



(19) **United States**

(12) **Patent Application Publication**
Shin et al.

(10) **Pub. No.: US 2016/0322586 A1**
(43) **Pub. Date: Nov. 3, 2016**

(54) **COMPOUND AND ORGANIC LIGHT-EMITTING DEVICE COMPRISING THE SAME**

51/0077 (2013.01); *H01L 27/3248* (2013.01); *C07D 223/14* (2013.01); *C07F 9/6561* (2013.01); *C07D 403/14* (2013.01); *H01L 51/0067* (2013.01); *H01L 51/0052* (2013.01); *C07D 405/14* (2013.01); *H01L 51/0073* (2013.01); *H01L 51/0085* (2013.01); *H01L 51/5206* (2013.01)

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(57) **ABSTRACT**

An organic light-emitting device includes: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode, wherein the organic layer includes an emission layer including a compound represented by Formula 1:

(21) Appl. No.: **15/139,208**

(22) Filed: **Apr. 26, 2016**

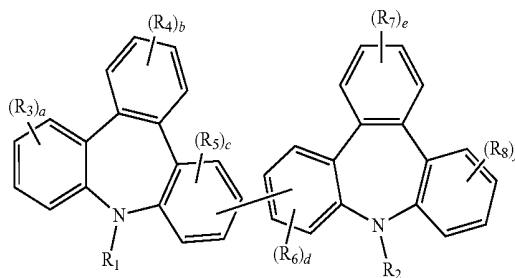
(30) **Foreign Application Priority Data**

Apr. 28, 2015 (KR) 10-2015-0059636
Aug. 3, 2015 (KR) 10-2015-0109571

Formula 1

Publication Classification

(51) **Int. Cl.**
H01L 51/00 (2006.01)
C09K 11/06 (2006.01)
C07D 405/14 (2006.01)
C07D 223/14 (2006.01)
C07F 9/6561 (2006.01)
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H01L 27/32 (2006.01)

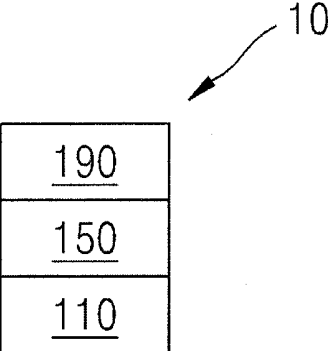


(52) **U.S. Cl.**
CPC *H01L 51/0072* (2013.01); *C09K 11/025* (2013.01); *C09K 11/06* (2013.01); *H01L*

An organic light-emitting device using the compound of Formula 1 may have high efficiency, low voltage, high luminance, and long lifespan.



<u>190</u>
<u>150</u>
<u>110</u>



**COMPOUND AND ORGANIC
LIGHT-EMITTING DEVICE COMPRISING
THE SAME**

CROSS-REFERENCE TO RELATED
APPLICATION

[0001] This application claims the benefit of Korean Patent Application Nos. 10-2015-0059636, filed on Apr. 28, 2015, and 10-2015-0109571, filed on Aug. 3, 2015, in the Korean Intellectual Property Office, the disclosure of each of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] 1. Field

[0003] One or more aspects of embodiments of the present disclosure relate to a compound and an organic light-emitting device including the same.

[0004] 2. Description of the Related Art

[0005] Organic light-emitting devices (OLEDs) are self-emission devices that have wide viewing angles, high contrast ratios, and short response times. In addition, the OLEDs exhibit high luminance, low driving voltage, and good response speed characteristics, and can produce full-color images.

[0006] An OLED may include a first electrode disposed (e.g., positioned) on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. The holes and the electrons recombine in the emission layer to produce excitons. These excitons change from an excited state to a ground state, thereby generating light.

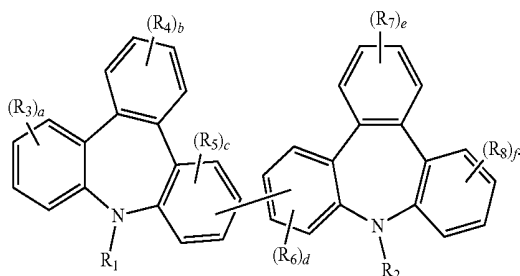
SUMMARY

[0007] One or more aspects of embodiments of the present disclosure are directed to a host compound (e.g., a phosphorescent host compound) having high efficiency, low driving voltage, high luminance, and long lifespan characteristics, and an organic light-emitting device including the same.

[0008] Additional aspects will be set forth in part in the description, which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0009] According to one or more example embodiments, a compound is represented by Formula 1:

Formula 1



[0010] In Formula 1,

[0011] R_1 to R_8 may be each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkynyl group, a substituted or unsubstituted C_1 - C_{60} alkoxy group, a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_1 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group;

[0012] a, b, e, and f may be each independently an integer selected from 1 to 4;

[0013] c and d may be each independently an integer selected from 1 to 3;

[0014] at least one of the substituents of the substituted C_1 - C_{60} alkyl group, substituted C_2 - C_{60} alkenyl group, substituted C_2 - C_{60} alkynyl group, substituted C_1 - C_{60} alkoxy group, substituted C_3 - C_{10} cycloalkyl group, substituted C_2 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_2 - C_{10} heterocycloalkenyl group, substituted C_6 - C_{60} aryl group, substituted C_6 - C_{60} aryloxy group, substituted C_6 - C_{60} arylthio group, substituted C_1 - C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

[0015] deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group;

[0016] a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q_{11})(Q_{12}), —Si(Q_{13})(Q_{14})(Q_{15}), and —B(Q_{16})(Q_{17});

[0017] a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl

group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0018] a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇); and

[0019] —P(=O)Q₃₁Q₃₂,

[0020] wherein Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₂ may be each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, and

[0021] when a to f are each independently 2 or more, a plurality of R₃(s) to R₈(s) may be respectively identical to or different from each other.

[0022] According to one or more example embodiments, an organic light-emitting device includes a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode and including an emission layer, wherein the organic layer includes the compound of Formula 1.

[0023] According to one or more example embodiments, a flat panel display apparatus may include the organic light-emitting device, wherein a first electrode is electrically coupled to a source electrode or drain electrode of a thin film transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

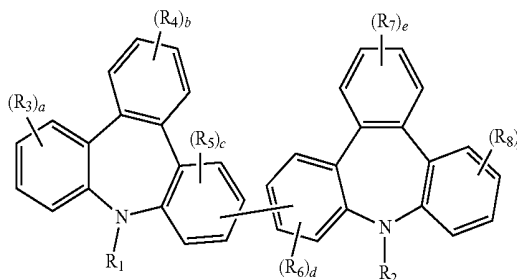
[0024] These and/or other aspects will become apparent and more readily appreciated from the following description of the example embodiments, taken in conjunction with the accompanying drawing, which is a schematic view of an organic light-emitting device according to an example embodiment.

DETAILED DESCRIPTION

[0025] Reference will now be made in more detail to example embodiments, examples of which are illustrated in the accompanying drawing, wherein like reference numerals refer to like elements throughout. In this regard, the present example embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the example embodiments are merely described below, by referring to the drawing, to explain aspects of the present description. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expressions such as “at least one of,” “one of,” “at least one selected from,” and “one selected from,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list. Further, the use of “may” when describing embodiments of the present invention refers to “one or more embodiments of the present invention.”

[0026] According to an example embodiment, a compound is represented by Formula 1:

Formula 1



[0027] In Formula 1,

[0028] R₁ to R₈ may be each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group;

[0029] a, b, e, and f may be each independently an integer selected from 1 to 4;

[0030] c and d may be each independently an integer selected from 1 to 3;

[0031] at least one of the substituents of the substituted C₁-C₆₀ alkyl group, substituted C₂-C₆₀ alkenyl group, substituted C₂-C₆₀ alkynyl group, substituted C₁-C₆₀ alkoxy

group, substituted C₃-C₁₀ cycloalkyl group, substituted C₂-C₁₀ heterocycloalkyl group, substituted C₃-C₁₀ cycloalkenyl group, substituted C₂-C₁₀ heterocycloalkenyl group, substituted C₆-C₆₀ aryl group, substituted C₆-C₆₀ aryloxy group, substituted C₆-C₆₀ arylthio group, substituted C₁-C₆₀ heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

[0032] deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0033] a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁₁)(Q₁₂), —Si(Q₁₃)(Q₁₄)(Q₁₅), and —B(Q₁₆)(Q₁₇);

[0034] a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0035] a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇); and

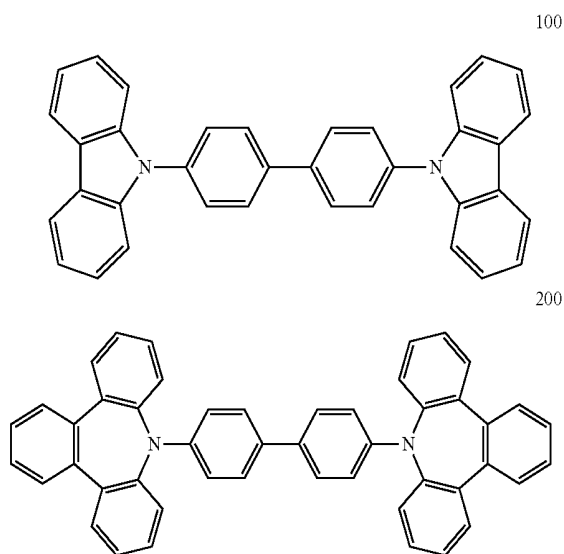
[0036] —P(=O)Q₃₁Q₃₂;

[0037] wherein Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₂ may be each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine

group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, and

[0038] when a to f are each independently 2 or more, a plurality of R₃(s) to R₈(s) may be respectively identical to or different from each other.

[0039] In related organic light-emitting devices, a material such as Compound 200 (illustrated below) was used as a material for a hole transport layer (HTL), but not as a phosphorescent material. For example, when Compound 100 (illustrated below) and Compound 200 are used as phosphorescent host, the resulting organic light-emitting device (OLED) may have low efficiency and short lifespan characteristics. In order to improve device characteristics, there is a need to develop a phosphorescent host.

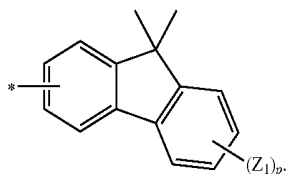
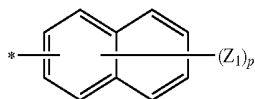
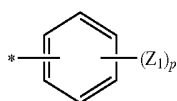


[0040] Hereinafter substituents of Formula 1 will be described in more detail.

[0041] In some embodiments, in Formula 1, R₃ to R₈ may be each independently selected from hydrogen and deuterium.

[0042] In some embodiments, in Formula 1, R₁ and R₂ may be each independently selected from a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

[0043] In some embodiments, in Formula 1, R₁ and R₂ may be each independently selected from Formulae 2a to 2c:



[0044] In Formulae 2a to 2c,

[0045] Z_1 may be selected from hydrogen, deuterium, a halogen group, a cyano group, a nitro group, a hydroxyl group, a carboxyl group, a substituted or unsubstituted C_1 - C_{20} alkyl group, a substituted or unsubstituted C_6 - C_{20} aryl group, a substituted or unsubstituted C_1 - C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, and $-P(=O)Q_{31}Q_{32}$,

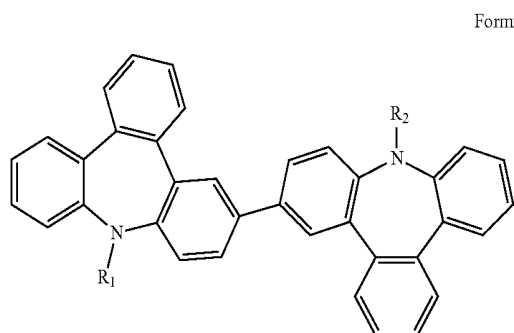
[0046] wherein Q_{31} to Q_{32} may be each independently selected from hydrogen, deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0047] when p is 2 or more, a plurality of Z_1 (s) may be respectively identical to or different from each other;

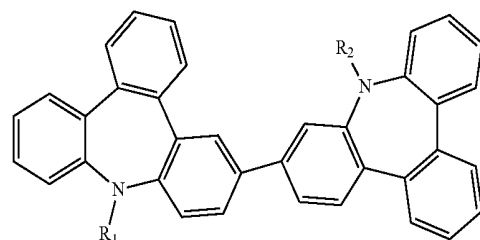
[0048] p in Formula 2a may be an integer selected from 1 to 5, p in Formulae 2b and 2c may be an integer selected from 1 to 7; and

[0049] *indicates a binding site.

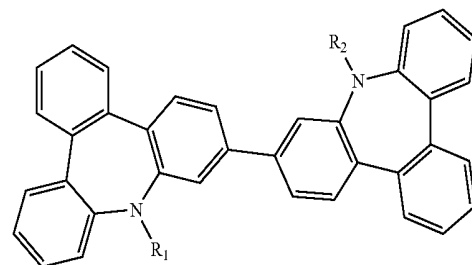
[0050] In some embodiments, the compound of Formula 1 may be represented by Formula 2:



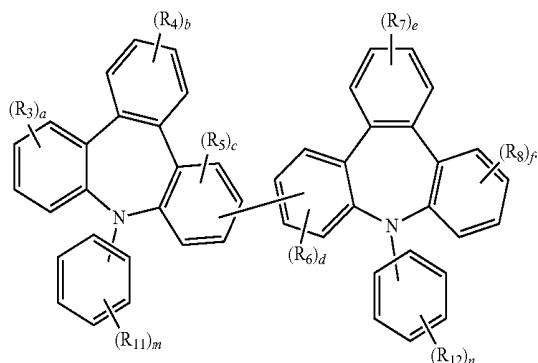
[0051] In some embodiments, the compound of Formula 1 may be represented by Formula 3:



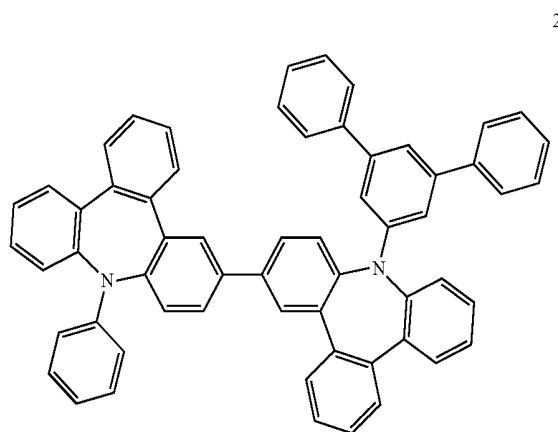
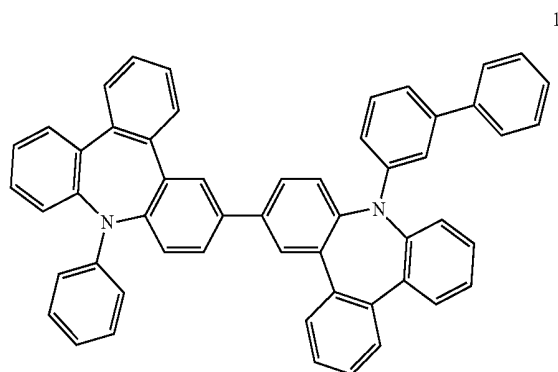
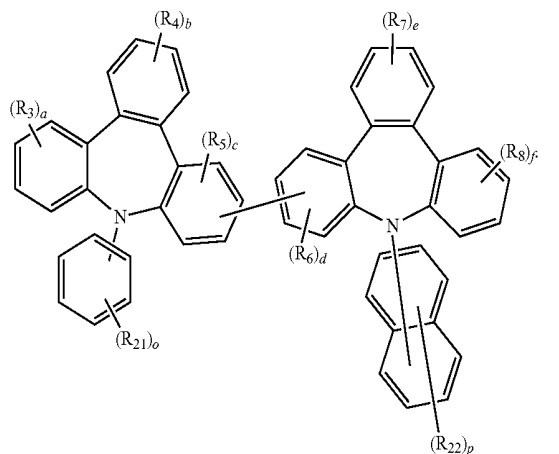
[0052] In some embodiments, the compound of Formula 1 may be represented by Formula 4:



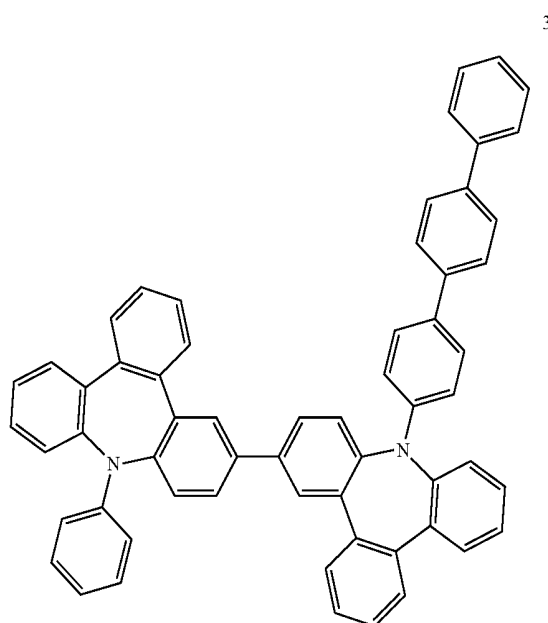
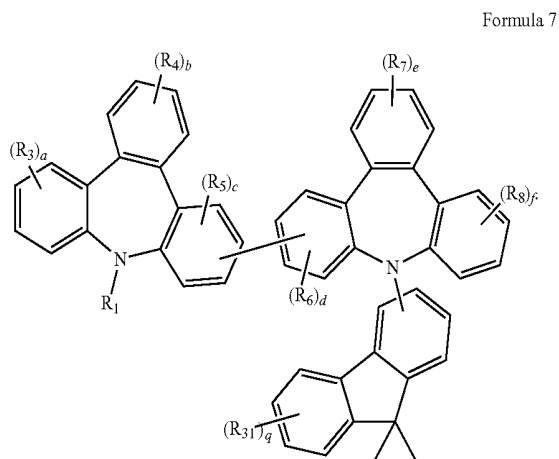
[0053] In some embodiments, the compound of Formula 1 may be represented by Formula 5:



[0054] In some embodiments, the compound of Formula 1 may be represented by Formula 6:



[0055] In some embodiments, the compound of Formula 1 may be represented by Formula 7:

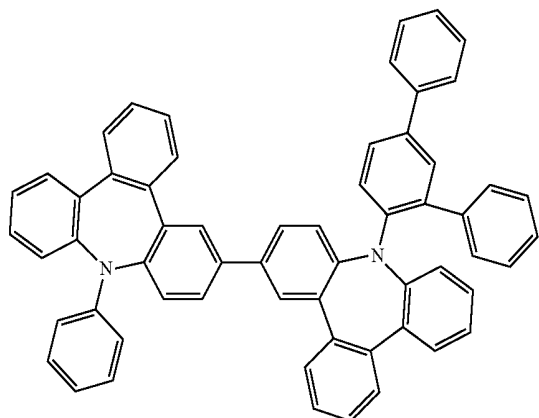


[0056] In Formulae 2 to 7, R_{11} , R_{12} , R_{21} , R_{22} , and R_{31} may be each independently defined the same as the definitions provided in connection with R_1 to R_8 , q may be an integer selected from 1 to 4, m , n , and o may be each independently an integer selected from 1 to 5, and p may be an integer selected from 1 to 7.

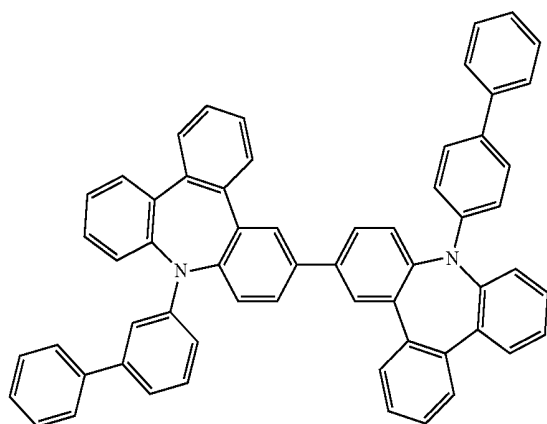
[0057] According to an embodiment of the present disclosure, the compound represented by Formula 1 may be selected from Compounds 1 to 69. In Compounds 1 to 69, "D" may refer to deuterium:

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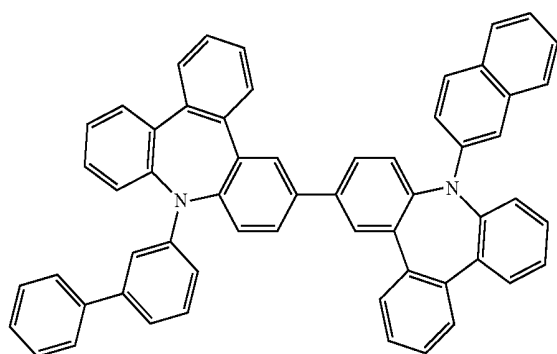
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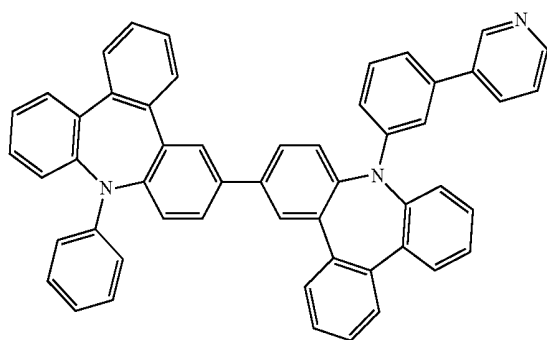
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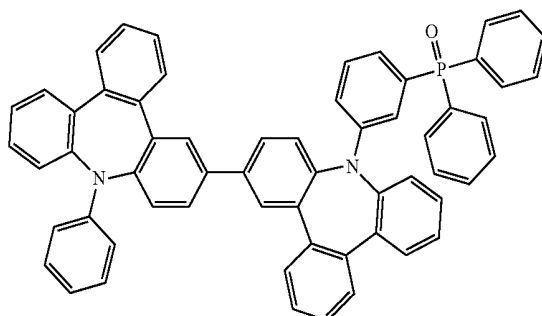


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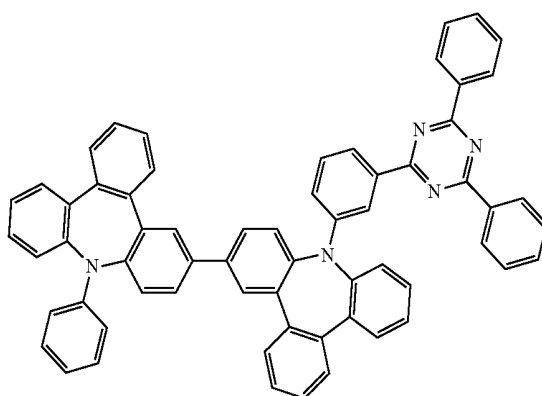


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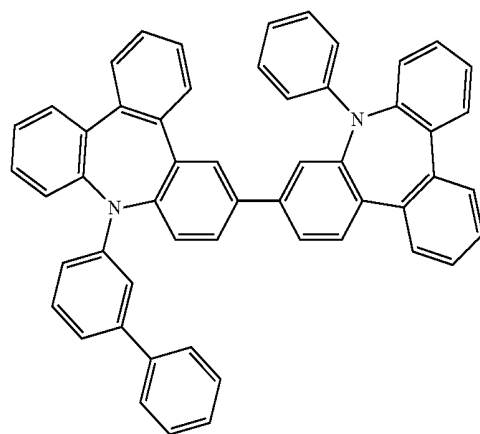
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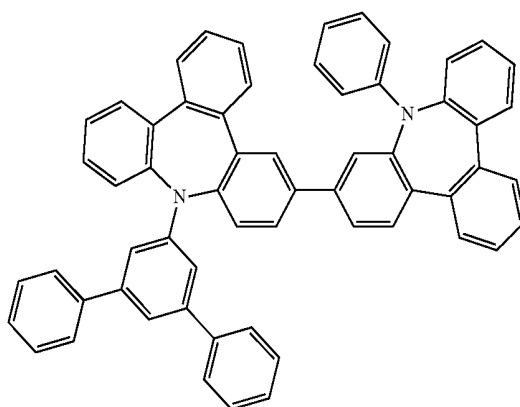
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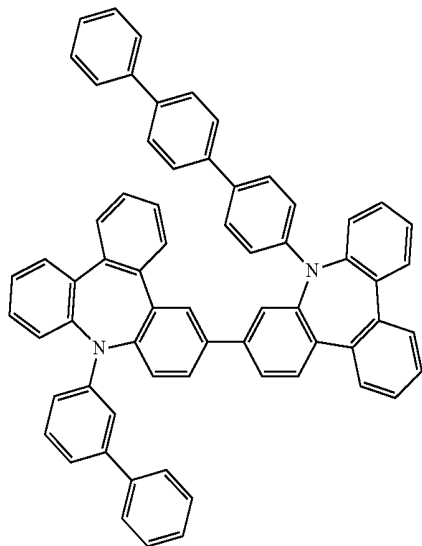


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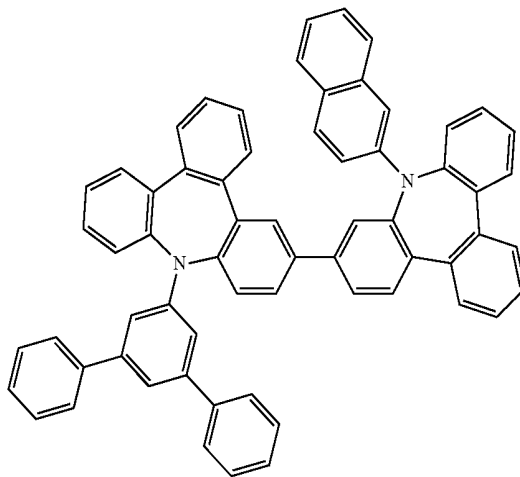


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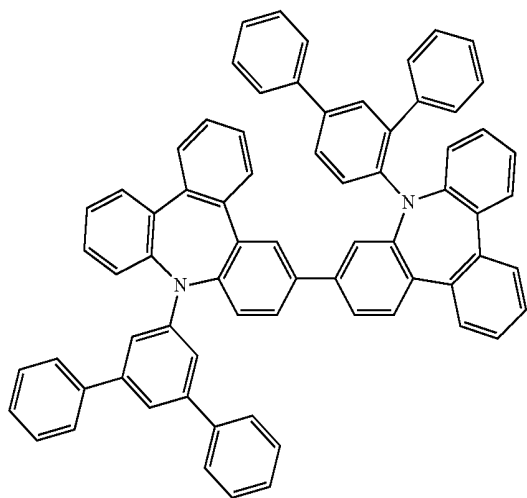
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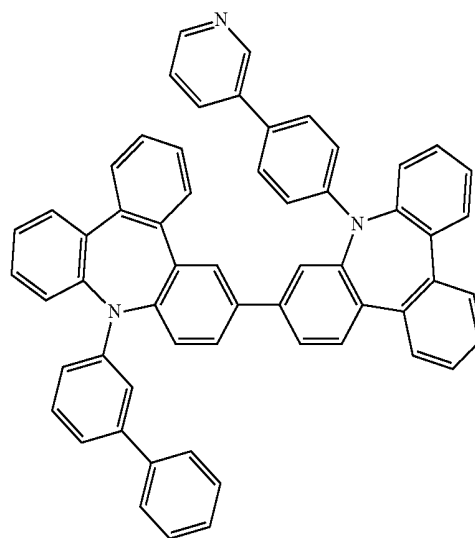
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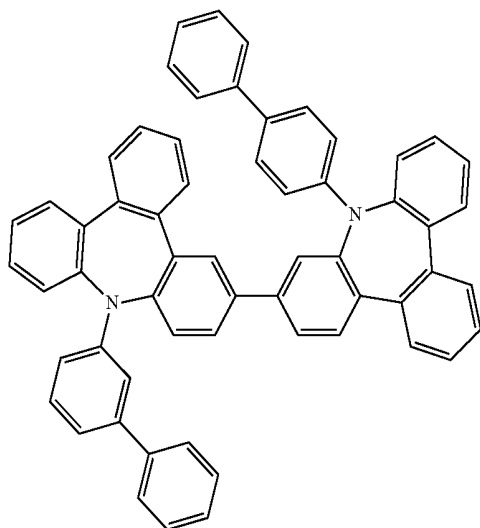
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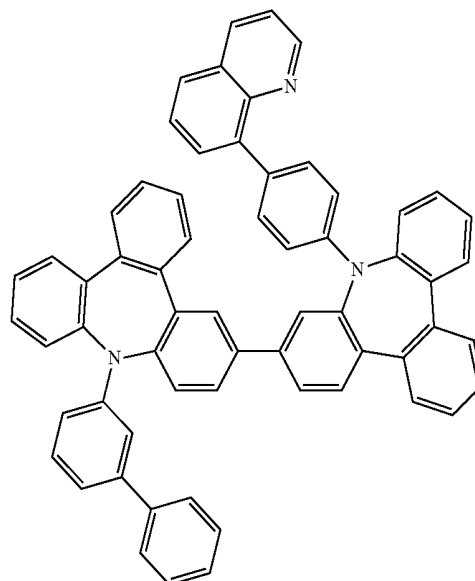
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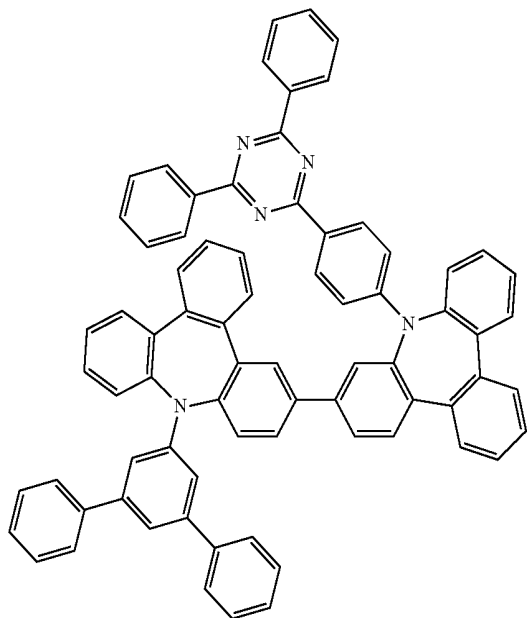
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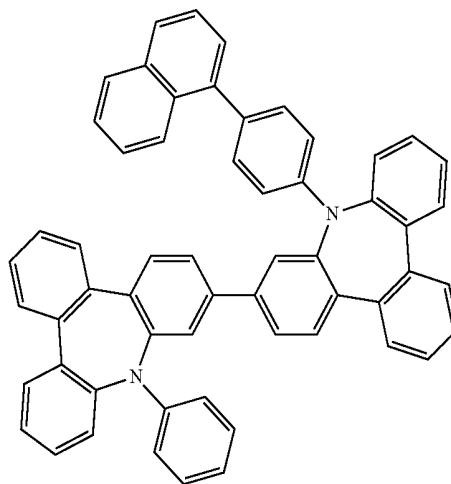
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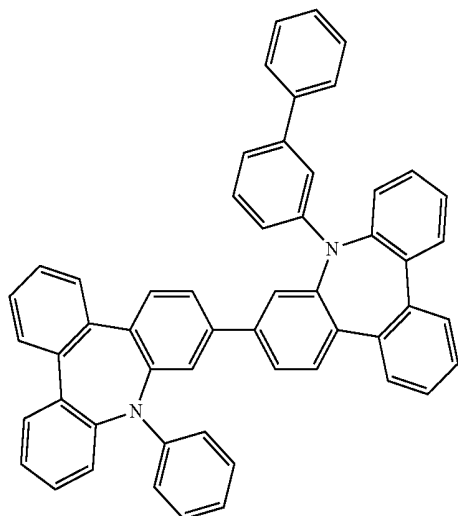


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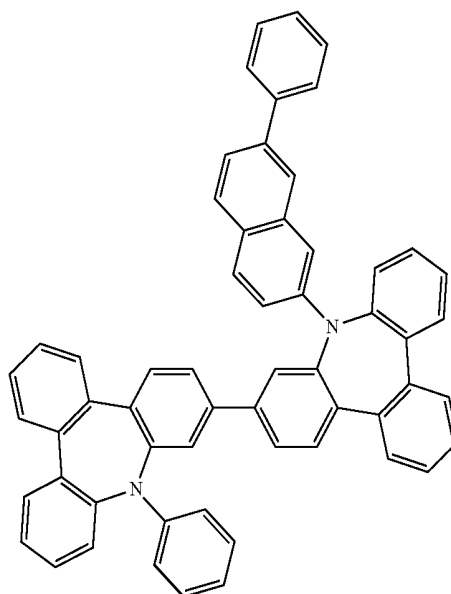
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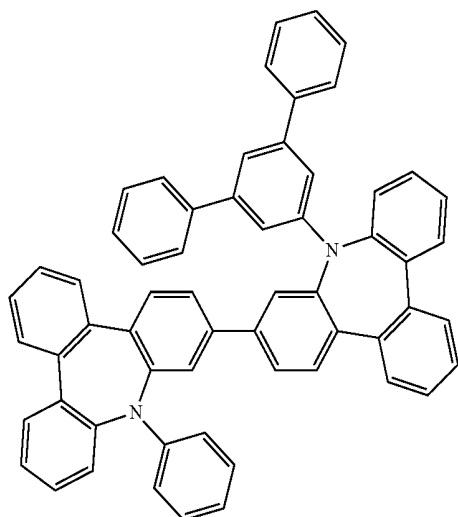
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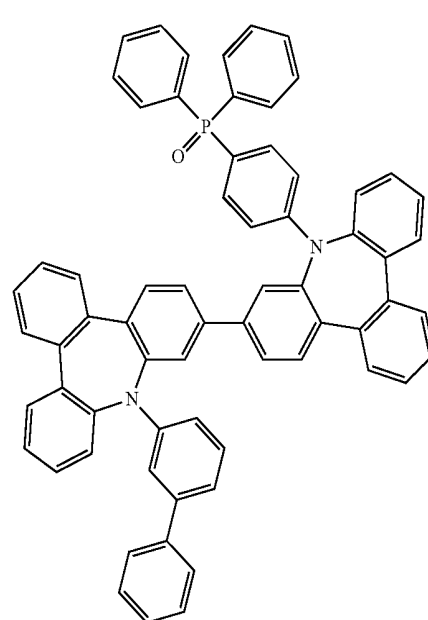
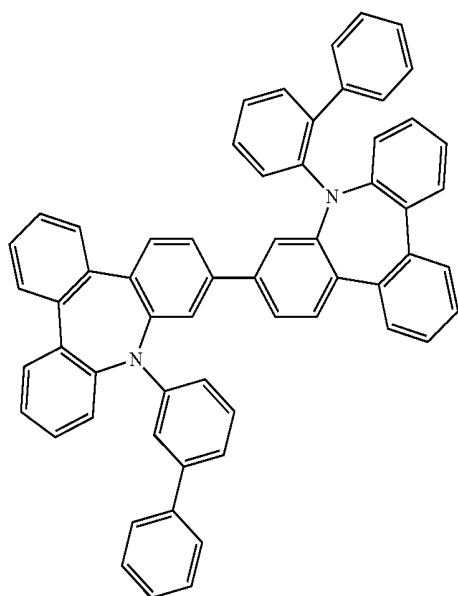
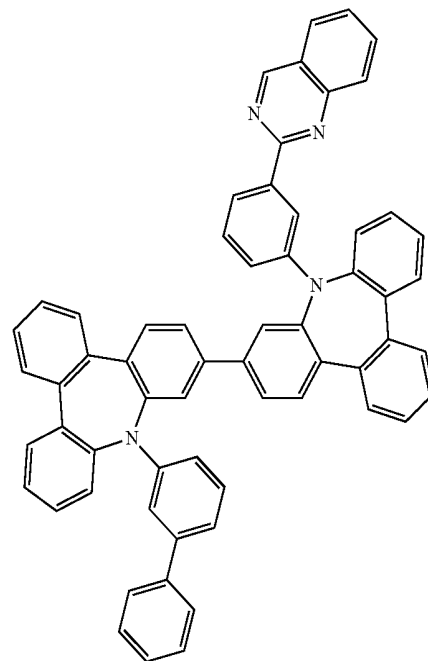
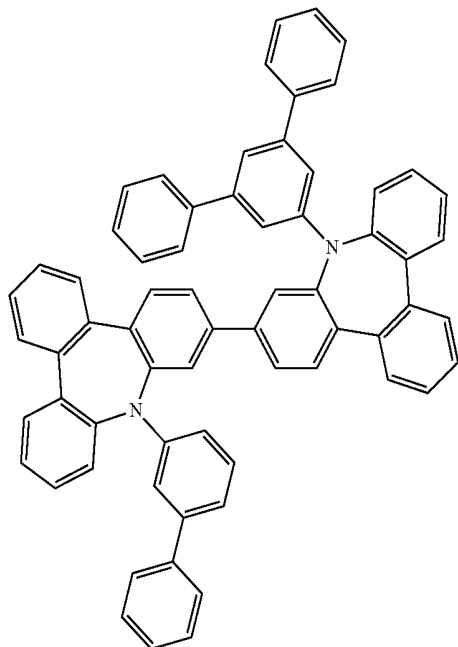


