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H10K 85/371 (2023.02)
C09K 11/06 (2022.01)
(21) 출원번호 10-2021-0125203
(22) 출원일자 2021년09월17일
심사청구일자 없음

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(뒷면에 계속)
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리앤목특허법인

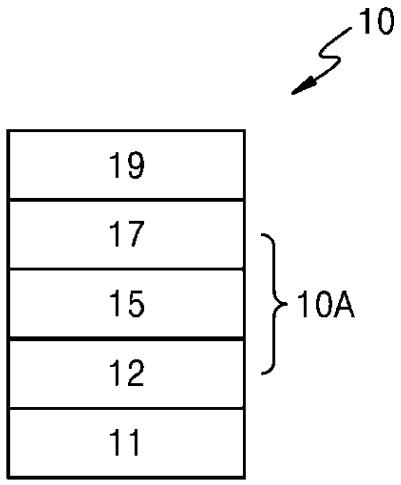
전체 청구항 수 : 총 20 항

(54) 발명의 명칭 **유기 발광 소자**

(57) 요 약

소정의 호스트, 센서타이저 및 에미터를 포함하는 발광층을 포함한 유기 발광 소자가 제시된다.

대 표 도 - 도1



(52) CPC특허분류
H10K 50/11 (2023.02)
H10K 50/121 (2023.02)
H10K 85/322 (2023.02)
H10K 85/615 (2023.02)
H10K 85/631 (2023.02)
H10K 85/654 (2023.02)
H10K 85/6572 (2023.02)
H10K 85/6574 (2023.02)
H10K 85/6576 (2023.02)

(72) 발명자
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명 세 서

청구범위

청구항 1

제1전극;

제2전극; 및

상기 제1전극 및 상기 제2전극 사이에 개재된 유기층을 포함하고; 상기 유기층은 발광층을 포함하고;

상기 발광층은 호스트, 센서타이저 및 에미터를 포함하고;

상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고;

상기 센서타이저는 하기 화학식 1로 표시되는, 유기 발광 소자:

<화학식 1>

$M_1(L_1)(L_2)$

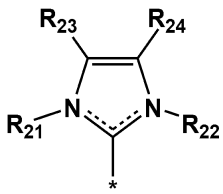
상기 화학식 1 중,

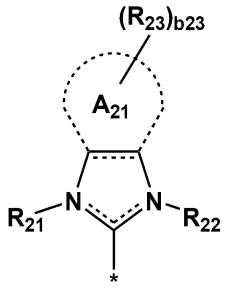
M_1은 Au, Ag 또는 Cu이고;

L_1은 하기 화학식 2-1 또는 2-2로 표시되는 리간드이고;

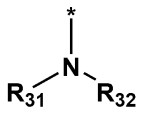
L_2는 하기 화학식 3-1, 3-2 및 3-3 중 어느 하나로 표시되는 리간드이고;

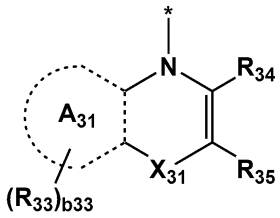
<화학식 2-1> <화학식 2-2>

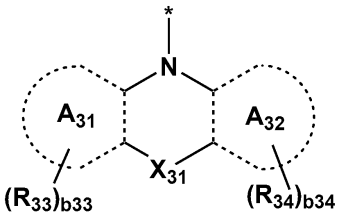




<화학식 3-1> <화학식 3-2> <화학식 3-3>







상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중,

A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, C_5-C_{30}카보시클릭 그룹 및 C_1-C_{30}헤테로시클릭 그룹 중에서 선택되고;

X_{31}은 단일 결합, O, S, $N(R_{36})$, $C(R_{36})=C(R_{37})$, $\{C(R_{36})(R_{37})\}_{n31}$ 또는 $\{Si(R_{36})(R_{37})\}_{n31}$이고, n31은 1 또는 2이고;

R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아

릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴옥시기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴티오기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$ 및 $-P(=S)(Q_1)(Q_2)$ 중에서 선택되고, R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{30}헤테로시클릭 그룹을 형성할 수 있고,

b23, b33 및 b34는 서로 독립적으로, 1, 2, 3, 4, 5, 6, 7, 8, 9 또는 10이고;

Q_1 내지 Q_3는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

*는 화학식 1 중의 M_1과의 결합 사이트이다.

청구항 2

제1항에 있어서,

A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, 벤젠 그룹, 나프탈렌 그룹, 페난트렌 그룹, 퓨란 그룹, 티오펜 그룹, 피롤 그룹, 시클로펜텐 그룹, 실롤 그룹, 저몰 그룹, 벤조퓨란 그룹, 벤조티오펜 그룹, 인돌 그룹, 인덴 그룹, 벤조실롤 그룹, 벤조저몰 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 플루오렌 그룹, 디벤조실롤 그룹, 디벤조저몰 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹인, 유기 발광 소자.

청구항 3

제1항에 있어서,

A_{21}은 벤젠 그룹, 나프탈렌 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹이고,

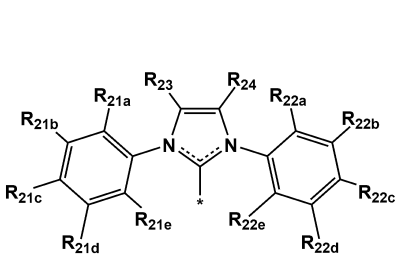
A_{31} 및 A_{32}는 서로 독립적으로, 벤젠 그룹, 나프탈렌 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹인, 유기 발광 소자.

청구항 4

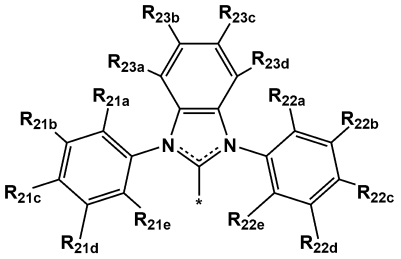
제1항에 있어서,

L_1은 하기 화학식 2-11 또는 2-12로 표시되는 리간드이고;

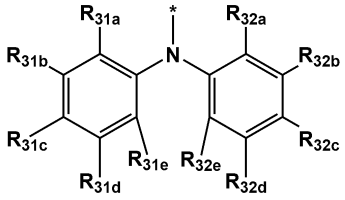
L_2는 하기 화학식 3-11 내지 3-17 중 어느 하나로 표시되는 리간드인, 유기 발광 소자:



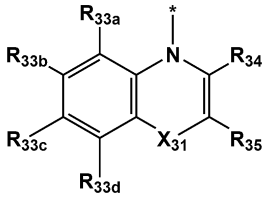
2-11



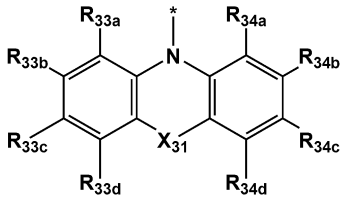
2-12



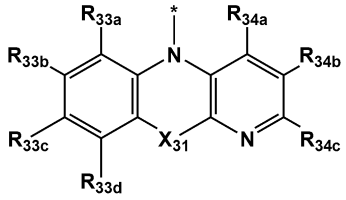
3-11



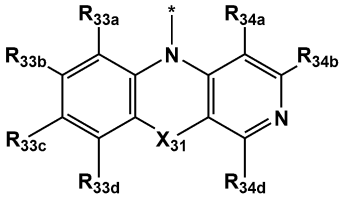
3-12



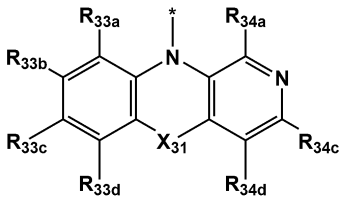
3-13



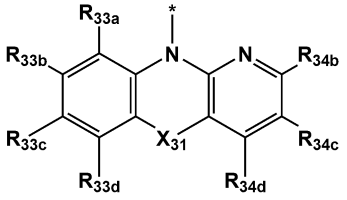
3-14



3-15



3-16



3-17

상기 화학식 2-11, 2-12 및 3-11 내지 3-17 중,

X_{31}, R_{23}, R_{24}, R_{34} 및 R_{35}의 정의는 제1항에서와 동일하고,

R_{21a} 내지 R_{21e}, R_{22a} 내지 R_{22e}, R_{23a} 내지 R_{23d}, R_{31a} 내지 R_{31e}, R_{32a} 내지 R_{32e}, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기,

테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고;

Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

*는 화학식 1 중의 M_1과의 결합 사이트이다.

청구항 5

제4항에 있어서,

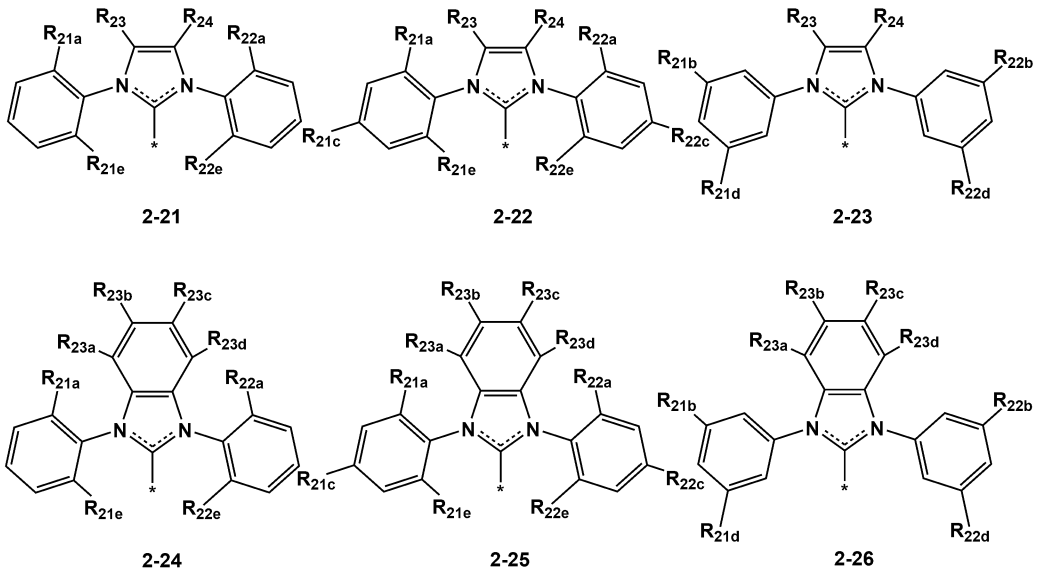
L_1은 상기 화학식 2-11 또는 2-12로 표시되는 리간드이고;

L_2는 상기 화학식 3-13으로 표시되는 리간드인, 유기 발광 소자.

청구항 6

제1항에 있어서,

L_1은 하기 화학식 2-21 내지 2-26 중 어느 하나로 표시되는 리간드인, 유기 발광 소자:



상기 화학식 2-21 내지 2-26 중,

R_{23}, R_{24} 및 R_{23a} 내지 R_{23d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 또는 니트로기;

중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-

C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기;

중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, $-P(=S)(Q_{21})(Q_{22})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

$-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, 또는 $-N(Q_1)(Q_2)$; 이고,

R_{21a}, R_{21b}, R_{21c}, R_{21d}, R_{21e}, R_{22a}, R_{22b}, R_{22c}, R_{22d} 및 R_{22e}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기,

피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고,

Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

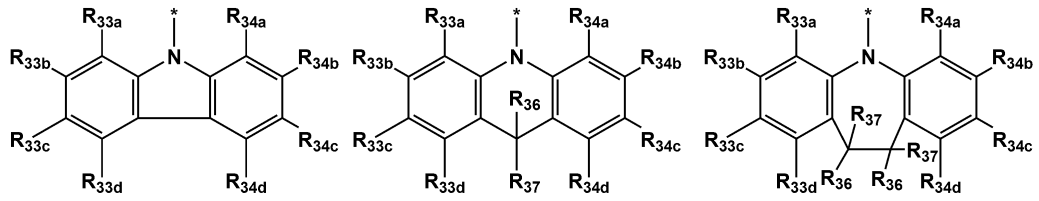
중수소, -F, C_1-C_{10}알킬기, 중수소화된 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

*는 화학식 1 중의 M_1과의 결합 사이트이다.

청구항 7

제1항에 있어서,

L_2는 하기 화학식 3-21 내지 3-26 중 어느 하나로 표시되는 리간드인, 유기 발광 소자:



3-21 3-22 3-23

3-24 3-25 3-26

상기 화학식 3-21 내지 3-26 중,

R_{36} 및 R_{37}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 또는 니트로기;

중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸

기, -Si(Q_{11})(Q_{12})(Q_{13}), -Ge(Q_{11})(Q_{12})(Q_{13}), -C(Q_{11})(Q_{12})(Q_{13}), -B(Q_{11})(Q_{12}), -N(Q_{11})(Q_{12}), -P(Q_{11})(Q_{12}), -C(=O)(Q_{11}), -S(=O)(Q_{11}), -S(=O)$_2$(Q_{11}), -P(=O)(Q_{11})(Q_{12}), -P(=S)(Q_{11})(Q_{12}), 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기;

중수소, -F, -Cl, -Br, -I, -CD_3, -CD_2H, -CDH_2, -CF_3, -CF_2H, -CFH_2, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, -Si(Q_{21})(Q_{22})(Q_{23}), -Ge(Q_{21})(Q_{22})(Q_{23}), -C(Q_{21})(Q_{22})(Q_{23}), -B(Q_{21})(Q_{22}), -N(Q_{21})(Q_{22}), -P(Q_{21})(Q_{22}), -C(=O)(Q_{21}), -S(=O)(Q_{21}), -S(=O)$_2$(Q_{21}), -P(=O)(Q_{21})(Q_{22}), -P(=S)(Q_{21})(Q_{22}), 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

-Si(Q_1)(Q_2)(Q_3), -Ge(Q_1)(Q_2)(Q_3), -C(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), 또는 -N(Q_1)(Q_2); 이고,

R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, -CD_3, -CD_2H, -CDH_2, -CF_3, -CF_2H, -CFH_2, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, -Si(Q_{21})(Q_{22})(Q_{23}), -Ge(Q_{21})(Q_{22})(Q_{23}),

$-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고,

Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

중수소, -F, C_1-C_{10}알킬기, 중수소화된 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

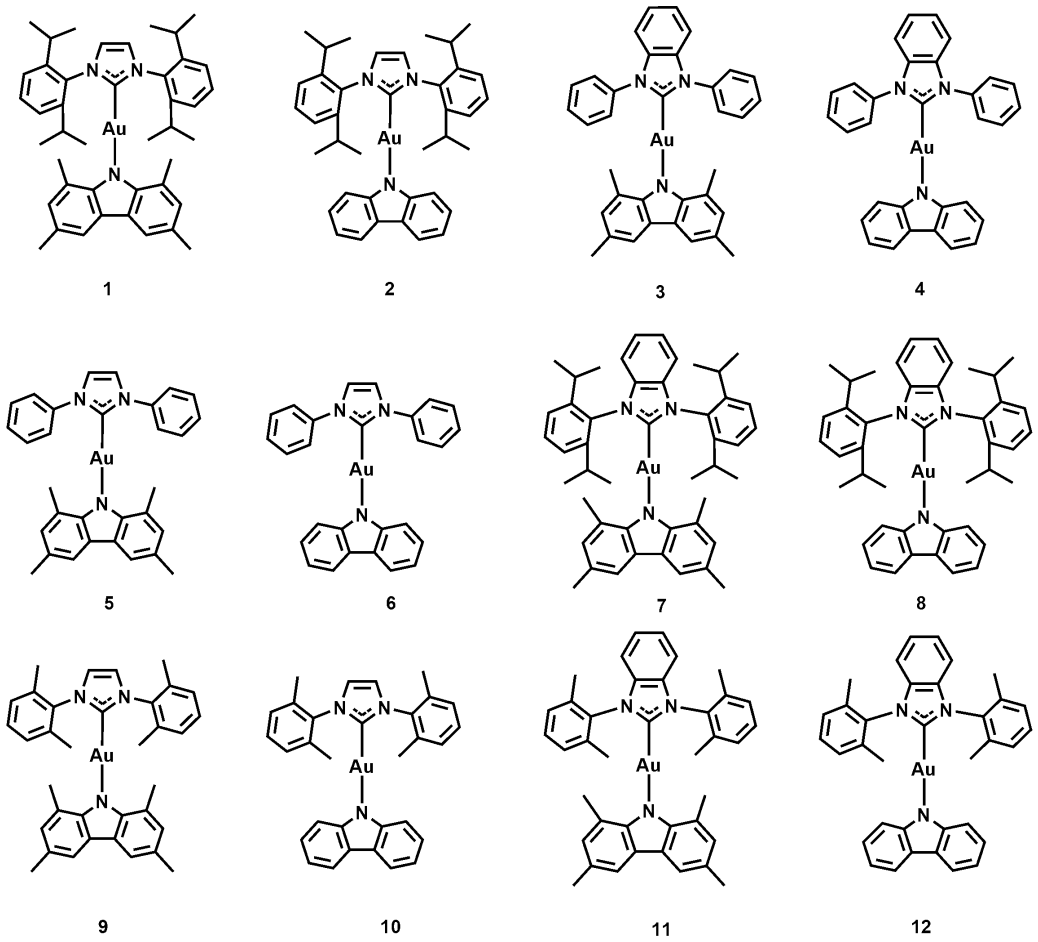
*는 화학식 1 중의 M_1과의 결합 사이트이다.

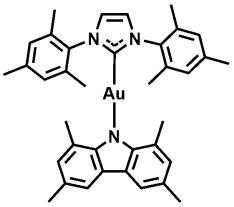
청구항 8

제1항에 있어서,

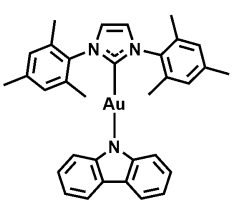
상기 센서타이저는 하기 그룹 I 중에서 선택되는, 유기 발광 소자:

<그룹 I>

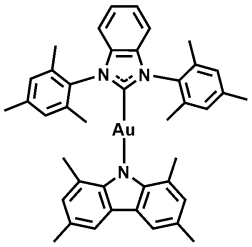




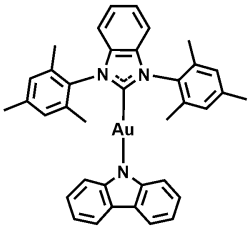
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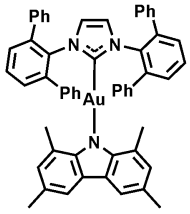
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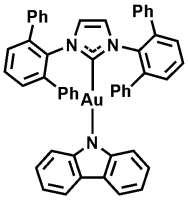
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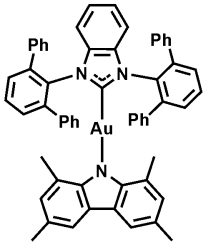
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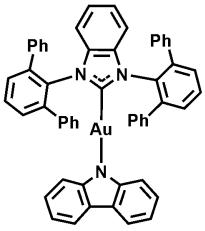
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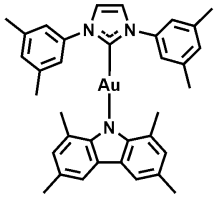
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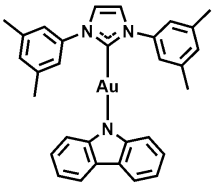
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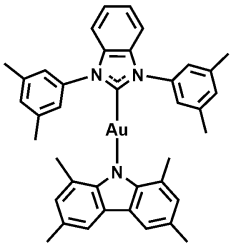
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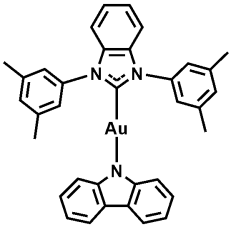
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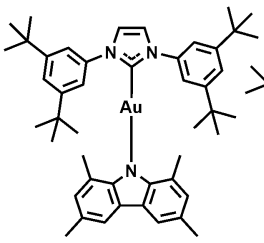
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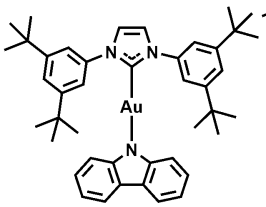
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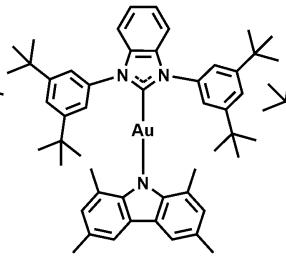
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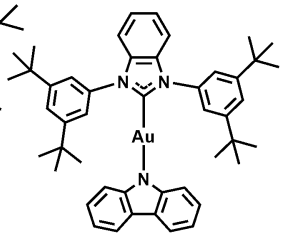
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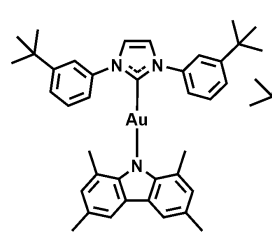
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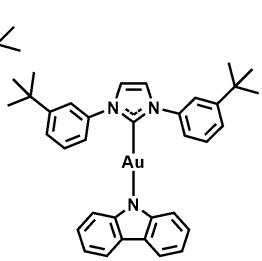
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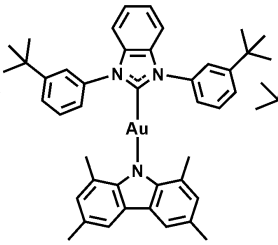
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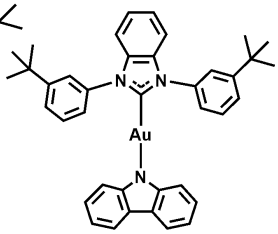
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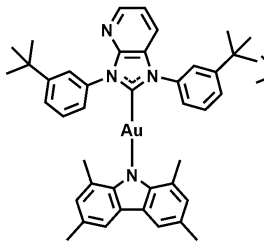
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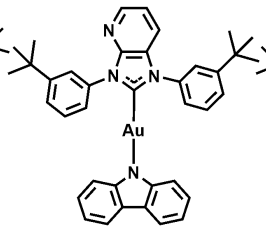
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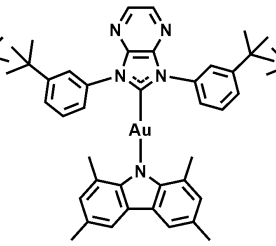
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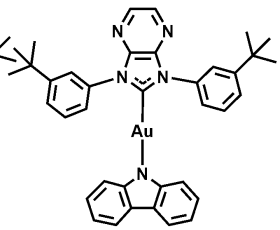
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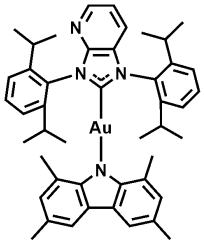
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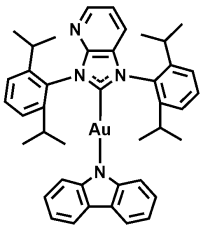
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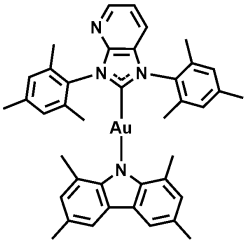
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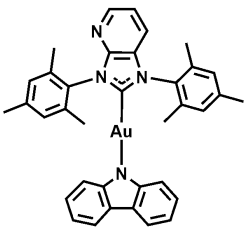
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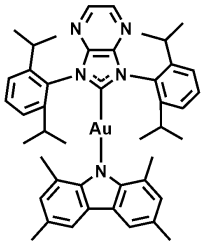
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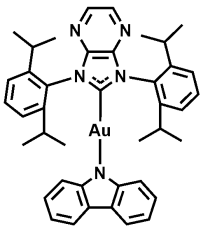
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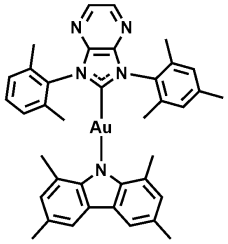
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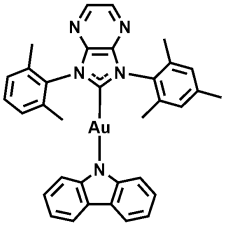
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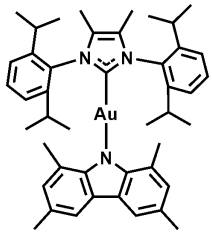
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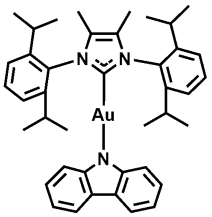


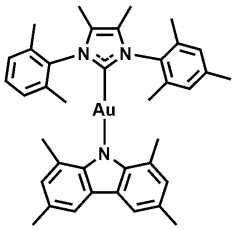
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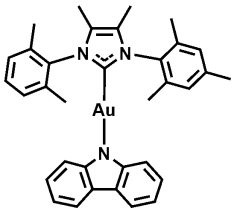


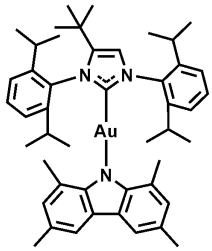
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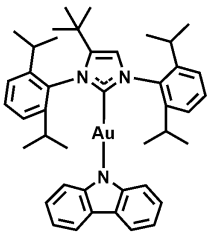

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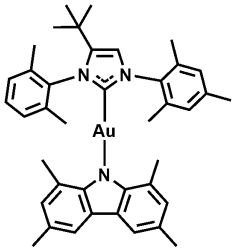

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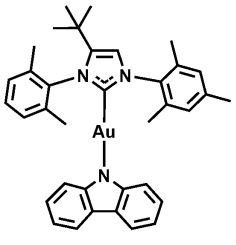

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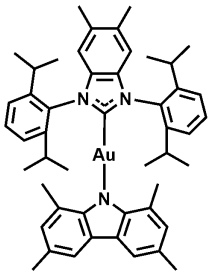

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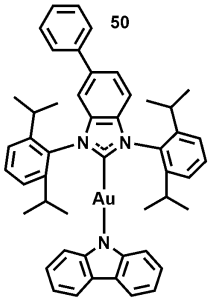

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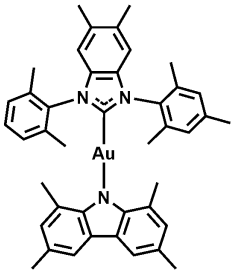

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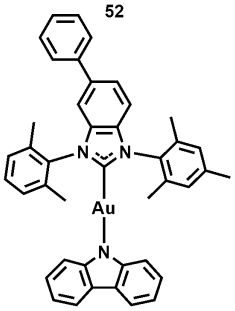

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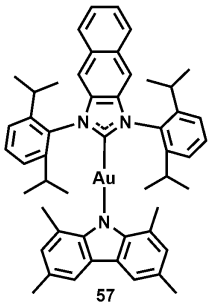

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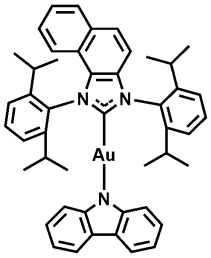

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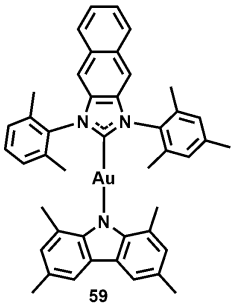

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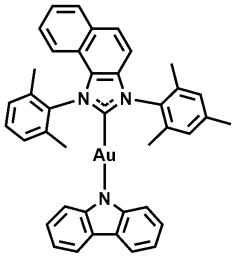

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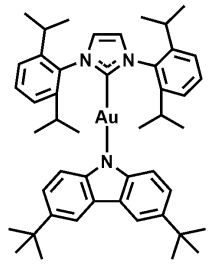

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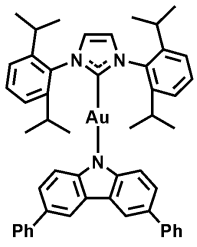

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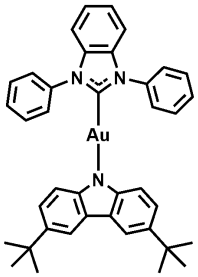

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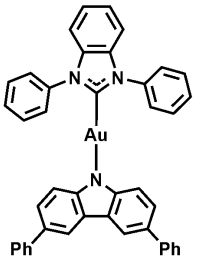

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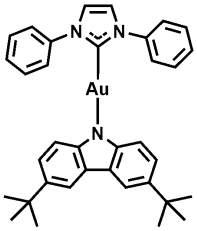

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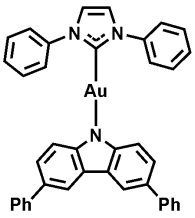

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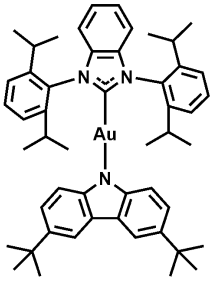

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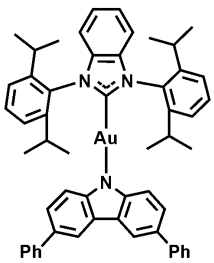

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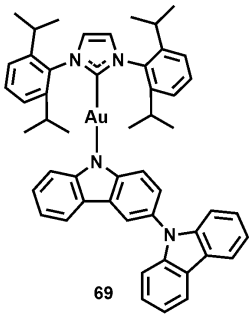

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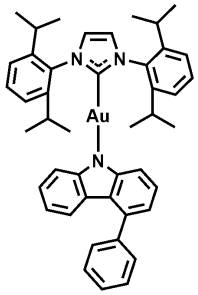

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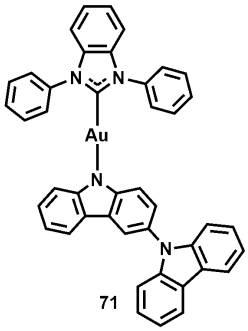

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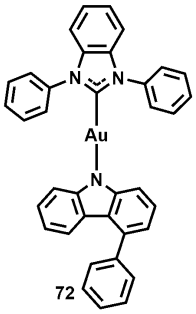

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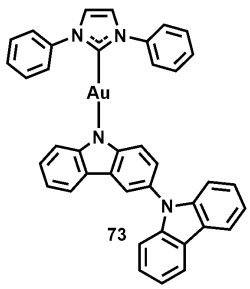

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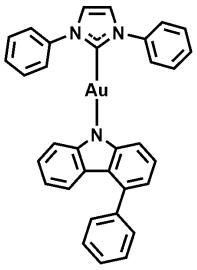

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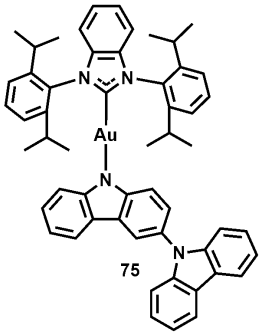

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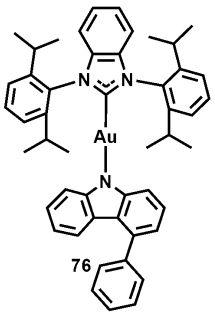

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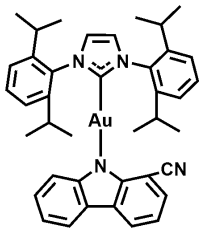

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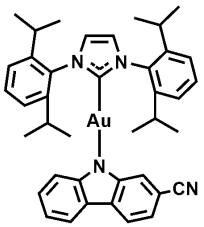

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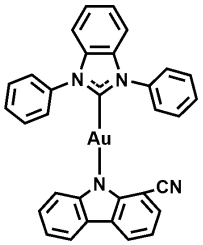

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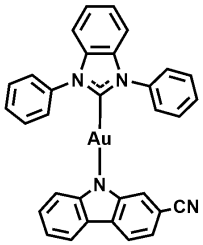
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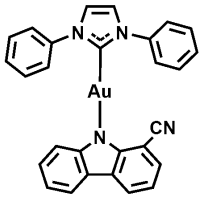
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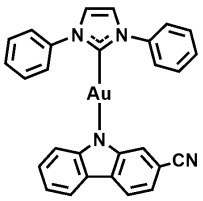
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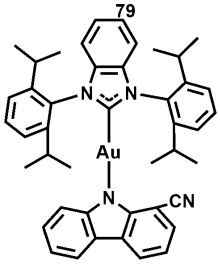
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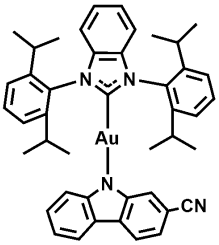
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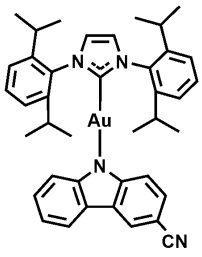
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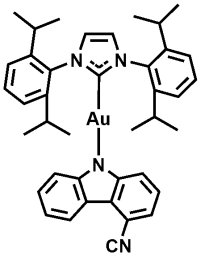
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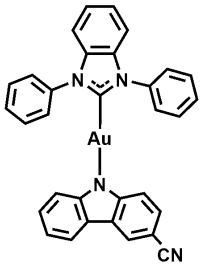
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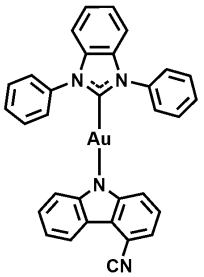
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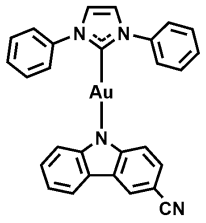
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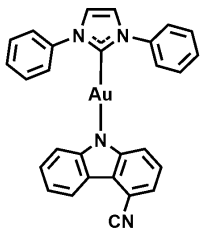
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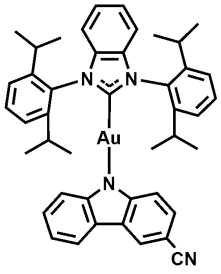
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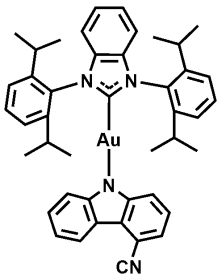
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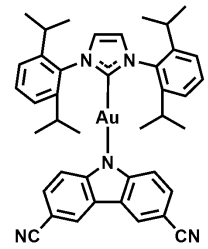
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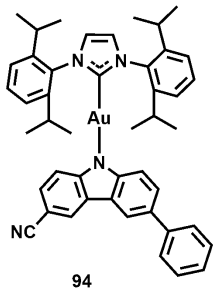


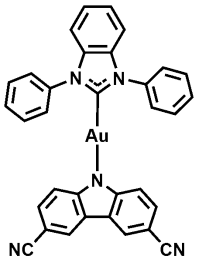
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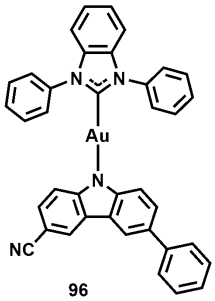


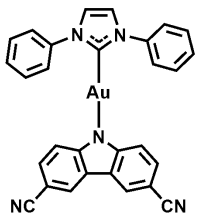
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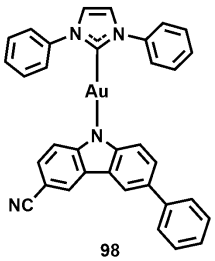

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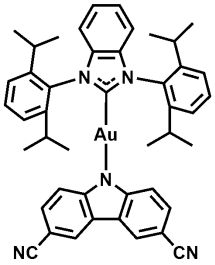

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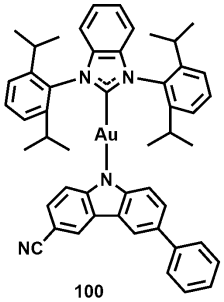

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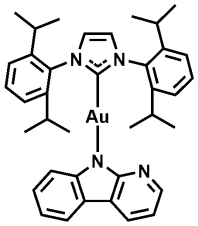

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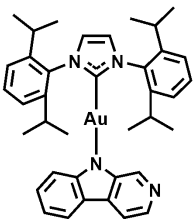

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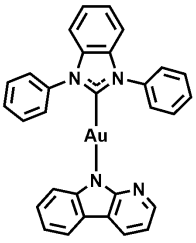

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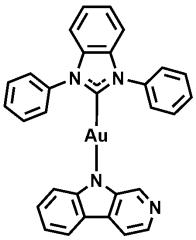

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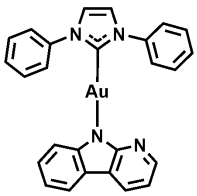

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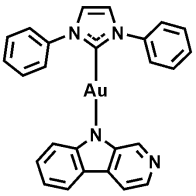

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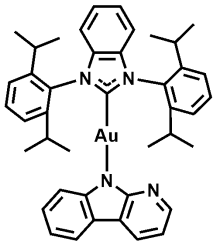

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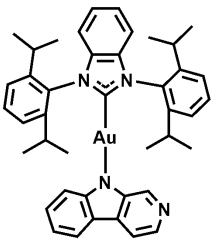

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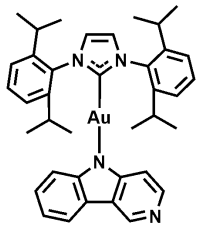

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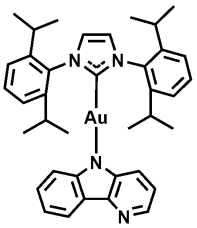

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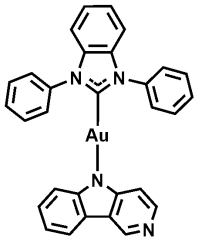

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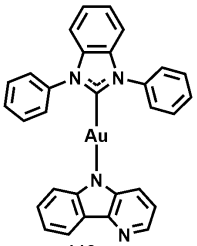

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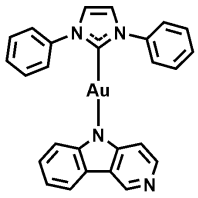

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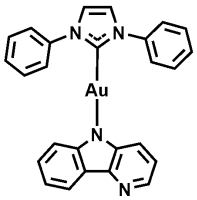

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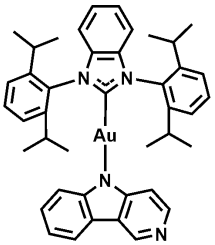

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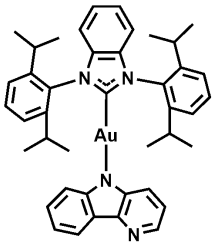

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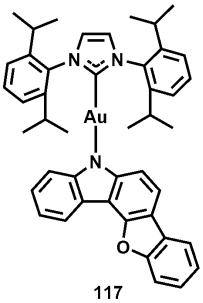

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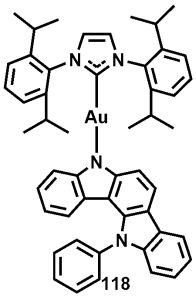

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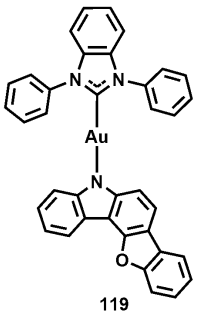

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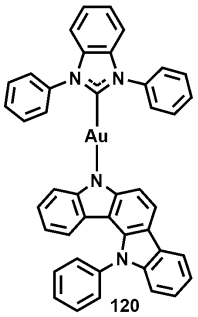

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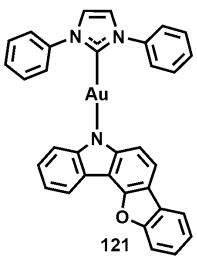

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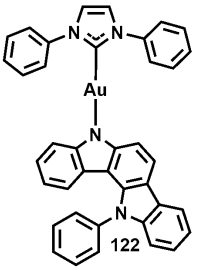

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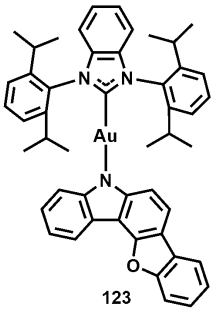

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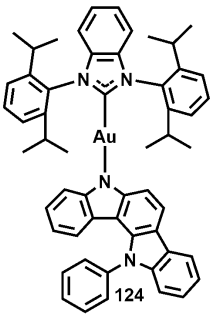

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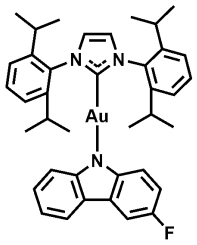

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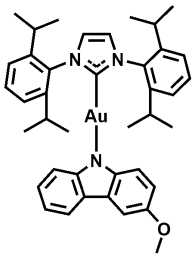

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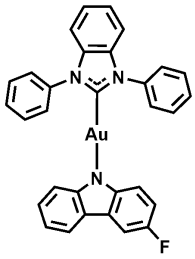

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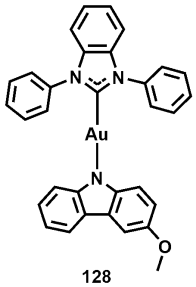
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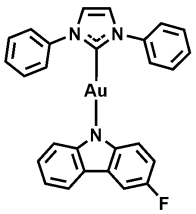
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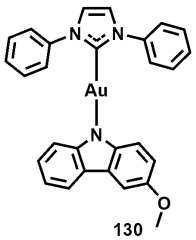
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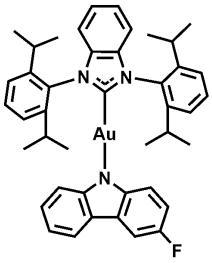
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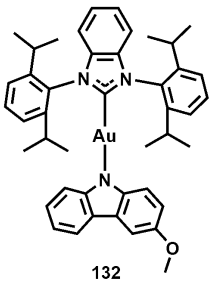
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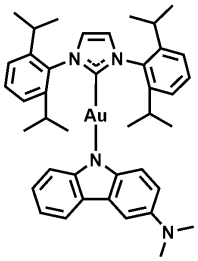
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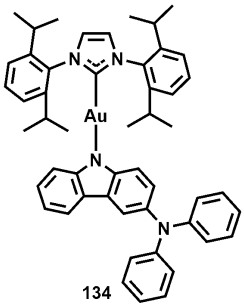
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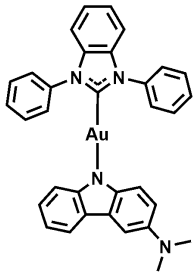
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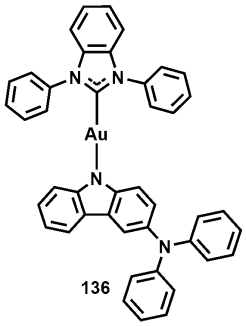
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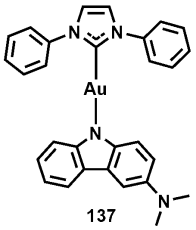
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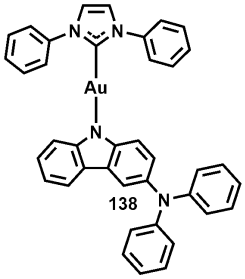
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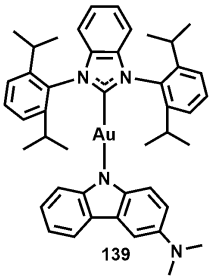
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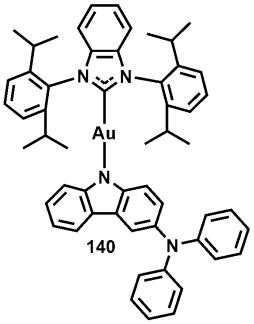
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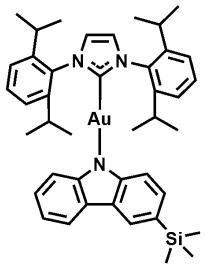
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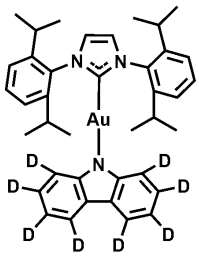


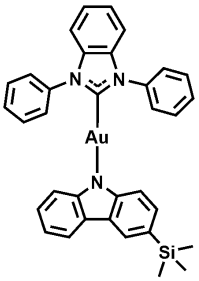
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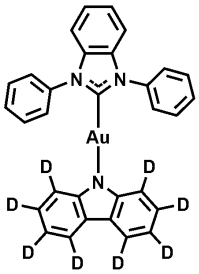


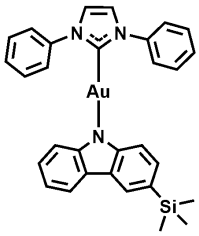
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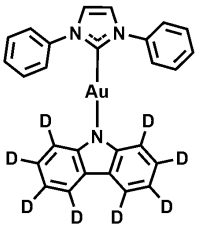

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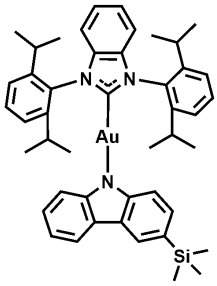

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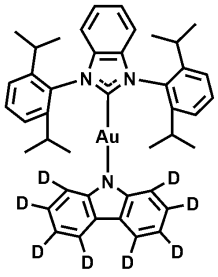

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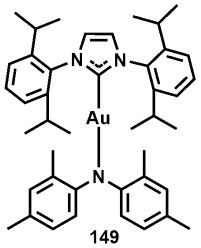

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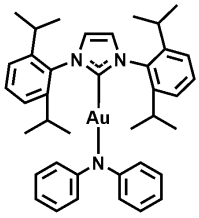

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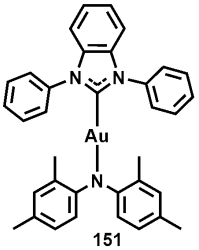

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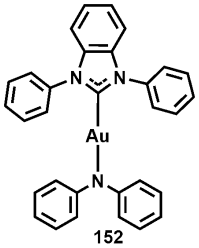

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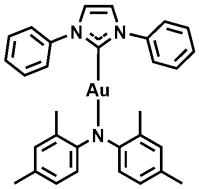

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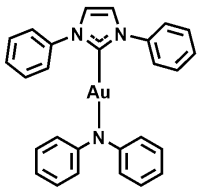

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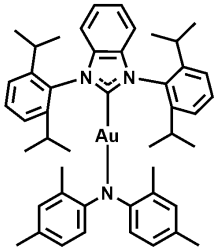

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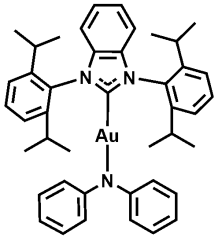

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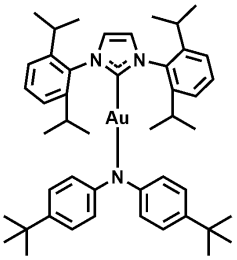

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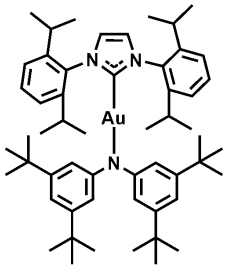

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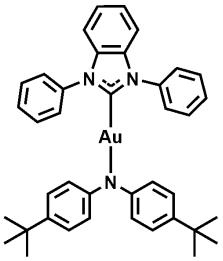

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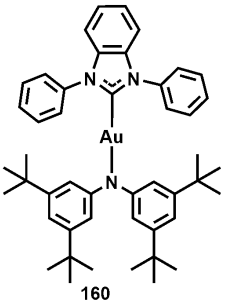

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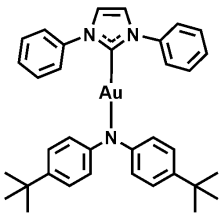

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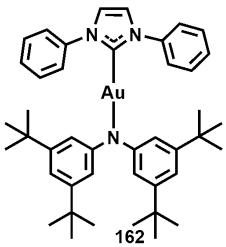

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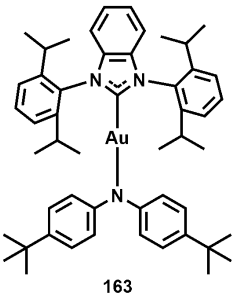

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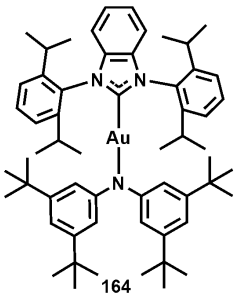

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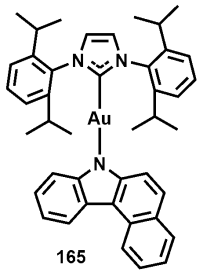

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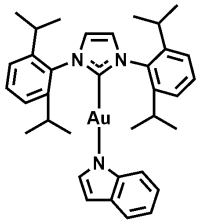

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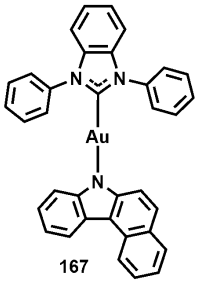

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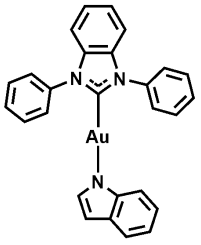

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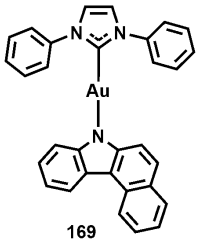

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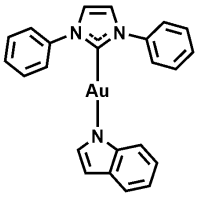

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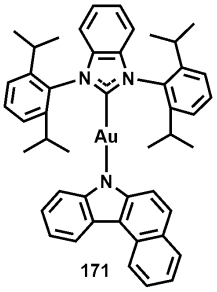

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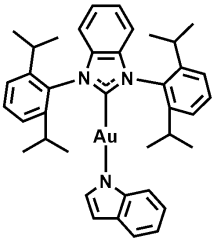

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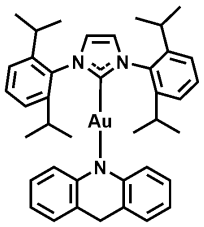

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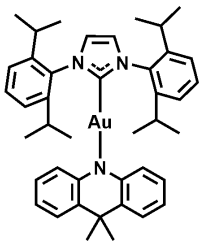

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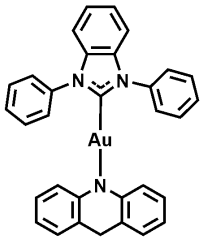

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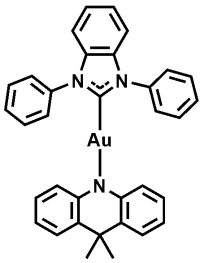
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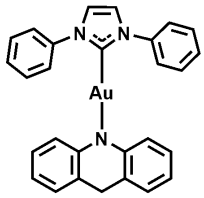
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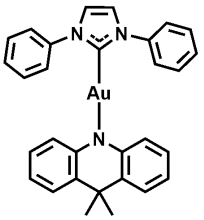
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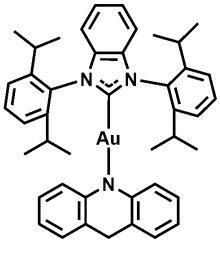
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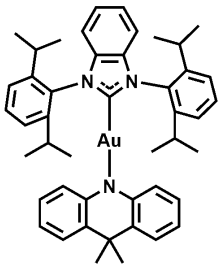
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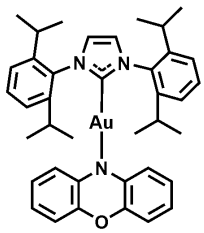
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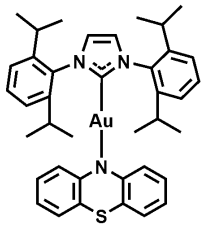
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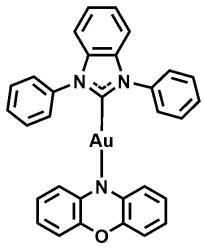
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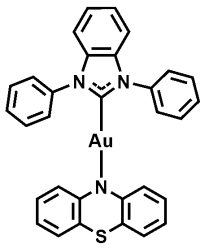
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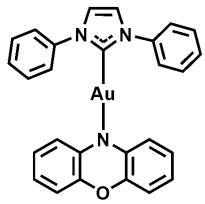
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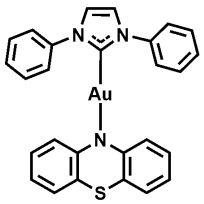
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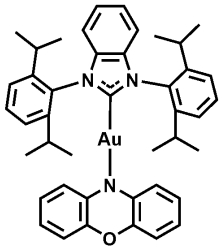
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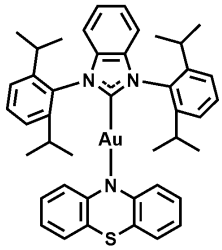
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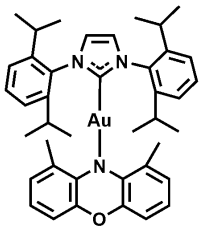
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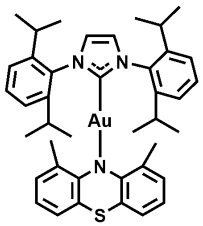
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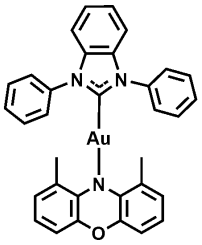
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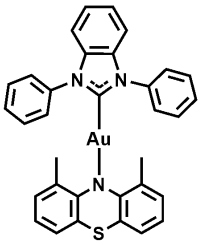
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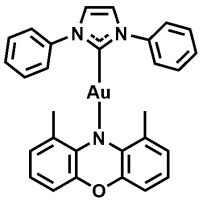
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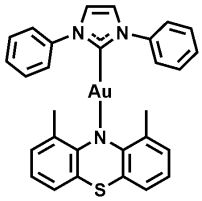
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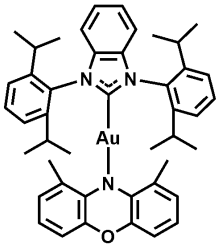
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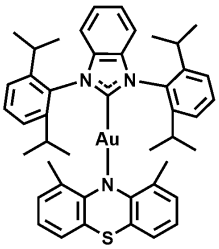
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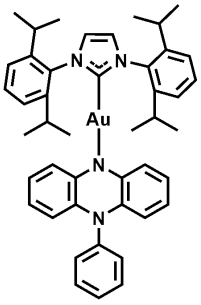
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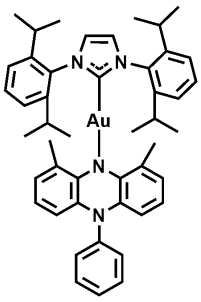
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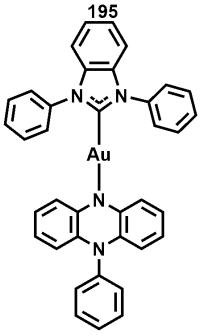
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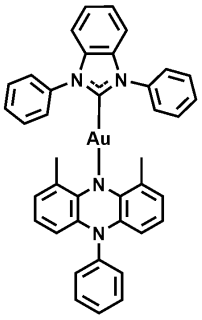
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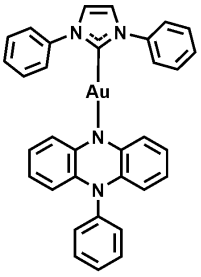
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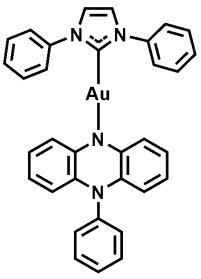
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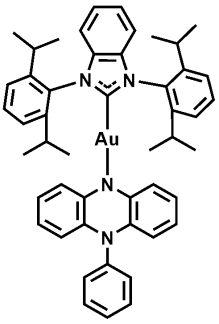
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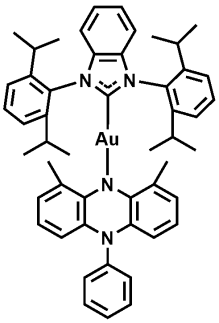
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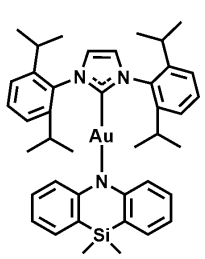
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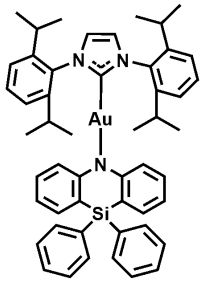


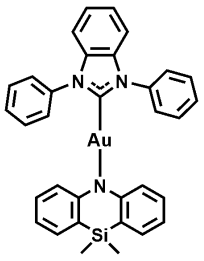
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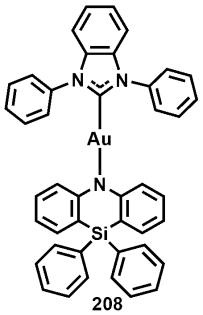


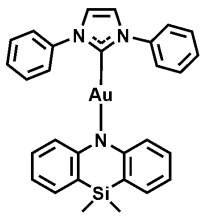
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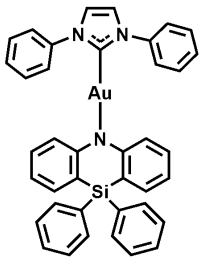

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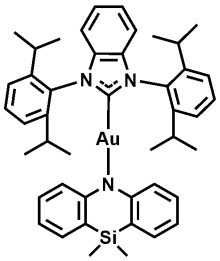

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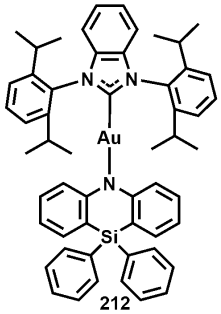

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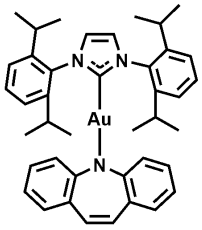

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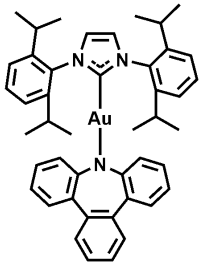

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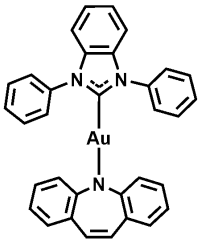

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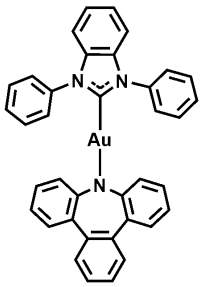

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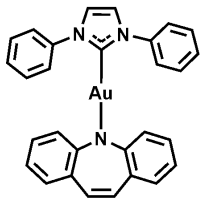

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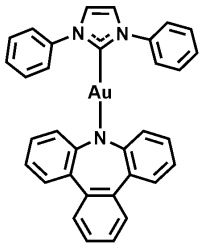

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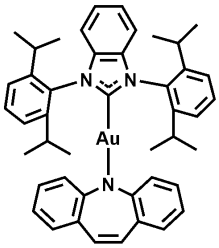

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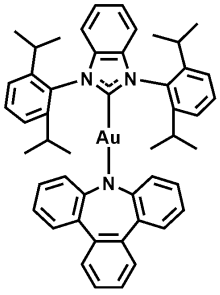

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상기 화합물들 중, Ph는 페닐기이다.

청구항 9

제1항에 있어서,

상기 호스트가 정공 수송성 호스트, 전자 수송성 호스트, 및 양쪽성 호스트 중에서 선택되는 1종 이상을 포함하고,

상기 전자 수송성 호스트는 전자 수송성 모이어티를 적어도 하나 포함하고,

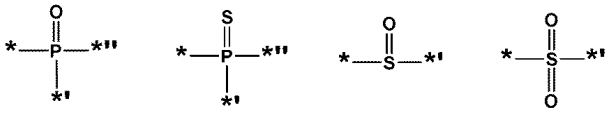
상기 정공 수송성 호스트는 정공 수송성 모이어티를 포함하고, 전자 수송성 모이어티를 비포함하고,

상기 양쪽성 호스트는 적어도 하나의 전자 수송성 모이어티 및 적어도 하나의 정공 수송성 모이어티를 포함하고,

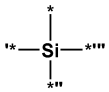
상기 전자 수송성 모이어티가, 시아노기, -F, $-CFH_2$, $-CF_2H$, $-CF_3$, π 전자 결핍성 함질소 시클릭 그룹 및 하기 화학식 ET-모이어티 중 하나로 표시된 그룹 중에서 선택되고,

상기 정공 수송성 모이어티는 π 전자 과잉 C_3-C_{60}시클릭 그룹 및 하기 화학식 HT-모이어티로 표시된 그룹 중에서 선택되는, 유기 발광 소자:

<ET-모이어티>



<HT-모이어티>



상기 화학식 중 *, *', *" 및 *'"은 각각 이웃한 임의의 원자와의 결합 사이트이다.

청구항 10

제9 항에 있어서,

상기 호스트는 제1화합물 및 제2화합물을 포함하고,

i) 상기 제1화합물은 정공 수송성 호스트 중에서 선택되고, 상기 제2화합물은 전자 수송성 호스트 중에서 선택되거나,

ii)상기 제1화합물은 전자 수송성 호스트 중에서 선택되고, 상기 제2화합물은 정공 수송성 호스트 중에서 선택되거나,

ii)상기 제1화합물 및 상기 제2화합물이 각각 양쪽성 호스트 중에서 선택되거나,

iv)상기 제1화합물이 정공 수송성 호스트 중에서 선택되고, 상기 제2화합물은 양쪽성 호스트 중에서 선택되거나,

v)상기 제1화합물이 전자 수송성 호스트 중에서 선택되고, 상기 제2화합물은 양쪽성 호스트 중에서 선택되거나,

vi)상기 제1화합물이 양쪽성 호스트 중에서 선택되고, 상기 제2화합물이 정공 수송성 호스트 중에서 선택되거나, 또는

vii)상기 제1화합물이 양쪽성 호스트 중에서 선택되고, 상기 제2화합물이 전자 수송성 호스트 중에서 선택되는, 유기 발광 소자.

청구항 11

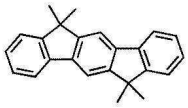
제1항에 있어서,

상기 에미터는 100 ㎲ 미만의 감쇠 시간을 갖는, 유기 발광 소자.

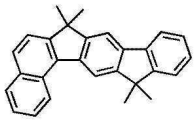
청구항 12

제1항에 있어서,

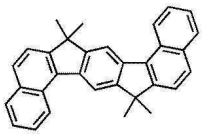
상기 에미터는 나프탈렌-함유 코어, 플루오렌-함유 코어, 스파이로-비플루오렌-함유 코어, 벤조플루오렌-함유 코어, 디벤조플루오렌-함유 코어, 페난트렌-함유 코어, 안트라센-함유 코어, 플루오란텐-함유 코어, 트리페닐렌-함유 코어, 파이렌-함유 코어, 크라이센-함유 코어, 피센-함유 코어, 페릴렌-함유 코어, 펜타센-함유 코어, 인데노안트라센-함유 코어, 테트라센-함유 코어, 비스안트라센-함유 코어 및 하기 화학식 501-1 내지 501-20으로 표시되는 코어 중 하나를 포함하는, 유기 발광 소자:



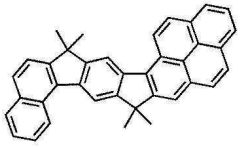
501-1



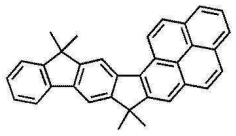
501-2



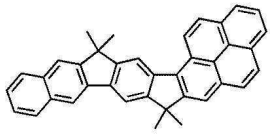
501-3



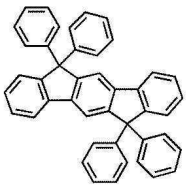
501-4



501-5



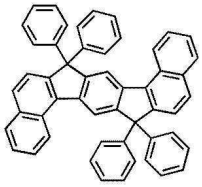
501-6



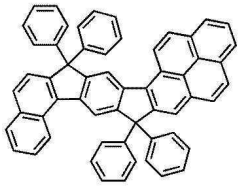
501-7



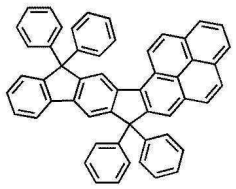
501-8



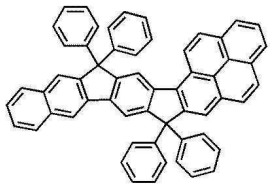
501-9



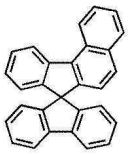
501-10



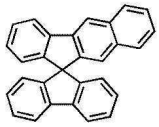
501-11



501-12



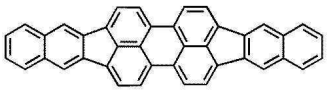
501-13



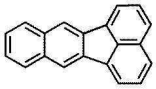
501-14



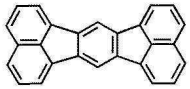
501-15



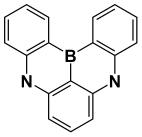
501-16



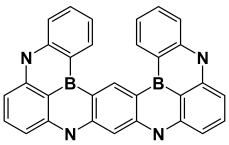
501-17



501-18



501-19



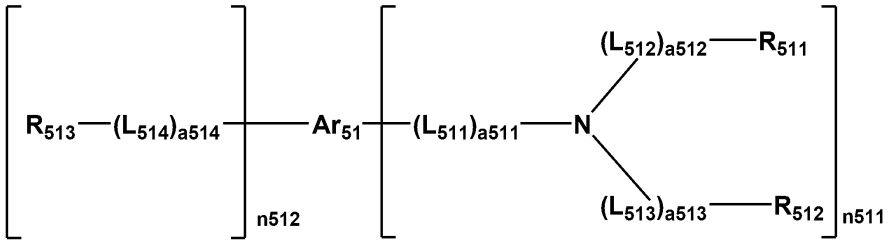
501-20

청구항 13

제1항에 있어서,

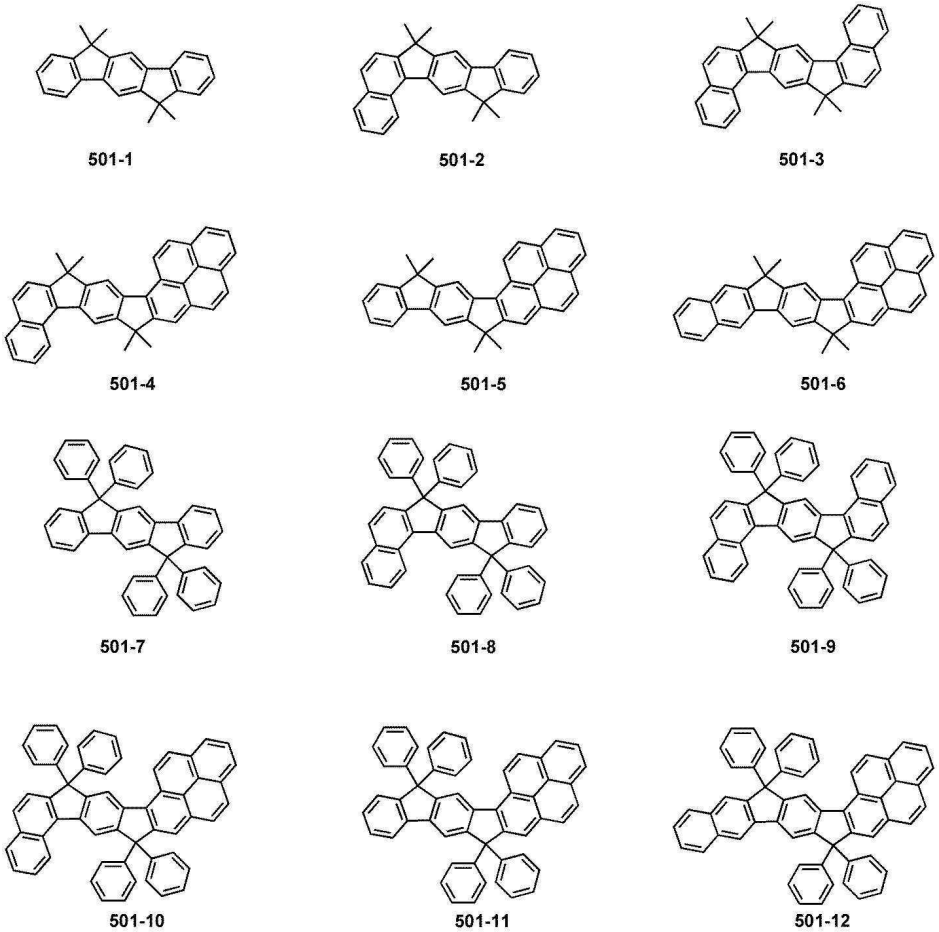
상기 에미터는 하기 화학식 51로 표시되는, 유기 발광 소자:

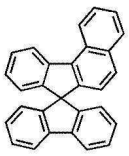
<화학식 51>



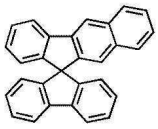
상기 화학식 51 중,

Ar_{51}은 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_{511})(Q_{512})(Q_{513})$, $-Ge(Q_{511})(Q_{512})(Q_{513})$, $-C(Q_{511})(Q_{512})(Q_{513})$, $-B(Q_{511})(Q_{512})$, $-N(Q_{511})(Q_{512})$, $-P(Q_{511})(Q_{512})$, $-C(=O)(Q_{511})$, $-S(=O)(Q_{511})$, $-S(=O)_2(Q_{511})$, $-P(=O)(Q_{511})(Q_{512})$, $-P(=S)(Q_{511})(Q_{512})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 나프탈렌 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 피센 그룹, 페릴렌 그룹, 펜타센 그룹, 인데노안트라센 그룹, 테트라센 그룹, 비스안트라센 그룹 또는 하기 화학식 501-1 내지 501-20으로 표시되는 그룹; 이고;

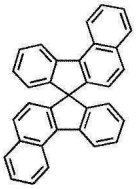




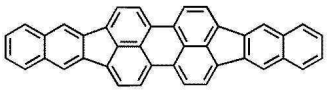
501-13



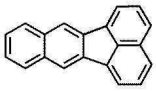
501-14



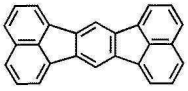
501-15



501-16



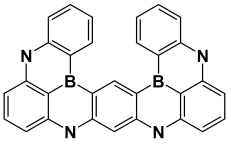
501-17



501-18



501-19



501-20

L_{511} 내지 L_{514}는 서로 독립적으로, 치환 또는 비치환된 C_3-C_{10}시클로알킬렌기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬렌기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐렌기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐렌기, 치환 또는 비치환된 C_6-C_{60}아릴렌기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴렌기, 치환 또는 비치환된 2가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 2가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

a511 내지 a514는 서로 독립적으로, 0, 1, 2 및 3 중에서 선택되고,

R_{511} 내지 R_{513}은 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

Q_{511} 내지 Q_{513}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

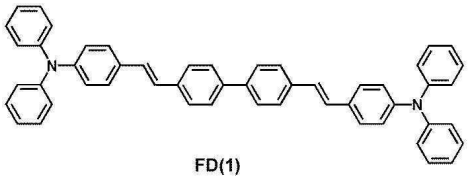
n511 및 n512는 서로 독립적으로, 0, 1, 2, 3, 4, 5 및 6 중에서 선택된다.

청구항 14

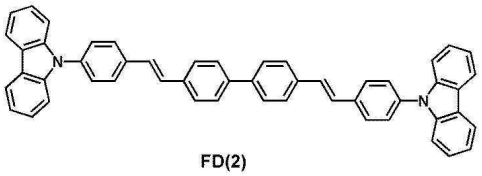
제1항에 있어서,

상기 에미터는 하기 그룹 FD1 중에서 선택되는, 유기 발광 소자:

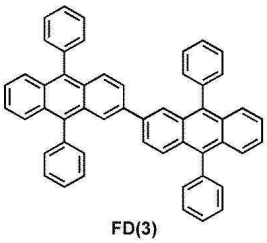
<그룹 FD1>



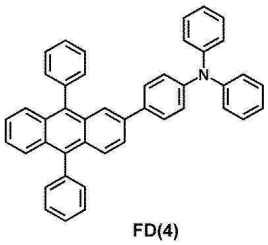
FD(1)



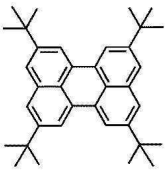
FD(2)



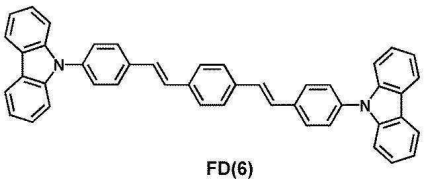
FD(3)



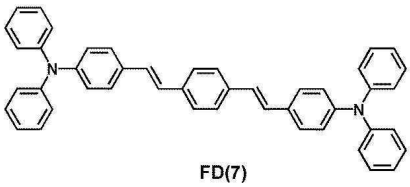
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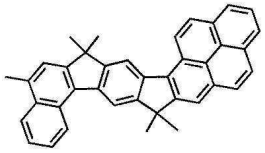
FD(5)



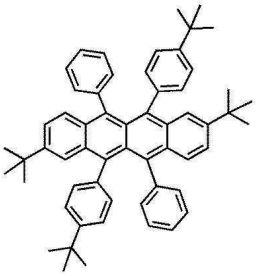
FD(6)



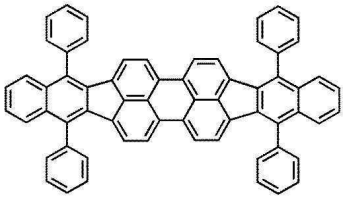
FD(7)



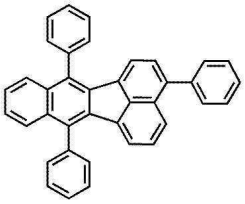
FD(8)



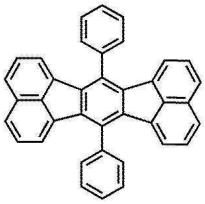
FD(9)



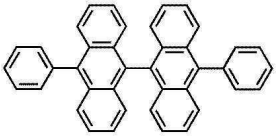
FD(10)



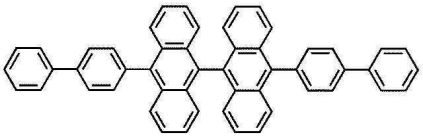
FD(11)



FD(12)



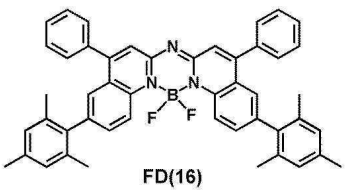
FD(13)



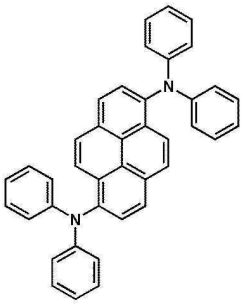
FD(14)



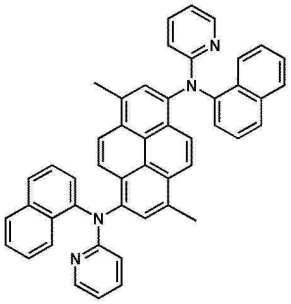
FD(15)



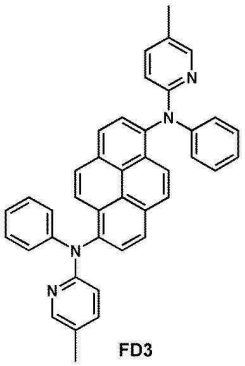
FD(16)



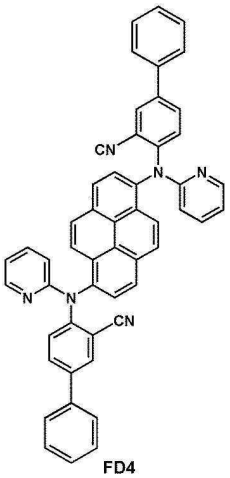
FD1



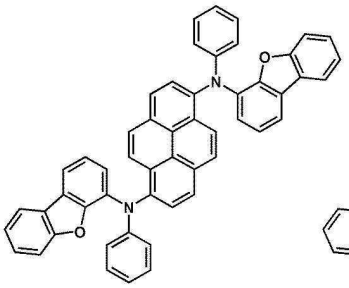
FD2



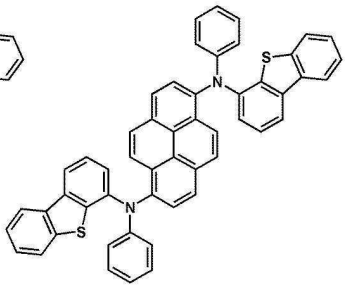
FD3



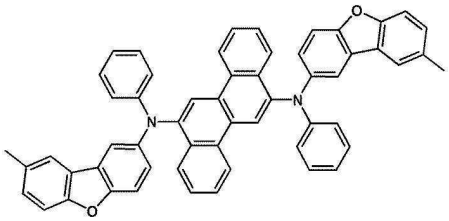
FD4



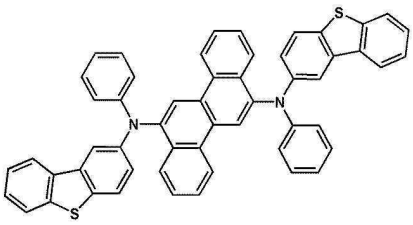
FD5



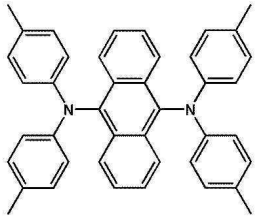
FD6



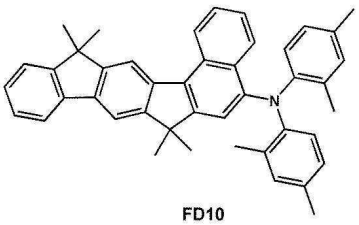
FD7



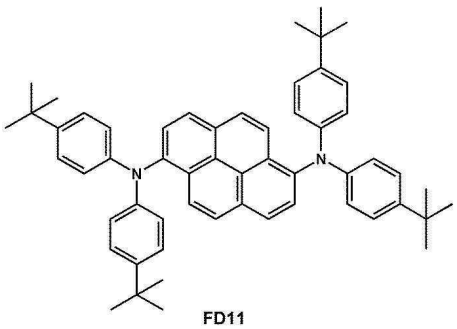
FD8



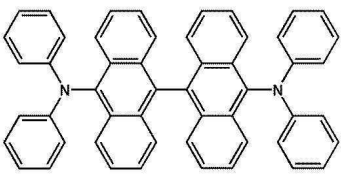
FD9



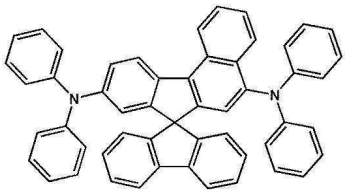
FD10



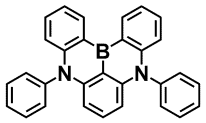
FD11



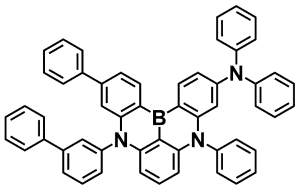
FD12



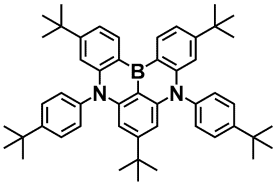
FD13



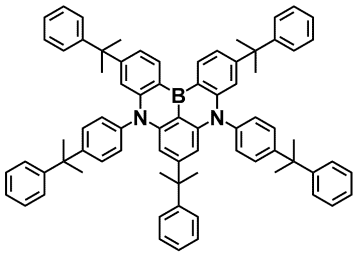
BD1-1



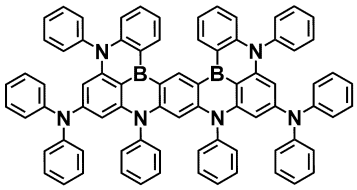
BD1-2



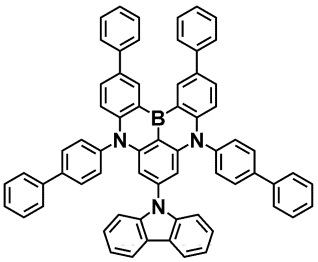
BD1-3



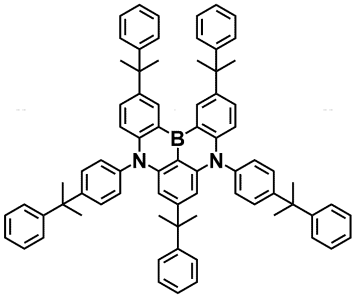
BD1-4



BD1-5



BD1-6



BD1-7

청구항 15

제1항에 있어서,

상기 호스트 및 상기 센서타이저는 실질적으로 발광하지 않고, 상기 에미터가 광을 방출하는, 유기 발광 소자.

청구항 16

제1항에 있어서,

하기 조건 1을 만족하는, 유기 발광 소자:

<조건 1>

$S_1(H) > S_1(S) \geq S_1(E)$

상기 조건 1 중,

$S_1(H)$은 상기 호스트의 최저 여기 일중항 에너지 레벨이고;

$S_1(S)$은 상기 센서타이저의 최저 여기 일중항 에너지 레벨이고;

$S_1(E)$는 상기 에미터의 최저 여기 일중항 에너지 레벨이다.

청구항 17

제1항에 있어서,

하기 조건 2를 만족하는, 유기 발광 소자:

<조건 2>

$T_1(H) \geq T_1(S)$

상기 조건 2 중,

$T_1(H)$은 상기 호스트의 최저 여기 삼중항 에너지 레벨이고;

$T_1(S)$은 상기 센서타이저의 최저 여기 삼중항 에너지 레벨이다.

청구항 18

제1항에 있어서,

상기 발광층 중 상기 센서타이저의 함량은 1 중량% 내지 50 중량% 범위 내에서 선택되고,

상기 발광층 중 상기 호스트의 함량은 30 중량% 내지 90 중량% 범위 내에서 선택되고,

상기 발광층 중 상기 에미터의 함량은 0.01 중량% 내지 15 중량% 범위에서 선택되는, 유기 발광 소자.

청구항 19

제1전극;

제2전극;

상기 제1전극과 상기 제2전극 사이에 개재되고, 적어도 하나의 발광층을 포함한, m개의 발광 유닛들; 및

상기 m개의 발광 유닛들 중 서로 인접한 2개의 발광 유닛들 사이에 배치되고, n형 전하 생성층 및 p형 전하 생성층을 포함한, m-1개의 전하 생성층;

을 포함하고,

상기 m은 2 이상의 정수이고,

상기 m개의 발광 유닛들 중 적어도 하나의 발광 유닛에서 방출되는 광의 최대 발광 파장은 나머지 발광 유닛들 중 적어도 하나의 발광 유닛에서 방출되는 광의 최대 발광 파장과 상이하고,

상기 m개의 발광층 중 적어도 하나는 상기 발광층은 호스트, 도펀트 및 센서타이저를 포함하고;

상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고;

상기 센서타이저는 하기 화학식 1로 표시되는, 유기 발광 소자:

<화학식 1>

$M_1(L_1)(L_2)$

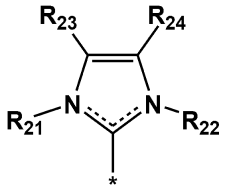
상기 화학식 1 중,

M_1은 Au, Ag 또는 Cu이고;

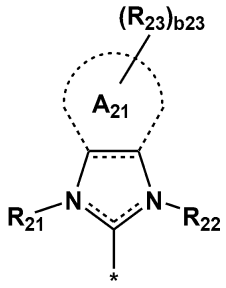
L_1은 하기 화학식 2-1 또는 2-2로 표시되는 리간드이고;

L_2는 하기 화학식 3-1, 3-2 및 3-3 중 어느 하나로 표시되는 리간드이고;

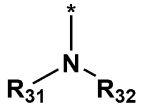
<화학식 2-1> <화학식 2-2>

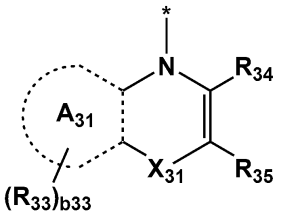


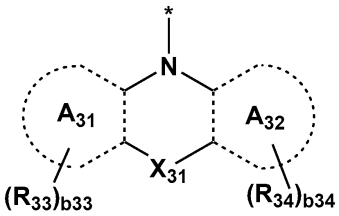
<화학식 3-1>



<화학식 3-2>







<화학식 3-3>

상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중,

A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, C_5-C_{30}카보시클릭 그룹 및 C_1-C_{30}헤테로시클릭 그룹 중에서 선택되고;

X_{31}은 단일 결합, O, S, N(R_{36}), C(R_{36})=C(R_{37}), {C(R_{36})(R_{37})}$_{n31}$ 또는 {Si(R_{36})(R_{37})}$_{n31}$이고, n31은 1 또는 2이고;

R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴옥시기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴티오기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, -Si(Q_1)(Q_2)(Q_3), -Ge(Q_1)(Q_2)(Q_3), -C(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2) 및 -P(=S)(Q_1)(Q_2) 중에서 선택되고, R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{30}헤테로시클릭 그룹을 형성할 수 있고,

b23, b33 및 b34는 서로 독립적으로, 1, 2, 3, 4, 5, 6, 7, 8, 9 또는 10이고;

Q_1 내지 Q_3는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수

소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

*는 화학식 1 중의 M_1과의 결합 사이트이다.

청구항 20

제1전극;

제2전극; 및

상기 제1전극과 상기 제2전극 사이에 개재된 m개의 발광층;

을 포함하고,

상기 m은 2 이상의 정수이고,

상기 m개의 발광층 중 적어도 하나의 발광층에서 방출되는 광의 최대 발광 파장은 나머지 발광층 중 적어도 하나의 발광층에서 방출되는 광의 최대 발광 파장과 상이하고,

상기 m개의 발광층 중 적어도 하나는 호스트, 센서타이저 및 에미터를 포함하고;

상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고;

상기 센서타이저는 하기 화학식 1로 표시되는, 유기 발광 소자:

<화학식 1>

$M_1(L_1)(L_2)$

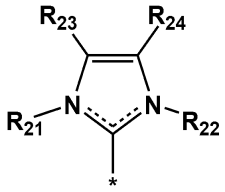
상기 화학식 1 중,

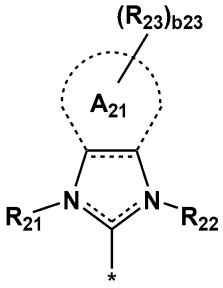
M_1은 Au, Ag 또는 Cu이고;

L_1은 하기 화학식 2-1 또는 2-2로 표시되는 리간드이고;

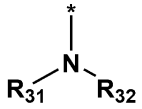
L_2는 하기 화학식 3-1, 3-2 및 3-3 중 어느 하나로 표시되는 리간드이고;

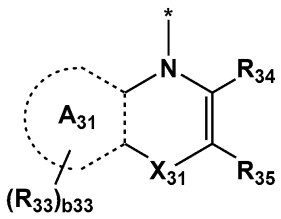
<화학식 2-1> <화학식 2-2>

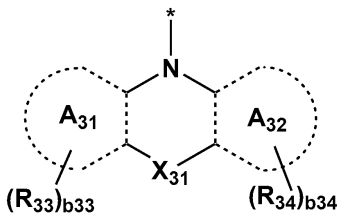




<화학식 3-1> <화학식 3-2> <화학식 3-3>







상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중,

A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, C_5-C_{30}카보시클릭 그룹 및 C_1-C_{30}헤테로시클릭 그룹 중에서 선택되고;

X_{31}은 단일 결합, O, S, $N(R_{36})$, $C(R_{36})=C(R_{37})$, $\{C(R_{36})(R_{37})\}_{n31}$ 또는 $\{Si(R_{36})(R_{37})\}_{n31}$이고, n31은 1 또는 2이고;

R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴옥시기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴티오기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$ 및 $-P(=S)(Q_1)(Q_2)$ 중에서 선택되고, R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{30}헤테로시클릭 그룹을 형성할 수 있고,

b23, b33 및 b34는 서로 독립적으로, 1, 2, 3, 4, 5, 6, 7, 8, 9 또는 10이고;

Q_1 내지 Q_3는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

*는 화학식 1 중의 M_1과의 결합 사이트이다.

발명의 설명

기 술 분 야

[0001] 소정의 조건을 만족하는 조성물 및 이를 포함하는 유기 발광 소자가 제시된다.

배 경 기 술

[0002] 유기 발광 소자(organic light emitting device)는 자발광형 소자로서 종래 소자에 비하여, 시야각이 넓고 콘트라스트가 우수할 뿐만 아니라, 응답시간이 빠르며, 휘도, 구동전압 및 응답속도 특성이 우수하고 다색화가 가능하다.

[0003] 일예에 따르면, 유기 발광 소자는, 애노드, 캐소드 및 상기 애노드와 캐소드 사이에 개재되고 발광층을 포함한 유기층 포함할 수 있다. 상기 애노드와 발광층 사이에는 정공 수송 영역이 구비될 수 있고, 상기 발광층과 캐소드 사이에는 전자 수송 영역이 구비될 수 있다. 상기 애노드로부터 주입된 정공은 정공 수송 영역을 경유하여

발광층으로 이동하고, 캐소드로부터 주입된 전자는 전자 수송 영역을 경유하여 발광층으로 이동한다. 상기 정공 및 전자는 발광층 영역에서 재결합하여 엑시톤(exciton)을 생성한다. 이 엑시톤이 여기 상태에서 기저상태로 변하면서 광이 생성된다.

발명의 내용

해결하려는 과제

[0004] 소정의 조건을 만족하는 조성물 및 이를 포함하는 유기 발광 소자를 제공하는 것이다.

과제의 해결 수단

[0005] 일 측면에 따르면, 제1전극; 제2전극; 및 상기 제1전극 및 상기 제2전극 사이에 개재된 유기층을 포함하고; 상기 유기층은 발광층을 포함하고; 상기 발광층은 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 하기 화학식 1로 표시되는, 유기 발광 소자가 제공된다:

[0006] <화학식 1>

[0007] $M_1(L_1)(L_2)$

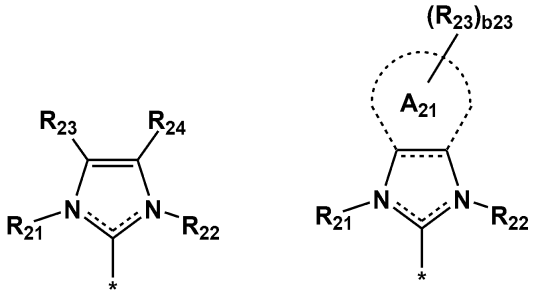
[0008] 상기 화학식 1 중,

[0009] M_1은 Au, Ag 또는 Cu이고;

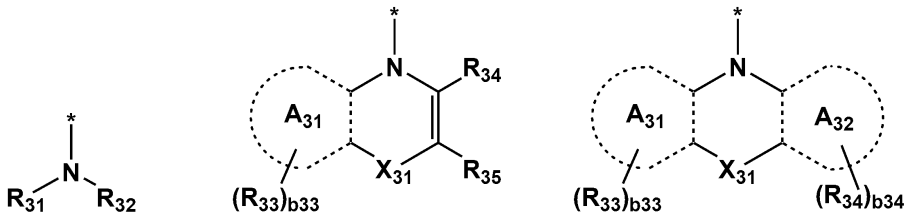
[0010] L_1은 하기 화학식 2-1 또는 2-2로 표시되는 리간드이고;

[0011] L_2는 하기 화학식 3-1, 3-2 및 3-3 중 어느 하나로 표시되는 리간드이고;

[0012] <화학식 2-1> <화학식 2-2>

[0013] 

[0014] <화학식 3-1> <화학식 3-2> <화학식 3-3>

[0015] 

[0016] 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중,

[0017] A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, C_5-C_{30}카보시클릭 그룹 및 C_1-C_{30}헤테로시클릭 그룹 중에서 선택되고;

[0018] X_{31}은 단일 결합, O, S, $N(R_{36})$, $C(R_{36})=C(R_{37})$, $\{C(R_{36})(R_{37})\}_{n31}$ 또는 $\{Si(R_{36})(R_{37})\}_{n31}$이고, n31은 1 또는 2이고;

[0019] R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아

릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

[0020] R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴옥시기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴티오기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$ 및 $-P(=S)(Q_1)(Q_2)$ 중에서 선택되고, R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{30}헤테로시클릭 그룹을 형성할 수 있고,

[0021] b23, b33 및 b34는 서로 독립적으로, 1, 2, 3, 4, 5, 6, 7, 8, 9 또는 10이고;

[0022] Q_1 내지 Q_3는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

[0023] *는 화학식 1 중의 M_1과의 결합 사이트이다.

