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(54) **ORGANOMETALLIC COMPOUND, ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE ORGANOMETALLIC COMPOUND, AND DIAGNOSTIC COMPOSITION INCLUDING THE ORGANOMETALLIC COMPOUND**

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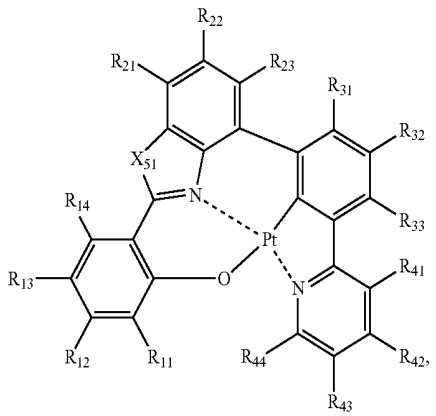
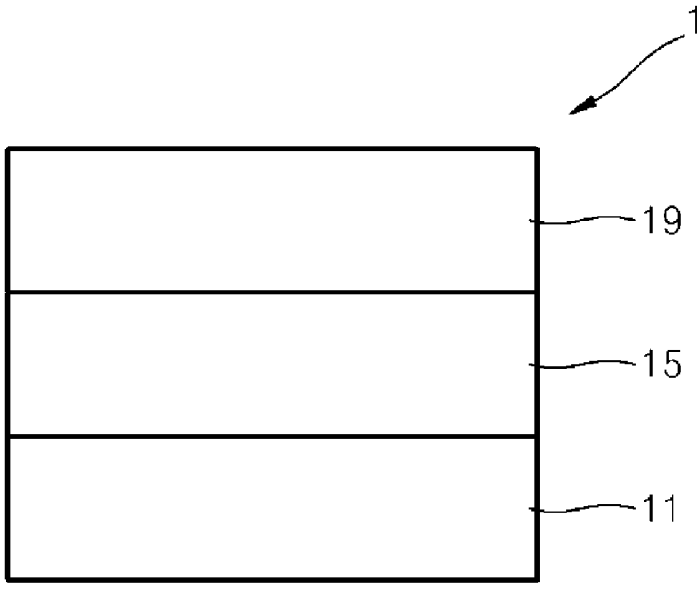
(57) **ABSTRACT**

An organometallic compound represented by Formula 1:

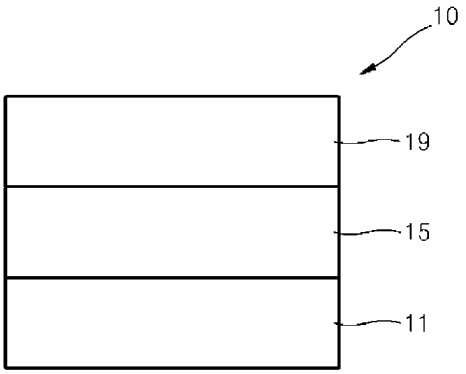
Formula 1




wherein, in Formula 1, groups and variables are the same as described in the specification.



# FIGURE



# ORGANOMETALLIC COMPOUND, ORGANIC LIGHT-EMITTING DEVICE INCLUDING THE ORGANOMETALLIC COMPOUND, AND DIAGNOSTIC COMPOSITION INCLUDING THE ORGANOMETALLIC COMPOUND

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** This application claims priority to Korean Patent Application No. 10-2017-0051077, filed on Apr. 20, 2017, in the Korean Intellectual Property Office, and all the benefits accruing therefrom under 35 U.S.C. § 119, the content of which is incorporated herein in its entirety by reference.

## BACKGROUND

### 1. Field

**[0002]** One or more embodiments relate to an organometallic compound, an organic light-emitting device including the organometallic compound, and a diagnostic composition including the organometallic compound.

### 2. Description of the Related Art

**[0003]** Organic light-emitting devices (OLEDs) are self-emission devices, which have superior characteristics in terms of a viewing angle, a response time, a brightness, a driving voltage, and a response speed, and which produce full-color images.

**[0004]** In an example, an organic light-emitting device includes an anode, a cathode, and an organic layer disposed between the anode and the cathode, wherein the organic layer includes an emission layer. A hole transport region may be disposed between the anode and the emission layer, and an electron transport region may be disposed between the emission layer and the cathode. Holes provided from the anode may move toward the emission layer through the hole transport region, and electrons provided from the cathode may move toward the emission layer through the electron transport region. The holes and the electrons recombine in the emission layer to produce excitons. These excitons transit from an excited state to a ground state, thereby generating light.

**[0005]** Meanwhile, luminescent compounds may be used to monitor, sense, or detect a variety of biological materials including cells and proteins. An example of the luminescent compounds includes a phosphorescent luminescent compound.

**[0006]** Various types of organic light emitting devices are known. However, there still remains a need in OLEDs having low driving voltage, high efficiency, high brightness, and long lifespan.

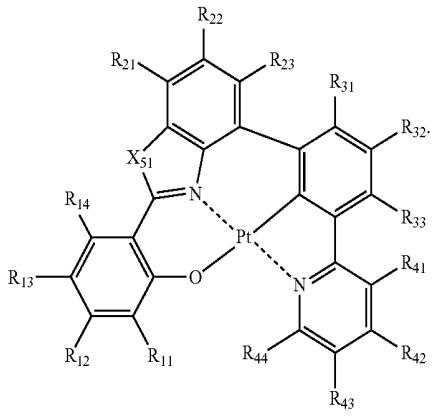
## SUMMARY

**[0007]** Aspects of the present disclosure provide an organometallic compound, an organic light-emitting device including the organometallic compound, and a diagnostic composition including the organometallic compound.

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

**[0009]** An aspect provides an organometallic compound represented by Formula 1 below:

Formula 1




**[0010]** In Formula 1,

**[0011]** $X_{51}$ may be selected from O, S, and $N(R_{51})$,

**[0012]** $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, —$SF_5$, a hydroxyl group, a cyano group, a nitro 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, —$N(Q_1)(Q_2)$, —$Si(Q_3)(Q_4)(Q_5)$, —$B(Q_6)(Q_7)$, and —$P(=O)(Q_8)(Q_9)$,

**[0013]** when $X_{51}$ is O or S, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ may be —$Si(Q_3)(Q_4)(Q_5)$,

**[0014]** when $X_{51}$ is $N(R_{51})$, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may be —$Si(Q_3)(Q_4)(Q_5)$,

**[0015]** at least one substituent of the substituted $C_1$-$C_{60}$ alkyl group, the substituted $C_2$-$C_{60}$ alkenyl group, the substituted $C_2$-$C_{60}$ alkynyl group, and the substituted $C_1$-$C_{60}$ alkoxy group may be selected from:

**[0016]** deuterium, —F, —Cl, —Br, —I, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_1$-$C_{60}$ alkoxy group;

**[0017]** a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_{60}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a

$C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —$N(Q_{11})(Q_{12})$, —$Si(Q_{13})(Q_{14})(Q_{15})$, —$B(Q_{16})(Q_{17})$, and —$P(=O)(Q_{18})(Q_{19})$;

**[0018]** a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

**[0019]** a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —$N(Q_{21})(Q_{22})$, —$Si(Q_{23})(Q_{24})(Q_{25})$, —$B(Q_{26})(Q_{27})$, and —$P(=O)(Q_{28})(Q_{29})$; and

**[0020]** —$N(Q_{31})(Q_{32})$, —$Si(Q_{33})(Q_{34})(Q_{35})$, —$B(Q_{36})(Q_{37})$, and —$P(=O)(Q_{38})(Q_{39})$, and

**[0021]** $Q_1$ to $Q_9$, $Q_{11}$ to $Q_{19}$, $Q_{21}$ to $Q_{29}$, and $Q_{31}$ to $Q_{39}$ may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro 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 $C_1$-$C_{60}$ alkyl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

**[0022]** Another aspect of the present disclosure provides an organic light-emitting device including:

**[0023]** a first electrode;

**[0024]** a second electrode; and

**[0025]** an organic layer disposed between the first electrode and the second electrode, wherein the organic layer includes an emission layer and the at least one organometallic compound.

**[0026]** In the organic layer, the organometallic compound serves as a dopant.

**[0027]** Another aspect of the present disclosure provides a diagnostic composition including at least one organometallic compound represented by Formula 1.

## BRIEF DESCRIPTION OF THE DRAWING

**[0028]** These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the FIGURE which is a schematic view of an organic light-emitting device according to an embodiment.

## DETAILED DESCRIPTION

**[0029]** Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present 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 figures, to explain aspects of the present description. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

**[0030]** It will be understood that when an element is referred to as being "on" another element, it can be directly in contact with the other element or intervening elements may be present therebetween. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

**[0031]** It will be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer, or section from another element, component, region, layer, or section. Thus, a first element, component, region, layer, or section discussed below could be termed a second element, component, region, layer, or section without departing from the teachings of the present embodiments.

**[0032]** The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

**[0033]** The term "or" means "and/or." It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

**[0034]** Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same mean-

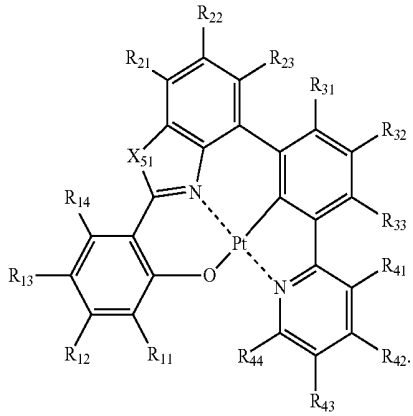
ing as commonly understood by one of ordinary skill in the art to which this general inventive concept belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

**[0035]** Exemplary embodiments are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments described herein should not be construed as limited to the particular shapes of regions as illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present claims.

**[0036]** "About" or "approximately" as used herein is inclusive of the stated value and means within an acceptable range of deviation for the particular value as determined by one of ordinary skill in the art, considering the measurement in question and the error associated with measurement of the particular quantity (i.e., the limitations of the measurement system). For example, "about" can mean within one or more standard deviations, or within ±30%, 20%, 10%, 5% of the stated value.

**[0037]** An organometallic compound according to an embodiment may be represented by Formula 1 below:

Formula 1




**[0038]** $X_{51}$ in Formula 1 may be selected from O, S, and $N(R_{51})$.

**[0039]** In an embodiment, $X_{51}$ may be $N(R_{51})$, but embodiments of the present disclosure are not limited thereto.

**[0040]** $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ in Formula 1 may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, $—SF_5$, a hydroxyl group, a cyano group, a nitro 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 $C_2$-$C_{69}$ alkenyl group, a substituted or unsubstituted $C_2$-$C_{69}$ alkynyl group, a substituted or unsubstituted $C_1$-$C_{60}$ alkoxy group, $—N(Q_1)(Q_2)$, $—Si(Q_3)(Q_4)(Q_5)$, $—B(Q_6)(Q_7)$, and $—P(=O)(Q_8)(Q_9)$. $Q_1$ to $Q_9$ are the same as described herein.

**[0041]** For example, $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may each independently be selected from:

**[0042]** hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, $—SF_5$, a $C_1$-$C_{20}$ alkyl group, and a $C_1$-$C_{20}$ alkoxy group;

**[0043]** a $C_1$-$C_{29}$ alkyl group and a $C_1$-$C_{29}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, 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 $C_1$-$C_{10}$ alkyl group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a pyridinyl group, and a pyrimidinyl group; and

**[0044]** $—N(Q_1)(Q_2)$, $—Si(Q_3)(Q_4)(Q_5)$, $—B(Q_6)(Q_7)$, and $—P(=O)(Q_8)(Q_9)$, and

**[0045]** $Q_1$ to $Q_9$ may each independently be selected from:

**[0046]** $—CH_3$, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CH_2CH_3$, $—CH_2CD_3$, $—CH_2CD_2H$, $—CH_2CDH_2$, $—CHDCH_3$, $—CHDCD_2H$, $—CHDCDH_2$, $—CHDCD_3$, $—CD_2CD_3$, $—CD_2CD_2H$, and $—CD_2CDH_2$;

**[0047]** an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

**[0048]** an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a $C_1$-$C_{10}$ alkyl group, and a phenyl group.

**[0049]** In an embodiment, $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may each independently be selected from:

**[0050]** hydrogen, deuterium, —F, a cyano group, a nitro group, $—SF_5$, a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an

n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, and a pentoxy group;

**[0051]** a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, and a pentoxy group, each substituted with at least one selected from deuterium, —F, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a cyano group, a nitro group, a $C_1$-$C_{10}$ alkyl group, a $C_1$-$C_{10}$ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group; and

**[0052]** —$Si(Q_3)(Q_4)(Q_5)$, and

**[0053]** $Q_3$ to $Q_5$ may each independently be selected from:

**[0054]** —$CH_3$, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CH_2CH_3$, —$CH_2CD_3$, —$CH_2CD_2H$, —$CH_2CDH_2$, —$CHDCH_3$, —$CHDCD_2H$, —$CHDCDH_2$, —$CHDCD_3$, —$CD_2CD_3$, —$CD_2CD_2H$, and —$CD_2CDH_2$;

**[0055]** an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group; and

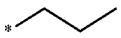
**[0056]** an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group, each substituted with at least one selected from deuterium and a $C_1$-$C_{10}$ alkyl group.

**[0057]** In one or more embodiments, $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may each independently be selected from hydrogen, deuterium, —F, a cyano group, a nitro group, —$SF_5$, —$CH_3$, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, groups represented by Formulae 9-1 to 9-19, and —$Si(Q_3)(Q_4)(Q_5)$, and $Q_3$ to $Q_5$ may each independently be selected from —$CH_3$, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CH_2CH_3$, —$CH_2CD_3$, —$CH_2CD_2H$, —$CH_2CDH_2$, —$CHDCH_3$, —$CHDCD_2H$, —$CHDCDH_2$, —$CHDCD_3$, —$CD_2CD_3$, —$CD_2CD_2H$, —$CD_2CDH_2$, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group, but embodiments of the present disclosure are not limited thereto:

Formula 9-1

-continued

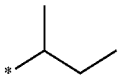
Formula 9-2



Formula 9-3

Formula 9-4

Formula 9-5



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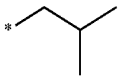

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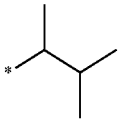

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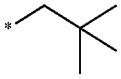

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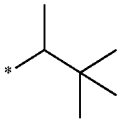

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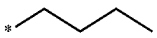
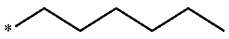


Formula 9-11

Formula 9-12



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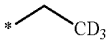


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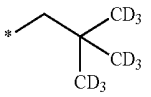


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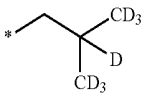


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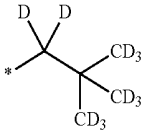


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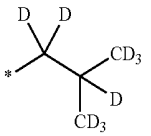


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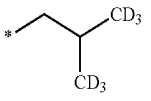

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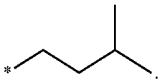
Formula 9-19



**[0058]** * in Formulae 9-1 to 9-19 indicates a binding site to a neighboring atom.

**[0059]** In Formula 1, when $X_{51}$ is O or S, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ may be —$Si(Q_3)(Q_4)(Q_5)$, and when $X_{51}$ is $N(R_{51})$, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may be —$Si(Q_3)(Q_4)(Q_5)$. That is, Formula 1 essentially includes at least one (for example, one or two) —$Si(Q_3)(Q_4)(Q_5)$ as a substituent.

**[0060]** For example, in —$Si(Q_3)(Q_4)(Q_5)$, $Q_3$=$Q_4$=$Q_5$, $Q_3$=$Q_4$≠$Q_5$, or $Q_3$≠$Q_4$≠$Q_5$.

**[0061]** In an embodiment, $Q_3$ to $Q_5$ in —$Si(Q_3)(Q_4)(Q_5)$ may be identical to one another, but embodiments of the present disclosure are not limited thereto.

**[0062]** In an embodiment, one or two of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ in Formula may be —$Si(Q_3)(Q_4)(Q_5)$. When two of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ are —$Si(Q_3)(Q_4)(Q_5)$, two groups —$Si(Q_3)(Q_4)(Q_5)$ may be identical to or different from each other.

**[0063]** In one or more embodiments, in Formula 1,

**[0064]** at least one of $R_{21}$ to $R_{23}$ may be —$Si(Q_3)(Q_4)(Q_5)$;

**[0065]** at least one of $R_{41}$ to $R_{44}$ may be —$Si(Q_3)(Q_4)(Q_5)$; or

**[0066]** at least one of $R_{21}$ to $R_{23}$ may be —$Si(Q_3)(Q_4)(Q_5)$, and at least one of $R_{41}$ to $R_{44}$ may be —$Si(Q_3)(Q_4)(Q_5)$, but embodiments of the present disclosure are not limited thereto.

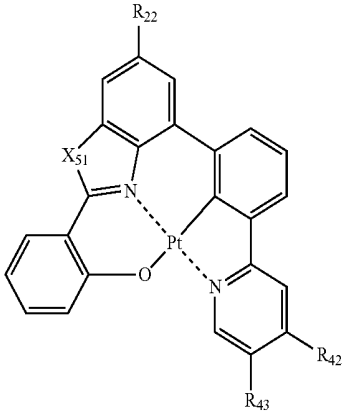
**[0067]** In one or more embodiments, one or two of $R_{22}$, $R_{42}$, and $R_{43}$ in Formula 1 may be —$Si(Q_3)(Q_4)(Q_5)$.

**[0068]** $Q_3$ to $Q_5$ are the same as described herein.

**[0069]** In one or more embodiments, at least one of $R_{11}$ to $R_{13}$, $R_{22}$, $R_{32}$, $R_{42}$, and $R_{43}$ in Formula 1 may not be hydrogen.

**[0070]** In one or more embodiments, the organometallic compound represented by Formula 1 may be represented by one of Formulae 1-1 to 1-8:

Formula 1-1



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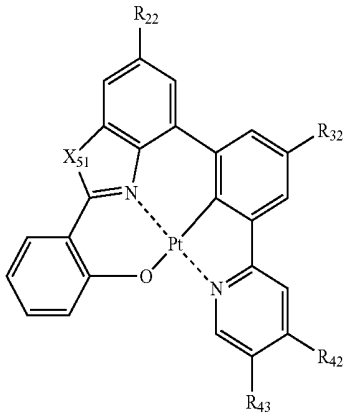
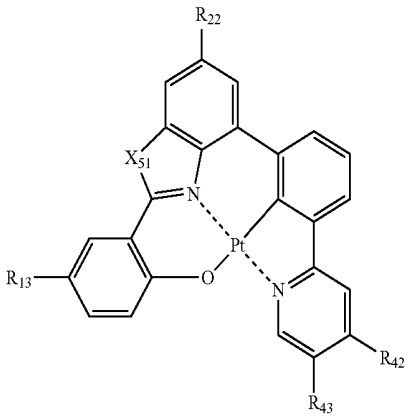
Formula 1-2



Formula 1-3



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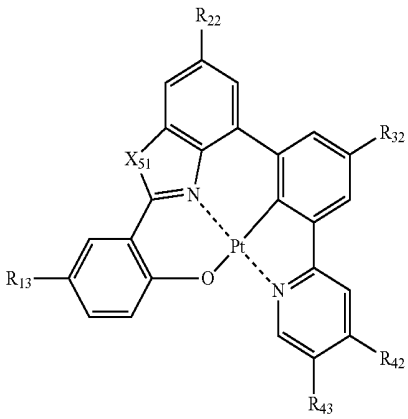
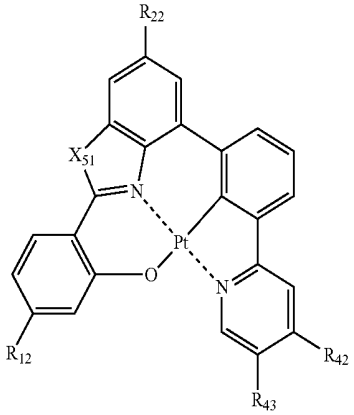


Formula 1-5



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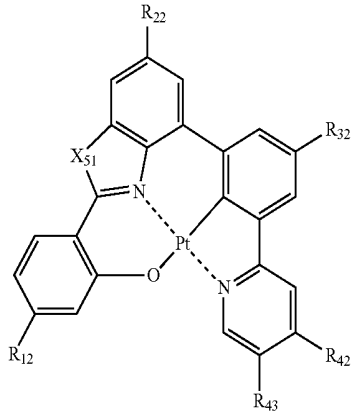
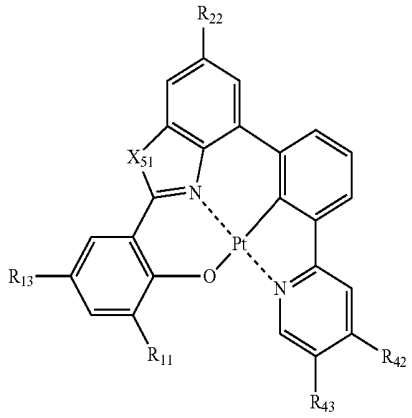
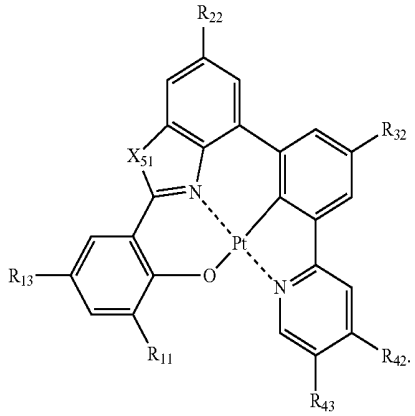
Formula 1-6



Formula 1-7



Formula 1-8



**[0071]** In Formulae 1-1 to 1-8,

**[0072]** $R_{11}$ to $R_{13}$, $R_{22}$, $R_{32}$, $R_{42}$, and $R_{43}$ are the same as described herein, provided that $R_{11}$ to $R_{13}$ and $R_{32}$ are not hydrogen, and

**[0073]** at least one of $R_{22}$, $R_{42}$, and $R_{43}$ may be —Si$(Q_3)(Q_4)(Q_5)$ as described above.

**[0074]** For example, in Formulae 1-1 to 1-8,

**[0075]** $R_{22}$ may be —Si$(Q_3)(Q_4)(Q_5)$;

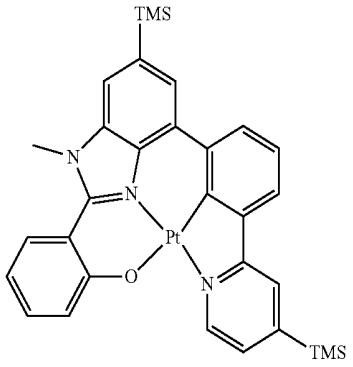
**[0076]** one of $R_{42}$ and $R_{43}$ may be —Si$(Q_3)(Q_4)(Q_5)$; or

**[0077]** $R_{22}$ may be —Si$(Q_3)(Q_4)(Q_5)$, and one of $R_{42}$ and $R_{43}$ may be —Si$(Q_3)(Q_4)(Q_5)$, but embodiments of the present disclosure are not limited thereto.

**[0078]** The organometallic compound represented by Formula 1 may be a neutral compound that does not consist of an ion pair of a cation and an anion.

**[0079]** The organometallic compound represented by Formula 1 may be one of Compounds 1 to 256, but embodiments of the present disclosure are not limited thereto:

1



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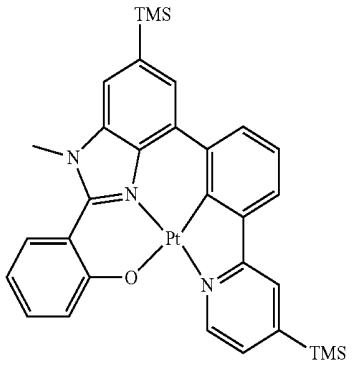

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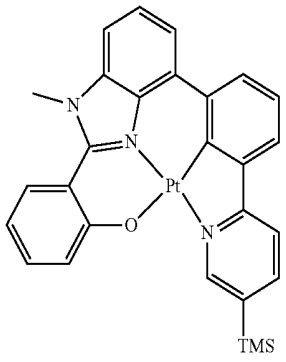

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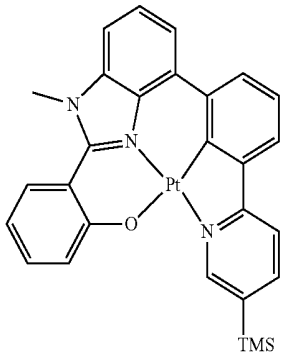

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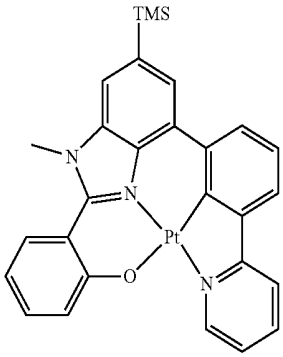


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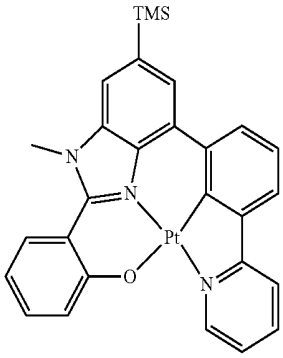


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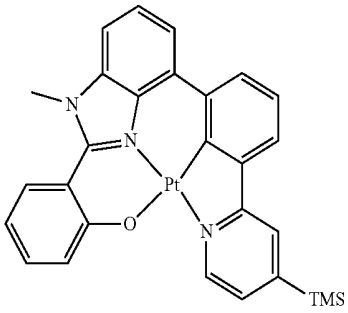


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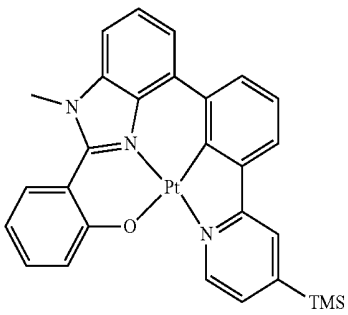


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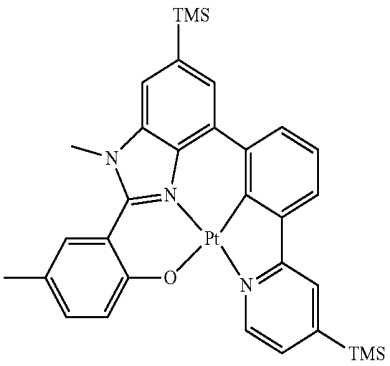


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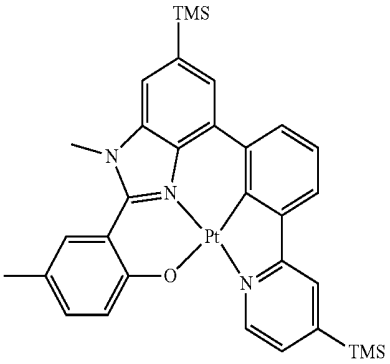


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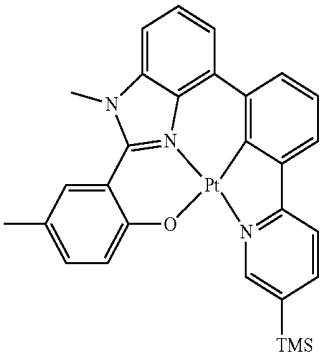


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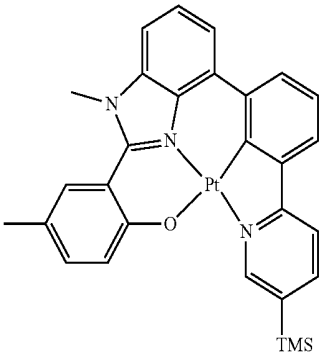

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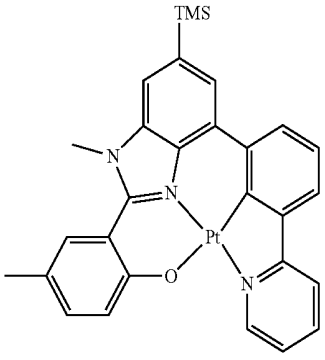


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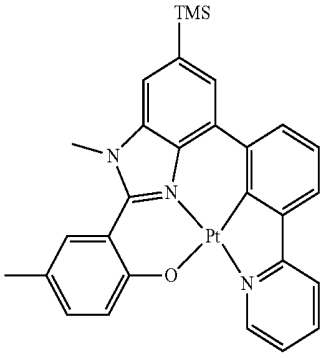


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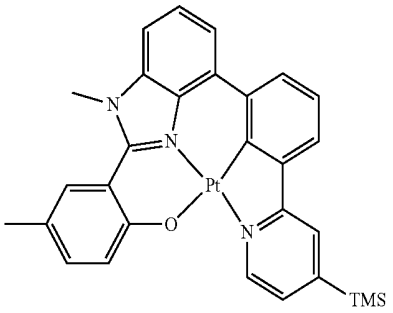


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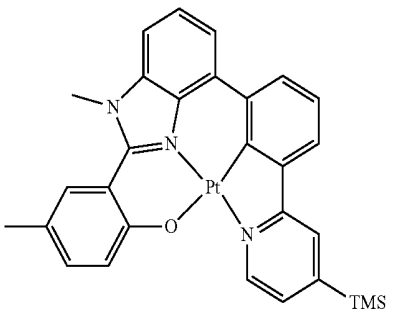


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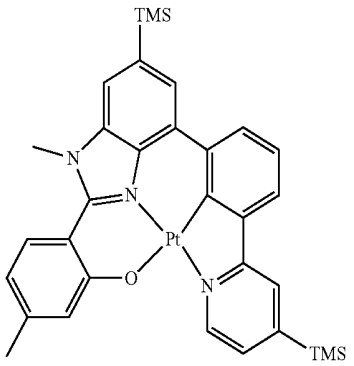


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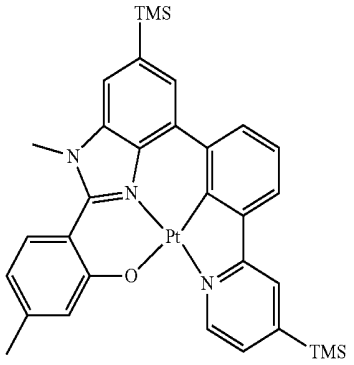


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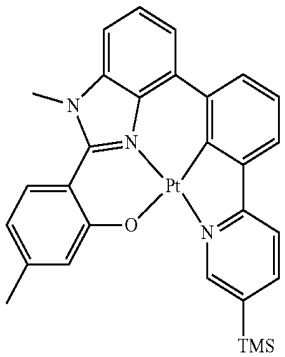


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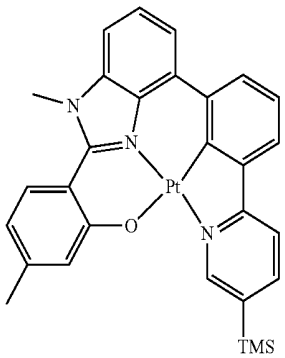

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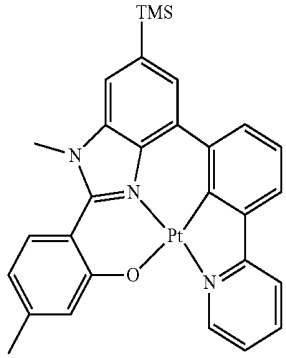


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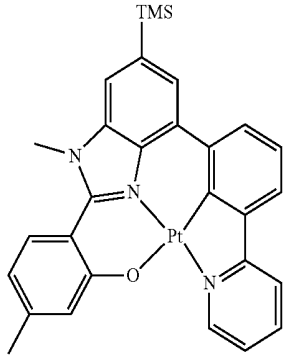


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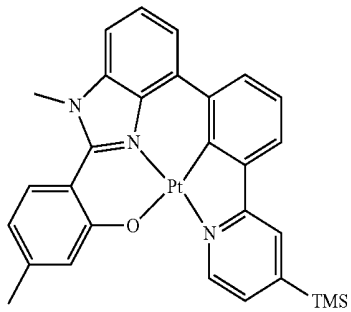


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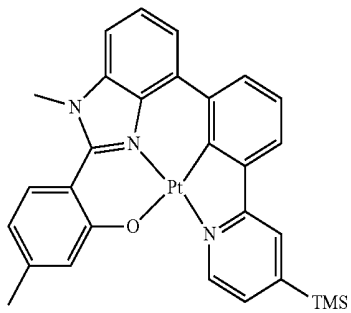


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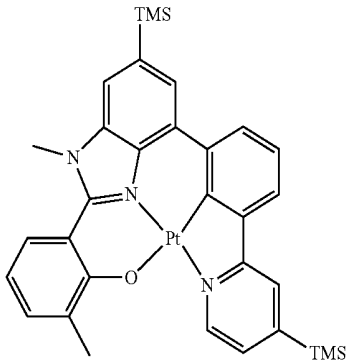


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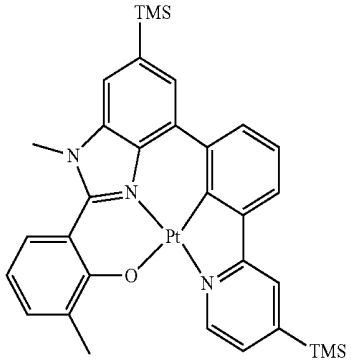


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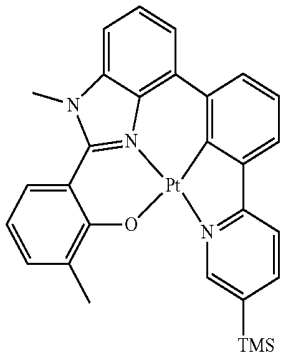


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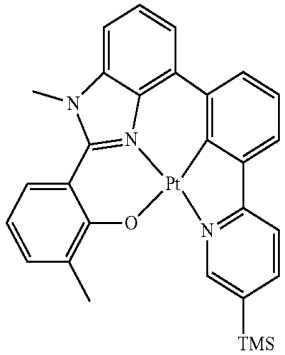

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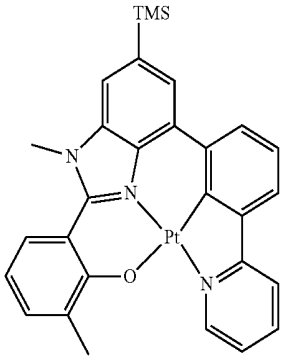


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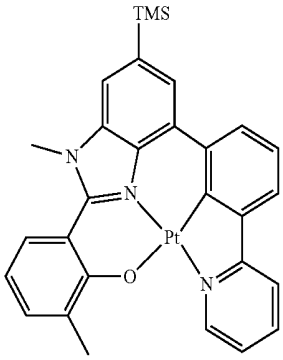


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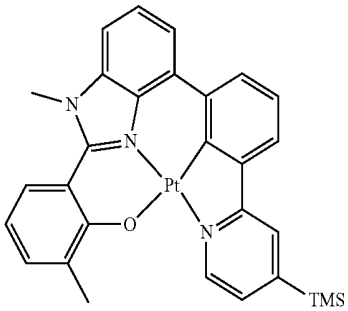


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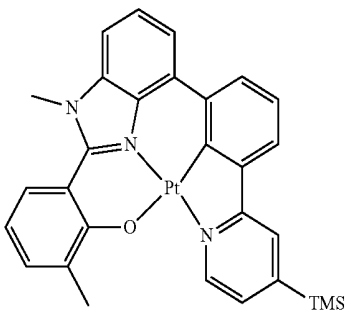


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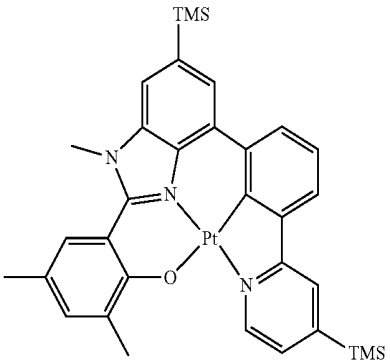


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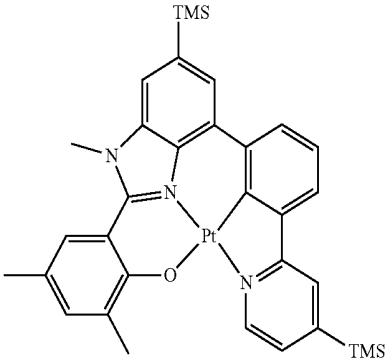


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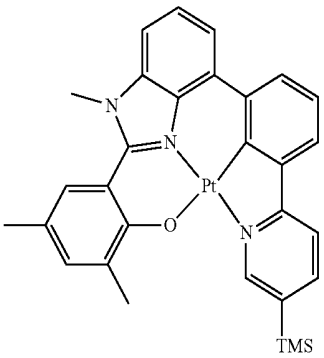


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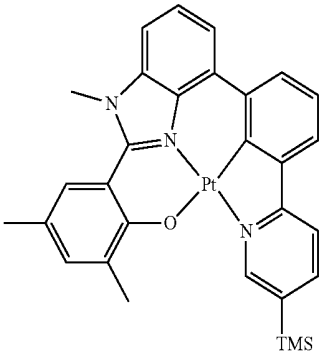

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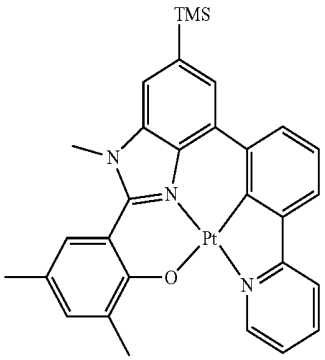


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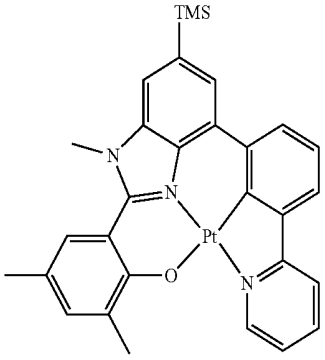


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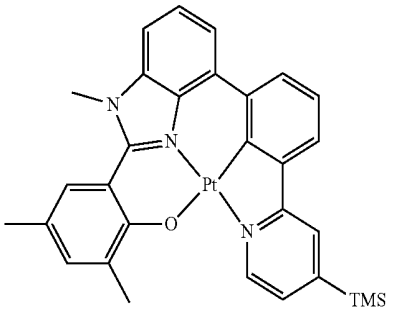


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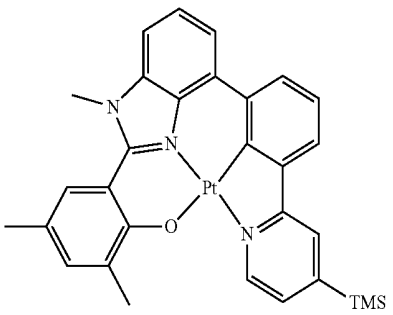


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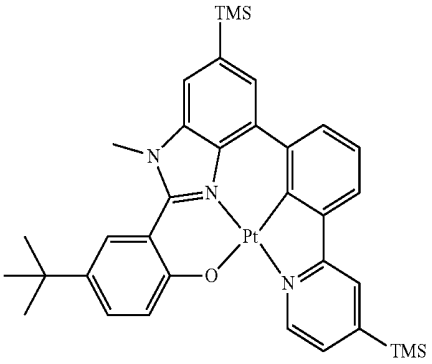


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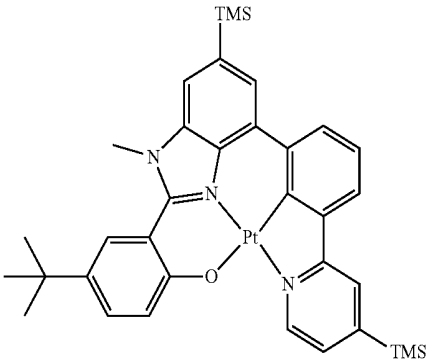


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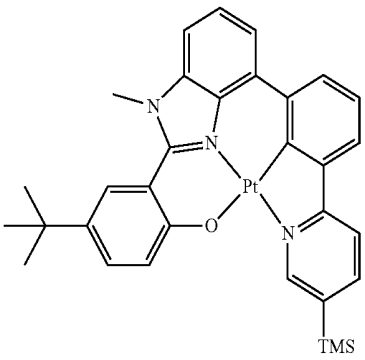


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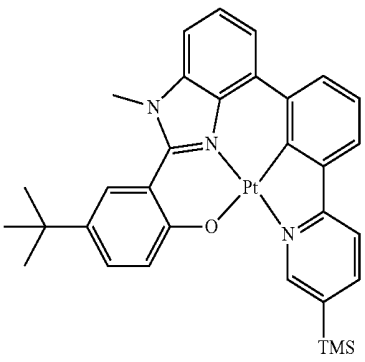

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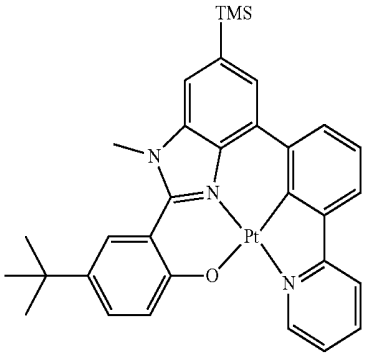

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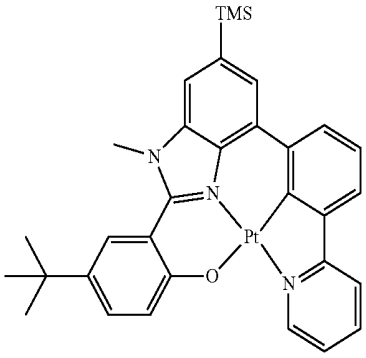

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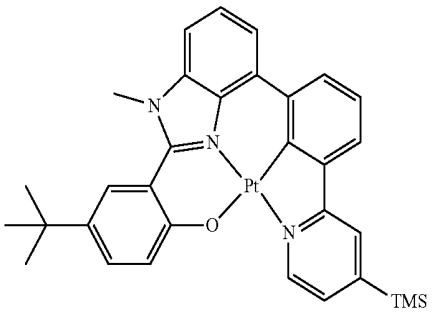

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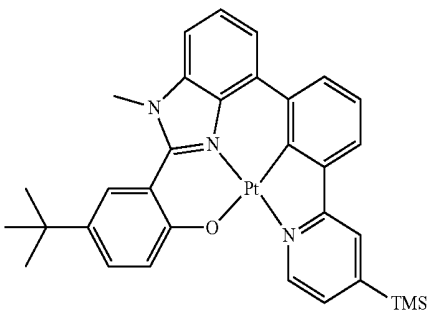

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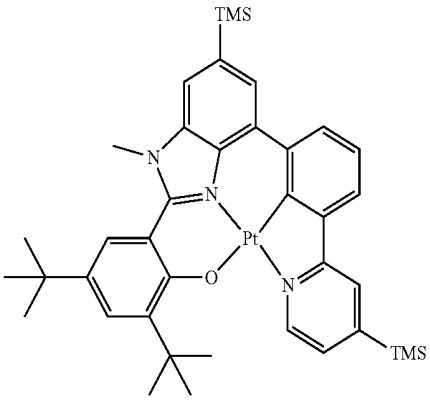

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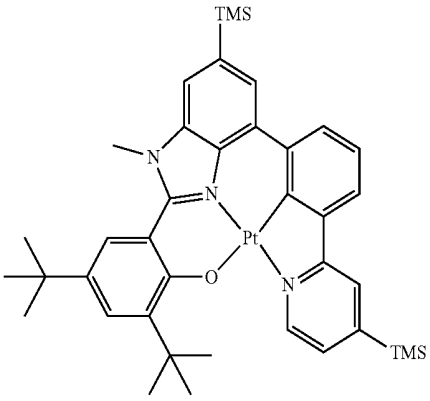

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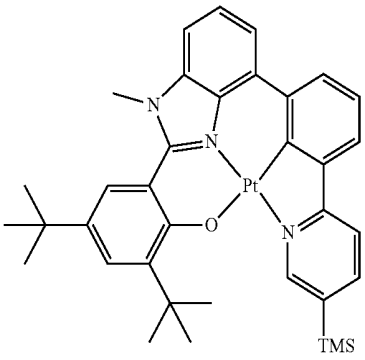

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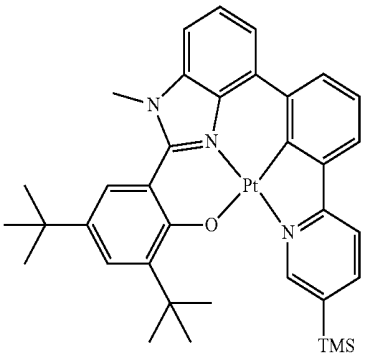

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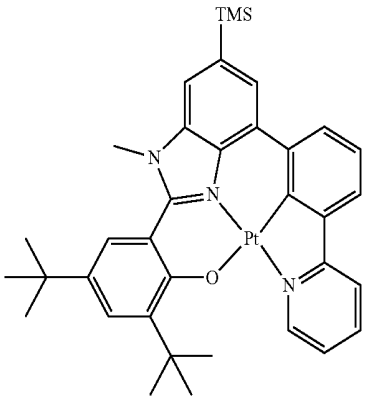


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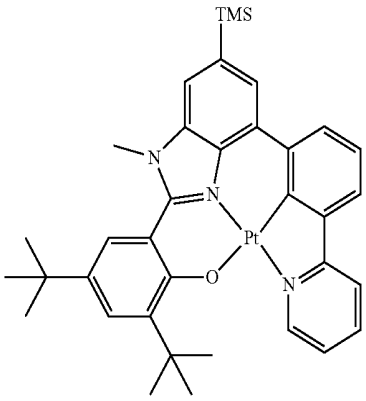


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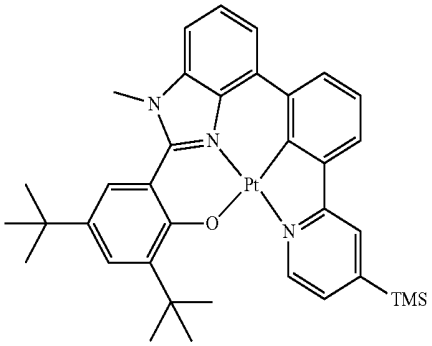


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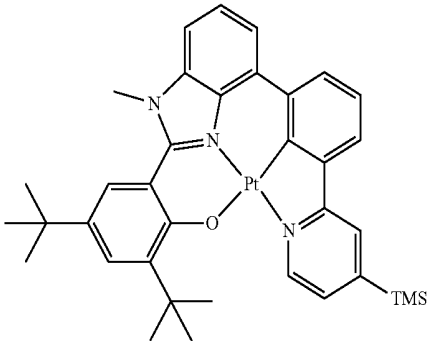


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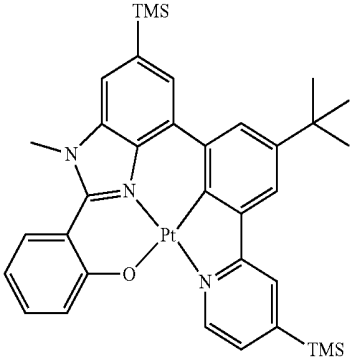


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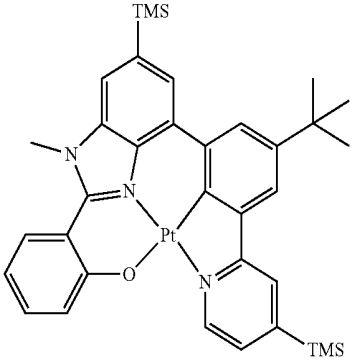


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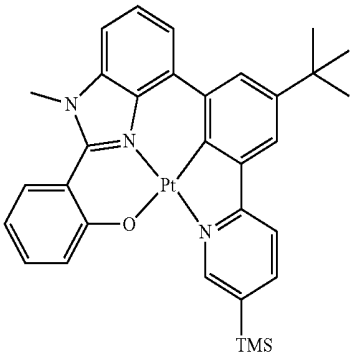


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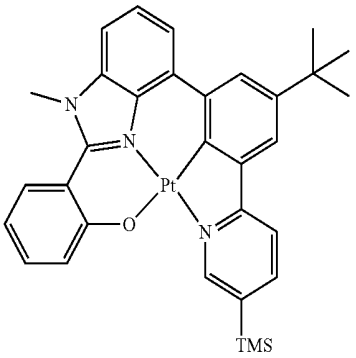

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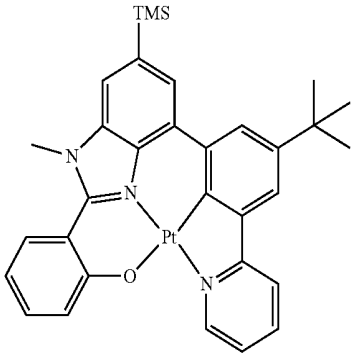


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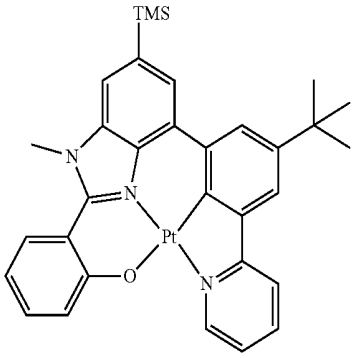


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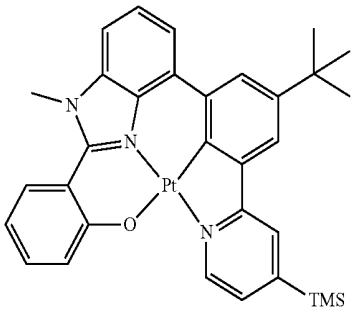