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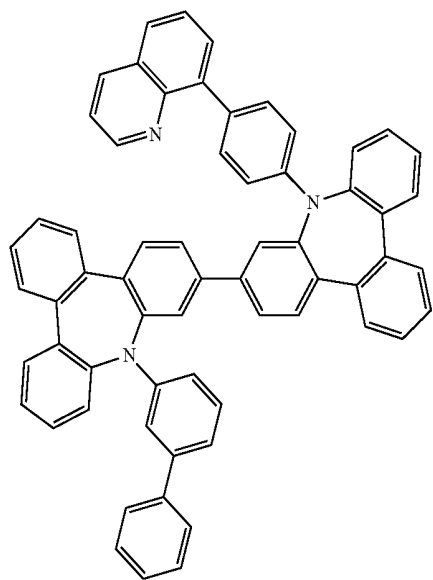


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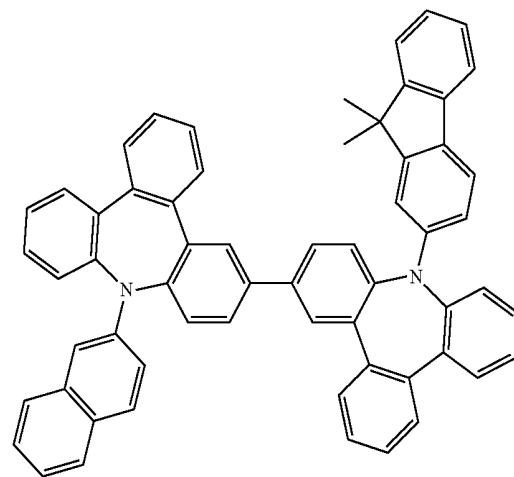
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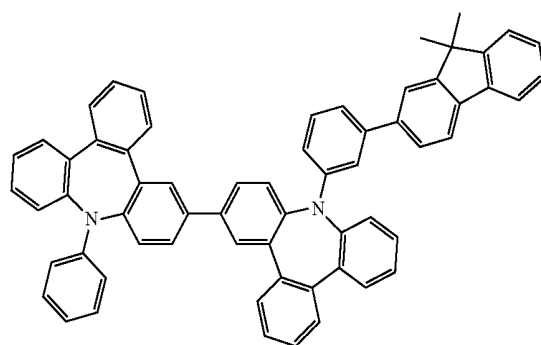
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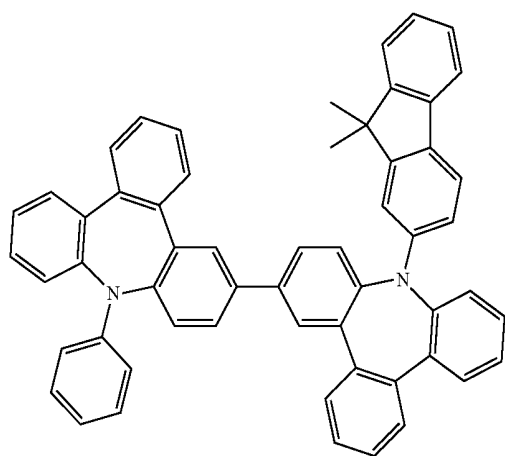
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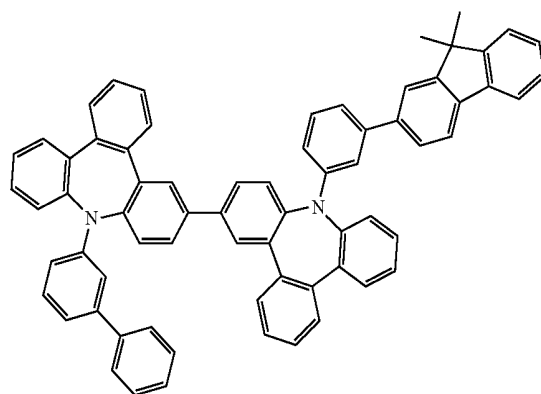
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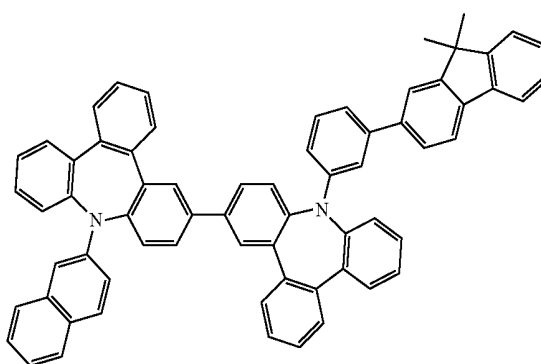
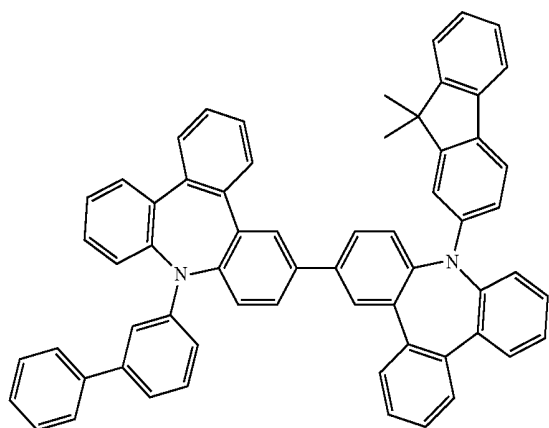
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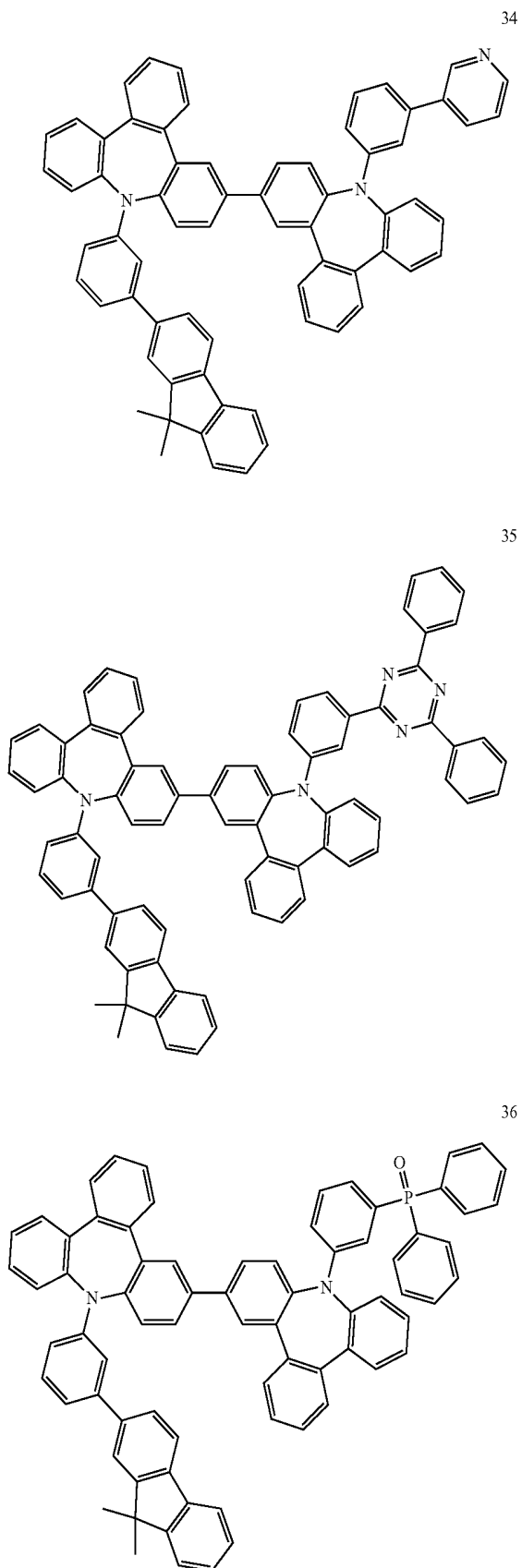
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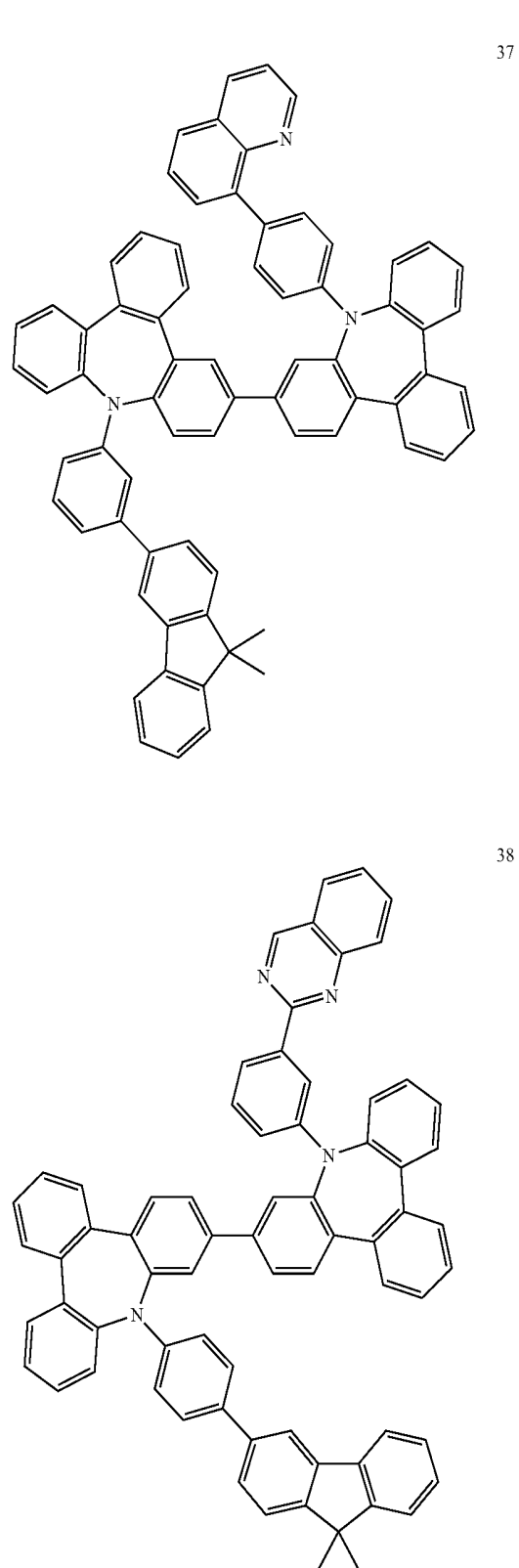
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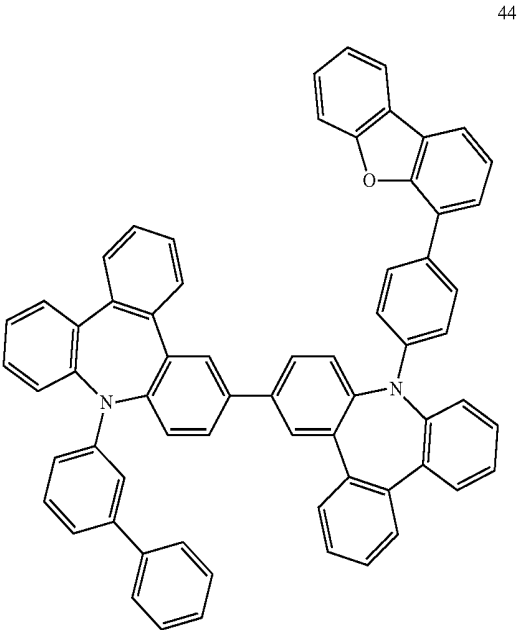
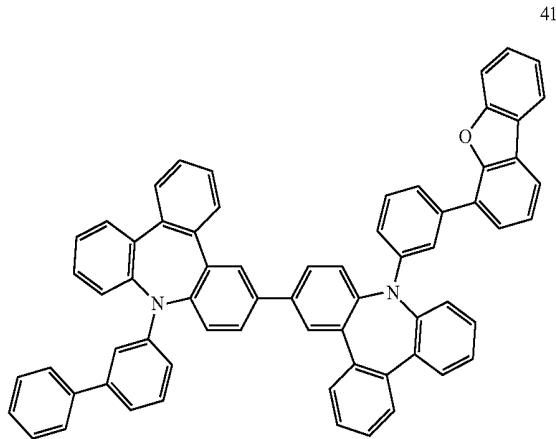
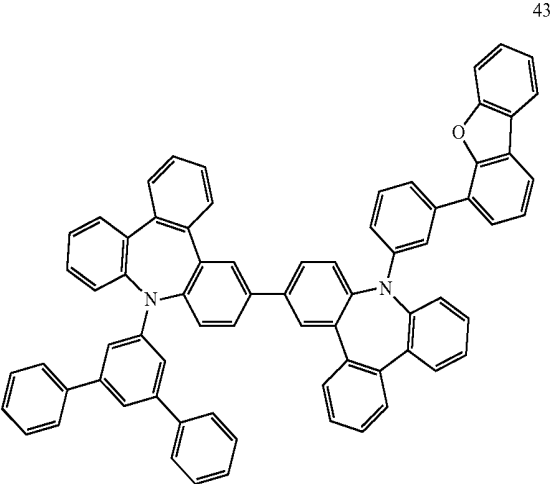
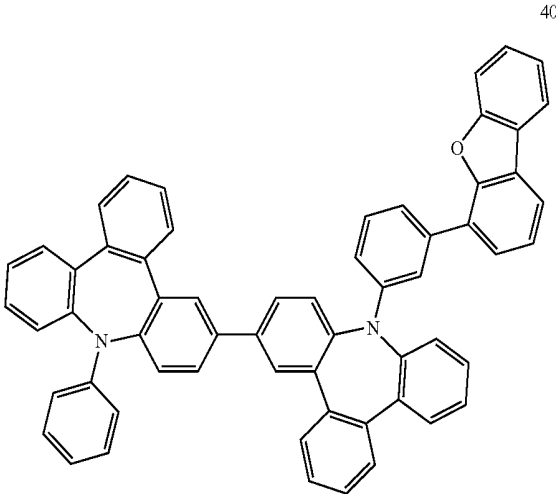
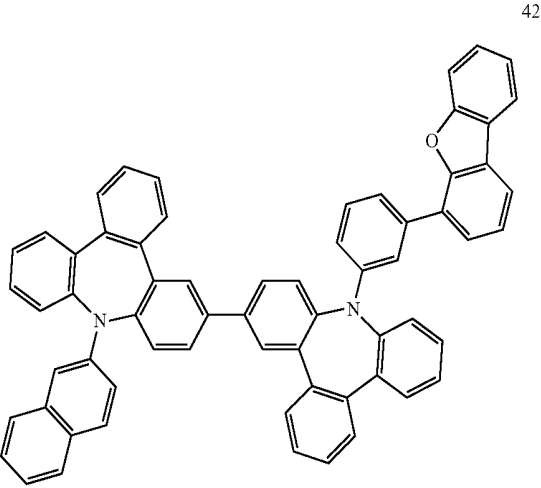
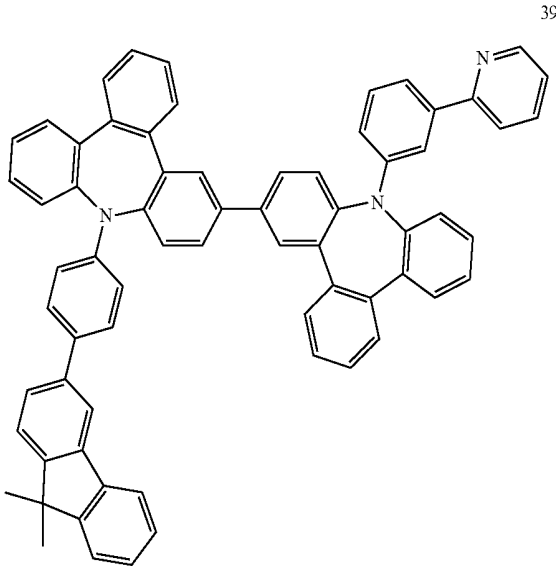


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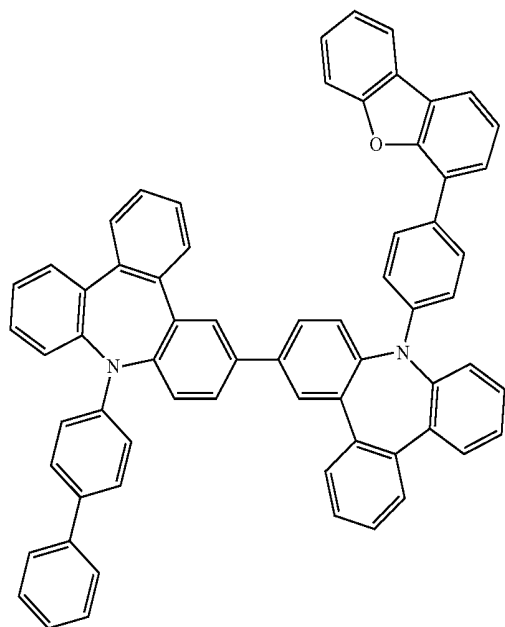
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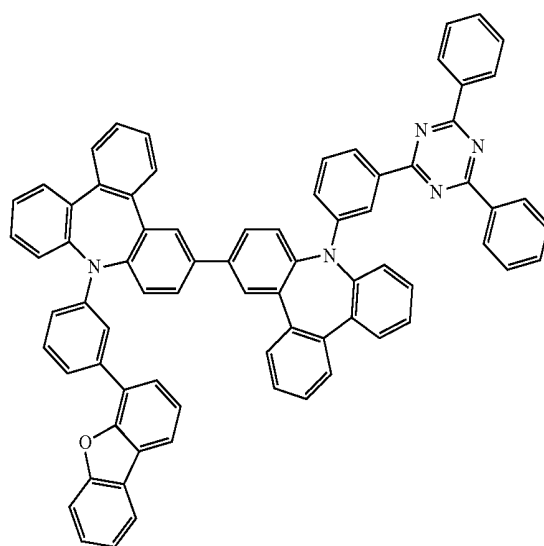
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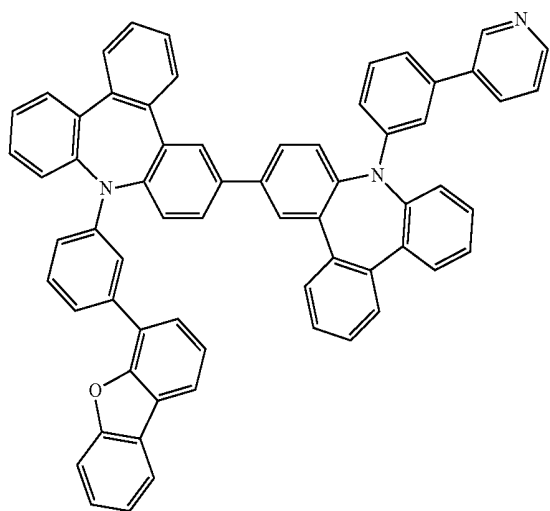
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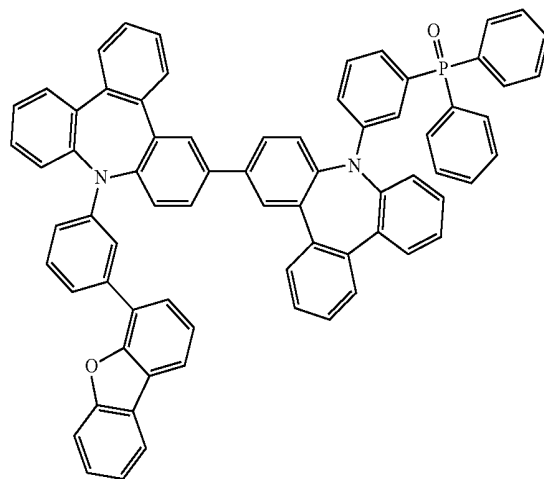
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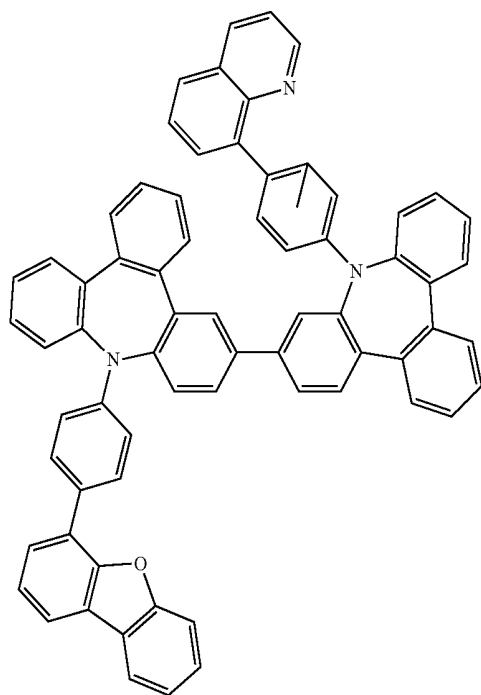
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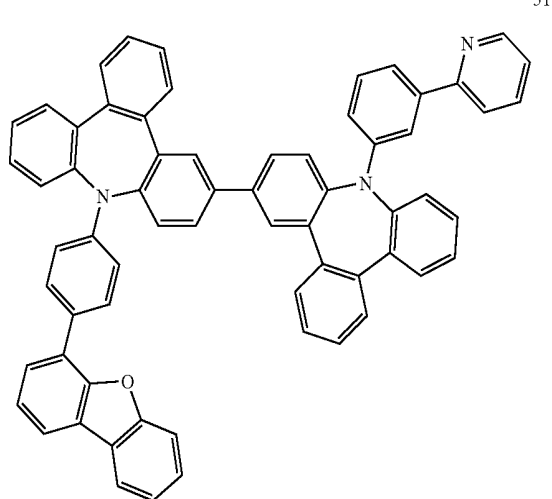
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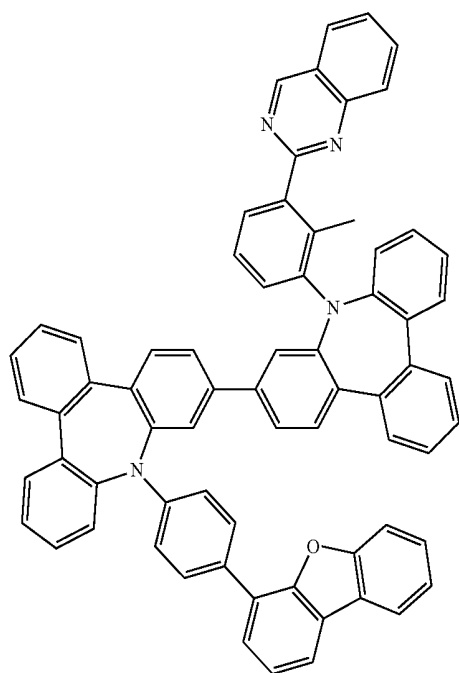
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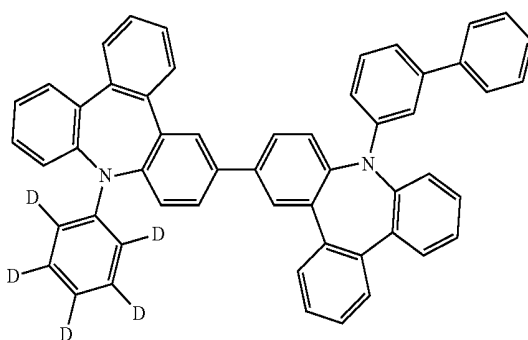
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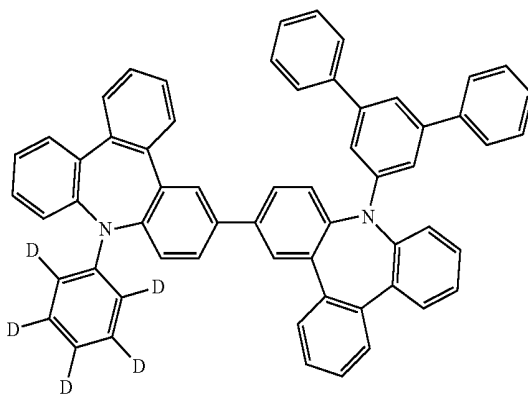
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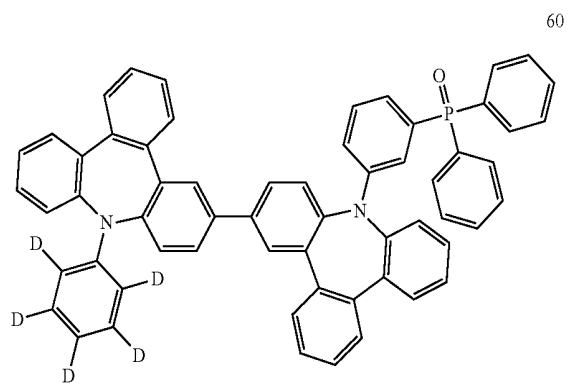
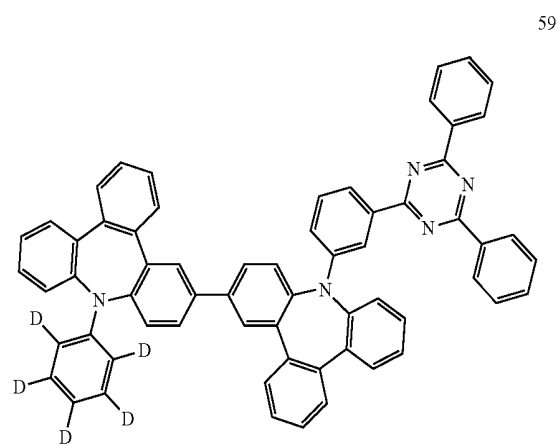
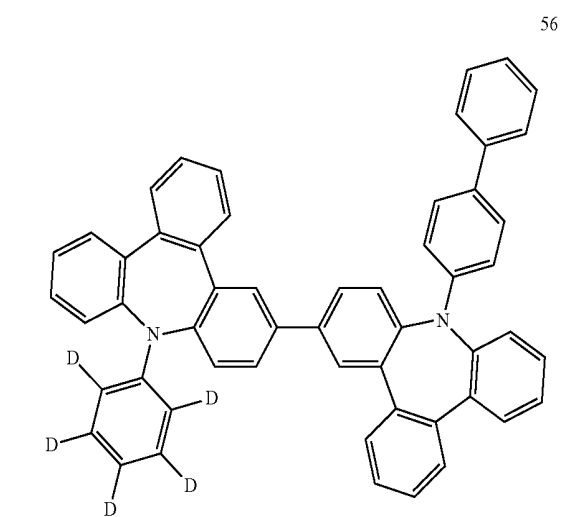
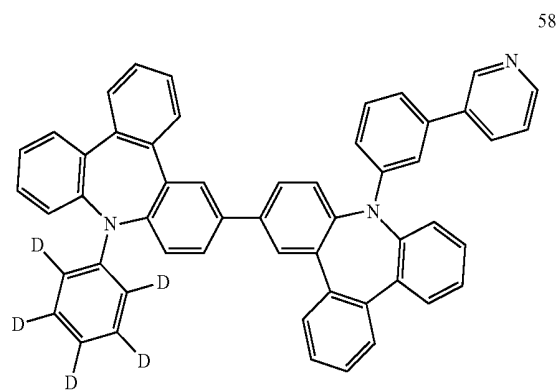
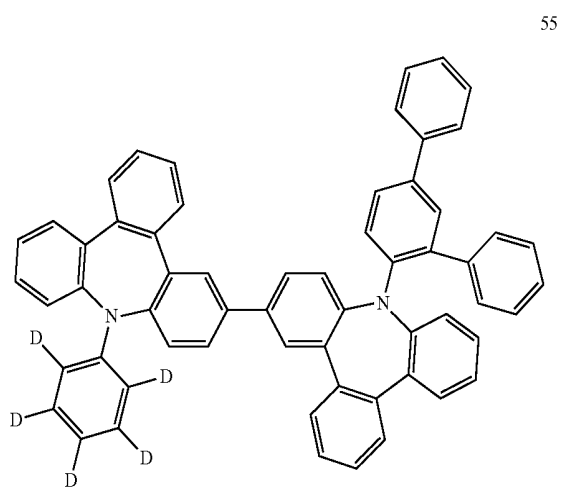
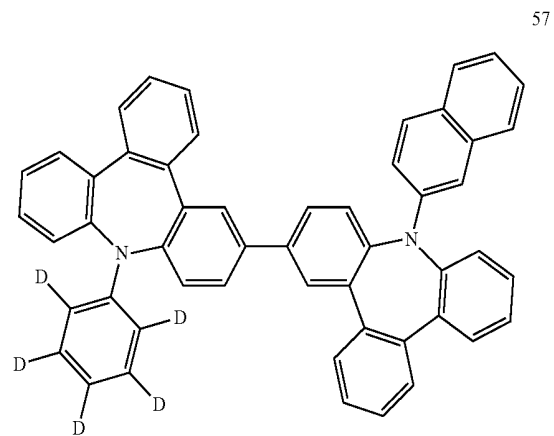
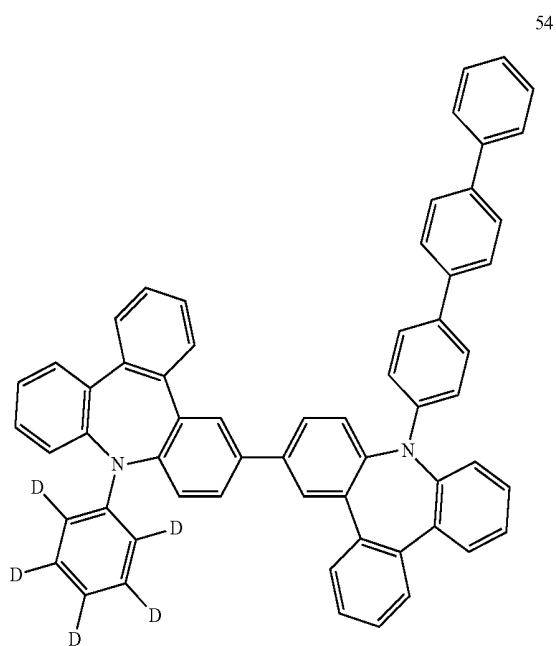


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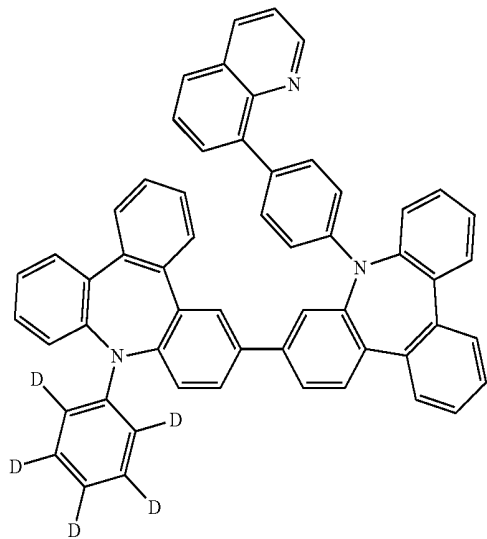
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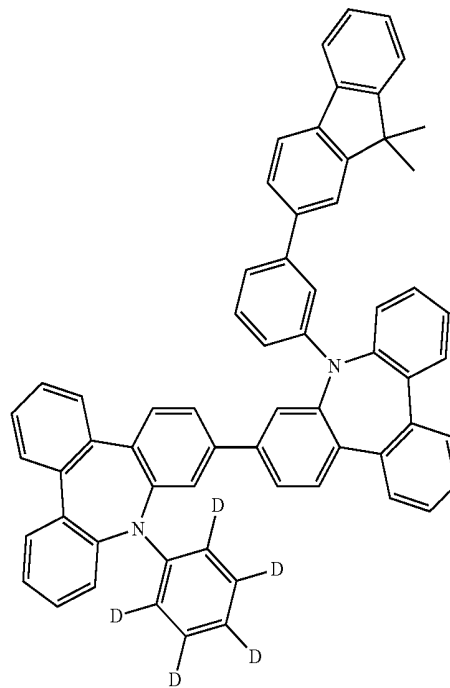
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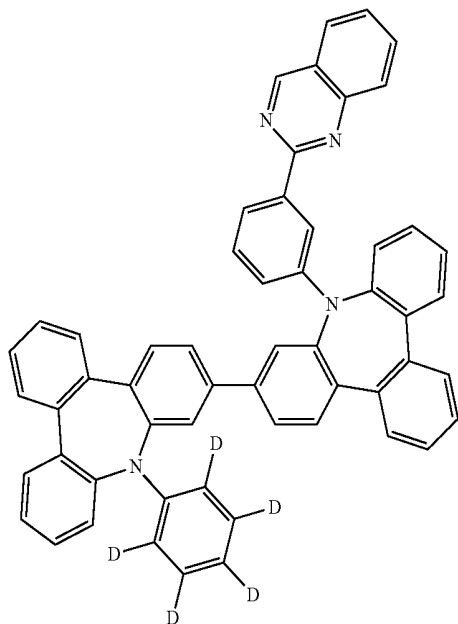


