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

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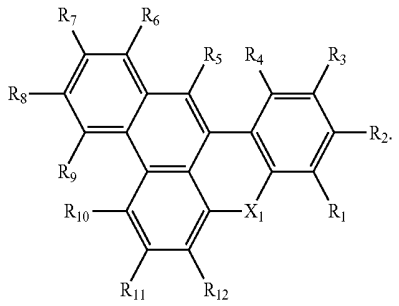
(57) **ABSTRACT**

A condensed cyclic compound represented by Formula 1:

Formula 1



An organic light-emitting device including a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode, the organic layer including an emission layer, and further including at least one of the condensed cyclic compounds of Formula 1.

FIG. 1

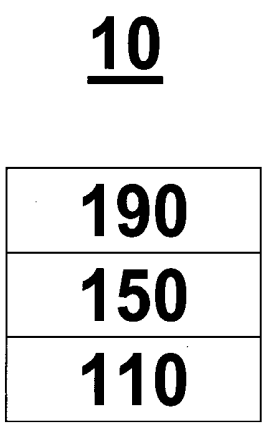


FIG. 2

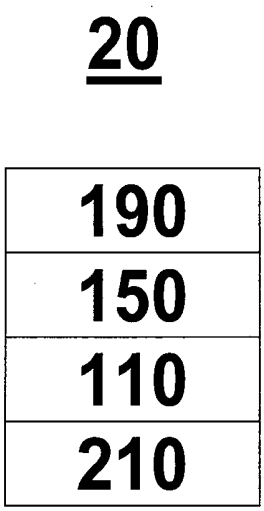


FIG. 3

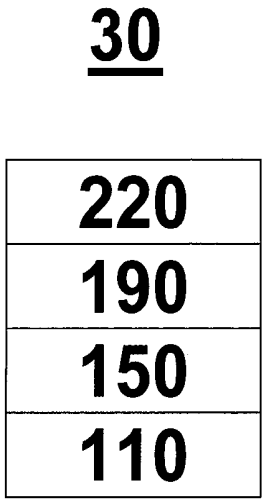
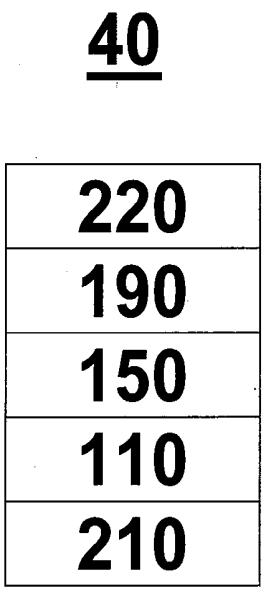


FIG. 4



CONDENSED CYCLIC COMPOUND AND ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2014-0144276, filed on Oct. 23, 2014, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] 1. Field

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

[0004] 2. Description of the Related Art

[0005] Organic light emitting devices are self-emission devices that have wide viewing angles, high contrast ratios, short response times, low driving voltage, and excellent brightness and response speed characteristics, and can produce full-color images.

[0006] The organic light-emitting device may include a first electrode disposed on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. Carriers (e.g., holes and electrons), are recombined in the emission layer to produce excitons. When these excitons change from an excited state to a ground state, light is generated.

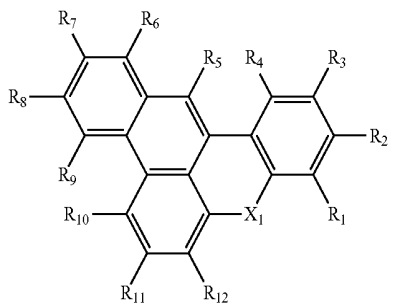
SUMMARY

[0007] One or more aspects of embodiments of the present invention relate to a novel condensed cyclic compound and an organic light-emitting device including the same.

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

[0009] An embodiment provides a condensed cyclic compound represented by Formula 1, where R_1 to R_{12} may be each independently a group represented by Formula 2:

Formula 1



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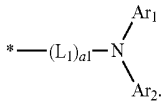
Formula 2



[0010] In Formulae 1 and 2,

[0011] X_1 may be O or S;

[0012] L_1 may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-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;

[0013] a1 is selected from 0, 1, 2, and 3, and when a1 is two or more, a plurality of L_1 may be identical to or different from each other;

[0014] Ar_1 and Ar_2 may be each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, 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;

[0015] R_1 to R_{12} may be each independently selected from a group represented by Formula 2, 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_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-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, —$Si(Q_1)(Q_2)(Q_3)$, and —$B(Q_4)(Q_5)$;

[0016] at least two selected from R_1 to R_{12} may be each independently the group represented by Formula 2;

[0017] 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:

[0018] 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_{60} alkoxy group;

[0019] 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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, —$Si(Q_{11})(Q_{12})(Q_{13})$, and —$B(Q_{14})(Q_{15})$;

[0020] a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic group;

[0021] a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic group, —$Si(Q_{21})(Q_{22})(Q_{23})$, and —$B(Q_{24})(Q_{25})$; and

[0022] —$Si(Q_{31})(Q_{32})(Q_{33})$ and —$B(Q_{34})(Q_{35})$,

[0023] where Q_1 to Q_5, Q_{11} to Q_{15}, Q_{21} to Q_{25}, and Q_{31} to Q_{35} 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_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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.

[0024] An embodiment provides an organic light-emitting device that includes: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode and including an emission layer, where the organic layer includes at least one of the condensed cyclic compounds of Formula 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] 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 drawings in which:

[0026] FIG. **1** is a schematic view of an organic light-emitting device according to some embodiments of the present invention;

[0027] FIG. **2** is a schematic view of an organic light-emitting device according to some embodiments of the present invention;

[0028] FIG. **3** is a schematic view of an organic light-emitting device according to some embodiments of the present invention; and

[0029] FIG. **4** is a schematic view of an organic light-emitting device according to some embodiments of the present invention.

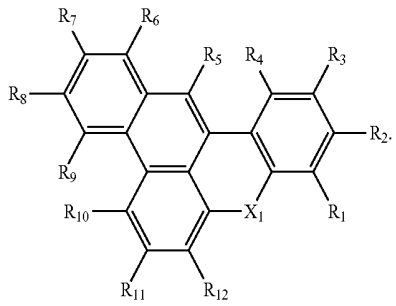
DETAILED DESCRIPTION

[0030] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, 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 figures, 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.

[0031] A condensed cyclic compound according to some embodiments is represented by Formula 1 below:

Formula 1

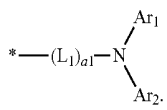


[0032] X_1 in Formula 1 may be O or S. According to some embodiments, X_1 in Formula 1 may be O, but is not limited thereto.

[0033] R_1 to R_{12} in Formula 1 may be each independently selected from a group represented by Formula 2 below, 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_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-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, —$Si(Q_1)(Q_2)(Q_3)$, and —$B(Q_4)(Q_6)$.

[0034] In some embodiments, at least two selected from R_1 to R_{12} in Formula 1 may be each independently a group represented by Formula 2 below:

Formula 2



[0035] L_1 in Formula 2 may be each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_r 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.

[0036] In some embodiments, L_1 in Formula 2 may be selected from:

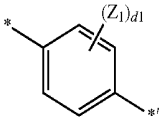
[0037] a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spirofluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, an ovalenylene group, a pyrrolylene group, a thiophenylene group (e.g., thiophenylene), a furanylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, a isoxazolylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, an indazolylene group, a purinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a carbazolylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzoimidazolylene group, a benzofuranylene group, a benzothiophenylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazoiylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylene group, and an imidazopyrimidinylene group; and

[0038] a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spirofluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, ovalenylene group, a pyrrolylene group, a thiophenylene group, a furanylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, a isoxazolylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, an indazolylene group, a purinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene

group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a carbazolylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzoimidazolylene group, a benzofuranylene group, a benzothiophenylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylene group, and an imidazopyrimidinylene 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a 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 (uranyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyi group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

[0039] In some embodiments, L_1 in Formula 2 may be selected from a group represented by any one of Formulae 3-1 to 3-35 illustrated below:

Formula 3-1



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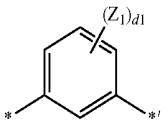
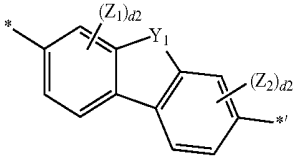
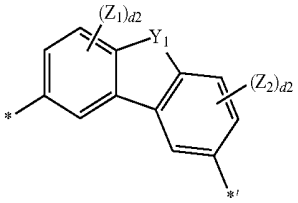
Formula 3-2



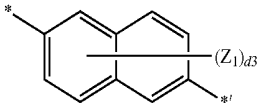
Formula 3-3



Formula 3-4



Formula 3-5



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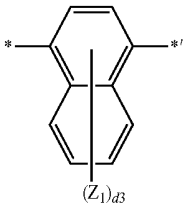
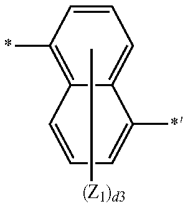


Formula 3-7



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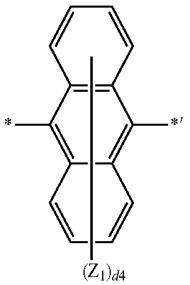

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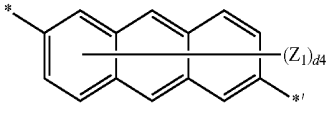

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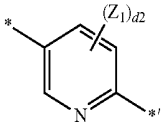

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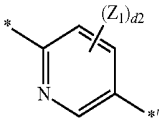

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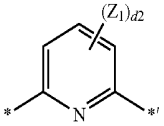
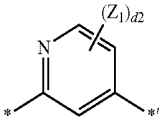
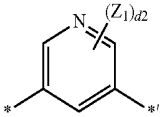


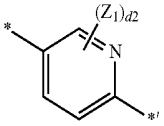
Formula 3-13



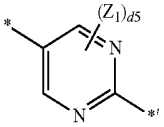
Formula 3-14



Formula 3-15



Formula 3-16



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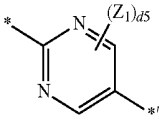
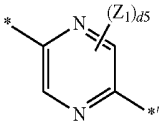


Formula 3-18



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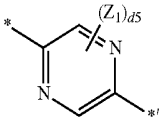
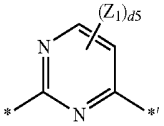
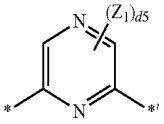


Formula 3-20



Formula 3-21



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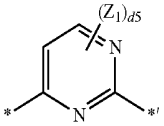

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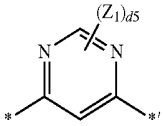

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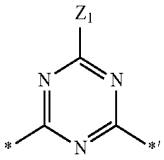

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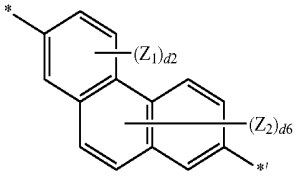

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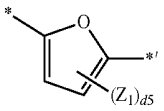

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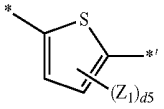

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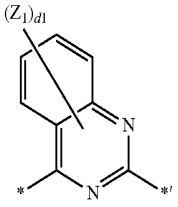

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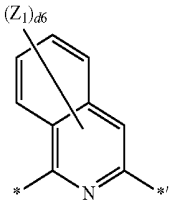
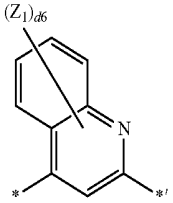
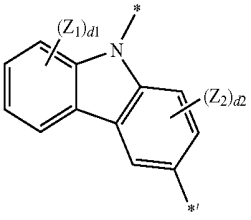


Formula 3-30



Formula 3-31



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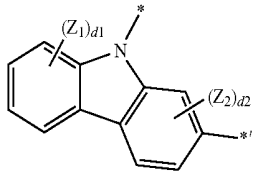
Formula 3-32



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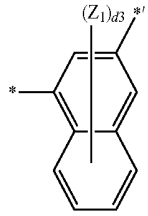
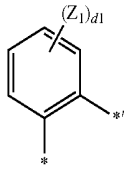
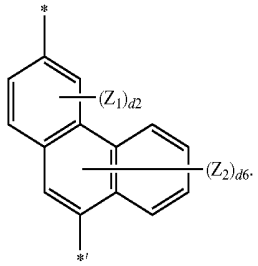


Formula 3-34



Formula 3-35



[0040] In Formulae 3-1 to 3-35, Y_1 may be O, S, $C(Z_3)(Z_4)$, $N(Z_5)$, or $Si(Z_6)(Z_7)$;

[0041] Z_1 to Z_7 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_{20} alkyl group, a C_1-C_{20} 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 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,

[0042] d1 is an integer selected from 1, 2, 3, and 4, d2 is an integer selected from 1, 2, and 3, d3 is an integer selected from 1, 2, 3, 4, 5, and 6, d4 is an integer selected from 1, 2, 3, 4, 5, 6, 7, and 8, d5 is 1 or 2, and d6 is an integer selected from 1, 2, 3, 4, and 5, and * and *' each indicate a binding site to a neighboring atom.

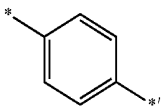
[0043] In some embodiments, L_1 in Formula 2 may be selected from:

[0044] a phenylene group, a naphthylene group, a pyridinylene group, a dibenzofuranylene group, and a dibenzothiophenylene group; and

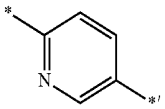
[0045] a phenylene group, a naphthylene group, a pyridinylene group, a dibenzofuranylene group, and a dibenzothiophenylene group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine 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_{10} alkyl group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group. However, embodiments of the present invention are not limited thereto.

[0046] In some embodiments, L_1 in Formula 2 may be selected from a group represented by any one of Formulae 4-1 to Formula 4-28. However, embodiments of the present invention are not limited thereto.

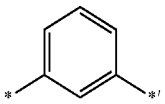
Formula 4-1



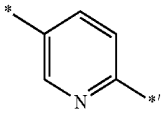
Formula 4-2



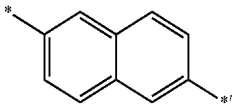
Formula 4-3



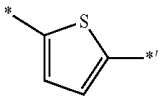
Formula 4-4



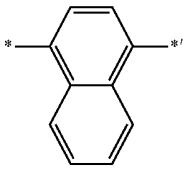
Formula 4-5



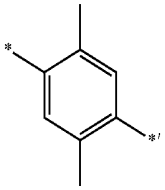
Formula 4-6



Formula 4-7



Formula 4-8



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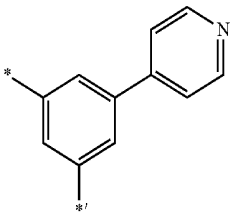
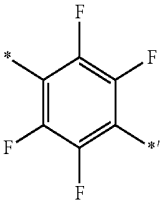
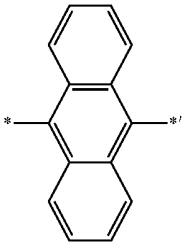
Formula 4-9



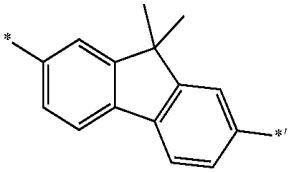
Formula 4-10



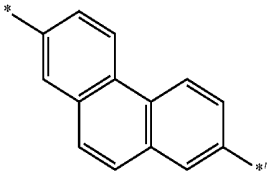
Formula 4-11



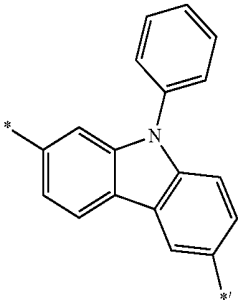
Formula 4-12



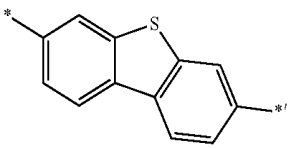
Formula 4-13



Formula 4-14



Formula 4-15



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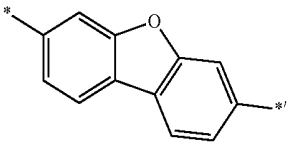
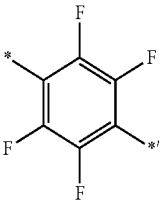
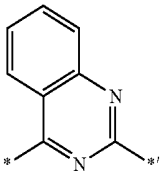
Formula 4-16



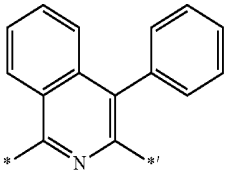
Formula 4-17



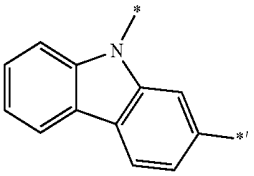
Formula 4-18



Formula 4-19



Formula 4-20



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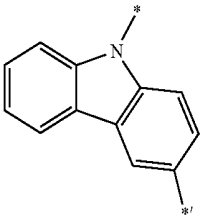
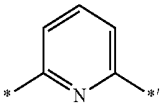
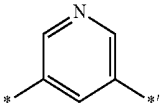


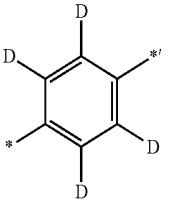
Formula 4-22



Formula 4-23

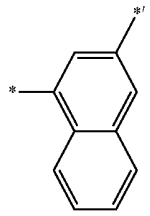


Formula 4-24

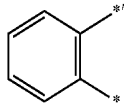


-continued

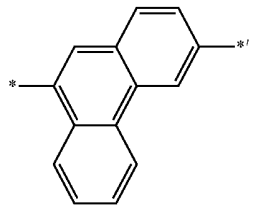
Formula 4-25



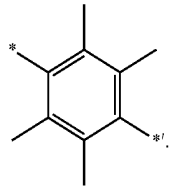
Formula 4-26



Formula 4-27



Formula 4-28



[0047] * and *' in Formulae 4-1 to 4-28 each indicate a binding site to a neighboring atom.

[0048] Referring to Formula 2, a1 indicates the number of L_1 and may be selected from 0, 1, 2, and 3. When a1 is 2 or greater, a plurality of L_1(s) may be identical to or different from each other. When a1 is 0, $-(L_1)_{a1}-$ is a single bond. In some embodiments, a1 may be 0, 1, or 2. In some embodiments, a1 may be 0 or 1.

[0049] Ar_1 and Ar_2 in Formula 2 may be each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, 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.

[0050] For example, Ar_1 and Ar_2 in Formula 2 may be each independently selected from:

[0051] 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 benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl 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 dibenzosllolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0052] 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 benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl group, a benzoxazolyt 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 dibenzosilolyl 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an Indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl

group, a chrysenyl group, a 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 isolndolyl group, an Indolyl group, an Indazolyl group, a purinyl group, a qulnolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl 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, and $—Si(Q_{31})(Q_{32})(Q_{33})$; and

[0053] Q_{31} to Q_{33} may be each Independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, a triazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

[0054] In some embodiments, A_1 and Ar_2 in Formula 2 may be each independently selected from:

[0055] 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a qulnoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0056] 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an Isobenzothlazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and $—Si(Q_{31})(Q_{32})(Q_{33})$, and

[0057] Q_{31} to Q_{33} may be each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group. However, embodiments of the present Invention are not limited thereto.

[0058] In some embodiments, Ar_1 and Ar_2 in Formula 2 may be each Independently selected from:

[0059] a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

[0060] a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$, and

[0061] Q_{31} to Q_{33} may be each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0062] R_1 to R_{12} in Formula 1 may be each independently selected from:

[0063] a group represented by Formula 2, 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_{20} alkyl group, and a C_1-C_{20} alkoxy group;

[0064] 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0065] 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl group, a benzoxazolyl group, an Isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$; and

[0066] —$Si(Q_1)(Q_2)(Q_3)$,

[0067] where Q_1 to Q_3 and Q_3 to Q_3 may be each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0068] For example, R_1 to R_{12} in Formula 1 may be each independently selected from:

[0069] a group represented by Formula 2, 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_{10} alkyl group, and a C_1-C_{10} alkoxy group;

[0070] a phenyl group, a naphthyl group, a pyrimidinyl group, and a triazinyl group;

[0071] a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl 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 C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$; and

[0072] —$Si(Q_1)(Q_2)(Q_3)$,

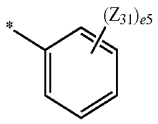
[0073] where Q_1 to Q_3 and Q_{31} to Q_{33} may be each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group. However, embodiments of the present invention are not limited thereto.

[0074] In some embodiments, in Formulae 1 and 2,

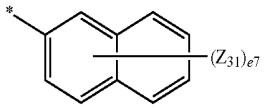
[0075] Ar_1 and Ar_2 may be each Independently selected from a group represented by any one of Formula 5-1 to Formula 5-42,

[0076] R_1 to R_{12} may be each independently selected from a group represented by Formula 2, 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 and a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxyl group, and a group represented by any one of Formula 5-1 to Formula 5-42:

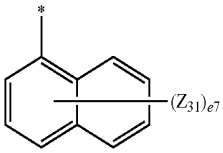
Formula 5-1



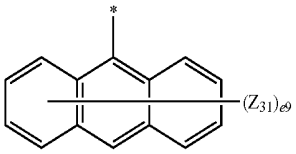
Formula 5-2



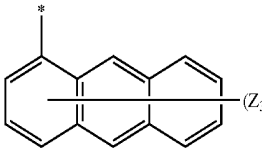
Formula 5-3



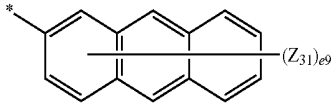
Formula 5-4



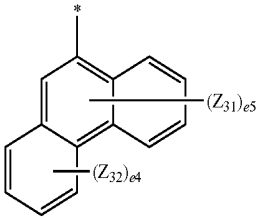
Formula 5-5



Formula 5-6



Formula 5-7



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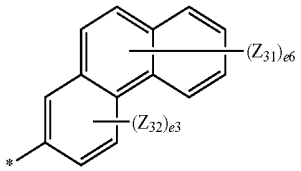
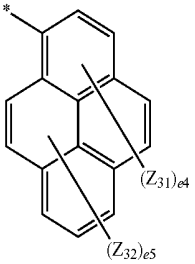


Formula 5-9



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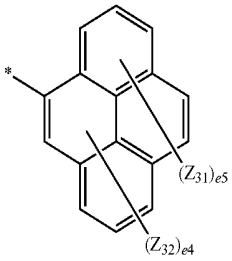
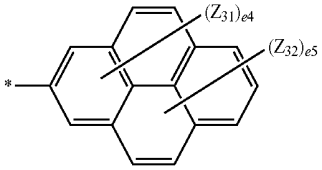


Formula 5-11



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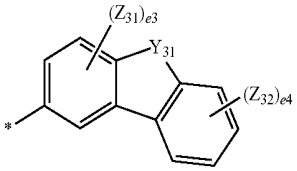
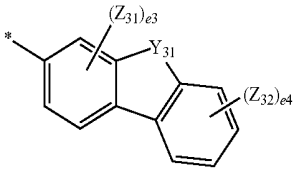
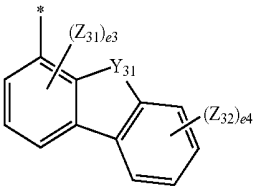


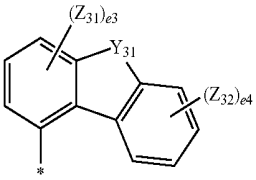
Formula 5-13



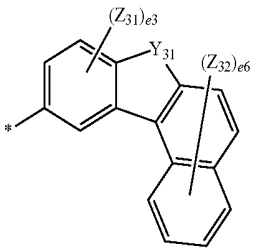
Formula 5-14



Formula 5-15



Formula 5-16



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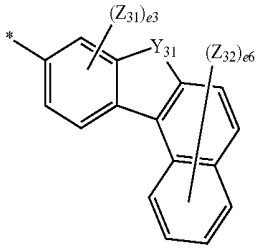
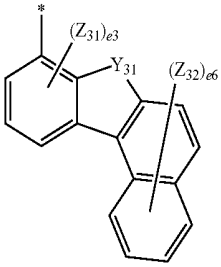


Formula 5-18



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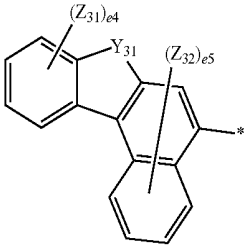

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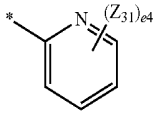

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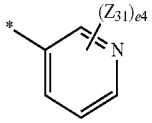
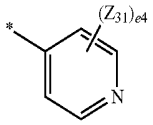
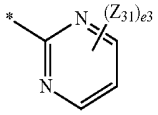


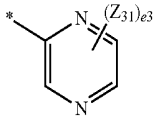
Formula 5-22



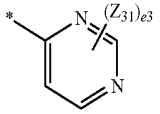
Formula 5-23



Formula 5-24



Formula 5-25



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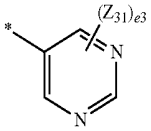
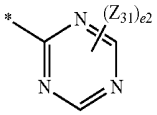
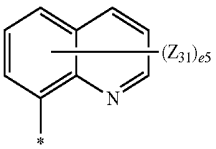
Formula 5-26



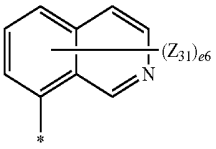
Formula 5-27



Formula 5-28



Formula 5-29



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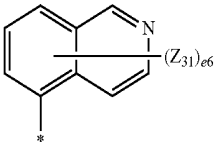
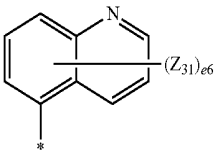
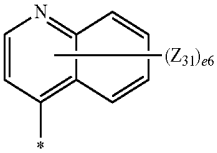


Formula 5-31



Formula 5-32



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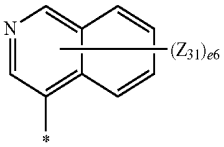
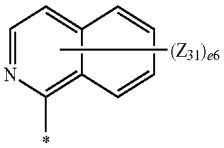
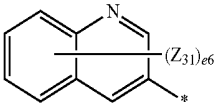


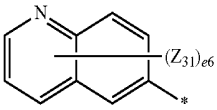
Formula 5-34



Formula 5-35



Formula 5-36



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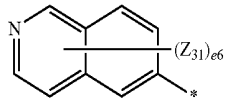
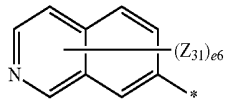
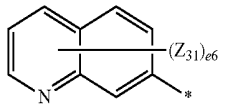
Formula 5-37



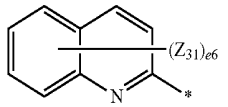
Formula 5-38



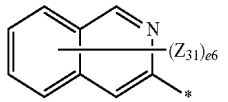
Formula 5-39



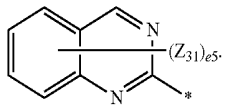
Formula 5-40



Formula 5-41



Formula 5-42



[0077] In Formulae 5-1 to 5-42,

[0078] Y_{31} may be O, S, $C(Z_{33})(Z_{34})$, $N(Z_{35})$, or $Si(Z_{36})(Z_{37})$;

[0079] Z_{31} to Z_{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_{20} alkyl group, a C_1-C_{20} 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 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,

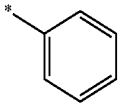
[0080] e2 may be 1 or 2, e3 may be an integer selected from 1, 2, and 3, e4 may be an integer selected from 1, 2, 3, and 4, e5 may be an integer selected from 1, 2, 3, 4, and 5, e6 may be an integer selected from 1, 2, 3, 4, 5, and 6, e7 may be an integer selected from 1, 2, 3, 4, 5, 6, and 7, e9 may be an integer selected from 1, 2, 3, 4, 5, 6, 7, 8, and 9, and * indicates a binding site to a neighboring atom.

[0081] In some embodiments, in Formulae 1 and 2,

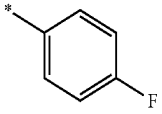
[0082] Ar_1 and Ar_2 may be each independently selected from a group represented by any one of Formula 6-1 to Formula 6-29 illustrated below,

[0083] R_1 to R_{12} may be each independently selected from a group represented by Formula 2, 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 and a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxyl group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group and a triazinyl group, but embodiments of the present invention are not limited thereto:

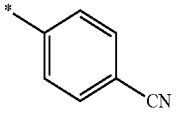
Formula 6-1



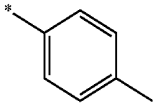
Formula 6-2



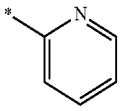
Formula 6-3



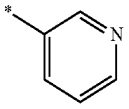
Formula 6-4



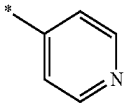
Formula 6-5



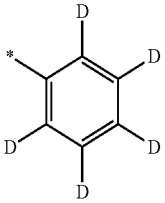
Formula 6-6



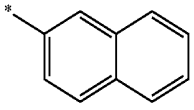
Formula 6-7



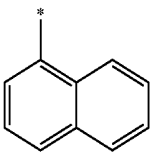
Formula 6-8



Formula 6-9



Formula 6-10



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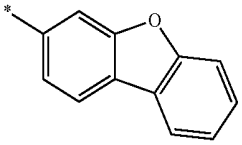
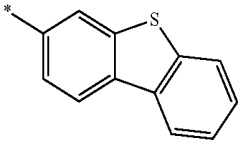
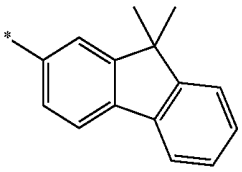
Formula 6-11



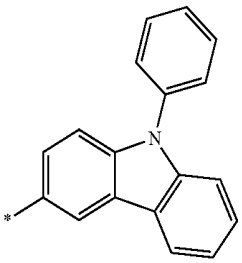
Formula 6-12



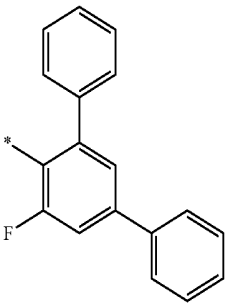
Formula 6-13



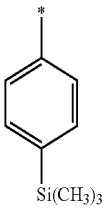
Formula 6-14



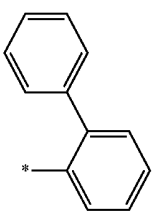
Formula 6-15



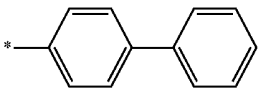
Formula 6-16



Formula 6-17



Formula 6-18



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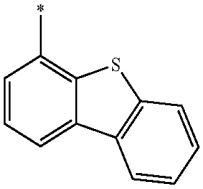
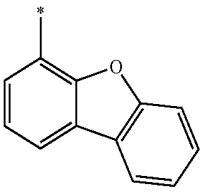


Formula 6-20



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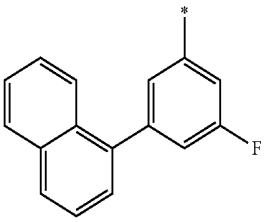
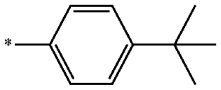
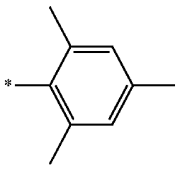


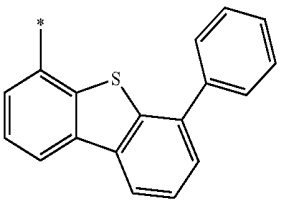
Formula 6-22



Formula 6-23



Formula 6-24



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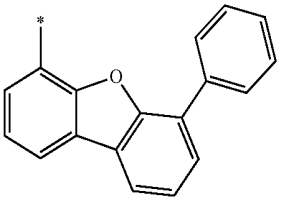
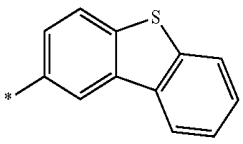
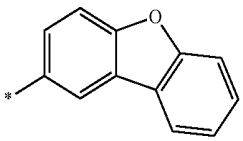


Formula 6-26



Formula 6-27



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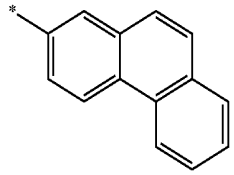
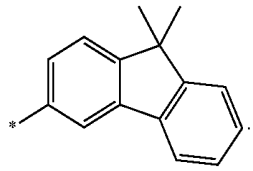
Formula 6-28



Formula 6-29



[0084] * in Formulae 6-1 to 6-29 indicates a binding site to a neighboring atom.

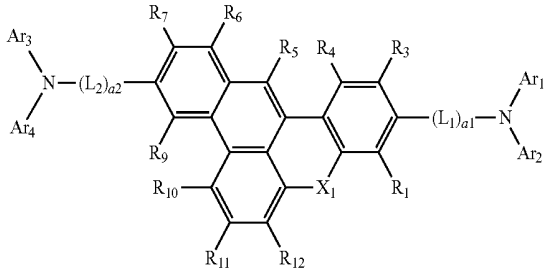
[0085] Referring to Formula 1, R_5 in Formula 1 may not be a hydrogen.

[0086] In some embodiments, R_5 may be 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 and a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxyl group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group and a triazinyl group.

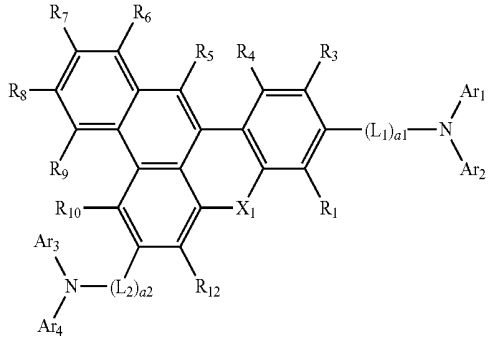
[0087] Any two substituents selected from R_1 to R_{12} in Formula 1 may be each Independently a group represented by Formula 2.

[0088] For example, the condensed cyclic compound represented by Formula 1 may be represented by one of Formulae 1-1 to 1-4 below:

Formula 1-1



Formula 1-2



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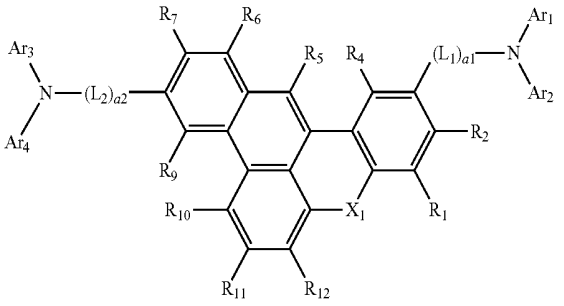
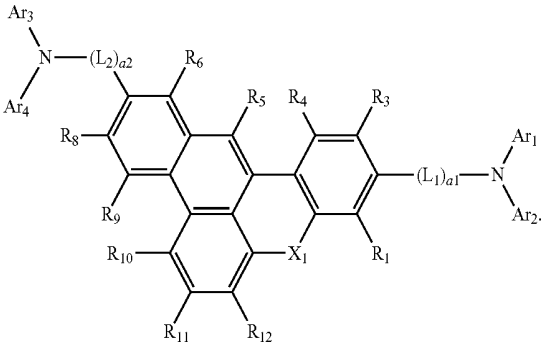
Formula 1-3



Formula 1-4



[0089] Regarding Formulae 1-1 to 1-4, descriptions of X_1, L_1, a1, Ar_1, Ar_2, and R_1 to R_{12} are as provided above, and descriptions of L_2, a2, Ar_3, and Ar_4 are the same as the descriptions presented in connection with L_1, a1, Ar_1, and Ar_2, respectively.

[0090] In some embodiments, in Formulae 1-1 and 1-4,

[0091] a1 is 0 and a2 is 0;

[0092] a1 is 0 and a2 is 1 or 2;

[0093] a1 is 1 or 2 and a2 is 0;

[0094] a1 is 1 and a2 is 1;

[0095] a1 is 1 and a2 is 2;

[0096] a1 is 2 and a2 is 1; or

[0097] a1 is 2 and a2 is 2.

[0098] In some embodiments, in Formulae 1-1 and 1-4,

[0099] a1 is 0 and a2 is 0;

[0100] a1 is 0 and a2 is 1;

[0101] a1 is 1 and a2 is 0; or

[0102] a1 is 1 and a2 is 1. However, embodiments of the present Invention are not limited thereto.

[0103] In Formulae 1-1 to 1-4,

[0104] Ar_1, Ar_2, Ar_3 and Ar_4 may be the same (A_1=Ar_2=Ar_3=Ar_4);

[0105] A_1 may be the same as Ar_3, and Ar_2 may be the same as Ar_4, but Ar_2 may be different from Ar_3 (Ar_1=Ar_3 and Ar_2=Ar_4, but Ar_2≠Ar_3);

[0106] A_1 may be the same as Ar_3, but Ar_2 may be different from Ar_4 and Ar_2 may be different from Ar_3 (A_1=Ar_3 and, Ar_2=Ar_4 and, Ar_2≠Ar_3); or

[0107] Ar_1, Ar_2, Ar_3 and Ar_4 may be all different from each other (Ar_1≠Ar_2≠Ar_3≠Ar_4).

[0108] In some embodiments, in Formulae 1-1 and 1-4,

[0109] R_1 to R_{12} 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 hydra-

zone 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group,

[0110] L_1 and L_2 may be each independently selected from a group represented by any one of Formula 3-1 to Formula 3-35,

[0111] a1 and a2 may be each independently 0, 1, or 2;

[0112] A_1 to Ar_4 may be each independently selected from a group represented by any one of Formula 5-1 to Formula 5-24.

[0113] In some embodiments, in Formulae 1-1 and 1-4,

[0114] R_1 to R_4, and R_6 to R_{12} may each be a hydrogen,

[0115] R_5 may be 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group,

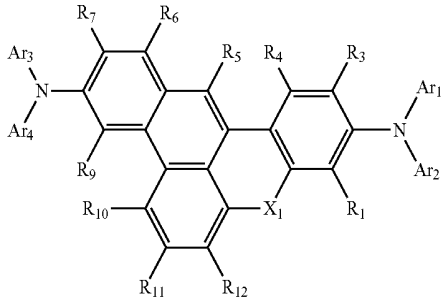
[0116] L_1 and L_2 may be each Independently selected from a group represented by any one of Formula 4-1 to Formula 4-28,

[0117] a1 and a2 may be each independently 0 or 1,

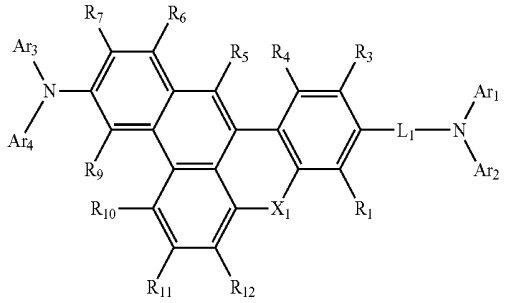
[0118] A_1 to Ar_4 may be each Independently selected from a group represented by any one of Formula 6-1 to Formula 6-29. However, embodiments of the present Invention are not limited thereto.

[0119] In some embodiments, the condensed cyclic compound represented by Formula 1 may be represented by one of Formulae 1-1(1) to 1-1(4) below, but embodiments of the present invention are not limited thereto:

Formula 1-1(1)



Formula 1-1(2)



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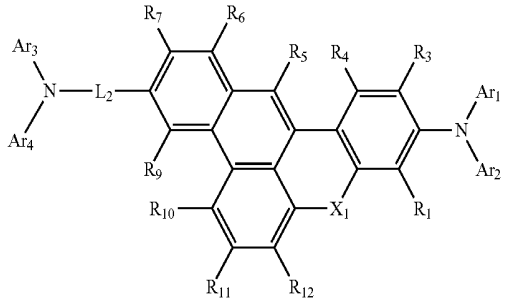
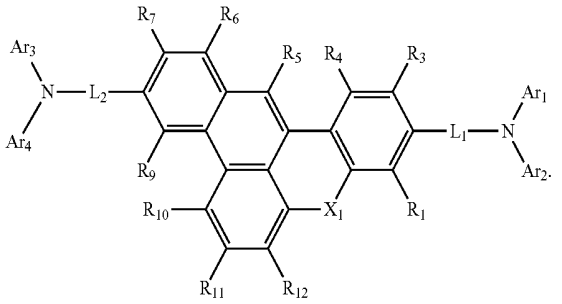
Formula 1-1(3)



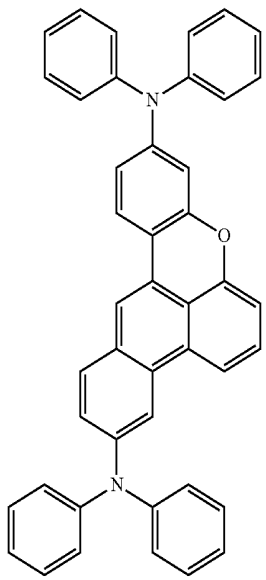
Formula 1-1(4)



[0120] Regarding Formulae 1-1(1) to 1-1(4), descriptions of X_1, L_1, a1, Ar_1, Ar_2, R_1, R_3 to R_7, and R_9 to R_{12} are the same as those provided above, and descriptions of L_2, a2, Ar_3, and Ar_4 are the same as the description presented in connection with L_1, a1, Ar_1, and Ar_2, respectively.

[0121] For example, the condensed cyclic compound represented by Formula 1 may be one selected from Compounds 1 to 189 and 1A to 164A below, but is not limited thereto:

1



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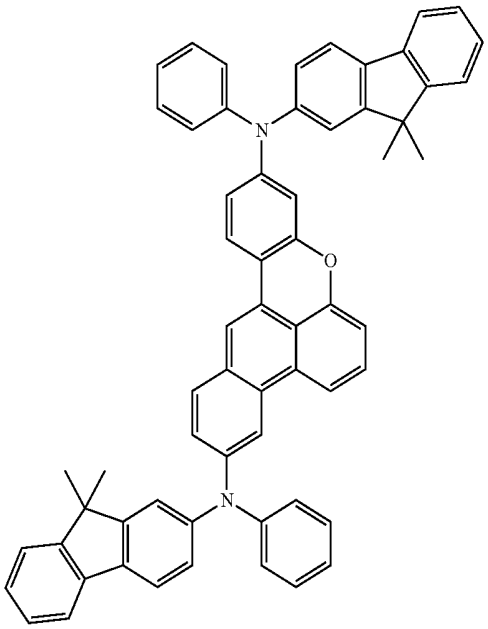

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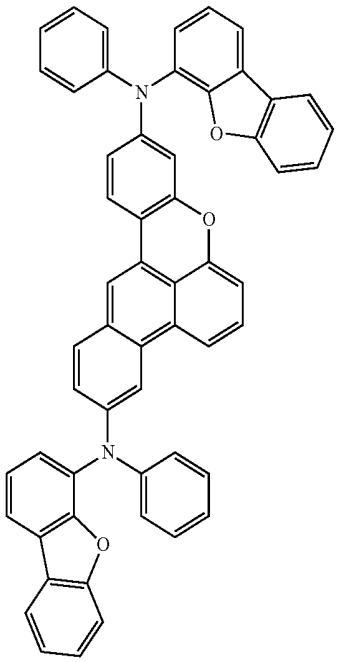

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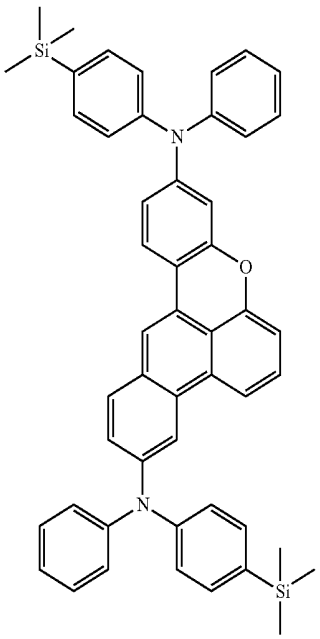

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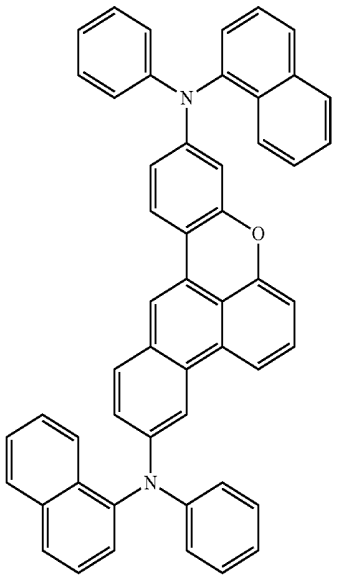

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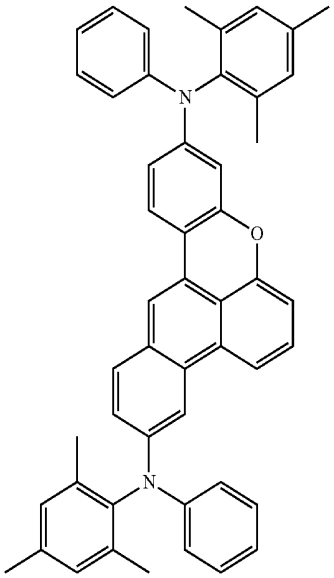

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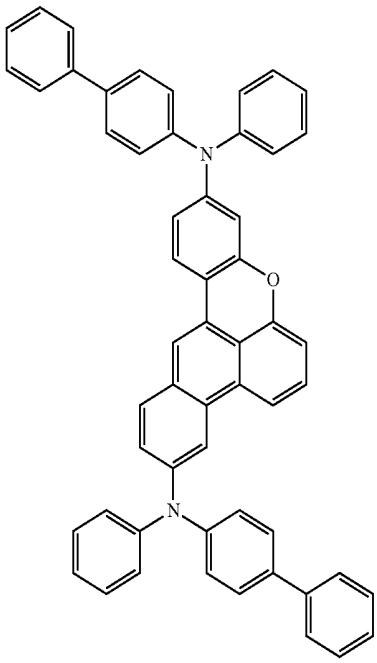

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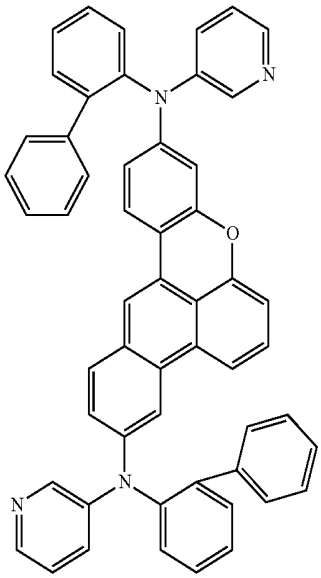

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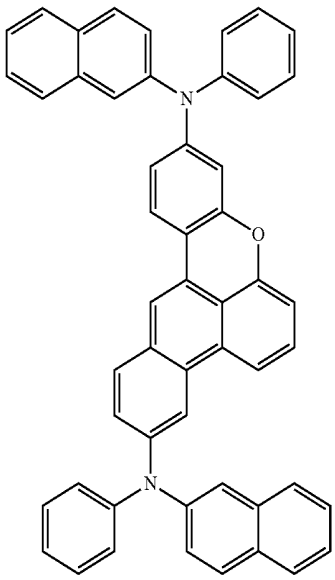

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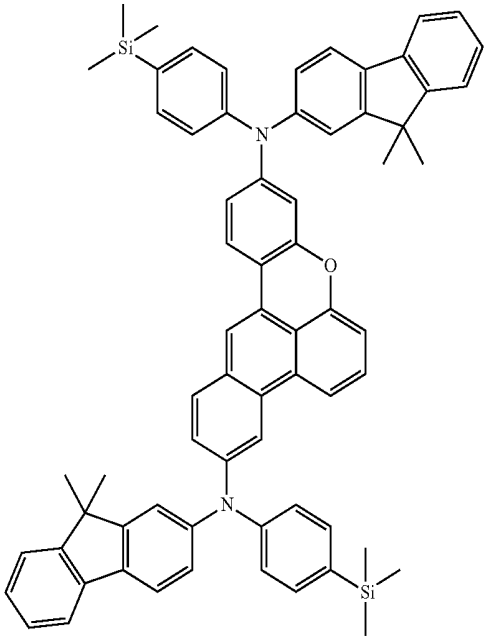

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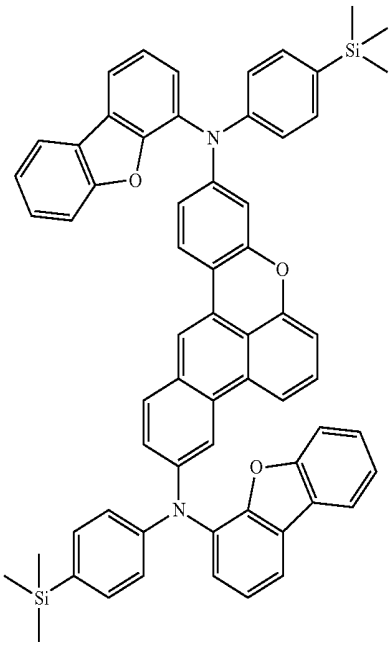

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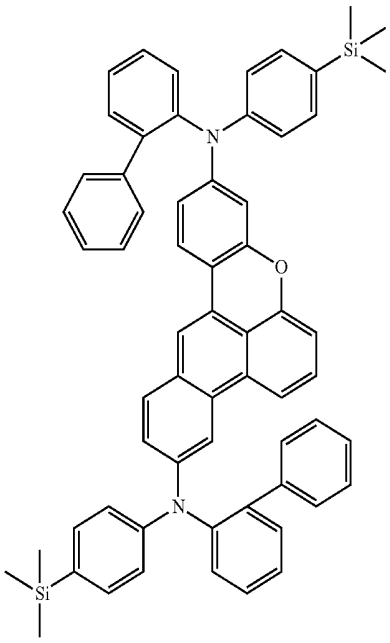

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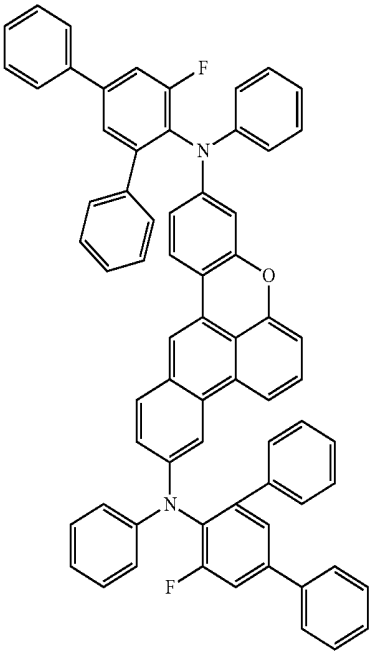

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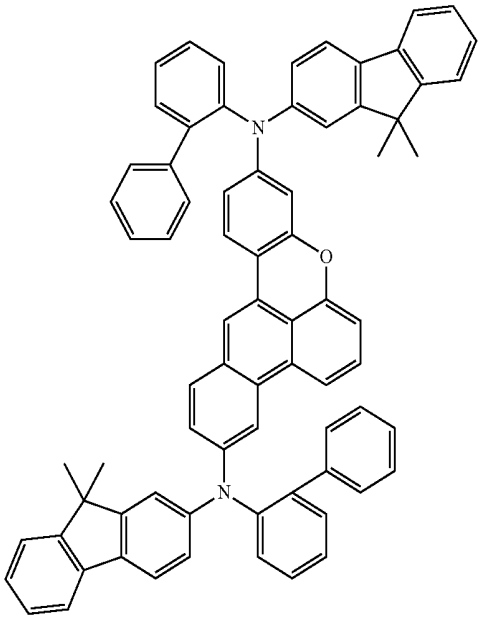

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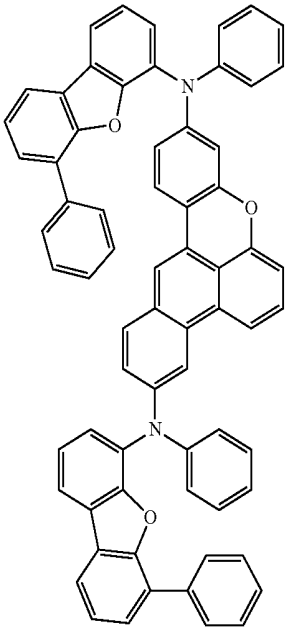
16



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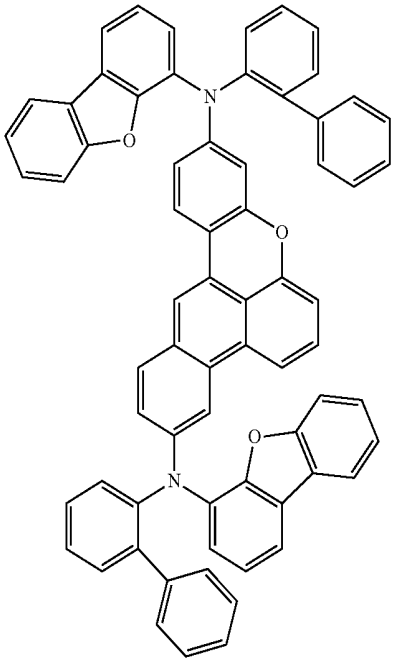

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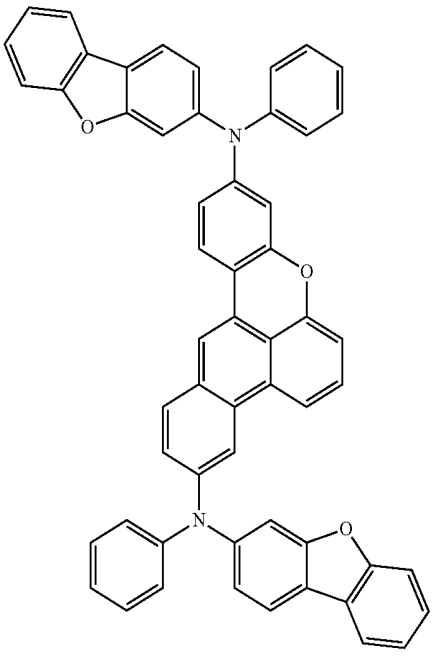

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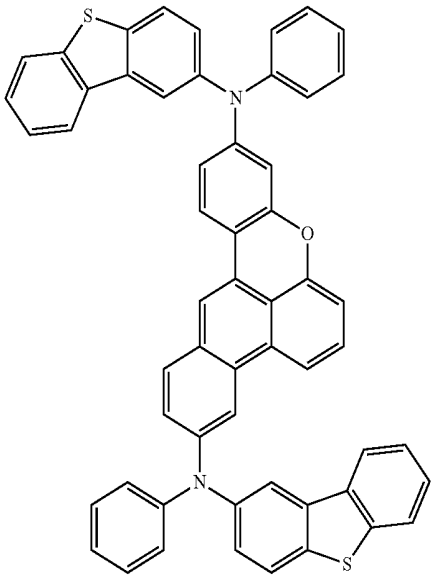

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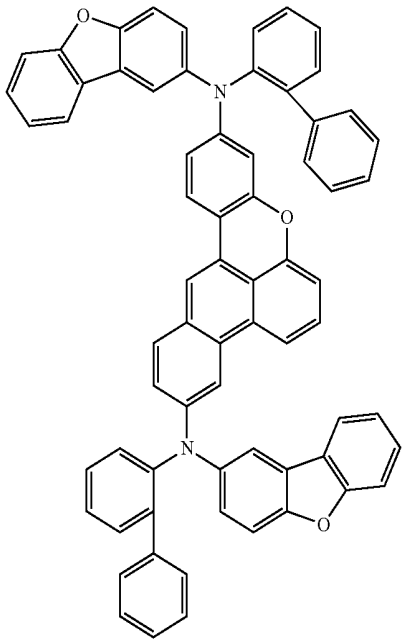

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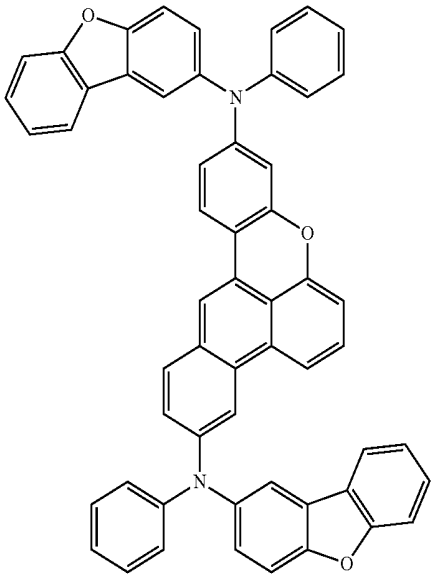

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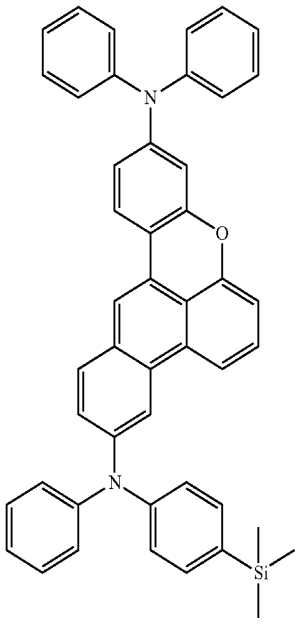

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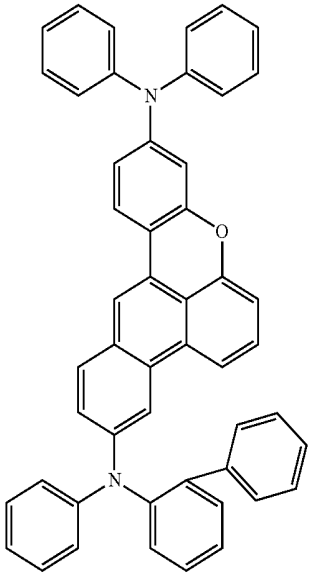

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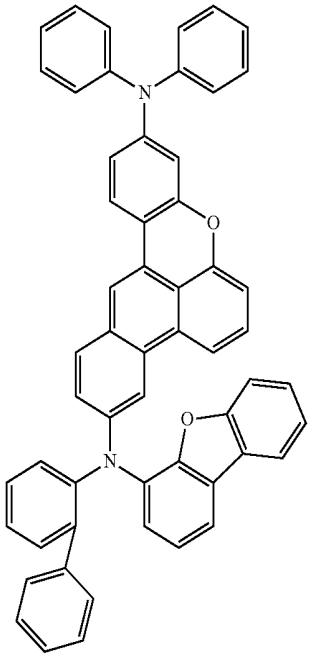

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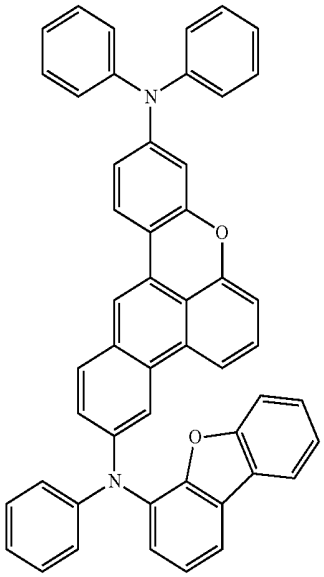

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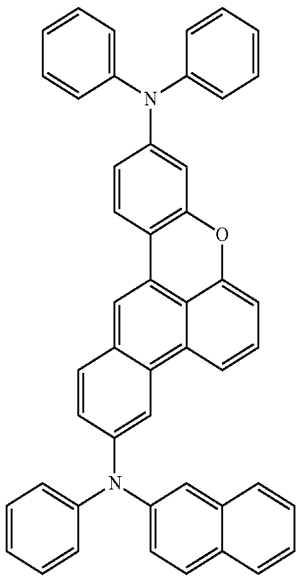

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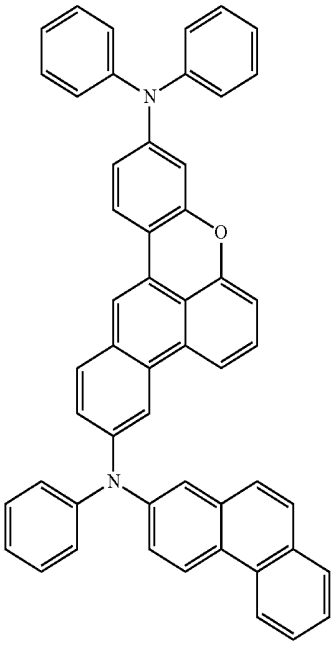

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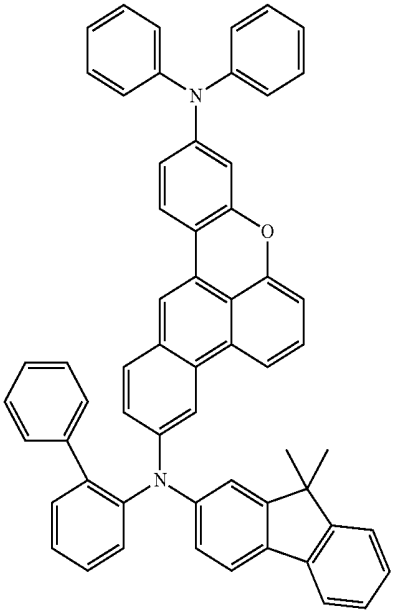

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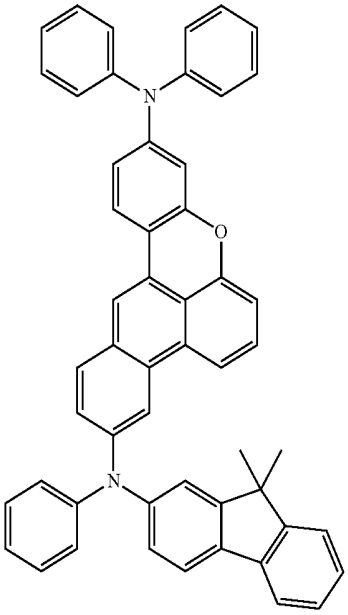

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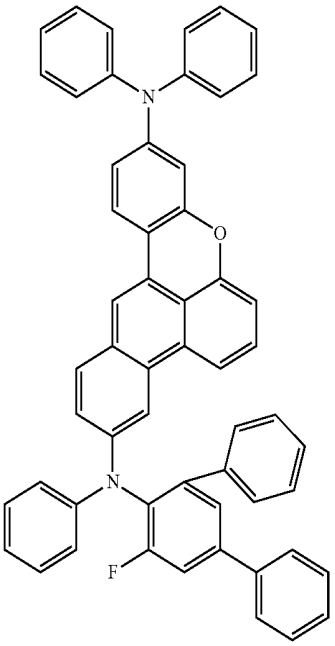

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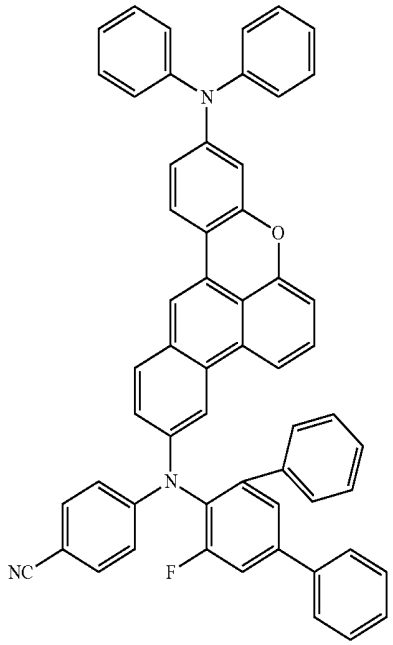

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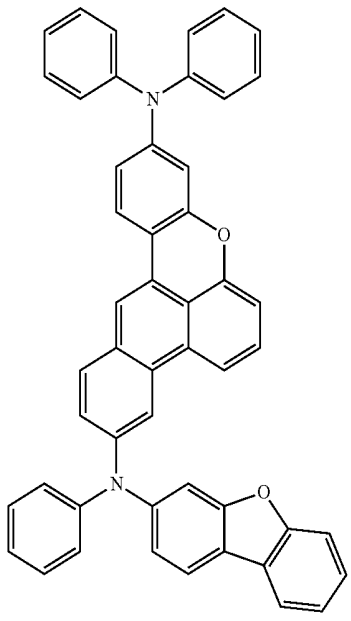

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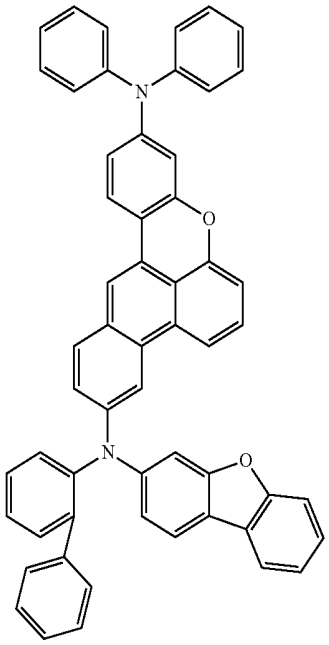

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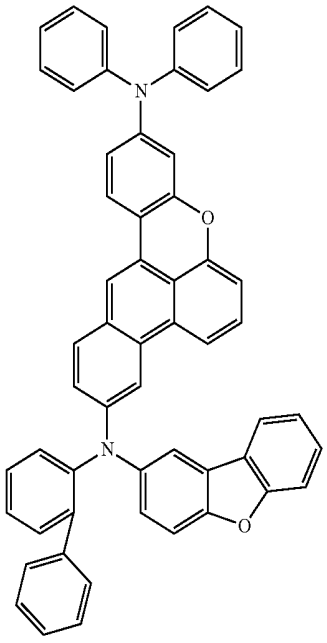

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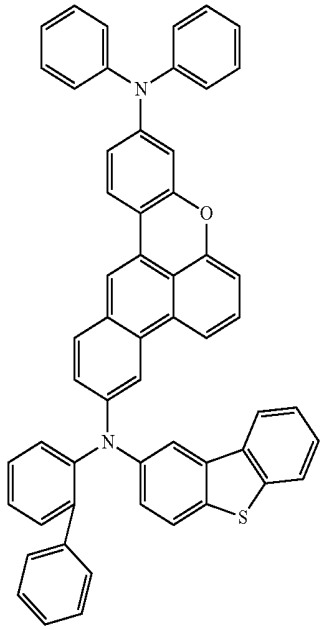

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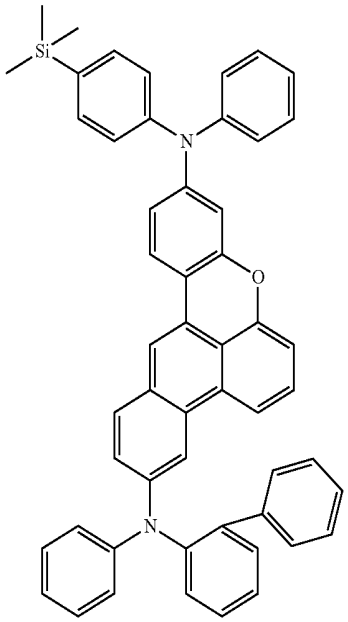

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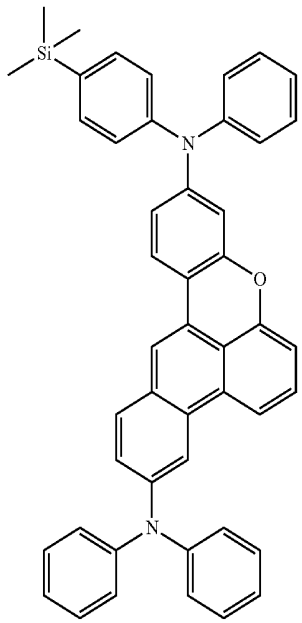

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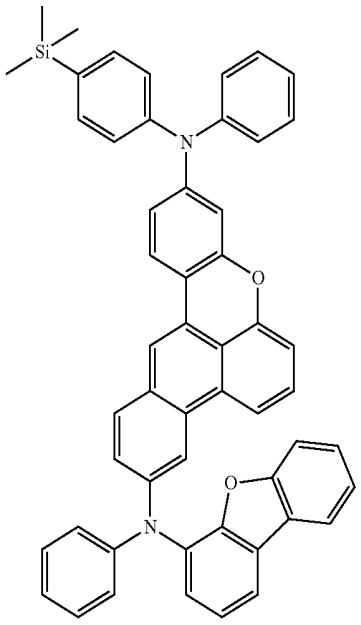

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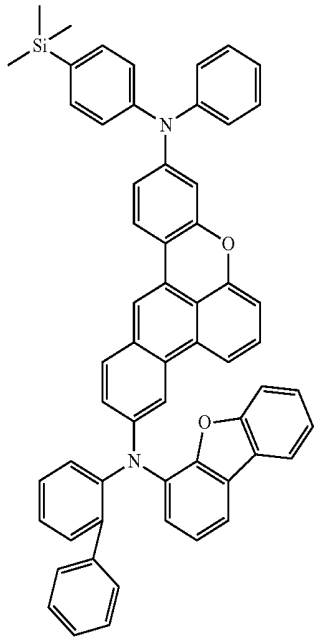

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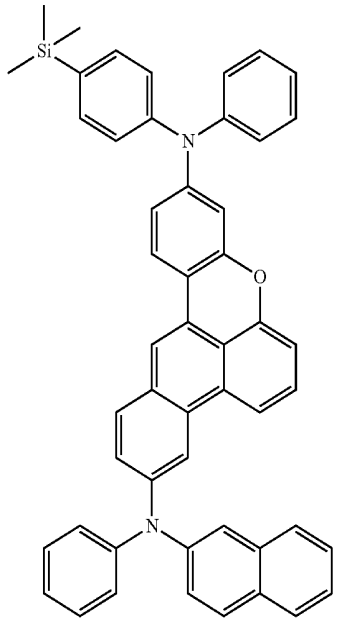

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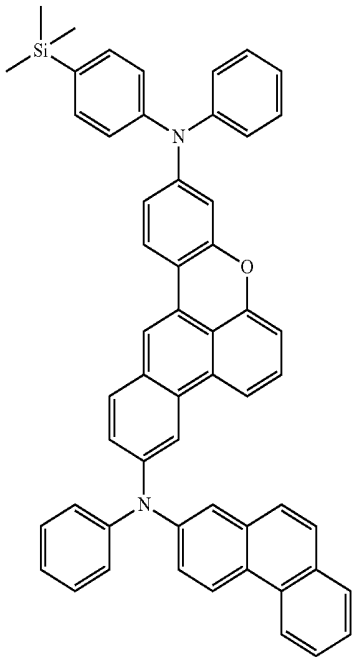

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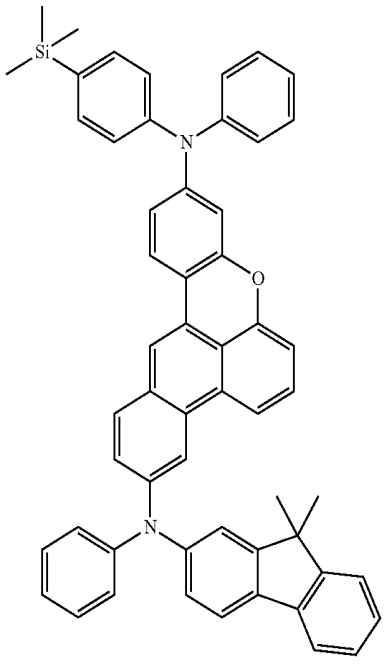

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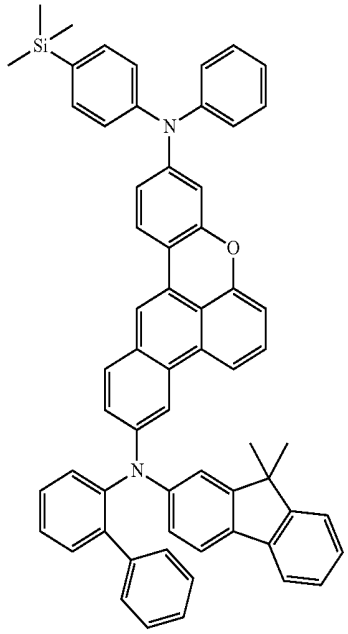

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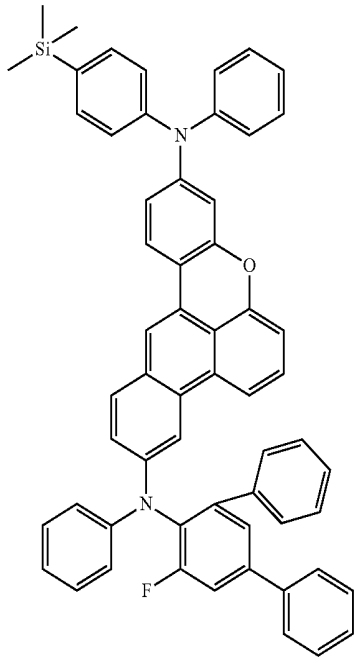

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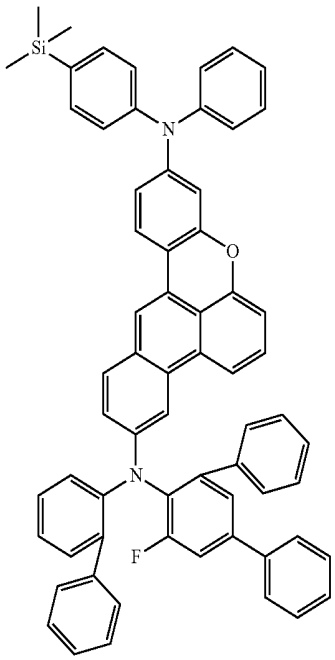

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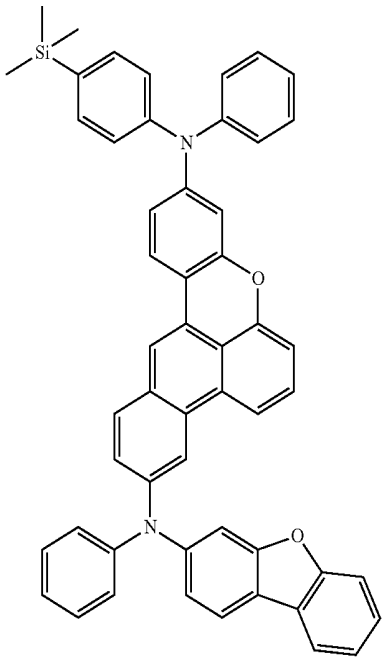

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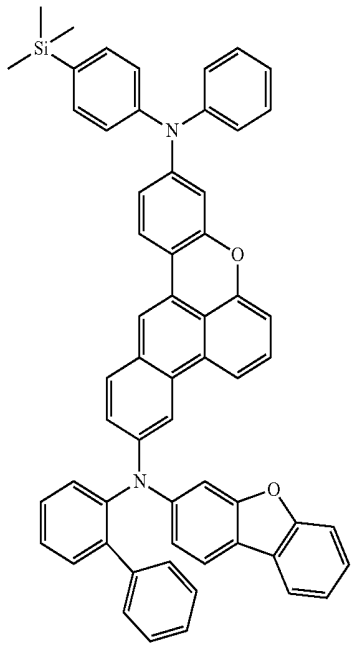

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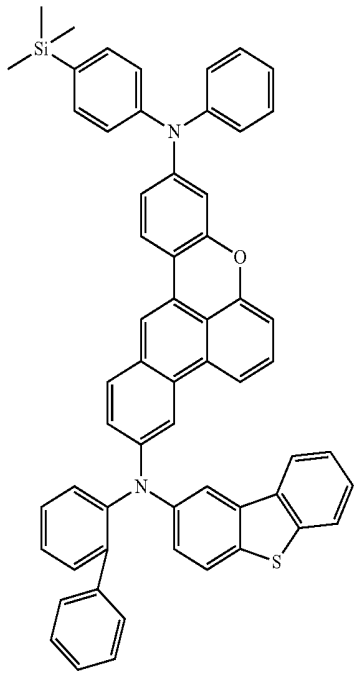

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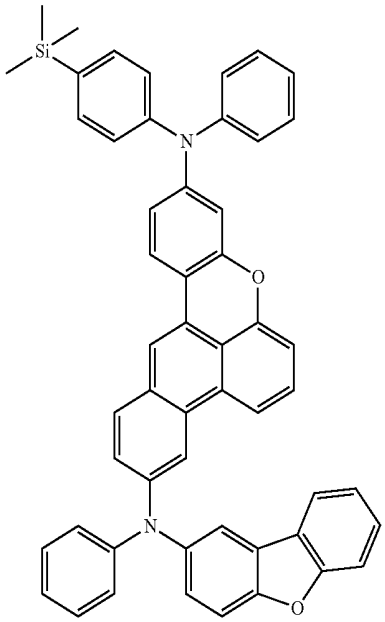

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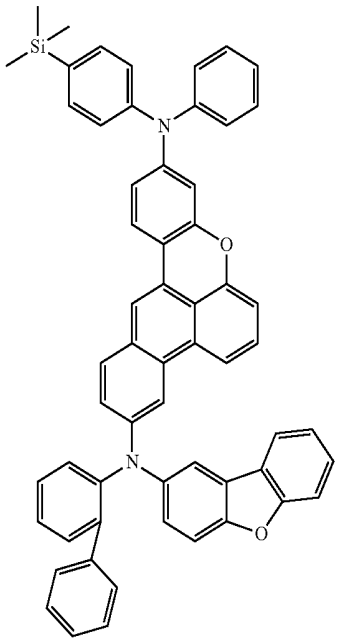

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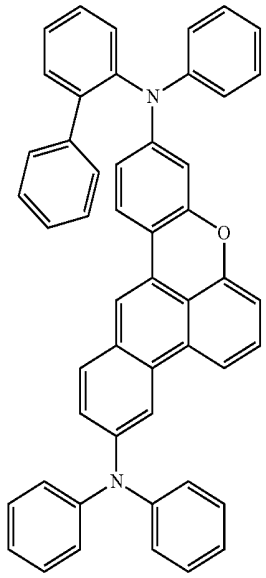

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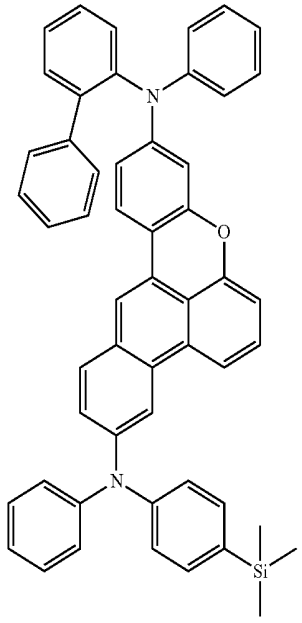

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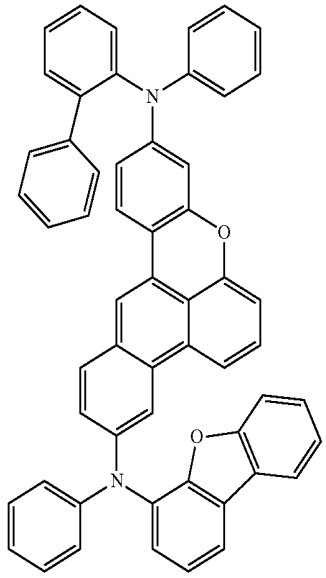

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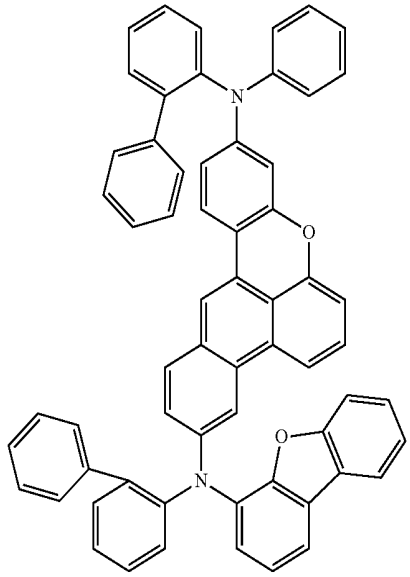

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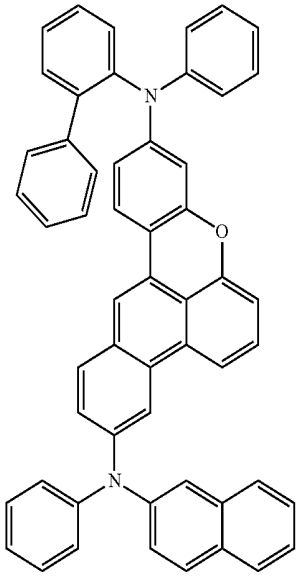

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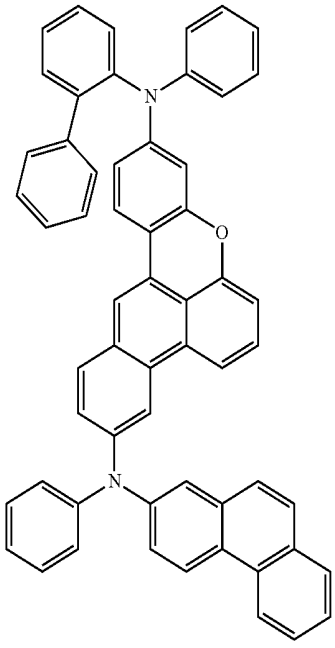

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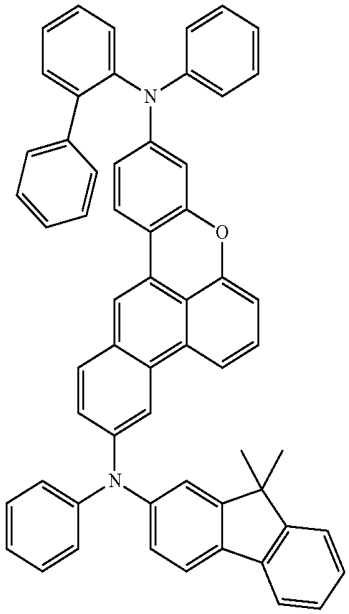

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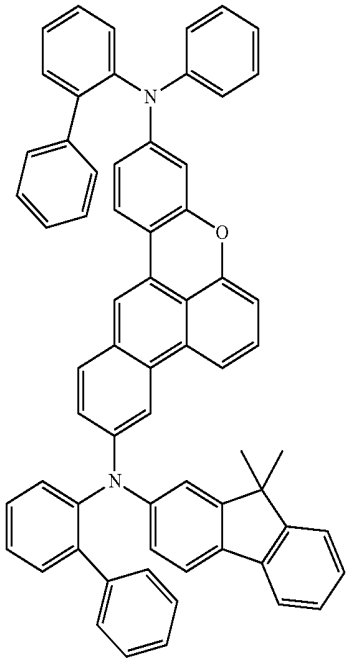

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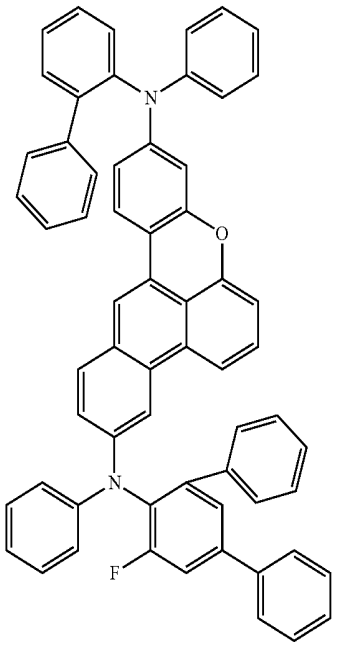

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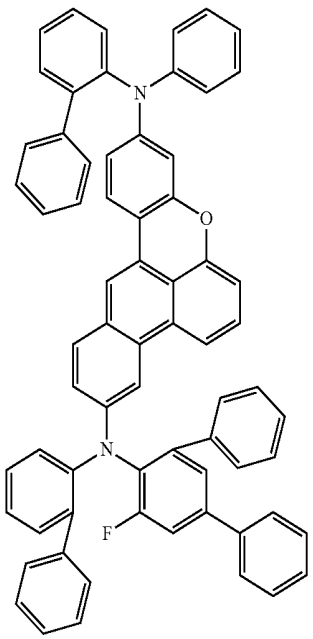

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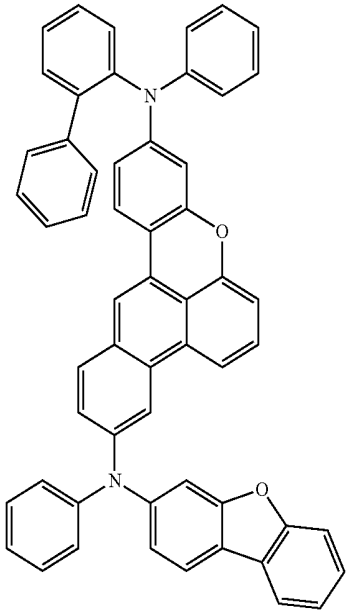

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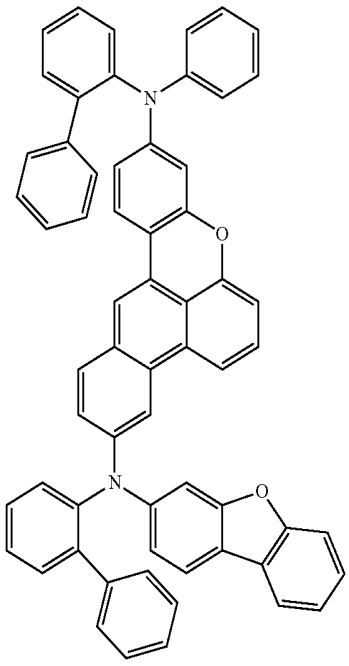

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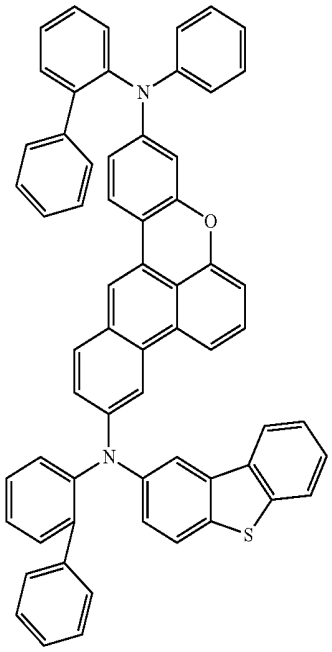

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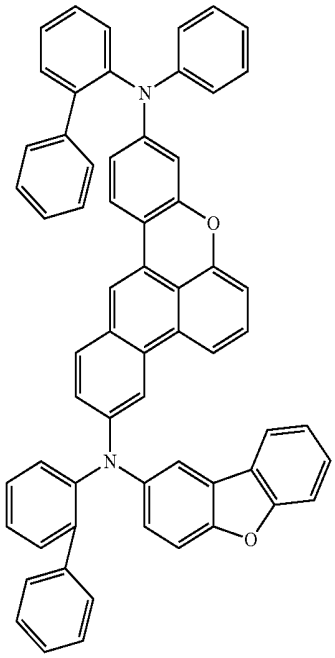

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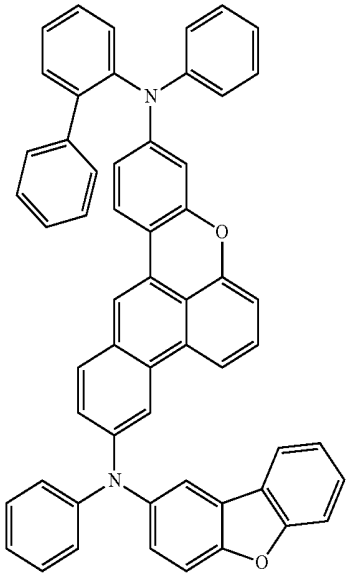

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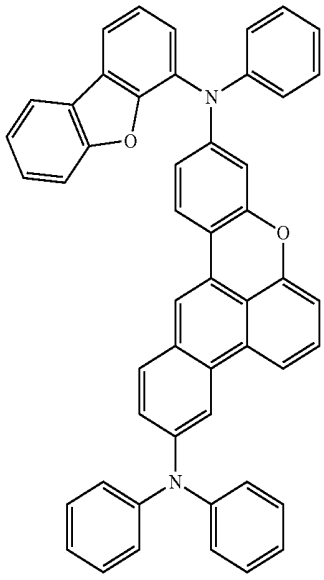

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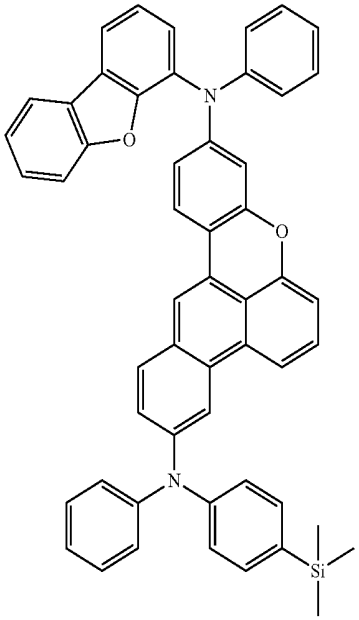

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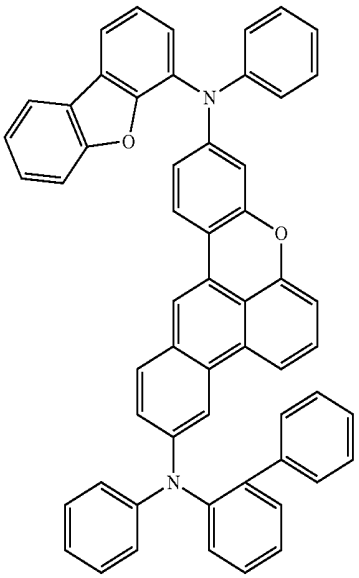

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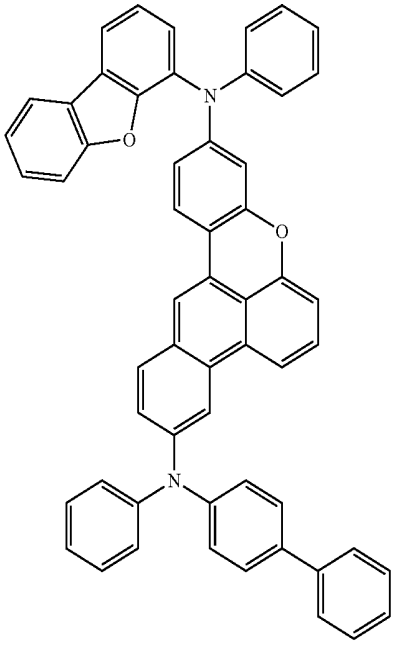

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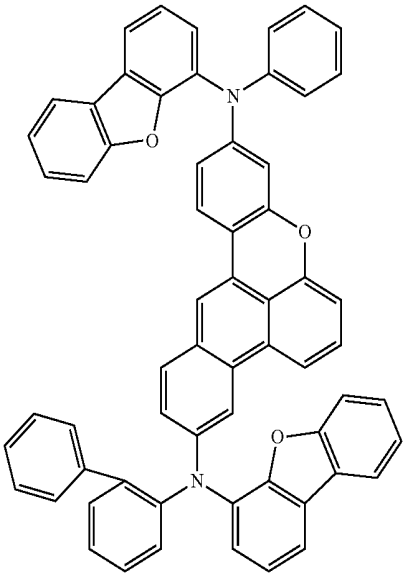

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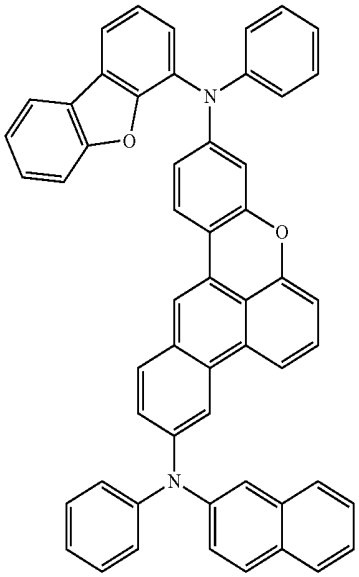

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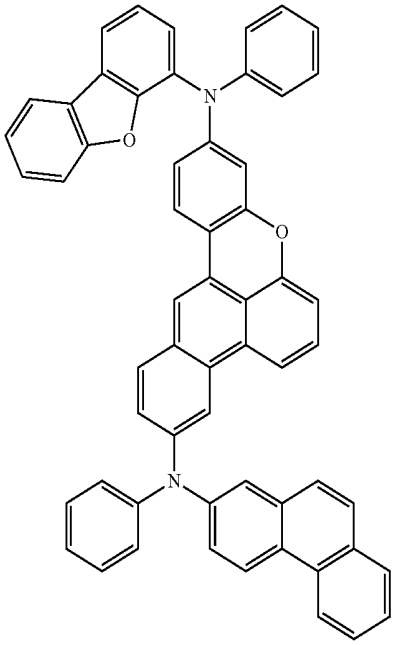

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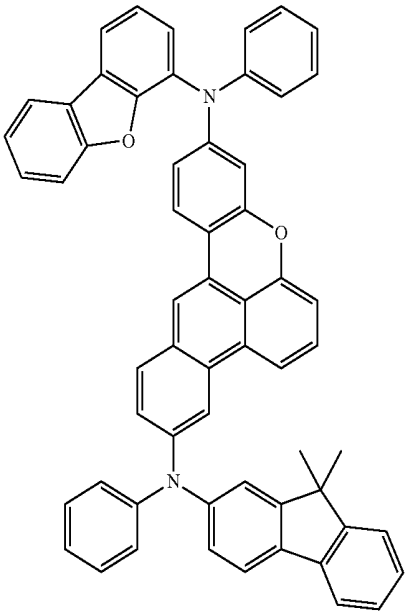

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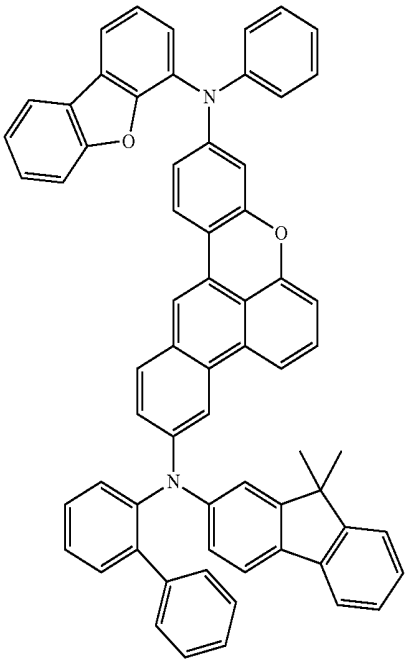

