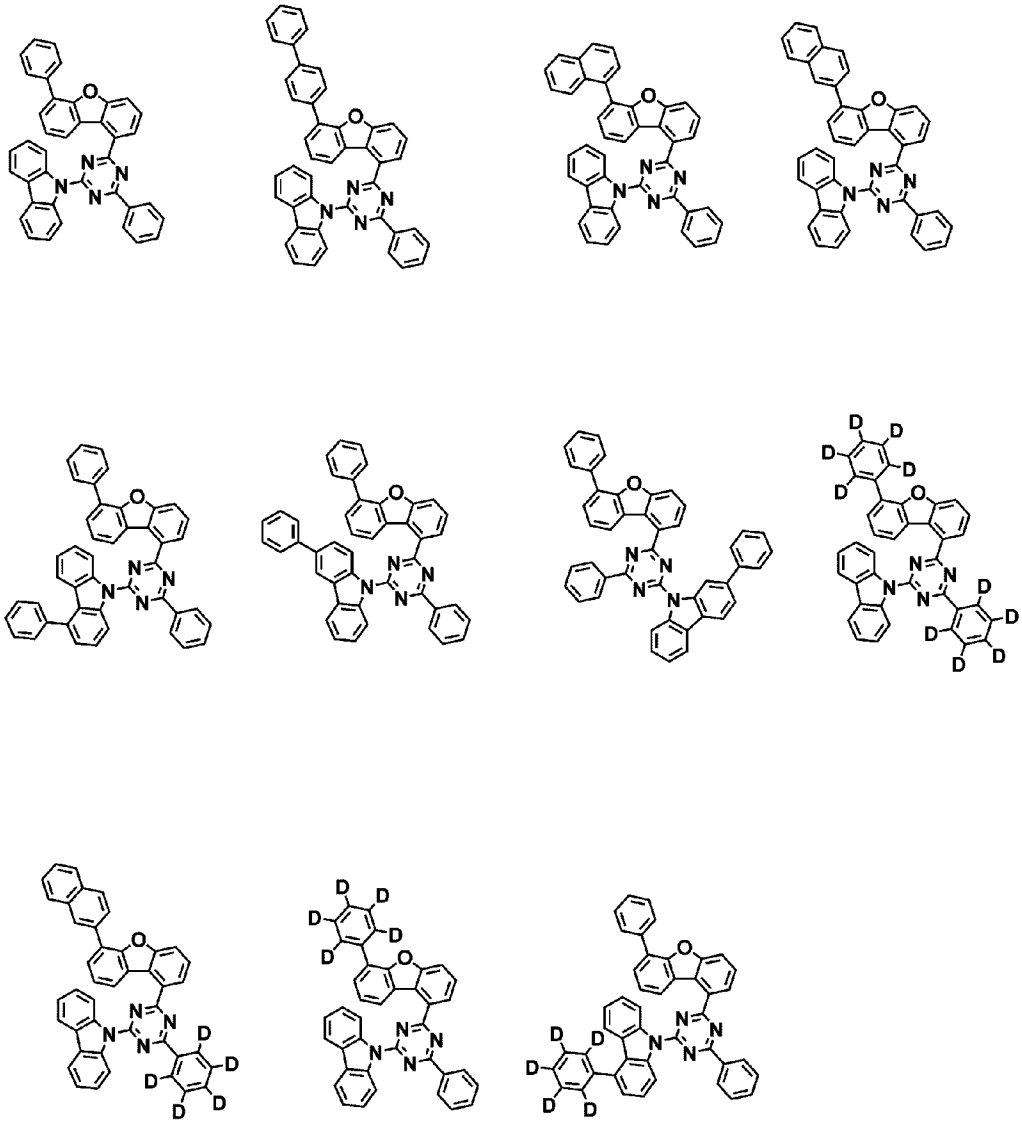










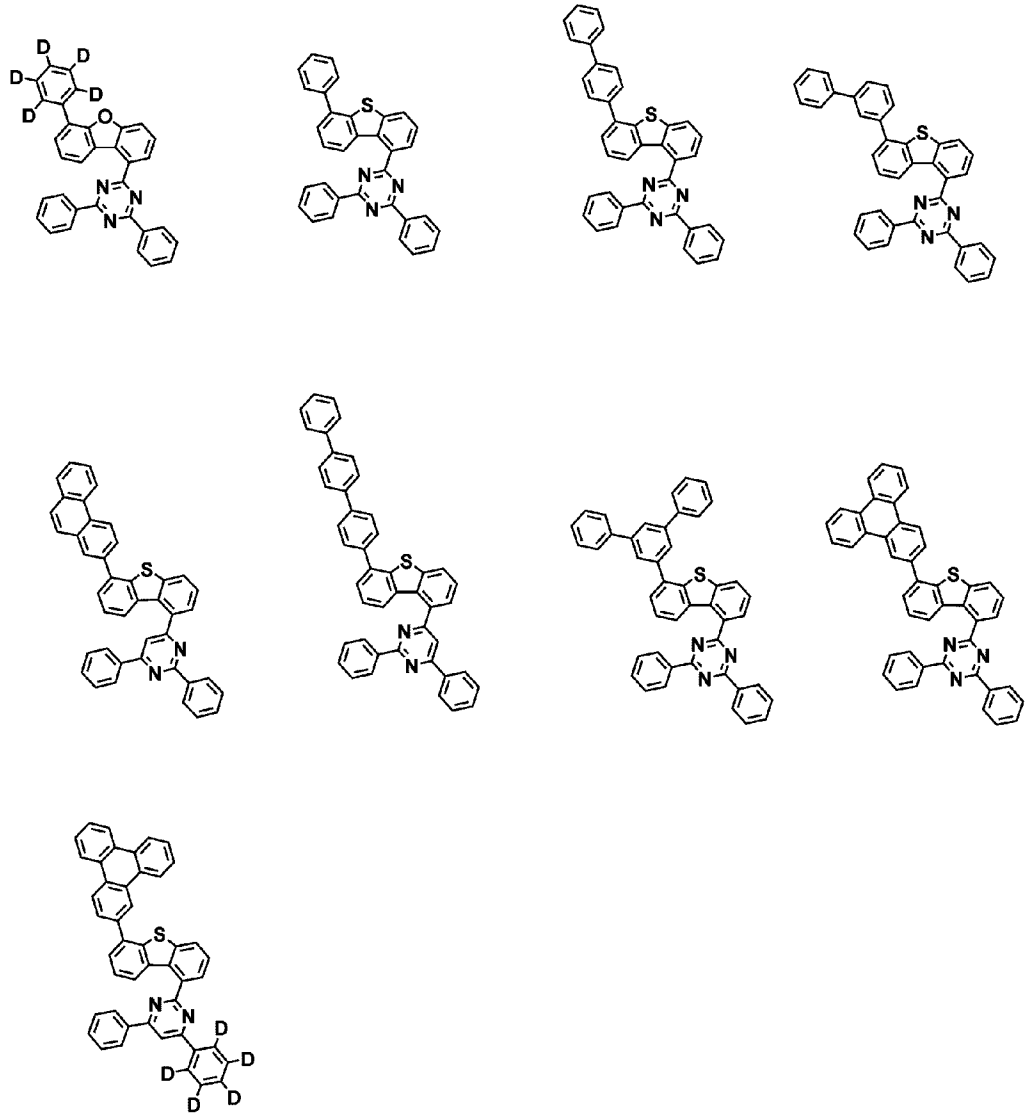



















