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**(12) United States Patent
Lee****(10) Patent No.: US 10,147,887 B2****(45) Date of Patent: Dec. 4, 2018****(54) COMPOUND AND ORGANIC
LIGHT-EMITTING DEVICE INCLUDING
THE SAME**

KR	10-2012-0072	*	7/2012
KR	10-2013-0007934		1/2013
KR	10-2013-0007951		1/2013

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Yongin, Gyeonggi-Do (KR)****OTHER PUBLICATIONS**Machine translation for KR publication No. 10-2012-0072784 A
(publication date Jul. 2012).***(72) Inventor: Jung-Sub Lee, Yongin (KR)****(73) Assignee: Samsung Display Co., Ltd., Yongin-si
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* cited by examiner

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 723 days.*Primary Examiner* — Dawn L. Garrett**(74) Attorney, Agent, or Firm** — Lewis Roca Rothgerber
Christie LLP**(21) Appl. No.: 14/444,961****(22) Filed: Jul. 28, 2014****(65) Prior Publication Data**

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(2013.01); **H01L 51/0072** (2013.01); **H01L**
51/0074 (2013.01); **H01L 51/0081** (2013.01);
H01L 51/0085 (2013.01); **H01L 51/5012**
(2013.01); **H01L 51/5016** (2013.01); **H01L**
51/5072 (2013.01)**(58) Field of Classification Search**

None

See application file for complete search history.

(56) References Cited**U.S. PATENT DOCUMENTS**

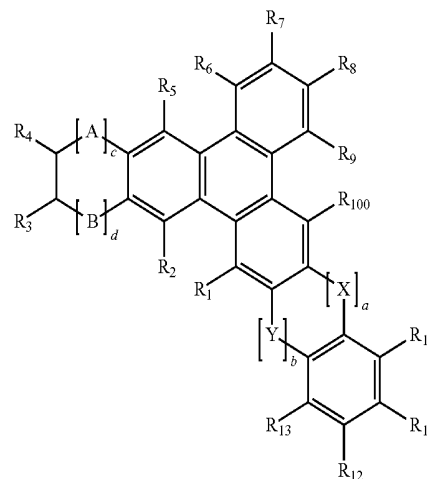
6,245,449	B1 *	6/2001	Tamano		C07C 43/20
					313/504
2006/0086938	A1 *	4/2006	Kang		G02F 1/1345
					257/72
2014/0319495	A1 *	10/2014	Itabashi		H01L 51/0072
					257/40

FOREIGN PATENT DOCUMENTS

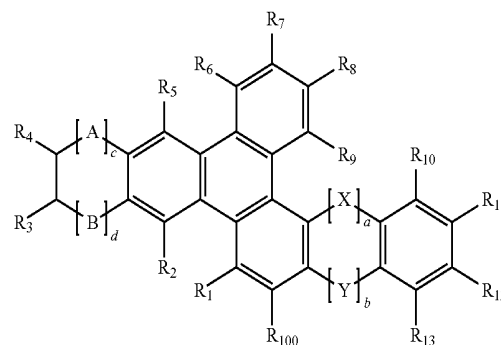
KR	10-2007-0102243	10/2007
KR	10-2011-0077909	7/2011

(57) ABSTRACTA compound is represented by Formula 1 or Formula 2, and
an organic light-emitting device includes the same.

Formula 1



Formula 2

**8 Claims, 1 Drawing Sheet**

10

190
150
110

1

COMPOUND AND ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2014-0027951, filed on Mar. 10, 2014, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

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

2. Description of the Related Art

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

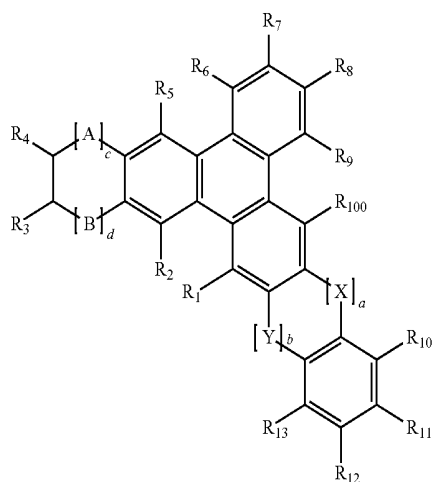
The organic light-emitting device may include a first electrode disposed on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward 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. Carriers, such as holes and electrons, are recombined in the emission layer to produce excitons. These excitons change from an excited state to a ground state, thereby generating light.

SUMMARY

Aspects according to one or more embodiments of the present invention are directed toward a novel 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.

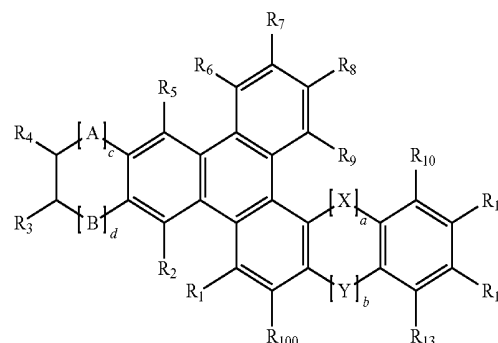
According to an embodiment, a compound is represented by Formula 1 or Formula 2 below:



2

-continued

Formula 2



wherein in Formulae 1 and 2,

X and Y may be each independently NR₂₀₀, O, or S;

A and B may be each independently CR₃₀₀R₃₀₁, O, or S;

R₁ to R₁₃, R₁₀₀, R₂₀₀, R₃₀₀, and R₃₀₁ may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₂-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇);

a, b, c, and d may be each independently 0 or 1, and a case in which a and b are both 0 or c and d are both 0 is excluded; at least one substituent of the substituted C₁-C₆₀ alkyl group, the substituted C₂-C₆₀ alkenyl group, the substituted C₂-C₆₀ alkynyl group, the substituted C₁-C₆₀ alkoxy group, the substituted C₃-C₁₀ cycloalkyl group, the substituted C₂-C₁₀ heterocycloalkyl group, the substituted C₃-C₁₀ cycloalkenyl group, the substituted C₂-C₁₀ heterocycloalkenyl group, the substituted C₆-C₆₀ aryl group, the substituted C₆-C₆₀ aryloxy group, the substituted C₆-C₆₀ arylthio group, the substituted C₂-C₆₀ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed hetero-polycyclic 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an

amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₁₁)(Q₁₂), —Si(Q₁₃)(Q₁₄)(Q₁₅), and —B(Q₁₆)(Q₁₇);

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

a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed hetero-polycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅) and —B(Q₂₆)(Q₂₇); and —N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇), wherein

Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed hetero-polycyclic group.

According to another embodiment, an organic light-emitting device includes: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode and including an emission layer, wherein the organic layer includes at least one of the compounds described above.

According to another embodiment, a flat panel display apparatus includes the organic light-emitting device, wherein the first electrode of the organic light-emitting

device is electrically coupled (e.g., connected) to a source electrode or a drain electrode of a thin film transistor.

BRIEF DESCRIPTION OF THE DRAWING

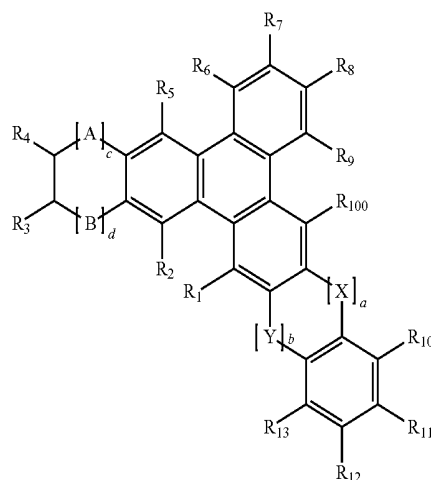
These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the drawing which is a schematic view of an organic light-emitting device according to an embodiment.

DETAILED DESCRIPTION

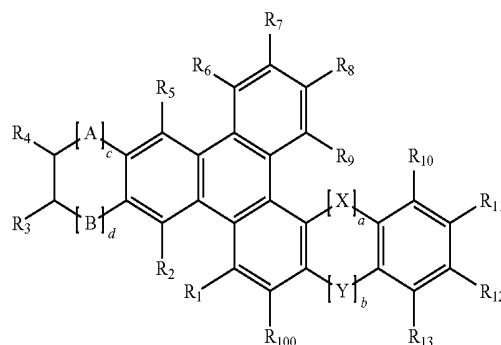
Reference will now be made in more detail to embodiments, examples of which are illustrated in the accompanying drawing, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to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

A compound according to an embodiment is represented by Formula 1 or 2 below:

Formula 1



Formula 2



wherein in Formulae 1 and 2,

X and Y may be each independently NR₂₀₀, O, or S;

A and B may be each independently CR₃₀₀R₃₀₁, O, or S;

R_1 to R_{13} , R_{100} , R_{200} , R_{300} , and R_{301} may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkynyl group, a substituted or unsubstituted C_1 - C_{60} alkoxy group, a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_2 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group, —N(Q_1)(Q_2), —Si(Q_3)(Q_4)(Q_5), and —B(Q_6)(Q_7);

a, b, c, and d may be each independently 0 or 1, and a case in which a and b are both 0 or c and d are both 0 is excluded;

at least one substituent of the substituted C₁-C₆₀ alkyl group, the substituted C₂-C₆₀ alkenyl group, the substituted C₂-C₆₀ alkynyl group, the substituted C₁-C₆₀ alkoxy group, the substituted C₃-C₁₀ cycloalkyl group, the substituted C₂-C₁₀ heterocycloalkyl group, the substituted C₃-C₁₀ cycloalkenyl group, the substituted C₂-C₁₀ heterocycloalkenyl group, the substituted C₆-C₆₀ aryl group, the substituted C₆-C₆₀ aryloxy group, the substituted C₆-C₆₀ arylthio group, the substituted C₂-C₆₀ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

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

a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₇-C₆₀ heteroaryl group, a

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

a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed hetero-polycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅) and —B(Q₂₆)(Q₂₇); and
—N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇), wherein

Q₁ to Q₇, Q₁₁to Q₁₇, Q₂₁to Q₂₇, and Q₃₁to Q₃₇ may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

Conventional (comparable) host materials for an organic light-emitting device are desired in terms of luminescent characteristics, but due to their low glass transition temperature and poor thermal stability, when high-temperature deposited in a vacuum condition, their properties changes. In addition, regarding an organic light-emitting device, power efficiency equals (=) (π voltage) $\times$ current efficiency. Since power efficiency is in reverse proportion to voltage, a lower consumption power (i.e., a lower voltage) is needed to obtain a higher power efficiency for an organic light-emitting device. In fact, an organic light-emitting device using (utilizing) a phosphorescent luminescent material has higher current efficiency (cd/A) than an organic light-emitting device using (utilizing) a fluorescent luminescent material. However, when BALq or CBP is used (utilized) as a phosphorescent luminescent material host, a formed organic light-emitting device may have high driving voltage, thereby showing a relatively low power efficiency (lm/w) compared to an organic light-emitting device using (utilizing) a fluorescent material. Also, the formed organic light-emitting device has unsatisfactory lifetime characteristics. Accordingly, there is a demand for the development of a host material with excellent performance. An organic luminescent compound according to embodiments of the present invention (compared to a comparable host material) may have high luminescent efficiency and long device lifespan, and an excellent skeleton with an appropriate color coordi-

nate. An organic luminescent device may have high efficiency and long-lifespan due to the inclusion of the novel organic luminescent compound as a luminescent material.

Meanwhile, Korean patent applications with the application numbers: KR2013-0007951 and 2013-0007934 fail to disclose how to improve the lifespan characteristics of an organic light-emitting device. According to these techniques, the hole transporting characteristics of triphenylene are added (included). However, in this case, the molecular stability decreases with respect to the incoming electrons, leading to a decrease in the lifespan the organic light-emitting device. This is because electrons in triphenylene are more present in only one side, and positions where activation may occur are exposed. To reduce or prevent these phenomena, according to embodiments of the present invention, an active site of a core is blocked, and a fused substituent is introduced to increase the T1 (energy) level (of the excited state). By doing so, a device having high efficiency and long lifespan is obtained.

Hereinafter, substituents of Formula 1 and Formula 2 are described in detail.

According to an embodiment, R_1 to R_{13} , R_{100} , R_{200} , R_{300} , and R_{301} in Formula 1 and Formula 2 may be each independently selected from a hydrogen, a deuterium, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkynyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_2 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group.

According to another embodiment, R_1 , R_2 , R_5 , R_6 to R_9 , and R_{100} in Formula 1 and Formula 2 may be each independently a hydrogen or a deuterium.

According to another embodiment, R_3 and R_4 in Formula 1 and Formula 2 may be fused to form a phenyl moiety.

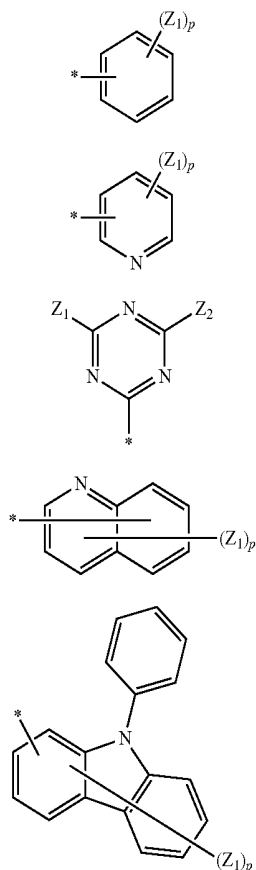
According to another embodiment of the present invention, R_{10} to R_{13} , and R_{200} in Formula 1 and Formula 2 may be each independently selected from a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolynyl group, an isoquinolynyl group, a benzoquinolynyl 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 benzooxazolyl 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 dibenzo-fluorenyl 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolynyl group, an isoquinolynyl group, a benzoquinolynyl 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 benzooxazolyl 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 and a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

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According to another embodiment, R_{10} to R_{13} in Formula 1 and Formula 2 may be each independently a hydrogen, a deuterium, or one of Formulae 2a to 2e below:

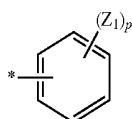


Z_1 and Z_2 in the formulae above may be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{20} aryl group, a substituted or unsubstituted C_1 to C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group;

p is an integer of 1 to 7; and when p is two or more, a plurality of Z_1 may be identical or different; and * indicates a binding site to a neighboring atom.

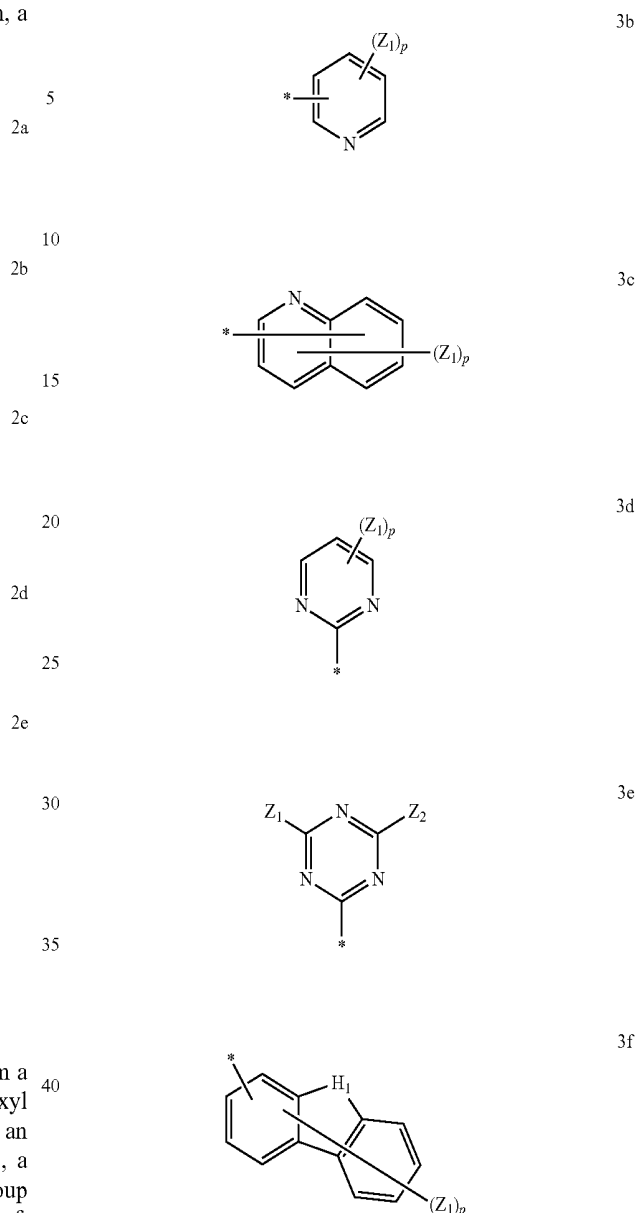
According to another embodiment, X and Y in Formula 1 and Formula 2 may be each independently NR_{200} , or S .

According to another embodiment, R_{200} may be any one of Formulae 3a to 3f:



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-continued



In the formulae above, H_1 may be NR_{400} or S ; R_{400} , Z_1 , and Z_2 may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{20} aryl group, a substituted or unsubstituted C_1 to C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group;

p is an integer of 1 to 7; and when p is two or more, a plurality of Z_1 may be identical or different; and * indicates a binding site to a neighboring atom.

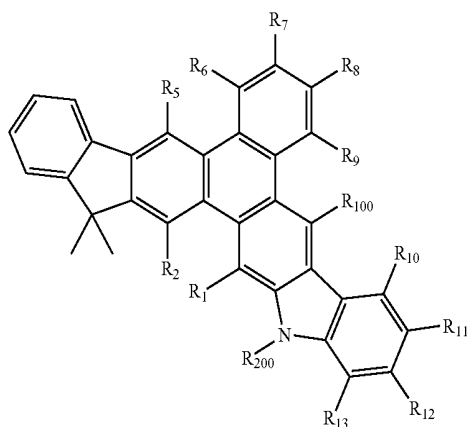
According to another embodiment, Formula 1 or Formula 2 may be any one of Formulae 3 to 10:

11**12**

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Formula 3

Formula 6



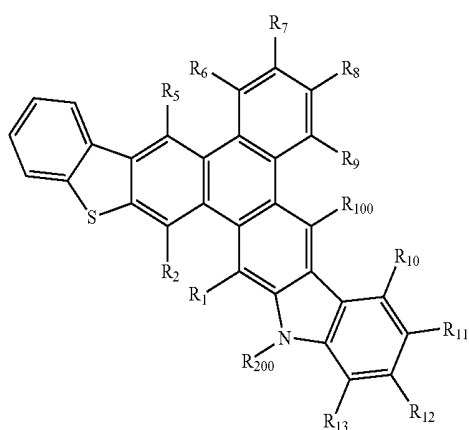
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Formula 4

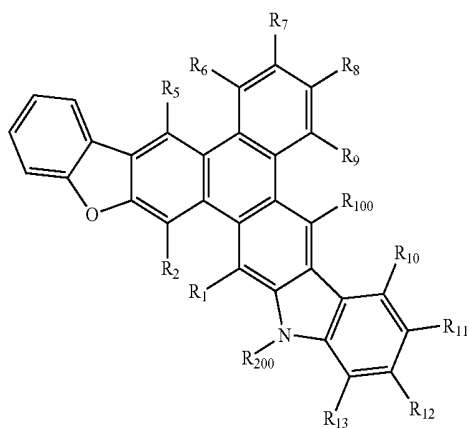


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Formula 5

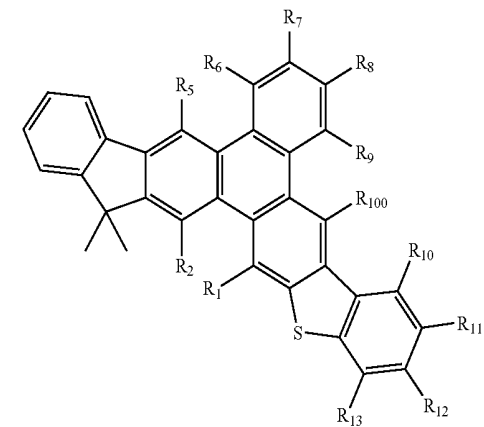


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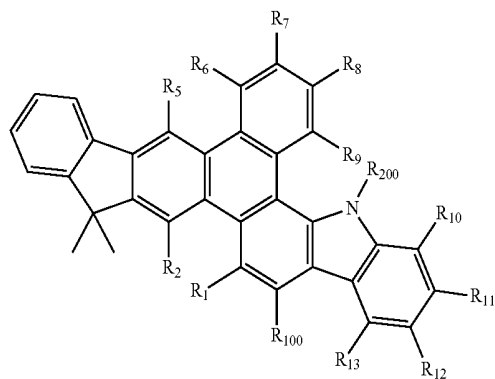
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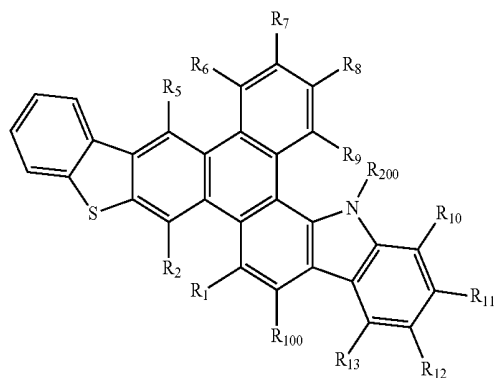
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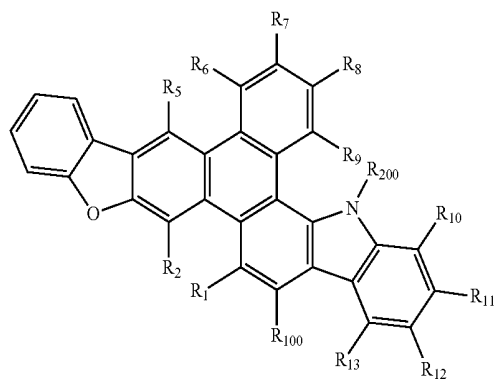
Formula 7



Formula 8



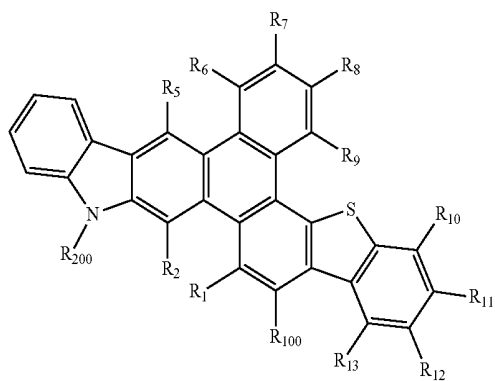
Formula 9



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-continued

Formula 10

**14**

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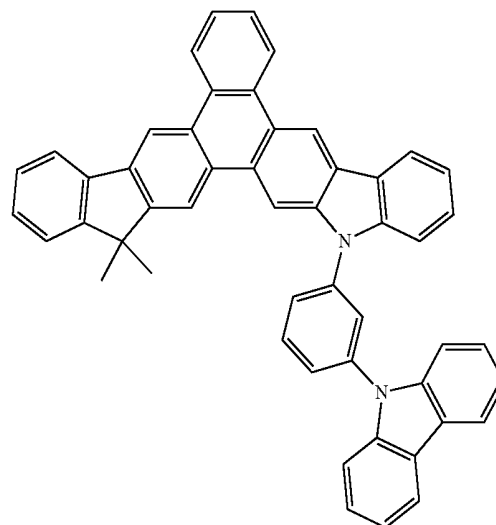
Inv-3

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wherein in Formulae 3 to 10, substituents are the same as those stated above.

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According to another embodiment, the compound of Formula 1 or 2 may be any one of compounds Inv-1 to Inv-63 illustrated below:

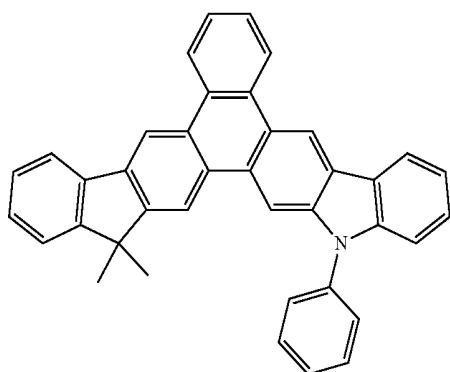
Inv-1

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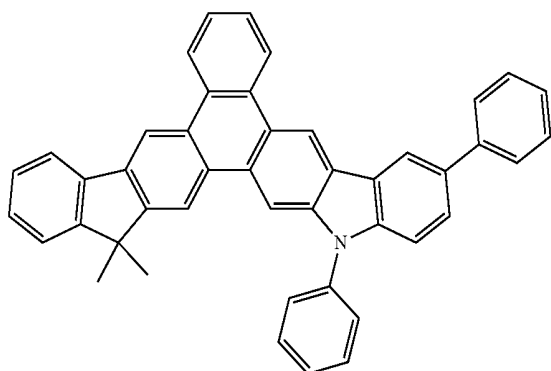
Inv-4

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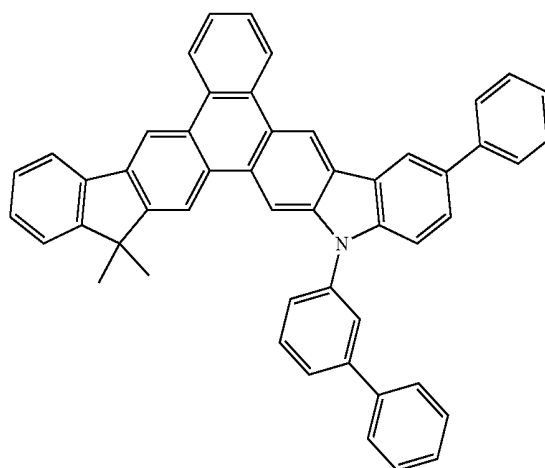
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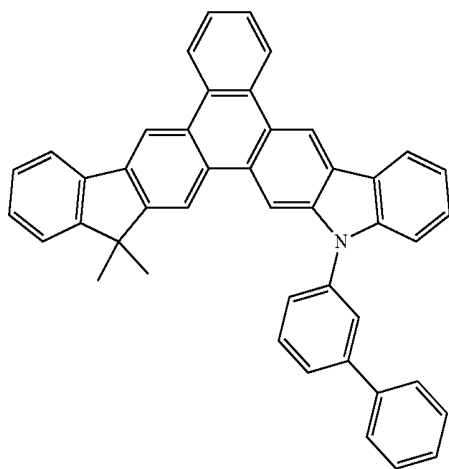
Inv-2

Inv-5



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-continued



Inv-6

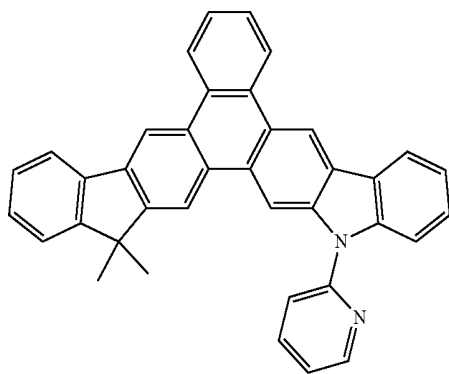
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Inv-7

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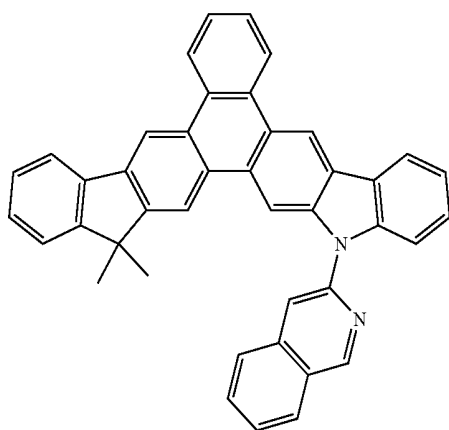


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Inv-8

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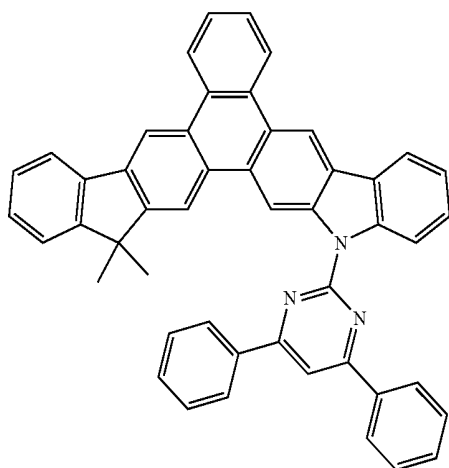