[0024] 또 다른 측면에 따르면, 제1전극; 제2전극; 상기 제1전극과 상기 제2전극 사이에 개재되고, 적어도 하나의 발광층을 포함한, m개의 발광 유닛들; 및 상기 m개의 발광 유닛들 중 서로 인접한 2개의 발광 유닛들 사이에 배치되고, n형 전하 생성층 및 p형 전하 생성층을 포함한, m-1개의 전하 생성층;을 포함하고, 상기 m은 2 이상의 정수이고, 상기 m개의 발광 유닛들 중 적어도 하나의 발광 유닛에서 방출되는 광의 최대 발광 파장은 나머지 발광 유닛들 중 적어도 하나의 발광 유닛에서 방출되는 광의 최대 발광 파장과 상이하고, 상기 m개의 발광층 중 적어도 하나는 상기 발광층은 호스트, 도펀트 및 센서타이저를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상술한 화학식 1로 표시되는, 유기 발광 소자가 제공된다.

[0025] 또 다른 측면에 따르면, 제1전극; 제2전극; 및 상기 제1전극과 상기 제2전극 사이에 개재된 m개의 발광층; 을 포함하고, 상기 m은 2 이상의 정수이고, 상기 m개의 발광층 중 적어도 하나의 발광층에서 방출되는 광의 최대 발광 파장은 나머지 발광층 중 적어도 하나의 발광층에서 방출되는 광의 최대 발광 파장과 상이하고, 상기 m개의 발광층 중 적어도 하나는 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상술한 화학식 1로 표시되는, 유기 발광 소자가 제공된다.

발명의 효과

[0026] 상기 유기 발광 소자는 장수명을 가질 수 있다.

도면의 간단한 설명

[0027] 도 1은 일 실시예를 따르는 유기 발광 소자(10)를 개략적으로 나타낸 단면도이다.

도 2는 다른 실시예를 따르는 유기 발광 소자(100)를 개략적으로 나타낸 단면도이다.

도 3은 또 다른 실시예를 따르는 유기 발광 소자(200)를 개략적으로 나타낸 단면도이다.

발명을 실시하기 위한 구체적인 내용

[0028] **도 1에 대한 설명**

[0029] 도 1은 본 발명의 일 실시예를 따르는 유기 발광 소자(10)의 단면도를 개략적으로 도시한 것이다. 이하, 도 1을 참조하여 본 발명의 일 실시예를 따르는 유기 발광 소자의 구조 및 제조 방법을 설명하면 다음과 같다.

[0030] 도 1의 유기 발광 소자(10)는 제1전극(11), 상기 제1전극(11)에 대향된 제2전극(19) 및 상기 제1전극(11)과 상기 제2전극(19) 사이에 배치된 유기층(10A)을 포함한다.

[0031] 상기 유기층(10A)은 발광층(15)을 포함하고, 상기 제1전극(11)과 상기 발광층(15) 사이에는 정공 수송 영역(12)이 배치되어 있고, 상기 발광층(15)과 상기 제2전극(19) 사이에는 전자 수송 영역(17)이 배치되어 있다.

[0032] 상기 제1전극(11) 하부 또는 제2전극(19) 상부에는 기판이 추가로 배치될 수 있다. 상기 기판으로는, 통상적인 유기 발광 소자에서 사용되는 기판을 사용할 수 있는데, 기계적 강도, 열안정성, 투명성, 표면 평활성, 취급용이성 및 방수성이 우수한 유리 기판 또는 투명 플라스틱 기판을 사용할 수 있다.

[0033] **[제1전극(11)]**

[0034] 상기 제1전극(11)은 예를 들면, 기판 상부에, 제1전극용 물질을 증착법 또는 스퍼터링법 등을 이용하여 제공함으로써 형성될 수 있다. 상기 제1전극(11)은 애노드일 수 있다. 상기 제1전극용 물질은 정공 주입이 용이하도록 높은 일함수를 갖는 물질 중에서 선택될 수 있다.

[0035] 상기 제1전극(11)은 반사형 전극, 반투과형 전극 또는 투과형 전극일 수 있다. 투과형 전극인 제1전극(11)을 형성하기 위하여, 제1전극용 물질은, 산화인듐주석(ITO), 산화인듐아연(IZO), 산화주석(SnO_2), 산화아연(ZnO) 및 이의 임의의 조합 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다. 또는, 반투과형 전극 또는 반사형 전극인 제1전극(110)을 형성하기 위하여, 제1전극용 물질은, 마그네슘(Mg), 은(Ag), 알루미늄(Al), 알루미늄-리튬(Al-Li), 칼슘(Ca), 마그네슘-인듐(Mg-In), 마그네슘-은(Mg-Ag) 및 이의 임의의 조합 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0036] 상기 제1전극(11)은 단일층 또는 2 이상의 층을 포함한 다층 구조를 가질 수 있다.

[0037] **[발광층(15)]**

[0038] 상기 발광층은 호스트, 센서타이저 및 에미터를 포함하고, 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하다.

[0039] [센서타이저]

[0040] 상기 센서타이저는 하기 화학식 1로 표시될 수 있다:

[0041] <화학식 1>

[0042] $M_1(L_1)(L_2)$

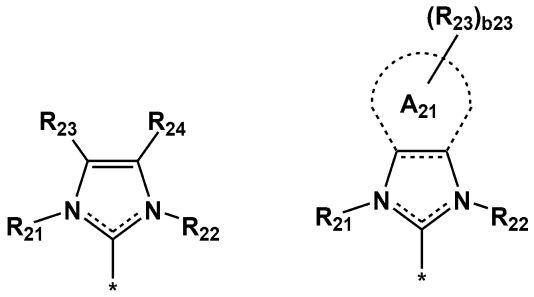
[0043] 상기 화학식 1 중,

[0044] M_1은 Au, Ag 또는 Cu이고;

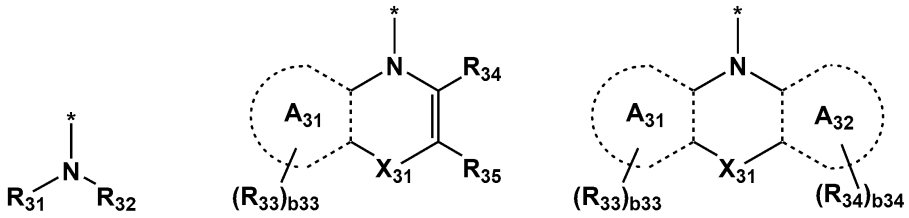
[0045] L_1은 하기 화학식 2-1 또는 2-2로 표시되는 리간드이고;

[0046] L_2는 하기 화학식 3-1, 3-2 및 3-3 중 어느 하나로 표시되는 리간드이다:

[0047] <화학식 2-1> <화학식 2-2>

[0048] 

[0049] <화학식 3-1> <화학식 3-2> <화학식 3-3>

[0050] 

[0051] 예를 들어, 상기 화학식 1 중, M_1은 Au일 수 있다.

[0052] 상기 화학식 2-2, 3-2 및 3-3 중, A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, C_5-C_{30}카보시클릭 그룹 및 C_1-C_{30}헤테로시클릭 그룹 중에서 선택될 수 있다.

[0053] 예를 들어, 상기 화학식 2-2, 3-2 및 3-3 중, A_{21}, A_{31} 및 A_{32}는 서로 독립적으로, 벤젠 그룹, 나프탈렌 그룹, 페난트렌 그룹, 퓨란 그룹, 티오펜 그룹, 피롤 그룹, 시클로펜텐 그룹, 실롤 그룹, 저몰 그룹, 벤조퓨란 그룹, 벤조티오펜 그룹, 인돌 그룹, 인덴 그룹, 벤조실롤 그룹, 벤조저몰 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 플루오렌 그룹, 디벤조실롤 그룹, 디벤조저몰 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹일 수 있다.

[0054] 다른 예로서, 상기 화학식 2-2 중, A_{21}은 벤젠 그룹, 나프탈렌 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹일 수 있다.

[0055] 또 다른 예로서, 상기 화학식 3-2 및 3-3 중, A_{31} 및 A_{32}는 서로 독립적으로, 벤젠 그룹, 나프탈렌 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 피리딘 그룹, 피리미딘 그룹, 피리다진 그룹 또는 피라진 그룹일 수 있다.

[0056] 상기 화학식 3-2 및 3-3 중, X_{31}은 단일 결합, O, S, $N(R_{36})$, $C(R_{36})=C(R_{37})$, $\{C(R_{36})(R_{37})\}_{n31}$ 또는 $\{Si(R_{36})(R_{37})\}_{n31}$이고, n31은 1 또는 2이고, R_{36} 및 R_{37}에 대한 설명은 후술하는 바를 참조한다.

[0057] 예를 들어, 상기 화학식 3-2 및 3-3 중, X_{31}은 단일 결합, O, S, $N(R_{36})$, $C(R_{36})=C(R_{37})$, $C(R_{36})(R_{37})$ 또는 $Si(R_{36})(R_{37})$일 수 있다.

[0058] 상기 화학식 2-1, 2-2 및 3-1 중, R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택될 수 있다.

[0059] 예를 들어, 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클

로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기; 또는

[0060] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기;이고;

[0061] Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$,

$-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0062] 중수소, -F, C_1-C_{10}알킬기, 중수소화된 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 일 수 있다.

[0063] 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 중, R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로,

[0064] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기; 또는

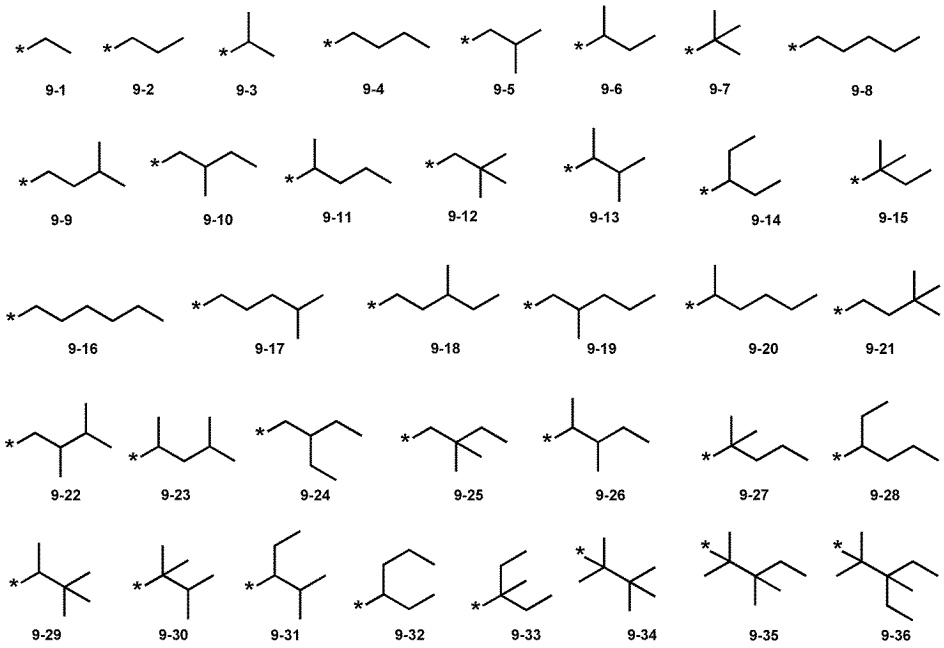
[0065] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, $-P(=S)(Q_{21})(Q_{22})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기;이고;

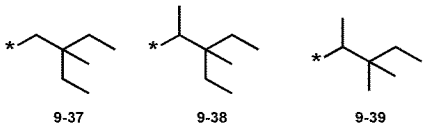
[0066] Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 중수소, -F, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$,

$-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

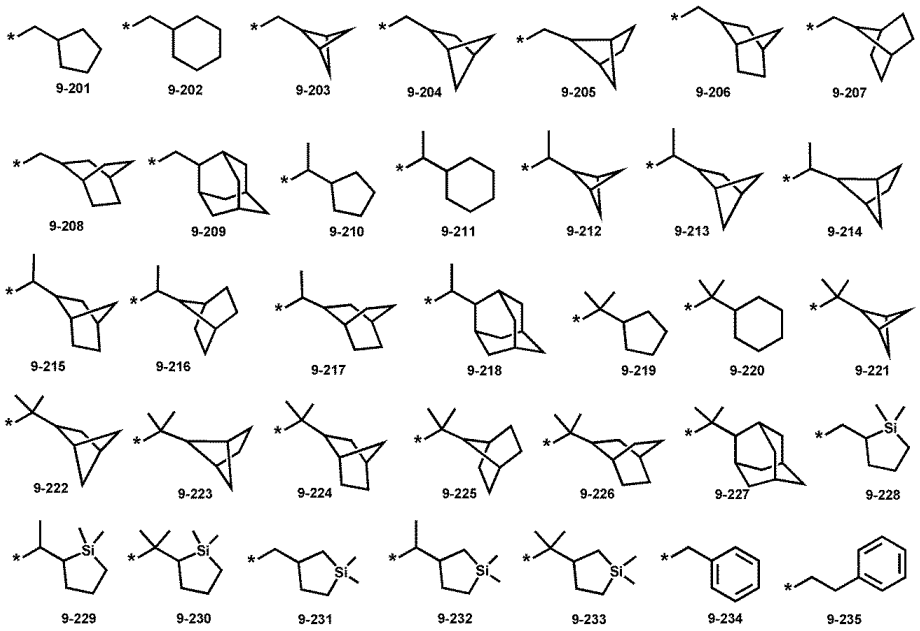
[0067] 중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 일 수 있다.

[0068] 또 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 중, R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 하기 화학식 9-1 내지 9-39 중 하나로 표시된 그룹, 하기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 하기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 하기 화학식 9-201 내지 9-236 중 하나로 표시된 그룹, 하기 화학식 9-201 내지 9-236 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 하기 화학식 9-201 내지 9-236 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 하기 화학식 10-1 내지 10-130 중 하나로 표시된 그룹, 하기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 하기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 하기 화학식 10-201 내지 10-358 중 하나로 표시된 그룹, 하기 화학식 10-201 내지 10-358 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 또는 하기 화학식 10-201 내지 10-358 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹일 수 있다:

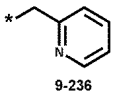
[0069] 

[0070] 

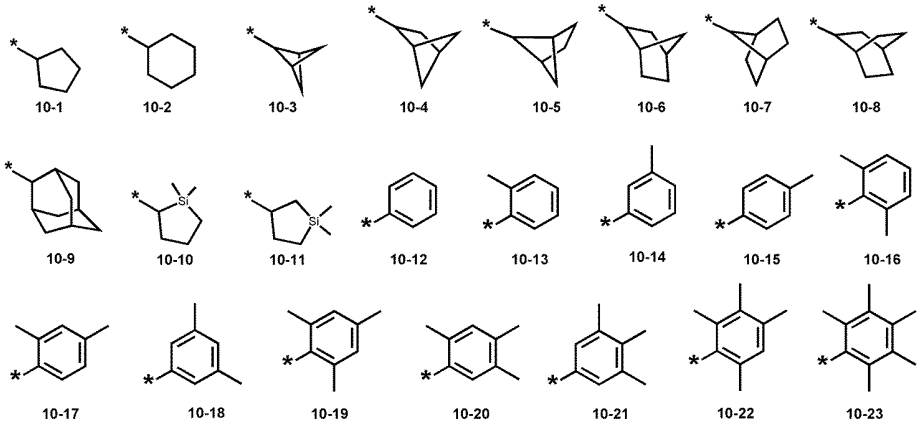
[0071]



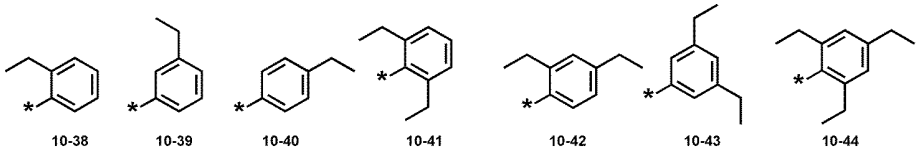
[0072]



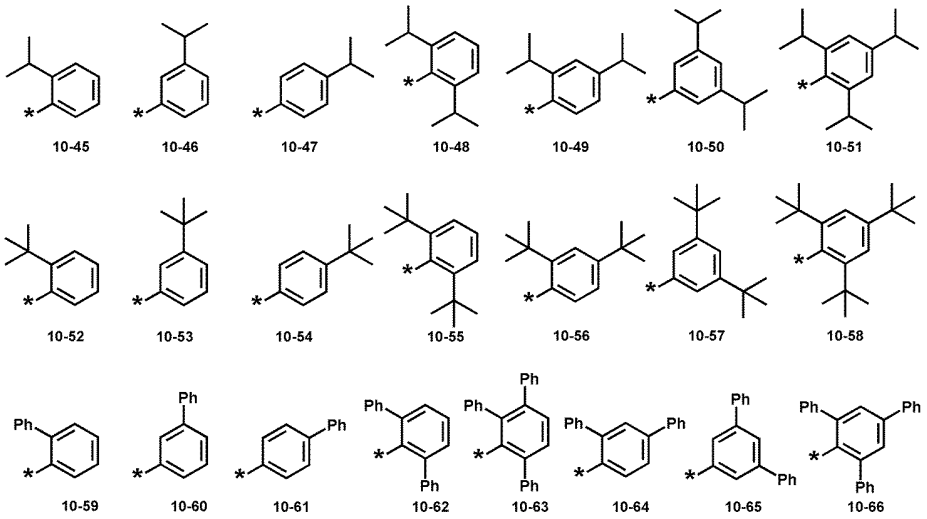
[0073]



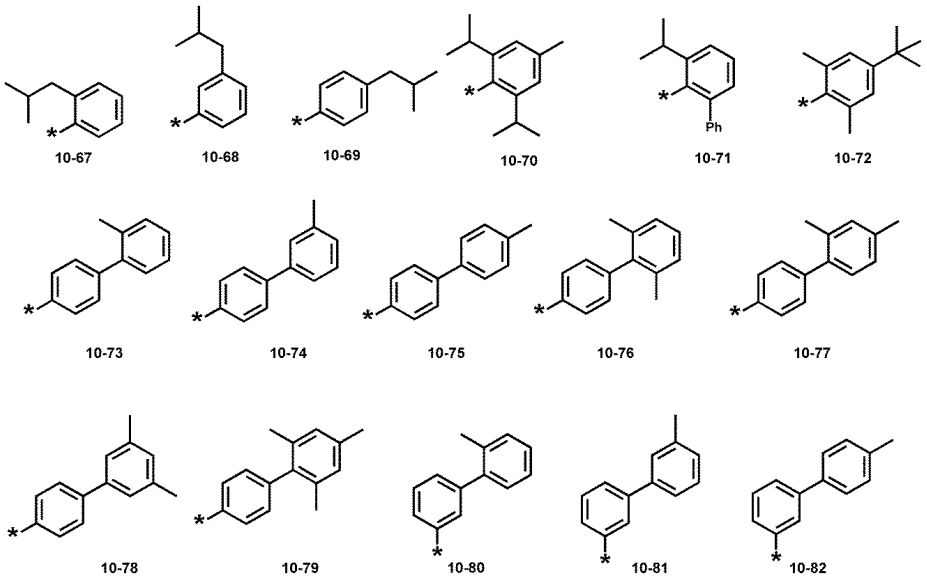
[0074]



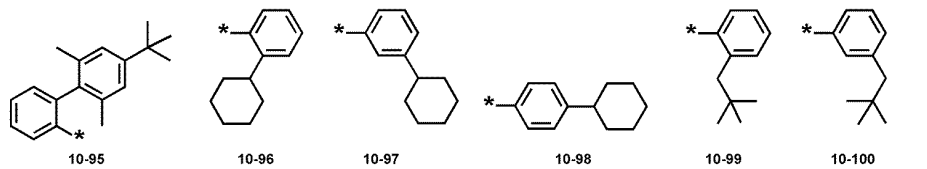
[0075]



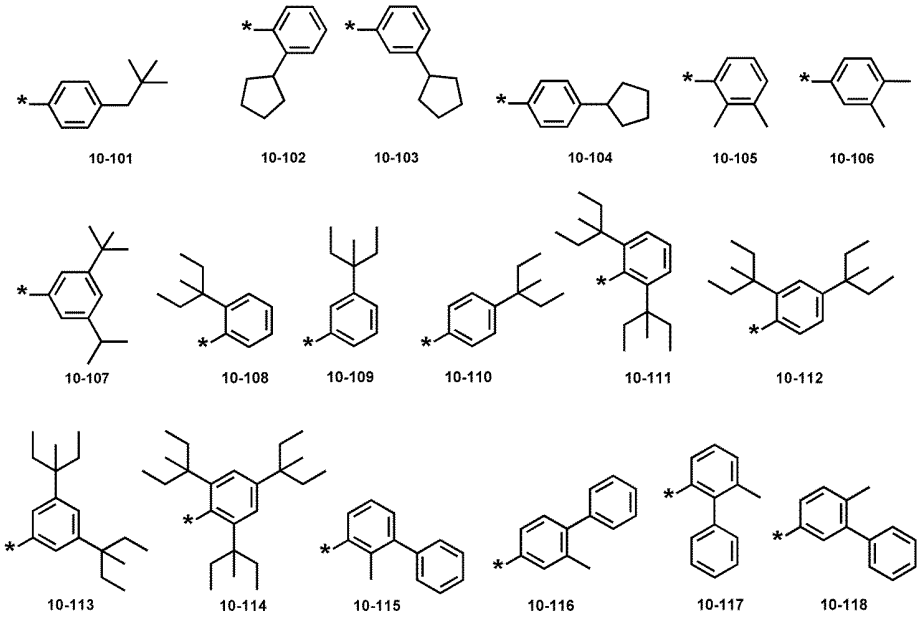
[0076]



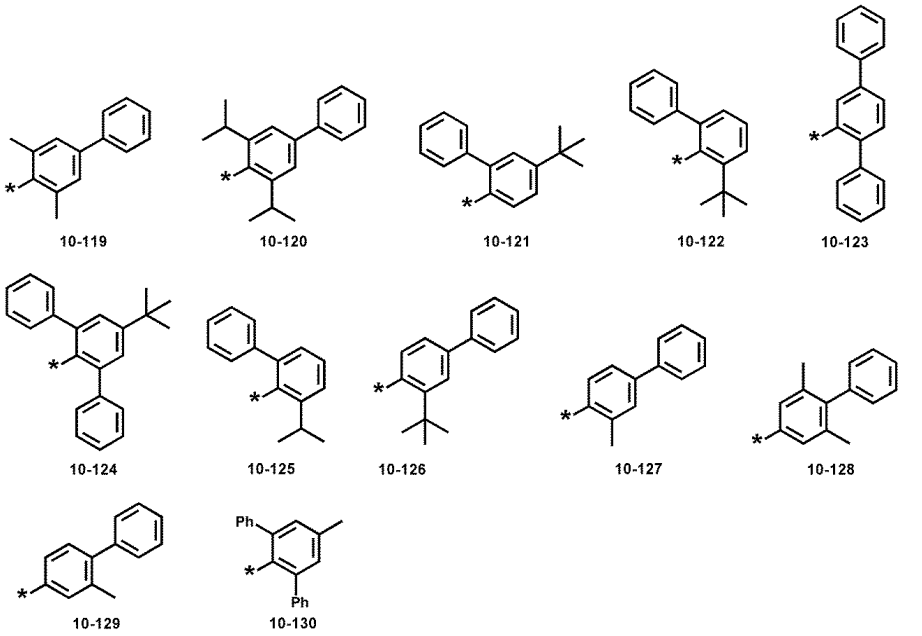
[0077]



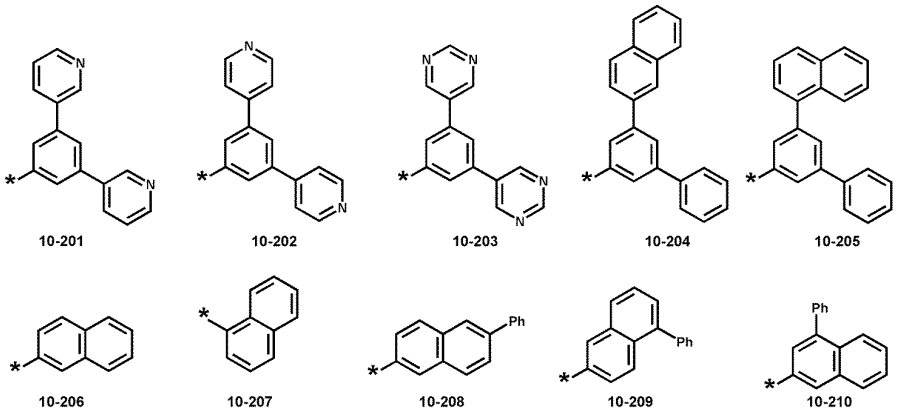
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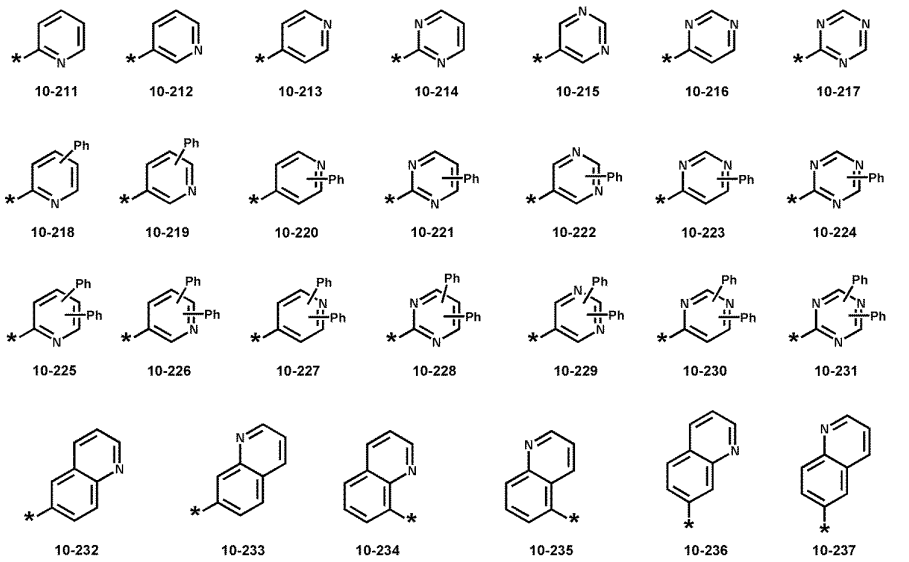
[0079]



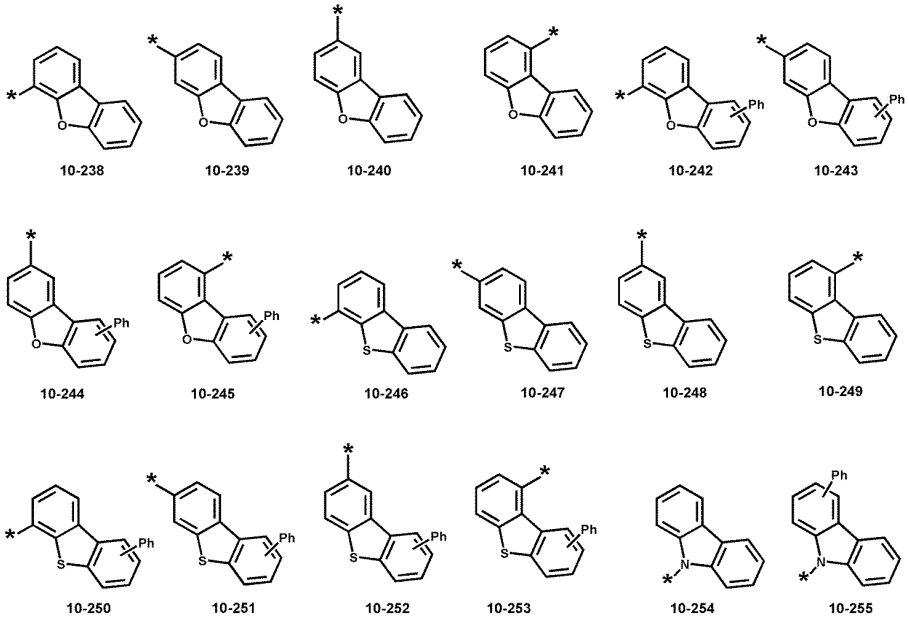
[0080]



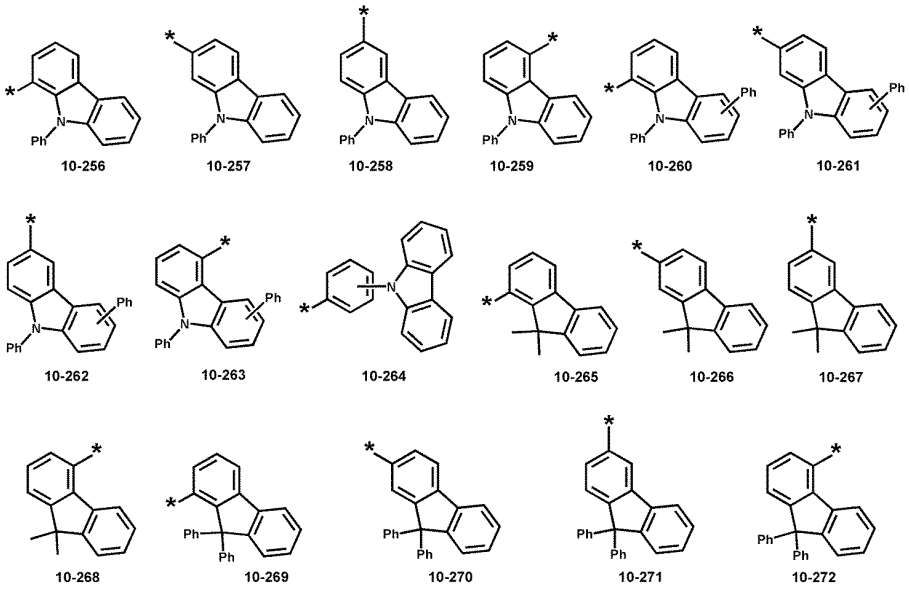
[0081]



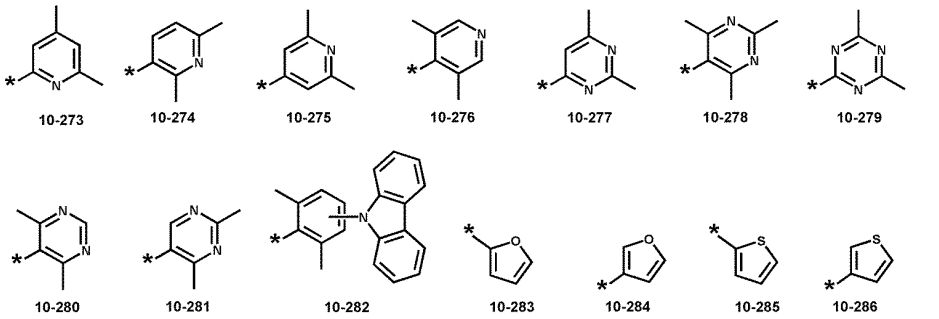
[0082]



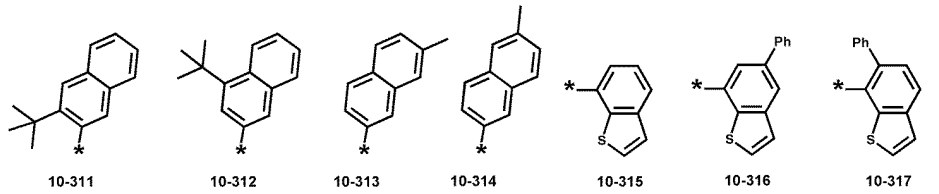
[0083]



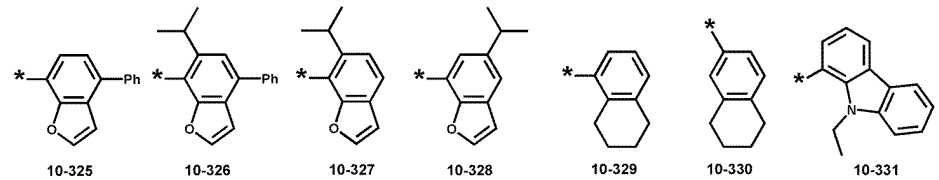
[0084]



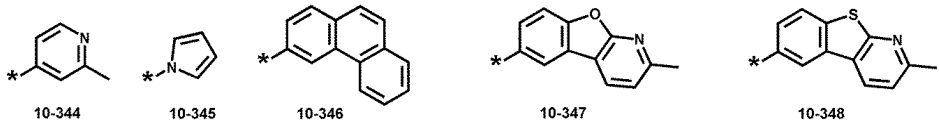
[0085]

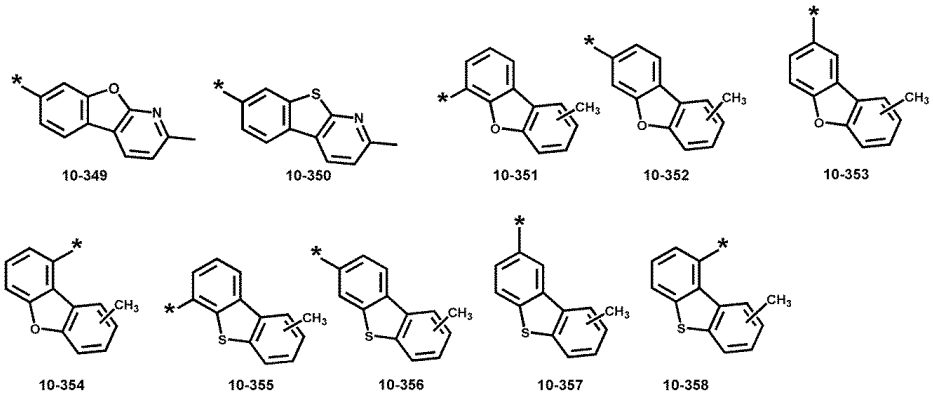


[0086]



[0087]

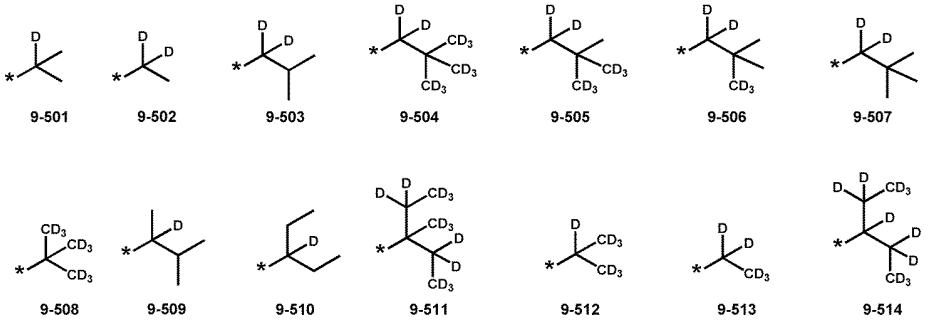


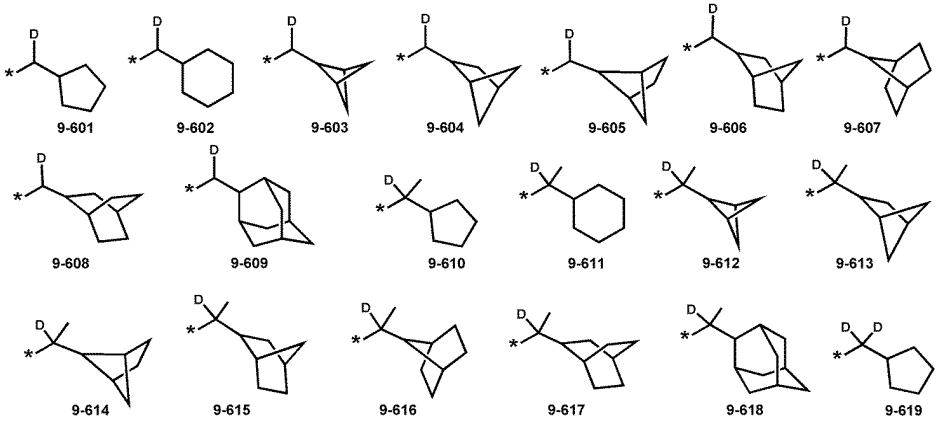
[0088] 

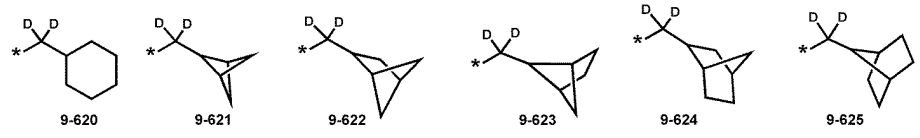
[0089] 상기 화학식 9-1 내지 9-39, 9-201 내지 9-236, 10-1 내지 10-130 및 10-201 내지 10-358 중 *는 이웃한 원자와의 결합 사이트이고, Ph는 페닐기이고, TMS 및 $SiMe_3$는 트리메틸실릴기이고, TMG 및 $GeMe_3$는 트리메틸저밀기(trimethylgermyl)이다.

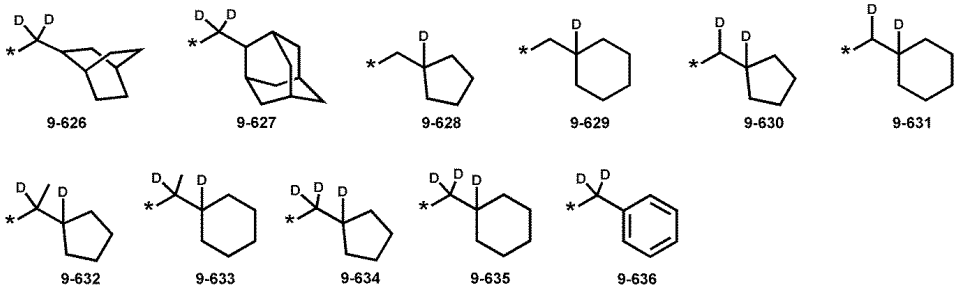
[0090] 또 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 중, R_{21}, R_{22}, R_{31} 및 R_{32}는 서로 독립적으로, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 상기 화학식 9-1 내지 9-39 중 하나로 표시된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 상기 화학식 10-1 내지 10-130 중 하나로 표시된 그룹, 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 또는 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹일 수 있다.

[0091] 상기 "화학식 9-1 내지 9-39 중 적어도 하나의 수소가 중수소로 치환된 그룹" 및 "화학식 9-201 내지 9-236 중 적어도 하나의 수소가 중수소로 치환된 그룹"은 예를 들면, 하기 화학식 9-501 내지 9-514 및 9-601 내지 9-636으로 표시된 그룹일 수 있다:

[0092] 

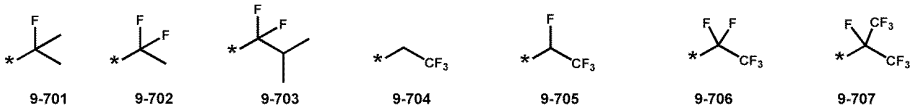


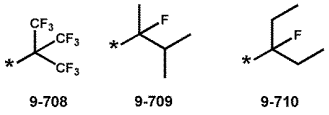
[0093] 



[0094]

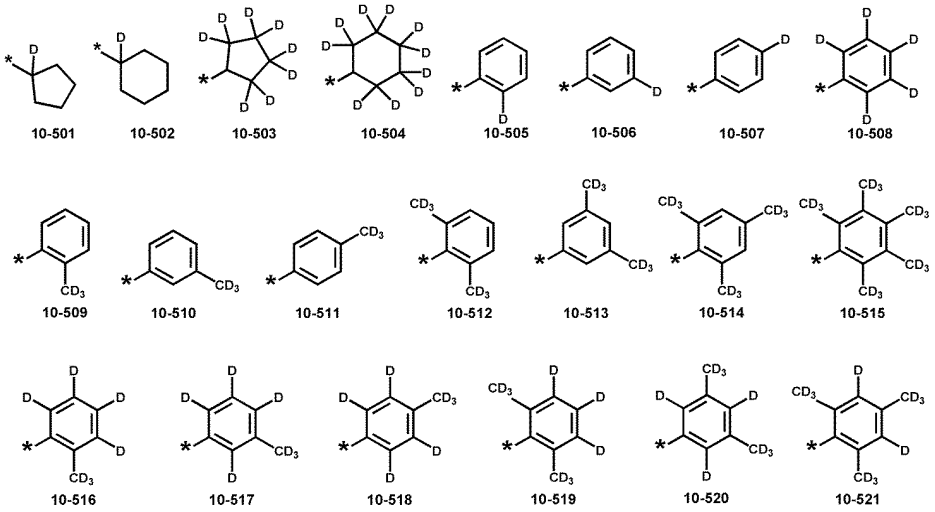
[0095] 상기 "화학식 9-1 내지 9-39 중 적어도 하나의 수소가 -F로 치환된 그룹" 및 "화학식 9-201 내지 9-236 중 적어도 하나의 수소가 -F로 치환된 그룹"은 예를 들면, 하기 화학식 9-701 내지 9-710으로 표시된 그룹일 수 있다:





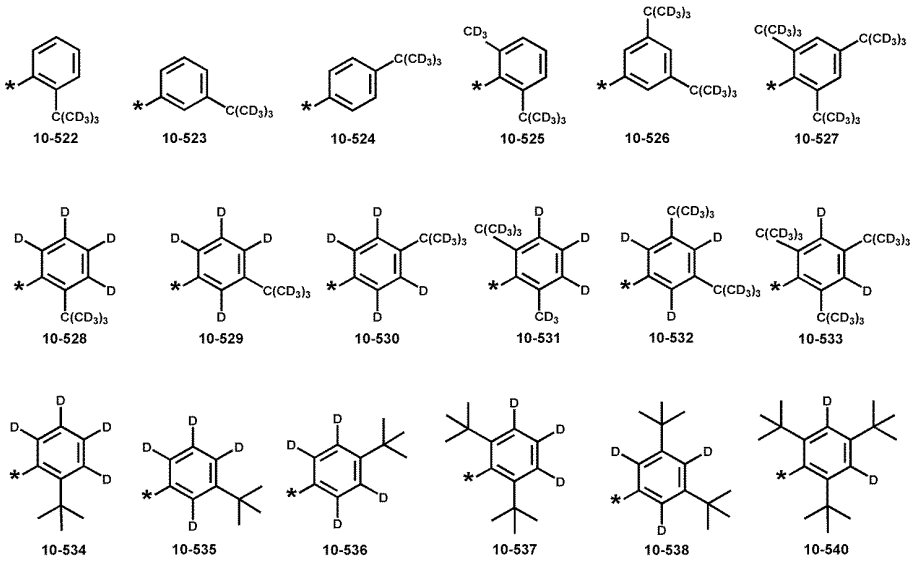
[0096]

[0097] 상기 "화학식 10-1 내지 10-130 중 적어도 하나의 수소가 중수소로 치환된 그룹" 및 "화학식 10-201 내지 10-358 중 적어도 하나의 수소가 중수소로 치환된 그룹"은 예를 들면, 하기 화학식 10-501 내지 10-576으로 표시된 그룹일 수 있다:

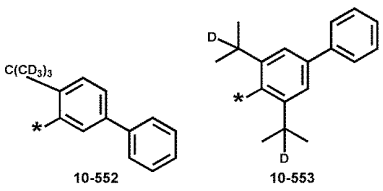


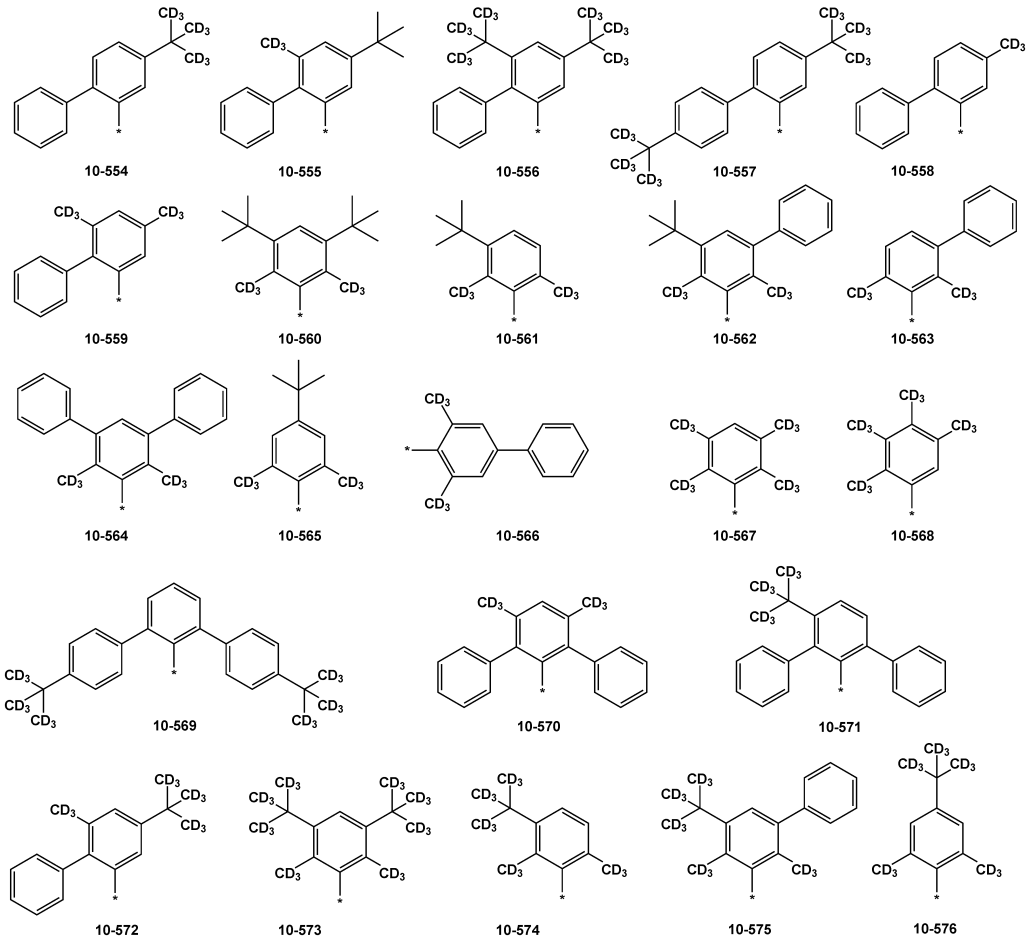
[0098]

[0099]


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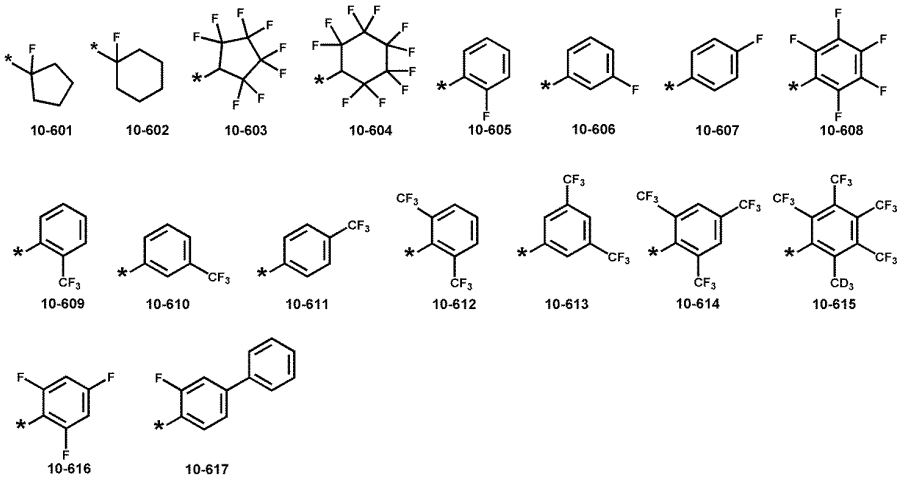
[0100]


10-552
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[0101]

[0102] 상기 "화학식 10-1 내지 10-130 중 적어도 하나의 수소가 -F로 치환된 그룹" 및 "화학식 10-201 내지 10-358 중 적어도 하나의 수소가 -F로 치환된 그룹"은 예를 들면, 하기 화학식 10-601 내지 10-617로 표시된 그룹일 수 있다:



[0103]

[0104] 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환

된 C_1-C_{60}헤테로아릴옥시기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴티오기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$ 및 $-P(=S)(Q_1)(Q_2)$ 중에서 선택되고,

[0105] R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{30}헤테로시클릭 그룹을 형성할 수 있고,

[0106] Q_1 내지 Q_3는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택될 수 있다.

[0107] 예를 들어, 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 또는 인산기 또는 이의 염;

[0108] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기 C_1-C_{20}알케닐기, C_1-C_{20}알콕시기, 또는 C_1-C_{20}알킬티오기;

[0109] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기,

(C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, $-P(=S)(Q_{21})(Q_{22})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

[0110] $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$, 또는 $-P(=S)(Q_1)(Q_2)$; 이고,

[0111] Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0112] 중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기;일 수 있다.

[0113] 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 또는 니트로기;

[0114] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸

기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기;

[0115] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, $-P(=S)(Q_{21})(Q_{22})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

[0116] $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, 또는 $-N(Q_1)(Q_2)$; 이고,

[0117] R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹을 형성할 수 있고,

[0118] Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 중수소, -F, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0119] 중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기;일 수 있다.

[0120] 또 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 상기 화학식 9-1 내지 9-39 중 하나로 표시된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 상기 화학식 9-201 내지 9-236 중 하나로 표시된 그룹, 상기 화학식 9-201 내지 9-236 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 9-201 내지 9-236 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 상기 화학식 10-1 내지 10-130 중 하나로 표시된 그룹, 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 상기 화학식 10-201 내지 10-358

중 하나로 표시된 그룹, 상기 화학식 10-201 내지 10-358 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 10-201 내지 10-358 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, 또는 $-C(Q_1)(Q_2)(Q_3)$이고,

[0121] R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹을 형성할 수 있고,

[0122] Q_1 내지 Q_3은 서로 독립적으로,

[0123] 중수소, -F, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0124] 중수소, -F, C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기;일 수 있다.

[0125] 또 다른 예로서, 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, R_{23}, R_{24} 및 R_{33} 내지 R_{37}은 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 상기 화학식 9-1 내지 9-39 중 하나로 표시된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 9-1 내지 9-39 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, 상기 화학식 10-1 내지 10-130 중 하나로 표시된 그룹, 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 중수소로 치환된 그룹, 상기 화학식 10-1 내지 10-130 중 하나의 적어도 하나의 수소가 -F로 치환된 그룹, $-Si(Q_1)(Q_2)(Q_3)$, 또는 $-Ge(Q_1)(Q_2)(Q_3)$이고,

[0126] R_{36} 및 R_{37}은 선택적으로, 서로 결합하여 치환 또는 비치환된 C_5-C_{30}카보시클릭 그룹을 형성할 수 있고,

[0127] Q_1 내지 Q_3은 서로 독립적으로,

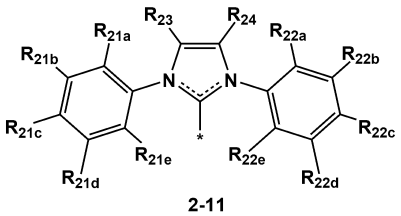
[0128] $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0129] 중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, 페닐기, 비페닐기 또는 나프틸기;일 수 있다.

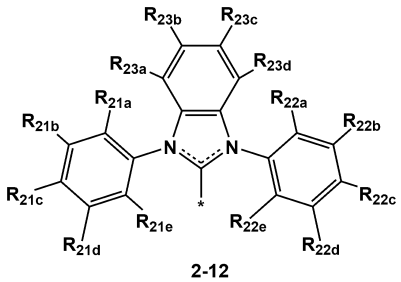
[0130] 상기 화학식 2-2, 3-2 및 3-3 중, b23, b33 및 b34는 각각 R_{23}, R_{33} 및 R_{34}의 치환 개수를 의미하고, b23, b33 및 b34는 서로 독립적으로, 1, 2, 3, 4, 5, 6, 7, 8, 9 또는 10일 수 있다.

[0131] 상기 화학식 2-1, 2-2 및 3-1 내지 3-3 중, *는 화학식 1 중의 M_1과의 결합 사이트이다.

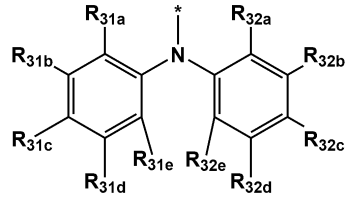
[0132] 일 실시예에 있어서, 상기 화학식 1 중, L_1은 하기 화학식 2-11 또는 2-12로 표시되는 리간드일 수 있다. 한편, 상기 화학식 1 중, L_2는 하기 화학식 3-11 내지 3-17 중 어느 하나로 표시되는 리간드일 수 있다:

[0133] 

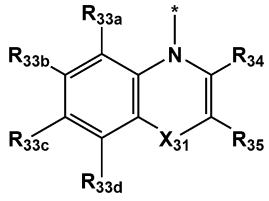
2-11



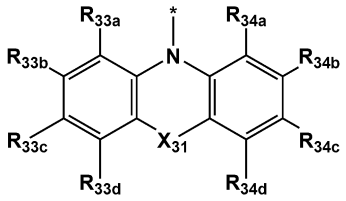
2-12



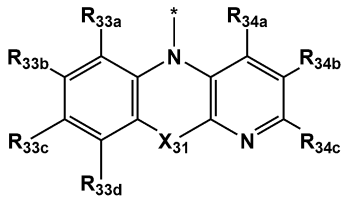
3-11



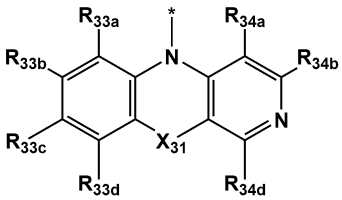
3-12



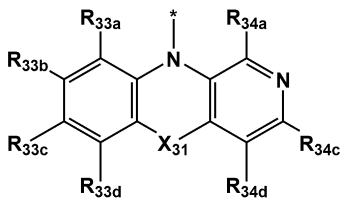
3-13



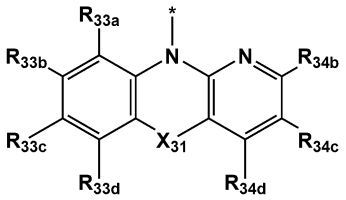
3-14



3-15



3-16



3-17

[0134]

[0135] 상기 화학식 2-11, 2-12 및 3-11 내지 3-17 중,

[0136] X_{31}, R_{23}, R_{24}, R_{34} 및 R_{35}의 정의는 상기 화학식 1에서와 동일하고,

[0137] R_{21a} 내지 R_{21e}, R_{22a} 내지 R_{22e}, R_{23a} 내지 R_{23d}, R_{31a} 내지 R_{31e}, R_{32a} 내지 R_{32e}, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고;

[0138] Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0139] 중수소, -F, C_1-C_{10}알킬기, 중수소화 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

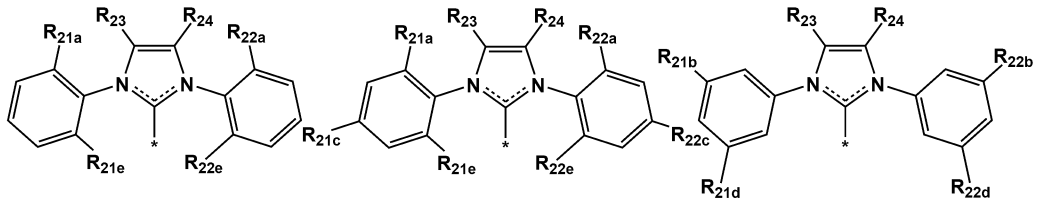
[0140] *는 화학식 1 중의 M_1과의 결합 사이트이다.

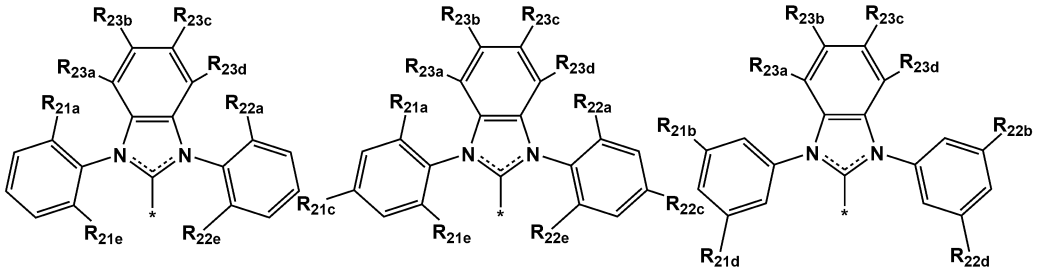
[0141] 예를 들어, 상기 화학식 3-13 중, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d} 중 적어도 하나는 시아노기일 수 있으나, 이에 한정되는 것은 아니다.

[0142] 다른 예로서, 상기 화학식 3-13 중, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d} 중 하나는 시아노기일 수 있고, 구체적으로, R_{34a}, R_{34b}, R_{34c} 또는 R_{34d}는 시아노기이다.

[0143] 다른 실시예에 있어서, 상기 화학식 1 중, L_1은 상기 화학식 2-11 또는 2-12로 표시되는 리간드이고; L_2는 상기 화학식 3-13으로 표시되는 리간드일 수 있다.

[0144] 또 다른 실시예에 있어서, 상기 화학식 1 중, L_1은 하기 화학식 2-21 내지 2-26 중 어느 하나로 표시되는 리간드일 수 있다:





[0145]

[0146] 상기 화학식 2-21 내지 2-26 중,

[0147] R_{23}, R_{24} 및 R_{23a} 내지 R_{23d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 또는 니트로기;

[0148] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기;

[0149] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

[0150] $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, 또는 $-N(Q_1)(Q_2)$; 이고,

[0151] R_{21a}, R_{21b}, R_{21c}, R_{21d}, R_{21e}, R_{22a}, R_{22b}, R_{22c}, R_{22d} 및 R_{22e}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고,

[0152] Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$,

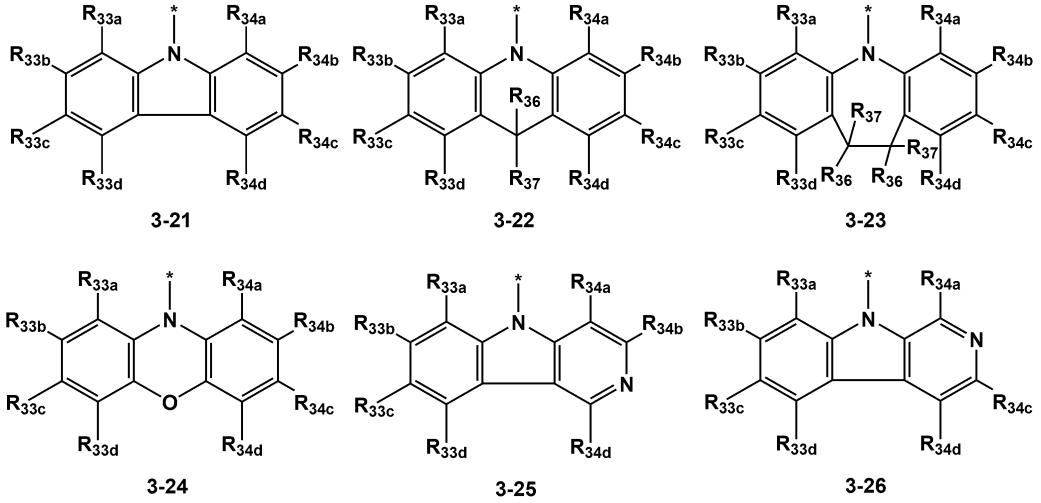
$-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0153] 중수소, -F, C_1-C_{10}알킬기, 중수소화된 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

[0154] *는 화학식 1 중의 M_1과의 결합 사이트이다.

[0155] 구체적으로, 상기 화학식 2-21, 2-22, 2-24 및 2-25 중, R_{21a}, R_{21b}, R_{22a} 및 R_{21b} 중 적어도 하나는 수소가 아닐 수 있다.

[0156] 또 다른 실시예에 있어서, 상기 화학식 1 중, L_2는 하기 화학식 3-21 내지 3-26 중 어느 하나로 표시되는 리간드일 수 있다:



[0157]

[0158] 상기 화학식 3-21 내지 3-26 중,

[0159] R_{36} 및 R_{37}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 또는 니트로기;

[0160] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-Ge(Q_{11})(Q_{12})(Q_{13})$, $-C(Q_{11})(Q_{12})(Q_{13})$, $-B(Q_{11})(Q_{12})$, $-N(Q_{11})(Q_{12})$, $-P(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, $-P(=O)(Q_{11})(Q_{12})$, $-P(=S)(Q_{11})(Q_{12})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, C_1-C_{20}알킬기;

[0161] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-

C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, $-P(=S)(Q_{21})(Q_{22})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기 또는 아자디벤조티오페닐기; 또는

[0162] $-Si(Q_1)(Q_2)(Q_3)$, $-Ge(Q_1)(Q_2)(Q_3)$, $-C(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, 또는 $-N(Q_1)(Q_2)$; 이고,

[0163] R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{20}알킬기, 중수소화 C_2-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로옥틸기, 아다만타닐기, 노르보나닐기, 노르보네닐기, 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기, 비시클로[1.1.1]펜틸기, 비시클로[2.1.1]헥실기, 비시클로[2.2.1]헵틸기, 비시클로[2.2.2]옥틸기, (C_1-C_{20}알킬)시클로펜틸기, (C_1-C_{20}알킬)시클로헥실기, (C_1-C_{20}알킬)시클로헵틸기, (C_1-C_{20}알킬)시클로옥틸기, (C_1-C_{20}알킬)아다만타닐기, (C_1-C_{20}알킬)노르보나닐기, (C_1-C_{20}알킬)노르보네닐기, (C_1-C_{20}알킬)시클로펜테닐기, (C_1-C_{20}알킬)시클로헥세닐기, (C_1-C_{20}알킬)시클로헵테닐기, (C_1-C_{20}알킬)비시클로[1.1.1]펜틸기, (C_1-C_{20}알킬)비시클로[2.1.1]헥실기, (C_1-C_{20}알킬)비시클로[2.2.1]헵틸기, (C_1-C_{20}알킬)비시클로[2.2.2]옥틸기, 페닐기, (C_1-C_{20}알킬)페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 피롤일기, 티오페닐기, 퓨라닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 카바졸일기, 페난트롤리닐기, 벤조이미다졸일기, 벤조퓨라닐기, 벤조티오페닐기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 이미다조피리디닐기, 이미다조피리미디닐기, 아자카바졸일기, 아자디벤조퓨라닐기, 아자디벤조티오페닐기, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-Ge(Q_{21})(Q_{22})(Q_{23})$, $-C(Q_{21})(Q_{22})(Q_{23})$, $-B(Q_{21})(Q_{22})$, $-N(Q_{21})(Q_{22})$, $-P(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, $-P(=O)(Q_{21})(Q_{22})$, 또는 $-P(=S)(Q_{21})(Q_{22})$이고,

[0164] Q_1 내지 Q_3, Q_{11} 내지 Q_{13} 및 Q_{21} 내지 Q_{23}는 서로 독립적으로, 수소, 중수소, -F, 시아노기, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, $-CD_2CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, $-CH_2CF_3$, $-CH_2CF_2H$, $-CH_2CFH_2$, $-CHFCH_3$, $-CHFCF_2H$, $-CHFCFH_2$, $-CHFCF_3$, $-CF_2CF_3$, $-CF_2CF_2H$, 또는 $-CF_2CFH_2$; 또는

[0165] 중수소, -F, C_1-C_{10}알킬기, 중수소화된 C_1-C_{10}알킬기, 페닐기, 또는 이의 임의의 조합으로 치환 또는 비치환된, *n*-프로필기, 이소프로필기, *n*-부틸기, *sec*-부틸기, 이소부틸기, *tert*-부틸기, *n*-펜틸기, *tert*-펜틸기, 네오펜틸기, 이소펜틸기, *sec*-펜틸기, 3-펜틸기, *sec*-이소펜틸기, 페닐기, 비페닐기 또는 나프틸기; 이고,

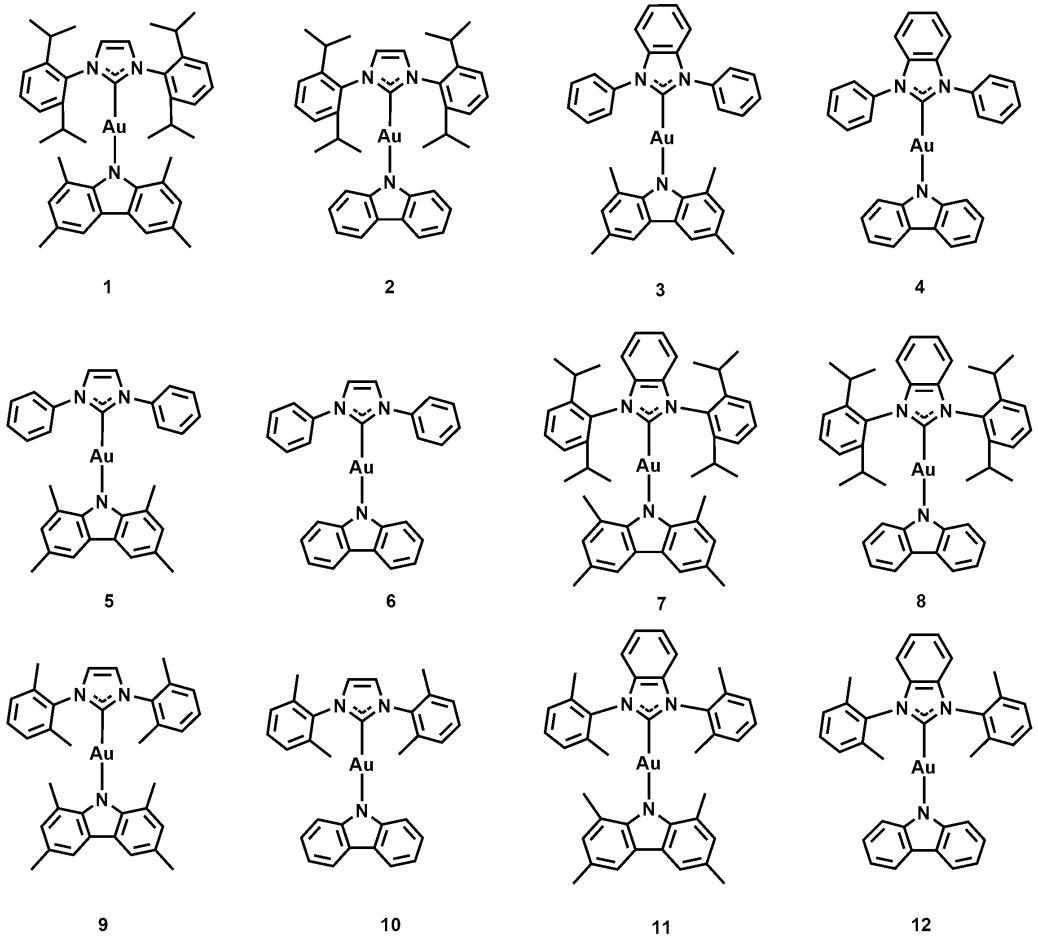
[0166] *는 화학식 1 중의 M_1과의 결합 사이트이다.

[0167] 예를 들어, 상기 화학식 3-21 중, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d} 중 적어도 하나는 시아노기일 수 있으나, 이에 한정되는 것은 아니다.

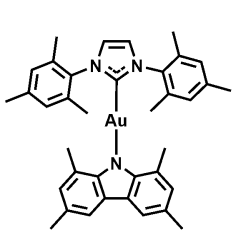
[0168] 다른 예로서, 상기 화학식 3-21 중, R_{33a} 내지 R_{33d} 및 R_{34a} 내지 R_{34d} 중 하나는 시아노기일 수 있고, 구체적으로, R_{34c} 또는 R_{34d}는 시아노기이다.

[0169] 또 다른 실시예에 있어서, 상기 센서타이저는 하기 그룹 I 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

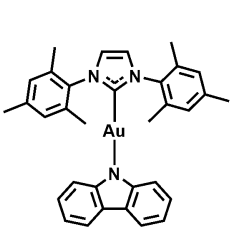
[0170] <그룹 I>



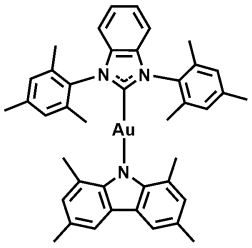
[0171]



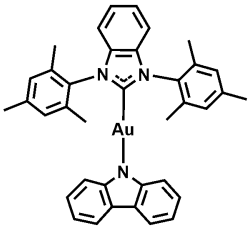
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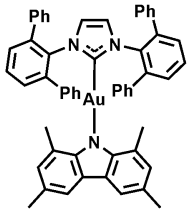
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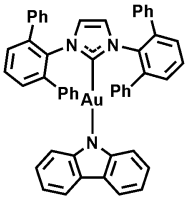
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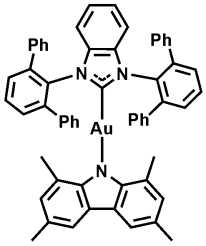
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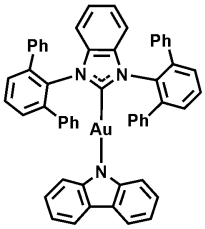
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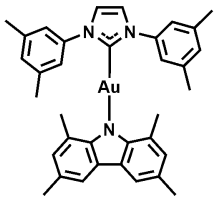
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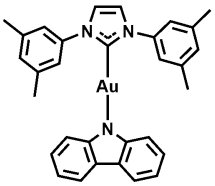
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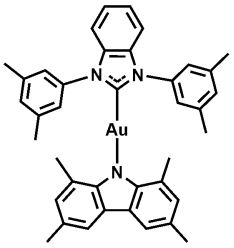
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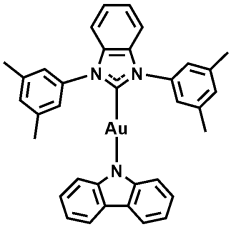
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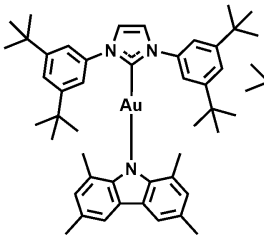
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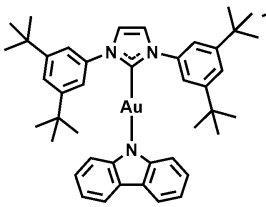
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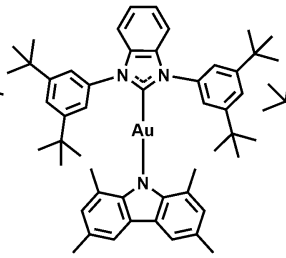
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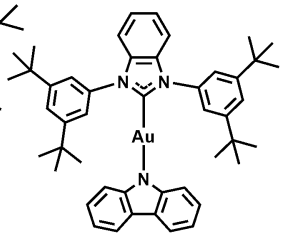
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26



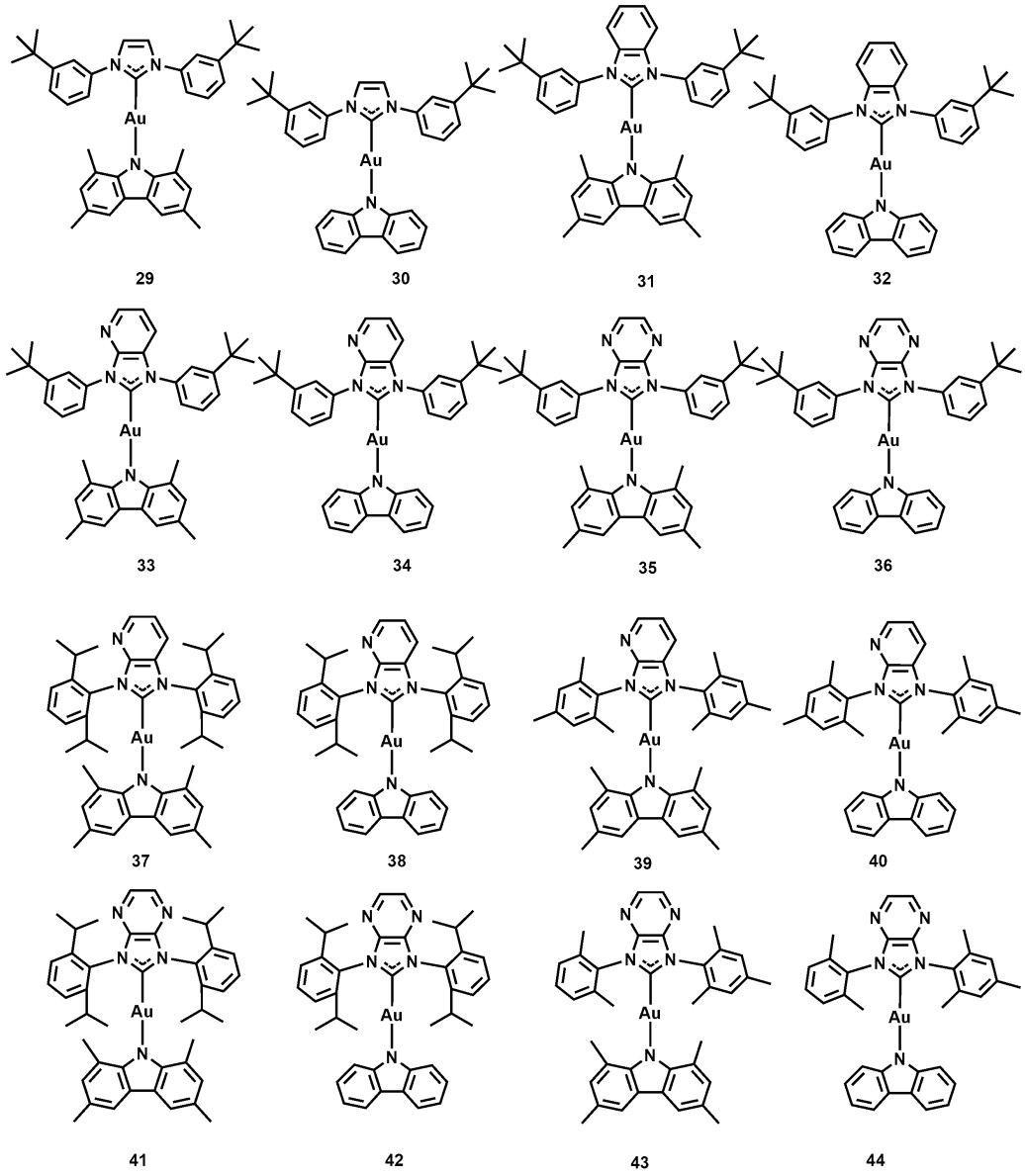
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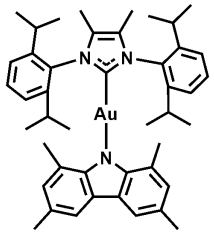
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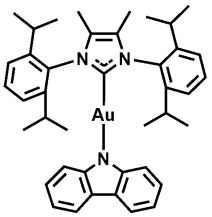
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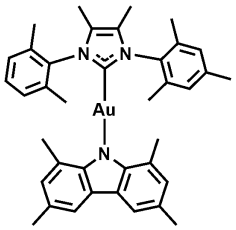
[0173]

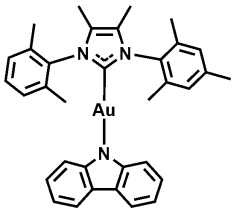


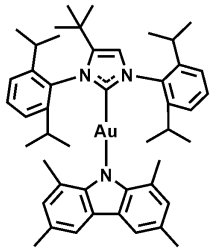
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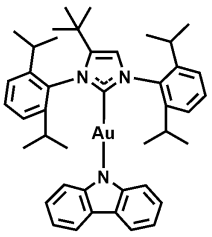

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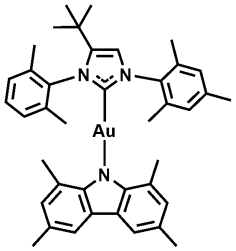

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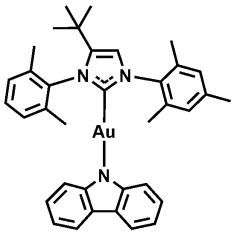

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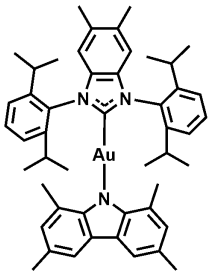

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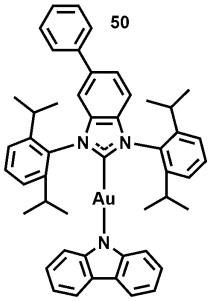

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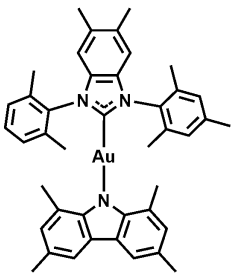

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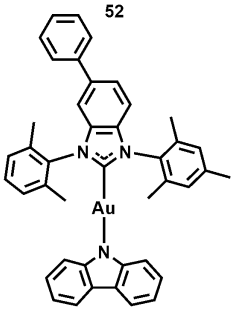

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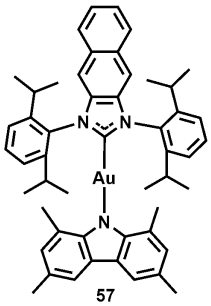

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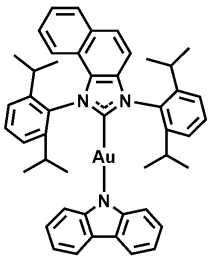

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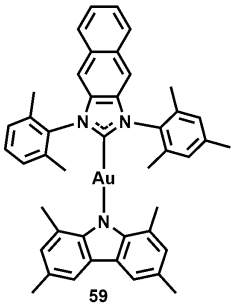

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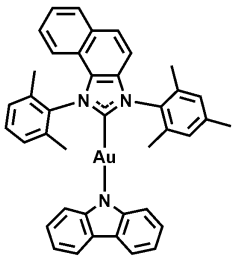

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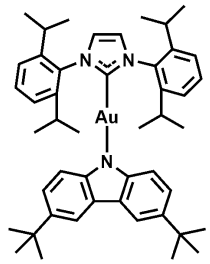

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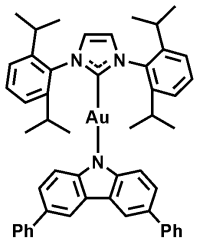

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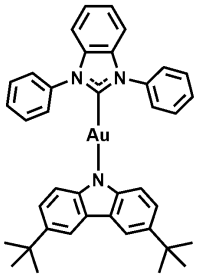

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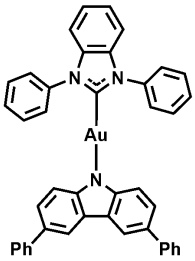

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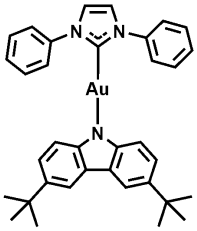

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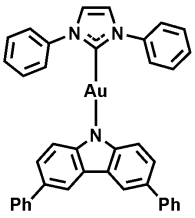

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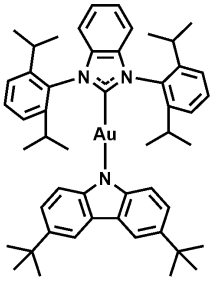

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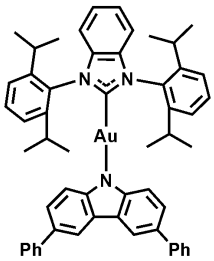

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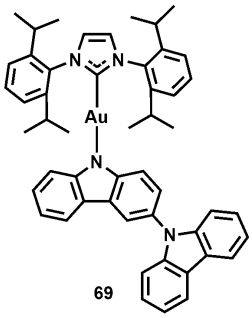

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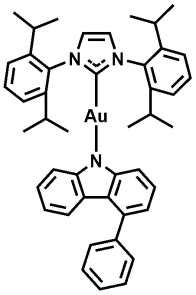

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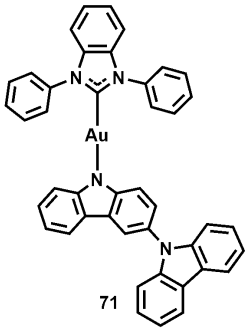

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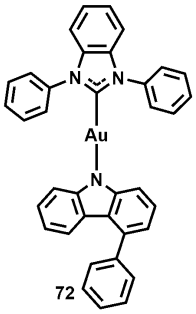

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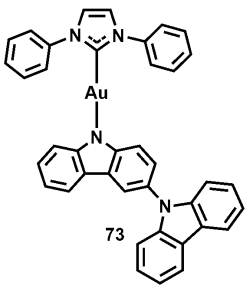

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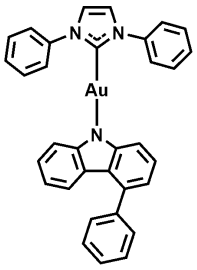

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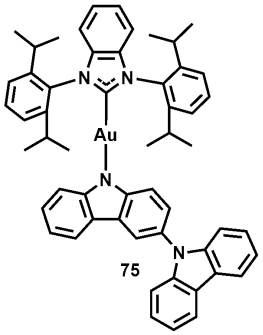

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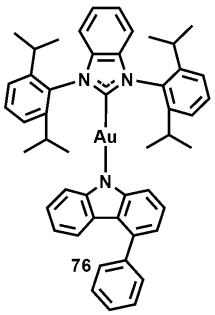

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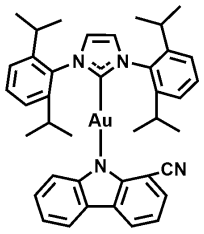

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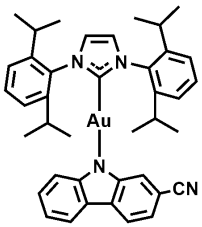

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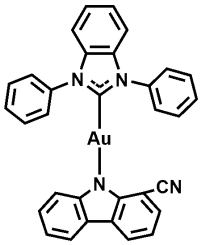
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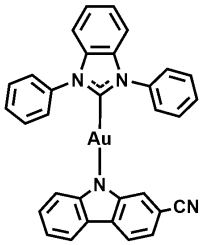
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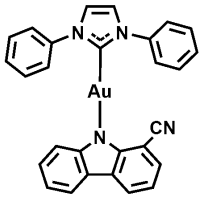
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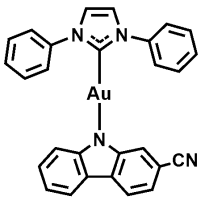
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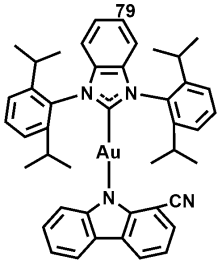
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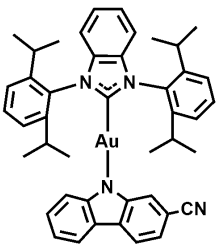
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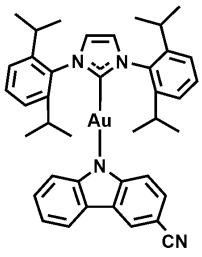
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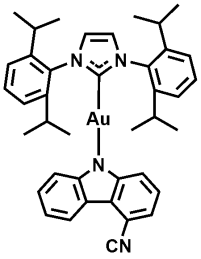
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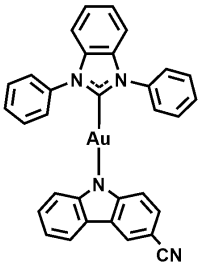
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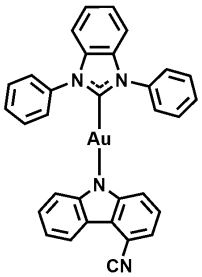
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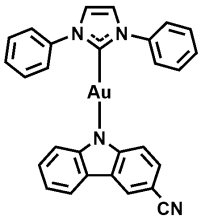
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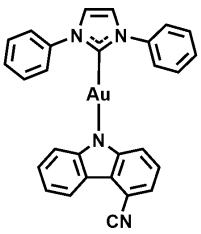
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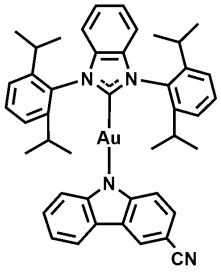
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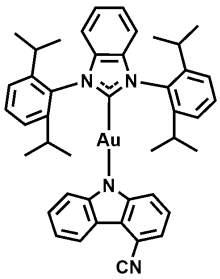
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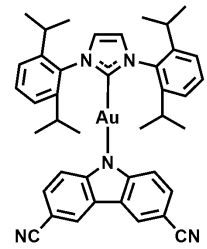


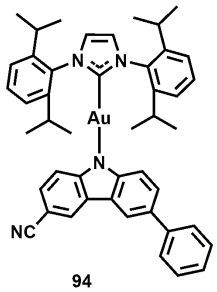
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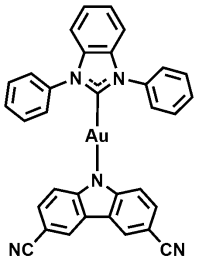


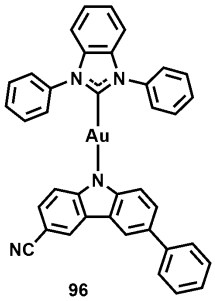
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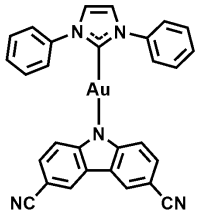
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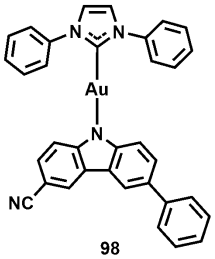

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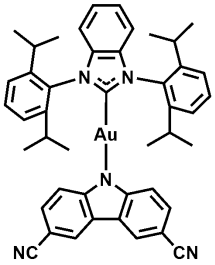

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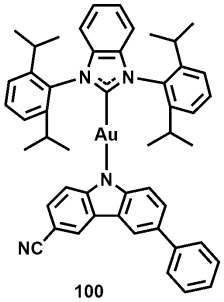

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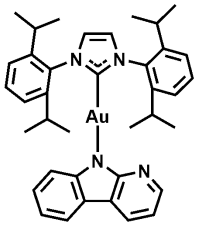

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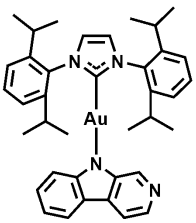

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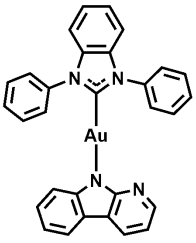

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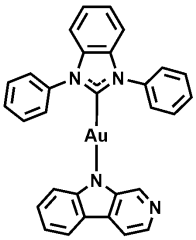

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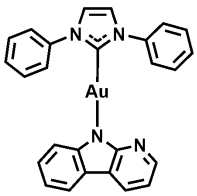

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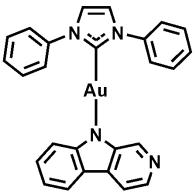

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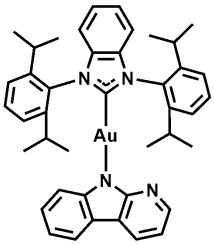

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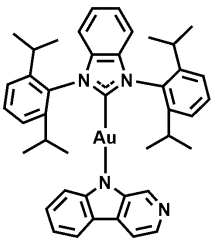

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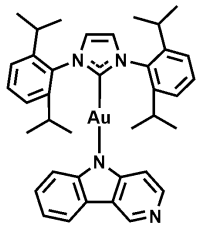

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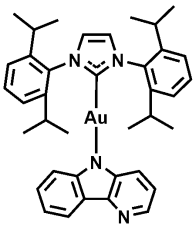

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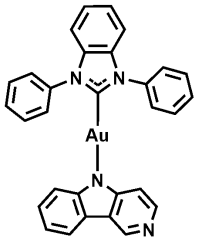

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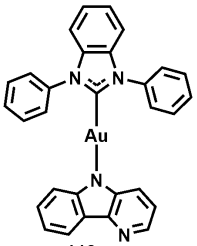

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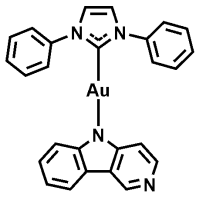
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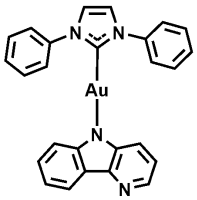

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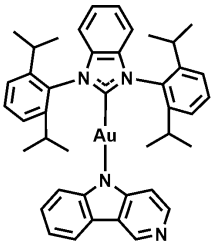

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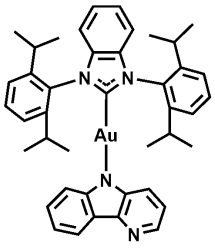

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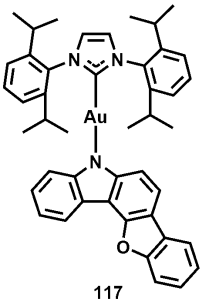

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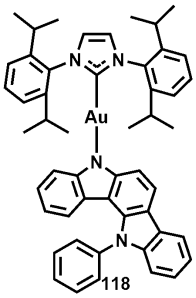

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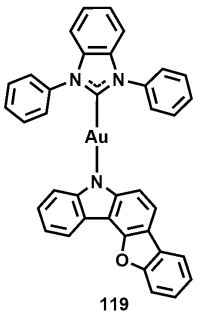