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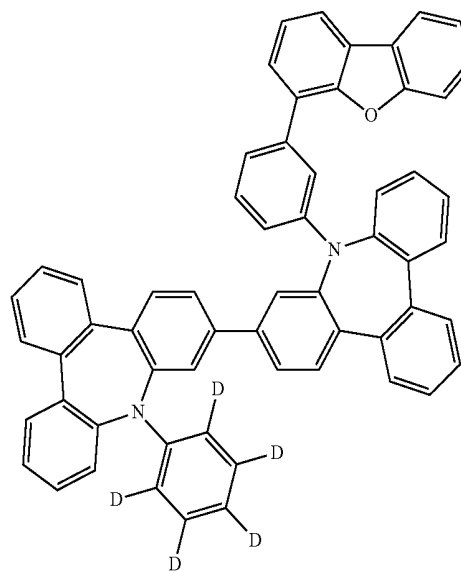
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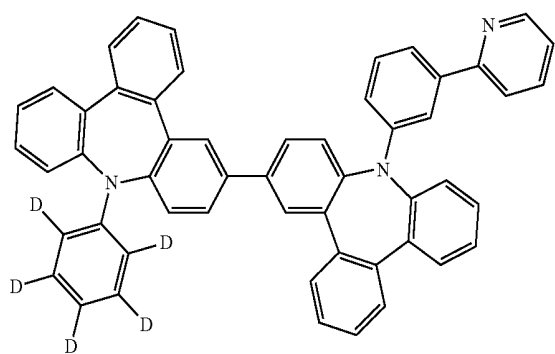
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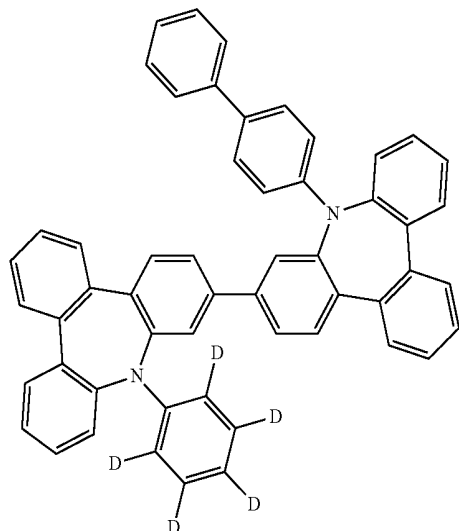
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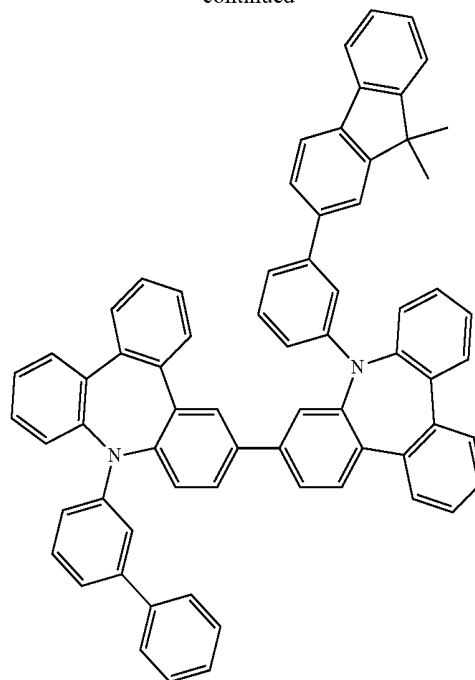


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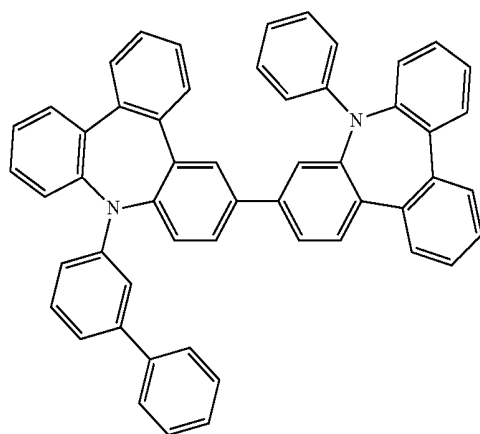
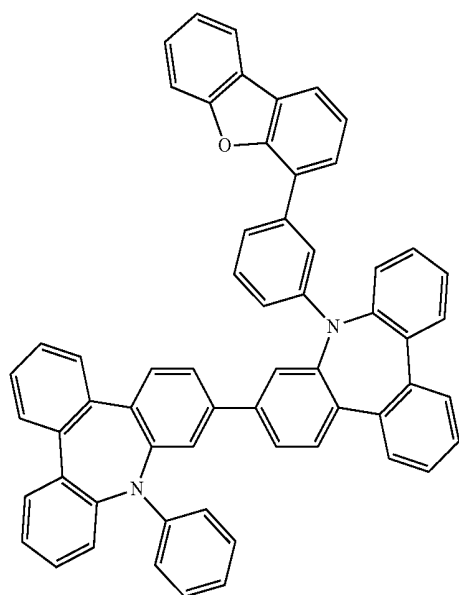


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68

[0058] As used herein, the term “organic layer” refers to a single layer and/or a plurality of layers between the first electrode and the second electrode in an organic light-emitting device. A material included in the “organic layer” is not limited to an organic material only.

[0059] The drawing is a schematic view of an organic light-emitting device 10 according to an embodiment. The organic light-emitting device 10 may include a first electrode 110, an organic layer 150, and a second electrode 190.

[0060] Hereinafter a structure and a method of manufacturing an organic light-emitting device according to an embodiment will be described with reference to the drawing.

[0061] Referring to the drawing, a substrate may be additionally disposed (e.g., positioned) under the first electrode 110 or on the second electrode 190. The substrate may be a glass substrate or transparent plastic substrate, each with excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and/or water resistance.

[0062] The first electrode 110 may be formed by depositing or sputtering a material for forming the first electrode 110 on the substrate. When the first electrode 110 is an anode, the material for the first electrode 110 may be selected from materials with a high work function, so as to facilitate hole injection. The first electrode 110 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. The material for the first electrode 110 may be a transparent and highly conductive material. Non-limiting examples of such material include indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO₂), and zinc oxide (ZnO). When the first electrode 110 is a semi-transmissive electrode or a reflective electrode, as a material for forming the first electrode 110, at least one selected from magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag) may be used.

[0063] The first electrode 110 may have a single-layer structure, or a multi-layer structure including a plurality of

layers. For example, the first electrode **110** may have a triple-layer structure of ITO/Ag/ITO, but embodiments of the present disclosure are not limited thereto.

[0064] The organic layer **150** may be on the first electrode **110**. The organic layer **150** may include an emission layer.

[0065] The organic layer **150** may further include a hole transport region between the first electrode **110** and the emission layer and an electron transport region between the emission layer and the second electrode **190**.

[0066] The hole transport region may include at least one selected from a hole injection layer (HIL), a hole transport layer (HTL), a buffer layer, and an electron blocking layer (EBL), and the electron transport region may include at least one selected from a hole blocking layer (HBL), an electron transport layer (ETL), and an electron injection layer (EIL), but the structures of the hole transport region and electron transport region are not limited thereto.

[0067] The hole transport region may have a single-layered structure including a single material, a single-layered structure including a plurality of different materials, or a multi-layered structure having a plurality of layers including a plurality of different materials.

[0068] For example, the hole transport region may have a single-layered structure including a plurality of different materials, or a structure of hole injection layer/hole transport layer, a structure of hole injection layer/hole transport layer/buffer layer, a structure of hole injection layer/buffer layer, a structure of hole transport layer/buffer layer, or a structure of hole injection layer/hole transport layer/electron blocking layer, wherein the layers of each structure are sequentially stacked from the first electrode **110** in this stated order, but embodiments of the present disclosure are not limited thereto.

[0069] When the hole transport region includes a hole injection layer, the hole injection layer may be formed on the first electrode **110** by using one or more suitable methods, such as vacuum deposition, spin coating, casting, a Langmuir-Blodgett (LB) method, ink-jet printing, laser printing, and/or laser-induced thermal imaging (LITI).

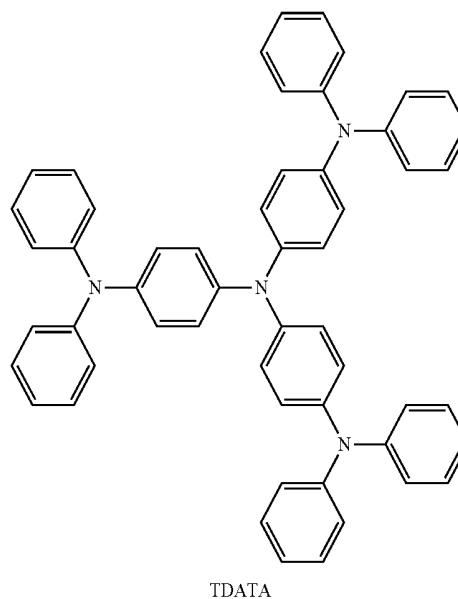
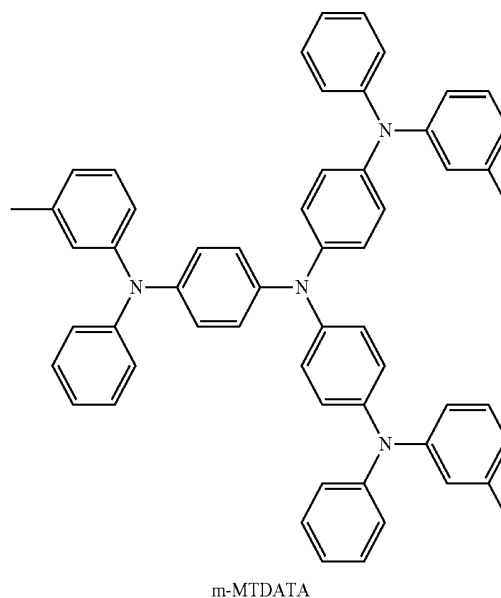
[0070] When the hole injection layer is formed by vacuum deposition, for example, the vacuum deposition may be performed at a temperature of about 100° C. to about 500° C., at a vacuum degree of about 10⁻⁸ Torr to about 10⁻³ Torr, and at a vacuum deposition rate in a range of about 0.01 Å/sec to about 100 Å/sec, depending on the compound for forming the hole injection layer, and the structure of the hole injection layer to be formed.

[0071] When the hole injection layer is formed by spin coating, for example, the spin coating may be performed at a coating rate of about 2000 rpm to about 5000 rpm, and at a temperature of about 80° C. to 200° C., by taking into account a compound for forming the hole injection layer to be deposited and the structure of the hole injection layer to be formed.

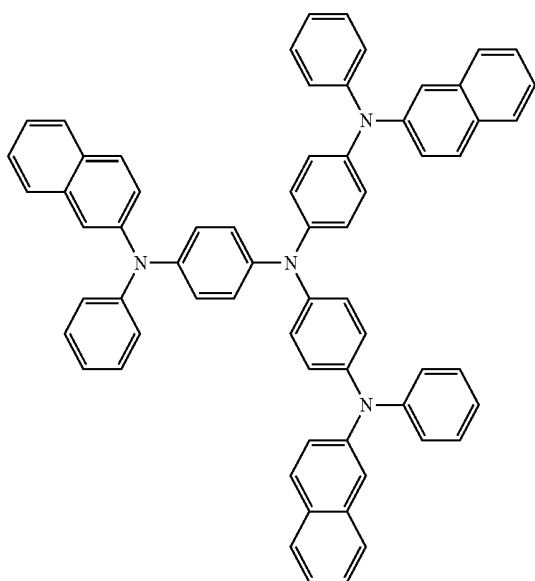
[0072] When the hole transport region includes a hole transport layer, the hole transport layer may be formed on the first electrode **110** or the hole injection layer by using one or more suitable methods, such as vacuum deposition, spin coating, casting, an LB method, ink-jet printing, laser printing, and/or LITI. When the hole transport layer is formed by vacuum deposition and/or spin coating, conditions for

vacuum deposition and coating may be similar to the vacuum deposition and coating conditions for forming the hole injection layer.

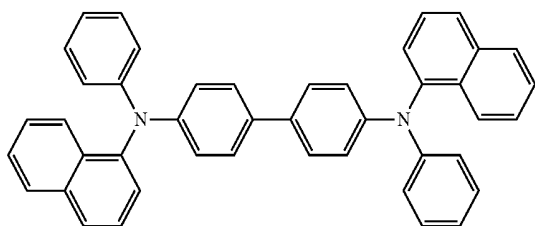
[0073] The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, a spiro-TPD, a spiro-NPB, methylated-NPB, TAPC, HMTPD, 4,4',4"-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzenesulfonic acid (Pani/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (Pani/CSA), (polyaniline)/poly(4-styrenesulfonate) (PANI/PSS), a compound represented by Formula 201 below, and a compound represented by Formula 202 below:



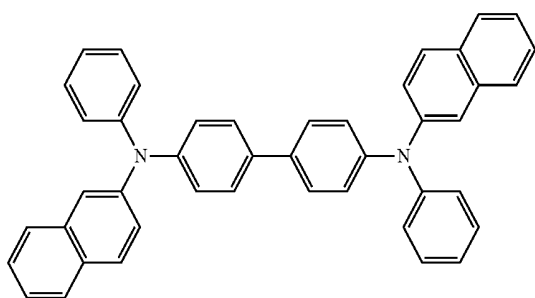
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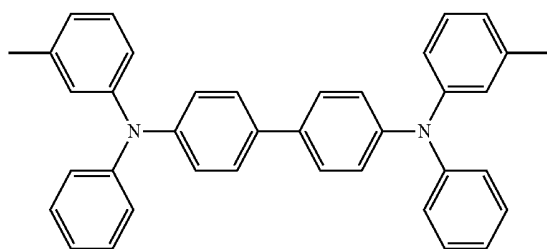
2-TNATA



NPB

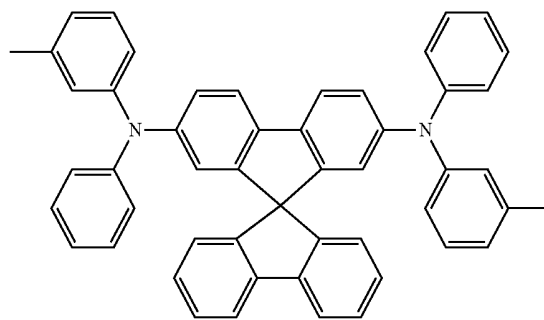


β -NPB

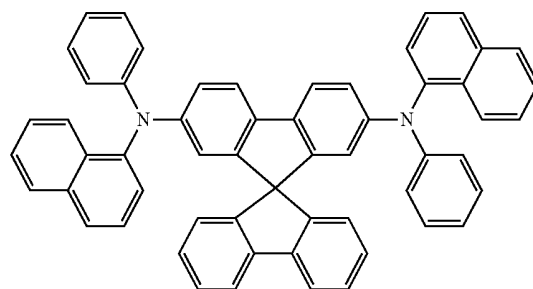


TPD

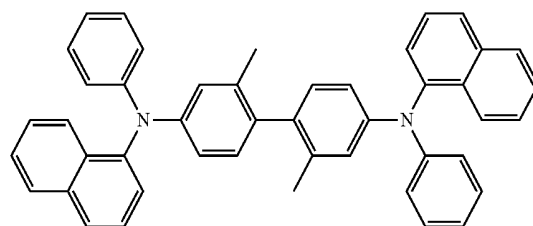
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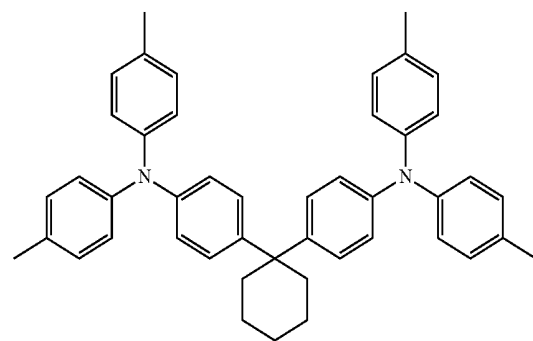
Spiro-TPD



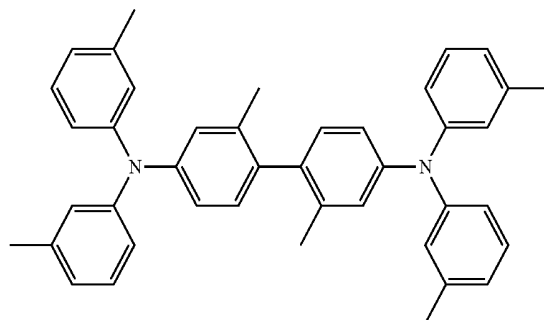
Spiro-NPB



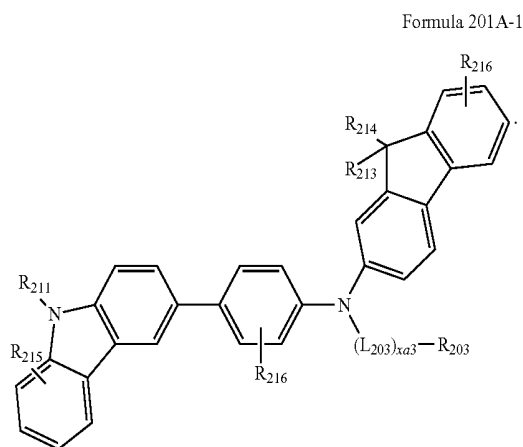
methylated NPB



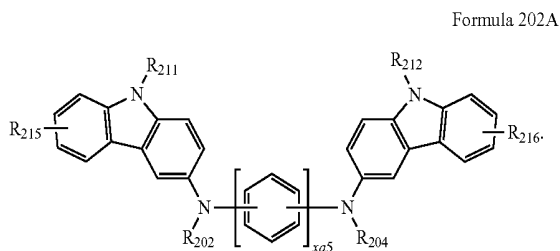
TAPC



HMTPD



[0090] In some embodiments, the compound represented by Formula 202 may be represented by Formula 202A, but embodiments are not limited thereto:



[0091] In Formulae 201A, 201A-1, and 202A, L_{201} to L_{203} , $xa1$ to $xa3$, $xa5$, and R_{202} to R_{204} may be each independently understood by referring to the descriptions provided herein. R_{211} may be defined the same as the definition provided in connection with R_{203} ; and R_{213} to R_{216} may be each independently selected from hydrogen, deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0092] In some embodiments, in Formulae 201A-1 and 202A,

[0093] L_{201} to L_{203} may be each independently selected from:

[0094] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinox-

alinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group; and

[0095] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxaliny group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0096] $xa1$ to $xa3$ may be each independently selected from 0 and 1;

[0097] R_{203} , R_{211} , and R_{212} may be each independently selected from:

[0098] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxaliny group, a quinazolinyl group, a carbazolyl group and a triazinyl group; and

[0099] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxaliny group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxaliny group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0100] R_{213} and R_{214} may be each independently selected from:

[0101] a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group;

[0102] a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group, each substituted with at least one selected from deuterium,

—F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0103] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

[0104] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0105] R_{215} and R_{216} may be each independently selected from:

[0106] hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, and a C_1 - C_{20} alkoxy group;

[0107] a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoqui-

nolynyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0108] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, and a triazinyl group; and

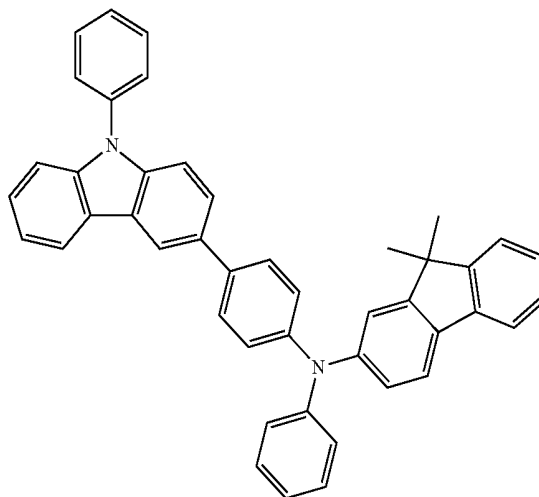
[0109] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, and

[0110] x_5 may be selected from 1 and 2.

[0111] In Formulae 201A and 201A-1, R_{213} and R_{214} may link to each other so as to form a saturated ring or an unsaturated ring.

[0112] The compound represented by Formula 201 and the compound represented by Formula 202 may each independently include Compounds HT1 to HT20, but embodiments of the present disclosure are not limited thereto:

HT1

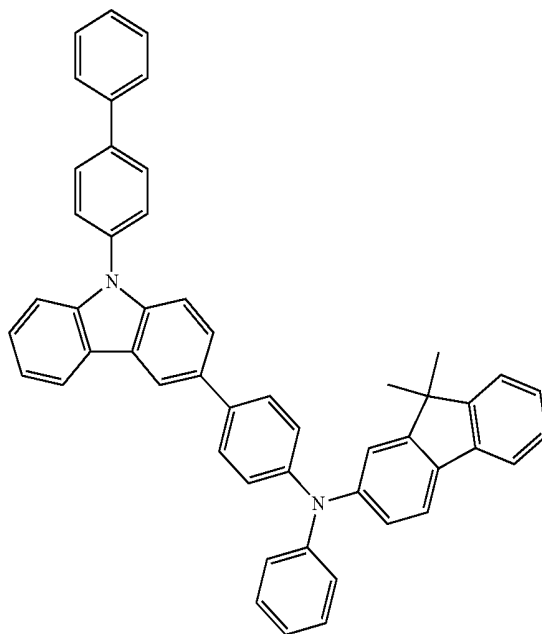
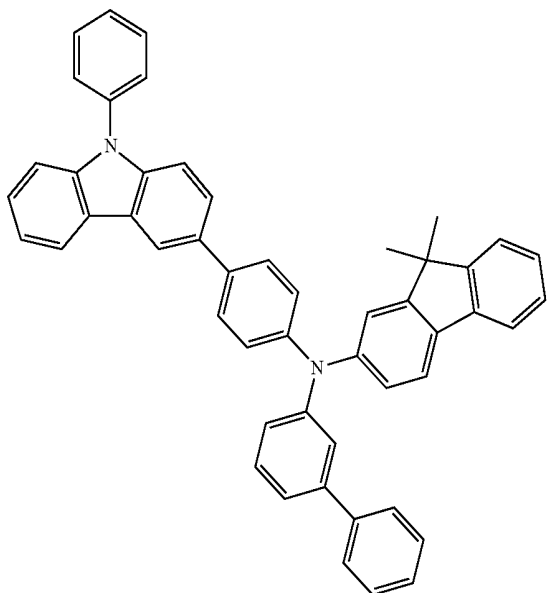


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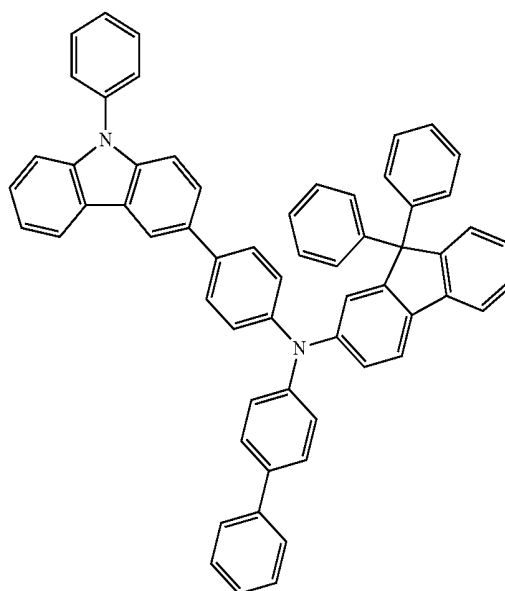
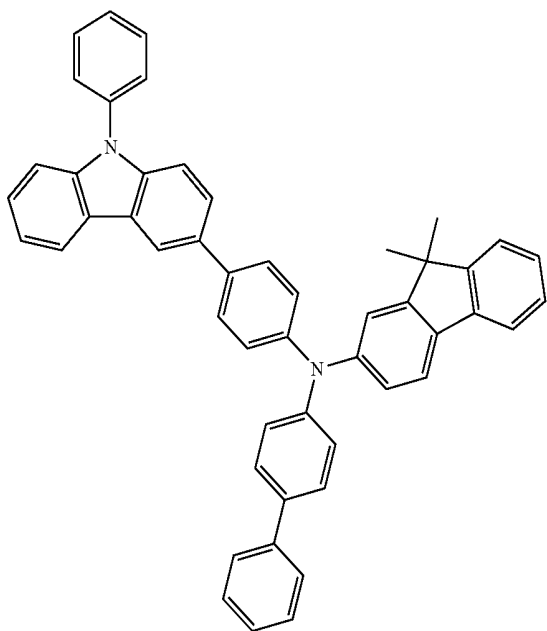
HT2

HT4



HT3

HT5

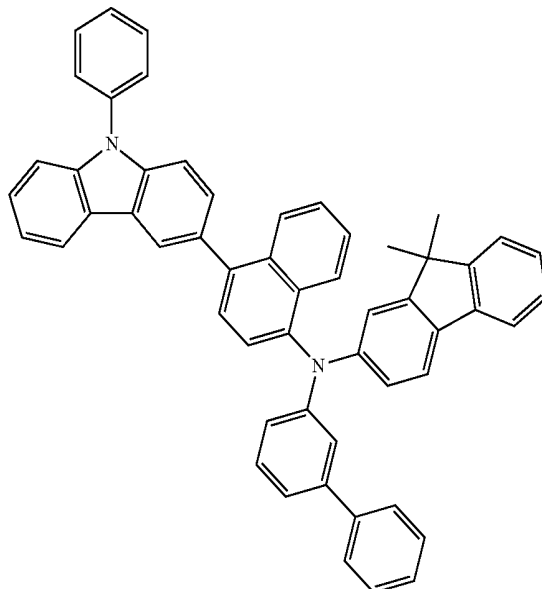
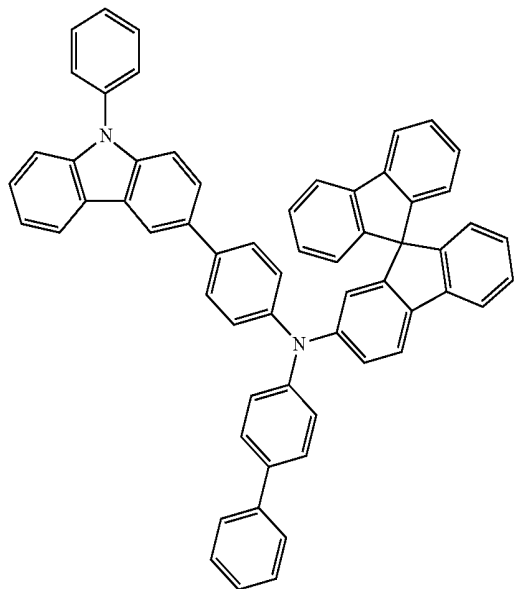


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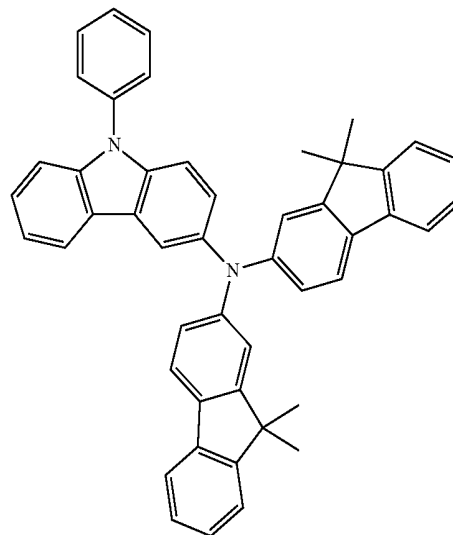
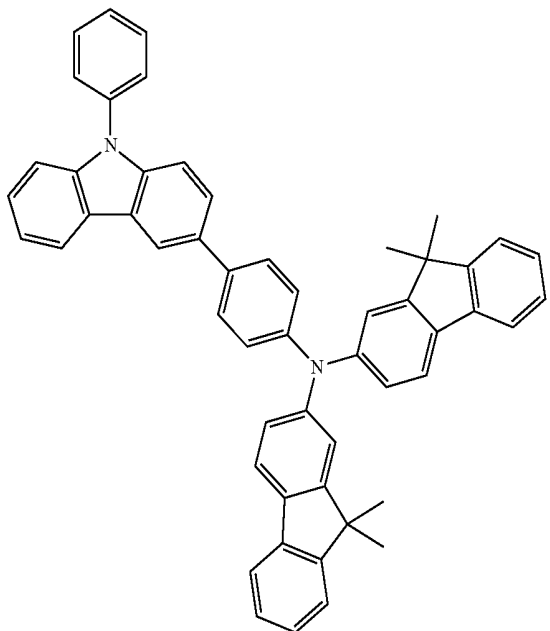
HT6

HT8



HT7

HT9

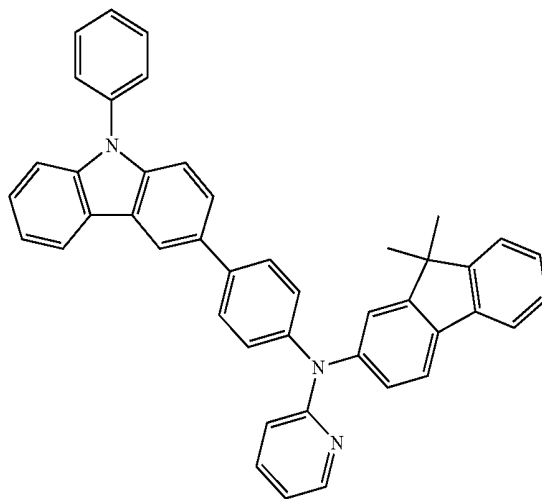
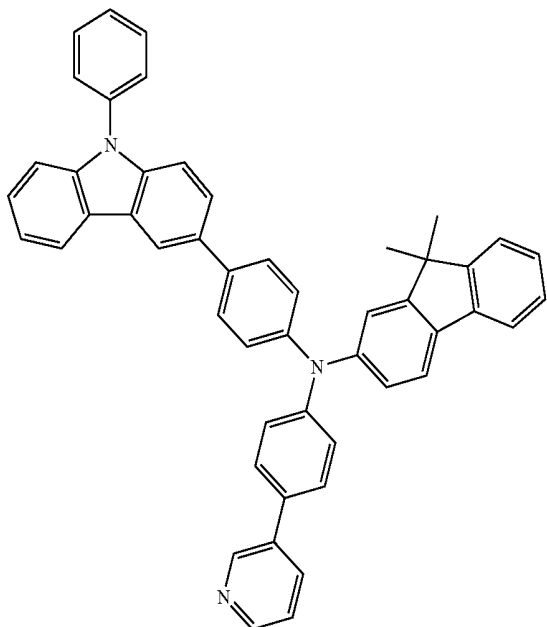


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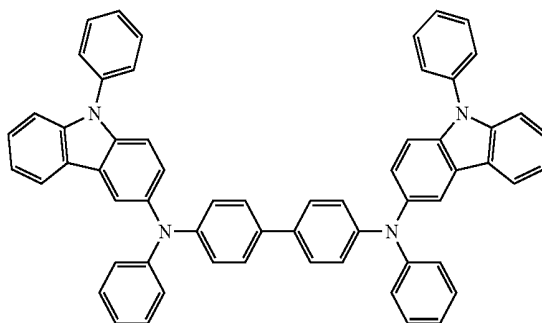
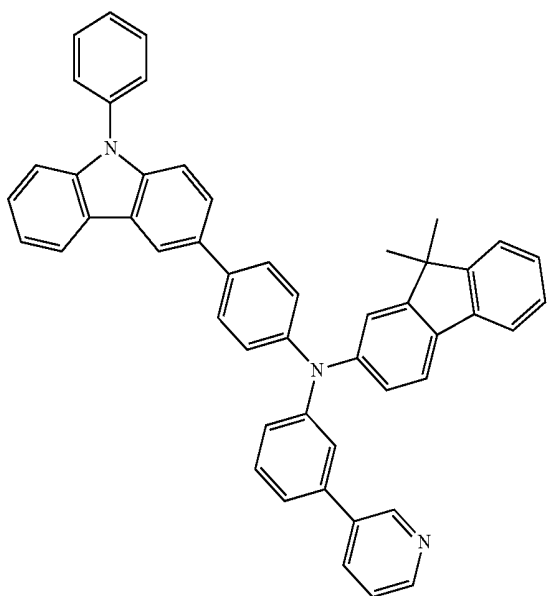
HT12

HT10

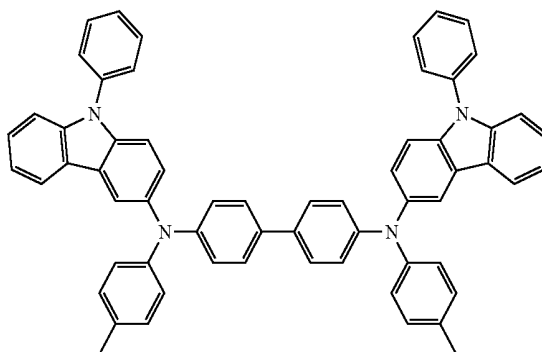


HT13

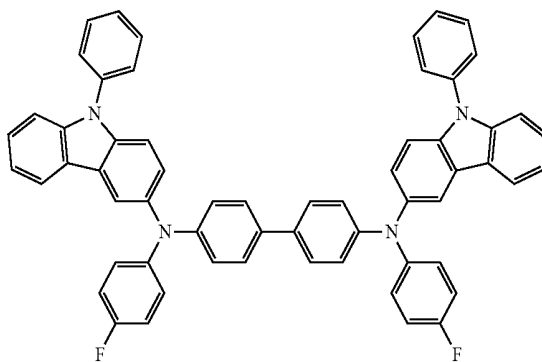
HT11



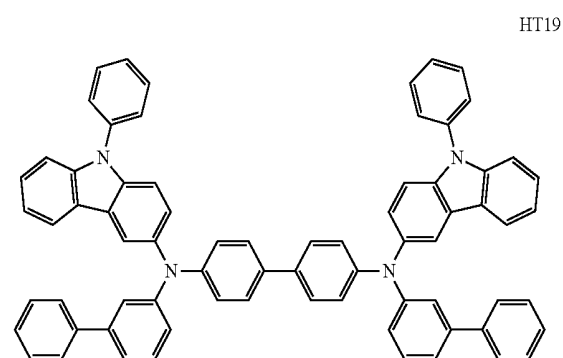
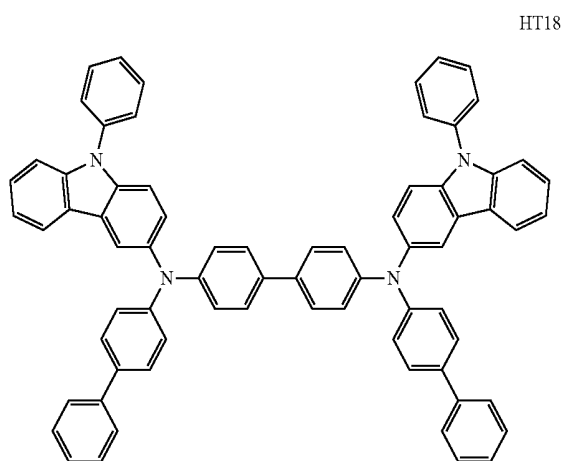
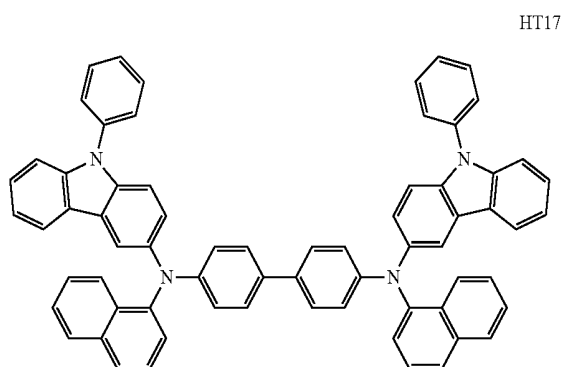
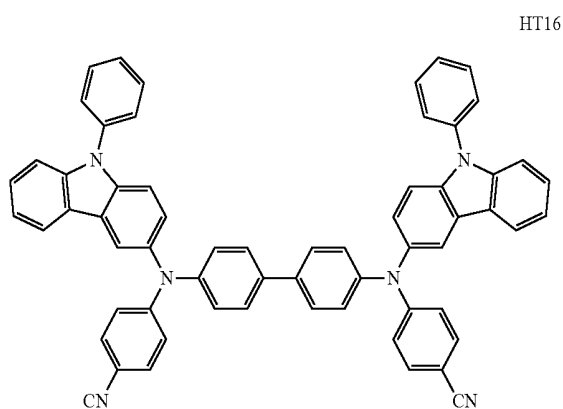
HT14



HT15

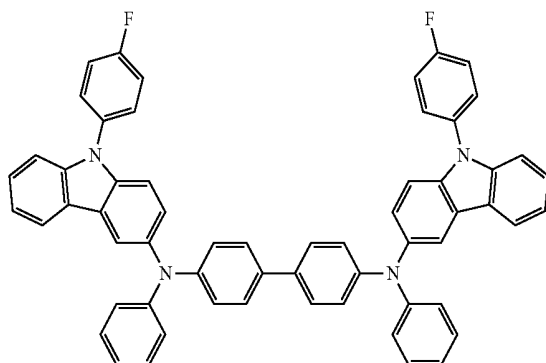


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HT20

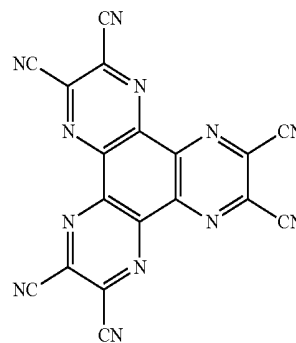


[0113] The thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1,000 Å. When the hole transport region includes a hole injection layer and a hole transport layer, the thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1,000 Å, and the thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, for example, about 100 Å to about 1,500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within any of these ranges, excellent hole transport characteristics may be obtained without a substantial increase in driving voltage.

