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Jang et al.

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

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H01L 51/00 (2006.01)
C07F 7/30 (2006.01)
H01L 51/50 (2006.01)

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CPC ***C07F 7/30*** (2013.01); ***H01L 51/0061*** (2013.01); ***H01L 51/0072*** (2013.01); *H01L 51/006* (2013.01); *H01L 51/0052* (2013.01); *H01L 51/0081* (2013.01); *H01L 51/5056* (2013.01); *H01L 2251/308* (2013.01)

(58) **Field of Classification Search**
CPC C07F 7/30; H01L 51/0061; H01L 51/0072; H01L 2251/308; H01L 51/0081; H01L 51/006; H01L 51/0052; H01L 51/5056
See application file for complete search history.

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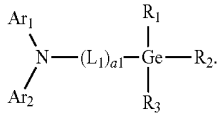
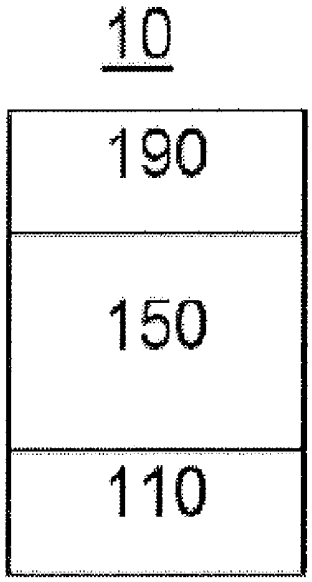
(57) **ABSTRACT**

An amine-based compound and an organic light-emitting device including the same, the amine-based compound being represented by Formula 1, below:

<Formula 1>



15 Claims, 1 Drawing Sheet



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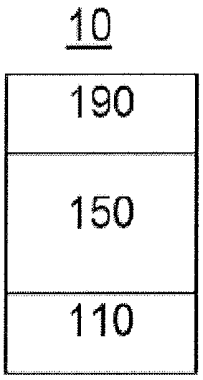

10
190
150
110

AMINE-BASED COMPOUND AND ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

Korean Patent Application No. 10-2014-0115400, filed on Sep. 1, 2014, in the Korean Intellectual Property Office, and entitled: "Amine-Based Compound and Organic Light-Emitting Device Including the Same," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

Embodiments relate to an amine-based compound and an organic light-emitting device including the same.

2. Description of the Related Art

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

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, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. The holes and the electrons may be recombined in the emission layer to produce excitons. These excitons may change from an excited state to a ground state, thereby generating light.

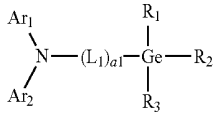
SUMMARY

One or more embodiments may include an amine-based compound and an organic light-emitting device including the same.

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.

An aspect provides an amine-based compound represented by Formula 1 below:

<Formula 1>



wherein in Formula 1,

L_1 is 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;

a1 is an integer selected from 1 to 5, and when a1 is 2 or more, L_1 that is 2 or more are each identical or different;

Ar_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;

Ar_1 and Ar_2 are optionally linked to each other to form a saturated or unsaturated ring;

R_1 to R_3 are each independently selected from

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; and

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, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_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, a monovalent non-aromatic condensed heteropolycyclic group, and $Si(Q_1)(Q_2)(Q_3)$;

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_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_1-C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from

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

a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, —$Si(Q_{11})(Q_{12})(Q_{13})$, —$B(Q_{14})(Q_{15})$, and —$N(Q_{16})(Q_{17})$;

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;

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

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

wherein Q_1 to Q_3, Q_{11} to Q_{17}, Q_{21} to Q_{27}, and Q_{31} to Q_{37} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_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.

According to one or more embodiments, an organic light-emitting device may include: a first electrode; a second electrode facing the first electrode; and an organic layer that is disposed between the first electrode and the second electrode and includes an emission layer, wherein the organic layer includes at least one selected from the amine-based compounds described above.

BRIEF DESCRIPTION OF THE DRAWING

Features will be apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawing in which:

The FIGURE illustrates a schematic view of an organic light-emitting device according to an embodiment.

DETAILED DESCRIPTION

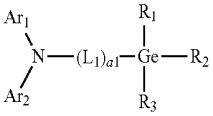
Example embodiments will now be described more fully hereinafter with reference to the accompanying drawing; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

In the drawing FIGURE, the dimensions of layers and regions may be exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

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.

An amine-based compound according to an embodiment may be represented by Formula 1 below:

<Formula 1>



In Formula 1,

L_1 may be selected from or may include 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.

In an implementation, L_1 in Formula 1 may be 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 spiro-fluorenylene 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 iso-

thiazolylene 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 benzooxazolylene group, an isobenzooxazolylene 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 spiro-fluorenylene 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 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 benzooxazolylene group, an isobenzooxazolylene 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 phenylenyl 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 dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

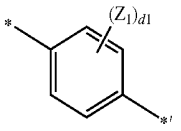
In an implementation, L_1 in Formula 1 may be selected from

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, a quinolinylene group, a benzoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a carbazolylene group, and a triazinylene group; and

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, a quinolinylene group, a benzoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene 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 phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a quinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinylene group, a carbazolyl group, and a triazinyl group.

In an implementation, L_1 in Formula 1 may be a group represented by one of Formulae 3-1 to 3-32 below:

Formula 3-1



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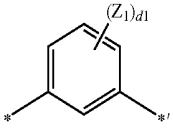
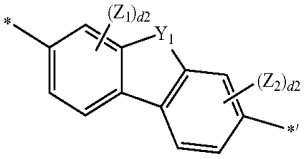
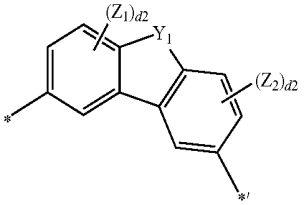
Formula 3-2



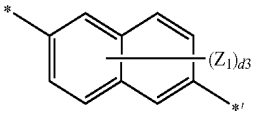
Formula 3-3



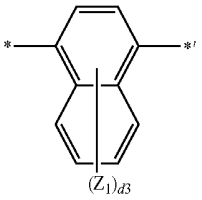
Formula 3-4



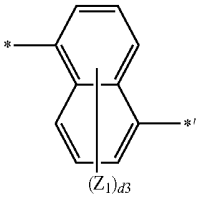
Formula 3-5



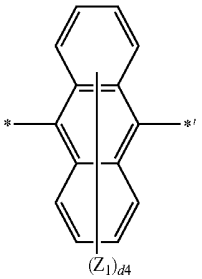
Formula 3-6



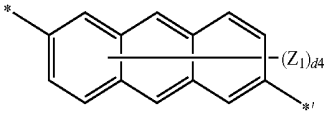
Formula 3-7



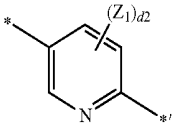
Formula 3-8



Formula 3-9



Formula 3-10



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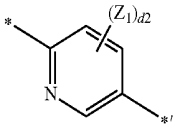
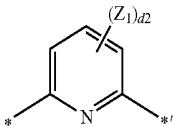
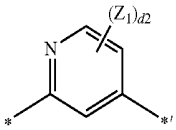
Formula 3-11



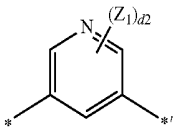
Formula 3-12



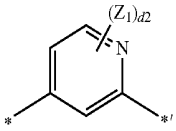
Formula 3-13



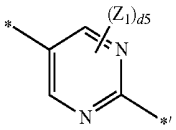
Formula 3-14



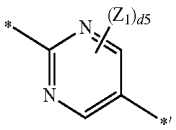
Formula 3-15



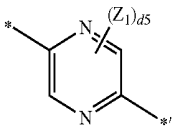
Formula 3-16



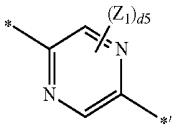
Formula 3-17



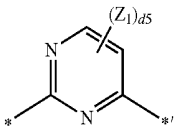
Formula 3-18



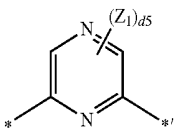
Formula 3-19



Formula 3-20



Formula 3-21



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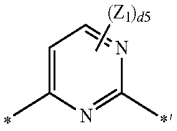
Formula 3-22



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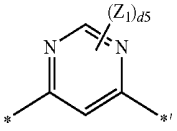
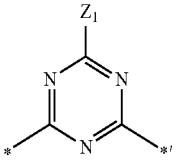
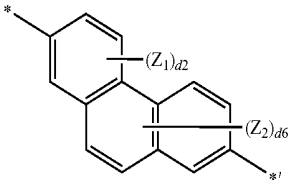


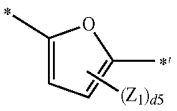
Formula 3-24



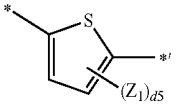
Formula 3-25



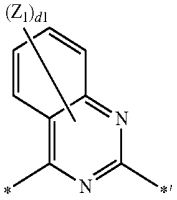
Formula 3-26



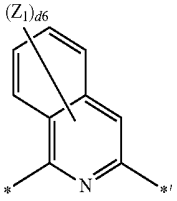
Formula 3-27



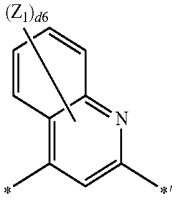
Formula 3-28



Formula 3-29



Formula 3-30



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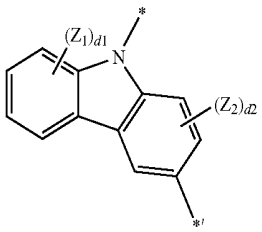
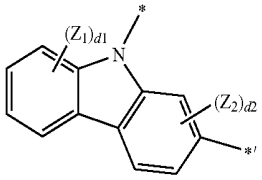
Formula 3-31



Formula 3-32



In Formulae 3-1 to 3-32,

Y_1, may be selected from O, S, $C(Z_3)(Z_4)$, $N(Z_5)$ and $Si(Z_6)(Z_7)$;

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, and a C_1-C_{20} alkoxy group;

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, and 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, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, and a naphthyl group; and

$—Si(Q_{31})(Q_{32})(Q_{33})$;

wherein Q_{31} to Q_{33} 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 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;

d1 may be an integer selected from 1 to 4,

d2 may be an integer selected from 1 to 3,

d3 may be an integer selected from 1 to 6,

d4 may be an integer selected from 1 to 8,

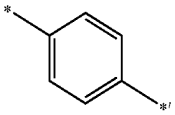
d5 may be an integer selected from 1 and 2,

d6 may be an integer selected from 1 to 5, and

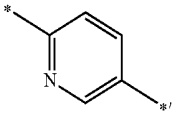
* and *' indicate a binding site with an adjacent atom.

In an implementation, L_1 in Formula 1 may be a group represented by one of Formulae 4-1 to 4-26 below:

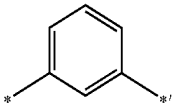
Formula 4-1



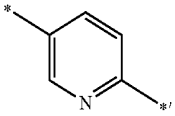
Formula 4-2



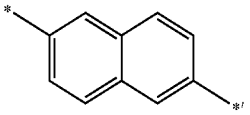
Formula 4-3



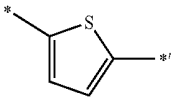
Formula 4-4



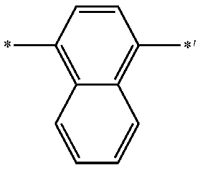
Formula 4-5



Formula 4-6



Formula 4-7



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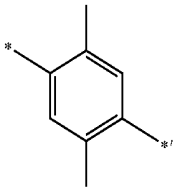
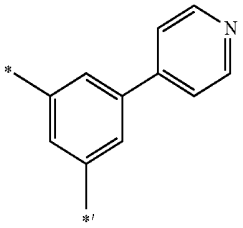
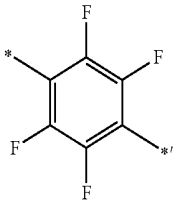
Formula 4-8



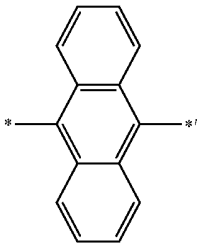
Formula 4-9



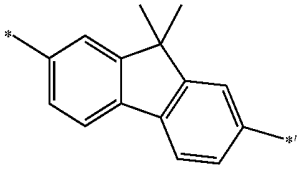
Formula 4-10



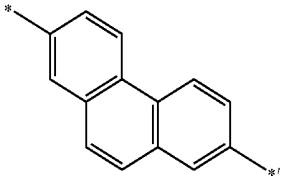
Formula 4-11



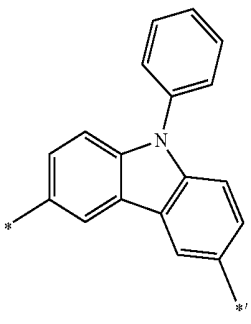
Formula 4-12



Formula 4-13



Formula 4-14



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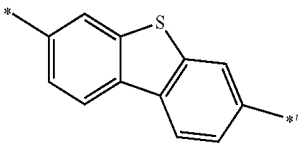
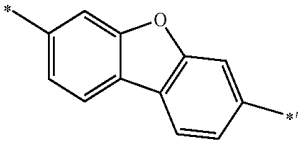
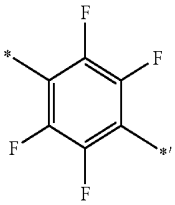
Formula 4-15



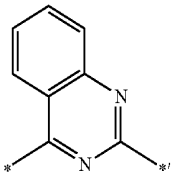
Formula 4-16



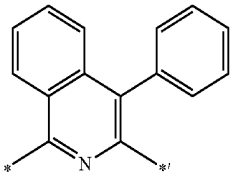
Formula 4-17



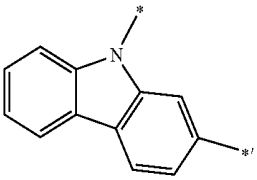
Formula 4-18



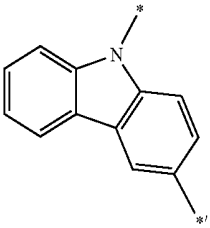
Formula 4-19



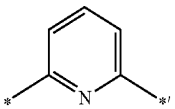
Formula 4-20



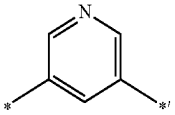
Formula 4-21



Formula 4-22



Formula 4-23



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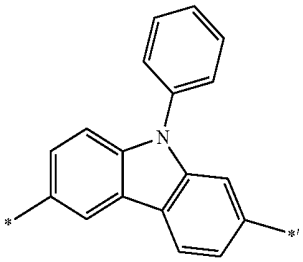
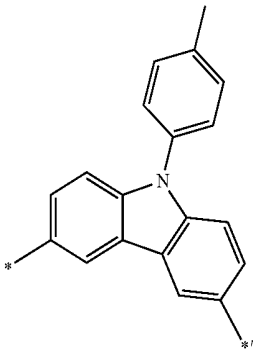
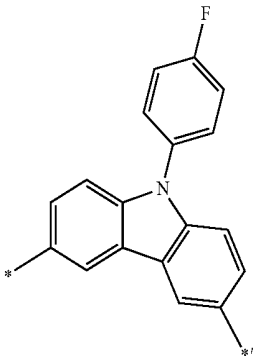
Formula 4-24



Formula 4-25



Formula 4-26



wherein in Formulae 4-1 to 4-26, * and *' indicate a binding site with an adjacent atom.

a1 in Formula 1 indicates the number of L_1, and a1 may be selected from an integer of 1 to 5. For example, a1 may be selected from an integer of 1 to 3, but is not limited thereto. When a1 is an integer of 2 or more, a plurality of L_1s may be identical or different.

In Formula 1, Ar_1 and Ar_2 may each independently be selected from or include 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.

In an implementation, in Formula 1, Ar_1 and Ar_2 may be 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 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, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

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 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 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, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, —$Si(Q_{31})(Q_{32})(Q_{33})$, —$B(Q_{34})(Q_{35})$, and —$N(Q_{36})(Q_{37})$,

wherein Q_{31} to Q_{37} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{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;

In an implementation, in Formula 1, Ar_1 and Ar_2 may be each independently selected from

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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl group; and

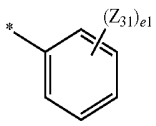
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, —Si(Q_{31})(Q_{32})(Q_{33}), —B(Q_{34})(Q_{35}), and —N(Q_{36})(Q_{37}),

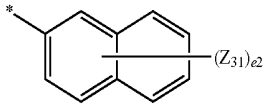
wherein Q_{31} to Q_{37} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{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.

In an implementation, in Formula 1, Ar_1 and Ar_2 may each independently be a group represented by one of Formulae 5-1 to 5-14 below:

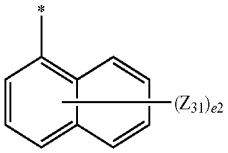
Formula 5-1



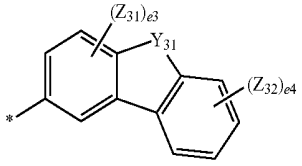
Formula 5-2



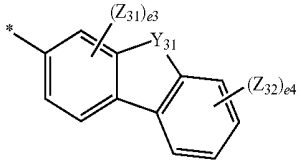
Formula 5-3



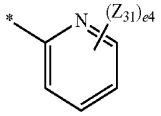
Formula 5-4



Formula 5-5

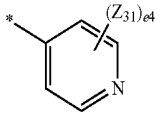


Formula 5-6

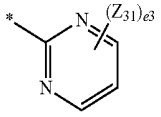


Formula 5-7

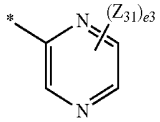
Formula 5-8



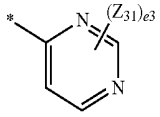
Formula 5-9



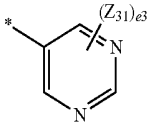
Formula 5-10



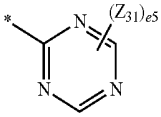
Formula 5-11



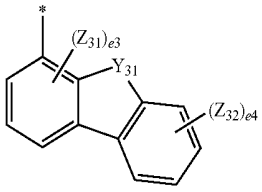
Formula 5-12



Formula 5-13



Formula 5-14



In Formulae 5-1 to 5-14,

Y_{31} may be selected from O, S, C(Z_{33})(Z_{34}), and N(Z_{35});

Z_{31} to Z_{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_{20} alkyl group, and a C_1-C_{20} alkoxy group;

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, and 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, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, and a naphthyl group; and

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

wherein Q_{31} to Q_{37} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{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;

e1 may be an integer selected from 1 to 5,

e2 may be an integer selected from 1 to 7,

e3 may be an integer selected from 1 to 3,

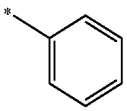
e4 may be an integer selected from 1 to 4,

e5 may be an integer selected from 1 and 2,

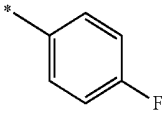
and * indicates a binding site with an adjacent atom.

In an implementation, in Formula 1, Ar_1 and Ar_2 may each independently be a group represented by one of Formulae 6-1 to 6-30 below:

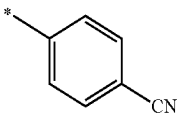
Formula 6-1



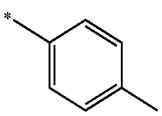
Formula 6-2



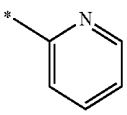
Formula 6-3



Formula 6-4



Formula 6-5



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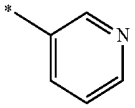
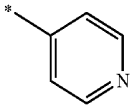
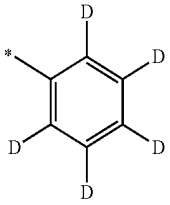
Formula 6-6



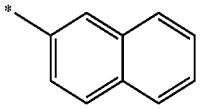
Formula 6-7



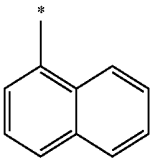
Formula 6-8



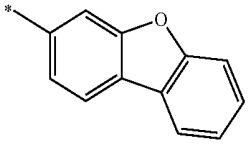
Formula 6-9



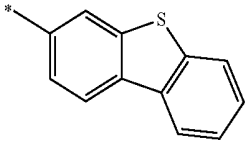
Formula 6-10



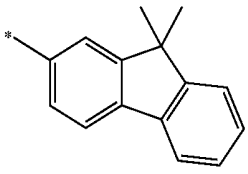
Formula 6-11



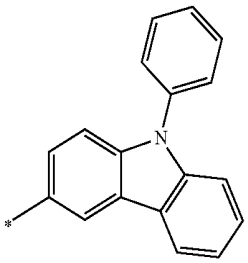
Formula 6-12



Formula 6-13



Formula 6-14



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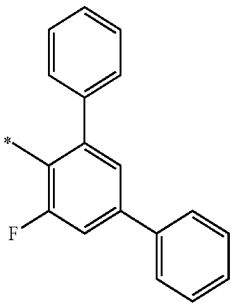
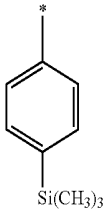
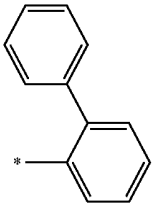
Formula 6-15



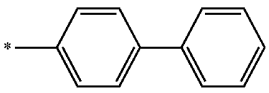
Formula 6-16



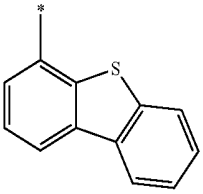
Formula 6-17



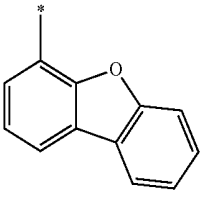
Formula 6-18



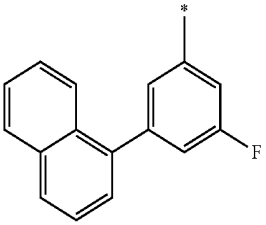
Formula 6-19



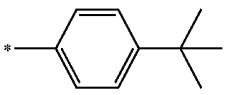
Formula 6-20



Formula 6-21



Formula 6-22



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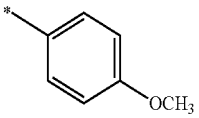
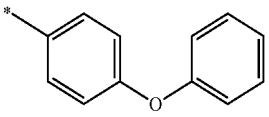
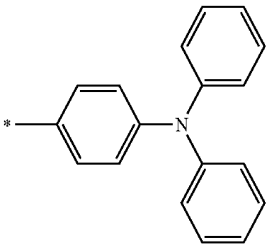
Formula 6-23



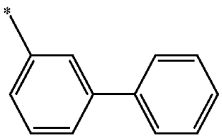
Formula 6-24



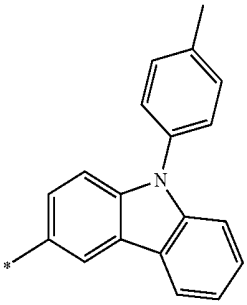
Formula 6-25



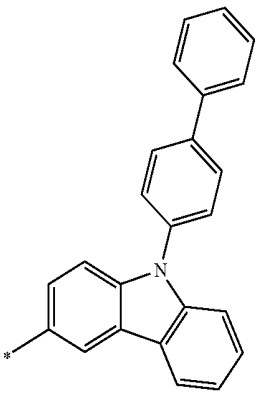
Formula 6-26



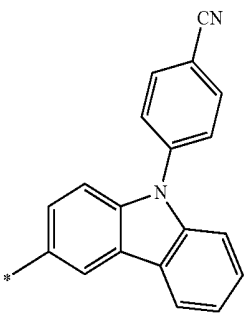
Formula 6-27



Formula 6-28



Formula 6-29



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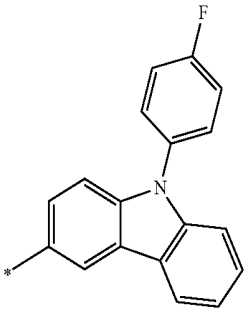
Formula 6-30



In Formulae 6-1 to 6-30, * indicates a binding site with an adjacent atom.

In an implementation, Ar_1 and Ar_2 in Formula 1 may be linked to each other to form a saturated or unsaturated ring. In an implementation, Ar_1 and Ar_2 in Formula 1 may be separate.

In an implementation, in Formula 1, Ar_1 and Ar_2 may be linked to each other via a single bond or a substituted or unsubstituted C_1-C_5 alkylene group.

In an implementation, in Formula 1, Ar_1 and Ar_2 may be linked to each other via a single bond.

In an implementation, in Formula 1, Ar_1=Ar_2. For example, the group of Ar_1 may be the same as the group of Ar_2. For example, Ar_1 and Ar_2 may both be a biphenyl group.

In an implementation, in Formula 1, $Ar_1 \neq Ar_2$. For example, the group of Ar_1 may be different from the group of Ar_2.

In an implementation, Ar_1 and Ar_2 may be each independently selected from a substituted or unsubstituted C_6-C_{20} aryl group and a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group.

In an implementation, Ar_1 and Ar_2 may be each independently selected from a substituted or unsubstituted C_1-C_{20} heteroaryl group and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

In an implementation, Ar_1 may be selected from a substituted or unsubstituted C_6-C_{20} aryl group and a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and Ar_2 may be selected from a substituted or unsubstituted C_1-C_{20} heteroaryl group and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

In formula 1, R_1 to R_3 may each independently be selected from or may include 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; and

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, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_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, a monovalent non-aromatic condensed heteropolycyclic group, and $Si(Q_1)(Q_2)(Q_3)$.

In an implementation, in Formula 1, R_1 to R_3 may be each independently selected from

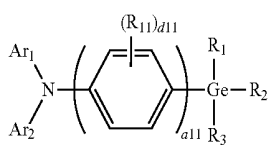
a phenyl group, a naphthyl group, a fluorenyl group, a Spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group; and

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, 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, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, and $—Si(Q_{31})(Q_{32})(Q_{33})$,

wherein Q_{31} to Q_{33} 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 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.

In an implementation, the amine-based compound represented by Formula 1 may be represented one of Formulae 1A (1) to 1A (6) below.

<Formula 1A (1)>



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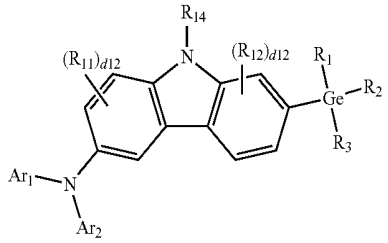
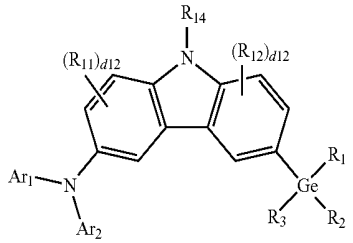
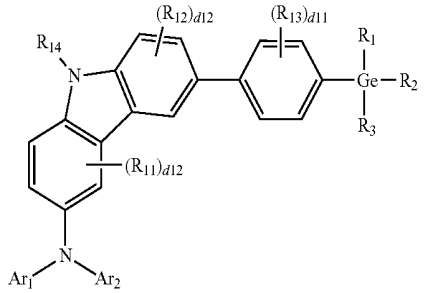
<Formula 1A (2)>



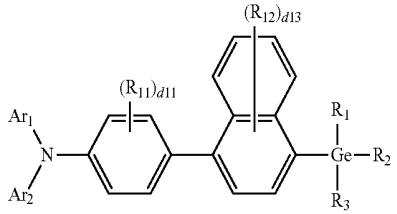
<Formula 1A (3)>



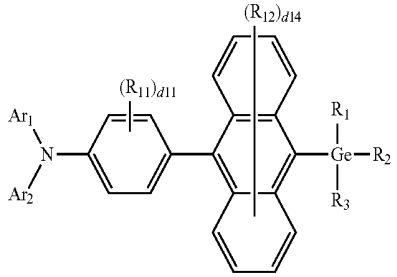
<Formula 1A (4)>



<Formula 1A (5)>



<Formula 1A (6)>



In Formulae 1A (1) to 1A (6), Ar_1, Ar_2 and R_1 to R_3 may be understood by referring to the description provided herein with respect to Formula 1, and a11 may be the same as a1 defined herein with respect to Formula 1.

R_{11} to R_{14} 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, and a C_1-C_{20} alkoxy group;

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, and 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, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, and a naphthyl group; and

$—Si(Q_{31})(Q_{32})(Q_{33})$;

wherein Q_{31} to Q_{33} 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 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;

d11 may be an integer selected from 1 to 4,

d12 may be an integer selected from 1 to 3,

d13 may be an integer selected from 1 to 6, and

d14 may be an integer selected from 1 to 8.

In an implementation, in Formulae 1A (1) to 1A (6), R_{14} may be selected from 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, and a naphthyl group.

In an implementation, in Formulae 1A (1) to 1A (6), Ar_1 and Ar_2 may each independently be a group represented by one of Formulae 5-1 to 5-14 above.

In an implementation, in Formulae 1A (1) to 1A (6), Ar_1 and Ar_2 may each independently be a group represented by one of Formulae 6-1 to 6-30 above.

In an implementation, in Formulae 1A (1) to 1A (6), R_1 to R_3 may be each independently selected from

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

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, 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, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, and —$Si(Q_{31})(Q_{32})(Q_{33})$;

wherein Q_{31} to Q_{33} 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 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.

In an implementation, in Formulae 1A (1) to 1A (6), Ar_1=Ar_2 and R_1=R_2=R_3; or Ar_1≠Ar_2 and R_1=R_2=R_3. For example, the = and ≠ may be understood as described above with respect to Ar_1 and Ar_2.

The amine-based compound represented by Formula 1 may be one of Compounds 1 to 280 below.

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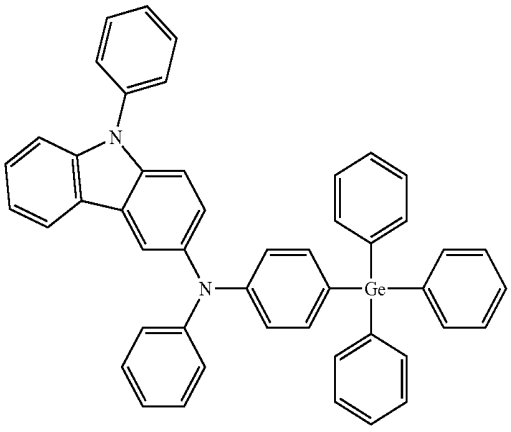

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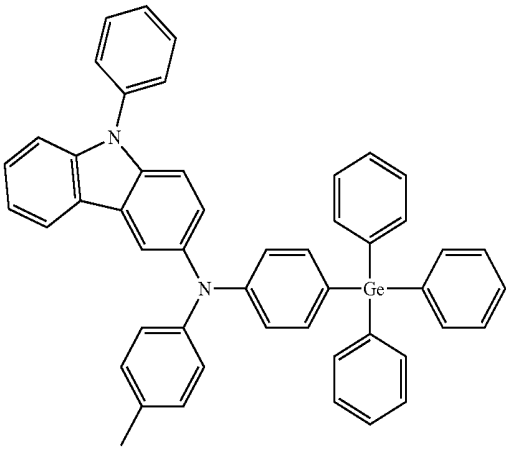

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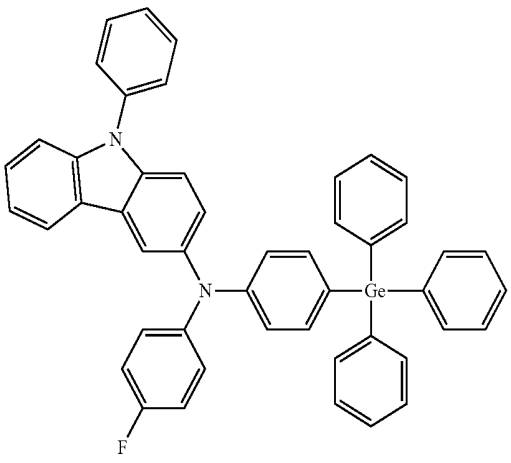

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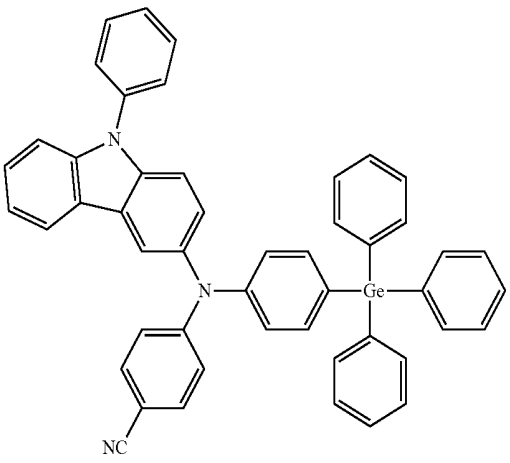

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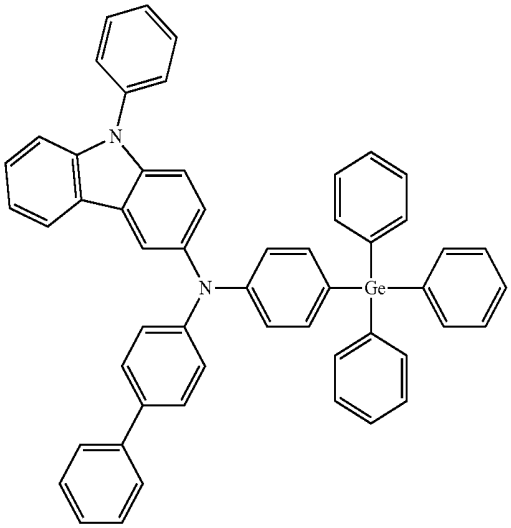

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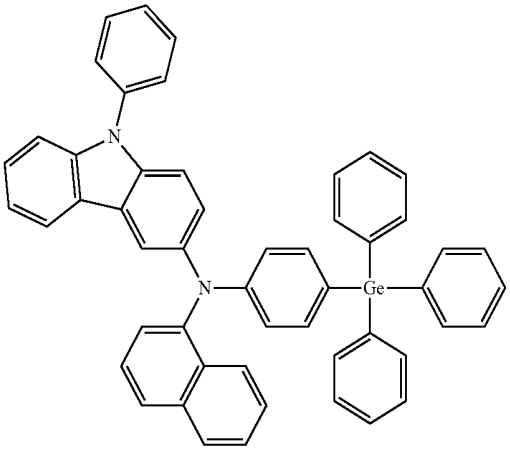

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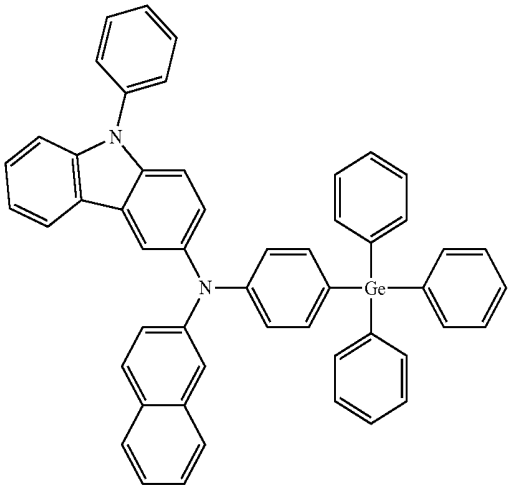

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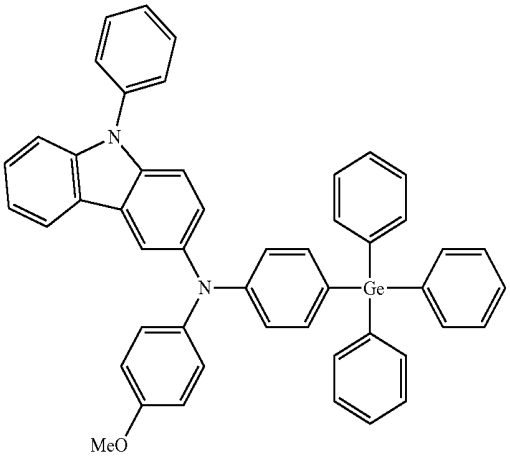

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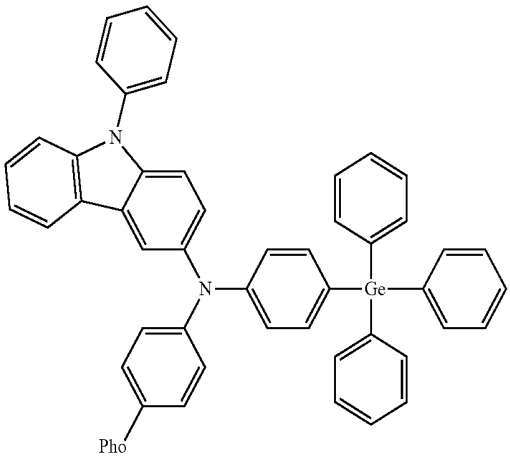

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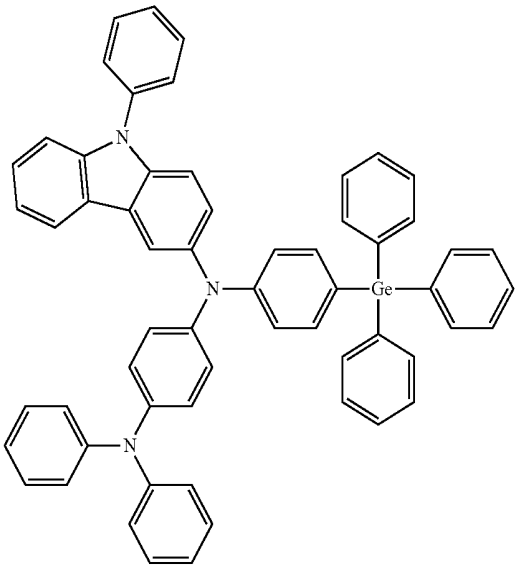

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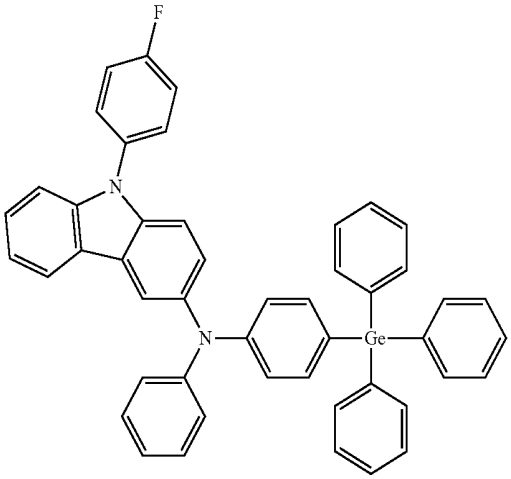

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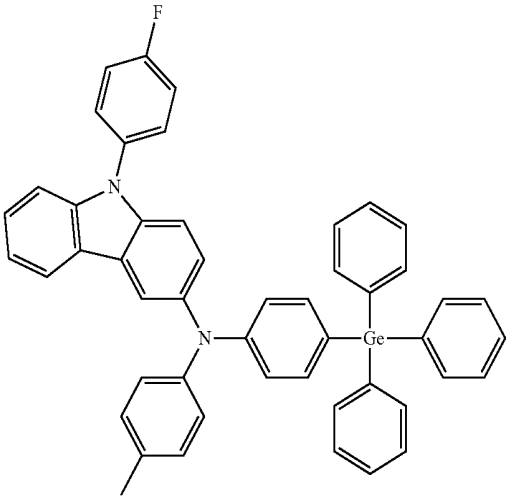

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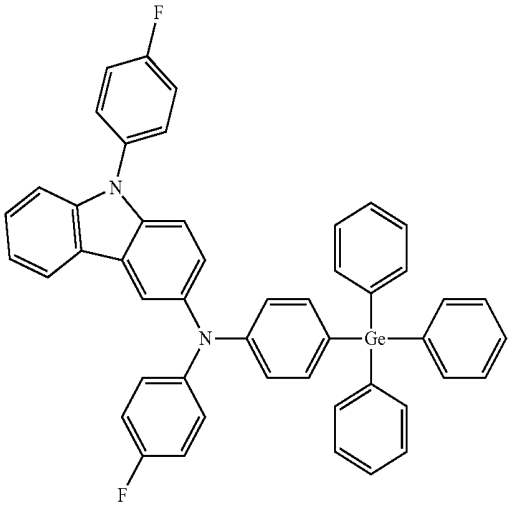

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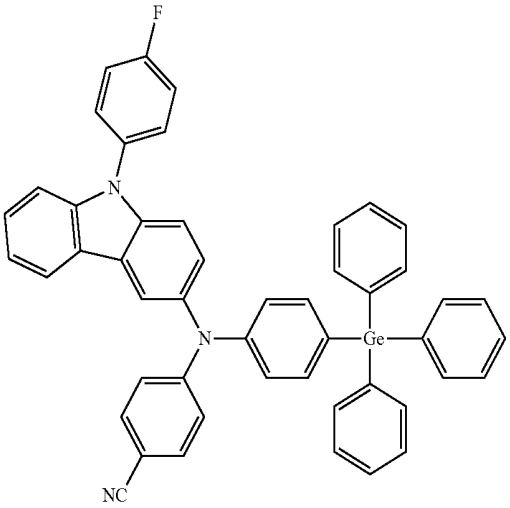

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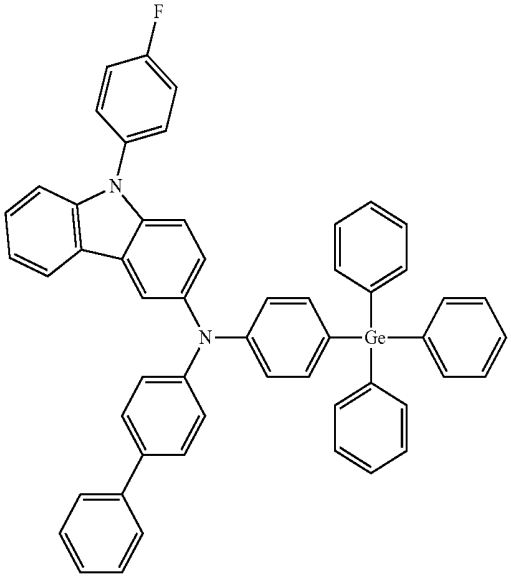

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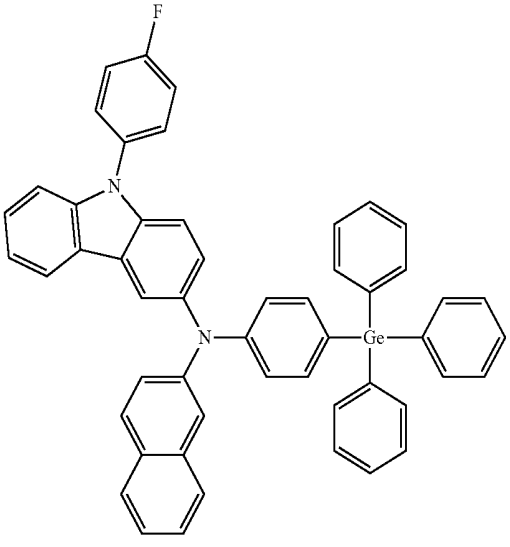

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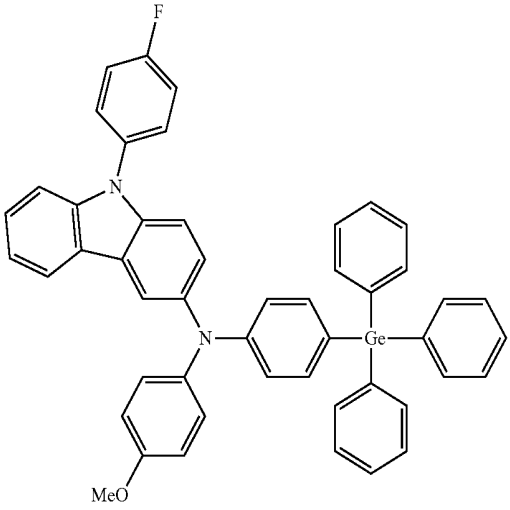

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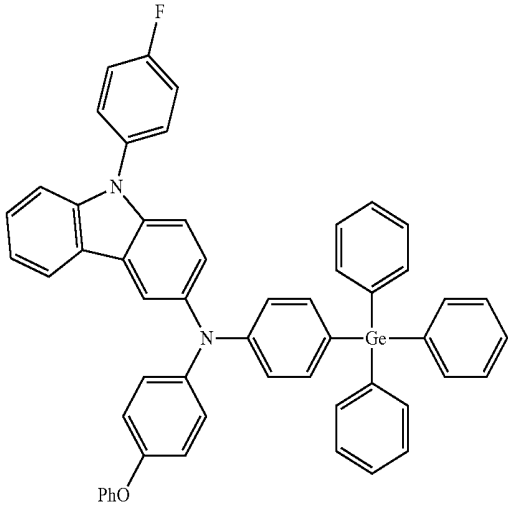

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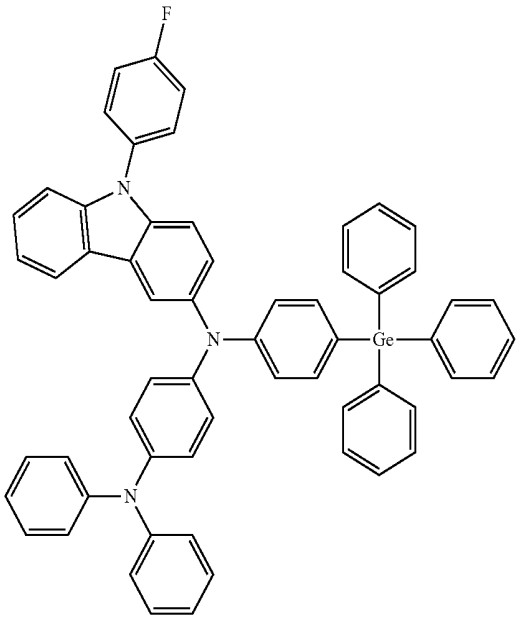

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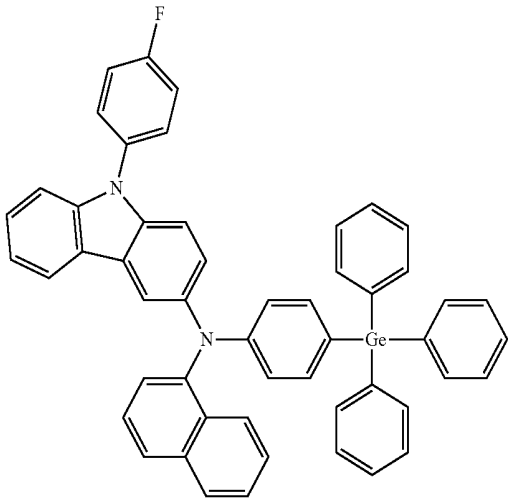

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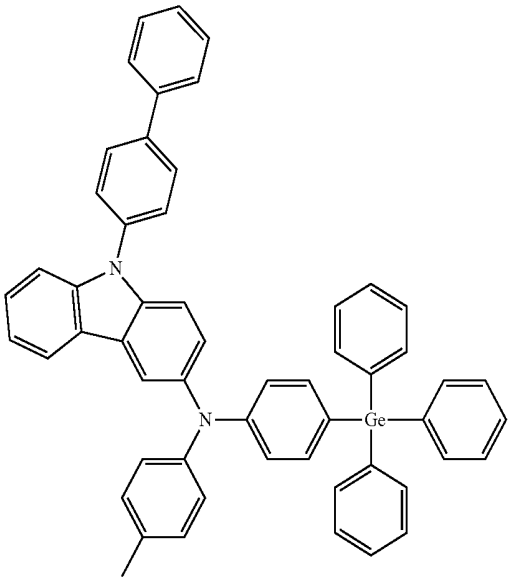

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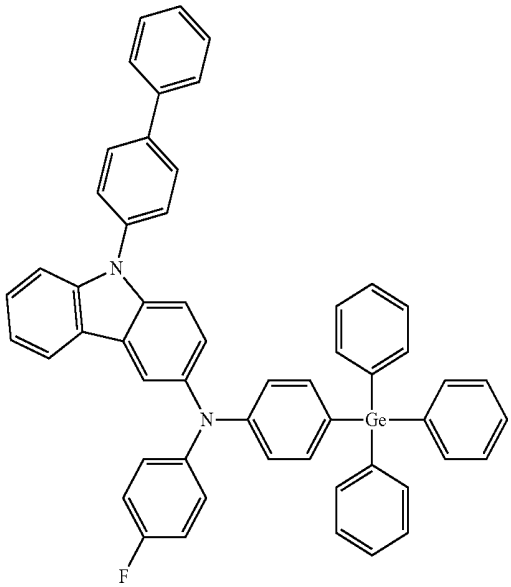

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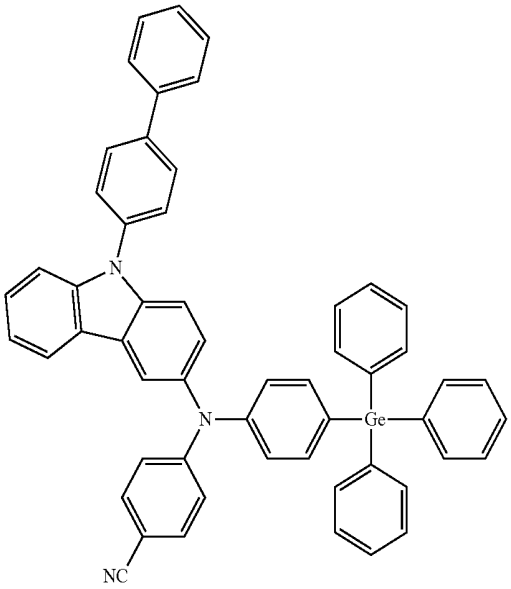

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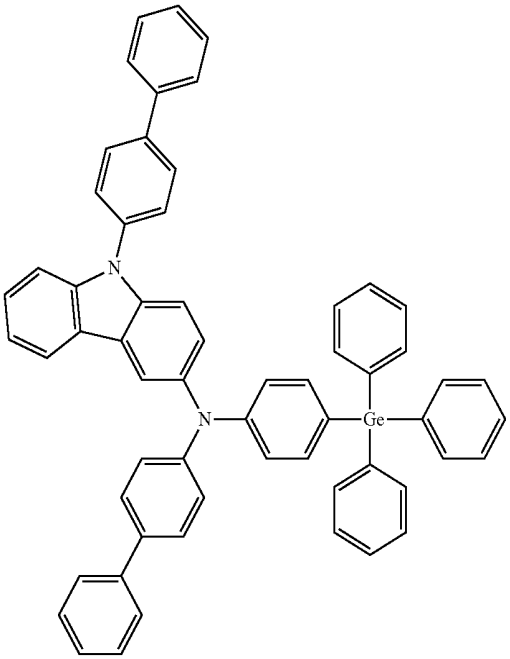

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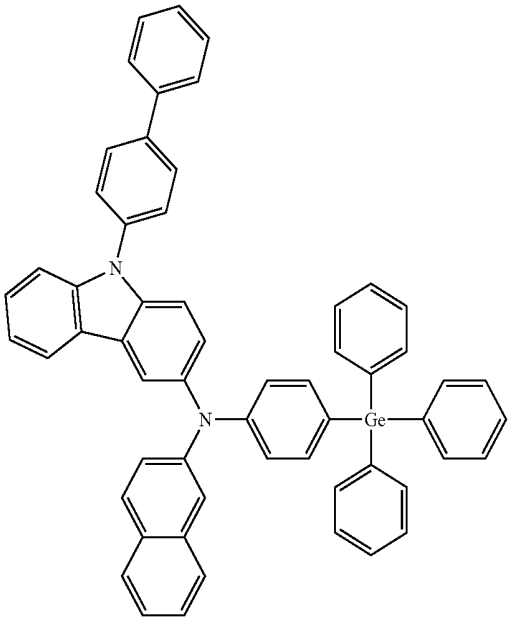

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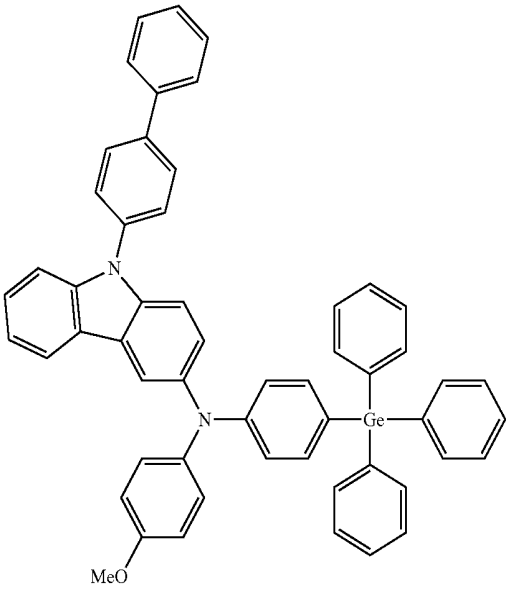

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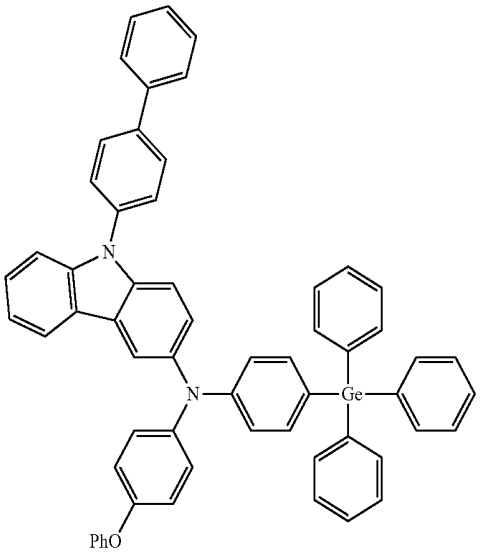

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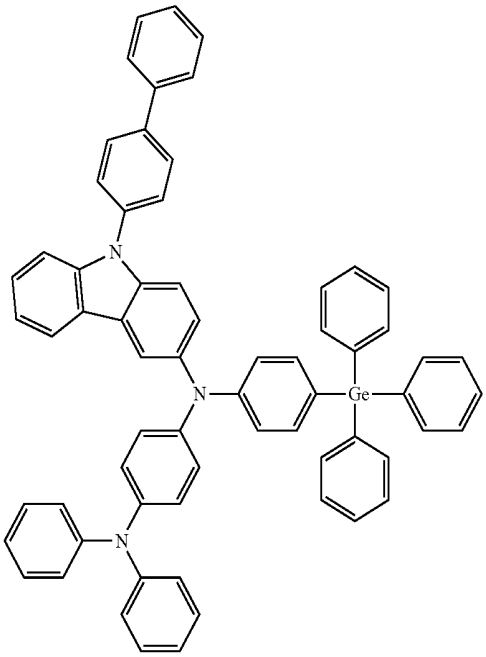

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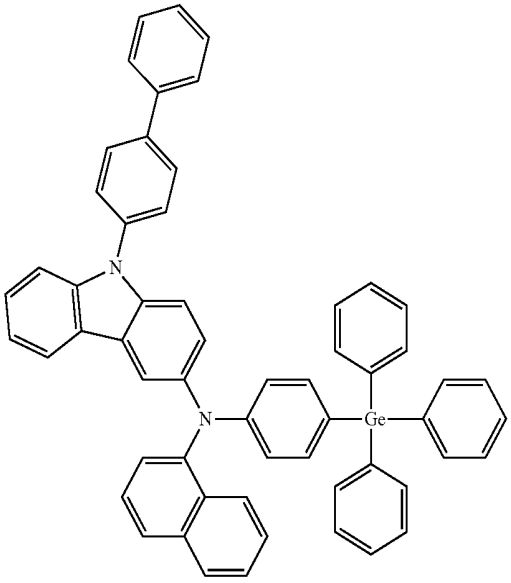

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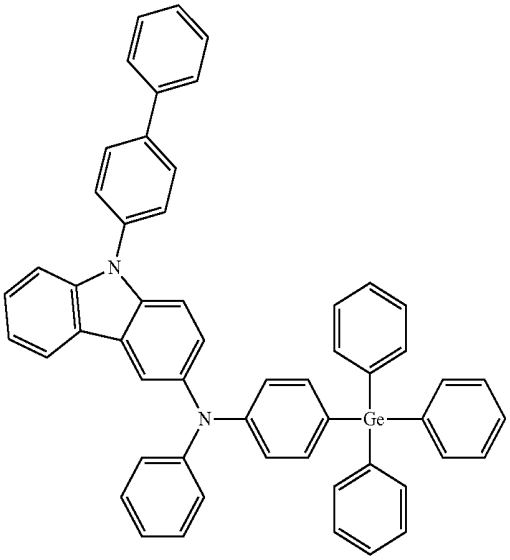

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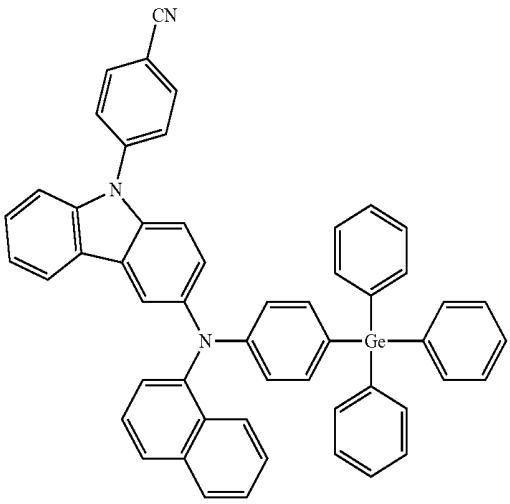

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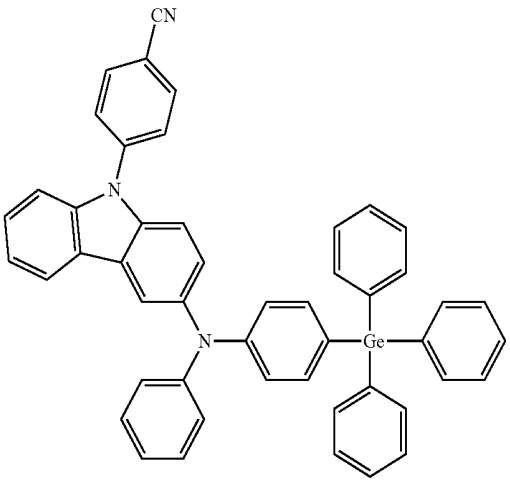