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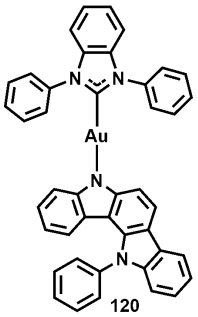

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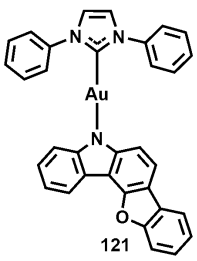

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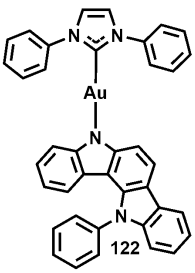

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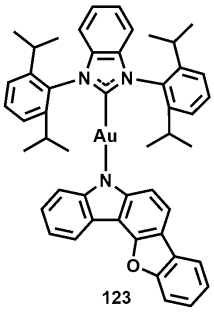

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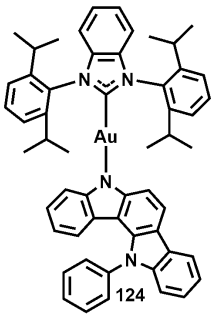

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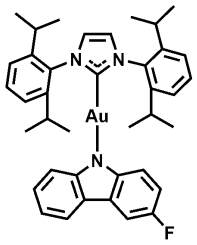

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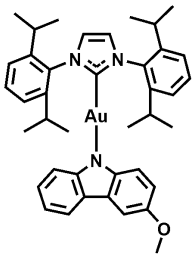

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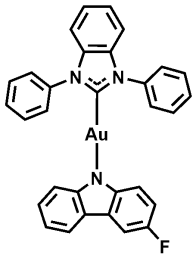

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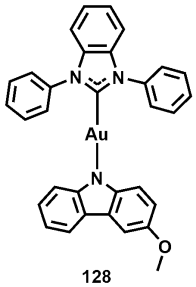

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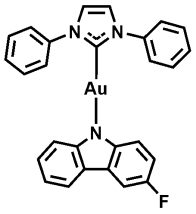
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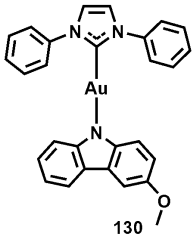

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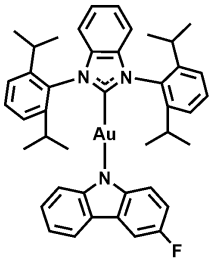

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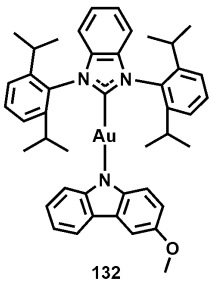

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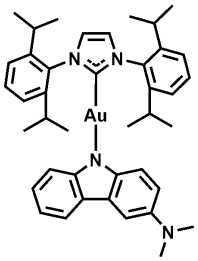

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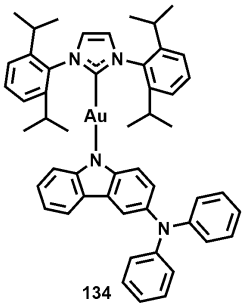

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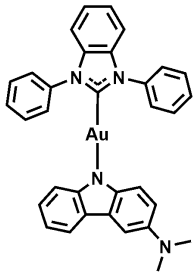

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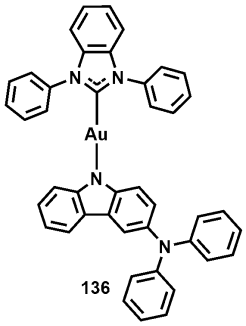

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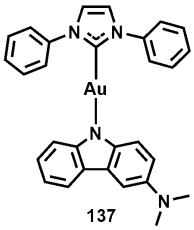

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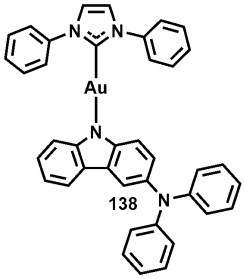

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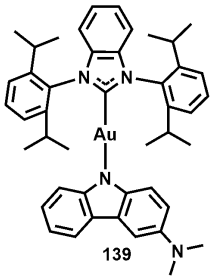

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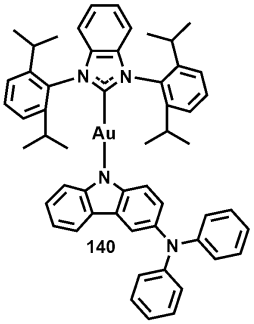

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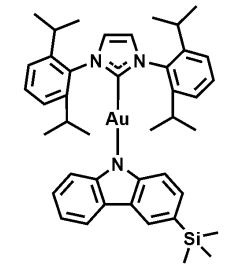

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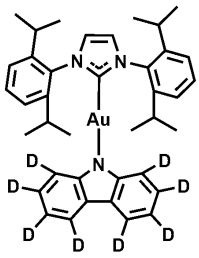

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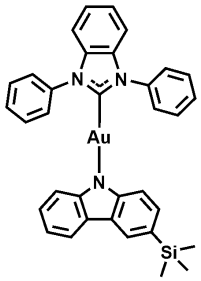

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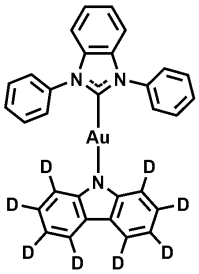
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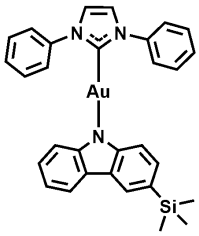
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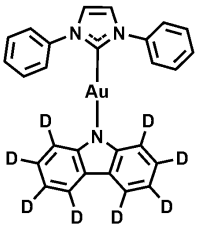

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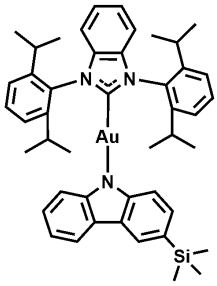

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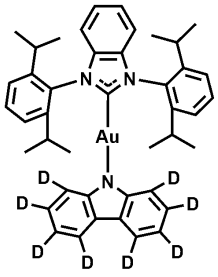

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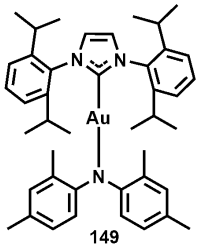

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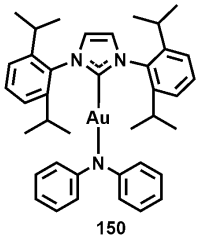

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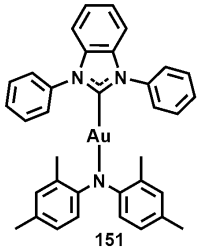

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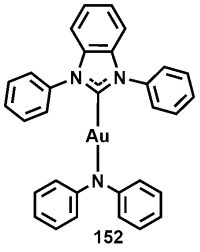

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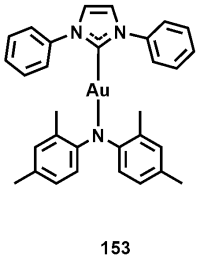

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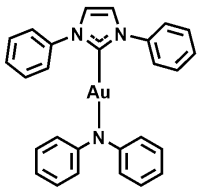

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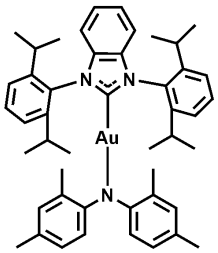

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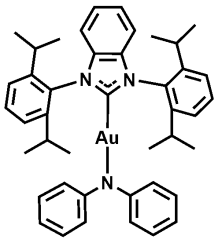

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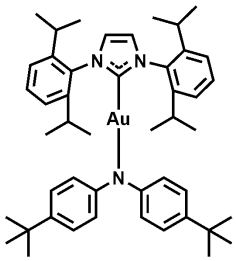

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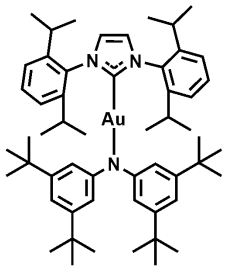

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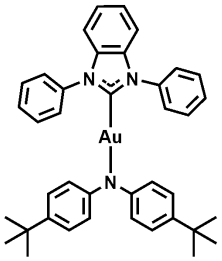

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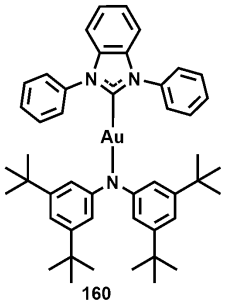

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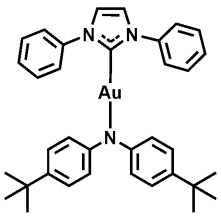
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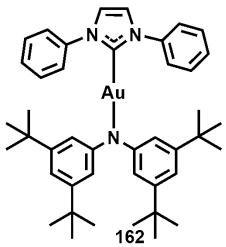

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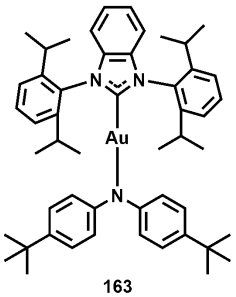

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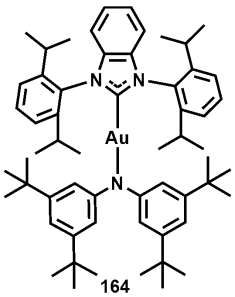

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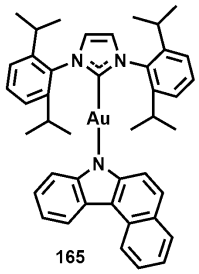

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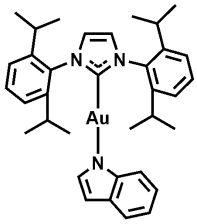

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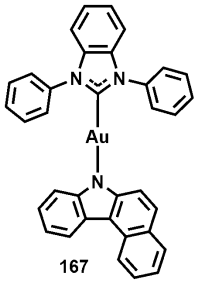

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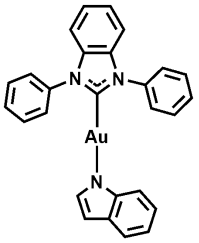

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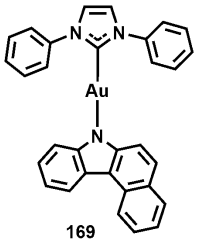

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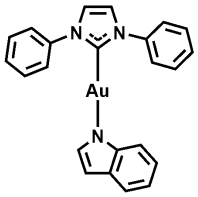

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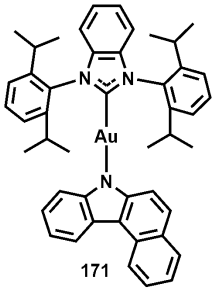

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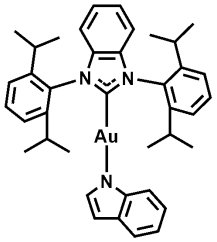

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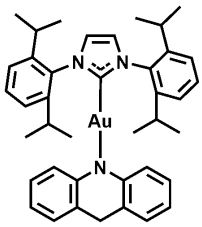

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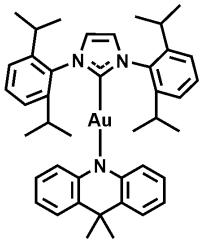

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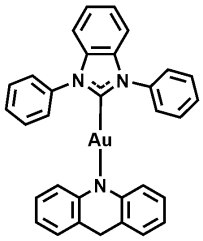

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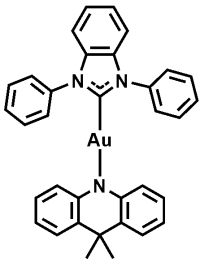
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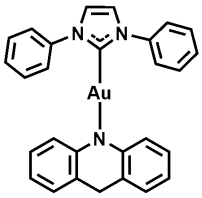
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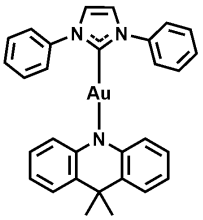
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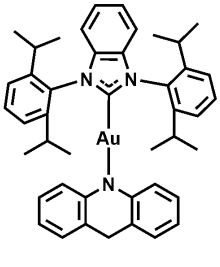
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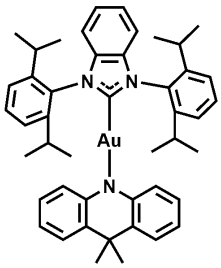
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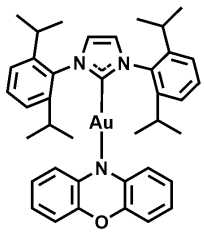
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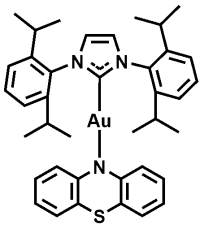
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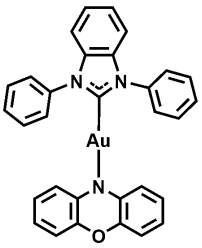
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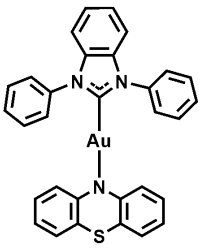
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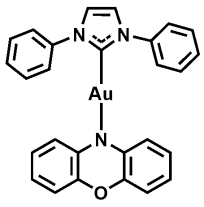
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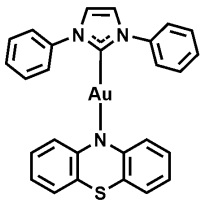
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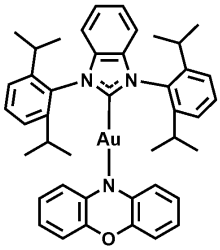
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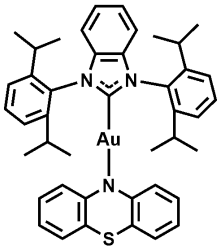
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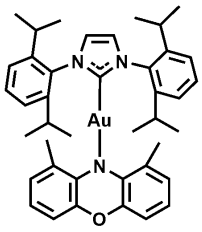


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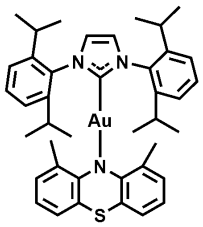


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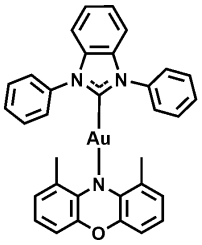
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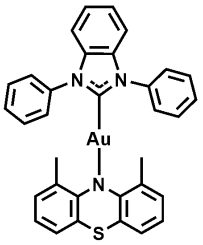
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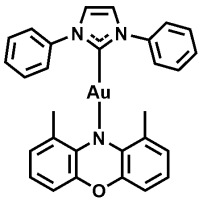
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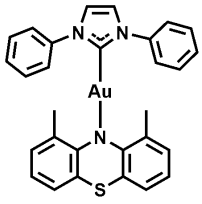
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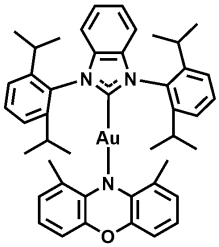
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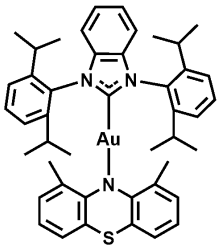
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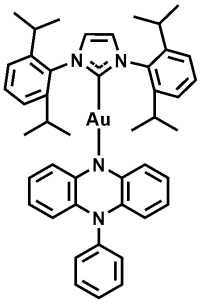
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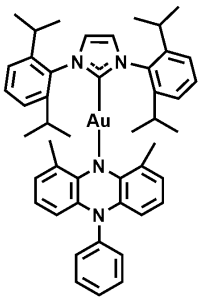
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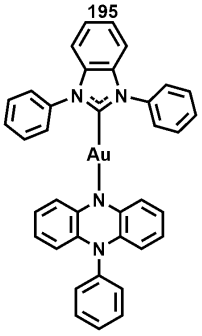
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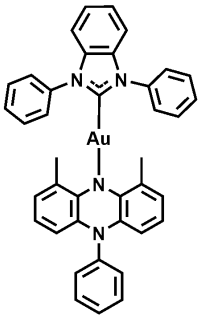
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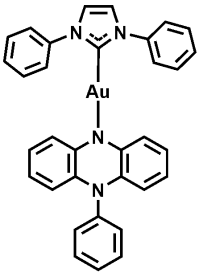
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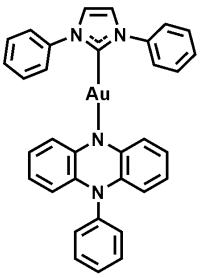
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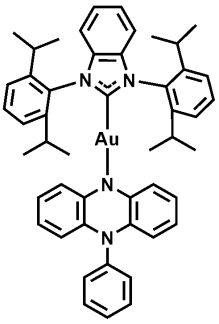
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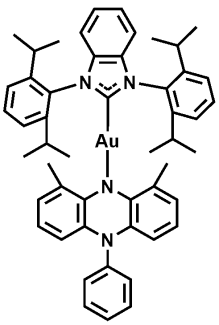
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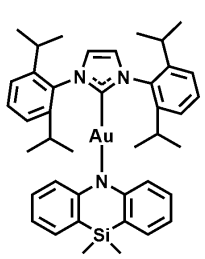


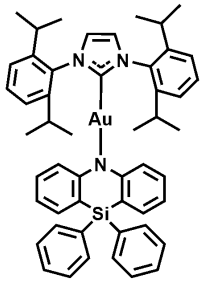
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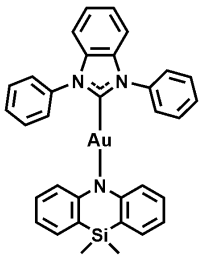


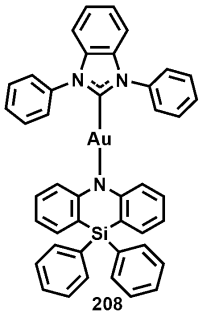
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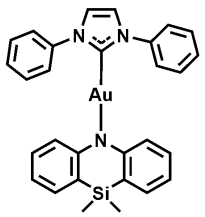
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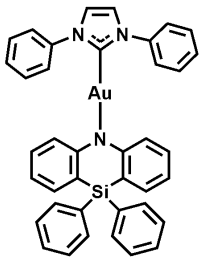

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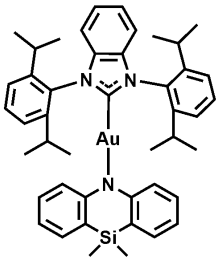

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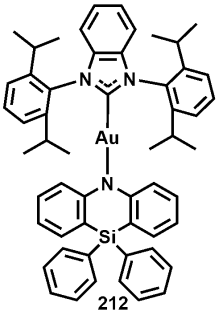

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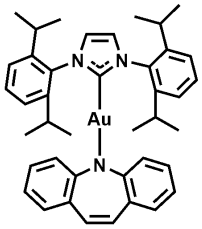

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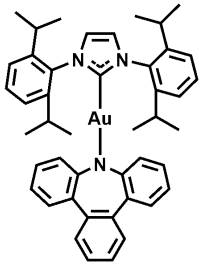

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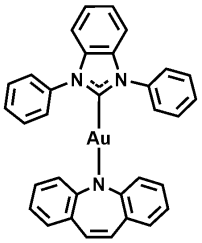

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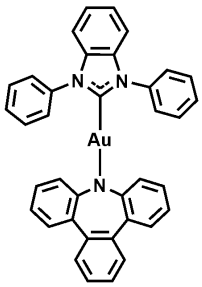

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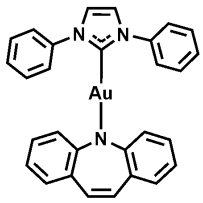

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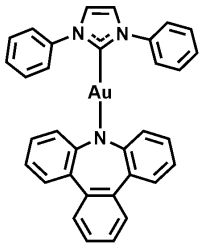

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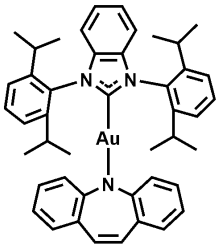

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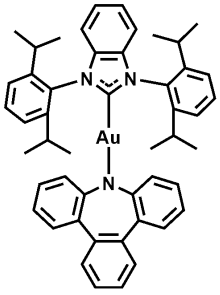

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[0184]

[0185] 상기 화합물들 중, Ph는 페닐기이다.

[0186] 상기 발광층 중 상기 센서타이저의 함량은 1 중량% 내지 50 중량% 범위, 구체적으로, 10 중량% 내지 20 중량% 범위 내에서 선택될 수 있다. 상술한 바와 같은 범위를 만족할 경우, 발광층 중 효과적인 에너지 전달을 달성할 수 있는 바, 고효율 및 장수명의 유기 발광 소자를 구현할 수 있다.

[0187] 상기 센서타이저의 최저 여기 일중항 에너지 레벨과 최저 여기 삼중항 에너지 레벨의 차는 0.3 eV 이하일 수 있으나, 이에 한정되는 것은 아니다. 상술한 범위를 만족하면, 상기 센서타이저의 역항간전이가 활발해지므로, 향상된 효율 및 색순도의 유기 발광 소자를 제공할 수 있다.

[0188] 한편, 상기 센서타이저는 광을 방출하지 않을 수 있다.

[0189] [호스트]

[0190] 상기 호스트는 금속 원자를 비포함할 수 있다.

[0191] 일 실시예에 따르면, 상기 호스트는 정공 수송성 호스트, 전자 수송성 호스트, 및 양쪽성 호스트 중에서 선택되는 1종 이상을 포함할 수 있다.

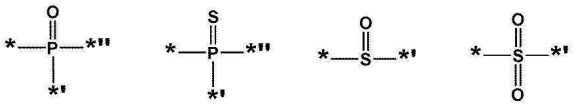
[0192] 상기 호스트가 제1화합물 및 제2화합물을 포함하는 경우, 상기 제1화합물 및 상기 제2화합물은 각각 정공 수송성 호스트, 전자 수송성 호스트, 또는 양쪽성 호스트를 포함할 수 있다.

[0193] 구체적으로, 상기 제1화합물은 정공 수송성 호스트를 포함하고, 상기 제2화합물은 전자 수송성 호스트를 포함하고, 상기 제1화합물은 전자 수송성 호스트 를 포함하고, 상기 제2화합물은 정공 수송성 호스트를 포함하고, 상기 제1화합물 및 상기 제2화합물이 각각 양쪽성 호스트를 포함하거나, 상기 제1화합물이 정공 수송성 호스트를 포함하고, 상기 제2화합물은 양쪽성 호스트를 포함하거나, 상기 제1화합물이 전자 수송성 호스트를 포함하고, 상기 제2화합물은 양쪽성 호스트를 포함하거나, 상기 제1화합물이 양쪽성 호스트를 포함하고, 상기 제2화합물이 정공 수송성 호스트를 포함하거나, 또는 상기 제1화합물이 양쪽성 호스트를 포함하고, 상기 제2화합물이 전자 수송성 호스트를 포함할 수 있다.

[0194] 상기 전자 수송성 호스트는 전자 수송성 모이어티를 적어도 하나 포함할 수 있다. 상기 정공 수송성 호스트는 정공 수송성 모이어티를 포함하고, 전자 수송성 모이어티를 비포함할 수 있다. 상기 양쪽성 호스트는 적어도 하나의 전자 수송성 모이어티 및 적어도 하나의 정공 수송성 모이어티를 포함할 수 있다.

[0195] 본 명세서 중 전자 수송성 모이어티는, 시아노기, -F, $-CFH_2$, $-CF_2H$, $-CF_3$, π 전자 결핍성 함질소 시클릭 그룹 및 하기 화학식 ET-모이어티 중 하나로 표시된 그룹 중에서 선택될 수 있다:

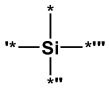
[0196] <ET-모이어티>

[0197] 

[0198] 상기 화학식 중 *, *' 및 *"은 각각 이웃한 임의의 원자와의 결합 사이트이다.

[0199] 본 명세서 중 정공 수송성 모이어티는 π 전자 과잉 C_3-C_{60}시클릭 그룹 및 하기 화학식 HT-모이어티로 표시된 그룹 중에서 선택될 수 있다:

[0200] <HT-모이어티>

[0201] 

[0202] 상기 화학식 중 *, *', *" 및 *'"은 각각 이웃한 임의의 원자와의 결합 사이트이다.

[0203] 일 실시예에 따르면, 상기 전자 수송성 호스트는 시아노기 및 π 전자 결핍성 함질소 시클릭 그룹 중 적어도 하나를 포함할 수 있다.

[0204] 또 다른 실시예에 따르면, 상기 전자 수송성 호스트는 적어도 하나의 시아노기를 포함할 수 있다.

[0205] 또 다른 실시예에 따르면, 상기 전자 수송성 호스트는 적어도 하나의 시아노기 및 적어도 하나의 π 전자 결핍성 함질소 시클릭 그룹을 포함할 수 있다.

[0206] 일 실시예에 따르면, 상기 정공 수송성 호스트는 적어도 하나의 π 전자 결핍성 질소-비함유 시클릭 그룹을 포함하고, 전자 수송성 모이어티를 비포함할 수 있다.

[0207] 본 명세서 중 "π 전자 결핍성 함질소 C_1-C_{60}시클릭 그룹(π electron-depleted nitrogen-containing C_1-C_{60} cyclic group)"은, 고리 구성 모이어티로서 *-N=*'(상기 * 및 *'은 각각 이웃한 원자와의 결합 사이트임)를 적어도 하나 포함한 탄소수 1 내지 60의 시클릭 그룹으로서, 예를 들면, a) 제1고리, b) 2 이상의 제1고리가 서로 축합된 축합환, 또는 c) 1 이상의 제1고리와 1 이상의 제2고리가 서로 축합환 축합환일 수 있다.

[0208] 본 명세서 중 상기 "제1고리"는 이미다졸 그룹, 피라졸 그룹, 티아졸 그룹, 이소티아졸 그룹, 옥사졸 그룹, 이속사졸 그룹, 피리딘 그룹, 피라진 그룹, 피리다진 그룹, 피리미딘 그룹, 트리아졸 그룹, 테트라졸 그룹, 옥사디아졸 그룹, 트리아진 그룹 또는 티아디아졸 그룹일 수 있다.

[0209] 본 명세서 중 상기 "제2고리"는 벤젠 그룹, 시클로펜타디엔 그룹, 피롤 그룹, 퓨란 그룹, 티오펜 그룹 또는 실롤 그룹일 수 있다.

[0210] 예를 들어, 상기 π 전자 결핍성 함질소 C_1-C_{60}시클릭 그룹은, 이미다졸 그룹, 피라졸 그룹, 티아졸 그룹, 이소티아졸 그룹, 옥사졸 그룹, 이속사졸 그룹, 피리딘 그룹, 피라진 그룹, 피리다진 그룹, 피리미딘 그룹, 인다졸 그룹, 푸린 그룹, 퀴놀린 그룹, 이소퀴놀린 그룹, 벤조퀴놀린 그룹, 벤조이소퀴놀린 그룹, 프탈라진 그룹, 나프티리딘 그룹, 퀴녹살린 그룹, 벤조퀴녹살린 그룹, 퀴나졸린 그룹, 시놀린 그룹, 페난트리딘 그룹, 아크리딘 그룹, 페난트롤린 그룹, 페나진 그룹, 벤조이미다졸 그룹, 이소벤조티아졸 그룹, 벤조옥사졸 그룹, 이소벤조옥사졸 그룹, 트리아졸 그룹, 테트라졸 그룹, 옥사디아졸 그룹, 트리아진 그룹, 티아디아졸 그룹, 이미다조피리딘 그룹, 이미다조피리미딘 그룹, 아자카바졸 그룹, 아자디벤조퓨란 그룹, 아자디벤조티오펜 그룹, 아자디벤조실롤 그룹, 아크리딘 그룹 또는 피리도피라진 그룹일 수 있다.

[0211] 본 명세서 중 "π 전자 과잉 C_3-C_{60}시클릭 그룹(π electron-rich C_3-C_{60} cyclic group)"은, 고리 구성 모이어티로서 *-N=*'(상기 * 및 *'은 각각 이웃한 원자와의 결합 사이트임)를 비포함한 탄소수 3 내지 60의 시클릭 그룹으로서, 예를 들면, a) 제2고리 또는 b) 2 이상의 제2고리가 서로 축합된 축합환일 수 있다.

[0212] 예를 들어, 상기 π 전자 과잉(rich) C_3-C_{60}시클릭 그룹은, 벤젠 그룹, 헵탈렌 그룹, 인덴 그룹, 나프탈렌 그룹, 아줄렌 그룹, 인다센 그룹, 아세나프틸렌 그룹, 플루오렌 그룹, 스파이로-바이플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 페릴렌 그룹, 펜타센 그룹, 헥사센 그룹, 펜타펜 그룹, 루비센 그룹, 코로넨 그룹, 오발렌 그룹, 피롤 그룹, 퓨란 그룹, 티오펜 그룹, 이소인돌 그룹, 인돌 그룹, 인덴 그룹, 벤조퓨란 그룹, 벤조티오펜 그룹, 벤조실롤 그룹, 나프토피롤 그룹, 나프토퓨란 그룹, 나프토티오펜 그룹, 나프토실롤 그룹, 벤조카바졸 그룹, 디벤조카바졸 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 디벤조실롤 그룹, 인데노카바졸 그룹, 인돌로카바졸 그룹, 벤조퓨로카바졸 그룹, 벤조티에노카바졸 그룹, 벤조실롤로카바졸 그룹, 트라이인돌로벤젠 그룹, 피롤로페난트렌 그룹, 퓨라노페난트렌 그룹, 티에노페난트렌 그룹, 벤조나프토퓨란 그룹, 벤조나프토티오펜 그룹, (인돌로)페난트렌 그룹, (벤조퓨라노)페난트렌 그룹, 또는 (벤조티에노)페난트렌 그룹일 수 있다.

[0213] 또 다른 실시예에 다르면, 상기 전자 수송성 호스트는 하기 화학식 E-1로 표시된 화합물 중에서 선택되고, 상기 정공 수송성 호스트가 하기 화학식 H-1로 표시된 화합물 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

[0214] <화학식 E-1>

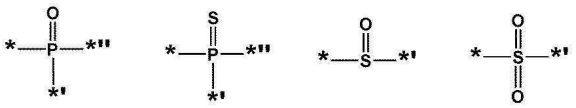
[0215] $[Ar_{301}]_{xb11}$-$[(L_{301})_{xb1}$-$R_{301}]_{xb21}$

[0216] 상기 화학식 E-1 중,

[0217] Ar_{301}은 치환 또는 비치환된 C_5-C_{60}카보시클릭 그룹 및 치환 또는 비치환된 C_1-C_{60}헤테로시클릭 그룹 중에서 선택되고,

[0218] xb11은 1, 2 또는 3이고,

[0219] L_{301}은 서로 독립적으로, 단일 결합, 하기 화학식 중 하나로 표시된 그룹, 치환 또는 비치환된 C_5-C_{60}카보시클릭 그룹 및 치환 또는 비치환된 C_1-C_{60}헤테로시클릭 그룹 중에서 선택되고, 상기 화학식 중 *, *' 및 *"은 각각 이웃한 임의의 원자와의 결합 사이트이고,

[0220] 

[0221] xb1는 1 내지 5의 정수 중에서 선택되고,

[0222] R_{301}은, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_2-C_{60}알케닐기, 치환 또는 비치환된 C_2-C_{60}알키닐기, 치환 또는 비치환된 C_1-C_{60}알콕시기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치

환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_{301})(Q_{302})(Q_{303})$, $-N(Q_{301})(Q_{302})$, $-B(Q_{301})(Q_{302})$, $-C(=O)(Q_{301})$, $-S(=O)_2(Q_{301})$, $-S(=O)(Q_{301})$, $-P(=O)(Q_{301})(Q_{302})$ 및 $-P(=S)(Q_{301})(Q_{302})$중에서 선택되고,

[0223] xb21는 1 내지 5의 정수 중에서 선택되고,

[0224] Q_{301} 내지 Q_{303}는 서로 독립적으로, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 비페닐기, 터페닐기 및 나프틸기 중에서 선택되고,

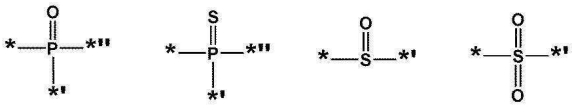
[0225] 하기 <조건 A> 내지 <조건 C> 중 적어도 하나를 만족한다:

[0226] <조건 A>

[0227] 상기 화학식 E-1의 Ar_{301}, L_{301} 및 R_{301} 중 적어도 하나가 서로 독립적으로, π 전자 결핍성 함질소 시클릭 그룹을 포함함

[0228] <조건 B>

[0229] 상기 화학식 E-1의 L_{301}은 하기 화학식 중 하나로 표시된 그룹임

[0230] 

[0231] <조건 C>

[0232] 상기 화학식 E-1의 R_{301}은, 시아노기, $-S(=O)_2(Q_{301})$, $-S(=O)(Q_{301})$, $-P(=O)(Q_{301})(Q_{302})$ 및 $-P(=S)(Q_{301})(Q_{302})$중에서 선택됨

[0233] <화학식 H-1>

[0234] Ar_{401}-$(L_{401})_{xd1}$-$(Ar_{402})_{xd11}$

[0235] 

[0236] 상기 화학식 H-1, 11 및 12 중,

[0237] L_{401}은, 단일 결합; 및

[0238] 중수소, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 트리페닐레닐기, 비페닐기, 터페닐기, 테트라페닐기 및 $-Si(Q_{401})(Q_{402})(Q_{403})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 벤젠 그룹, 헵탈렌 그룹, 인덴 그룹, 나프탈렌 그룹, 아줄렌 그룹, 인다센 그룹, 아세나프틸렌 그룹, 플루오렌 그룹, 스파이로-바이플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 페릴렌 그룹, 펜타센 그룹, 헥사센 그룹, 펜타펜 그룹, 루비센 그룹, 코로젠 그룹, 오발렌 그룹, 피롤 그룹, 이소인돌 그룹, 인돌 그룹, 퓨란 그룹, 티오펜 그룹, 벤조퓨란 그룹, 벤조티오펜 그룹, 벤조카바졸 그룹, 디벤조카바졸 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 디벤조티오펜 설폰(dibenzothiophene sulfone) 그룹, 카바졸 그룹, 디벤조실롤 그룹, 인데노카바졸 그룹, 인돌로카바졸 그룹, 벤조퓨로카바졸 그룹, 벤조티에노카바졸 그룹 및 트라이인돌로벤젠 그룹; 중에서 선택되고,

[0239] xd1은 1 내지 10의 정수 중에서 선택되고, xd1이 2 이상일 경우 2 이상의 L_{401}은 서로 동일하거나 상이하고,

[0240] Ar_{401}은 상기 화학식 11 및 12로 표시되는 그룹 중에서 선택되고,

[0241] Ar_{402}는, 상기 화학식 11 및 12로 표시되는 그룹, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기; 및

[0242] 중수소, 히드록실기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기 중에서 선택된 적어도 하나로 치환된, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기; 중에서 선택되고,

[0243] CY_{401} 및 CY_{402}는 서로 독립적으로, 벤젠 그룹, 나프탈렌 그룹, 플루오렌 그룹, 카바졸 그룹, 벤조카바졸 그룹, 인돌로카바졸 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 디벤조실롤 그룹, 벤조나프토퓨란 그룹, 벤조나프토티오펜 그룹, 벤조나프토실롤 그룹 중에서 선택되고,

[0244] A_{21}은 단일 결합, O, S, $N(R_{51})$, $C(R_{51})(R_{52})$ 및 $Si(R_{51})(R_{52})$ 중에서 선택되고,

[0245] A_{22}는 단일 결합, O, S, $N(R_{53})$, $C(R_{53})(R_{54})$ 및 $Si(R_{53})(R_{54})$ 중에서 선택되고,

[0246] 화학식 12의 A_{21} 및 A_{22} 중 적어도 하나는 단일 결합이 아니고,

[0247] R_{51} 내지 R_{54}, R_{60} 및 R_{70}은 서로 독립적으로,

[0248] 수소, 중수소, 히드록실기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{20}알킬기 및 C_1-C_{20}알콕시기;

[0249] 중수소, 히드록실기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기 및 디벤조티오페닐기 중에서 선택된 적어도 하나로 치환된, C_1-C_{20}알킬기 및 C_1-C_{20}알콕시기;

[0250] π 전자 결핍성 질소-비함유 시클릭 그룹(예를 들면, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기);

[0251] 중수소, 히드록실기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기 및 비페닐기 중에서 선택된 적어도 하나로 치환된, π 전자 결핍성 질소-비함유 시클릭 그룹(예를 들면, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기); 및

[0252] $-Si(Q_{404})(Q_{405})(Q_{406})$; 중에서 선택되고,

[0253] e1 및 e2는 서로 독립적으로, 0 내지 10 중에서 선택된 정수이고,

[0254] 상기 Q_{401} 내지 Q_{406}은 서로 독립적으로, 수소, 중수소, 히드록실기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 비페닐기, 터페닐기 및 트리페닐레닐기 중에서 선택되고,

[0255] *는 이웃한 원자와의 결합 사이트이다.

[0256] 일 실시예에 따르면, 상기 화학식 E-1 중, Ar_{301} 및 L_{301}은 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기, 시아노-함유 나프틸기, 피리디닐기, 페닐피리디닐기, 디페닐피리디닐기, 비페닐피리디닐기, 디(비페닐)피리디닐기, 피라지닐기, 페닐피라지닐기, 디페닐피라지닐기, 비페닐피라지닐기, 디(비페닐)피라지닐기, 피리다지닐기, 페닐피리다지닐기, 디페닐피리다지닐기, 비페닐피리다지닐기, 디(비페닐)피리다지닐기, 피리미디닐기, 페닐피리미디닐기, 디페닐피리미디닐기, 비페닐피리미디닐기, 디(비페닐)피리미디닐기, 트리아지닐기, 페닐트리아지닐기, 디페닐트리

아지닐기, 비페닐트리아지닐기, 디(비페닐)트리아지닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 벤젠 그룹, 나프탈렌 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 펜타펜 그룹, 헥세펜 그룹, 인데노안트라센 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 이미다졸 그룹, 피라졸 그룹, 티아졸 그룹, 이소티아졸 그룹, 옥사졸 그룹, 이속사졸 그룹, 피리딘 그룹, 피라진 그룹, 피리다진 그룹, 피리미딘 그룹, 인다졸 그룹, 푸린(purine) 그룹, 퀴놀린 그룹, 이소퀴놀린 그룹, 벤조퀴놀린 그룹, 프탈라진 그룹, 나프티리딘 그룹, 퀴녹살린 그룹, 퀴나졸린 그룹, 시놀린 그룹, 페난트리딘 그룹, 아크리딘 그룹, 페난트롤린 그룹, 페나진 그룹, 벤조이미다졸 그룹, 이소벤조티아졸 그룹, 벤조옥사졸 그룹, 이소벤조옥사졸 그룹, 트리아졸 그룹, 테트라졸 그룹, 옥사디아졸 그룹, 트리아진 그룹, 티아디아졸 그룹, 이미다조피리딘 그룹, 이미다조피리미딘 그룹 및 아자카바졸 그룹 중에서 선택되고,

[0257] xb1개의 L_{301} 중 적어도 하나는, 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기, 시아노-함유 나프틸기, 피리디닐기, 페닐피리디닐기, 디페닐피리디닐기, 비페닐피리디닐기, 디(비페닐)피리디닐기, 피라지닐기, 페닐피라지닐기, 디페닐피라지닐기, 비페닐피라지닐기, 디(비페닐)피라지닐기, 피리다지닐기, 페닐피리다지닐기, 디페닐피리다지닐기, 비페닐피리다지닐기, 디(비페닐)피리다지닐기, 피리미디닐기, 페닐피리미디닐기, 디페닐피리미디닐기, 비페닐피리미디닐기, 디(비페닐)피리미디닐기, 트리아지닐기, 페닐트리아지닐기, 디페닐트리아지닐기, 비페닐트리아지닐기, 디(비페닐)트리아지닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 이미다졸 그룹, 피라졸 그룹, 티아졸 그룹, 이소티아졸 그룹, 옥사졸 그룹, 이속사졸 그룹, 피리딘 그룹, 피라진 그룹, 피리다진 그룹, 피리미딘 그룹, 인다졸 그룹, 푸린(purine) 그룹, 퀴놀린 그룹, 이소퀴놀린 그룹, 벤조퀴놀린 그룹, 프탈라진 그룹, 나프티리딘 그룹, 퀴녹살린 그룹, 퀴나졸린 그룹, 시놀린 그룹, 페난트리딘 그룹, 아크리딘 그룹, 페난트롤린 그룹, 페나진 그룹, 벤조이미다졸 그룹, 이소벤조티아졸 그룹, 벤조옥사졸 그룹, 이소벤조옥사졸 그룹, 트리아졸 그룹, 테트라졸 그룹, 옥사디아졸 그룹, 트리아진 그룹, 티아디아졸 그룹, 이미다조피리딘 그룹, 이미다조피리미딘 그룹 및 아자카바졸 그룹 중에서 선택되고,

[0258] R_{301}은 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 테트라페닐기, 나프틸기, 시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기, 시아노-함유 테트라페닐기, 시아노-함유 나프틸기, 피리디닐기, 페닐피리디닐기, 디페닐피리디닐기, 비페닐피리디닐기, 디(비페닐)피리디닐기, 피라지닐기, 페닐피라지닐기, 디페닐피라지닐기, 비페닐피라지닐기, 디(비페닐)피라지닐기, 피리다지닐기, 페닐피리다지닐기, 디페닐피리다지닐기, 비페닐피리다지닐기, 디(비페닐)피리다지닐기, 피리미디닐기, 페닐피리미디닐기, 디페닐피리미디닐기, 비페닐피리미디닐기, 디(비페닐)피리미디닐기, 트리아지닐기, 페닐트리아지닐기, 디페닐트리아지닐기, 비페닐트리아지닐기, 디(비페닐)트리아지닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$ 중에서 선택되고,

[0259] Q_{31} 내지 Q_{33}은 서로 독립적으로, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 비페닐기, 터페닐기 및 나프틸기 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

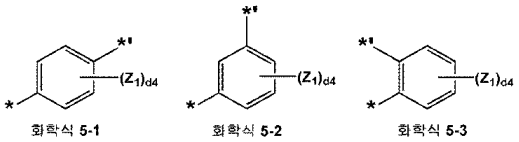
[0260] 다른 구현에에 따르면, 상기 Ar_{301}은, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기, 시아노-함유 나프틸기, 피리디닐기, 페닐피리디닐기, 디페닐피리디닐기, 비페닐피리디닐기, 디(비페닐)피리디닐기, 피라지닐기, 페닐피라지닐기, 디페닐피라지닐기, 비페닐피라지닐기, 디(비페닐)피라지닐기, 피리다지닐기, 페닐피리다지닐기, 디페닐피리다지닐기, 비페닐피리다지닐기, 디(비페닐)피리다지닐기, 피리미디닐기, 페닐피리미디닐기, 디페닐피리미디닐기, 비페닐피리미디닐기, 디(비페닐)피리미디닐기, 트리아지닐기, 페닐트리아지닐기, 디페닐트리아지닐기, 비페닐트리아지닐기, 디(비페닐)트리아지닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$

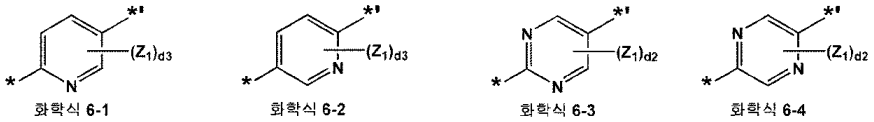
중에서 선택된 적어도 하나로 치환 또는 비치환된, 벤젠 그룹, 나프탈렌 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 페릴렌 그룹, 펜타펜 그룹, 인데노안트라센 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹; 및

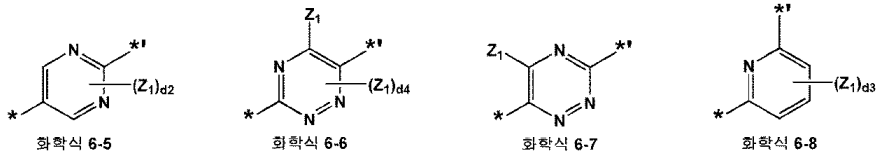
[0261] 하기 화학식 5-1 내지 5-3 및 화학식 6-1 내지 6-33으로 표시된 그룹;

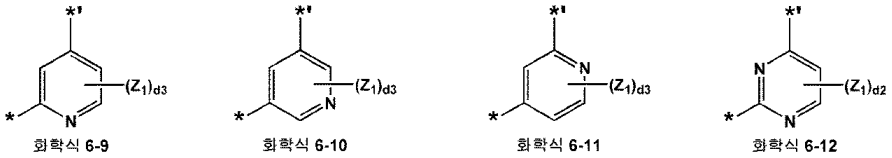
[0262] 중에서 선택되고,

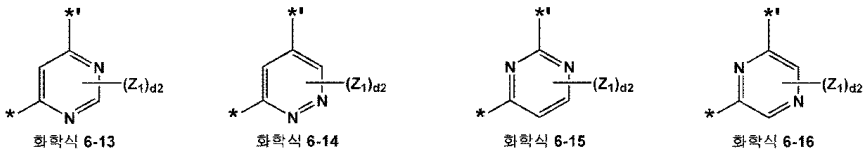
[0263] 상기 L_{301}은 하기 화학식 5-1 내지 5-3 및 화학식 6-1 내지 6-33으로 표시된 그룹 중에서 선택될 수 있다:

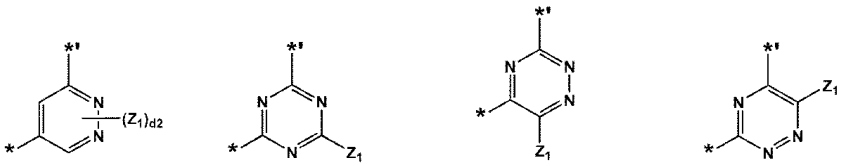
[0264] 
화학식 5-1 화학식 5-2 화학식 5-3

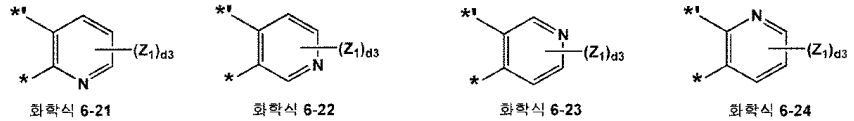

화학식 6-1 화학식 6-2 화학식 6-3 화학식 6-4

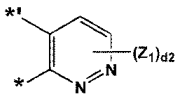

화학식 6-5 화학식 6-6 화학식 6-7 화학식 6-8

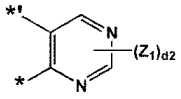
[0265] 
화학식 6-9 화학식 6-10 화학식 6-11 화학식 6-12

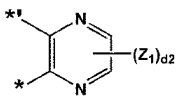

화학식 6-13 화학식 6-14 화학식 6-15 화학식 6-16

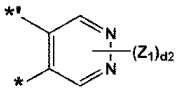

화학식 6-17 화학식 6-18 화학식 6-19 화학식 6-20

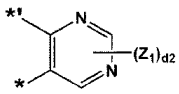
[0266] 
화학식 6-21 화학식 6-22 화학식 6-23 화학식 6-24

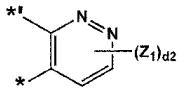

화학식 6-25

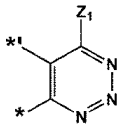

화학식 6-26

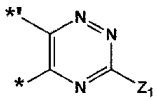

화학식 6-27

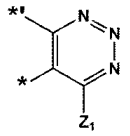

화학식 6-28


화학식 6-29


화학식 6-30


화학식 6-31


화학식 6-32


화학식 6-33

[0267]

[0268] 상기 화학식 5-1 내지 5-3 및 6-1 내지 6-33 중,

[0269] Z_1은 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기, 시아노-함유 나프틸기, 피리디닐기, 페닐피리디닐기, 디페닐피리디닐기, 비페닐피리디닐기, 디(비페닐)피리디닐기, 피라지닐기, 페닐피라지닐기, 디페닐피라지닐기, 비페닐피라지닐기, 디(비페닐)피라지닐기, 피리다지닐기, 페닐피리다지닐기, 디페닐피리다지닐기, 비페닐피리다지닐기, 디(비페닐)피리다지닐기, 피리미디닐기, 페닐피리미디닐기, 디페닐피리미디닐기, 비페닐피리미디닐기, 디(비페닐)피리미디닐기, 트리아지닐기, 페닐트리아지닐기, 디페닐트리아지닐기, 비페닐트리아지닐기, 디(비페닐)트리아지닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$ 중에서 선택되고,

[0270] d4는 0, 1, 2, 3 또는 4이고,

[0271] d3은 0, 1, 2 또는 3이고,

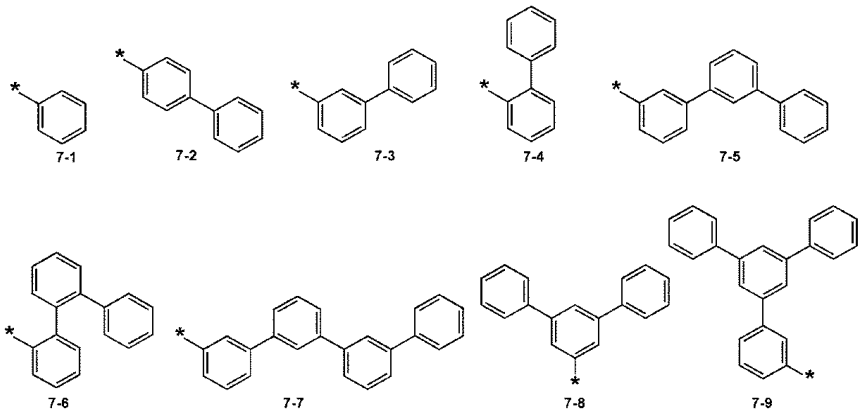
[0272] d2는 0, 1 또는 2이고,

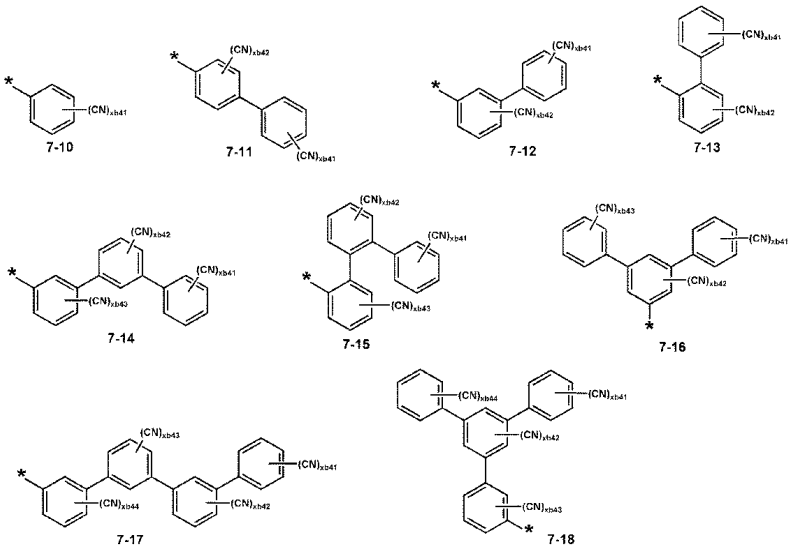
[0273] * 및 *'은 각각 이웃한 원자와의 결합 사이트이다.

[0274] 상기 Q_{31} 내지 Q_{33}에 대한 설명은 본 명세서에 기재된 바를 참조한다.

[0275] 또 다른 실시예에 따르면, 상기 L_{301}은 상기 화학식 5-2, 5-3 및 6-8 내지 6-33으로 표시된 그룹 중에서 선택될 수 있다.

[0276] 또 다른 실시예에 따르면, 상기 R_{301}은 시아노기 및 하기 화학식 7-1 내지 7-18로 표시된 그룹 중에서 선택되고, xd11개의 Ar_{402} 중 적어도 하나는 하기 화학식 7-1 내지 7-18로 표시된 그룹 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

[0277] 
7-1 7-2 7-3 7-4 7-5 7-6 7-7 7-8 7-9

[0278] 

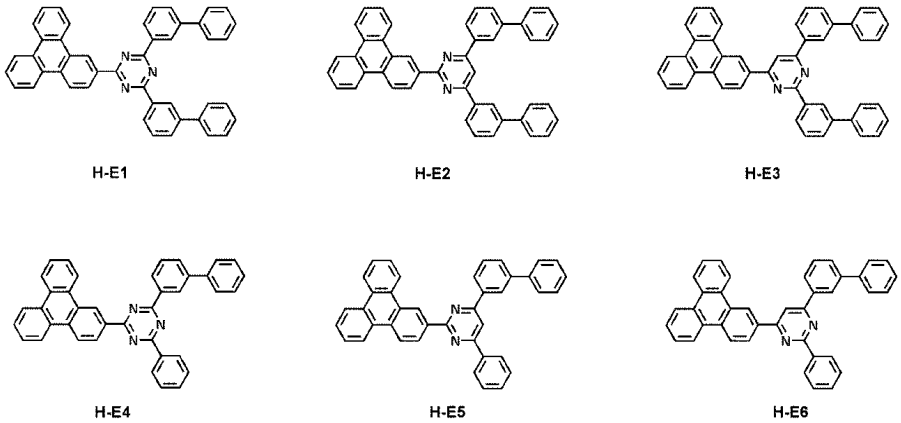
[0279] 상기 화학식 7-1 내지 7-18 중

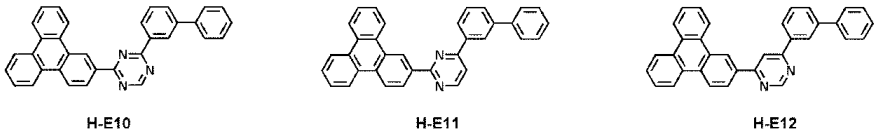
[0280] xb41 내지 xb44는 0, 1 또는 2이되, 화학식 7-10 중 xb41은 0이 아니고, 화학식 7-11 내지 7-13 중 xb41 + xb42는 0이 아니고, 화학식 7-14 내지 7-16 중 xb41 + xb42 + xb43은 0이 아니고, 화학식 7-17 및 7-18 중 xb41 + xb42 + xb43 + xb44는 0이 아니고, *는 이웃한 원자와의 결합 사이트이다.

[0281] 상기 화학식 E-1 중 2 이상의 Ar_{301}은 서로 동일하거나 상이하고, 2 이상의 L_{301}은 서로 동일하거나 상이하고, 상기 화학식 H-1 중 2 이상의 L_{401}은 서로 동일하거나 상이하고, 2 이상의 Ar_{402}는 서로 동일하거나 상이하다.

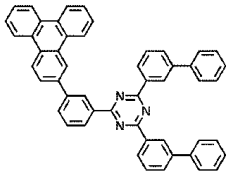
[0282] 상기 전자 수송성 호스트는 예를 들어, 그룹 HE1 내지 HE7 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

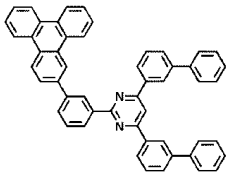
[0283] <그룹 HE1>

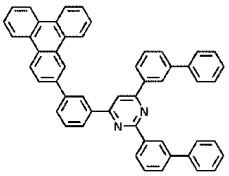
[0284] 

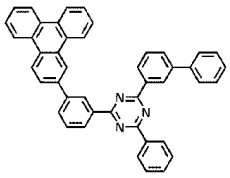
[0285] 

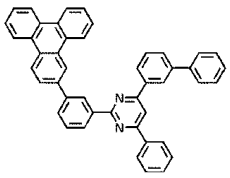
[0286]

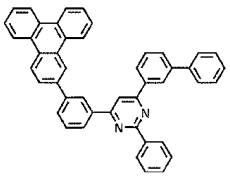

H-E13


H-E14

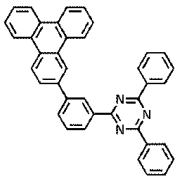

H-E15

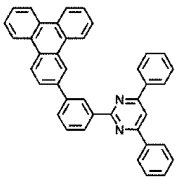

H-E16

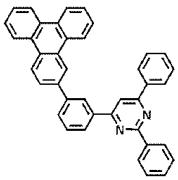

H-E17

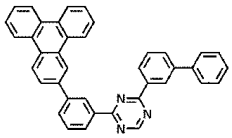

H-E18

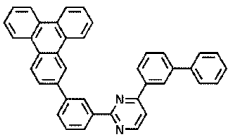
[0287]

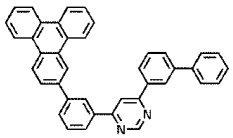

H-E19


H-E20

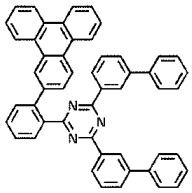

H-E21

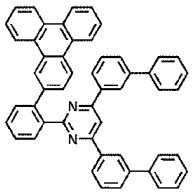

H-E22

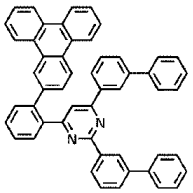

H-E23

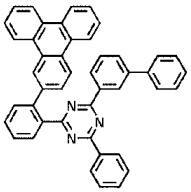

H-E24

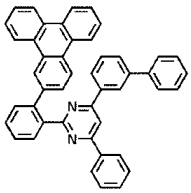
[0288]

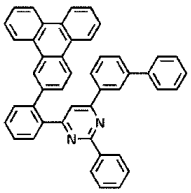

H-E25


H-E26

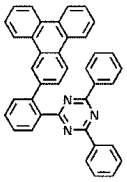

H-E27

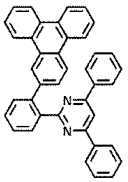

H-E28

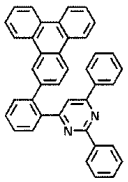

H-E29

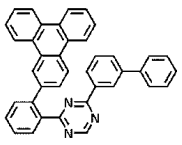

H-E30

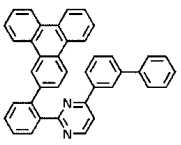
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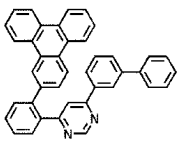

H-E31

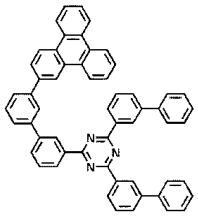

H-E32


H-E33

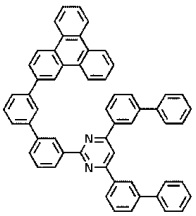

H-E34


H-E35

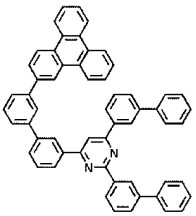

H-E36



H-E37

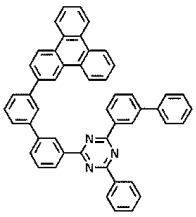


H-E38

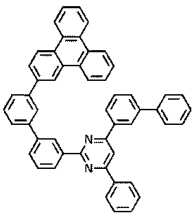


H-E39

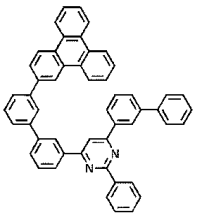
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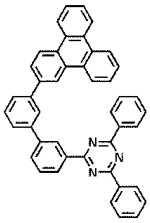
H-E40



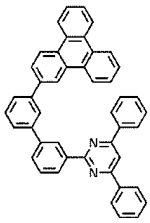
H-E41



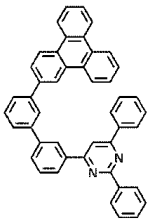
H-E42



H-E43

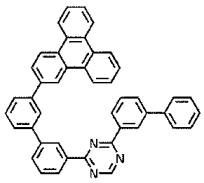


H-E44

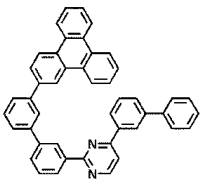


H-E45

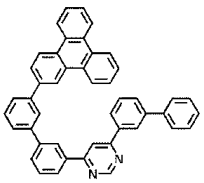
[0291]



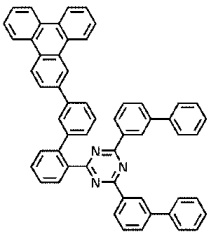
H-E46



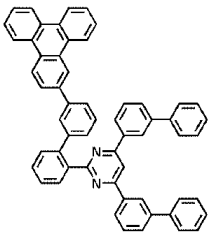
H-E47



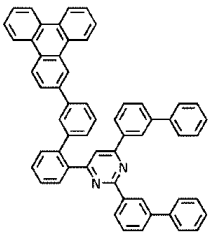
H-E48



H-E49

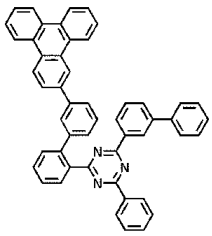


H-E50

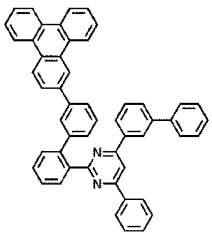


H-E51

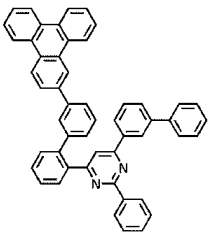
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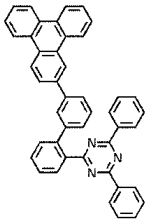
H-E52



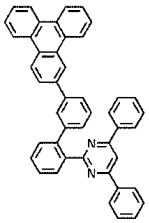
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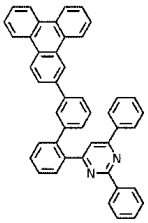
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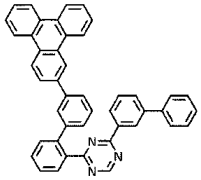
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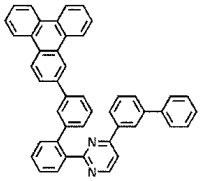
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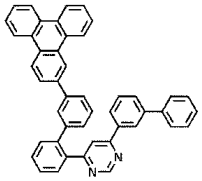
H-E57



H-E58

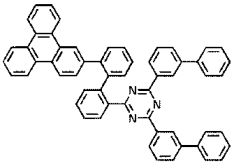


H-E59

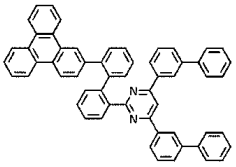


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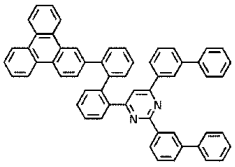
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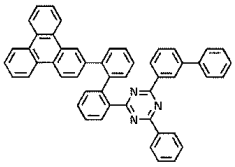
H-E61



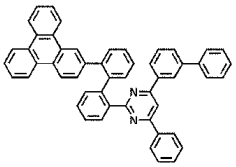
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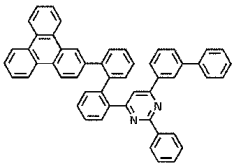
H-E63



H-E64

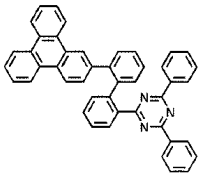


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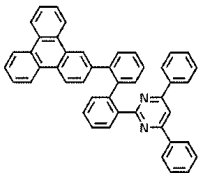


H-E66

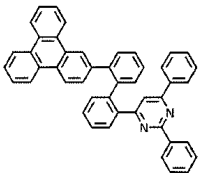
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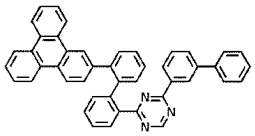
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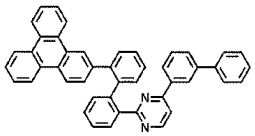
H-E68



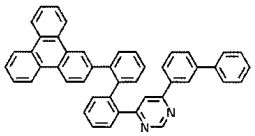
H-E69



H-E70

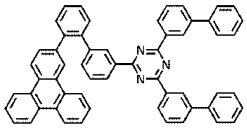


H-E71

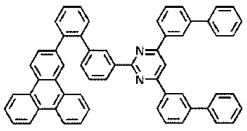


H-E72

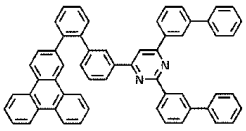
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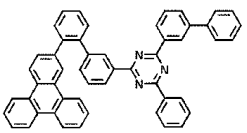
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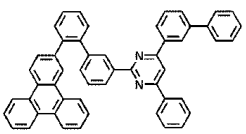
H-E74



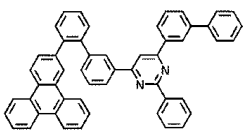
H-E75



H-E76



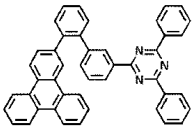
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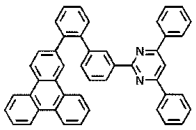


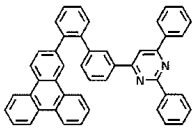
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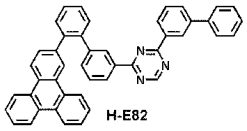
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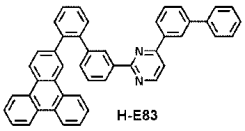
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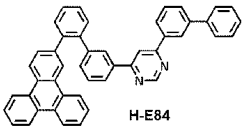

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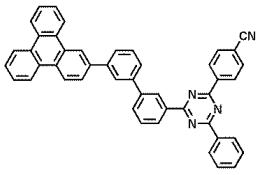

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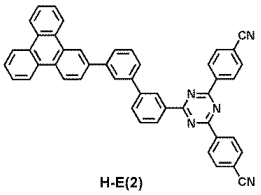

H-E81

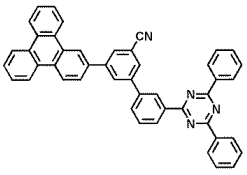

H-E82


H-E83

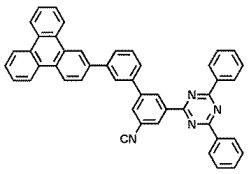

H-E84


H-E(1)

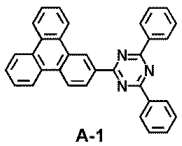

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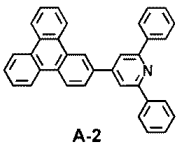

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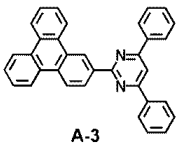
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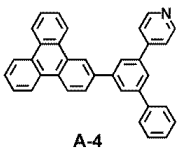

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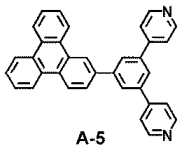
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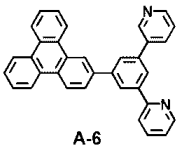

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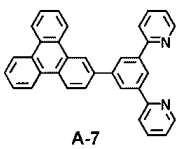

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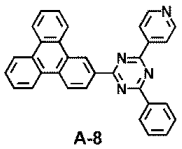

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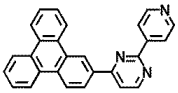

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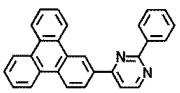

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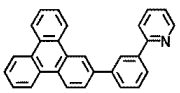

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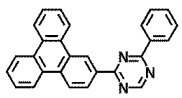

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A-8

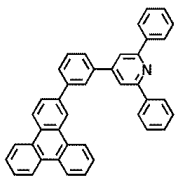

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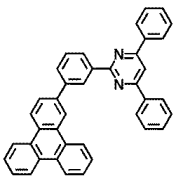

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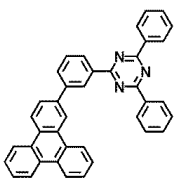

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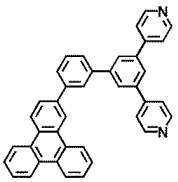

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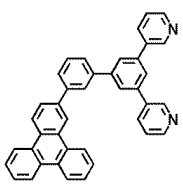
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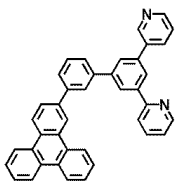

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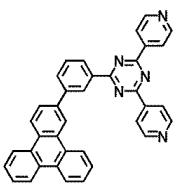

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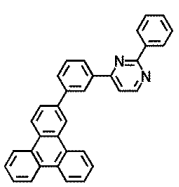

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A-16

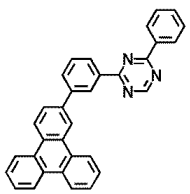

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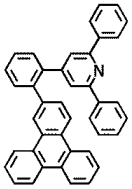

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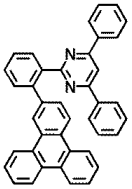

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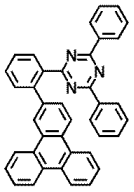

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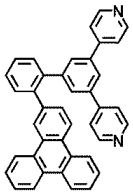
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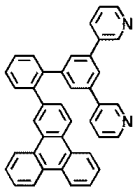

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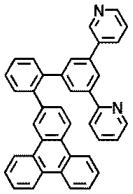

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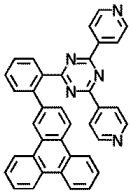

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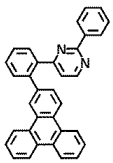

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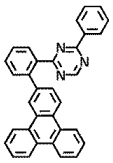

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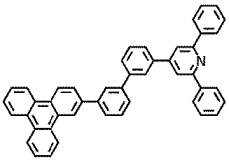

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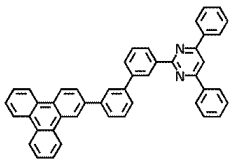

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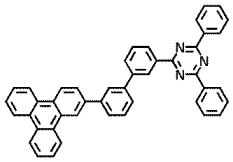

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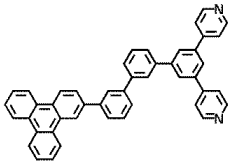

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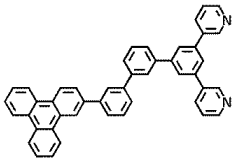

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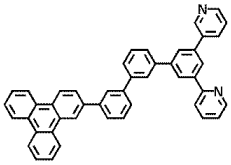

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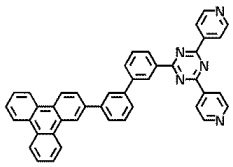
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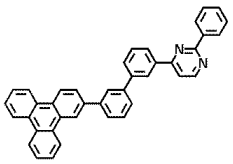

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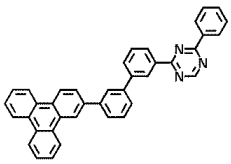

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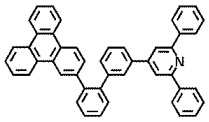

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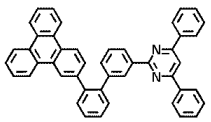

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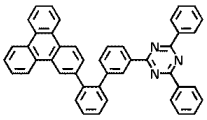

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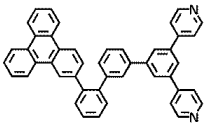

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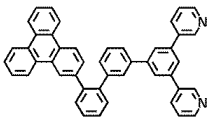

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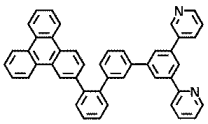

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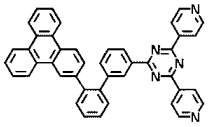

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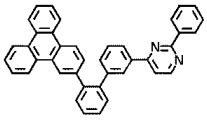

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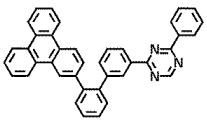

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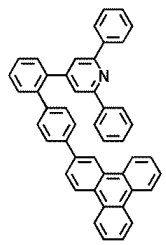

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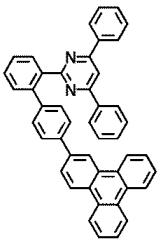

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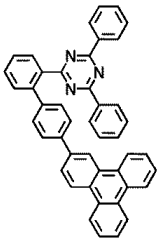

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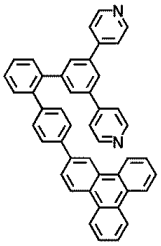

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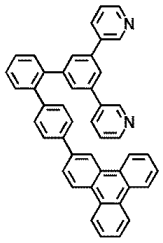
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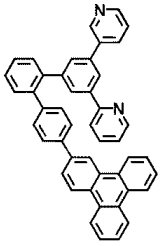

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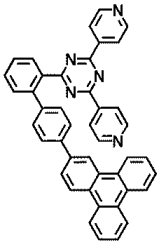

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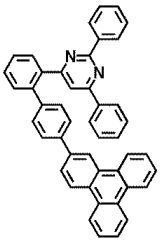

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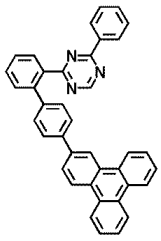

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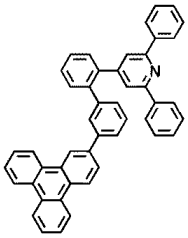

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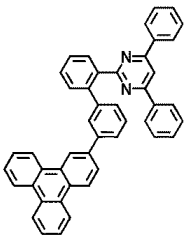

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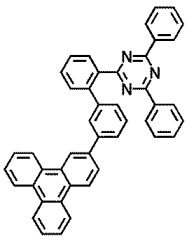

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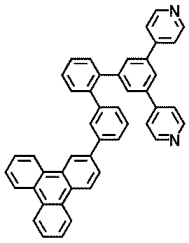
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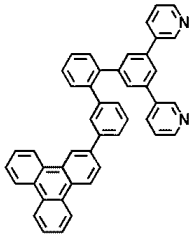

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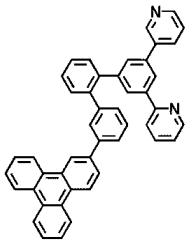

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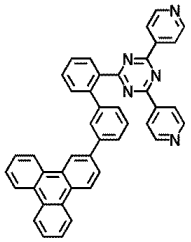

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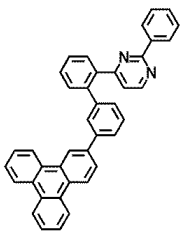

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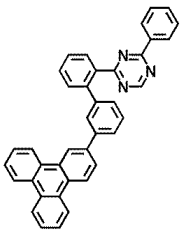

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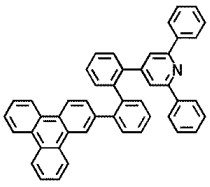

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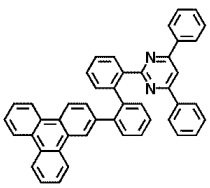

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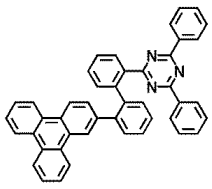
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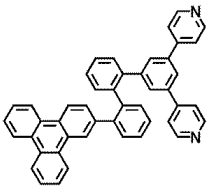

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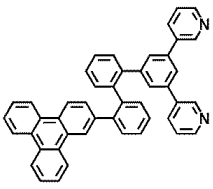

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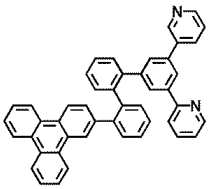

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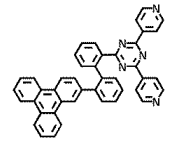

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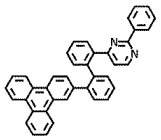

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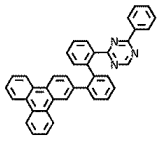

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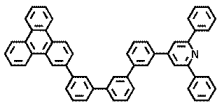

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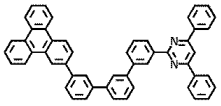
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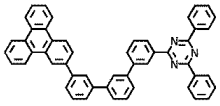

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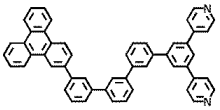

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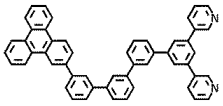

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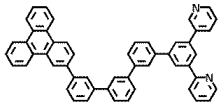

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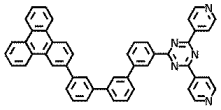

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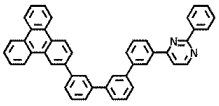

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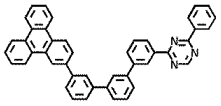

A-79


A-80

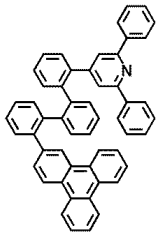

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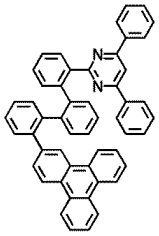

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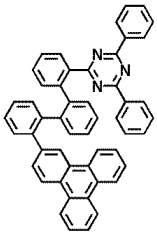

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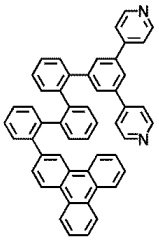

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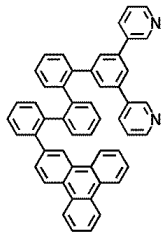
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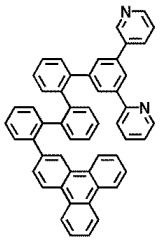

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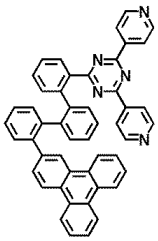

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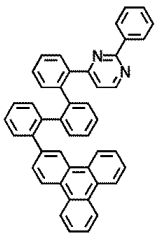

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A-88

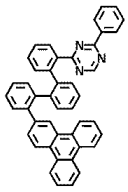

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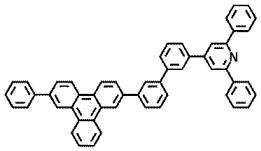

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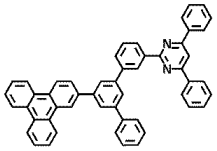

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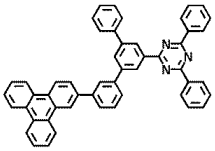

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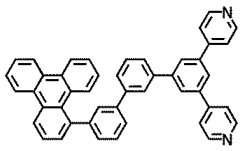
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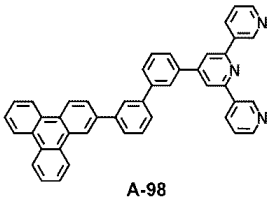

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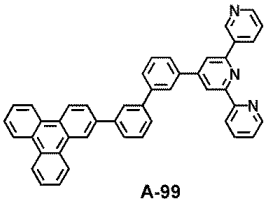

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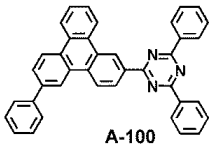
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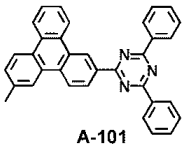
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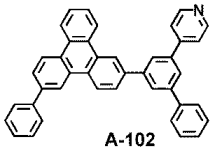
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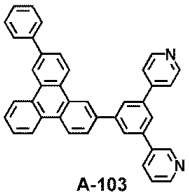
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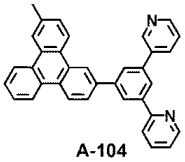
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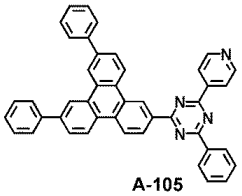
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A-103

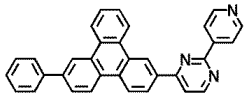


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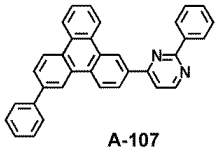


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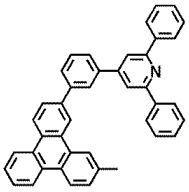
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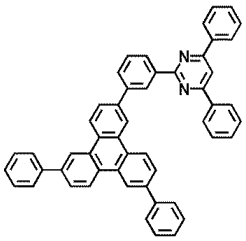
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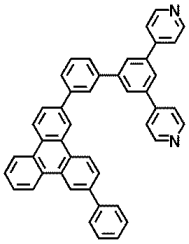
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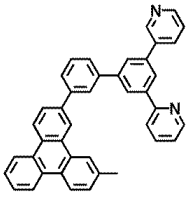
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A-109

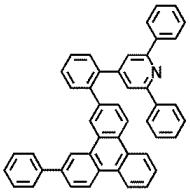


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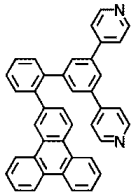


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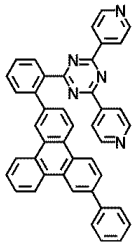
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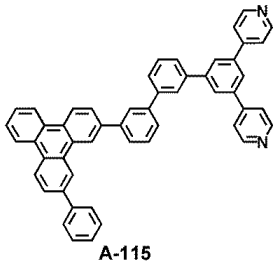
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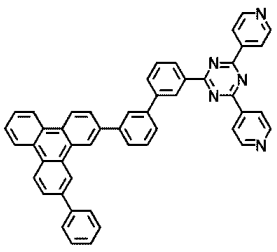
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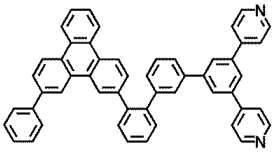
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A-115



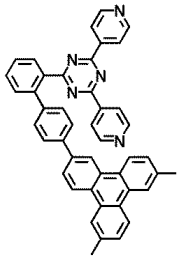
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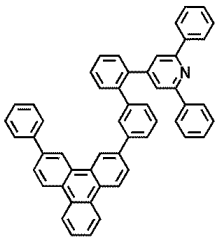
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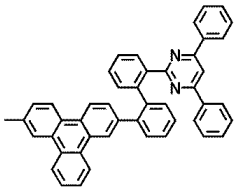
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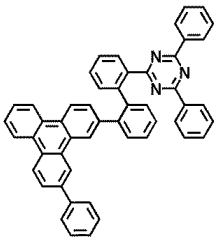
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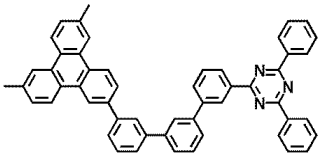
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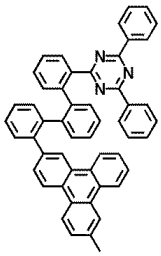
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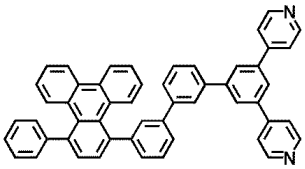


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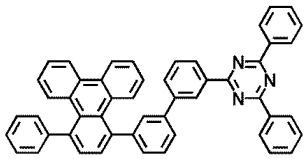


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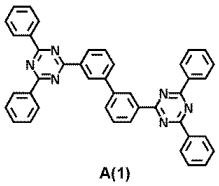


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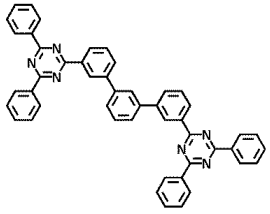


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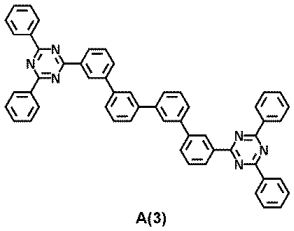
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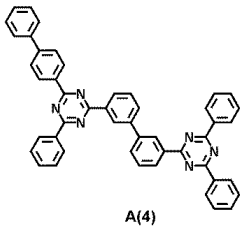
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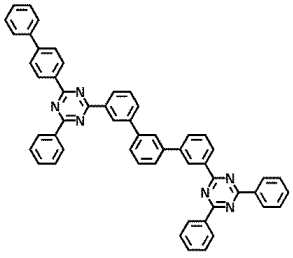
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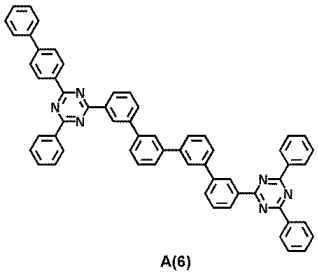
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A(4)

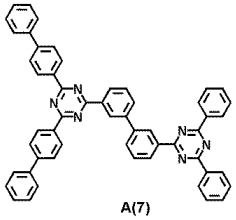


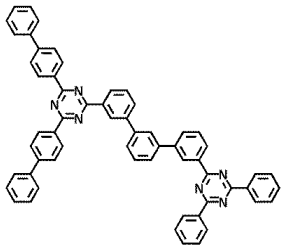
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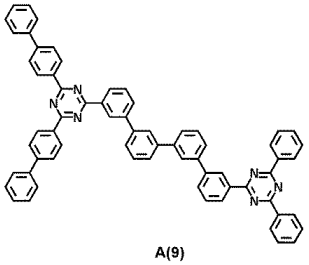


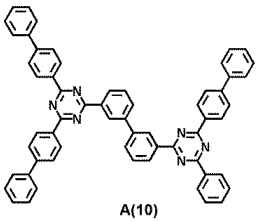
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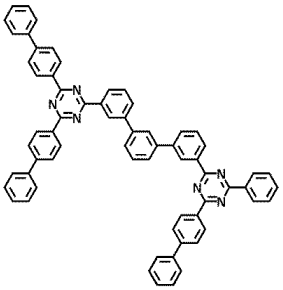
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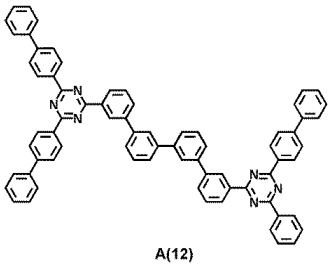

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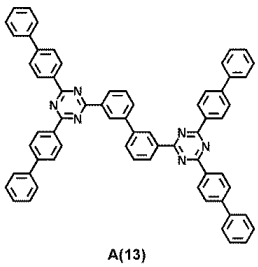

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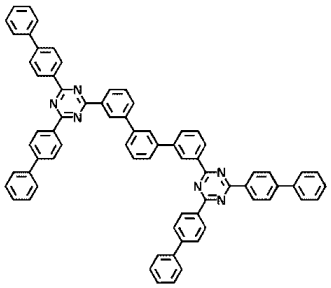

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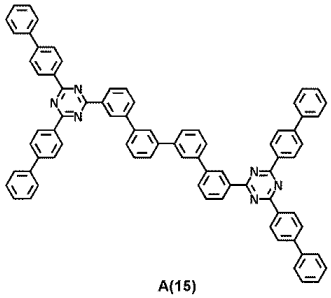

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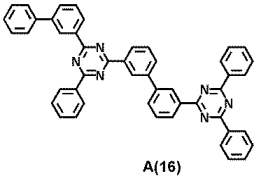

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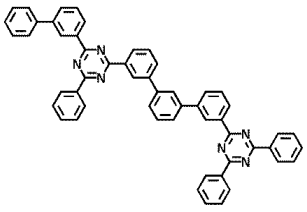
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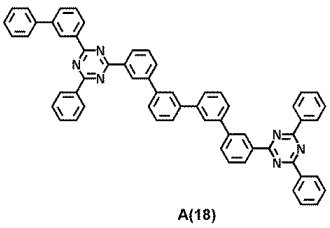

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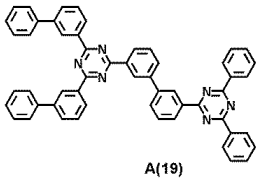

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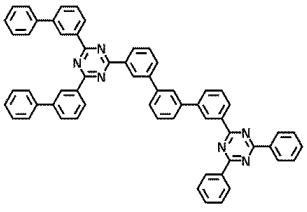

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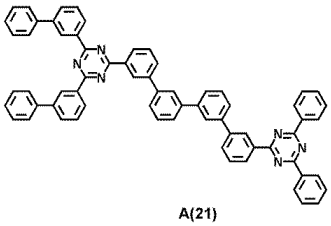

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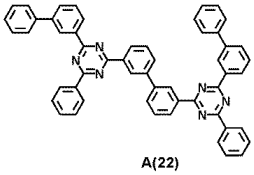
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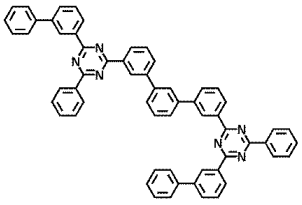

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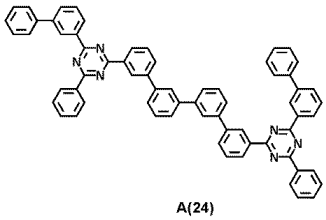

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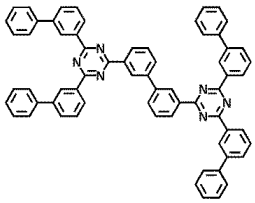

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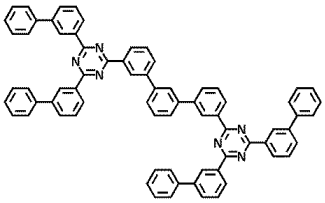
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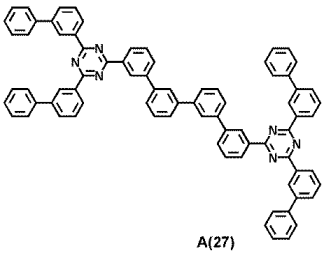

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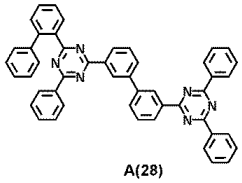

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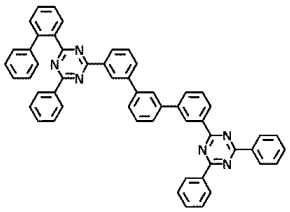

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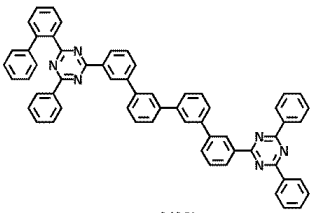

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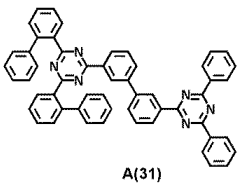

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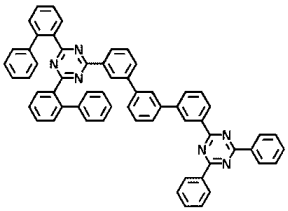
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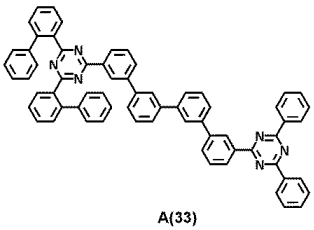

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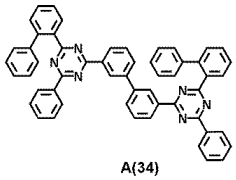

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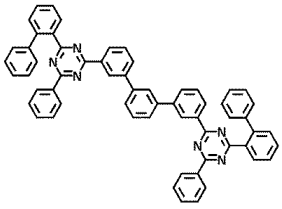

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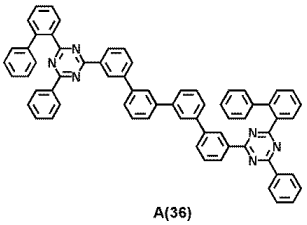