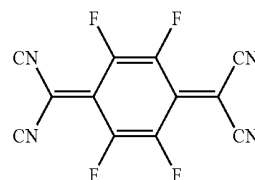
[0114] The hole transport region may include a charge-generating material, in addition to the materials mentioned above, to improve conductive properties. The charge-generating material may be homogeneously or non-homogeneously dispersed throughout the hole transport region.

[0115] The charge-generating material may be, for example, a p-dopant. The p-dopant may be selected from a quinone derivative, a metal oxide, and a cyano group-containing compound, but is not limited thereto. Non-limiting examples of the p-dopant may include quinone derivatives (such as tetracyanoquinonodimethane (TCNQ) and/or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonodimethane (F4-TCNQ)); metal oxides (such as tungsten oxide and/or molybdenum oxide); and Compound HT-D1, but embodiments are not limited thereto:

Compound HT-D1



F4-TCNQ



[0116] The hole transport region may further include a buffer layer and/or an electron blocking layer, in addition to the hole injection layer and the hole transport layer that are described above. Since the buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, the light-emission efficiency of the resulting organic light-emitting device may be improved. Any of the materials included in the hole transport region may be used as a material included in the buffer layer. In some embodiments, the electron blocking layer prevents or reduces the injection of electrons from the electron transport region.

[0117] An emission layer may be formed on the first electrode 110 or the hole transport region by using one or more suitable methods, such as vacuum deposition, spin coating, casting, an LB method, ink-jet printing, laser printing, and/or LITI. When the emission layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the emission layer may be similar to the deposition and coating conditions for the hole injection layer.

[0118] When the organic light-emitting device 10 is a full color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, or a blue emission layer, according to a sub-pixel. In some embodiments, the emission layer may have a stacked structure of a red emission layer, a green emission layer, and a blue emission layer, or may include a red-light emission material, a green-light emission material, and a blue-light emission material, which are mixed with each other in a single layer, to emit white light.

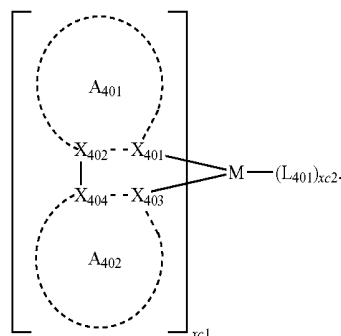
[0119] The emission layer may include a host and a dopant.

[0120] In some embodiments, the host may include the compound represented by Formula 1.

[0121] The dopant may include one or more suitable fluorescent dopants and/or phosphorescent dopants.

[0122] The dopant may be, for example, at least one selected from an iridium (Ir) complex, a platinum (Pt) complex, an osmium (Os) complex, and a copper (Cu) complex.

[0123] The phosphorescent dopant may include an organometallic complex represented by Formula 401 below:



Formula 401

[0124] In Formula 401,

[0125] M may be selected from iridium (Ir), platinum (Pt), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), and thulium (Tm);

[0126] X₄₀₁ to X₄₀₄ may be each independently nitrogen or carbon;

[0127] A₄₀₁ and A₄₀₂ rings may be each independently selected from a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene, a substituted or unsubstituted fluorene, a substituted or unsubstituted spiro-fluorene, a substituted or unsubstituted indene, a substituted or unsubstituted pyrrole, a substituted or unsubstituted thiophene, a substituted or unsubstituted furan, a substituted or unsubstituted imidazole, a substituted or unsubstituted pyrazole, a substituted or unsubstituted thiazole, a substituted or unsubstituted isothiazole, a substituted or unsubstituted oxazole, a substituted or unsubstituted isoxazole, a substituted or unsubstituted pyridine, a substituted or unsubstituted pyrazine, a substituted or unsubstituted pyrimidine, a substituted or unsubstituted pyridazine, a substituted or unsubstituted quinoline, a substituted or unsubstituted isoquinoline, a substituted or unsubstituted benzoquinoline, a substituted or unsubstituted quinoxaline, a substituted or unsubstituted quinazoline, a substituted or unsubstituted carbazole, a substituted or unsubstituted benzimidazole, a substituted or unsubstituted benzofuran, a substituted or unsubstituted benzothiophene, a substituted or unsubstituted isobenzothiophene, a substituted or unsubstituted benzoxazole, a substituted or unsubstituted isobenzoxazole, a substituted or unsubstituted triazole, a substituted or unsubstituted oxadiazole, a substituted or unsubstituted triazine, a substituted or unsubstituted dibenzofuran, and a substituted or unsubstituted dibenzothiophene;

[0128] at least one of the substituents of the substituted benzene, substituted naphthalene, substituted fluorene, substituted spiro-fluorene, substituted indene, substituted pyrrole, substituted thiophene, substituted furan, substituted imidazole, substituted pyrazole, substituted thiazole, substituted isothiazole, substituted oxazole, substituted isoxazole, substituted pyridine, substituted pyrazine, substituted pyrimidine, substituted pyridazine, substituted quinoline, substituted isoquinoline, substituted benzoquinoline, substituted quinoxaline, substituted quinazoline, substituted carbazole, substituted benzimidazole, substituted benzofuran, substituted benzothiophene, substituted isobenzothiophene, substituted benzoxazole, substituted isobenzoxazole, substituted triazole, substituted oxadiazole, substituted triazine, substituted dibenzofuran, and substituted dibenzothiophene may be selected from:

[0129] deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0130] a C₂-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₁-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic con-

densed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $-\text{N}(\text{Q}_{401})(\text{Q}_{402})$, $-\text{Si}(\text{Q}_{403})(\text{Q}_{404})(\text{Q}_{405})$, and $-\text{B}(\text{Q}_{406})(\text{Q}_{407})$;

[0131] a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0132] a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkynyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $-\text{N}(\text{Q}_{411})(\text{Q}_{412})$, $-\text{Si}(\text{Q}_{413})(\text{Q}_{414})(\text{Q}_{415})$, and $-\text{B}(\text{Q}_{416})(\text{Q}_{417})$; and

[0133] $-\text{N}(\text{Q}_{421})(\text{Q}_{422})$, $-\text{Si}(\text{Q}_{423})(\text{Q}_{424})(\text{Q}_{425})$, and $-\text{B}(\text{Q}_{426})(\text{Q}_{427})$,

[0134] wherein Q_{401} to Q_{407} , Q_{411} to Q_{417} , and Q_{421} to Q_{427} may be each independently selected from hydrogen, deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkynyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0135] L_{401} may be an organic ligand;

[0136] xc1 may be selected from 1, 2, and 3; and

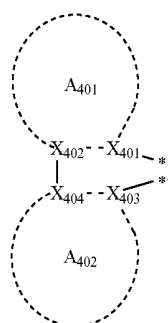
[0137] xc2 may be selected from 0, 1, 2, and 3.

[0138] In Formula 401, L_{401} may be any suitable monovalent, divalent, or trivalent organic ligand. For example, L_{401} may be selected from a halogen ligand (e.g., Cl and/or F), a diketone ligand (e.g., acetylacetonate, 1,3-diphenyl-1,3-propanedionate, 2,2,6,6-tetramethyl-3,5-heptanedionate, and/or hexafluoroacetonate), a carboxylic acid ligand (e.g., picolinate, dimethyl-3-pyrazolecarboxylate, and/or benzoate), a carbon monoxide ligand, an isonitrile ligand, a cyano ligand, and a phosphorous ligand (e.g., phosphine and/or phosphite), but embodiments of the present disclosure are not limited thereto.

[0139] When A_{401} in Formula 401 includes a plurality of substituents, the plurality of substituents of A_{401} may bind to each other to form a saturated or unsaturated ring.

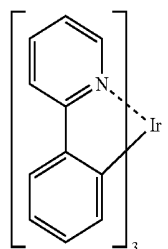
[0140] When A_{402} in Formula 401 includes a plurality of substituents, the plurality of substituents of A_{402} may bind to each other to form a saturated or unsaturated ring.

[0141] When xc1 in Formula 401 is two or more, a plurality of ligands

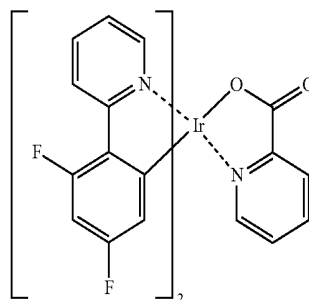


in Formula 401 may be identical to or different from each other. In Formula 401, when xc1 is 2 or more, A_{401} and/or A_{402} of one ligand may be respectively connected (e.g., coupled) to A_{401} and/or A_{402} of another adjacent ligand either directly (e.g., via a bond such as a single bond) or via a linking group (e.g., a $\text{C}_1\text{-C}_5$ alkylene group, $-\text{N}(\text{R})-$ (where R' is a $\text{C}_1\text{-C}_{10}$ alkyl group or a $\text{C}_6\text{-C}_{20}$ aryl group), and/or $-\text{C}(=\text{O})-$).

[0142] The phosphorescent dopant may include at least one selected from Compounds PD1 to PD74, but embodiments of the present disclosure are not limited thereto:

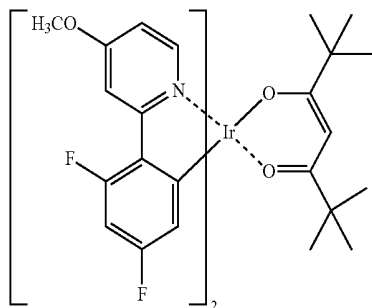


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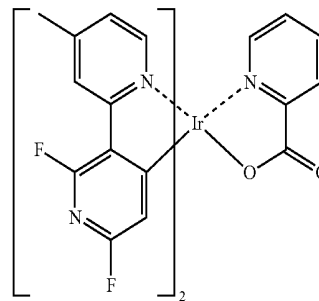


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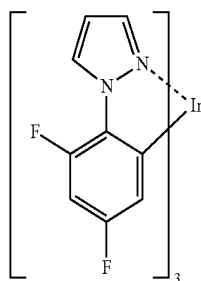
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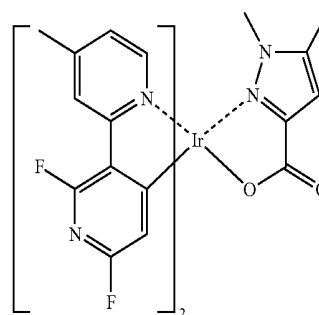
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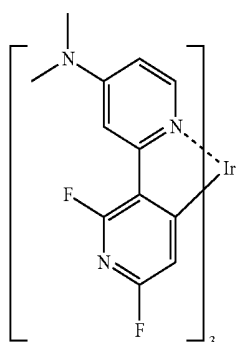
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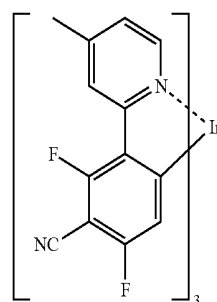
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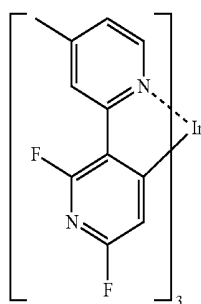
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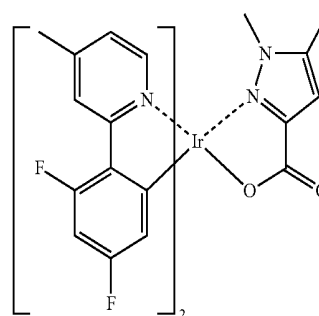
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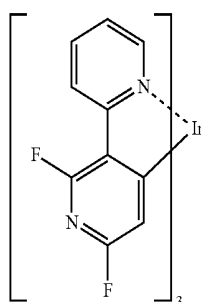
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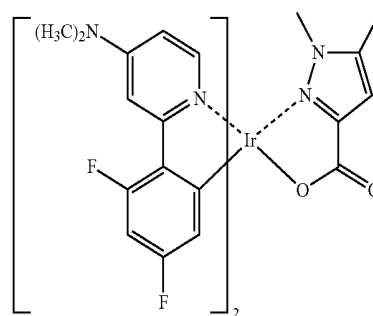
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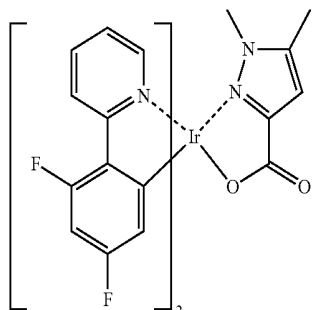


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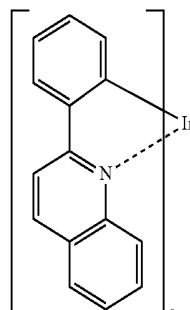
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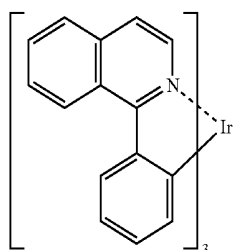


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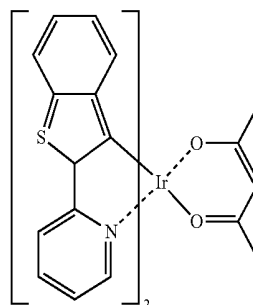


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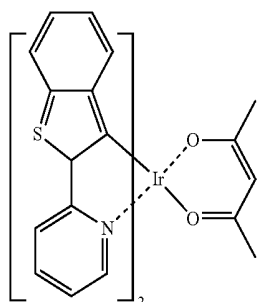
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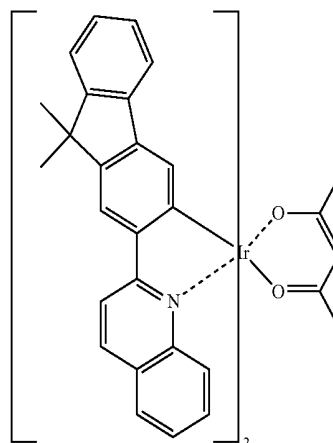


PD15

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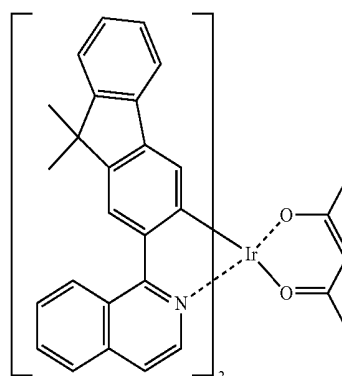
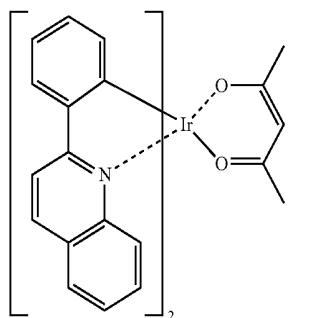


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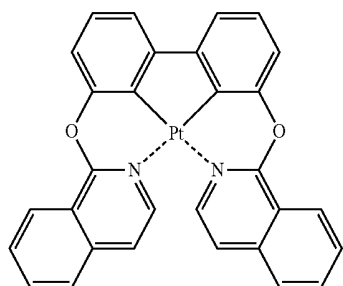
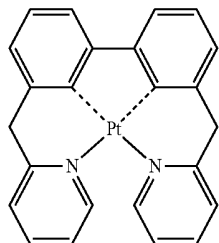
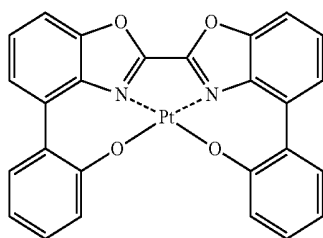
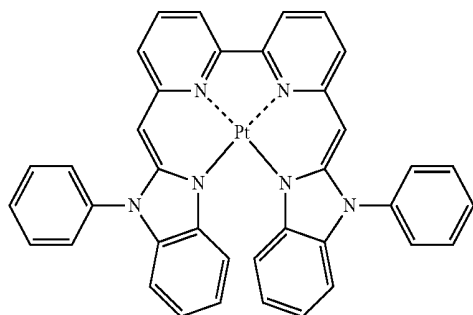
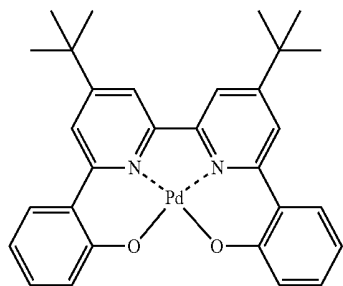
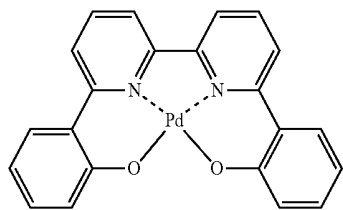


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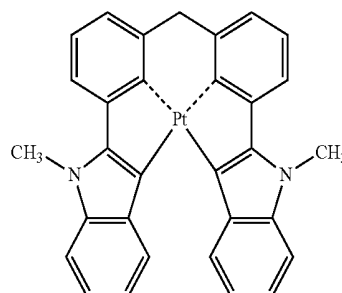
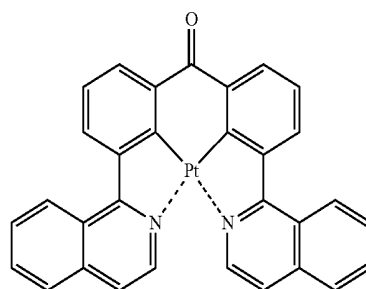
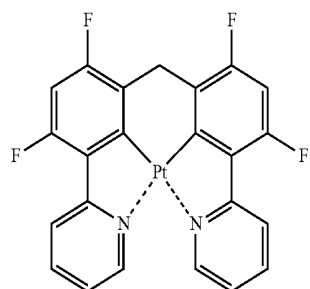
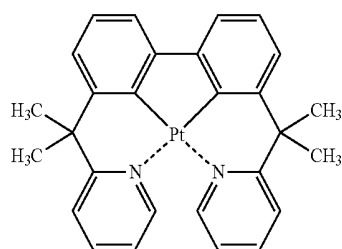
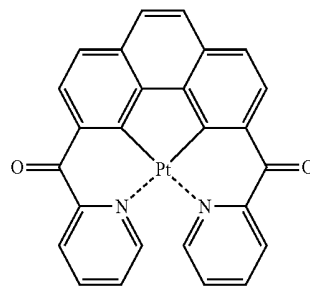
PD21



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PD22

PD23

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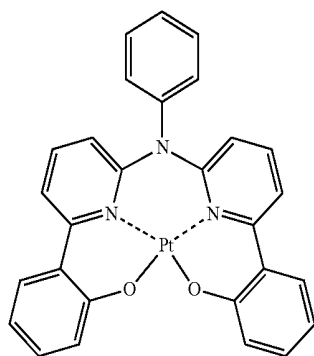
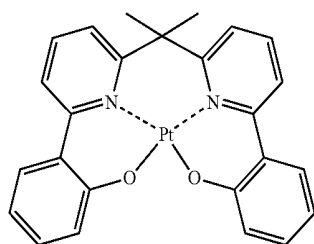
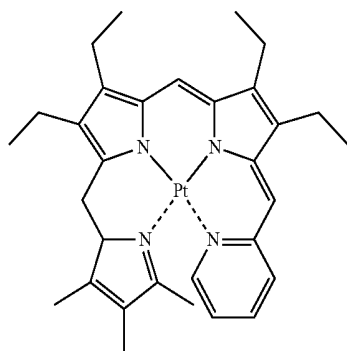
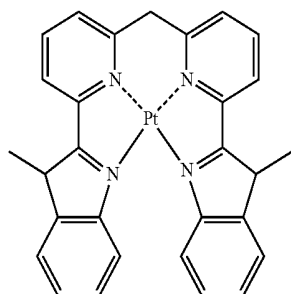
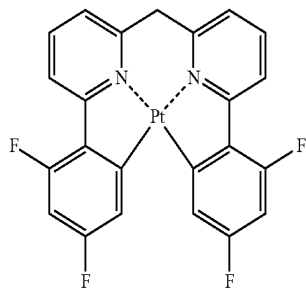
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PD30

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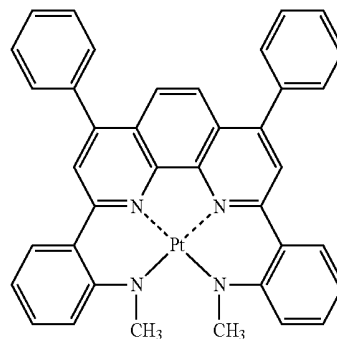
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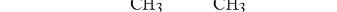
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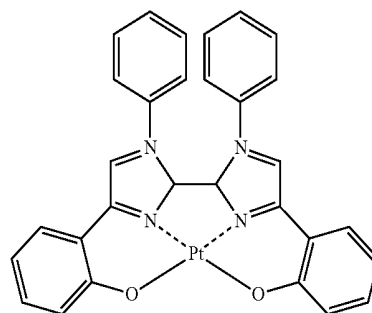
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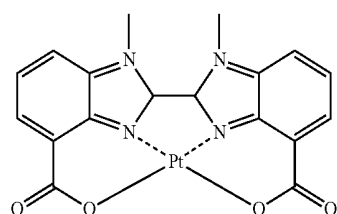
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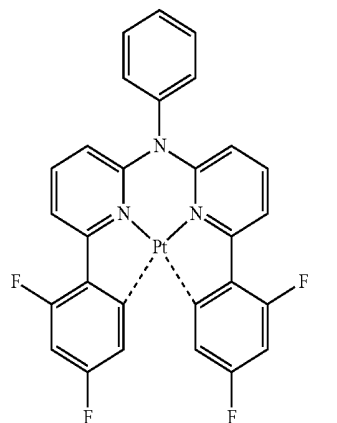
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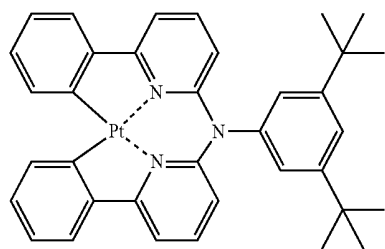
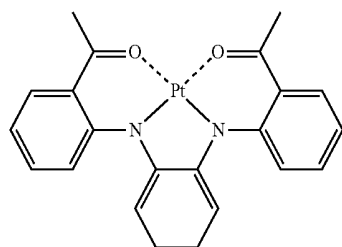
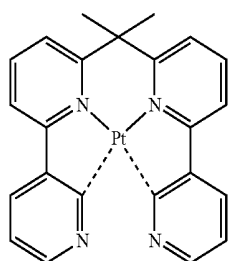
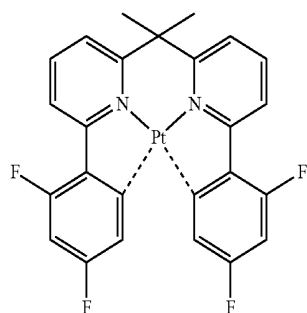
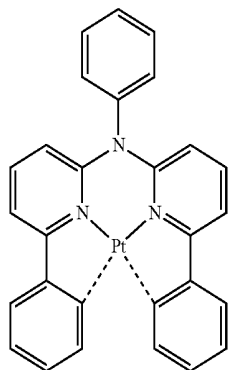
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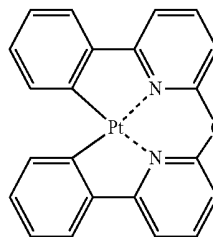
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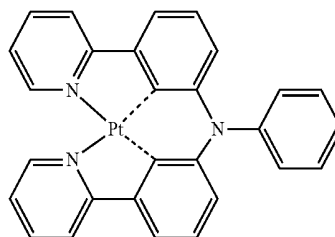
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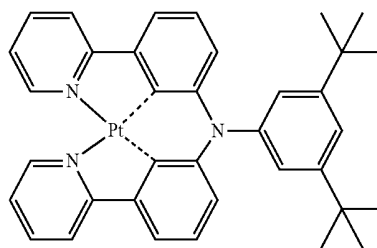
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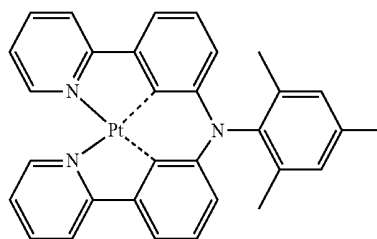
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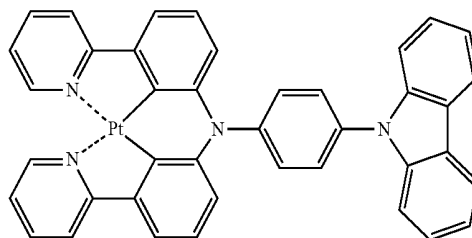
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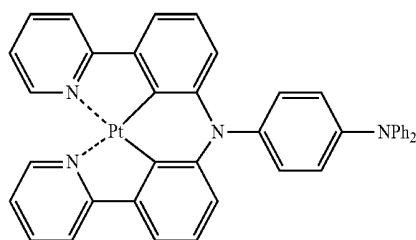
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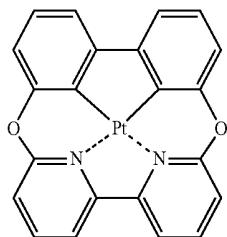


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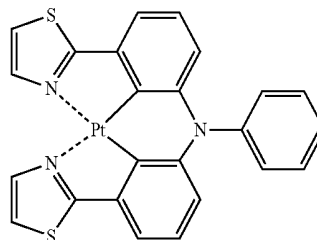
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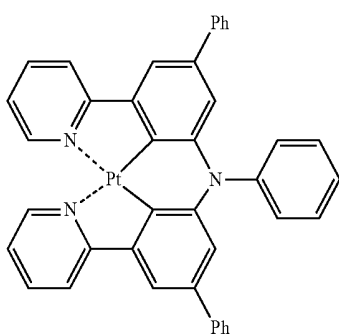
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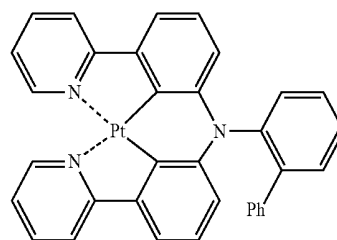
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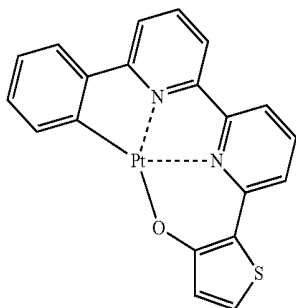
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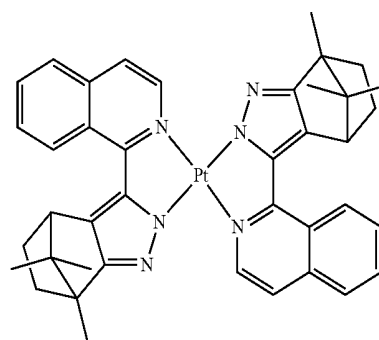
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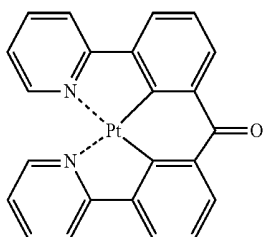
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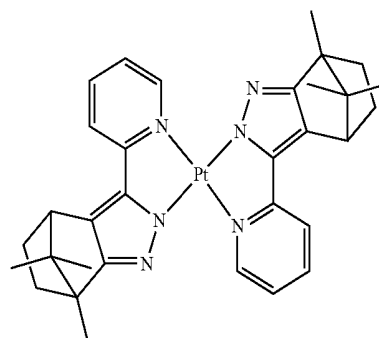
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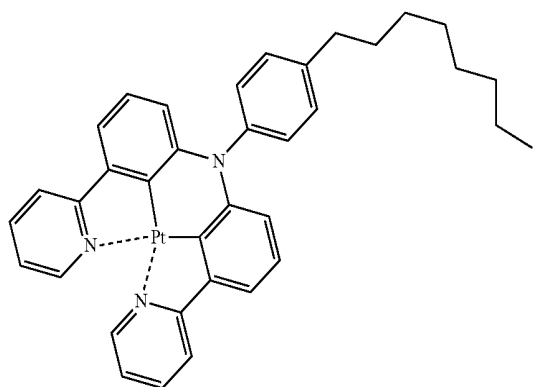
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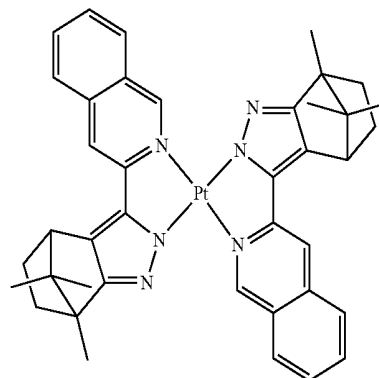
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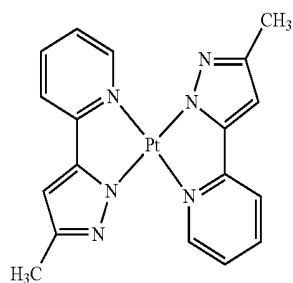


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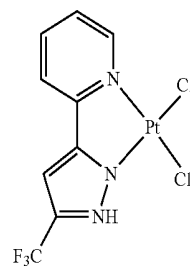


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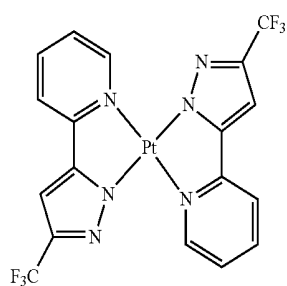
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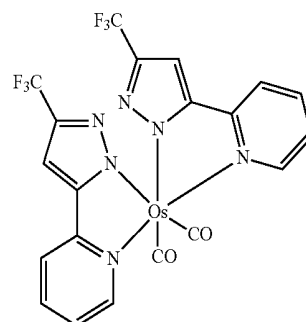
PD64



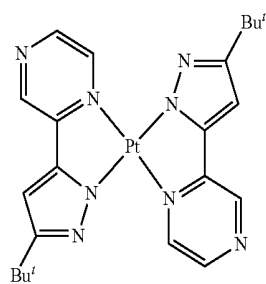
PD65



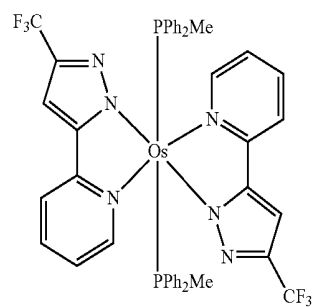
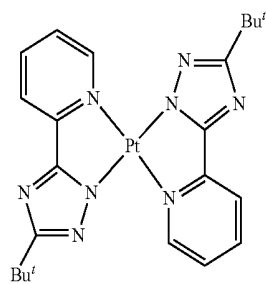
PD66



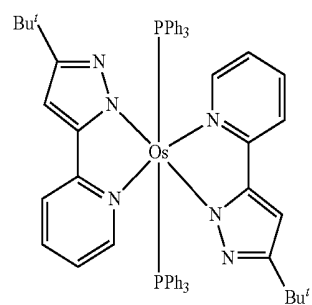
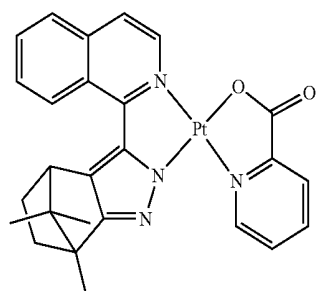
PD67



PD68



PD68



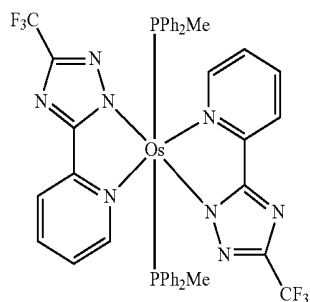
PD69

PD70

PD71

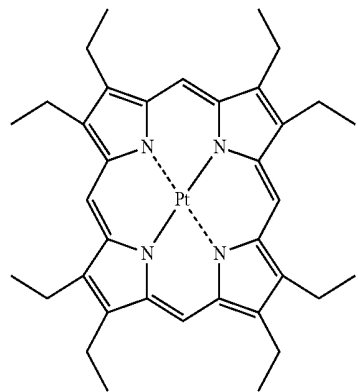
PD72

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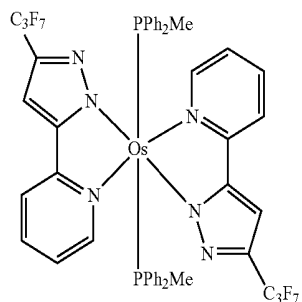
PD73

[0143] In some embodiments, the phosphorescent dopant may include PtOEP:

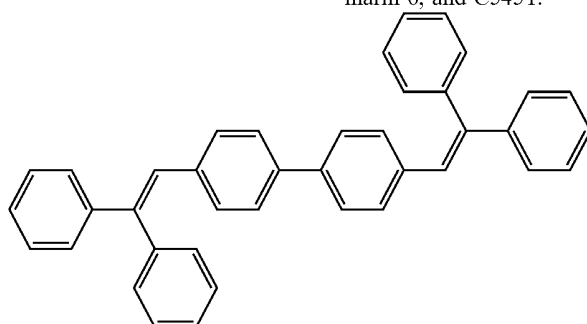


PD74

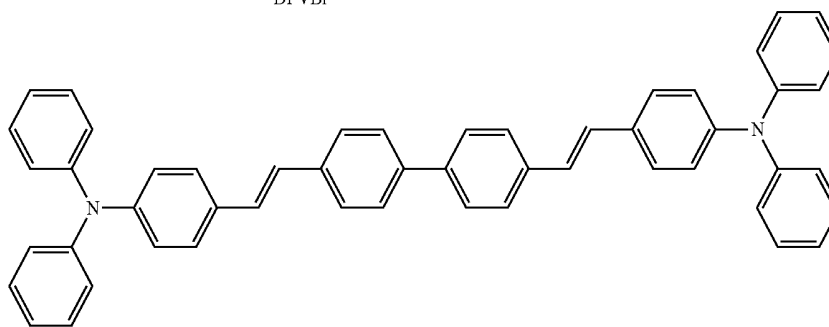
PtOEP



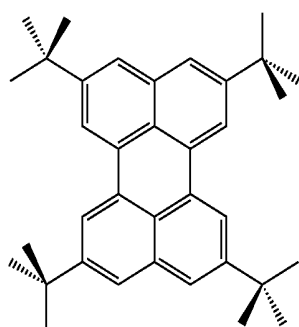
[0144] The fluorescent dopant may include at least one selected from DPVBi, DPAVBi, TBPe, DCM, DCJTb, Coumarin 6, and C545T.



