



**FIG. 1**

**10**

<b>190</b>
<b>150</b>
<b>110</b>

# FIG. 2

20

190
150
110
210

**FIG. 3**

**30**

<b>220</b>
<b>190</b>
<b>150</b>
<b>110</b>

# FIG. 4

40

220
190
150
110
210

**ARYLAMINE-BASED COMPOUND  
INCLUDING THERMALLY  
DECOMPOSABLE GROUPS AND ORGANIC  
LIGHT-EMITTING DEVICE INCLUDING  
THE SAME**

CROSS-REFERENCE TO RELATED  
APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2018-0046984, filed on Apr. 23, 2018, in the Korean Intellectual Property Office, the entire content of which is incorporated herein by reference.

BACKGROUND

1. Field

[0002] One or more embodiments relate to an arylamine-based compound including a thermally decomposable group and an organic light-emitting including the arylamine-based compound.

2. Description of the Related Art

[0003] Organic light-emitting devices are self-emission devices that produce full-color images, and also have wide viewing angles, high contrast ratios, short response times, and excellent characteristics in terms of brightness, driving voltage, and response speed, as compared to other devices in the art.

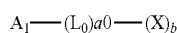
[0004] An example of such organic light-emitting devices may include a first electrode disposed on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. Carriers, such as holes and electrons, recombine in the emission layer to produce excitons. These excitons transit (e.g., transition or relax) from an excited state to a ground state, thereby generating light.

SUMMARY

[0005] One or more embodiments provide an arylamine-based compound including a thermally decomposable group and an organic light-emitting device including the same.

[0006] Additional aspects of embodiments 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.

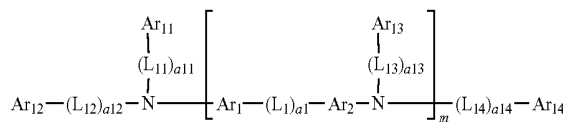
[0007] An aspect of an embodiment provides an arylamine-based compound including a thermally decomposable group, the arylamine-based compound including the thermally decomposable group being represented by Formula 1:



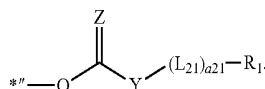
Formula 1

-continued

Formula 2



Formula 2-1



[0008] In Formula 1,

[0009]  $A_1$  may be a group represented by Formula 2,

[0010]  $L_0$  may be a single bond,  $*(CH_2)_p-*'$ ,  $*(CH_2)_p-O-*'$ ,  $*-O-(CH_2)_q-*'$ ,  $*(CH_2)_p-O-(CH_2)_q-*'$ ,  $*(CH_2)_p-O-(CH_2)_q-O-(CH_2)_r-*'$ ,  $*(CH_2)_p-S-*'$ ,  $*-S-(CH_2)_q-*'$ , or  $*(CH_2)_p-S-(CH_2)_q-*'$ , and  $*$  and  $*'$  each indicate a binding site to a neighboring atom,

[0011]  $p$ ,  $q$ , and  $r$  may each independently be an integer from 1 to 5,

[0012]  $a_0$  may be an integer from 1 to 100, and when  $n_1$  is two or more, two or more  $L_0(s)$  may be identical to or different from each other,

[0013]  $X$  may be a thermally decomposable group represented by Formula 2-1, and when  $L_0$  is a single bond,  $*''$  may be a binding site to  $A_1$ , and when  $L_0$  is not a single bond,  $*''$  may be a binding site to  $L_0$ ,

[0014]  $b$  may be an integer from 1 to 100, and when  $b$  is two or more, two or more  $X(s)$  may be identical to or different from each other,

[0015] in Formula 2,

[0016]  $m$  may be an integer from 0 to 100,

[0017] when  $m$  is 0,  $-Ar_1-(L_1)_{a1}-Ar_2-N[(L_{13})_{a13}-Ar_{13}]$  may be a single bond, and when  $m$  is two or more, two or more  $-Ar_1-(L_1)_{a1}-Ar_2-N[(L_{13})_{a13}-Ar_{13}]$ -(s) may be identical to or different from each other,

[0018]  $L_1$  and  $L_{11}$  to  $L_{14}$  may each independently be selected from a single bond, a substituted or unsubstituted  $C_5-C_{60}$  carbocyclic group, and a substituted or unsubstituted  $C_1-C_{60}$  heterocyclic group,

[0019]  $a_1$  and  $a_{11}$  to  $a_{14}$  may each independently be an integer from 1 to 5,

[0020] when  $a_1$  is two or more, two or more  $L_1(s)$  may be identical to or different from each other, when  $a_{11}$  is two or more, two or more  $L_{11}(s)$  may be identical to or different from each other, when  $a_{12}$  is two or more, two or more  $L_{12}(s)$  may be identical to or different from each other, when  $a_{13}$  is two or more, two or more  $L_{13}(s)$  may be identical to or different from each other, and when  $a_{14}$  is two or more, two or more  $L_{14}(s)$  may be identical to or different from each other,

[0021]  $Ar_1$ ,  $Ar_2$ , and  $Ar_{11}$  to  $Ar_{14}$  may each independently be selected from a substituted or unsubstituted  $C_5-C_{60}$  carbocyclic group and a substituted or unsubstituted  $C_1-C_{60}$  heterocyclic group, wherein at least one of  $Ar_1$ ,  $Ar_2$  and  $Ar_{11}$  to  $Ar_{14}$  is linked to  $-(L_0)_{a0}-(X)_b$  in Formula 1,

[0022] two groups selected from  $Ar_1$ ,  $Ar_2$ , and  $Ar_{11}$  to  $Ar_{14}$  may optionally be linked via single bond to form a condensed polycyclic group,

[0023] in Formula 2-1,

[0024]  $Y$  may be sulfur (S), nitrogen (N), or oxygen (O),

[0025]  $Z$  may be sulfur (S) or oxygen (O),

**[0026]**  $L_{21}$  may be selected from a single bond, a substituted or unsubstituted  $C_1$ - $C_{20}$  alkylene group, a substituted or unsubstituted  $C_2$ - $C_{20}$  alkenylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylene group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

**[0027]**  $a_{21}$  may be an integer from 1 to 3, wherein, when  $a_{21}$  is two or more, two or more  $L_{21}(s)$  may be identical to or different from each other,

**[0028]**  $R_1$  may be selected from hydrogen, deuterium (-D), -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted  $C_1$ - $C_{60}$  alkyl group, a substituted or unsubstituted  $C_2$ - $C_{60}$  alkenyl group, a substituted or unsubstituted  $C_2$ - $C_{60}$  alkynyl group, a substituted or unsubstituted  $C_1$ - $C_{60}$  alkoxy group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryloxy group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylthio group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,

**[0029]** at least one substituent of the substituted  $C_5$ - $C_{60}$  carbocyclic group, the substituted  $C_1$ - $C_{60}$  heterocyclic group, the substituted  $C_1$ - $C_{20}$  alkylene group, the substituted  $C_2$ - $C_{20}$  alkenylene group, the substituted  $C_2$ - $C_{20}$  alkynylene 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:

**[0030]** deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $C_1$ - $C_{60}$  alkyl group, a  $C_2$ - $C_{60}$  alkenyl group, a  $C_2$ - $C_{60}$  alkynyl group, and a  $C_1$ - $C_{60}$  alkoxy group;

**[0031]** a  $C_1$ - $C_{60}$  alkyl group, a  $C_2$ - $C_{60}$  alkenyl group, a  $C_2$ - $C_{60}$  alkynyl group, and a  $C_1$ - $C_{60}$  alkoxy group, each substituted with at least one selected from deuterium, -F,

-Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $C_3$ - $C_{10}$  cycloalkyl group, a  $C_1$ - $C_{10}$  heterocycloalkyl group, a  $C_3$ - $C_{10}$  cycloalkenyl group, a  $C_1$ - $C_{10}$  heterocycloalkenyl group, a  $C_6$ - $C_{60}$  aryl group, a  $C_6$ - $C_{60}$  aryloxy group, a  $C_6$ - $C_{60}$  arylthio group, a  $C_1$ - $C_{60}$  heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si( $Q_{11}$ )( $Q_{12}$ )( $Q_{13}$ ), -N( $Q_{11}$ )( $Q_{12}$ ), -B( $Q_{11}$ )( $Q_{12}$ ), -C(=O)( $Q_{11}$ ), -S(=O)<sub>2</sub>( $Q_{11}$ ), and -P(=O)( $Q_{11}$ )( $Q_{12}$ );

**[0032]** 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, a biphenyl group, and a terphenyl group;

**[0033]** 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, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $C_1$ - $C_{60}$  alkyl group, a  $C_2$ - $C_{60}$  alkenyl group, a  $C_2$ - $C_{60}$  alkynyl group, a  $C_1$ - $C_{60}$  alkoxy group, a  $C_3$ - $C_{10}$  cycloalkyl group, a  $C_1$ - $C_{10}$  heterocycloalkyl group, a  $C_3$ - $C_{10}$  cycloalkenyl group, a  $C_1$ - $C_{10}$  heterocycloalkenyl group, a  $C_6$ - $C_{60}$  aryl group, a  $C_6$ - $C_{60}$  aryloxy group, a  $C_6$ - $C_{60}$  arylthio group, a  $C_1$ - $C_{60}$  heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si( $Q_{21}$ )( $Q_{22}$ )( $Q_{23}$ ), -N( $Q_{21}$ )( $Q_{22}$ ), -B( $Q_{21}$ )( $Q_{22}$ ), -C(=O)( $Q_{21}$ ), -S(=O)<sub>2</sub>( $Q_{21}$ ), and -P(=O)( $Q_{21}$ )( $Q_{22}$ ); and

**[0034]** -Si( $Q_{31}$ )( $Q_{32}$ )( $Q_{33}$ ), -N( $Q_{31}$ )( $Q_{32}$ ), -B( $Q_{31}$ )( $Q_{32}$ ), -C(=O)( $Q_{31}$ ), -S(=O)<sub>2</sub>( $Q_{31}$ ), and -P(=O)( $Q_{31}$ )( $Q_{32}$ ), and

**[0035]**  $Q_{11}$  to  $Q_{13}$ ,  $Q_{21}$  to  $Q_{23}$ ,  $Q_{31}$  to  $Q_{33}$ , and  $Q_{41}$  to  $Q_{42}$  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 hydrazino group, a hydrazono group, a  $C_1$ - $C_{60}$  alkyl group, a  $C_2$ - $C_{60}$  alkenyl group, a  $C_2$ - $C_{60}$  alkynyl group, a  $C_1$ - $C_{60}$  alkoxy group, a  $C_3$ - $C_{10}$  cycloalkyl group, a  $C_1$ - $C_{10}$  heterocycloalkyl group, a  $C_3$ - $C_{10}$  cycloalkenyl group, a  $C_1$ - $C_{10}$  heterocycloalkenyl group, a  $C_6$ - $C_{60}$  aryl group, a  $C_1$ - $C_{60}$  heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group.

**[0036]** Another aspect of an embodiment provides an organic light-emitting device including: a first electrode; a second electrode facing a first electrode; and an organic layer between the first electrode and the second electrode and including an emission layer, wherein the organic layer includes an arylamine-based compound in which a thermally decomposable group is (or has been) thermally decomposed and removed from the arylamine-based compound including the thermally decomposable group.

**[0037]** Another aspect of an embodiment provides an electronic apparatus including a thin film transistor and the

organic light-emitting device, wherein the thin film transistor includes a source electrode, a drain electrode, an active layer, and a gate electrode, and the first electrode of the organic light-emitting device is electrically coupled to one of the source electrode and the drain electrode of the thin film transistor.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0038] These and/or other aspects of embodiments will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

[0039] FIG. 1 is a schematic view of an organic light-emitting device according to an embodiment;

[0040] FIG. 2 is a schematic view of an organic light-emitting device according to an embodiment;

[0041] FIG. 3 is a schematic view of an organic light-emitting device according to an embodiment; and

[0042] FIG. 4 is a schematic view of an organic light-emitting device according to an embodiment.

#### DETAILED DESCRIPTION

[0043] Reference will now be made in more 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 embodiments 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.

[0044] An arylamine-based compound including a thermally decomposable group may be represented by Formula 1:



[0045]  $A_1$  may be a group represented by Formula 2, which will be described below.

[0046]  $L_0$  may be a single bond,  $*(CH_2)_p-*$ ,  $*(CH_2)_p-O-*$ ,  $*O-(CH_2)_q-*$ ,  $*(CH_2)_p-O-(CH_2)_q-*$ ,  $*(CH_2)_p-O-(CH_2)_r-*$ ,  $*(CH_2)_p-S-*$ ,  $*S-(CH_2)_q-*$ , or  $*(CH_2)_p-S-(CH_2)_q-*$ , and

[0047]  $p$ ,  $q$ , and  $r$  may each independently be an integer from 1 to 5, and  $*$  and  $^*$  each indicate a binding site to a neighboring atom.

[0048] In one embodiment, in Formula 1,  $L_0$  may be selected from a single bond,  $*(CH_2)_p-*$ ,  $*O-(CH_2)_q-*$ , and  $*(CH_2)_p-O-(CH_2)_q-*$ , but embodiments of the present disclosure are not limited thereto.

[0049] For example, in Formula 1,  $L_0$  may be selected from  $*(CH_2)_p-*$ ,  $*O-(CH_2)_q-*$ , and  $*(CH_2)_p-O-(CH_2)_q-*$ .

[0050]  $a_0$  may be an integer from 1 to 100, and when  $n_1$  is two or more, two or more  $L_0(s)$  may be identical to or different from each other. In one embodiment,  $a_0$  may be 1, 2, or 3, but embodiments of the present disclosure are not limited thereto. For example,  $a_0$  may be 1 or 2.

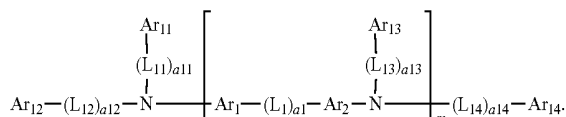
[0051]  $X$  may be a thermally decomposable group represented by Formula 2-1, which will be described in more detail herein below, and when  $L_0$  is a single bond,  $^*$  may be a binding site to  $A_1$ , and when  $L_0$  is not a single bond,  $^*$  may be a binding site to  $L_0$ .

[0052] The term “thermally decomposable group,” as used herein, may mean a group that is (or can be) decomposed and removed at a set temperature or more (e.g., 100° C. to 300° C.).

[0053]  $b$  may be an integer from 1 to 100, wherein, when  $b$  is two or more, two or more  $X(s)$  may be identical to or different from each other. In one embodiment,  $b$  may be an integer from 1 to 4, but embodiments of the present disclosure are not limited thereto. For example,  $b$  may be 1 or 2.

[0054] A group represented by Formula 2 will now be described in more detail.

Formula 2



[0055] In Formula 2,  $m$  may be an integer from 0 to 100. In one embodiment,  $m$  may be an integer from 1 to 100, but embodiments of the present disclosure are not limited thereto. For example,  $m$  may be 1.

[0056] In Formula 2, when  $m$  is 0,  $-Ar_1-(L_1)_{a_1}-Ar_2-N$  [ $(L_{13})_{a_{13}}-Ar_{13}$ ]- may be a single bond, and when  $m$  is two or more, two or more  $-Ar_1-(L_1)_{a_1}-Ar_2-N$  [ $(L_{13})_{a_{13}}-Ar_{13}$ ]- ( $s$ ) may be identical to or different from each other.

[0057] For example, when  $m$  is 0,  $N$  and  $(L_{14})_{a_{14}}$  may be linked via a single bond.

[0058] In Formula 2,  $L_1$  and  $L_{11}$  to  $L_{14}$  may each independently be selected from a single bond, a substituted or unsubstituted  $C_5-C_{60}$  carbocyclic group, and a substituted or unsubstituted  $C_1-C_{60}$  heterocyclic group.

[0059] In one embodiment,  $L_1$  and  $L_{11}$  to  $L_{14}$  may each independently be selected from:

[0060] a single bond;

[0061] a benzene group, a naphthalene group, a fluorene group, a phenalene group, a phenanthrene group, an anthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group; and

[0062] a benzene group, a naphthalene group, a fluorene group, a phenalene group, a phenanthrene group, an anthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole

group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group;

**[0063]** but embodiments of the present disclosure are not limited thereto.

**[0064]** In Formula 2, a<sub>1</sub> and a<sub>11</sub> to a<sub>14</sub> may each independently be an integer from 1 to 5, wherein, when a<sub>1</sub> is two or more, two or more of L<sub>1</sub>(s) may be identical to or different from each other, when a<sub>11</sub> is two or more, two or more of L<sub>11</sub>(s) may be identical to or different from each other, when a<sub>12</sub> is two or more, two or more of L<sub>12</sub>(s) may be identical to or different from each other, when a<sub>13</sub> is two or more, two or more of L<sub>13</sub>(s) may be identical to or different from each other, and when a<sub>14</sub> is two or more, two or more of L<sub>14</sub>(s) may be identical to or different from each other.

**[0065]** In Formula 2, Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> may each independently be selected from a substituted or unsubstituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group and a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group, wherein at least one group selected from Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> may be bound to -(L<sub>0</sub>)<sub>a0</sub>-(X)<sub>b</sub> in Formula 1, and two groups selected from Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> may optionally be linked each other via a single bond, to form a condensed polycyclic group.

**[0066]** In one embodiment, Ar<sub>11</sub> to Ar<sub>14</sub> may each independently be selected from:

**[0067]** a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;

azolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group; and

**[0068]** a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;

**[0069]** but embodiments of the present disclosure are not limited thereto.

**[0070]** For example, Ar<sub>11</sub> to Ar<sub>14</sub> may each independently be selected from a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, and an azacarbazolyl group; and

[0071] a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, and an azacarbazolyl group.

[0072] In one embodiment, Ar<sub>1</sub> and Ar<sub>2</sub> may each independently be selected from:

[0073] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a fluoranthenylenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylenylene group, a hexacenylenylene group, a pentacenylenylene group, a thiophenylenylene group, a furanylene group, a carbazolylene group, an indolylenylene group, an isoindolylenylene group, a benzofuranylene group, a benzothiophenylenylene group, a dibenzofuranylene group, a dibenzothiophenylenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylenylene group, a pyridinylenylene group, an imidazolylene group, a pyrazolylenylene group, a thiazolylenylene group, an isothiazolylenylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylenylene group, an oxadiazolylenylene group, a pyrazinylenylene group, a pyrimidinylenylene group, a pyridazinylenylene group, a triazinylenylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylenylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylenylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group; and

[0074] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a fluoranthenylenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylenylene group, a hexacenylenylene group, a pentacenylenylene group, a thiophenylenylene group, a furanylene group, a carbazolylene group, an indolylenylene group, an isoindolylenylene group, a benzofuranylene group, a benzothiophenylenylene group, a dibenzofuranylene group, a dibenzothiophenylenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylenylene group, a pyridinylenylene group, an imidazolylene group, a pyrazolylenylene group, a thiazolylenylene group, an isothiazolylenylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylenylene group, an oxadiazolylenylene group, a pyrazinylenylene group, a pyrimidinylenylene group, a pyridazinylenylene group, a triazinylenylene group, a quinolinylene

group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylenylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylenylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;

[0075] but embodiments of the present disclosure are not limited thereto.

[0076] For example, Ar<sub>1</sub> and Ar<sub>2</sub> may each independently be selected from:

[0077] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a carbazolylene group, a dibenzofuranylene group, a dibenzothiophenylenylene group, a dibenzosilolylenylene group, and an azacarbazolylene group; and

[0078] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a carbazolylene group, a dibenzofuranylene group, a dibenzothiophenylenylene group, a dibenzosilolylenylene group, and an azacarbazolylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, and an azacarbazolyl group.

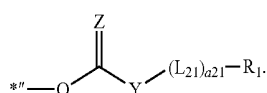
**[0079]** In one embodiment, Ar<sub>1</sub> and Ar<sub>2</sub> may be the same group.

**[0080]** In Formula 2, two groups selected from Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> may optionally be linked each other via a single bond to form a condensed polycyclic group.

**[0081]** In one embodiment, Ar<sub>11</sub> and Ar<sub>12</sub>, or Ar<sub>13</sub> and Ar<sub>14</sub> may be linked each other via a single bond to form a carbazole group. For example, L<sub>11</sub> and L<sub>12</sub> may each be a single bond, and Ar<sub>11</sub> and Ar<sub>12</sub> may each be a phenyl group, wherein Ar<sub>11</sub> and Ar<sub>12</sub> may be linked each other via a single bond to form a carbazole group along with Ar<sub>11</sub>, N, and Ar<sub>12</sub>.