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Inv-9

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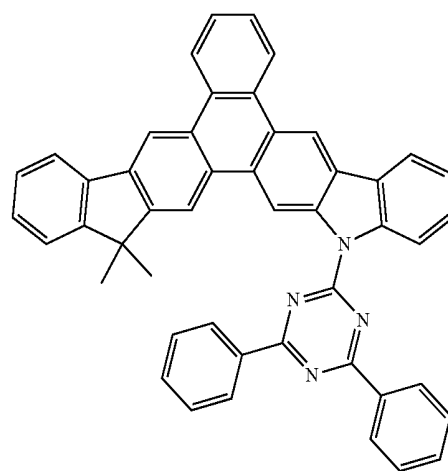
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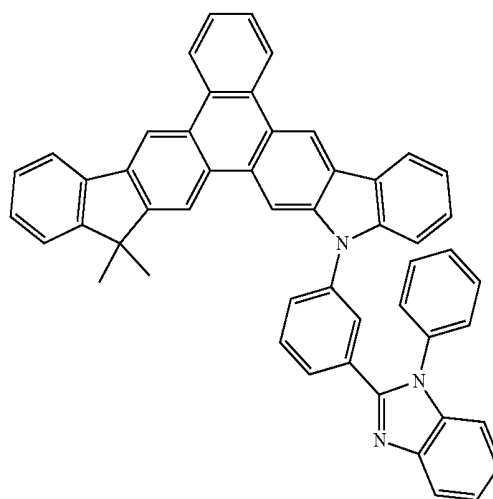
16

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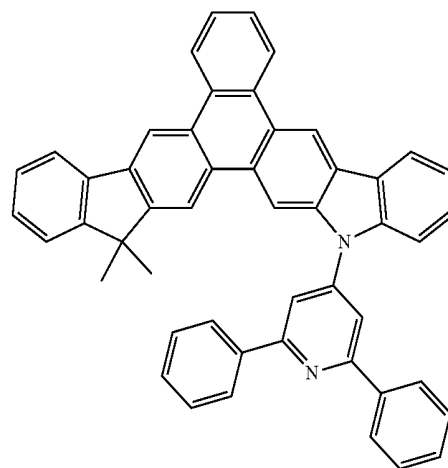


Inv-10

Inv-11



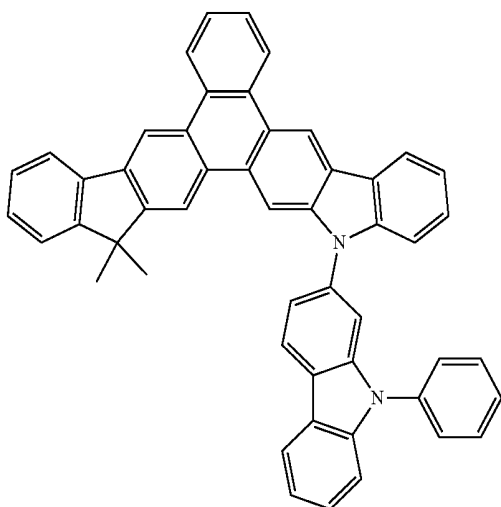
Inv-12



17

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Inv-13



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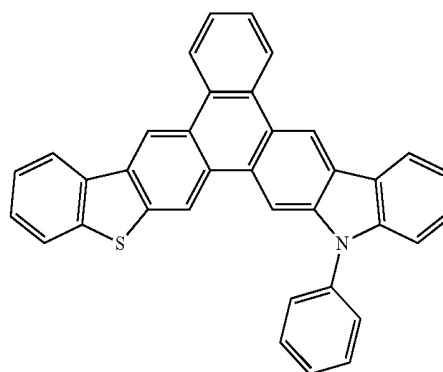
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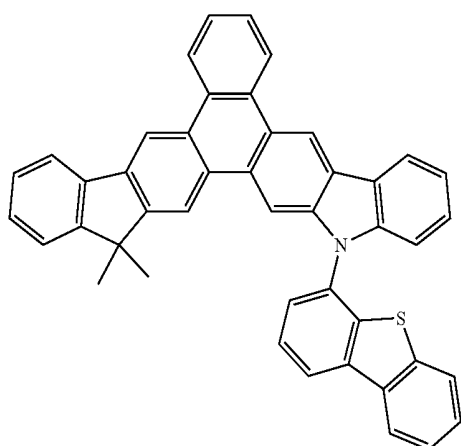
Inv-16



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Inv-17

Inv-14

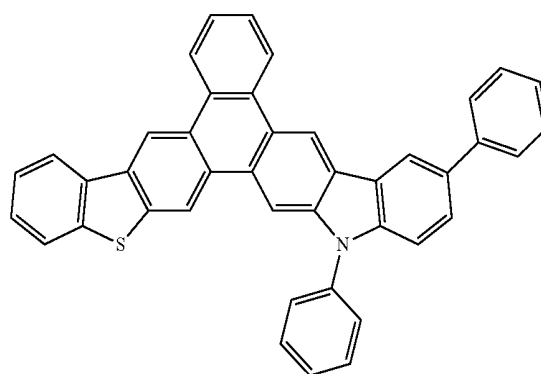


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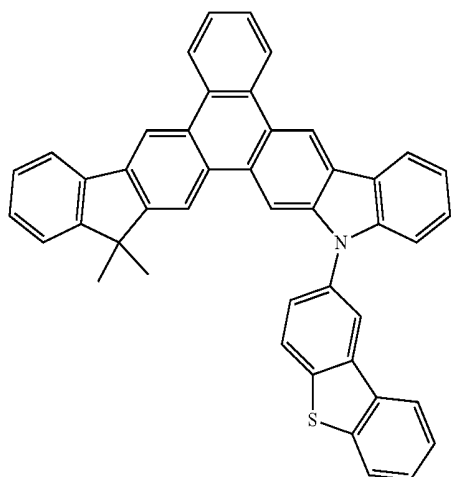
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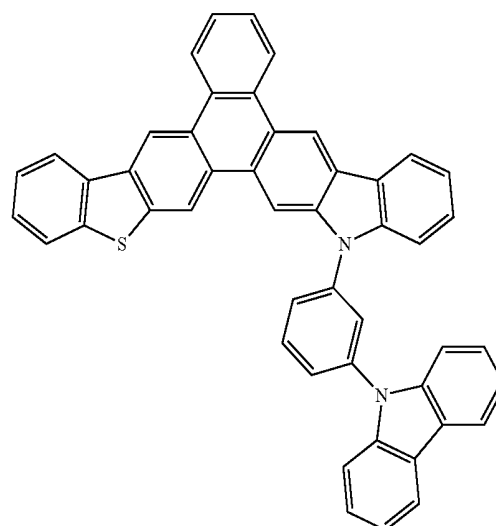
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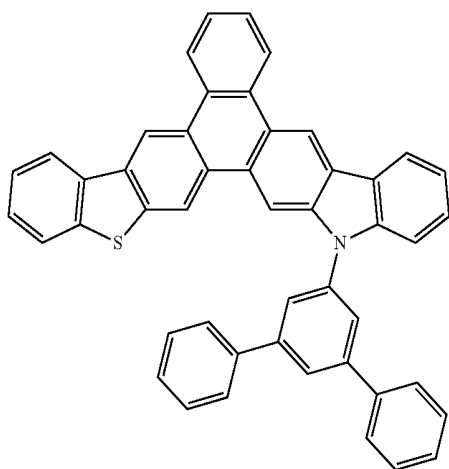


Inv-18



19

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Inv-19

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Inv-20

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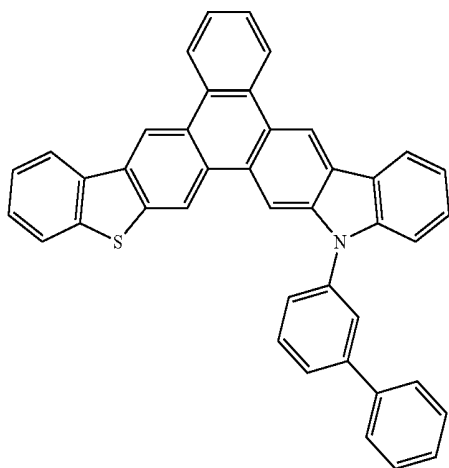
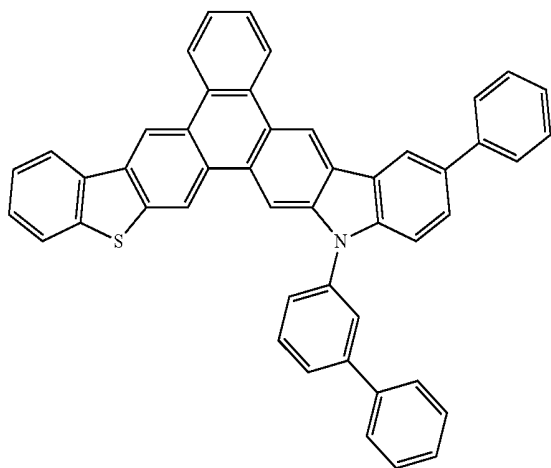
Inv-21

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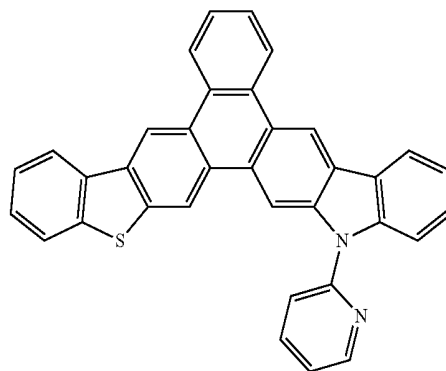
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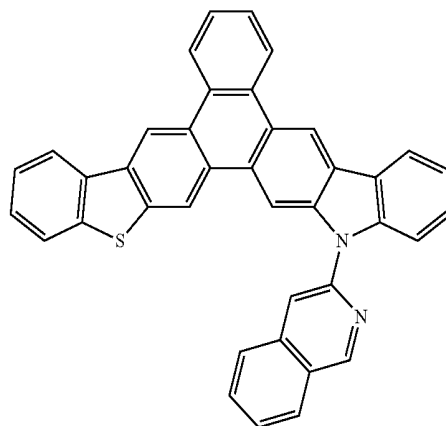
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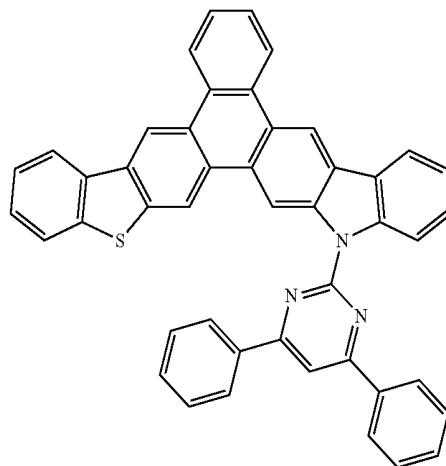


Inv-22

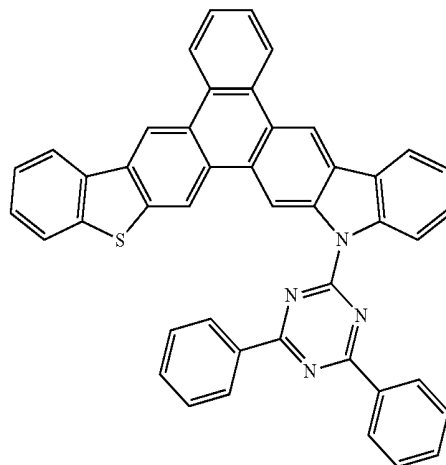
Inv-23



Inv-24



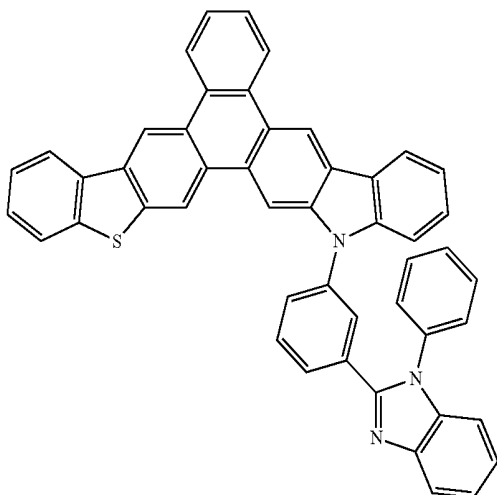
Inv-25



21

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Inv-26



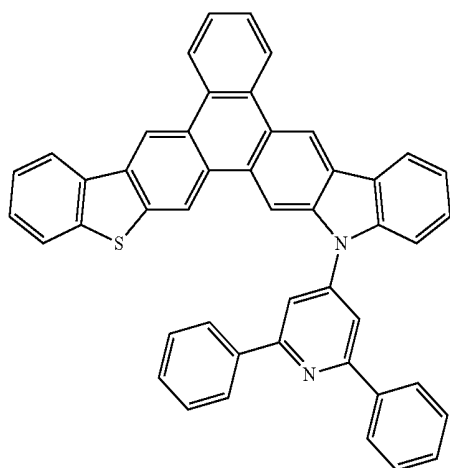
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Inv-27



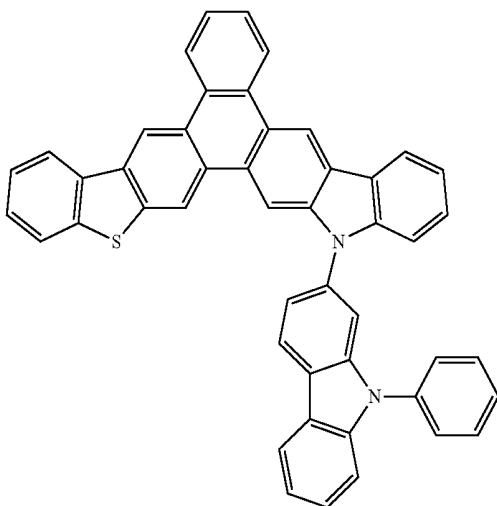
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Inv-28



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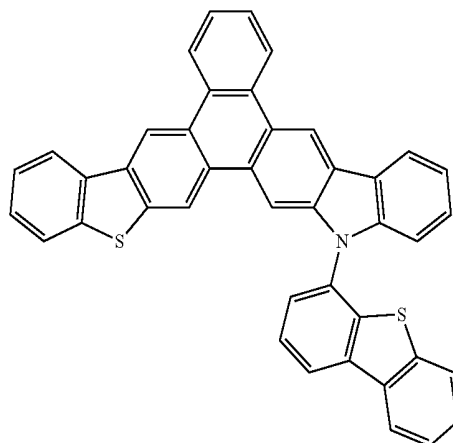
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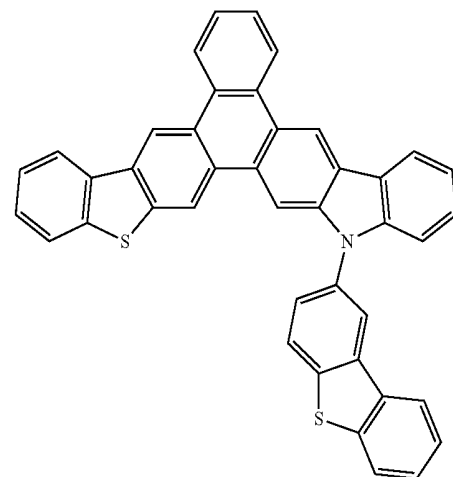
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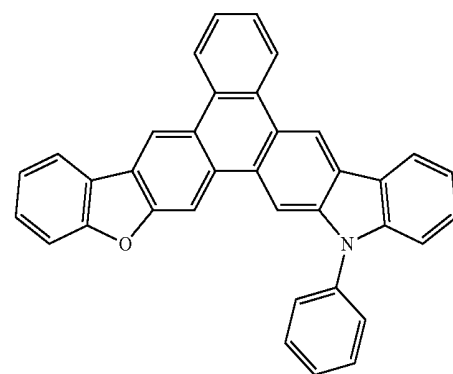
Inv-29



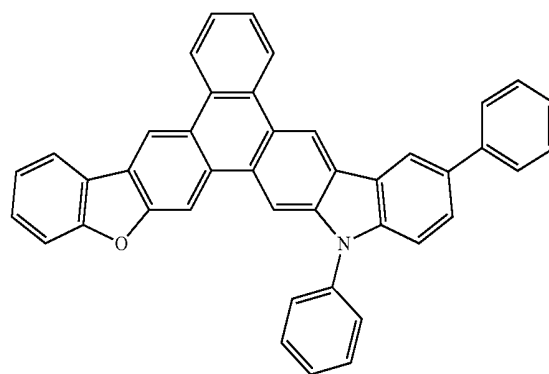
Inv-30



Inv-31



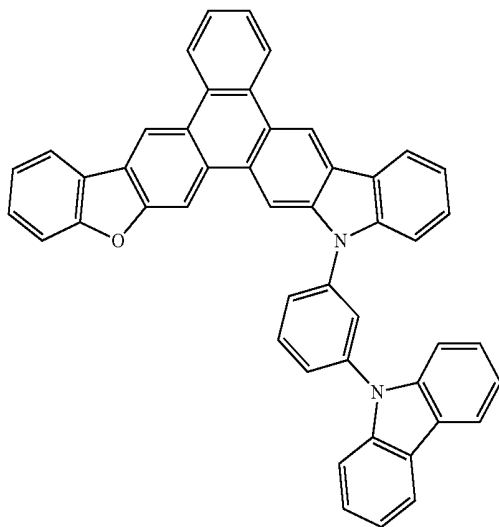
Inv-32



23

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Inv-33



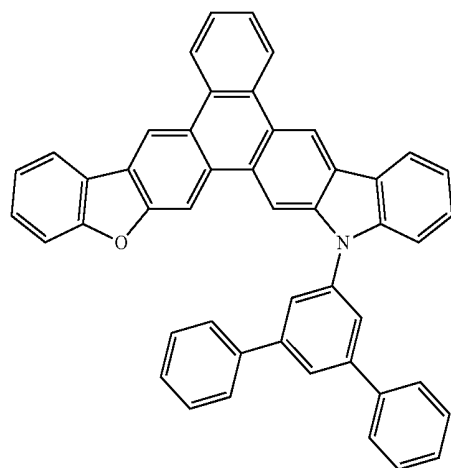
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Inv-34



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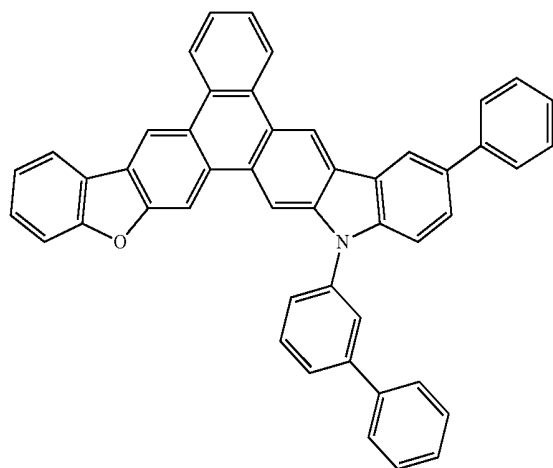
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Inv-35



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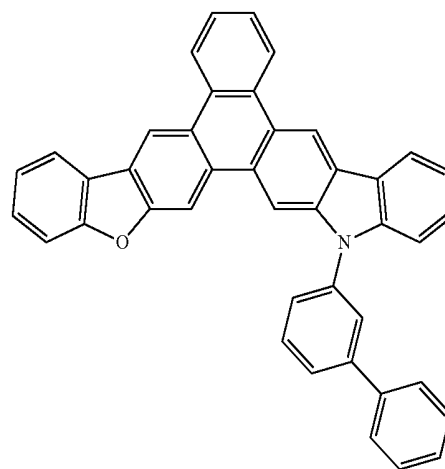
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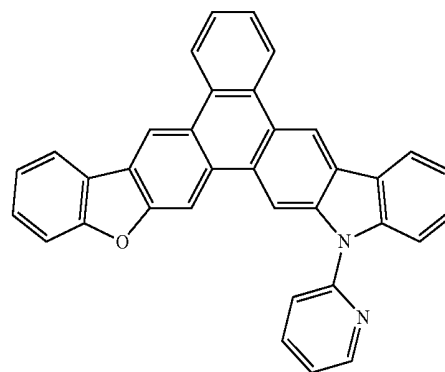
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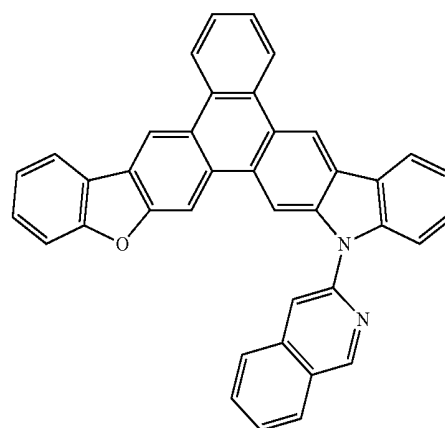
Inv-36



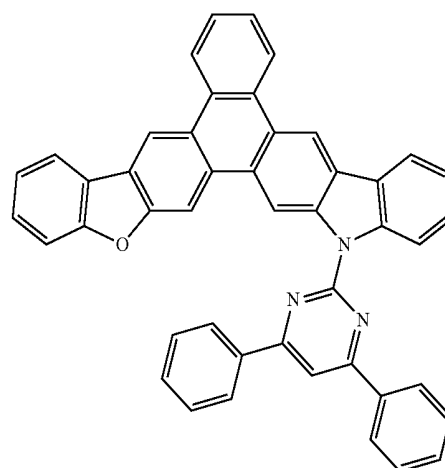
Inv-37



Inv-38

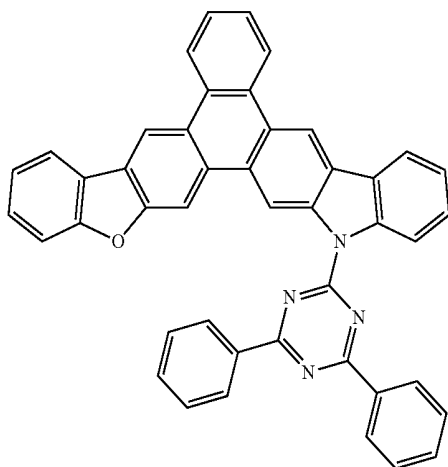


Inv-39



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Inv-40

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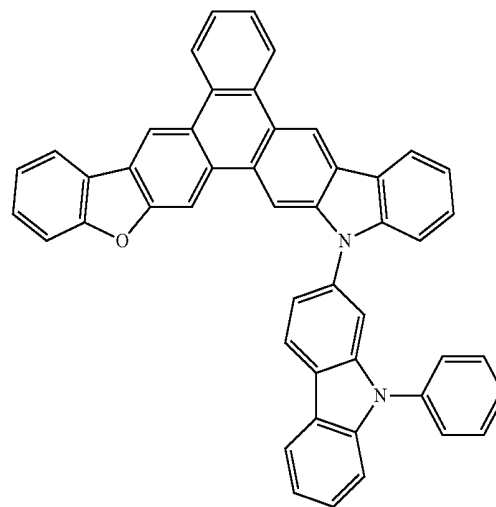
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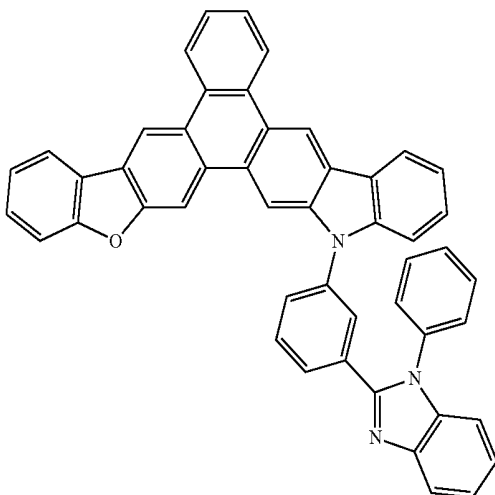
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Inv-43

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Inv-41



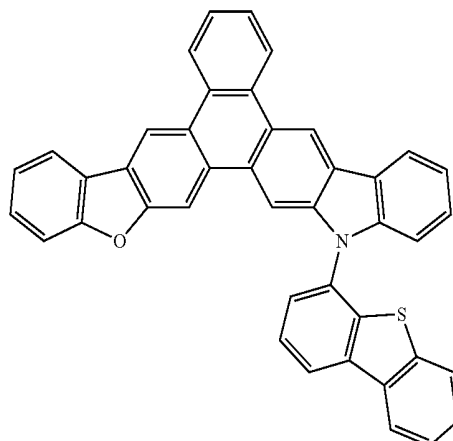
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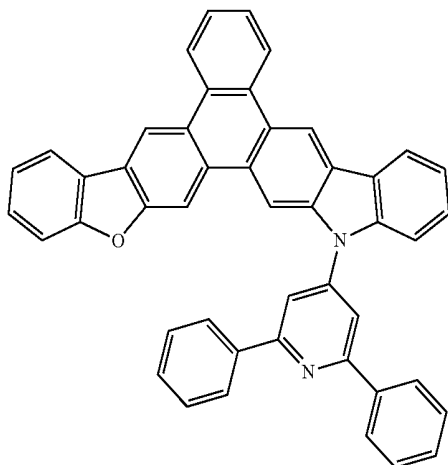
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Inv-44



Inv-42

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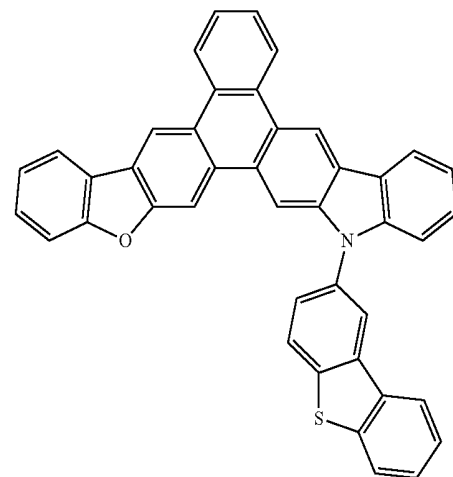


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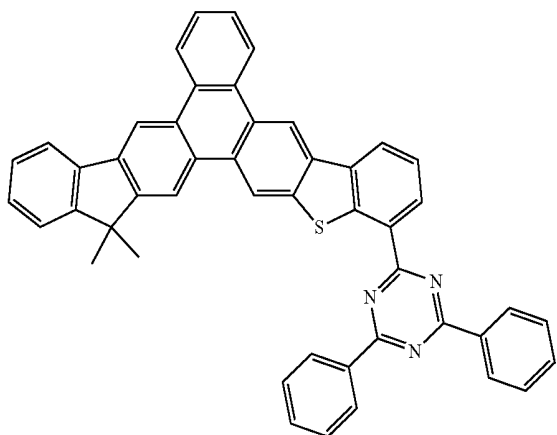
Inv-45



27

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Inv-46



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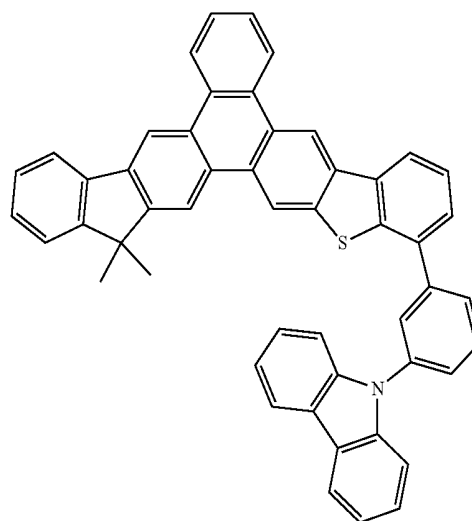
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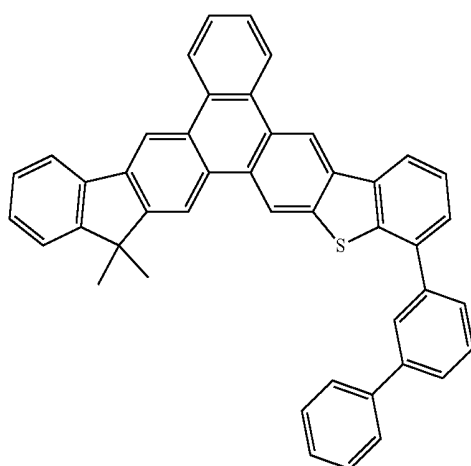
Inv-49



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Inv-47

Inv-50

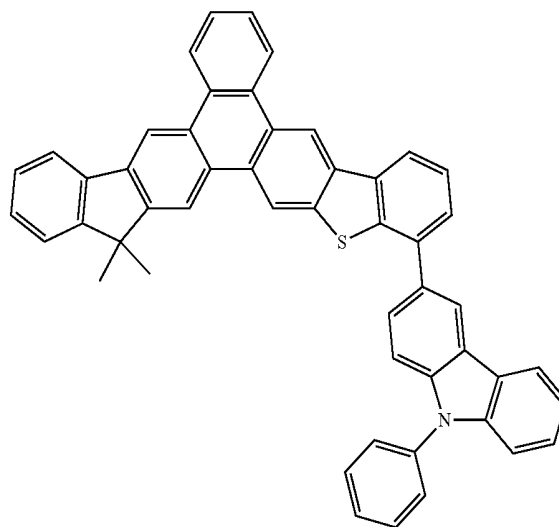


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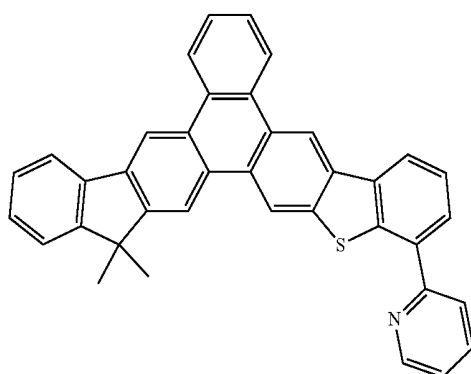
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Inv-48