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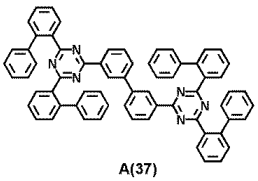

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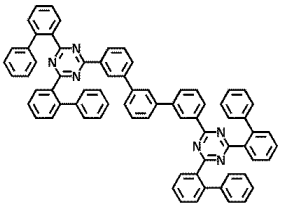
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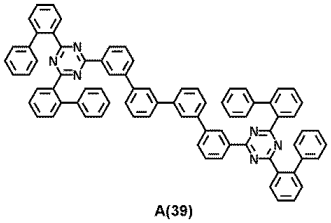

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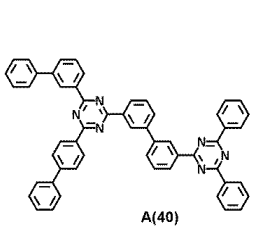

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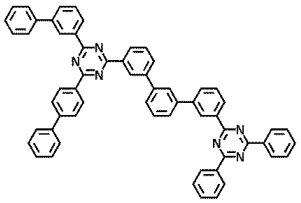

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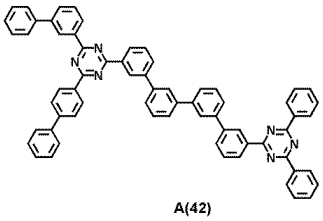

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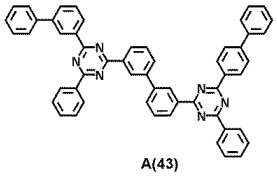

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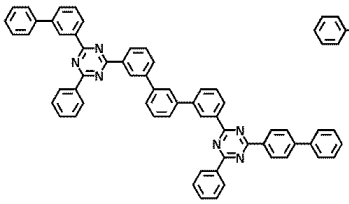
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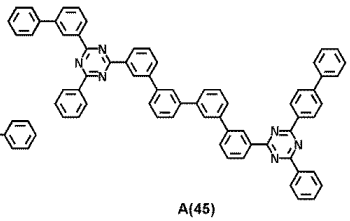

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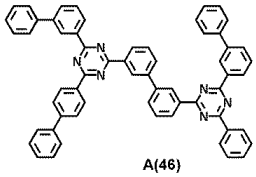

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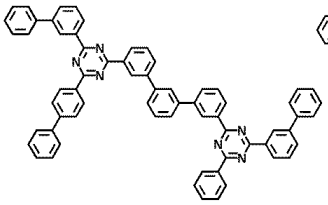

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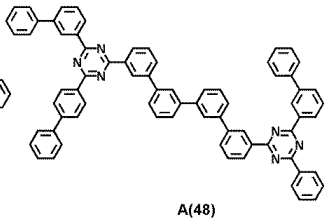

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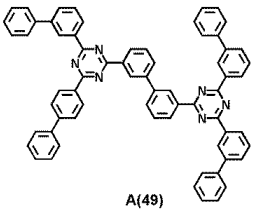

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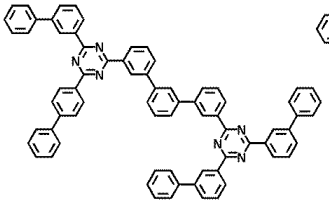

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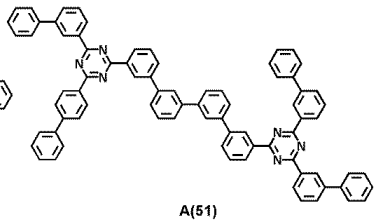

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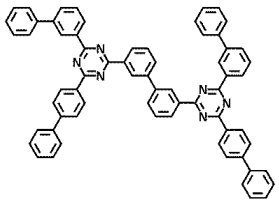

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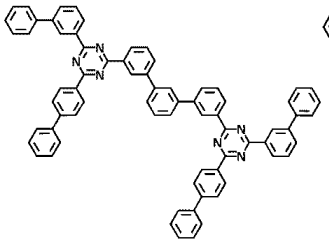
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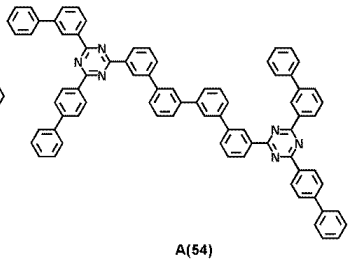

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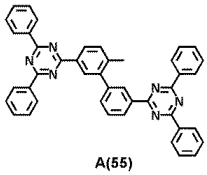

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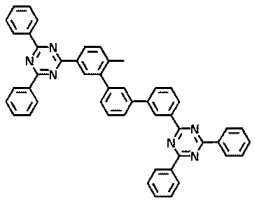

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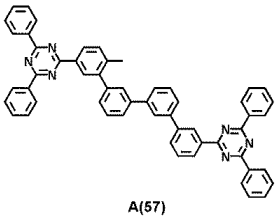

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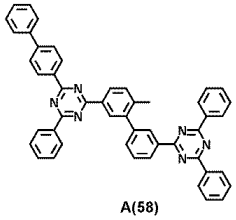
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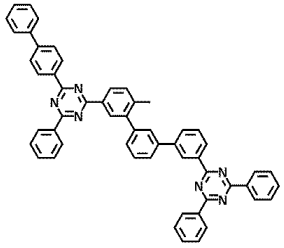

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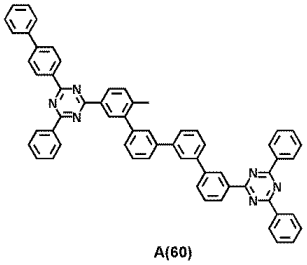

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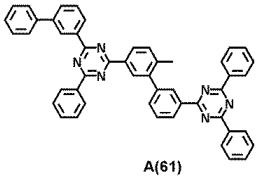

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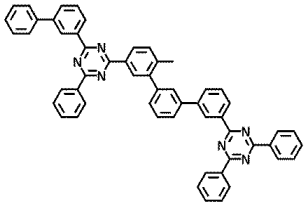
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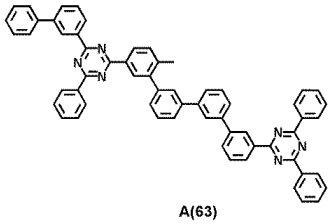

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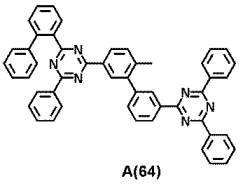

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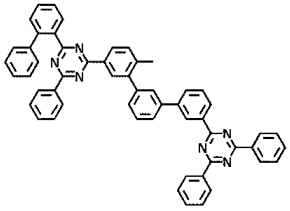

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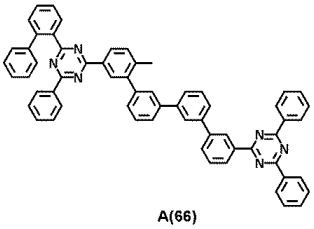

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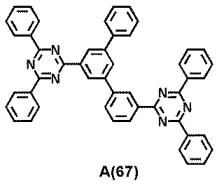

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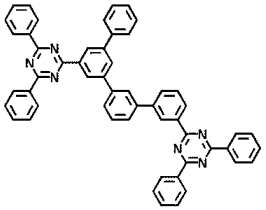

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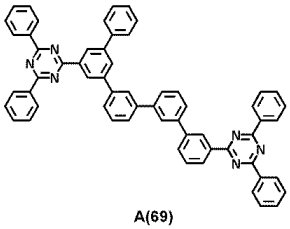

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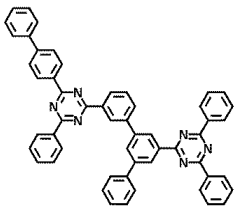

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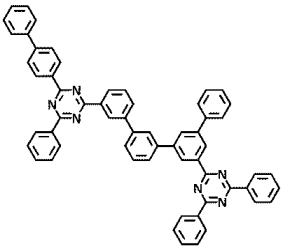
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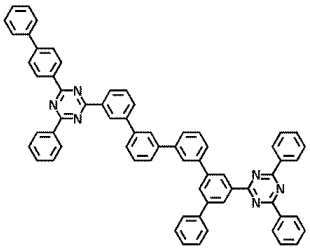

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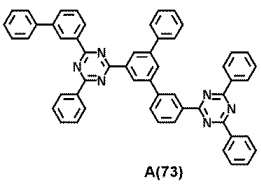

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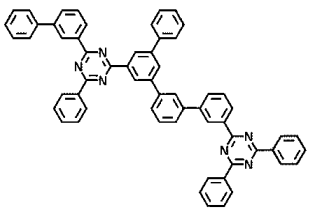

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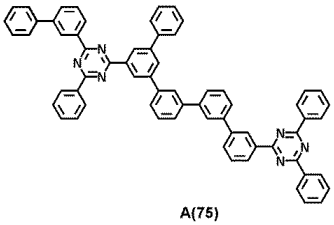

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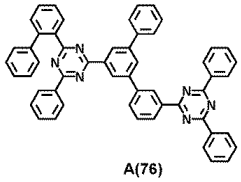
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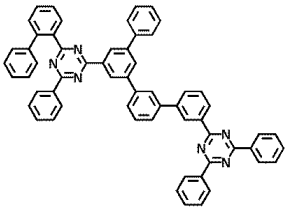

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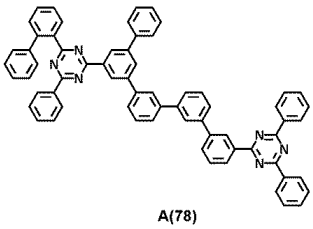

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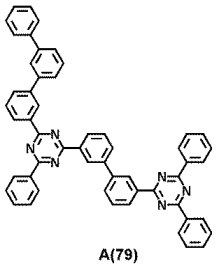

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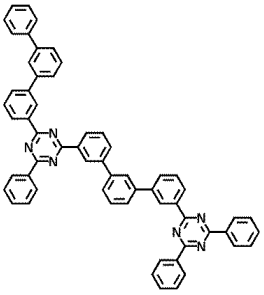
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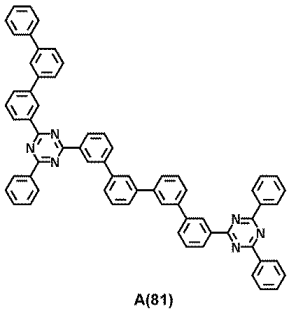

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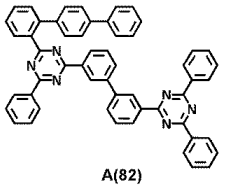

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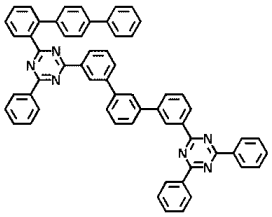

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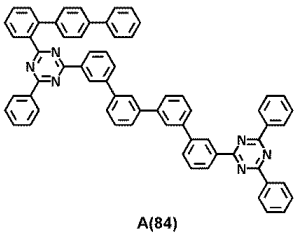

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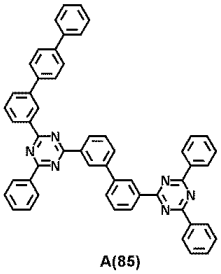

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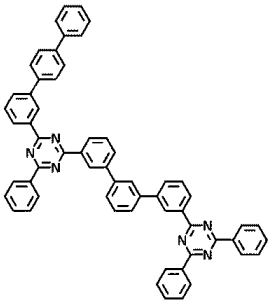
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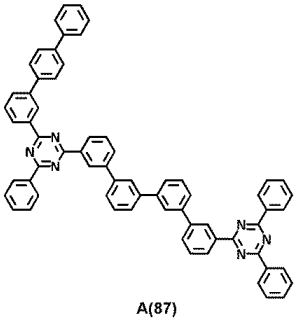

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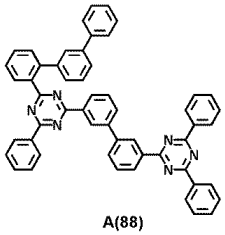

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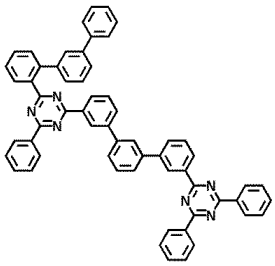

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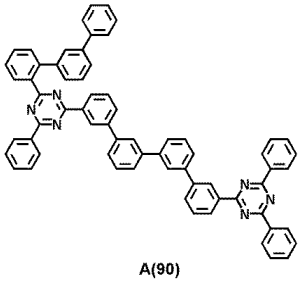

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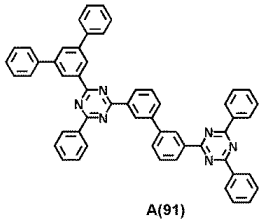
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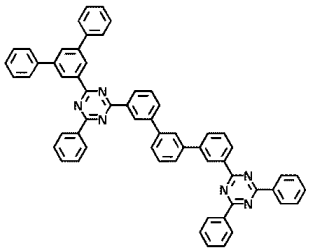

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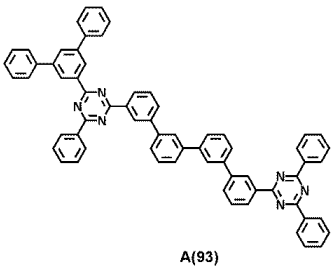

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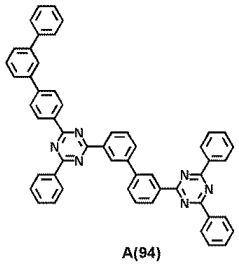

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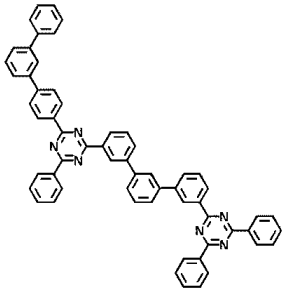
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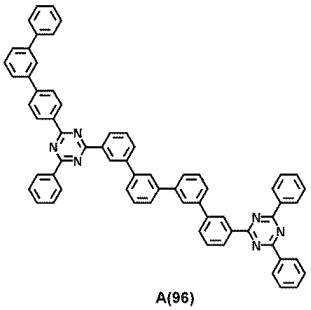

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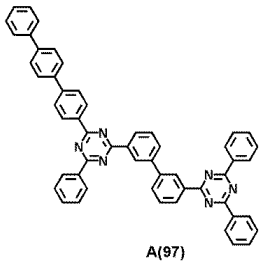

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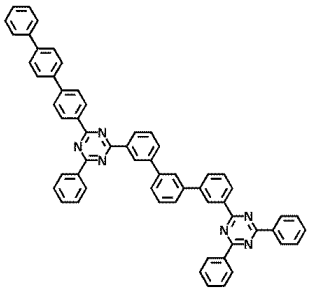

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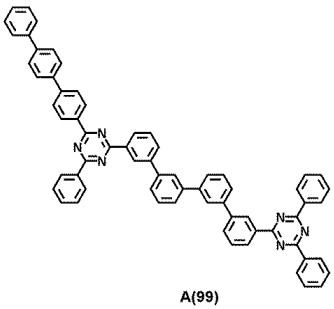

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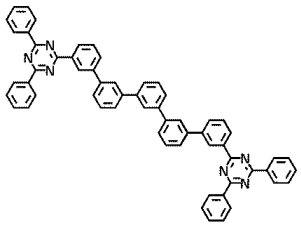

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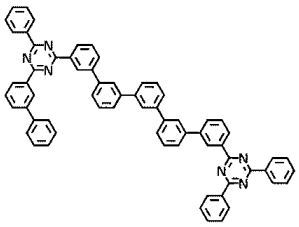
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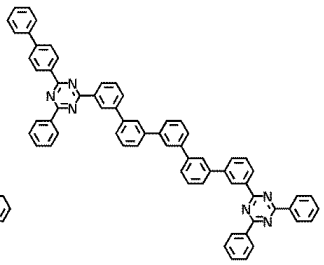

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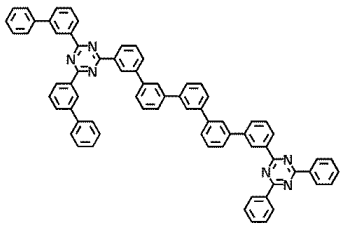

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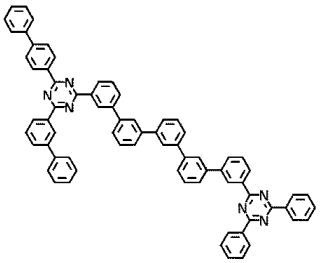

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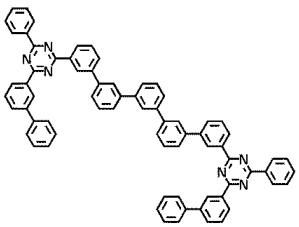

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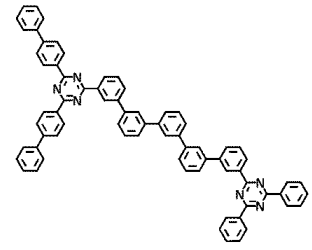
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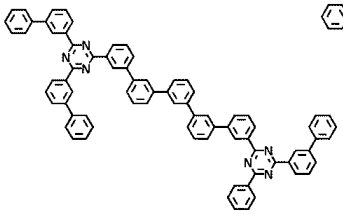

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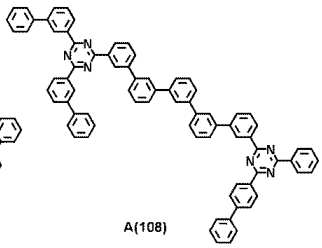

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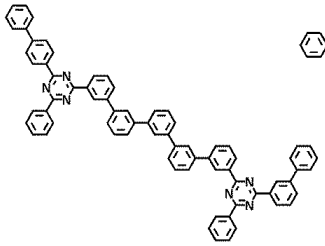

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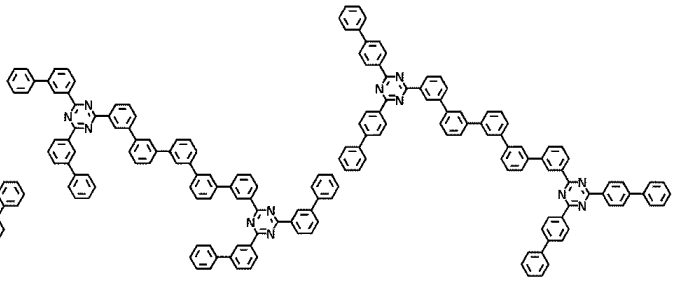
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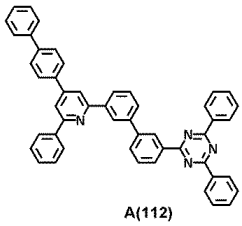

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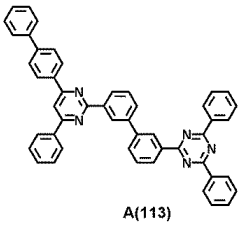

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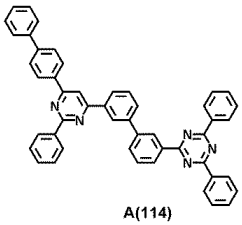

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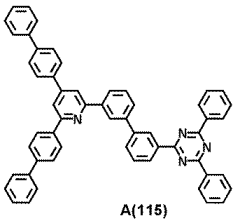
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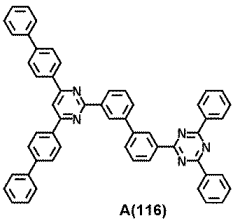

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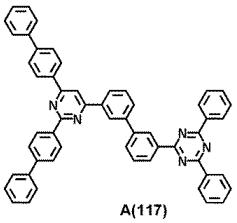

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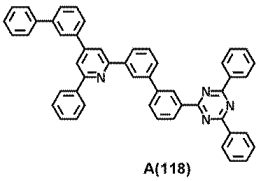
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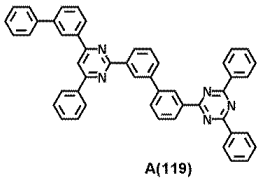

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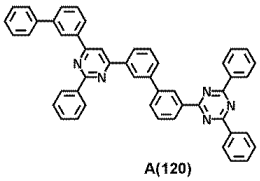

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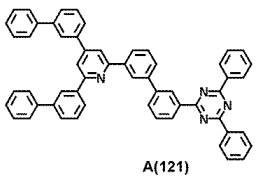
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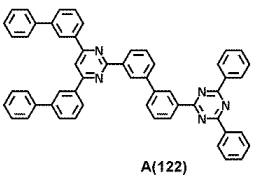

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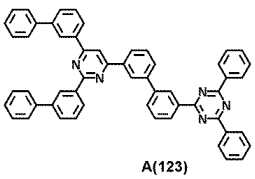

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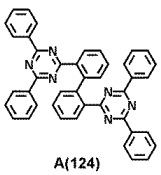
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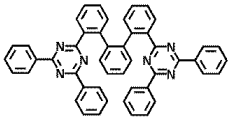

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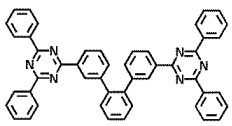

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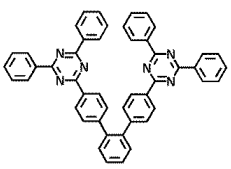

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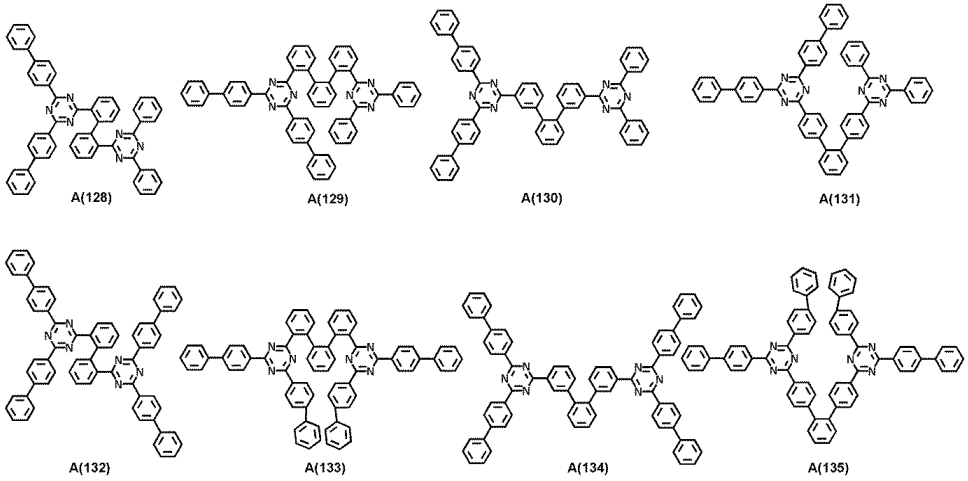

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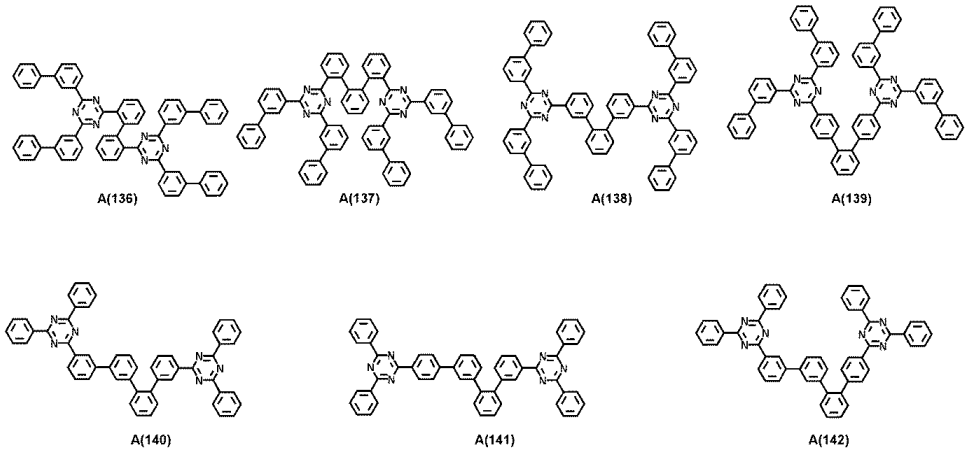

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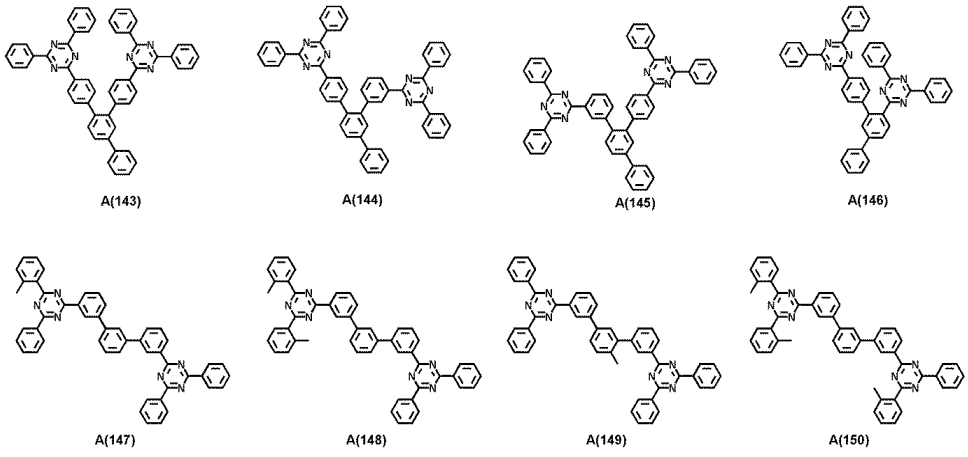
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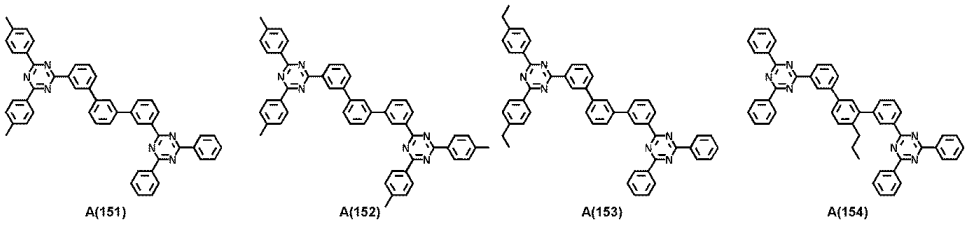
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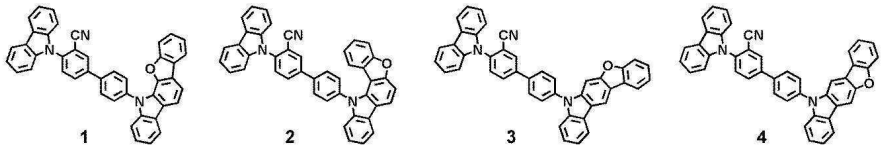
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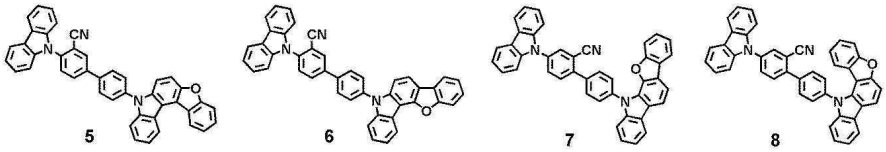


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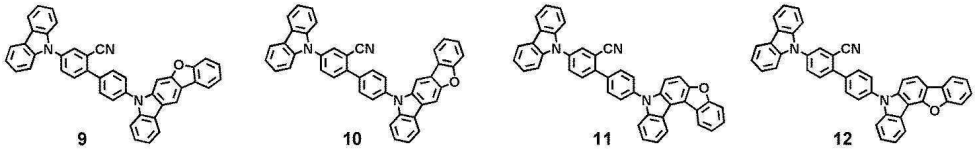


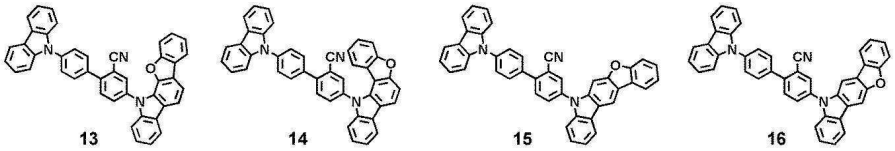
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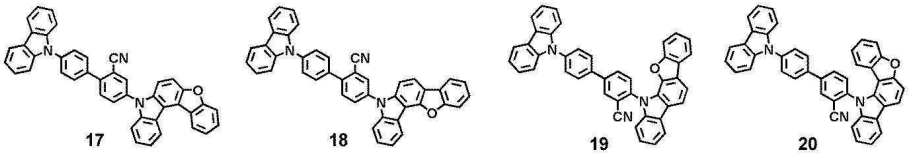




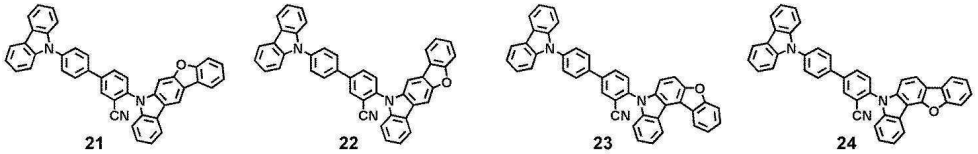
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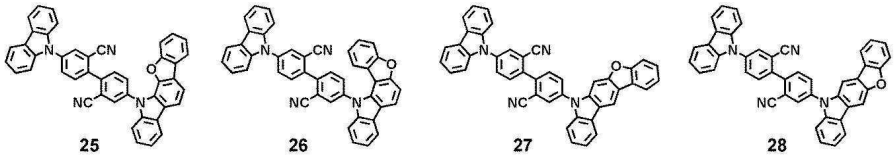


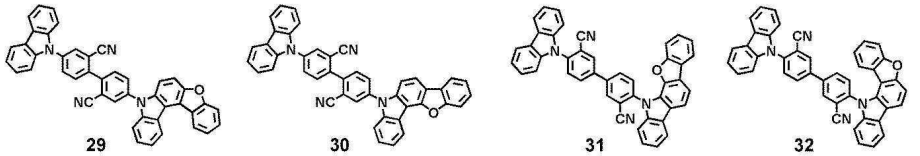




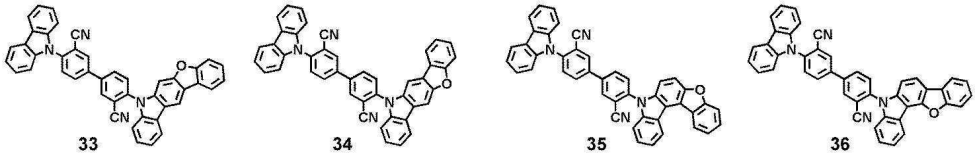
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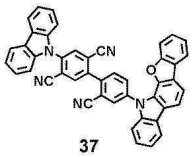


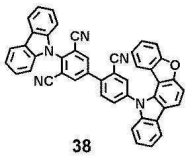


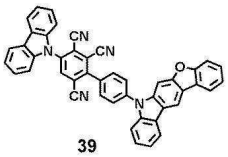
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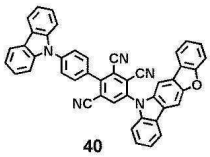


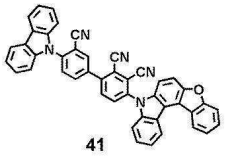
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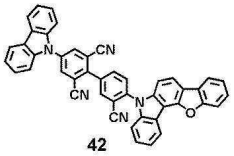

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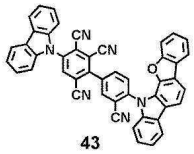

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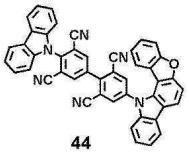

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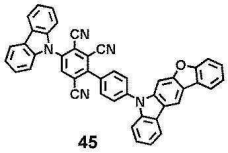

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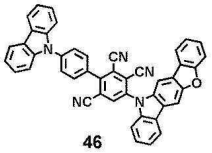

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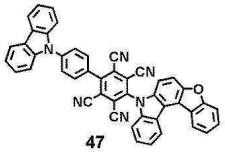

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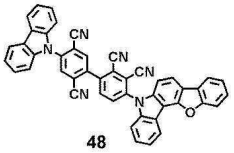

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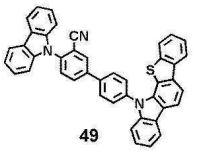

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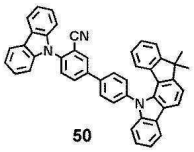

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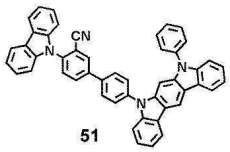

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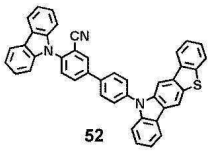

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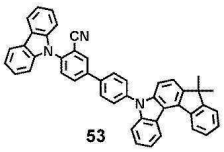

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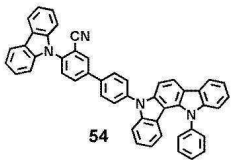

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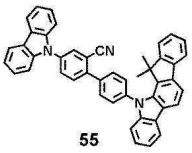

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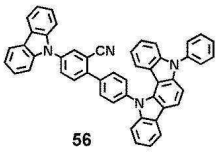

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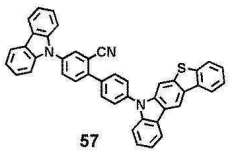
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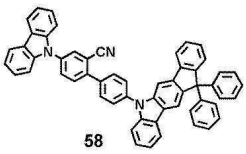

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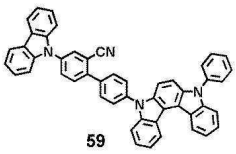

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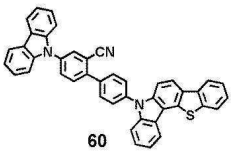

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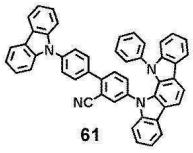

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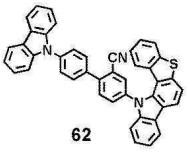

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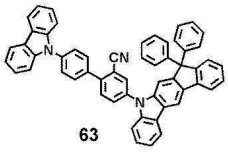

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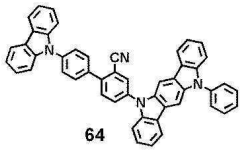

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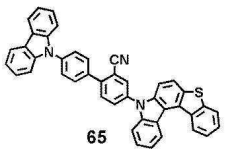

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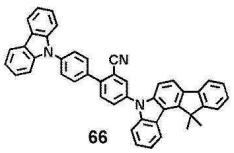

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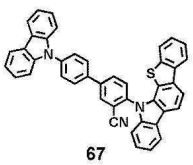

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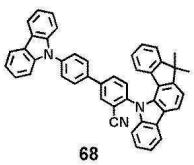

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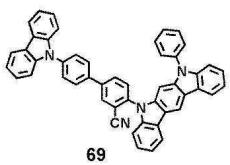
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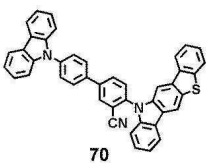

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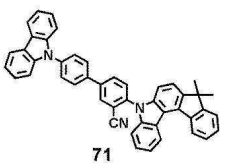

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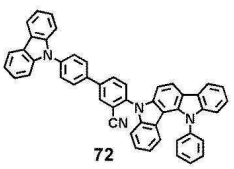

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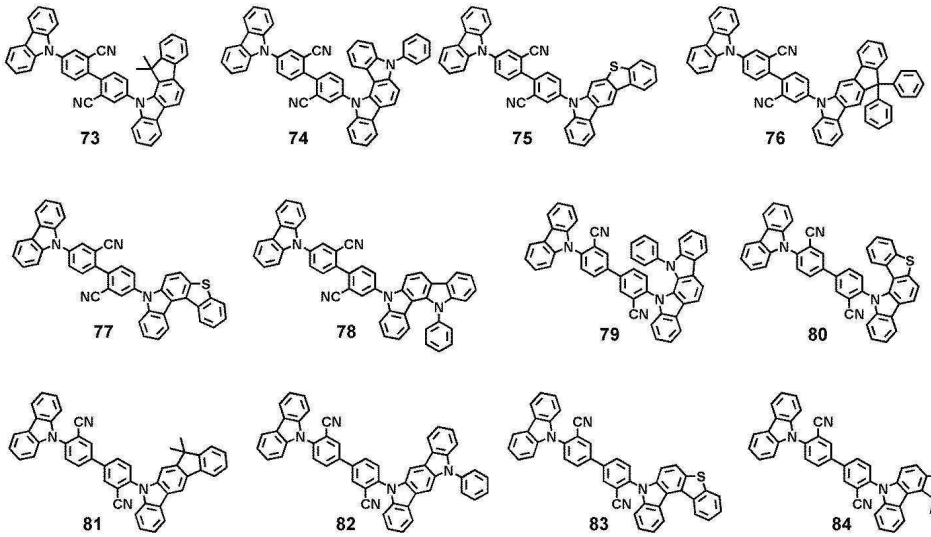

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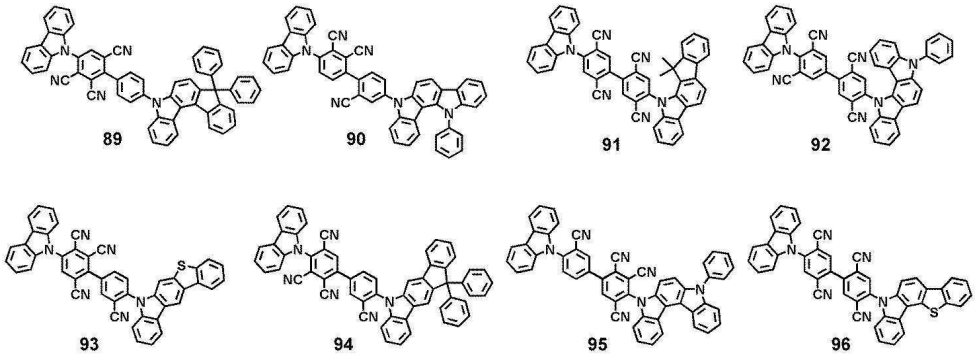

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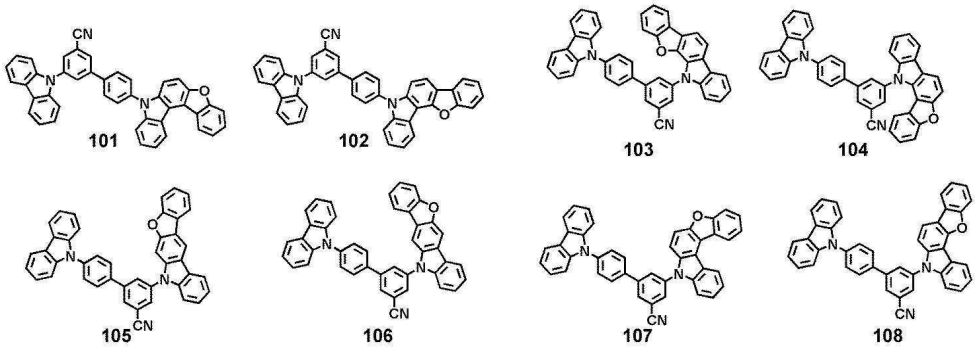
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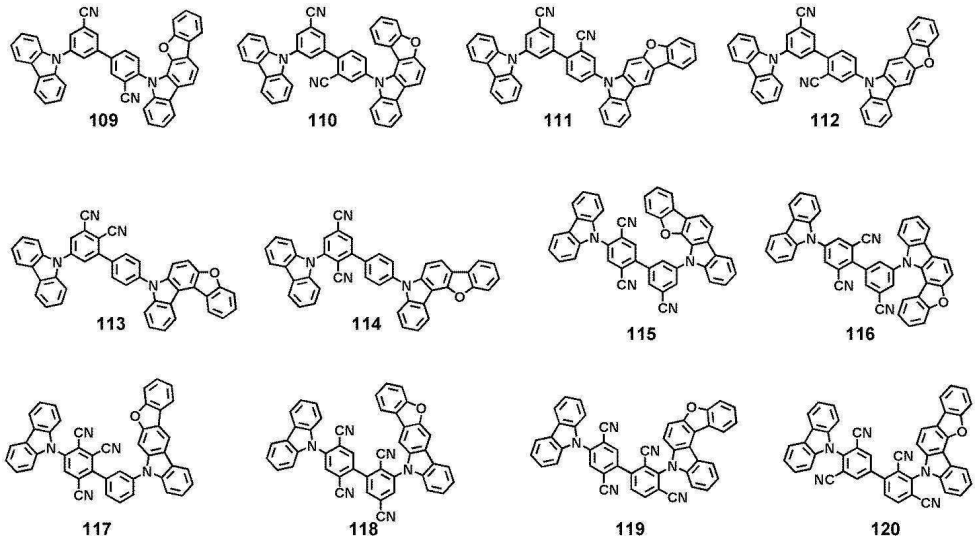
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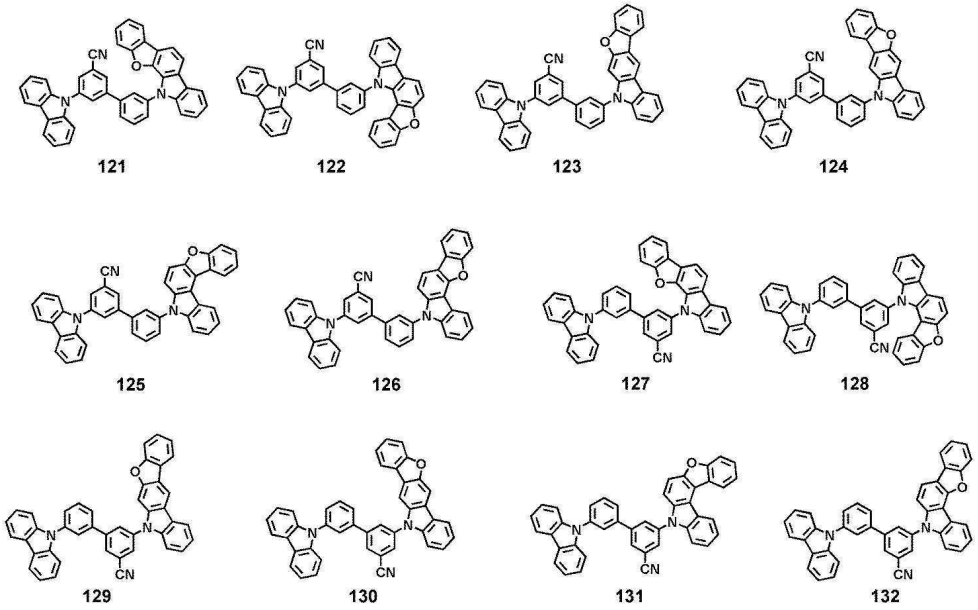
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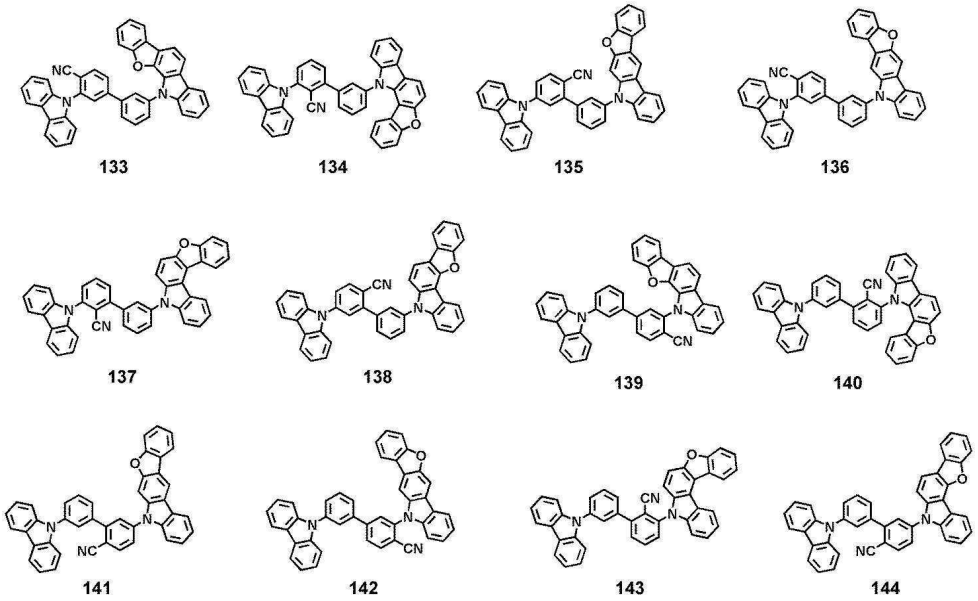
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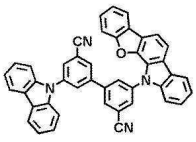
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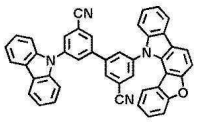


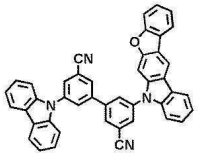
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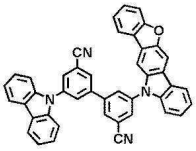


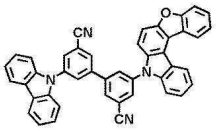
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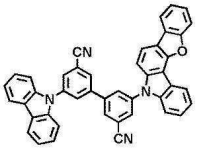

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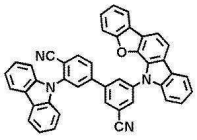

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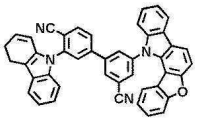

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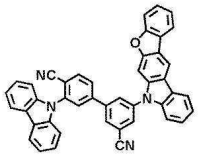

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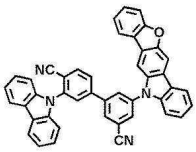

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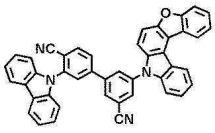

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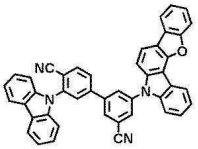

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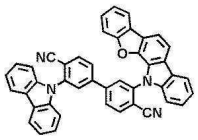

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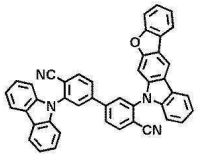

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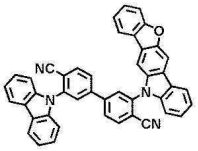

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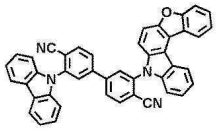

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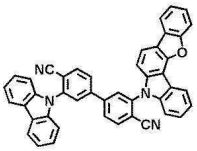

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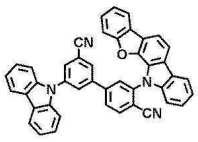

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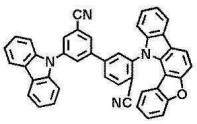

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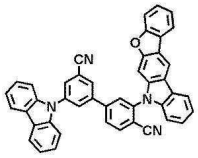
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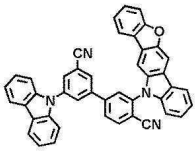

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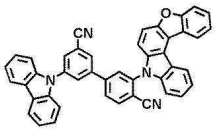

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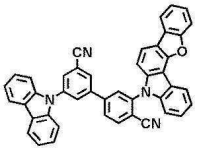

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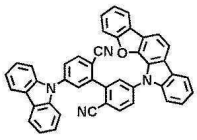

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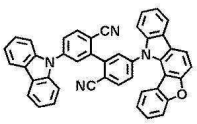

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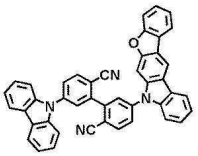

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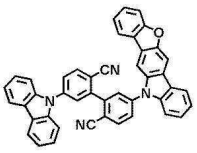

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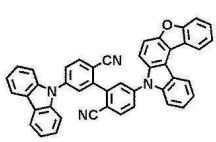

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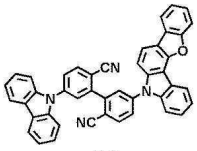

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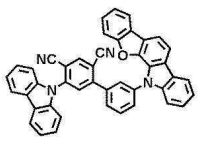

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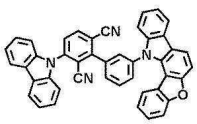

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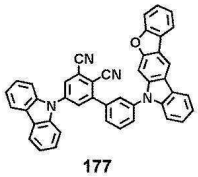

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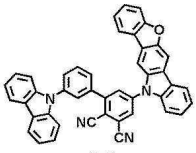

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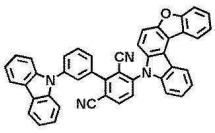

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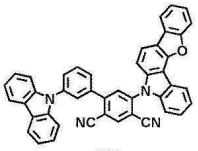

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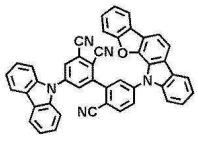

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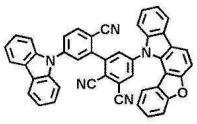

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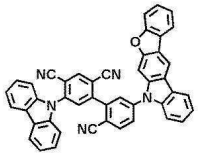

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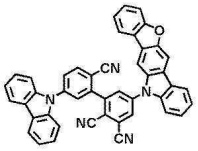
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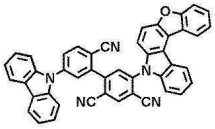
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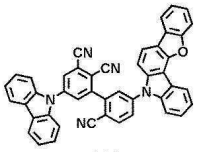

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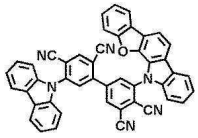

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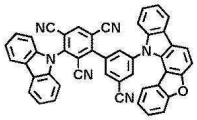

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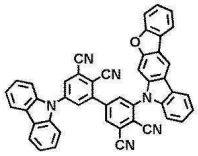

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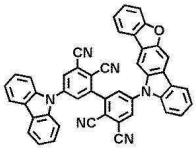

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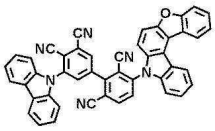

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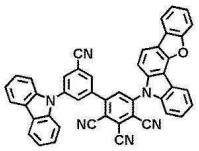

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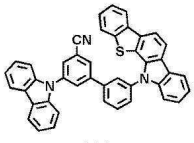

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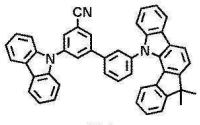

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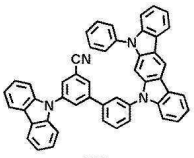

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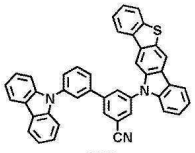

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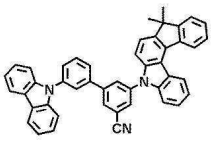
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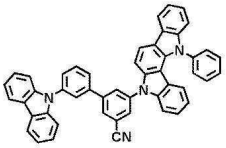

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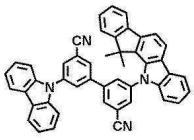

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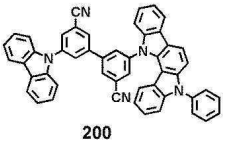

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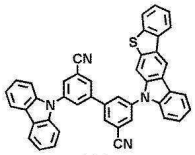

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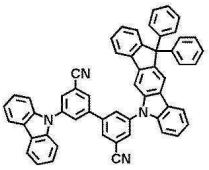

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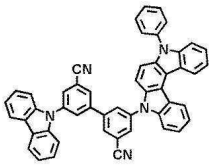

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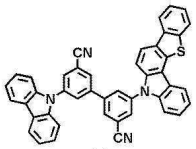

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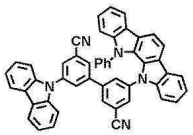
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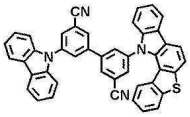

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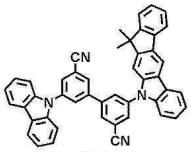

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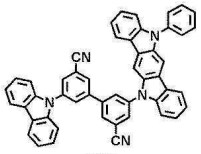

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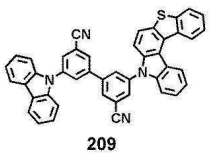

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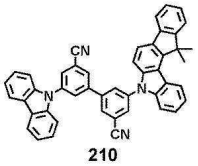

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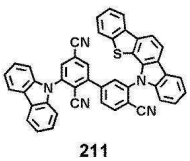

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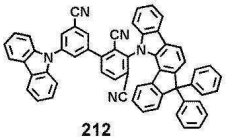

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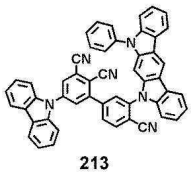

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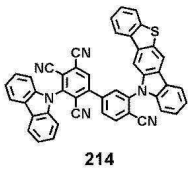

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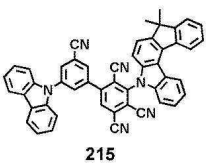

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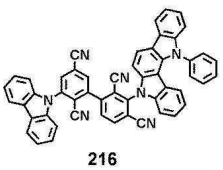

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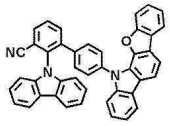

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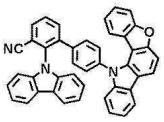

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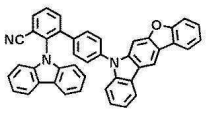

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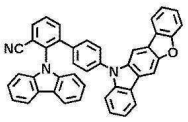

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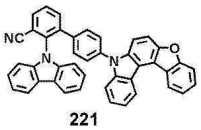
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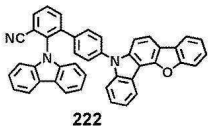

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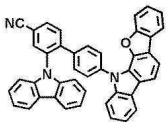

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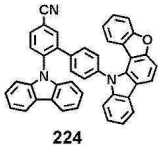

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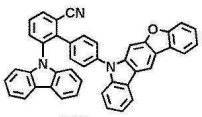

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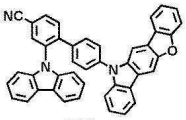

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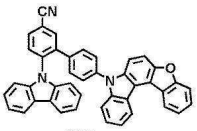

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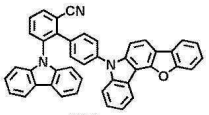

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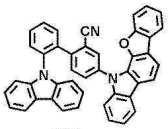

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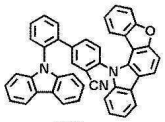

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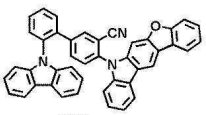

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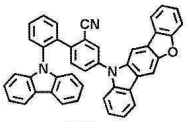

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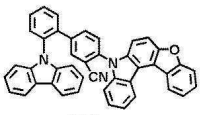
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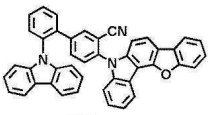

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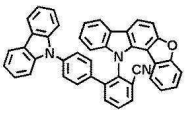

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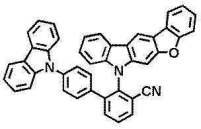

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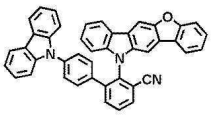

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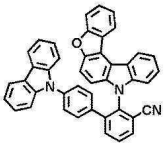

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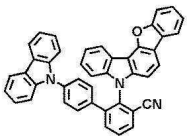

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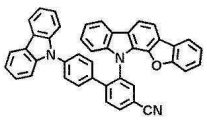

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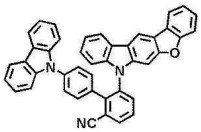

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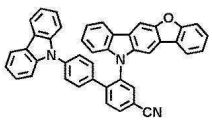

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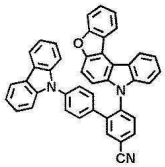
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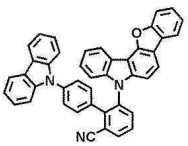

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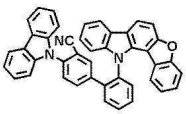

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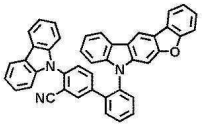

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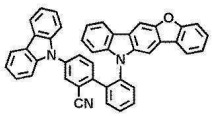

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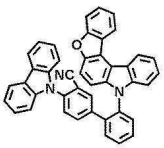

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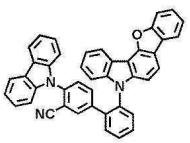

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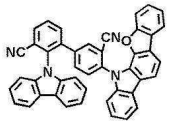

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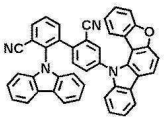

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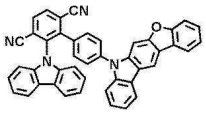

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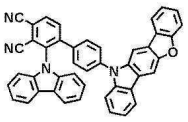

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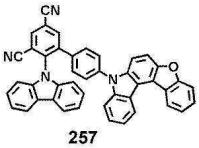

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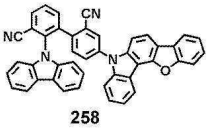

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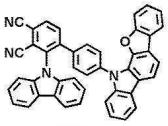

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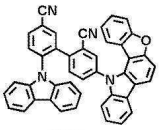

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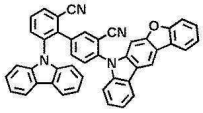

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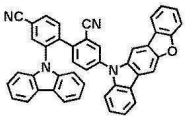

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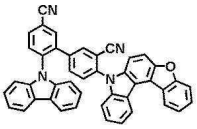

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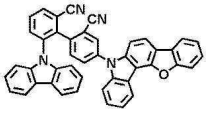

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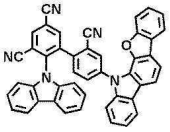
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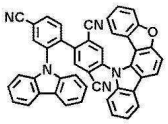

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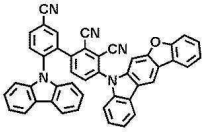

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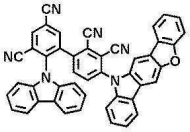

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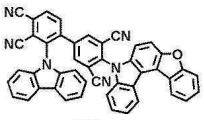

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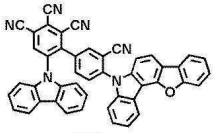

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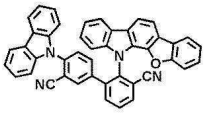

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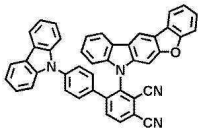

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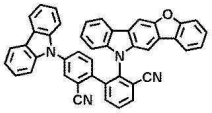

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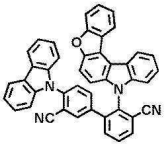

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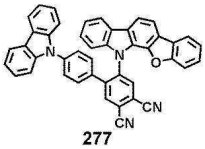

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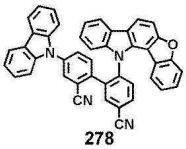

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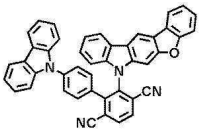

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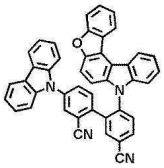
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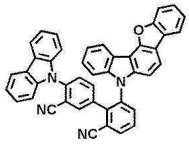

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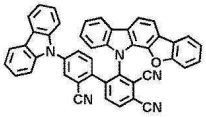

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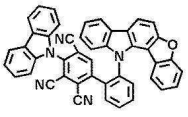

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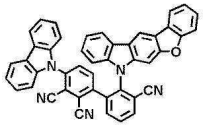

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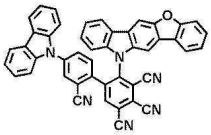

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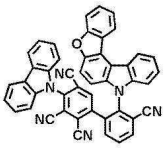

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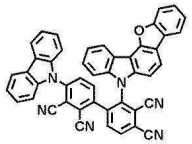

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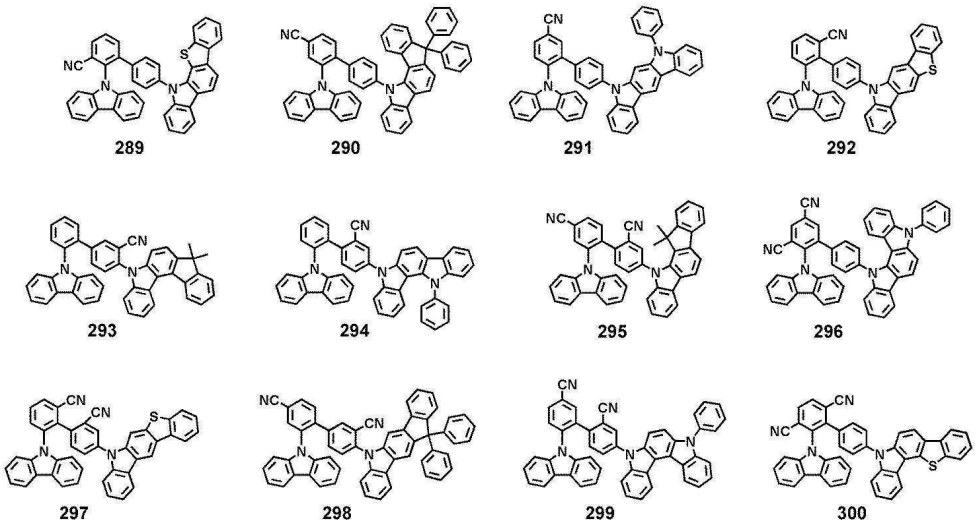

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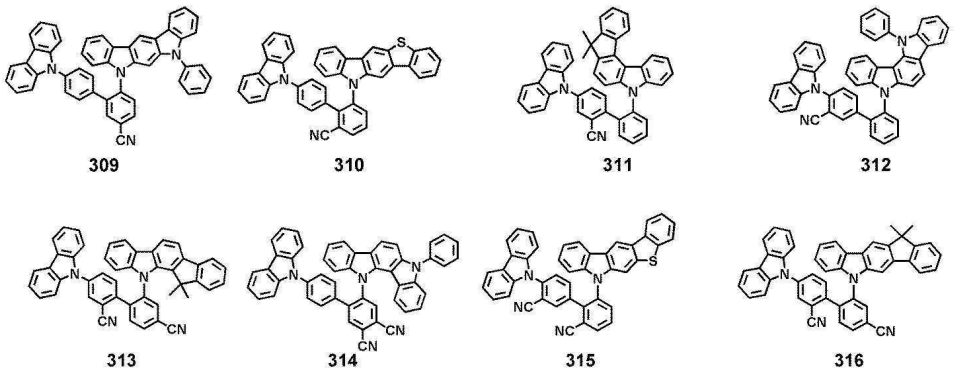

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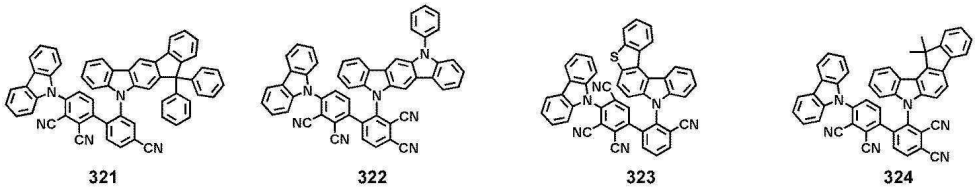
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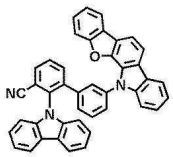


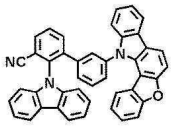
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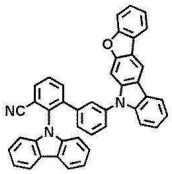


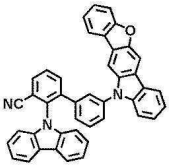
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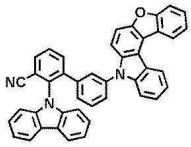


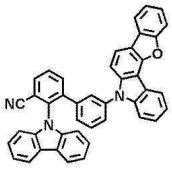

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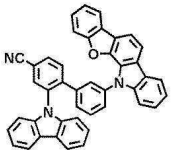

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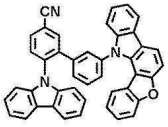

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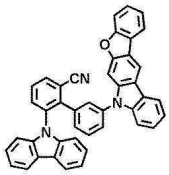

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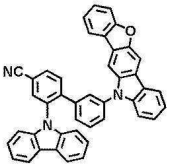

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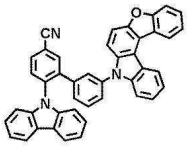

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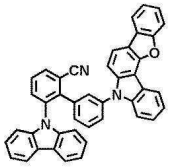

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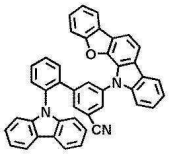

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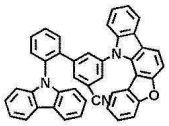

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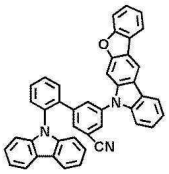

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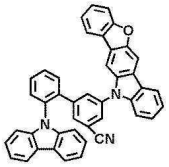

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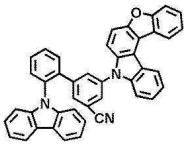
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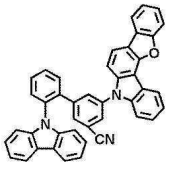

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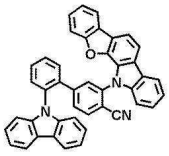

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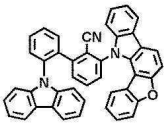

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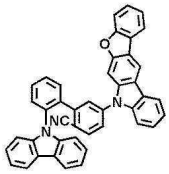

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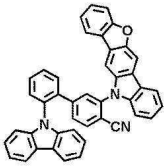

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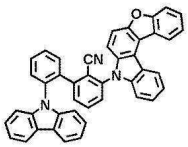

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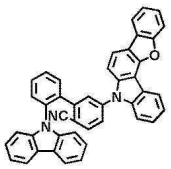

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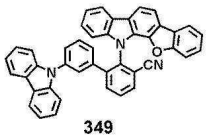

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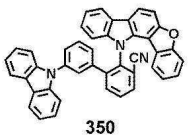

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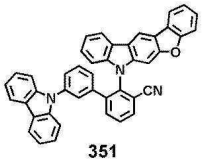

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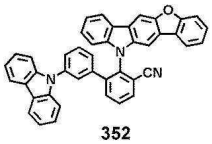

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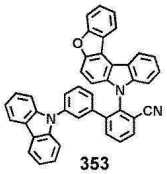
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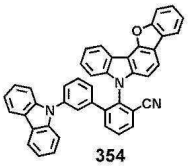

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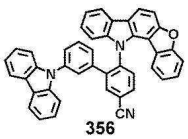

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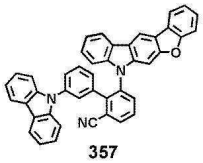

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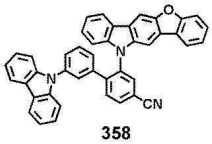

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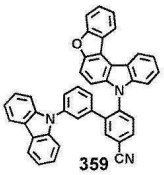

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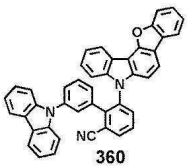

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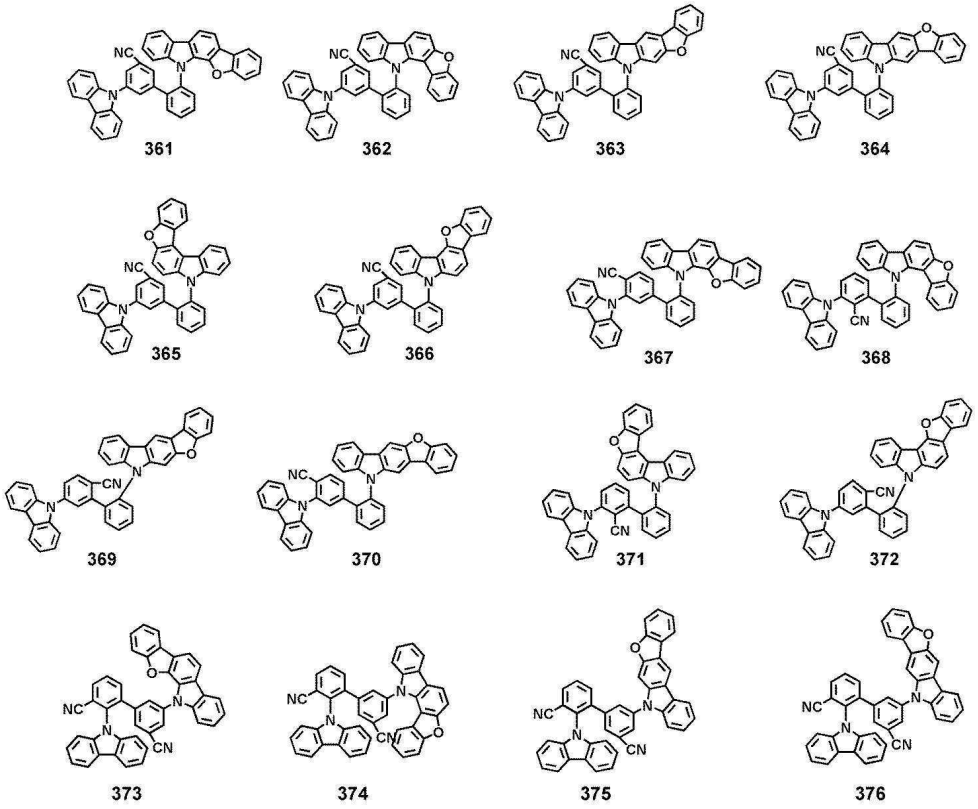

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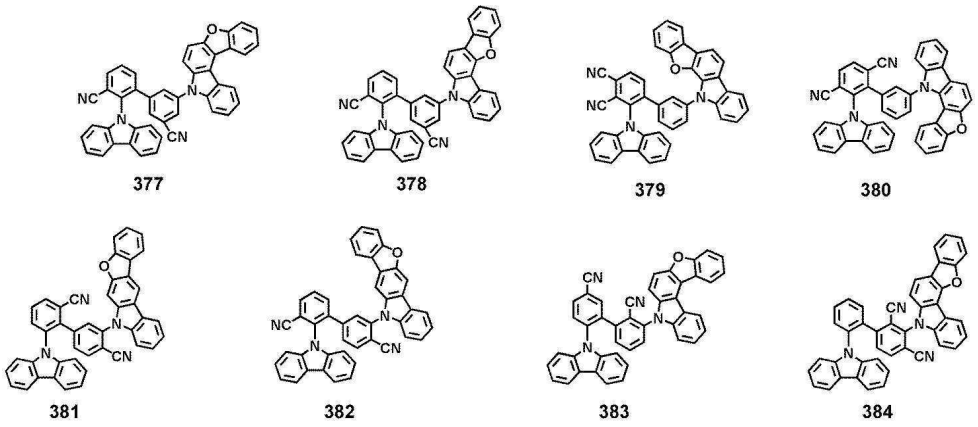

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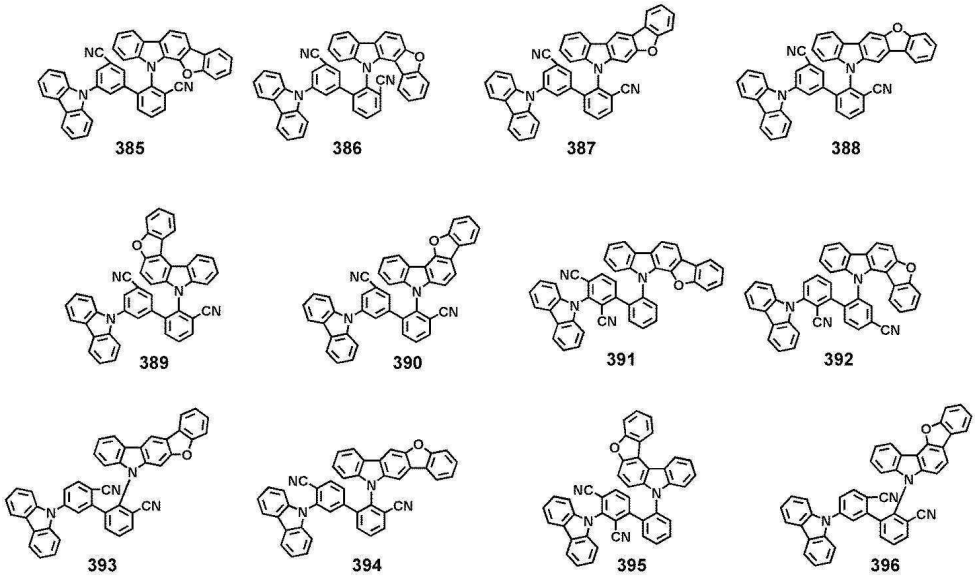
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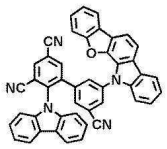
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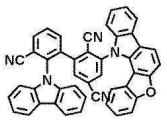


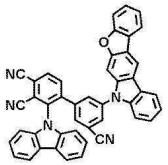
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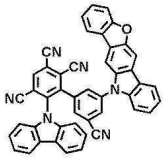


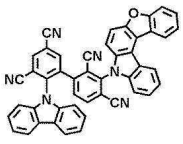
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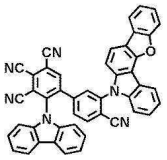

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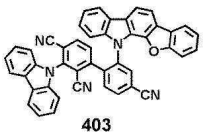

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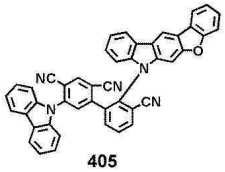

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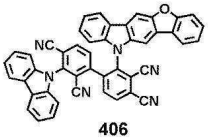

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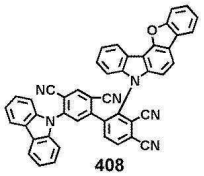

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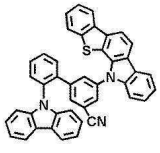

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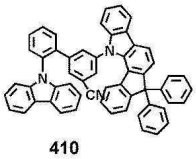

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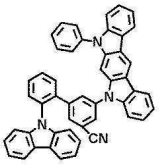

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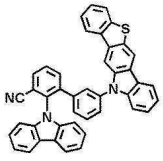

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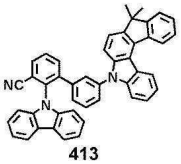
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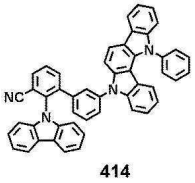

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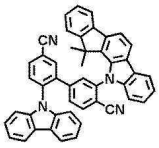

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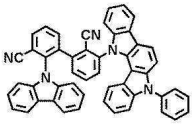

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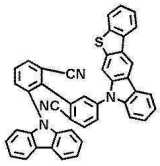

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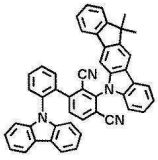

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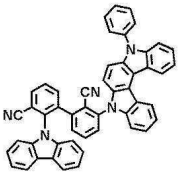

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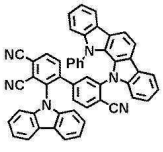

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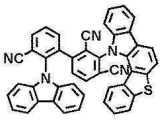

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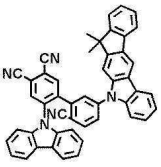

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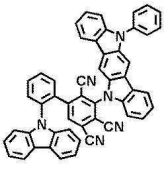

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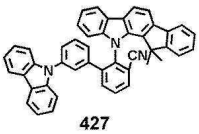

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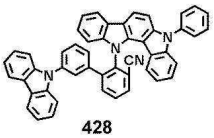

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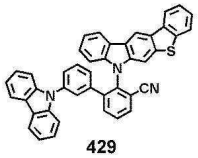

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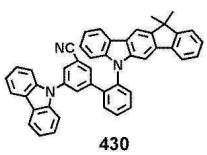

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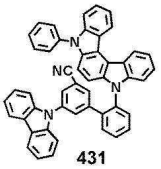

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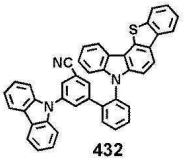

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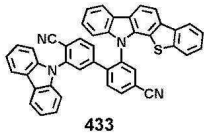

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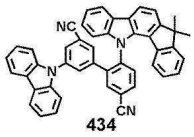

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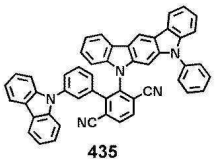

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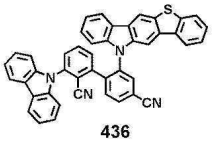

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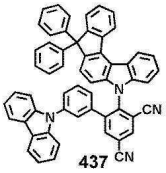

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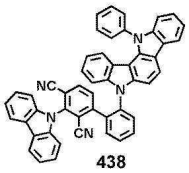

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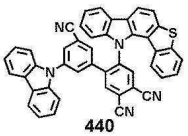

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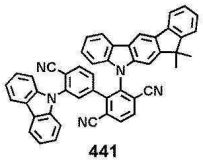

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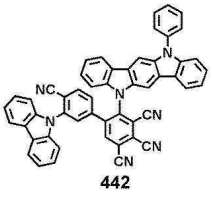

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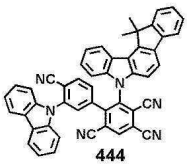

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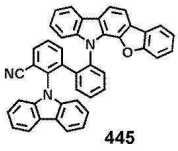

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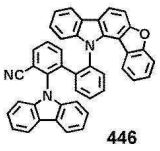

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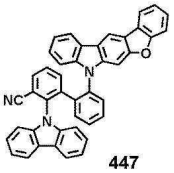

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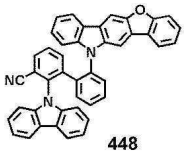

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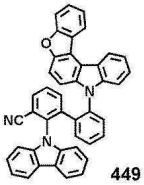
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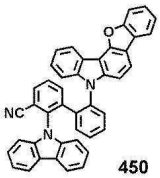

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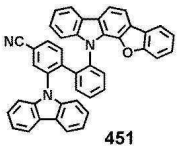

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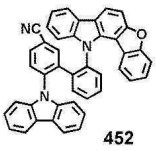

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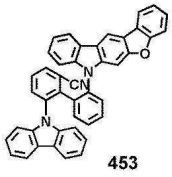

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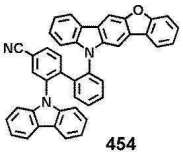

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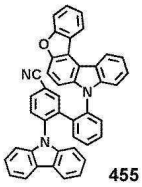

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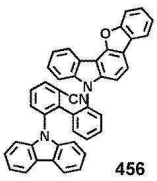

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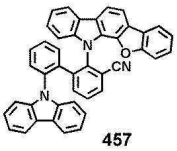

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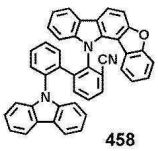

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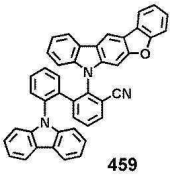

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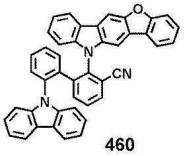

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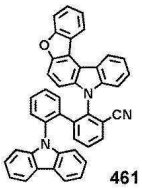
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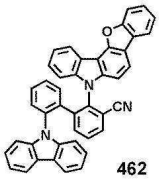

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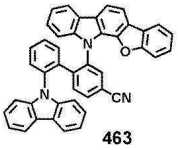

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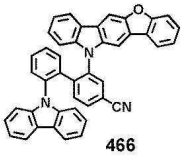

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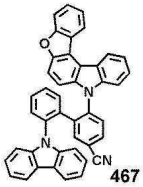

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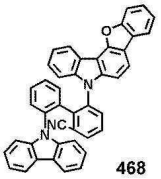

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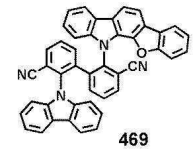

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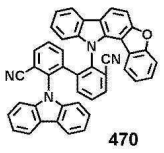

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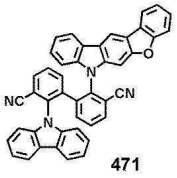

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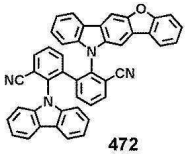
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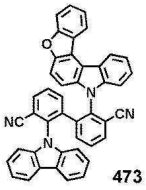
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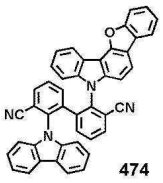

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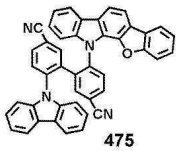

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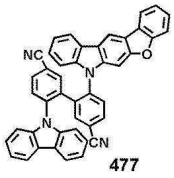

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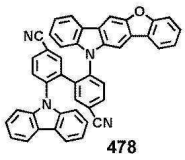

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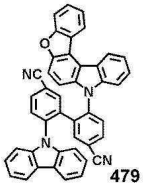

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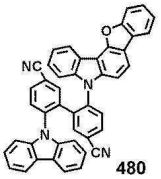

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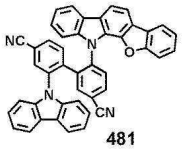

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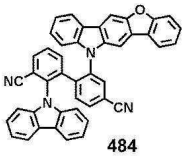

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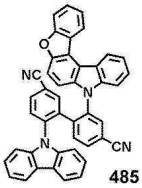
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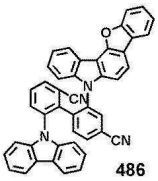

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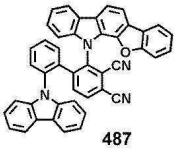

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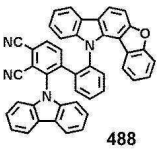

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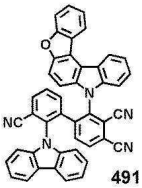

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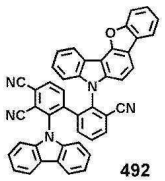

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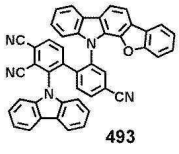

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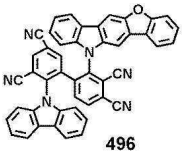

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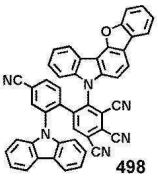

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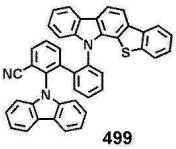

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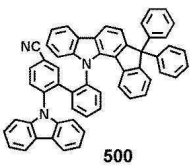

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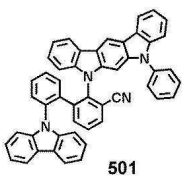

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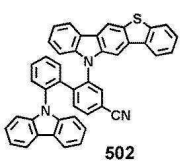

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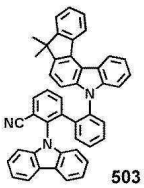

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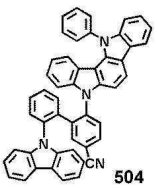

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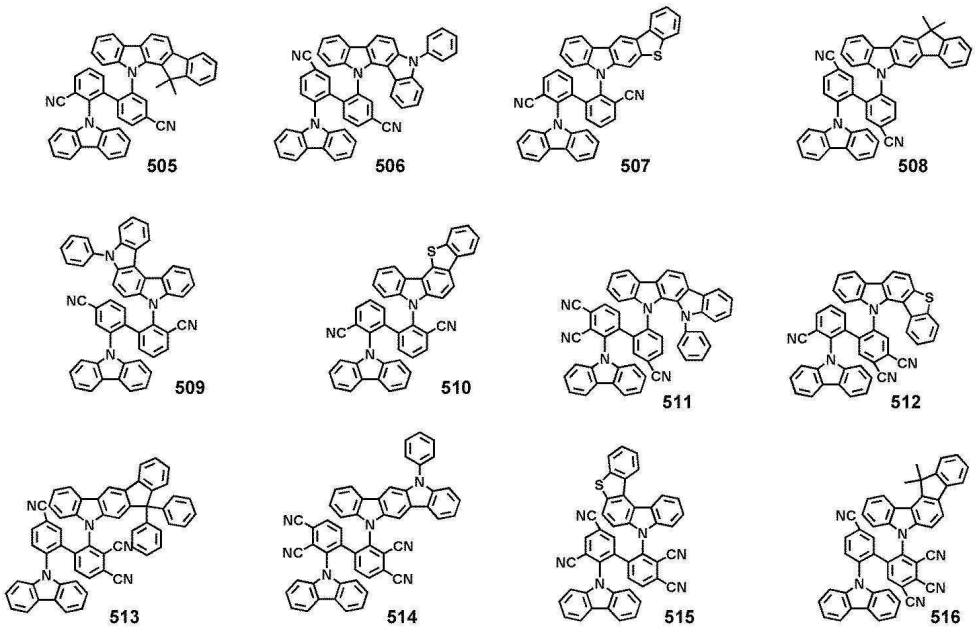

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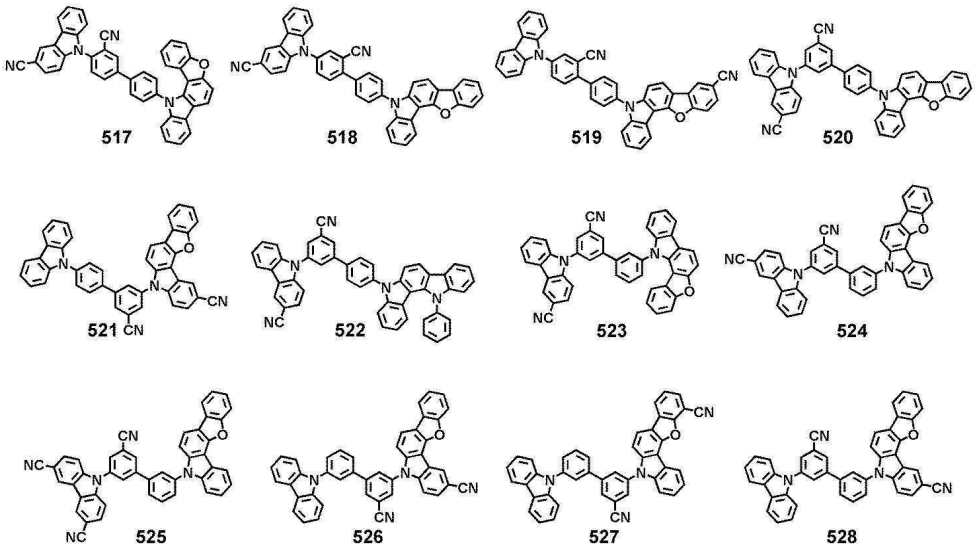