**[0082]** In one or more embodiments, Ar<sub>11</sub> and Ar<sub>1</sub>, or Ar<sub>13</sub> and Ar<sub>2</sub> may be linked each other via a single bond to form a carbazole group. For example, L<sub>11</sub> may be a single bond, m may be 1 or greater, Ar<sub>11</sub> and Ar<sub>1</sub> may each be a phenyl group, and Ar<sub>11</sub> and Ar<sub>1</sub> may be linked via a single bond to form a carbazole group along with Ar<sub>11</sub>, N, and Ar<sub>1</sub>.

**[0083]** A group represented by Formula 2-1 below will now be described in more detail herein below:



Formula 2-1

**[0084]** In Formula 2-1, Y may be sulfur (S), nitrogen (N), or oxygen (O).

**[0085]** In one embodiment, Y may be S or O.

**[0086]** In one embodiment, in Formula 2-1, Z may be S or O.

**[0087]** In one embodiment, in Formula 2-1, Y may be S, and Z may be S; Y may be S, and Z may be O; Y may be O, and Z may be S; or Y may be O, and Z may be O, but embodiments of the present disclosure are not limited thereto.

**[0088]** In Formula 2-1, L<sub>21</sub> may be selected from a single bond, a substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkylene group, a substituted or unsubstituted C<sub>2</sub>-C<sub>20</sub> alkenylene group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group.

**[0089]** In one embodiment, L<sub>21</sub> may be a linear or branched substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkylene group, or a linear or branched substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, but embodiments of the present disclosure are not limited thereto.

**[0090]** For example, in Formula 2-1, a  $^{*}-(L_{21})_{a21}-^{*}$  moiety may be  $^{*}-C(R_2)(R_3)-^{*}$ ,

**[0091]** wherein R<sub>2</sub> and R<sub>3</sub> 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 hydrazino group, a hydrazono group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, and a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, and

**[0092]** R<sub>2</sub> and R<sub>3</sub> may optionally be linked to form a substituted or unsubstituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group.

**[0093]** For example, R<sub>2</sub> and R<sub>3</sub> may optionally be linked each other to form a substituted or unsubstituted 5-membered or 6-membered ring.

**[0094]** In Formula 2-1, a<sub>21</sub> may be an integer from 1 to 3, wherein, when a<sub>21</sub> is two or more, two or more of L<sub>21</sub>(s) may be identical to or different from each other.

**[0095]** In Formula 2-1, R<sub>1</sub> may be selected from hydrogen, deuterium (-D), —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkoxy group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> cycloalkyl group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylthio group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

**[0096]** In one embodiment, R<sub>1</sub> may be selected from:

**[0097]** a methyl group, an ethyl group, a propyl group, a butyl group, an ethenyl group and ethynyl group;

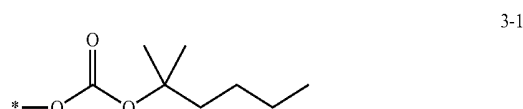
**[0098]** a methyl group, an ethyl group, a propyl group, a butyl group, an ethenyl group, and ethynyl group, each substituted with at least one selected from a methyl group, an ethyl group, a propyl group, and a butyl group;

**[0099]** a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group; and

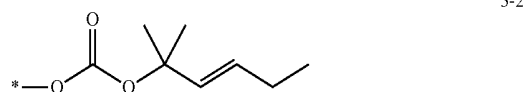
**[0100]** a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from a methyl group, an ethyl group, a propyl group, a butyl group, a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group;

**[0101]** but embodiments of the present disclosure are not limited thereto.

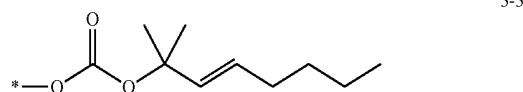
**[0102]** In one embodiment, the thermally decomposable group represented by Formula 2-1 may be selected from groups represented by Formulae 3-1 to 3-12, but embodiments of the present disclosure are not limited thereto:



3-1

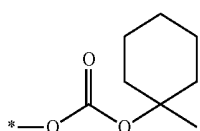
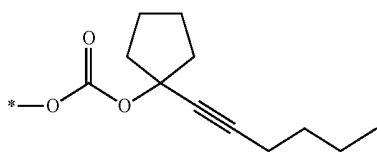
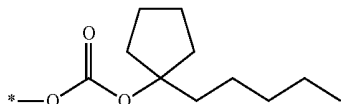
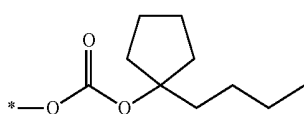
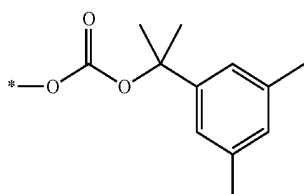
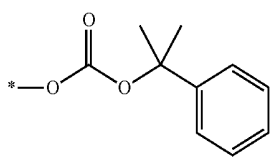


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3-3

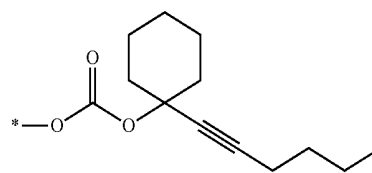
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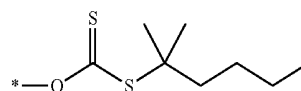
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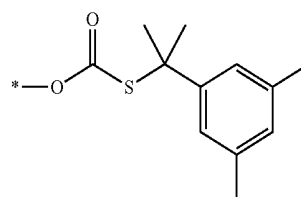
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3-11



3-6

3-12

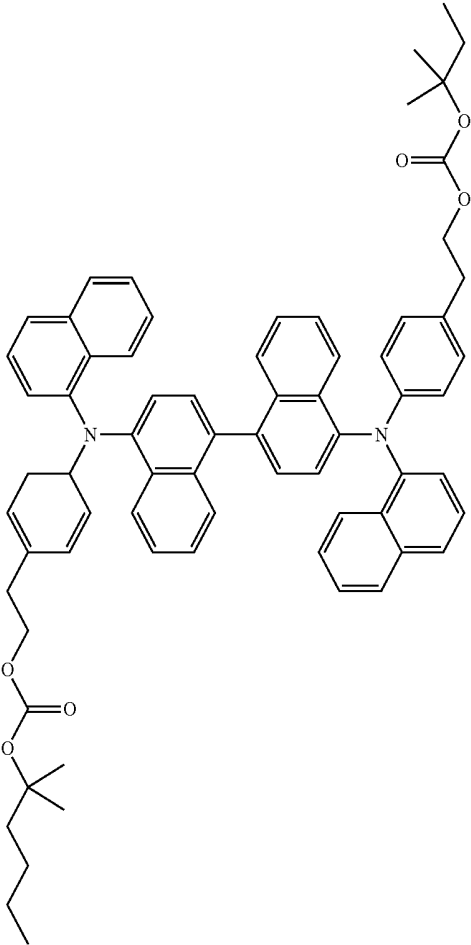


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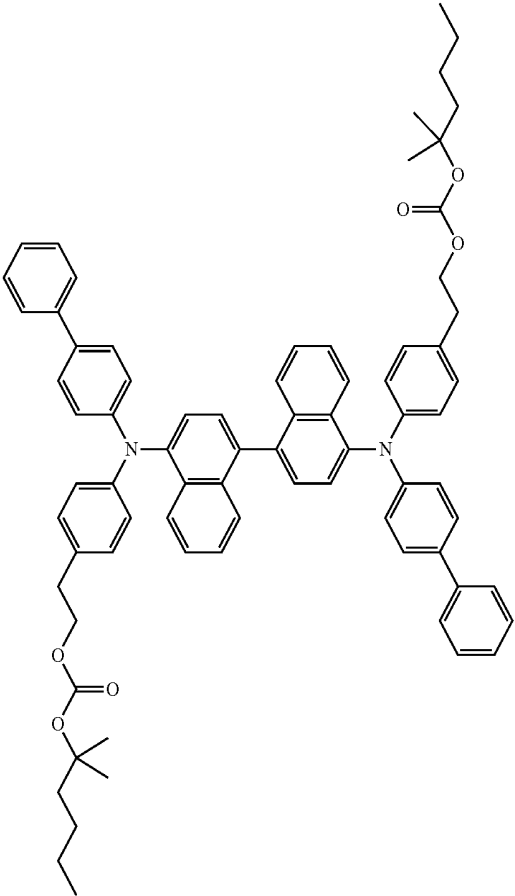
[0103] The arylamine-based compound including the thermally decomposable group may be selected from Compounds 1 to 44, but embodiments of the present disclosure are not limited thereto:

3-8

3-9



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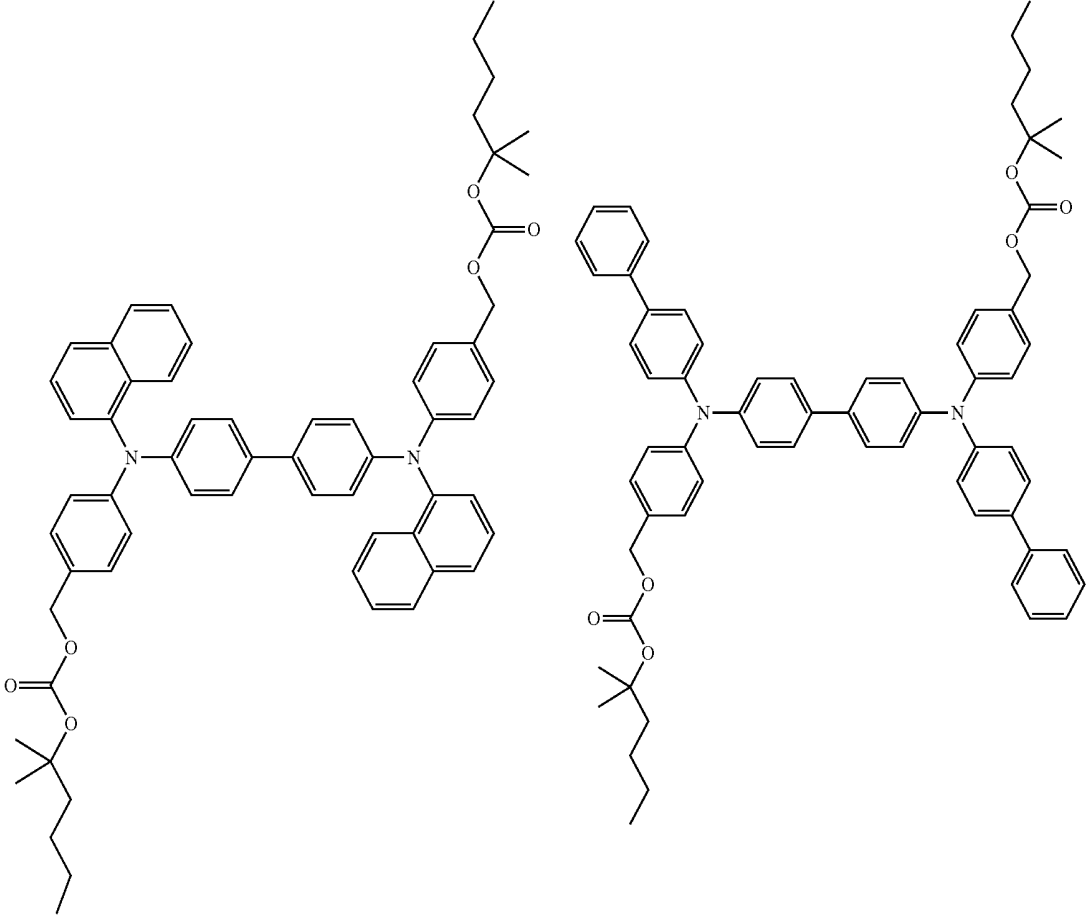


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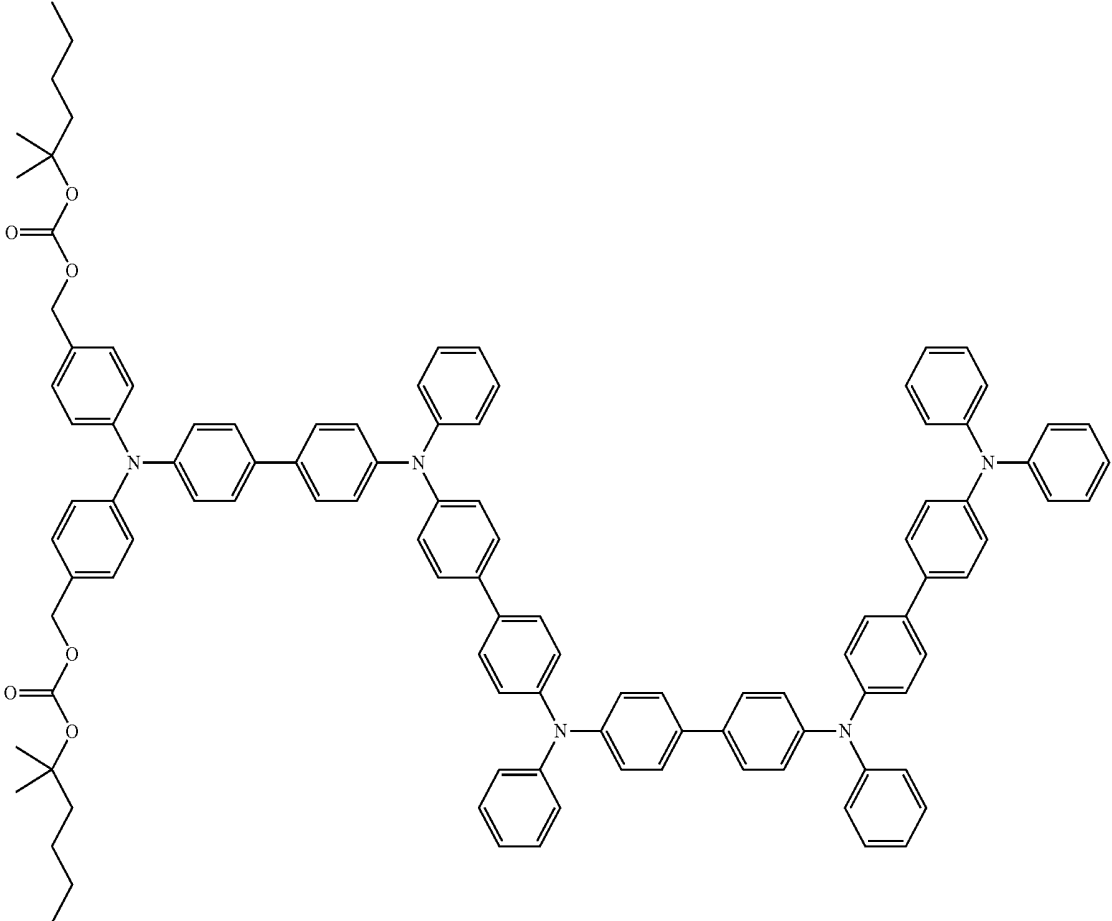
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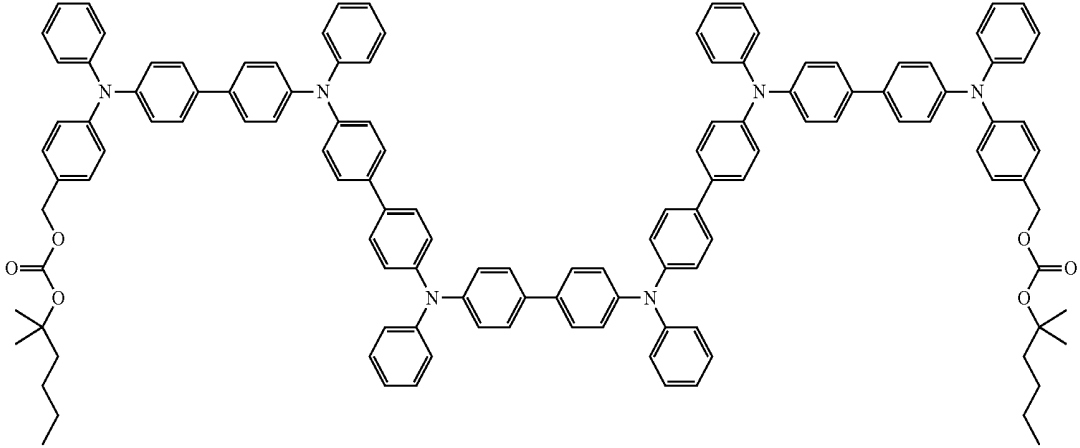


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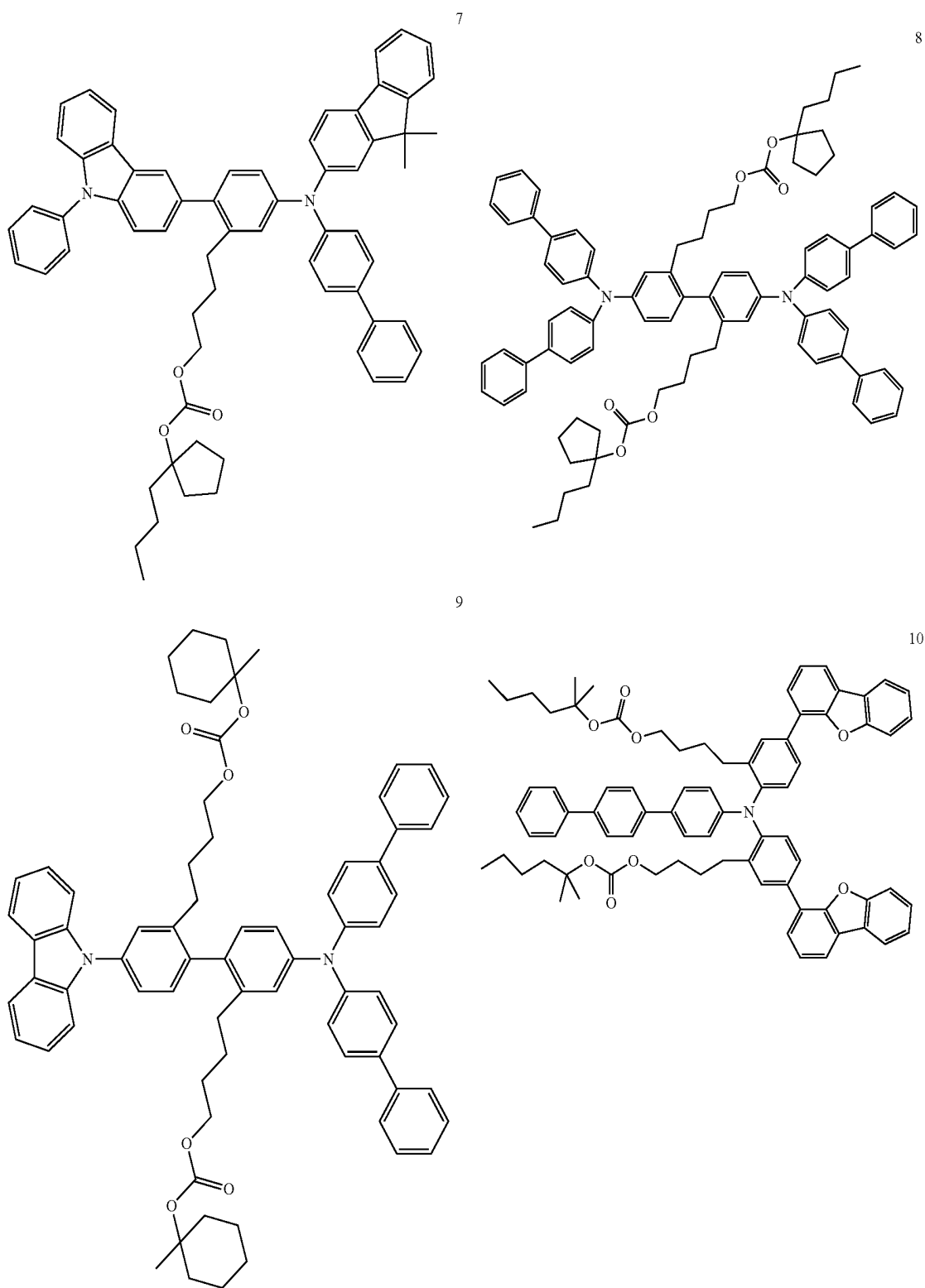
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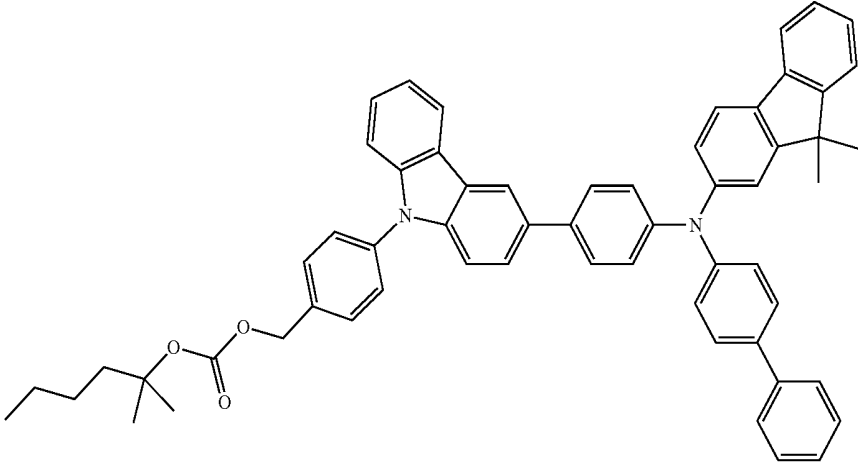