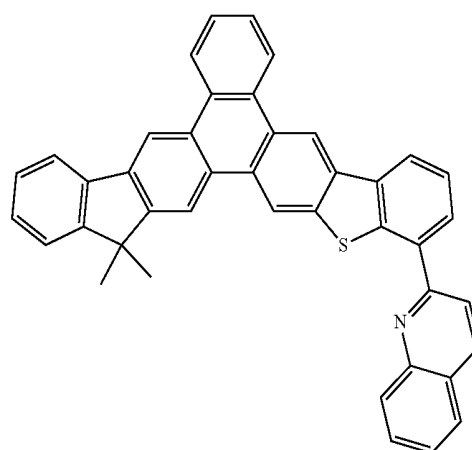
Inv-51



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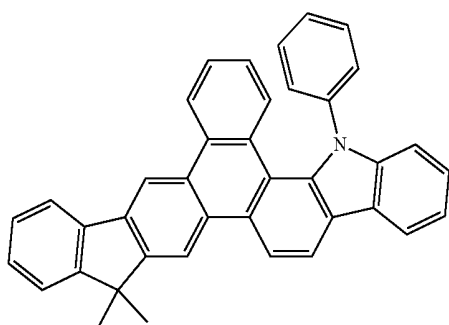
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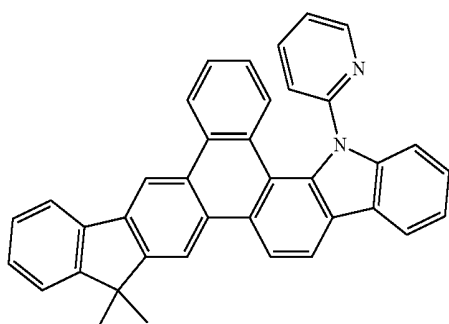
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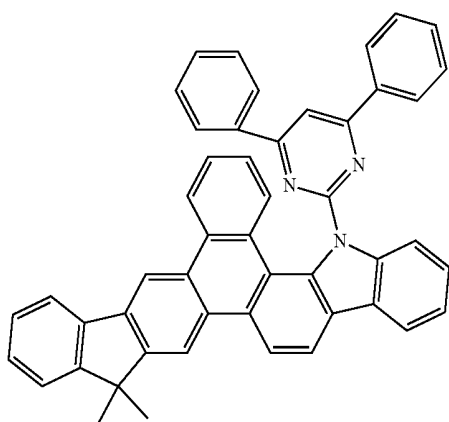
Inv-52

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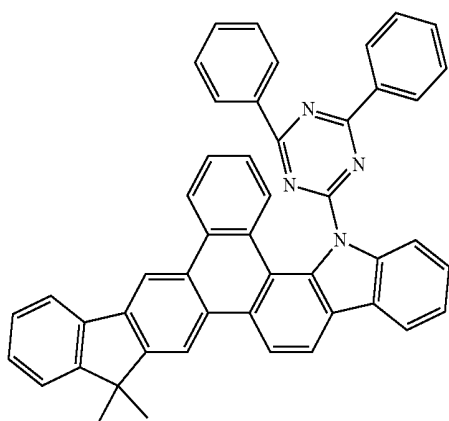
Inv-53

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Inv-54

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Inv-55

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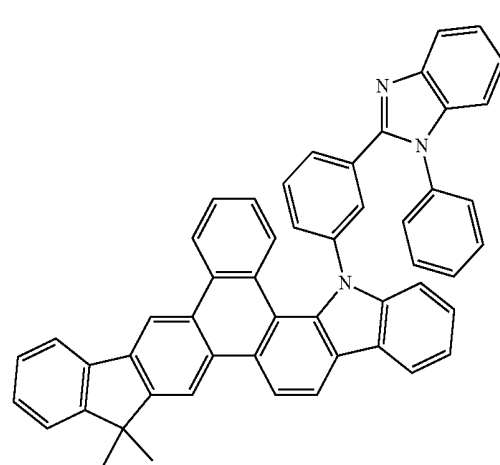
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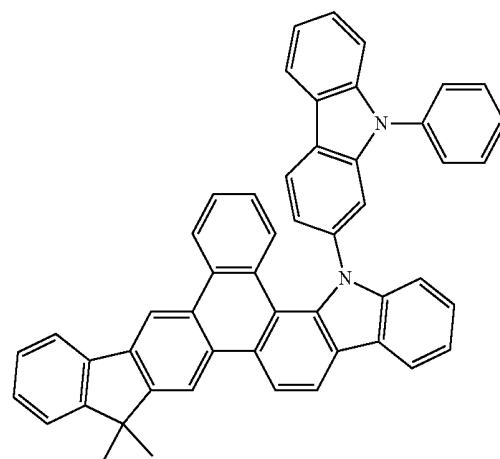
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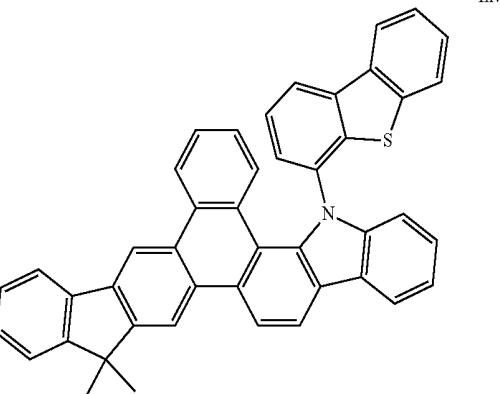
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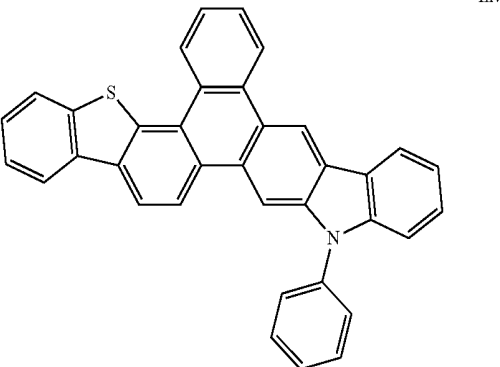
Inv-56



Inv-57



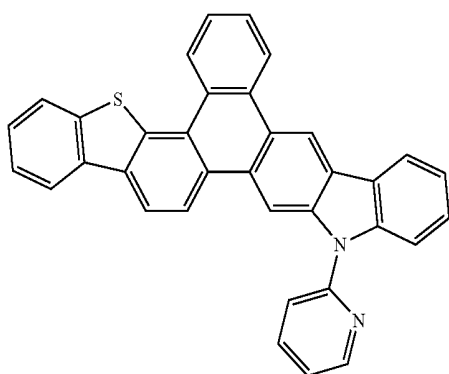
Inv-58



Inv-59

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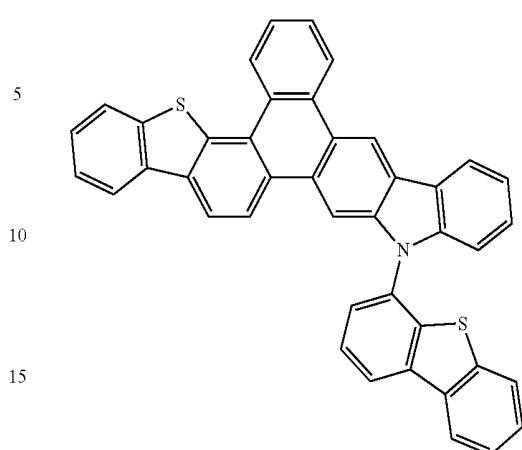
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Inv-60

32

-continued



Inv-63

20 The compound of Formula 1 or 2 may be synthesized by using (utilizing) a known or suitable organic synthesis method. A synthesis method of the organic compound may be obvious to one of ordinary skill in the art in view of the following embodiments.

Inv-61

25 The compound of Formula 1 or 2 may be used (utilized) between a pair of electrodes of an organic light-emitting device. For example, the compound may be included in an electron transport region, for example, an electron transport layer. Accordingly, an organic light-emitting device according to an embodiment includes: 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 of the compounds of

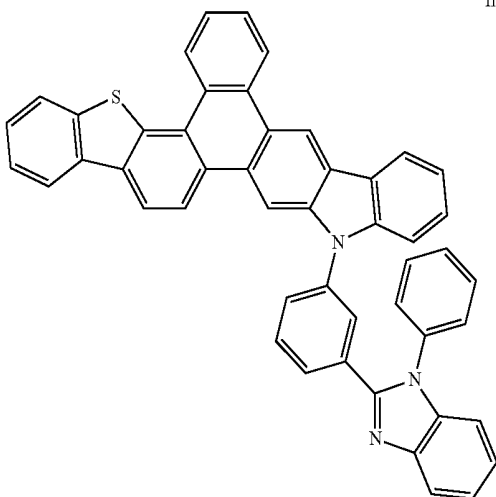
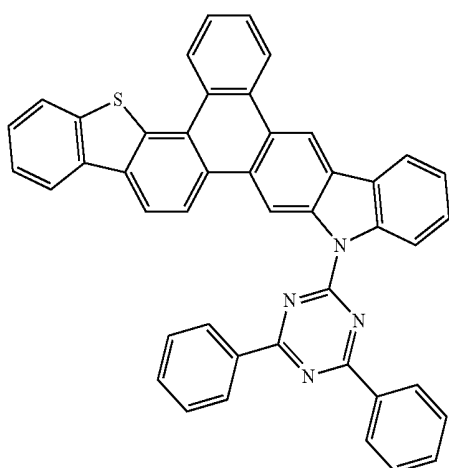
35 Formula 1 or 2. The expression “(an organic layer) includes at least one of the compounds” used herein may include a case in which (an organic layer) includes one compound of Formula 1 or 2, and a case in which (an organic layer) includes two or more different compounds of Formula 1 or 2.

40 For example, the organic layer may include, as the compound, only Compound 1 (e.g., compound Inv-1). In this regard, Compound 1 may exist in an electron transport layer of the organic light-emitting device. In another embodiment, 45 the organic layer may include, as the compound, Compound 1 and Compound 2 (e.g., compound Inv-1 and Inv-2). In this regard, Compound 1 and Compound 2 may exist in an identical (the same) layer (for example, Compound 1 and Compound 2 may both exist in an electron transport layer), 50 or different layers (for example, Compound 1 may exist in an emission layer and Compound 2 may exist in an electron transport layer).

Inv-62

The organic layer includes 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 60 hole blocking layer, an electron transport layer, and an electron injection layer. The emission layer may include the compound of Formula 1 or 2.

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



The drawing is a schematic view of an organic light-emitting device 10 according to an embodiment. The organic light-emitting device 10 includes a first electrode 110, an organic layer 150, and a second electrode 190. In one embodiment, the first electrode 110 is (or configured to be) coupled (e.g., connected) to a source electrode or a drain electrode of a thin film transistor.

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

In the drawing, a substrate may be additionally disposed under the first electrode 110 or above 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 repellency.

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 110 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 or a transmissive electrode. The material for the first electrode 110 may be a transparent and highly conductive material, and examples of such a material are indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO₂), and zinc oxide (ZnO). When the first electrode 110 is a semi-transmissive electrode or a reflective electrode, as a material for forming the first electrode, at least one of magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), magnesium-silver (Mg—Ag) may be used (utilized).

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

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 disposed between the first electrode and the emission layer, and an electron transport region disposed between the emission layer and the second electrode.

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

The hole transport region may have a single-layered structure formed of a single material, a single-layered structure formed of a plurality of different materials, or a multi-layered structure including 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, but are not limited thereto.

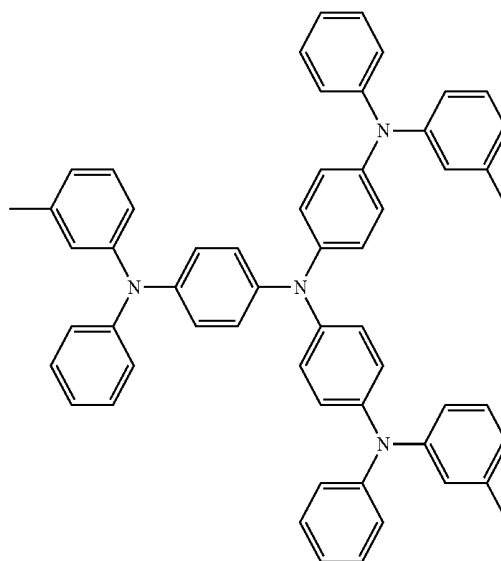
When the hole transport region includes a hole injection layer, the hole injection layer may be formed on the first electrode 110 by using (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, a Langmuir-Blodgett (LB) method, ink-jet printing, laser-printing, or laser-induced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

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

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

When the hole transport region includes a hole transport layer, the hole transport layer may be formed on the first electrode 110 or the hole injection layer by using (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, an LB method, ink-jet printing, laser-printing, or laser-induced thermal imaging. When the hole transport layer is formed by vacuum deposition or spin coating, deposition and coating conditions for the hole transport layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

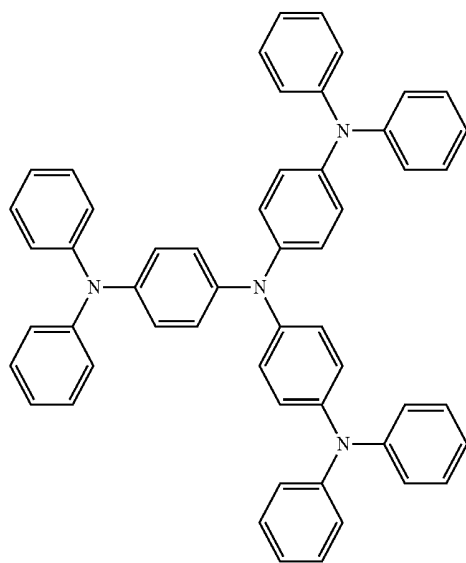
The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, Spiro-TPD, Spiro-NPB, α-NPB, TAPC, HMTDP, 4,4',4"-tris(N-carbazolyl)triphenylamine (TCTA), polyanilinedodecylbenzenesulfonic acid (Pani/DBSA), poly(3,4-ethylenedioxythiophene)poly(4-styrenesulfonate)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



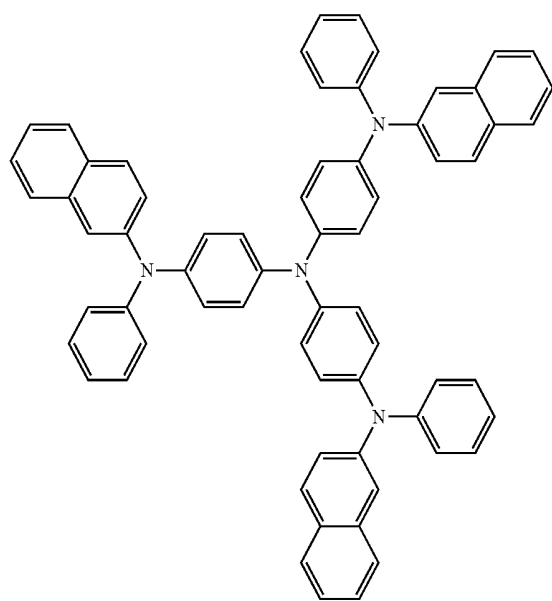
m-MTDATA

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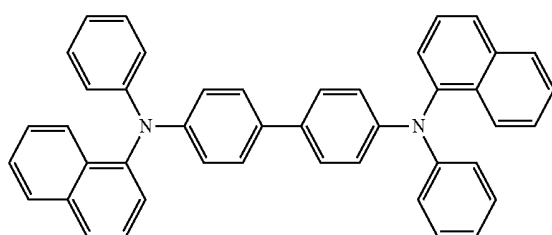
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TDATA



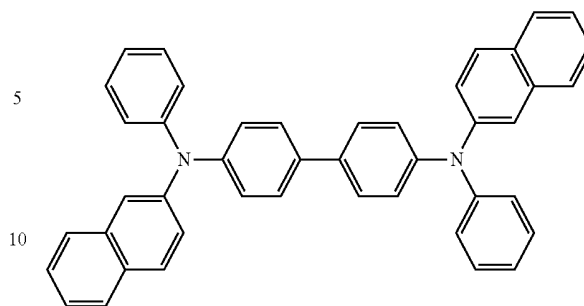
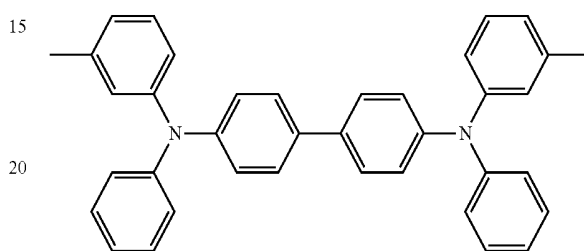
2-TNATA



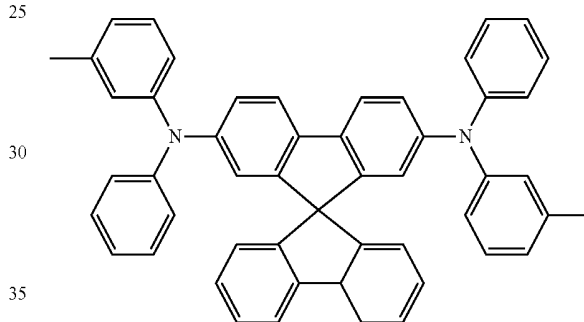
NPB

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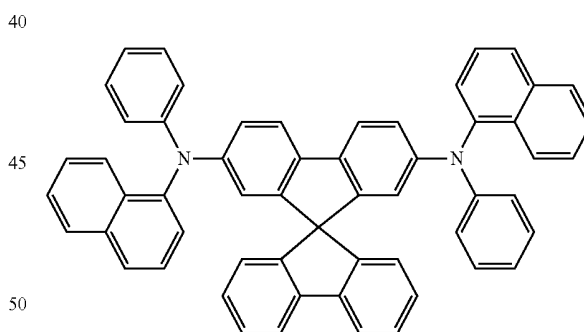
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 β -NPB

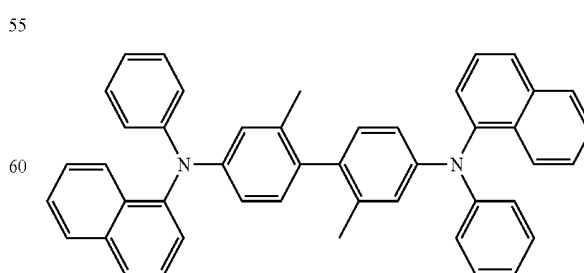
TPD



Spiro-TPD

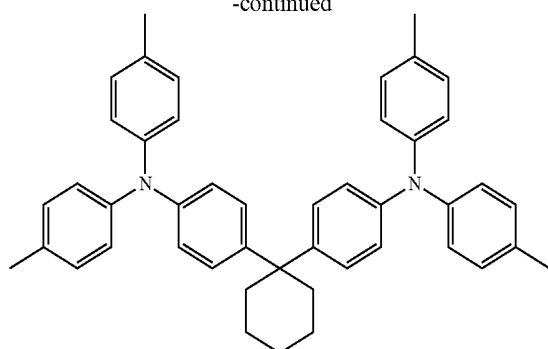


Spiro-NPB

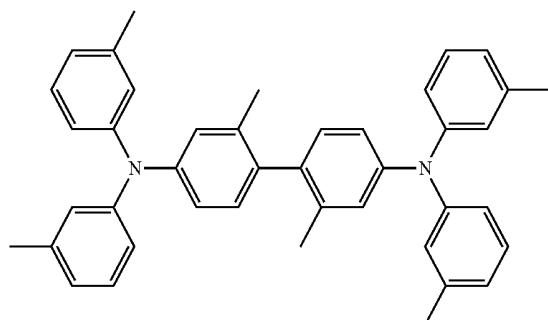
 α -NPB

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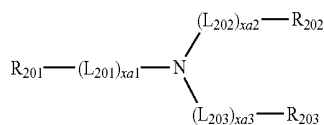
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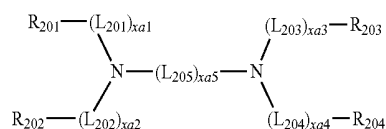
TAPC



HMTPD



Formula 201



Formula 202

wherein in Formulae 201 and 202,

L_{201} to L_{205} may be understood by referring to the description provided herein in connection with L_1 ;

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

$xa5$ may be selected from 1, 2, 3, 4, and 5; and

R_{201} to R_{204} may be each independently selected from a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_2 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_2 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group.

In Formulae 201 and 202,

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

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene

38

group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolyne group, and a triazinylene group; and

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

$xa1$ to $xa4$ may be each independently 0, 1, or 2;

$xa5$ may be 1, 2, or 3;

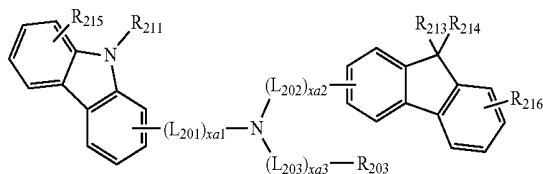
R_{201} to R_{204} may be each independently selected from:

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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, an azulenyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group.

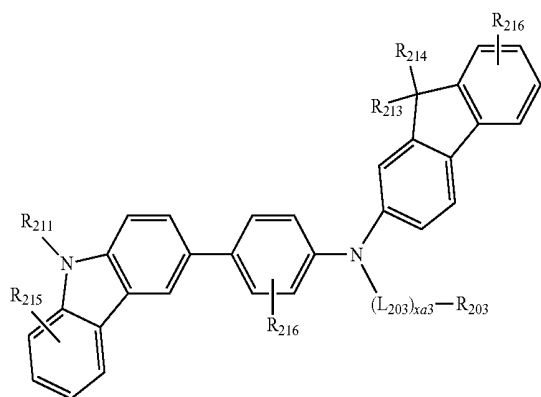
The compound represented by Formula 201 may be represented by Formula 201A:

Formula 201A



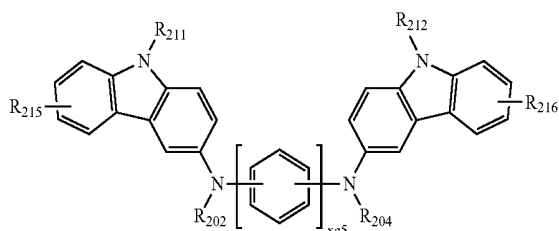
For example, the compound represented by Formula 201 may be represented by Formula 201A-1 below, but is not limited thereto:

Formula 201A-1



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

Formula 202A



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

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

For example, in Formulae 201A, 201A-1, and 202A,

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

- 5 a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group,
- 10 a group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group; and

- a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group, each substituted with at least one of a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{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;

$xa1$ to $xa3$ may be each independently 0 or 1;

R_{203} , R_{211} , and R_{212} 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 of a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{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;

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R₂₁₃ and R₂₁₄ may be each independently selected from:
a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group;

a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a 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 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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

R₂₁₅ and R₂₁₆ may be each independently selected from:

a hydrogen atom, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, and a C₁-C₂₀ alkoxy group;

a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a 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;

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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, and a triazinyl group; and

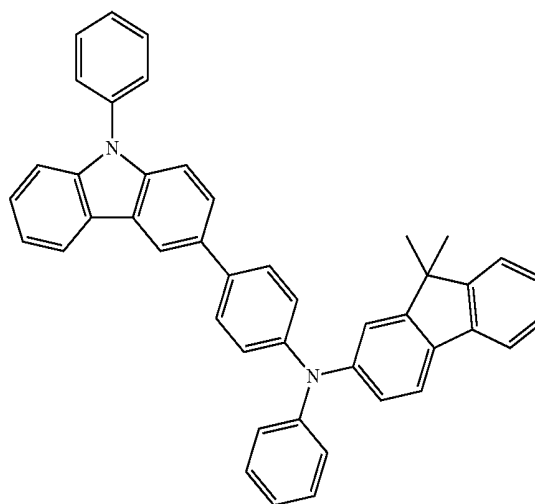
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

xa5 is 1 or 2.

R₂₁₃ and R₂₁₄ in Formulae 201A and 201A-1 may bind to each other to form a saturated or unsaturated ring.

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

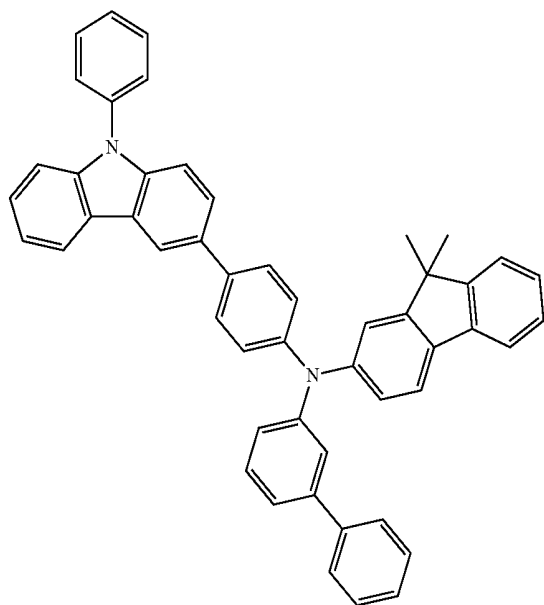
HT1



43

-continued

HT2

**44**

-continued

HT4

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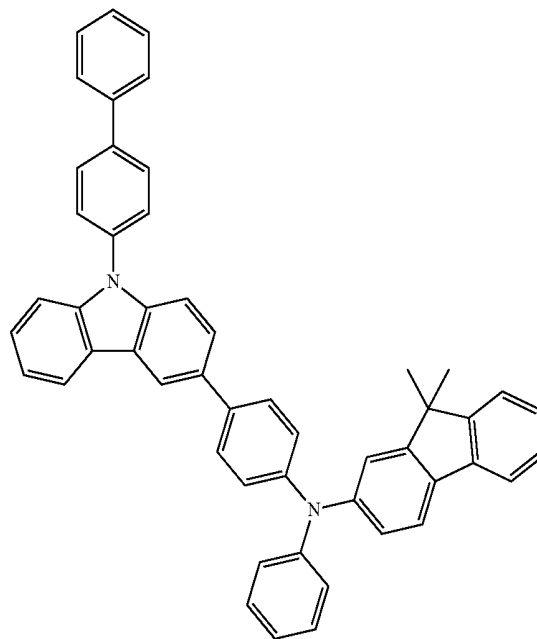
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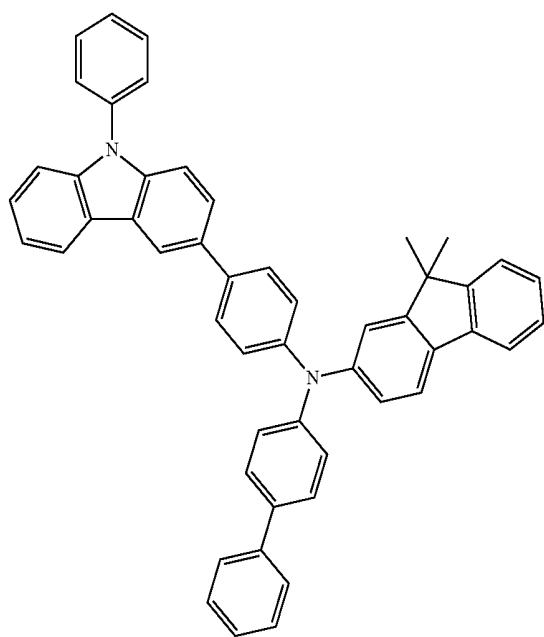
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HT3 40



HT5

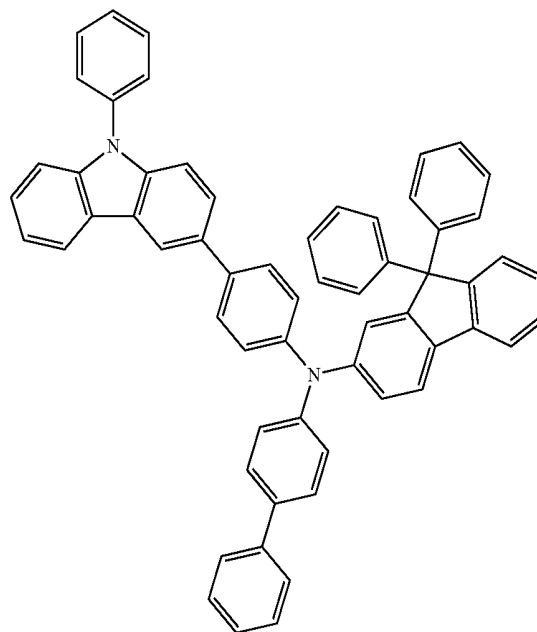
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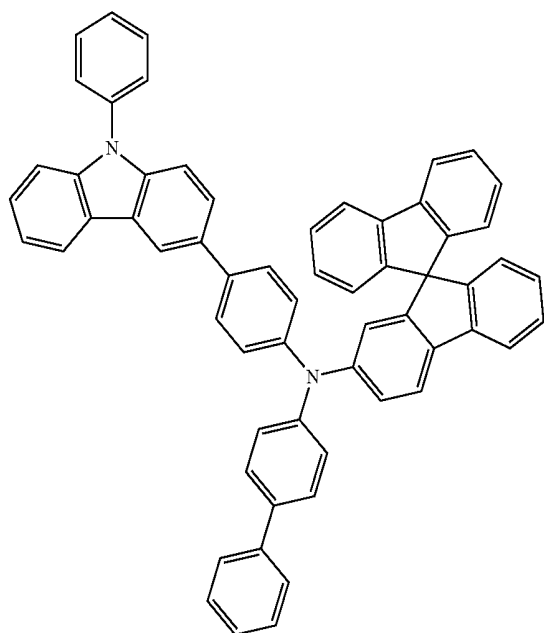
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45