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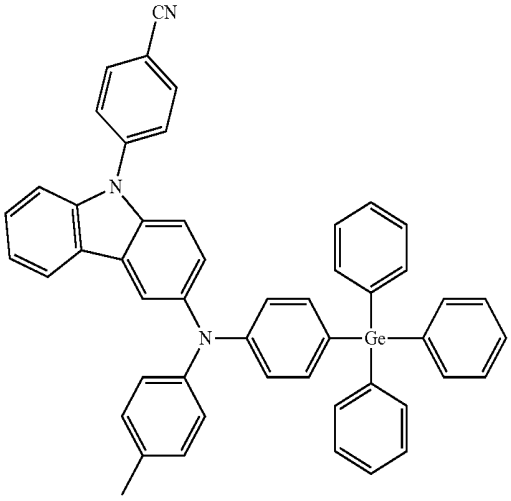

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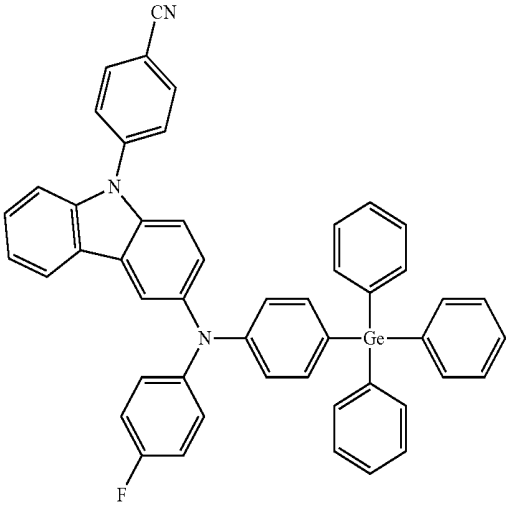

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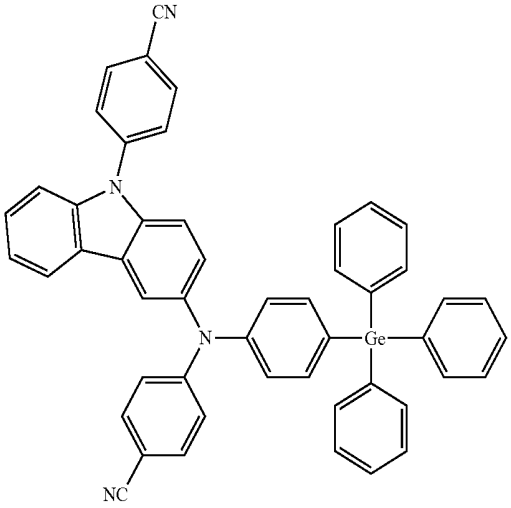

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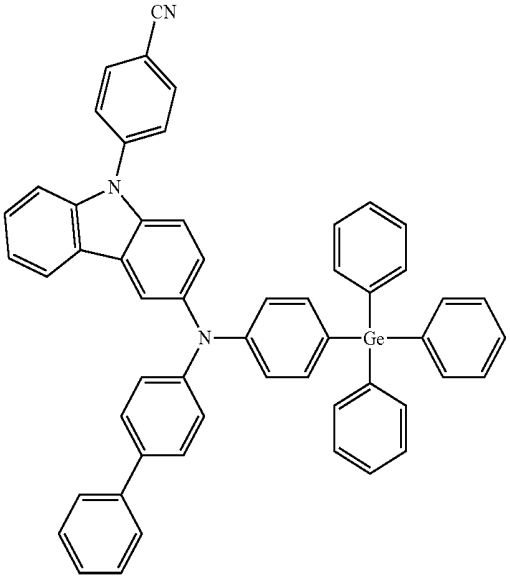

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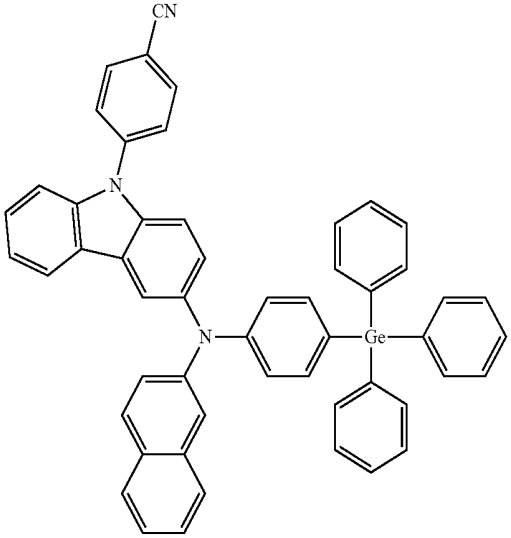

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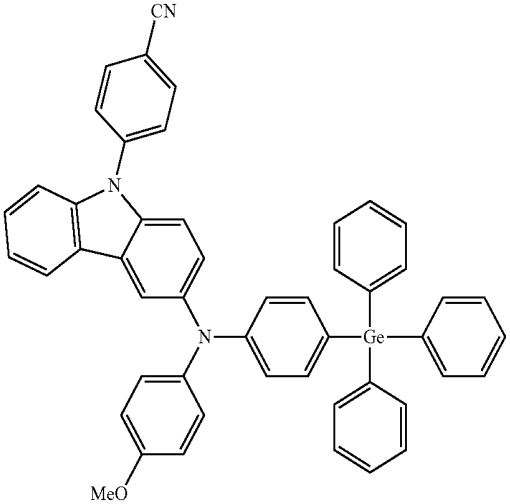

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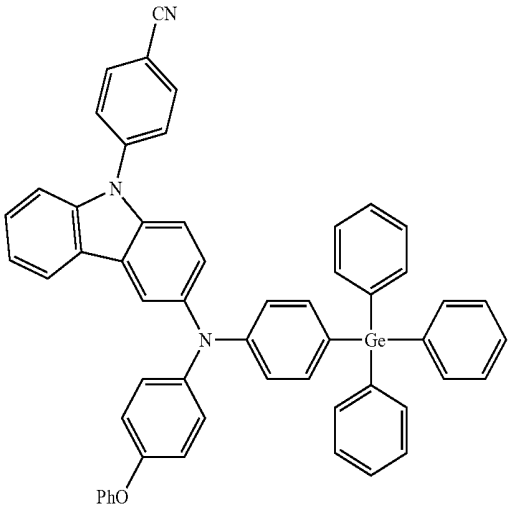

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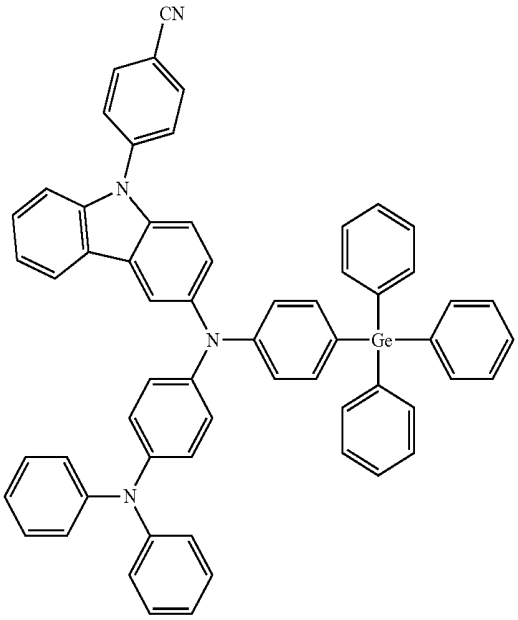

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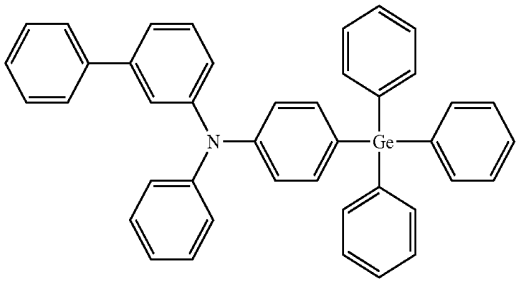

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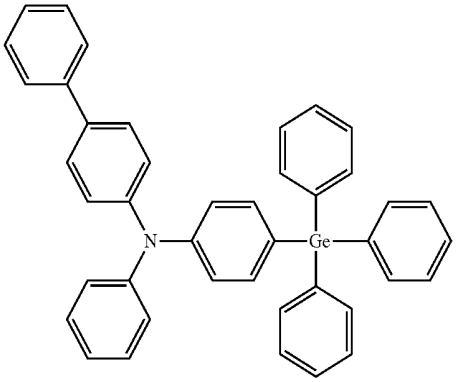

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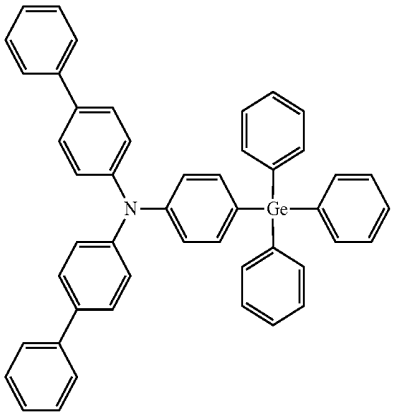

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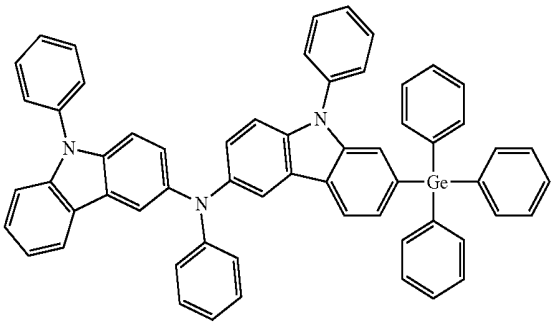

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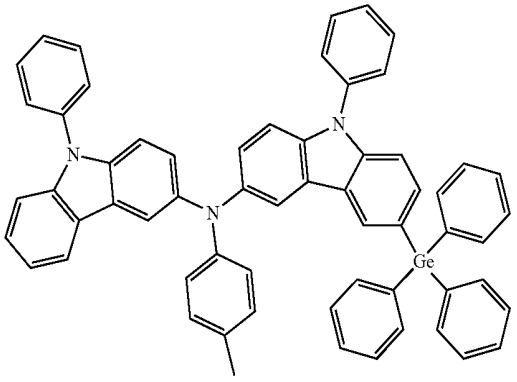

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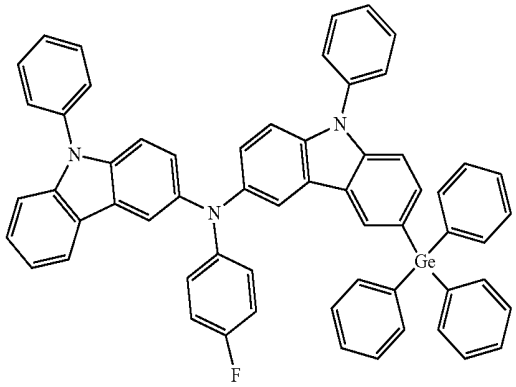

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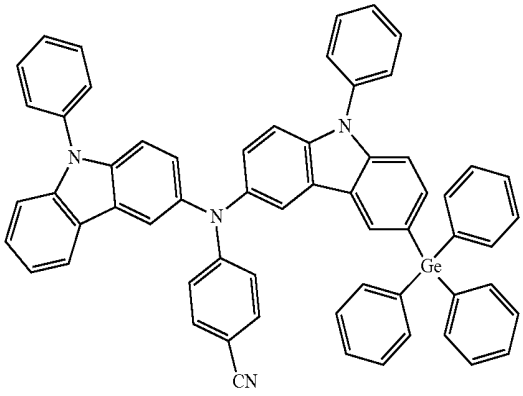

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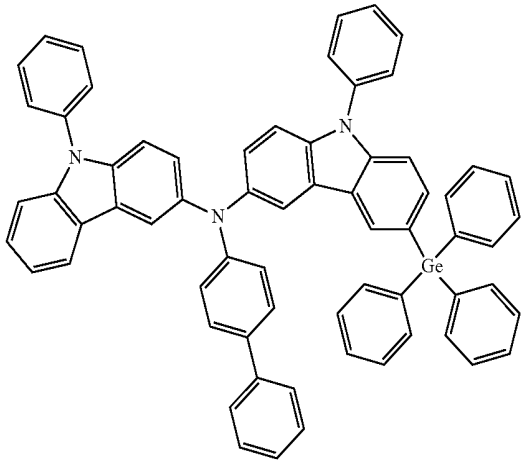

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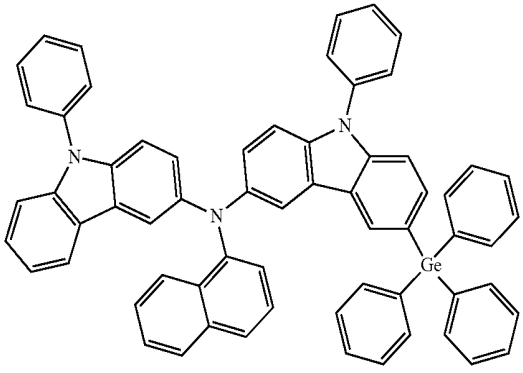

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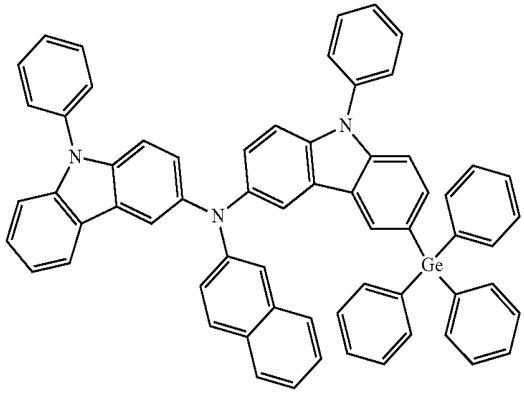

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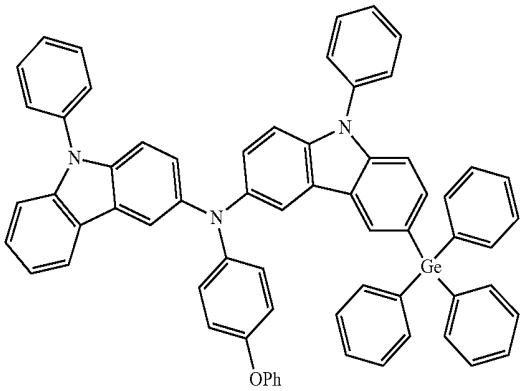

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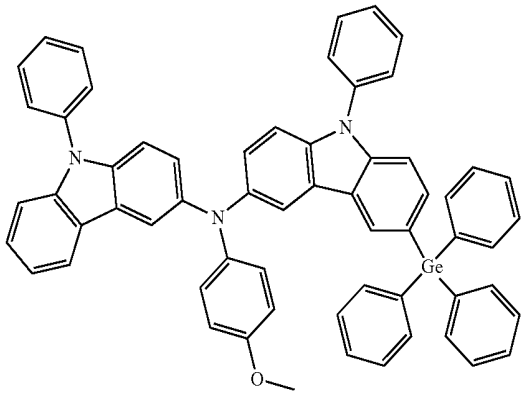

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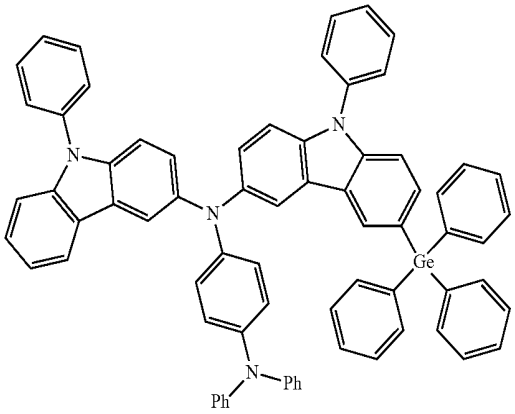

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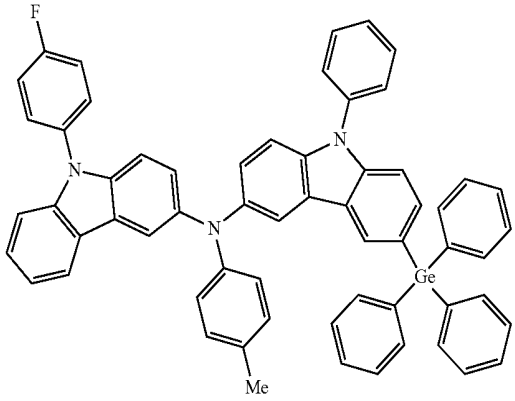

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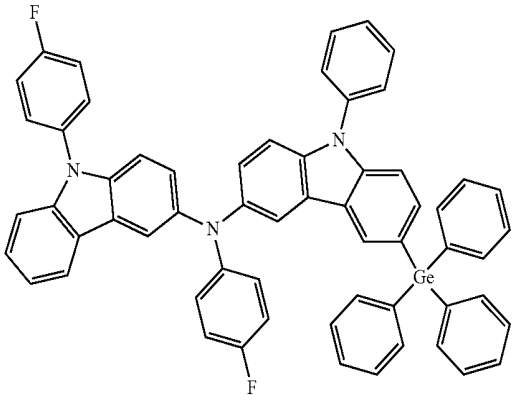

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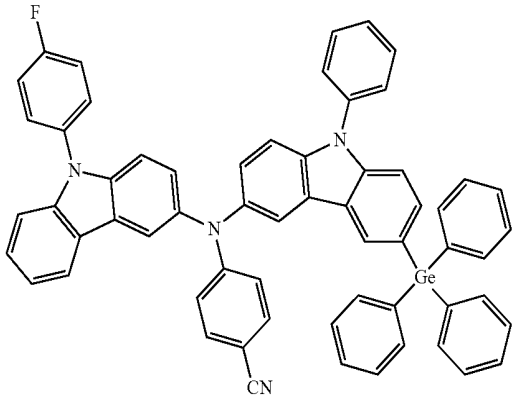

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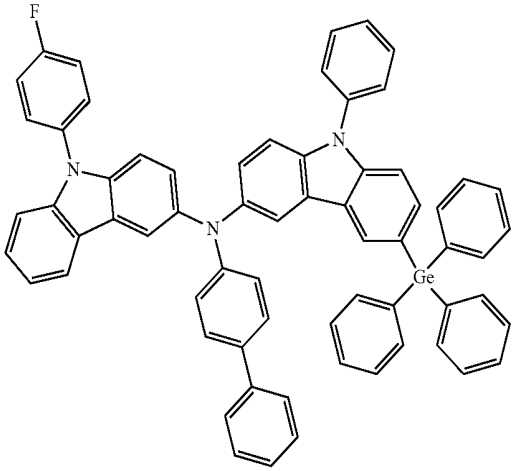

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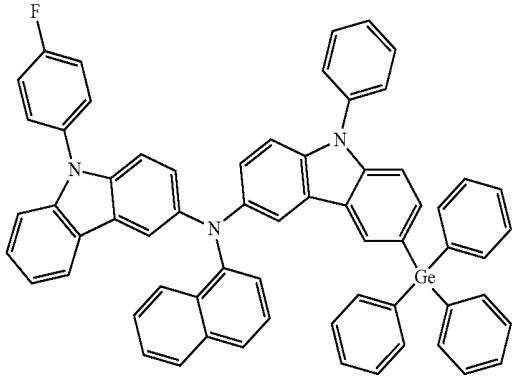

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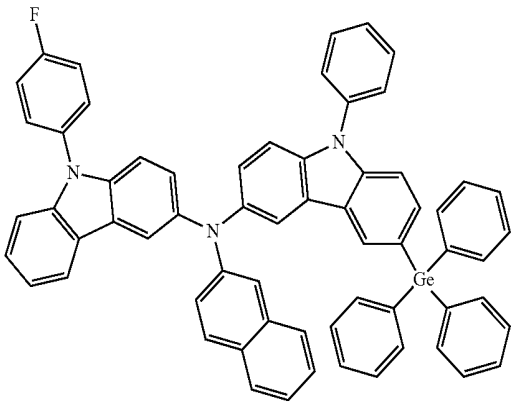

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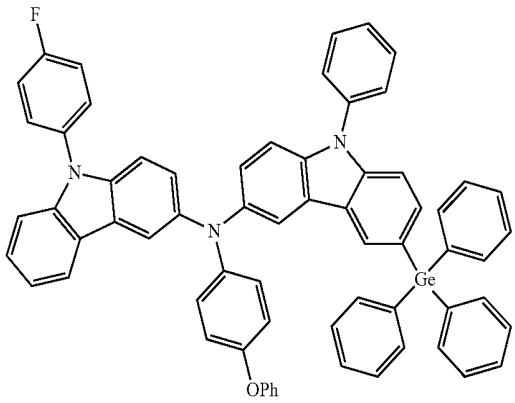

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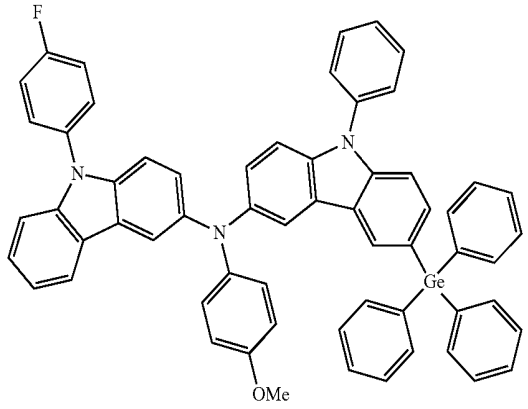

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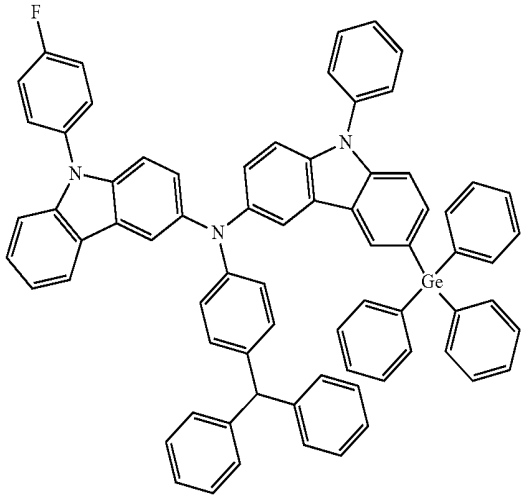

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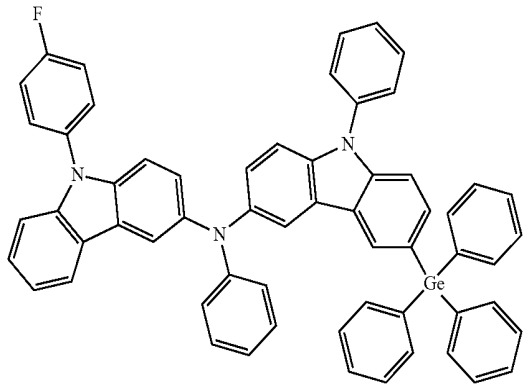

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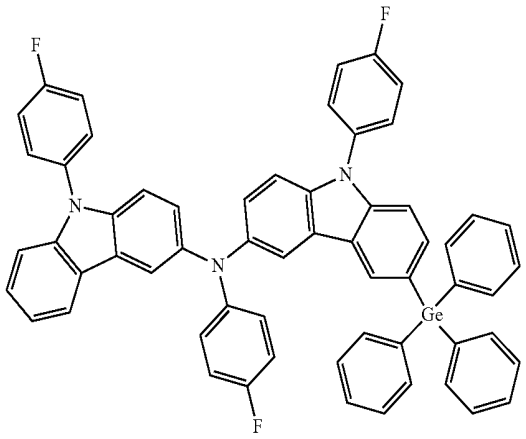

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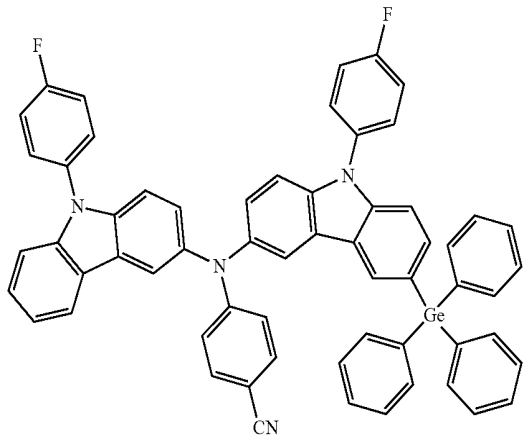

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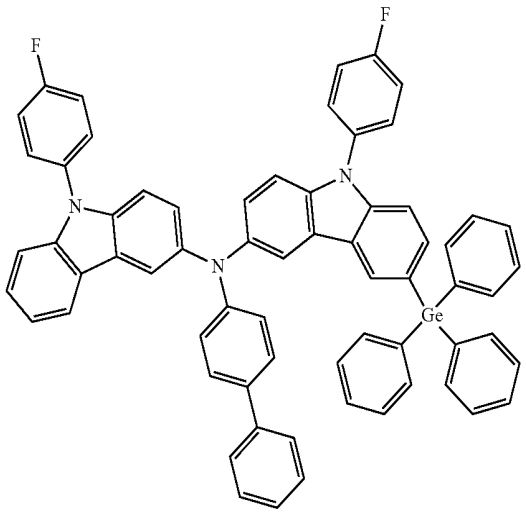

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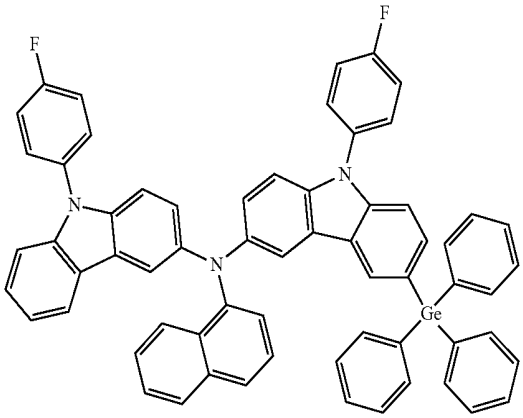

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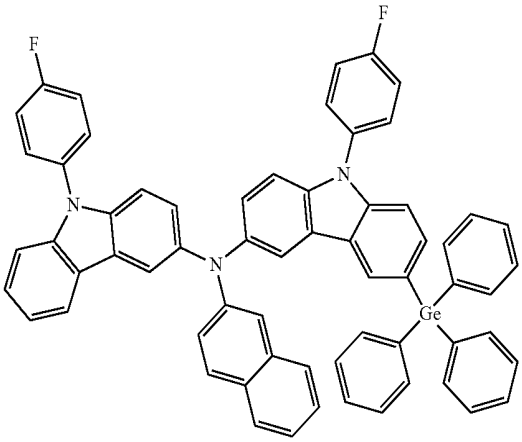

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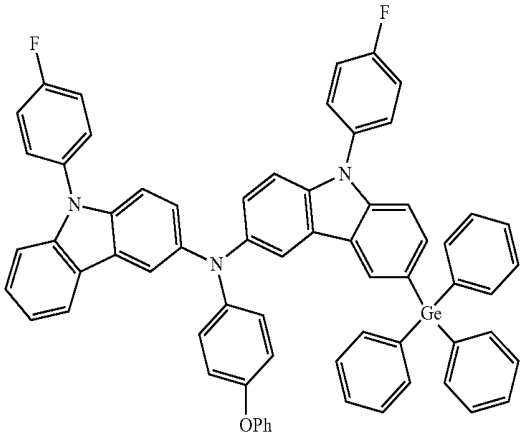

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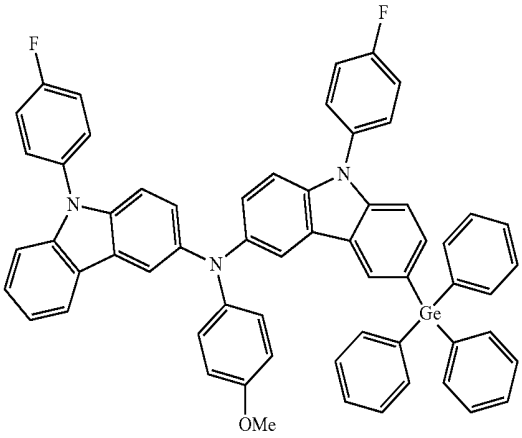

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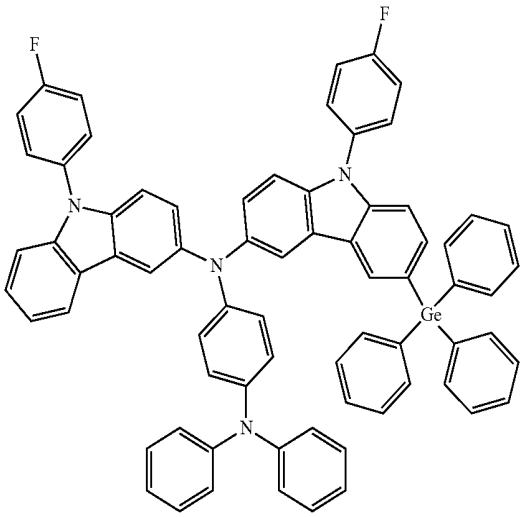

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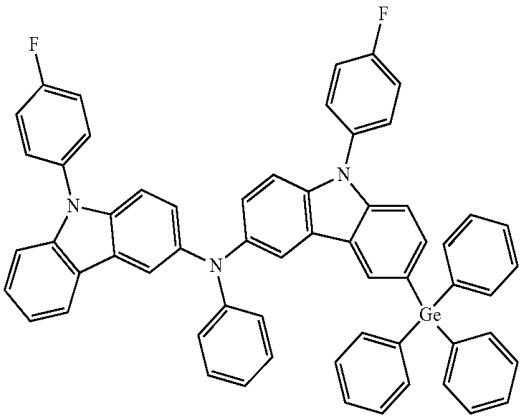

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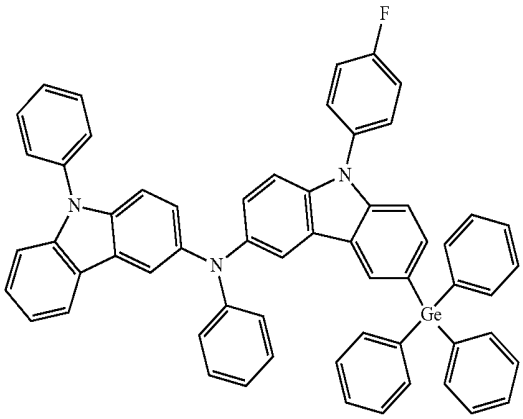

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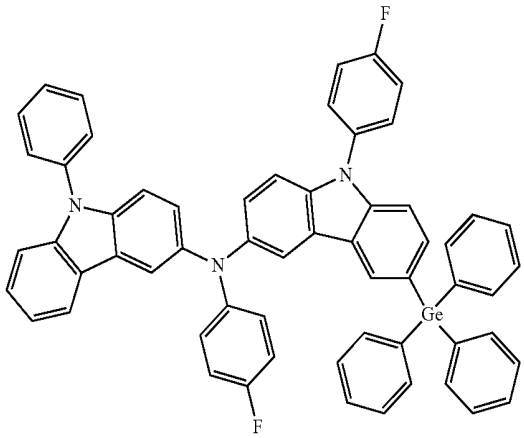

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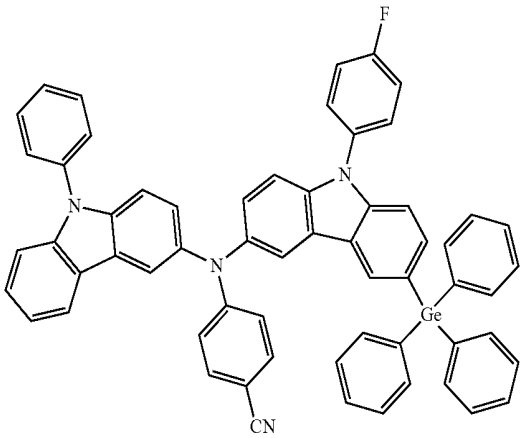

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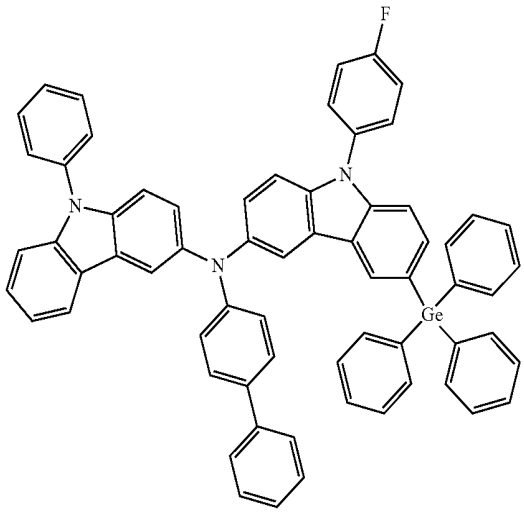

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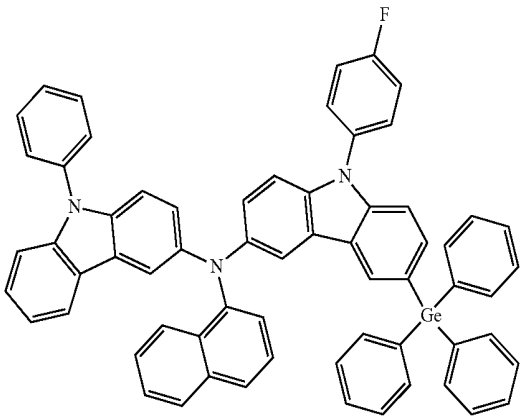

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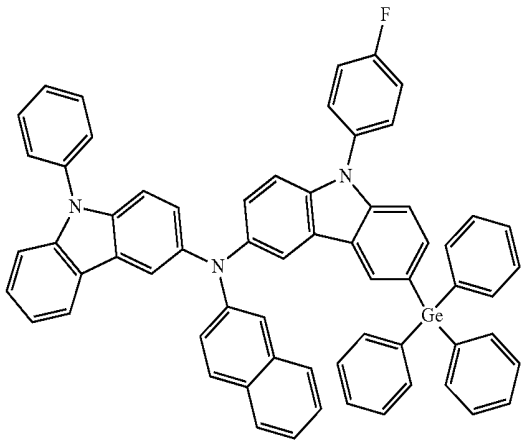

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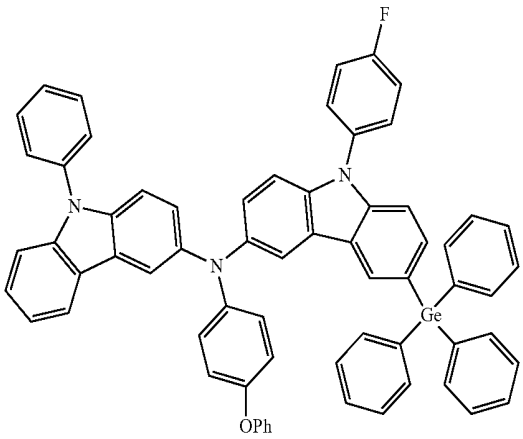

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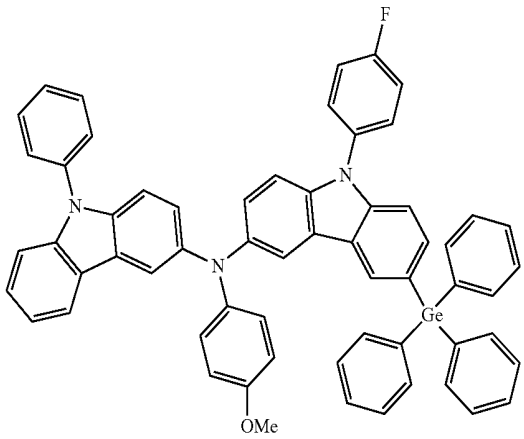

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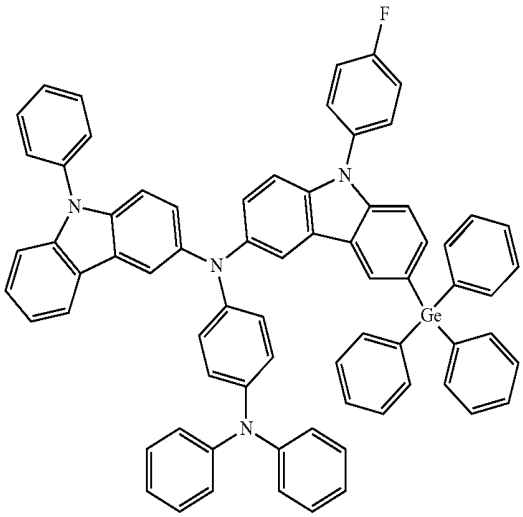

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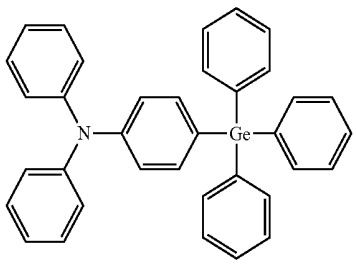

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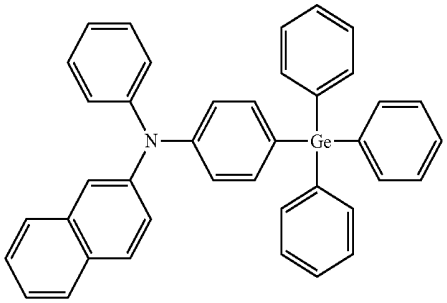

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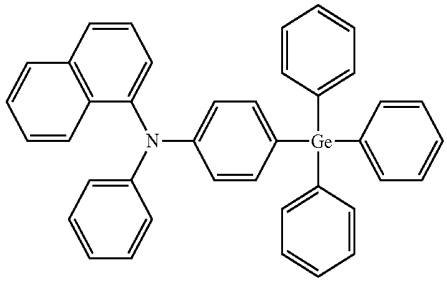

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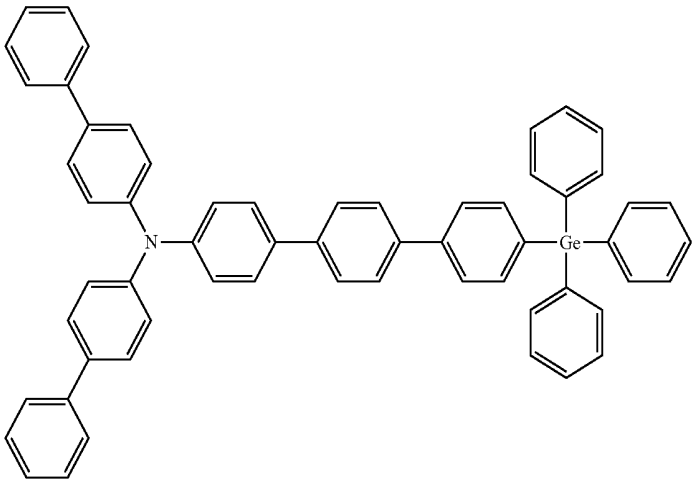

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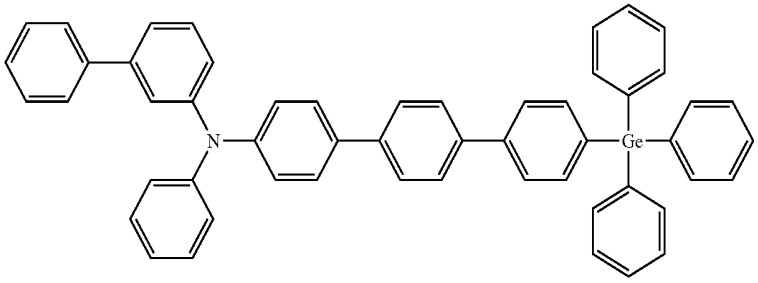

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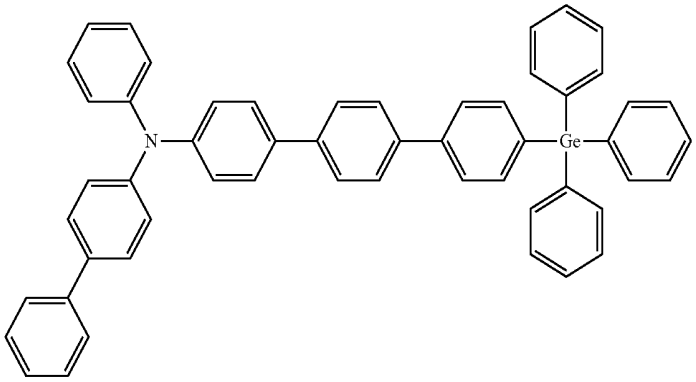

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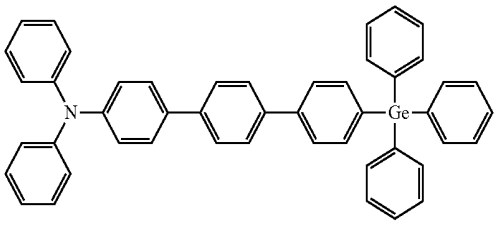

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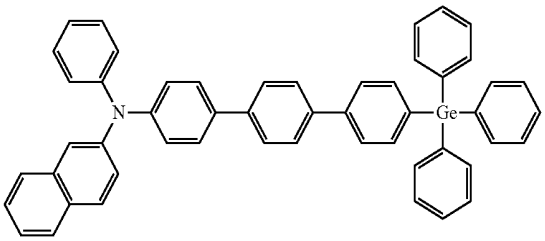

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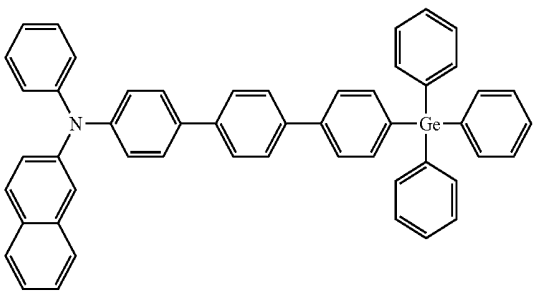

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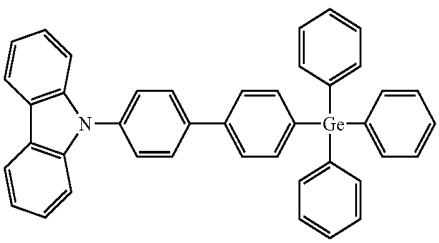

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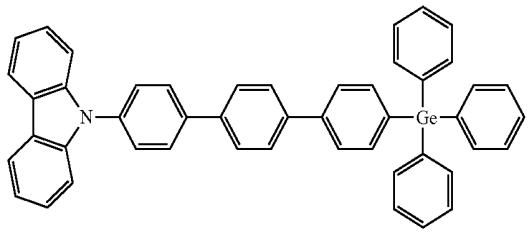

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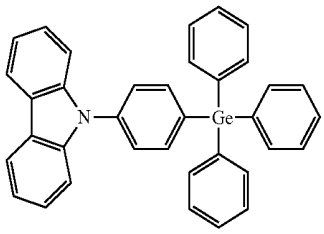

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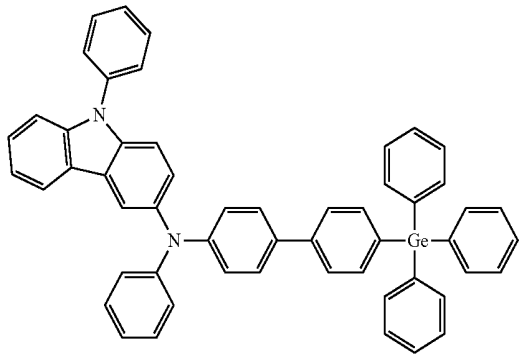

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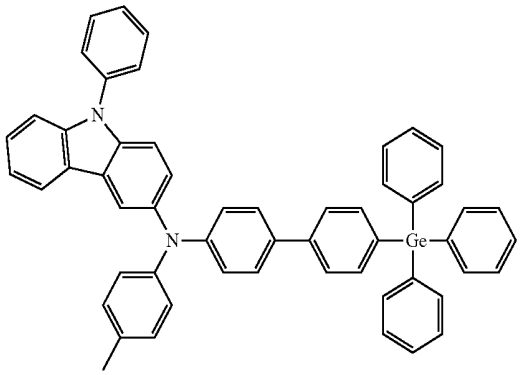

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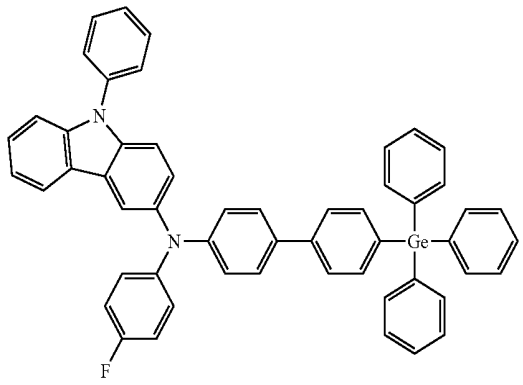

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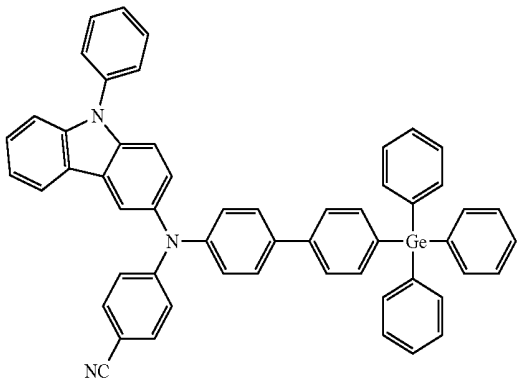

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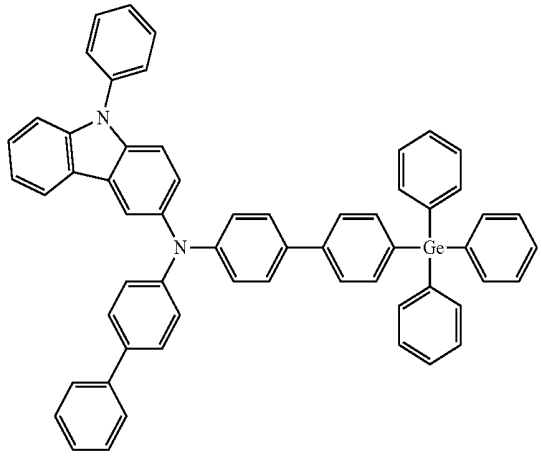

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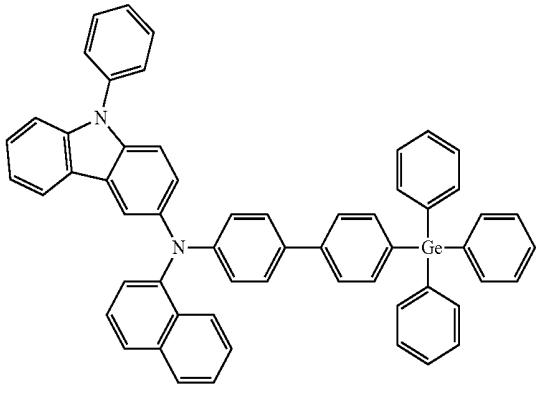

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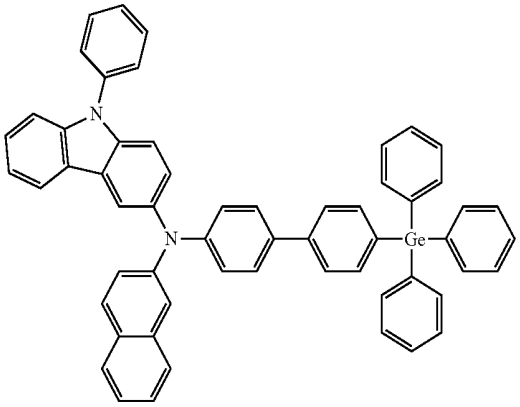

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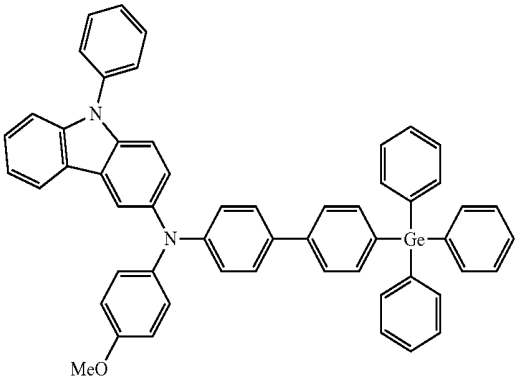

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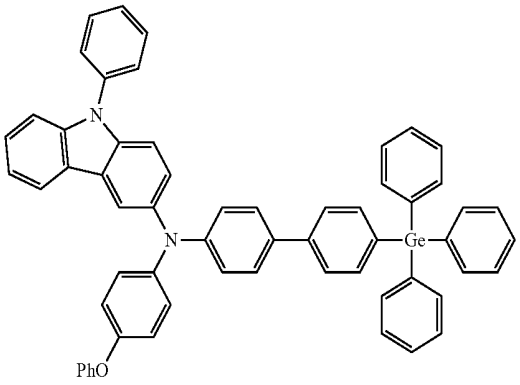

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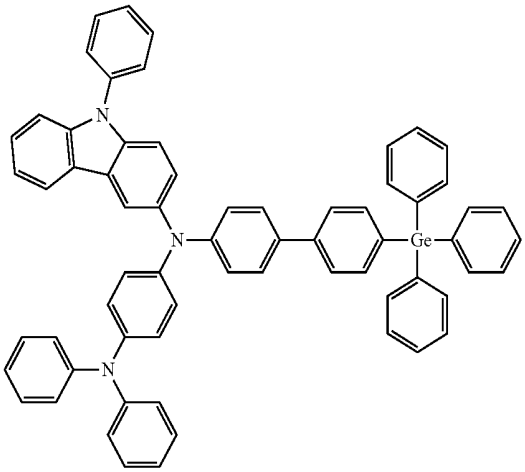

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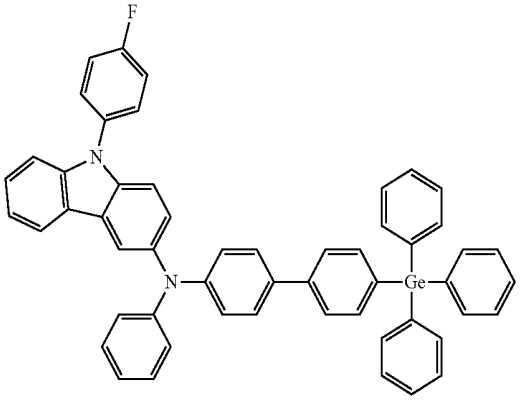

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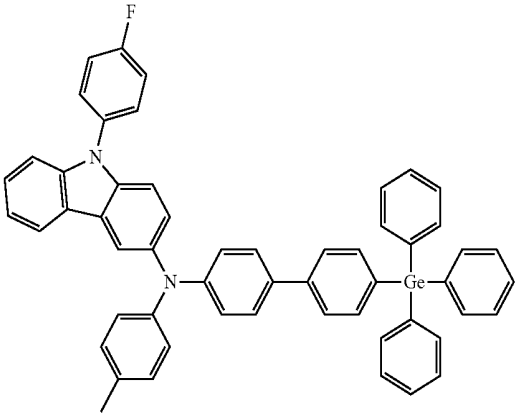

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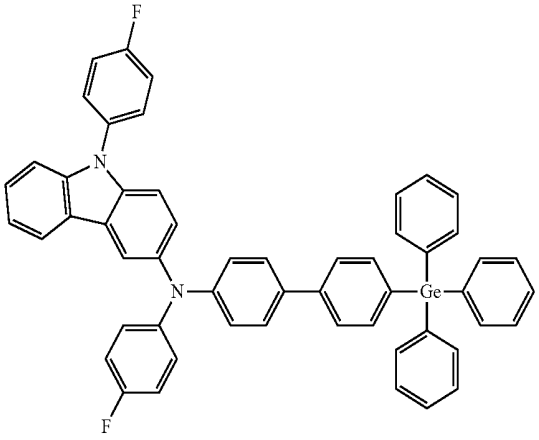

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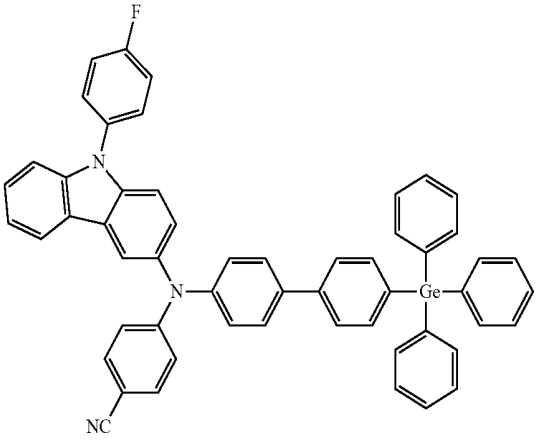

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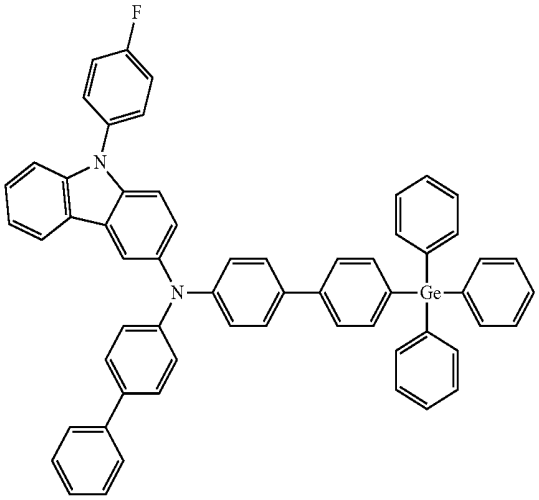

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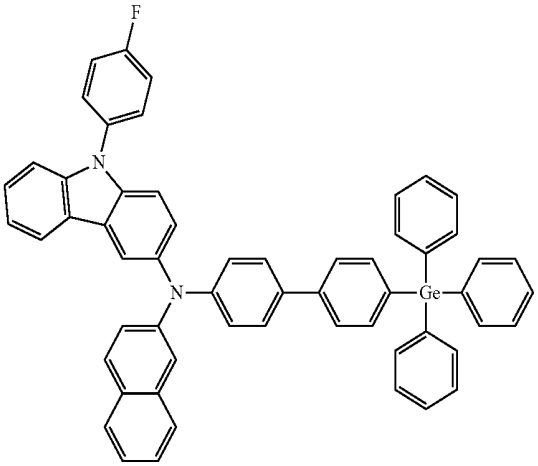

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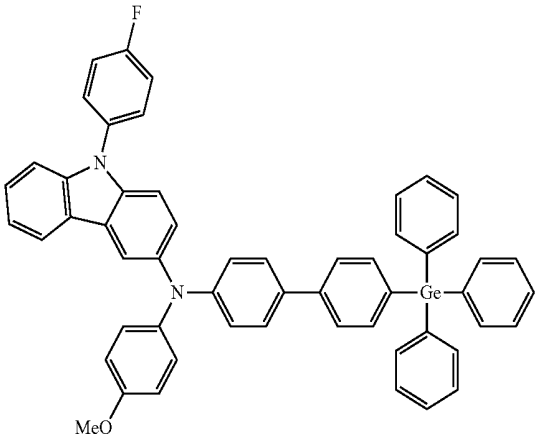

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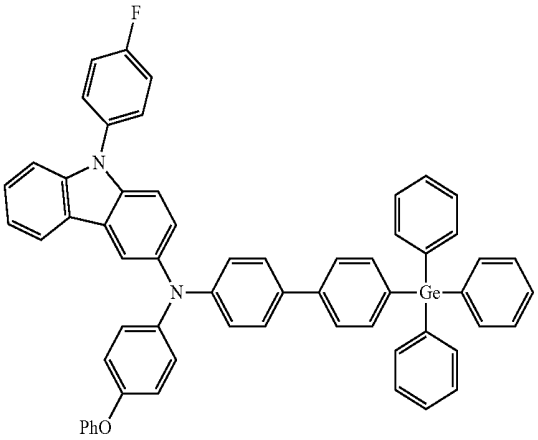

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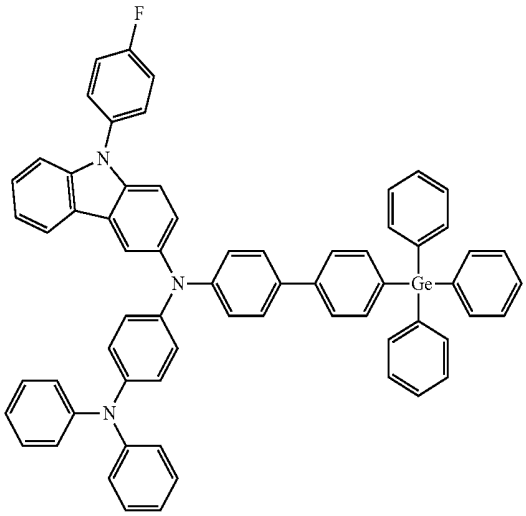

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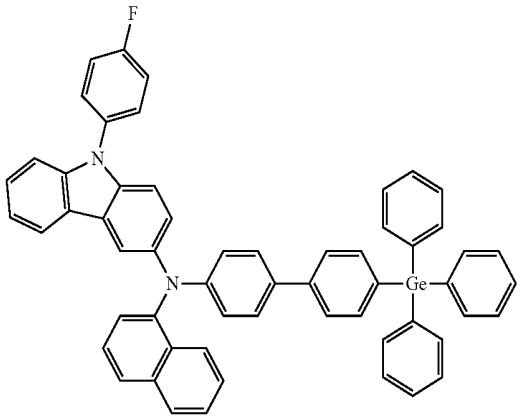