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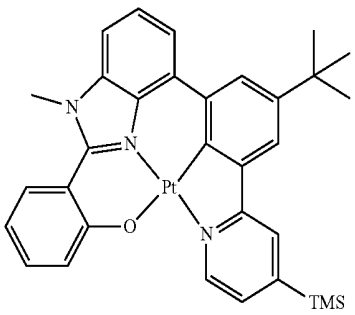


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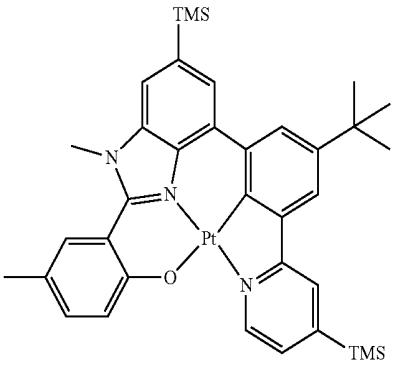


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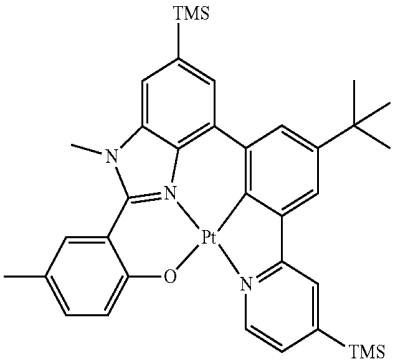


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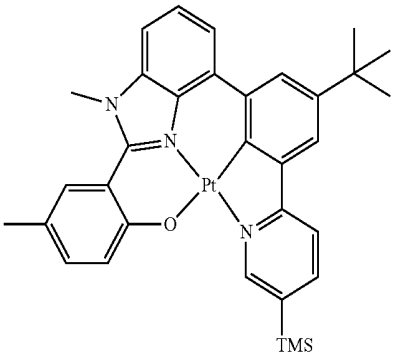


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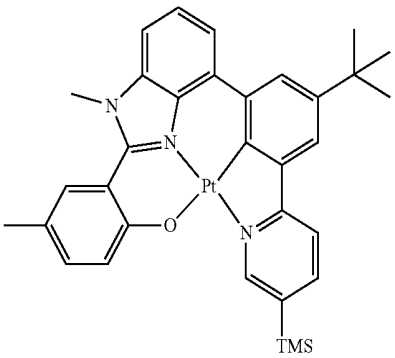

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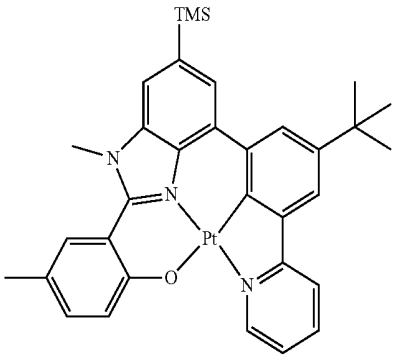


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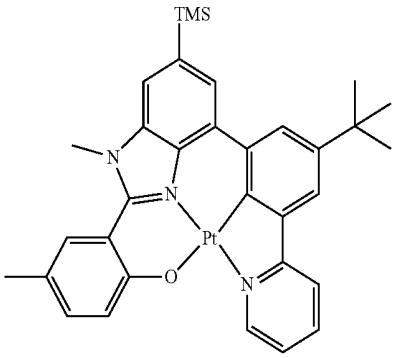


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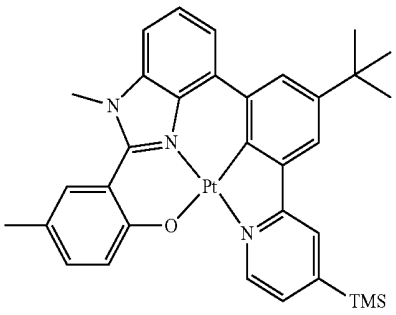


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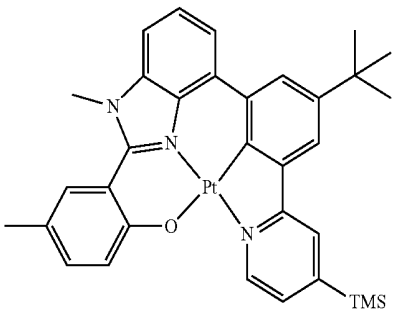


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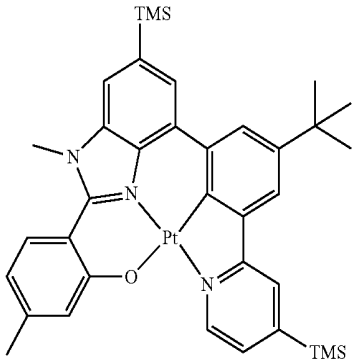


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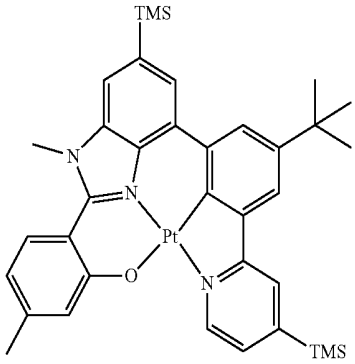


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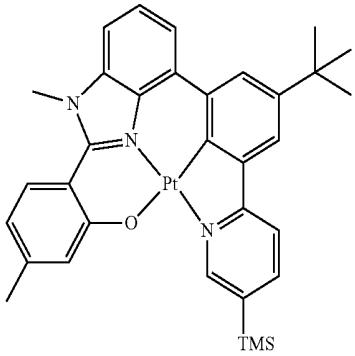


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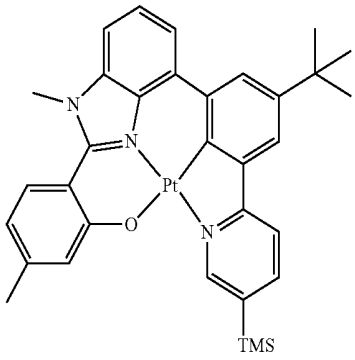

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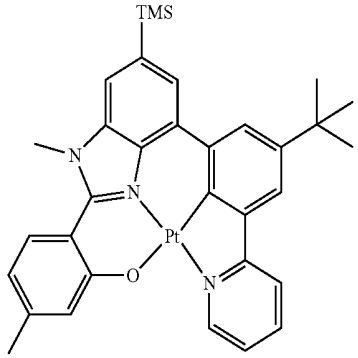


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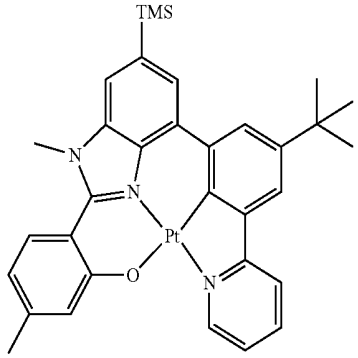


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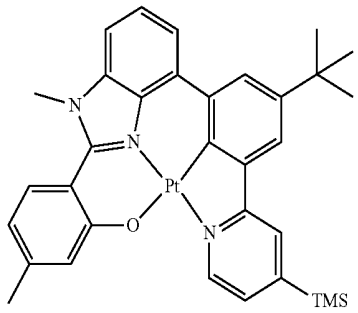


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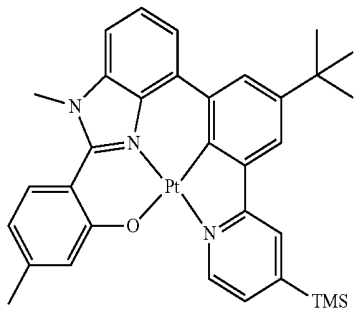


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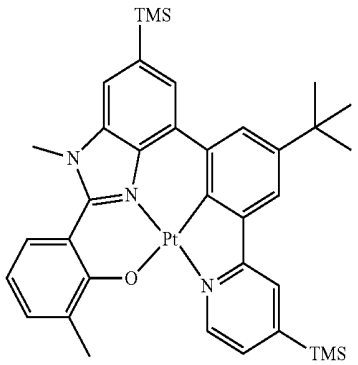


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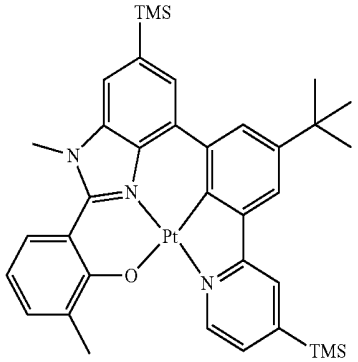


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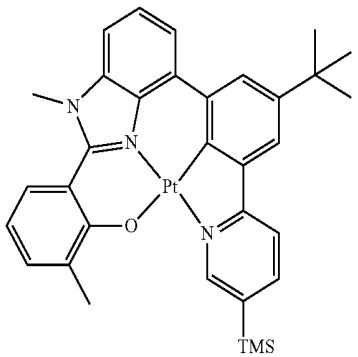


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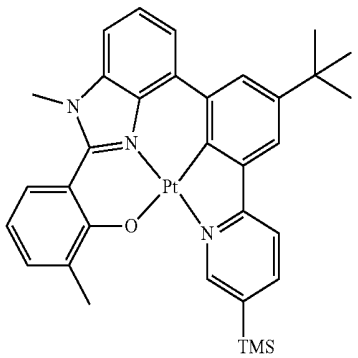

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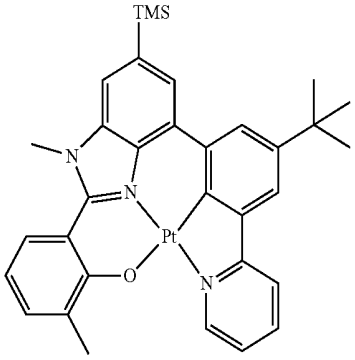


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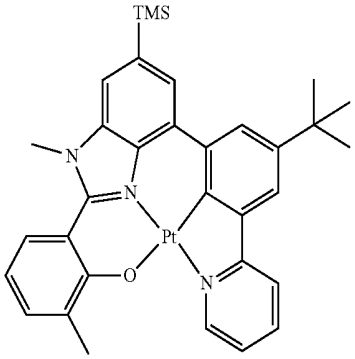


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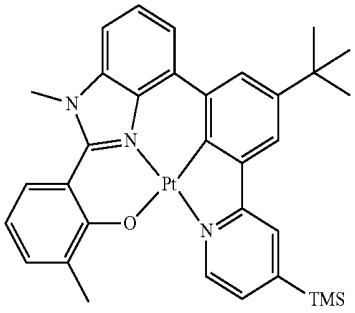


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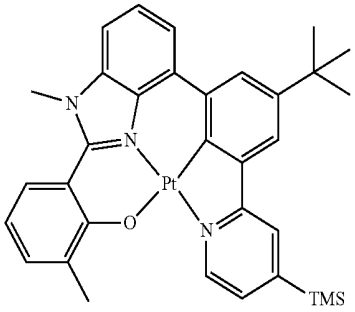


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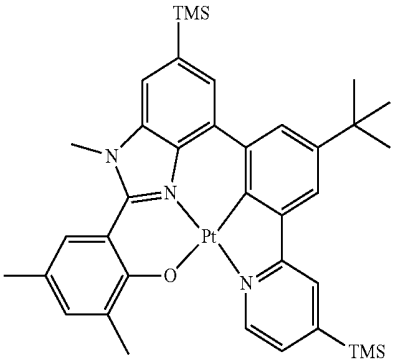


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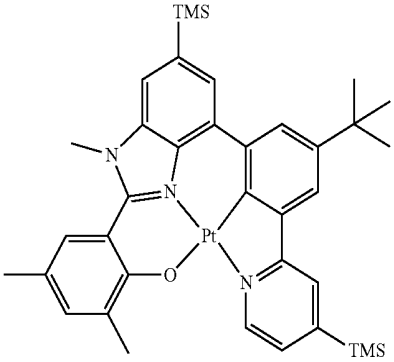


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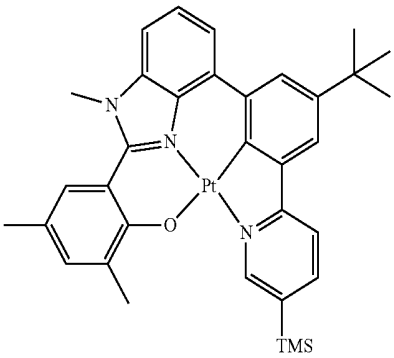


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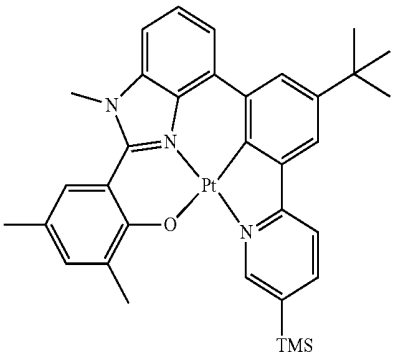

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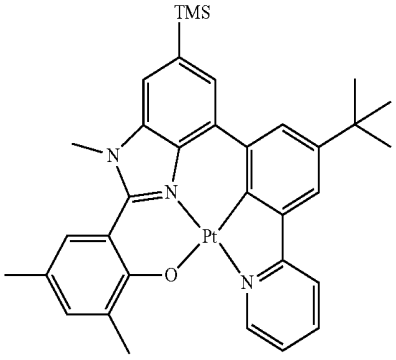


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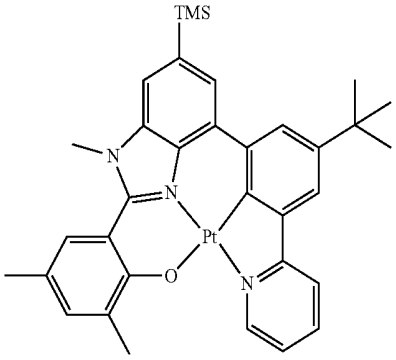


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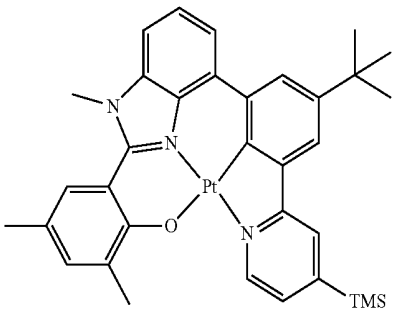


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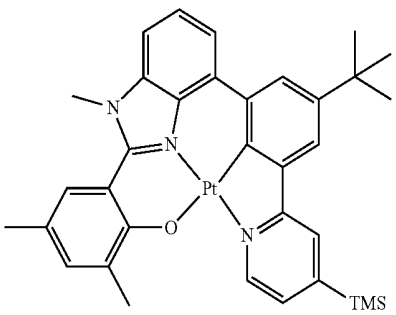


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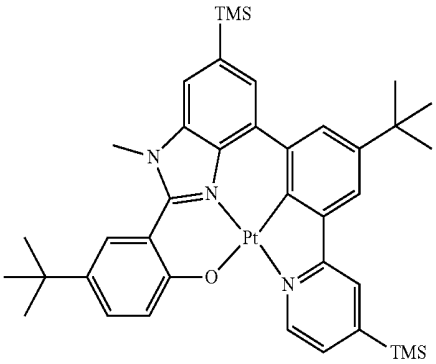


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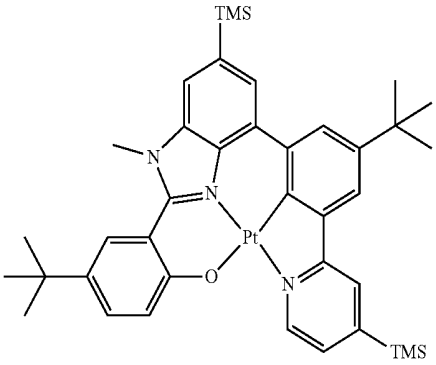


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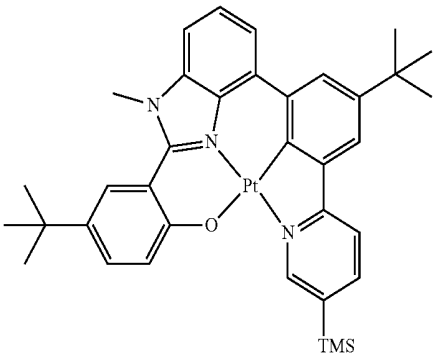


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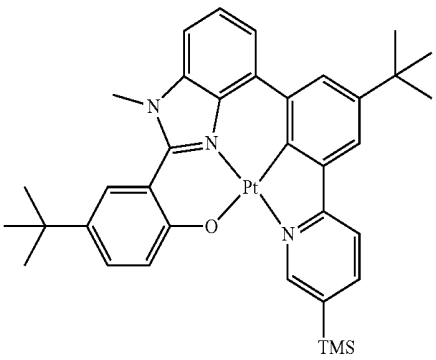

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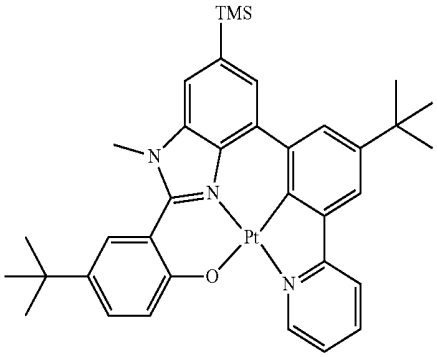


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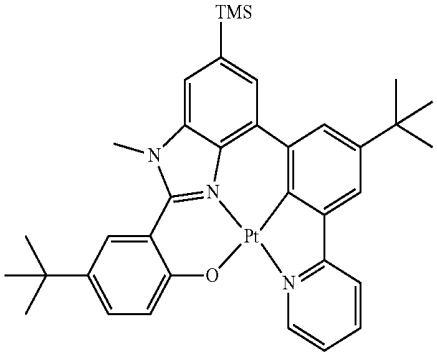


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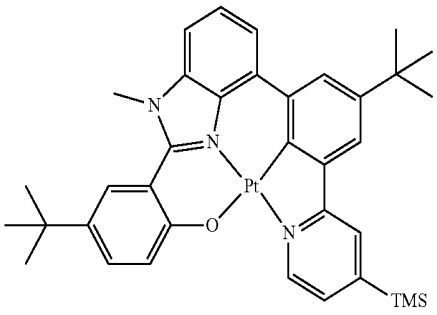


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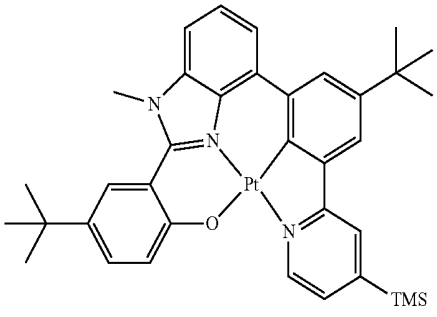


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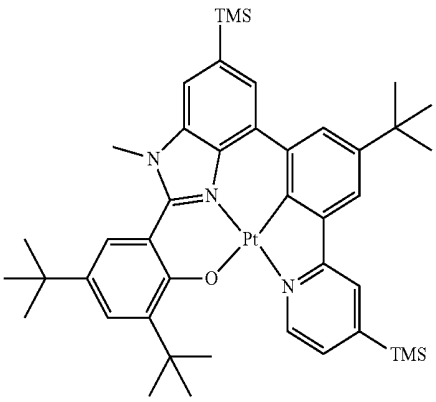


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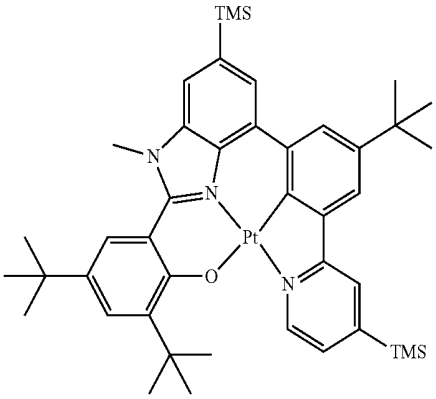


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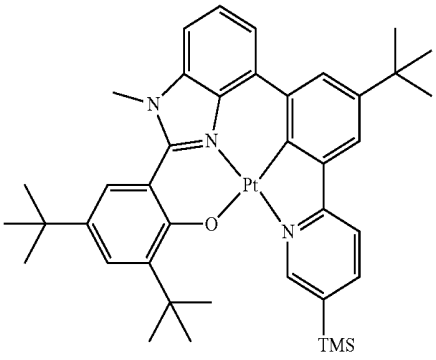


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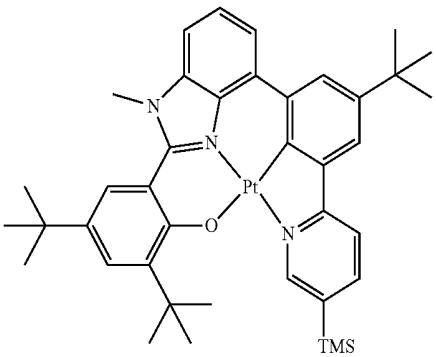

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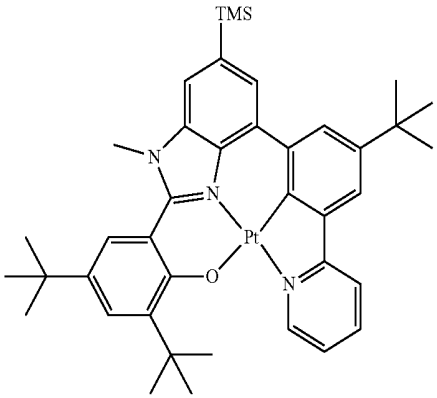


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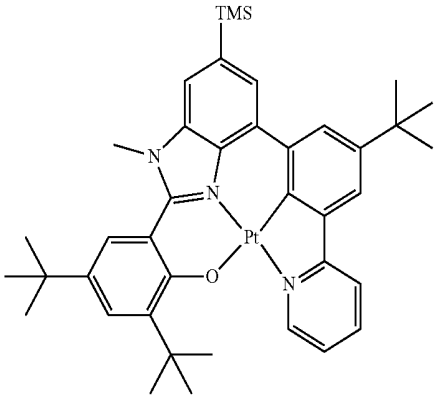


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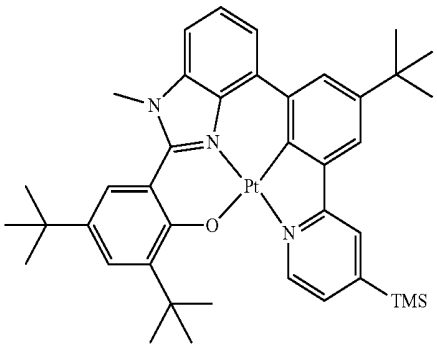


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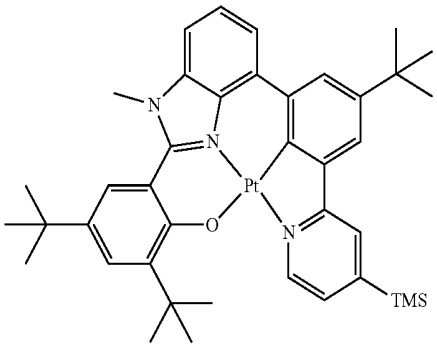


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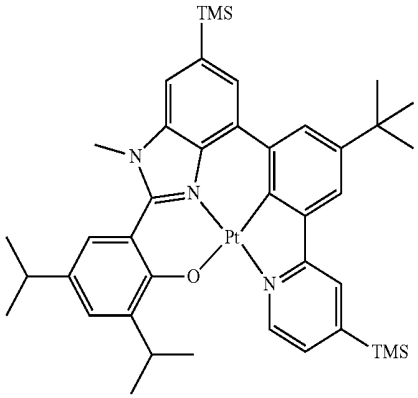


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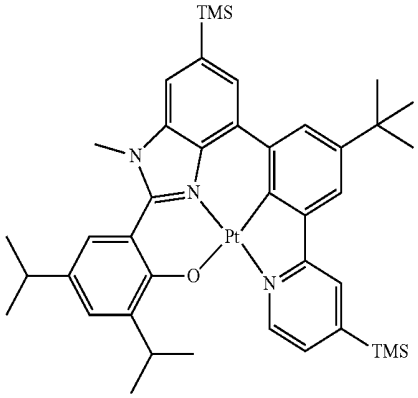


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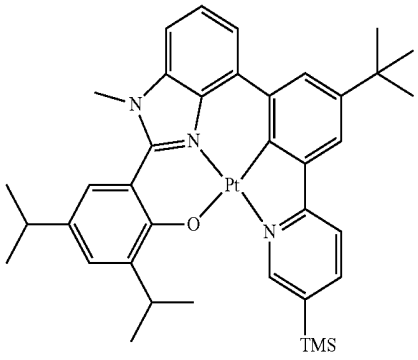


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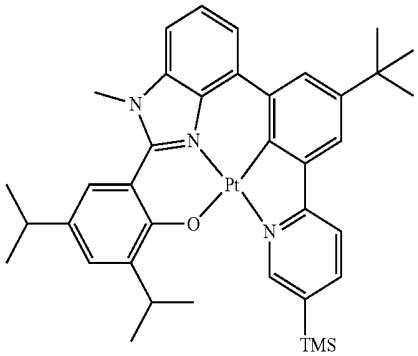

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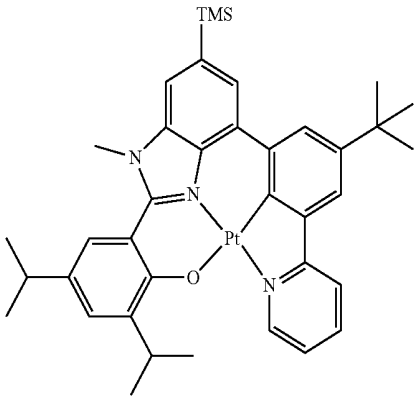


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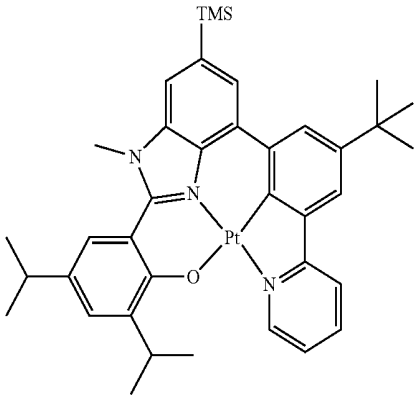


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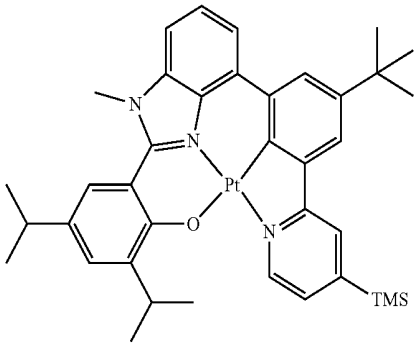


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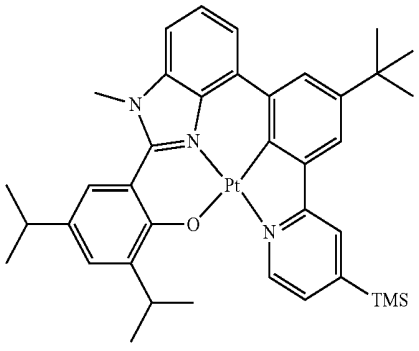


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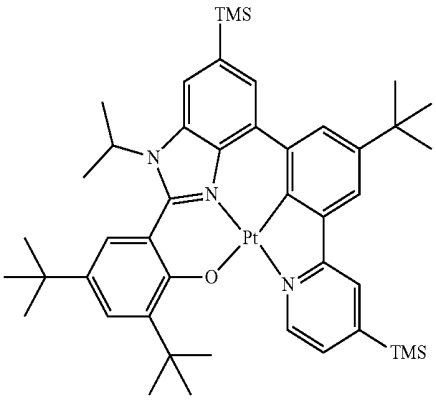


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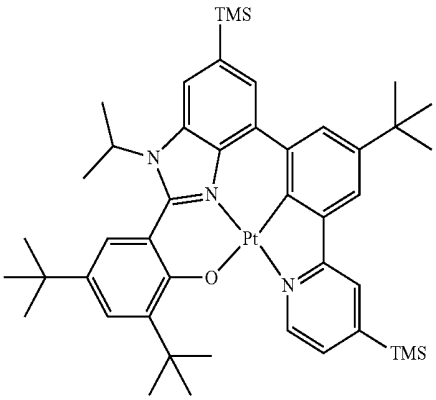


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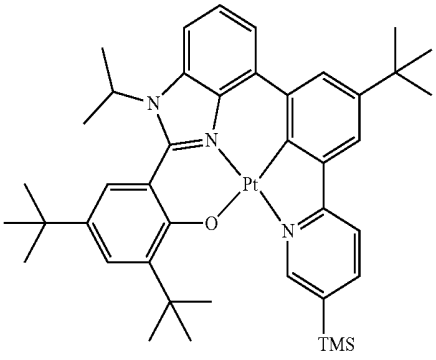


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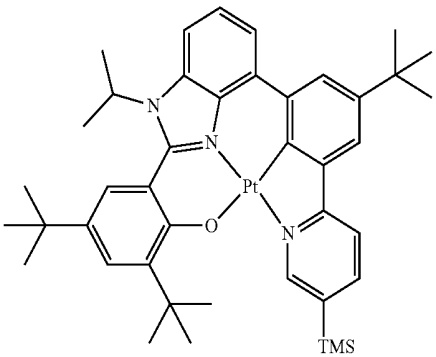

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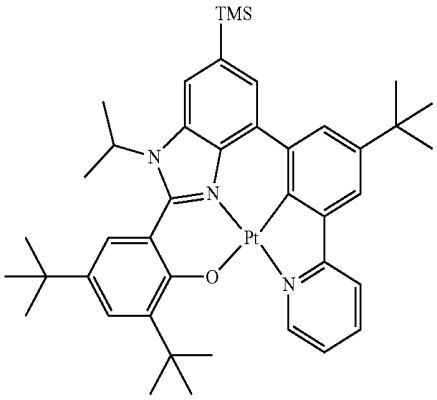

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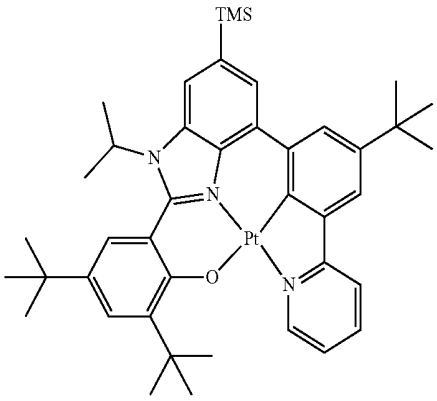

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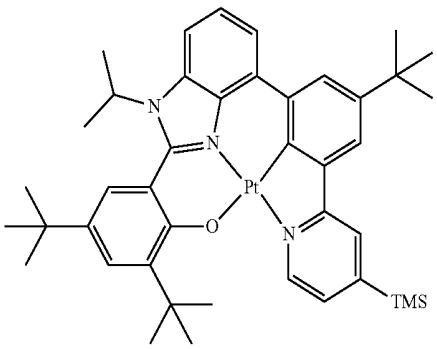

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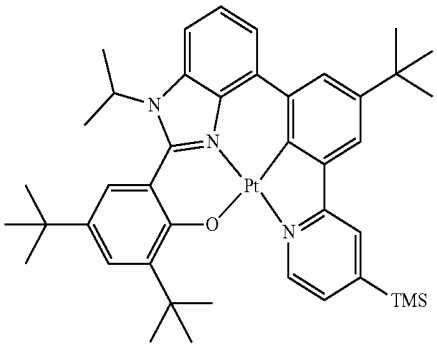

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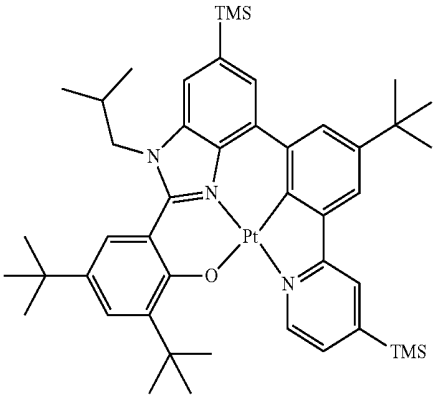

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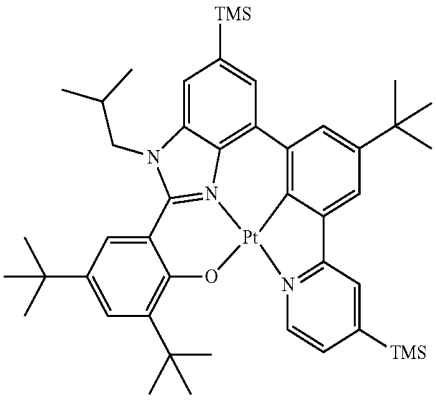

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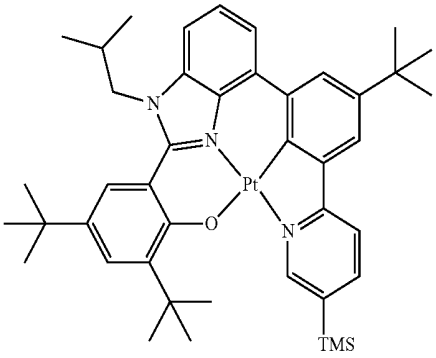

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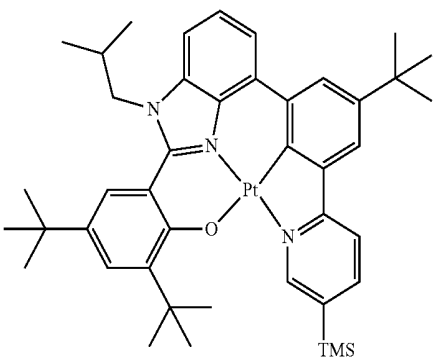

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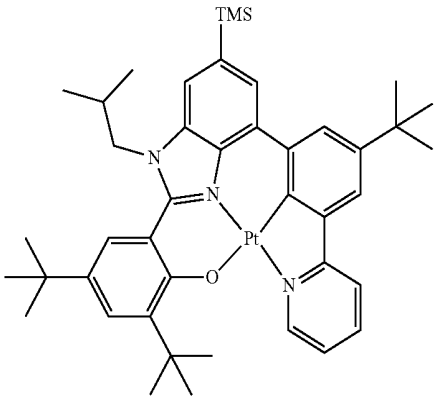


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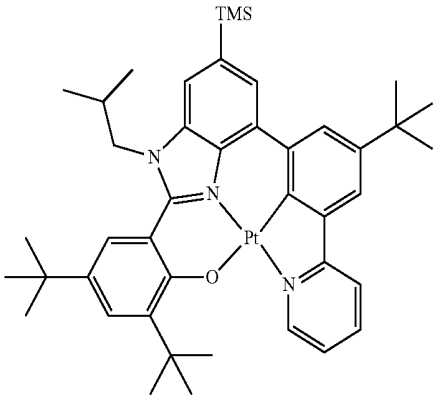


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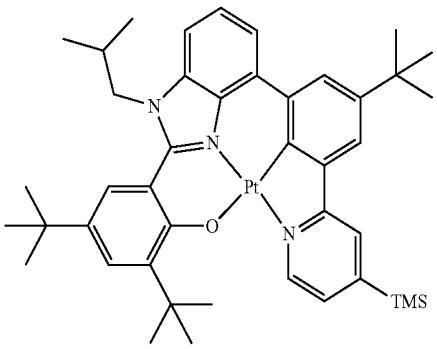


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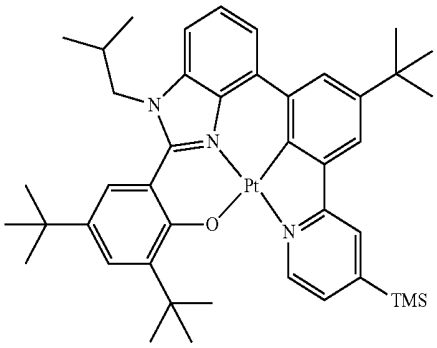


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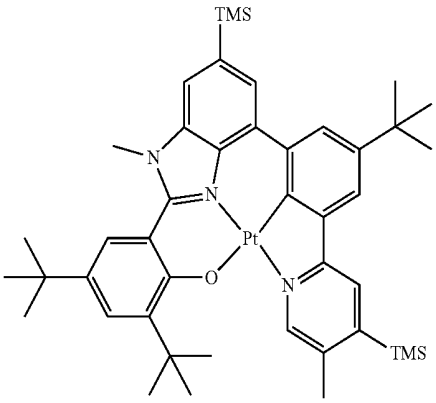


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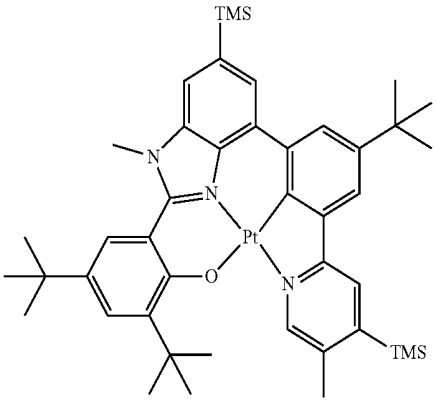


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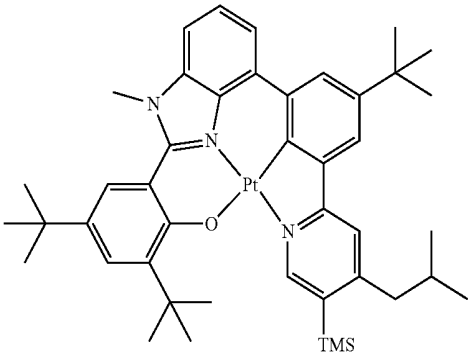


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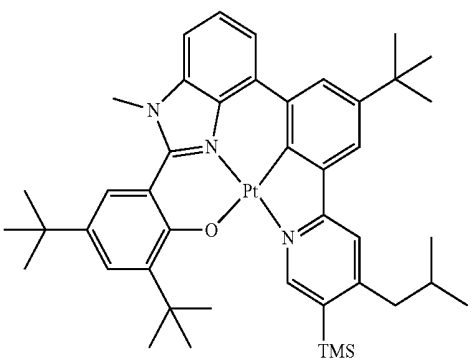

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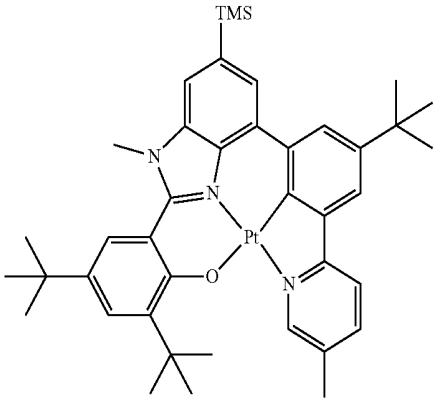


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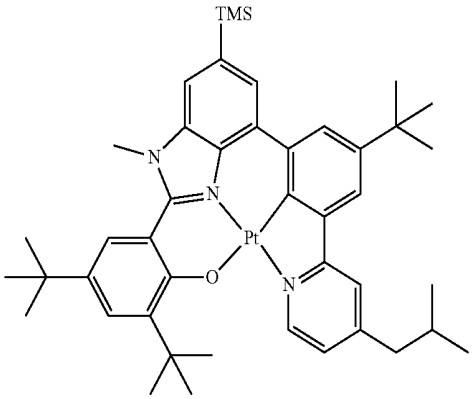


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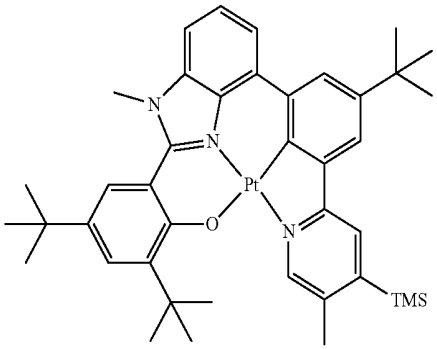


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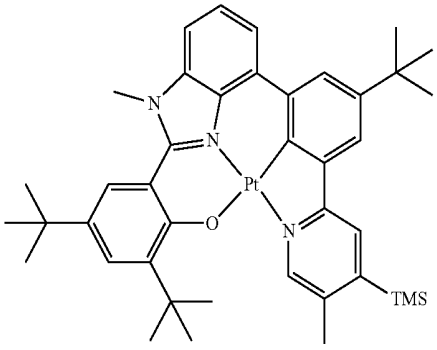


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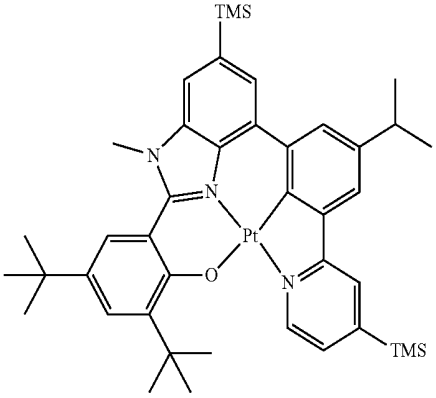


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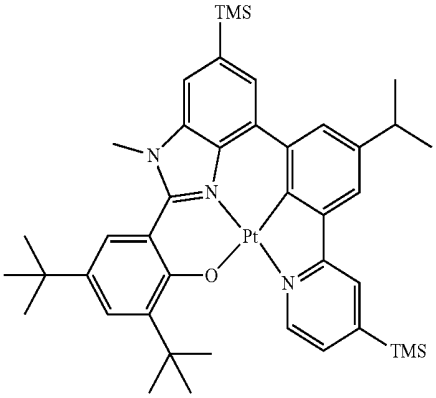


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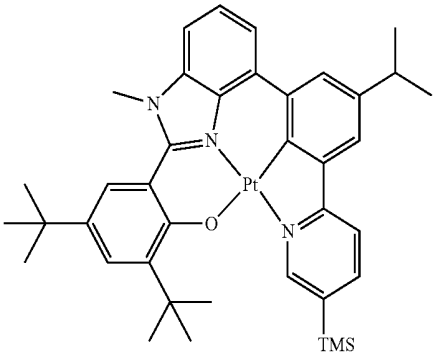


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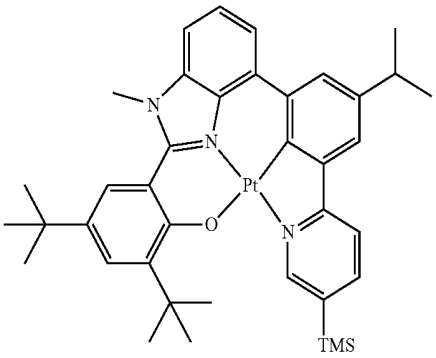

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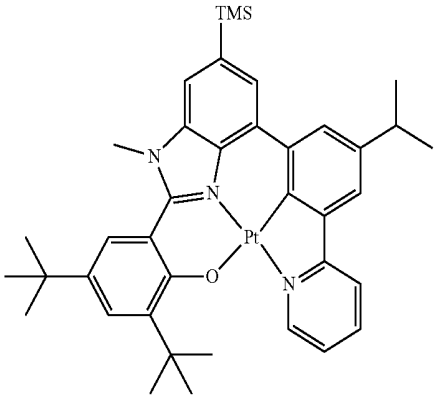


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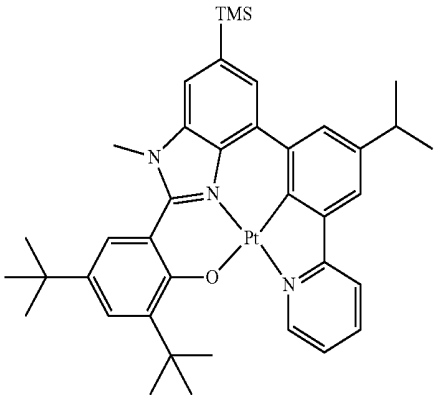


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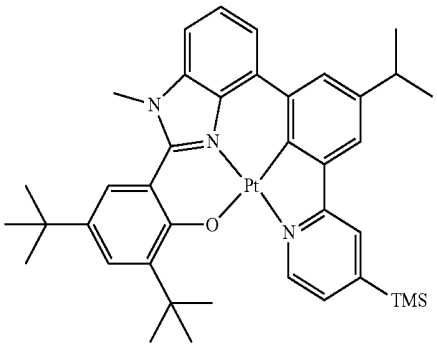


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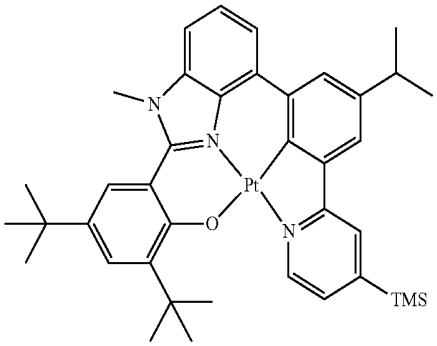


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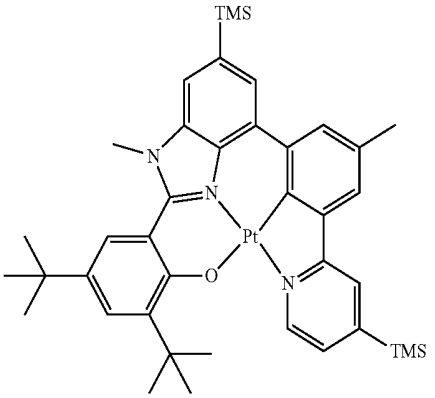


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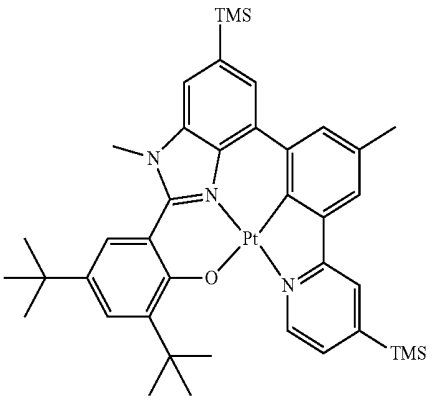


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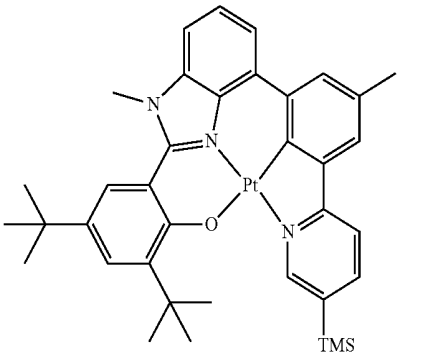


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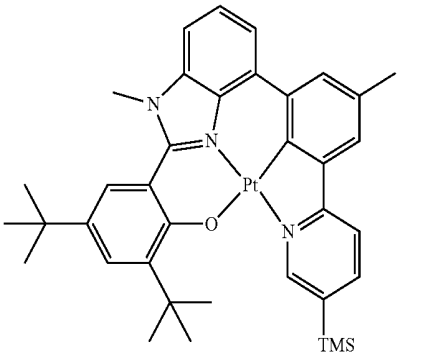

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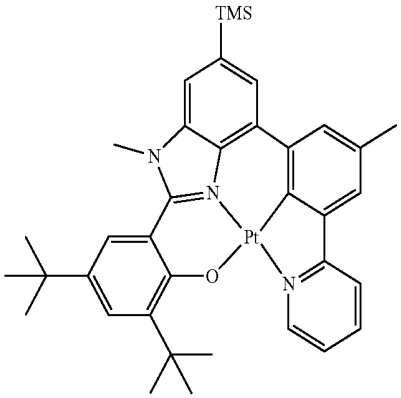


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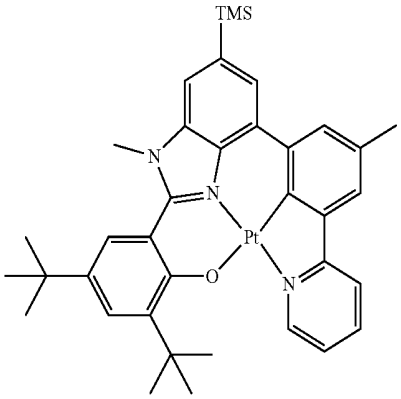


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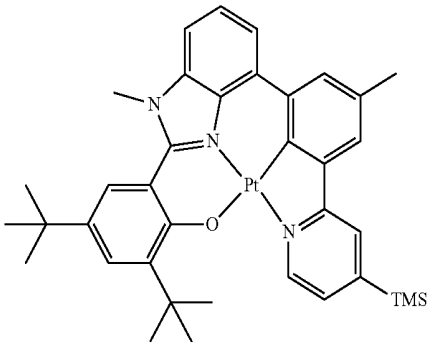


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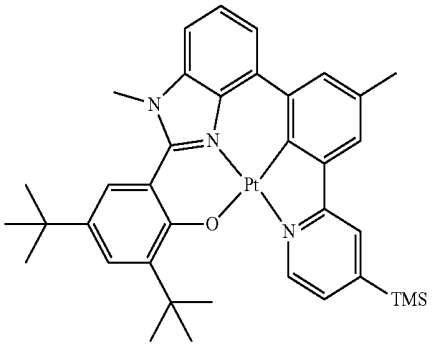


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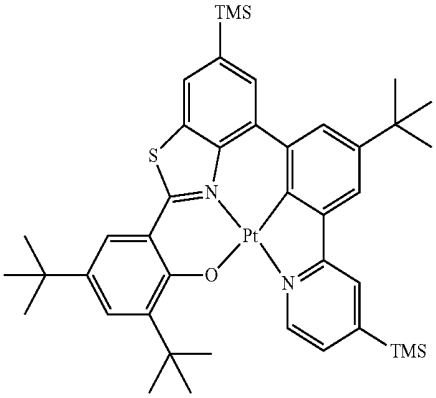