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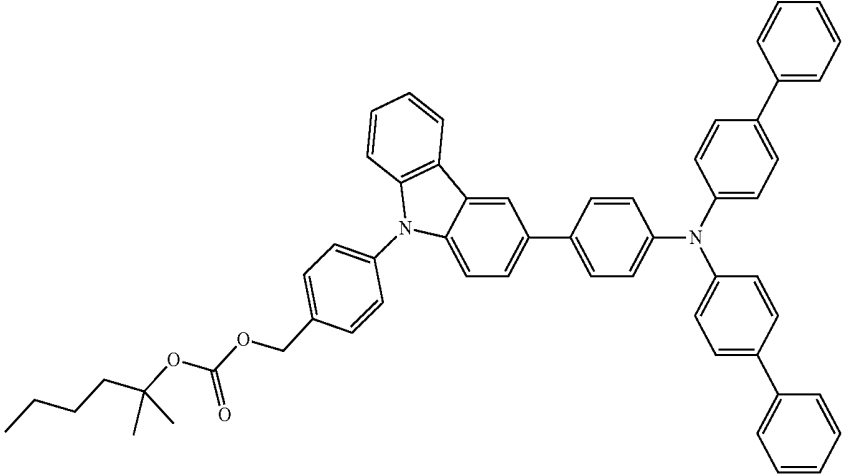


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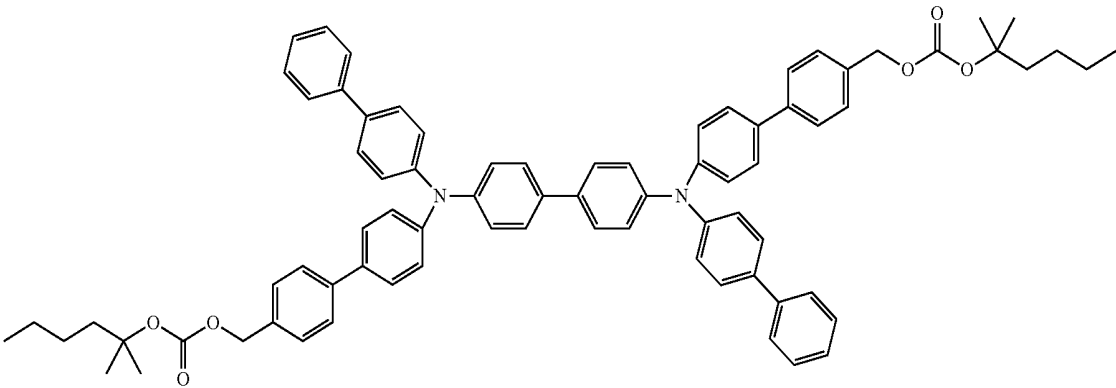
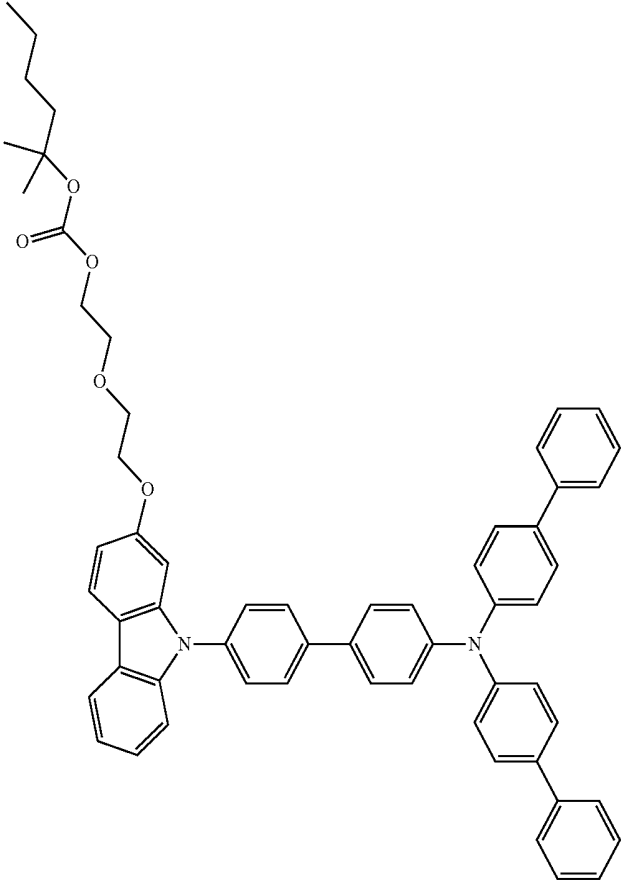
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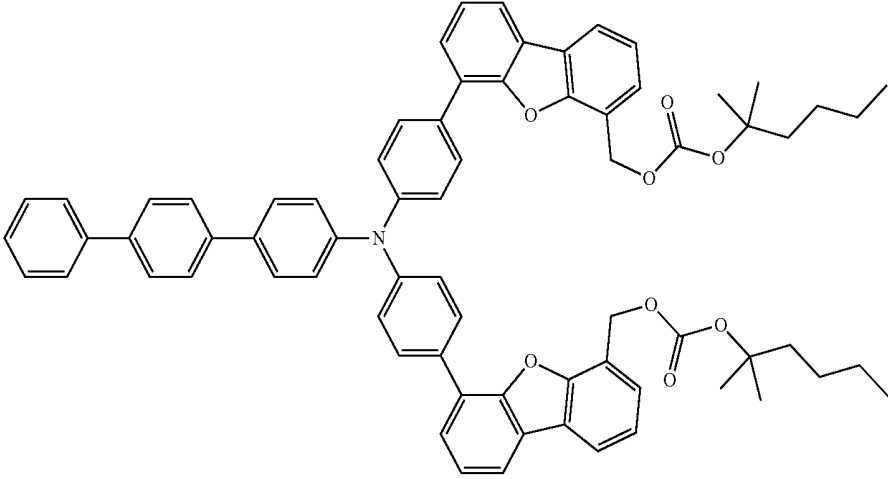


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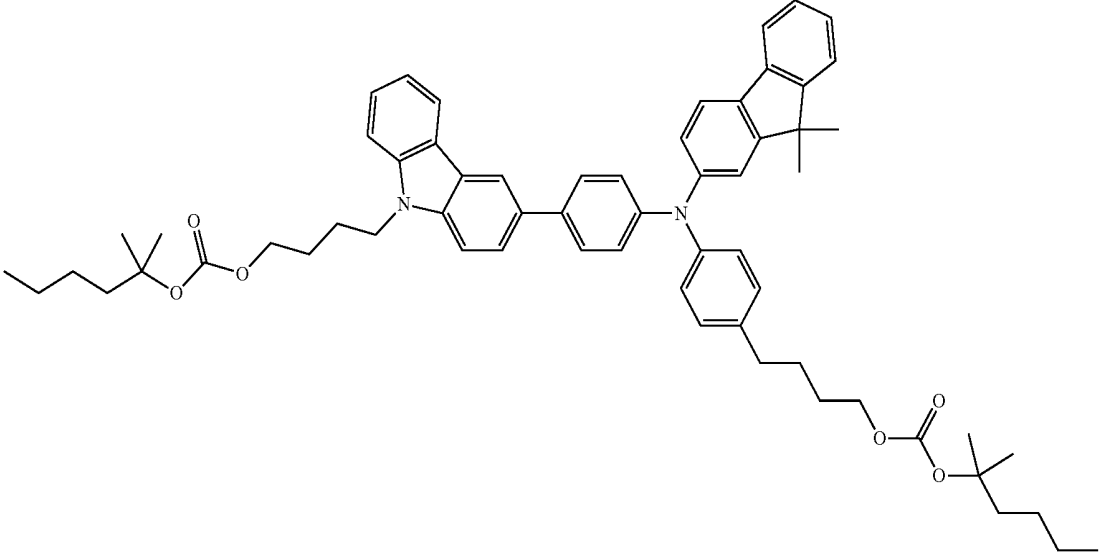


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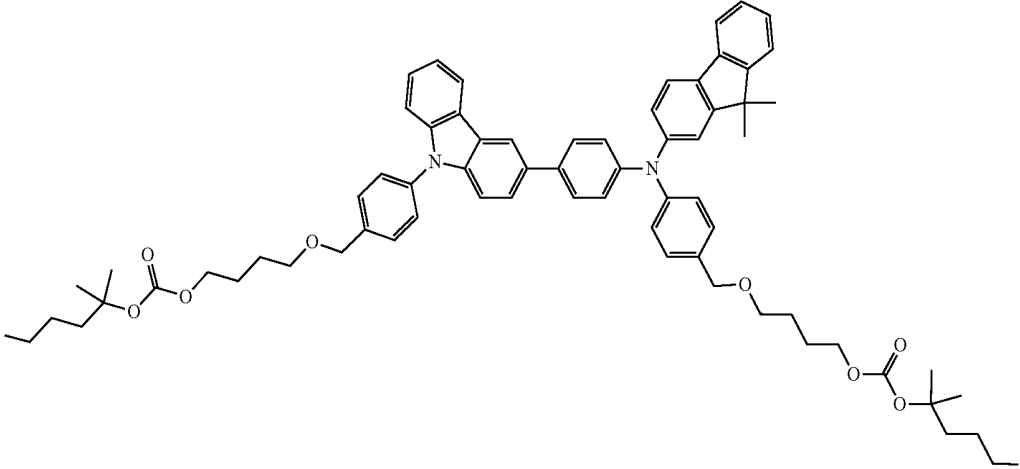
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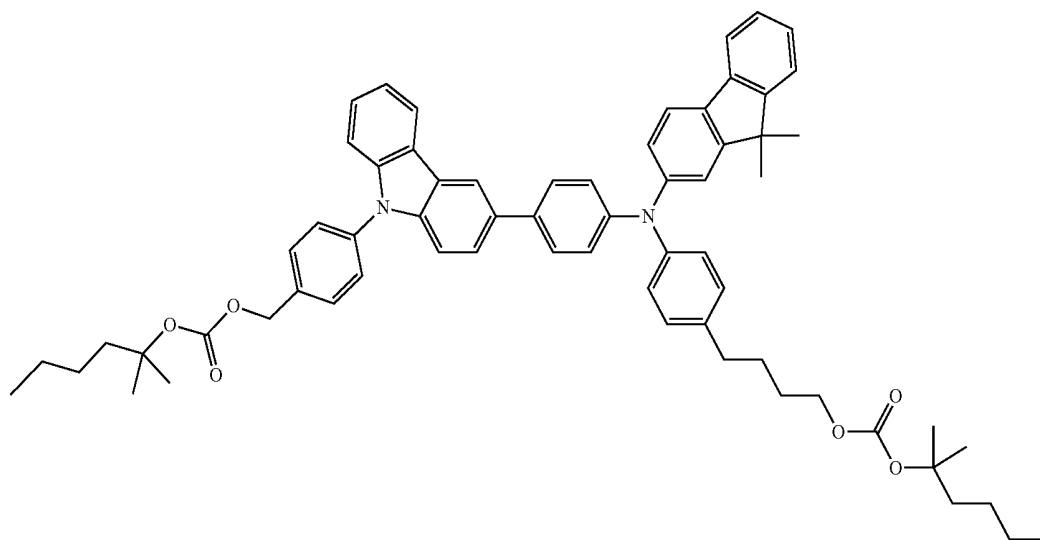


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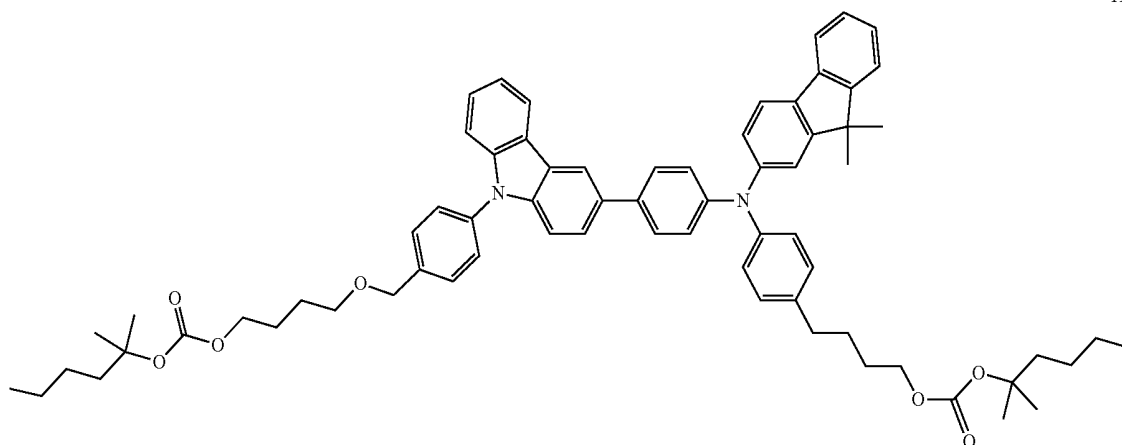


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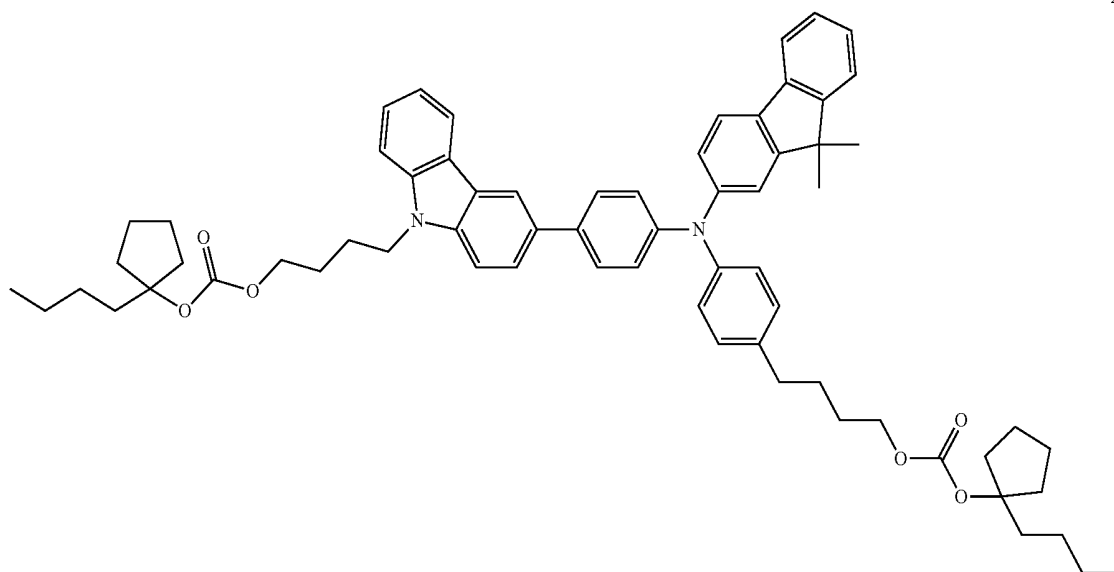
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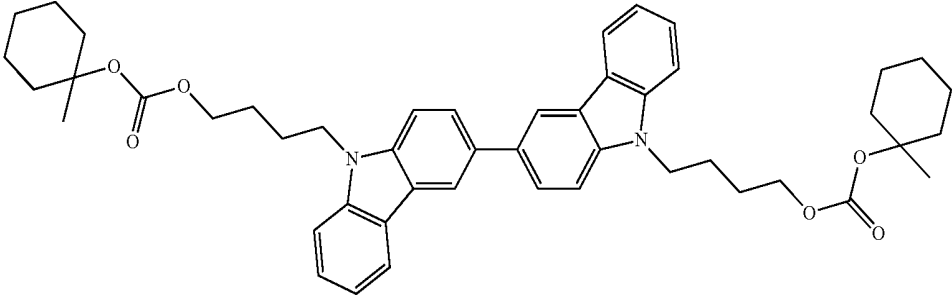
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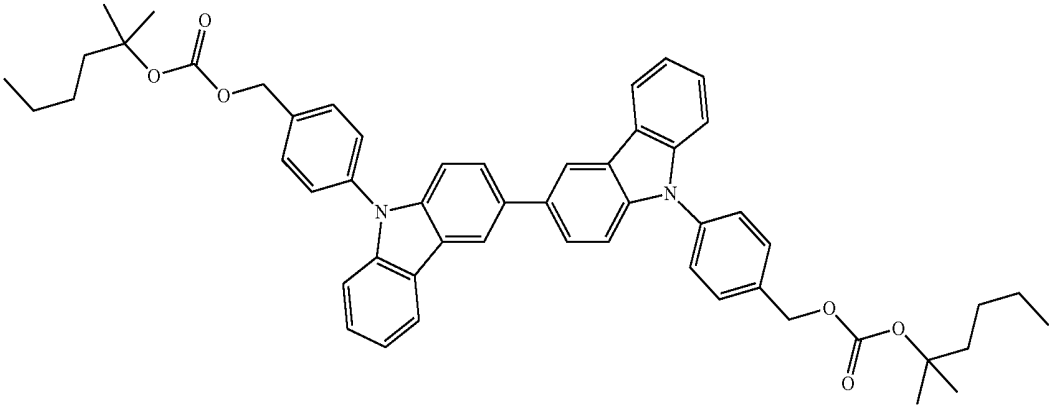


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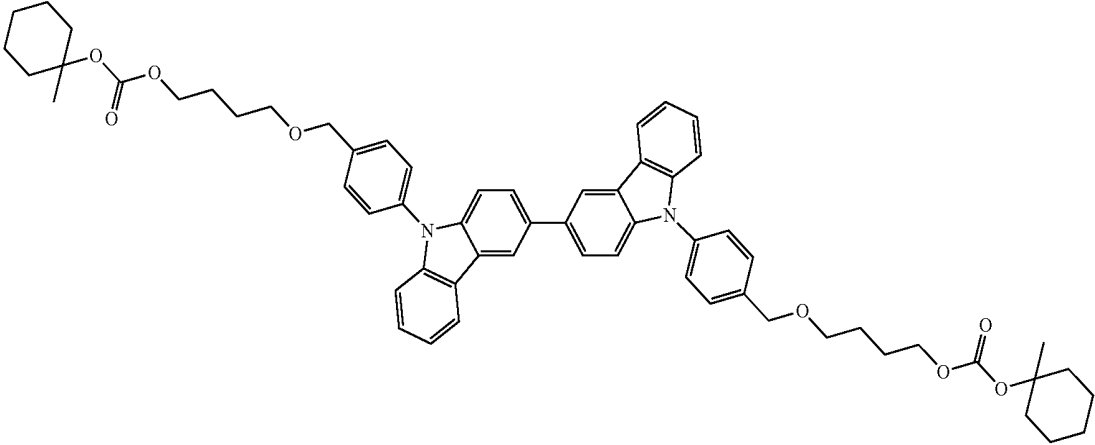
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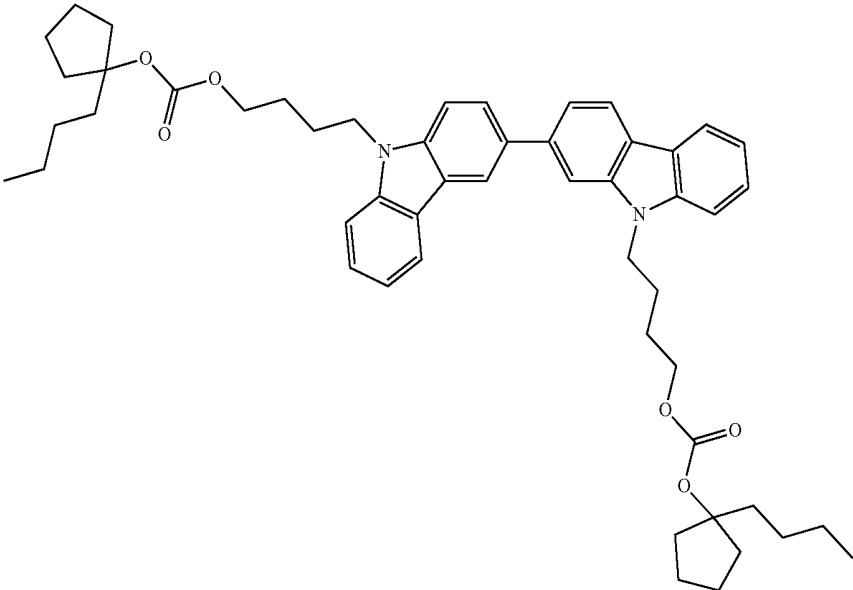