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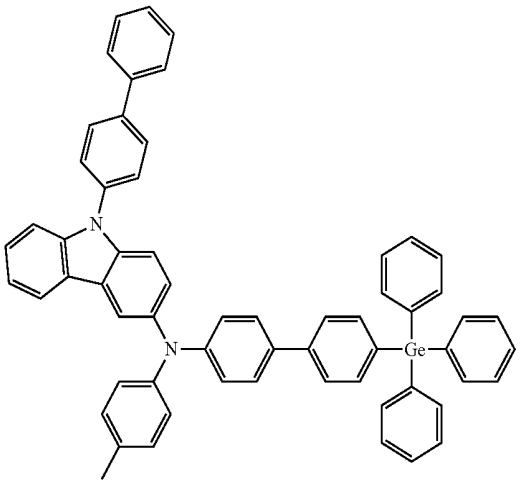

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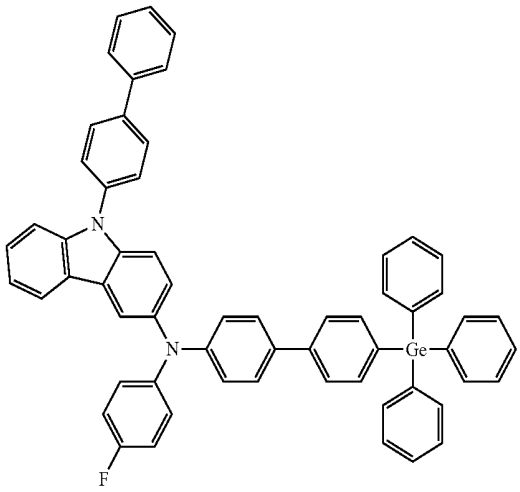

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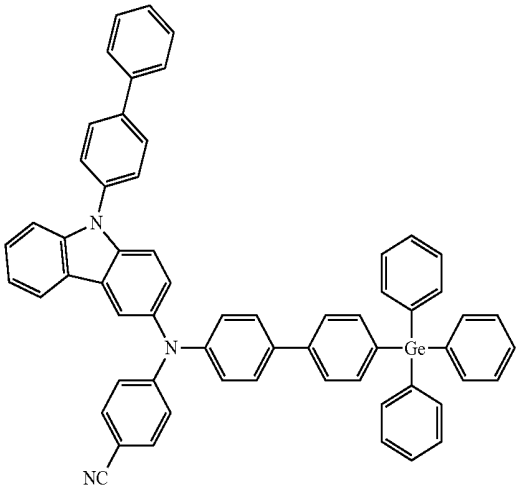

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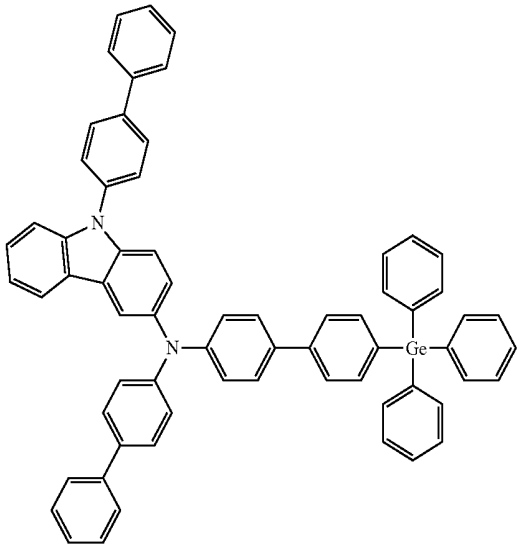

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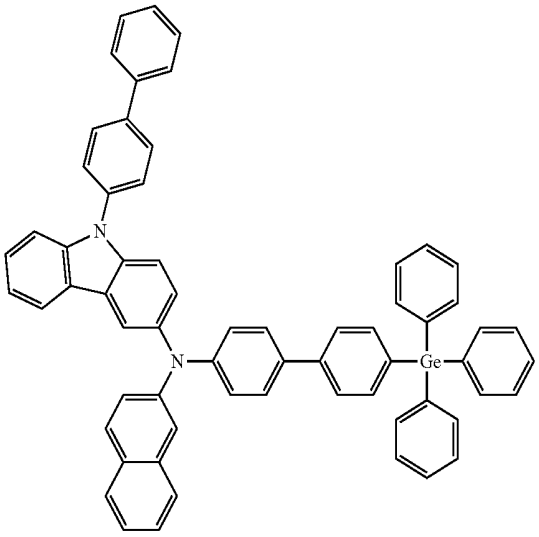

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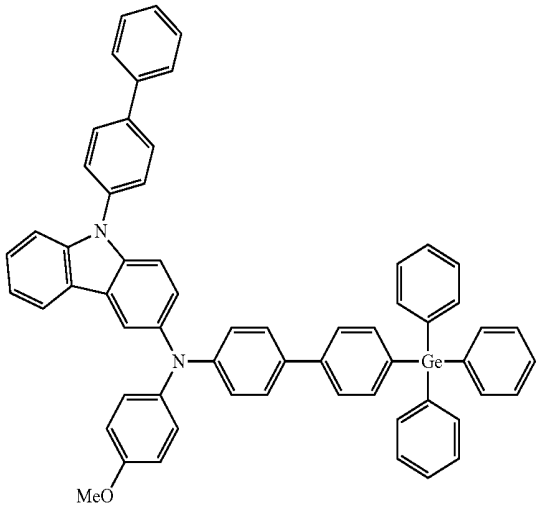

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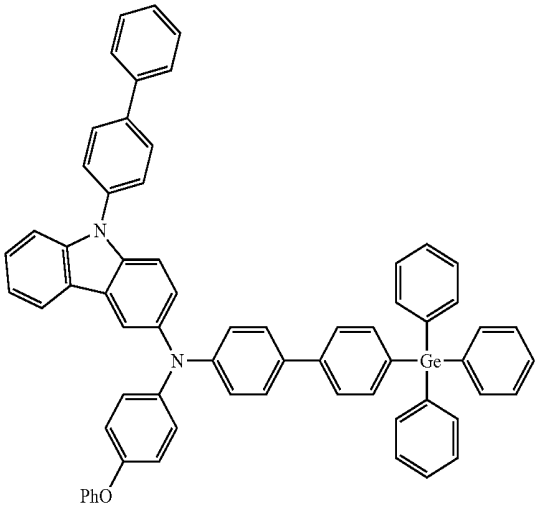

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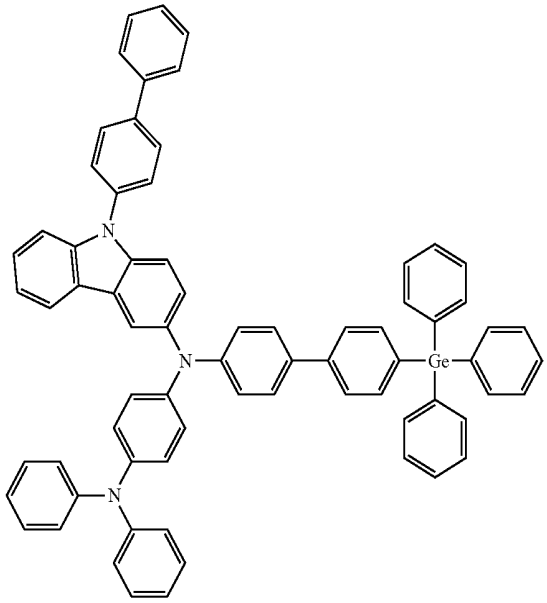

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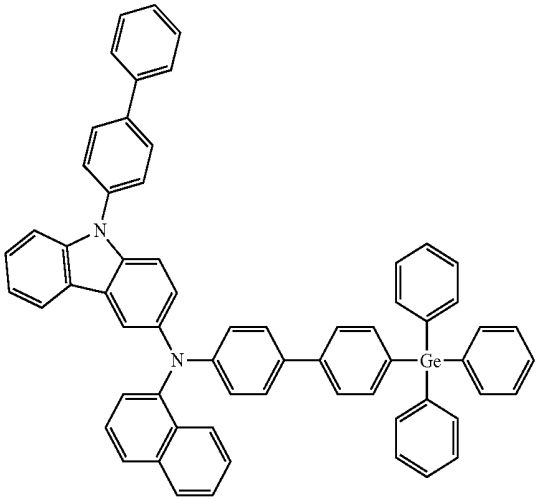

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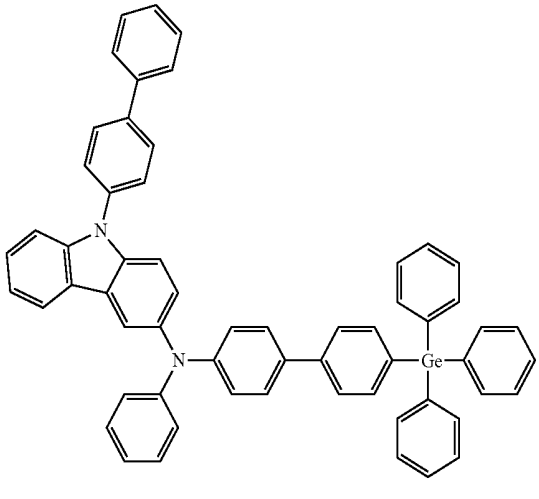

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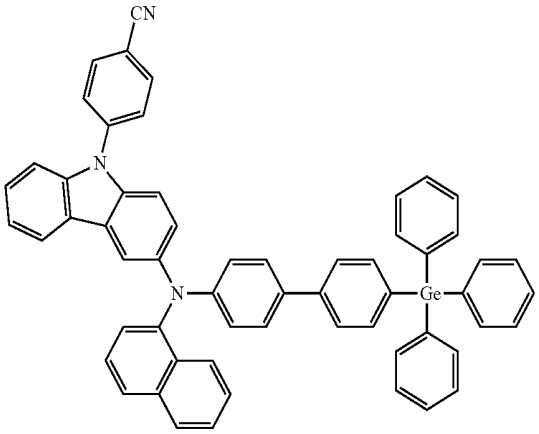

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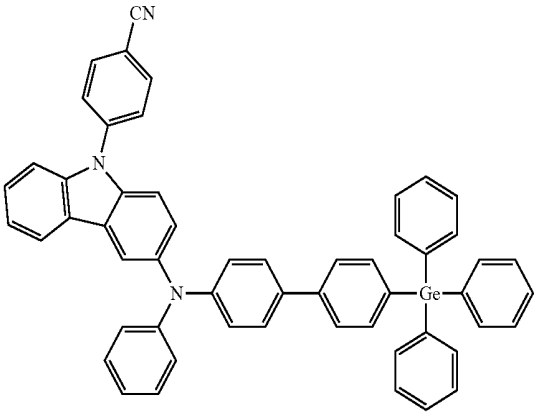

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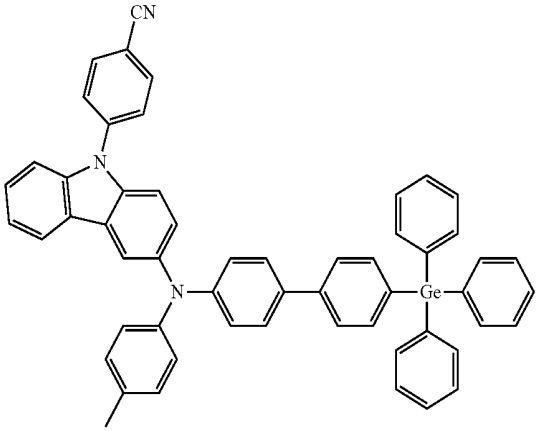

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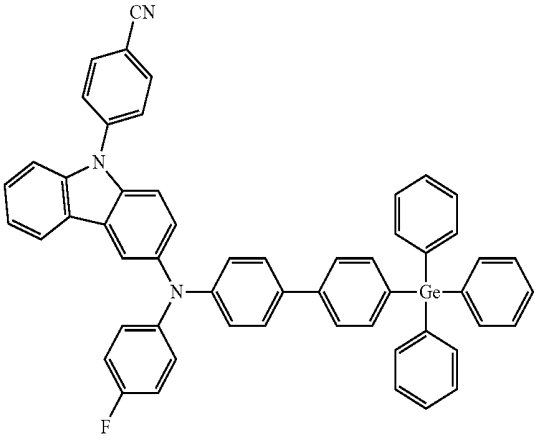

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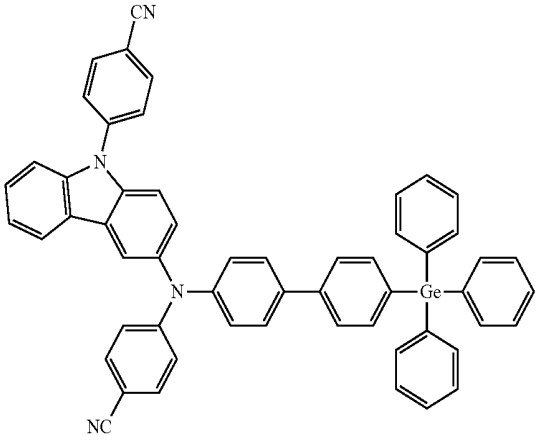

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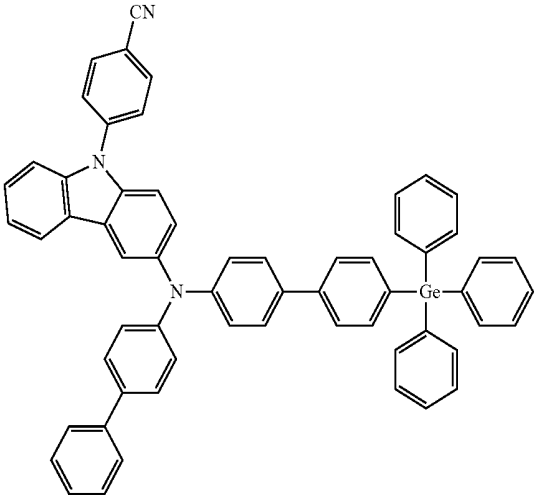

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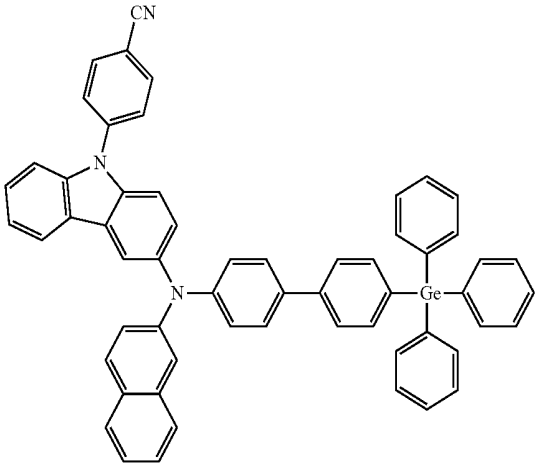

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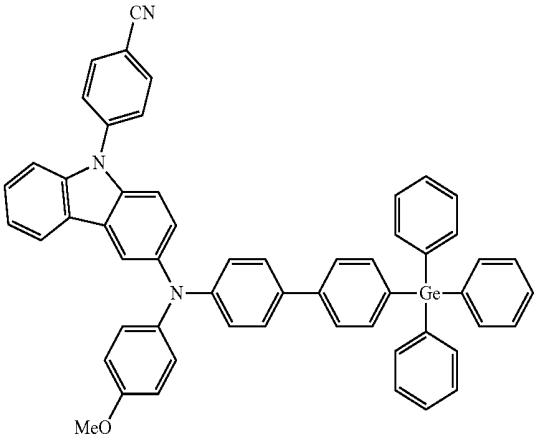

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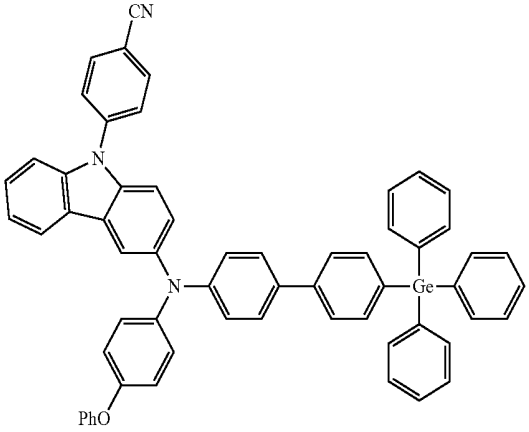

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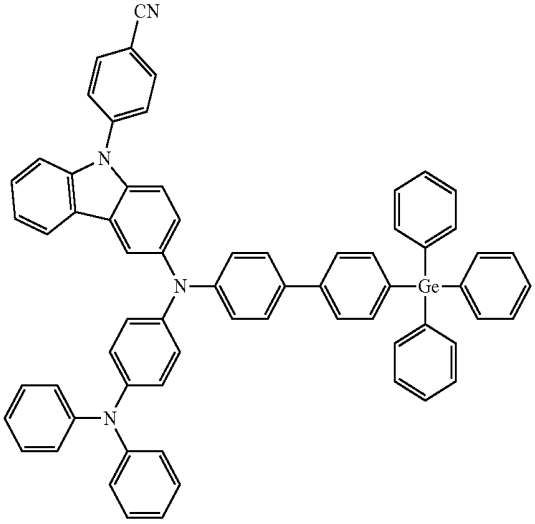

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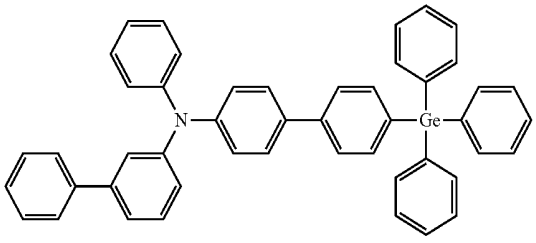

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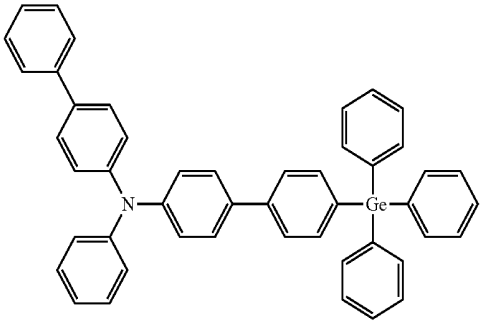

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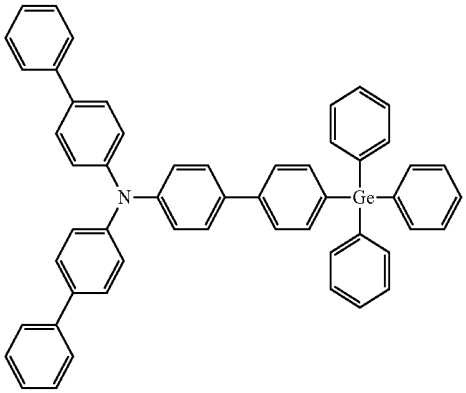

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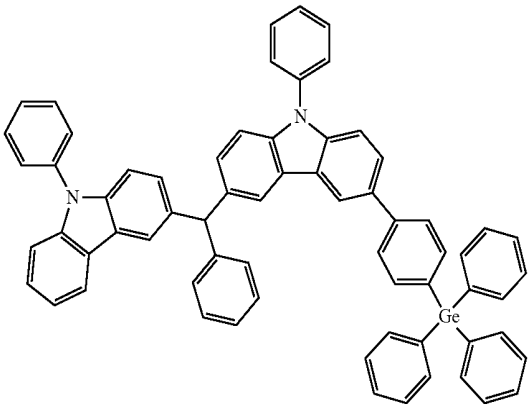

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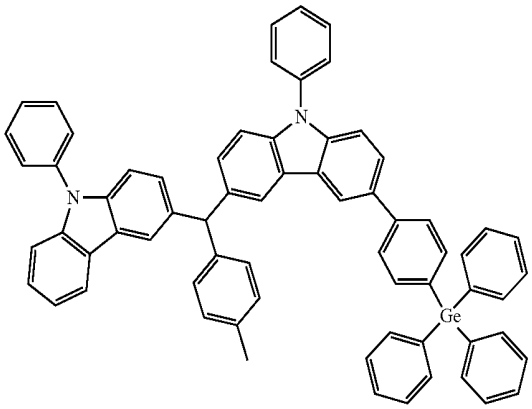

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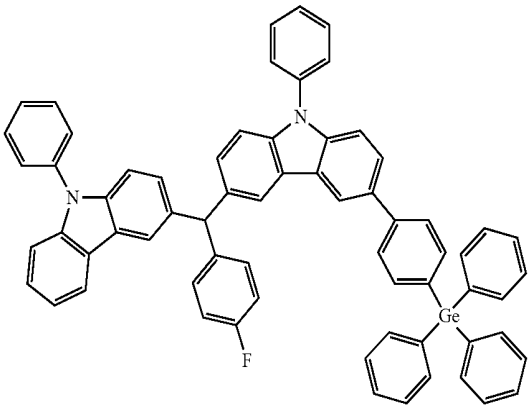

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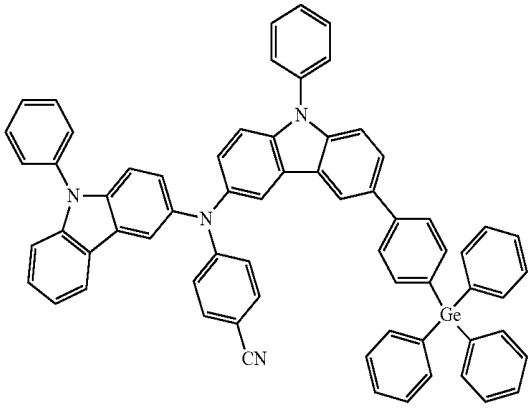

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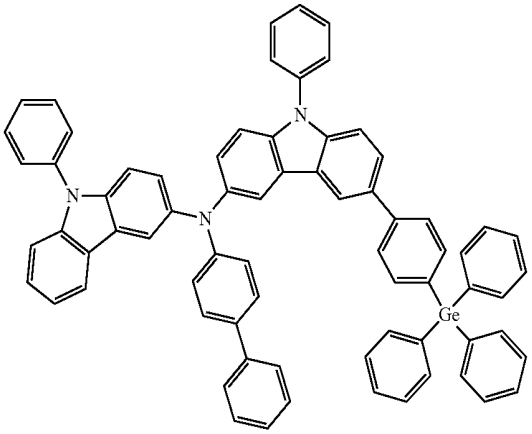

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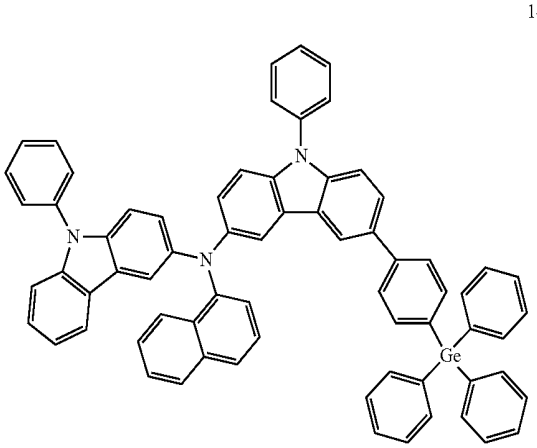

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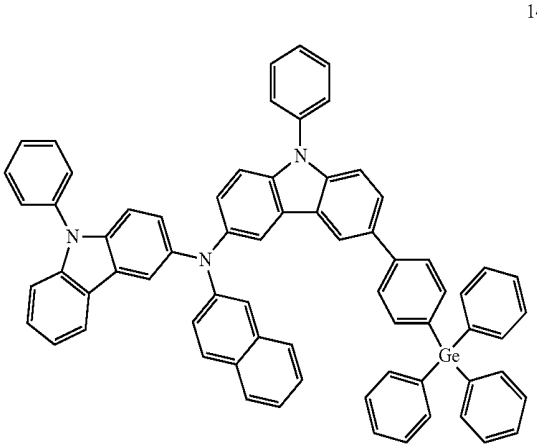

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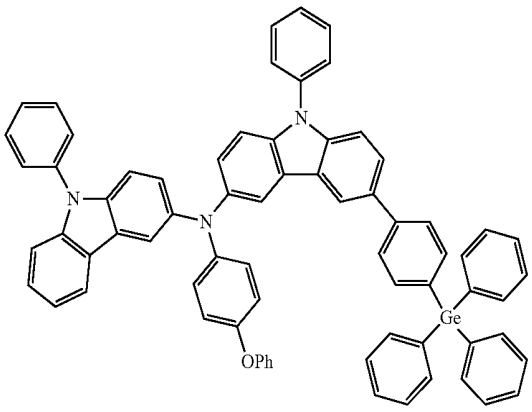

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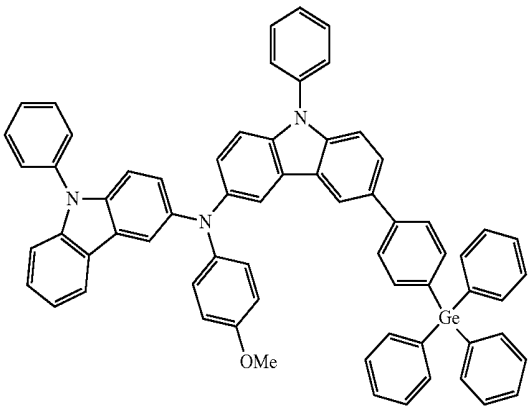

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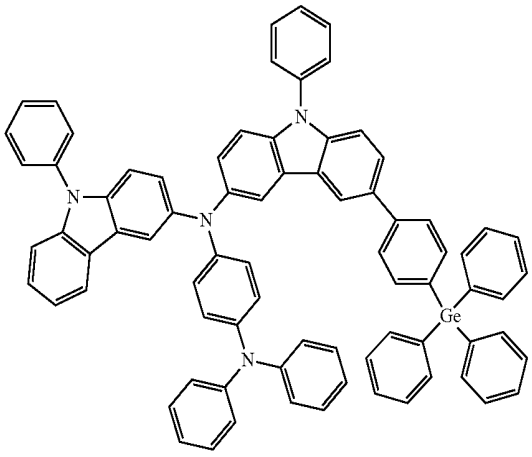

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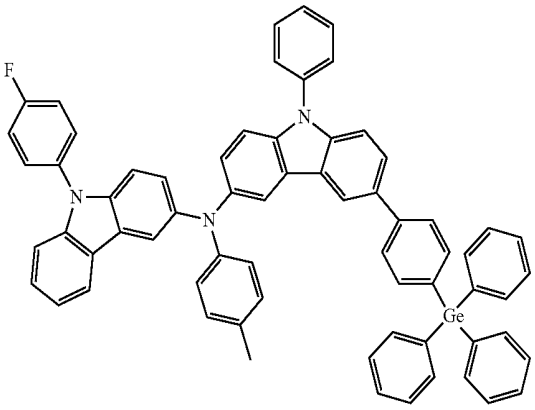

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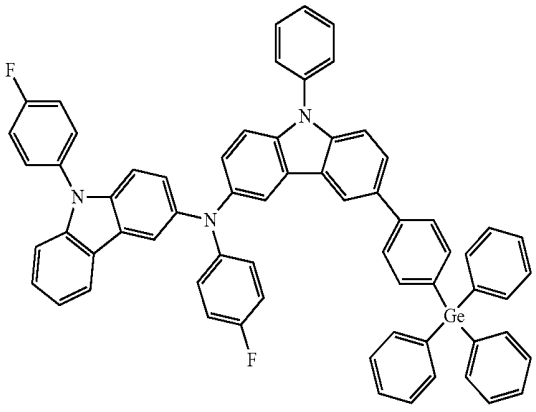

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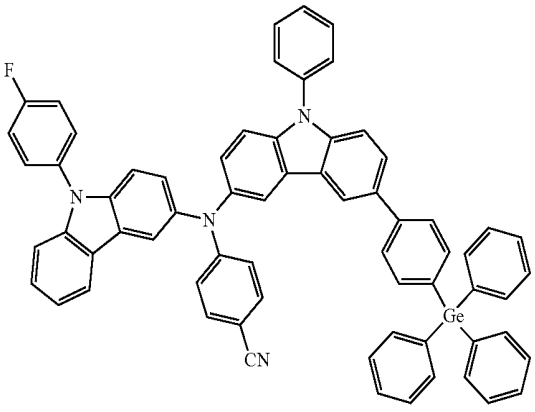

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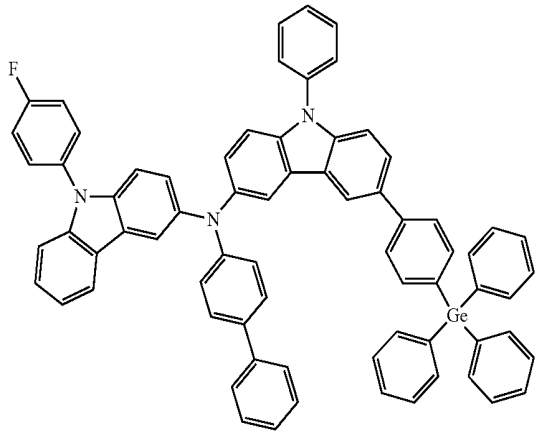

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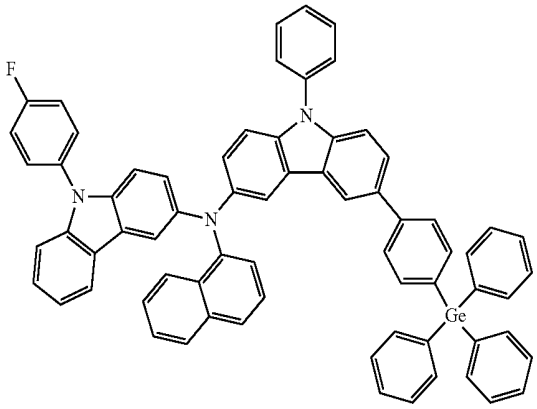

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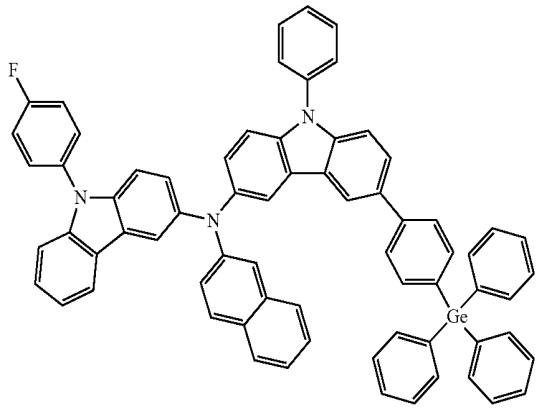

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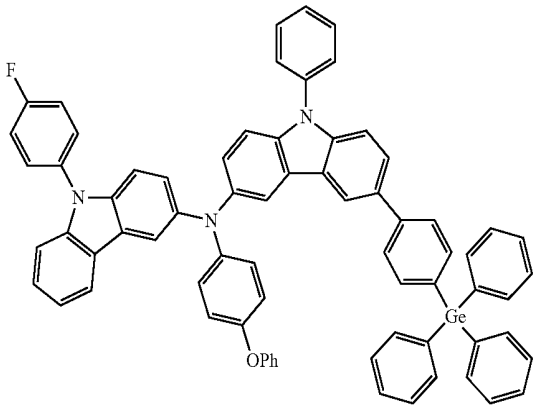

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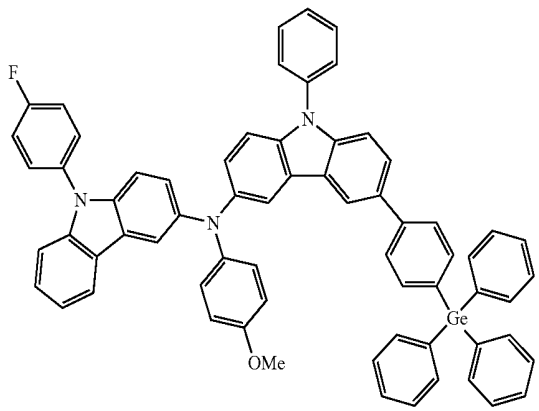

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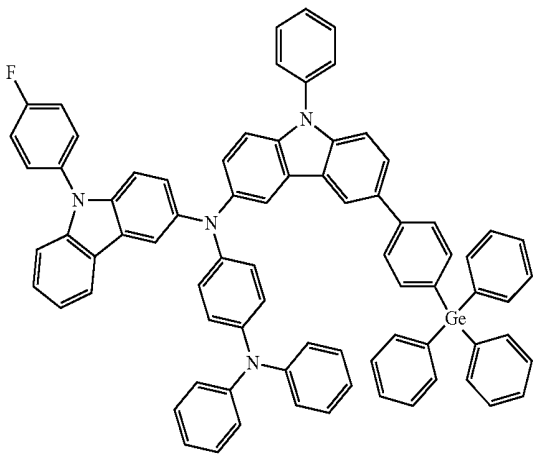

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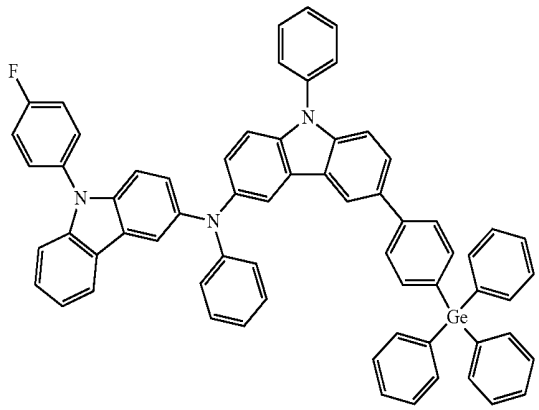

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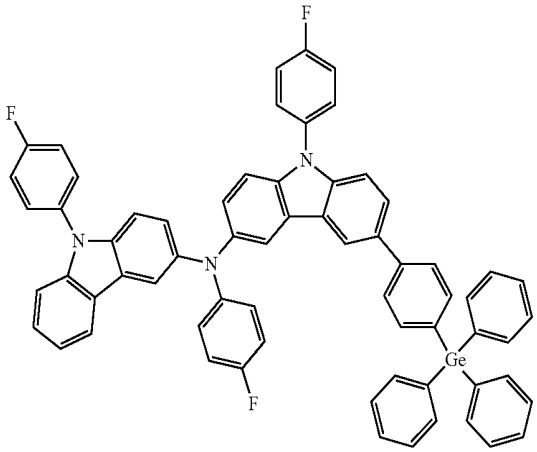

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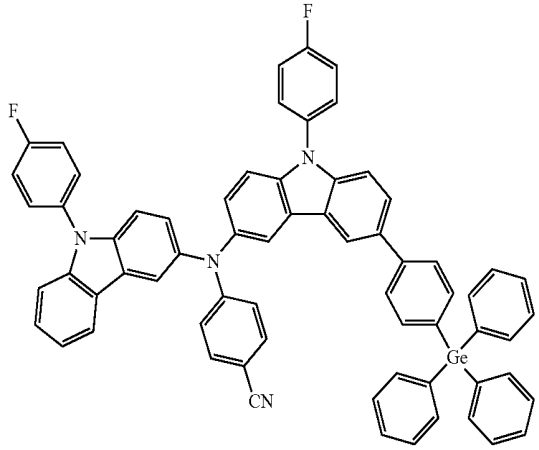

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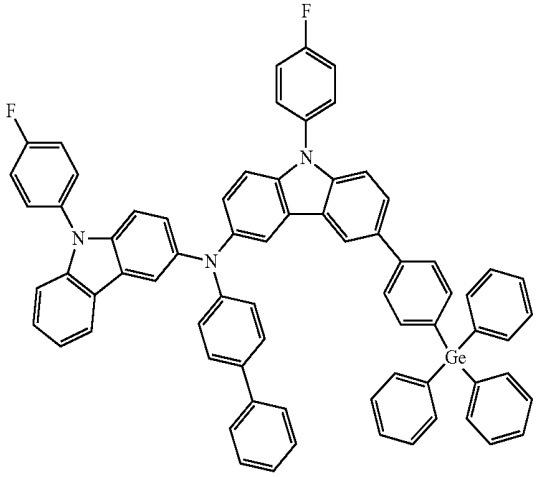

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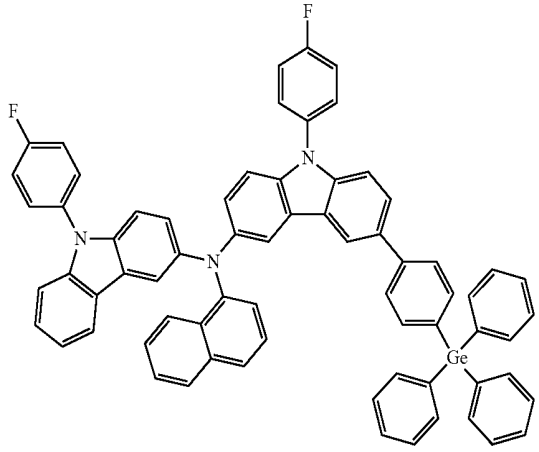

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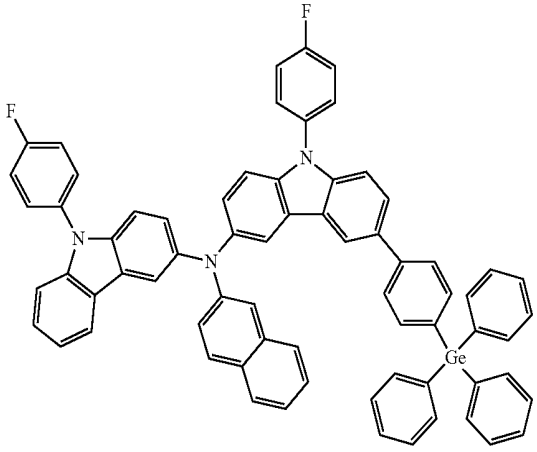

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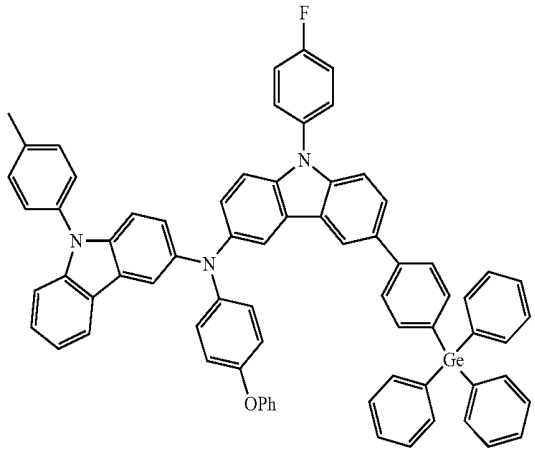

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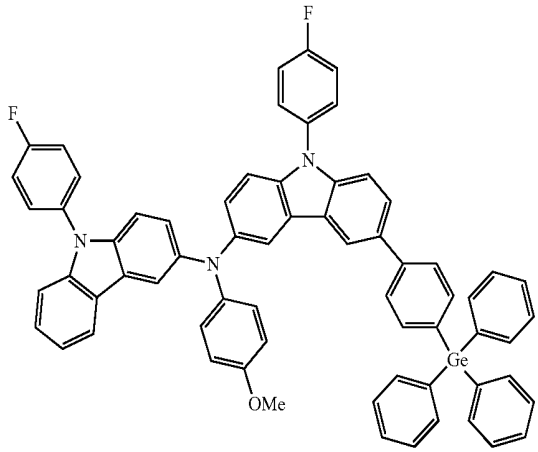

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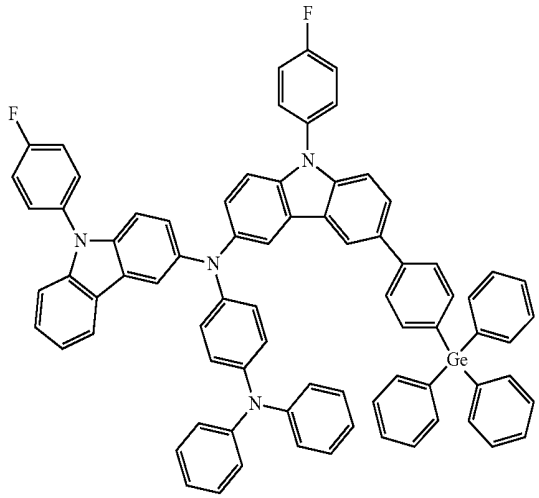

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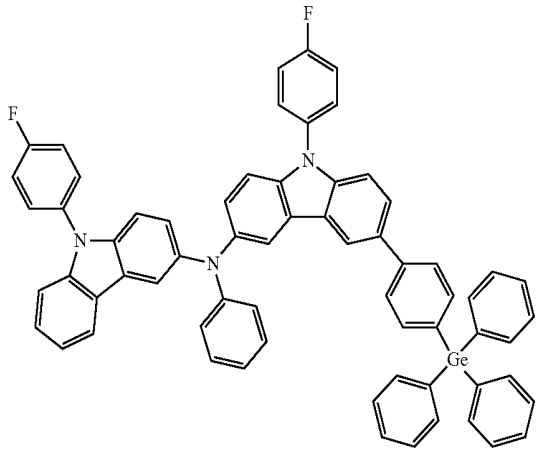

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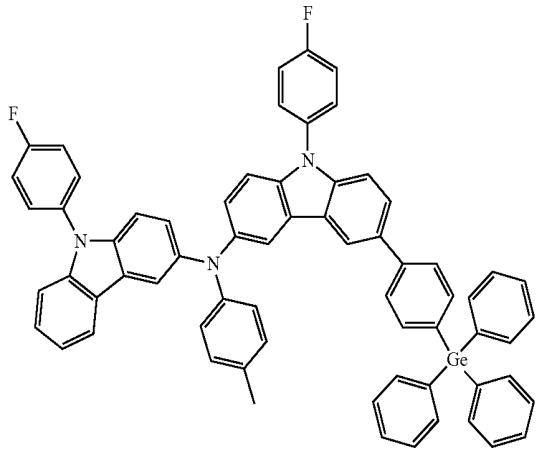

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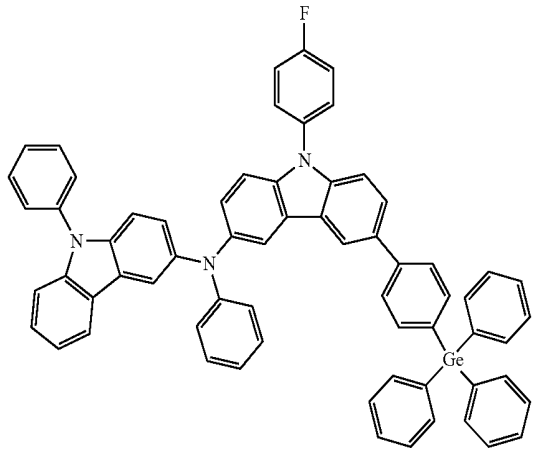

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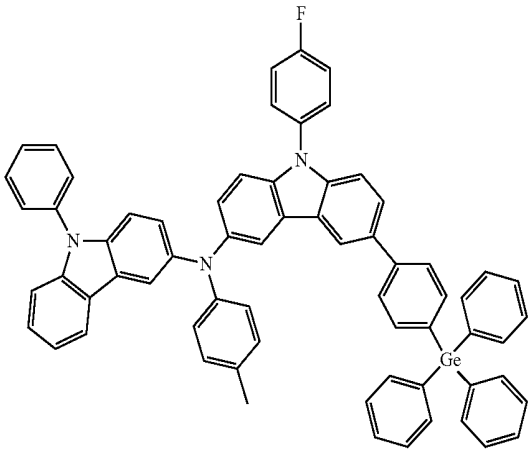

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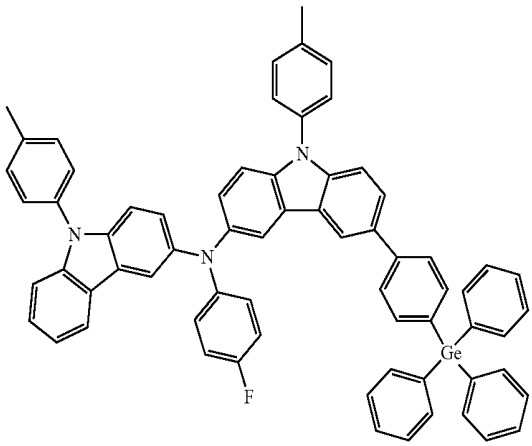

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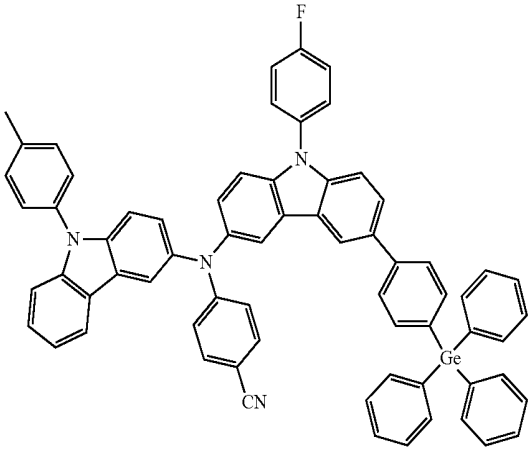

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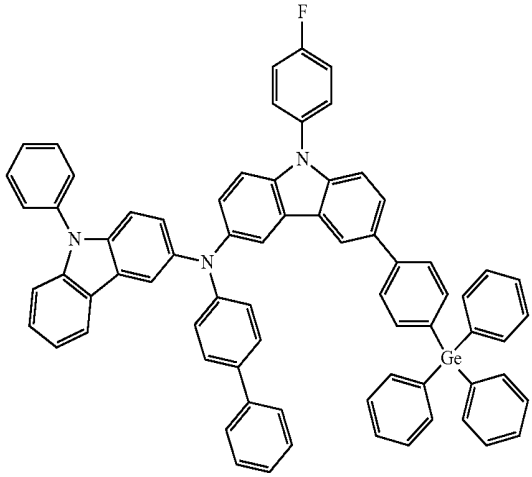

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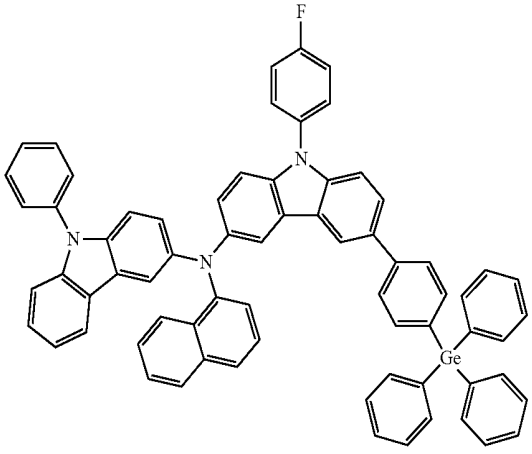

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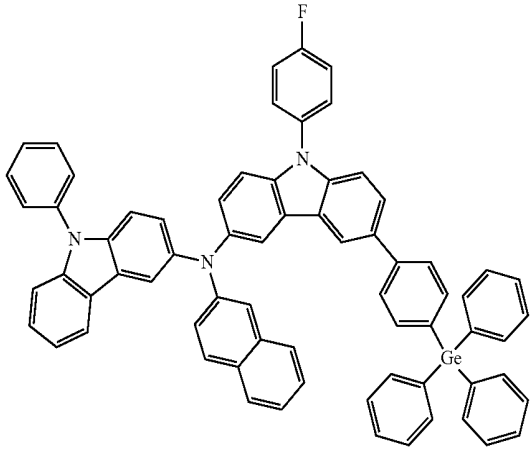

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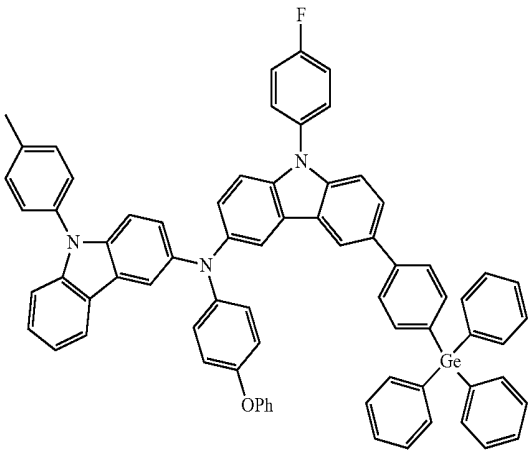

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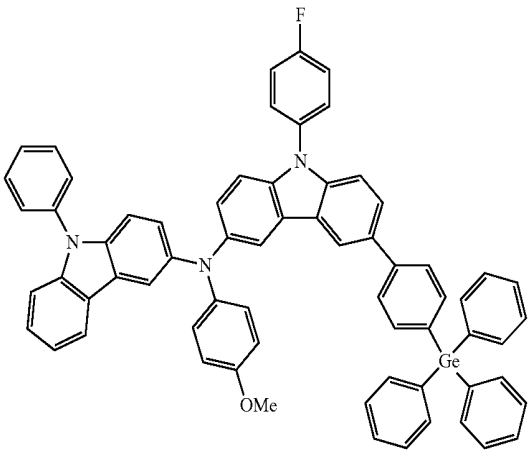

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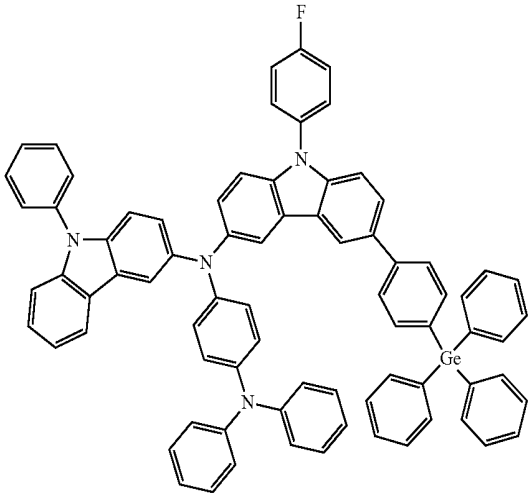

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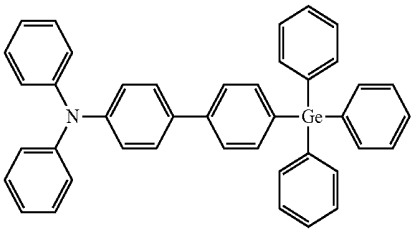

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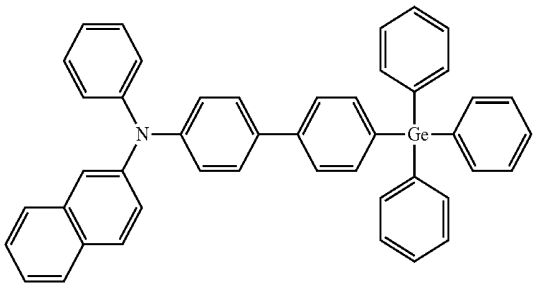

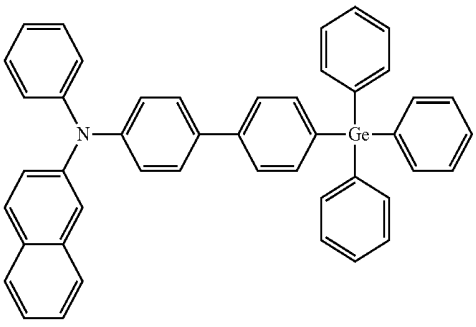

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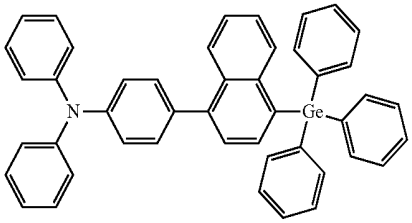

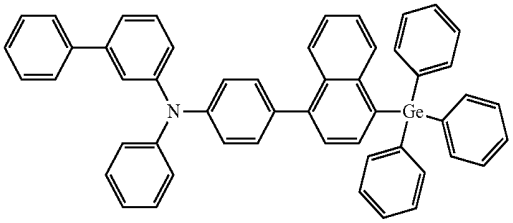

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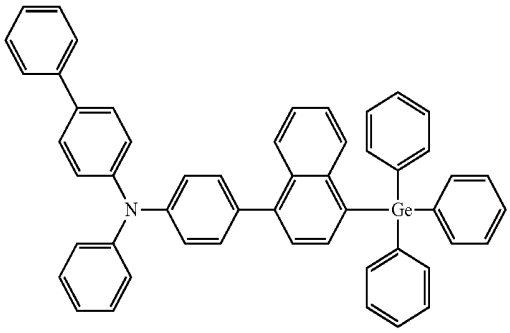

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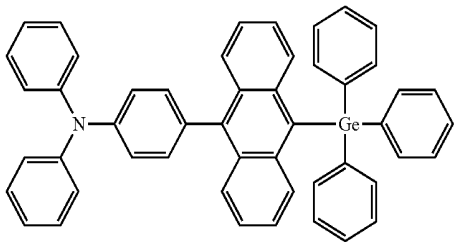

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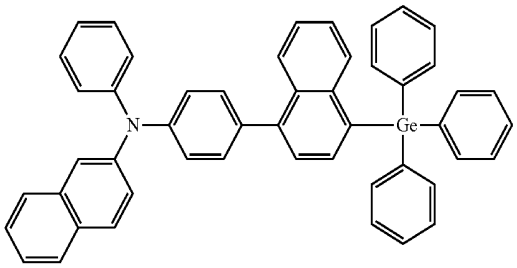

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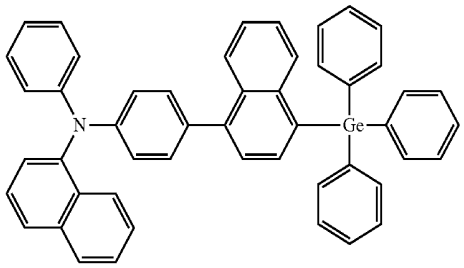

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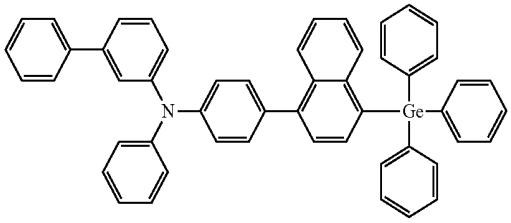

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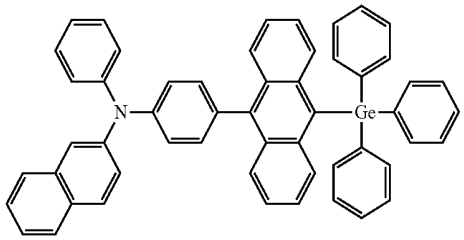

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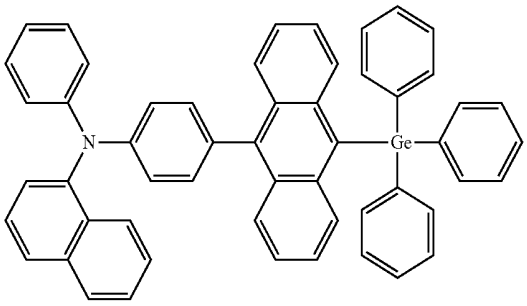

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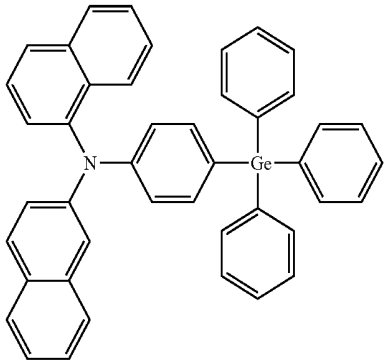

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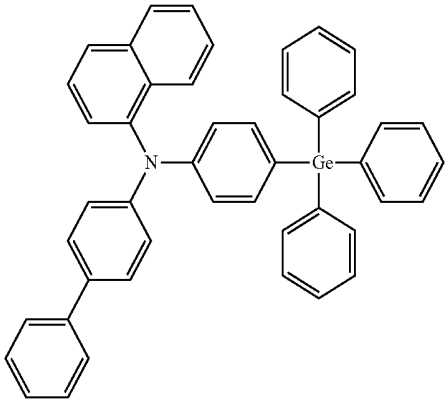

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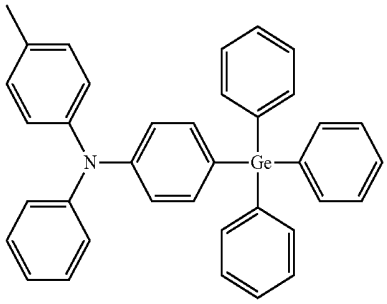

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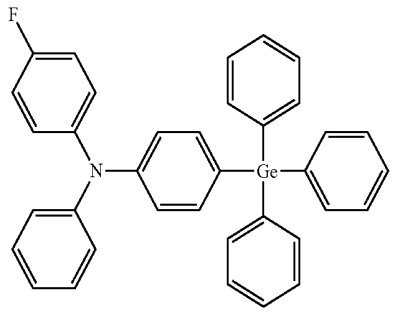

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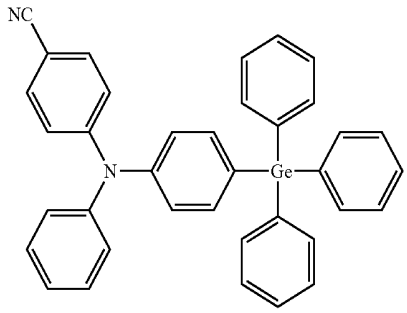

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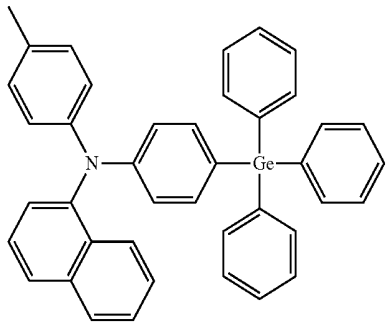

