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

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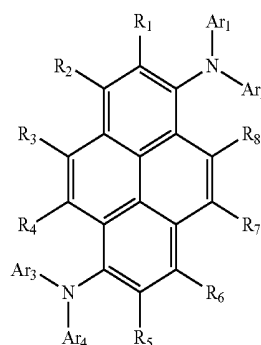
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(57) **ABSTRACT**

The present disclosure relates to a compound represented by
Formula 1 and an organic light-emitting device including the
same.

Formula 1



The compound represented by Formula 1 has excellent
stability and is suitable as an electron transporting material.
An organic light-emitting device using the compound of
(Continued)

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Formula 1 may have high efficiency, low voltage, high luminance, and long lifespan.

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H05B 33/14 (2006.01)
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H01L 51/0054 (2013.01); **H01L 51/0073**
(2013.01); **H05B 33/14** (2013.01); **C09K**
2211/1007 (2013.01); **C09K 2211/1011**
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307/77; C09K 11/06; C09K 2211/1088;
C09K 2211/1007; C09K 2211/1011
USPC 428/690
See application file for complete search history.

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COMPOUND AND ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2014-0170821, filed on Dec. 2, 2014, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

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

2. Description of the Related Art

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

An organic light-emitting device may have a structure including an anode disposed on a substrate, a hole transport layer, an emission layer, an electron transport layer, and a cathode which are sequentially stacked on the anode in the stated order. Here, the hole transport layer, the emission layer, and the electron transport layer may be organic thin films formed of organic compounds.

The operating principle of an organic light-emitting device having the above-described structure is as follows:

When a voltage is applied between the anode and the cathode, holes provided from the anode may move toward the emission layer through the hole transport layer, and electrodes provided from the cathode may move toward the emission layer through the electron transport layer. The holes and the electrons are then recombined in the emission layer to produce excitons. These excitons change from an excited state to a ground state to thereby generate light.

There is a need to develop a material that has improved electric stability, high charge transporting and/or light-emitting capability, high glass transition temperature, and capability to prevent or reduce crystallization, as compared to an organic material of the related art.

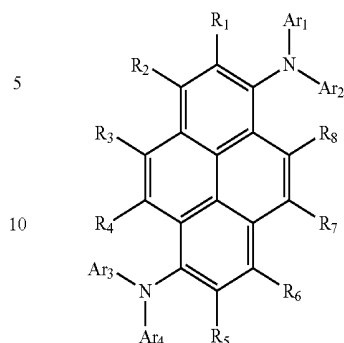
SUMMARY

One or more aspects of embodiments of the present invention include a compound that is suitable as an electron transporting material and has excellent electric characteristics, high charge transporting and light-emitting capability, high glass transition temperature, and/or high capability to prevent or substantially reduce crystallization. An organic light-emitting device including the compound may have high efficiency, low voltage, high luminance, and/or long lifespan.

Additional aspects of embodiments of the present invention 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.

According to one or more exemplary embodiments, a compound is represented by Formula 1:

Formula 1

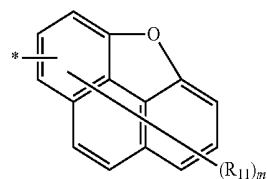


In Formula 1,

R₁ to R₈ and Ar₁ to Ar₄ are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇);

where at least one selected from Ar₁ to Ar₄ is represented by Formula 1-a:

Formula 1-a



In Formula 1-a,

R₁₁ is the same as defined in connection with R₁ to R₈;

m is an integer selected from 1 to 7; and

* indicates a binding site.

In Formulae 1 and 1-a, 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 is selected from:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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;

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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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);

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;

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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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

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

where Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

According to one or more exemplary 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, wherein the organic layer includes an emission layer and the compound represented by Formula 1.

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

BRIEF DESCRIPTION OF THE DRAWINGS

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

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawing, wherein like reference numerals refer to like elements throughout. In this regard, the present exemplary embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the exemplary 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”, 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.”

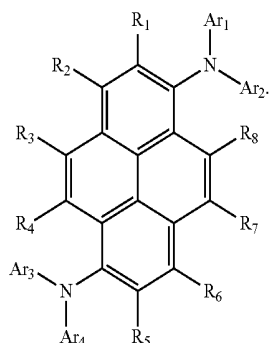
In addition, as used herein, the terms “use,” “using,” and “used” may be considered synonymous with the terms “utilize,” “utilizing,” and “utilized,” respectively. Also, the term “exemplary” is intended to refer to an example or illustration.

As used herein, the term “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.

Also, any numerical range recited herein is intended to include all sub-ranges 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, first paragraph, and 35 U.S.C. § 132(a).

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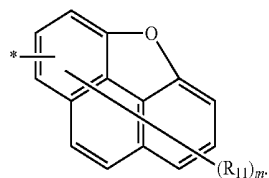
According to one or more exemplary embodiments, a compound is represented by Formula 1:



In Formula 1,

R_1 to R_8 and Ar_1 to Ar_4 may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q_1)(Q_2), —Si(Q_3)(Q_4)(Q_5), and —B(Q_6)(Q_7);

where at least one selected from Ar_1 to Ar_4 may be represented by Formula 1-a:



In Formula 1-a,

R_{11} may be the same as defined in connection with R_1 to R_8 ;

m may be an integer selected from 1 to 7; and

* indicates a binding site.

In Formulae 1 and 1-a, 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,

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substituted C_1 - C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

Formula 1 5 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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;

10 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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});

20 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;

30 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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

55 —N(Q_{31})(Q_{32}), —Si(Q_{33})(Q_{34})(Q_{35}), and —B(Q_{36})(Q_{37});

where Q_1 to Q_7 , Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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.

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

Compounds represented by Formula 1 and including a condensed ring structure may have a high glass transition temperature (T_g) or a high melting point, due to the presence of a condensed ring. Therefore, during emission, an organic light-emitting device may have improved heat resistance to Joule heating generated in an organic layer of the organic light-emitting device, between the layers included in the organic layer, and between the organic layer and a metal electrode, and an improved resistance to a high temperature. Thus, an organic light-emitting device manufactured using the compound represented by Formula 1 may retain high durability during storing and driving.

In addition, Formula 1-a has a phenanthrofur structure in which phenanthrene structure is condensed with a furan structure, so that π -electrons in the overall structure are delocalized and lone pairs of oxygen (O) are capable to partially provide excess electrons.

Accordingly, $\pi \rightarrow \pi^*$ transition and $n \rightarrow \pi^*$ transition may occur easily due to a phenanthrofur structure connected to an amine group as well as the pyrene structure enriched with π -electrons that is positioned in the center of Formula 1.

Based on this principle, ultimately, molecular extinction coefficient in the structure of Formula 1 may increase. Such an increase of the molecular extinction coefficient may lead to increase of luminous efficiency of the molecule, and thus, the compound represented by Formula 1 may have an improved luminous efficiency compared to other known and/or commonly used pyrene derivatives.

Accordingly, when the compound represented by Formula 1 is used as a dopant in an emission layer in an organic light-emitting device, the organic light-emitting device may have high efficiency.

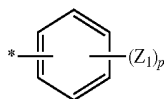
In some embodiments, when a compound represented by Formula 4 (described below) is used as a host in the emission layer together with the compound of Formula 1 (used as a dopant), the organic light-emitting device may have an excellent efficiency.

Substituents of Formula 1 will be described in more detail below.

In some embodiments, among Ar_1 to Ar_4 in Formula 1, substituents other than Formula 1-a may be each independently selected from a substituted or unsubstituted C_6 - C_{60} aryl 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.

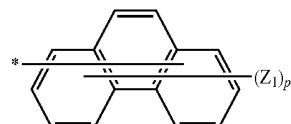
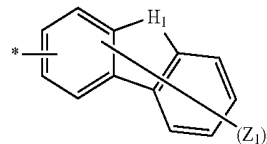
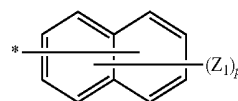
In some embodiments, in Formula 1, R_1 to R_8 may be each independently selected from a hydrogen, a deuterium, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, and $-\text{Si}(Q_3)(Q_4)(Q_5)$, where Q_3 to Q_5 are as defined above.

In some embodiments, among Ar_1 to Ar_4 in Formula 1, substituents other than Formula 1-a may be each independently represented by any one of Formulae 2a to 2d:



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In Formulae 2a to 2d, Z_1 may be selected from a hydrogen atom, a deuterium, 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 C_6 - C_{20} condensed polycyclic group, a halogen group, a cyano group, a nitro group, a hydroxyl group, and a carboxyl group;

H_1 may be selected from $-\text{O}-$, $-\text{S}-$, and $-\text{CR}_{51}\text{R}_{52}-$; p may be an integer selected from 1 to 9;

R_{51} and R_{52} may be the same as defined in connection with R_1 to R_8 ; and

* indicates a binding site.

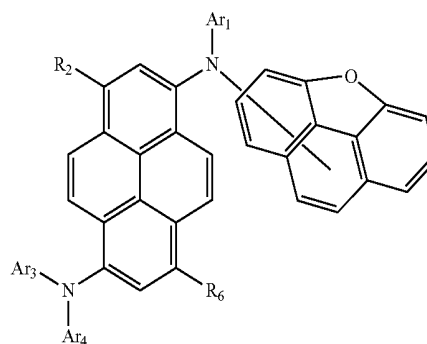
In some embodiments, in Formula 1, R_2 and R_6 may be each independently selected from a hydrogen, a deuterium, a C_1 - C_{20} alkyl group, a C_6 - C_{20} aryl group, and $-\text{Si}(Q_{41})(Q_{42})(Q_{43})$, where Q_{41} to Q_{43} may be each independently selected from a C_1 - C_{60} alkyl group and a C_6 - C_{60} aryl group. In some embodiments, in Formula 1, R_2 and R_6 may be each independently selected from a hydrogen, a deuterium, a methyl group, a t -butyl group, a phenyl group, and a tri-methyl silyl group.

In some embodiments, in Formula 1, R_1 , R_3 to R_5 , R_7 , and R_8 may be each independently selected from a hydrogen and a deuterium.

In some embodiments, in Formula 1-a, R_{11} may be selected from a hydrogen and a deuterium.

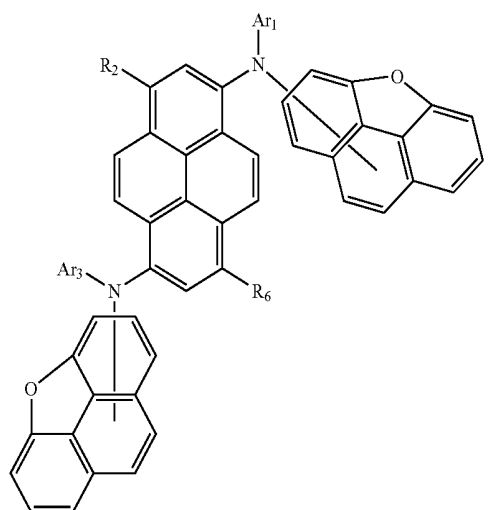
In some embodiments, the compound represented by Formula 1 may be represented by any one of Formula 2 and 3:

Formula 2

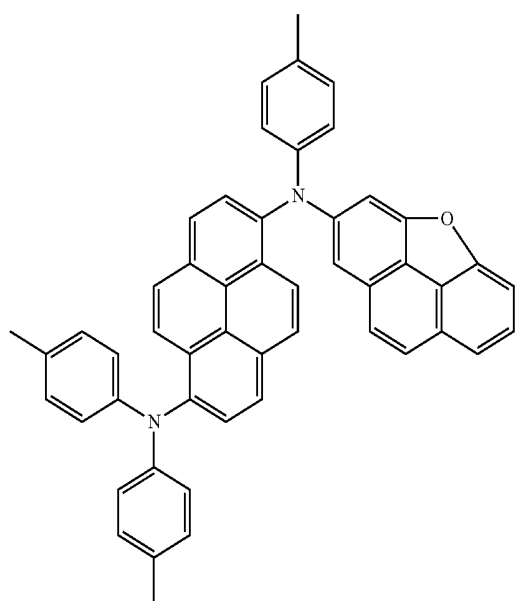
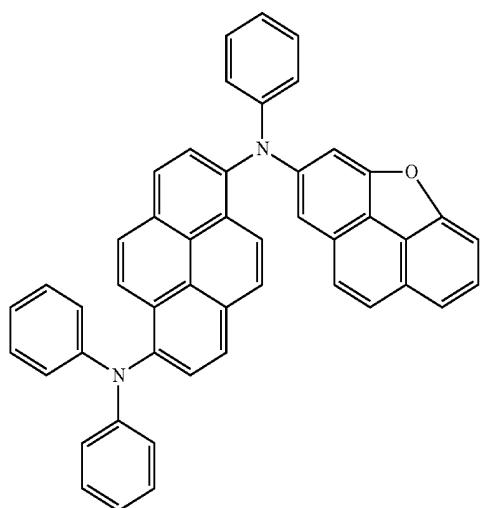


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Formula 3

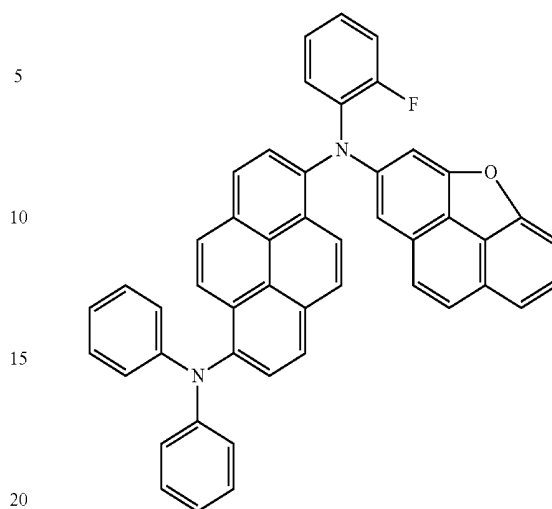


Examples of the compound represented by Formula 1 include compounds shown below, but embodiments of the present invention are not limited thereto.

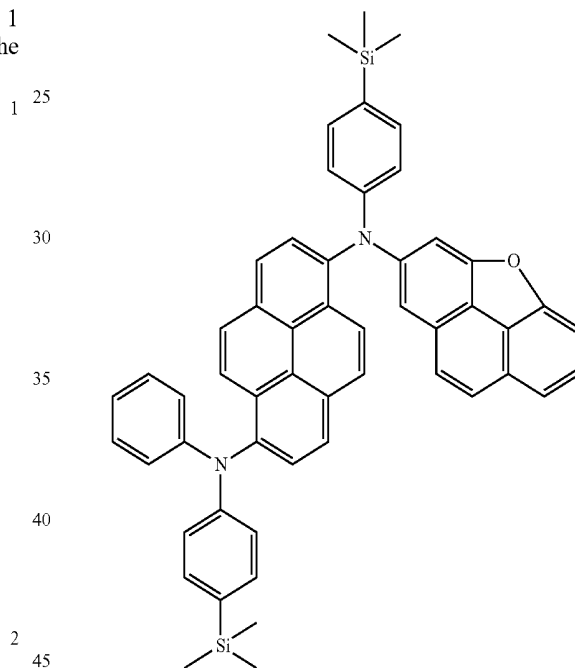


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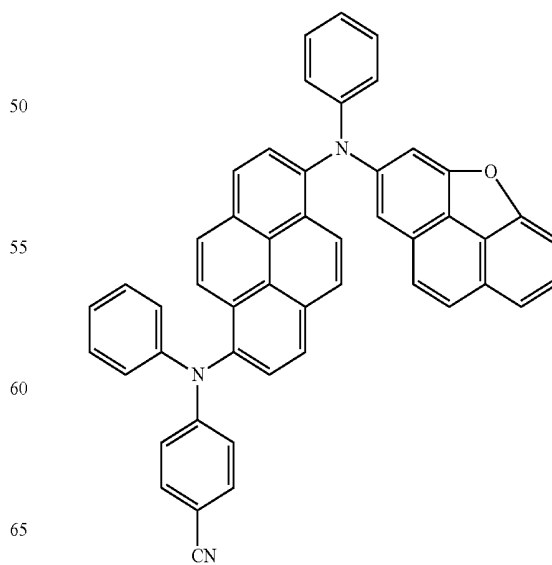
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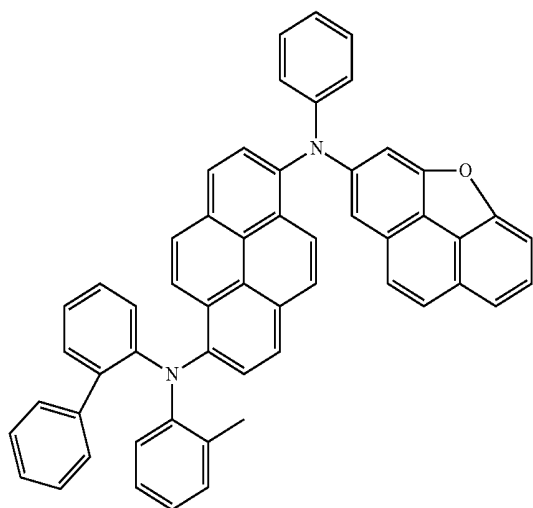
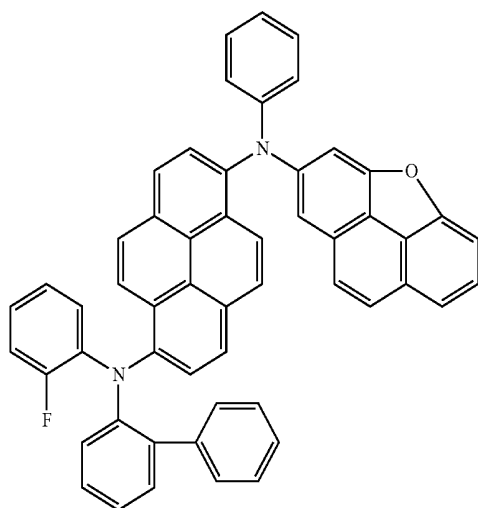
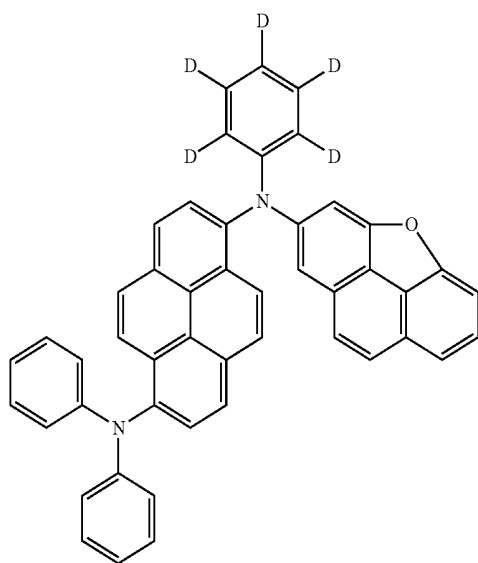


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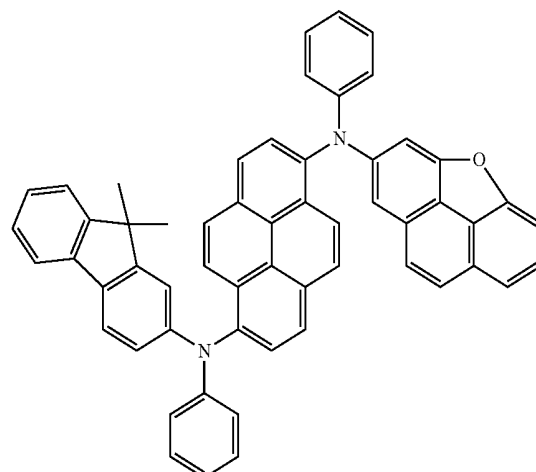
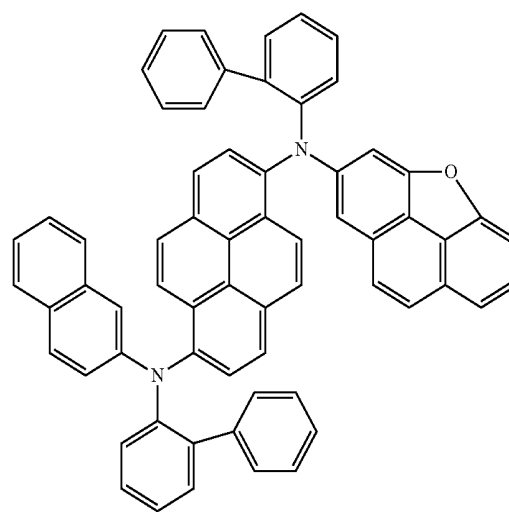
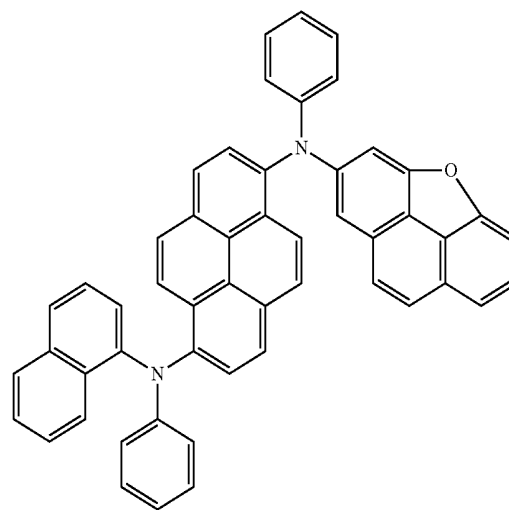
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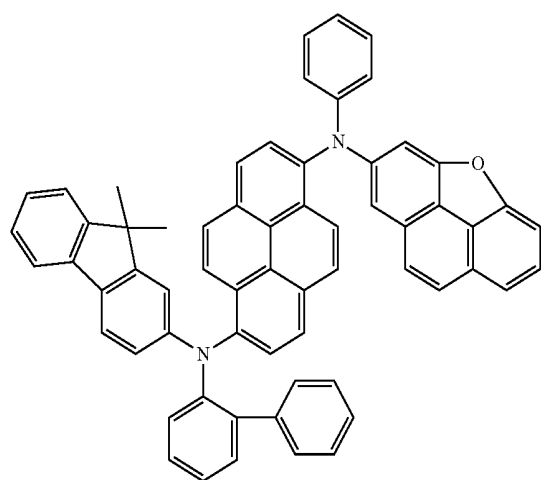
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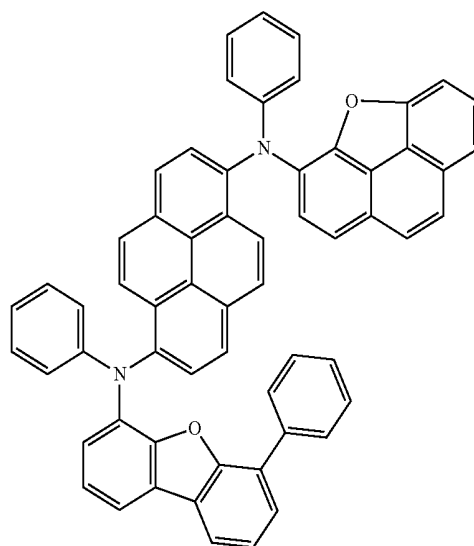
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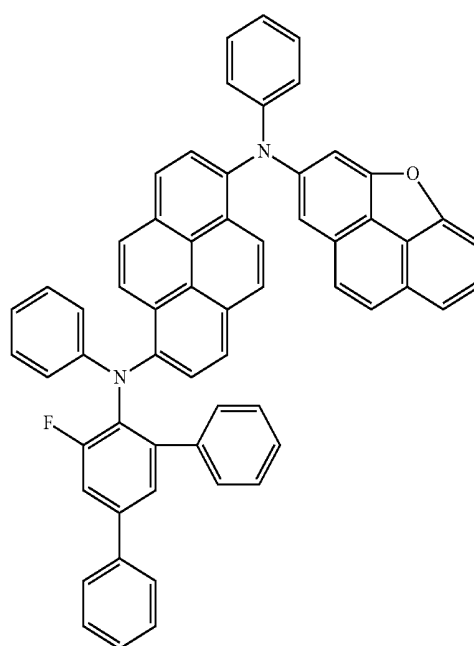
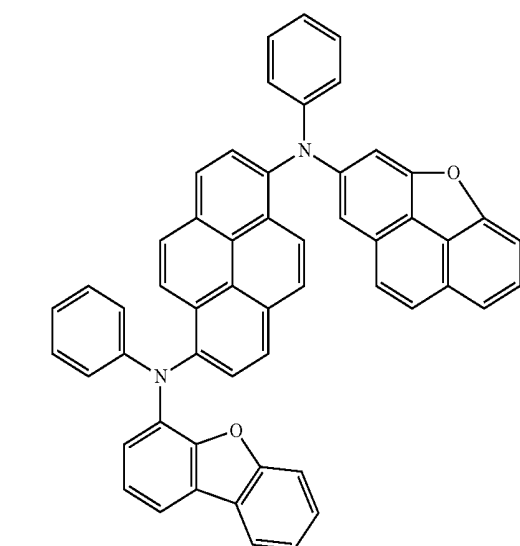
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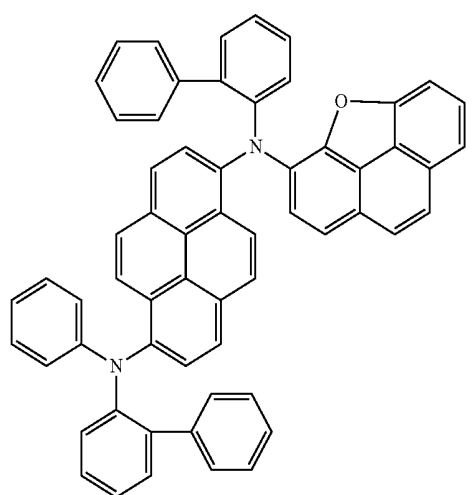
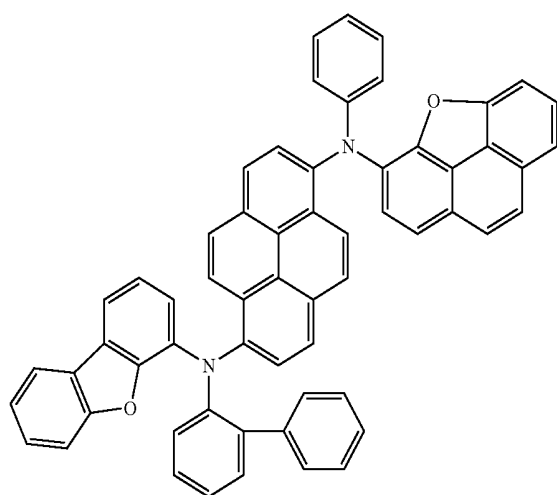
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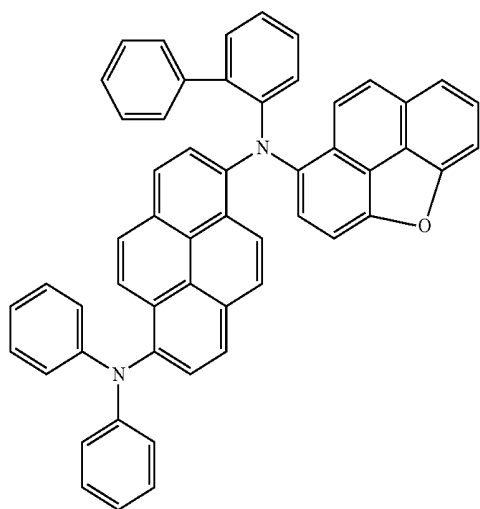
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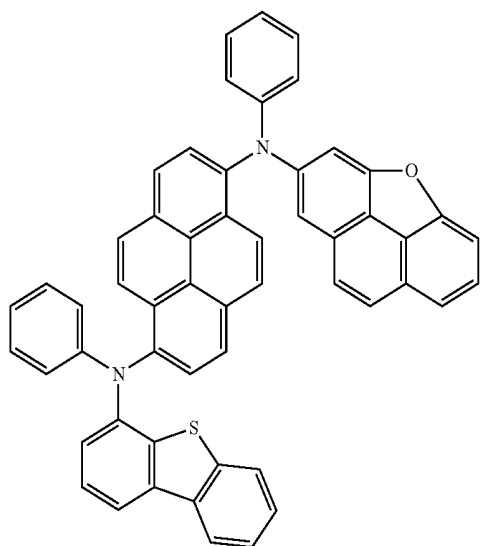
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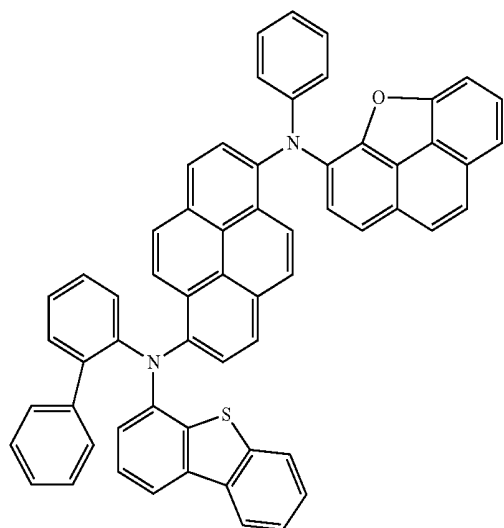
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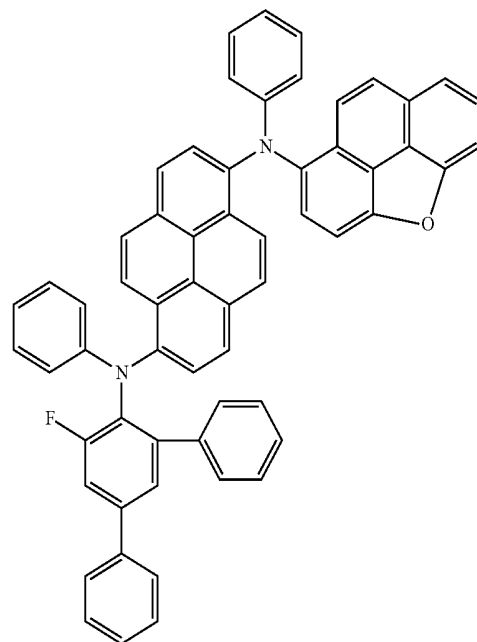
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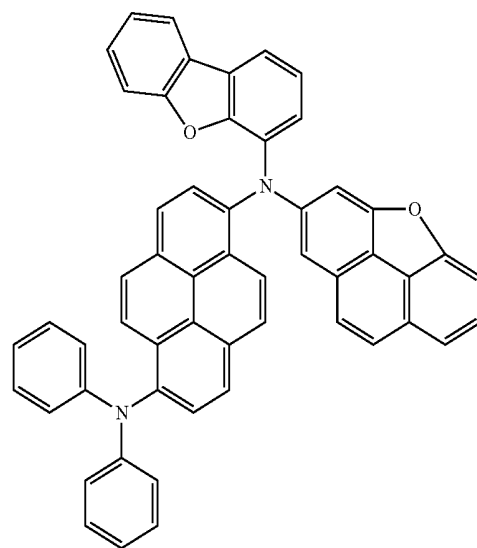
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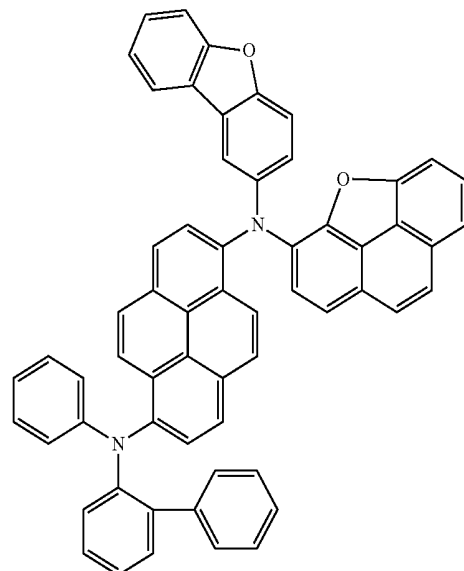
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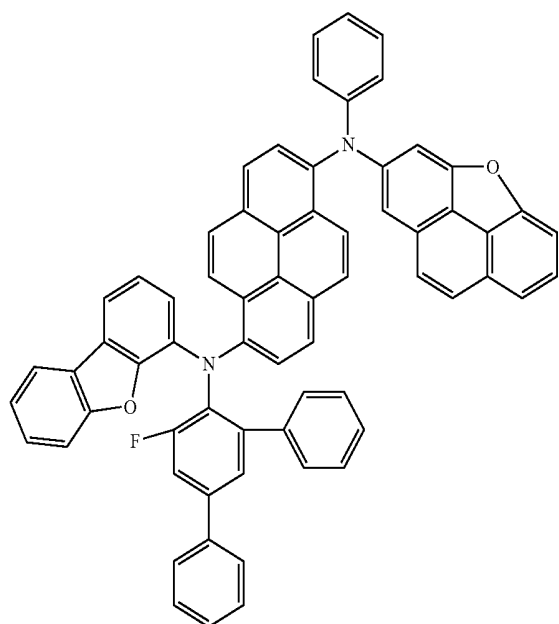
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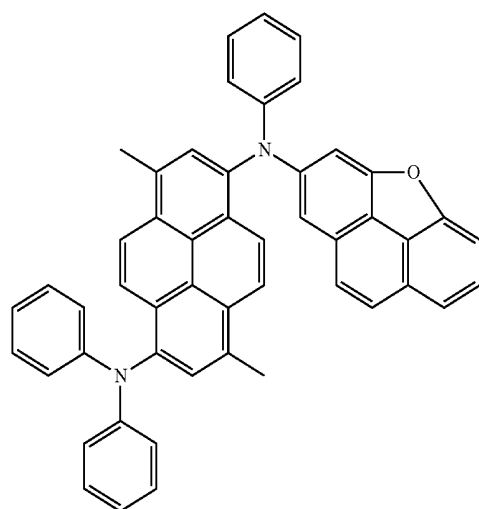
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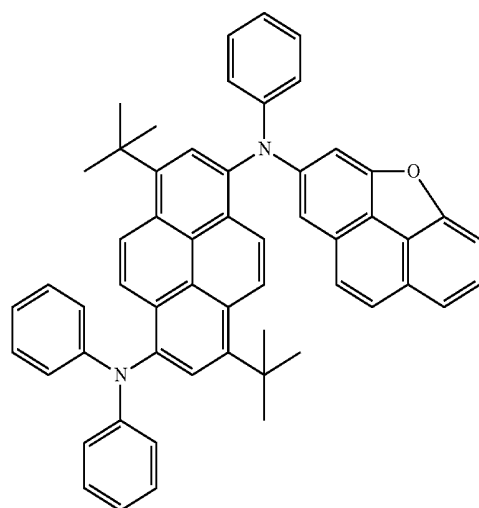
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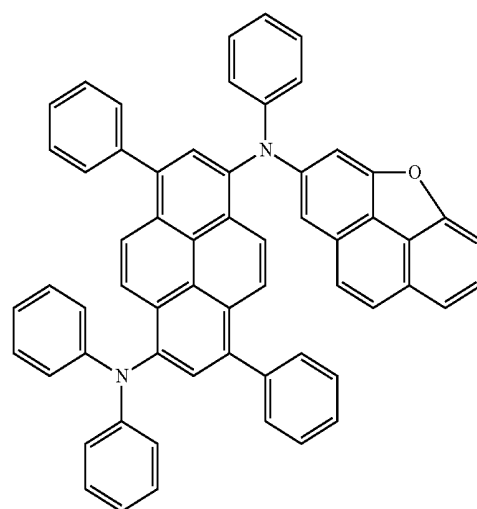
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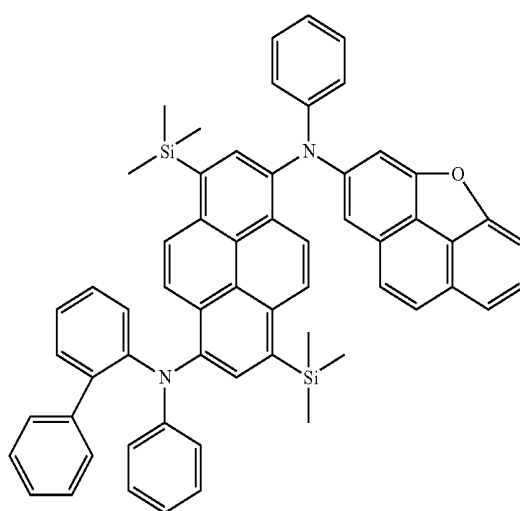
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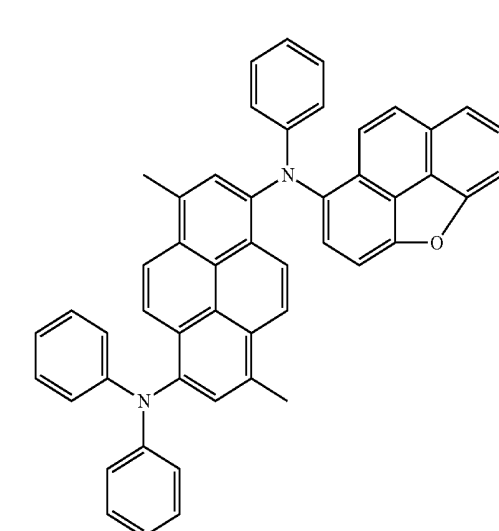
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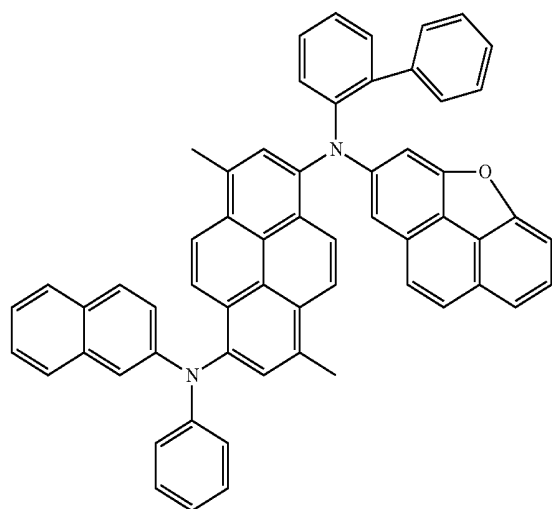
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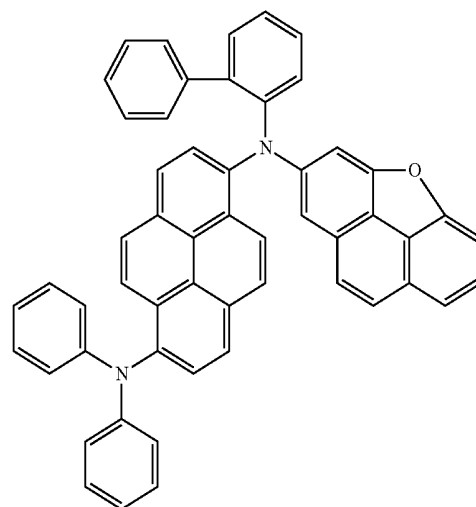
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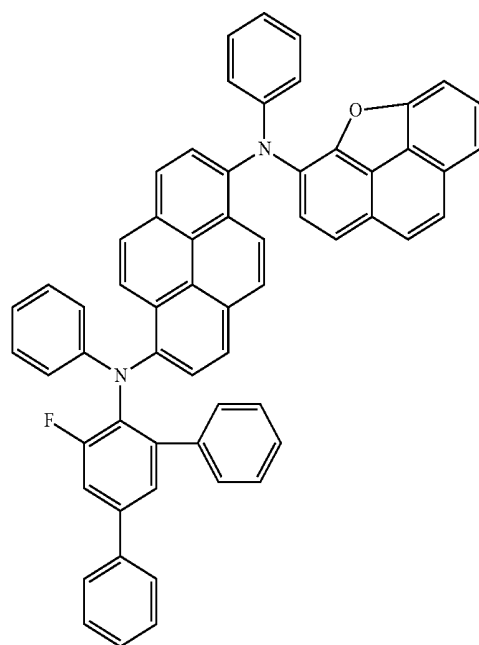
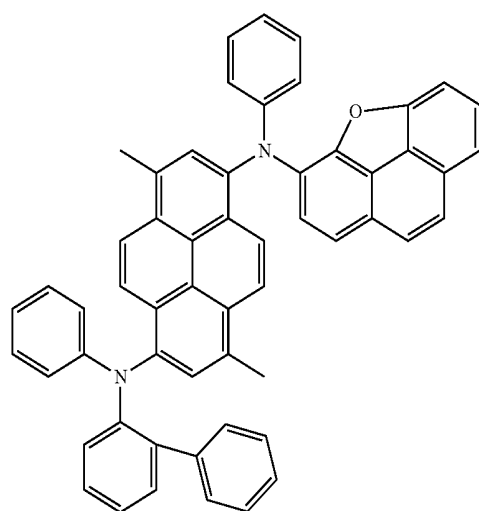
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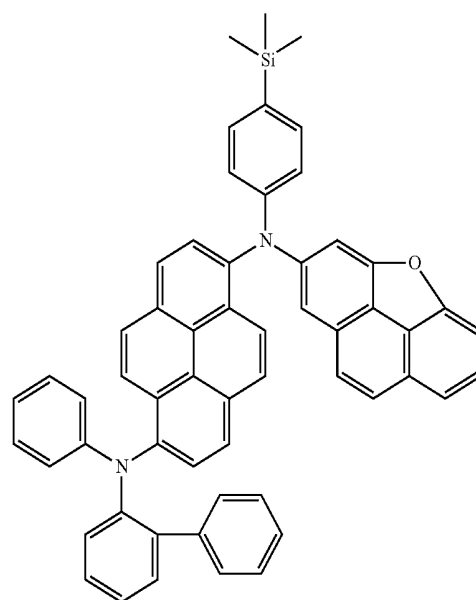
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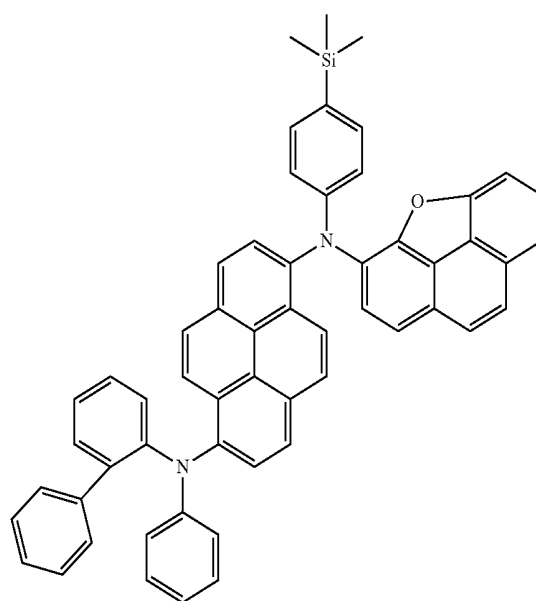
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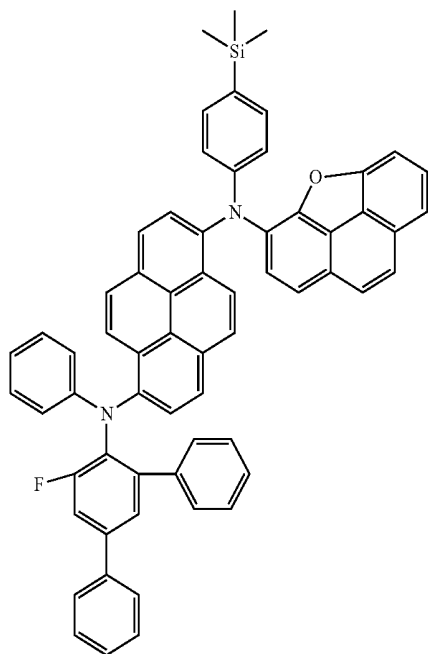


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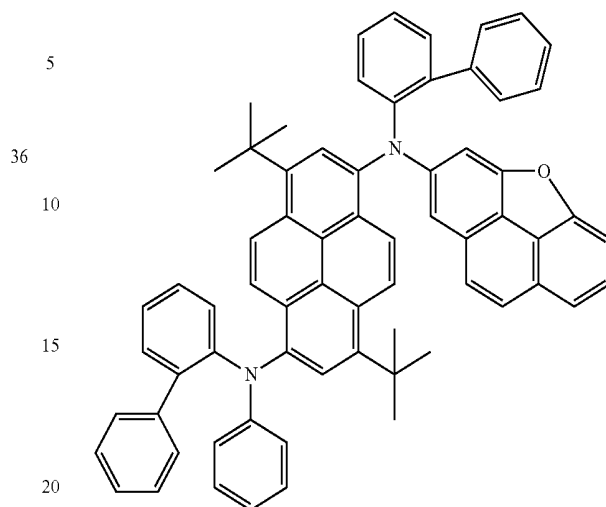
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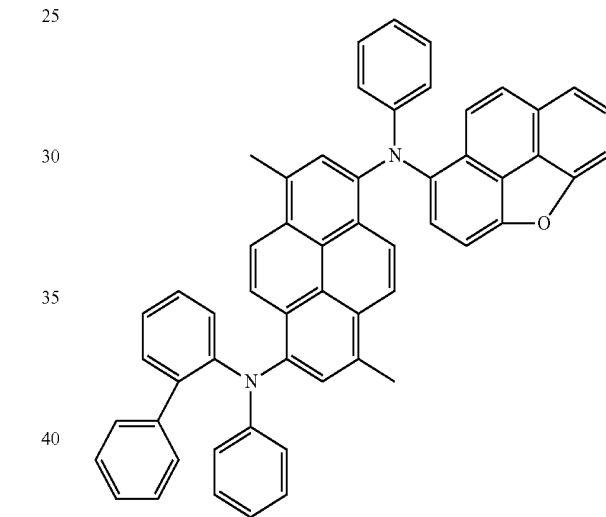
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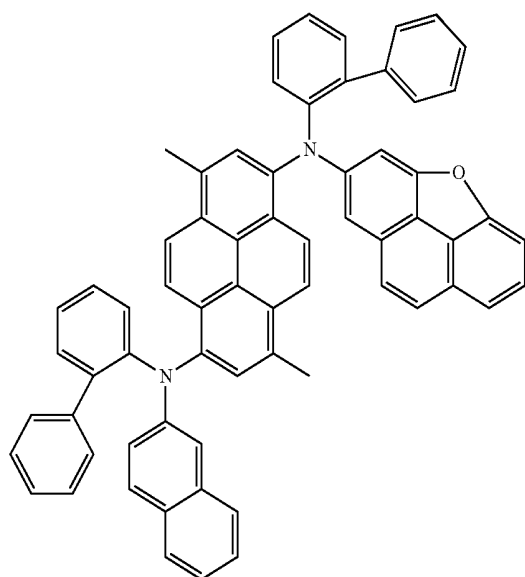


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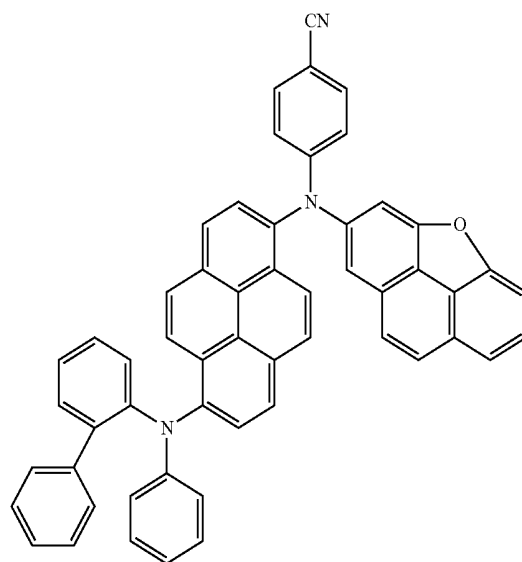