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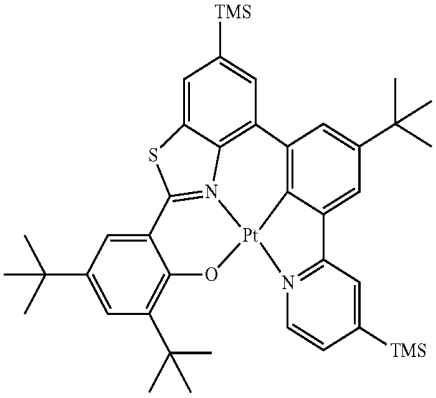


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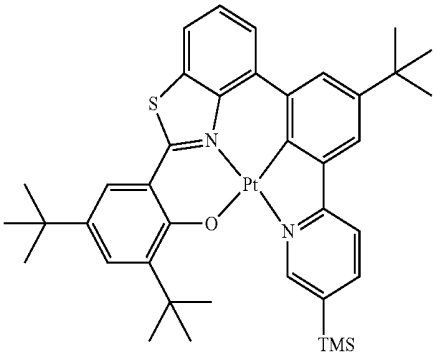


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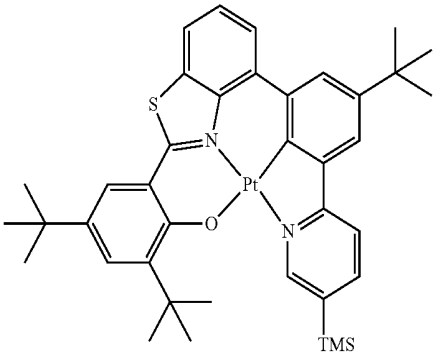

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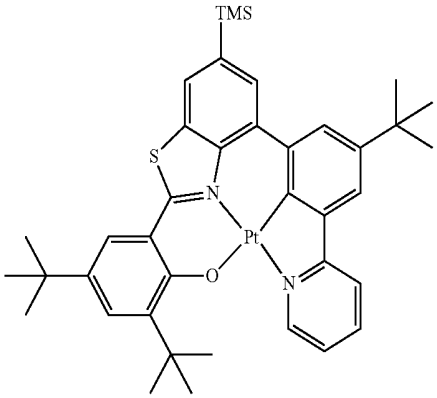


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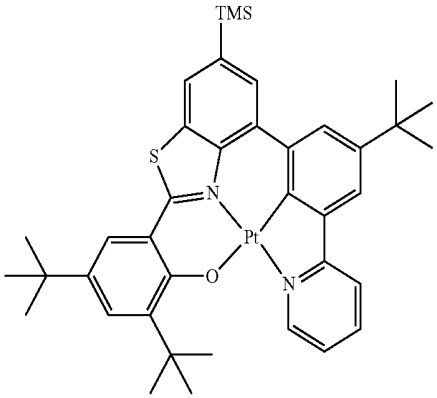


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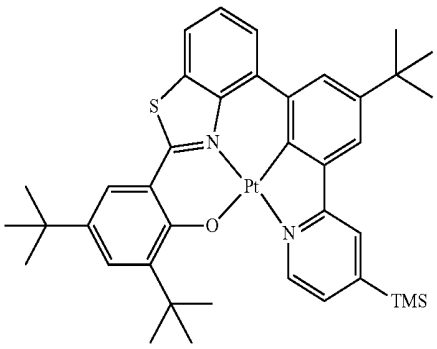


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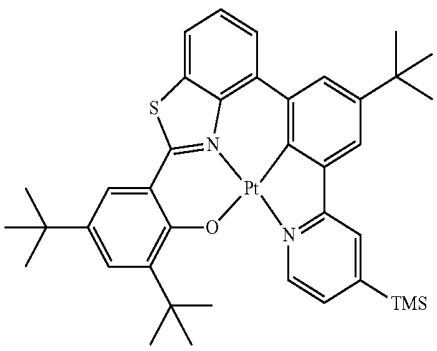


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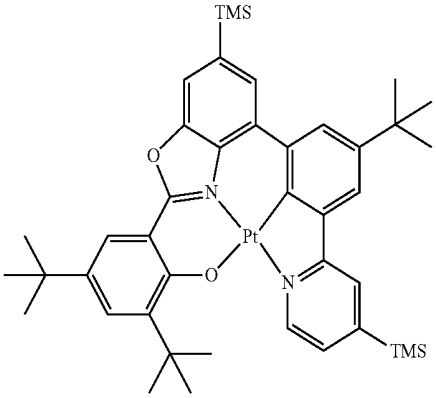


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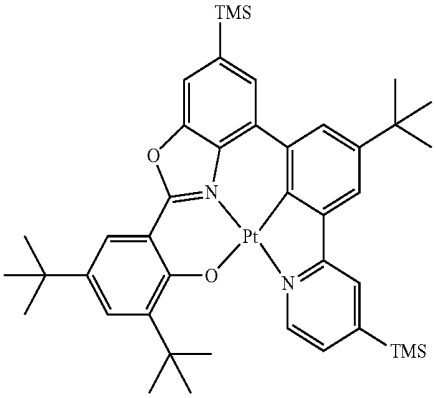


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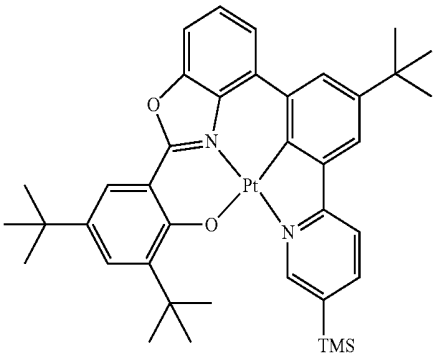


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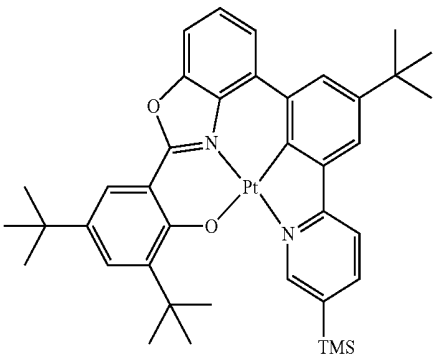

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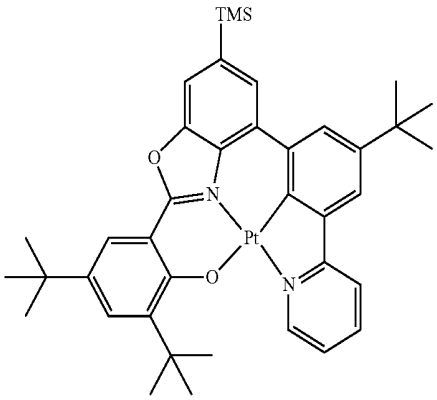


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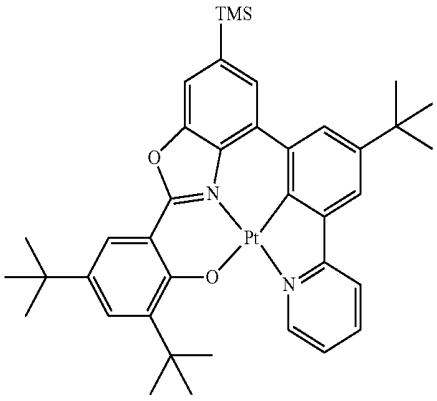


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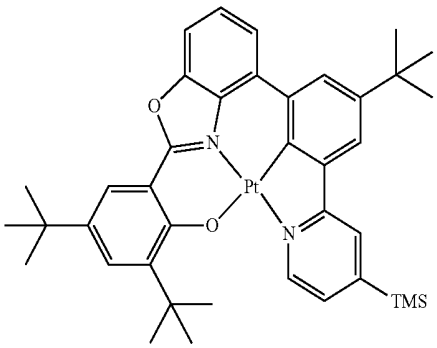


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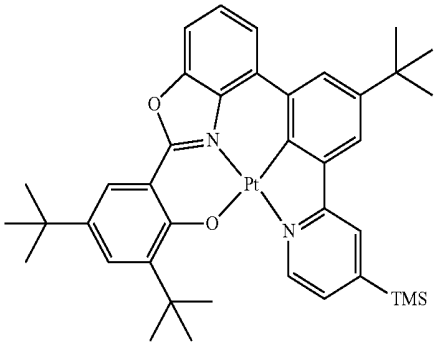


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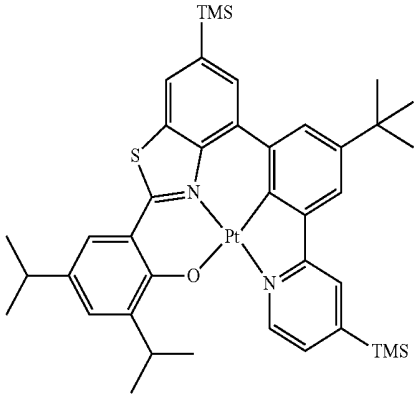


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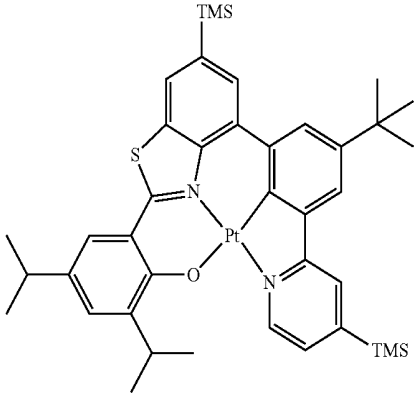


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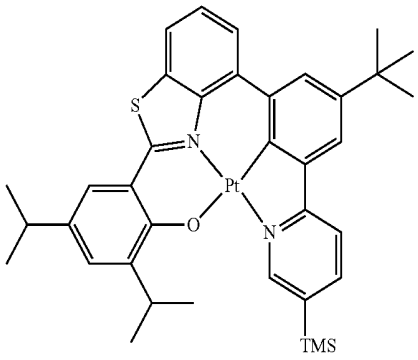


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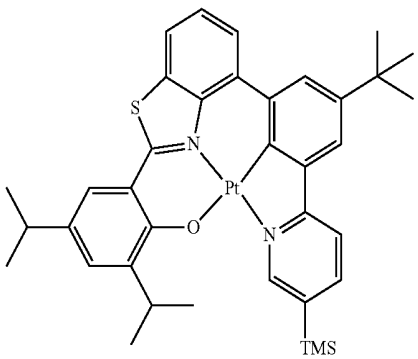

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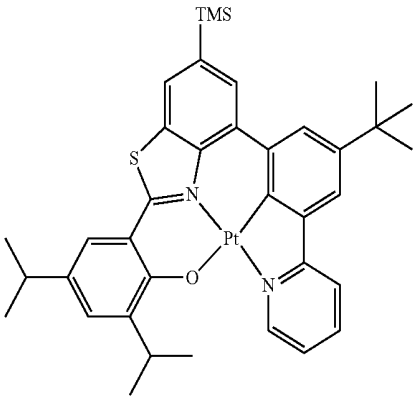


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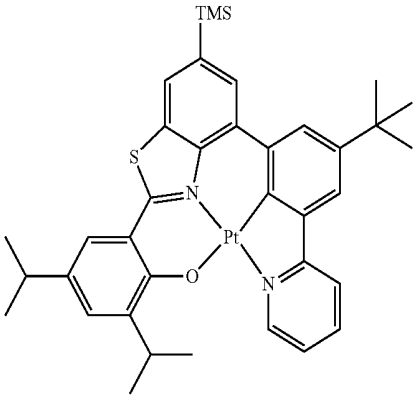


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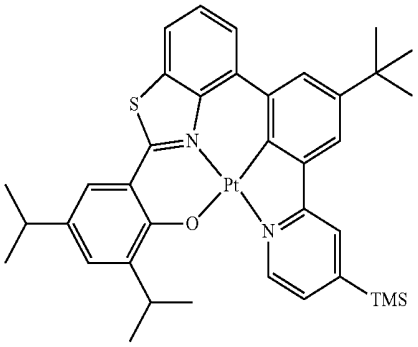


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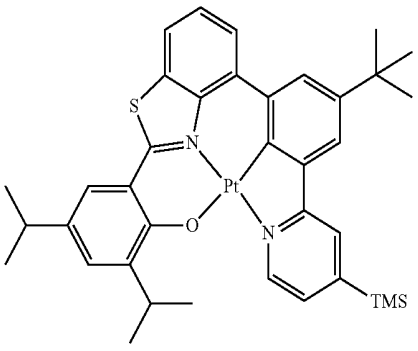


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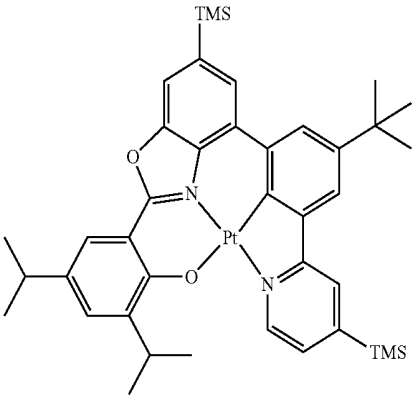


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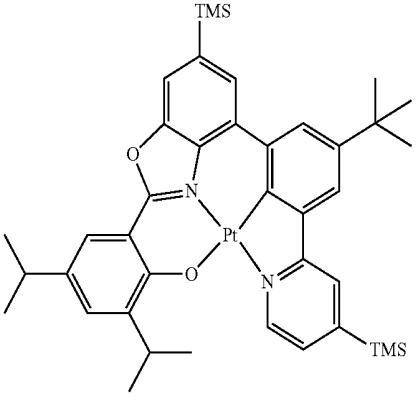


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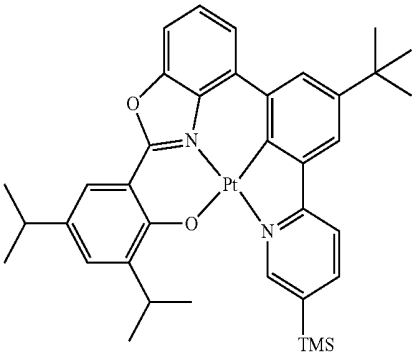


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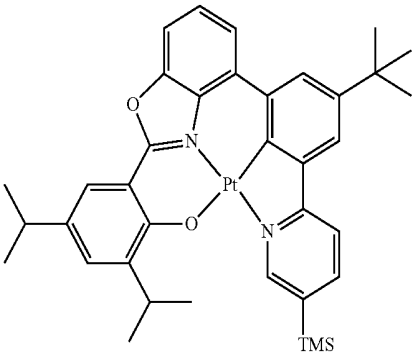

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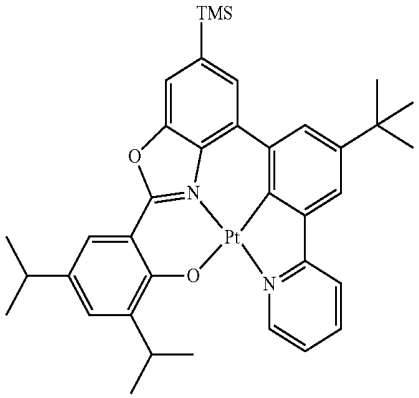


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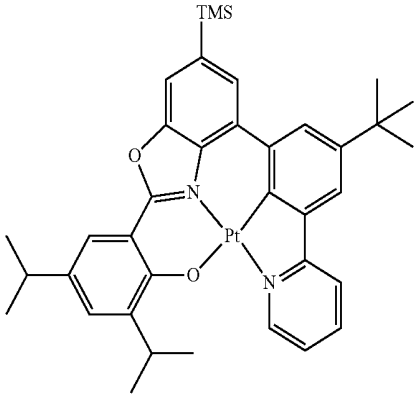


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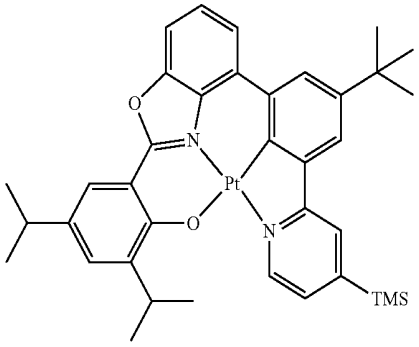


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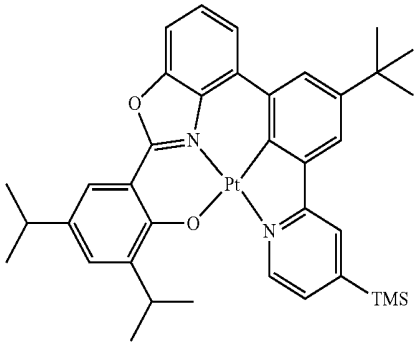


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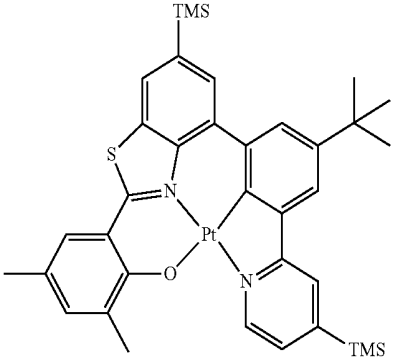


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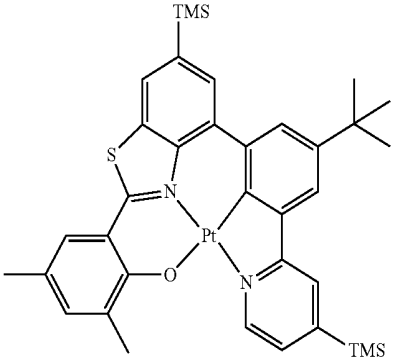


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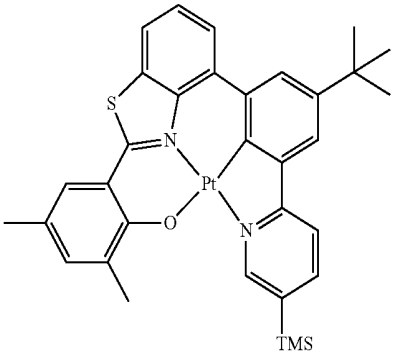


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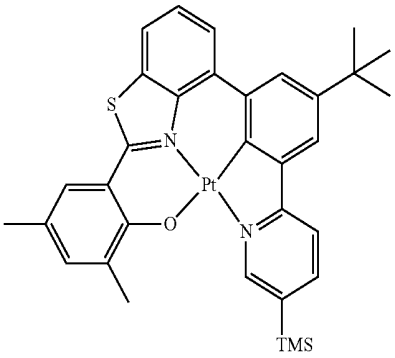

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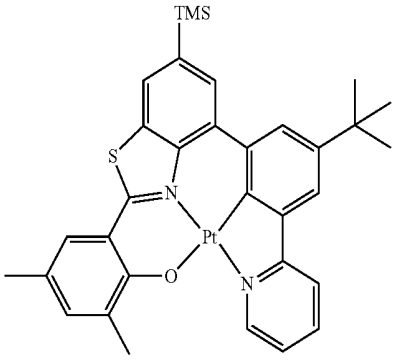


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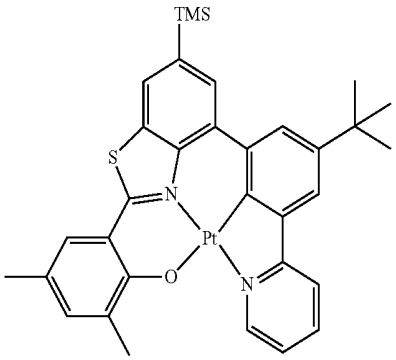


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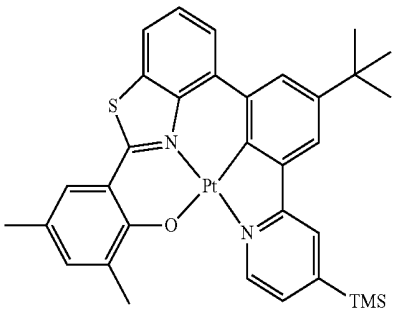


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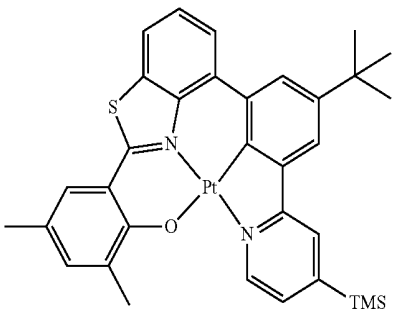


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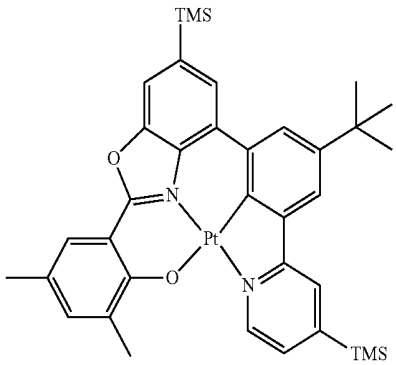


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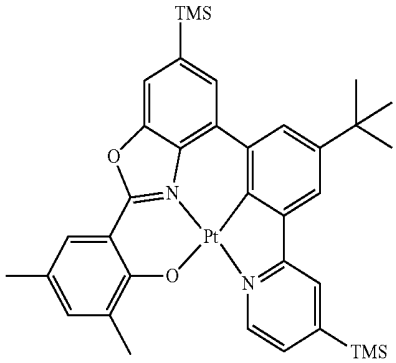


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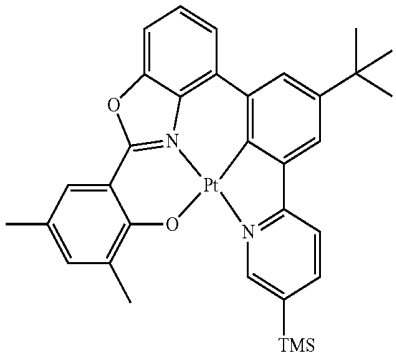


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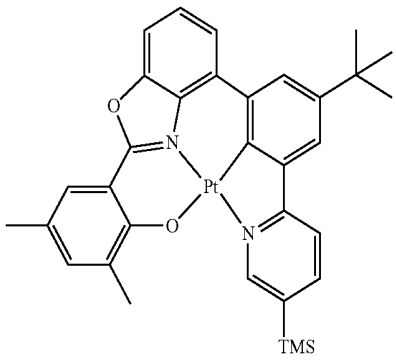

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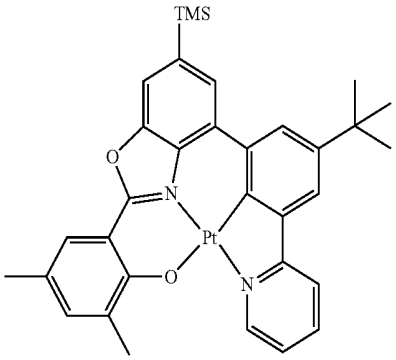


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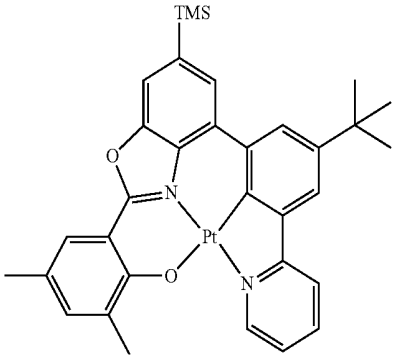


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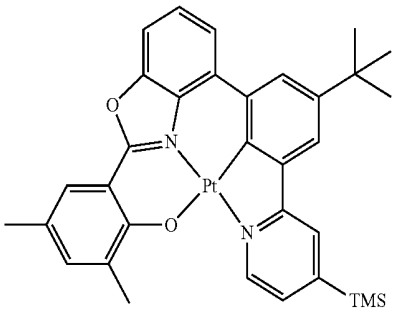


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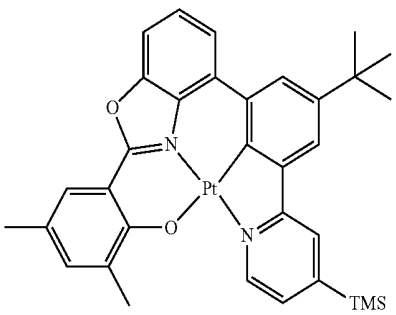


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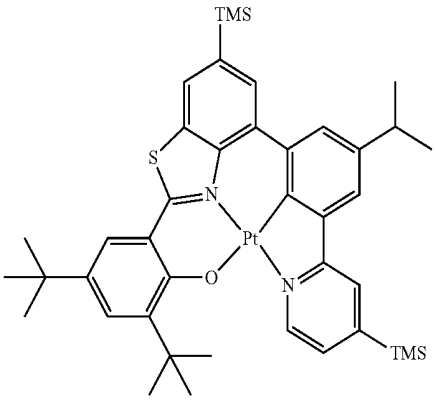


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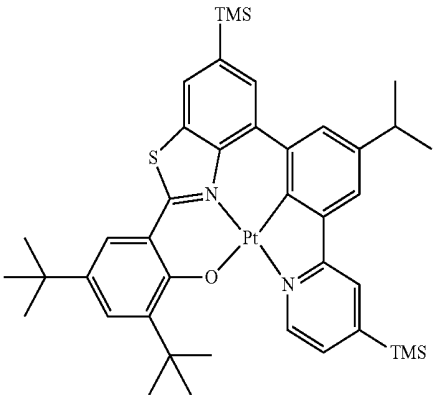


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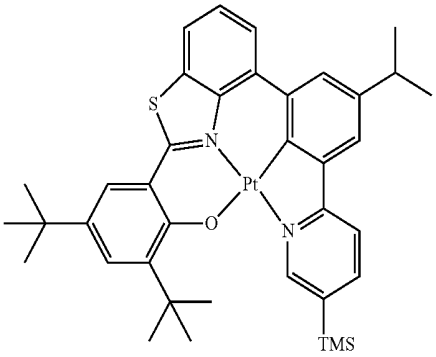


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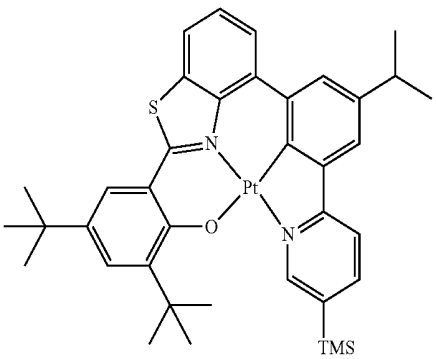

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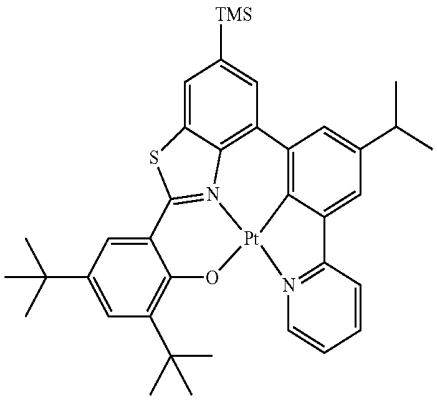


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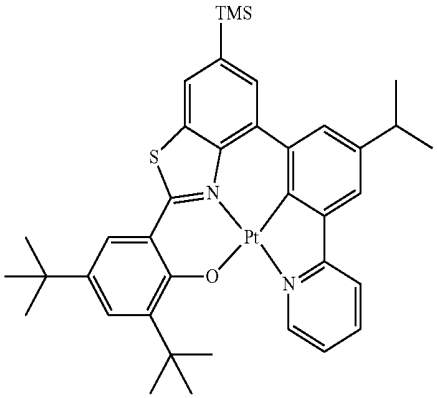


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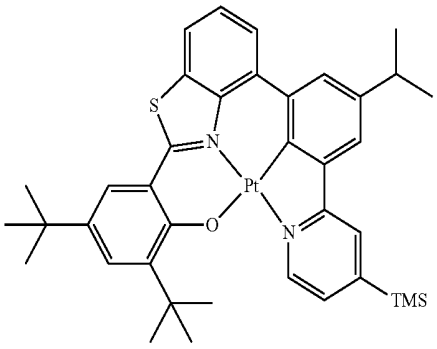


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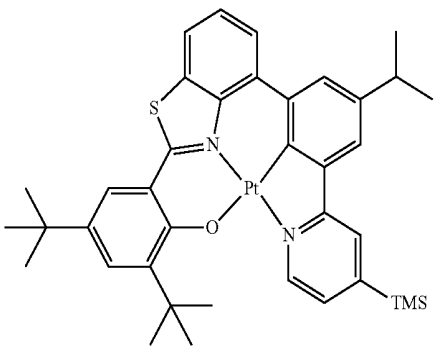


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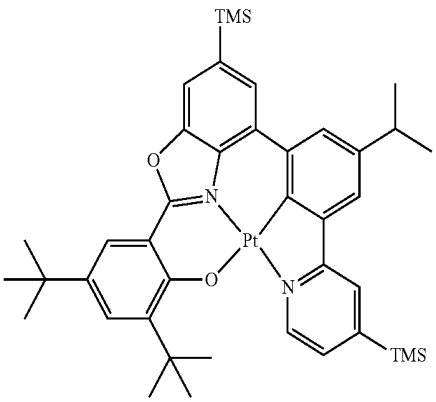


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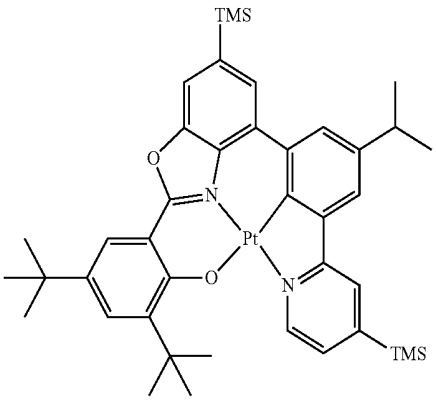


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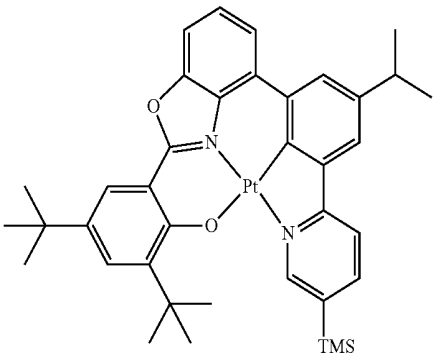


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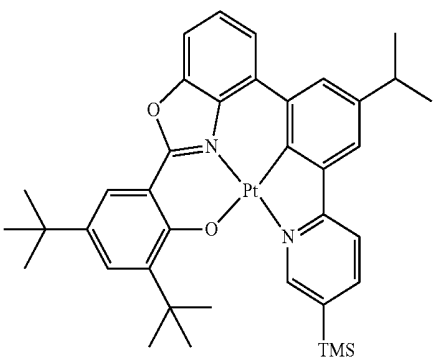

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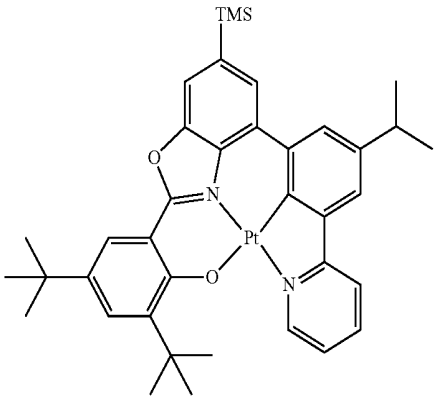


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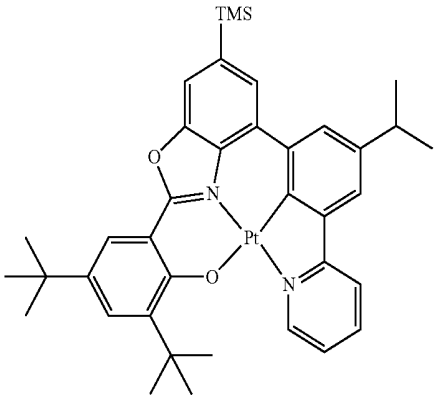


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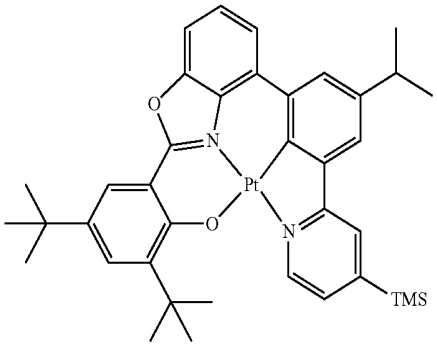


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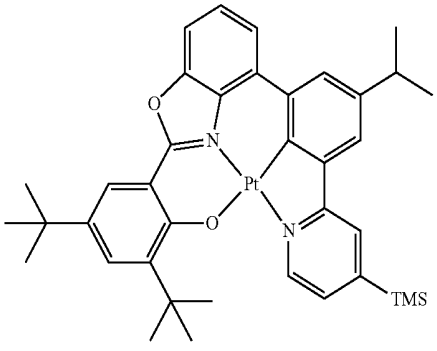


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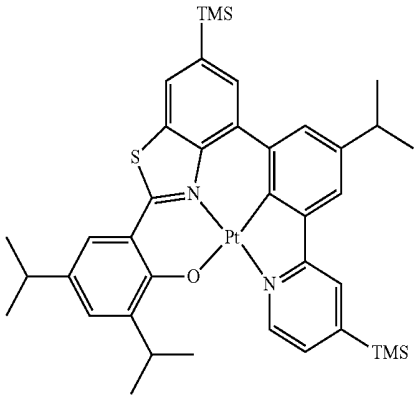


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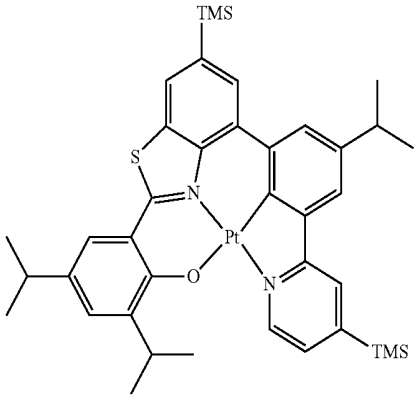


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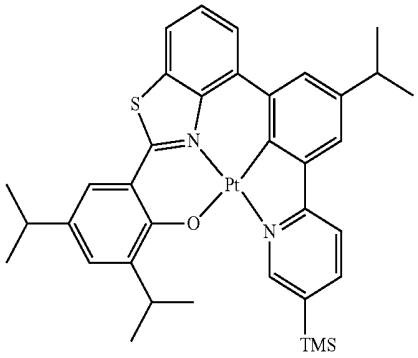


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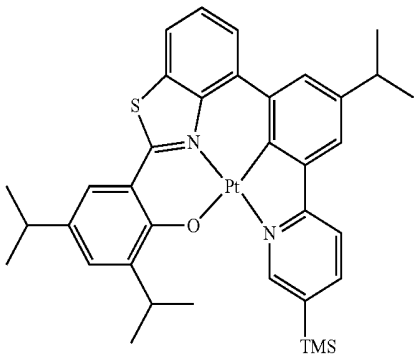

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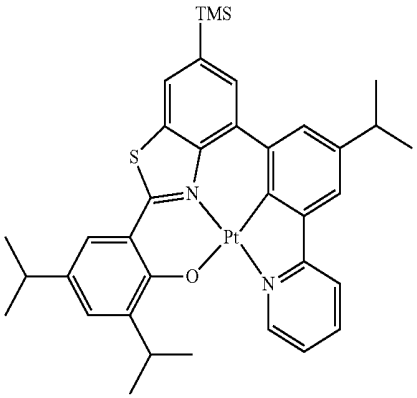


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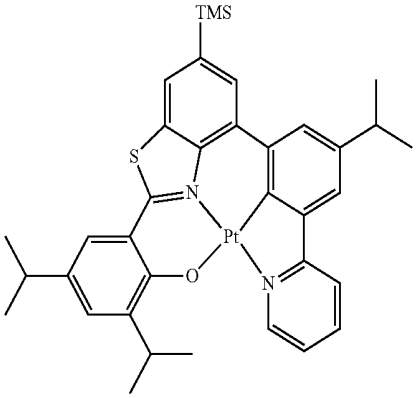


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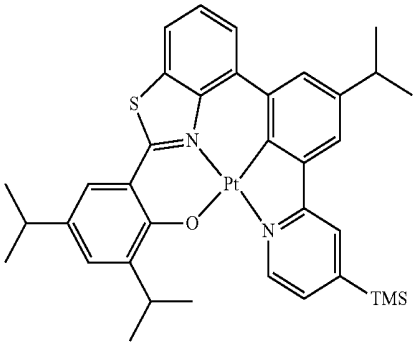


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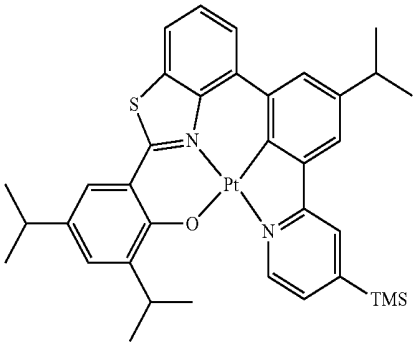


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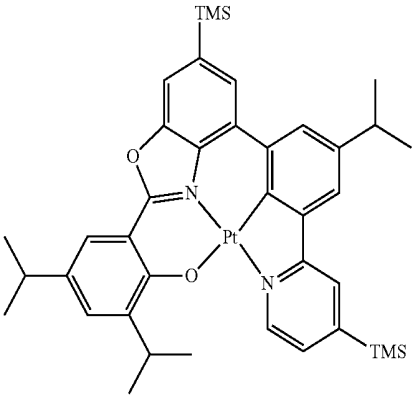


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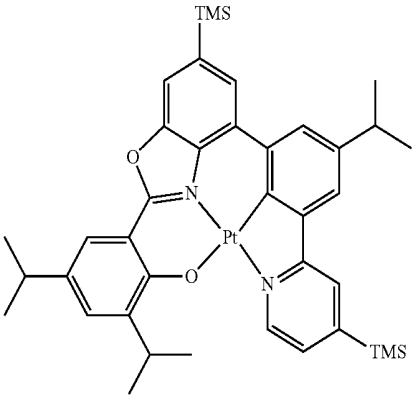


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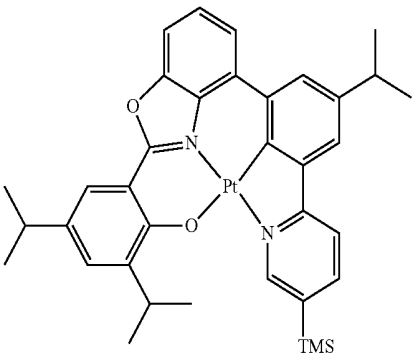


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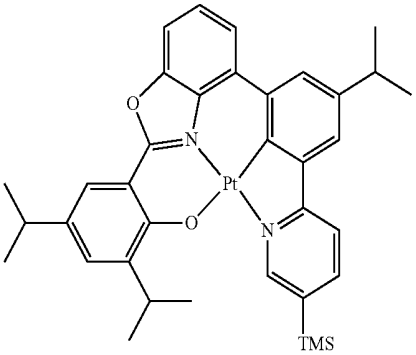

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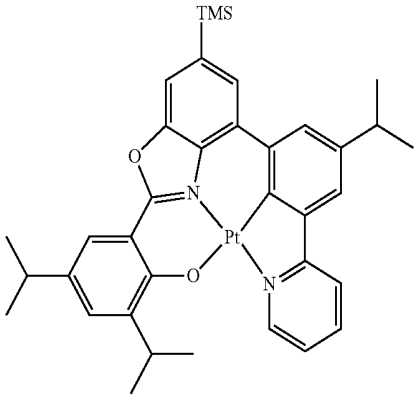


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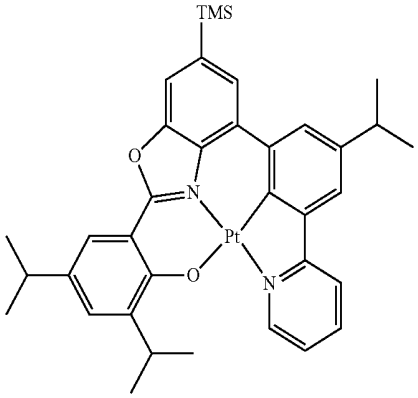


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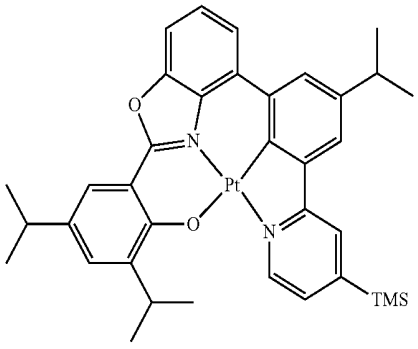


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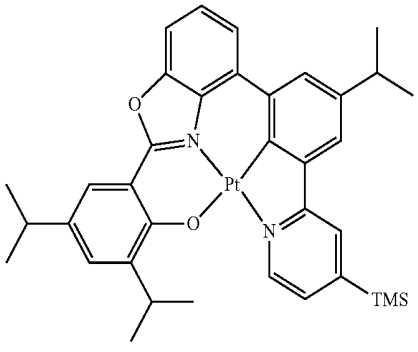


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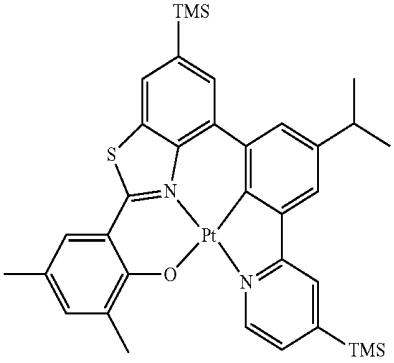


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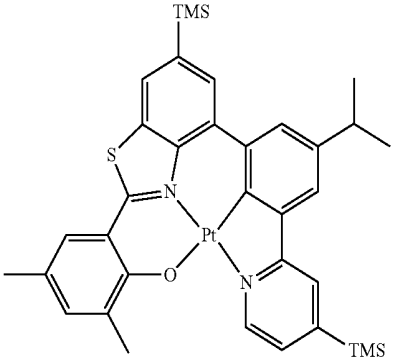


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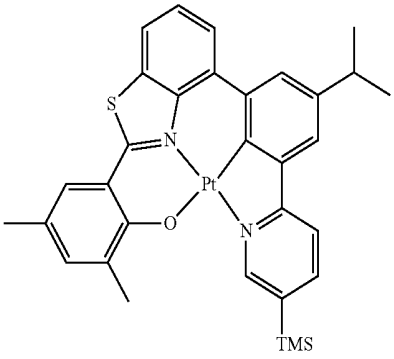


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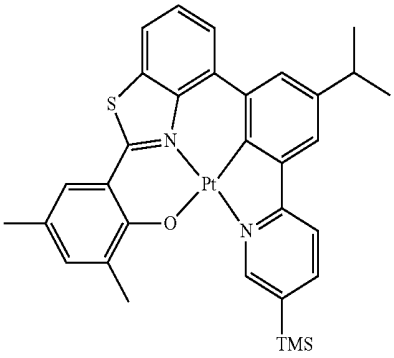

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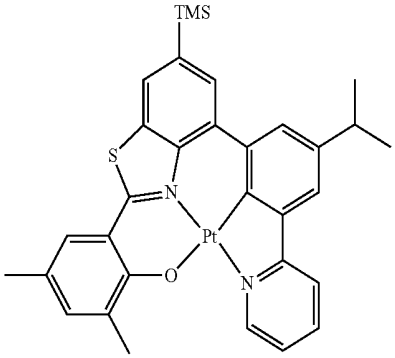


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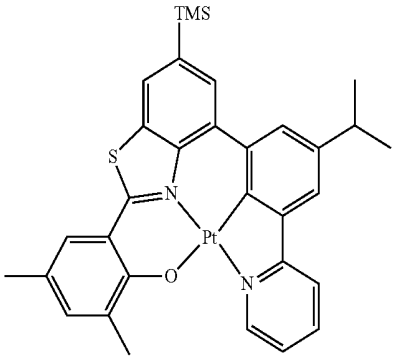


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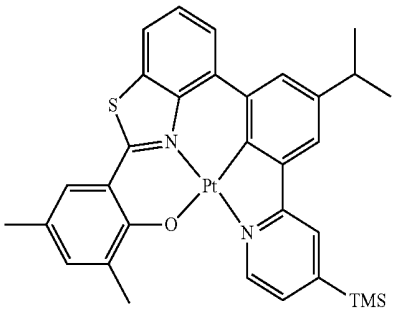


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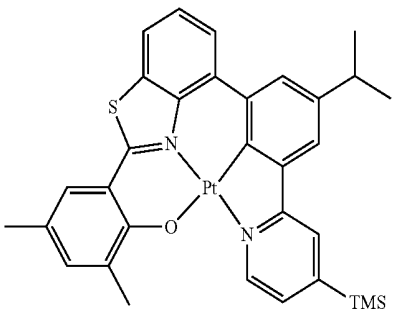


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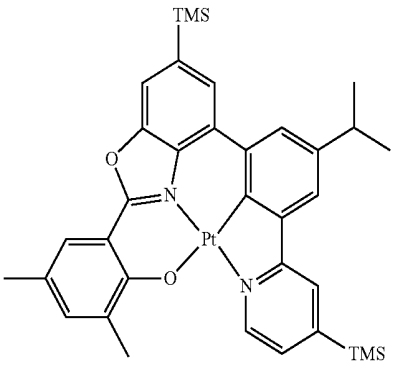


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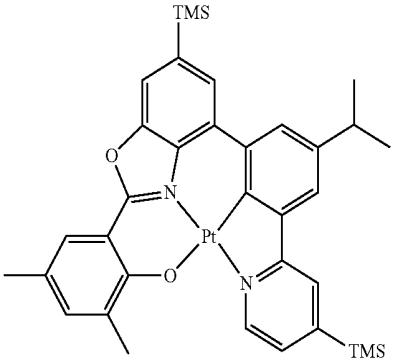


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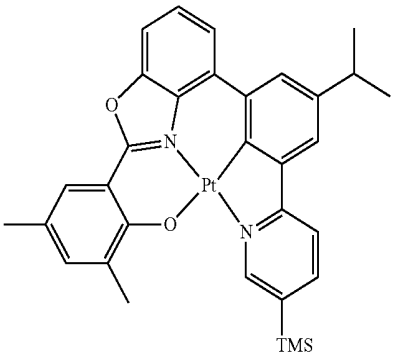


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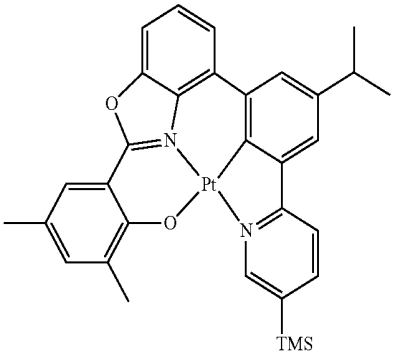

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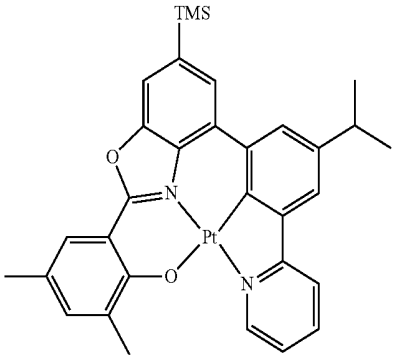


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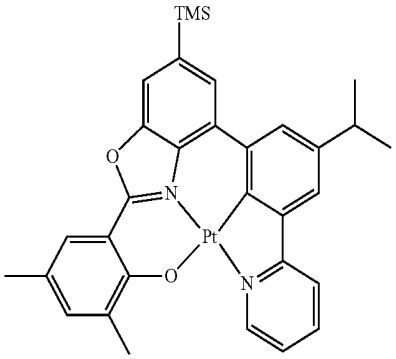


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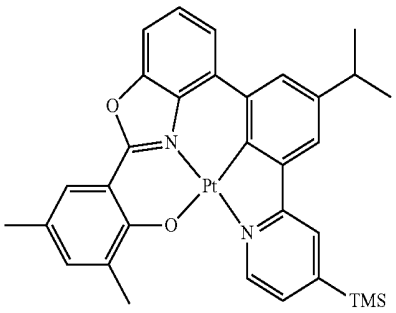


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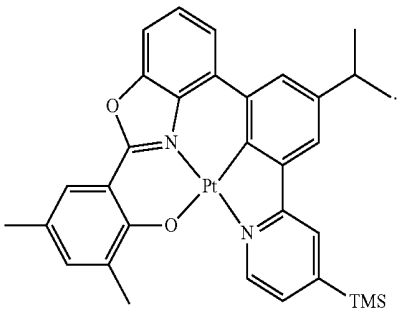
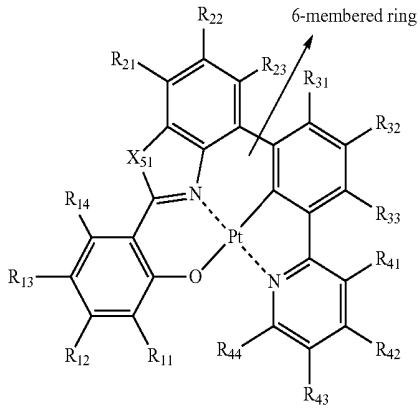



**[0080]** "TMS" in Compounds 1 to 256 indicates a trimethylsilyl group.

**[0081]** A cyclometalated ring formed by a benzimidazole-based ring, a benzene ring, and Pt in Formula 1 is a 6-membered ring (see Formula 1' below). Accordingly, since a stable bond angle may be formed between a four-coordinate ligand and a metal in Formula 1, molecular stability of the organometallic compound represented by Formula 1 may be improved:

Formula 1'




**[0082]** Also, in Formula 1, i) when $X_{51}$ is O or S, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ may be —$Si(Q_3)(Q_4)(Q_5)$, and ii) when $X_{51}$ is $N(R_{51})$, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ may be —$Si(Q_3)(Q_4)(Q_5)$. That is, Formula 1 essentially includes at least one —$Si(Q_3)(Q_4)(Q_5)$ as a substituent. Accordingly, the organometallic compound represented by Formula 1 may have a small decay time, and an electronic device, for example, an organic light-emitting device, which includes the organometallic compound represented by Formula 1, may have improved luminescent efficiency and a small full width at half maximum (FWHM).