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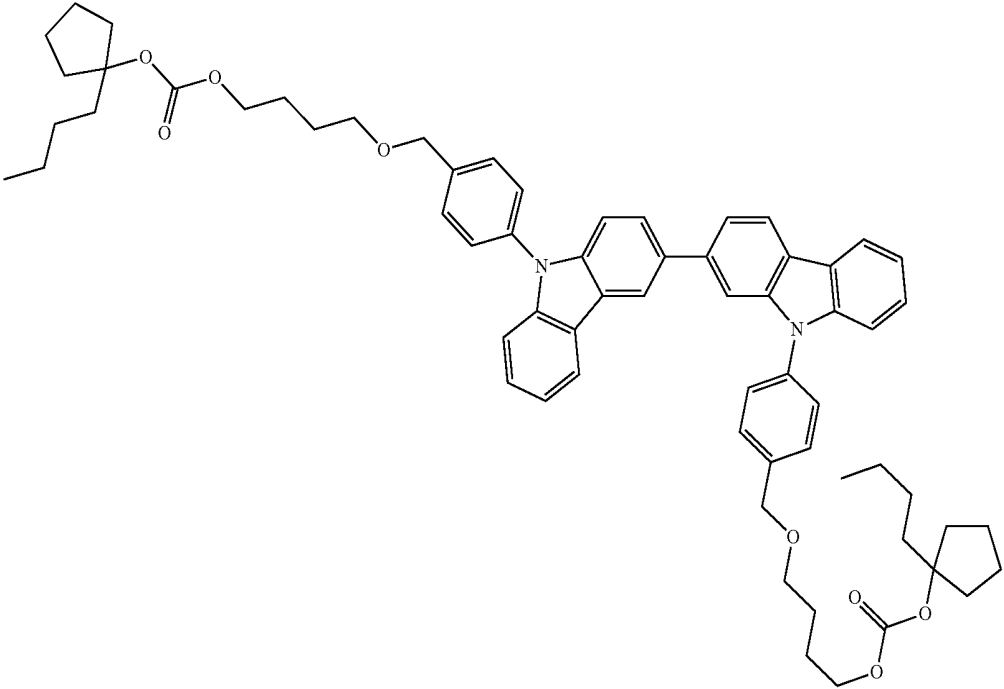


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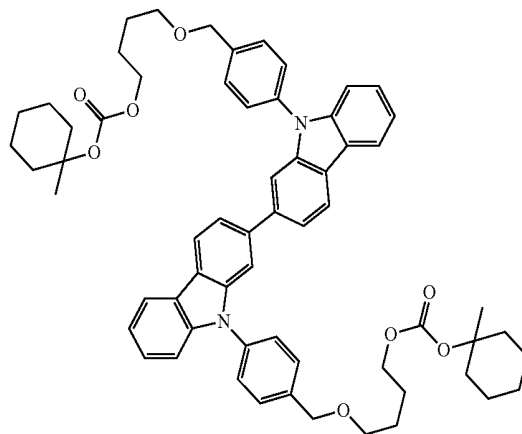
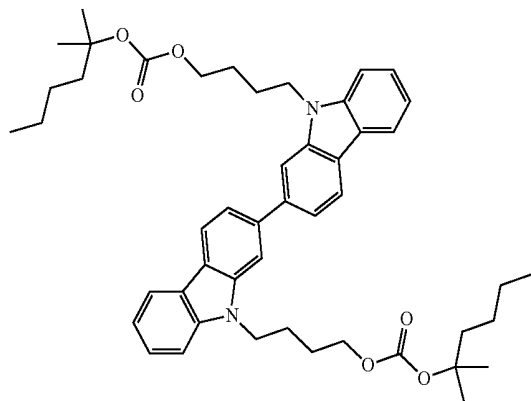
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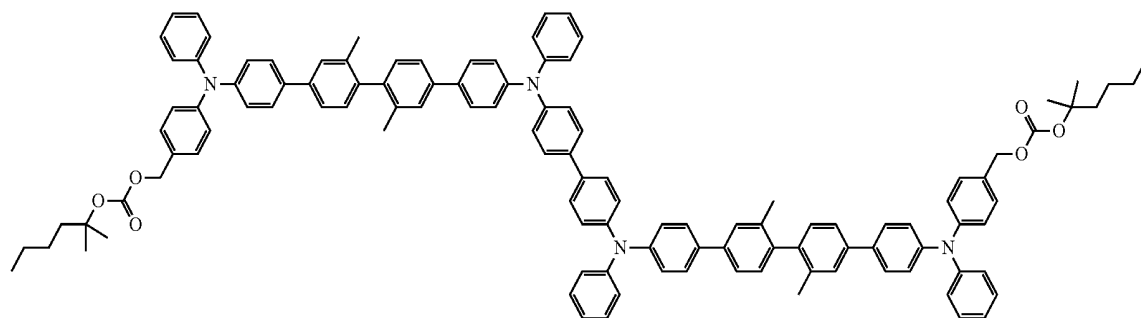
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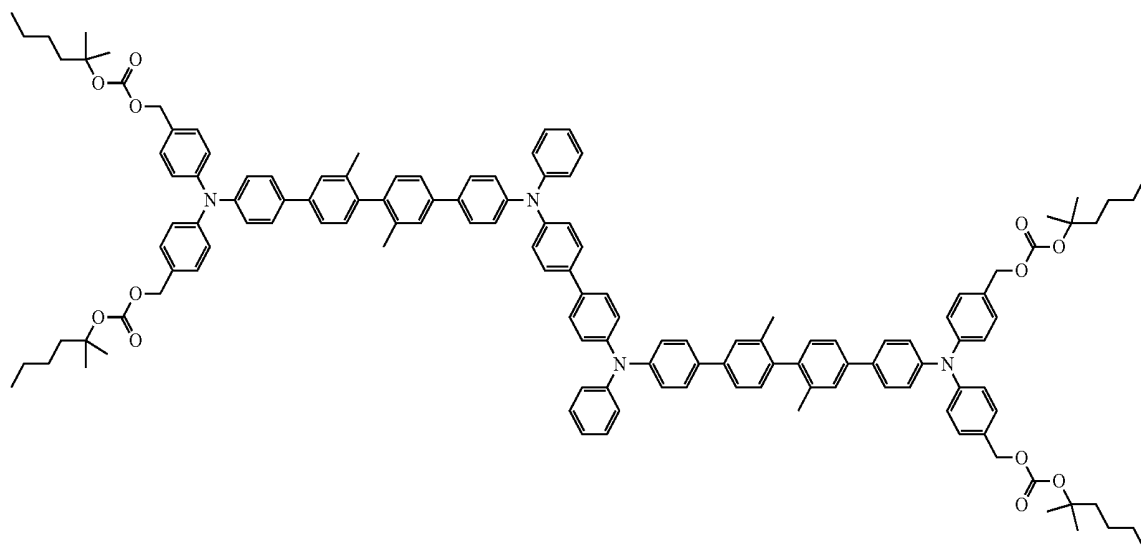
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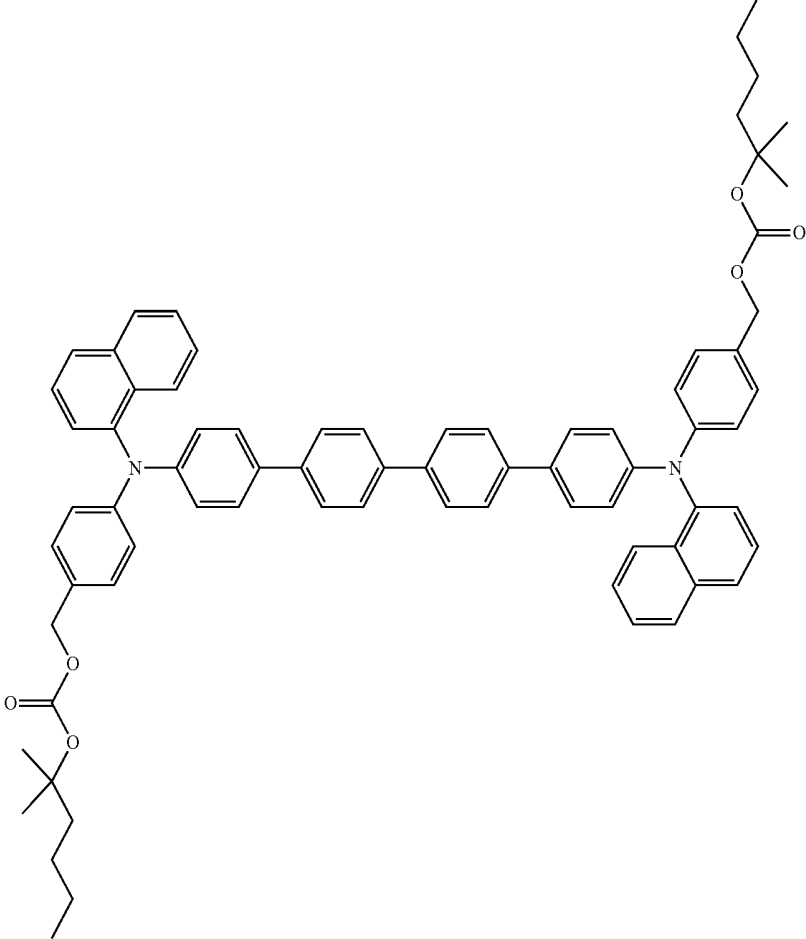


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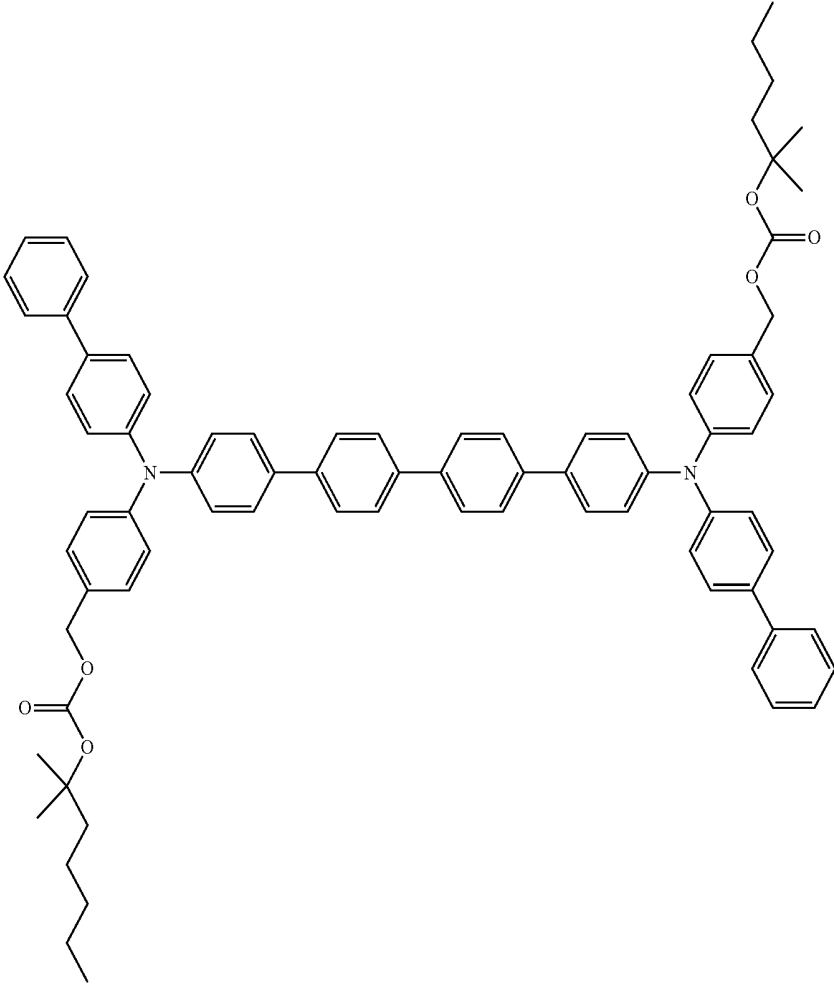


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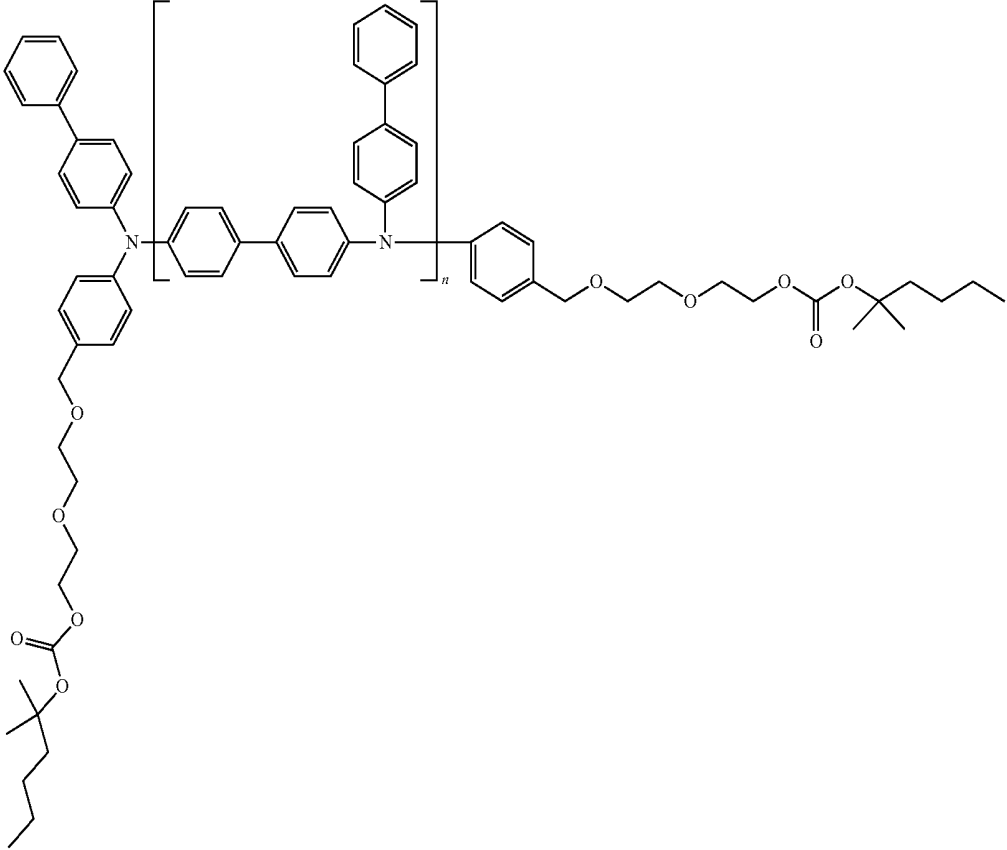






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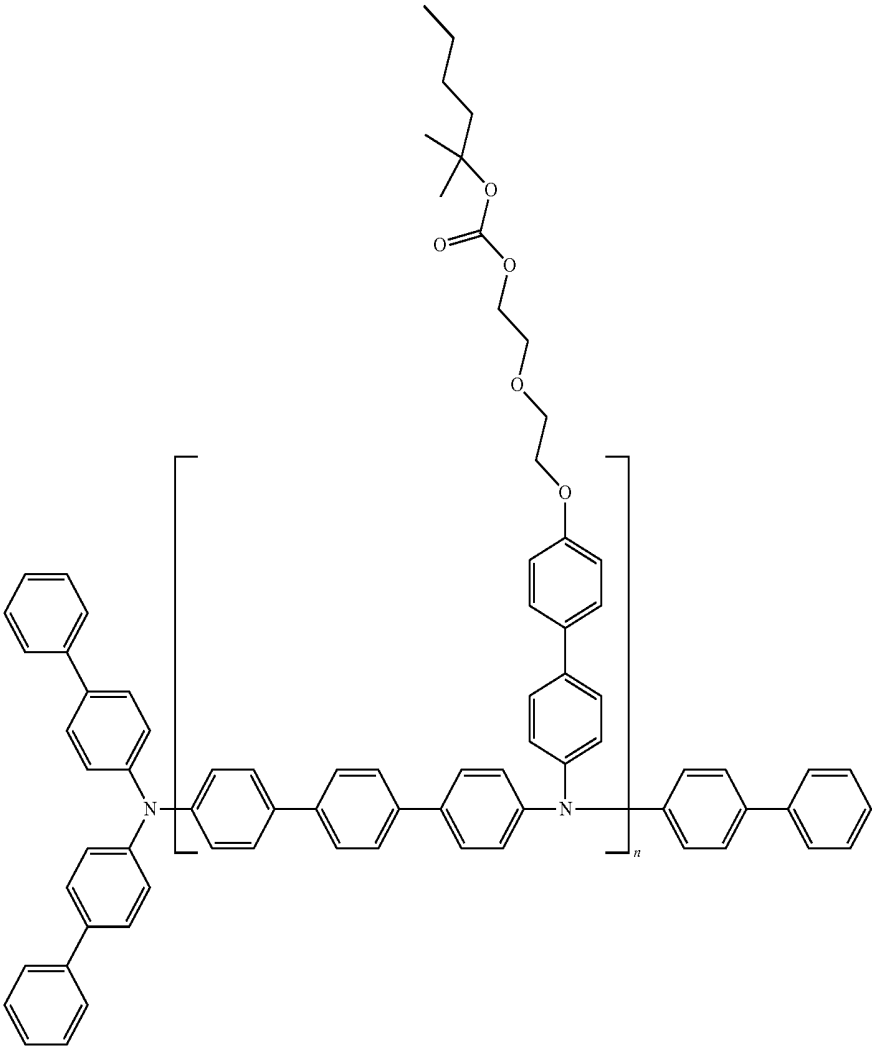
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n = 1~100