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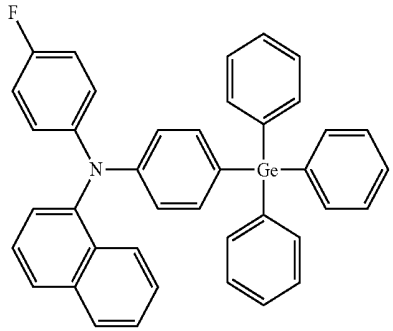

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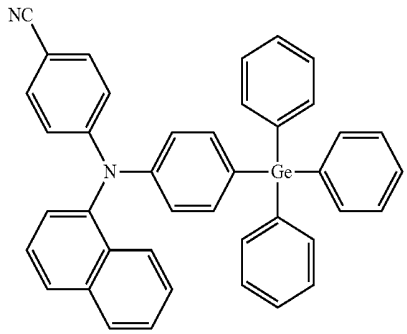

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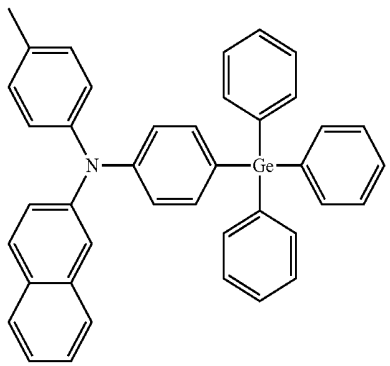

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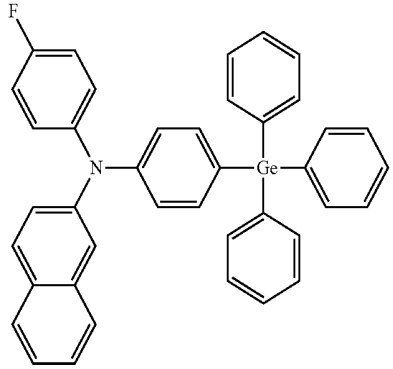

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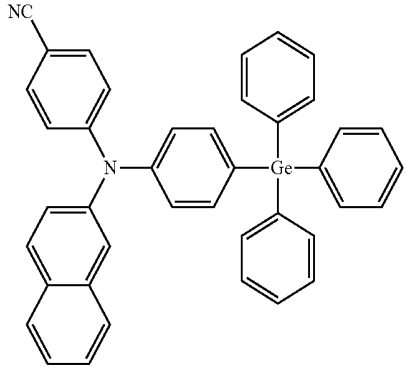

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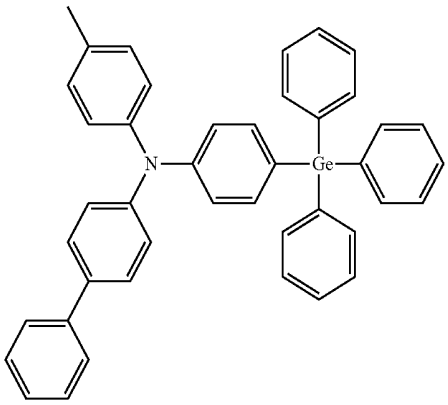

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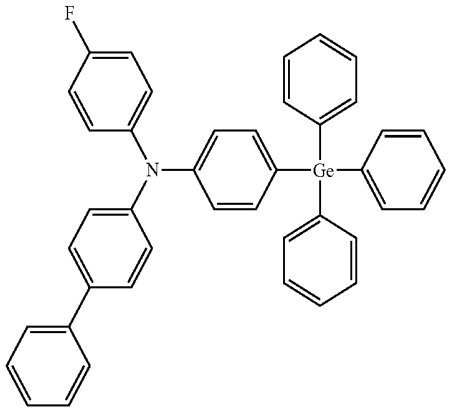

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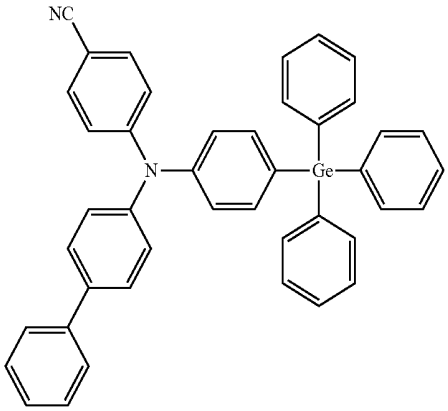

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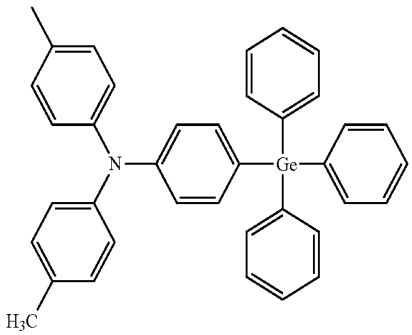

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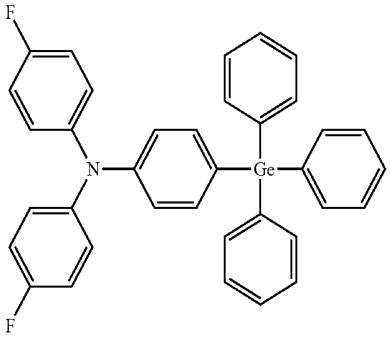

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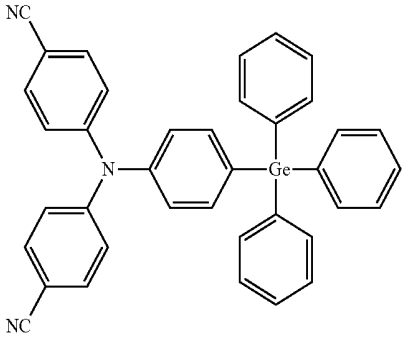

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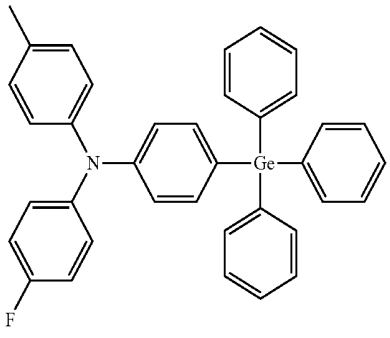

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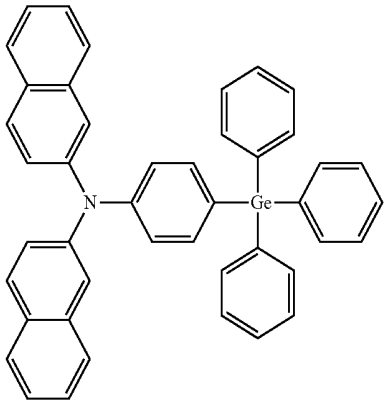

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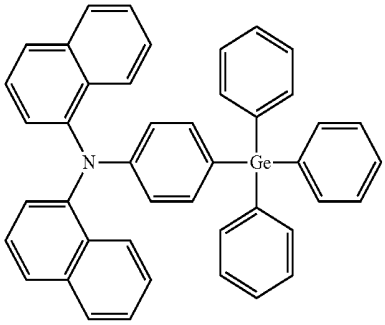

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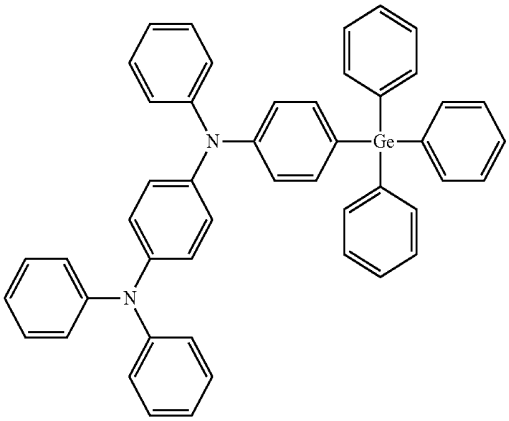

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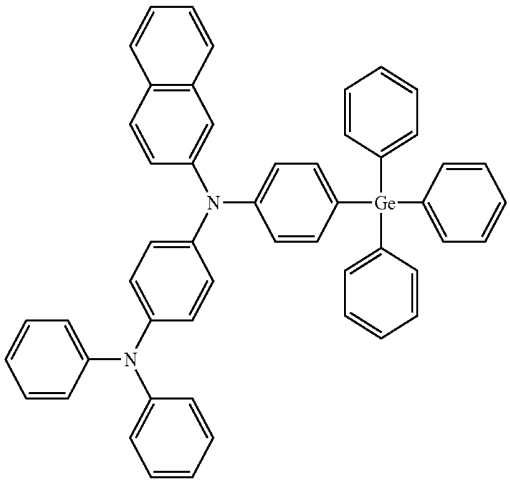

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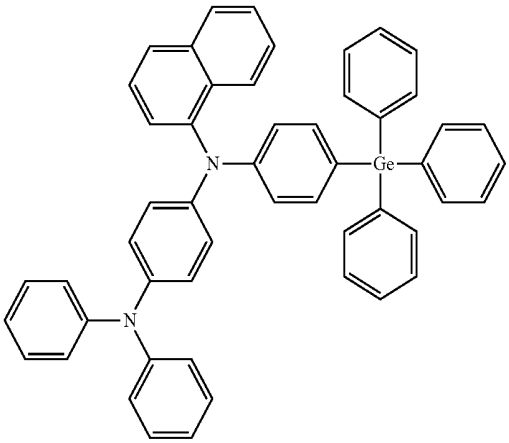

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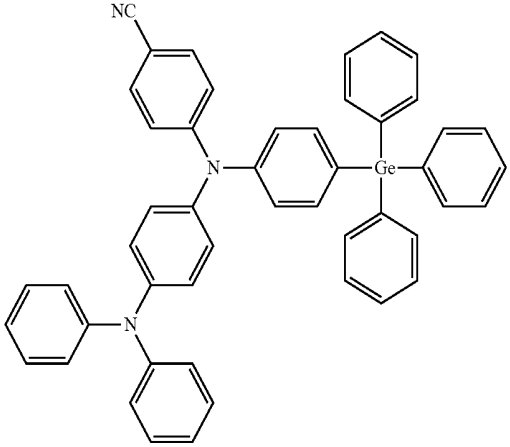

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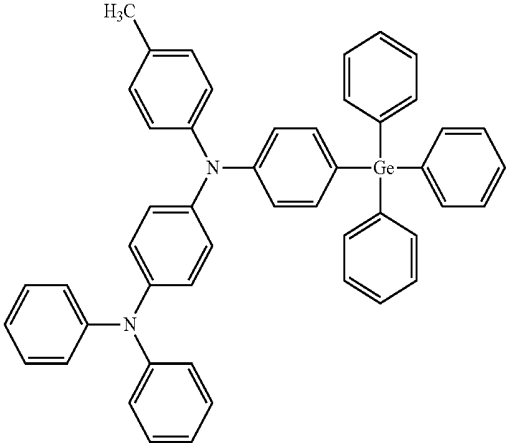

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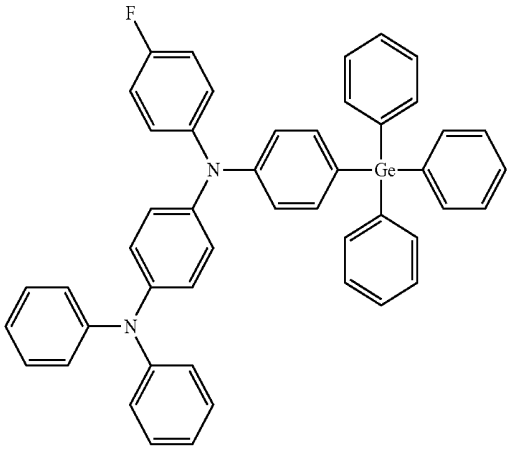

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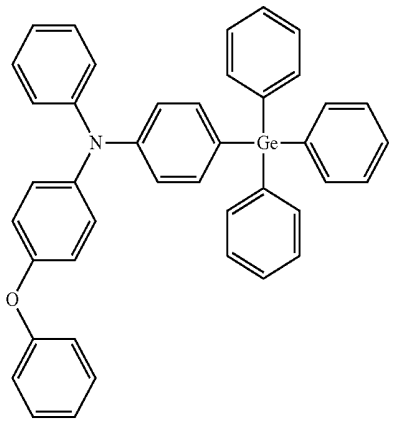

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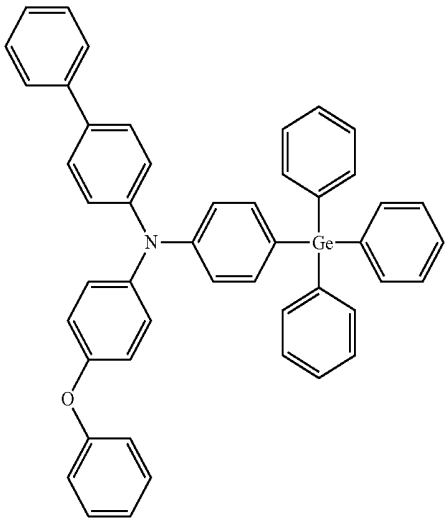

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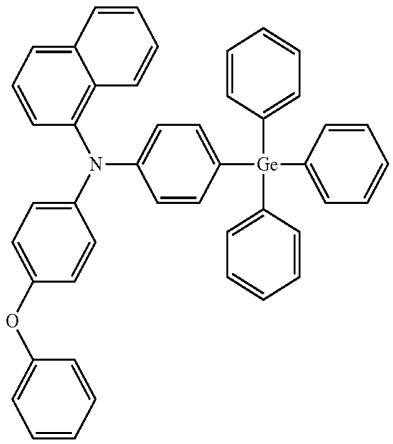

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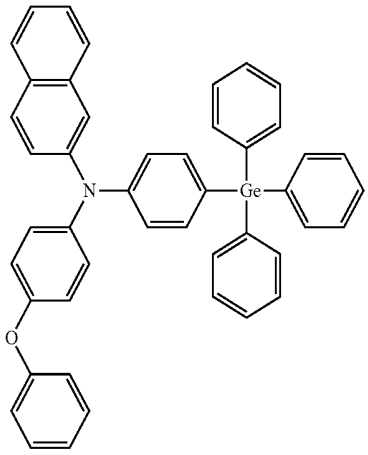

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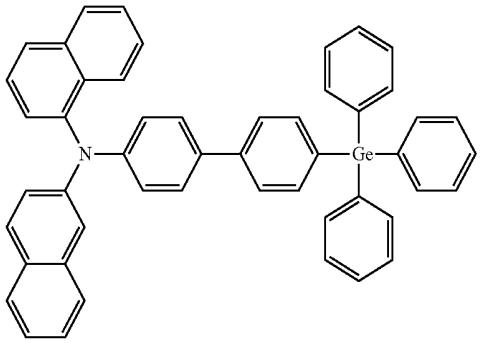

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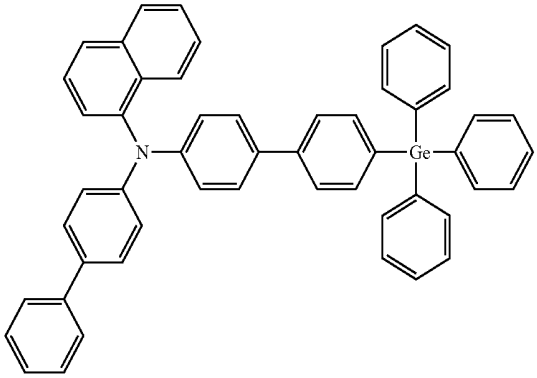

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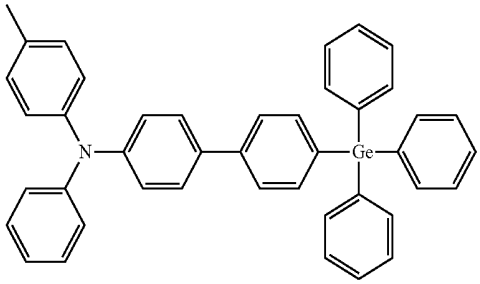

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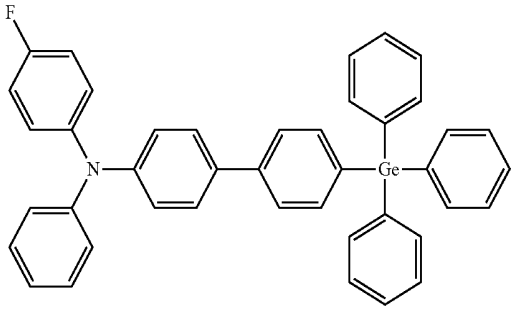

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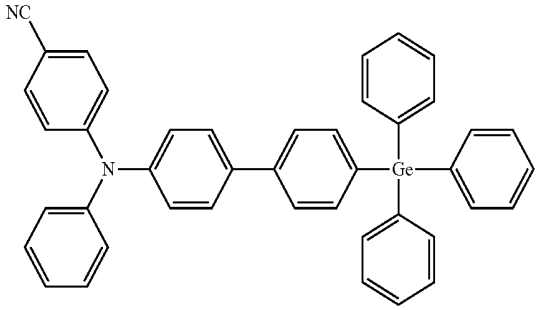

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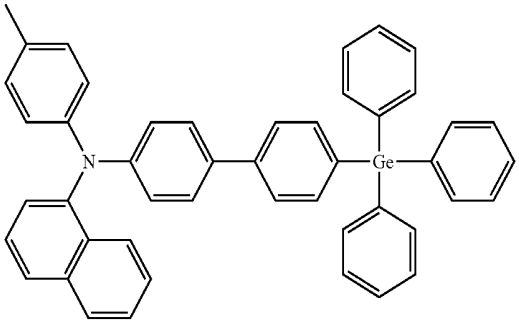

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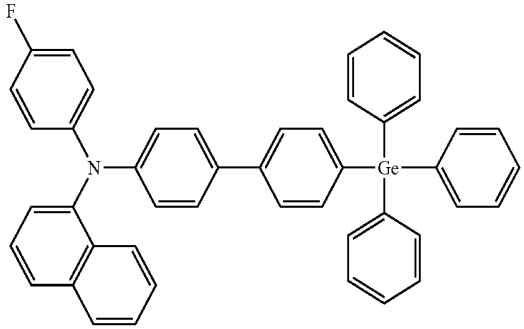

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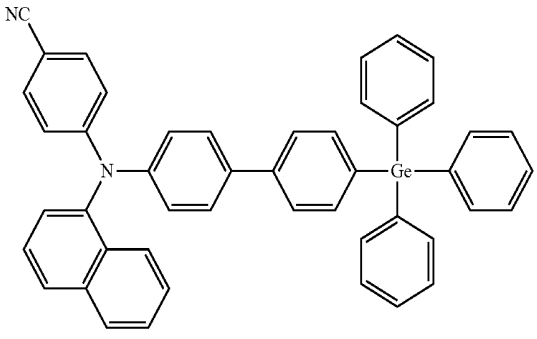

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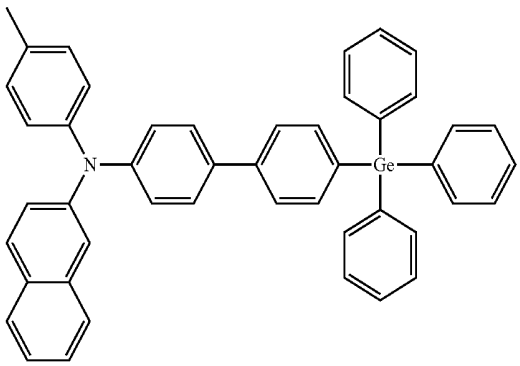

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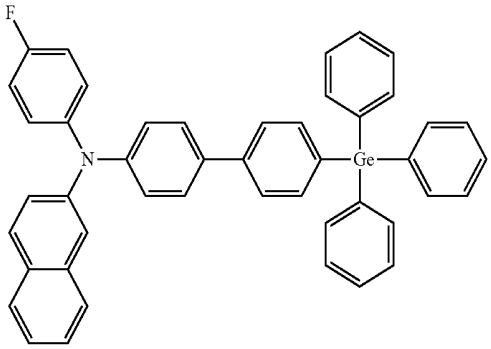

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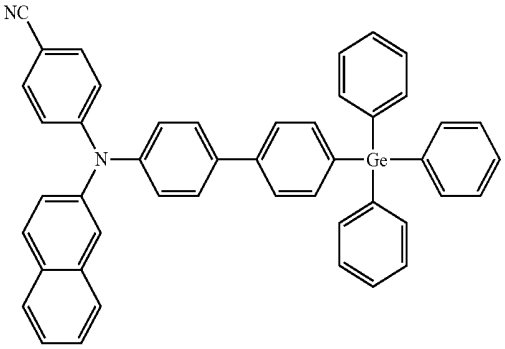

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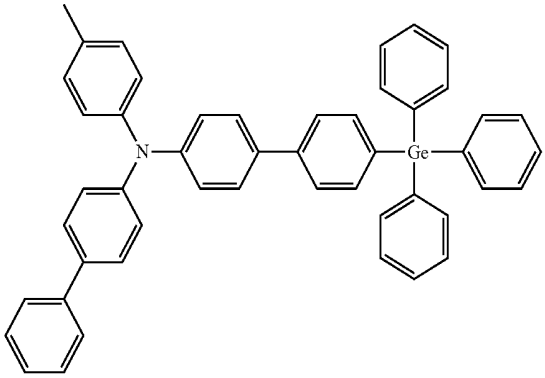

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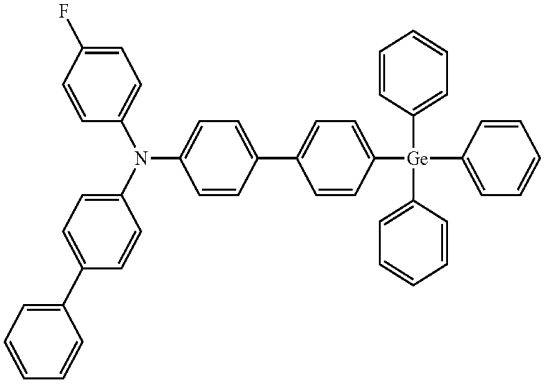

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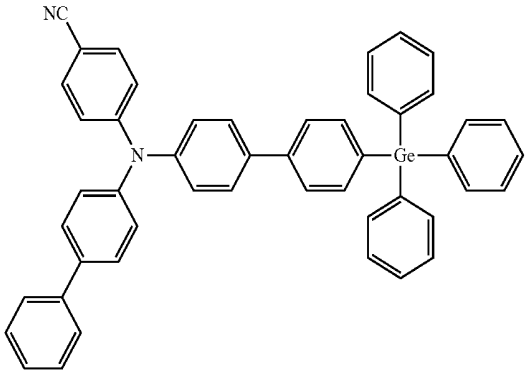

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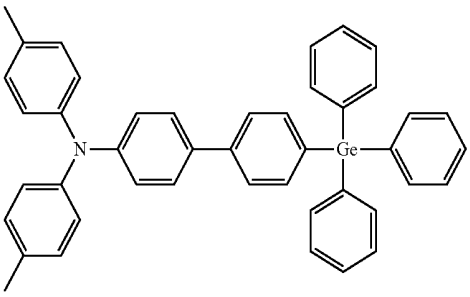

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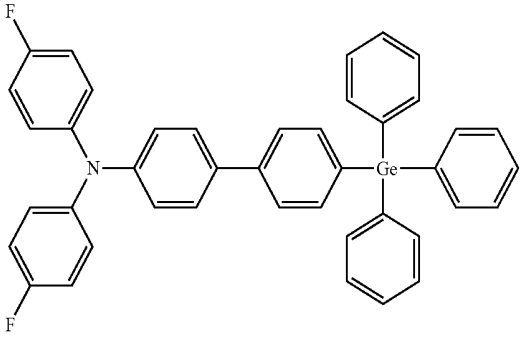

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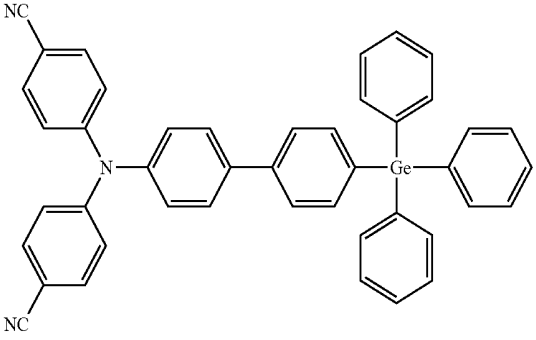

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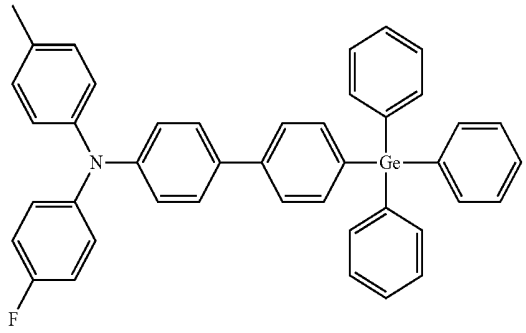

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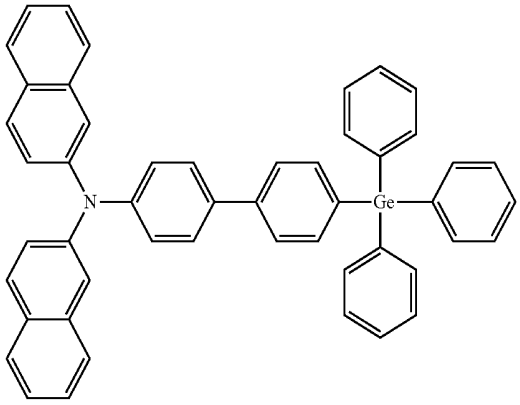

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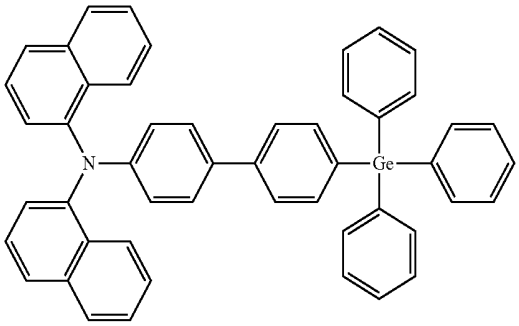

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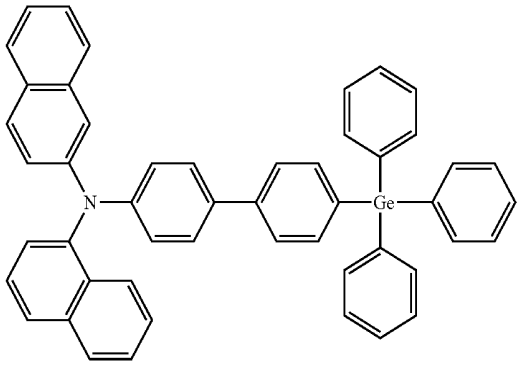

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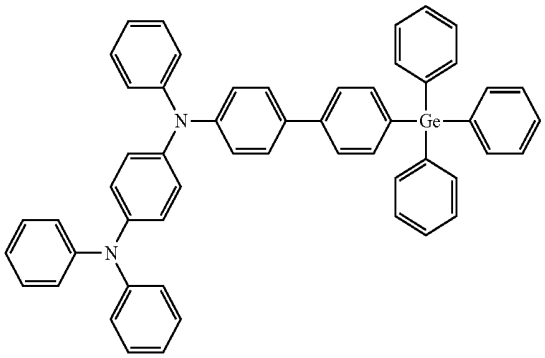

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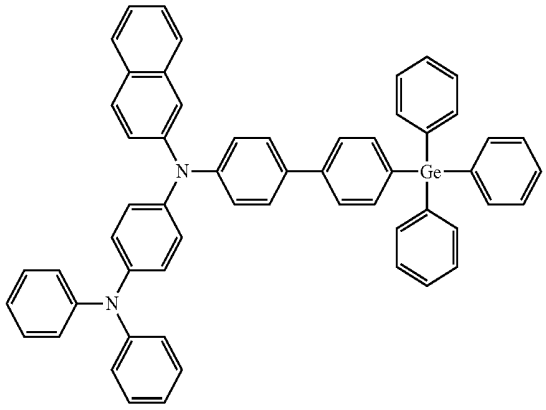

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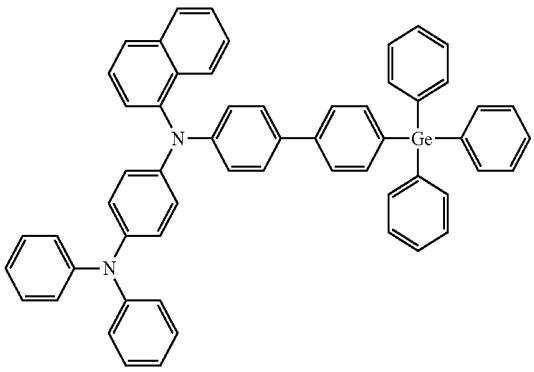

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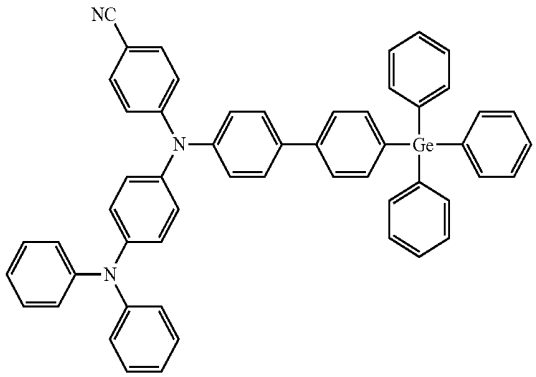

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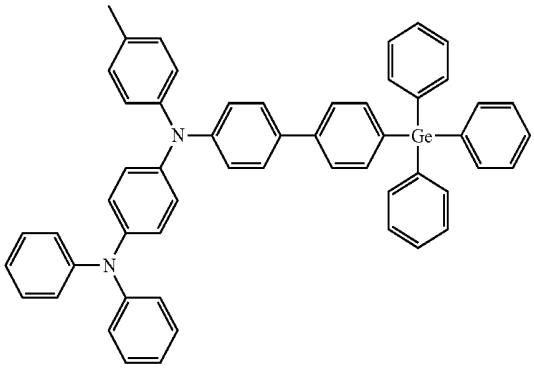

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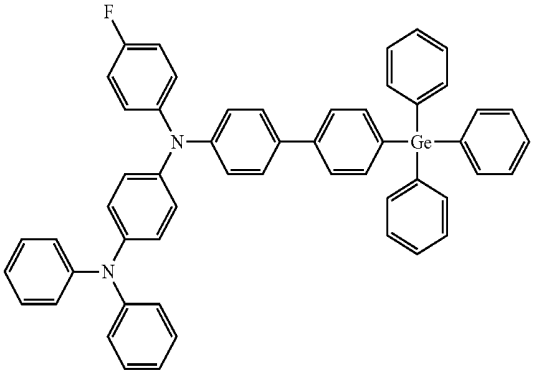

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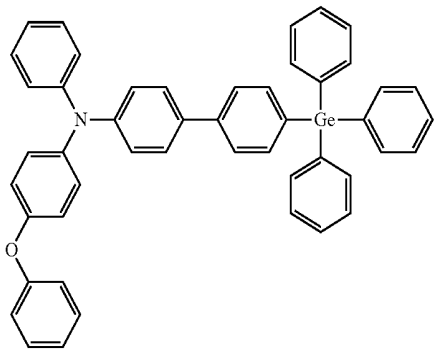

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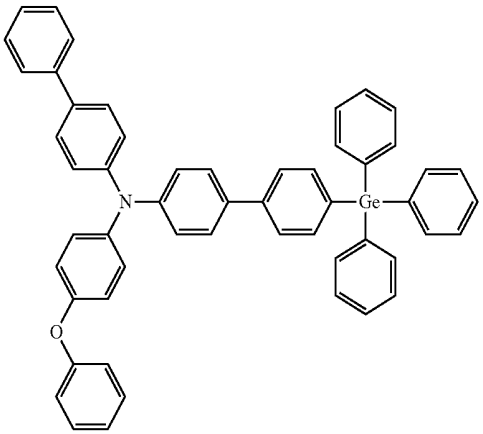

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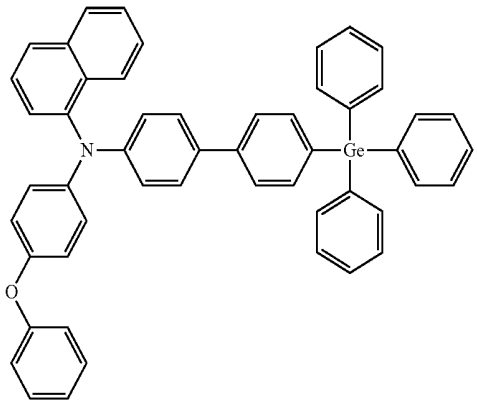

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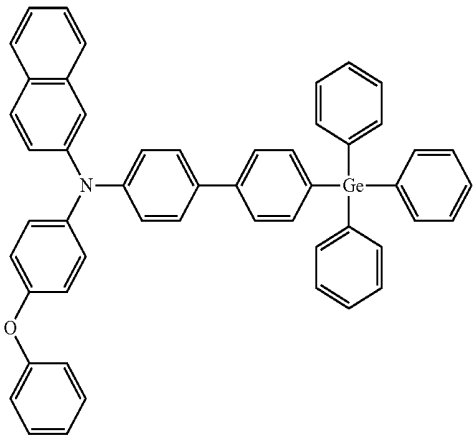

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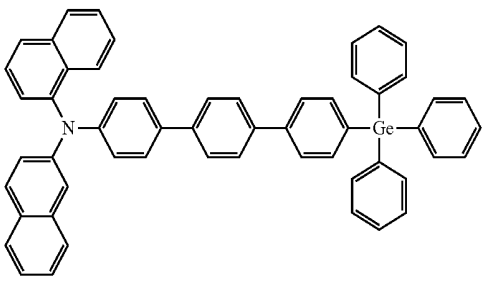

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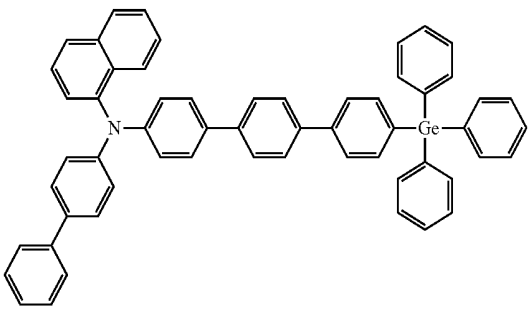

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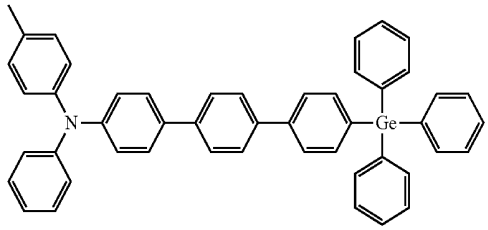

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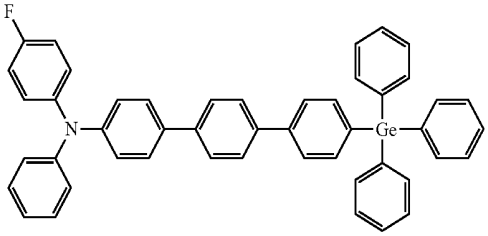

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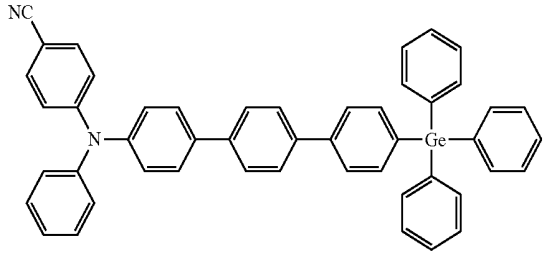

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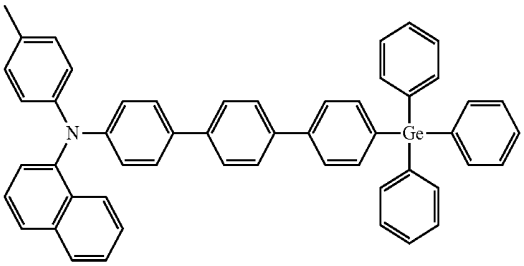

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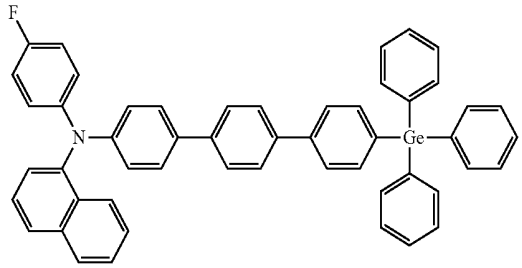

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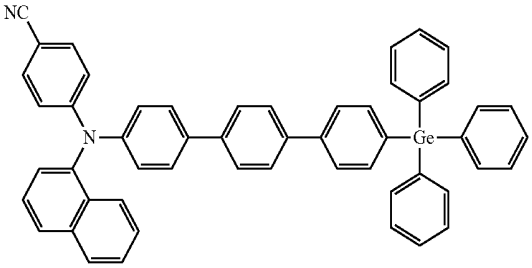

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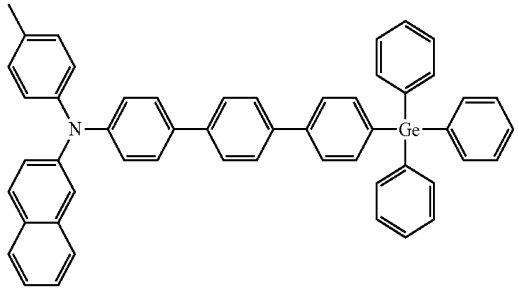

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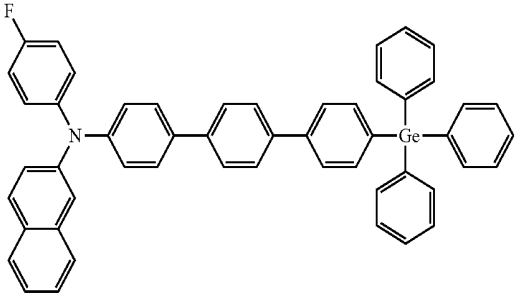

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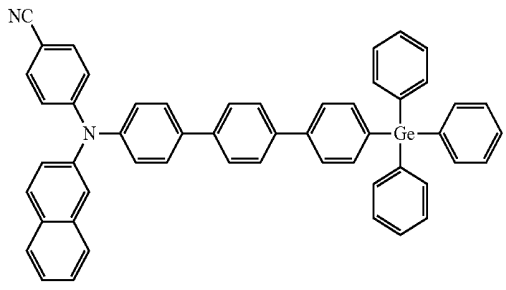

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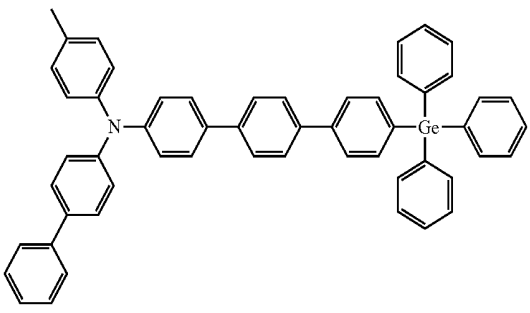

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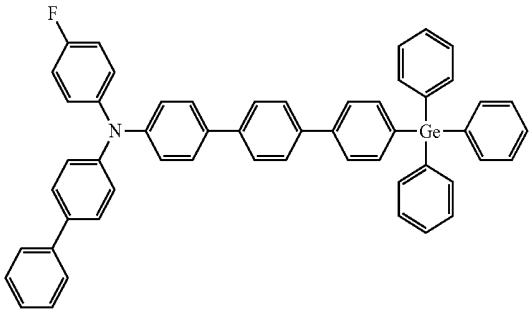

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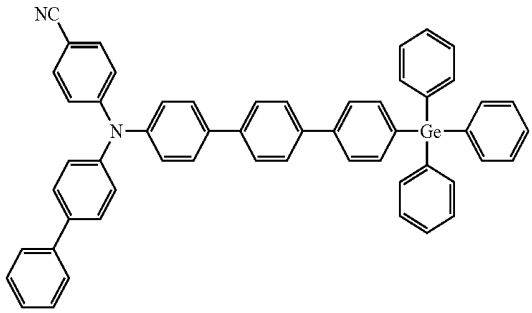

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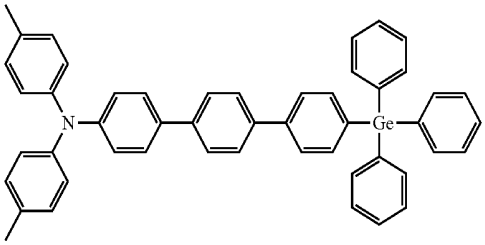

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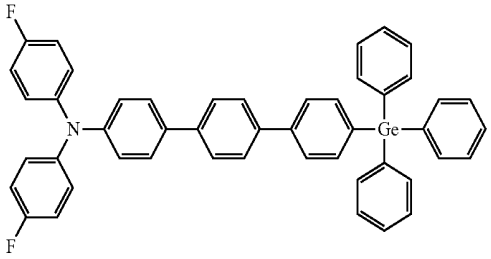

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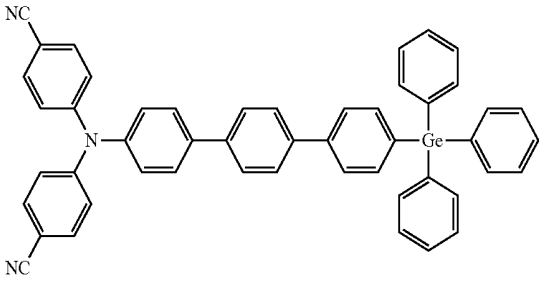

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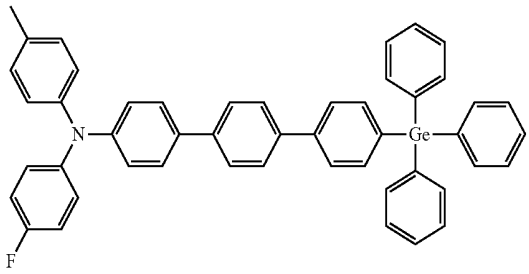

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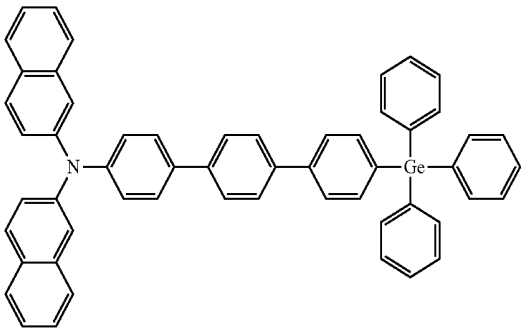

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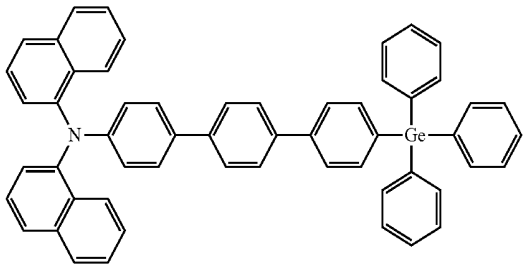

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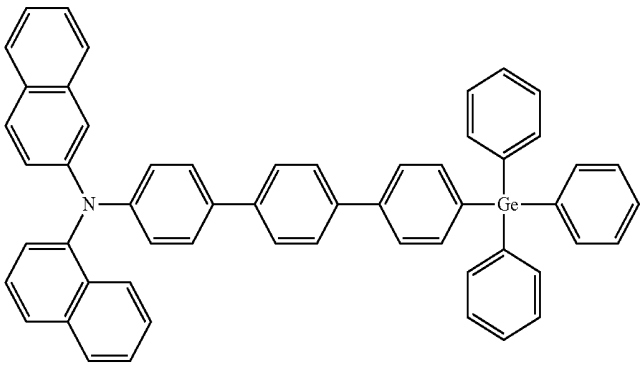

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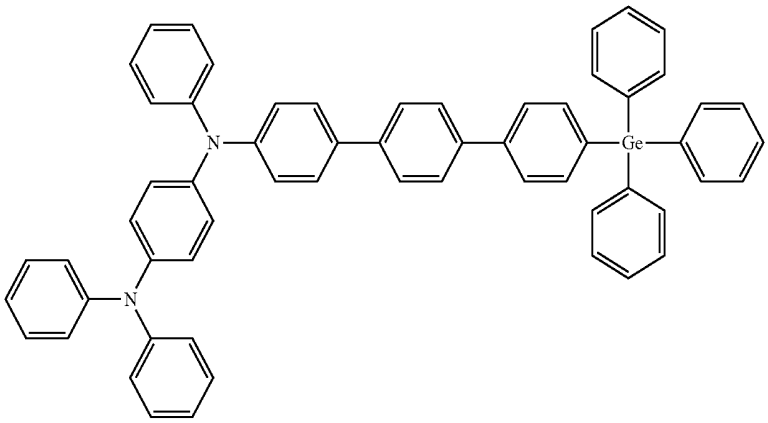

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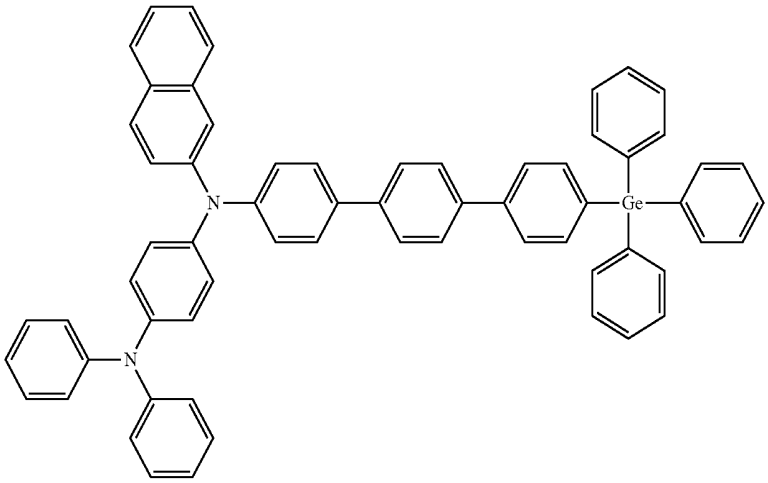

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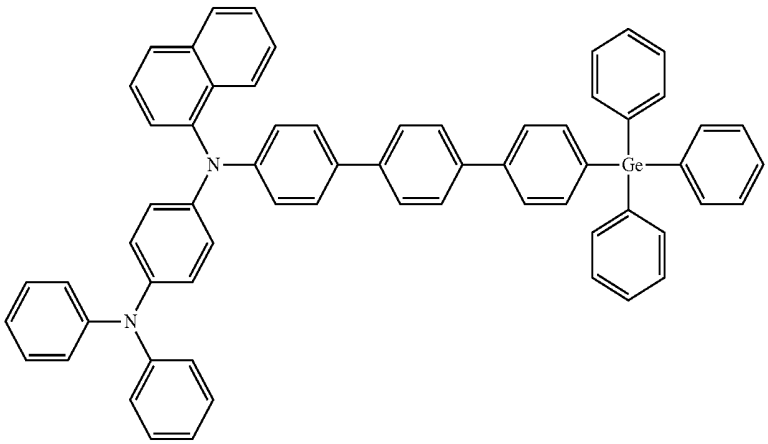

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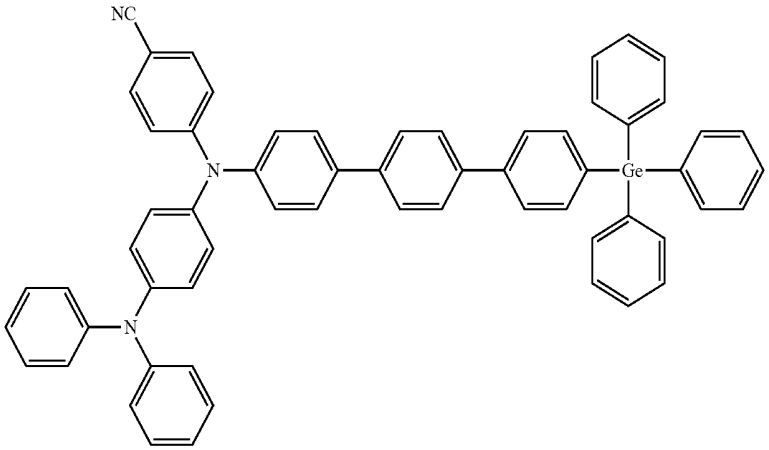

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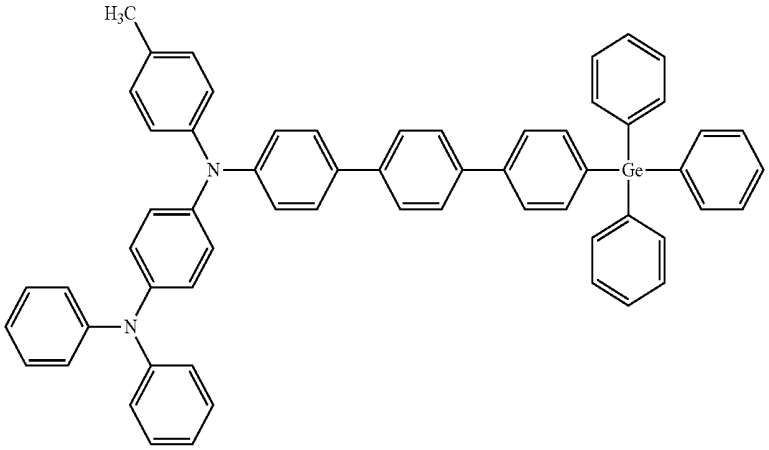

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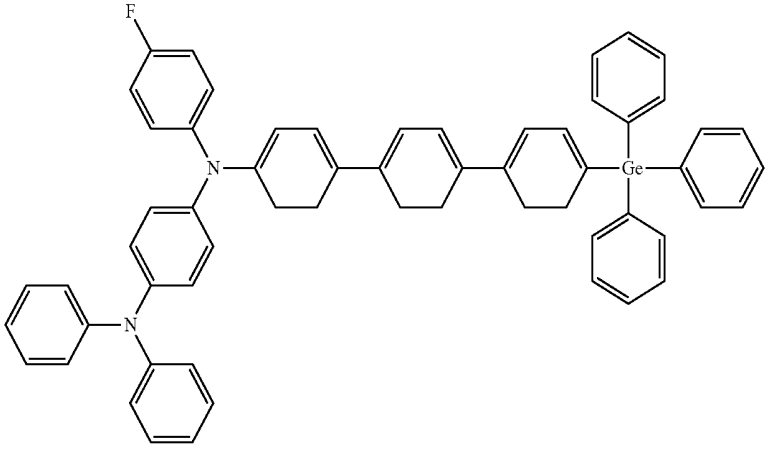

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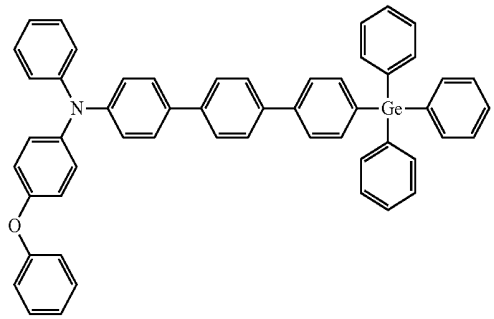

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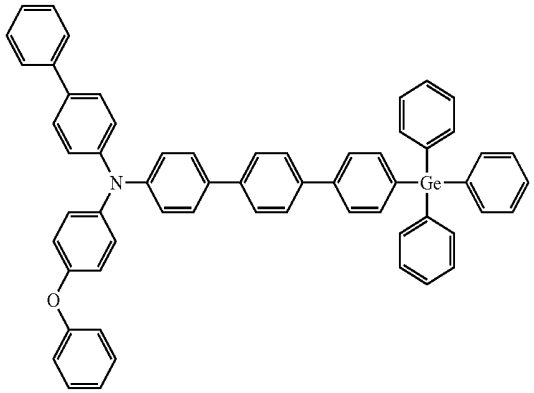

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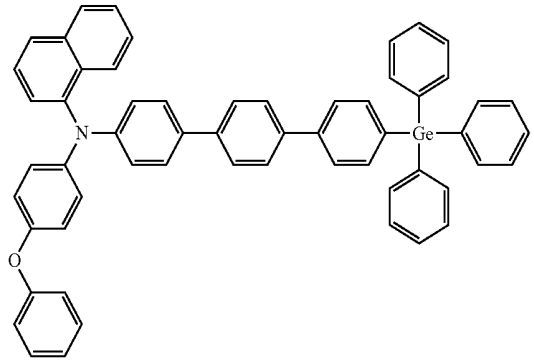

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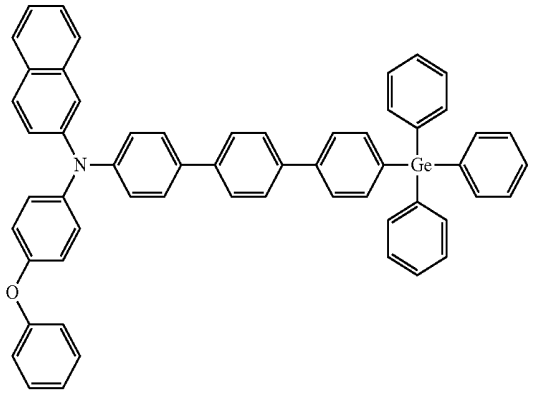
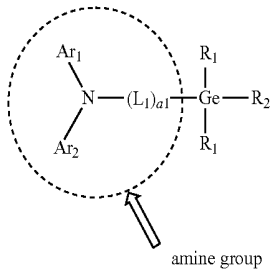


The amine-based compound represented by Formula 1 may have a structure wherein an amine group (e.g., amine-containing group) binds to a germanium (Ge) atom (refer to Formula 1' below). The amine-based compound represented by Formula 1 may facilitate injection of electrons or holes at high speed, e.g., the amine-based compound includes a germanium atom that has a higher number of orbitals than a silicon atom (e.g., Compound A of Comparative Example 2, below) having the same structure as the amine-based compound but containing a silicon atom instead of a germanium atom. Thus, an organic light-emitting device using the amine-based compound according to an embodiment as an organic light-emitting material may have high efficiency.

<Formula 1'>



R_1 to R_3 may not include an amine group, and the amine-based compound represented by Formula 1 may have one amine group bound to a germanium atom (refer to Formula 1' above). Therefore, hole mobility disturbance due to doping of a lone pair electron of the amine group may be reduced. Thus, an organic light-emitting device using the amine-based compound may have high efficiency.

The amine-based compound represented by Formula 1 may be synthesized by using a suitable organic synthetic method. A method of synthesizing the amine-based compound may be understood by one of ordinary skill in the art by referring to examples used herein.

The amine-based compound represented by Formula 1 may be used or included between a pair of electrodes in an organic light-emitting device. In an implementation, the amine-based compound may be included in a hole transport region, e.g., a hole transport layer. An organic light-emitting device according to an embodiment may include, e.g., a first electrode; a second electrode facing the first electrode; and an organic layer that is disposed between the first electrode and the second electrode and including an emission layer. The organic layer includes the amine-based compound represented by Formula 1 described above.

As used herein, the expression the "(organic layer) includes at least one amine-based compound" may be construed as meaning the "(organic layer) may include one amine-based compound in a range of Formula 1 or two different amine-based compounds in a range of Formula 1".

For example, the organic layer may include only Compound 1 as the amine-based compound. In this regard, Compound 1 may be included in the emission layer of the organic light-emitting device. Alternatively, the organic layer may include Compound 1 and Compound 2 as the amine-based compounds. In this regard, Compound 1 and Compound 2 may exist in an identical layer (for example, Compound 1 and Compound 2 may all exist in a hole transport layer), or different layers (for example, Compound 1 may exist in an emission layer and Compound 2 may exist in a hole transport layer).

The organic layer may include, e.g., i) a hole transport region that is disposed between the first electrode (anode) and the emission layer and includes 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 that is disposed between the emission layer and the second electrode (cathode) and includes at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer. The emission layer may include the amine-based compound represented by Formula 1.

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

The FIGURE illustrates a schematic view of an organic light-emitting device **10** according to an embodiment. The organic light-emitting device **10** may include a first electrode **110**, an organic layer **150**, and a second electrode **190**.

Hereinafter, a structure and a method of manufacturing the organic light-emitting device according to an embodiment will be described with reference to the FIGURE.

Referring to the FIGURE, a substrate may be additionally disposed under the first electrode **110** or on the second electrode **190**. The substrate may be a glass substrate or transparent plastic substrate, each with excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

The first electrode **110** may be formed by depositing or sputtering a material for forming the first electrode on the substrate. When the first electrode **110** is an anode, the material for the first electrode may be selected from materials with a high work function to make holes be easily injected. The first electrode **110** may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. The material for the first electrode may be a transparent and highly conductive material, and examples of such a material may include indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), and zinc oxide (ZnO). When the first electrode **110** is a semi-transmissive electrode or a reflective electrode, as a material for forming the first electrode, at least one selected from magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag) may be used.

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 triple-layer structure of ITO/Ag/ITO.

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

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

The hole transport region may include at least one selected from a hole injection layer (HIL), a hole transport layer (HTL), a buffer layer, and an electron blocking layer (EBL), and the electron transport region may include at least one selected from a hole blocking layer (HBL), an electron transport layer (ETL), and an electron injection layer (EIL).