**[0083]** For example, a highest occupied molecular orbital (HOMO) energy level, a lowest unoccupied molecular orbital (LUMO) energy level, a singlet ($S_1$) energy level, and a triplet (Ti) energy level of Compounds 60 and 140 were evaluated by using a density functional theory (DFT) of a Gaussian program (B3LYP, structurally optimized at a level of 6-31G(d,p)). Evaluation results thereof are shown in Table 1.

TABLE 1

| Compound No. | HOMO (eV) | LUMO (eV) | $S_1$ energy level (eV) | $T_1$ energy level (eV) |
|---|---|---|---|---|
| 60 | −4.82 | −1.543 | 2.732 | 2.512 |
| 140 | −4.671 | −1.515 | 2.658 | 2.461 |

**[0084]** From Table 1, it has been determined that the organometallic compound represented by Formula 1 has such electrical characteristics that are suitable for use in an electronic device, for example, for use as a dopant for an organic light-emitting device.

**[0085]** Synthesis methods of the organometallic compound represented by Formula 1 may be recognizable by one of ordinary skill in the art by referring to Synthesis Examples provided below.

**[0086]** The organometallic compound represented by Formula 1 is suitable for use in an organic layer of an organic light-emitting device, for example, for use as a dopant in an emission layer of the organic layer. Thus, another aspect provides an organic light-emitting device that includes:

**[0087]** a first electrode;

**[0088]** a second electrode; and

**[0089]** an organic layer disposed between the first electrode and the second electrode,

[0090] wherein the organic layer includes an emission layer and at least one organometallic compound represented by Formula 1.

[0091] The organic light-emitting device may have, due to the inclusion of an organic layer including the organometallic compound represented by Formula 1, a low driving voltage, high luminescence efficiency, high power efficiency, high photoluminescence quantum efficiency, a long lifespan, a low roll-off ratio, and excellent color purity.

[0092] The organometallic compound of Formula 1 may be used between a pair of electrodes of an organic light-emitting device. For example, the organometallic compound represented by Formula 1 may be included in the emission layer. In this regard, the organometallic compound may act as a dopant, and the emission layer may further include a host (that is, an amount of the organometallic compound represented by Formula 1 is smaller than an amount of the host).

[0093] The expression "(an organic layer) includes at least one of organometallic compounds" as used herein may include a case in which "(an organic layer) includes identical organometallic compounds represented by Formula 1" and a case in which "(an organic layer) includes two or more different organometallic compounds represented by Formula 1."

[0094] For example, the organic layer may include, as the organometallic compound, only Compound 1. In this regard, Compound 1 may be included in an emission layer of the organic light-emitting device. In one or more embodiments, the organic layer may include, as the organometallic compound, Compound 1 and Compound 2. In this regard, Compound 1 and Compound 2 may be included in an identical layer (for example, Compound 1 and Compound 2 all may be included in an emission layer).

[0095] The first electrode may be an anode, which is a hole injection electrode, and the second electrode may be a cathode, which is an electron injection electrode; or the first electrode may be a cathode, which is an electron injection electrode, and the second electrode may be an anode, which is a hole injection electrode.

[0096] In an embodiment, in the organic light-emitting device, the first electrode is an anode, the second electrode is a cathode, and the organic layer further includes 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, wherein the hole transport region includes a hole injection layer, a hole transport layer, an electron blocking layer, or any combination thereof, and wherein the electron transport region includes a hole blocking layer, an electron transport layer, an electron injection layer, or any combination thereof.

[0097] The term "organic layer" as used herein refers to a single layer and/or a plurality of layers disposed between the first electrode and the second electrode of the organic light-emitting device. The "organic layer" may include, in addition to an organic compound, an organometallic complex including metal.

[0098] The FIG. **1***s* a schematic view of an organic light-emitting device **10** according to an embodiment. 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 FIGURE. The organic light-emitting device **10** includes a first electrode **11**, an organic layer **15**, and a second electrode **19**, which are sequentially stacked.

[0099] A substrate may be additionally disposed under the first electrode **11** or above the second electrode **19**. For use as the substrate, any substrate that is used in general organic light-emitting devices may be used, and the substrate may be a glass substrate or a transparent plastic substrate, each having excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

[0100] The first electrode **11** may be formed by depositing or sputtering a material for forming the first electrode **11** on the substrate. The first electrode **11** may be an anode. The material for forming the first electrode **11** may be selected from materials with a high work function to facilitate hole injection. The first electrode **11** may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. The material for forming the first electrode may be, for example, indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide ($SnO_2$), and zinc oxide (ZnO). In one or more embodiments, magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag) may be used as the material for forming the first electrode.

[0101] The first electrode **11** may have a single-layered structure or a multi-layered structure including two or more layers. For example, the first electrode **11** may have a three-layered structure of ITO/Ag/ITO, but the structure of the first electrode **110** is not limited thereto.

[0102] The organic layer **15** is disposed on the first electrode **11**.

[0103] The organic layer **15** may include a hole transport region, an emission layer, and an electron transport region.

[0104] The hole transport region may be disposed between the first electrode **11** and the emission layer.

[0105] The hole transport region may include a hole injection layer, a hole transport layer, an electron blocking layer, a buffer layer, or any combination thereof.

[0106] The hole transport region may include only either a hole injection layer or a hole transport layer. In one or more embodiments, the hole transport region may have a hole injection layer/hole transport layer structure or a hole injection layer/hole transport layer/electron blocking layer structure, which are sequentially stacked in this stated order from the first electrode **11**.

[0107] A hole injection layer may be formed on the first electrode **11** by using one or more suitable methods selected from vacuum deposition, spin coating, casting, or Langmuir-Blodgett (LB) deposition.

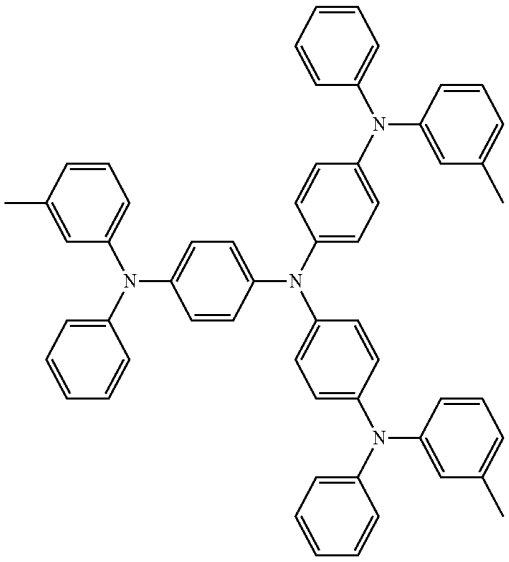
[0108] When a hole injection layer is formed by vacuum deposition, the deposition conditions may vary depending on a compound that is used to form the hole injection layer, and the structure and thermal characteristics of the hole injection layer. For example, the deposition conditions may include a deposition temperature of about 100° C. to about 500° C., a vacuum pressure of about $10^{-8}$ torr to about $10^{-3}$ torr, and a deposition rate of about 0.01 Angstroms per second (A/sec) to about 100 Å/sec. However, the deposition conditions are not limited thereto.

[0109] When the hole injection layer is formed using spin coating, coating conditions may vary depending on the material used to form the hole injection layer, and the structure and thermal properties of the hole injection layer.

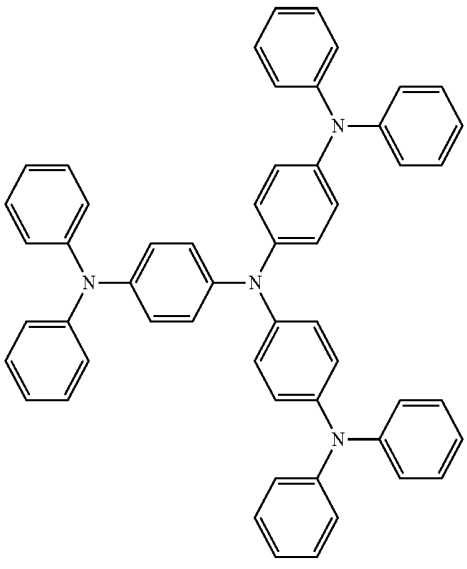
For example, a coating speed may be from about 2,000 revolutions per minute (rpm) to about 5,000 rpm, and a temperature at which a heat treatment is performed to remove a solvent after coating may be from about 80° C. to about 200° C. However, the coating conditions are not limited thereto.

**[0110]** Conditions for forming a hole transport layer and an electron blocking layer may be understood by referring to conditions for forming the hole injection layer.

**[0111]** The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, spiro-TPD, spiro-NPB, methylated-NPB, TAPC, HMTPD, 4,4',4"-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzene sulfonic acid (PANI/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrene-sulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (PANI/CSA), polyaniline/poly(4-styrene sulfonate) (PANI/PSS), a compound represented by Formula 201 below, and a compound represented by Formula 202 below:



m-MTDATA



TDATA

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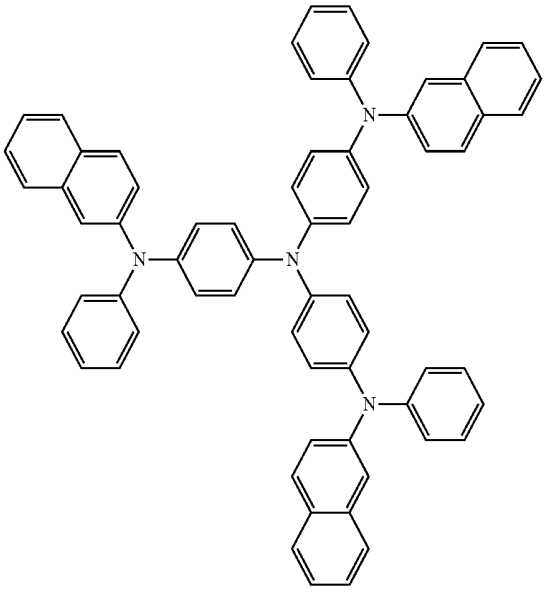
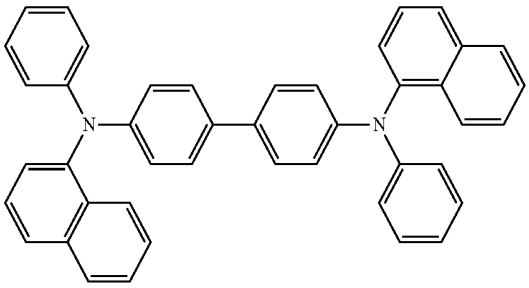
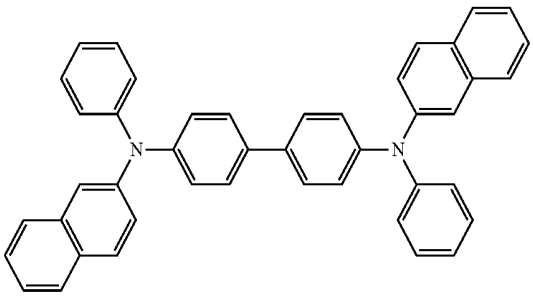


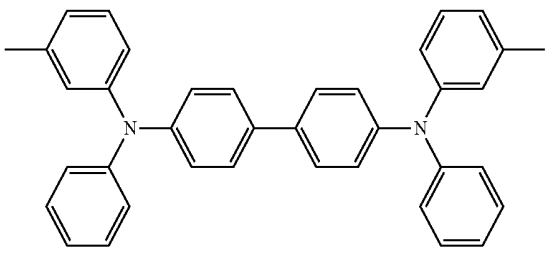
2-TNATA



NPB



β-NPB



TPD

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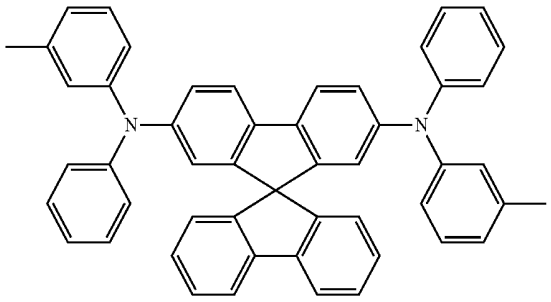
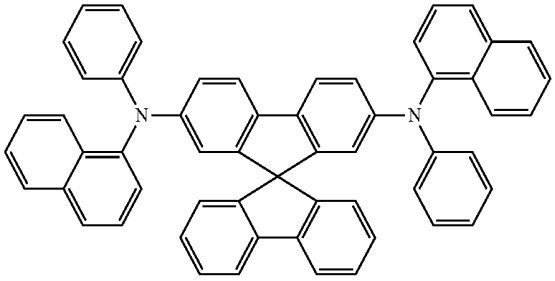
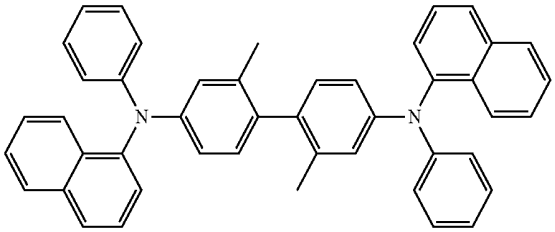


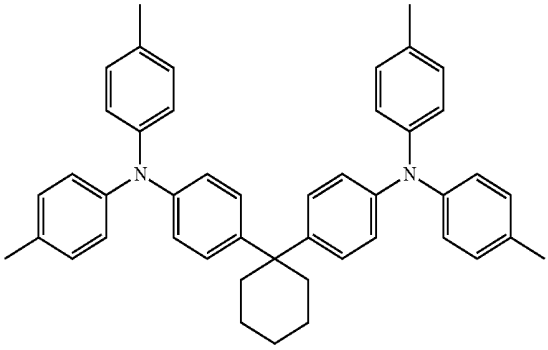
Spiro-TPD



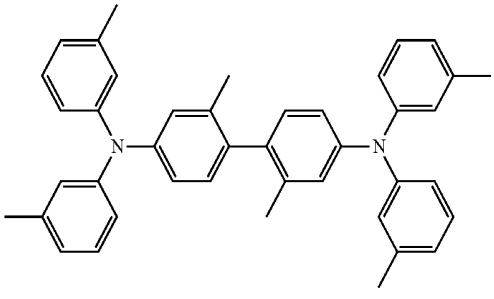
Spiro-NPB



methylated NPB



TAPC



HMTPD

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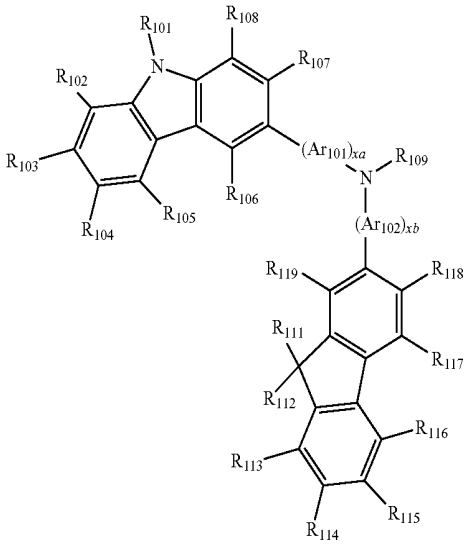
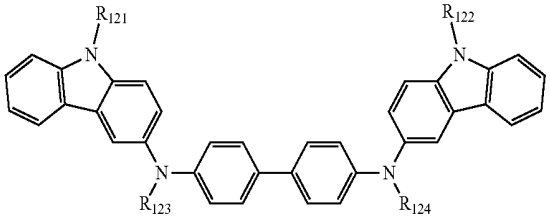
Formula 201



Formula 202



**[0112]** $Ar_{101}$ and $Ar_{102}$ in Formula 201 may each independently be selected from:

**[0113]** a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an acenaphthylene group, a fluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, and a pentacenylene group; and

**[0114]** a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an acenaphthylene group, a fluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, and a pentacenylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

**[0115]** xa and xb in Formula 201 may each independently be an integer from 0 to 5, or may each independently be 0, 1, or 2. For example, xa may be 1, and xb may be 0, but embodiments of the present disclosure are not limited thereto.

**[0116]** $R_{101}$ to $R_{108}$, $R_{111}$ to $R_{119}$, and $R_{121}$ to $R_{124}$ in Formulae 201 and 202 may each independently be selected from:

**[0117]** hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{10}$ alkyl group (for example, a methyl group, an ethyl group, a propyl group, a butyl group, pentyl group, a hexyl group, or the like), and a $C_1$-$C_{10}$ alkoxy group (for example, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, a pentoxy group, or the like);

**[0118]** a $C_1$-$C_{10}$ alkyl group and a $C_1$-$C_{10}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, and a phosphoric acid group or a salt thereof;

**[0119]** a phenyl group, a naphthyl group, an anthracenyl group, a fluorenyl group, and a pyrenyl group; and

**[0120]** a phenyl group, a naphthyl group, an anthracenyl group, a fluorenyl group, and a pyrenyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{10}$ alkyl group, and a $C_1$-$C_{10}$ alkoxy group, but embodiments of the present disclosure are not limited thereto.

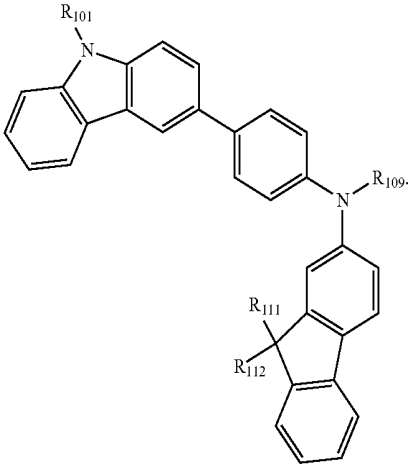
**[0121]** $R_{109}$ in Formula 201 may be selected from:

**[0122]** a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group; and

**[0123]** a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{20}$ alkyl group, a $C_1$-$C_{20}$ alkoxy group, a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group.

**[0124]** According to an embodiment, the compound represented by Formula 201 may be represented by Formula 201A, but embodiments of the present disclosure are not limited thereto:

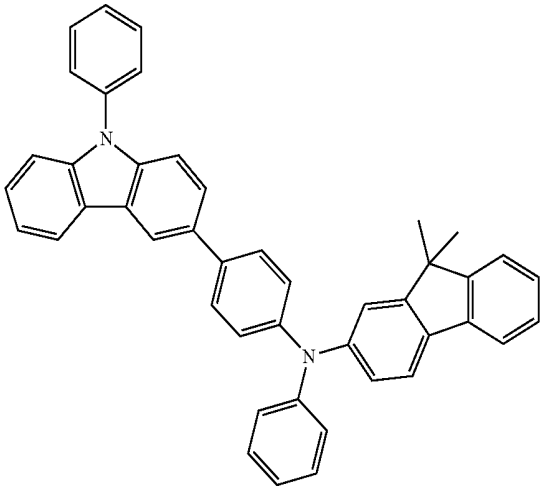
Formula 201A



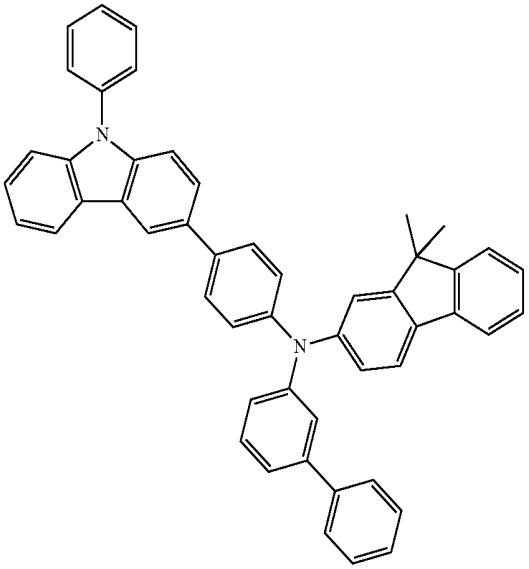

**[0125]** $R_{101}$, $R_{111}$, $R_{112}$, and $R_{109}$ in Formula 201A may be understood by referring to the description provided herein.

**[0126]** For example, the compound represented by Formula 201, and the compound represented by Formula 202 may include compounds HT1 to HT20 illustrated below, but are not limited thereto.

HT1




HT2



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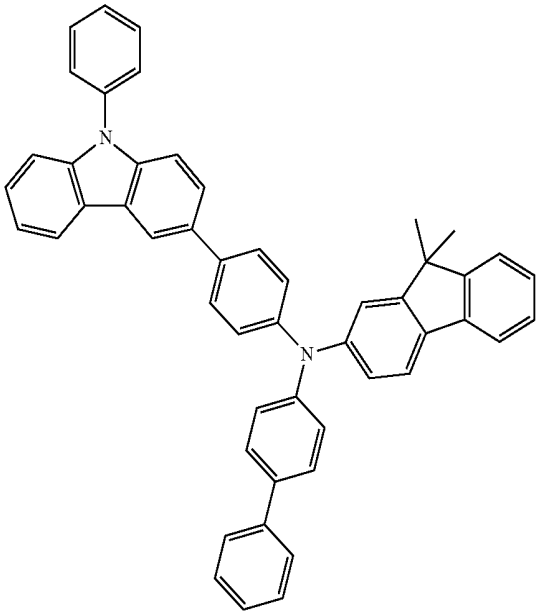
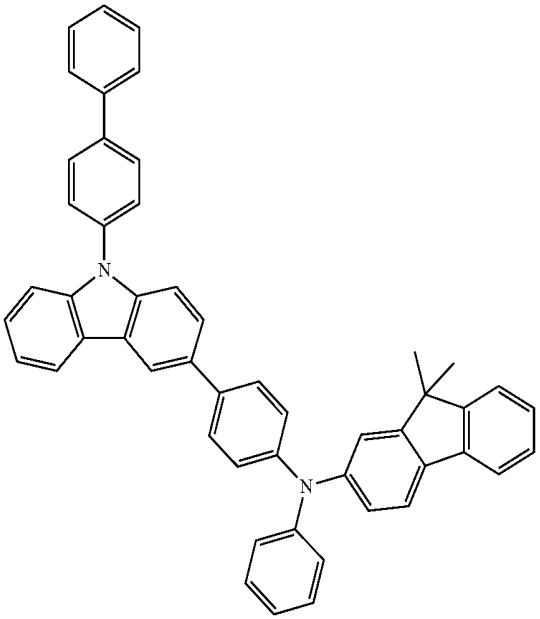
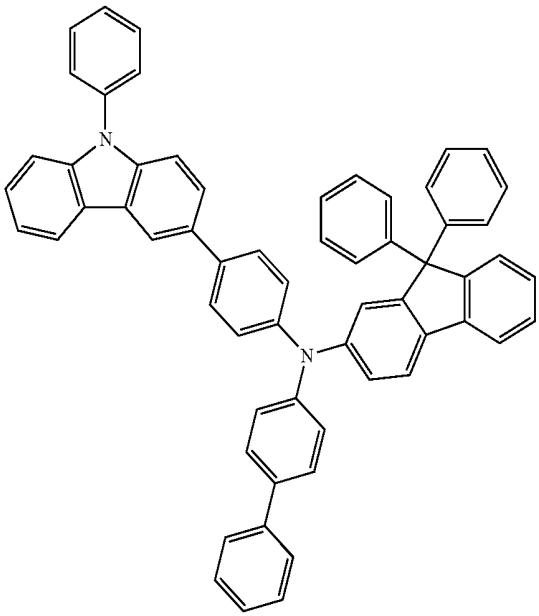
HT3



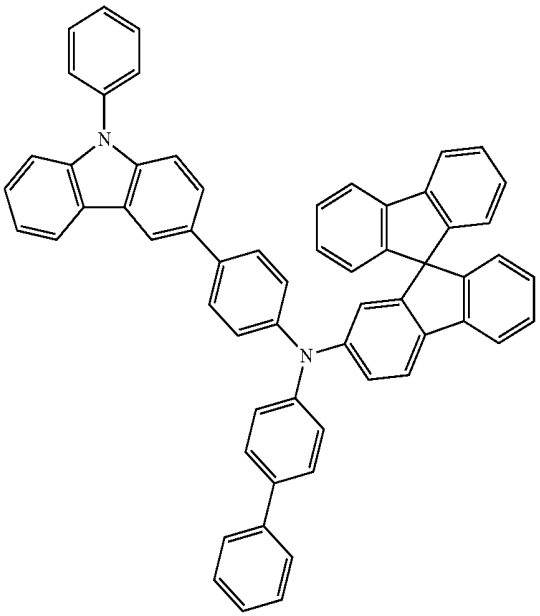
HT4



HT5



HT6



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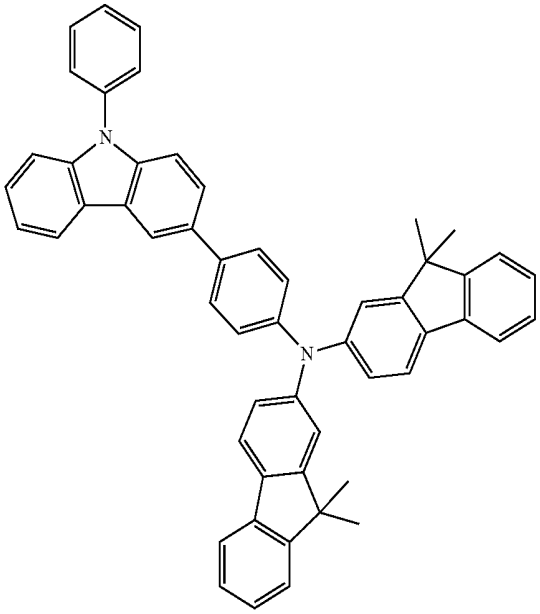
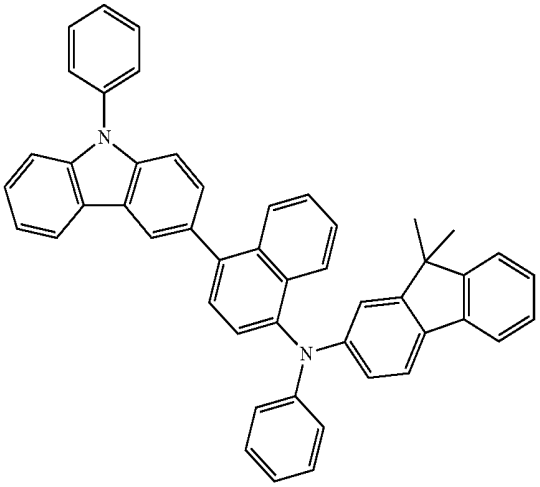
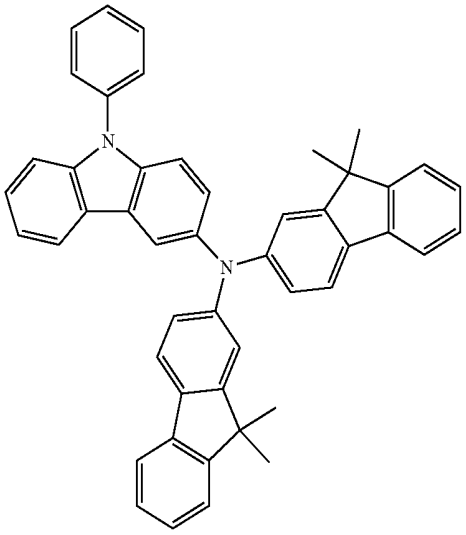
HT7



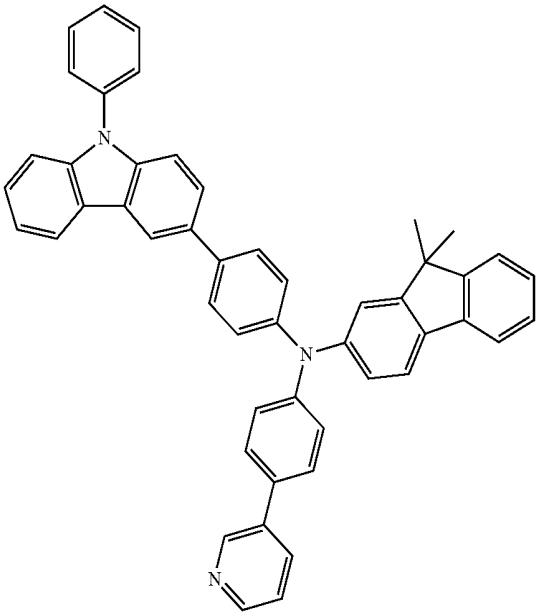
HT8



HT9



HT10



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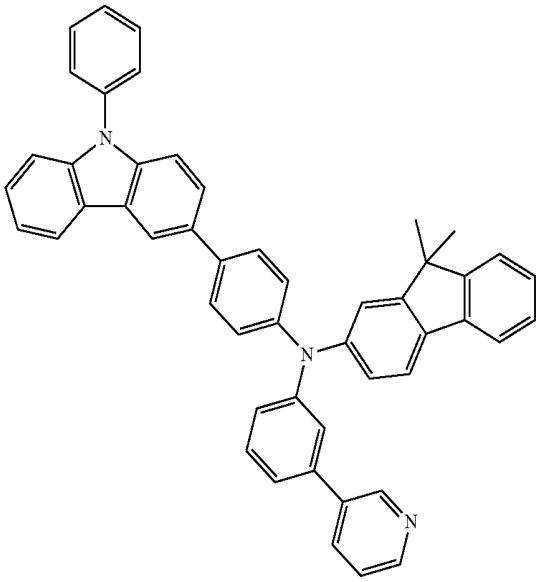
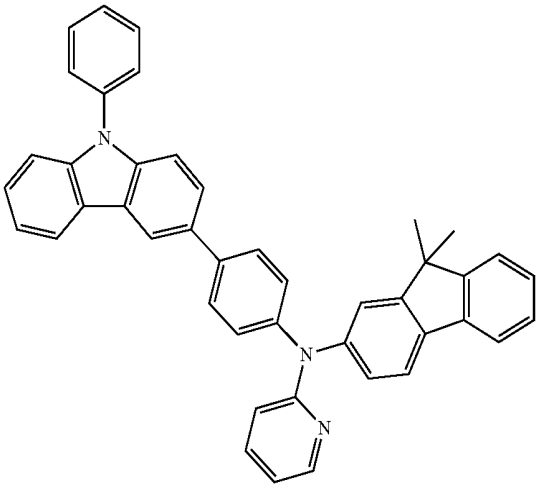
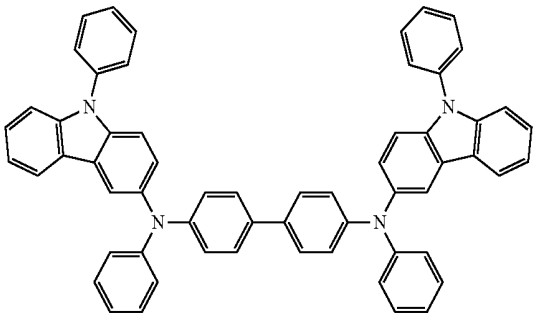
HT11



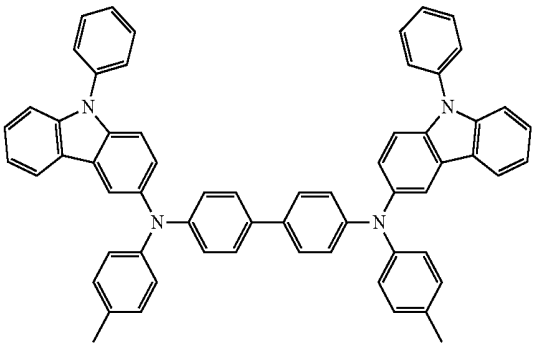
HT12



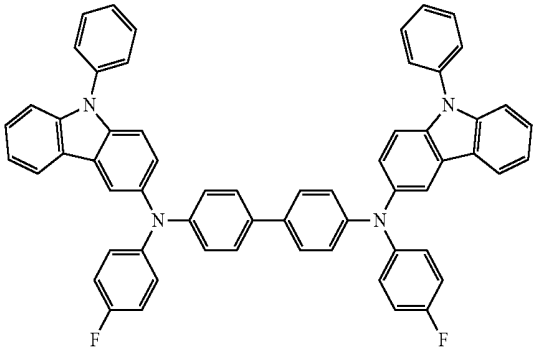
HT13



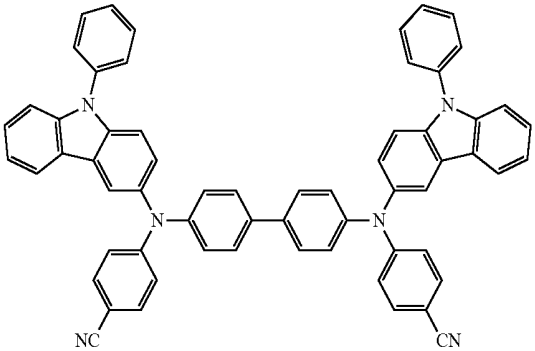
HT14



HT15



HT16



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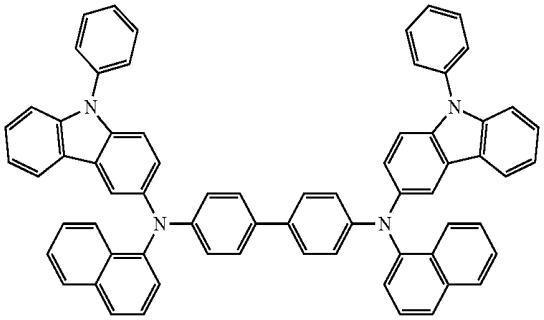
HT17



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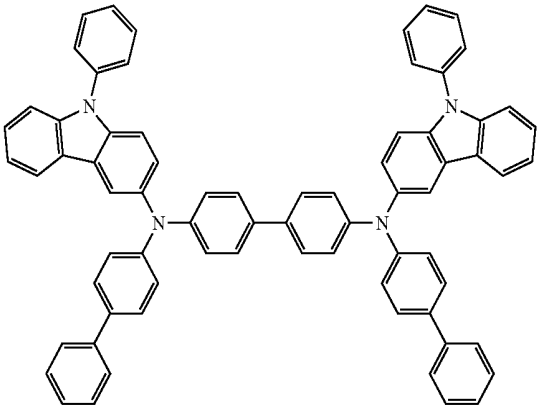
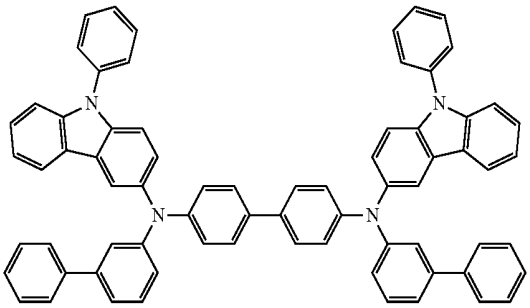
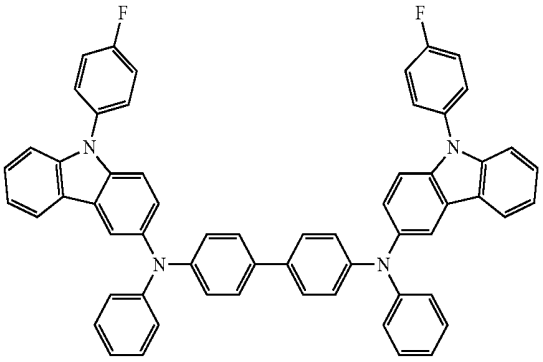


HT19



HT20

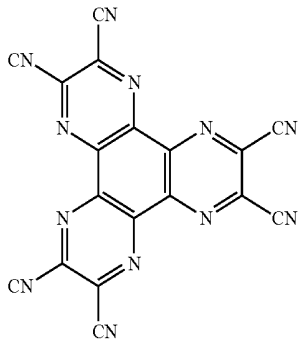


**[0127]** A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about 100 Å to about 1,000 Å. When the hole transport region includes at least one of a hole injection layer and a hole transport layer, the thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, and for example, about 100 Å to about 1,000 Å, and the thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, and for example, about 100 Å to about 1,500 Å. While not wishing to be bound by theory, it is understood that 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 may be obtained without a substantial increase in driving voltage.

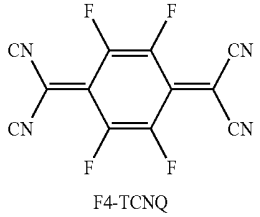
**[0128]** The hole transport region may further include, in addition to these materials, a charge-generation material for the improvement of conductive properties. The charge-generation material may be homogeneously or non-homogeneously dispersed in the hole transport region.

**[0129]** The charge-generation material may be, for example, a p-dopant. The p-dopant may be one selected from a quinone derivative, a metal oxide, and a cyano group-containing compound, but embodiments of the present disclosure are not limited thereto. Non-limiting examples of the p-dopant are a quinone derivative, such as tetracyanoquinonedimethane (TCNQ) or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonedimethane (F4-TCNQ); a metal oxide, such as a tungsten oxide or a molybdenium oxide; and a cyano group-containing compound, such as Compound HT-D1 or Compound HT-D2 below, but are not limited thereto.

Compound HT-D1



HT-D1



F4-TCNQ

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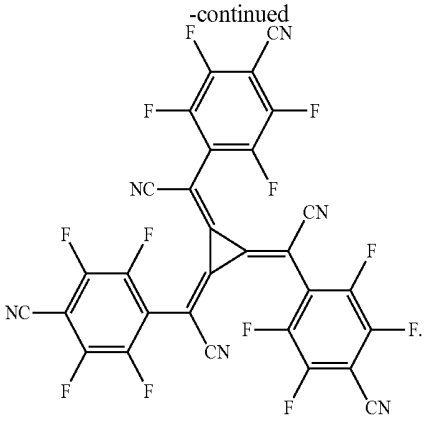


HT-D2

[0130] The hole transport region may include a buffer layer.

[0131] Also, the buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, and thus, efficiency of a formed organic light-emitting device may be improved.

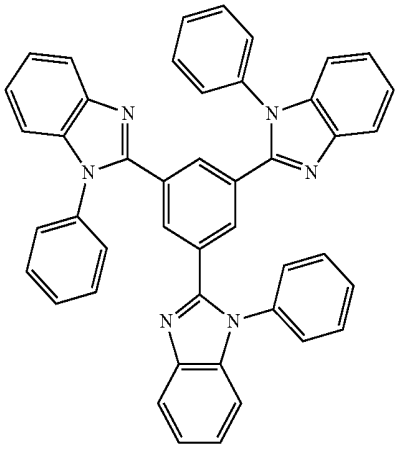
[0132] Then, an emission layer may be formed on the hole transport region by vacuum deposition, spin coating, casting, LB deposition, or the like. When the emission layer is formed by vacuum deposition or spin coating, the deposition or coating conditions may be similar to those applied in forming the hole injection layer although the deposition or coating conditions may vary according to a compound that is used to form the emission layer.

[0133] Meanwhile, when the hole transport region includes an electron blocking layer, a material for the electron blocking layer may be selected from materials for the hole transport region described above and materials for a host to be explained later. However, the material for the electron blocking layer is not limited thereto. For example, when the hole transport region includes an electron blocking layer, a material for the electron blocking layer may be mCP, which will be explained later.

[0134] The emission layer may include a host and a dopant, and the dopant may include the organometallic compound represented by Formula 1.

[0135] The emission layer may include a host and a dopant, and an amount of the host may be larger than that of the organometallic compound in the emission layer.

[0136] The host may include at least one selected from TPBi, TBADN, ADN (also referred to as "DNA"), CBP, CDBP, TCP, mCP, Compound H50, and Compound H51:



TPBi

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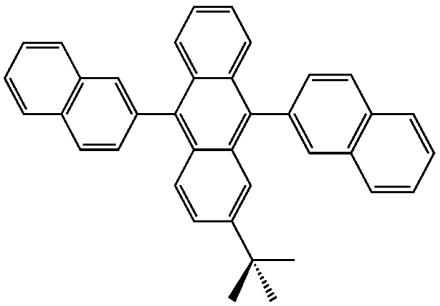
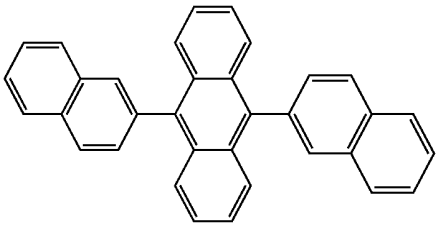
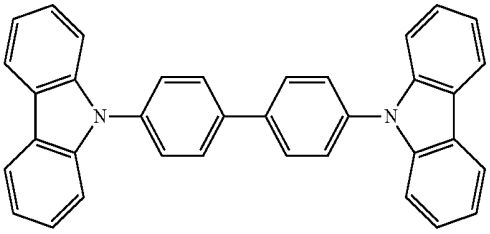


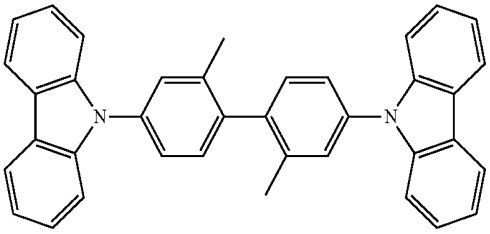
TBADN



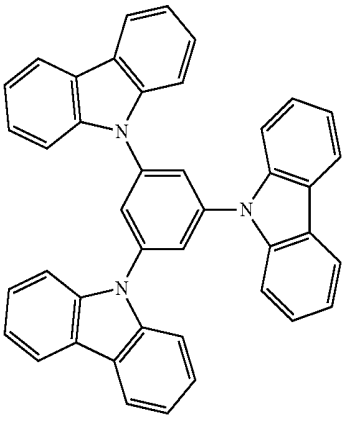
ADN



CBP



CDBP



TCP

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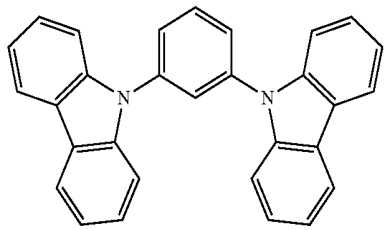
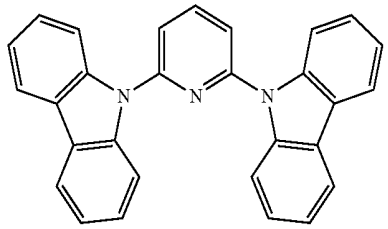
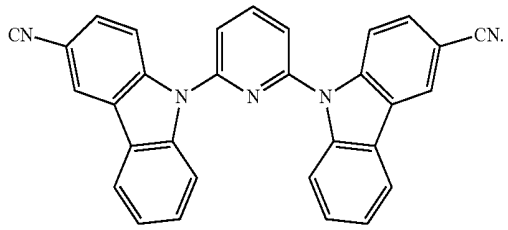


mCP

H50

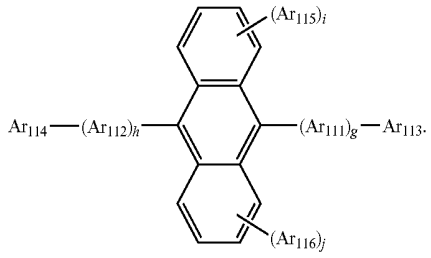


H51



**[0137]** In one or more embodiments, the host may further include a compound represented by Formula 301 below.

Formula 301



**[0138]** $Ar_{111}$ and $Ar_{112}$ in Formula 301 may each independently be selected from:

**[0139]** a phenylene group, a naphthylene group, a phenanthrenylene group, and a pyrenylene group; and

**[0140]** a phenylene group, a naphthylene group, a phenanthrenylene group, and a pyrenylene group, each substituted with at least one selected from a phenyl group, a naphthyl group, and an anthracenyl group.

**[0141]** $Ar_{113}$ to $Ar_{116}$ in Formula 301 may each independently be selected from:

**[0142]** a $C_1$-$C_{10}$ alkyl group, a phenyl group, a naphthyl group, a phenanthrenyl group, and a pyrenyl group; and

**[0143]** a phenyl group, a naphthyl group, a phenanthrenyl group, and a pyrenyl group, each substituted with at least one selected from a phenyl group, a naphthyl group, and an anthracenyl group.

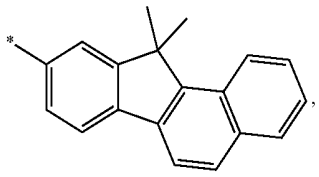
**[0144]** g, h, i, and j in Formula 301 may each independently be an integer from 0 to 4, for example, 0, 1, or 2.

**[0145]** $Ar_{113}$ to $Ar_{116}$ in Formula 301 may each independently be selected from:

**[0146]** a $C_1$-$C_{10}$ alkyl group substituted with at least one selected from a phenyl group, a naphthyl group, and an anthracenyl group;

**[0147]** a phenyl group, a naphthyl group, an anthracenyl group, a pyrenyl, a phenanthrenyl group, and a fluorenyl group;

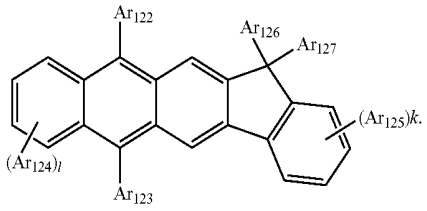
**[0148]** a phenyl group, a naphthyl group, an anthracenyl group, a pyrenyl group, a phenanthrenyl group, and a fluorenyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a alkoxy group, a phenyl group, a naphthyl group, an anthracenyl group, a pyrenyl group, a phenanthrenyl group, and a fluorenyl group; and



**[0149]** but embodiments of the present disclosure are not limited thereto.

**[0150]** In one or more embodiments, the host may include a compound represented by Formula 302 below:

Formula 302



**[0151]** $Ar_{122}$ to $Ar_{125}$ in Formula 302 are the same as described in detail in connection with $Ar_{113}$ in Formula 301.

**[0152]** $Ar_{126}$ and $Ar_{127}$ in Formula 302 may each independently be a $C_1$-$C_{10}$ alkyl group (for example, a methyl group, an ethyl group, or a propyl group).

**[0153]** k and l in Formula 302 may each independently be an integer from 0 to 4. For example, k and 1 may each independently be 0, 1, or 2.

**[0154]** In one or more embodiments, the host may include, in addition to the compounds described above, a carbazole-containing compound, but embodiments of the present disclosure are not limited thereto.

**[0155]** When the organic light-emitting device is a full-color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, and a blue emission layer. In one or more embodiments, due to a stacked structure including a red emission

layer, a green emission layer, and/or a blue emission layer, the emission layer may emit white light.

**[0156]** When the emission layer includes a host and a dopant, an amount of the dopant is generally in a range of about 0.01 parts by weight to about 15 parts by weight based on 100 parts by weight of the host, but embodiments of the present disclosure are not limited thereto.

**[0157]** 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.

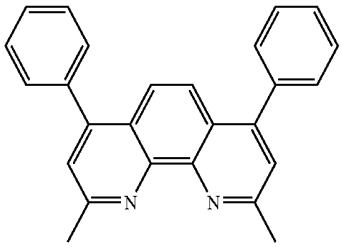
**[0158]** Then, an electron transport region may be disposed on the emission layer.

**[0159]** The electron transport region may include a hole blocking layer, an electron transport layer, an electron injection layer, or any combination thereof.

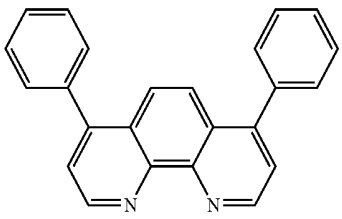
**[0160]** For example, the electron transport region may have a hole blocking layer/electron transport layer/electron injection layer structure or an electron transport layer/electron injection layer structure, but the structure of the electron transport region is not limited thereto. The electron transport layer may have a single-layered structure or a multi-layered structure including two or more different materials.

**[0161]** Conditions for forming the hole blocking layer, the electron transport layer, and the electron injection layer which constitute the electron transport region may be understood by referring to the conditions for forming the hole injection layer.

**[0162]** When the electron transport region includes a hole blocking layer, the hole blocking layer may include, for example, at least one of BCP, Bphen, and BAlq but embodiments of the present disclosure are not limited thereto.



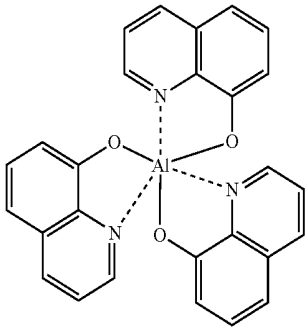
BCP



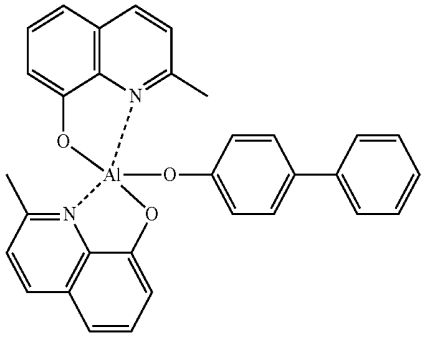
Bphen

**[0163]** 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. While not wishing to be bound by theory, it is understood that when the thickness of the hole blocking layer is within these ranges, the hole blocking layer may have improved hole blocking ability without a substantial increase in driving voltage.