-continued

HT6



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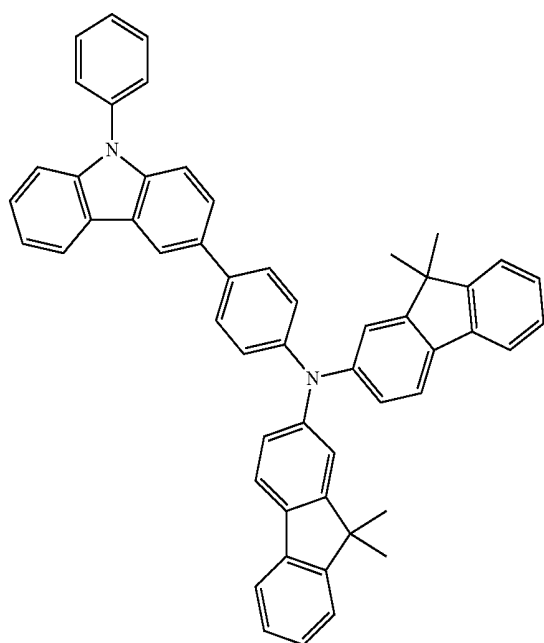
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HT7



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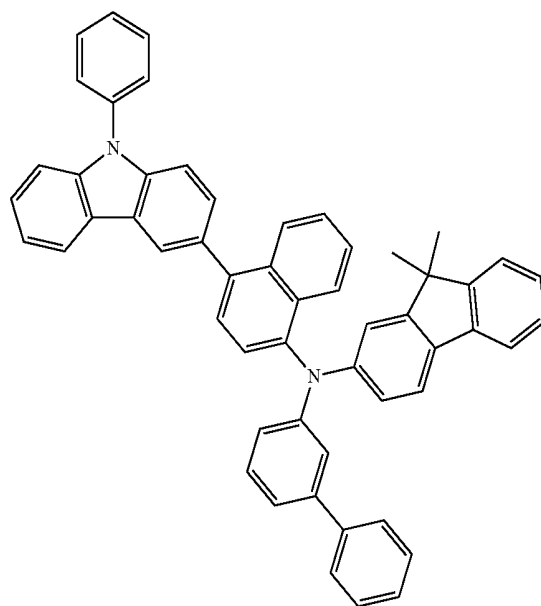
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46

-continued

HT8



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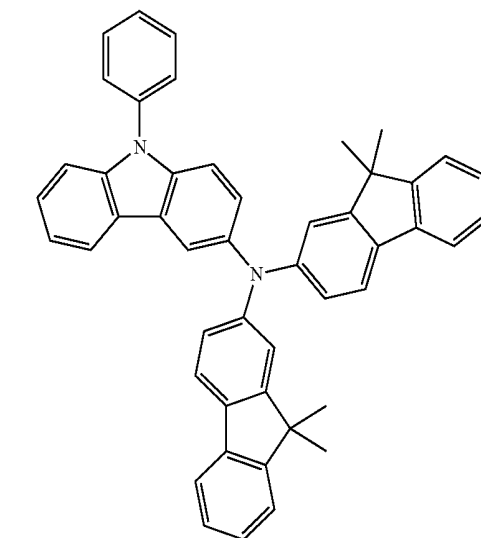
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HT9



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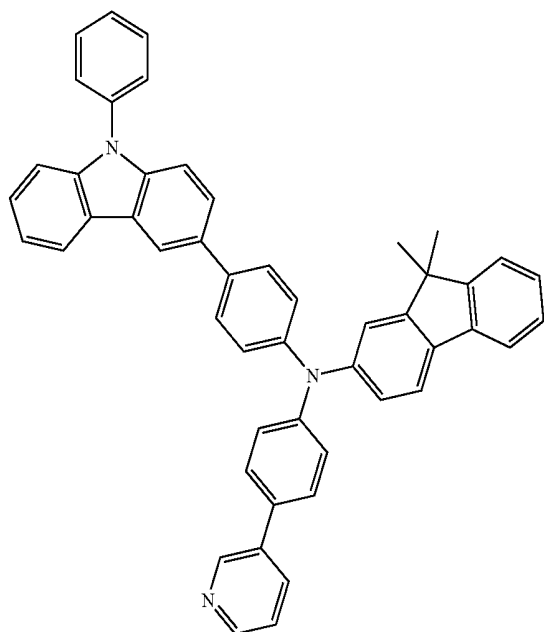
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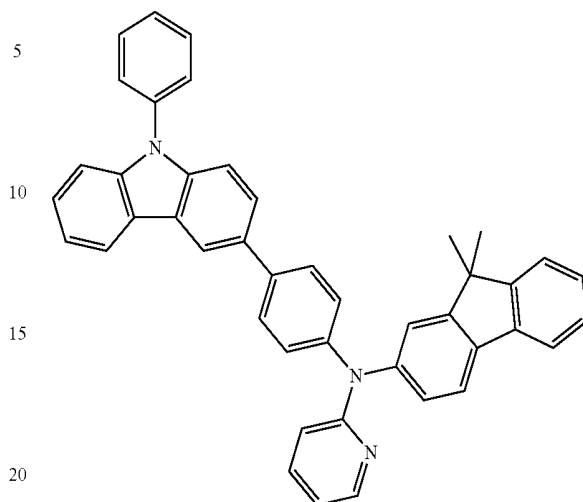
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HT10

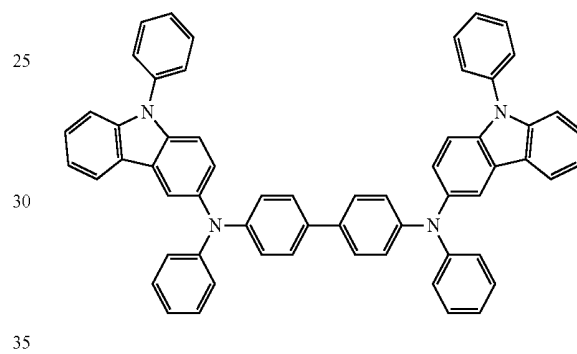
**48**

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HT12

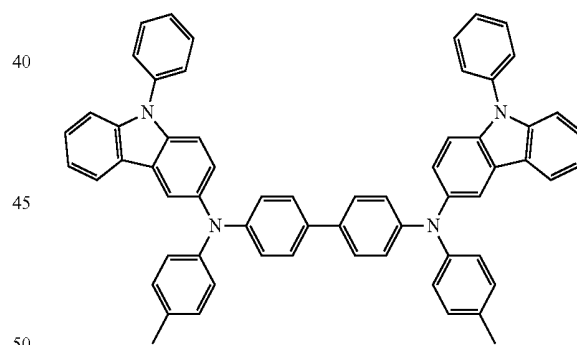
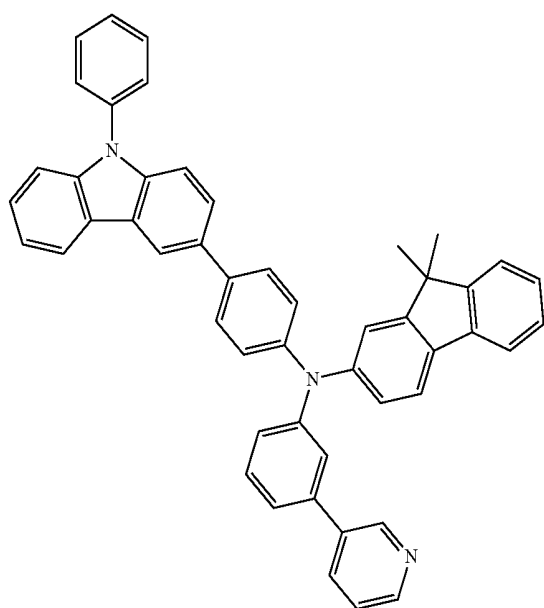


HT13

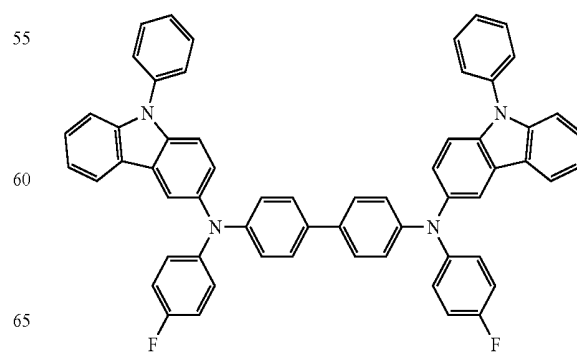


HT14

HT11

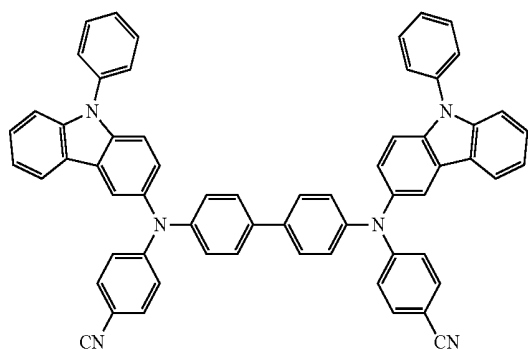


HT15



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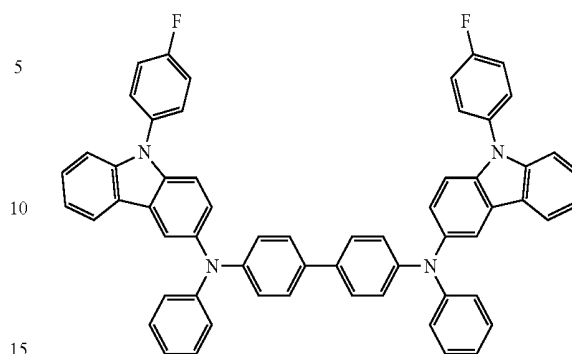
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HT16

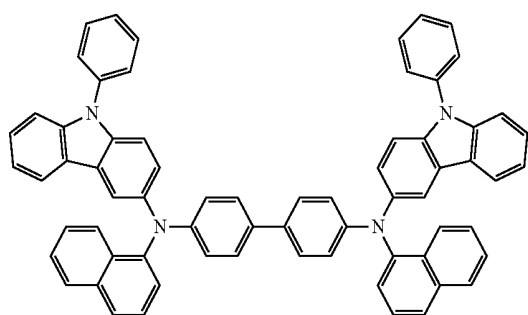
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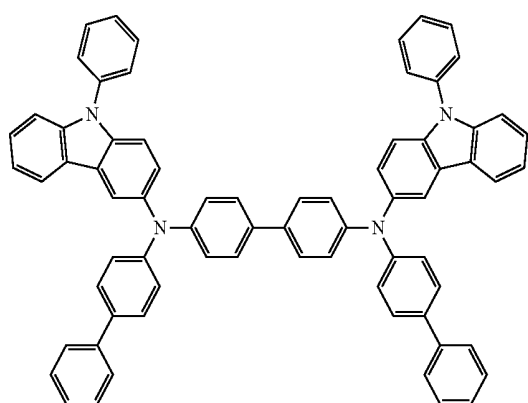


HT20

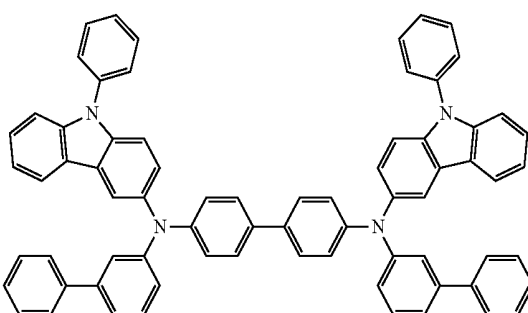
HT17 20



HT18



HT19

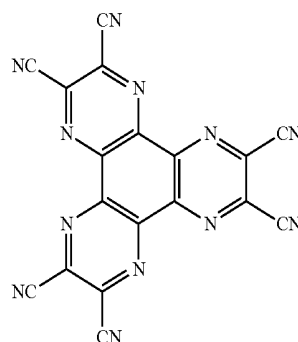


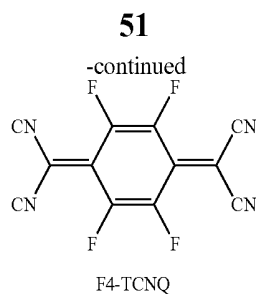
A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1000 Å. When the hole transport region includes both a hole injection layer and a hole transport layer, a thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1000 Å; and a thickness of the hole transport layer may be in a range of about 50 Å to about 2000 Å, for example, about 100 Å to about 1500 Å. In one embodiment, when the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within these ranges, satisfactory hole transporting characteristics are obtained without a substantial increase in driving voltage.

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

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

Compound HT-D1





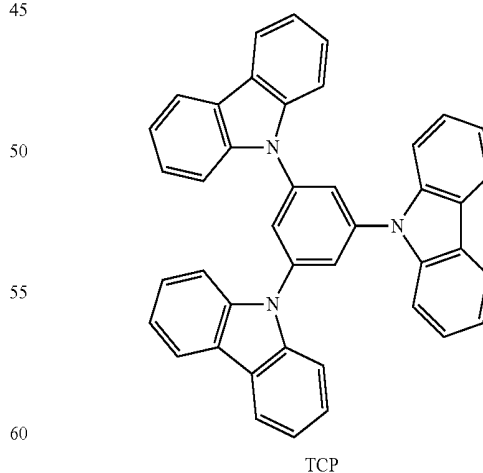
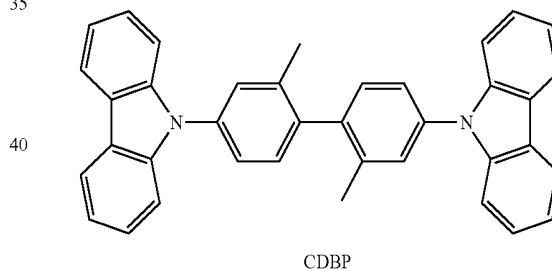
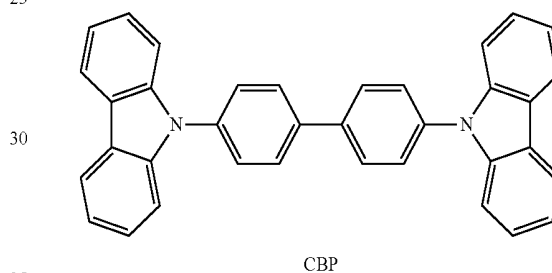
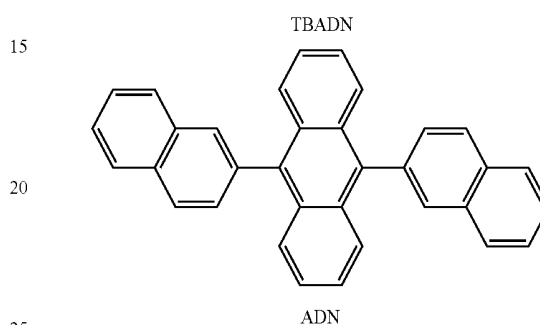
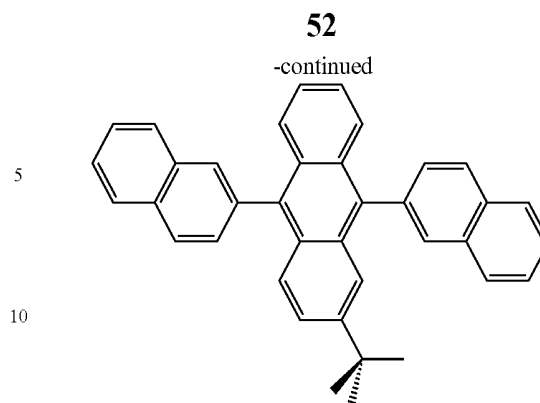
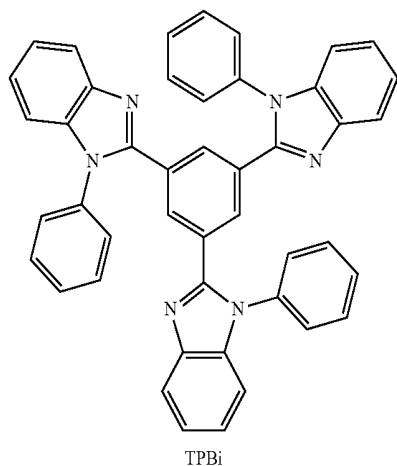
The hole transport region may further include, in addition to the hole injection layer and the hole transport layer, at least one of a buffer layer and an electron blocking layer. Since the buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the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

An emission layer is formed on the first electrode **110** or the hole transport region by using (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, an 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 (the color of) a sub-pixel. In some embodiments, the emission layer may have a stacked structure of a red emission layer, a green emission layer, and a blue emission layer; or may include a red-light emission material, a green-light emission material, and a blue-light emission material mixed with each other in a single layer, to emit white light.

The emission layer may include a host and a dopant.

The host may further include, in addition to the compound of Formula 1 or Formula 2 according to an embodiment of the present invention, at least one of TPBi, TBADN, ADN (also referred to as "DNA" or "AND"), CBP, CDBP, and TCP:



According to another embodiment, the host may include a compound represented by Formula 301 below.

wherein in Formula 301,

Ar₃₀₁ 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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, and —Si(Q₃₀₁)(Q₃₀₂)(Q₃₀₃) (Q₃₀₁ to Q₃₀₃ may be each independently selected from a hydrogen, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₆-C₆₀ aryl group, and a C₂-C₆₀ heteroaryl group);

L₃₀₁ may be understood by referring to the description provided in connection with L₂₀₁;

R₃₀₁ may be selected from:

a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group;

a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a 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 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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group,

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

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

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

In Formula 301,

L₃₀₁ 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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group;

R₃₀₁ may be selected from:

a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group;

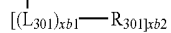
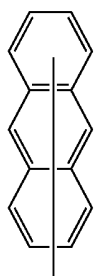
a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a 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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, and a chrysenyl group, but is not limited thereto.

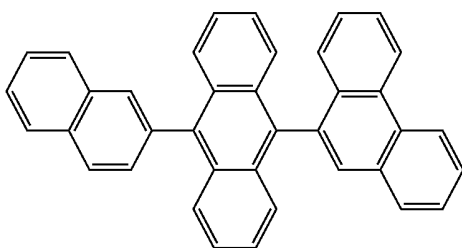
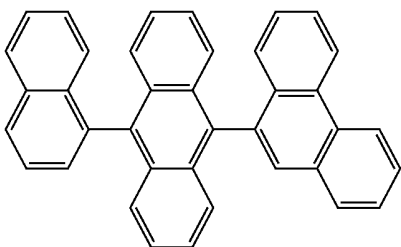
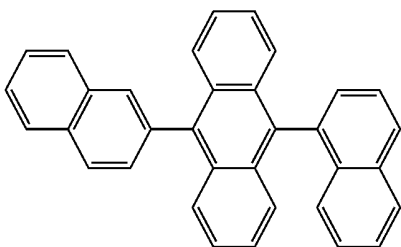
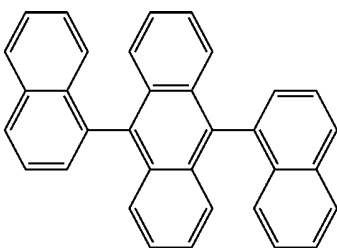
For example, the host may include a compound represented by Formula 301A below:

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Substituents of Formula 301A may be understood by corresponding descriptions provided herein.

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



Formula 301A

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H1

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H2

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H3

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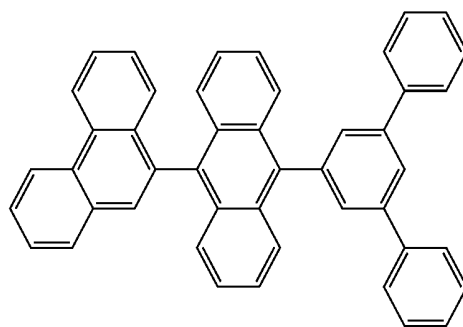
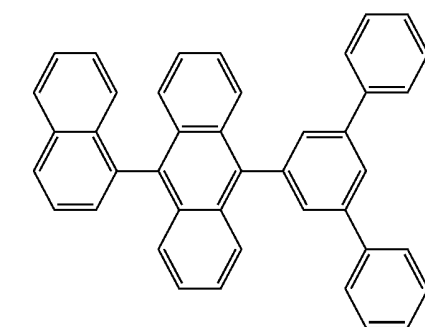
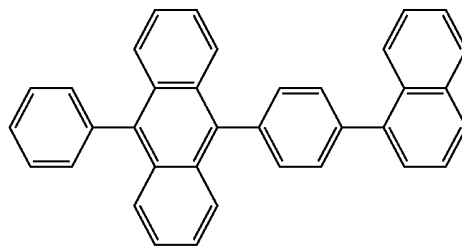
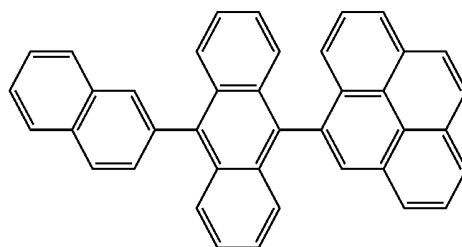
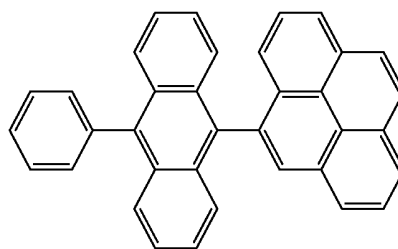
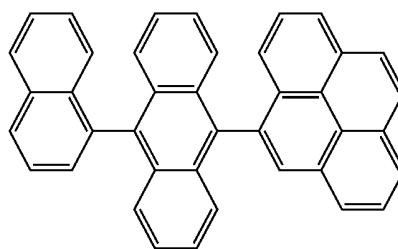
H4

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56

-continued



H5

H6

H7

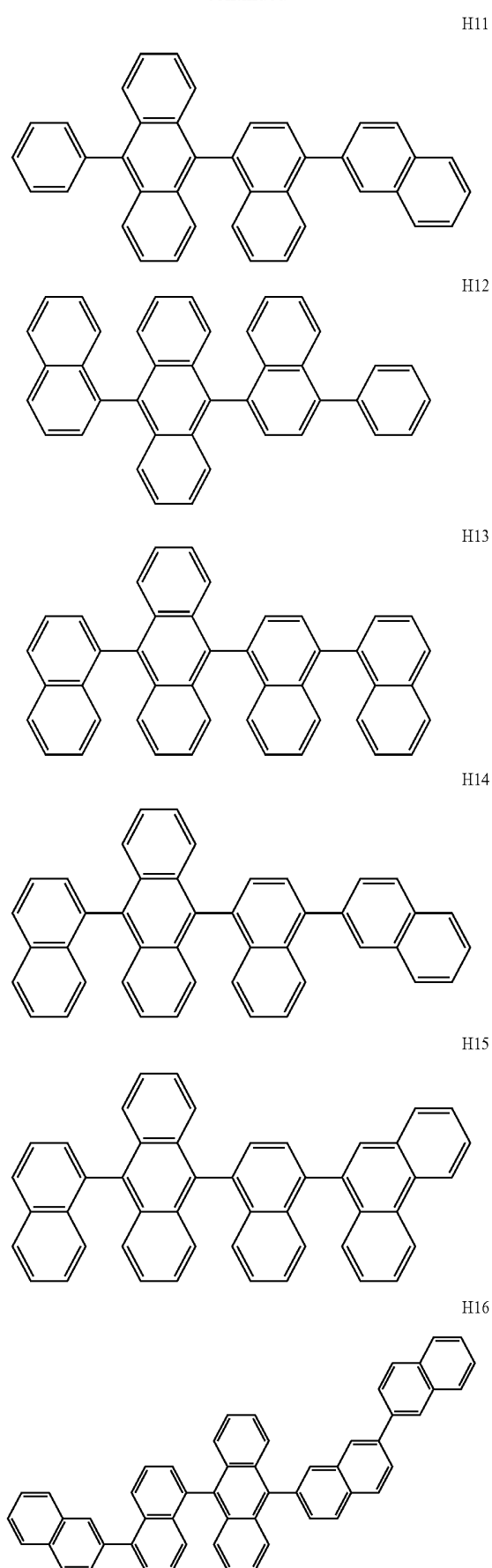
H8

H9

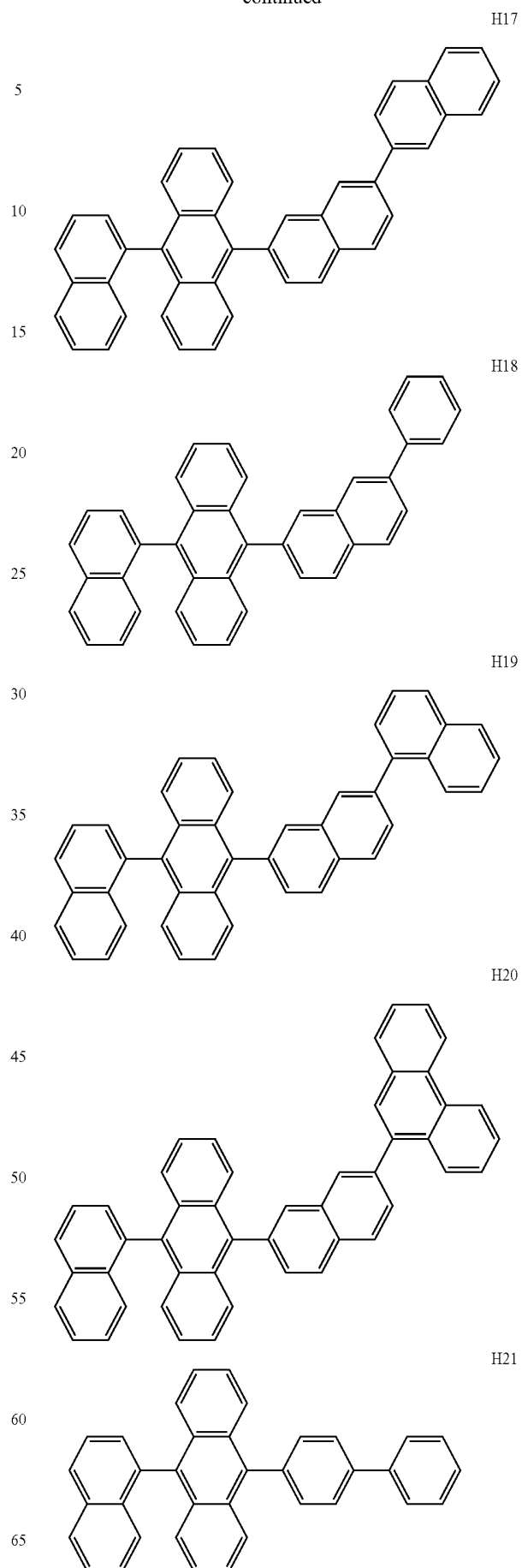
H10

57

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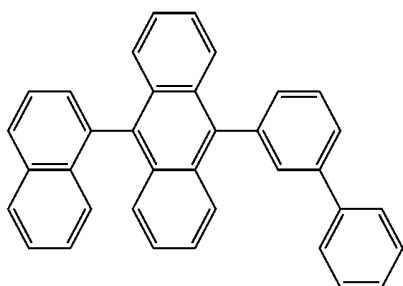
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-continued



59

-continued



H22

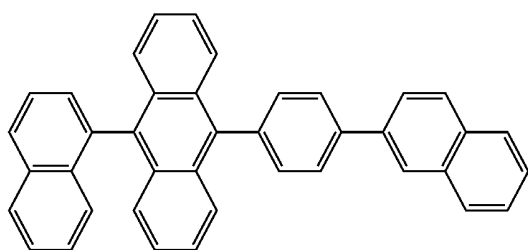
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H23

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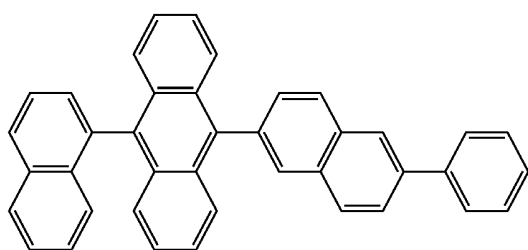


H24

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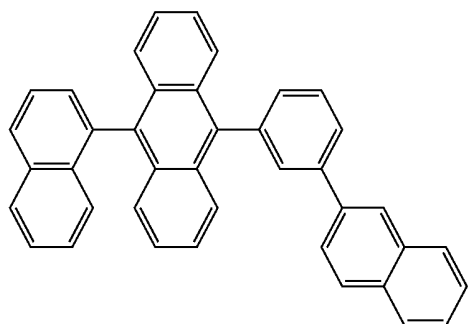