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

For example, the hole transport region may have a single-layered structure formed of a plurality of different materials, or a structure of hole injection layer/hole transport layer, a structure of hole injection layer/hole transport layer/buffer layer, a structure of hole injection layer/buffer layer, a structure of hole transport layer/buffer layer, or a structure of hole injection layer/hole transport layer/electron blocking layer, wherein layers of each structure are sequentially stacked from the first electrode **110** in this stated order.

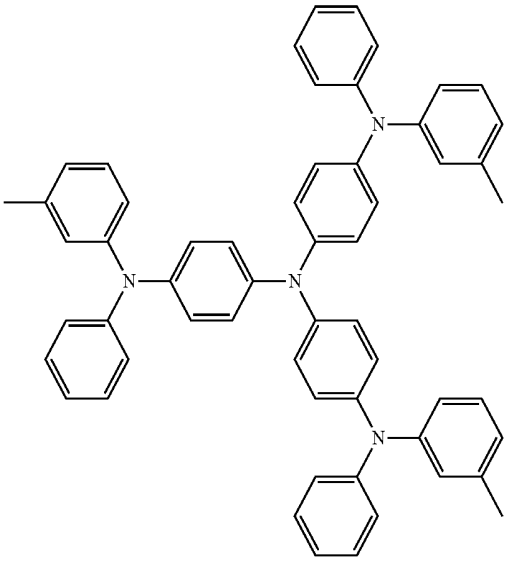
When the hole transport region includes a hole injection layer, the hole injection layer may be formed on the first electrode **110** by using various methods, e.g., vacuum deposition, spin coating, casting, a Langmuir-Blodgett (LB) method, ink-jet printing, laser-printing, or laser-induced thermal imaging.

When a hole injection layer is formed by vacuum deposition, e.g., the vacuum deposition may be performed at a temperature of a deposition temperature of about 100 to about 500° C., at a vacuum degree of about 10^{-8} to about 10^{-3} torr, and/or at a deposition rate of about 0.01 to about 100 Å/sec, in consideration of a compound for a hole injection layer to be deposited, and the structure of a hole injection layer to be formed.

When a hole injection layer is formed by spin coating, the spin coating may be performed at a coating rate of about 2,000 rpm to about 5,000 rpm, and/or at a temperature of about 80° C. to 200° C., in consideration of a compound for a hole injection layer to be deposited, and the structure of a hole injection layer to be formed.

A suitable hole injection material may be used as a hole injection material, e.g., DNTPD (N,N'-diphenyl-N,N'-bis-[4-(phenyl-m-tolyl-amino)-phenyl]-biphenyl-4,4'-diamine), a phthalocyanine compound such as copper phthalocyanine, m-MTDATA [4,4',4"-tris(3-methylphenylphenylamino)triphenylamine], NPB(N,N'-di(1-naphthyl)-N,N'-diphenylbenzidine)), TDATA, 2-TNATA, Pani/DBSA (polyaniline/dodecylbenzenesulfonic acid), PEDOT/PSS (poly(3,4-ethylenedioxythiophene)/Poly(4-styrenesulfonate)), Pani/CSA (polyaniline/camphorsulfonic acid), or PANI/PSS (polyaniline/poly(4-styrenesulfonate)).

m-MTDATA



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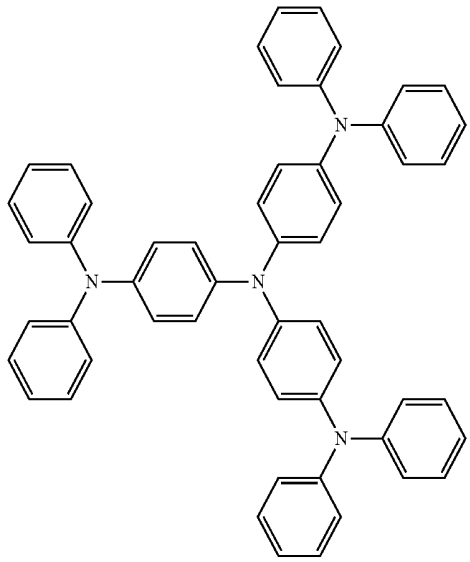
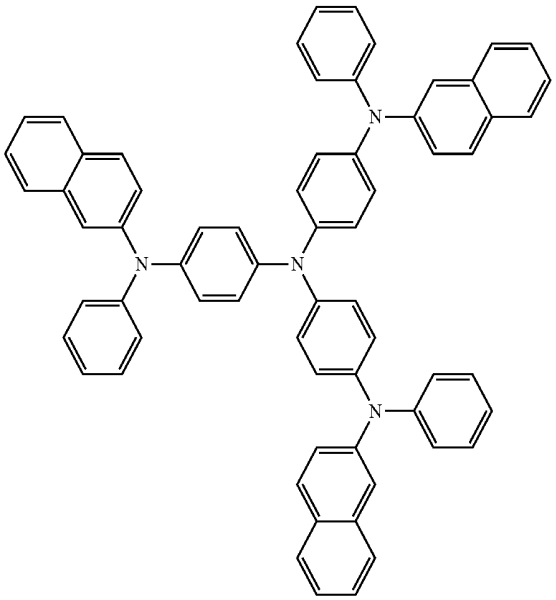
TDATA



2-TNATA



In an implementation, the hole injection layer may include the amine-based compound represented by Formula 1.

The hole transport layer may be formed on the first electrode **110** or on the hole injection layer by using various methods, e.g., vacuum deposition, spin coating, casting, a LB method, ink jet printing, laser-printing, or laser-induced thermal imaging. When a hole transport layer is formed by vacuum deposition or spin coating, vacuum deposition and coating conditions for the hole transport layer may be determined by referring to the vacuum deposition and coating conditions for the hole injection layer.

A suitable hole transport material may be used for a hole transport material.

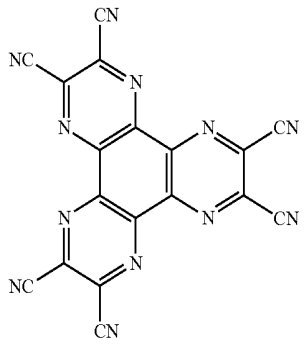
In an implementation, the amine-based compound represented by Formula 1 may be used for the hole transport material.

A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, e.g., 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, e.g., 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, e.g., about 100 Å to about 1500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within the ranges described above, excellent hole transport characteristics may be obtained without a substantial increase in driving voltage.

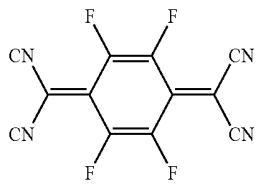
The hole transport region may further include, in addition to the mentioned materials above, a charge-generating material to improve conductive properties. The charge-generating material may be homogeneously or non-homogeneously dispersed throughout the hole transport region.

The charge-generating material may be, e.g., a p-dopant. The p-dopant may be one selected from a quinone derivative, a metal oxide, and a cyano group-containing compound, but is not limited thereto. For example, non-limiting examples of the p-dopant are a quinone derivative, such as tetracyanoquinonedimethane (TCNQ) or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonedimethane (F4-TCNQ); a metal oxide, such as a tungsten oxide or a molybdenum oxide, and Compound HT-D1 illustrated below, but they are not limited thereto.

<Compound HT-D1>



<F4-TCNQ>



The hole transport region may further include, in addition to the hole injection layer and the hole transport layer, at least one selected from a buffer layer and an electron blocking layer. The buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, and light-emission efficiency of a formed organic light-emitting device may be improved. For use as a material included in the buffer layer, materials that are included in the hole transport region may be used. The electron blocking layer may help prevent injection of electrons from the electron transport region.

An emission layer may be formed on the first electrode **110** or the hole transport region by using various methods, such as vacuum deposition, spin coating, casting, a LB method, ink jet printing, laser-printing, or laser-induced thermal imaging. When the emission layer is formed by vacuum deposition or spin coating, deposition and coating

conditions for the emission layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

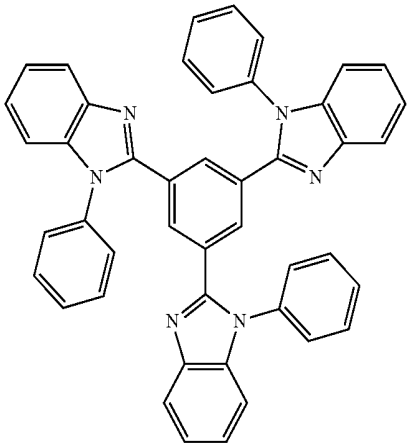
When the organic light-emitting device **10** is a full color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, or a blue emission layer, according to a sub pixel. Alternatively, the emission layer may have a stacked structure of a red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

In an implementation, the emission layer may include the amine-based compound represented by Formula 1.

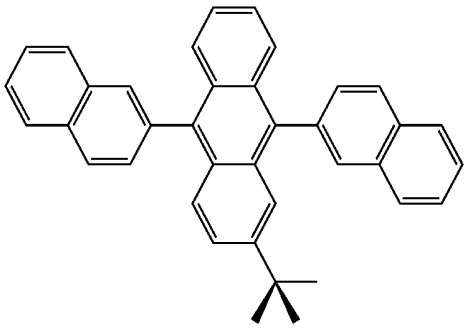
The emission layer may include a host and a dopant.

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

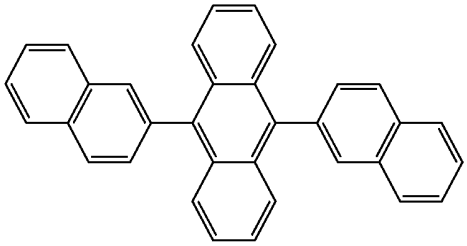
TPBi



TBADN



ADN



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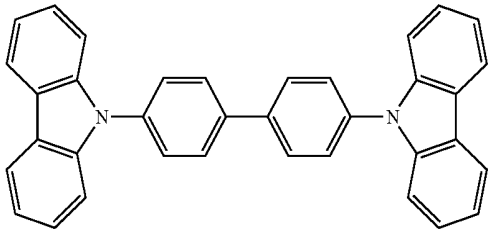
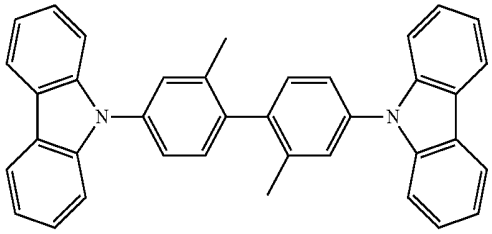
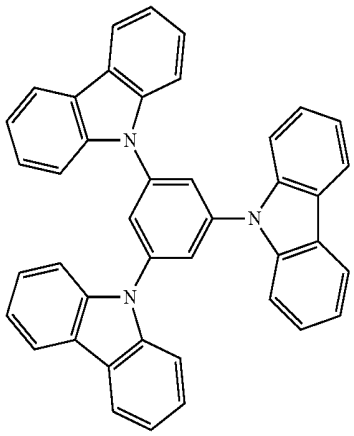
CBP



CDBP



TCP



In an implementation, the host may further include a compound represented by Formula 301:

$$Ar_{301}\text{-}[(L_{301})_{xb1}\text{-}R_{301}]_{xb2} \quad \text{<Formula 301>}$$

In Formula 301,

Ar_{301} may be selected from

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

a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, naphthacene, a picene, a perylene, a pentaphene and an indenoanthracene, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{20}) 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 condensed heteropolycyclic group, and —$Si(Q_{301})(Q_{302})(Q_{303})$ (Q_{301}

to Q_{303} may be 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);

L_{301} may be the same as defined in connection with L_1;

R_{301} may be selected from

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

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;

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 carbazole group, and a triazinyl 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 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;

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

xb2 may be selected from 1, 2, 3, and 4;

In some embodiments, in Formula 301,

L_{301} may be selected from

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, and a chrysenylene group; and

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, 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, a chrysenyl group, and a chrysenyl group;

R_{301} may be selected from

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

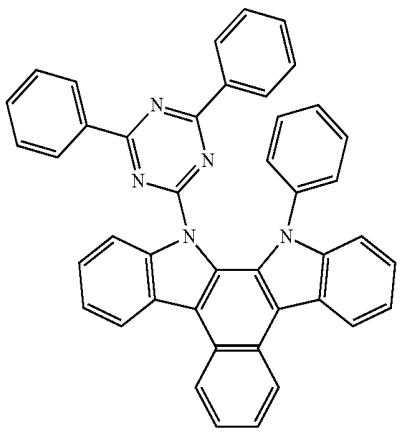
a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic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

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

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 is not limited thereto.

In an implementation, the host may include at least one selected from Compounds H43 to H49 below.

H43



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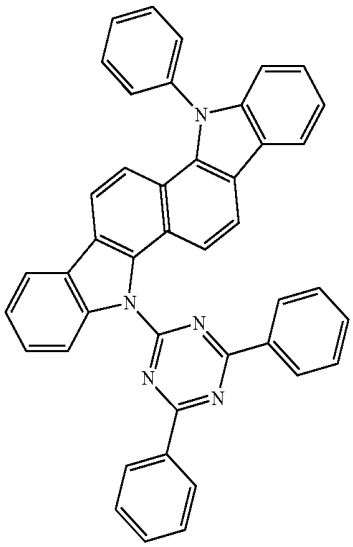
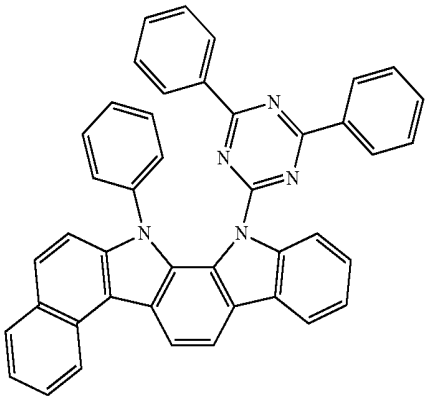
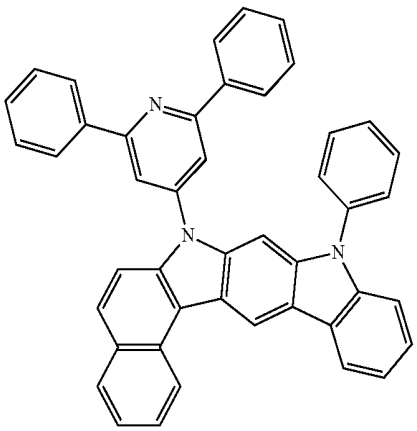
H44



H45



H46



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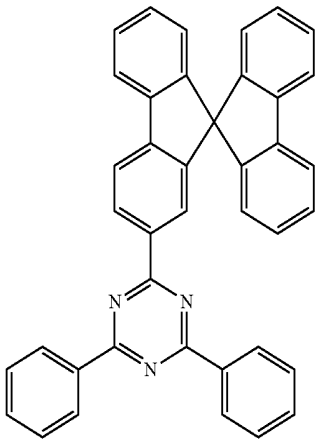
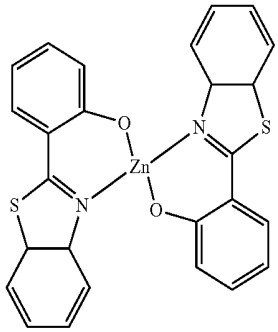
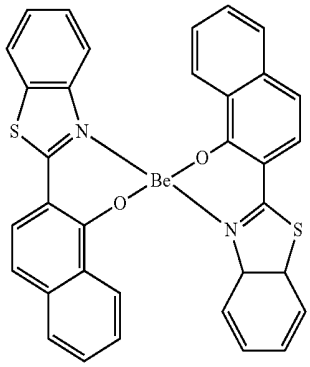
H47



H48



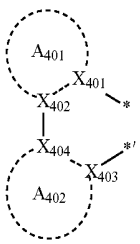
H49



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

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

<Formula 401>



wherein in Formula 401,

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

X_{401} to X_{404} may be each independently nitrogen or carbon;

A_{401} and A_{402} rings may be each independently selected from a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene, a substituted or unsubstituted fluorene, a substituted or unsubstituted spiro-fluorene, a substituted or unsubstituted indene, a substituted or unsubstituted pyrrole, a substituted or unsubstituted thiophene, a substituted or unsubstituted furan, a substituted or unsubstituted imidazole, a substituted or unsubstituted pyrazole, a substituted or unsubstituted thiazole, a substituted or unsubstituted isothiazole, a substituted or unsubstituted oxazole, a substituted or unsubstituted isoxazole, a substituted or unsubstituted pyridine, a substituted or unsubstituted pyrazine, a substituted or unsubstituted pyrimidine, a substituted or unsubstituted pyridazine, a substituted or unsubstituted quinoline, a substituted or unsubstituted isoquinoline, a substituted or unsubstituted benzoquinoline, a substituted or unsubstituted quinoxalaine, a substituted or unsubstituted quinazoline, a substituted or unsubstituted carbazole, a substituted or unsubstituted benzoimidazole, a substituted or unsubstituted benzofuran, a substituted or unsubstituted benzothiophene, a substituted or unsubstituted isobenzothiophene, a substituted or unsubstituted benzoxazole, a substituted or unsubstituted isobenzoxazole, a substituted or unsubstituted triazole, a substituted or unsubstituted oxadiazole, a substituted or unsubstituted triazine, a substituted or unsubstituted dibenzofuran, and a substituted or unsubstituted dibenzothiophene;

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

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

a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_3-C_{10} cycloalkyl group, a C_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, —$N(Q_{401})(Q_{402})$, —$Si(Q_{403})(Q_{404})(Q_{405})$, and —$B(Q_{406})(Q_{407})$;

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;

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, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_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, —$N(Q_{411})(Q_{412})$, —$Si(Q_{413})(Q_{414})(Q_{415})$, and —$B(Q_{416})(Q_{417})$; and

—$N(Q_{421})(Q_{422})$, —$Si(Q_{423})(Q_{424})(Q_{425})$, and —$B(Q_{426})(Q_{427})$;

L_{401} may be an organic ligand;

xc1 may be 1, 2, or 3; and

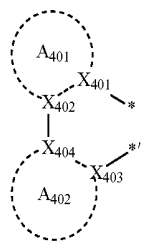
xc2 may be 0, 1, 2, or 3.

L_{401} may be a monovalent, divalent, or trivalent organic ligand. For example, L_{401} may be selected from a halogen ligand (for example, Cl or F), a diketone ligand (for example, acetylacetonate, 1,3-diphenyl-1,3-propandionate, 2,2,6,6-tetramethyl-3,5-heptandionate, or hexafluoroacetonate), a carboxylic acid ligand (for example, picolinate, dimethyl-3-pyrazolecarboxylate, or benzoate), a carbon monooxide ligand, an isonitrile ligand, a cyano ligand, and a phosphorous ligand (for example, phosphine, or phosphite), but is not limited thereto.

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

When A_{402} in Formula 401 has two or more substituents, the two or more substituents of A_{402} may bind to each other to form a saturated or unsaturated ring.

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

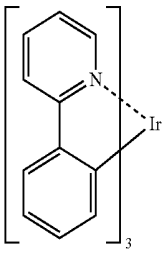


in Formula 401 may be identical or different. When xc1 in Formula 401 is two or more, A_{401} and A_{402} may directly link to A_{401} and A_{402} of a different neighboring ligand or may link to A_{401} and A_{402} of a different neighboring ligand via a

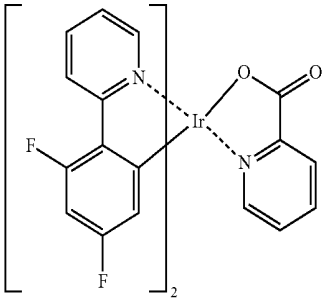
linking group (e.g. a C_1-C_5 alkylene group, —N(R')— (here, R' is a C_1-C_{10} alkyl group or a C_6-C_{20} aryl group) or —C(═O)—) therebetween.

In an implementation, the phosphorescent dopant may include at least one selected from Compounds PD1 to PD74 below:

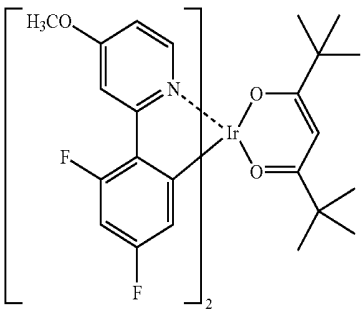
PD1



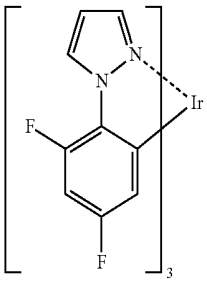
PD2



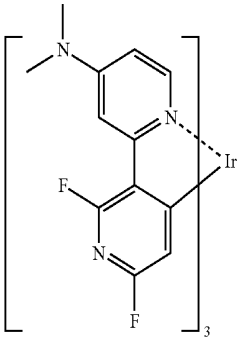
PD3



PD4



PD5



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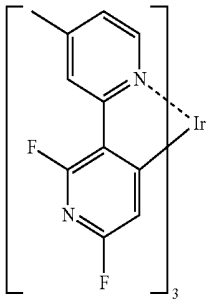

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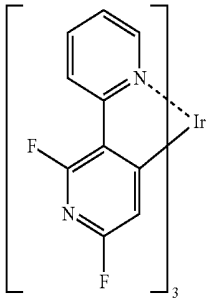

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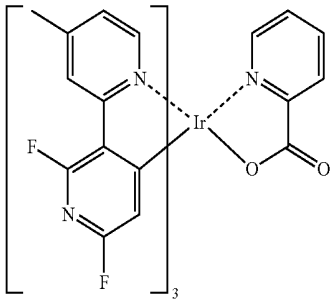

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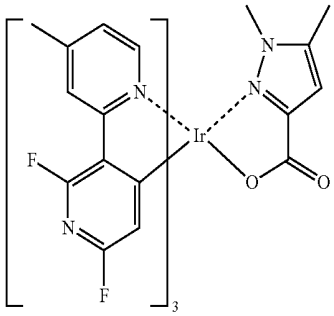

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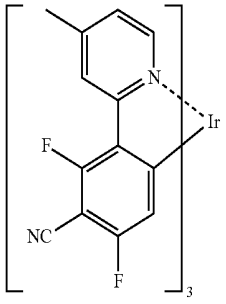

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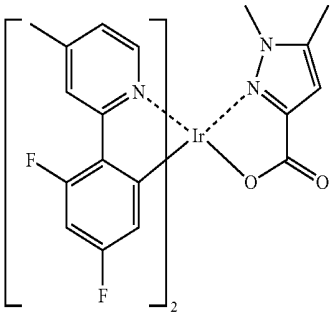

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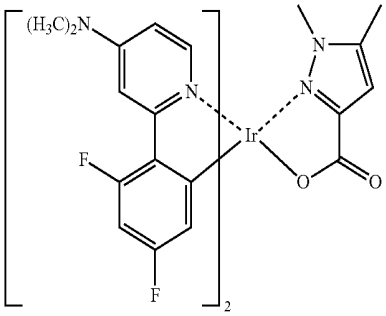

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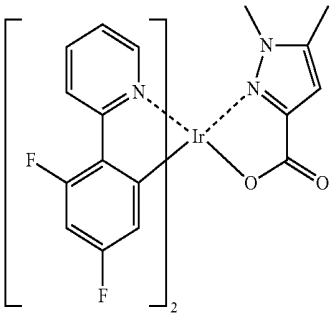

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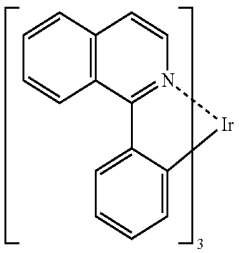

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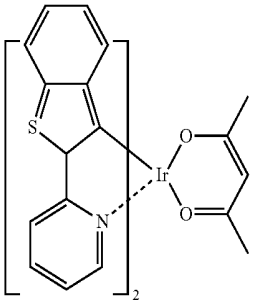

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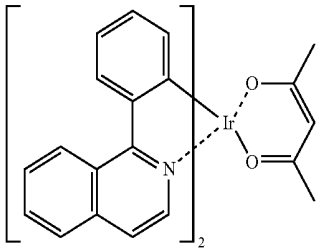
PD16



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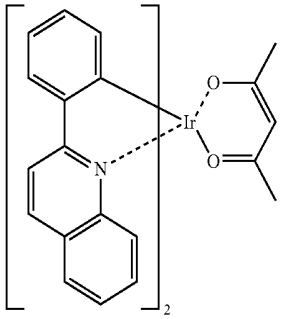

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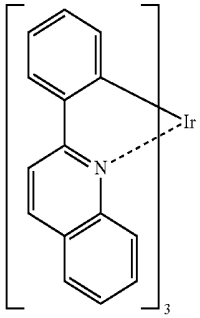

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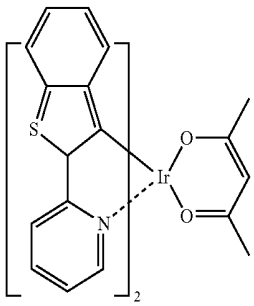

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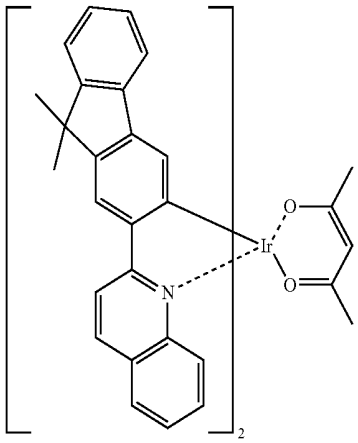

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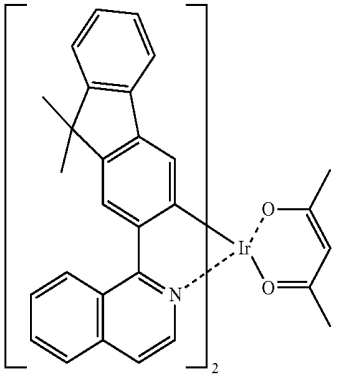

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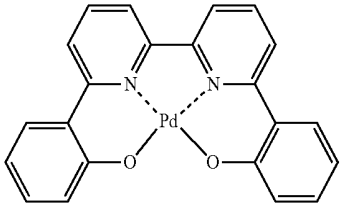

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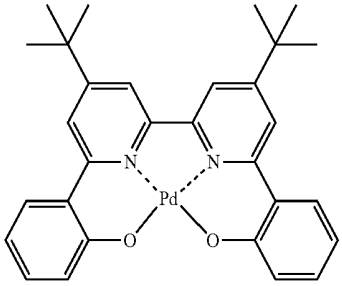

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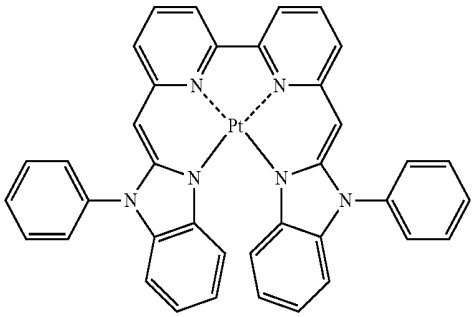
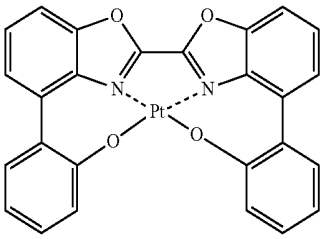


PD25



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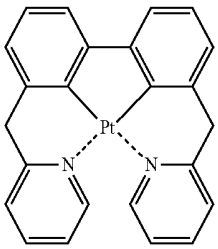

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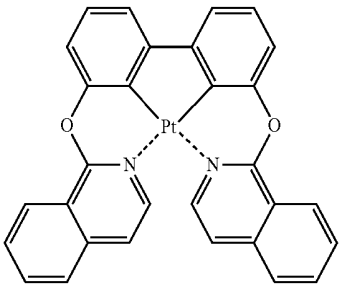
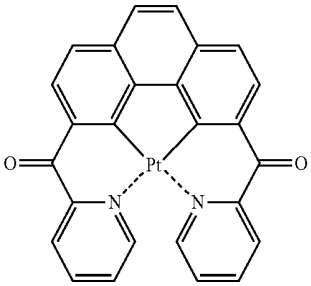
PD27



PD28



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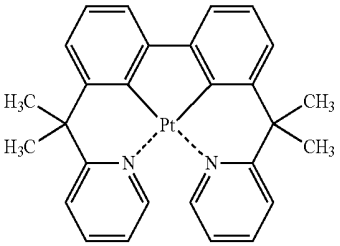

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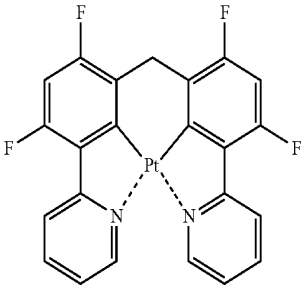

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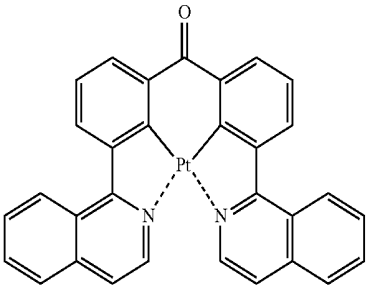

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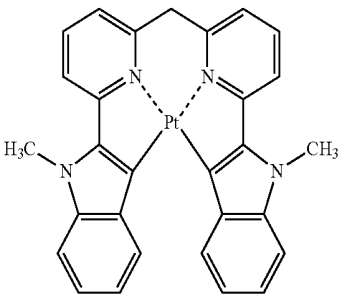

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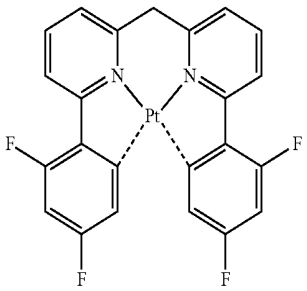
PD33



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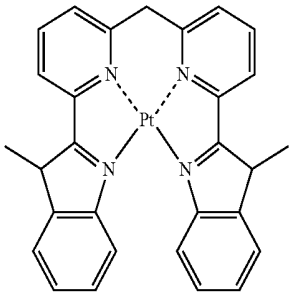

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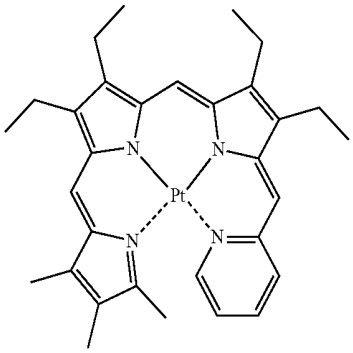

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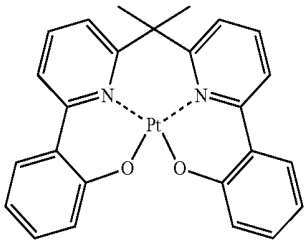

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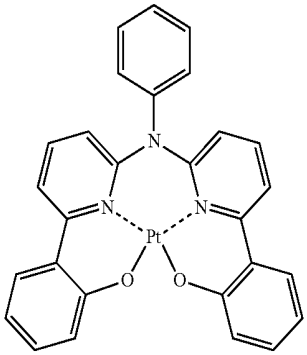

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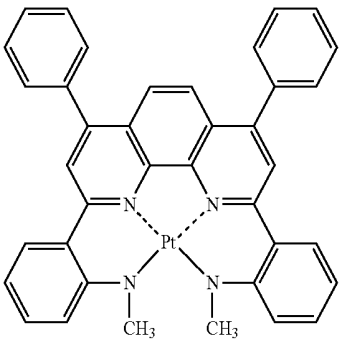
PD38



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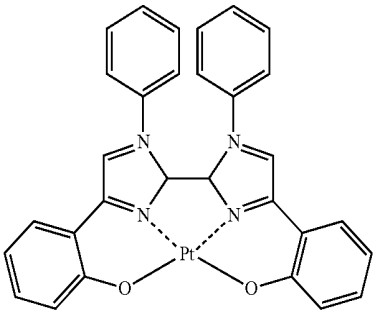

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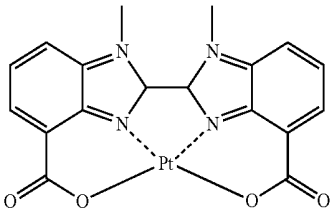

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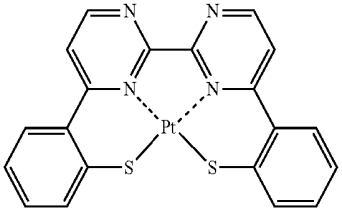
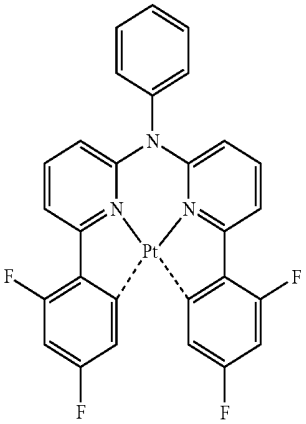


PD42



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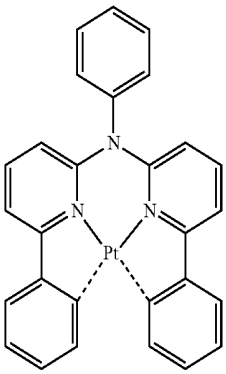
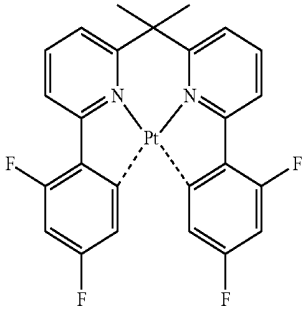
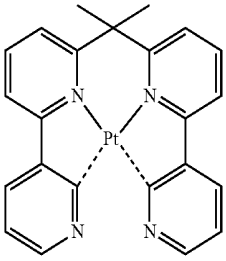
PD43



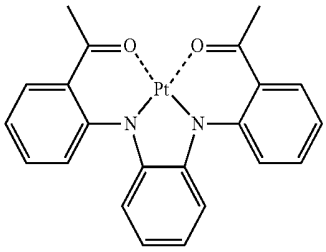
PD44



PD45



PD46



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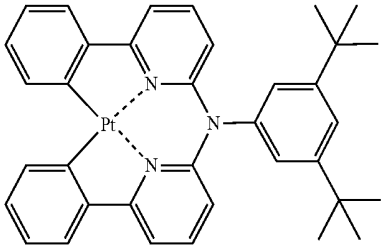
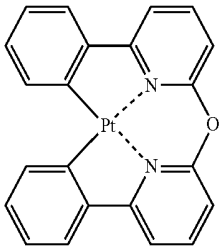


PD48



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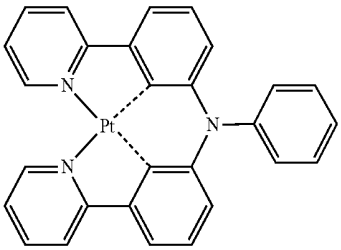
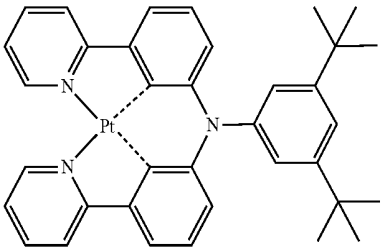
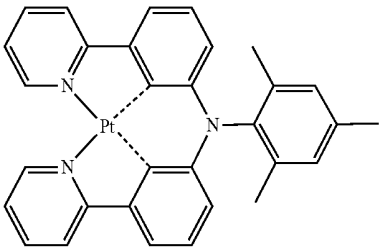
PD49



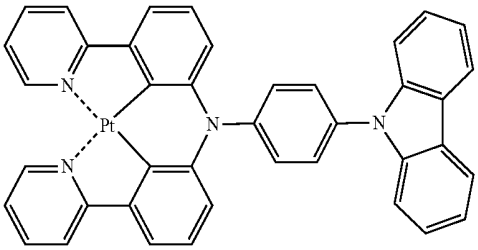
PD50



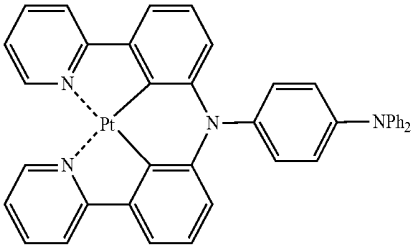
PD51



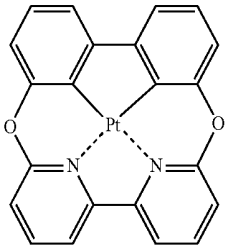
PD52



PD53



PD54



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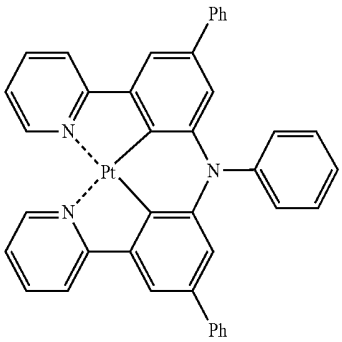
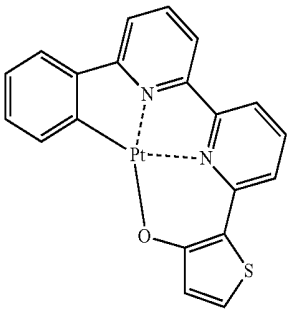
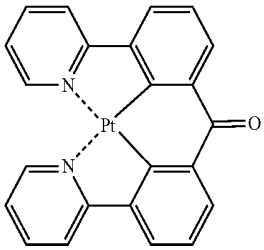
PD55



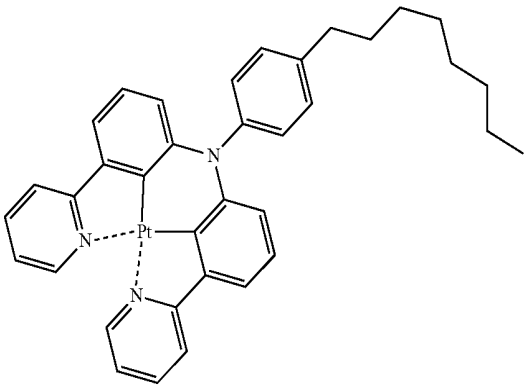
PD56



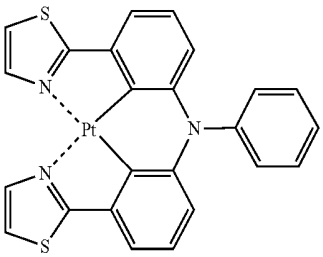
PD57



PD58



PD59



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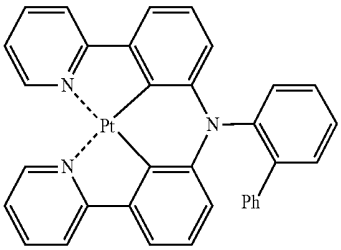
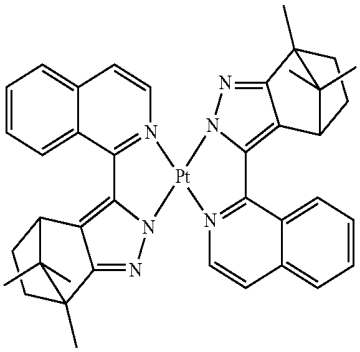
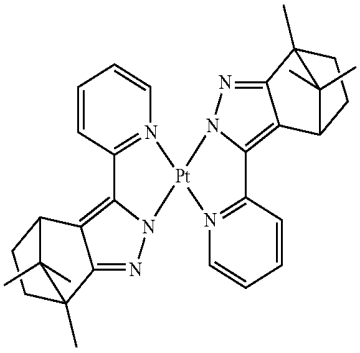
PD60



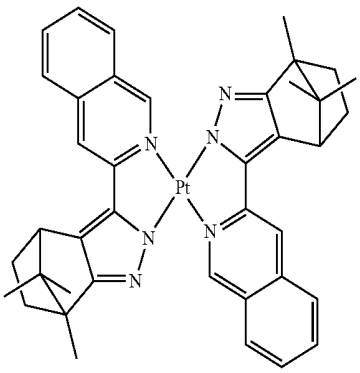
PD61



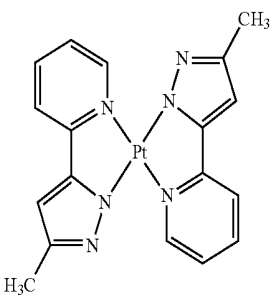
PD62



PD63



PD64



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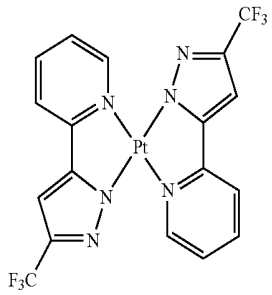
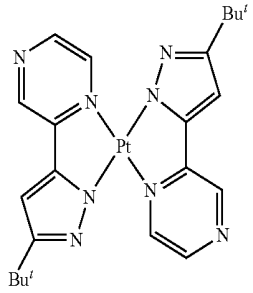
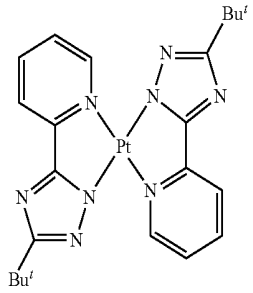
PD65



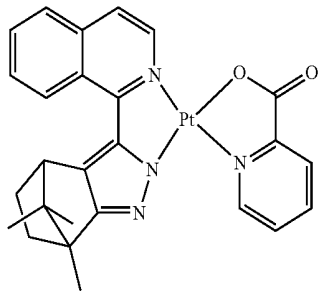
PD66



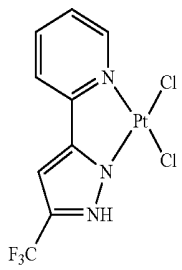
PD67



PD68



PD69



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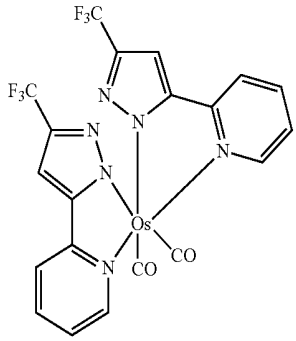
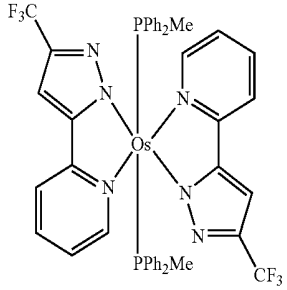
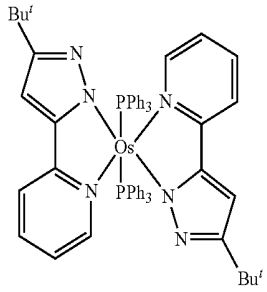
PD70



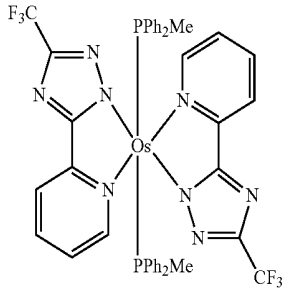
PD71



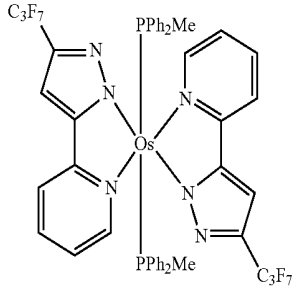
PD72



PD73

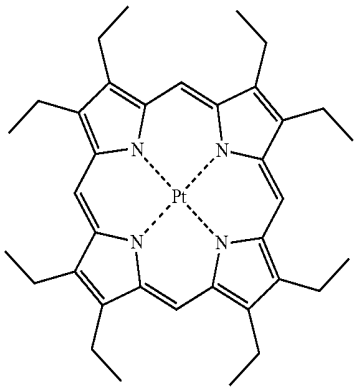


PD74



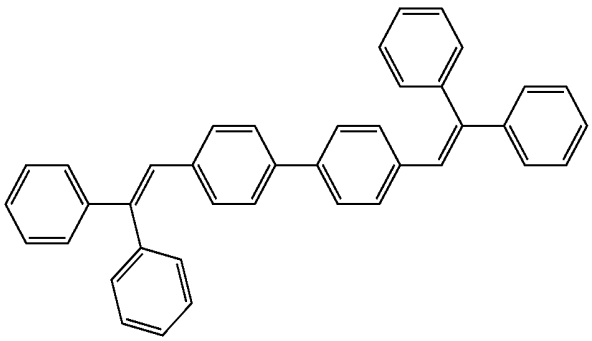
In an implementation, the phosphorescent dopant may include PtOEP below:

PtOEP

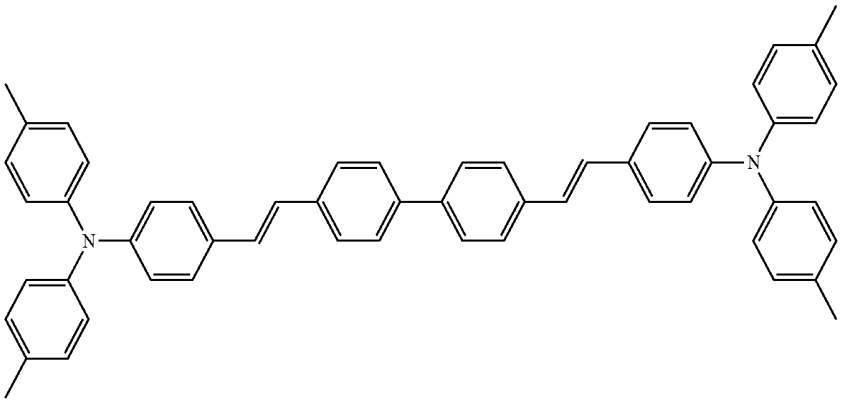


In an implementation, the fluorescent dopant may include at least one selected from DPAVBi, BDAVBi, TBPe, DCM, DCJTB, Coumarin 6, and C545T.

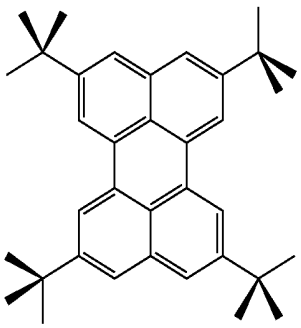
DPVBi



DPAVBi



TBPe



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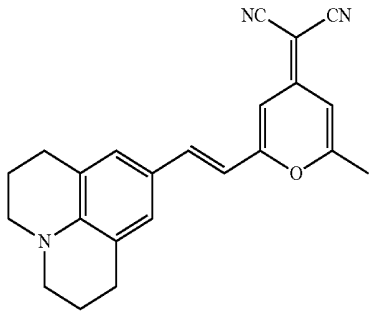
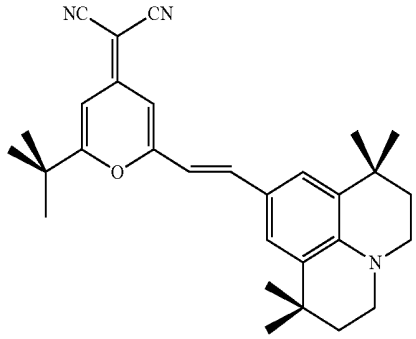
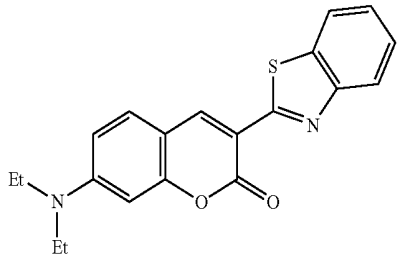
DCM



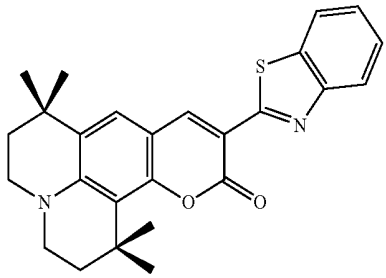
DCJTB



Coumarin 6

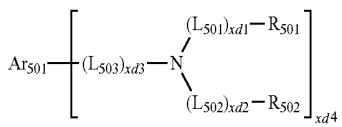


C545T



In an implementation, the fluorescent dopant may include a compound represented by Formula 501:

<Formula 501>



wherein in Formula 501,

Ar_{501} may be selected from a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene and an indenoanthracene, each substituted with at least one selected from 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_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, and —$Si(Q_{501})(Q_{502})(Q_{503})$($Q_{501}$ to

Q_{503} may be 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);

L_{501} to L_{503} may be each the same as defined in connection with L_{201} provided herein;

R_{501} and R_{502} may be each independently selected from 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 carbazole group, a triazinyl group, a dibenzofuranyl group and a dibenzothiophenyl 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 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;

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

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

An amount of the dopant in the emission layer may be, e.g., 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.

A thickness of the emission layer may be in a range of about 100 Å to about 1,000 Å, e.g., about 200 Å to about 600 Å. When the thickness of the emission layer is within this range, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

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

The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer (ETL), and an electron injection layer.

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, wherein layers of each structure are sequentially stacked from the emission layer in the stated order, but is not limited thereto.

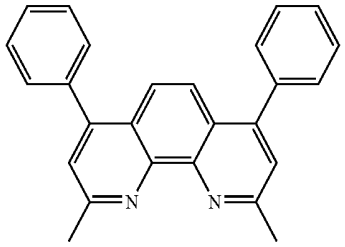
In an implementation, the organic layer **150** of the organic light-emitting device may include an electron transport region disposed between the emission layer and the second electrode **190**.

The electron transport transport region may include a hole blocking layer. The hole blocking layer may be formed, when the emission layer includes a phosphorescent dopant, to help prevent diffusion of excitons or holes into an electron transport layer.

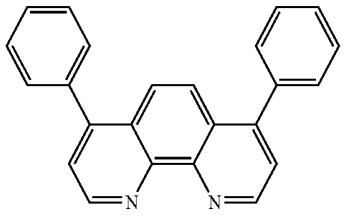
When the electron transport region includes a hole blocking layer, the hole blocking layer may be formed on the emission layer by using various methods, e.g., vacuum deposition, spin coating casting, a LB method, ink-jet printing, laser-printing, or laser-induced thermal imaging. When the hole blocking layer is formed by vacuum deposition or spin coating, deposition and coating conditions for the hole blocking layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

The hole blocking layer may include, e.g., at least one selected from BCP and Bphen.

BCP



Bphen



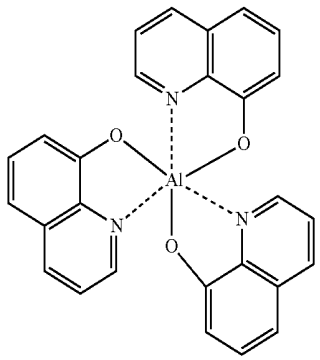
A thickness of the hole blocking layer may be in a range of about 20 Å to about 1,000 Å, e.g., about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within this range, excellent hole blocking characteristics may be obtained without a substantial increase in driving voltage.

The electron transport region may include an electron transport layer. The electron transport layer may be formed on the emission layer or the hole blocking layer by using various methods, e.g., vacuum deposition, spin coating casting, a LB method, ink-jet printing, laser-printing, or laser-induced thermal imaging. When an electron transport layer is formed by vacuum deposition or spin coating, vacuum deposition and coating conditions for the electron transport layer may be determined by referring to the vacuum deposition and coating conditions for the hole injection layer.

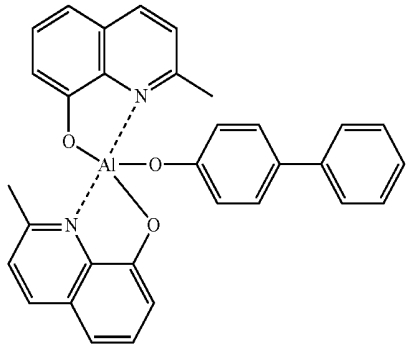
In an implementation, the organic layer **150** of the organic light-emitting device may include an electron transport region disposed between the emission layer and the second electrode **190**. The electron transport region may include at least one selected from an electron transport layer and an electron injection layer.

In an implementation, the electron transport layer may include at least one selected from BCP, Bphen, Alq_3, BAlq, and NTAZ.