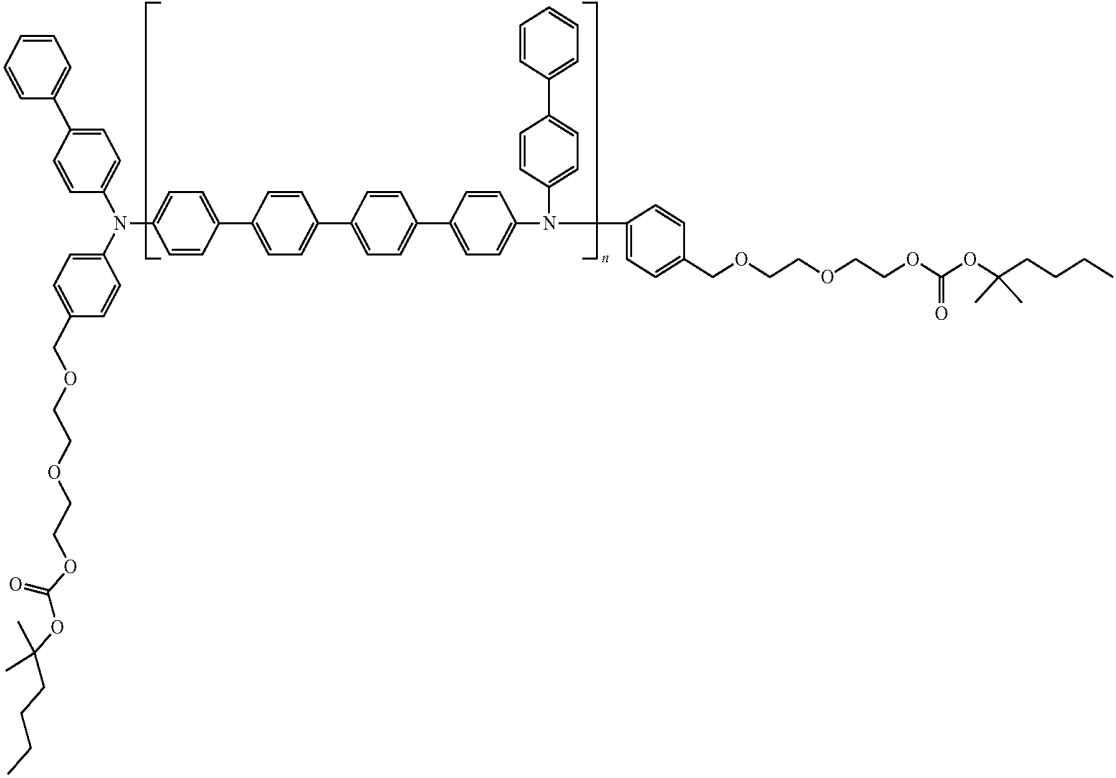


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n = 1~100

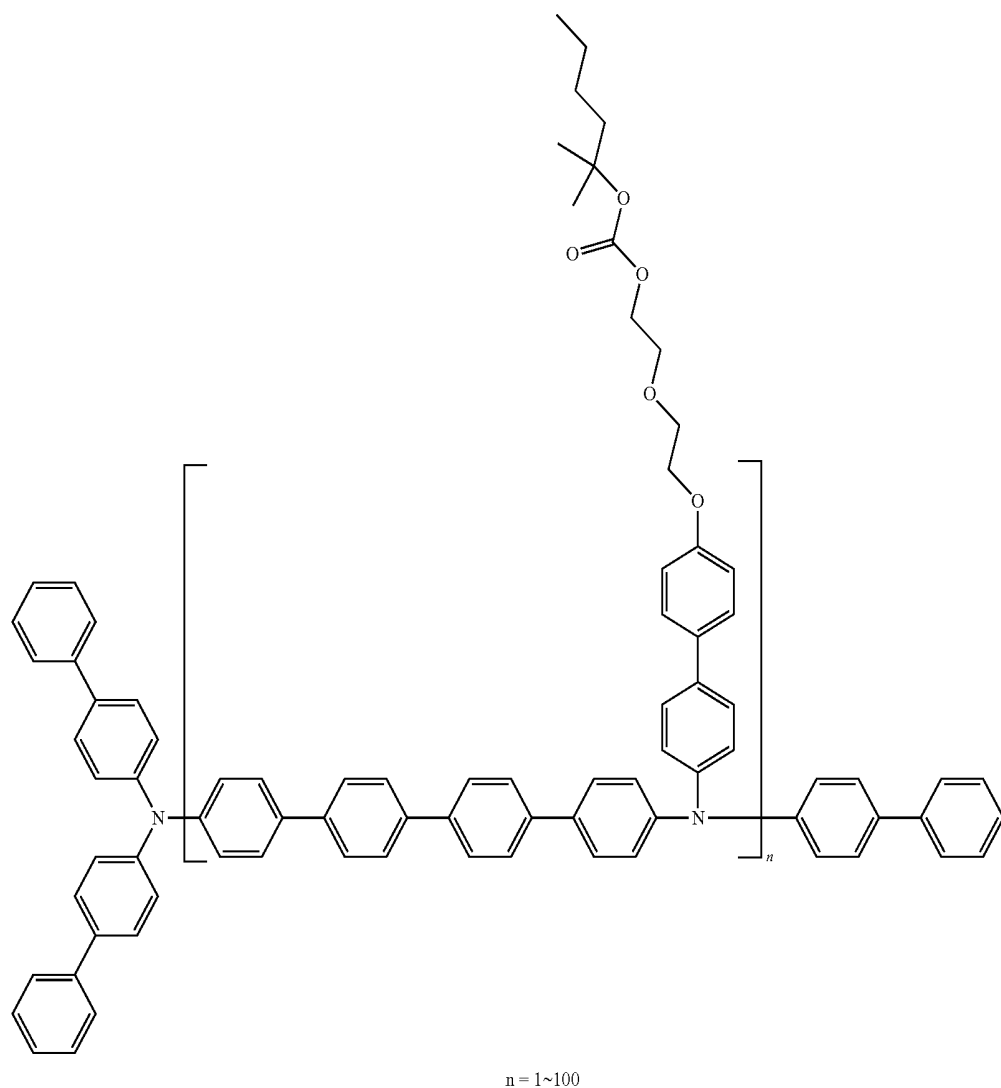
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n = 1~100

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**[0104]** Even when coated and heat-treated, the thermally decomposable group of the arylamine-based compound including the thermally decomposable group does not form a double bond as being bound to a primary carbon, so that a hydroxyl ( $-\text{OH}$ ) group remains after thermal decomposition and accordingly a solvent resistance may be secured in the process of forming an additional thin film. For example, in Formula 1, X may be a hydroxyl group ( $-\text{OH}$  group) after the thermally decomposable group has been thermally decomposed and removed. For example, the thermally decomposable group may be thermally decomposed and removed when  $\text{Z}=\text{C}-\text{Y}$  group in Formula 2-1 is converted to gas, e.g.,  $\text{CO}_2$ . Thus, the arylamine-based compound in which the thermally decomposable group has been thermally decomposed and removed may be represented by Formula 1 in which X is a hydroxyl group ( $-\text{OH}$  group) and the remaining components are as described herein above. The arylamine-based compound in which the thermally decomposable group has been thermally decomposed and removed may be polymerized and/or cross-linked to form an arylamine-based polymer formed from the arylamine-based compound.

**[0105]** A synthesis method for the thermally decomposable group-containing arylamine-based compound represented by Formula 1 would be apparent to those of ordinary skill in the art by referring to the following examples described herein.

**[0106]** Another aspect of an embodiment provides an organic light-emitting device that includes: a first electrode; a second electrode facing the first electrode; and an organic layer disposed between the first electrode and the second electrode, the organic layer including an emission layer and an arylamine-based compound from which a thermally decomposable group is (or has been) removed by heat treatment performed on the arylamine-based compound including the thermally decomposable group.

**[0107]** The expression “(an organic layer) includes at least one arylamine-based compound,” as used herein, may include a case in which “(an organic layer) includes identical or two or more different arylamine-based polymers described above.”

**[0108]** According to one embodiment,

[0109] the first electrode of the organic light-emitting device may be an anode,

[0110] the second electrode of the organic light-emitting device may be a cathode,

[0111] The organic layer includes i) a hole transport region disposed between the first electrode and the emission layer, the hole transport region including at least one selected from a hole injection layer, a hole transport layer, an emission auxiliary layer, and an electron blocking layer, and any combination thereof, and ii) an electron transport region disposed between the emission layer and the second electrode, the electron transport region including at least one selected from a buffer layer, hole blocking layer, an electron transport layer, an electron injection layer, or any combination thereof.

[0112] In one or more embodiments, the hole transport region may include at least one arylamine-based compound.

[0113] For example, the electron transport region may include a hole injection layer and a hole transport layer, and the hole transport layer may include at least one arylamine-based compound.

[0114] In the organic light-emitting device, the emission layer may be a first color light emission layer, and may further include i) at least one second color light emission layer or ii) at least one second color light emission layer and at least one third color light emission layer, between the first electrode and the second electrode,

[0115] wherein, a maximum emission wavelength of the first color light, a maximum emission wavelength of the second color light, and a maximum emission wavelength of the third color light are identical to or different from each other, and

[0116] the first color light and the second color light are emitted in the form of mixed light, or the first color light, the second color light, and the third color light are emitted in the form of mixed light.

[0117] The organic light-emitting device may further include at least one selected from a first capping layer disposed at (or in) a pathway along which light generated in an emission layer proceeds toward the outside through the first electrode and a second capping layer disposed at (or in) a pathway along which light generated in an emission layer proceeds toward the outside through the second electrode, and the at least one selected from the first capping layer and the second capping layer may include at least one condensed cyclic compound represented by Formula 1.

[0118] For example, the organic light-emitting device may have i) a stacked structure including a first electrode, an organic layer, a second electrode, and a second capping layer which are sequentially stacked in this stated order, ii) a stacked structure including a first capping layer, a first electrode, an organic layer, and a second electrode which are sequentially stacked in this stated order, or iii) a stacked structure including a first capping layer, a first electrode, an organic layer, a second electrode, and a second capping layer which are sequentially stacked in this stated order, and at least one selected from the first capping layer and the second capping layer may include the condensed cyclic compound.

[0119] In one embodiment, there is provided an electronic device including a thin film transistor and the organic light-emitting device, wherein the thin film transistor may include a source electrode, a drain electrode, an activation layer, and a gate electrode, and the first electrode of the organic light-emitting device may be electrically coupled

with (e.g., electrically connected with) at least one of the source electrode and the drain electrode of the thin film transistor.

[0120] 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. A material included in the “organic layer” is not limited to an organic material.

#### Description of FIG. 1

[0121] FIG. 1 is a schematic view of an organic light-emitting device 10 according to an embodiment. The organic light-emitting device 10 includes a first electrode 110, an organic layer 150, and a second electrode 190.

[0122] Hereinafter, the structure of the organic light-emitting device 10 according to an embodiment and a method of manufacturing the organic light-emitting device 10 will be described in connection with FIG. 1.

#### First Electrode 110

[0123] In FIG. 1, a substrate may be additionally disposed under the first electrode 110 or above the second electrode 190. The substrate may be a glass substrate or a plastic substrate, each having excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

[0124] The first electrode 110 may be formed by depositing or sputtering a material for forming the first electrode 110 on the substrate. When the first electrode 110 is an anode, the material for a first electrode may be selected from materials with a high work function to facilitate hole injection.

[0125] The first electrode 110 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. When the first electrode 110 is a transmissive electrode, a material for forming a first electrode may be selected from indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO<sub>2</sub>), zinc oxide (ZnO), and any combinations thereof, but embodiments of the present disclosure are not limited thereto. In one or more embodiments, when the first electrode 110 is a semi-transmissive electrode or a reflectable electrode, a material for forming a first electrode may be selected from magnesium (Mg), silver (Ag), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), magnesium-silver (Mg—Ag), and any combinations thereof, but embodiments of the present disclosure are not limited thereto.

[0126] The first electrode 110 may have a single-layered structure, or a multi-layered structure including two or more layers. For example, the first electrode 110 may have a three-layered structure of ITO/Ag/ITO, but the structure of the first electrode 110 is not limited thereto.

#### Organic Layer 150

[0127] The organic layer 150 is disposed on the first electrode 110. The organic layer 150 may include an emission layer.

[0128] The organic layer 150 may further include a hole transport region between the first electrode 110 and the emission layer, and an electron transport region between the emission layer and the second electrode 190.

## Hole Transport Region in Organic Layer 150

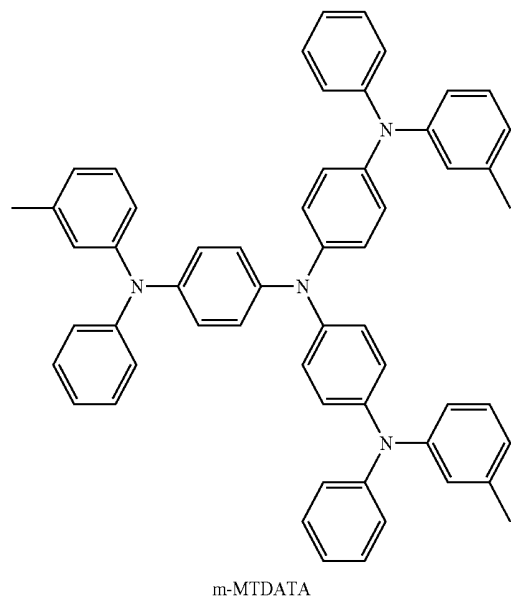
[0129] The hole transport region may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

[0130] The hole transport region may include at least one layer selected from a hole injection layer, a hole transport layer, an emission auxiliary layer, and an electron blocking layer.

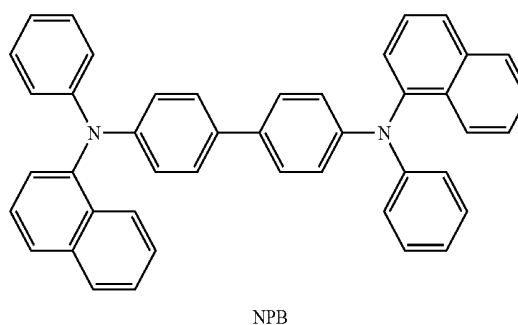
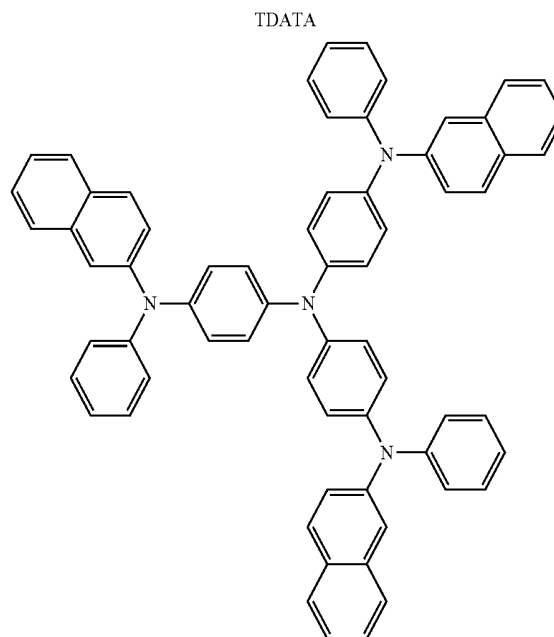
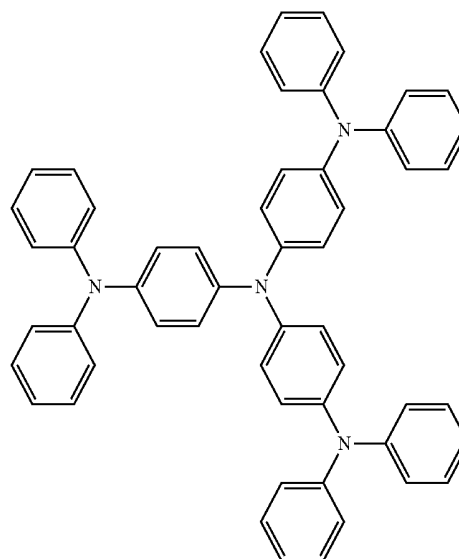
[0131] For example, the hole transport region may have a single-layered structure including a single layer including a plurality of different materials, or a multi-layered structure having a hole injection layer/hole transport layer structure, a hole injection layer/hole transport layer/emission auxiliary layer structure, a hole injection layer/emission auxiliary layer structure, a hole transport layer/emission auxiliary layer structure, or a hole injection layer/hole transport layer/electron blocking layer structure, wherein for each structure, constituting layers are sequentially stacked from the first electrode 110 in this stated order, but the structure of the hole transport region is not limited thereto.

[0132] The hole transport region may include an arylamine-based polymer formed by crosslinking the arylamine-based compound represented by Formula 1.

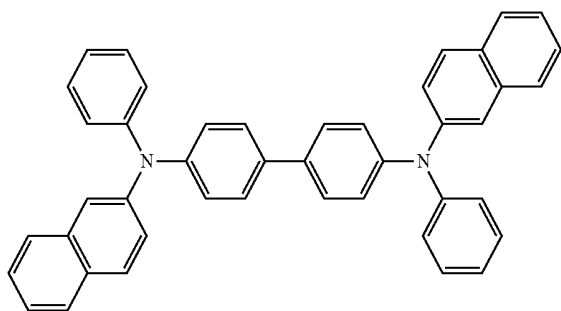
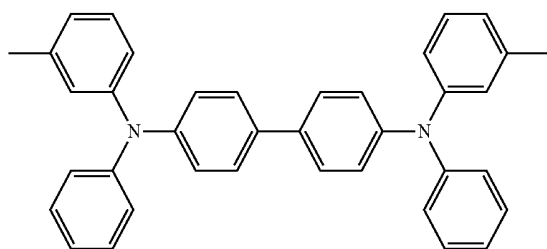
[0133] In one embodiment, the hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB(NPD),  $\beta$ -NPB, TPD, Spiro-TPD, Spiro-NPB, methylated-NPB, TAPC, HMTPD, 4,4',4''-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzenesulfonic acid (PANI/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (PANI/CSA), polyaniline/poly(4-styrenesulfonate) (PANI/PSS), a compound represented by Formula 201, and a compound represented by Formula 202:



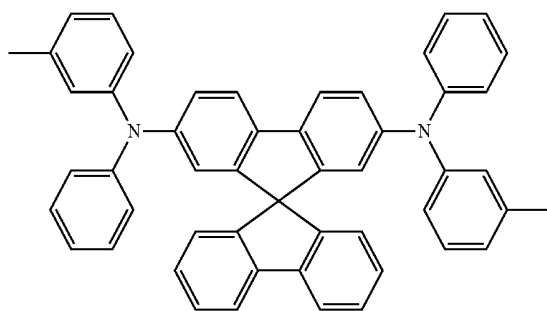
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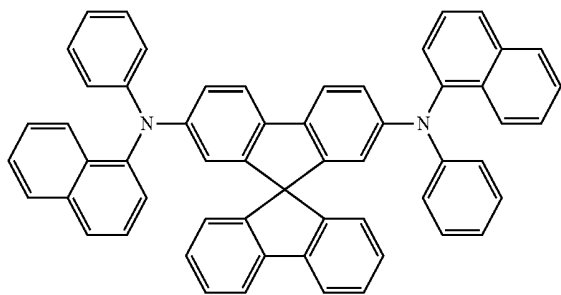
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 $\beta$ -NPB

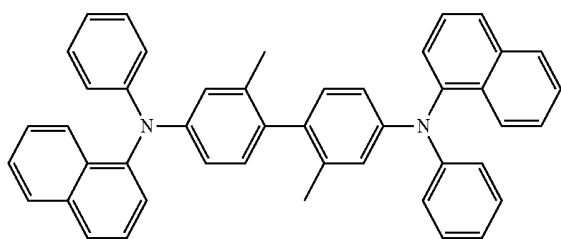
TPD



Spiro-TPD

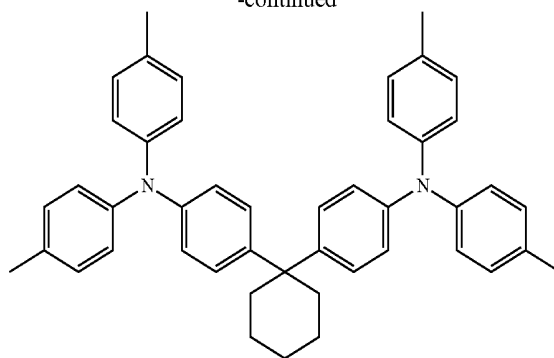


Spiro-NPB

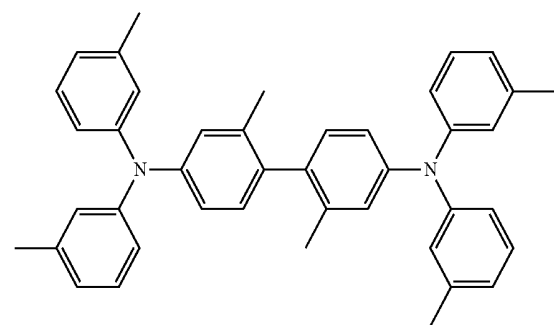


methylated NPB

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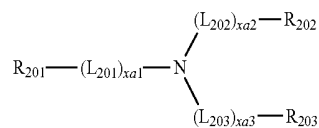


TAPC

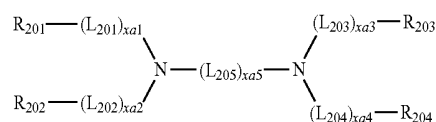


HMTPD

Formula 201



Formula 202

**[0134]** In Formulae 201 and 202,

**[0135]**  $L_{201}$  to  $L_{204}$  may each independently be selected from a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylene group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

**[0136]**  $L_{205}$  may be selected from  $*-O-*$ ,  $*-S-*$ ,  $*-N(Q_{201})-*$ , a substituted or unsubstituted  $C_1$ - $C_{20}$  alkylene group, a substituted or unsubstituted  $C_2$ - $C_{20}$  alkenylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylene group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a

substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

**[0137]** xa1 to xa4 may each independently be an integer from 0 to 3,

**[0138]** xa5 may be an integer from 1 to 10, and

**[0139]** R<sub>201</sub> to R<sub>204</sub> and Q<sub>201</sub> may each independently be selected from a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylthio group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

**[0140]** For example, in Formula 202, R<sub>201</sub> and R<sub>202</sub> may optionally be linked each other via a single bond, a dimethyl-methylene group, or a diphenyl-methylene group, and R<sub>203</sub> and R<sub>204</sub> may optionally be linked each other via a single bond, a dimethyl-methylene group, or a diphenyl-methylene group.