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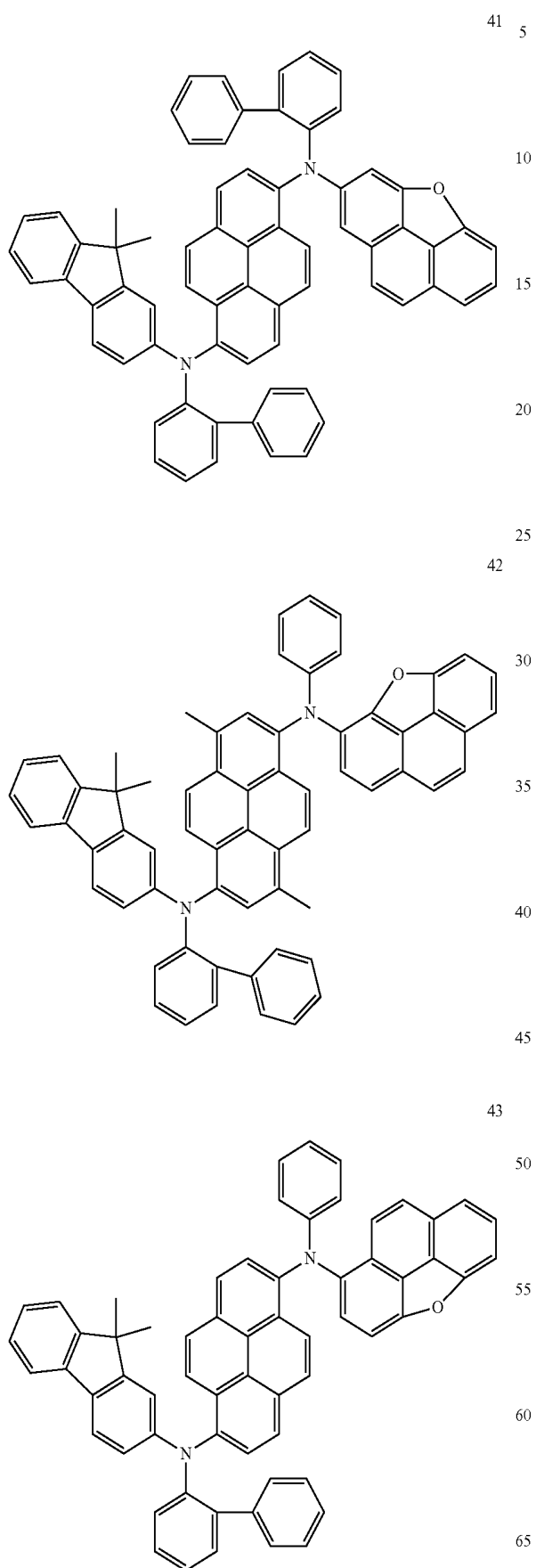
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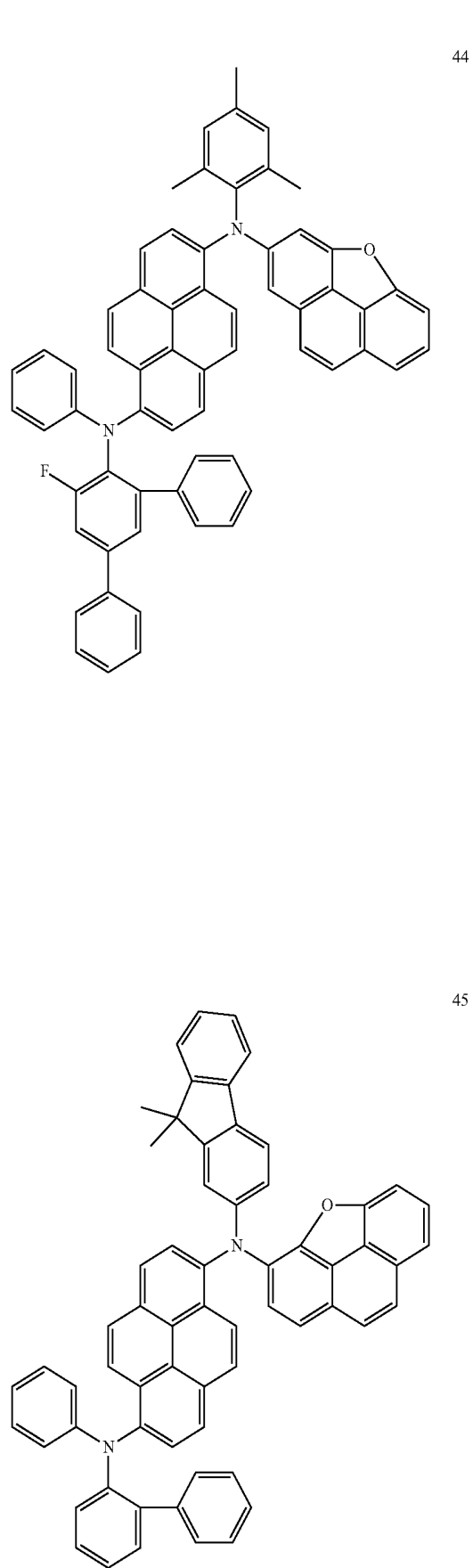


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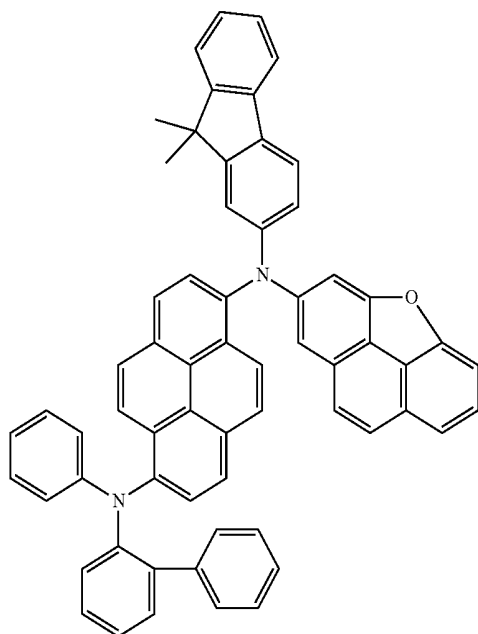
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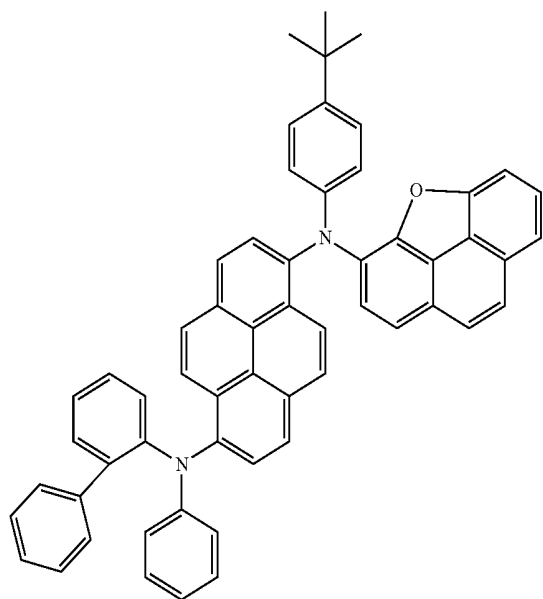
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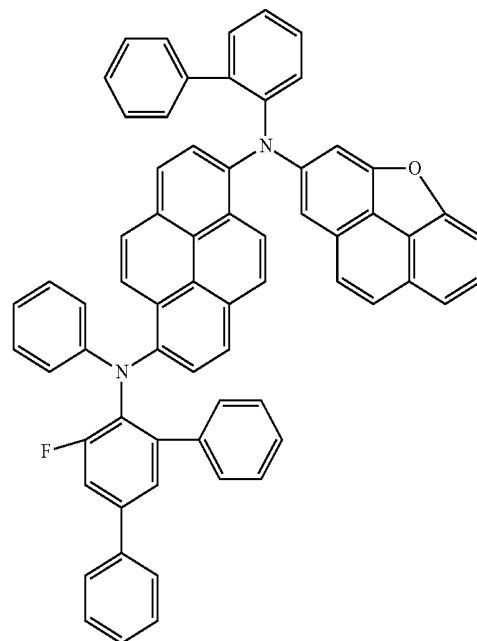
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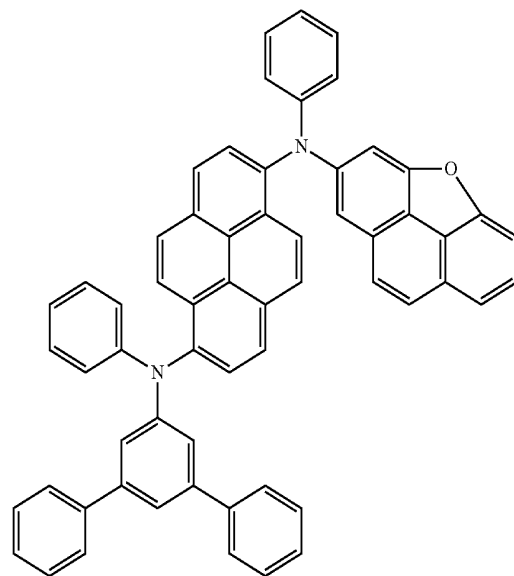
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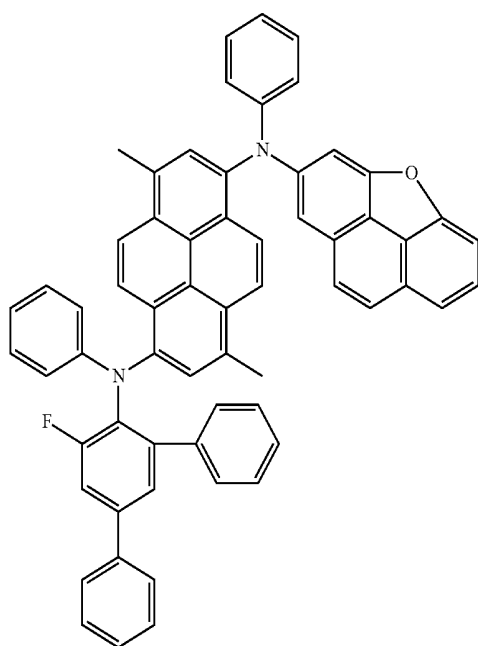
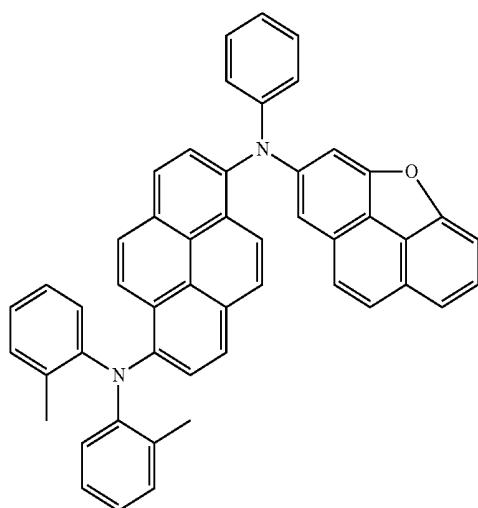
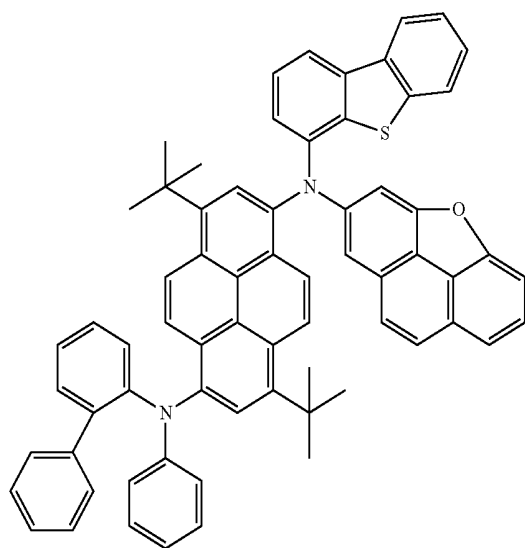
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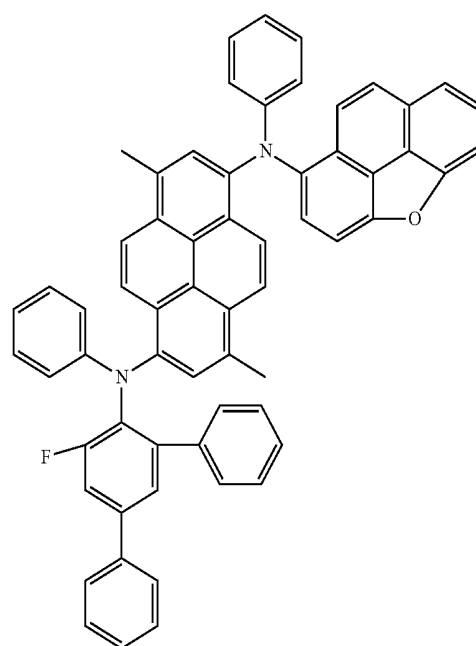
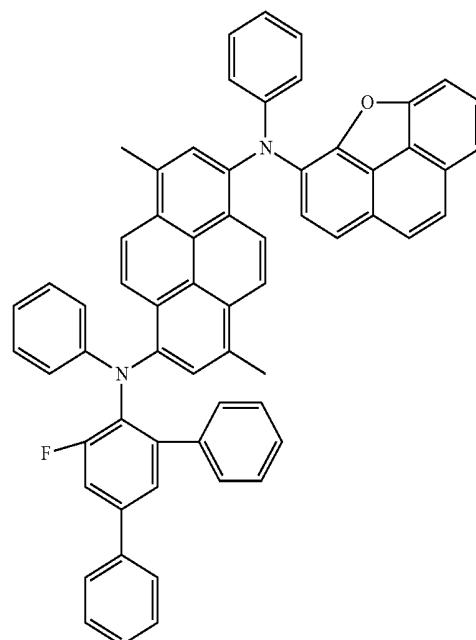


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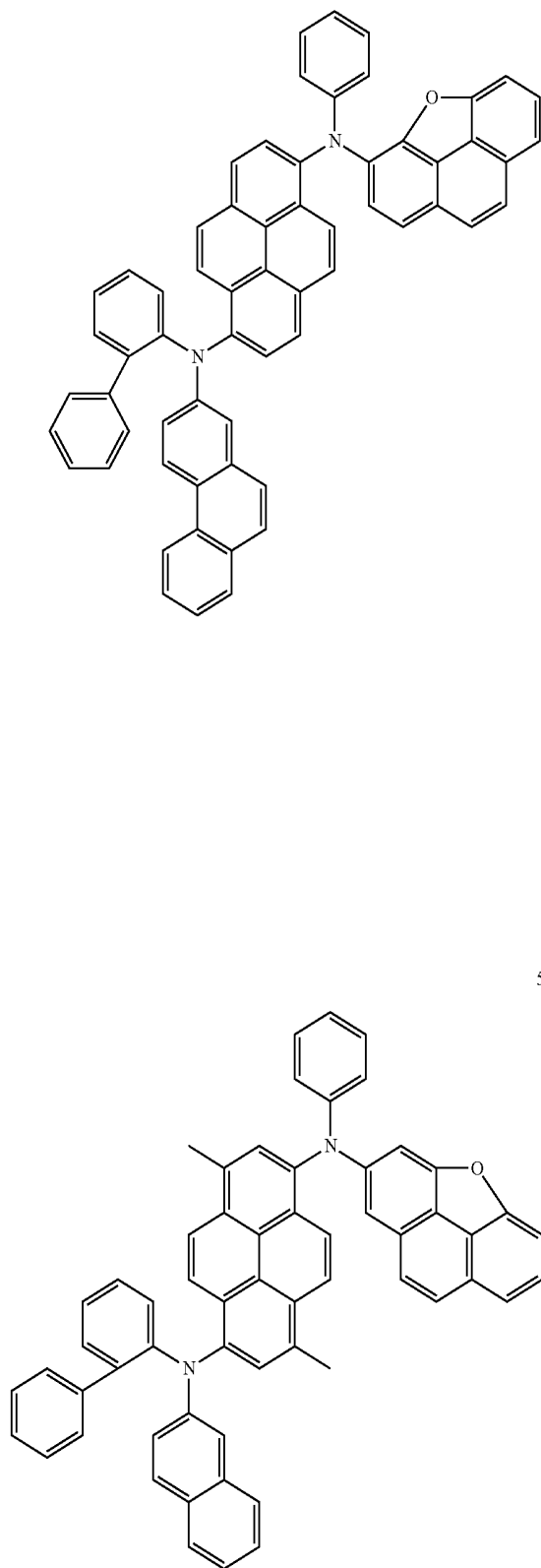
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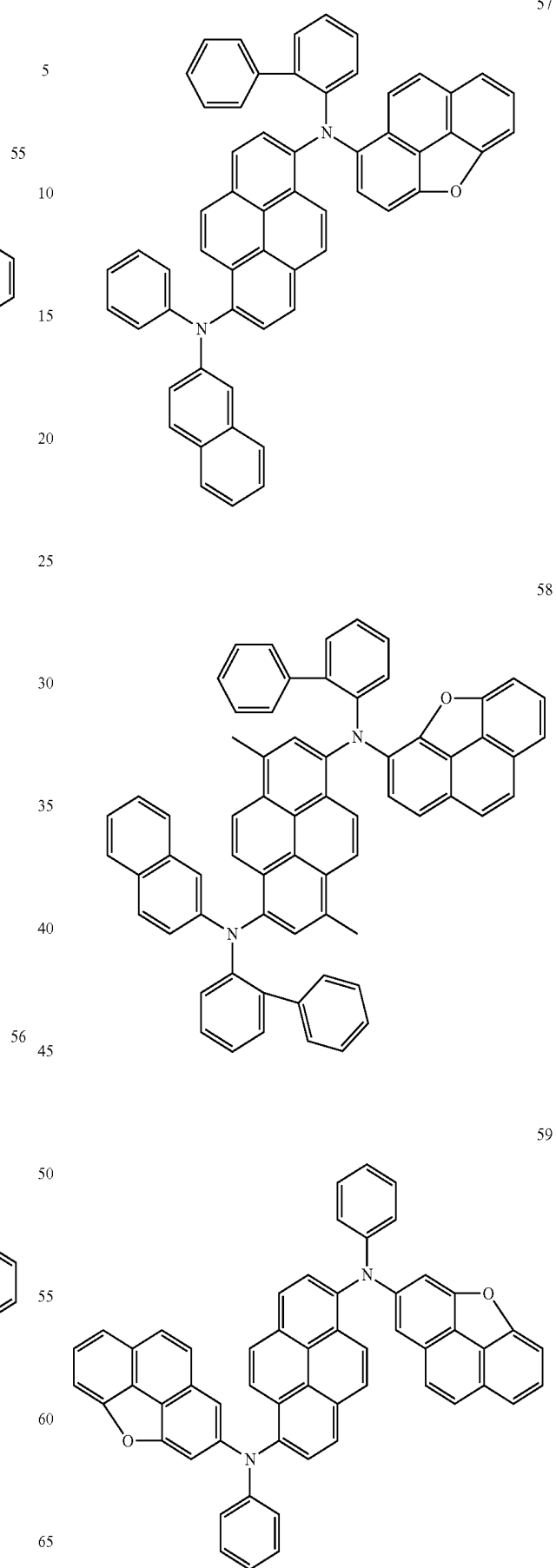


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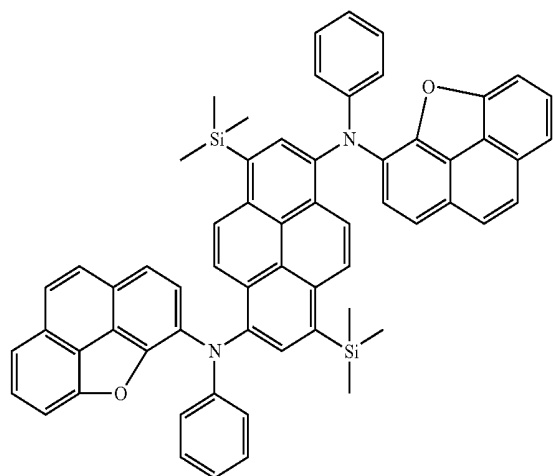
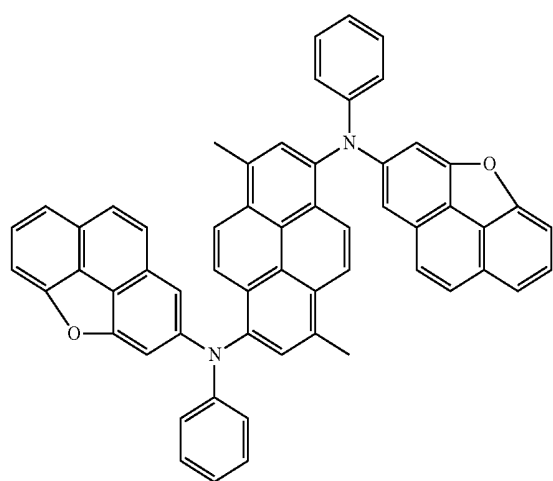
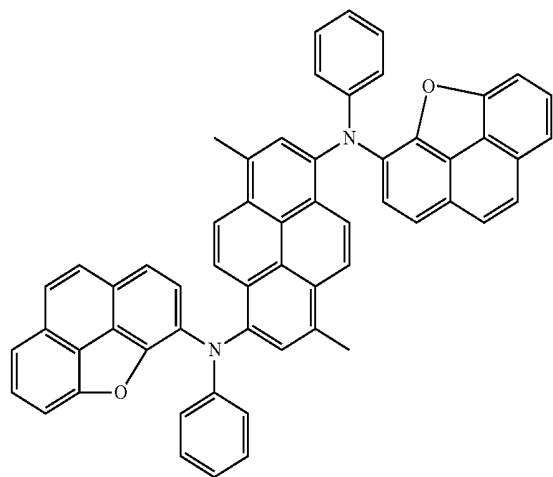
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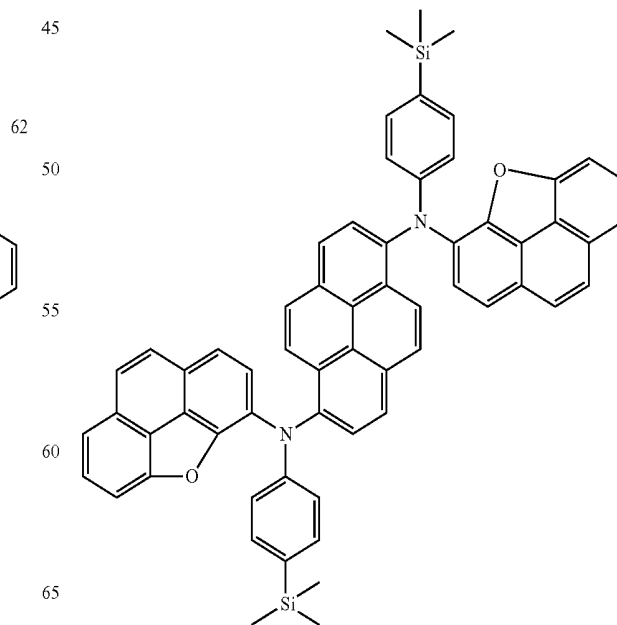
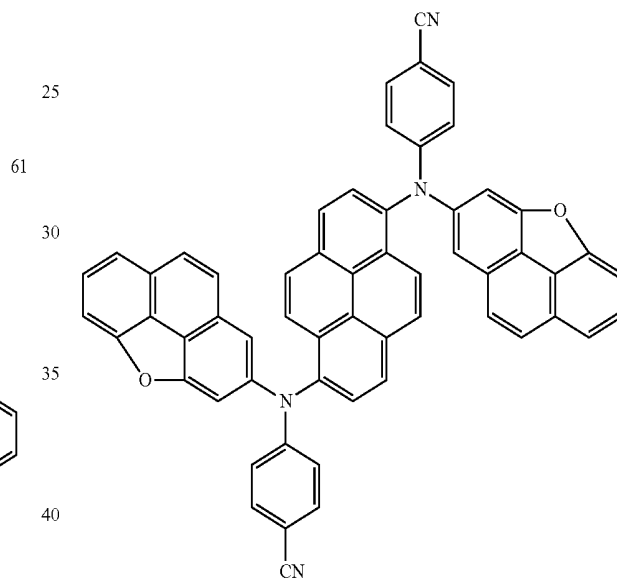
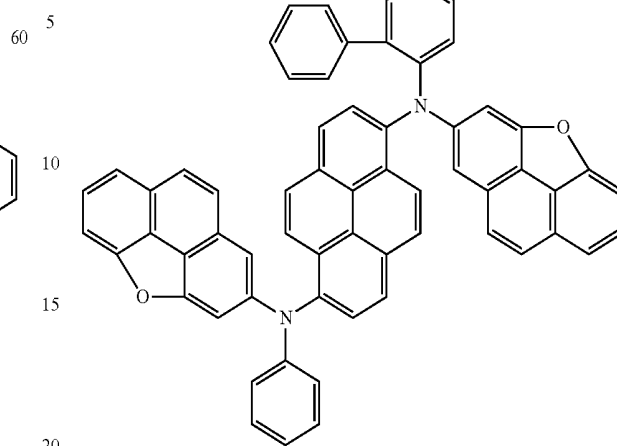
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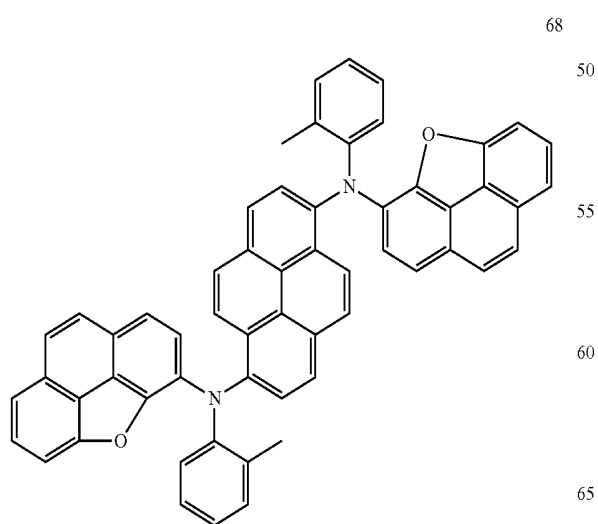
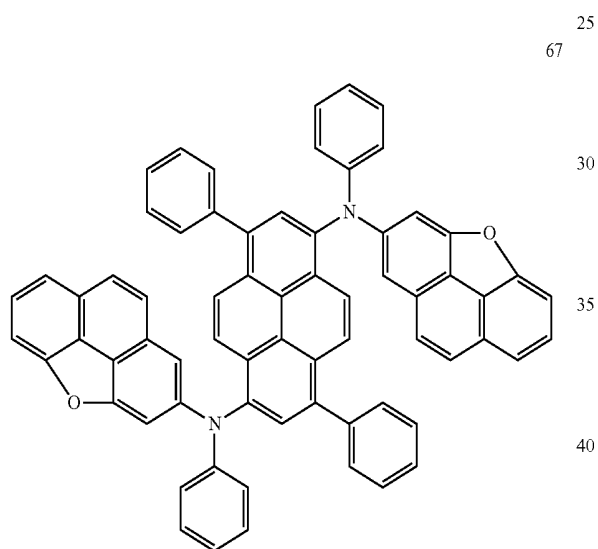
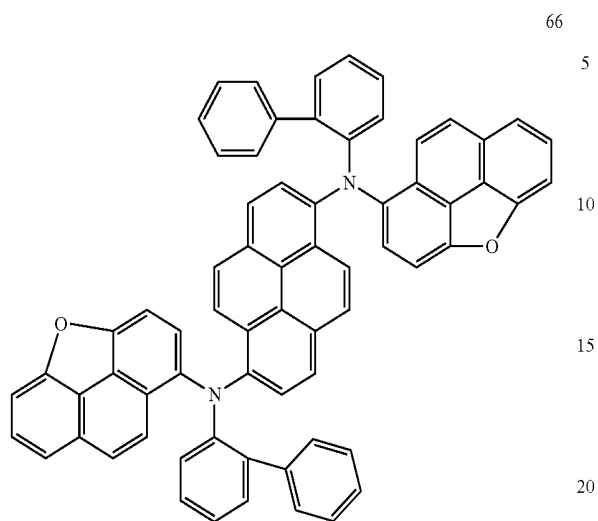
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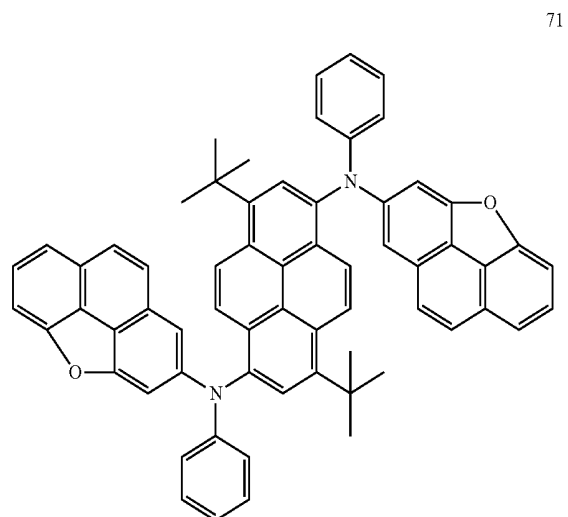
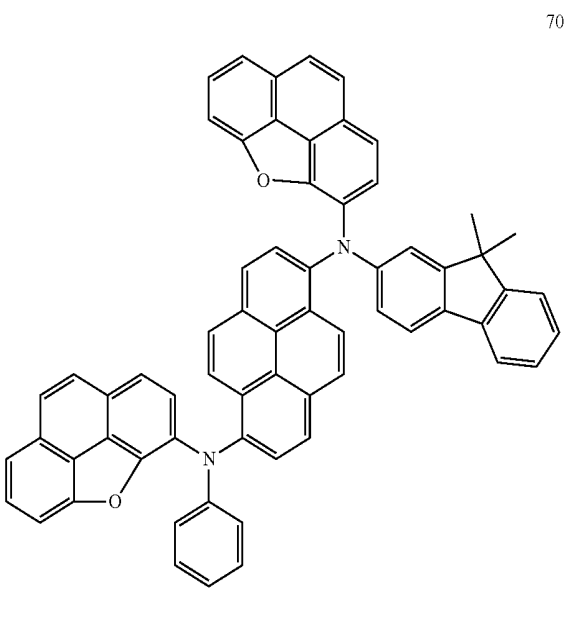
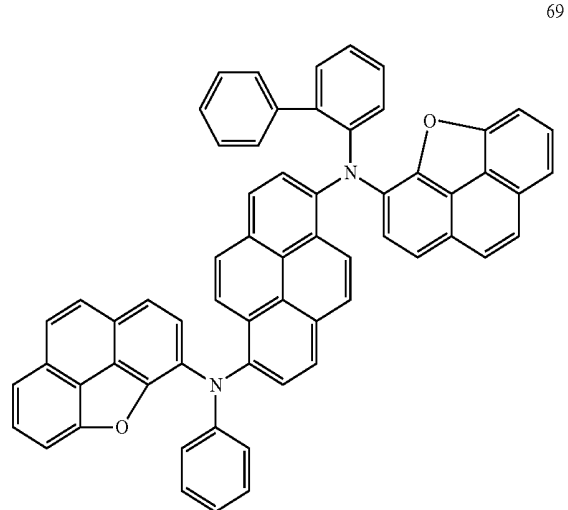


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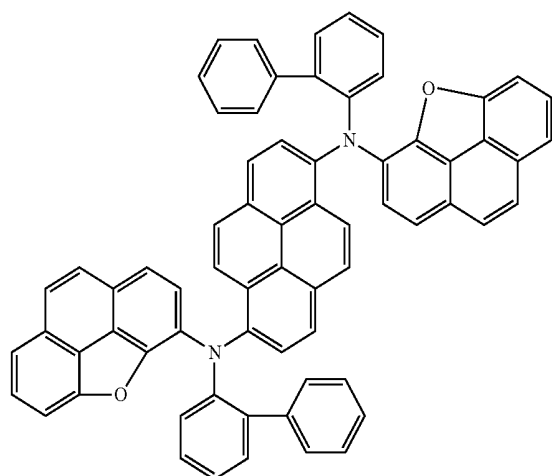
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According to some exemplary embodiments, an organic light-emitting device may include, a first electrode; a second electrode; and an organic layer between the first electrode and the second electrode, wherein the organic layer includes an emission layer and the compound represented by Formula 1.

In some embodiments, the first electrode is an anode, the second electrode is a cathode, and the organic layer may include i) a hole-transport region between the first electrode and the emission layer, the hole-transport region including 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 including at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

According to some embodiments, the emission layer may include the compound according to one or more embodiments of the present invention. When the emission layer includes the compound, the compound may serve as a dopant.

As used herein, the term "organic layer" refers to a single layer and/or a plurality of layers disposed between the first electrode and the second electrode in an organic light-emitting device.

The drawing is a schematic view of an organic light-emitting device 10 according to one or more embodiments of the present invention. The organic light-emitting device 10 includes a first electrode 110, an organic layer 150, and a second electrode 190.

Hereinafter, a structure and a method of manufacturing the organic light-emitting device according to some embodiments will be described with reference to the drawing.

Referring to the drawing, a substrate may be additionally 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 water resistance.

The first electrode 110 may be formed by depositing or sputtering a material for forming the first electrode on the substrate. When the first electrode 110 is an anode, the material for the first electrode may be selected from materials with a high work function such that the holes may be easily injected. The first electrode 110 may be a reflective electrode, a semi-transmissive electrode, or a transmissive

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electrode. The material for the first electrode may be a transparent and highly conductive material, and non-limiting examples of such material include indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), 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, 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 (utilized).

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 invention are not limited thereto.

The organic layer 150 is disposed on the first electrode 110. The organic layer 150 may include an emission layer.

The organic layer 150 may further include a hole transport region between the first electrode and the emission layer, and an electron transport region between the emission layer and the second electrode.

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 embodiments of the present invention are not limited thereto.

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

For example, the hole transport region may have a single-layered structure formed of 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, where the layers of each structure are sequentially stacked from the first electrode 110 in the stated order, but embodiments of the present invention are not limited thereto.

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

When the hole injection layer is formed by vacuum-deposition, for example, the vacuum-deposition may be performed at a deposition 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 $0.01\text{ \AA/sec}$ to about $100\text{ \AA/sec}$, depending on the compound for forming the hole injection layer, and the structure of the hole injection layer to be formed.

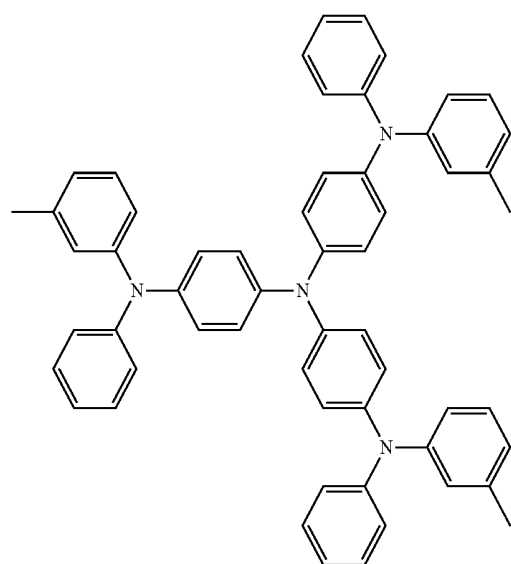
When a hole injection layer is formed by spin coating, the spin coating may be performed at a coating rate of about 2000 rpm to about 5000 rpm, and at a temperature of about 80°C . to 200°C ., depending on the compound for forming the hole injection layer, and the structure of the hole injection layer to be formed.

When the hole transport region includes a hole transport layer, the hole transport layer may be formed on the first

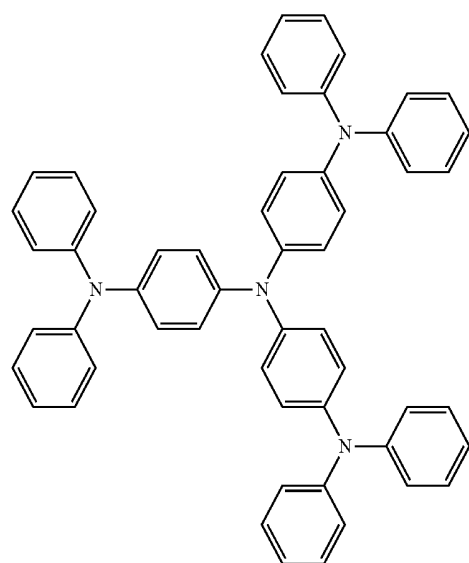
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electrode **110** or the hole injection layer by using one or more suitable methods, such as vacuum-deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, and/or LITI. When the hole transport layer is formed by vacuum-deposition and/or spin coating, conditions for vacuum-deposition and coating may be similar to the above-described vacuum-deposition and coating conditions for forming the hole injection layer.

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:



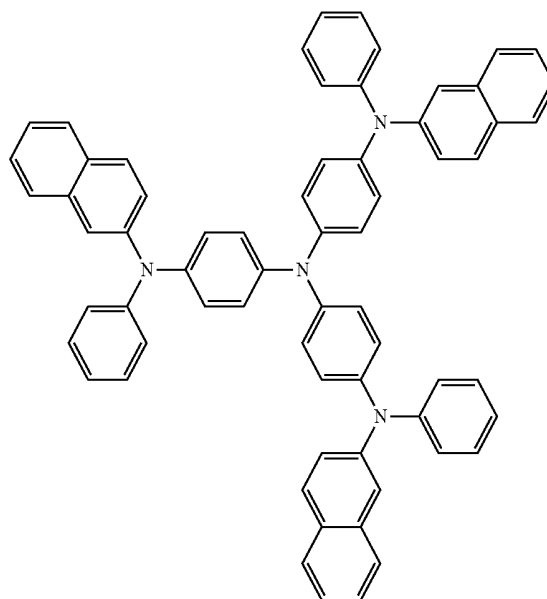
m-MTDATA



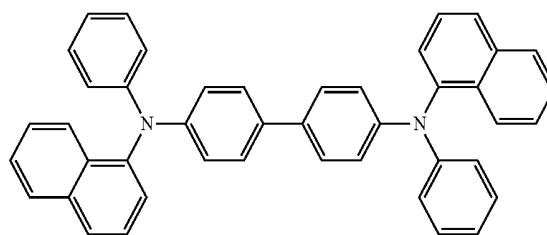
TDATA

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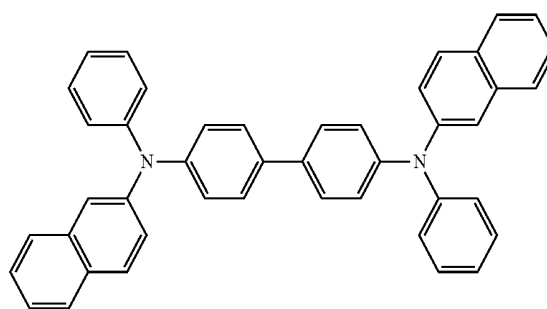
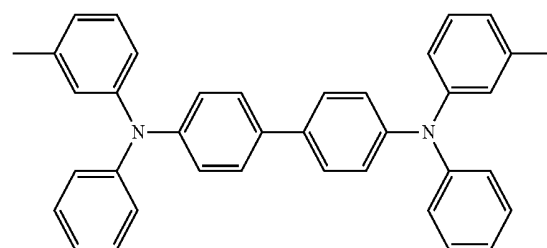
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2-TNATA



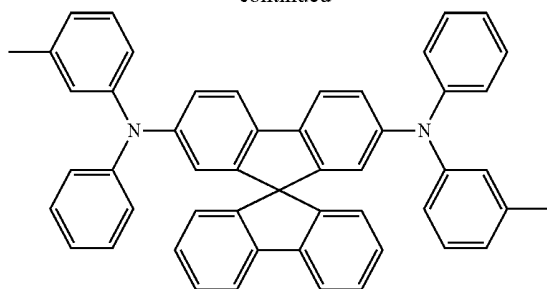
NPB

 β -NPB

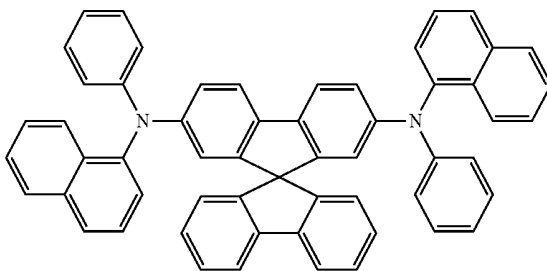
TPD

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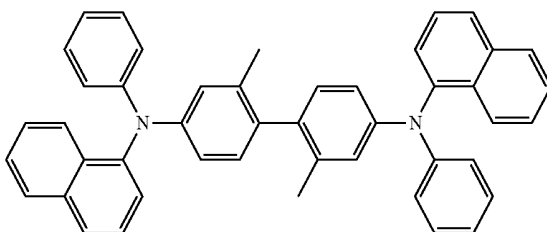
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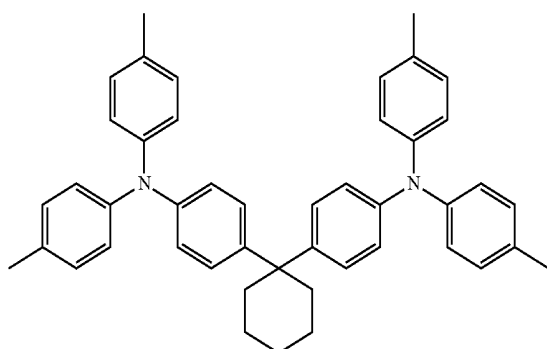
Spiro-TPD



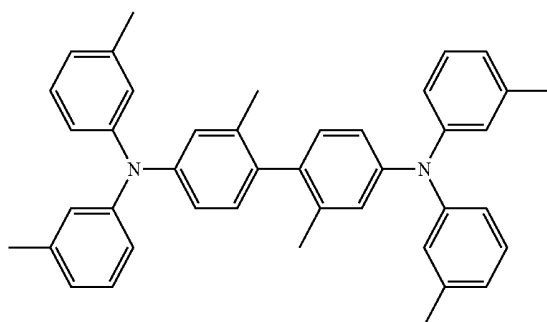
Spiro-NPB



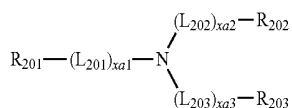
methylated NPB



TAPC



HMTDP

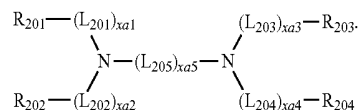


Formula 201

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Formula 202



In Formulae 201 and 202,

L_{201} and L_{205} may be each independently selected from a substituted or unsubstituted $\text{C}_3\text{-C}_{10}$ cycloalkylene group, a substituted or unsubstituted $\text{C}_2\text{-C}_{10}$ heterocycloalkylene group, a substituted or unsubstituted $\text{C}_3\text{-C}_{10}$ cycloalkenylene group, a substituted or unsubstituted $\text{C}_2\text{-C}_{10}$ heterocycloalkenylene group, a substituted or unsubstituted $\text{C}_6\text{-C}_{60}$ arylene group, a substituted or unsubstituted $\text{C}_1\text{-C}_{60}$ heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group;

x_{a1} to x_{a4} may be each independently selected from 0, 1, 2, and 3; and

x_{a5} may be selected from 1, 2, 3, 4, and 5;

R_{201} to R_{204} may be each independently selected from a substituted or unsubstituted $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a substituted or unsubstituted $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a substituted or unsubstituted $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a substituted or unsubstituted $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a substituted or unsubstituted $\text{C}_6\text{-C}_{60}$ aryl group, a substituted or unsubstituted $\text{C}_6\text{-C}_{60}$ aryloxy group, a substituted or unsubstituted $\text{C}_6\text{-C}_{60}$ arylthio group, a substituted or unsubstituted $\text{C}_1\text{-C}_{60}$ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

In some embodiments, in Formulae 201 and 202,

L_{201} to L_{205} may be each independently selected from:

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; and

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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

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xa1 to xa4 may be each independently selected from 0, 1, and 2;

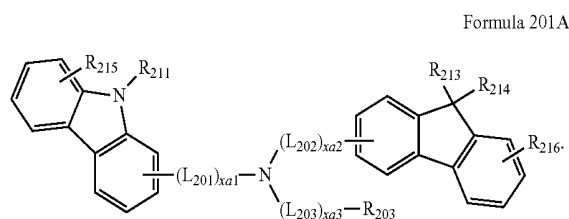
xa5 may be selected from 1, 2, and 3;

R₂₀₁ to R₂₀₄ may be each independently selected from:

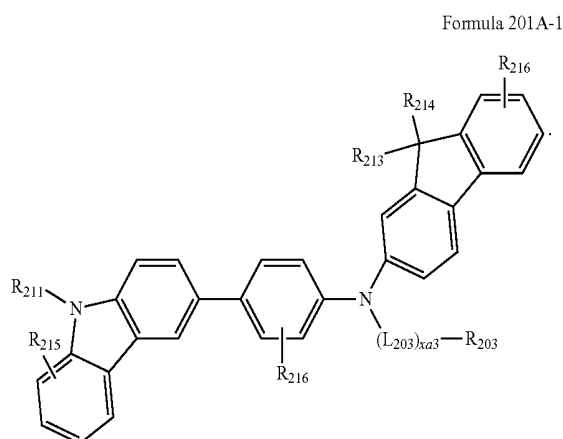
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzo-fluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzo-fluorenyl 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, an azulenyl 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, and a triazinyl group; but embodiments of the present invention are not limited thereto.

The compound represented by Formula 201 may be represented by Formula 201A:



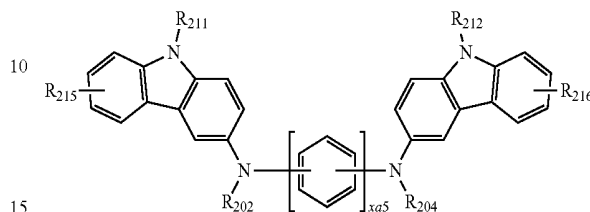
In some embodiments, the compound represented by Formula 201 may be represented by Formula 201A-1, but embodiments of the present invention are not limited thereto:



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In some embodiments, the compound represented by Formula 202 may be represented by Formula 202A, but embodiments of the present invention are not limited thereto:

Formula 202A



In Formulae 201A, 201A-1, and 202A, L₂₀₁ to L₂₀₃, xa1 to xa3, xa5, and R₂₀₂ to R₂₀₄ may be understood by referring to the descriptions provided herein, and R₂₁₁ may be the same as defined in connection with R₂₀₃; and R₂₁₃ to R₂₁₆ may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, and a monovalent non-aromatic condensed heteropolycyclic group.