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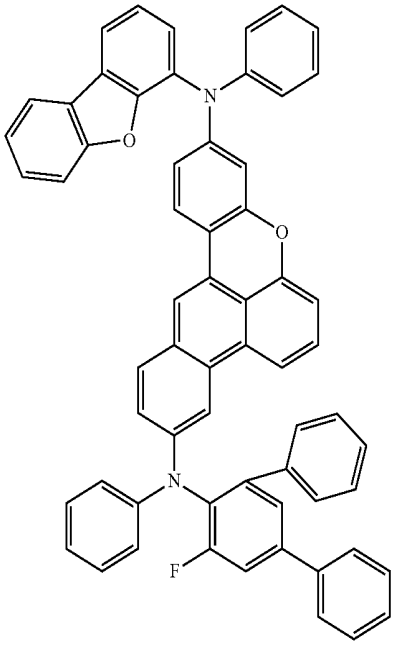

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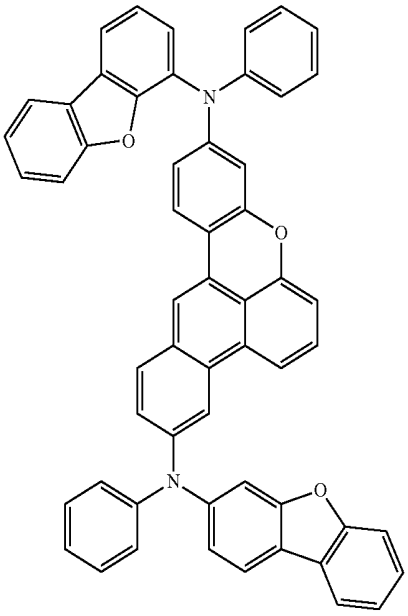

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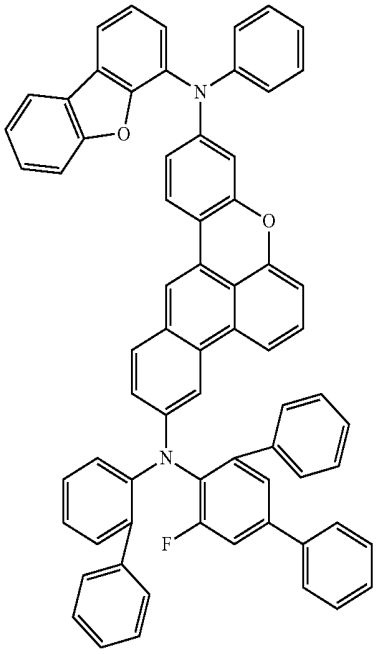

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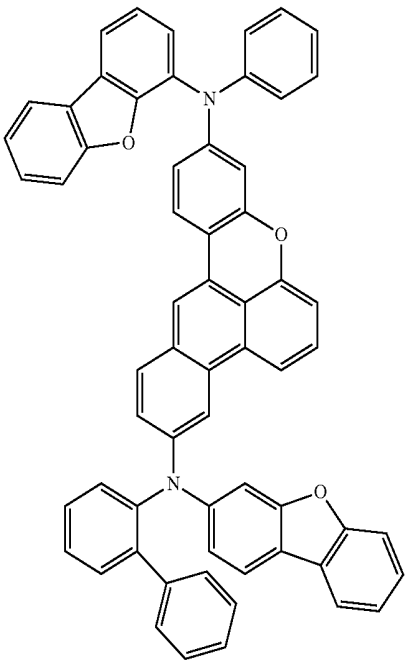

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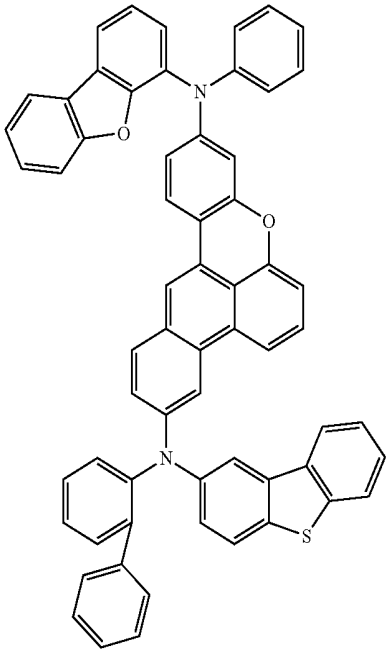

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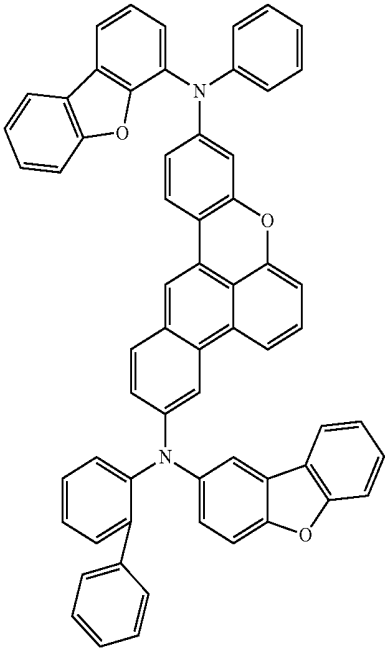

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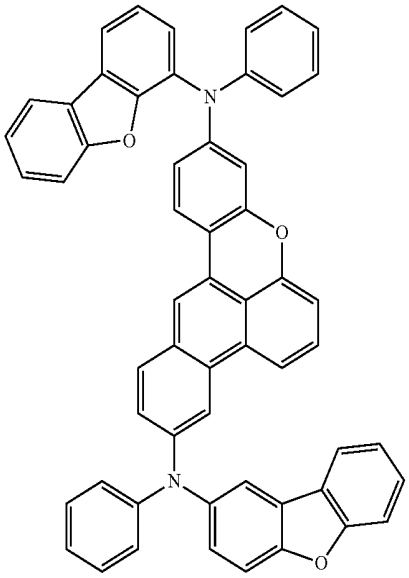

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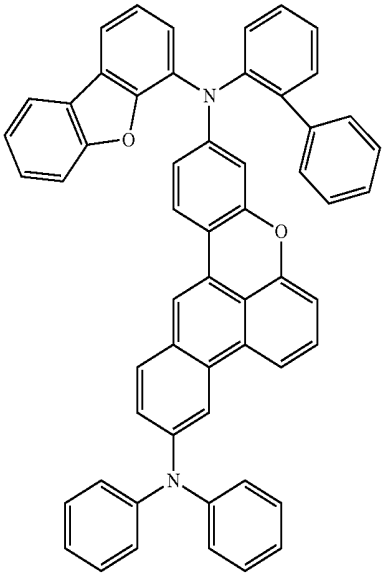

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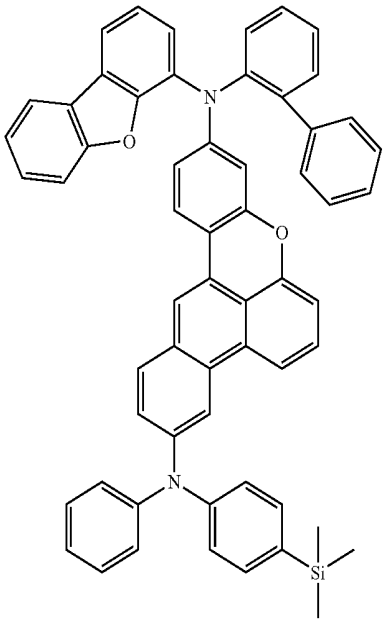

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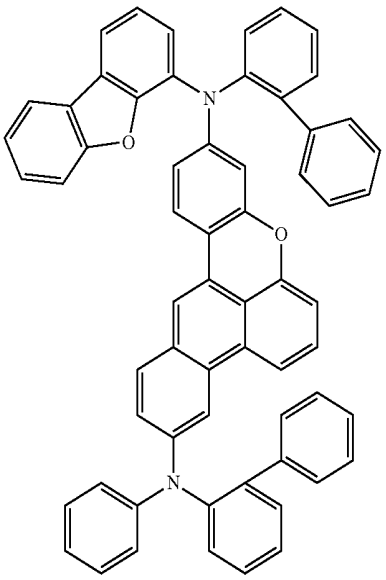

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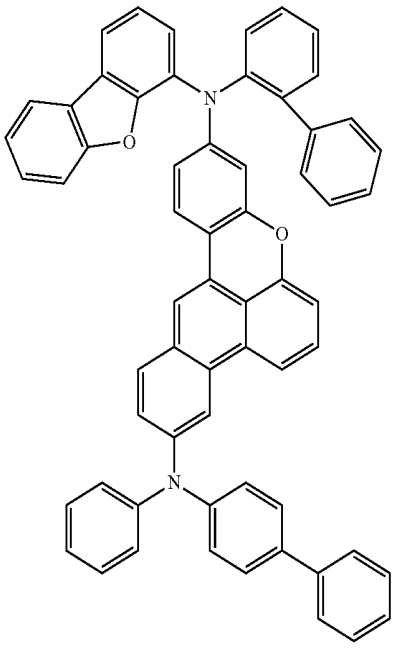

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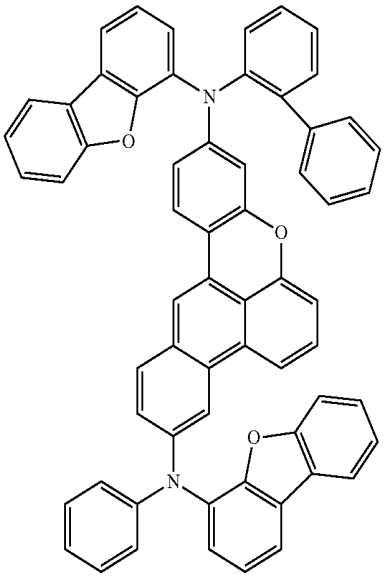

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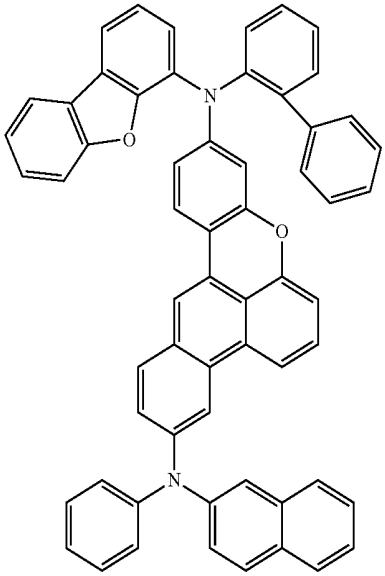

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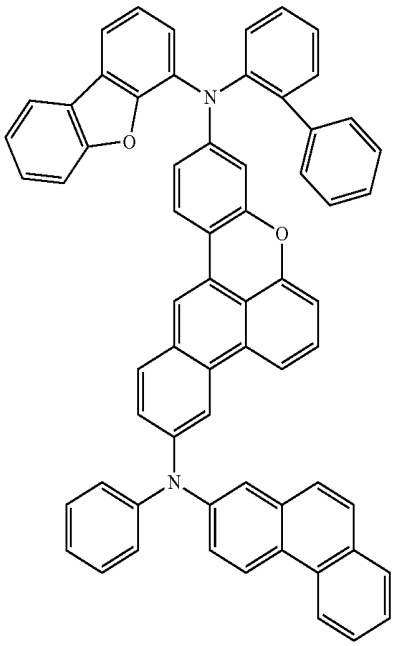

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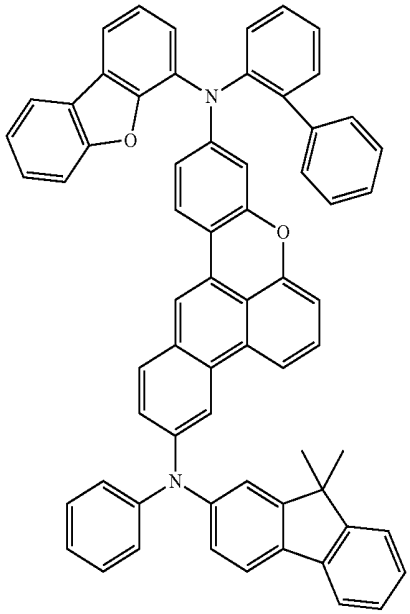

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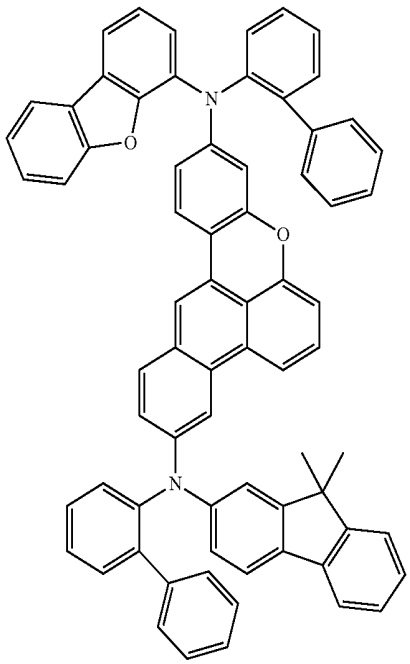

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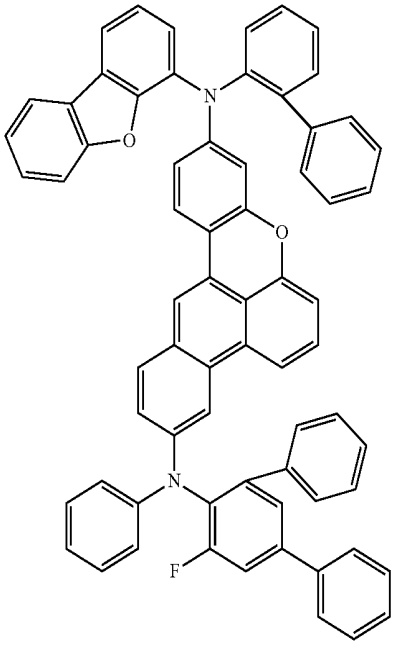

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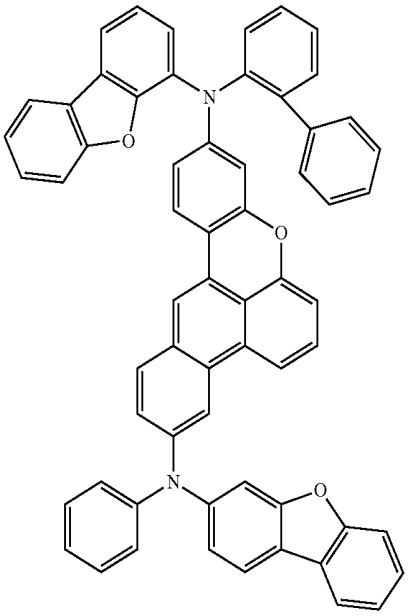

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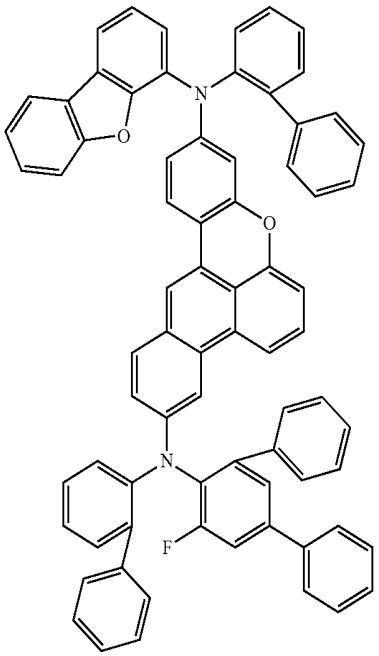

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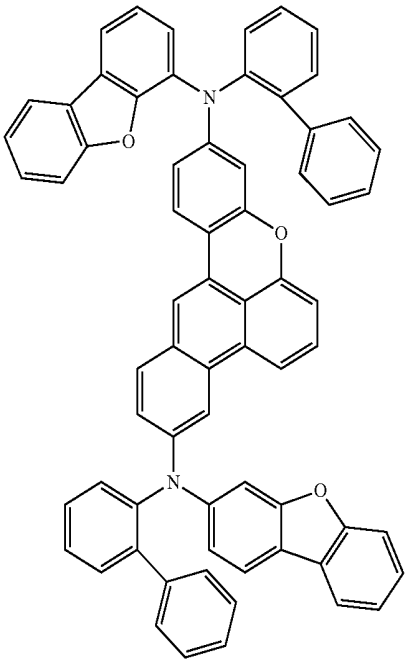

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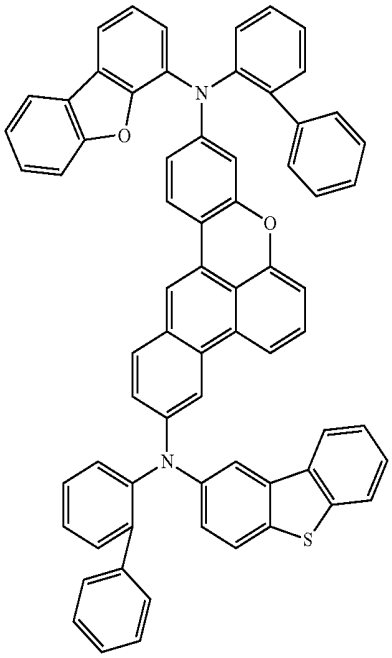

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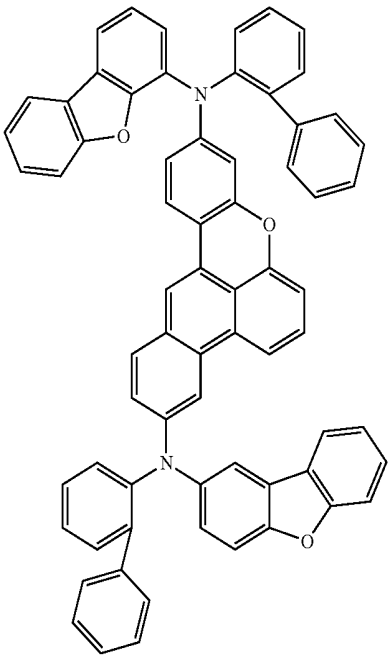

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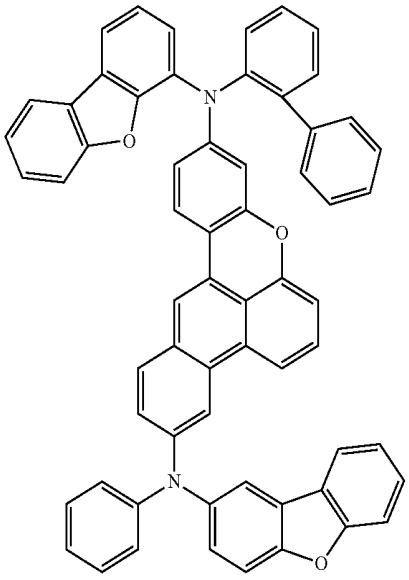

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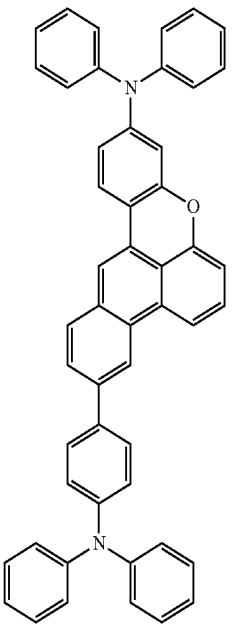

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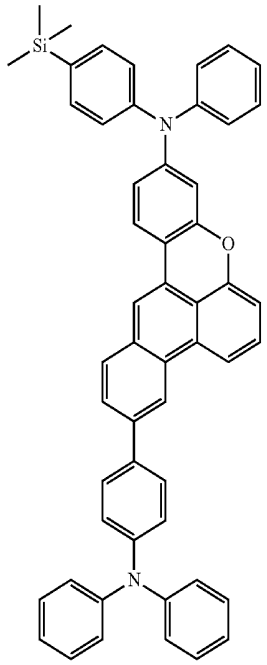

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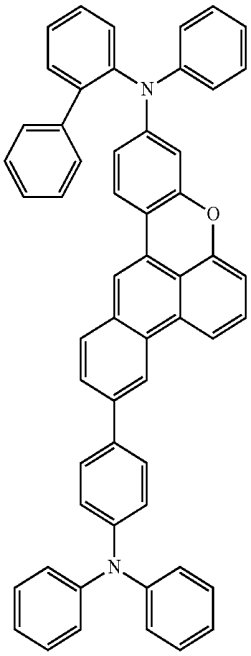

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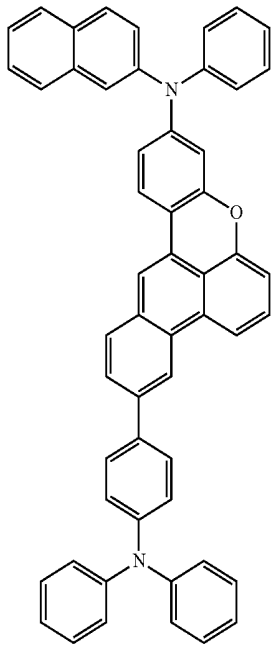

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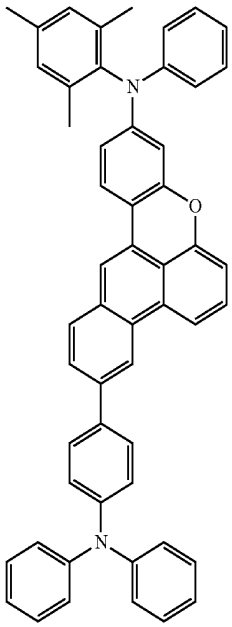

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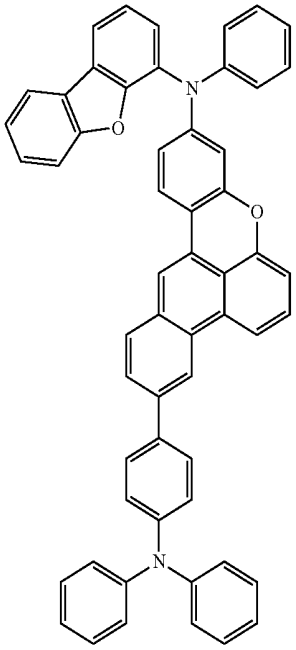

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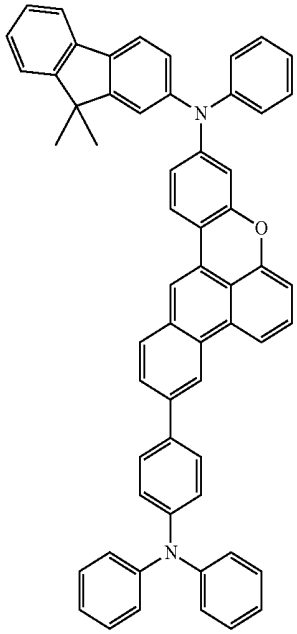

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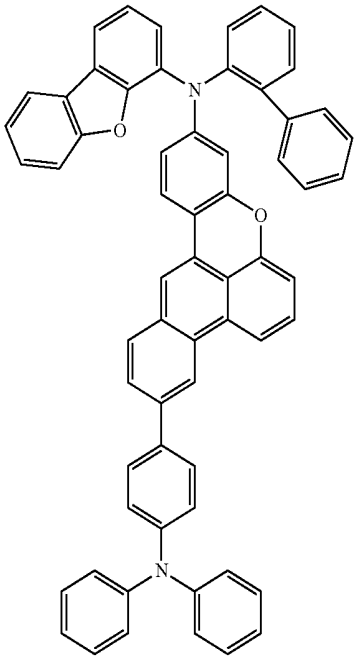

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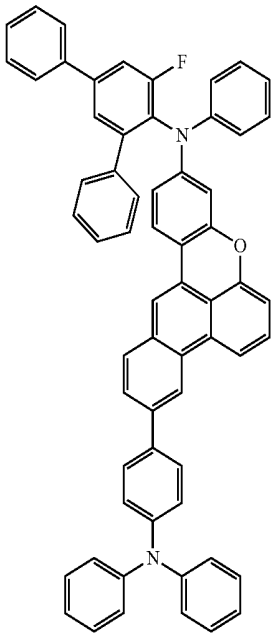

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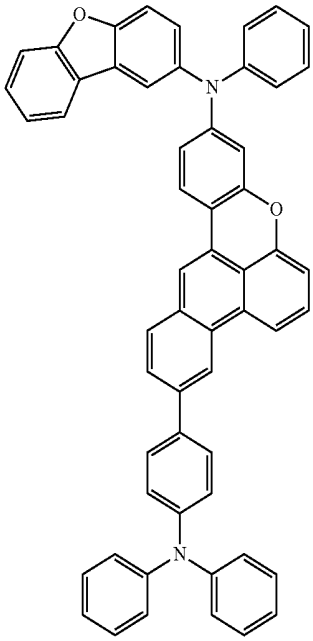

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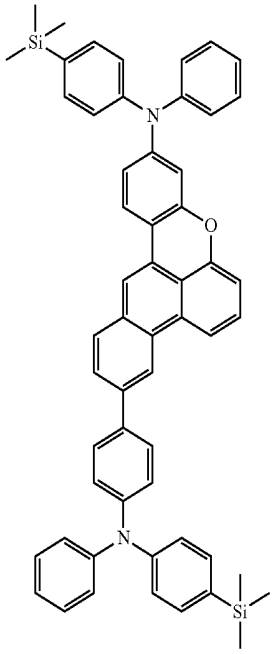

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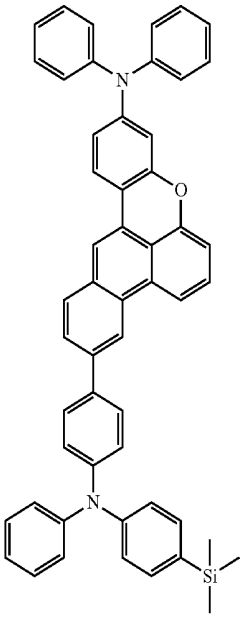

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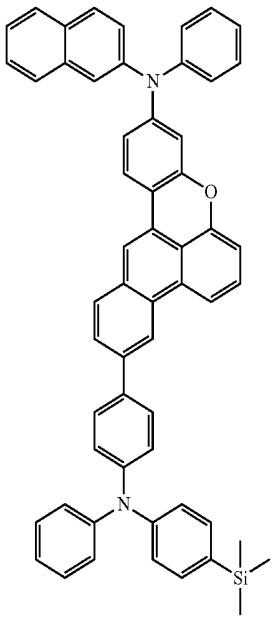

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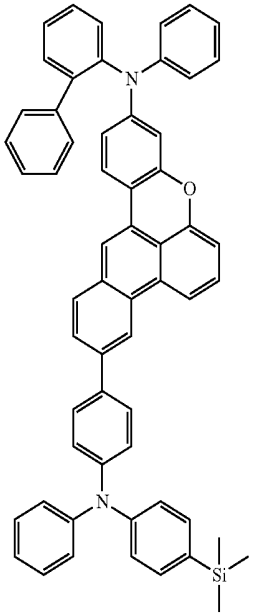

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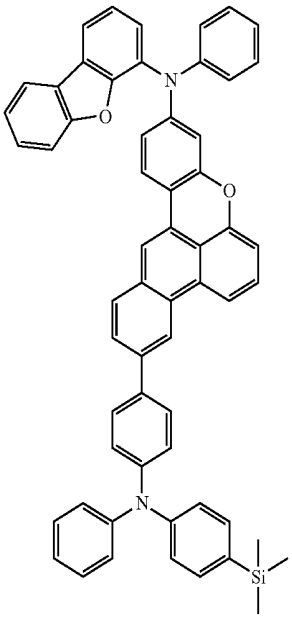

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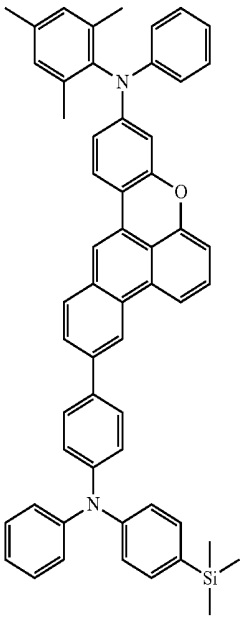

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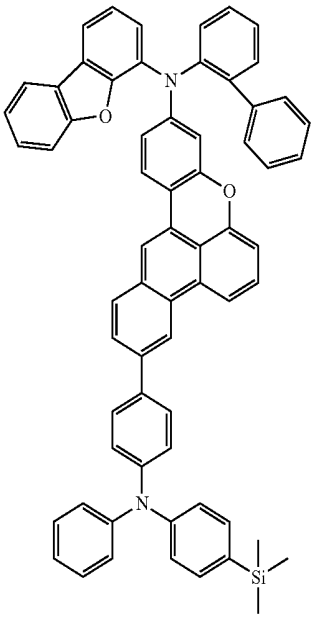

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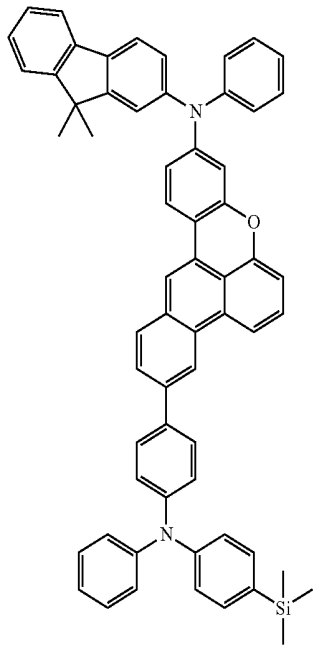

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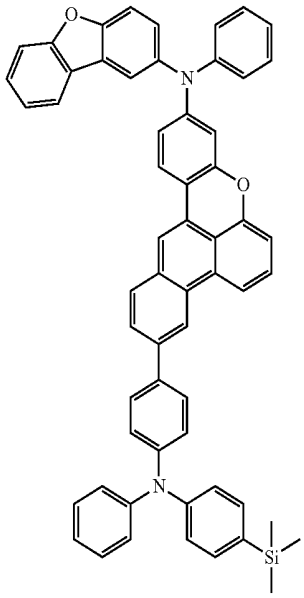

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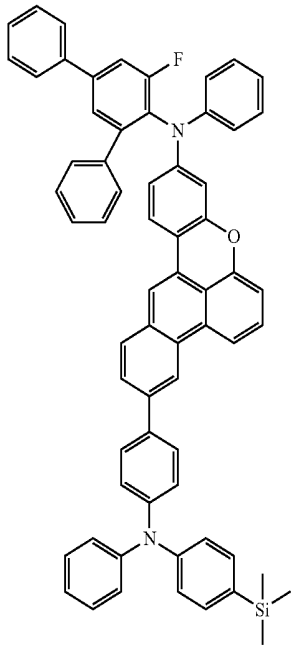

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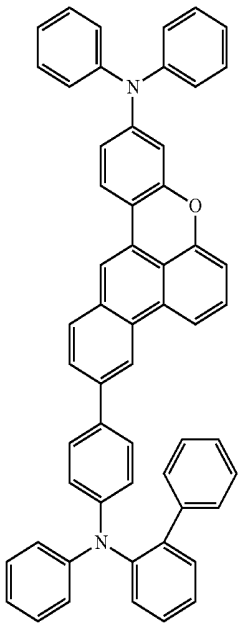

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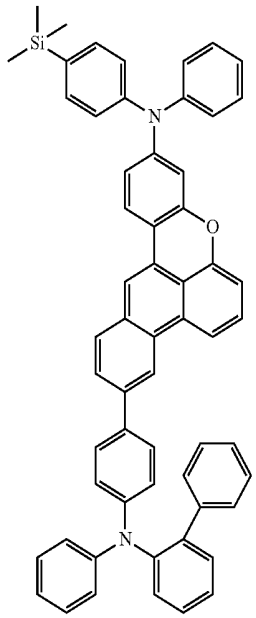

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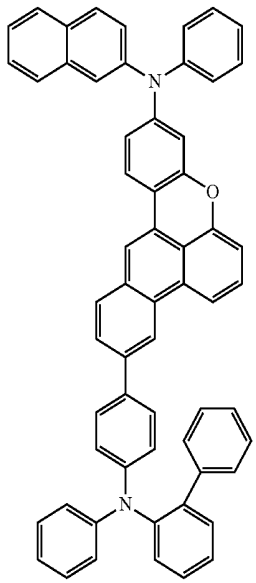

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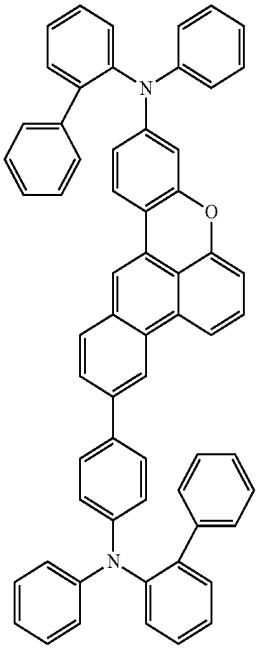

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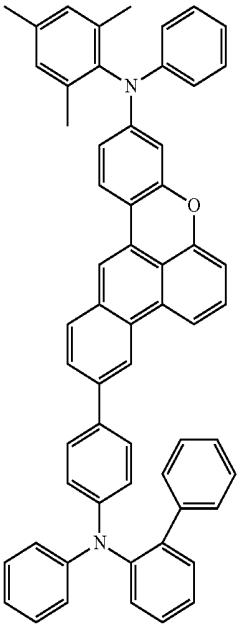

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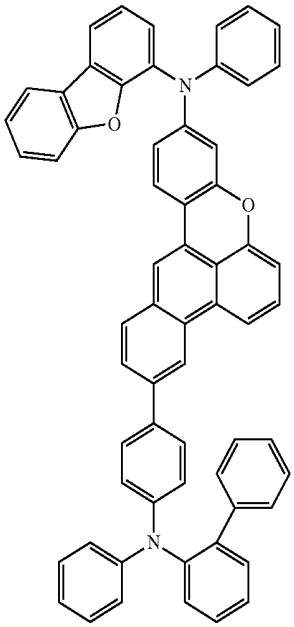

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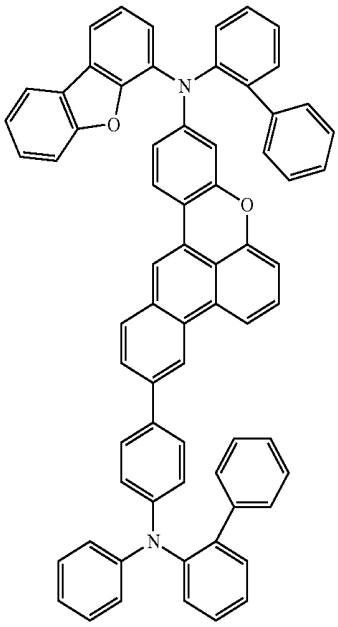

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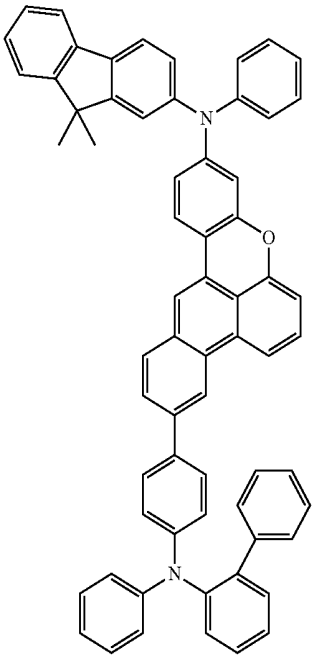

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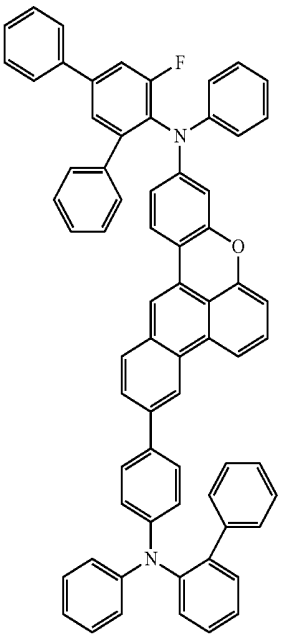

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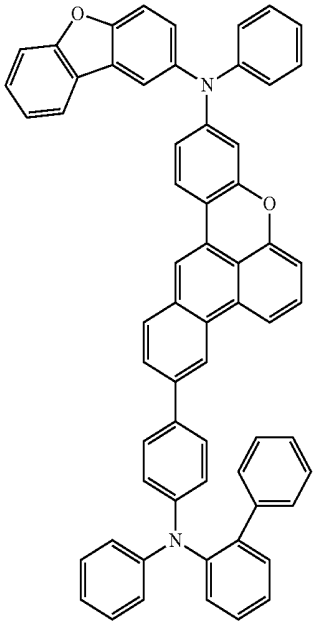

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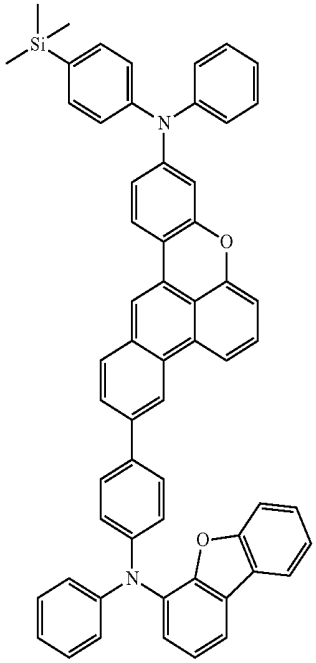

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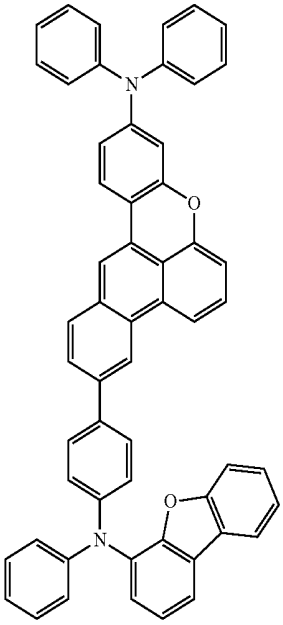

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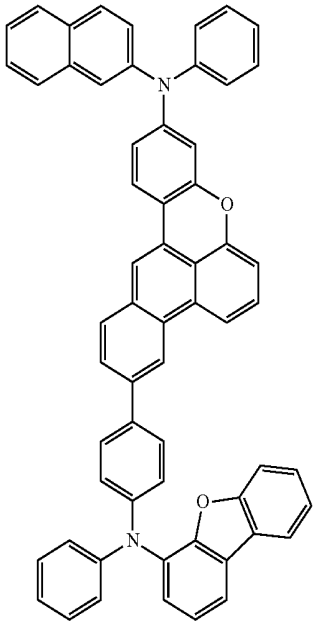

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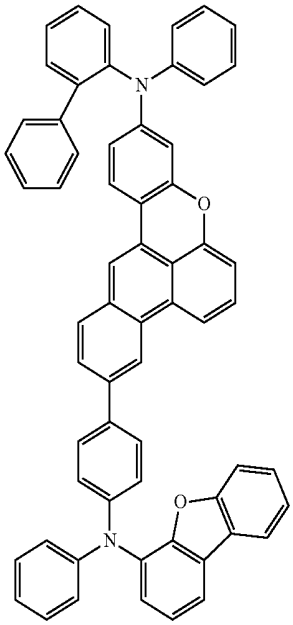

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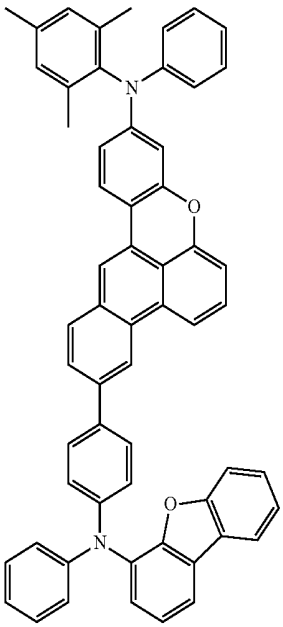

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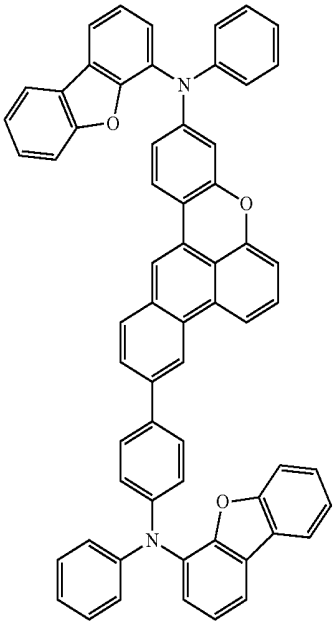

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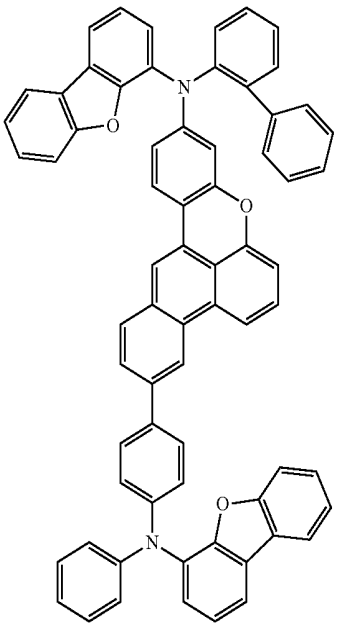

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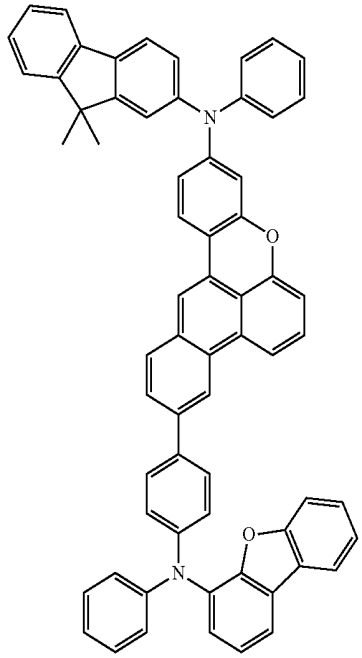

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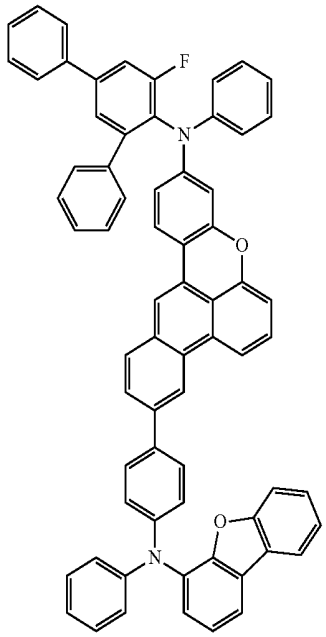

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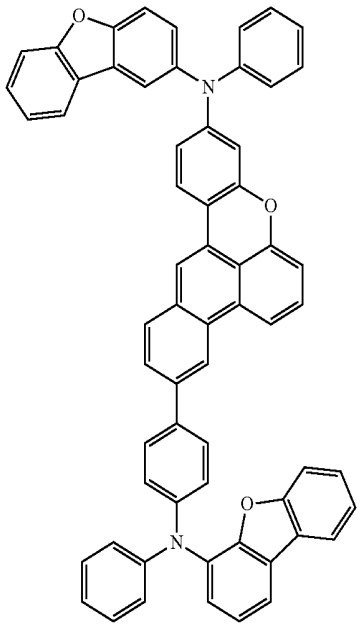

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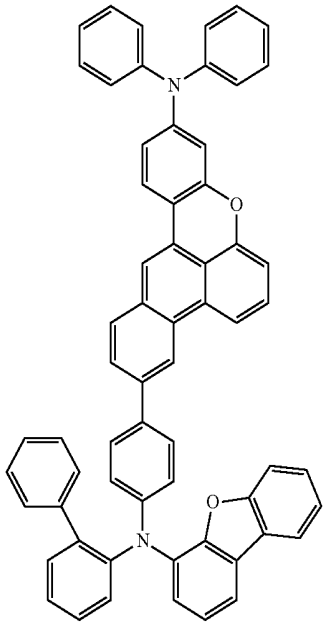

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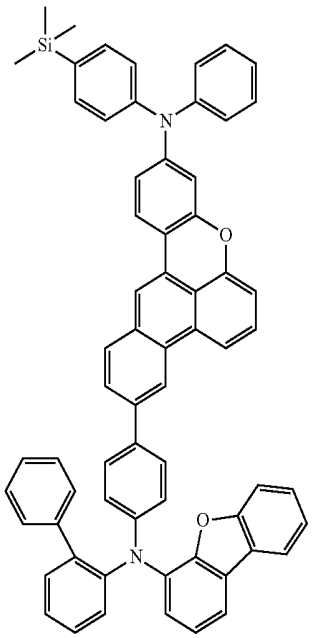

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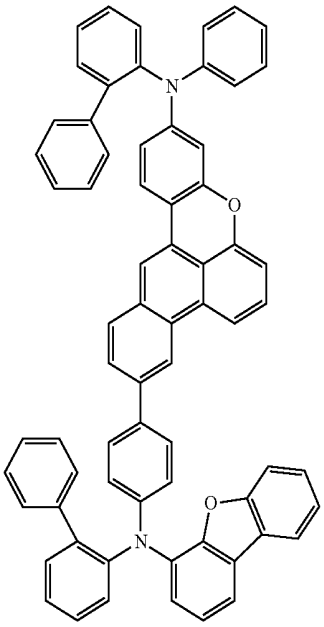

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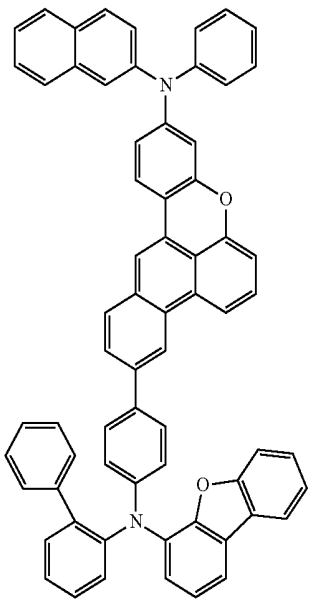

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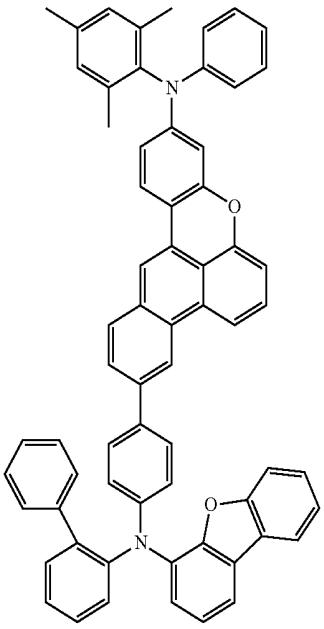

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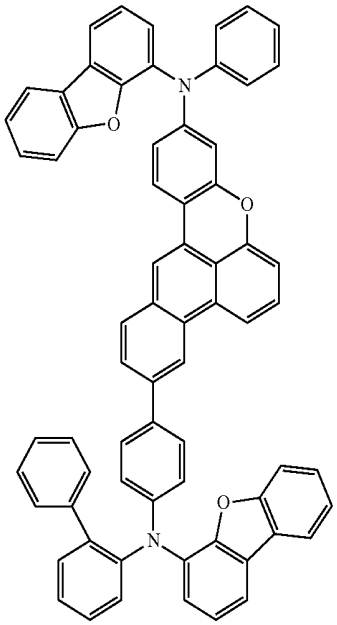

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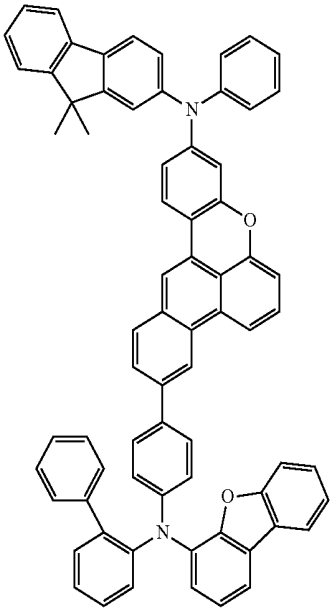

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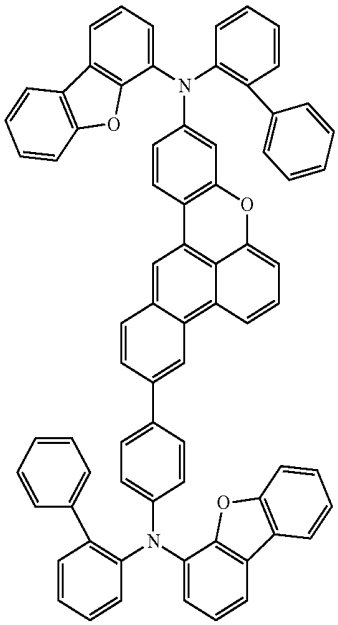

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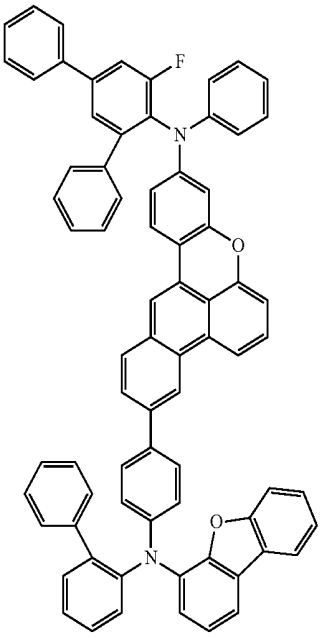

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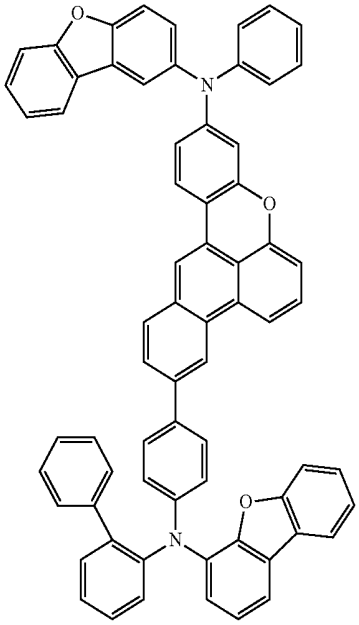

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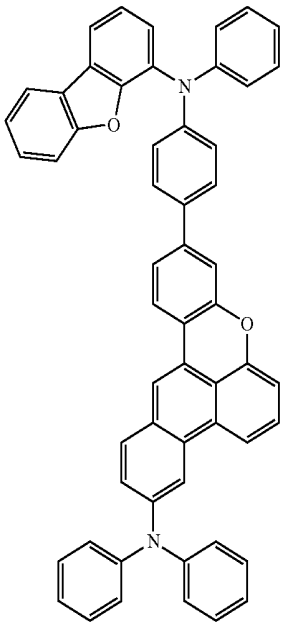

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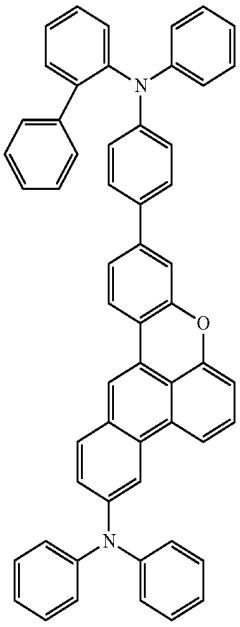

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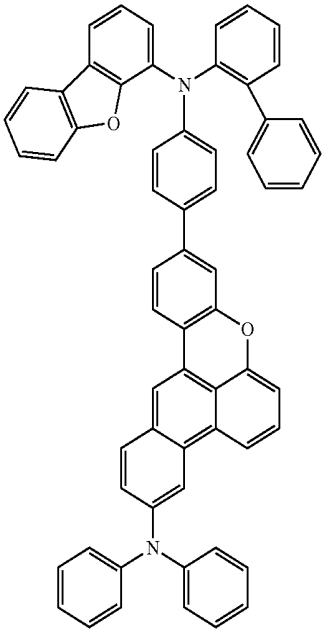

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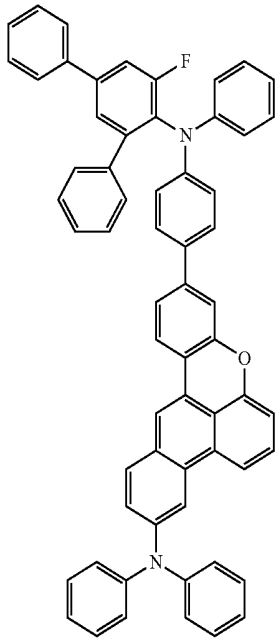

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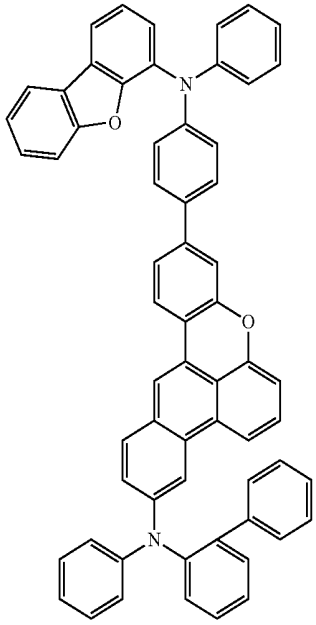

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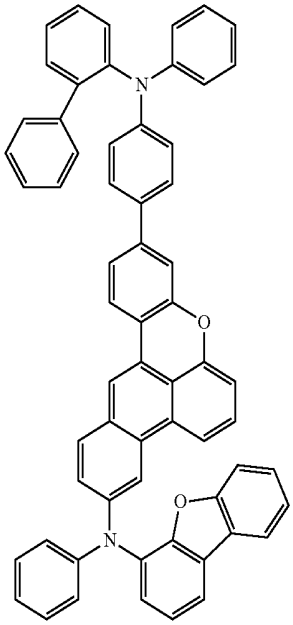

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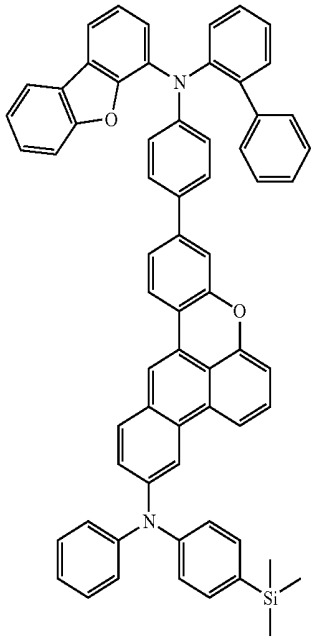

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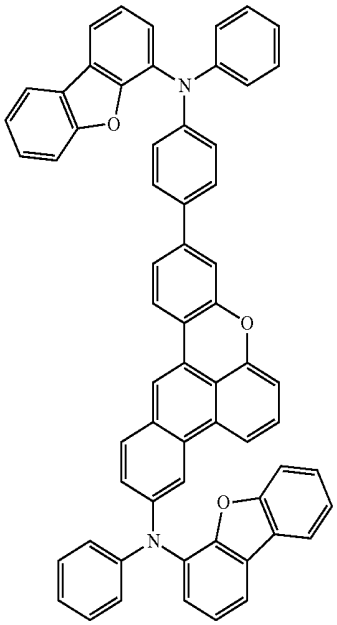

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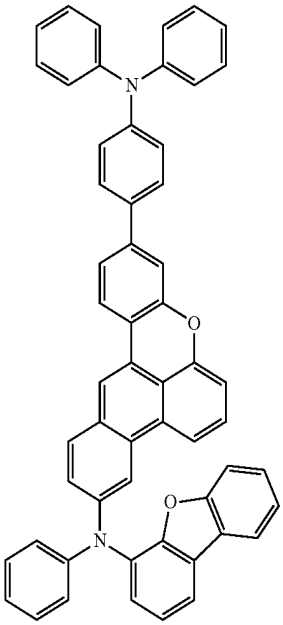

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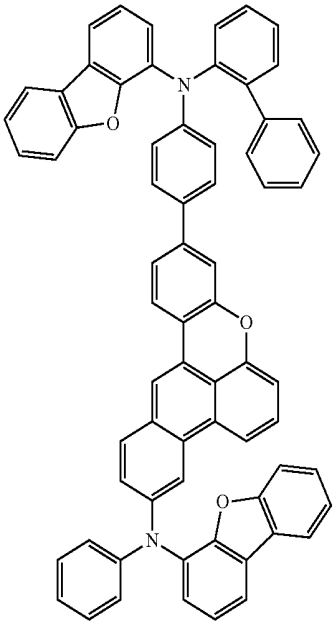

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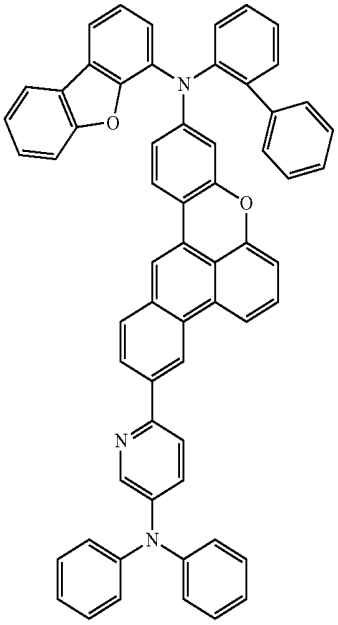

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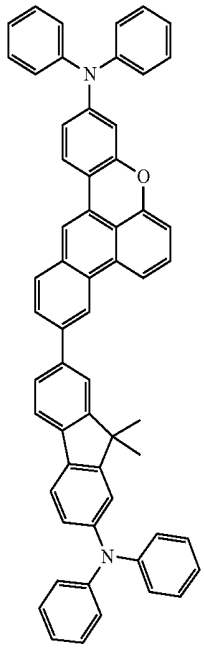

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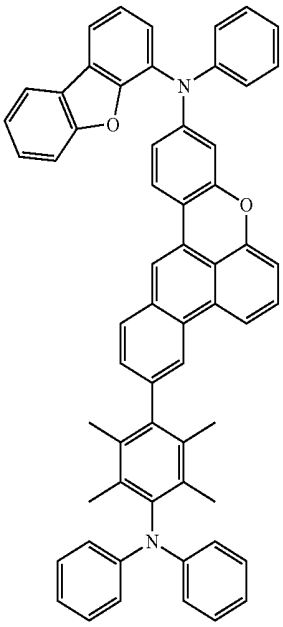

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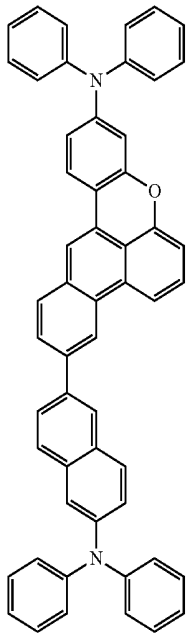

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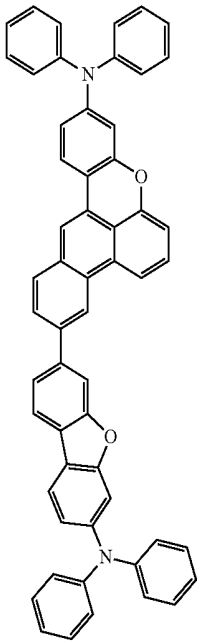

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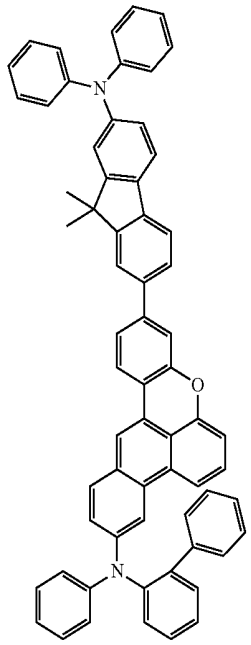

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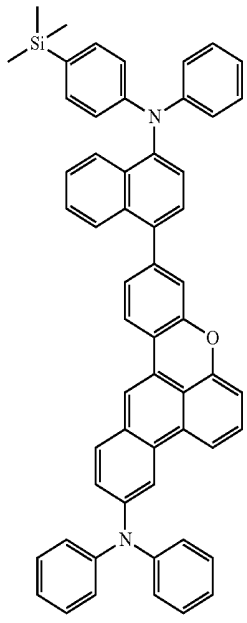

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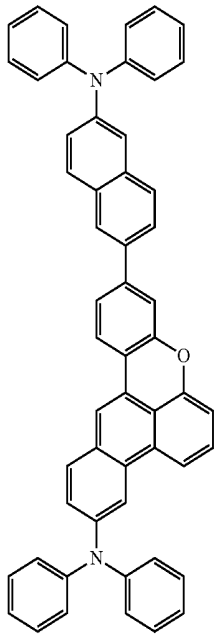

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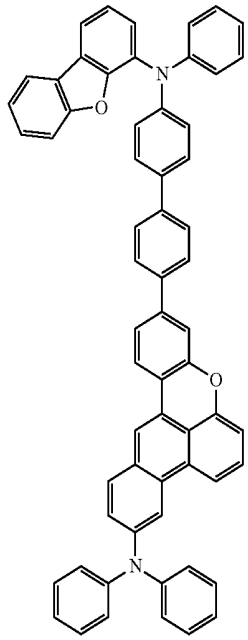

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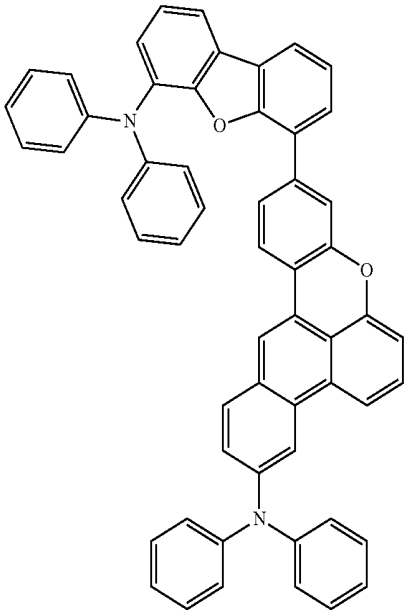

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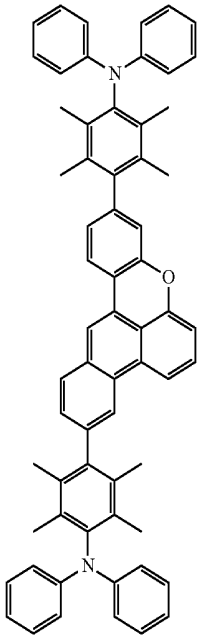

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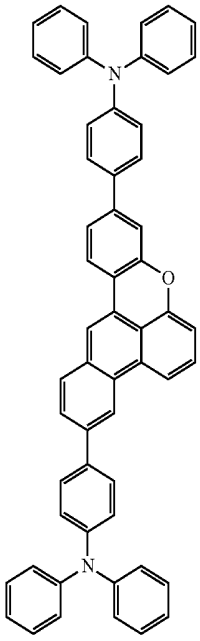

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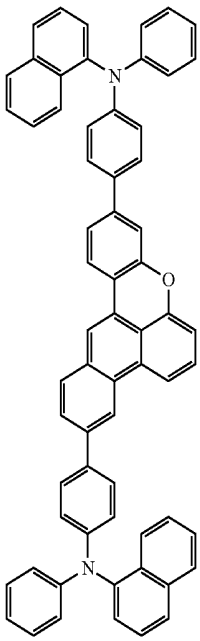

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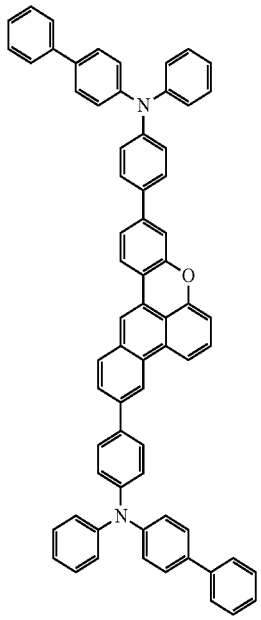

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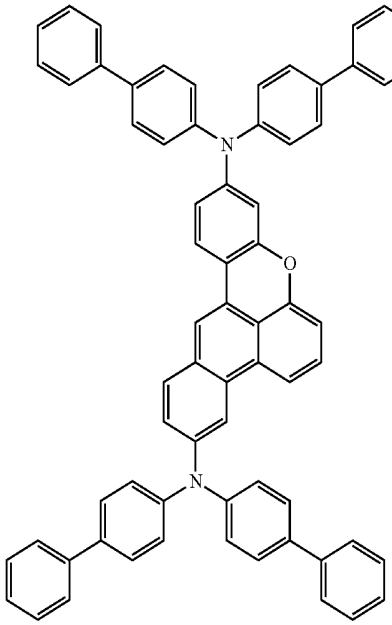

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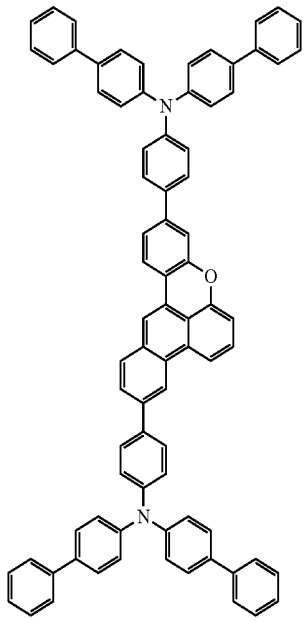

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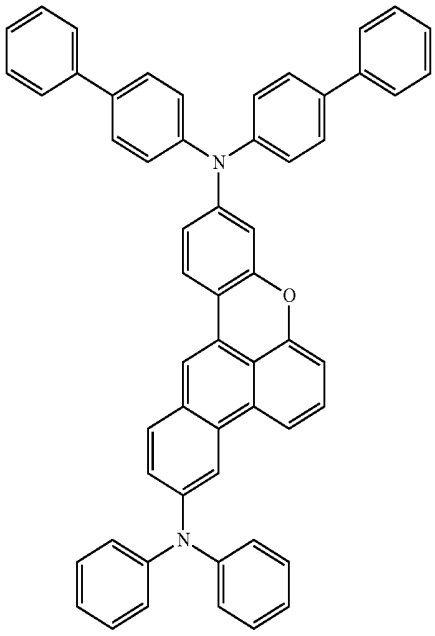

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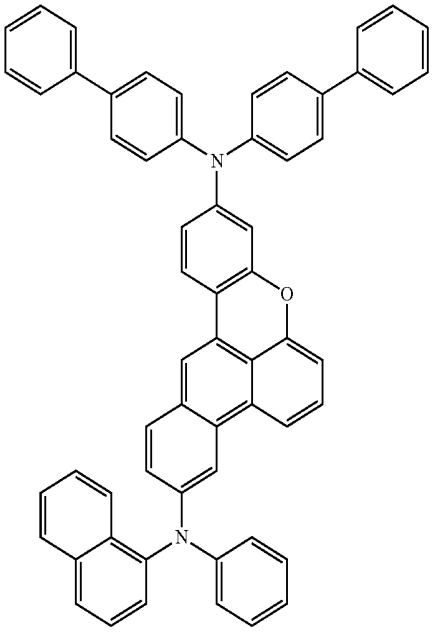

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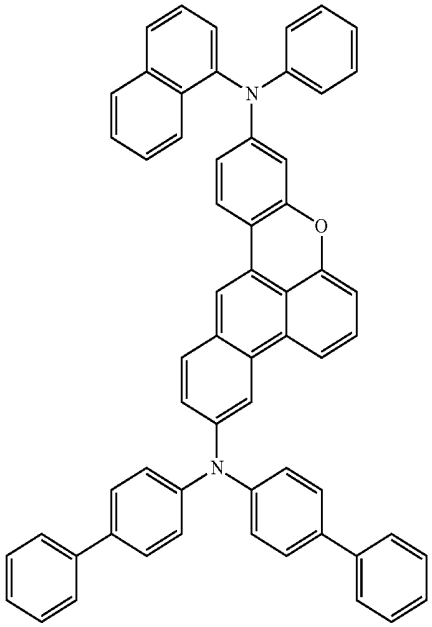

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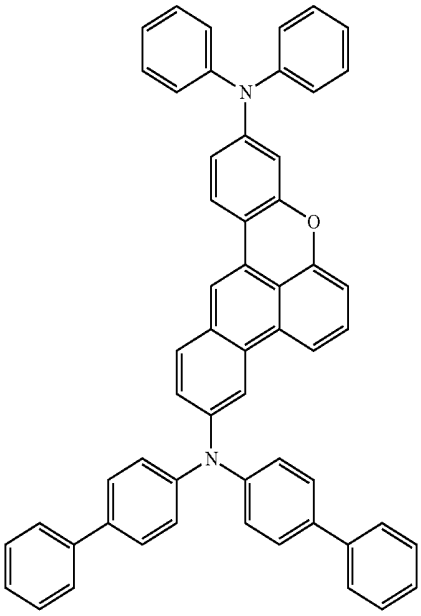

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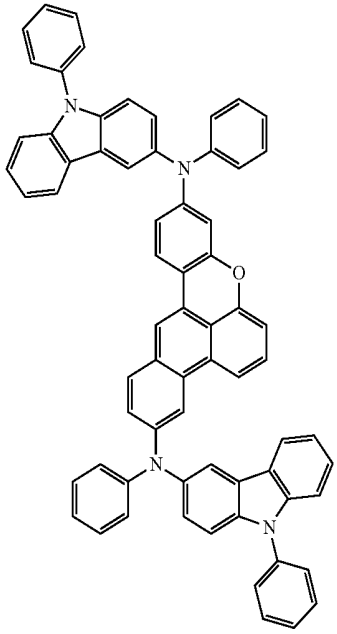

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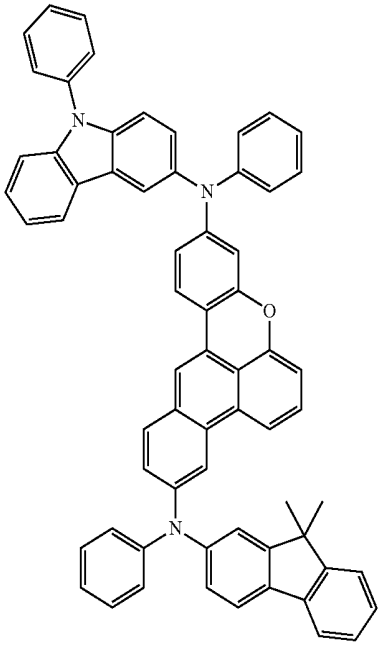

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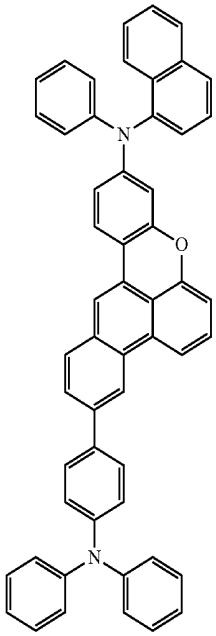

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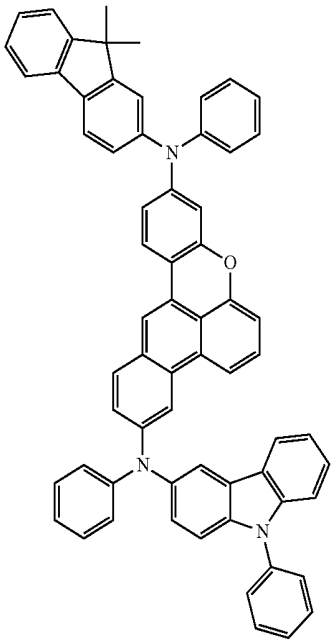

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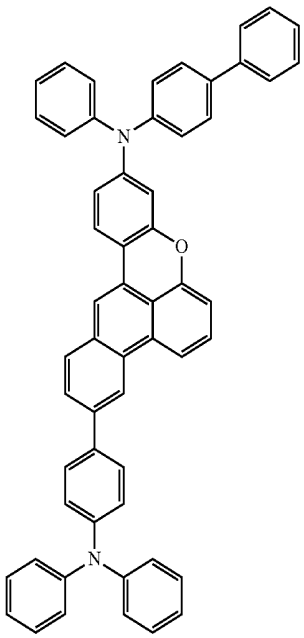

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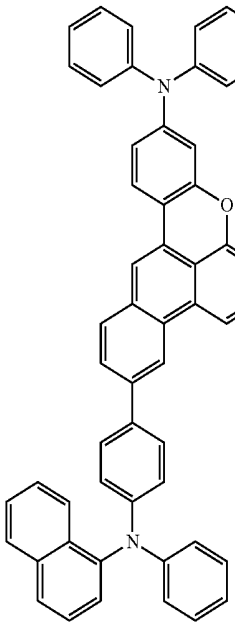

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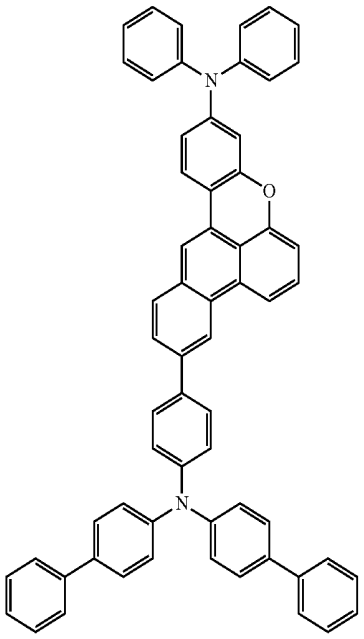

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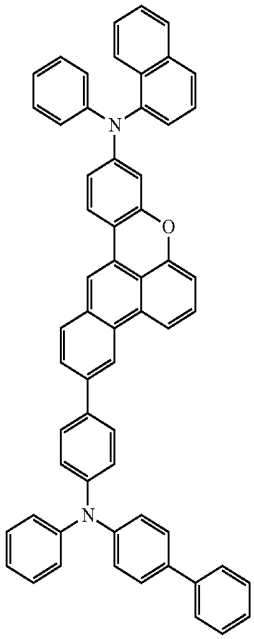

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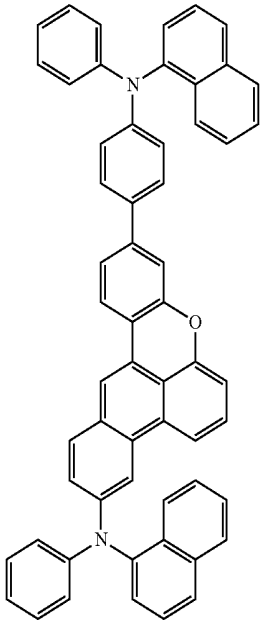

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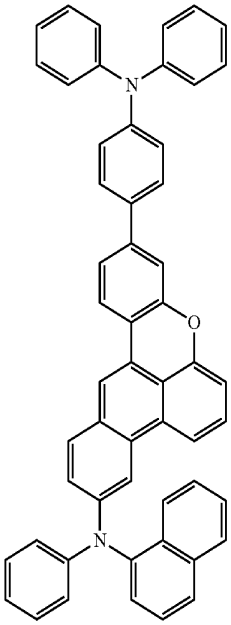

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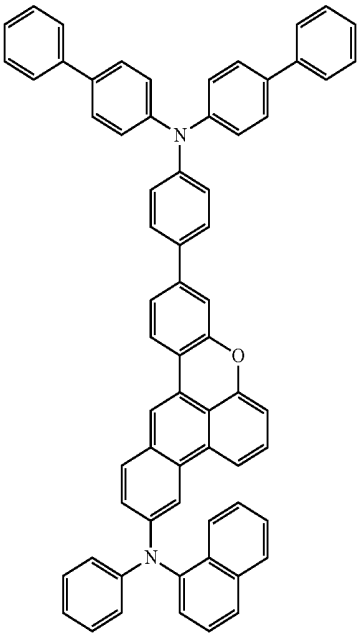

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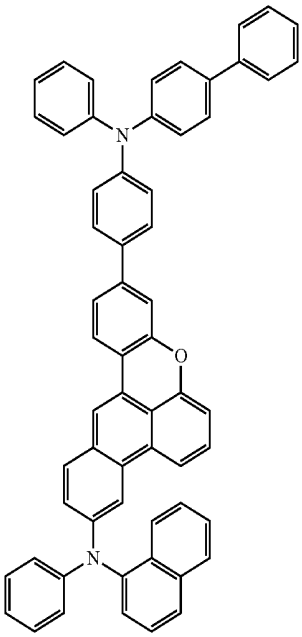

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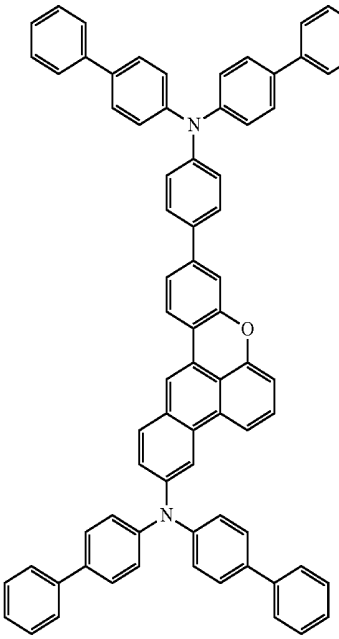

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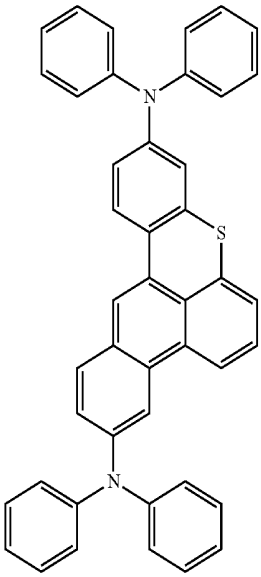

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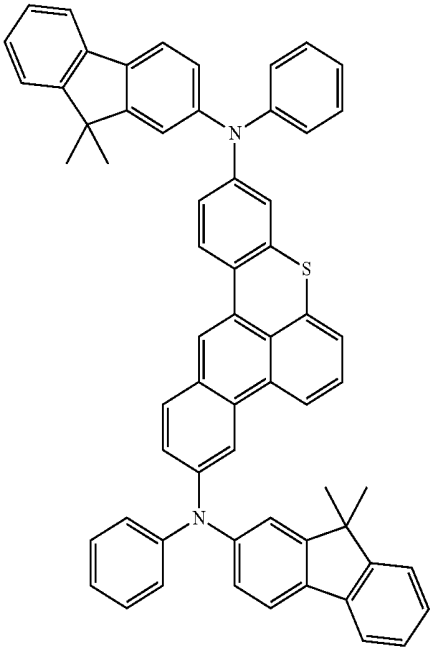

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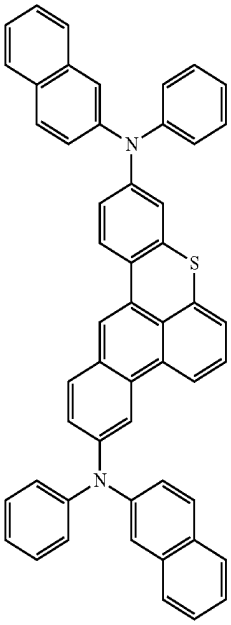

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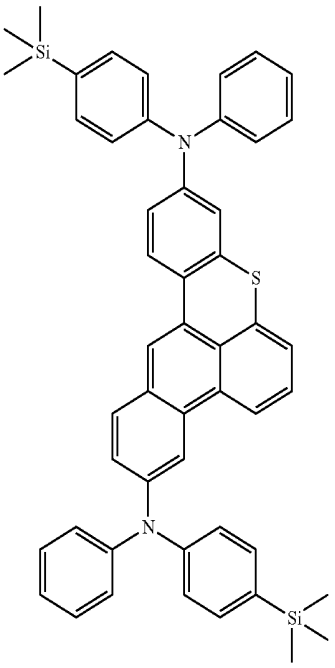

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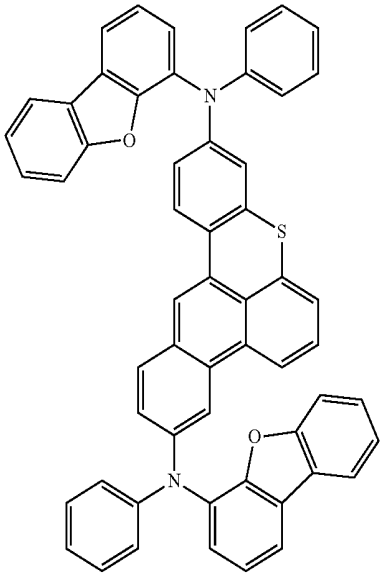

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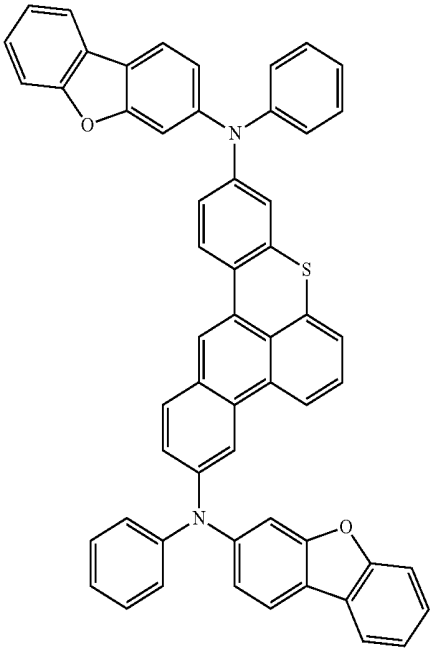

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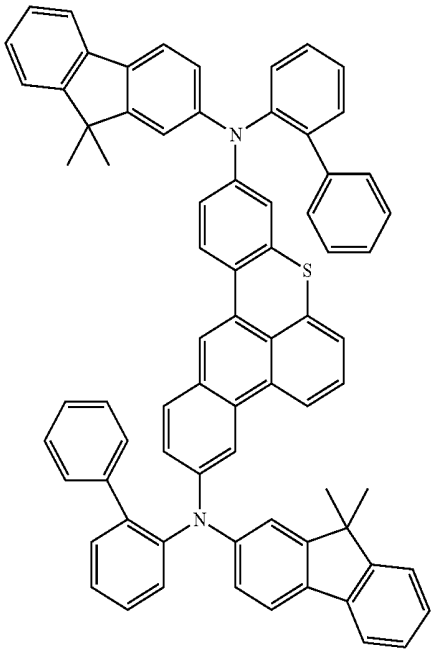

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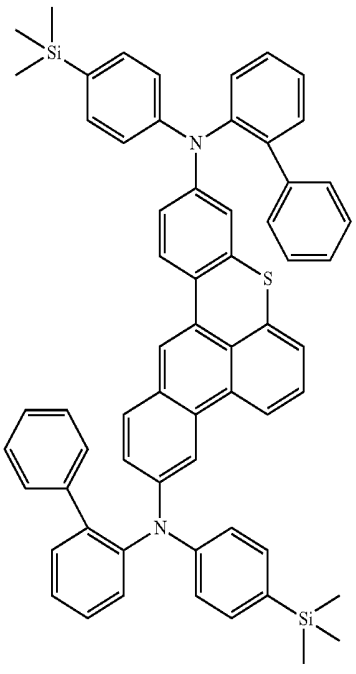

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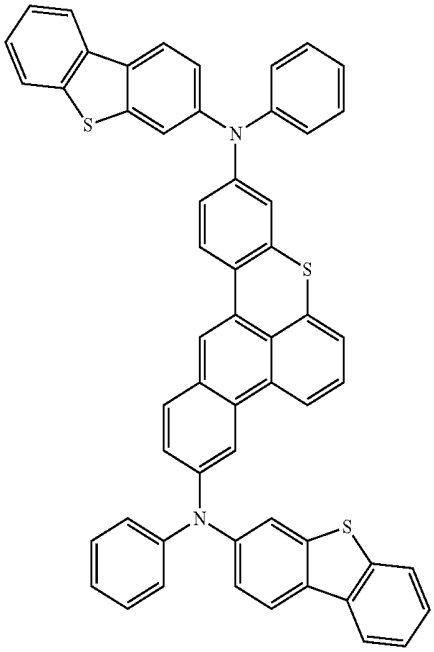

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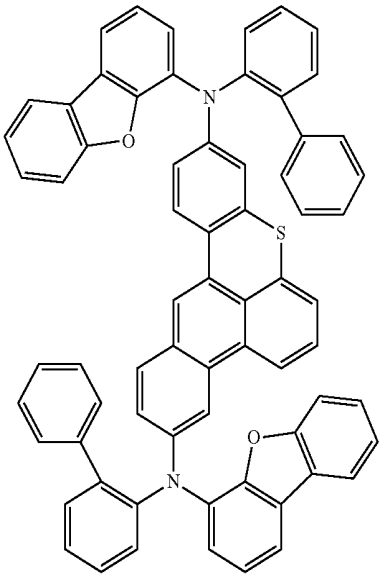

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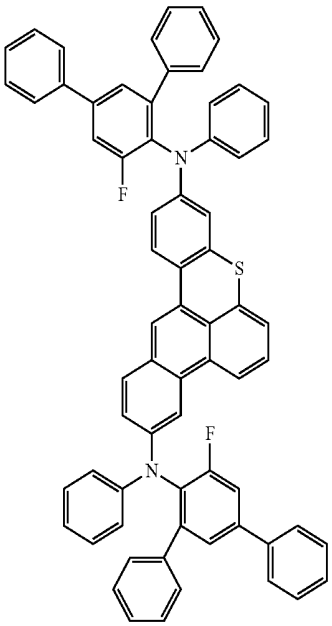

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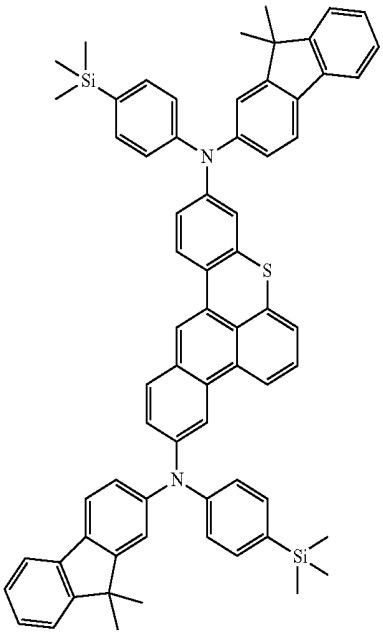

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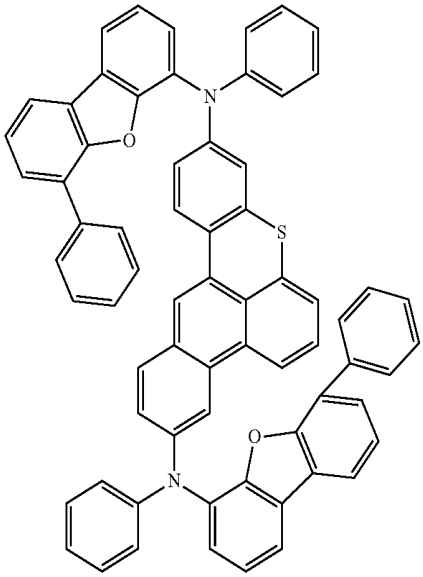

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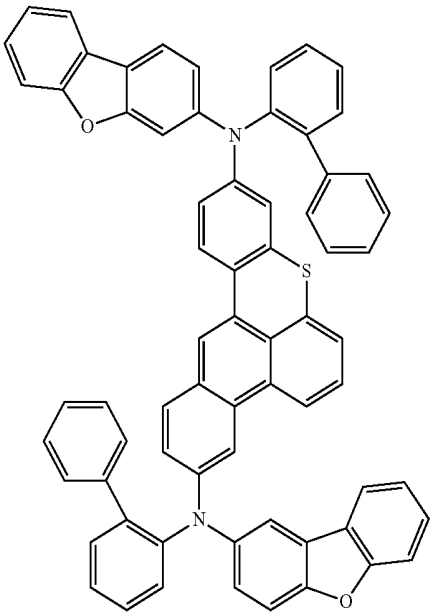

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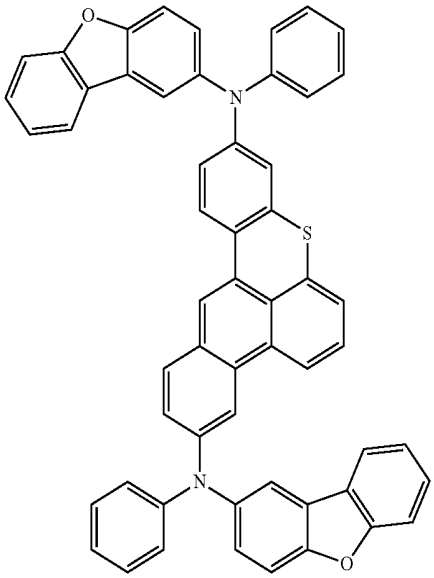

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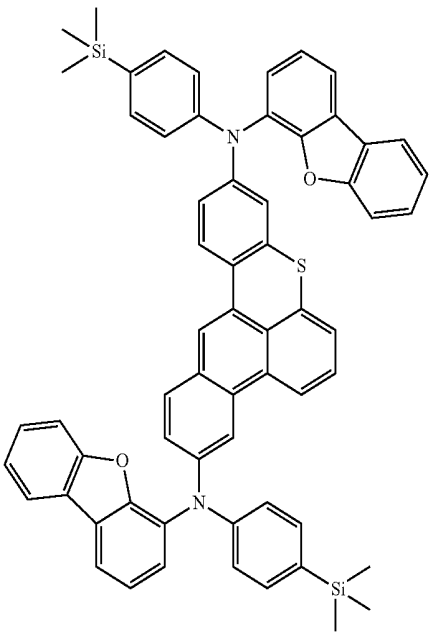

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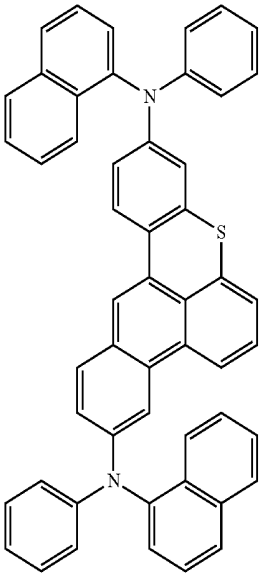

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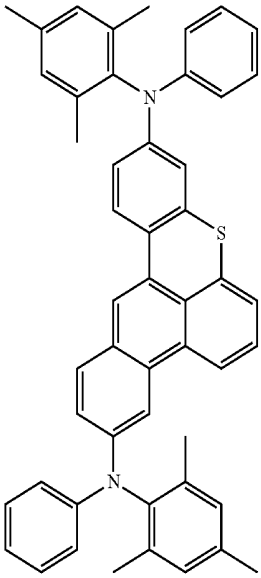

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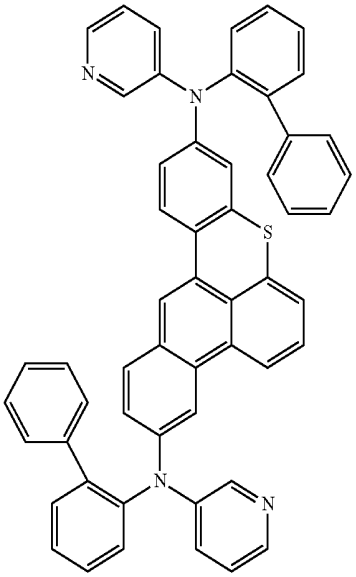

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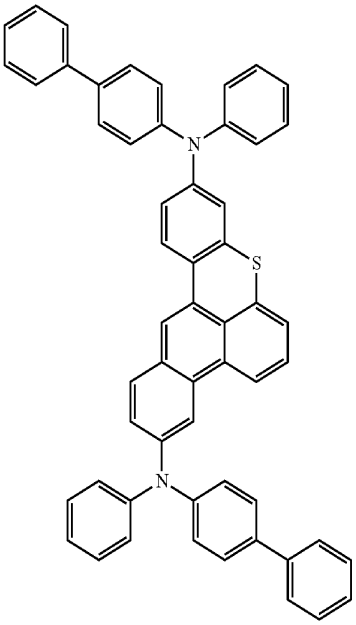

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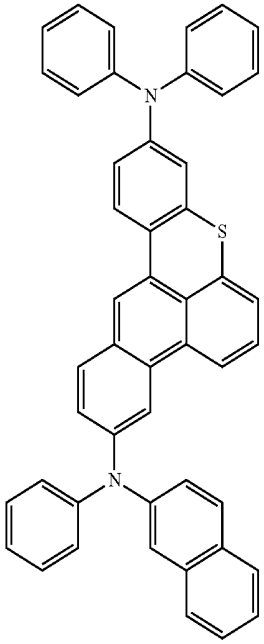

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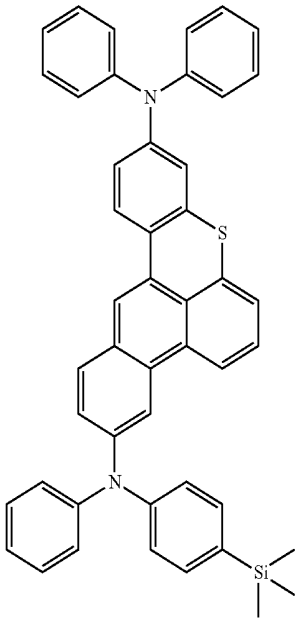

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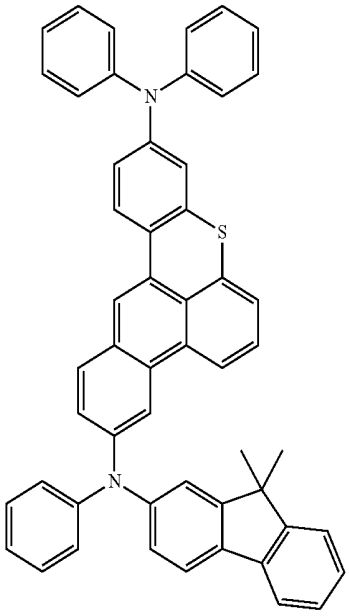