**[0141]** In one or more embodiments, in Formulae 201 and 202,

**[0142]** L<sub>201</sub> to L<sub>205</sub> may each independently be selected from:

**[0143]** a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylenylene group, a fluoranthenylenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylenylene group, a picenylene group, a perylenylene group, a pentaphenylenylene group, a hexacenylenylene group, a pentacenylenylene group, a rubicenylenylene group, a coronenylenylene group, an ovalenylenylene group, a thiophenylenylene group, a furanylenylene group, a carbazolylenylene group, an indolylenylene group, an isoindolylenylene group, a benzofuranylenylene group, a benzothiophenylenylene group, a dibenzofuranylenylene group, a dibenzothiophenylenylene group, a benzocarbazolylenylene group, a dibenzocarbazolylenylene group, a dibenzosilolylenylene group, and a pyridinylenylene group;

**[0144]** a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylenylene group, a fluoranthenylenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylenylene group, a picenylene group, a perylenylene group, a pentaphenylenylene group, a hexacenylenylene group, a pentacenylenylene group, a rubicenylenylene group, a coronenylenylene group, an ovalenylenylene group, a thiophenylenylene group, a furanylenylene group, a carbazolylenylene group, an indolylenylene group, an isoindolylenylene group, a benzofuranylenylene group, a benzothiophenylenylene group, a dibenzofuranylenylene group, a dibenzothiophenylenylene group, a benzocarbazolylenylene group, a dibenzocarbazolylenylene group, a dibenzosilolylenylene group, and a pyridinylenylene group, each

substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C<sub>1</sub>-C<sub>10</sub> alkyl group, a phenyl group substituted with —F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a rubicenylyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), and —N(Q<sub>31</sub>)(Q<sub>32</sub>), and

**[0145]** Q<sub>31</sub> to Q<sub>33</sub> may each independently be selected from a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>1</sub>-C<sub>10</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

**[0146]** In one or more embodiments, xa1 to xa4 may each independently be 0, 1, or 2.

**[0147]** In one or more embodiments, xa5 may be 1, 2, 3, or 4.

**[0148]** In one or more embodiments, R<sub>201</sub> to R<sub>204</sub> and Q<sub>201</sub> may each independently be selected from:

**[0149]** a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a rubicenylyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group;

**[0150]** a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a rubicenylyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl

group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl 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 amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C<sub>1</sub>-C<sub>10</sub> alkyl group, a phenyl group substituted with —F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), and —N(Q<sub>31</sub>)(Q<sub>32</sub>), and

[0151] Q<sub>31</sub> to Q<sub>33</sub> may respectively be the same as described above.

[0152] In one or more embodiments, in Formula 201, at least one selected from R<sub>201</sub> to R<sub>203</sub> may each independently be selected from:

[0153] a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

[0154] a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C<sub>1</sub>-C<sub>10</sub> alkyl group, a phenyl group substituted with —F, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group,

[0155] but embodiments of the present disclosure are not limited thereto.

[0156] In one or more embodiments, in Formula 202, i) R<sub>201</sub> and R<sub>202</sub> may be linked each other via a single bond, and/or ii) R<sub>203</sub> and R<sub>204</sub> may be linked each other via a single bond.

[0157] In one or more embodiments, in Formula 202, at least one selected from R<sub>201</sub> to R<sub>204</sub> may be selected from:

[0158] a carbazolyl group; and

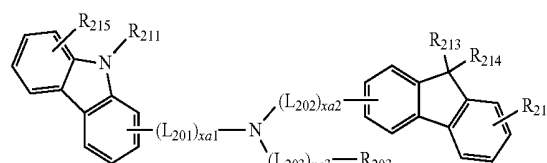
[0159] a carbazolyl group substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphe-

nyl group, a phenyl group substituted with a C<sub>1</sub>-C<sub>10</sub> alkyl group, a phenyl group substituted with —F, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group,

[0160] but embodiments of the present disclosure are not limited thereto.

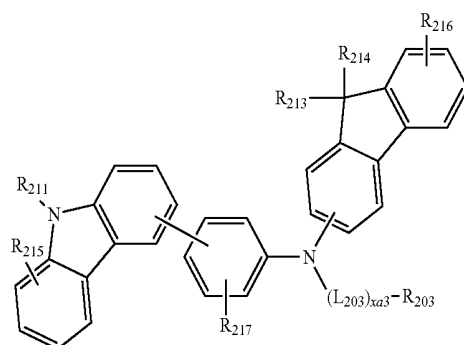
[0161] The compound represented by Formula 201 may be represented by Formula 201A:

Formula 201A



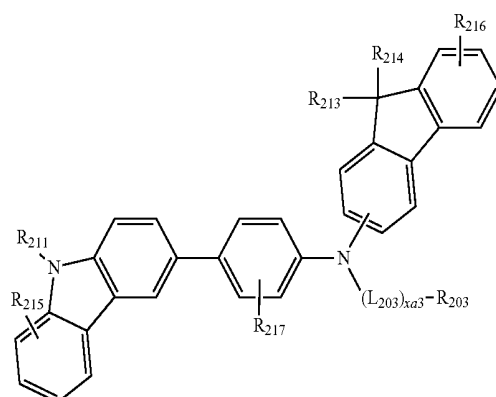
[0162] In one embodiment, the compound represented by Formula 201 may be represented by Formula 201A(1) below, but embodiments of the present disclosure are not limited thereto:

Formula 201A(1)

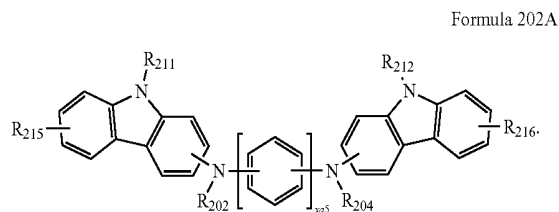


[0163] In one embodiment, the compound represented by Formula 201 may be represented by Formula 201A-1 below, but embodiments of the present disclosure are not limited thereto:

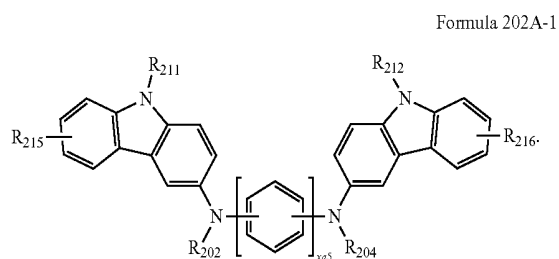
Formula 201A-1



[0164] In one embodiment, the compound represented by Formula 202 may be represented by Formula 202A:



[0165] In one embodiment, the compound represented by Formula 202 may be represented by Formula 202A-1:



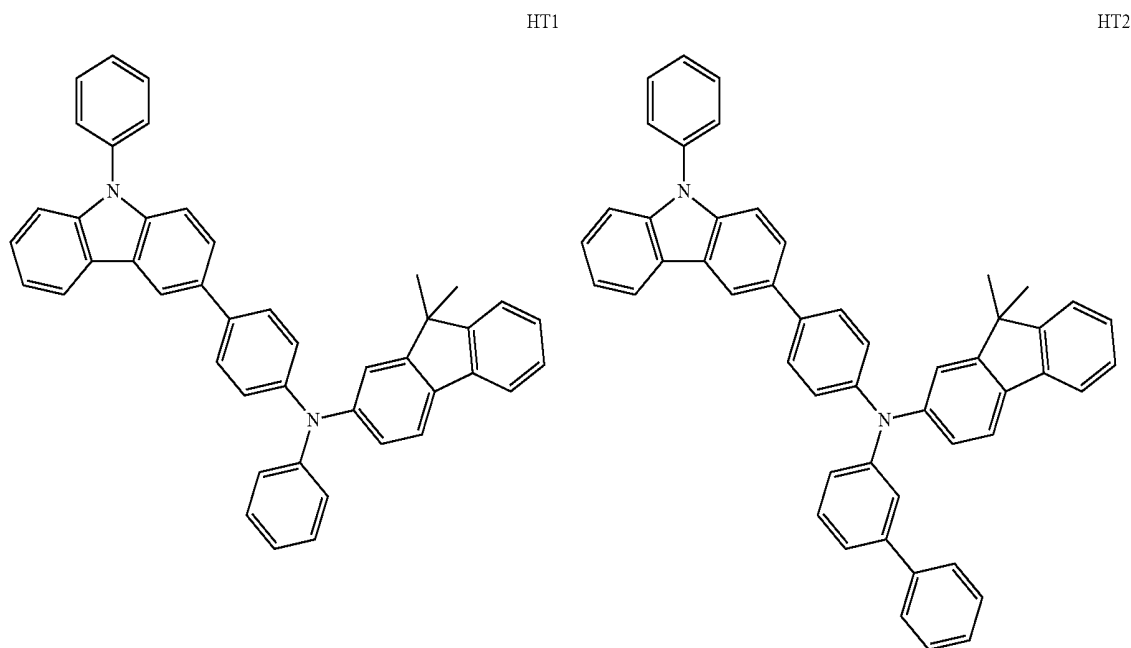
[0166] In Formulae 201A, 201A(1), 201A-1, 202A, and 202A-1,

[0167]  $L_{201}$  to  $L_{203}$ ,  $xa1$  to  $xa3$ ,  $xa5$ , and  $R_{202}$  to  $R_{204}$  may respectively be the same as described above,

[0168]  $R_{211}$  and  $R_{212}$  may respectively be the same as described in connection with  $R_{203}$ , and

[0169]  $R_{213}$  to  $R_{217}$  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 hydrazino group, a hydrazono group, a  $C_1$ - $C_{20}$  alkyl group, a  $C_1$ - $C_{20}$  alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a  $C_1$ - $C_{10}$  alkyl group, a phenyl group substituted with —F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group.

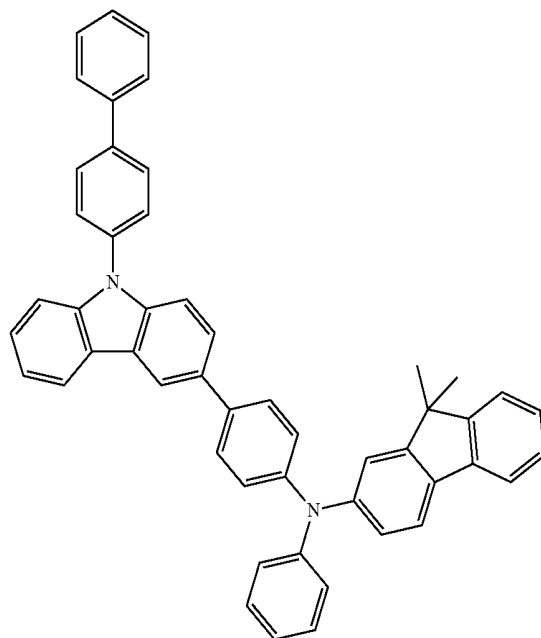
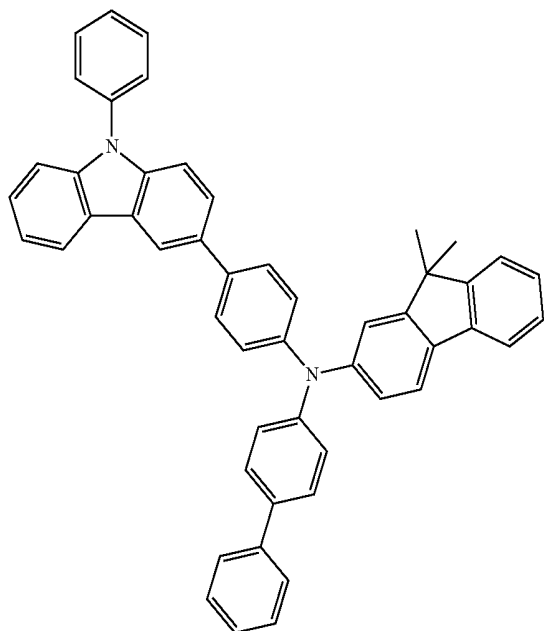
[0170] The hole transport region may include at least one compound selected from Compounds HT1 to HT39, but embodiments of the present disclosure are not limited thereto:



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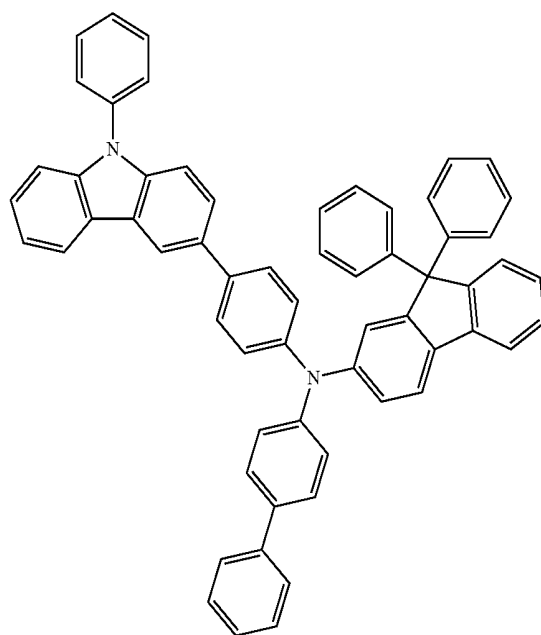
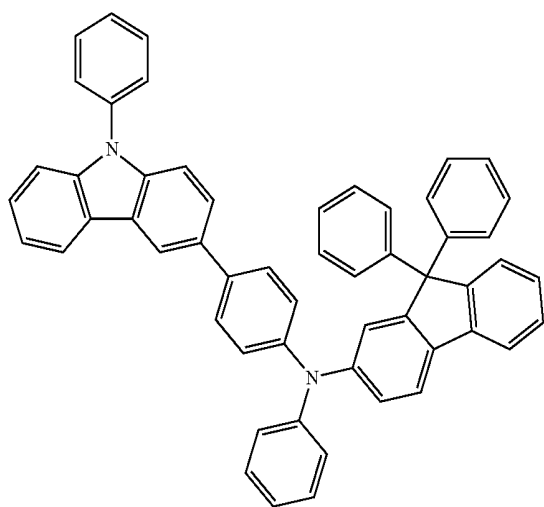
HT3

HT4



HT5

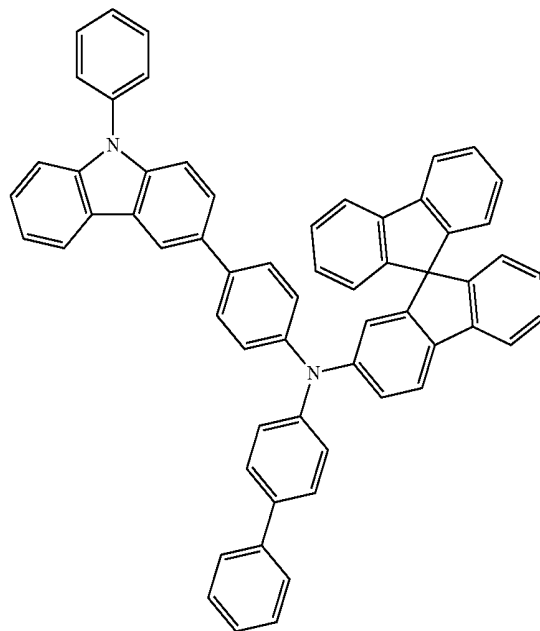
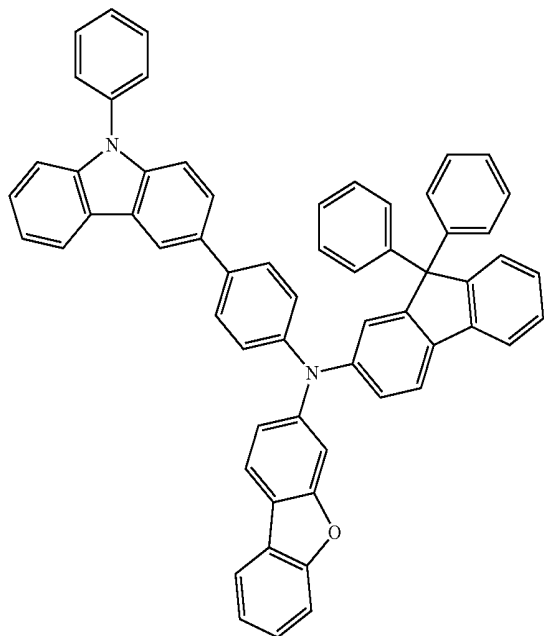
HT6



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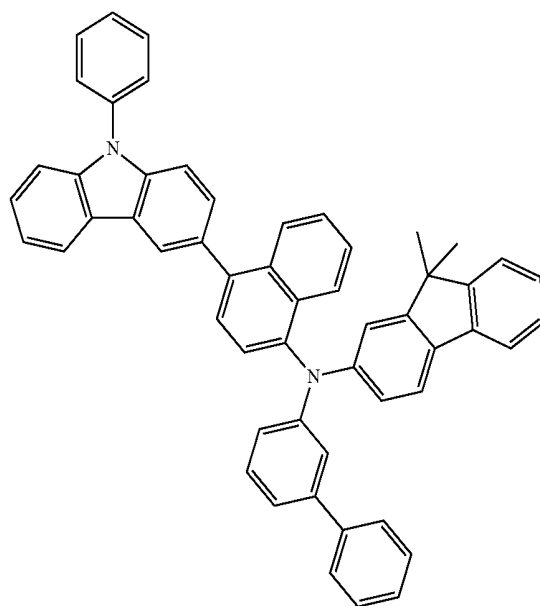
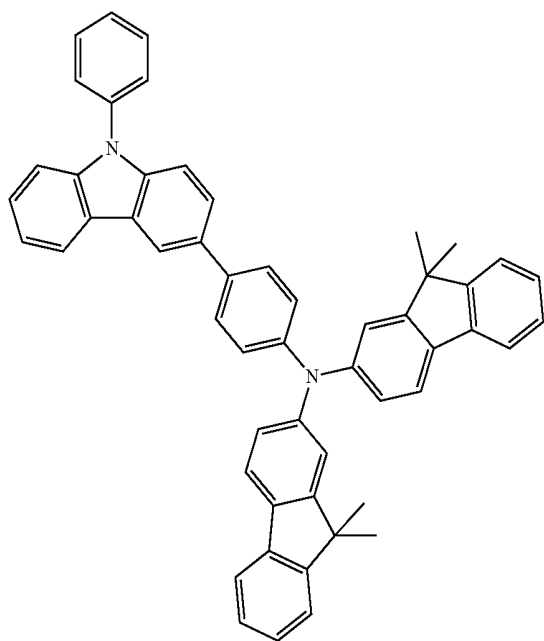
HT7