In some embodiments, in Formulae 201A-1 and 202A, L₂₀₁ to L₂₀₃ may be each independently selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylenylene group, a pyrazinylenylene group, a pyrimidinylenylene group, a pyridazinylenylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group; and

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylenylene group, a pyrazinylenylene group, a pyrimidinylenylene group, a pyridazinylenylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group, each substituted with at least one selected from a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, 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 quinazolinyl group, a carbazolyl group, and a triazinyl group;

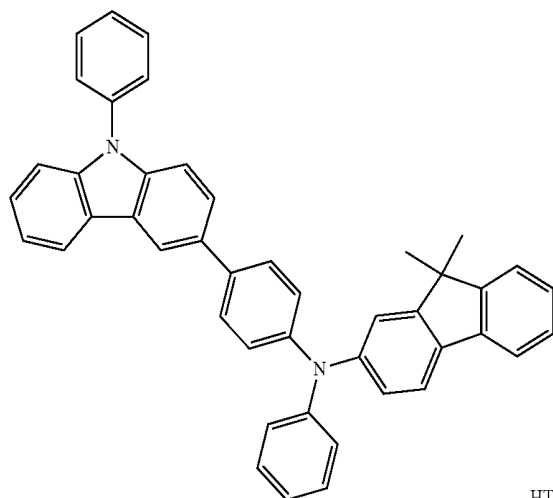
xa1 to xa3 may be each independently selected from 0 and 1;

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HT1



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HT2

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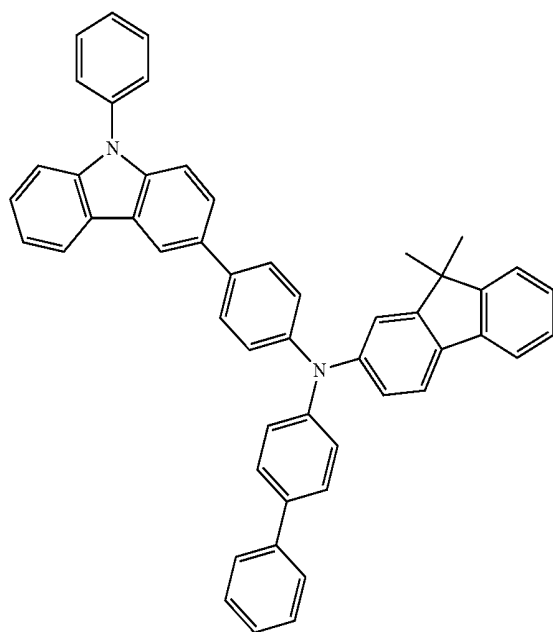
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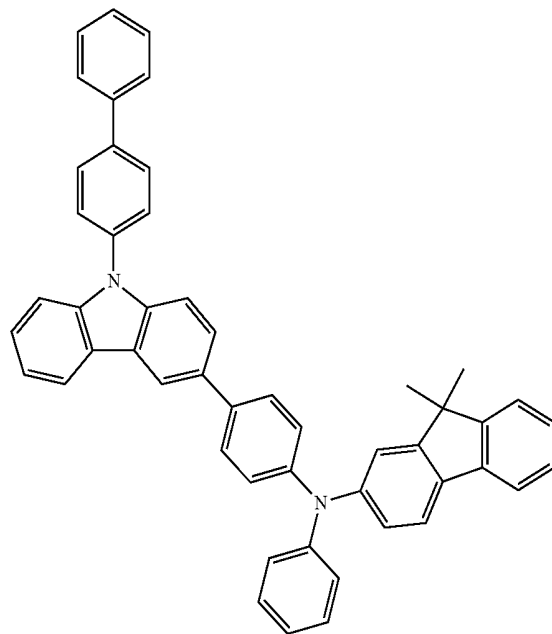
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HT3

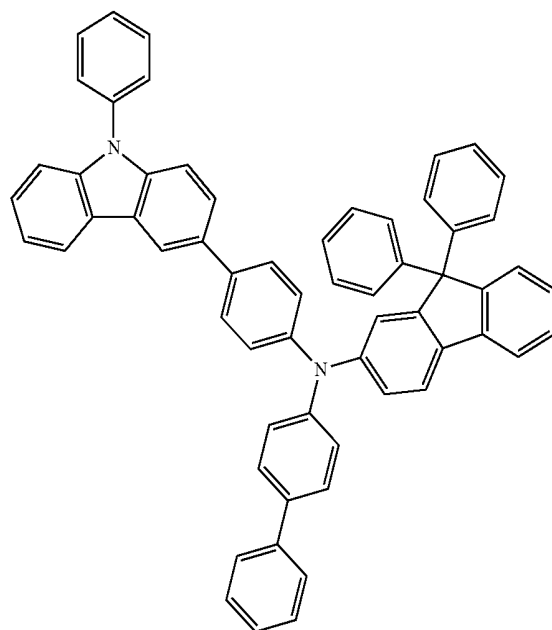


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HT4



HT5



47

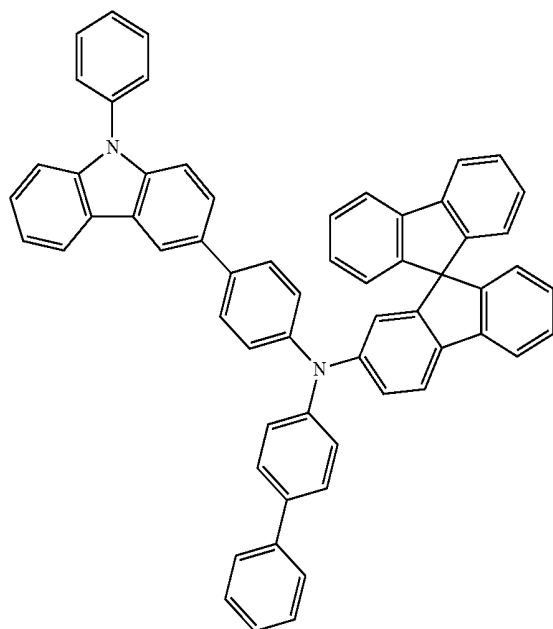
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HT6



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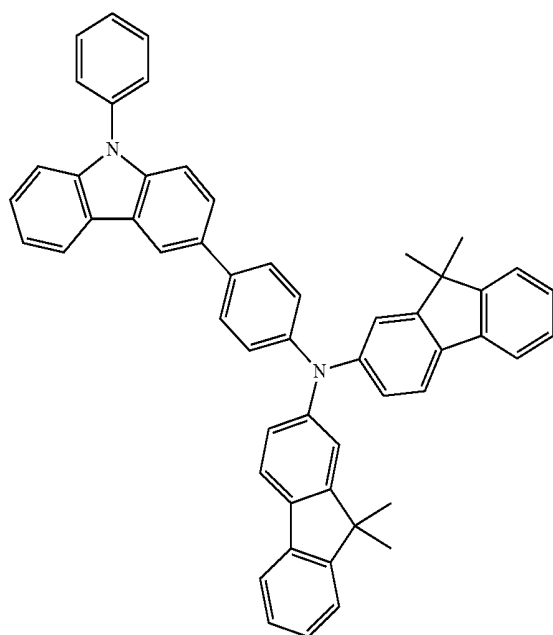
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HT7



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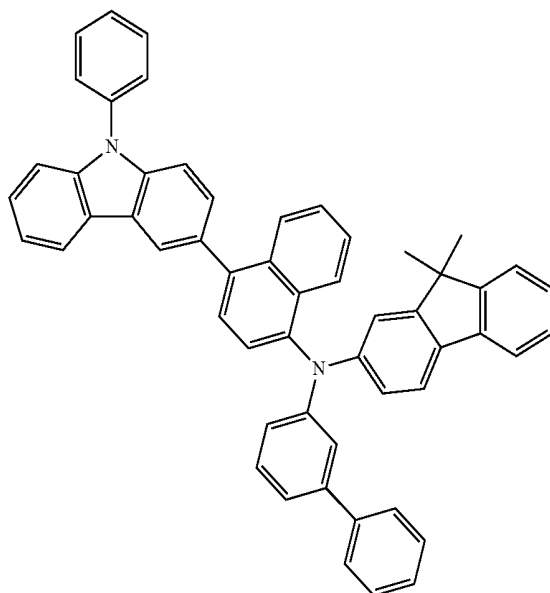
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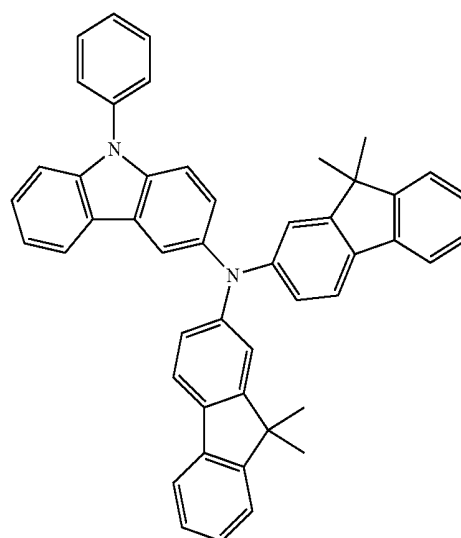
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HT8

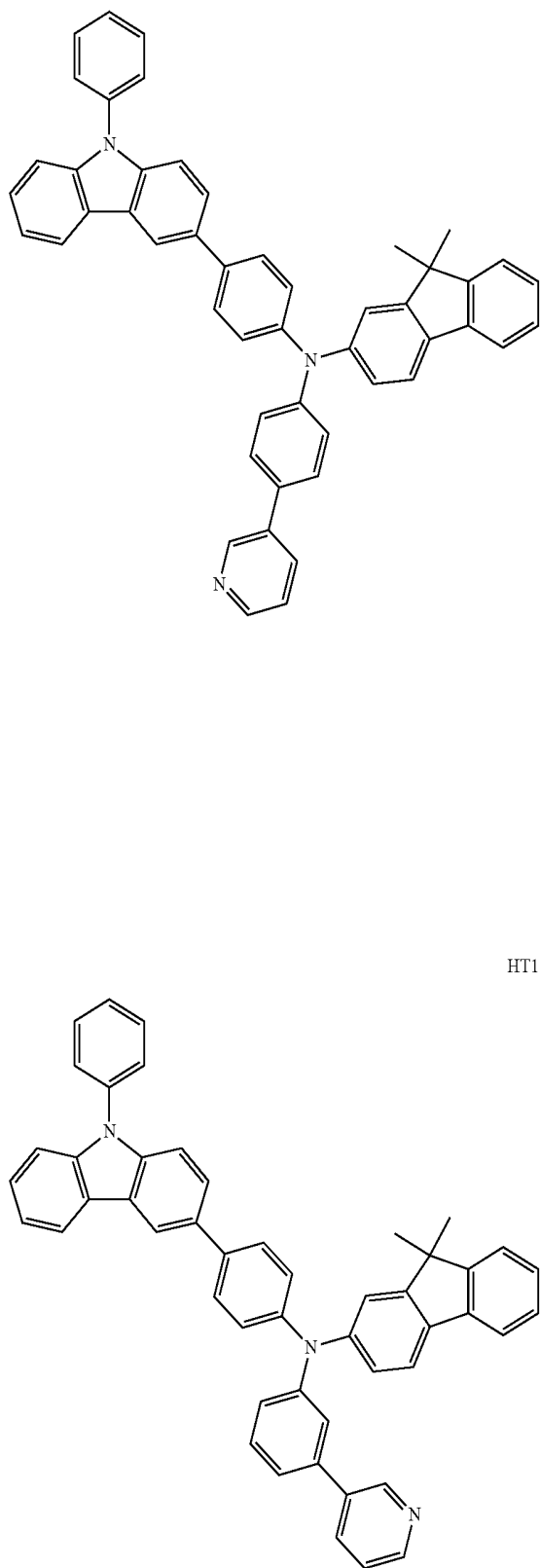


HT9



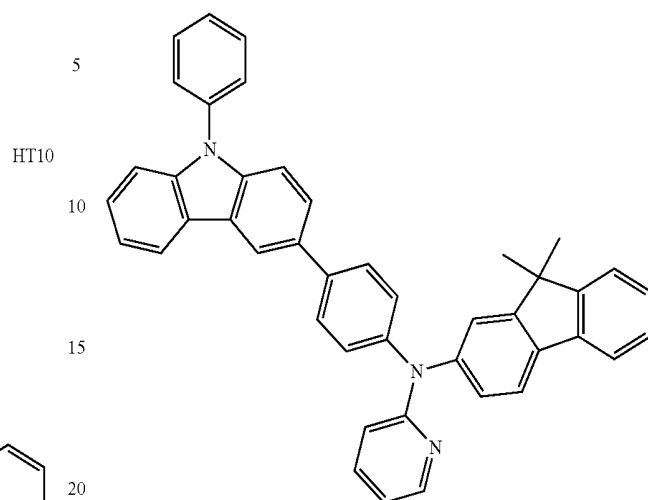
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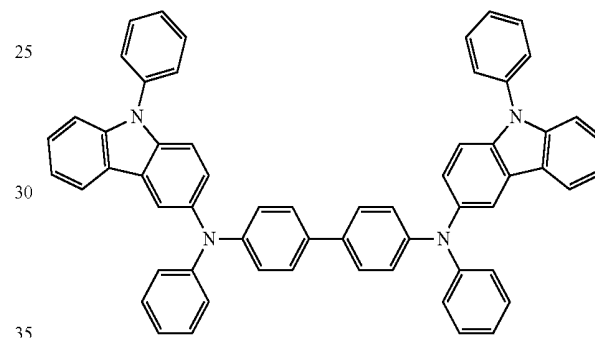
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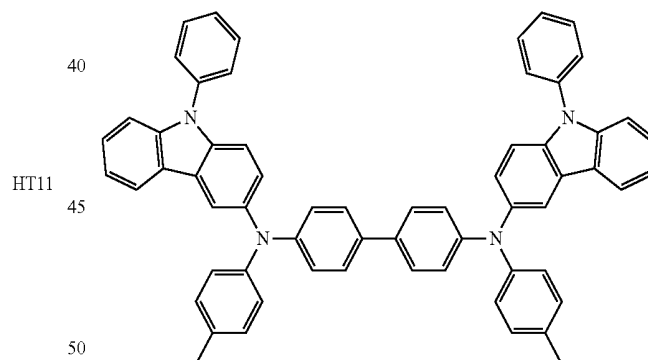
HT12



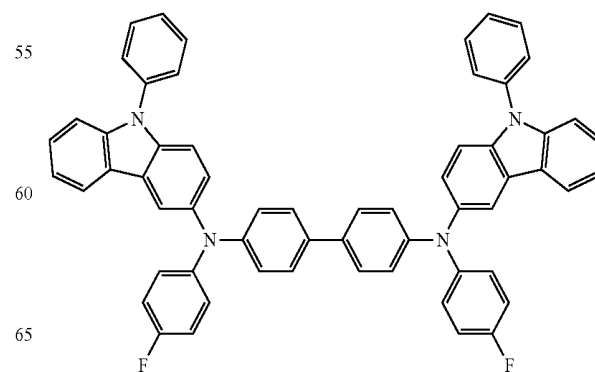
HT13



HT14

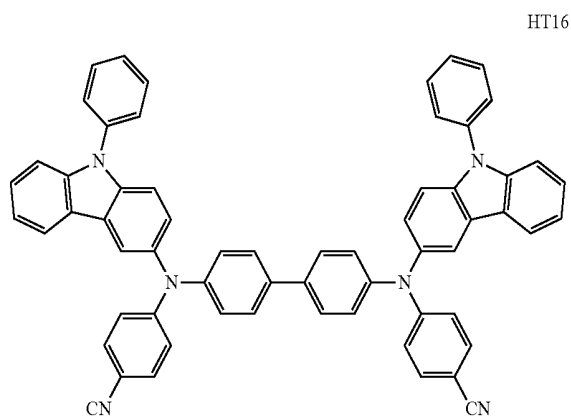


HT15



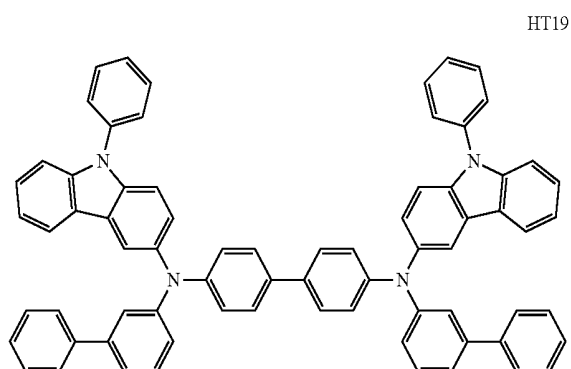
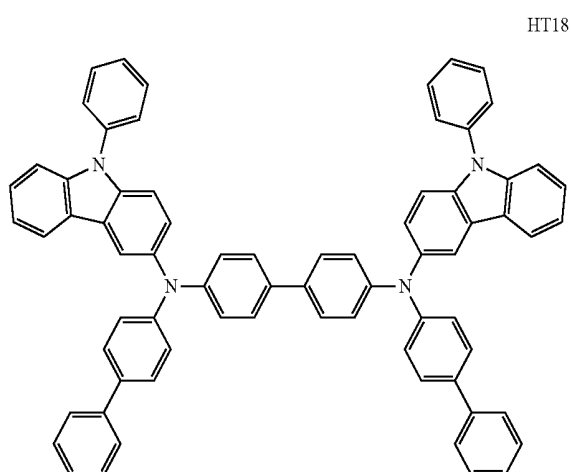
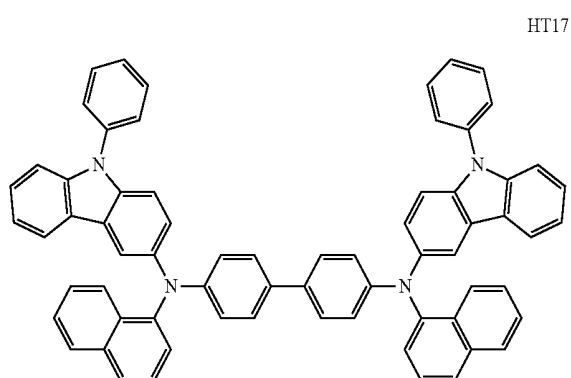
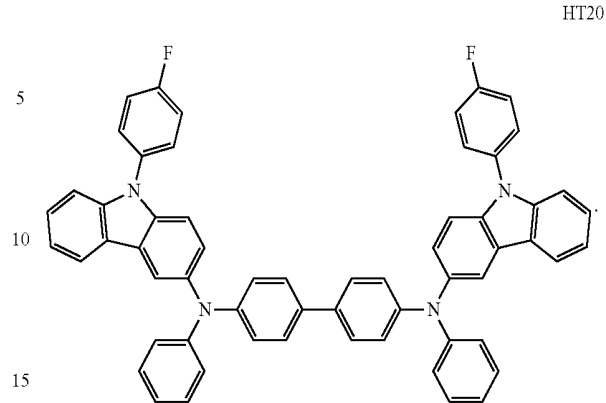
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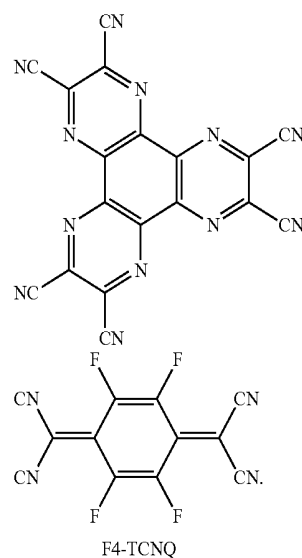


A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1000 Å. When the hole transport region includes a hole injection layer and a hole transport layer, the thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 9,950 Å, or about 100 Å to about 1000 Å, and the thickness of the hole transport layer may be in a range of about 50 Å to about 2000 Å, and for example, about 100 Å to about 1500 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.

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

The charge-generating material may be, for example, a p-dopant. The p-dopant may be one 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 include quinone derivatives such as tetracyanoquinonodimethane (TCNQ) and/or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonodimethane (F4-TCNQ); metal oxides such as a tungsten oxide and/or a molybdenum oxide; and Compound HT-D1 illustrated below.

Compound HT-D1

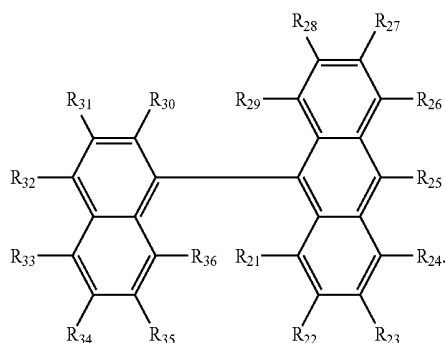


The hole transport region may further include, in addition to the hole injection layer and the hole transport layer, at least one selected from a buffer layer and an electron blocking layer. Since the buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, light-emission efficiency of the resulting organic light-emitting device may be improved. As a material included in the buffer layer, materials that are included in the hole transport region may be used (utilized). In some embodiments, the electron blocking layer prevents or substantially reduces the injection of electrons from the electron transport region.

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, 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.

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. Alternatively, 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.

According to some embodiments, the emission layer may further include a compound represented by Formula 4.



In Formula 4, R_{21} to R_{36} may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q_1)(Q_2), —Si(Q_3)(Q_4)(Q_5), and —B(Q_6)(Q_7);

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 may be selected from:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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});

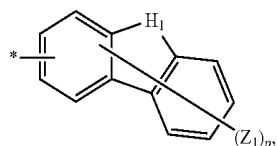
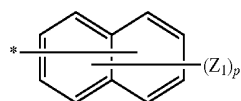
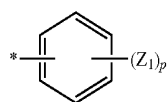
and —N(Q_{31})(Q_{32}), —Si(Q_{33})(Q_{34})(Q_{35}), and —B(Q_{36})(Q_{37});

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where Q_1 to Q_7 , Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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.

In some embodiments, the compound represented by Formula 4 may serve as a host.

In some embodiments, in Formula 4, R_{25} , R_{27} , R_{31} , R_{32} , and R_{33} may be each independently selected from a hydrogen, a deuterium, a cyano group, a substituted or unsubstituted C_1 - C_{60} alkyl group, —Si(Q_3)(Q_4)(Q_5) (where Q_3 to Q_5 are as defined above), and Formulae 3a to 3c:



In Formulae 3a to 3c, Z_1 may be selected from a hydrogen atom, a deuterium, 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 C_6 - C_{20} condensed polycyclic group, a halogen group, a cyano group, a nitro group, a hydroxyl group, and a carboxyl group;

H_1 may be selected from —O—, —S—, —CR₅₁R₅₂—, and —NR₅₃—; p may be an integer selected from 1 to 7; and * indicates a binding site;

R_{51} and R_{53} may be the same as defined in connection with R_{21} to R_{36} described above; and

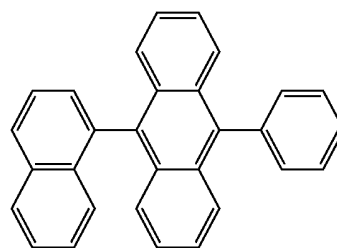
optionally, R_{51} and R_{52} may be linked to each other to form a ring.

In some embodiments, in Formula 4, R_{21} to R_{24} , R_{26} , R_{28} to R_{30} , and R_{34} to R_{36} may be each independently selected from a hydrogen and a deuterium.

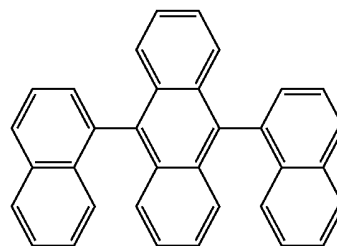
In some embodiments, the emission layer may include the compound represented by Formula 1 as a fluorescent or phosphorescent dopant and the compound represented by Formula 4 as a fluorescent or phosphorescent host.

The compound represented by Formula 4 may be, for example, represented by any one of compounds below, but is not limited thereto:

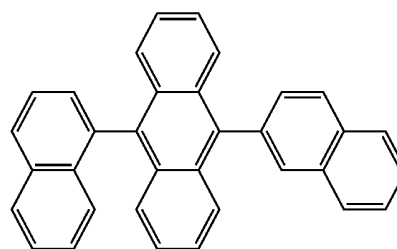
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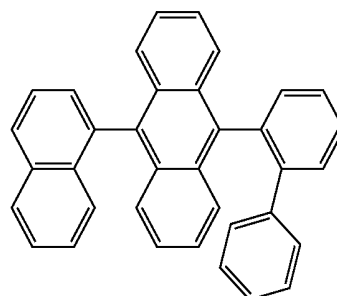
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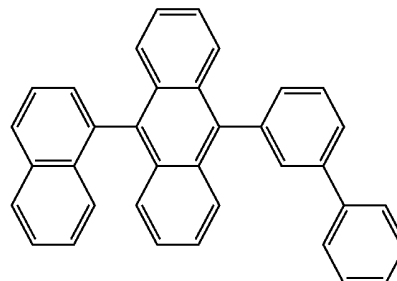
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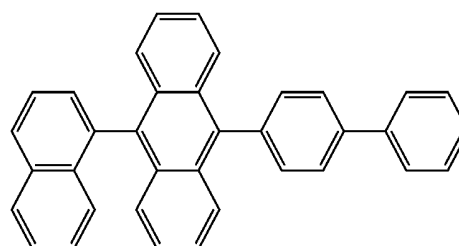
H3



H4



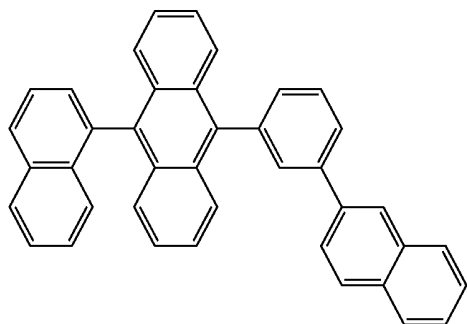
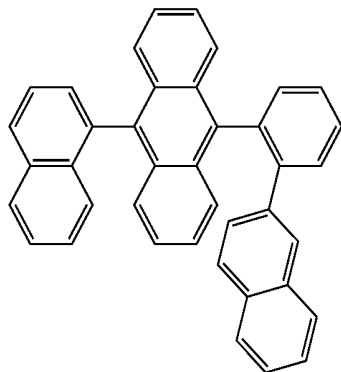
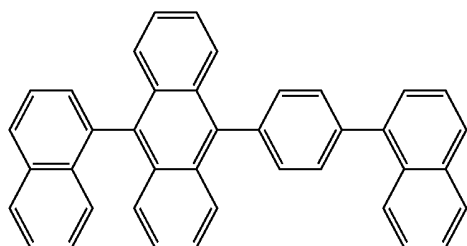
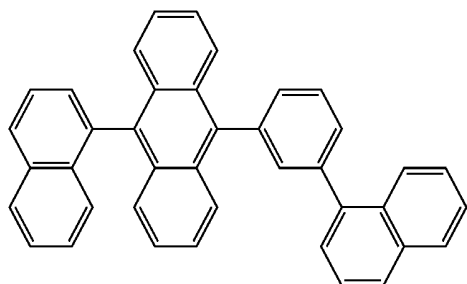
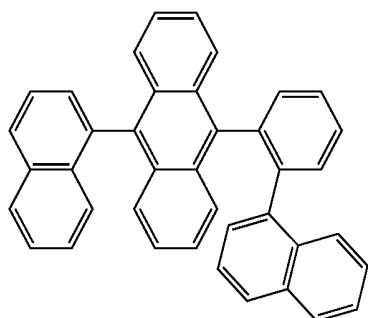
H5



H6

57

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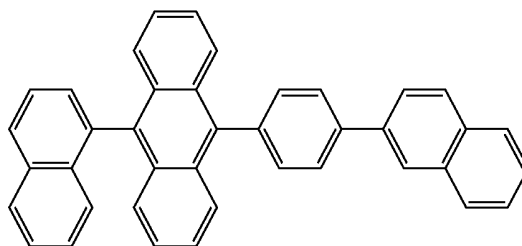
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H7

H12

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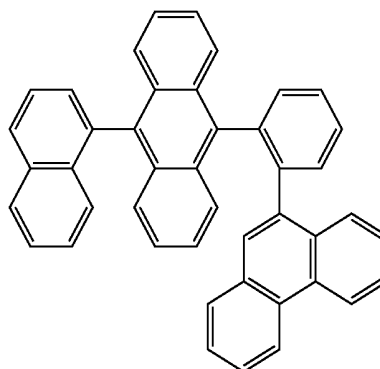
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H8

H13

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H9

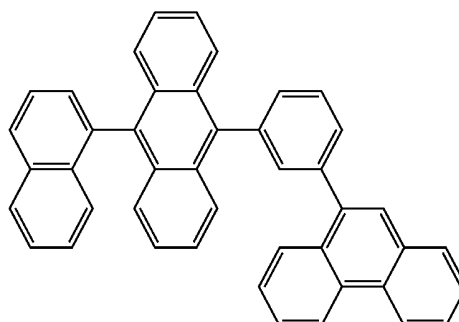
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H14

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H10

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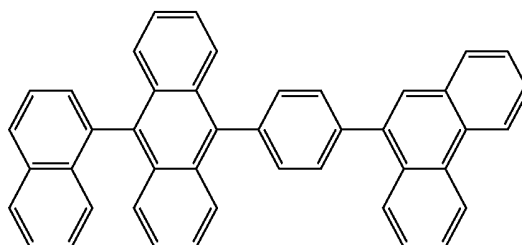
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H15

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H11

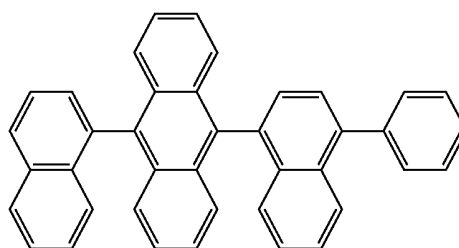
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H16

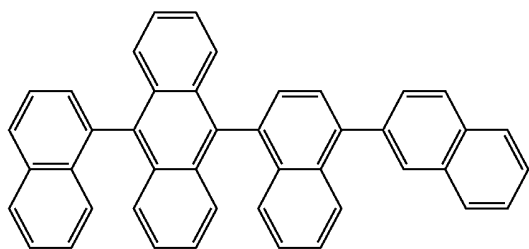
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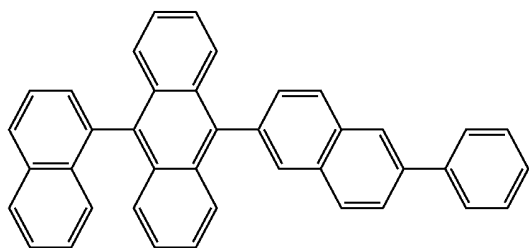
H17



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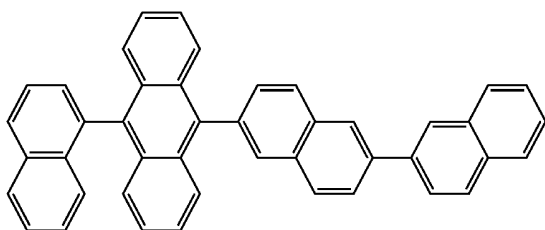
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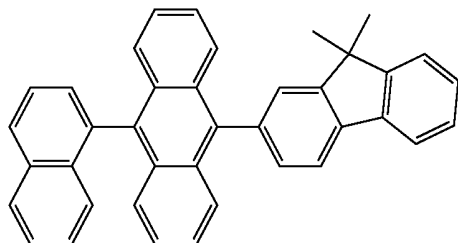
H19



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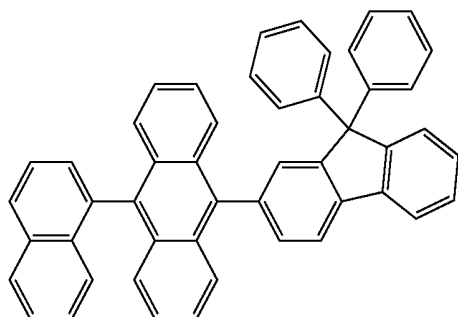
H20



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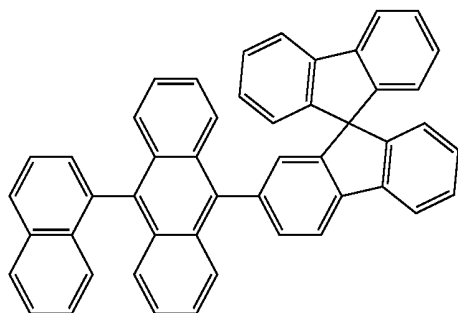
H21



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H22



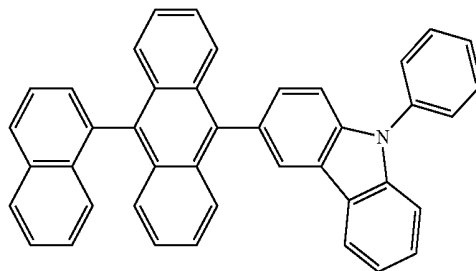
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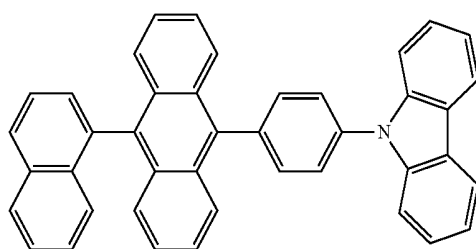
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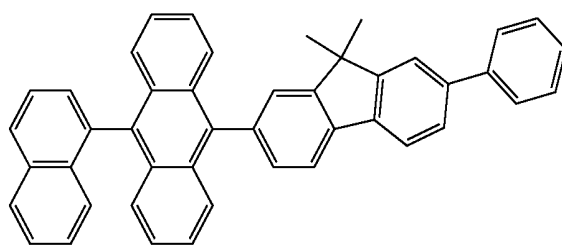
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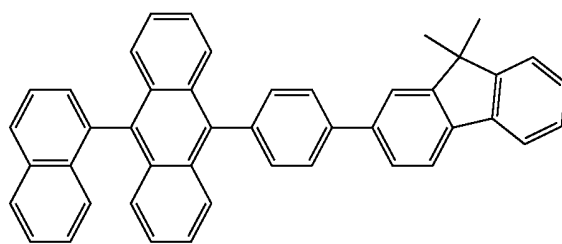
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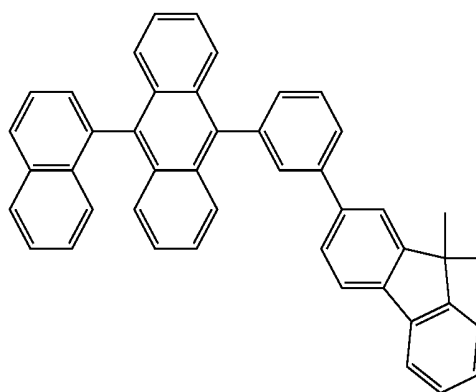
H25



H26

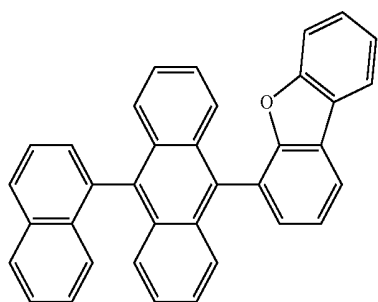


H27



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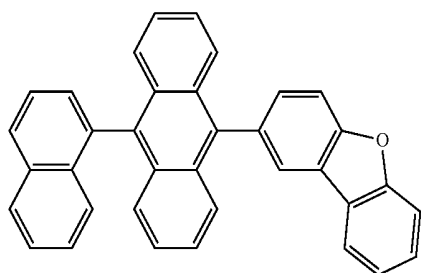
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H28

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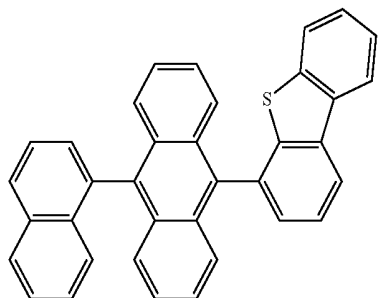


H29

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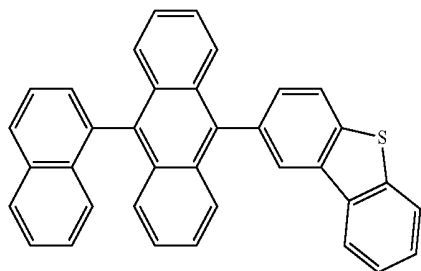
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H30

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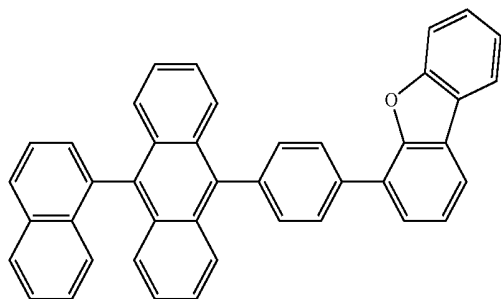
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H31

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H32

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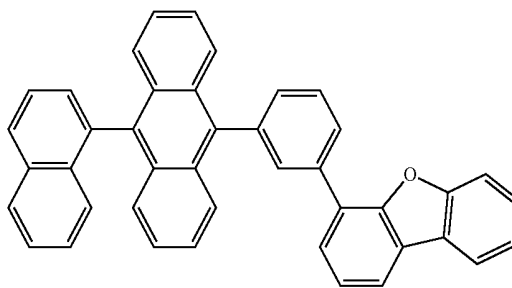
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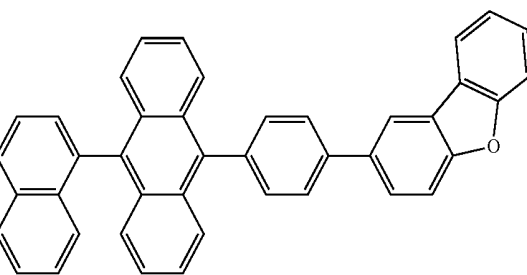
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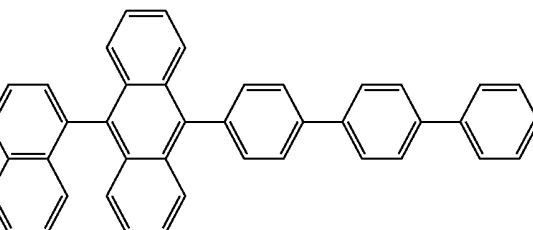
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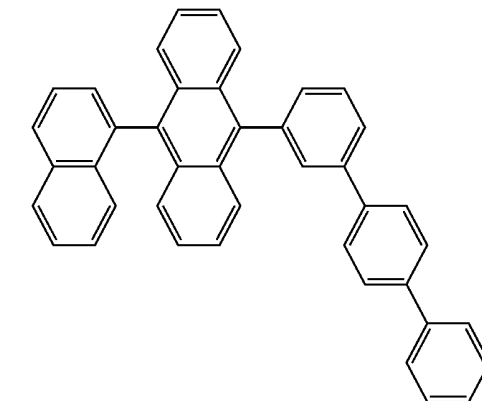
H34



H35



H36

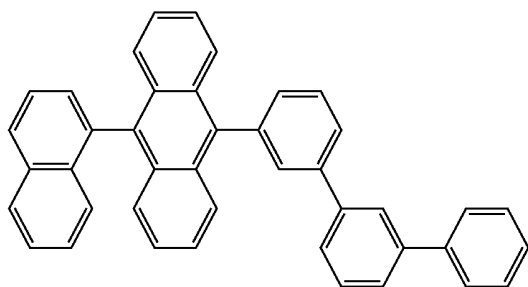


H37

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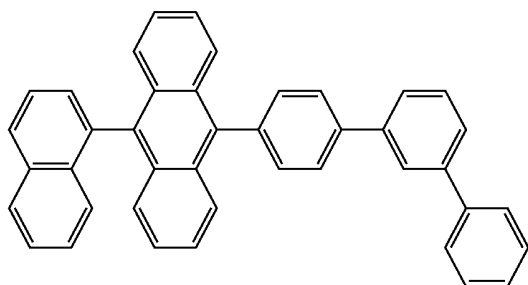
H38



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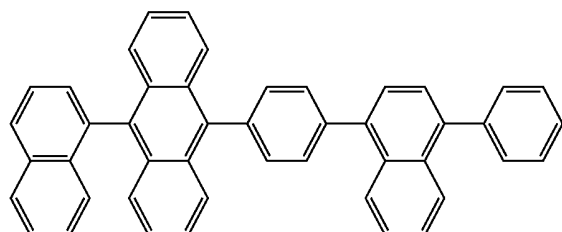
H39



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H40

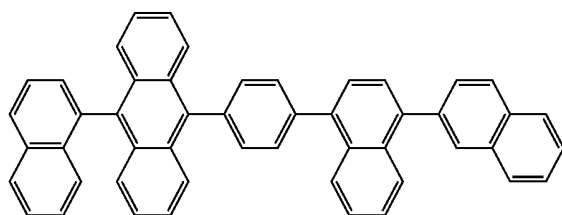


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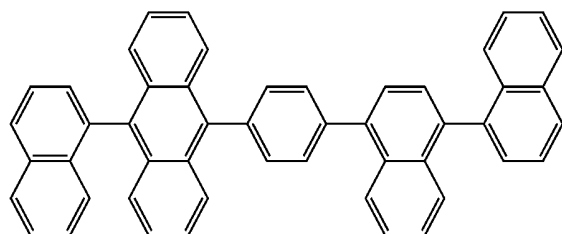
H41



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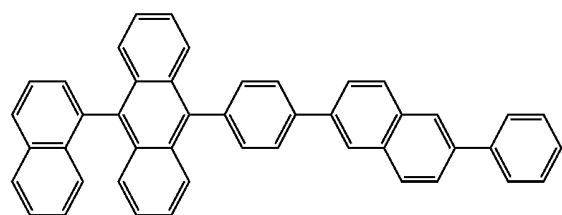
H42



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H43



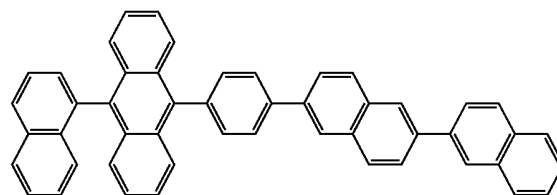
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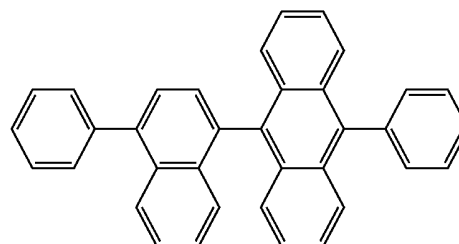
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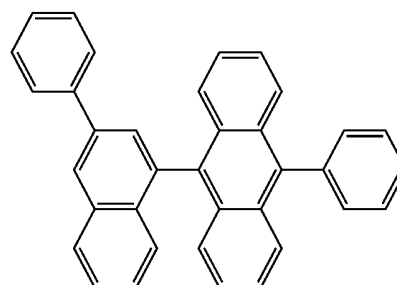
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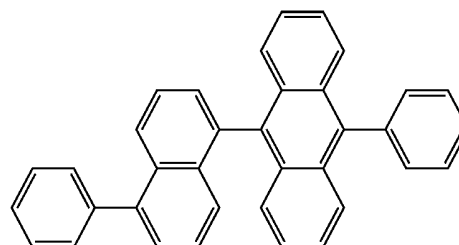
H45



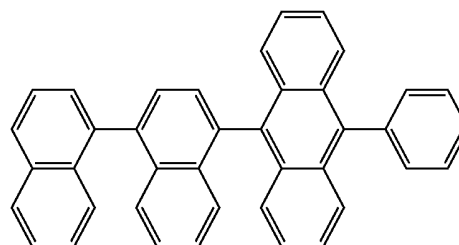
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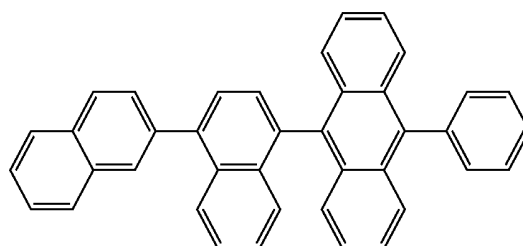
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H48



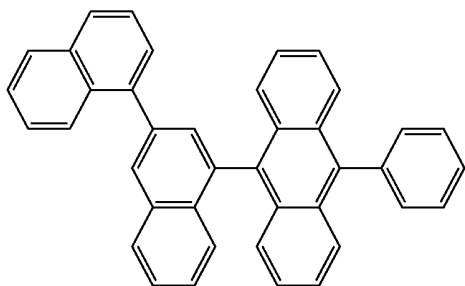
H49



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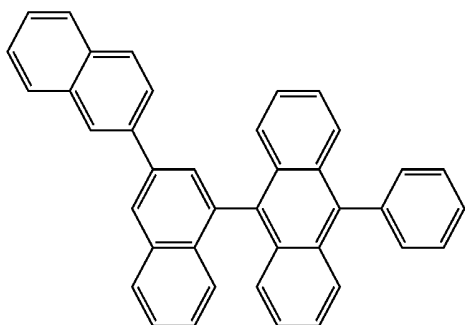
H50



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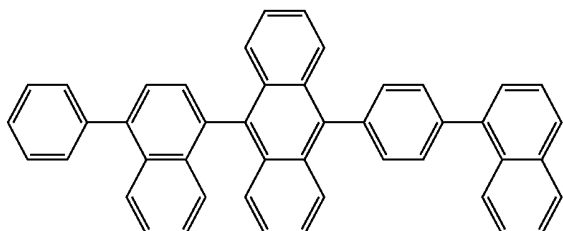
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H51



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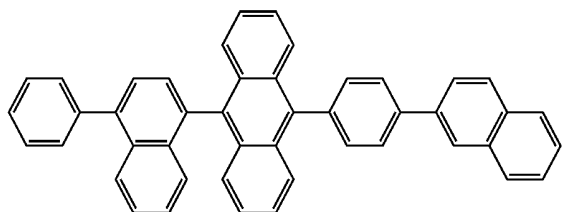
H52



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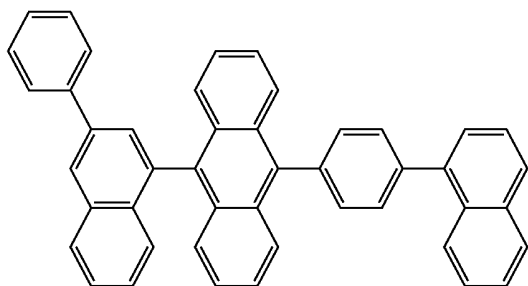
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H53



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H54

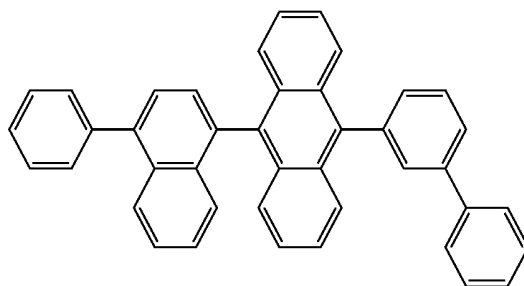


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66

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H55



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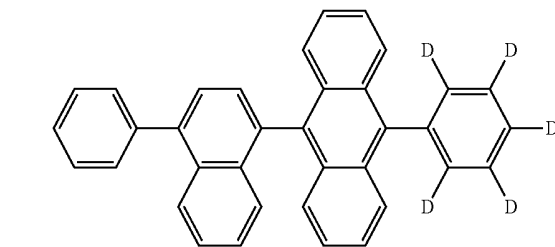
H56

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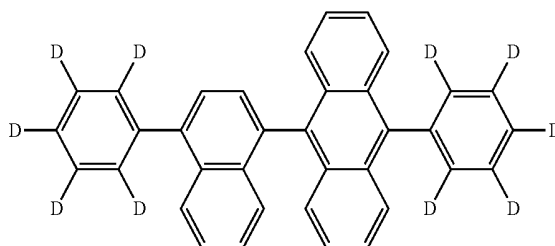
H57



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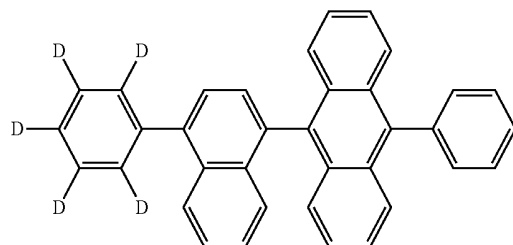
H58



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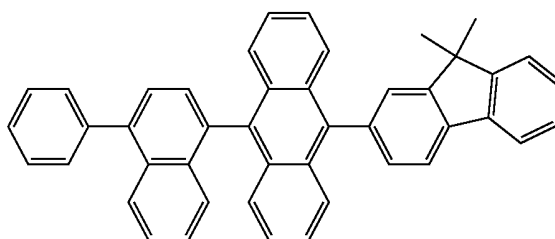
H59