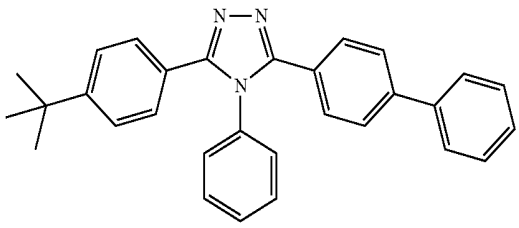
**[0164]** The electron transport layer may further include at least one selected from BCP, Bphen, $Alq_3$, BAlq, TAZ, and NTAZ.



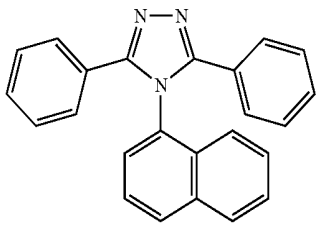
$Alq_3$



BAlq



TAZ



NTAZ

**[0165]** In one or more embodiments, the electron transport layer may include at least one of ET1 and ET25, but are not limited thereto:

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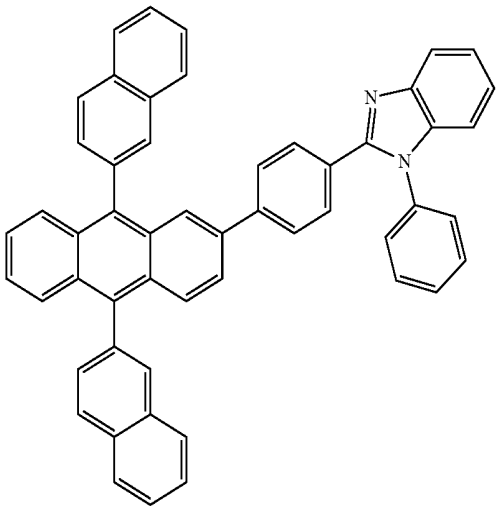
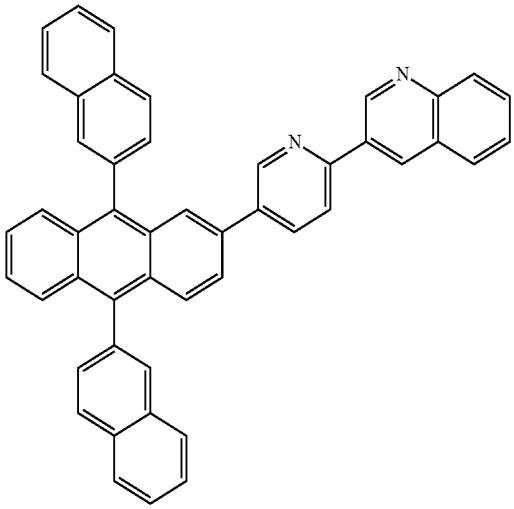
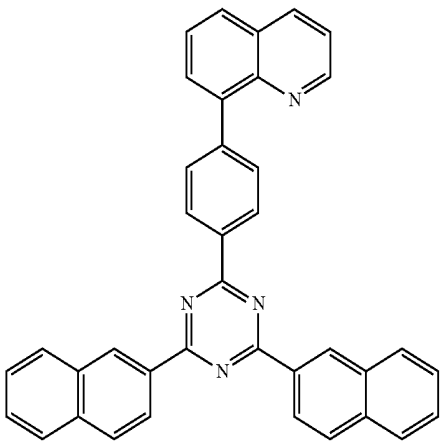
ET1



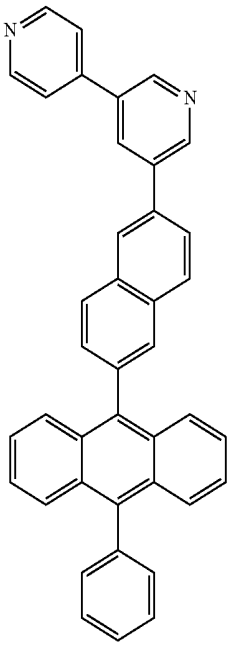
ET2



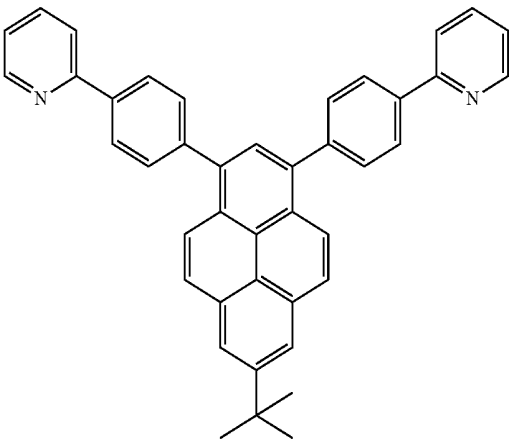
ET3



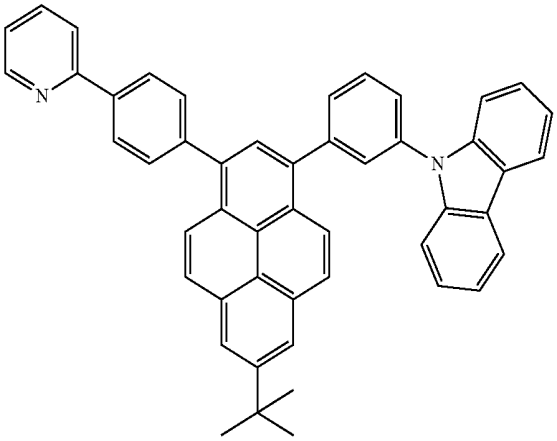
ET4



ET5



ET6



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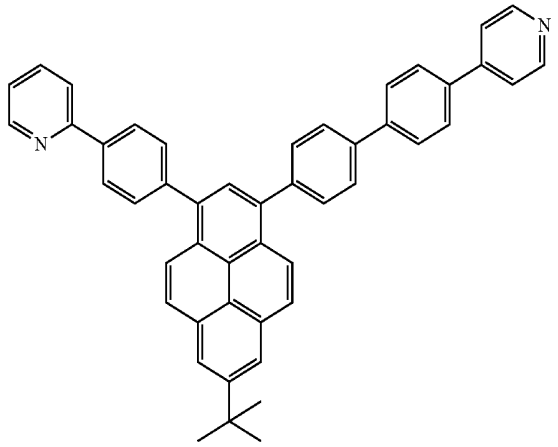
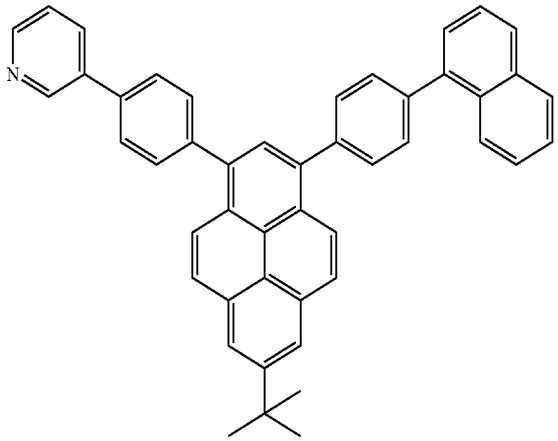
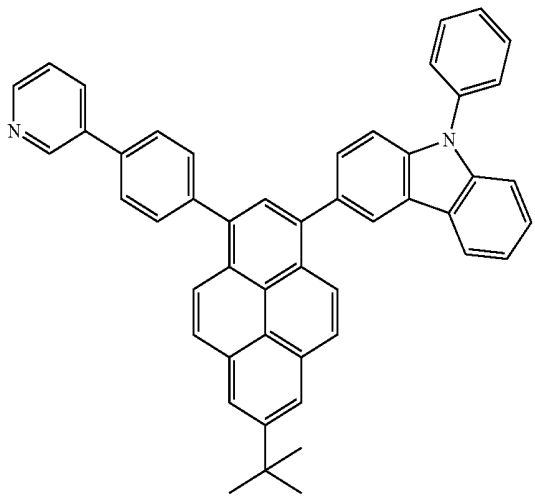
ET7



ET8



ET9



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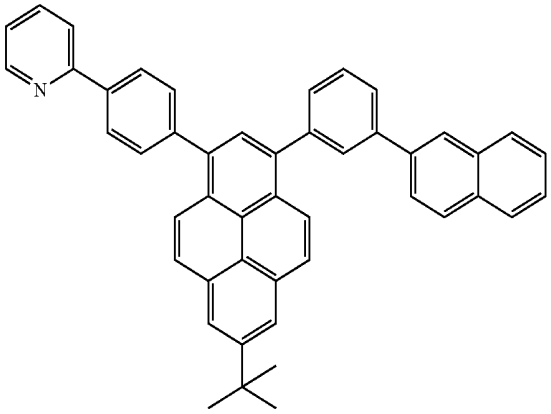
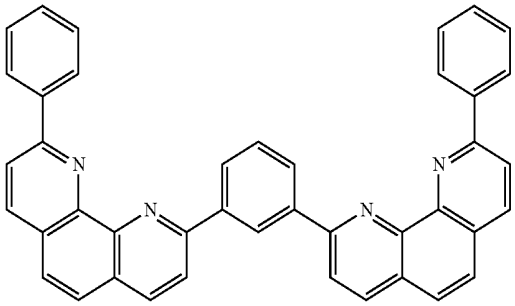
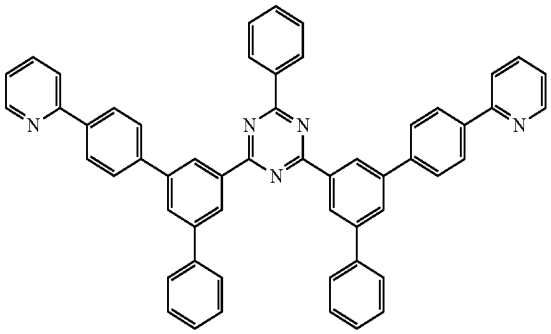
ET10



ET11



ET12



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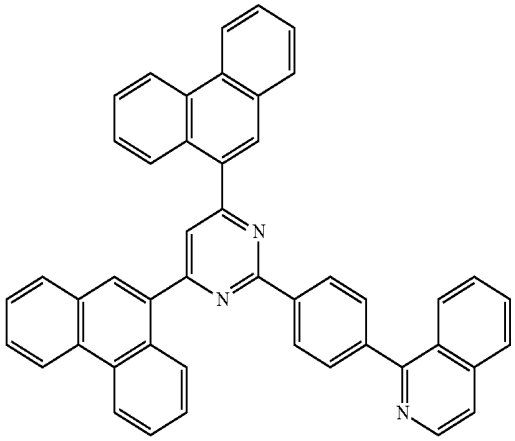

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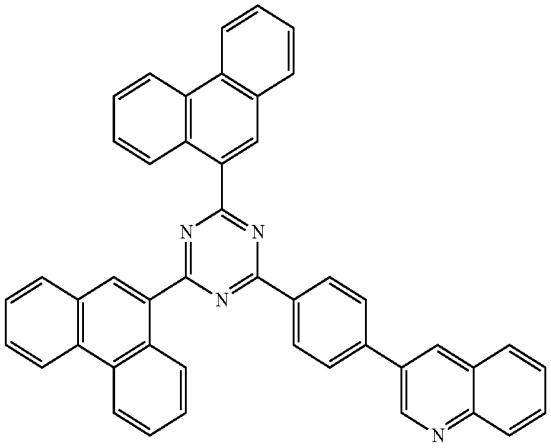
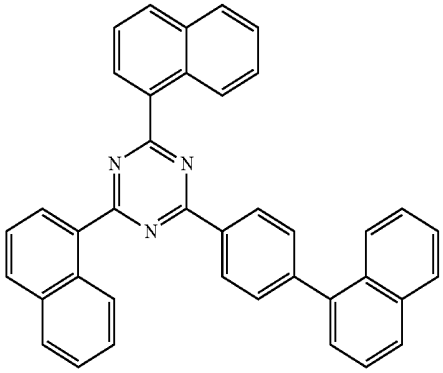
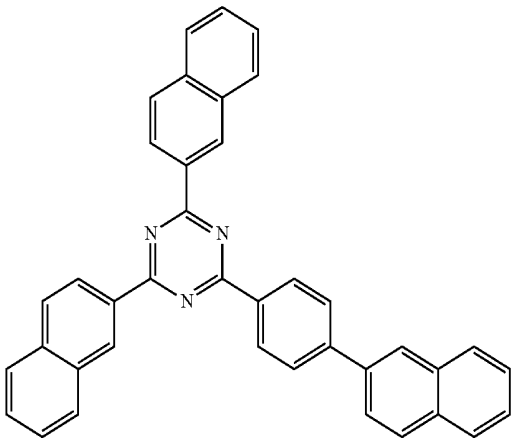
ET14



ET15



ET16



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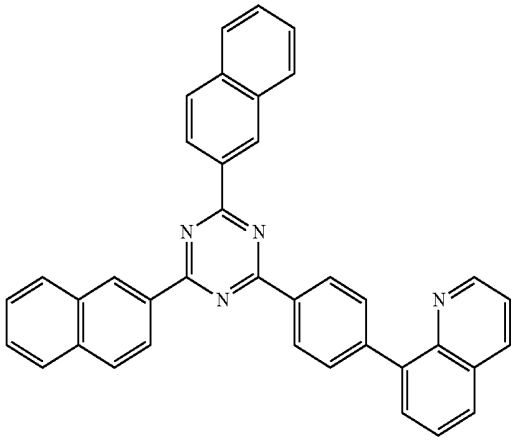
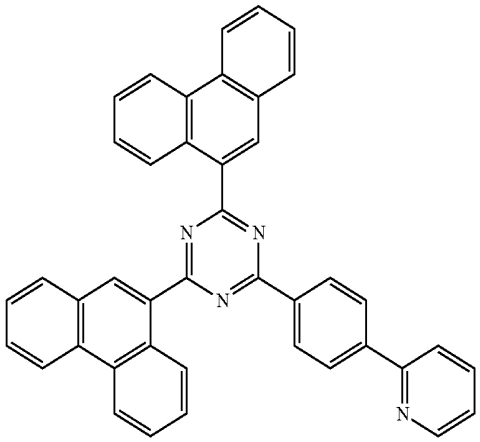
ET17



ET18



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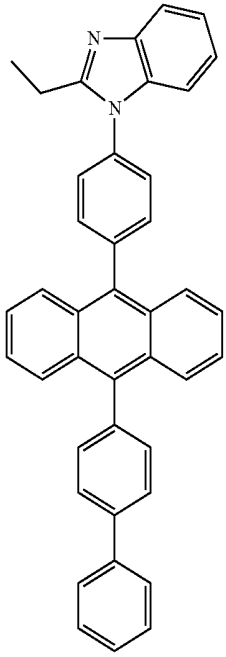

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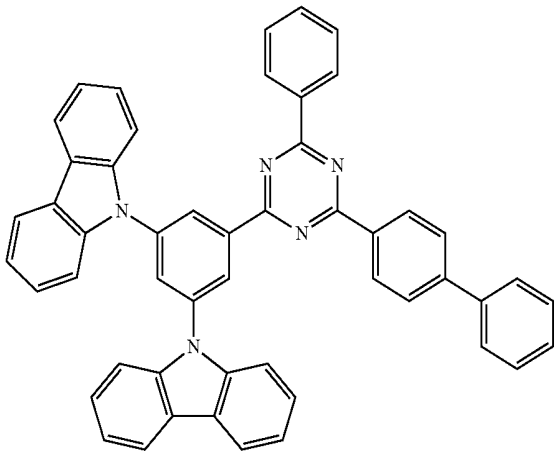
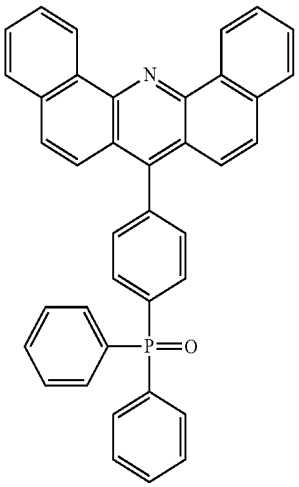
ET20



ET21



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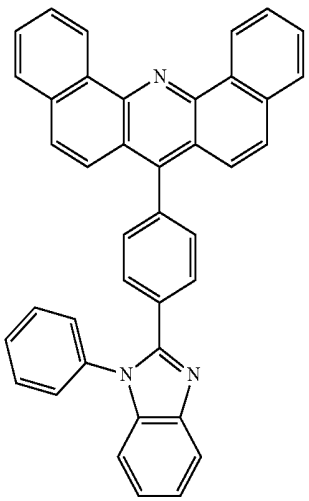

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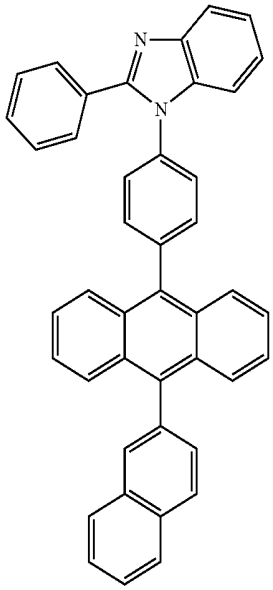
ET23



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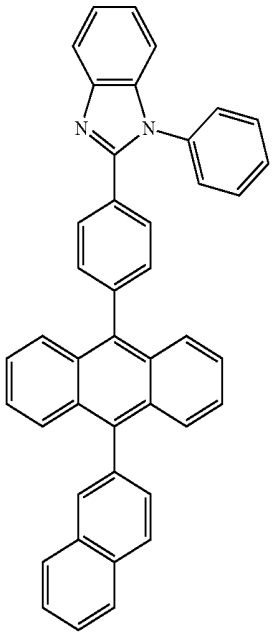
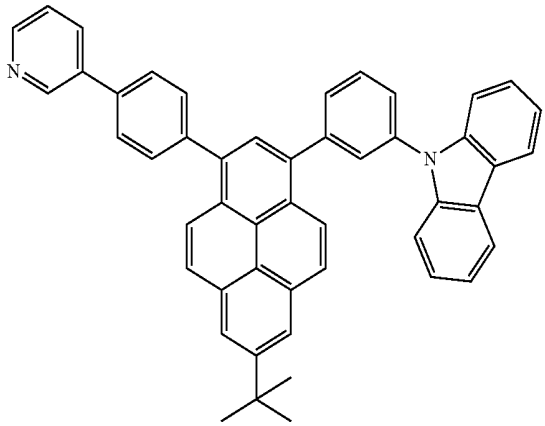


ET25

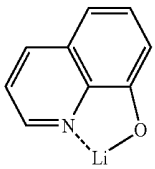


**[0166]** A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, for example, about 150 Å to about 500 Å. While not wishing to be bound by theory, it is understood that when the thickness of the electron transport layer is within the range described above, the electron transport layer may have satisfactory electron transport characteristics without a substantial increase in driving voltage.

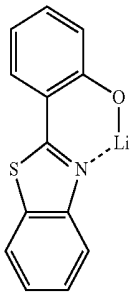
**[0167]** Also, the electron transport layer may further include, in addition to the materials described above, a metal-containing material.

**[0168]** The metal-containing material may include a Li complex. The Li complex may include, for example, Compound ET-D1 (lithium quinolate, LiQ) or ET-D2.

ET-D1




ET-D2




**[0169]** The electron transport region may include an electron injection layer that promotes flow of electrons from the second electrode **19** thereinto.

**[0170]** The electron injection layer may include at least one selected from LiF, NaCl, CsF, $Li_2O$, and BaO.

**[0171]** 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. While not wishing to be bound by theory, it is understood that when the thickness of the electron injection layer is within the range described above, the electron injection layer may have satisfactory electron injection characteristics without a substantial increase in driving voltage.

**[0172]** The second electrode **19** is disposed on the organic layer **15**. The second electrode **19** may be a cathode. A material for forming the second electrode **19** may be selected from metal, an alloy, an electrically conductive compound, and a combination thereof, which have a relatively low work function. For example, lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag) may be used as a material for forming the second electrode **19**. In one or more embodiments, to manufacture a top-emission type light-emitting device, a transmissive electrode formed using ITO or IZO may be used as the second electrode **19**.

**[0173]** Hereinbefore, the organic light-emitting device has been described with reference to the FIGURE, but embodiments of the present disclosure are not limited thereto.

**[0174]** Another aspect of the present disclosure provides a diagnostic composition including at least one organometallic compound represented by Formula 1.

**[0175]** The organometallic compound represented by Formula 1 provides high luminescent efficiency. Accordingly, a diagnostic composition including the organometallic compound may have high diagnostic efficiency.

**[0176]** The diagnostic composition may be used in various applications including a diagnosis kit, a diagnosis reagent, a biosensor, and a biomarker.

**[0177]** The term "$C_1$-$C_{60}$ alkyl group" as used herein refers to a linear or branched saturated aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms, and non-limiting examples thereof include a methyl group, an ethyl group, a propyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an iso-amyl group, and a hexyl group. The term "$C_1$-$C_{60}$ alkylene group" as used herein refers to a divalent group having the same structure as the $C_1$-$C_{60}$ alkyl group.

**[0178]** The term "$C_1$-$C_{60}$ alkoxy group" as used herein refers to a monovalent group represented by —$OA_{101}$ (wherein $A_{101}$ is the $C_1$-$C_{60}$ alkyl group), and non-limiting examples thereof include a methoxy group, an ethoxy group, and an iso-propyloxy group.

**[0179]** The term "$C_2$-$C_{60}$ alkenyl group" as used herein refers to a hydrocarbon group formed by including at least one carbon-carbon double bond in the middle or at the terminus of the $C_2$-$C_{60}$ alkyl group, and examples thereof include an ethenyl group, a propenyl group, and a butenyl group. The term "$C_2$-$C_{60}$ alkenylene group" as used herein refers to a divalent group having the same structure as the $C_2$-$C_{60}$ alkenyl group.

**[0180]** The term "$C_2$-$C_{60}$ alkynyl group" as used herein refers to a hydrocarbon group formed by including at least one carbon-carbon triple bond in the middle or at the terminus of the $C_2$-$C_{60}$ alkyl group, and examples thereof include an ethynyl group, and a propynyl group. The term "$C_2$-$C_{60}$ alkynylene group" as used herein refers to a divalent group having the same structure as the $C_2$-$C_{60}$ alkynyl group.

**[0181]** The term "$C_3$-$C_{10}$ cycloalkyl group" as used herein refers to a monovalent saturated hydrocarbon monocyclic group having 3 to 10 carbon atoms, and non-limiting examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. The term "$C_3$-$C_{10}$ cycloalkylene group" as used herein refers to a divalent group having the same structure as the $C_3$-$C_{10}$ cycloalkyl group.

**[0182]** The term "$C_1$-$C_{10}$ heterocycloalkyl group" as used herein refers to a monovalent saturated monocyclic group having at least one heteroatom selected from N, O, P, Si and S as a ring-forming atom and 1 to 10 carbon atoms, and non-limiting examples thereof include a tetrahydrofuranyl group, and a tetrahydrothiophenyl group. The term "$C_1$-$C_{10}$ heterocycloalkylene group" as used herein refers to a divalent group having the same structure as the $C_1$-$C_{10}$ heterocycloalkyl group.

**[0183]** The term "$C_3$-$C_{10}$ cycloalkenyl group" as used herein refers to a monovalent monocyclic group that has 3 to 10 carbon atoms and at least one carbon-carbon double bond in the ring thereof, and that has no aromaticity, and non-limiting examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group.

The term "$C_3$-$C_{10}$ cycloalkenylene group" as used herein refers to a divalent group having the same structure as the $C_3$-$C_{10}$ cycloalkenyl group.

**[0184]** The term "$C_1$-$C_{10}$ heterocycloalkenyl group" as used herein refers to a monovalent monocyclic group that has at least one heteroatom selected from N, O, P, Si, and S as a ring-forming atom, 1 to 10 carbon atoms, and at least one carbon-carbon double bond in its ring. Examples of the $C_1$-$C_{10}$ heterocycloalkenyl group are a 2,3-dihydrofuranyl group, and a 2,3-dihydrothiophenyl group. The term "$C_1$-$C_{10}$ heterocycloalkenylene group" as used herein refers to a divalent group having the same structure as the $C_1$-$C_{10}$ heterocycloalkenyl group.

**[0185]** The term "$C_6$-$C_{60}$ aryl group" as used herein refers to a monovalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms, and the term "$C_6$-$C_{60}$ arylene group" as used herein refers to a divalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms. Non-limiting examples of the $C_6$-$C_{60}$ aryl group include a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the $C_6$-$C_{60}$ aryl group and the $C_6$-$C_{60}$ arylene group each include two or more rings, the rings may be fused to each other.

**[0186]** The term "$C_1$-$C_{60}$ heteroaryl group" as used herein refers to a monovalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, P, Si, and S as a ring-forming atom, and 1 to 60 carbon atoms. The term "$C_1$-$C_{60}$ heteroarylene group" as used herein refers to a divalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, P, and S as a ring-forming atom, and 1 to 60 carbon atoms. Non-limiting examples of the $C_1$-$C_{60}$ heteroaryl group include a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, and an isoquinolinyl group. When the $C_1$-$C_{60}$ heteroaryl group and the $C_1$-$C_{60}$ heteroarylene group each include two or more rings, the rings may be fused to each other.

**[0187]** The term "$C_6$-$C_{60}$ aryloxy group" as used herein indicates —$OA_{102}$ (wherein $A_{102}$ is the $C_6$-$C_{60}$ aryl group), and a $C_6$-$C_{60}$ arylthio group as used herein indicates —$SA_{103}$ (wherein $A_{103}$ is the $C_6$-$C_{60}$ aryl group).

**[0188]** The term "monovalent non-aromatic condensed polycyclic group" as used herein refers to a monovalent group (for example, having 8 to 60 carbon atoms) having two or more rings condensed to each other, only carbon atoms as ring-forming atoms, and no aromaticity in its entire molecular structure. Examples of the monovalent non-aromatic condensed polycyclic group include a fluorenyl group. The term "divalent non-aromatic condensed polycyclic group," as used herein, refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

**[0189]** The term "monovalent non-aromatic condensed heteropolycyclic group" as used herein refers to a monovalent group (for example, having 2 to 60 carbon atoms) having two or more rings condensed to each other, a heteroatom selected from N, O, P, Si, and S, other than carbon atoms, as a ring-forming atom, and no aromaticity in its entire molecular structure. Non-limiting examples of the monovalent non-aromatic condensed heteropolycyclic group include a carbazolyl group. The term "divalent non-aromatic condensed heteropolycyclic group" as used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

**[0190]** The term "$C_5$-$C_{30}$ carbocyclic group" as used herein refers to a saturated or unsaturated cyclic group having, as a ring-forming atom, 5 to 30 carbon atoms only. The term "$C_5$-$C_{30}$ carbocyclic group" as used herein refers to a monocyclic group or a polycyclic group, and, according to its chemical structure, a monovalent, divalent, trivalent, tetravalent, pentavalent, or hexavalent group.

**[0191]** The term "$C_2$-$C_{30}$ heterocyclic group" as used herein refers to a saturated or unsaturated cyclic group having, as a ring-forming atom, at least one heteroatom selected from N, O, Si, P, and S other than 2 to 30 carbon atoms. The term "$C_2$-$C_{30}$ heterocyclic group" as used herein refers to a monocyclic group or a polycyclic group, and, according to its chemical structure, a monovalent, divalent, trivalent, tetravalent, pentavalent, or hexavalent group.

**[0192]** At least one substituent of the substituted $C_5$-$C_{30}$ carbocyclic group, the substituted $C_2$-$C_{30}$ heterocyclic group, the substituted $C_3$-$C_{10}$ cycloalkylene group, the substituted $C_1$-$C_{10}$ heterocycloalkylene group, the substituted $C_3$-$C_{10}$ cycloalkenylene group, the substituted $C_1$-$C_{10}$ heterocycloalkenylene group, the substituted $C_6$-$C_{60}$ arylene group, the substituted $C_1$-$C_{60}$ heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted $C_1$-$C_{60}$ alkyl group, the substituted $C_2$-$C_{60}$ alkenyl group, the substituted $C_2$-$C_{60}$ alkynyl group, the substituted $C_1$-$C_{60}$ alkoxy group, the substituted $C_3$-$C_{10}$ cycloalkyl group, the substituted $C_1$-$C_{10}$ heterocycloalkyl group, the substituted $C_3$-$C_{10}$ cycloalkenyl group, the substituted $C_1$-$C_{10}$ heterocycloalkenyl group, the substituted $C_6$-$C_{60}$ aryl group, the substituted $C_6$-$C_{60}$ aryloxy group, the substituted $C_6$-$C_{60}$ arylthio group, the substituted $C_1$-$C_{60}$ heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

**[0193]** deuterium, —F, —Cl, —Br, —I, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_1$-$C_{60}$ alkoxy group;

**[0194]** a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_{60}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, —$CD_3$, —$CD_2H$, —$CDH_2$, —$CF_3$, —$CF_2H$, —$CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —$N(Q_{11})(Q_{12})$, —$Si(Q_{13})(Q_{14})(Q_{15})$, —$B(Q_{16})(Q_{17})$, and —$P(=O)(Q_{18})(Q_{19})$;

**[0195]** a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

**[0196]** a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $—N(Q_{21})(Q_{22})$, $—Si(Q_{23})(Q_{24})(Q_{25})$, $—B(Q_{26})(Q_{27})$, and $—P(=O)(Q_{28})(Q_{29})$; and

**[0197]** $—N(Q_{31})(Q_{32})$, $—Si(Q_{33})(Q_{34})(Q_{35})$, $—B(Q_{36})(Q_{37})$, and $—P(=O)(Q_{38})(Q_{39})$, and

**[0198]** $Q_1$ to $Q_9$, $Q_{11}$ to $Q_{19}$, $Q_{21}$ to $Q_{29}$, and $Q_{31}$ to $Q_{39}$ may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro 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 $C_1$-$C_{60}$ alkyl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

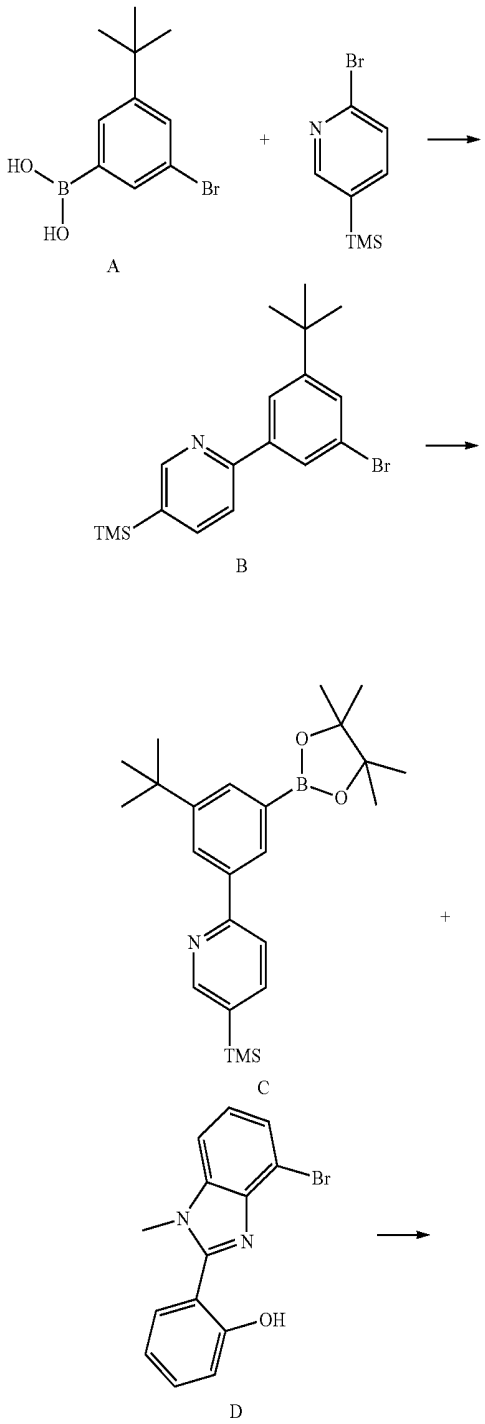
**[0199]** When a group containing a specified number of carbon atoms is substituted with any of the groups listed in the preceding paragraph, the number of carbon atoms in the resulting "substituted" group is defined as the sum of the carbon atoms contained in the original (unsubstituted) group and the carbon atoms (if any) contained in the substituent. For example, when the term "substituted $C_1$-$C_{30}$ alkyl" refers to a $C_1$-$C_{30}$ alkyl group substituted with $C_6$-$C_{30}$ aryl group, the total number of carbon atoms in the resulting aryl substituted alkyl group is $C_7$-$C_{60}$.

**[0200]** Hereinafter, a compound and an organic light-emitting device according to embodiments are described in detail with reference to Synthesis Example and Examples. However, the organic light-emitting device is not limited thereto. The wording "B was used instead of A" used in describing Synthesis Examples means that an amount of A used was identical to an amount of B used, in terms of a molar equivalent.

## EXAMPLES

### Synthesis Example 1: Synthesis of Compound 60

**[0201]**



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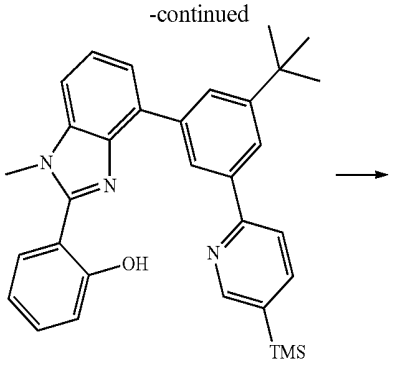
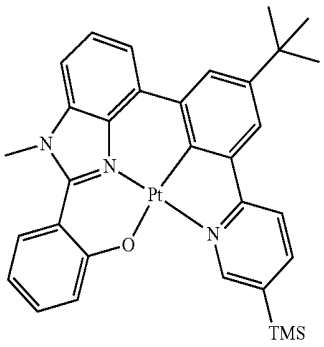


E



Compound 60

Synthesis of Intermediate B (2-(3-bromo-5-(tert-butyl)phenyl)-5-(trimethylsilyl)pyridine)

**[0202]** 3 grams (g) (0.011 millimoles (mmol), 1.2 equivalents, equiv.) of Intermediate A, 2.2 g (0.01 mmol, 1 equiv.) of 2-bromo-5-(trimethylsilyl)pyridine, 0.77 g (0.001 mol, 0.07 equiv.) of tetrakis(triphenylphosphine)palladium(0), and 3.9 g (0.03 mol, 3 equiv.) of potassium carbonate were mixed with 32 milliliters (mL) of 0.8 molar (M) solvent in which tetrahydrofuran (THF) and distilled water ($H_2O$) were mixed at a ratio of 3:1, and the resultant mixture was refluxed for 12 hours. A resultant obtained therefrom was cooled to room temperature. Then, a filtrate obtained by filtering a precipitate was washed by using ethylene acetate (EA) and $H_2O$, and column chromatography (eluent=methylene chloride (MC)/hexane (Hex) 20% to 50%) was performed thereon to obtain 2.6 g (yield: 75%) of Intermediate B. The obtained product was identified by Mass and HPLC analysis.

**[0203]** HRMS (MALDI) calcd for $C_{18}H_{24}BrNSi$: m/z 361.0861, Found: 361.0862.

Synthesis of Intermediate C (2-(3-(tert-butyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-5-(trimethylsilyl)pyridine)

**[0204]** 2.6 g (0.007 mmol, 1.0 equiv.) of Intermediate B, 2.7 g (0.011 mmol, 1.5 equiv.) of bispinacolatodiboron, 1.4 g (0.014 mmol, 2 equiv.) of potassium acetate, and 0.3 g (0.05 equiv.) of $PdCl_2$(dppf) were mixed with 25 mL of 0.8 M toluene and refluxed for 12 hours. The resultant thus obtained was cooled to room temperature. Then, a filtrate obtained by filtering a precipitate was washed by using EA and H2O, and column chromatography (EA/Hex 2% to 5%) was performed thereon to obtain 2.4 g (yield: 80%) of Intermediate C. The obtained product was identified by Mass and HPLC analysis.

**[0205]** HRMS (MALDI) calcd for $C_{24}H36BNO_2Si$: m/z 409.2608, Found: 409.2605.

Synthesis of Intermediate E (2-(4-(3-(tert-butyl)-5-(5-(trimethylsilyl)pyridin-2-yl)phenyl)-1-methyl-1H-benzo[d]imidazol-2-yl)phenol)

**[0206]** 2.4 g (0.006 mmol, 1.2 equiv.) of Intermediate C, 1.5 g (0.005 mol, 1 equiv.) of Intermediate D 2-(4-bromo-1-methyl-1H-benzo[d]imidazol-2-yl)phenol, 0.40 g (0.001 mmol, 0.07 equiv.) of tetrakis(triphenylphosphine)palladium(0), and 2.0 g (0.015 mmol, 3 equiv.) of potassium carbonate were mixed with 20 mL of a solvent in which THF and distilled water ($H_2O$) were mixed at a ratio of 3:1, and the resultant mixture was refluxed for 12 hours. The resultant thus obtained was cooled to room temperature. Then, a filtrate obtained by filtering a precipitate was washed by using EA and H2O, and column chromatography (EA/Hex 20% to 35%) was performed thereon to obtain 1.7 g (yield: 68%) of Intermediate E. The obtained product was identified by Mass and HPLC analysis.

**[0207]** HRMS (MALDI) calcd for $C_{32}H_{35}N_3OSi$: m/z 505.2549, Found: 505.2548.

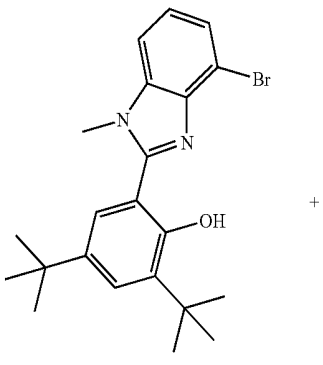
Synthesis of Compound 60

**[0208]** 1.7 g (3.36 mmol) of Intermediate E and 1.58 g (3.36 mmol, 1.0 equiv.) of $K_2PtCl_4$ were mixed with 35 mL of a solvent in which 30 mL of AcOH and 5 mL of $H_2O$ were mixed, and the resultant mixture was refluxed for 16 hours. The resultant thus obtained was cooled to room temperature. Then, a precipitate was filtered, mixed again with MC, and washed by using H2O, and column chromatography (MC 40%, EA 1%, Hex 59%) was performed thereon to obtain 1.9 g (yield: 81%) of Compound 60. The obtained product was identified by Mass and HPLC analysis.

**[0209]** HRMS (MALDI) calcd for $C_{32}H33N_3OPtSi$: m/z 698.2041, Found: 698.2039.

Synthesis Example 2: Synthesis of Compound 140

**[0210]**



F

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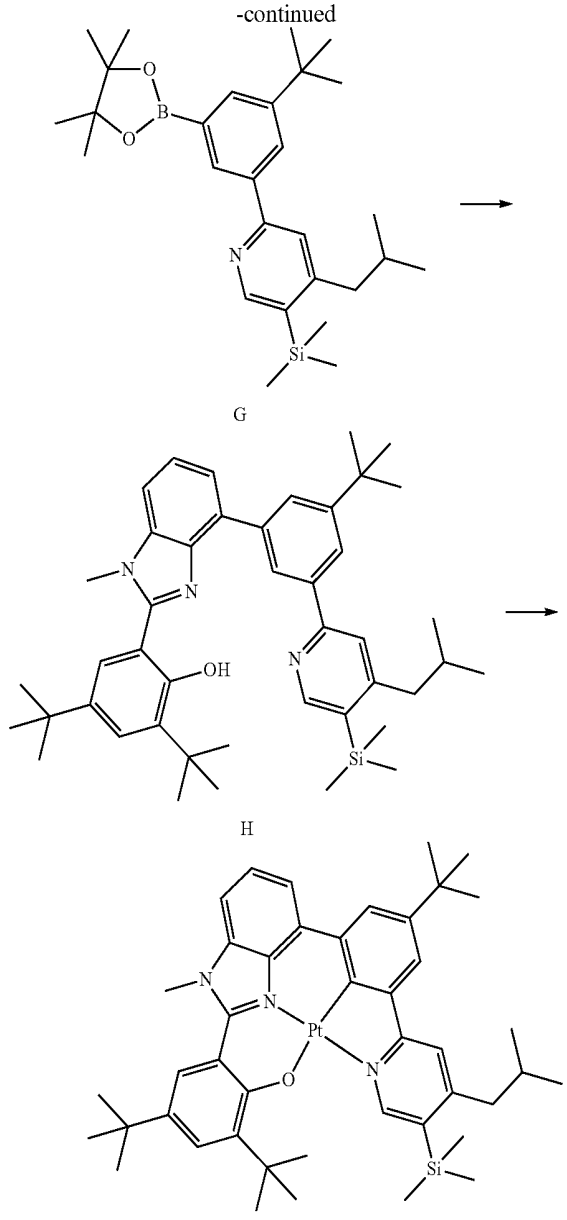



Synthesis of Intermediate F

**[0211]** Intermediate H was synthesized in the same manner as used to synthesize Intermediate E in Synthesis Example 1, except that 1.8 g (0.006 mmol) of Intermediate F (2-(4-bromo-1-methyl-1H-benzo[d]imidazol-2-yl)-4,6-di-tert-butylphenol) was used instead of Intermediate D, and 2.9 g (0.007 mmol) of Intermediate G was used instead of Intermediate C.

**[0212]** HRMS (MALDI) calcd for $C_{44}H_{59}N_3OSi$: m/z 673.4427, Found: 673.4423.

Synthesis of Compound 140

**[0213]** Compound 140 was synthesized in the same manner as used to synthesize Compound 60 in Synthesis Example 1, except that 2.1 g (3.12 mmol) of Intermediate H was used instead of Intermediate E.

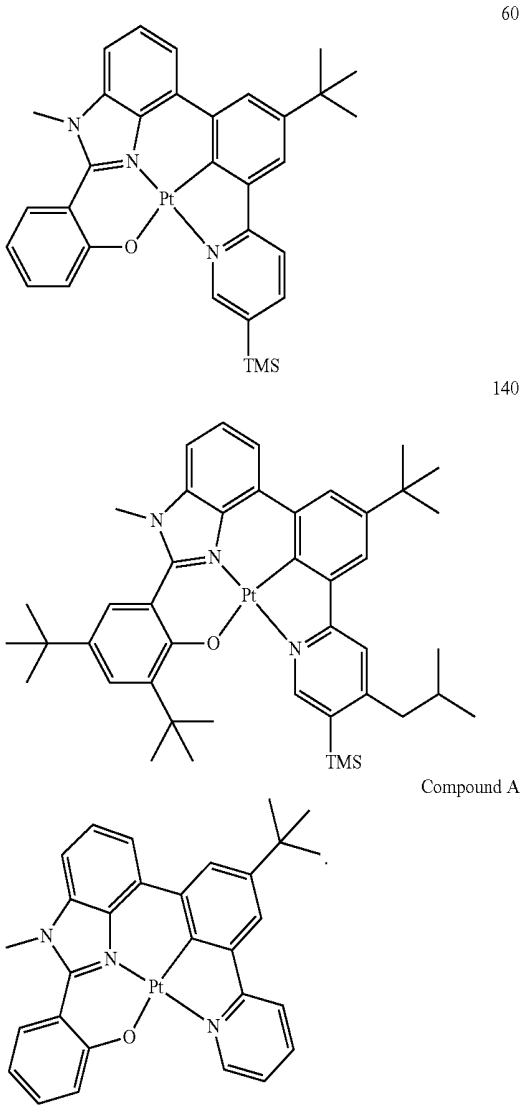
**[0214]** HRMS (MALDI) calcd for $C_{44}H57N_3OPtSi$: m/z 866.3919, Found: 866.3921.

Evaluation Example 1: Measurement of Decay Time

**[0215]** A quartz substrate washed by using chloroform and distilled water was prepared, and films 1, 2, and A, each having a thickness of 50 nanometers (nm), were prepared by vacuum-depositing (co-depositing) certain materials shown in Table 2 below at a degree of vacuum of $10^{-7}$ torr.

TABLE 2

| Film name | Compound used to manufacture film |
|---|---|
| Film 1 | CBP: Compound 60 (weight ratio of 9:1) |
| Film 2 | CBP: Compound 140 (weight ratio of 9:1) |
| Film A | CBP: Compound A (weight ratio of 9:1) |




**[0216]** Then, PL spectra of the films 1, 2, and A prepared as described above were evaluated at room temperature by using a time-resolved photoluminescence (TRPL) measure-

ment system FluoTime 300 (manufactured by PicoQuant) and a pumping source PLS340 (excitation wavelength=340 nm, spectral width=20 nm) (manufactured by PicoQuant), wavelengths of main peaks of the PL spectra were determined, and the number of photons emitted from each film at the main peak by a photon pulse (pulse width=500 picoseconds, ps) applied to each film by PLS340 was measured over time based on Time-Correlated Single Photon Counting (TCSPC). By repeating the above processes, a sufficiently fittable TRPL curve was obtained. Then, a decay time $T_{decay}$(Ex) of each of the films 1, 2, and A was obtained by fitting two or more exponential decay functions to a result obtained from the TPRL curve. Results thereof are shown in Table 3. A function represented by Equation 1 was used for the fitting, and a greatest value among $T_{decay}$ values obtained from the exponential decay functions used for the fitting was taken as $T_{decay}$(Ex). At this time, the same measurement was performed once more for the time as that for calculating the TRPL curve in a dark state (a state in which the pumping signal input to the certain film was blocked) to obtain a baseline or background signal curve. The baseline or background curve was used as a baseline for fitting.
□=□=1□□□□□□-□/□□□□□□, □

TABLE 3

| Film name | Decay time (μs) |
|---|---|
| Film 1 | 6.6 |
| Film 2 | 6.2 |
| Film A | 7.1 |

**[0217]** Referring to Table 3, it is confirmed that Compounds 60 and 140 have a short decay time, as compared with Compound A.

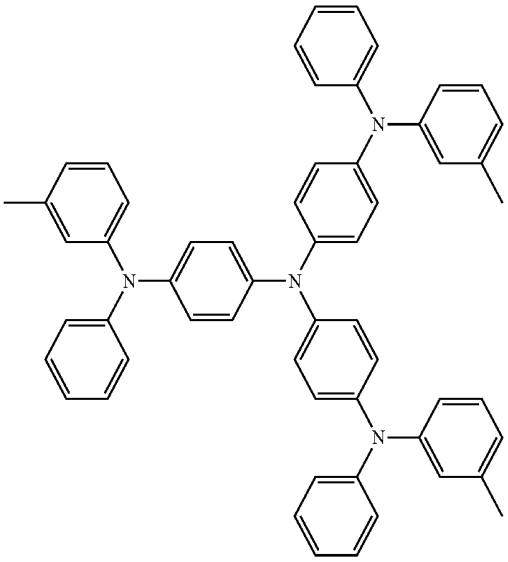
Example 1

**[0218]** An ITO glass was cut to a size of 50 mm×50 mm×0.5 mm (mm=millimeter), sonicated with acetone, isopropyl alcohol, and pure water, each for 15 minutes, and then cleaned by exposure to ultraviolet rays and ozone for 30 minutes.

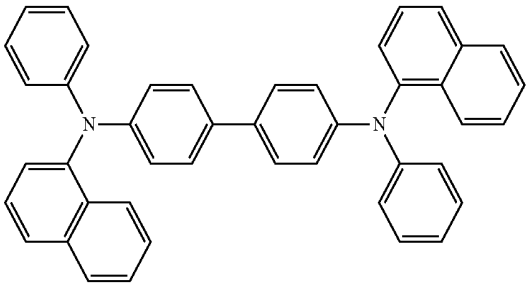
**[0219]** Then, m-MTDATA was deposited on an ITO electrode (anode) of the ITO glass substrate at a deposition rate of 1 Angstroms per second (Å/sec) to form a hole injection layer having a thickness of 600 Angstroms (Å), and α-NPD (NPB) was deposited on the hole injection layer at a deposition rate of 1 Å/sec to form a hole transport layer having a thickness of 250 Å.

**[0220]** Compound 60 (dopant) and CBP (host) were respectively co-deposited on the hole transport layer at deposition rates of 0.1 Å/sec and 1 Å/sec to form an emission layer having a thickness of 400 Å.

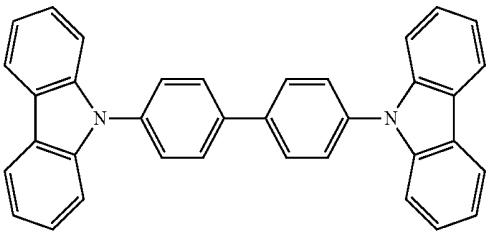
**[0221]** BAlq was deposited on the emission layer at a deposition rate of 1 Å/sec to form a hole blocking layer having a thickness of 50 Å, $Alq_3$ was deposited on the hole blocking layer to form an electron transport layer having a thickness of 300 Å, LiF was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vacuum-deposited on the electron injection layer to form a second electrode (cathode) having a thickness of 1,200 Å, thereby completing the manufacture of an organic light-emitting device having a structure of ITO/m-MTDATA (600 Å)/α-NPD (250 Å)/CBP+Compound 60 (10%) (400 Å)/BAlq (50 Å)/$Alq_3$ (300 Å)/LiF (10 Å)/Al (1,200 Å).