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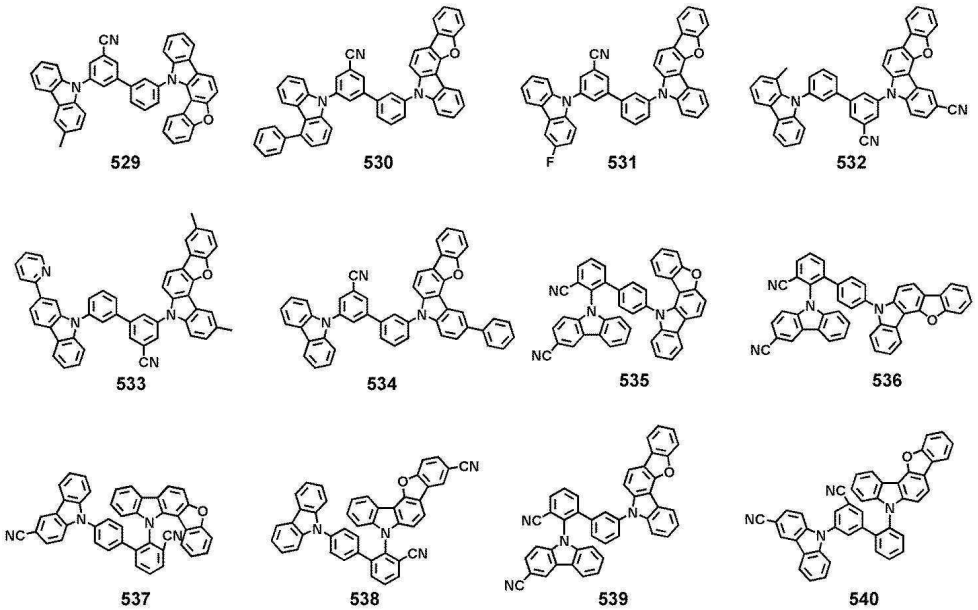
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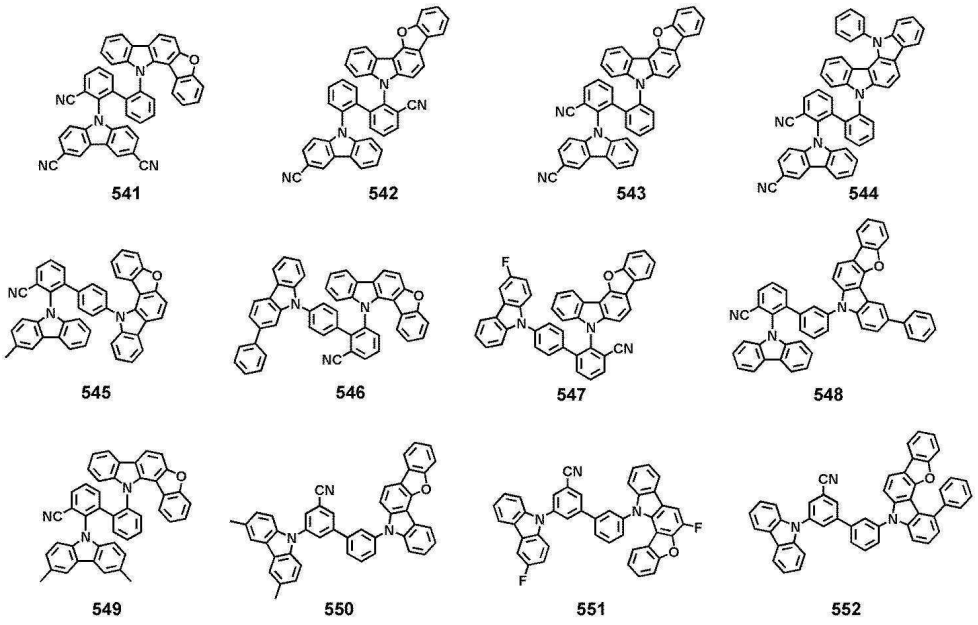
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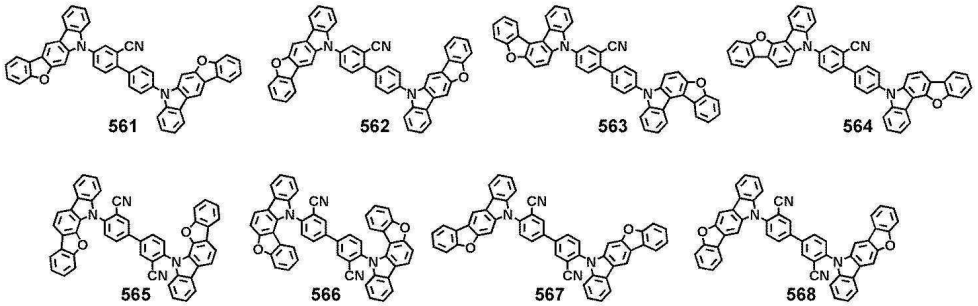
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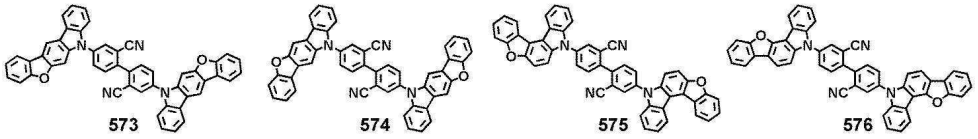
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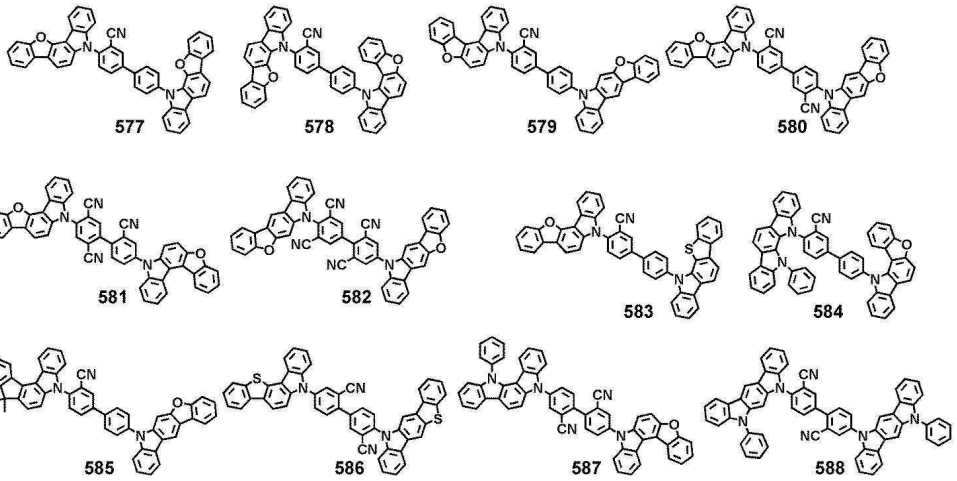
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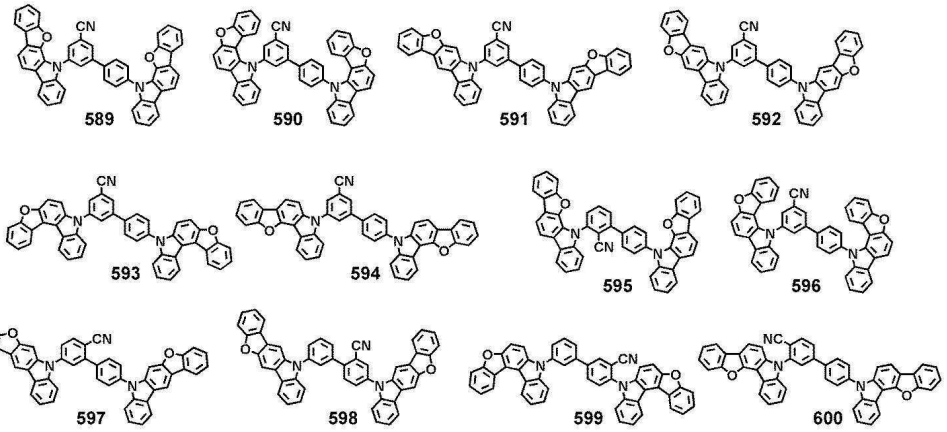
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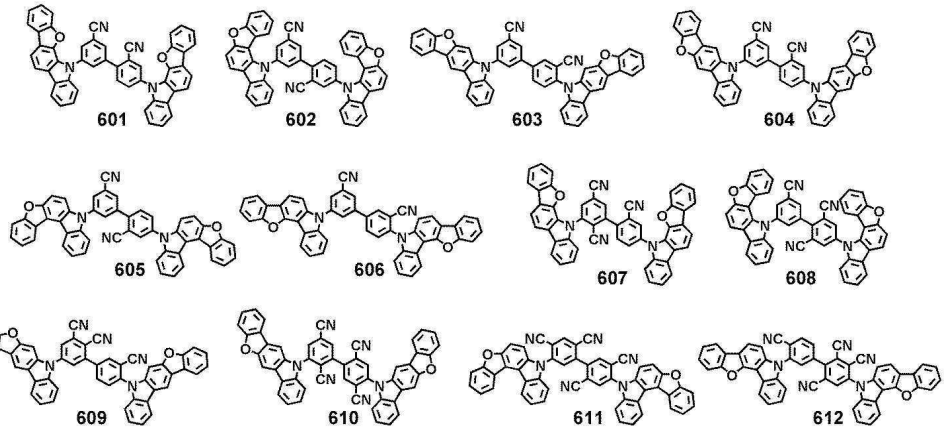
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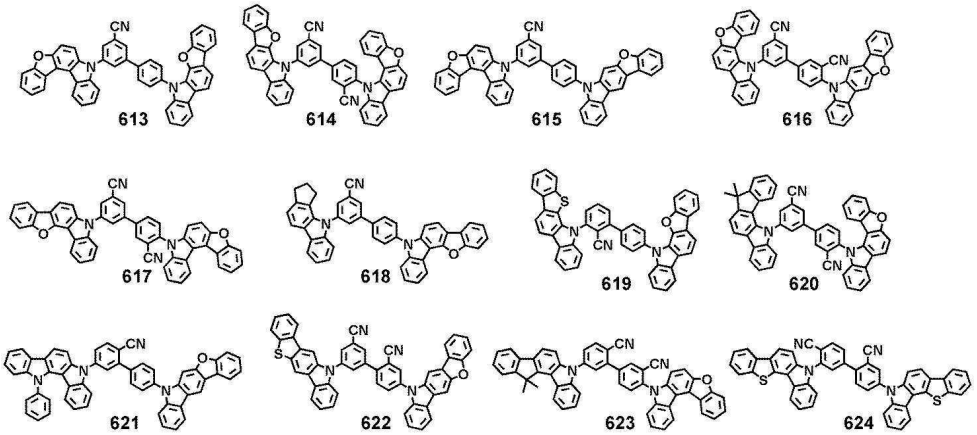
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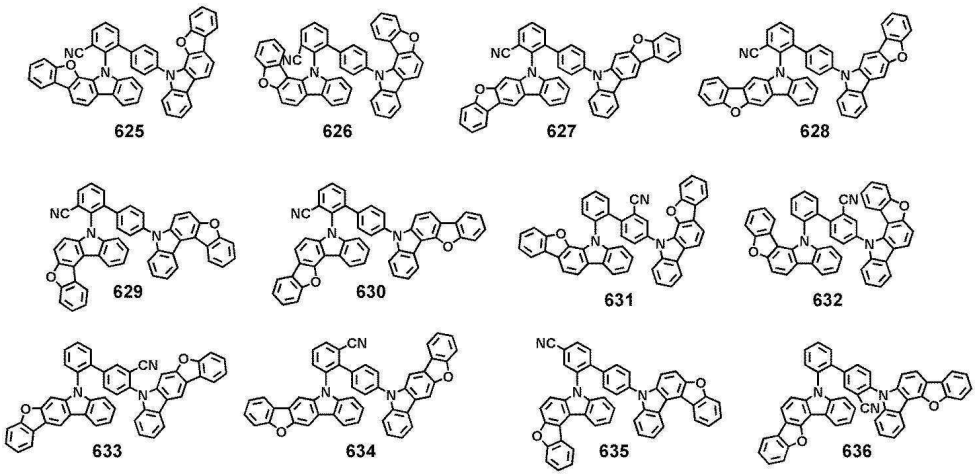
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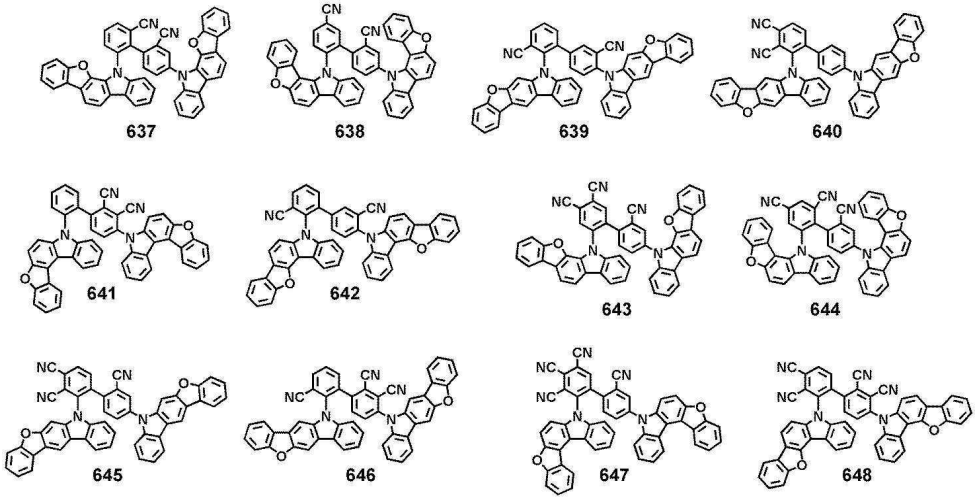
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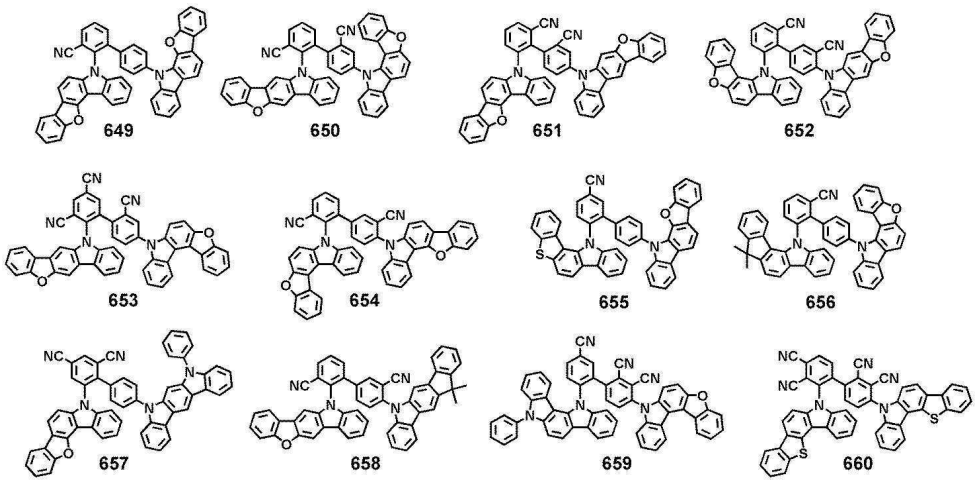
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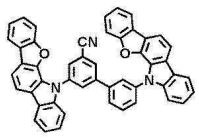


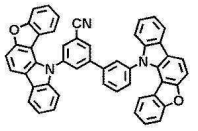
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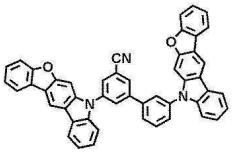


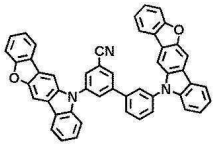
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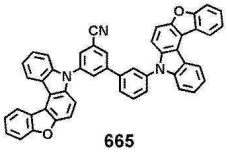



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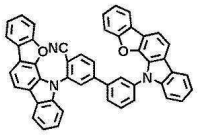

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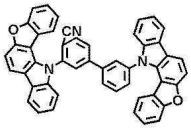

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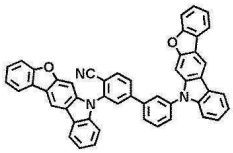

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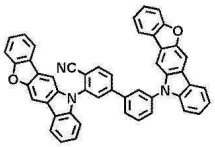

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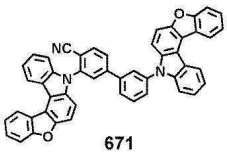

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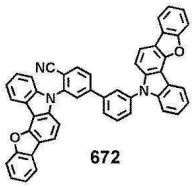

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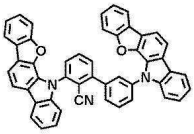

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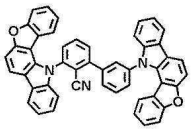

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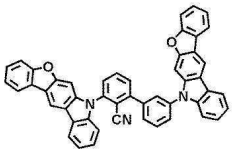

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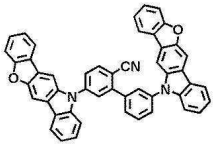

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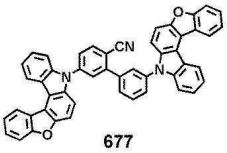
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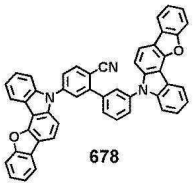

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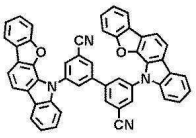

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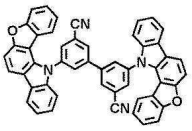

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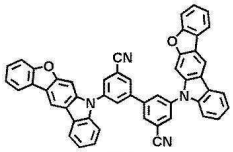

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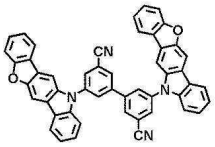

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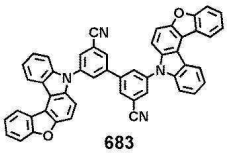

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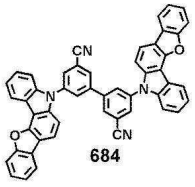

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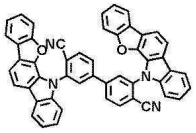

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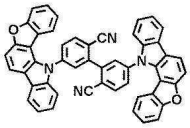

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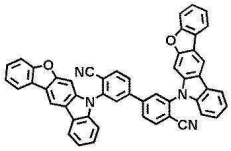

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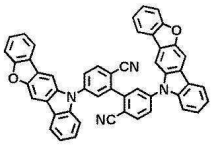

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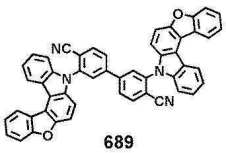
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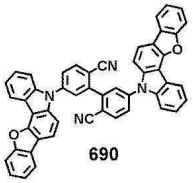

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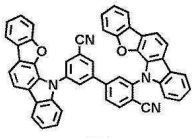

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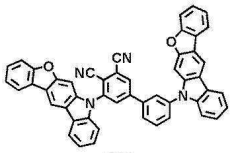

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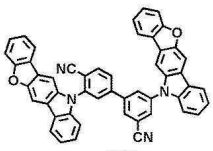

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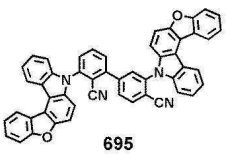

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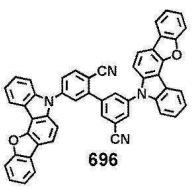

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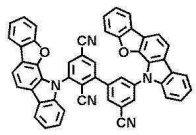

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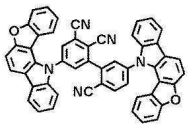

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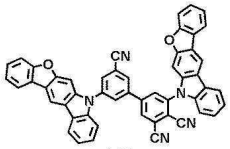

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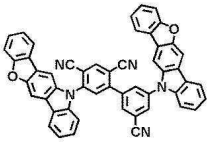

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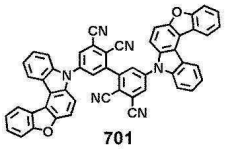
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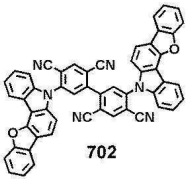

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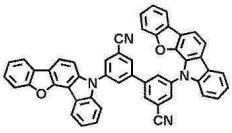

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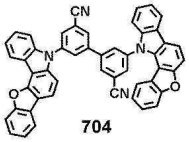

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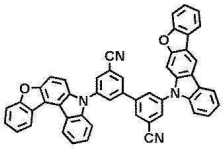

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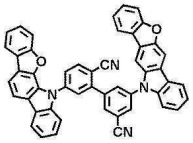

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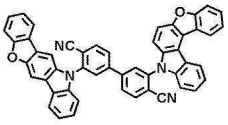

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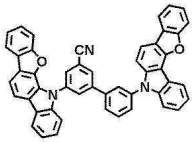

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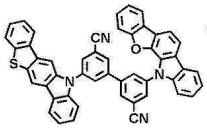

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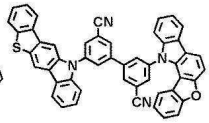

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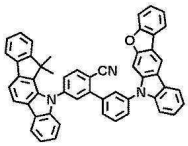

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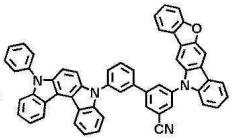

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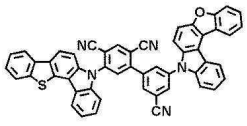
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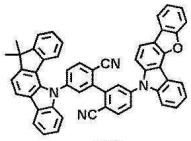

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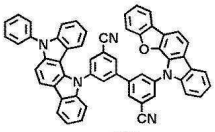

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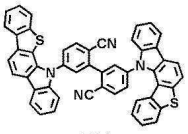

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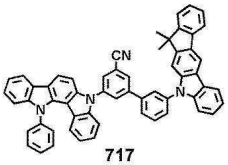

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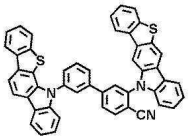

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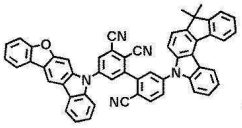

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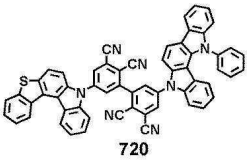

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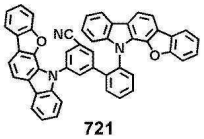

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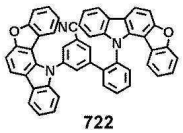

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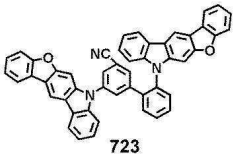

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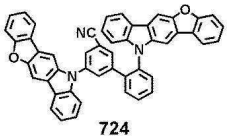

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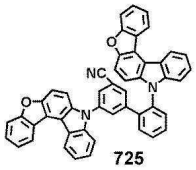
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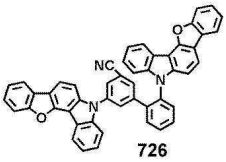

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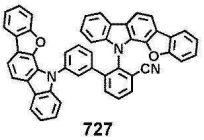

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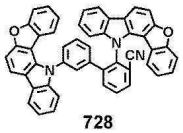

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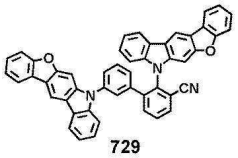

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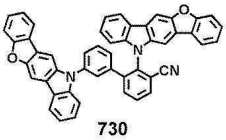

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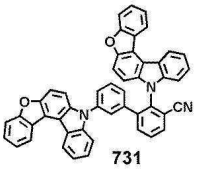

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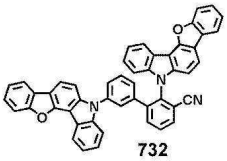

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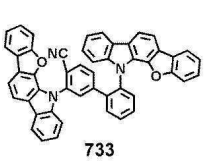

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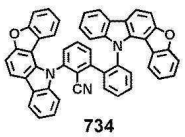

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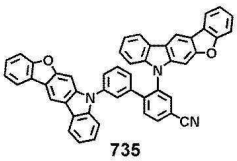

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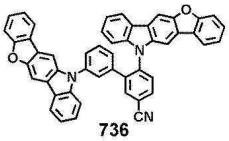

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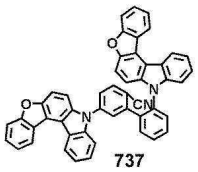
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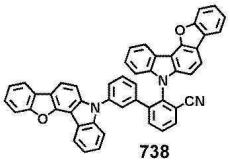

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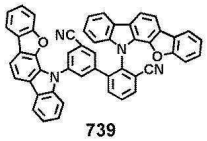

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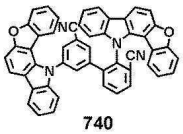

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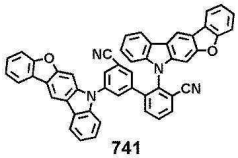

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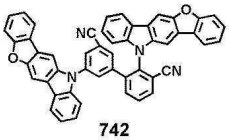

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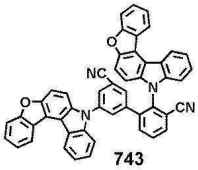

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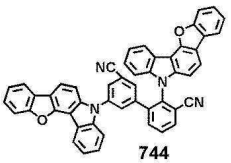

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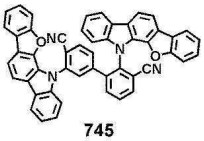
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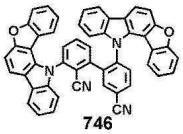

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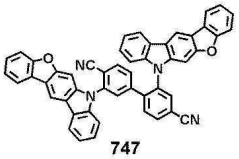

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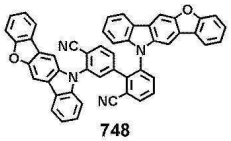

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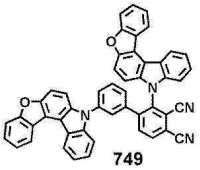

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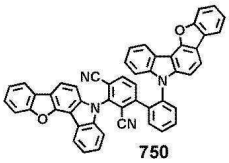

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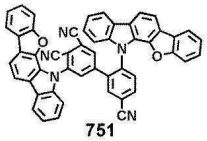

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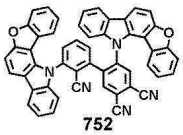

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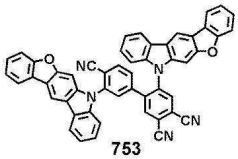

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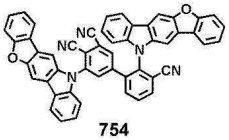

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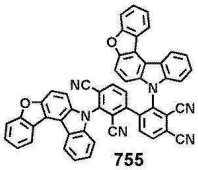

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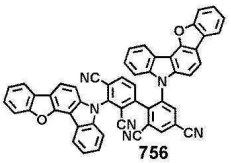

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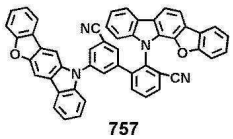
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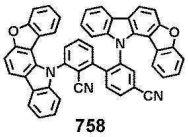

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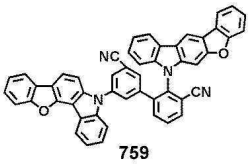

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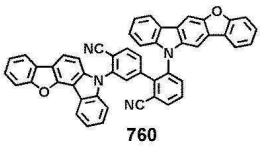

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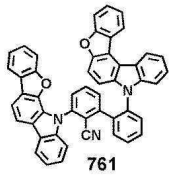

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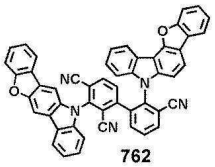

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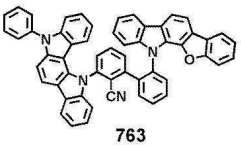

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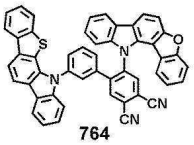

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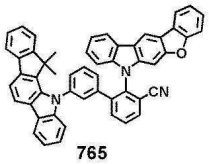

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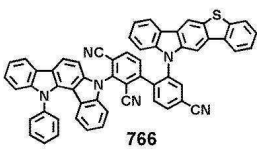

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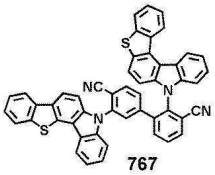

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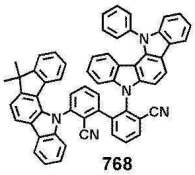

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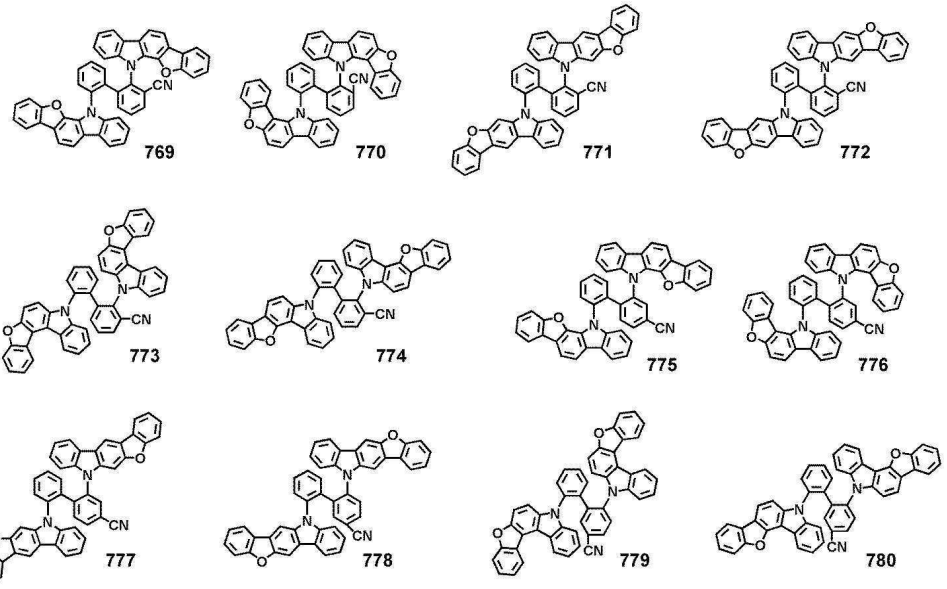

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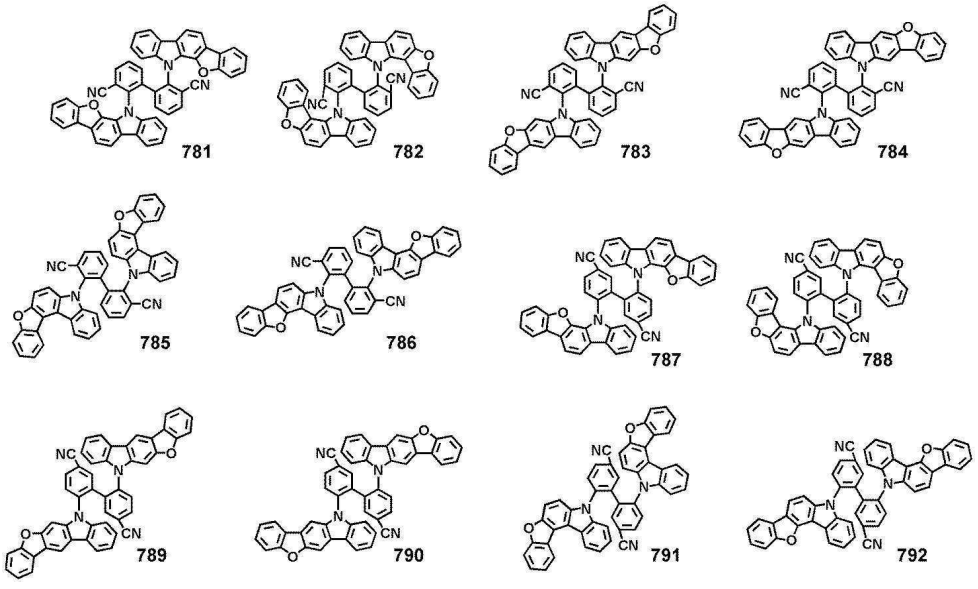

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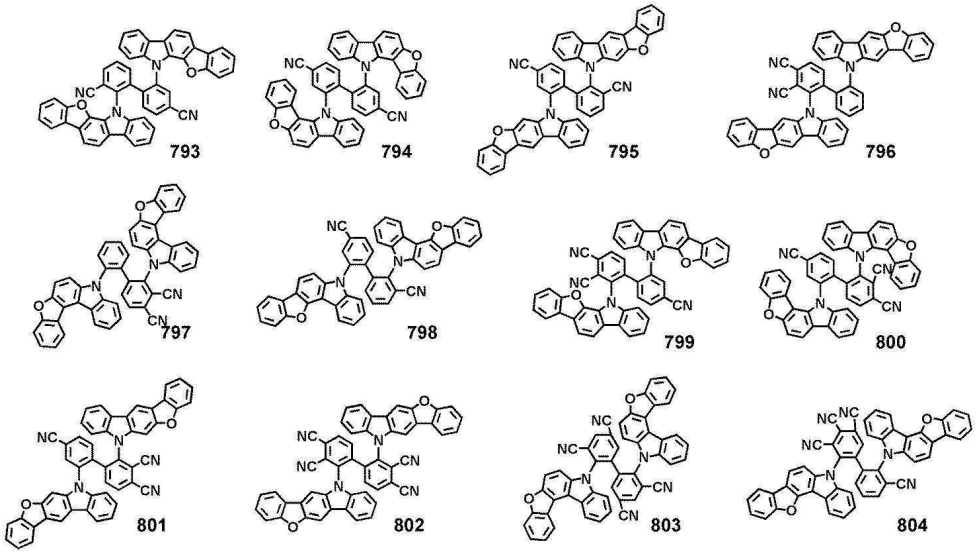
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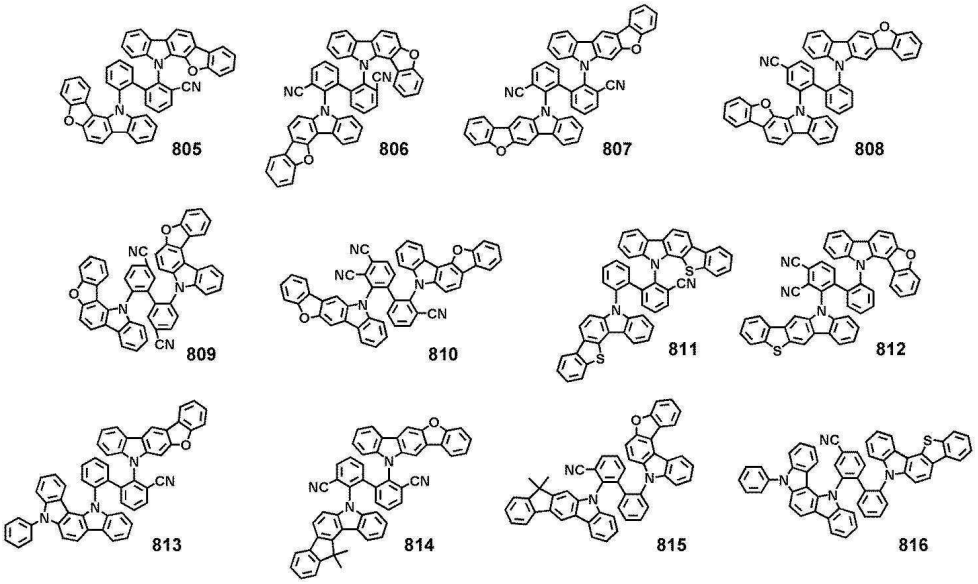
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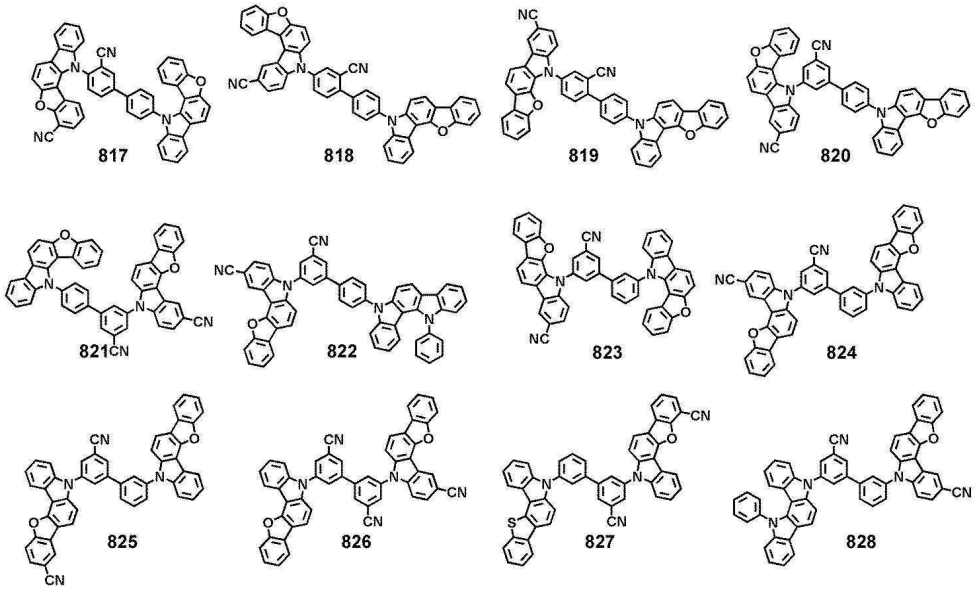
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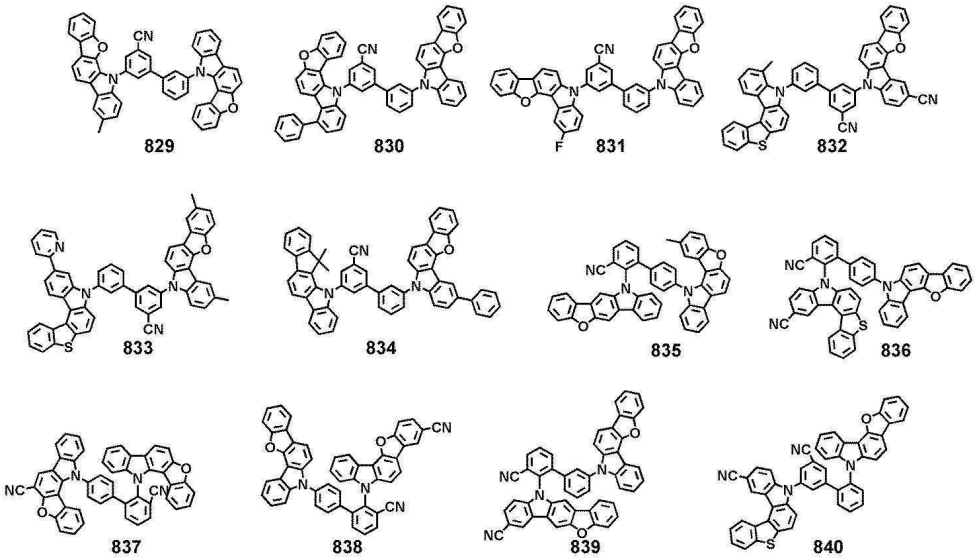
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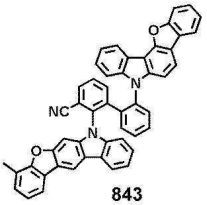


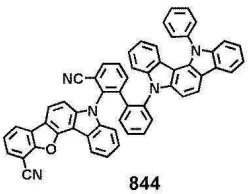
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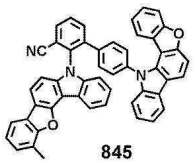


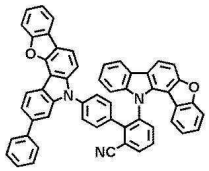

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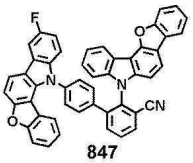

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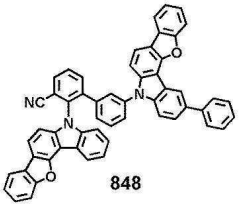

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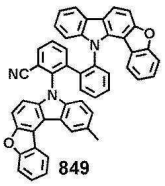

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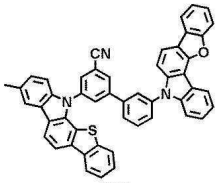

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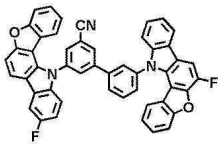

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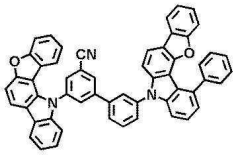

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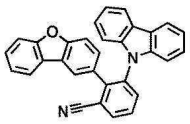

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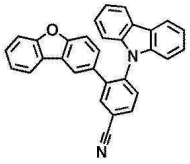

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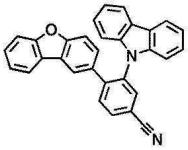

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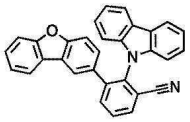
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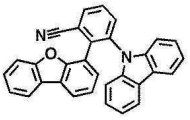
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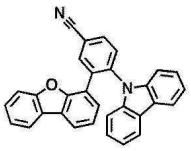

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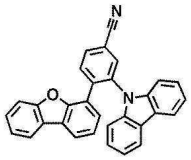

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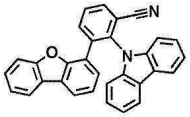

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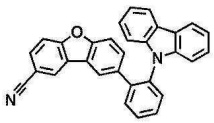

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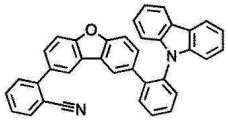

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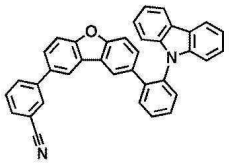

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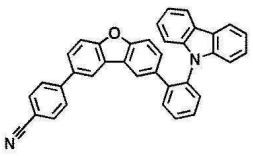

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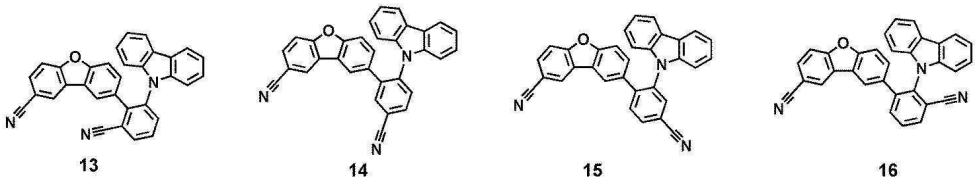

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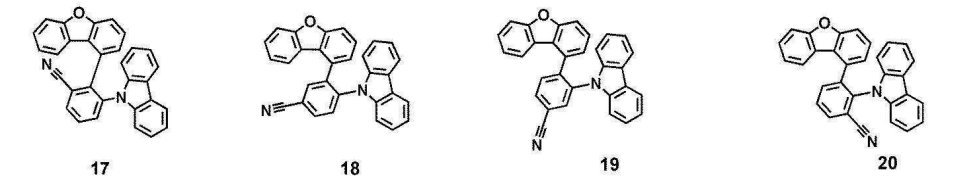

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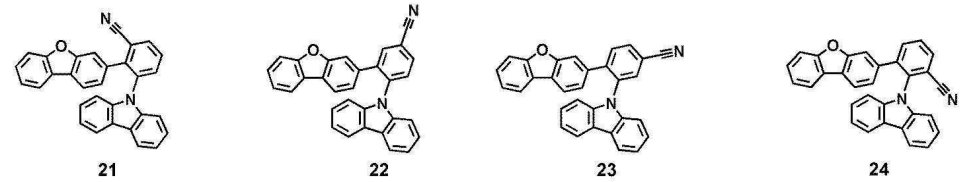

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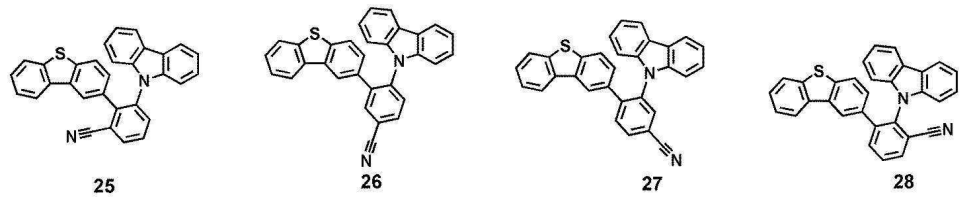
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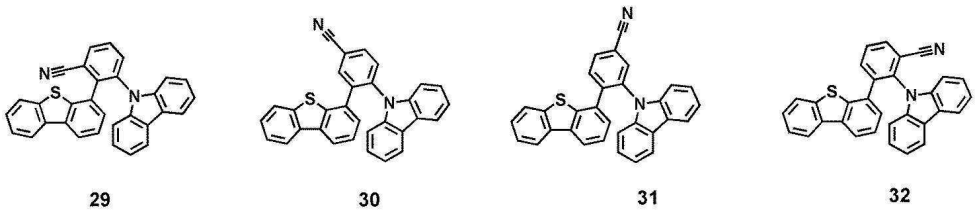
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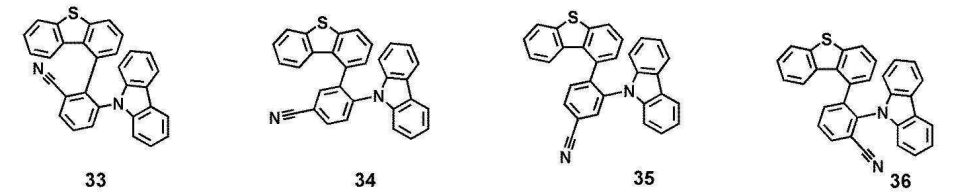


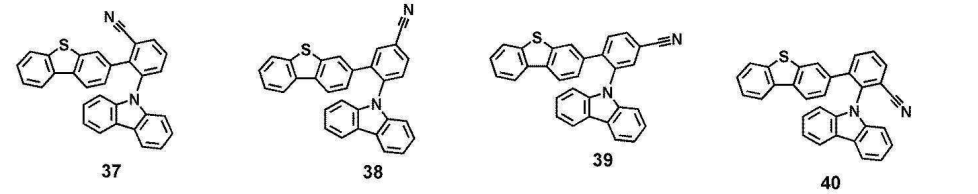




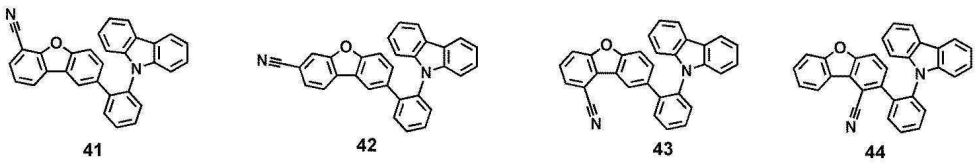


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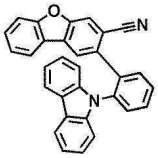




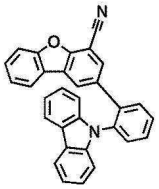
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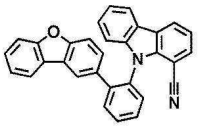
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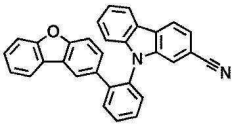
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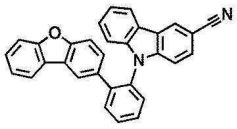
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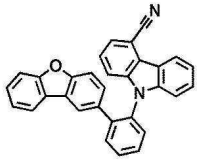
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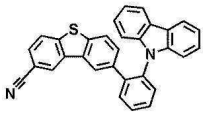


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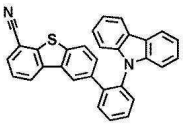


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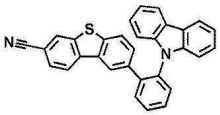
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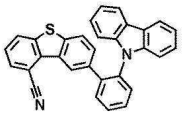
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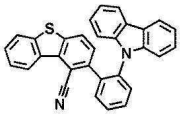
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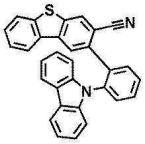
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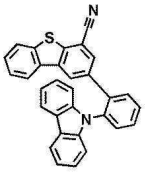
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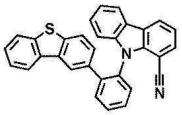
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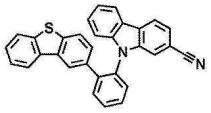


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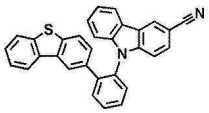


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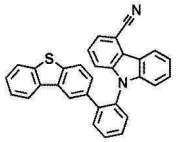
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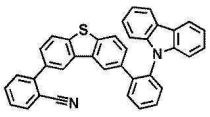
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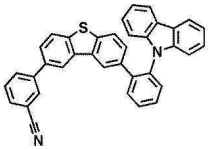
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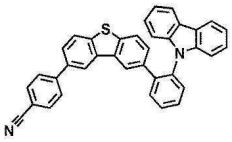
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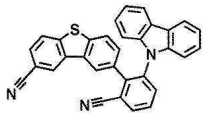


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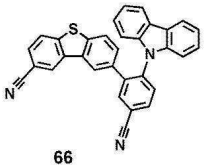


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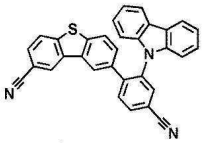
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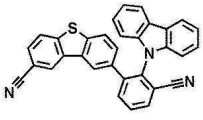
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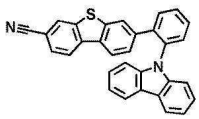
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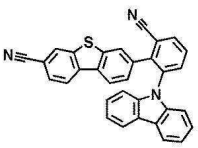
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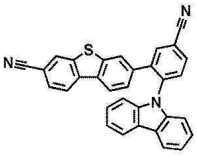
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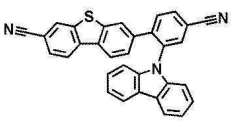
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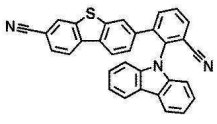
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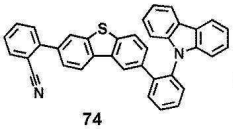
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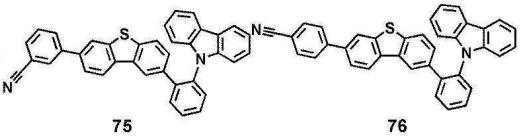
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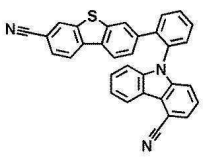


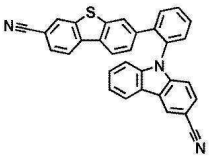
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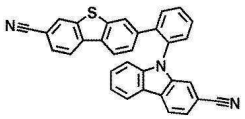


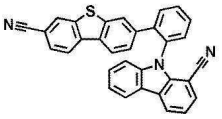
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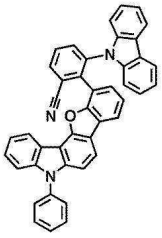

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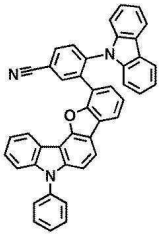

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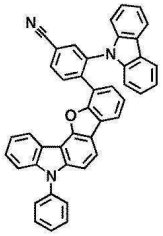

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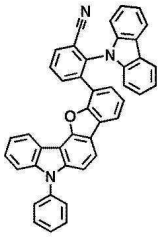

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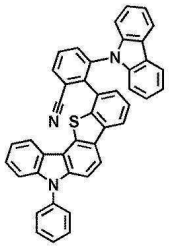
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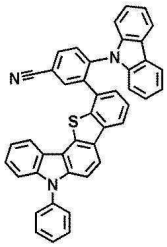

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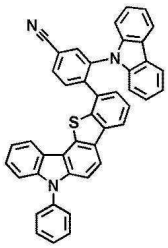

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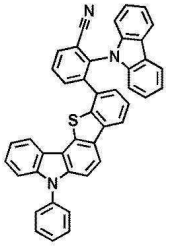

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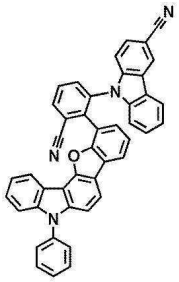

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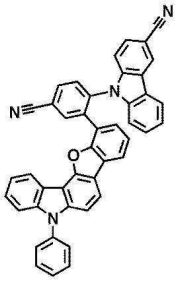

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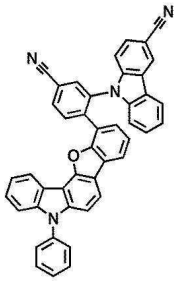

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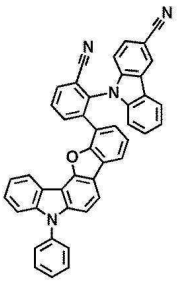

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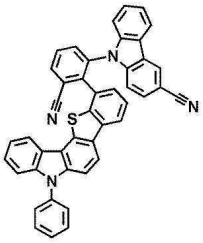
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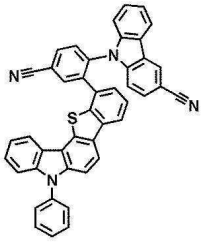

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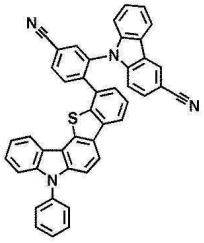

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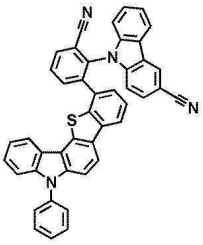

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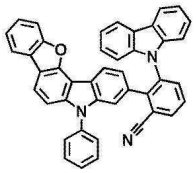

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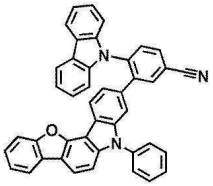

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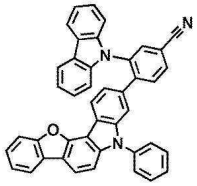

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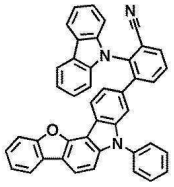

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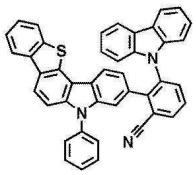

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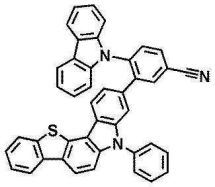

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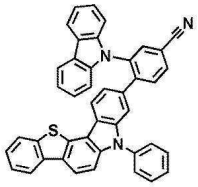

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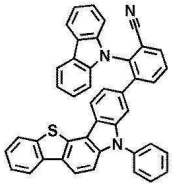

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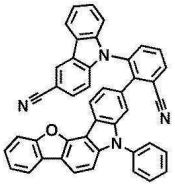
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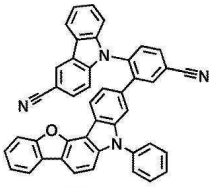

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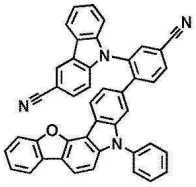

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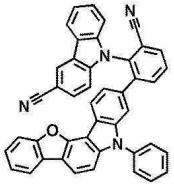

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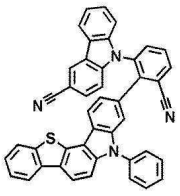

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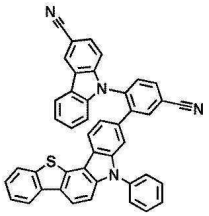

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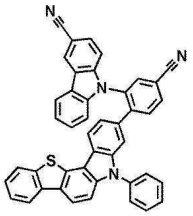

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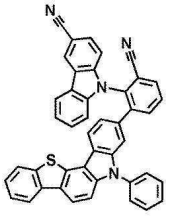

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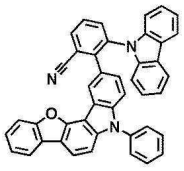
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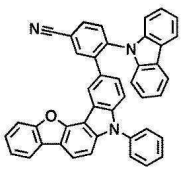

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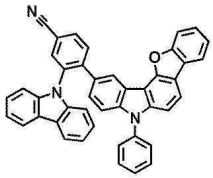

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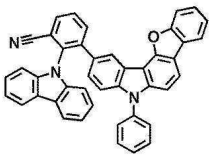

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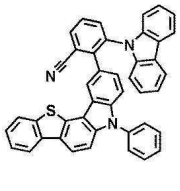

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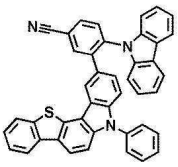

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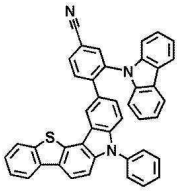

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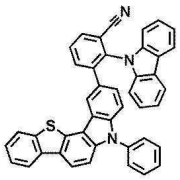

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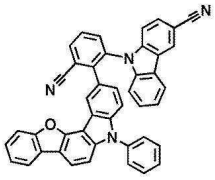
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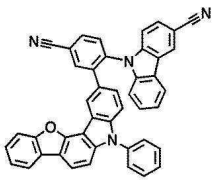

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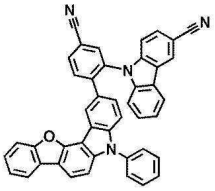

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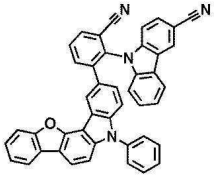

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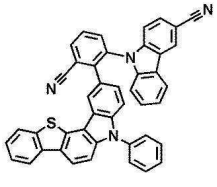

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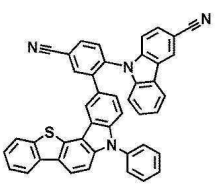

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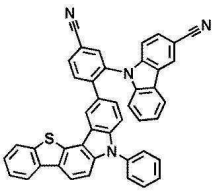

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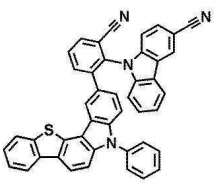

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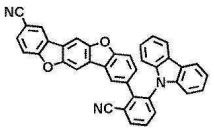

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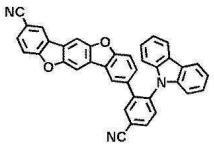

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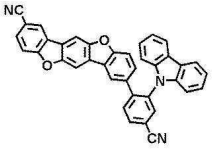
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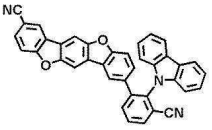
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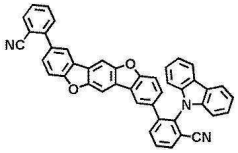
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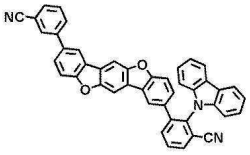
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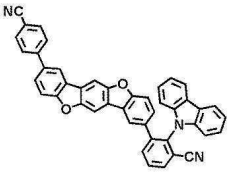
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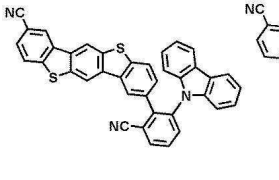


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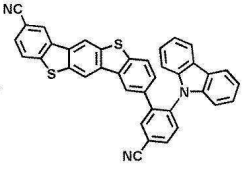


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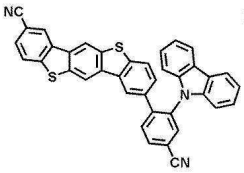
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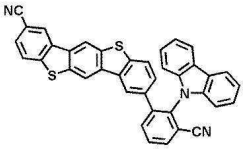
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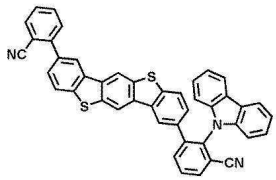
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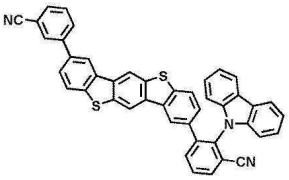
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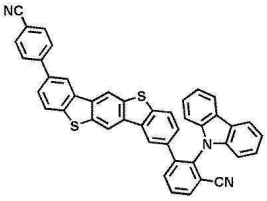
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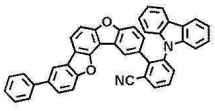


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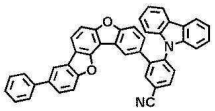


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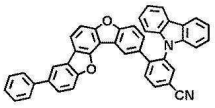
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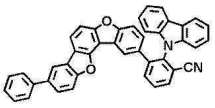
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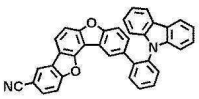
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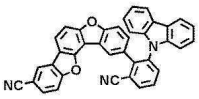
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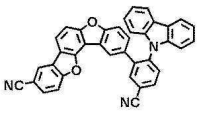
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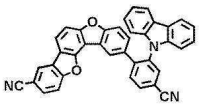
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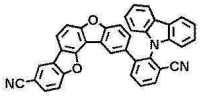
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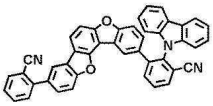
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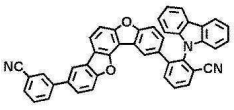
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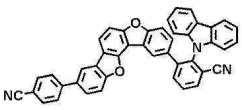
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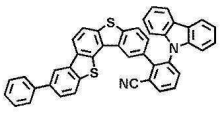
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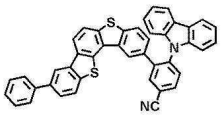


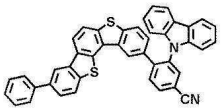
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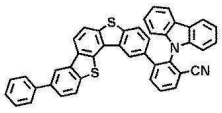


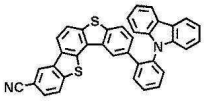
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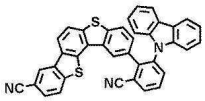

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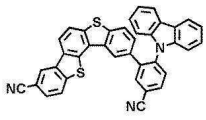

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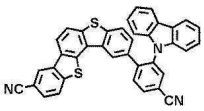

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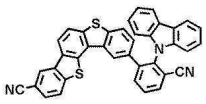

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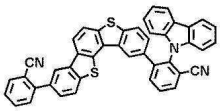

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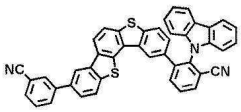

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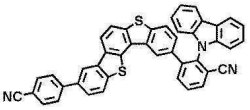

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162


163

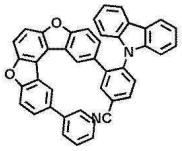

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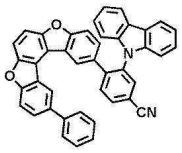

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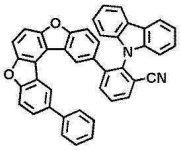

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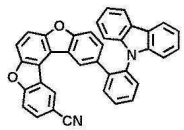
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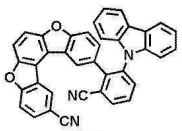

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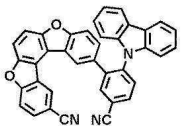

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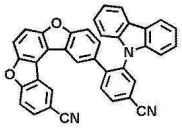

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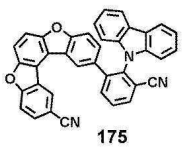

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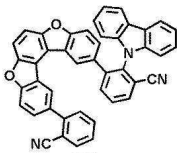

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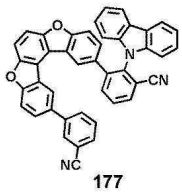

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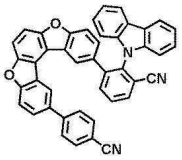

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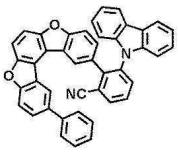

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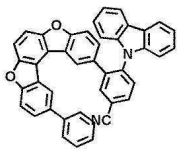

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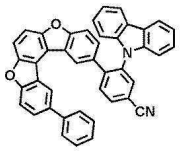

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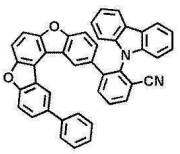

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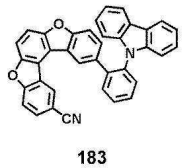
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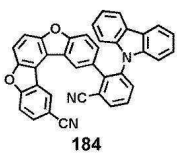

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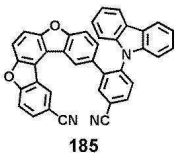

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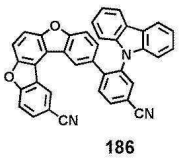

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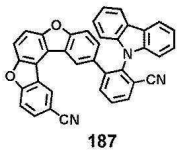

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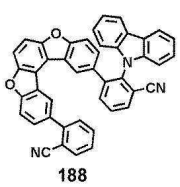

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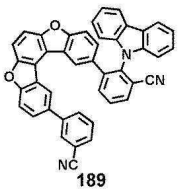

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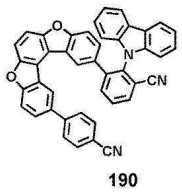

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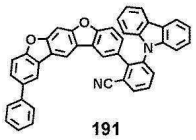

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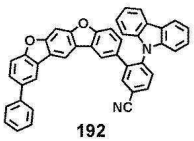

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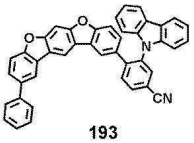

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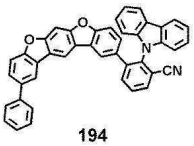
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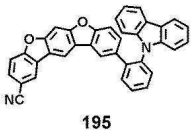
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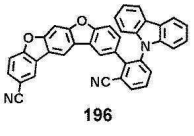

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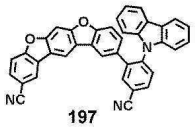

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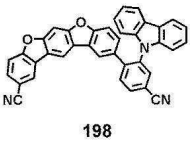

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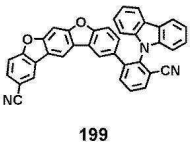

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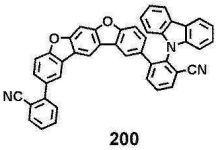

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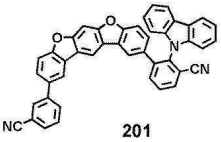

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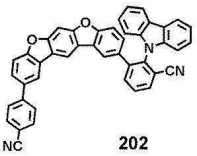

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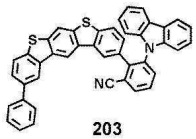

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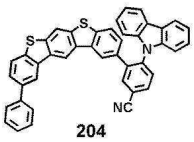

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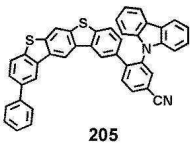

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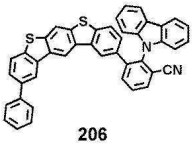

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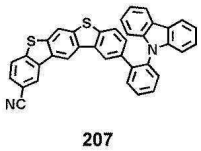

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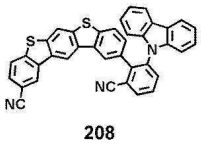

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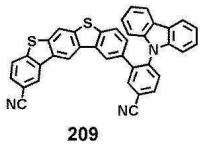

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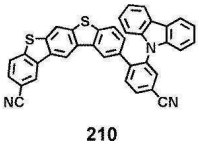

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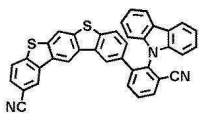

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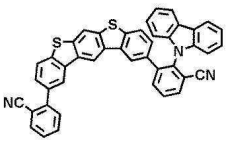

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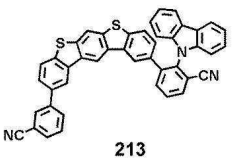

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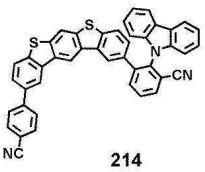

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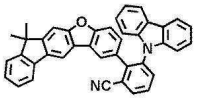

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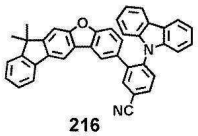

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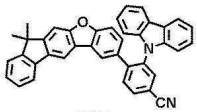

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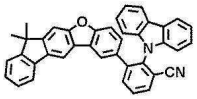

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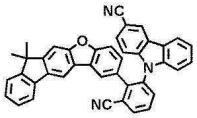

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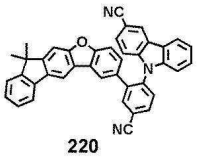

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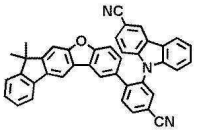

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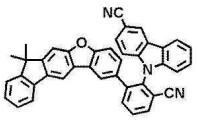

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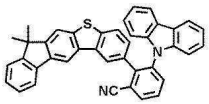
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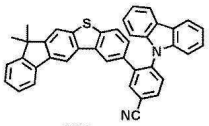

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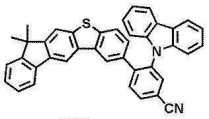

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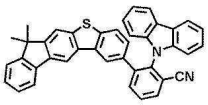

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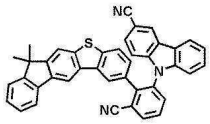

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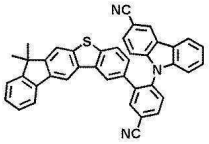

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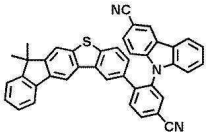

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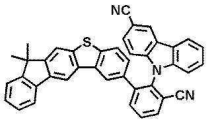

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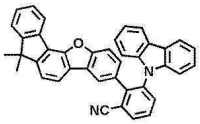

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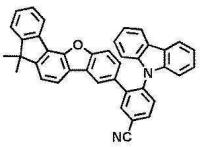

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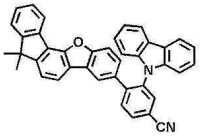

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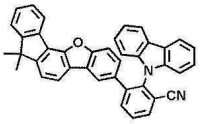

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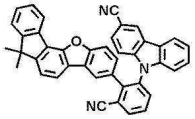

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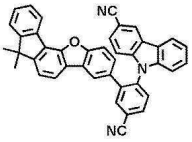

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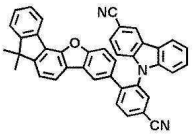

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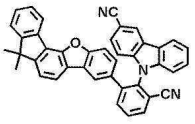

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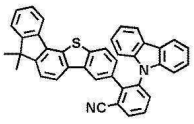
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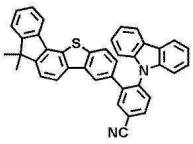

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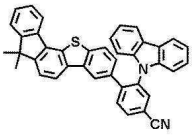

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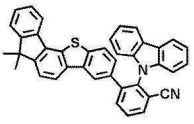

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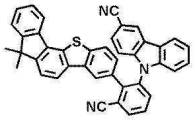

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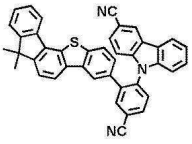

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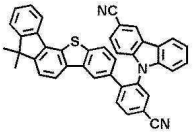

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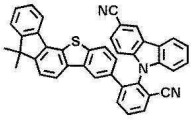

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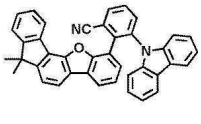

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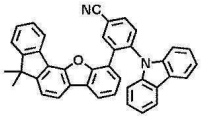

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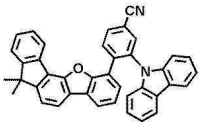

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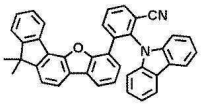

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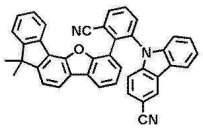
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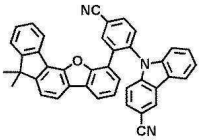

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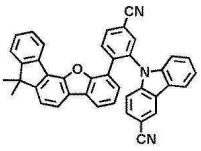

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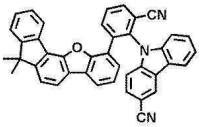

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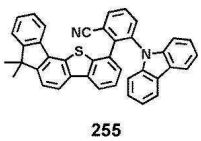

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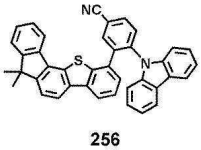

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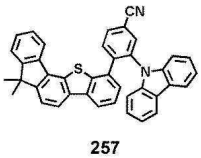

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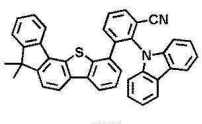

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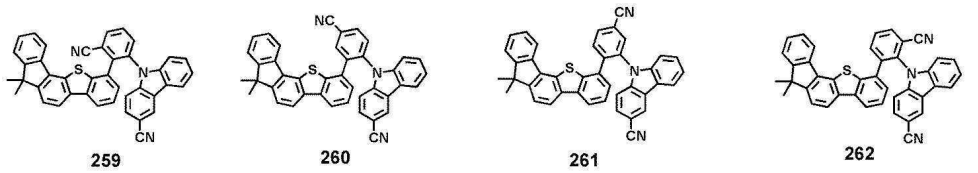

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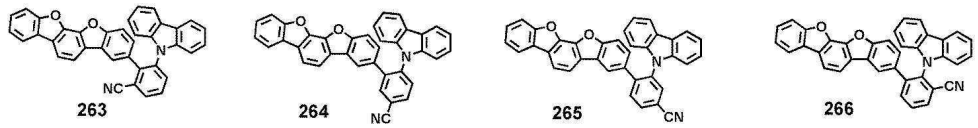

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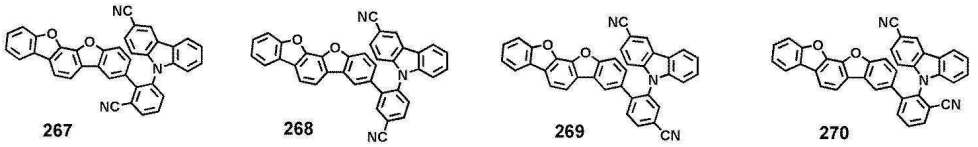

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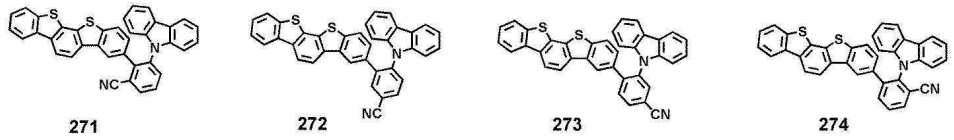
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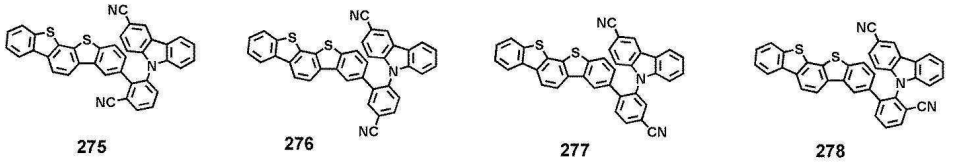
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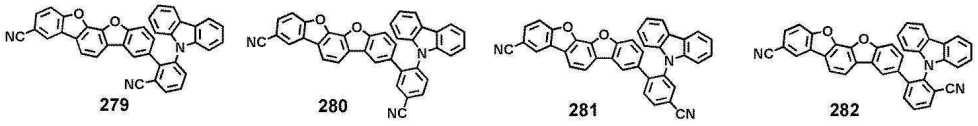


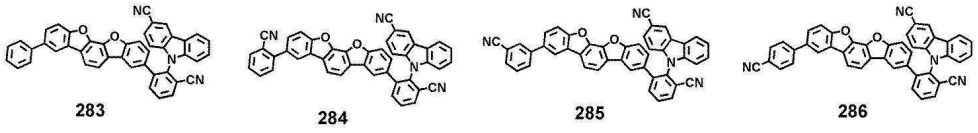


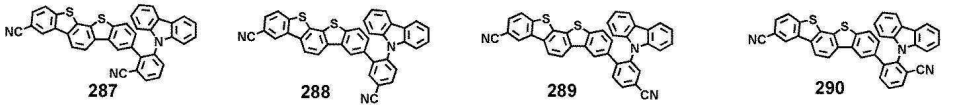


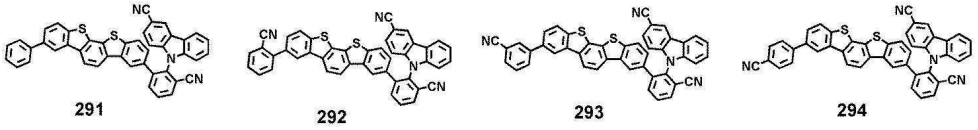


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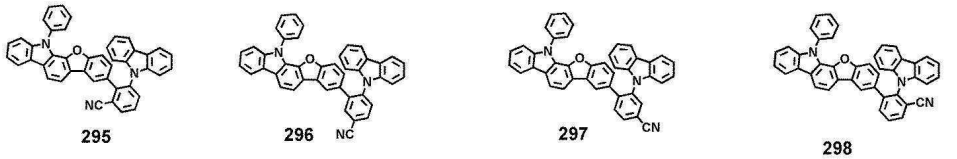




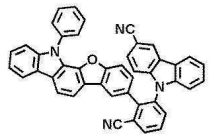


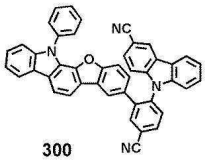


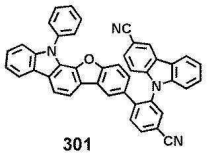
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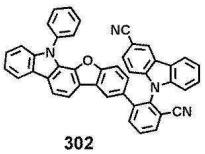


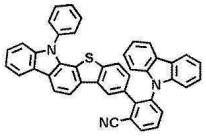
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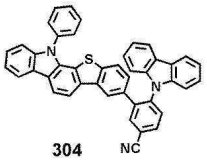

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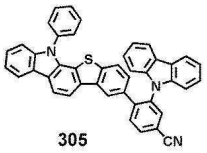

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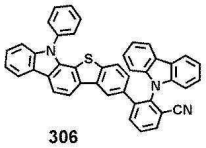

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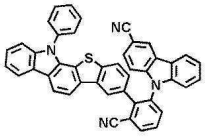

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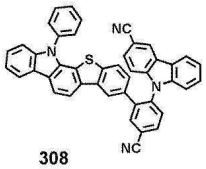

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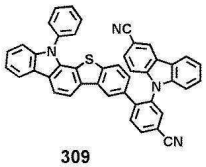

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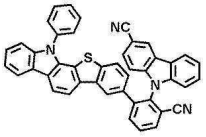

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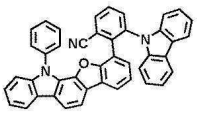

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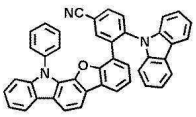

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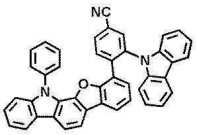

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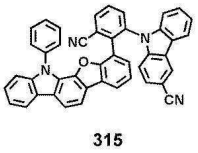
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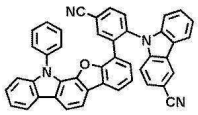

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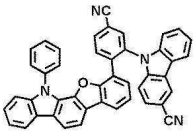

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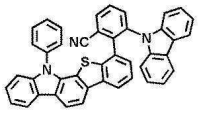

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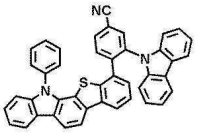

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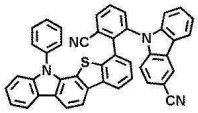

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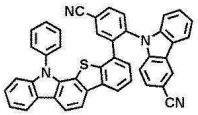

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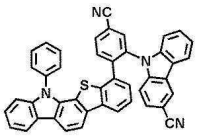

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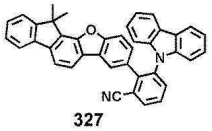
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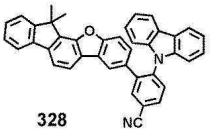

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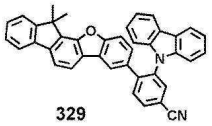

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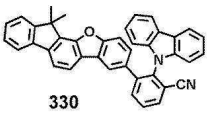

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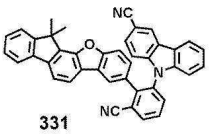

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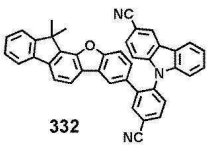

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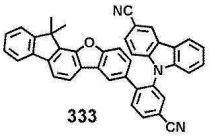

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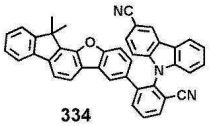

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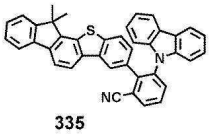

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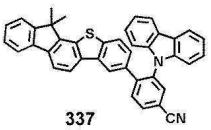

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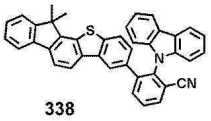

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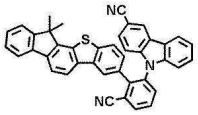

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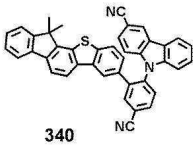

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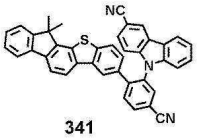

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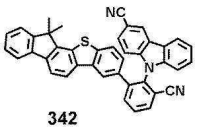

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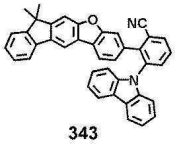
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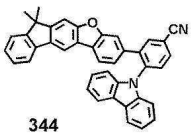

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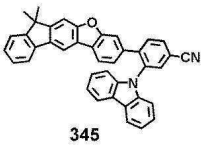

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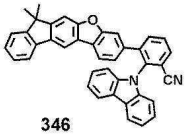

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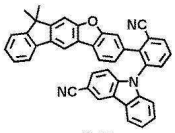

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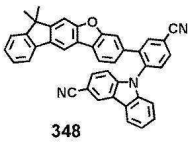

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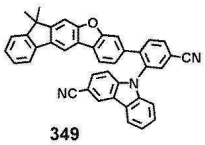

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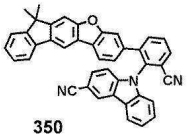

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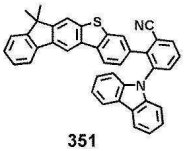

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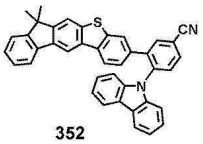

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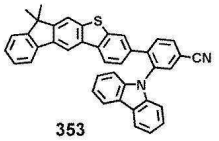

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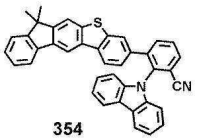

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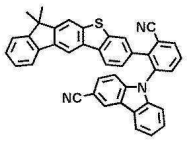
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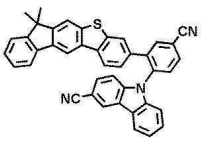

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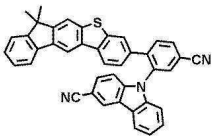

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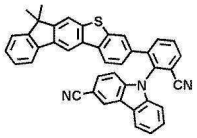

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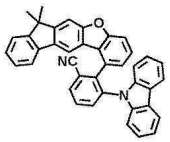

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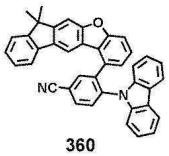

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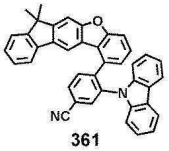

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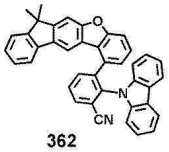

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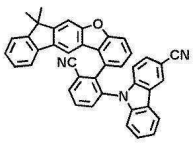

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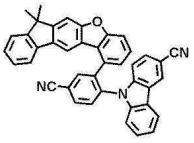

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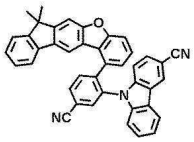

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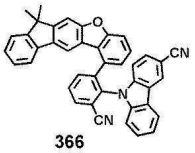

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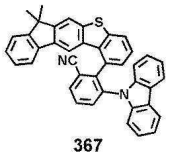
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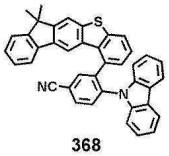

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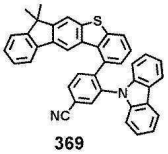

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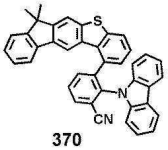

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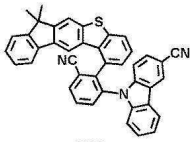

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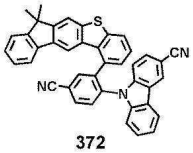

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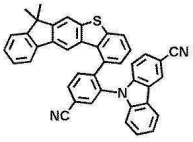

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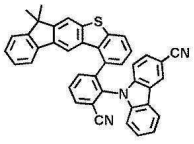

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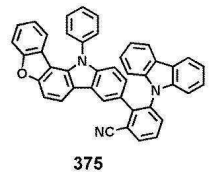

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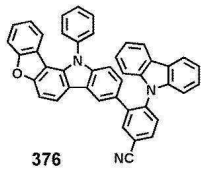

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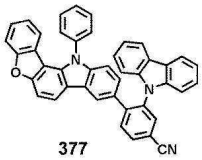

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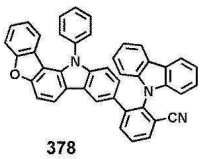

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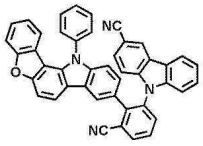
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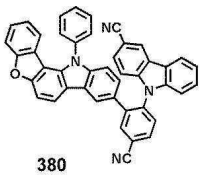

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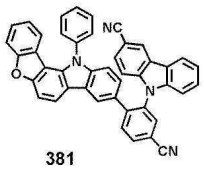

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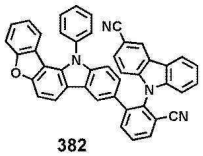

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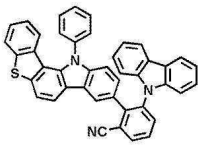

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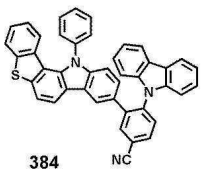

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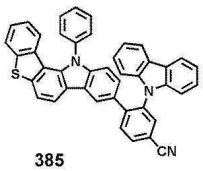

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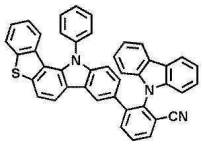

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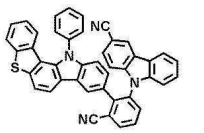

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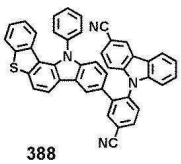

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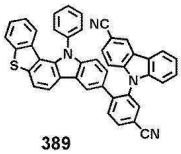

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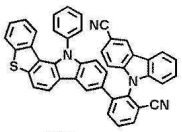

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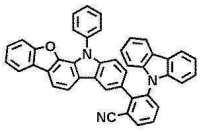
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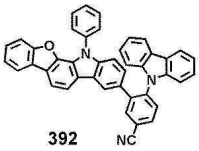

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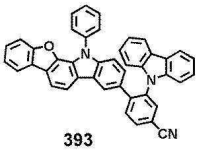

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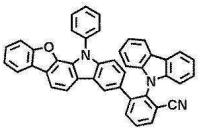

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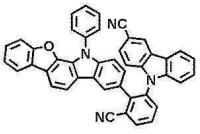

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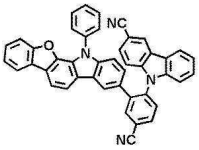

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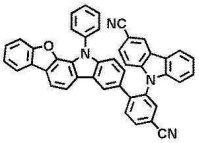

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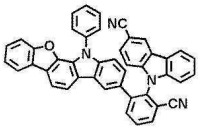

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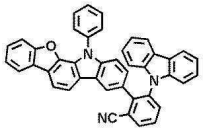

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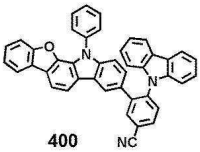

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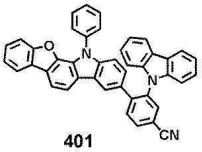

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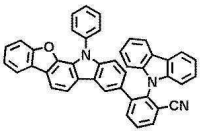

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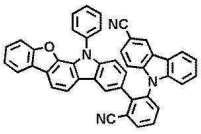
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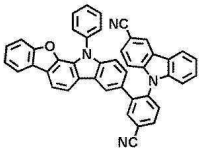

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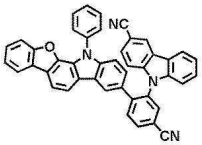

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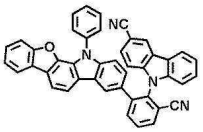

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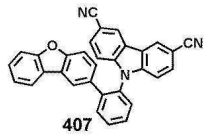

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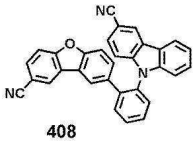

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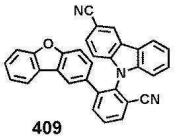

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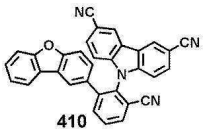

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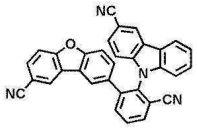

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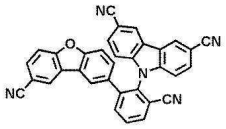

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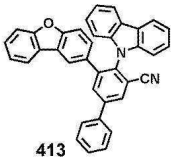

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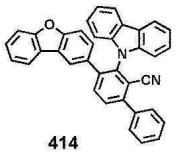

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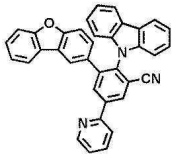

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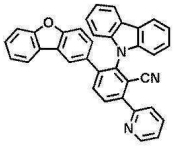

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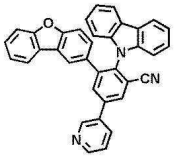

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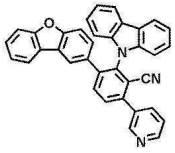

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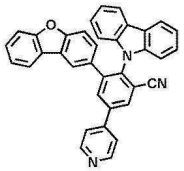
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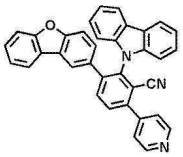

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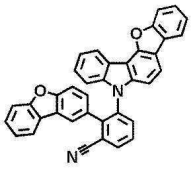

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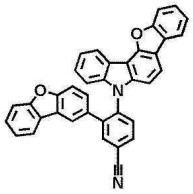

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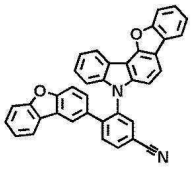

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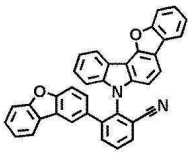

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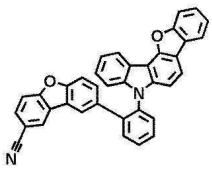
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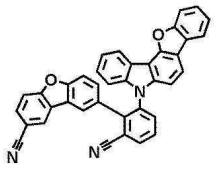

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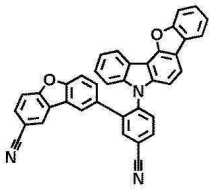

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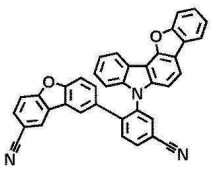

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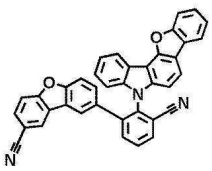

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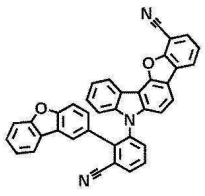

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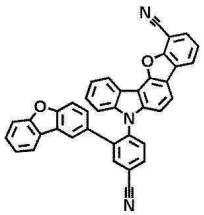

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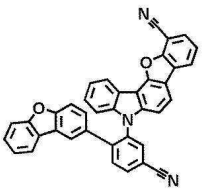

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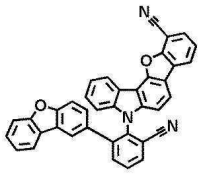

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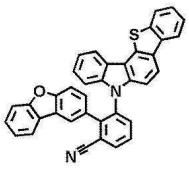

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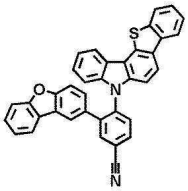
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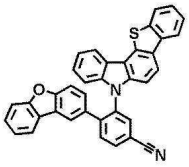
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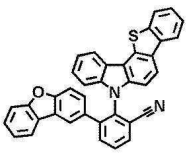
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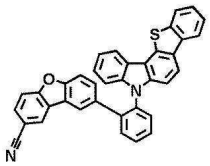
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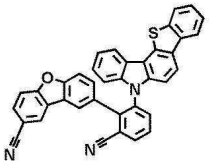
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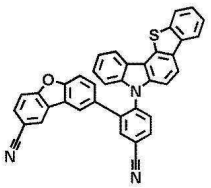
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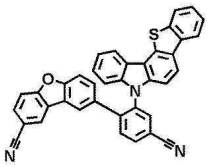
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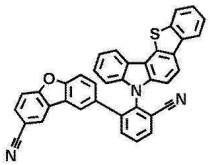
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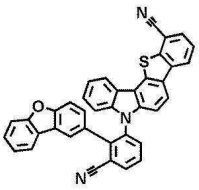
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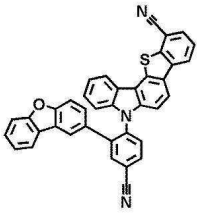
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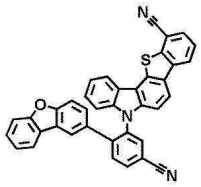


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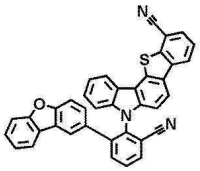


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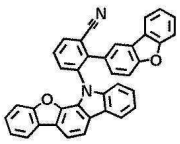
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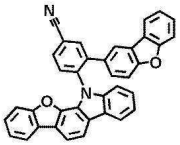
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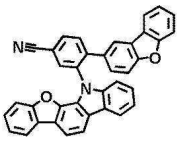
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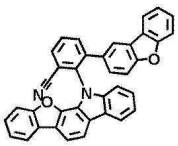
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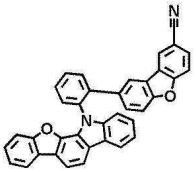
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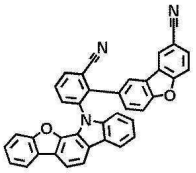
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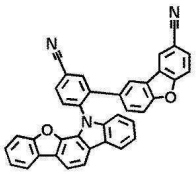
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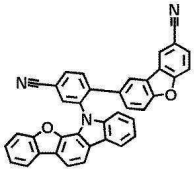
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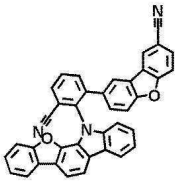
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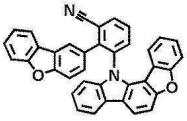
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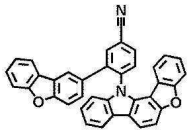


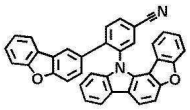
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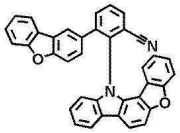


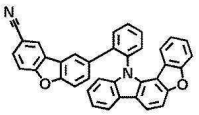
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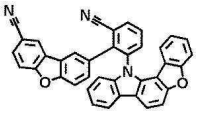
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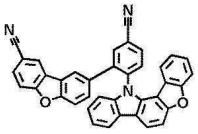

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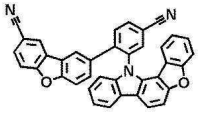

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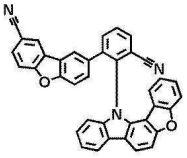