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H60

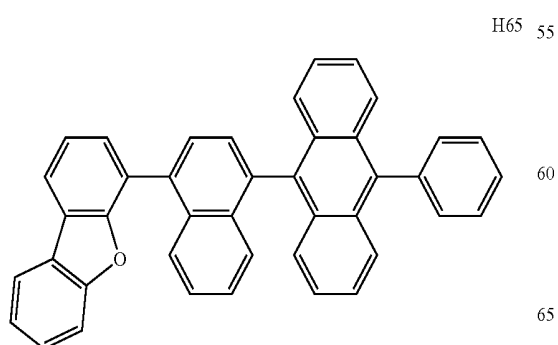
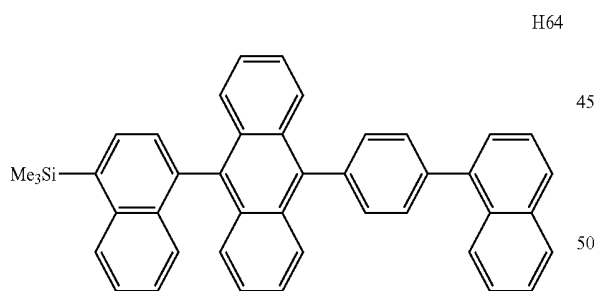
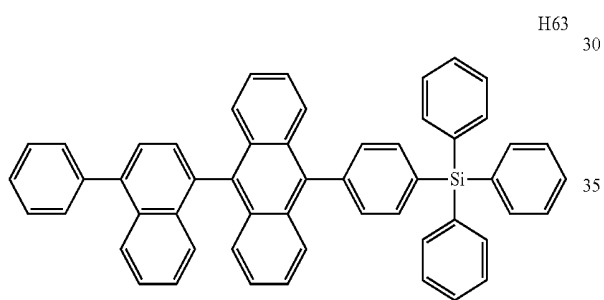
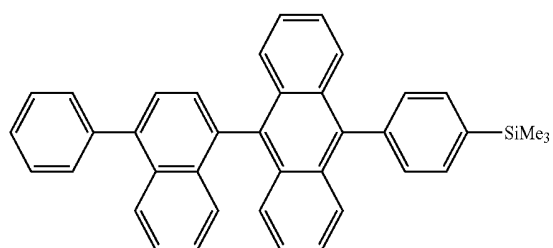
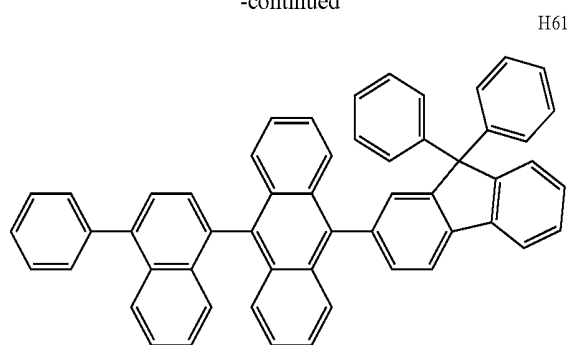


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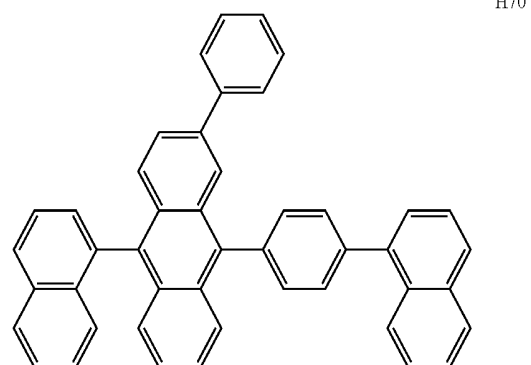
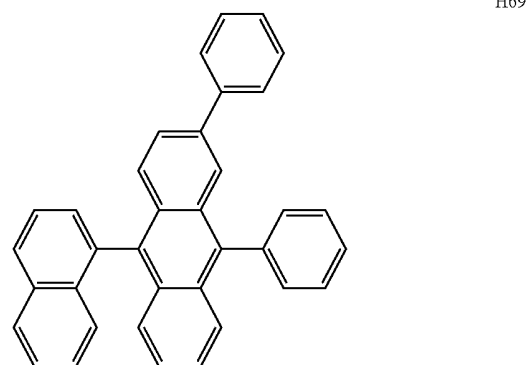
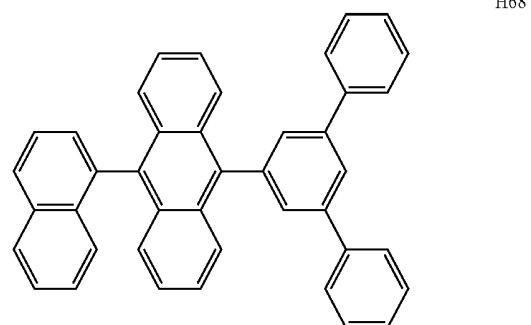
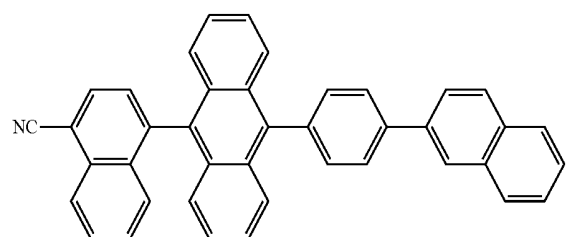
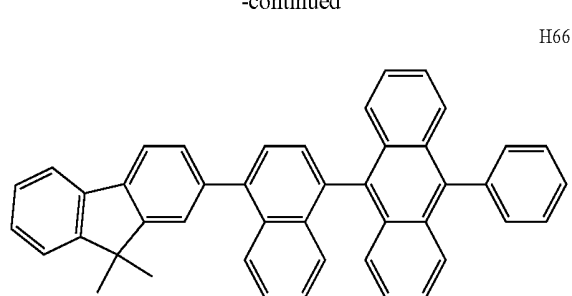
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67

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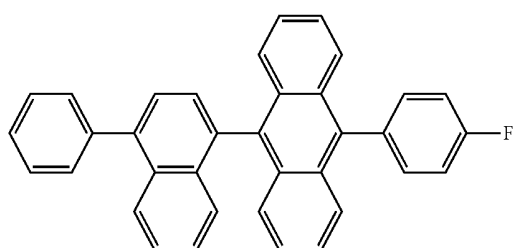
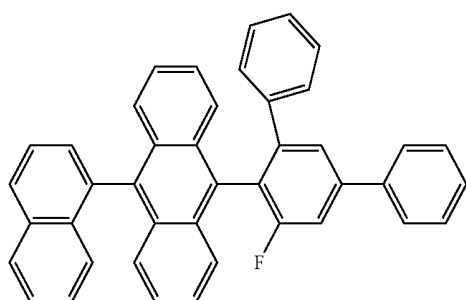
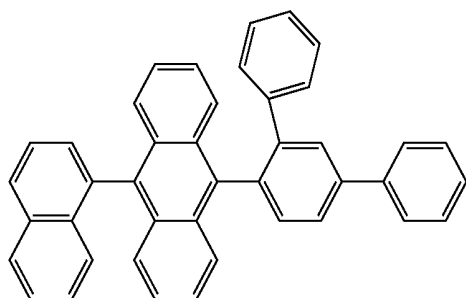
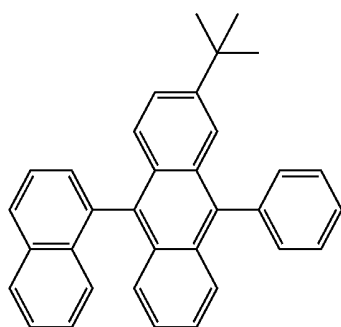
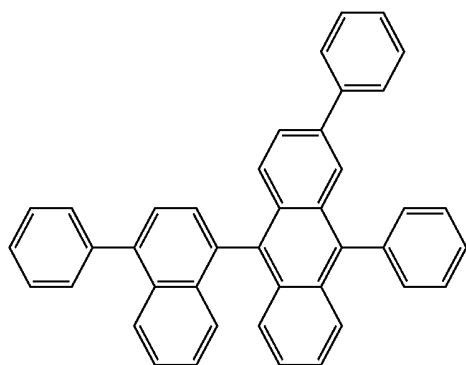
**68**

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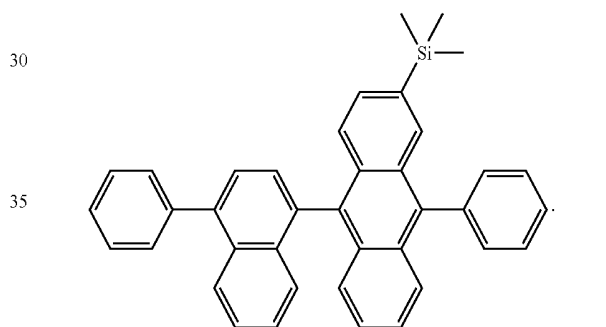
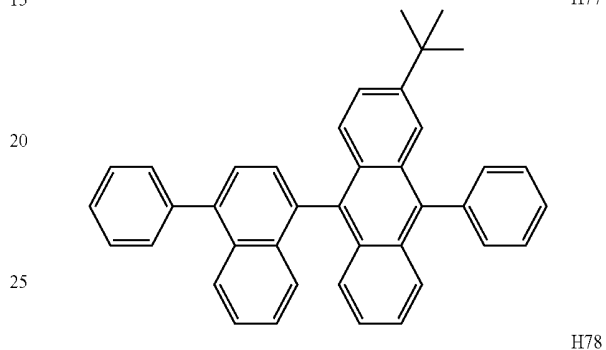
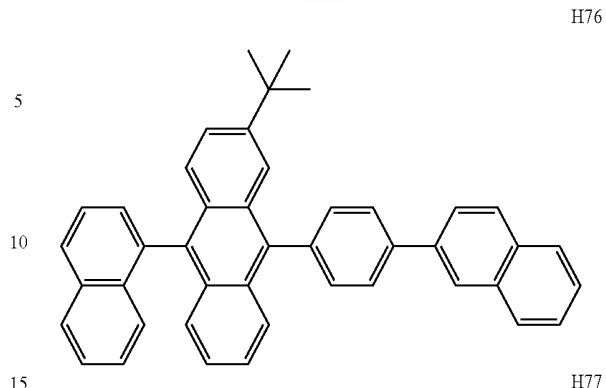


69

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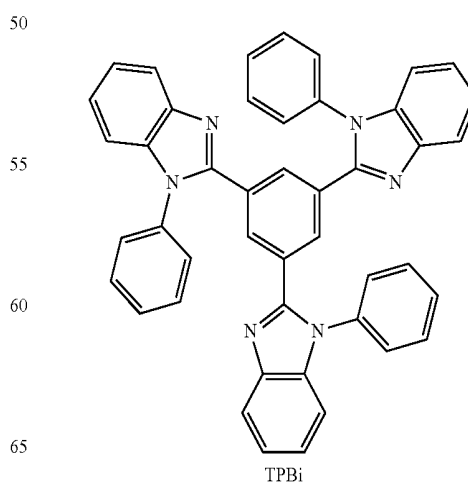
**70**

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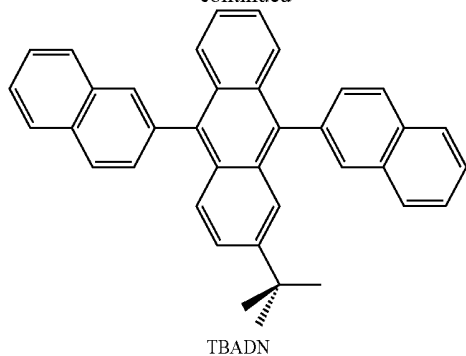
The emission layer may include any suitable host and dopant commonly known to those of skill in the art, as well as the compound represented by Formula 1 and compound represented by Formula 4.

The host may include at least one selected from TPBi, TBADN, ADN (herein, also known as "DNA"), CBP, CDBP, and TCP:

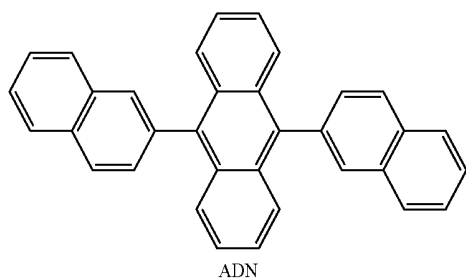


71

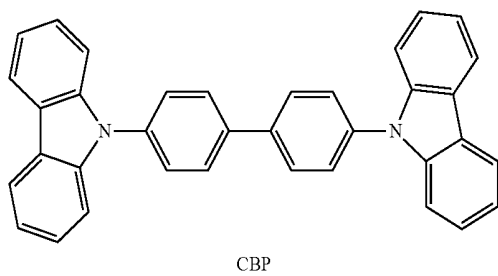
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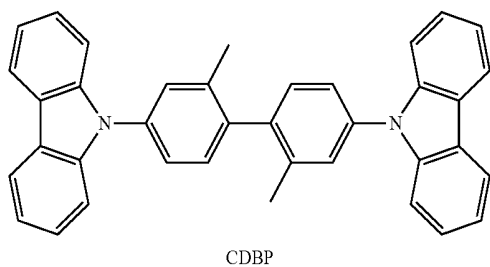
TBADN



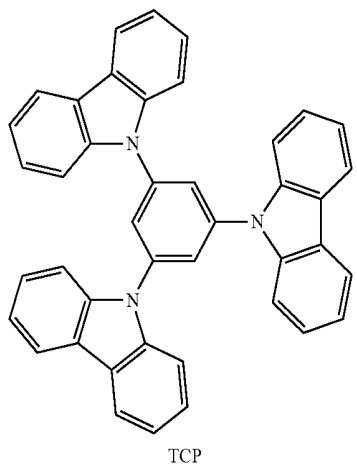
ADN



CBP

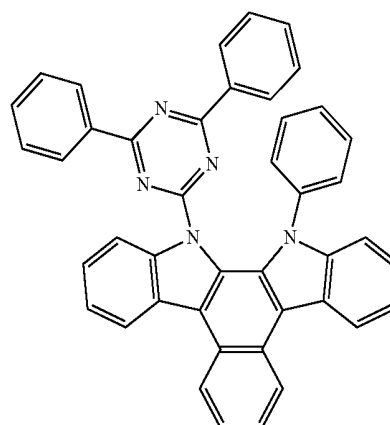


CDBP

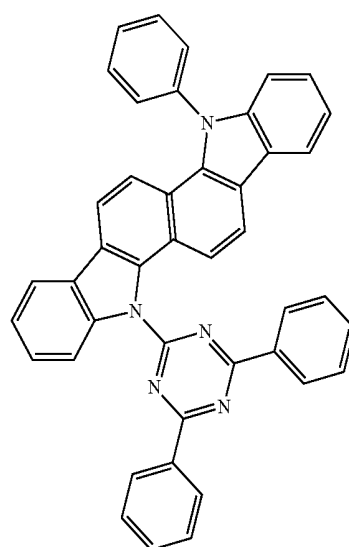


TCP

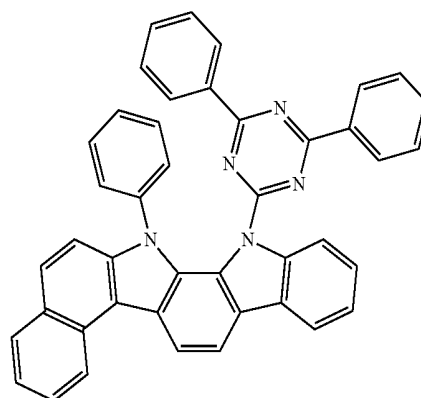
72



H43



H44

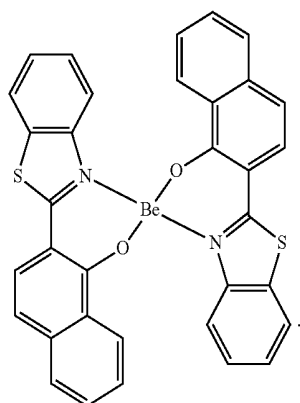
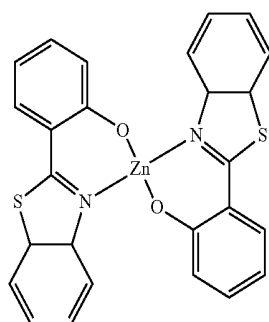
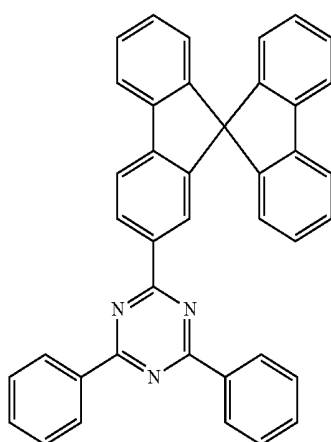
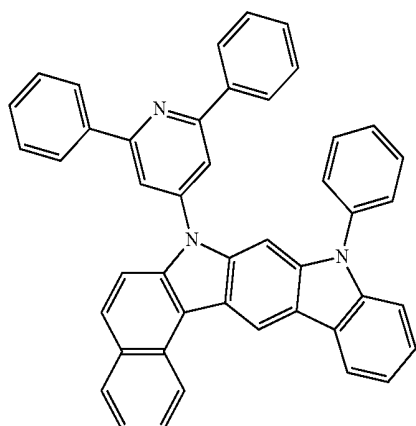


H45

In some embodiments, the host may include at least one selected from Compounds H43 to H49 below, but is not limited thereto:

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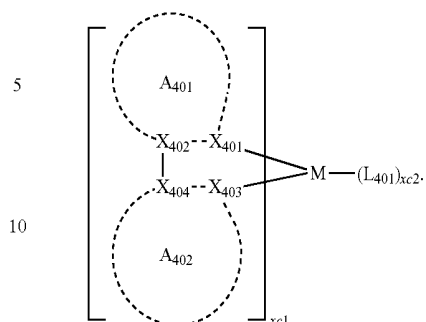
The dopant may further include at least one selected from a suitable fluorescent dopant and a phosphorescent dopant.

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

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H46

Formula 401



In Formula 401,

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

X₄₀₁ to X₄₀₄ may be each independently nitrogen or carbon;

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;

at least one of 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:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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;

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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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₄₀₁)(Q₄₀₂), —Si(Q₄₀₃)(Q₄₀₄)(Q₄₀₅), and —B(Q₄₀₆)(Q₄₀₇),

a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-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;

a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₁-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-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(Q₄₁₁)(Q₄₁₂), —Si(Q₄₁₃)(Q₄₁₄)(Q₄₁₅), and —B(Q₄₁₆)(Q₄₁₇), and

—N(Q₄₂₁)(Q₄₂₂), —Si(Q₄₂₃)(Q₄₂₄)(Q₄₂₅), and —B(Q₄₂₆)(Q₄₂₇);

where Q₄₀₁ to Q₄₀₇, Q₄₁₁ to Q₄₁₇, and Q₄₂₁ to Q₄₂₇, are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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

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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.

L₄₀₁ may be an organic ligand;

xc1 may be selected from 1, 2, and 3; and

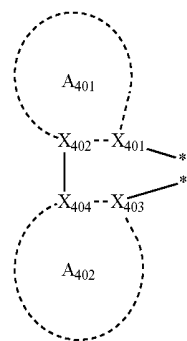
xc2 may be selected from 0, 1, 2, and 3.

L₄₀₁ may be any suitable monovalent, divalent, or trivalent organic ligand. For example, L₄₀₁ may be selected from a halogen ligand (for example, Cl[−] or F[−]), a diketone ligand (for example, acetylacetonate, 1,3-diphenyl-1,3-propanedione, 2,2,6,6-tetramethyl-3,5-heptanedione, and/or hexafluoroacetonate), a carboxylic acid ligand (for example, picolinate, dimethyl-3-pyrazolecarboxylate, and/or benzoate), a carbon monoxide ligand, an isonitrile ligand, a cyano ligand, and a phosphorous ligand (for example, phosphine, or phosphate), but embodiments of the present invention are not limited thereto.

When A₄₀₁ in Formula 401 has a plurality of substituents, two or more of the plurality of substituents of A₄₀₁ may bind to each other to form a saturated or unsaturated ring.

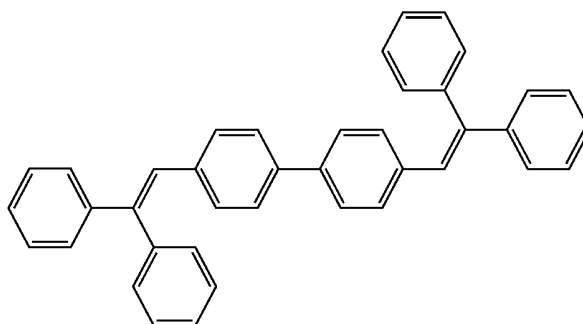
When A₄₀₂ in Formula 401 has a plurality of substituents, two or more of the plurality of substituents of A₄₀₂ may bind to each other to form a saturated or unsaturated ring.

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



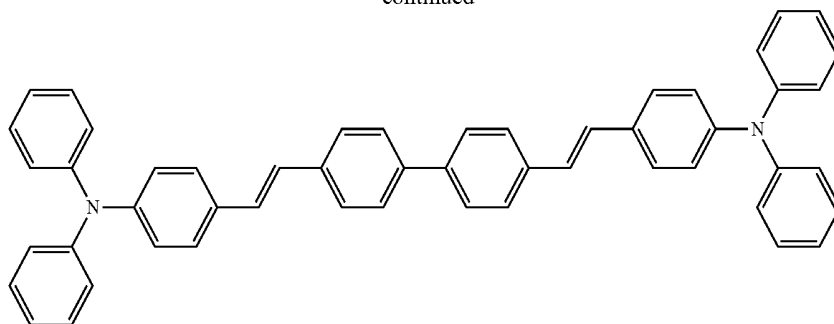
in Formula 401 may be identical to or different from each other. In Formula 401, when xc1 is 2 or more, A₄₀₁ and/or A₄₀₂ of one ligand may be respectively linked to A₄₀₁ and/or A₄₀₂ of an adjacent ligand, directly (e.g., via a single bond) or connected via a linking group (for example, a C₁-C₅ alkylene group, —N(R')— (wherein R' is a C₁-C₁₀ alkyl group or a C₆-C₂₀ aryl group), and/or —C(=O)—).

The fluorescent dopant may include at least one selected from DPVBi, BDAVB, TBPe, DCM, DCJTb, Coumarin 6, and C545T as well as the compound represented by Formula 1.

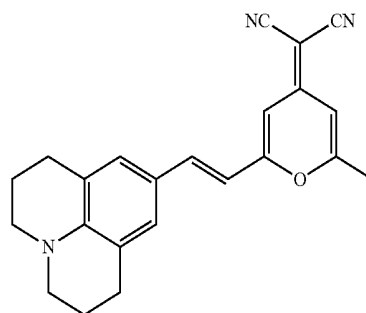
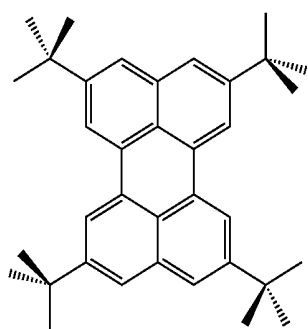


DPVBi

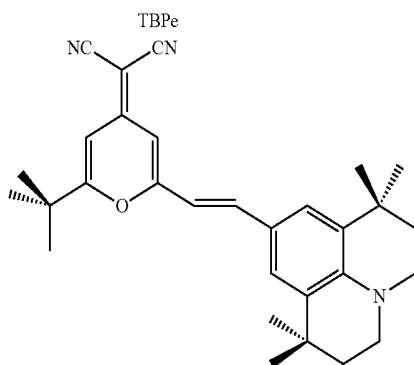
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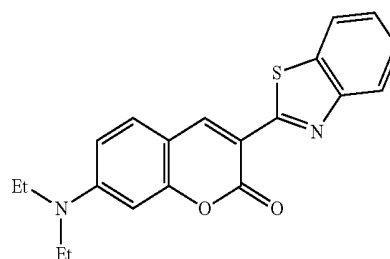
BDAVBi



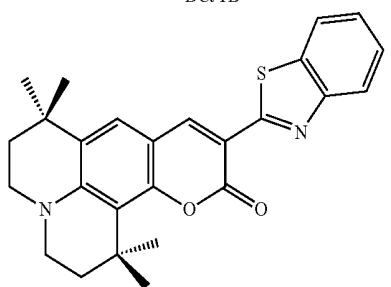
DCM



DCJTB



Coumarin 6



C545T

An amount of the dopant in the emission layer may be, in general, 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 the amount of the dopant is not limited thereto.

A 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 this range, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

Then, an electron transport region may be disposed on the emission layer.

The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer (ETL), and an electron injection layer, but embodiments of the present invention are not limited thereto.

For example, 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, where the layers of each structure are sequentially stacked from the emission layer in the stated order, but the structure of the electron transport region is not limited thereto.

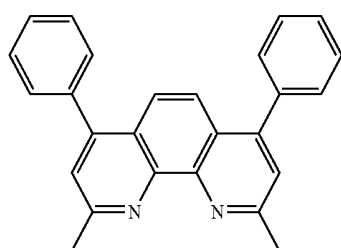
The electron transport region may include a hole blocking layer. When the emission layer includes a phosphorescent

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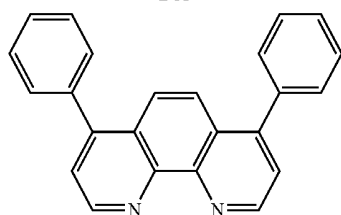
dotant, the hole blocking layer may be formed to prevent or substantially reduce the diffusion of excitons or holes into an electron transport layer.

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, LB method, ink-jet printing, laser-printing, and/or LITI. When the hole blocking layer is formed by vacuum-deposition and/or spin coating, the deposition and coating conditions for the hole blocking layer may be similar to the deposition and coating conditions for the hole injection layer.

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



BCP



Bphen

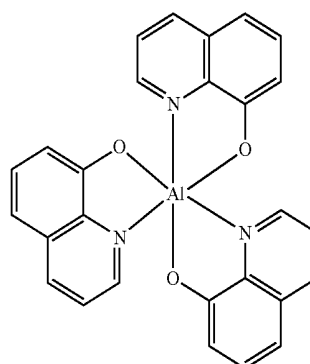
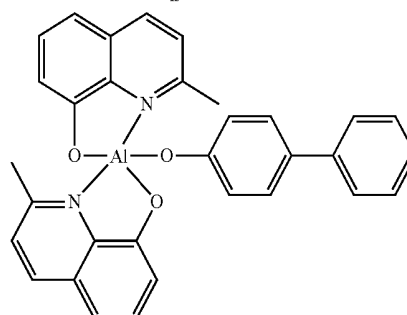
A thickness of the hole blocking layer may be in a range of about 20 Å to about 1000 Å, for example, about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within this range, excellent hole blocking characteristics may be obtained without a substantial increase in driving voltage.

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

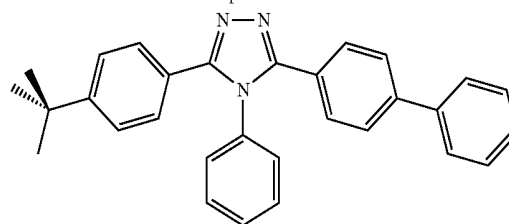
In some embodiments, the organic layer 150 of the organic light-emitting device includes an electron transport region between the emission layer and the second electrode 190. The electron transport region may include at least one selected from an electron transport layer and an electron injection layer, but is not limited thereto.

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

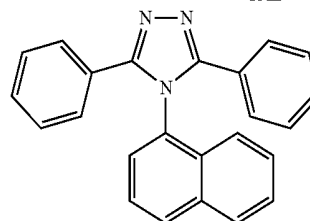
80

Alq₃

BALq

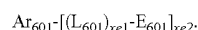


TAZ



NTAZ

In some embodiments, the electron transport layer may include at least one compound selected from a compound represented by Formula 601 and a compound represented by Formula 602 illustrated below: Formula 601



In Formula 601,

Ar₆₀₁ may be selected from:

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;

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, naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene, each substituted with at least one selected from a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-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, and —Si(Q₃₀₁)(Q₃₀₂)(Q₃₀₃),

where Q₃₀₁ to Q₃₀₃ may be each independently selected from a hydrogen, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₆-C₆₀ aryl group, and a C₁-C₆₀ heteroaryl group;

L₆₀₁ may be the same as defined in connection with L₂₀₁;

E₆₀₁ may be selected from:

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 phenanthroline 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

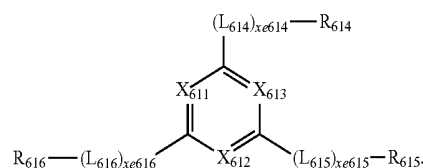
a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl 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 phenanthroline 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ 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 spirofluorenyl 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 phenanthroline 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;

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

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

Formula 602



In Formula 602,

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;

L₆₁₁ to L₆₁₆ may be each independently the same as defined in connection with L₂₀₁ provided herein;

R₆₁₁ to R₆₁₆ may be each independently selected from:

a phenyl group, a naphthyl group, a fluorenyl group, a spirofluorenyl 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, and a triazinyl group; and

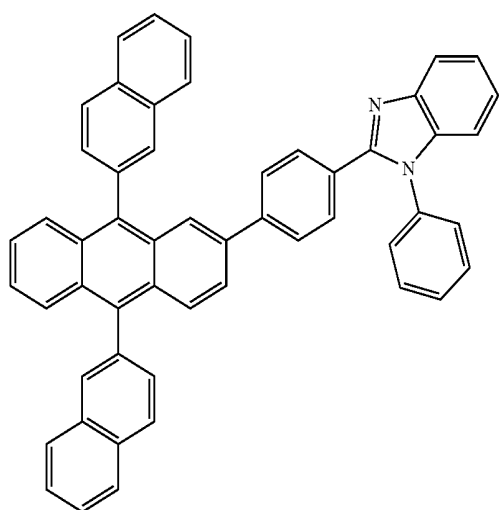
a phenyl group, a naphthyl group, a fluorenyl group, a spirofluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spirofluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl

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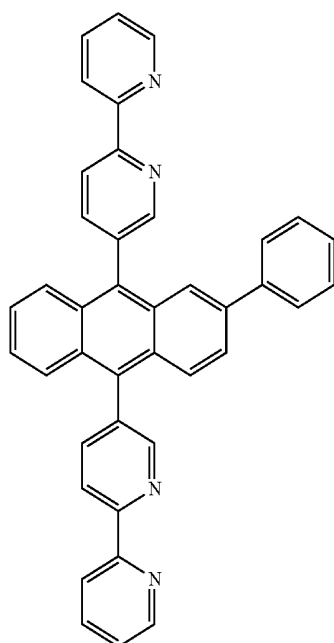
group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

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

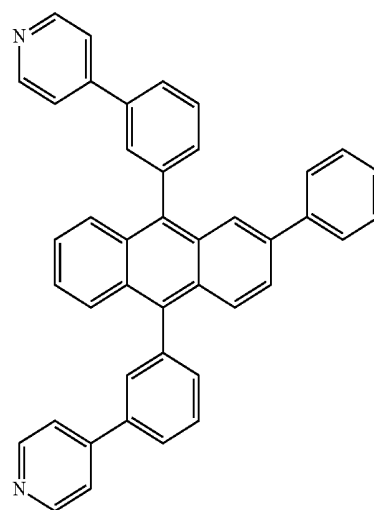
The compound represented by Formula 601 and the compound represented by Formula 602 may each independently be selected from Compounds ET1 to ET15 illustrated below:



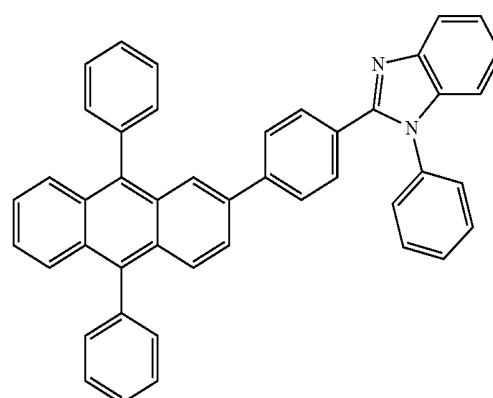
ET1



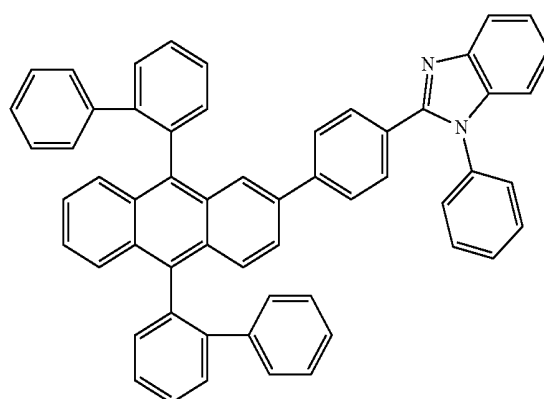
ET2



ET3



ET4



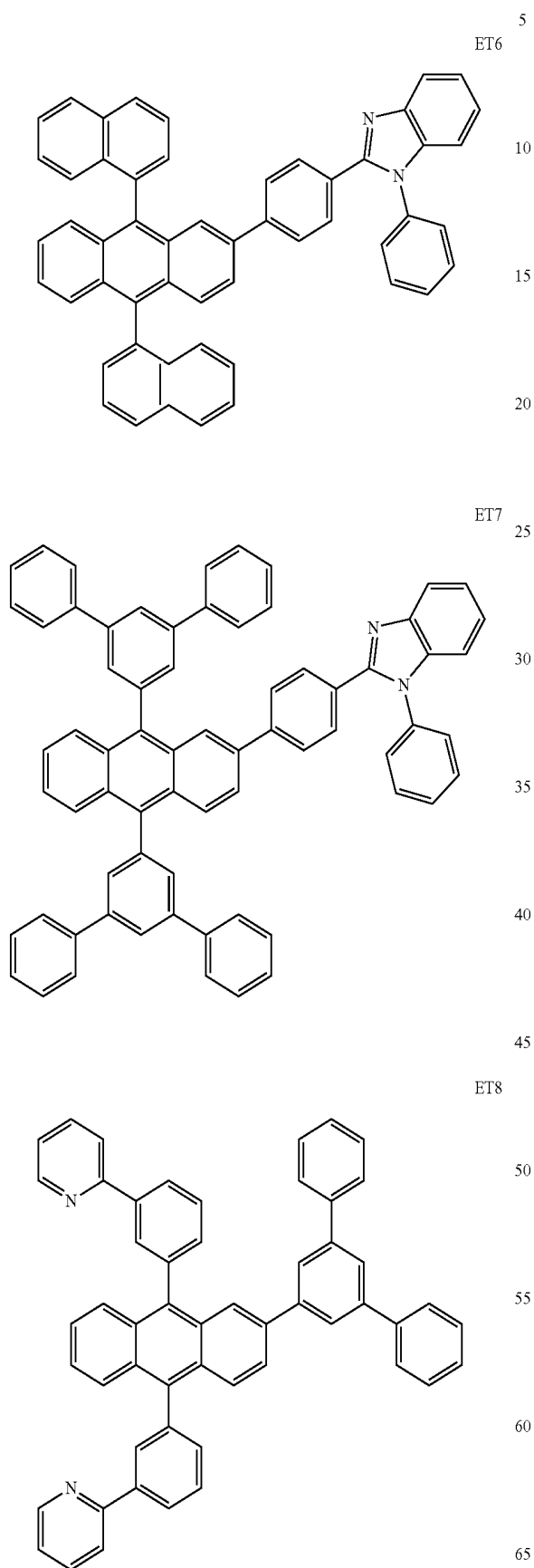
ET5

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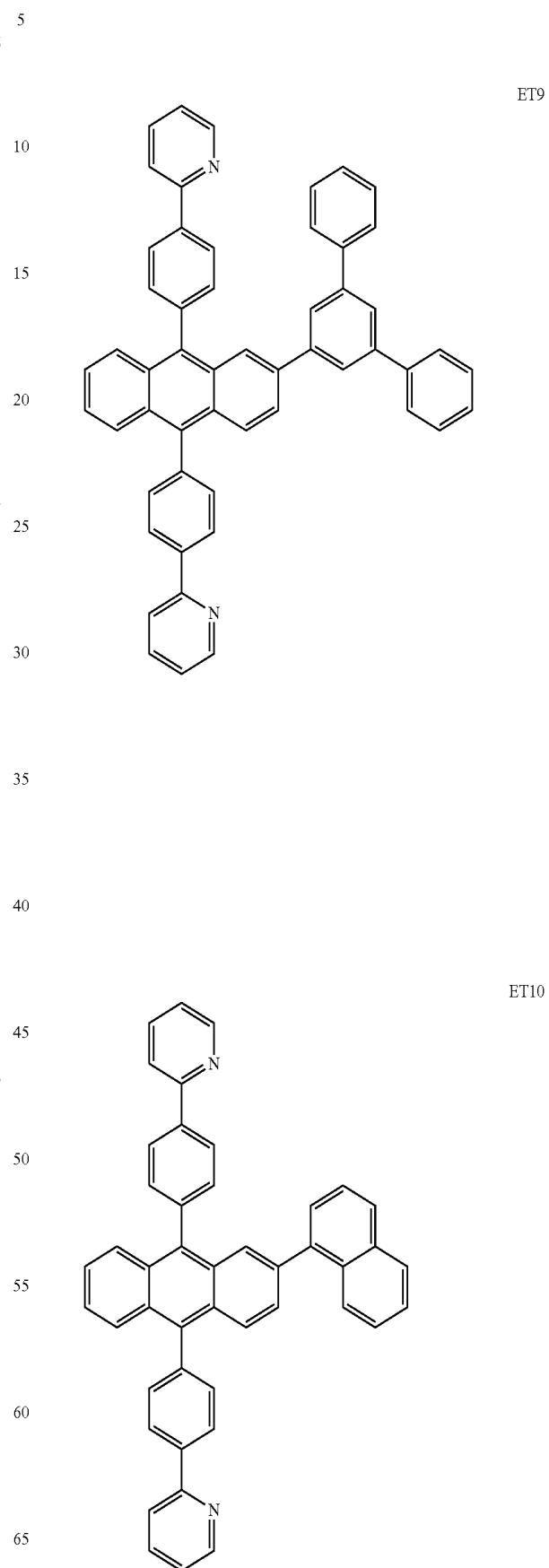
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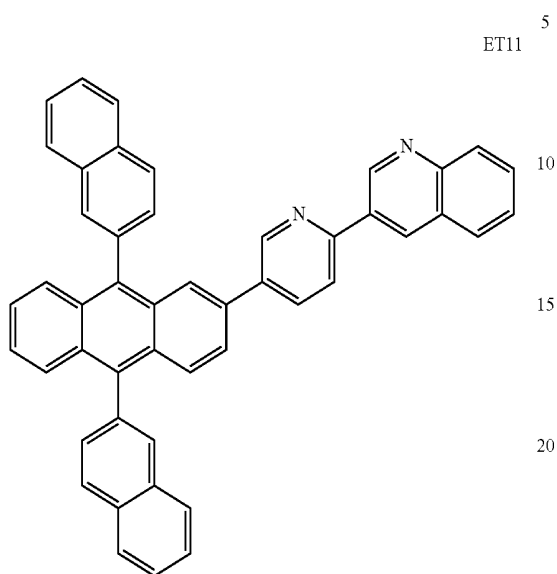
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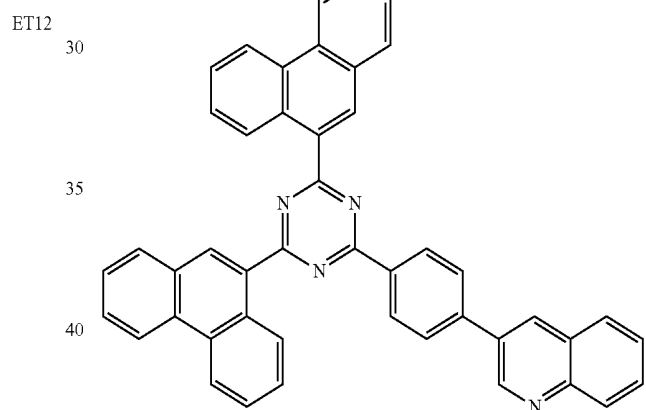
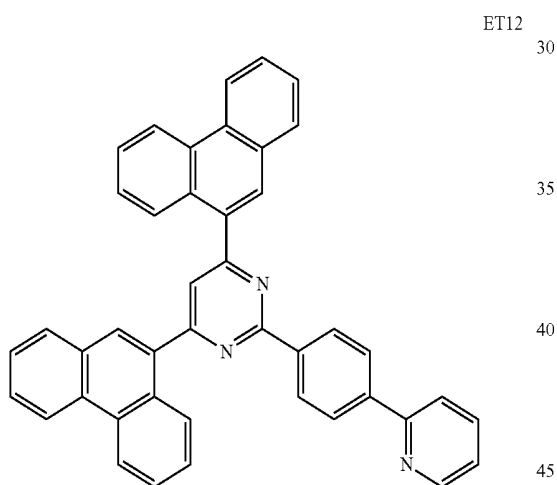
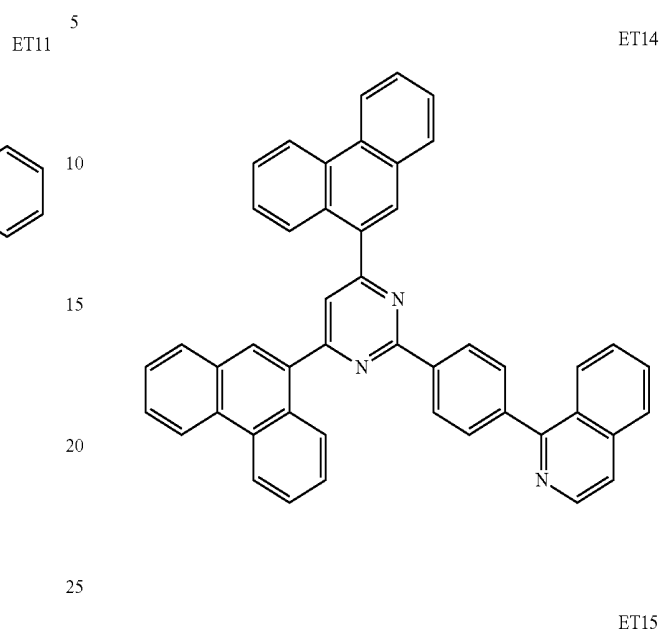
87

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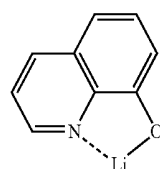
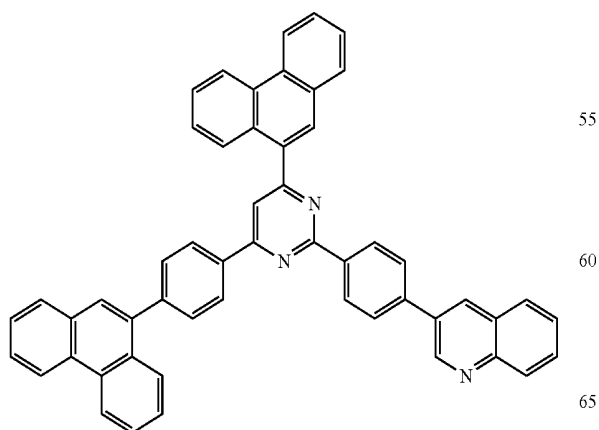
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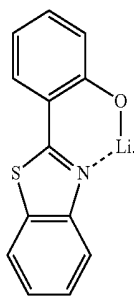
ET13 50 A thickness of the electron transport layer may be in a range of about 100 Å to about 1000 Å, for example, about 150 Å to about 500 Å. When the thickness of the electron transport layer is within this range, excellent electron transport characteristics may be obtained without a substantial increase in driving voltage.

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

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



-continued



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

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, 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.

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

A 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 this range, excellent electron injection characteristics may be obtained without a substantial increase in driving voltage.

The second electrode **190** is positioned on the organic layer **150**. The second electrode **190** may be a cathode that is an electron injection electrode, and 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** 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 or IZO. The second electrode **190** may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode.

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

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).

A C₁-C₆₀ alkyl group used herein refers to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms in the main carbon chain, and 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 C₁-C₆₀ alkylene group used herein refers to a divalent group having the same structure as the C₁-C₆₀ alkyl group.

A C₁-C₆₀ alkoxy group used herein refers to a monovalent group represented by —OA₁₀₁ (where A₁₀₁ is the C₁-C₆₀

ET-D2

alkyl group), and non-limiting examples thereof include a methoxy group, an ethoxy group and an isopropoxy group.

A C₂-C₆₀ alkenyl group used herein refers to a hydrocarbon group having at least one carbon-carbon double bond at one or more positions along a carbon chain of the C₂-C₆₀ alkyl group (e.g., in the middle or at either terminal end of the C₂-C₆₀ alkyl group), and non-limiting examples thereof include an ethenyl group, a propenyl group, and a butenyl group. A C₂-C₆₀ alkenylene group used herein refers to a divalent group having the same structure as the C₂-C₆₀ alkenyl group.

A C₂-C₆₀ alkynyl group used herein refers to a hydrocarbon group having at least one carbon-carbon triple bond at one or more positions along a carbon chain of the C₂-C₆₀ alkyl group (e.g., in the middle or at either terminal end of the C₂-C₆₀ alkyl group), and non-limiting examples thereof include an ethynyl group and a propynyl group. A C₂-C₆₀ alkynylene group used herein refers to a divalent group having the same structure as the C₂-C₆₀ alkynyl group.

A C₃-C₁₀ cycloalkyl group used herein refers to a monovalent monocyclic saturated hydrocarbon group including 3 to 10 carbon atoms as ring-forming atoms, and non-limiting examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. A C₃-C₁₀ cycloalkylene group used herein refers to a divalent group having the same structure as the C₃-C₁₀ cycloalkyl group.

A C₁-C₁₀ heterocycloalkyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 1 to 10 carbon atoms as the remaining ring-forming atoms. Non-limiting examples thereof include a tetrahydrofuran group and a tetrahydrothiophenyl group. A C₁-C₁₀ heterocycloalkylene group used herein refers to a divalent group having the same structure as the C₁-C₁₀ heterocycloalkyl group.

A C₃-C₁₀ cycloalkenyl group used herein refers to a monovalent monocyclic group that has 3 to 10 carbon atoms as ring-forming atoms and at least one double bond in its ring, and is not aromatic. Non-limiting examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. A C₃-C₁₀ cycloalkenylene group used herein refers to a divalent group having the same structure as the C₃-C₁₀ cycloalkenyl group.

A C₁-C₁₀ heterocycloalkenyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, P, and S as a ring-forming atom, 1 to 10 carbon atoms as the remaining ring-forming atoms, and at least one double bond in its ring. Non-limiting examples of the C₁-C₁₀ heterocycloalkenyl group include a 2,3-dihydrofuran group and a 2,3-dihydrothiophenyl group. A C₁-C₁₀ heterocycloalkenylene group used herein refers to a divalent group having the same structure as the C₁-C₁₀ heterocycloalkenyl group.

A C₆-C₆₀ aryl group used herein refers to a monovalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms, and a C₆-C₆₀ arylene group used herein refers to a divalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms. Non-limiting examples of the C₆-C₆₀ aryl group include a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C₆-C₆₀ aryl group and/or the C₆-C₆₀ arylene group each include a plurality of rings, the rings may be fused to each other.

A C₁-C₆₀ heteroaryl group used herein refers to a monovalent group having a carbocyclic aromatic system including at least one hetero atom selected from N, O, P, and S as

a ring-forming atom and 1 to 60 carbon atoms as the remaining ring-forming atoms. A C_1 - C_{60} heteroarylene group used herein refers to a divalent group having a carbocyclic aromatic system including at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 1 to 60 carbon atoms as the remaining ring-forming atoms. Non-limiting examples of the C_1 - C_{60} heteroaryl group 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 each include a plurality of rings, the rings may be fused to each other.