H25

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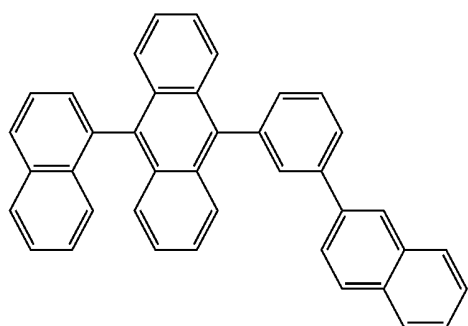
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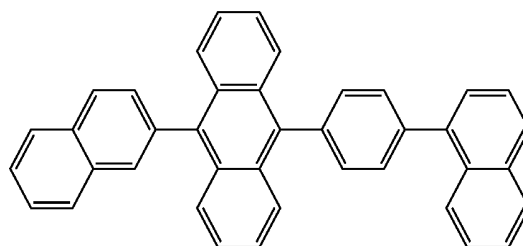


H26

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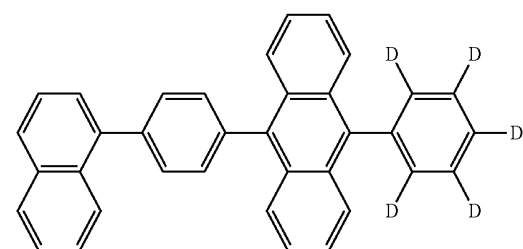
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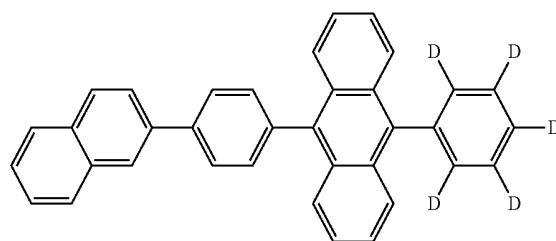


H27

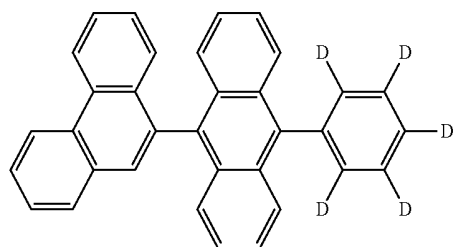
H28



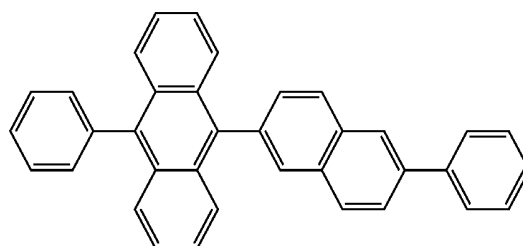
H29



H30

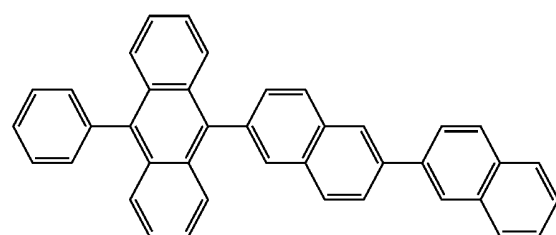


H31



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H32

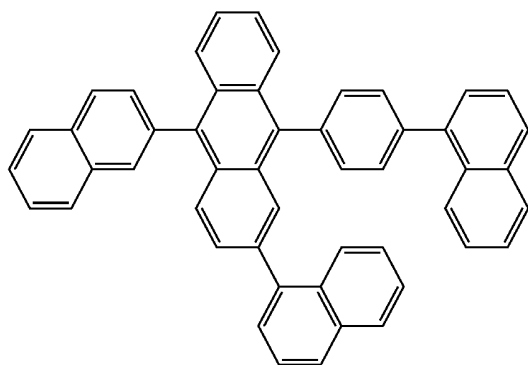


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61

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H33



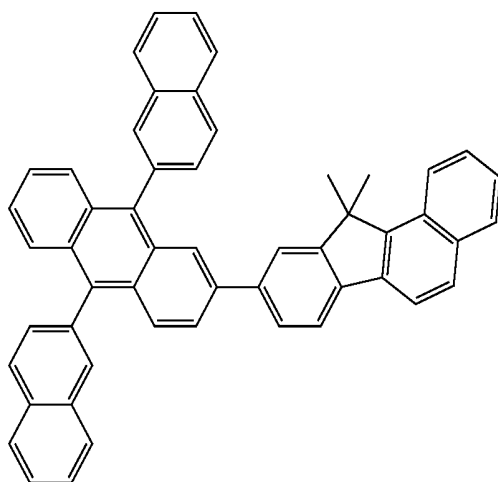
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H34 25



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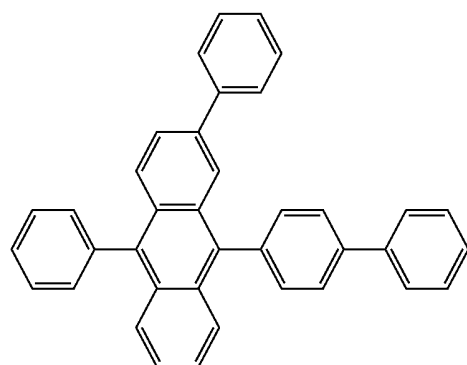
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H35



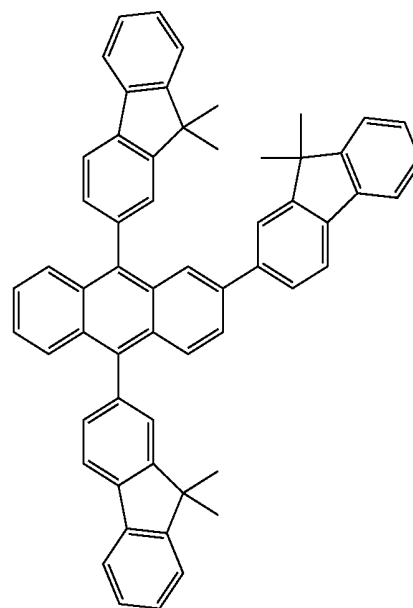
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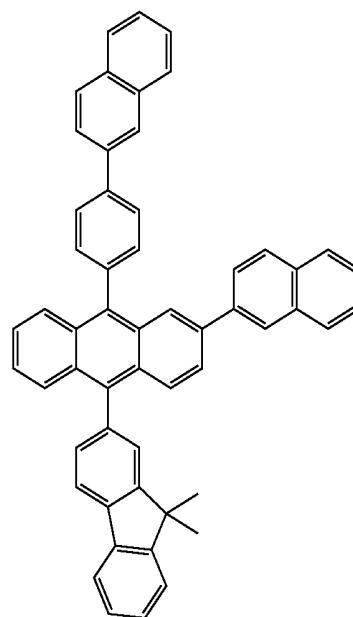
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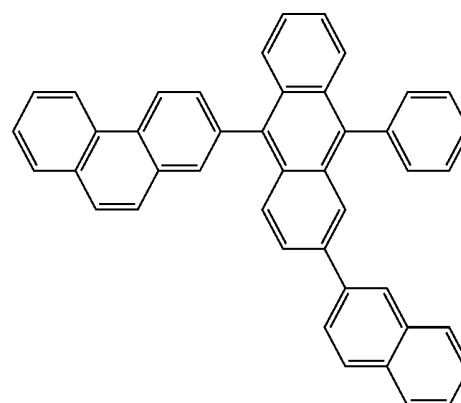
H36



H37



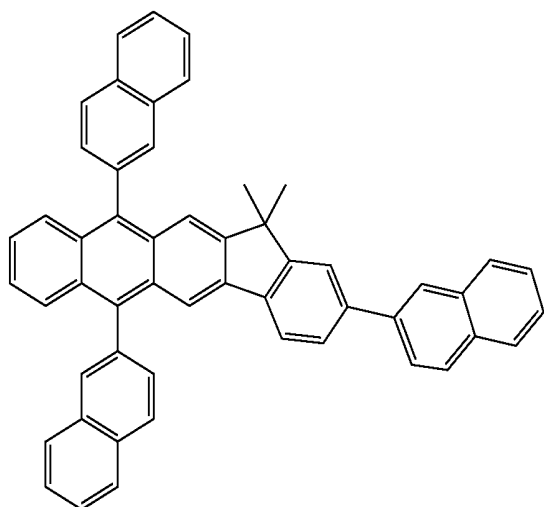
H38



63

-continued

H39

**64**

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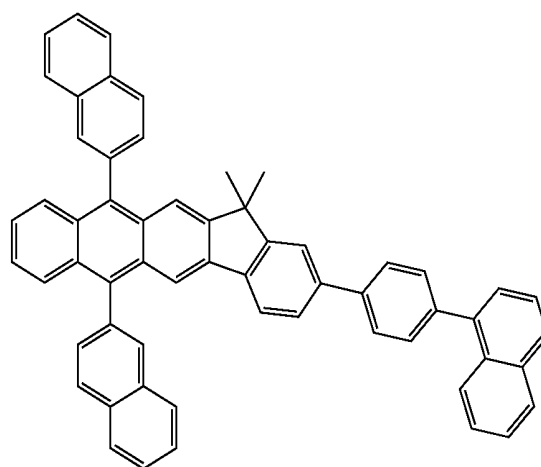
H42

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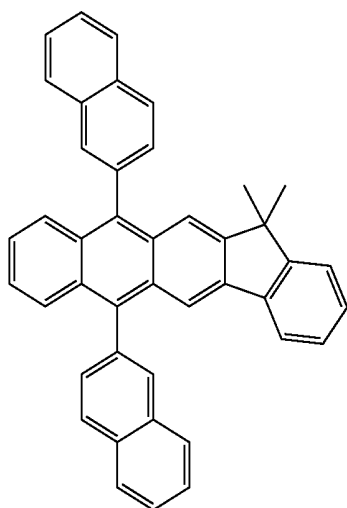
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According to another embodiment, the host may include at least one of Compounds H43 to H49 below, but are not limited thereto:

H40 25



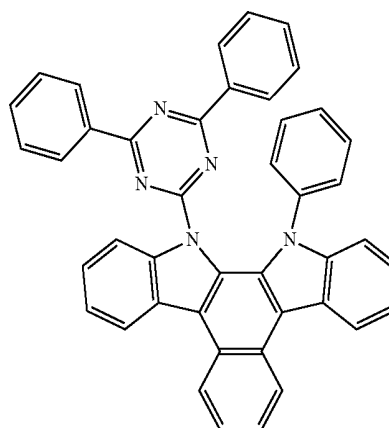
H43

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H44

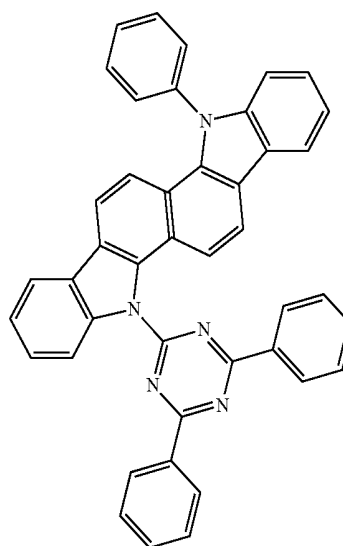
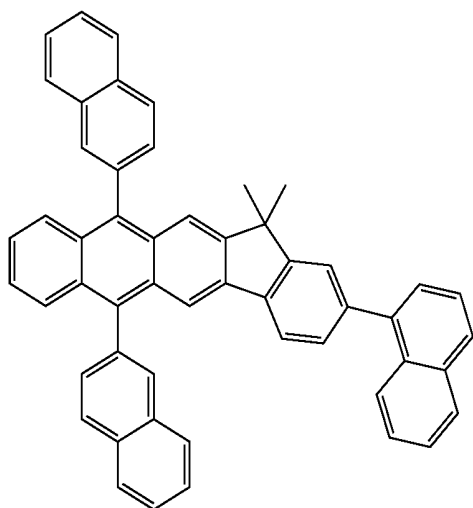
H41

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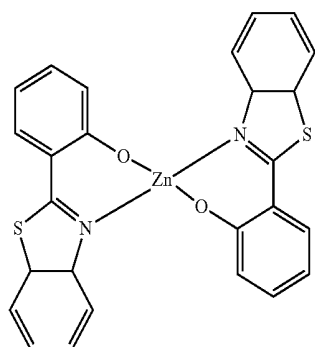
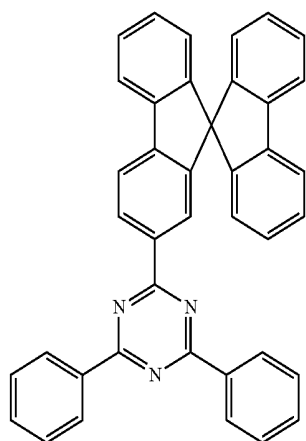
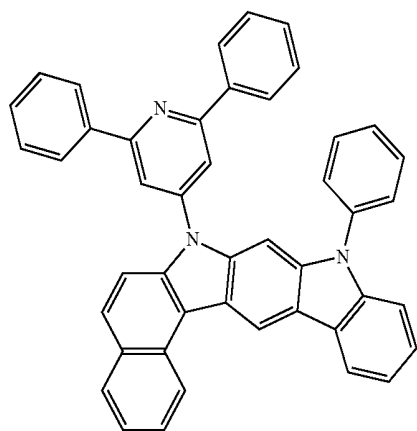
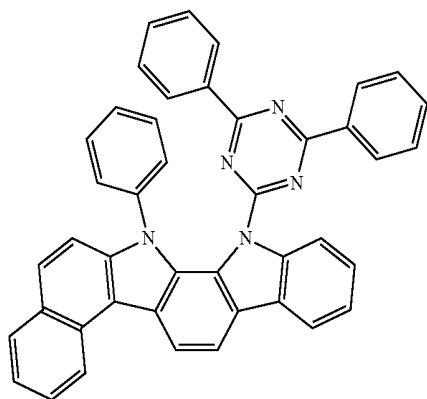
60

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65

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-continued

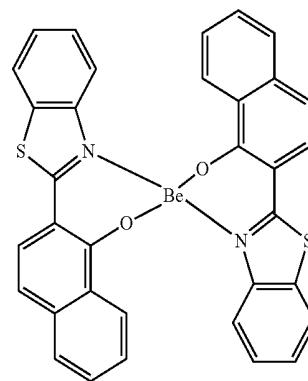
H45

H49

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H46

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

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

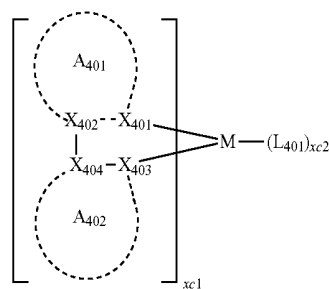
Formula 401

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H47

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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);

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X₄₀₁ to X₄₀₄ may be each independently nitrogen or carbon;

A₄₀₁ and A₄₀₂ rings may be each independently selected from a substituted or unsubstituted benzene group, a substituted or unsubstituted naphthalene group, a substituted or unsubstituted fluorene group, a substituted or unsubstituted spiro-fluorene group, a substituted or unsubstituted indene group, a substituted or unsubstituted pyrrole group, a substituted or unsubstituted thiophene group, a substituted or unsubstituted furan group, a substituted or unsubstituted imidazole group, a substituted or unsubstituted pyrazole group, a substituted or unsubstituted thiazole group, a substituted or unsubstituted isothiazole group, a substituted or unsubstituted oxazole group, a substituted or unsubstituted isoxazole group, a substituted or unsubstituted pyridine group, a substituted or unsubstituted pyrazine group, a substituted or unsubstituted pyrimidine group, a substituted or unsubstituted pyridazine group, a substituted or unsubstituted quinoline group, a substituted or unsubstituted benzoquinoline group, a substituted or unsubstituted quinoxaline group, a substituted or unsubstituted quinazoline group, a substituted or unsubstituted carbazole group, a substituted or unsubstituted benzoimidazole group, a substituted or unsubstituted benzofuran group, a substituted or unsubstituted benzothiophene group, a substituted or unsubstituted isobenzothiophene group, a substituted or unsubstituted benzoox-

H48

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azole group, a substituted or unsubstituted isobenzoxazole group, a substituted or unsubstituted triazole group, a substituted or unsubstituted oxadiazole group, a substituted or unsubstituted triazine group, a substituted or unsubstituted dibenzofuran group, and a substituted or unsubstituted

dibenzothiophene group; and
at least one substituent of the substituted benzene group, substituted naphthalene group, substituted fluorene group, substituted spiro-fluorene group, substituted indene group, substituted pyrrol group, substituted thiophene group, substituted furan group, substituted imidazole group, substituted pyrazole group, substituted thiazole group, substituted isothiazole group, substituted oxazole group, substituted isoxazole group, substituted pyridine group, substituted pyrazine group, substituted pyrimidine group, substituted pyridazine group, substituted quinoline group, substituted isoquinoline group, substituted benzoquinoline group, substituted quinoxaline group, substituted quinazoline group, substituted carbazol group, substituted benzimidazole group, substituted benzofuran group, substituted benzothiophene group, substituted isobenzothiophene group, substituted benzoxazole group, substituted isobenzoxazole group, substituted triazole group, substituted oxadiazole group, substituted triazine group, substituted dibenzofuran group, and substituted dibenzothiophene 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₄₀₁)(Q₄₀₂), —Si(Q₄₀₃)(Q₄₀₄)(Q₄₀₅), and —B(Q₄₀₆)(Q₄₀₇);

a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, and a non-aromatic condensed polycyclic group;

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

cycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₄₁₁)(Q₄₁₂), —Si(Q₄₁₃)(Q₄₁₄)(Q₄₁₆) and —B(Q₄₁₆)(Q₄₁₇); and

—N(Q₄₂₁)(Q₄₂₂), —Si(Q₄₁₃)(Q₄₁₄)(Q₄₁₅) and —B(Q₄₂₆)(Q₄₂₇) (Q₄₀₁-Q₄₀₇, Q₄₁₁-Q₄₁₇, Q₄₂₁-Q₄₂₇ may be each independently selected from a hydrogen, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₆-C₆₀ aryl group, and a C₂-C₆₀ heteroaryl group);

L₄₀₁ is an organic ligand;

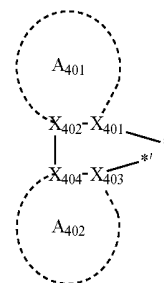
xc1 is 1, 2, or 3;

xc2 is 0, 1, 2, or 3.

L₄₀₁ may be a monovalent, divalent, or trivalent organic ligand. For example, L₄₀₁ may be selected from a halogen ligand (for example, Cl or F), a diketone ligand (for example; acetylacetonate, 1,3-diphenyl-1,3-propanedionate, 2,2,6,6-tetramethyl-3,5-heptandionate, or hexafluoroacetate), a carboxylic acid group ligand (for example, picolinate, dimethyl-3-pyrazolecarboxylate, or benzoate), a carbon monoxide ligand, an isonitrile ligand, a cyano ligand, and a phosphorous ligand (for example, phosphine, or phosphite), but is not limited thereto.

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

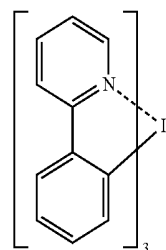
When A₄₀₁ in Formula 402 has two or more substituents, the substituents of A₄₀₂ may bind to each other to form a saturated or unsaturated ring.



When xc1 in Formula 401 is two or more, a plurality of ligands in Formula 401 may be identical or different. When xc1 in Formula 401 is two or more, A₄₀₁ and A₄₀₂ may be respectively directly connected to A₄₀₁ and A₄₀₂ of other neighboring ligands with or without a linker (for example, a C₁-C₅ alkylene, or —N(R')— (wherein R' may be a C₁-C₁₀ alkyl group or a C₆-C₂₀ aryl group) or C(=O)—) therebetween.

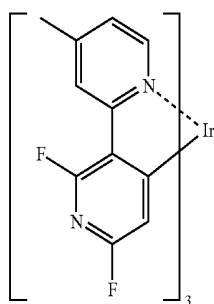
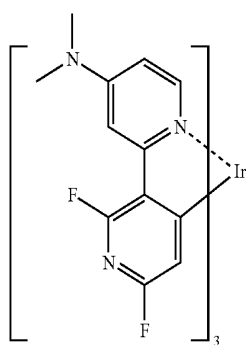
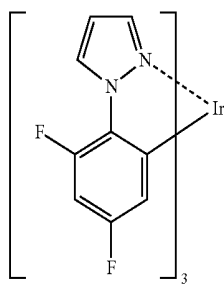
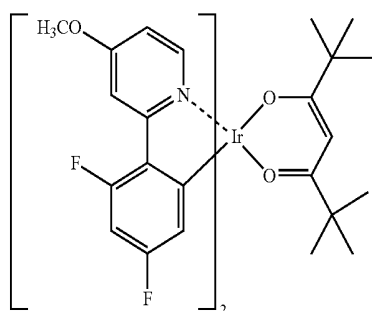
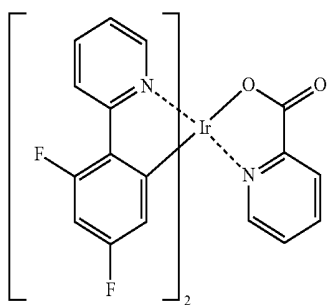
The phosphorescent dopant may include at least one of Compounds PD1 to PD74 below, but is not limited thereto:

PD1



69

-continued

**70**

-continued

PD2

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PD3

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PD4

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PD5

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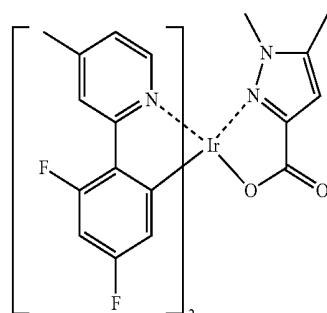
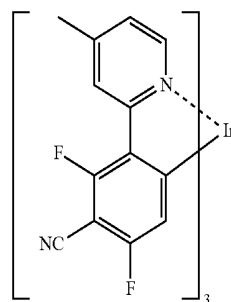
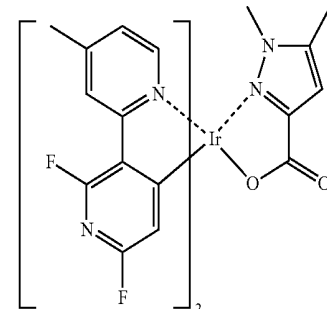
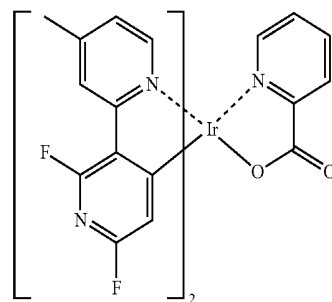
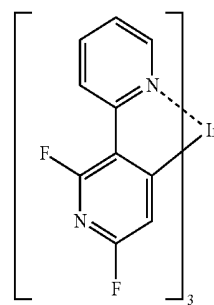
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PD6

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PD7

PD8

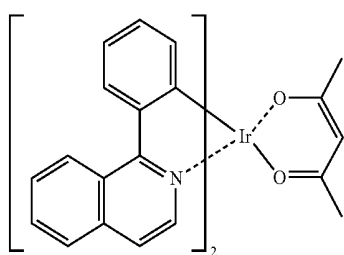
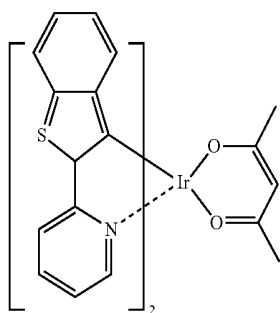
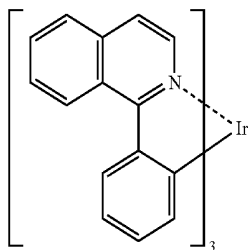
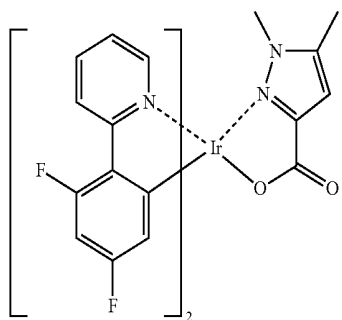
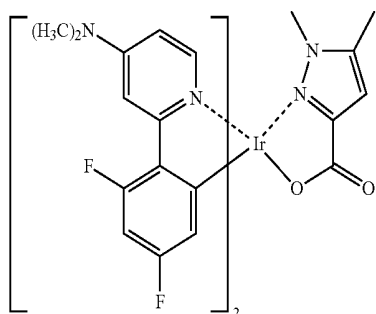
PD9

PD10

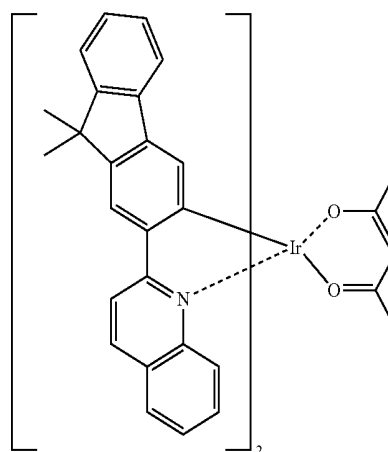
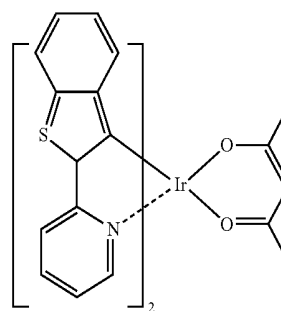
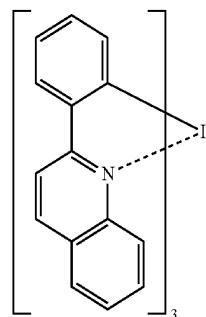
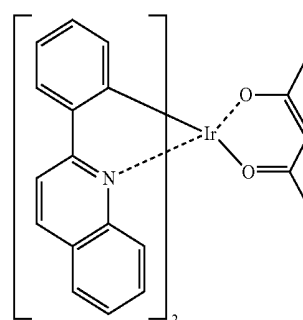
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**72**

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PD12

PD17

PD13

PD18

PD14

PD19

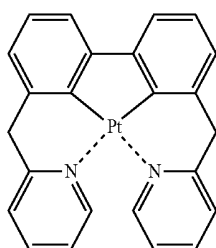
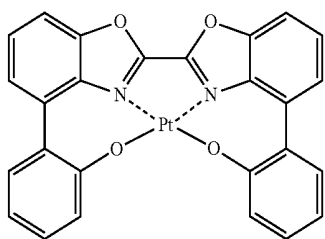
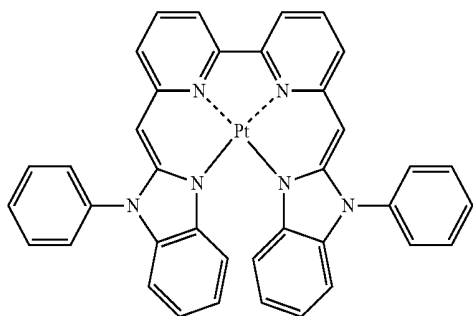
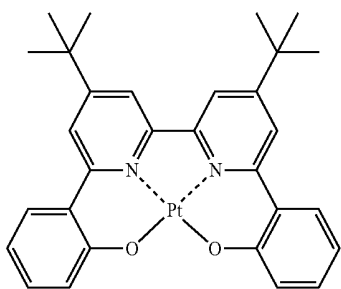
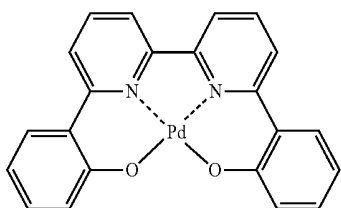
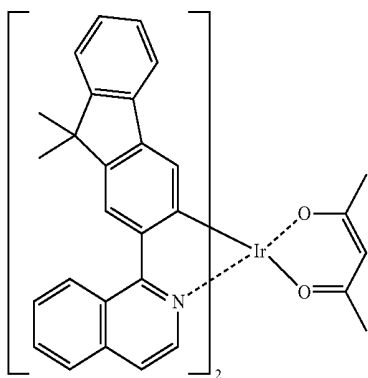
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PD20

PD16

73

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**74**

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PD21

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PD23 25

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PD24 35

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PD25

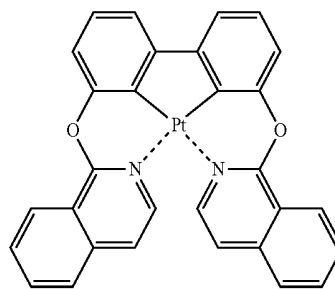
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PD26

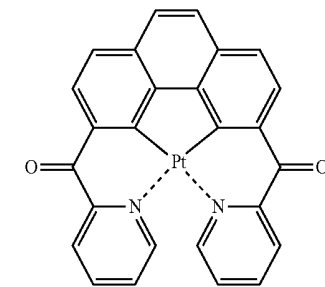
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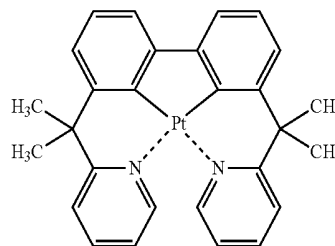