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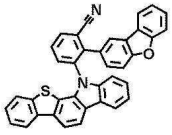

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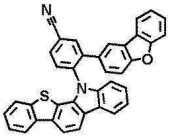

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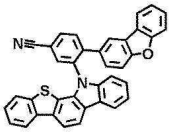

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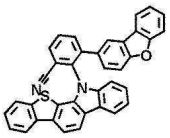

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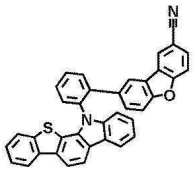

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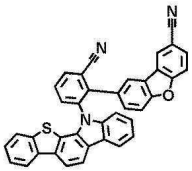

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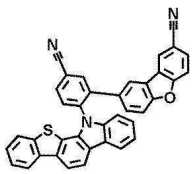

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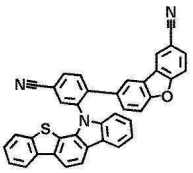

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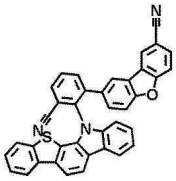
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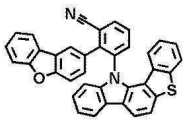

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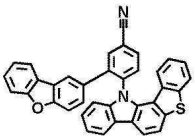

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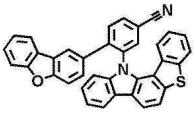

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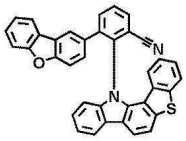

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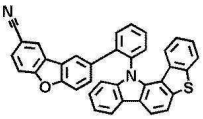

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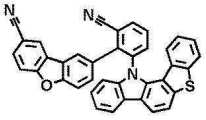

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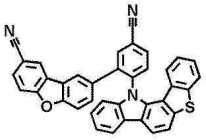

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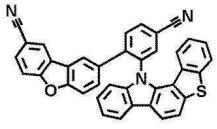

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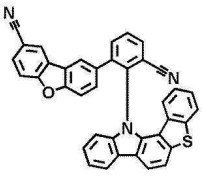

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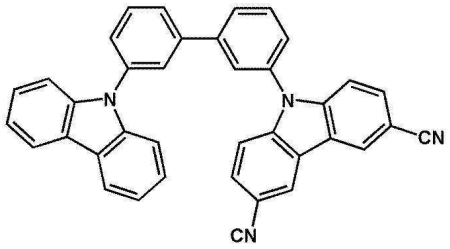
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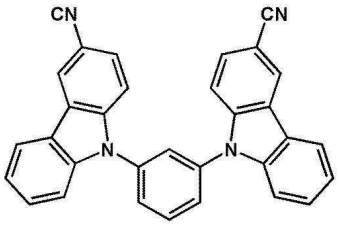

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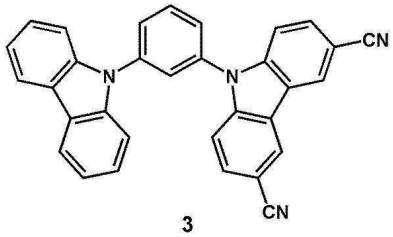


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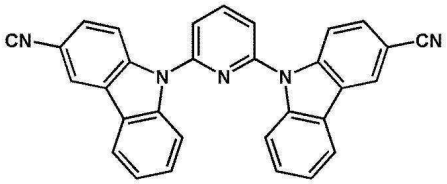


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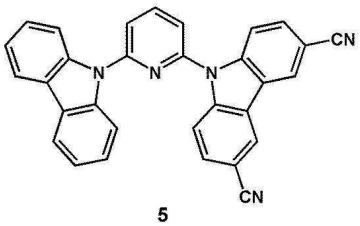
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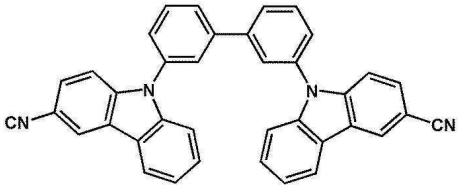
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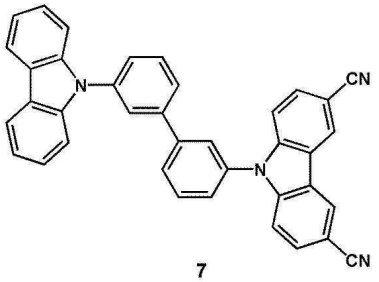


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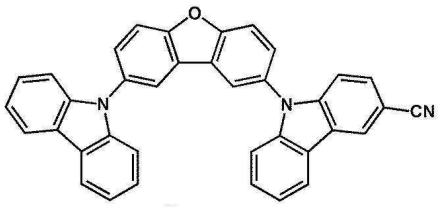


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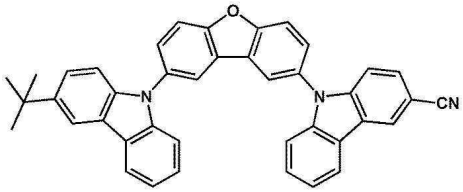
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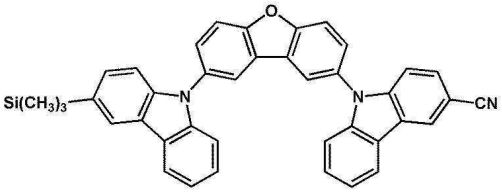
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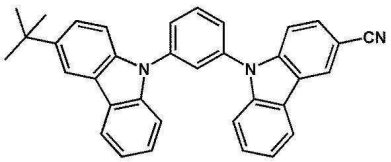
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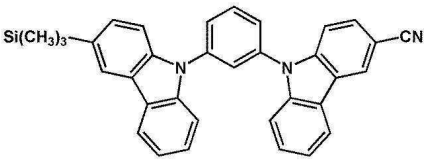
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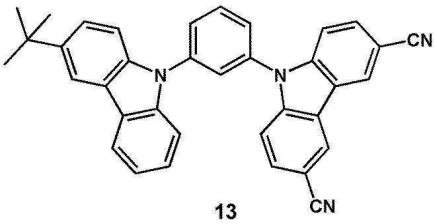
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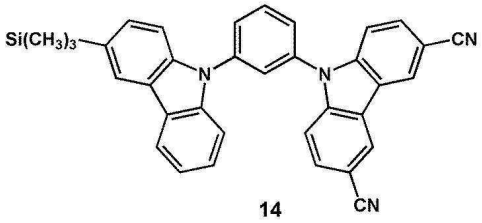
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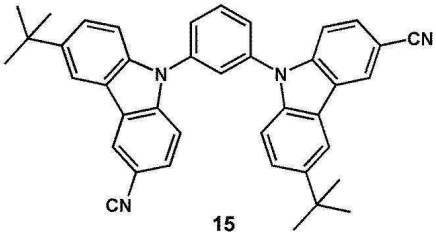
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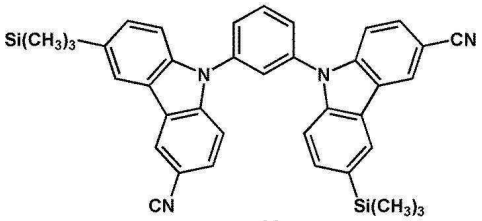
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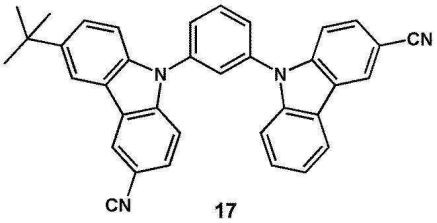
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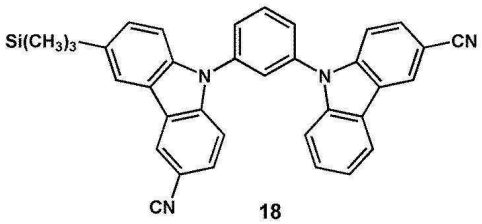
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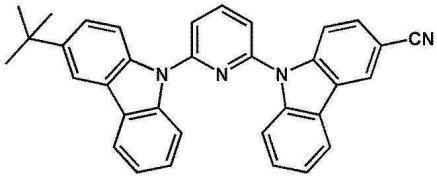


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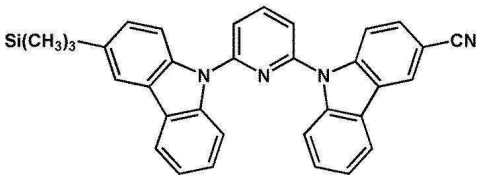


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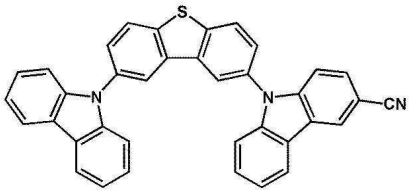
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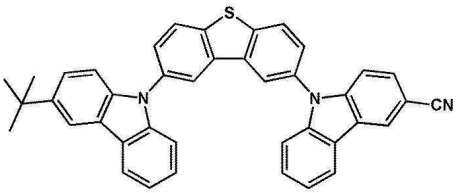
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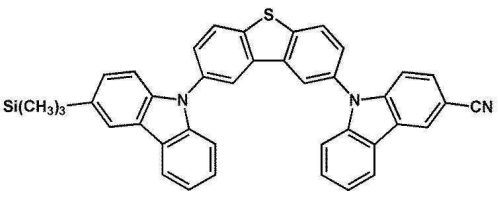


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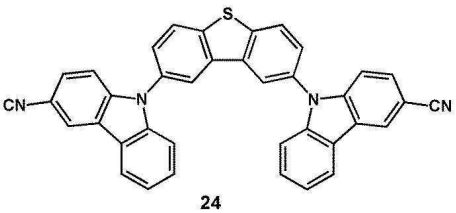


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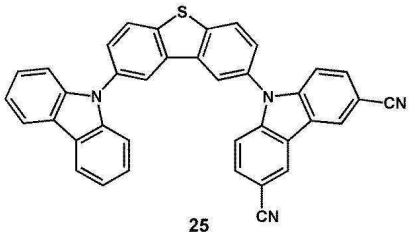


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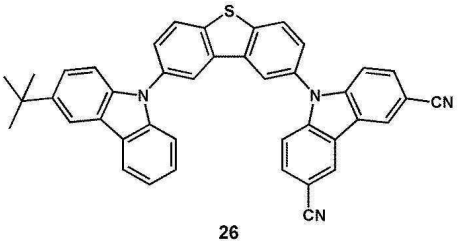


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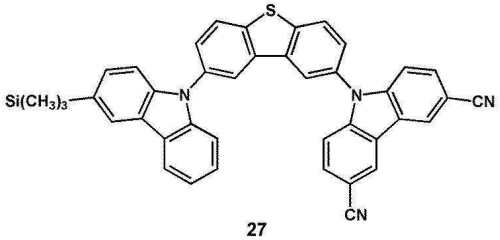
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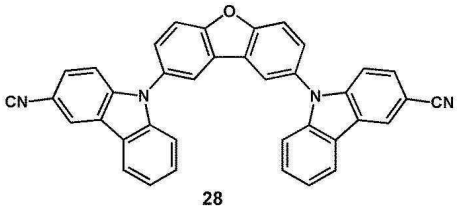
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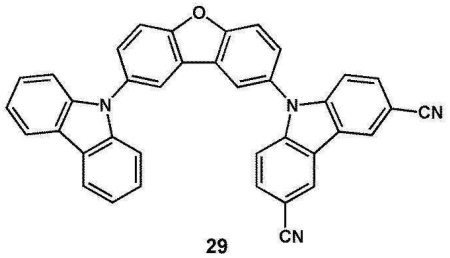


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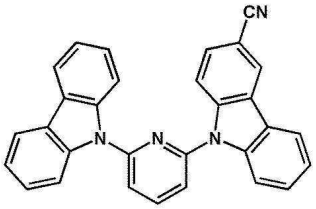


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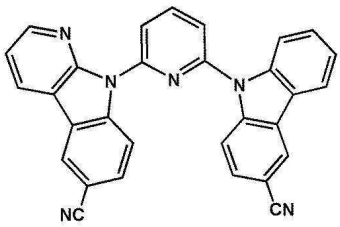
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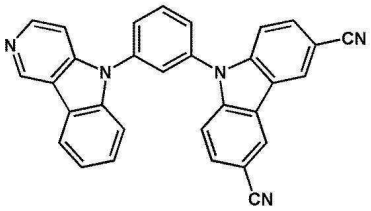
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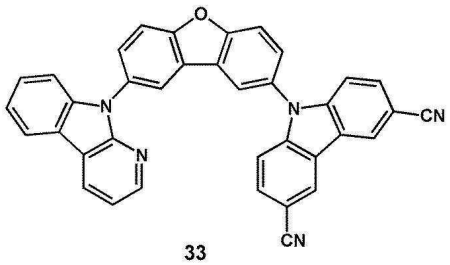


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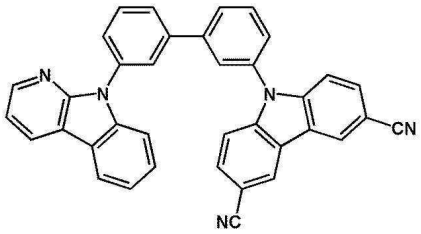


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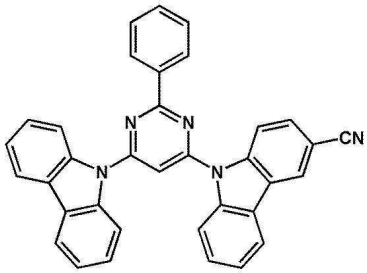
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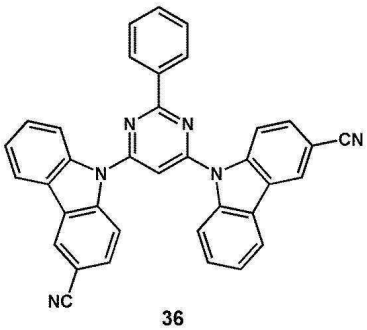
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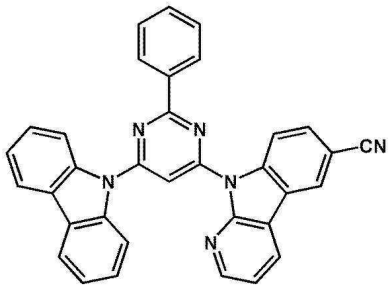
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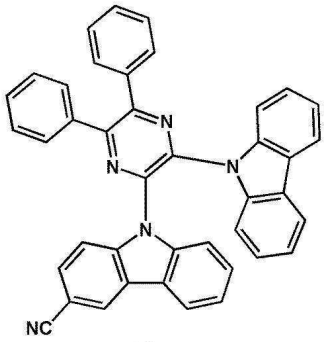
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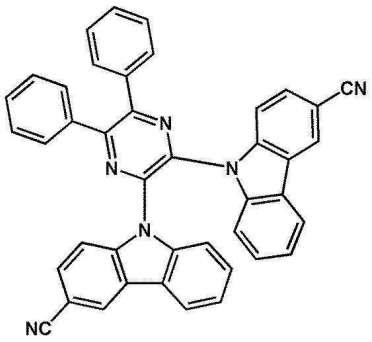
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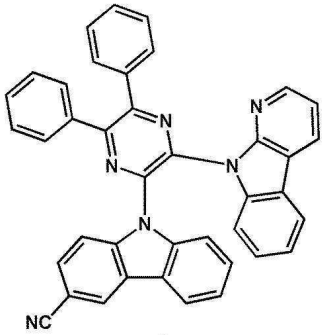
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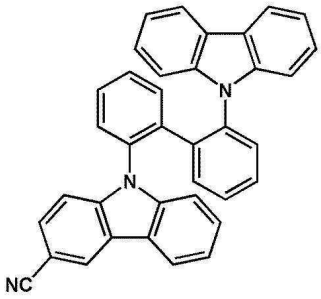


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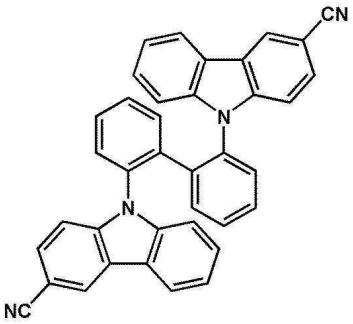


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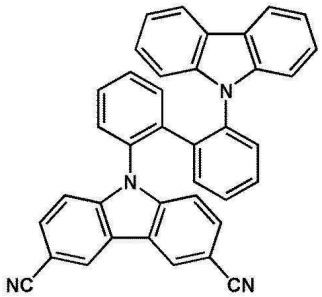
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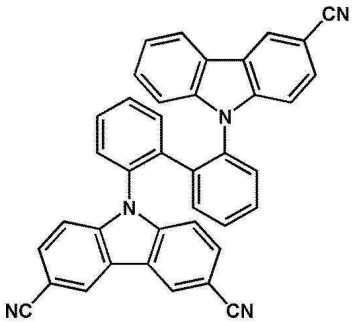
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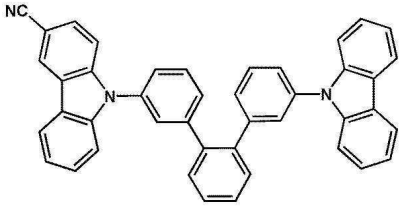


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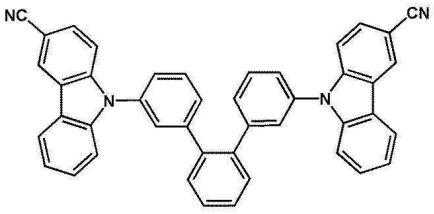


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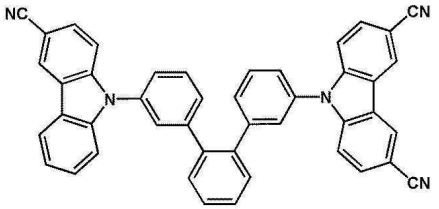
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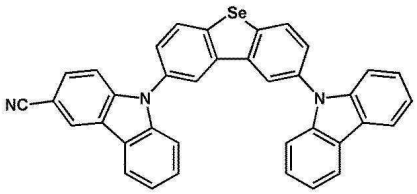
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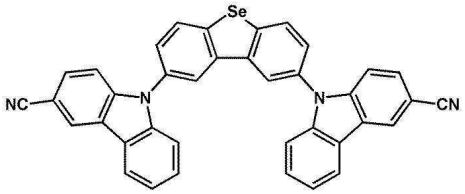


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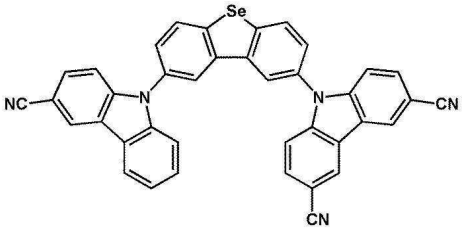


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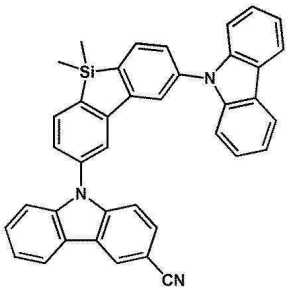
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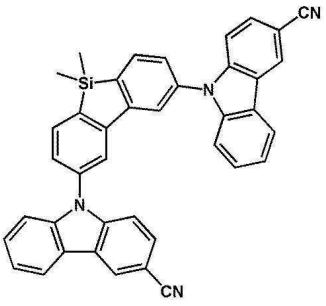
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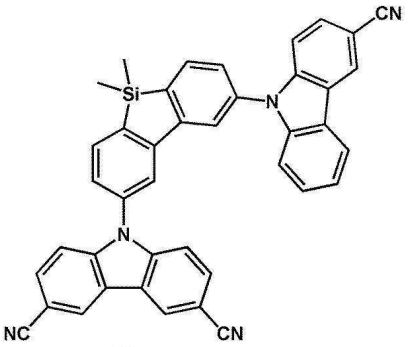


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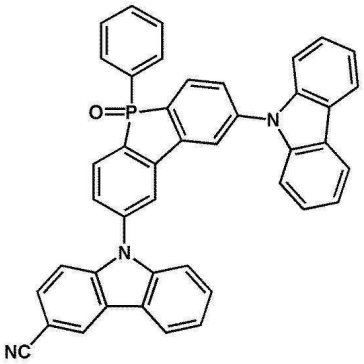


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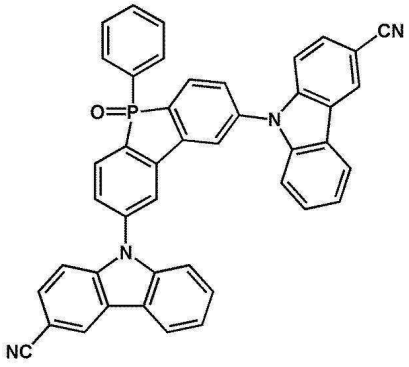
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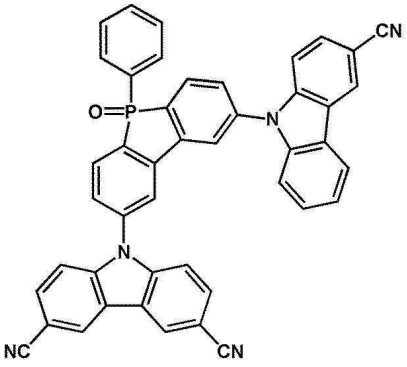
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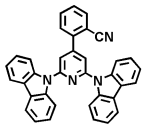
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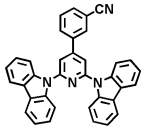
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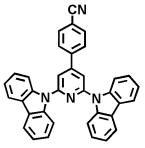
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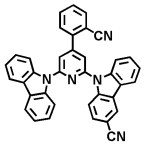
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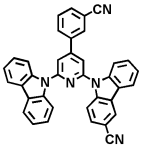
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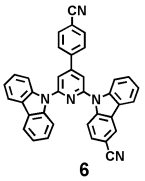
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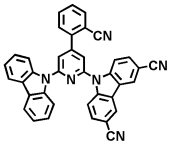
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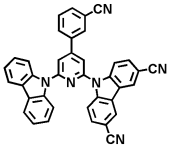
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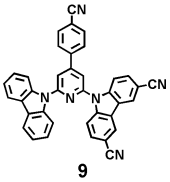
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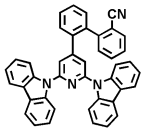
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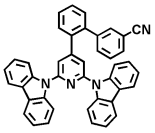
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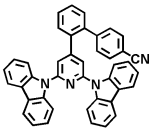
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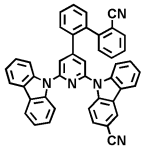
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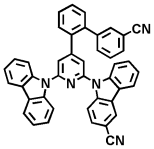
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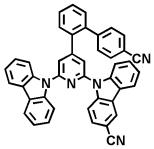
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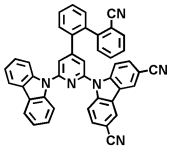
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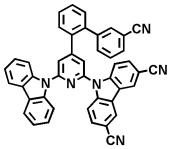
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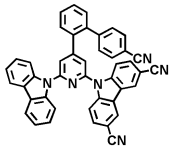
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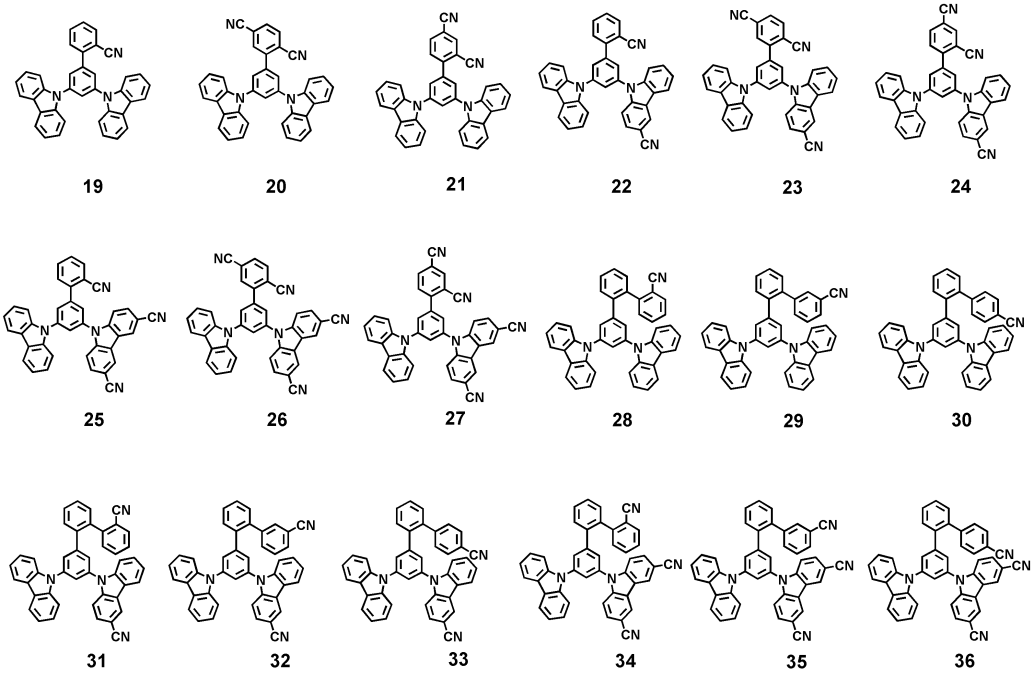
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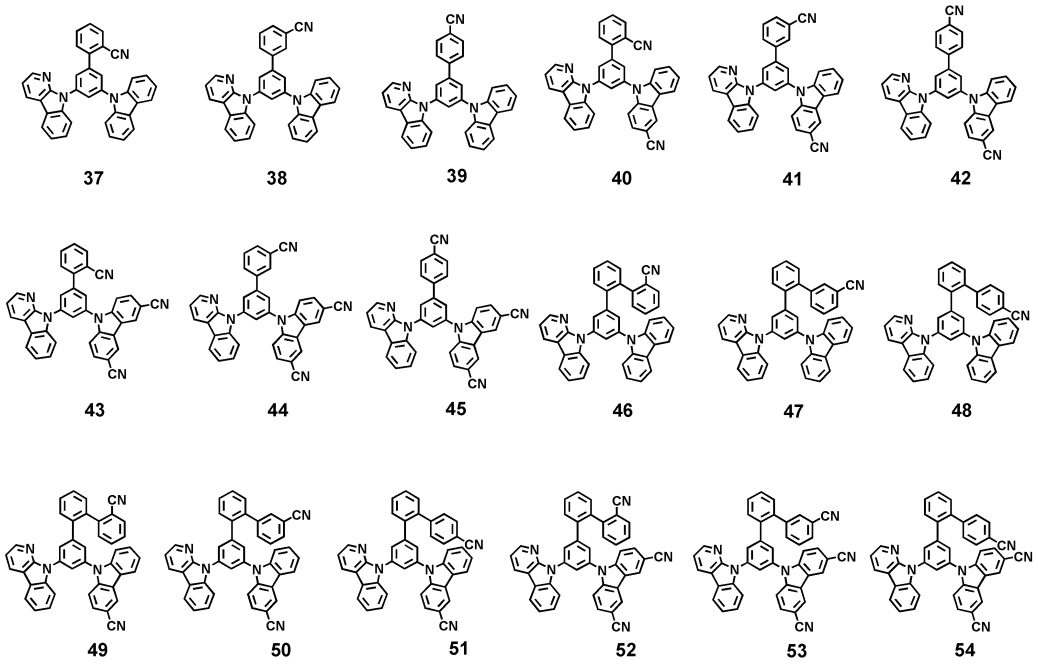
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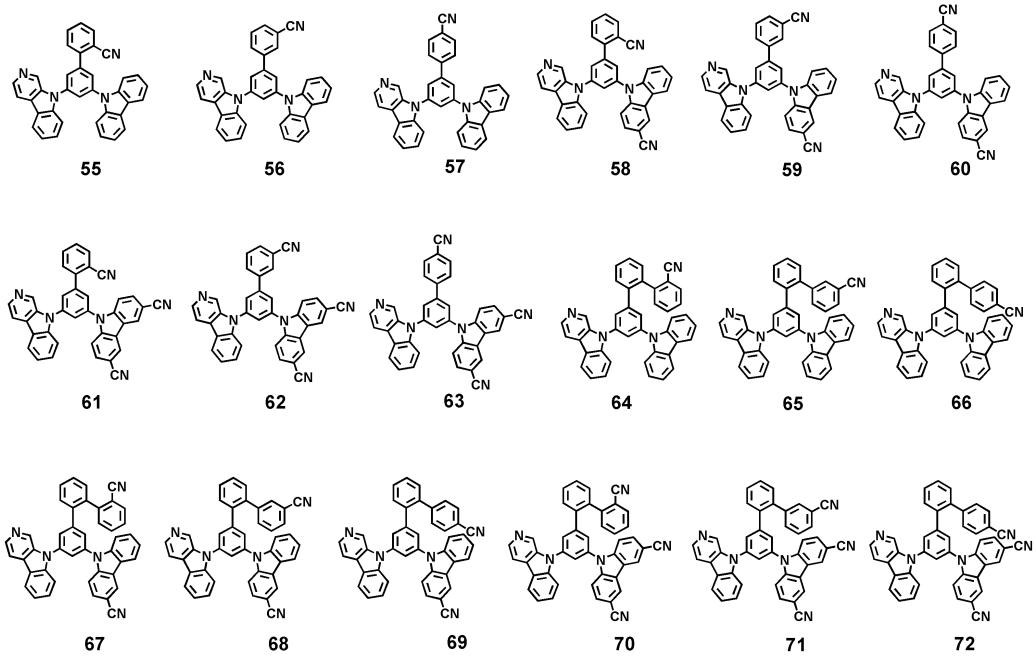
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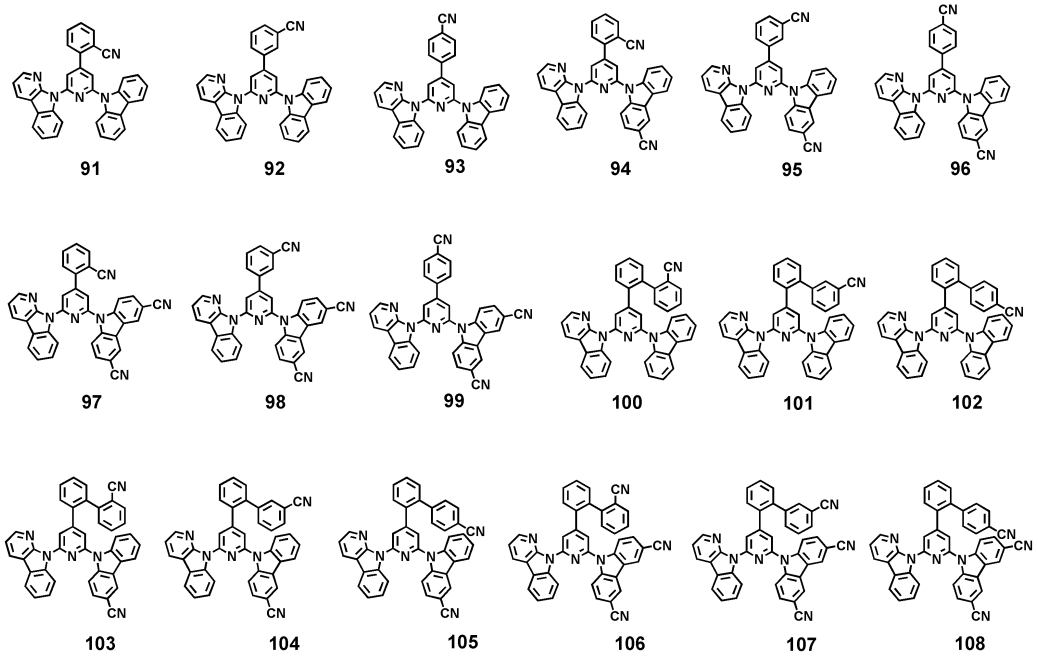

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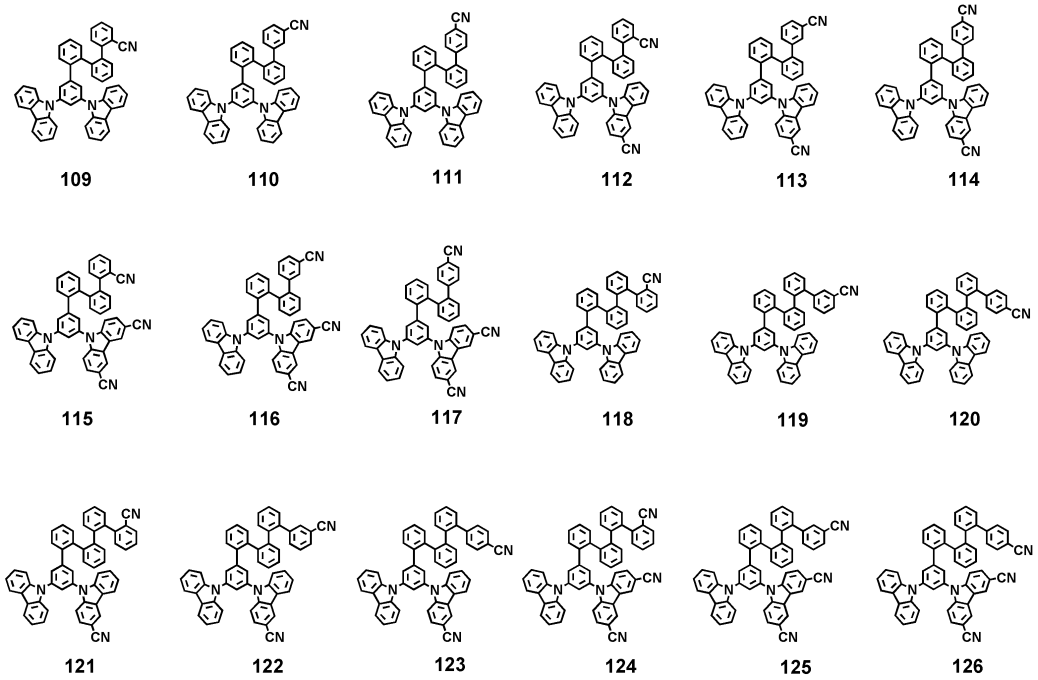

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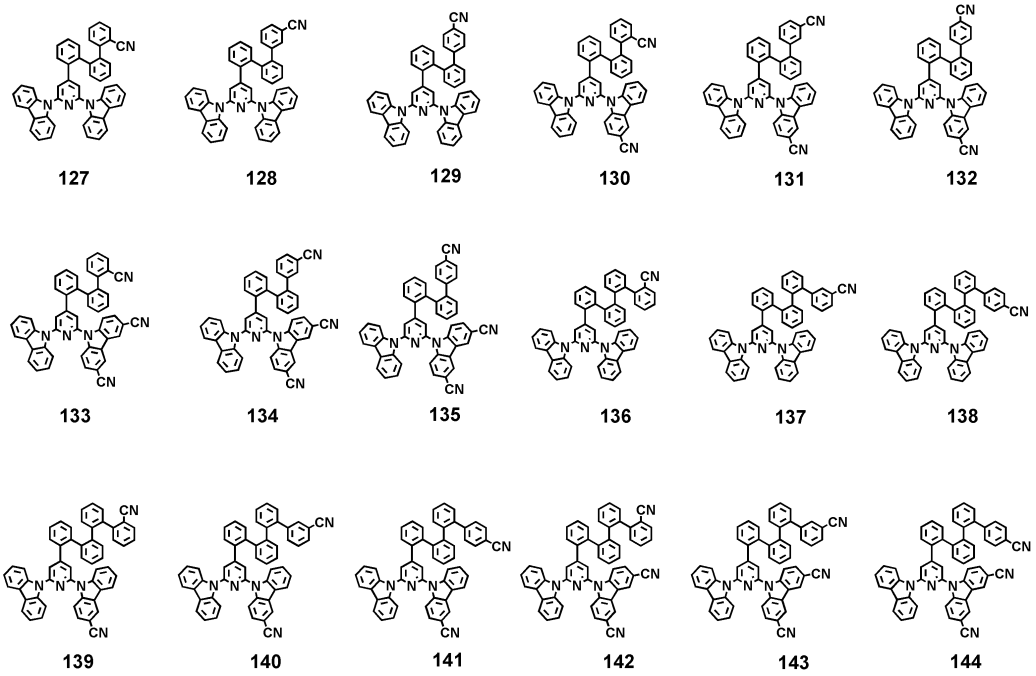
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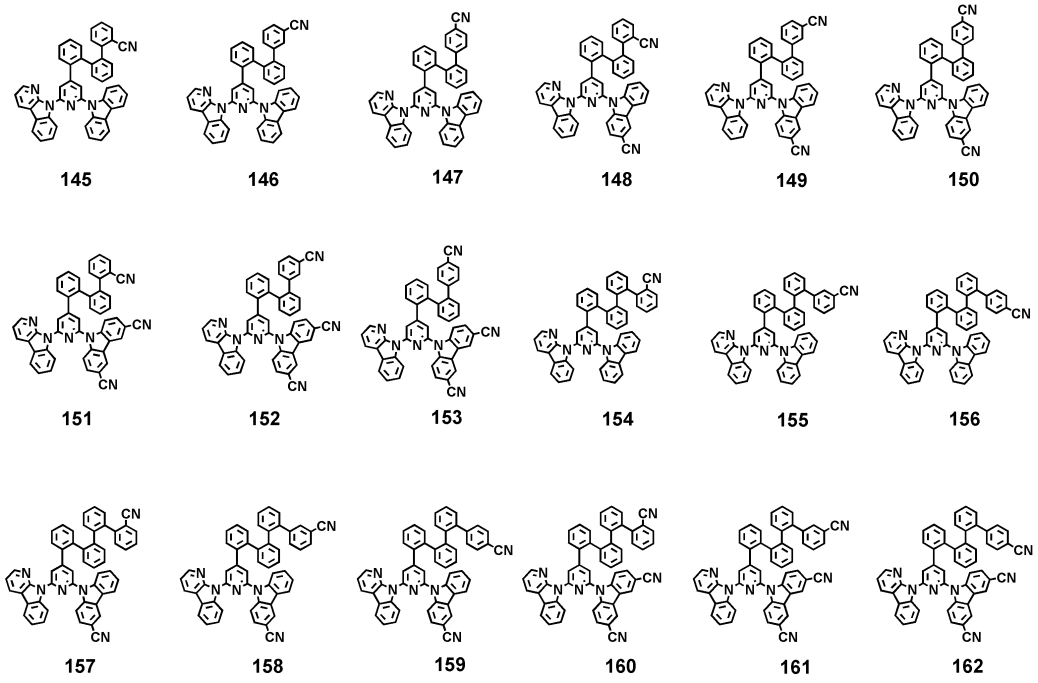
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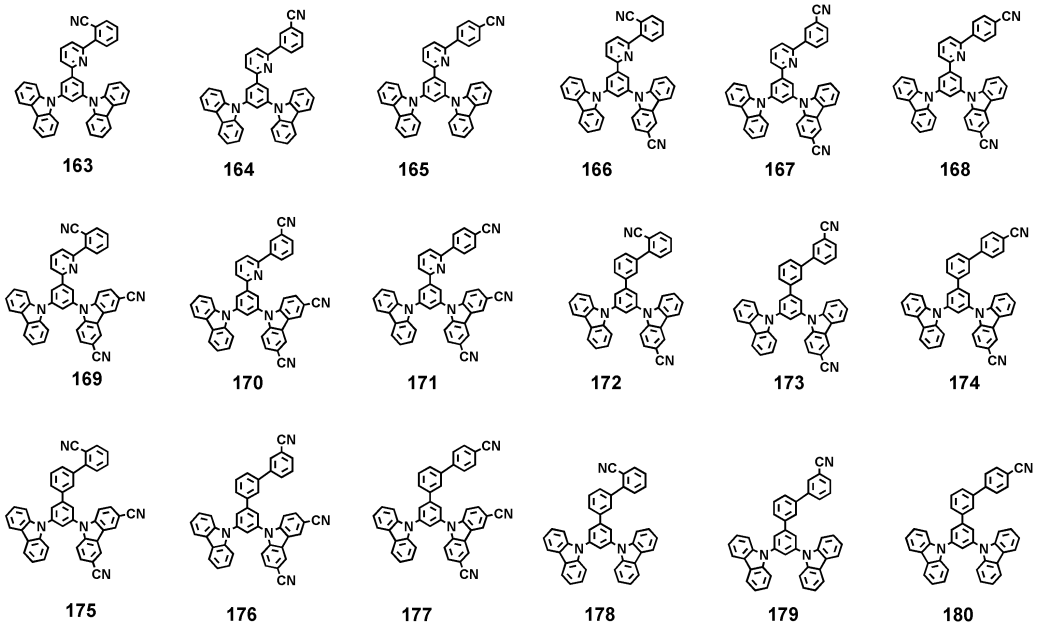
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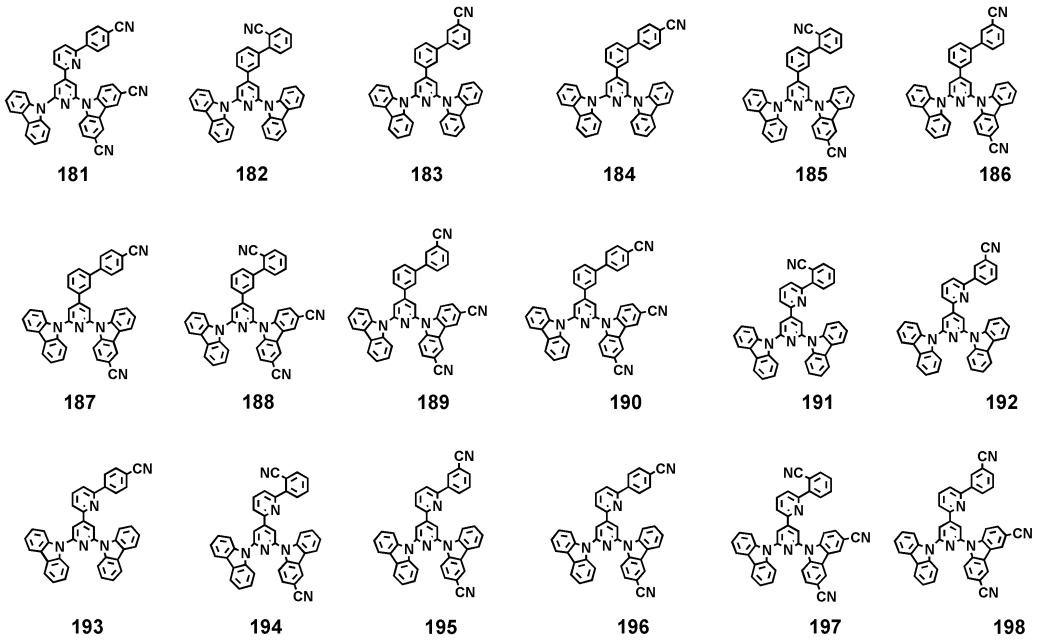
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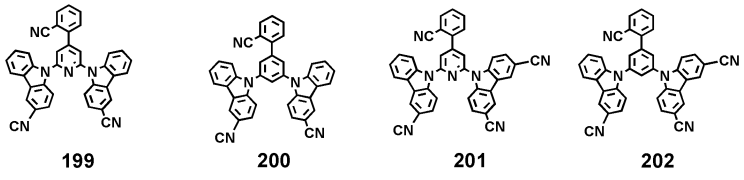
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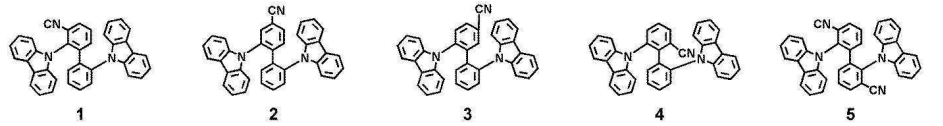
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[0489] <그룹 HE6>

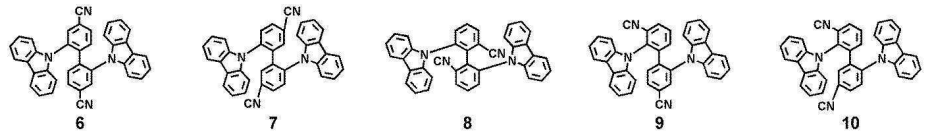

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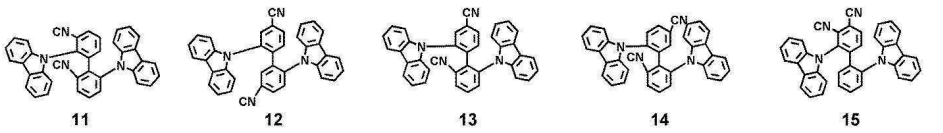

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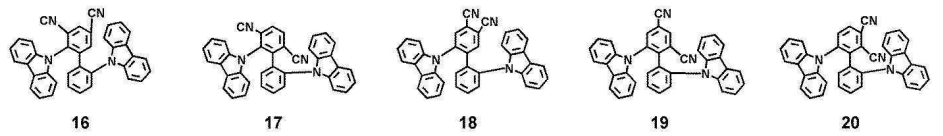

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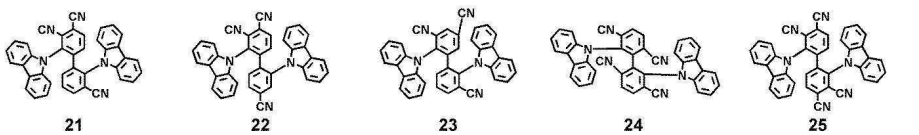
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[0490]


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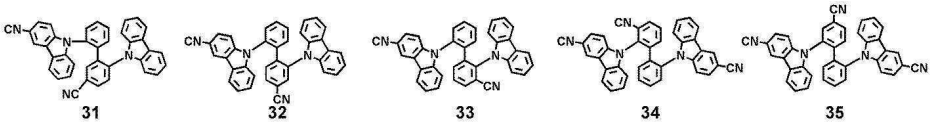

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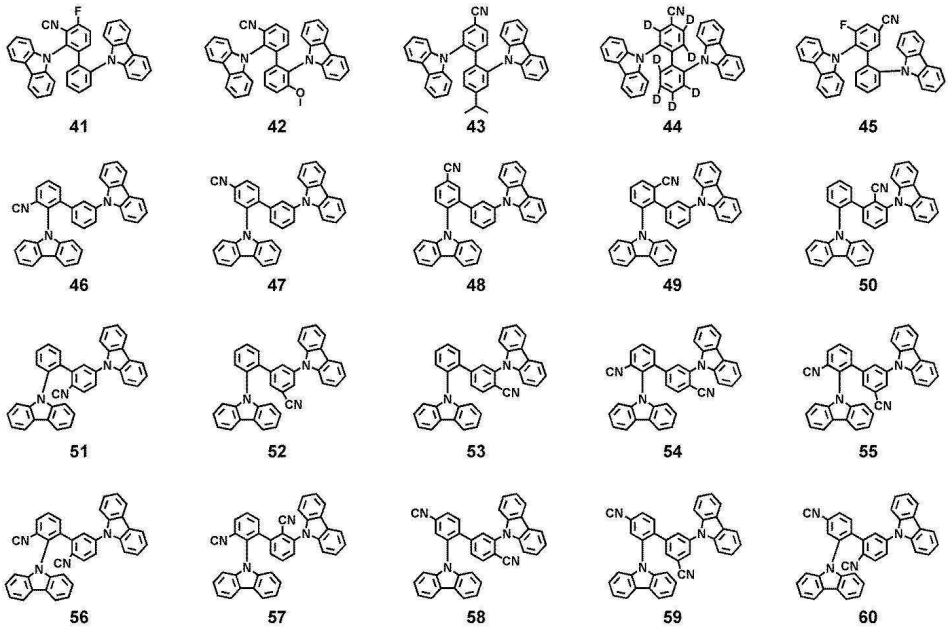
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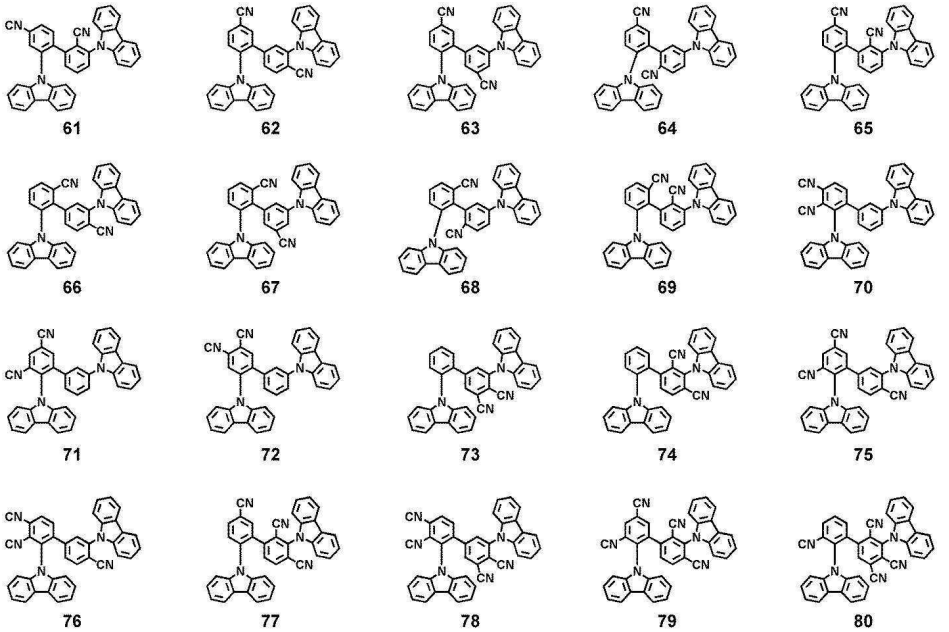
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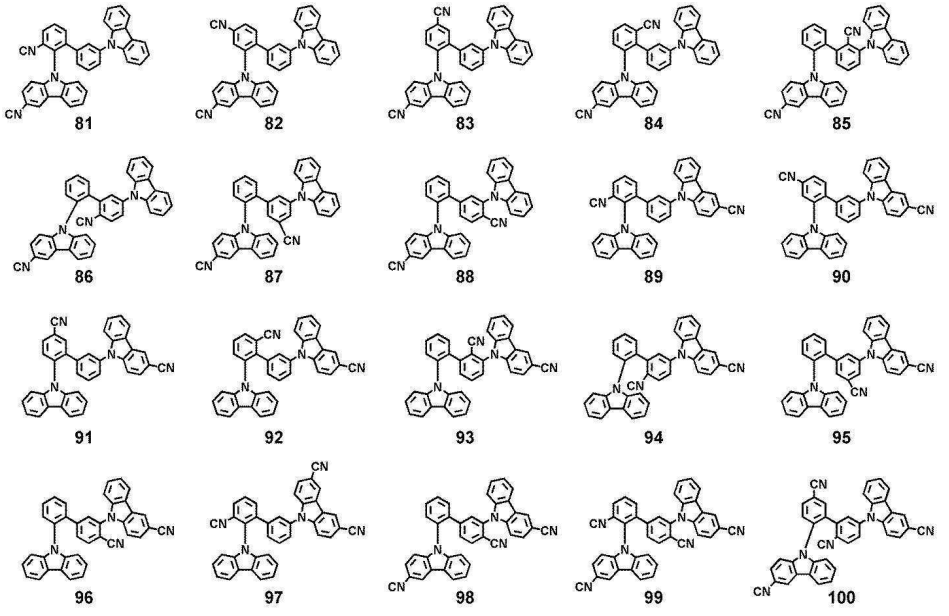
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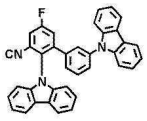
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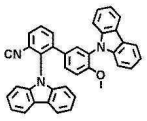


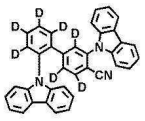
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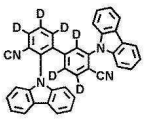


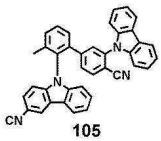
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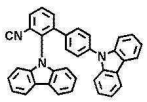

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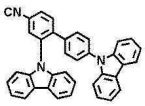

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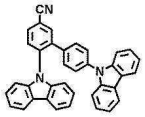

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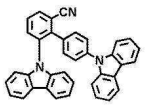

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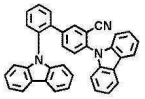

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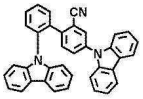

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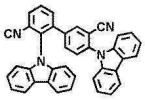

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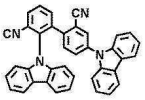

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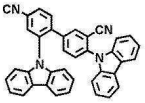

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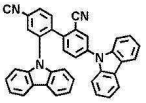

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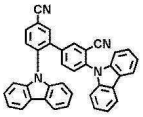

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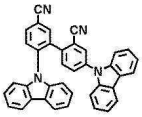

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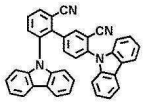

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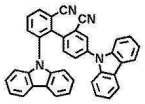

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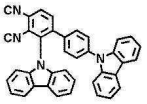

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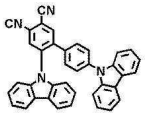

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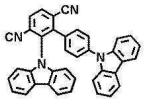

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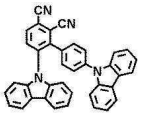

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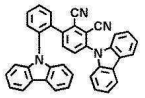

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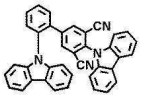
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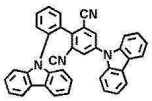

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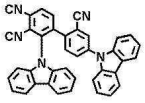

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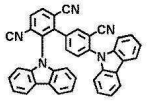

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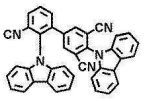

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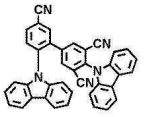

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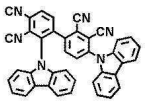

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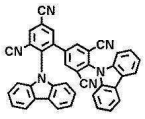

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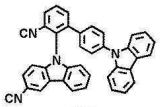

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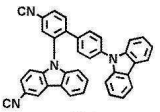

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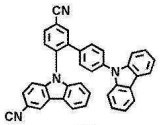

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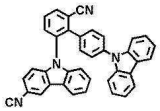

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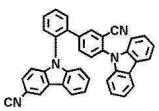

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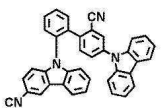

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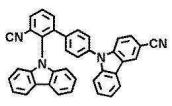

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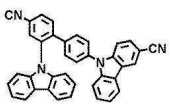

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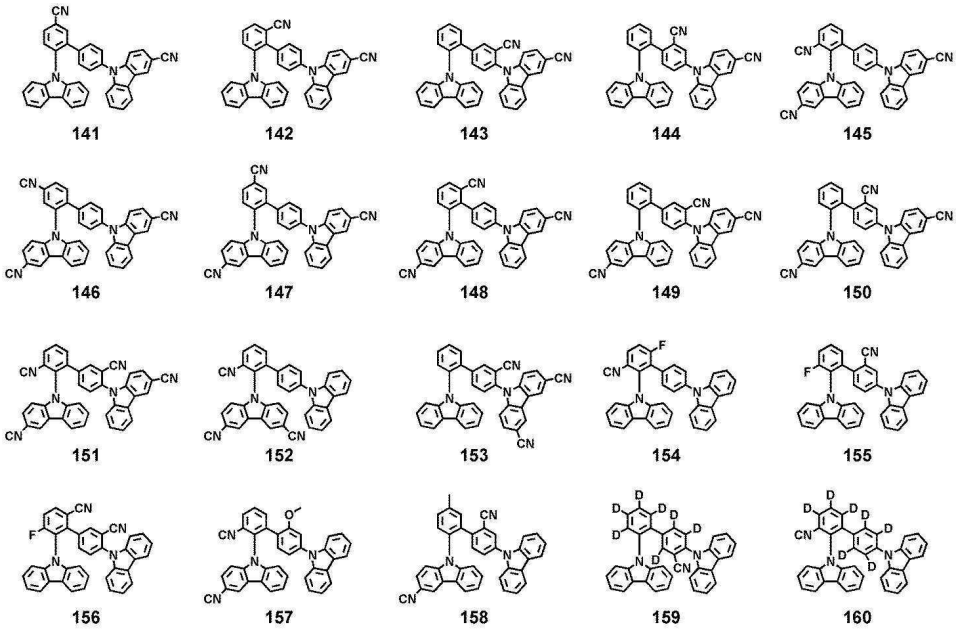

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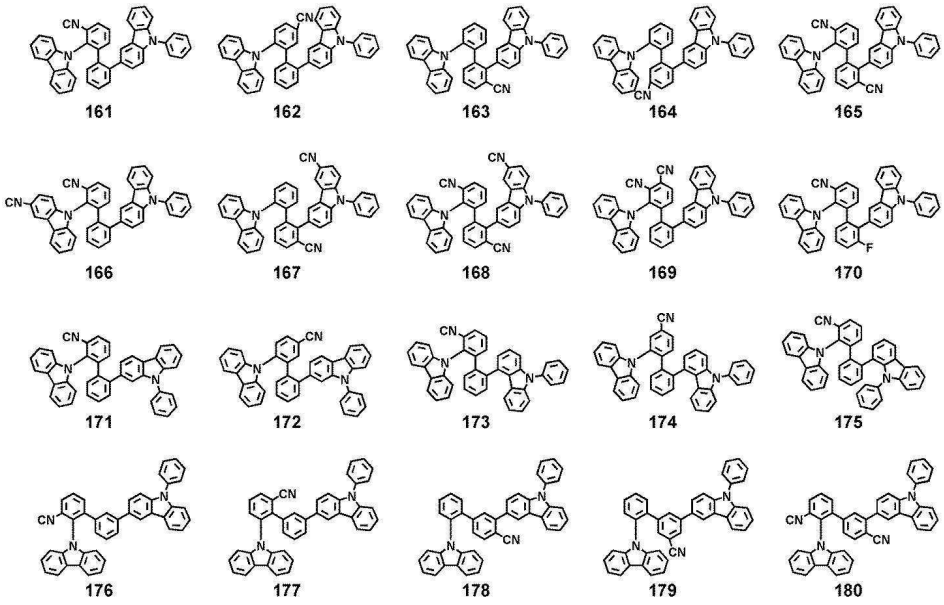

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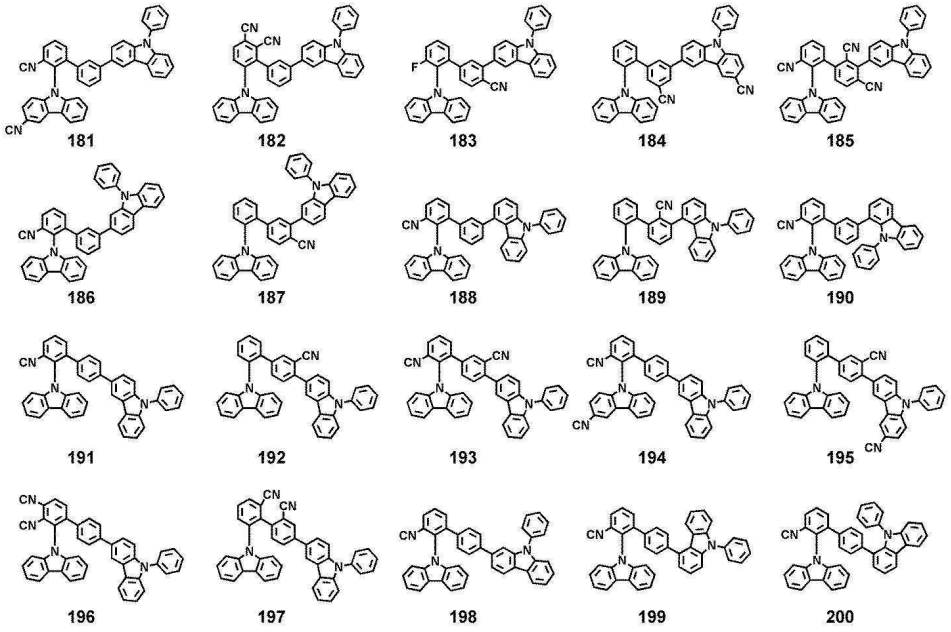
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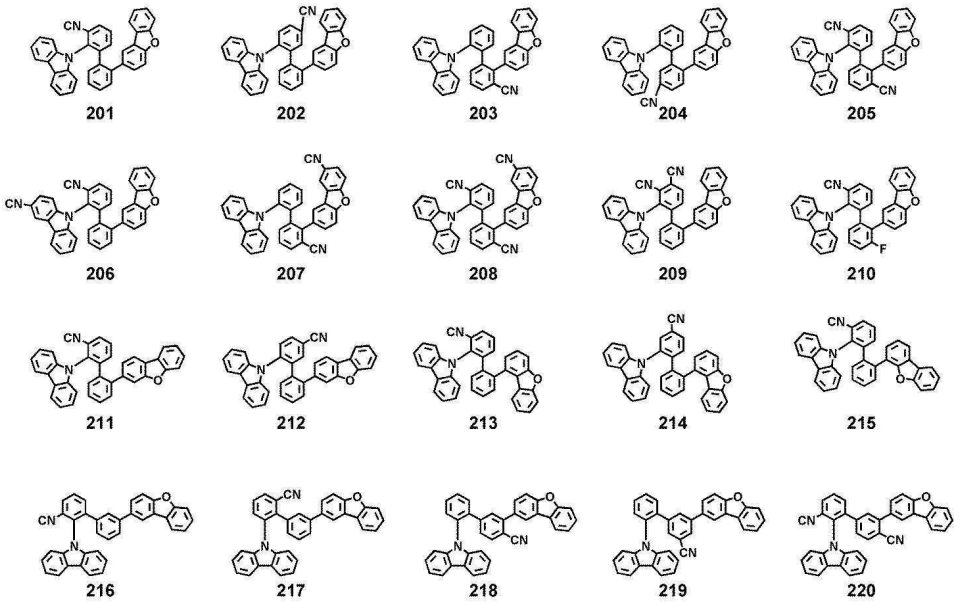
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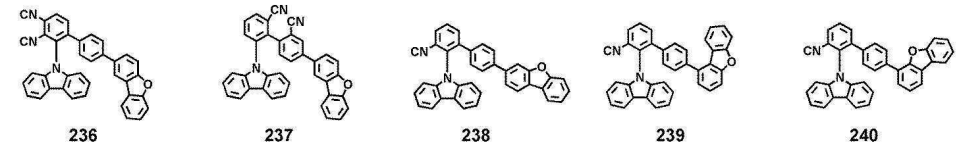
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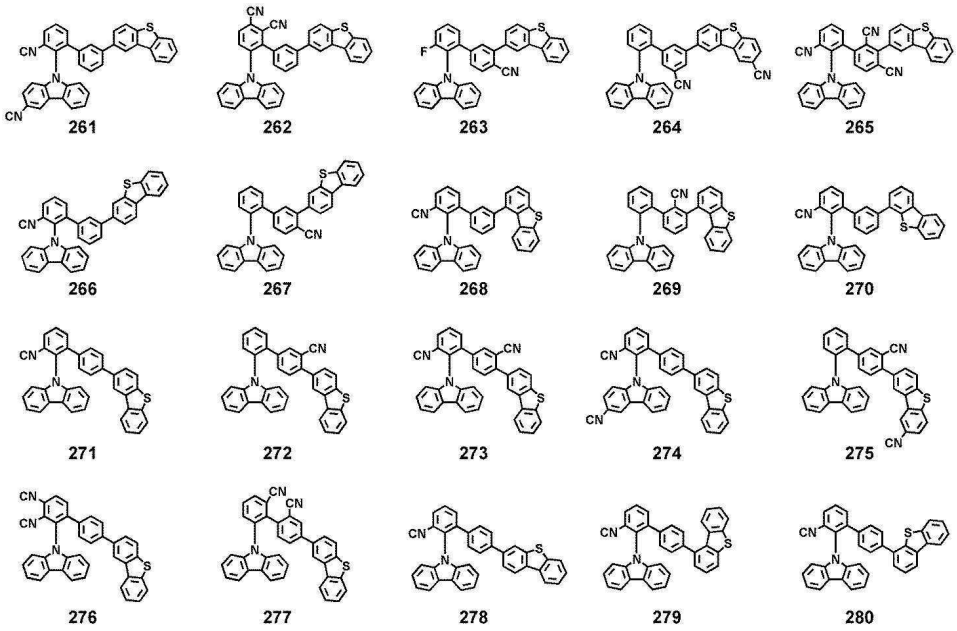
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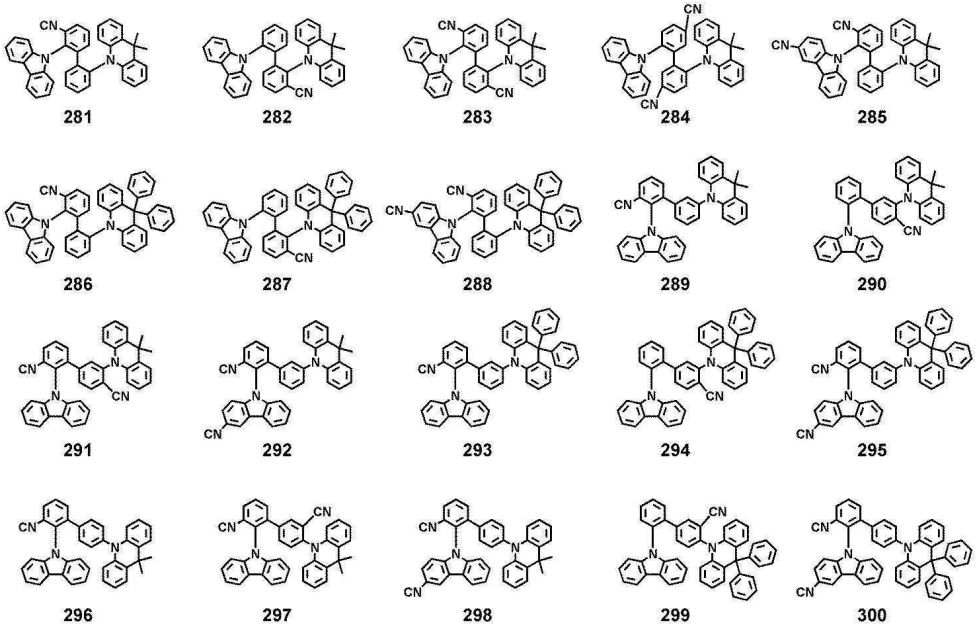
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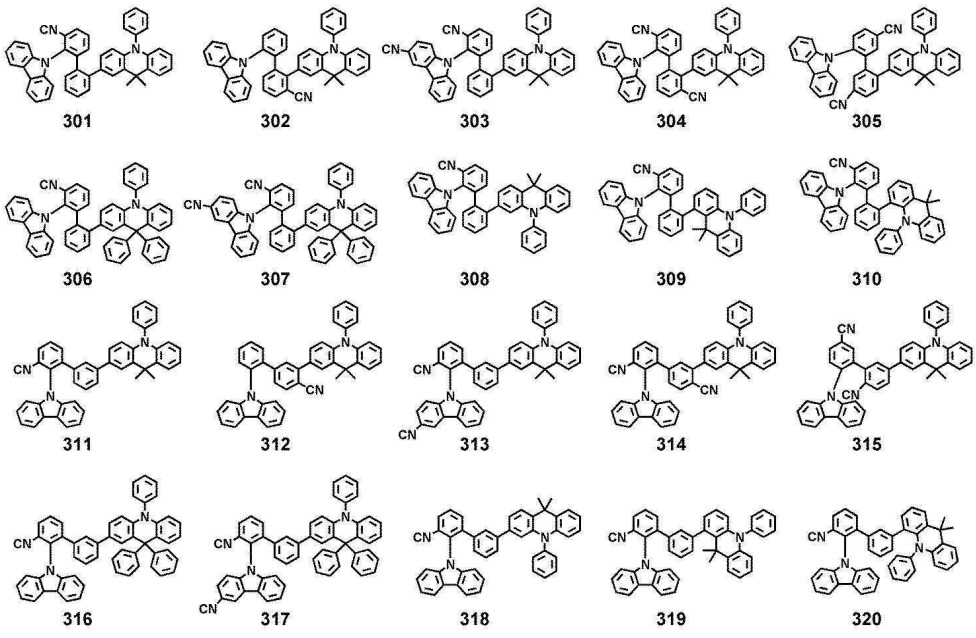
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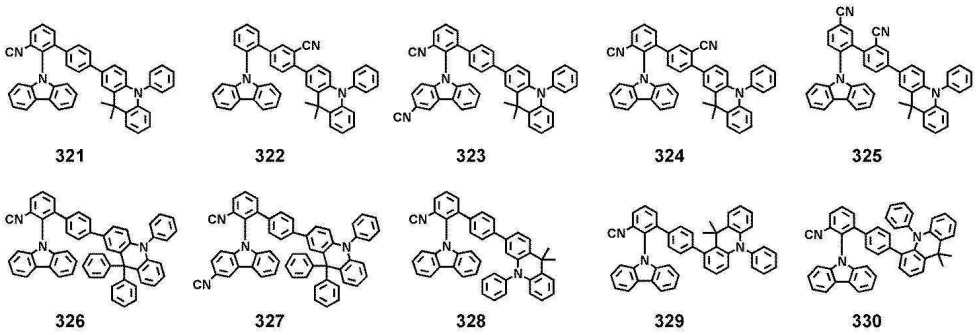


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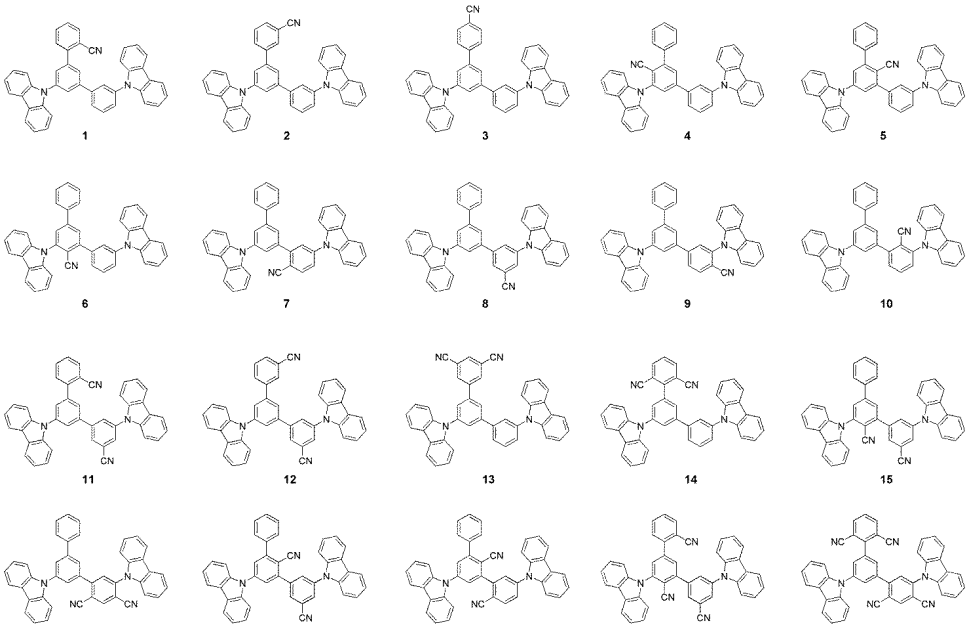
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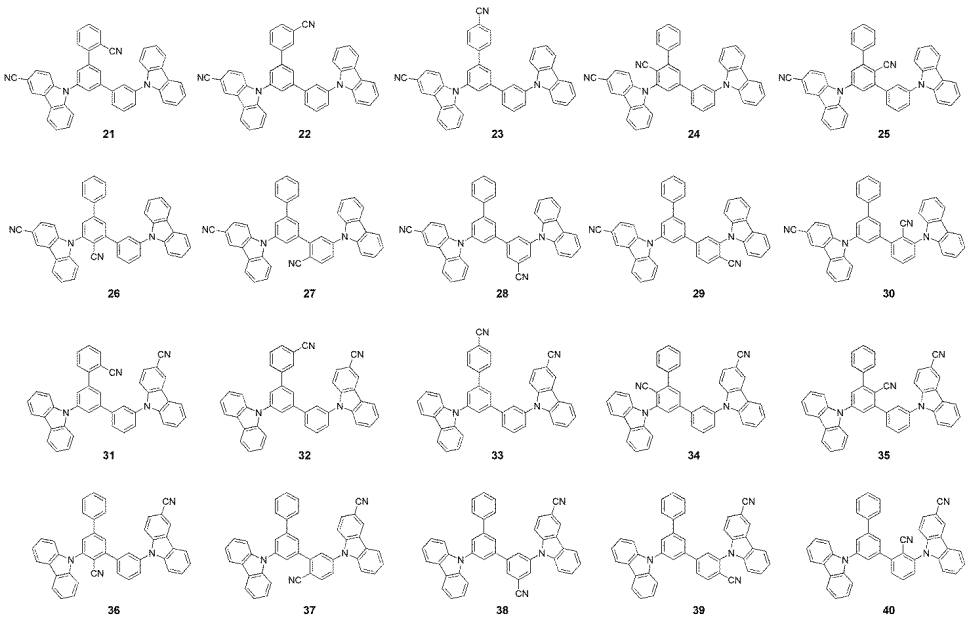


[0506]

[0507] <그룹 HE7>

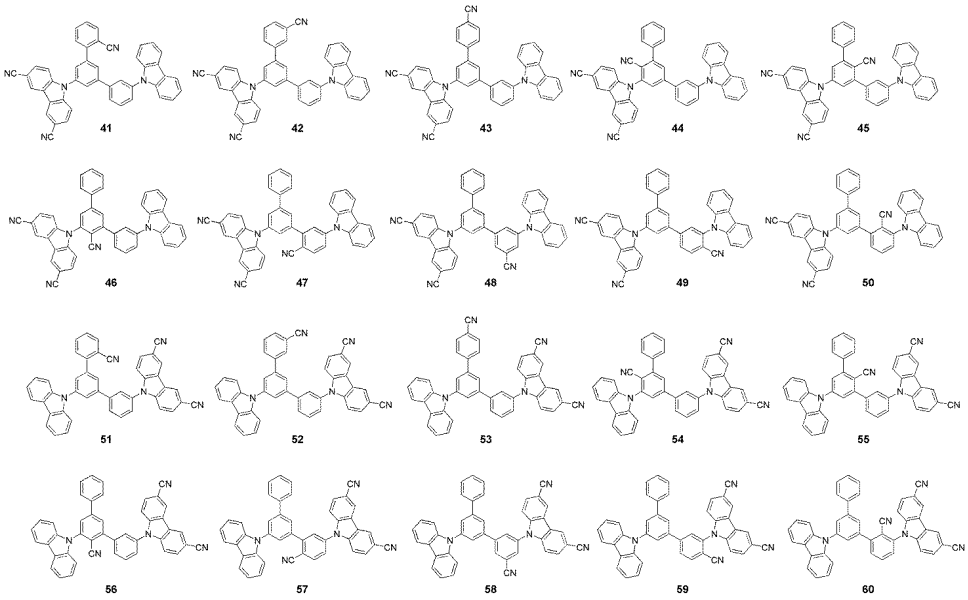


[0508]

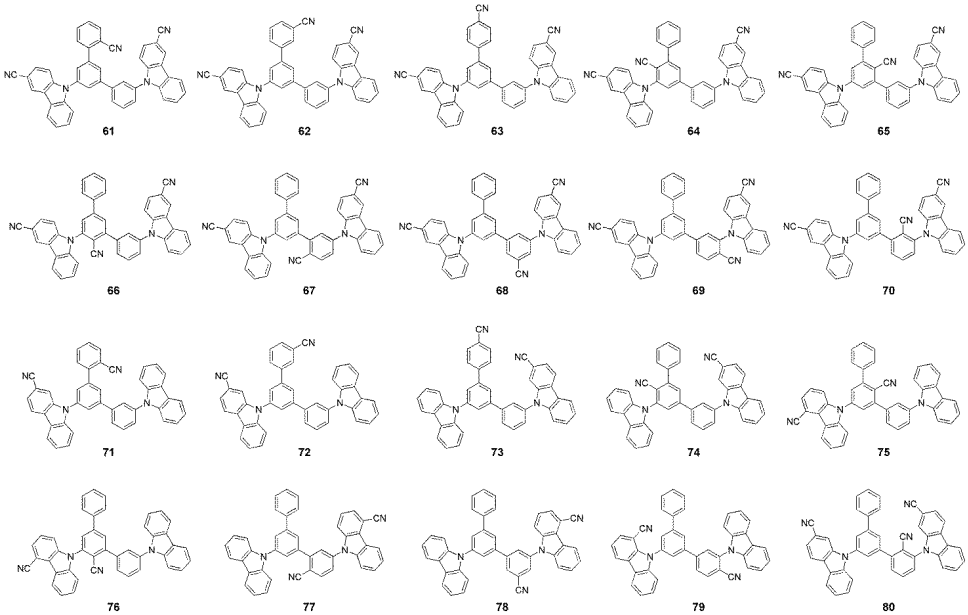


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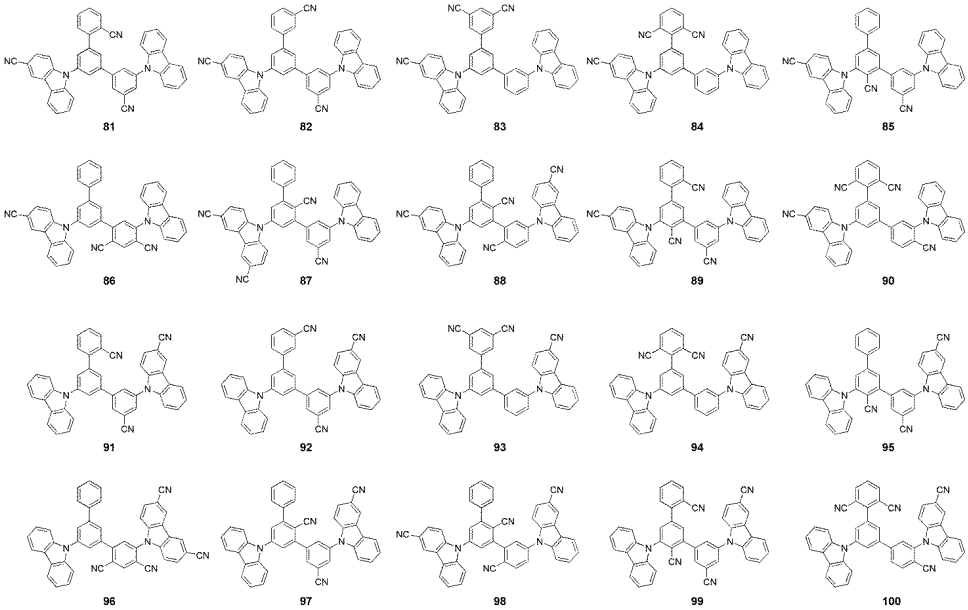
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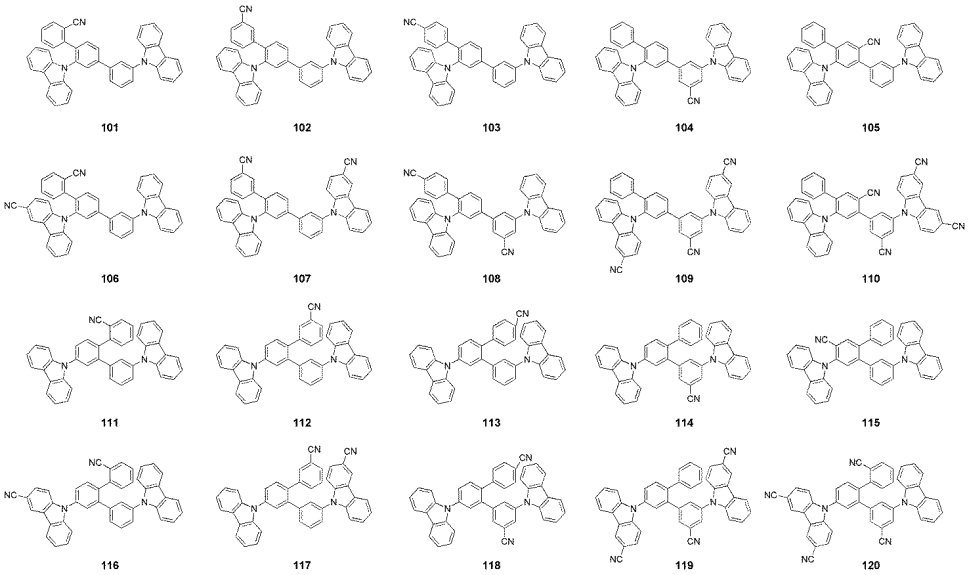
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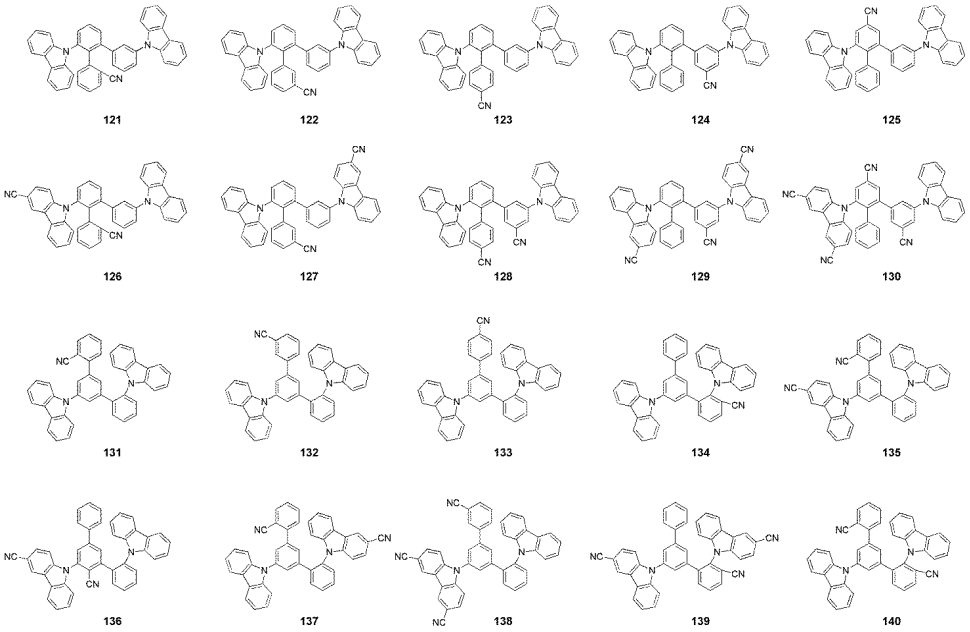
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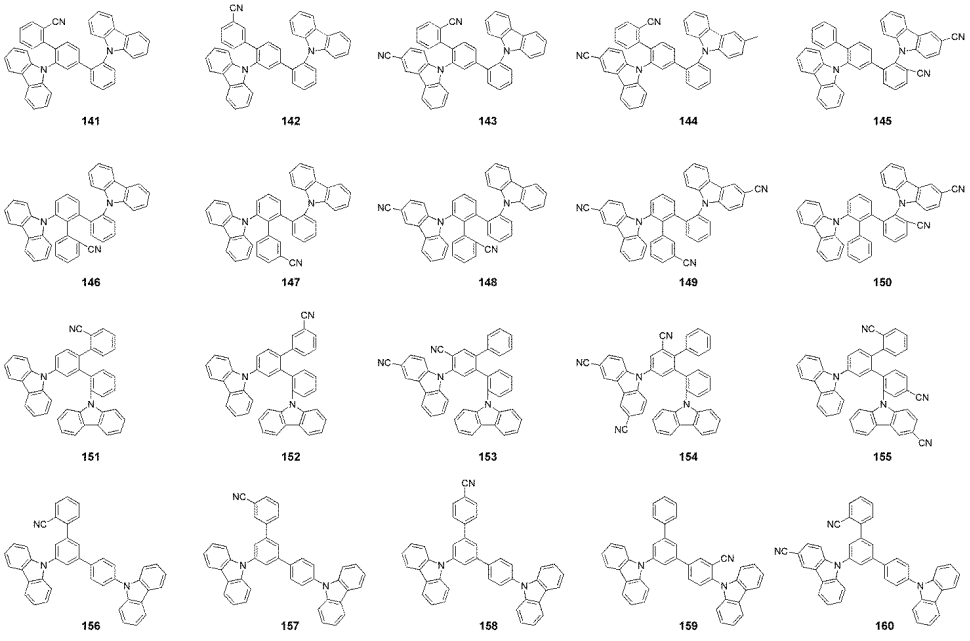
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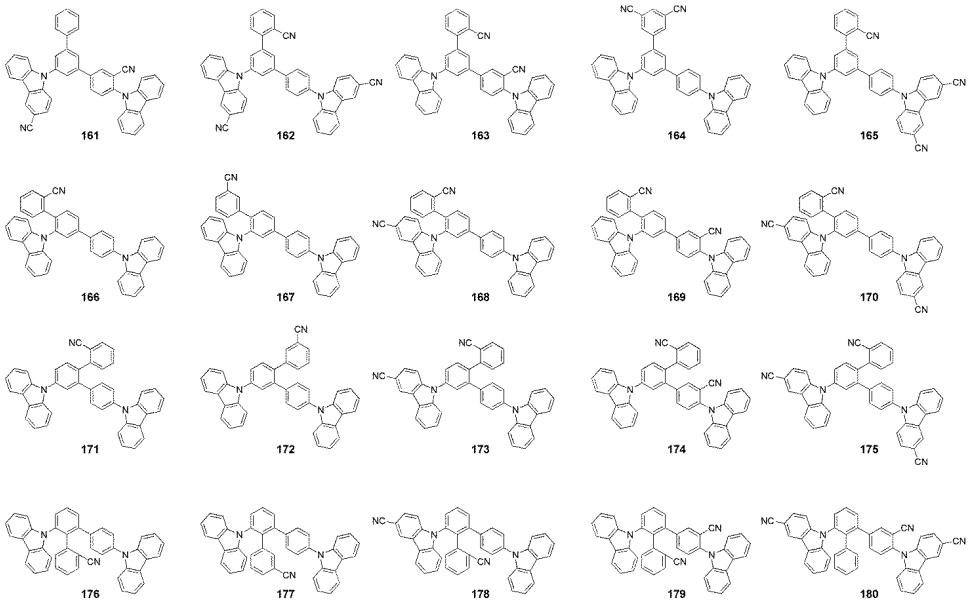
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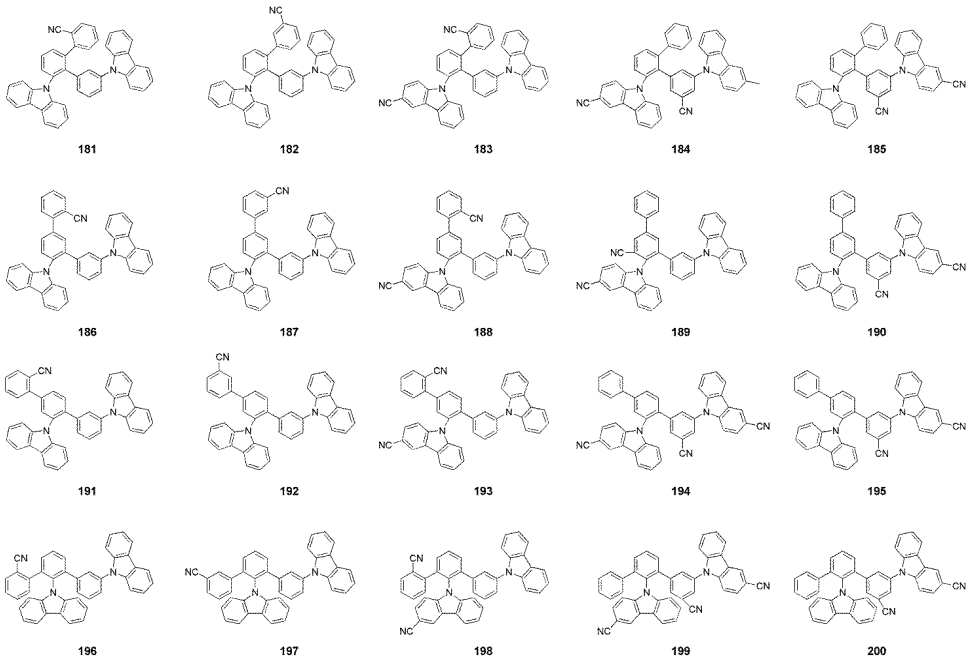
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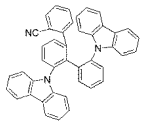
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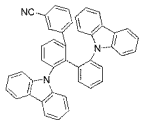

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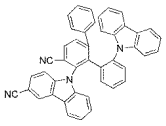
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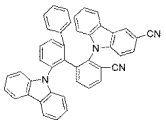

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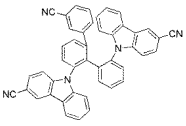
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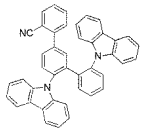

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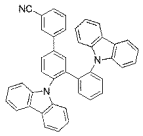

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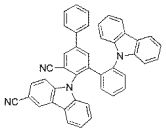

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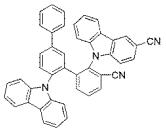

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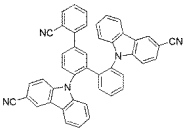

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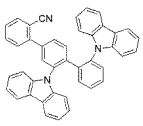

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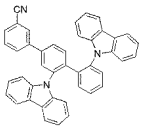

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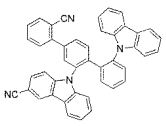

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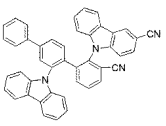

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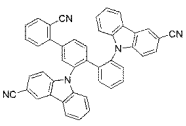

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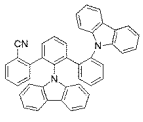

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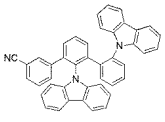

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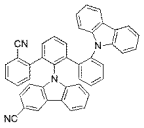

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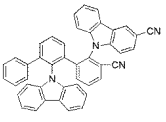

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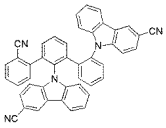

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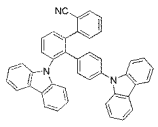

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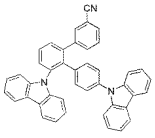

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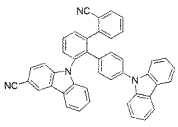

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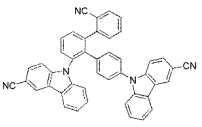

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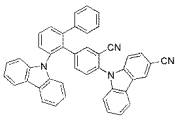
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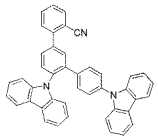

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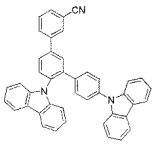

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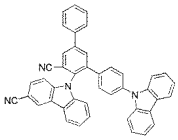