A C_6 - C_{60} aryloxy group used herein refers to a group represented by $-OA_{102}$ (where A_{102} is the C_6 - C_{60} aryl group), and a C_6 - C_{60} arylthio group used herein refers to a group represented by $-SA_{103}$ (where A_{103} is the C_6 - C_{60} aryl group).

A monovalent non-aromatic condensed polycyclic group used herein refers to a monovalent group that has two or more rings condensed to each other, only carbon atoms as ring forming atoms (for example, the number of carbon atoms may be in a range of 6 to 60 as in, for example, a C_6 - C_{20} condensed polycyclic group), wherein the molecular structure 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 refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

A monovalent non-aromatic condensed heteropolycyclic group used herein refers to a monovalent group that has two or more rings condensed to each other, has a hetero atom selected from N, O, P, and S as a ring-forming atom, and carbon atoms as the remaining ring-forming atoms (for example, the number of carbon atoms may be in a range of 2 to 60), wherein the molecular structure as a whole is non-aromatic. A non-limiting example of the monovalent non-aromatic condensed heteropolycyclic group is a carbazolyl group. A divalent non-aromatic condensed heteropolycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

At least one of substituents of the substituted C_3 - C_{10} cycloalkylene group, substituted C_1 - C_{10} heterocycloalkylene group, substituted C_3 - C_{10} cycloalkenylene group, substituted C_1 - C_{10} heterocycloalkenylene group, substituted C_6 - C_{60} arylene group, substituted C_1 - C_{60} heteroarylene group, substituted divalent non-aromatic condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, 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_1 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_1 - 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 may be selected from:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a

phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 $-N(Q_{31})(Q_{32})$, $-Si(Q_{33})(Q_{34})(Q_{35})$, and $-B(Q_{36})(Q_{37})$;

where Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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.

In some embodiments, at least one substituent of the substituted C_3 - C_{10} cycloalkylene group, substituted C_1 - C_{10} heterocycloalkylene group, substituted C_3 - C_{10} cycloalkenylene group, substituted C_1 - C_{10} heterocycloalkenylene group, substituted C_6 - C_{60} arylene group, substituted C_1 - C_{60} heteroarylene group, substituted divalent non-aromatic con-

condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, 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_1 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_1 - 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 may be selected from:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 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 benzofuran-yl 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, an imidazopyrimidinyl group, —N(Q_{11})(Q_{12}), —Si(Q_{13})(Q_{14})(Q_{15}), and —B(Q_{16})(Q_{17});

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 benzofuran-yl 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;

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 benzofuran-yl 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 phenanthroline 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, an imidazopyrimidinyl group, $-N(Q_{21})(Q_{22})$, $-Si(Q_{23})(Q_{24})(Q_{25})$, and $-B(Q_{26})(Q_{27})$; and $-N(Q_{31})(Q_{32})$, $-Si(Q_{33})(Q_{34})(Q_{35})$, and $-B(Q_{36})(Q_{37})$,

where Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 phenanthroline 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.

The organic light-emitting device according to one or more embodiments of the present invention may be included in various types (kinds) 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. When the organic light-emitting device is included in an active matrix organic light-emitting display apparatus, a first electrode disposed on a substrate is a pixel electrode, and the first electrode may be electrically connected to a source electrode or 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.

Further, the organic layer of the organic light-emitting device according to the present embodiments may be formed by vacuum-depositing the compound described above in connection with one or more embodiments of the present invention and/or using (utilizing) a wet method in which the compound according to one or more embodiments of the present invention is prepared in the form of a solution, and then the solution of the compound is used for coating.

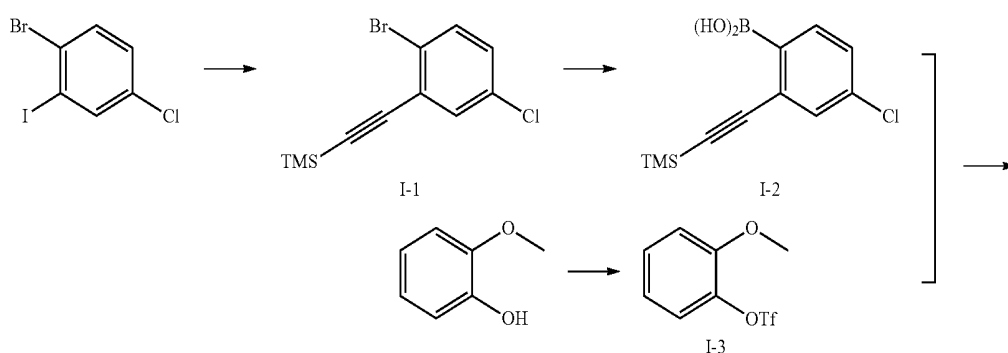
"Ph" used herein refers to a phenyl group, "Me" refers to a methyl group, "Et" refers to an ethyl group, and "ter-Bu" or "Bu" refers to a tert-butyl group.

Hereinafter, an organic light-emitting device according to one or more embodiments will be described in detail with reference to Synthesis Examples and Examples. However, these examples are for illustrative purposes only and are not intended to limit the scope of the present invention.

EXAMPLE

Synthesis Example 1

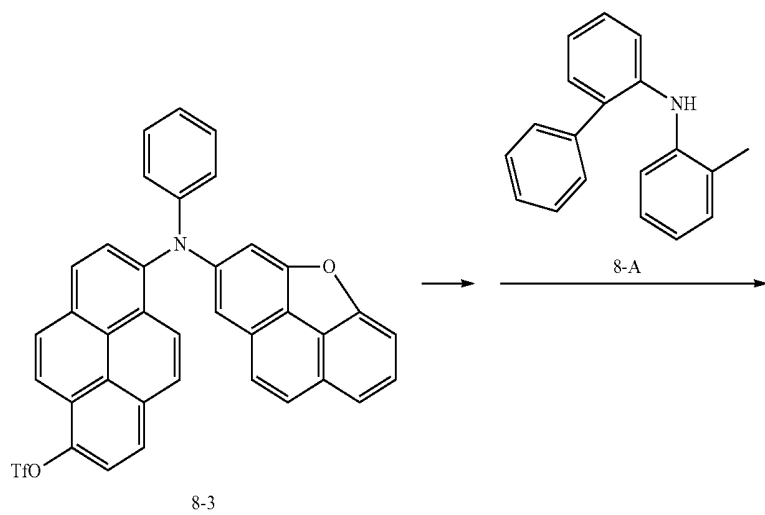
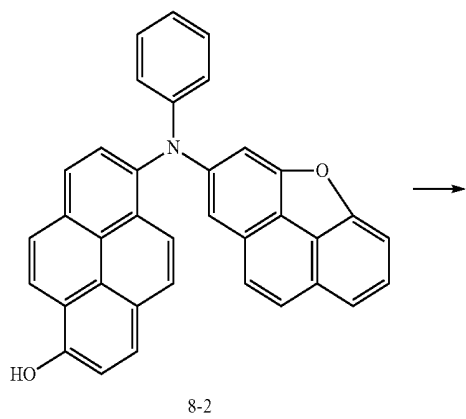
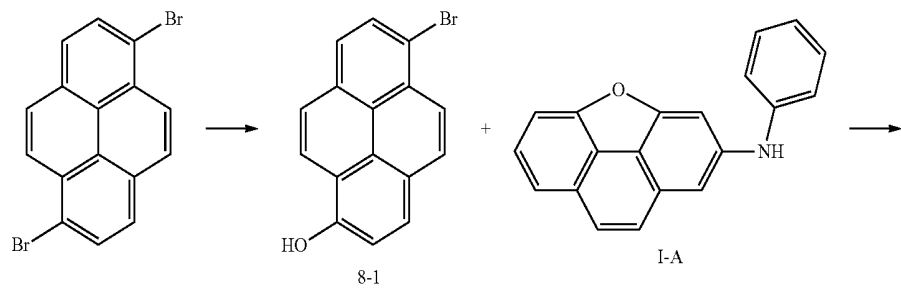
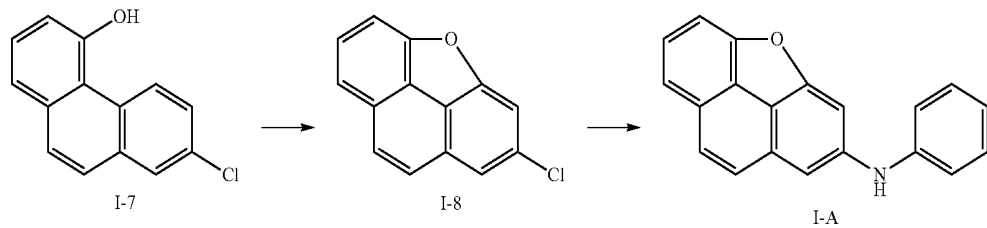
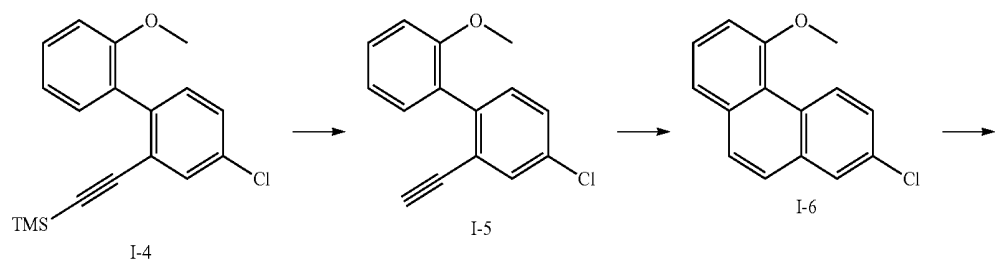
Synthesis of Compound 8



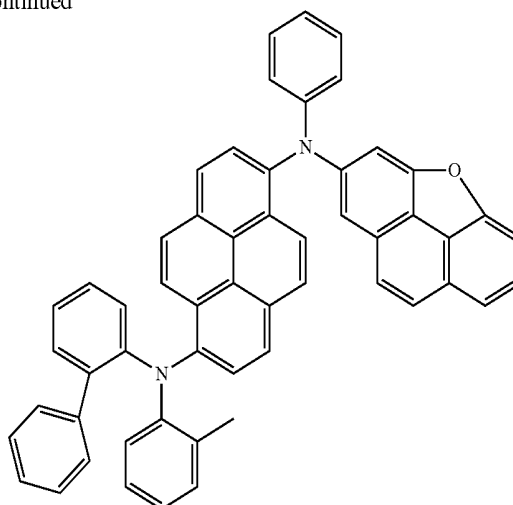
97

98

-continued



-continued



8

Synthesis of Intermediate I-1

17.2 g (54.4 mmol) of 1-bromo-4-chloro-2-iodobenzene, 600 mg (2.7 mmol) of $\text{Pd}(\text{OAc})_2$, 1.5 g (5.72 mmol) of PPh_3 , and 1.1 g (5.77 mmol) of CuI were dissolved in 375 ml (272 mmol) of triethylamine, and the resulting solution was stirred at 60° C. for 12 hours under N_2 atmosphere. Once the reaction was complete, the result was allowed to cool down to room temperature. Then, an organic layer was extracted five times therefrom by using each of water and diethyl ether. The obtained organic layer was dried by using magnesium sulfate (MgSO_4). Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 25.2 g (47.6 mmol) of Intermediate I-1 (yield: 87.5%). The obtained compound was identified by mass spectroscopy/fast atom bombardment (MS/FAB).

$\text{C}_{11}\text{H}_{12}\text{BrBrSi}$ cal. 287.65, found 287.68.

Synthesis of Intermediate I-2

25.2 g (47.6 mmol) of Intermediate I-1 was dissolved in 500 ml of tetrahydrofuran (THF), and was stirred at -78° C. for 10 minutes under N_2 atmosphere. Then, 19 ml of 2.5 M $n\text{-BuLi}$ was slowly added dropwise by using a dropping funnel, and the resulting solution was stirred for additional 30 minutes. Then, 4.95 g (52.4 mmol) of trimethyl borate was slowly added dropwise by using a dropping funnel, and the solution was additionally stirred for three hours at room temperature. Then, 300 ml of 1M hydro-chloride solution was added thereto. An organic layer was extracted once therefrom, and was extracted three times additionally therefrom by using each of water and diethyl ether. The obtained organic layer was dried by using MgSO_4 . A solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to obtain 8.64 g (34.2 mmol) of Intermediate I-2 (yield: 72%). The obtained compound was identified by MS/FAB.

$\text{C}_{11}\text{H}_{14}\text{BClO}_2\text{Si}$ cal. 252.58, found 252.60.

Synthesis of Intermediate I-3

24.8 g (20.0 mmol) of 2-methoxyphenol and 3 g (60.0 mmol) of a pyridine were dissolved in 60 mL of dichloromethane. Then, 6.0 g (22 mmol) of triflic anhydride were slowly added thereto at 0° C., and the resulting product was allowed to cool down to room temperature and was then stirred for 2 hours. An organic layer was extracted three times therefrom by adding each of 30 mL of water and 50 mL of dichloromethane. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed there-

from by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 47.1 g (18.4 mmol) of Intermediate I-3 (yield: 92%). The obtained compound was identified by MS/FAB.

$\text{C}_8\text{H}_7\text{F}_3\text{O}_4\text{S}$ cal. 256.19, found 256.22.

Synthesis of Intermediate I-4

2.52 g (10 mmol) of Intermediate I-2, 2.82 g (11 mmol) of Intermediate I-3, 1.16 g (7.5 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 4.15 g (30 mmol) of K_2CO_3 were added to a 200 ml of mixture of THF/ H_2O (at a volume ratio of 9:1), and the resulting solution was stirred at 80° C. for 12 hours. The mixture was allowed to cool down to room temperature. Then, an organic layer was extracted three times therefrom by using each of 50 mL of water and 50 mL of diethyl ether. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to obtain 2.36 g (7.5 mmol) of Intermediate I-4 (yield: 75%). The obtained compound was identified by MS/FAB.

$\text{C}_{18}\text{H}_{19}\text{ClO}_3\text{Si}$ cal. 314.88, found 314.90.

Synthesis of Intermediate I-5

2.36 g (7.5 mmol) of Intermediate I-4 and 3.11 g (22.5 mmol) of K_2CO_3 were dissolved in 200 ml of $\text{MeOH}/\text{CH}_2\text{Cl}_2$ (at a volume ratio of 2:1), and the resulting solution was stirred at room temperature for 1 hour. Once the reaction was complete, the obtained compound was filtered by using a filter. An organic solvent was removed from the filtrate by evaporation. Then, an organic layer was extracted therefrom two times by using water and dichloromethane. Then, the resulting organic layer was dried by using MgSO_4 . The residue obtained by evaporating the solvent was separated and purified through a silica gel chromatography to thereby obtain 1.61 g (6.63 mmol) of Intermediate I-5 (yield: 88.5%). The obtained compound was identified by MS/FAB.

$\text{C}_{15}\text{H}_{11}\text{ClO}$ cal. 242.70, found 242.75.

Synthesis of Intermediate I-6

1.61 g (6.63 mmol) of Intermediate I-5 was dissolved in 100 mL of methylene chloride, and was stirred for 30 minutes while maintaining 0° C. in an ice bath. Then, 4.33 g (7.02 mmol) of iodine chloride was added thereto and the resulting solution was stirred for 30 minutes. Once the reaction was complete, an organic layer was extracted therefrom five times by using 100 mL of water, and ethyl-acetate. Then, the obtained organic layer was dried by using MgSO_4 , and a solvent was removed therefrom by evaporation. The obtained residue was recrystallized with a mixture

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solution of methylene chloride and n-hexane to thereby obtain 1.34 g (5.54 mmol) of Intermediate I-6 (yield: 83.5%). The obtained compound was identified by MS/FAB. C₁₅H₁₁ClO cal. 242.70, found 242.73.

Synthesis of Intermediate I-7

1.34 g (5.54 mmol) of Intermediate I-6 and 4.67 g (27.8 mmol) of sodium ethanethiolate were dissolved in 100 mL of dimethylformamide (DMF), and the resulting solution was stirred at 130° C. 4 hours later, the result was allowed to cool down to room temperature. Then, an organic layer was extracted six times therefrom by using water and ethyl acetate. The obtained organic layer was dried by using MgSO₄. Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 1.19 g (5.21 mmol) of Intermediate I-7 (yield: 94%). The obtained compound was identified by MS/FAB.

C₁₄H₉ClO cal. 228.67, found 228.70.

Synthesis of Intermediate I-8

1.19 g (5.21 mmol) of Intermediate I-7 and 2.24 g (15.6 mmol) of copper (I) oxide were added to 100 mL of nitro-benzene and the resulting solution was stirred at 190° C. for 48 hours. The result was allowed to cool down to room temperature, and then, an organic layer was extracted four times therefrom by using 50 mL of water and 50 mL of diethyl ether. The obtained organic layer was dried by using MgSO₄. Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 0.93 g (4.11 mmol) of Intermediate I-8 (yield: 79.3%). The obtained compound was identified by MS/FAB.

C₁₄H₇ClO cal. 226.65, found 226.71.

Synthesis of Intermediate I-A

0.93 g (4.11 mmol) of Intermediate I-8, 0.28 g (3.00 mmol) of aniline, 0.03 g (0.03 mmol) of Pd₂(dba)₃, 0.003 g (0.03 mmol) of PtBu₃, and 0.86 g (9 mmol) of NaOtBu were dissolved in 30 mL of toluene, and then, the resulting solution was stirred at 85° C. for 4 hours. After allowing the result to cool down to room temperature, an organic layer was extracted three times therefrom by using 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO₄. A solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to obtain 0.61 g (2.16 mmol) of Intermediate I-A (yield: 72%). The obtained compound was identified by MS/FAB.

C₂₀H₁₃NO cal. 283.33, found 283.35.

Synthesis of Intermediate 8-1

3.6 g (20.0 mmol) of 1,6-dibromopyrene, 0.38 g (2.0 mmol) of CuI, and 6.7 g (120.0 mmol) of KOH were dissolved in 100 mL of mixture solution of toluene/PEG400/H₂O (at a volume ratio of 5:4:1) under N₂ atmosphere, and the resulting solution was stirred for 8 hours while heating up to maintain 110° C. The result was allowed to cool down

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to room temperature, and then, 10 mL of 1N HCl was added thereto to adjust pH to be in a range of about 2 to about 3. Then, an organic layer was extracted three times therefrom by using 60 mL of ethyl acetate. The obtained organic layer was dried by using MgSO₄. Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 3.8 g (12.8 mmol) of Intermediate 8-1 (yield: 64%). The obtained compound was identified by MS/FAB.

C₁₆H₉BrO cal. 297.15, found 297.21.

Synthesis of Intermediate 8-2

2.97 g (10.0 mmol) of Intermediate 8-1, 3.11 g (11.0 mmol) of Intermediate I-A, 0.18 g (0.2 mmol) of Pd₂(dba)₃, 0.04 g (0.2 mmol) of PtBu₃, and 1.9 g (20.0 mmol) of NaOtBu were dissolved in 30 mL of toluene, and then the resulting solution was stirred at 85° C. for 4 hours. After allowing the result to cool down to room temperature, an organic layer was extracted three times therefrom by using 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO₄. A solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to obtain 4.68 g (7.2 mmol) of Intermediate 8-2 (yield: 72%). The obtained compound was identified by MS/FAB.

C₃₆H₂₁NO₂ cal. 499.56, found 499.61.

Synthesis of Intermediate 8-3

4.27 g (6.77 mmol) of Intermediate 8-3 (yield: 94%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-3 except that Intermediate 8-2 was used instead of 2-methoxyphenol. The obtained compound was identified by MS/FAB.

C₃₇H₂₀F₃NO₄S cal. 631.62, found 631.66.

Synthesis of Compound 8

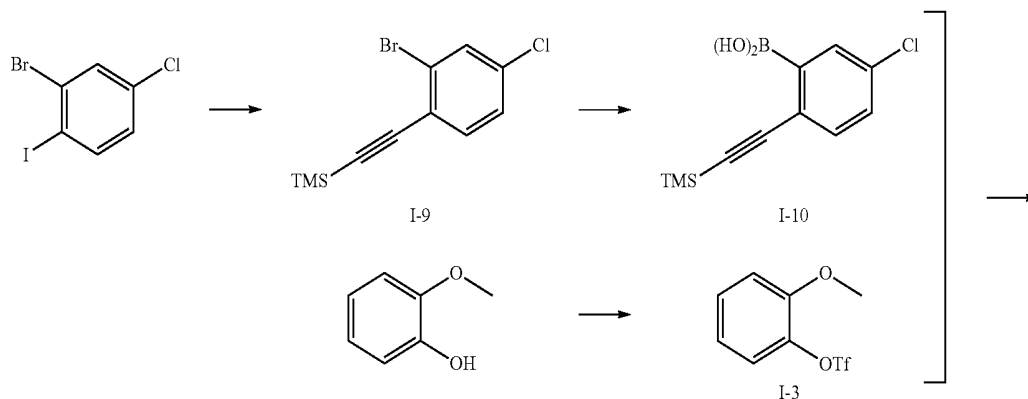
4.28 g (6.77 mmol) of Intermediate 8-3, 1.84 g (7.11 mmol) of Compound 8-A, 0.06 g (0.07 mmol) of Pd₂(dba)₃, 0.01 g (0.07 mmol) of PtBu₃, and 0.97 g (10.2 mmol) of NaOtBu were dissolved in 30 mL of toluene, and then the resulting solution was stirred at 85° C. for 4 hours. After allowing the result to cool down to room temperature, an organic layer was extracted three times therefrom by using 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO₄. Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 4.31 g (5.82 mmol) of Compound 8 (yield: 86%). The obtained compound was identified by MS/FAB and ¹H NMR.

C₅₅H₃₆N₂O cal. 740.90, found 740.92.

¹H NMR (400 MHz, CDCl₃) ** 7.93-7.48 (m, 16H), 7.13-6.51 (m, 15H), 6.29-6.27 (m, 2H), 1.86 (s, 3H)

Synthesis Example 2

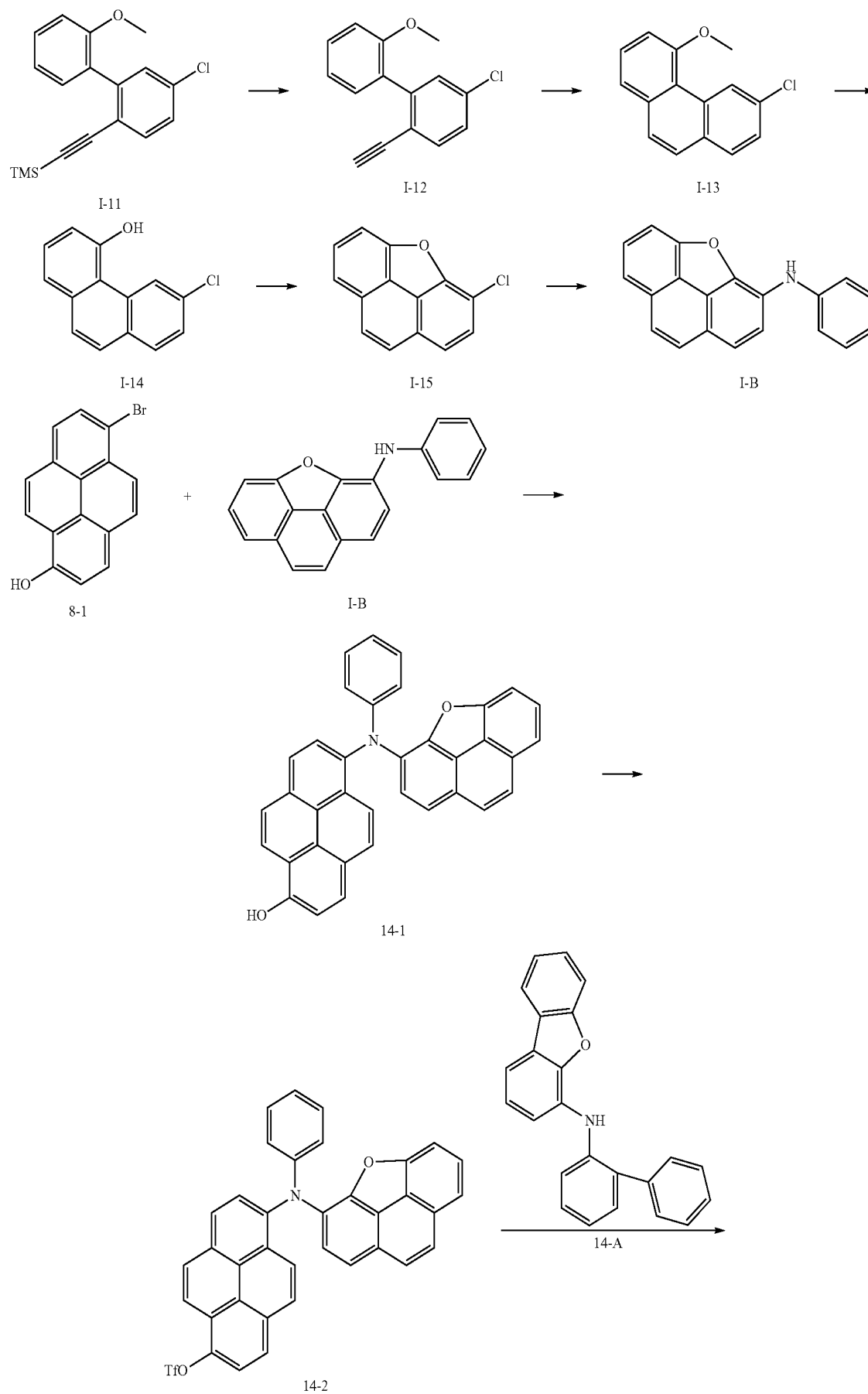
Synthesis of Compound 14

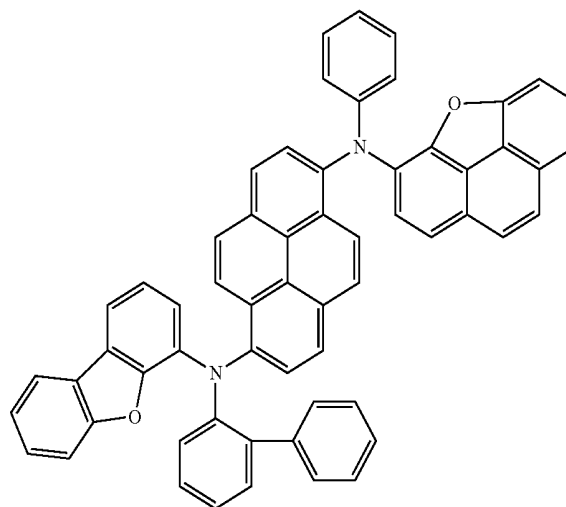


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Synthesis of Intermediate I-9

12.8 g (45 mmol) of Intermediate I-9 (yield: 86%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-1 except that 2-bromo-4-chloro-1-iodobenzene was used instead of 1-bromo-4-chloro-2-iodobenzene. The obtained compound was identified by MS/FAB.

C₁₁H₁₂BrClSi cal. 287.66, found 287.69.

Synthesis of Intermediate I-10

8.51 g (33.8 mmol) of Intermediate I-10 (yield: 75%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-2 except that Intermediate I-9 was used instead of Intermediate I-1. The obtained compound was identified by MS/FAB.

C₁₁H₁₄BClO₂Si cal. 252.57, found 252.62.

Synthesis of Intermediate I-11

6.58 g (20.9 mmol) of Intermediate I-11 (yield: 62%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-4 except that Intermediate I-10 was used instead of Intermediate I-2. The obtained compound was identified by MS/FAB.

C₁₈H₁₉ClOSi cal. 314.88, found 314.96.

Synthesis of Intermediate I-12

4.60 g (19.0 mmol) of Intermediate I-12 (yield: 91%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-5 except that Intermediate I-11 was used instead of Intermediate I-4. The obtained compound was identified by MS/FAB.

C₁₅H₁₁ClO cal. 242.70, found 242.73.

Synthesis of Intermediate I-13

3.63 g (15.0 mmol) of Intermediate I-13 (yield: 79%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-6 except that Intermediate I-12 was used instead of Intermediate I-5. The obtained compound was identified by MS/FAB.

C₁₅H₁₁ClO cal. 242.70, found 242.74.

Synthesis of Intermediate I-14

2.91 g (12.8 mmol) of Intermediate I-14 (yield: 85%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-7 except that Intermediate

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I-13 was used instead of Intermediate I-6. The obtained compound was identified by MS/FAB.

C₁₄H₉ClO cal. 228.67, found 228.72.

Synthesis of Intermediate I-15

30

2.35 g (10.4 mmol) of Intermediate I-15 (yield: 81.1%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-8 except that Intermediate I-14 was used instead of Intermediate I-7. The obtained compound was identified by MS/FAB.

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C₁₄H₇ClO cal. 226.66, found 226.68.

Synthesis of Intermediate I-B

2.53 g (8.94 mmol) of Intermediate I-B (yield: 86%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-A except that Intermediate I-15 was used instead of Intermediate I-8. The obtained compound was identified by MS/FAB.

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C₂₀H₁₃NO cal. 283.33, found 283.37.

Synthesis of Intermediate 14-1

45

2.35 g (5.8 mmol) of Intermediate 14-1 (yield: 79.5%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate 8-2 except that Intermediate I-B was used instead of Intermediate I-A. The obtained compound was identified by MS/FAB.

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C₃₆H₂₁NO₂ cal. 499.57, found 499.60.

Synthesis of Intermediate 14-2

3.44 g (5.45 mmol) of Intermediate 14-2 (yield: 94%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-3 except that Intermediate 14-1 was used instead of 2-methoxyphenol. The obtained compound was identified by MS/FAB.

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C₃₇H₂₀F₃NO₄S cal. 631.62, found 631.65.

Synthesis of Compound 14

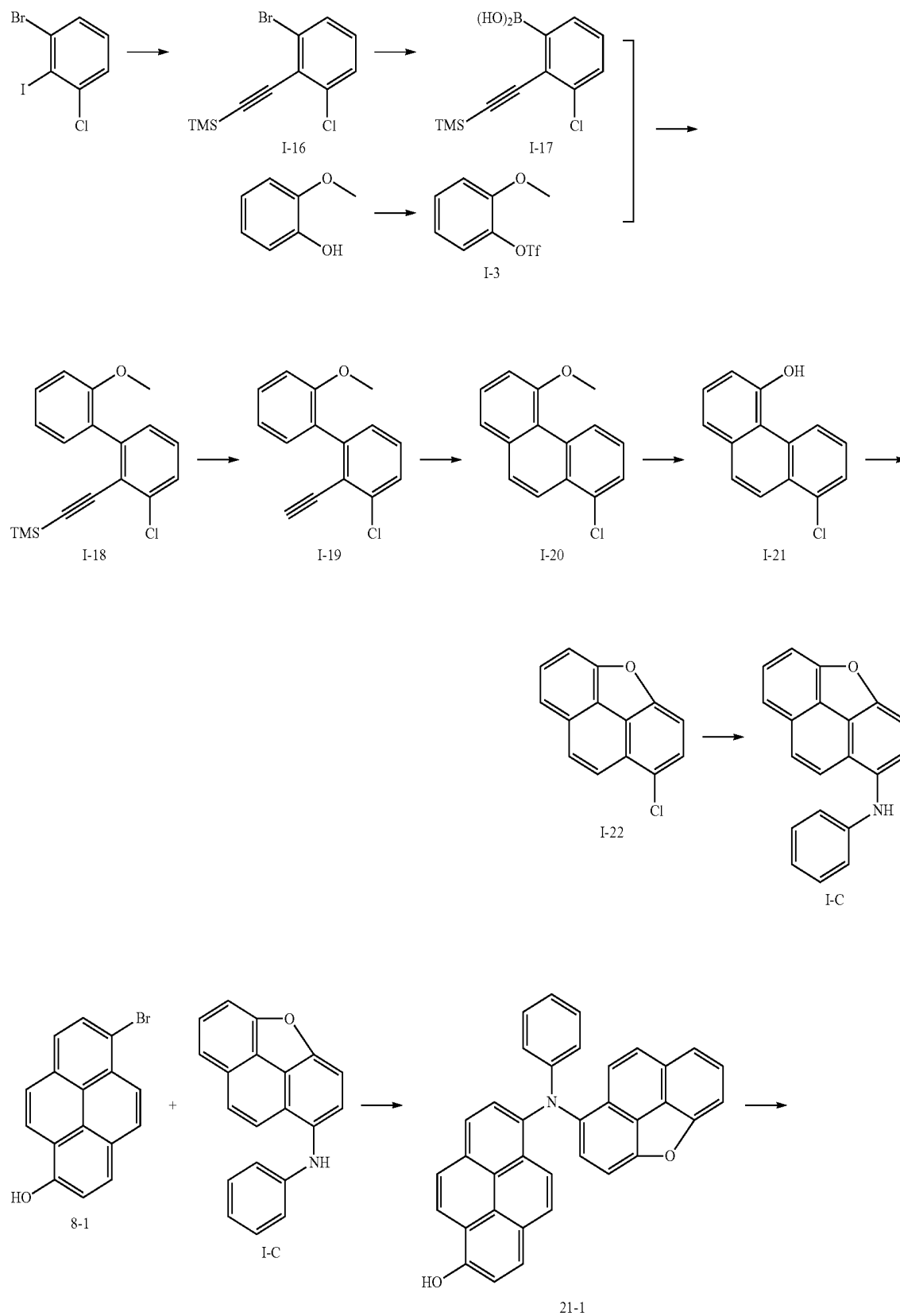
3.17 g (3.87 mmol) of Compound 14 (yield: 71%) was obtained in the same (or substantially the same) manner as in Synthesis of Compound 8 except that Intermediate 14-2 was used instead of Intermediate 8-3, and Compound 14-A was used instead of Compound 8-A. The obtained compound was identified by MS/FAB and ¹H NMR.

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C₆₀H₃₆N₂O₂ cal. 816.96, found 816.99.

65

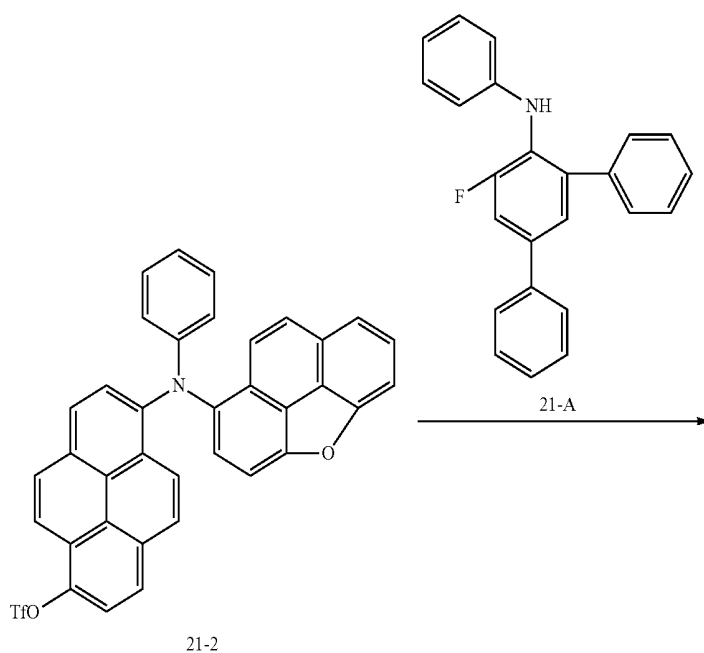
¹H NMR (400 MHz, CDCl₃) □□ 7.98-7.42 (m, 22H), 7.42-6.85 (m, 11H), 6.63-6.61 (m, 1H), 6.29-6.27 (m, 2H)



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-continued



Synthesis of Intermediate I-16

10.3 g (36 mmol) of Intermediate I-16 (yield: 82%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-1 except that 1-bromo-3-chloro-2-iodobenzene was used instead of 1-bromo-4-chloro-2-iodobenzene.

The obtained compound was identified by MS/FAB.

C₁₁H₁₂BrClSi cal. 287.66, found 287.69.

Synthesis of Intermediate I-17

7.17 g (28.4 mmol) of Intermediate I-17 (yield: 79%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-2 except that Intermediate

I-16 was used instead of Intermediate I-1. The obtained compound was identified by MS/FAB.

C₁₁H₁₄BClO₂Si cal. 252.57, found 252.62.

Synthesis of Intermediate I-18

5.89 g (18.7 mmol) of Intermediate I-18 (yield: 66%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-4 except that Intermediate I-17 was used instead of Intermediate I-2. The obtained compound was identified by MS/FAB.

C₁₈H₁₉ClOSi cal. 314.88, found 314.96.

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Synthesis of Intermediate I-19

4.30 g (17.8 mmol) of Intermediate I-19 (yield: 95%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-5 except that Intermediate I-18 was used instead of Intermediate I-4. The obtained compound was identified by MS/FAB.

C₁₅H₁₁ClO cal. 242.70, found 242.73.

Synthesis of Intermediate I-20

2.97 g (12.3 mmol) of Intermediate I-20 (yield: 69%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-6 except that Intermediate I-19 was used instead of Intermediate I-5. The obtained compound was identified by MS/FAB.

C₁₅H₁₁ClO cal. 242.70, found 242.74.

Synthesis of Intermediate I-21

2.53 g (11.1 mmol) of Intermediate I-21 (yield: 90%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-7 except that Intermediate I-20 was used instead of Intermediate I-6. The obtained compound was identified by MS/FAB.

C₁₄H₉ClO cal. 228.67, found 228.72.

Synthesis of Intermediate I-22

1.91 g (8.44 mmol) of Intermediate I-22 (yield: 76%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-8 except that Intermediate I-21 was used instead of Intermediate I-7. The obtained compound was identified by MS/FAB.

C₁₄H₇ClO cal. 226.66, found 226.68.

Synthesis of Intermediate I-C

1.94 g (6.84 mmol) of Intermediate I-C (yield: 81%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-A except that Intermediate I-22 was used instead of Intermediate I-8. The obtained compound was identified by MS/FAB.

C₂₀H₁₃NO cal. 283.33, found 283.37.

Synthesis of Intermediate 21-1

2.50 g (5.0 mmol) of Intermediate 21-1 (yield: 77%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate 8-2 except that Intermediate I-C was used instead of Intermediate I-A. The obtained compound was identified by MS/FAB.

C₃₆H₂₁NO₂ cal. 499.57, found 499.60.

Synthesis of Intermediate 21-2

2.97 g (4.70 mmol) of Intermediate 21-2 (yield: 94%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate I-3 except that Intermediate 21-1 was used instead of 2-methoxyphenol. The obtained compound was identified by MS/FAB.

C₃₇H₂₀F₃NO₄S cal. 631.62, found 631.65.

Synthesis of Compound 21

2.74 g (3.34 mmol) of Compound 21 (yield: 71%) was obtained in the same (or substantially the same) manner as in Synthesis of Compound 8 except that Intermediate 21-2 was used instead of Intermediate 8-3, and Compound 21-A was used instead of Compound 8-A. The obtained compound was identified by MS/FAB and ¹H NMR.

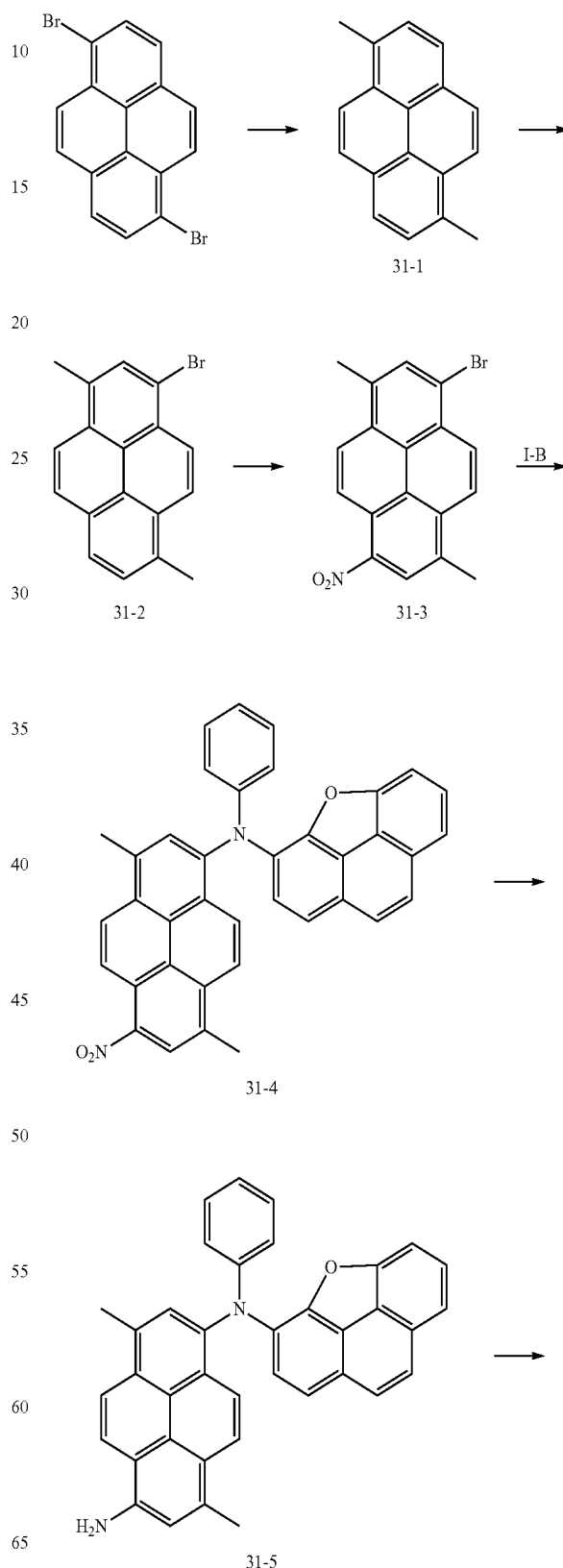
C₆₀H₃₇FN₂O cal. 820.96, found 820.99.

¹H NMR (400 MHz, CDCl₃) δ 7.84-7.32 (m, 24H), 7.11-7.00 (m, 6H), 6.82-6.80 (m, 1H), 6.59-6.55 (m, 2H), 6.17-6.12 (m, 4H)

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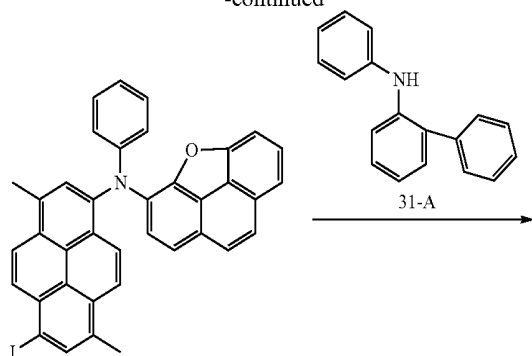
Synthesis Example 4

Synthesis of Compound 31

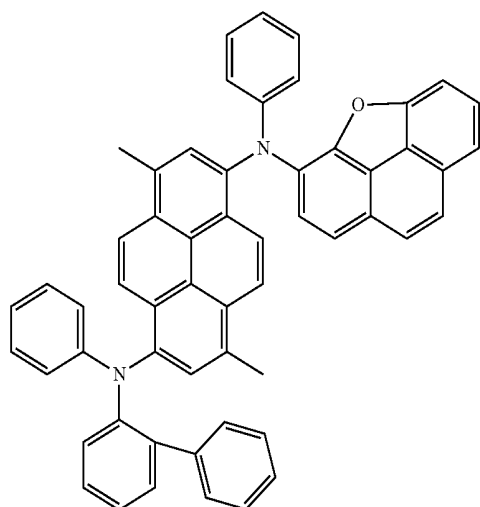


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-continued



31-6



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Synthesis of Intermediate 31-1

7.2 g (20.0 mmol) of 1,6-dibromopyrene was dissolved in 60 mL of THF, and was cooled to -78°C . 48.0 mL of n-BuLi (2.5M in hexane) was slowly added thereto, and the resulting solution was heated up to -30°C ., and then was stirred. 1 hour later, the result was cooled to -78°C . 7.5 mL of iodomethane was slowly added thereto, and the resulting solution was stirred at room temperature for 4 hours. An organic layer was extracted three times therefrom by using 60 mL of water and 60 mL of diethyl ether. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 2.99 g (13 mmol) of Intermediate 31-1 (yield: 65%). The obtained compound was identified by MS/FAB.

$\text{C}_{18}\text{H}_{14}$ cal. 230.31, found 230.35.

Synthesis of Intermediate 31-2

2.9 g (12.6 mmol) of Intermediate 31-1 was dissolved in 30 mL of a mixture solution of diethyl ether/methanol (at a volume ratio of 2.5:1). 3.8 mL of HBr (33 wt % in AcOH) was slowly added thereto at 0°C ., and the resulting solution was stirred for 30 minutes. 1.73 mL of hydrogenperoxide (30 wt % in H_2O) was slowly added to the resulting solution at the same temperature, and the obtained solution was stirred at room temperature for 8 hours. Once the reaction was complete, an organic layer was extracted three times therefrom by using 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evapo-

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ration. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 3.58 g (11.6 mmol) of Intermediate 31-2 (yield: 92%). The obtained compound was identified by MS/FAB.

$\text{C}_{18}\text{H}_{13}\text{Br}$ cal. 309.21, found 309.26.

Synthesis of Intermediate 31-3

3.5 g (11.3 mmol) of Intermediate 31-2 was dissolved in 30 mL of dichloromethane, and then, a solution of 0.85 g (12.4 mmol) of NaNO_2 dissolved in 10 mL of trifluoroacetic acid was slowly added thereto, and the resulting solution was stirred at 0°C . for 30 minutes. 10 mL of triethylamine was then added to the resulting solution in order to complete the reaction. Then, the formed solid was filtered. Then, an organic layer was extracted three times therefrom by using 40 mL of water and 30 mL of dichloromethane. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 2.88 g (8.14 mmol) of Intermediate 31-3 (yield: 72%). The obtained compound was identified by MS/FAB.

$\text{C}_{18}\text{H}_{12}\text{BrNO}_2$ cal. 354.20, found 354.24.

Synthesis of Intermediate 31-4

2.86 g (8.1 mmol) of Intermediate 31-3, 2.75 g (9.72 mmol) of Intermediate I-B, 0.15 g (0.17 mmol) of $\text{Pd}_2(\text{dba})_3$, 0.03 g (0.17 mmol) of PtBu_3 , and 1.2 g (12.5 mmol) of NaOtBu were dissolved in 30 mL of toluene, and then the resulting solution was stirred at 85°C . for 4 hours. After allowing the result to cool down to room temperature, an organic layer was extracted three times therefrom by using each of 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 3.38 g (6.08 mmol) of Intermediate 31-4 (yield: 75%). The obtained compound was identified by MS/FAB.

$\text{C}_{38}\text{H}_{24}\text{N}_2\text{O}_3$ cal. 556.62, found 556.66.

Synthesis of Intermediate 31-5

3.38 g (6.08 mmol) of Intermediate 31-4 was dissolved in 20 mL of a mixture solution of dichloromethane/methanol (at a volume ratio of 1:1). Then, 0.5 g of Pd/C was added thereto, and the resulting solution was stirred in a reaction vessel while introducing hydrogen gas into the reaction vessel at 1 atm for 3 hours. Once the reaction was complete, the resulting solution was filtrated by using a celite. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 2.85 g (5.41 mmol) of Intermediate 31-5 (yield: 89%). The obtained compound was identified by MS/FAB.

$\text{C}_{38}\text{H}_{26}\text{N}_2\text{O}_3$ cal. 526.63, found 526.67.