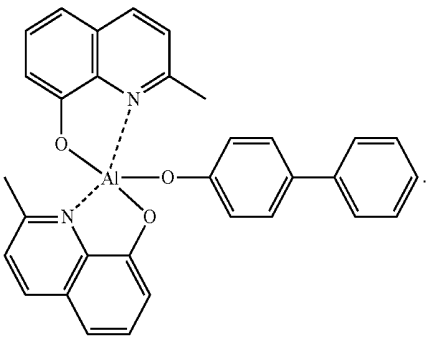
m-MTDATA



NPB



NPB



BAlq

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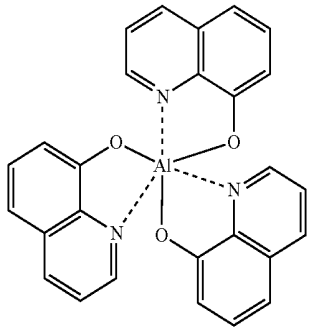

$Alq_3$

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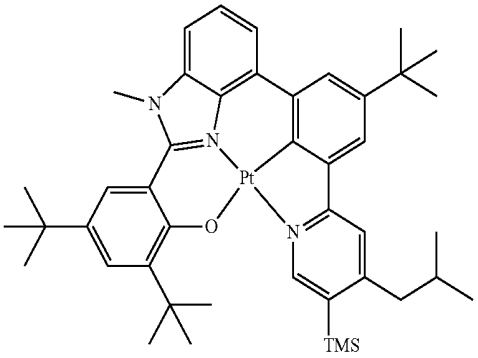
140



TMS

Example 2 and Comparative Example A

**[0222]** Organic light-emitting devices were manufactured in the same manner as in Example 1, except that Compounds shown in Table 4 were each used instead of Compound 60 as a dopant in forming an emission layer.

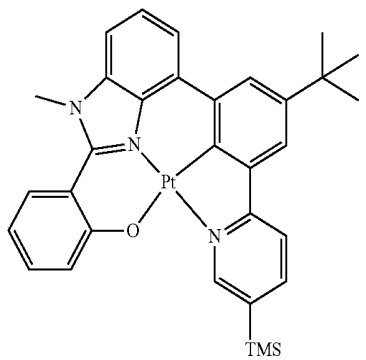
Evaluation Example 2: Evaluation of Characteristics of Organic Light-Emitting Devices

**[0223]** The luminescent efficiency and full width at half maximum (FWHM) of the organic light-emitting devices manufactured according to Examples 1 and 2 and Comparative Example A were evaluated by using a current-voltage meter (Keithley 2400) and a luminance meter (Minolta Cs-1000A). Evaluation results thereof are shown in Table 4.

TABLE 4

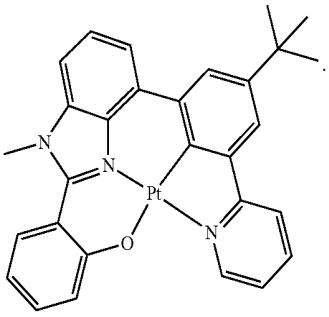
| | Dopant | Luminescent efficiency (cd/A) | FWHM (nm) |
|---|---|---|---|
| Example 1 | Compound 60 | 52.4 | 81.01 |
| Example 2 | Compound 140 | 55.5 | 75.37 |
| Comparative Example A | Compound A | 49.2 | 121.7 |

60



TMS

Compound A



**[0224]** Referring to Table 4, it has been determined that the organic light-emitting devices of Examples 1 and 2 have excellent luminescent efficiency and a small FWHM, as compared with the organic light-emitting device of Comparative Example A.

**[0225]** Since the organometallic compounds have excellent electrical characteristics and/or decay time, organic light-emitting devices including such organometallic compounds may have excellent luminescent efficiency and a small FWHM. Also, due to excellent phosphorescent luminescent characteristics, such organometallic compounds may provide a diagnostic composition having high diagnostic efficiency.

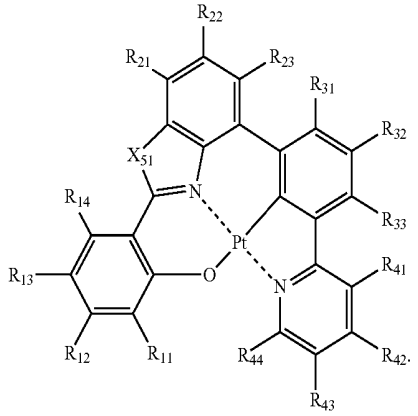
**[0226]** It should be understood that embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

**[0227]** While one or more embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present description as defined by the following claims.

What is claimed is:

**1**. An organometallic compound represented by Formula 1:

Formula 1



wherein, in Formula 1,

$X_{51}$ is selected from O, S, and $N(R_{51})$,

$R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, $—SF_5$, a hydroxyl group, a cyano group, a nitro 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, $—N(Q_1)(Q_2)$, $—Si(Q_3)(Q_4)(Q_5)$, $—B(Q_6)(Q_7)$, and $—P(=O)(Q_8)(Q_9)$,

when $X_{51}$ is O or S, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ is $—Si(Q_3)(Q_4)(Q_5)$,

when $X_{51}$ is $N(R_{51})$, at least one of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ is $—Si(Q_3)(Q_4)(Q_5)$,

at least one substituent of the substituted $C_1$-$C_{60}$ alkyl group, the substituted $C_2$-$C_{60}$ alkenyl group, the substituted $C_2$-$C_{60}$ alkynyl group, and the substituted $C_1$-$C_{60}$ alkoxy group is selected from:

deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_1$-$C_{60}$ alkoxy group;

a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, and a $C_{60}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $—N(Q_{11})(Q_{12})$, $—Si(Q_{13})(Q_{14})(Q_{15})$, $—B(Q_{16})(Q_{17})$, and $—P(=O)(Q_{18})(Q_{19})$;

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

a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a $C_1$-$C_{60}$ alkyl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $—N(Q_{21})(Q_{22})$, $—Si(Q_{23})(Q_{24})(Q_{25})$, $—B(Q_{26})(Q_{27})$, and $—P(=O)(Q_{28})(Q_{29})$; and

$—N(Q_{31})(Q_{32})$, $—Si(Q_{33})(Q_{34})(Q_{35})$, $—B(Q_{36})(Q_{37})$, and $—P(=O)(Q_{38})(Q_{39})$, and

$Q_1$ to $Q_9$, $Q_{11}$ to $Q_{19}$, $Q_{21}$ to $Q_{29}$, and $Q_{31}$ to $Q_{39}$ are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro 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 $C_1$-$C_{60}$ alkyl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_2$-$C_{60}$ alkenyl group, a $C_2$-$C_{60}$ alkynyl group, a $C_1$-$C_{60}$ alkoxy group, a $C_3$-$C_{10}$ cycloalkyl group, a $C_1$-$C_{10}$ heterocycloalkyl group, a $C_3$-$C_{10}$ cycloalkenyl group, a $C_1$-$C_{10}$ heterocycloalkenyl group, a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryl group substituted with at least one selected from deuterium, a $C_1$-$C_{60}$ alkyl group, and a $C_6$-$C_{60}$ aryl group, a $C_6$-$C_{60}$ aryloxy group, a $C_6$-$C_{60}$ arylthio group, a $C_1$-$C_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

**2**. The organometallic compound of claim **1**, wherein

$X_{51}$ is $N(R_{51})$.

3. The organometallic compound of claim 1, wherein

$R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ are each independently selected from:

hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, $—SF_5$, a $C_1$-$C_{20}$ alkyl group, and a $C_1$-$C_{20}$ alkoxy group;

a $C_1$-$C_{20}$ alkyl group and a $C_1$-$C_{20}$ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, 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 $C_1$-$C_{10}$ alkyl group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a pyridinyl group, and a pyrimidinyl group; and

$—N(Q_1)(Q_2)$, $—Si(Q_3)(Q_4)(Q_5)$, $—B(Q_6)(Q_7)$, and $—P(=O)(Q_8)(Q_9)$, and

$Q_1$ to $Q_9$ are each independently selected from:

$—CH_3$, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CH_2CH_3$, $—CH_2CD_3$, $—CH_2CD_2H$, $—CH_2CDH_2$, $—CHDCH_3$, $—CHDCD_2H$, $—CHDCDH_2$, $—CHDCD_3$, $—CD_2CD_3$, $—CD_2CD_2H$, and $—CD_2CDH_2$;

an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a $C_1$-$C_{10}$ alkyl group, and a phenyl group.

4. The organometallic compound of claim 1, wherein

$R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ are each independently selected from:

hydrogen, deuterium, —F, a cyano group, a nitro group, $—SF_5$, a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, and a pentoxy group;

a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, and a pentoxy group, each substituted with at least one selected from deuterium, —F, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, a cyano group, a nitro group, a $C_1$-$C_{10}$ alkyl group, a $C_1$-$C_{10}$ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group; and

$—Si(Q_3)(Q_4)(Q_5)$, and

$Q_3$ to $Q_5$ are each independently selected from:

$—CH_3$, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CH_2CH_3$, $—CH_2CD_3$, $—CH_2CD_2H$, $—CH_2CDH_2$, $—CHDCH_3$, $—CHDCD_2H$, $—CHDCDH_2$, $—CHDCD_3$, $—CD_2CD_3$, $—CD_2CD_2H$, and $—CD_2CDH_2$;

an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group; and

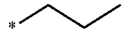
an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group, each substituted with at least one selected from deuterium and a $C_1$-$C_{10}$ alkyl group.

5. The organometallic compound of claim 1, wherein

$R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, $R_{41}$ to $R_{44}$, and $R_{51}$ are each independently selected from hydrogen, deuterium, —F, a cyano group, a nitro group, $—SF_5$, $—CH_3$, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CF_3$, $—CF_2H$, $—CFH_2$, groups represented by Formulae 9-1 to 9-19, and $—Si(Q_3)(Q_4)(Q_5)$, and

$Q_3$ to $Q_5$ are each independently selected from $—CH_3$, $—CD_3$, $—CD_2H$, $—CDH_2$, $—CH_2CH_3$, $—CH_2CD_3$, $—CH_2CD_2H$, $—CH_2CDH_2$, $—CHDCH_3$, $—CHDCD_2H$, $—CHDCDH_2$, $—CHDCD_3$, $—CD_2CD_3$, $—CD_2CD_2H$, $—CD_2CDH_2$, an n-propyl group, an iso-propyl group, an n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, and a tert-pentyl group:

Formula 9-1



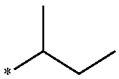
Formula 9-2

Formula 9-3

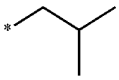
-continued

Formula 9-4

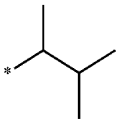
Formula 9-5



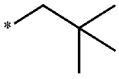
Formula 9-6



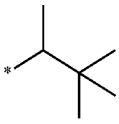
Formula 9-7



Formula 9-8



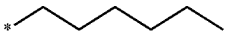
Formula 9-9



Formula 9-10

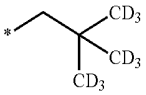
Formula 9-11

Formula 9-12

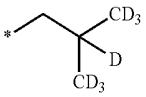


Formula 9-13

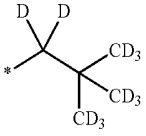
Formula 9-14



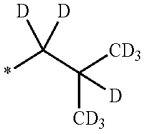
Formula 9-15



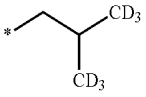
Formula 9-16



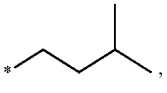
Formula 9-17



Formula 9-18



Formula 9-19



wherein * in Formulae 9-1 to 9-19 indicates a binding site to a neighboring atom.

**6**. The organometallic compound of claim **1**, wherein

$Q_3$ to $Q_5$ in —$Si(Q_3)(Q_4)(Q_5)$ are identical to one another.

**7**. The organometallic compound of claim **1**, wherein

one or two of $R_{11}$ to $R_{14}$, $R_{21}$ to $R_{23}$, $R_{31}$ to $R_{33}$, and $R_{41}$ to $R_{44}$ are —$Si(Q_3)(Q_4)(Q_5)$.

**8**. The organometallic compound of claim **1**, wherein

at least one of $R_{21}$ to $R_{23}$ is —$Si(Q_3)(Q_4)(Q_5)$;

at least one of $R_{41}$ to $R_{44}$ is —$Si(Q_3)(Q_4)(Q_5)$; or

at least one of $R_{21}$ to $R_{23}$ is —$Si(Q_3)(Q_4)(Q_5)$, and at least one of $R_{41}$ to $R_{44}$ is —$Si(Q_3)(Q_4)(Q_5)$.

**9**. The organometallic compound of claim **1**, wherein

one or two of $R_{22}$, $R_{42}$, and $R_{43}$ are —$Si(Q_3)(Q_4)(Q_5)$.

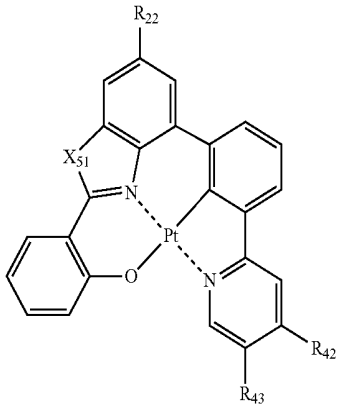
**10**. The organometallic compound of claim **1**, wherein

at least one of $R_{11}$ to $R_{13}$, $R_{22}$, $R_{32}$, $R_{42}$, and $R_{43}$ is not hydrogen.

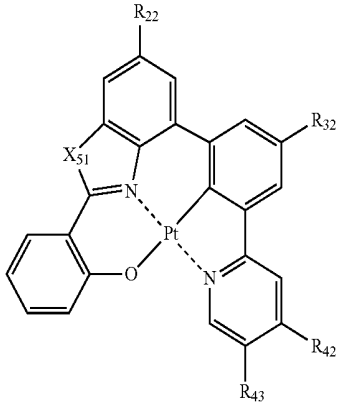
**11**. The organometallic compound of claim **1**, wherein

the organometallic compound is represented by one of Formulae 1-1 to 1-8:

Formula 1-1




Formula 1-2



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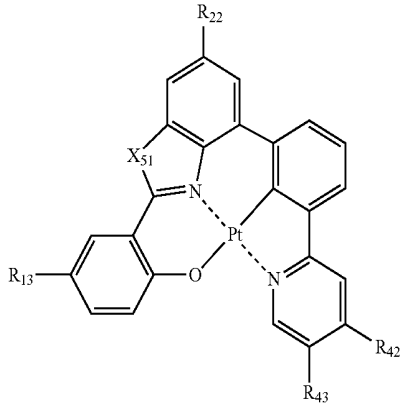
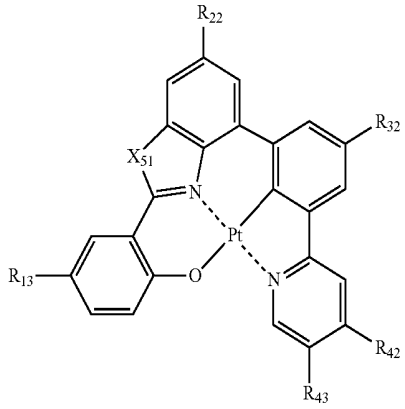
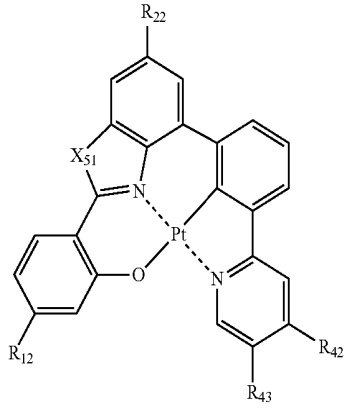
Formula 1-3



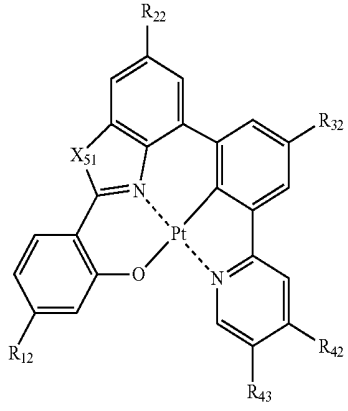
Formula 1-4



Formula 1-5



Formula 1-6



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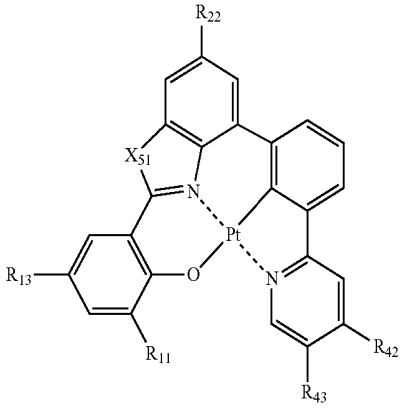
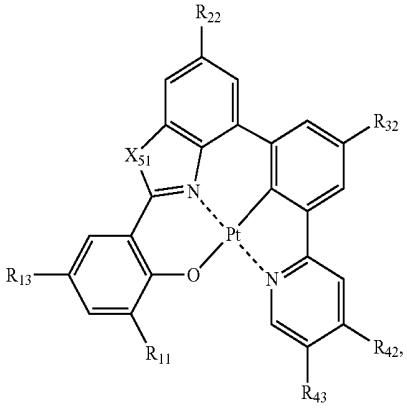
Formula 1-7



Formula 1-8



wherein, in Formulae 1-1 to 1-8,

$R_{11}$ to $R_{13}$, $R_{22}$, $R_{32}$, $R_{42}$, and $R_{43}$ are the same as described in claim **1**, provided that $R_{11}$ to $R_{13}$ and $R_{32}$ are not hydrogen, and

at least one of $R_{22}$, $R_{42}$, and $R_{43}$ is —$Si(Q_3)(Q_4)(Q_5)$.

**12**. The organometallic compound of claim **11**, wherein

$R_{22}$ is —$Si(Q_3)(Q_4)(Q_5)$,

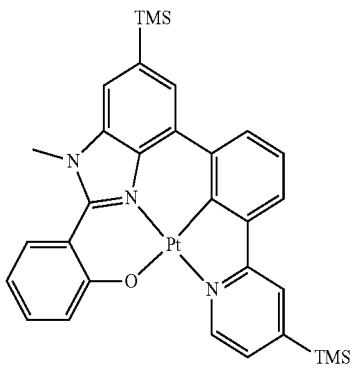
one of $R_{42}$ and $R_{43}$ is —$Si(Q_3)(Q_4)(Q_5)$; or

$R_{22}$ is —$Si(Q_3)(Q_4)(Q_5)$, and one of $R_{42}$ and $R_{43}$ is —$Si(Q_3)(Q_4)(Q_5)$.

**13**. The organometallic compound of claim **1**, wherein

the organometallic compound is one of Compounds 1 to 256:

1



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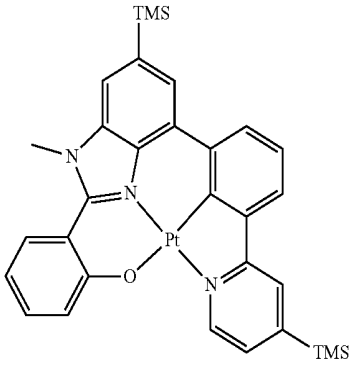


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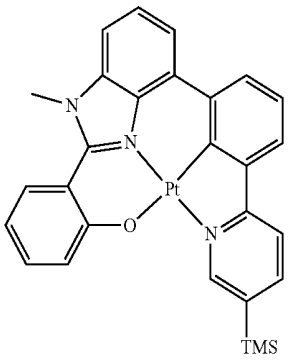


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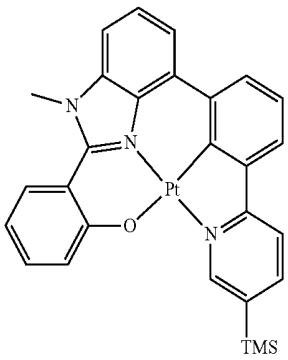


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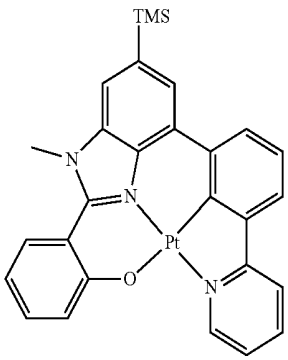


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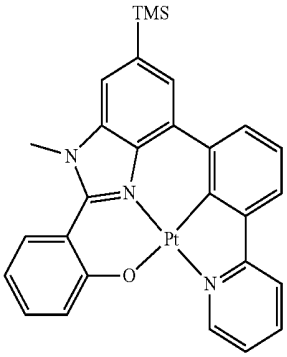


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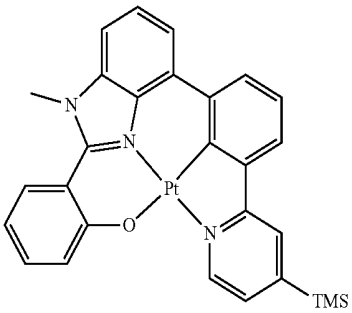


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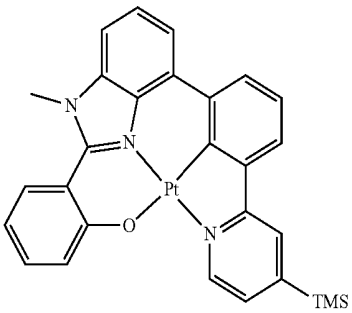


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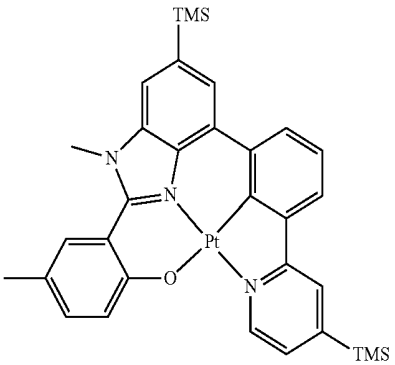

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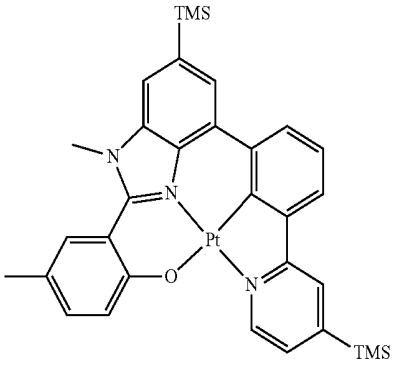


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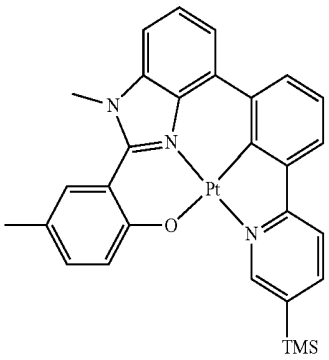


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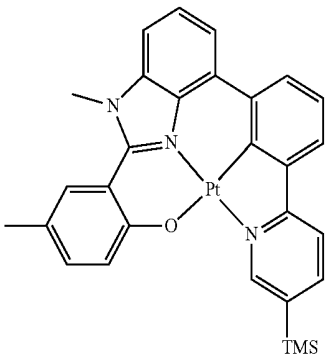


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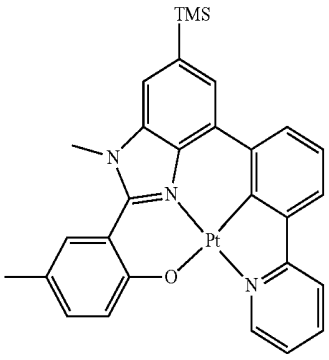


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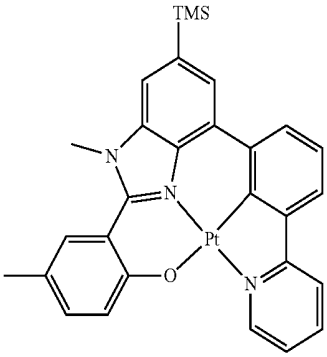


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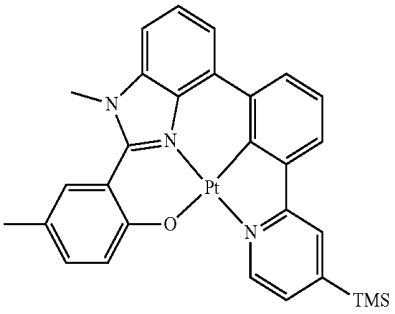


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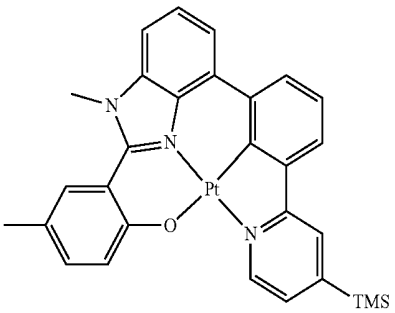


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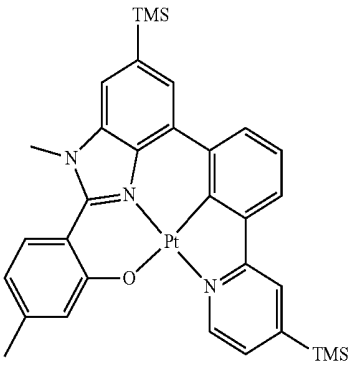

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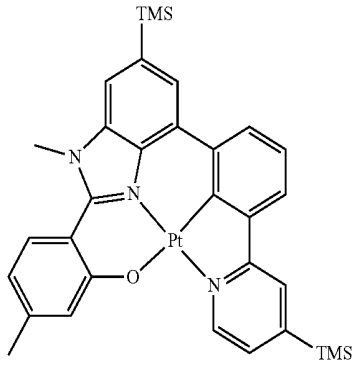


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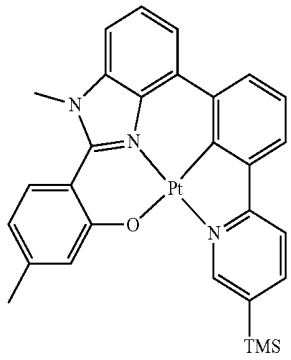


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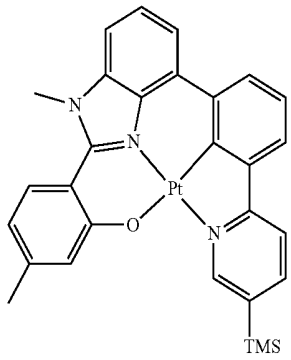


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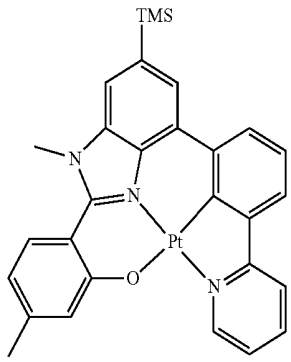


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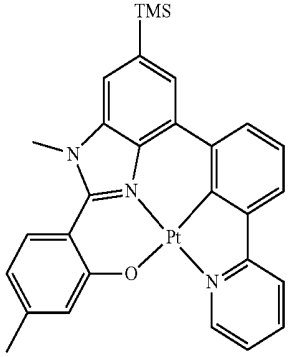


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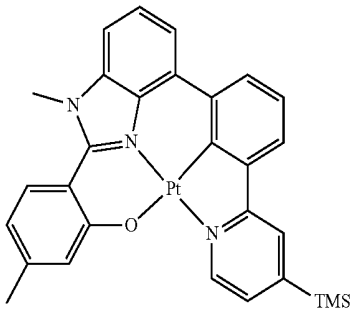


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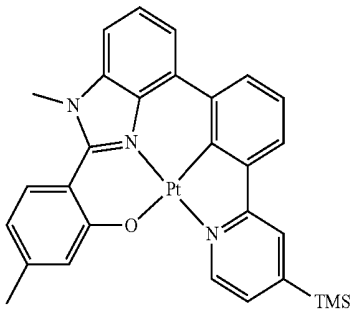


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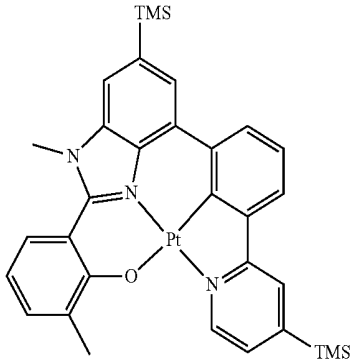

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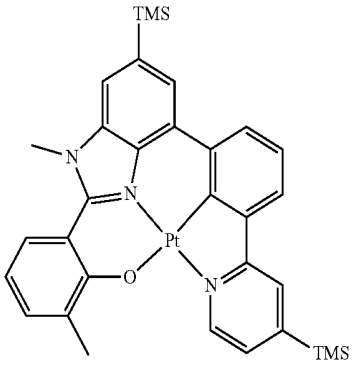


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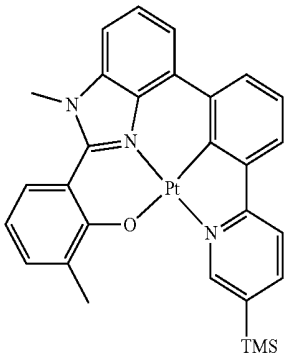


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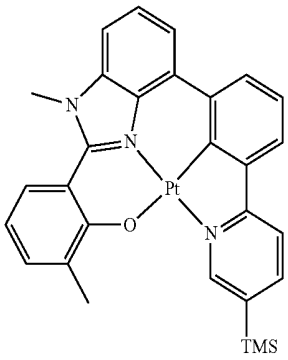


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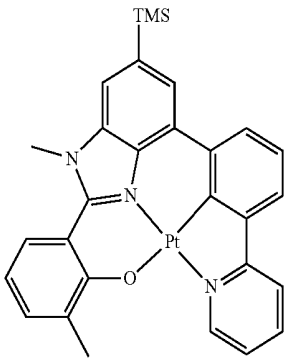


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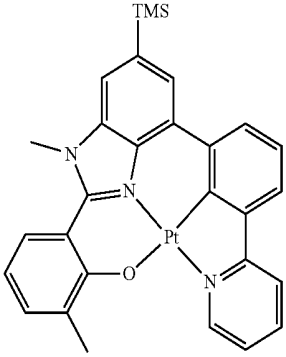


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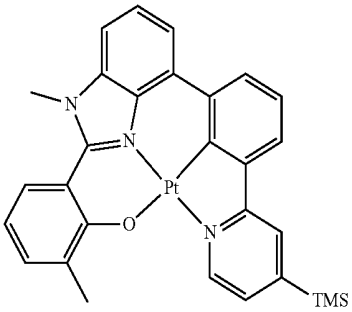


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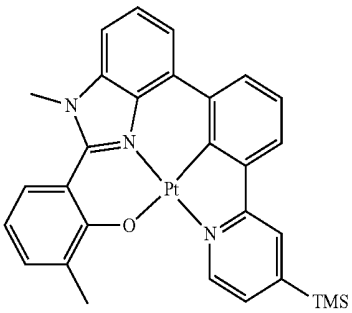


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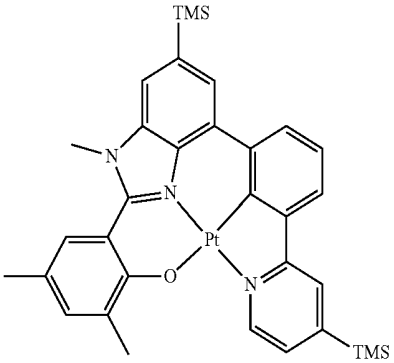

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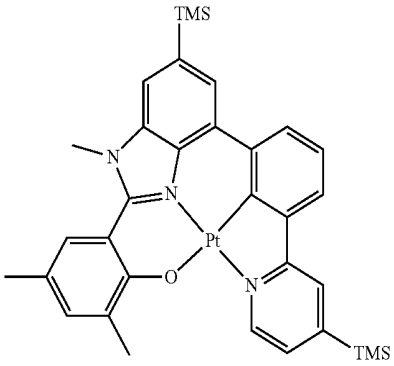


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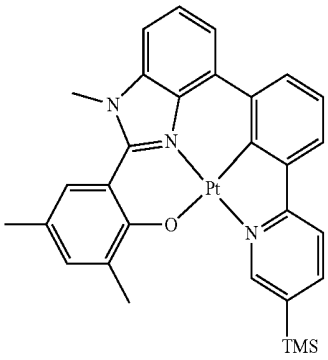


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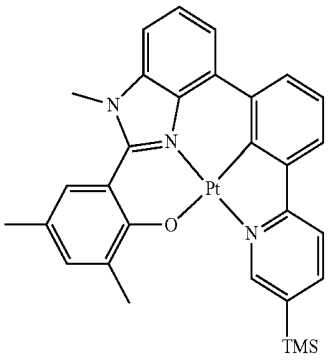


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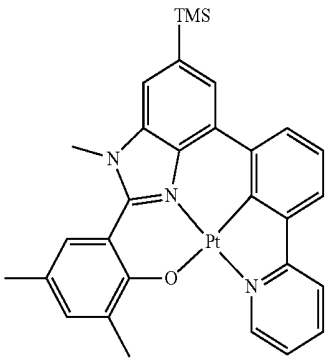


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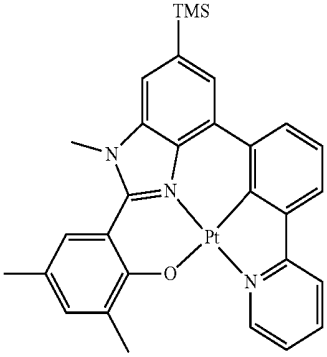


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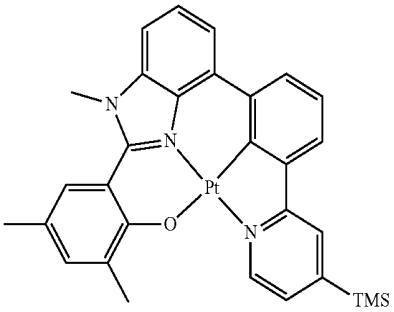


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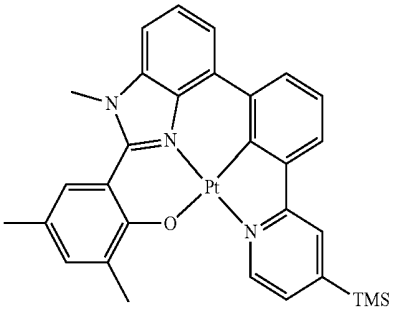


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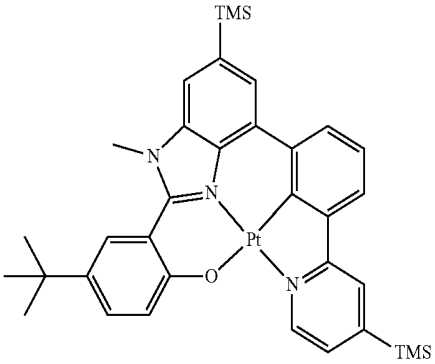

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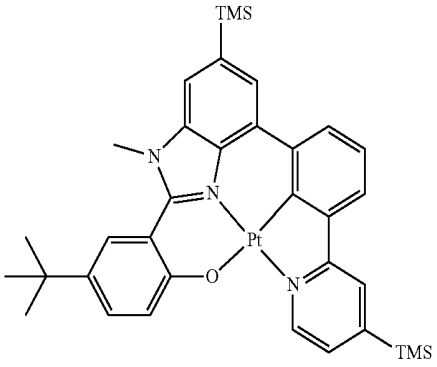


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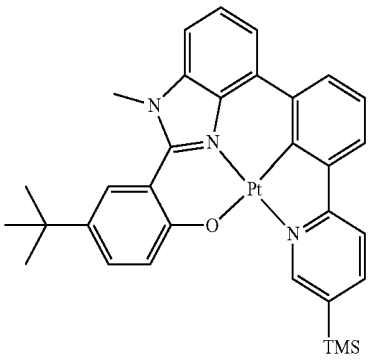


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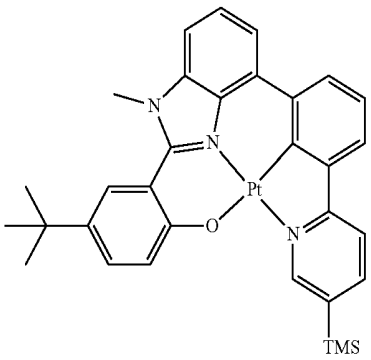


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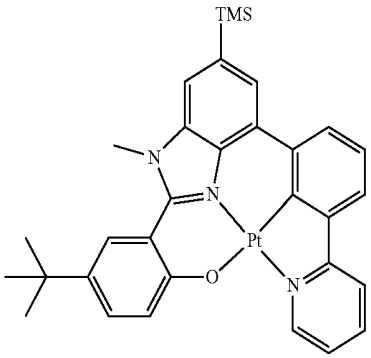


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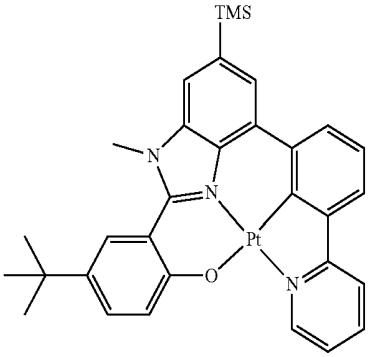


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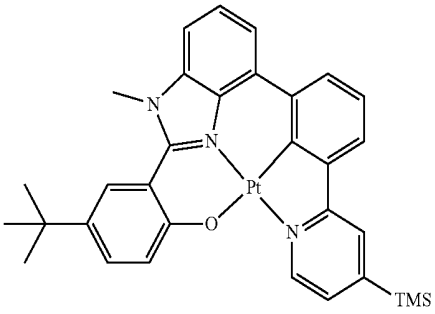


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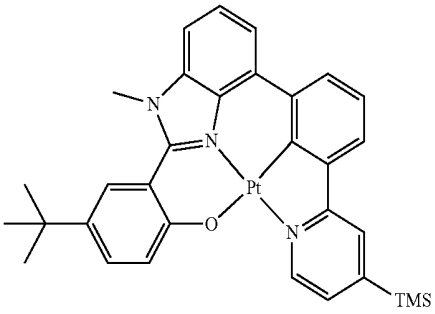


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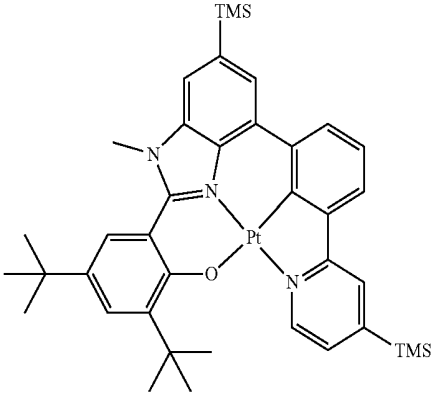

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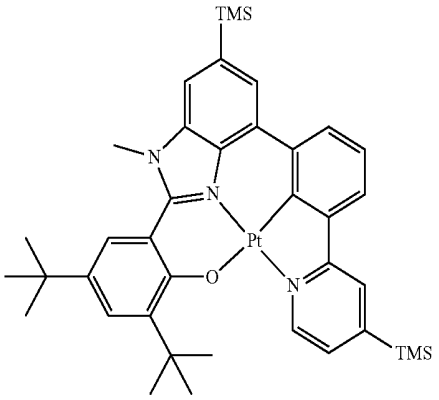


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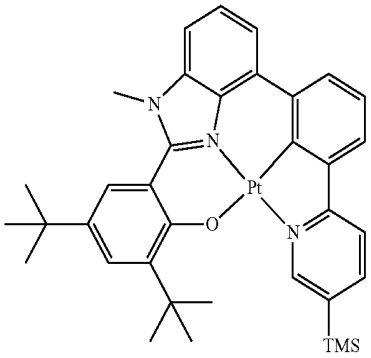


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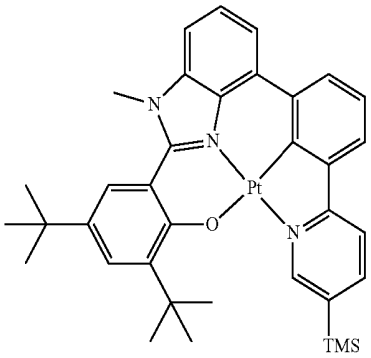


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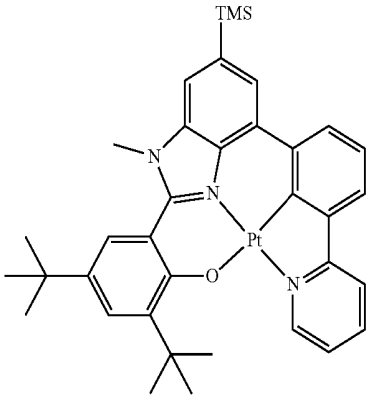


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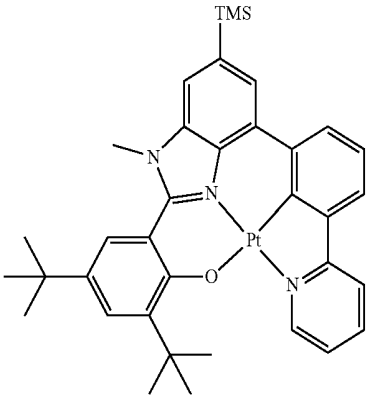


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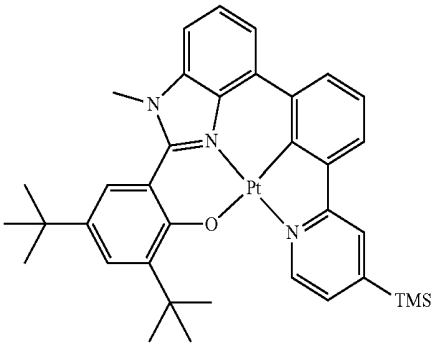


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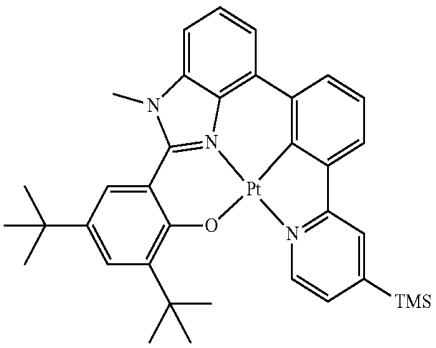


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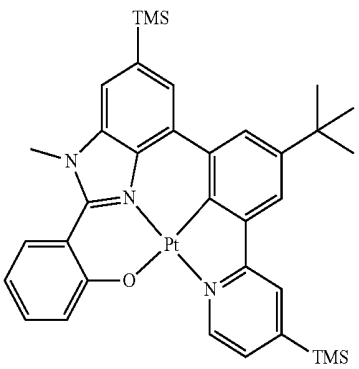

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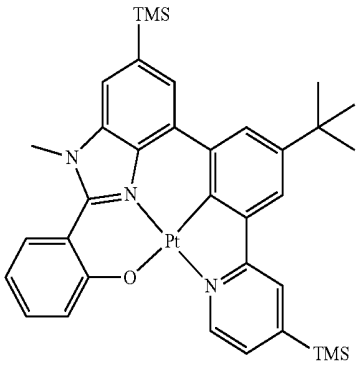


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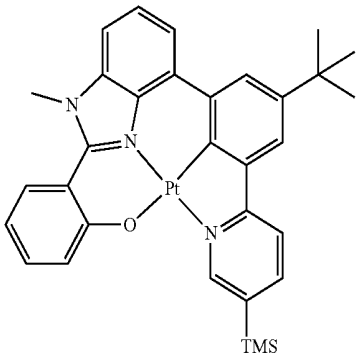


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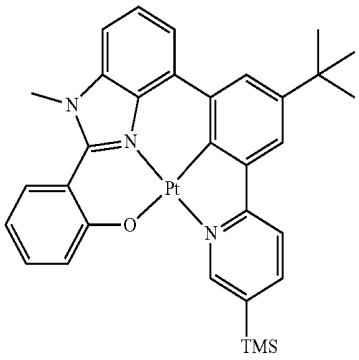


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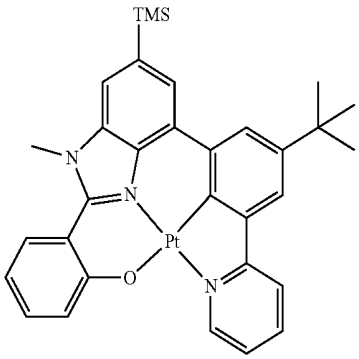


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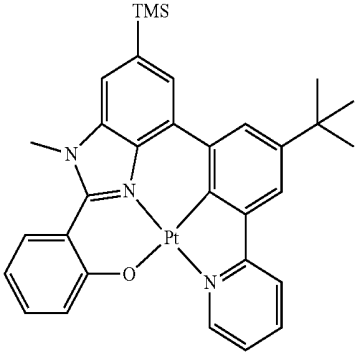


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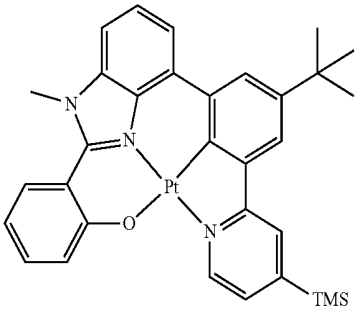


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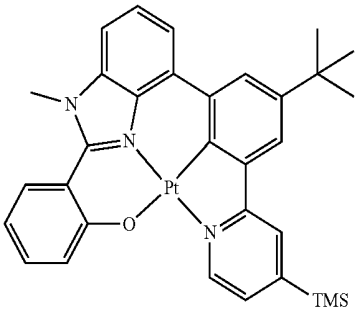


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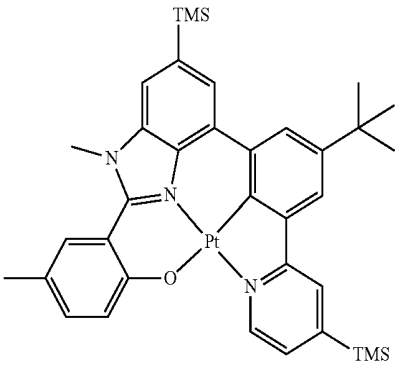

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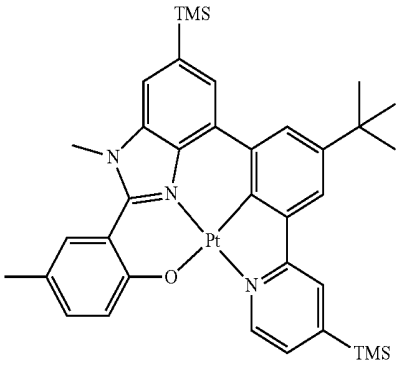


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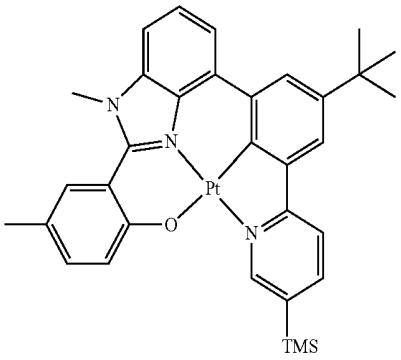


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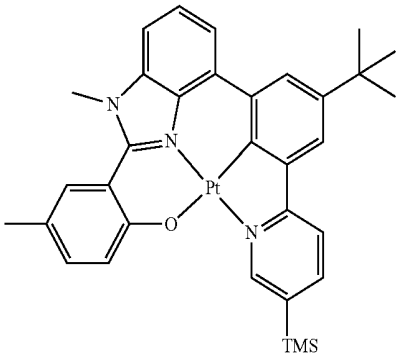


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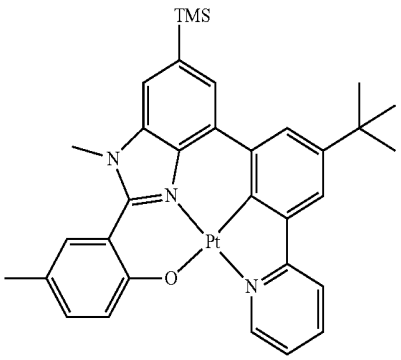


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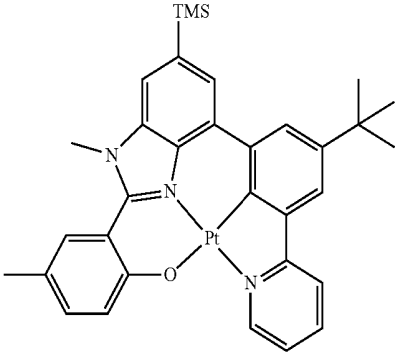


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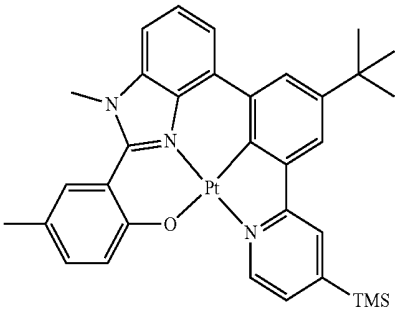


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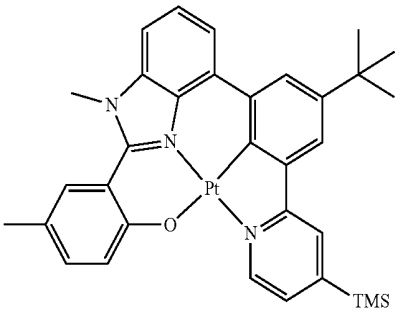