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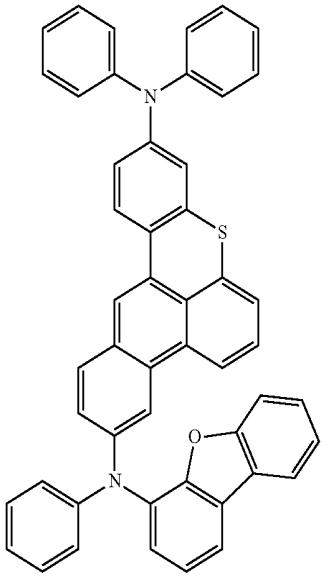

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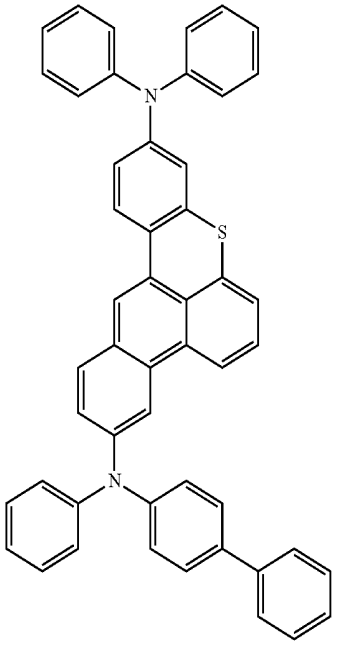

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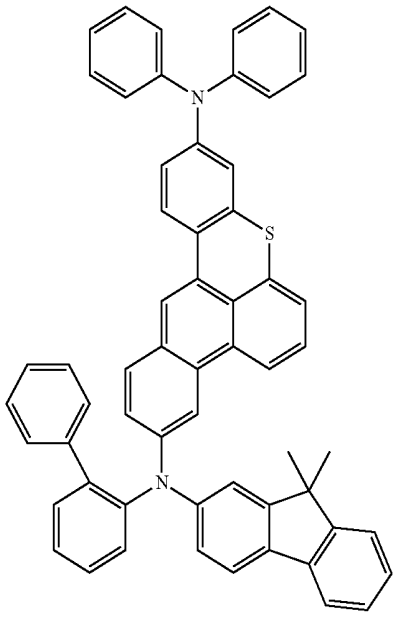

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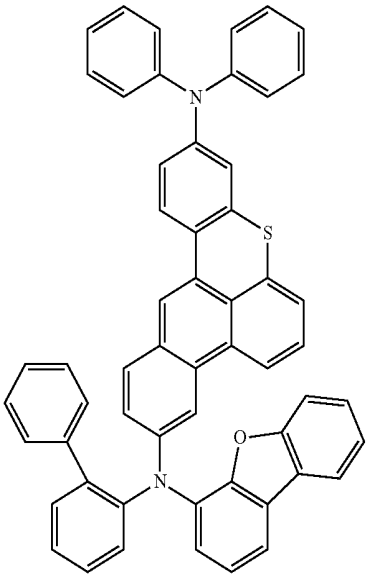

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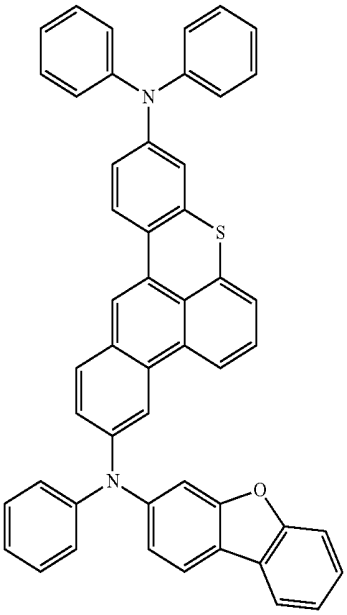

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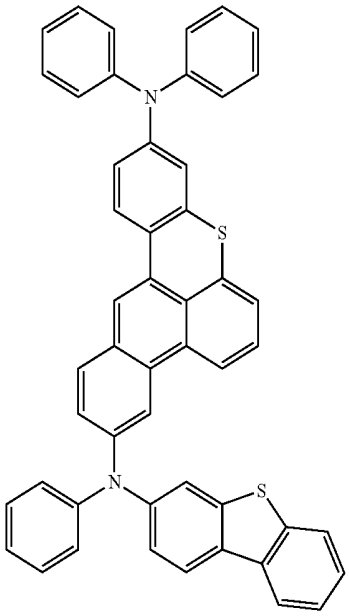

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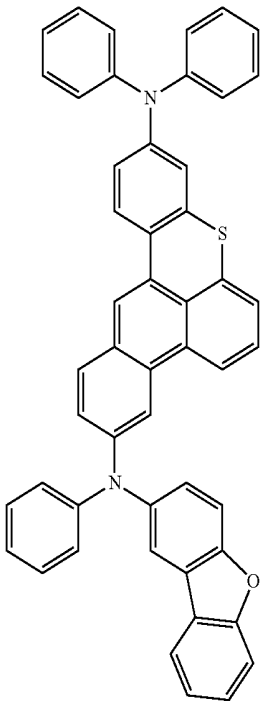

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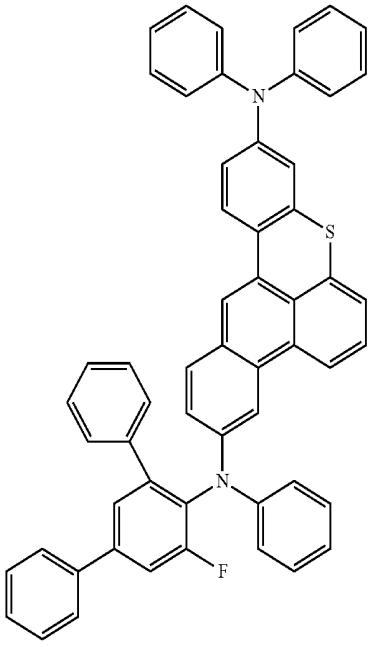

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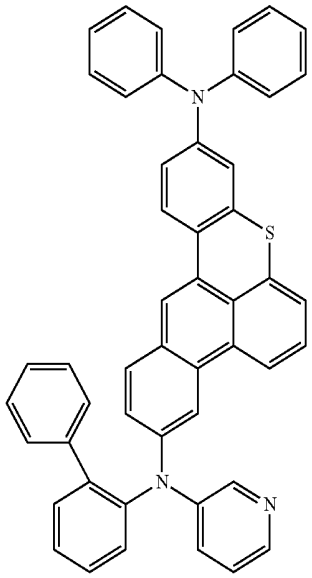

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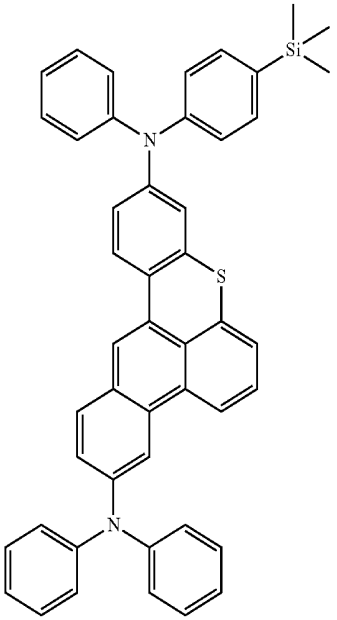

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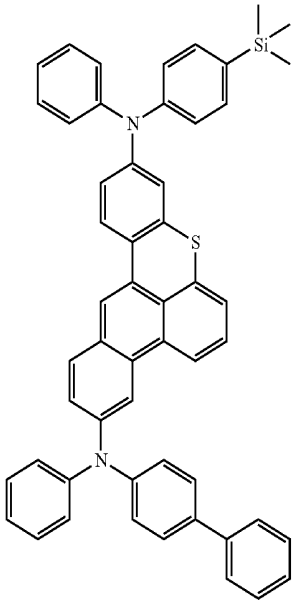

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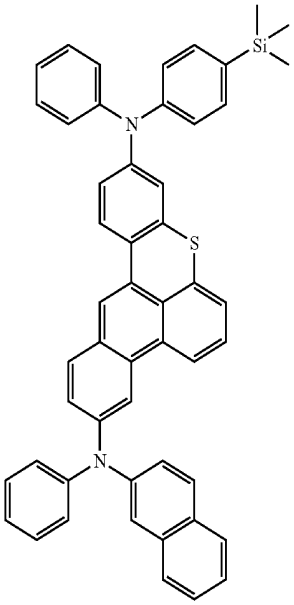

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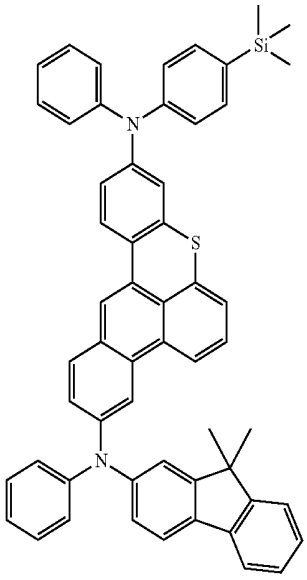

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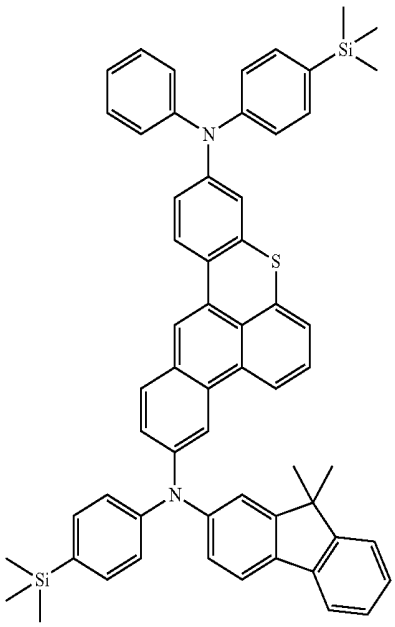

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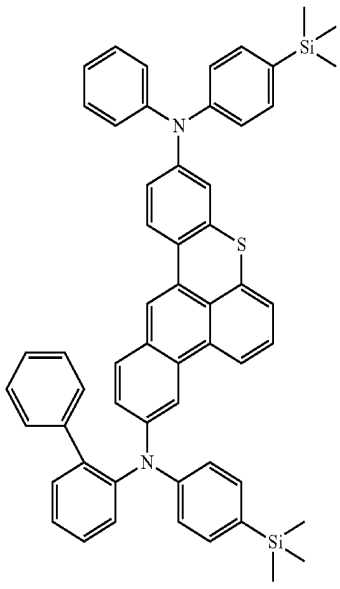

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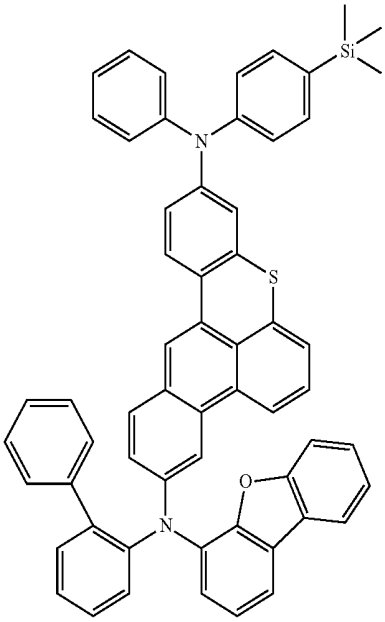

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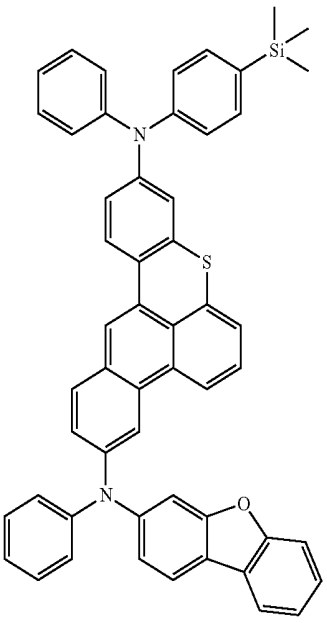

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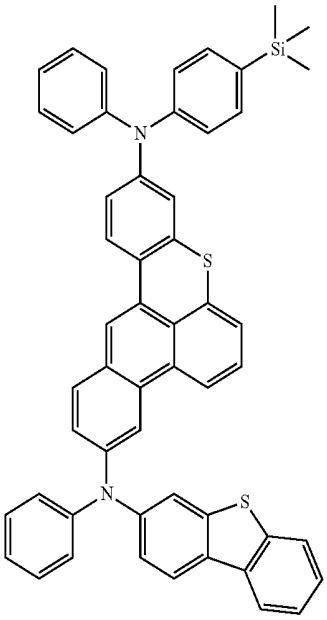

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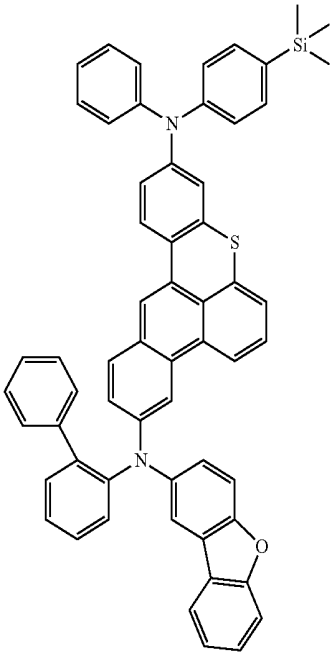

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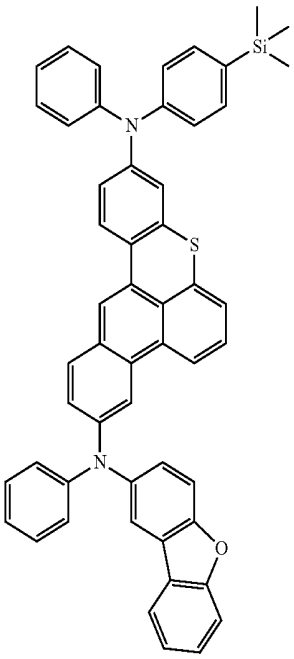

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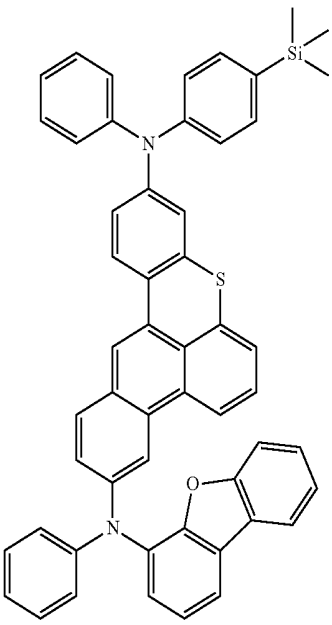

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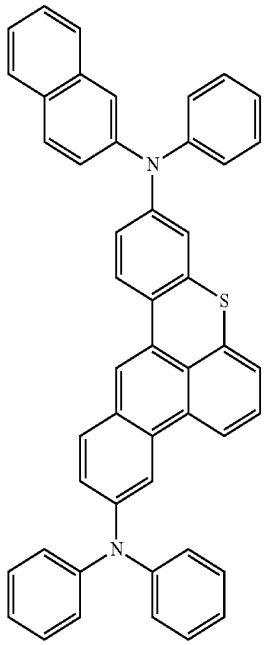

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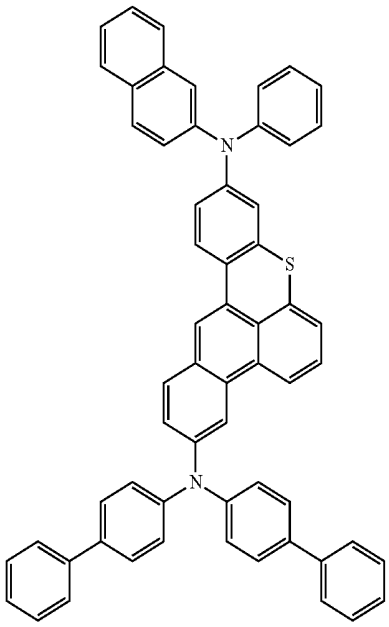

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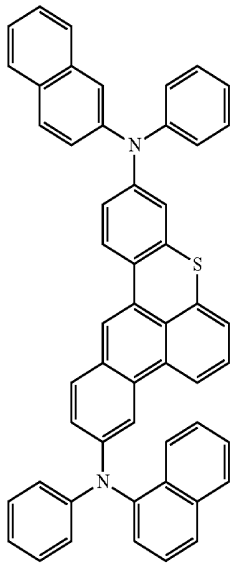

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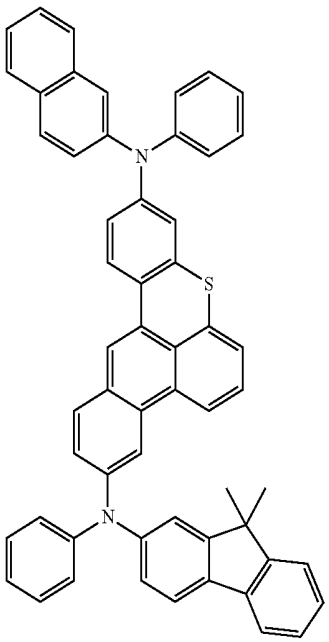

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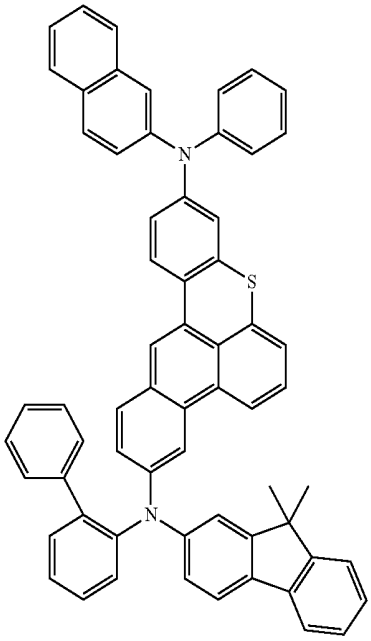

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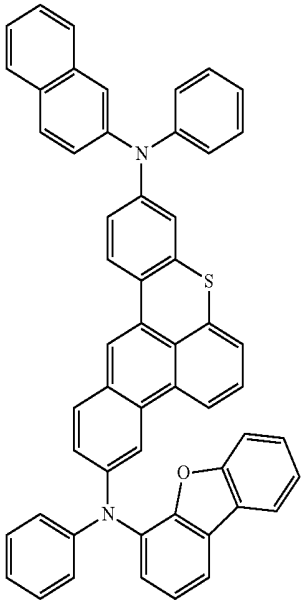

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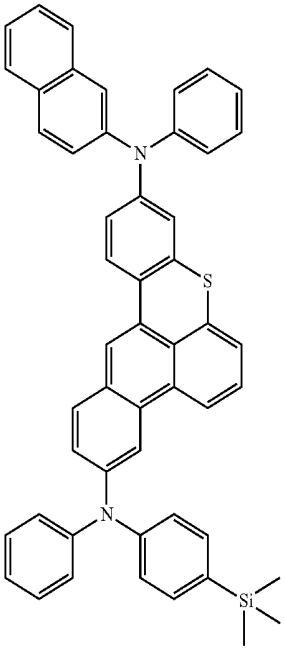

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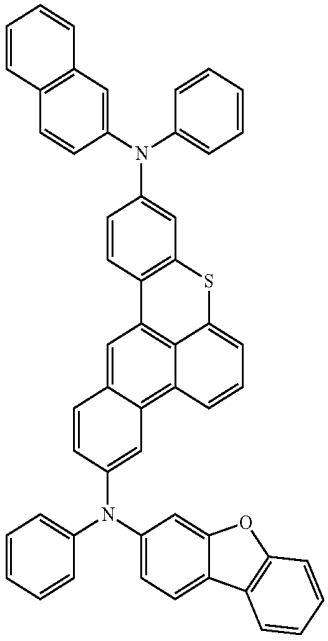

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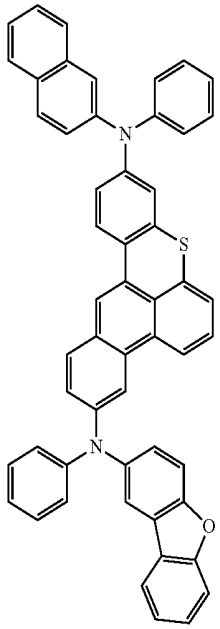

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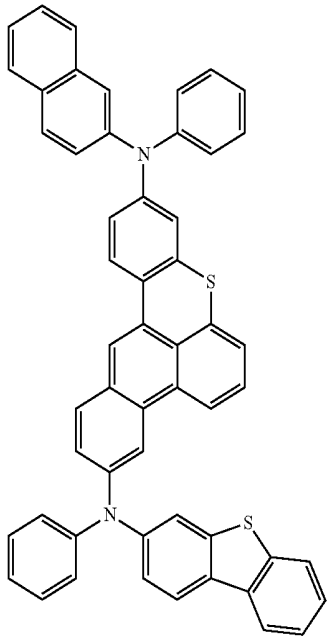

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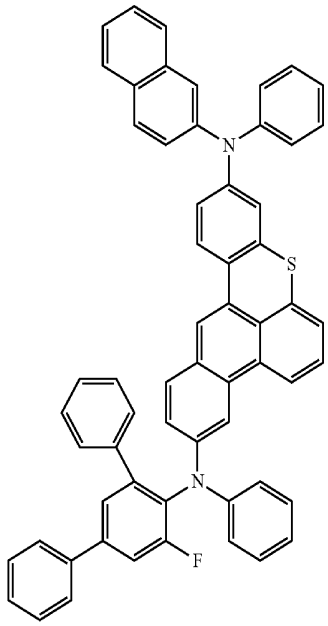

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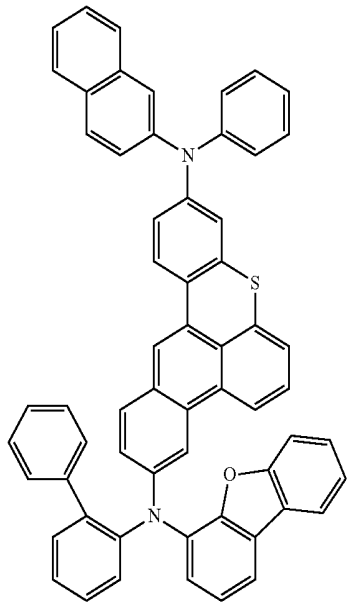

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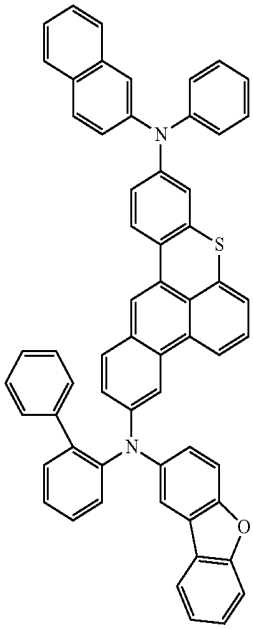

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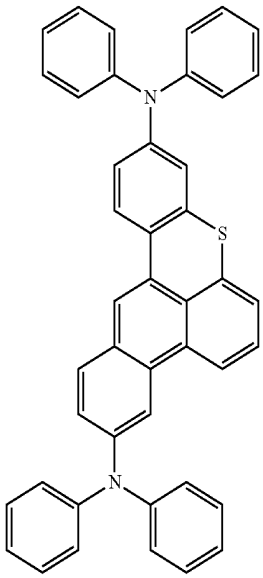

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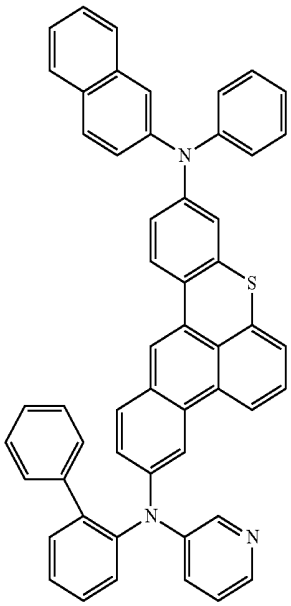

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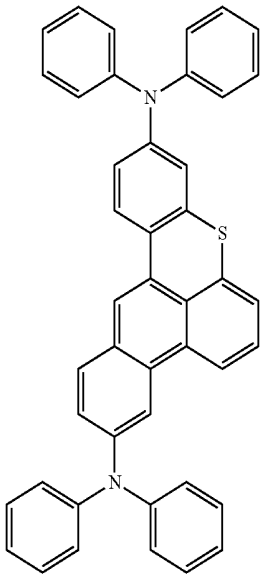

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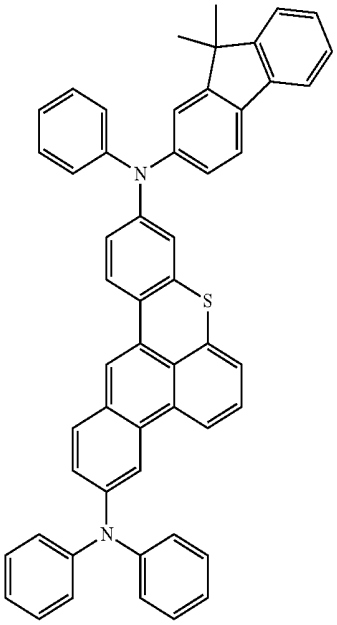

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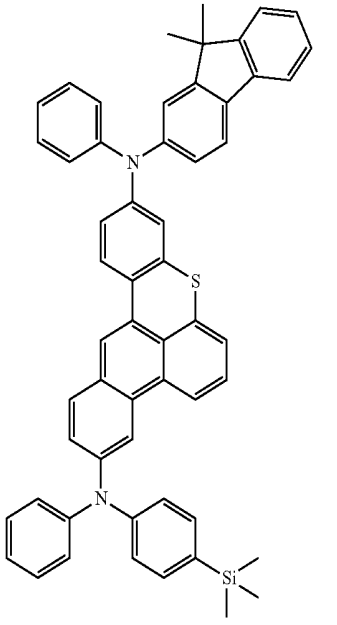

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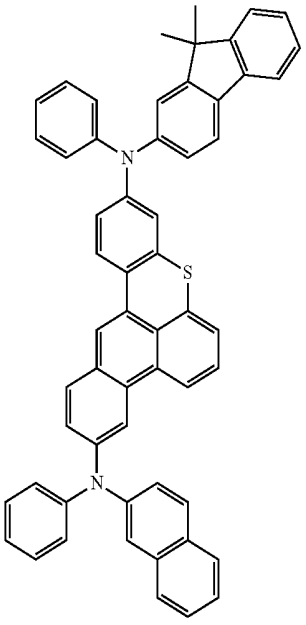

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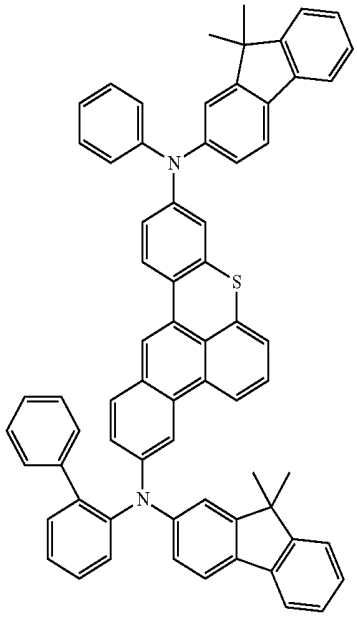

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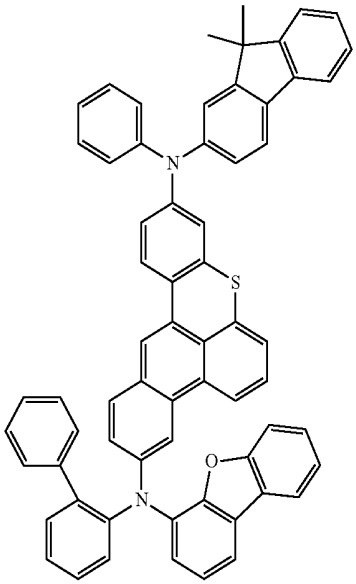

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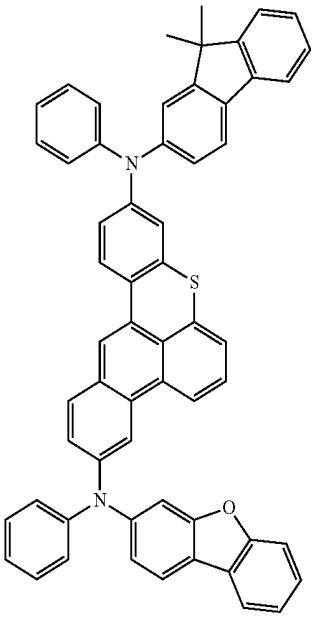

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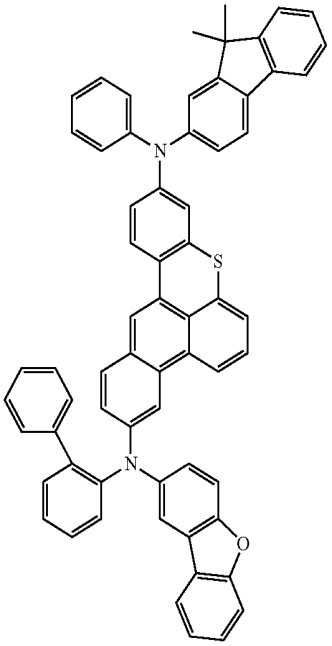

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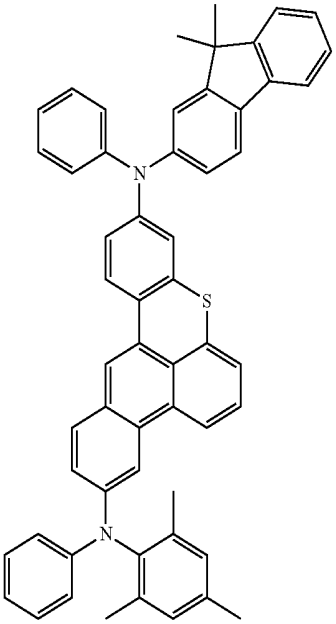

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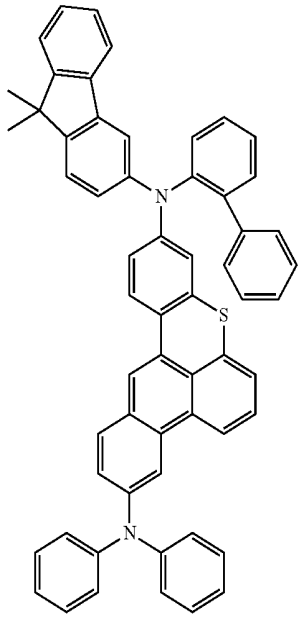

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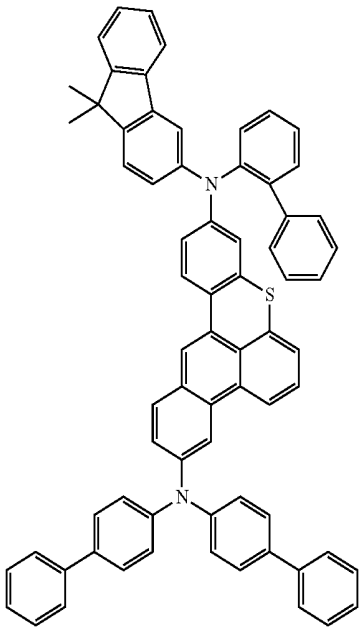
71A



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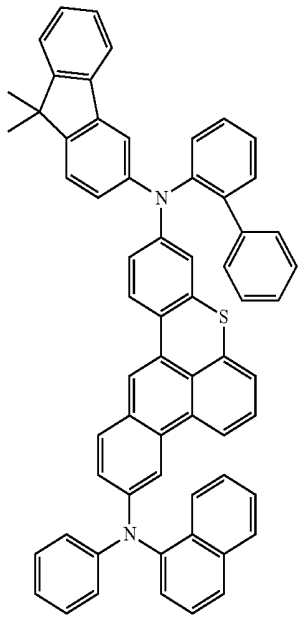

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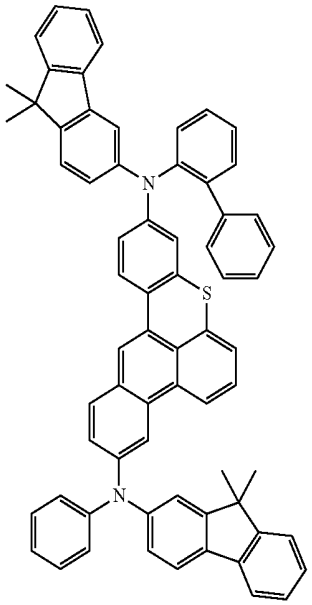

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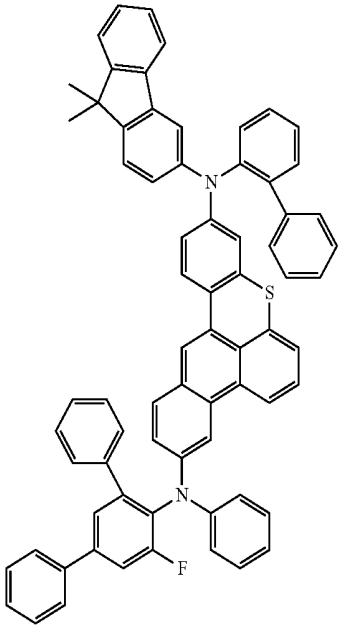

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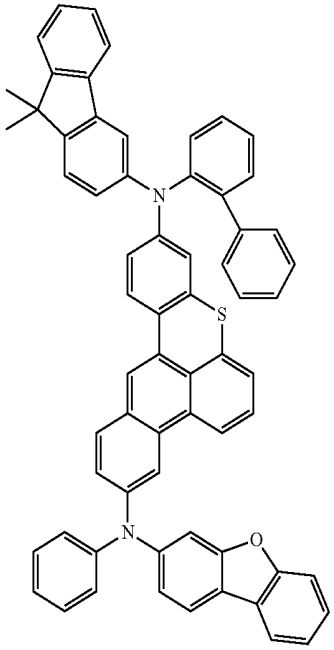

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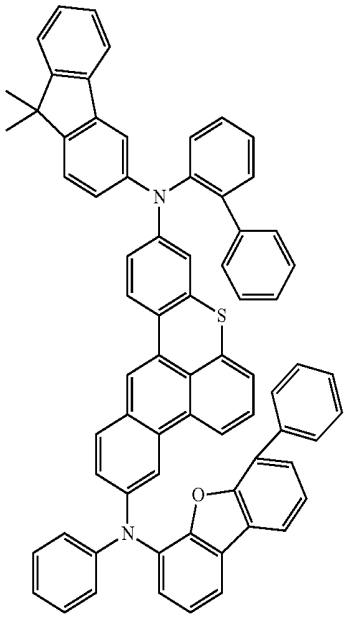

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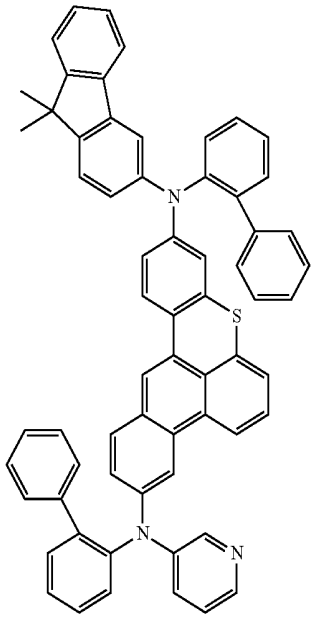

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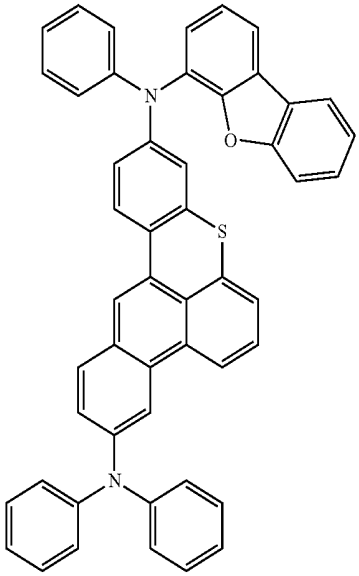

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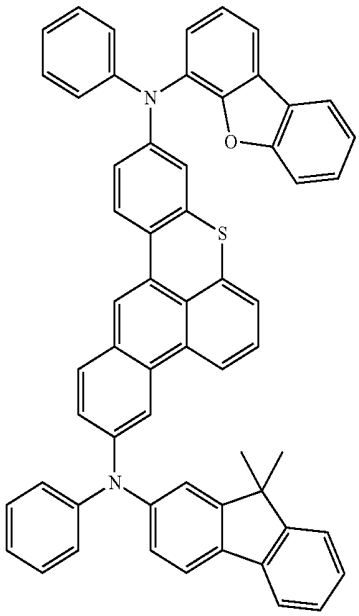

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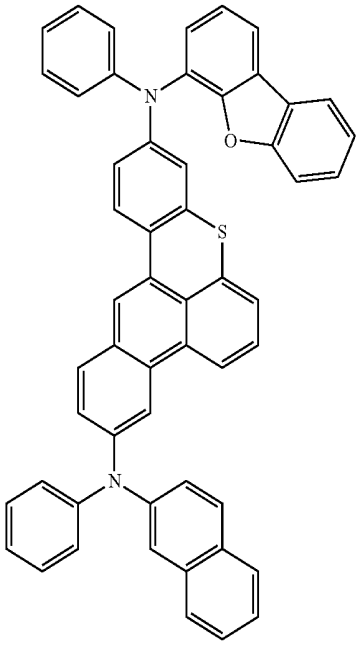

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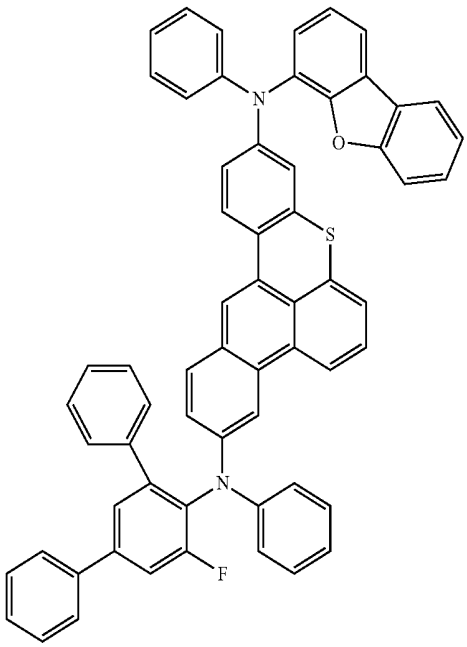

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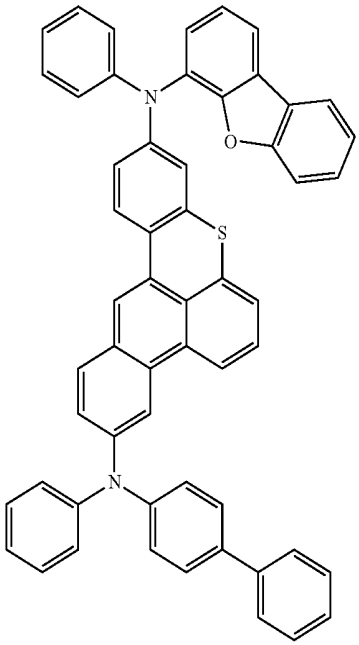

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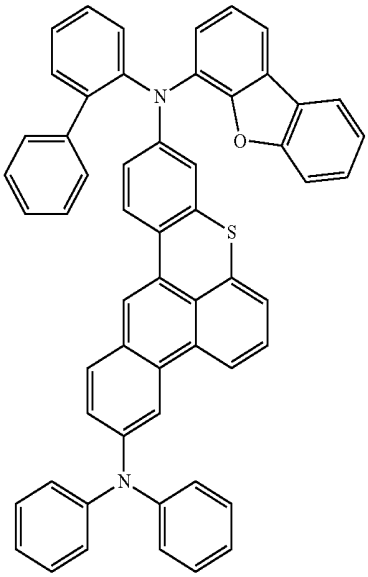

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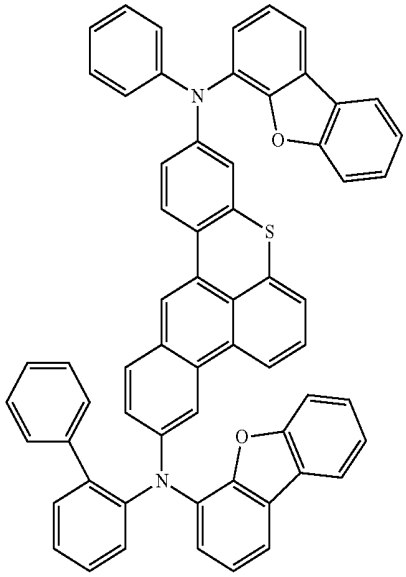

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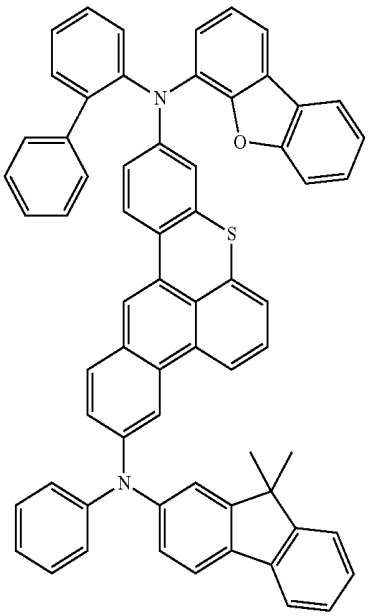

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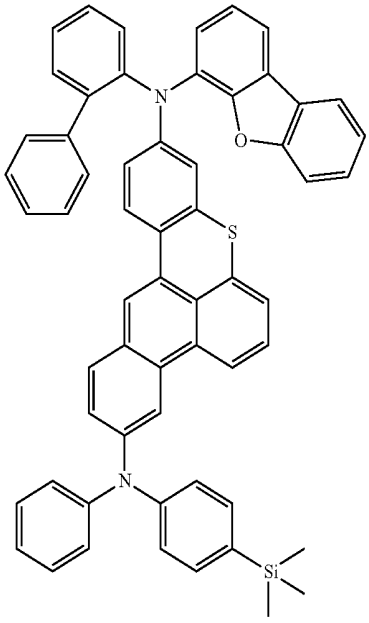

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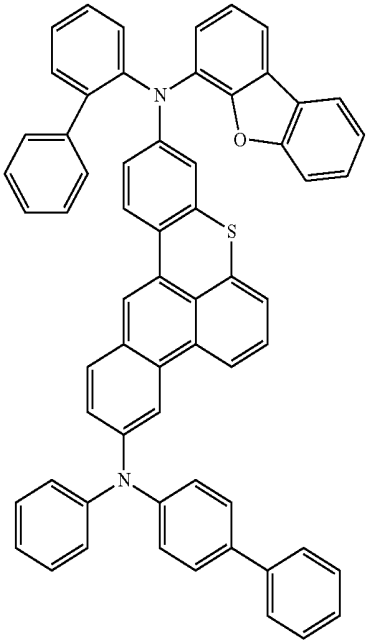

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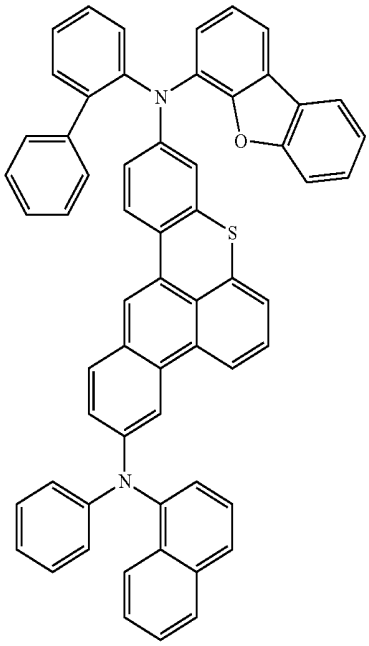

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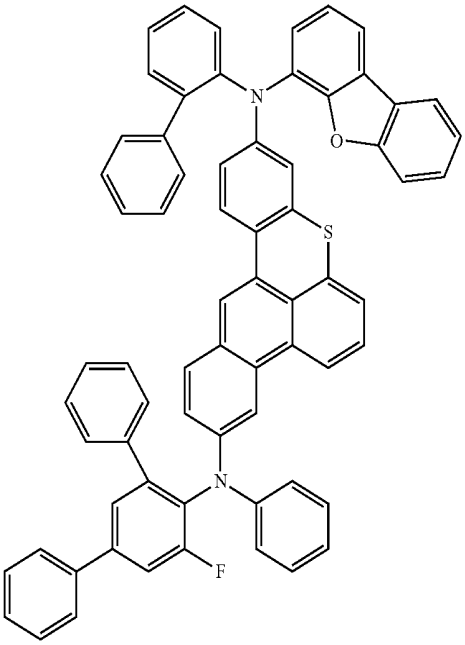

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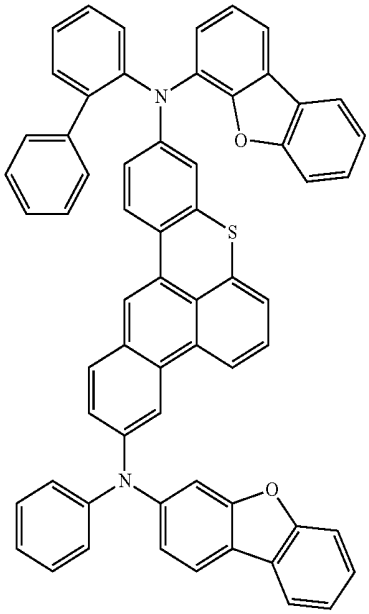

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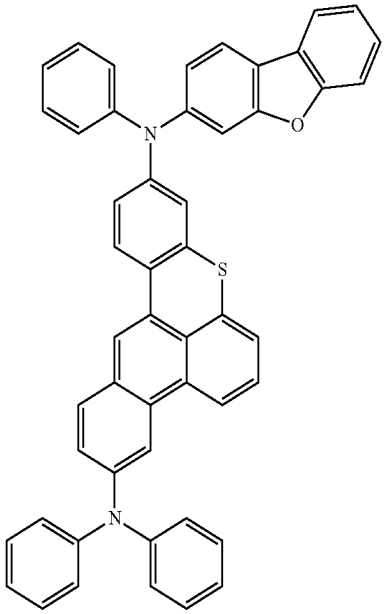

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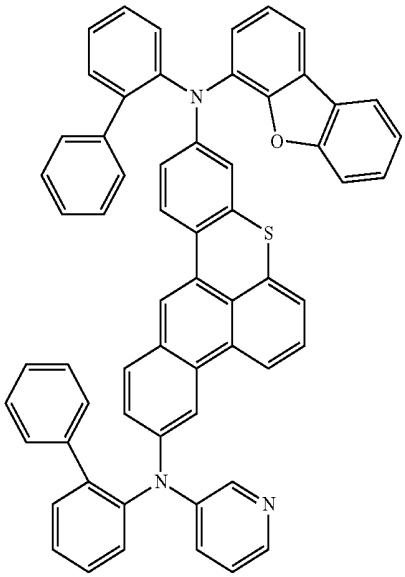

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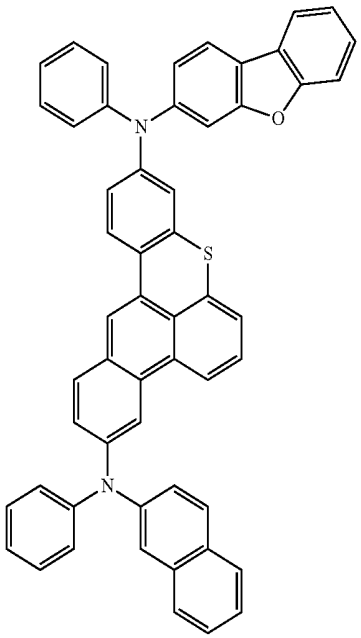

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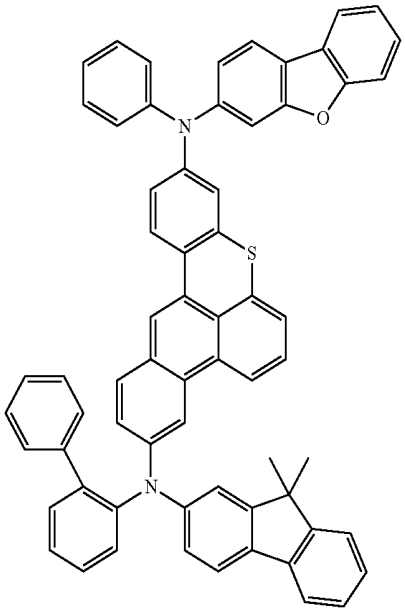

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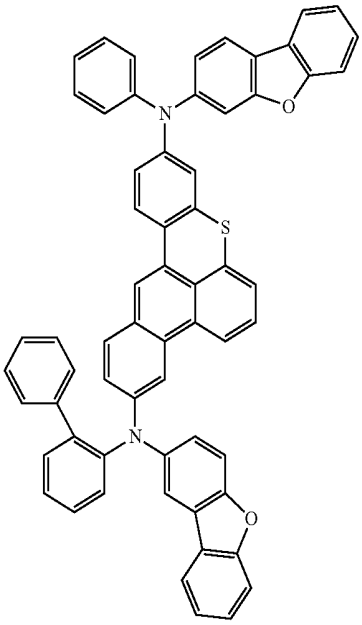

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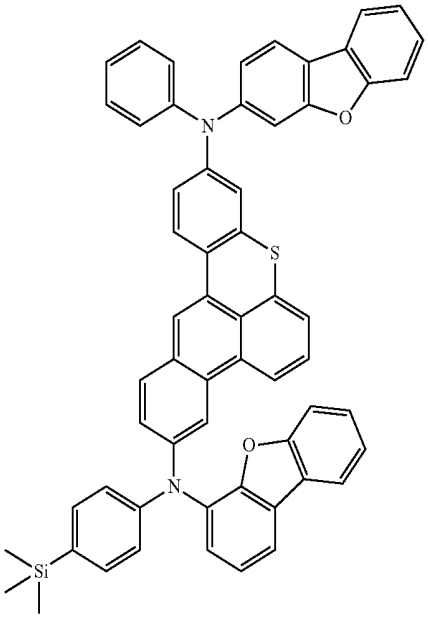

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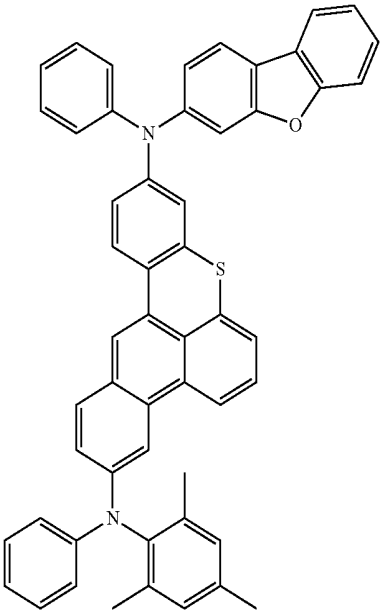

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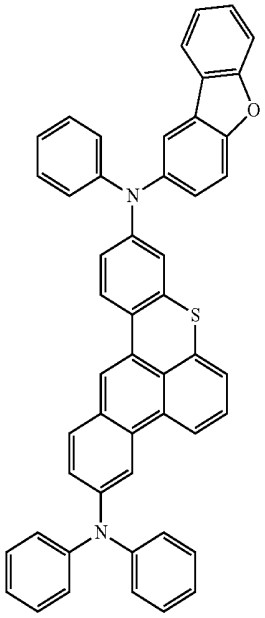

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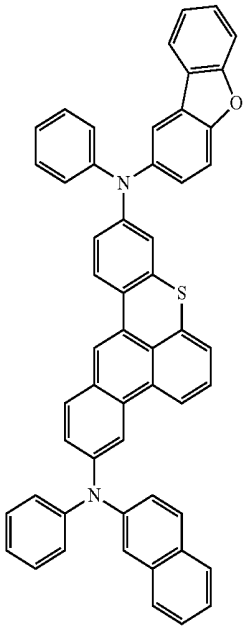

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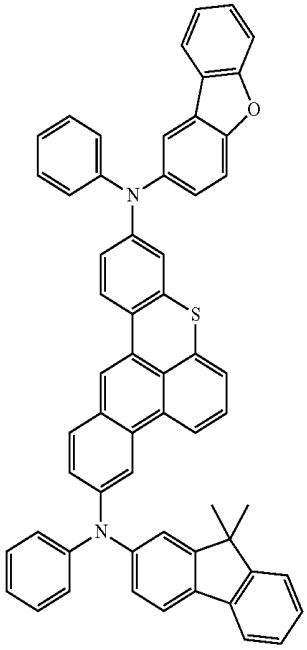

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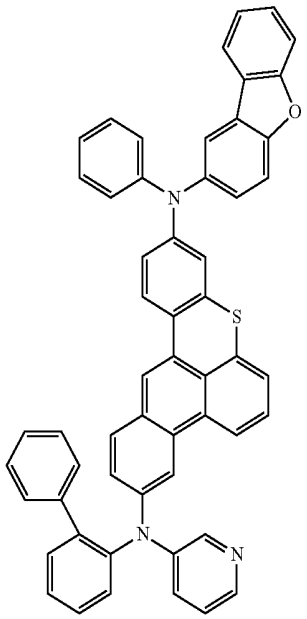

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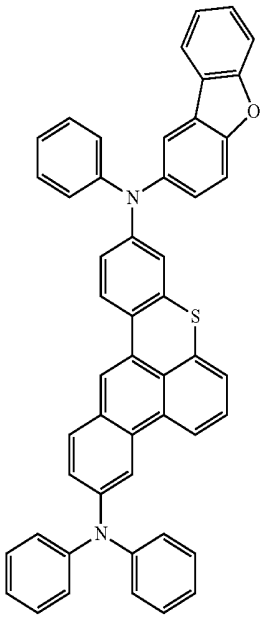

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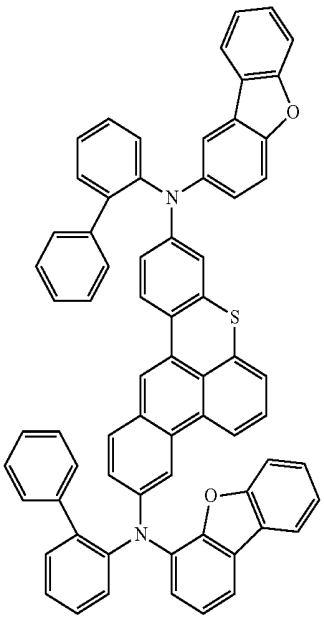

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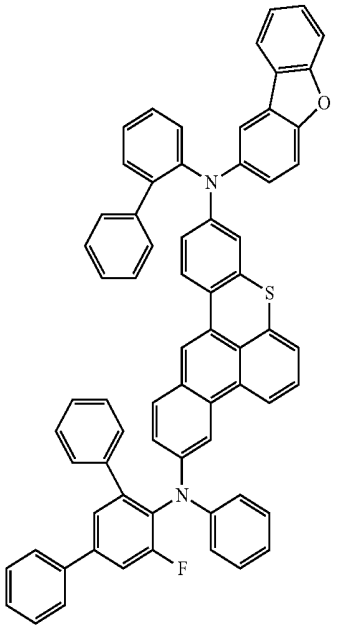

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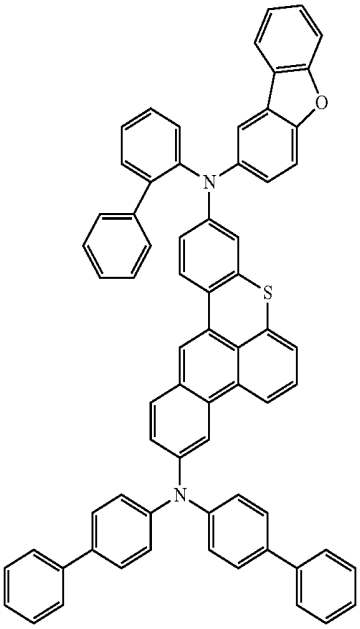

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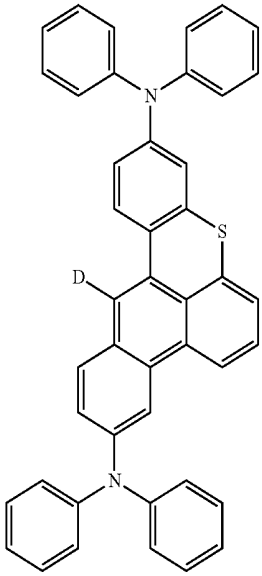

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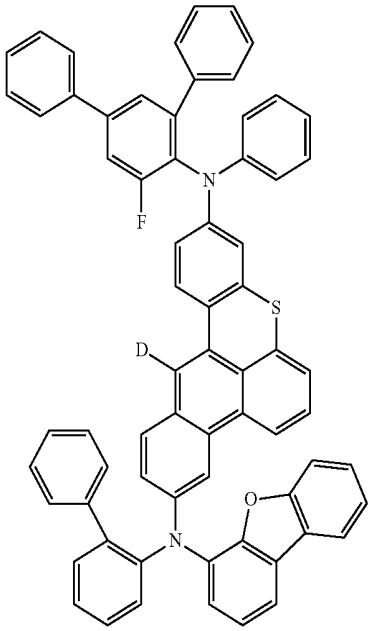

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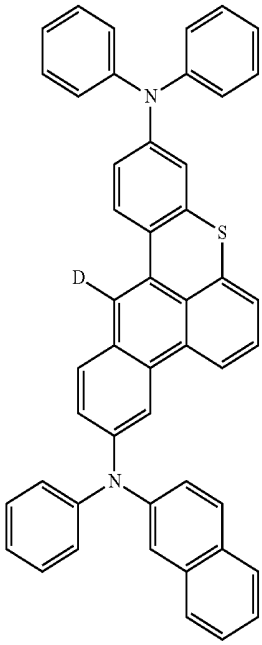

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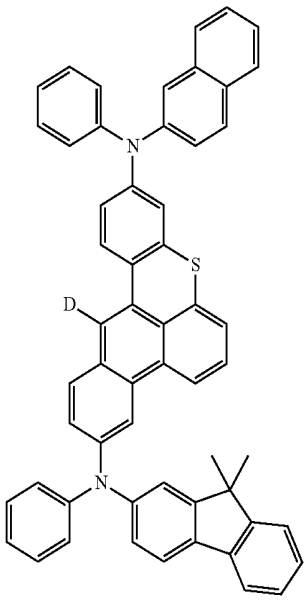

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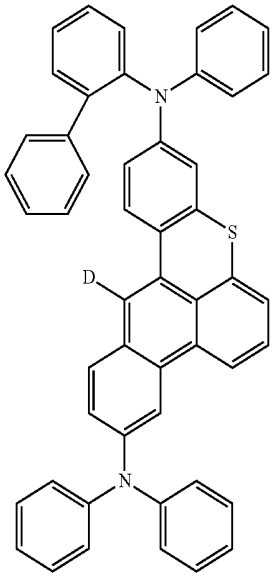

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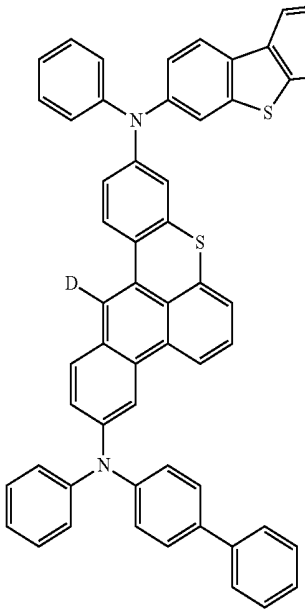

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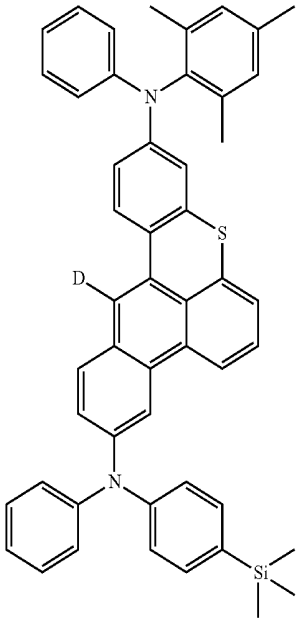

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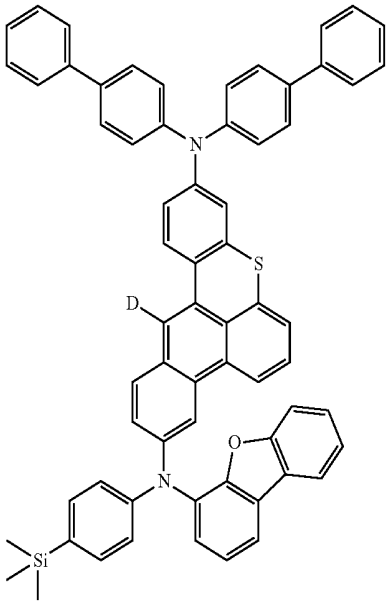

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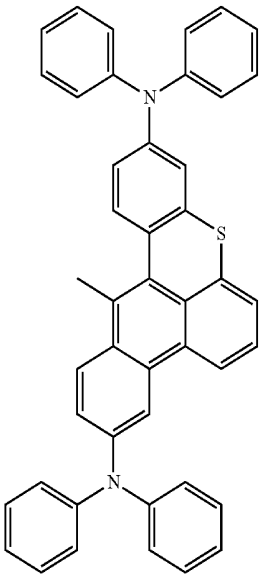

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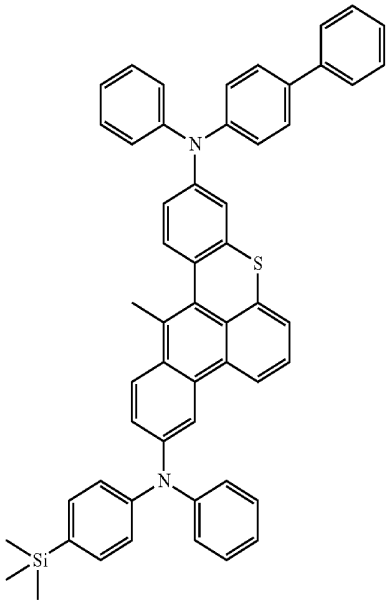

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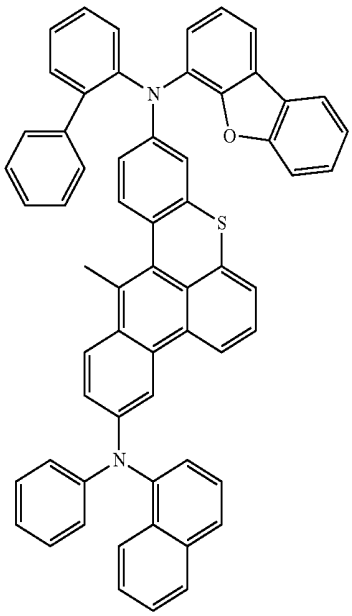

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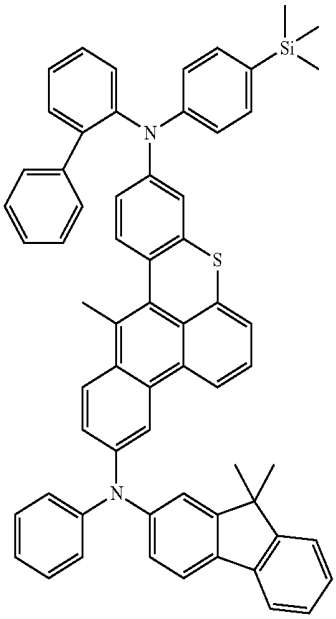

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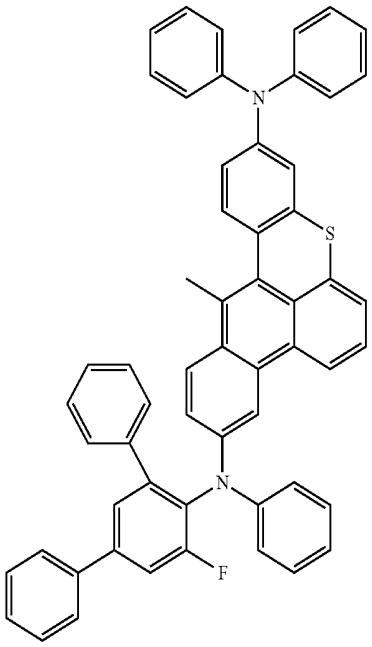

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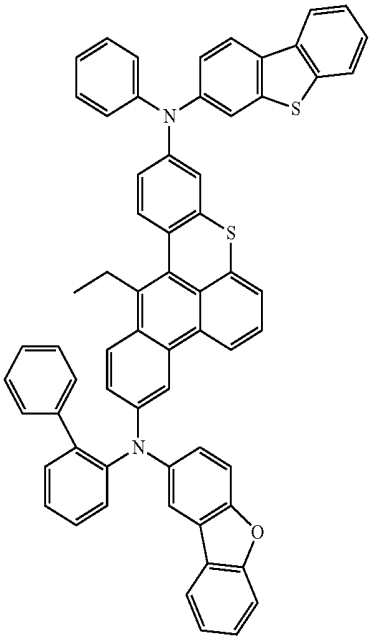

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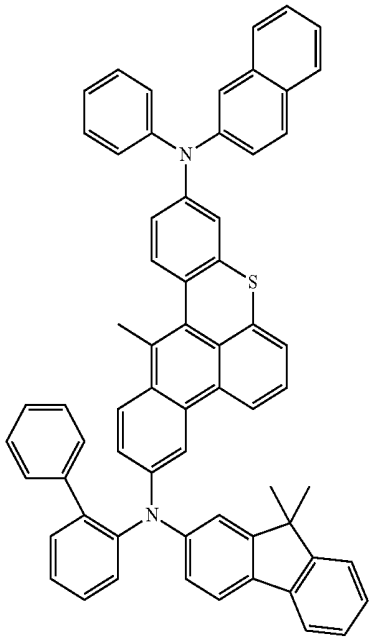

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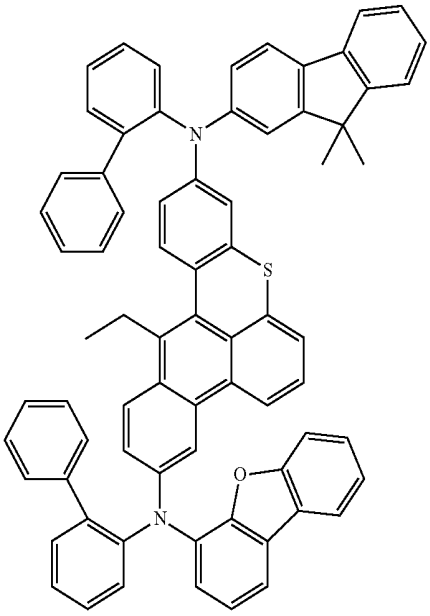

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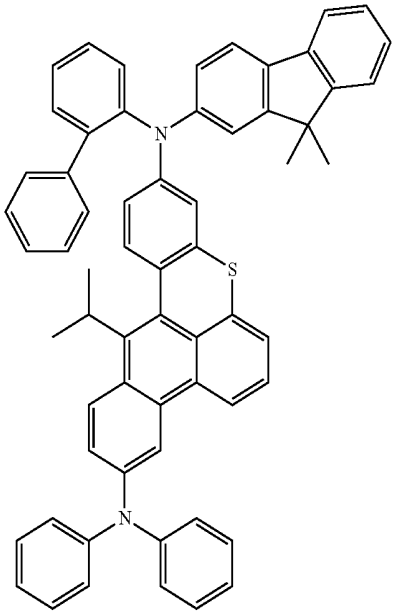

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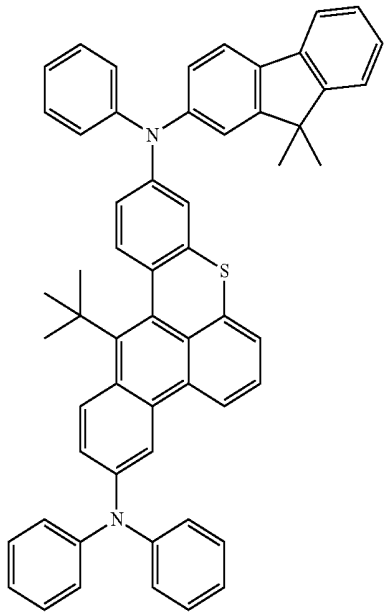

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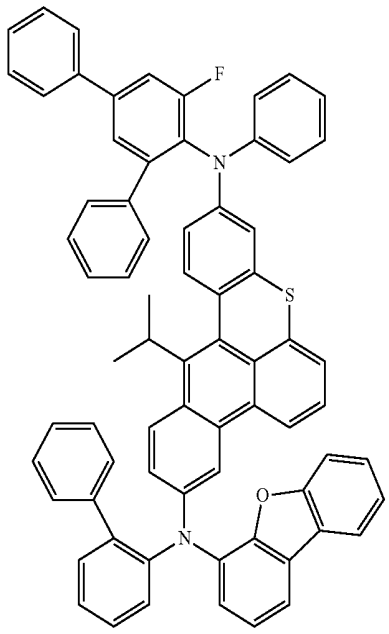

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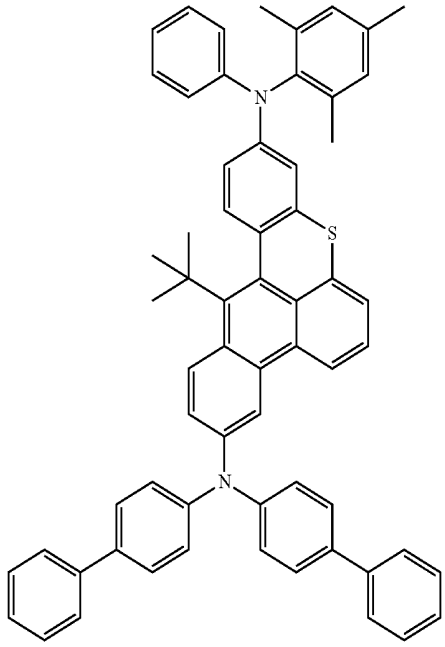

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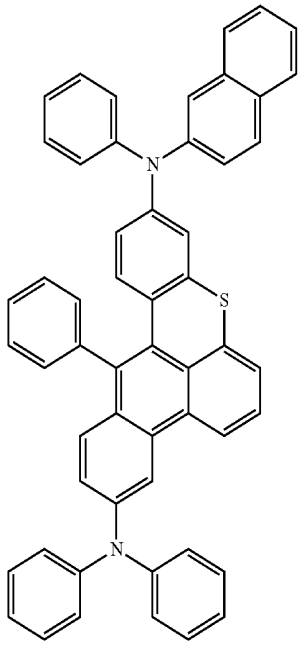

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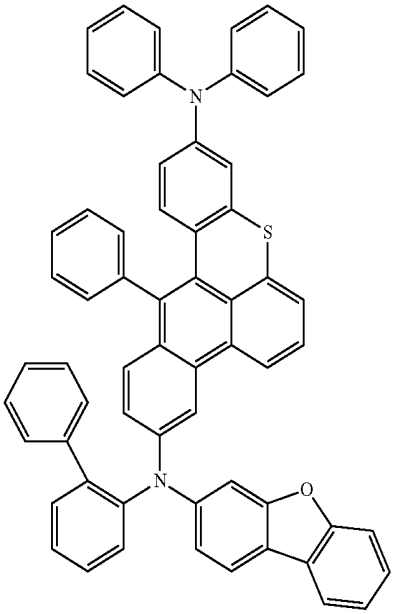

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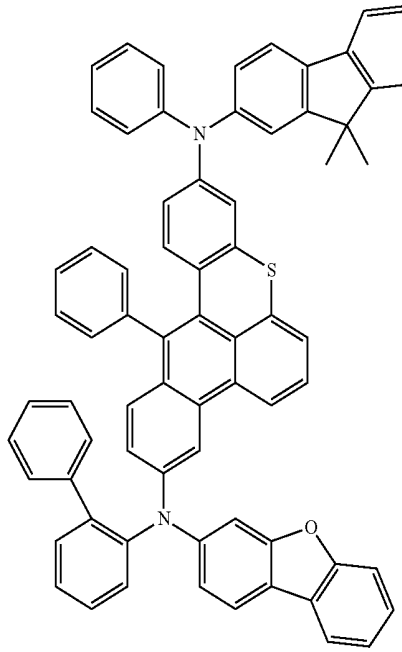

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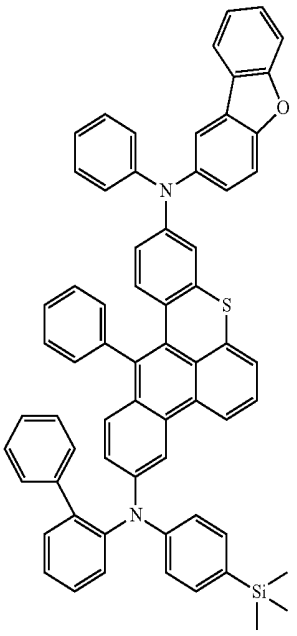

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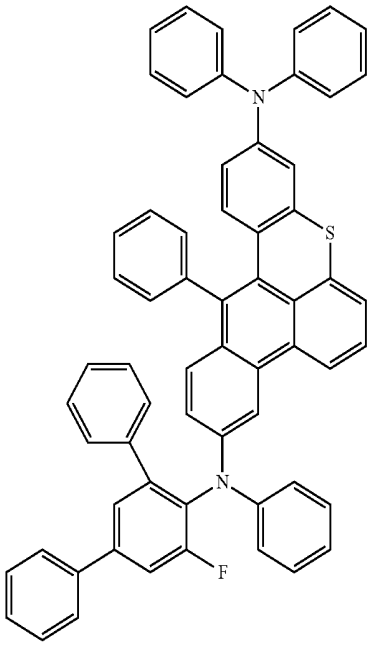

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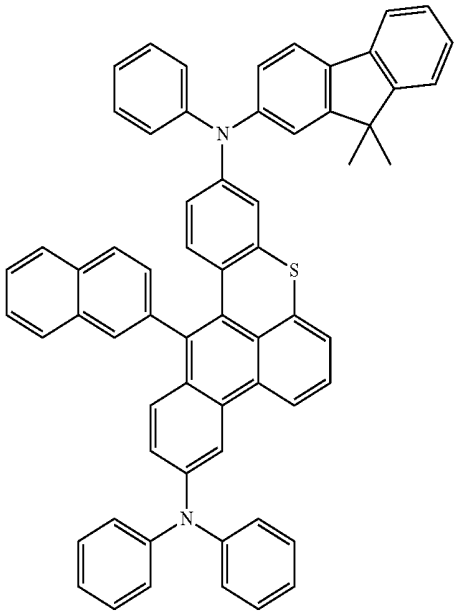

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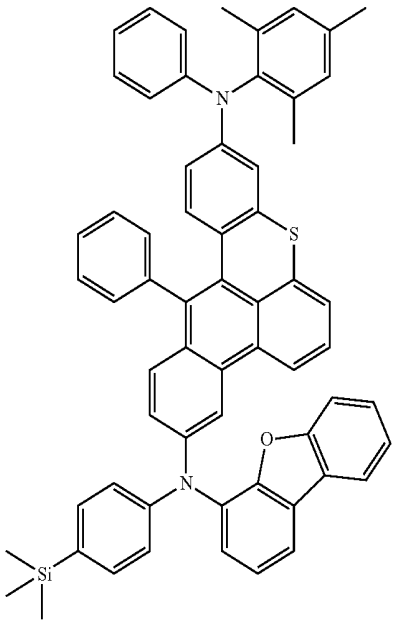

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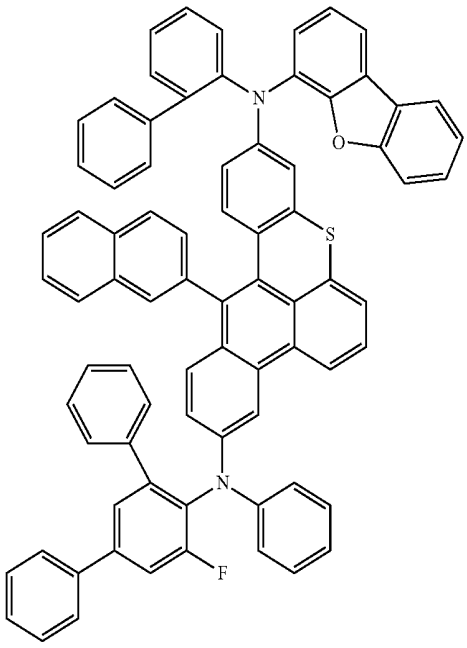

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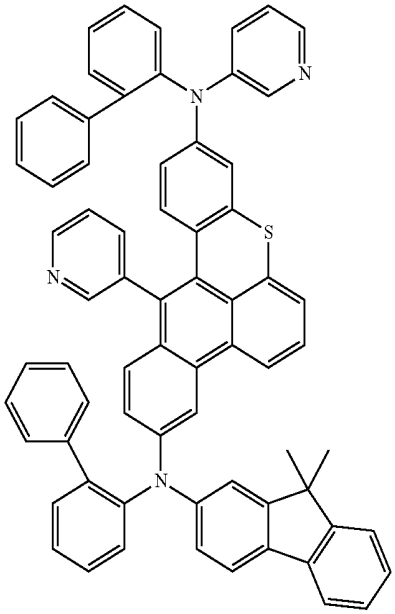

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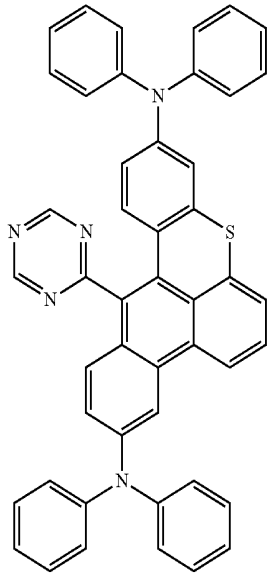

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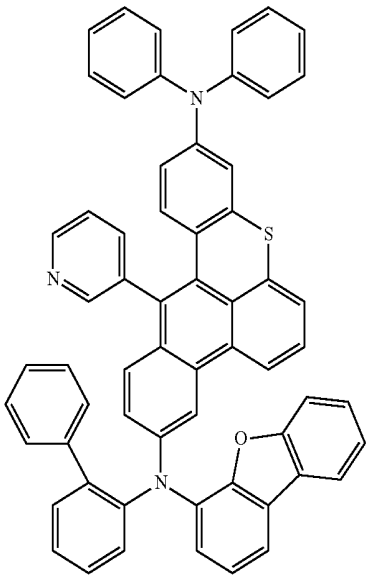

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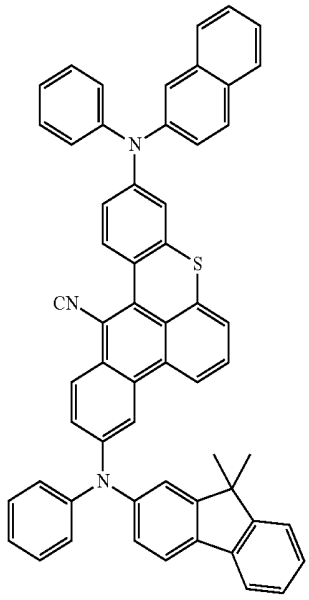

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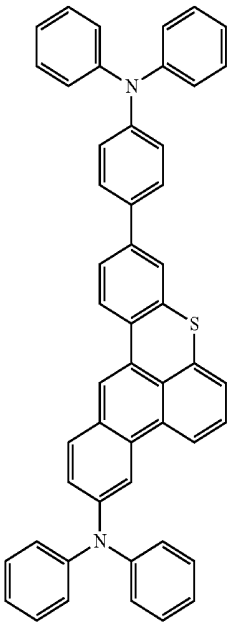

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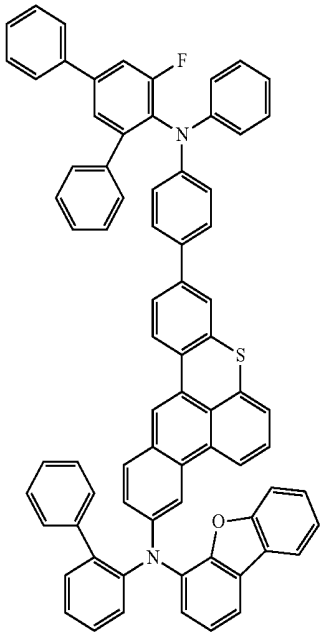

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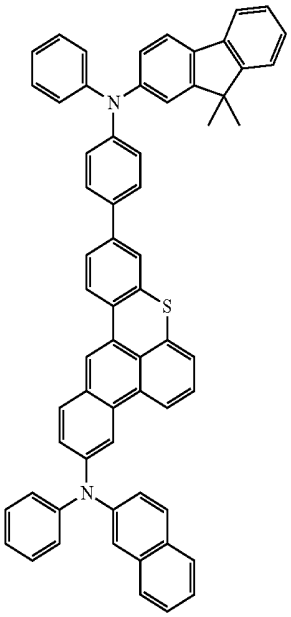

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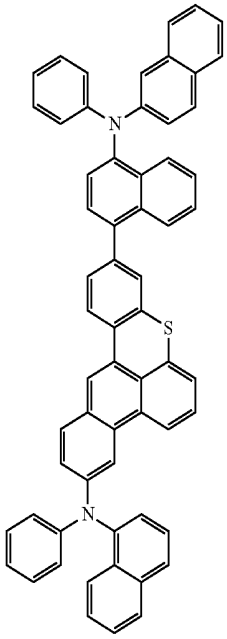

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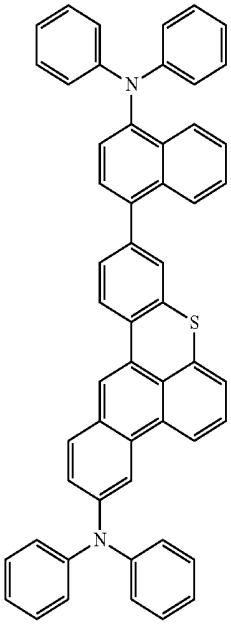

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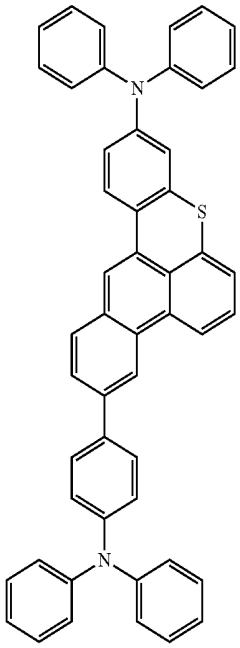

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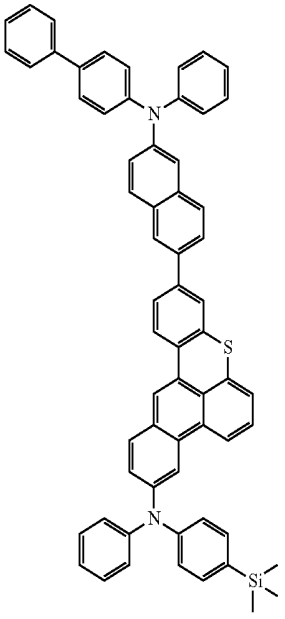

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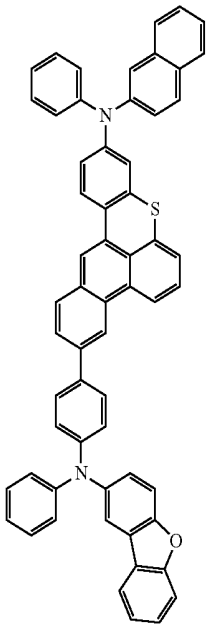

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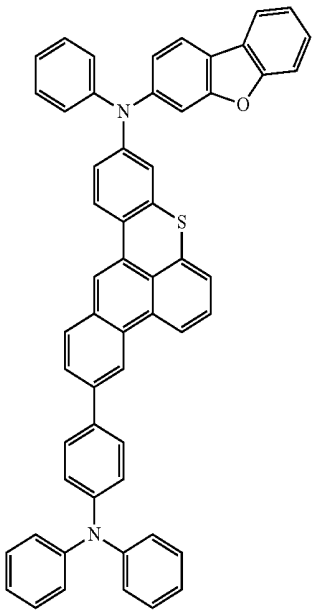

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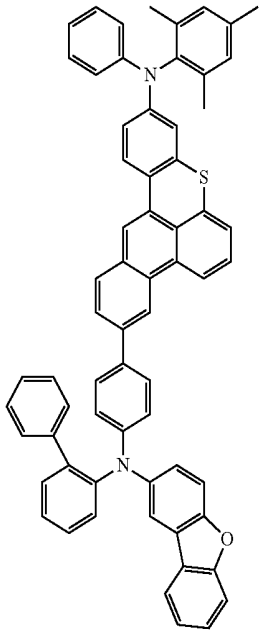

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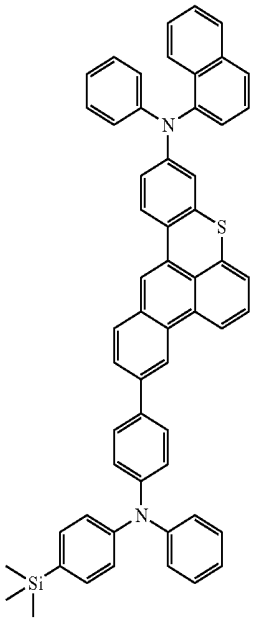

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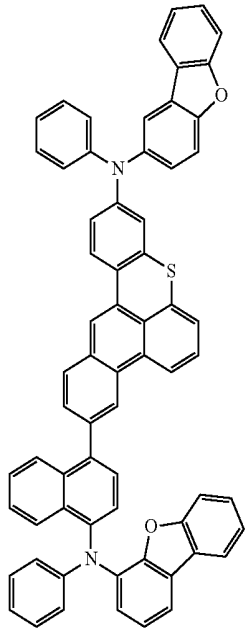

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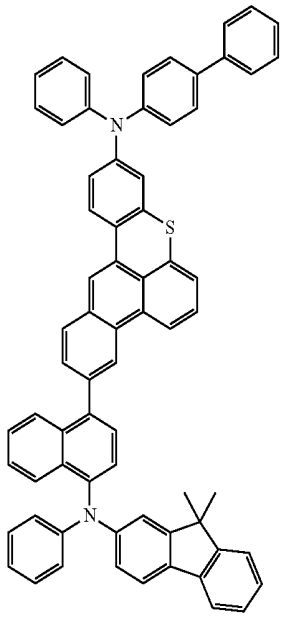

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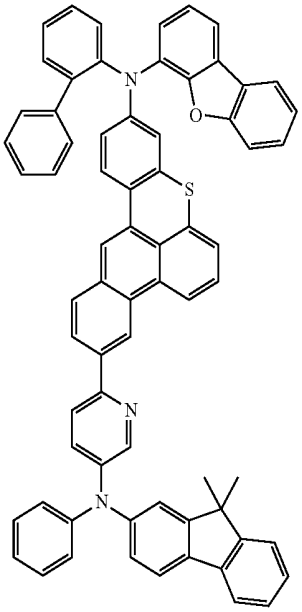

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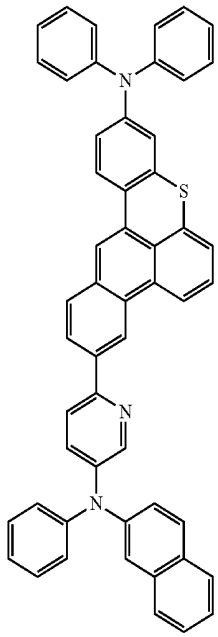

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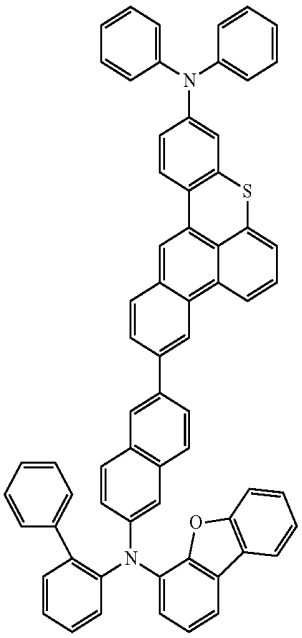

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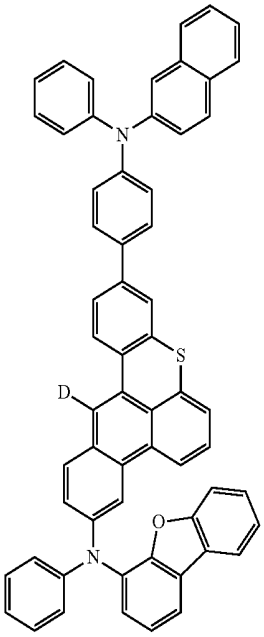

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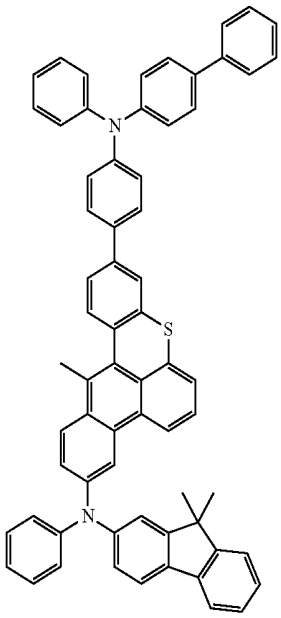

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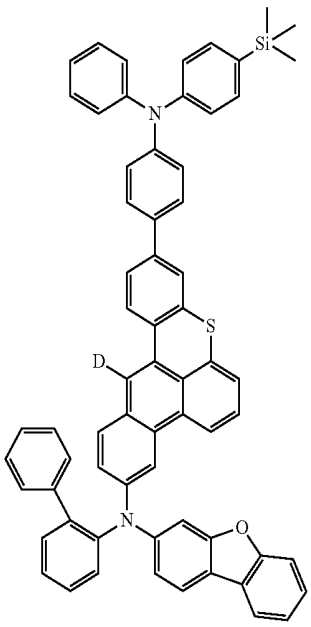

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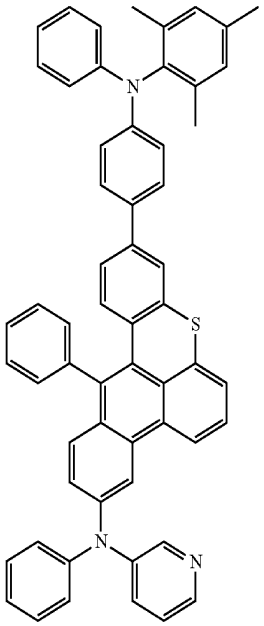

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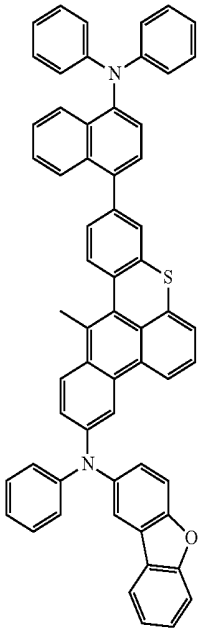

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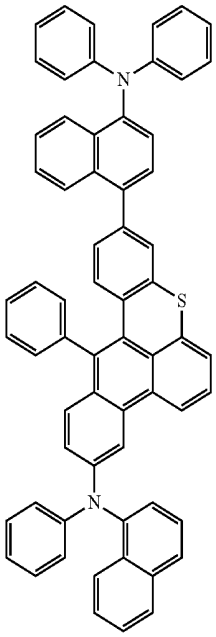

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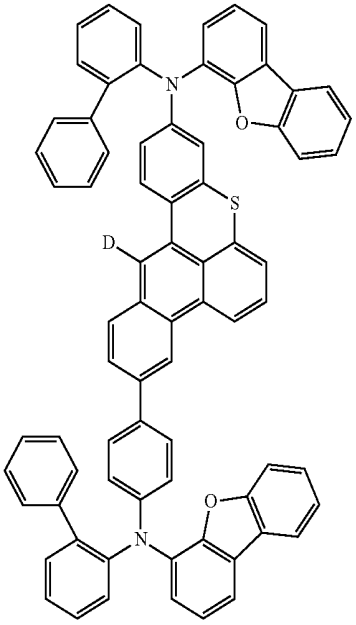

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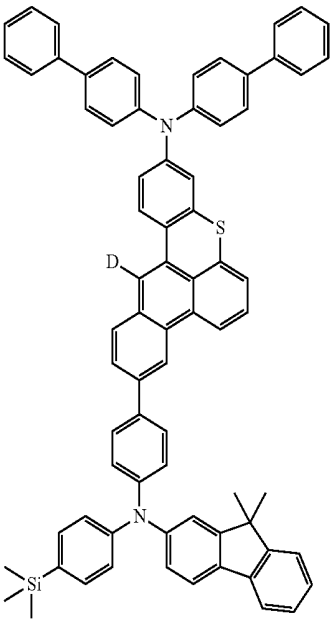

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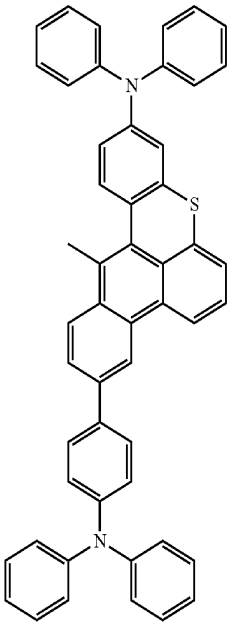

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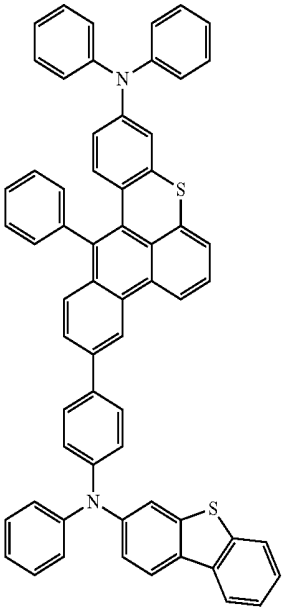

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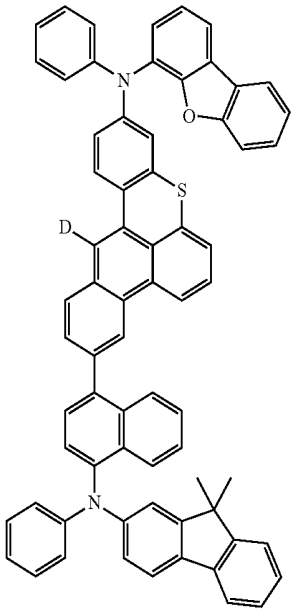

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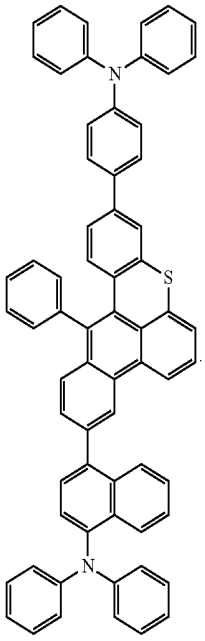


[0122] The condensed cyclic compound represented by Formula 1 has a core that has a phenanthrene moiety fused to a benzene moiety, each of which is enriched with π-electrons, with X_1 (O or S) therebetween, and at least two substituents selected from a group represented by Formula 2. Accordingly, radical cations or anions generated by the group represented by Formula 2 may be effectively delocalized and stabilized in the condensed cyclic compound represented by Formula 1. Accordingly, p-p* (pi to pi star) or n-p* (n to pi star) electron transition may be highly likely to occur in the molecule of the condensed cyclic compound represented by Formula 1, and thus the condensed cyclic compound represented by Formula 1 may provide high-efficient emission. Also, since the core of the condensed cyclic compound represented by Formula 1 has a relatively short conjugation length, relatively deep blue light emission may be achieved. Accordingly, an organic

light-emitting device using the condensed cyclic compound represented by Formula 1 may have high efficiency and long lifespan.