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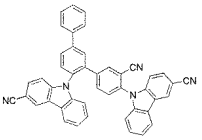

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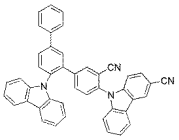

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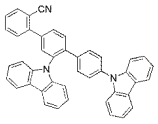

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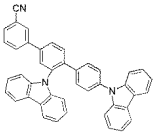

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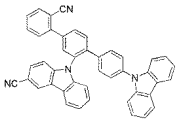

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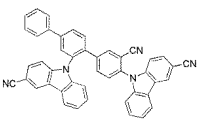

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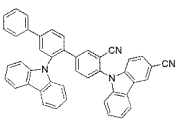

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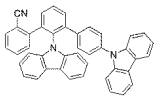

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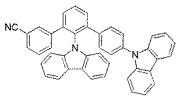

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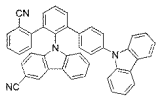

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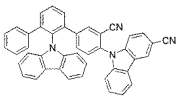

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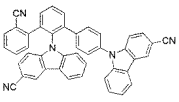
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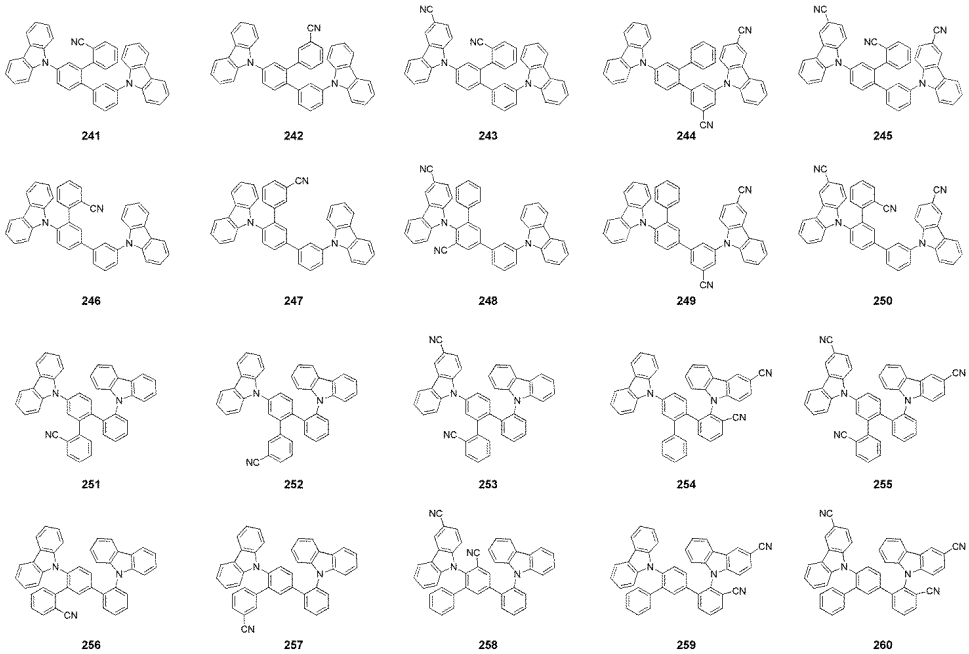

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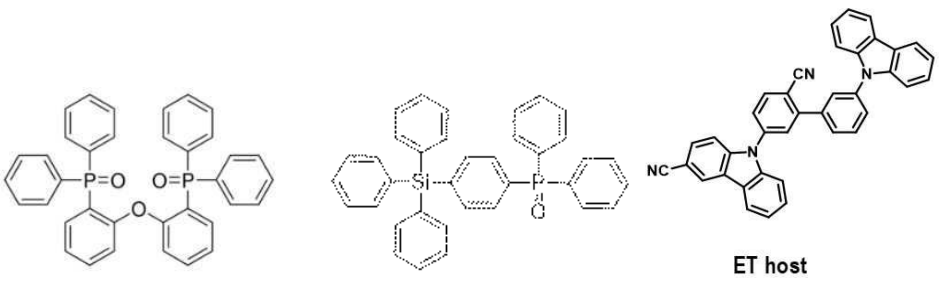

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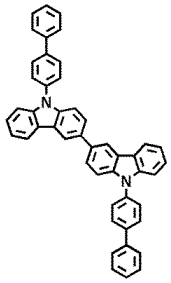
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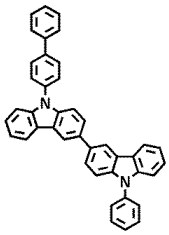
[0521] 또는, 상기 전자 수송성 호스트는 DPEPO, TSPO1 또는 하기 화합물 ET host를 포함할 수 있다:

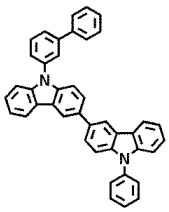
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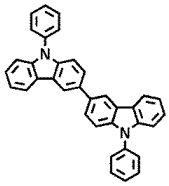
[0523] 또 다른 예로서, 상기 정공 수송성 호스트는 하기 그룹 HH1 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

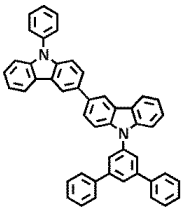
[0524] <그룹 HH1>

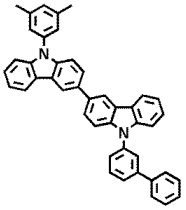

H-H1

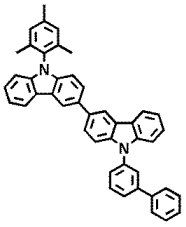

H-H2

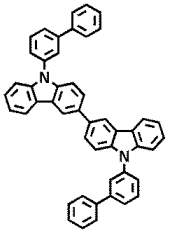

H-H3

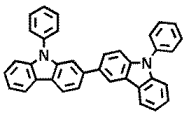

H-H4

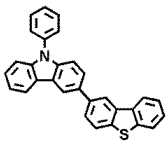

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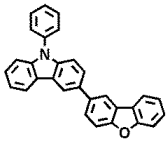

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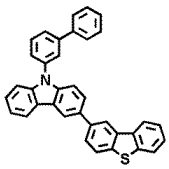

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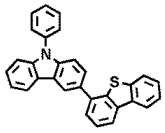

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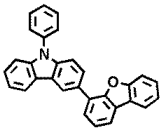

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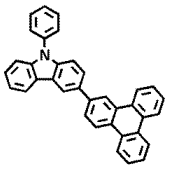

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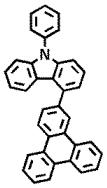

H-H11


H-H12

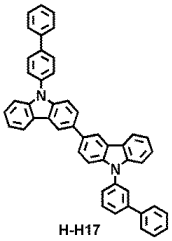

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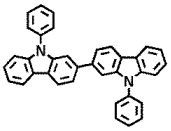

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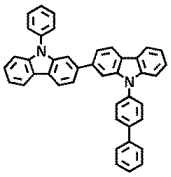

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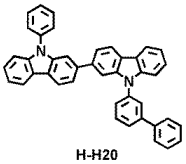

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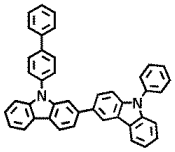
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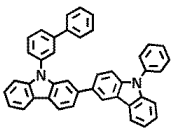

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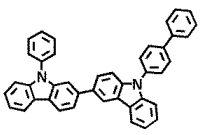

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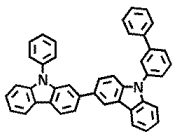

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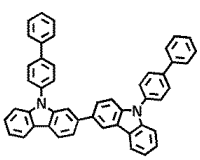

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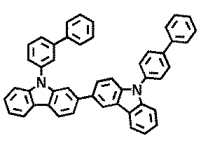

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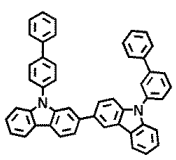

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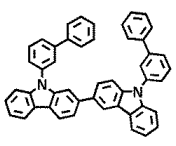

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H-H24

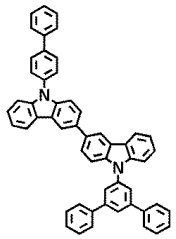

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H-H26

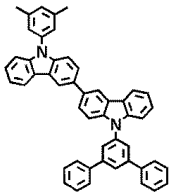

H-H27


H-H28

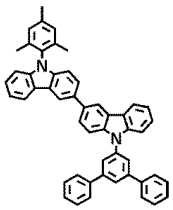
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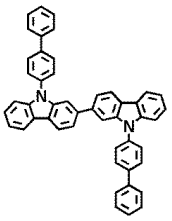
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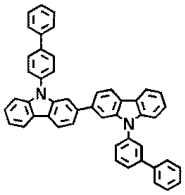
H-H30



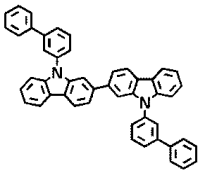
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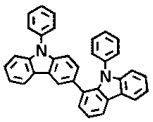
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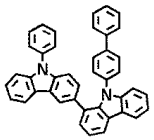
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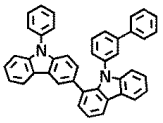
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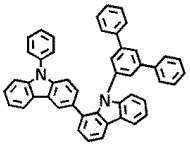
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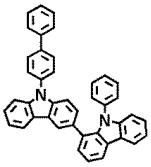
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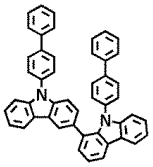
H-H37



H-H38

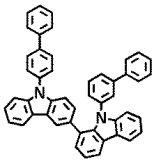


H-H39

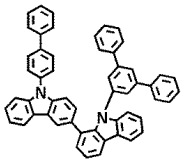


H-H40

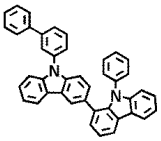
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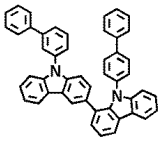
H-H41



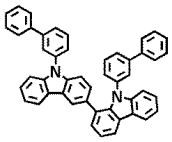
H-H42



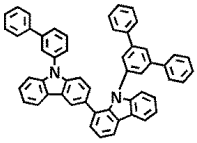
H-H43



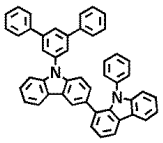
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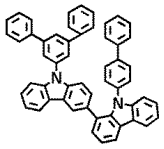
H-H45



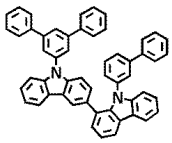
H-H46



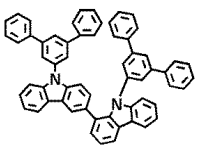
H-H47



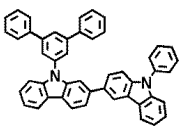
H-H48



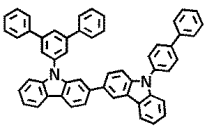
H-H49



H-H50



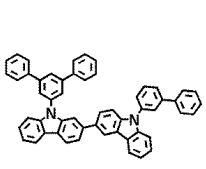
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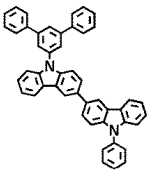


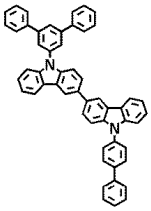
H-H52

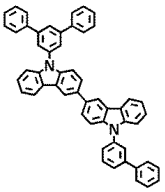
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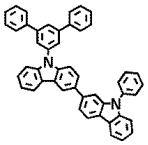
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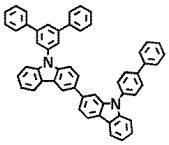

H-H53

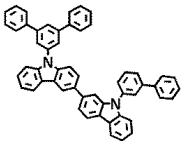

H-H54

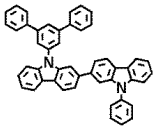

H-H55

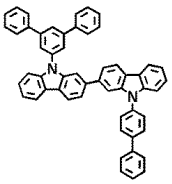

H-H56

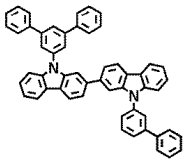

H-H57

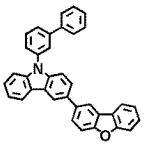

H-H58

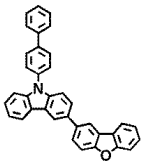

H-H59


H-H60

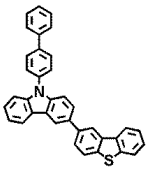

H-H61

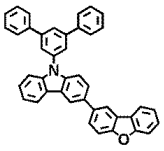

H-H62

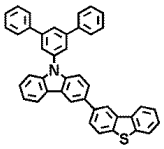

H-H63

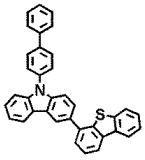

H-H64

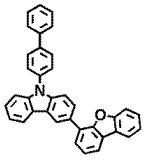
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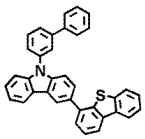

H-H65

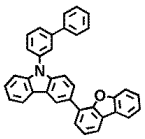

H-H66

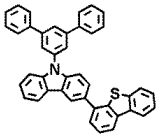

H-H67

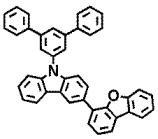

H-H68

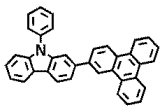

H-H69

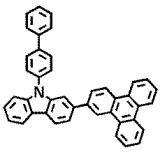

H-H70

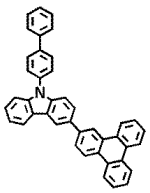

H-H71

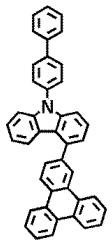

H-H72


H-H73

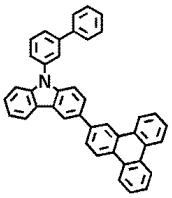

H-H74


H-H75

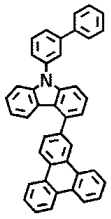

H-H76



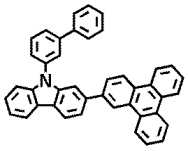
H-H77



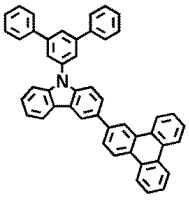
H-H78



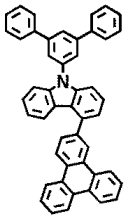
H-H79



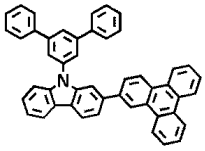
H-H80



H-H81

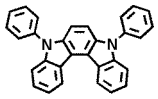


H-H82

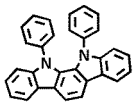


H-H83

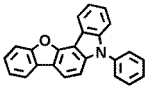
[0531]



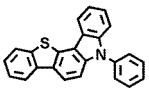
H-H84



H-H85

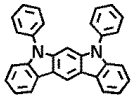


H-H86

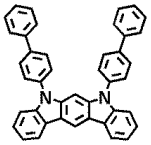


H-H87

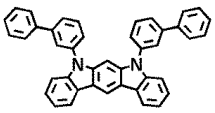
[0532]



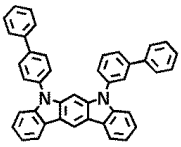
H-H88



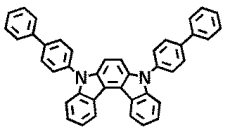
H-H89



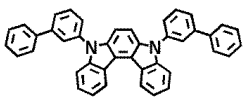
H-H90



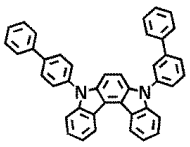
H-H91



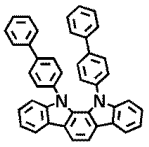
H-H92



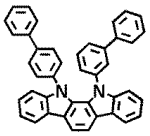
H-H93



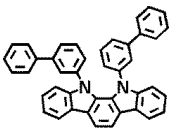
H-H94



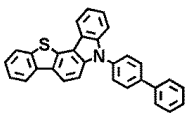
H-H95



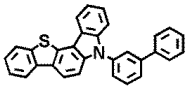
H-H96



H-H97

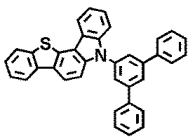


H-H98

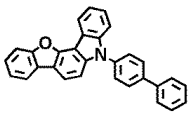


H-H99

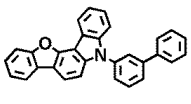
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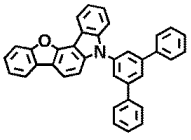
H-H100



H-H101



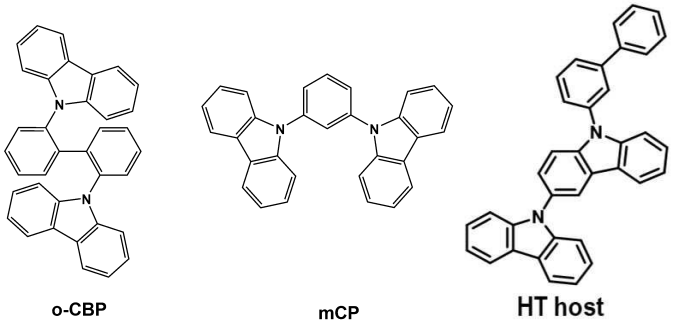
H-H102



H-H103

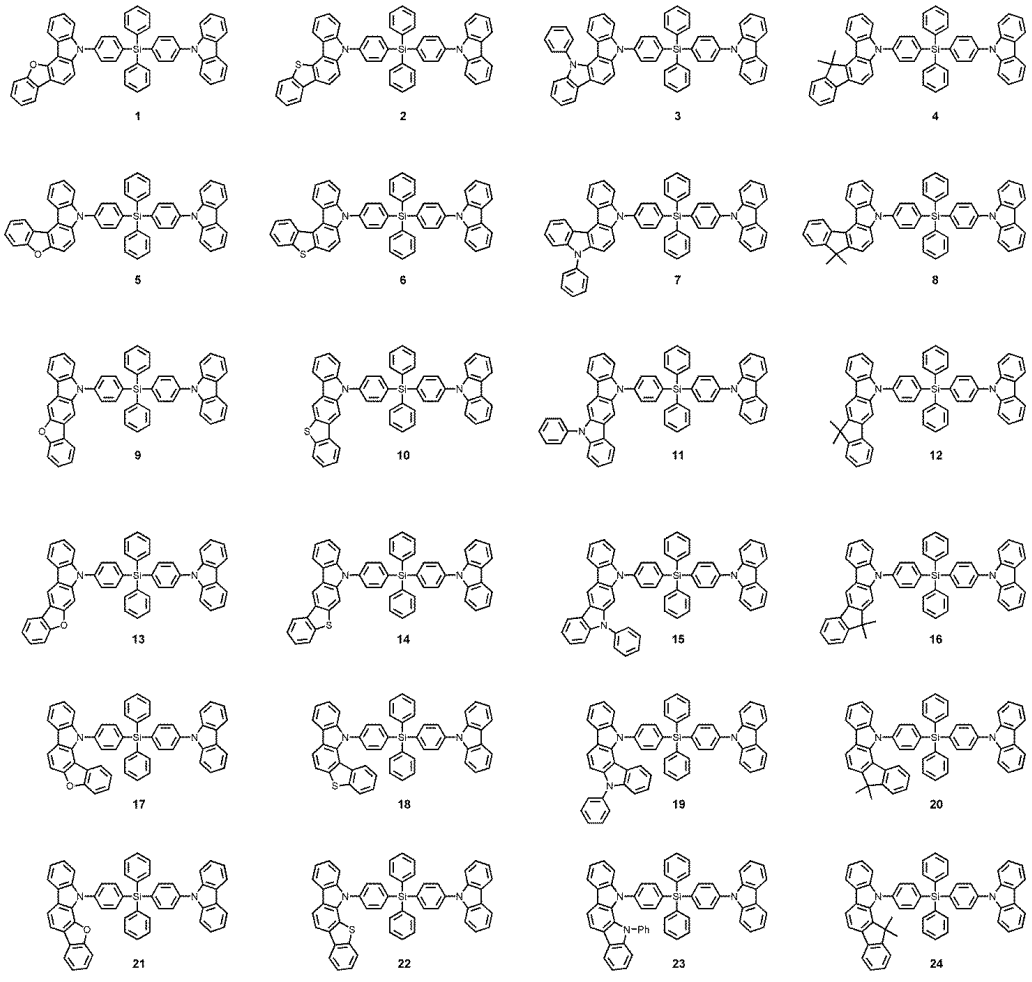
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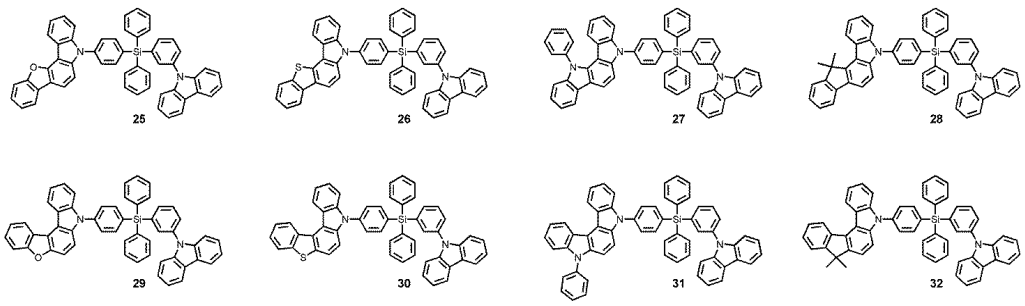
[0535] 또는, 상기 정공 수송성 호스트는 o-CBP, mCP 또는 하기 화합물 HT host를 포함할 수도 있다:

[0536] 

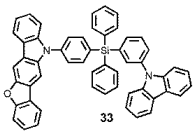
[0537] 또 다른 예로서, 상기 양쪽성 호스트는 하기 그룹 HEH1 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:

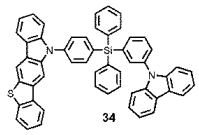
[0538] <그룹 HEH1>

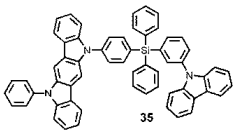
[0539] 

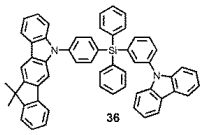
[0540] 

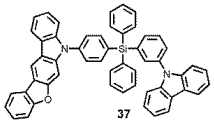
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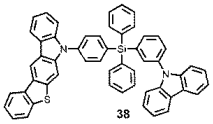

33

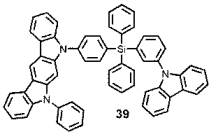

34

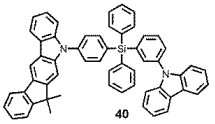

35

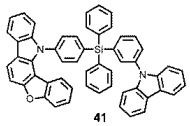

36

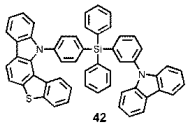

37

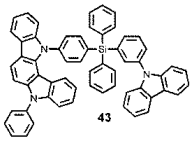

38

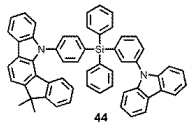

39

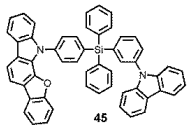

40

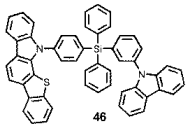

41

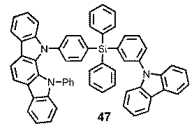

42

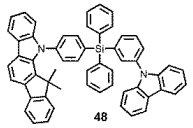

43

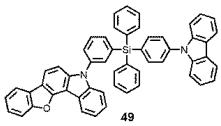

44

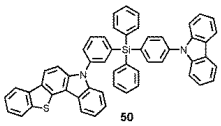

45

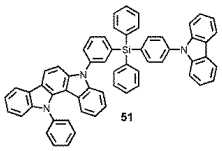

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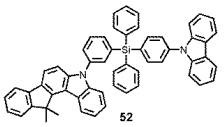

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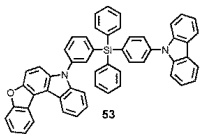

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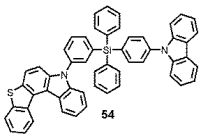

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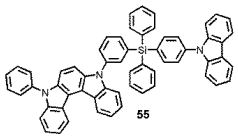

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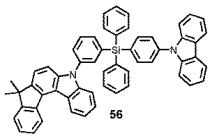

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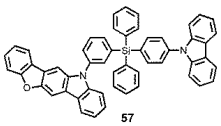

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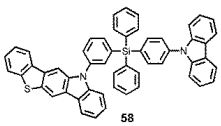

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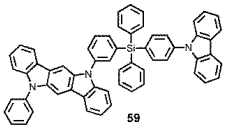

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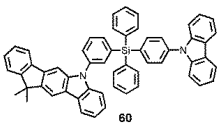

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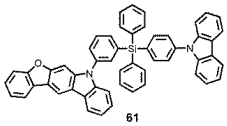

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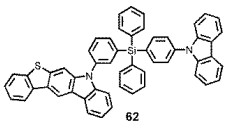

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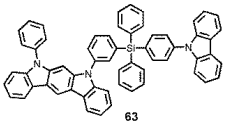

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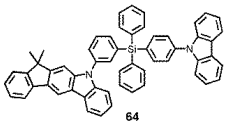

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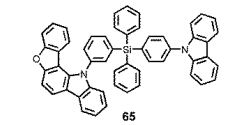

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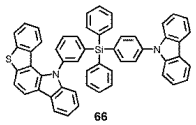

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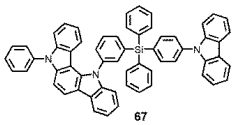

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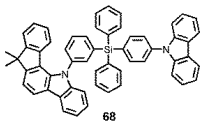

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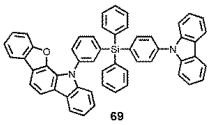
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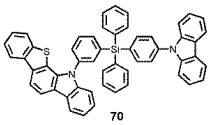

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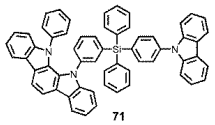

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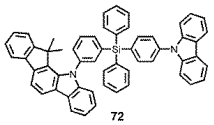

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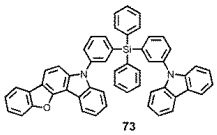

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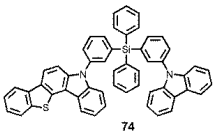

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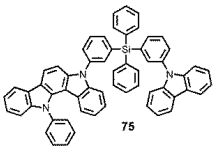

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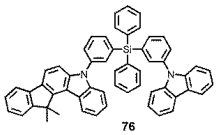

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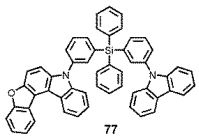

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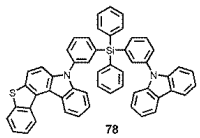

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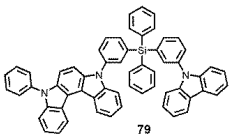

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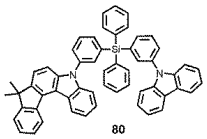

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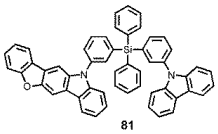

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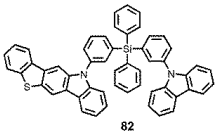

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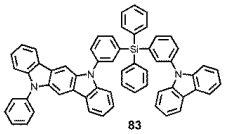

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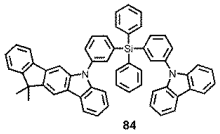

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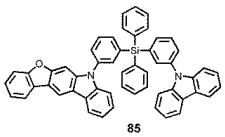

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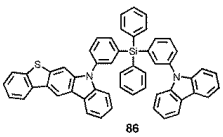

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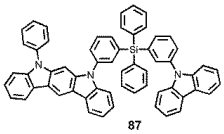

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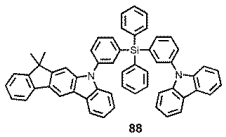

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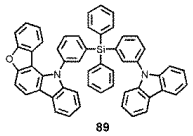

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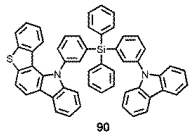

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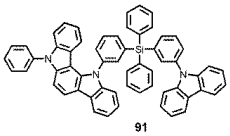

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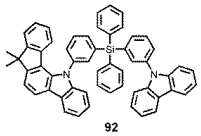

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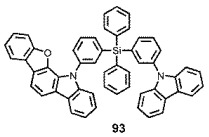

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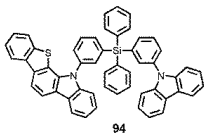

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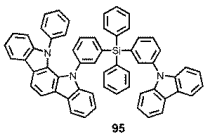

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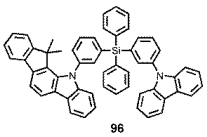

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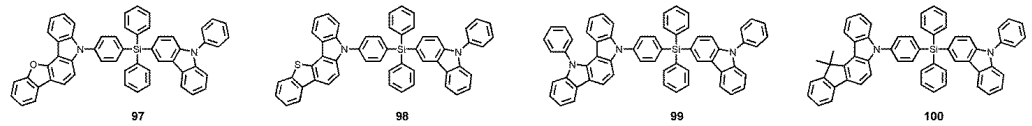

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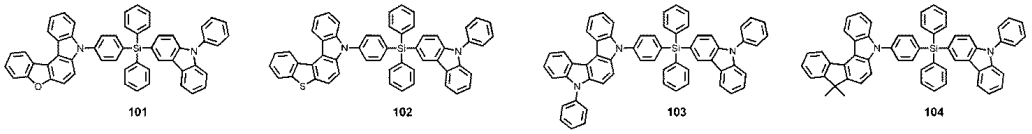

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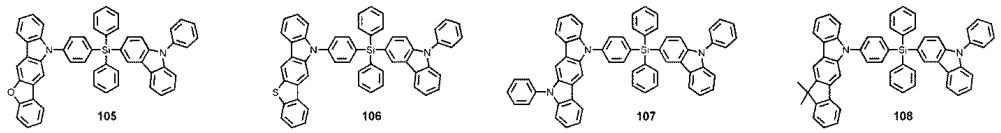

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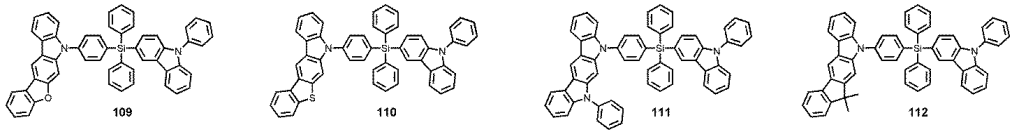

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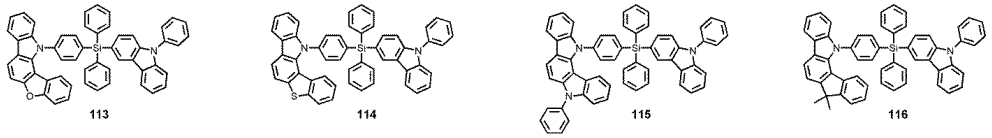
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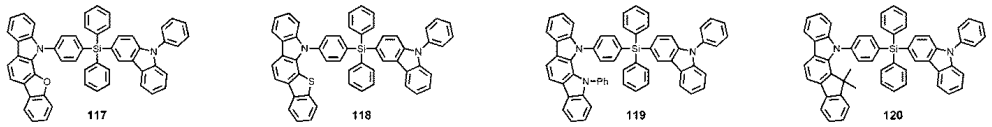

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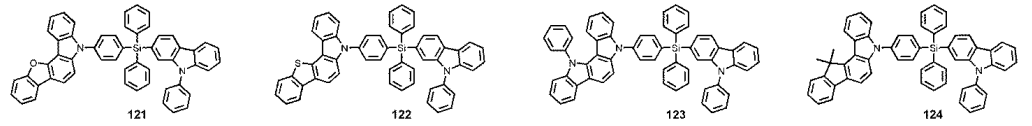

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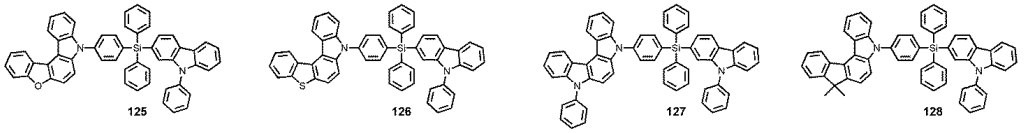

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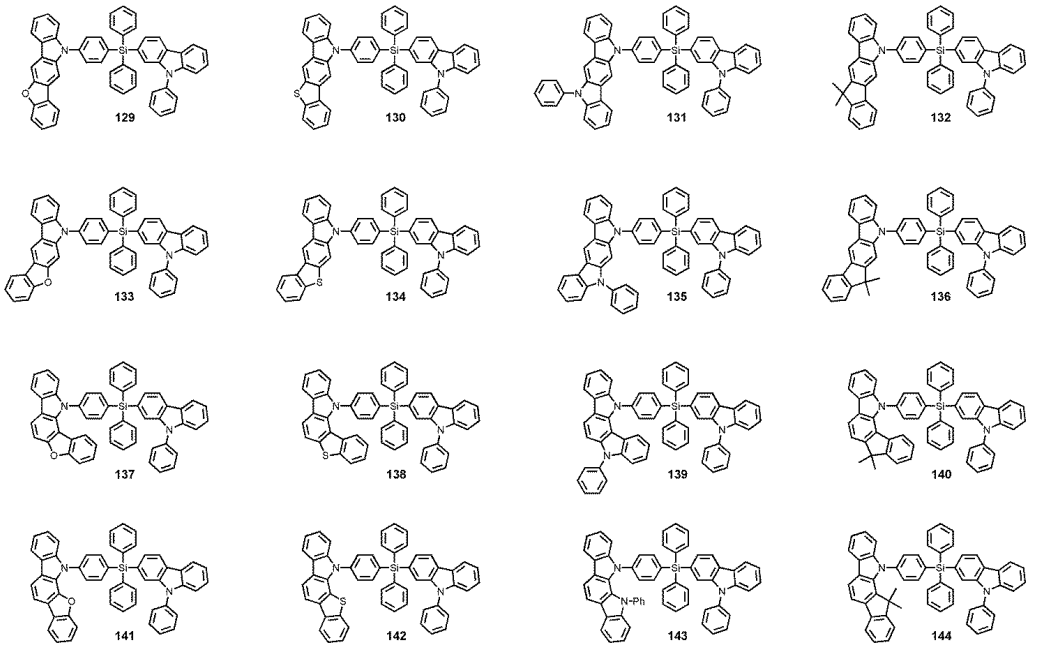

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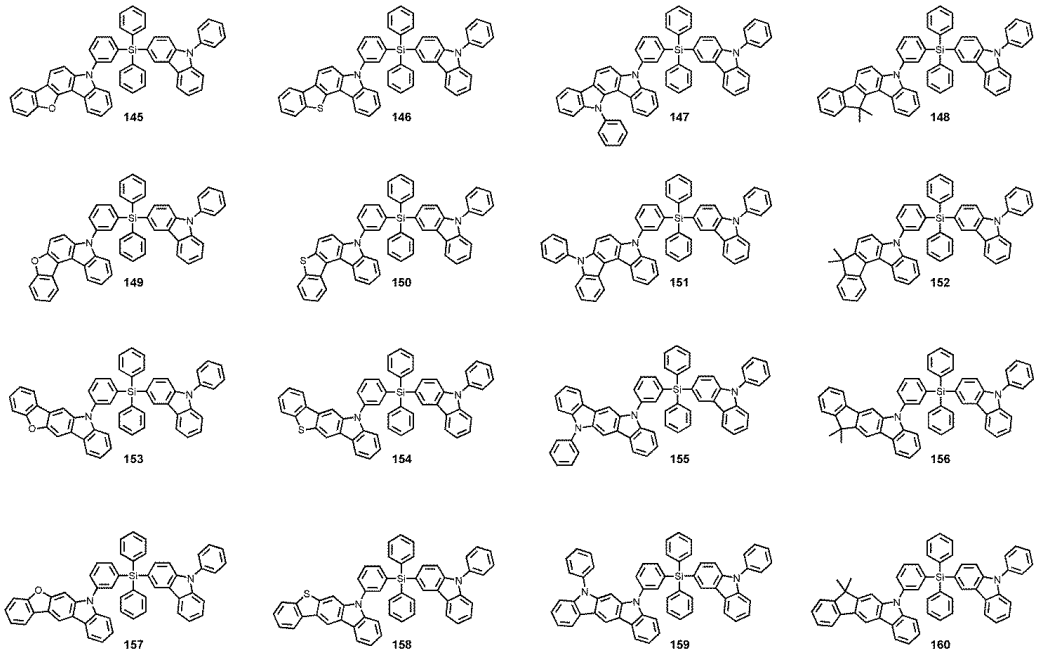

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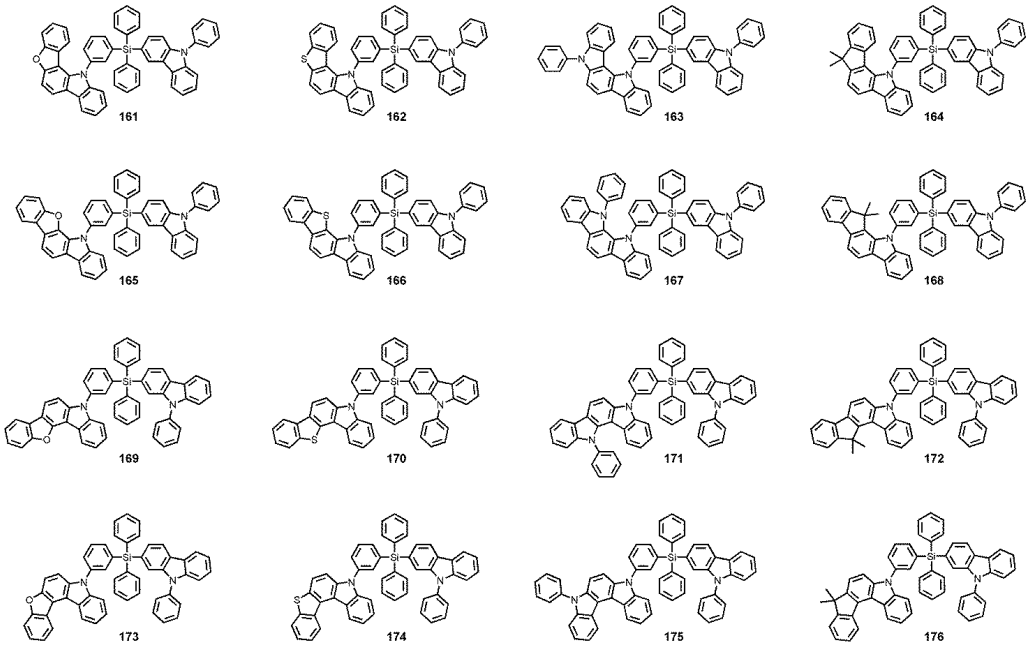
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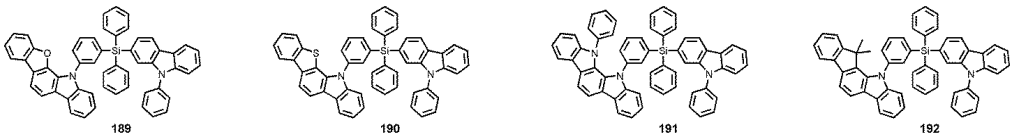
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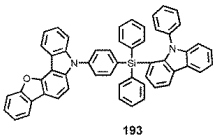
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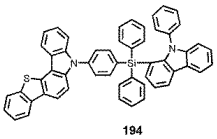

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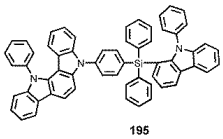
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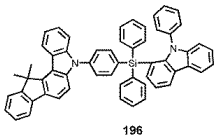

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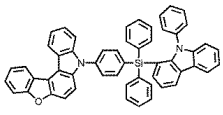
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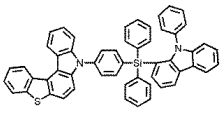

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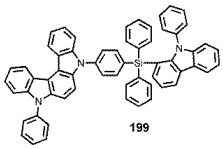

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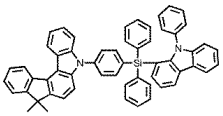

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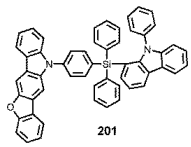

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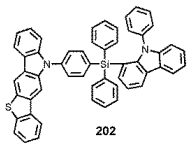

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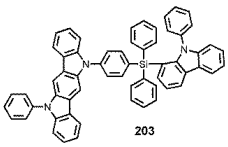

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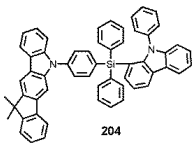

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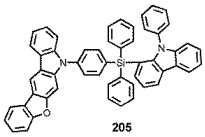

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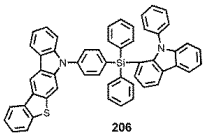

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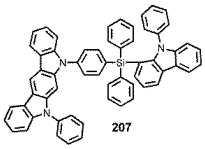

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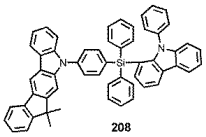

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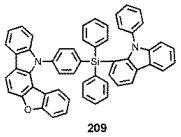

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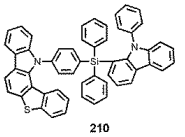

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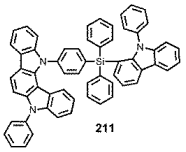

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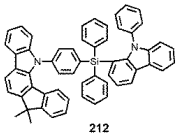

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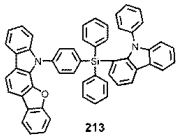

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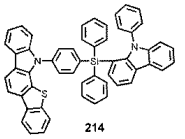

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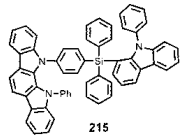

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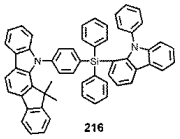

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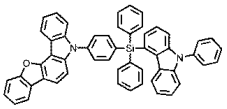

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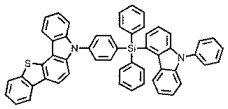

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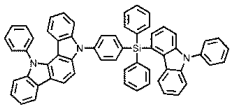

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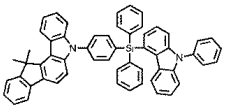

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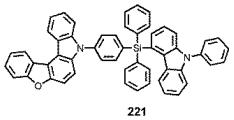
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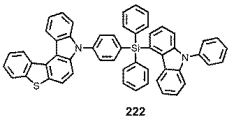

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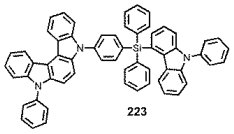

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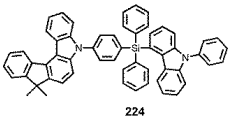

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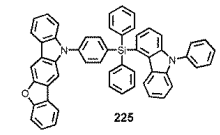

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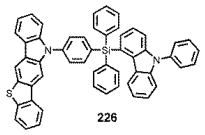

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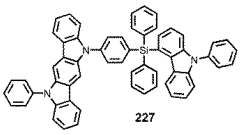

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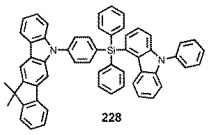

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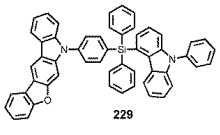
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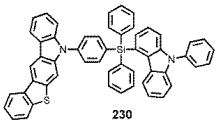

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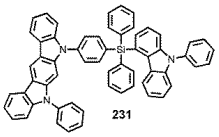

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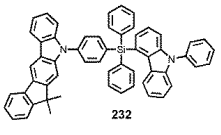

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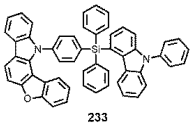

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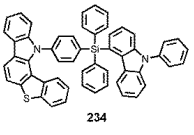

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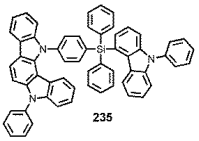

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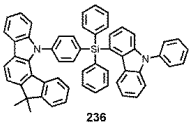

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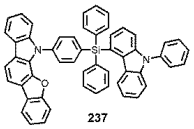

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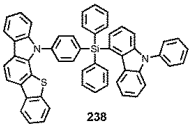

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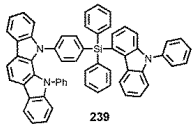

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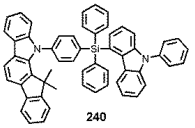

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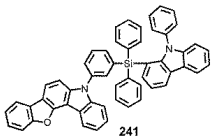

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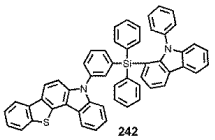

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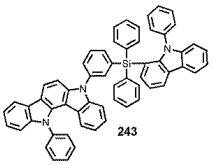

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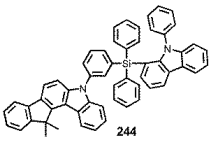

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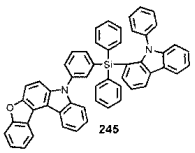
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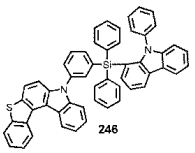

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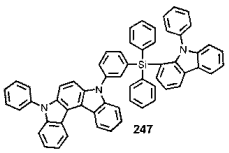

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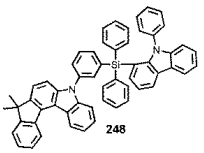

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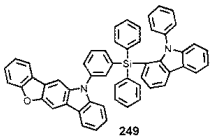

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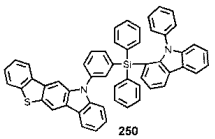

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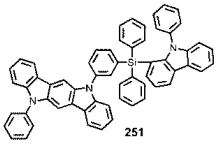

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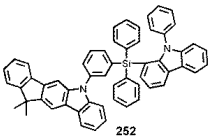

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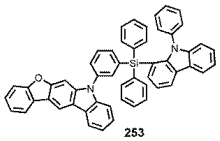

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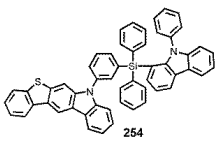

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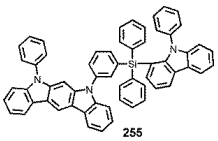

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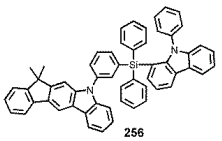

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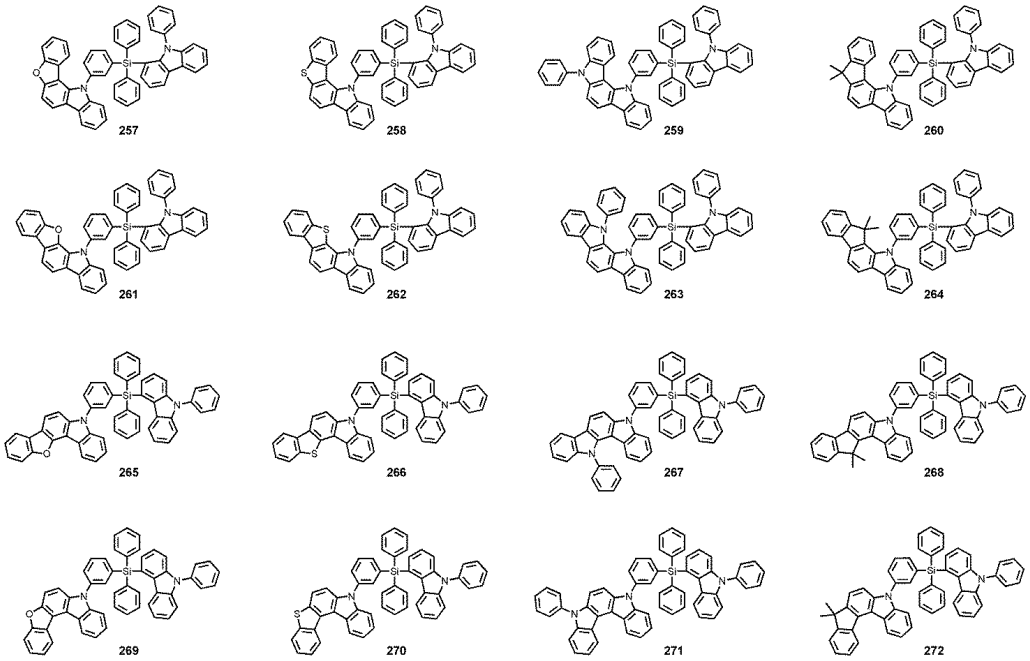

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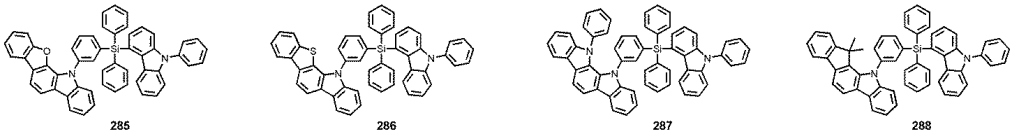

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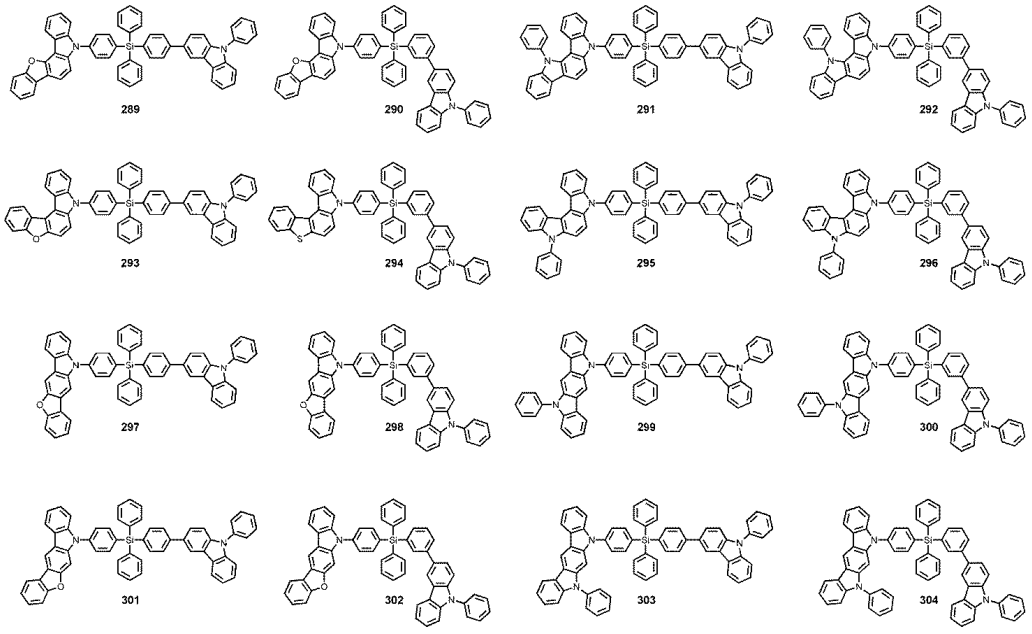
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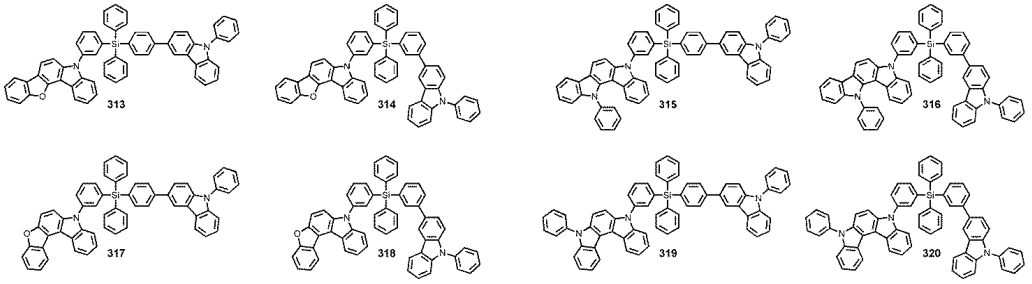
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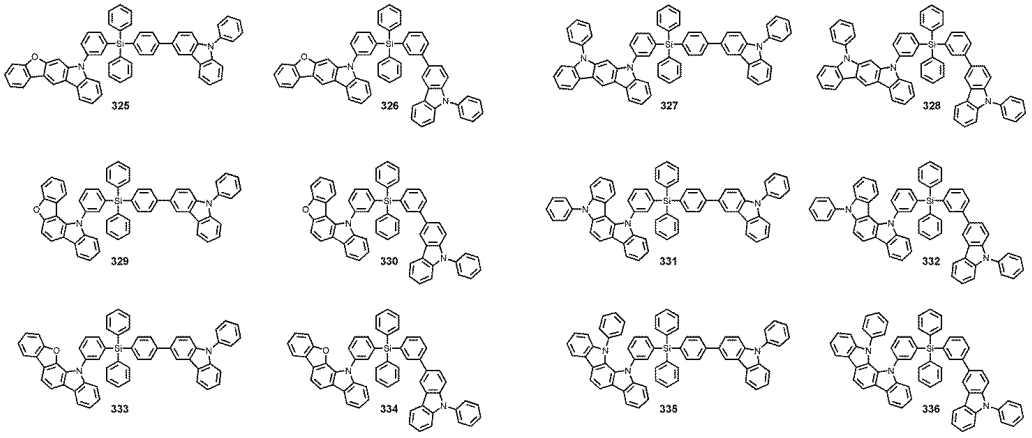
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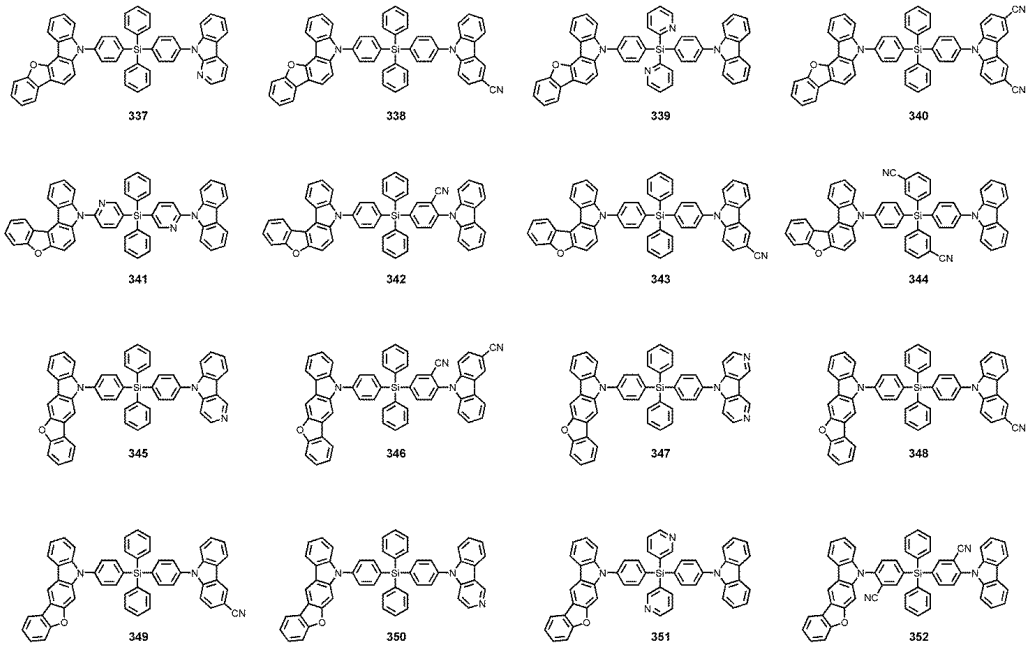
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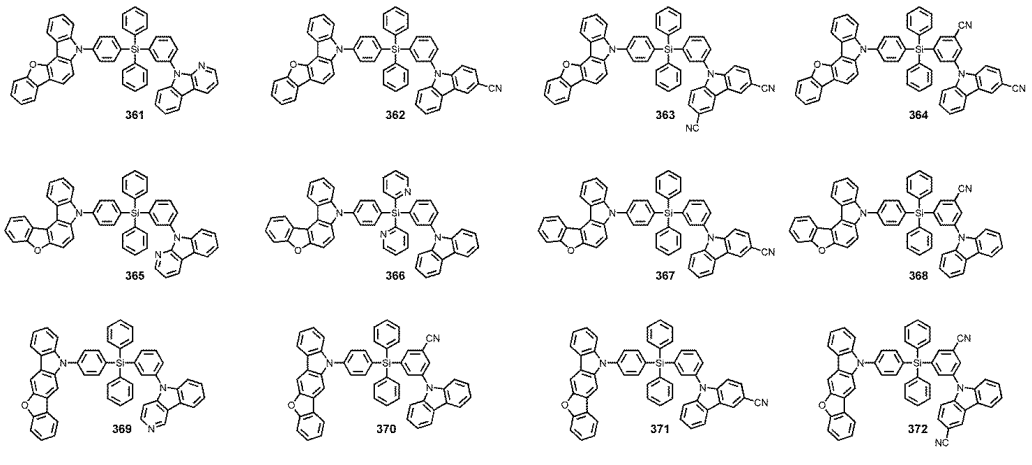
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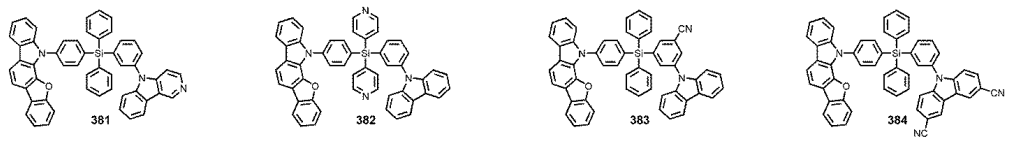
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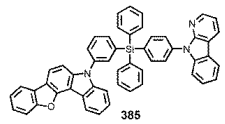
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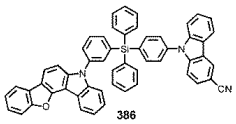


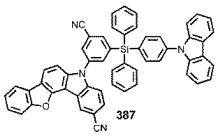
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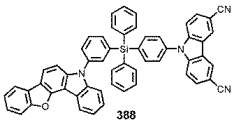


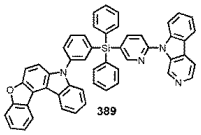
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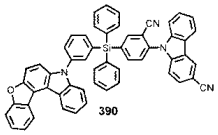

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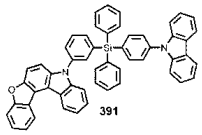

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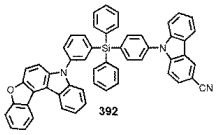

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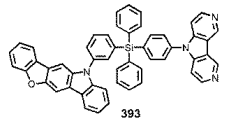

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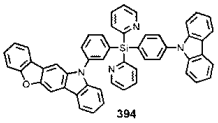

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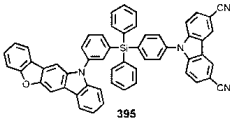

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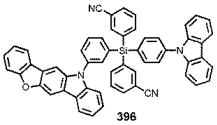

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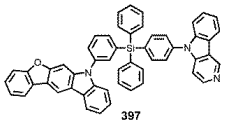

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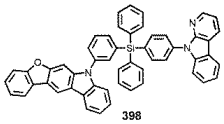

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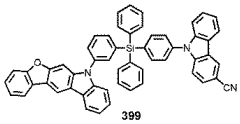

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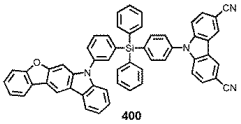

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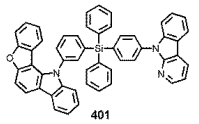

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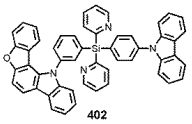

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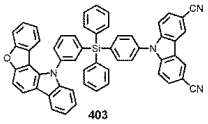

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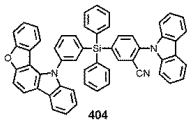

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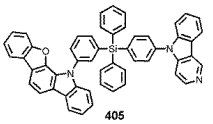
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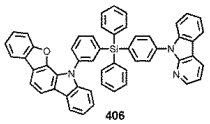

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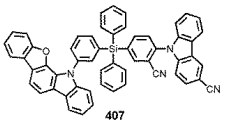

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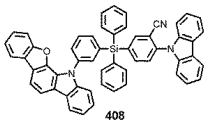

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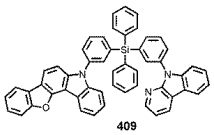

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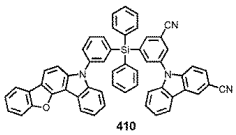

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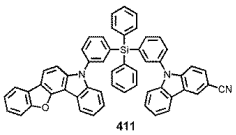

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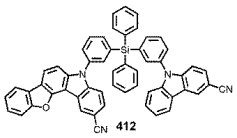

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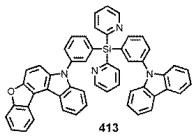

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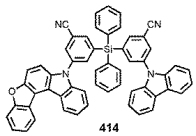

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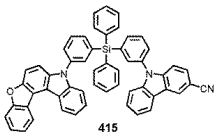

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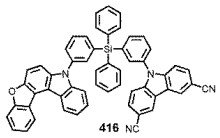

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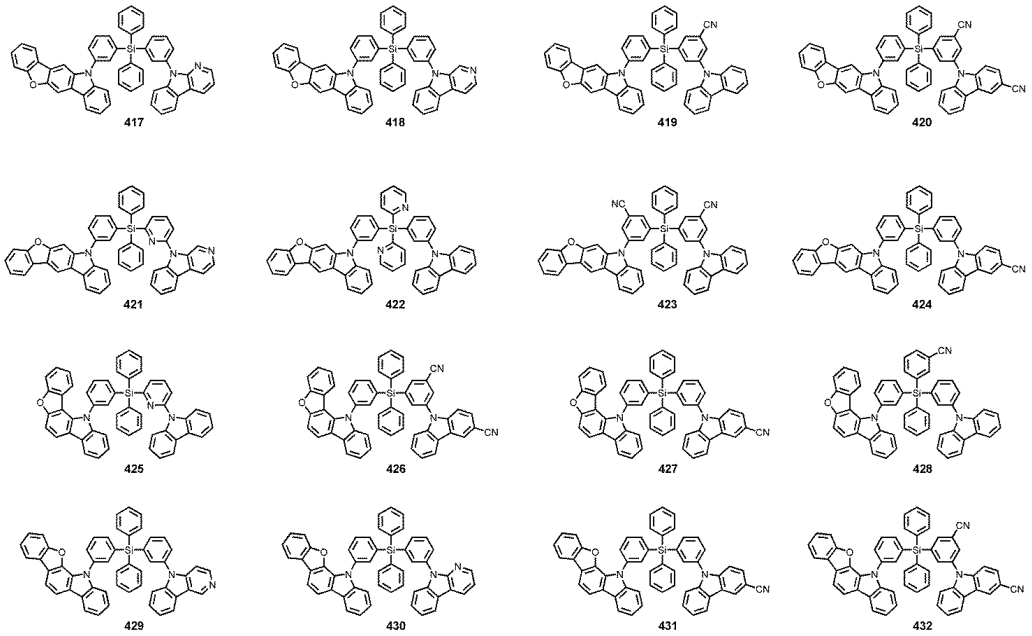

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[0565] 

[0566] 상기 화합물 1 내지 432 중,

[0567] Ph는 페닐기이다.

[0568] 상기 발광층 중 상기 호스트의 함량은 30 중량% 내지 90 중량% 범위 내에서 선택될 수 있다. 상술한 바와 같은 범위를 만족할 경우, 발광층 중 효과적인 에너지 전달을 달성할 수 있는 바, 고효율 및 장수명의 유기 발광 소자를 구현할 수 있다.

[0569] 일 실시예에 있어서, 상기 호스트가 제1화합물 및 제2화합물을 포함하는 경우, 상기 제1화합물 및 상기 제2화합물은 엑시플렉스를 형성할 수도 있으나, 이에 한정되는 것은 아니다. 엑시플렉스가 형성되는 경우, 후술하는 조건 1 등의 호스트에 관한 기재는 엑시플렉스로 대체되어 이해될 수 있다.

[0570] 한편, 상기 호스트가 제1화합물 및 제2화합물을 포함하는 경우, 상기 제1화합물과 상기 제2화합물의 중량비는 1 : 9 내지 9 : 1, 예를 들면, 2 : 8 내지 8 : 2, 또 다른 예로서, 4 : 6 내지 6 : 4, 또 다른 예로서, 5 : 5의 범위 중에서 선택될 수 있다.

[0571] 상기 호스트는 광을 방출하지 않을 수 있다.

[0572] [에미터]

[0573] 상기 에미터는 광을 방출할 수 있다.

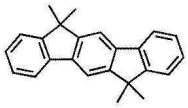
[0574] 구체적으로, 상기 에미터는 형광 및/또는 지연 형광을 방출하는 형광 및/또는 지연 형광 도펀트일 수 있다. 이에 따라, 상기 에미터의 감쇠 시간($T_{decay}(E)$)은 100 μs 미만일 수 있다.

[0575] $T_{decay}(E)$은 쿼츠 기판 상에 상기 발광층에 포함된 호스트 및 에미터를 90:10의 중량비로 10^{-7} torr의 진공도에서 진공 공증착하여 수득한 40nm 두께의 필름에 대한 상온에서의 TRPL(Time-Resolved Photoluminescece) 스펙트럼으로부터 계산한 값이다.

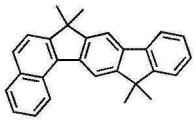
[0576] 상기 에미터는 축합다환 화합물 및 스티릴계 화합물 중에서 선택될 수 있다.

[0577] 일 실시예에 있어서, 상기 에미터는 나프탈렌-함유 코어, 플루오렌-함유 코어, 스파이로-비플루오렌-함유 코어, 벤조플루오렌-함유 코어, 디벤조플루오렌-함유 코어, 페난트렌-함유 코어, 안트라센-함유 코어, 플루오란텐-함유 코어, 트리페닐렌-함유 코어, 파이렌-함유 코어, 크라이센-함유 코어, 피센-함유 코어, 페릴렌-함유 코어, 펜타센-함유 코어, 인데노안트라센-함유 코어, 테트라센-함유 코어, 비스안트라센-함유 코어 및 하기 화학식 501-1 내지 501-20으로 표시되는 코어 중 하나를 포함할 수 있다:

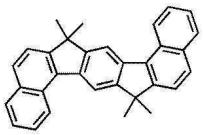
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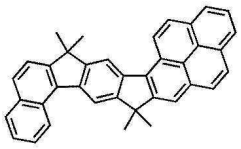
501-1



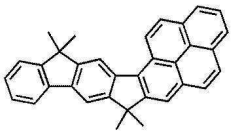
501-2



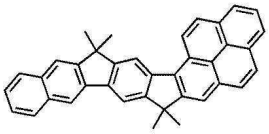
501-3



501-4

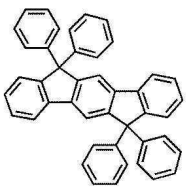


501-5



501-6

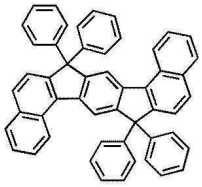
[0579]



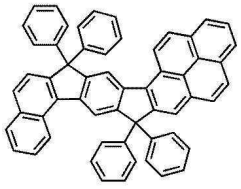
501-7



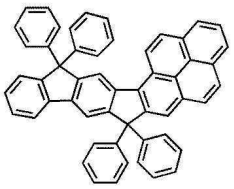
501-8



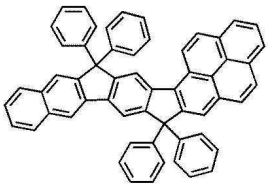
501-9



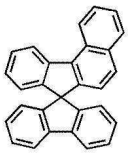
501-10



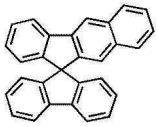
501-11



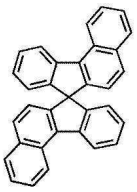
501-12



501-13

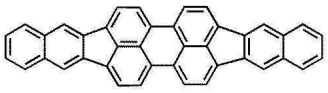


501-14

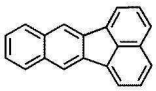


501-15

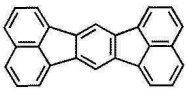
[0580]



501-16

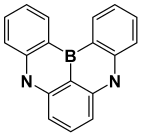


501-17

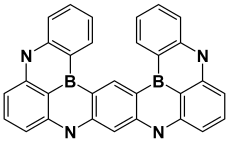


501-18

[0581]



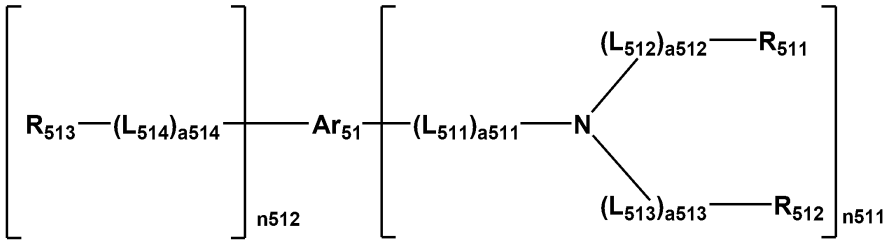
501-19



501-20

[0582] 구체적으로, 상기 에미터는 하기 화학식 51로 표시될 수 있다:

[0583] <화학식 51>

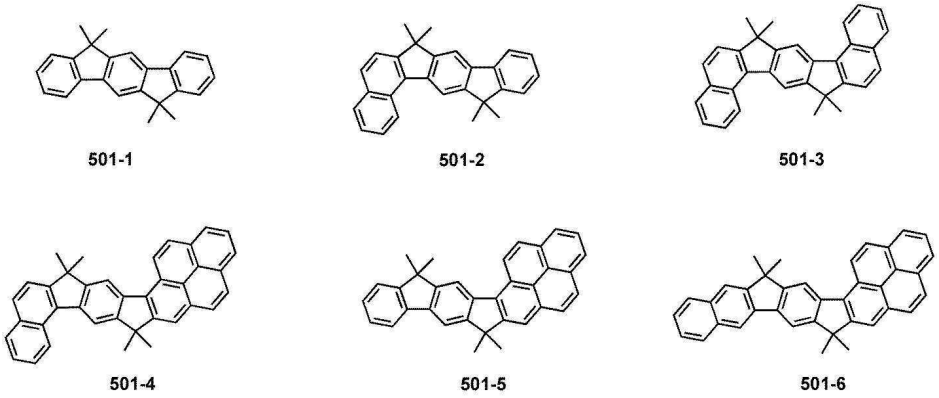


[0584]

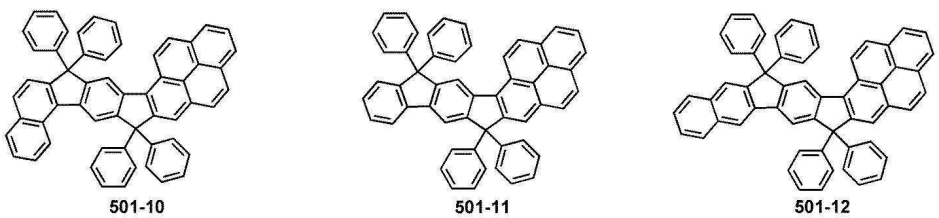
[0585] 상기 화학식 51 중,

[0586] Ar_{51}은 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라진기, 히드라존기, 술폰산기 또는 이의 염, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, $-Si(Q_{511})(Q_{512})(Q_{513})$, $-Ge(Q_{511})(Q_{512})(Q_{513})$, $-C(Q_{511})(Q_{512})(Q_{513})$, $-B(Q_{511})(Q_{512})$, $-N(Q_{511})(Q_{512})$, $-P(Q_{511})(Q_{512})$, $-C(=O)(Q_{511})$, $-S(=O)(Q_{511})$, $-S(=O)_2(Q_{511})$, $-P(=O)(Q_{511})(Q_{512})$, $-P(=S)(Q_{511})(Q_{512})$, 또는 이의 임의의 조합으로 치환 또는 비치환된, 나프탈렌 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 피센 그룹, 페릴렌 그룹, 펜타센 그룹, 인데노안트라센 그룹, 테트라센 그룹, 비스안트라센 그룹 또는 하기 화학식 501-1 내지 501-20으로 표시되는 그룹; 이고;

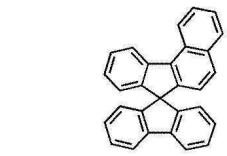
[0587]



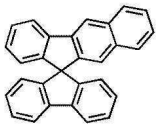
[0588]



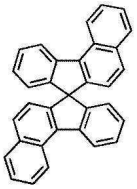
[0589]



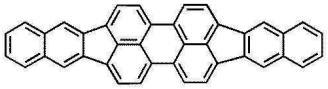
501-13



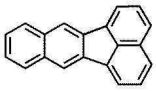
501-14



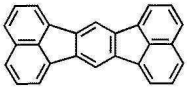
501-15



501-16



501-17

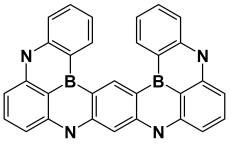


501-18

[0590]



501-19



501-20

[0591] L_{511} 내지 L_{514}는 서로 독립적으로, 치환 또는 비치환된 C_3-C_{10}시클로알킬렌기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬렌기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐렌기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐렌기, 치환 또는 비치환된 C_6-C_{60}아릴렌기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴렌기, 치환 또는 비치환된 2가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 2가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

[0592] a511 내지 a514는 서로 독립적으로, 0, 1, 2 및 3 중에서 선택되고,

[0593] R_{511} 내지 R_{513}은 서로 독립적으로, 치환 또는 비치환된 C_1-C_{60}알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_7-C_{60}알킬아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 C_2-C_{60}알킬헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고,

[0594] Q_{511} 내지 Q_{513}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_7-C_{60}알킬아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, C_2-C_{60}알킬헤테로아릴기, C_1-C_{60}헤테로아릴옥시기, C_1-C_{60}헤테로아릴티오기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_1-C_{60}알킬기 및 중수소, -F, 시아노기, C_1-C_{20}알킬기 및 C_6-C_{30}아릴기 중에서 선택된 적어도 하나로 치환된 C_6-C_{60}아릴기 중에서 선택되고,

[0595] n511 및 n512는 서로 독립적으로, 0, 1, 2, 3, 4, 5 및 6 중에서 선택된다.

[0596] 예를 들어, 상기 화학식 51 중, n511 및 n512의 합은 1 이상일 수 있으나, 이에 한정되는 것은 아니다.

[0597] 예를 들어, 상기 화학식 51 중, R_{511} 및 R_{512}는 서로 독립적으로, 페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페난트레닐기, 안트라세닐기, 파이레닐기, 크라이세닐기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 카바졸기, 트리아지닐기, 디벤조퓨라닐기 및 디벤조티오페닐기; 및

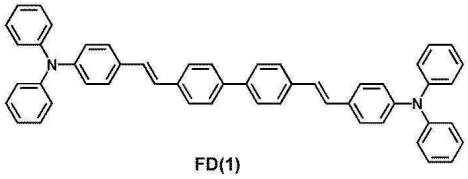
[0598] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페난트레닐기, 안트라세닐기, 파이레닐기, 크라이세닐기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리

다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 카바졸일기, 트리아지닐기, 디벤조퓨라닐기 및 디벤조티오페닐기 중에서 선택된 적어도 하나로 치환된, 페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페난트레닐기, 안트라세닐기, 파이레닐기, 크라이세닐기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 퀴녹살리닐기, 퀴나졸리닐기, 카바졸일기, 트리아지닐기, 디벤조퓨라닐기 및 디벤조티오페닐기; 중에서 선택될 수 있다.

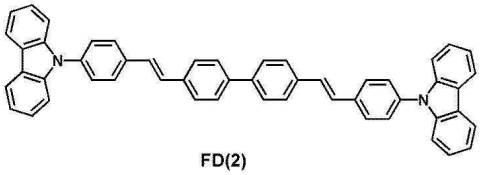
[0599] 일 실시예에 있어서, 상기 에미터는 하기 그룹 FD1 중에서 선택될 수 있다:

[0600] <그룹 FD1>

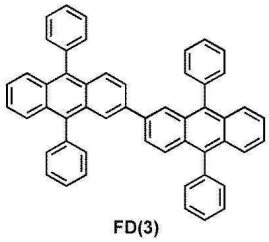
[0601]



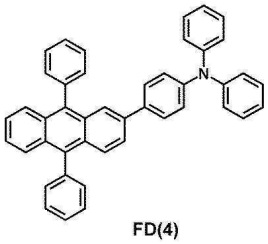
FD(1)



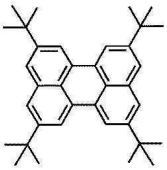
FD(2)



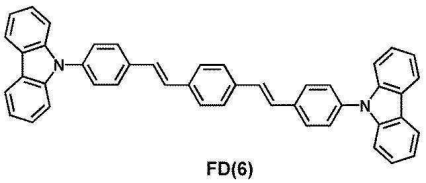
FD(3)



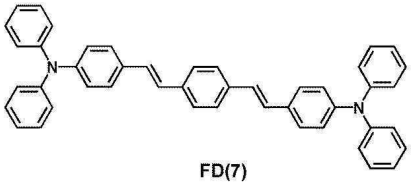
FD(4)



FD(5)

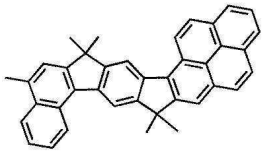


FD(6)

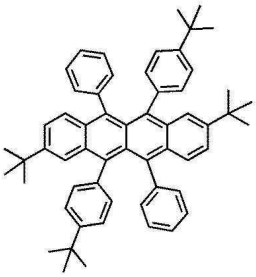


FD(7)

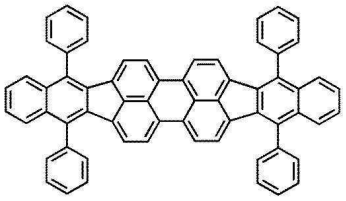
[0602]



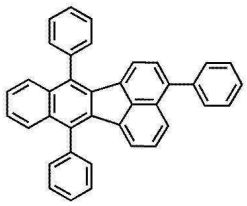
FD(8)



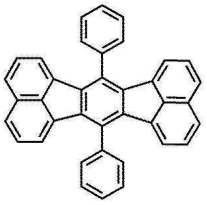
FD(9)



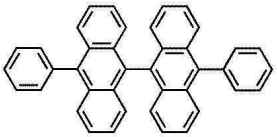
FD(10)



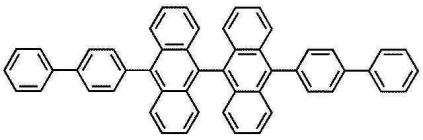
FD(11)



FD(12)



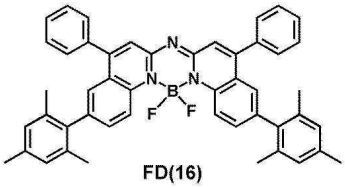
FD(13)



FD(14)

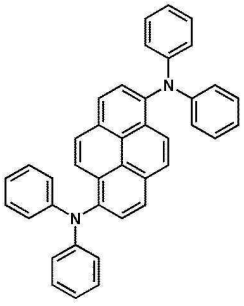


FD(15)

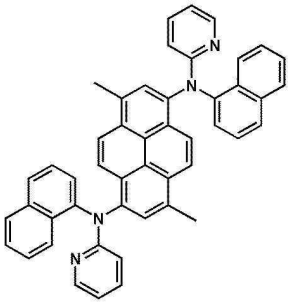


FD(16)

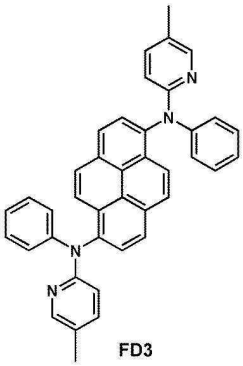
[0603]



FD1

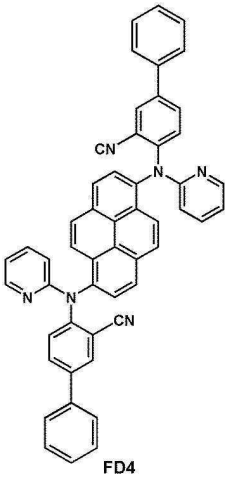


FD2

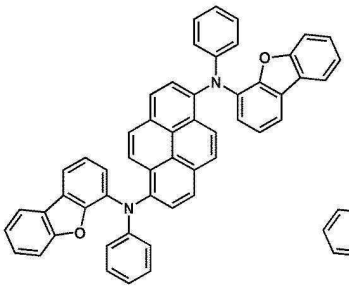


FD3

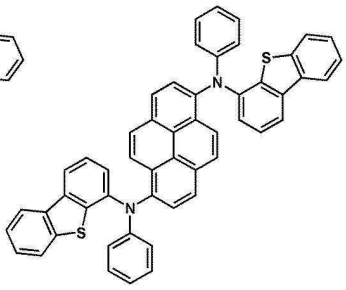
[0604]



FD4

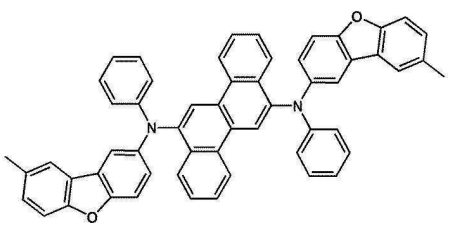


FD5

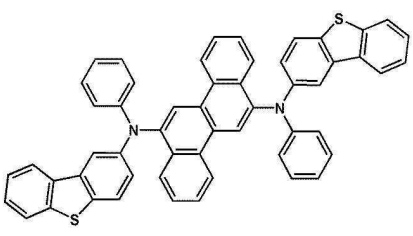


FD6

[0605]



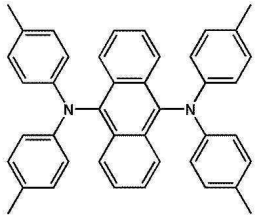
FD7



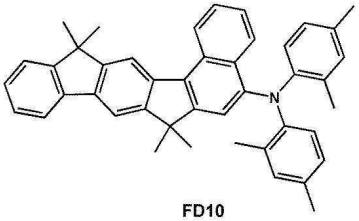
FD8

[0606]

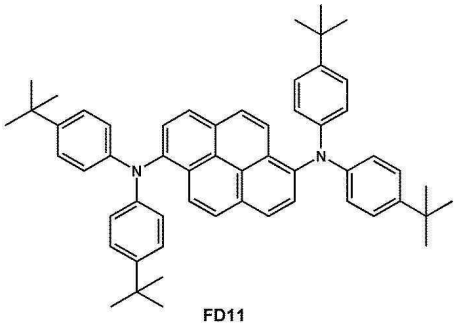
[0607]



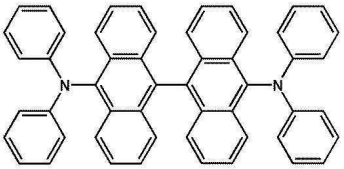
FD9



FD10

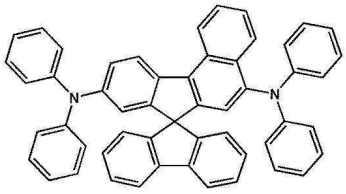


FD11



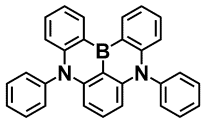
FD12

[0608]

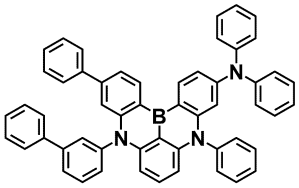


FD13

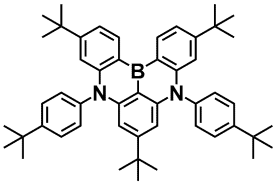
[0609]



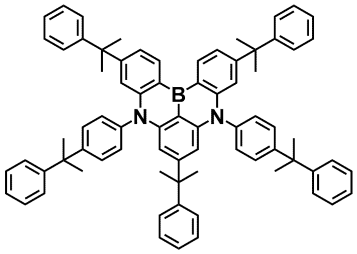
BD1-1



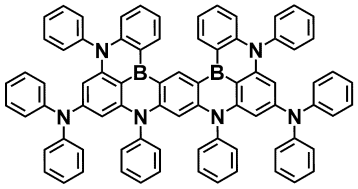
BD1-2



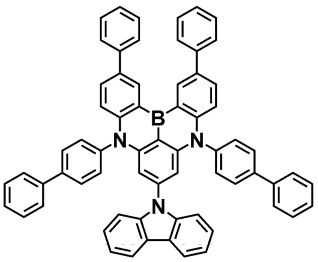
BD1-3



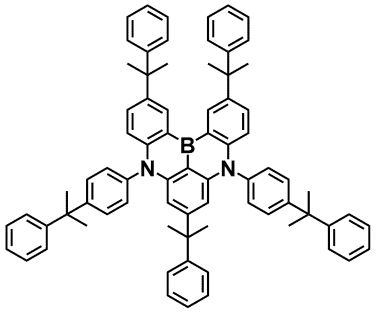
BD1-4



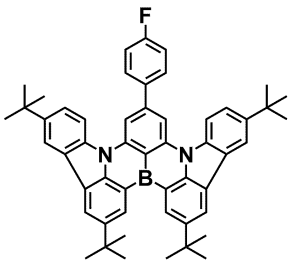
BD1-5



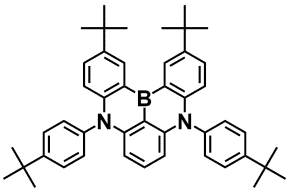
BD1-6



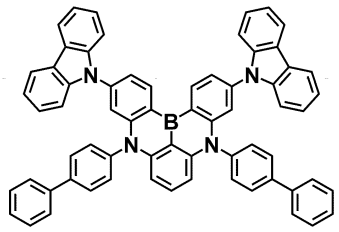
BD1-7



BD1-8



BD1-9



BD1-10

[0610]

[0611] 상기 에미터의 발광 스펙트럼의 최대 발광 파장은 400nm 이상 및 650nm 이하일 수 있다. 예를 들어, 상기 에미터의 발광 스펙트럼의 최대 발광 파장은 400nm 이상 및 550nm 이하, 40nm 이상 및 495nm 이하, 450 nm 이상 및 495 nm 이하일 수 있으나, 이에 한정되는 것은 아니다. 상기 에미터는 청색광 내지 녹색광, 구체적으로 청색광을 방출할 수 있으나, 이에 한정되는 것은 아니다. 상기 "최대 발광 파장"은 발광 세기가 최대인 파장을 가리키는 것으로서, "피크 발광 파장"이라고도 할 수 있다.

[0612] 상기 발광층 중 상기 에미터의 함량은 0.01 중량% 내지 15 중량% 범위에서 선택될 수 있으며, 이에 한정되는 것은 아니다.

[0613] 상기 발광층 중 상기 호스트, 상기 센서타이저 및 상기 에미터의 함량은 상기 호스트가 가장 크고, 상기 에미터가 가장 작을 수 있으나, 이에 한정되는 것은 아니다.

[0614] 상기 유기 발광 소자는 하기 조건 1을 만족할 수 있다:

[0615] <조건 1>

[0616] $S_1(H) > S_1(S) \geq S_1(E)$

[0617] 상기 조건 1 중,

[0618] $S_1(H)$은 상기 호스트의 최저 여기 일중항 에너지 레벨이고;

[0619] $S_1(S)$은 상기 센서타이저의 최저 여기 일중항 에너지 레벨이고;

[0620] $S_1(E)$는 상기 에미터의 최저 여기 일중항 에너지 레벨이다.

[0621] $S_1(H)$, $S_1(S)$ 및 $S_1(E)$는 각각 쿼츠 기판 상에 호스트, 센서타이저 또는 에미터를 10^{-7} torr의 진공도에서 진공 공증착하여 수득한 40nm 두께의 필름에 대해 얻어진 PL 스펙트럼으로부터 계산한 값이다.

[0622] 상기 조건 1을 만족하면, 상기 에미터가 발광할 수 있고, 향상된 효율의 유기 발광 소자를 제공할 수 있다.

[0623] 예를 들어, 상기 조건 1을 만족하면, 상기 유기 발광 소자에서 상기 에미터로부터의 발광 비율이 85% 이상일 수 있다. 즉, 상술한 범위를 만족하면, 상기 유기 발광 소자에서 상기 에미터만이 실질적으로 발광하고, 상기 엑시플렉스와 상기 센서타이저는 실질적으로 발광하지 않는다.

[0624] 상기 호스트에서 형성된 일중항 및/또는 삼중항 엑시톤이 상기 센서타이저에 전이된 다음, 역항간전이(RISC)를

통해 상기 센서타이저에서 삼중항 엑시톤이 일중항 엑시톤으로 변환된 후, Förster 에너지 전이(FRET)를 통해 에미터로 전이된다. 상기 호스트의 일중항 엑시톤 및 삼중항 엑시톤을 모두 상기 에미터에 전달할 수 있기 때문에, 상기 유기 발광 소자는 현저히 향상된 수명 및 효율을 가질 수 있다.

[0625] 한편, 상기 호스트 및 상기 센서타이저는 하기 조건 2를 만족할 수 있다:

[0626] <조건 2>

[0627] $T_1(H) \geq T_1(S)$

[0628] 상기 조건 2 중,

[0629] $T_1(H)$은 상기 호스트의 최저 여기 삼중항 에너지 레벨이고;

[0630] $T_1(S)$은 상기 센서타이저의 최저 여기 삼중항 에너지 레벨이다.

[0631] 상기 발광층의 두께는 약 100Å 내지 약 1000Å, 예를 들면 약 200Å 내지 약 600Å일 수 있다. 상기 발광층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 우수한 발광 특성을 나타낼 수 있다.

[0632] **[정공 수송 영역(12)]**

[0633] 유기 발광 소자(10) 중 제1전극(11)과 발광층(15)과 사이에는 정공 수송 영역(12)이 배치되어 있다.

[0634] 상기 정공 수송 영역(12)은 단층 또는 다층 구조를 가질 수 있다.

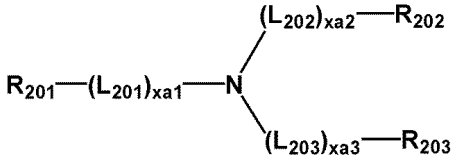
[0635] 예를 들어, 상기 정공 수송 영역(12)은 정공 주입층, 정공 수송층, 정공 주입층/정공 수송층, 정공 주입층/제1정공 수송층/제2정공 수송층, 정공 수송층/중간층, 정공 주입층/정공 수송층/중간층, 정공 수송층/전자 저지층 또는 정공 주입층/정공 수송층/전자 저지층의 구조를 가질 수 있으나, 이에 한정되는 것은 아니다.

[0636] 상기 정공 수송 영역(12)은, 정공 수송 특성을 갖는 임의의 화합물을 포함할 수 있다.

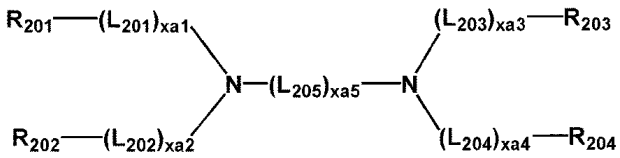
[0637] 예를 들어, 상기 정공 수송 영역(12)은 아민계 화합물을 포함할 수 있다.