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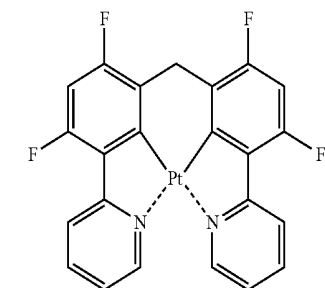
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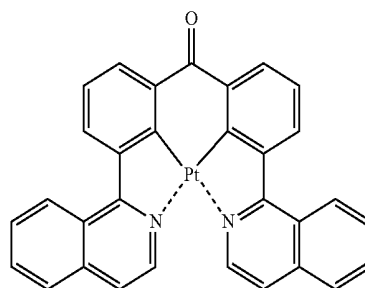
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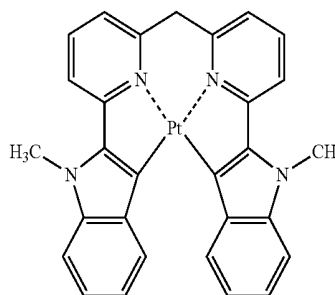
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PD31

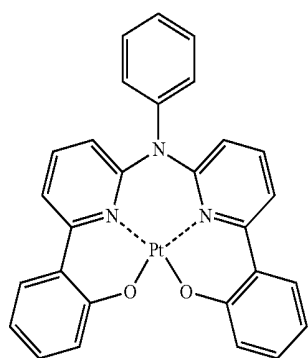
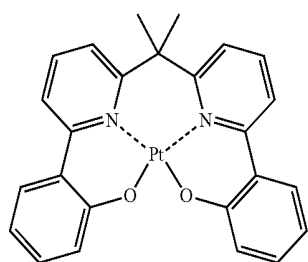
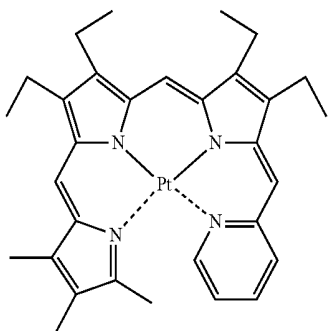
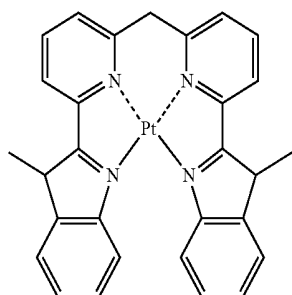
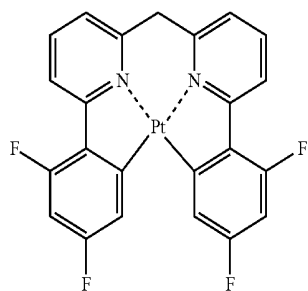


PD32



75

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**76**

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PD33

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PD34

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PD35

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PD36

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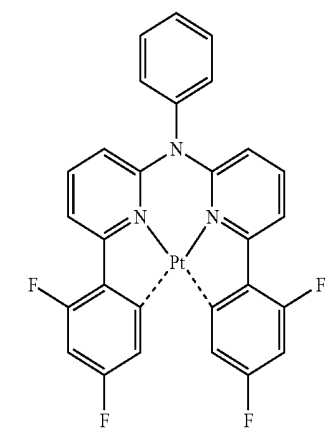
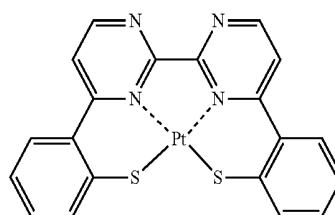
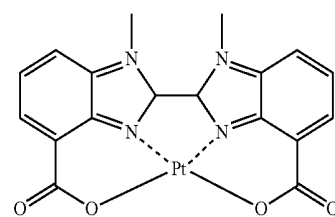
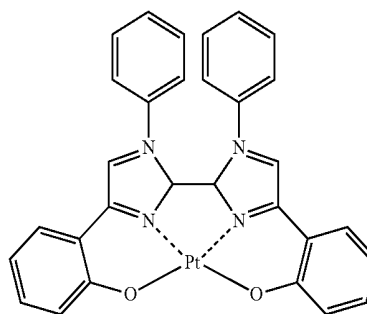
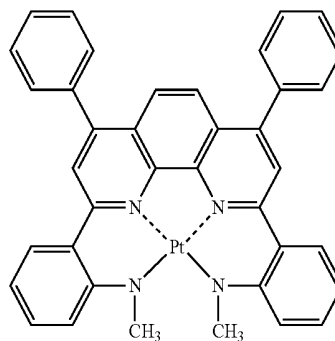
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PD37

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PD38

PD39

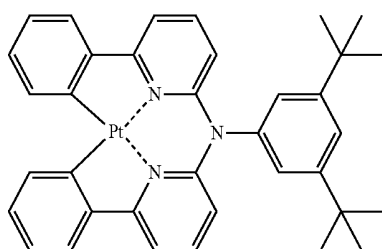
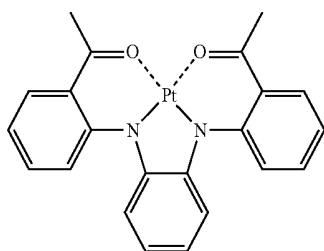
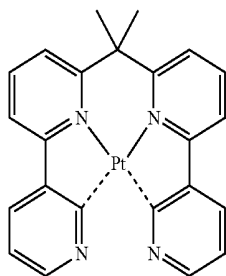
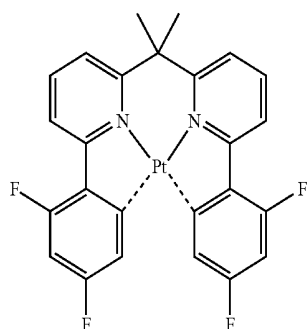
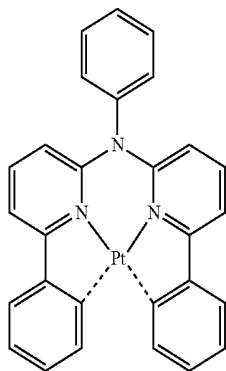
PD40

PD41

PD42

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**78**

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PD43

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PD44

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PD45

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PD46 45

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PD47

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PD48

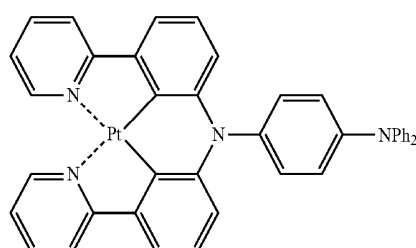
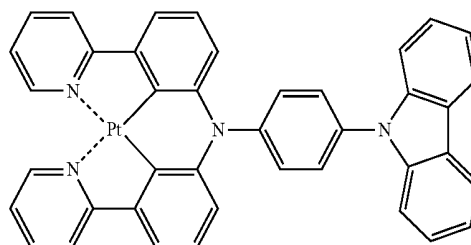
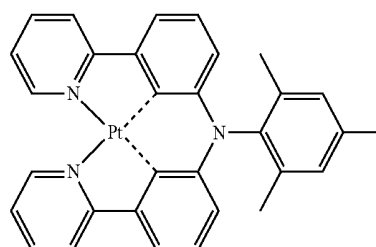
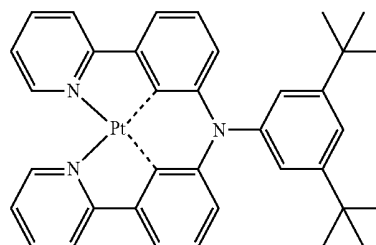
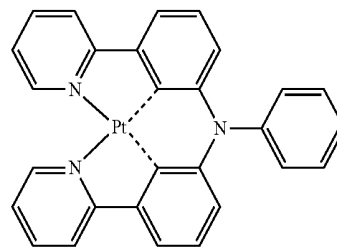
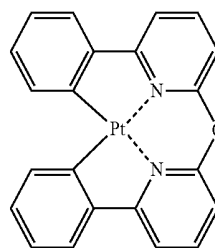
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PD50

PD51

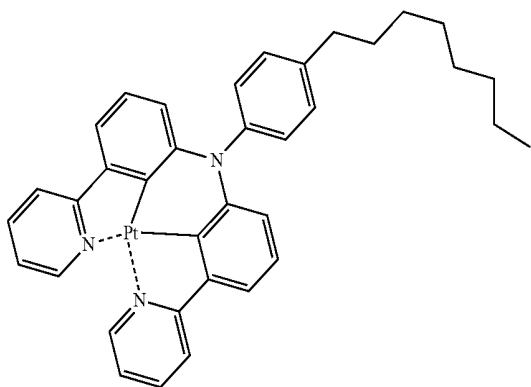
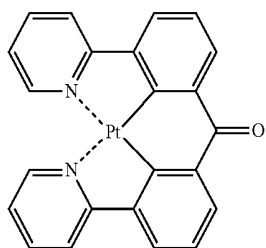
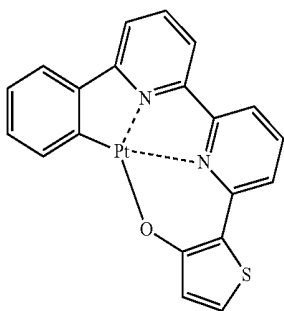
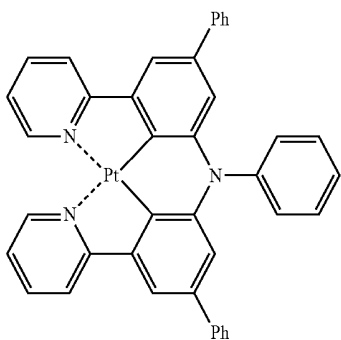
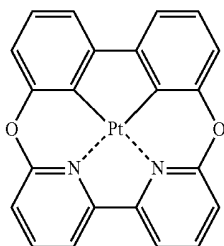
PD52

PD53



79

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**80**

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PD54

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PD55

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PD56 25

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PD57 40

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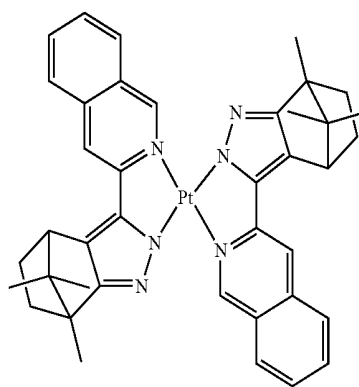
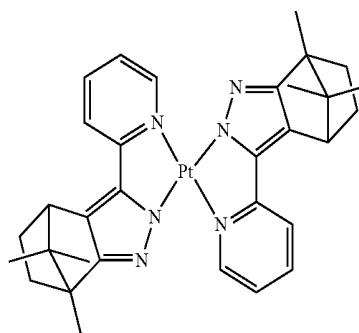
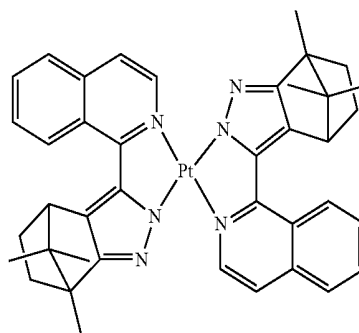
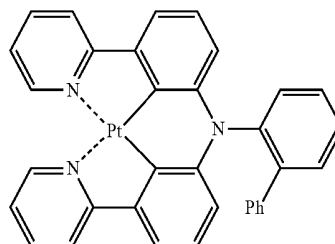
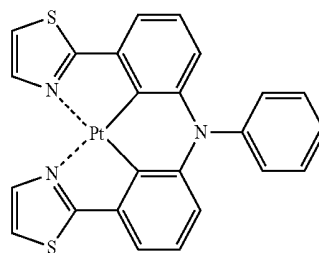
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PD58

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PD59

PD60

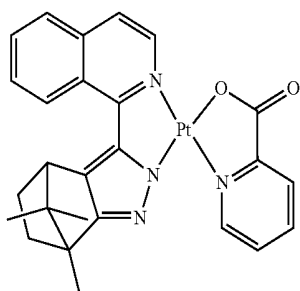
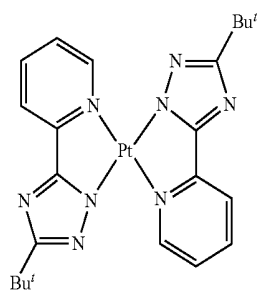
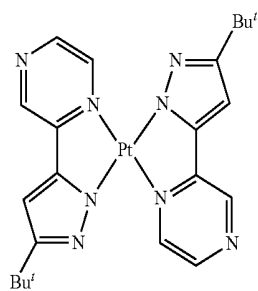
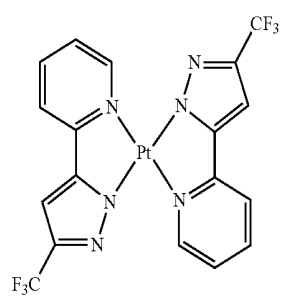
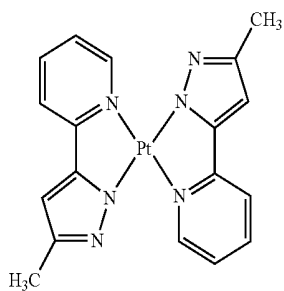
PD61

PD62

PD63

81

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**82**

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PD64

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PD65

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PD66

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PD67

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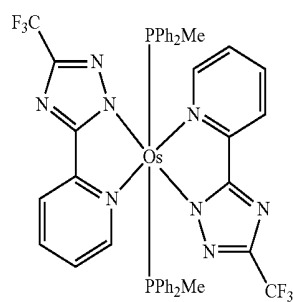
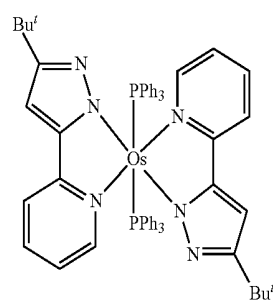
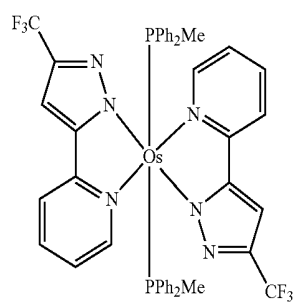
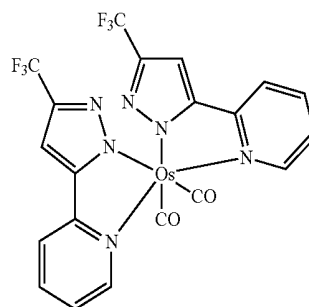
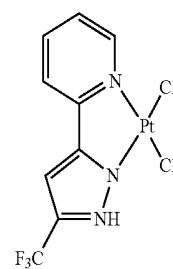
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PD68

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PD69

PD70

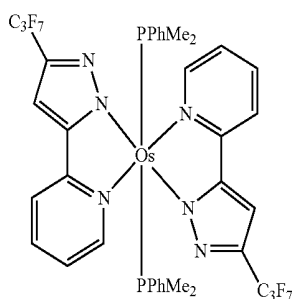
PD71

PD72

PD73

83

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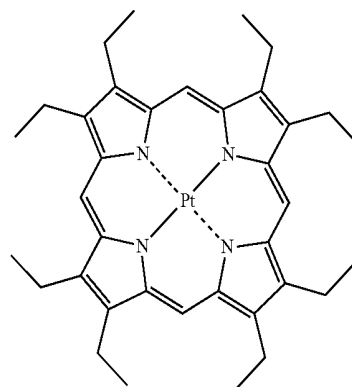


PD74

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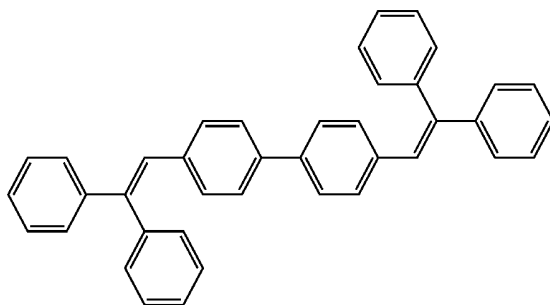
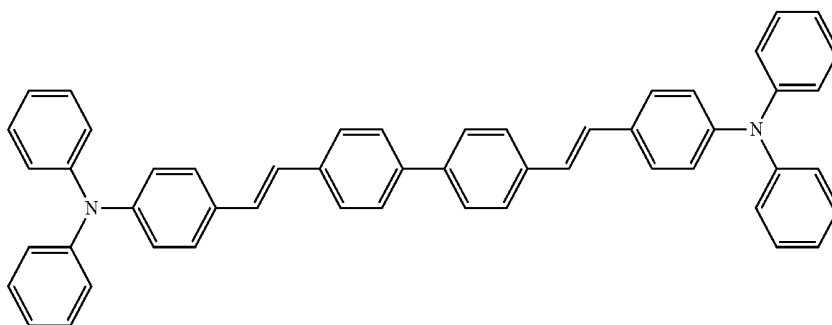
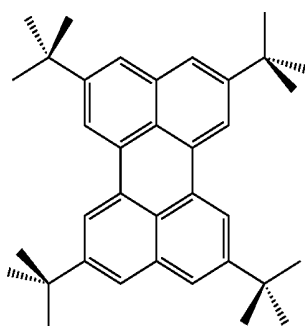
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84

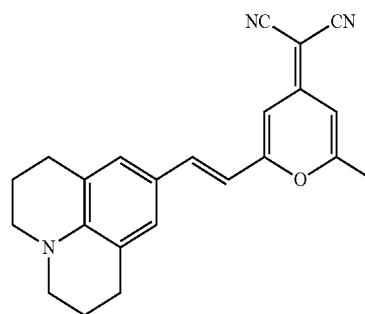
PtOEP

According to another embodiment, the phosphorescent dopant may include PtOEP:

The fluorescent dopant may include at least one selected from DPAVB_i, BDAVB_i, TBPe, DCM, DCJT_B, Coumarin 6, and C545T.

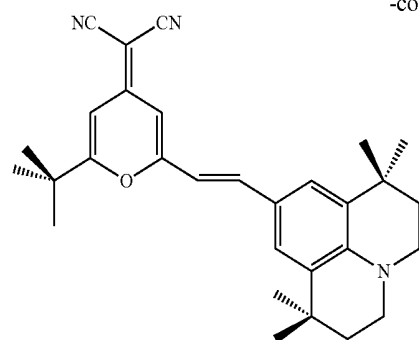
DPAVB_iDPAVB_i

TBPe

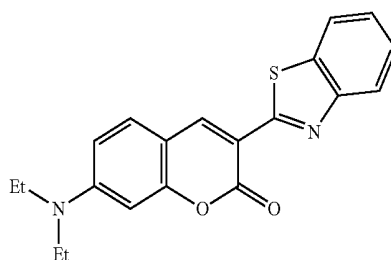


DCM

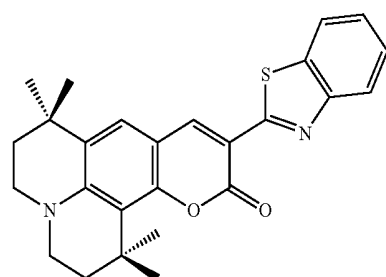
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DCJT B



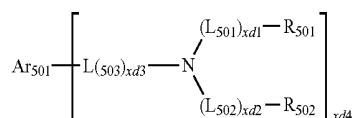
Coumarin 6



CS45T

According to another embodiment, the fluorescent dopant may include a compound represented by Formula 501 below.

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 of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkynyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_2\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_2\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed hetero-polycyclic group, and —Si(Q_{501})(Q_{502})(Q_{503}) (Q_{501} to Q_{503} may be each independently selected

from a hydrogen, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, and a $\text{C}_2\text{-C}_{60}$ heteroaryl group);

L_{501} to L_{503} may be understood by referring to the description provided herein in connection with L_{201} ;

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 carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

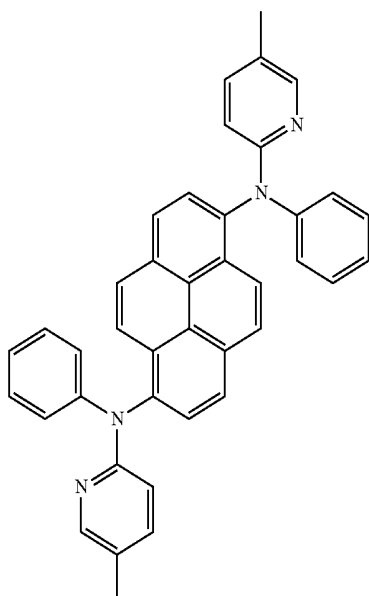
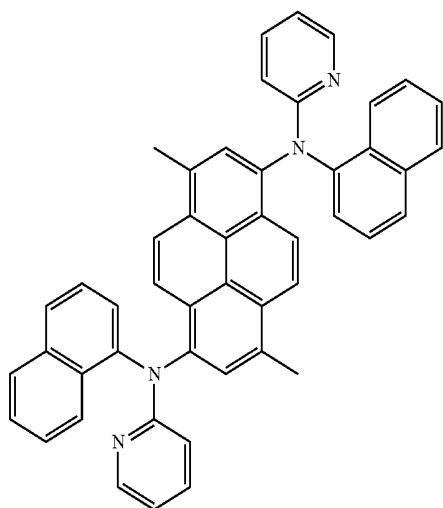
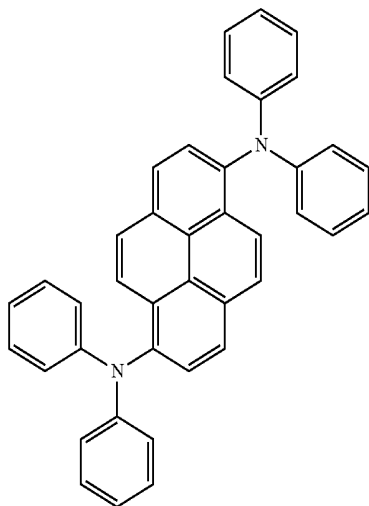
a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl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

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.

87

The fluorescent host may include at least one of Compounds FD1 to FD8.

**88**

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FD4

FD1 5

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FD2 25

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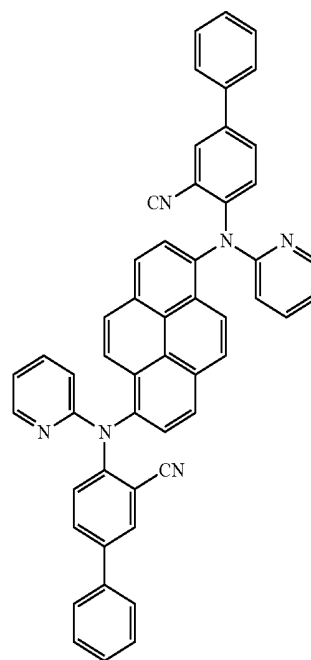
FD3 45

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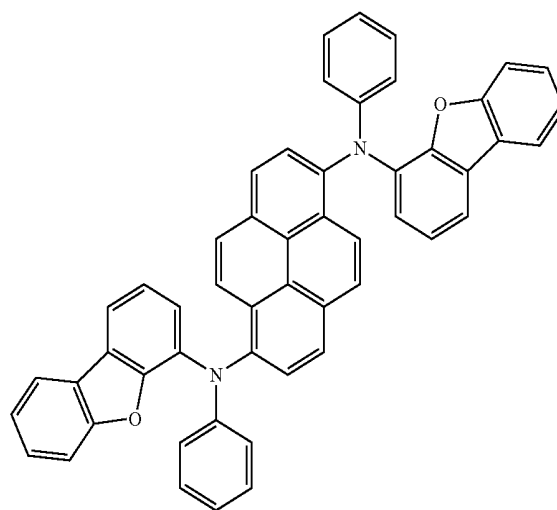
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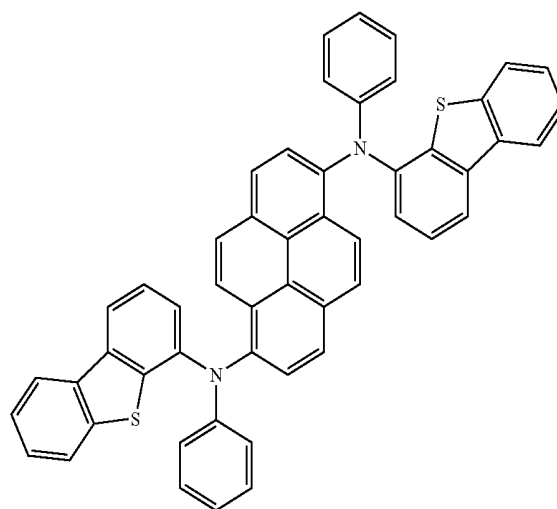
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FD5

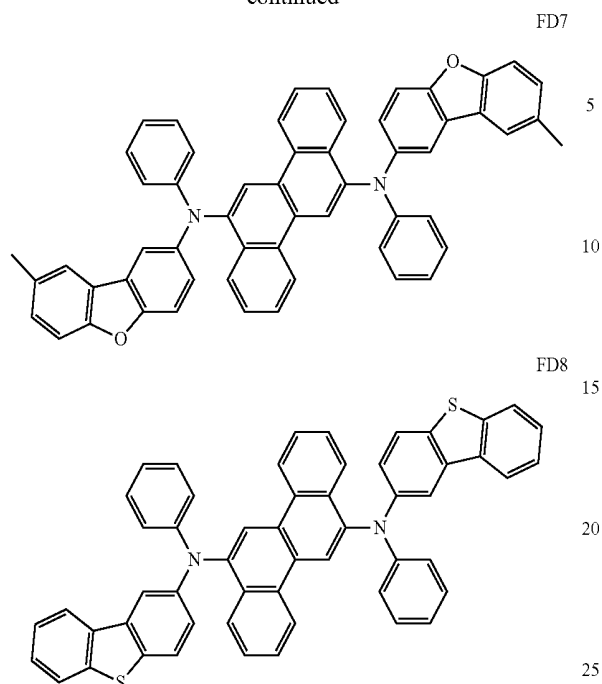


FD6



89

-continued



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

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

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

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

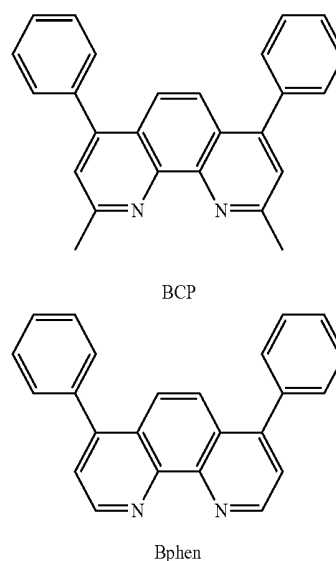
For example, the electron transport region may have a structure of electron transport layer/electron injection layer, or a structure of hole blocking layer/electron transport layer/electron injection layer, wherein layers of each structure are sequentially stacked from the emission layer in the stated order, but is not limited thereto.

The electron transport region may include a hole blocking layer. The hole blocking layer may be formed, when the emission layer includes a phosphorescent dopant, to reduce or 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 (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, a Langmuir-Blodgett (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, for example, at least one of BCP and Bphen, but is not limited thereto.

90

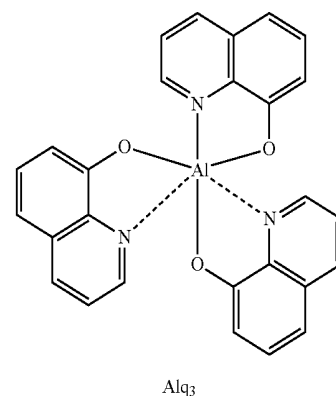


A thickness of the hole blocking layer may be in a range of about 20 Å to about 1,000 Å, for example, about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within these ranges, the hole blocking layer may have excellent hole blocking characteristics without a substantial increase in driving voltage.

The electron transport layer may be formed on the emission layer or the hole blocking layer by using (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, an 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, deposition and coating conditions for the electron transport layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

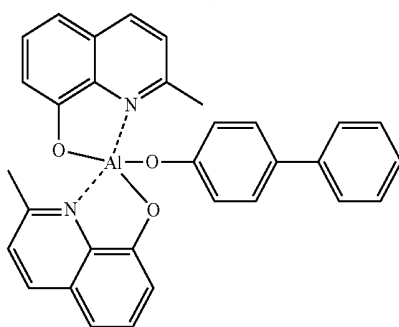
According to an embodiment, the organic layer 150 of the organic light-emitting device includes an electron transport region disposed between the emission layer and the second electrode 190, and the electron transport region may include an electron transport layer.

In some embodiments, the electron transport layer may further include, in addition to the condensed cyclic compound represented by Formula 1, at least one selected from BCP, Bphen, Alq₃, Balq, TAZ, and NTAZ.

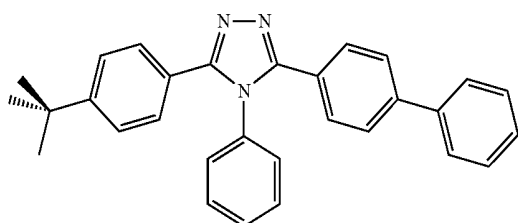


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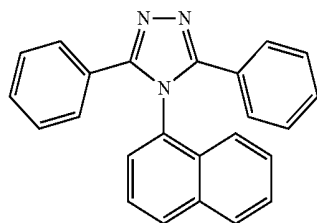
-continued



BAQ



TAZ

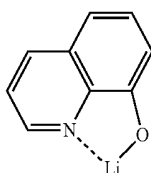


NTAZ

A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, for example, about 150 Å to about 500 Å. In one embodiment, when the thickness of the electron transport layer is within the range described above, the electron transport layer has satisfactory electron transport characteristics without a substantial increase in driving voltage.

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

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.