[0123] The condensed cyclic compound represented by Formula 1 may be synthesized using one or more suitable organic synthesis methods known to those of ordinary skill in the art. Suitable synthesis method of the condensed cyclic compound should be apparent to those of ordinary skill in the art in view of the following embodiments.

[0124] At least one condensed cyclic compound of Formula 1 may be positioned between a pair of electrodes of an organic light-emitting device. In some embodiments, the condensed cyclic compound may be included in a hole transport region, for example, in a hole transport layer. In some embodiments, the condensed cyclic compound may be included in an emission layer. In some embodiments, the condensed cyclic compound of Formula 1 may be used as a material for a capping layer located outside a pair of electrodes of an organic light-emitting device.

[0125] An organic light-emitting device according to some embodiments includes: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode, the organic layer including an emission layer, where the organic layer includes at least one of the condensed cyclic compounds represented by Formula 1.

[0126] The expression "a layer includes at least one condensed cyclic compound of Formula 1" as used herein may refer to embodiments in which a layer includes one or more of the same condensed cyclic compounds represented by Formula 1 and embodiments in which a layer includes two or more different condensed cyclic compounds represented by Formula 1.

[0127] For example, the organic layer may include, as the condensed cyclic compound, only Compound 1. In this regard, Compound 1 may be in a hole transport layer of the organic light-emitting device. In some embodiments, the organic layer may include, as the condensed cyclic compound, Compound 1 and Compound 2. In this regard, Compound 1 and Compound 2 may both be in the same layer (for example, Compound 1 and Compound 2 may both be in an emission layer), or in different layers (for example, Compound 1 may be in a hole transport layer and Compound 2 may be in an emission layer).

[0128] In some embodiments, the organic layer further includes i) a hole transport region between the first electrode (anode) and the emission layer, the hole transport region including at least one of a hole injection layer, a hole transport layer, a buffer layer, and an electron blocking layer, and ii) an electron transport region between the emission layer and the second electrode (cathode), the electron transport region including at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer. At least one of the hole transport region and the emission layer may include at least one condensed cyclic compound represented by Formula 1. For example, the hole transport region may include the hole transport layer, and the hole transport layer may include at least one condensed cyclic compound represented by Formula 1.

[0129] In some embodiments, in the organic layer of the organic light-emitting device, the emission layer may include the condensed cyclic compound represented by Formula 1. In the emission layer, the condensed cyclic compound represented by Formula 1 may act as a dopant, and the emission layer may further include a host.

[0130] In some embodiments, each of the hole transport region (for example, a hole transport layer in the hole transport region) and the emission layer may include the condensed cyclic compound of Formula 1, and the condensed cyclic compound included in the hole transport region (for example, in the hole transport layer of the hole transport region) may be different from the condensed cyclic compound Included in the emission layer.

[0131] The organic light-emitting device may further include at least one selected from a first capping layer positioned in a pathway along which the light generated in the emission layer proceeds toward the outside through the first electrode and a second capping layer positioned in a pathway along which the light generated in the emission layer proceeds toward the outside through the second electrode, and the at least one selected from the first capping layer and the second capping layer may include at least one condensed cyclic compound of Formula 1.

[0132] For example, the organic light-emitting device may have i) a stack structure including a first electrode, an organic layer, a second electrode, and a second capping layer which are sequentially stacked in this stated order, ii) a stack structure including a first capping layer, a first electrode, an organic layer, and a second electrode which are sequentially stacked in this stated order, or iii) a stack structure including a first capping layer, a first electrode, an organic layer, a second electrode, and a second capping layer which are sequentially stacked in this stated order, and at least one selected from the first capping layer and the second capping layer may include the condensed cyclic compound.

[0133] The term "organic layer" as used herein refers to a single layer and/or a plurality of layers disposed between the first electrode and the second electrode of an organic light-emitting device. A material included in the "organic layer" is not limited to an organic material.

[0134] FIG. **1** is a schematic view of an organic light-emitting device **10** according to an embodiment. The organic light-emitting device **10** includes a first electrode **110**, an organic layer **150**, and a second electrode **190**.

[0135] Hereinafter, the structure of an organic light-emitting device and a method of manufacturing an organic light-emitting device according to some embodiments will be described in connection with FIG. **1**.

[0136] In FIG. **1**, a substrate may be additionally positioned under the first electrode **110** or above the second electrode **190**. The substrate may be a glass substrate or transparent plastic substrate, each having excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and being waterproof.

[0137] The first electrode **110** may be formed by depositing and/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 or a transmissive electrode. The material for the first electrode may be a transparent and highly conductive material, and non-limiting examples of such a 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 of magnesium

(Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag) may be used.

[0138] The first electrode **110** may have a single-layer structure, or a multi-layer structure including two or more layers. For example, the first electrode **110** may have a three-layered structure of ITO/Ag/ITO, but the structure of the first electrode **110** is not limited thereto.

[0139] The organic layer **150** is positioned on the first electrode **110**. The organic layer **150** may include an emission layer.

[0140] 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.

[0141] 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.

[0142] 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.

[0143] 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 on the first electrode **110** in this stated order, but the structure of the hole transport region is not limited thereto.

[0144] When the hole transport region includes a hole injection layer, the hole injection layer may be formed on the first electrode **110** using one or more suitable methods, such as vacuum deposition, spin coating casting, a Langmuir-Blodgett (LB) method, Ink-jet printing, laser-printing, and/or laser-Induced thermal Imaging.

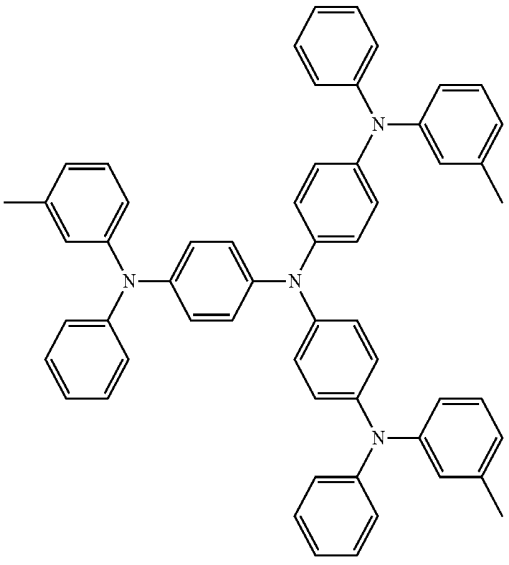
[0145] When the hole injection layer is formed by vacuum deposition, for example, the vacuum deposition may be performed at a deposition temperature of about 100 to about 500° C., at a vacuum degree of about 10^{-8} to about 10^{-3} torr, and at a deposition rate of about 0.01 to about 100 Å/sec, depending on a compound for forming the hole injection layer, and the structure of the hole injection layer to be formed.

[0146] When the 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 a compound for forming the hole injection layer, and the structure of the hole injection layer to be formed.

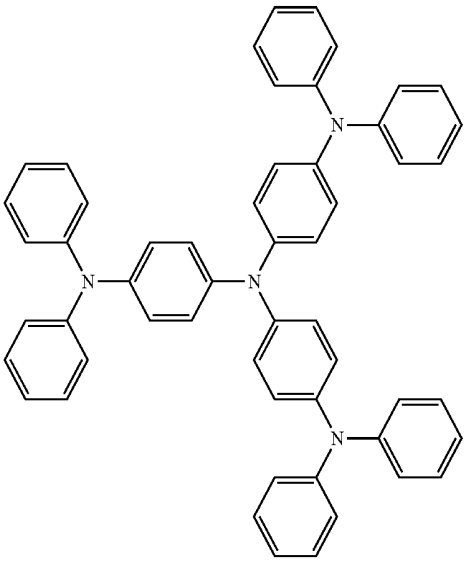
[0147] When the hole transport region Includes a hole transport layer, the hole transport layer may be formed on the first electrode **110** or the hole injection layer using one or more suitable methods, such as vacuum deposition, spin coating, casting, a LB method, ink-jet printing, laser-printing, and/or laser-induced thermal imaging. When the hole transport layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the hole transport layer may be similar to the deposition and coating conditions for the hole injection layer.

[0148] The hole transport region may include the condensed cyclic compound represented by Formula 1. For example, the hole transport region may include the hole transport layer, and the hole transport layer may include the condensed cyclic compound represented by Formula 1.

[0149] In some embodiments, the hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, Spiro-TPD, 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 sulfonicacid (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



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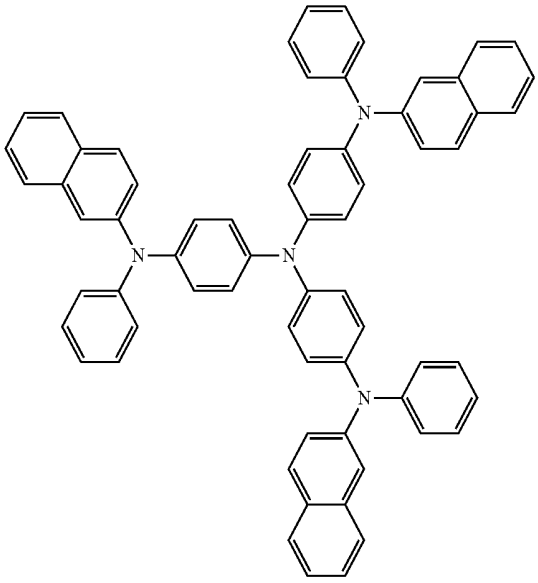

2-TNATA

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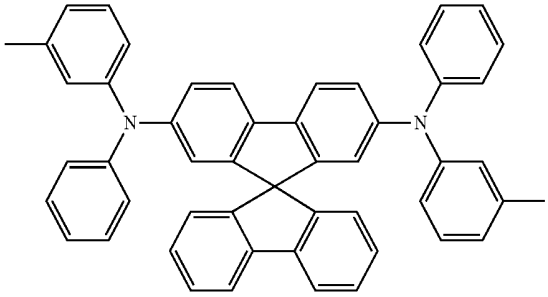
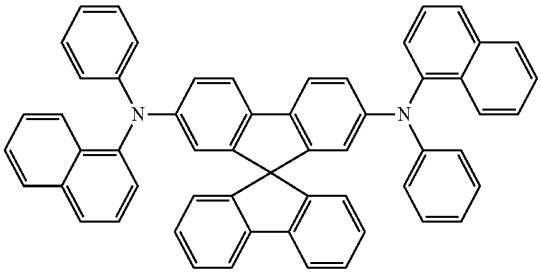
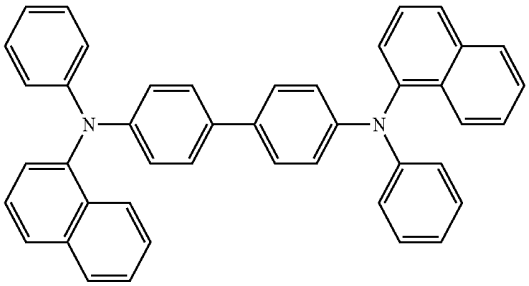


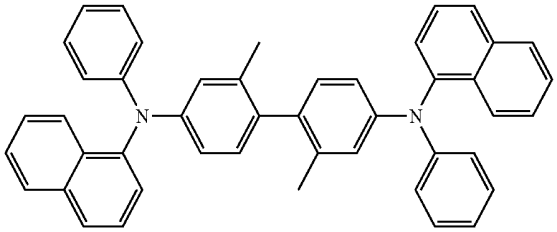
Spiro-TPD



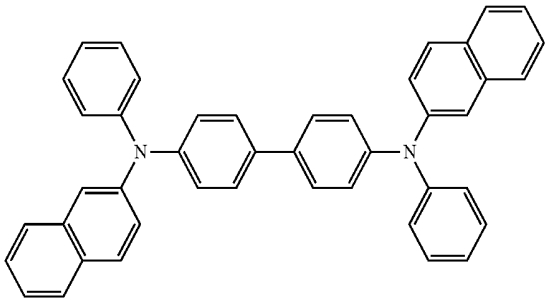
Spiro-NPB



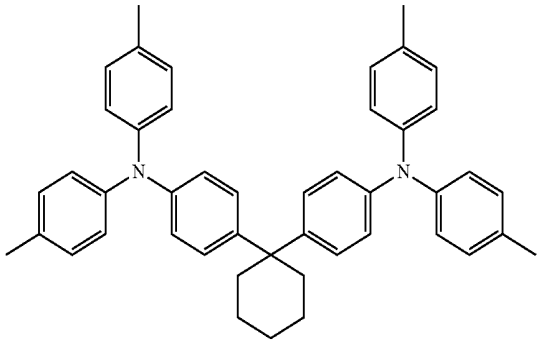
NPB



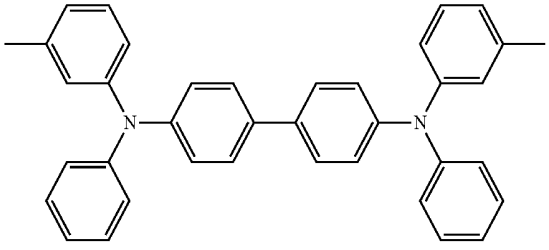
methylated NPB



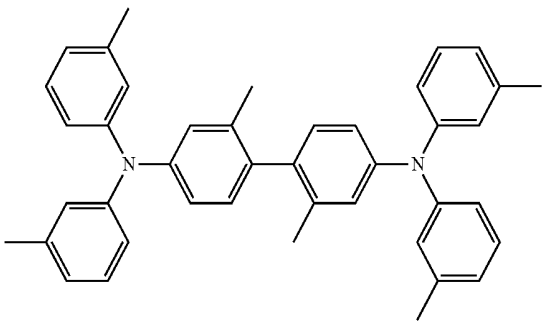
β-NPB



TAPC



TPD



HMTPD

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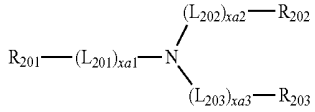
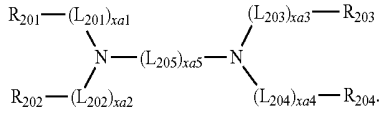
Formula 201



Formula 202



[0150] In Formulae 201 and 202,

[0151] L_{201} to L_{205} may each independently be the same as described in connection with L_1;

[0152] xa1 to xa4 may be each independently selected from 0, 1, 2, and 3;

[0153] xa5 may be selected from 1, 2, 3, 4, and 5; and

[0154] R_{201} to R_{204} may be each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

[0155] In some embodiments, in Formulae 201 and 202,

[0156] L_{201} to L_{205} may be each independently selected from:

[0157] 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

[0158] 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 qulnazolinylene 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 C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0159] xa1 to xa4 may be each independently 0, 1, or 2;

[0160] xa5 may be 1, 2, or 3;

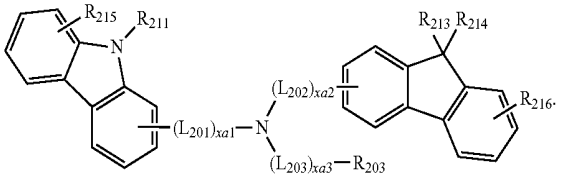
[0161] R_{201} to R_{204} may be each independently selected from:

[0162] 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; and

[0163] 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 quinazolnyl 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 C_1-C_{20} alkyl group, a C_1-C_{20} 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.

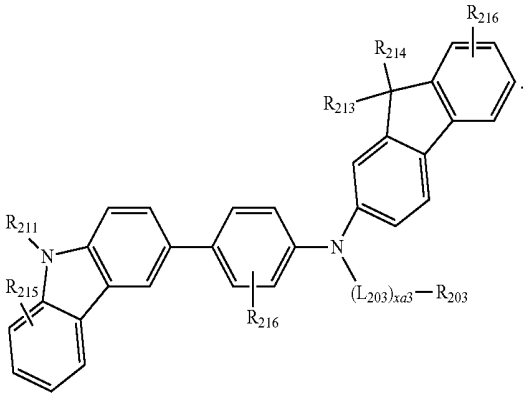
[0164] The compound represented by Formula 201 may be represented by Formula 201A:

Formula 201A



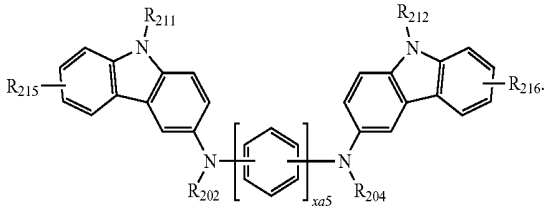
[0165] For example, the compound represented by Formula 201 may be represented by Formula 201A-1 below, but is not limited thereto:

Formula 201A-1



[0166] For example, the compound represented by Formula 202 may be represented by Formula 202A below, but is not limited thereto:

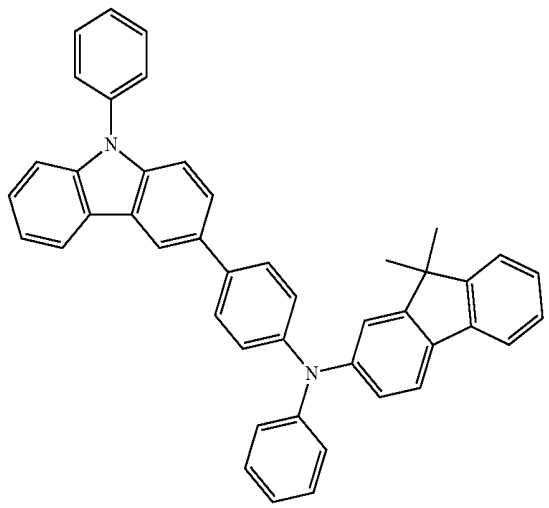
Formula 202A



[0167] Regarding Formulae 201A, 201A-1, and 202A, descriptions of L_{201} to L_{203}, xa1 to xa3, xa5, and R_{202} to R_{204} are the same as provided above, descriptions of R_{211} and R_{212} are the same as the description of R_{203}, and R_{213} to R_{216} 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 group 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_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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.

[0168] The compound represented by Formula 201, and the compound represented by Formula 202 may each include compounds HT1 to HT20 illustrated below, but are not limited thereto.

HT1



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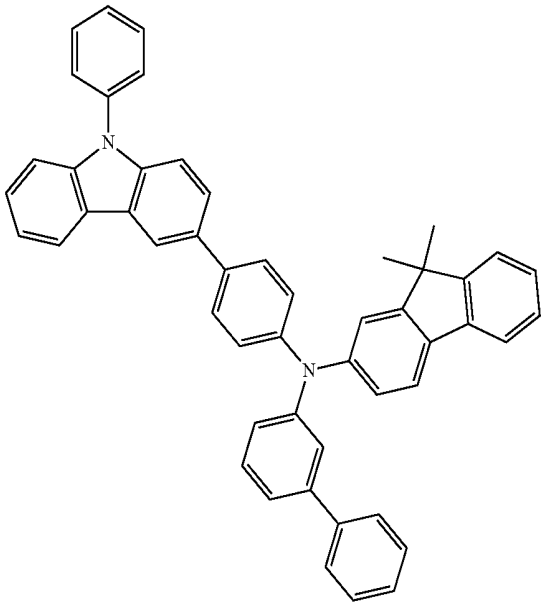
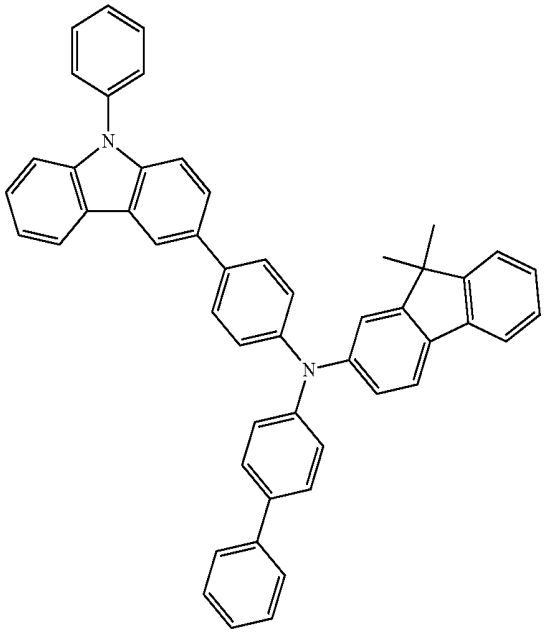
HT2



HT3



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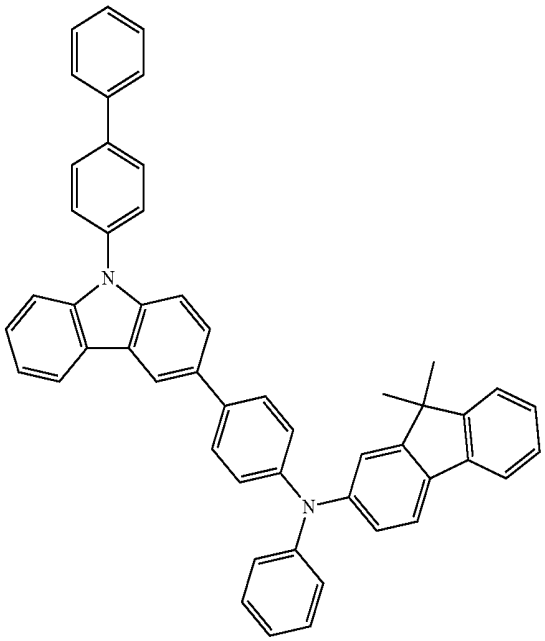
HT4



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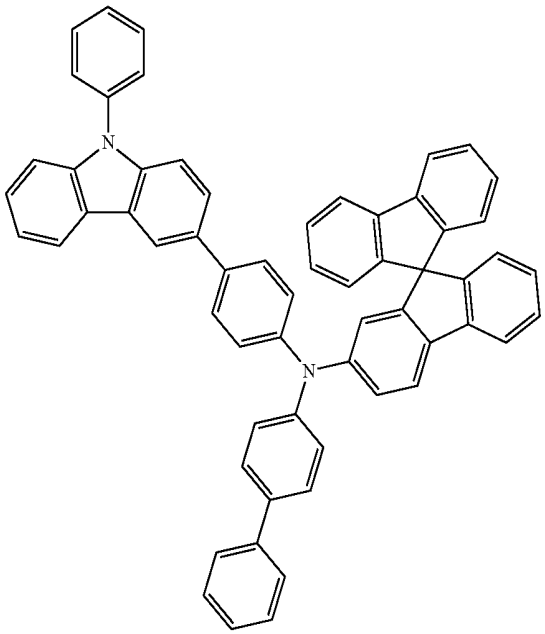
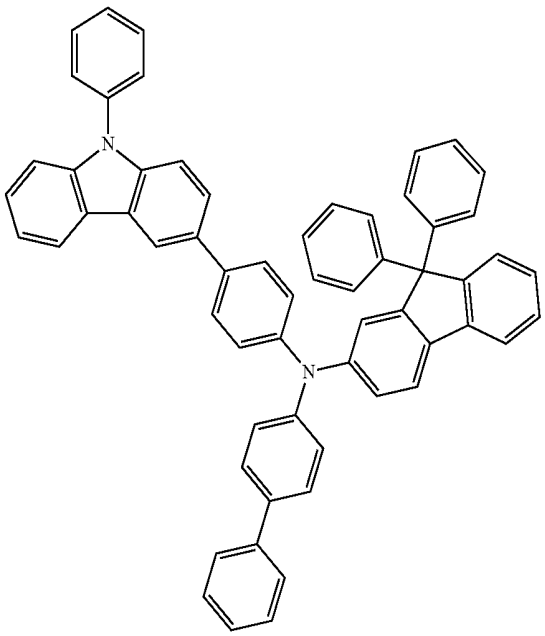
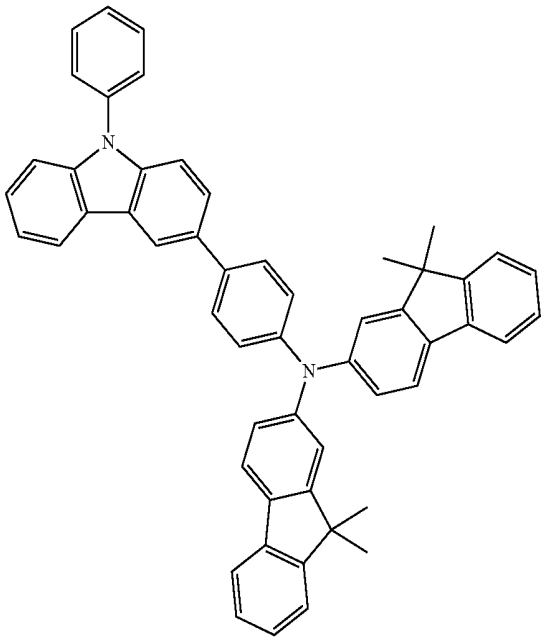
HT6



HT5



HT7



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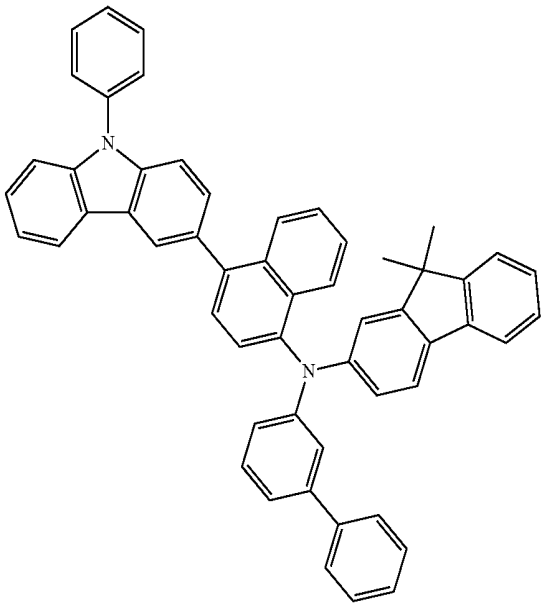
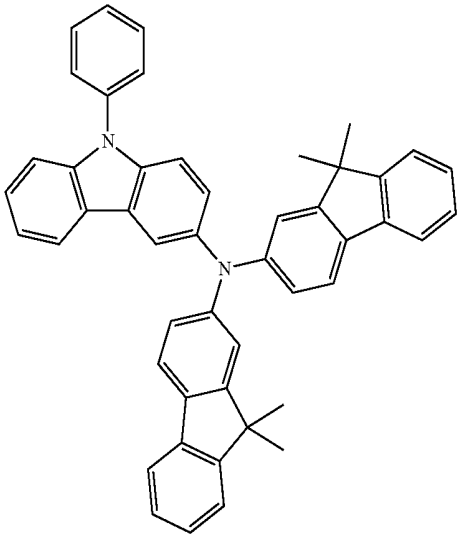
HT8



HT9



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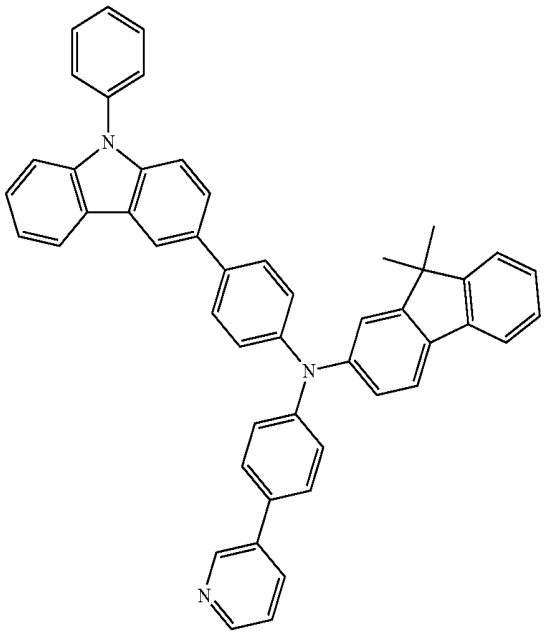
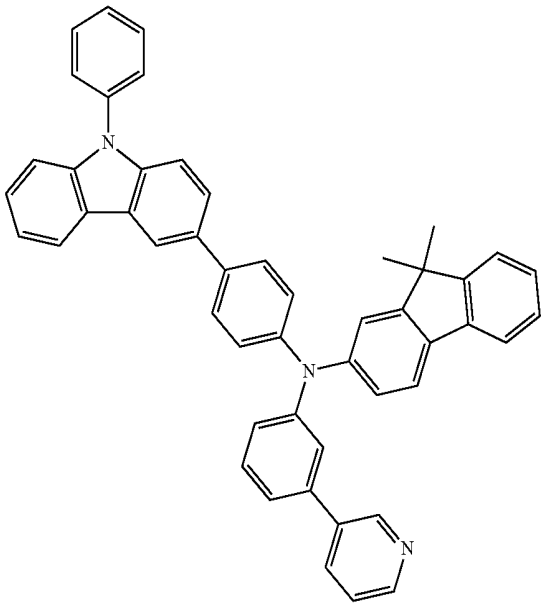
HT10



HT11



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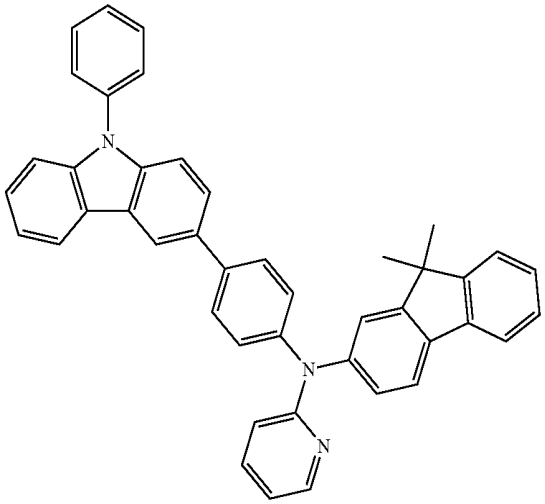
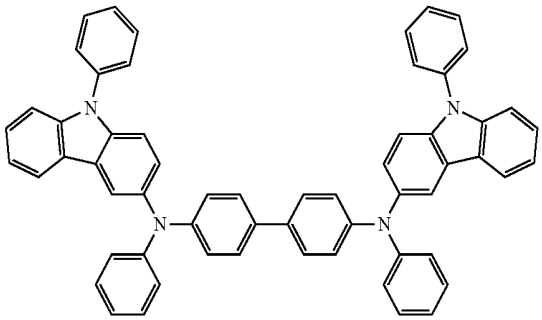
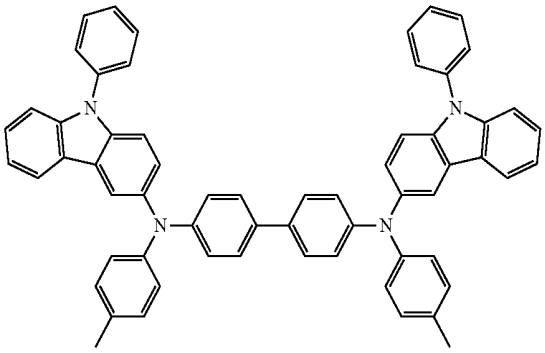
HT12



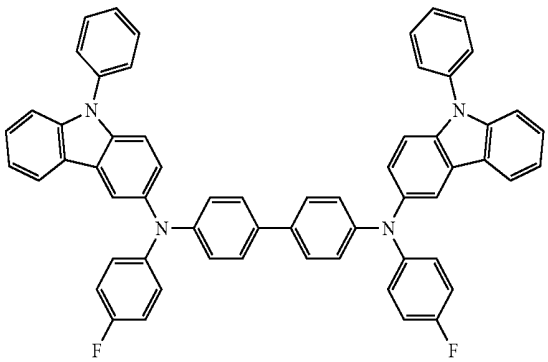
HT13



HT14



HT15



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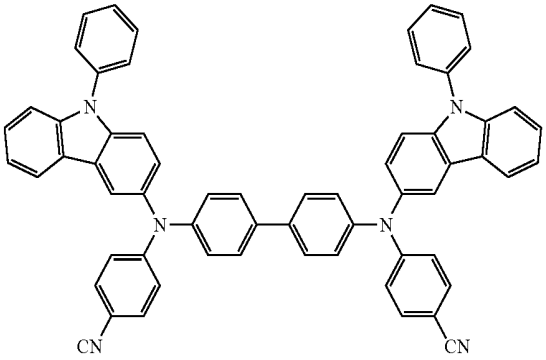
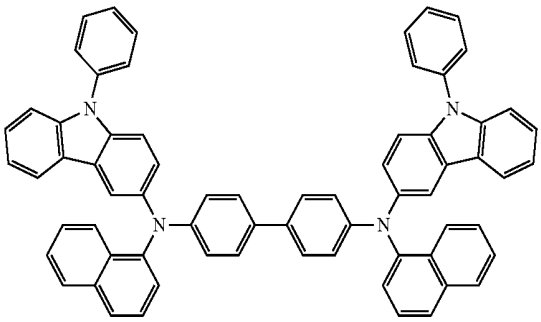
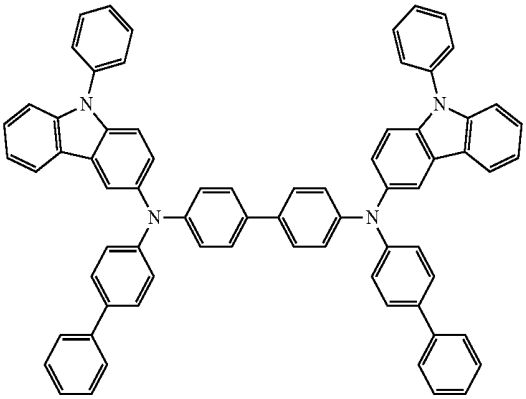
HT16



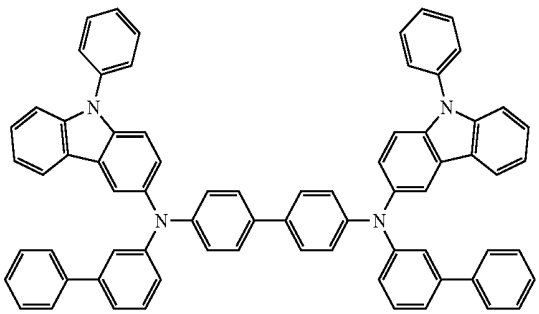
HT17



HT18



HT19



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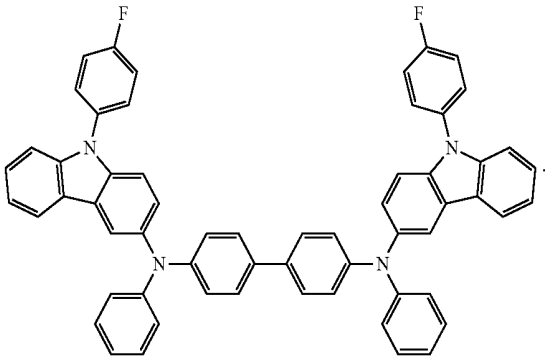
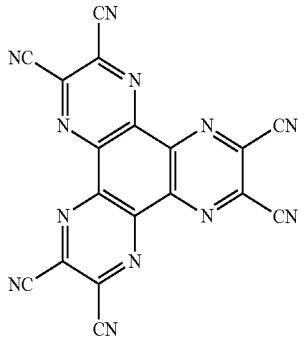
HT20



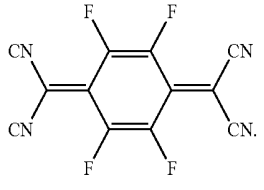
[0169] A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1,000 Å. When the hole transport region Includes a hole injection layer and a hole transport layer, the thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, or in a range of about 100 Å to about 1,000 Å, and the thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, for example, about 100 Å to about 1,500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within any of these ranges, satisfactory hole transporting characteristics may be obtained without a substantial increase in driving voltage.

[0170] The hole transport region may further include, in addition to these materials, a charge-generation material for the improvement of conductive properties. The charge-generation material may be homogeneously or unhomogeneously dispersed in the hole transport region.

[0171] The charge-generation material may be, for example, a p-dopant. The p-dopant may be one of 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 tetracyanoquinonedimethane (TCNQ) and/or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonedimethane (F4-TCNQ)); metal oxides (such as a tungsten oxide and/or a molybdenum oxide); and Compound HT-D1 illustrated below:



Compound HT-D1



F4-TCNQ

[0172] The hole transport region may further include, in addition to the hole injection layer and the hole transport layer, at least one of 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 a formed 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. In some embodiments, the electron blocking layer prevents (or substantially blocks) the injection of electrons from the electron transport region.

[0173] 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, a LB method, ink-jet printing, laser-printing, and/or laser-induced thermal Imaging. 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.

[0174] 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, corresponding to a sub pixel. In some embodiments, the emission layer may have a stacked structure of a red emission layer, a green emission layer, and a blue emission layer, or may include a red-light emission material, a green-light emission material, and a blue-light emission material, which are mixed with each other in a single layer, to emit white light.

[0175] The emission layer may include a host and a dopant.

[0176] In some embodiments, the host may include a compound represented by Formula 301 below.

$$Ar_{301}\text{-}[(L_{301})_{xb1}\text{-}R_{301}]_{xb2}. \qquad \text{Formula 301}$$

[0177] In Formula 301,

[0178] Ar_{301} may be selected from:

[0179] 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;

[0180] a naphthalene group, a heptalene group, a fluorene group, a spiro-fluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, a anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, and an indenoanthracene 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, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy, 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, and —$Si(Q_{301})(Q_{302})$

(Q_{303}) (where Q_{301} to Q_{303} are each Independently selected from a hydrogen, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_1-C_{60} aryl group, and a C_1-C_{10} heteroaryl group);

[0181] L_3 so may be the same as described in connection with L_1;

[0182] R_{301} may be selected from:

[0183] a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group;

[0184] a C_1-C_{20} alkyl group and a C_1-C_{20} 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 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;

[0185] 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 carbazol group, and a triazinyl group; and

[0186] 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, 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0187] xb1 may be selected from 0, 1, 2, and 3;

[0188] xb2 may be selected from 1, 2, 3, and 4.

[0189] For example, in Formula 301,

[0190] L_{301} may be selected from:

[0191] 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, and a chrysenylene group; and

[0192] 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, and a chrysenylene 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group; and

[0193] R_{301} may be selected from:

[0194] a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group;

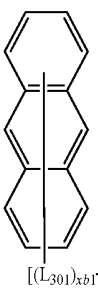
[0195] a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a 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, and a chrysenyl group;

[0196] 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, and a chrysenyl group; and

[0197] 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, and a chrysenyl 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group, but embodiments of the present invention are not limited thereto.

[0198] For example, the host may include a compound represented by Formula 301A below:

Formula 301A

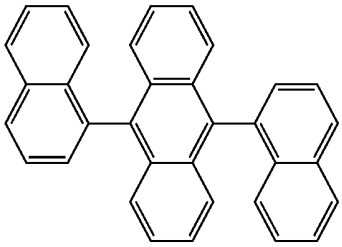


$[(L_{301})_{xb1}—R_{301}]_{xb2}$.

[0199] Descriptions of substituents of Formula 301A are the same as the descriptions provided herein.

[0200] The compound represented by Formula 301 may include at least one of Compounds H1 to H42, but is not limited thereto:

H1



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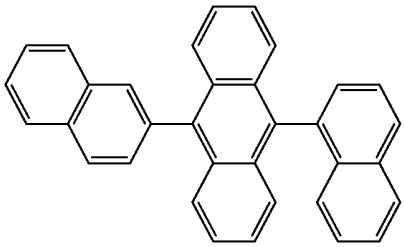
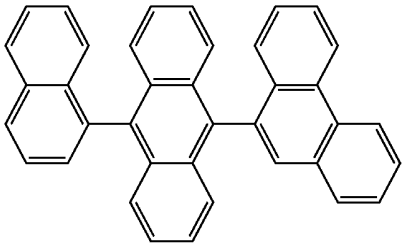


H3



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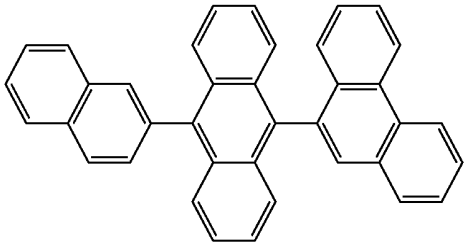

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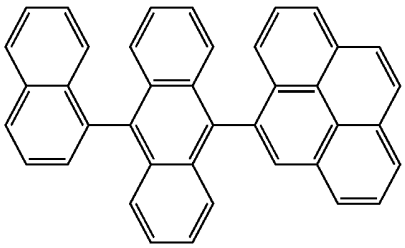
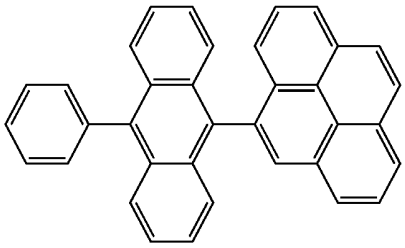


H6



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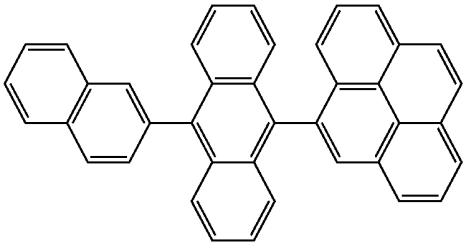
H7



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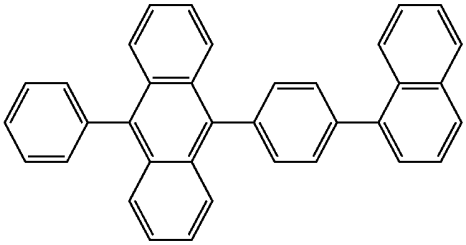

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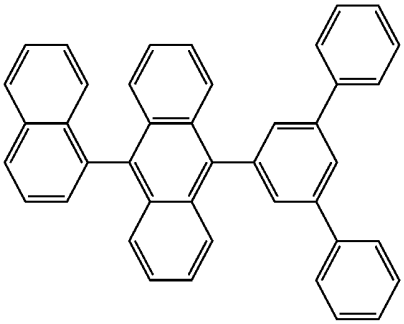

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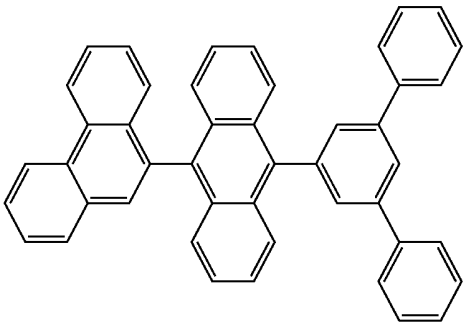

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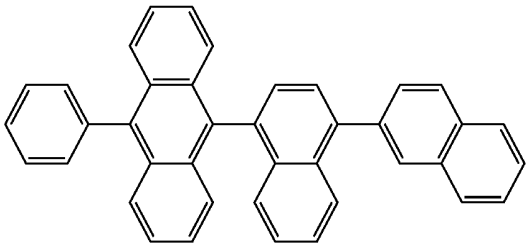

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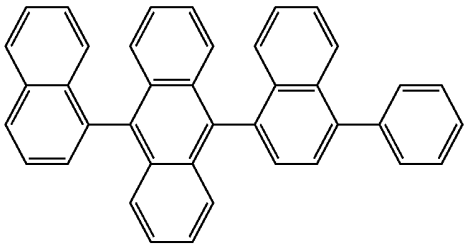

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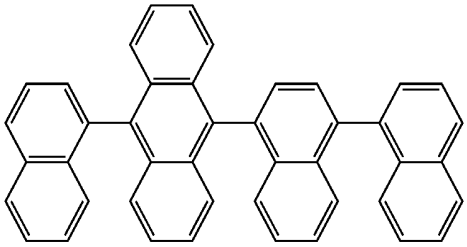

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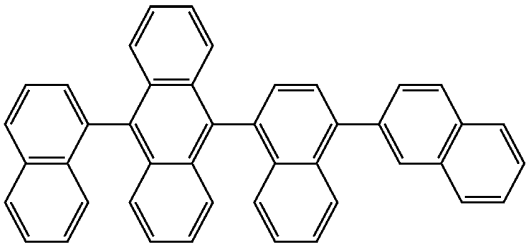

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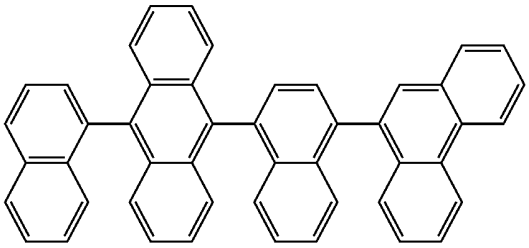
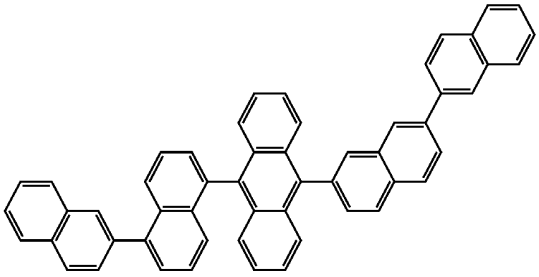


HT16



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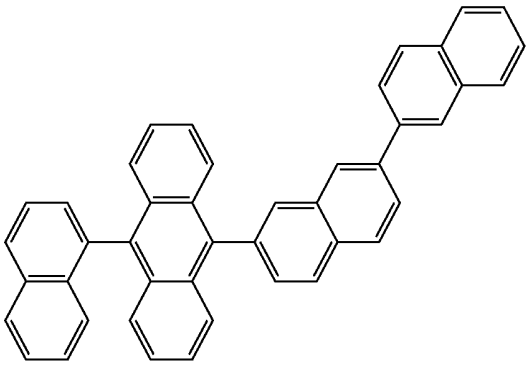
HT17



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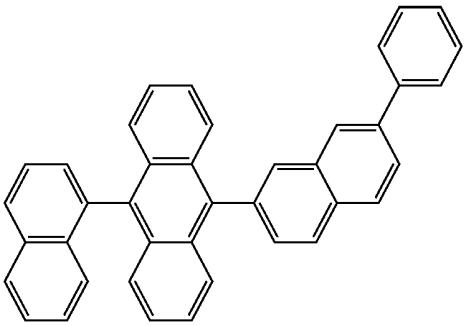

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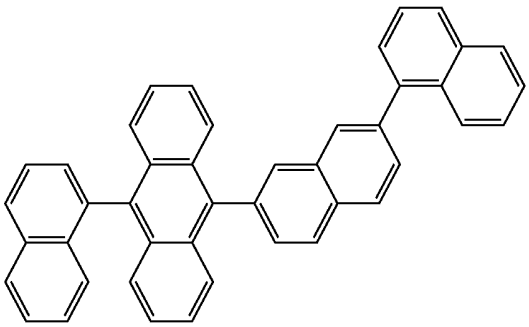

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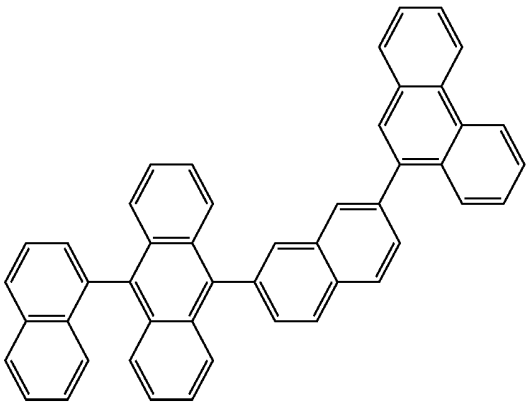

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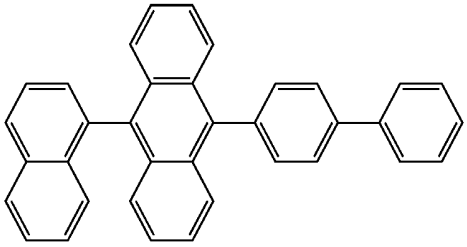

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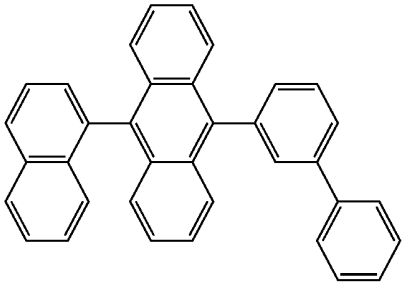

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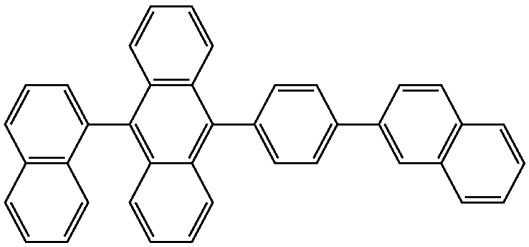

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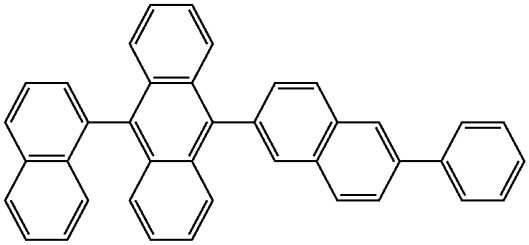

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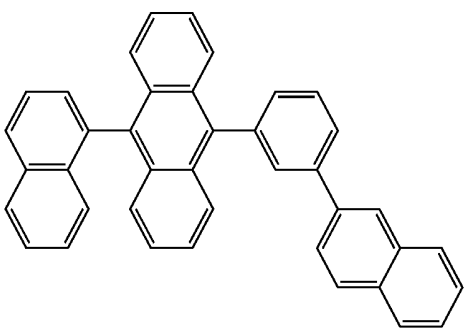

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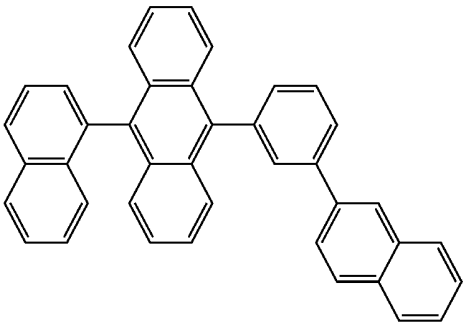

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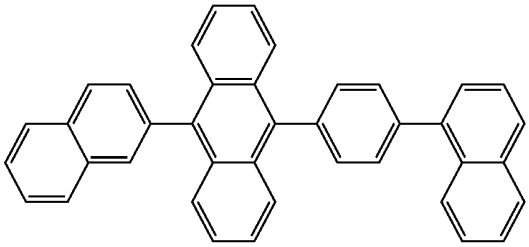

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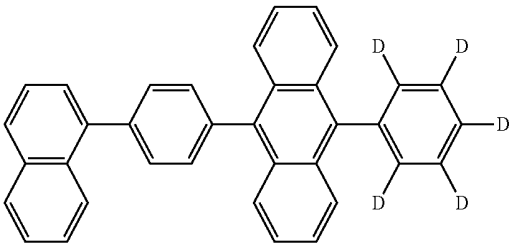

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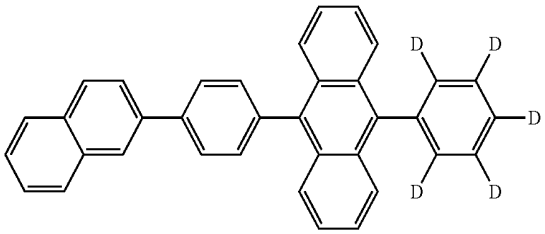

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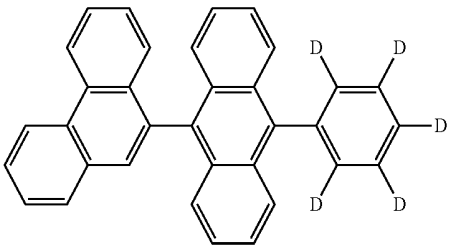

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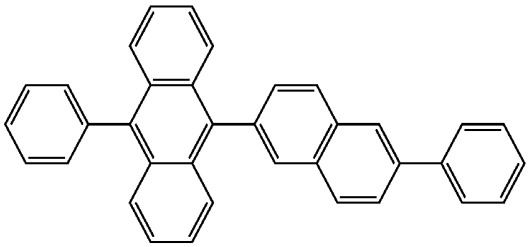

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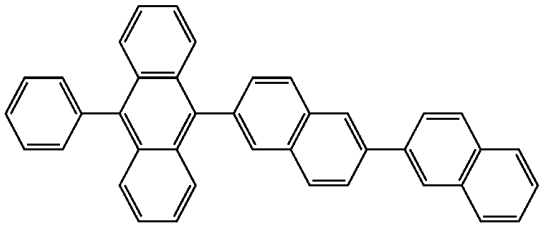
H32



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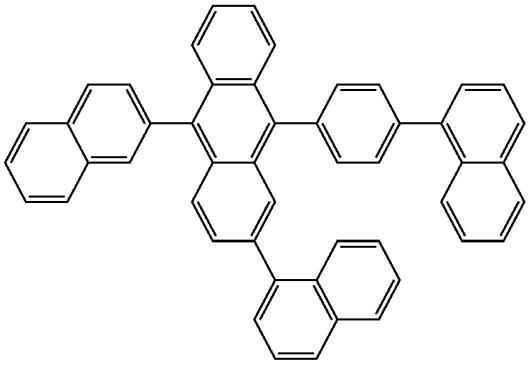

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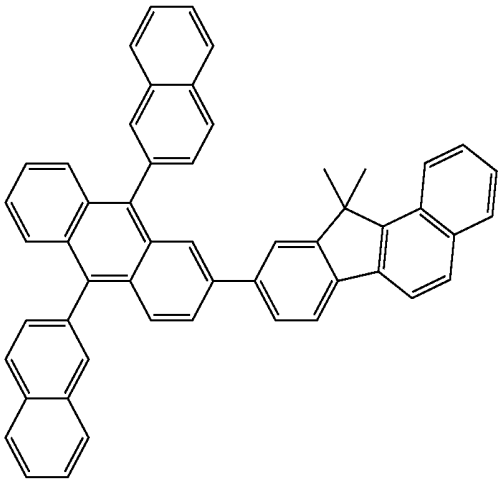

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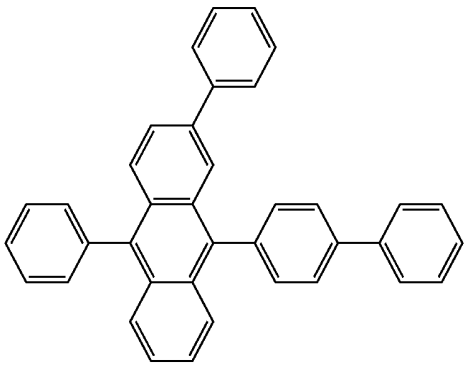

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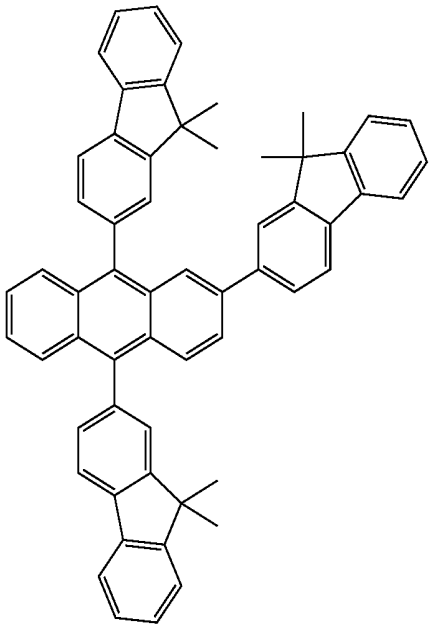

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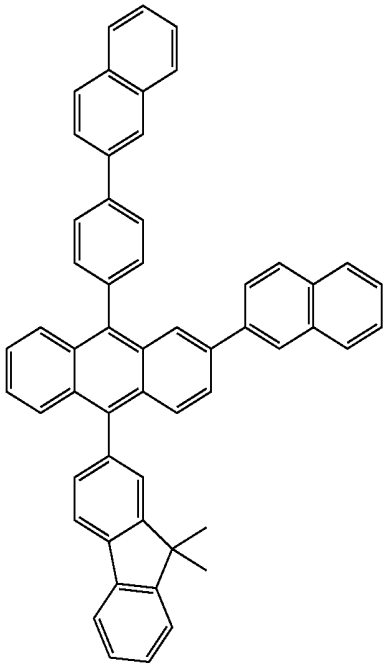

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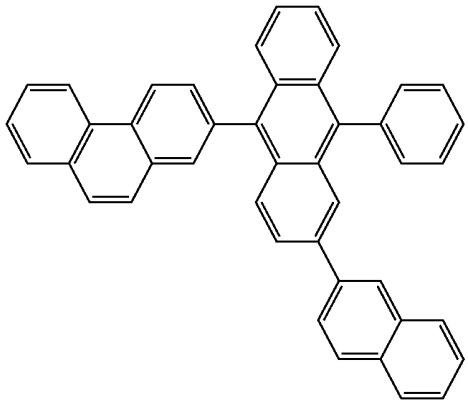

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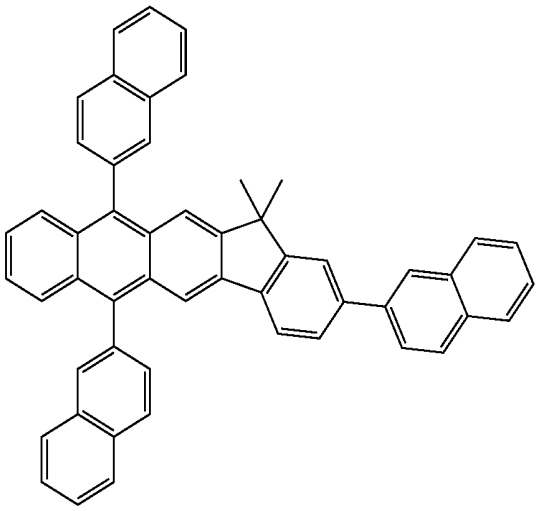
H39



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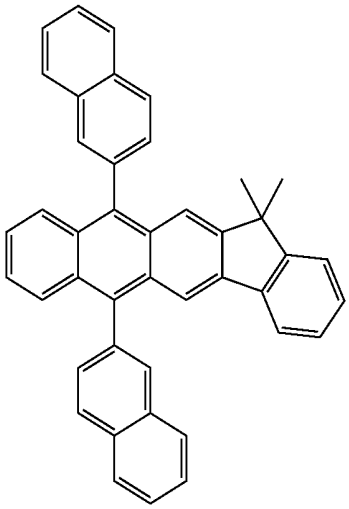
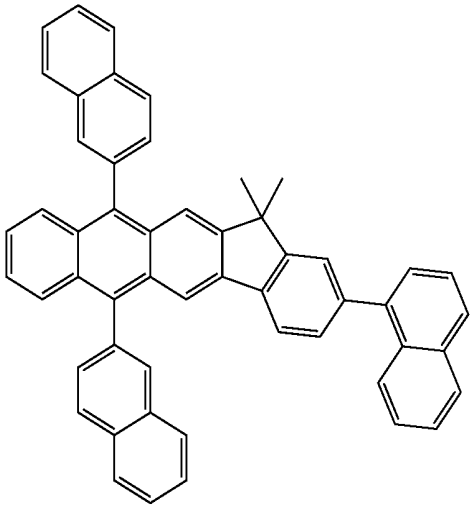


H41



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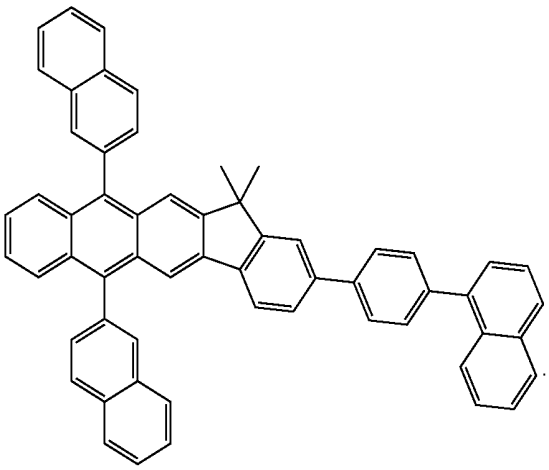
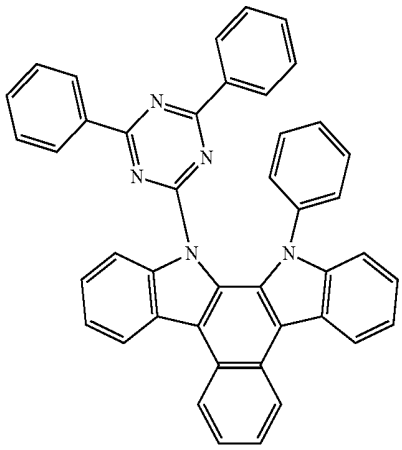
H42

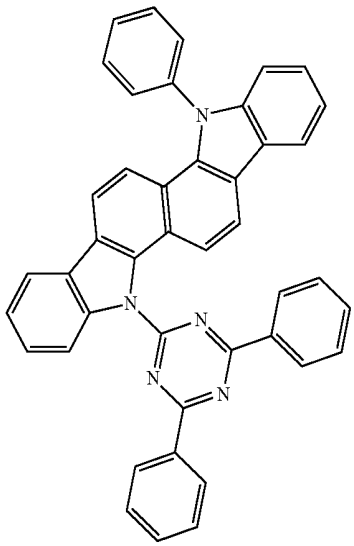


[0201] In some embodiments, the host may include at least one of Compounds 43 to H49 below, but Is not limited thereto:

H43



H44



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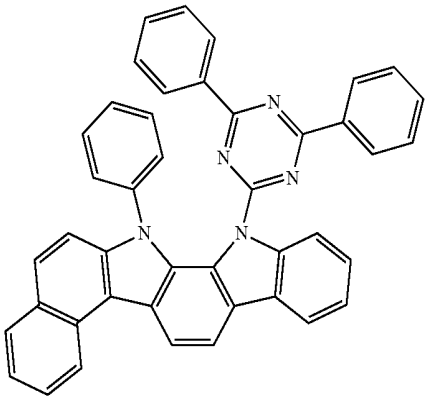
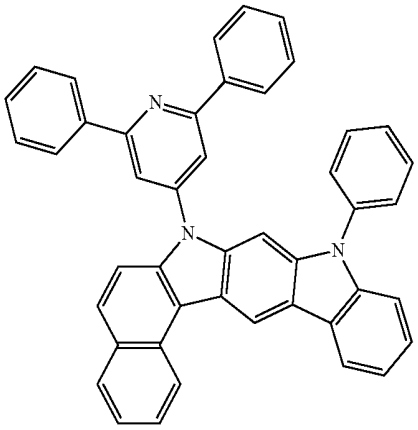
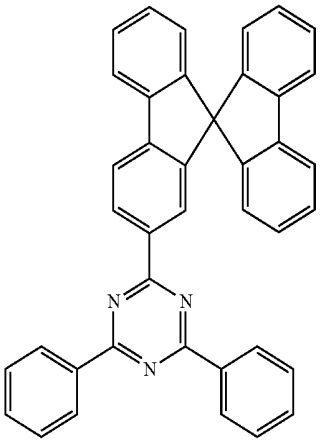
H45



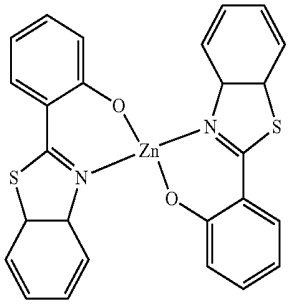
H46



H47



H48



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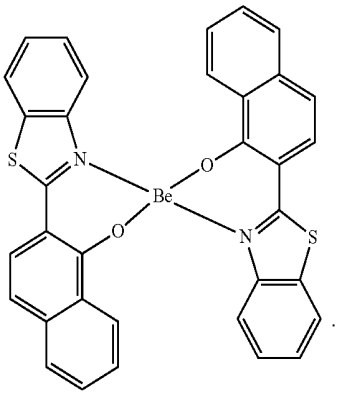
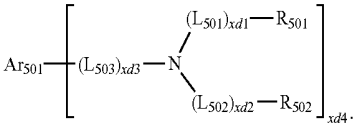
H49



[0202] The dopant may include the condensed cyclic compound represented by Formula 1.

[0203] in some embodiments, the dopant may include a compound represented by Formula 501 below.

Formula 501



[0204] In Formula 501,

[0205] Ar_{501} may be selected from:

[0206] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0207] a naphthalene group, a heptalene group, a fluorene group, a spiro-fluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, a anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, and an indenoanthracene 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 group or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_6 alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy, 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, and —$Si(Q_{501})(Q_{502})(Q_{503})$ (where Q_{501} to Q_{501} to Q_{503} are each independently selected from a hydrogen, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_6-C_{60} aryl group, and a C_1-C_{60} heteroaryl group);

[0208] L_{501} to L_{503} may be the same as defined in connection with L_1;

[0209] R_{501} and R_{502} may be each Independently selected from:

[0210] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

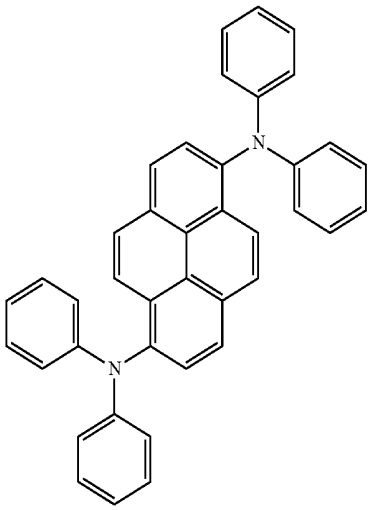
[0211] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

[0212] xd1 to xd3 may be each independently selected from 0, 1, 2, and 3; and

[0213] xb4 may be selected from 1, 2, 3, and 4.

[0214] When the host is a fluorescent host, it may include at least one of Compounds FD1 to FD9:

FD1



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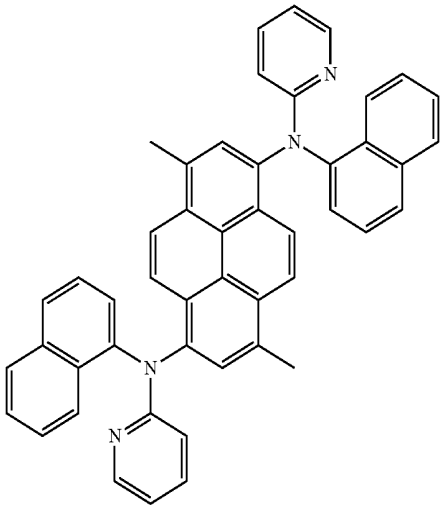
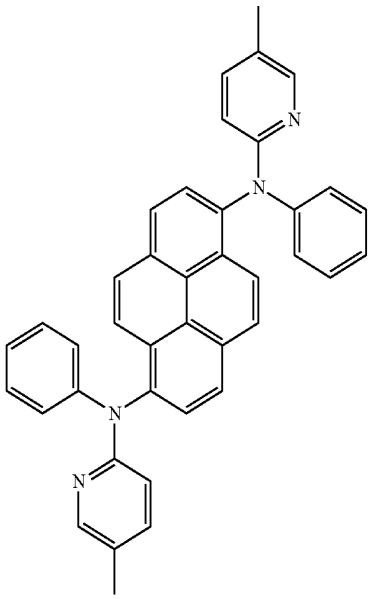
FD2



FD3



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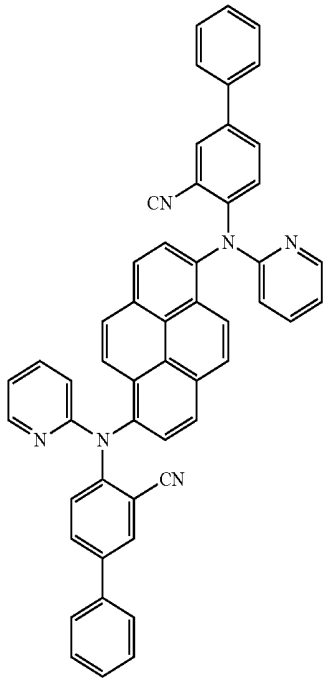
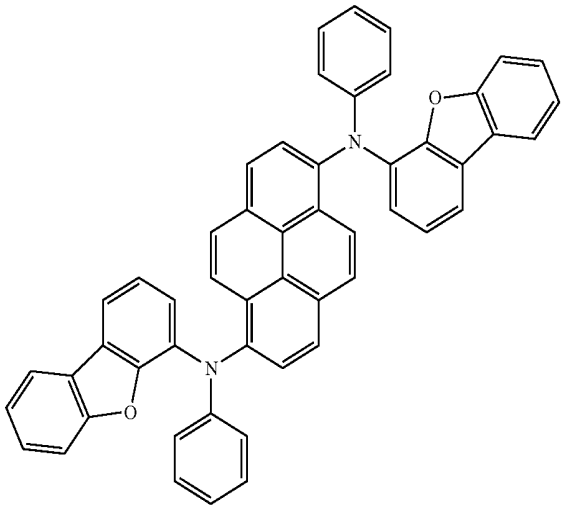
FD4



FD5



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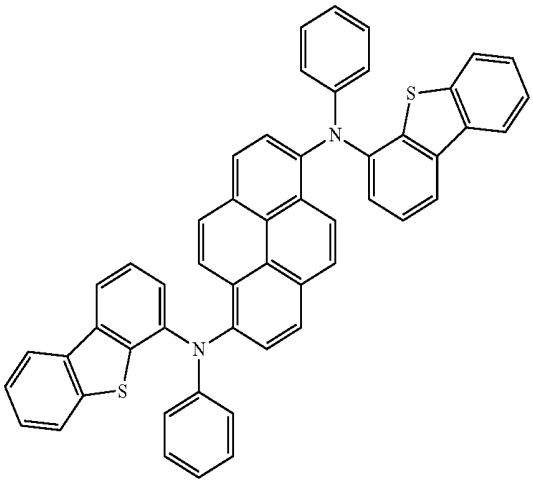
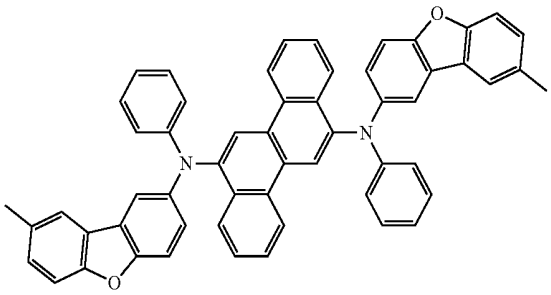
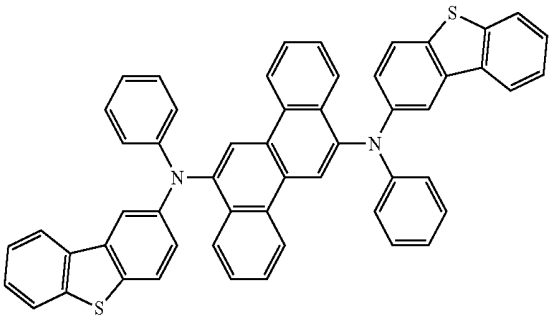
FD6



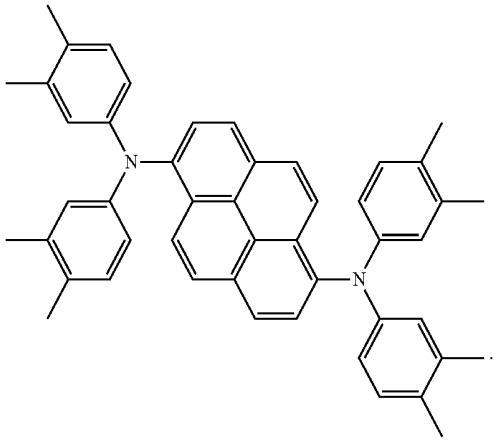
FD7



FD8



Compound FD9



[0215] An amount of the dopant in the emission layer may be, in general, in a range of about 0.01 to about 15 parts by weight based on 100 parts by weight of the host, but is not limited thereto.

[0216] A thickness of the emission layer may be in a range of about 100 Å to about 1,000 Å, for example, about 200 Å to about 600 Å. When the thickness of the emission layer is within any of these ranges, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

[0217] An electron transport region may be positioned on the emission layer.

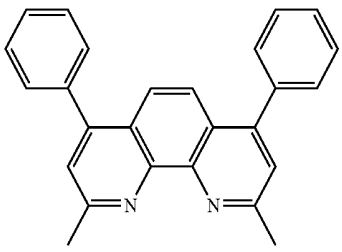
[0218] The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer (ETL), and an electron injection layer, but is not limited thereto.

[0219] 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 on the emission layer in the stated order, but the structure of the electron transport region is not limited thereto.

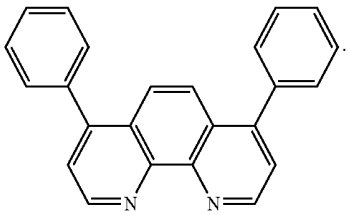
[0220] According to some embodiments, the organic layer **150** of the organic light-emitting device may include an electron transport region between the emission layer and the second electrode **190**.

[0221] When the electron transport region includes a hole blocking layer, the hole blocking layer may be formed on the emission layer using one or more suitable methods, such as vacuum deposition, spin coating casting, a LB method, ink-jet printing, laser-printing, and/or laser-induced thermal Imaging. When the hole blocking layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the hole blocking layer may be similar to the deposition and coating conditions for the hole injection layer.

[0222] The hole blocking layer may include, for example, at least one of BCP and Bphen, but is not limited thereto.



BCP



Bphen

[0223] A thickness of the hole blocking layer may be in a range of about 20 Å to about 1,000 Å, for example, about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within any of these ranges, the hole blocking layer may have improved hole blocking ability without a substantial Increase in driving voltage.

[0224] 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 using one or more suitable methods, such as vacuum deposition, spin coating casting, a LB method, ink-Jet printing, laser-printing, and/or laser-induced thermal imaging. When an electron transport layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the electron transport layer may be similar to the deposition and coating conditions for the hole injection layer.

[0225] 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:

$$Ar_{601}\text{-}[(L_{601})_{xe1}\text{-}E_{601}]_{xe2}. \qquad \text{Formula 601}$$

[0226] In Formula 601,

[0227] Ar_{601} may be selected from:

[0228] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0229] a naphthalene group, a heptalene group, a fluorene group, a spiro-fluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, a anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, and an indenoanthracene 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 group 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, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy, 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, and —Si(Q_{301})(Q_{302})(Q_{303}) (where Q_{301} to Q_{303} are each independently a hydrogen, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_6-C_{60} aryl group, or a C_1-C_{60} heteroaryl group);

[0230] L_{601} may be the same as described in connection with L_{201};

[0231] E_{601} may be selected from:

[0232] 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 qulnoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenan-

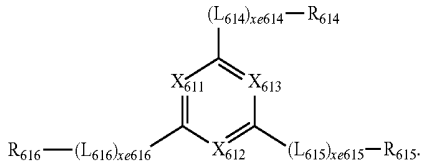
thridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0233] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an Isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an Isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl 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, 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_{20} alkyl group, a C_1-C_{20} alkoxy 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 benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyi group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0234] xe1 may be selected from 0, 1, 2, and 3; and

[0235] xe2 may be selected from 1, 2, 3, and 4.

Formula 602



[0236] In Formula 602,

[0237] X_{611} is N or C-$(L_{611})_{xe611}$-R_{611}, X_{612} is N or C-$(L_{612})_{xe612}$-R_{612}, X_{613} is N or C-$(L_{613})_{xe613}$-R_{613} and, at least one of X_{611} to X_{613} is N;

[0238] L_{611} to L_{616} may be the same as described in connection with L_1;

[0239] R_{611} to R_{616} may each Independently be selected from:

[0240] 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 quinolnyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

[0241] 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, 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_{20} alkyl group, a C_1-C_{20} 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;

[0242] xe611 to xe616 may be each independently selected from 0, 1, 2, and 3.

[0243] The compound represented by Formula 601 and the compound represented by Formula 602 may be each independently selected from Compounds ET1 to ET15 illustrated below, but are not limited thereto:

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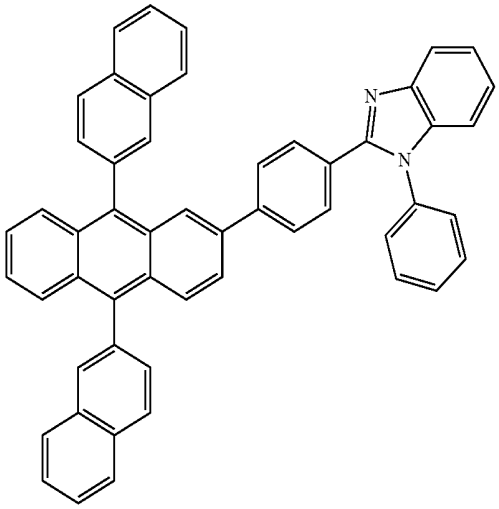
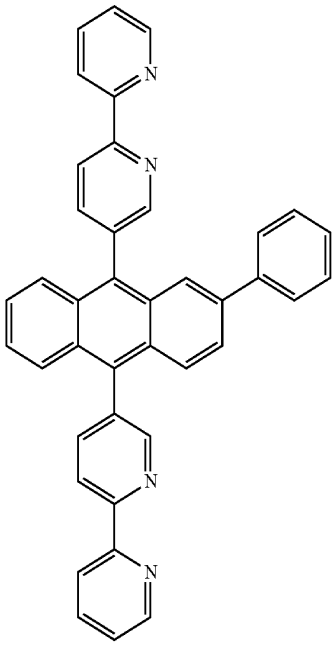
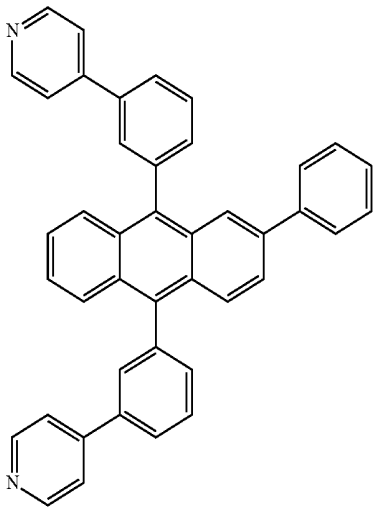
ET1



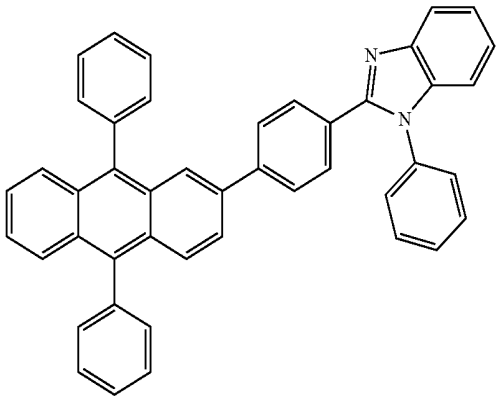
ET2



ET3



ET4



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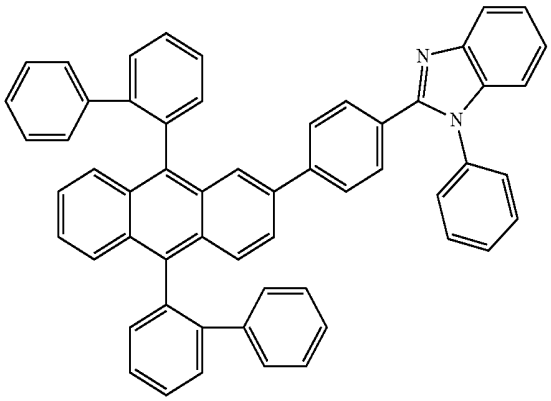

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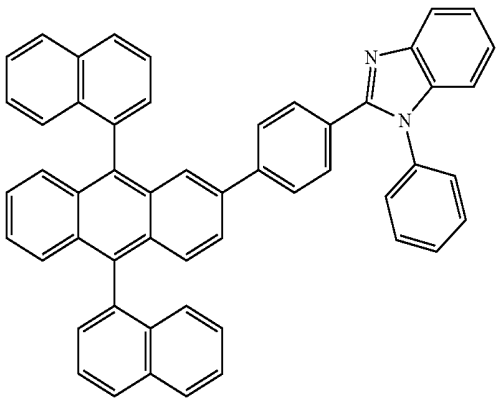

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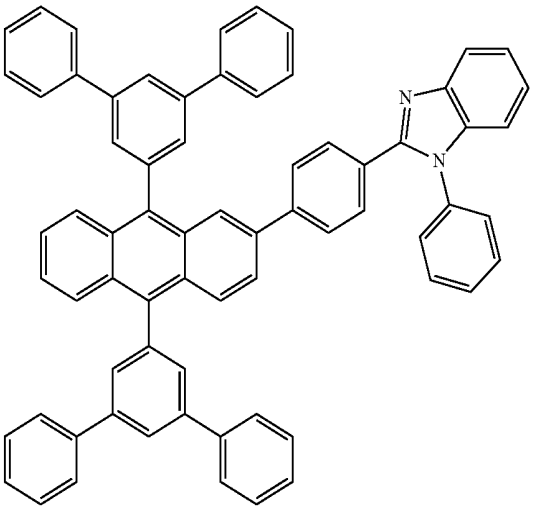
ET7



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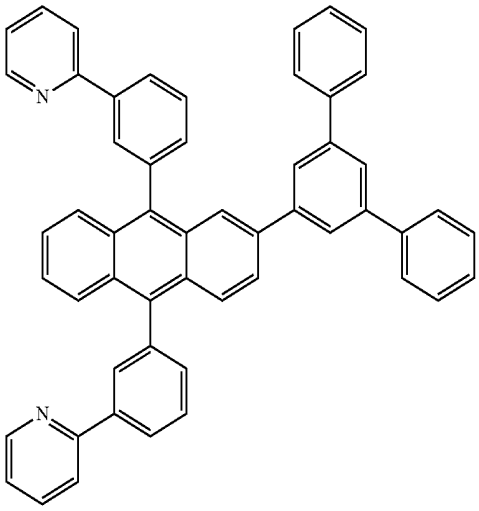

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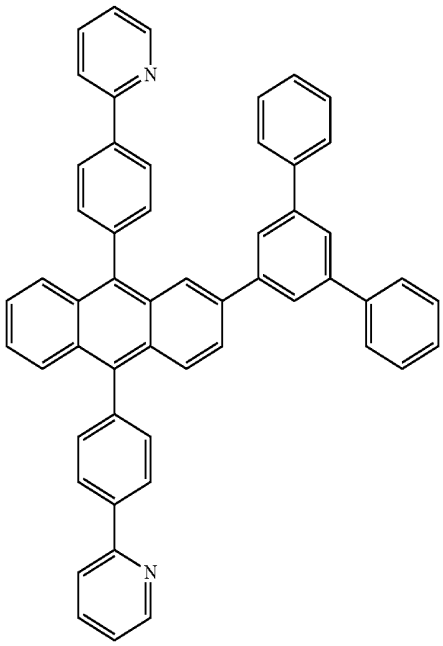
ET9



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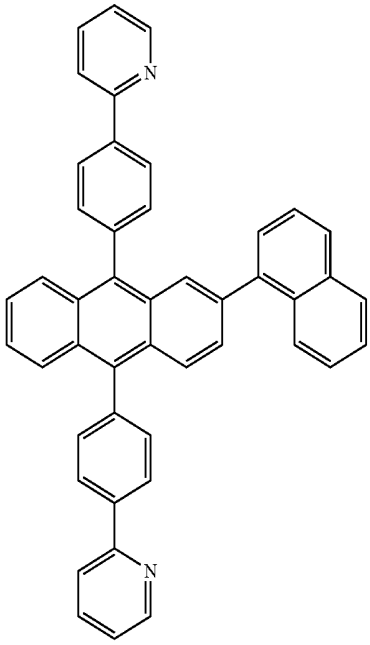

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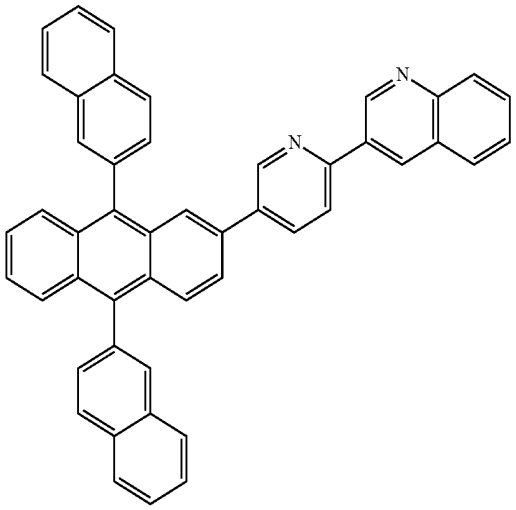

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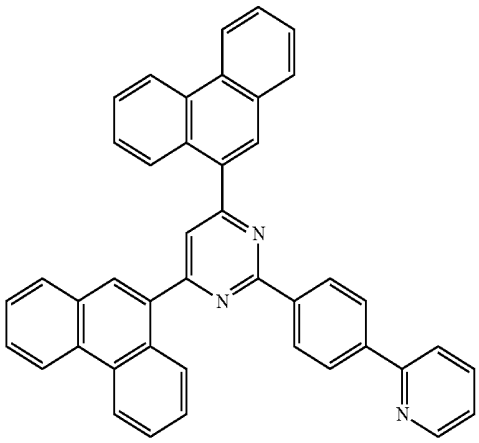

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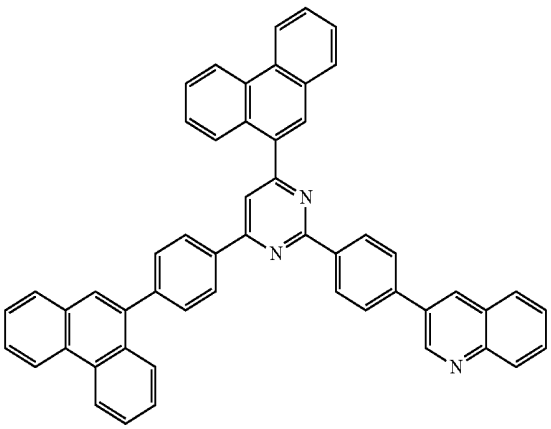

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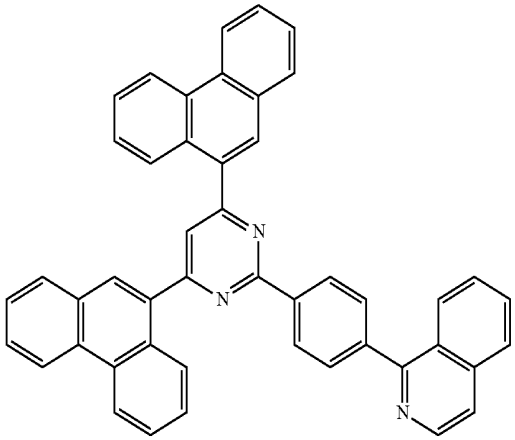
ET14



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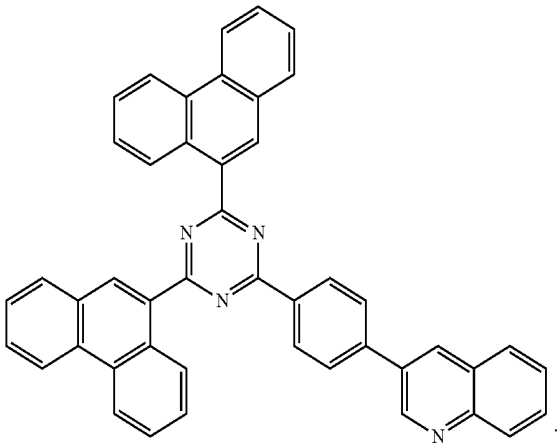
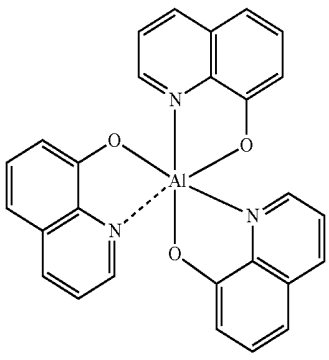


[0244] In some embodiments, the electron transport layer may further include at least one selected from BCP, Bphen, Alq3, Balq, TAZ, and NTAZ.



Alq_3

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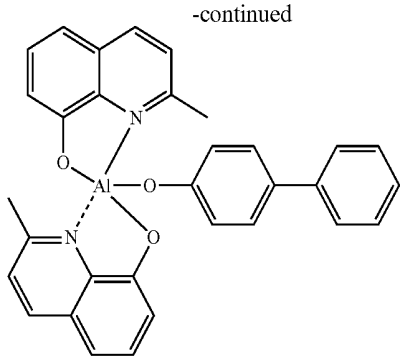
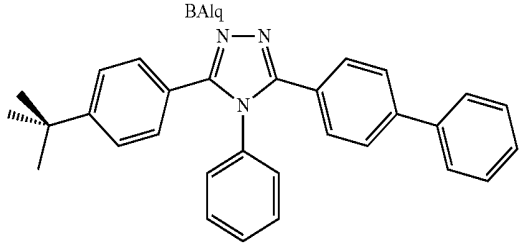
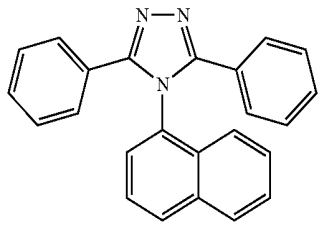


BAlq



TAZ



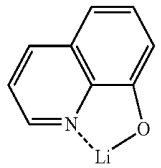
NTAZ

[0245] A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, for example, about 150 Å to about 500 Å. When the thickness of the electron transport layer is within any of the ranges described above, the electron transport layer may have satisfactory electron transport characteristics without a substantial increase in driving voltage.

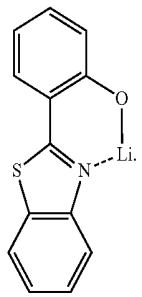
[0246] Also, the electron transport layer may further include, in addition to the materials described above, a metal-containing material.

[0247] 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.

ET-D1



ET-D2



[0248] The electron transport region may include an electron Injection layer that can facilitate injection of electrons from the second electrode **190**.

[0249] The electron injection layer may be formed on the electron transport layer using one or more suitable methods, such as vacuum deposition, spin coating casting, a LB method, ink-jet printing, laser-printing, and/or laser-induced thermal Imaging. When an electron injection layer is formed by vacuum deposition and/or spin coating, deposition and coating conditions for the electron Injection layer may be similar to the deposition and coating conditions for the hole injection layer.

[0250] The electron Injection layer may include at least one selected from LiF, NaCl, CsF, Li_2O, BaO, and LiQ.

[0251] 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 any of the ranges described above, the electron injection layer may have satisfactory electron injection characteristics without a substantial Increase in driving voltage.

[0252] In some embodiments, the second electrode **190** is positioned on the organic layer **150** having the structure as described herein. 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, such as 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/or 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 semi-transmissive electrode or a transmissive electrode.

[0253] An organic light-emitting device **20** of FIG. **2** includes a first capping layer **210**, the first electrode **110**, the organic layer **150**, and the second electrode **190**, which are sequentially stacked in this stated order. An organic light-emitting device **30** of FIG. **3** includes the first electrode **110**, the organic layer **150**, the second electrode **190**, and a second capping layer **220**, which are sequentially stacked in this stated order. An organic light-emitting device **40** of FIG. **4** includes the first capping layer **210**, the first electrode **110**, the organic layer **150**, the second electrode **190**, and the second capping layer **220**.

[0254] Regarding FIGS. **2** to **4**, descriptions of the first electrode **110**, the organic layer **150**, and the second electrode **190** are the same as the descriptions presented in connection with FIG. **1**.

[0255] In the organic layer **150** of each of the organic light-emitting devices **20** and **40**, light generated by the emission layer may be extracted toward the outside through the first electrode **110** and the first capping layer **210**. The first electrode **110** may be a semi-transmissive electrode or a transmissive electrode. In the organic layer **150** of each of the organic light-emitting devices **30** and **40**, light generated by the emission layer may be extracted toward the outside through the second electrode **190** and the second capping layer **220**. The second electrode **190** may be a semi-transmissive electrode or a transmissive electrode.

[0256] The first capping layer **210** and the second capping layer **220** may increase external luminescent efficiency based on the principle of constructive interference.

[0257] The first capping layer **210** illustrated in FIG. **2** and the second capping layer **220** illustrated in FIG. **3** may include the condensed cyclic compound represented by Formula 1.

[0258] At least one selected from the first capping layer **210** and the second capping layer **220** illustrated in FIG. **4** may include the condensed cyclic compound represented by Formula 1.