HT8

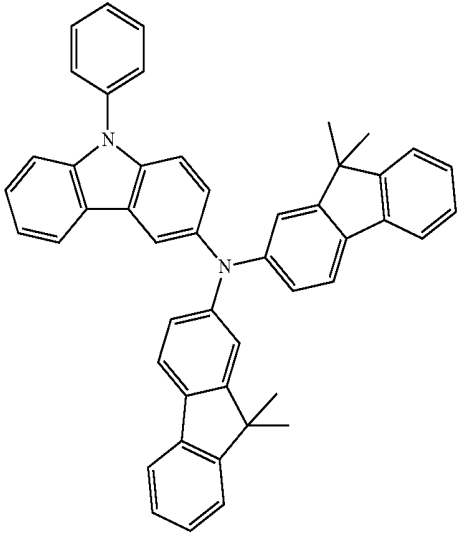


HT9

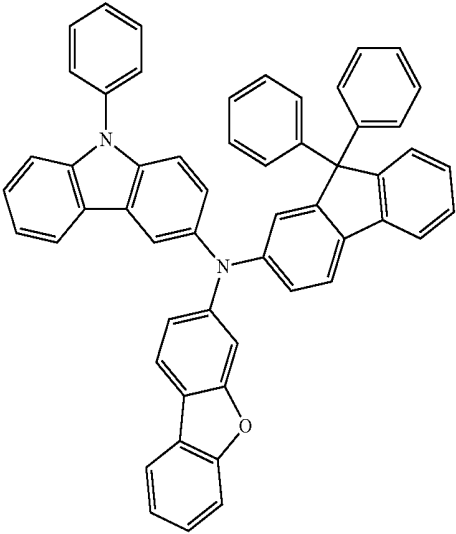
HT10



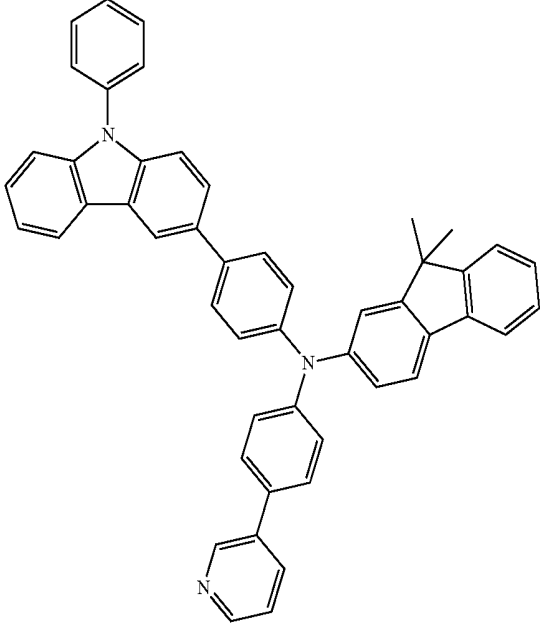
-continued  
HT11



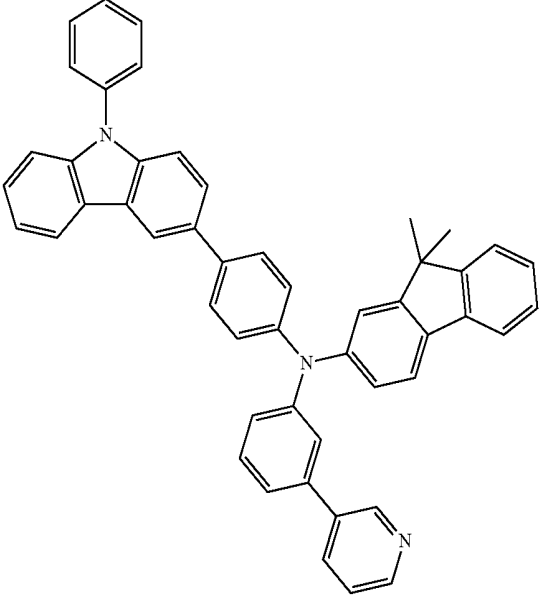
HT12



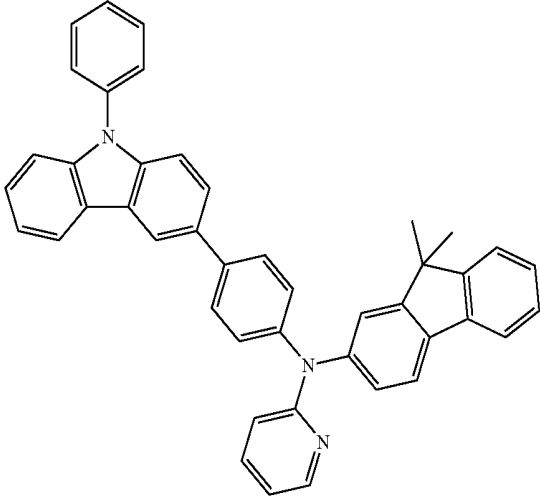
HT13



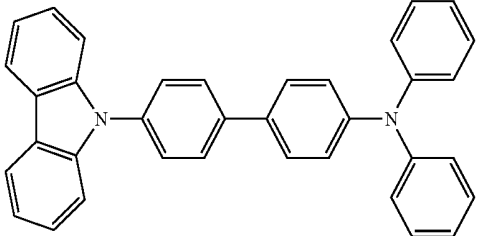
HT14



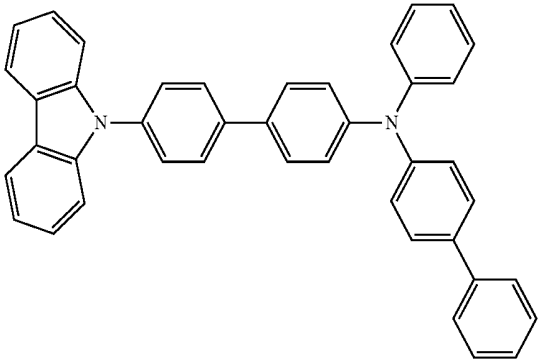
-continued  
HT15



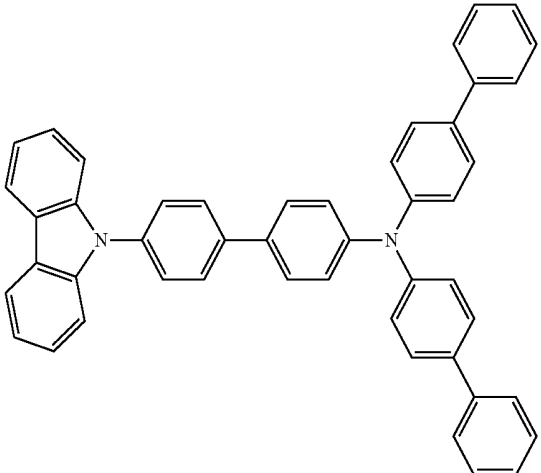
HT16



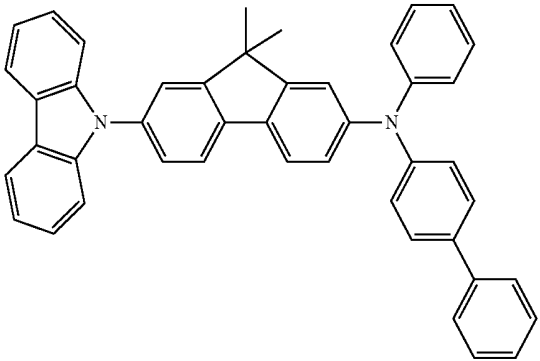
HT17



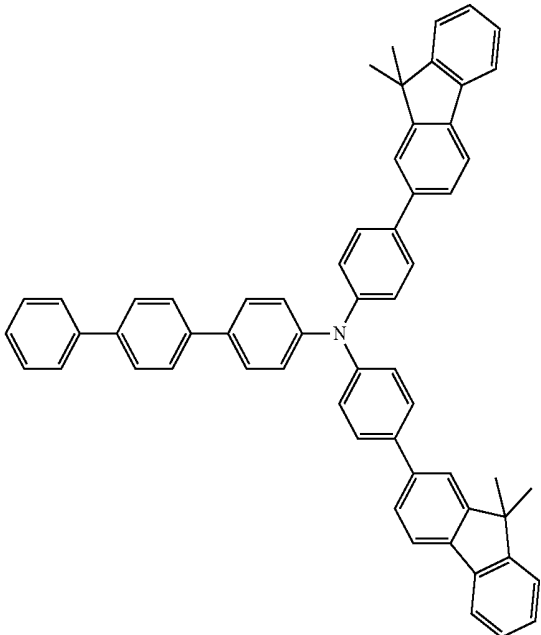
HT18



HT19

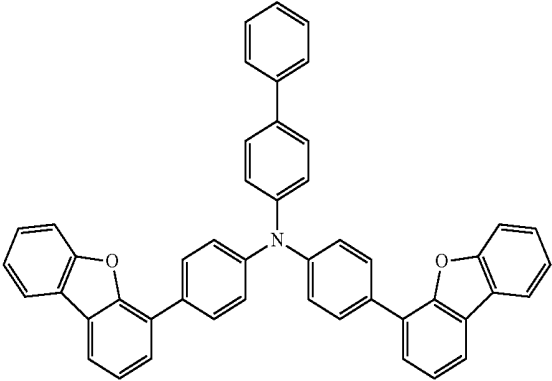
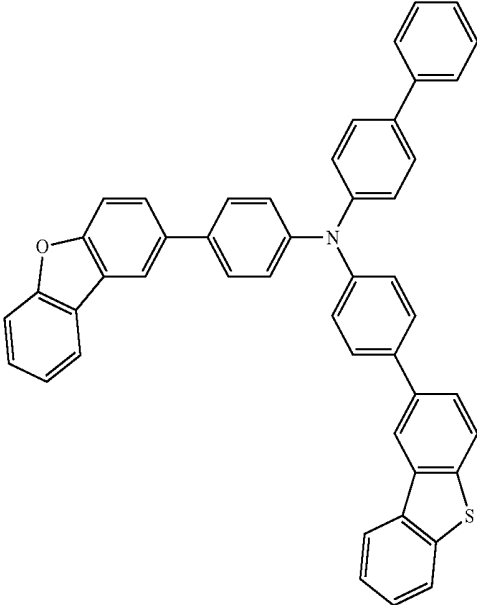


HT20

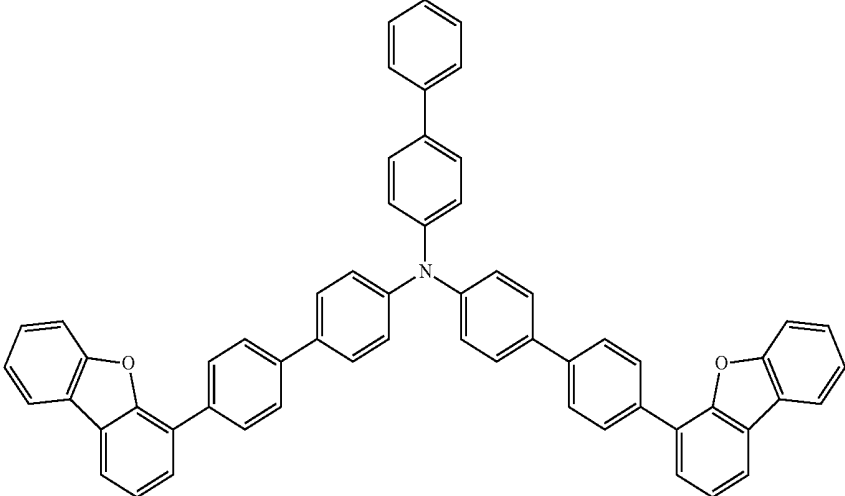


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HT21

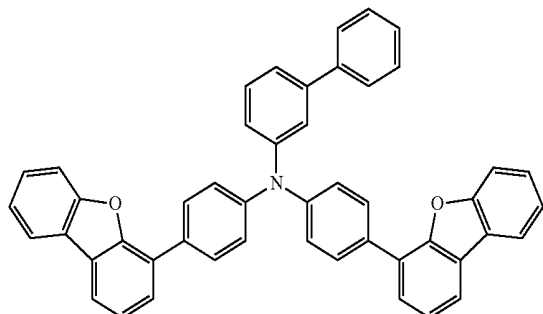
HT22



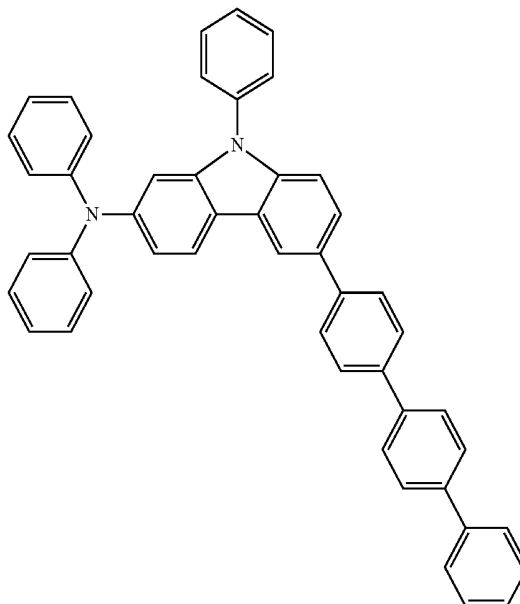
HT23



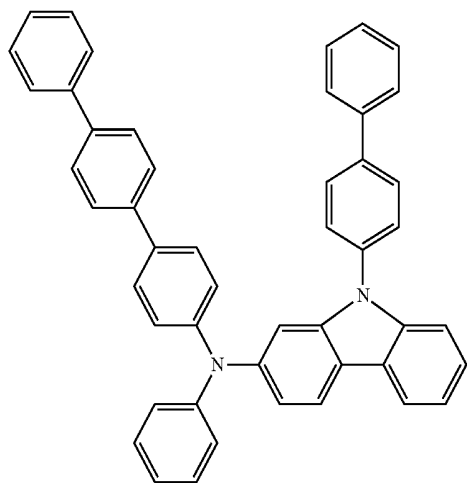
-continued  
HT24



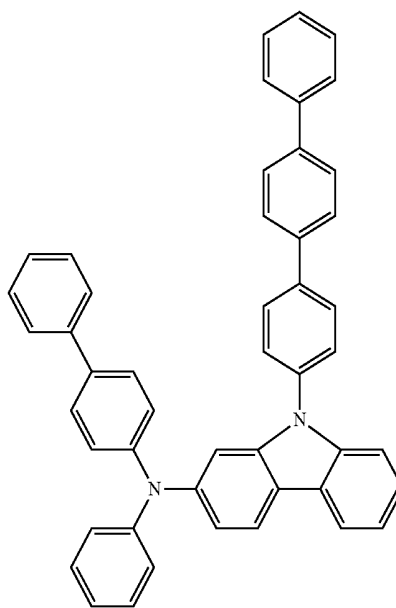
HT25



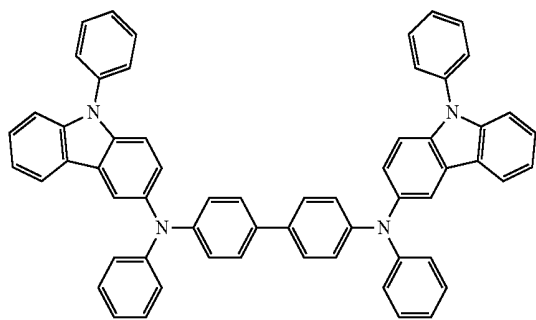
HT26



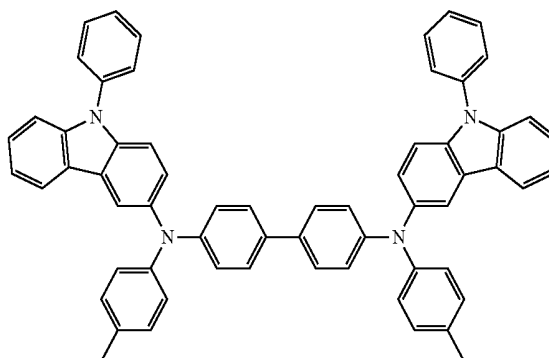
HT27



HT28

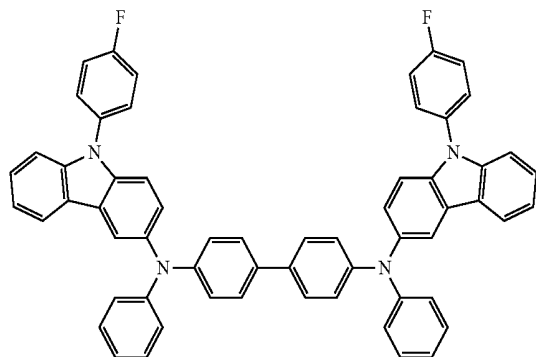


HT29

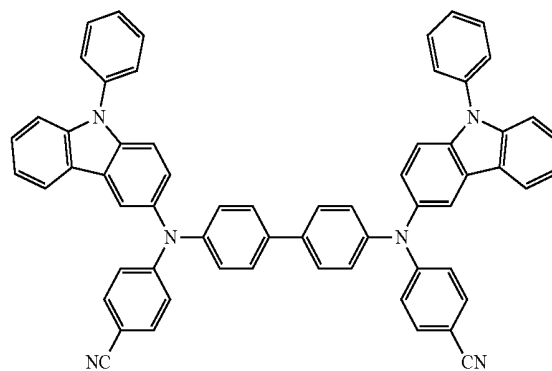


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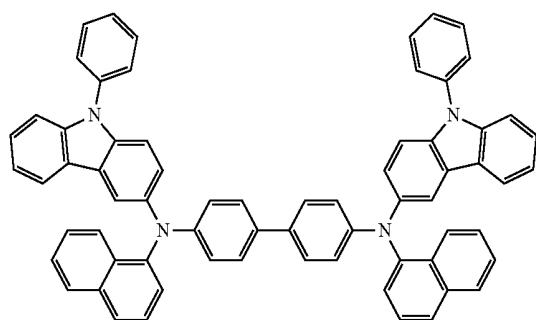
HT30



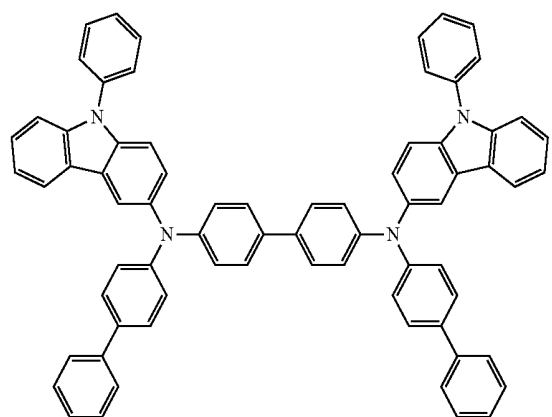
HT31



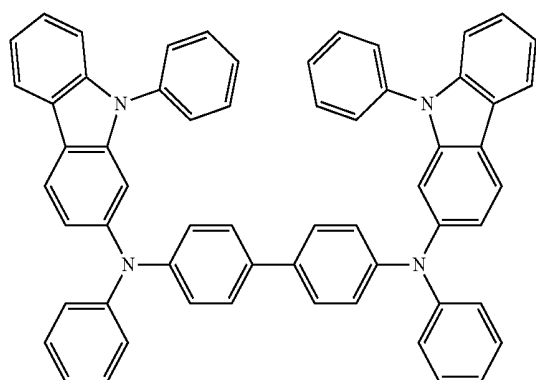
HT32



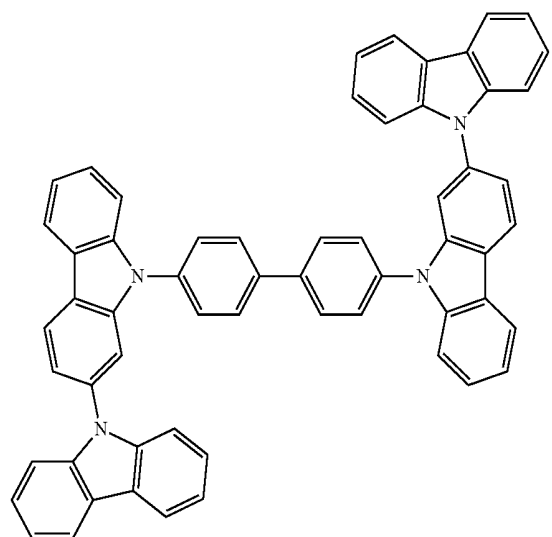
HT33



HT34

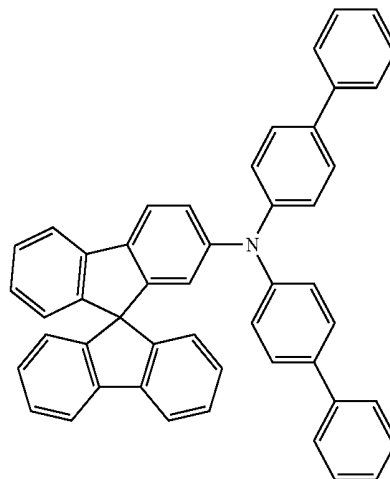
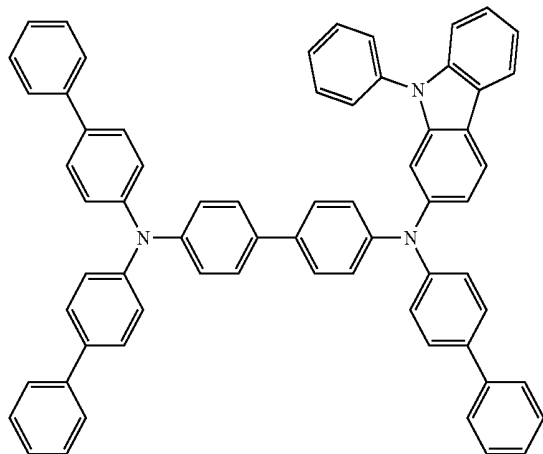


HT35



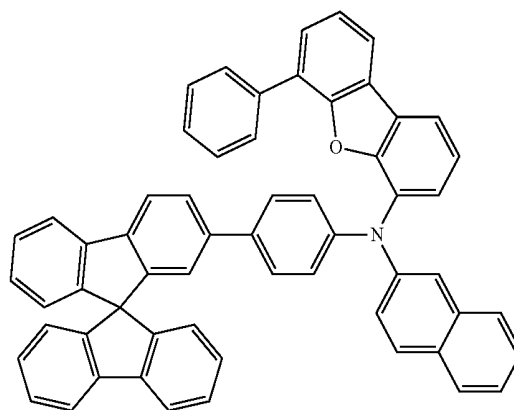
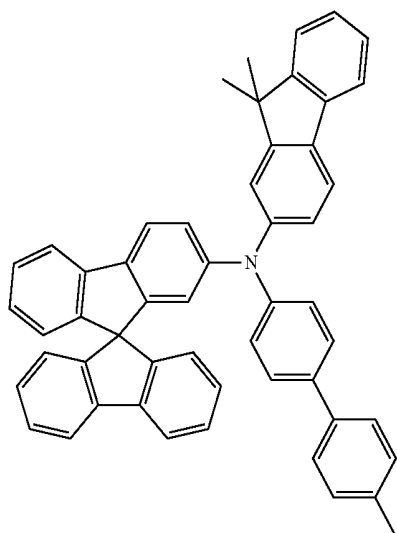
-continued  
HT36

HT37



HT38

HT39



[0171] 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, a thickness of the hole injection layer may be in a range of about 100 Å to about 9,000 Å, for example, about 100 Å to about 1,000 Å, and a thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, for example about 100 Å to about 1,500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within these ranges, suitable or satisfactory hole transporting characteristics may be obtained without a substantial increase in driving voltage.