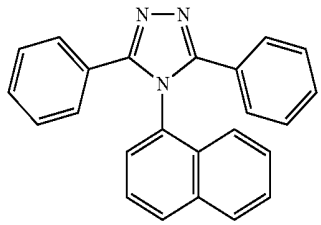
Alq3



BAlq



NTAZ



In an implementation, 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:

$$Ar_{601}\text{-}[(L_{601})_{xe1}\text{-}E_{601}]_{xe2} \quad \text{<Formula 601>}$$

wherein in Formula 601,

Ar_{601} may be selected from

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

a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene and an indenoanthracene, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a 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 condensed heteropolycyclic group, and —$Si(Q_{301})(Q_{302})(Q_{303})$ (Q_{301} to Q_{303} may be 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);

L_{601} may be the same as defined in connection with L_{201};

E_{601} may be selected from

a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a 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, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

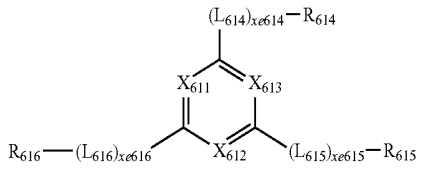
a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a 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, 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 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, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

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

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

<Formula 602>



wherein in Formula 602,

X_{611} may be N or C-$(L_{611})_{xe611}$-R_{611}, X_{612} may be N or C-$(L_{612})_{xe612}$-R_{612}, X_{613} may be N or C-$(L_{613})_{xe613}$-R_{613}, and at least one selected from X_{611} to X_{613} may be N;

L_{611} to L_{616} may be each the same as defined in connection with L_{201} provided herein;

R_{611} to R_{616} may be each independently selected from

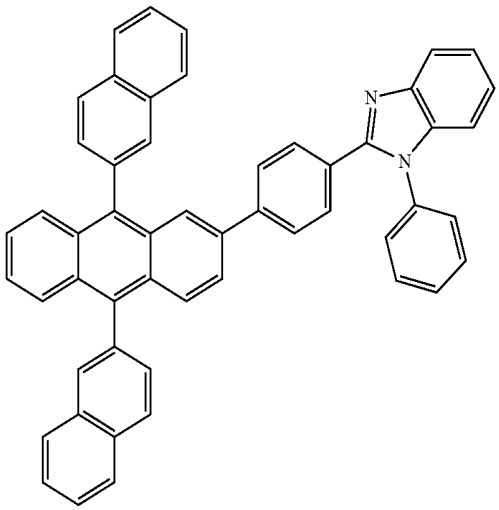
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl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

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;

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

In an implementation, the compound represented by Formula 601 and the compound represented by Formula 602 may each be selected from Compounds ET1 to ET15 illustrated below:

ET1



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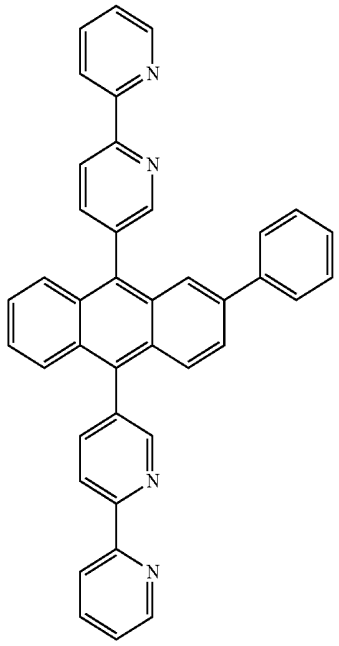
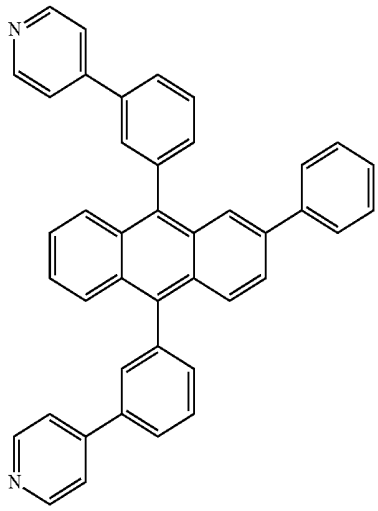
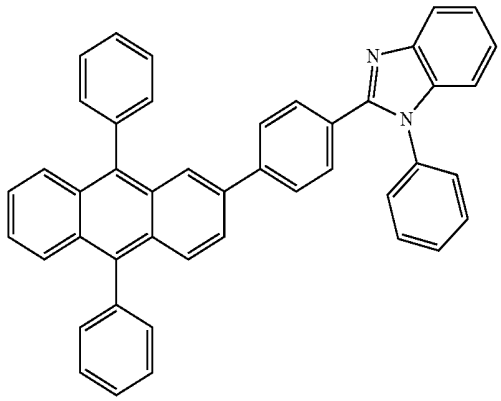
ET2



ET3



ET4



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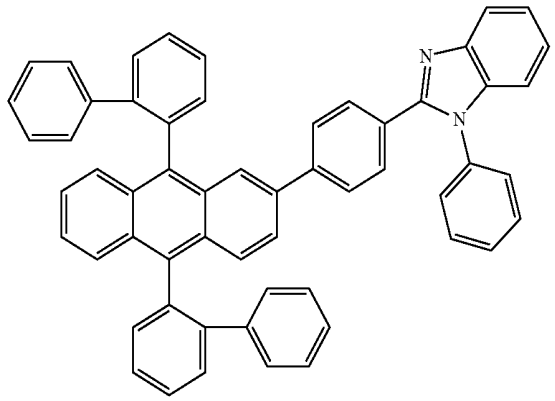
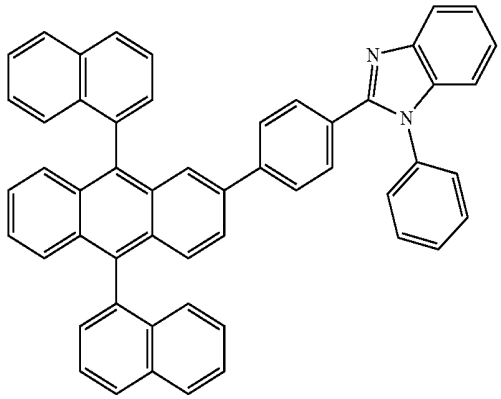
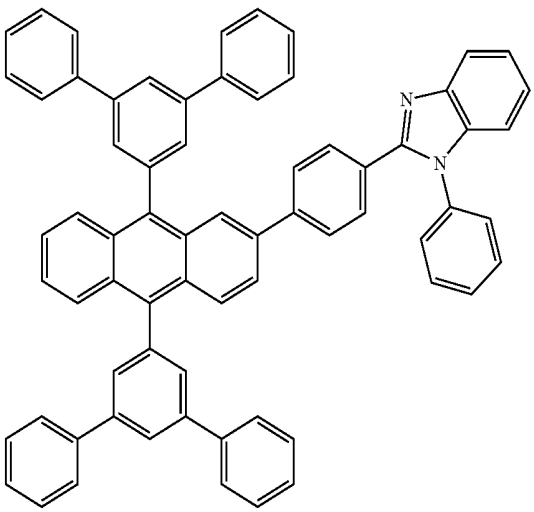
ET5



ET6



ET7



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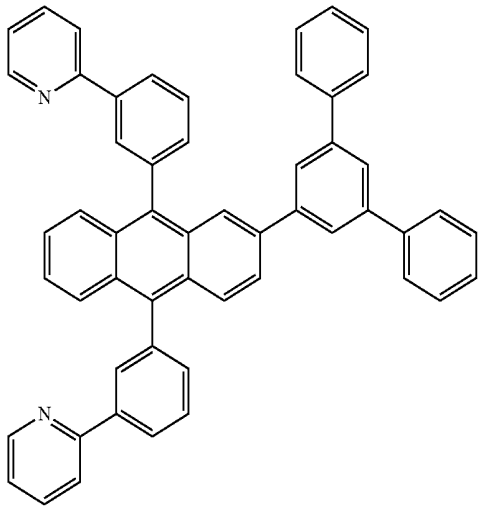
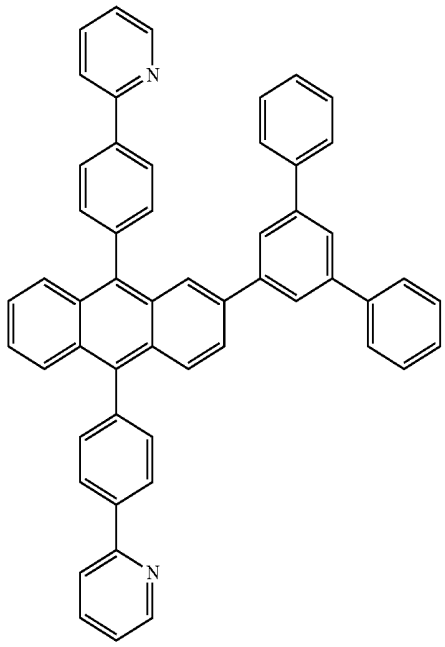
ET8



ET9



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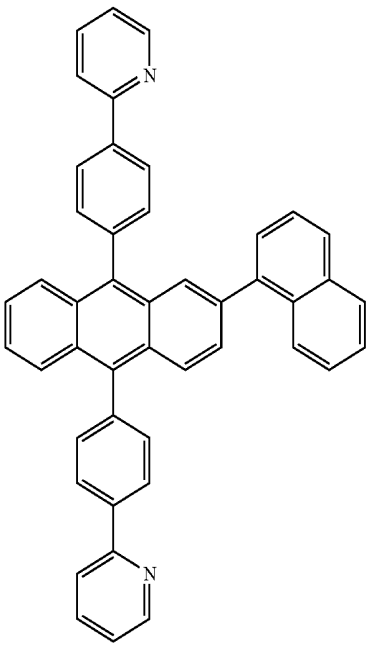
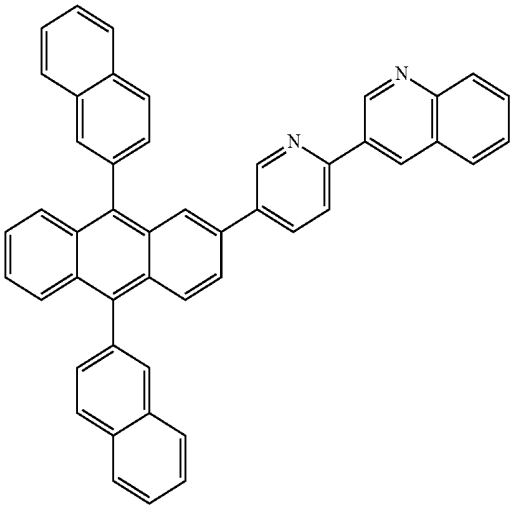
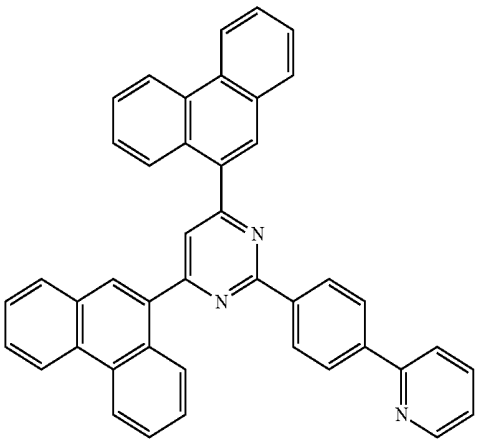
ET10



ET11



ET12



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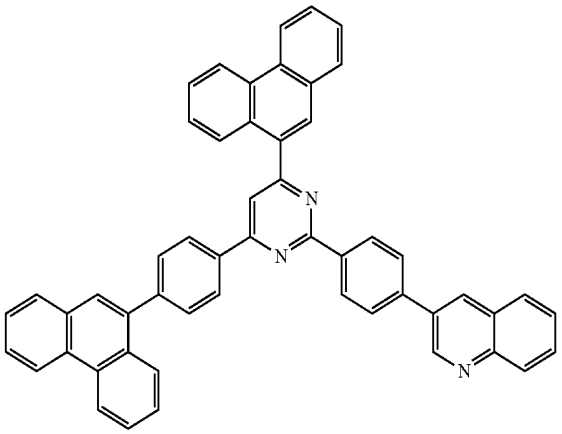
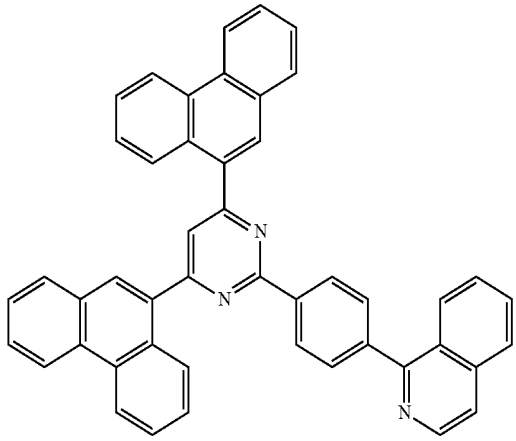
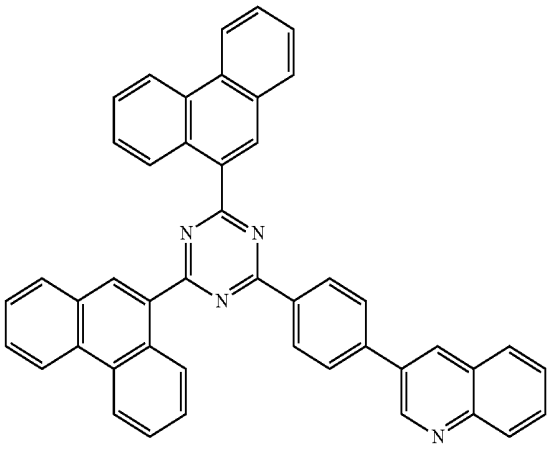
ET13



ET14



ET15

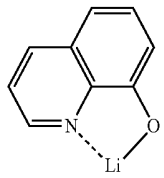


A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, e.g., about 150 Å to about 500 Å. When the thickness of the electron transport layer is within this range, excellent electron transport characteristics may be obtained without a substantial increase in driving voltage.

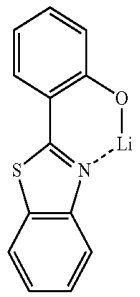
In an implementation, the electron transport layer may further include a metal-containing material in addition to the materials described above.

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



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

The electron injection layer may be formed on the electron transport layer by using various methods, e.g., vacuum deposition, spin coating, casting, a LB method, ink-jet printing, laser-printing, or laser-induced thermal imaging. When an electron injection layer is formed by vacuum deposition or spin coating, vacuum deposition and coating conditions for the electron injection layer may be determined by referring to the vacuum deposition and coating conditions for the hole injection layer.

In an implementation, the electron injection layer may include at least one selected from, LiF, NaCl, CsF, Li_2O, BaO, and LiQ.

A thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, e.g., about 3 Å to about 90 Å. When the thickness of the electron injection layer is within this range, excellent electron injection characteristics may be obtained without a substantial increase in driving voltage.

The second electrode **190** may be disposed on the organic layer **150**. The second electrode **190** may be a cathode that is an electron injection electrode, and in this regard, a material for forming the second electrode **190** may be a material having a low work function, and such a material may be metal, alloy, an electrically conductive compound, or a mixture thereof. Examples of materials for the second electrode **190** may include lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag). In an implementation, the material for forming the second electrode **190** may be ITO or IZO. The second electrode **190** may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode.

Hereinbefore, the organic light-emitting device has been described with reference to the FIGURE.

A C_1-C_{60} alkyl group used herein refers to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms, and detailed examples thereof are such as a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an iso-amyl group, or a hexyl group. A C_1-C_{60} alkylene group used herein refers to a divalent group having the same structure as a C_1-C_{60} alkyl group.

A C_1-C_{60} alkoxy group used herein refers to a monovalent group represented by —OA_{101} (wherein A_{101} is the C_1-C_{60} alkyl group), and detailed examples thereof are such as a methoxy group, an ethoxy group, or an isopropyloxy group.

A C_2-C_{60} alkenyl group used herein refers to a hydrocarbon group formed by substituting at least one carbon double bond in the middle or terminal of the C_2-C_{60} alkyl group, and detailed examples thereof are such as an ethenyl group, a propenyl group, or a butenyl group. A C_2-C_{60} alkenylene group used herein refers to a divalent group having the same structure as a C_2-C_{60} alkenyl group.

A C_2-C_{60} alkynyl group used herein refers to a hydrocarbon group formed by substituting at least one carbon triple bond in the middle or terminal of the C_2-C_{60} alkyl group, and detailed examples thereof are such as an ethynyl group or a propynyl group. A C_2-C_{60} alkynylene group used herein refers to a divalent group having the same structure as a C_2-C_{60} alkynyl group.

A C_3-C_{10} cycloalkyl group used herein refers to a monovalent monocyclic saturated hydrocarbon group including 3 to 10 carbon atoms, and detailed examples thereof are such as a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, or a cycloheptyl group. A C_3-C_{10} cycloalkylene group used herein refers to a divalent group having the same structure as a C_3-C_{10} cycloalkyl group.

A C_1-C_{10} heterocycloalkyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 1 to 10 carbon atoms, and detailed examples thereof are such as a tetrahydrofuranyl group, or a tetrahydrothiophenyl group. A C_1-C_{10} heterocycloalkylene group used herein refers to a divalent group having the same structure as a C_1-C_{20} heterocycloalkyl group.

A C_3-C_{10} cycloalkenyl group used herein refers to a monovalent monocyclic group including 3 to 10 carbon atoms and at least one double bond in the ring thereof and does not have aromacity, and detailed examples thereof are such as a cyclopentenyl group, a cyclohexenyl group, or a cycloheptenyl group. A C_3-C_{10} cycloalkenylene group used herein refers to a divalent group having the same structure as a C_3-C_{10} cycloalkenyl group.

A C_1-C_{10} heterocycloalkenyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, P, and S as a ring-forming atom, 1 to 10 carbon atoms, and at least one double bond in its ring. Detailed examples of the C_1-C_{10} heterocycloalkenyl group are such as a 2,3-hydrofuranyl group or a 2,3-hydrothiophenyl group. A C_1-C_{10} heterocycloalkenylene group used herein refers to a divalent group having the same structure as a C_1-C_{10} heterocycloalkenyl group.

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

A C_1-C_{60} heteroaryl group used herein refers to a monovalent group having a carbocyclic aromatic system including at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 1 to 60 carbon atoms. A C_1-C_{60} heteroarylene group used herein refers to a divalent group having a carbocyclic aromatic system including at least one hetero atom selected from N, O, P, and S as a ring-forming

atom and 1 to 60 carbon atoms. Detailed examples of the C_1-C_{60} heteroaryl group are such as a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, or an isoquinolinyl group. When the C_1-C_{60} heteroaryl group and the C_1-C_{60} heteroarylene group each include two or more rings, the rings may be fused to each other.

A C_6-C_{60} aryloxy group used herein indicates —OA_{102} (wherein A_{102} is the C_6-C_{60} aryl group), and a C_6-C_{60} arylthio group used herein indicates —SA_{103} (wherein A_{103} is the C_6-C_{60} aryl group).

A monovalent non-aromatic condensed polycyclic group 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 a ring forming atom, and non-aromacity in the entire molecular structure. A detailed example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. A divalent non-aromatic condensed polycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

A monovalent non-aromatic condensed heteropolycyclic group used herein refers to a monovalent group (for example, having 1 to 60 carbon atoms) that has two or more rings condensed to each other, has a hetero atom selected from N, O, P, and S, other than carbon atoms, as a ring forming atom, and has non-aromacity in the entire molecular structure. A detailed example of the monovalent non-aromatic condensed heteropolycyclic group is a carbazolyl group. A divalent non-aromatic condensed hetero-polycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

As used herein, 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 a divalent non-aromatic condensed heteropolycyclic 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_1-C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from

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

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

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;

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

—$Si(Q_{31})(Q_{32})(Q_{33})$, —$B(Q_{34})(Q_{35})$, and —$N(Q_{26})(Q_{27})$;

wherein Q_{11} to Q_{17}, Q_{21} to Q_{27}, and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_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.

For example, 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 a divalent non-aromatic condensed heteropolycyclic 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_1-C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from

a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a

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

a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a 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, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, —$Si(Q_{11})(Q_{12})(Q_{13})$, —$B(Q_{14})(Q_{15})$, and —$N(Q_{16})(Q_{17})$;

a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a 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, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group,

a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a 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, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, $—Si(Q_{21})(Q_{22})(Q_{23})$, $—B(Q_{24})(Q_{25})$, and $—N(Q_{26})(Q_{27})$; and

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

wherein Q_{11} to Q_{17}, Q_{21} to Q_{27}, and Q_{31} to Q_{37} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a 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, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

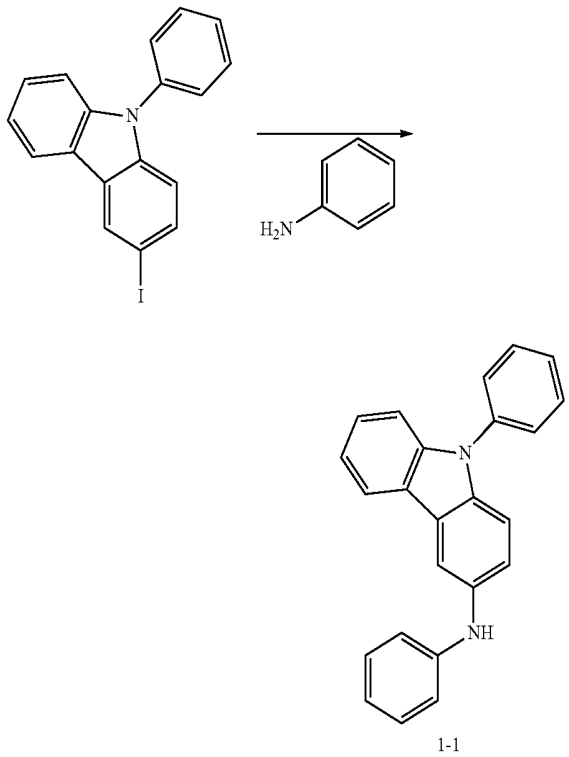
"Ph" used herein refers to a phenyl group, "Me" refers to a methyl group, "Et" refers to an ethyl group, and "ter-Bu" or "But" refers to a tert-butyl group.

Hereinafter, an organic light-emitting device according to an embodiment will be described in detail with reference to Synthesis Examples and Examples. The wording "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.

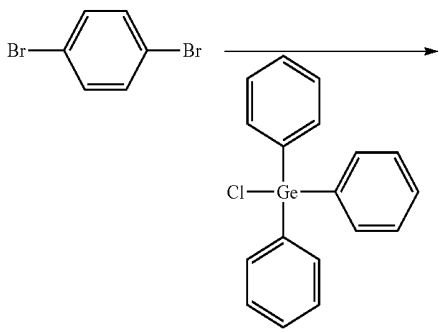
The following Examples and Comparative Examples are provided in order to highlight characteristics of one or more embodiments, but it will be understood that the Examples and Comparative Examples are not to be construed as limiting the scope of the embodiments, nor are the Comparative Examples to be construed as being outside the scope of the embodiments. Further, it will be understood that the embodiments are not limited to the particular details described in the Examples and Comparative Examples.

EXAMPLE

Synthesis Example 1: Synthesis of Compound 1



1-1



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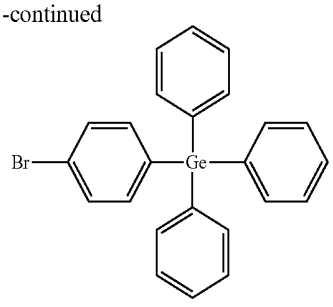
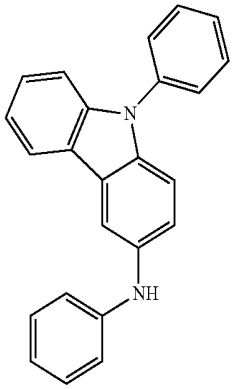


1-2



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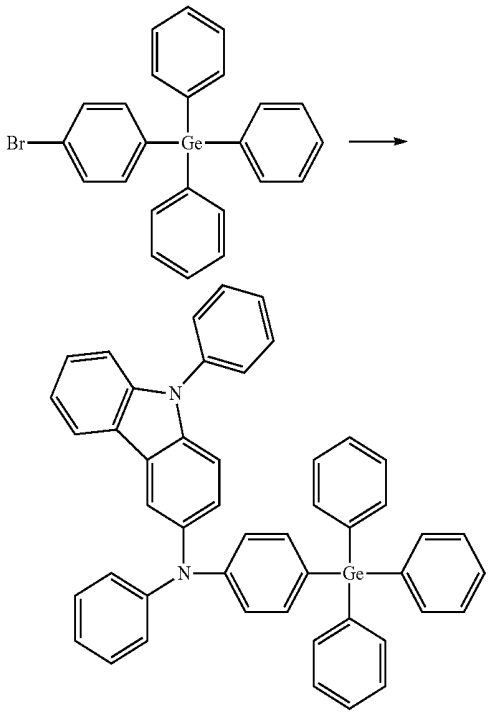


1

Synthesis of Intermediate 1-1

3.69 g (10.0 mmol) of 3-iodo-9-phenylcarbazole, 1.11 g (12.0 mmol) of aniline, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the reaction solution was stirred at 90° C. for 3 hours. When the reaction stopped, the solution was cooled to ambient temperature, and distilled water was added thereto, and then an organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 2.34 g (yield of 70%) of Intermediate 1-1.

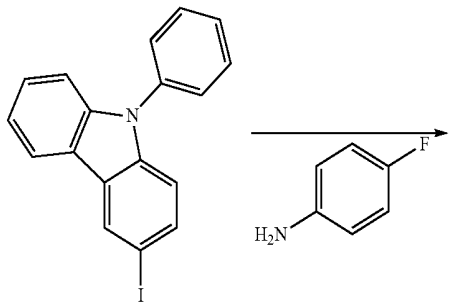
Synthesis of Intermediate 1-2

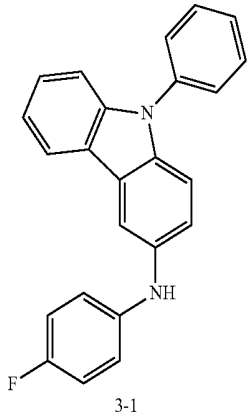
2.35 g (10 mmol) of dibromophenyl was dissolved in 30 mL of tetrahydrofuran (THF), and then 4 mL of n-BuLi (2.5 M in hexane) was added thereto at −78° C. After 1 hour, a solution of 3.39 g (10 mmol) of triphenylgermanium chloride dissolved in 5 mL of THF was slowly added thereto at −78° C. The reaction solution was stirred at ambient temperature for 5 hours, and distilled water was added thereto, and then the reaction solution was washed three times with 30 mL of diethyl ether. The washed diethyl ether layer was dried by using $MgSO_4$, and then distilled under reduced pressure. The residue was separated and purified by silica gel column chromatography to obtain 3.7 g (yield of 81%) of Intermediate 1-2.

Synthesis of Compound 1

2.0 g (6.0 mmol) of Intermediate 1-1, 3.7 g (8.0 mmol) of Intermediate 1-2, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the reaction solution was stirred at 90° C. for 3 hours. When the reaction stopped, the solution was cooled to ambient temperature, and distilled water was added thereto, and then an organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 3.2 g (yield of 75%) of Compound 1. The obtained compound was identified by HR-MS and NMR.

Synthesis Example 2: Synthesis of Compound 3





3-1

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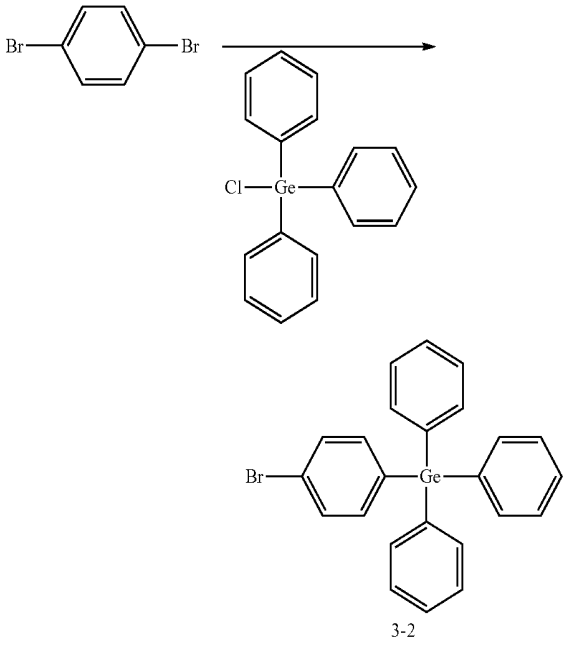
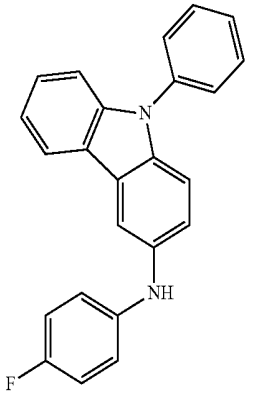
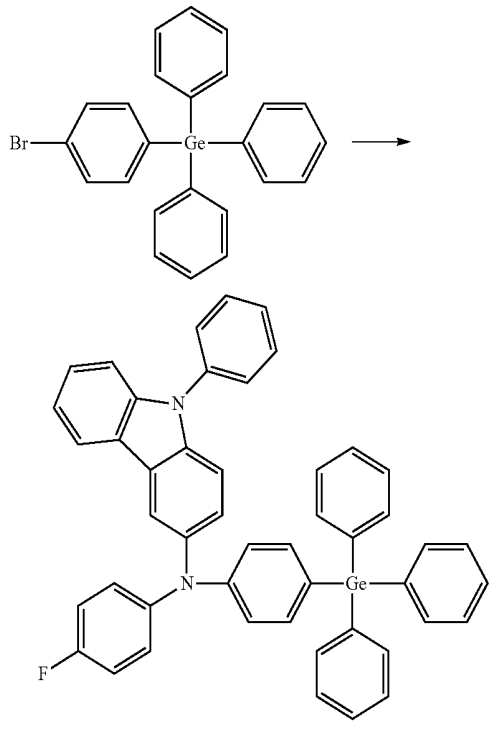


3-2





3

Synthesis of Intermediate 3-1

3.69 g (10.0 mmol) of 3-iodo-9-phenylcarbazole, 1.33 g (12.0 mmol) of 4-fluoroaniline, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the reaction solution was stirred at 90° C. for 3 hours. When the reaction stopped, the solution was cooled to ambient temperature, and distilled water was added thereto, and then an organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 2.13 g (yield of 60%) of Intermediate 3-1.

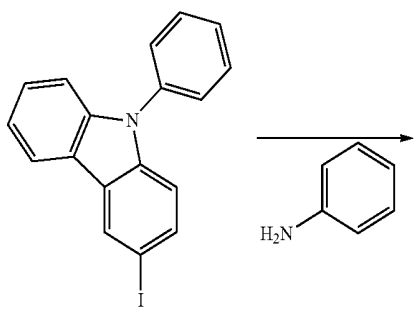
Synthesis of Intermediate 3-2

2.35 g (10 mmol) of dibromophenyl was dissolved in 30 mL of tetrahydrofuran (THF), and then 4 mL of n-BuLi (2.5 M in hexane) was added thereto at −78° C. After 1 hour, a solution of 3.39 g (10 mmol) of triphenylgermanium chloride dissolved in 5 mL of THF was slowly added thereto at −78° C. The reaction solution was stirred at ambient temperature for 5 hours, and distilled water was added thereto, and then the reaction solution was washed three times with 30 mL of diethylether. The washed diethylether layer was dried by using $MgSO_4$, and then distilled under reduced pressure. The residue was separated and purified by silica gel column chromatography to obtain 3.7 g (yield of 81%) of Intermediate 3-2.

Synthesis of Compound 3

2.0 g (6.1 mmol) of Intermediate 3-1, 3.7 g (8.0 mmol) of Intermediate 3-2, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the result was stirred at 90° C. for 3 hours. When the reaction stopped, a reaction solution was cooled to ambient temperature, and distilled water was added thereto, and then an organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 3.0 g (yield of 68%) of Compound 3. The obtained compound was identified by HR-MS and NMR.

Synthesis Example 3: Synthesis of Compound 94



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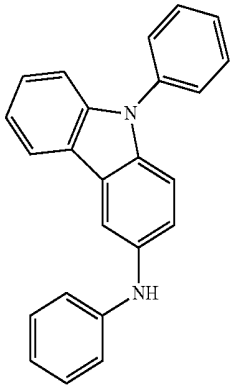
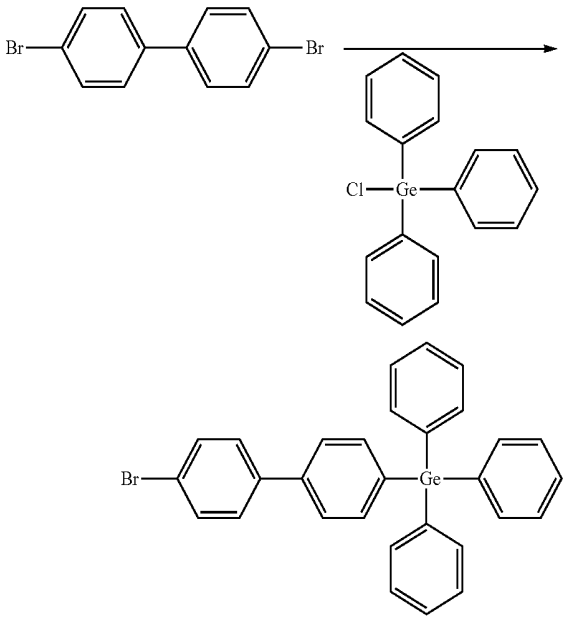
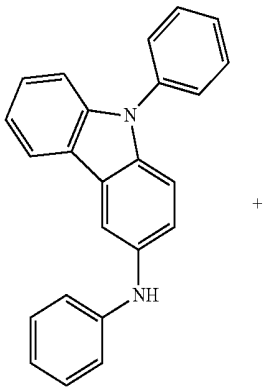


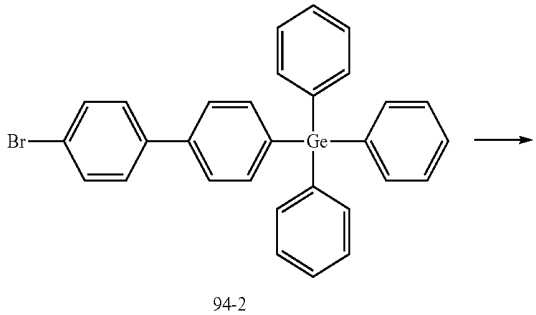
94-1



94-2



94-1



94-2

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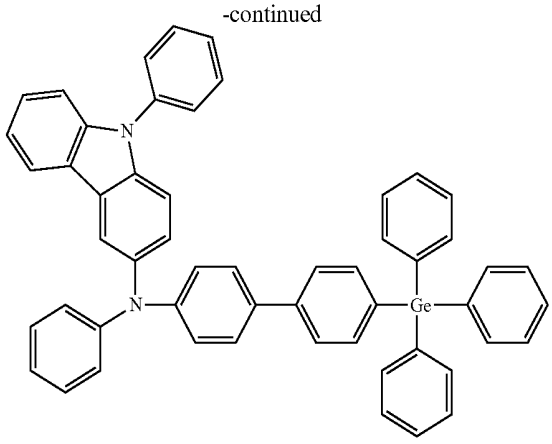


94

Synthesis of Intermediate 94-1

3.69 g (10.0 mmol) of 3-iodo-9-phenylcarbazole, 1.11 g (12.0 mmol) of aniline, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the reaction solution was stirred at 90° C. for 3 hours. When the reaction stopped, the solution was cooled to ambient temperature, and distilled water was added thereto, and then an organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 2.17 g (yield of 65%) of Intermediate 94-1.

Synthesis of Intermediate 94-2

3.12 g (10 mmol) of dibromobiphenyl was dissolved in 30 mL of tetrahydrofuran (THF), and then 4 mL of n-BuLi (2.5 M in hexane) was added thereto at −78° C. After 1 hour, 3.39 g (10 mmol) of triphenylgermanium chloride dissolved in 5 mL of THF was slowly added thereto at −78° C. A reaction solution was stirred at ambient temperature for 5 hours, and distilled water was added thereto, and then the solution was washed three times with 30 mL of diethylether. The washed diethylether layer was dried by using $MgSO_4$, and then distilled under reduced pressure. The residue was separated and purified by silica gel column chromatography to obtain 4.2 g (yield of 78%) of Intermediate 94-2.

Synthesis of Compound 94

2.0 g (6.0 mmol) of Intermediate 94-1, 4.2 g (7.8 mmol) of Intermediate 94-2, 2.88 g (30.0 mmol) of t-BuONa, 183 mg (0.2 mmol) of $Pd_2(dba)_3$, and 40 mg (0.2 mmol) of $P(t\text{-}Bu)_3$ were dissolved in 40 mL of toluene, and the reaction solution was stirred at 90° C. for 3 hours. When the reaction stopped, the solution was cooled to ambient temperature, and distilled water was added thereto, and then an

organic layer was extracted three times by using 40 mL of diethyl ether. The obtained organic layer was dried by using $MgSO_4$, and then a solvent was removed therefrom by distillation. The residue was separated and purified by silica gel column chromatography to obtain 3.4 g (yield of 72%) of Compound 94. The obtained compound was identified by HR-MS and NMR.

Compounds 1, 3, and 94 (synthesized in Synthesis Examples 1 to 3) were identified by 1H NMR and MS/FAB. Results thereof are shown in Table 1 below.

TABLE 1

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.
1	8.2(d, 1H), 7.62(ddd, 3H), 7.61(dd, 6H), 7.60(dd, 6H), 7.59(dd, 6H), 7.58(t, 6H), 7.50(d, 1H), 7.49(ttt, 4H), 7.48(s, 1H), 7.47(tt, 2H), 7.42(t, 1H), 7.40(t, 1H), 7.39(d, 1H), 7.38(t, 1H), 7.37(t, 1H), 7.35(t, 1H), 7.31(t, 1H), 7.30(d, 1H), 7.28(t 1H), 7.26(t, 1H), 7.25(d, 1H), 6.90(d, 1H), 6.67(t, 1H), 6.32(t, 1H), 6.25(t, 1H), 6.23(t, 1H)	713.52	713.46
3	8.2(d, 1H), 7.62(ddd, 3H), 7.61(dd, 6H), 7.60(dd, 6H), 7.59(dd, 6H), 7.58(t, 6H), 7.50(d, 1H), 7.49(ttt, 4H), 7.48(s, 1H), 7.47(tt, 2H), 7.42(t, 1H), 7.40(t, 1H), 7.39(d, 1H), 7.38(t, 1H), 7.37(t, 1H), 7.35(t, 1H), 7.31(t, 1H), 7.30(d, 1H), 7.28(t 1H), 7.26(t, 1H), 7.25(d, 1H), 7.12(t, 1H), 7.10(t, 1H), 7.08(d, 1H), 6.63(d, 1H), 6.60(d, 1H), 6.57(d, 1H), 6.66(d, 1H), 6.66(d, 1H), 6.53(d, 1H), 6.52(d, 1H), 6.40(d, 1H), 6.39(dd, 1H), 6.37(d, 1H), 6.36(d 1H), 6.29 (t, 1H), 6.27(t, 1H), 6.10(d, 1H)	731.50	731.45
94	8.2(d, 1H), 7.62(ddd, 3H), 7.61(dd, 6H), 7.60(dd, 6H), 7.59(dd, 6H), 7.58(t, 6H), 7.50(d, 1H), 7.49(ttt, 4H), 7.48(s, 1H), 7.47(tt, 2H), 7.42(t, 1H), 7.40(t, 1H), 7.39(d, 1H), 7.38(t, 1H), 7.37(t, 1H), 7.35(t, 1H), 7.31(t, 1H), 7.30(d, 1H), 7.28(t 1H), 7.26(t, 1H), 7.25(d, 1H), 6.90(d, 1H), 6.75(t, 1H), 6.74(t, 1H), 6.67(t, 1H), 6.63(d, 1H), 6.62(d, 1H), 6.56(d, 1H), 6.54(d, 1H), 6.40(d, 1H), 6.37(t, 1H), 6.0(d, 1H)	789.63	789.56

TABLE 1-continued

Compound	^{1}H NMR ($CDCl_3$, 400 MHz)	MS/FAB found	MS/FAB calc.

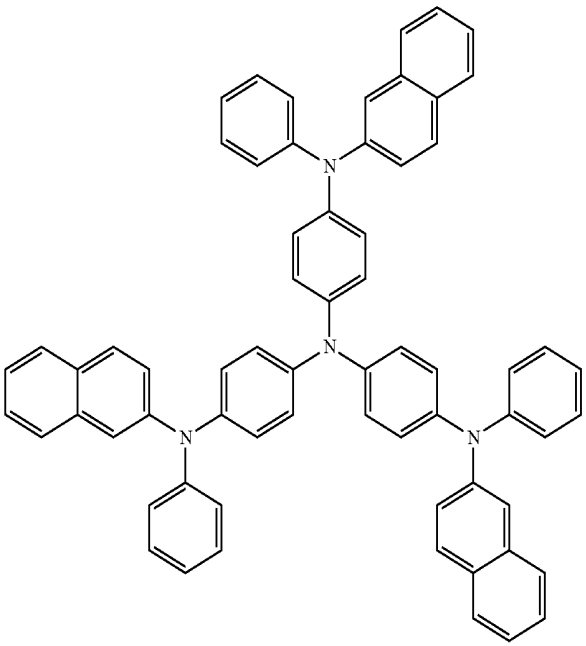
Example 1

An ITO glass substrate (a product of Corning Co., Ltd) with an ITO layer having a resistance and thickness of 15 Ω/cm^2 and 1,200 Å was cut to a size of 50 mm×50 mm×0.7 mm, and then, sonicated by using isopropyl alcohol and pure water each for 5 minutes, and cleaned by the exposure to ultraviolet rays for 30 minutes, and then ozone. The ITO glass substrate was mounted on a vacuum deposition apparatus.

2-TNATA was vapor deposited on the ITO anode to form a hole injection layer having a thickness of 600 Å, and Compound 1 was vapor deposited on the hole injection layer to form a hole transport layer having a thickness of 300 Å, and then ADN (host) and DPAVBi (dopant) were co-vapor deposited on the hole transport layer in a weight ratio of 98:2 to form an emission layer having a thickness of 300 Å.

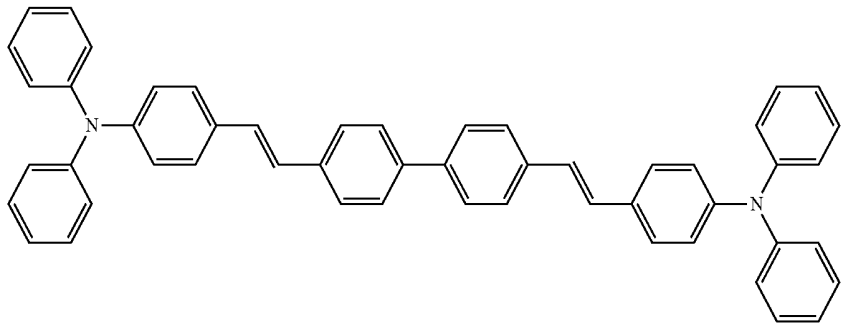
Thereafter, Alq_3 was vapor deposited on the emission layer to form an electron transport layer having a thickness of 300 Å, and LiF was vapor deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vapor deposited on the electron injection layer to form a cathode having a thickness of 3,000 Å, thereby completing the manufacture of an organic light-emitting device.

2-TNATA

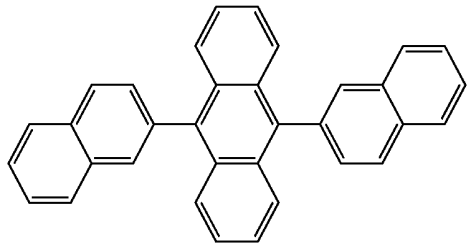


-continued

DPAVBi



ADN



Example 2

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming a hole transport layer, Compound 3 was used instead of Compound 1.

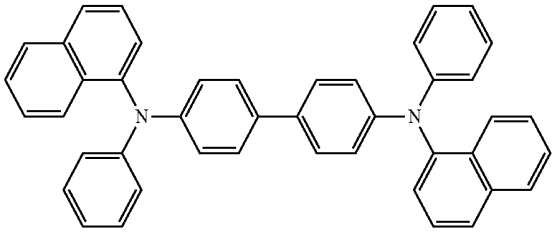
Example 3

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming a hole transport layer, Compound 94 was used instead of Compound 1.

Comparative Example 1

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

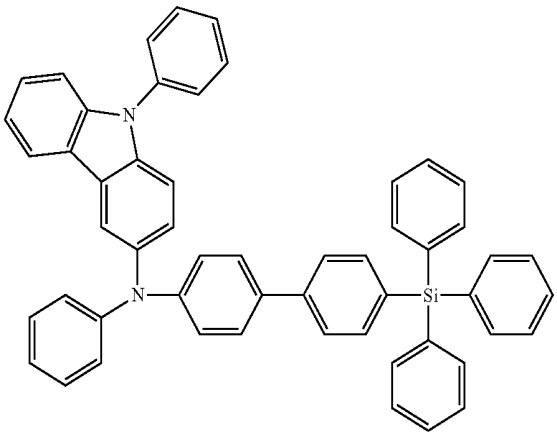
NPB



Comparative Example 2

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming a hole transport layer, Compound A, below, was used instead of Compound 1.

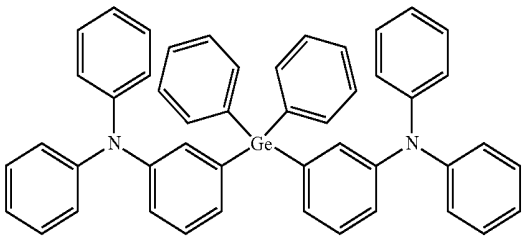
<Compound A>



Comparative Example 3

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming a hole transport layer, Compound B, below, was used instead of Compound 1.

<Compound B>



Evaluation Example 1

The driving voltage, current density, brightness, efficiency, and half-lifespan of the organic light-emitting devices manufactured according to Examples 1 to 3, and Comparative Examples 1 to 3 were measured by using Kethley SMU 236 and a brightness photometer PR650, and results thereof are shown in Table 2. The half-lifespan is a period of time that is taken until the brightness of the organic light-emitting device was 50% of initial brightness.

TABLE 2

	Hole Transport Layer Material	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	6.03	50	3935	7.97	blue	355
Example 2	Compound 3	5.91	50	4120	8.20	blue	375
Example 3	Compound 94	5.75	50	4030	8.14	blue	364
Comparative Example 1	NPB	7.01	50	2645	5.29	blue	258
Comparative Example 2	Compound A	6.21	50	3321	7.31	blue	350
Comparative Example 3	Compound B	6.91	50	3251	7.55	blue	330

Referring to Table 2, it may be seen that the organic light-emitting devices manufactured according to Examples 1 to 3 exhibited improved driving voltage, improved brightness, improved efficiency, and improved half-lifespan, compared to those of the organic light-emitting devices manufactured according to Comparative Examples 1 to 3.

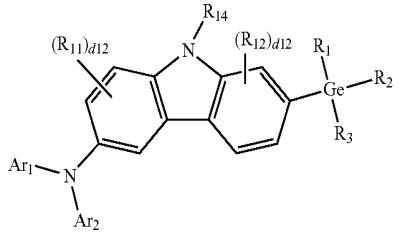
As described above, according to the embodiments, an organic light-emitting device including the amine-based compound may have a low driving voltage, high efficiency, high brightness, and long lifespan.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

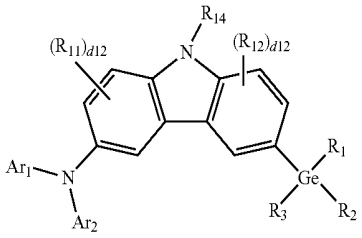
What is claimed is:

1. An amine-based compound represented by represented by one of the following Formulae 1A (2) to 1A (4):

<Formula 1A (2)>



<Formula 1A (3)>



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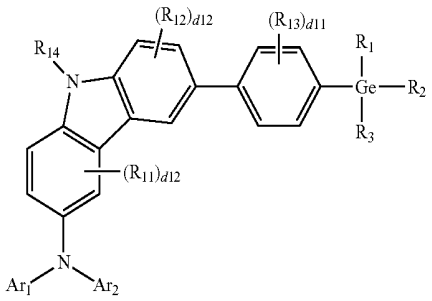
<Formula 1A (4)>



wherein, in Formulae 1A (2) to 1A (4),

Ar_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; in which Ar_1 and Ar_2 are separate or are linked to each other to form a saturated or unsaturated ring;

R_1 to R_3 are the same and are selected from:

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; and

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, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro 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,

R_{11} to R_{13} 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, and a C_1-C_{20} alkoxy group;

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, and 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, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, and a naphthyl group; and

$—Si(Q_{31})(Q_{32})(Q_{33})$,

wherein Q_{31} to Q_{33} 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 quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

R_{14} is selected from 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

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 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, and 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, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, 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, and a naphthyl group,

d11 is an integer selected from 1 to 4,

d12 is an integer selected from 1 to 3,

provided that, in Formula 1(A) 4, at least one of Ar_1 and Ar_2 is selected from a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, and

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_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_1-C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

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

a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid 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, —$Si(Q_{11})(Q_{12})(Q_{13})$, —$B(Q_{14})(Q_{15})$, and —$N(Q_{16})(Q_{17})$;

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;

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

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

wherein Q_{11} to Q_{17}, Q_{21} to Q_{27}, and Q_{31} to Q_{37} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_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 amine-based compound as claimed in claim **1**, wherein, in Formulae 1A (2) to 1A (4), 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 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, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl group; and

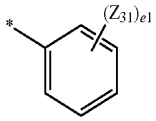
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, —$Si(Q_{31})(Q_{32})(Q_{33})$, —$B(Q_{34})(Q_{35})$, and —$N(Q_{36})(Q_{37})$, and

wherein Q_{31} to Q_{37} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{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

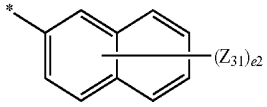
group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group.

3. The amine-based compound as claimed in claim 1, wherein in Formulae 1A (2) to 1A (4), Ar_1 and Ar_2 are each independently a group represented by one of Formulae 5-1 to 5-14, below:

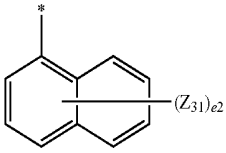
Formula 5-1



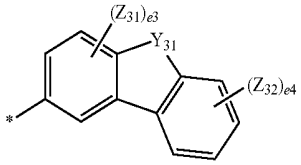
Formula 5-2



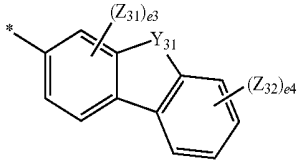
Formula 5-3



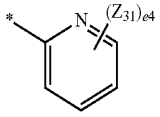
Formula 5-4



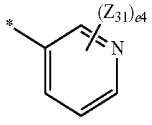
Formula 5-5



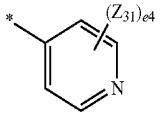
Formula 5-6



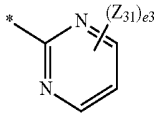
Formula 5-7



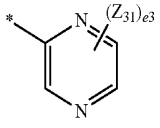
Formula 5-8



Formula 5-9



Formula 5-10



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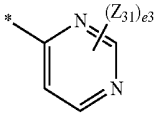
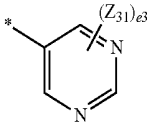
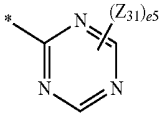
Formula 5-11



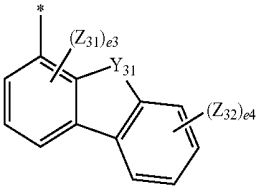
Formula 5-12



Formula 5-13



Formula 5-14



wherein, in Formulae 5-1 to 5-14,

Y_{31} is selected from O, S, $C(Z_{33})(Z_{34})$, and $N(Z_{35})$;

Z_{31} to Z_{35} are each independently selected from: dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, and a dibenzocarbazolyl 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, and a naphthyl group; and

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

wherein Q_{31} to Q_{37} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1-C_{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;

e1 is an integer selected from 1 to 5,

e2 is an integer selected from 1 to 7,

e3 is an integer selected from 1 to 3,

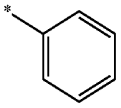
e4 is an integer selected from 1 to 4,

e5 is an integer selected from 1 and 2, and

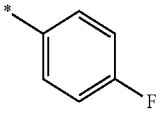
* indicates a binding site with an adjacent atom.

4. The amine-based compound as claimed in claim 1, wherein, in Formulae 1A (2) to 1A (4), Ar_1 and Ar_2 are each independently a group represented by one of Formulae 6-1 to 6-30, below:

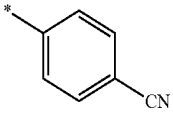
Formula 6-1



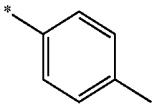
Formula 6-2



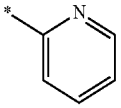
Formula 6-3



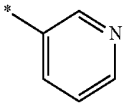
Formula 6-4



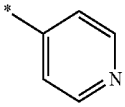
Formula 6-5



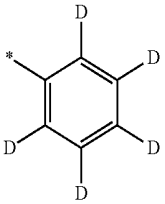
Formula 6-6



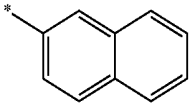
Formula 6-7



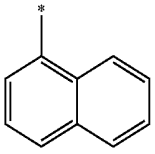
Formula 6-8



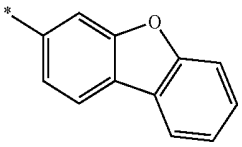
Formula 6-9



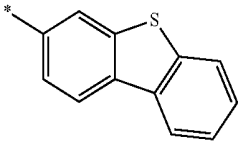
Formula 6-10



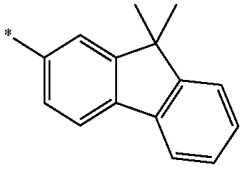
Formula 6-11



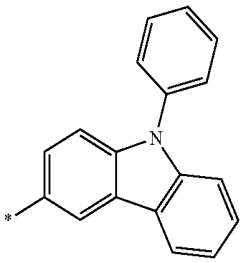
Formula 6-12



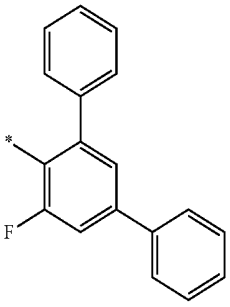
Formula 6-13



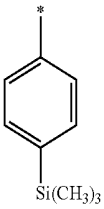
Formula 6-14



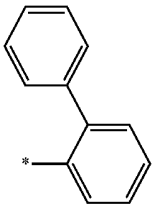
Formula 6-15



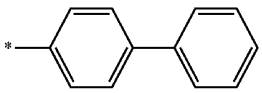
Formula 6-16



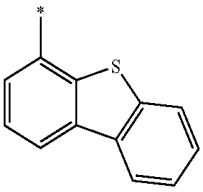
Formula 6-17



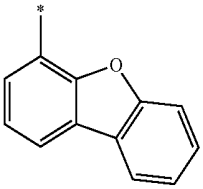
Formula 6-18



Formula 6-19



Formula 6-20



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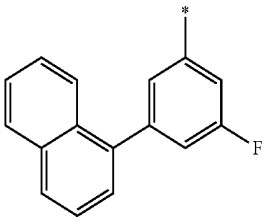
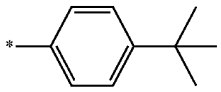
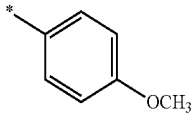
Formula 6-21



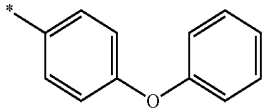
Formula 6-22



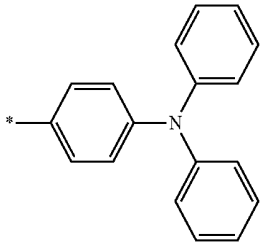
Formula 6-23



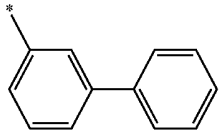
Formula 6-24



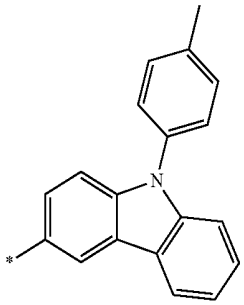
Formula 6-25



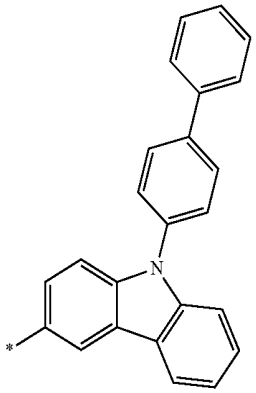
Formula 6-26



Formula 6-27



Formula 6-28



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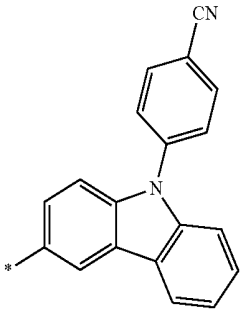
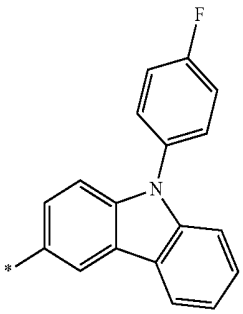
Formula 6-29



Formula 6-30



in Formulae 6-1 to 6-30, * indicates a binding site with an adjacent atom.

5. The amine-based compound as claimed in claim **1**, wherein Ar_1 and Ar_2 are linked to each other via a single bond or a substituted or unsubstituted C_1-C_5 alkylene group.

6. The amine-based compound as claimed in claim **1**, wherein the group of Ar_1 is the same as the group of Ar_2.

7. The amine-based compound as claimed in claim **1**, wherein the group of Ar_1 is different from the group of Ar_2.

8. The amine-based compound as claimed in claim **1**, wherein:

Ar_1 and Ar_2 are each independently selected from a substituted or unsubstituted C_6-C_{20} aryl group and a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group;

Ar_1 and Ar_2 are each independently selected from a substituted or unsubstituted C_1-C_{20} heteroaryl group and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group; or

Ar_1 is selected from a substituted or unsubstituted C_6-C_{20} aryl group and a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and Ar_2 is selected from a substituted or unsubstituted C_1-C_{20} heteroaryl group and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

9. The amine-based compound as claimed in claim **1**, wherein, in Formulae 1A (2) to 1A (4), R_1 to R_3 are the same and are selected from:

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

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, 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.

10. An organic light-emitting device, comprising:

a first electrode;

a second electrode; and

an organic layer including an emission layer and being between the first electrode and the second electrode,

wherein the organic layer includes the amine-based compound as claimed in claim **1**.

11. The organic light-emitting device as claimed in claim **10**, wherein:

the first electrode is an anode,

the second electrode is a cathode, and

the organic layer includes:

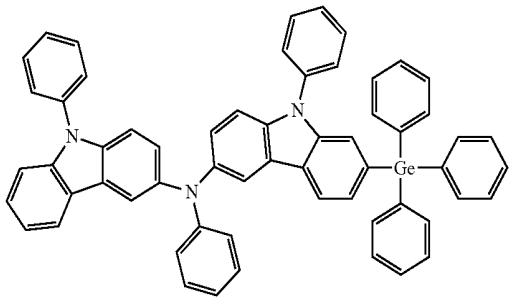
a hole transport region between the first electrode and the emission layer, the hole transport region including at least one selected from a hole injection layer, a hole transport layer, a buffer layer, and an electron blocking layer, and

an electron transport region between the emission layer and the second electrode, the electron transport region including at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

12. The organic light-emitting device as claimed in claim **11**, wherein the hole transport region includes the amine-based compound.