Synthesis of Intermediate 31-6

2.85 g (5.41 mmol) of Intermediate 31-5 was dissolved in 15 mL of acetonitrile. Then, 16 mL of 1N HCl was added slowly thereto at 0°C . The resulting solution was stirred at the same temperature for 30 minutes. NaNO_2 0.92 g (13.3 mmol) was slowly added thereto, and the obtained solution was stirred for additional 30 minutes. 8 g (48 mmol) of potassium iodide (KI) was added to the resulting solution, and the obtained reaction mixture was stirred for 2 hours. 20 mL of saturated NaHCO_3 solution was added to the reaction mixture. Then, an organic layer was extracted three times therefrom by using 30 mL of ethyl acetate. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained resi-

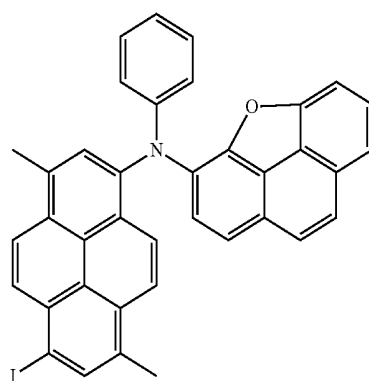
115

due was separated and purified through a silica gel chromatography to thereby obtain 2.10 g (3.30 mmol) of Intermediate 31-6 (yield: 61%). The obtained compound was identified by MS/FAB.

C₃₈H₂₄INO cal. 637.52, found 637.55.

Synthesis of Compound 31

1.97 g (3.1 mmol) of Intermediate 31-6, 0.88 g (3.6 mmol) of Compound 31-A, 0.05 g (0.06 mmol) of Pd₂(dba)₃, 0.01



31-6

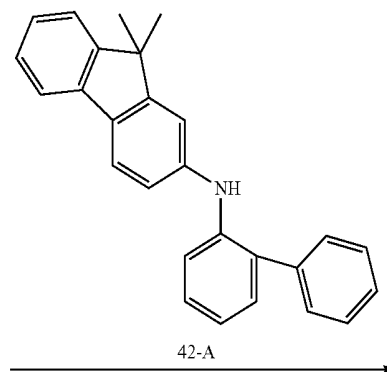
116

¹H NMR (400 MHz, CDCl₃) 8.09 (d, 1H), 7.98 (d, 1H), 7.78-7.45 (m, 13H), 7.25-7.00 (m, 9H), 6.82 (d, 1H), 6.63-6.55 (m, 3H), 6.28-6.26 (m, 2H), 6.04-6.02 (m, 2H), 2.57 (s, 6H)

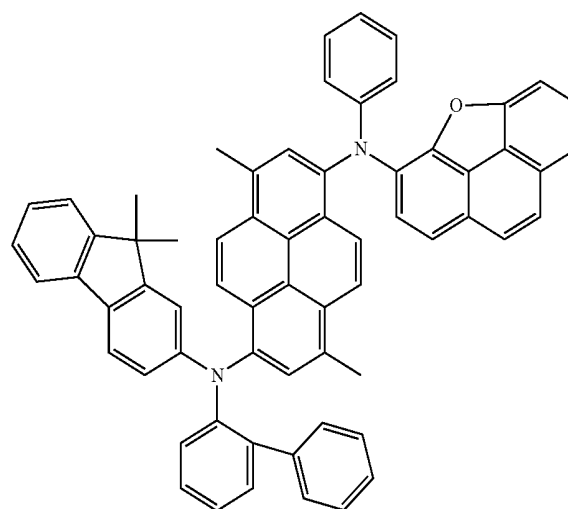
5

Synthesis Example 5

Synthesis of Compound 42



42-A



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g (0.06 mmol) of PtBu₃, and 0.44 g (4.6 mmol) of NaOtBu were dissolved in 20 mL of toluene, and then the resulting solution was stirred at 85° C. for 4 hours. After allowing the result to cool down to room temperature, an organic layer was extracted three times therefrom by using each of 20 mL of water and 20 mL of diethyl ether. The obtained organic layer was dried by using MgSO₄. Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 1.94 g (2.57 mmol) of Compound 31 (yield: 83%). The obtained compound was identified by MS/FAB and ¹H NMR.

C₃₈H₂₄INO cal. 754.93, found 754.96.

2.65 g (3.04 mmol) of Compound 42 (yield: 79%) was obtained in the same (or substantially the same) manner as in Synthesis of Compound 31 except that

Compound 42-A was used instead of Compound 31-A. The obtained compound was identified by MS/FAB and ¹H NMR.

C₆₅H₄₆N₂O cal. 871.09, found 871.14.

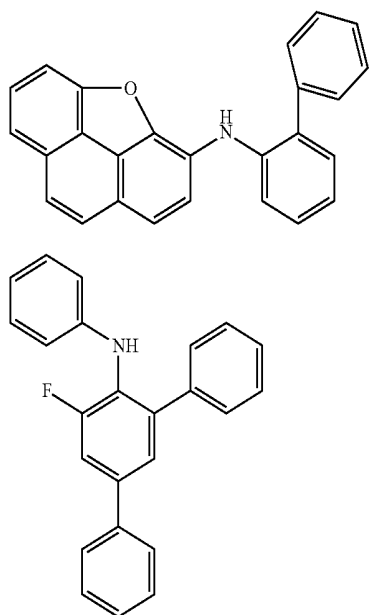
¹H NMR (400 MHz, CDCl₃) 8.00 (d, 1H), 7.97 (d, 1H), 7.78-7.70 (m, 6H), 7.65-7.43 (m, 8H), 7.36-7.30 (m, 2H), 7.21 (d, 1H), 7.15-6.93 (m, 9H), 6.63-6.55 (m, 3H), 6.30-6.24 (m, 3H), 6.06 (s, 1H), 2.57 (s, 6H), 1.61 (s, 6H)

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Synthesis Example 6

Synthesis of Compound 48



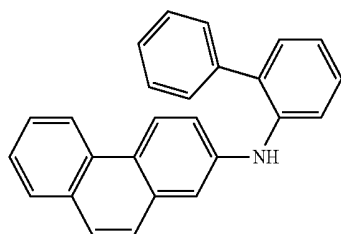
3.10 g (3.46 mmol) of Compound 48 (yield: 71%) was obtained in the same (or substantially the same) manner as in Synthesis of Compound 8 except that Intermediate I-D was used instead of Intermediate I-A, and Compound 48-A was used instead of Compound 8-A. The obtained compound was identified by MS/FAB and ^1H NMR.

$\text{C}_{66}\text{H}_{41}\text{FN}_2\text{O}$ cal. 897.06, found 897.12.

^1H NMR (400 MHz, CDCl_3) 7.91-7.30 (m, 28H), 7.13-6.89 (m, 8H), 6.76-6.61 (m, 3H), 6.10-6.08 (m, 2H)

Synthesis Example 7

Synthesis of Compound 55



2.50 g (3.02 mmol) of Compound 55 (yield: 78%) was obtained in the same (or substantially the same) manner as in Synthesis of Compound 14 except that Compound 55-A was used instead of Compound 14-A. The obtained compound was identified by MS/FAB and ^1H NMR.

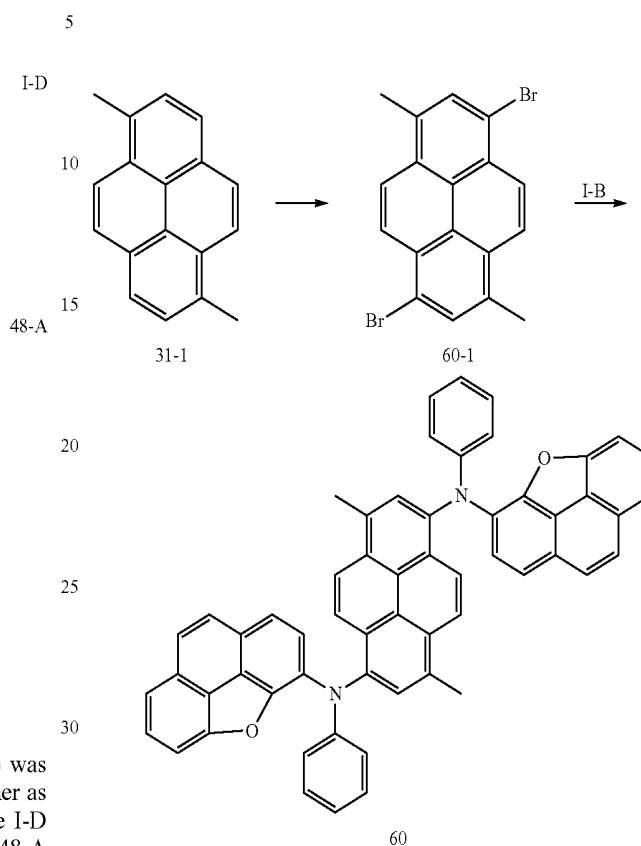
$\text{C}_{62}\text{H}_{38}\text{N}_2\text{O}$ cal. 826.99, found 827.03.

^1H NMR (400 MHz, CDCl_3) 8.46 (d, 1H), 7.98-7.45 (m, 22H), 7.16-6.67 (m, 10H), 6.63-6.60 (m, 2H), 6.29-6.27 (m, 2H)

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Synthesis Example 8

Synthesis of Compound 60



Synthesis of Intermediate 60-1

2.9 g (12.6 mmol) of Compound 31-1 was dissolved in 30 mL of a mixture solution of diethyl ether/methanol (at a volume ratio of 2.5:1). 7.6 mL of HBr (33 wt % in AcOH) was slowly added thereto at 0°C ., and the resulting solution was stirred for 30 minutes. 3.4 mL of hydrogenperoxide (30 wt % in H_2O) was slowly added to the resulting solution at the same temperature, and the mixture was stirred at room temperature for 8 hours. Once the reaction was complete, an organic layer was extracted three times therefrom by using each of 30 mL of water and 30 mL of diethyl ether. The obtained organic layer was dried by using MgSO_4 . Then, a solvent was removed therefrom by evaporation. The obtained residue was separated and purified through a silica gel chromatography to thereby obtain 4.11 g (10.6 mmol) of Intermediate 60-1 (yield: 84%). The obtained compound was identified by MS/FAB.

$\text{C}_{18}\text{H}_{12}\text{Br}_2$ cal. 388.10, found 388.22.

Synthesis of Compound 60

2.08 g (2.62 mmol) of Compound 60 (yield: 81%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate 31-4 except that Intermediate 60-1 was used instead of Intermediate 31-3. The obtained compound was identified by MS/FAB and ^1H NMR.

$\text{C}_{58}\text{H}_{36}\text{N}_2\text{O}_2$ cal. 792.93, found 792.95.

^1H NMR (400 MHz, CDCl_3) 8.11-8.09 (m, 2H), 7.76-7.49 (m, 14H), 7.23-7.21 (m, 2H), 7.06-7.00 (m, 6H), 6.63-6.60 (m, 2H), 6.28-6.20 (m, 4H), 2.57 (m, 6H),

Synthesis of Compound 72

3.11 g (3.39 mmol) of Compound 72 (yield: 72%) was obtained in the same (or substantially the same) manner as in Synthesis of Intermediate 31-4 except that 1,6-dibromopyrene was used instead of Intermediate 31-3, and Intermediate I-D was used instead of Intermediate I-B. The obtained compound was identified by MS/FAB and ¹H NMR.

C₆₈H₄₀N₂O₂ cal. 917.08, found 917.13.

¹H NMR (400 MHz, CDCl₃) 7.96-7.94 (m, 2H), 7.78-7.30 (m, 26H), 7.20-7.15 (m, 6H), 7.01-6.97 (m, 6H)

The following Compounds were prepared and identified by ¹H NMR and MS/FAB. The results thereof are shown in Table 1.

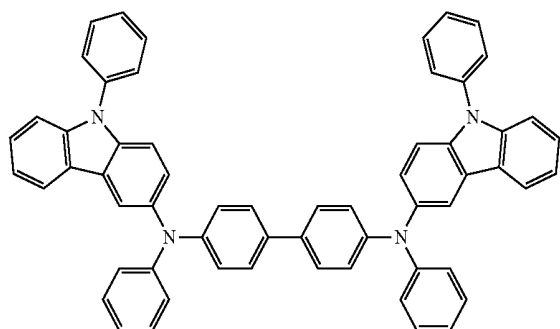
Methods of synthesizing compounds other than Compounds shown in Table 1 should be apparent to those skilled in the art by referring to the synthesis pathways and raw materials described in Synthesis Examples 1 to 8.

A Corning 15 Ohms per square centimeter (Ω/cm_2) (1200 Å) ITO glass substrate was cut to a size of 50 millimeters (mm)×50 mm×0.7 mm, sonicated in isopropyl alcohol and pure water, for 5 minutes in each solvent, and cleaned by exposure to ultraviolet rays with ozone so as to use the glass substrate as an anode. Then, the obtained glass substrate was mounted in a vacuum-deposition apparatus. 4,4'-Bis[N-phenyl-N-(9-phenylcarbazol-3-yl)amino]-1,1'-biphenyl (Compound 301) was first vacuum-deposited on the substrate as a hole injection layer having a thickness of about 600 Å. Then, a hole transporting compound (N-[1,1'-biphenyl]-4-yl-9,9-dimethyl-N-[4-(9-phenyl-9H-carbazol-3-yl)phenyl]-9H-fluorene-2-amine (Compound 311)) was vacuum-deposited on the hole injection layer to form a hole transport layer having a thickness of about 300 Å.

TABLE 1

Compound	¹ H NMR (CDCl ₃ , 400 MHz)	MS/FAB	
		found	calc.
1	δ = 7.93-7.90 (m, 2H), 7.80-7.70 (m, 3H), 7.52-7.47 (m, 7H), 7.14-7.02 (m, 8H), 6.71-6.61 (m, 4H), 6.29-6.27 (m, 2H), 6.14-6.10 (m, 4H)	650.80	650.78
4	δ = 7.97 (d, 1H), 7.90 (d, 1H), 7.78-7.74 (m, 3H), 7.65-7.45 (m, 7H), 7.40-7.32 (m, 5H), 7.23-7.15 (m, 3H), 7.06-7.01 (m, 2H), 6.65-6.62 (m, 1H), 6.56-6.50 (m, 5H), 6.20-6.12 (m, 2H), 0.24 (s, 9H), 0.27 (s, 9H)	795.16	795.14
12	δ = 7.98-7.70 (m, 3H), 7.55-7.48 (m, 5H), 7.35-7.07 (m, 22H), 6.53-6.50 (m, 2H), 6.32-6.29 (m, 3H), 6.25-6.20 (m, 1H), 1.61 (s, 6H)	843.06	843.04
16	δ = 7.96-7.30 (m, 22H), 7.11-7.07 (m, 8H), 6.71-6.65 (m, 3H), 6.29-6.25 (m, 2H), 6.08-6.05 (m, 2H)	820.97	820.96
20	δ = 8.11-7.75 (m, 9H), 7.70-7.35 (m, 13H), 7.29-6.97 (m, 10H), 6.67-6.60 (m, 2H), 6.29-6.25 (m, 2H)	833.04	833.02
23	δ = 7.99 (d, 1H), 7.85-7.75 (m, 5H), 7.66-7.39 (m, 17H), 7.30-6.82 (m, 10H), 6.63-6.61 (m, 1H), 6.04-6.02 (m, 2H)	816.99	816.96
29	δ = 8.01-7.70 (m, 7H), 7.48-7.45 (m, 2H), 7.32 (d, 1H), 7.05-7.00 (m, 8H), 6.83 (d, 1H), 6.64-6.62 (m, 3H), 6.15-6.10 (m, 6H), 2.57 (s, 6H)	772.29	772.29
34	δ = 7.91 (d, 1H), 7.85-7.68 (m, 4H), 7.60-7.43 (m, 11H), 7.40-7.37 (m, 2H), 7.20-7.09 (m, 4H), 7.04-6.95 (m, 4H), 6.83 (d, 1H), 6.69-6.59 (m, 4H), 6.04-6.02 (m, 2H), 0.24 (s, 9H)	799.07	799.06
38	δ = 8.32-8.30 (m, 2H), 8.04-7.96 (m, 2H), 7.80-7.68 (m, 3H), 7.60-7.45 (m, 11H), 7.34 (d, 1H), 7.20-7.11 (m, 3H), 7.06-6.97 (m, 7H), 6.82-6.79 (m, 2H), 6.74-6.63 (m, 2H), 6.63-6.60 (m, 1H), 6.03-6.00 (m, 2H), 1.48 (s, 18H)	915.21	915.19
40	δ = 7.93-7.70 (m, 5H), 7.52-7.39 (m, 13H), 7.16-7.00 (m, 8H), 6.79-6.63 (m, 5H), 6.04-6.02 (m, 2H)	751.90	751.88
44	δ = 7.93-7.30 (m, 22H), 7.07-7.00 (m, 5H), 6.74-6.52 (m, 5H), 6.10-6.08 (m, 2H), 2.28 (s, 3H), 2.15 (s, 6H)	863.10	863.04
49	δ = 7.93-7.41 (m, 22H), 7.18-7.06 (m, 7H), 6.80-6.69 (m, 5H), 6.27-6.20 (m, 4H)	802.99	802.97
62	δ = 8.45-8.43 (m, 2H), 8.27-8.25 (m, 2H), 7.78-7.75 (m, 6H), 7.68-7.63 (m, 4H), 7.48-7.46 (m, 2H), 7.23-7.21 (m, 2H), 7.09-7.02 (m, 6H), 6.63-6.59 (m, 2H), 6.27-6.23 (m, 4H), 0.41 (s, 18H)	909.27	909.25
67	δ = 8.08-7.99 (m, 6H), 7.64-7.58 (m, 6H), 7.50-7.43 (m, 12H), 7.18-7.04 (m, 8H), 6.73-6.70 (m, 4H), 6.32-6.28 (m, 4H)	917.10	917.08
70	δ = 8.00-7.98 (m, 2H), 7.90-7.84 (m, 2H), 7.78-7.71 (m, 7H), 7.67-7.54 (m, 6H), 7.48-7.40 (m, 3H), 7.33-7.30 (m, 1H), 7.11-7.09 (m, 2H), 7.06-7.01 (m, 4H), 6.67-6.59 (m, 2H), 6.46-6.44 (m, 1H), 6.29-6.27 (m, 2H), 1.61 (s, 6H)	881.07	881.04

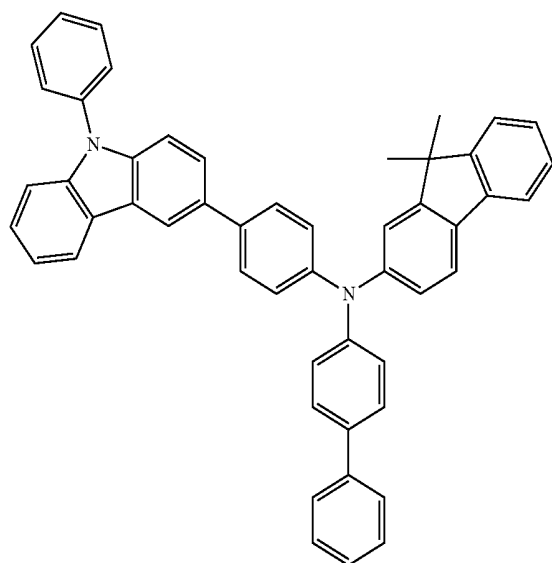
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301

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311 15

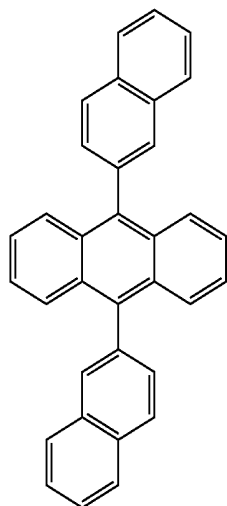


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ADN

9,10-di-naphthalene-2-yl-anthracene (ADN) as a blue fluorescent host, and

Compound 8 as a blue fluorescent dopant, were co-deposited at a weight ratio of about 98:2 on the hole transport layer to form an emission layer having a thickness of about 300 Å.

Afterward, Alq₃ was vacuum-deposited on the emission layer to form an electron transport layer having a thickness of about 300 Å. Then, LiF, an alkali metal halide, was vacuum-deposited on the electron transport layer to form an

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electron injection layer having a thickness of about 10 Å. Aluminum (Al) was vacuum-deposited on the electron injection layer to form a cathode having a thickness of about 3000 Å, thereby forming a LiF/Al electrode to complete the manufacture of an organic light-emitting device.

Example 2

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 14 was used instead of Compound 8 to form an emission layer.

Example 3

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 21 was used instead of Compound 8 to form an emission layer.

Example 4

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 31 was used instead of Compound 8 to form an emission layer.

Example 5

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 42 was used instead of Compound 8 to form an emission layer.

Example 6

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 48 was used instead of Compound 8 to form an emission layer.

Example 7

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 55 was used instead of Compound 8 to form an emission layer.

Example 8

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 60 was used instead of Compound 8 to form an emission layer.

Example 9

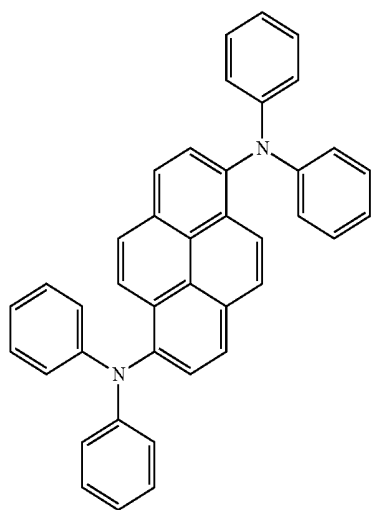
Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1 except that Compound 72 was used instead of Compound 8 to form an emission layer.

Comparative Example 1

Organic light-emitting devices were manufactured in the same (or substantially the same) manner as in Example 1

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except that N,N,N',N'-tetraphenyl-pyrene-1,6-diamine (TPD) was used as a dopant instead of Compound 8.



TPD

The characteristics of organic light-emitting devices according to Examples 1 to 9 and Comparative Example 1 are shown in Table 2.

TABLE 2

	Dopant	Driving voltage (V)	Current density (mA/cm ²)	Luminance (cd/m ²)	Efficiency (cd/A)	Emission color	Half-life (hr @100 mA/cm ²)
Example 1	Compound 8	6.64	50	3,105	6.21	blue	333 hr
Example 2	Compound 14	6.67	50	3,185	6.37	blue	342 hr
Example 3	Compound 21	6.70	50	3,200	6.40	blue	338 hr
Example 4	Compound 31	6.62	50	3,210	6.42	blue	347 hr
Example 5	Compound 42	6.71	50	3,230	6.46	blue	361 hr
Example 6	Compound 48	6.72	50	3,165	6.33	blue	341 hr
Example 7	Compound 55	6.75	50	3,205	6.41	blue	376 hr
Example 8	Compound 60	6.64	50	3,325	6.65	blue	383 hr
Example 9	Compound 72	6.58	50	3,290	6.58	blue	365 hr
Comparative Example 1	TPD	6.96	50	2,730	5.46	blue	248 hr

Comparative Example 2

An organic emission layer was manufactured in the same (or substantially the same) manner as in Example 1 except that in forming an emission layer, Compound H9 represented by Formula 4 was used as a host instead of ADN, and TPD was used as a dopant instead of Compound 8.

Example 10

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 1 except that in forming an emission layer, Compound H9 represented by Formula 4 was used as a host instead of ADN.

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Example 11

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 10 except that Compound 14 was used instead of Compound 8 to form an emission layer.

Example 12

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 10 except that Compound 21 was used instead of Compound 8 to form an emission layer.

Example 13

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 10 except that Compound 31 was used instead of Compound 8 to form an emission layer.

Example 14

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 10 except that Compound 42 was used instead of Compound 8 to form an emission layer.

Example 15

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 10 except that in forming an emission layer, Compound H45 was used as a host instead of Compound H9, and Compound 14 was used as a dopant instead of Compound 8.

Example 16

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 21 was used instead of Compound 14 to form an emission layer.

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Example 17

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 31 was used instead of Compound 14 to form an emission layer.

Example 18

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 42 was used instead of Compound 14 to form an emission layer.

Example 19

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 48 was used instead of Compound 14 to form an emission layer.

Example 20

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 55 was used instead of Compound 14 to form an emission layer.

Example 21

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 15 except that Compound 60 was used instead of Compound 14 to form an emission layer.

Example 22

An organic light-emitting device was manufactured in the same manner as in Example 10 except that in forming an emission layer, Compound H60 was used as a host instead of Compound H9, and Compound 14 was used as a dopant instead of Compound 8.

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Example 23

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 22 except that Compound 21 was used instead of Compound 14 to form an emission layer.

Example 24

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 22 except that Compound 42 was used instead of Compound 14 to form an emission layer.

Example 25

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 22 except that Compound 55 was used instead of Compound 14 to form an emission layer.

Example 26

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 22 except that Compound 60 was used instead of Compound 14 to form an emission layer.

Example 27

An organic light-emitting device was manufactured in the same (or substantially the same) manner as in Example 22 except that Compound 72 was used instead of Compound 14 to form an emission layer.

The characteristics of organic light-emitting devices according to Examples 10 to 27 and Comparative Examples 1 and 2 are shown in Table 3.

TABLE 3

	Host	Dopant	Driving voltage (V)	Current density (mA/cm ²)	Luminance (cd/m ²)	Efficiency (cd/A)	Emission color	half-life (hr @100 mA/cm ²)
Example 10	Compound H9	Compound 8	6.54	50	3,275	6.55	blue	442 hr
Example 11	Compound H9	Compound 14	6.55	50	3,330	6.66	blue	456 hr
Example 12	Compound H9	Compound 21	6.61	50	3,370	6.74	blue	437 hr
Example 13	Compound H9	Compound 31	6.58	50	3,365	6.73	blue	479 hr
Example 14	Compound H9	Compound 42	6.57	50	3,375	6.75	blue	481 hr
Example 15	Compound H45	Compound 14	6.52	50	3,345	6.69	blue	467 hr
Example 16	Compound H45	Compound 21	6.58	50	3,365	6.73	blue	471 hr
Example 17	Compound H45	Compound 31	6.53	50	3,425	6.85	blue	478 hr
Example 18	Compound H45	Compound 42	6.54	50	3,475	6.95	blue	492 hr
Example 19	Compound H45	Compound 48	6.52	50	3,420	6.84	blue	468 hr
Example 20	Compound H45	Compound 55	6.53	50	3,505	7.01	blue	495 hr
Example 21	Compound	Compound	6.48	50	3,575	7.15	blue	490 hr

TABLE 3-continued

	Host	Dopant	Driving voltage (V)	Current density (mA/cm ²)	Luminance (cd/m ²)	Efficiency (cd/A)	Emission color	half-life (hr @100 mA/cm ²)
Example 22	H45	60						
	Compound H60	Compound 14	6.53	50	3,325	6.65	blue	420 hr
Example 23	Compound H60	Compound 21	6.53	50	3,380	6.76	blue	399 hr
Example 24	Compound H60	Compound 42	6.54	50	3,430	6.86	blue	437 hr
Example 25	Compound H60	Compound 55	6.53	50	3,460	6.92	blue	445 hr
Example 26	Compound H60	Compound 60	6.48	50	3,510	7.02	blue	457 hr
Example 27	Compound H60	Compound 72	6.43	50	3,490	6.98	blue	453 hr
Comparative Example 1	ADN	TPD	6.96	50	2,730	5.46	blue	248 hr
Comparative Example 2	H9	TPD	6.73	50	2,835	5.67	blue	384 hr

When a compound represented by Formula 1 according to embodiments of the present invention was used as a dopant in a blue emission layer, efficiency and lifespan of an organic light-emitting device may improve compared to those of an organic light-emitting device using a related compound as a blue dopant. In addition, when a compound represented by Formula 4 according to embodiments of the present invention is also used at the same time as a host in the emission layer, this effect may be further increased.

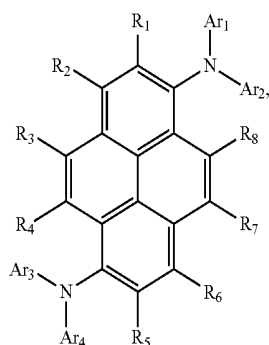
As described above, according to one or more embodiments of the present invention, the compound represented by Formula 1 has excellent stability and is suitable as an electron transporting material. An organic light-emitting device using the compound of Formula 1 may have high efficiency, low voltage, high luminance, and long lifespan.

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

While one or more exemplary 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 as defined by the following claims and equivalents thereof.

What is claimed is:

1. A compound represented by Formula 1:

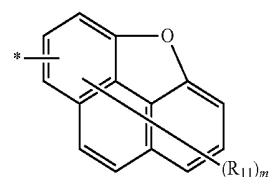


wherein in Formula 1,

R₁ to R₈ and Ar₁ to Ar₄ are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇);

and at least one selected from Ar₁ to Ar₄ is represented by Formula 1-a:



Formula 1-a

wherein in Formula 1-a,

R₁₁ is as defined in connection with R₁ to R₈;

m is an integer selected from 1 to 7;

* indicates a binding site; and

wherein in Formulae 1 and 1-a, 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 is selected from:

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a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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;

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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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);

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;

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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 —N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇);

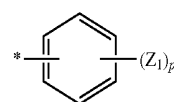
wherein Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, and a monovalent non-aromatic condensed heteropolycyclic group.

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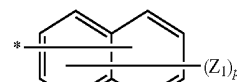
2. The compound of claim 1, wherein Ar₁ to Ar₄ in Formula 1 that are not represented by Formula 1-a are each independently selected from a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

3. The compound of claim 1, wherein in Formula 1, R₁ to R₈ are each independently selected from a hydrogen, a deuterium, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, and —Si(Q₃)(Q₄)(Q₅).

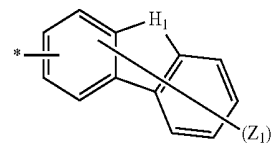
4. The compound of claim 1, wherein Ar₁ to Ar₄ in Formula 1 that are not represented by Formula 1-a are each independently a compound represented by any one of Formulae 2a to 2d:



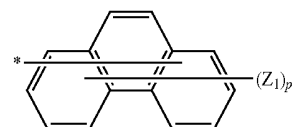
2a



2b



2c



2d

wherein in Formulae 2a to 2d, Z₁ is selected from a hydrogen atom, a deuterium, 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 C₆-C₂₀ condensed polycyclic group, a halogen group, a cyano group, a nitro group, a hydroxyl group, and a carboxyl group;

H₁ is selected from —O—, —S—, and —CR₅₁R₅₂—;

p is an integer selected from 1 to 9;

R₅₁ and R₅₂ are as defined in connection with R₁ to R₈; and

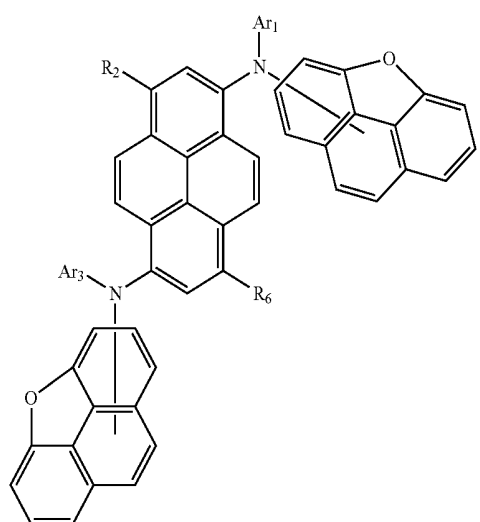
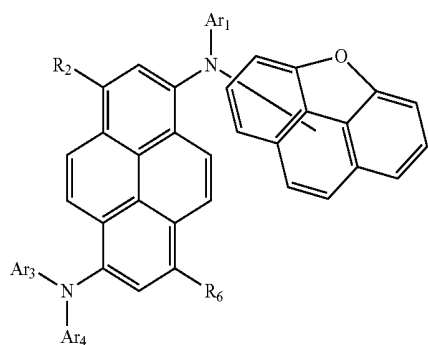
* indicates a binding site.

5. The compound of claim 1, wherein in Formula 1, R₂ and R₆ are each independently selected from a hydrogen, a deuterium, a C₁-C₂₀ alkyl group, a C₆-C₂₀ aryl group, and —Si(Q₄₁)(Q₄₂)(Q₄₃); wherein Q₄₁ to Q₄₃ are each independently selected from a C₁-C₆₀ alkyl group and a C₆-C₆₀ aryl group.

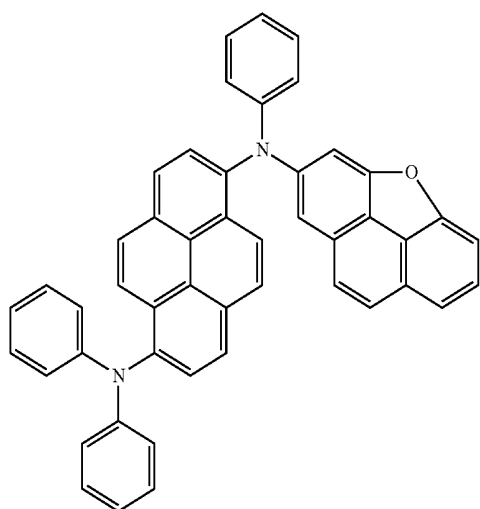
6. The compound of claim 1, wherein in Formula 1, R₁, R₃ to R₅, R₇, and R₈ are each independently selected from a hydrogen and a deuterium.

7. The compound of claim 1, wherein in Formula 1-a, R₁₁ is selected from a hydrogen and a deuterium.

8. The compound of claim 1, wherein the compound represented by Formula 1 is represented by any one of Formulae 2 and 3:

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9. The compound of claim 1, wherein
the compound of Formula 1 is selected from compounds
1 through 72:

**132**

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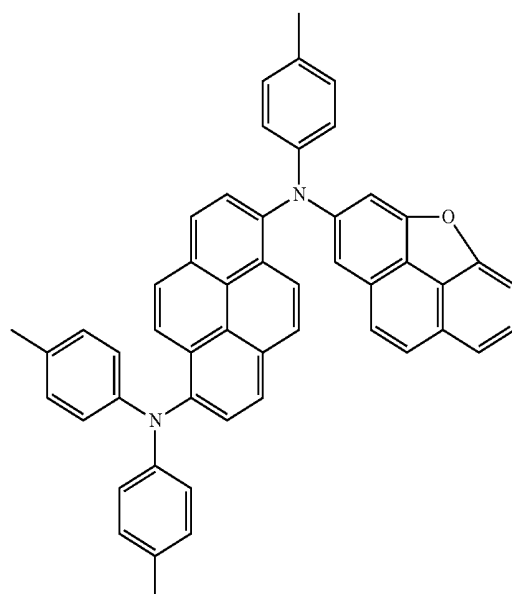
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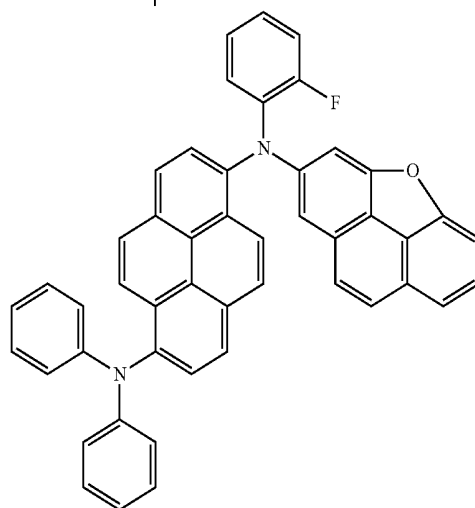
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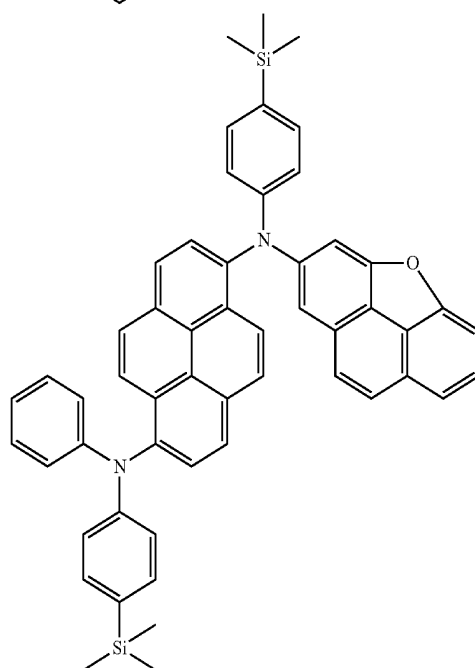
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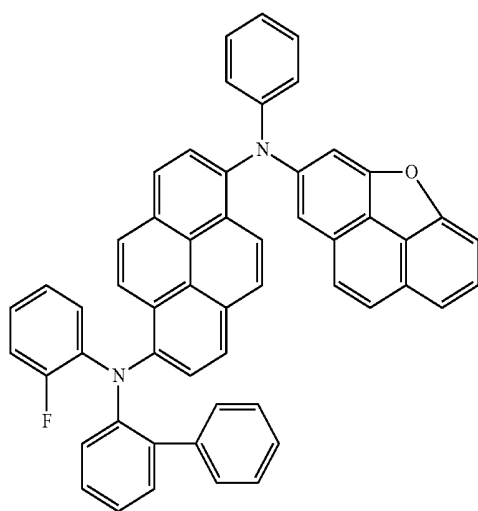
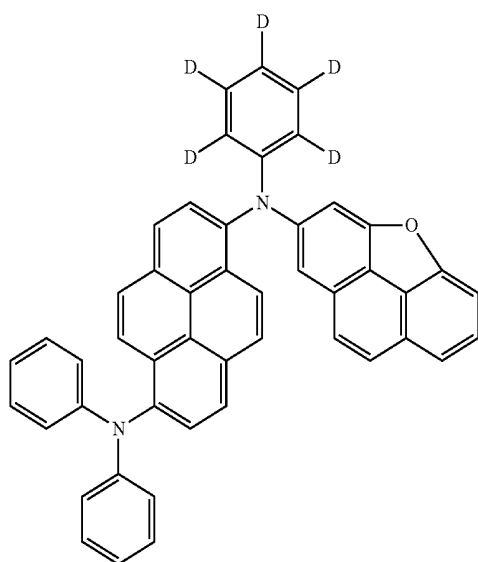
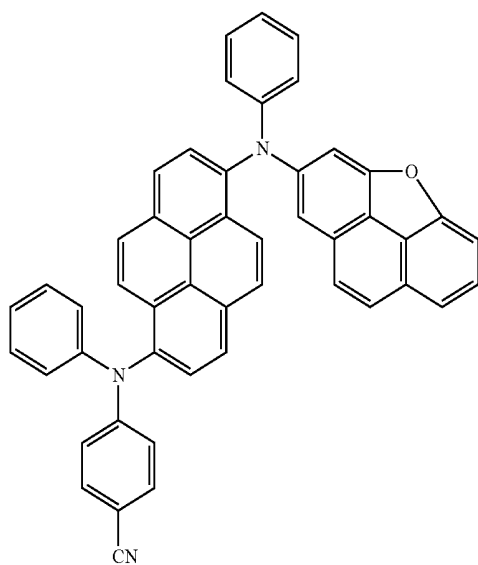
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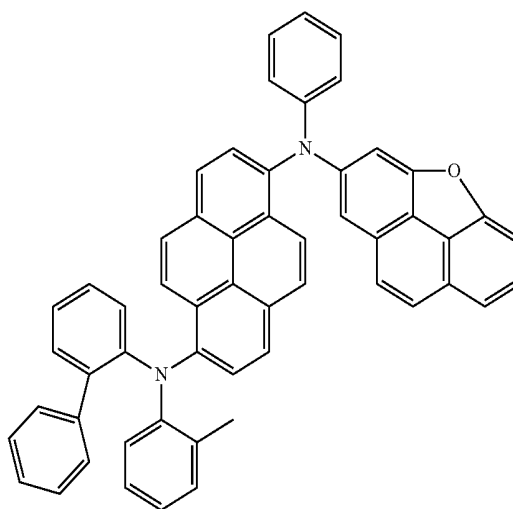
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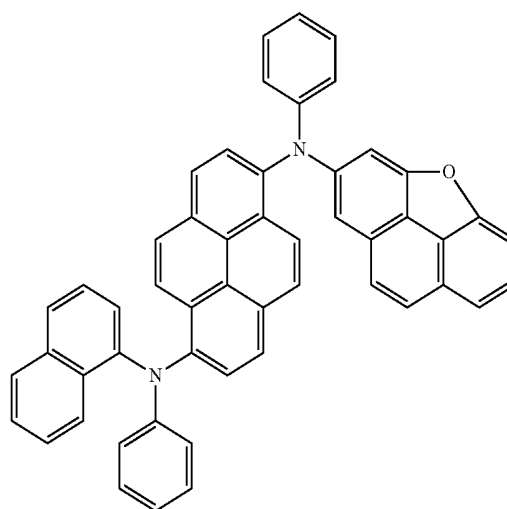
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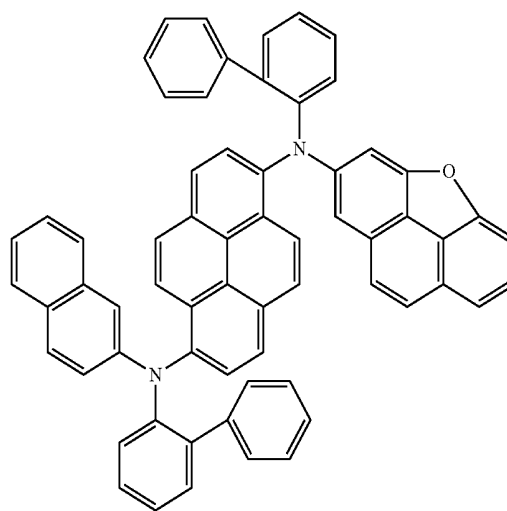
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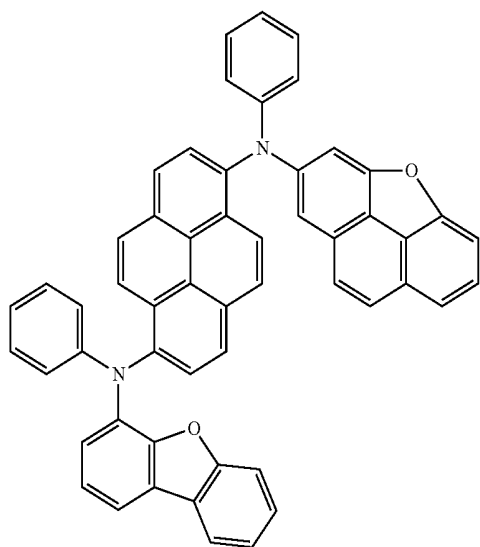
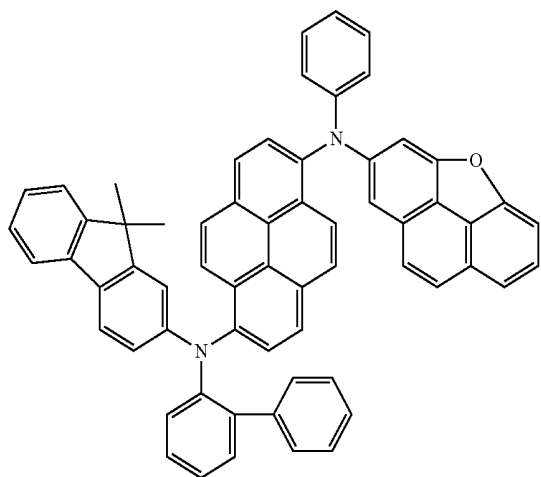
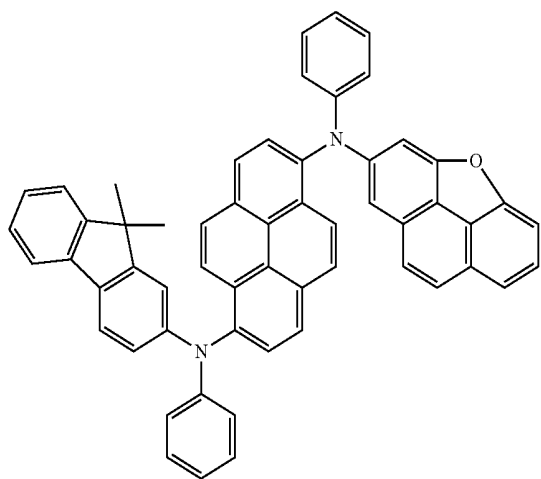
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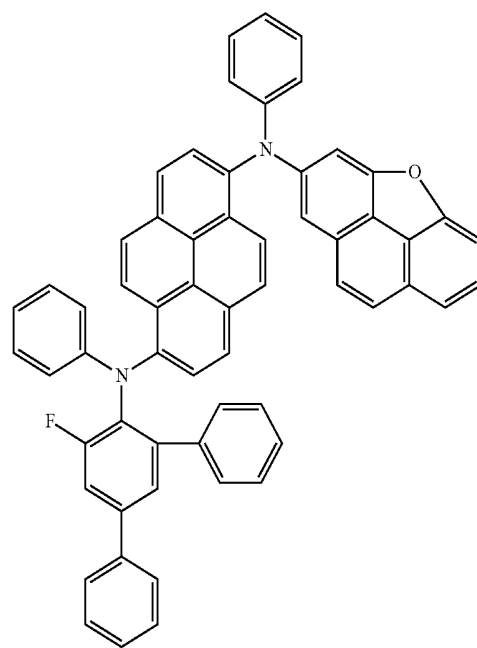
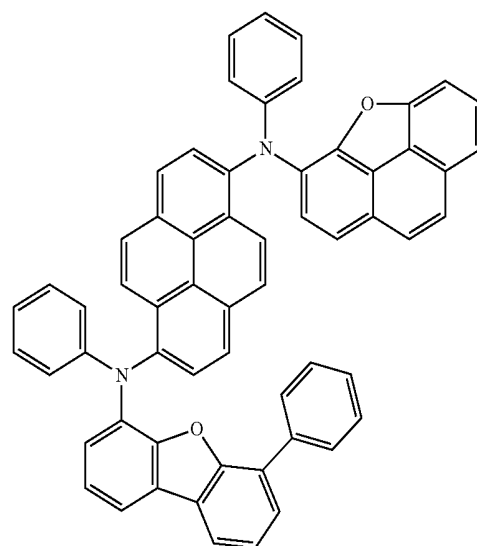
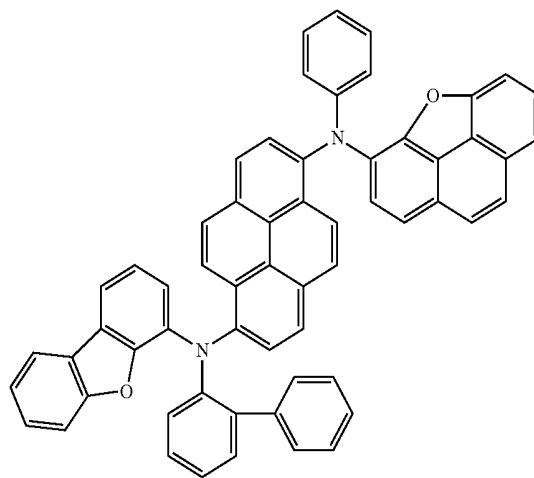
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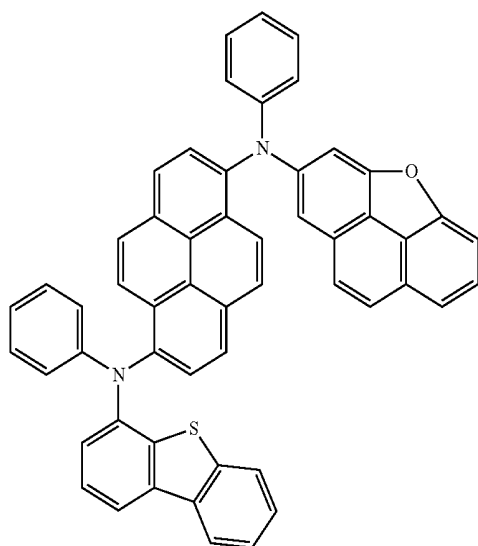
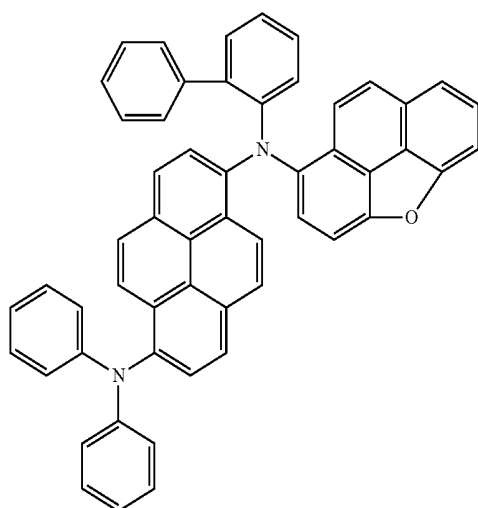
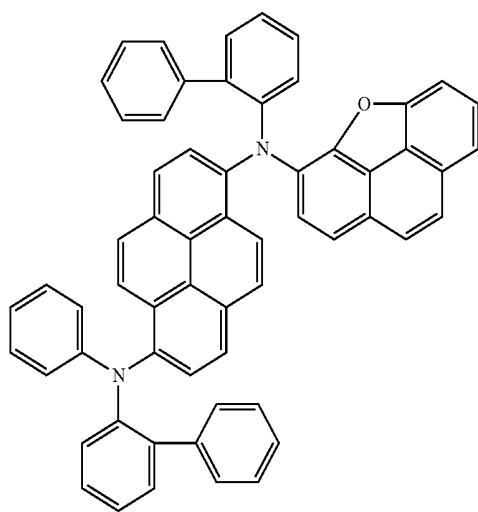
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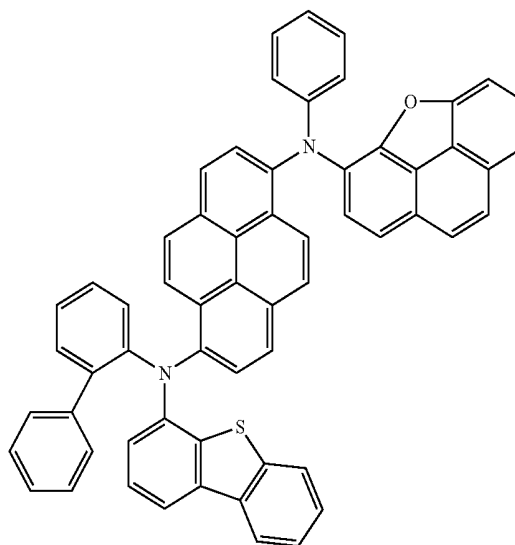
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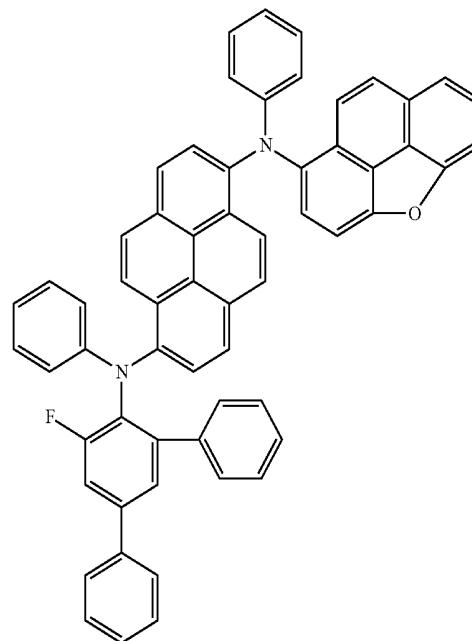
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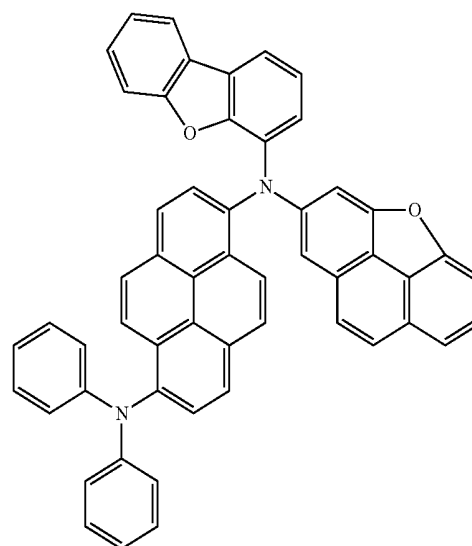
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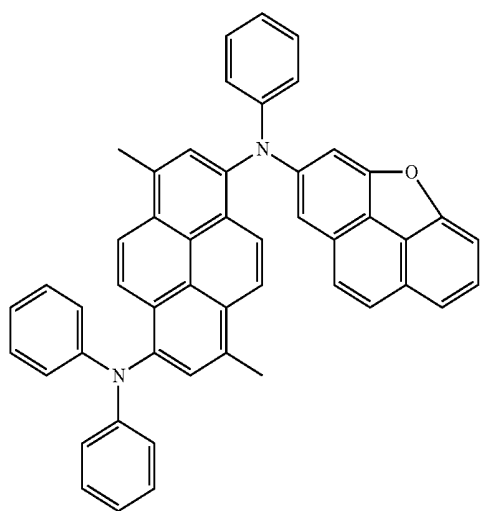
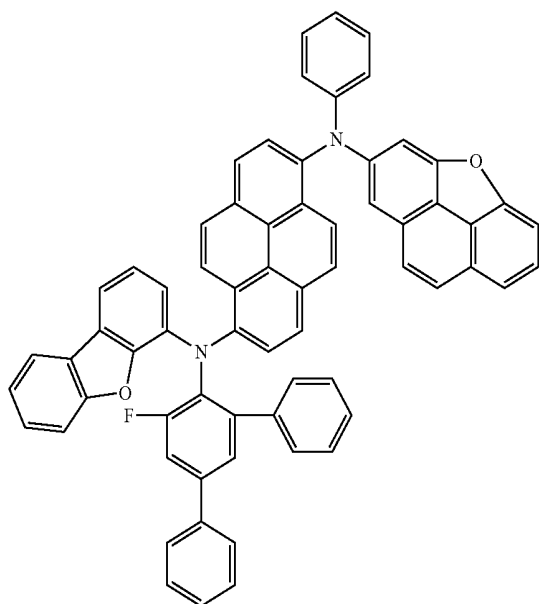
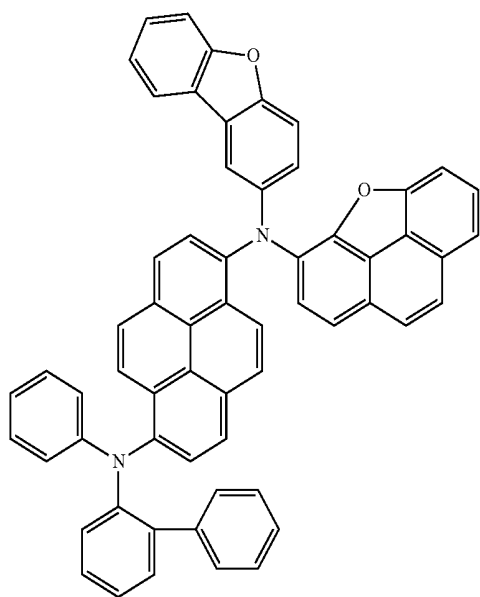
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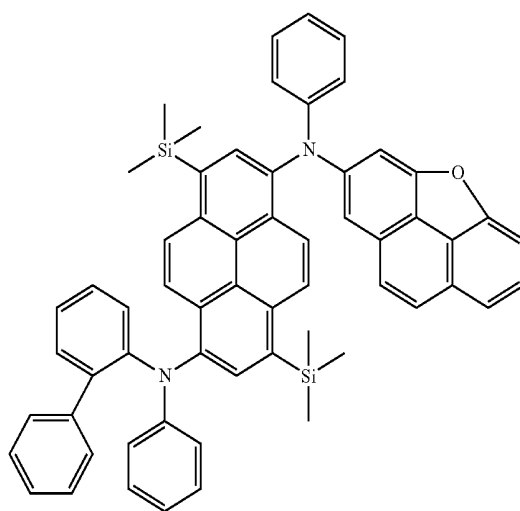
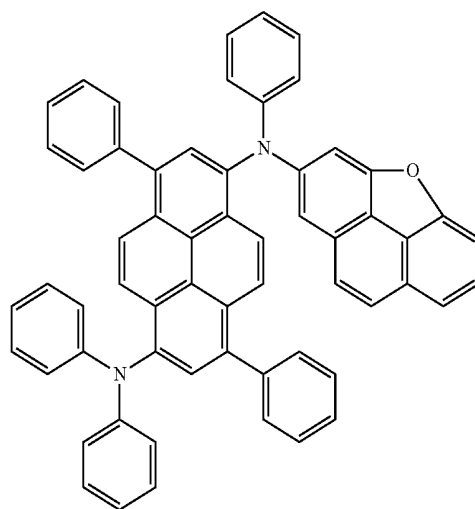
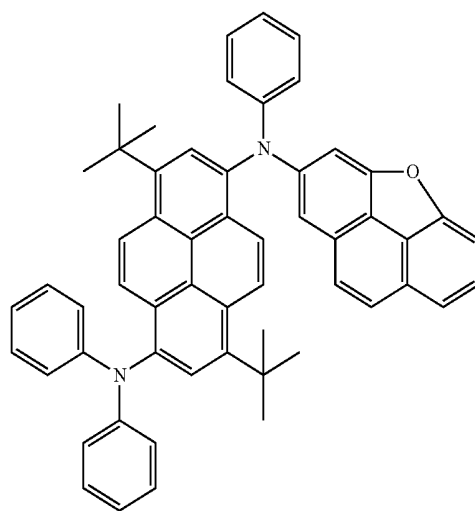
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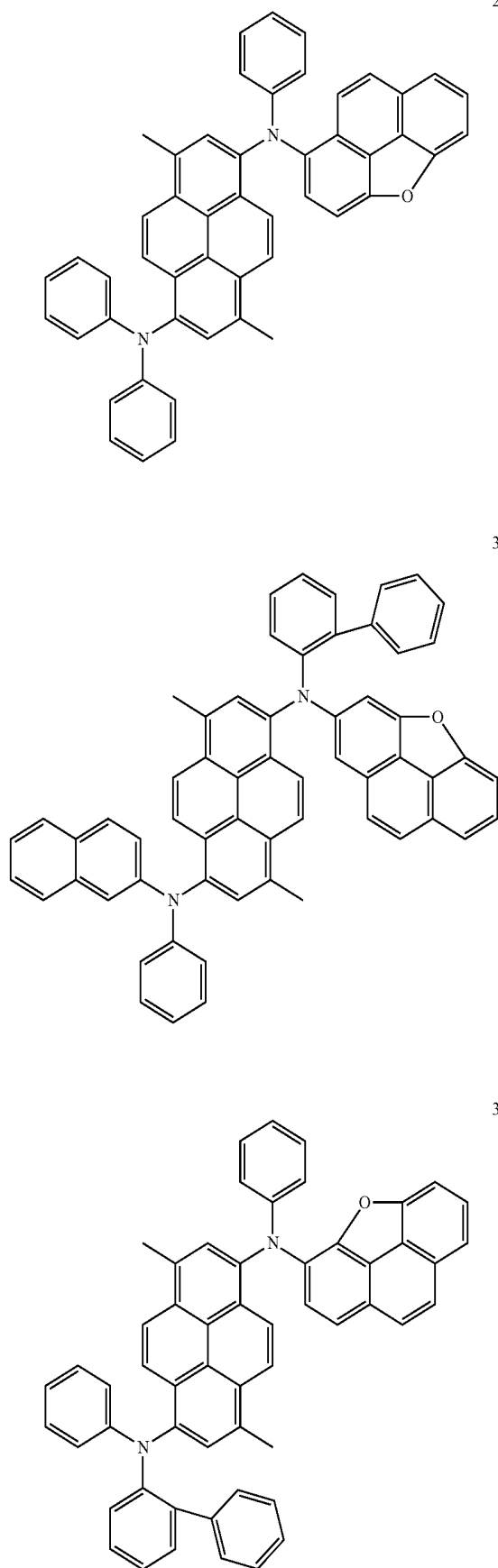
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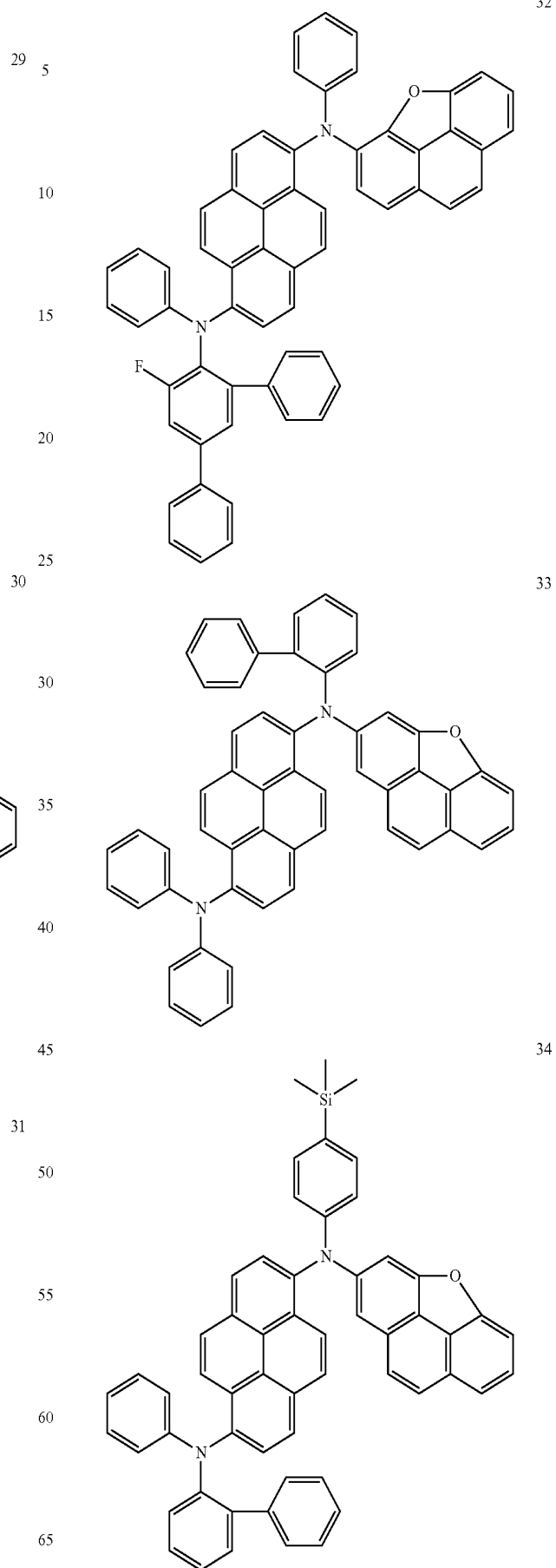


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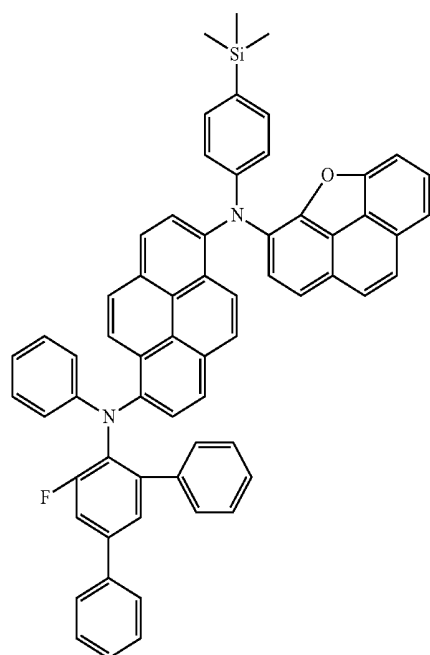
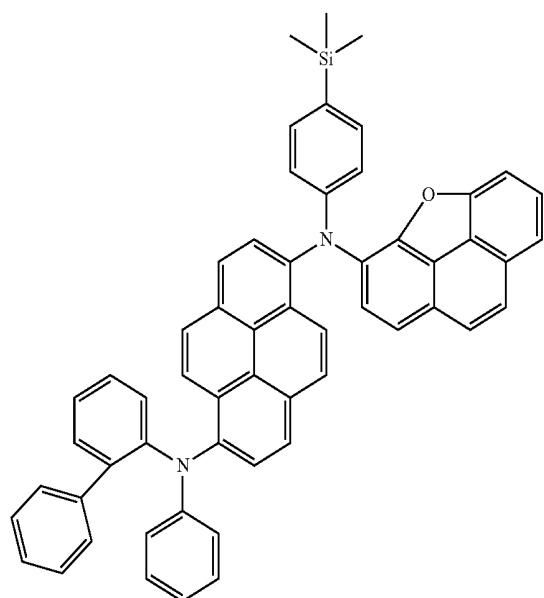
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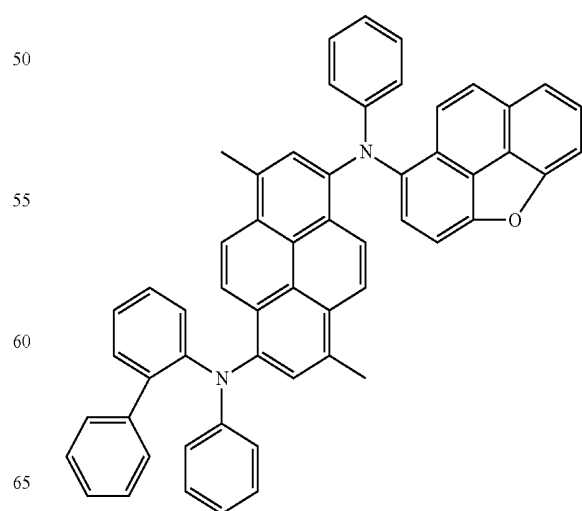
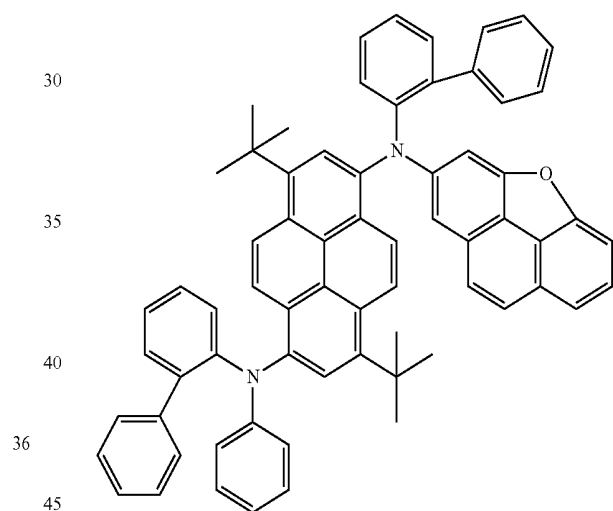
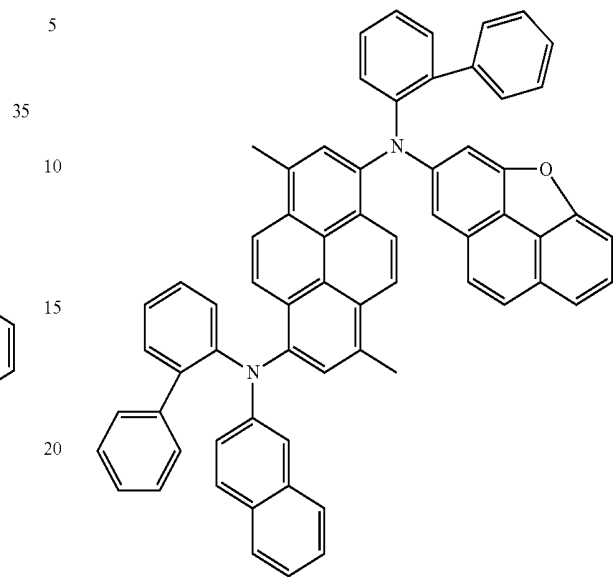


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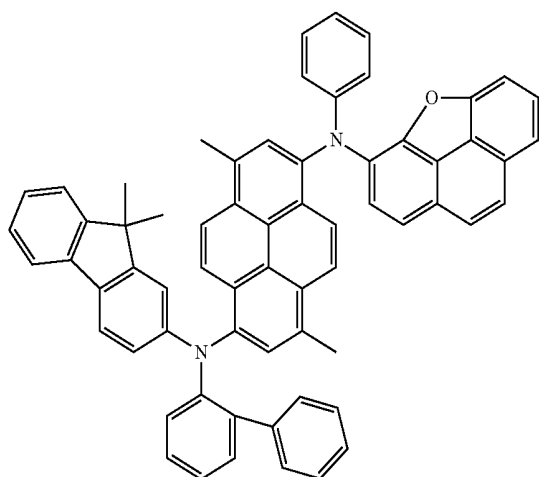
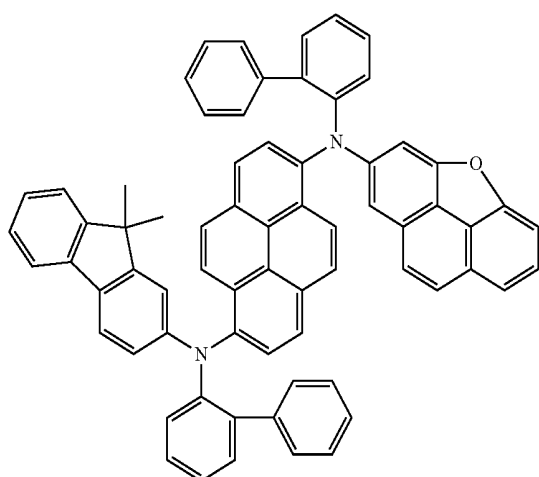
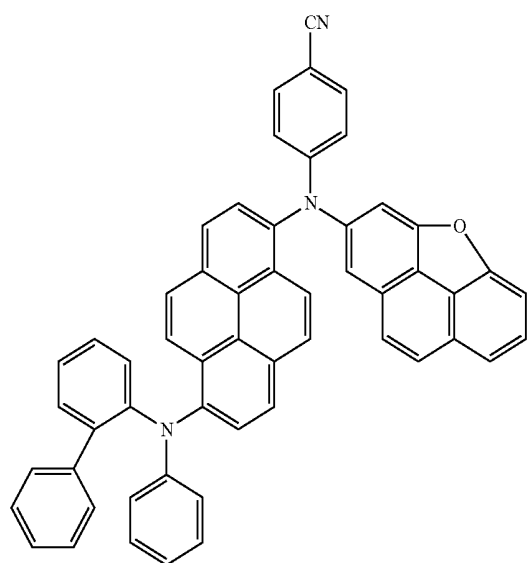
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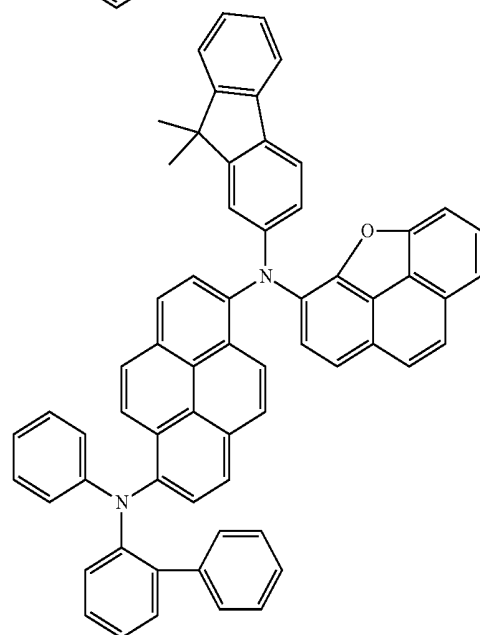
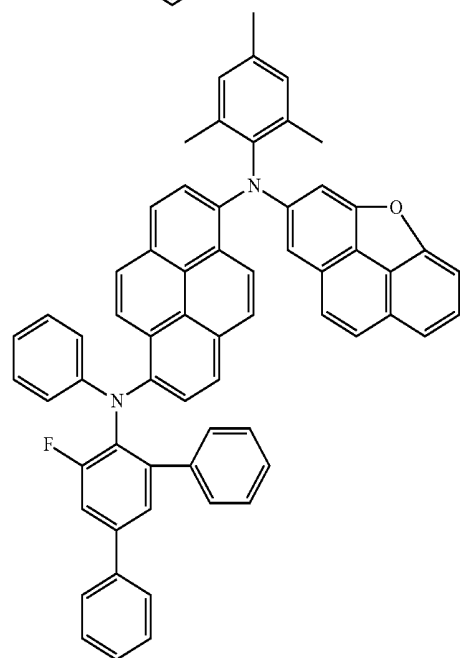
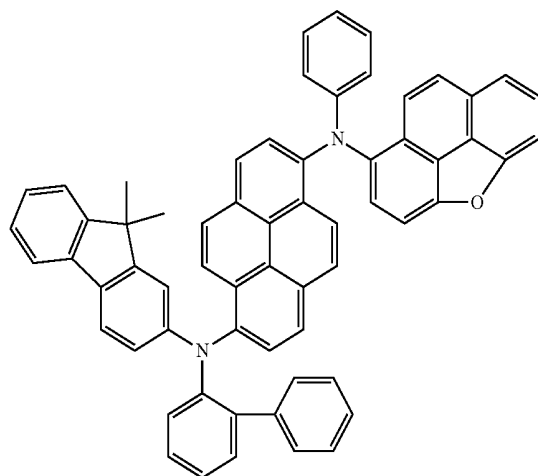


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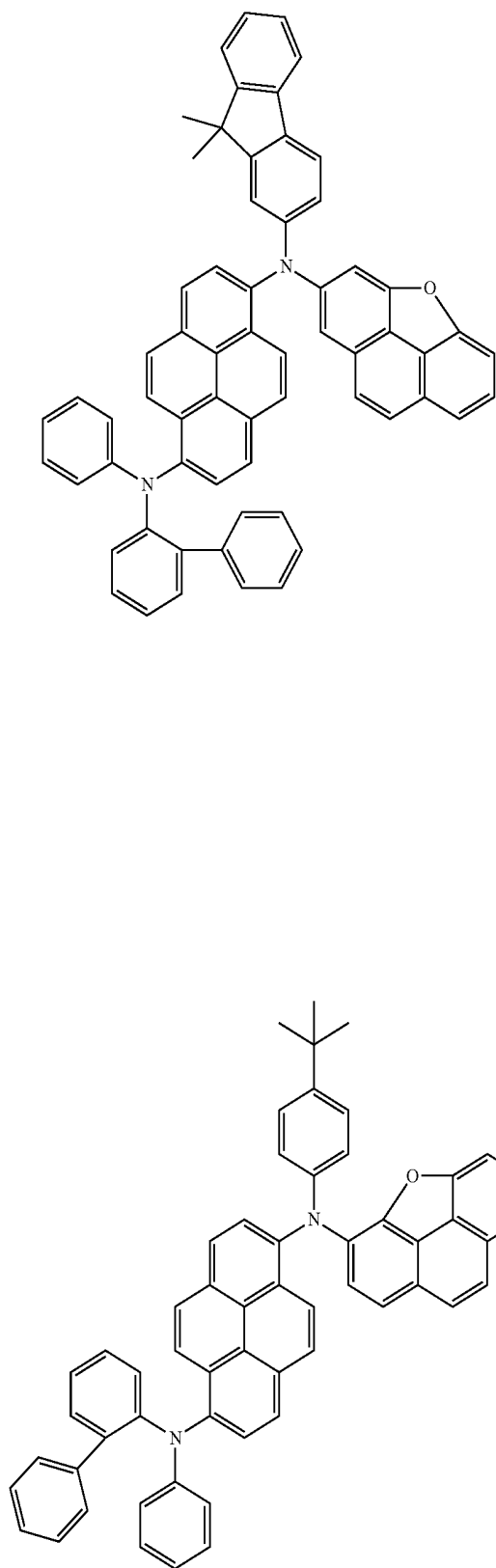
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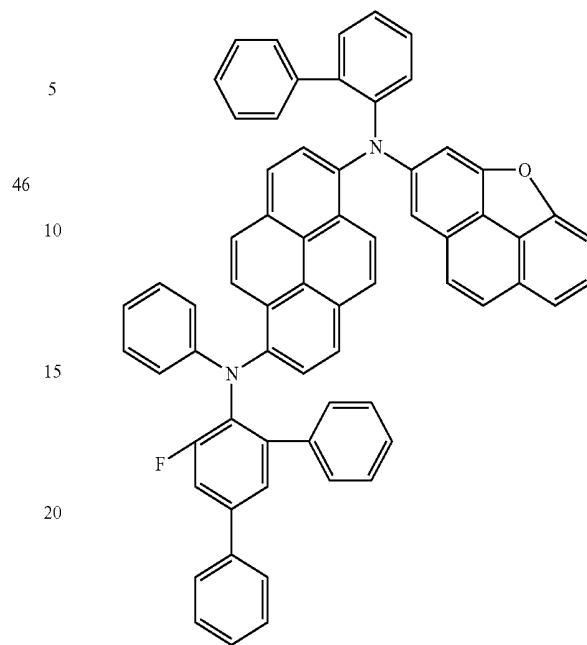
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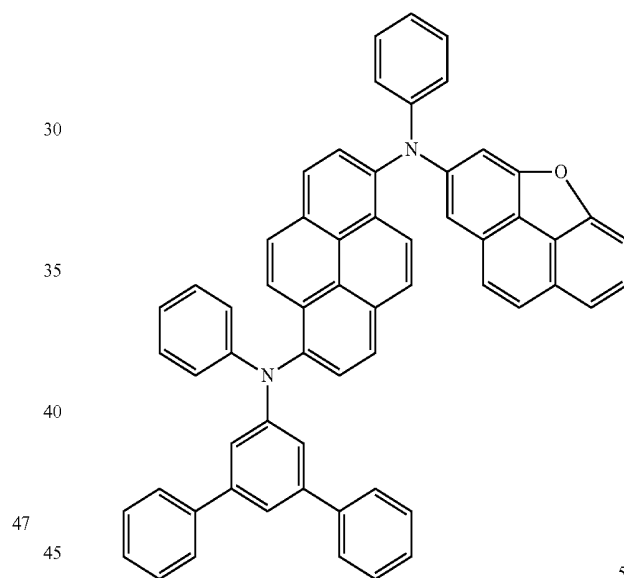
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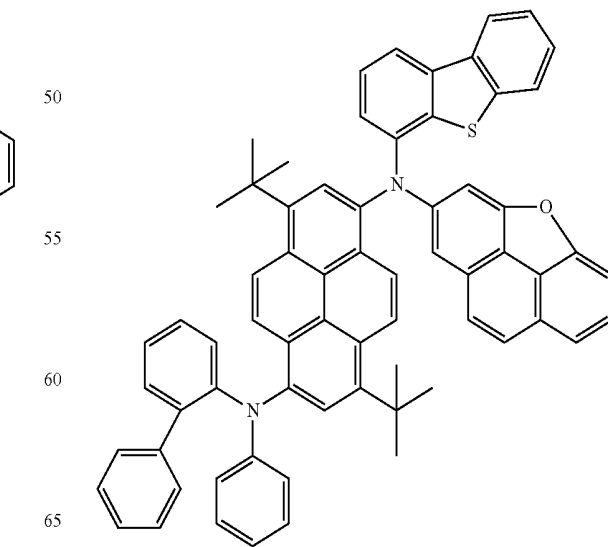
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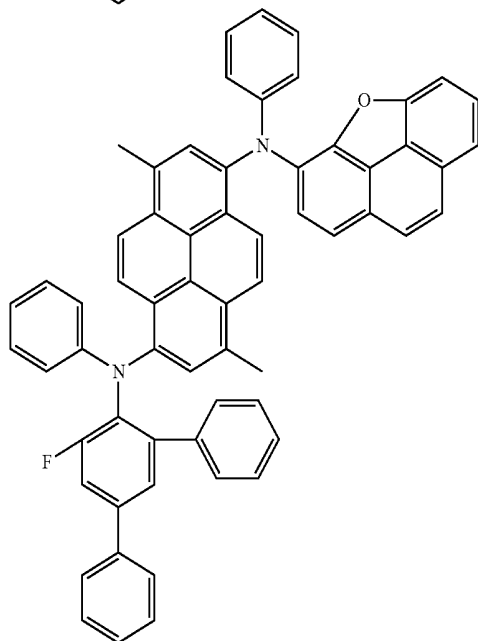
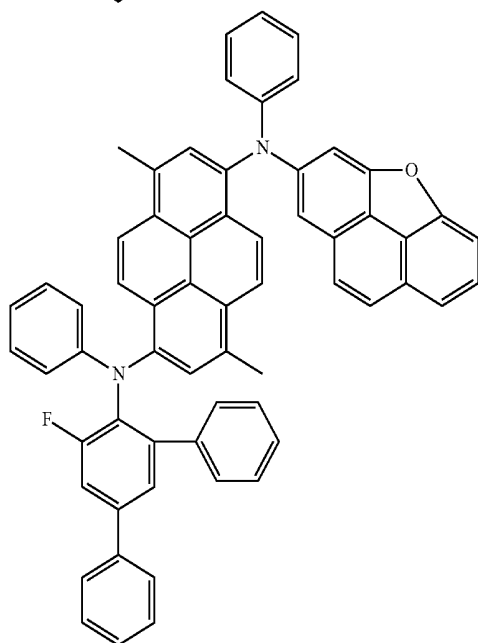
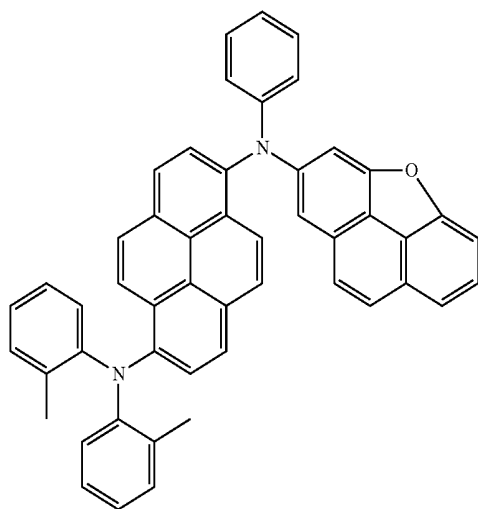


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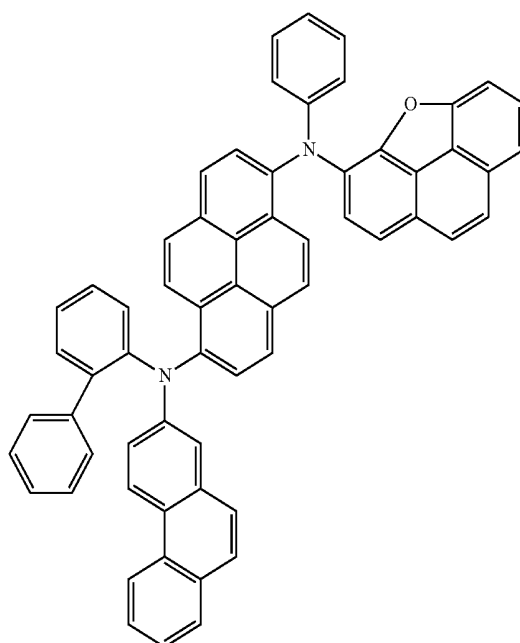
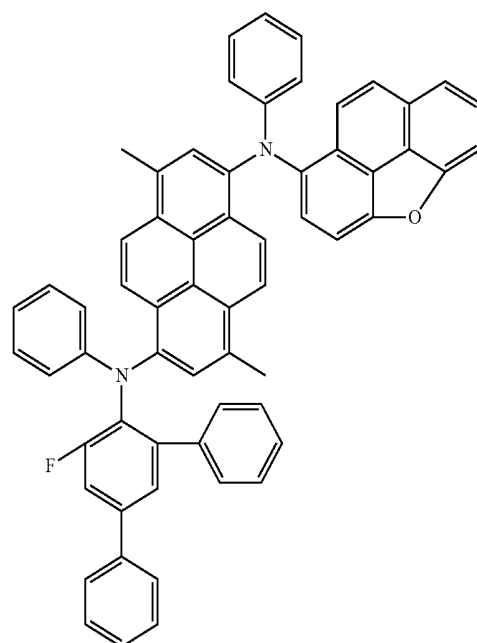
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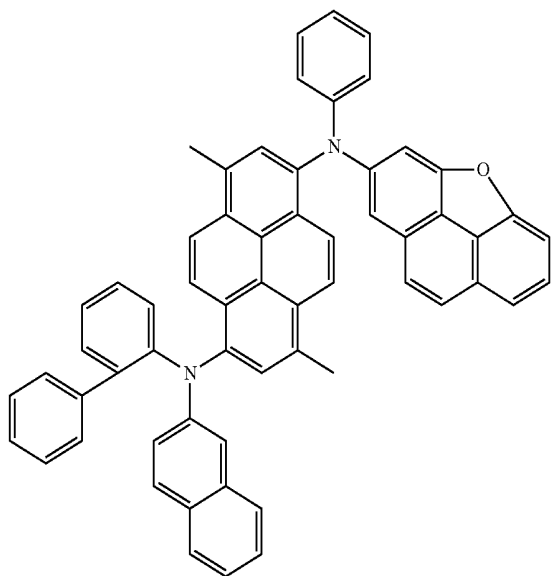
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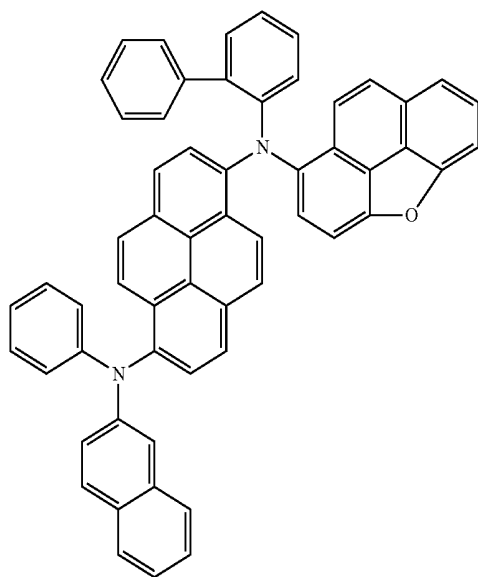
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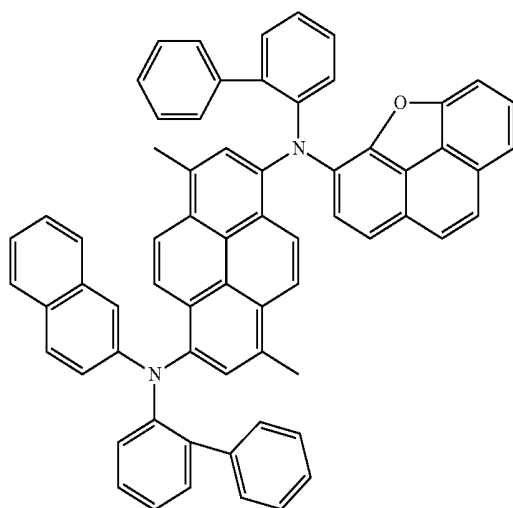
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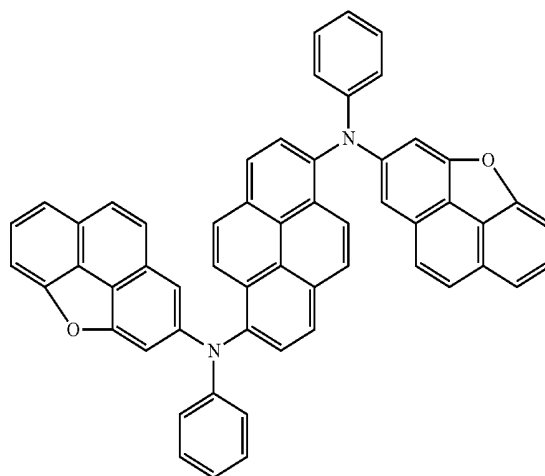
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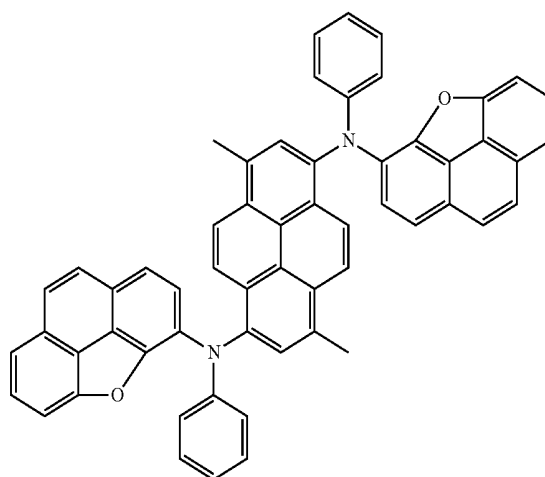
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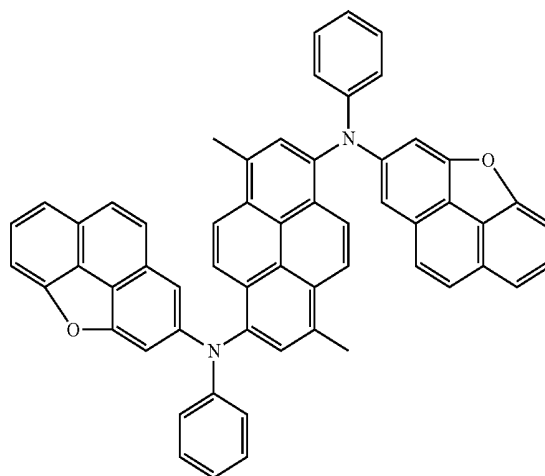
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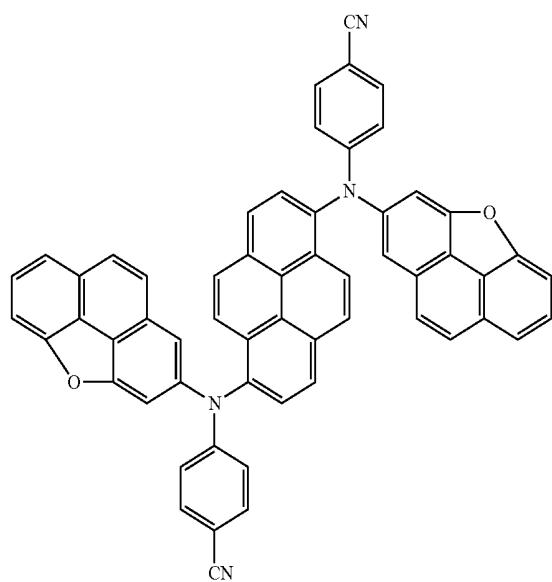
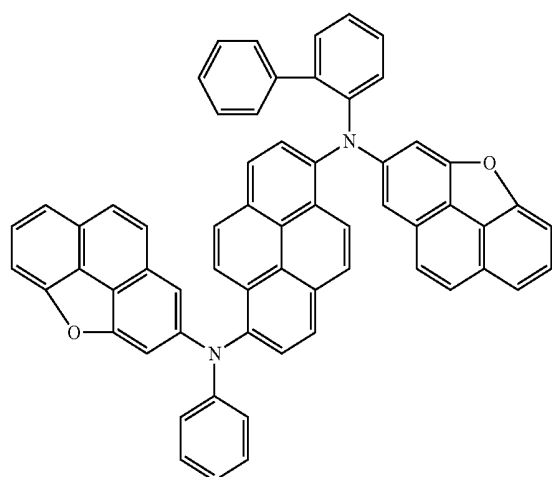
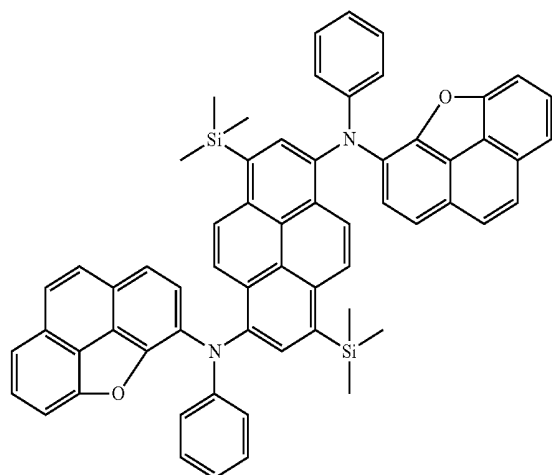


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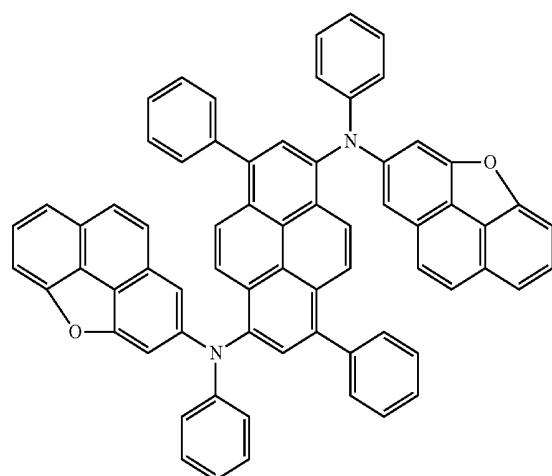
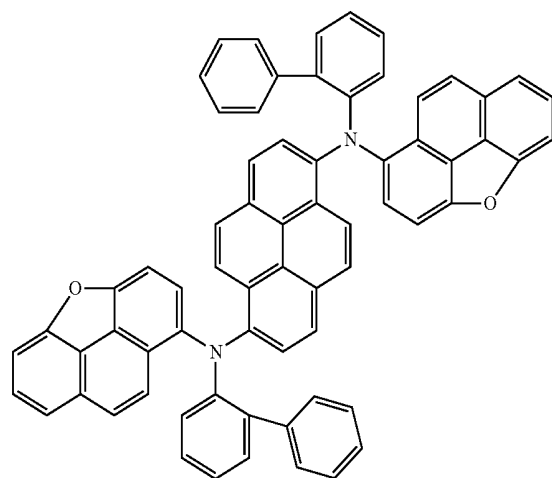
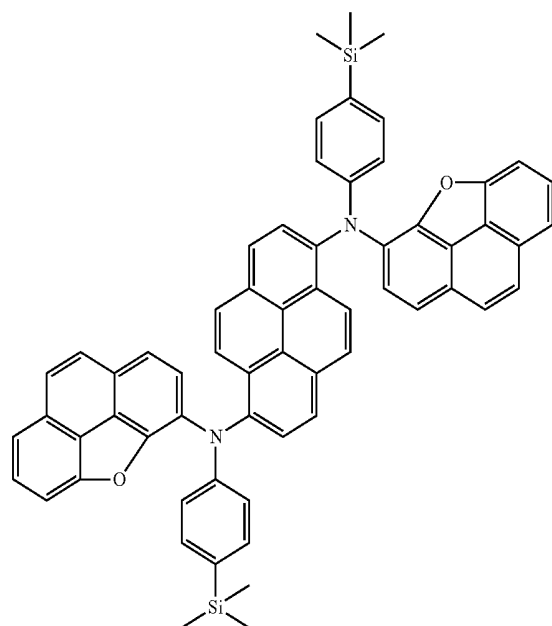


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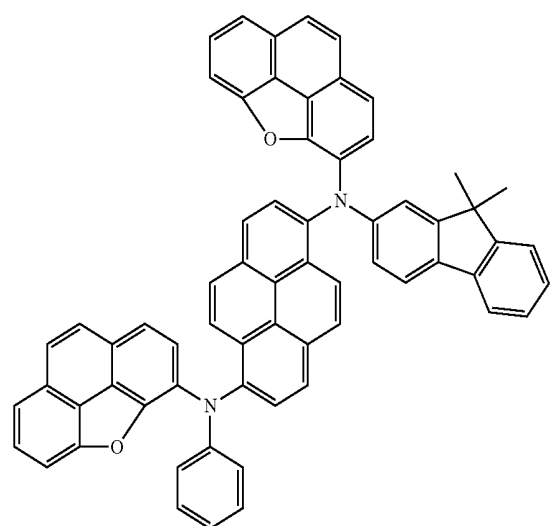
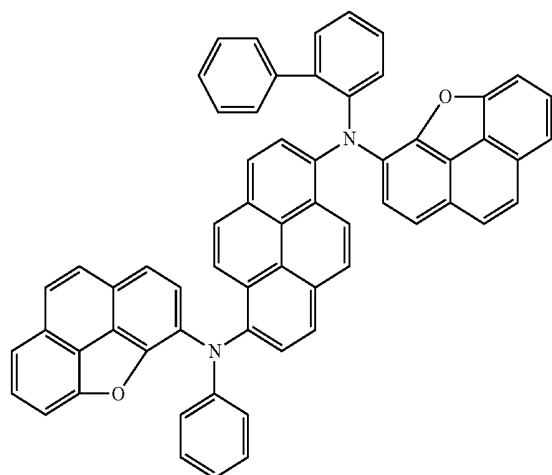
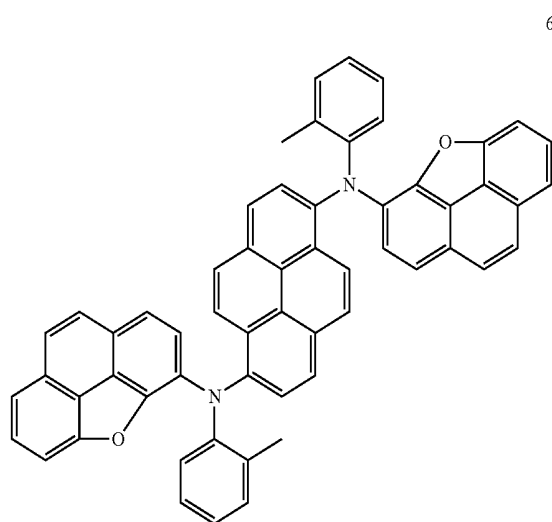
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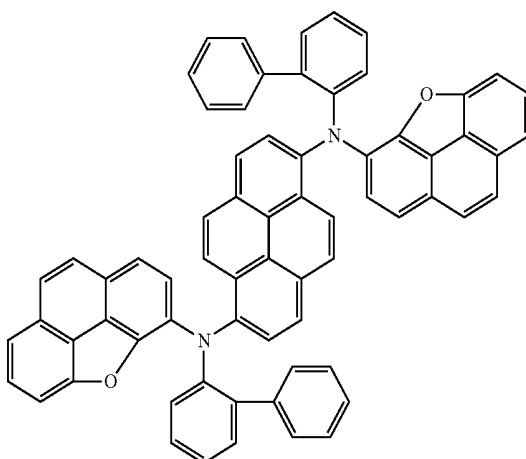
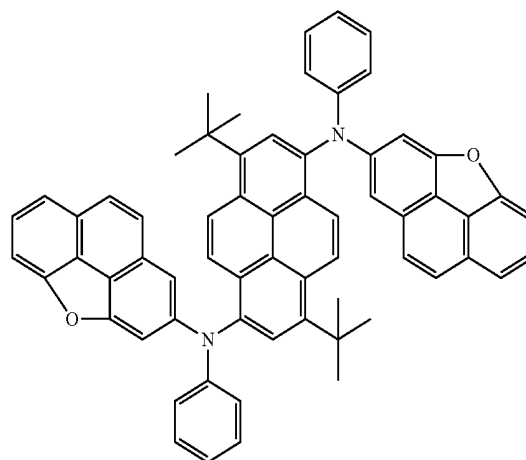
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10. An organic light-emitting device comprising:

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 represented by Formula 1 of claim 1.