[0259] In some embodiments, the organic layer **150** illustrated in FIGS. **2** to **4** may not include the condensed cyclic compound represented by Formula 1.

[0260] Hereinbefore, the organic light-emitting device according to some embodiments of the present invention has been described in connection with FIGS. **1-4**. However, embodiments of the present Invention are not limited thereto.

[0261] A C_1-C_{10} alkyl group as used herein refers to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms in the main chain, and non-limiting examples thereof include a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a ter-butyl group, a pentyl group, an iso-amyl group, and a hexyl group. A C_1-C_{60} alkylene group as used herein refers to a divalent group having the same structure as the C_1-C_{60} alkyl group.

[0262] A C_1-C_{60} alkoxy group as used herein refers to a monovalent group represented by —OA_{101} (where A_{101} is the C_1-C_{60} alkyl group), and non-limiting examples thereof include a methoxy group, an ethoxy group, and an isopropyloxy group.

[0263] A C_2-C_{60} alkenyl group as 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 C_2-C_{60} alkyl group (e.g., In the middle or at either terminal end of the C_2-C_{60} alkyl group), and non-limiting examples thereof include an ethenyl group, a propenyl group, and a butenyl group. A C_2-C_{60} alkenylene group as used herein refers to a divalent group having the same structure as the C_2-C_{60} alkenyl group.

[0264] A C_2-C_{60} alkynyl group as 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 C_2-C_{60} alkyl group (e.g., in the middle or at either terminal end of the C_2-C_{60} alkyl group), and non-limiting examples thereof include an ethynyl group and a propynyl group. A C_2-C_{60} alkynylene group as used herein refers to a divalent group having the same structure as the C_2-C_{60} alkynyl group.

[0265] A C_3-C_{10} cycloalkyl group as used herein refers to a monovalent hydrocarbon monocyclic group having 3 to 10 carbon atoms as ring atoms, and non-limiting examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. A C_3-C_{10} cycloalkylene group as used herein refers to a divalent group having the same structure as the C_3-C_{10} cycloalkyl group.

[0266] A C_1-C_{10} heterocycloalkyl group as used herein refers to a monovalent monocyclic group having at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom and 1 to 10 carbon atoms as the remaining ring atoms, and non-limiting examples thereof include a tetrahydrofuranyl group and a tetrahydrothiophenyl group. A C_1-C_{10} heterocycloalkylene group as used herein refers to a divalent group having the same structure as the C_1-C_{10} heterocycloalkyl group.

[0267] A C_3-C_{10} cycloalkenyl group as used herein refers to a monovalent monocyclic group that has 3 to 10 carbon atoms as ring atoms and at least one carbon-carbon double bond in the ring thereof and does not have aromaticity, and non-limiting examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. A C_3-C_{10} cycloalkenylene group as used herein refers to a divalent group having the same structure as the C_3-C_{10} cycloalkenyl group.

[0268] A C_1-C_{10} heterocycloalkenyl group as used herein refers to a monovalent monocyclic group that has at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom, 1 to 10 carbon atoms as the remaining ring atoms, and at least one double bond in its ring. Non-limiting examples of the C_1-C_{10} heterocycloalkenyl group include a 2,3-hydrofuranyl group and a 2,3-hydrothiophenyl group. A C_1-C_{10} heterocycloalkenylene group as used herein refers to a divalent group having the same structure as the C_1-C_{10} heterocycloalkenyl group.

[0269] A C_6-C_{60}, aryl group as used herein refers to a monovalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms as ring atoms, and a C_6-C_{60} arylene group as used herein refers to a divalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms as ring atoms. Non-limiting examples of the C_6-C_{60} aryl group include a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C_6-C_{60} aryl group and/or the C_6-C_{60} arylene group include two or more rings, the rings may be fused to each other.

[0270] A C_1-C_{60} heteroaryl group as used herein refers to a monovalent group having a carbocyclic aromatic system that has at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom, and 1 to 60 carbon atoms as the remaining ring atoms. A C_1-C_{60} heteroarylene group as used herein refers to a divalent group having a carbocyclic aromatic system that has 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 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 include two or more rings, the rings may be fused to each other.

[0271] A C_6-C_{60} aryloxy group as 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 as used herein refers to a group represented by —SA_{103} (where A_{103} is the C_6-C_{60} aryl group).

[0272] A monovalent non-aromatic condensed polycyclic group as used herein refers to a monovalent group (for example, having 8 to 60 carbon atoms) that has two or more rings condensed to each other, only carbon atoms as ring-forming atoms, and does not have overall aromaticity. A non-limiting example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. A divalent non-aromatic condensed polycyclic group as used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

[0273] A monovalent non-aromatic condensed heteropolycyclic group as used herein refers to a monovalent group (for example, having 1 to 60 carbon atoms) that has two or more rings condensed to each other, has at least one heteroatom selected from N, O, Si, P, and S, and carbon atoms, as ring-forming atoms, and does not have overall aromaticity. A non-limiting example of the monovalent non-aromatic con-

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

[0274] 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 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/or substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

[0275] 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;

[0276] 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_3-C_{10} cycloalkyl group, a C_1-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, —$Si(Q_{11})(Q_{12})(Q_{13})$, and —$B(Q_{14})(Q_{15})$;

[0277] a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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;

[0278] a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_3-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 heterocondensed polycyclic group, —$Si(Q_{21})(Q_{22})(Q_{23})$, and —$B(Q_{24})(Q_{25})$; and

[0279] —$Si(Q_{31})(Q_{32})(Q_{33})$ and —$B(Q_{34})(Q_{35})$,

[0280] where Q_{11} to Q_{15}, Q_{21} to Q_{25}, and Q_{31} to Q_{35} may be each independently 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_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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, or a monovalent non-aromatic condensed heteropolycyclic group.

[0281] The term "Ph" as used herein refers to a phenyl group, the term "Me" as used herein refers to a methyl group, the term "Et" as used herein refers to an ethyl group, and the term "ter-Bu" or "Bu^t" as used herein refers to a tert-butyl group.

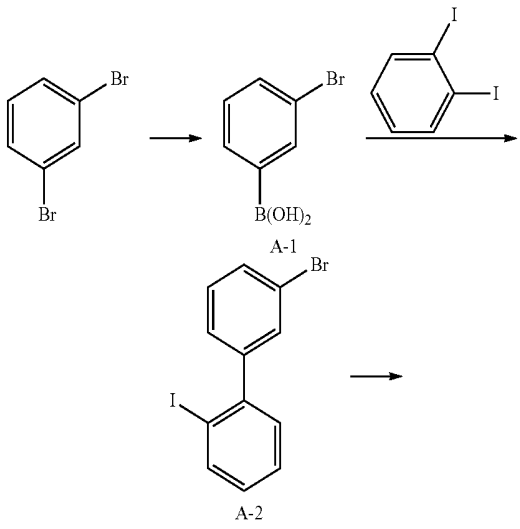
[0282] Hereinafter, an organic light-emitting device according to some embodiments will be described in detail with reference to Synthesis Examples and Examples. The expression "B was used instead of A" used in describing Synthesis Examples means that a molar equivalent of A was identical to a molar equivalent of B.

EXAMPLES

Synthesis Example 1

Synthesis of Compound 1

[0283]



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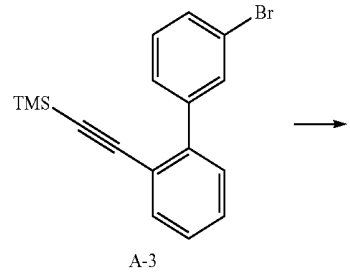
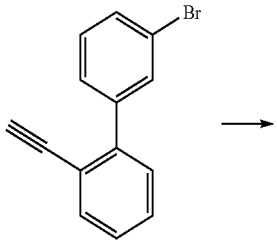


A-3



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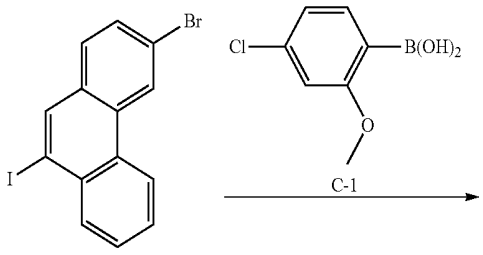

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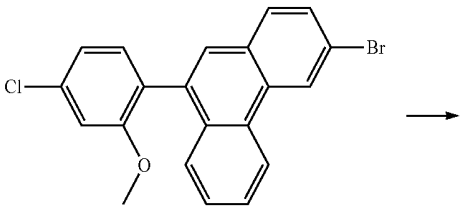

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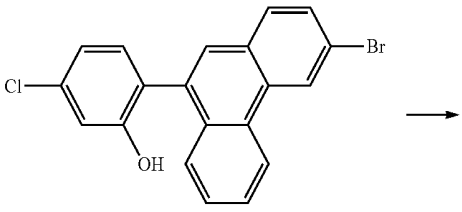

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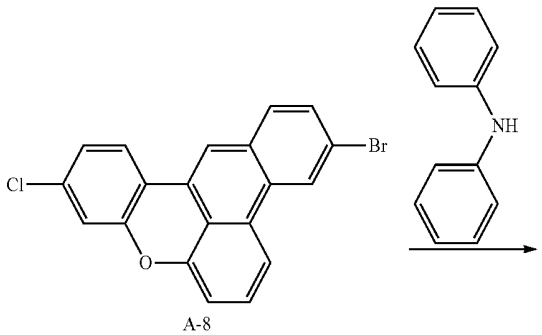

A-8

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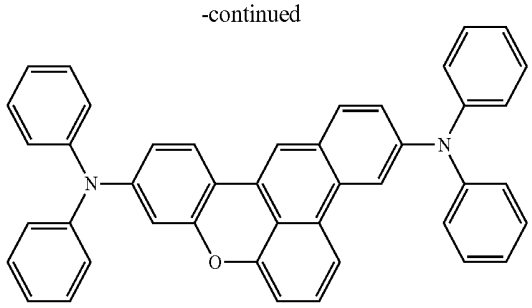

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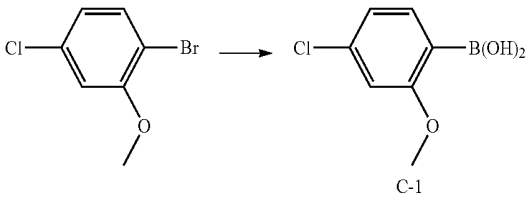


C-1

Synthesis of Intermediate A-1

[0284] 25 g (105.9 mmol) of 1,3-dibromobenzene was stirred in 500 ml of THF in an N_2 atmosphere at a temperature of −78° C. for 10 minutes, and then, 44 ml of 2.5M n-BuLi was slowly added dropwise thereto through a dropping funnel, and the resulting solution was stirred for 30 minutes. Thereafter, 10.4 g (110 mmol) of trimethyl borate was slowly added dropwise thereto through a dropping funnel, and then, the resulting solution was stirred at room temperature for 3 hours; then 300 ml of 1M hydro-chloride solution was added thereto, and an extraction process was performed thereon once. An organic layer separated therefrom was then subjected to an extraction process three times by using water and diethyl ether. The resulting organic layer was dried by using magnesium sulfate, and the residue obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 15.3 g (76.2 mmol, yield of 71.9%) of Intermediate A-1. The obtained compound was identified by MS/FAB.

[0285] $C_6H_6BBrO_2$ cal. 200.83. found 200.67.

Synthesis of Intermediate A-2

[0286] 15.3 g (76.2 mmol) of Intermediate A-1, 30 g (90.9 mmol) of 1,2-diiodobenzene, 8.67 g (7.5 mmol) of $Pd(PPh_3)_4$, and 31.1 g (225 mmol) of K_2CO_3 were added to 1 L of THF/H_2O (a volumetric ratio of 9/1), and the resulting solution was stirred at a temperature of 80° C. for 12 hours, and then cooled to room temperature. Then, the result was subjected to an extraction process three times by using 500 ml of water and 500 ml of diethyl ether. The resulting organic layer was dried by using magnesium sulfate, and the residue obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 19.5 g (54.4 mmol, yield of 71.4%) of Intermediate A-2. The obtained compound was identified by MS/FAB.

[0287] $C_{12}H_8BrI$ cal. 359.00. found 359.14.

Synthesis of Intermediate A-3

[0288] 19.5 g (54.4 mmol) of Intermediate A-2, 600 mg (2.7 mmol) of $Pd(OAc)_2$, 1.5 g (5.72 mmol) of PPh_3, 1.1 g (5.77 mmol) of CuI, and 375 ml (272 mmol) of triethylamine were mixed, and the mixture was stirred at a temperature of 60° C. in N_2 atmosphere for 12 hours. When the reaction stopped, the reaction product was cooled to room temperature, and then subjected to an extraction process 5 times by using diethyl ether. The obtained organic layer was dried by using magnesium sulfate and the residue obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 15.7 g (47.6 mmol, yield of 87.5%) of Intermediate A-3. The obtained compound was identified by MS/FAB.

[0289] $C_{17}H_{17}BrSi$ cal. 329.31. found 328.96.

Synthesis of Intermediate A-4

[0290] 15.7 g (47.6 mmol) of Intermediate A-3 and 27.6 g (200 mmol) of K_2CO_3 were mixed with 600 ml of MeOH/CH_2Cl_2 (a volumetric ratio of 2:1), and the resulting solution was stirred at room temperature for 1 hour. When the reaction stopped, the mixture was filtered through filtering paper, and an organic solvent was removed from the remaining solution by evaporation. The obtained residue was then subjected to an extraction process two times by using water and dichloromethane. An organic layer separated therefrom was dried by using magnesium sulfate and the residue obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 10.9 g (42.5 mmol, yield of 89.3%) of Intermediate A-4. The obtained compound was identified by MS/FAB.

[0291] $C_{14}H_9Br$ cal. 257.13. found 257.42.

Synthesis of Intermediate A-5

[0292] 10.9 g (42.5 mmol) of Intermediate A-4 was sufficiently dissolved in 500 ml of methylene chloride, and the resulting solution was stirred in an ice bath at a temperature of 0° C. for 30 minutes. Then, 7.3 g (45 mmol) of iodine chloride was added thereto and then stirred for 30 minutes. A reaction solution obtained therefrom was subjected to an extraction process five times by using 500 ml of water and ethylacetate. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was recrystallized by using a mixed solution including methylene chloride and n-hexane to obtain 14.1 g (36.9 mmol, yield of 86.7%) of Intermediate A-5. The obtained compound was identified by MS/FAB.

[0293] $C_{14}H_8BrI$ cal. 383.03. found 383.31.

Synthesis of Intermediate A-6

[0294] 5.17 g (13 mmol, yield of 71.2%) of Intermediate A-6 was obtained by the same or substantially the same method as the one used to synthesize Intermediate A-2, except that Intermediate A-5 and Intermediate C-1 were respectively used instead of 1,2-diiodobenzene and Intermediate A-1. The obtained compound was identified by MS/FAB.

[0295] $C_{21}H_{14}BrClO$ cal. 397.70. found 397.65.

Synthesis of Intermediate C-1

[0296] 14.4 g (77.2 mmol, yield of 68.4%) of Intermediate C-1 was obtained by the same or substantially the same method as the one used to synthesize Intermediate A-1, except that 1-bromo-4-chloro-2-methoxybenzene was used instead of 1,3-dibromobenzene. The obtained compound was identified by MS/FAB.

[0297] $C_7H_8BClO_3$ cal. 186.40. found 186.47.

Synthesis of Intermediate A-7

[0298] 5.17 g (13 mmol) of Intermediate A-6 and 6.72 g (40 mmol) of sodium ethanethiolate were mixed with 250 ml of DMF, and then, the mixture was stirred at a temperature of 130° C. 4 hours after, the reaction product was cooled to room temperature, and then, subjected to an extraction process 6 times by using water and ethylacetate. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 4.64 g (12.1 mmol, yield of 93.1%) of Intermediate A-7. The obtained compound was identified by MS/FAB.

[0299] $C_{20}H_{12}BrClO$ cal. 383.67. found 383.59.

Synthesis of Intermediate A-8

[0300] 4.64 g (12.1 mmol) of Intermediate A-7 and 5.15 g (36 mmol) of copper(I) oxide were added to 250 ml of nitrobenzene, and the resulting solution was stirred at a temperature of 190° C. for 48 hours while heating. The reaction solution was then cooled to room temperature and subjected to an extraction process 4 times by using 150 ml of water and 150 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 3.66 g (9.6 mmol, yield of 79.3%) of Intermediate A-8. The obtained compound was identified by MS/FAB.

[0301] $C_{20}H_{10}BrClO$ cal. 381.65. found 381.74.

Synthesis of Compound 1

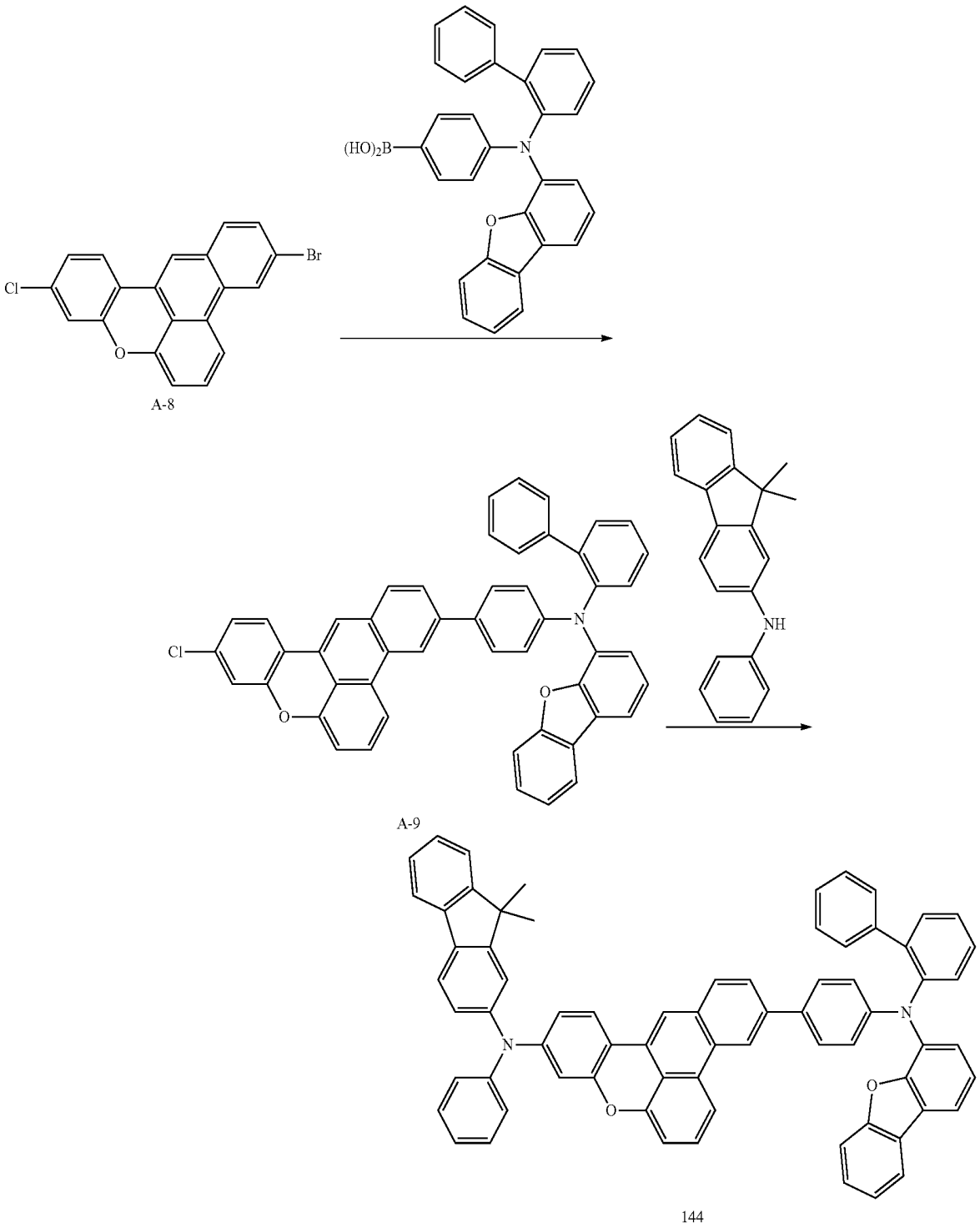
[0302] 600 mg (1.57 mmol) of Intermediate A-8, 762 mg (4.5 mmol) of diphenylamine, 495 mg (0.5 mmol) of tris(dibenzylideneacetone)dipalladium(0), 100 mg (0.5 mmol) of tri(tert-butyl)phosphine, and 432 mg (4.5 mmol) of sodium tert-butoxide were added to 10 ml of toluene, and the mixture was stirred at a temperature of 80° C. for 2 hours. The resulting reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 20 ml of water and 20 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 681 mg (1.13 mmol, yield of 72%) of Compound 1. The obtained compound was identified by MS/FAB and ^1H NMR.

[0303] $C_{44}H_{30}N_2S$ cal. 602.74. found 602.71.

Synthesis Example 2

Synthesis of Compound 144

[0304]



Synthesis of Intermediate A-9

[0305] 600 mg (1.57 mmol) of Intermediate A-8, 730 mg (1.6 mmol) of (4-([1,1'-biphenyl]-2-yl(dibenzo[b,d]furan-4-yl)amino)phenyl)boronic acid, 173 mg (0.15 mmol) of $Pd(PPh_3)_4$, and 620 mg (2.25 mmol) of K_2CO_3 were added to 35 ml of a mixture of THF/H_2O (a volumetric ratio of 9/1), and the resulting solution was stirred at a temperature of 80% for 12 hours, and then cooled to room temperature. Then, the resulting reaction mixture was subjected to an extraction process by using 50 ml of water and 50 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a sol-

vent therefrom was separation-purified by silica gel chromatography to obtain 762 mg (1.07 mmol, yield of 71.3%) of Intermediate A-9. The obtained compound was identified by MS/FAB.

[0306] $C_{50}H_{30}ClNO_2$ cal. 712.25. found 712.08.

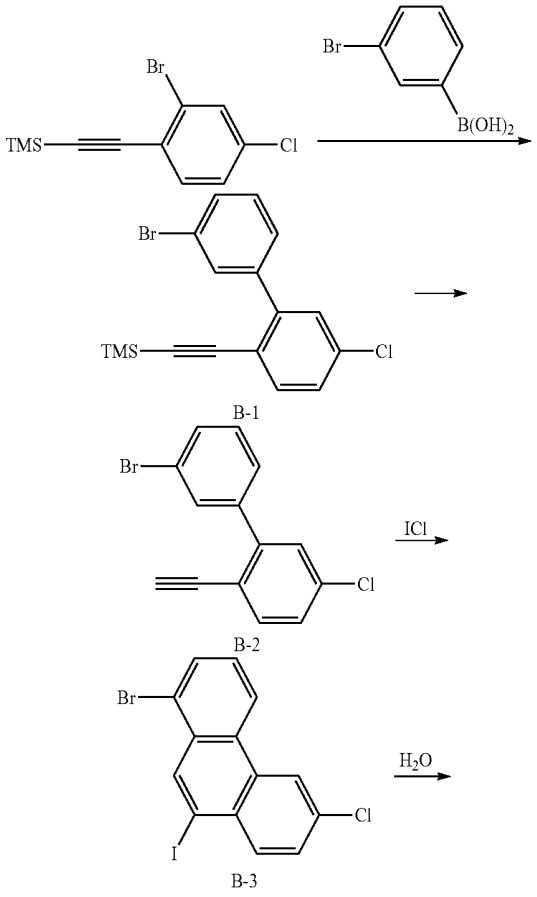
Synthesis of Compound 144

[0307] 762 mg (1.07 mmol) of Intermediate A-9, 542 mg (2.1 mmol) of 9-methyl-N-phenyl-9H-fluoren-2-amine, 192 mg (0.21 mmol) of tris(dibenzylideneacetone)dipalladium (0), 19 mg (0.21 mmol) of tri(tert-butyl)phosphine, and 288 mg (3 mmol) of sodium tert-butoxide were added to 10 ml of toluene, and the mixture was stirred at a temperature of 80° C. for 2 hours. The resulting reaction solution was cooled to room temperature, and then, subjected to an extraction process three times by using 20 ml of water and 20 ml of diethylether. An organic layer separated therefrom was dried by using magnesiumsulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 749 mg (0.76 mmol, yield of 71%) of Compound 144. The obtained compound was identified by MS/FAB and ^{1}H NMR. $C_{71}H_{48}N_2O_2$ cal. 961.18. found 960.98.

Synthesis Example 3

Synthesis of Compound 1A

[0308]



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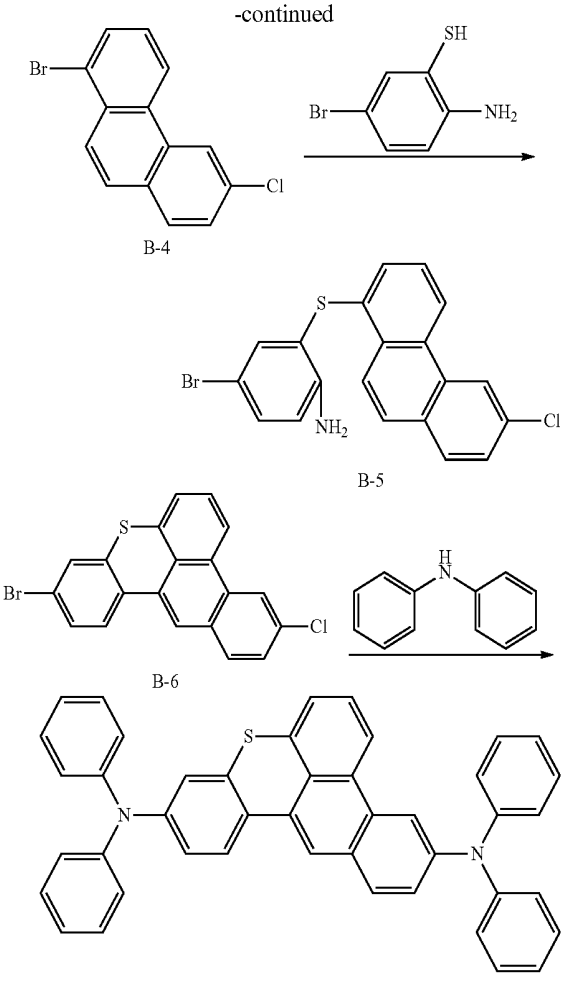


B-6

Synthesis of Intermediate B-1

[0309] 8.63 g (30.0 mmol) of ((2-bromo-4-chlorophenyl) ethynyl)trimethylsilane, 6.03 g (30.0 mmol) of (3-bromophenyl)boronic acid, 1.37 g (1.5 mmol) of $Pd(PPh_3)_4$, and 12.44 g (90.0 mmol) of K_2CO_3 were dissolved in 250 ml of a mixed solution including THF/H_2O (a volumetric ratio of 9/1), and then, the resulting mixture was stirred at a temperature of 80° C. for 12 hours. The resulting reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 200 ml of water and 200 ml of ethylether. The obtained organic layer was dried with magnesium sulfate and the residual obtained by removing a solvent used herein by evaporation was separation-purified by silica gel column chromatography to obtain 7.86 g (21.6 mmol, yield of 72%) of Intermediate B-1. The obtained compound was identified by MS/FAB. $C_{17}H_{16}BrClSi$ cal. 363.75. found 363.69.

Synthesis of Intermediate B-2

[0310] 7.86 g (21.6 mmol) of Intermediate B-1 and 13.82 g (100.0 mmol) of K_2CO_3 were dissolved in 200 ml of methanol, and the resulting solution was stirred at room temperature for 30 minutes. The resulting reaction mixture was filtered to separate the remaining K_2CO_3, and the residual solvent was removed therefrom by evaporation. Then, the resulting product was dissolved in 200 ml of methylene chloride, and then

subjected to an extraction process by using water. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent thereform was separation-purified by silica gel chromatography to obtain 5.92 g (20.3 mmol, yield of 94%) of Intermediate B-2. The obtained compound was identified by MS/FAB.

[0311] $C_{14}H_8BrCl$ cal. 291.57. found 291.63.

Synthesis of Intermediate B-3

[0312] 5.92 g (20.3 mmol) of Intermediate B-2 was sufficiently dissolved in 200 ml of methylene chloride, and the resulting solution was stirred in an ice bath at a temperature of 0° C. for 30 minutes, and then 3.3 g of Iodine chloride was added thereto and stirred for 30 minutes. The resulting reaction solution was subjected to an extraction process 5 times by using 250 ml of water and ethylacetate. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was re-crystallized by using a mixed solution including methylene chloride and n-hexane to obtain 7.20 g (17.3 mmol, yield of 85%) of Intermediate B-3. The obtained compound was identified by MS/FAB.

[0313] $C_{14}H_7BrCl$ cal. 417.47. found 417.43.

Synthesis of Intermediate B-4

[0314] 1.25 g (3.0 mmol) of Intermediate B-3 was dissolved in 50 ml of THF, and then, at a temperature of −78° C., 1.2 ml (3.0 mmol, 2.5M in Hexane) of n-BuLi was slowly added dropwise thereto, and the resulting solution was stirred at a temperature of −78° C. for 1 hour. Then, 0.27 ml (15.0 mmol) of H_2O was slowly added dropwise thereto, and then stirred at room temperature for 6 hours. When the reaction stopped, 40 ml of water was added thereto, and then, the resulting mixture was subjected to an extraction process three times by using 30 ml of diethylether. An organic layer separated therefrom was dried with magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 797 mg (2.73 mmol, yield of 91%) of Intermediate B-4. The obtained compound was identified by MS/FAB.

[0315] $C_{14}HsBrCl$ cal. 291.57. found 291.64.

Synthesis of Intermediate B-5

[0316] 797 mg (2.73 mmol) of Intermediate B-4, 612 mg (3.0 mmol) of 2-amino-5-bromobenzenethiol, and 300 mg (2.2 mmol) of K_2CO_3 were added to 20 ml of DMF, and the resulting solution was stirred at a temperature of 150° C. for 48 hours while heating. The reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 50 ml of water and 40 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 792 mg (1.91 mmol, yield of 70%) of Intermediate B-5. The obtained compound was identified by MS/FAB.

[0317] $C_{20}H_{13}BrClNS$ cal. 414.74. found 414.76.

Synthesis of Intermediate B-6

[0318] 792 mg (1.91 mmol) of Intermediate B-5, 1.73 g (25 mmol) of sodium nitrite, 0.8 ml of HCl, 8 ml of glacial acetic acid, and 1.2 ml of water were stirred in an ice bath for 1 hour, and then the resulting solution was stirred at room temperature for 12 hours. The reaction solution was heated to a temperature of 90° C., and then, an aqueous solution of 1.59 g (10 mmol) of copper sulfate dissolved in 30 ml of water and 1.5 ml of acetic acid was added dropwise thereto for 1 hour. The resulting mixture was stirred for 30 minutes, and then cooled to room temperature and subjected to an extraction process four times by using 20 ml of water and 20 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 708 mg (1.78 mmol, yield of 93%) of Intermediate B-6. The obtained compound was identified by MS/FAB.

[0319] $C_{20}H_{10}BrClS$ cal. 397.71. found 397.69.

Synthesis of Compound 1A

[0320] 708 mg (1.78 mmol) of Intermediate B-6, 762 mg (4.5 mmol) of diphenylamine, 495 mg (0.54 mmol) of tris(dibenzylideneacetone)dipalladium(0), 108 mg (0.54 mmol) of tri(tert-butyl)phosphine, and 513 mg (5.34 mmol) of sodium tert-butoxide were added to 10 ml of toluene, and the resulting mixture was stirred at a temperature of 80° C. for 2 hours. The reaction solution was cooled to room temperature, and then, was subjected to an extraction process three times by using 20 ml of water and 20 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silicagel column chromatography to obtain 749 mg (1.21 mmol, yield of 68%) of Compound 1A. The obtained compound was identified by MS/FAB and ^1H NMR.

[0321] $C_{44}H_{30}N_2S$ cal. 618.80. found 618.77.

Synthesis Example 4

Synthesis of Compound 2

[0322] 894 mg (1.07 mmol, yield of 70.3%) of Compound 2 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that 9,9-dimethyl-N-phenyl-9H-fluoren-2-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^1H NMR.

Synthesis Example 5

Synthesis of Compound 5

[0323] 794 mg (1.13 mmol, yield of 72.7%) of Compound 5 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that N-phenylnaphthalen-1-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^1H NMR.

Synthesis Examples

Synthesis of Compound 7

[0324] 636 mg (0.84 mmol, yield of 59.8%) of Compound 7 was prepared in the same or substantially the same manner as in Synthesis Example 1, except that N-([1,1'-biphenyl]-2-yl)pyridin-3-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^1H NMR.

Synthesis Example 7

Synthesis of Compound 8

[0325] 914 mg (1.21 mmol, yield of 78.7%) of Compound 8 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that N-phenyl-[1,1'-biphenyl]-4-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 8

Synthesis of Compound 9

[0326] 689 mg (0.98 mmol, yield of 65.3%) of Compound 9 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that N-phenylnaphthalen-2-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 9

Synthesis of Compound 13

[0327] 960 mg (1.02 mmol, yield of 71.4%) of Compound 13 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that 5'-fluoro-N-phenyl-[1,1':3',1"-terphenyl]-4'-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 10

Synthesis of Compound 15

[0328] 785 mg (0.84 mmol, yield of 61.7%) of Compound 15 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 11

Synthesis of Compound 19

[0329] 930 mg (1.19 mmol, yield of 78.6%) of Compound 19 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that N-phenyldibenzo[b,d]furan-2-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 12

Synthesis of Compound 172

[0330] 935 mg (1.03 mmol, yield of 72.4%) of Compound 172 was prepared in the same or substantially the same manner as the one used to synthesize Compound 1 in Synthesis Example 1, except that di([1,1'-biphenyl]-4-yl)amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 13

Synthesis of Compound 26

[0331] 950 mg (2.5 mmol) of Intermediate A-8, 810 mg (3 mmol) of N-phenylphenanthren-2-amine, 229 mg (0.25 mmol) of tris(dibenzylideneacetone)dipalladium(0), 50 mg (0.5 mmol) of tri(tert-butyl)phosphine, and 720 mg (7.5 mmol) of sodium tert-butoxide were added to 25 ml of toluene, and the resulting mixture was stirred at a temperature of 80° C. for 2 hours. The reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 40 ml of water and 40 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography. The result was added to 20 ml of toluene together with 340 mg (2 mmol) of diphenylamine, 137 mg (0.15 mmol) of tris(dibenzylideneacetone)dipalladium(0), 30 mg (0.3 mmol) of tri(tert-butyl)phosphine, and 577 mg (6 mmol) of sodium tert-butoxide and then, stirred at a temperature of 80° C. for 3 hours. The obtained reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 30 ml of water and 30 ml of diethylether, and an organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 900 mg (1.28 mmol, yield of 51.2%) of Compound 26. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 14

Synthesis of Compound 29

[0332] 865 mg (1.12 mmol, yield of 49.7%) of Compound 29 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that 5'-fluoro-N-phenyl-[1,1':3',1"-terphenyl]-4'-amine was used instead of N-phenylphenanthrene-2-amine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 15

Synthesis of Compound 30

[0333] 774 mg (0.97 mmol, yield of 41.3%) of Compound 30 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that 4-((5'-fluoro-[1,1':3',1"-terphenyl]-4'-yl)amino)benzonitrile was used instead of N-phenylphenanthrene-2-amine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 16

Synthesis of Compound 38

[0334] 993 mg (1.18 mmol, yield of 53.8%) of Compound 38 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine and N-phenyl-4-(trimethylsilyl)aniline were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively.

[0335] The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 17

Synthesis of Compound 54

[0336] 1.12 g (1.53 mmol, yield of 69.4%) of Compound 54 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that N-phenylnaphthalen-2-amine and N-phenyl-[1,1'-biphenyl]-2-amine(N-phenyl-[1,1'-biphenyl]-2-amine) were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 18

Synthesis of Compound 57

[0337] 1.18 g (1.36 mmol, yield of 65.7%) of Compound 57 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that N-([1,1'-biphenyl]-2-yl)-9,9-dimethyl-9H-fluoren-2-amine and N-phenyl-[1,1'-biphenyl]-2-amine were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 19

Synthesis of Compound 72

[0338] 1.31 g (1.62 mmol, yield of 73.1%) of Compound 72 was prepared in the same or substantially the same manner as Synthesis Example 13, except that 9,9-dimethyl-N-phenyl-9H-fluoren-2-amine and N-phenyldibenzo[b,d]furan-4-amine were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 20

Synthesis of Compound 88

[0339] 1.01 g (1.14 mmol, yield of 59.1%) of Compound 88 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that 9,9-dimethyl-N-phenyl-9H-fluoren-2-amine and N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Syntheses Example 21

Synthesis of Compound 90

[0340] 1.25 g (1.33 mmol, yield of 65.8%) of Compound 90 was prepared in the same or substantially the same manner as in Synthesis Example 13, except that 5'-fluoro-N-phenyl-[1,1':3',1"-terphenyl]-4'-amine and N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 22

Synthesis of Compound 174

[0341] 1.02 g (1.27 mmol, yield of 72.4%) of Compound 174 was prepared in the same manner as in Synthesis Example 13, except that N-phenylnaphthalen-1-amine and di([1,1'-biphenyl]-4-yl)amine were used instead of N-phenylphenanthrene-2-amine and diphenylamine, respectively. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 23

Synthesis of Compound 129

[0342] 785 mg (0.96 mmol, yield of 71.3%) of Compound 129 was prepared in the same or substantially the same manner as the one used to synthesize Intermediate A-9 and Compound 144 in Synthesis Example 2, except that (4-(dibenzo[b,d]furan-4-yl(phenyl)amino)phenyl)boronic acid was used instead of (4-([1,1'-biphenyl]-2-yl(dibenzo[b,d]furan-4-yl)amino)phenyl)boronic acid and N-phenylnaphthalen-2-amine was used instead of 9,9-methyl-N-phenyl-9H-fluoren-2-amine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 24

Synthesis of Compound 134

[0343] 823 mg (0.93 mmol, yield of 70.7%) of Compound 134 was prepared in the same or substantially the same manner as the one used to synthesize Intermediate A-9 in Synthesis Example 2, except that (4-(dibenzo[b,d]furan-4-yl(phenyl)amino)phenyl)boronic acid was used instead of (4-([1,1'-biphenyl]-2-yl(dibenzo[b,d]furan-4-yl)amino)phenyl) boronic acid. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 25

Synthesis of Compound 183

[0344] 900 mg (1.08 mmol, yield of 74.1%) of Compound 183 was prepared in the same or substantially the same manner as the one used to synthesize Intermediate A-9 and Compound 144 in Synthesis Example 2, except that (4-(di([1,1'-biphenyl]-4-yl)amino)phenyl)boronic acid was used instead of (4-([1,1'-biphenyl]-2-yl(dibenzo[b,d]furan-4-yl)amino) phenyl)boronic acid and diphenylamine was used instead of 9,9-methyl-N-phenyl-9H-fluoren-2-amine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 26

Synthesis of Compound 167

[0345] 800 mg (2.10 mmol) of Intermediate A-8, 1.45 g (5 mmol) of (4-(diphenylamino)phenyl)boronic acid, 580 mg (0.5 mmol) of $Pd(PPh_3)_4$, and 900 mg (6.5 mmol) of K_2CO_3 were added to 60 ml of a mixed solution including THF/H_2O (a volumetric ratio of 9/1), and the resulting mixture was stirred at a temperature of 80° C. for 12 hours. The resulting solution was cooled to room temperature, and then subjected to an extraction process three times by using 80 ml of water and 80 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography to obtain 955 mg (1.28 mmol, yield of 60.9%) of Compound 167. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 27

Synthesis of Compound 185

[0346] 1.05 g (1.35 mmol, yield of 64.3%) of Compound 185 was obtained in the same or substantially the same manner as in Synthesis Example 26, except that (4-(naphthalen-1-yl(phenyl)amino)phenyl)boronic acid was used instead of (4-(diphenylamino)phenyl)boronic acid. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 28

Synthesis of Compound 2A

[0347] 783 mg (1.09 mmol, yield of 61.2%) of Compound 2A was prepared in the same or substantially the same manner as the one used to synthesize Compound 1A in Synthesis Example 3, except that N-phenylnaphthalen-2-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 29

Synthesis of Compound 3A

[0348] 859 mg (1.01 mmol, yield of 56.7%) of Compound 3A was prepared in the same or substantially the same manner the one as used to synthesize Compound 1A in Synthesis Example 3, except that 9,9-dimethyl-N-phenyl-9H-fluoren-2-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 30

Synthesis of Compound 5A

[0349] 862 mg (1.08 mmol, yield of 60.7%) of Compound 5A was prepared in the same or substantially the same manner as the one used to synthesize Compound 1A In Synthesis Example 3, except that N-phenyldibenzo[b,d]furan-4-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 31

Synthesis of Compound 9A

[0350] 847 mg (1.14 mmol, yield of 64.0%) of Compound 9A was prepared in the same or substantially the same manner as the one used to synthesize Compound 1A in Synthesis Example 3, except that N-phenyldibenzo[b,d]thiophen-3-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 32

Synthesis of Compound 11A

[0351] 999 mg (1.05 mmol, yield of 59.0%) of Compound 11A was prepared in the same or substantially the same manner as the one used to synthesize Compound 1A in Synthesis Example 3, except that N-([1,1'-biphenyl]-2-yl) dibenzo[b,d]furan-4-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 33

Synthesis of Compound 15A

[0352] 995 mg (2.5 mmol) of Intermediate B-6, 1005 mg (3 mmol) of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine, 229 mg (0.25 mmol) of tris(dibenzylideneacetone) dipalladium(0), 50 mg (0.5 mmol) of tri(tert-butyl)phosphine, and 720 mg (7.5 mmol) of sodium tert-butoxide were added to 25 ml of toluene, and the resulting mixture was stirred at a temperature of 80° C. for 2 hours. The reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 40 ml of water and 40 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel chromatography. The resulting product was added to 20 ml of toluene together with 670 mg (2 mmol) of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine, 137 mg (0.15 mmol) of tris(dibenzylideneacetone)dipalladium, 30 mg (0.3 mmol) of tri(tert-butyl)phosphine, and 577 mg (6 mmol) of sodium tert-butoxide, and then stirred at a temperature of 80° C. for 3 hours. The resulting reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 30 ml of water and 30 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 1159 mg (1.22 mmol, yield of 48.8%) of Compound 15A. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 34

Synthesis of Compound 17A

[0353] 812 mg (1.13 mmol, yield of 63.5%) of Compound 17A was prepared in the same or substantially the same manner as the one used to synthesize Compound 1A in Synthesis Example 3, except that N-phenylnaphthalen-1-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 35

Synthesis of Compound 25A

[0354] 909 mg (1.31 mmol, yield of 52.5%) of Compound 25A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that diphenylamine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo [b,d]furan-3-amine (3 mmol) and N-phenyl-[1,1'-biphenyl]-4-amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-y)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 36

Synthesis of Compound 27A

[0355] 988 mg (1.26 mmol, yield of 50.3%) of Compound 27A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that diphenylamine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo [b,d]furan-3-amine (3 mmol) and N-([1,1'-biphenyl]-2-y) dibenzo[b,d]furan-4-amine (2 mmol) was used instead of

N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 37

Synthesis of Compound 32A

[0356] 911 mg (1.31 mmol, yield of 52.4%) of Compound 32A was obtained in the same or substantially the same manner as in Synthesis Example 36, except that N-([1,1'-biphenyl]-2-yl)pyridin-3-amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 38

Synthesis of Compound 50A

[0357] 829 mg (1.12 mmol, yield of 44.6%) of Compound 50A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that N-phenylnaphthalen-2-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol) and N-phenyl-4-(trimethylsilyl)aniline (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 39

Synthesis of Compound 56A

[0358] 968 mg (1.16 mmol, yield of 46.4%) of Compound 56A was obtained in the same or substantially the same manner as in Synthesis Example 38, except that N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine (2 mmol) was used instead of N-phenyl-4-(trimethylsilyl)aniline (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 40

Synthesis of Compound 72A

[0359] 1102 mg (1.19 mmol, yield of 47.6%) of Compound 72A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that N-([1,1'-biphenyl]-2-yl)-9,9-dimethyl-9H-fluoren-3-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol), and 9,9-dimethyl-N-phenyl-9H-fluoren-2-amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl) dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 41

Synthesis of Compound 83A

[0360] 855 mg (1.09 mmol, yield of 43.6%) of Compound 83A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol), and diphenylamine(2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 42

Synthesis of Compound 88A

[0361] 973 mg (1.02 mmol, yield of 40.9%) of Compound 88A was obtained in the same or substantially the same manner as in Synthesis Example 41, except for 5'-fluoro-N-phenyl-[1,1':3',**1**"-terphenyl]-4'-amine was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 43

Synthesis of Compound 71A

[0362] 1164 mg (1.21 mmol, yield of 48.3%) of Compound 71A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that N-([1,1'-biphenyl]-2-yl)-9,9-dimethyl-9H-fluoren-3-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol), and di([1,1'-biphenyl]-4-yl)amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

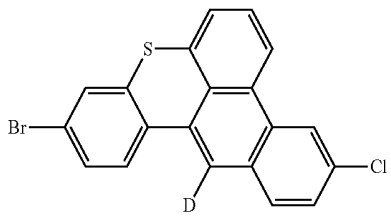
Synthesis Example 44

Synthesis of Compound 106A

Synthesis of Intermediate B-6(1)

[0363]

B-6(1)



[0364] Intermediate B-6(1) was prepared in the same or substantially the same manner as the one used to synthesize Intermediate B-1 to Intermediate B-6 in Synthesis Example 3, except that in synthesizing Intermediate B-4, D_2O was used Instead of H_2O.

Synthesis of Compound 106A

[0365] 709 mg (1.06 mmol, yield of 42.3%) of Compound 106A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that Intermediate B-6(1) was used instead of intermediate B-6, diphenylamine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl) dibenzo[b,d]furan-3-amine (3 mmol), and N-phenylnaphthalen-2-amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 45

Synthesis of Compound 110A

[0366] 821 mg (1.12 mmol, yield of 44.6%) of Compound 110A was obtained in the same or substantially the same manner as the one used to synthesize Compound 106A in

Synthesis Example 44, except that 2,4,6-trimethyl-N-phenylaniline (3 mmol) was used instead of diphenylamine (3 mmol), and N-phenyl-4-(trimethylsilyl)aniline (2 mmol) was used instead of N-phenylnaphthalen-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

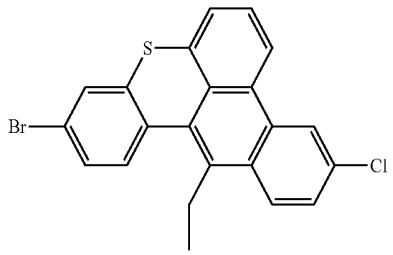
Synthesis Example 46

Synthesis of Compound 120A

Synthesis of Intermediate B-6(2)

[0367]

B-6(2)



[0368] Intermediate B-6(2) was prepared in the same or substantially the same manner as the one used to synthesize Intermediate B-1 to Intermediate B-6 in Synthesis Example 3, except that in synthesizing Intermediate B-4, ethyl iodide was used instead of H_2O.

Synthesis of Compound 120A

[0369] 1225 mg (1.22 mmol, yield of 48.6%) of Compound 120A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that Intermediate B-6(2) was used instead of Intermediate B-6, N-([1,1'-biphenyl]-2-yl)-9,9-dimethyl-9H-fluoren-2-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol), and N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-4-amine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

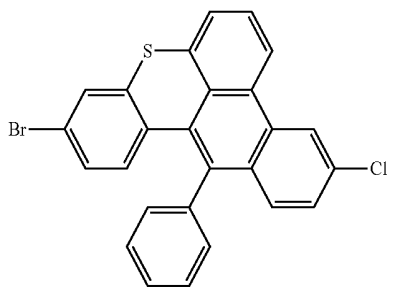
Synthesis Example 47

Synthesis of Compound 125A

Synthesis of Intermediate B-6(3)

[0370]

B-6(3)



[0371] Intermediate B-6(3) was obtained in the same or substantially the same manner as the one used to synthesize Intermediate B-1 to Intermediate B-6 in Synthesis Example 3, except that in synthesizing Intermediate B-4, 1-bromobenzene was used instead of H_2O.

Synthesis of Compound 125A

[0372] 774 mg (1.04 mmol, yield of 41.5%) of Compound 125A was obtained in the same or substantially the same manner as in Synthesis Example 33, except that Intermediate B-6(3) was used instead of Intermediate B-6, N-phenylnaphthalen-2-amine (3 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-3-amine (3 mmol), and diphenylamine (2 mmol) was used instead of N-([1,1'-biphenyl]-2-yl)dibenzo[b,d]furan-2-amine (2 mmol). The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 48

Synthesis of Compound 137A

[0373] 622 mg (1.57 mmol) of Intermediate B-6, 463 mg (1.6 mmol) of (4-(diphenylamino)phenyl)boronic acid, 173 mg (0.15 mmol) of $Pd(PPh_3)_4$, and 620 mg (225 mmol) of K_2CO_3 were added to 35 ml of a mixture including THF/H_2O (a volumetric ratio of 9/1), and the resulting solution was stirred at a temperature of 80° C. for 12 hours, and then cooled to room temperature and subjected to an extraction process three times by using 500 ml of water and 500 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent was separation-purified by silica gel chromatography. 600 mg (1.07 mmol) of the resulting product was added to 10 ml of toluene together with 366 mg (2.1 mmol) of diphenylamine, 192 mg (0.21 mmol) of tris(dibenzylideneacetone)dipalladium(0), 19 mg (0.21 mmol) of tri(tert-butyl) phosphine, and 288 mg (3 mmol) of sodium tert-butoxide and then, the resulting mixture was stirred at a temperature of 80° C. for 2 hours. The reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 20 ml of water and 20 ml of diethylether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography to obtain 535 mg (0.77 mmol, yield of 72.3%) of Compound 137A. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 49

Synthesis of Compound 142A

[0374] 656 mg (0.735 mmol, yield of 68.7%) of Compound 142A was obtained in the same or substantially the same manner as in Synthesis Example 48, except that (6-([1,1'-biphenyl]-4-yl(phenyl)amino)naphthalen-2-yl)boronic acid was used instead of (4-(diphenylamino)phenyl)boronic acid, and N-phenyl-4-(trimethylsilyl)aniline was used instead of diphenylamine. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 50

Synthesis of Compound 160A

[0375] 623 mg (1.57 mmol) of Intermediate B-6(1) was added to 35 ml of toluene together with 514 mg (1.6 mmol) of

di([1,1'-biphenyl]-4-yl)amine, 192 mg (0.21 mmol) of tris (dibenzylideneacetone)dipalladium(0), 19 mg (0.21 mmol) of tri(tert-butyl)phosphine, and 288 mg (3 mmol) of sodium tert-butoxide, and the resulting mixture was stirred at a temperature of 80° C. for 2 hours. The reaction solution was cooled to room temperature, and then subjected to an extraction process three times by using 500 ml of water and 500 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate and the residual obtained by evaporating a solvent therefrom was separation-purified by silica gel column chromatography. 683 mg (1.07 mmol) of the resulting product was added to 15 ml of a mixture including THF/H_2O (a volumetric ratio of 9/1) together with 764 mg (1.6 mmol) of (4-((9,9-dimethyl-9H-fluoren-2-yl)(4-(trimethylsilyl)phenyl)amino)phenyl)boronic acid, 115 mg (0.10 mmol) of $Pd(PPh_3)_4$, and 413 mg (150 mmol) of K_2CO_3, and the resulting solution was stirred at a temperature of 80° C. for 12 hours, and then cooled to room temperature and subjected to an extraction process three times by using 30 ml of water and 20 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent was separation-purified by silica gel chromatography to obtain 674 mg (0.65 mmol, yield of 60.5%) of Compound 160 Å. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 51

Synthesis of Compound 161A

[0376] 475 mg (0.67 mmol, yield of 62.4%) of Compound 161A was obtained in the same or substantially the same manner as in Synthesis Example 50, except that Intermediate B-6(2) was used instead of Intermediate B-6(1), diphenylamine was used instead of di([1,1'-biphenyl]-4-yl)amine, and (4-(diphenylamino)phenyl)boronic acid was used instead of (4-((9,9-dimethyl-9H-fluoren-2-yl)(4-(trimethylsilyl)phenyl)amino)phenyl)boronic acid. The obtained compound was identified by MS/FAB and ^{1}H NMR.

Synthesis Example 52

Synthesis of Compound 164A

[0377] 741 mg (1.57 mmol) of Intermediate B-6(3), 463 mg (1.6 mmol) of (4-(diphenylamino)phenyl)boronic acid, 173 mg (0.15 mmol) of $Pd(PPh_3)_4$, and 620 mg (225 mmol) of K_2CO_3 were added to 35 ml of a mixture Including THF/H_2O (a volumetric ratio of 9/1), and the resulting solution was stirred at a temperature of 80° C. for 12 hours, and then cooled to room temperature and subjected to an extraction process three times by using 500 ml of water and 500 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent was separation-purified by silica gel chromatography. 896 mg (1.07 mmol) of the resulting product was added to 15 ml of a mixture including THF/H_2O (a volumetric ratio of 9/1) together with 543 mg (4-(diphenylamino)naphthalen-1-yl)boronic acid, 115 mg (0.10 mmol) of $Pd(PPh_3)_4$, and 413 mg (150 mmol) of K_2CO_3, and then stirred at a temperature of 80° C. for 12 hours, and then cooled to room temperature, and subjected to an extraction process three times by using 30 ml of water and 20 ml of diethyl ether. An organic layer separated therefrom was dried by using magnesium sulfate, and the residual obtained by evaporating a solvent was separation-purified by silica gel chromatography to obtain 592 mg (0.66 mmol, yield of 61.4%) of Compound 164A. The obtained compound was Identified by MS/FAB and ^{1}H NMR.

[0378] MS/FAB and ^{1}H NMR of the compounds synthesized in Synthesis Examples 1 to 52 are shown in Table 1 below:

TABLE 1

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.
2	8.29(s, 1H), 8.01(s, 1H), 7.55-7.50(m, 3H), 7.43-7.37(m, 2H), 7.33-7.29(m, 3H), 7.23-7.20(m, 2H), 7.15(dd, 1H), 7.05-6.97(m, 9H), 6.86(dd, 1H), 6.75(dd, 1H), 6.72-6.68(m, 3H), 6.61-6.56(m, 3H), 6.46-6.41(m, 4H), 1.86(s, 12H)	835.12	835.06
9	8.34(s, 1H), 8.07(d, 1H), 7.63(ss, 2H), 7.5(ss, 1H), 7.4-7.22(m, 13H), 7.11(dd, 1H), 7.06(dd, 1H), 6.98-6.89(m, 5H), 6.79(dd, 1H), 6.69(t, 1H), 6.62-6.58(m, 2H), 6.62(dd, 1H), 6.36-6.28(m, 4H)	702.74	702.86
13	8.42(s, 1H), 8.14(d, 1H), 7.53-7.45(m, 9H), 7.4-7.34(m, 12H), 7.29-7.27(m, 2H), 7.22(dd, 2H), 7.16(dd, 2H), 7.04-6.98(m, 6H), 6.82(dd, 1H), 6.63-6.59(m, 2H), 6.5(t, 1H), 6.41(dd, 1H), 6.3-6.21(m, 4H)	943.17	943.11
15	8.31(s, 1H), 8.05(d, 1H), 7.58(d, 2H), 7.48-7.43(m, 5H), 7.4-7.22(m, 17H), 7.11(dd, 1H), 7.03-6.99(m, 4H), 6.92-6.83(m, 8H), 6.77(dd, 1H), 6.45(s, 1H), 6.37(dd, 1H)	934.95	935.09
19	8.16(s, 1H), 7.92(d, 1H), 7.5(dd, 2H), 7.43(dd, 2H), 7.34-7.16(m, 12H), 7.09(dd, 1H), 6.99-6.91(m, 6H), 6.85(dd, 1H), 6.76(t, 1H), 6.67-6.58(m, 3H), 6.49-6.44(m, 4H)	782.87	782.90
26	8.33(s, 1H), 8.12(dd, 1H), 8.08(dd, 1H), 7.93(d, 1H), 7.64(dd, 1H), 7.49(dd, 2H), 7.44-7.32(m, 7H), 7.16(dd, 1H), 7.04-6.94(m, 8H), 6.73(t, 1H), 6.68(t, 3H), 6.56(dd, 1H), 6.40-6.36(m, 6H)	702.65	702.86
29	8.36(s, 1H), 8.13(d, 1H), 7.61-7.27(m, 16H), 7.18-7.11(m, 7H), 6.99(dd, 1H), 6.88(t, 1H), 6.85-6.79(m, 3H), 6.72(dd, 1H), 6.56(dd, 4H), 6.48(dd, 2H)	772.76	772.92
30	8.12(s, 1H), 7.85(d, 1H), 7.28-7.19(m, 6H), 7.15-6.98(m, 11H), 6.92(d, 1H), 6.82-6.75(m, 5H), 6.68(dd, 1H), 6.50-6.41(m, 5H), 6.31(dd, 1H), 6.15(dd, 4H)	798.01	797.93

TABLE 1-continued

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.
38	8.30(s, 1H), 8.00(d, 1H), 7.48(d, 1H), 7.37-7.32(m, 3H), 7.28-7.07(m, 12H), 6.97(dd, 1H), 6.89-6.66(m, 8H), 6.59(dd, 1H), 6.53(t, 1H), 6.49-6.41(m, 3H), 6.35(dd, 1H), 6.25(dd, 2H), 0.66(s, 9H)	840.96	841.10
54	8.23(s, 1H), 7.97(d, 1H), 7.56(d, 1H), 7.34-7.17(m, 14H), 7.08-6.84(m, 10H), 6.72(d, 1H), 6.63-6.55(m, 3H), 6.41(dd, 1H), 6.31(dd, 2H), 6.23(dd, 2H)	729.10	728.89
57	8.46(s, 1H), 8.18(d, 1H), 7.62(dd, 2H), 7.48-7.44(m, 6H), 7.39-7.31(m, 8H), 7.26-7.22(m, 1H), 7.18-6.91(m, 11H), 6.83-6.78(m, 2H), 6.65-6.57(m, 3H), 6.46-6.43(m, 2H), 6.31-6.22(m, 3H), 1.68 (s, 6H)	871.04	871.10
72	8.42(s, 1H), 8.12(d, 1H), 7.61(s, 1H), 7.56-7.39(m, 6H), 7.32-7.10(m, 6H), 6.97-6.81(m, 9H), 6.64-6.52(m, 4H), 6.45-6.42(m, 2H), 6.32-6.11(m, 4H), 1.72 (s, 6H)	809.03	808.98
88	8.31(s, 1H), 8.09(d, 1H), 7.7(d, 1H), 7.66(d, 1H), 7.61-7.31(m, 16H), 7.24-7.07(m, 11H), 6.95(dd, 1H), 6.9(t, 1H), 6.79(d, 1H), 6.74(t, 1H), 6.69-6.64(m, 3H), 1.69(s, 6H)	884.99	885.08
90	8.27(s, 1H), 8.01(d, 1H), 7.54(d, 1H), 7.44-7.18(m, 22H), 7.13-7.07(m, 3H), 6.99-6.75(m, 10H), 6.6(t, 1H), 6.41(t, 1H), 6.32(d, 1H), 6.21(dd, 2H)	939.03	939.10
129	8.34(s, 1H), 8.20(d, 1H), 8.00(s, 1H), 7.88(d, 1H), 7.77-7.66(m, 3H), 7.59-7.29(m, 13H), 7.20(dd, 1H), 7.07-6.96(m, 6H), 6.88(dd, 1H), 6.78(t, 1H), 6.69(dd, 2H), 6.61(dd, 3H), 6.45(dd, 2H), 6.36(dd, 2H)	819.07	818.98
134	8.26(s, 1H), 8.12(d, 1H), 7.93(s, 1H), 7.81(d, 1H), 7.69(dd, 1H), 7.6(d, 1H), 7.56-7.46(m, 4H), 7.34-7.19(m, 7H), 7.14(dd, 1H), 7.03-6.96(m, 6H), 6.92(dd, 2H), 6.83(dd, 1H), 6.69-6.53(m, 7H), 6.39(dd, 2H), 6.32(dd, 2H), 1.76(s, 6H)	885.16	885.08
1	8.43(s, 1H), 8.12(d, 1H), 7.46(d, 1H), 7.42(d, 1H), 7.38(d, 1H), 7.29(t, 1H), 7.09(d, 1H), 6.94-6.84(m, 9H), 6.62(t, 1H), 6.56(dd, 4H), 6.41(dd, 1H), 6.23(dd, 4H), 6.17(dd, 4H)	602.66	602.74
5	8.40(s, 1H), 8.13(d, 1H), 7.9(dd, 2H), 7.67(d, 2H), 7.41(d, 2H), 7.37-7.26(m, 5H), 7.17-7.08(m, 5H), 7.03(d, 1H), 6.97-6.91(m, 4H), 6.71(d, 1H), 6.64(dd, 1H), 6.59-6.51(m, 4H), 6.37(dd, 1H), 6.17(dd, 2H). 6.1(dd. 2H)	702.92	702.86
7	8.31(s, 1H), 8.01(d, 1H), 7.93(dd, 2H), 7.66(dd, 2H), 7.29-7.12(m, 13H), 7.03-6.86(m, 9H), 6.79(dd, 1H), 6.68(t, 2H), 6.65-6.58(m, 3H), 6.44(dd, 1H), 6.33(dd, 1H)	756.78	756.91
8	8.33(s, 1H), 8.09(d, 1H), 7.62(d, 1H), 7.55(dd, 1H), 7.49-7.46(m, 5H), 7.4-7.36(m, 9H), 7.33-7.29(m, 2H), 7.15(d, 1H), 7.10-7.07(m, 5H), 6.86(dd, 1H), 6.79-6.67(m, 7H), 6.56-6.50(m, 4H)	754.97	754.93
144	8.39(s, 1H), 8.25(d, 1H), 8.05(s, 1H), 7.93(d, 1H), 7.8(dd, 1H), 7.71(d, 1H), 7.67-7.56(m, 4H), 7.53-7.29(m, 12H), 7.24(dd, 1H), 7.15-6.90(m, 11H), 6.77-6.71(m, 2H), 6.64-6.61(m, 2H), 6.55(dd, 2H), 6.45(dd, 2H), 1.59(s, 6H)	961.11	961.18
167	8.29(s, 1H), 8.14(d, 1H), 7.93(s, 1H), 7.81(d, 1H), 7.69(dd, 2H), 7.33-7.19(m, 7H), 6.98-6.90(m, 9H), 6.76-6.70(m, 4H), 6.57-6.54(m, 4H), 6.06-6.02(m, 8H)	755.01	754.93
172	8.56(s, 1H), 8.27(d, 1H), 7.81(d, 1H), 7.61(dd, 1H), 7.55-7.50(m, 9H), 7.45-7.39(m, 17H), 7.35-7.31(m, 4H), 7.23(dd, 1H), 7.14(dd, 1H), 7.14(dd, 1H), 6.81(dd, 1H), 6.75(dd, 4H), 6.68(dd, 4H), 6.6(dd, 1H).	907.17	907.13
174	8.60(s, 1H), 8.28(d, 1H), 8.01(d, 1H), 7.77(d, 1H), 7.56(dd, 1H), 7.51-7.11(m, 21H), 7.05(d, 1H), 6.99-6.93(m, 2H), 6.71-6.47(m, 9H), 6.13(dd, 2H)	805.04	804.99
183	8.24(s, 1H), 8.10(d, 1H), 7.91(s, 1H), 7.78(d, 1H), 7.65(dd, 1H), 7.44(d, 1H), 7.34(dd, 4H), 7.29-7.18(m, 13H), 7.1(dd, 1H), 6.96-6.92(m, 4H), 6.76-6.73(m, 4H), 6.66(t, 1H), 6.61-6.57(m, 4H), 6.47(dd, 1H), 6.29(dd, 4H)	831.11	831.03
185	8.30(s, 1H), 8.06(d, 1H), 7.88(dd, 1H), 7.85(dd, 1H), 7.69(d, 1H), 7.63(dd, 2H), 7.41(d, 1H), 7.36-7.24(m, 9H), 7.17-6.92(m, 10H), 6.75-6.59(m, 5H), 6.4(dd, 2H), 6.19(dd, 2H), 6.15(dd, 2H)	779.02	778.95
1A	8.44(s, 1H), 8.07(d, 1H), 7.64(m, 2H), 7.59(dd, 1H), 7.51(m, 2H), 7.07-7.03(m, 8H), 6.98(dd, 1H), 6.85(d, 1H), 6.70(t, 4H), 6.60(dd, 1H), 6.42(dd, 4H), 6.35(dd, 4H)	618.04	618.80
5A	8.52(s, 1H), 8.13(d, 1H), 7.74(dd, 2H), 7.68-7.55(m, 9H), 7.43(t, 2H), 7.37(t, 2H), 7.11-7.06(m, 5H), 7.03-6.98(m, 5H), 6.73(t, 2H), 6.63(dd, 1H), 6.52(dd, 2H), 6.43(dd, 2H)	798.84	798.96

TABLE 1-continued

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.
9A	8.49(s, 1H), 8.10(d, 1H), 8.04(d, 2H), 7.95(d, 2H), 7.69(d, 2H), 7.64(dd, 1H), 7.60-7.51(m, 4H), 7.36(t, 2H), 7.30(t, 2H), 7.09-7.02(m, 7H), 6.96(dd, 2H), 6.91(d, 1H), 6.67(t, 3H), 6.53(d, 2H), 6.49(d, 2H)	831.01	831.08
17A	8.47(s, 1H), 8.08(d, 1H), 7.95(dd, 2H), 7.83(d, 1H), 7.73(dd, 2H), 7.65(dd, 1H), 7.58(dd, 1H), 7.52(m, 1H), 7.44(m, 3H), 7.36(t, 2H), 7.23(t, 2H), 7.18(t, 2H), 7.03(t, 4H), 6.85(d, 1H), 6.80(dd, 1H), 6.76(t, 2H), 6.68(t, 3H), 6.31(dd, 2H), 6.23(dd, 2H)	718.99	718.92
25A	8.52(s, 1H), 8.11(d, 1H), 7.74(d, 1H), 7.64(d, 1H), 7.59(dd, 1H), 7.52(m, 2H), 7.46(dd, 2H), 7.38-7.35(m, 4H), 7.30-7.26(m, 1H), 7.01(t, 7H), 6.80(d, 1H), 6.64(t, 3H), 6.58(d, 2H), 6.54(dd, 1H), 6.33(dd, 6H)	694.92	694.90
71A	8.53(s, 1H), 8.13(d, 1H), 7.85(d, 1H), 7.67-7.60(m, 3H), 7.55(d, 2H), 7.51-7.47(m, 6H), 7.42-7.36(m, 11H), 7.34-7.28(m, 3H), 7.12-7.07(m, 4H), 7.04-7.02(m, 2H), 6.97(m, 2H), 6.81(d, 2H), 6.68(d, 4H), 6.46(m, 2H), 2.19(s, 6H)	936.21	963.25
110A	8.12(d, 1H), 7.90(d, 1H), 7.74(d, 1H), 7.65(d, 1H), 7.59(dd, 1H), 7.52(t, 1H), 7.30(d, 2H), 7.03-6.98(m, 5H), 6.76(d, 1H), 6.65-6.58(m, 7H), 6.33(dd, 2H), 6.22(dd, 2H), 2.71(d, 9H), 0.91(s, 9H)	733.98	734.07
142A	8.58(s, 1H), 8.15(d, 1H), 8.05(d, 1H), 7.91(m, 2H), 7.75(d, 1H), 7.66-7.44(m, 7H), 7.40-7.32(m, 6H), 7.28-7.23(m, 4H), 6.98(t, 6H), 6.59-6.55(m, 4H), 6.46(d, 2H), 6.25(d, 2H), 6.18(d, 2H), 0.49(s, 9H)	893.31	893.24
160A	8.18(s, 1H), 8.11(d, 1H), 7.71(q, 2H), 7.63-7.51(m, 4H), 7.45(d, 4H), 7.37-7.32(m, 11H), 7.28-7.21(m, 5H), 7.03(d, 2H), 6.78(d, 1H), 6.70-6.65(m, 5H), 6.59-6.53(m, 5H), 6.40(d, 1H), 2.09(s, 6H), 0.85(s, 9H)	1036.32	1036.44
164A	8.34(d, 1H), 8.28(d, 1H), 8.05(d, 1H), 8.03(t, 1H), 7.99(d, 1H), 7.85(dd, 1H), 7.75(dd, 2H), 7.69(dd, 1H), 7.57-7.50(m, 4H), 7.42-7.26(m, 8H), 7.00-6.93(m, 8H), 6.89(d, 1H), 6.58(q, 4H), 6.51(d, 2H), 6.12(dd, 4H), 6.03(dd, 4H)	897.01	897.15
2A	8.46(s, 1H), 8.07(d, 1H), 7.71(d, 2H), 7.63(d, 1H), 7.57(d, 1H), 7.55(d, 1H), 7.53(d, 1H), 7.50-7.39(m, 7H), 7.35(t, 2H), 7.30(t, 2H), 7.13(dd, 1H), 7.04(t, 4H), 6.98(dd, 1H), 6.87(dd, 1H), 6.84(d, 1H), 6.67(t, 2H), 6.59(dd, 1H), 6.42(dd, 2H), 6.36(dd, 2H)	718.96	718.92
3A	8.47(s, 1H), 8.08(d, 1H), 7.65-7.61(m, 3H), 7.58(d, 1H), 7.54-7.49(m, 3H), 7.36(d, 2H), 7.27-7.23(m, 2H), 1.20(d, 1H), 7.08-6.98(m, 9H), 6.79(dd, 1H), 6.74(dd, 1H), 6.68(t, 2H), 6.62(t, 2H), 6.53(d, 1H), 6.43(d, 2H), 6.36(d, 2H), 2.44(s, 12H)	851.18	851.12
11A	8.44(s, 1H), 8.06(d, 1H), 7.66(d, 2H), 7.59(d, 1H), 7.56-7.41(m, 20H), 7.31(t, 2H), 7.08(m, 4H), 6.98(m, 9H), 6.83(dd, 1H), 6.35(dd, 1H)	951.14	951.16
15A	8.51(s, 1H), 8.1(d, 1H), 7.7-7.66(m, 3H), 7.62(d, 1H), 7.58(dd, 1H), 7.52(d, 2H), 7.51-7.43(m, 9H), 7.4-7.34(m, 6H), 7.32-7.28(m, 3H), 7.16(t, 1H), 7.1(m, 2H), 6.97-6.92(m, 5H), 6.9(dd, 1H), 6.86-6.82(m, 2H), 6.78-6.74(m, 3H), 6.59(dd, 1H)	951.19	951.16
27A	8.45(s, 1H), 8.06(d, 1H), 7.66(d, 1H), 7.59(d, 1H), 7.56-7.51(m, 6H), 7.47-7.42(m, 4H), 7.38-7.35(m, 2H), 7.31(t, 1H), 7.10-7.01(m, 6H), 6.97-6.91(m, 4H), 6.82(m, 2H), 6.68(t, 2H), 6.57(dd, 1H), 6.39(dd, 4H)	785.03	784.98
32A	8.45(s, 1H), 8.06(m, 2H), 7.84(d, 1H), 7.64(d, 1H), 7.57(d, 1H), 7.53-7.43(m, 5H), 7.39-7.34(m, 3H), 7.24(dd, 1H), 7.18(t, 1H), 7.14(d, 1H), 7.06-7.01(m, 5H), 6.96(t, 1H), 6.89(m, 2H), 6.83(d, 1H), 6.68(t, 2H), 6.57(d, 1H), 6.38(d, 4H)	695.97	695.88
50A	8.42(s, 1H), 8.05(d, 1H), 7.7(m, 2H), 7.62(dd, 1H), 7.56(dd, 1H), 7.52(d, 1H), 7.50-7.33(m, 5H), 7.29(d, 3H), 7.06-7.01(m, 5H), 6.88(dd, 1H), 6.85(dd, 1H), 6.70-6.66(m, 4H), 6.69(dd, 1H), 6.45(dd, 2H), 6.41(dd, 2H), 1.45(s, 9H)	740.98	741.04
56A	8.50(s, 1H), 8.11(d, 1H), 7.75(d, 1H), 7.70(dd, 1H), 7.64-7.32(m, 19H), 7.13-7.04(m, 4H), 7.01-6.94(m, 4H), 6.9(dd, 1H), 6.87(d, 1H), 6.86(dd, 1H), 6.70(t, 1H), 6.62(dd, 1H), 6.45(dd, 2H)	835.11	835.04

TABLE 1-continued

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.
72A	8.47(s, 1H), 8.09(d, 1H), 7.68-7.59(m, 5H), 7.56(d, 2H), 7.54-7.45(m, 2H), 7.44-7.41(m, 4H), 7.37-7.30(m, 2H), 7.17-7.03(m, 12H), 6.89(m, 2H), 6.83(dd, 1H), 6.76(t, 1H), 6.63(d, 1H), 6.58(m, 2H), 6.48(dd, 2H), 2.73(s, 6H), 2.69(s, 6H)	927.29	927.22
83A	8.45(s, 1H), 8.08(d, 1H), 7.70(d, 1H), 7.66(t, 2H), 7.62-7.40(m, 11H), 7.36(t, 1H), 7.16-6.98(m, 12H), 6.76(t, 2H), 6.46(m, 5H)	785.01	784.98
88A	8.47(s, 1H), 8.08(d, 1H), 7.67(d, 1H), 7.63(d, 1H), 7.59-7.30(m, 23H), 7.26(m, 1H), 7.10-6.90(m, 10H), 6.86(dd, 1H), 6.64(t, 1H), 6.35(dd, 1H), 6.28(dd, 2H)	955.09	955.16
106A	8.09(d, 1H), 7.74(d, 1H), 7.64(d, 1H), 7.60(d, 1H), 7.57(d, 1H), 7.55-7.33(m, 7H), 7.16(dd, 1H), 7.08-7.03(m, 6H), 7.01(dd, 1H), 6.86(d, 1H), 6.70(t, 3H), 6.60(dd, 1H), 6.44-6.69(m, 6H)	669.83	669.86
120A	8.10(d, 1H), 7.67(d, 1H), 7.62-7.58(m, 2H), 7.55(d, 1H), 7.52(d, 1H), 7.47-7.29(m, 17H), 7.24(m, 1H), 7.16(d, 1H), 7.11-7.05(m, 5H), 6.97-6.90(m, 6H), 6.68(dd, 1H), 6.57-6.52(m, 3H), 6.32-6.28(m, 1H), 2.42(s, 9H), 2.14(t, 2H)	1005.27	1005.29
125A	7.94(dd, 1H), 7.77(d, 1H), 7.72(m, 3H), 7.57(d, 1H), 7.52-7.29(m, 10H), 7.13(d, 1H), 7.05-7.00(m, 6H), 6.92(dd, 1H), 6.86(d, 2H), 6.69-6.64(m, 4H), 6.40(dd, 2H), 6.30(dd, 4H)	744.91	744.96
137A	8.44(s, 1H), 8.06(d, 1H), 7.94(d, 1H), 7.86(d, 1H), 7.63(m, 2H), 7.50(dd, 2H), 7.39(dd, 1H), 7.36(d, 2H), 7.06-7.02(m, 8H), 6.98(dd, 1H), 6.69(t, 4H), 6.64(d, 2H), 6.35(dd, 4H), 6.27(dd, 4H)	694.82	694.90
161A	8.05(s, 1H), 7.98(m, 1H), 7.78(d, 1H), 7.60(dd, 1H), 7.53-7.47(m, 3H), 7.39(m, 2H), 7.05-7.01(m, 8H), 6.86-6.82(m, 3H), 6.69 (t, 4H), 6.65(dd, 1H), 6.42(dd, 4H), 6.28(dd, 4H), 3.68(s, 3H)	708.93	708.92

Example 1

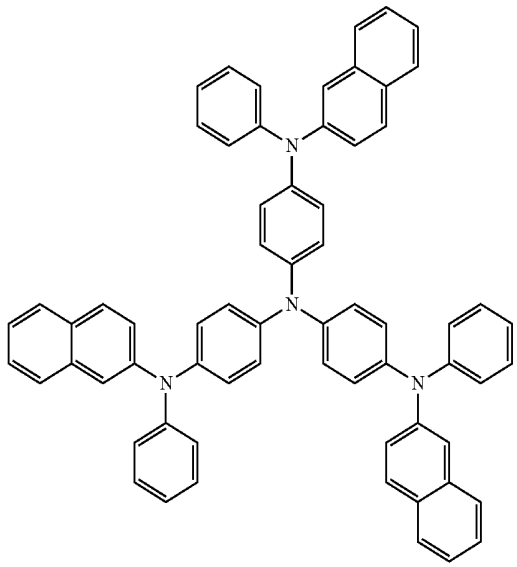
[0379] A 15 Ωcm^2 (1200 Å) ITO glass substrate (a product of Corning) was cut to a size of 50 mm×50 mm×0.7 mm, and was ultrasonically cleaned by using isopropyl alcohol and pure water for 5 minutes each, and then UV light was Irradiated thereon for 30 minutes and the substrate was further exposed to ozone to clean. Then, the resultant structure was loaded into a vacuum deposition apparatus.

[0380] On the iTO glass substrate acting as an anode, 2-TNATA was vacuum-deposited to form a hole Injection layer having a thickness of 600 Å, and Compound 1 was vacuum-deposited on the hole injection layer to form a hole transport layer having a thickness of 300 Å, thereby completing the formation of a hole transport region.

[0381] 9,10-di-naphthalene-2-yl-anthracene (ADN) acting as a host and N,N,N',N'-tetraphenyl-pyrene-1,6-diamine (TPD) acting as a dopant were co-deposited on the hole transport region at a weight ratio of 98:2 to form an emission layer having a thickness of 300 Å.

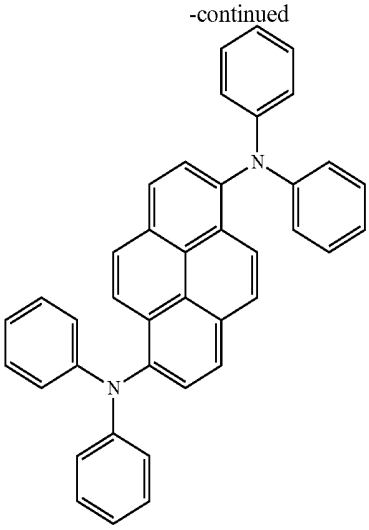
[0382] Alq_3 was vacuum-deposited on the emission layer to form an electron transport layer having a thickness of 300 Å, and LiF was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, thereby completing the formation of an electron transport region.

[0383] Al was vacuum-deposited on the electron transport region to form a cathode having a thickness of 3,000 Å, thereby completing the manufacture of an organic light-emitting device.

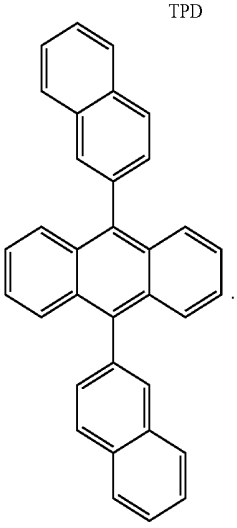


2-TNATA

-continued



TPD



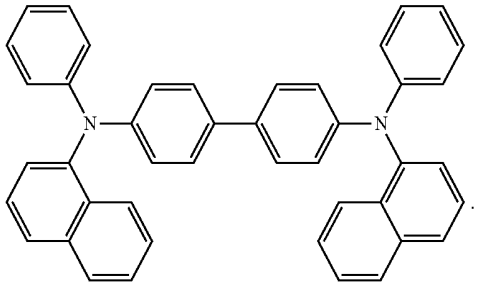
ADN

Examples 2 to 20

[0384] Organic light-emitting devices were manufactured in the same or substantially the same manner as in Example 1, except that in forming a hole transport layer, compounds shown in Table 2 were used instead of Compound 1.

Comparative Example 1

[0385] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 1, except that in forming a hole transport layer, NPB was used instead of Compound 1.



NPB

Evaluation Example 1

[0386] The driving voltage, current density, brightness, efficiency, and half-lifespan of the organic light-emitting devices manufactured according to Examples 1 to 20, and Comparative Example 1 were measured by using Keithley SMU 236 (from Keithley Instruments Inc.) and a brightness photometer PR_{650} (from Photo Research, Inc.), and the results are shown in Table 2. The half-lifespan as used herein is a period of time that it takes for the brightness of the organic light-emitting device to reduce to 50% of the initial brightness.

TABLE 2

	Hole transport layer	Driving voltage (V)	Current Density (mA/cm^2)	Brightness (cd/m^2)	Efficiency (cd/A)	Emission color	Half lifespan (hr @100 mA/cm^2)
Example 1	Compound 1	5.83	50	3210	6.42	Blue	376
Example 2	Compound 5	5.66	50	3330	6.66	Blue	359
Example 3	Compound 7	5.72	50	3165	6.33	Blue	292
Example 4	Compound 8	5.79	50	3340	6.68	Blue	366
Example 5	Compound 144	5.89	50	3210	6.42	Blue	319
Example 6	Compound 167	5.64	50	3290	6.58	Blue	368
Example 7	Compound 172	5.62	50	3395	6.79	Blue	389
Example 8	Compound 174	5.61	50	3380	6.76	Blue	393
Example 9	Compound 183	5.71	50	3335	6.67	Blue	368
Example 10	Compound 185	5.64	50	3270	6.54	Blue	356
Example 11	Compound 1A	6.03	50	3070	6.14	Blue	342
Example 12	Compound 5A	5.82	50	3170	6.34	Blue	327
Example 13	Compound 9A	5.76	50	3135	6.27	Blue	278
Example 14	Compound 17A	5.94	50	3035	6.07	Blue	354
Example 15	Compound 25A	5.98	50	3105	6.21	Blue	326
Example 16	Compound 71A	6.12	50	2990	5.98	Blue	372
Example 17	Compound 110A	5.87	50	3240	6.48	Blue	318
Example 18	Compound 142A	5.66	50	3285	6.57	Blue	347
Example 19	Compound 160A	5.94	50	3205	6.41	Blue	336
Example 20	Compound 164A	6.07	50	3255	6.51	Blue	327

TABLE 2-continued

	Hole transport layer	Driving voltage (V)	Current Density (mA/cm^2)	Bright-ness (cd/m^2)	Effi-ciency (cd/A)	Emis-sion color	Half lifespan (hr @100 mA/cm^2)
Comparative Example 1	NPB	7.01	50	2645	5.29	Blue	258

Example 1

[0387] As illustrated in Table 2, the organic light-emitting devices manufactured according to Examples 1 to 20 have lower driving voltage, higher brightness, higher efficiency, and longer half-lifespan than the organic light-emitting device manufactured according to Comparative Example 1.

Example 21

[0388] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 1, except that in forming a hole transport layer, NPB was used instead of Compound 1, and in forming an emission layer, as a dopant, Compound 2 was used instead of TPD.

Examples 22 to 36

[0389] Organic light-emitting devices were manufactured in the same or substantially the same manner as in Example 21, except that in forming an emission layer, for use as a dopant, corresponding compounds shown in Table 3 were used instead of Compound 2.

Example 37

[0390] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 21, except that in forming a hole transport layer, Compound 172 was used instead of NPB.

Examples 38 to 41

[0391] Organic light-emitting devices were each manufactured in the same or substantially the same manner as in Example 37, except that in forming an emission layer, for use as a dopant, corresponding compounds shown in Table 3 were used Instead of Compound 2.

Examples 42 to 57

[0392] Organic light-emitting devices were each manufactured in the same or substantially the same manner as in Example 21, except that in forming an emission layer, for use as a dopant, corresponding compounds shown in Table 3 were used Instead of Compound 2.

Example 58

[0393] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 42, except that in forming a hole transport layer, Compound 142A was used instead of NPB.

Examples 59 to 62

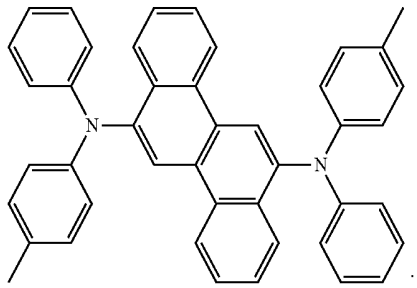
[0394] Organic light-emitting devices were each manufactured in the same or substantially the same manner as in Example 58, except that in forming an emission layer, for use as a dopant, corresponding compounds shown in Table 3 were used Instead of Compound 2A.

Comparative Example 2

[0395] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 21, except that in forming an emission layer, as a dopant, Compound A was used instead of Compound 2.

Compound A

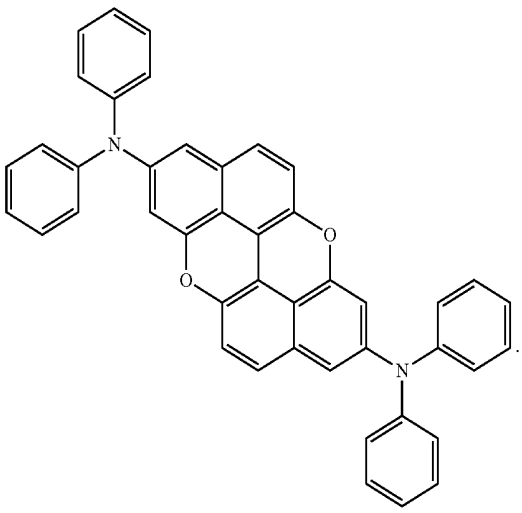
A



Comparative Example 3

[0396] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 21, except that in forming an emission layer, as a dopant, Compound B was used instead of Compound 2.

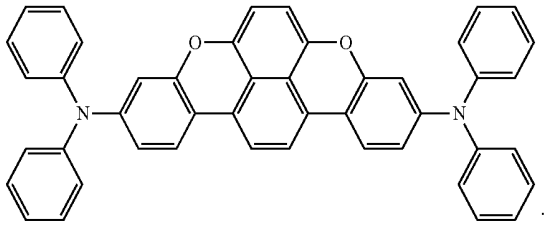
Compound B



Comparative Example 4

[0397] An organic light-emitting device was manufactured in the same or substantially the same manner as in Example 21, except that in forming an emission layer, as a dopant, Compound C was used instead of Compound 2.

Compound C



Evaluation Example 2

[0398] The driving voltage, current density, brightness, efficiency, and half-lifespan of the organic light-emitting devices manufactured according to Examples 21 to 62, and Comparative Examples 1 to 4 were measured by using Keithley SMU 236 (from Keithley Instruments Inc.) and a brightness photometer PR_{650} (from Photo Research, Inc.), and the results are shown in Table 3. The half-lifespan as used herein is a period of time that it takes for the brightness of the organic light-emitting device to reduce to 50% of the initial brightness.

TABLE 3

	Hole transport layer	Dopant	Driving voltage (V)	Current Density (mA/cm^2)	Brightness (cd/m^2)	Efficiency (cd/A)	Emission color	Half lifespan (hr @100 mA/cm^2)
Example 21	NPB	Compound 2	6.83	50	3565	7.13	Blue	336
Example 22	NPB	Compound 9	6.84	50	3460	6.92	Blue	349
Example 23	NPB	Compound 13	6.87	50	3575	7.15	Blue	346
Example 24	NPB	Compound 15	6.86	50	3555	7.11	Blue	358
Example 25	NPB	Compound 19	6.89	50	3525	7.05	Blue	339
Example 26	NPB	Compound 26	6.84	50	3545	7.09	Blue	348
Example 27	NPB	Compound 29	6.87	50	3505	7.01	Blue	329
Example 28	NPB	Compound 30	6.87	50	3360	6.72	Blue	333
Example 29	NPB	Compound 38	6.86	50	3570	7.14	Blue	318
Example 30	NPB	Compound 54	6.84	50	3465	6.93	Blue	356
Example 31	NPB	Compound 57	6.83	50	3560	7.12	Blue	366
Example 32	NPB	Compound 72	6.85	50	3550	7.1	Blue	359
Example 33	NPB	Compound 88	6.85	50	3575	7.15	Blue	342
Example 34	NPB	Compound 90	6.86	50	3565	7.13	Blue	363
Example 35	NPB	Compound 129	6.86	50	3460	6.92	Blue	347
Example 36	NPB	Compound 134	6.87	50	3455	6.91	Blue	338
Example 37	Compound 172	Compound 2	5.56	50	3690	7.38	Blue	397
Example 38	Compound 172	Compound 13	5.55	50	3725	7.45	Blue	389
Example 39	Compound 172	Compound 38	5.56	50	3755	7.51	Blue	328
Example 40	Compound 172	Compound 57	5.55	50	3765	7.53	Blue	415
Example 41	Compound 172	Compound 88	5.54	50	3785	7.57	Blue	408
Example 42	NPB	Compound 2A	6.79	50	3570	7.14	Blue	343
Example 43	NPB	Compound 3A	6.75	50	3455	6.91	Blue	321
Example 44	NPB	Compound 11A	6.65	50	3520	7.04	Blue	307
Example 45	NPB	Compound 15A	6.72	50	3460	6.92	Blue	342
Example 46	NPB	Compound 27A	6.84	50	3420	6.84	Blue	347
Example 47	NPB	Compound 32A	6.87	50	3490	6.98	Blue	351
Example 48	NPB	Compound 50A	6.92	50	3560	7.12	Blue	319
Example 49	NPB	Compound 56A	6.68	50	3630	7.26	Blue	342
Example 50	NPB	Compound 72A	6.78	50	3605	7.21	Blue	327
Example 51	NPB	Compound 83A	6.85	50	3420	6.84	Blue	342
Example 52	NPB	Compound 88A	6.78	50	3505	7.01	Blue	324
Example 53	NPB	Compound 106A	6.81	50	3410	6.82	Blue	337
Example 54	NPB	Compound 120A	6.88	50	3525	7.05	Blue	314
Example 55	NPB	Compound 125A	6.85	50	3495	6.99	Blue	319
Example 56	NPB	Compound 137A	6.77	50	3410	6.82	Blue	346
Example 57	NPB	Compound 161A	6.92	50	3480	6.96	Blue	327
Example 58	Compound 142A	Compound 2A	5.42	50	3620	7.24	Blue	397
Example 59	Compound 142A	Compound 11A	5.44	50	3685	7.37	Blue	407
Example 60	Compound 142A	Compound 56A	5.52	50	3805	7.61	Blue	369
Example 61	Compound 142A	Compound 72A	5.47	50	3705	7.41	Blue	401
Example 62	Compound 142A	Compound 120A	5.61	50	3655	7.31	Blue	384
Comparative Example 1	NPB	TPD	7.01	50	2645	5.29	Blue	258
Comparative Example 2	NPB	Compound A	6.95	50	2420	4.84	Blue	250
Comparative Example 3	NPB	Compound B	6.68	50	3120	6.24	Blue	294
Comparative Example 4	NPB	Compound C	6.84	50	2745	5.49	Blue	338

[0399] As Illustrated in Table 3, it was confirmed that the organic light-emitting devices manufactured according to Examples 21 to 62 have higher driving voltage, higher brightness, higher efficiency, and/or longer half-lifespan than the organic light-emitting devices manufactured according to Comparative Examples 1 to 4.

[0400] An organic light-emitting device including the compound according to embodiments of the present invention may have low driving voltage, high efficiency, high brightness, and long lifespan.

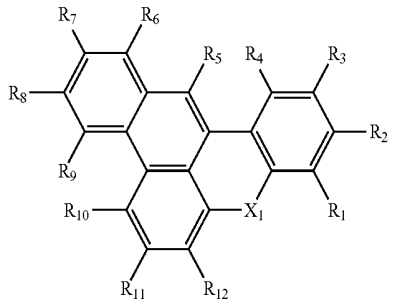
[0401] It should be understood that the exemplary embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each exemplary embodiment should typically be considered as available for other similar features or aspects in other exemplary embodiments.

[0402] While one or more exemplary embodiments have been described with reference to the figures, 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.

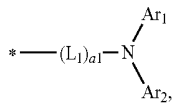
What is claimed is:

1. A condensed cyclic compound represented by Formula 1:

Formula 1



Formula 2



wherein in Formulae 1 and 2,

X_1 is O or S;

L_1 is each Independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-C_{10} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group;

a1 is selected from 0, 1, 2, and 3, and when a1 is two or more, a plurality of L_1 are identical to or different from each other;

A_1 and Ar_2 are each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, 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;

R_1 to R_{12} are each Independently selected from a group represented by Formula 2, 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_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-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, —$Si(Q_1)(Q_2)(Q_3)$, and —$B(Q_4)(Q_5)$;

at least two selected from R_1 to R_{12} are each independently the group represented by Formula 2;

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 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_1-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 group or a

salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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_{10} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —$Si(Q_{11})(Q_{12})(Q_{13})$, and —$B(Q_{14})(Q_{15})$;

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic group;

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric add group or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_6-C_{60} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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 heterocondensed polycyclic group, —$Si(Q_{21})(Q_{22})(Q_{23})$, and —$B(Q_{24})(Q_{25})$; and

—$Si(Q_{31})(Q_{32})(Q_{33})$ and —$B(Q_{34})(Q_{35})$,

wherein Q_1 to Q_5, Q_{11} to Q_{15}, Q_{21} to Q_{25}, and Q_{31} to Q_{35} 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_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-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.