13. An amine-based compound represented by one of the following Compounds:

44



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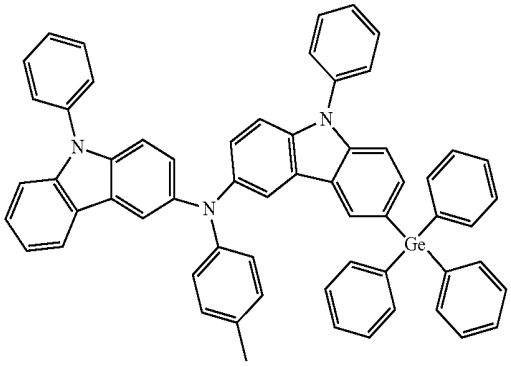

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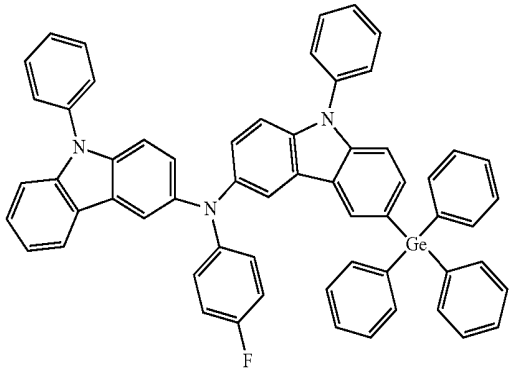

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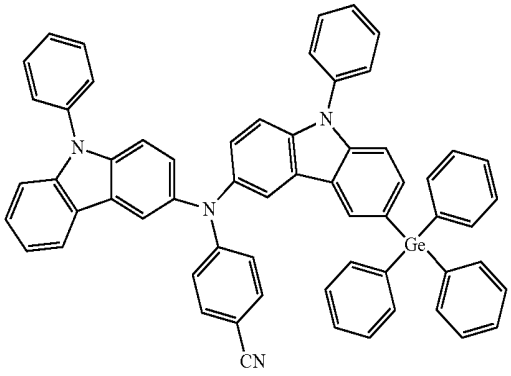

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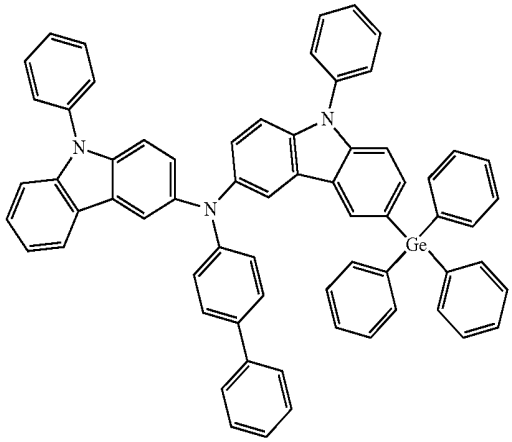

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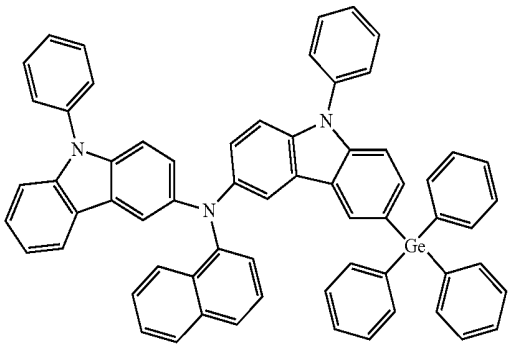

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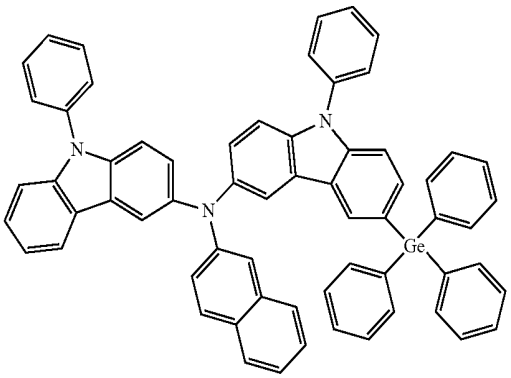

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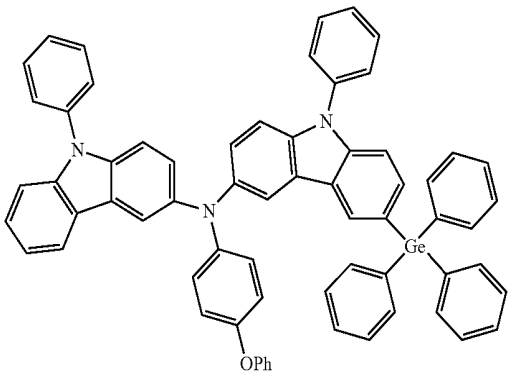

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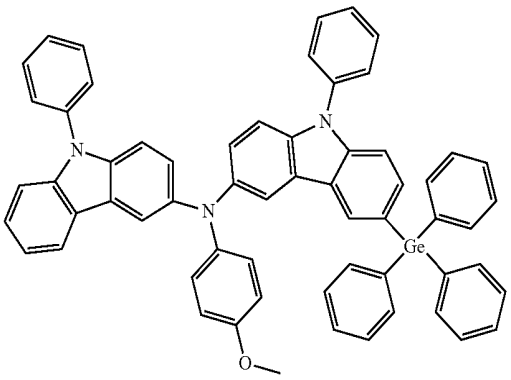

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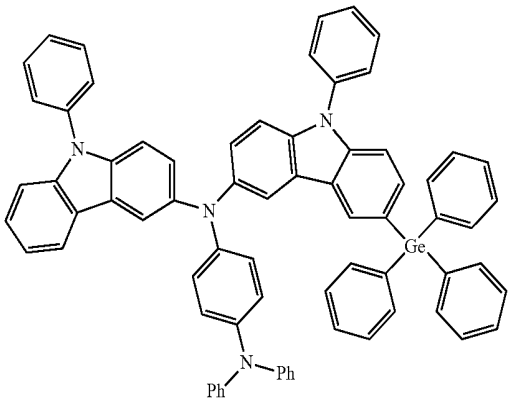

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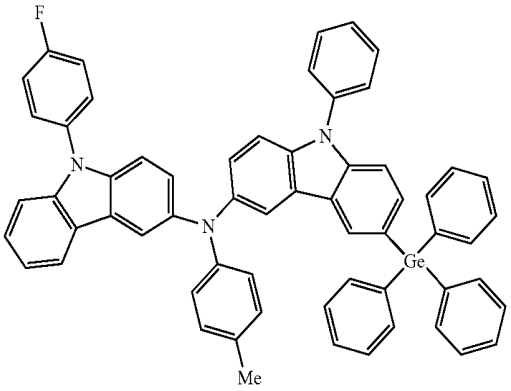

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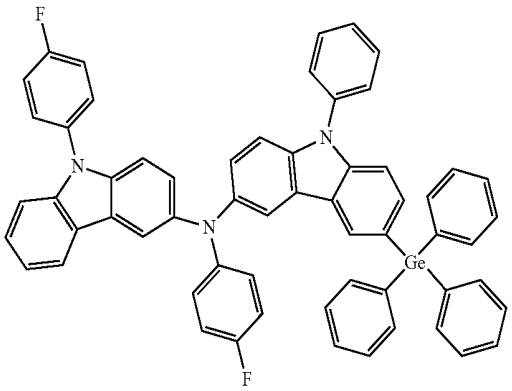

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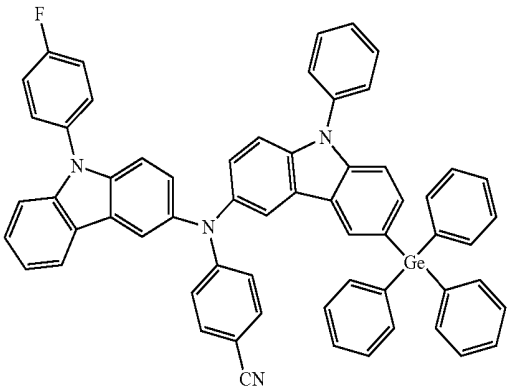

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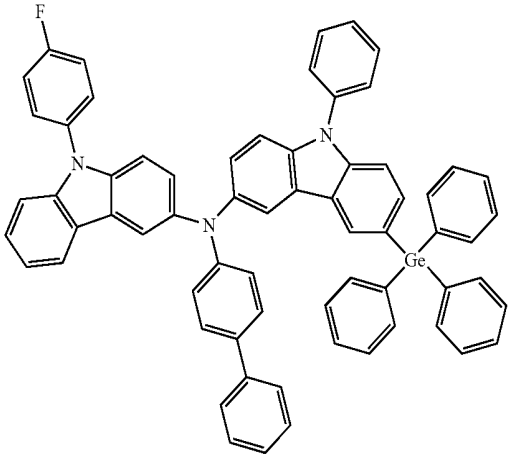

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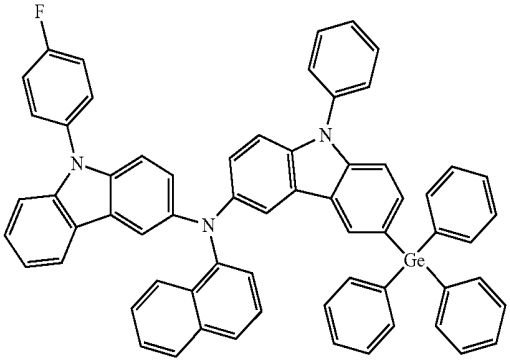

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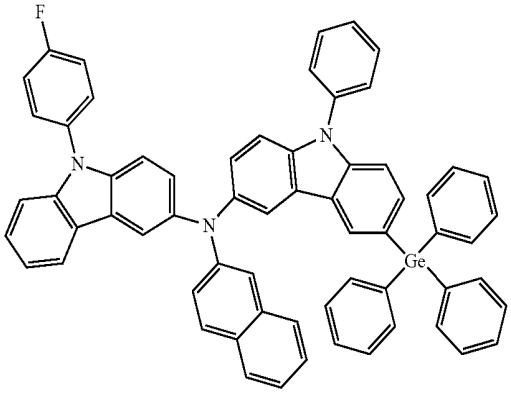

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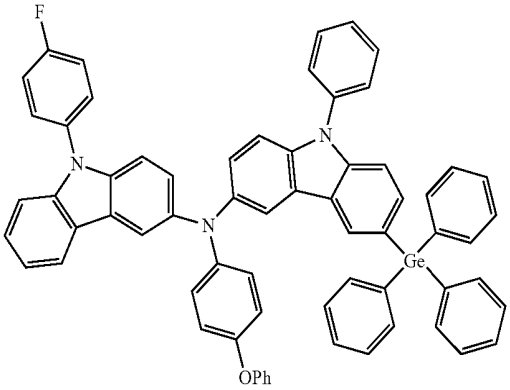

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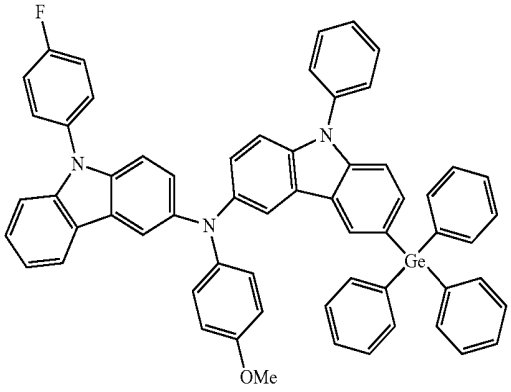

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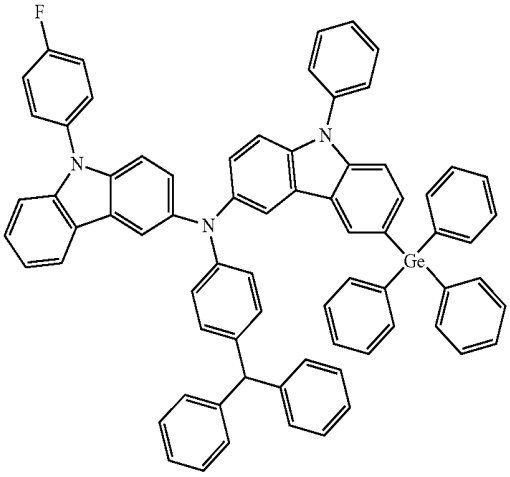

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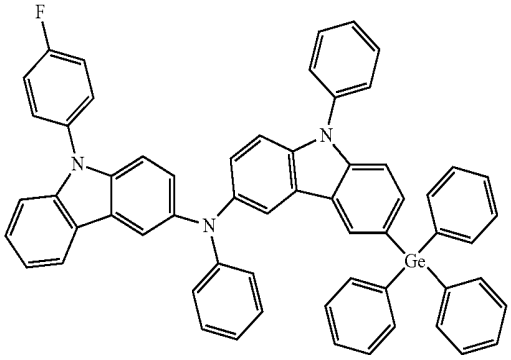

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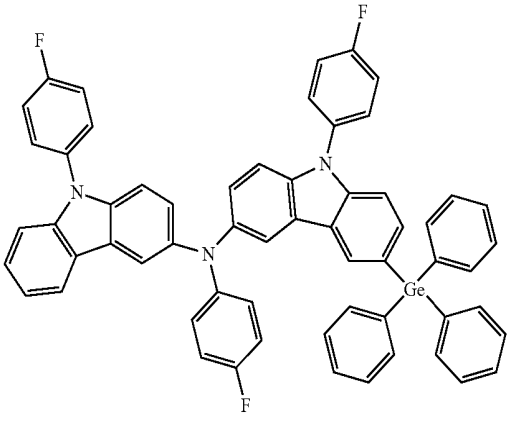

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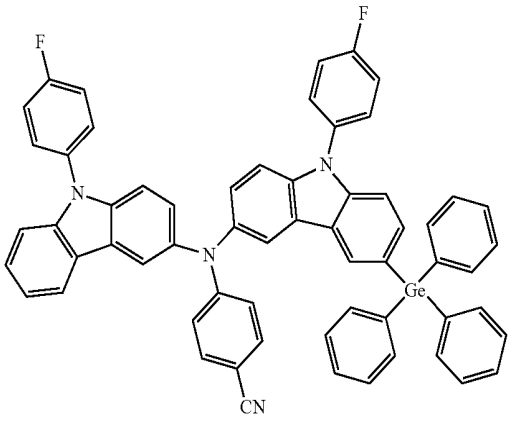

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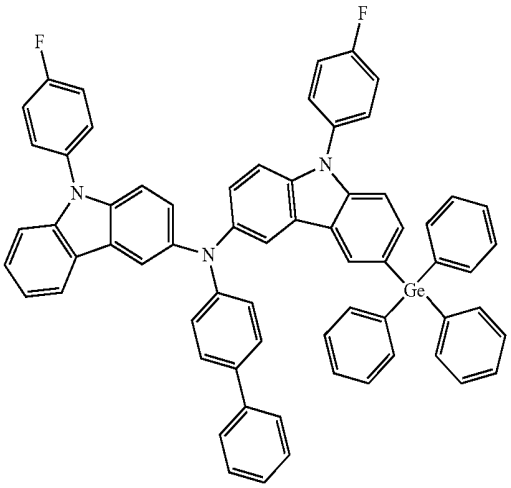

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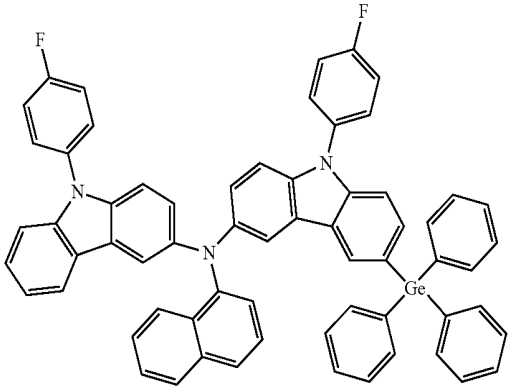

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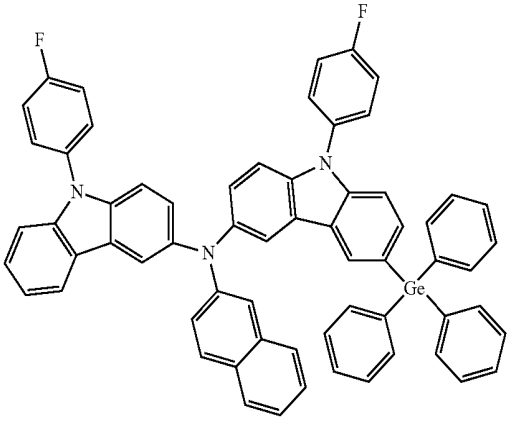

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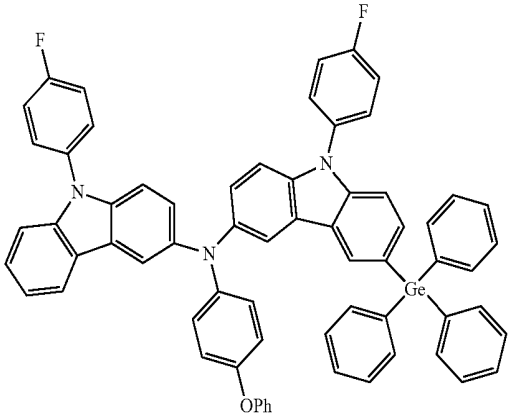

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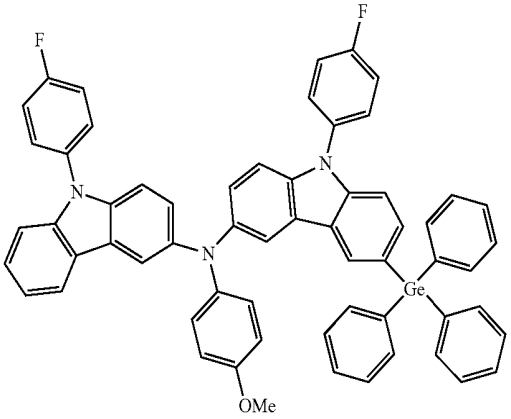

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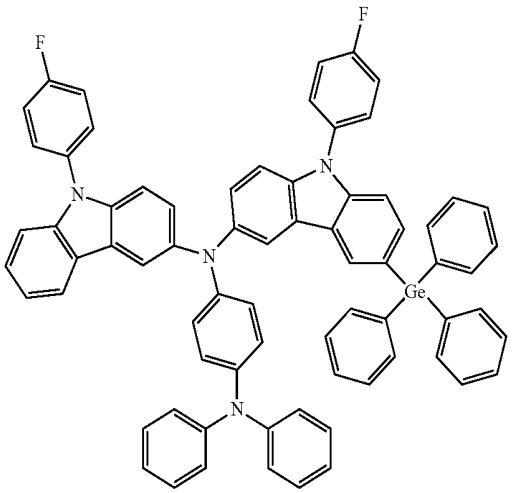

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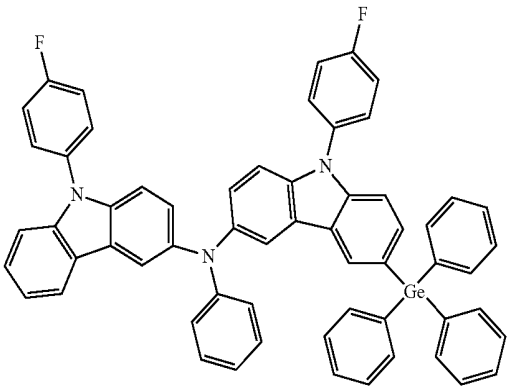

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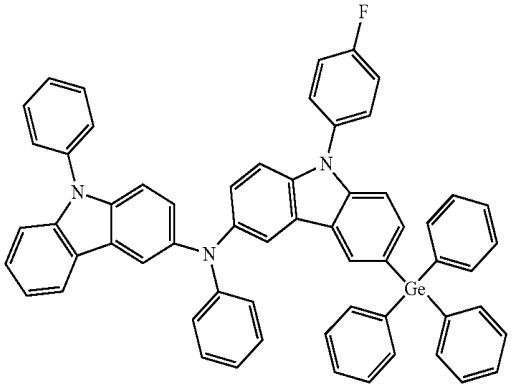

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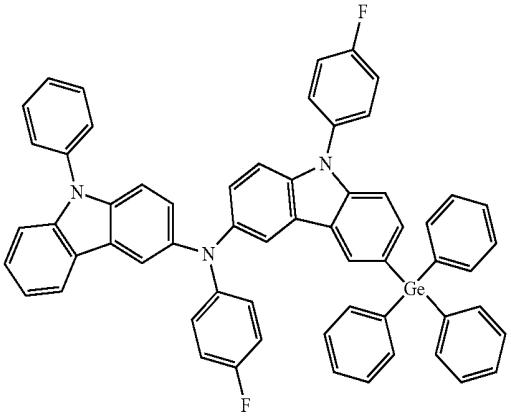

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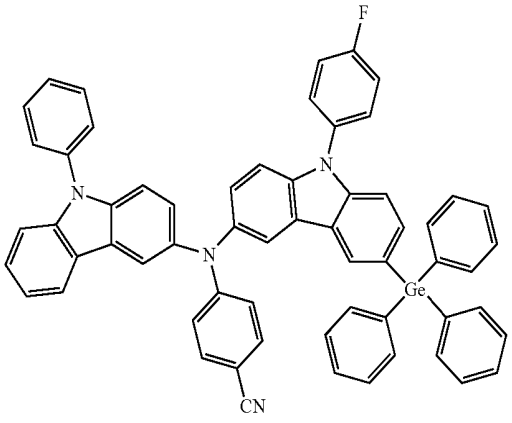

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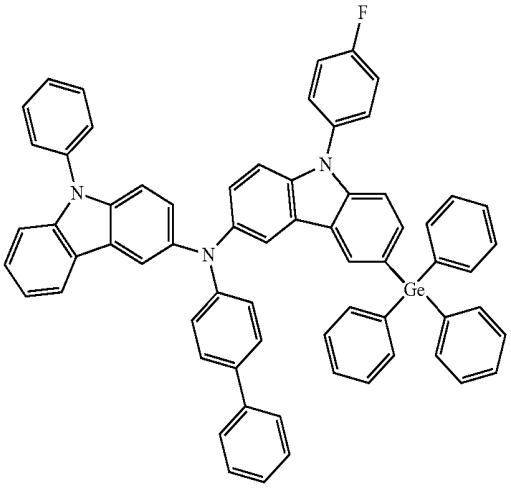

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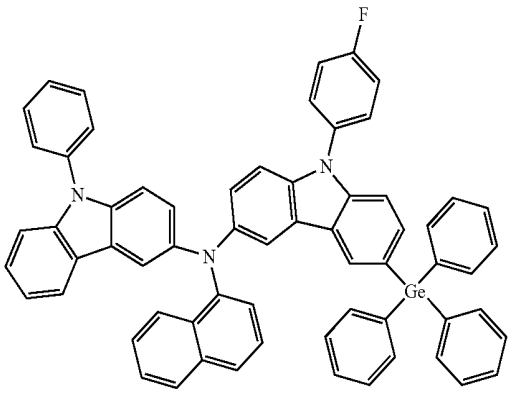

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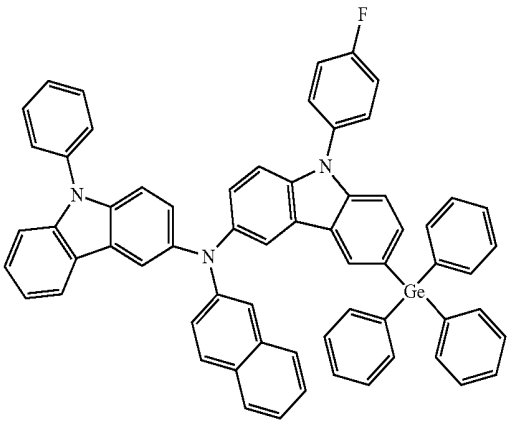

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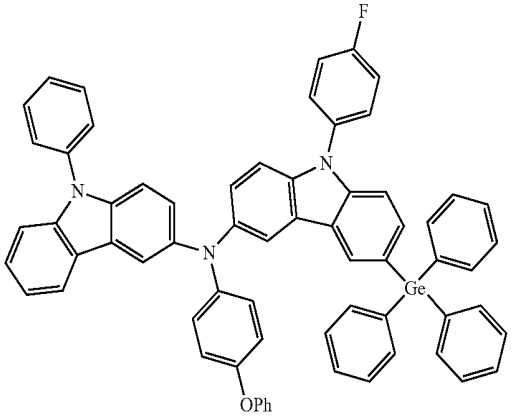

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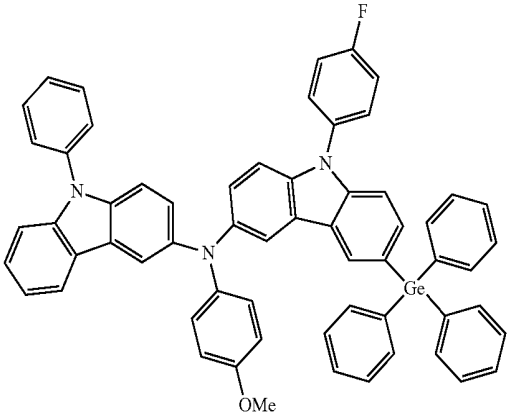

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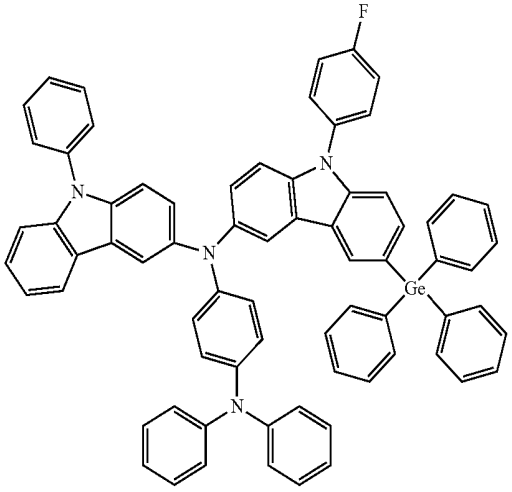

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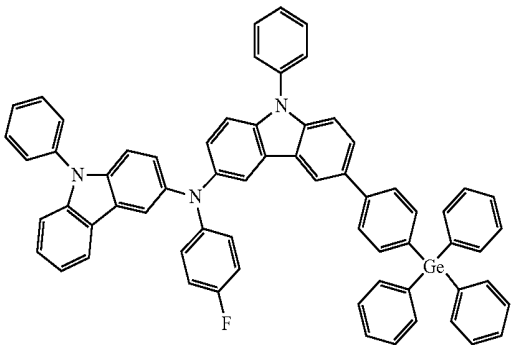

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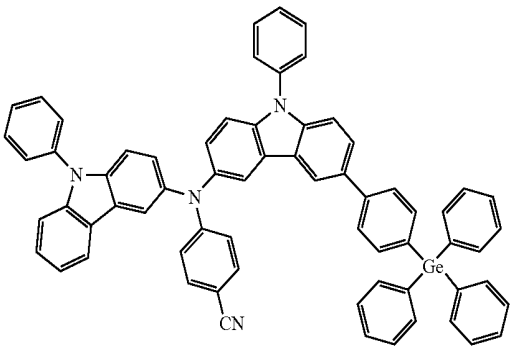

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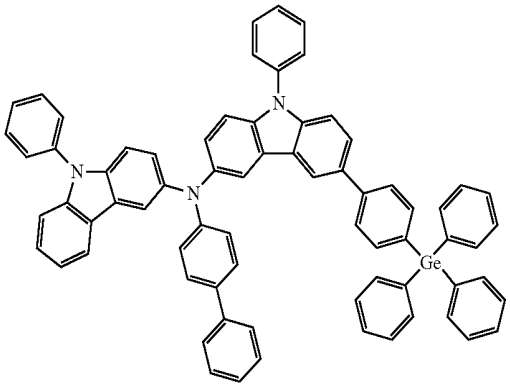

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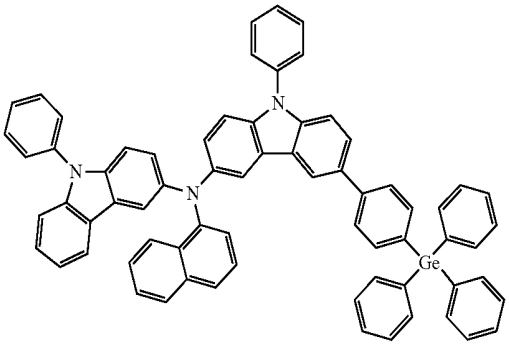

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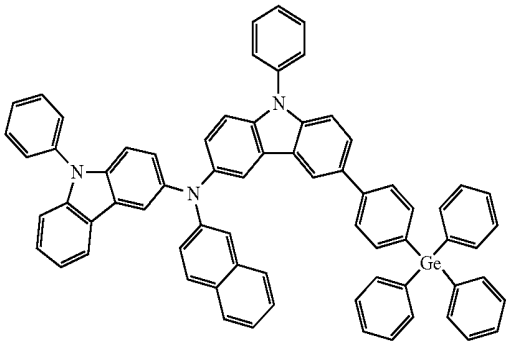

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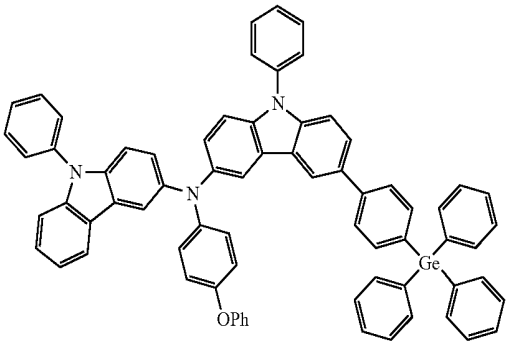

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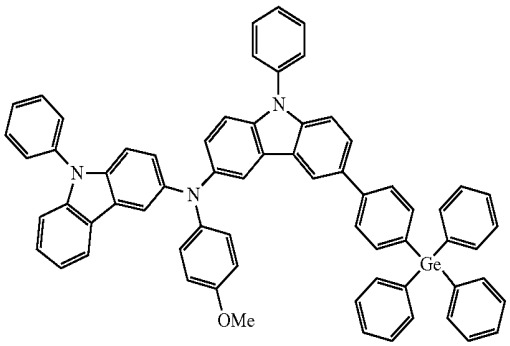

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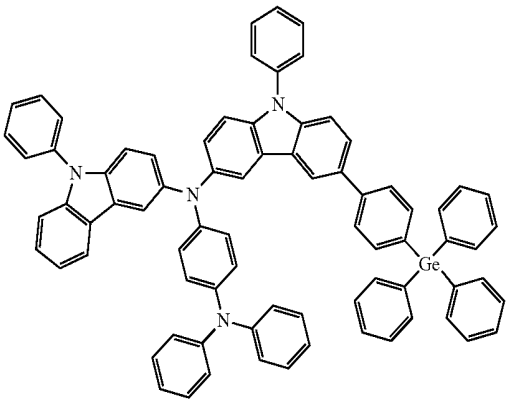

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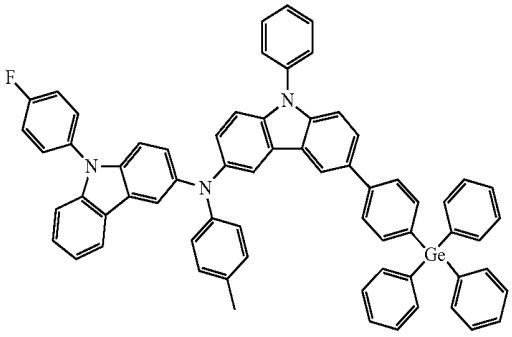

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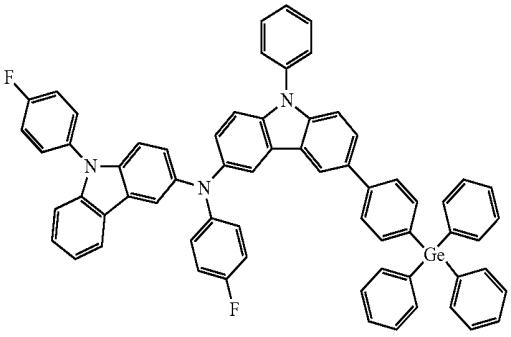

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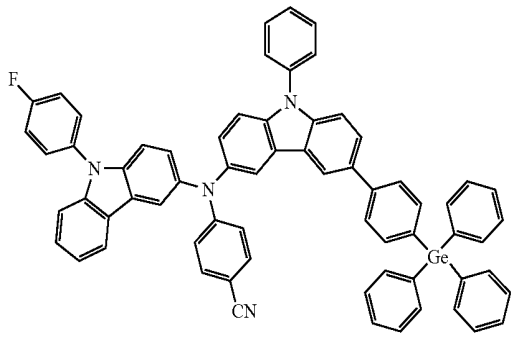

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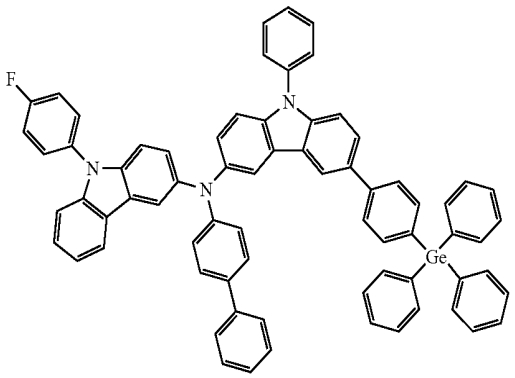

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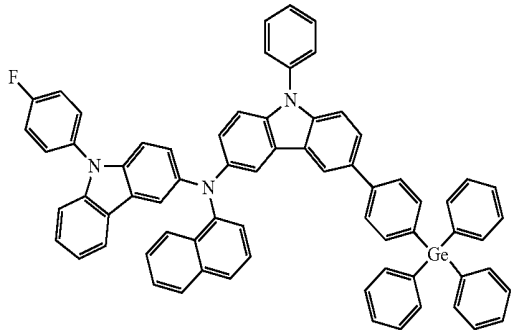

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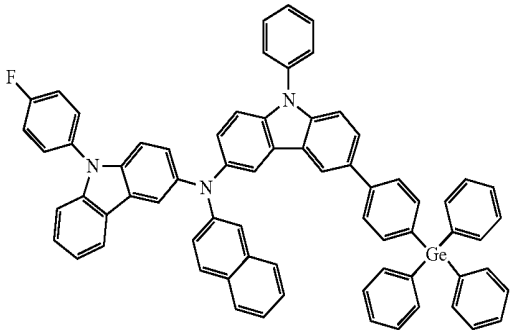

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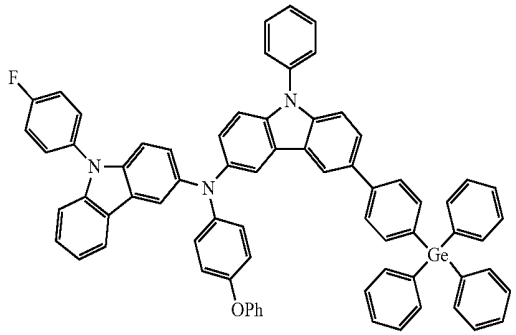

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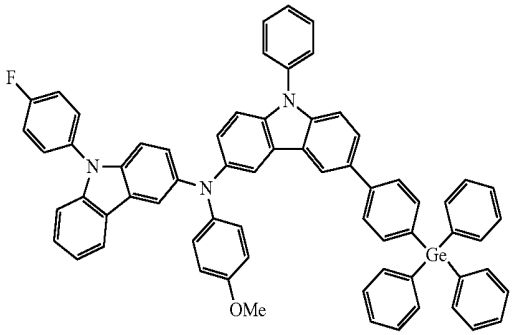

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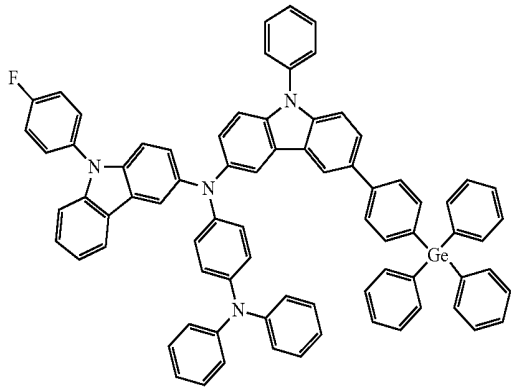

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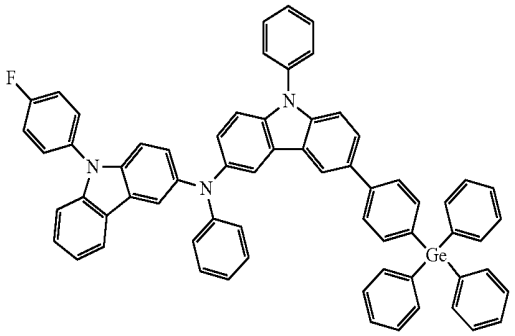

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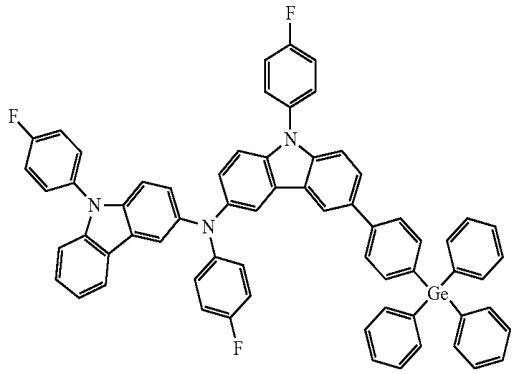

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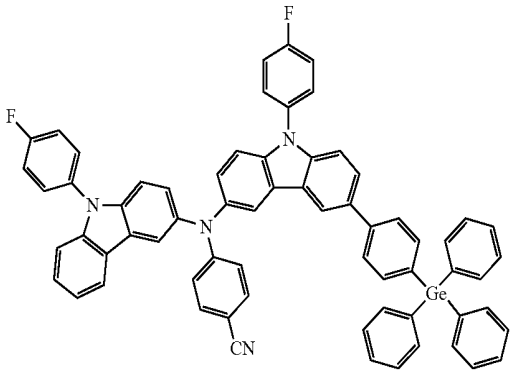

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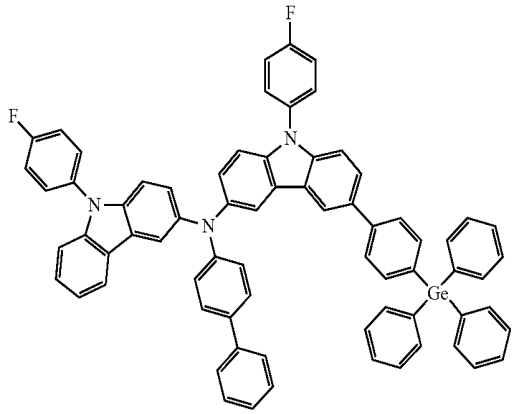

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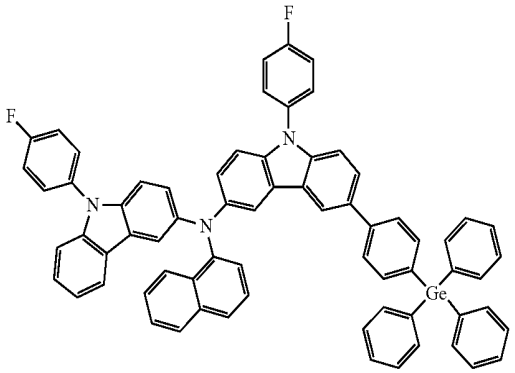

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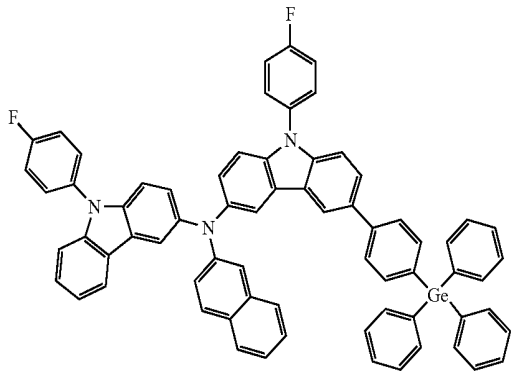

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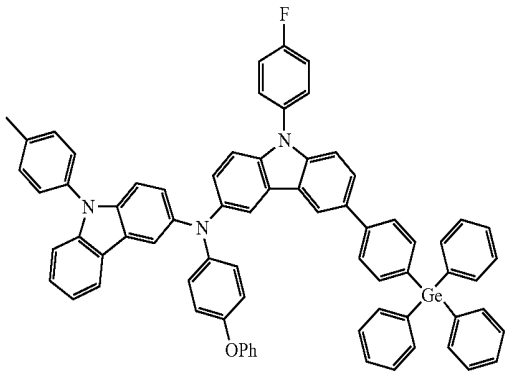

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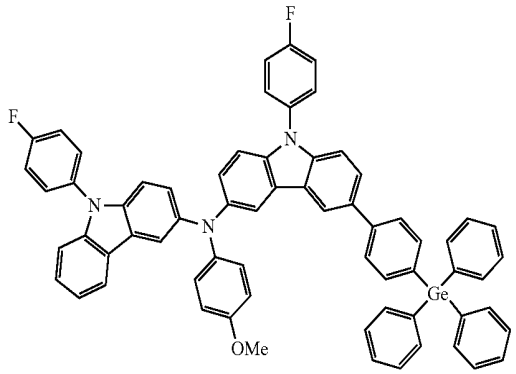

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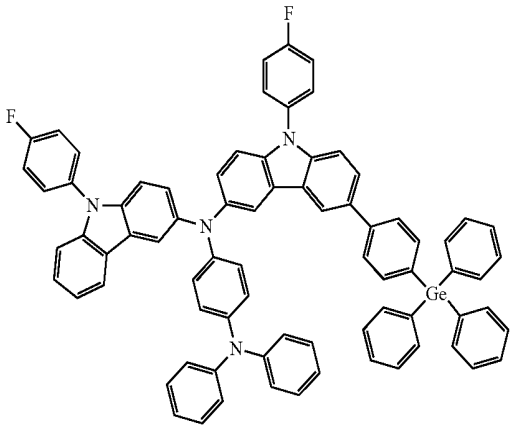

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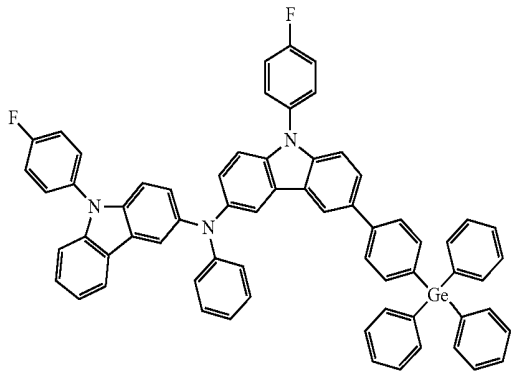

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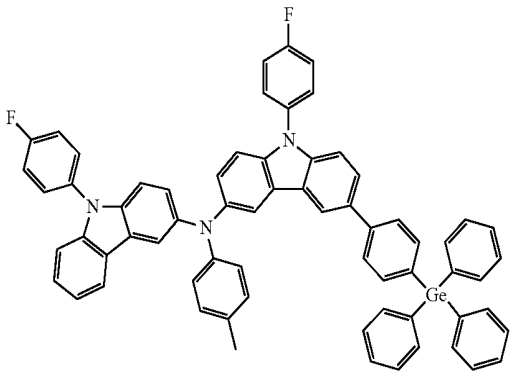

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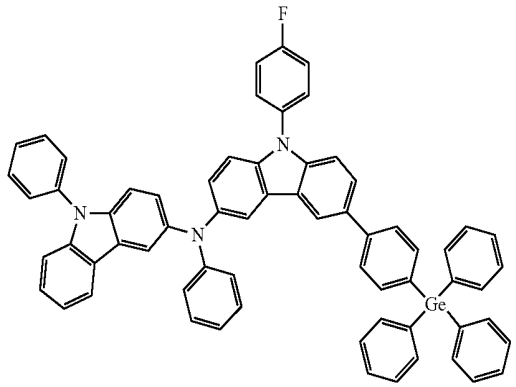

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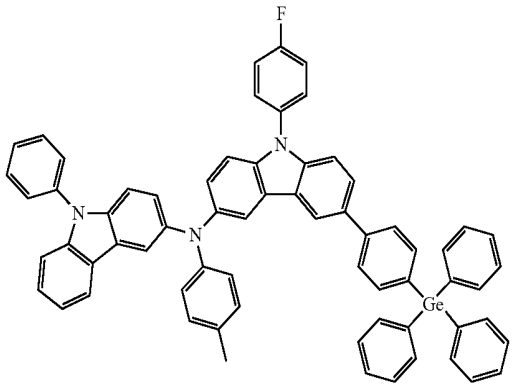

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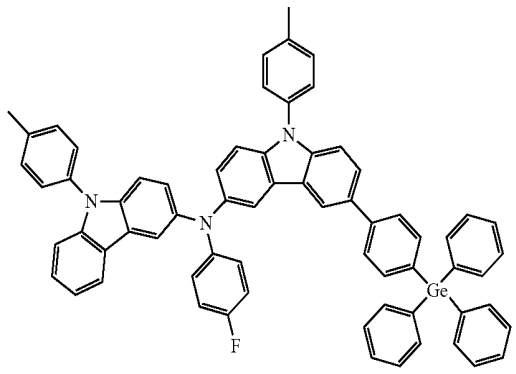

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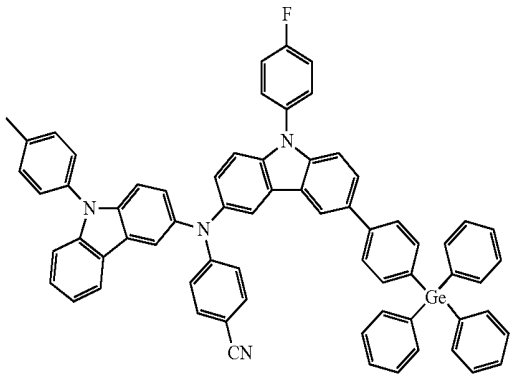

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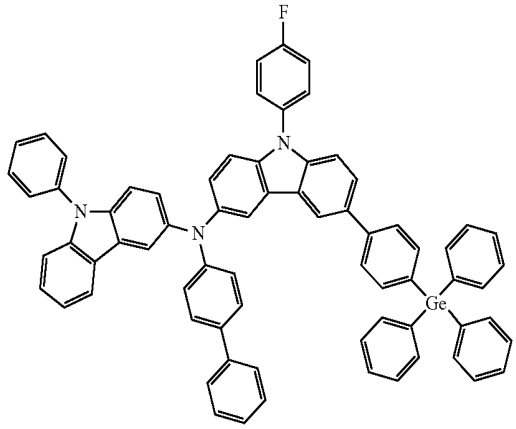

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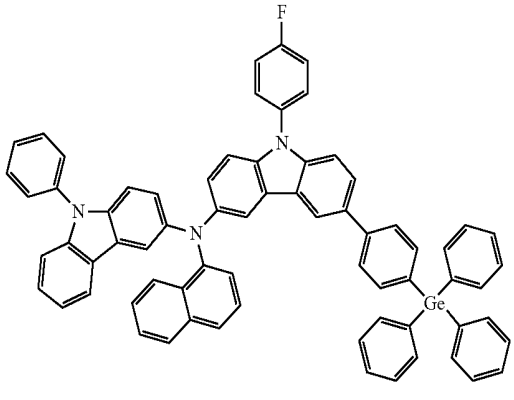

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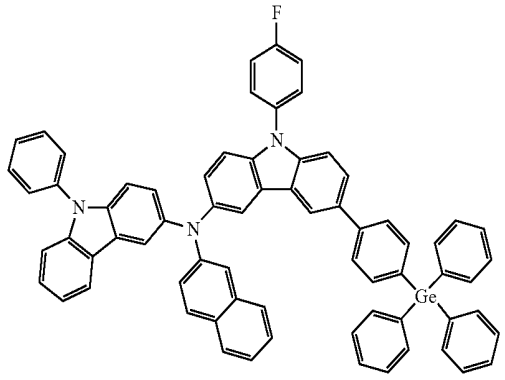

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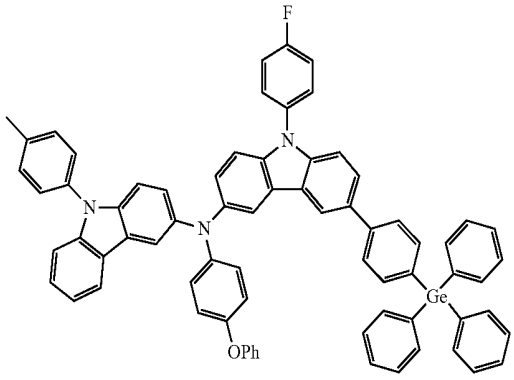

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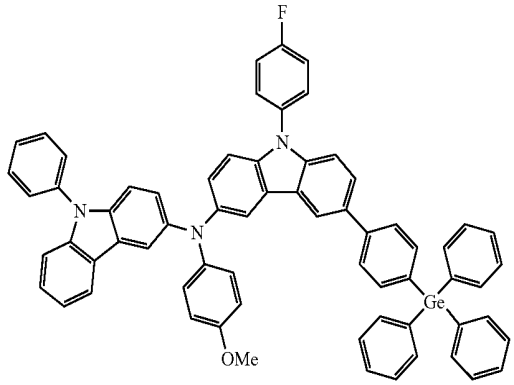

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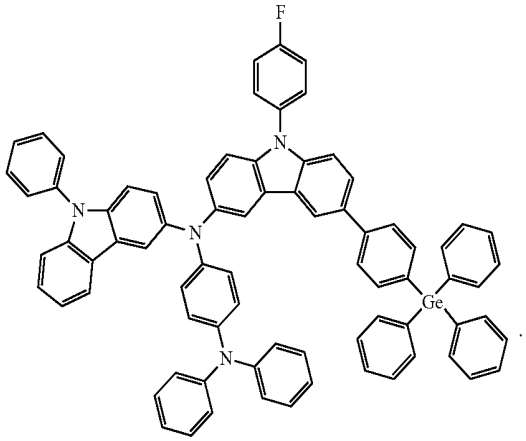


14. An organic light-emitting device, comprising:

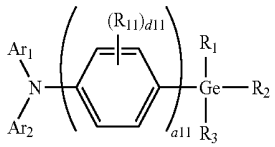
a first electrode;

a second electrode; and

an organic layer including an emission layer and being between the first electrode and the second electrode,

wherein the organic layer includes the amine-based compound represented by represented by Formulae 1A(1):

<Formula 1A (1)>



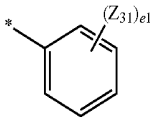
wherein, in Formulae 1A(1),

a11 is an integer selected from 1 and 2,

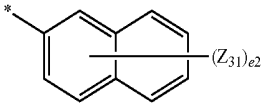
Ar_1 is a group selected from Formulae 5-1 to 5-3,

Ar_2 is a group selected from Formulae 5-4, 5-5 and 5-14,

Formula 5-1



Formula 5-2



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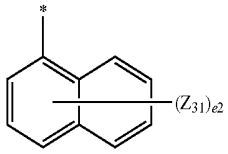
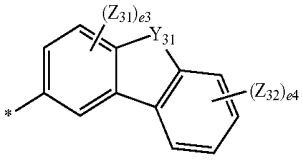
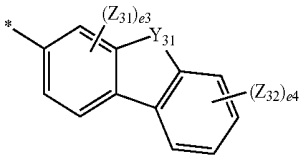
Formula 5-3



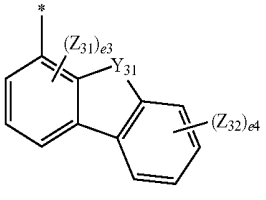
Formula 5-4



Formula 5-5



Formula 5-14



wherein, in Formulae 5-1 to 5-5 and 5-14,

Y_{31} is $N(Z_{35})$;

Z_{31} to Z_{35} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl

group, a cyano group, a C_1-C_{20} alkyl group, and a C_1-C_{20} alkoxy group, a phenyl group, a naphthyl group, a phenoxy group, and —$N(Q_{36})(Q_{37})$;

wherein Q_{36} and Q_{37} are each independently selected from a hydrogen, a C_1-C_{20} alkyl group, a phenyl group, and a naphthyl group,

R_1 to R_3 are the same and are selected from:

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

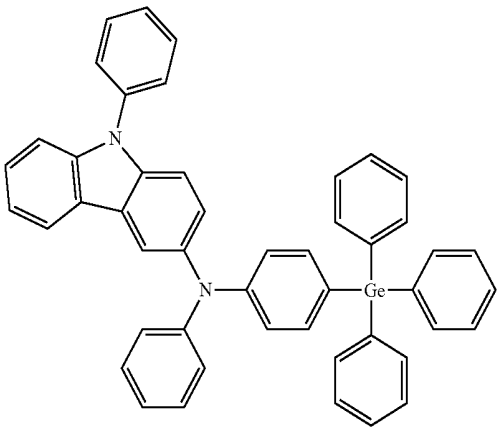
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, 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,

R_{11} is hydrogen,

d11 is an integer selected from 1 to 4.