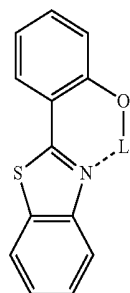


ET-D1

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-continued

ET-D2



The electron transport region may include an electron injection layer that allows electrons to be easily provided from the second electrode **190**.

The electron injection layer may be formed on the electron transport layer by using (utilizing) various suitable methods, such as vacuum deposition, spin coating, casting, an 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, deposition and coating conditions for the electron injection layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

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

A thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, for example, about 3 Å to about 90 Å. In one embodiment, when the thickness of the electron injection layer is within the range described above, the electron injection layer has satisfactory electron injection characteristics without a substantial increase in driving voltage.

The second electrode **190** is disposed on the organic layer **150** having such a structure. The second electrode **190** may be a cathode which is an electron injection electrode, and in this regard, a material for the second electrode **190** may be a metal, an alloy, an electrically conductive compound, or a mixture thereof, which have a relatively low work function. Non-limiting examples of the second electrode **190** are lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag). According to another embodiment, 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.

Also, an organic layer according to an embodiment may be formed by depositing the compound represented by Formula 1 or 2, or may be formed by using (utilizing) a wet method in which the compound represented by Formula 1 or 2 is prepared in the form of a solution and then the solution of the compound is used (utilized) for coating.

An organic light-emitting device according to an embodiment may be used (utilized) in various flat panel display apparatuses, such as a passive matrix organic light-emitting display apparatus or an active matrix organic light-emitting display apparatus. In particular, when the organic light-emitting device is included in an active matrix organic light-emitting display apparatus, a first electrode disposed on a substrate acts as a pixel electrode and may be electrically coupled (e.g., connected) to a source electrode or a drain electrode of a thin film transistor. In addition, the organic light-emitting device may be included in a flat panel display apparatus that emits light in opposite directions.

Hereinbefore, the organic light-emitting device has been described with reference to the drawing, but is not limited thereto.

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

A C₁-C₆₀ alkyl group used herein refers to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms, and non-limiting examples thereof are a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a ter-butyl group, a pentyl group, an iso-amyl group, and a hexyl group. A C₁-C₆₀ alkylene group used herein refers to a divalent group having the same structure as the C₁-C₆₀ alkyl group.

A C₁-C₆₀ alkoxy group used herein refers to a monovalent group represented by —OA₁₀₁ (wherein A₁₀₁ is the C₁-C₆₀ alkyl group), and non-limiting examples thereof are a methoxy group, an ethoxy group, and an isopropoxy group.

A C₂-C₆₀ alkenyl group used herein refers to a hydrocarbon group having at least one carbon double bond in the middle or terminal of the C₂-C₆₀ alkyl group, and non-limiting examples thereof are an ethenyl group, a propenyl group, and a butenyl group. A C₂-C₆₀ alkenylene group used herein refers to a divalent group having the same structure as the C₂-C₆₀ alkenyl group.

A C₂-C₆₀ alkynyl group used herein refers to a hydrocarbon group having one carbon triple bond in the middle or terminal of the C₂-C₆₀ alkyl group, and non-limiting examples thereof are an ethynyl group, and a propynyl group. A C₂-C₆₀ alkynylene group used herein refers to a divalent group having the same structure as the C₂-C₂ alkynyl group.

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

A C₂-C₁₀ heterocycloalkyl group used herein refers to a monovalent monocyclic group having at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 2 to 10 carbon atoms, and non-limiting examples thereof are a tetrahydrofuranyl group, and a tetrahydrothiophenyl group. A C₂-C₁₀ heterocycloalkylene group used herein refers to a divalent group having the same structure as the C₂-C₁₀ heterocycloalkyl group.

A C₃-C₁₀ cycloalkenyl group used herein refers to a monovalent monocyclic group that has 3 to 10 carbon atoms and at least one double bond in the ring thereof and does not have aromaticity, and non-limiting examples thereof are a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. A C₃-C₁₀ cycloalkenylene group used herein refers to a divalent group having the same structure as the C₃-C₁₀ cycloalkenyl group.

A C₂-C₁₀ heterocycloalkenyl group used herein refers to a monovalent monocyclic group that has at least one hetero atom selected from N, O, P, and S as a ring-forming atom, 2 to 10 carbon atoms, and at least one double bond in its ring. Non-limiting examples of the C₂-C₁₀ heterocycloalkenyl group are a 2,3-hydrofuranyl group and a 2,3-hydrothiophenyl group. A C₂-C₁₀ heterocycloalkenylene group used

herein refers to a divalent group having the same structure as the C₂-C₁₀ heterocycloalkenyl group.

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

A C₂-C₆₀ heteroaryl group used herein refers to a monovalent group having a carbocyclic aromatic system that has at least one hetero atom selected from N, O, P, and S as a ring-forming atom, and 2 to 60 carbon atoms. A C₂-C₆₀ heteroarylene group used herein refers to a divalent group having a carbocyclic aromatic system that has at least one hetero atom selected from N, O, P, and S as a ring-forming atom, and 2 to 60 carbon atoms. Examples of the C₂-C₆₀ heteroaryl group are a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, and an isoquinolinyl group. When the C₂-C₂ heteroaryl group and the C₂-C₂ heteroarylene group each include two or more rings, the rings may be fused to each other.

A C₆-C₆₀ aryloxy group used herein refers to a monovalent group represented by —OA₁₀₂ (wherein A₁₀₂ is the C₆-C₆₀ aryl group), and a C₆-C₆₀ arylthio group refers to a monovalent group represented by —SA₁₀₃ (wherein A₁₀₃ is the C₆-C₆₀ 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-aromaticity in the entire molecular structure. A non-limiting example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. A divalent non-aromatic condensed polycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

A monovalent non-aromatic condensed heteropolycyclic group used herein refers to a monovalent group (for example, having 2 to 60 carbon atoms) that has two or more rings condensed to each other, has a heteroatom selected from N, O, P, and S, other than carbon atoms, as a ring forming atom, and has non-aromaticity in the entire molecular structure. An example of the monovalent non-aromatic condensed heteropolycyclic group is a carbazolyl group. A divalent non-aromatic condensed heteropolycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

In the present specification, at least one substituent of the substituted C₃-C₁₀ cycloalkylene group, the substituted C₂-C₁₀ heterocycloalkylene group, the substituted C₃-C₁₀ cycloalkenylene group, the substituted C₂-C₁₀ heterocycloalkenylene group, the substituted C₆-C₆₀ arylene group, the substituted C₂-C₆₀ heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C₁-C₆₀ alkyl group, the substituted C₂-C₆₀ alkenyl group, the substituted C₂-C₆₀ alkynyl group, the substituted C₁-C₆₀ alkoxy group, the substituted C₃-C₁₀ cycloalkyl group, the substituted C₂-C₁₀ heterocycloalkyl group, the substituted C₃-C₁₀ cycloalkenyl group, the sub-

stituted C₂-C₁₀ heterocycloalkenyl group, the substituted C₆-C₆₀ aryl group, the substituted C₆-C₆₀ aryloxy group, the substituted C₆-C₆₀ arylthio group, the substituted C₂-C₆₀ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed hetero-polycyclic 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

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

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

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

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

Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇ and Q₃₁ to Q₃₇ 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 hydrazine group, a hydrazine group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy

group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed hetero-polycyclic group.

For example, at least one substituent of the substituted C₃-C₁₀ cycloalkylene group, the substituted C₂-C₁₀ heterocycloalkylene group, the substituted C₃-C₁₀ cycloalkenylene group, the substituted C₂-C₁₀ heterocycloalkenylene group, the substituted C₆-C₆₀ arylene group, the substituted C₂-C₆₀ heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed hetero-polycyclic group, the substituted C₁-C₆₀ alkyl group, the substituted C₂-C₆₀ alkenyl group, the substituted C₂-C₆₀ alkynyl group, the substituted C₁-C₆₀ alkoxy group, the substituted C₃-C₁₀ cycloalkyl group, the substituted C₂-C₁₀ heterocycloalkyl group, the substituted C₃-C₁₀ cycloalkenyl group, the substituted C₂-C₁₀ heterocycloalkenyl group, the substituted C₆-C₆₀ aryl group, the substituted C₆-C₆₀ aryloxy group, the substituted C₆-C₆₀ arylthio group, the substituted C₂-C₆₀ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed hetero-polycyclic 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 hydrazine group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one of 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 hydrazine group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzo-fluorenyl 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl 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 carbazolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuran-yl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzooxazolyl group, an isobenzooxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophe-nyl group, a benzocarbazolyl group, a dibenzocarbazolyl

group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, $-\text{N}(\text{Q}_{11})(\text{Q}_{12})$, $-\text{Si}(\text{Q}_{13})(\text{Q}_{14})(\text{Q}_{15})$, and $-\text{B}(\text{Q}_{16})(\text{Q}_{17})$;

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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoioxazolyl group, an isobenzooxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

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 dibenzo fluorenyl 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoidolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzooxazolyl group, an isobenzooxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one of a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt

thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl 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 benzooxazolyl 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, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇);
—N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇);

Q₁ to Q₇, Q11 to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a 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 isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuran-yl group, a benzothiophenyl group, an isobenzothiazolyl

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group, a benzooxazolyl 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.

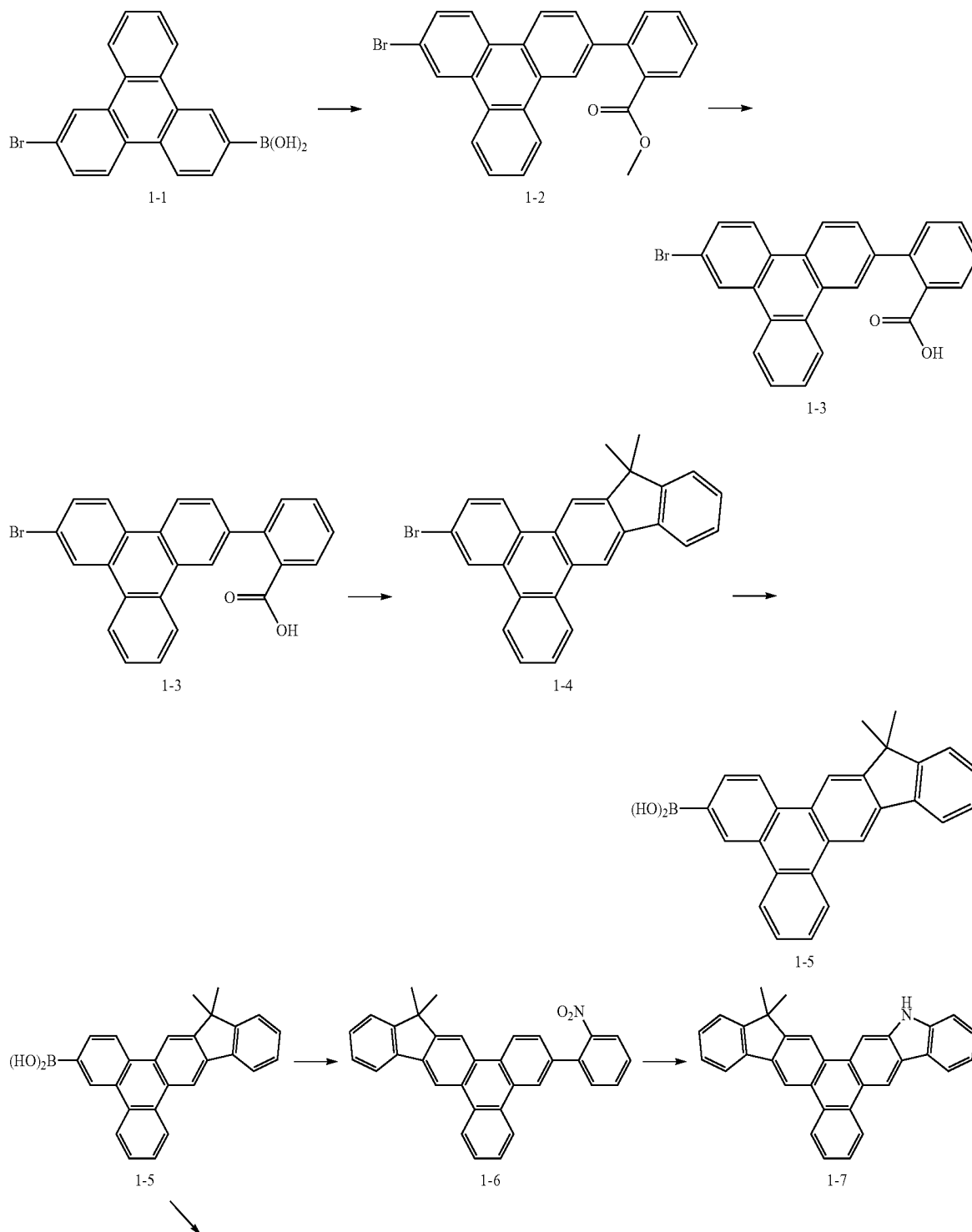
The term "Ph" used herein refers to a phenyl group, the term "Me" used herein refers to a methyl group, the term "Et" used herein refers to an ethyl group, and the term "ter-Bu" or "Bu" used herein refers to a tert-butyl group.

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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 (utilized) instead of A" used in describing Synthesis Examples means that a molar equivalent of A was identical to a molar equivalent of B.

SYNTHESIS EXAMPLE

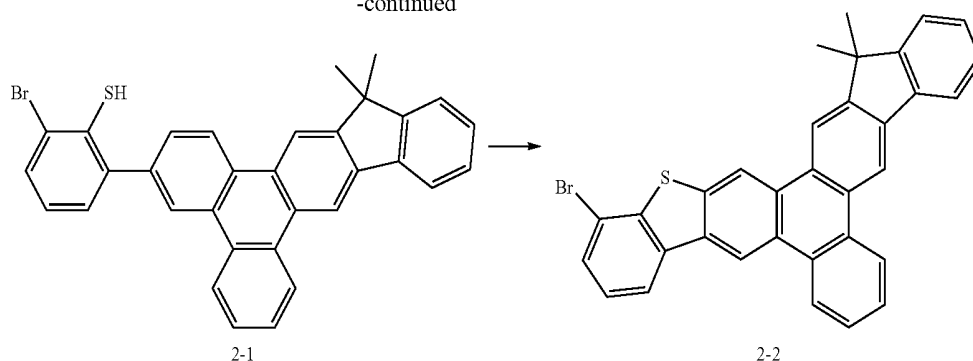
Synthesis of Intermediate 1-7



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-continued



Synthesis of Intermediate 1-2

50 g (0.142 mol) of Compound 1-1, 26.8 g (0.156 mol) of methyl-2-iodobenzoate, 3.28 g (0.002 mol) of $\text{PPd}(\text{PPh}_3)_4$, 16.53 g (0.156 mmol) of Na_2CO_3 , 80 mL of distilled water, 160 mL of toluene, and 50 mL of ethanol were mixed by stirring while refluxing. 12 hours after the mixing, the mixture was cooled to room temperature, and extracted with MC and then washed with distilled water. The resultant material was dried with MgSO_4 and then distilled under reduced pressure. The residual material was separated by using (utilizing) a column to obtain 50.7 g (0.114 mol, 80.91%) of Compound 1-2.

Synthesis of Intermediate 1-3

7.2 g (16.12 mmol) of Compound 1-2 was dissolved in 1000 mL of diethylether, and then, at a temperature of -78°C ., 80.6 mL of MeLi (129.00 mmol, 1.6 M in diethyl ether) was added thereto, and 30 minutes after the addition, the mixture was stirred at room temperature. After 12 hours of the stirring, distilled water was added thereto, and then, extraction using (utilizing) EA was performed thereon. The resultant material was dried with MgSO_4 and distilled under reduced pressure. The residual material was separated by using (utilizing) a column to obtain 5.8 g (12.98 mmol, 80.56%) of Compound 1-3.

Synthesis of Intermediate 1-4

5.8 g (12.98 mmol) of Compound 1-3, 100 mL of an acetic acid, and 80 mL of H_3PO_4 were mixed at room temperature for 2 hours. Distilled water was added thereto, and the resultant material was neutralized using (utilizing) a NaOH aqueous solution, and then extracted using (utilizing) MC and separated by using (utilizing) a column to obtain 2.2 g (10.7 mmol, 42.56%) of Compound 1-4.

Synthesis of Intermediate 1-5

8 g (13.98 mmol) of Compound 1-4 was dissolved in 1000 mL of THF, and then, at a temperature of -78°C ., 80.6 mL of BuLi (129.00 mmol, 1.6 M in hexane) was added thereto. 30 minutes after the addition, the mixture was stirred at room temperature. After 12 hours of stirring, 10 mL of 1N HCl was added thereto, and then, extraction using (utilizing) EA was performed thereon. The resultant material was dried with MgSO_4 and distilled under reduced pressure. The residual material was separated by using (utilizing) a column to obtain 6.2 g (12.98 mmol, 80.1%) of Compound 1-5.

Synthesis of Intermediate 1-6

7 g (14.7 mmol) of Compound 1-5, 4.2 g (17.4 mmol) of bromonitrobenzene, 1.2 g (0.2 mmol) of $\text{PPd}(\text{PPh}_3)_4$, 3.2 g (0.156 mmol) of Na_2CO_3 , 40 mL of distilled water, 80 mL of toluene, and 20 mL of ethanol were mixed by stirring while refluxing. 12 hours after the mixing, the mixture was cooled to room temperature, and extracted with MC and then washed with distilled water. The resultant material was dried with MgSO_4 and then distilled under reduced pressure. The residual material was separated by using (utilizing) a column to obtain 4.2 g (11.4 mmol, 81%) of Compound 1-6.

Synthesis of Intermediate 1-7

At a temperature of 0°C ., 3.4 g (12.6 mmol) of Compound 1-6 was slowly added to 140 mL of a mixed solution of an acetic acid and a sulfuric acid (1:4). After 5 minutes of mixing, the temperature was rapidly raised to 50°C . and then, slowly raised up to 110°C . 20 minutes thereafter, the temperature was decreased to room temperature and the resultant material was stirred for 12 hours. Ethanol was added thereto, and one hour after the addition, a produced solid was filtered out under reduced pressure and then neutralized. The solid was dried under reduced pressure to obtain 2.9 g (6.4 mmol, 51.1%) of Compound 1-7.

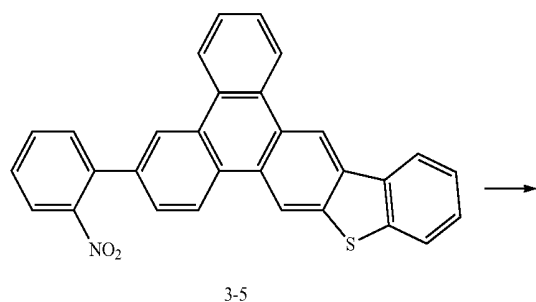
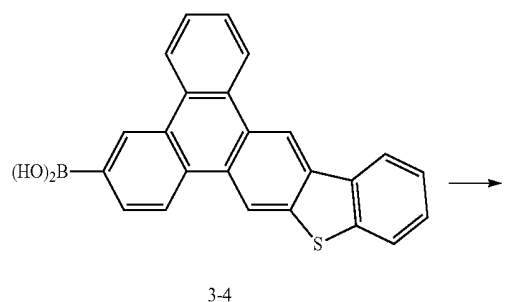
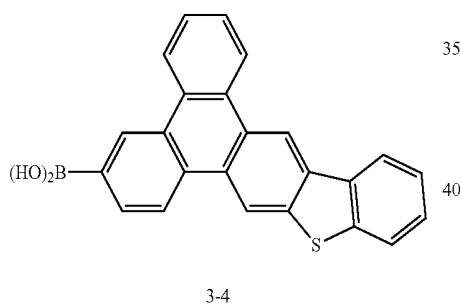
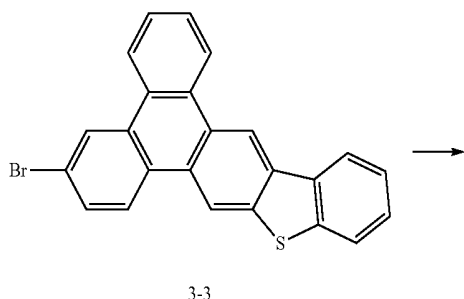
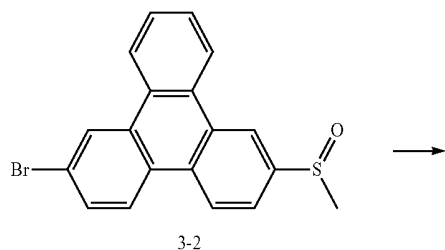
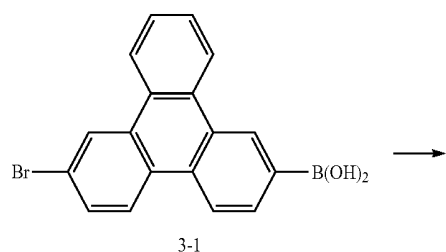
Synthesis of Intermediate 2-1

Compound 2-1 was obtained with a yield of 74% in the same manner as used (utilized) to obtain Intermediate 1-6 except that 2,6-dibromobenzenethiol was used (utilized) instead of bromonitrobenzene.

Synthesis of Intermediate 2-2

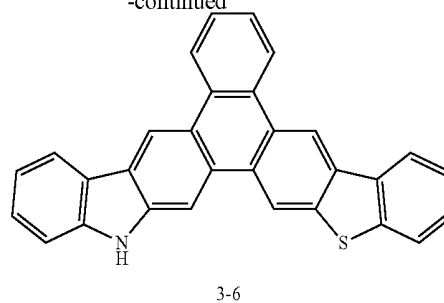
Intermediate 2-1 was added in an amount of 20 mL per gram of THF in a flask, and then, the temperature was decreased to -78°C . (acetone+dry ice), and n-BuLi 2 eq was slowly added thereto. The temperature was raised to room temperature, and then, distilled water was slowly added thereto. When the reaction stopped, the reaction solution was extracted using (utilizing) MC, and then, subjected to column chromatography to obtain Compound 2-2 (yield of 66.4%).

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-continued



Synthesis of Intermediate 3-2

The same manner as used (utilized) to synthesize Intermediate 2-1 was performed to obtain Compound 3-2 with a yield of 79.3%.

Synthesis of Intermediate 3-3

The same manner as used (utilized) to synthesize Intermediate 2-2 was performed to obtain Compound 3-3 with a yield of 52%.

Synthesis of Intermediate 3-4

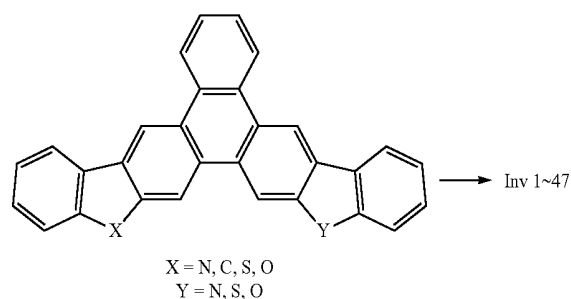
The same manner as used (utilized) to synthesize Intermediate 1-5 was performed to obtain Compound 3-4 with a yield of 75.7%.

Synthesis of Intermediate 3-5

The same manner as used (utilized) to synthesize Intermediate 1-6 was performed to obtain Compound 3-5 with a yield of 77.4%.

Synthesis of Intermediate 3-6

The same manner as used (utilized) to synthesize Intermediate 1-7 was performed to obtain Compound 3-6 with a yield of 43.7%.



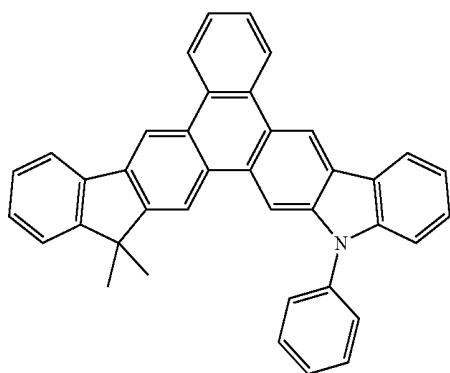
Synthesis Example 1

0.02 eq of $\text{Pd}(\text{PPh}_3)_4$, 1.2 eq of Na_2CO_3 , and toluene, distilled water, and ethanol (0.1 M, at a ratio of 5:3:2) were added to a flask containing the respective finally prepared intermediate compound, and 12 hours after the addition, the temperature was decreased to room temperature. The resultant material was extracted with MC and then washed with distilled water. Then, the resultant material was dried with

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MgSO₄ and distilled under reduced pressure. The residual material was separated by using (utilizing) a column to obtain the final compounds Inv-1 to 47.

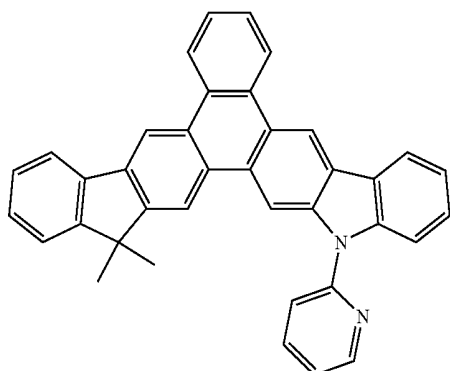
Inv-1



Elemental Analysis for C₃₉H₂₇N: calcd C, 91.91; H, 5.34; N, 2.75.

HRMS for C₃₉H₂₇N [M]⁺: calcd 509.65. found 508.

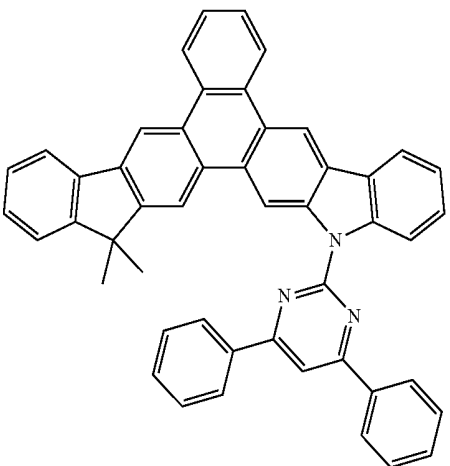
Inv-7



Elemental Analysis for C₃₈H₂₆N₂: calcd C, 89.38; H, 5.13; N, 5.49.

HRMS for C₃₈H₂₆N₂ [M]⁺: calcd 510.64. found 509.

Inv-9

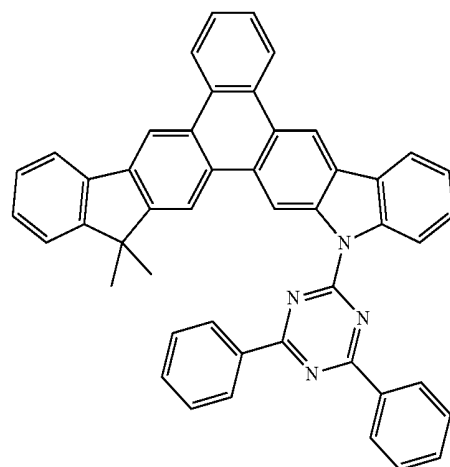


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Elemental Analysis for C₃₈H₂₆N₂: calcd C, 89.38; H, 5.13; N, 5.49.

HRMS for C₃₈H₂₆N₂ [M]⁺: calcd 510.64. found 509.

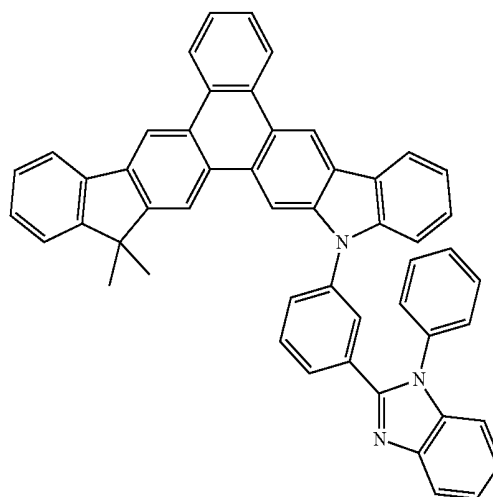
Inv-10



Elemental Analysis for C₄₈H₃₂N₄: calcd C, 86.72; H, 4.85; N, 8.43.

HRMS for C₄₈H₃₂N₄ [M]⁺: calcd 664.81. found 663.

Inv-11

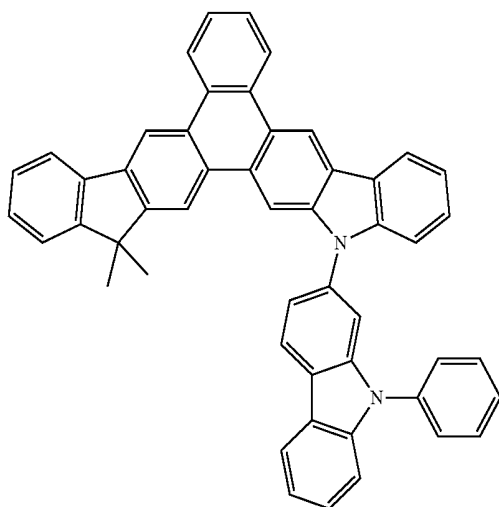


Elemental Analysis for C₅₂H₃₅N₃: calcd C, 88.99; H, 5.03; N, 5.99.

HRMS for C₅₂H₃₅N₃ [M]⁺: calcd 701.87. found 700.