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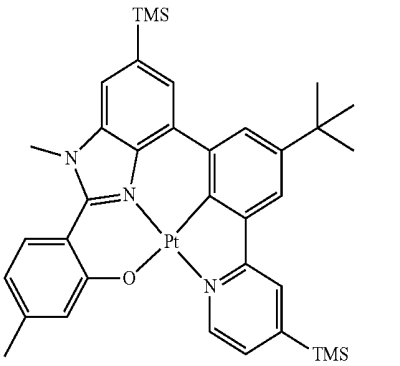

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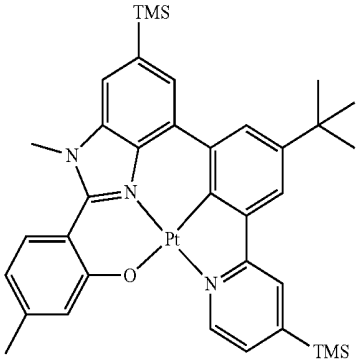


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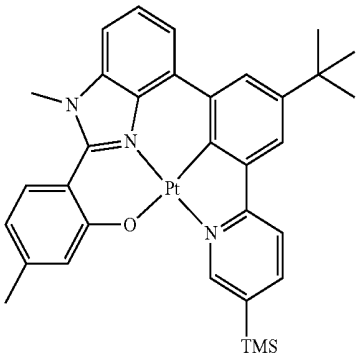


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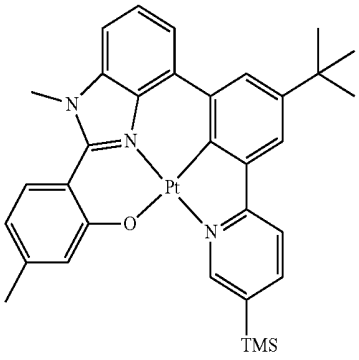


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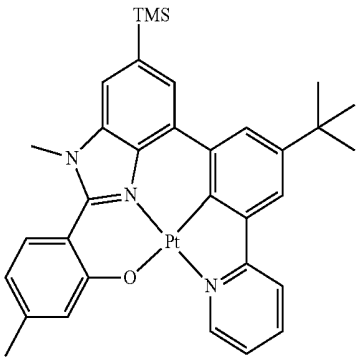


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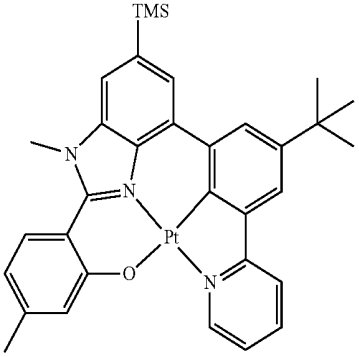


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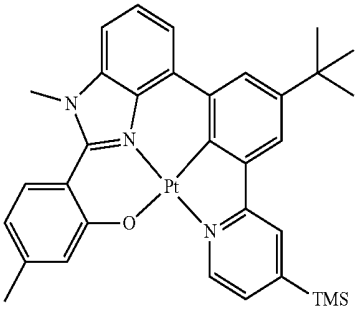


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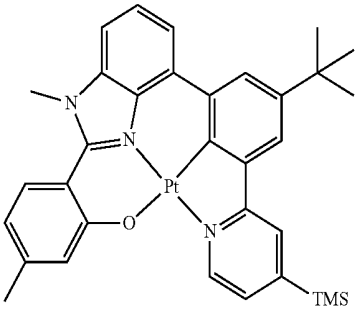


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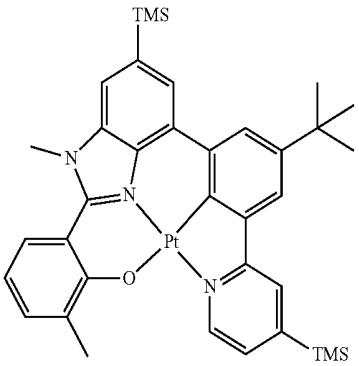

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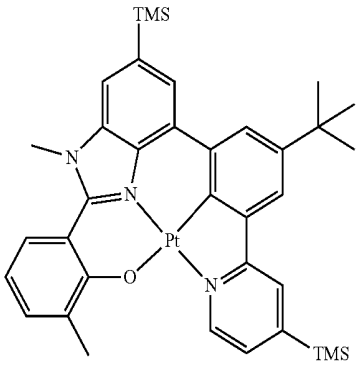


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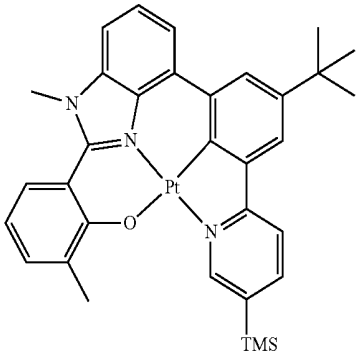


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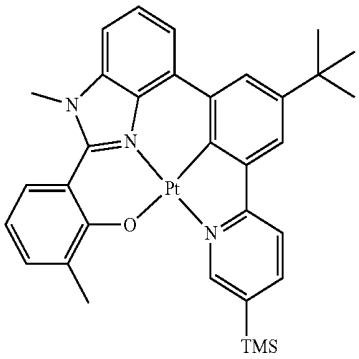


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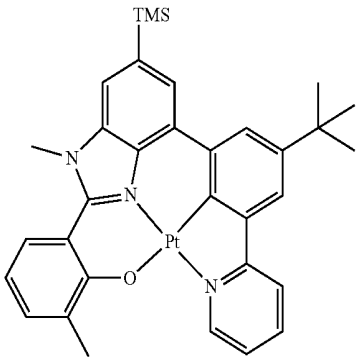


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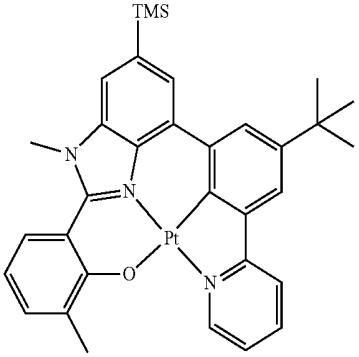


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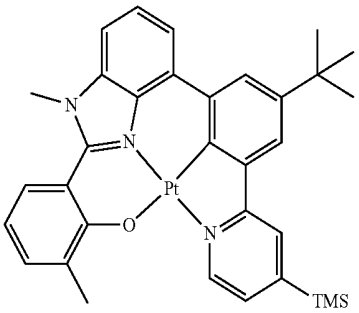


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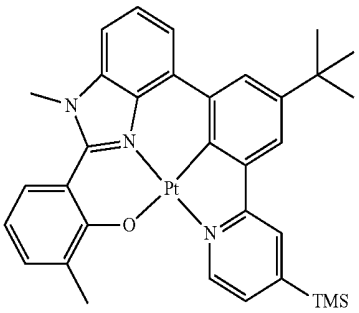


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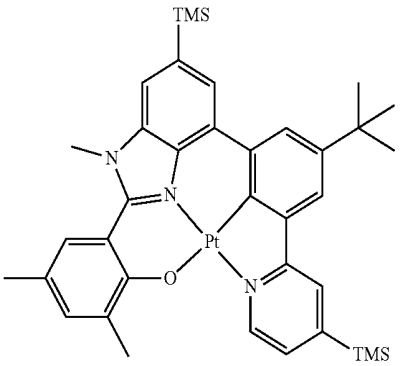

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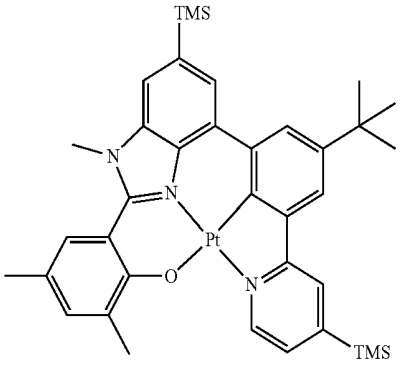


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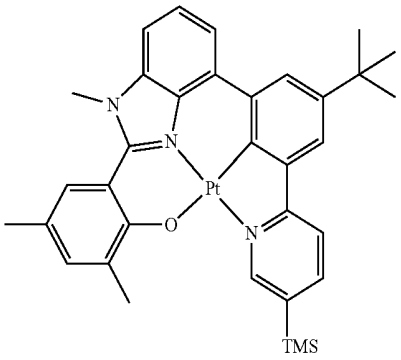


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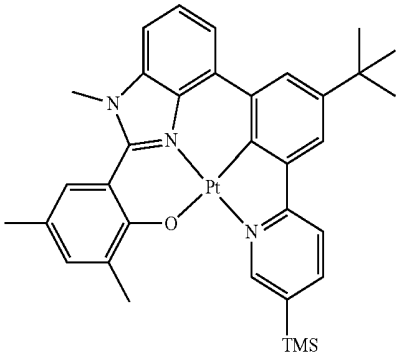


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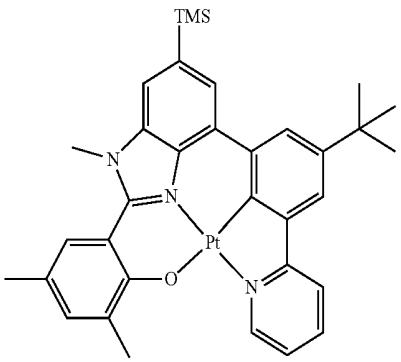


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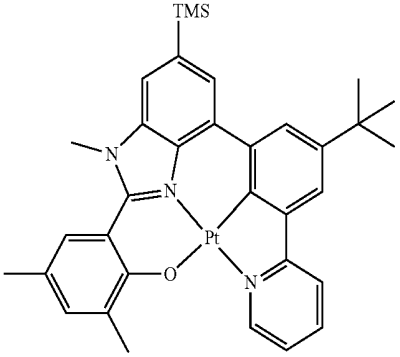


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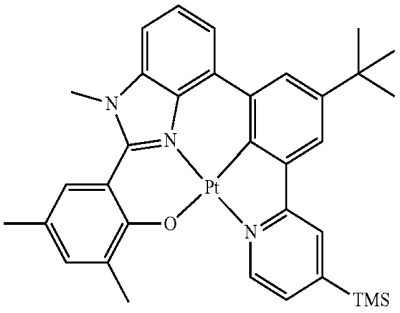


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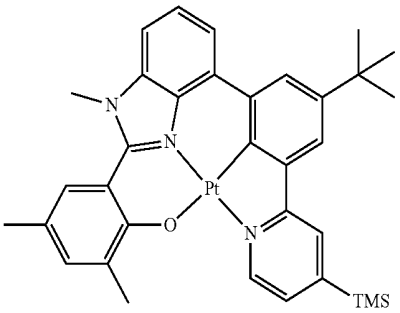


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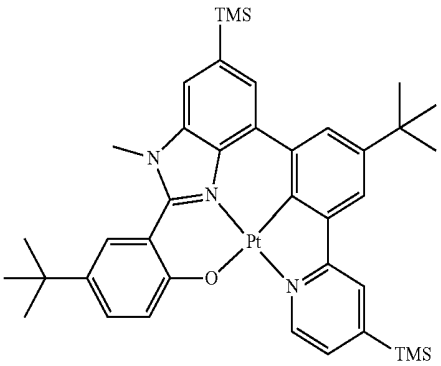

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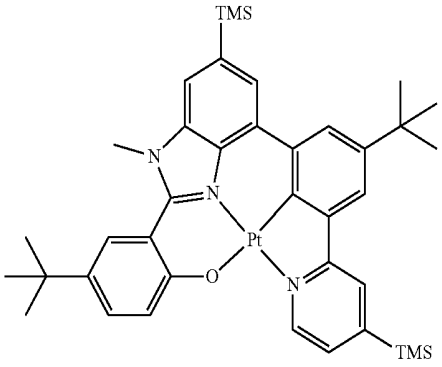


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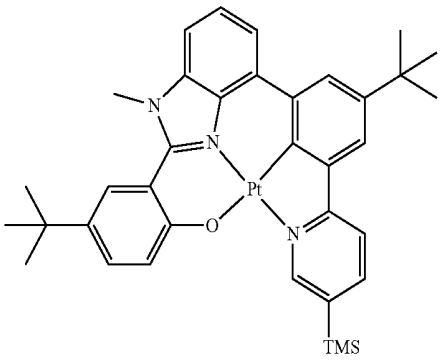


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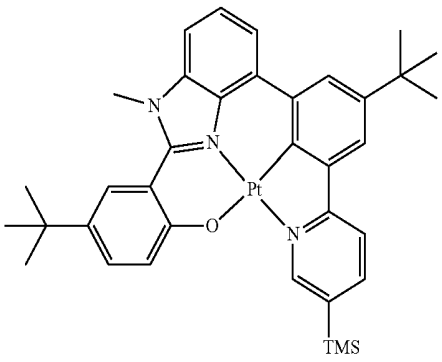


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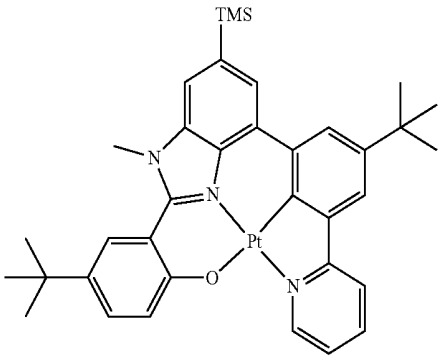


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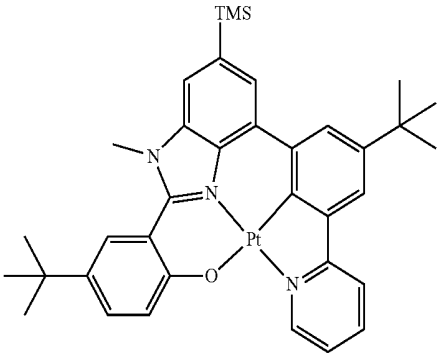


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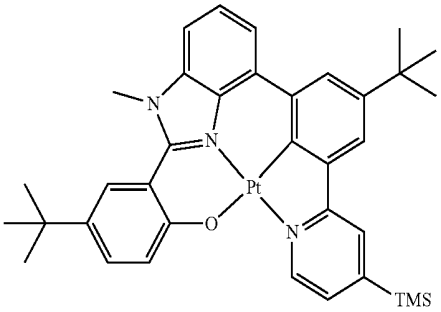


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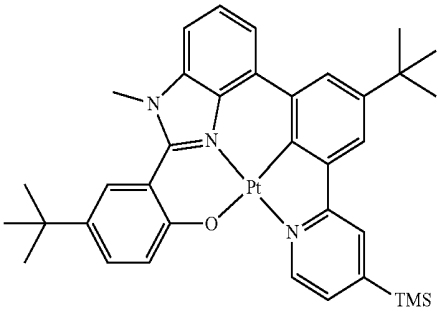


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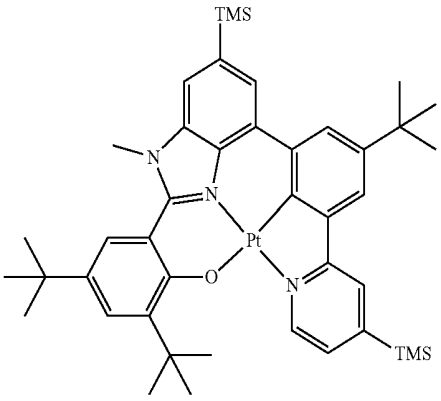

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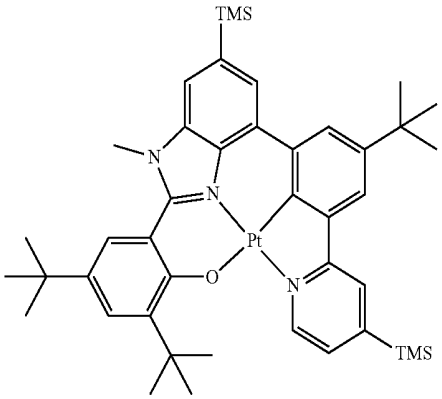


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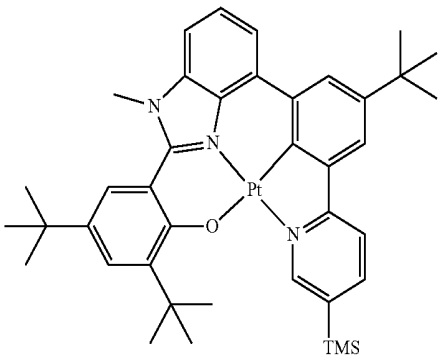


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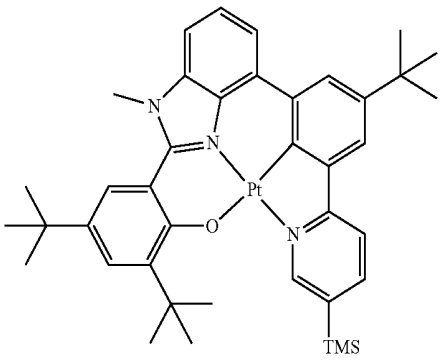


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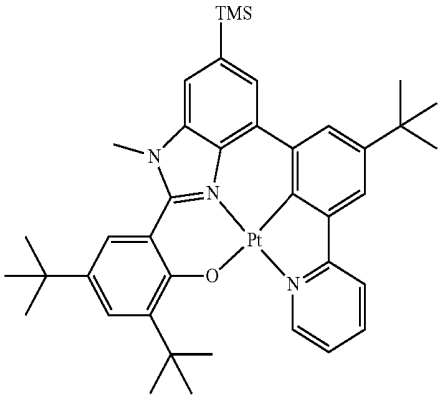


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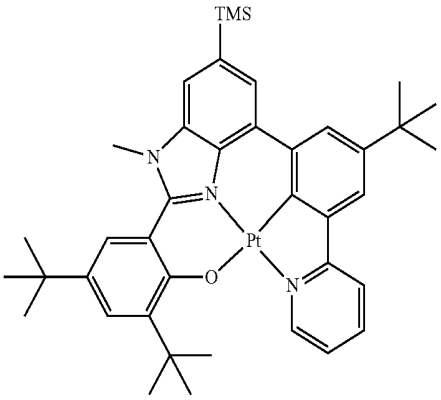


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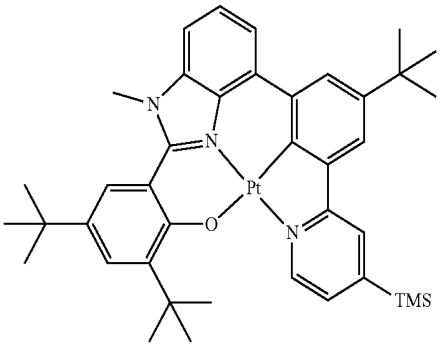


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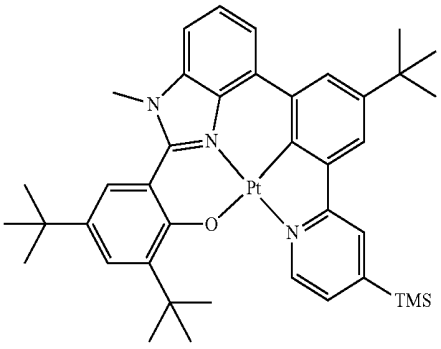


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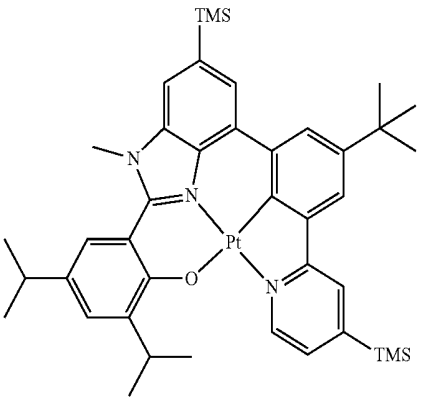

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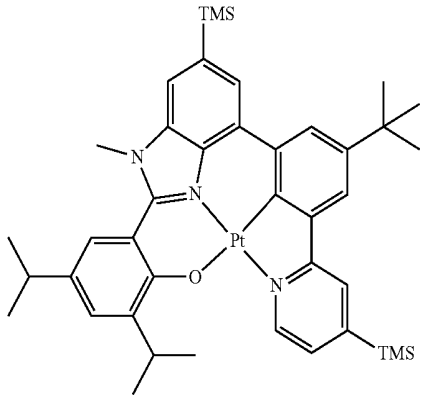


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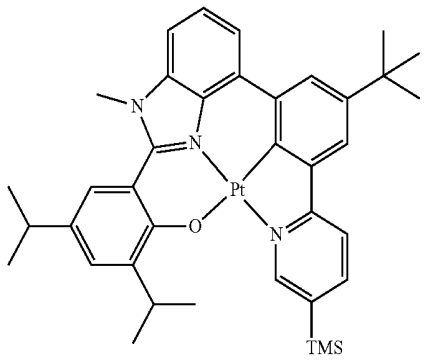


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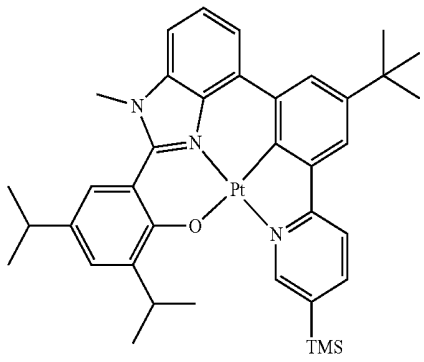


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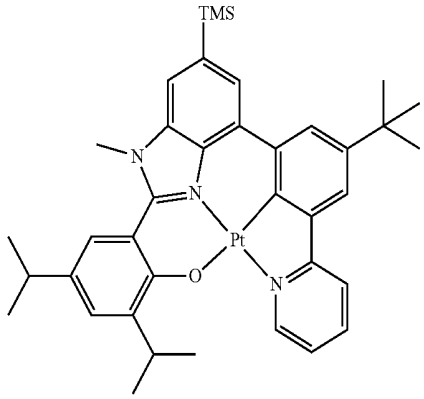


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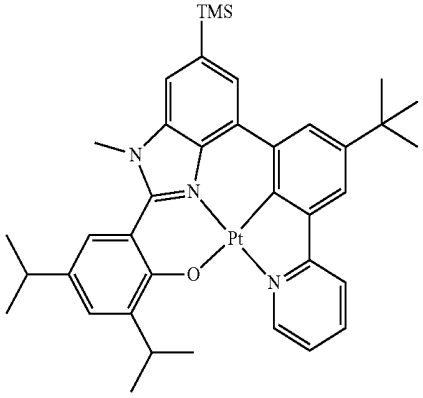


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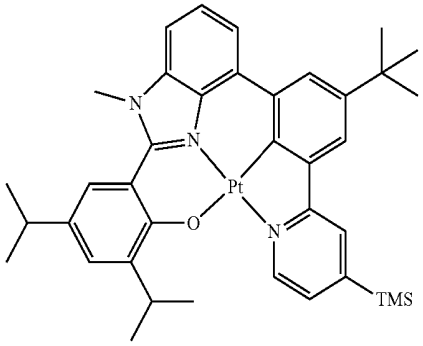


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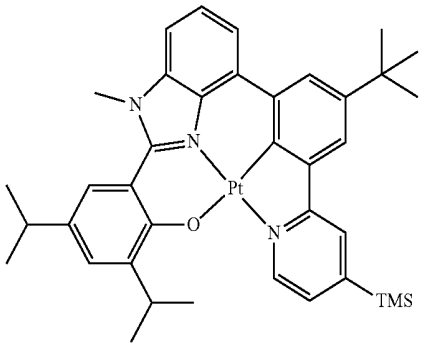


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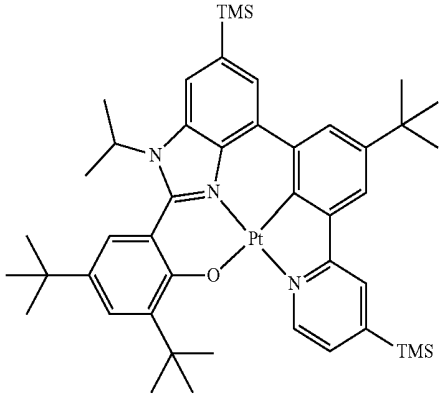

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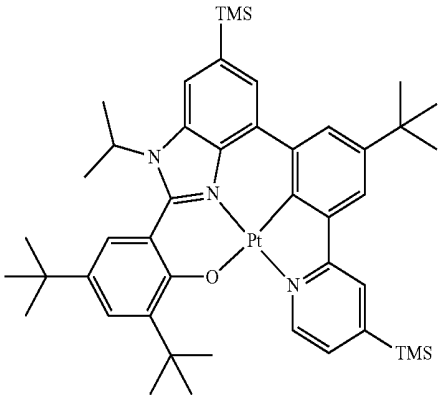


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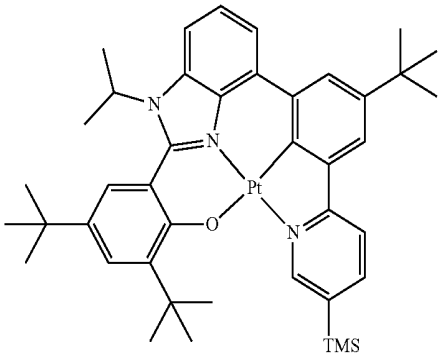


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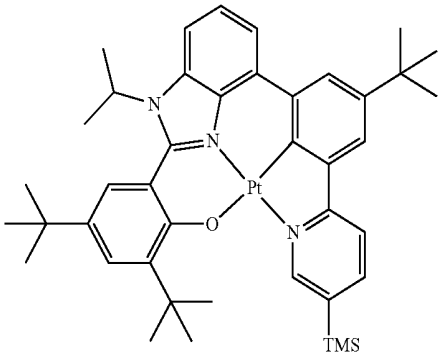


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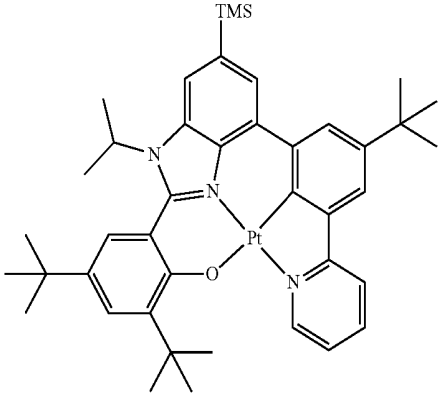


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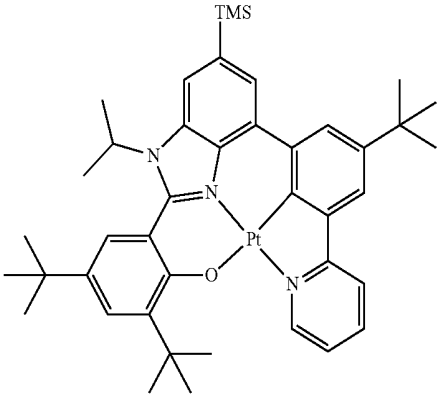


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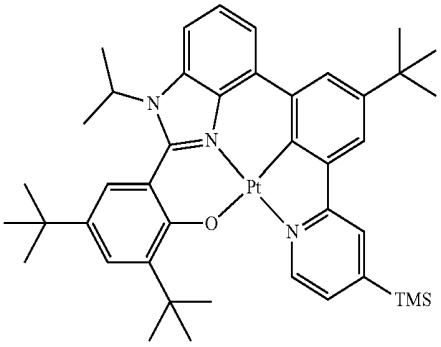


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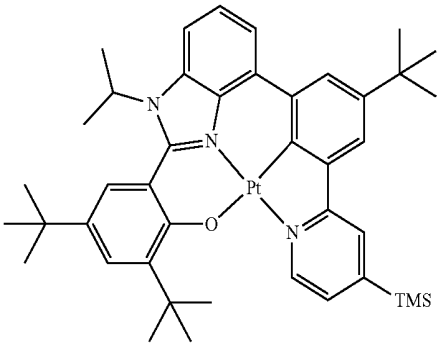


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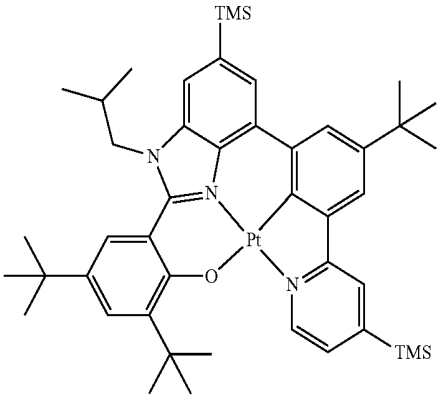

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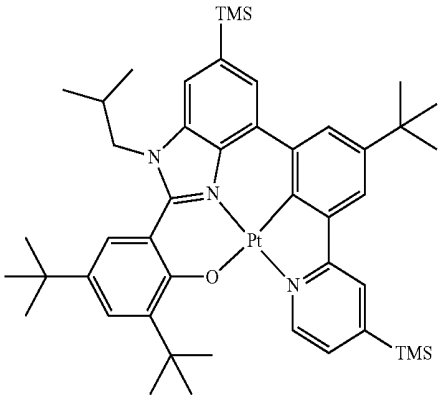


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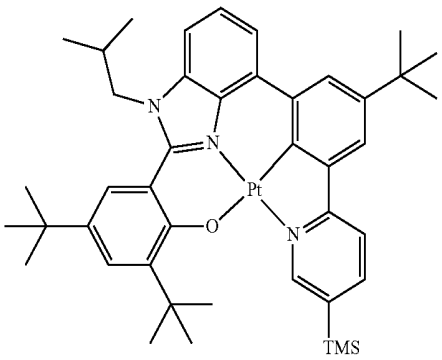


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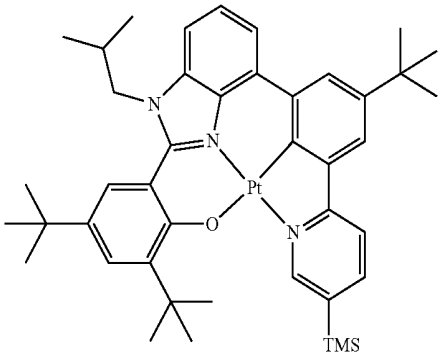


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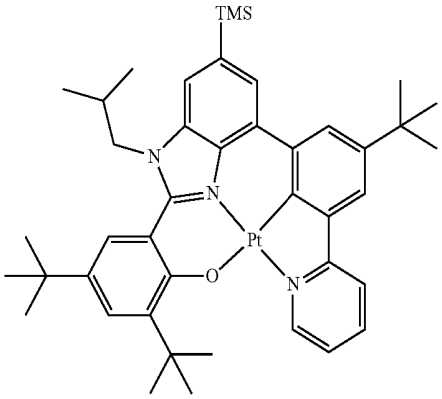


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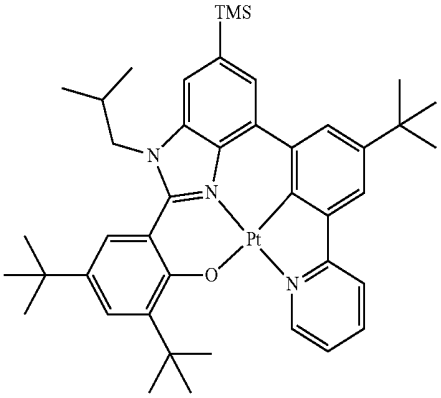


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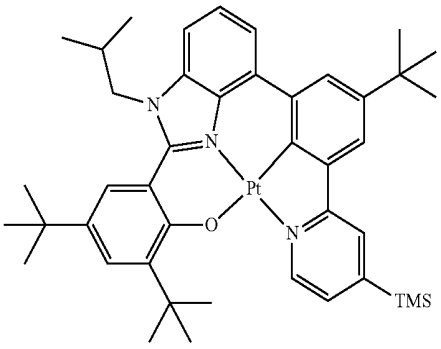


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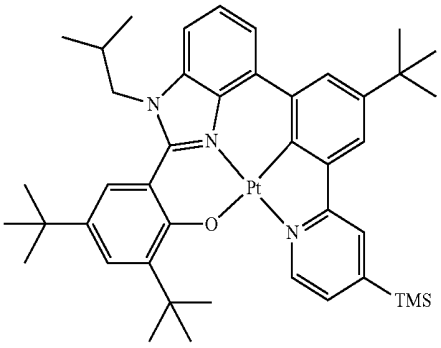


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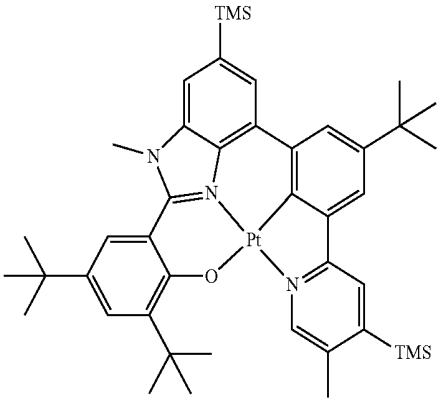

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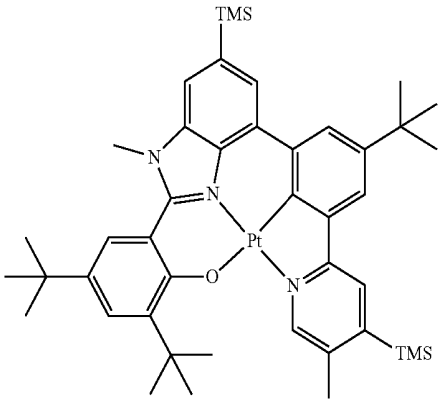

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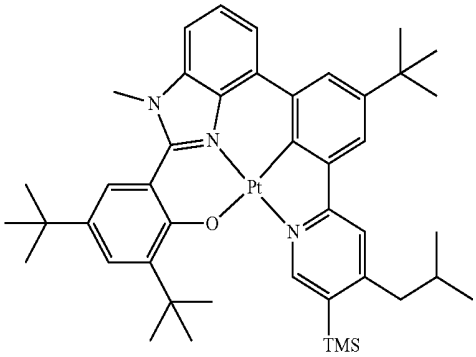

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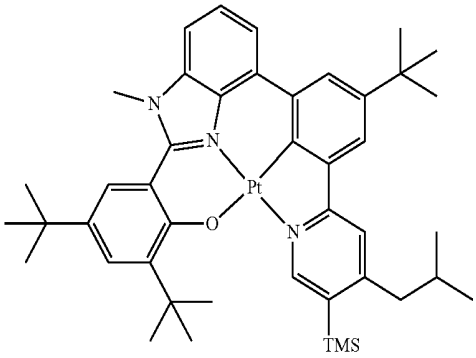

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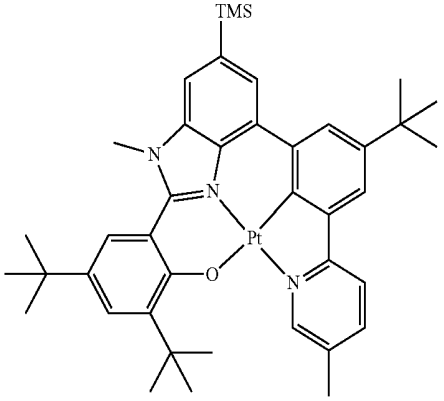

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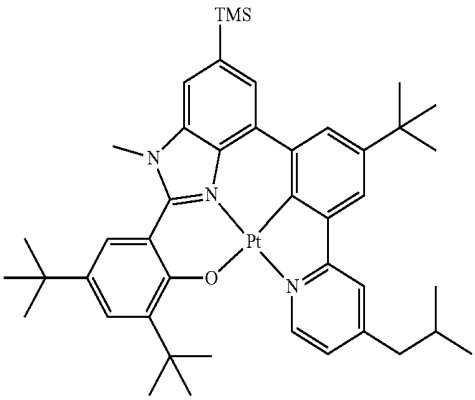

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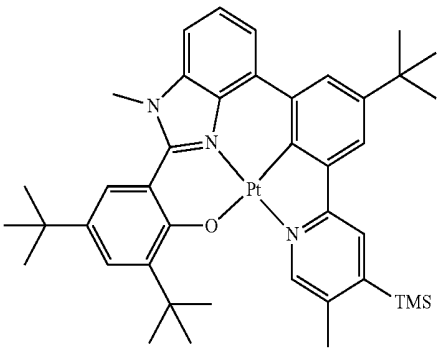

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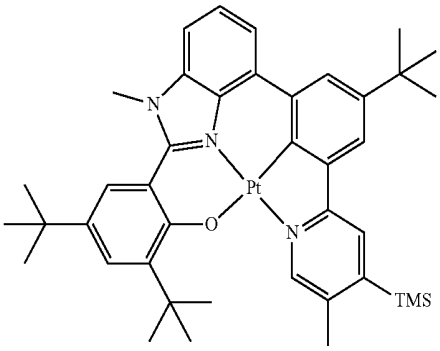

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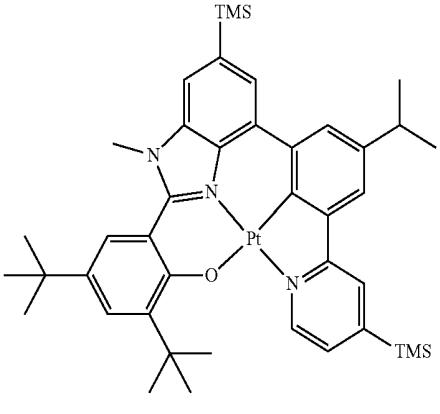

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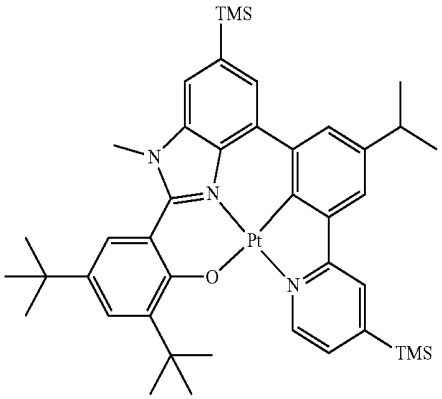


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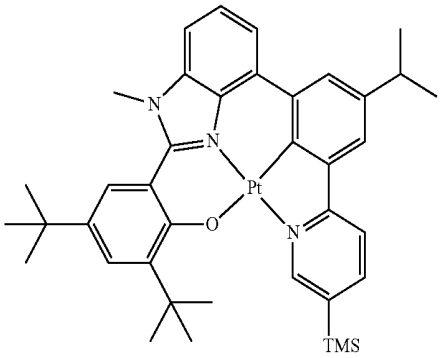


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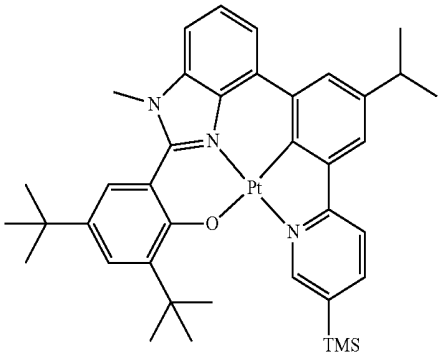


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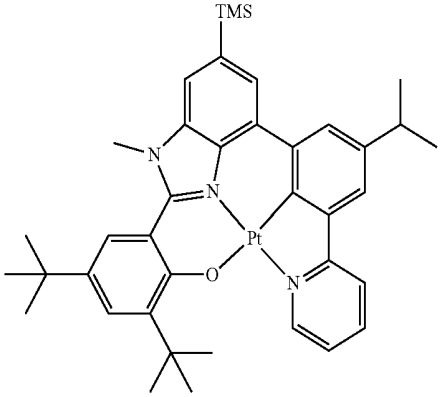


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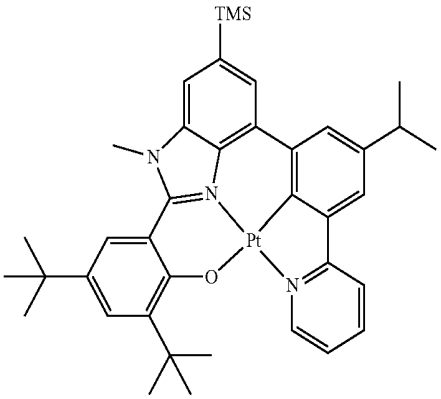


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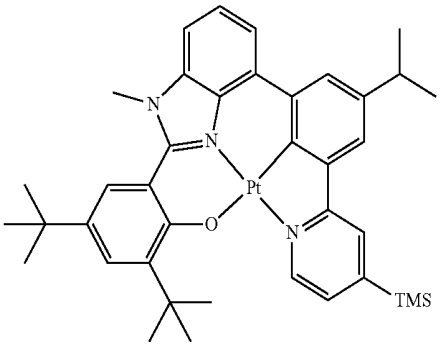


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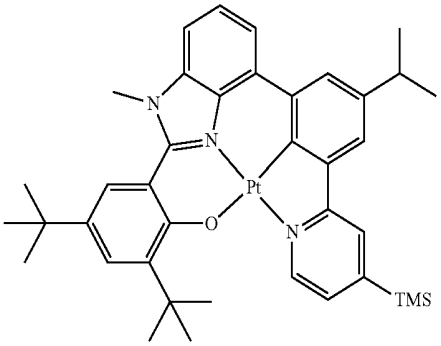


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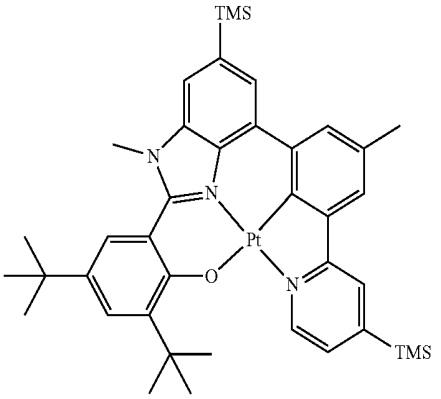

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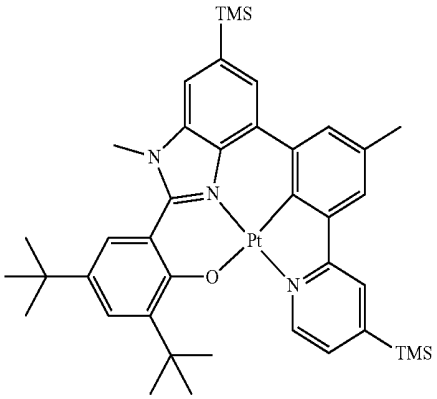


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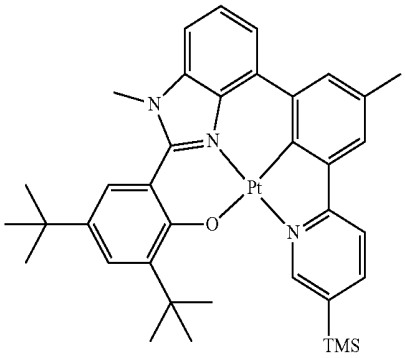


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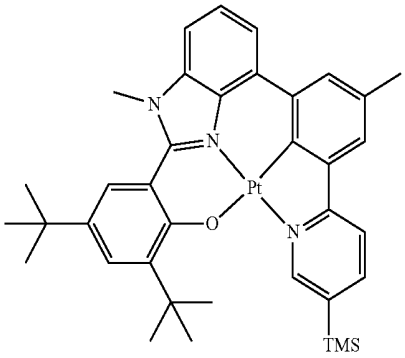


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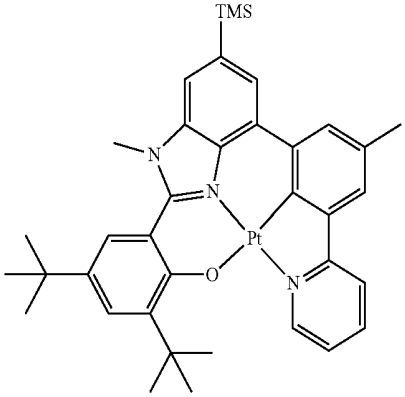


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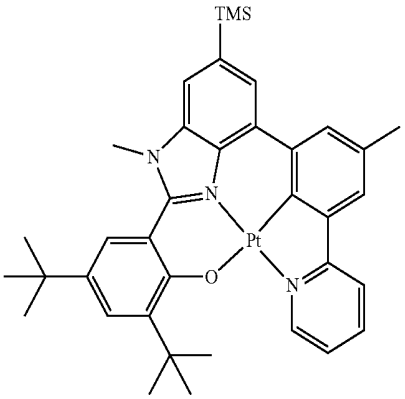


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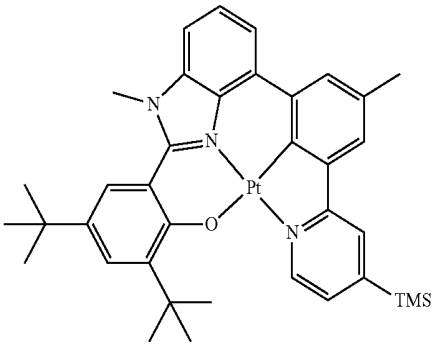


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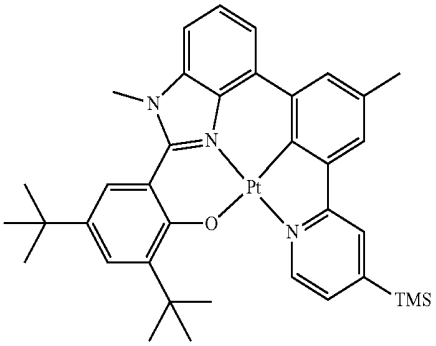


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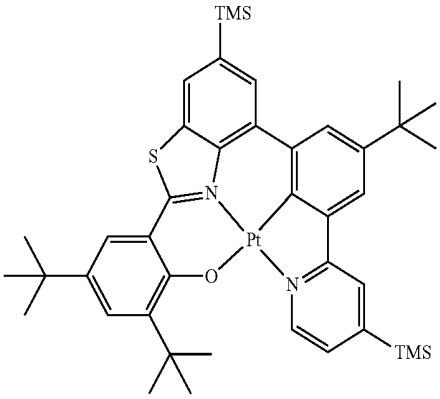

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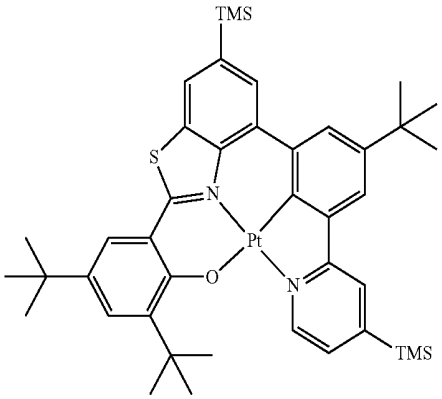


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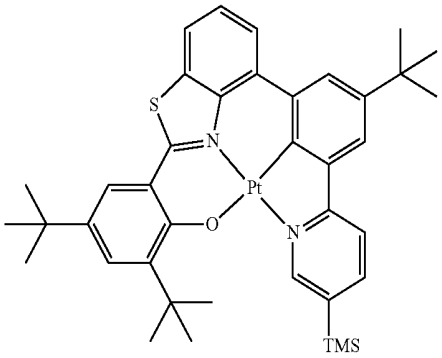


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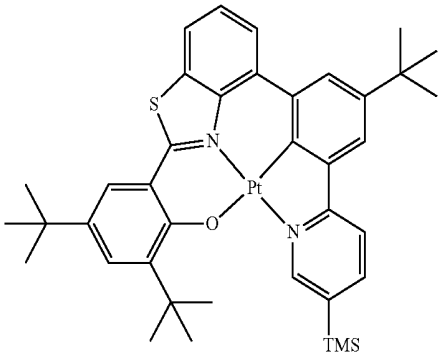


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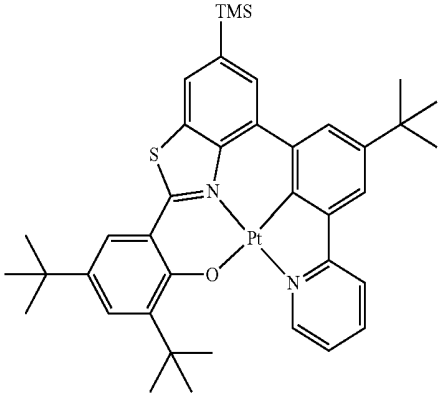


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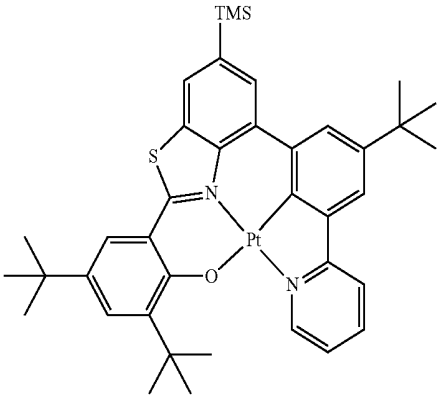


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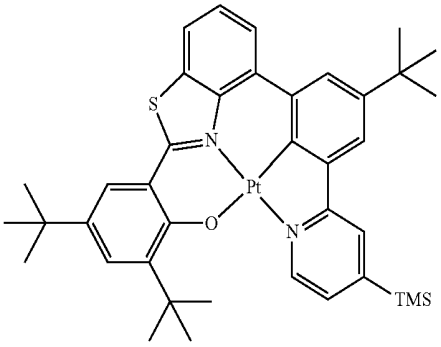