15. The organic light-emitting device as claimed in claim **14**, wherein the amine-based compound is represented by one of the following Compounds 1 to 39 and 94 to 132:

1



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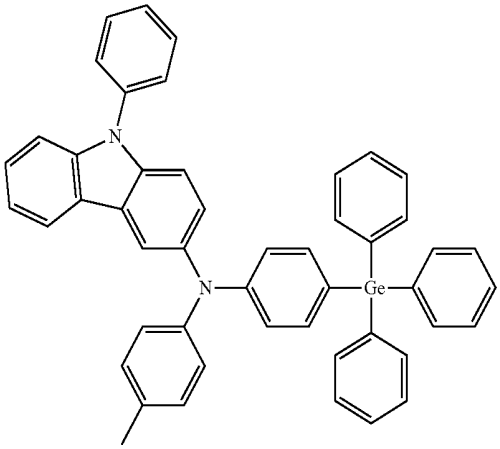

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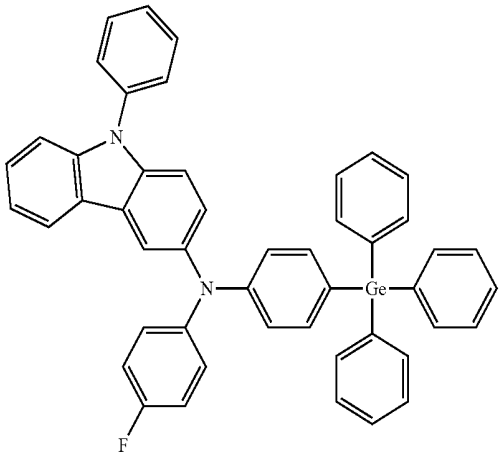
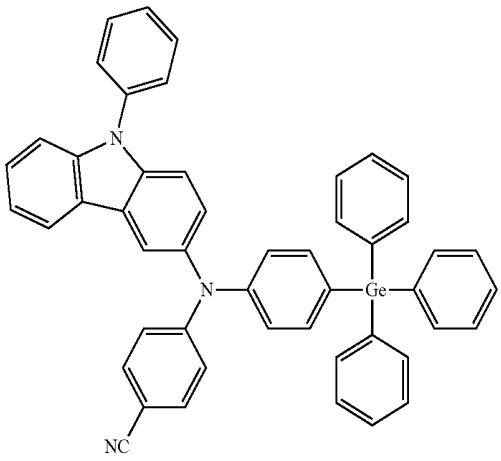
3



4



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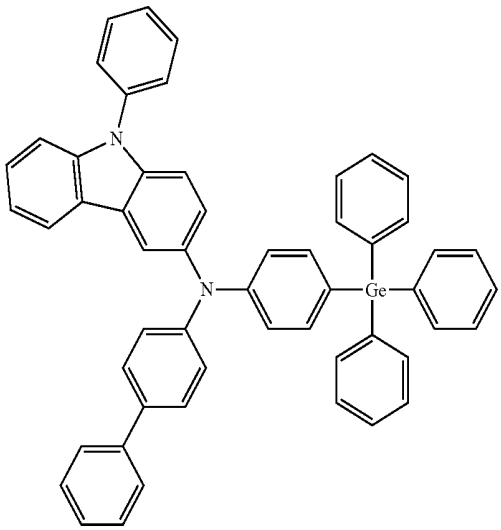

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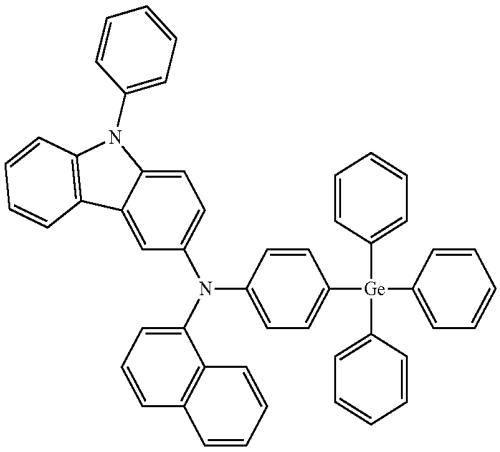

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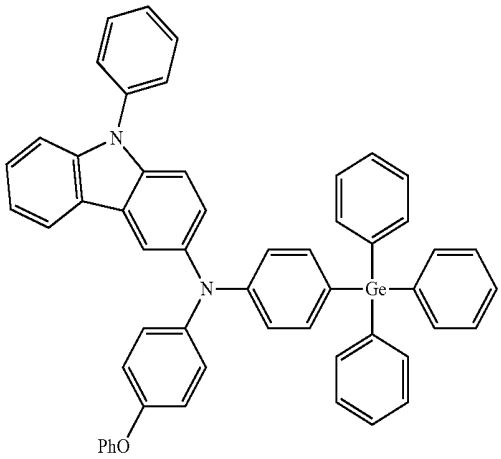
9



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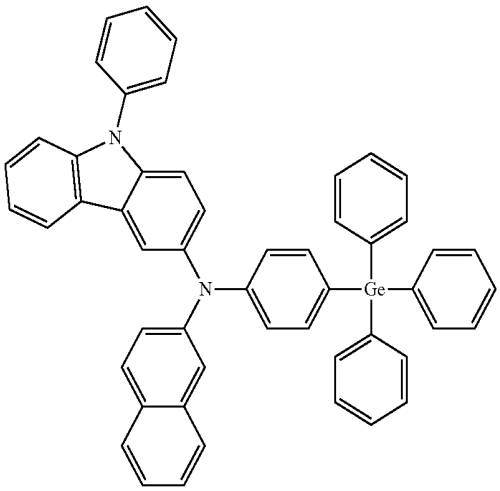

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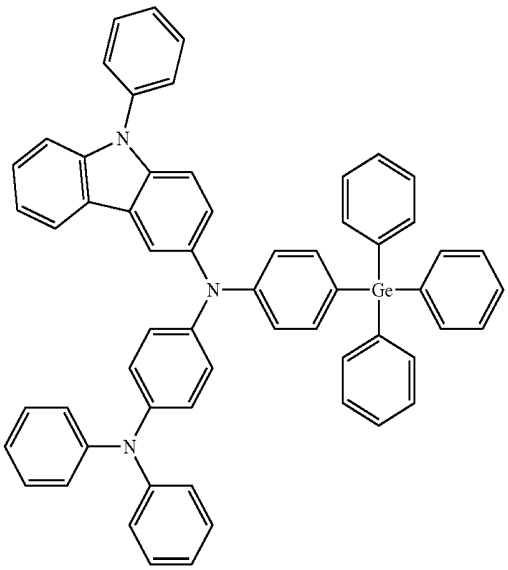

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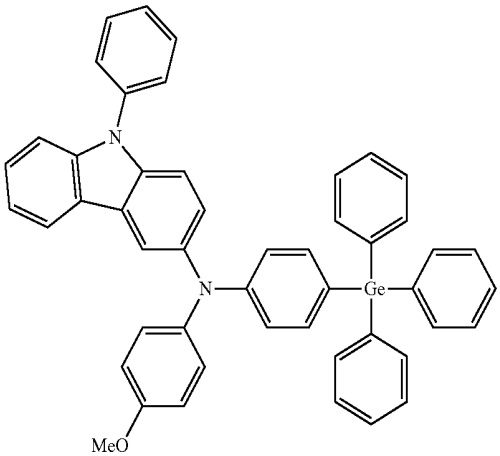

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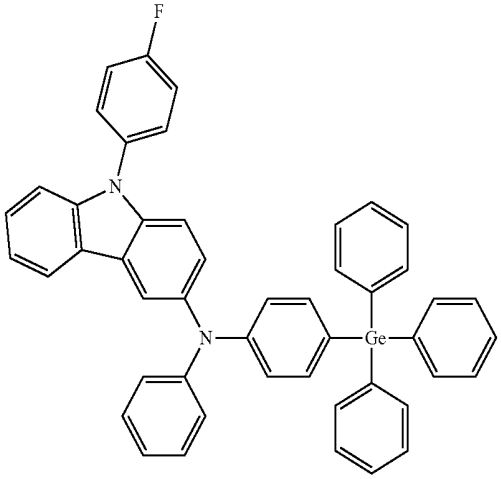

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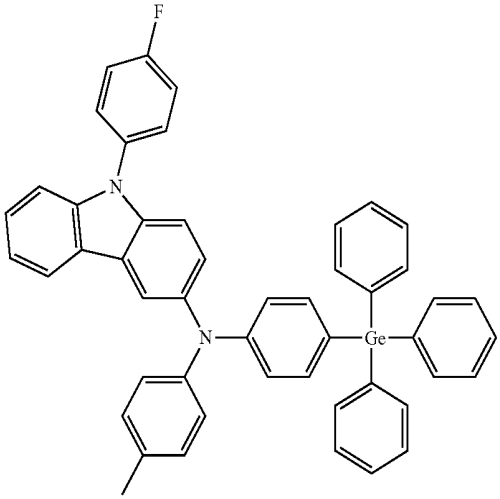

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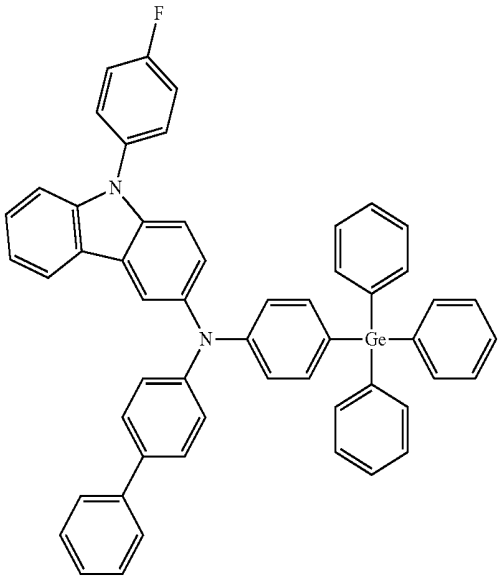

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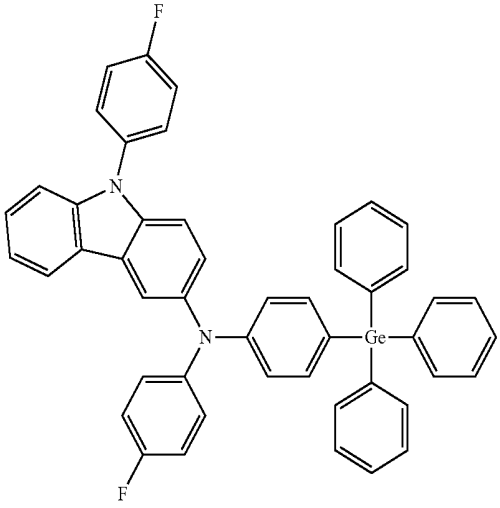

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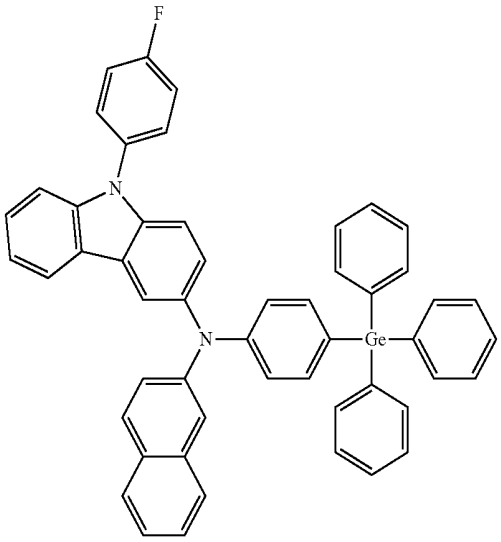
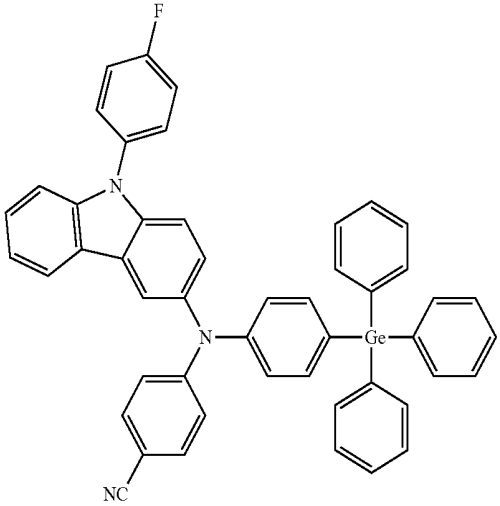


14



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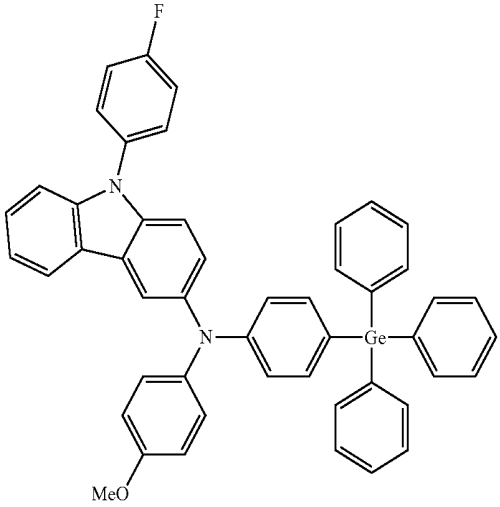

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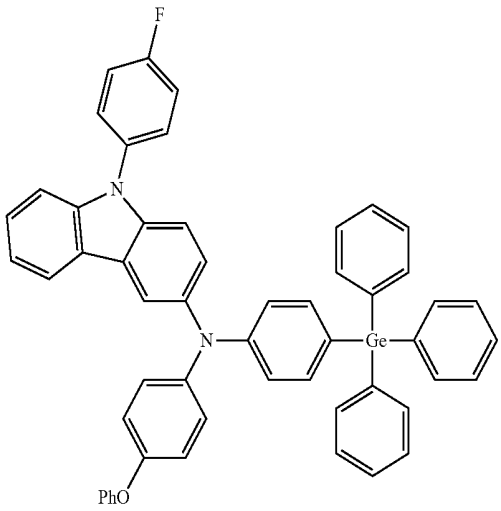

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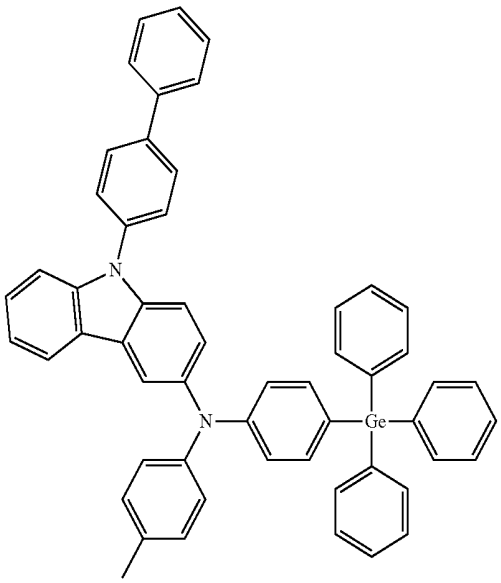

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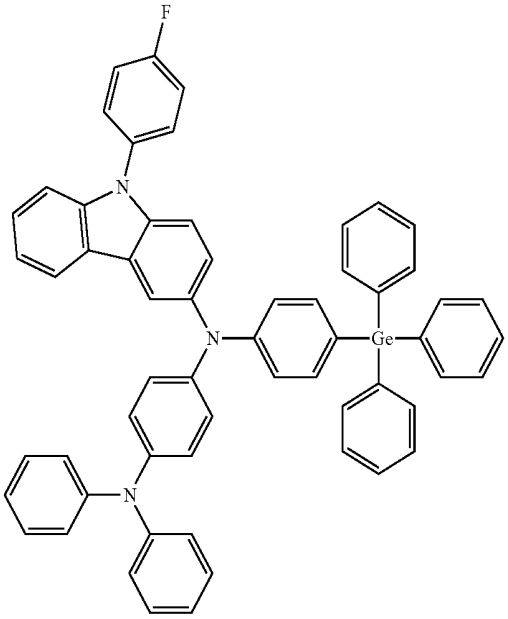

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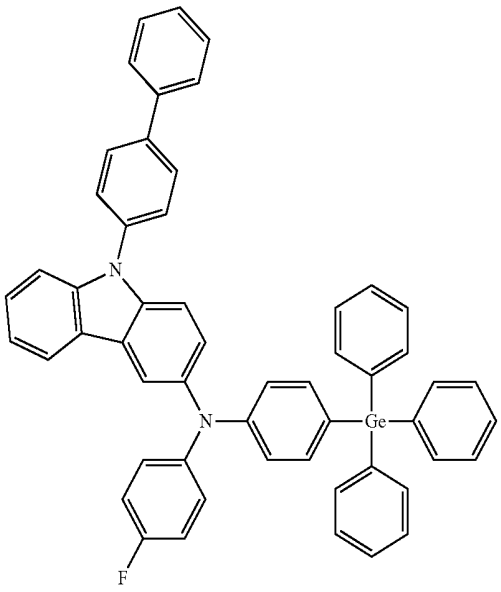

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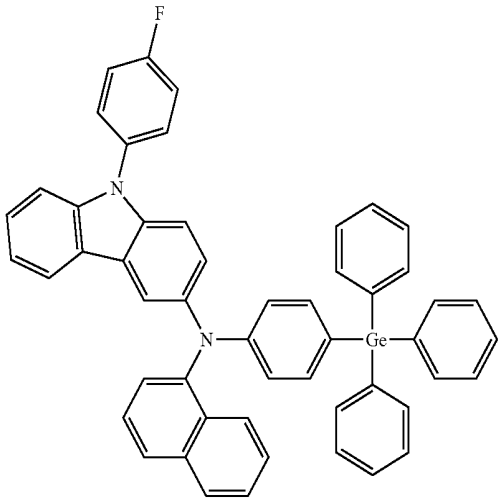

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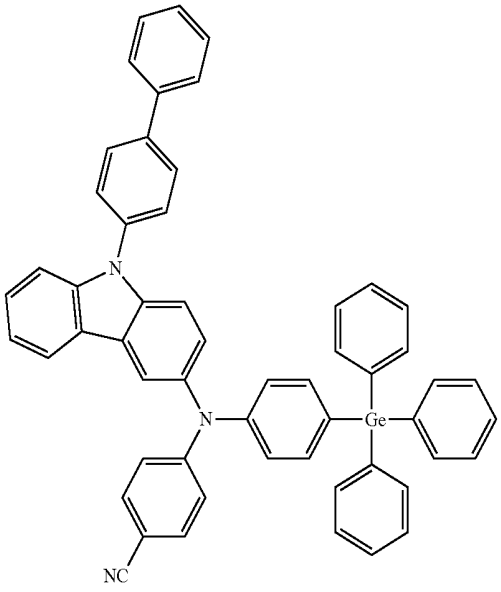

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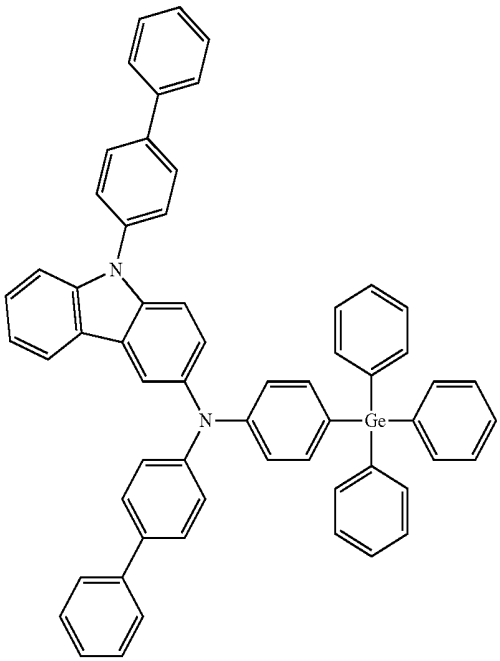

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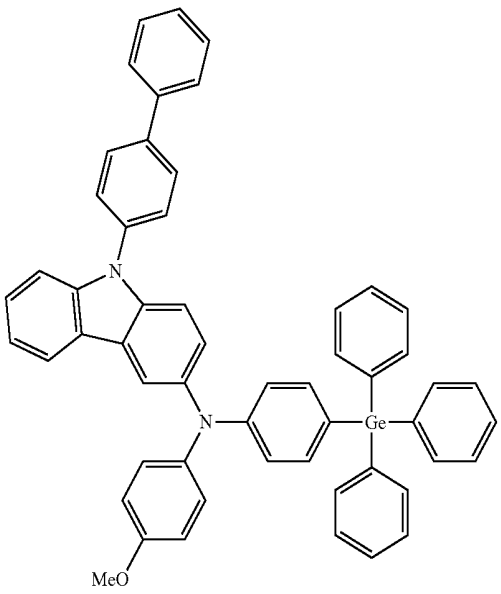

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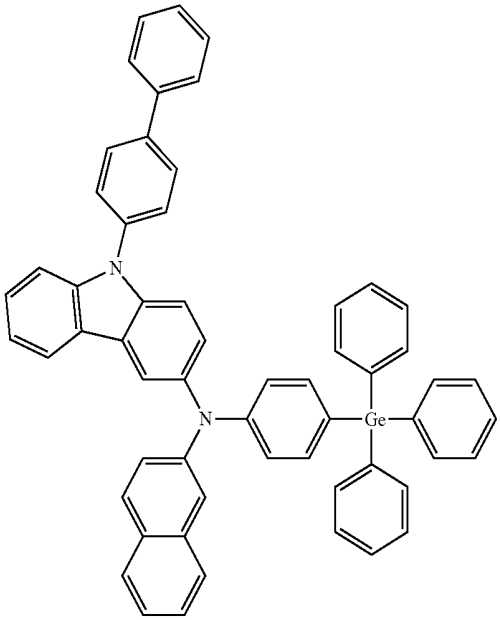

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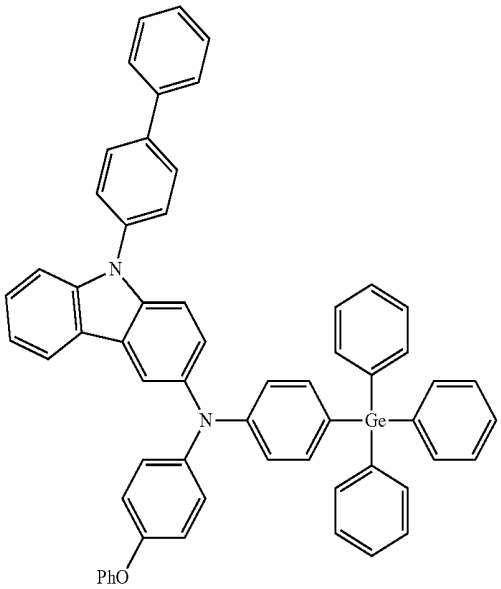

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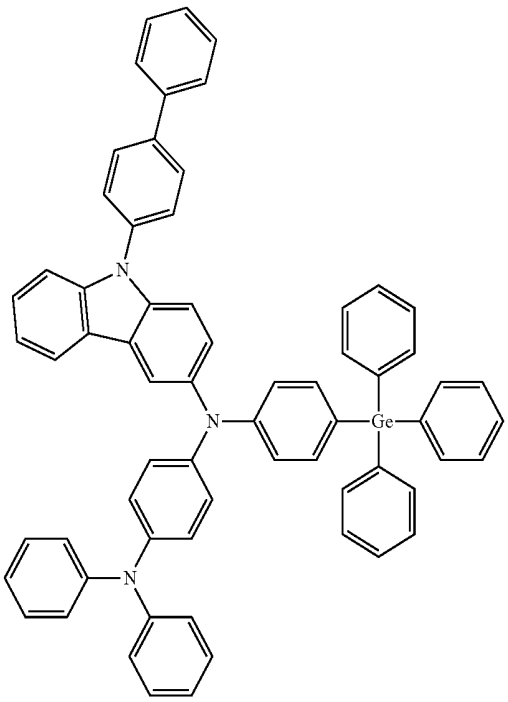

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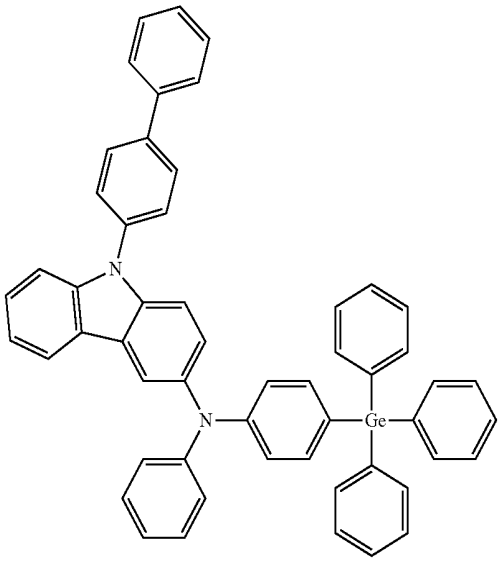

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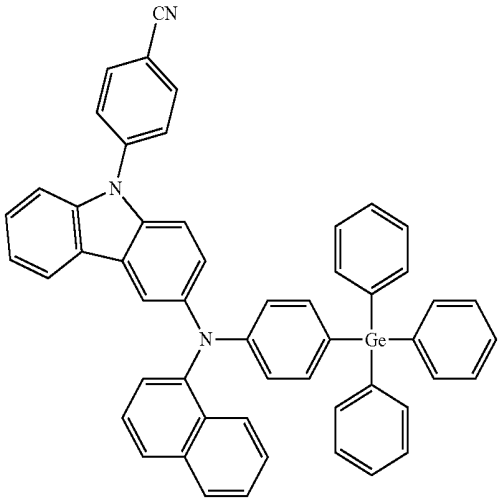

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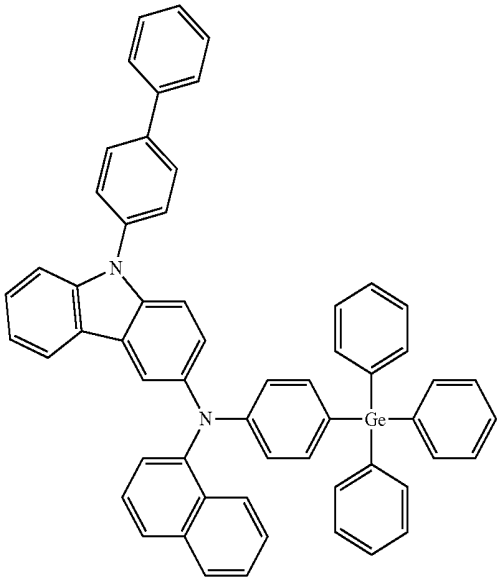

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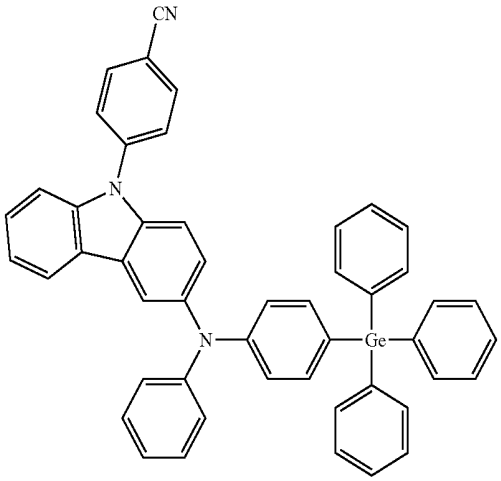

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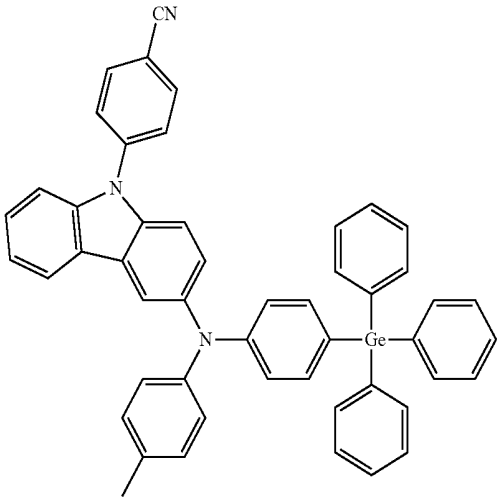

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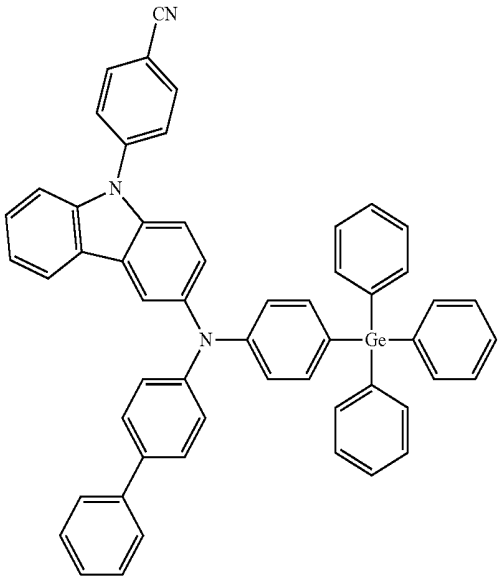

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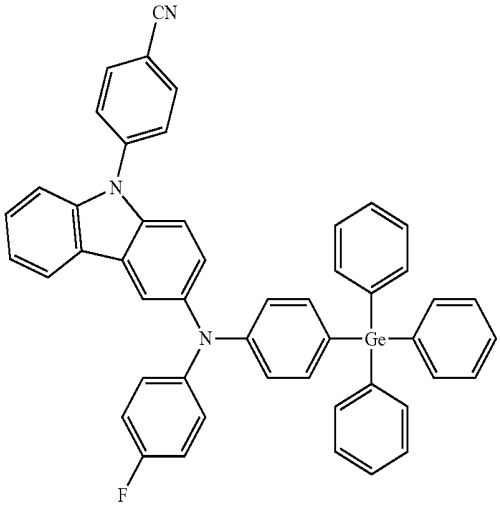

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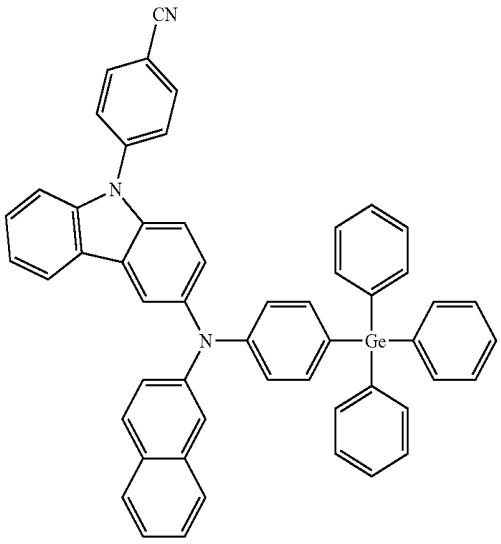

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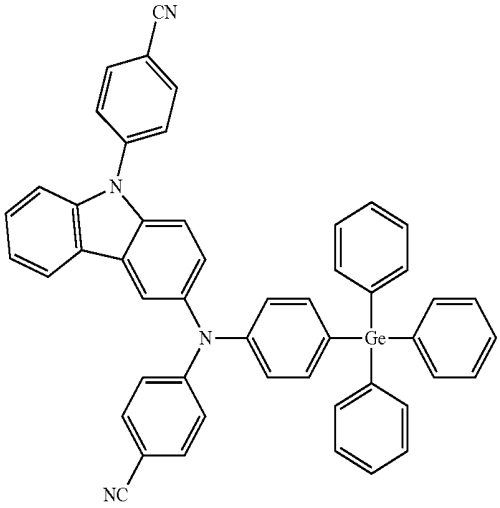

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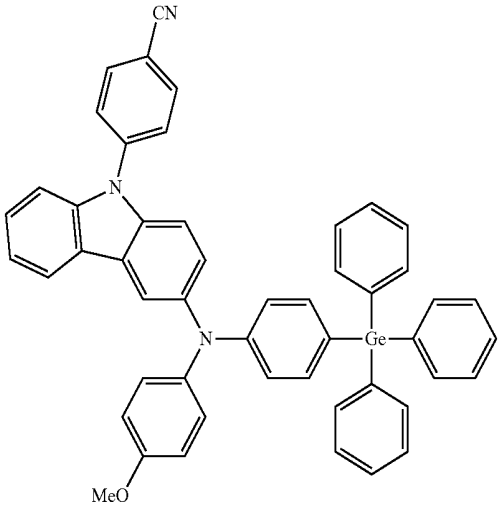

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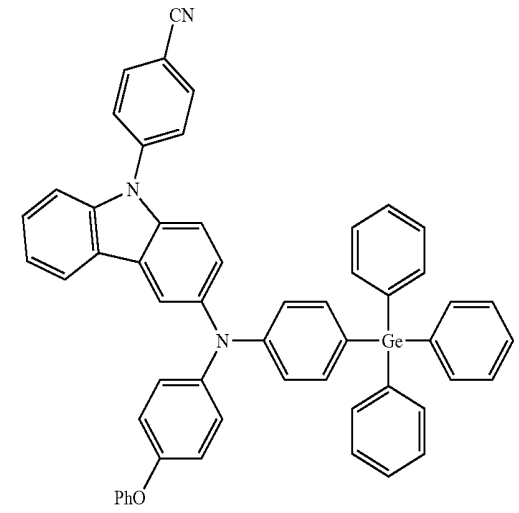

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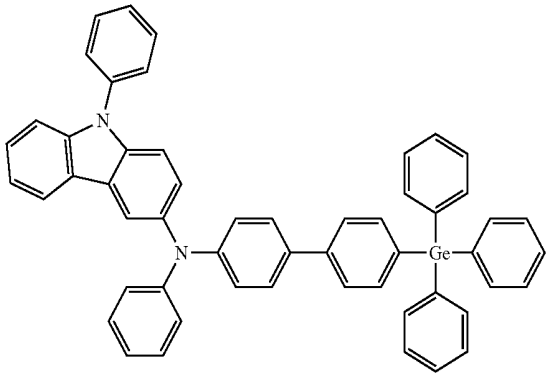

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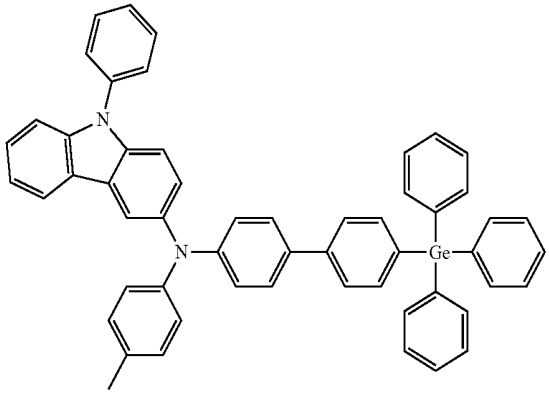

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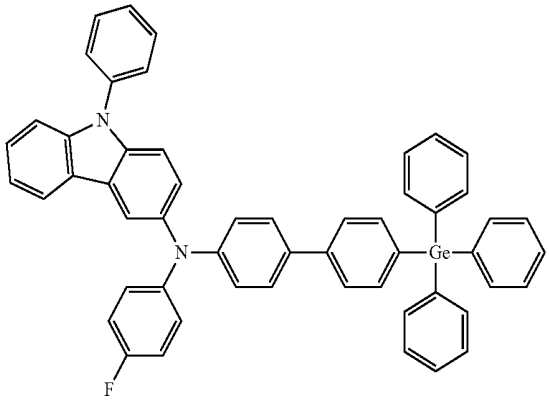

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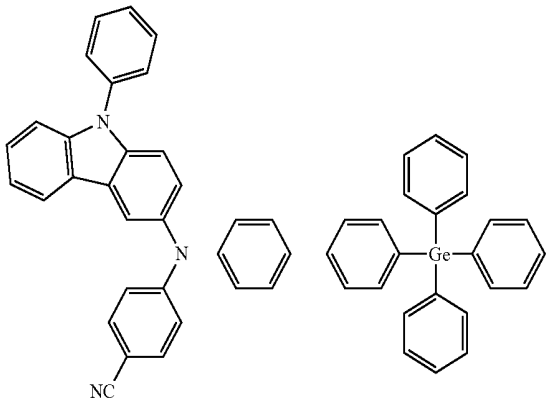

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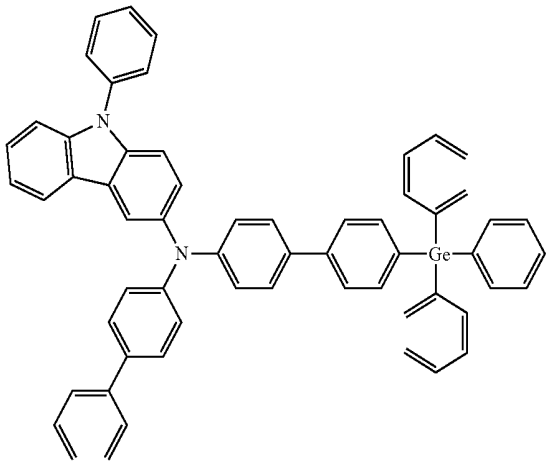

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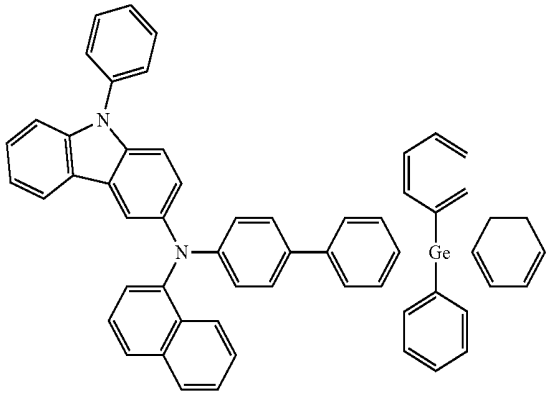

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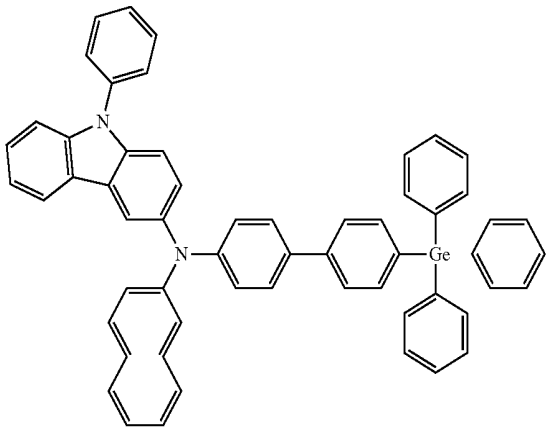

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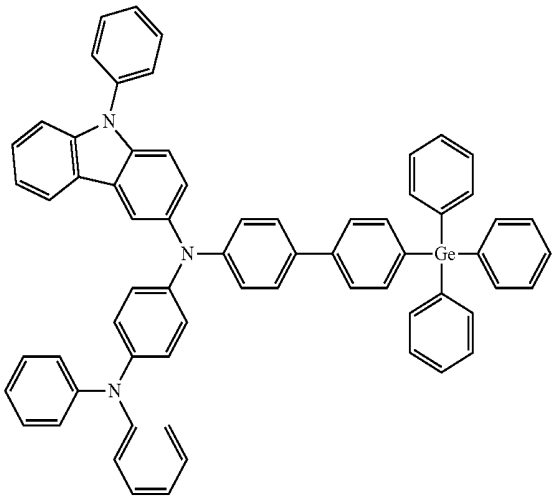

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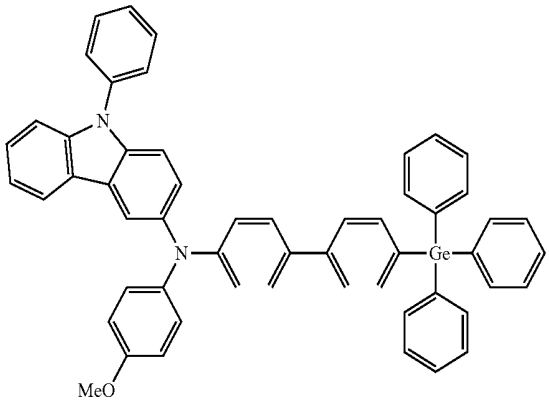

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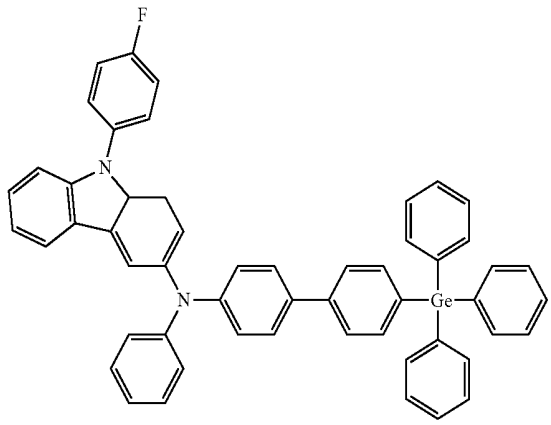

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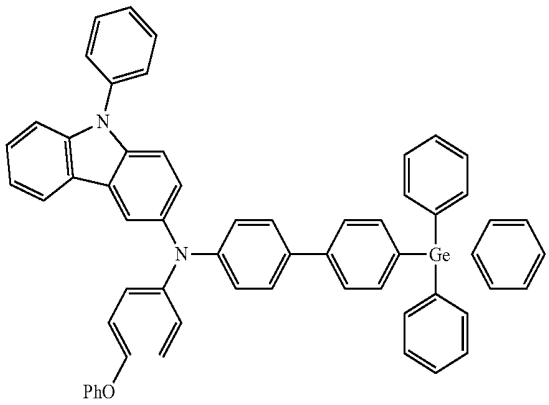

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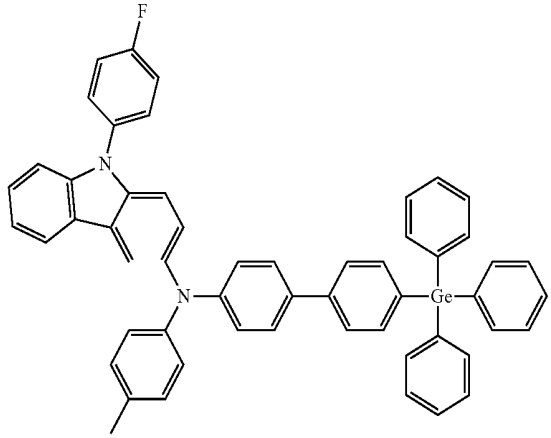

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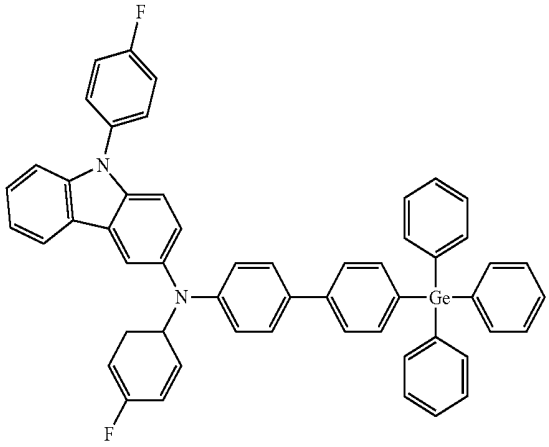

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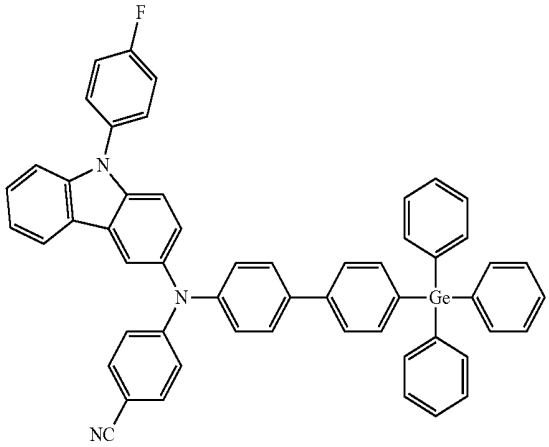

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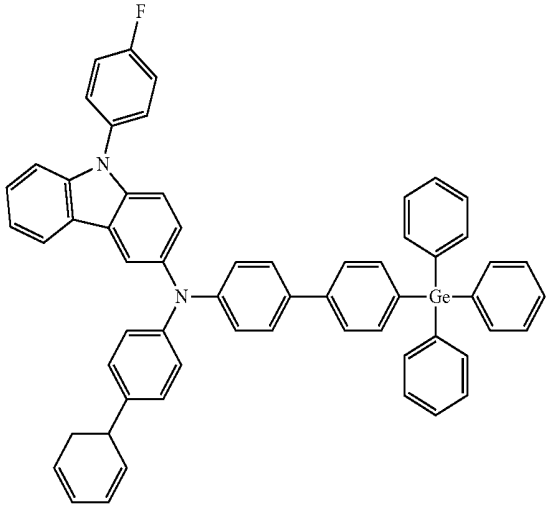

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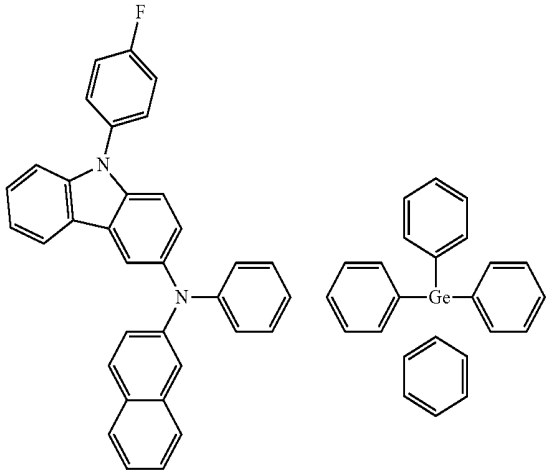

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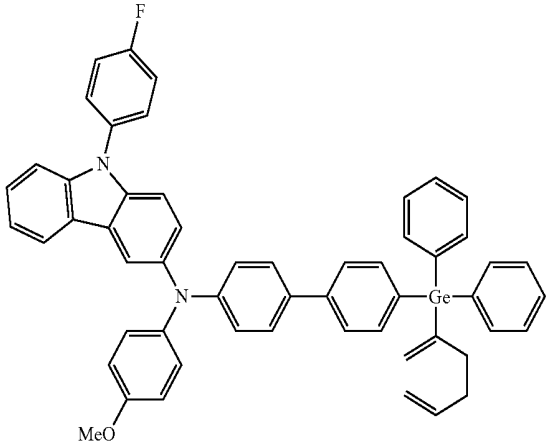

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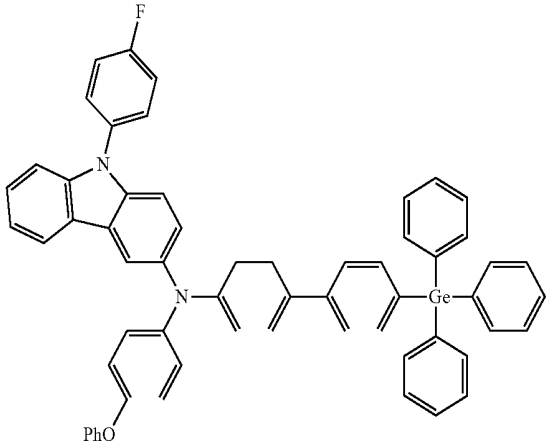

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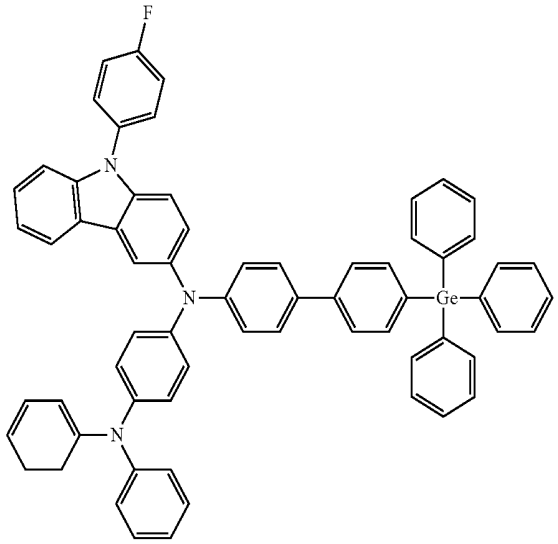

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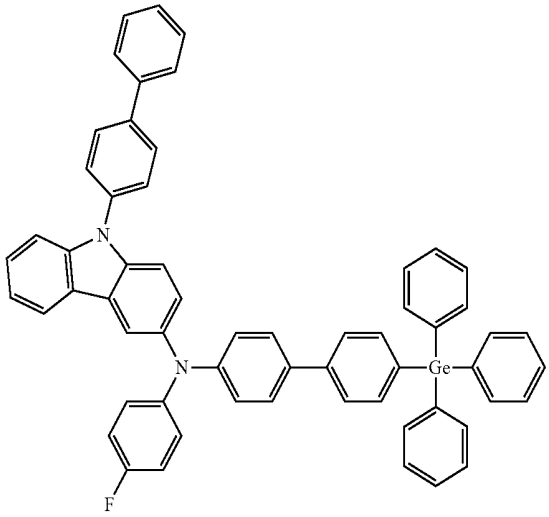

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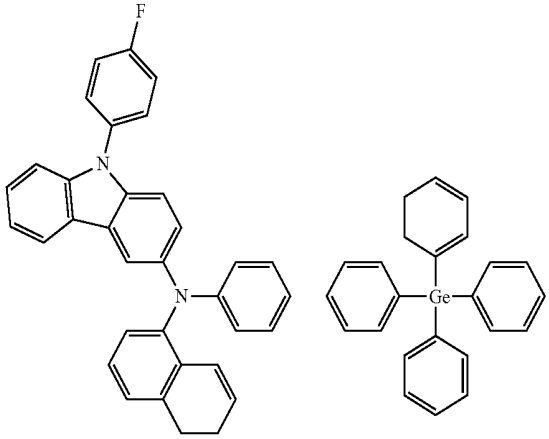

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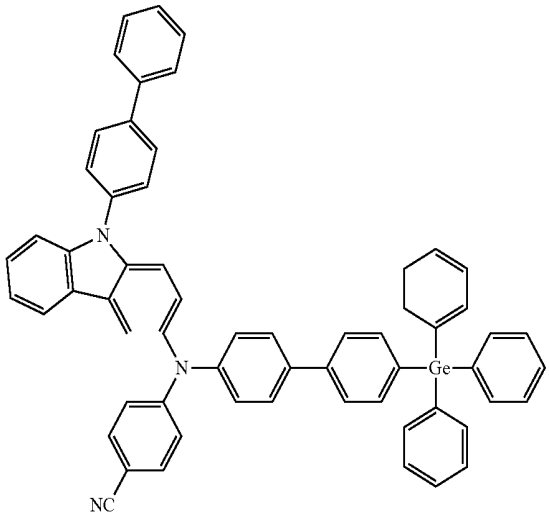

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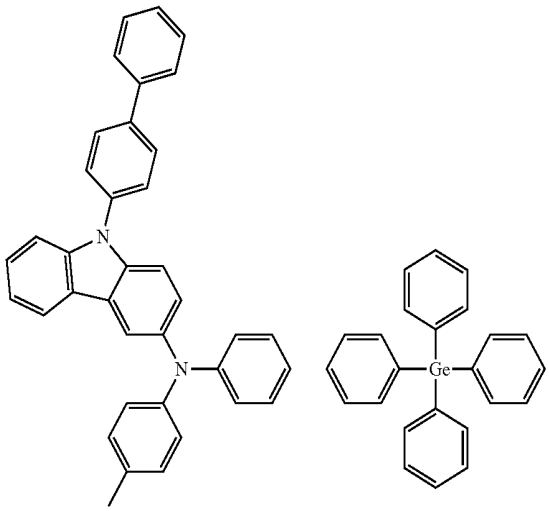

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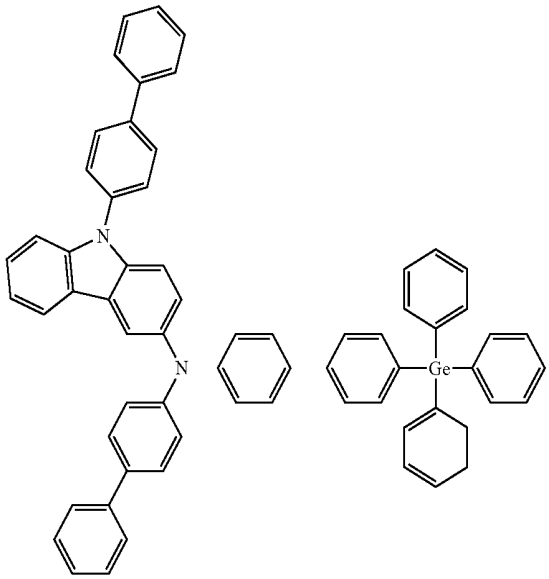

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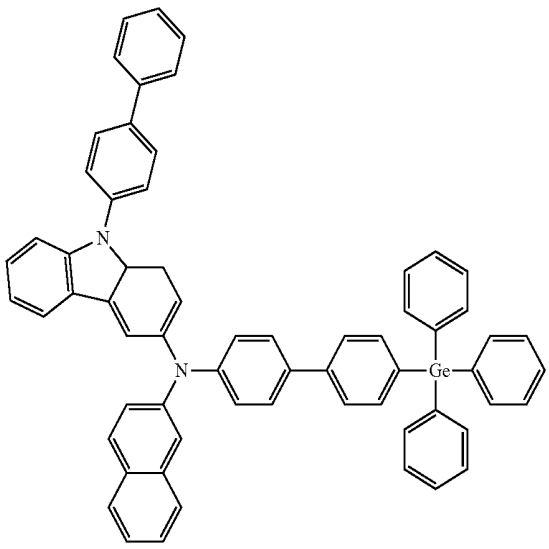

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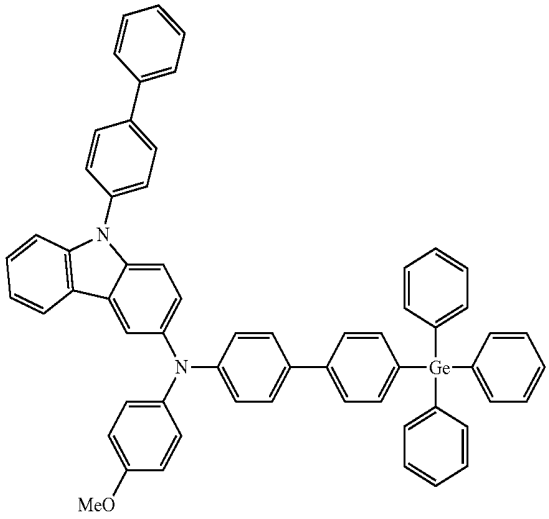

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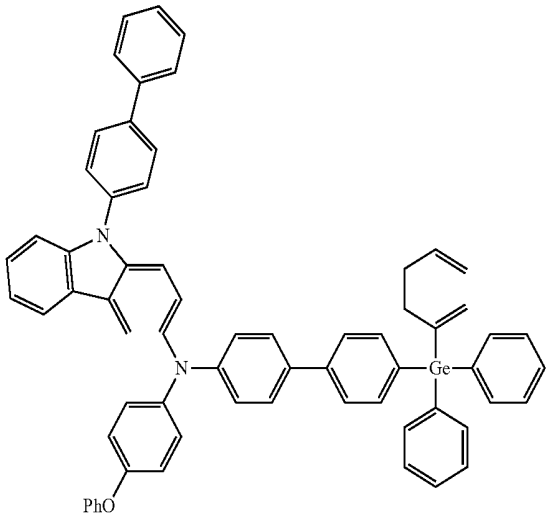

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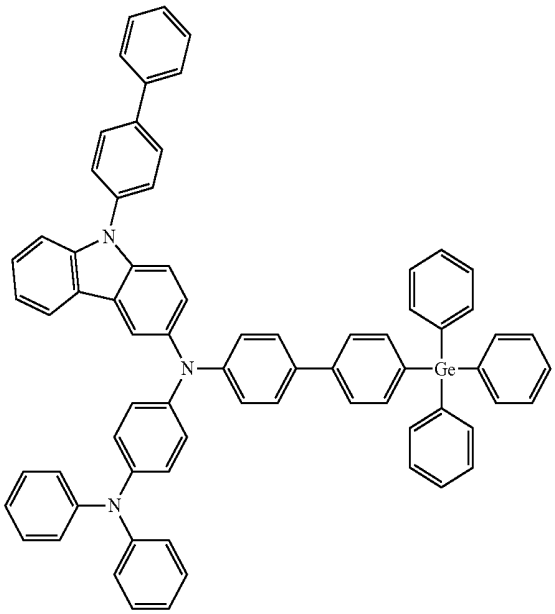

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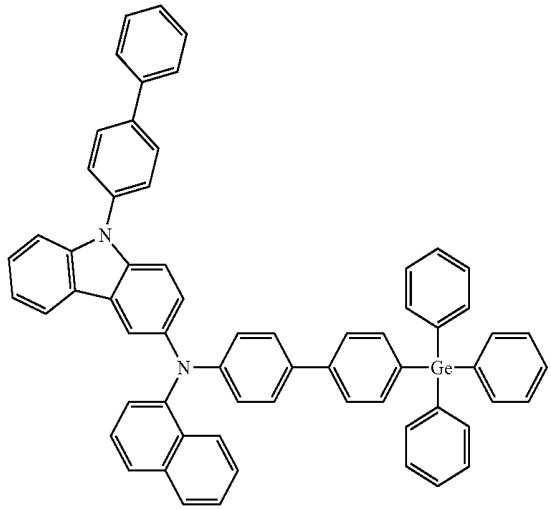

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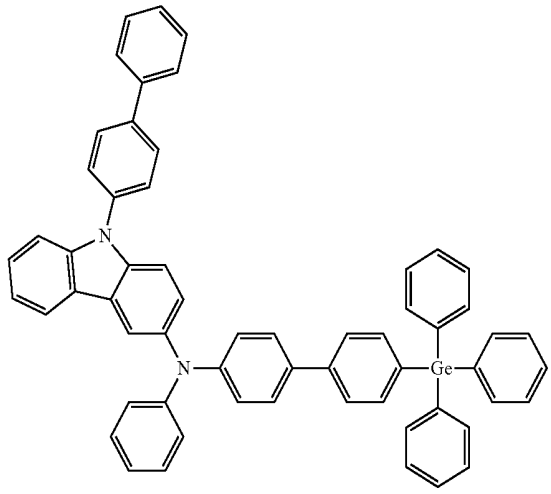

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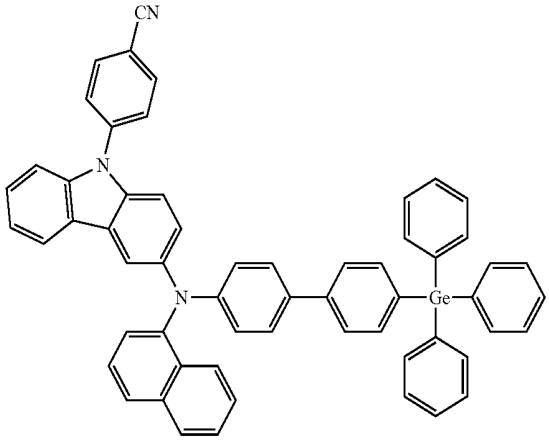

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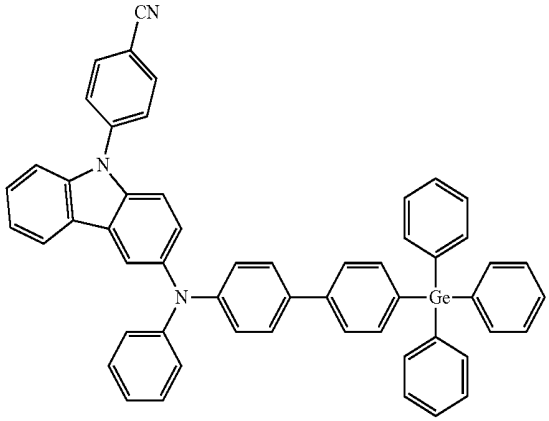

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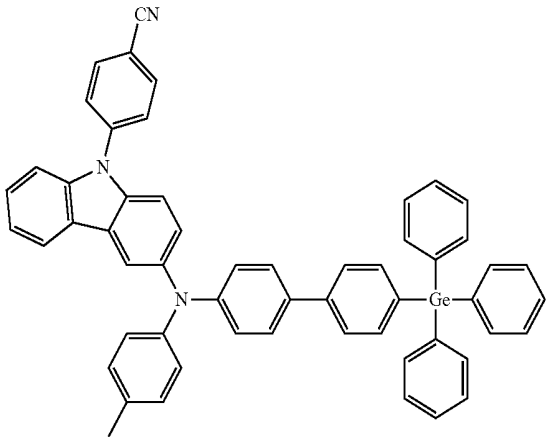

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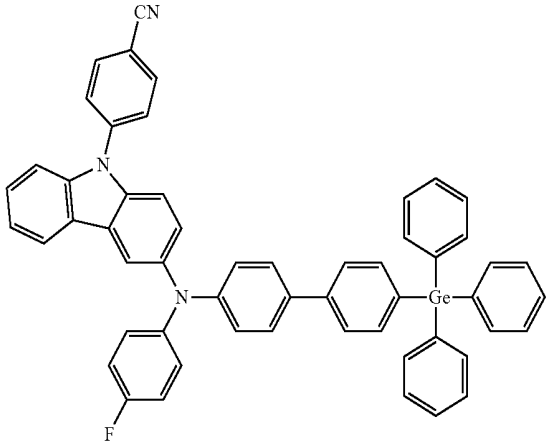

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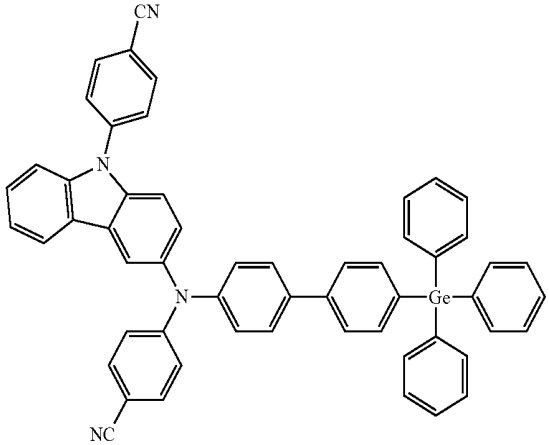

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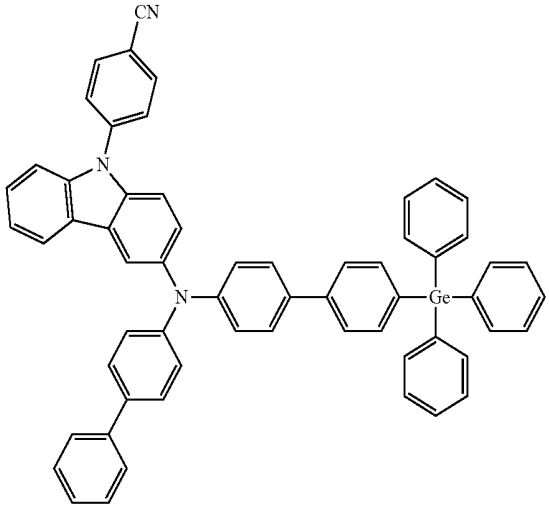

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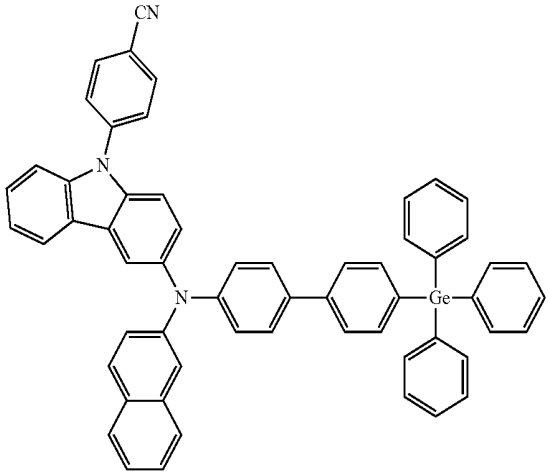

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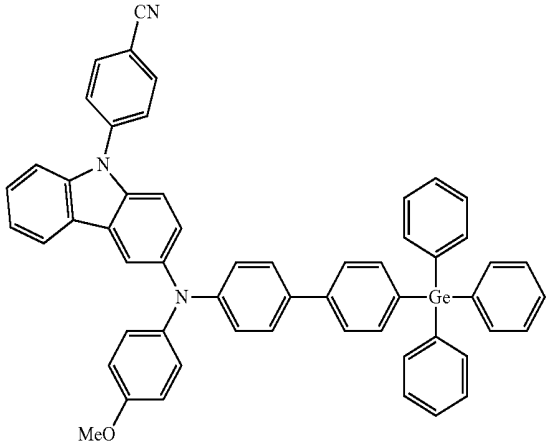

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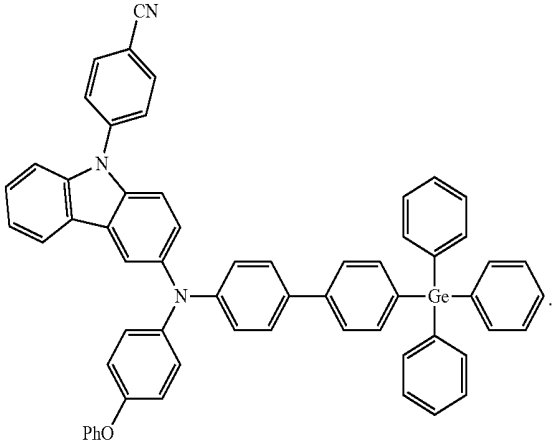

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专利名称(译)	胺基化合物和包括该胺基化合物的有机发光器件		
公开(公告)号	US10519174	公开(公告)日	2019-12-31
申请号	US14/618895	申请日	2015-02-10
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
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摘要(译)

胺基化合物和包括该胺基化合物的有机发光装置，该胺基化合物由下式1表示：