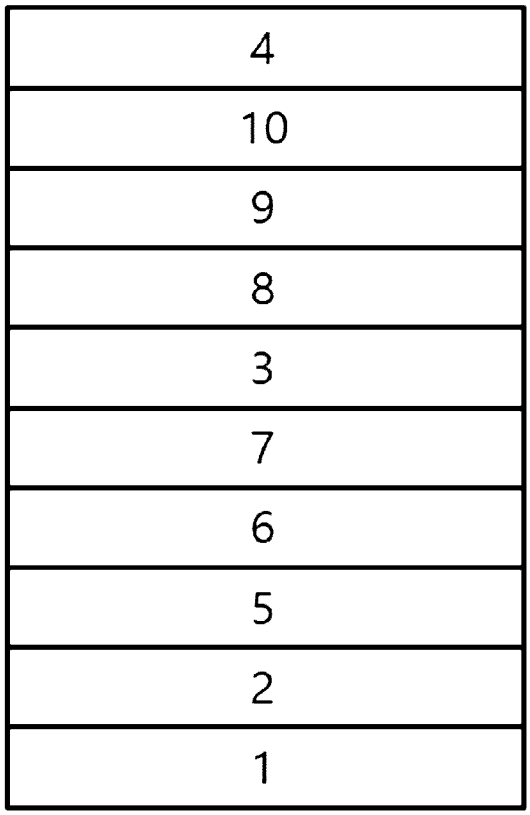
.