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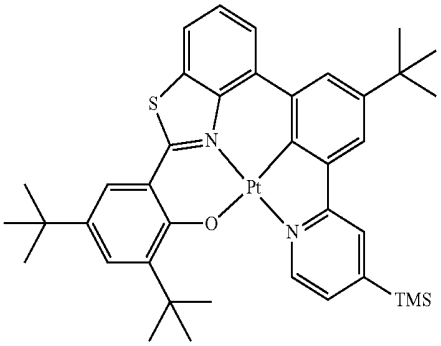


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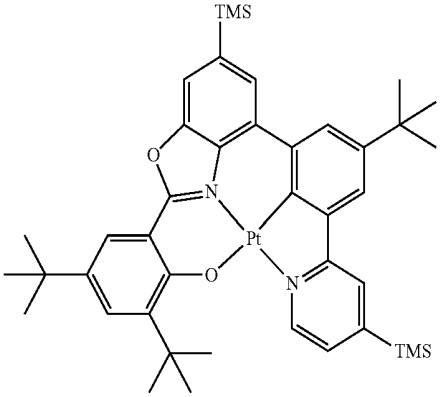

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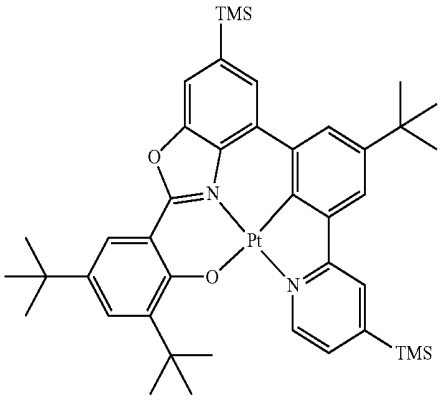


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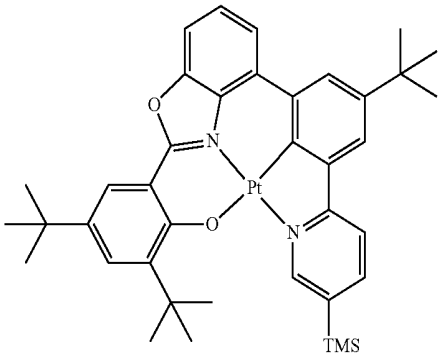


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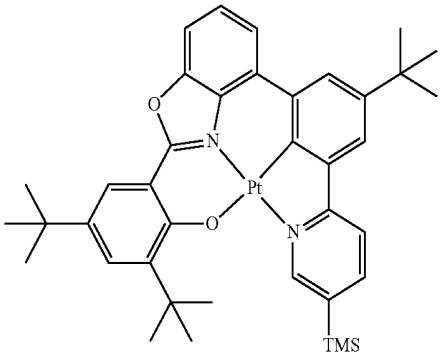


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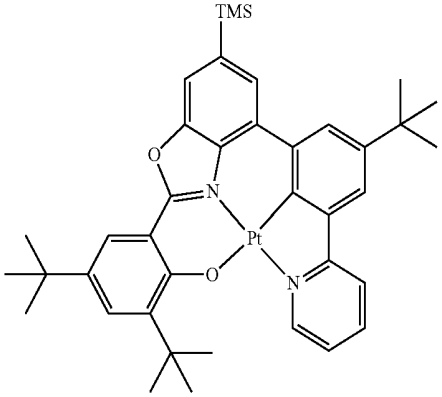


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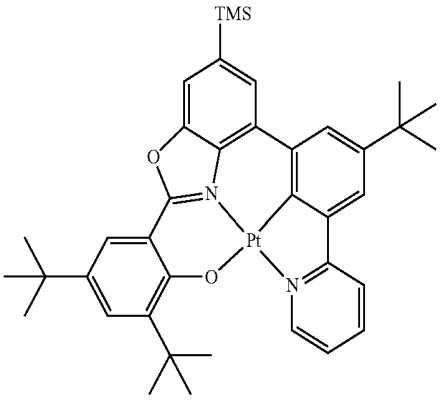


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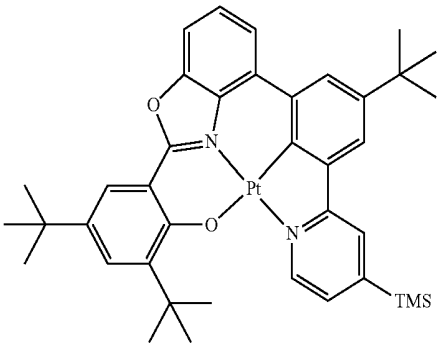


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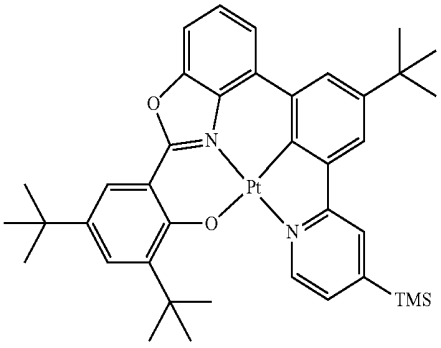


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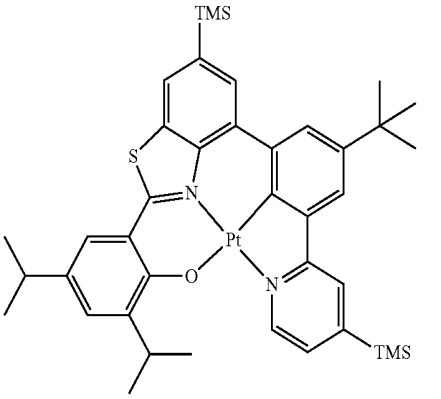

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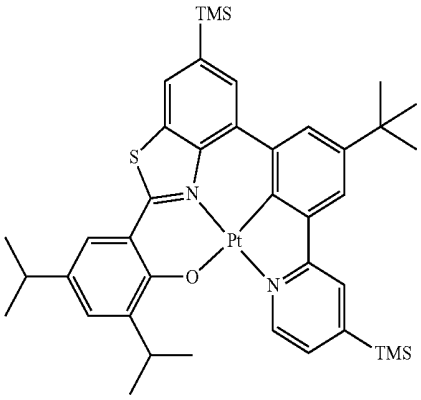


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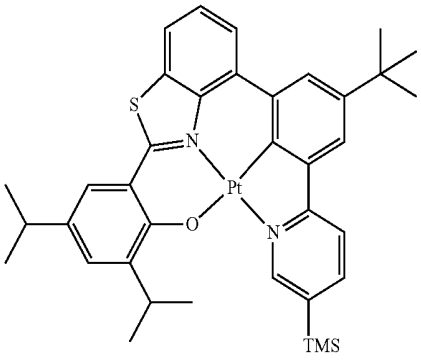


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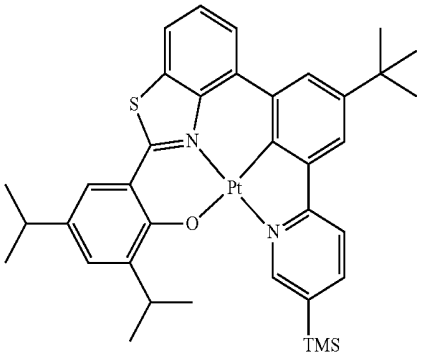


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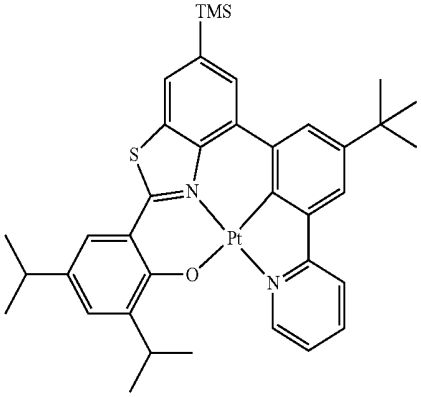


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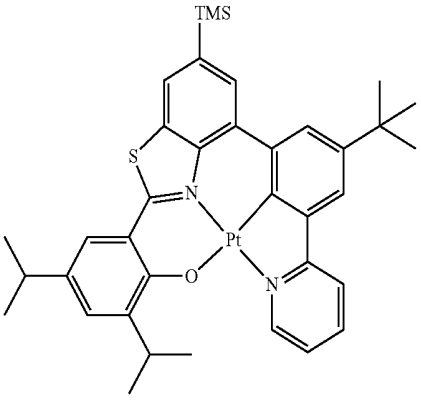


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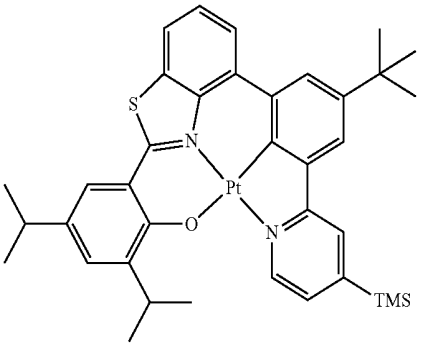


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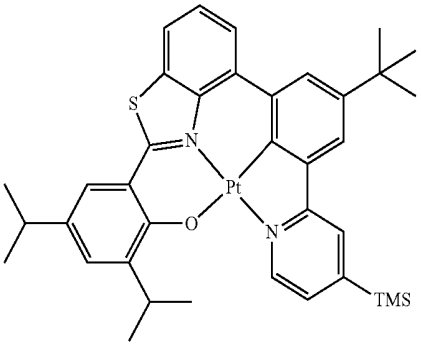


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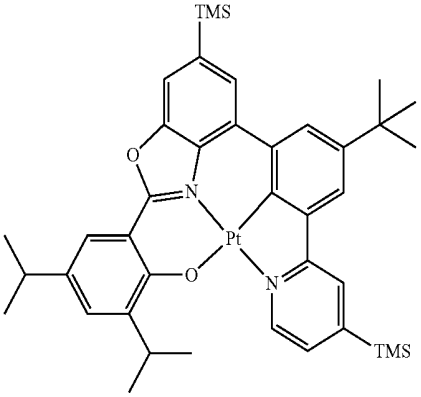

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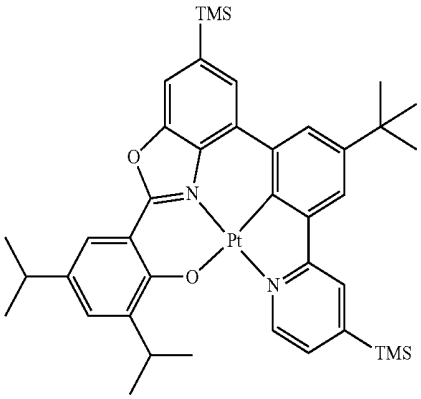


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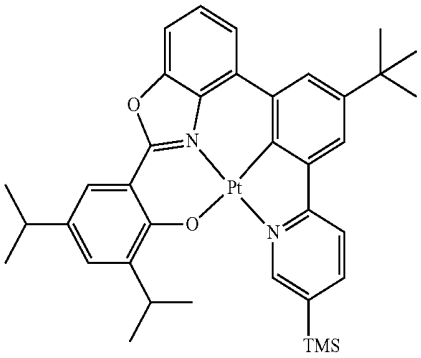


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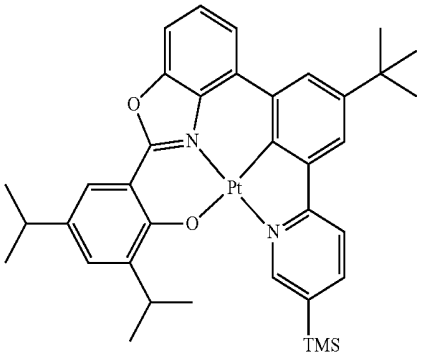


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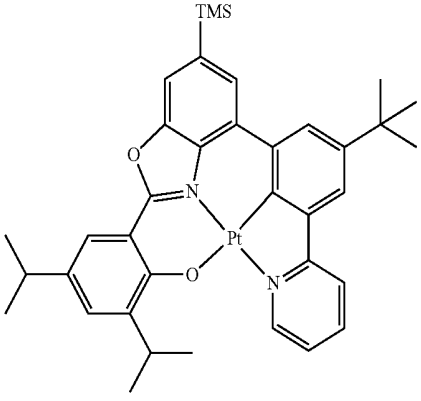


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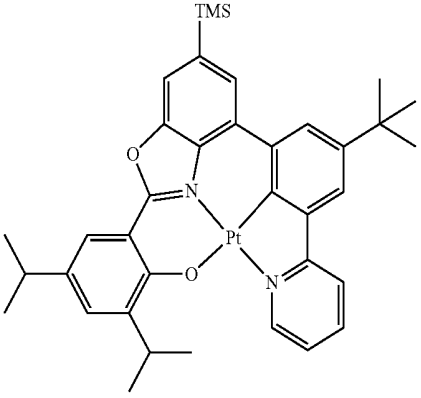


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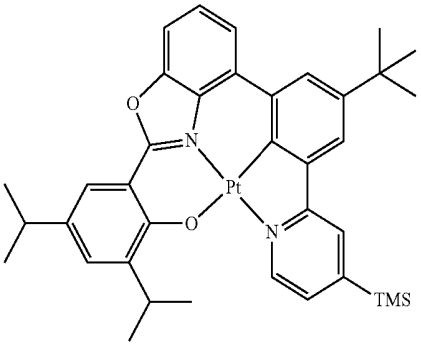


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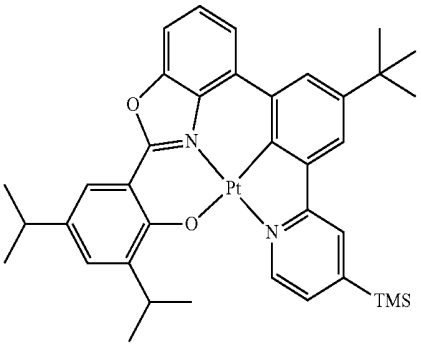


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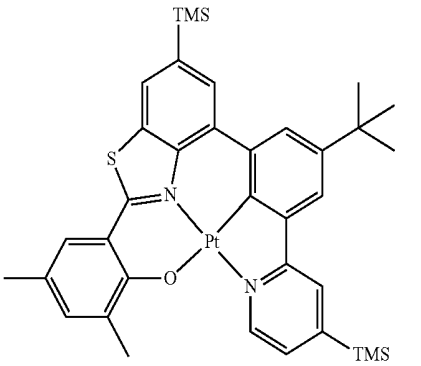

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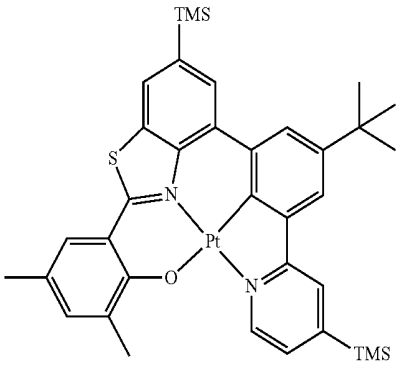


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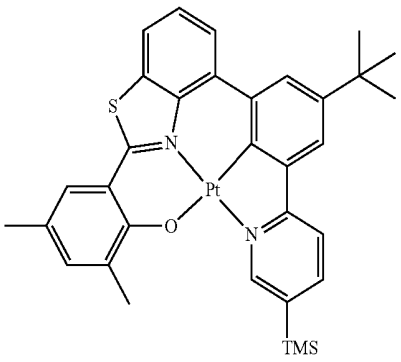


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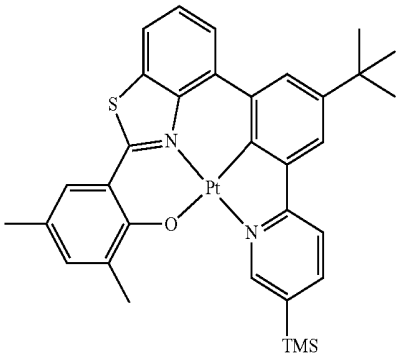


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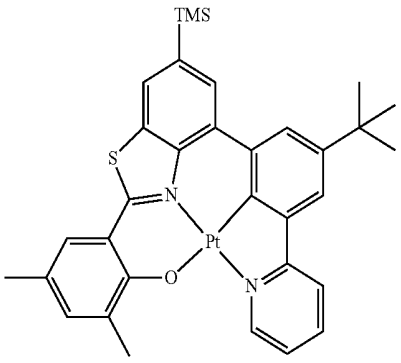


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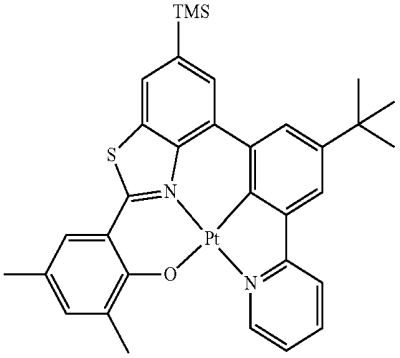


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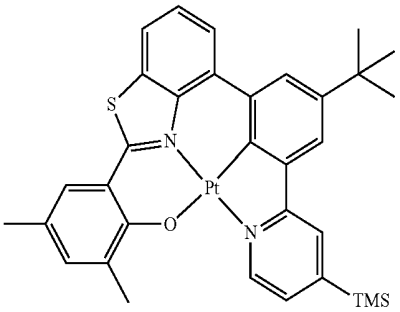


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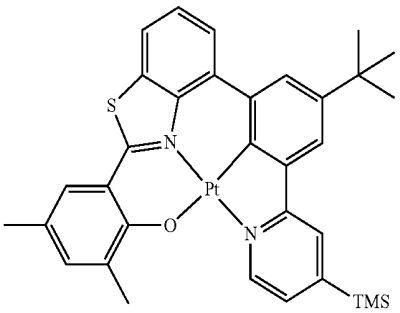


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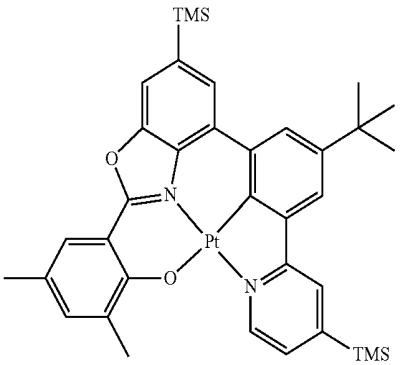

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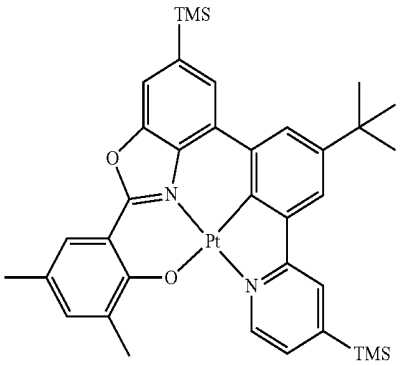


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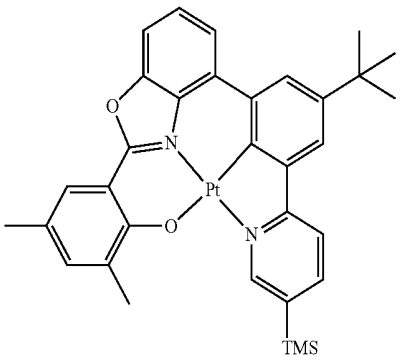


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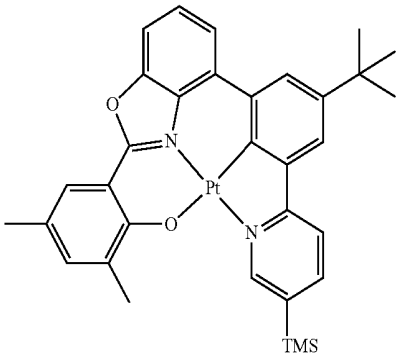


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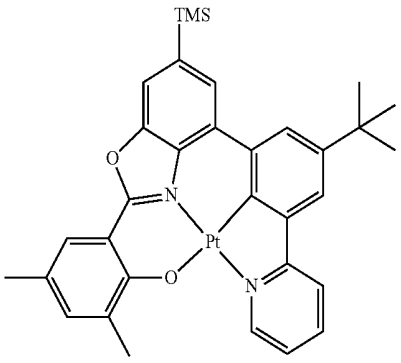


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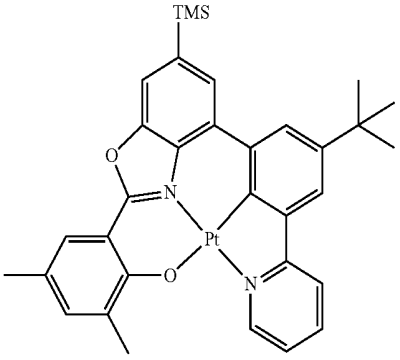


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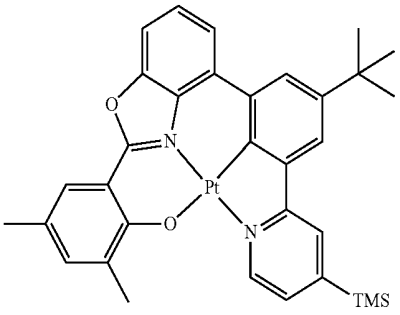


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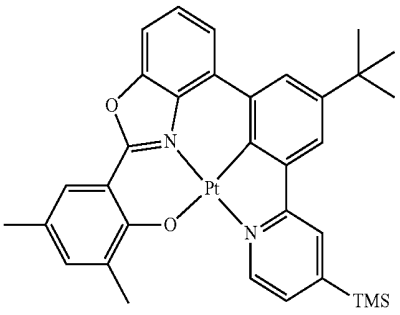


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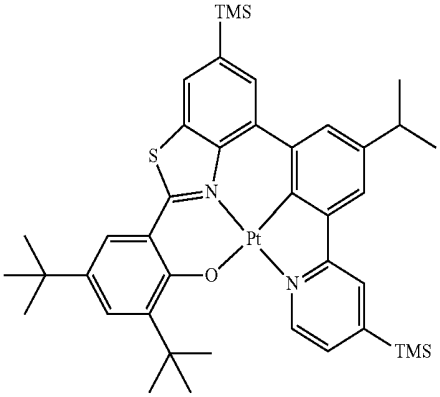

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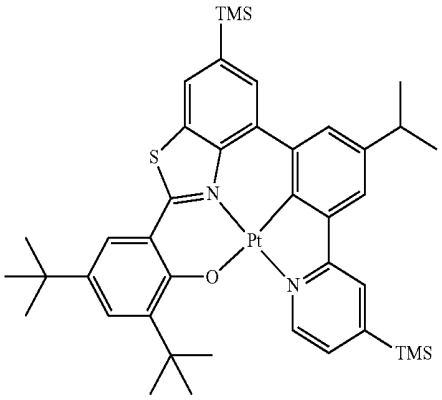


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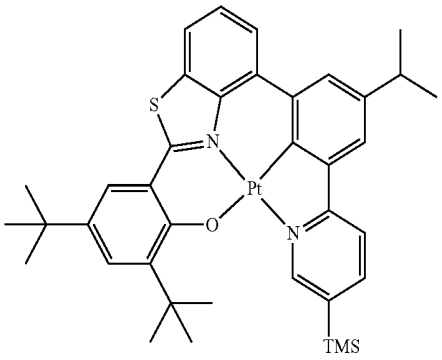


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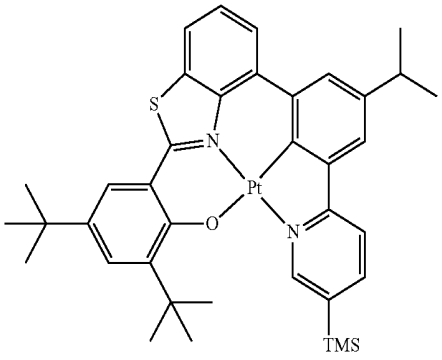


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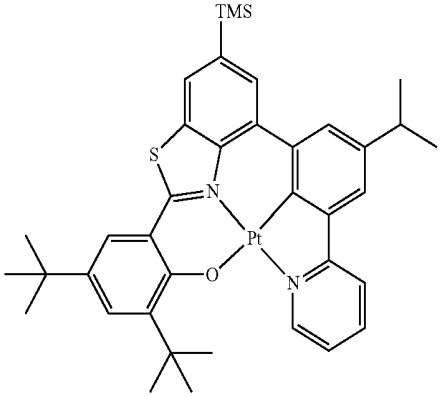


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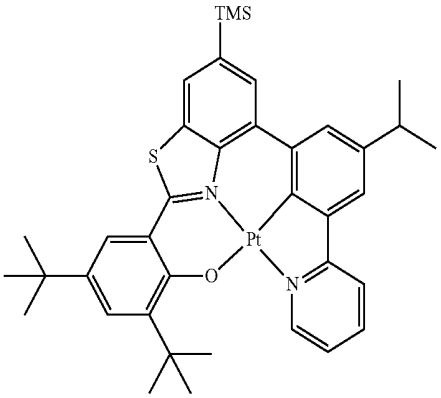


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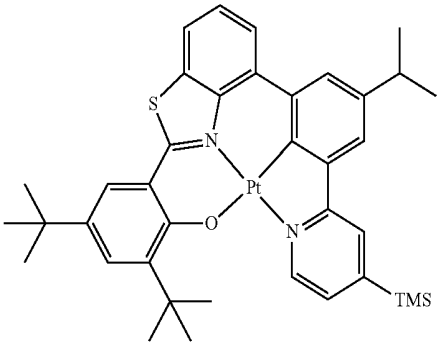


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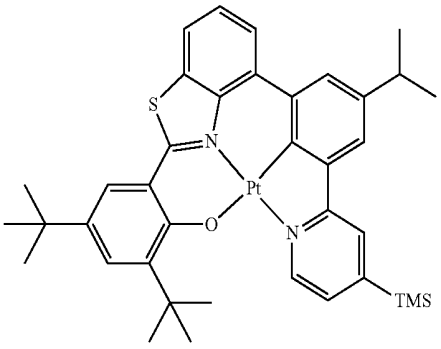


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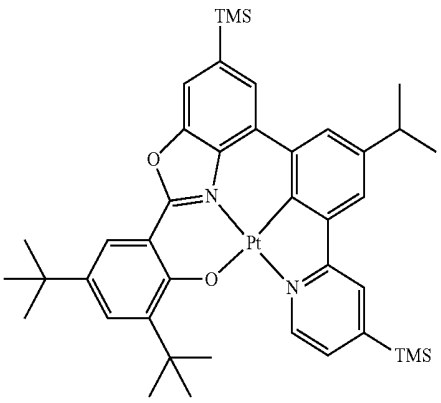

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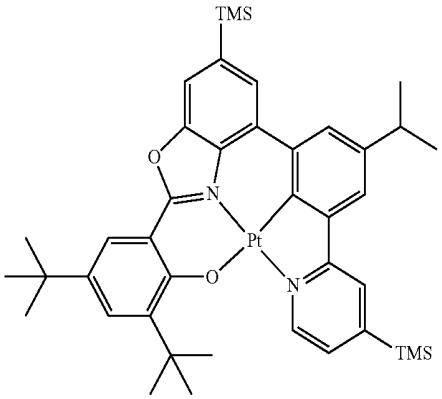


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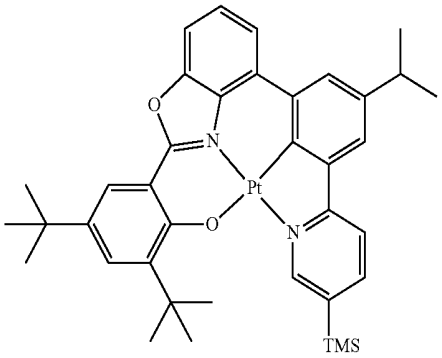


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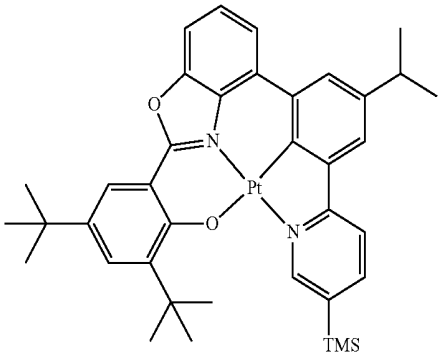


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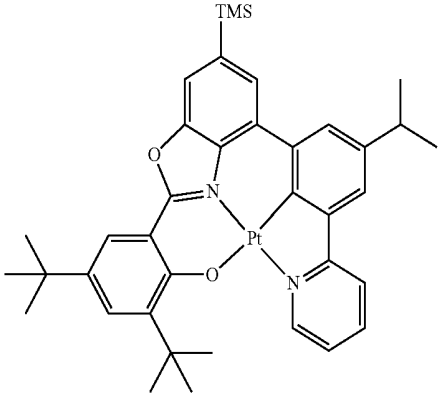


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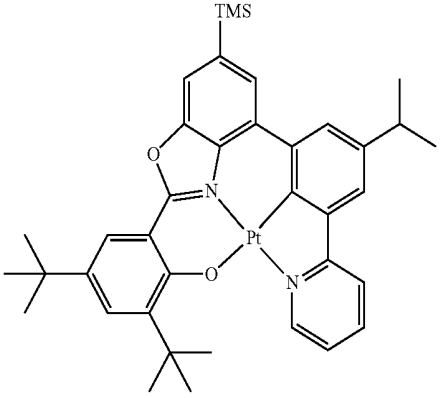


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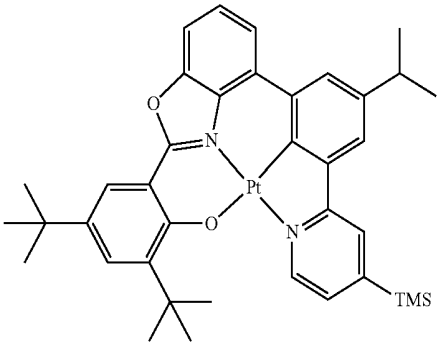


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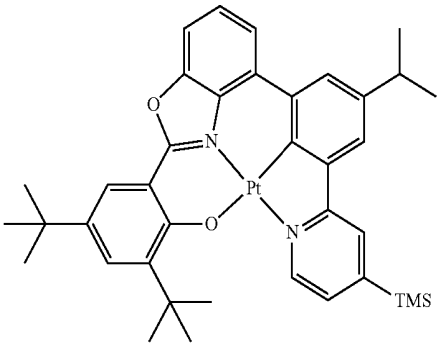


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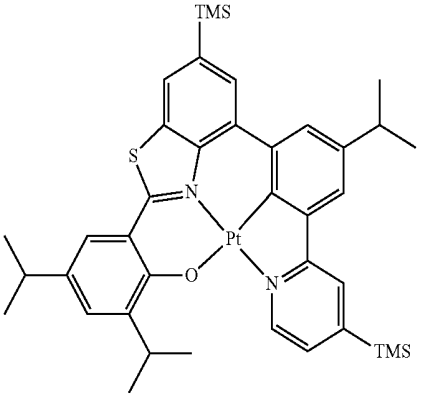

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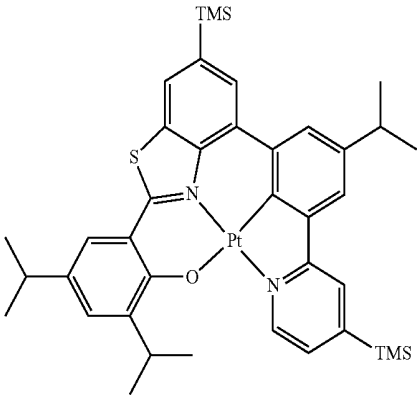


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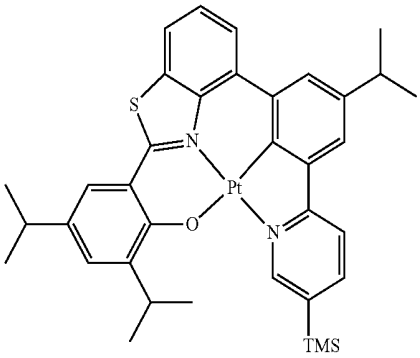


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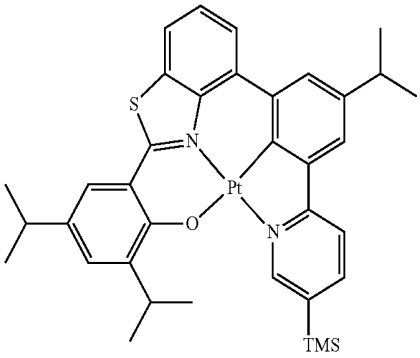


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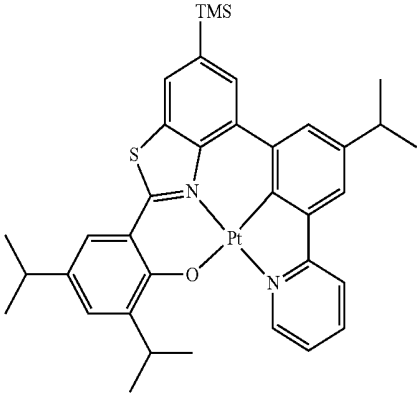


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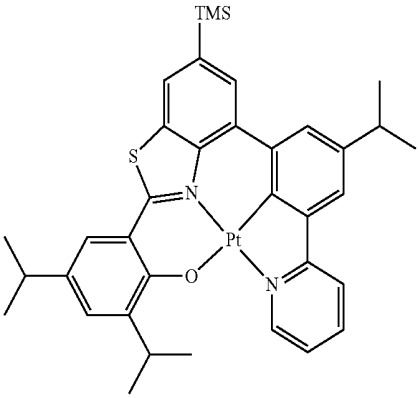


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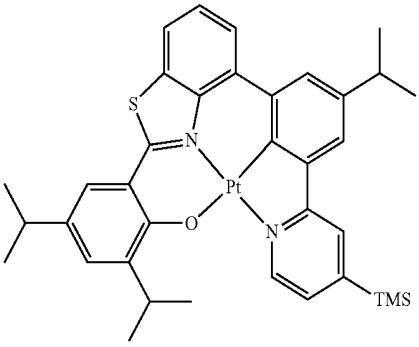


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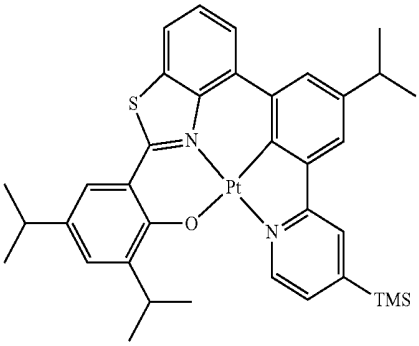


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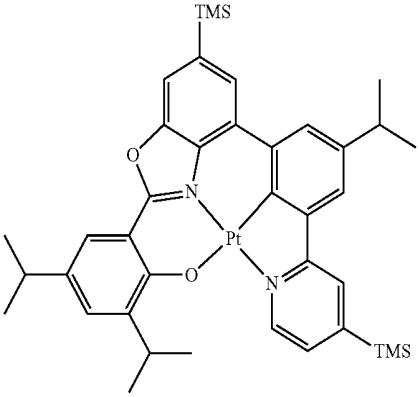

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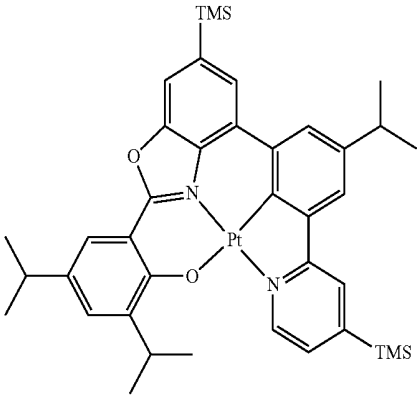


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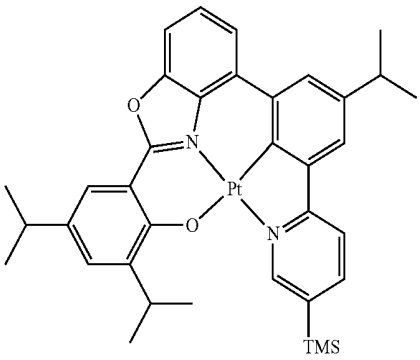


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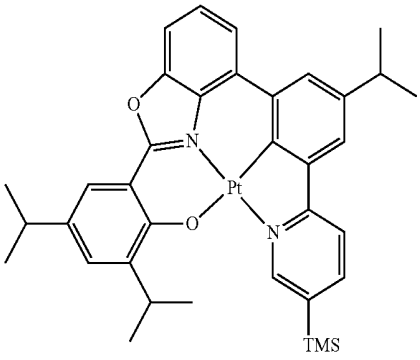


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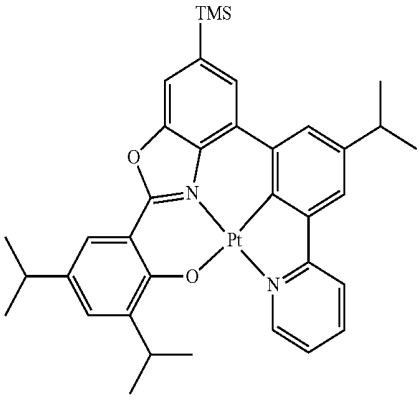


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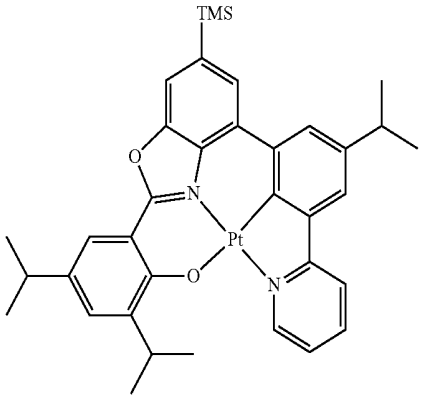


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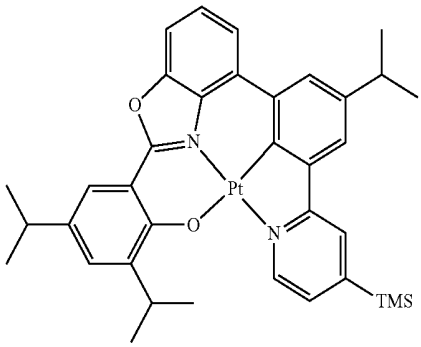


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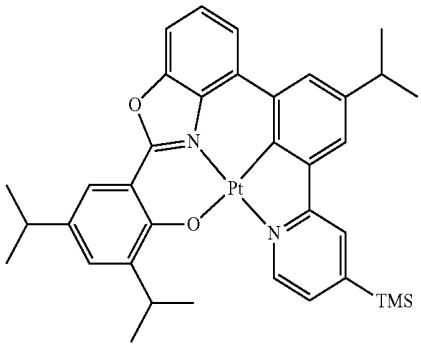


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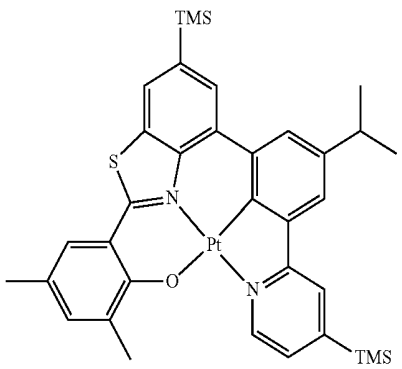

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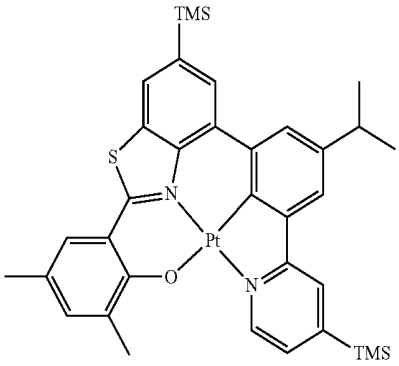


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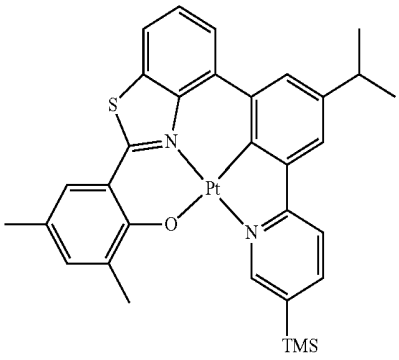


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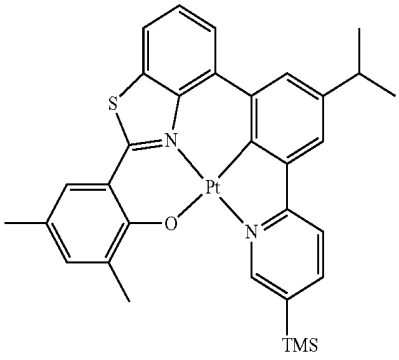


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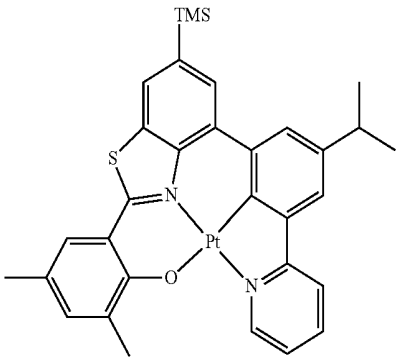


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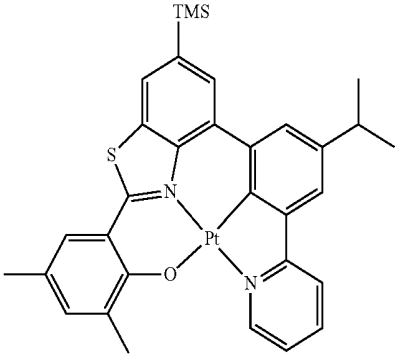


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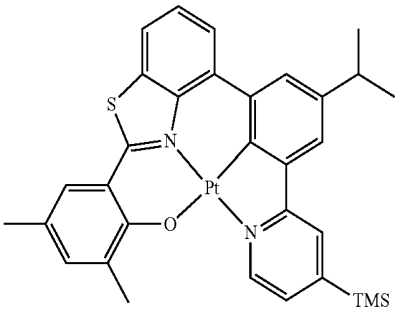


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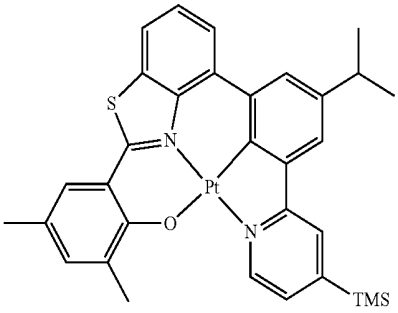


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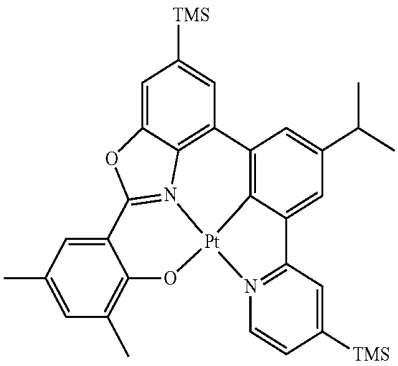

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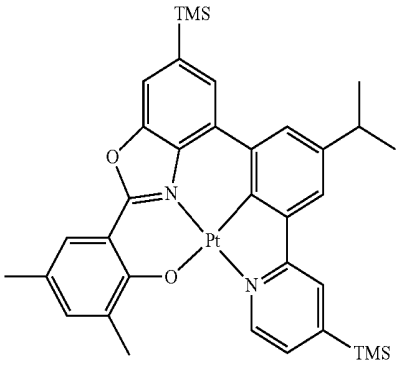

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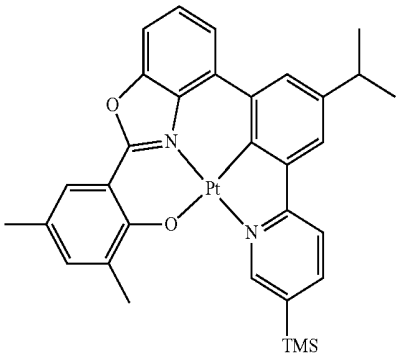

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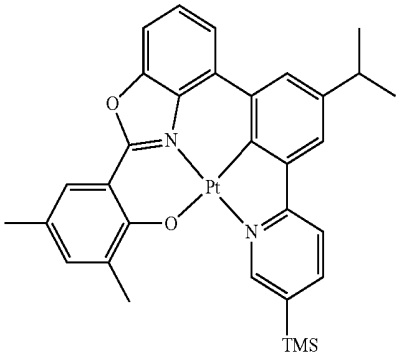

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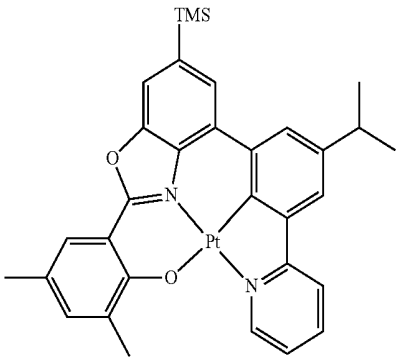

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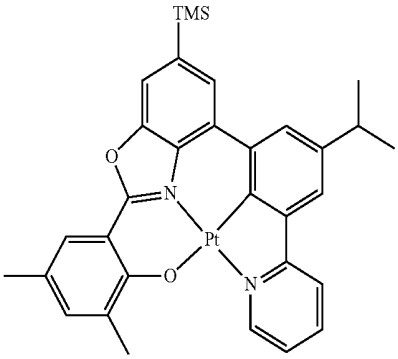

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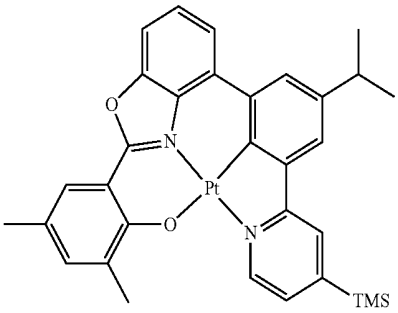

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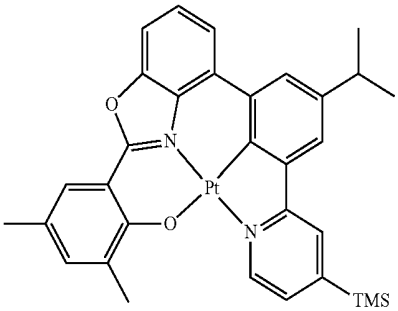

wherein TMS in Compounds 1 to 256 indicates a trimethylsilyl group.

**14**. An organic light-emitting device comprising:

a first electrode;

a second electrode; and

an organic layer disposed between the first electrode and the second electrode,

wherein the organic layer comprises an emission layer and at least one organometallic compound of claim **1**.

**15**. The organic light-emitting device of claim **14**, wherein

the first electrode is an anode,

the second electrode is a cathode, and

the organic layer further comprises 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,

wherein the hole transport region comprises a hole injection layer, a hole transport layer, an electron blocking layer, or any combination thereof, and

wherein the electron transport region comprises a hole blocking layer, an electron transport layer, an electron injection layer, or any combination thereof.

**16**. The organic light-emitting device of claim **14**, wherein the emission layer comprises the organometallic compound.

**17**. The organic light-emitting device of claim **16**, wherein the emission layer further comprises a host, wherein an amount of the host in the emission layer is larger than an amount of the organometallic compound in the emission layer.

**18**. The organic light-emitting device of claim **17**, wherein the amount of the organometallic compound in the emission layer is in a range of 0.01 parts by weight to 15 parts by weight based on 100 parts by weight of the emission layer.

**19**. The organic light-emitting device of claim **17**, wherein the host comprises a carbazole-containing compound.

**20**. A diagnostic composition comprising at least one organometallic compound of claim **1**.

* * * * *

| | | | |
|---|---|---|---|
| 专利名称(译) | 有机金属化合物，包括有机金属化合物的有机发光装置和包含有机金属化合物的诊断组合物 | | |
| 公开(公告)号 | US20180309070A1 | 公开(公告)日 | 2018-10-25 |
| 申请号 | US15/871382 | 申请日 | 2018-01-15 |
| [标]申请(专利权)人(译) | 三星电子株式会社 | | |
| 申请(专利权)人(译) | SAMSUNG ELECTRONICS CO.，LTD. | | |
| 当前申请(专利权)人(译) | SAMSUNG ELECTRONICS CO.，LTD. | | |
| [标]发明人 | LEE JUNGIN<br>HWANG KYUYOUNG<br>KIM SOYEON<br>YOON SEONGJUN<br>LEE SUNGHUN<br>CHOI HYEONHO<br>CHOI BYOUNGKI<br>KWAK YOONHYUN | | |
| 发明人 | LEE, JUNGIN<br>HWANG, KYUYOUNG<br>KIM, SOYEON<br>YOON, SEONGJUN<br>LEE, SUNGHUN<br>CHOI, HYEONHO<br>CHOI, BYOUNGKI<br>KWAK, YOONHYUN | | |
| IPC分类号 | H01L51/00 C07F15/00 C09K11/06 C09K11/02 | | |
| CPC分类号 | H01L51/0087 C07F15/0086 H01L51/0094 H01L51/0072 C09K11/06 C09K11/025 H01L51/5206 H01L51/5221 H01L51/5016 H01L51/5088 H01L51/5056 H01L51/5096 H01L51/5072 H01L51/5092 C09K2211/185 C09K2211/1029 C09K2211/1044 | | |
| 优先权 | 1020170051077 2017-04-20 KR | | |
| 外部链接 | Espacenet USPTO | | |


摘要(译)

由式1表示的有机金属化合物： 其中，在公式1中，组和变量与规范中描述的相同。