11. The organic light-emitting device of claim 10, wherein the first electrode is an anode, the second electrode is a cathode, and the organic layer comprises

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 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.

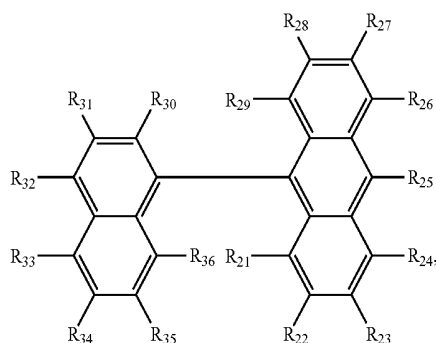
12. The organic light-emitting device of claim 10, wherein the emission layer comprises the compound represented by Formula 1.

13. The organic light-emitting device of claim 10, wherein the emission layer comprises the compound represented by Formula 1 as a dopant.

14. The organic light-emitting device of claim 10, wherein the emission layer further comprises a compound represented by Formula 4:

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Formula 4



wherein in Formula 4, R_{21} to R_{36} are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, $-N(Q_1)(Q_2)$, $-Si(Q_3)(Q_4)(Q_5)$, and $-B(Q_6)(Q_7)$;

wherein 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:

a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a

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phosphoric acid 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 a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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

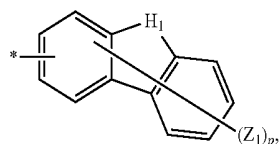
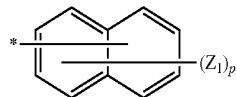
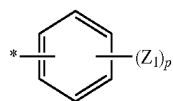
$-N(Q_{31})(Q_{32})$, $-Si(Q_{33})(Q_{34})(Q_{35})$, and $-B(Q_{36})(Q_{37})$, and

wherein Q_1 to Q_7 , Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} are each independently selected from a hydrogen, a 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 or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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.

15. The organic light-emitting device of claim 14, wherein the organic light-emitting device comprises the compound represented by Formula 4 as a host.

16. The organic light-emitting device of claim 14, wherein in Formula 4, R_{25} , R_{27} , R_{31} , R_{32} , and R_{33} are each independently selected from a hydrogen, a deuterium, a cyano group, a substituted or unsubstituted C_1 - C_{60} alkyl group, $-Si(Q_3)(Q_4)(Q_5)$, and Formulae 3a to 3c:

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wherein in Formulae 3a to 3c, Z_1 is selected from a hydrogen atom, a deuterium, 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 C_6 - C_{20} condensed polycyclic group, a halogen group, a cyano group, a nitro group, a hydroxyl group, and a carboxyl group;

H_1 is selected from $-O-$, $-S-$, $-CR_{51}R_{52}-$, and $-NR_{53}-$;

p is an integer selected from 1 to 7;

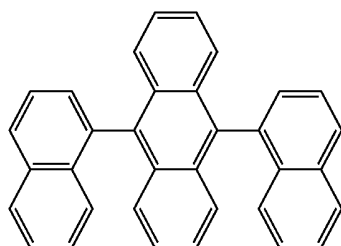
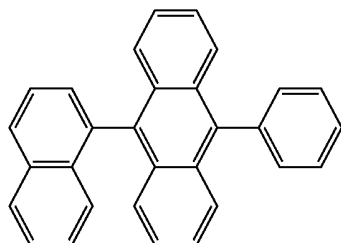
R_{51} and R_{53} are defined the same as R_{21} to R_{36} , wherein, optionally, R_{51} and R_{52} are linked to each other to form a ring; and

* indicates a binding site.

17. The organic light-emitting device of claim 14, wherein in Formula 4, R_{21} to R_{24} , R_{26} , R_{28} to R_{30} , R_{34} to R_{36} are each independently selected from a hydrogen and a deuterium.

18. The organic light-emitting device of claim 14, wherein the emission layer comprises the compound represented by Formula 1 as a fluorescent or phosphorescent dopant and the compound represented by Formula 4 as a fluorescent or phosphorescent host.

19. The organic light-emitting device of claim 14, wherein the compound represented by Formula 4 is represented by one of Compounds H1 to H78:



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3a

H3

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3b

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3c

H4

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H5

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H6

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H7

H1

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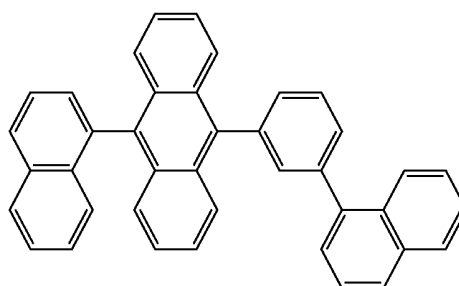
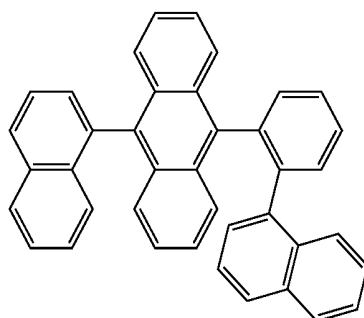
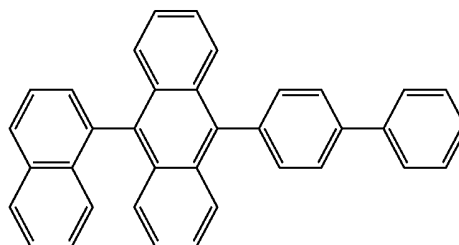
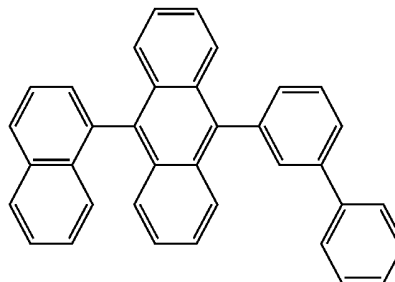
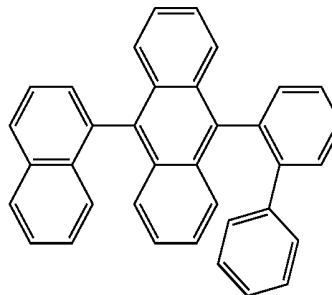
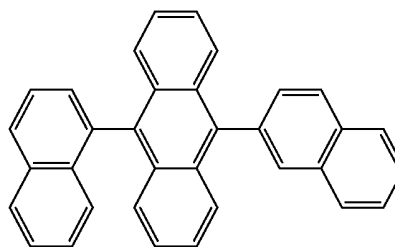
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H8

H2

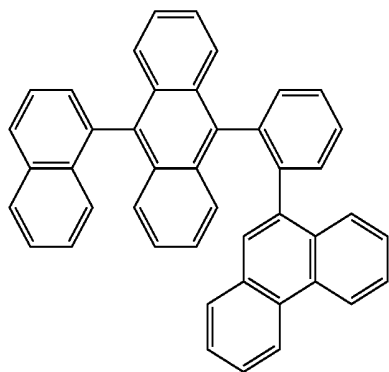
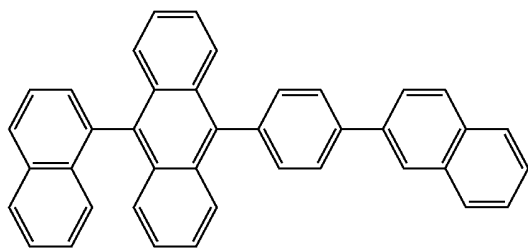
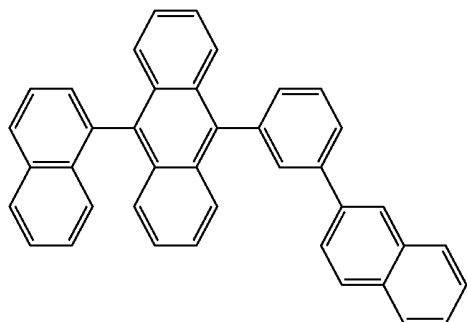
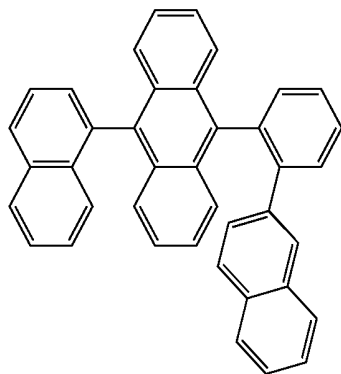
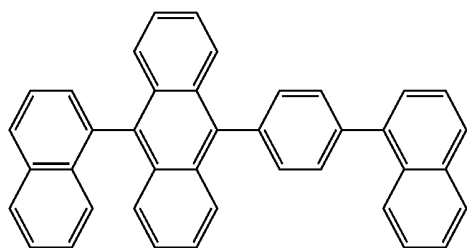
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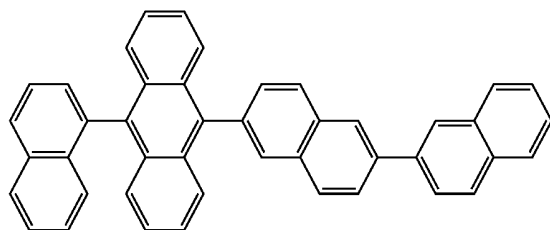
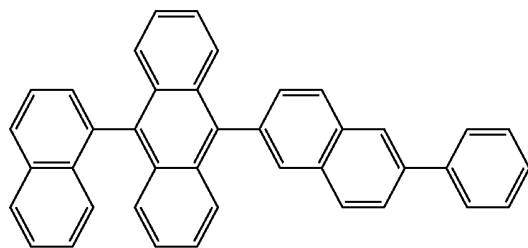
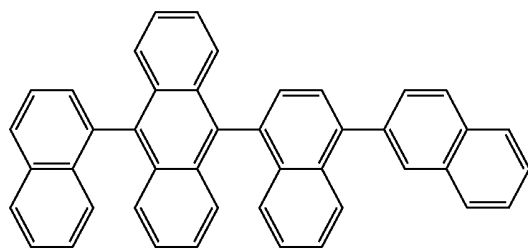
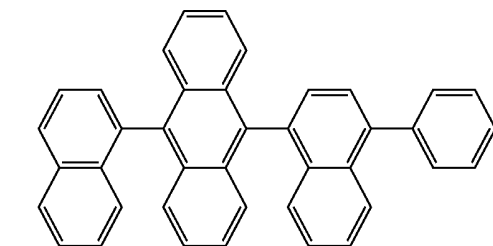
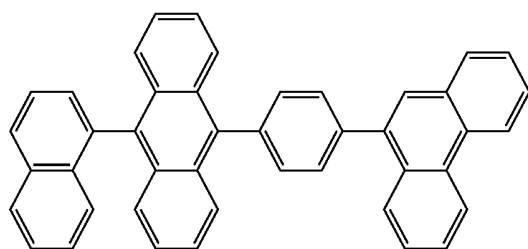
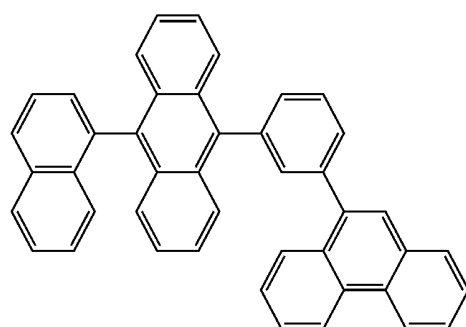
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H9

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H10

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H11

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H12

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H13

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H14

H15

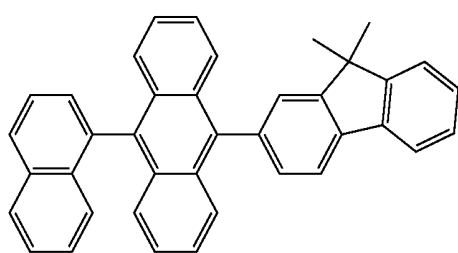
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H17

H18

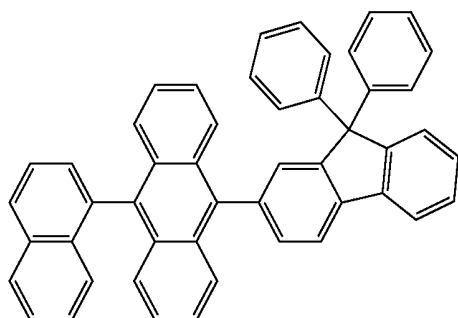
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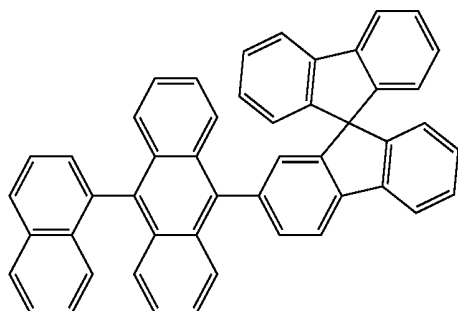
H20

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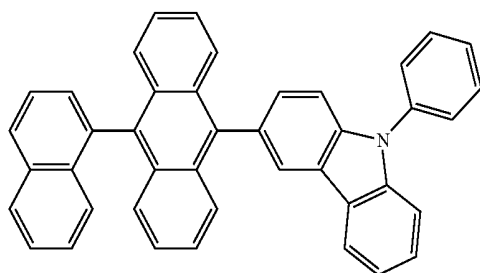
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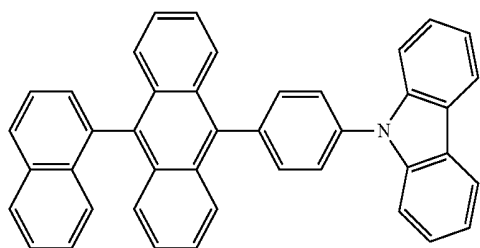
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H23

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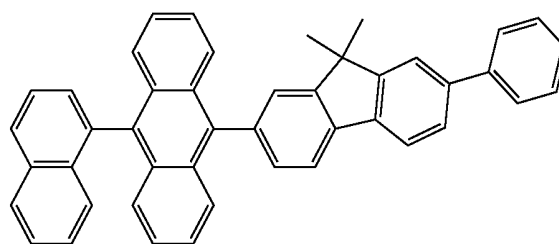


H24

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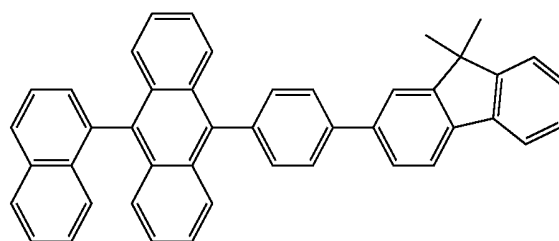
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H25

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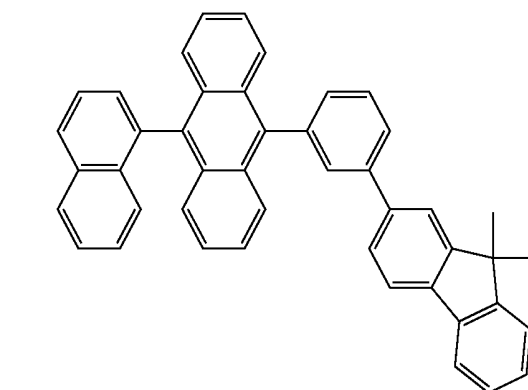


H26

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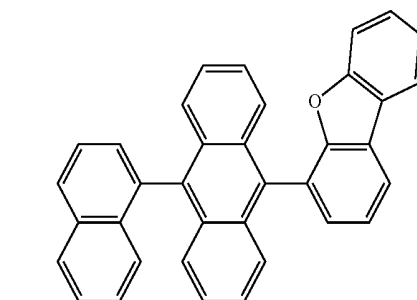


H27

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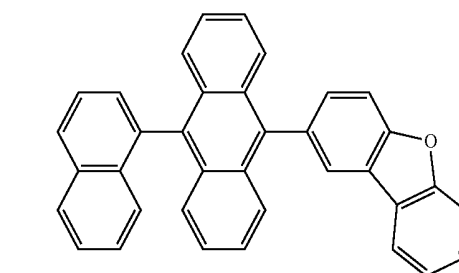


H28

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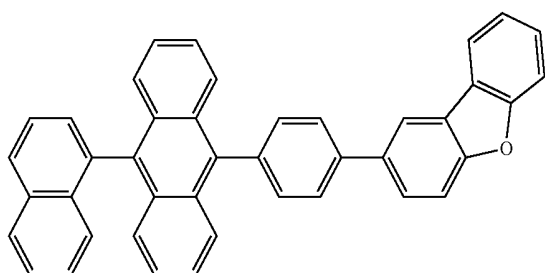
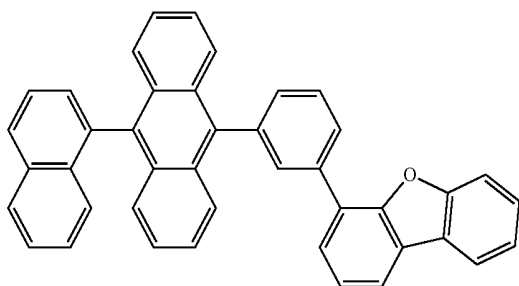
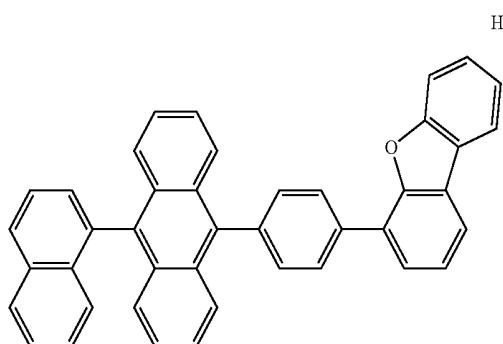
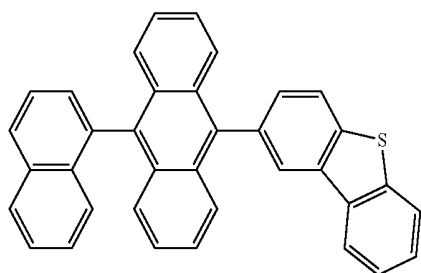
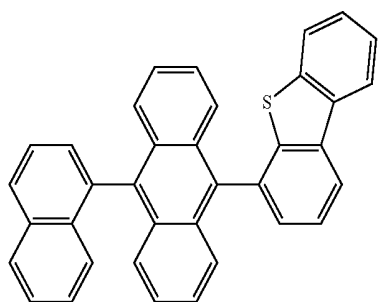
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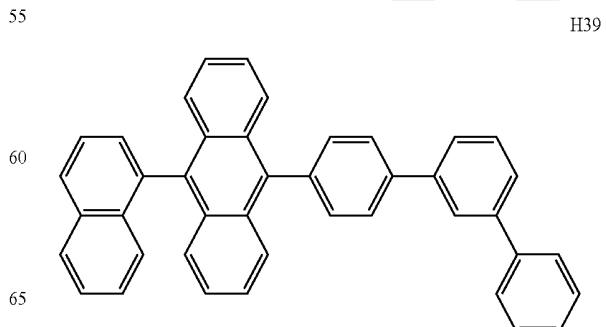
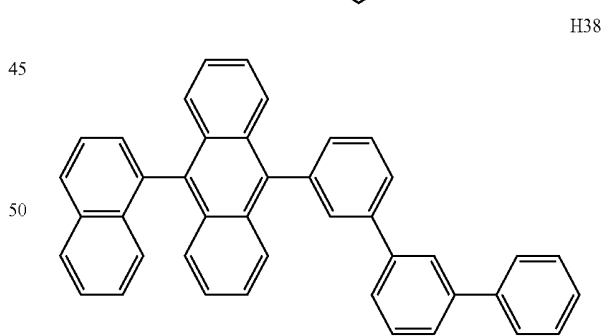
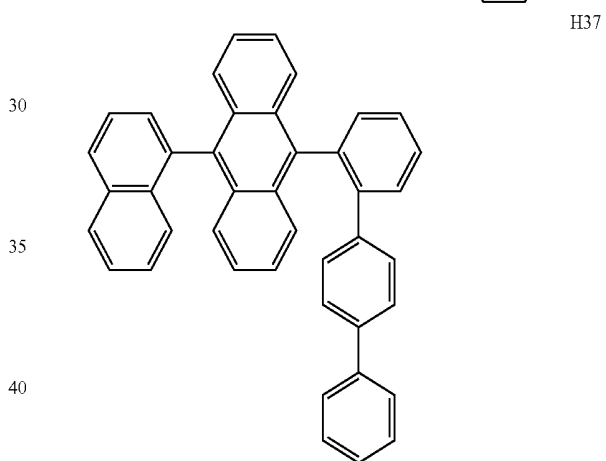
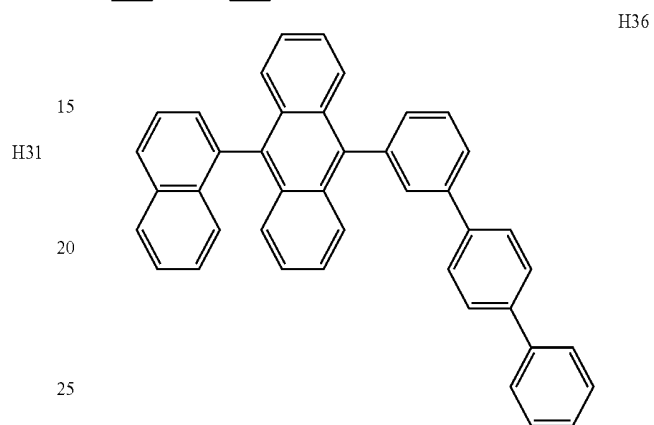
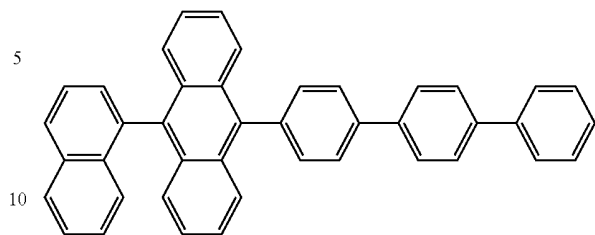
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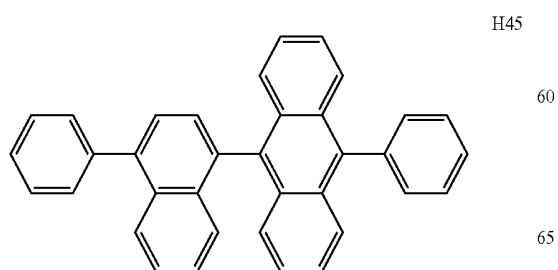
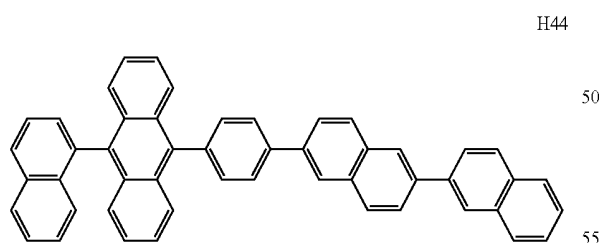
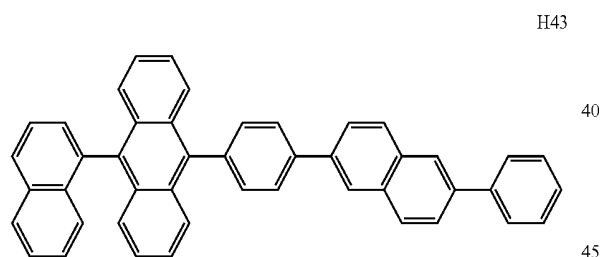
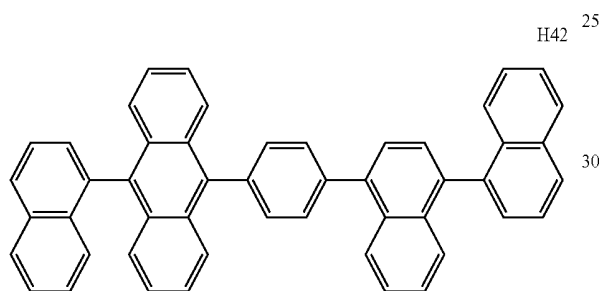
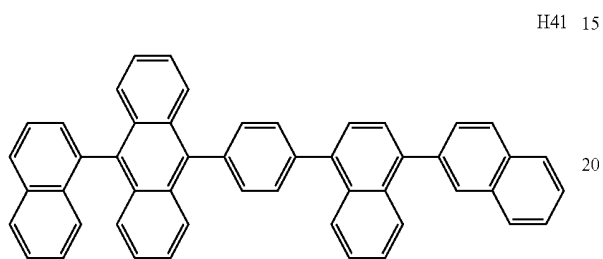
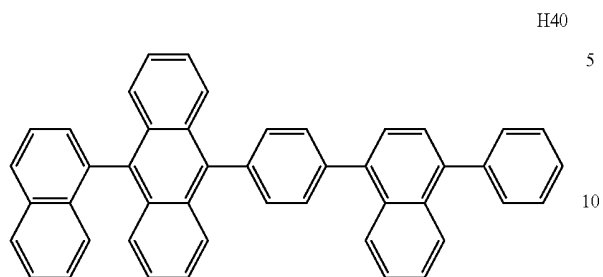
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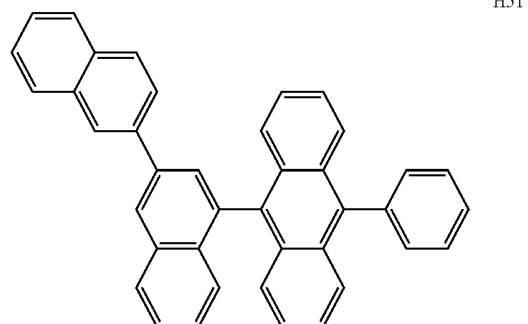
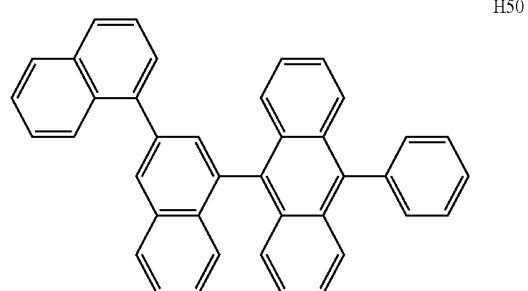
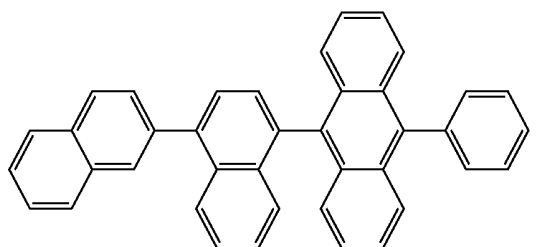
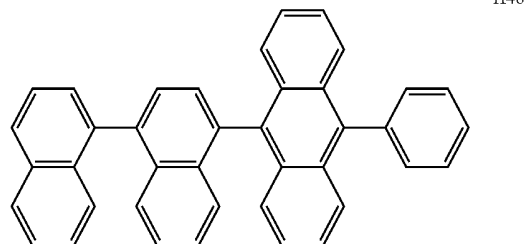
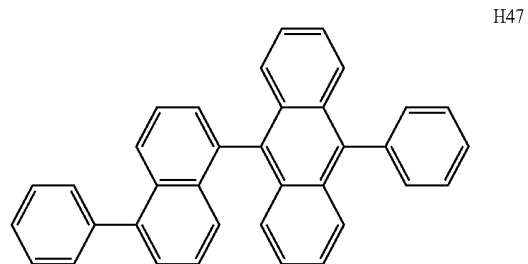
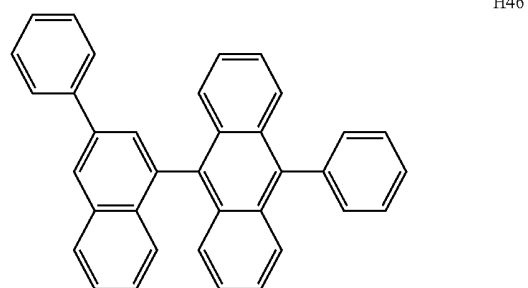
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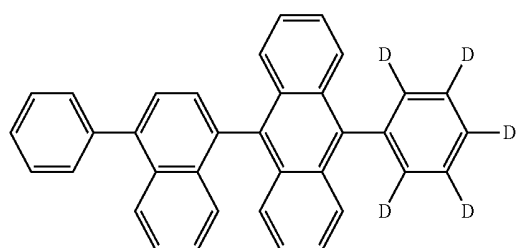
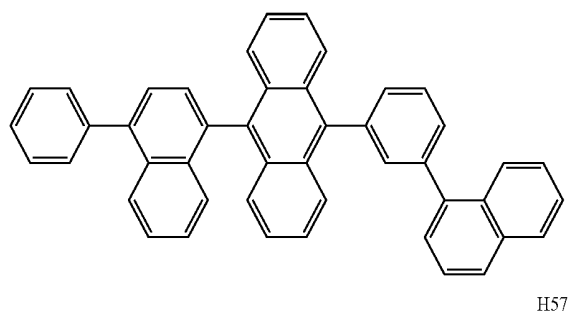
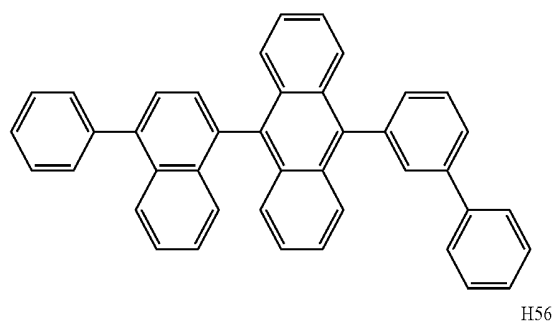
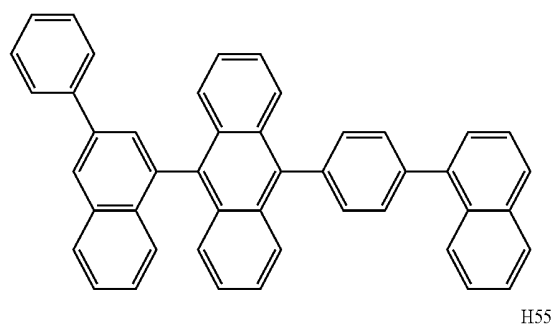
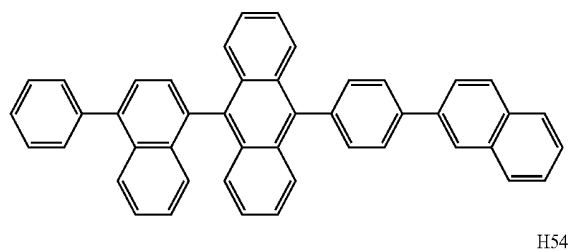
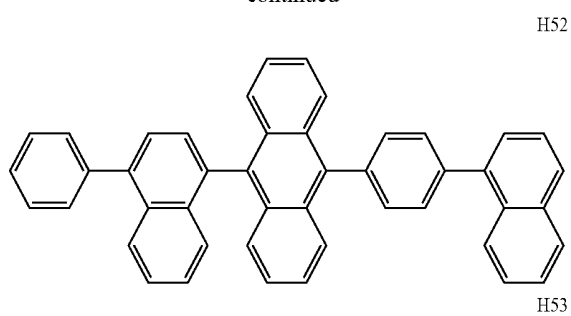
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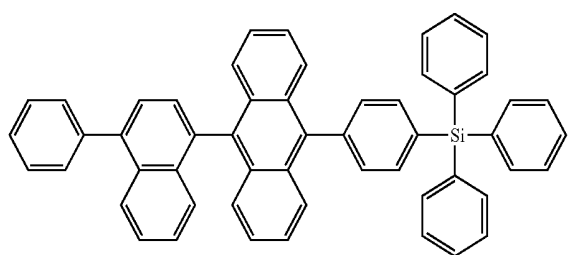
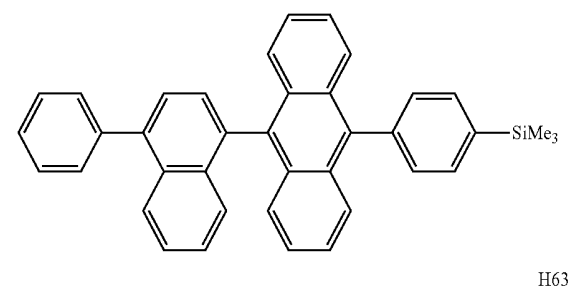
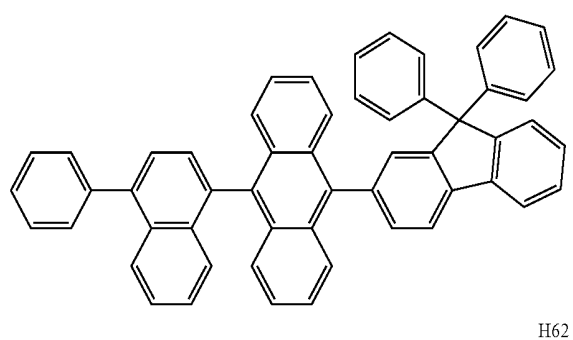
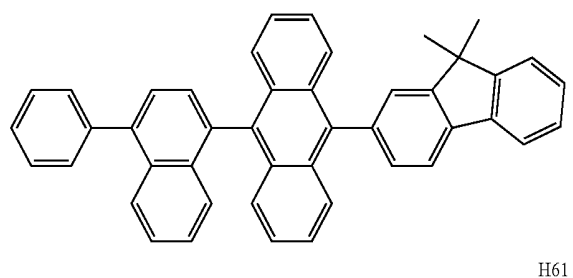
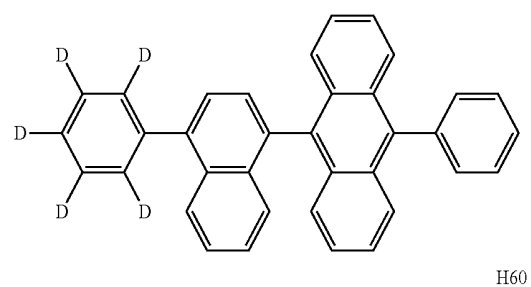
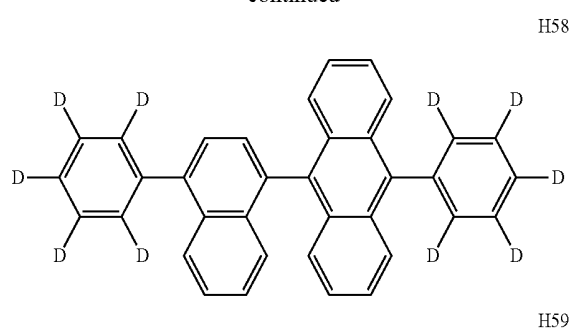


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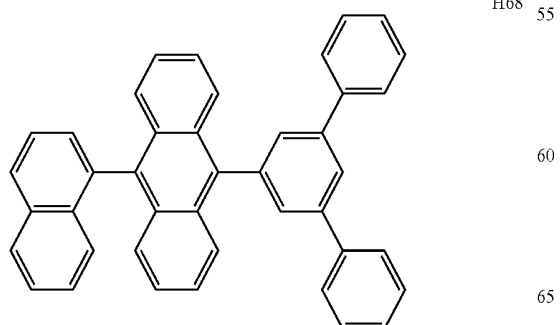
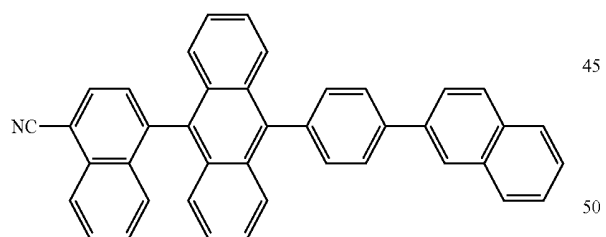
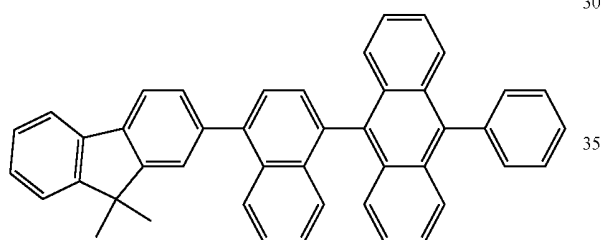
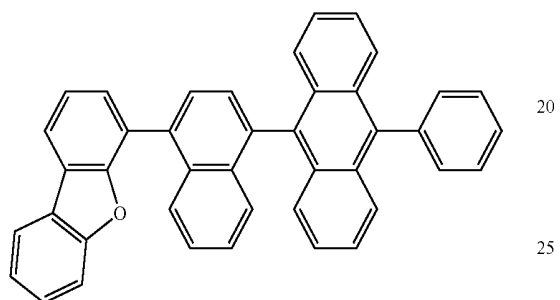
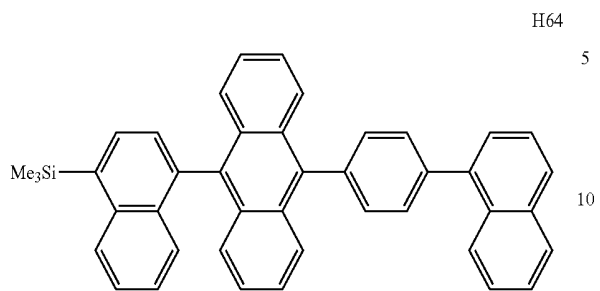
**170**

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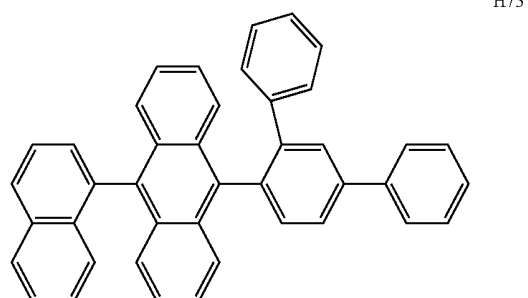
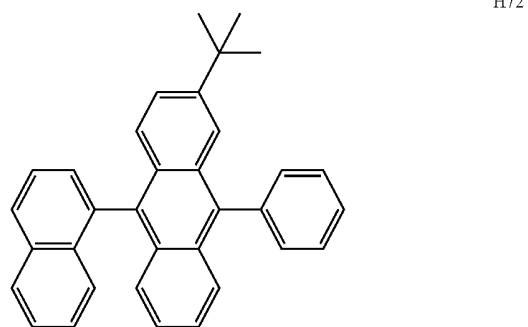
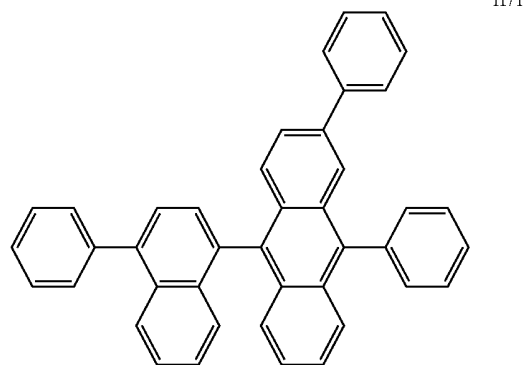
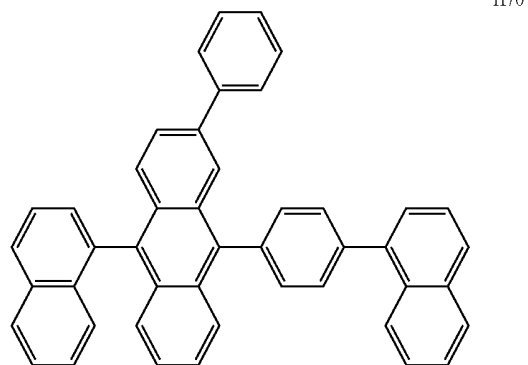
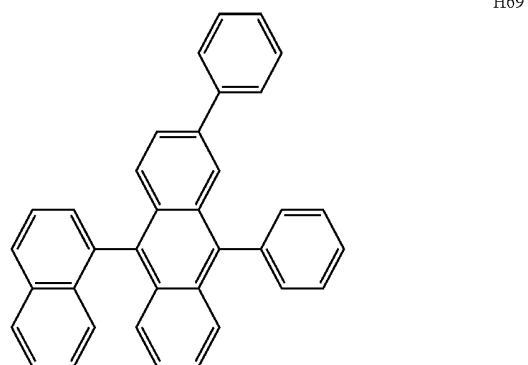


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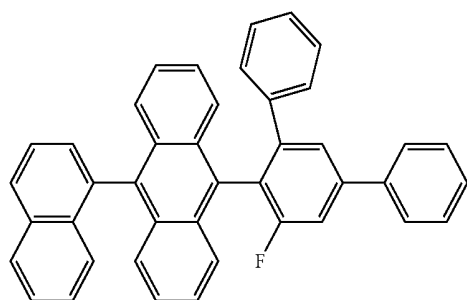
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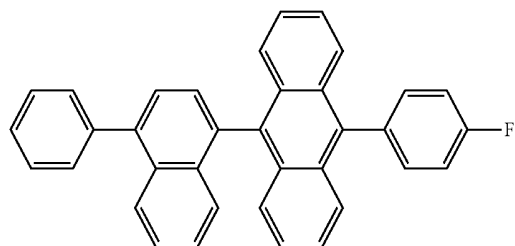


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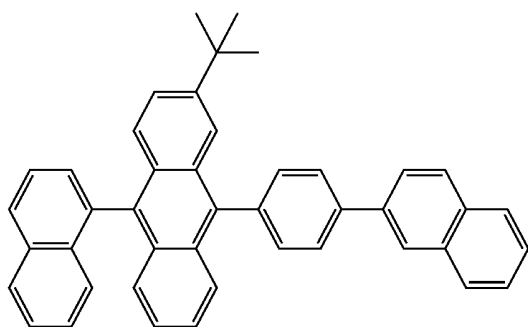
H75

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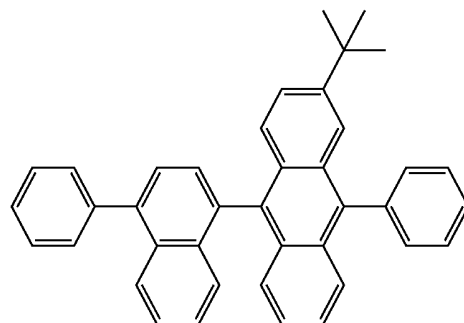


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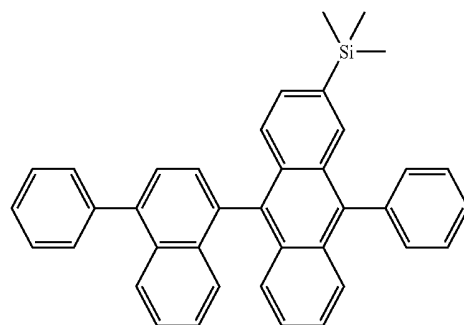
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H77

H78



20. A flat panel display apparatus comprising the organic light-emitting device of claim **14**, wherein the first electrode of the organic light-emitting device is electrically connected to a source electrode or a drain electrode of a thin film transistor.

* * * * *

专利名称(译)	包括其的化合物和有机发光装置		
公开(公告)号	US9793491	公开(公告)日	2017-10-17
申请号	US14/702620	申请日	2015-05-01
[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	HWANG SEOKHWAN JUN MIEUN JUNG HYEJIN KIM YOUNGKOOK		
发明人	HWANG, SEOKHWAN JUN, MIEUN JUNG, HYEJIN KIM, YOUNGKOOK		
IPC分类号	H01L51/00 H05B33/14 C07F7/08 C07D307/77 C07D409/12 C07D307/91 C09K11/06 H01L51/50		
CPC分类号	H01L51/0061 C07D307/77 C07D307/91 C07D409/12 C07F7/0809 C07F7/0812 C09K11/06 H01L51/006 H01L51/0054 H01L51/0073 H05B33/14 C09K2211/1007 C09K2211/1011 C09K2211/1088 H01L51/0058 H01L51/0072 H01L51/0081 H01L51/5012 C07F7/0805 C07D407/12 H01L51/50 Y10S514/825		
优先权	1020140170821 2014-12-02 KR		
其他公开文献	US20160155952A1		
外部链接	Espacenet USPTO		

摘要(译)

本公开涉及由式1表示的化合物和包含其的有机发光装置。由式1表示的化合物具有优异的稳定性并且适合作为电子传输材料。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。

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150
110