[청구항 25] 제1항에 있어서,
(상기 제1 화합물과 상기 제2 화합물의 중량의 합) 및 (상기 제3 화합물의 중량)의 비는 90:10 내지 10:90인,
유기 발광 소자

[도1]



[도2]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/009191

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(2006.01); C07D 209/88(2006.01); C07D 401/12(2006.01); C07D 401/14(2006.01); H01L 51/50(2006.01)

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) & keywords: 유기 발광 소자(organic light emitting device), 발광층(light emitting layer), 카바졸(carbazole), 디벤조티오펜(dibenzothiophene), 디벤조퓨란(dibenzofuran)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2020-0083171 A (SAMSUNG ELECTRONICS CO., LTD.) 08 July 2020 (2020-07-08) See claims 1, 12 and 14-16; pages 28 and 35; paragraphs [0168] and [0273]-[0275]; table 2; and example 1.	1-25
A	KR 10-2020-0076817 A (SAMSUNG DISPLAY CO., LTD.) 30 June 2020 (2020-06-30) See claims 1 and 13.	1-25
A	KR 10-2020-0082176 A (LT MATERIALS CO., LTD.) 08 July 2020 (2020-07-08) See claims 1, 8 and 9.	1-25
A	US 2020-0079735 A1 (UNIVERSAL DISPLAY CORPORATION) 12 March 2020 (2020-03-12) See entire document.	1-25
A	CN 110615782 A (BEIJING ETERNAL MATERIAL TECHNOLOGY CO., LTD. et al.) 27 December 2019 (2019-12-27) See entire document.	1-25

☐ 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
"D" document cited by the applicant in the international application
"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
01 November 2021	**01 November 2021**

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2021/009191

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2020-0083171 A	08 July 2020	CN 111384300 A	07 July 2020
		EP 3675194 A1	01 July 2020
		JP 2020-107868 A	09 July 2020
		US 2020-0212314 A1	02 July 2020
KR 10-2020-0076817 A	30 June 2020	CN 111341924 A	26 June 2020
		EP 3671884 A1	24 June 2020
		EP 3671884 B1	06 January 2021
		JP 2020-102603 A	02 July 2020
		US 2020-0203621 A1	25 June 2020
KR 10-2020-0082176 A	08 July 2020	KR 10-2261984 B1	09 June 2021
		TW 202033741 A	16 September 2020
		WO 2020-138959 A1	02 July 2020
US 2020-0079735 A1	12 March 2020	CN 110890472 A	17 March 2020
		KR 10-2020-0030480 A	20 March 2020
CN 110615782 A	27 December 2019	None	

국 제 조 사 보 고 서

국제출원번호
PCT/KR2021/009191

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(2006.01); C07D 209/88(2006.01); C07D 401/12(2006.01); C07D 401/14(2006.01); H01L 51/50(2006.01)

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) & 키워드: 유기 발광 소자 (organic light emitting device), 발광층(light emitting layer), 카바졸(carbazole), 디벤조티오펜(dibenzothiophene), 디벤조퓨란(dibenzofuran)

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
X	KR 10-2020-0083171 A (삼성전자주식회사) 2020.07.08 청구항 1, 12, 14-16; 페이지 28, 35; 단락 [0168], [0273]-[0275]; 표 2; 실시예 1	1-25
A	KR 10-2020-0076817 A (삼성디스플레이 주식회사) 2020.06.30 청구항 1, 13	1-25
A	KR 10-2020-0082176 A (엘티소재주식회사) 2020.07.08 청구항 1, 8, 9	1-25
A	US 2020-0079735 A1 (UNIVERSAL DISPLAY CORPORATION) 2020.03.12 전체 문헌	1-25
A	CN 110615782 A (BEIJING ETERNAL MATERIAL TECHNOLOGY CO., LTD. 등) 2019.12.27 전체 문헌	1-25

☐ 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

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