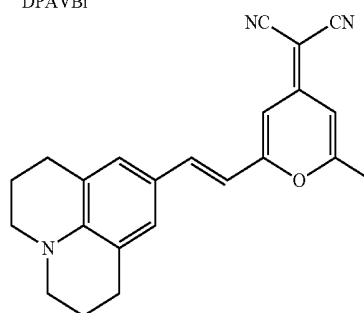
DPVBi



DPAVBi

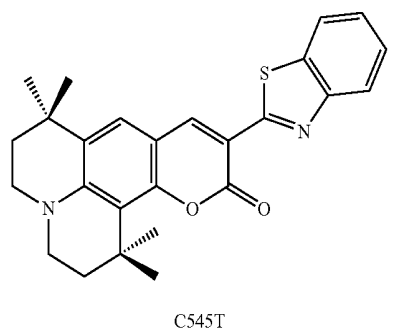
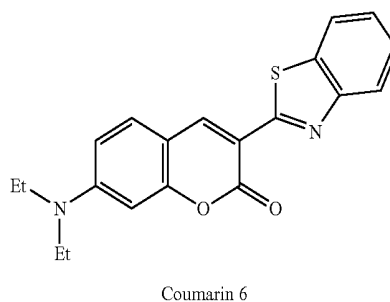
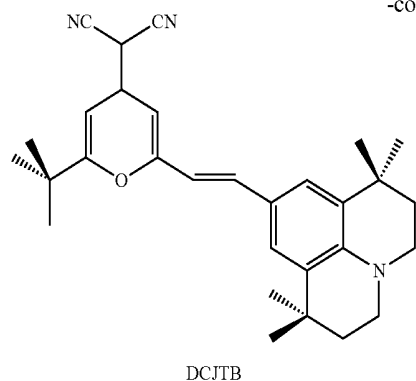


TBPe

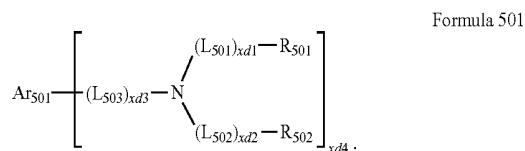


DCM

-continued



[0145] In some embodiments, the fluorescent dopant may include a compound represented by Formula 501:



[0146] In Formula 501,

[0147] Ar_{501} may be selected from:

[0148] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0149] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkynyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, and —Si(Q_{501})(Q_{502})(Q_{503}), wherein Q_{501} to Q_{503} may be each independently selected from hydrogen, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, and a $\text{C}_1\text{-C}_{60}$ heteroaryl group;

[0150] L_{501} to L_{503} may be each independently defined the same as the definition provided herein in connection with L_{203} ;

[0151] R_{501} and R_{502} may be each independently selected from:

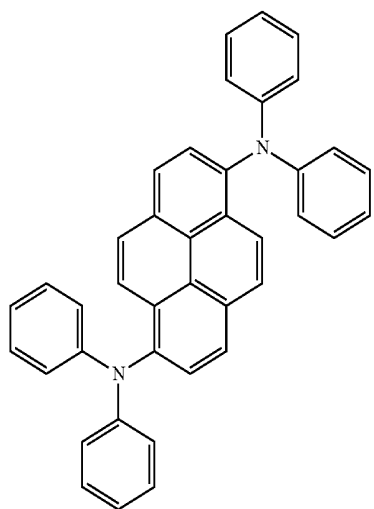
[0152] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

[0153] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{20}$ alkyl group, a $\text{C}_1\text{-C}_{20}$ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

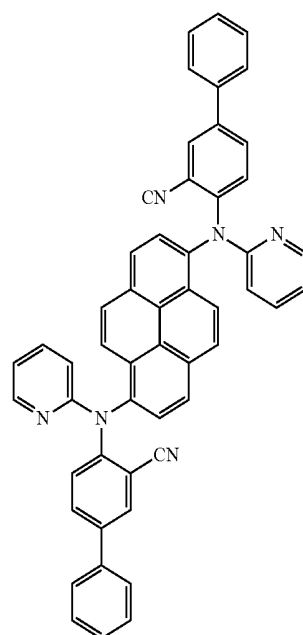
[0154] $x d 1$ to $x d 3$ may be each independently selected from 0, 1, 2, and 3; and

[0155] $x d 4$ may be selected from 1, 2, 3, and 4.

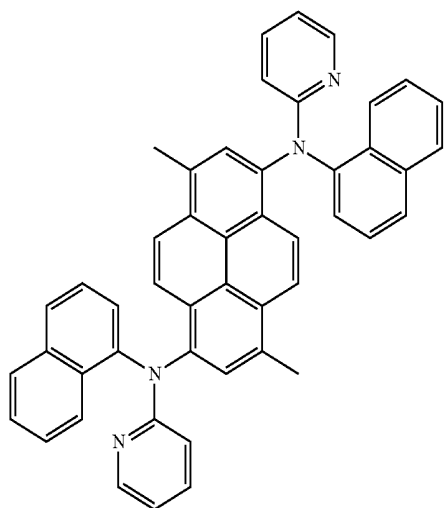
[0156] The fluorescent dopant may include at least one selected from compounds FD1 to FD8:



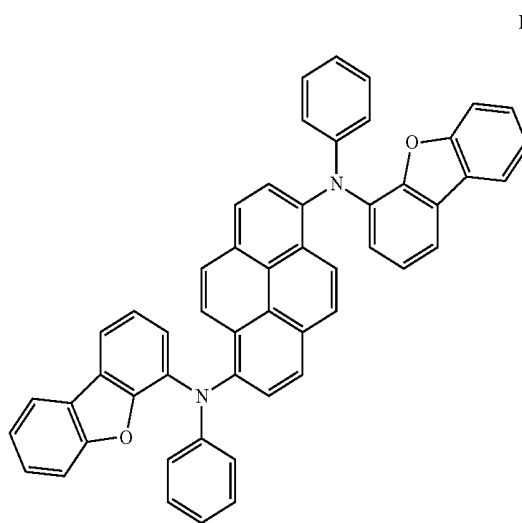
FD1



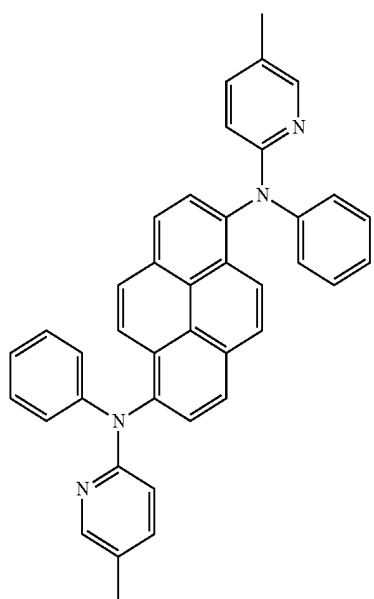
FD2



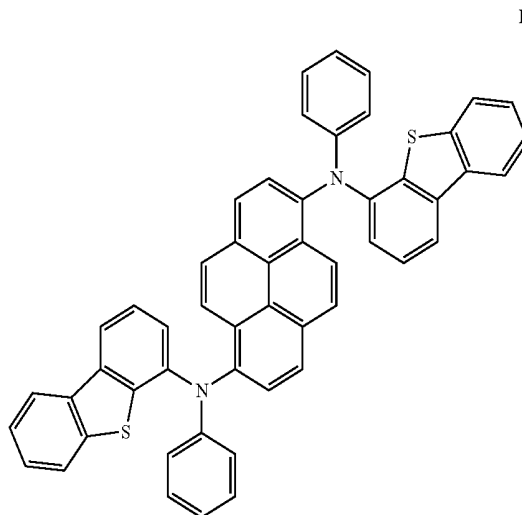
FD3



FD4

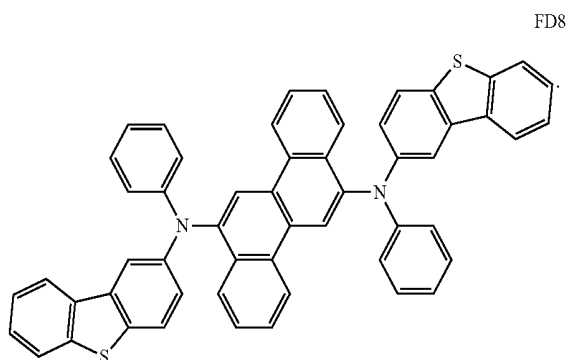
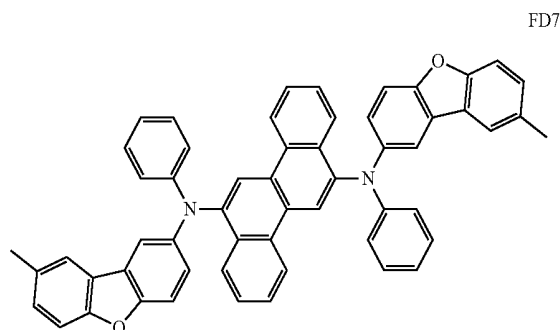


FD5



FD6

-continued



[0157] The amount of the dopant in the emission layer may be, for example, in a range of about 0.01 parts by weight to about 15 parts by weight based on 100 parts by weight of the host, but embodiments of the present disclosure are not limited thereto.

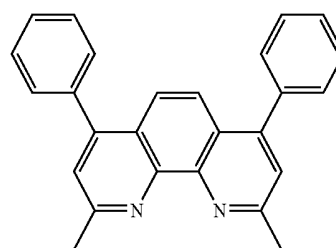
[0158] The thickness of the emission layer may be in a range of about 100 Å to about 1000 Å, for example, about 200 Å to about 600 Å. When the thickness of the emission layer is within any of these ranges, excellent light-emission characteristics may be achieved without a substantial increase in driving voltage.

[0159] An electron transport region may be on the emission layer.

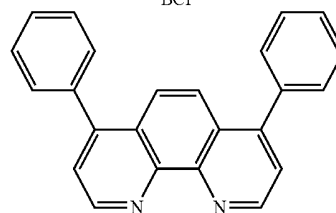
[0160] The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer, but is not limited thereto.

[0161] When the electron transport region includes a hole blocking layer, the hole blocking layer may be formed on the emission layer by using one or more suitable methods, such as vacuum deposition, spin coating, casting, an LB method, ink-jet printing, laser printing, and/or LITI. When the hole blocking layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the hole blocking layer may be similar to the deposition and coating conditions for the hole injection layer.

[0162] The hole blocking layer may include, for example, at least one selected from BCP and Bphen, but is not limited thereto:



BCP



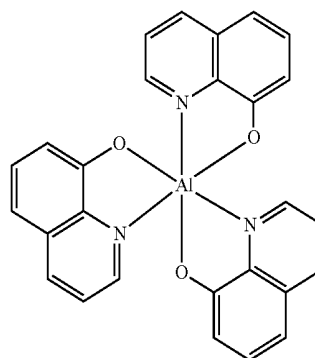
Bphen

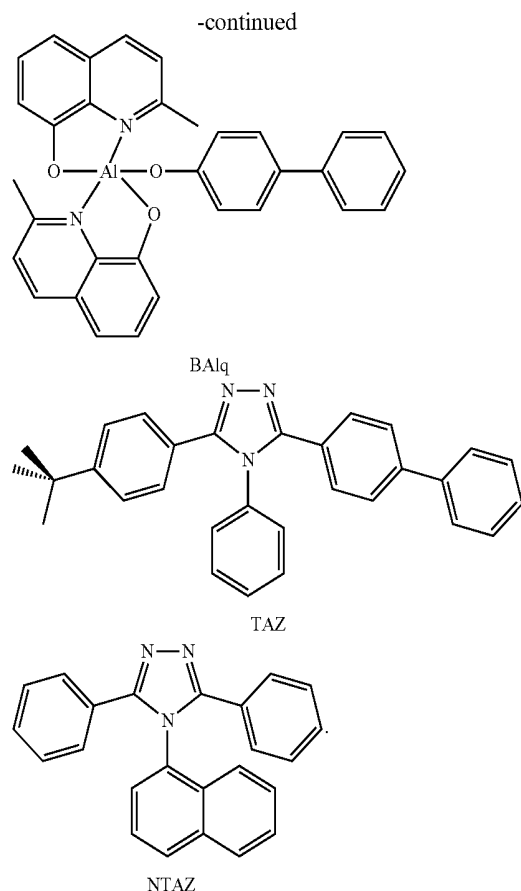
[0163] The thickness of the hole blocking layer may be in a range of about 20 Å to about 1000 Å, for example, about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within any of these ranges, excellent hole blocking characteristics may be achieved without a substantial increase in driving voltage.

[0164] The electron transport region may have a structure of electron transport layer/electron injection layer or a structure of hole blocking layer/electron transport layer/electron injection layer, wherein the layers of each structure are sequentially stacked from the emission layer in the stated order, but embodiments of the present disclosure are not limited thereto.

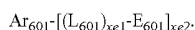
[0165] In some embodiments, the organic layer 150 of the organic light-emitting device may include an electron transport region between the emission layer and the second electrode 190, and the electron transport region may include an electron transport layer. The electron transport layer may be a plurality of layers. In some embodiments, the electron transport region may include a first electron transport layer and a second electron transport layer.

[0166] The electron transport layer may include at least one selected from BCP, Bphen, Alq₃, BALq, TAZ, and NTAZ.

Alq₃



[0167] In some embodiments, the electron transport layer may include at least one compound selected from compounds represented by Formula 601 and compounds represented by Formula 602:



Formula 601

[0168] In Formula 601,

[0169] Ar_{601} may be selected from:

[0170] a naphthalene, a heptalene, a fluorene, a spirofluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0171] a naphthalene, a heptalene, a fluorene, a spirofluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_3\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_3\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, and —Si(Q_{301})

(Q_{302})(Q_{303}), wherein Q_{301} to Q_{303} may be each independently selected from hydrogen, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, and a $\text{C}_1\text{-C}_{60}$ heteroaryl group;

[0172] L_{601} may be defined the same as L_{203} ;

[0173] E_{601} may be selected from:

[0174] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0175] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{20}$ alkyl group, a $\text{C}_1\text{-C}_{20}$ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenylyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an

oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazoliny group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuran group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuran group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0176] xe1 may be selected from 0, 1, 2, and 3; and

[0177] xe2 may be selected from 1, 2, 3, and 4.

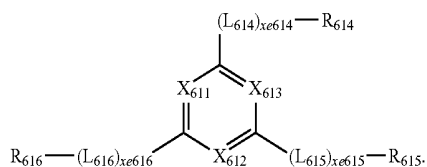
a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazoliny group, a carbazolyl group, and a triazinyl group, and

[0184] xe611 to xe616 may be each independently selected from 0, 1, 2, and 3.

[0185] The compound represented by Formula 601 and the compound represented by Formula 602 may be each independently selected from Compounds ET1 to ET15:

ET1

Formula 602



[0178] In Formula 602,

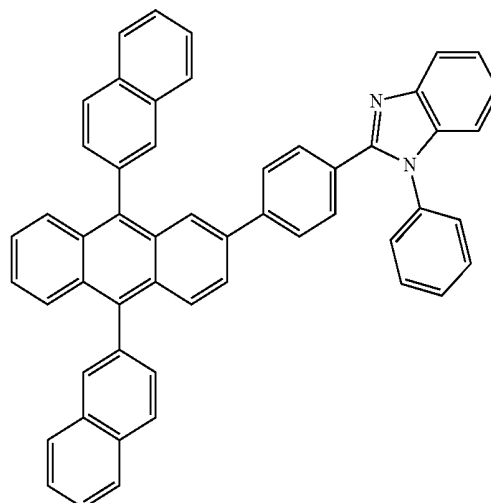
[0179] X₆₁₁ may be N or C-(L₆₁₁)_{xe611}-R₆₁₁; X₆₁₂ may be N or C-(L₆₁₂)_{xe612}-R₆₁₂; X₆₁₃ may be N or C-(L₆₁₃)_{xe613}-R₆₁₃; and at least one selected from X₆₁₁ to X₆₁₃ may be N,

[0180] L₆₁₁ to L₆₁₆ may be each independently defined the same as the definition provided herein in connection with L₂₀₃,

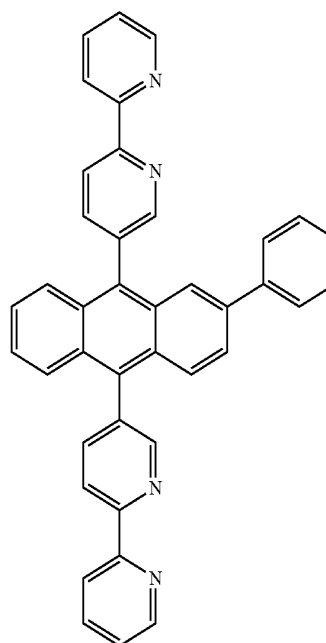
[0181] R₆₁₁ to R₆₁₆ may be each independently selected from:

[0182] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazoliny group, a carbazolyl group, and a triazinyl group; and

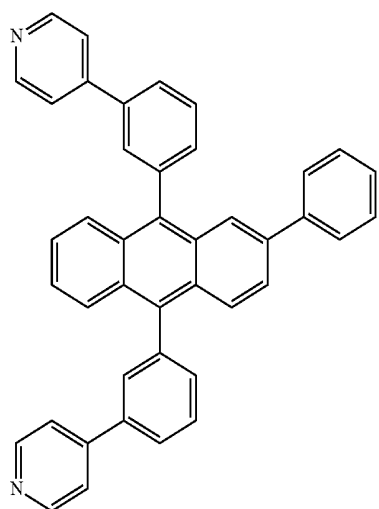
[0183] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazoliny group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof,



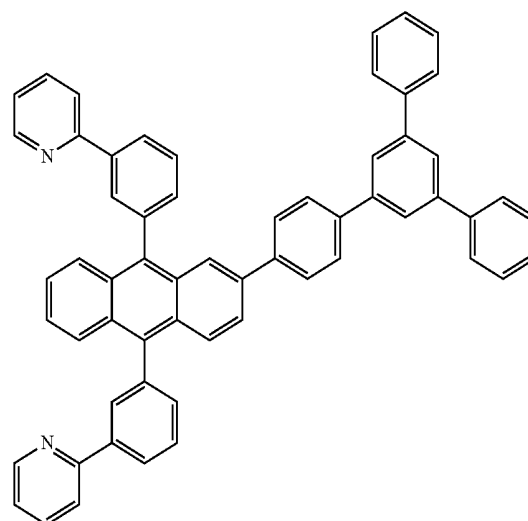
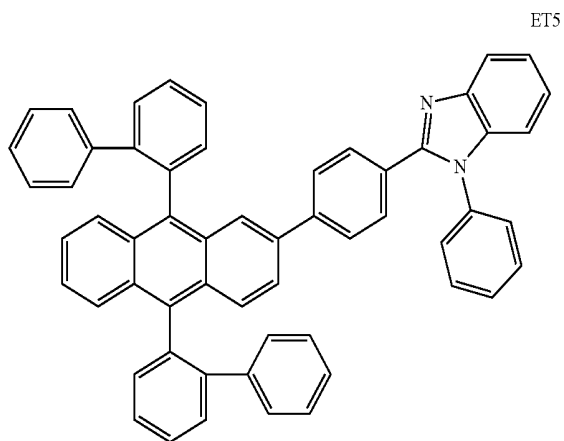
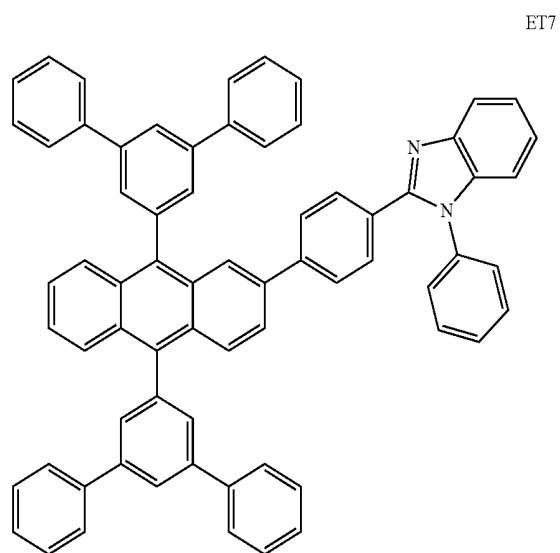
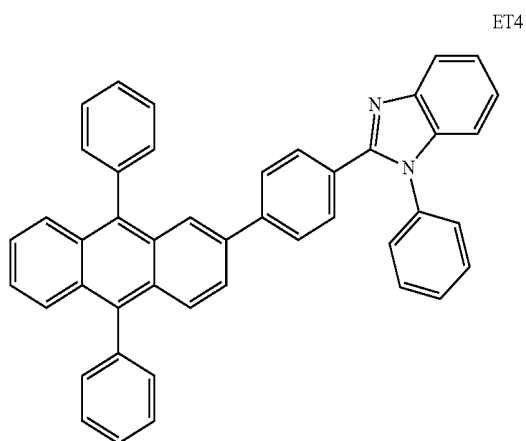
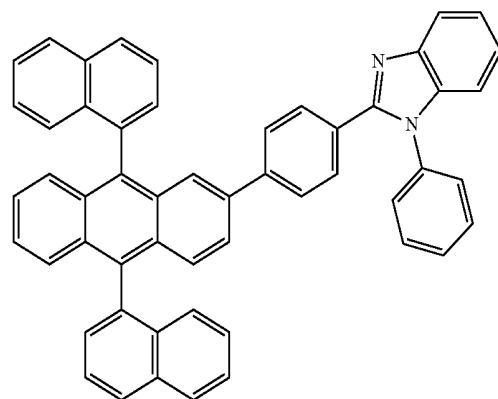
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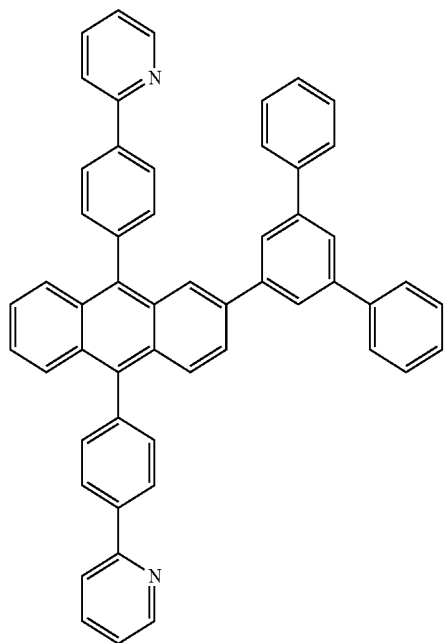
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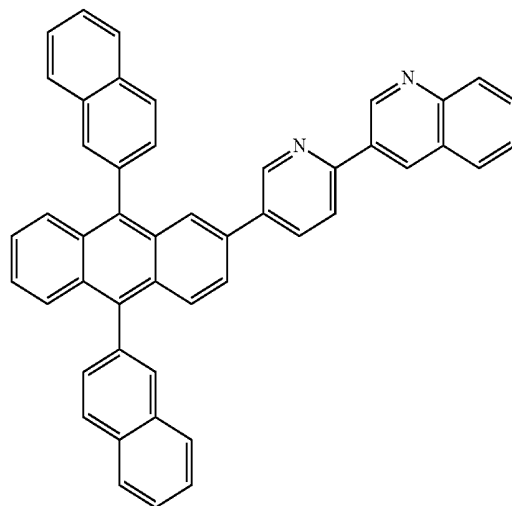


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ET9

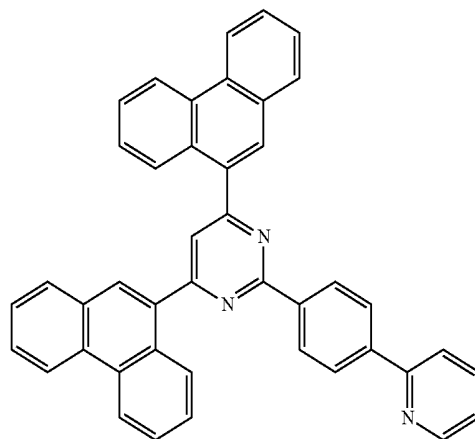
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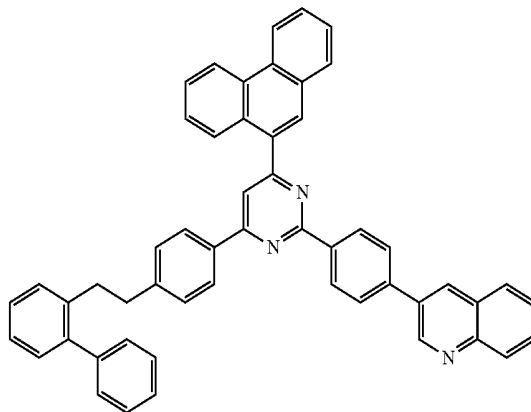
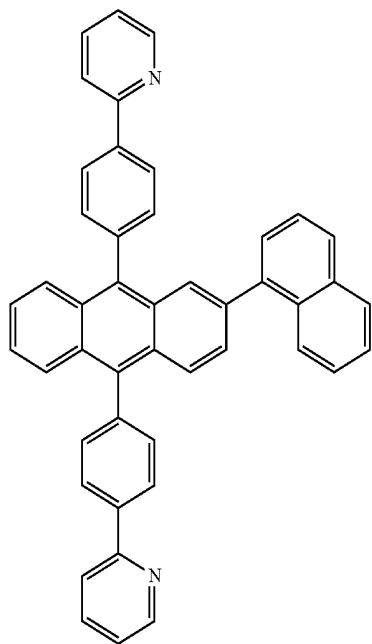
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ET12

ET10



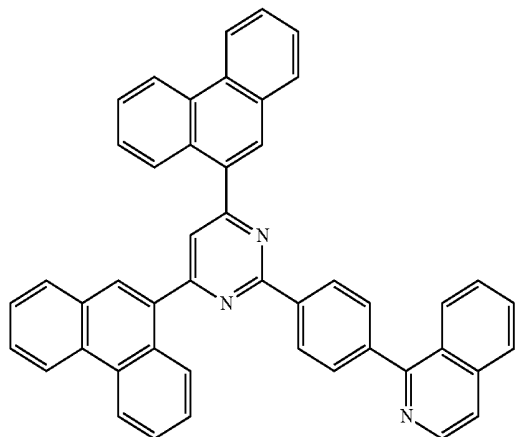
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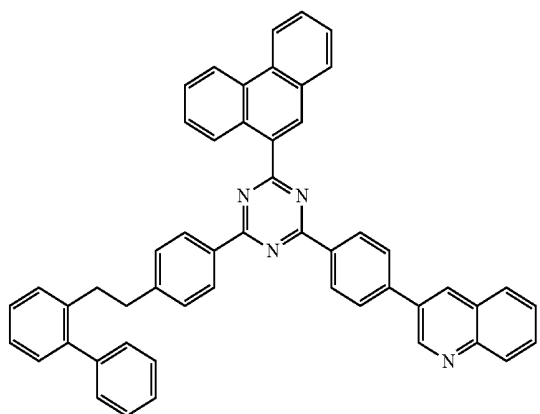
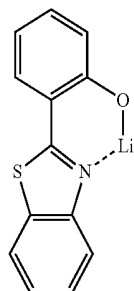
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ET-D2



ET14

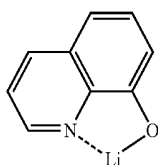


ET15

[0186] The thickness of the electron transport layer may be in a range of about 100 Å to about 1000 Å, for example, about 150 Å to about 500 Å. When the thickness of the electron transport layer is within any of these ranges, excellent electron transport characteristics may be obtained without a substantial increase in driving voltage.

[0187] The electron transport layer may further include a metal-containing material, in addition to the materials described above.

[0188] The metal-containing material may include a Li complex. The Li complex may include, for example, Compound ET-D1 (lithium quinolate or LiQ) and/or Compound ET-D2:



ET-D1

[0189] The electron transport region may include an electron injection layer that facilitates electron injection from the second electrode 190.

[0190] The electron injection layer may be formed on the electron transport layer by using one or more suitable methods, such as vacuum deposition, spin coating, casting, an LB method, ink-jet printing, laser printing, and/or LITI. When the electron injection layer is formed by vacuum deposition and/or spin coating, vacuum deposition and coating conditions for the electron injection layer may be similar to the vacuum deposition and coating conditions for the hole injection layer.

[0191] The electron injection layer may include at least one selected from LiF, NaCl, CsF, Li₂O, BaO, and LiQ.

[0192] The thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, for example, about 3 Å to about 90 Å. When the thickness of the electron injection layer is within any of these ranges, excellent electron injection characteristics may be obtained without a substantial increase in driving voltage.

[0193] The second electrode 190 may be on the organic layer 150. The second electrode 190 may be a cathode (that is an electron injection electrode). In this regard, a material for forming the second electrode 190 may be a material having a low work function, for example, a metal, an alloy, an electrically conductive compound, or a mixture thereof. Non-limiting examples of the material for forming the second electrode 190 may include lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag). In some embodiments, the material for forming the second electrode 190 may be ITO and/or IZO. The second electrode 190 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode.

[0194] The organic layer of the organic light-emitting device according to an embodiment of the present disclosure may be formed by vacuum-depositing the above-described compound(s) or by using a wet method in which the above-described compound(s) is prepared in the form of a solution, which is then used for coating.

[0195] The organic light-emitting device according to an embodiment may be included in various types of flat panel display apparatuses, for example, in a passive matrix organic light-emitting display apparatus and/or an active matrix organic light-emitting display apparatus. For example, when the organic light-emitting device is included in an active matrix organic light-emitting display apparatus, a first electrode on a substrate is a pixel electrode, and the first electrode may be electrically connected (e.g., coupled) to a source electrode or a drain electrode of a thin film transistor.

In addition, the organic light-emitting device may be included in a flat panel display apparatus that may display images on both sides thereof.

[0196] Hereinbefore the organic light-emitting device has been described with reference to the drawing, but embodiments of the present disclosure are not limited thereto.

[0197] Hereinafter definitions of substituents used herein will be presented (the number of carbon numbers used to restrict a substituent is not limited, and does not limit properties of the substituent, and unless stated otherwise, the definition of the substituent is consistent with a general definition thereof).

[0198] A C_1 - C_{60} alkyl group used herein may refer to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms. Non-limiting examples thereof include a methyl group, an ethyl group, a propyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an iso-amyl group, and a hexyl group. A C_1 - C_{60} alkenylene group used herein may refer to a divalent group having the same structure as the C_1 - C_{60} alkyl group.

[0199] A C_1 - C_{60} alkoxy group used herein may refer to a monovalent group represented by $-OA_{101}$ (where A_{101} is the C_1 - C_{60} alkyl group). Non-limiting examples thereof may include a methoxy group, an ethoxy group, and an isopropoxy group.

[0200] A C_2 - C_{60} alkenyl group used herein may refer to a hydrocarbon group having at least one carbon-carbon double bond at one or more positions along the hydrocarbon chain of the C_2 - C_{60} alkyl group (e.g., in the middle or at either terminal end of the C_2 - C_{60} alkyl group). Non-limiting examples thereof may include an ethenyl group, a propenyl group, and a butenyl group. A C_2 - C_{60} alkenylene group used herein may refer to a divalent group having the same structure as the C_2 - C_{60} alkenyl group.

[0201] A C_2 - C_{60} alkynyl group used herein may refer to a hydrocarbon group having at least one carbon-carbon triple bond at one or more positions along the hydrocarbon chain of the C_2 - C_{60} alkyl group (e.g., in the middle or at either terminal end of the C_2 - C_{60} alkyl group). Non-limiting examples thereof may include an ethynyl group and a propynyl group. A C_2 - C_{60} alkynylene group used herein may refer to a divalent group having the same structure as the C_2 - C_{60} alkynyl group.

[0202] A C_3 - C_{10} cycloalkyl group used herein may refer to a monovalent monocyclic saturated hydrocarbon group including 3 to 10 carbon atoms. Non-limiting examples thereof may include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. A C_3 - C_{10} cycloalkylene group used herein may refer to a divalent group having the same structure as the C_3 - C_{10} cycloalkyl group.

[0203] A C_2 - C_{10} heterocycloalkyl group used herein may refer to a monovalent monocyclic group including at least one heteroatom selected from N, O, P, and S as a ring-forming atom and 2 to 10 carbon atoms. Non-limiting examples thereof may include a tetrahydrofuran group and a tetrahydrothiophenyl group. A C_2 - C_{10} heterocycloalkylene group used herein may refer to a divalent group having the same structure as the C_2 - C_{10} heterocycloalkyl group.