2. The condensed cyclic compound of claim **1**, wherein L_1 is selected from:

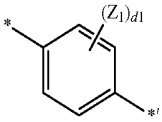
a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spirofluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, an ovalenylene group, a pyrrolylene group, a thiophenylene group, a furanylene group, an Imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, a isoxazolytene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an Indolylene group, an indazolylene group, a purinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a carbazolylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzoimidazolylene group, a benzofuranylene group, a benzothiophenylene group, an isobenzothlazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylene group, and an imidazopyrimidinylene group; and

a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an Indacenylene group, an acenaphthylene group, a fluorenylene group, a spirofluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, ovalenylene group, a pyrrolylene group, a thiophenylene group, a furanylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, an indazolylene group, a purinylene group, a quinolinylene group, an isoquinolinylene group, a benzoqulnolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a carbazolylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzoimidazolylene group, a benzofuranylene group, a benzothiophenylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylene group, and an imidazopyrmidinylene 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

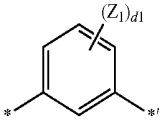
group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a 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 quinazofinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

3. The condensed cyclic compound of claim **1**, wherein L_1 is selected from a group represented by any one of Formulae 3-1 to 3-35:

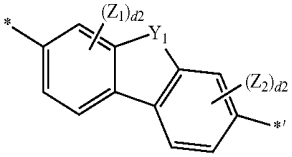
Formula 3-1



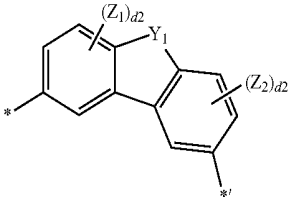
Formula 3-2



Formula 3-3



Formula 3-4



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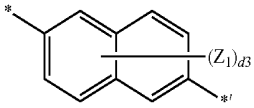
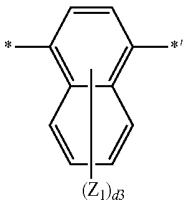
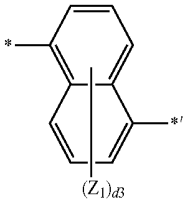
Formula 3-5



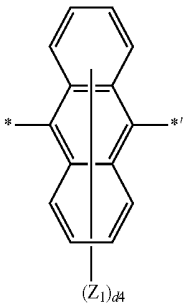
Formula 3-6



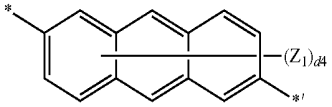
Formula 3-7



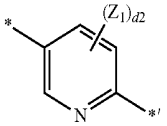
Formula 3-8



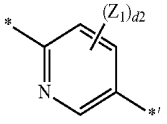
Formula 3-9



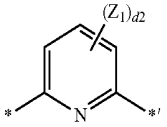
Formula 3-10



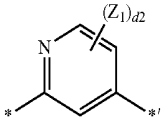
Formula 3-11



Formula 3-12



Formula 3-13



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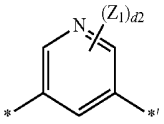
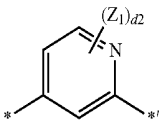
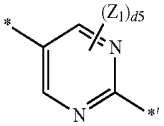
Formula 3-14



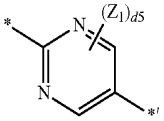
Formula 3-15



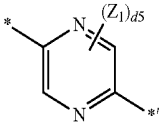
Formula 3-16



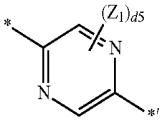
Formula 3-17



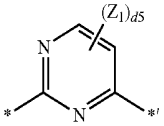
Formula 3-18



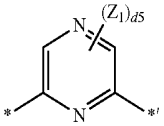
Formula 3-19



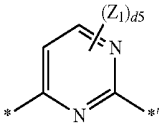
Formula 3-20



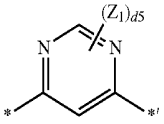
Formula 3-21



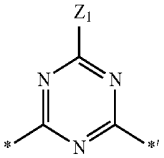
Formula 3-22



Formula 3-23



Formula 3-24



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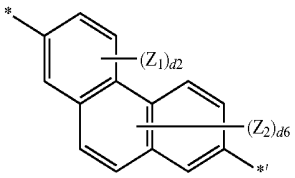
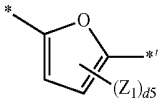
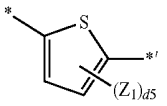
Formula 3-25



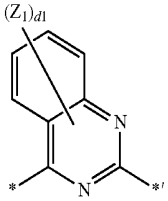
Formula 3-26



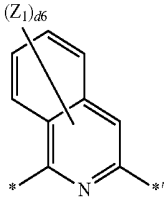
Formula 3-27



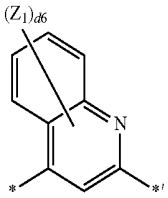
Formula 3-28



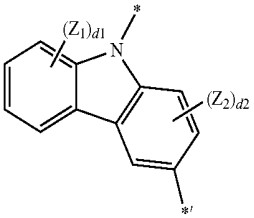
Formula 3-29



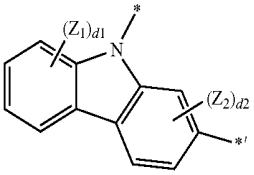
Formula 3-30



Formula 3-31



Formula 3-32



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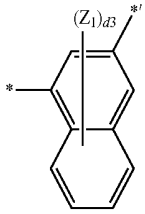
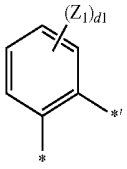
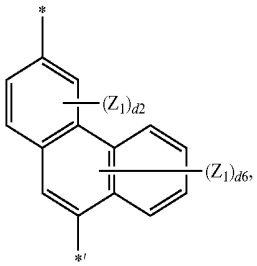
Formula 3-33



Formula 3-34



Formula 3-35



wherein in Formulae 3-1 to 3-35,

Y_1 is O, S, $C(Z_3)(Z_4)$, $N(Z_5)$, or $Si(Z_6)(Z_7)$;

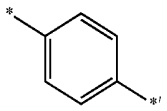
Z_1 to Z_7 are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a qulnolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group,

d1 is an integer selected from 1, 2, 3, and 4, d2 is an integer selected from 1, 2, and 3, d3 is an integer selected from 1, 2, 3, 4, 5, and 6, d4 is an integer selected from 1, 2, 3, 4, 5, 6, 7, and 8, d5 is 1 or 2, and d6 is an integer selected from 1, 2, 3, 4, and 5, and * and *' each indicate a binding site to a neighboring atom.

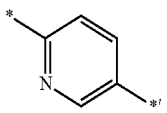
4. The condensed cyclic compound of claim **1**, wherein

L_1 is selected from a group represented by any one of Formulae 4-1 to 4-28:

Formula 4-1



Formula 4-2



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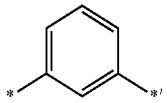
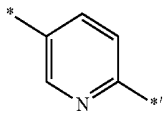
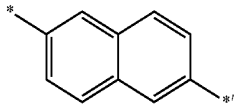
Formula 4-3



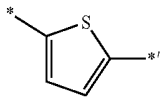
Formula 4-4



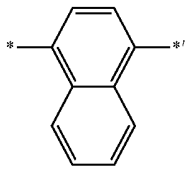
Formula 4-5



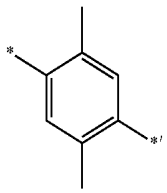
Formula 4-6



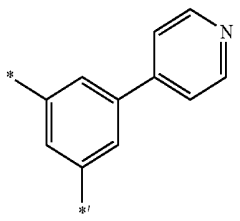
Formula 4-7



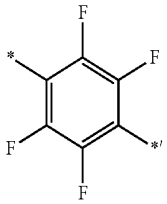
Formula 4-8



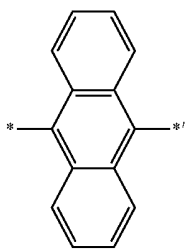
Formula 4-9



Formula 4-10



Formula 4-11



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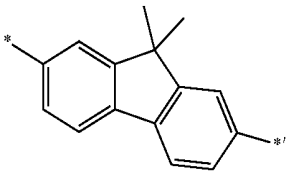
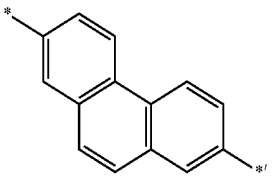
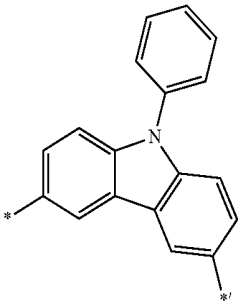
Formula 4-12



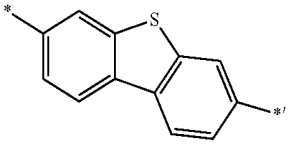
Formula 4-13



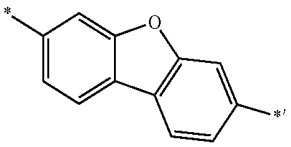
Formula 4-14



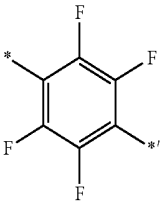
Formula 4-15



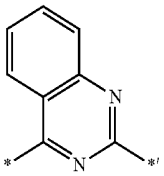
Formula 4-16



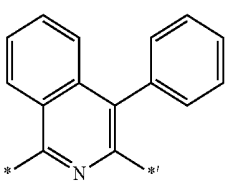
Formula 4-17



Formula 4-18



Formula 4-19



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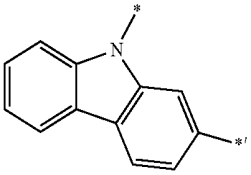
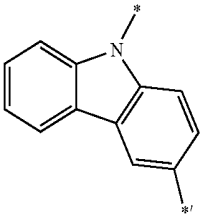
Formula 4-20



Formula 4-21



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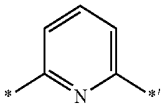
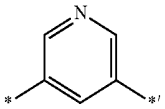
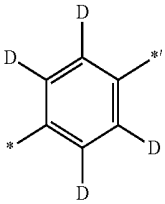


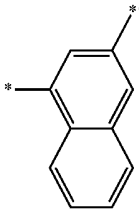
Formula 4-23



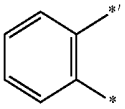
Formula 4-24



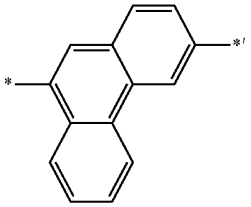
Formula 4-25



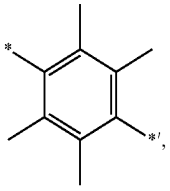
Formula 4-26



Formula 4-27



Formula 4-28



wherein * and *' in Formulae 4-1 to 4-28 each indicate a binding site to a neighboring atom.

5. The condensed cyclic compound of claim **1**, wherein a1 is 0 or 1.

6. The condensed cyclic compound of claim **1**, wherein Ar_1 and Ar_2 are each Independently selected from:

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 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 dibenzosilolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl 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 benzofuranyl group, a benzothiophenyl group, an Isobenzothlazolyl 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 dibenzosilolyl 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_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyi 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 benzofuranyl group, a benzothiophenyl group, an Isobenzothlazolyl 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 and a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$; and

wherein Q_{31} to Q_{33} are each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothlazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an Isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an Isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, a triazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an Imidazopyrimidinyl group.

7. The condensed cyclic compound of claim **1**, wherein Ar_1 and Ar_2 are each independently selected from:

a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a diben-

zofluorenyl group, a phenanthrenyl group, an anthracenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an Isoqulnolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an Isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$, and

wherein Q_{31} to Q_{33} are each Independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

8. The condensed cyclic compound of claim **1**, wherein

Ar_1 and Ar_2 are each independently selected from:

a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$, and

wherein Q_{31} to Q_{33} are each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

9. The condensed cyclic compound of claim **1**, wherein

R_1 to R_{12} are each independently selected from:

a group represented by Formula 2, 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_{20} alkyl group, and a C_1-C_{20} alkoxy group;

a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoqulnolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyi group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothlazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl 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_{10} alkyl group, a C_1-C_{10} 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 triphenylenyl group, a pyrenyl group, a chrysenyl 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, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzooxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$; and

—$Si(Q_1)(Q_2)(Q_3)$,

wherein Q_1 to Q_3 and Q_{31} to Q_{33} are each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

10. The condensed cyclic compound of claim **1**, wherein

R_1 to R_{12} are each independently selected from:

a group represented by Formula 2, 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_{10} alkyl group, and a C_1-C_{10} alkoxy group;

a phenyl group, a naphthyl group, a pyrimidinyl group, and a triazinyl group;

a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl 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 C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, a triazinyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$; and

—$Si(Q_1)(Q_2)(Q_3)$,

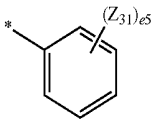
wherein Q_1 to Q_3 and Q_{31} to Q_{33} are each independently selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, and a naphthyl group.

11. The condensed cyclic compound of claim **1**, wherein

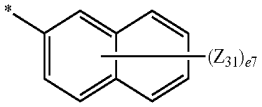
Ar_1 and Ar_2 are each independently selected from a group represented by any one of Formula 5-1 to Formula 5-42, and

R_1 to R_{12} are each independently selected from a group represented by Formula 2, 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 and a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_2 alkoxyl group, and the group represented by any one of Formula 5-1 to Formula 5-42:

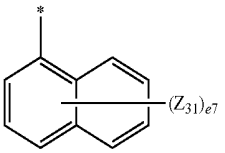
Formula 5-1



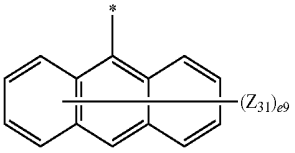
Formula 5-2



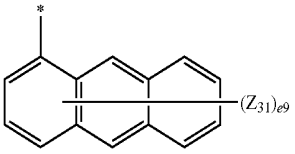
Formula 5-3



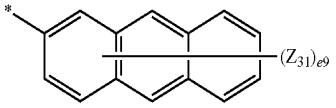
Formula 5-4



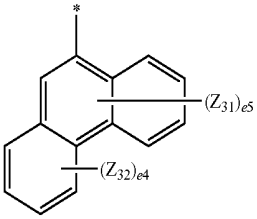
Formula 5-5



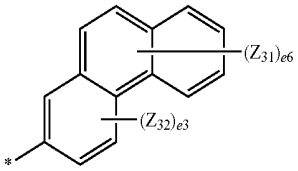
Formula 5-6



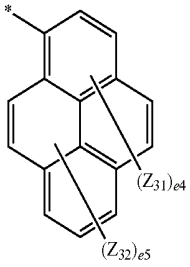
Formula 5-7



Formula 5-8

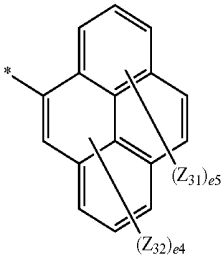


Formula 5-9

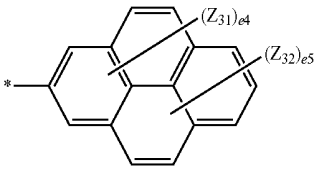


-continued

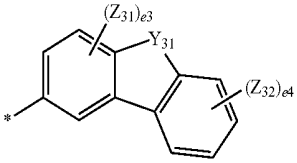
Formula 5-10



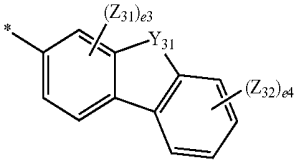
Formula 5-11



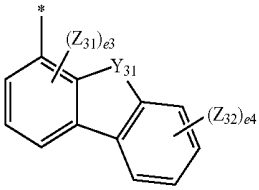
Formula 5-12



Formula 5-13



Formula 5-14



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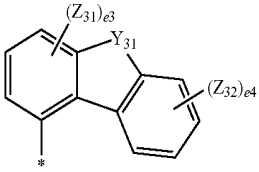
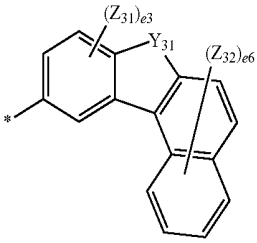


Formula 5-16



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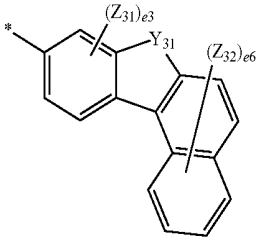
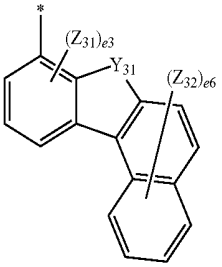
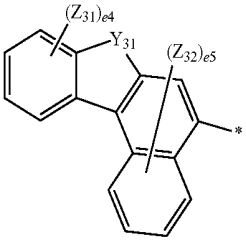
Formula 5-17



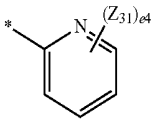
Formula 5-18



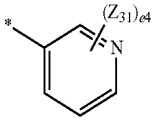
Formula 5-19



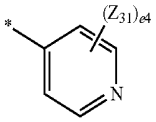
Formula 5-20



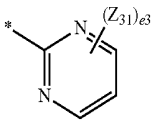
Formula 5-21



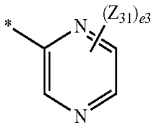
Formula 5-22



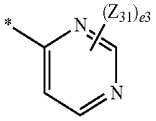
Formula 5-23



Formula 5-24



Formula 5-25



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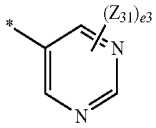
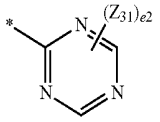
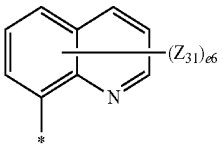
Formula 5-26



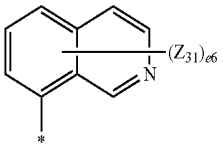
Formula 5-27



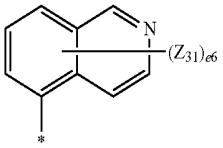
Formula 5-28



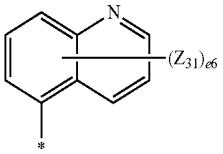
Formula 5-29



Formula 5-30



Formula 5-31



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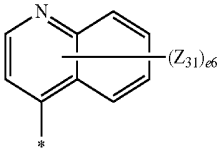
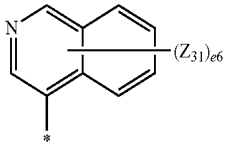
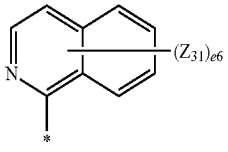


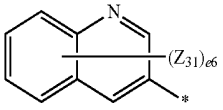
Formula 5-33



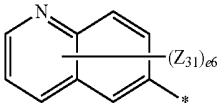
Formula 5-34



Formula 5-35



Formula 5-36



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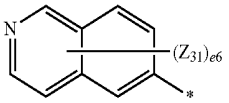
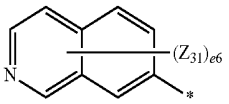
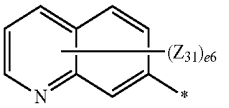
Formula 5-37



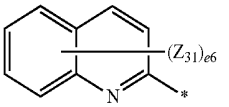
Formula 5-38



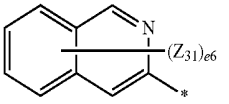
Formula 5-39



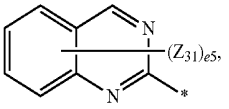
Formula 5-40



Formula 5-41



Formula 5-42



wherein in Formulae 5-1 to 5-42,

Y_{31} is O, S, $C(Z_{23})(Z_{34})$, $N(Z_{35})$, or $Si(Z_{36})(Z_{37})$;

Z_{31} to Z_{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_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyndazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group,

e2 is 1 or 2, e3 is an integer selected from 1, 2, and 3, e4 is an integer selected from 1, 2, 3, and 4, e5 is an integer selected from 1, 2, 3, 4, and 5, e6 is an integer selected from 1, 2, 3, 4, 5, and 6, e7 is an integer selected from 1, 2, 3, 4, 5, 6, and 7, e9 is an integer selected from 1, 2, 3, 4, 5, 6, 7, 8, and 9, and * Indicates a binding site to a neighboring atom.

12. The condensed cyclic compound of claim **1**, wherein

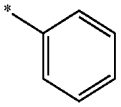
A_1 and Ar_2 are each independently selected from a group represented by any one of Formula 6-1 to Formula 6-29, and

R_1 to R_{12} are each Independently selected from:

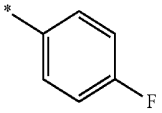
a group represented by Formula 2, a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid and a salt thereof, a C_1-C_{20} alkyl group,

a C_1-C_2 alkoxyl group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group:

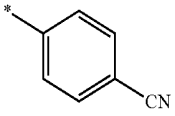
Formula 6-1



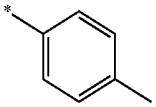
Formula 6-2



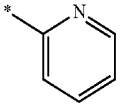
Formula 6-3



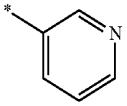
Formula 6-4



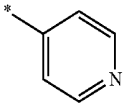
Formula 6-5



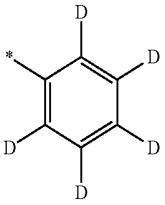
Formula 6-6



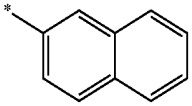
Formula 6-7



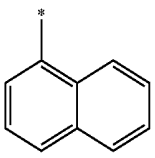
Formula 6-8



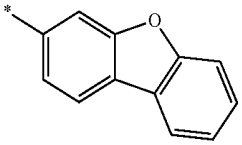
Formula 6-9



Formula 6-10



Formula 6-11



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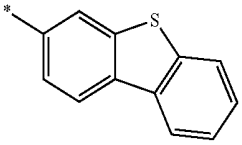
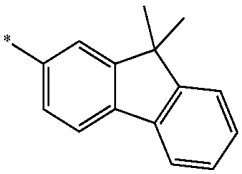
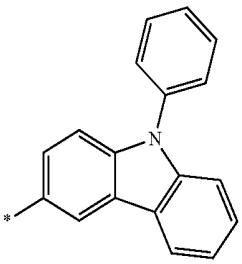
Formula 6-12



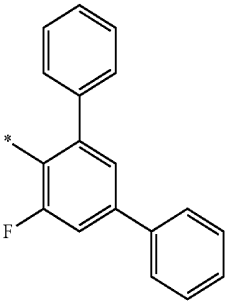
Formula 6-13



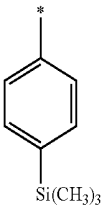
Formula 6-14



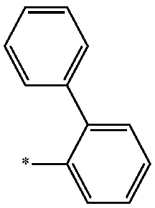
Formula 6-15



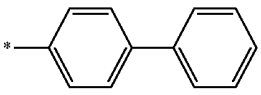
Formula 6-16



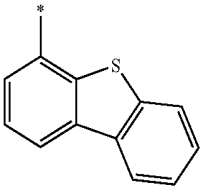
Formula 6-17



Formula 6-18



Formula 6-19



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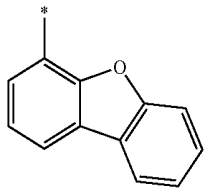
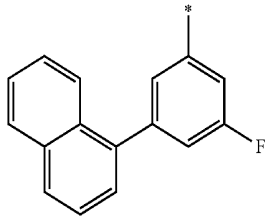
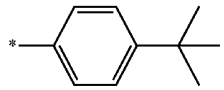


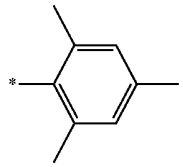
Formula 6-21



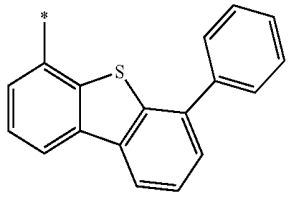
Formula 6-22



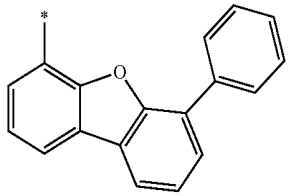
Formula 6-23



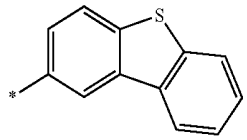
Formula 6-24



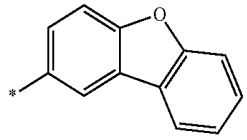
Formula 6-25



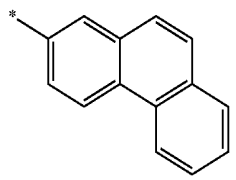
Formula 6-26



Formula 6-27



Formula 6-28



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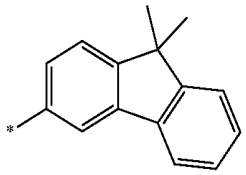
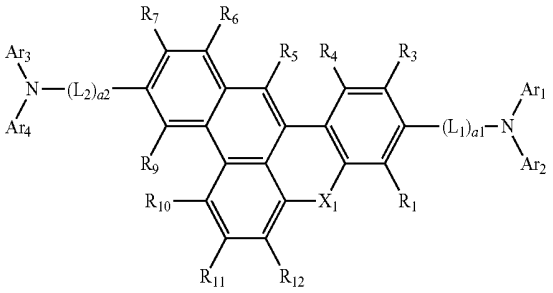
Formula 6-29



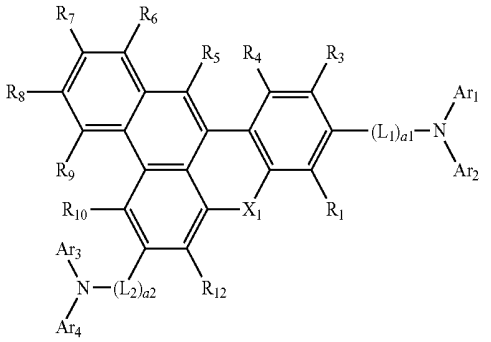
wherein * in Formulae 6-1 to 6-29 indicates a binding site to a neighboring atom.

13. The condensed cyclic compound of claim **1**, wherein the condensed cyclic compound is represented by any one of Formulae 1-1 to 1-4:

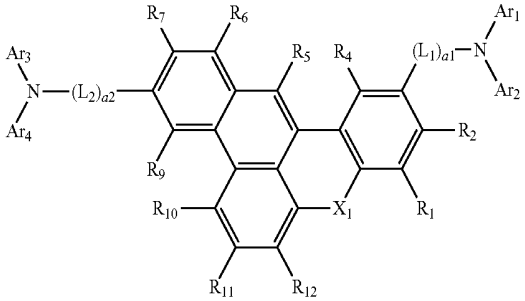
Formula 1-1



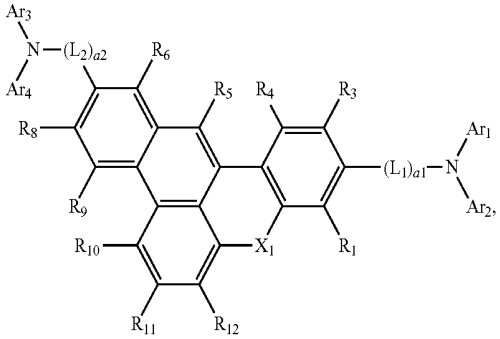
Formula 1-2



Formula 1-3



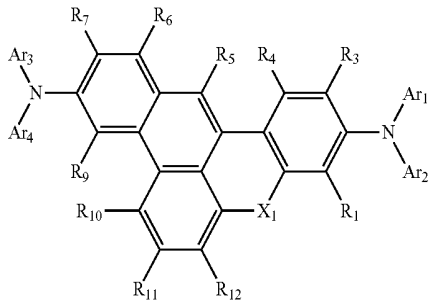
Formula 1-4



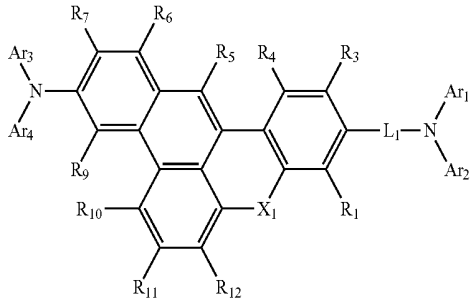
wherein in Formulae 1-1 to 1-4, descriptions of L_2, a2, Ar_3, and Ar_4 are the same as those of L_1, a1, Ar_1, and Ar_2, respectively.

14. The condensed cyclic compound of claim **1**, wherein the condensed cyclic compound is represented by any one of Formulae 1-1(1) to 1-1(4):

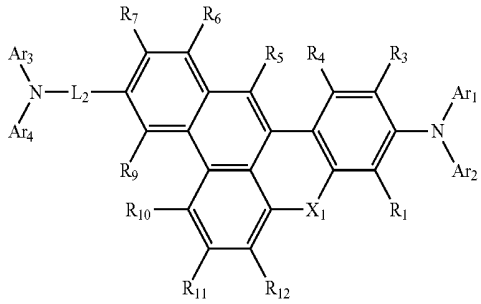
Formula 1-1(1)



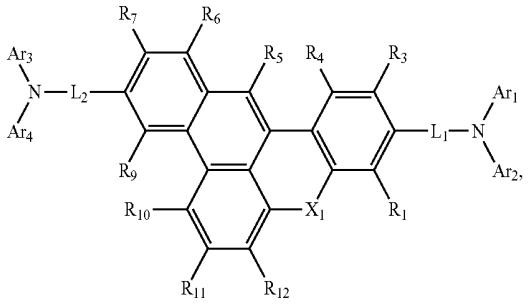
Formula 1-1(2)



Formula 1-1(3)



Formula 1-1(4)



wherein in Formulae 1-1(1) to 1-1(4), descriptions of L_2, a_2, Ar_3, and Ar_4 are the same as those of L_1, a1, Ar_1, and Ar_2, respectively.

15. The condensed cyclic compound of claim **13**, wherein

R_1 to R_4, and R_6 to R_{12} are each a hydrogen,

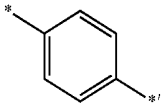
R_5 is selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group,

L_1 and L_2 are each independently selected from a group represented by any one of Formula 4-1 to Formula 4-28,

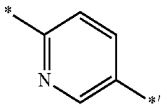
a1 and a2 are each independently 0 or 1, and

A_1 to Ar_4 are each independently selected from a group represented by any one of Formula 6-1 to Formula 6-29:

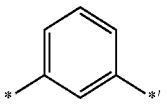
Formula 4-1



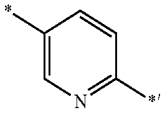
Formula 4-2



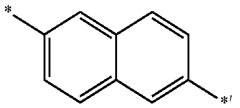
Formula 4-3



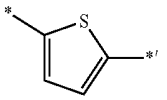
Formula 4-4



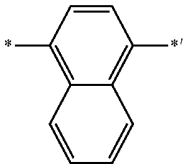
Formula 4-5



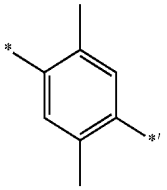
Formula 4-6



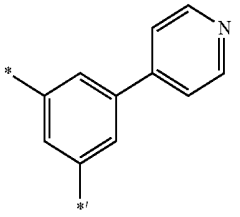
Formula 4-7



Formula 4-8



Formula 4-9



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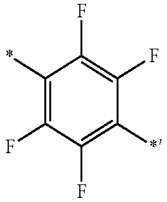
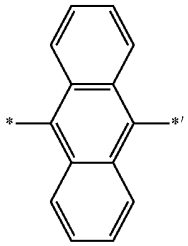
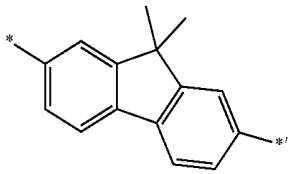
Formula 4-10



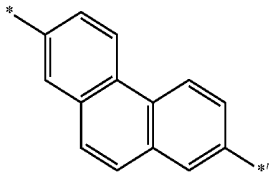
Formula 4-11



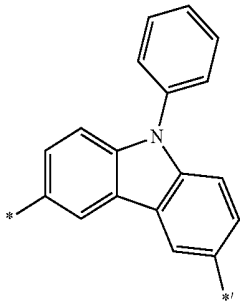
Formula 4-12



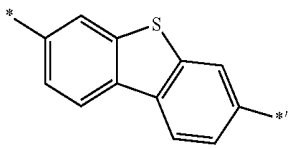
Formula 4-13



Formula 4-14



Formula 4-15



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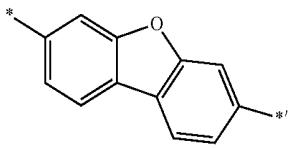

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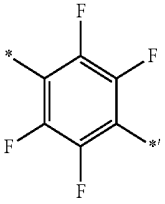

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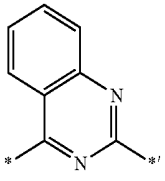

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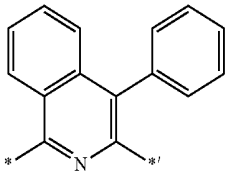

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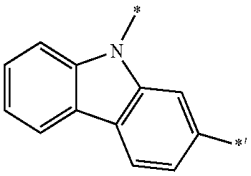

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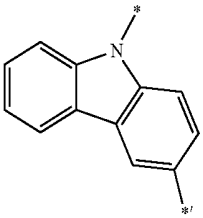
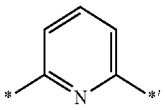


Formula 4-22



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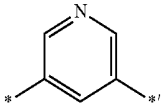

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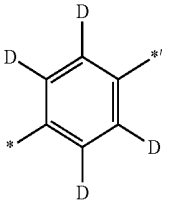

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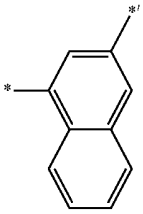

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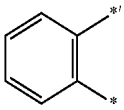

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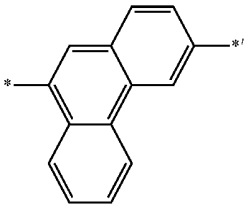

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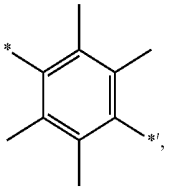
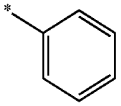
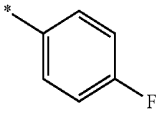


Formula 6-1



Formula 6-2



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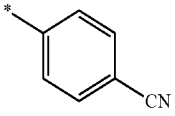

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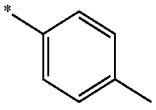
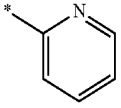


Formula 6-5



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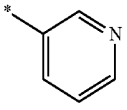

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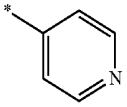

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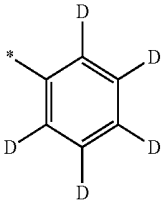

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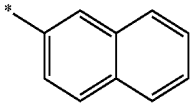

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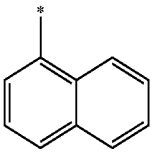
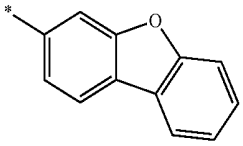


Formula 6-11



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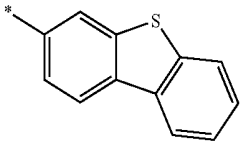

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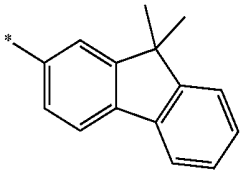

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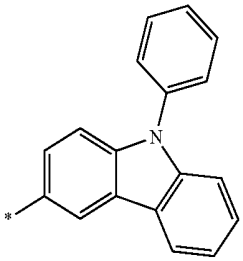

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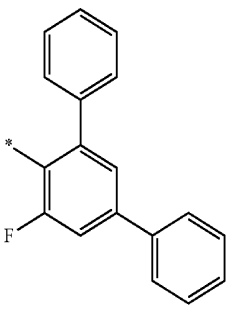

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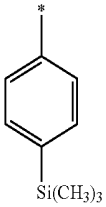

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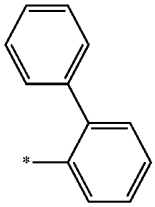

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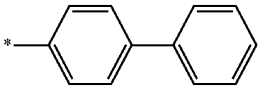

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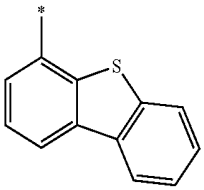

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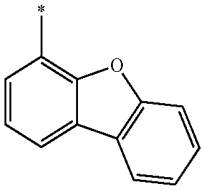

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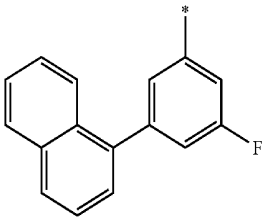

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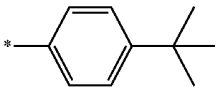

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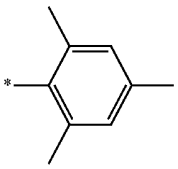

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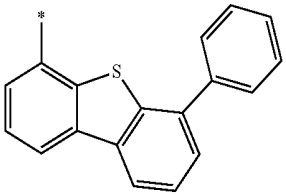

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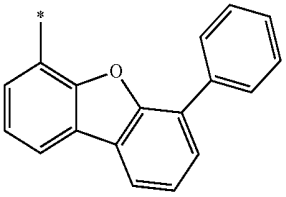

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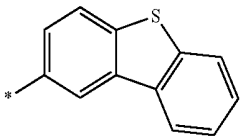

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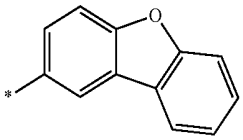

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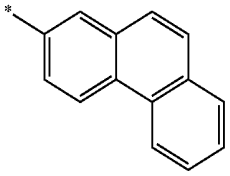

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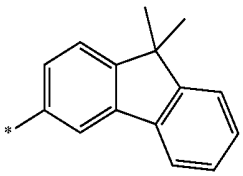

16. The condensed cyclic compound of claim **1**, wherein the condensed cyclic compound is selected from Compounds 1 to 189 and 1A to 164A below:

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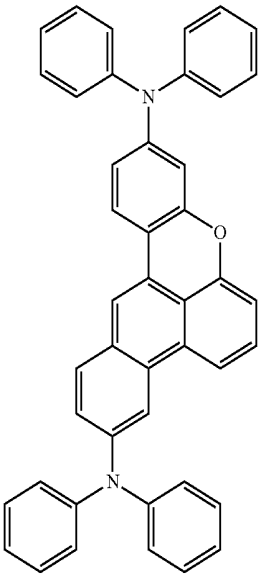

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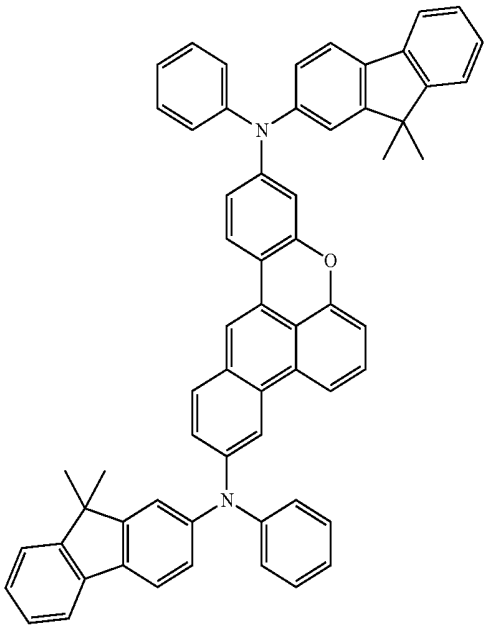

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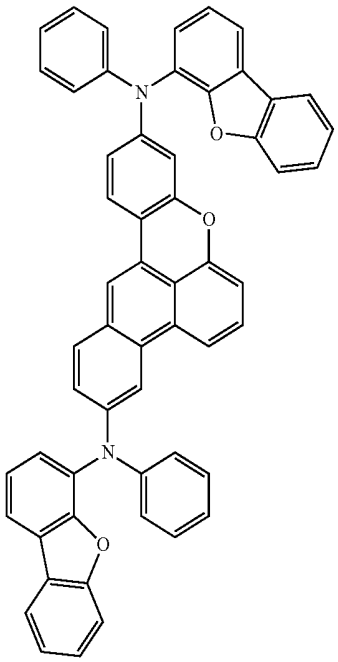

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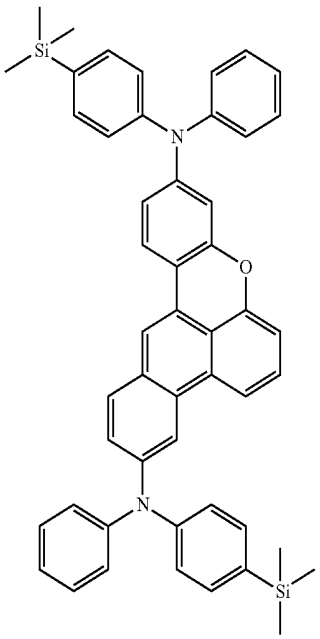

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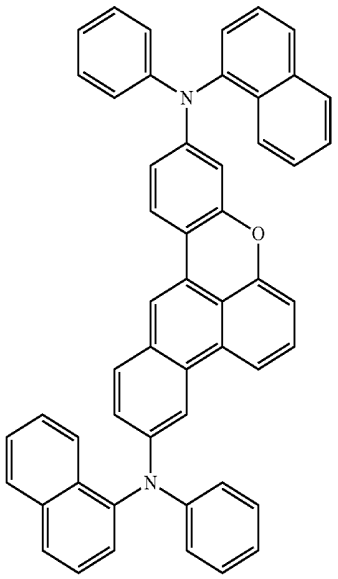

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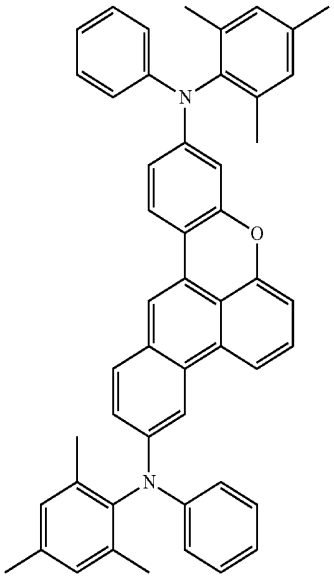

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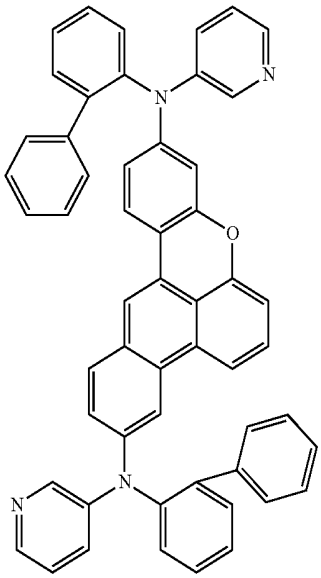

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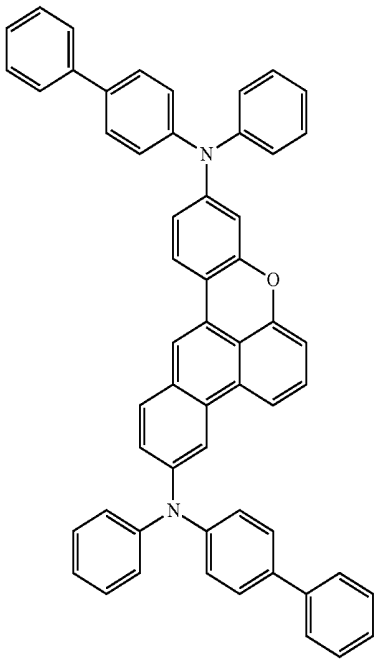

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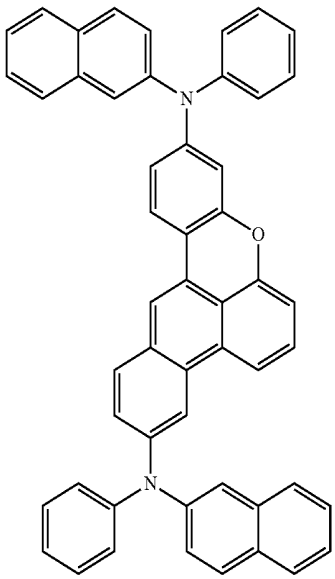

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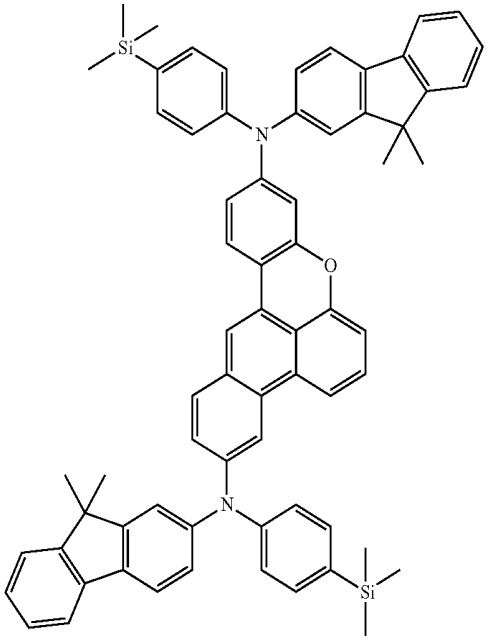

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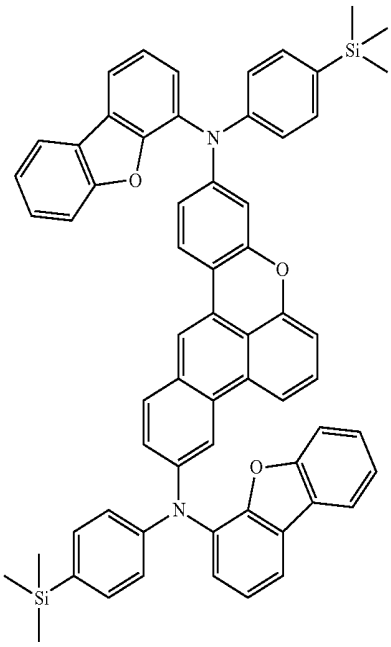

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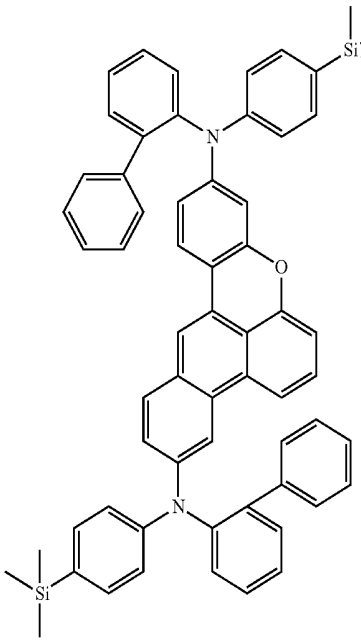

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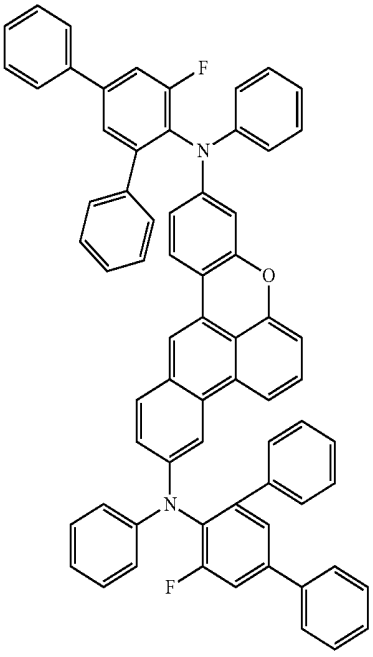

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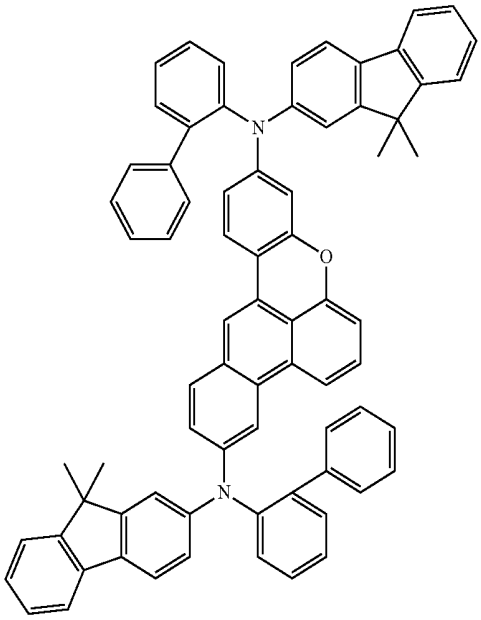

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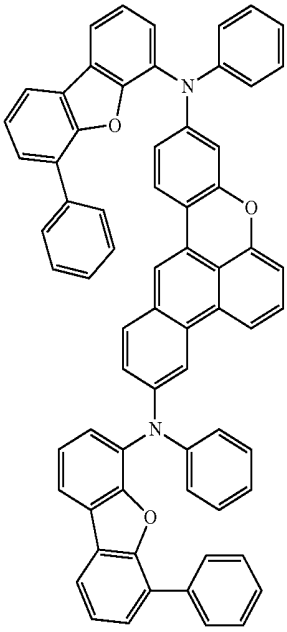

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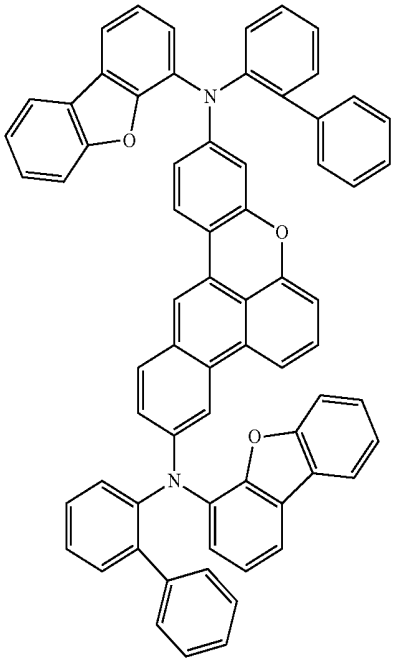

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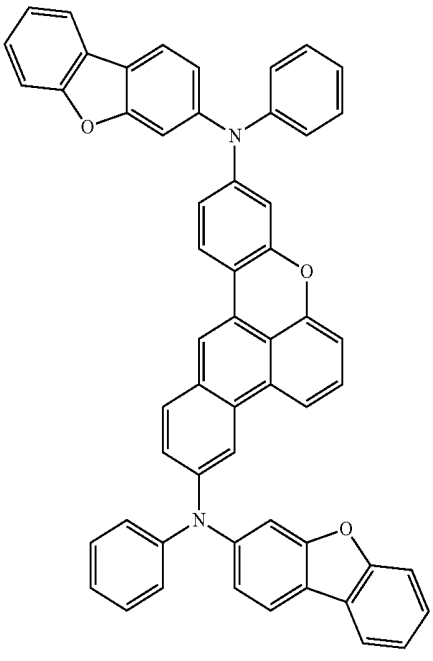

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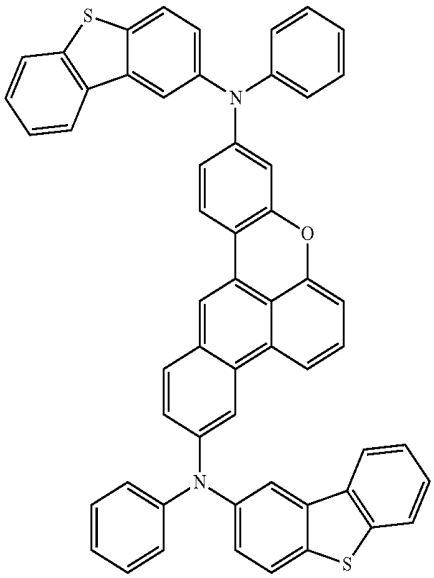

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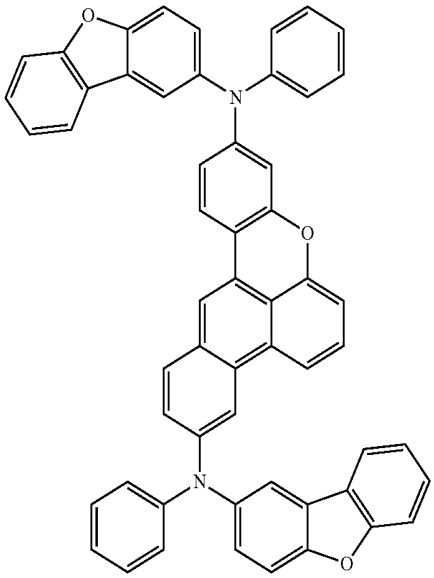

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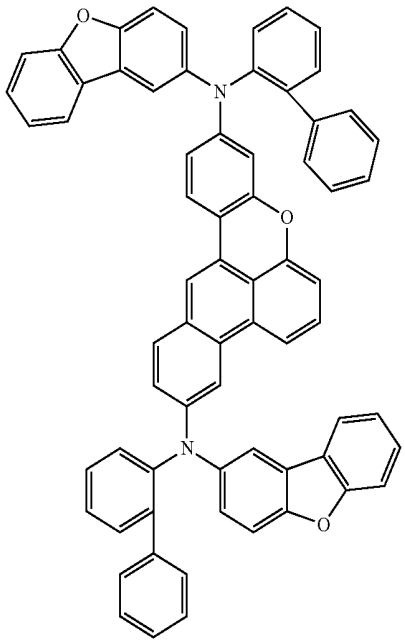

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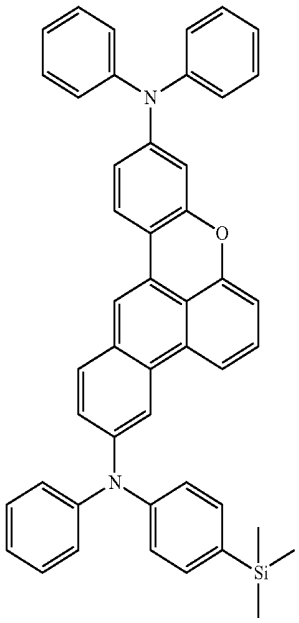

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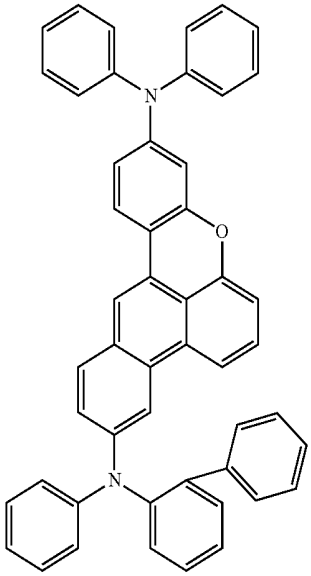

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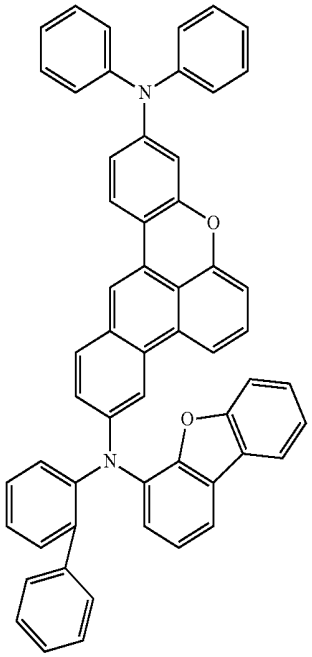

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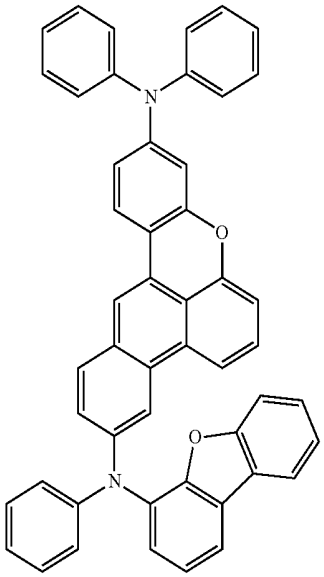

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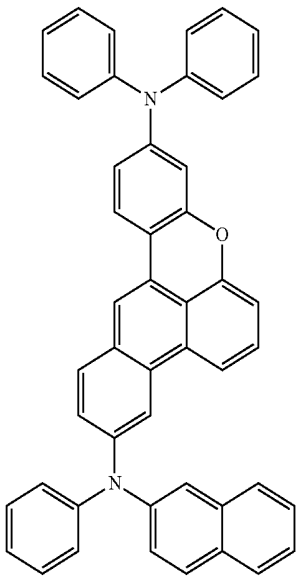

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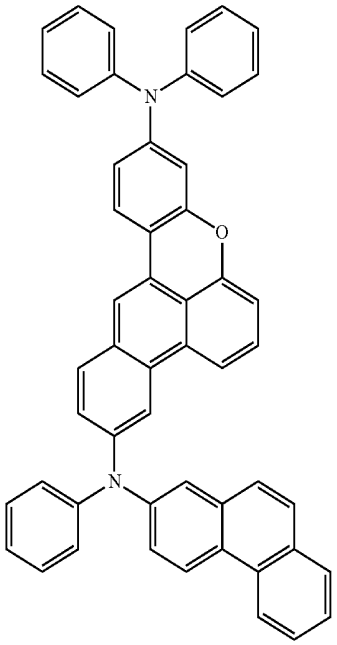

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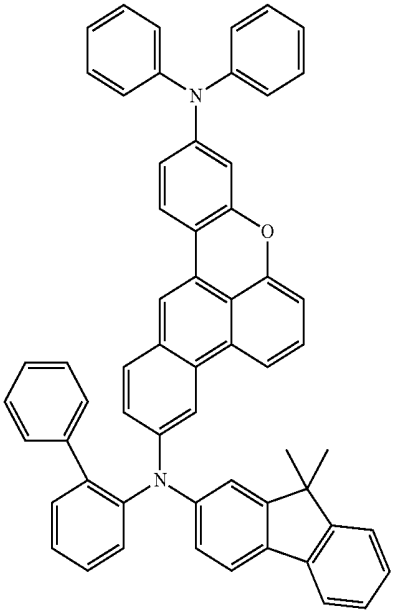

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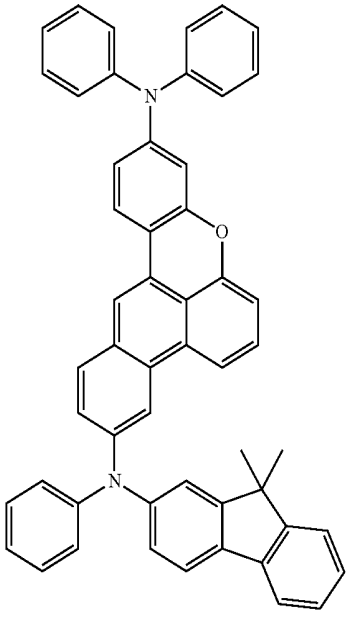

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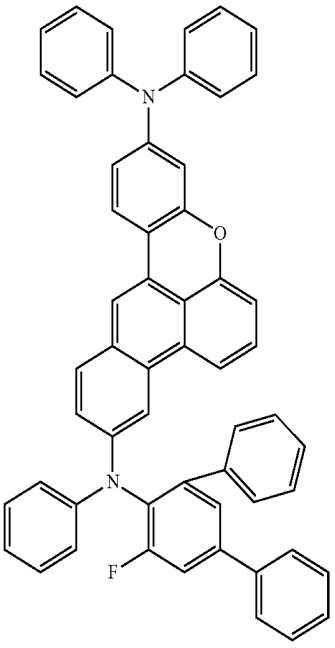

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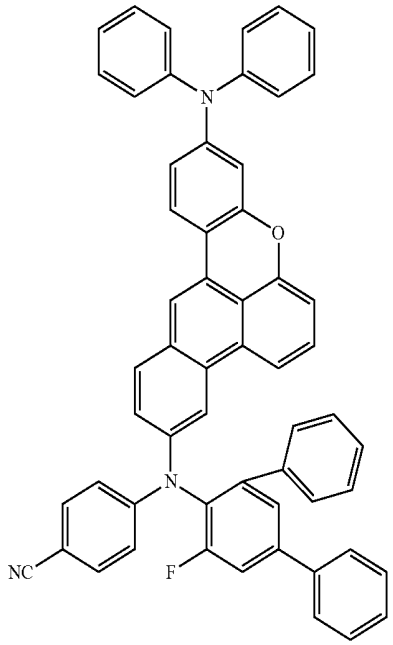

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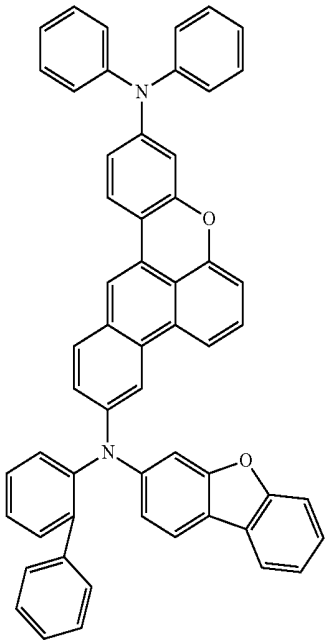

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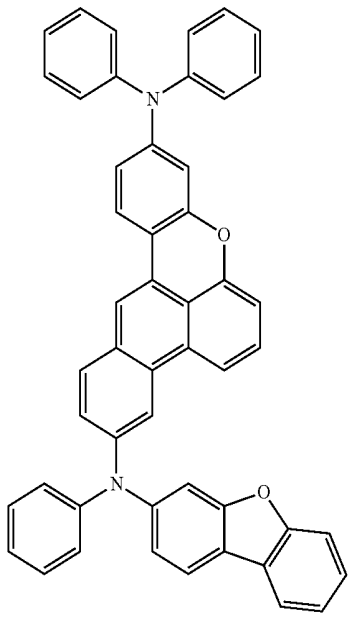

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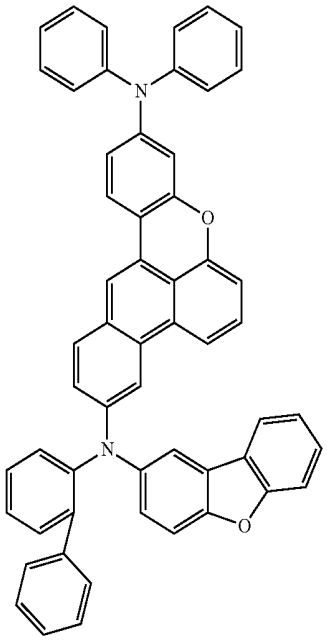

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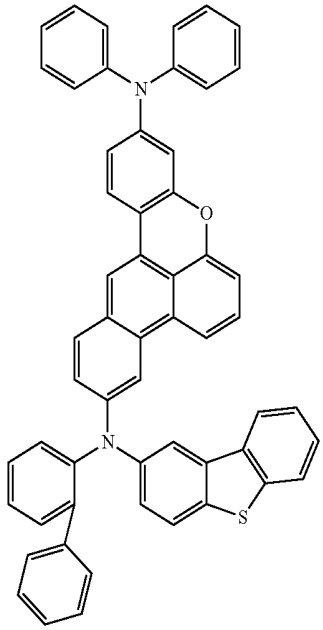

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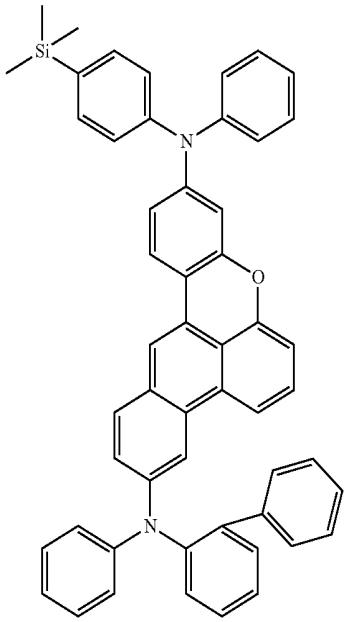

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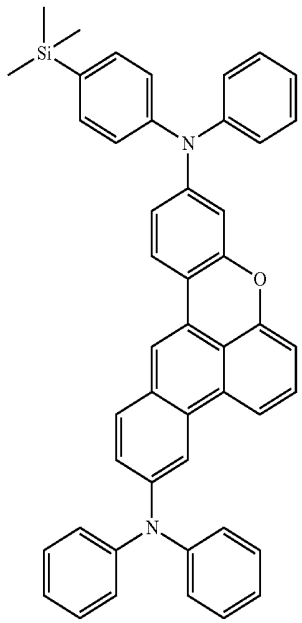

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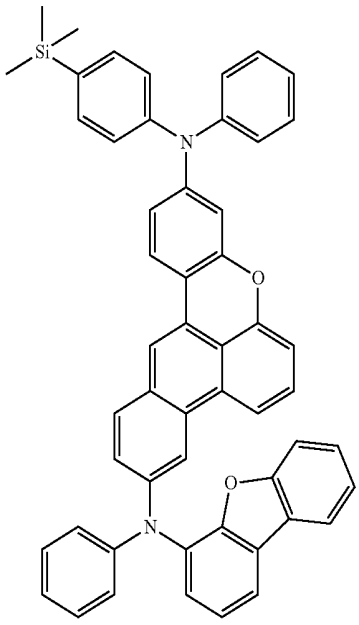

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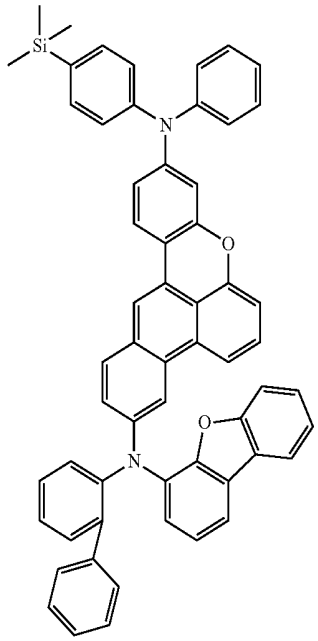

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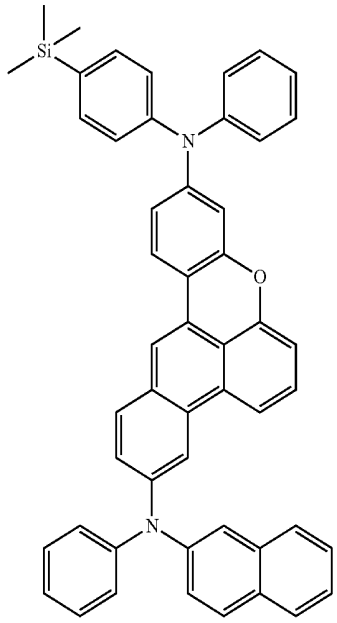

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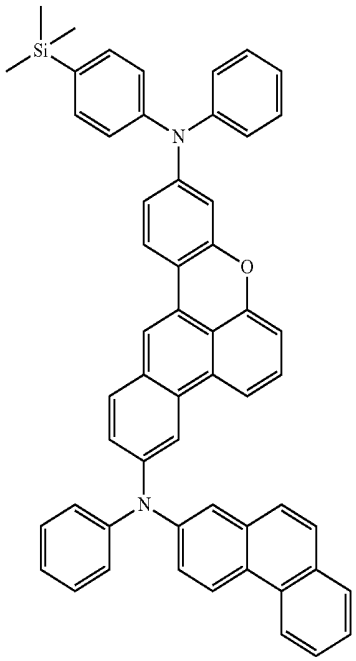

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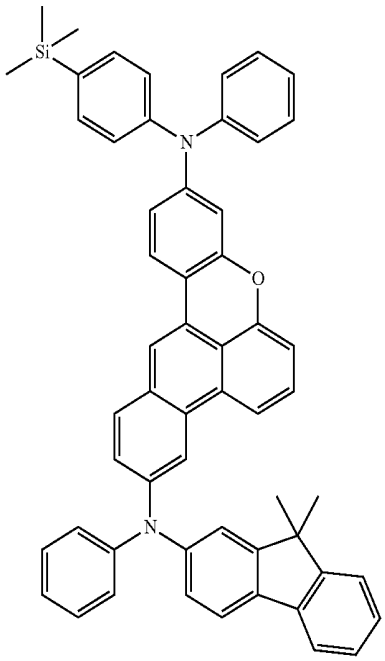

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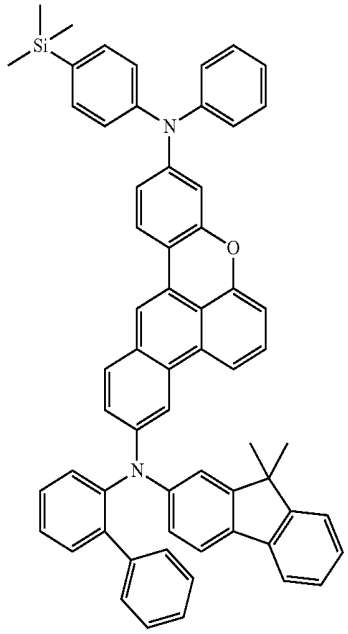

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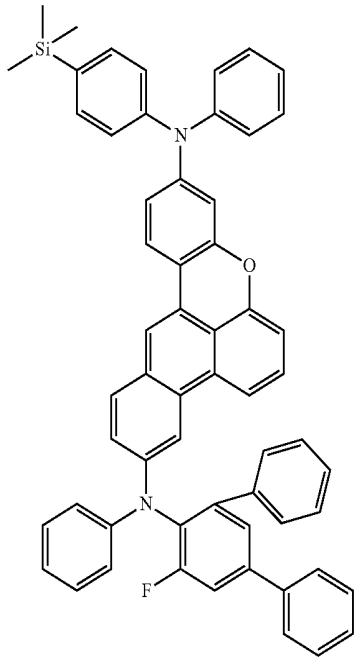

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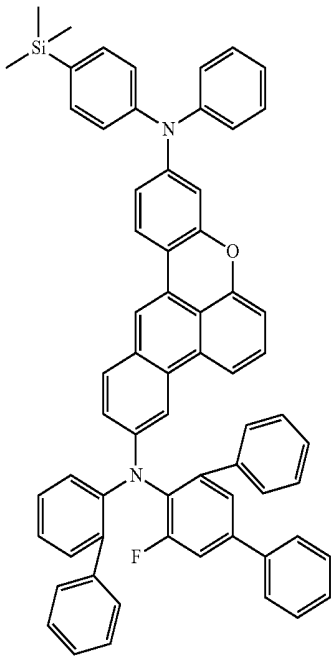

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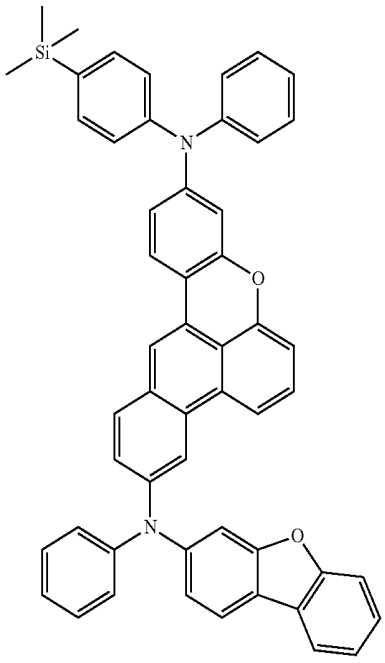

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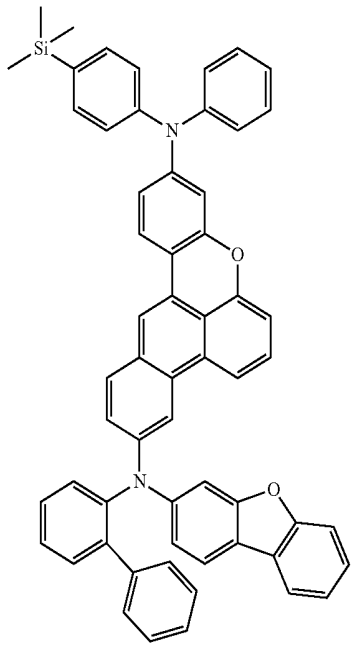

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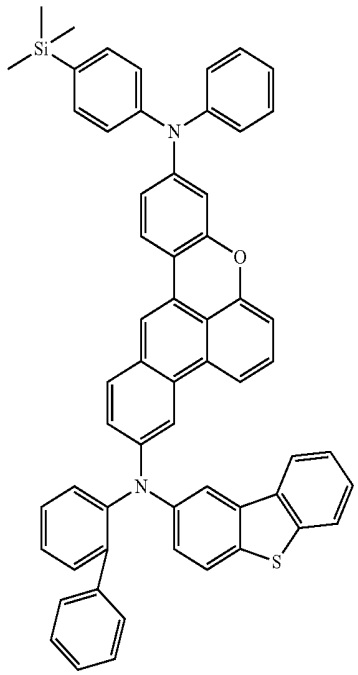

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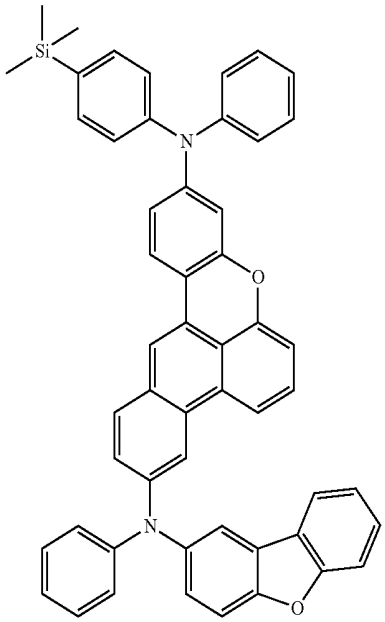

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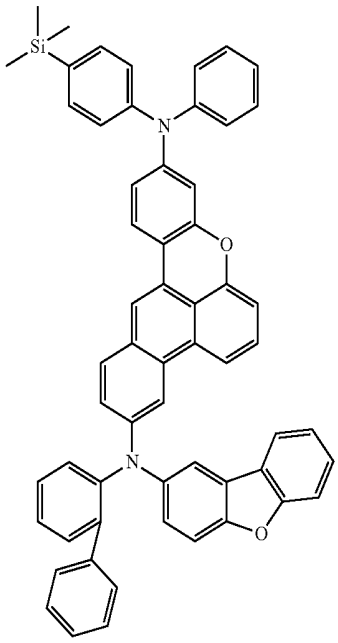

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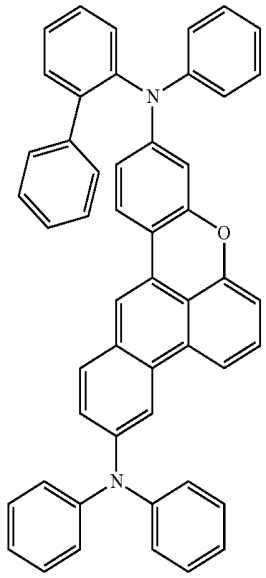

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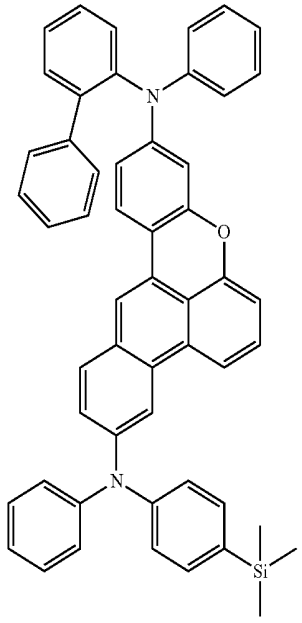

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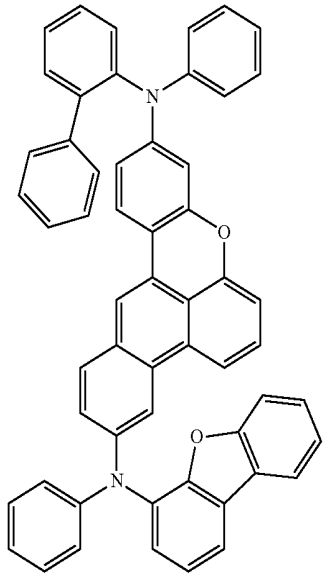

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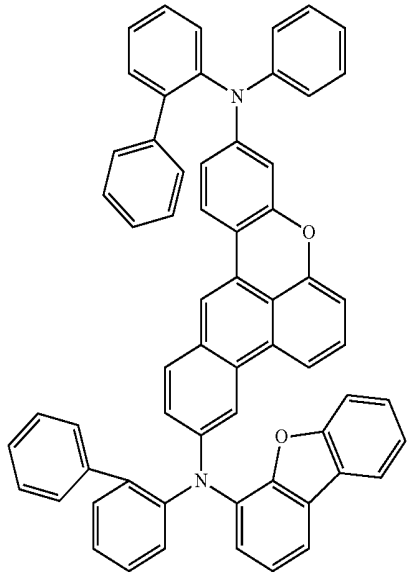

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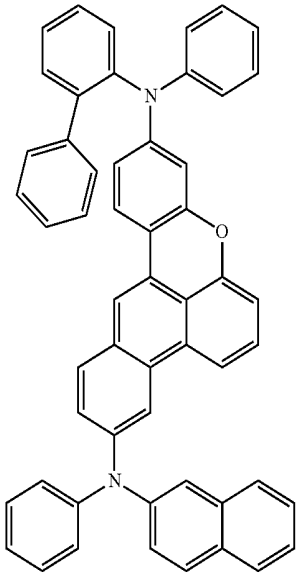

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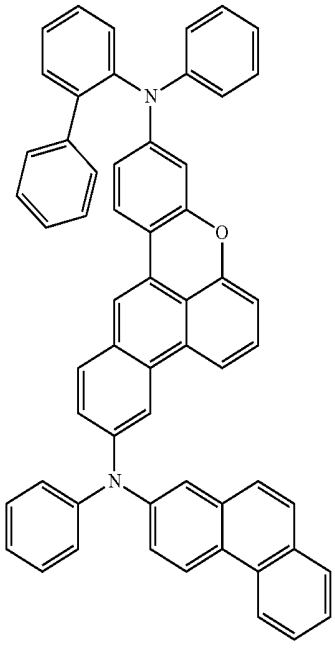

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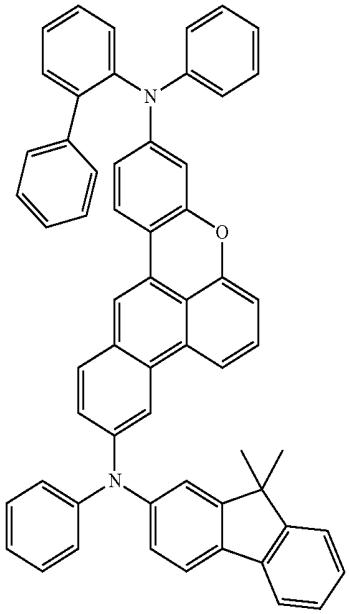

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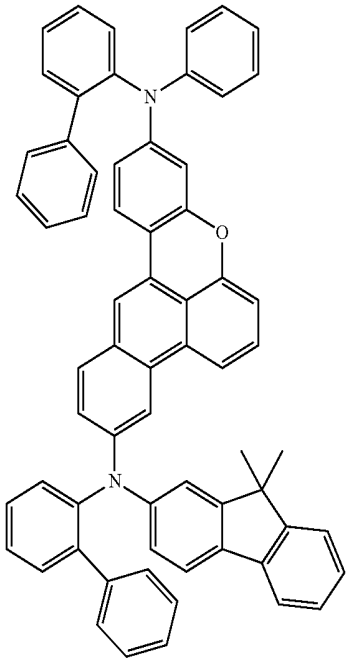

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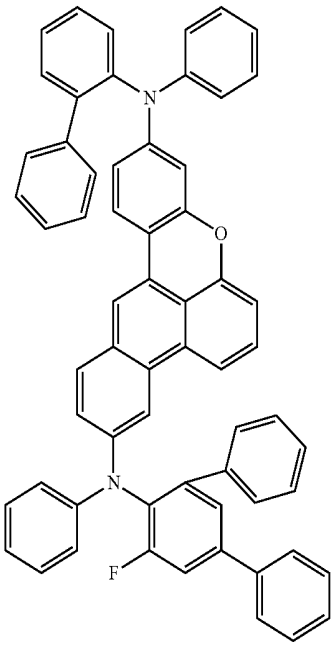

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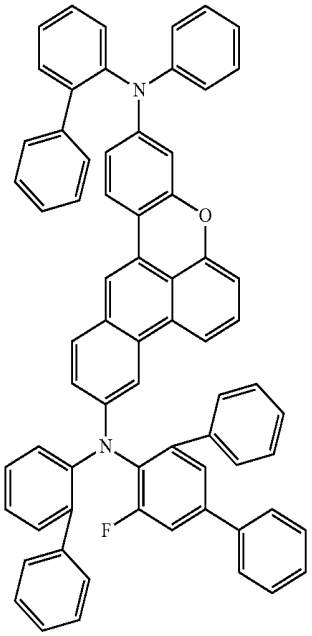

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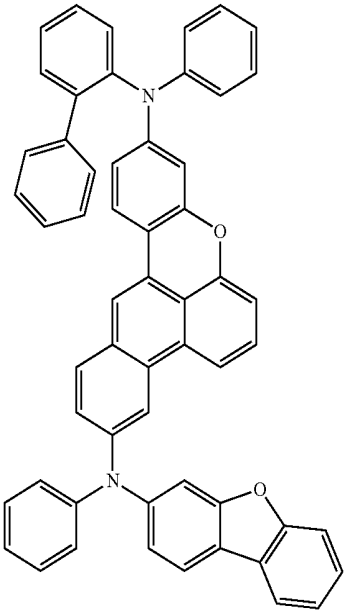

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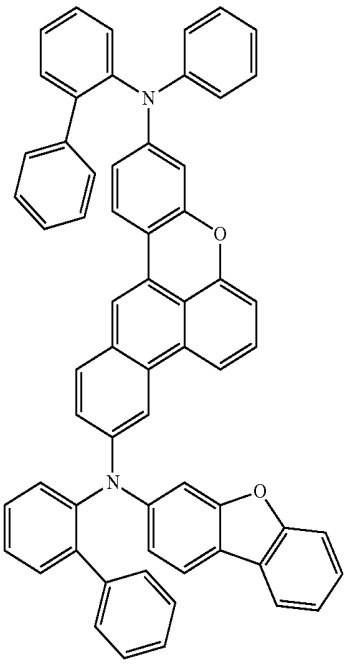

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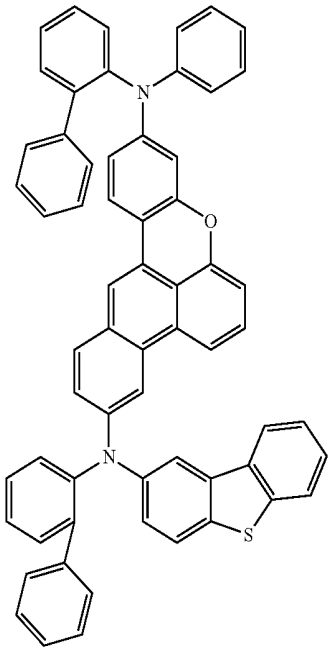

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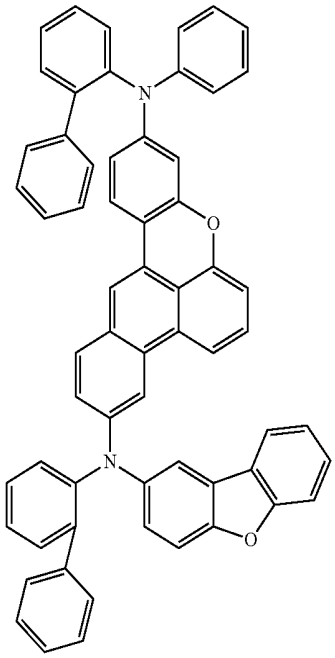

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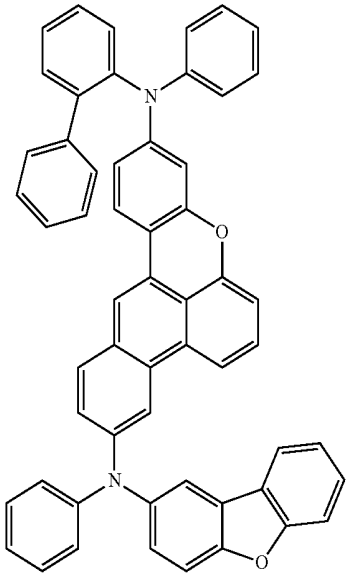

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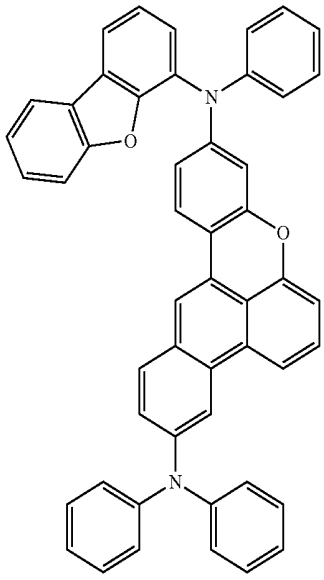

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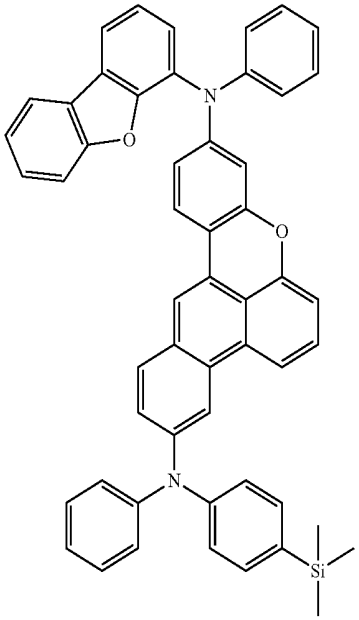

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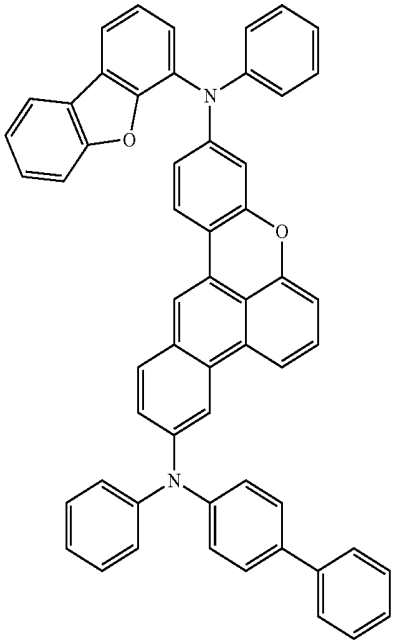

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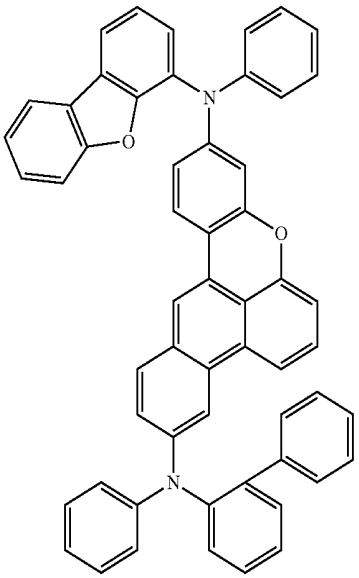

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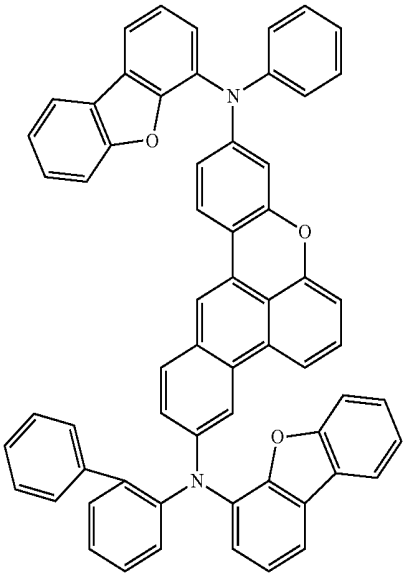

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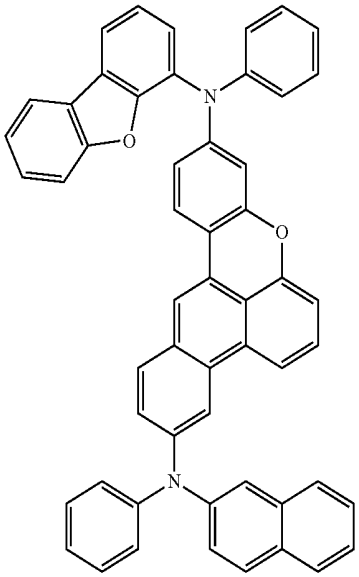

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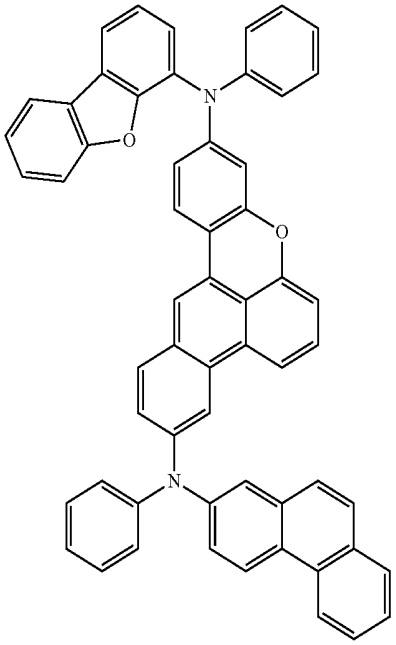

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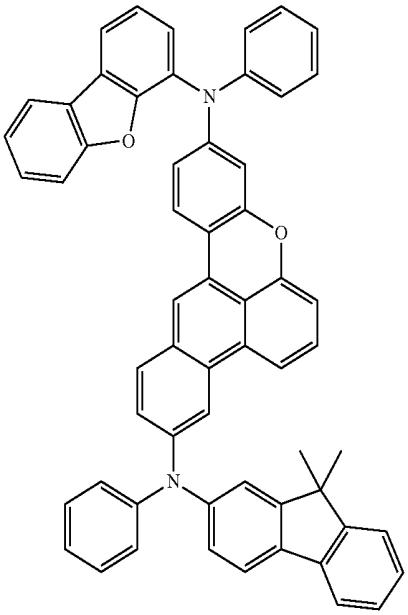

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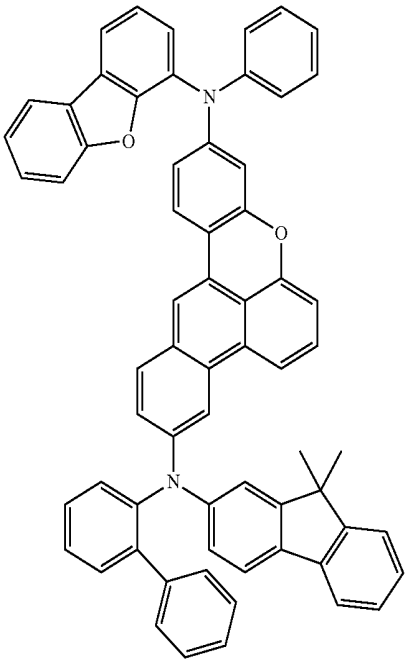

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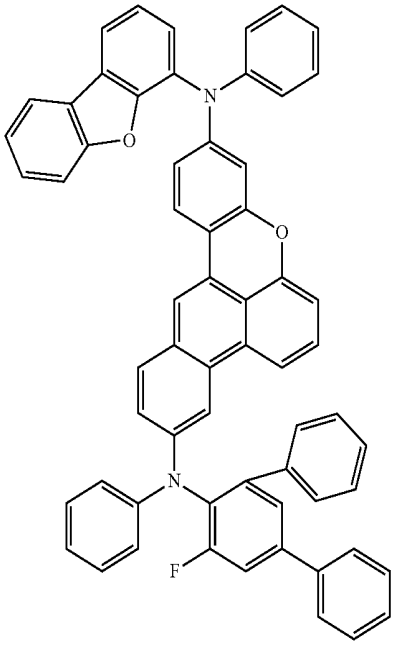

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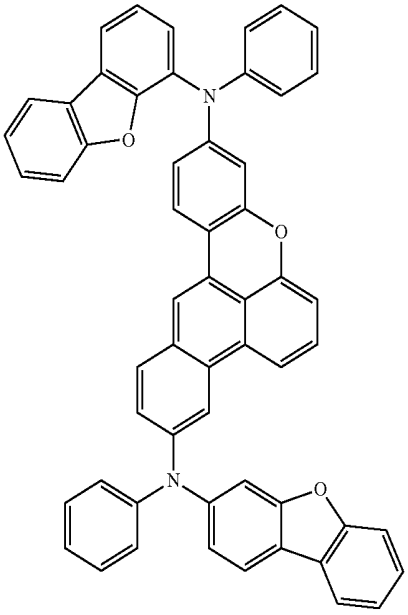

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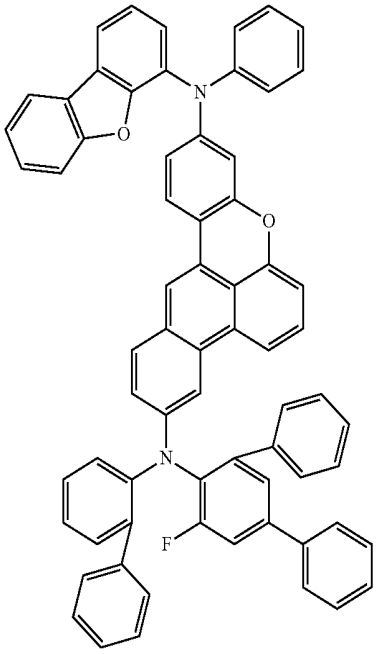

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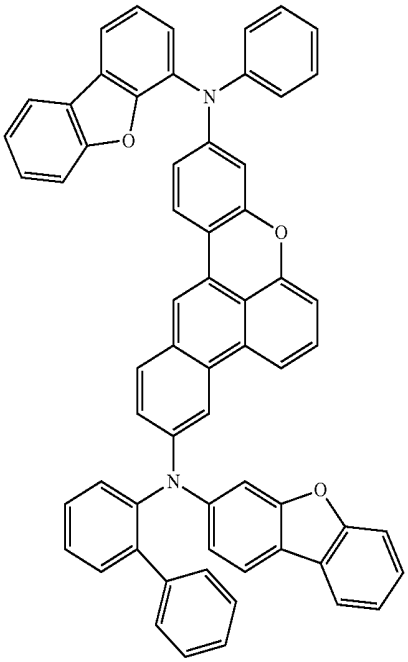