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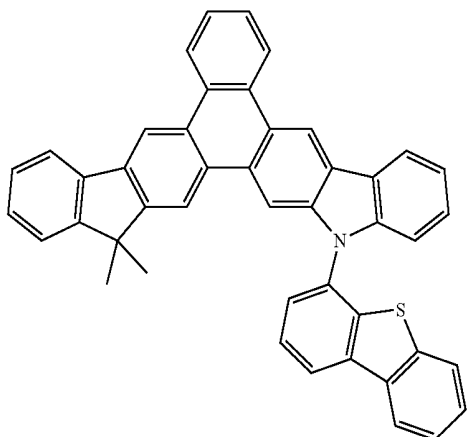
Inv-13



Elemental Analysis for C₅₁H₃₄N₂: calcd C, 90.77; H, 5.08; N, 4.15.

HRMS for C₅₁H₃₄N₂ [M]⁺: calcd 674.85. found 673.

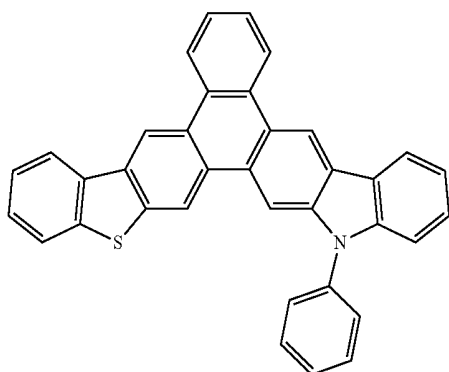
Inv-14



Elemental Analysis for C₄₅H₂₉NS: calcd C, 87.77; H, 4.75; N, 2.27; S, 5.21.

HRMS for C₄₅H₂₉NS [M]⁺: calcd 615.79. found 614.

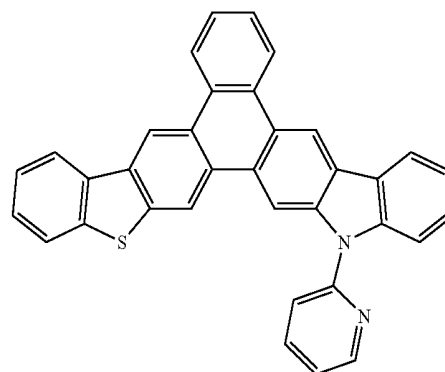
Inv-16

**108**

Elemental Analysis for C₃₆H₂₁ NS: calcd C, 86.54; H, 4.24; N, 2.80; S, 6.42.

HRMS for C₃₆H₂₁ NS [M]⁺: calcd 499.63. found 498.

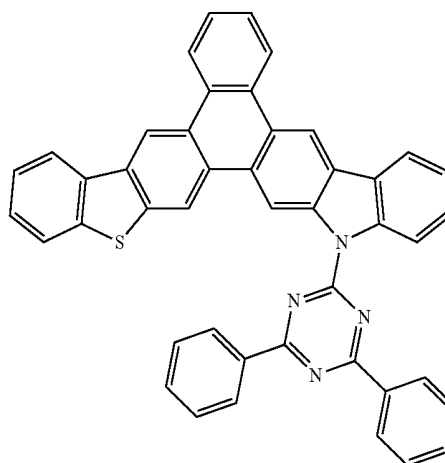
Inv-22



Elemental Analysis for C₃₅H₂₀N₂S: calcd C, 83.97; H, 4.03; N, 5.60; S, 6.40.

HRMS for C₃₅H₂₀N₂S [M]⁺: calcd 500.62. found 499.

Inv-25

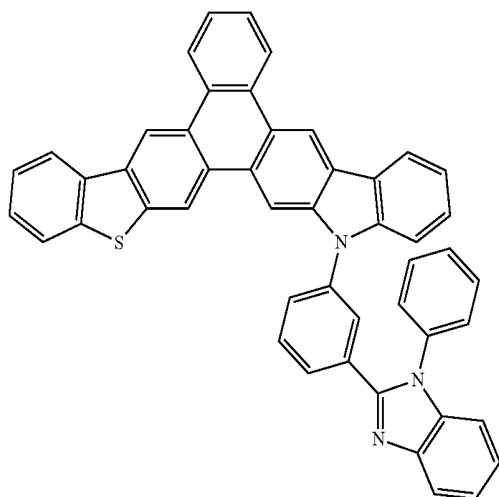


Elemental Analysis for C₄₅H₂₆N₄S: calcd C, 82.54; H, 4.00; N, 8.56; S, 4.90.

HRMS for C₄₅H₂₆N₄S [M]⁺: calcd 645.79. found 644.

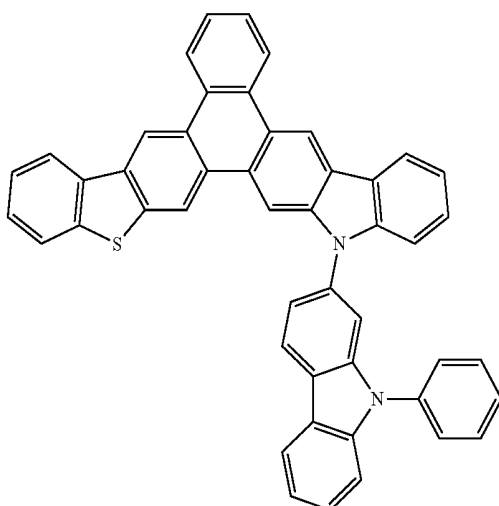
109

Inv-26



Elemental Analysis for C₄₉H₂₉N₃S: calcd C, 85.07; H, 4.23; N, 6.07; S, 4.63.

HRMS for C₄₉H₂₉N₃S [M]⁺: calcd 691.85. found 690.
Inv-28

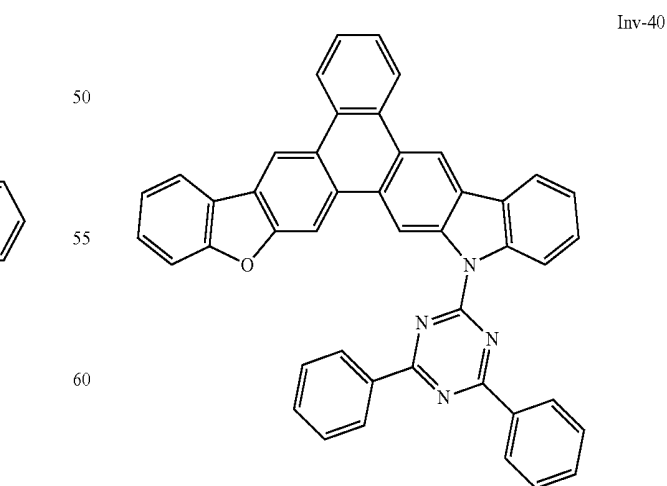
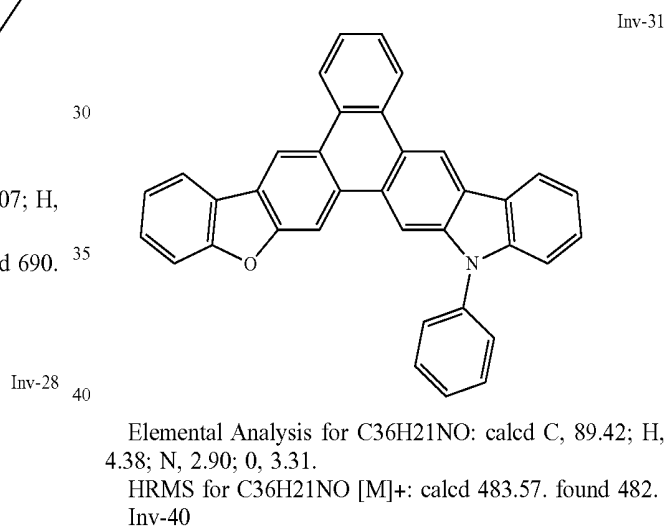
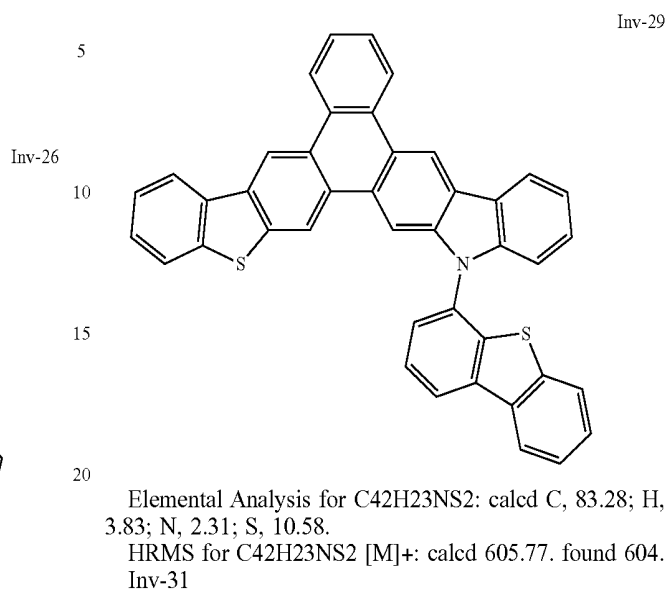


Elemental Analysis for C₄₈H₂₈N₂S: calcd C, 86.72; H, 4.25; N, 4.21; S, 4.82.

HRMS for C₄₈H₂₈N₂S [M]⁺: calcd 664.72. found 663.

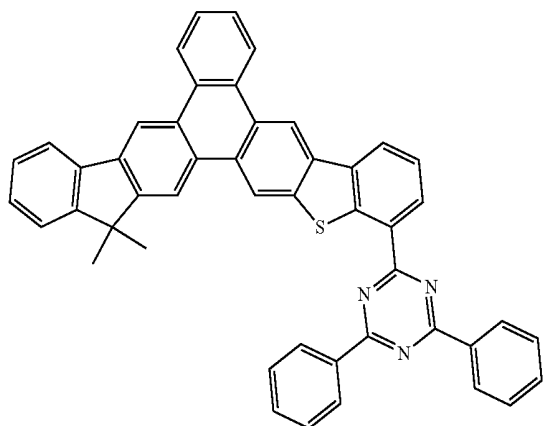
110

Inv-29



111

HRMS for C₄₅H₂₆N₄O [M]⁺: calcd 638.73. found 637.
Inv-46



Inv-46 5

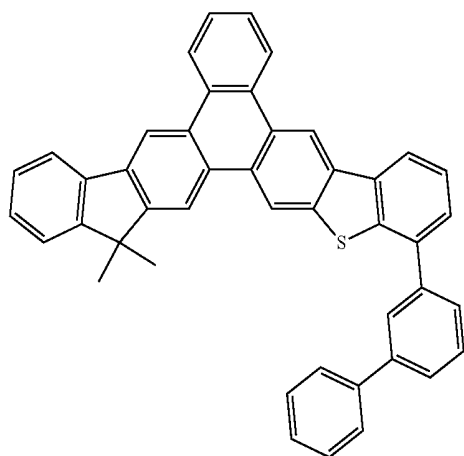
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Elemental Analysis for C₄₈H₃₁N₃S: calcd C, 84.55; H, 4.58; N, 6.16; S, 4.70.

HRMS for C₄₈H₃₁N₃S [M]⁺: calcd 681.86. found 680.
Inv-47



Inv-47

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Elemental Analysis for C₄₅H₃₀S: calcd C, 89.66; H, 5.02; S, 5.32.

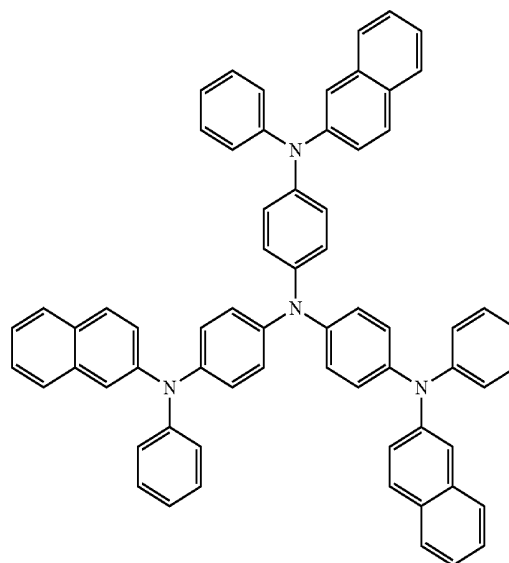
HRMS for C₄₅H₃₀S [M]⁺: calcd 602.80. found 602.

EXAMPLE

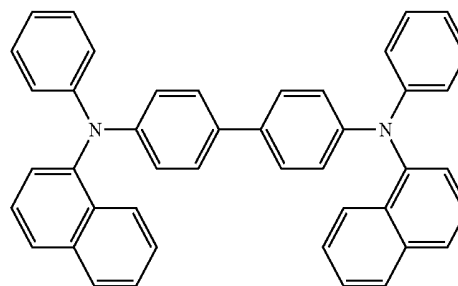
Example 1

An anode was prepared by cutting a Corning 15 Ωcm² (500 Å) ITO glass substrate to a size of 50 mm×50 mm×0.5 mm, ultrasonically cleaning the glass substrate by using (utilizing) isopropyl alcohol for 10 minutes and pure water for 10 minutes, and then irradiating UV light for 10 minutes thereto and exposing to ozone to clean. Then, the anode was loaded onto a vacuum deposition apparatus. 2-TNATA was vacuum deposited thereon to form a hole injection layer having a thickness of 600 Å, and 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB), which is a hole transport compound, was deposited on the hole injection layer to form a hole transport layer having a thickness of 300 Å.

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2-TNATA



NPB

Ir(ppy)₃ [bis-(1-phenylisoquinolyl) iridium(III)acetylacetonate] (which is a green phosphorescent dopant) and Inv-1 were co-deposited on the hole transport layer at a weight ratio of 15:85 to form an emission layer having a thickness of 300 Å. Then, Alq₃ was deposited on the emission layer to form an electron transport layer having a thickness of 300 Å, and Al was vacuum deposited to form an Al electrode having a thickness of 1200 Å (cathode), thereby completing the manufacturing of an organic light-emitting device.

Example 2

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-7 was used (utilized) instead of Inv-1.

Example 3

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-9 was used (utilized) instead of Inv-1.

Example 4

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-10 was used (utilized) instead of Inv-1.

Example 5

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-11 was used (utilized) instead of Inv-1.

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Example 6

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-13 was used (utilized) instead of Inv-1.

Example 7

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-14 was used (utilized) instead of Inv-1.

Example 8

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-16 was used (utilized) instead of Inv-1.

Example 9

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-22 was used (utilized) instead of Inv-1.

Example 10

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-25 was used (utilized) instead of Inv-1.

Example 11

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-26 was used (utilized) instead of Inv-1.

Example 12

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-28 was used (utilized) instead of Inv-1.

Example 13

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-29 was used (utilized) instead of Inv-1.

Example 14

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-31 was used (utilized) instead of Inv-1.

Example 15

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-40 was used (utilized) instead of Inv-1.

Example 16

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-46 was used (utilized) instead of Inv-1.

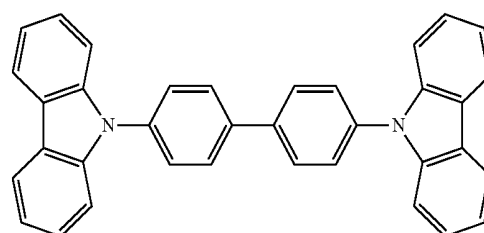
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Example 17

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Inv-47 was used (utilized) instead of Inv-1.

Comparative Example 1

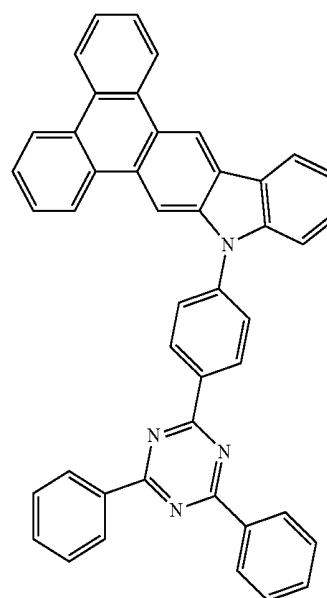
An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, CBP, which is a host material, was used (utilized) instead of Inv-1, and bis(2-methyl-8-quinolino)(p-phenylphenolato)aluminum (III) (BALq) was used (utilized) to form a hole blocking layer.



CBP

Comparative Example 2

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Compound A disclosed in KR2013-0007951 was used (utilized) as a host material instead of Inv-1.

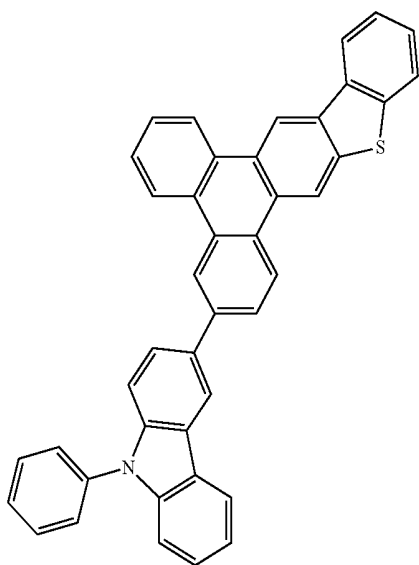


A

Comparative Example 3

An organic light-emitting device was manufactured in the same manner as in Example 1, except that in forming the emission layer, Compound B disclosed in KR2013-0007934 was used (utilized) as a host instead of Inv-1.

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Lifespan results of the compounds used (utilized) in Examples 1 to 17 of the present disclosure were summarized and results thereof are shown in Table 1 below. As described in Examples 1 to 17, when compounds according to embodiments of the present invention were used (utilized) as a phosphorescent host in forming an emission layer of an organic light-emitting device, they all provided a lower driving voltage than CBP (which is a known phosphorescent host material) by 10% or more, and had high efficiency and excellent I-V-L characteristics. For example, lifespan characteristics thereof are improved: the organic light-emitting devices manufactured according to Examples 1 to 17 had a longer lifespan than that of Comparative Example 1 by 20% or more. In addition, compared to the molecules disclosed in KR2013-0007951 and KR2013-0007934, compounds represented by Formula 1 or 2 according to embodiments of the present invention provided excellent lifespan characteristics.

TABLE 1

	Luminescent material	Voltage	Efficiency	T95 lifespan (hr @100 mA/cm ²)
Example 1	Inv1	7.22	18.2	970
Example 2	Inv7	7.26	18.3	921
Example 3	Inv9	7.30	19.0	943
Example 4	Inv10	7.43	19.2	921
Example 5	Inv11	7.32	21.9	991
Example 6	Inv13	7.84	22.0	937
Example 7	Inv14	6.93	17.9	897
Example 8	Inv16	7.21	18.8	911
Example 9	Inv22	7.37	17.9	956
Example 10	Inv25	7.45	19.1	971
Example 11	Inv26	7.52	17.7	923
Example 12	Inv28	7.02	18.1	970
Example 13	Inv29	7.26	18.0	921
Example 14	Inv31	6.82	17.9	943
Example 15	Inv40	7.09	17.6	937
Example 16	Inv46	6.95	17.4	912
Example 17	Inv47	7.24	20.5	887
Comparative Example 1	CBP	7.9	12.7	456
Comparative Example 2	Compound A	7.23	20.1	760
Comparative Example 3	Compound B	7.42	19.8	684

As described above, it was confirmed that compounds represented by Formula 1 or 2 according to embodiments of

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the present invention have better luminescent characteristics than those of a comparable material. Also, a device using (utilizing) the organic luminescent compound represented by Formula 1 or 2 according to embodiments of the present invention as a host material for luminescence has (even without the use (usage) of a hole blocking layer in the structure thereof) excellent luminescent characteristics and a lower driving voltage, thereby leading to a higher power efficiency (more efficient in the consumption of power).

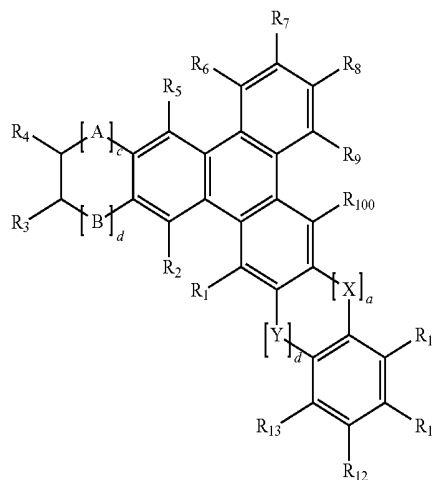
An organic light-emitting device including the compound according to an embodiment of the present invention may have a low driving voltage, high efficiency, high brightness, and long lifespan.

It should be understood that the example embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments. Those of ordinary skill in the art will understand that certain modification can be made to the described embodiments without departing from the spirit and scope of the present invention, as defined in the following claims, and equivalents thereof.

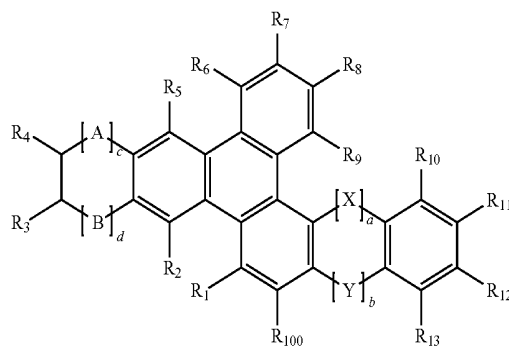
What is claimed is:

1. A compound represented by Formula 1 or Formula 2 below:

Formula 1



Formula 2



wherein in Formulae 1 and 2,

X and Y are each independently NR₂₀₀, O, or S;

A and B are each independently CR₃₀₀R₃₀₁, O, or S;

R₃, R₄, R₁₀ to R₁₃, R₂₀₀, R₃₀₀, and R₃₀₁ 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₂-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₂-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇);

a, b, c, and d are each independently 0 or 1, and a case in which a and b are both 0 or c and d are both 0 is excluded;

at least one substituent of the substituted C₁-C₆₀ alkyl group, the substituted C₂-C₆₀ alkenyl group, the substituted C₂-C₆₀ alkynyl group, the substituted C₁-C₆₀ alkoxy group, the substituted C₃-C₁₀ cycloalkyl group, the substituted C₂-C₁₀ heterocycloalkyl group, the substituted C₃-C₁₀ cycloalkenyl group, the substituted C₂-C₁₀ heterocycloalkenyl group, the substituted C₆-C₆₀ aryl group, the substituted C₆-C₆₀ aryloxy group, the substituted C₆-C₆₀ arylthio group, the substituted C₂-C₆₀ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed hetero-polycyclic group are selected from:

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

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

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

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

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

wherein Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇ and Q₃₁ to Q₃₇ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₂-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₂-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₂-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed hetero-polycyclic group, wherein

R₁, R₂, R₅, R₆ to R₉, and R₁₀₀ in Formula 1 and Formula 2 are each independently a hydrogen or a deuterium.

2. The compound of claim 1, wherein

R₁₀ to R₁₃, and R₂₀₀ in Formula 1 and Formula 2 are each independently selected from a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isooxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a furinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quiazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a

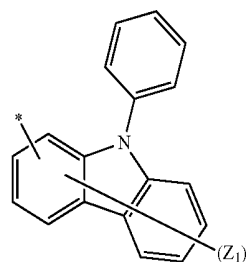
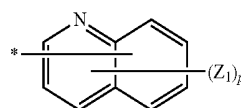
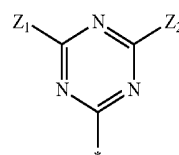
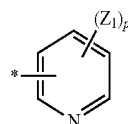
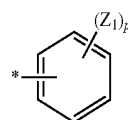
phenaziny group, a benzimidazolyl group, a benzo-
furanyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzooxazolyl group, an isobenzo-
oxazolyl group, a triazolyl group, a tetrazolyl group, an
oxadiazolyl group, a triazinyl group, a dibenzofuranyl
group, a dibenzothiophenyl group, 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 fluo-
ranthenyl group, a triphenylenyl group, a pyrenyl
group, a chrysenyl group, a naphthaceny 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 imida-
zolyl group, a pyrazolyl group, a thiazolyl group, an
isothiazolyl group, an oxazolyl group, an isooxazolyl
group, a pyridinyl group, a pyrazinyl group, a pyrim-
idinyl group, a pyridazinyl group, an isoindolyl group,
an indolyl group, an indazolyl group, a furinyl group,
a quinolinyl group, an isoquinolinyl group, a benzo-
quinolinyl group, a phthalazinyl group, a naphthyridi-
nyl group, a quinoxalinyl group, a quinazolinyl group,
a cinnolinyl group, a carbazolyl group, a phenanthridi-
nyl group, an acridinyl group, a phenanthrolinyl group,
a phenaziny group, a benzimidazolyl group, a benzo-
furanyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzooxazolyl group, an isobenzo-
oxazolyl group, a triazolyl group, a tetrazolyl group,
an oxadiazolyl group, a triazinyl group, a dibenzofura-
nyl group, a dibenzothiophenyl group, a benzocarba-
zolyl group, a dibenzocarbazolyl group, a thiadiazolyl
group, an imidazopyridinyl group, and an imidazopyri-
midinyl group, each substituted with at least one of 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 car-
boxylic acid group or a salt thereof, a sulfonic acid
group or a salt thereof, a phosphoric acid group or a salt
thereof, a C₁-C₂₀ alkyl group, C₁-C₂₀ alkoxy group, a
cyclopentyl group, a cyclohexyl group, a cycloheptyl
group, a cyclopentenyl group, a cyclohexenyl group, a
phenyl group, a pentalenyl group, an indenyl group, a
naphthyl group, an azulenyl group, a heptalenyl group,
an indacenyl group, an acenaphthyl group, a fluorenyl
group, a spiro-fluorenyl group, a benzofluorenyl group,
a dibenzofluorenyl group, a phenalenyl group, a
phenanthrenyl group, an anthracenyl group, a fluo-
ranthenyl group, a triphenylenyl group, a pyrenyl
group, a chrysenyl group, a naphthaceny 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 imida-
zolyl group, a pyrazolyl group, a thiazolyl group, an
isothiazolyl group, an oxazolyl group, an isooxazolyl
group, a pyridinyl group, a pyrazinyl group, a pyrim-
idinyl group, a pyridazinyl group, an isoindolyl group,
an indolyl group, an indazolyl group, a furinyl group,
a quinolinyl group, an isoquinolinyl group, a benzo-
quinolinyl group, a phthalazinyl group, a naphthyridi-

nyl group, a quinoxalinylnyl group, a quinazolinyl group, a cinnolinyl group, a carbazoyl 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 benzooxazolyl 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 and a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group.

3. The compound of claim 1, wherein

R₁₀ to R₁₃ in Formula 1 and Formula 2 are each independently a hydrogen, a deuterium, or one of Formulae 2a to 2e below:



Wherein Z_1 and Z_2 in Formulae 2a-2e above 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{20} aryl group, a substituted or unsubstituted C_1 to C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group;
p is an integer of 1 to 7;

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when p is 2 or more, a plurality of Z_1 are identical or different; and

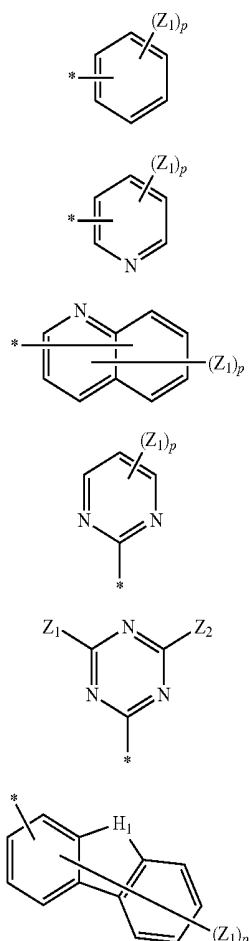
* indicates a binding site to a neighboring atom.

4. The compound of claim 1, wherein

X and Y in Formula 1 and Formula 2 are each independently NR_{200} , or S.

5. The compound of claim 1, wherein

R_{200} is any one of Formulae 3a to 3f:



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wherein in Formulae 3a-3f above,

H_1 is NR_{400} or S;

R_{400} , Z_1 and Z_2 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 group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{20} aryl group, a substituted or unsubstituted C_1 to C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed hetero-polycyclic group;

p is an integer of 1 to 7;

when p is 2 or more, a plurality of Z_1 are identical or different; and

* indicates a binding site to a neighboring atom.

6. An organic light-emitting device comprising:

a first electrode;

a second electrode facing the first electrode; and

an organic layer between the first electrode and the second electrode and comprising an emission layer,

wherein the organic layer comprises at least one of the compounds of claim 1.

7. The organic light-emitting device of claim 6, wherein the first electrode is an anode,

the second electrode is a cathode, and

the organic layer comprises:

a hole transport region between the first electrode and the emission layer and comprising at least one layer selected from the group consisting of 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 and comprising at least one layer selected from the group consisting of a hole blocking layer, an electron transport layer, and an electron injection layer.

8. A flat display apparatus comprising the organic light-emitting device of claim 6, wherein the first electrode of the organic light-emitting device is electrically configured to be coupled to a source electrode or a drain electrode of a thin film transistor.

* * * * *

专利名称(译)	包括其的化合物和有机发光装置		
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申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
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摘要(译)

化合物由式1或式2表示，并且有机发光装置包括该化合物。