[0204] A C_3 - C_{10} cycloalkenyl group as used herein may refer to a monovalent monocyclic group that has 3 to 10 carbon atoms and at least one double bond in its ring, and is not aromatic. Non-limiting examples thereof may include a cyclopentenyl group, a cyclohexenyl group, and a cyclohep-

tenyl group. A C_3 - C_{10} cycloalkenylene group used herein may refer to a divalent group having the same structure as the C_3 - C_{10} cycloalkenyl group.

[0205] A C_2 - C_{10} heterocycloalkenyl group used herein may refer to a monovalent monocyclic group including at least one heteroatom selected from N, O, P, and S as a ring-forming atom, 2 to 10 carbon atoms, and at least one double bond in its ring. Non-limiting examples of the C_2 - C_{10} heterocycloalkenyl group may include a 2,3-hydrofuran group and a 2,3-hydrothiophenyl group. A C_2 - C_{10} heterocycloalkenylene group used herein may refer to a divalent group having the same structure as the C_2 - C_{10} heterocycloalkenyl group.

[0206] A C_6 - C_{60} aryl group used herein may refer to a monovalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms. A C_6 - C_{60} arylene group used herein may refer to a divalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms. Non-limiting examples of the C_6 - C_{60} aryl group may include a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C_6 - C_{60} aryl group and/or the C_6 - C_{60} arylene group include a plurality of rings, the respective rings may be fused to each other.

[0207] A C_1 - C_{60} heteroaryl group used herein may refer to a monovalent group having a carbocyclic aromatic system including at least one heteroatom selected from N, O, P, and S as a ring-forming atom and 1 to 60 carbon atoms. A C_1 - C_{60} heteroarylene group used herein may refer to a divalent group having a carbocyclic aromatic system including at least one heteroatom selected from N, O, P, and S as a ring-forming atom and 1 to 60 carbon atoms. Non-limiting examples of the C_1 - C_{60} heteroaryl group may include a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, and an isoquinolinyl group. When the C_1 - C_{60} heteroaryl group and/or the C_1 - C_{60} heteroarylene group include a plurality of rings, the respective rings may be fused to each other.

[0208] A C_6 - C_{60} aryloxy group used herein may refer to a group represented by $-OA_{102}$ (where A_{102} is the C_6 - C_{60} aryl group). A C_6 - C_{60} arylthio group used herein may refer to a group represented by $-SA_{103}$ (where A_{103} is the C_6 - C_{60} aryl group).

[0209] A monovalent non-aromatic condensed polycyclic group used herein may refer to a monovalent group that has two or more rings condensed to each other, and has only carbon atoms as ring-forming atoms (for example, the number of carbon atoms may be in a range of 8 to 60), wherein the molecular structure of the group as a whole is non-aromatic. A non-limiting example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. A divalent non-aromatic condensed polycyclic group used herein may refer to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

[0210] A monovalent non-aromatic condensed heteropolycyclic group used herein may refer to a monovalent group that has two or more rings condensed to each other, and has at least one heteroatom selected from N, O, P, and S as a ring-forming atom, and carbon atoms (for example, the number of carbon atoms may be in a range of 2 to 60), wherein the molecular structure of the group as a whole is non-aromatic. A non-limiting example of the monovalent non-aromatic condensed heteropolycyclic group includes a

carbazolyl group. A divalent non-aromatic condensed heteropolycyclic group used herein may refer to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

[0211] At least one substituent of the substituted C₃-C₁₀ cycloalkylene group, substituted C₂-C₁₀ heterocycloalkylene group, substituted C₃-C₁₀ cycloalkenylene group, substituted C₂-C₁₀ heterocycloalkenylene group, substituted C₆-C₆₀ arylene group, substituted C₁-C₆₀ heteroarylene group, substituted divalent non-aromatic condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, substituted C₁-C₆₀ alkyl group, substituted C₂-C₆₀ alkenyl group, substituted C₂-C₆₀ alkynyl group, substituted C₁-C₆₀ alkoxy group, substituted C₃-C₁₀ cycloalkyl group, substituted C₂-C₁₀ heterocycloalkyl group, substituted C₃-C₁₀ cycloalkenyl group, substituted C₂-C₁₀ heterocycloalkenyl group, substituted C₆-C₆₀ aryl group, substituted C₆-C₆₀ aryloxy group, substituted C₆-C₆₀ arylthio group, substituted C₁-C₆₀ heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

[0212] deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0213] a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁₁)(Q₁₂), —Si(Q₁₃)(Q₁₄)(Q₁₅), and —B(Q₁₆)(Q₁₇);

[0214] a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0215] a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group,

a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇); and

[0216] —N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇);

[0217] wherein Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ may be each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0218] For example, at least one substituent of the substituted C₃-C₁₀ cycloalkylene group, substituted C₂-C₁₀ heterocycloalkylene group, substituted C₃-C₁₀ cycloalkenylene group, substituted C₂-C₁₀ heterocycloalkenylene group, substituted C₆-C₆₀ arylene group, substituted C₁-C₆₀ heteroarylene group, substituted divalent non-aromatic condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, substituted C₁-C₆₀ alkyl group, substituted C₂-C₆₀ alkenyl group, substituted C₂-C₆₀ alkynyl group, substituted C₁-C₆₀ alkoxy group, substituted C₃-C₁₀ cycloalkyl group, substituted C₂-C₁₀ heterocycloalkyl group, substituted C₃-C₁₀ cycloalkenyl group, substituted C₂-C₁₀ heterocycloalkenyl group, substituted C₆-C₆₀ aryl group, substituted C₆-C₆₀ aryloxy group, substituted C₆-C₆₀ arylthio group, substituted C₁-C₆₀ heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

[0219] deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0220] a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl

thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

[0225] "Ph" used herein may refer to a phenyl group. "Me" may refer to a methyl group. "Et" may refer to an ethyl group. "Ter-Bu" or "But" may refer to a tert-butyl group.

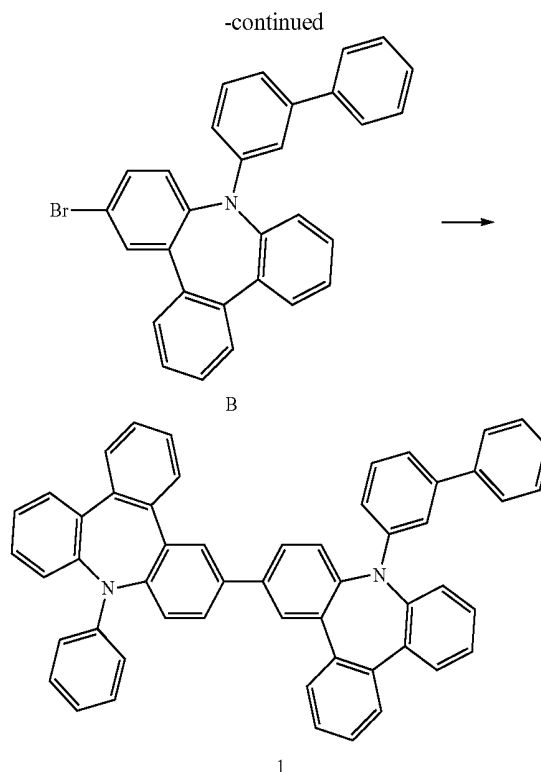
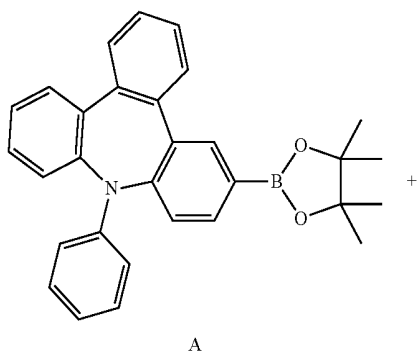
[0226] Hereinafter an organic light-emitting device according to one or more embodiments of the present disclosure will be described in more detail with reference to Examples.

SYNTHESIS EXAMPLES

Synthesis Example 1

Synthesis of Compound 1

[0227]



[0228] Under nitrogen atmosphere, 1.8 g (4 mmol) of Intermediate A, 1.9 g (4 mmol) of Intermediate B, 231 mg (0.2 mmol) of $Pd(PPh_3)_4$, and 1.1 g (12 mmol) of sodium tert-butoxide were added to 100 ml of toluene and 25 ml of ethanol, and the resulting solution was refluxed for about 24 hours.

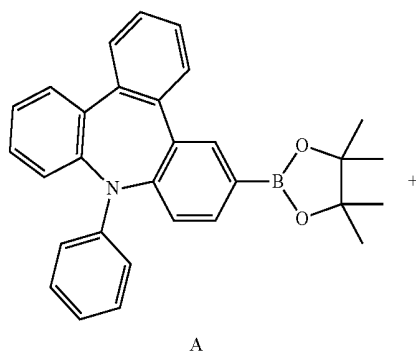
[0229] Once the reaction was complete, a solvent was removed by evaporation. 800 ml of methylene chloride and 800 ml of water for washing were each added thereto. An organic layer was obtained therefrom, and the obtained organic layer was dried by using anhydrous magnesium sulfate ($MgSO_4$). The obtained residue was recrystallized and was separated through a silica gel chromatography to thereby obtain 1.1 g of Compound 1 (yield: 40%).

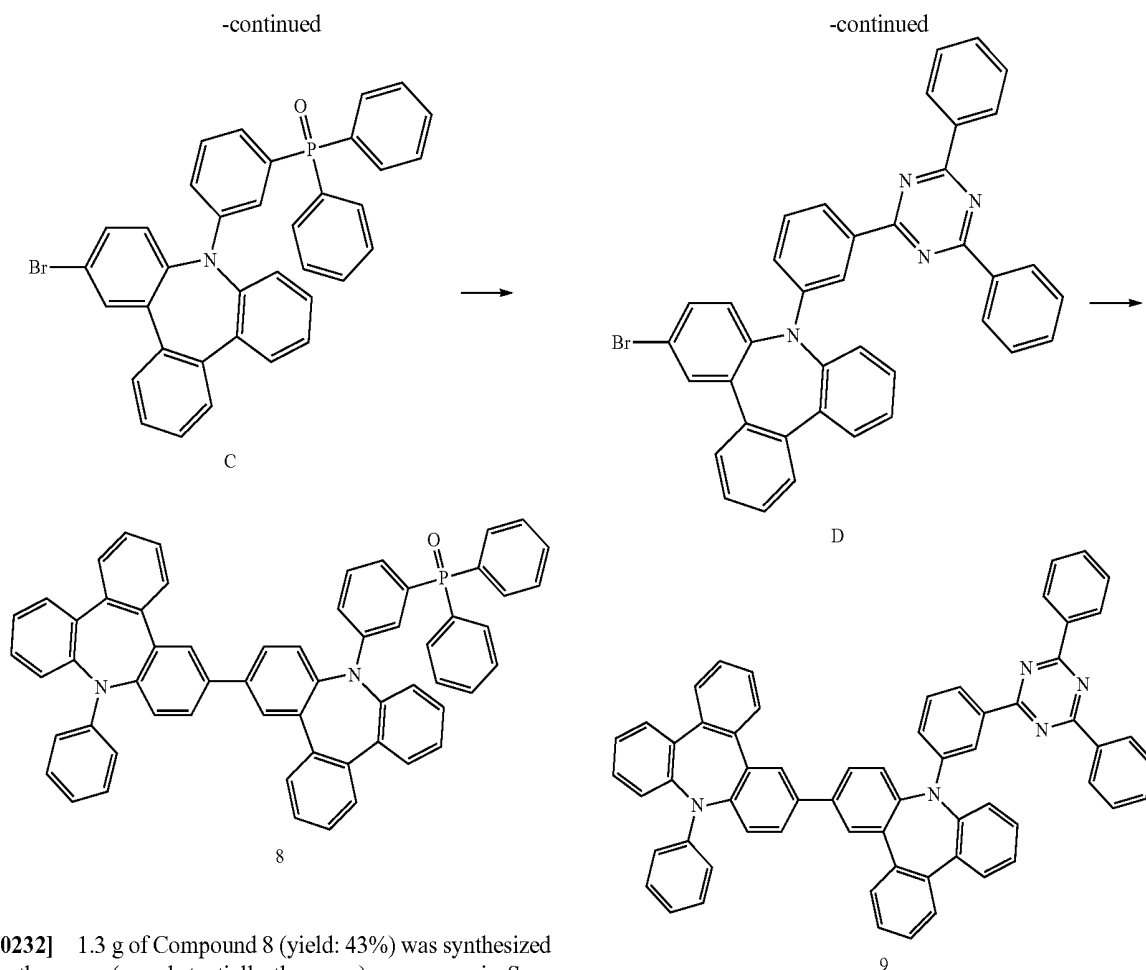
[0230] Mass Spectrometry (Matrix-assisted laser desorption/ionization-time-of-flight) (MS (MALDI-TOF)) m/z : 712 [M]⁺.

Synthesis Example 2

Synthesis of Compound 8

[0231]





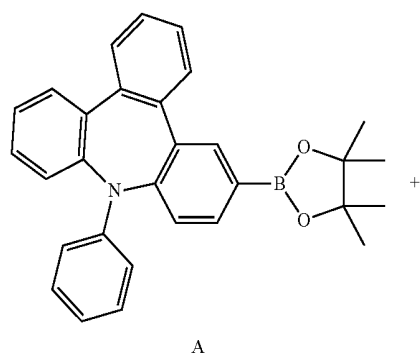
[0232] 1.3 g of Compound 8 (yield: 43%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate C was used instead of Intermediate B.

[0233] MS (MALDI-TOF) m/z : 836 [M]⁺.

Synthesis Example 3

Synthesis of Compound 9

[0234]



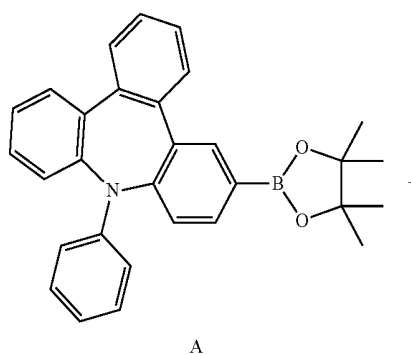
[0235] 1.7 g of Compound 9 (yield: 45%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate D was used instead of Intermediate B.

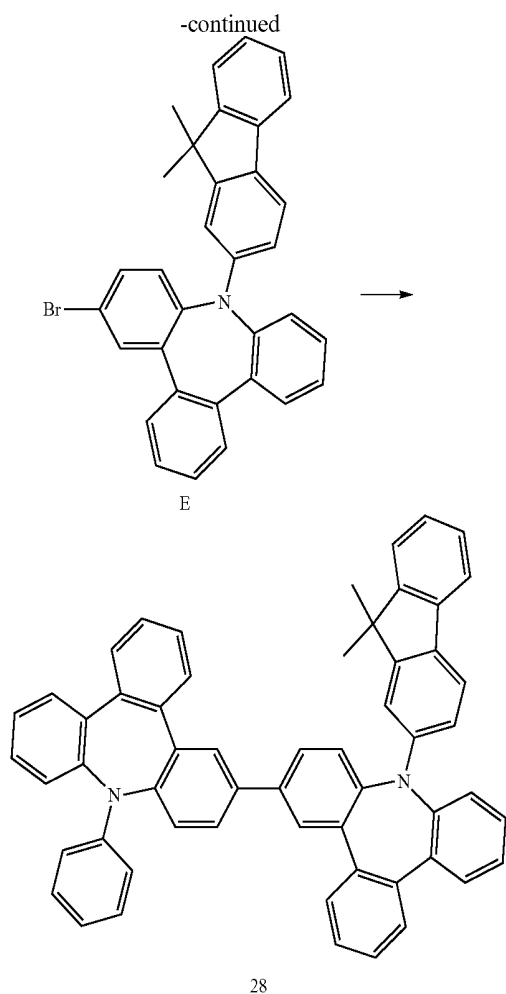
[0236] MS (MALDI-TOF) m/z : 867 [M]⁺.

Synthesis Example 4

Synthesis of Compound 28

[0237]





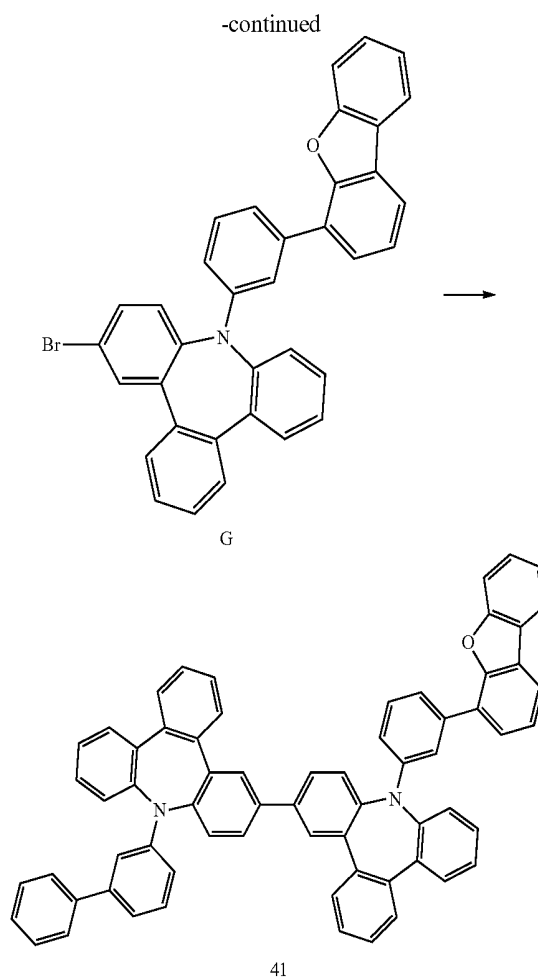
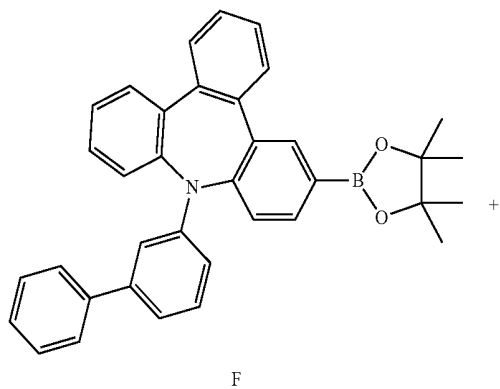
[0238] 2 g of Compound 28 (yield: 41%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate E was used instead of Intermediate B.

[0239] MS (MALDI-TOF) m/z : 752 [M]⁺.

Synthesis Example 5

Synthesis of Compound 41

[0240]



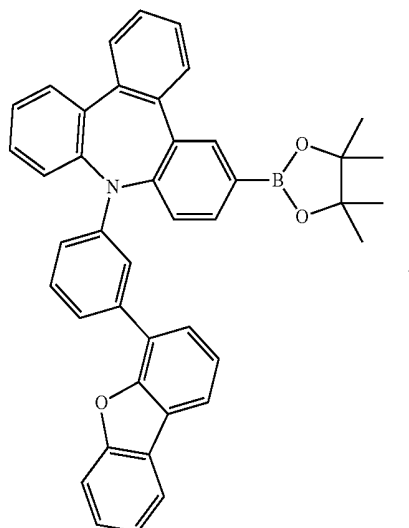
[0241] 1.0 g of Compound 41 (yield: 35%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate F was used instead of Intermediate A, and Intermediate G was used instead of Intermediate B.

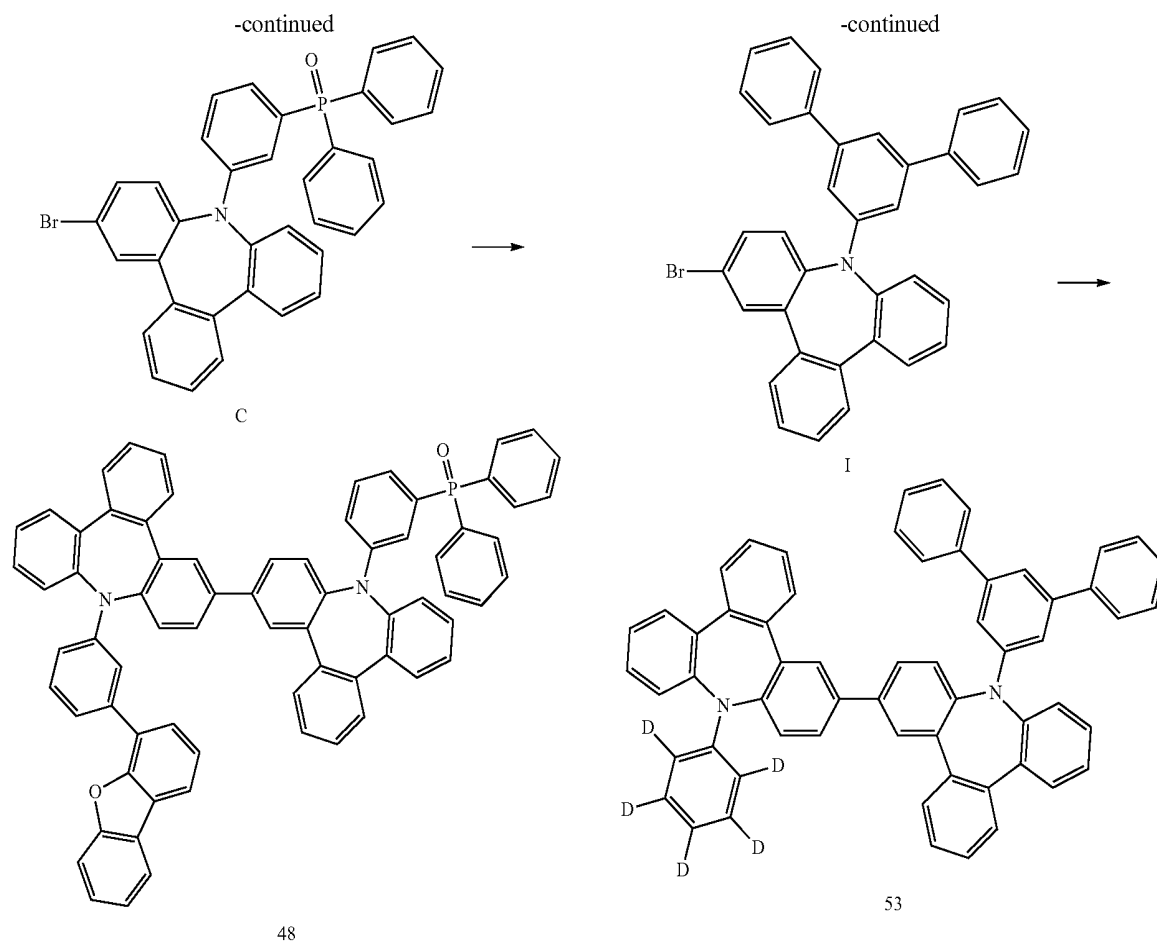
[0242] MS (MALDI-TOF) m/z : 878 [M]⁺.

Synthesis Example 6

Synthesis of Compound 48

[0243]





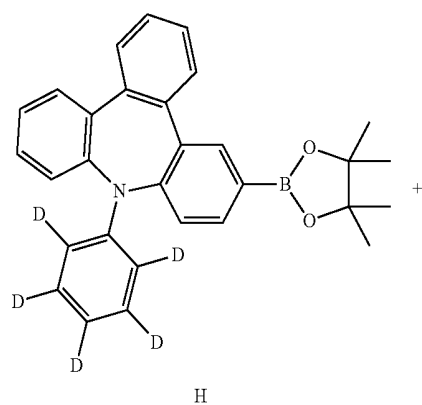
[0244] 1.3 g of Compound 48 (yield: 37%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate F was used instead of Intermediate A, and Intermediate C was used instead of Intermediate B.

[0245] MS (MALDI-TOF) m/z : 1002 [M]⁺.

Synthesis Example 7

Synthesis of Compound 53

[0246]



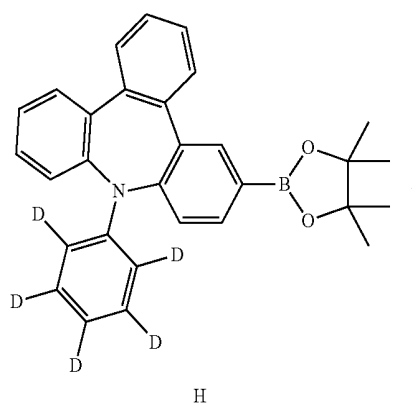
[0247] 1.1 g of Compound 53 (yield: 41%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate H was used instead of Intermediate A, and Intermediate I was used instead of Intermediate B.

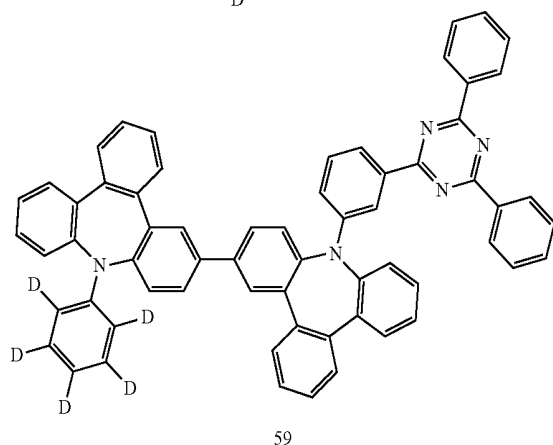
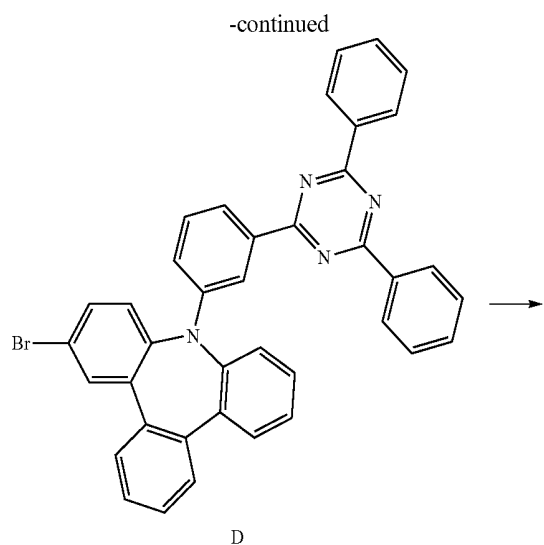
[0248] MS (MALDI-TOF) m/z : 793 [M]⁺.

Synthesis Example 8

Synthesis of Compound 59

[0249]





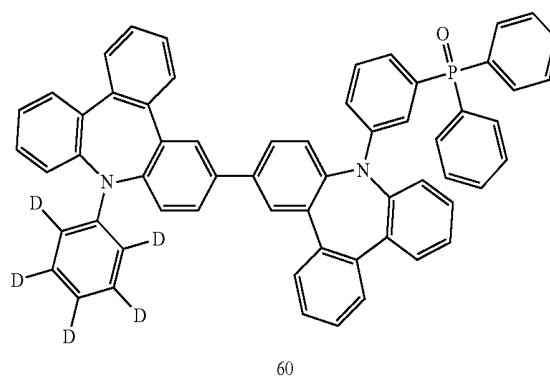
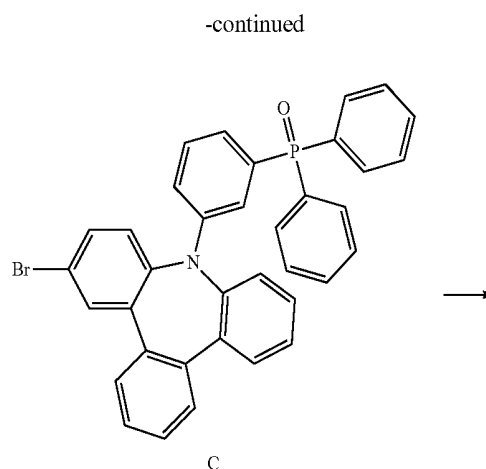
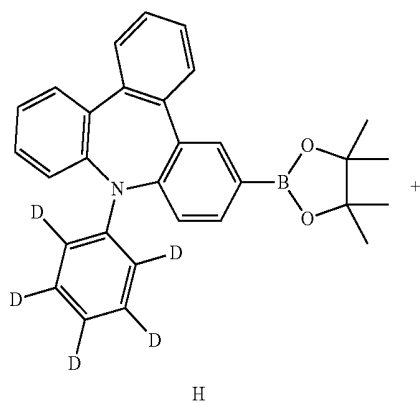
[0250] 0.9 g of Compound 59 (yield: 31%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate H was used instead of Intermediate A, and Intermediate D was used instead of Intermediate B.

[0251] MS (MALDI-TOF) m/z : 872 [M]⁺.

Synthesis Example 9

Synthesis of Compound 60

[0252]



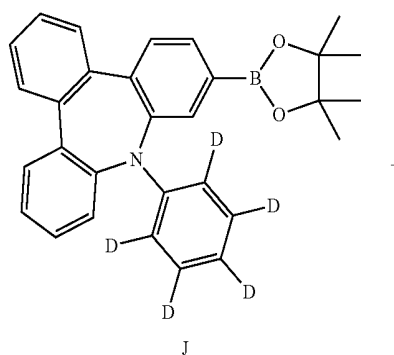
[0253] 1.1 g of Compound 60 (yield: 33%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate H was used instead of Intermediate A, and Intermediate C was used instead of Intermediate B.

[0254] MS (MALDI-TOF) m/z : 841 [M]⁺.

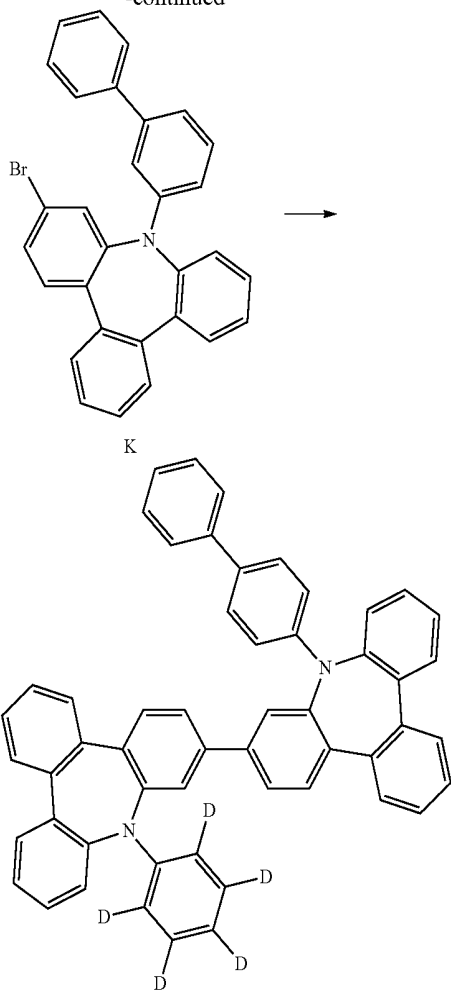
Synthesis Example 10

Synthesis of Compound 66

[0255]



-continued



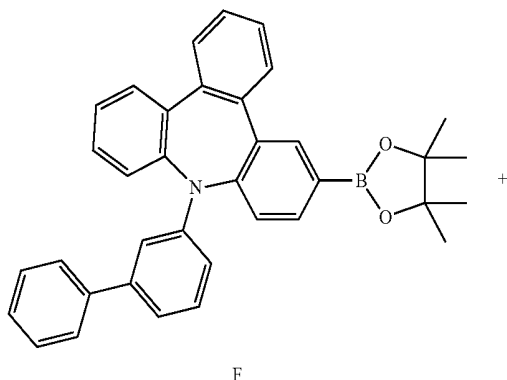
[0256] 1.9 g of Compound 66 (yield: 47%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate J was used instead of Intermediate A, and Intermediate K was used instead of Intermediate B.

[0257] MS (MALDI-TOF) m/z : 717 [M]⁺.

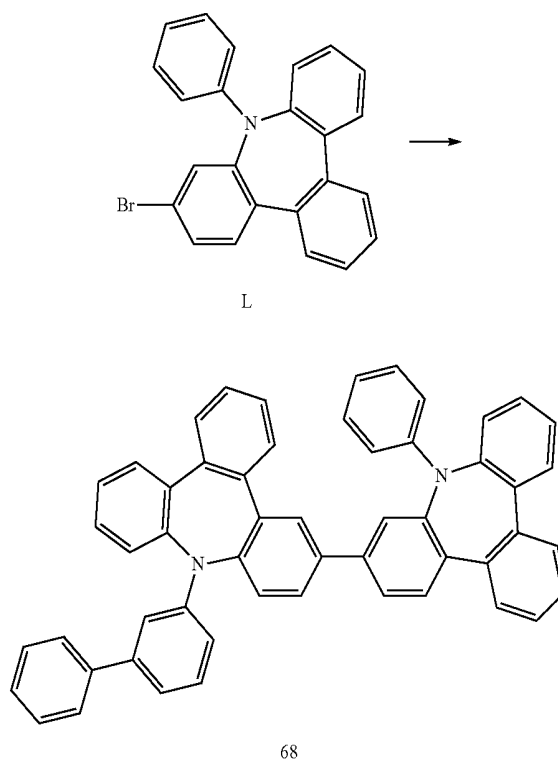
Synthesis Example 11

Synthesis of Compound 68

[0258]



-continued

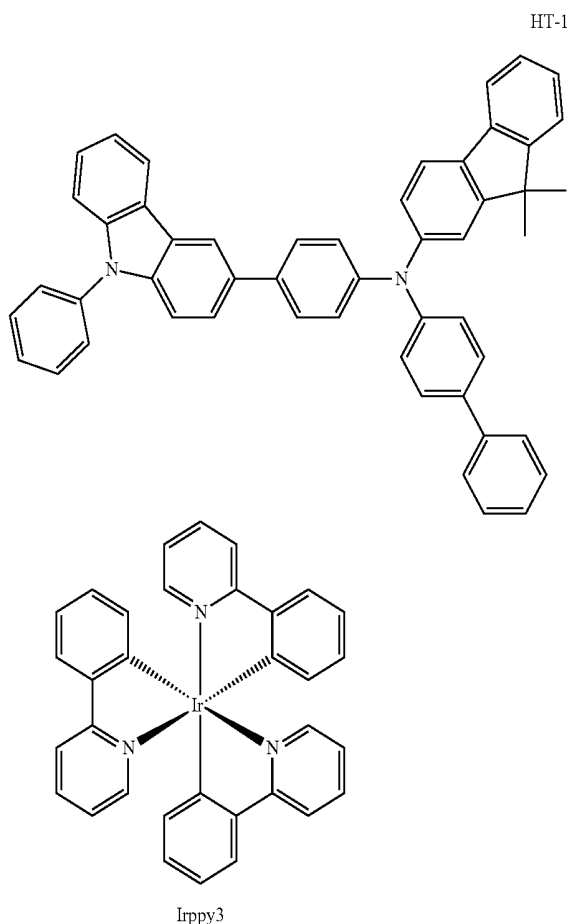


[0259] 0.9 g of Compound 68 (yield: 34%) was synthesized in the same (or substantially the same) manner as in Synthesis of Compound 1, except that Intermediate F was used instead of Intermediate A, and Intermediate L was used instead of Intermediate B.