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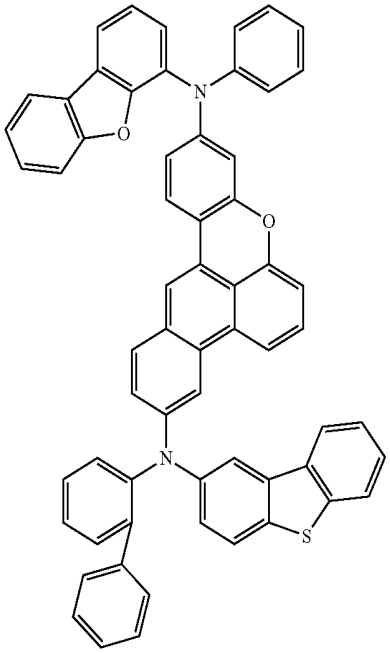

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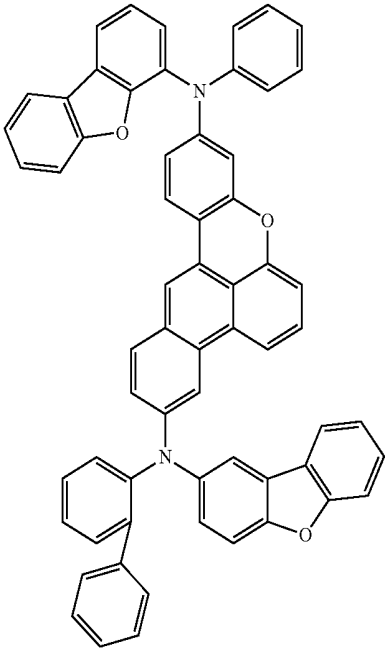

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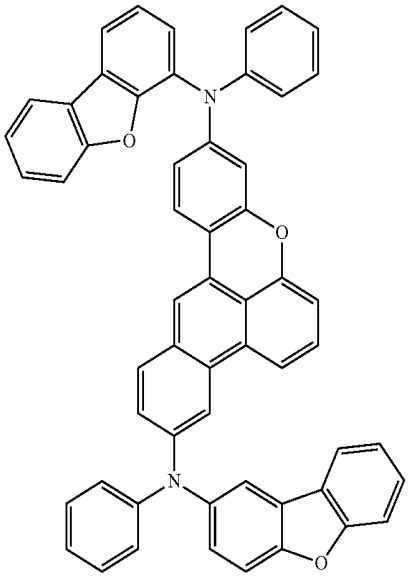

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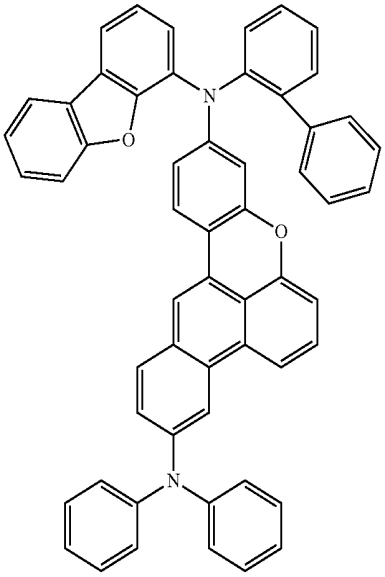

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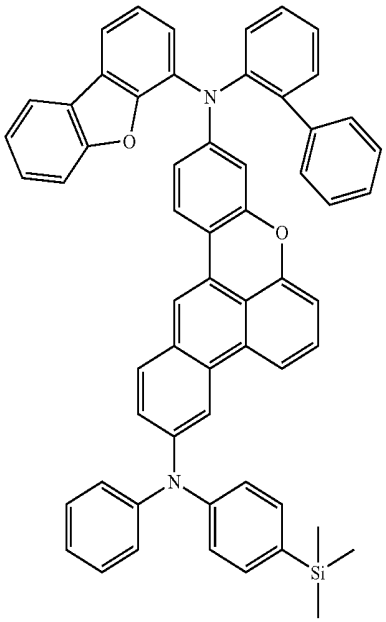

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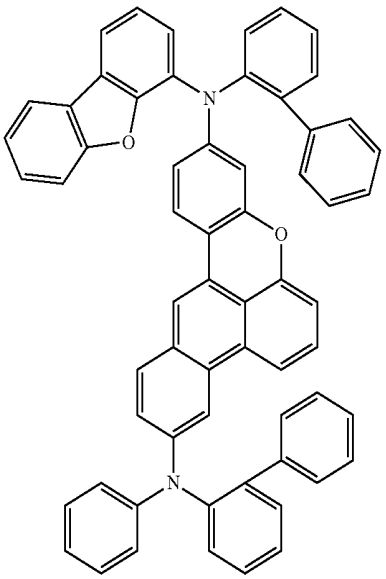

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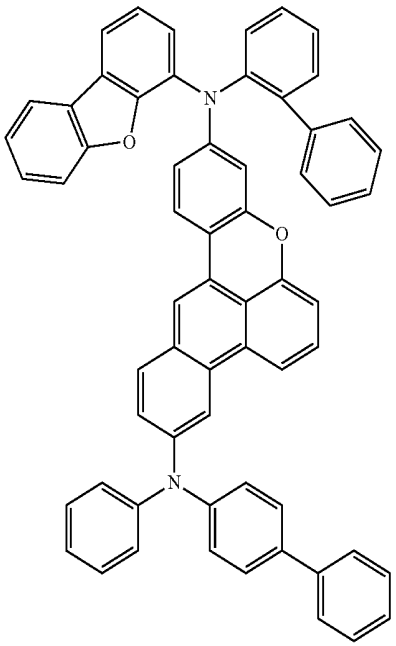

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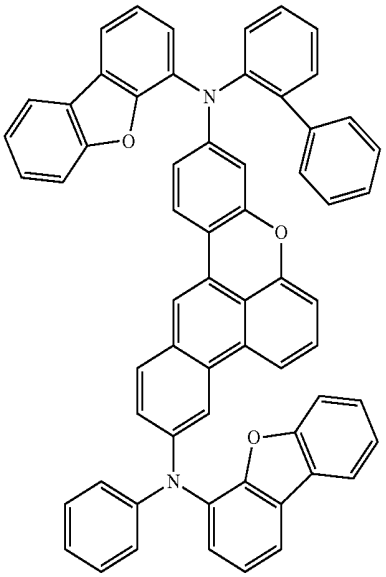

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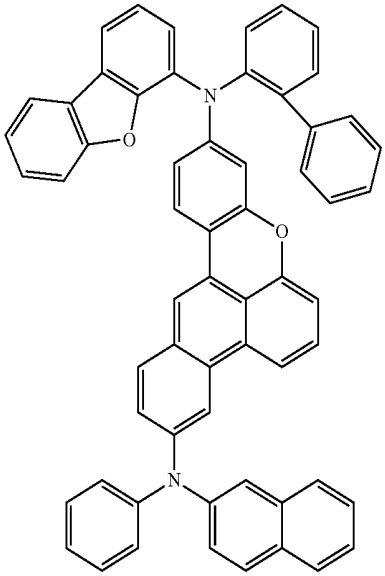

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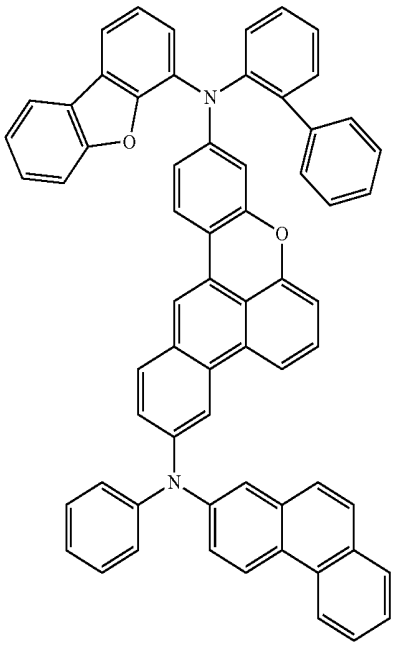

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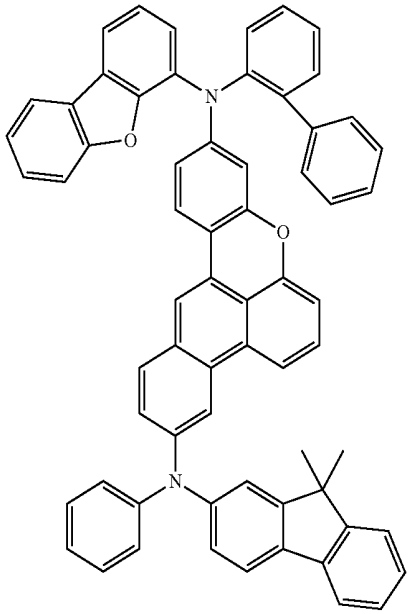

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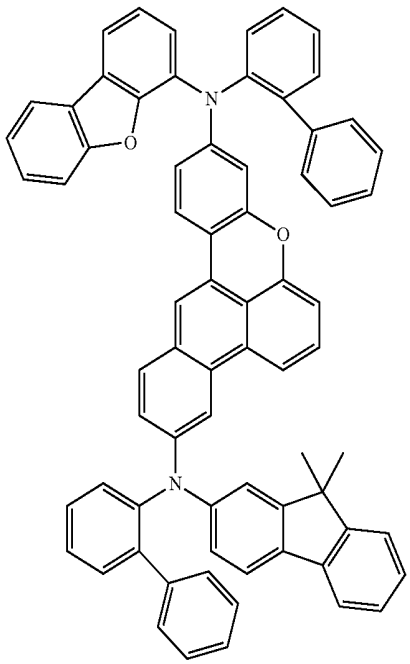

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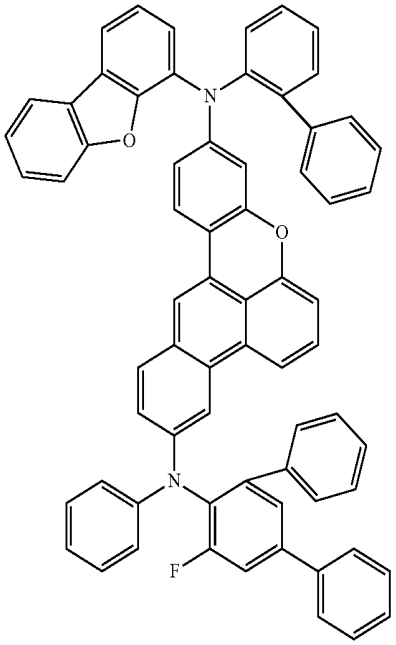

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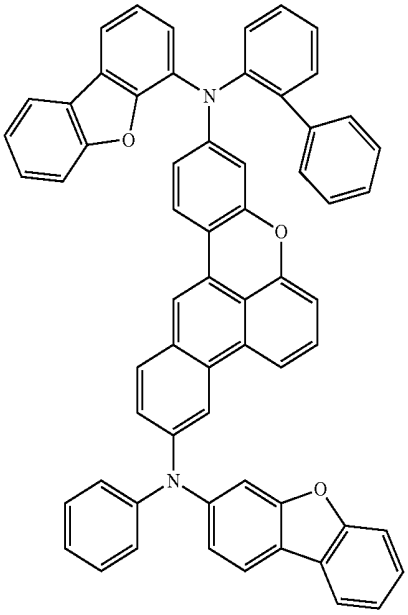

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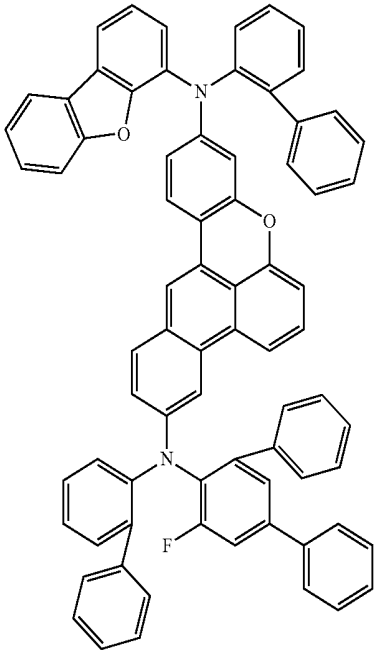

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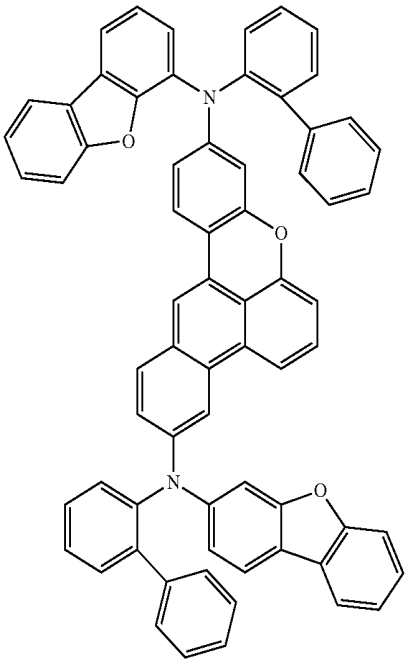

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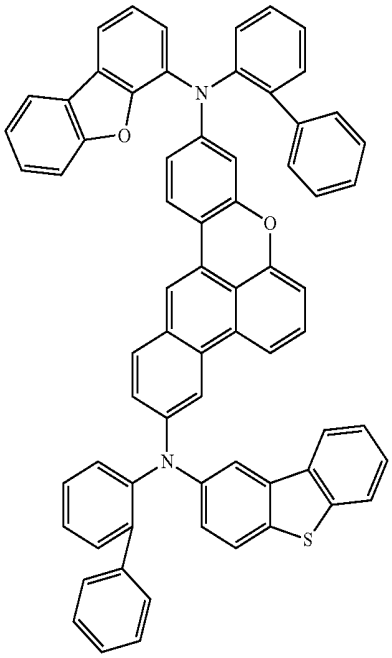

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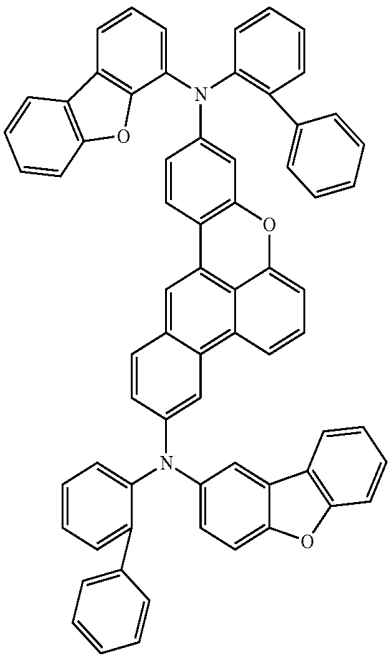

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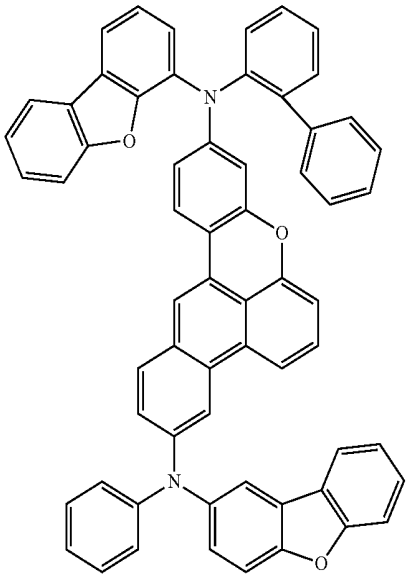

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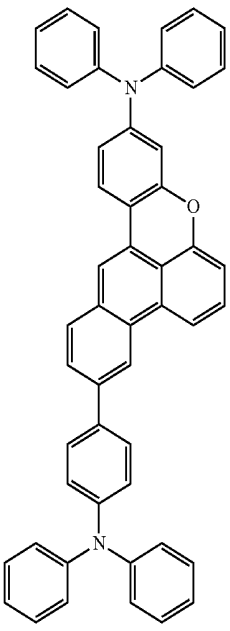

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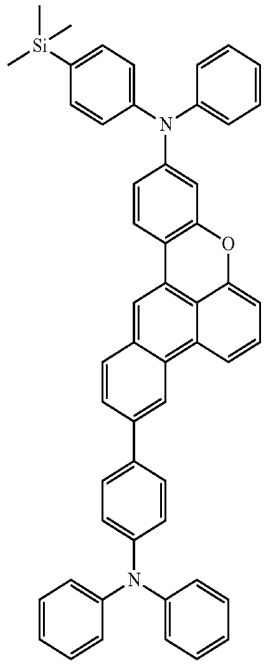

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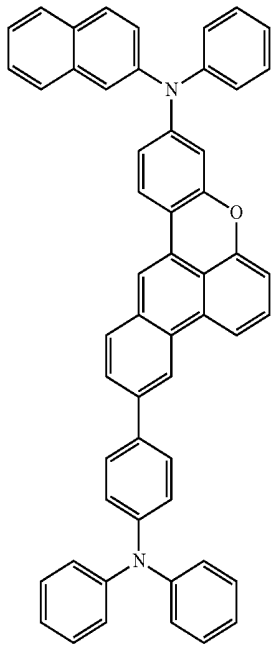

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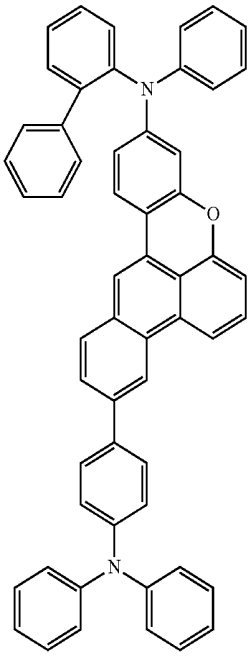

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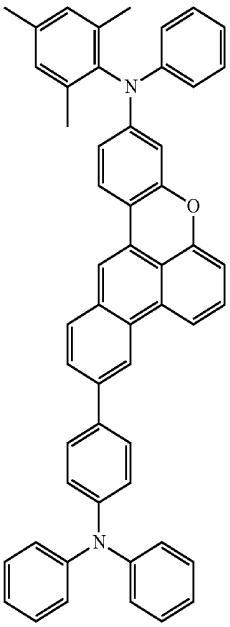

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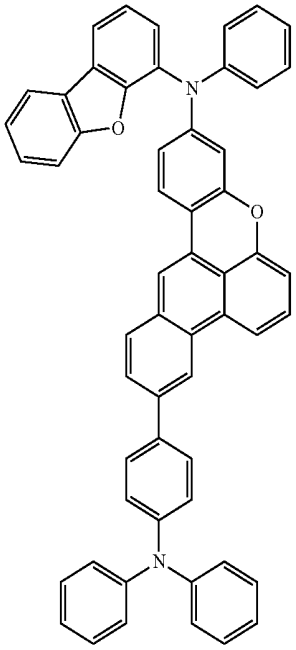

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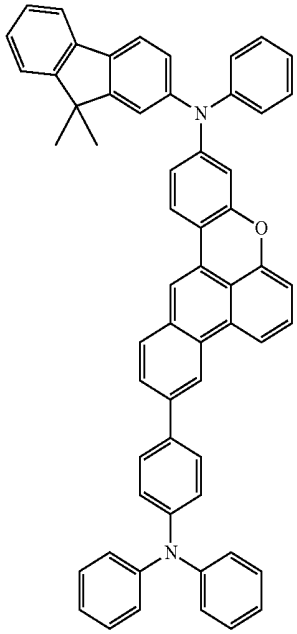

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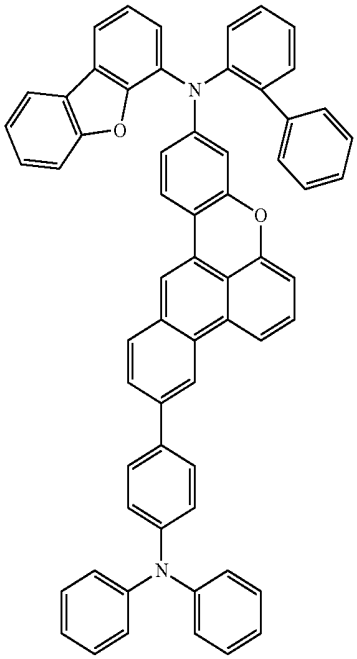

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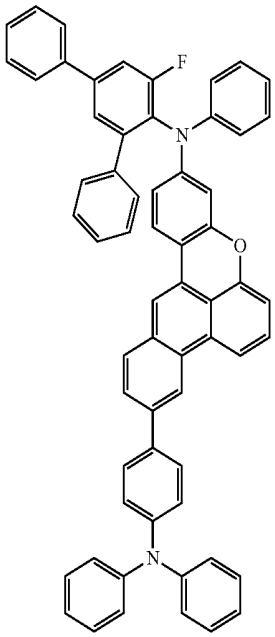

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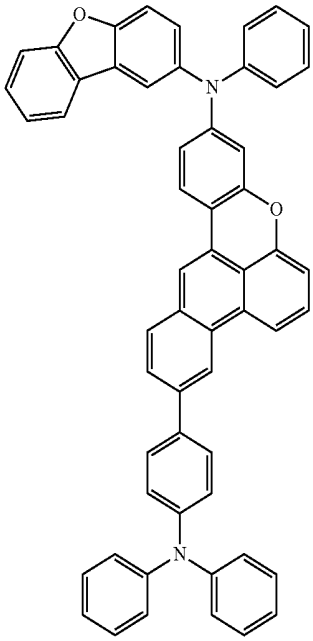

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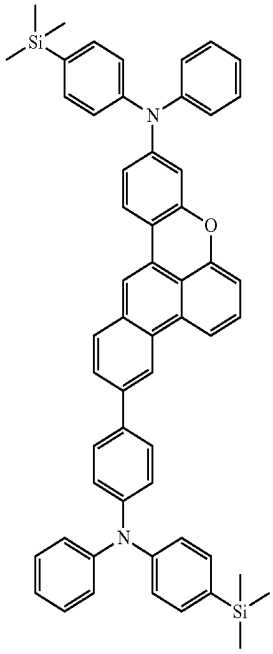

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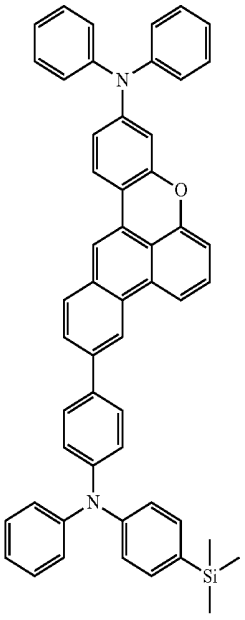

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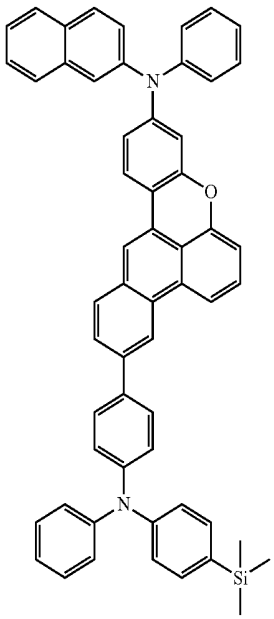

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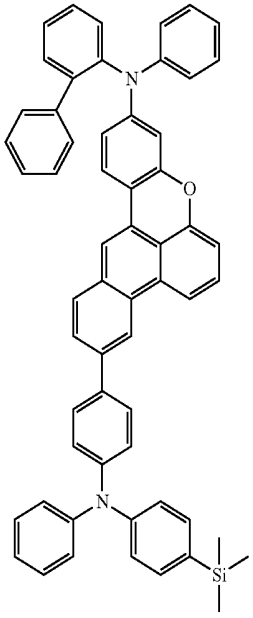

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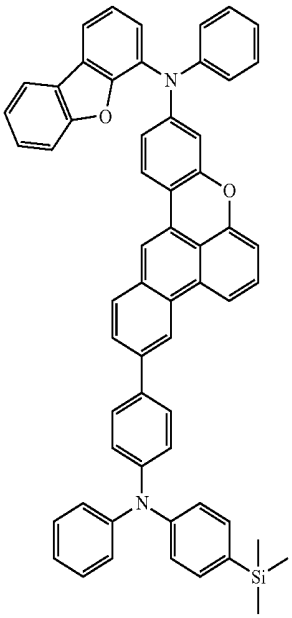

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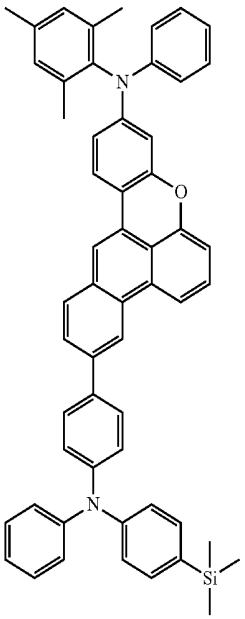

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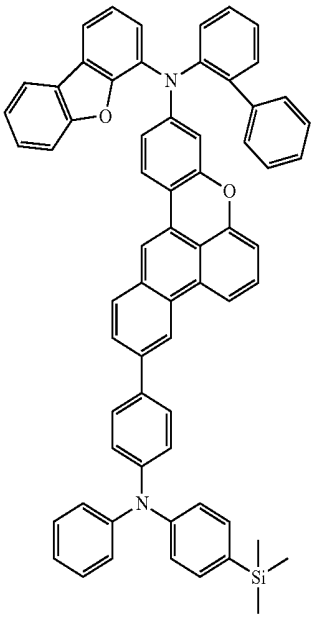

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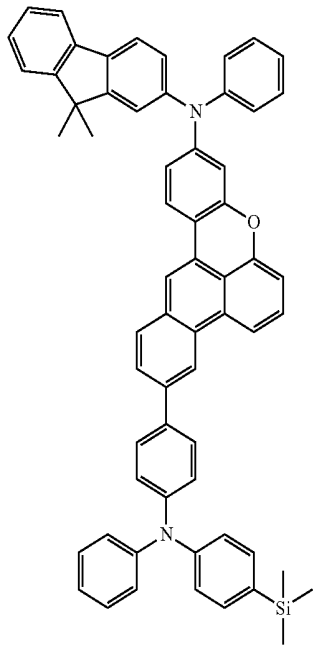

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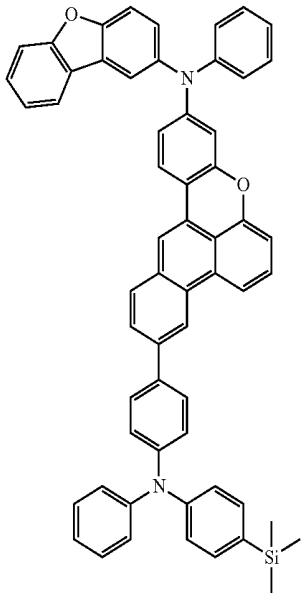

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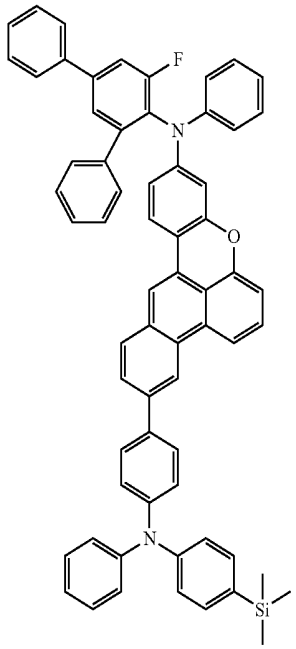

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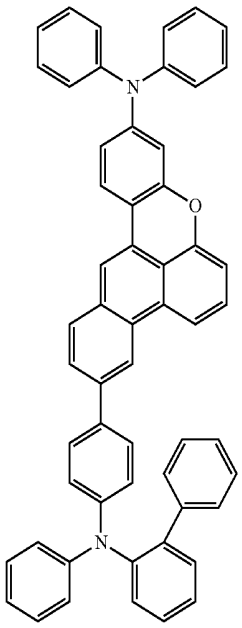

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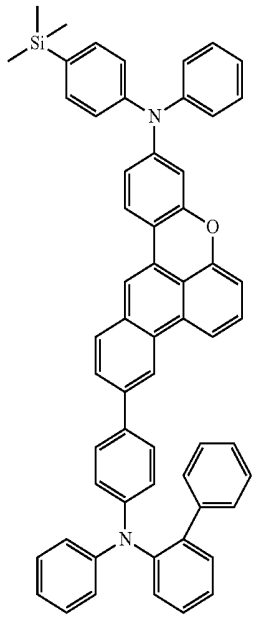

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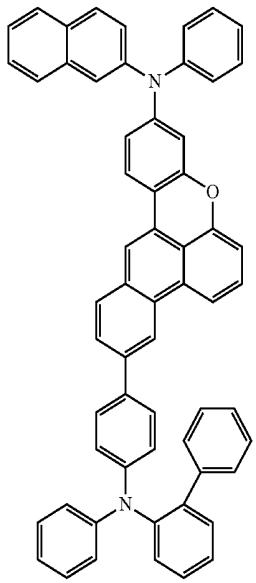

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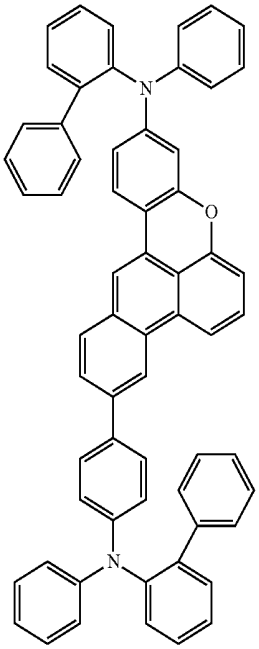

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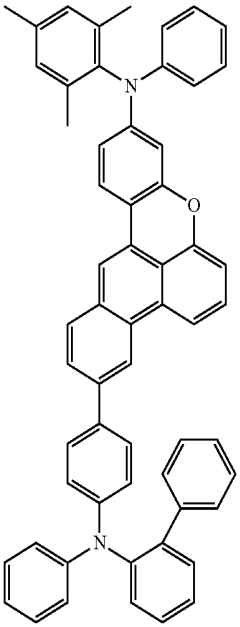

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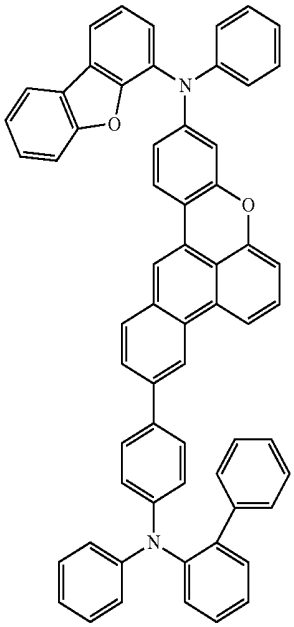

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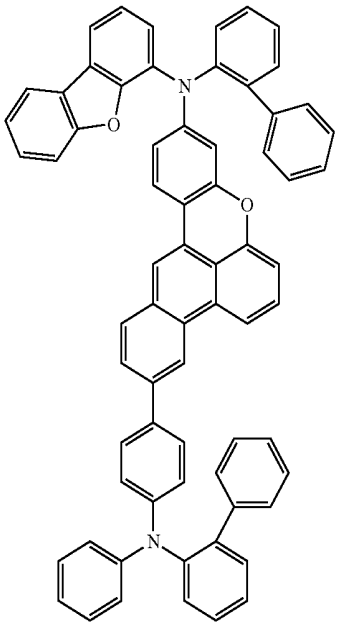

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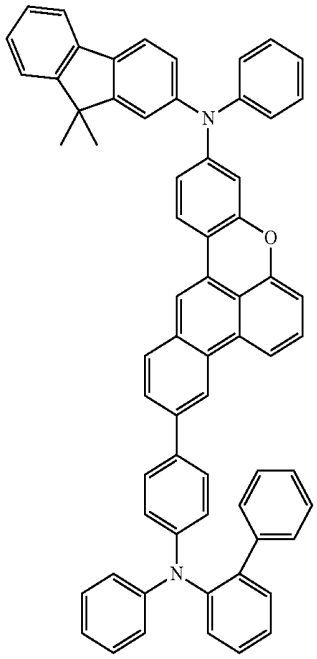

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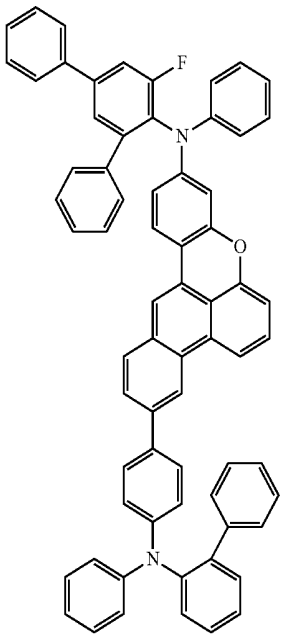

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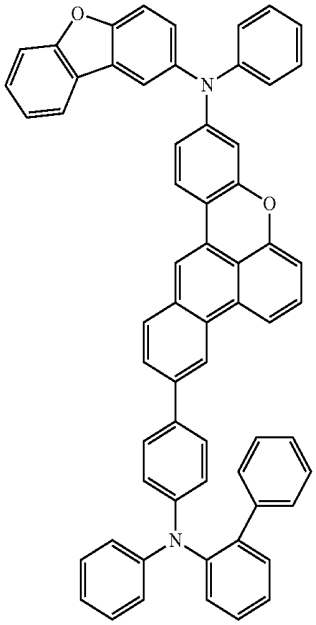

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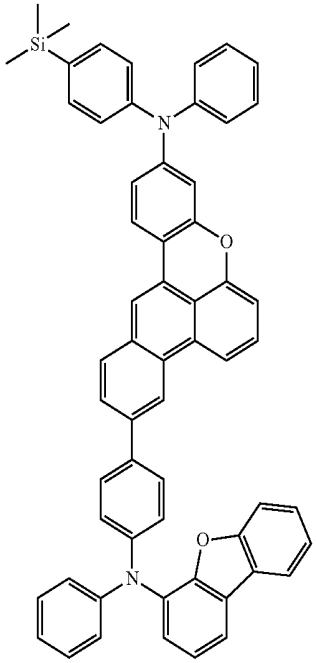

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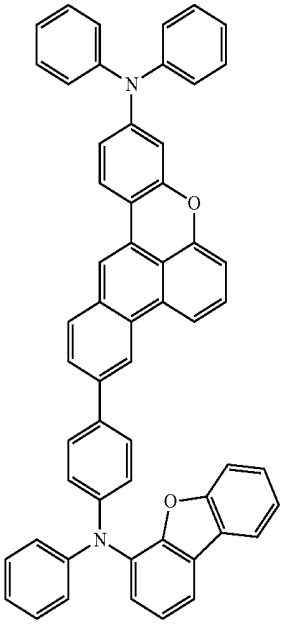

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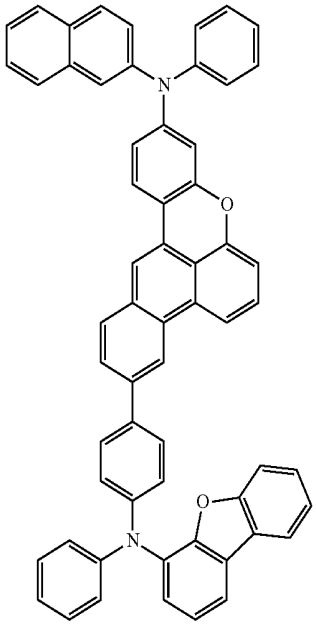

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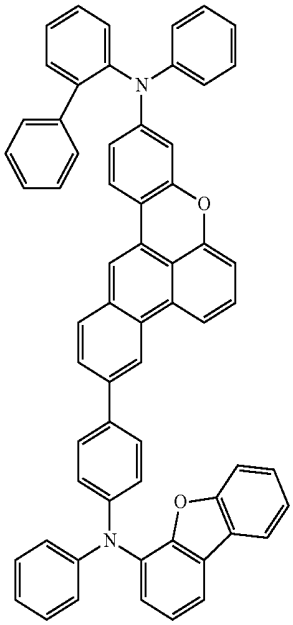

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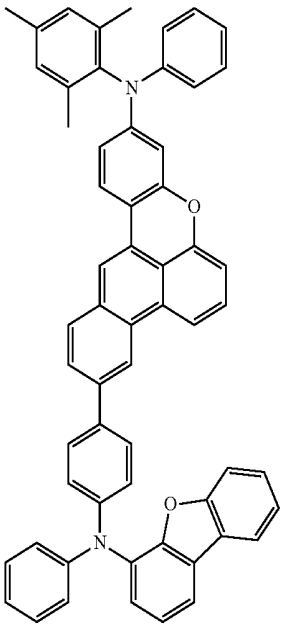

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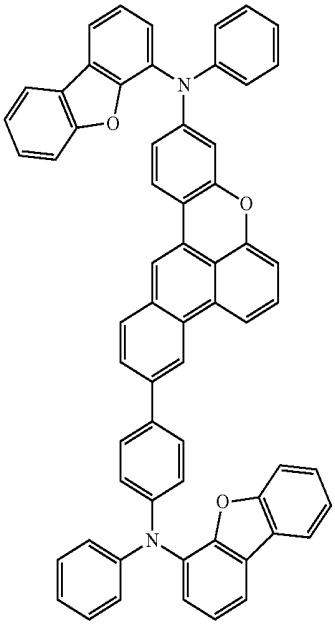

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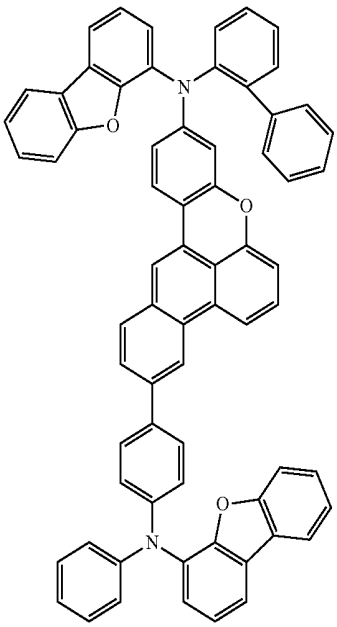

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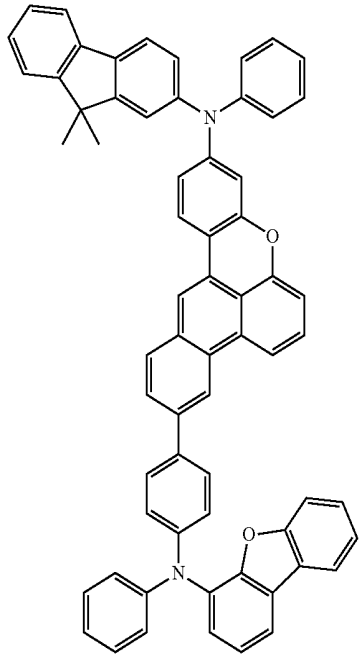

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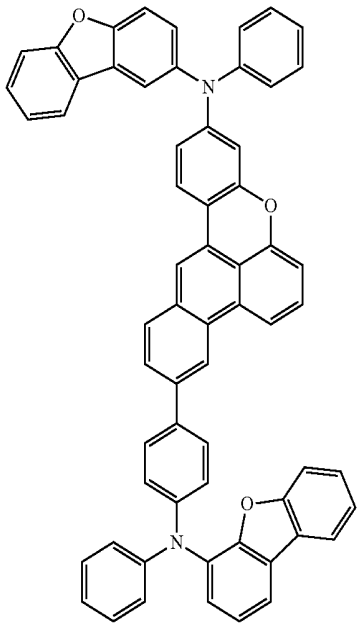

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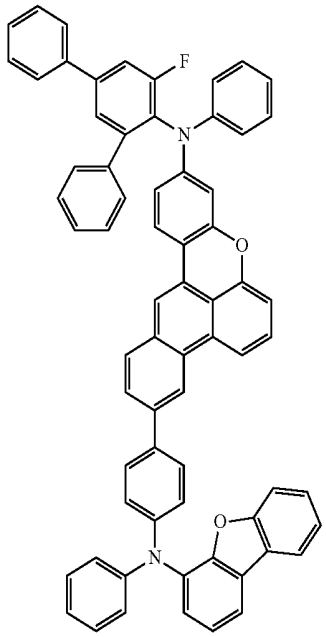

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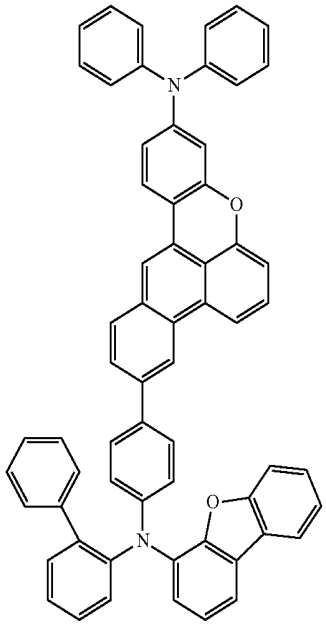

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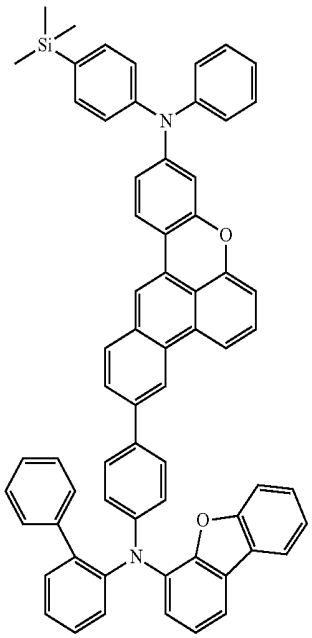

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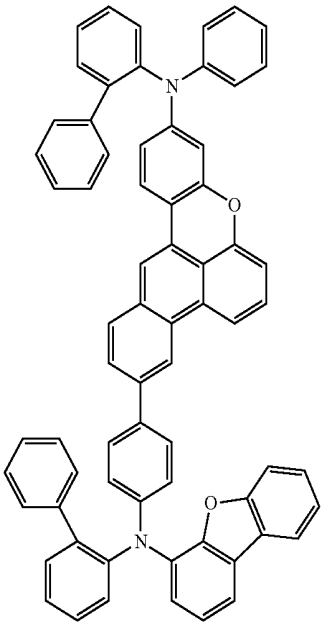

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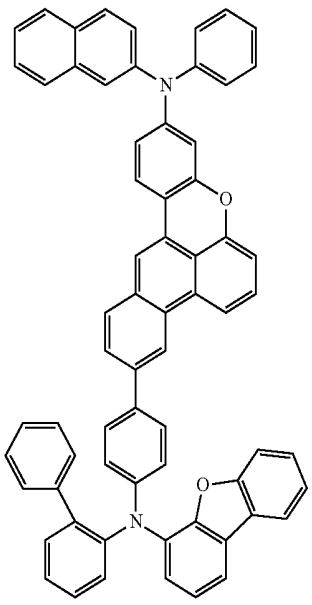

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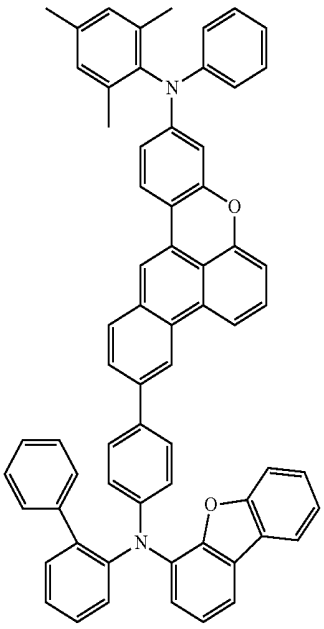

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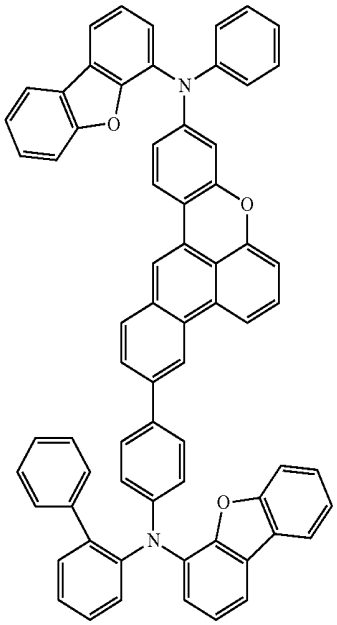

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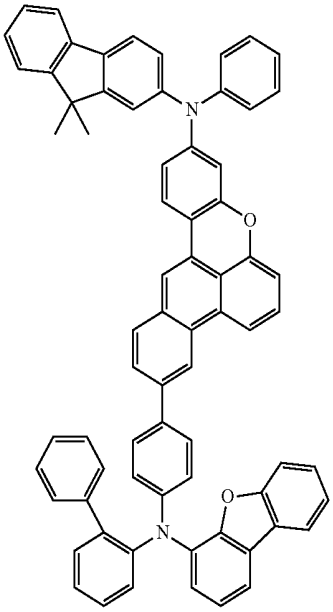

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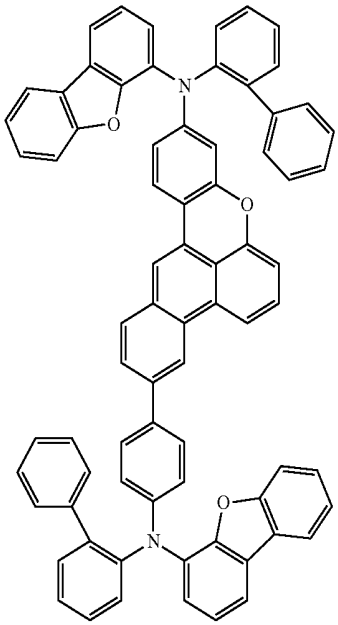

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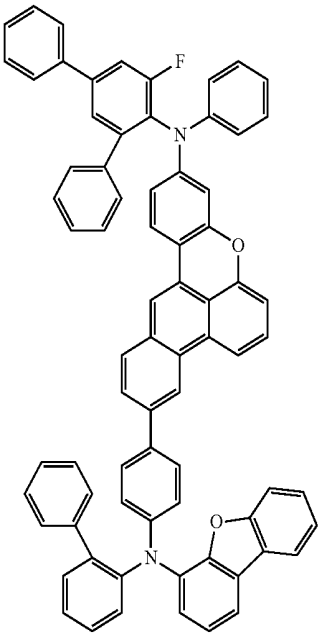

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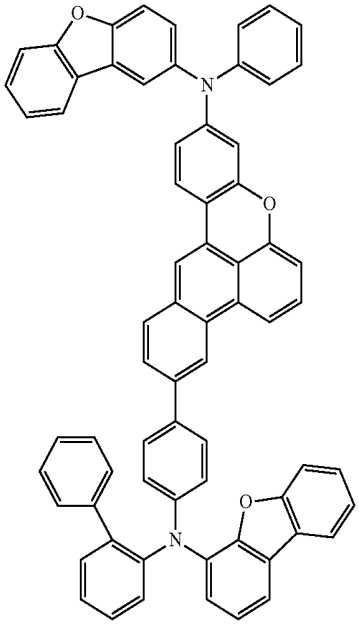

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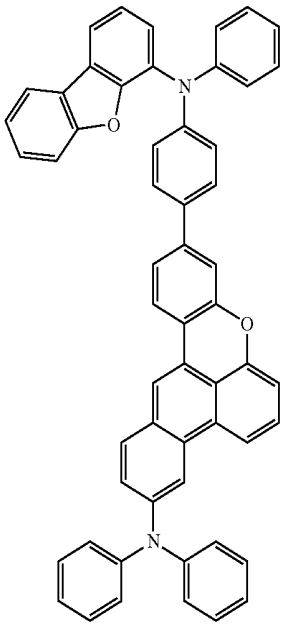

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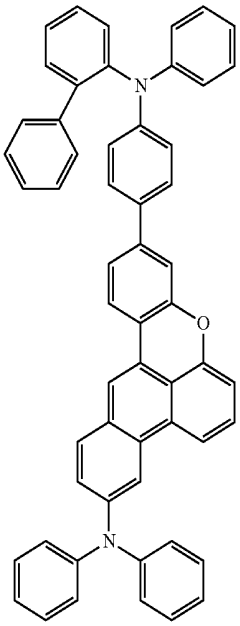

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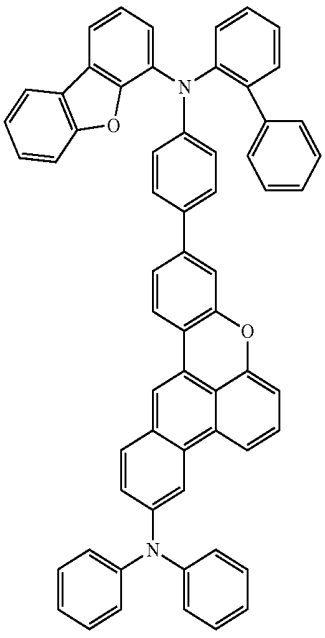

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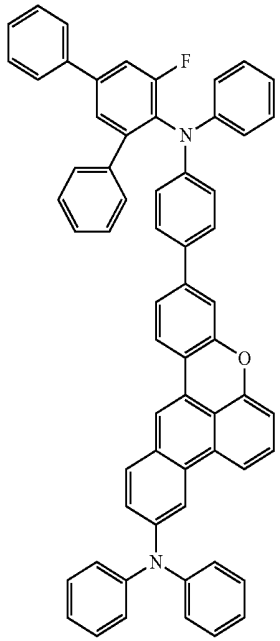

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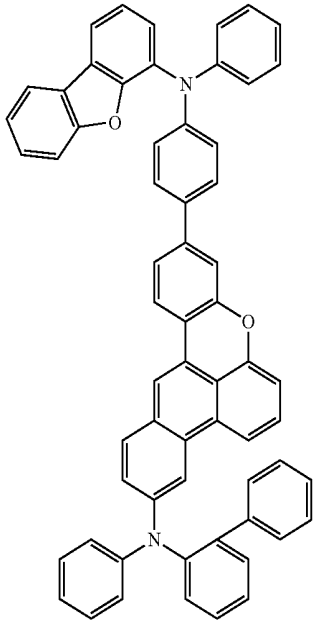

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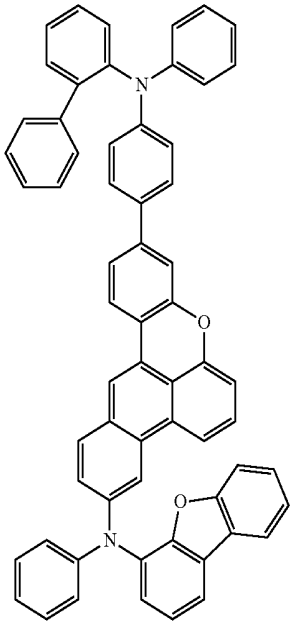

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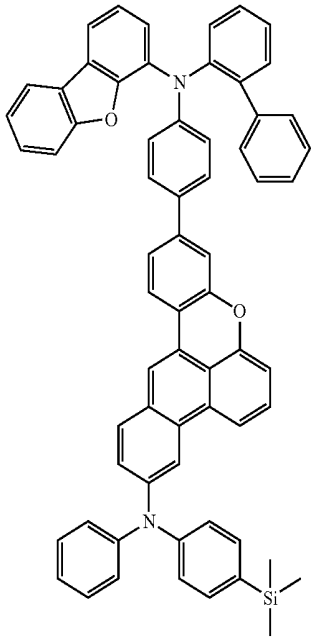

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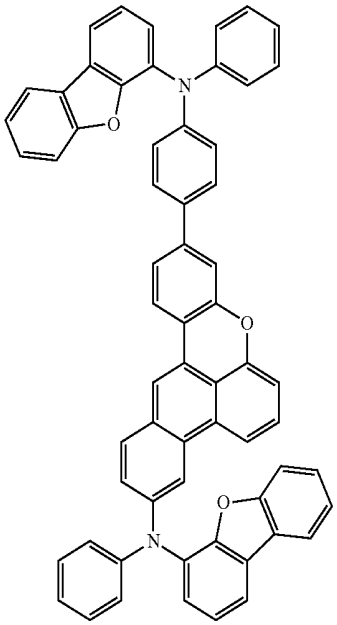

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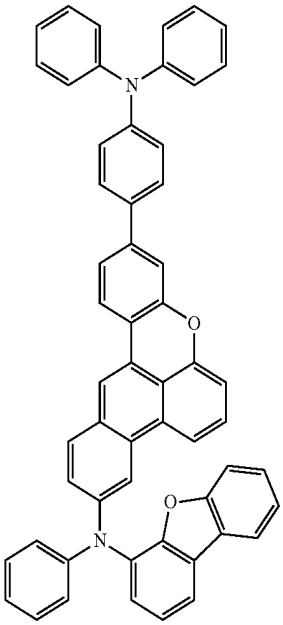

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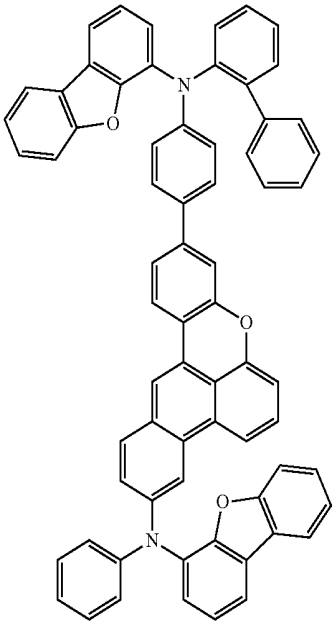

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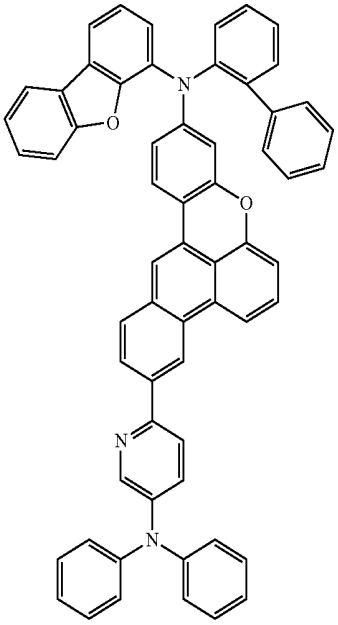

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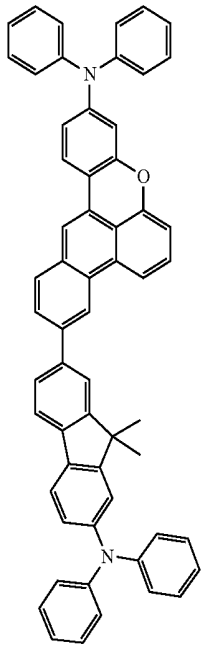

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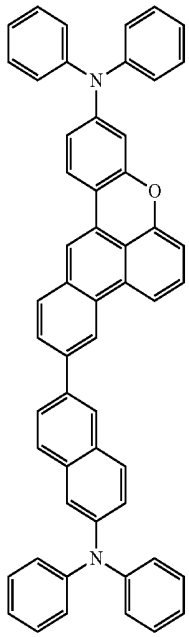

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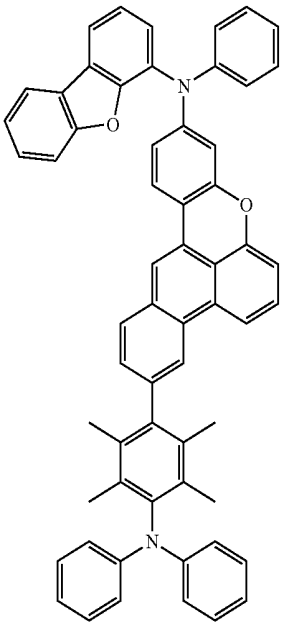

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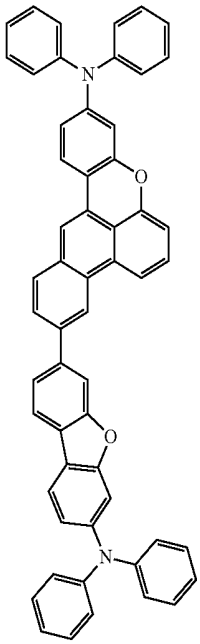

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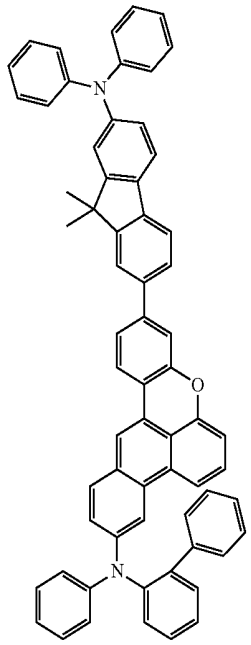

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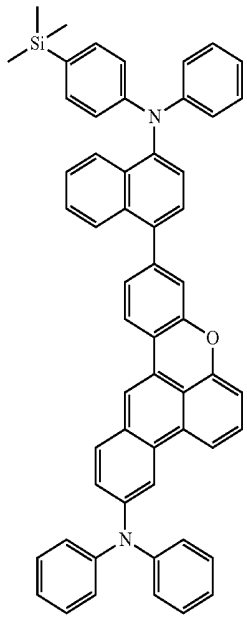

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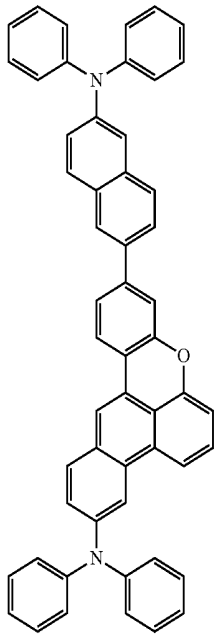

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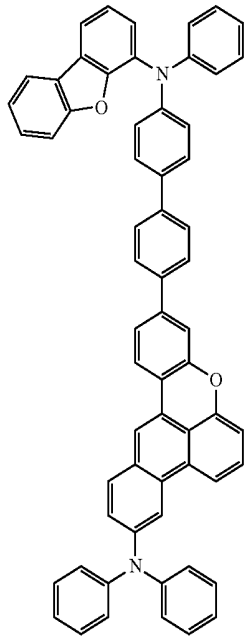

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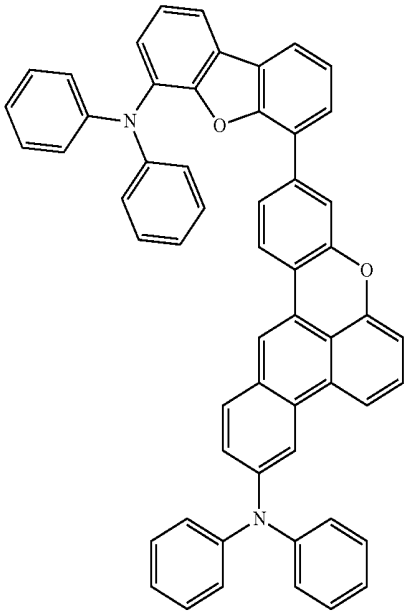

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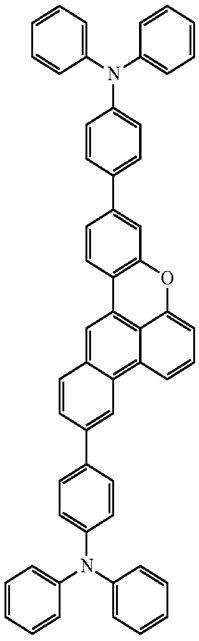

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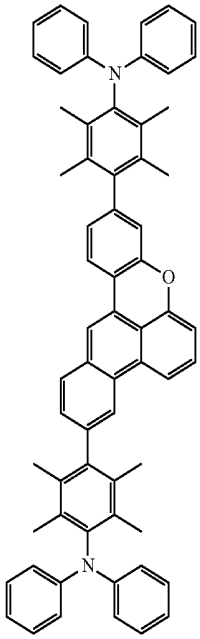

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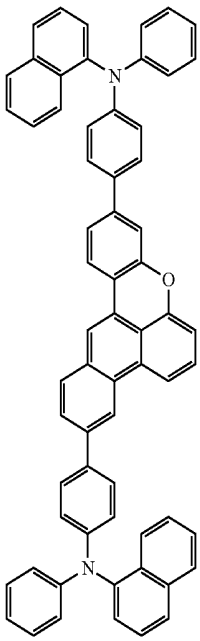

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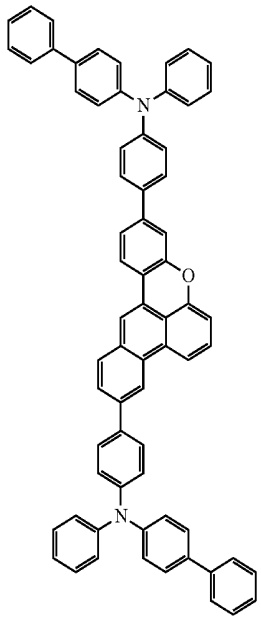

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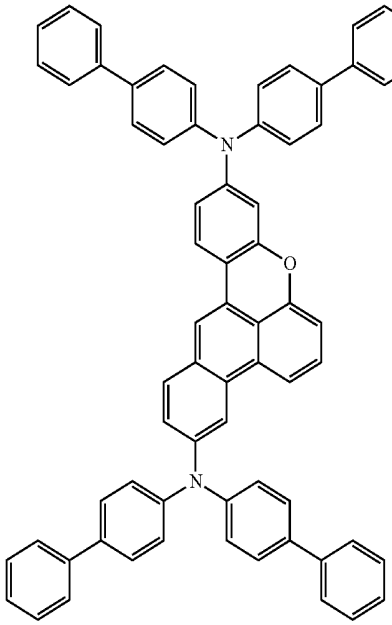

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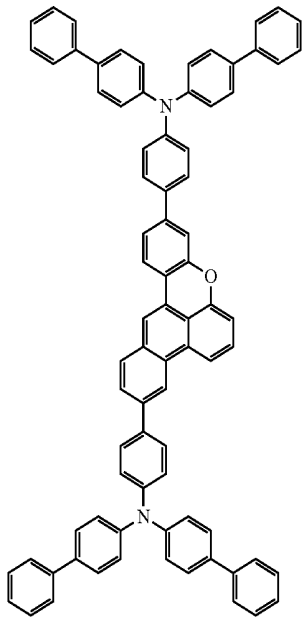

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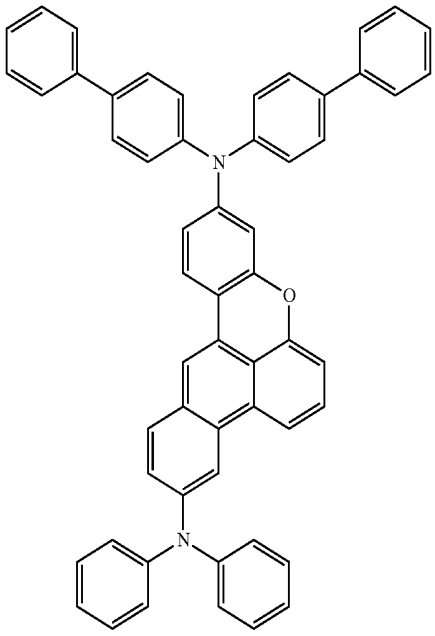

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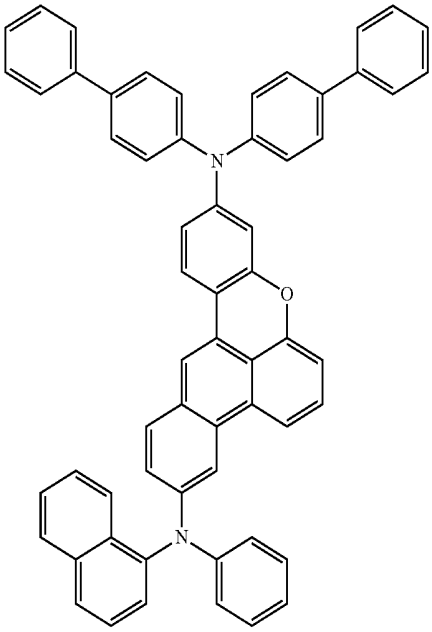

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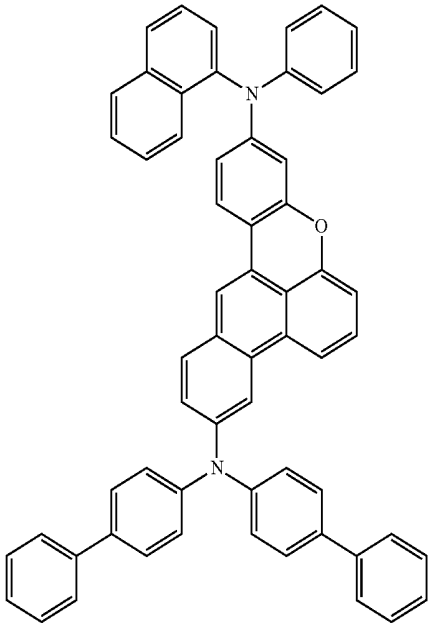

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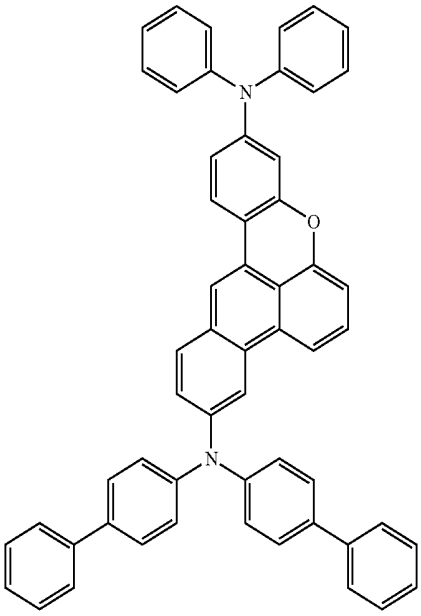

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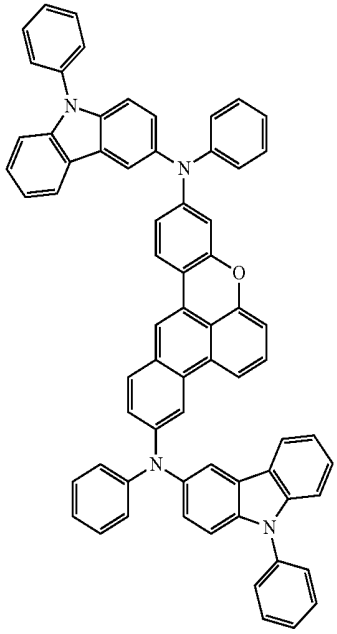

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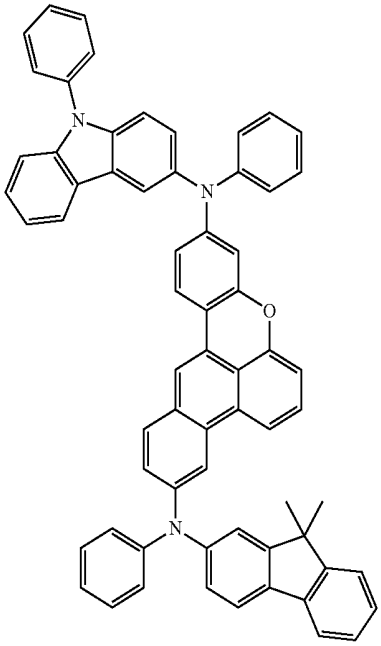

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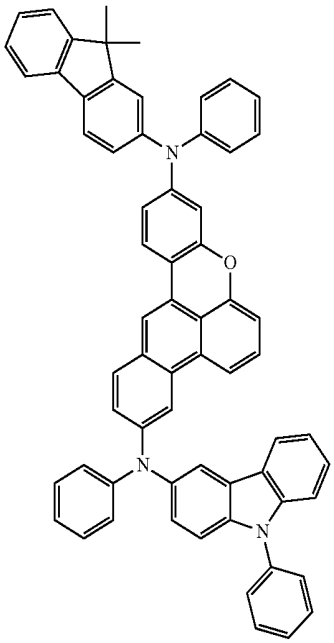

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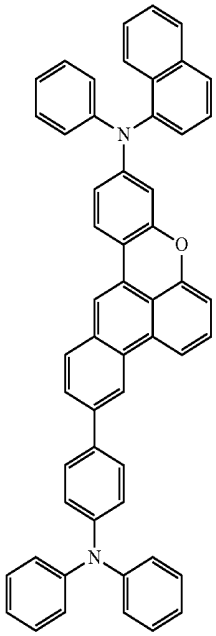

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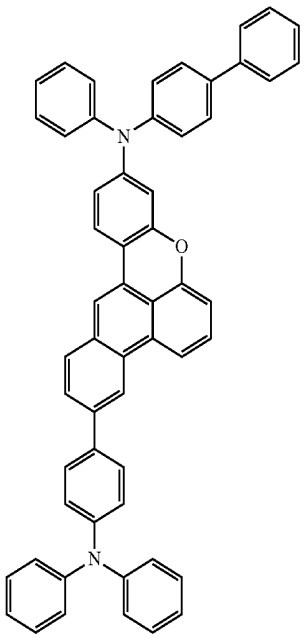

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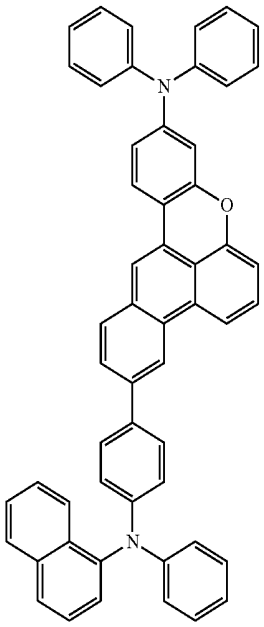

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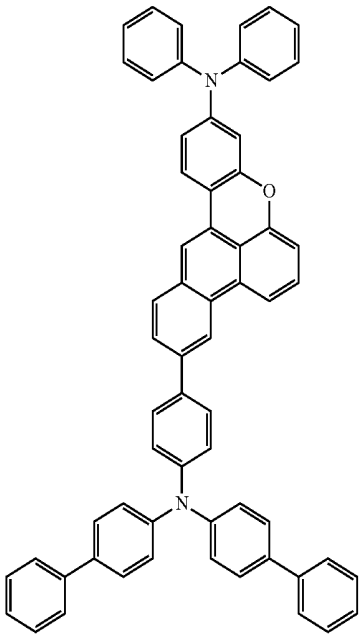

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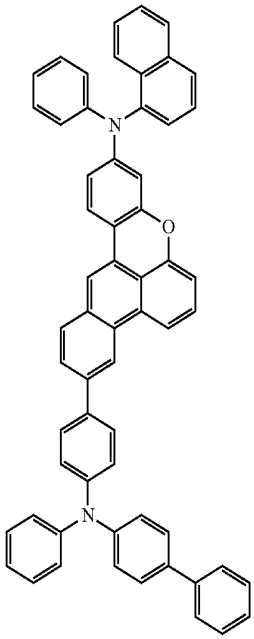

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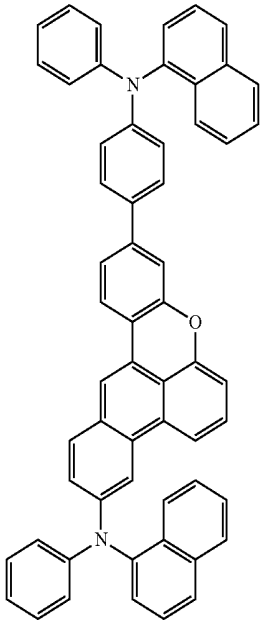

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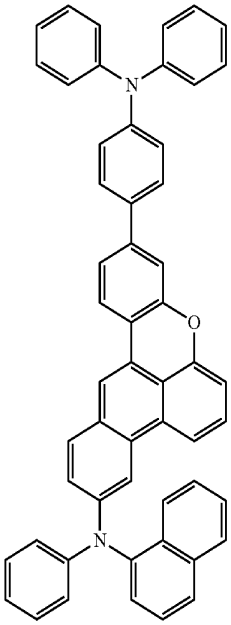

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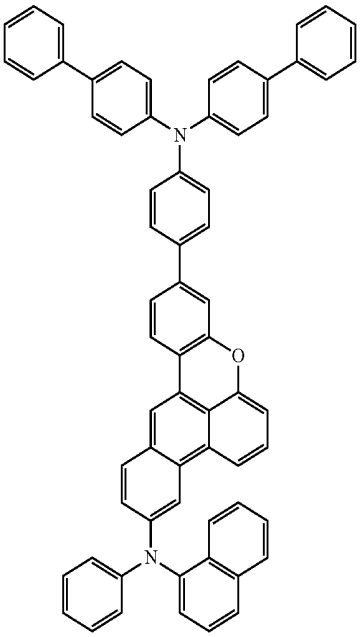

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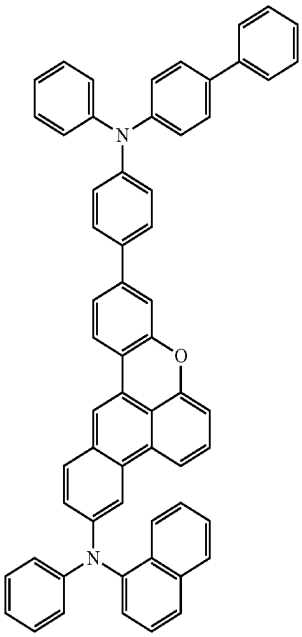

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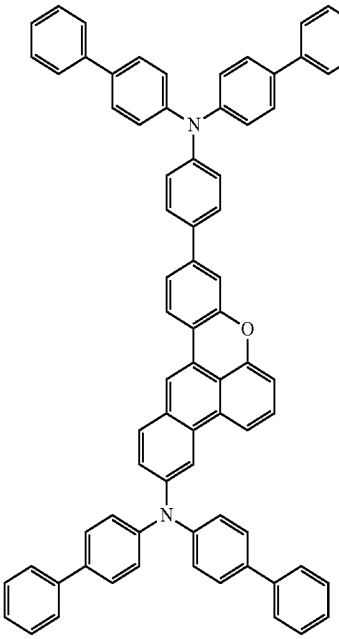

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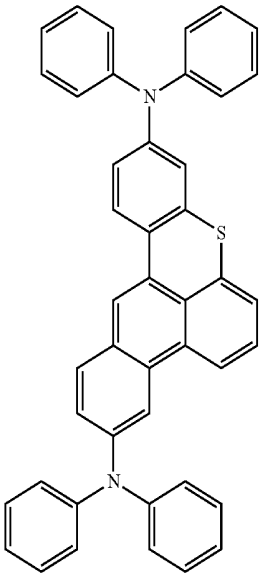

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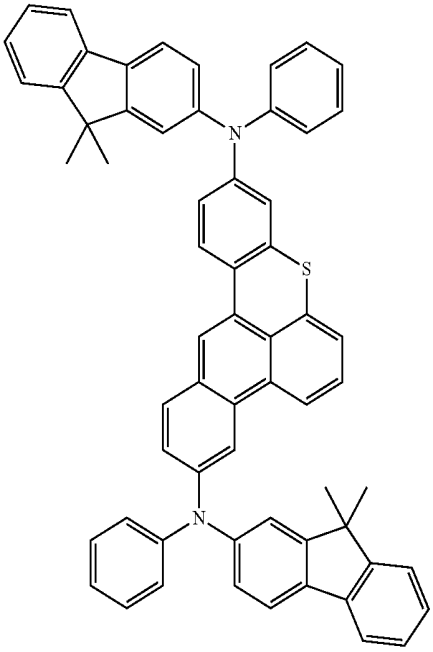

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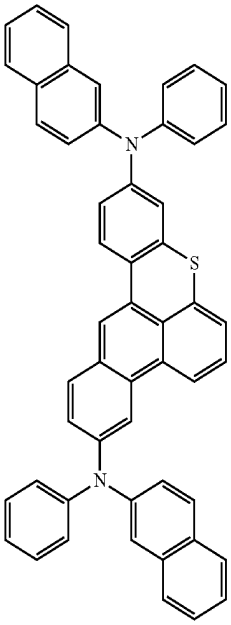

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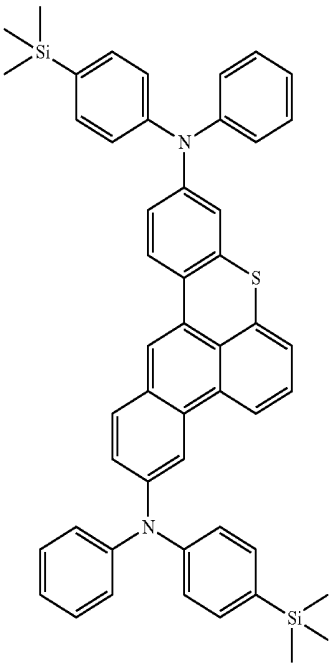

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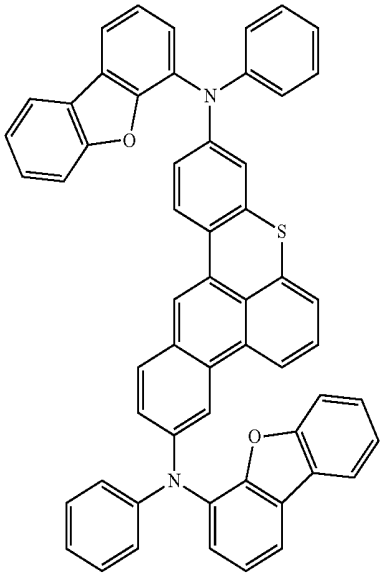

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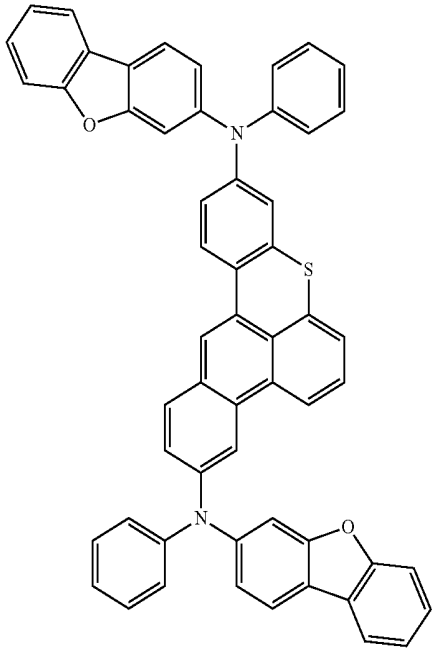

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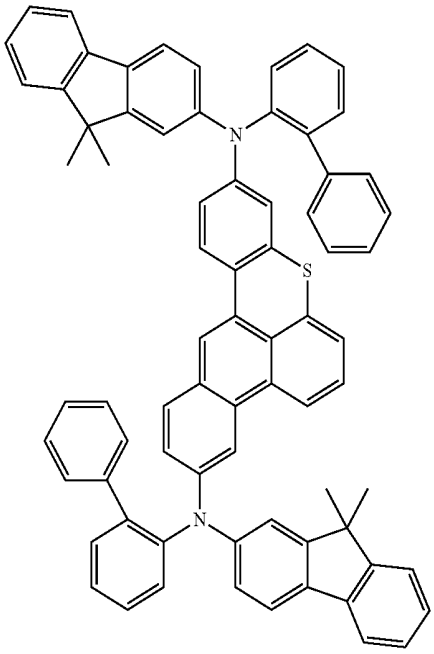

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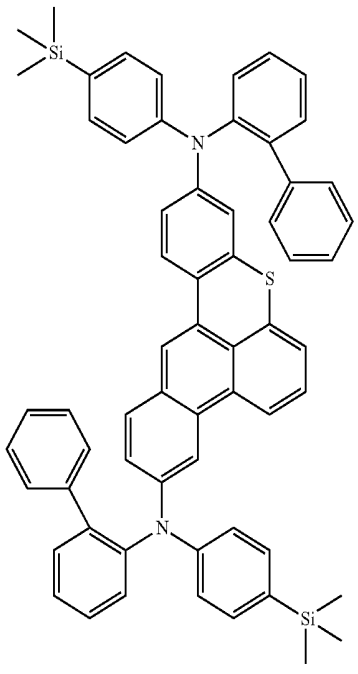

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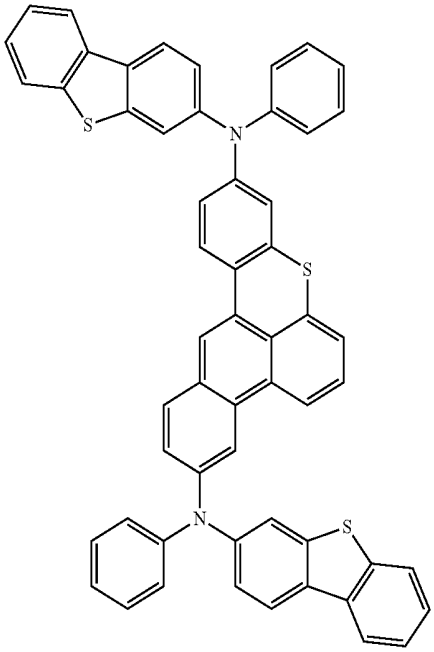

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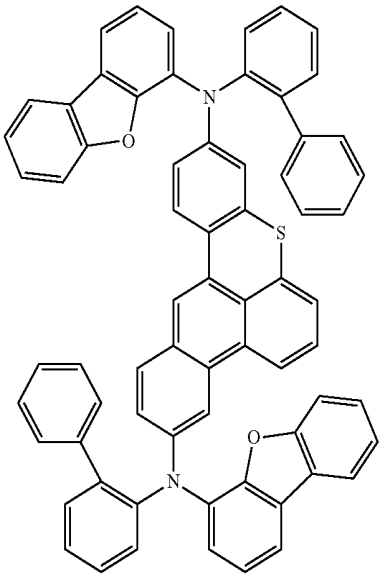

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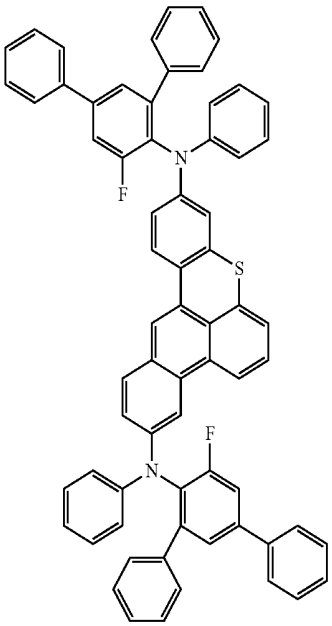

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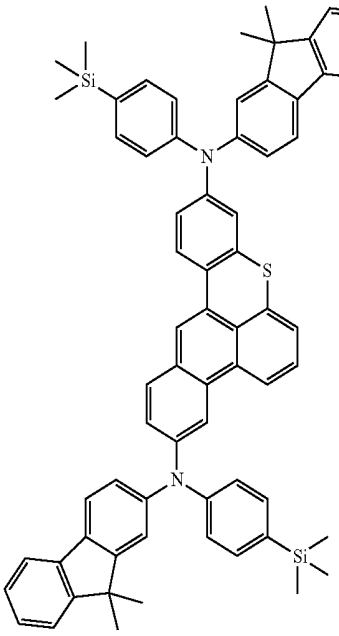

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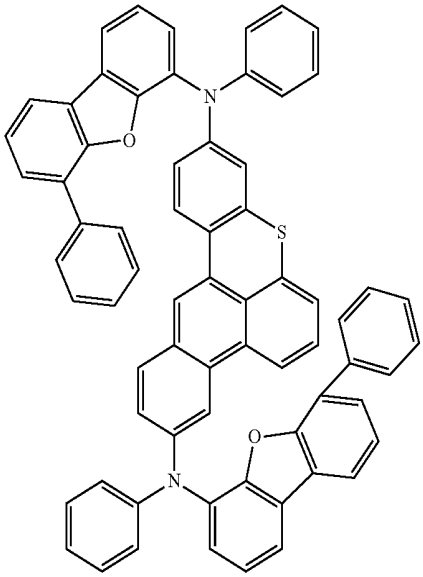

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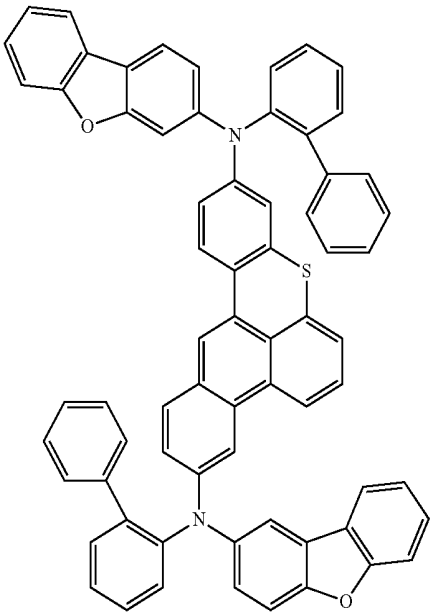

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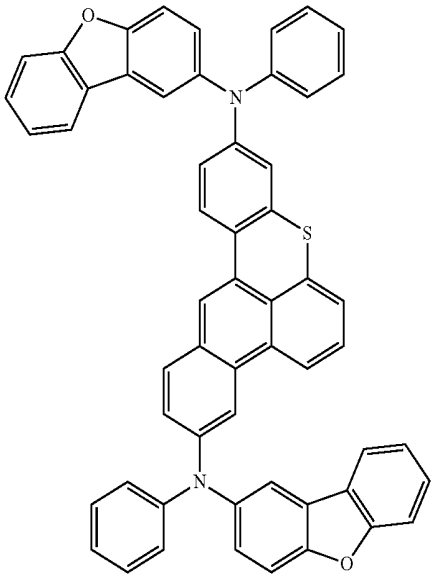

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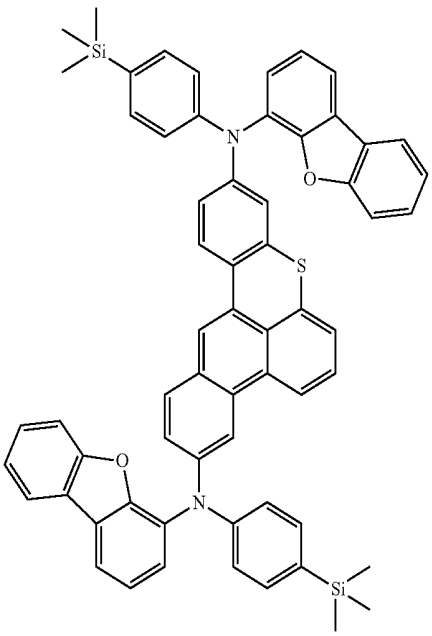

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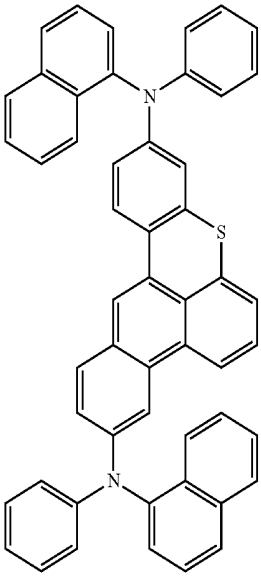

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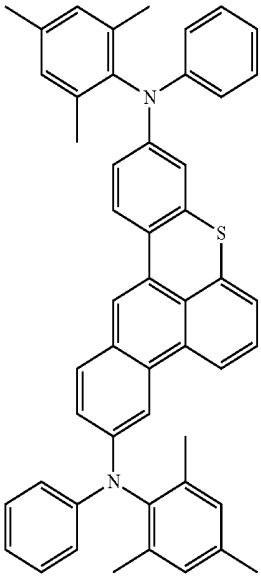

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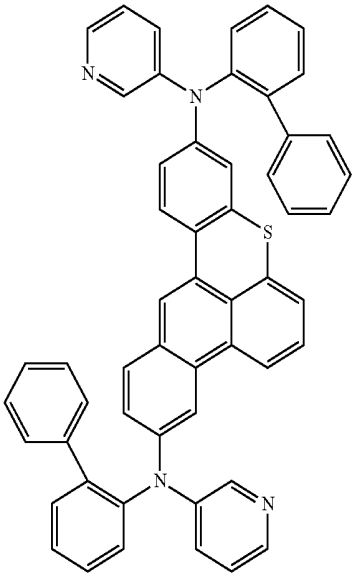

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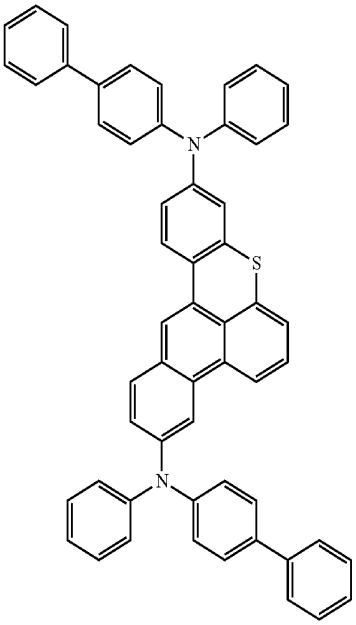

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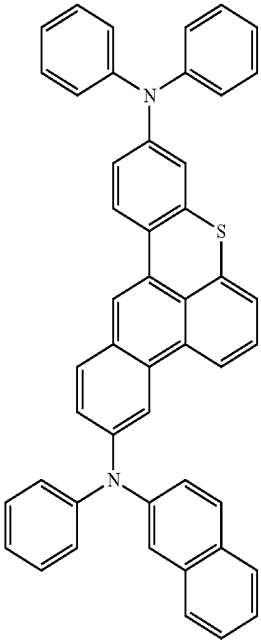

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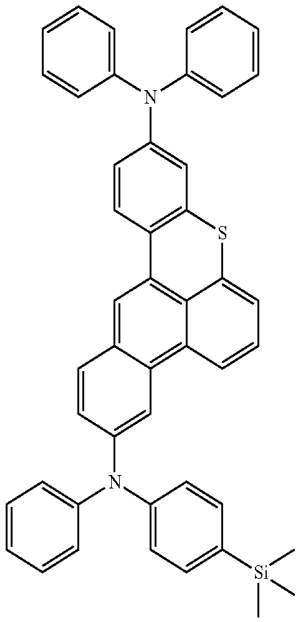

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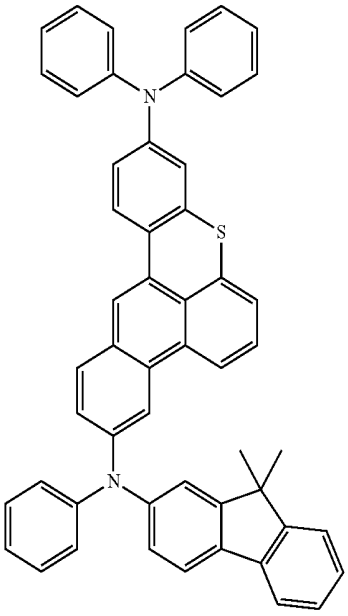

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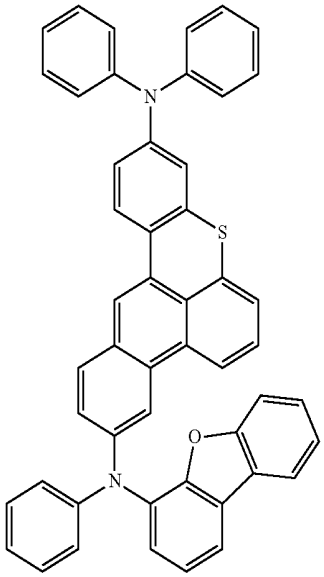

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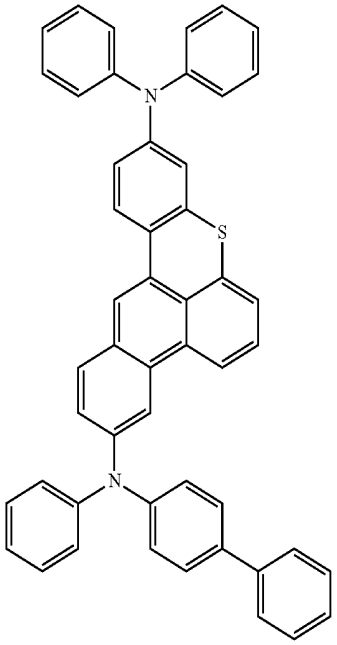

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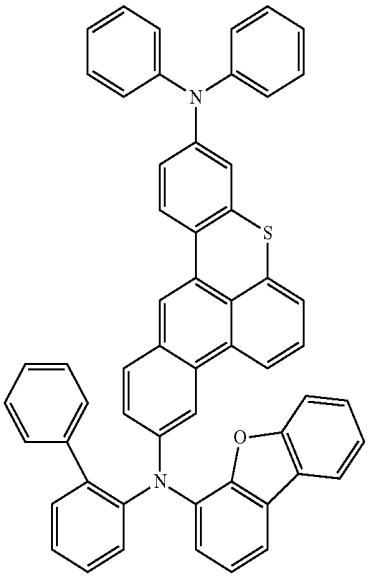
27A



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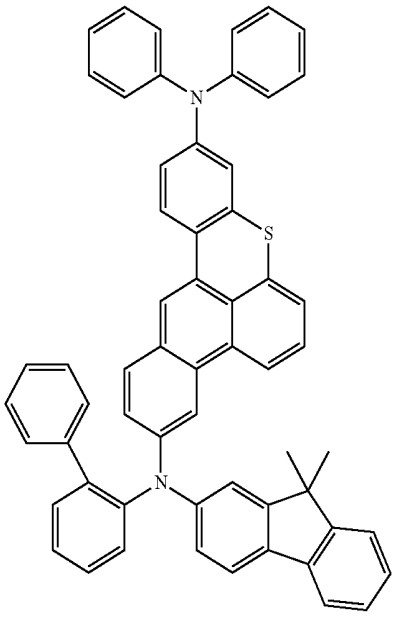

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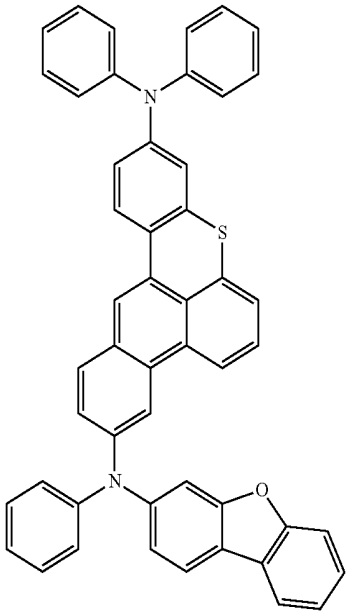