[0638] 일 실시예에 따르면, 상기 정공 수송 영역(12)은 하기 화학식 201로 표시된 화합물 내지 하기 화학식 205로 표시된 화합물 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다:

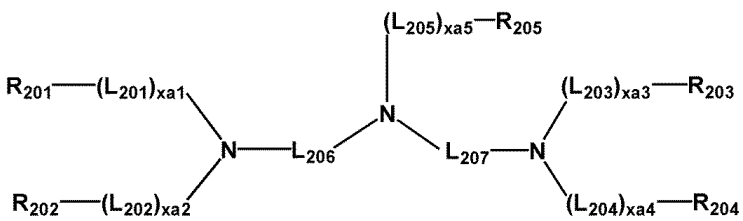
[0639] <화학식 201>

[0640] 

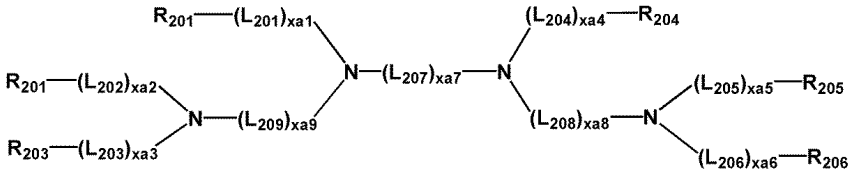
[0641] <화학식 202>

[0642] 

[0643] <화학식 203>

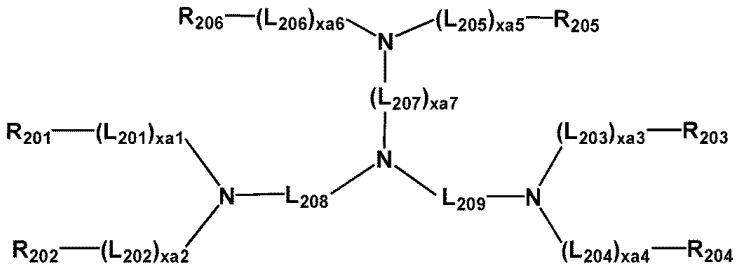
[0644] 

[0645] <화학식 204>



[0646]

[0647] <화학식 205>



[0648]

[0649] 상기 화학식 201 내지 205 중,

[0650] L_{201} 내지 L_{209}는 서로 독립적으로, *-O-*', *-S-*', 치환 또는 비치환된 C_5-C_{60}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{60}헤테로시클릭 그룹이고,

[0651] xa1 내지 xa9는 서로 독립적으로, 0 내지 5의 정수 중에서 선택되고,

[0652] R_{201} 내지 R_{206}은 서로 독립적으로, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되고, R_{201} 내지 R_{206} 인접한 2개의 그룹은 선택적으로, 단일 결합, 디메틸-메틸렌기 또는 디페닐-메틸렌기를 통하여 서로 연결될 수 있다.

[0653] 예를 들어,

[0654] 상기 L_{201} 내지 L_{209}는 중수소, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 나프틸기, 플루오레닐기, 카바졸일기, 디벤조퓨라닐기, 디벤조티오페닐기, 트리페닐레닐기, 비페닐기, 터페닐기, 테트라페닐기 및 $-Si(Q_{11})(Q_{12})(Q_{13})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 벤젠 그룹, 헵탈렌 그룹, 인덴 그룹, 나프탈렌 그룹, 아줄렌 그룹, 헵탈렌 그룹, 인다센 그룹, 아세나프틸렌 그룹, 플루오렌 그룹, 스파이로-바이플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 페릴렌 그룹, 펜타센 그룹, 헥사센 그룹, 펜타펜 그룹, 루비센 그룹, 코로젠 그룹, 오발렌 그룹, 피롤 그룹, 이소인돌 그룹, 인돌 그룹, 퓨란 그룹, 티오펜 그룹, 벤조퓨란 그룹, 벤조티오펜 그룹, 벤조카바졸 그룹, 디벤조카바졸 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 디벤조티오펜 설폰(dibenzothiophene sulfone) 그룹, 카바졸 그룹, 디벤조실롤 그룹, 인데노카바졸 그룹, 인돌로카바졸 그룹, 벤조퓨로카바졸 그룹, 벤조티에노카바졸 그룹 및 트라이인돌로벤젠 그룹 중에서 선택될 수 있고,

[0655] xa1 내지 xa9는 서로 독립적으로, 0, 1 또는 2이고,

[0656] R_{201} 내지 R_{206}은 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기, 시클로펜테닐기, 시클로헥세닐기, 페닐기, 비페닐기, 터페닐기, C_1-C_{10}알킬기로 치환된 페닐기, -F로 치환된 페닐기, 펜탈레닐기, 인데닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페날레닐기, 페난트레닐기, 안트라세닐기, 플루오란테

닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페릴레닐기, 펜타페닐기, 헥사세닐기, 펜타세닐기, 루비세닐기, 코로네닐기, 오발레닐기, 티오페닐기, 퓨라닐기, 카바졸일기, 인돌일기, 이소인돌일기, 벤조퓨라닐기, 벤조티오페닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 디벤조실롤일기, 피리디닐기, $-Si(Q_{31})(Q_{32})(Q_{33})$ 및 $-N(Q_{31})(Q_{32})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 페닐기, 비페닐기, 터페닐기, 펜탈레닐기, 인데닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페날레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페릴레닐기, 펜타페닐기, 헥사세닐기, 펜타세닐기, 루비세닐기, 코로네닐기, 오발레닐기, 티오페닐기, 퓨라닐기, 카바졸일기, 인돌일기, 이소인돌일기, 벤조퓨라닐기, 벤조티오페닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 디벤조실롤일기, 피리디닐기, 인데노카바졸일기, 인돌로카바졸일기, 벤조퓨로카바졸일기 및 벤조티에노카바졸일기 중에서 선택되고,

[0657] 상기 Q_{11} 내지 Q_{13} 및 Q_{31} 내지 Q_{33}은 서로 독립적으로, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 비페닐기, 터페닐기 및 나프틸기 중에서 선택된다.

[0658] 일 구현에에 따르면, 상기 정공 수송 영역(12)은 카바졸-함유 아민계 화합물을 포함할 수 있다.

[0659] 다른 실시예에 따르면, 상기 정공 수송 영역(12)은 카바졸-함유 아민계 화합물 및 카바졸-비함유 아민계 화합물을 포함할 수 있다.

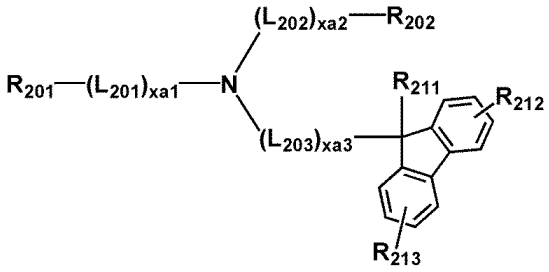
[0660] 상기 카바졸-함유 아민계 화합물은, 예를 들어, 카바졸 그룹은 포함하고, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 인데노카바졸 그룹, 인돌로카바졸 그룹, 벤조퓨로카바졸 그룹 및 벤조티에노카바졸 그룹 중 적어도 하나를 더 포함한, 화학식 201로 표시된 화합물 중에서 선택될 수 있다.

[0661] 상기 카바졸-비함유 아민계 화합물은, 예를 들어, 카바졸 그룹은 비포함하고, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 인데노카바졸 그룹, 인돌로카바졸 그룹, 벤조퓨로카바졸 그룹 및 벤조티에노카바졸 그룹 중 적어도 하나는 포함한, 화학식 201로 표시된 화합물 중에서 선택될 수 있다.

[0662] 또 다른 실시예에 따르면, 상기 정공 수송 영역(12)은, 상기 화학식 201 또는 202로 표시된 화합물 중에서 선택된 적어도 하나를 포함할 수 있다.

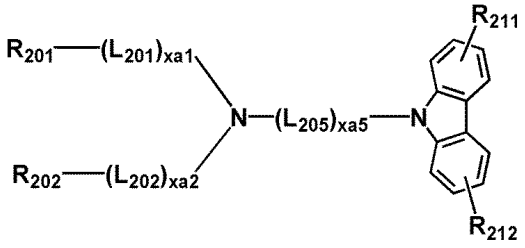
[0663] 일 실시예에 따르면, 상기 정공 수송 영역(12)은 하기 화학식 201-1, 202-1 및 201-2로 표시된 화합물 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다:

[0664] <화학식 201-1>



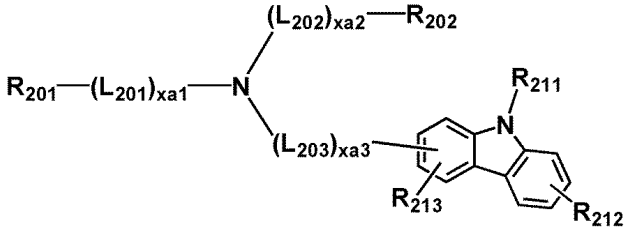
[0665]

[0666] <화학식 202-1>



[0667]

[0668] <화학식 201-2>

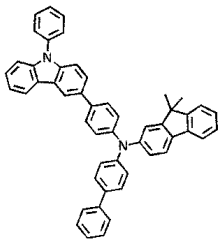


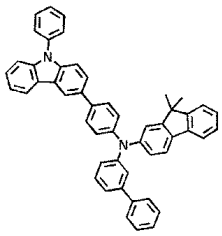
[0669]

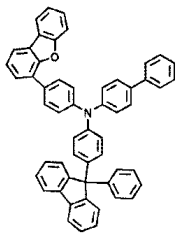
[0670] 상기 화학식 201-1, 202-1 및 201-2 중 L_{201} 내지 L_{203}, L_{205}, xa1 내지 xa3, xa5, R_{201} 및 R_{202}에 대한 설명은 각각 본 명세서에 기재된 바를 참조하고, R_{211} 내지 R_{213}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, C_1-C_{10}알킬기로 치환된 페닐기, -F로 치환된 페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 디메틸플루오레닐기, 디페닐플루오레닐기, 트리페닐레닐기, 티오페닐기, 퓨라닐기, 카바졸일기, 인돌일기, 이소인돌일기, 벤조퓨라닐기, 벤조티오페닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 디벤조실롤일기 및 피리디닐기 중에서 선택된다.

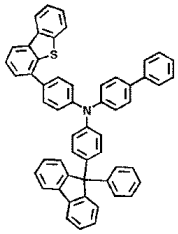
[0671] 예를 들어, 상기 정공 수송 영역(12)은 하기 화합물 HT1 내지 HT39 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다.

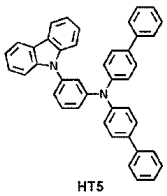
[0672]

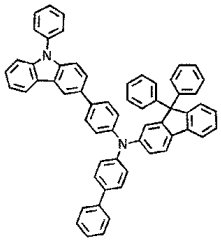

HT1

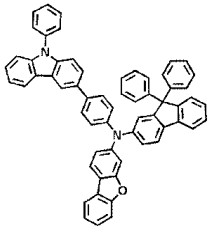

HT2

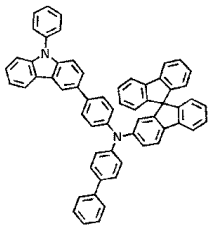

HT3

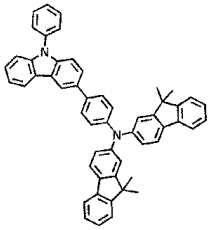

HT4


HT5

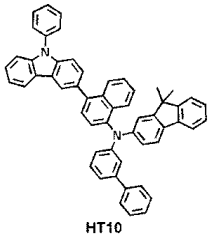

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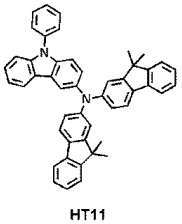

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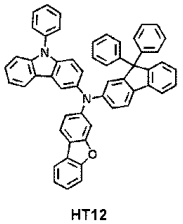

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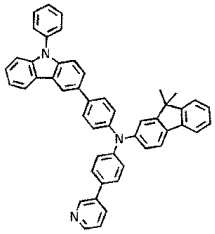

HT9

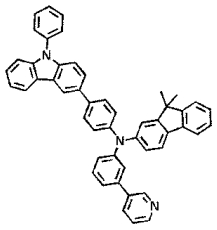
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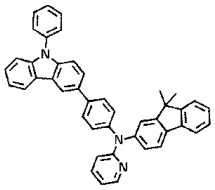

HT10


HT11

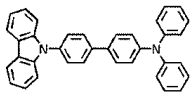

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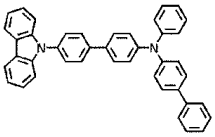

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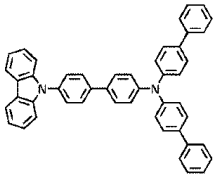

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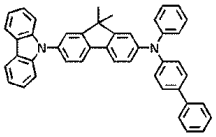

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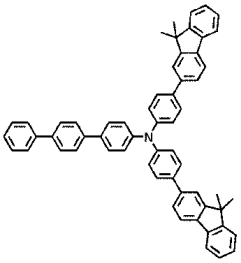
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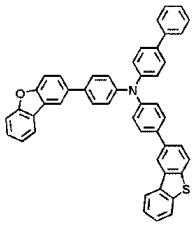

HT16


HT17

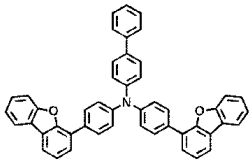

HT18

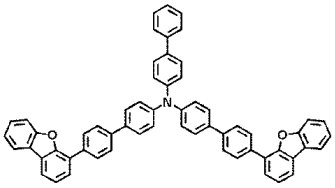

HT19

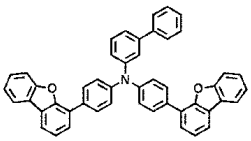

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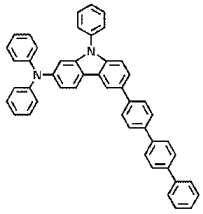

HT21

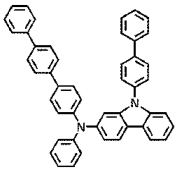
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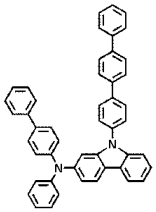

HT22


HT23

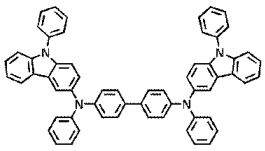

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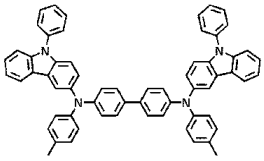

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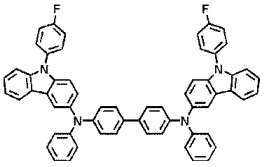

HT26

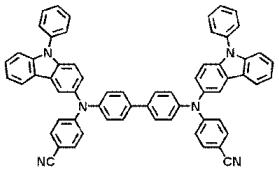

HT27

[0676]

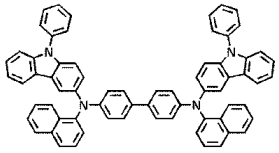

HT28


HT29

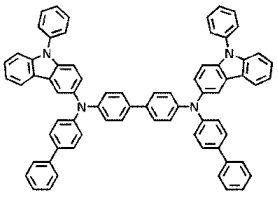

HT30



HT31

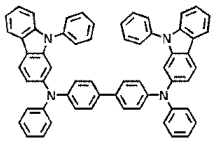


HT32

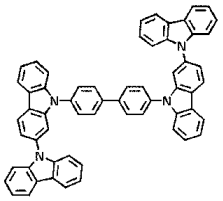


HT33

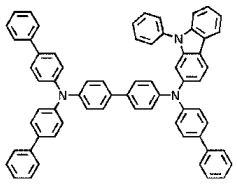
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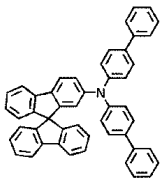
HT34



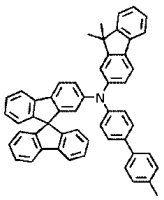
HT35



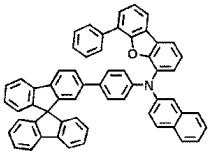
HT36



HT37



HT38



HT39

[0678]

[0679] 한편, 상기 유기 발광 소자(10)의 정공 수송 영역(12)은 p-도펀트를 더 포함할 수 있다. 상기 정공 수송 영역(12)이 p-도펀트를 더 포함할 경우, 상기 정공 수송 영역(12)은 매트릭스(예를 들면, 상기 화학식 201 내지 205로 표시된 화합물 중 적어도 하나) 및 상기 매트릭스에 포함된 p-도펀트를 포함한 구조를 가질 수 있다. 상기 p-도펀트는 정공 수송 영역(12)에 균일 또는 불균일하게 도핑될 수 있다.

[0680] 일 실시예에 따르면, 상기 p-도펀트의 LUMO 에너지 레벨은 -3.5eV 이하일 수 있다.

[0681] 상기 p-도펀트는, 퀴논 유도체, 금속 산화물 및 시아노기-함유 화합물 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다.

[0682] 예를 들어, 상기 p-도펀트는,

[0683] TCNQ (Tetracyanoquinodimethane), F4-TCNQ (2,3,5,6-Tetrafluoro-7,7,8,8-tetracyanoquinodimethane), F6-TCNNQ 등과 같은 퀴논 유도체;

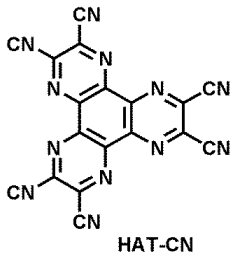
[0684] 텅스텐 산화물 및 몰리브덴 산화물 등과 같은 금속 산화물;

[0685] HAT-CN (1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile); 및

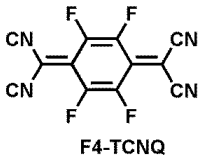
[0686] 하기 화학식 221로 표시되는 화합물;

[0687] 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다:

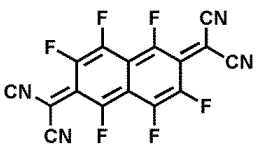
[0688]



HAT-CN

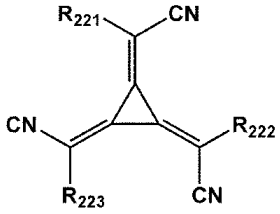


F4-TCNQ



F6-TCNNQ

[0689] <화학식 221>

[0690] 

[0691] 상기 화학식 221 중,

[0692] R_{221} 내지 R_{223}은 서로 독립적으로, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹 및 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 중에서 선택되되, 상기 R_{221} 내지 R_{223} 중 적어도 하나는 시아노기, -F, -Cl, -Br, -I, -F로 치환된 C_1-C_{20}알킬기, -Cl로 치환된 C_1-C_{20}알킬기, -Br로 치환된 C_1-C_{20}알킬기 및 -I로 치환된 C_1-C_{20}알킬기 중에서 선택된 적어도 하나의 치환기를 갖는다.

[0693] 상기 정공 수송 영역(12)의 두께는 약 100Å 내지 약 10000Å, 예를 들면, 약 400Å 내지 약 2000Å일 수 있고, 상기 발광층(15)의 두께는 약 100Å 내지 약 3000Å, 예를 들면, 약 300Å 내지 약 1000Å일 수 있다. 상기 정공 수송 영역(12) 및 발광층(15)의 두께가 상술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 정공 수송 특성 및/또는 발광 특성을 얻을 수 있다.

[0694] **[전자 수송 영역(17)]**

[0695] 유기 발광 소자(10) 중 발광층(15)과 제2전극(19) 사이에는 전자 수송 영역(17)이 배치되어 있다.

[0696] 상기 전자 수송 영역(17)은 단층 또는 다층 구조를 가질 수 있다.

[0697] 예를 들어, 상기 전자 수송 영역(17)은 전자 수송층, 전자 수송층/전자 주입층, 버퍼층/전자 수송층, 정공 저지층/전자 수송층, 버퍼층/전자 수송층/전자 주입층 또는 정공 저지층/전자 수송층/전자 주입층의 구조를 가질 수 있으나, 이에 한정되는 것은 아니다. 상기 전자 수송 영역(17)은 전자 제어층을 더 포함할 수 있다.

[0698] 상기 전자 수송 영역(17)은 공지된 전자 수송 물질을 포함할 수 있다.

[0699] 상기 전자 수송 영역(예를 들면, 상기 전자 수송 영역 중 버퍼층, 정공 저지층, 전자 조절층 또는 전자 수송층)은, π 전자 결핍성 함질소 시클릭 그룹을 적어도 하나 포함한 금속-비함유 화합물을 포함할 수 있다. 상기 π 전자 결핍성 함질소 시클릭 그룹에 대한 설명은 본 명세서에 기재된 바를 참조한다.

[0700] 예를 들어, 상기 전자 수송 영역은 하기 화학식 601로 표시되는 화합물을 포함할 수 있다.

[0701] <화학식 601>

[0702] $[Ar_{601}]_{xe11}$-$[(L_{601})_{xe1}$-$R_{601}]_{xe21}$

[0703] 상기 화학식 601 중,

[0704] Ar_{601} 및 L_{601}은 서로 독립적으로 치환 또는 비치환된 C_5-C_{60}카보시클릭 그룹 또는 치환 또는 비치환된 C_1-C_{60}헤테로시클릭 그룹이고,

[0705] xe11은 1, 2 또는 3이고,

[0706] xe1는 0 내지 5의 정수 중에서 선택되고,

[0707] R_{601}은, 치환 또는 비치환된 C_3-C_{10}시클로알킬기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알킬기, 치환 또는 비치환된 C_3-C_{10}시클로알케닐기, 치환 또는 비치환된 C_1-C_{10}헤테로시클로알케닐기, 치환 또는 비치환된 C_6-C_{60}아릴기, 치환 또는 비치환된 C_6-C_{60}아릴옥시기, 치환 또는 비치환된 C_6-C_{60}아릴티오기, 치환 또는 비치환된 C_1-C_{60}헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그

룹, $-Si(Q_{601})(Q_{602})(Q_{603})$, - $-C(=O)(Q_{601})$, $-S(=O)_2(Q_{601})$ 및 $-P(=O)(Q_{601})(Q_{602})$ 중에서 선택되고,

[0708] 상기 Q_{601} 내지 Q_{603}은 서로 독립적으로, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 비페닐기, 터페닐기 또는 나프틸기이고,

[0709] xe21는 1 내지 5의 정수 중에서 선택된다.

[0710] 일 실시예에 따르면, 상기 xe11개의 Ar_{601} 및 xe21개의 R_{601} 중 적어도 하나는, 상술한 바와 같은 π 전자 결핍성 함질소 시클릭 그룹을 포함할 수 있다.

[0711] 일 실시예에 따르면, 상기 화학식 601 중 고리 Ar_{601} 및 L_{601}은 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-S(=O)_2(Q_{31})$ 및 $-P(=O)(Q_{31})(Q_{32})$ 중에서 선택된 적어도 하나로 치환 또는 비치환된, 벤젠 그룹, 나프탈렌 그룹, 플루오렌 그룹, 스파이로-비플루오렌 그룹, 벤조플루오렌 그룹, 디벤조플루오렌 그룹, 페날렌 그룹, 페난트렌 그룹, 안트라센 그룹, 플루오란텐 그룹, 트리페닐렌 그룹, 파이렌 그룹, 크라이센 그룹, 나프타센 그룹, 피센 그룹, 페릴렌 그룹, 펜타펜 그룹, 인데노안트라센 그룹, 디벤조퓨란 그룹, 디벤조티오펜 그룹, 카바졸 그룹, 이미다졸 그룹, 피라졸 그룹, 티아졸 그룹, 이소티아졸 그룹, 옥사졸 그룹, 이속사졸 그룹, 피리딘 그룹, 피라진 그룹, 피리미딘 그룹, 피리다진 그룹, 인다졸 그룹, 푸린 그룹, 퀴놀린 그룹, 이소퀴놀린 그룹, 벤조퀴놀린 그룹, 프탈라진 그룹, 나프티리딘 그룹, 퀴녹살린 그룹, 퀴나졸린 그룹, 시놀린 그룹, 페난트리딘 그룹, 아크리딘 그룹, 페난트롤린 그룹, 페나진 그룹, 벤조이미다졸 그룹, 이소벤조티아졸 그룹, 벤조옥사졸 그룹, 이소벤조옥사졸 그룹, 트리아졸 그룹, 테트라졸 그룹, 옥사디아졸 그룹, 트리아진 그룹, 티아디아졸 그룹, 이미다조피리딘 그룹, 이미다조피리미딘 그룹 및 아자카바졸 그룹;

[0712] 중에서 선택될 수 있고,

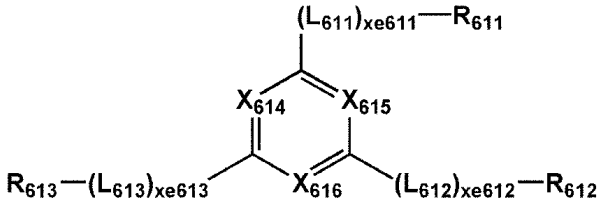
[0713] 상기 Q_{31} 내지 Q_{33}은 서로 독립적으로, C_1-C_{10}알킬기, C_1-C_{10}알콕시기, 페닐기, 비페닐기, 터페닐기 및 나프틸기 중에서 선택될 수 있다.

[0714] 상기 화학식 601 중 xe11이 2 이상일 경우 2 이상의 Ar_{601}은 단일 결합을 통하여 서로 연결될 수 있다.

[0715] 다른 실시예에 따르면, 상기 화학식 601 중 Ar_{601}은 안트라센 그룹일 수 있다.

[0716] 또 다른 실시예에 따르면, 상기 601로 표시되는 화합물은 하기 화학식 601-1로 표시될 수 있다:

[0717] <화학식 601-1>

[0718] 

[0719] 상기 화학식 601-1 중,

[0720] X_{614}는 N 또는 $C(R_{614})$이고, X_{615}는 N 또는 $C(R_{615})$이고, X_{616}은 N 또는 $C(R_{616})$이고, X_{614} 내지 X_{616} 중 적어도 하나는 N이고,

[0721] L_{611} 내지 L_{613}은 서로 독립적으로, 상기 L_{601}에 대한 설명을 참조하고,

[0722] xe611 내지 xe613은 서로 독립적으로, 상기 xe1에 대한 설명을 참조하고,

[0723] R_{611} 내지 R_{613}은 서로 독립적으로, 상기 R_{601}에 대한 설명을 참조하고,

[0724] R_{614} 내지 R_{616}은 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기 및 나프틸기 중에

서 선택될 수 있다.

[0725] 다른 실시예에 따르면, 상기 화학식 601 및 601-1 중 xe1 및 xe611 내지 xe613은 서로 독립적으로, 0, 1 또는 2일 수 있다.

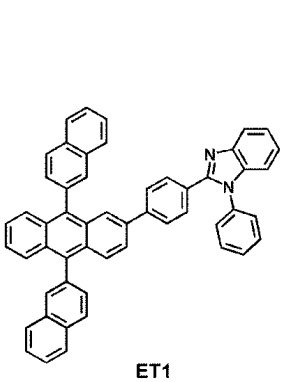
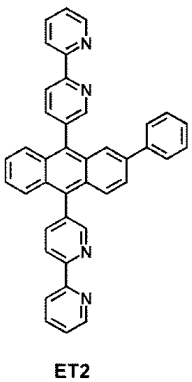
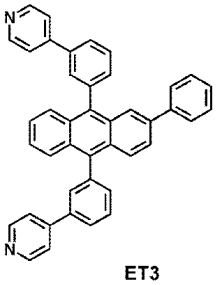
[0726] 또 다른 실시예에 따르면, 상기 화학식 601 및 601-1 중 R_{601} 및 R_{611} 내지 R_{613}은 서로 독립적으로, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미디노기, 히드라지노기, 히드라조노기, C_1-C_{20}알킬기, C_1-C_{20}알콕시기, 페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 페릴레닐기, 펜타페닐기, 헥사세닐기, 펜타세닐기, 티오페닐기, 퓨라닐기, 카바졸일기, 인돌일기, 이소인돌일기, 벤조퓨라닐기, 벤조티오페닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 디벤조실롤일기, 피리디닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 티아디아졸일기, 옥사디아졸일기, 피라지닐기, 피리미디닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조이미다졸일기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 이미다조피리디닐기, 이미다조피리미디닐기 및 아자카바졸일기 중에서 선택된 적어도 하나로 치환 또는 비치환된, 페닐기, 비페닐기, 터페닐기, 나프틸기, 플루오레닐기, 스파이로-비플루오레닐기, 벤조플루오레닐기, 디벤조플루오레닐기, 페난트레닐기, 안트라세닐기, 플루오란테닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 페릴레닐기, 펜타페닐기, 헥사세닐기, 펜타세닐기, 티오페닐기, 퓨라닐기, 카바졸일기, 인돌일기, 이소인돌일기, 벤조퓨라닐기, 벤조티오페닐기, 디벤조퓨라닐기, 디벤조티오페닐기, 벤조카바졸일기, 디벤조카바졸일기, 디벤조실롤일기, 피리디닐기, 이미다졸일기, 피라졸일기, 티아졸일기, 이소티아졸일기, 옥사졸일기, 이속사졸일기, 티아디아졸일기, 옥사디아졸일기, 피라지닐기, 피리미디닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조이미다졸일기, 이소벤조티아졸일기, 벤조옥사졸일기, 이소벤조옥사졸일기, 트리아졸일기, 테트라졸일기, 이미다조피리디닐기, 이미다조피리미디닐기 및 아자카바졸일기; 및

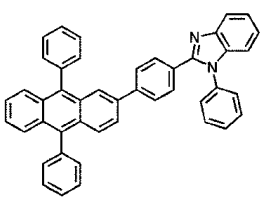
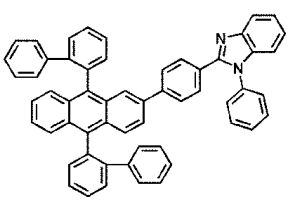
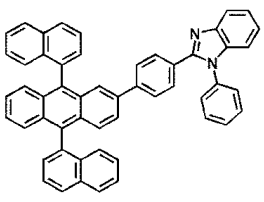
[0727] $-S(=O)_2(Q_{601})$ 및 $-P(=O)(Q_{601})(Q_{602})$;

[0728] 중에서 선택되고,

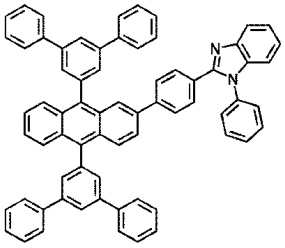
[0729] 상기 Q_{601} 및 Q_{602}에 대한 설명은 본 명세서에 기재된 바를 참조한다.

[0730] 상기 전자 수송 영역은 하기 화합물 ET1 내지 ET36 중에서 선택된 적어도 하나의 화합물을 포함할 수 있으나, 이에 한정되는 것은 아니다:

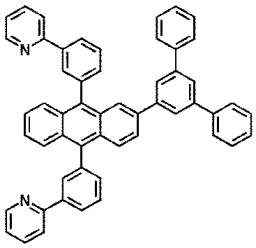
[0731] 
ET1

ET2

ET3

[0732] 
ET4

ET5

ET6

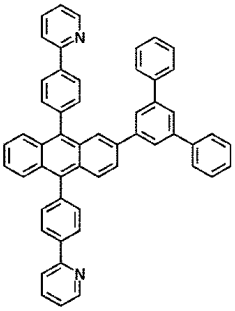
[0733]



ET7

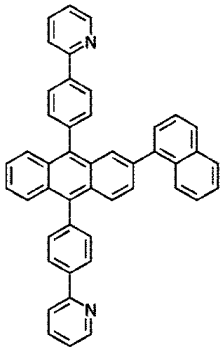


ET8

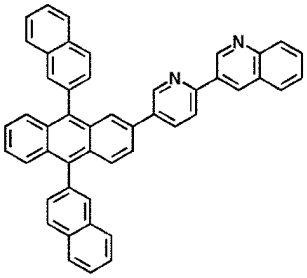


ET9

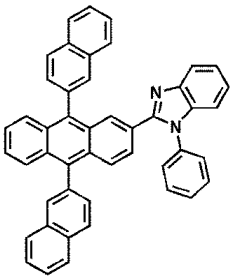
[0734]



ET10

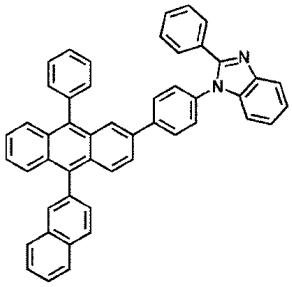


ET11

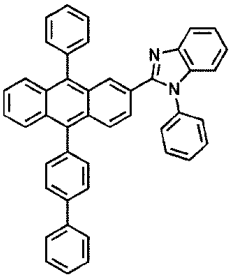


ET12

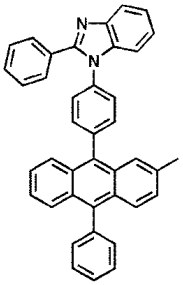
[0735]



ET13

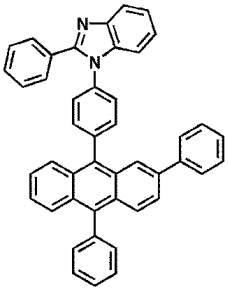


ET14

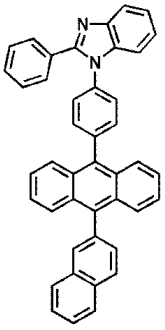


ET15

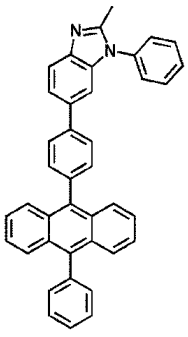
[0736]



ET16

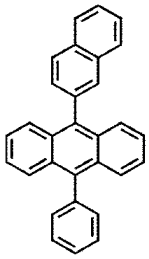


ET17

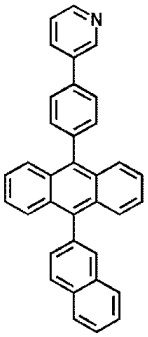


ET18

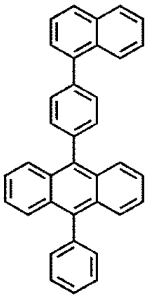
[0737]



ET19

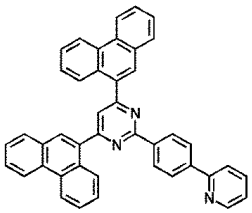


ET20

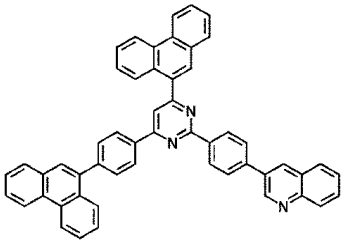


ET21

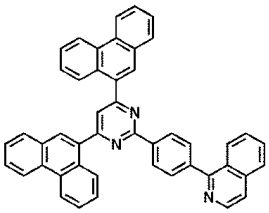
[0738]



ET22

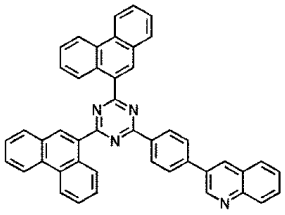


ET23

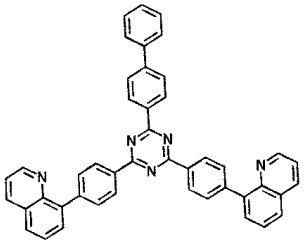


ET24

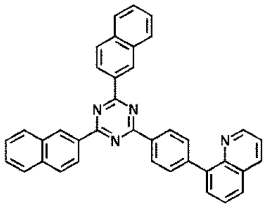
[0739]



ET25

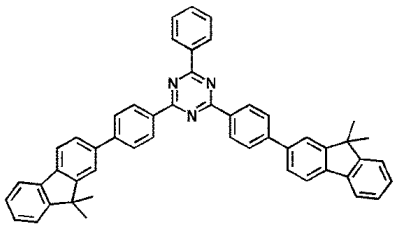


ET26

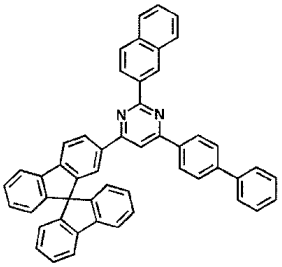


ET27

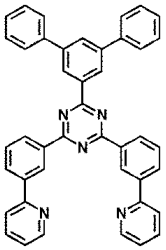
[0740]



ET28

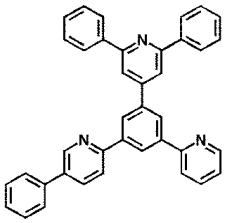


ET29

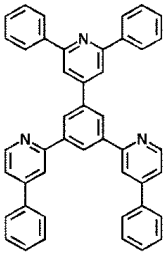


ET30

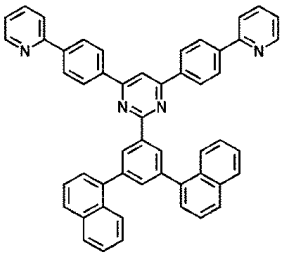
[0741]



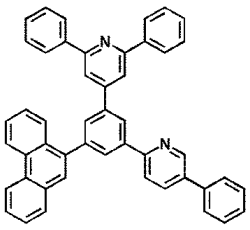
ET31



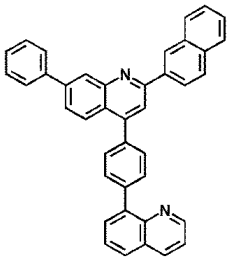
ET32



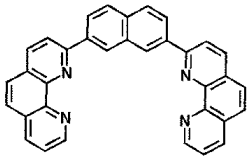
ET33



ET34



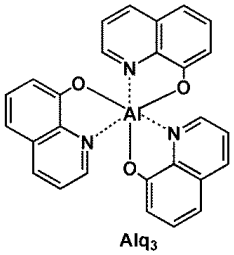
ET35



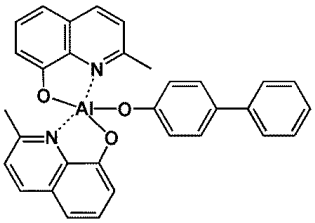
ET36

[0742]

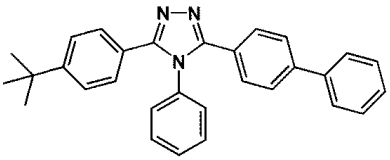
[0743] 또는, 상기 전자 수송 영역은 BCP(2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline), Bphen(4,7-Diphenyl-1,10-phenanthroline), Alq_3, BAlq, TAZ(3-(Biphenyl-4-yl)-5-(4-tert-butylphenyl)-4-phenyl-4H-1,2,4-triazole) 및 NTAZ 중에서 선택된 적어도 하나의 화합물을 포함할 수 있다.



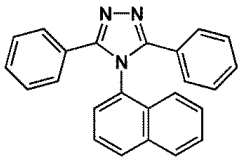
Alq_3



BAlq



TAZ



NTAZ

[0744]

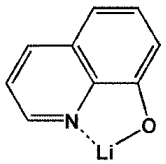
[0745] 상기 버퍼층, 정공 저지층 또는 전자 조절층의 두께는 서로 독립적으로, 약 20Å 내지 약 1000Å, 예를 들면 약 30Å 내지 약 300Å일 수 있다. 상기 버퍼층, 정공 저지층 또는 전자 조절층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 우수한 정공 저지 특성 또는 전자 조절 특성을 얻을 수 있다.

[0746] 상기 전자 수송층의 두께는 약 100Å 내지 약 1000Å, 예를 들면 약 150Å 내지 약 500Å일 수 있다. 상기 전자 수송층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 전자 수송 특성을 얻을 수 있다.

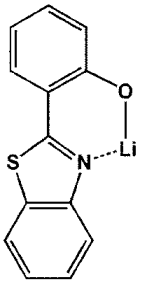
[0747] 상기 전자 수송 영역(17)(예를 들면, 상기 전자 수송 영역 중 전자 수송층)은 상술한 바와 같은 물질 외에, 금속-함유 물질을 더 포함할 수 있다.

[0748] 상기 금속-함유 물질은 알칼리 금속 착체 및 알칼리 토금속 착체 중에서 선택된 적어도 하나를 포함할 수 있다. 상기 알칼리 금속 착체의 금속 이온은, Li 이온, Na 이온, K 이온, Rb 이온 및 Cs 이온 중에서 선택될 수 있고, 상기 알칼리 토금속 착체의 금속 이온은 Be 이온, Mg 이온, Ca 이온, Sr 이온 및 Ba 이온 중에서 선택될 수 있다. 상기 알칼리 금속 착체 및 알칼리 토금속 착체의 금속 이온에 배위된 리간드는, 서로 독립적으로, 히드록시퀴놀린, 히드록시이소퀴놀린, 히드록시벤조퀴놀린, 히드록시아크리딘, 히드록시페난트리딘, 히드록시페닐옥사졸, 히드록시페닐티아졸, 히드록시디페닐옥사디아졸, 히드록시디페닐티아디아졸, 히드록시페닐피리딘, 히드록시페닐벤조이미다졸, 히드록시페닐벤조티아졸, 비피리딘, 페난트롤린 및 시클로펜타다이엔 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0749] 예를 들면, 상기 금속-함유 물질은 Li 착체를 포함할 수 있다. 상기 Li 착체는, 예를 들면, 하기 화합물 ET-D1(리튬 퀴놀레이트, LiQ) 또는 ET-D2을 포함할 수 있다.



ET-D1



ET-D2

[0750]

[0751] 상기 전자 수송 영역(17)은, 제2전극(19)으로부터의 전자 주입을 용이하게 하는 전자 주입층을 포함할 수 있다. 상기 전자 주입층은 상기 제2전극(19)과 직접(directly) 접촉할 수 있다.

[0752] 상기 전자 주입층은 i) 단일 물질로 이루어진 단일층으로 이루어진 단층 구조, ii) 복수의 서로 다른 물질로 이루어진 단일층으로 이루어진 단층 구조 또는 iii) 복수의 서로 다른 물질로 이루어진 복수의 층을 갖는 다층 구조를 가질 수 있다.

[0753] 상기 전자 주입층은 알칼리 금속, 알칼리 토금속, 희토류 금속, 알칼리 금속 화합물, 알칼리 토금속 화합물, 희토류 금속 화합물, 알칼리 금속 착체, 알칼리 토금속 착체, 희토류 금속 착체 또는 이들 중 임의의 조합을 포함할 수 있다.

[0754] 상기 알칼리 금속은, Li, Na, K, Rb 및 Cs 중에서 선택될 수 있다. 일 실시예에 따르면, 상기 알칼리 금속은 Li, Na 또는 Cs일 수 있다. 다른 실시예에 따르면, 상기 알칼리 금속은 Li 또는 Cs일 수 있으나, 이에 한정되는 것은 아니다.

[0755] 상기 알칼리 토금속은, Mg, Ca, Sr, 및 Ba 중에서 선택될 수 있다.

[0756] 상기 희토류 금속은 Sc, Y, Ce, Tb, Yb 및 Gd 중에서 선택될 수 있다.

[0757] 상기 알칼리 금속 화합물, 알칼리 토금속 화합물 및 상기 희토류 금속 화합물은, 상기 알칼리 금속, 상기 알칼리 토금속 및 희토류 금속의 산화물 및 할로겐화물(예를 들면, 불화물, 염화물, 브롬화물, 요오드화물 등) 중에서 선택될 수 있다.

[0758] 상기 알칼리 금속 화합물은, Li_2O, Cs_2O, K_2O 등과 같은 알칼리 금속 산화물 및 LiF, NaF, CsF, KF, LiI, NaI, CsI, KI 등과 같은 알칼리 금속 할로겐화물 중에서 선택될 수 있다. 일 실시예에 따르면, 상기 알칼리 금속 화합물은, LiF, Li_2O, NaF, LiI, NaI, CsI, KI 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0759] 상기 알칼리 토금속 화합물은, BaO, SrO, CaO, $Ba_xSr_{1-x}O(0<x<1)$, $Ba_xCa_{1-x}O(0<x<1)$ 등과 같은 알칼리 토금속 화합물 중에서 선택될 수 있다. 일 실시예에 따르면, 상기 알칼리 토금속 화합물은, BaO, SrO 및 CaO 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0760] 상기 희토류 금속 화합물은, YbF_3, ScF_3, ScO_3, Y_2O_3, Ce_2O_3, GdF_3, 및 TbF_3 중에서 선택될 수 있다. 일 실시예에 따르면, 상기 희토류 금속 화합물은 YbF_3, ScF_3, TbF_3, YbI_3, ScI_3, TbI_3 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0761] 상기 알칼리 금속 착체, 알칼리 토금속 착체 및 희토류 금속 착체는, 상술한 바와 같은 알칼리 금속, 알칼리 토금속 및 희토류 금속의 이온을 포함하고, 상기 알칼리 금속 착체, 알칼리 토금속 착체 및 희토류 금속 착체의 금속 이온에 배위된 리간드는, 서로 독립적으로, 히드록시퀴놀린, 히드록시이소퀴놀린, 히드록시벤조퀴놀린, 히드록시아크리딘, 히드록시페난트리딘, 히드록시페닐옥사졸, 히드록시페닐티아졸, 히드록시디페닐옥사디아졸, 히드록시디페닐티아디아졸, 히드록시페닐피리딘, 히드록시페닐벤조이미다졸, 히드록시페닐벤조티아졸, 비피리딘, 페난트롤린 및 시클로펜타다이엔 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0762] 상기 전자 주입층은 상술한 바와 같은 알칼리 금속, 알칼리 토금속, 희토류 금속, 알칼리 금속 화합물, 알칼리 토금속 화합물, 희토류 금속 화합물, 알칼리 금속 착체, 알칼리 토금속 착체, 희토류 금속 착체 또는 이들 중 임의의 조합만으로 이루어져 있거나, 상기 유기물을 더 포함할 수 있다. 상기 전자 주입층이 유기물을 더 포함할 경우, 상기 알칼리 금속, 알칼리 토금속, 희토류 금속, 알칼리 금속 화합물, 알칼리 토금속 화합물, 희토류

금속 화합물, 알칼리 금속 착체, 알칼리 토금속 착체, 희토류 금속 착체 또는 이들 중 임의의 조합은 상기 유기물로 이루어진 매트릭스에 균일 또는 불균일하게 분산되어 있을 수 있다.

[0763] 상기 전자 주입층의 두께는 약 1Å 내지 약 100Å, 약 3Å 내지 약 90Å일 수 있다. 상기 전자 주입층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 전자 주입 특성을 얻을 수 있다.

[0764] **[제2전극(19)]**

[0765] 상술한 바와 같은 유기층(10A) 상부에는 제2전극(19)이 배치되어 있다. 상기 제2전극(19)은 전자 주입 전극인 캐소드(cathode)일 수 있는데, 이 때, 상기 제2전극(19)용 물질로는 낮은 일함수를 가지는 금속, 합금, 전기전도성 화합물 및 이들의 조합(combination)을 사용할 수 있다.

[0766] 상기 제2전극(19)은, 리튬(Li), 은(Ag), 마그네슘(Mg), 알루미늄(Al), 알루미늄-리튬(Al-Li), 칼슘(Ca), 마그네슘-인듐(Mg-In), 마그네슘-은(Mg-Ag), ITO 및 IZO 중에서 선택된 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다. 상기 제2전극(19)은 투과형 전극, 반투과형 전극 또는 반사형 전극일 수 있다.

[0767] 상기 제2전극(19)은 단일층인 단층 구조 또는 복수의 층을 갖는 다층 구조를 가질 수 있다.

[0768] 이상, 상기 유기 발광 소자를 도 1을 참조하여 설명하였으나, 이에 한정되는 것은 아니다.

[0769] **<u>도 2에 대한 설명</u>**

[0770] 도 2는 다른 구현예에 따른 유기 발광 소자(100)의 단면을 개략적으로 나타낸 도면이다.

[0771] 도 2의 유기 발광 소자(100)는, 제1전극(110), 상기 제1전극(110)에 대향된 제2전극(190) 및 상기 제1전극(100)과 상기 제2전극(190) 사이에 개재된 제1발광 유닛(151) 및 제2발광 유닛(152)을 포함한다. 상기 제1발광 유닛(151)과 제2발광 유닛(152) 사이에는 전하 생성층(141)이 배치되고, 상기 전하 생성층(141)은 n형 전하 생성층(141-N) 및 p형 전하 생성층(141-P)을 포함한다. 상기 전하 생성층(141)은 전하를 생성하여 인접한 발광 유닛에 공급하는 역할을 하는 층으로서, 공지의 물질을 사용할 수 있다.

[0772] 제1발광 유닛(151)은 제1발광층(151-EM)을 포함하고, 제2발광 유닛(152)은 제2발광층(152-EM)을 포함한다. 상기 제1발광 유닛(151)에서 방출되는 광의 최대 발광 파장은 제2발광 유닛(152)에서 방출되는 광의 최대 발광 파장과 상이할 수 있다. 예를 들어, 상기 제1발광 유닛(151)에서 방출되는 광과 상기 제2발광 유닛(152)에서 방출되는 광의 혼합광은 백색광일 수 있으나, 이에 한정되는 것은 아니다.

[0773] 상기 제1발광 유닛(151)과 제1전극(110) 사이에는 정공 수송 영역(120)이 배치되어 있고, 제2발광 유닛(152)은 상기 제1전극(110) 측에 배치된 제1정공 수송 영역(121)을 포함한다.

[0774] 상기 제2발광 유닛(152)과 제2전극(190) 사이에는 전자 수송 영역(170)이 배치되어 있고, 제1발광 유닛(151)은 전하 생성층(141)과 제1발광층(151-EM) 사이에 배치된 제1전자 수송 영역(171)을 포함한다.

[0775] 상기 제1발광층(151-EM)은 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상술한 화학식 1로 표시될 수 있다.

[0776] 상기 제2발광층(152-EM)은 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상술한 화학식 1로 표시될 수 있다.

[0777] 도 2 중 제1전극(110) 및 제2전극(190)에 대한 설명은 각각 도 1 중 제1전극(11) 및 제2전극(19)에 대한 설명을 참조한다.

[0778] 도 3 중 제1발광층(151-EM) 및 제2발광층(152-EM)에 대한 설명은 각각 도 1 중 발광층(15)에 대한 설명을 참조한다.

[0779] 도 2 중 정공 수송 영역(120) 및 제1정공 수송 영역(121)에 대한 설명은 각각 도 1 중 정공 수송 영역(12)에 대한 설명을 참조한다.

[0780] 도 2 중 전자 수송 영역(170) 및 제1전자 수송 영역(171)에 대한 설명은 각각 도 1 중 전자 수송 영역(17)에 대한 설명을 참조한다.

[0781] 이상, 도 2를 참조하여, 제1발광 유닛(151) 및 제2발광 유닛(152) 모두, 호스트, 센서타이저 및 에미터를 포함한 유기 발광 소자에 대하여 설명하였으나, 도 2의 유기 발광 소자의 제1발광 유닛(151) 및 제2발광 유닛(152)

중 하나는 공지된 임의의 발광 유닛으로 교체되거나, 3 이상의 발광 유닛을 포함할 수 있는 등, 다양한 변형예가 다양하다.

[0782] **도 3에 대한 설명**

[0783] 도 3은 또 다른 구현예에 따른 유기 발광 소자(200)의 단면을 개략적으로 나타낸 도면이다.

[0784] 상기 유기 발광 소자(200)는, 제1전극(210), 상기 제1전극(210)에 대향된 제2전극(290) 및 상기 제1전극(210)과 상기 제2전극(290) 사이에 적층된 제1발광층(251) 및 제2발광층(252)을 포함한다.

[0785] 상기 제1발광층(251)에서 방출되는 광의 최대 발광 파장은 제2발광층(252)에서 방출되는 광의 최대 발광 파장과 상이할 수 있다. 예를 들어, 상기 제1발광 층(251)에서 방출되는 광과 상기 제2발광층(252)에서 방출되는 광의 혼합광은 백색광일 수 있으나, 이에 한정되는 것은 아니다.

[0786] 한편, 상기 제1발광층(251)과 상기 제1전극(210) 사이에는 정공 수송 영역(220)이 배치되어 있고, 상기 제2발광층(252)과 상기 제2전극(290) 사이에는 전자 수송 영역(270)이 배치되어 있다.

[0787] 상기 제1발광층(251)은 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상기 화학식 1로 표시될 수 있다.

[0788] 상기 제2발광층(252)은 호스트, 센서타이저 및 에미터를 포함하고; 상기 호스트, 상기 센서타이저 및 상기 에미터는 서로 상이하고; 상기 센서타이저는 상기 화학식 1로 표시될 수 있다.

[0789] 도 3 중 제1전극(210), 정공 수송 영역(220) 및 제2전극(290)에 대한 설명은 각각 도 1 중 제1전극(11), 정공 수송 영역(12) 및 제2전극(19)에 대한 설명을 참조한다.

[0790] 도 3 중 제1발광층(251) 및 제2발광층(252)에 대한 설명은 각각 도 1 중 발광층(15)에 대한 설명을 참조한다.

[0791] 도 3 중 전자 수송 영역(270)에 대한 설명은 도 1 중 전자 수송 영역(17)에 대한 설명을 참조한다.

[0792] 이상, 도 3을 참조하여, 제1발광층(251) 및 제2발광층(252) 모두, 본 명세서에 기재된 바와 같은, 호스트, 센서타이저 및 에미터를 포함하는 유기 발광 소자에 대하여 설명하였으나, 도 3의 제1발광층(251) 및 제2발광층(252) 중 임의의 1개는 공지의 층으로 교체되거나, 3개 이상의 발광층을 포함하거나, 서로 이웃한 발광층들 사이에 중간층이 추가도 배치될 수 있는 등, 다양한 변형예가 가능하다.

[0793] **용어에 대한 설명**

[0794] 본 명세서 중 C_1-C_{60}알킬기는 탄소수 1 내지 60의 선형 또는 분지형 포화 지방족 탄화수소 1가(monovalent) 그룹을 의미하며, 구체적인 예에는, 메틸기, 에틸기, 프로필기, 이소부틸기, sec-부틸기, ter-부틸기, 펜틸기, iso-아밀기, 헥실기 등이 포함된다. 본 명세서 중 C_1-C_{60}알킬렌기는 상기 C_1-C_{60}알킬기와 동일한 구조를 갖는 2가(divalent) 그룹을 의미한다.

[0795] 본 명세서 중 C_1-C_{60}알콕시기는 $-OA_{101}$(여기서, A_{101}은 상기 C_1-C_{60}알킬기임)의 화학식을 갖는 1가 그룹을 의미하며, 이의 구체적인 예에는, 메톡시기, 에톡시기, 이소프로필옥시기 등이 포함된다.

[0796] 본 명세서 중 C_2-C_{60}알케닐기는 상기 C_2-C_{60}알킬기의 중간 또는 말단에 하나 이상의 탄소-탄소 이중 결합을 포함한 구조를 가지며, 이의 구체적인 예에는, 에테닐기, 프로페닐기, 부테닐기 등이 포함된다. 본 명세서 중 C_2-C_{60}알케닐렌기는 상기 C_2-C_{60}알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0797] 본 명세서 중 C_2-C_{60}알키닐기는 상기 C_2-C_{60}알킬기의 중간 또는 말단에 하나 이상의 탄소-탄소 삼중 결합을 포함한 구조를 가지며, 이의 구체적인 예에는, 에티닐기(ethynyl), 프로피닐기(propynyl), 등이 포함된다. 본 명세서 중 C_2-C_{60}알키닐렌기는 상기 C_2-C_{60}알키닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0798] 본 명세서 중 C_3-C_{10}시클로알킬기는 탄소수 3 내지 10의 1가 포화 탄화수소 모노시클릭 그룹을 의미하며, 이의 구체예는 시클로프로필기, 시클로부틸기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기 등을 포함한다. 본 명세서 중 C_3-C_{10}시클로알킬렌기는 상기 C_3-C_{10}시클로알킬기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0799] 본 명세서 중 C_1-C_{10}헤테로시클로알킬기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-

형성 원자로서 포함한 탄소수 1 내지 10의 1가 모노시클릭 그룹을 의미하며, 이의 구체예는 테트라히드로퓨라닐기(tetrahydrofuranyl), 테트라히드로티오페닐기 등을 포함한다. 본 명세서 중 C_1-C_{10}헤테로시클로알킬렌기는 상기 C_1-C_{10}헤테로시클로알킬기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0800] 본 명세서 중 C_3-C_{10}시클로알케닐기는 탄소수 3 내지 10의 1가 모노시클릭 그룹으로서, 고리 내에 적어도 하나의 탄소-탄소 이중 결합을 가지나, 방향족성(aromaticity)을 갖지 않는 그룹을 의미하며, 이의 구체예는 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기 등을 포함한다. 본 명세서 중 C_3-C_{10}시클로알케닐렌기는 상기 C_3-C_{10}시클로알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0801] 본 명세서 중 C_1-C_{10}헤테로시클로알케닐기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함한 탄소수 1 내지 10의 1가 모노시클릭 그룹으로서, 고리 내에 적어도 하나의 이중 결합을 갖는다. 상기 C_1-C_{10}헤테로시클로알케닐기의 구체예는, 2,3-디히드로퓨라닐기, 2,3-디히드로티오페닐기 등을 포함한다. 본 명세서 중 C_1-C_{10}헤테로시클로알케닐렌기는 상기 C_1-C_{10}헤테로시클로알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.

[0802] 본 명세서 중 C_6-C_{60}아릴기는 탄소 원자수 6 내지 60개의 카보시클릭 방향족 시스템을 갖는 1가(monovalent) 그룹을 의미하며, C_6-C_{60}아릴렌기는 탄소 원자수 6 내지 60개의 카보시클릭 방향족 시스템을 갖는 2가(divalent) 그룹을 의미한다. 상기 C_6-C_{60}아릴기의 구체예는, 페닐기, 나프틸기, 안트라세닐기, 페난트레닐기, 파이레닐기, 크라이세닐기 등을 포함한다. 상기 C_6-C_{60}아릴기 및 C_6-C_{60}아릴렌기가 2 이상의 고리를 포함할 경우, 2 이상의 고리들은 서로 융합될 수 있다.

[0803] 본 명세서 중 C_1-C_{60}헤테로아릴기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함하고 탄소수 1 내지 60개의 헤테로사이클릭 방향족 시스템을 갖는 1가 그룹을 의미하고, C_1-C_{60}헤테로아릴렌기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함하고 탄소수 1 내지 60개의 카보시클릭 방향족 시스템을 갖는 2가 그룹을 의미한다. 상기 C_1-C_{60}헤테로아릴기의 구체예는, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기 등을 포함한다. 상기 C_1-C_{60}헤테로아릴기 및 C_1-C_{60}헤테로아릴렌기가 2 이상의 고리를 포함할 경우, 2 이상의 고리들은 서로 융합될 수 있다.

[0804] 본 명세서 중 C_6-C_{60}아릴옥시기는 $-OA_{102}$(여기서, A_{102}는 상기 C_6-C_{60}아릴기임)를 가리키고, 상기 C_6-C_{60}아릴티오기(arylthio)는 $-SA_{103}$(여기서, A_{103}은 상기 C_6-C_{60}아릴기기임)를 가리킨다.

[0805] 본 명세서 중 1가 비-방향족 축합다환 그룹(non-aromatic condensed polycyclic group)은 2 이상의 고리가 서로 축합되어 있고, 고리 형성 원자로서 탄소만을 포함(예를 들어, 탄소수는 8 내지 60일 수 있음)하고, 분자 전체가 비-방향족성(non-aromaticity)를 갖는 1가 그룹을 의미한다. 상기 비-방향족 축합다환 그룹의 구체예는 플루오레닐기 등을 포함한다. 본 명세서 중 2가 비-방향족 축합다환 그룹은 상기 1가 비-방향족 축합다환 그룹과 동일한 구조를 갖는 2가 그룹을 의미한다.

[0806] 본 명세서 중 1가 비-방향족 헤테로축합다환 그룹(non-aromatic condensed heteropolycyclic group)은 2 이상의 고리가 서로 축합되어 있고, 고리 형성 원자로서 탄소(예를 들어, 탄소수는 1 내지 60일 수 있음) 외에 N, O, P, Si 및 S 중에서 선택된 헤테로 원자를 포함하고, 분자 전체가 비-방향족성(non-aromaticity)를 갖는 1가 그룹을 의미한다. 상기 1가 비-방향족 헤테로축합다환 그룹은, 카바졸일기 등을 포함한다. 본 명세서 중 2가 비-방향족 헤테로축합다환 그룹은 상기 1가 비-방향족 헤테로축합다환 그룹과 동일한 구조를 갖는 2가 그룹을 의미한다.

[0807] 본 명세서 중 C_5-C_{30}카보시클릭 그룹은 고리 형성 원자로서 5 내지 30개의 탄소만을 갖는 포화 또는 불포화 시클릭 그룹을 가리킨다. 상기 C_5-C_{30}카보시클릭 그룹은 모노시클릭 그룹 또는 폴리시클릭 그룹일 수 있고, 화학식 구조에 따라, 1가, 2가, 3가, 4가, 5가 또는 6가 그룹일 수 있다.

[0808] 본 명세서 중 C_1-C_{30}헤테로시클릭 그룹은 고리 형성 원자로서 1 내지 30개의 탄소 외에, N, O, P, Si 및 S 중에

서 선택된 헤테로 원자를 적어도 하나 갖는 포화 또는 불포화 시클릭 그룹을 가리킨다. 상기 C_1-C_{30}헤테로시클릭 그룹은 모노시클릭 그룹 또는 폴리시클릭 그룹일 수 있고, 화학식 구조에 따라, 1가, 2가, 3가, 4가, 5가 또는 6가 그룹일 수 있다.

[0809] 본 명세서 중 상기 치환된 C_5-C_{30}카보시클릭 그룹, 치환된 C_1-C_{30}헤테로시클릭 그룹, 치환된 C_1-C_{60}알킬기, 치환된 C_2-C_{60}알케닐기, 치환된 C_2-C_{60}알키닐기, 치환된 C_1-C_{60}알콕시기, 치환된 C_3-C_{10}시클로알킬기, 치환된 C_1-C_{10}헤테로시클로알킬기, 치환된 C_3-C_{10}시클로알케닐기, 치환된 C_1-C_{10}헤테로시클로알케닐기, 치환된 C_6-C_{60}아릴기, 치환된 C_6-C_{60}아릴옥시기, 치환된 C_6-C_{60}아릴티오기, 치환된 C_1-C_{60}헤테로아릴기, 치환된 1가 방향족 축합다환 그룹, 치환된 1가 방향족 헤테로축합다환 그룹, 치환된 1가 비-방향족 축합다환 그룹 및 치환된 1가 비-방향족 헤테로축합다환 그룹의 치환기는,

[0810] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기 및 C_1-C_{60}알콕시기;

[0811] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 방향족 축합다환 그룹, 1가 방향족 헤테로축합다환 그룹, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, $-N(Q_{11})(Q_{12})$, $-Si(Q_{13})(Q_{14})(Q_{15})$, $-B(Q_{16})(Q_{17})$ 및 $-P(=O)(Q_{18})(Q_{19})$ 중 적어도 하나로 치환된, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기 및 C_1-C_{60}알콕시기;

[0812] C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 방향족 축합다환 그룹, 1가 방향족 헤테로축합다환 그룹, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹;

[0813] 중수소, -F, -Cl, -Br, -I, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 방향족 축합다환 그룹, 1가 방향족 헤테로축합다환 그룹, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹, $-N(Q_{21})(Q_{22})$, $-Si(Q_{23})(Q_{24})(Q_{25})$, $-B(Q_{26})(Q_{27})$ 및 $-P(=O)(Q_{28})(Q_{29})$ 중 적어도 하나로 치환된, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 방향족 축합다환 그룹, 1가 방향족 헤테로축합다환 그룹, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹; 및

[0814] $-N(Q_{31})(Q_{32})$, $-Si(Q_{33})(Q_{34})(Q_{35})$, $-B(Q_{36})(Q_{37})$ 및 $-P(=O)(Q_{38})(Q_{39})$; 중에서 선택되고,

[0815] 상기 Q_1 내지 Q_9, Q_{11} 내지 Q_{19}, Q_{21} 내지 Q_{29} 및 Q_{31} 내지 Q_{39}는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C_1-C_{60}알킬기, C_2-C_{60}알케닐기, C_2-C_{60}알키닐기, C_1-C_{60}알콕시기, C_3-C_{10}시클로알킬기, C_1-C_{10}헤테로시클로알킬기, C_3-C_{10}시클로알케닐기, C_1-C_{10}헤테로시클로알케닐기, C_6-C_{60}아릴기, C_1-C_{60}알킬기 및 C_6-C_{60}아릴기 중 적어도 하나로 치환된 C_6-C_{60}아릴기, C_6-C_{60}아릴옥시기, C_6-C_{60}아릴티오기, C_1-C_{60}헤테로아릴기, 1가 방향족 축합다환 그룹, 1가 방향족 헤테로축합다환 그룹, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹 중에서 선택된다.

[0816] 본 명세서 중 "상온"이란 약 25℃의 온도를 가리킨다.

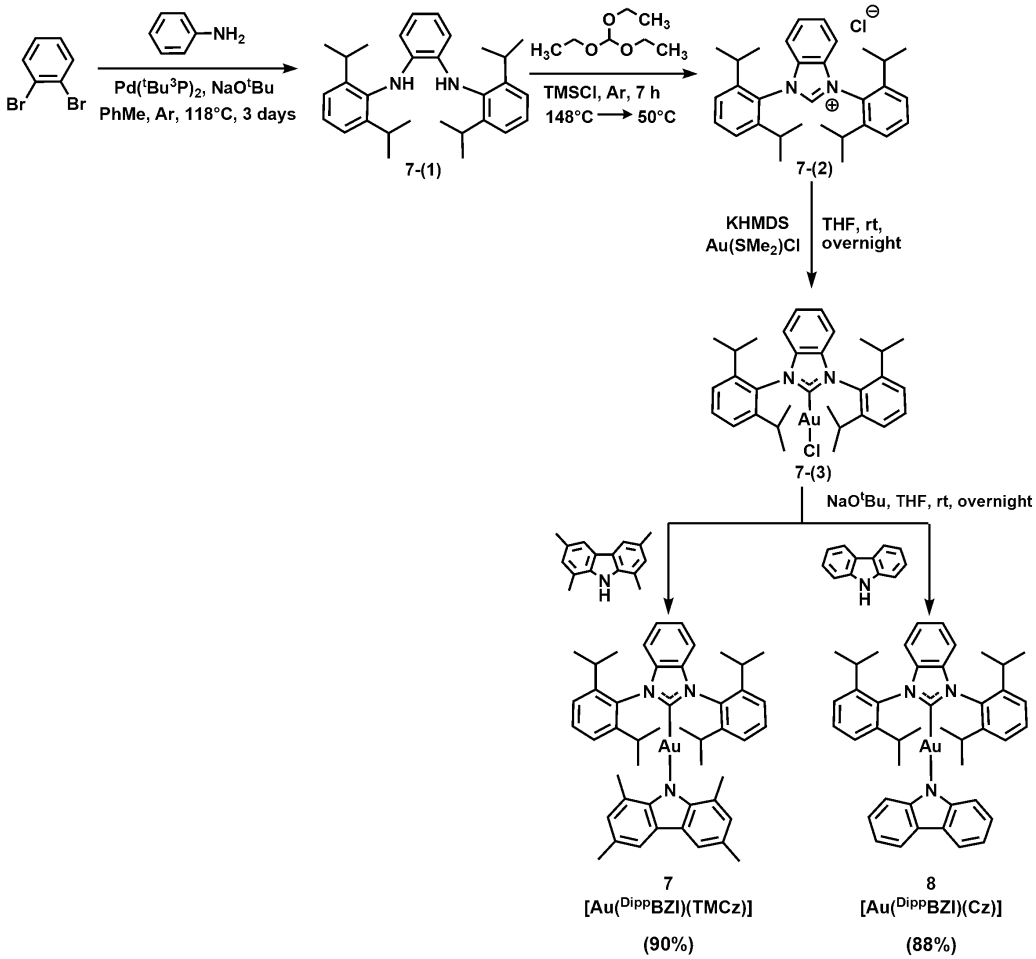
[0817] 본 명세서 중 "비페닐기, 터페닐기 및 테트라페닐기"는 각각 2개, 3개 또는 4개의 페닐기가 서로 단일 결합을 통하여 연결되어 있는 1가 그룹을 의미한다.

[0818] 본 명세서 중 "시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기 및 시아노-함유 테트라페닐기"는 각각, 적어도 하나의 시아노기로 치환된, 페닐기, 비페닐기, 터페닐기 및 테트라페닐기를 의미한다. 상기 "시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기 및 시아노-함유 테트라페닐기" 중 시아노기는 임의의 위치에 치환될 수 있고, 상기 "시아노-함유 페닐기, 시아노-함유 비페닐기, 시아노-함유 터페닐기 및 시아노-함유 테트라페닐기"는 시아노기 외에 다른 치환기를 더 포함할 수 있다. 예를 들어, 시아노기로 치환된 페닐기 및 시아노기 및 메틸기로 치환된 페닐기 모두, "시아노-함유 페닐기"에 속한다.

[0819] 이하, 합성예 및 실시예를 들어, 본 발명의 일 실시예를 따르는 화합물 및 유기 발광 소자에 대하여 보다 구체적으로 설명하나, 본 발명이 하기의 합성예 및 실시예로 한정되는 것은 아니다. 하기 합성예 중 "'A' 대신 'B'를 사용하였다"란 표현 중 'B'의 사용량과 'A'의 사용량은 몰당량 기준으로 동일하다.

[0820] **[실시예]**

[0821] **합성예**



[0822]

[0823] **합성예 1: 화합물 7의 합성**

[0824] **1) 중간체 7-(1)의 합성**

[0825] 250 mL 2구 둥근바닥 플라스크에 자석 stir bar를 넣고 콘덴서를 연결한 채 flame drying하여 수분을 제거해주고 식은 플라스크에 1,2-디브로모벤젠 6.70 g (28.4 mmol)와 2,6-디이소프로필아닐린 20.1 g (114 mmol) 및 소듐터트부톡사이드 (NaO^tBu) 10.9 g (114 mmol)을 넣고 아르곤을 주입하였다. 가열교반기를 이용하여 교반하면서 유리주사기를 이용하여 무수 톨루엔 100 mL 주입한 뒤 10분 동안 상온에서 교반하였다. 비스(트리-터트-뷰틸포

스핀)팔라듐(0) ($Pd(t\text{-}Bu_3P)_2$) 1.45 g (2.84 mmol)을 바이알에 넣고 아르곤을 주입한 상태에서 무수 톨루엔 5 mL에 첨가하였다. 유리 주사기를 이용하여 $Pd(tBu^3P)_2$용액을 반응 플라스크에 첨가하였다. 온도를 118 °C로 서서히 올려주고 3일 동안 교반 환류시켰다. 그 후 교반을 중지시킨 뒤 필터에 셀라이트를 깔고 반응용액을 500 mL 리커버리 플라스크로 여과시켰다. 여과 용액을 회전증발농축기를 이용하여 반응 용매를 증발시키고, 컬럼 크로마토그래피 (디클로로메테인:헥세인 1:49)를 이용하여 분리하였다. (TLC: R_f 값 아세트산에틸:헥세인 (1:99) = 0.25) 수율: 76% (9.30 g, 갈색~노랑 파우더).

[0826] ^1H NMR (300 MHz, CD_2Cl_2) δ(ppm) : 1.14 (d, J =6.9 Hz, 12H), 1.22 (d, J = 6.9 Hz, 12H), 3.18 (sept, J = 6.9 Hz, 4H), 5.23 (s, 2H) 6.22 (dd, J =6.3 Hz, 3.0 Hz, 2H), 6.60 (dd, J =6.3 Hz, 3.0 Hz, 2H), 7.23 - 7.29 (m, 6H).

[0827] $^{13}C\{^1H\}$ NMR (126 MHz, CD_2Cl_2) δ(ppm) : 23.45, 25.00, 28.77, 114.89, 120.39, 124.35, 126.69, 137.45, 137.45, 145.98.

[0828] HR MS (FAB): Calcd for $C_{30}H_{40}N_2$ ($[M]^+$), 428.3191. Found: 428.3194.

[0829] Anal. Calcd for $C_{30}H_{40}N_2$: C, 84.06; H, 9.41; N, 6.54. Found: C, 84.12; H, 9.43; N, 6.35%.

[0830] **2) 중간체 7-(2)의 합성**

[0831] 500 mL 2구 둥근바닥 플라스크에 자석 stir bar와 중간체 7-(1) 9.00 g (21.0 mmol)을 넣고 콘덴서와 비그럭스 컬럼과 연결한 상태로 아르곤을 주입하였다. 열교반기를 이용하여 교반하면서 트리에틸오르도포름산 200 mL를 유리 주사기로 반응 플라스크에 첨가하였다. 145 °C에서 4시간 동안 환류시키면서 생성되는 부산물인 에탄올을 제거하였다. 온도를 낮춘 뒤 진공펌프를 이용하여 플라스크 내부에 감압을 가해 남은 에탄올을 완전히 제거하였다. 열교반기를 이용해 50 °C로 온도를 높이고 트리메틸실릴클로라이드 43 mL (과량) 주입 후 8시간 동안 교반하였다. 온도를 낮춰 반응 용액을 식힌 뒤, 500 mL 리커버리 플라스크에 옮겨 담은 후 회전증발농축기를 이용하여 반응 용매를 증발시켰다. 디클로로메테인에 고농도로 농축되어 있는 반응용액에 에테르를 넣어 침전시켰다. 침전물이 생긴 용액을 유리필터에 부어 필터에 걸러진 침전물만을 얻는다. 수율: 45% (4.20 g, 회색기 도는 어두운 초록색 파우더).

[0832] ^1H NMR (300 MHz, CD_2Cl_2) δ(ppm) : 1.16 (d, J =6.9 Hz, 12H), 1.30 (d, J = 6.9 Hz, 12H), 2.27 (sept, J = 6.9 Hz, 4H), 7.37 (dd, J =6.3 Hz, 3.0 Hz, 2H), 7.49 (d, J = 7.8 Hz 4H), 7.70 (dd, J =6.3 Hz, 3.0 Hz, 2H), 7.72 (t, J = 7.8 Hz, 2H).

[0833] $^{13}C\{^1H\}$ NMR (126 MHz, CD_2Cl_2) δ(ppm) : 23.57, 25.19, 29.89, 113.94, 125.48, 127.94, 129.06, 132.73, 133.31, 146.54, 147.07, 147.21.

[0834] HR MS (FAB): Calcd for $C_{30}H_{40}N_2$ ($[M]^+$), 439.3108; Found: 439.3112.

[0835] Anal. Calcd for $C_{31}H_{39}ClN_2$: C, 78.37; H, 8.27; N, 5.90. Found: C, 74.25; H, 8.50; N, 5.44%.

[0836] **3) 중간체 7-(3)의 합성**

[0837] 100 mL 2구 둥근바닥 플라스크에 자석 stir bar와 중간체 7-(2) 4.00 g (8.42 mmol)을 넣고 아르곤을 주입하였다. 교반기를 이용하여 교반하면서 유리주사기를 이용하여 무수 테트라하이드로퓨란 30 mL 주입한 뒤 5분 동안 25 °C에서 교반한다. 포타슘 비스(트리메틸실릴)아마이드 1.0 M in THF를 9.26 mL (9.26 mmol)을 아르곤 주입한 상태에서 유리주사기를 이용하여 반응 플라스크에 주입하였다. 1시간 동안 25 °C에서 교반하였다. 바이알에 $AuClSMe_2$ 2.48 g (8.42 mmol)를 넣고 아르곤을 주입한 상태에서 무수 테트라하이드로퓨란 10 mL에 녹인 뒤 반응 플라스크에서 유리 주사기를 이용하여 주입 후 25 °C에서 교반하였다. 그 후 교반을 중지시킨 뒤 필터에 셀라이트를 깔고 반응용액을 500 mL 리커버리 플라스크로 여과시켰다. 여과 용액을 회전증발농축기를 이용하여 반응

용매를 증발시켰다. 디클로로메테인에 용매에 고농도로 농축되어 있는 반응용액에 헥세인을 넣어 침전시켰다. 침전물이 생긴 용액을 유리필터에 부어 필터에 걸러진 침전물만을 얻었다. 수율 45% (2.58 g, 회색기 도는 보라색 파우더).

[0838] ^{1}H NMR (300 mHz, CD_2Cl_2) δ(ppm) : 1.10 (d, *J* =6.9 Hz, 12H), 1.32 (d, *J* = 6.9 Hz, 12H), 2.40 (sept, *J* = 6.9 Hz, 4H), 7.11 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.44 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.44 (d, *J* = 7.8 Hz 4H), 7.66 (t, *J* = 7.8 Hz, 2H).

[0839] ^{13}C{^{1}H} NMR (126 MHz, CD_2Cl_2) δ(ppm) : 24.16, 24.92, 29.48, 112.62, 125.25, 126.09, 131.60, 131.81, 135.08, 147.15, 182.07.

[0840] Anal. Calcd for $C_{31}H_{38}AuClN_2$: C, 55.48; H, 5.71; N, 4.17. Found: C, 55.86; H, 5.76; N, 4.12%.

[0841] **4) 화합물 7의 합성**

[0842] 100 mL 2구 둥근바닥 플라스크에 자석 stir bar, 1,3,6,8-테트라메틸-9H-카바졸 0.44 g (1.97 mmol), 중간체 7-(3) 1.2 g (1.79 mmol), NaO^tBu 0.21 g (2.15 mmol)을 넣고 아르곤을 주입하였다. 교반기를 이용하여 교반하면서 유리주사기로 무수 테트라하이드로퓨란 40 mL 주입한 뒤 밤새 25 °C에서 교반하였다. 그 후 교반을 중지시킨 뒤 필터에 셀라이트를 깔고 반응용액을 500 mL 리커버리 플라스크로 여과시켰다. 여과 용액을 회전증발농축기를 이용하여 반응 용매를 증발시켰다. 디클로로메테인에 용매에 고농도로 농축되어 있는 반응용액에 헥세인을 넣어 침전시켰다. 침전물이 생긴 용액을 유리필터에 부어 필터에 걸러진 침전물만을 얻었다. 수율 90% (1.38 g, 베이지색 파우더).

[0843] ^{1}H NMR (300 mHz, CD_2Cl_2) δ(ppm) : 1.09 (d, *J* =6.9 Hz, 12H), 1.30 (d, *J* = 6.9 Hz, 12H), 2.00 (s, 6H), 2.37 (s, 6H), 2.53 (sept, *J* = 6.9 Hz, 4H), 6.67 (s, 2H), 7.07 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.42 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.51 (s, 2H), 7.51 (d, *J* = 7.8 Hz 4H), 7.74 (t, *J* = 7.8 Hz, 2H).

[0844] ^{13}C{^{1}H} NMR (126 MHz, CD_2Cl_2) δ(ppm) : 21.17, 21.37, 24.28, 24.71, 29.55, 112.55, 116.88, 122.75, 125.15, 125.22, 125.77, 125.78, 127.37, 131.83, 132.54, 135.43, 147.06, 147.33, 184.14.

[0845] HR MS (FAB): Calcd for $C_{43}H_{46}AuN_3$, 857.3983; Found: 857.3973.

[0846] Anal. Calcd for $C_{47}H_{54}AuN_3$: C, 65.80; H, 6.34; N, 4.90. Found: C, 65.96; H, 6.31; N, 4.80%

[0847] **<u>합성예 2: 화합물 8의 합성</u>**

[0848] 100 mL 2구 둥근바닥 플라스크에 자석 stir bar, 카바졸 0.33 g (1.97 mmol), 중간체 7-(3) 1.2 g (1.79 mmol), NaO^tBu 0.21 g (2.15 mmol)을 넣고 아르곤을 주입한다. 교반기를 이용하여 교반하면서 유리주사기로 무수 테트라하이드로퓨란 40 mL 주입한 뒤 밤새 25 °C에서 교반하였다. 그 후 교반을 중지시킨 뒤 필터에 셀라이트를 깔고 반응용액을 500 mL 리커버리 플라스크로 여과시켰다. 여과 용액을 회전증발농축기를 이용하여 반응 용매를 증발시켰다. 디클로로메테인에 용매에 고농도로 농축되어 있는 반응용액에 헥세인을 넣어 침전시켰다. 침전물이 생긴 용액을 유리필터에 부어 필터에 걸러진 침전물만을 얻었다. 수율 88% (1.27 g, 연보라 파우더).

[0849] ^{1}H NMR (300 mHz, CD_2Cl_2) δ(ppm) : 1.16 (d, *J* =6.9 Hz, 12H), 1.35 (d, *J* = 6.9 Hz, 12H), 2.56 (sept, *J* = 6.9 Hz, 4H), 6.69 (ddd, *J* =7.8 Hz, 1.2 Hz, 6 Hz, 2H), 6.87 (td, *J* =7.2 Hz, 1.2 Hz 3.0 Hz, 2H), 7.04 (td, *J* =7.2 Hz, 1.2 Hz 3.0 Hz, 2H), 7.24 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.49 (dd, *J* =6.2 Hz, 3.0 Hz, 2H), 7.53 (d, *J* = 7.8 Hz 4H), 7.76 (t, *J* = 7.8 Hz, 2H), 6.69 (ddd, *J* =7.8 Hz, 1.2 Hz, 6 Hz, 2H).

[0850] ^{13}C{^{1}H} NMR (126 MHz, CD_2Cl_2) δ(ppm) : 24.37, 24.89, 29.66, 112.51, 114.01, 116.32, 119.66, 123.96, 124.09, 125.22, 125.90, 131.53, 132.19, 135.51, 147.62, 149.90, 185.93.

[0851] HR MS (FAB): Calcd for $C_{43}H_{46}AuN_3$, 801.3357; Found: 801.3362.

[0852] Anal. Calcd for $C_{43}H_{46}AuN_3$: C, 64.41; H, 5.78; N, 5.24. Found: C, 64.49; H, 5.75; N, 5.14%.

[0853] **실시예 1-1**

[0854] 50 nm 두께의 ITO 전극 패턴이 되어있는 유리 기판을 아세톤, 이소프로필 알콜과 순수물 속에서 각 15분 동안 초음파 세정한 후, 30분 동안 UV 오존 세정하였다.

[0855] 이어서, 상기 유리 기판 상의 ITO 전극(애노드) 상에 차례로, NDP-9을 10 nm 두께로 증착하고, HT211을 40 nm 두께로 증착하고, 2,2'-Di(9H-carbazol-9-yl)biphenyl(o-CBP)를 10 nm 두께로 증착하였다.

[0856] 그 다음, 발광층을 HT host(제1화합물), ET host(제2화합물), 화합물 7(센서타이저) 및 BD1-8을 하기 표 1에 기재된 비율로 공증착하여, 30 nm 두께의 발광층을 형성하였다.

[0857] 상기 발광층 상에 9-(3-(9H-카바졸-9-일)페닐)-9H-카바졸-3,6-디카보니트릴(mCP-2CN)을 10 nm 두께로 증착하고, DPEPO 및 LiQ를 (1:1)의 중량비로 30nm 두께로 공증착하고, LiQ를 1 nm 두께로 증착하고, Al을 100 nm 두께로 증착함으로써, ITO(50 nm)/ NDP-9(10 nm)/ HT211(40nm)/o-CBP (10 nm)/발광층 (30 nm)/mCP-2CN (10nm)/ DPEPO:LiQ(1 : 1)를 (30nm)/LiQ (1 nm)/Al (100nm) 구조의 유기 발광 소자를 제작하였다.

[0858] **실시예 1-2, 비교예 1-1 내지 1-3, 실시예 2-1, 2-2, 비교예 2-1 및 2-2**

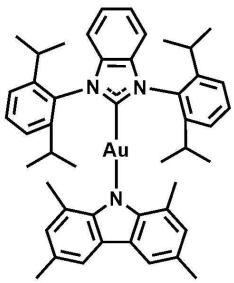
[0859] 발광층의 호스트, 센서타이저 및 에미터를 각각 하기 표 1에 표시된 바와 같이 사용하였다는 점을 제외하고는, 상기 실시예 1과 동일한 방법을 이용하여 유기 발광 소자를 제작하였다.

표 1

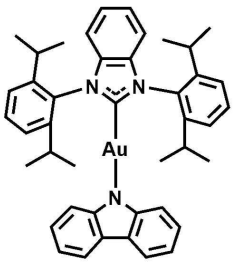
[0860]

	제1화합물	제2화합물	제1화합물:제2화합물의 중량비	센서타이저	센서타이저 함량 (중량%, 발광층 총 중량 기준)	에미터	에미터 함량 (중량%, 발광층 총 중량 기준)
실시예 1-1	HT host	ET host	6:4	화합물 7	20	BD1-8	3
실시예 1-2	HT host	ET host	6:4	화합물 8	20	BD1-5	3
비교예 1-1	HT host	ET host	6:4	화합물 7	20	-	-
비교예 1-2	HT host	ET host	6:4	화합물 8	20	-	-
비교예 1-3	HT host	ET host	6:4	BD1-9	20	-	-
실시예 2-1	HT host	ET host	6:4	화합물 7	20	BD1-8	1.5
실시예 2-2	HT host	ET host	6:4	화합물 8	20	BD1-5	1.5
비교예 2-1	HT host	ET host	6:4	BD1-9	20	BD1-8	1.5
비교예 2-2	HT host	ET host	6:4	BD1-9	20	BD1-5	1.5

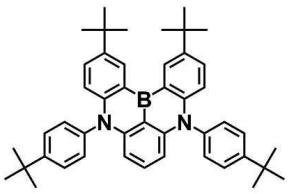
[0861]



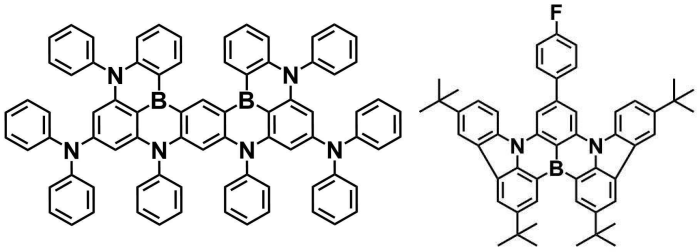
7

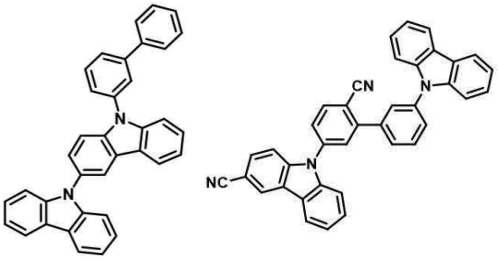


8



BD1-9

[0862] 

[0863] 

[0864] **평가예 1**

[0865] 실시예 1-1, 실시예 1-2, 비교예 1-1, 1-2, 실시예 2-1 내지 2-3, 비교예 2-1, 2-2, 실시예 3-1, 3-2 및 비교예 3-1에서 제조된 각각의 유기 발광 소자에 대하여, 구동 전압, 전류 효율, 전류밀도, 색좌표, 효율/y, 외부양자 효율(EQE), 최대 EQE, 롤-오프, 최대 발광 파장, 수명 및 전계 발광 스펙트럼(EL spectrum)을 평가한 후, 그 결과를 표 2에 나타내었다. 이 때, 수명(T_{95})은 1000nit에서 초기 휘도 100% 대비 95%의 휘도가 될 때까지 걸리는 시간(T_{95})을 측정한 것고, 수명(T_{80})은 1000nit에서 초기 휘도 100% 대비 80%의 휘도가 될 때까지 걸리는 시간(T_{80})을 측정한 것이다. 효율/y는 전류 효율을 CIEy 좌표값으로 나눈 값을 의미한다.

표 2

[0866]

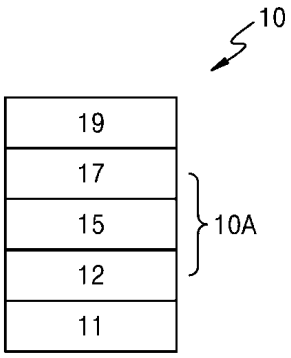
구조요약	구동 전압 (V)	전류 효율 (cd/A)	최대 EQE (%)	λ_{max} (nm)	반치폭 (nm)	T_{95} (시간)	T_{80} (시간)
실시예 1-1	4.68	44.09	21.9	496	31	8.83	80.60
실시예 1-2	4.47	25.50	30.2	475	20	1.43	11.10
비교예 1-1	4.49	40.84	14.8	519	90	2.66	26.85
비교예 1-2	5.01	12.24	7.9	492	79	0.43	2.58
비교예 1-3	6.64	2.84	13.4	519	31	0.16	0.75
실시예 2-1	4.61	43.89	22.8	494	29	9.19	79.36
실시예 2-2	4.53	24.78	29.1	474	19	2.12	13.34
비교예 2-1	4.85	22.76	21.4	519	28	2.95	15.61
비교예 2-2	6.15	4.22	14.8	519	26	0.16	0.90

[0867] 상기 표 2를 참조하면, 실시예 1-1 및 1-2의 유기 발광 소자는 비교예 1-1, 1-2 및 1-3에 비해 향상된 발광 효율, 수명 및/또는 색순도를 가짐을 확인할 수 있는데, 이로부터 화학식 1로 표시되는 화합물을 센서타이저로 사용함으로써, 이를 에미터로 사용하는 유기 발광 소자에 비해 발광 효율, 수명 및/또는 색순도가 향상될 수 있음을 알 수 있다.

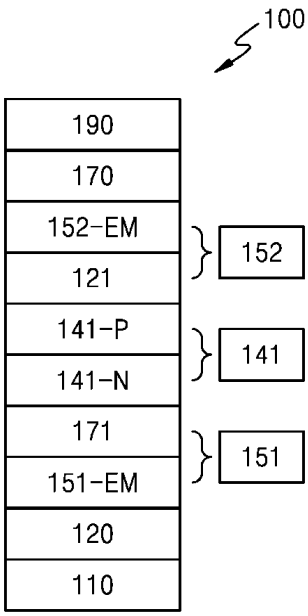
[0868] 또한, 상기 표 2를 참조하면, 실시예 2-1 및 2-2의 유기 발광 소자는 비교예 2-1 및 2-2의 유기 발광 소자보다 수명 및/또는 색순도를 가짐을 확인할 수 있는데, 이로부터 화학식 1로 표시되는 화합물을 센서타이저로 사용하는 것이 다른 알려진 유기 화합물을 센서타이저로 사용하는 유기 발광 소자에 비해 발광 효율, 수명 및/또는 색순도가 향상될 수 있음을 알 수 있다.

도면

도면1



도면2



도면3