[0260] MS (MALDI-TOF) m/z : 712 [M]⁺.

Example 1

[0261] An ITO glass substrate was cut to a size of 50 mm×50 mm×0.5 mm. Then the glass substrate was sonicated in acetone, isopropyl alcohol and pure water for about 15 minutes in each solvent, and cleaned by exposure to ultraviolet rays with ozone for 30 minutes. HT-1 was vacuum-deposited thereon at a deposition rate of about 1 Å/sec to form a hole injection layer having a thickness of about 600 Å. α-NPD was vacuum-deposited on the hole injection layer at a deposition rate of about 1 Å/sec to form a hole transport layer having a thickness of about 300 Å. Next, Ir(ppy)₃ and Compound 1 (as a host) were each vacuum-deposited at a deposition rate of about 0.15 Å/sec and about 1 Å/sec, respectively, on the hole transport layer to form an emission layer having a thickness of about 400 Å. Thereafter, BCP was vacuum-deposited on the emission layer to form an electron transport layer having a thickness of about 100 Å. LiF was vacuum-deposited on the electron transport layer to form an electron injection layer having a thickness of about 10 Å, and Al was vacuum-deposited on the electron injection layer to form a cathode having a thickness of about 2000 Å, thereby completing the manufacture of an organic light-emitting device.



Example 2

[0262] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 8 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 8 was used as a host instead of Compound 1.

Example 3

[0263] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 9 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 9 was used as a host instead of Compound 1.

Example 4

[0264] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 28 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 28 was used as a host instead of Compound 1.

Example 5

[0265] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Com-

ound 41 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 41 was used as a host instead of Compound 1.

Example 6

[0266] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 48 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 48 was used as a host instead of Compound 1.

Example 7

[0267] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 53 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 53 was used as a host instead of Compound 1.

Example 8

[0268] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 59 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 59 was used as a host instead of Compound 1.

Example 9

[0269] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 60 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 60 was used as a host instead of Compound 1.

Example 10

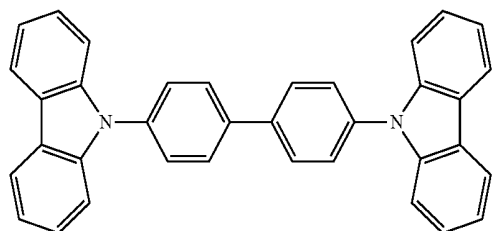
[0270] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 66 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 66 was used as a host instead of Compound 1.

Example 11

[0271] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 68 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 68 was used as a host instead of Compound 1.

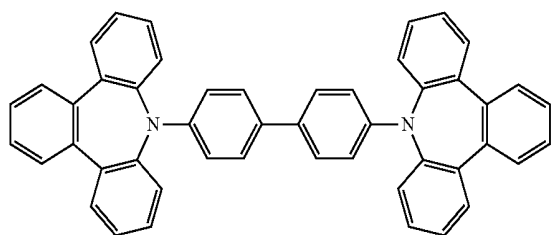
Comparative Example 1

[0272] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 100 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 100 was used as a host instead of Compound 1.



Comparative Example 2

[0273] An organic light-emitting device having a structure of ITO/HT-1 (600 Å)/ α -NPD (300 Å)/15% Ir(ppy)₃+Compound 200 (400 Å)/BCP (100 Å)/LiF (10 Å)/Al (2000 Å) was manufactured in the same (or substantially the same) manner as in Example 1, except that Compound 200 was used as a host instead of Compound 1.



[0274] The results of measuring the current efficiency (cd/A) and lifespan (T90) of the organic light-emitting devices manufactured in Examples 1 to 11 and Comparative Examples 1 and 2 are shown in Table 1.

TABLE 1

	Emission Host	Current Efficiency (cd/A)	Lifespan (T90)
Example 1	Compound 1	49	104
Example 2	Compound 8	51	99
Example 3	Compound 9	53	95
Example 4	Compound 28	57	120
Example 5	Compound 41	57	103
Example 6	Compound 48	58	121
Example 7	Compound 53	61	120
Example 8	Compound 59	59	135
Example 9	Compound 60	61	125
Example 10	Compound 66	53	104
Example 11	Compound 68	50	100
Comparative Example 1	Compound 100	28	60
Comparative Example 2	Compound 200	27	52

[0275] Referring to Table 1, it was found that when a compound represented Formula 1 according to an example embodiment of the present inventive concept is used as an emission layer host in an organic light-emitting device, the organic light-emitting device may have excellent current-voltage-luminance (I-V-L) characteristics, with significantly improved efficiency and excellent lifespan characteristics, as

compared to the organic light-emitting devices manufactured in Comparative Examples.

[0276] As described above, according to one or more example embodiments, a compound represented by Formula 1 may have excellent emission characteristics. Thus, the compound of Formula 1 is suitable for an emission material for a fluorescent and/or phosphorescent device of red, green, blue, and/or white color. An organic light-emitting device using the compound of Formula 1 may have high efficiency, low voltage, high luminance, and long lifespan.

[0277] As used herein, when specific definition is not otherwise provided, it will be understood that when an element such as a layer, film, region, or substrate is referred to as being “on” another element, it can be directly on the other element or intervening elements may also be present.

[0278] In addition, as used herein, the terms “use,” “using,” and “used” may be considered synonymous with the terms “utilize,” “utilizing,” and “utilized,” respectively.

[0279] As used herein, the terms “substantially,” “about,” and similar terms are used as terms of approximation and not as terms of degree, and are intended to account for the inherent deviations in measured or calculated values that would be recognized by those of ordinary skill in the art.

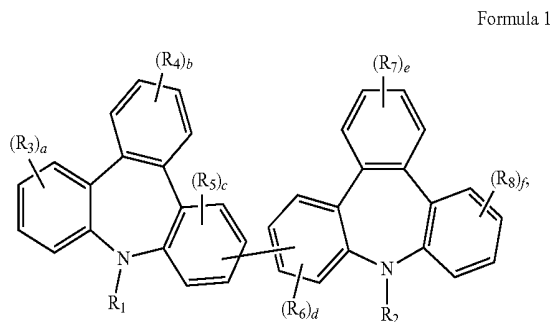
[0280] Also, any numerical range recited herein is intended to include all subranges of the same numerical precision subsumed within the recited range. For example, a range of “1.0 to 10.0” is intended to include all subranges between (and including) the recited minimum value of 1.0 and the recited maximum value of 10.0, that is, having a minimum value equal to or greater than 1.0 and a maximum value equal to or less than 10.0, such as, for example, 2.4 to 7.6. Any maximum numerical limitation recited herein is intended to include all lower numerical limitations subsumed therein and any minimum numerical limitation recited in this specification is intended to include all higher numerical limitations subsumed therein. Accordingly, Applicant reserves the right to amend this specification, including the claims, to expressly recite any sub-range subsumed within the ranges expressly recited herein. All such ranges are intended to be inherently described in this specification such that amending to expressly recite any such subranges would comply with the requirements of 35 U.S.C. §112(a) and 35 U.S.C. §132(a).

[0281] It should be understood that example embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each example embodiment should typically be considered as available for other similar features or aspects in other example embodiments.

[0282] While one or more example embodiments have been described with reference to the drawing, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present disclosure as defined by the following claims and equivalents thereof.

What is claimed is:

1. A compound represented by Formula 1:



wherein, in Formula 1,

R_1 to R_8 are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkynyl group, a substituted or unsubstituted C_1 - C_{60} alkoxy group, a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_1 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group;

a, b, e, and f are each independently an integer selected from 1 to 4;

c and d are each independently an integer selected from 1 to 3;

at least one substituent of the substituted C_1 - C_{60} alkyl group, substituted C_2 - C_{60} alkenyl group, substituted C_2 - C_{60} alkynyl group, substituted C_1 - C_{60} alkoxy group, substituted C_3 - C_{10} cycloalkyl group, substituted C_2 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_2 - C_{10} heterocycloalkenyl group, substituted C_6 - C_{60} aryl group, substituted C_6 - C_{60} aryloxy group, substituted C_6 - C_{60} arylthio group, substituted C_1 - C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino

group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group;

a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q_{11})(Q_{12}), —Si(Q_{13})(Q_{14})(Q_{15}), and —B(Q_{16})(Q_{17});

a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_2 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_2 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q_{21})(Q_{22}), —Si(Q_{23})(Q_{24})(Q_{25}), and —B(Q_{26})(Q_{27}); and

—P(=O) $Q_{31}Q_{32}$,

wherein Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{32} are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60}

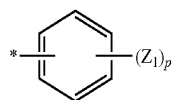
alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, and

when a to f are each independently 2 or more, a respective plurality of R₃(s) to R₈(s) are identical to or different from each other.

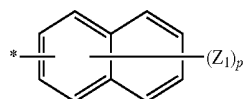
2. The compound of claim 1, wherein, in Formula 1, R₃ to R₈ are each independently hydrogen or deuterium.

3. The compound of claim 1, wherein, in Formula 1, R₁ and R₂ are each independently selected from a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

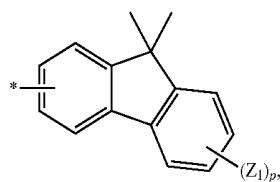
4. The compound of claim 1, wherein, in Formula 1, R₁ and R₂ are each independently selected from Formulae 2a to 2c:



2a



2b



2c

wherein, in Formulae 2a to 2c,

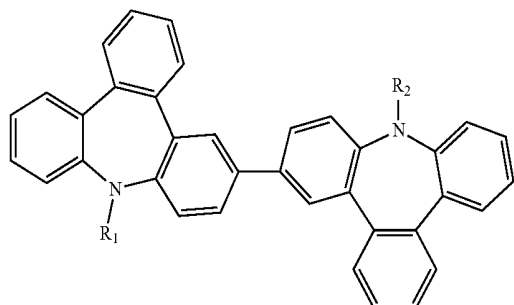
Z₁ is selected from hydrogen, deuterium, a halogen group, a cyano group, a nitro group, a hydroxyl group, a carboxyl group, a substituted or unsubstituted C₁-C₂₀ alkyl group, a substituted or unsubstituted C₆-C₂₀ aryl group, a substituted or unsubstituted C₁-C₂₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, and —P(=O)Q₃₁Q₃₂;

p in Formula 2a is an integer selected from 1 to 5, p in Formulae 2b and 2c is an integer selected from 1 to 7, and when p is 2 or more, a respective plurality of Z₁(s) are identical to or different from each other; and

*indicates a binding site.

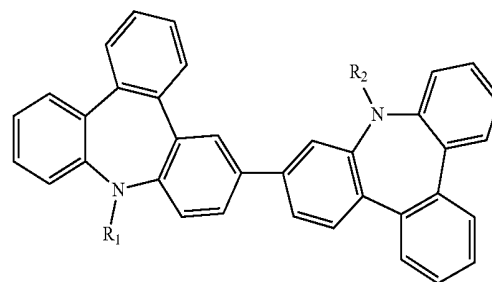
5. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 2:

Formula 2



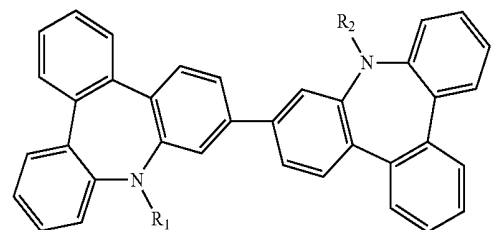
6. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 3:

Formula 3



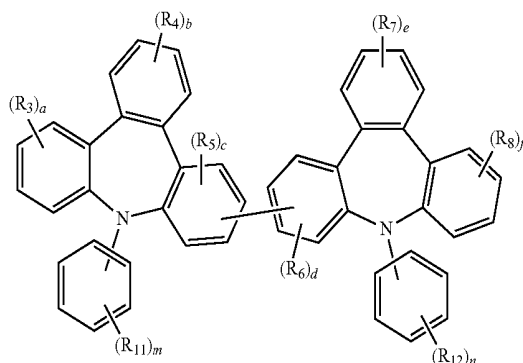
7. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 4:

Formula 4



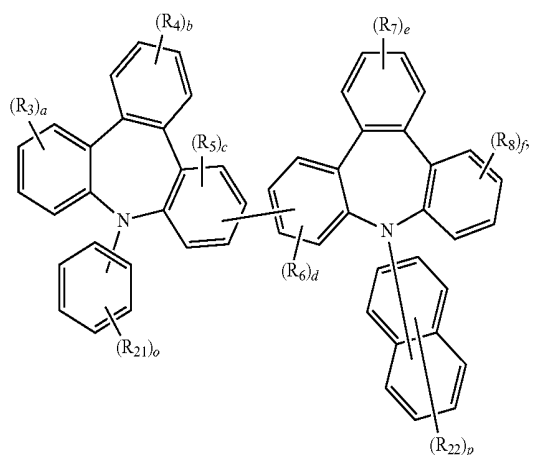
8. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 5:

Formula 5



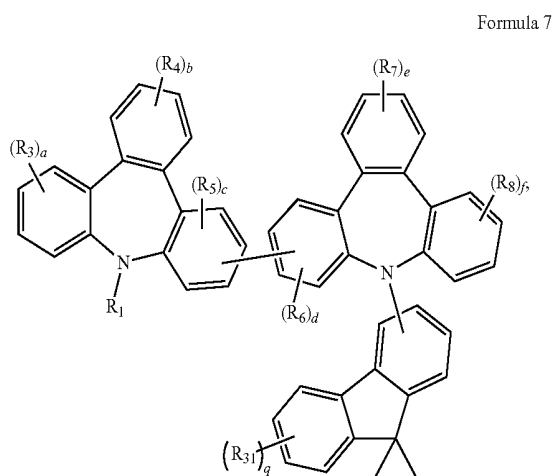
wherein, in Formula 5, R_{11} and R_{12} are each independently defined the same as R_3 to R_8 , and m and n are each independently an integer selected from 1 to 5.

9. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 6:



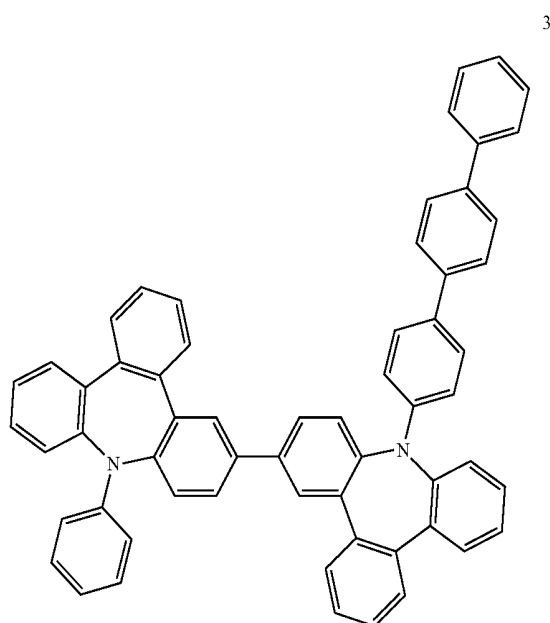
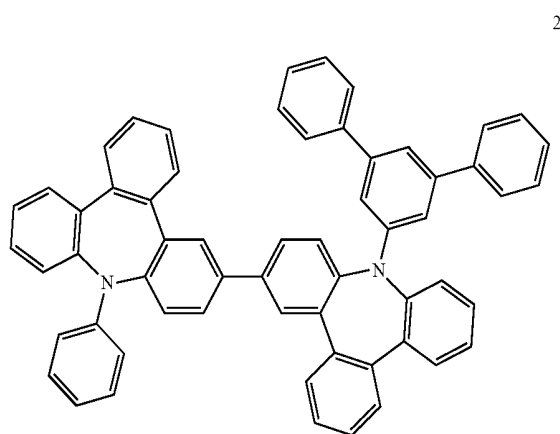
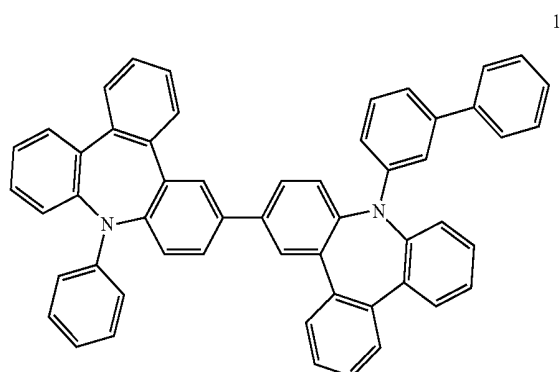
wherein, in Formula 6, R_{21} and R_{22} are each independently defined the same as R_3 to R_8 , o is an integer selected from 1 to 5, and p is an integer selected from 1 to 7.

10. The compound of claim 1, wherein the compound represented by Formula 1 is represented by Formula 7:



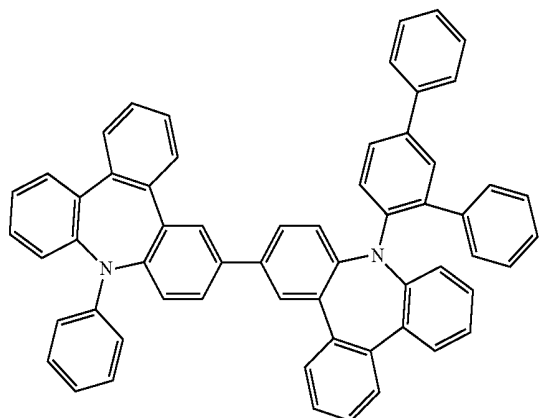
wherein, in Formula 7, R_{31} is defined the same as R_1 and R_3 to R_8 , and q is an integer selected from 1 to 4.

11. The compound of claim 1, wherein the compound represented by Formula 1 is represented by one of Compounds 1 to 69:

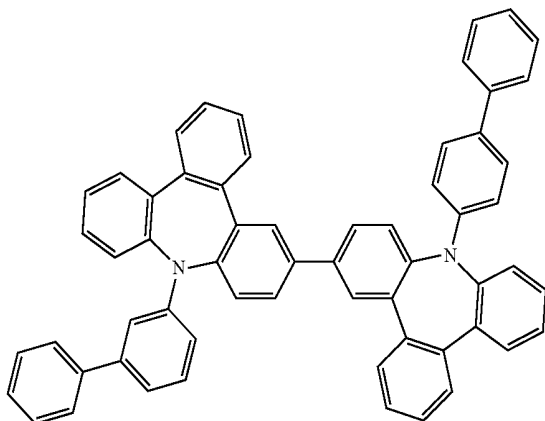


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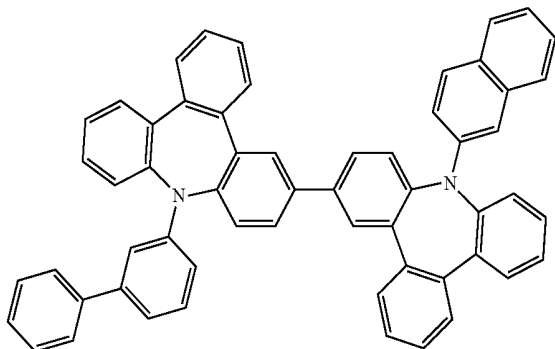
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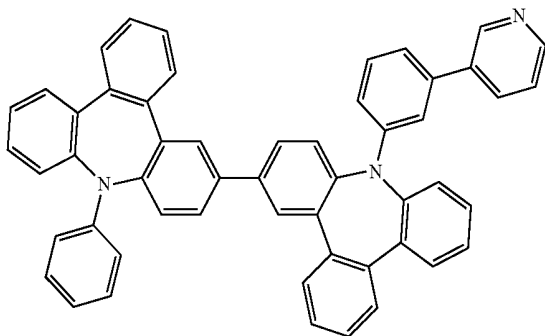
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6

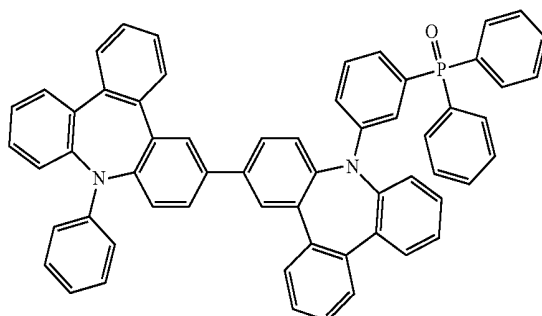


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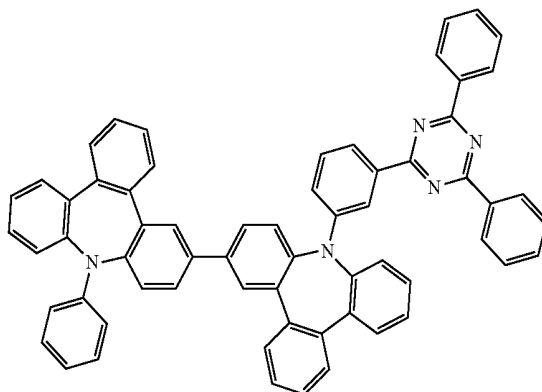


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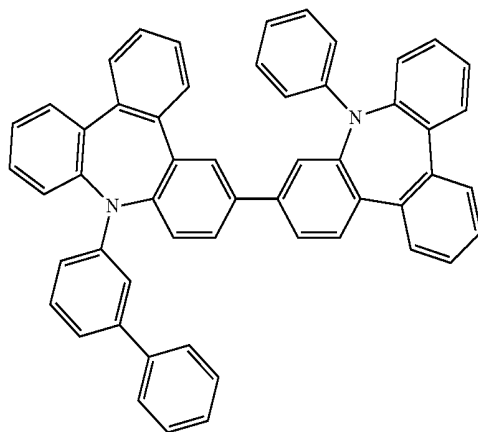
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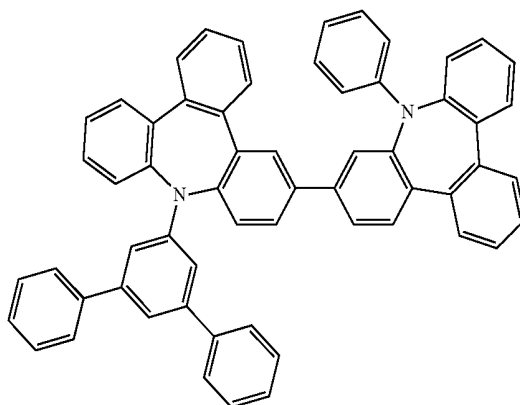
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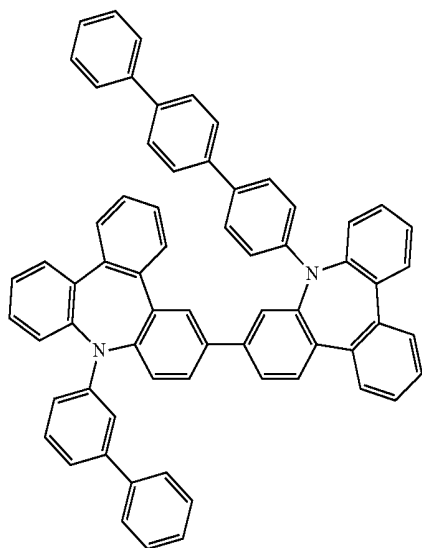


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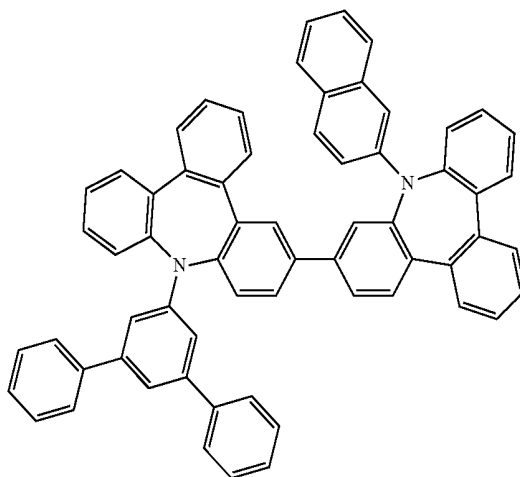
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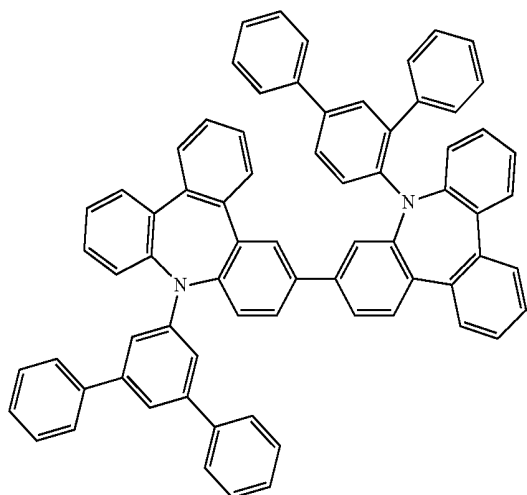


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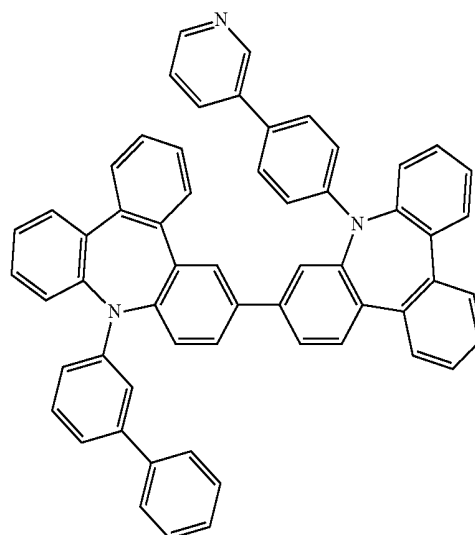
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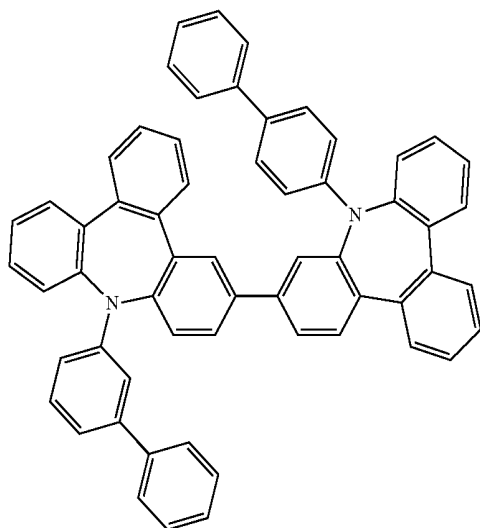
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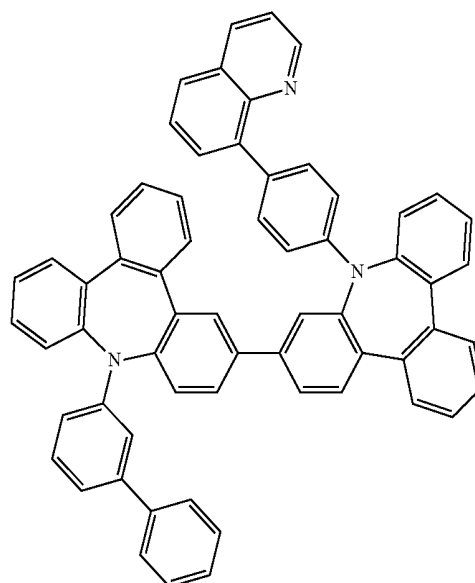
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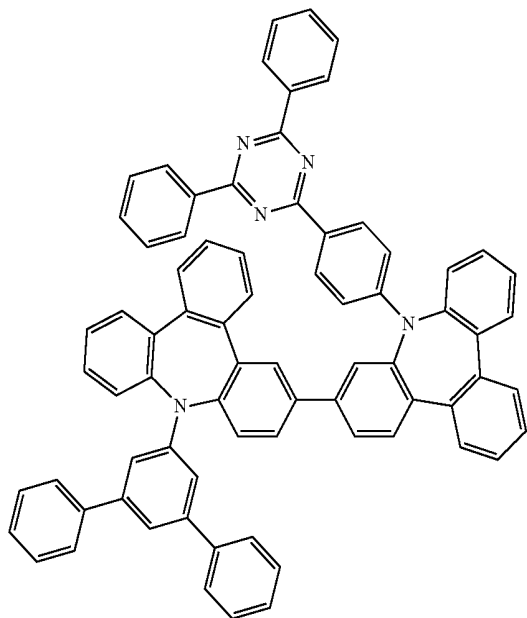


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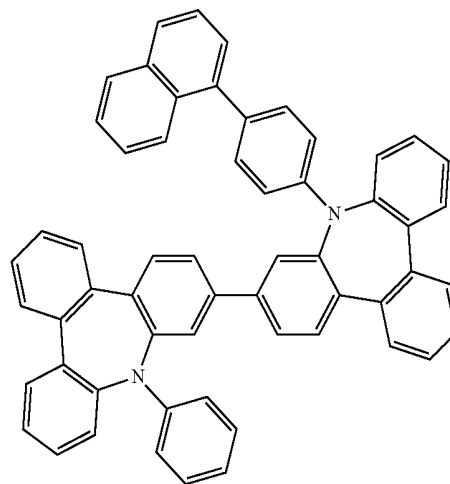
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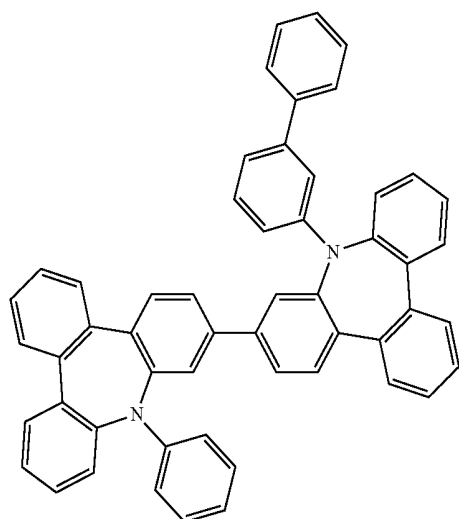


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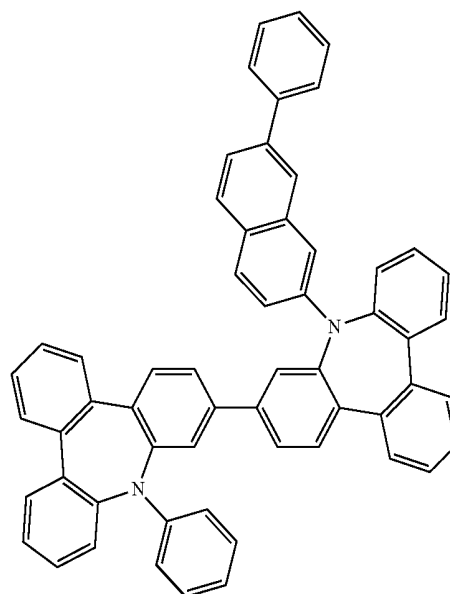
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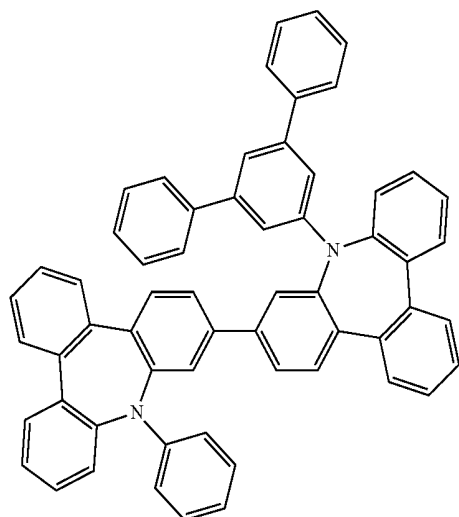
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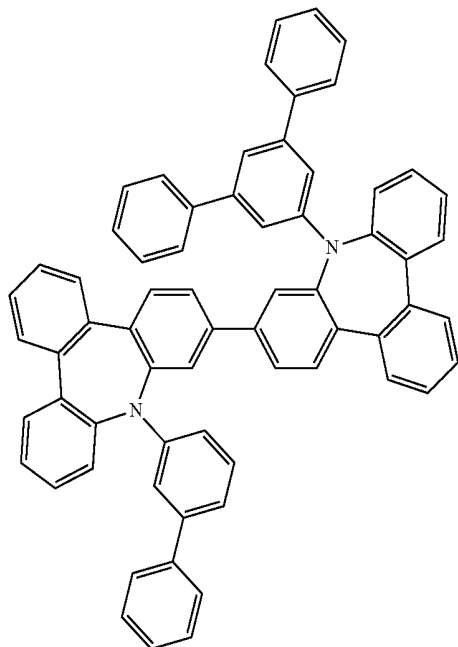
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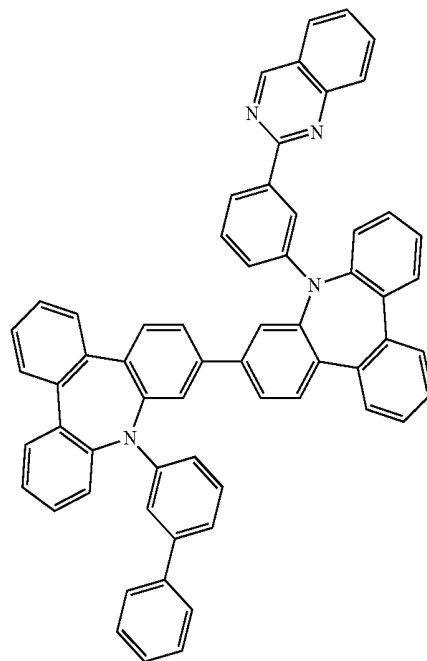
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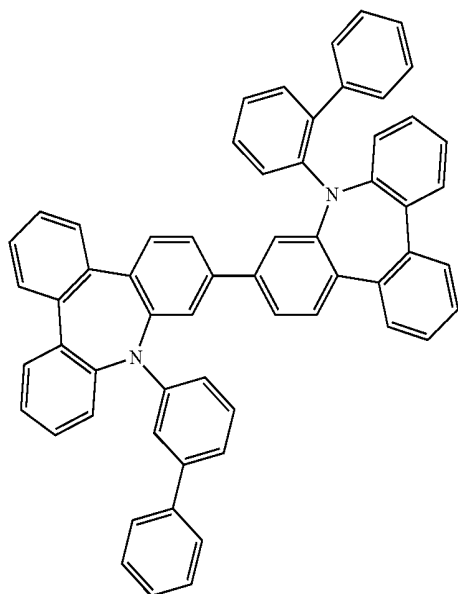
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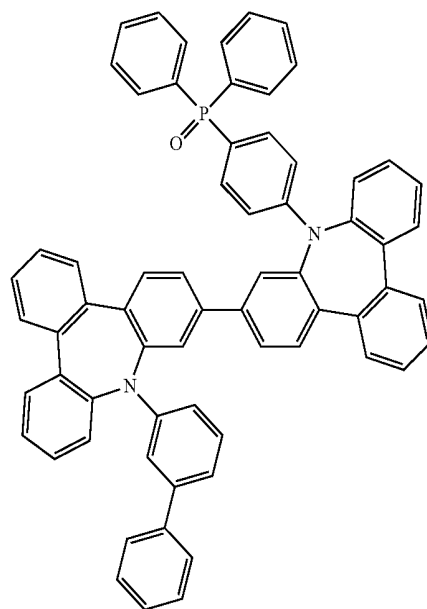
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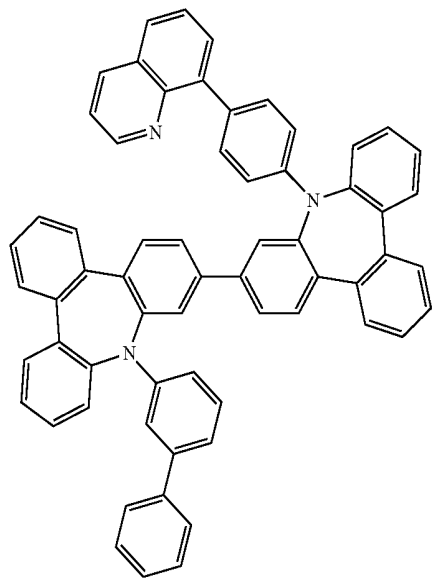