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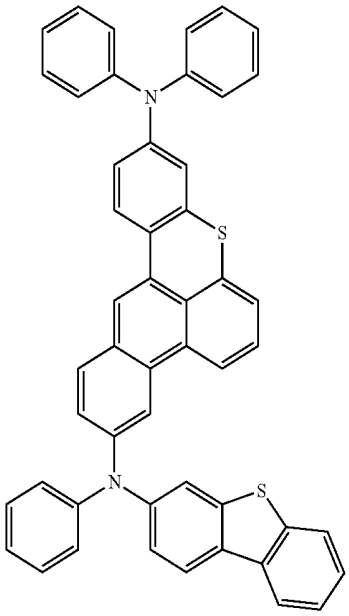

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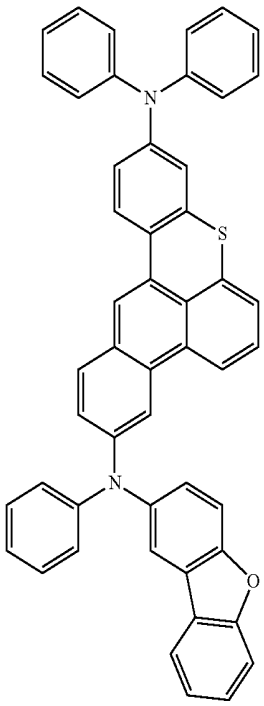

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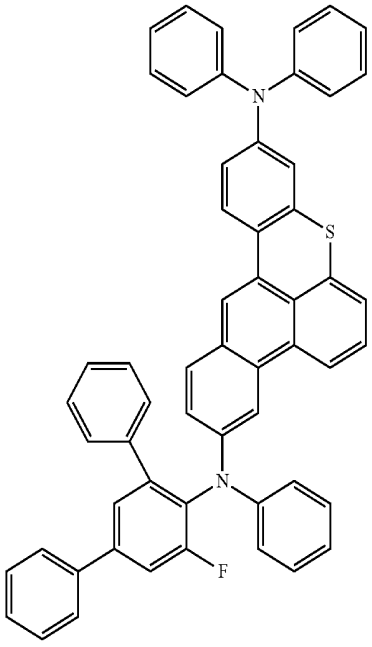

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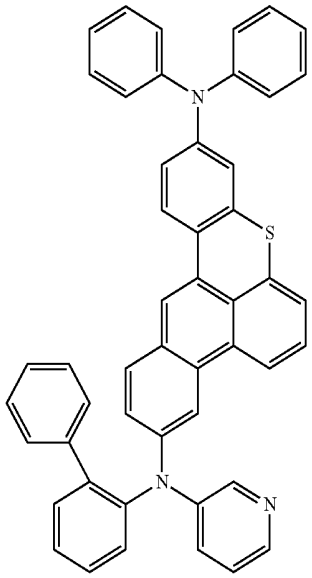

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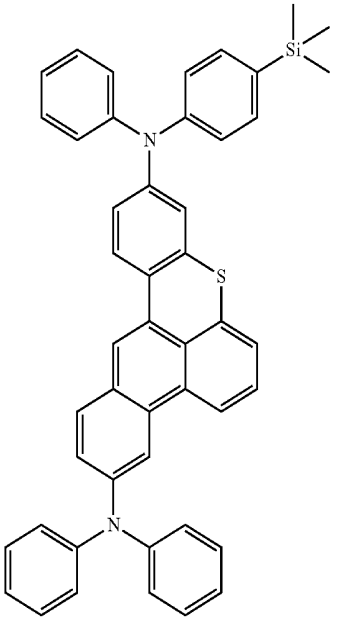

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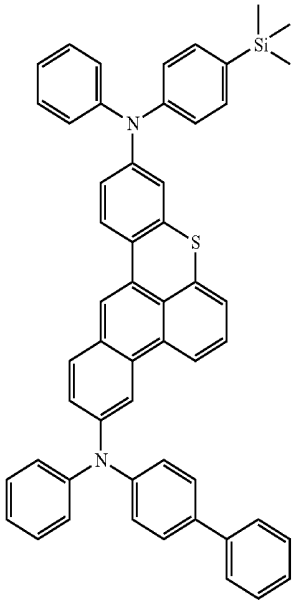

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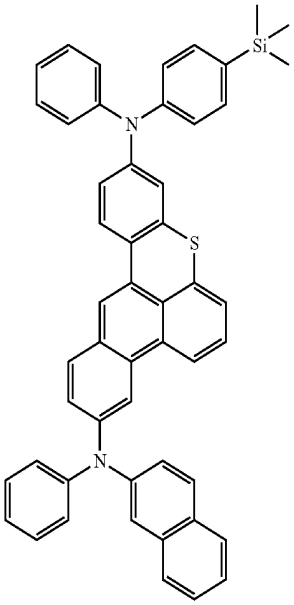

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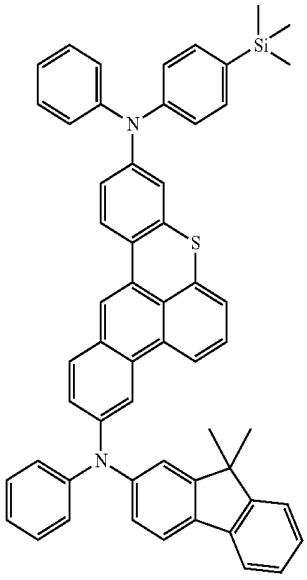

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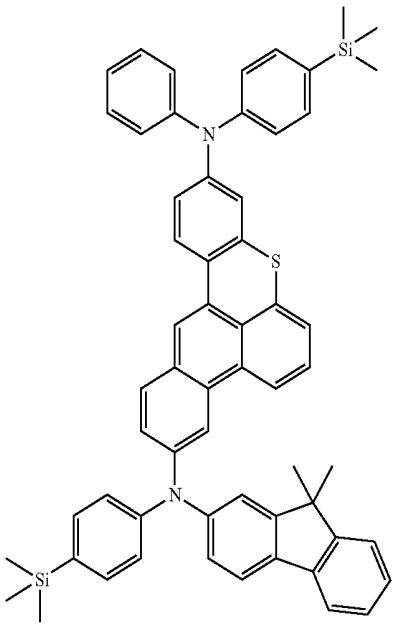

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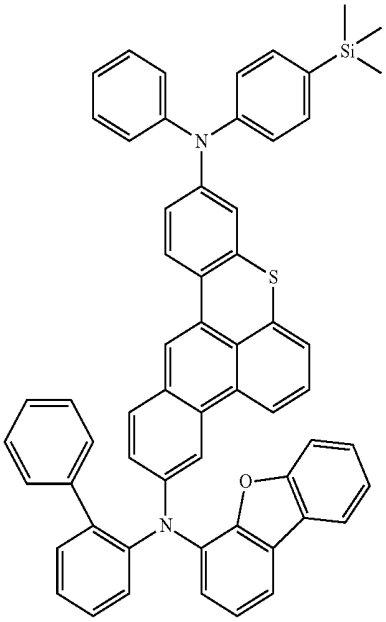

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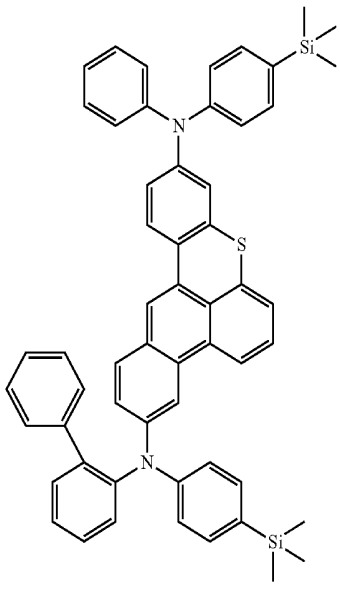

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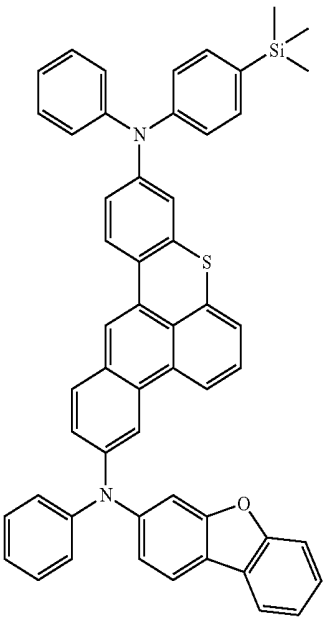

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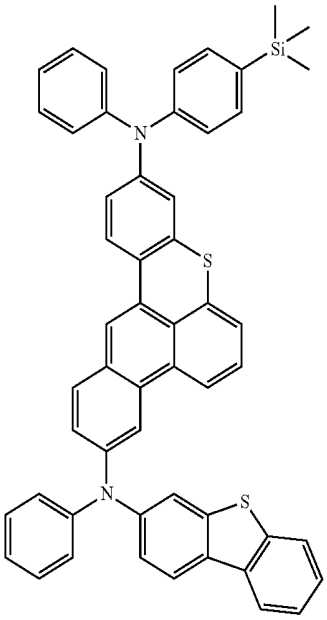

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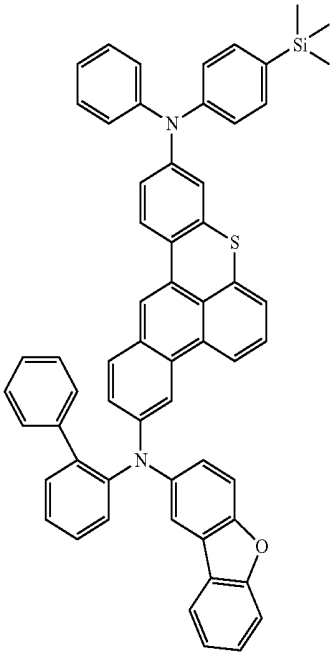

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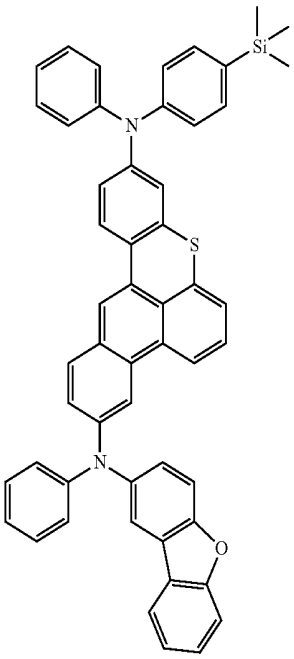

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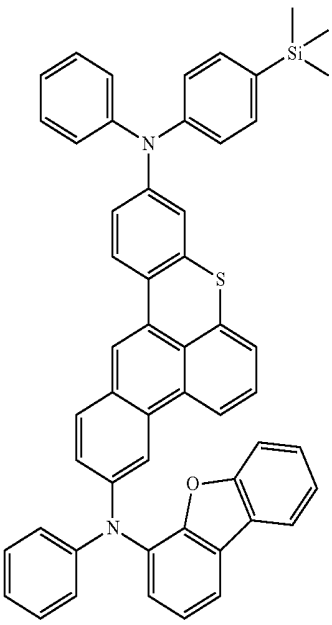

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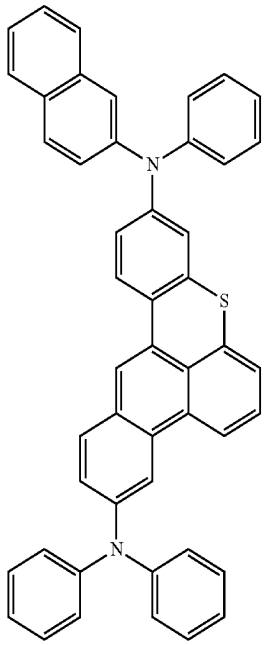

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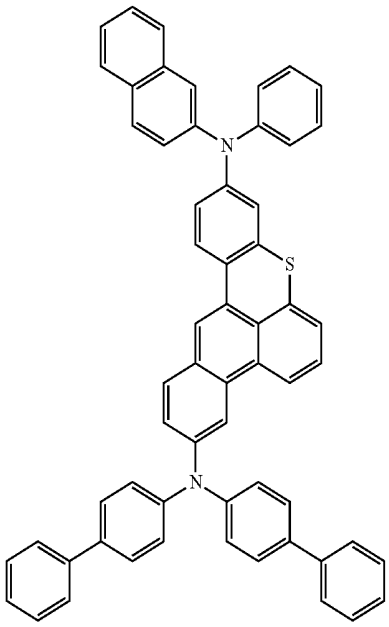

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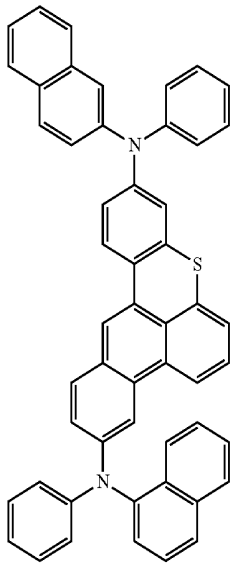

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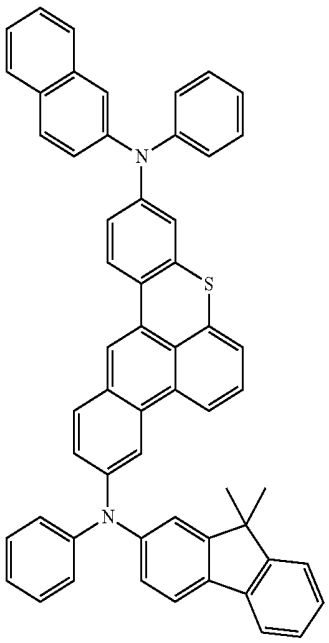

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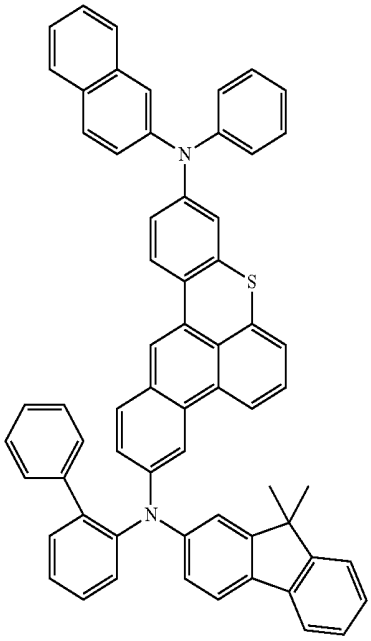

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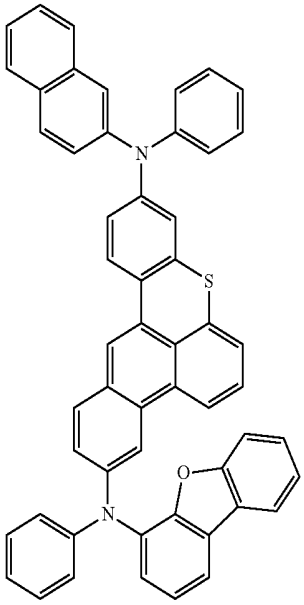

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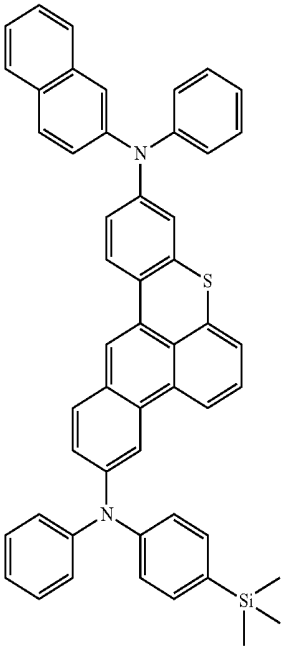

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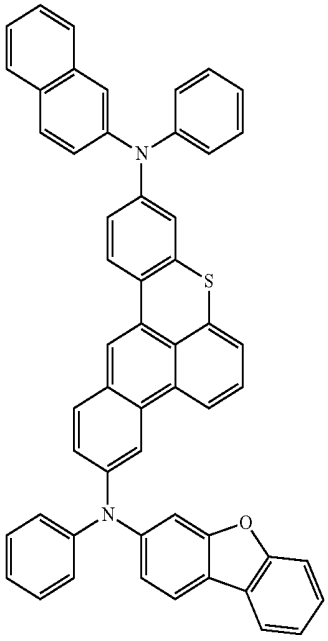

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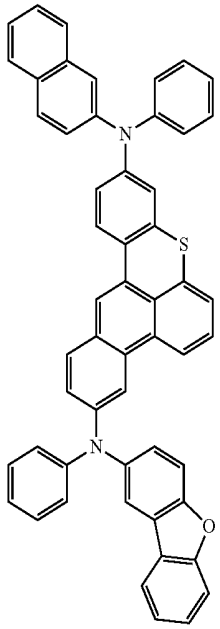

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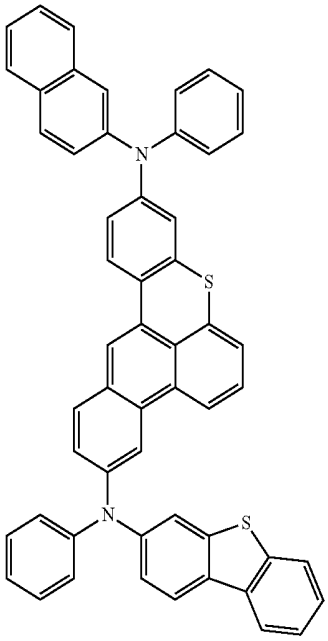

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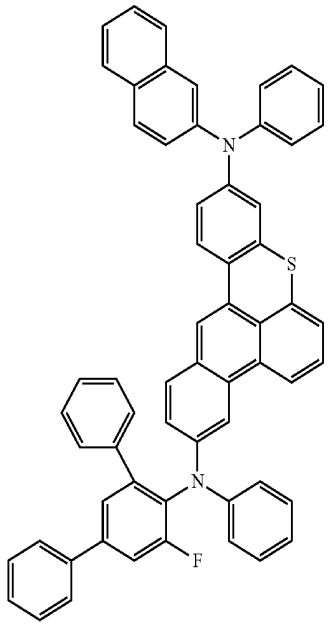

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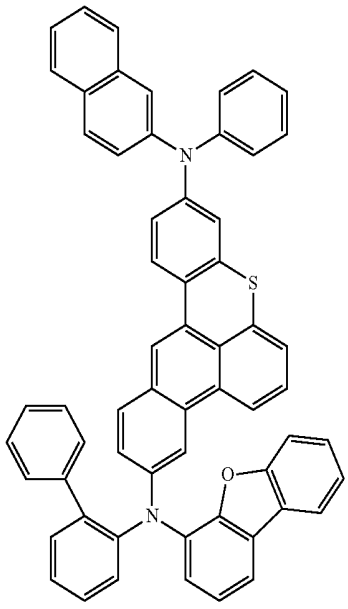

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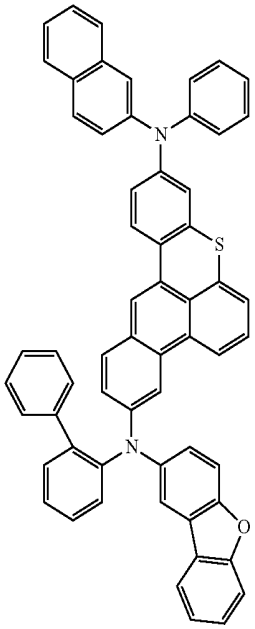

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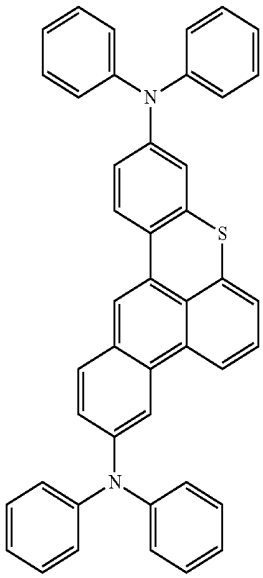

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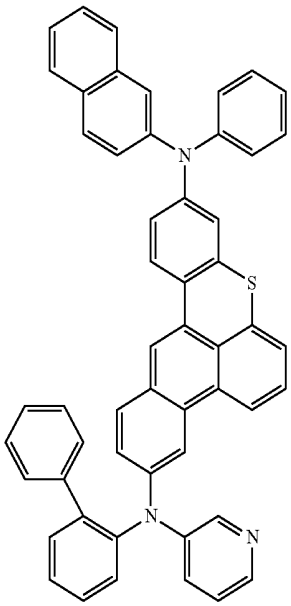

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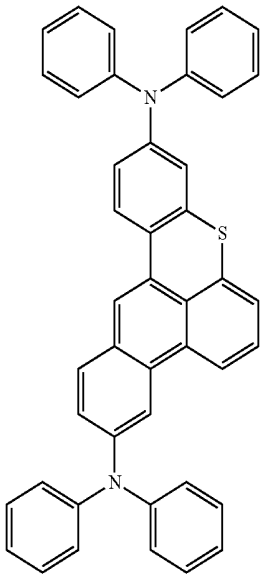

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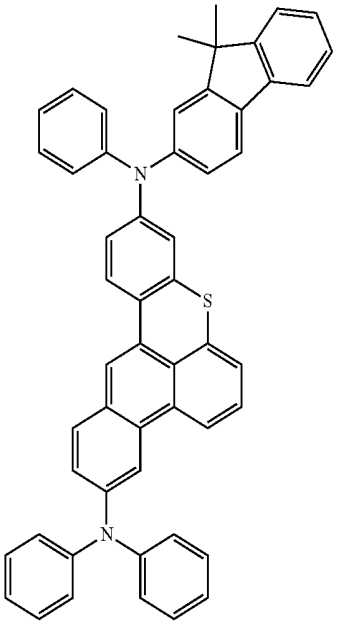

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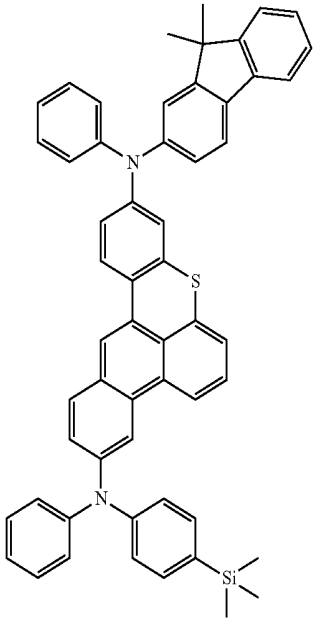

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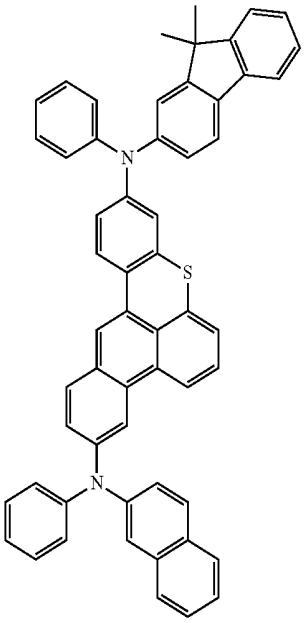

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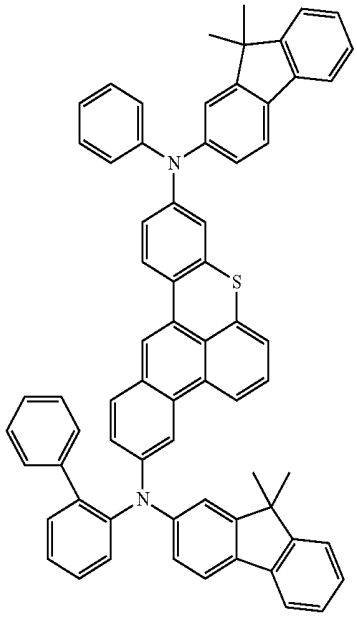

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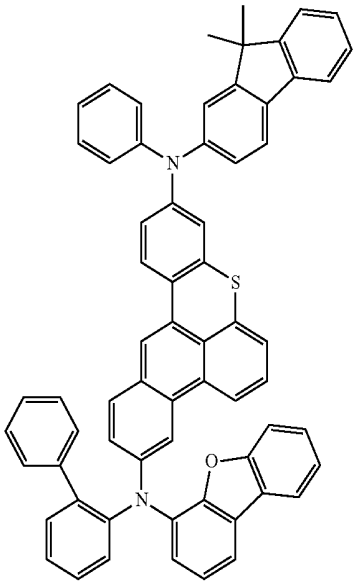

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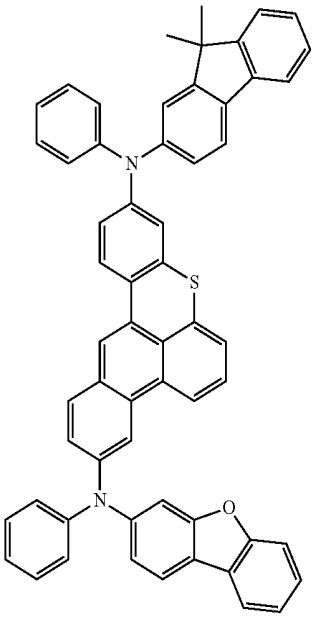

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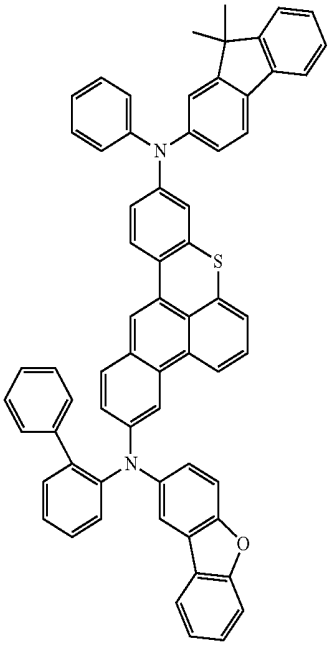

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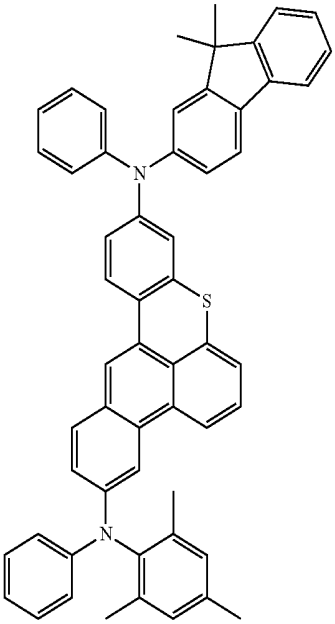

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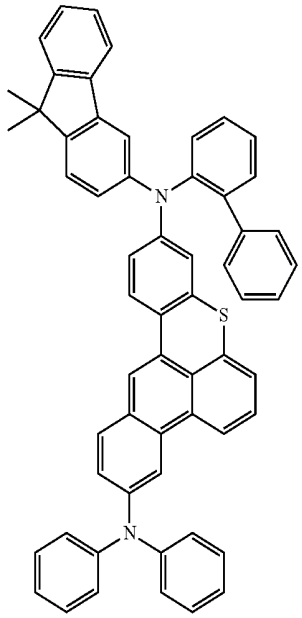

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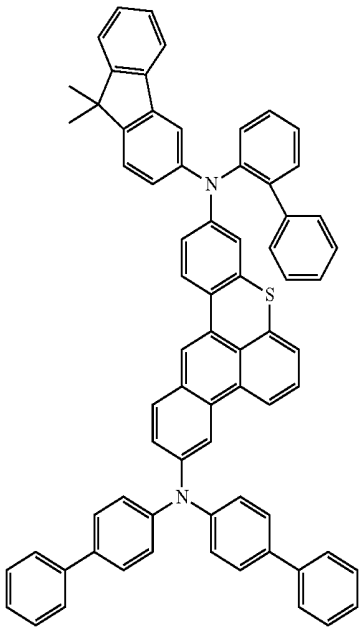

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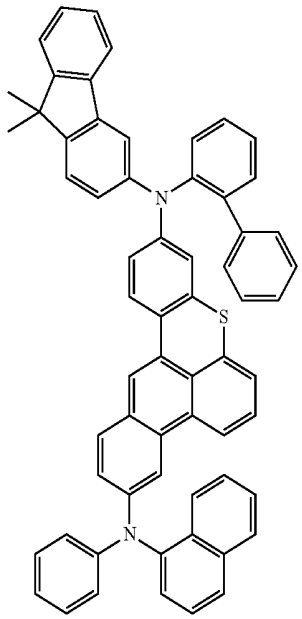

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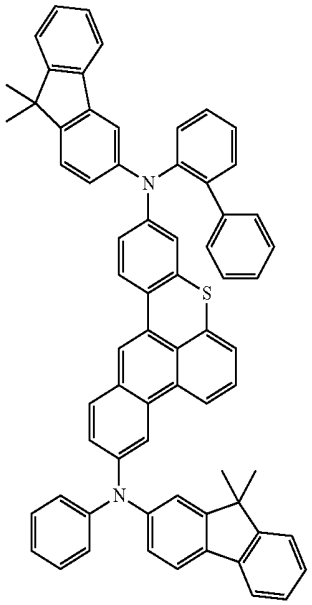

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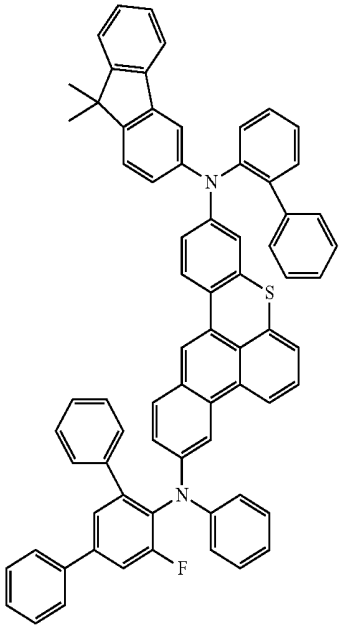

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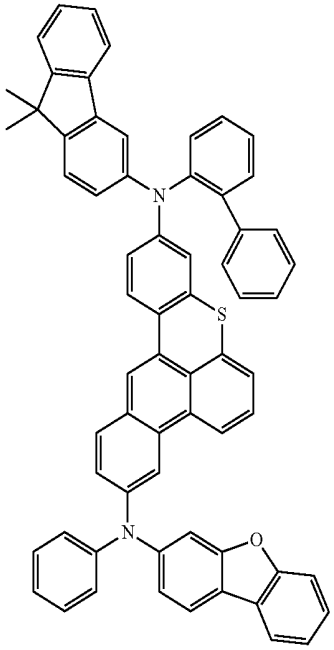

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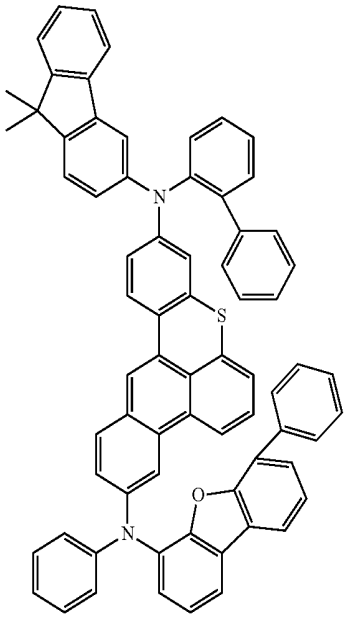

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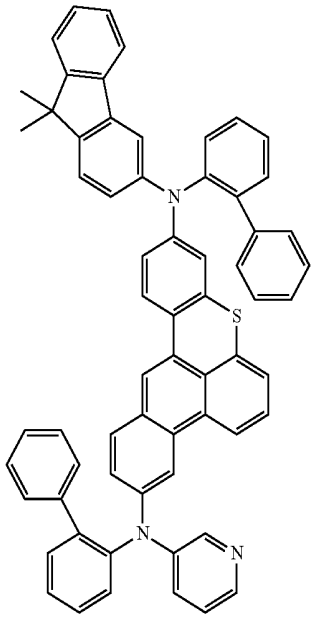

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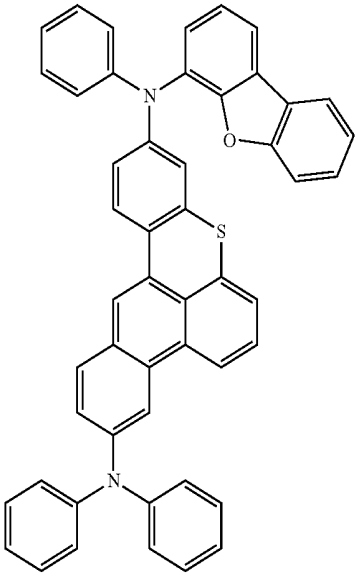

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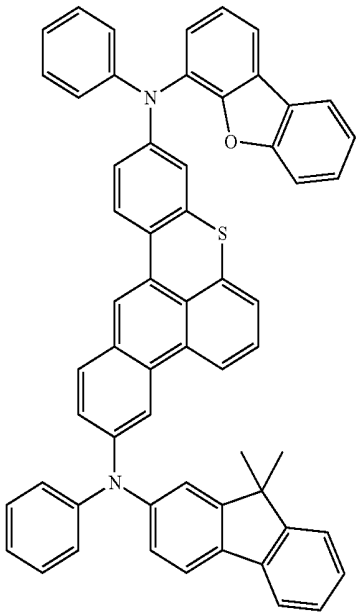

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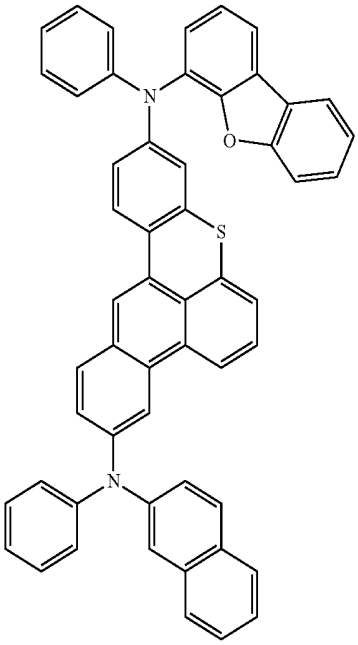

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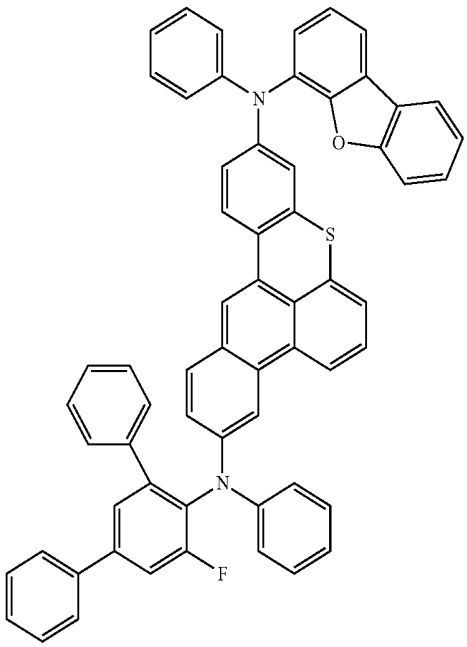

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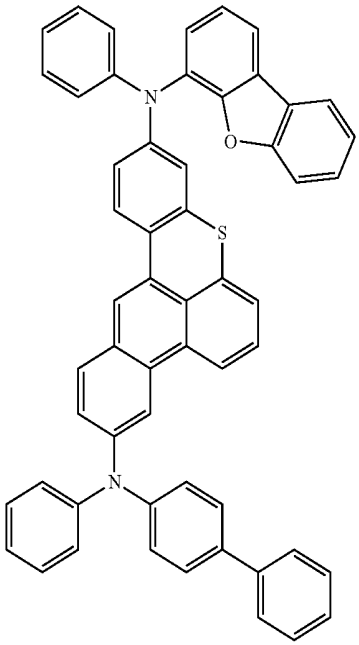

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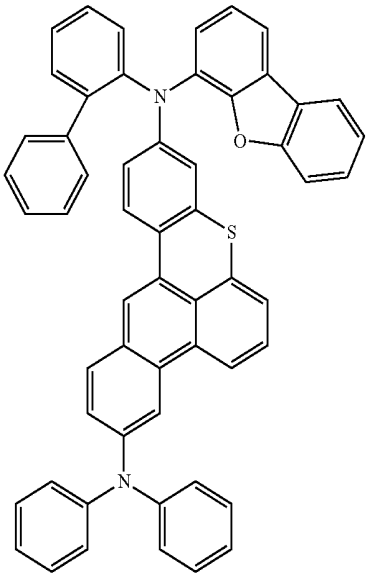

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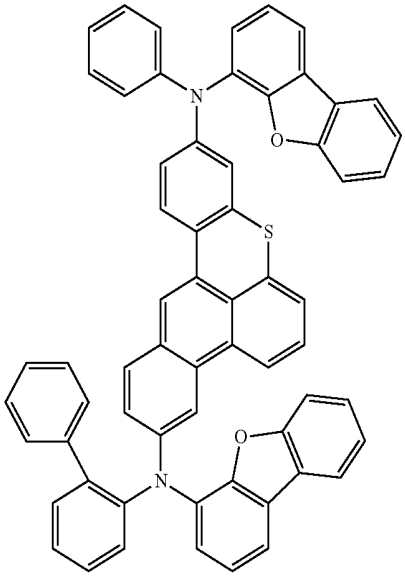

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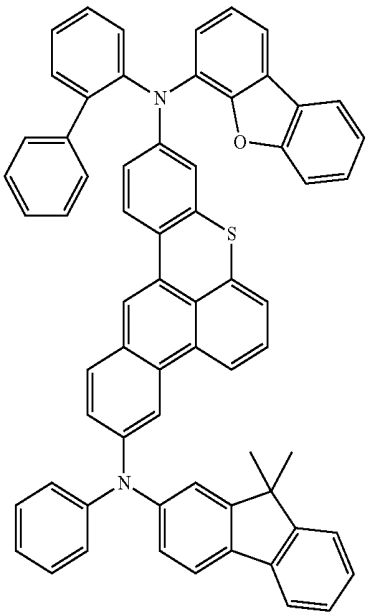

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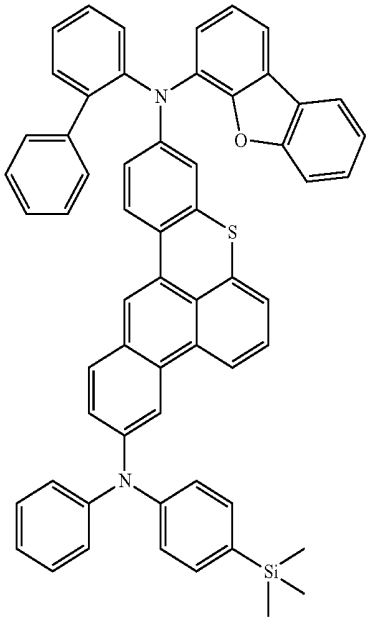
85A



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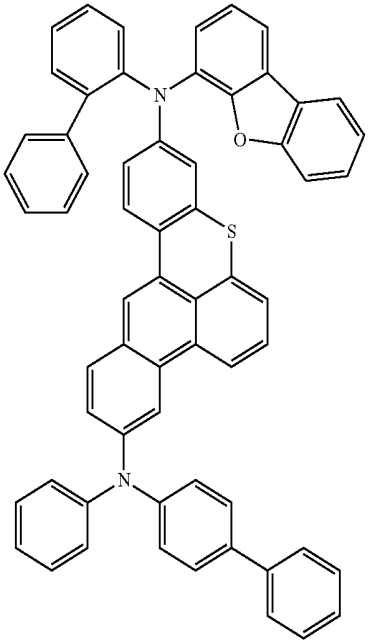
87A



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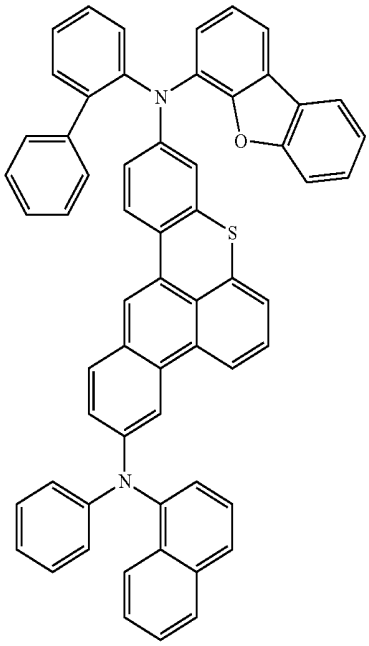

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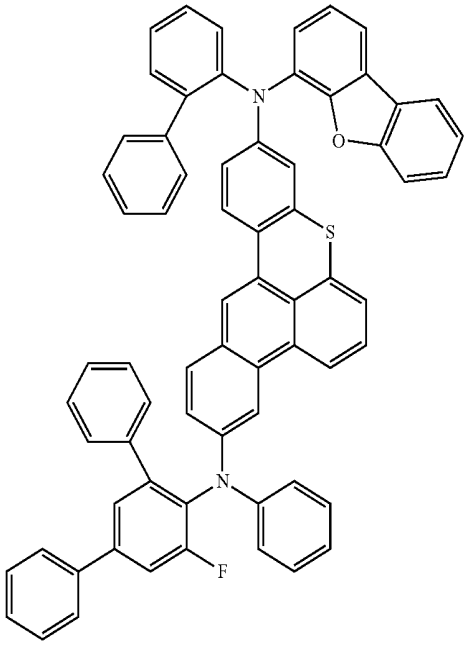

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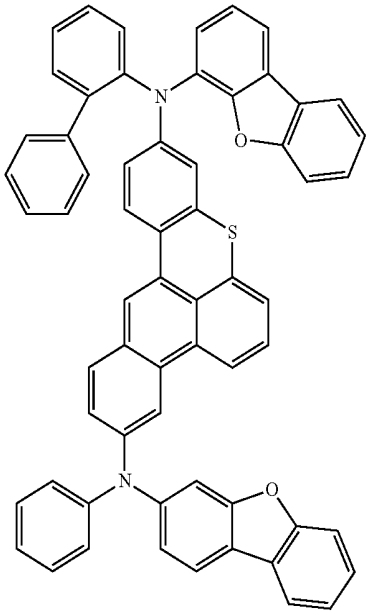

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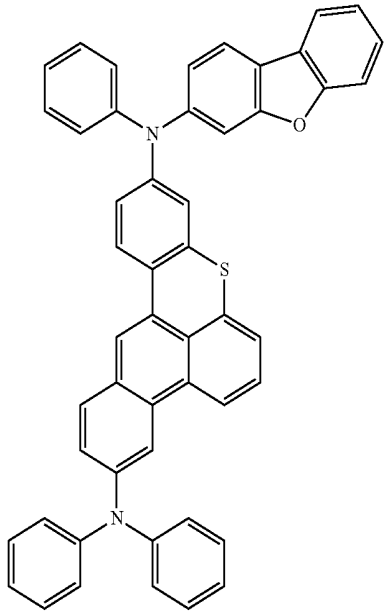

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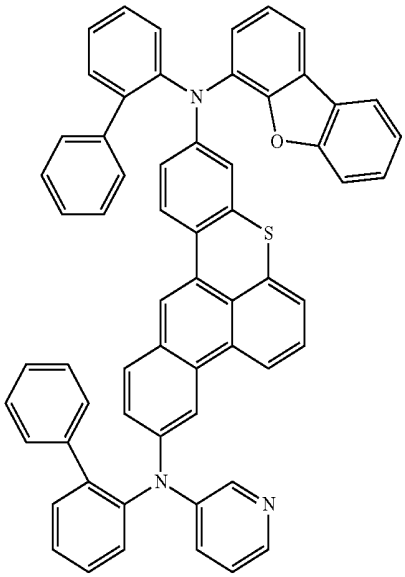

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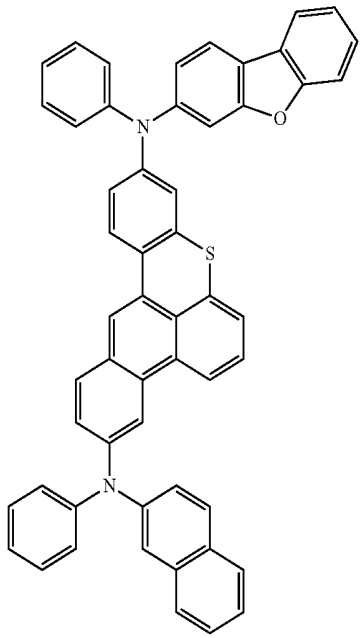

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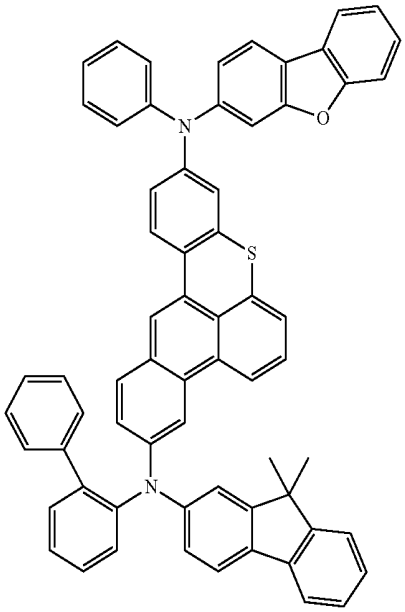

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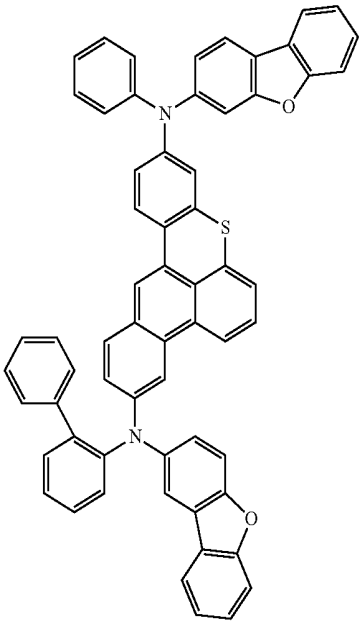

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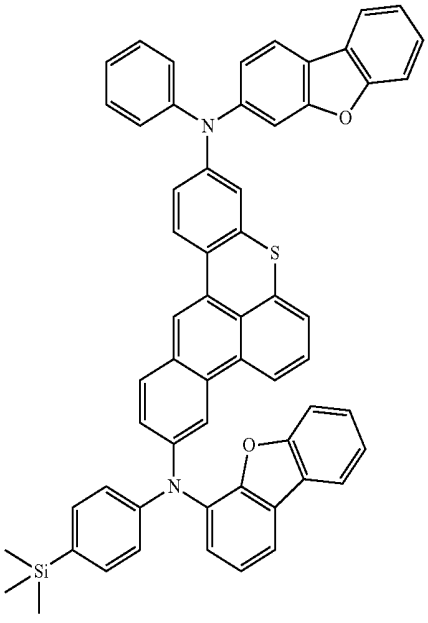

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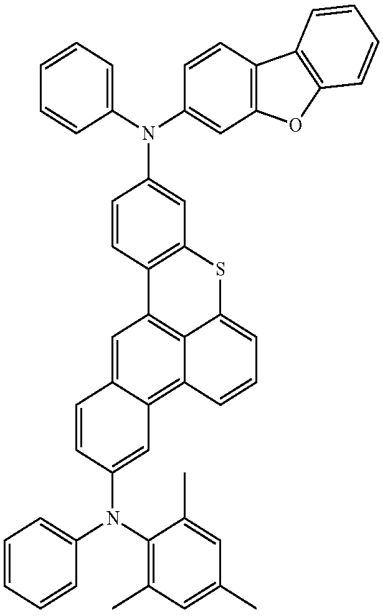

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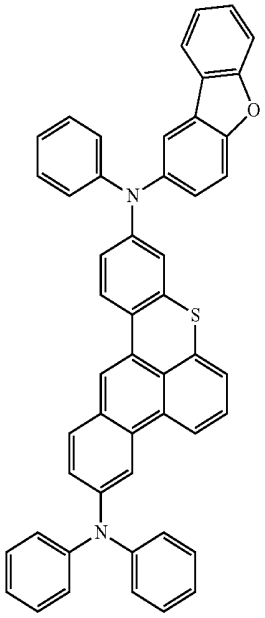

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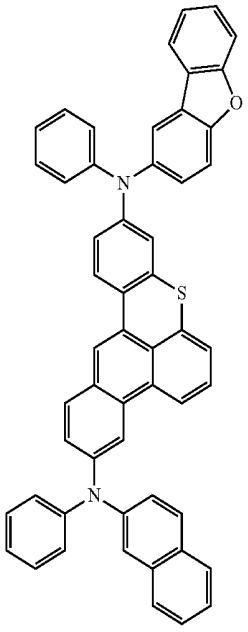

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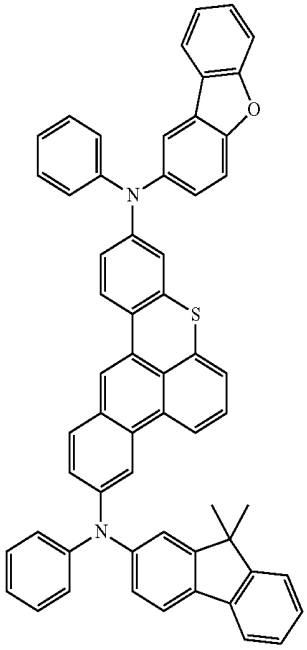

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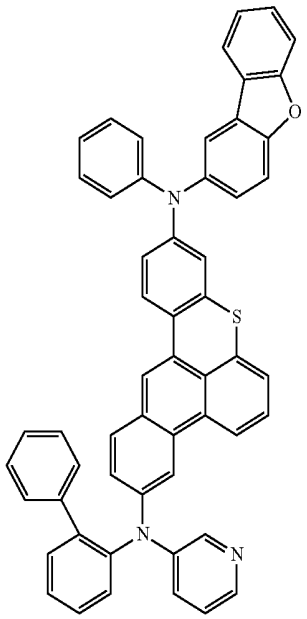

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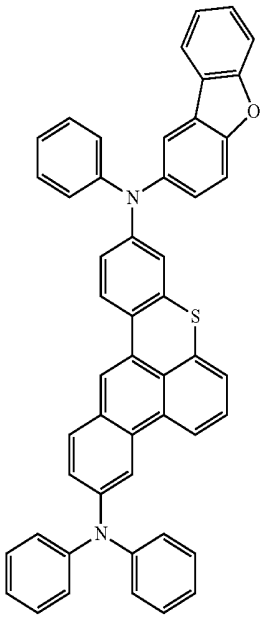

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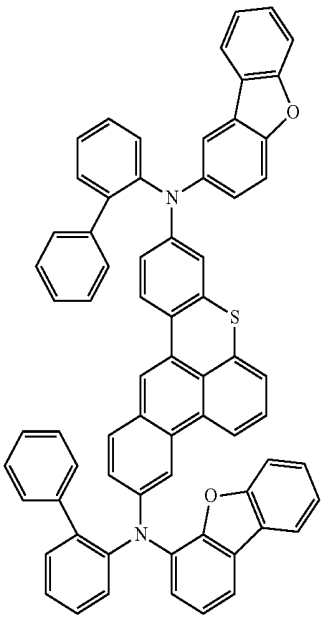

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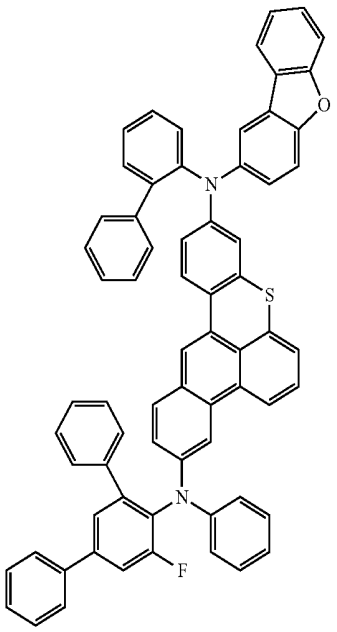

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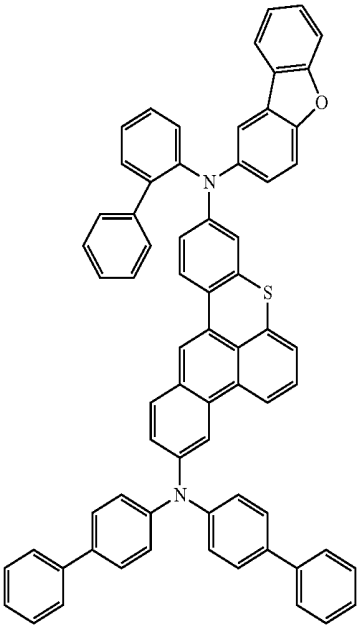

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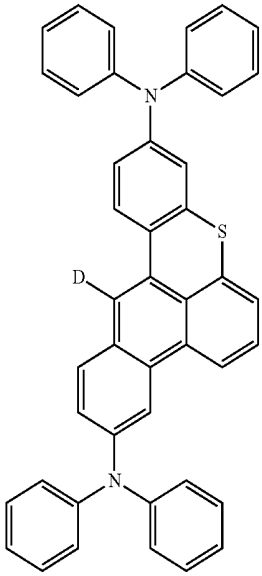

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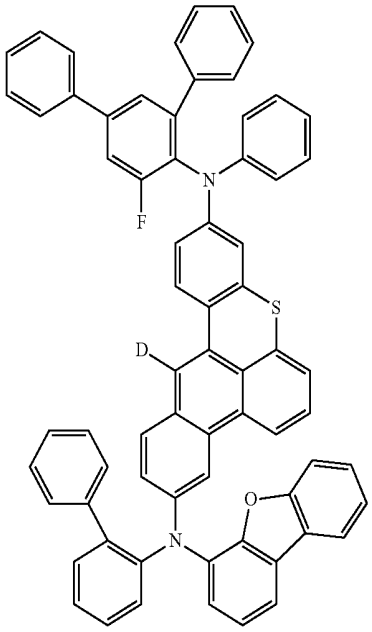

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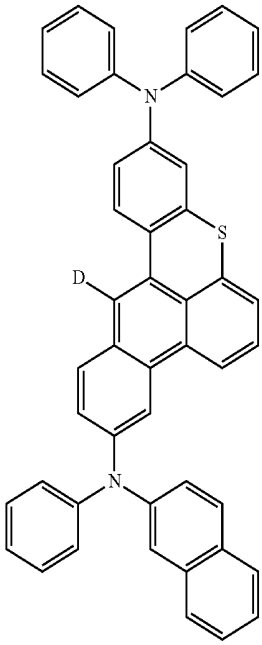

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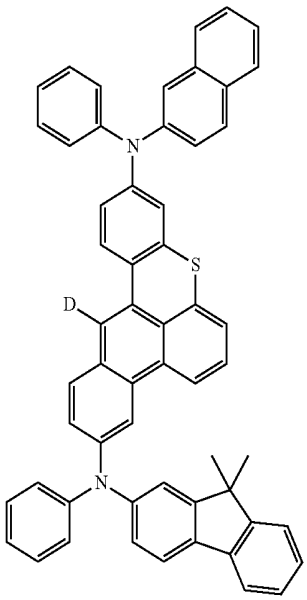

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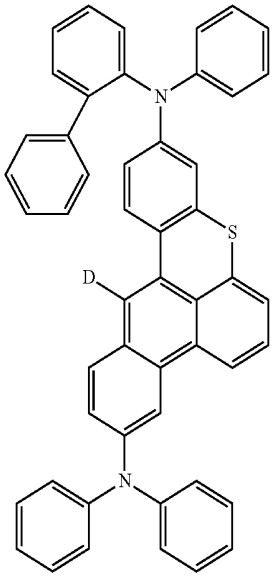

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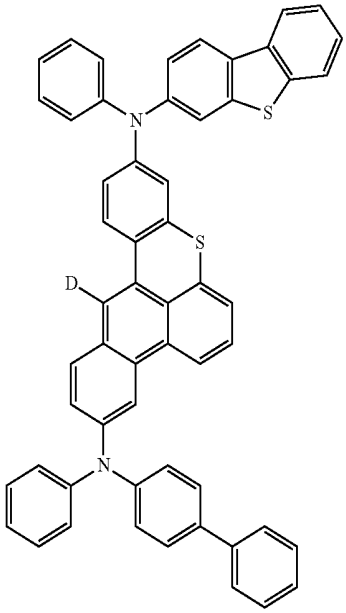

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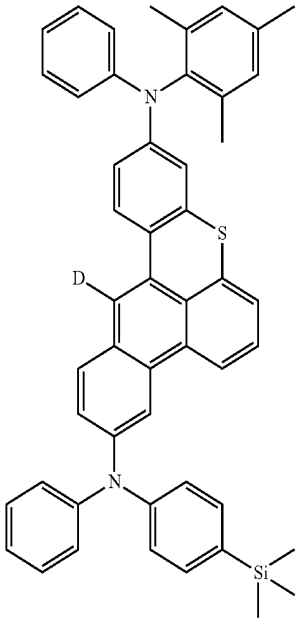

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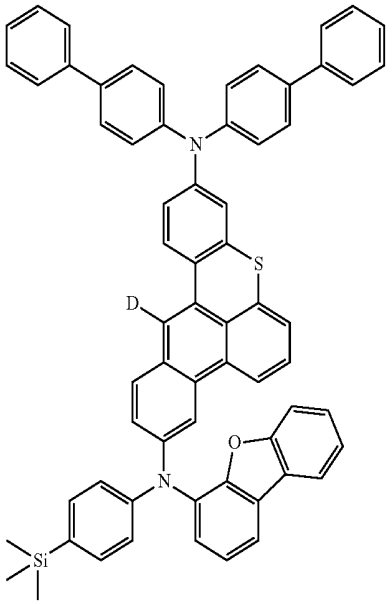

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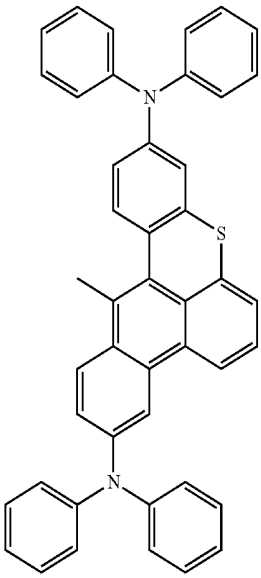

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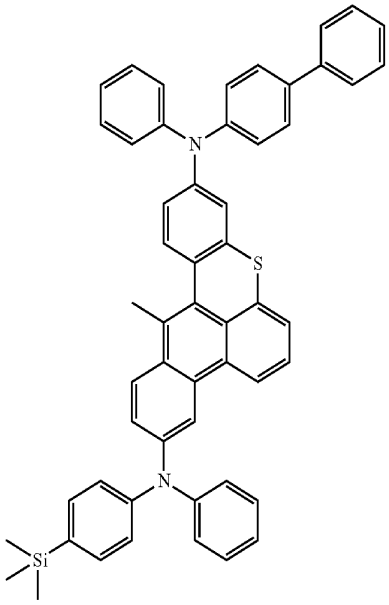

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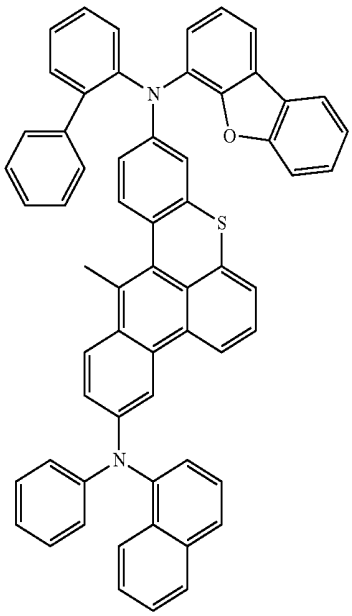

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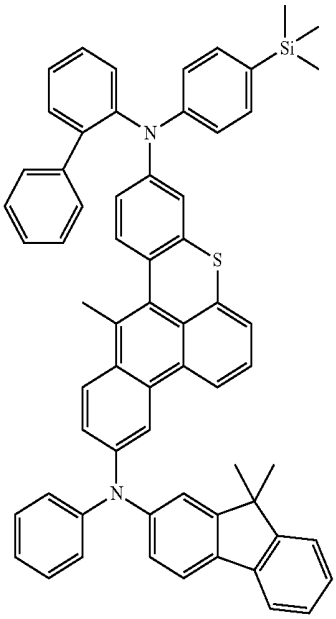

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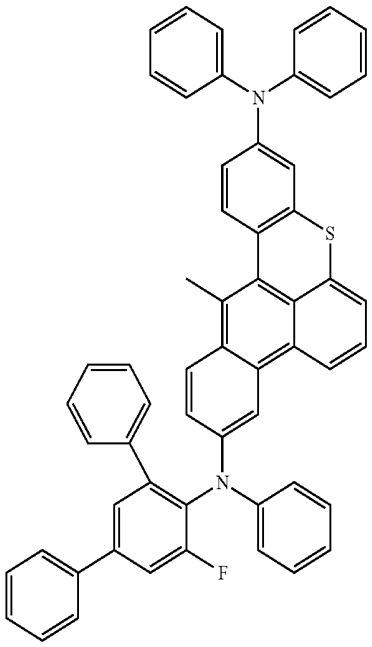

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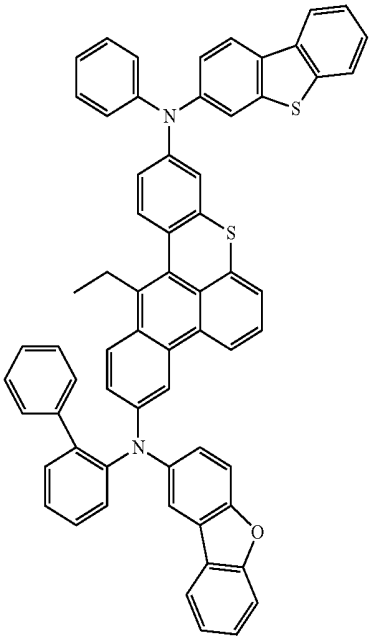

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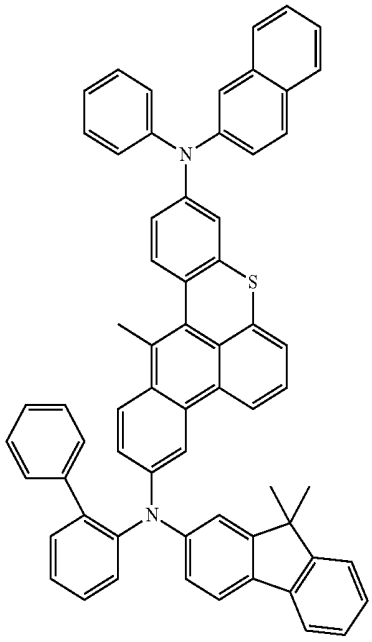

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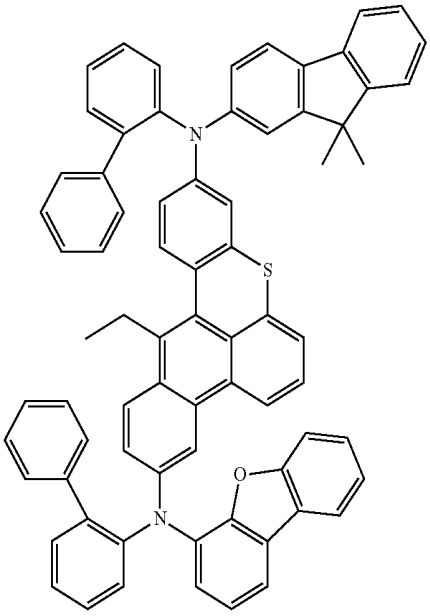

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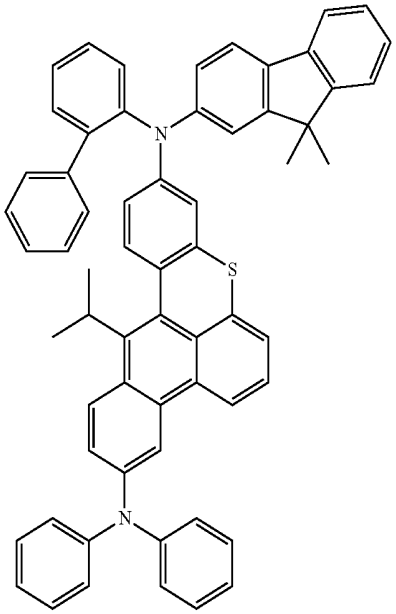

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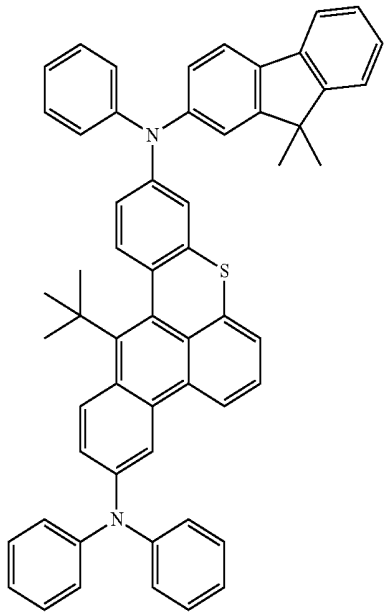

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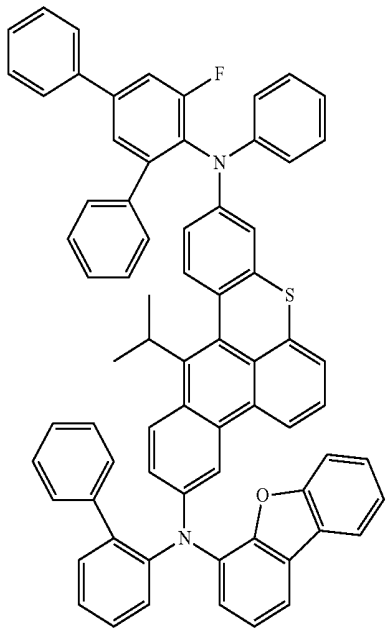

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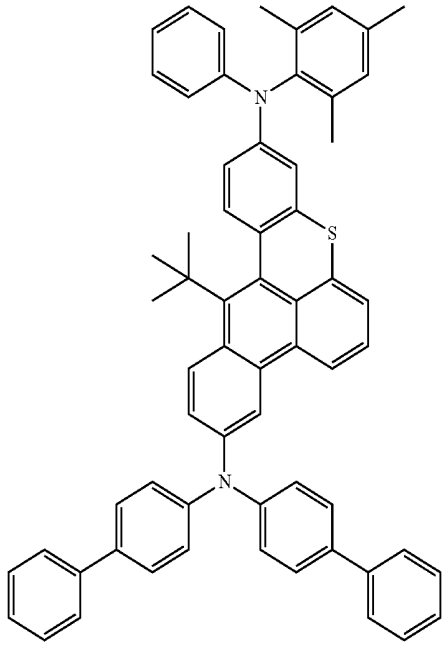

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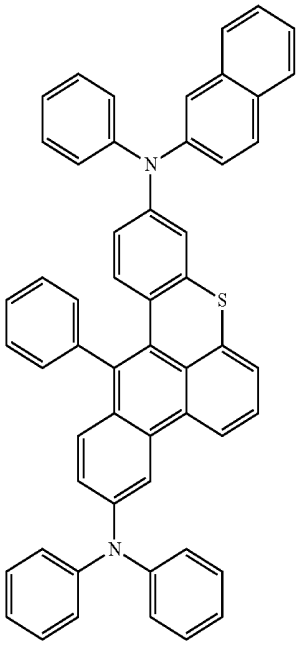

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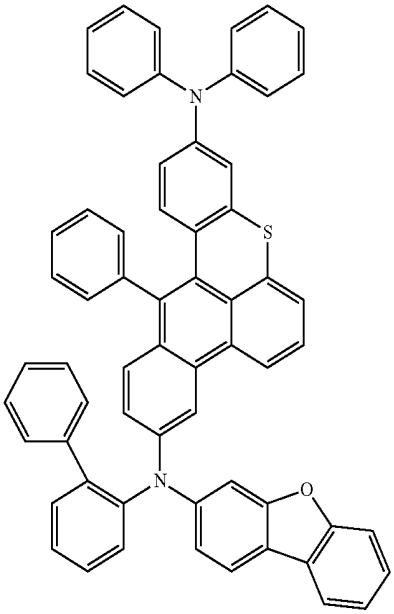

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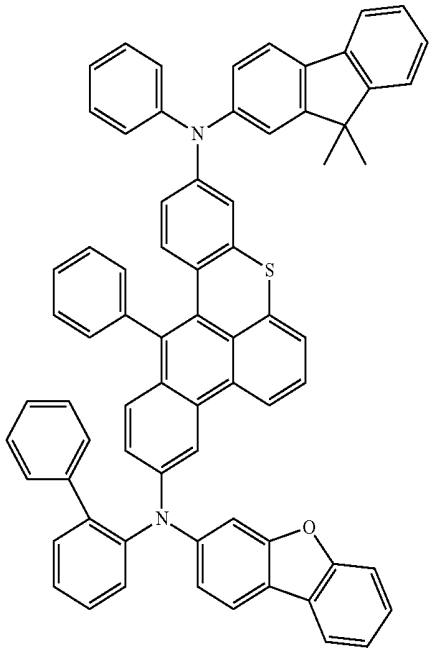

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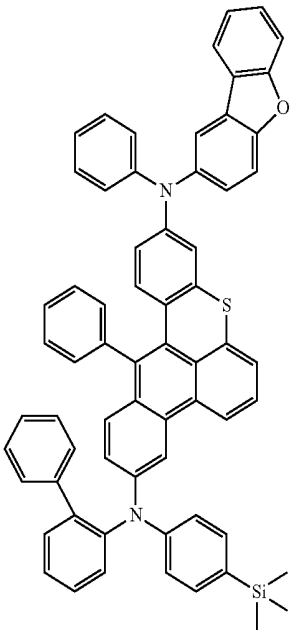

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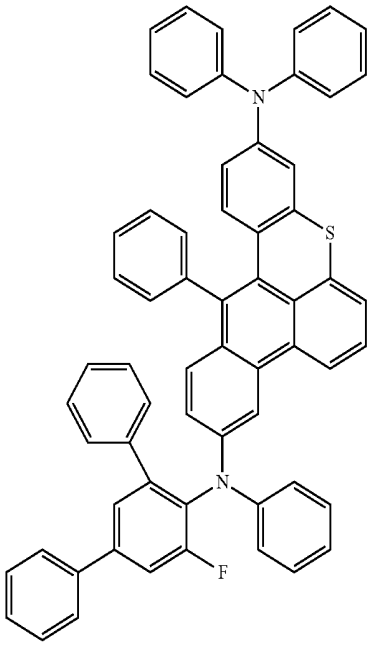

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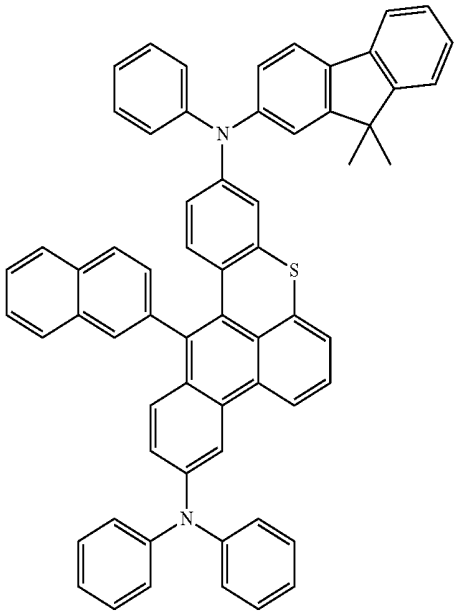

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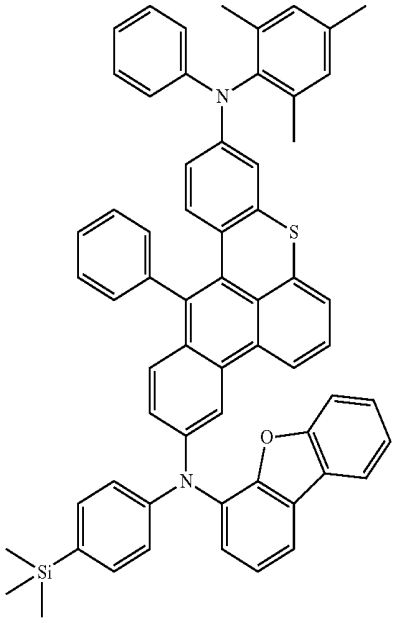

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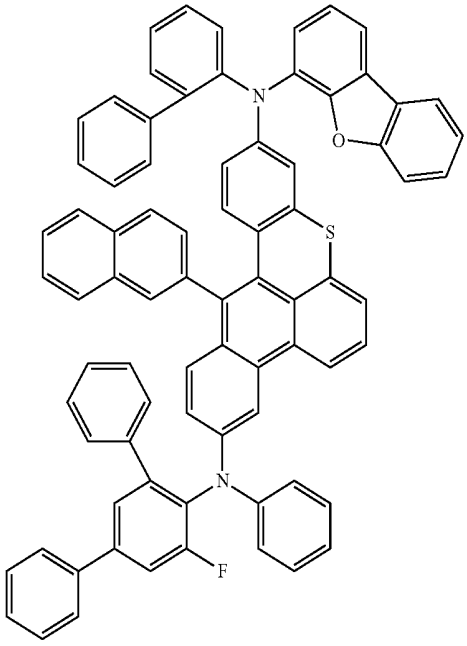

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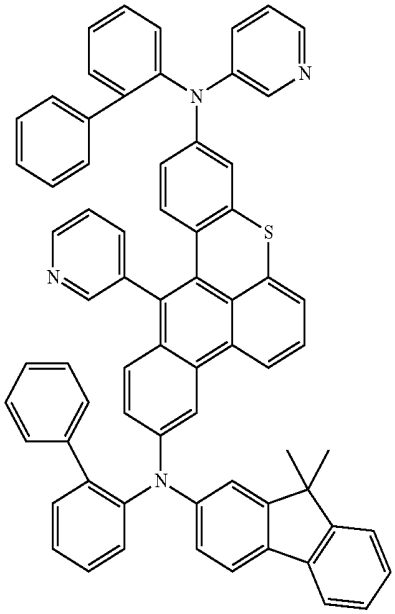

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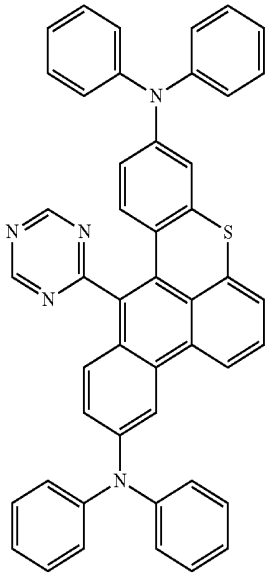

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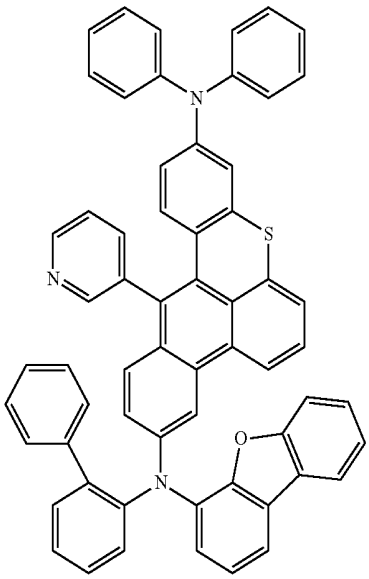

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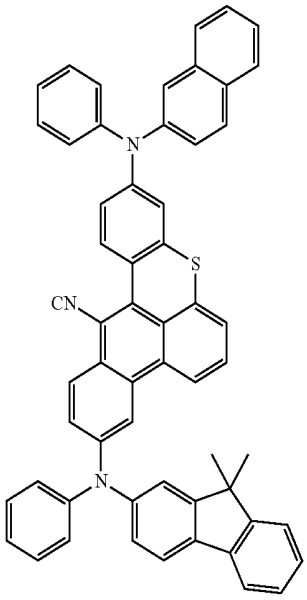

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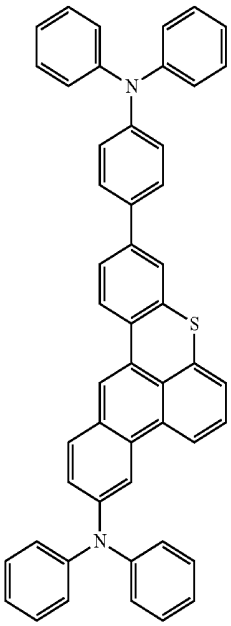

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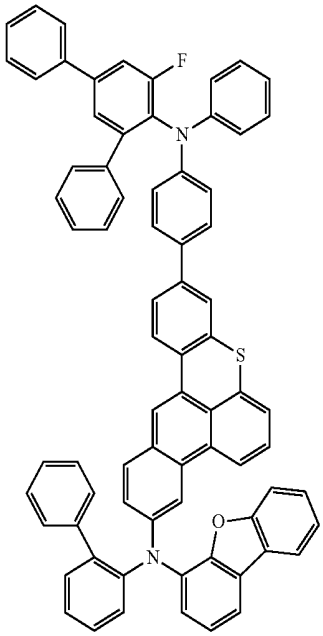

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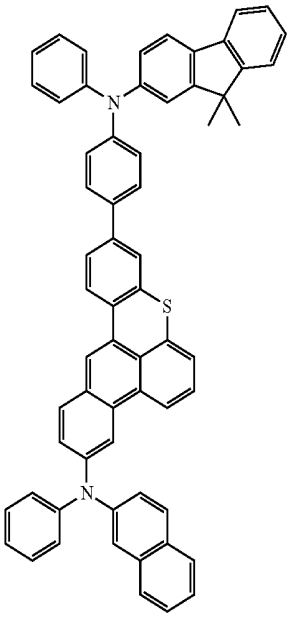

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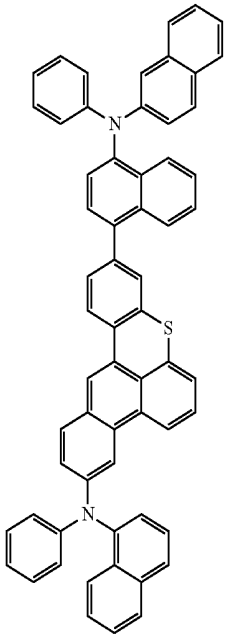

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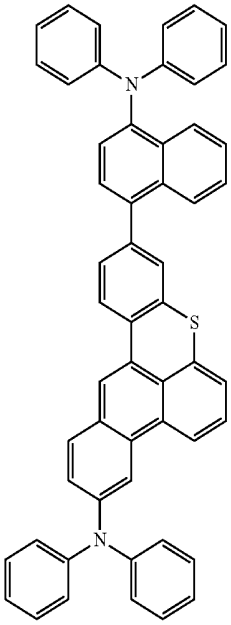

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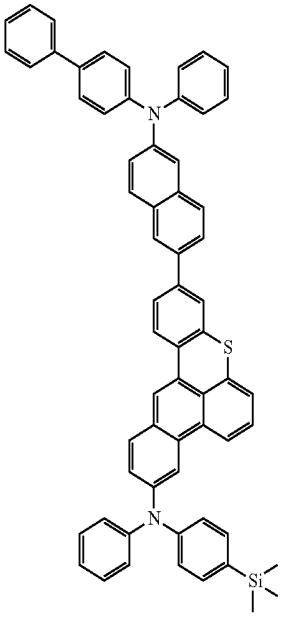

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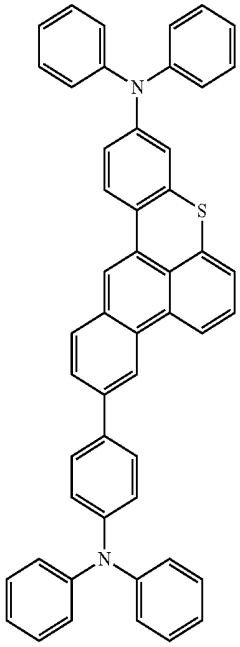

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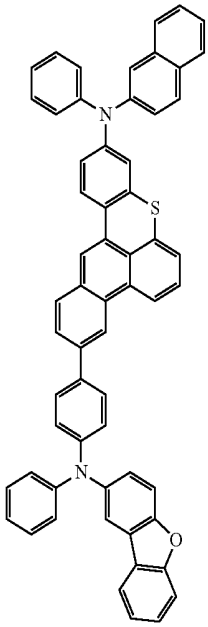

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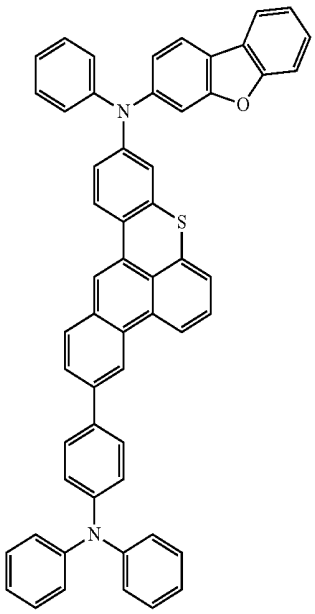

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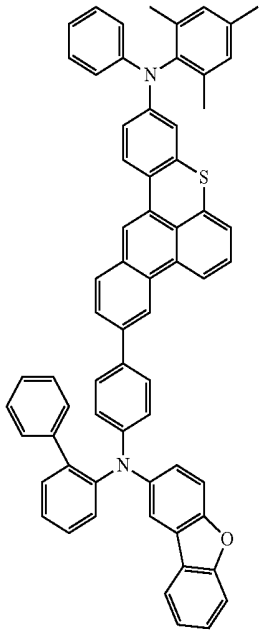

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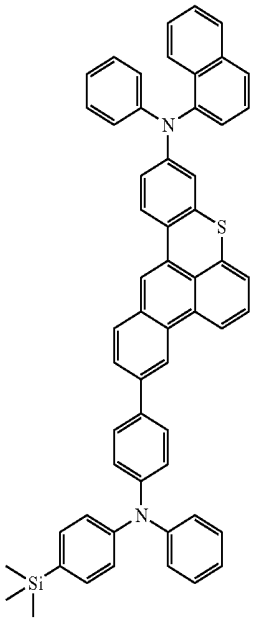

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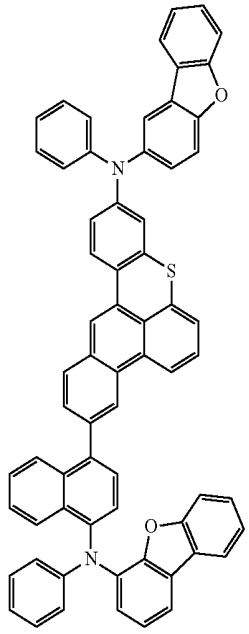

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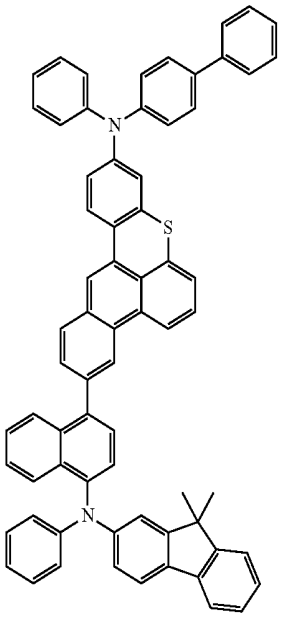

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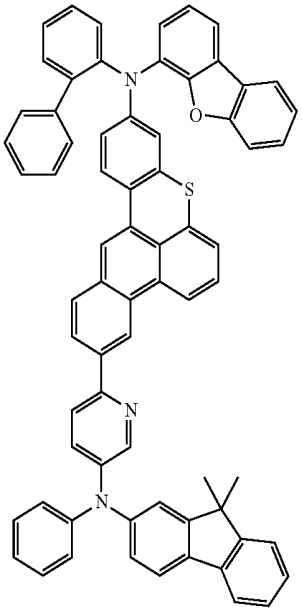

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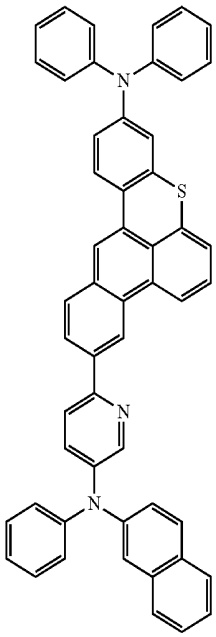

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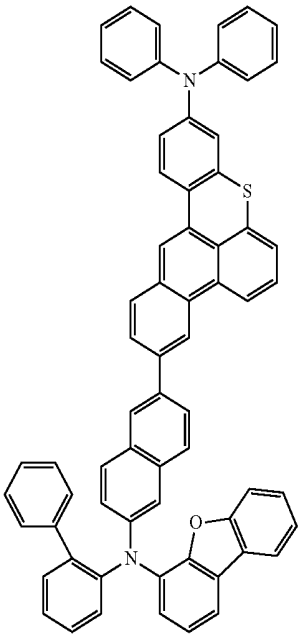

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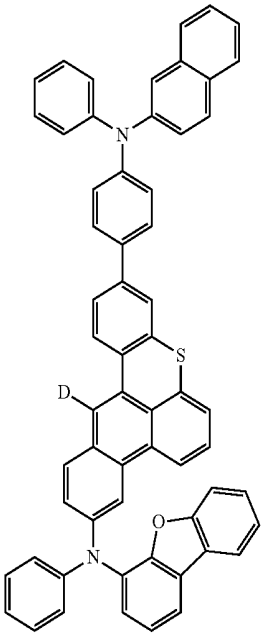

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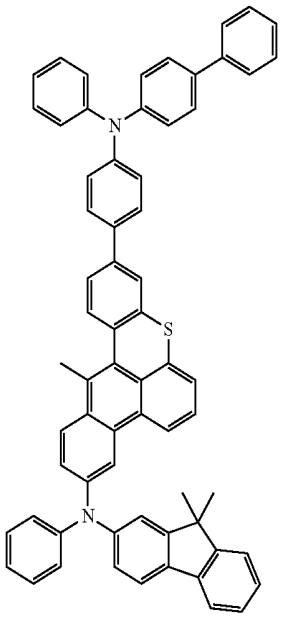

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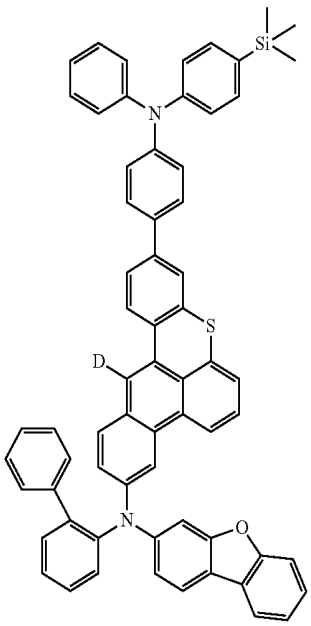

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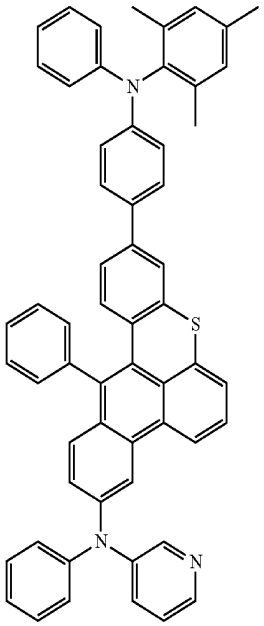

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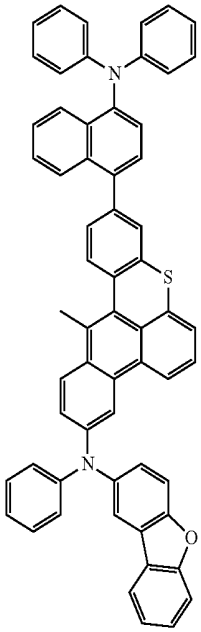

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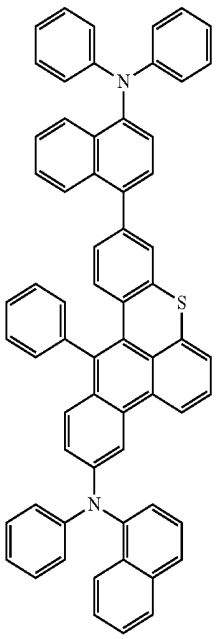

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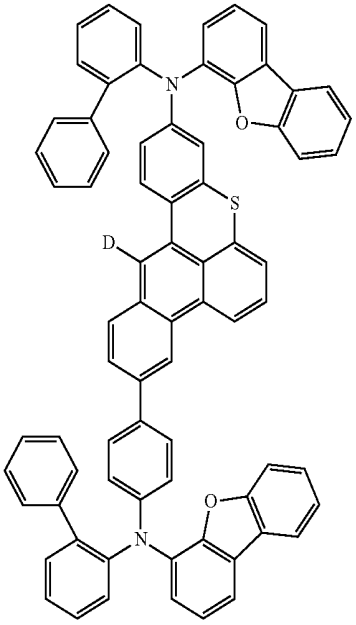

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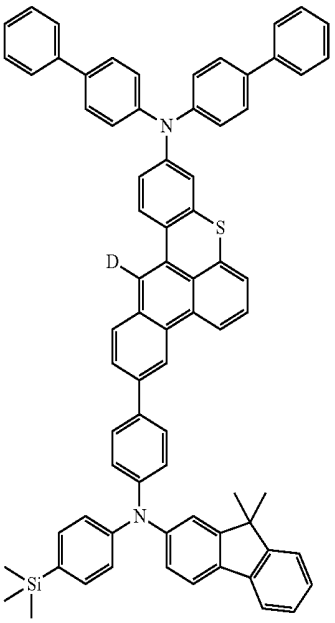

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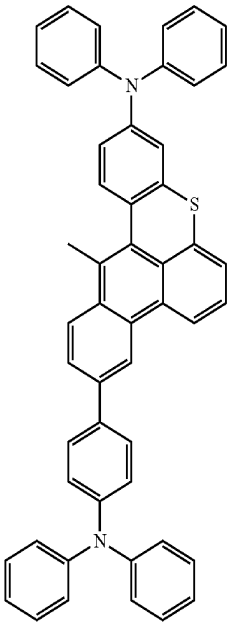

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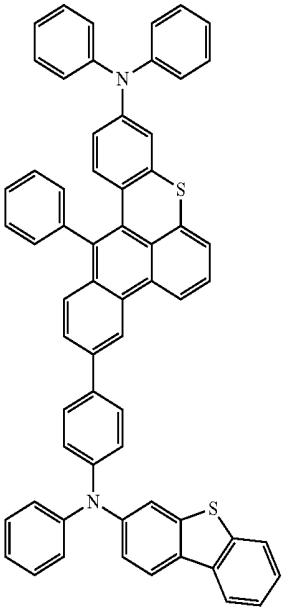

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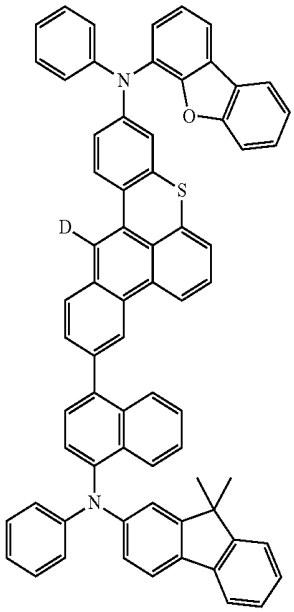

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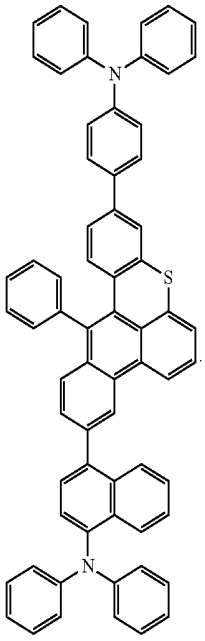

17. An organic light-emitting device comprising:
a first electrode;
a second electrode facing the first electrode; and
an organic layer between the first electrode and the second electrode, the organic layer comprising an emission layer, and further comprising at least one of the condensed cyclic compounds of claim **1**.

18. The organic light-emitting device of claim **17**, 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, a buffer 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,

wherein at least one selected from the hole transport region and the emission layer comprises the condensed cyclic compound.

19. The organic light-emitting device of claim **17**, wherein the condensed cyclic compound is in the emission layer and the emission layer further comprises a host.

20. The organic light-emitting device of claim **18**, wherein the hole transport region comprises the hole transport layer, and each of the hole transport layer and the emission layer comprises the condensed cyclic compound,

wherein the condensed cyclic compound in the hole transport layer is different from the condensed cyclic compound in the emission layer.

* * * * *

专利名称(译)	缩合环状化合物和包括其的有机发光器件		
公开(公告)号	US20160118593A1	公开(公告)日	2016-04-28
申请号	US14/695021	申请日	2015-04-23
[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	KIM YOUNGKOOK KIM KWANGHYUN KIM JONGWOO JUN MIEUN HWANG SEOKHWAN		
发明人	KIM, YOUNGKOOK KIM, KWANGHYUN KIM, JONGWOO JUN, MIEUN HWANG, SEOKHWAN		
IPC分类号	H01L51/00 C09K11/06 C07D405/14 C07D335/04 C07D407/14 C07D409/14 C07D409/12 C07D407/12 C07D311/78 C07F7/08		
CPC分类号	H01L51/0061 C09K2211/1062 C09K11/06 H01L51/006 H01L51/0094 C07D405/14 C07F7/0812 C07D407/14 C07D409/14 C07D409/12 C07D407/12 C07D335/04 C09K2211/1048 H01L51/0073 H01L51/0058 H01L51/0067 H01L51/5206 H01L51/5221 H01L51/5012 H01L51/5056 H01L51/5088 H01L51/5096 H01L51/5072 H01L51/5092 H01L2251/308 H01L2251/301 C09K2211/1077 C09K2211/1055 H01L51/0074 C09K2211/1051 H01L51/0052 C07D311/78 H01L51/0081 H01L51/5016 H05B33/22		
优先权	1020140144276 2014-10-23 KR		
其他公开文献	US9741939		
外部链接	Espacenet USPTO		

摘要(译)

由式1表示的稠合环状化合物： 一种有机发光装置，包括第一电极;面向第一电极的第二电极;第一电极和第二电极之间的有机层，有机层包括发光层，并且还包含至少一种式1的稠环化合物。