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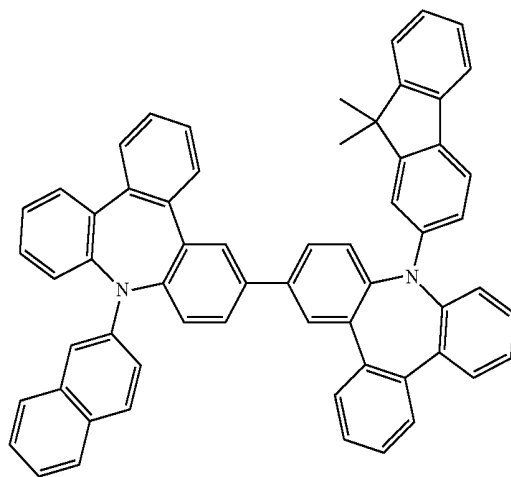
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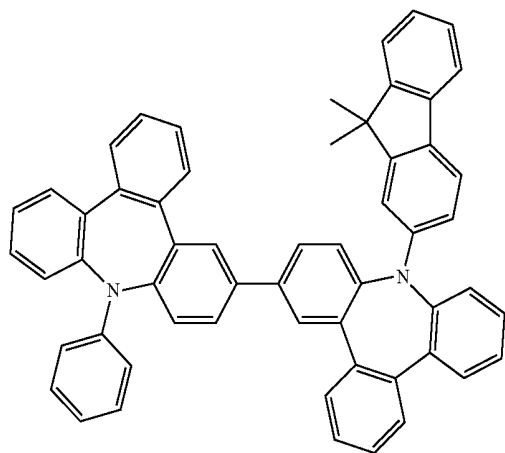


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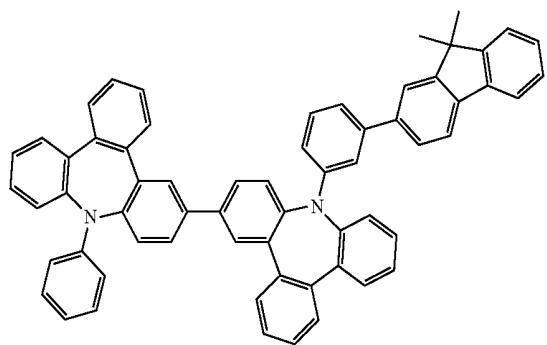
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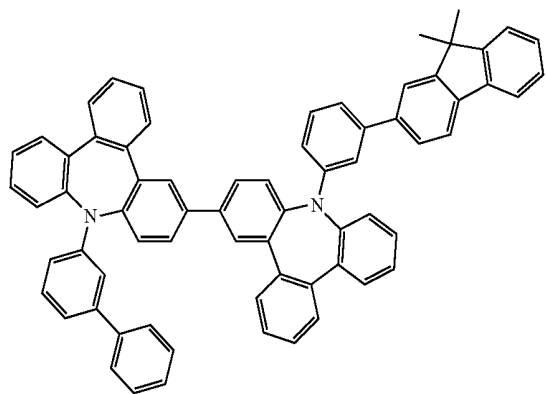
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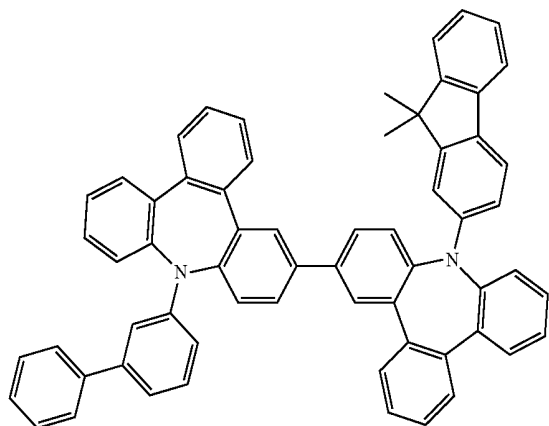
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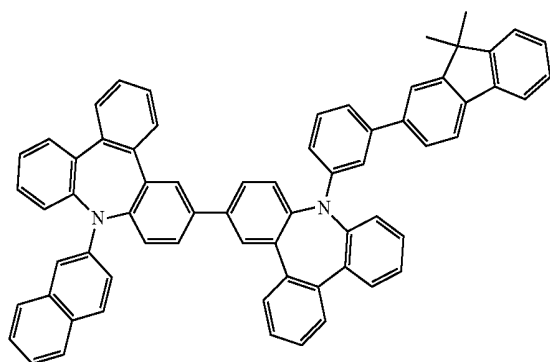
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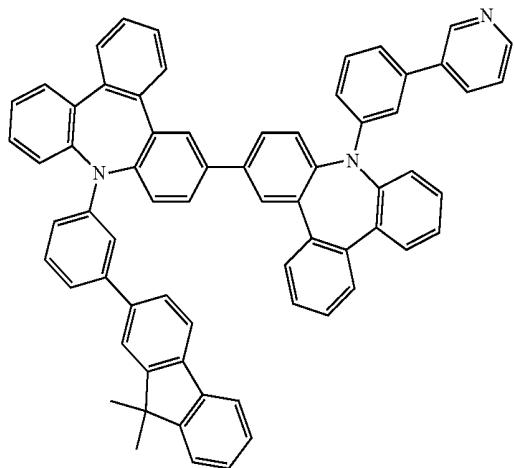


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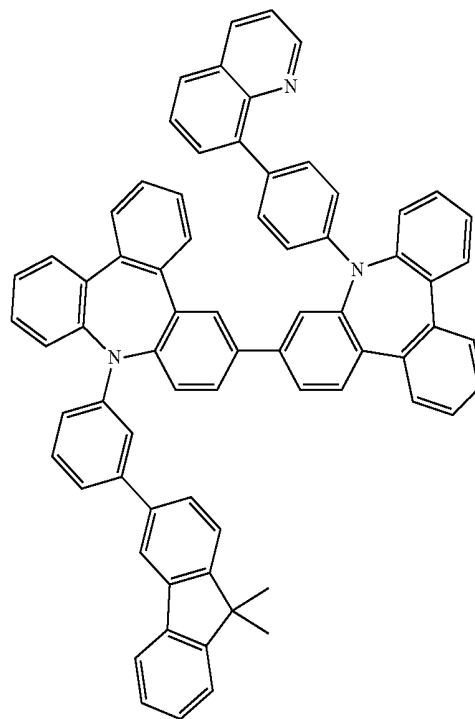
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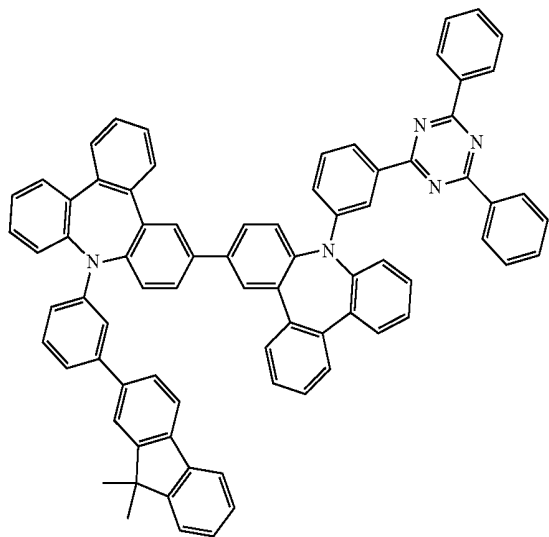


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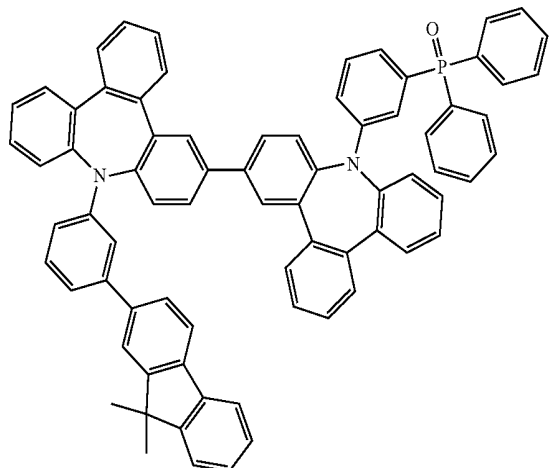
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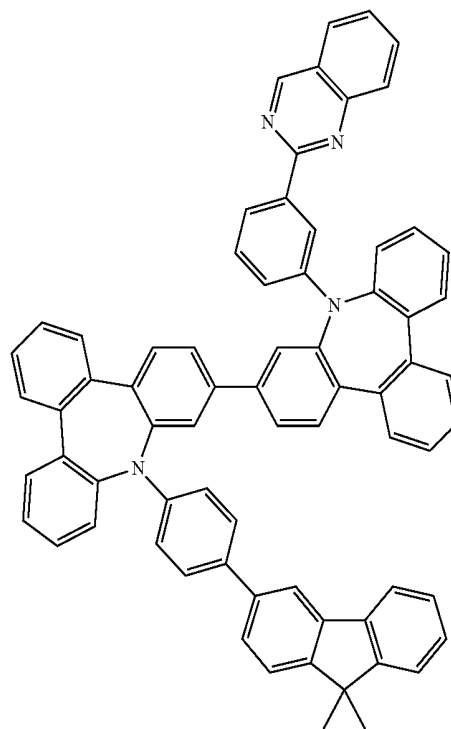
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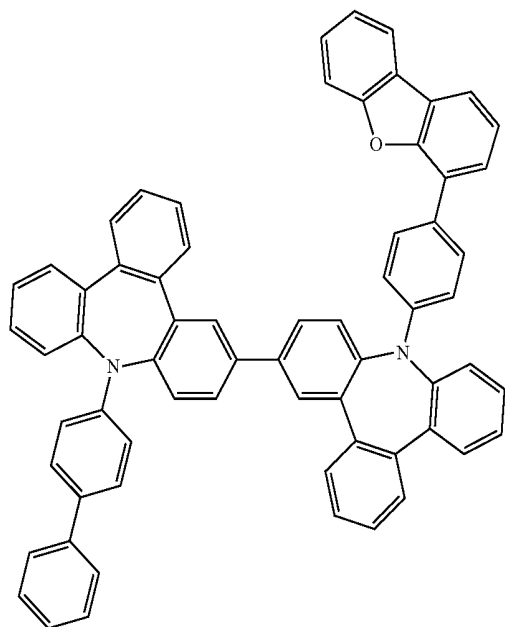
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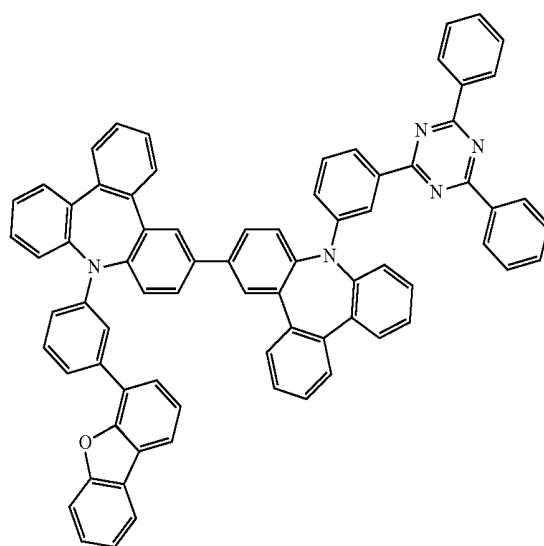
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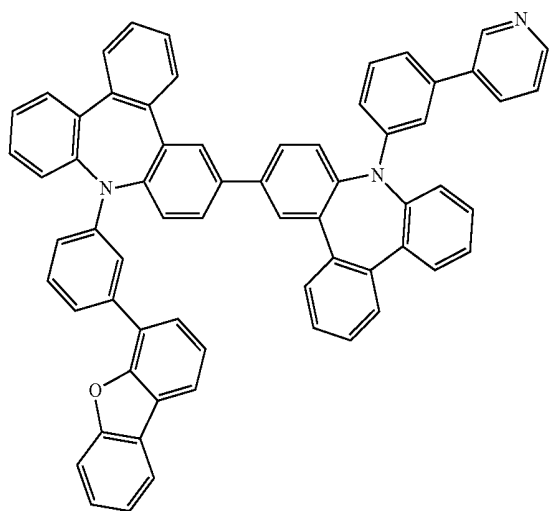
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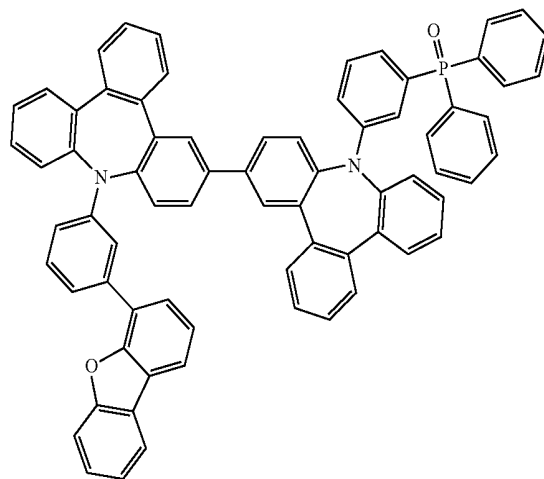
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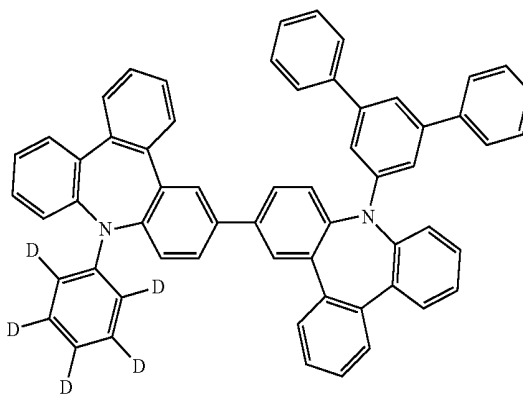
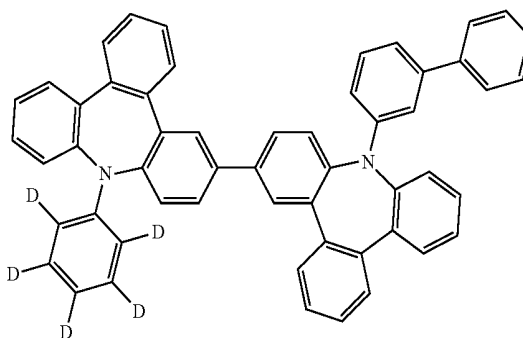
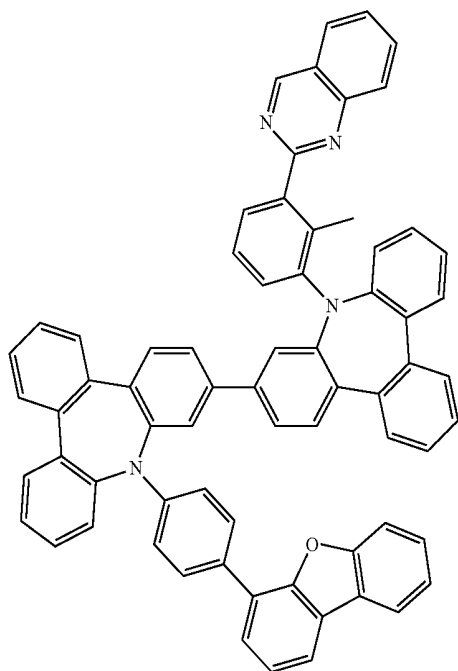
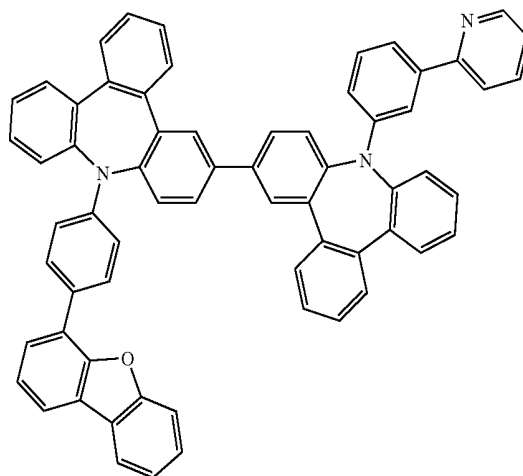
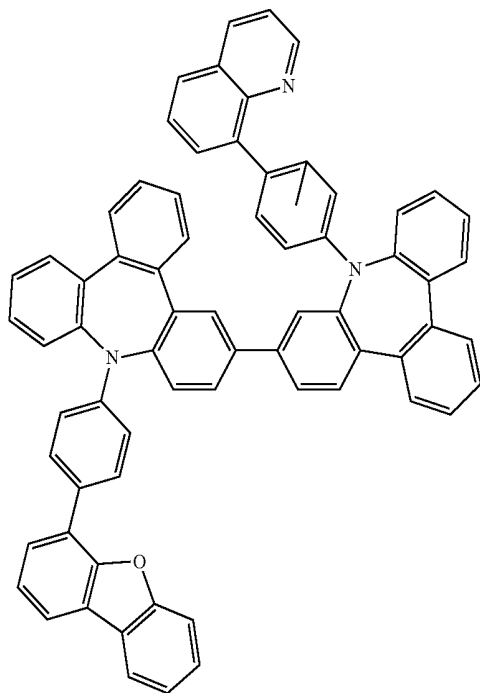


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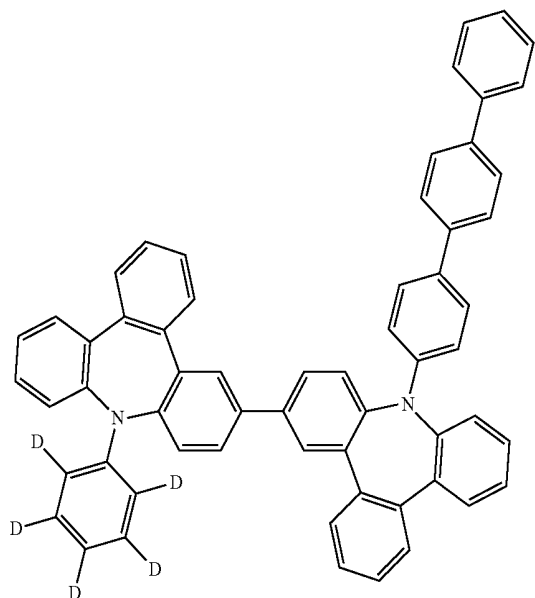
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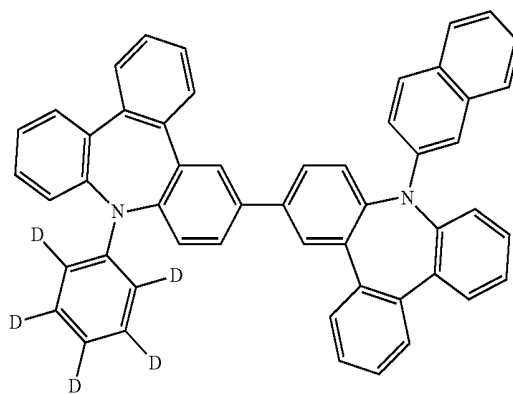
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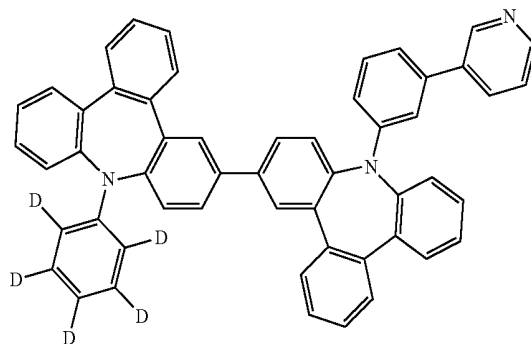


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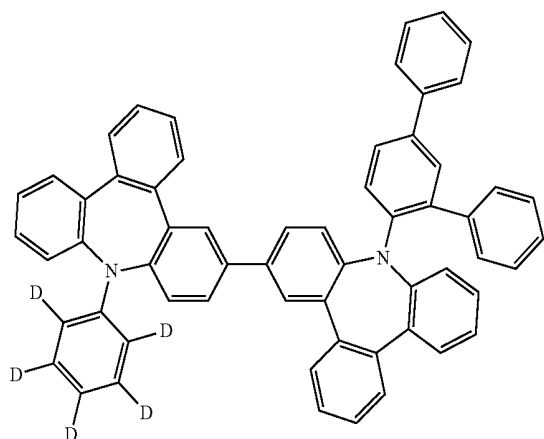
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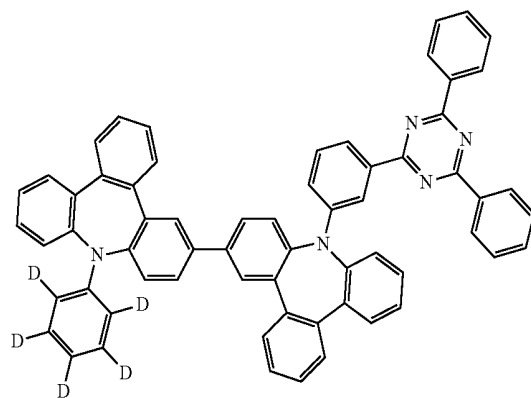
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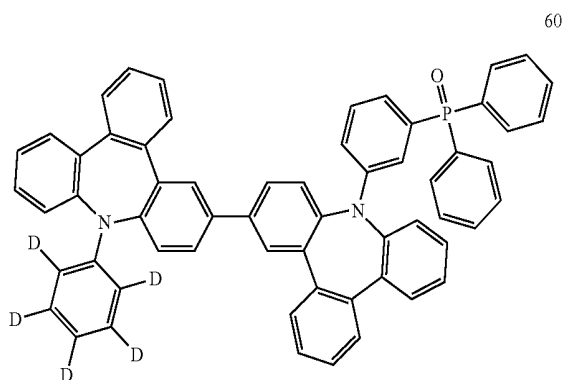
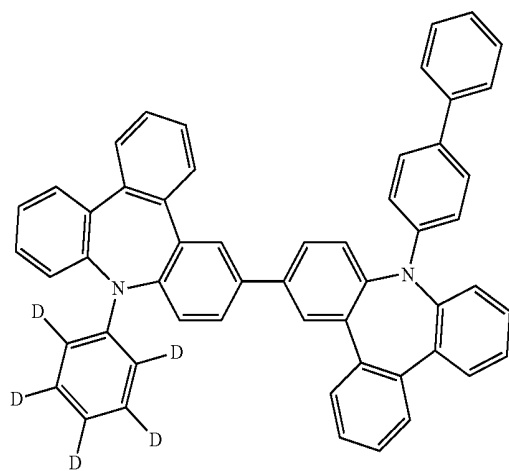
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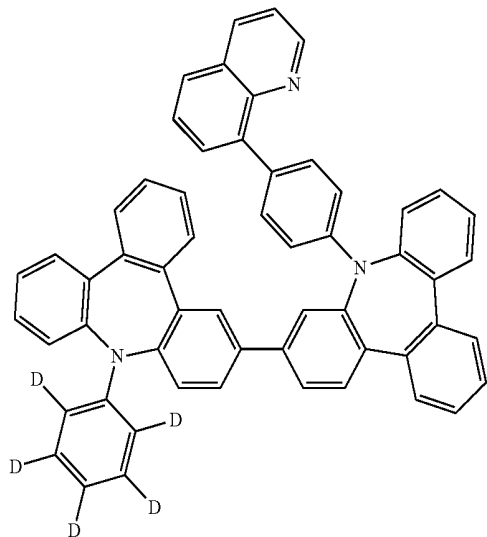
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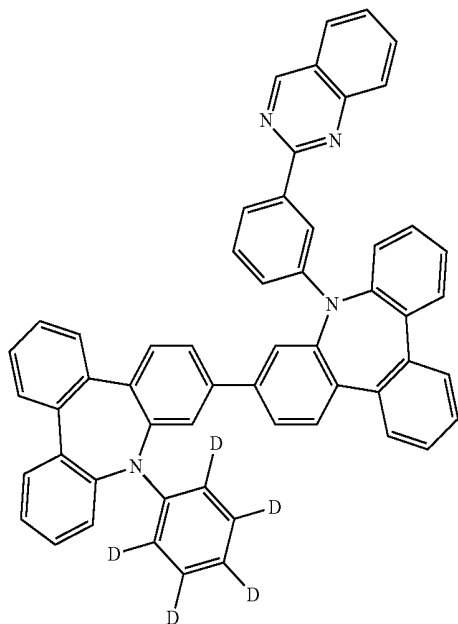
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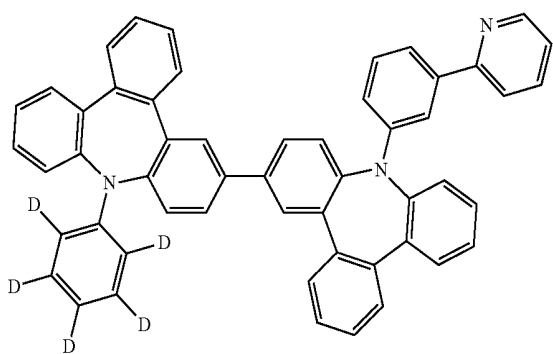
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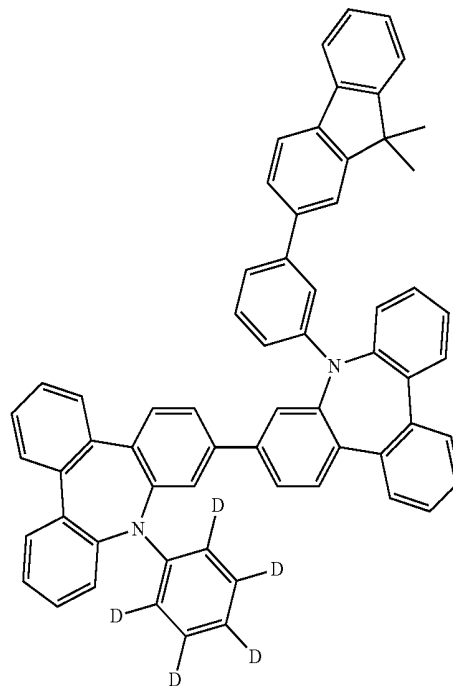


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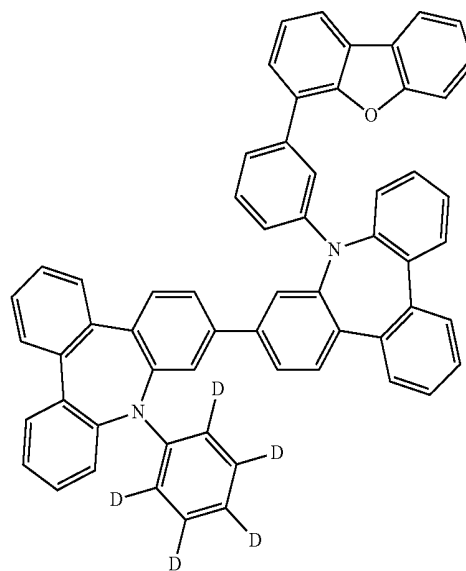


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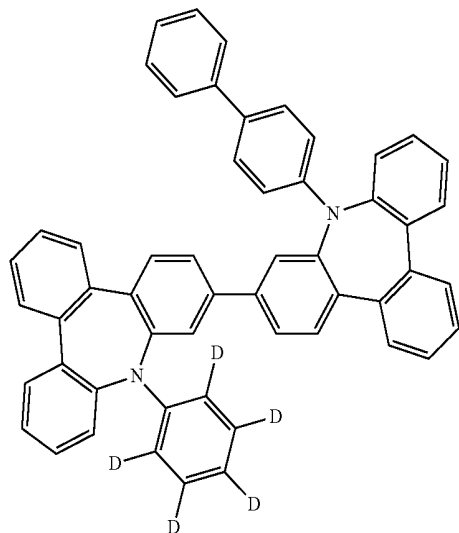
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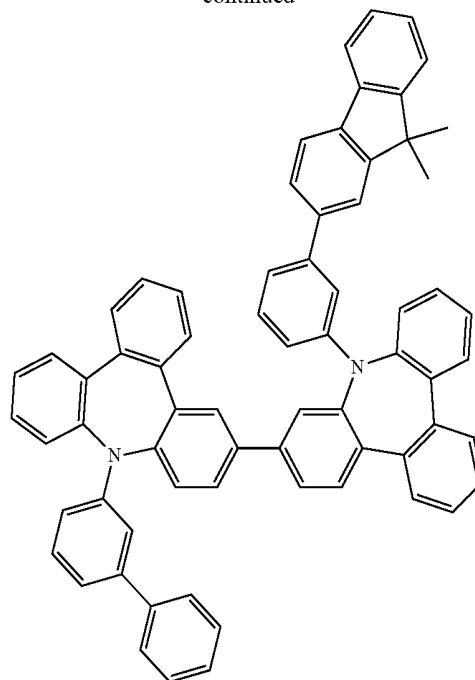


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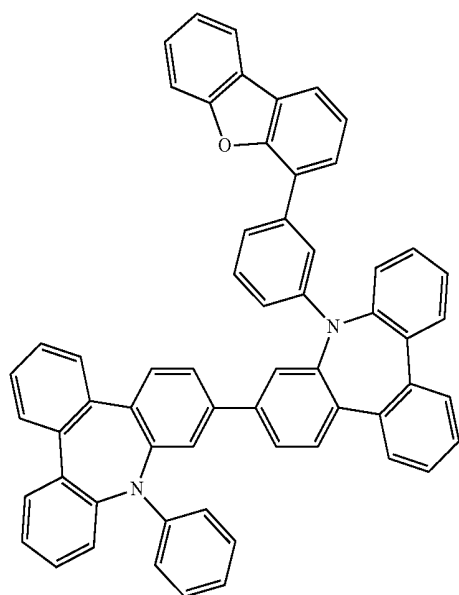


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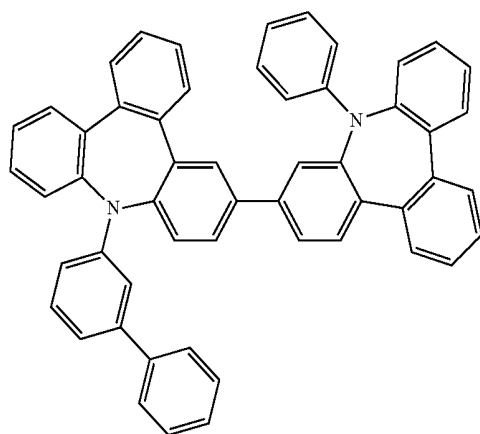
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- 12.** An organic light-emitting device comprising:
 a first electrode;
 a second electrode facing the first electrode; and
 an organic layer between the first electrode and the second electrode and comprising an emission layer, wherein the organic layer comprises the compound of claim 1.
- 13.** The organic light-emitting device of claim 12, wherein the first electrode is an anode, the second electrode is a cathode, and the organic layer further comprises i) a hole transport region between the first electrode and the emission layer, the hole transport region comprising at least one selected from a hole injection layer, a hole transport layer, and an electron blocking layer, and ii) an electron transport region between the emission layer and the second electrode, the electron transport region comprising at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

14. The organic light-emitting device of claim 13, wherein the emission layer comprises the compound represented by Formula 1.

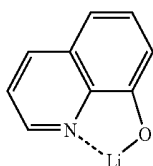
15. The organic light-emitting device of claim 13, wherein the emission layer comprises the compound represented by Formula 1 as a host.

16. The organic light-emitting device of claim 13, wherein the emission layer comprises at least one selected from an iridium (Ir) complex, a platinum (Pt) complex, an osmium (Os) complex, and a copper (Cu) complex as a dopant.

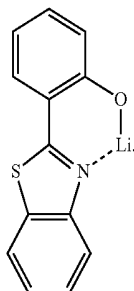
17. The organic light-emitting device of claim 13, wherein the hole transport region comprises a charge-generating material.

18. The organic light-emitting device of claim 13, wherein the electron transport region comprises a metal complex.

19. The organic light-emitting device of claim 13, wherein the electron transport region comprises at least one selected from Compound ET-D1 and Compound ET-D2:



ET-D1



ET-D2

20. A flat panel display apparatus comprising the organic light-emitting device of claim 12, wherein the first electrode of the organic light-emitting device is electrically coupled to a source electrode or a drain electrode of a thin film transistor.

* * * * *

专利名称(译)	包含其的化合物和有机发光装置		
公开(公告)号	US20160322586A1	公开(公告)日	2016-11-03
申请号	US15/139208	申请日	2016-04-26
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	SHIN DONGWOO KIM SEULONG KIM YOUNSUN LEE JUNGSUB ITO NAOYUKI		
发明人	SHIN, DONGWOO KIM, SEULONG KIM, YOUNSUN LEE, JUNGSUB ITO, NAOYUKI		
IPC分类号	H01L51/00 C09K11/06 C07D405/14 C07D223/14 C07F9/6561 C07D403/14 C09K11/02 H01L27/32		
CPC分类号	H01L51/0072 C09K2211/185 C09K11/06 H01L51/0077 H01L27/3248 C07D223/14 C07F9/6561 C07D403/14 H01L51/0067 H01L51/0052 C07D405/14 H01L51/0073 H01L51/0085 H01L51/5206 H01L51/5221 H01L51/5028 H01L51/506 H01L51/5088 H01L51/5096 H01L51/5076 H01L51/5092 H01L51/5016 H01L51/001 H01L51/0003 H01L2251/558 H01L51/504 C09K2211/1007 C09K2211/1029 C09K11/025 C07D223/18 H01L51/0059		
优先权	1020150059636 2015-04-28 KR 1020150109571 2015-08-03 KR		
其他公开文献	US10181562		
外部链接	Espacenet USPTO		

摘要(译)

Formula 1

一种有机发光装置，包括：第一电极；面向第一电极的第二电极；以及第一电极和第二电极之间的有机层，其中有有机层包括包含由式1表示的化合物的发光层：使用式1化合物的有机发光装置可具有高效率，低电压，高亮度和长寿命。