[0172] The emission auxiliary layer may increase light-emission efficiency by compensating for an optical resonance distance according to the wavelength of light emitted by an emission layer, and the electron blocking layer may block the flow of electrons from an electron transport region. The emission auxiliary layer and the electron blocking layer may include the materials as described above.  
p-dopant

[0173] 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.

[0174] The charge-generation material may be, for example, a p-dopant.

[0175] In one embodiment, the p-dopant may have a lowest unoccupied molecular orbital (LUMO) level of  $-3.5$  eV or less.

[0176] The p-dopant may include at least 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.

[0177] For example, the p-dopant may include at least one selected from:

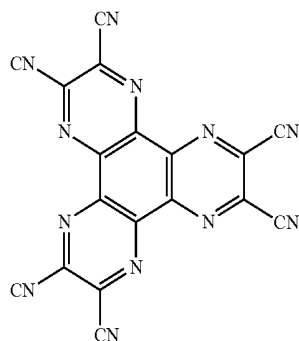
[0178] a quinone derivative, such as tetracyanoquinodimethane (TCNQ) or 2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane (F4-TCNQ);

[0179] a metal oxide, such as tungsten oxide or molybdenum oxide;

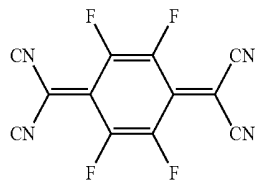
[0180] 1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (HAT-CN); and

[0181] a compound represented by Formula 221 below,

[0182] but embodiments of the present disclosure are not limited thereto:

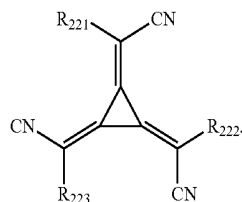


HAT-CN



F4-TCNQ

Formula 221



[0183] In Formula 221,

[0184]  $R_{221}$  to  $R_{223}$  may each independently be selected from a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryl group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, provided that at least one selected from  $R_{221}$  to  $R_{223}$  has at least one substituent selected from a cyano group, —F, —Cl, —Br, —I, a  $C_1$ - $C_{20}$  alkyl group substituted with —F, a  $C_1$ - $C_{20}$  alkyl group substituted with —Cl, a  $C_1$ - $C_{20}$  alkyl group substituted with —Br, and a  $C_1$ - $C_{20}$  alkyl group substituted with —I.

#### Emission Layer in Organic Layer 150

[0185] When the organic light-emitting device 10 is a full-color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, or a blue emission layer, according to a sub-pixel. In one or more embodiments, the emission layer may have a stacked structure of two or more layers selected from a red emission layer, a green emission layer, and a blue emission

layer, in which the two or more layers contact each other or are separated from each other. In one or more embodiments, the emission layer may include two or more materials selected from a red light-emitting material, a green light-emitting material, and a blue light-emitting material, in which the two or more materials are mixed with each other in a single layer to emit white light.

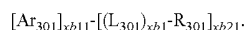
[0186] The emission layer may include a host and a dopant. The dopant may include at least one selected from a phosphorescent dopant and a fluorescent dopant.

[0187] An amount of the dopant in the emission layer may be 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.

[0188] 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.

#### Host in Emission Layer

[0189] In one or more embodiments, the host may include a compound represented by Formula 301 below.



Formula 301

[0190] In Formula 301,

[0191]  $Ar_{301}$  may be a substituted or unsubstituted  $C_5$ - $C_{60}$  carbocyclic group or a substituted or unsubstituted  $C_1$ - $C_{60}$  heterocyclic group,

[0192]  $xb11$  may be 1, 2, or 3,

[0193]  $L_{301}$  may each independently be selected from a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylene group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group;

[0194]  $xb1$  may be an integer from 0 to 5,

[0195]  $R_{301}$  may be selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted  $C_1$ - $C_{60}$  alkyl group, a substituted or unsubstituted  $C_2$ - $C_{60}$  alkenyl group, a substituted or unsubstituted  $C_2$ - $C_{60}$  alkynyl group, a substituted or unsubstituted  $C_1$ - $C_{60}$  alkoxy group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryloxy group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylthio group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —Si( $Q_{301}$ )( $Q_{302}$ )( $Q_{303}$ ), —N( $Q_{301}$ )( $Q_{302}$ ), —B( $Q_{301}$ )( $Q_{302}$ ), —C(=O)( $Q_{301}$ ), —S(=O)<sub>2</sub>( $Q_{301}$ ), and —P(=O)( $Q_{301}$ )( $Q_{302}$ ),

[0196]  $xb21$  may be an integer from 1 to 5, and

[0197]  $Q_{301}$  to  $Q_{303}$  may each independently be selected from a  $C_1$ - $C_{10}$  alkyl group, a  $C_1$ - $C_{10}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, but embodiments of the present disclosure are not limited thereto.

[0198] In one embodiment, in Formula 301,  $Ar_{301}$  may be selected from:

[0199] a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, and a dibenzothiophene group; and

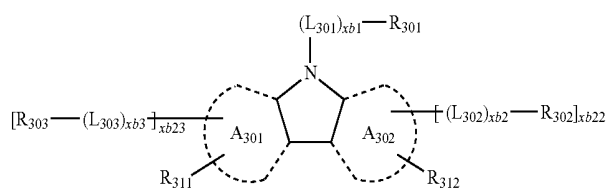
[0200] a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a

pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, and a dibenzothiophene group, each substituted with at least one selected from deuterium,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ , a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $C_1$ - $C_{20}$  alkyl group, a  $C_1$ - $C_{20}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group,  $-Si(Q_{31})(Q_{32})(Q_{33})$ ,  $-N(Q_{31})(Q_{32})$ ,  $-B(Q_{31})(Q_{32})$ ,  $-C(=O)(Q_{31})$ ,  $-S(=O)_2(Q_{31})$ , and  $-P(=O)(Q_{31})(Q_{32})$ , and

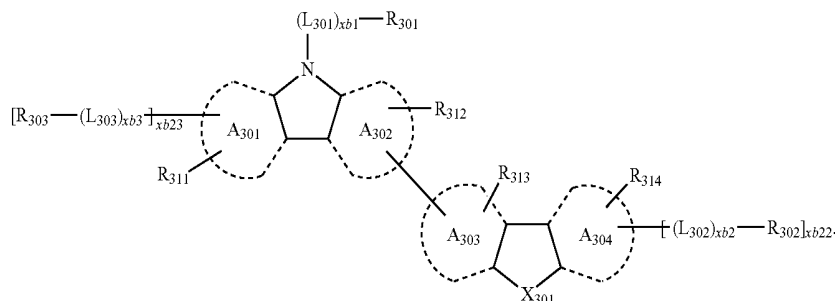
[0201]  $Q_{31}$  to  $Q_{33}$  may each independently be selected from a  $C_1$ - $C_{10}$  alkyl group, a  $C_1$ - $C_{10}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, but embodiments of the present disclosure are not limited thereto.

[0202] In Formula 301, when  $xb11$  is two or more, two or more of  $Ar_{301}(s)$  may be linked each other via a single bond.

[0203] In one or more embodiments, the compound represented by Formula 301 may be represented by Formula 301-1 or 301-2:



Formula 301-1



Formula 301-2

[0204] In Formulae 301-1 and 301-2,

[0205]  $A_{301}$  to  $A_{304}$  may each independently be selected from a benzene, a naphthalene, a phenanthrene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a pyridine, a pyrimidine, an indene, a fluorene, a spiro-bifluorene, a benzofluorene, a dibenzofluorene, an indole, a carbazole, benzocarbazole, dibenzocarbazole, a furan, a benzofuran, a dibenzofuran, a naphthofuran, a benzonaphthofuran, dinaphthofuran, a thiophene, a benzothiophene, a dibenzothiophene, a naphthothiophene, a benzonaphthothiophene, and a dinaphthothiophene,

[0206]  $X_{301}$  may be O, S, or N- $[(L_{304})_{xb4}-R_{304}]$ ,

[0207]  $R_{311}$  to  $R_{314}$  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 hydrazino group, a hydrazono group, a  $C_1$ - $C_{20}$  alkyl group, a  $C_1$ - $C_{20}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group  $-Si(Q_{31})(Q_{32})(Q_{33})$ ,  $-N(Q_{31})(Q_{32})$ ,  $-B(Q_{31})(Q_{32})$ ,  $-C(=O)(Q_{31})$ ,  $-S(=O)_2(Q_{31})$ , and  $-P(=O)(Q_{31})(Q_{32})$ ,

[0208]  $xb22$  and  $xb23$  may each independently be 0, 1, or 2,

[0209]  $L_{301}$ ,  $xb1$ ,  $R_{301}$ , and  $Q_{31}$  to  $Q_{33}$  may respectively be the same as described above,

[0210]  $L_{302}$  to  $L_{304}$  may respectively be the same as described in connection with  $L_{301}$ ,

[0211]  $xb2$  to  $xb4$  may respectively be the same as described in connection with  $xb1$ , and

[0212]  $R_{302}$  to  $R_{304}$  may respectively be the same as described in connection with  $R_{301}$ .

[0213] For example, in Formulae 301, 301-1, and 301-2,  $L_{301}$  to  $L_{304}$  may each independently be selected from:

[0214] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylylene group, a fluoranthenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylylene group, a thiophenylylene group, a furanylylene group, a carbazolylylene group, an indolylylene group, an isoindolylylene group, a ben-



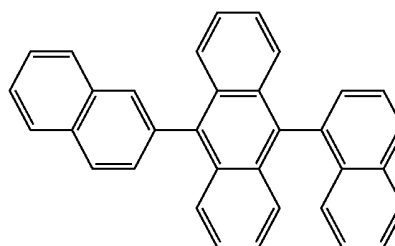
zoyl group, an isobenzothiazoyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an azacarbazolyl group, —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), —N(Q<sub>31</sub>)(Q<sub>32</sub>), —B(Q<sub>31</sub>)(Q<sub>32</sub>), —C(=O)(Q<sub>31</sub>), —S(=O)<sub>2</sub>(Q<sub>31</sub>), and —P(=O)(Q<sub>31</sub>)(Q<sub>32</sub>), and

[0220] Q<sub>31</sub> and Q<sub>33</sub> may respective be the same as described above.

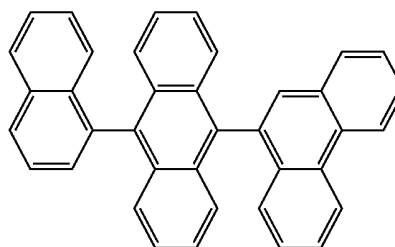
[0221] In one or more embodiments, the host may include an alkaline earth metal complex. For example, the host may be selected from a Be complex (for example, Compound H55, below), a Mg complex, and a Zn complex.

[0222] The host may include at least one selected from 9,10-di(2-naphthyl)anthracene (ADN), 2-methyl-9,10-bis(naphthalen-2-yl)anthracene (MADN), 9,10-di-(2-naphthyl)-2-t-butyl-anthracene (TBADN), 4,4'-bis(N-carbazolyl)-1,1'-biphenyl (CBP), 1,3-di-9-carbazolylbenzene (mCP), 1,3,5-tri(carbazol-9-yl)benzene (TCP), and Compounds H1 to H55, but embodiments of the present disclosure are not limited thereto:

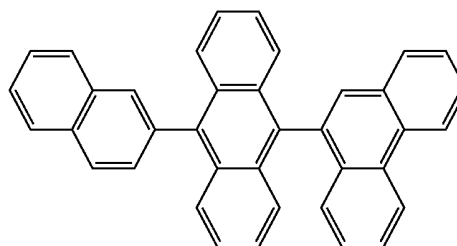
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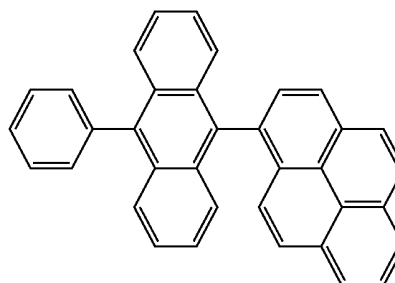
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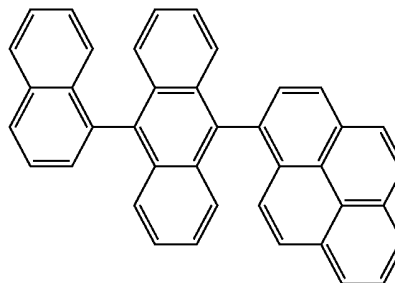
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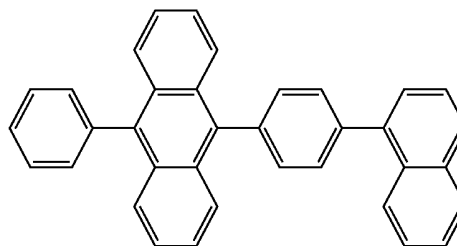
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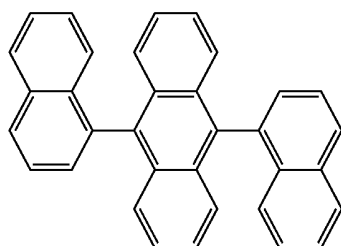
H5



H6

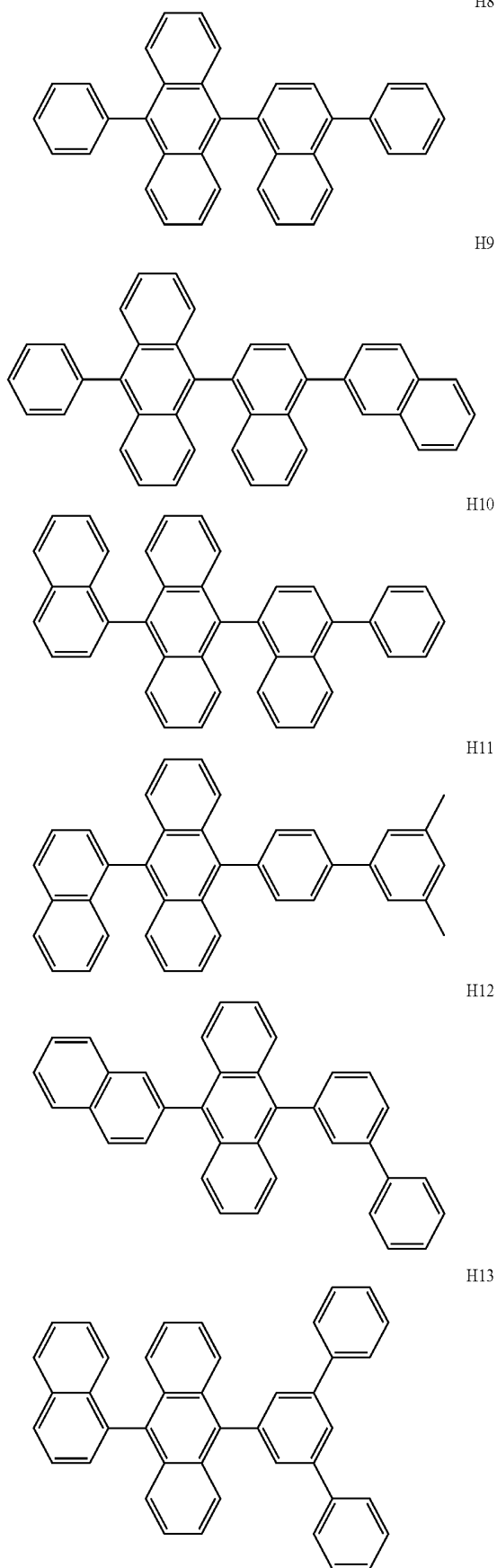


H7

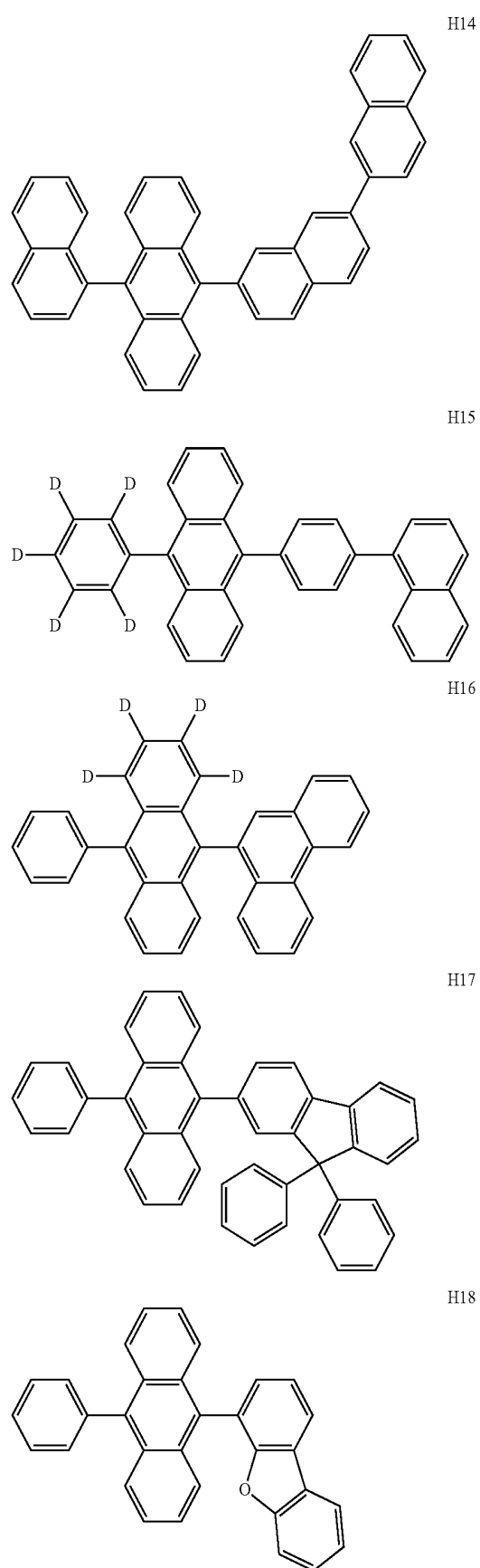


H1

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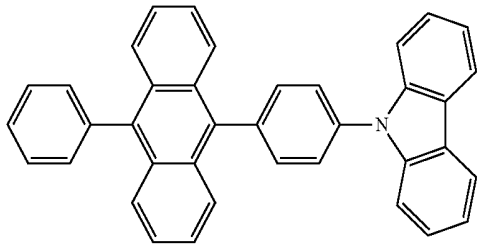


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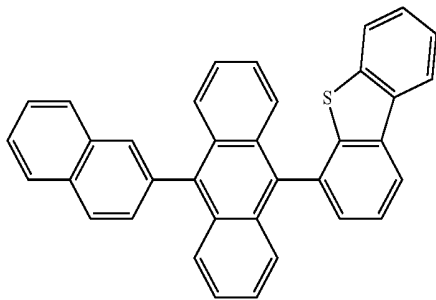


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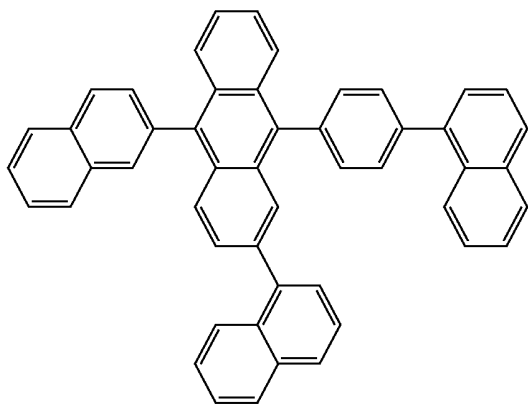
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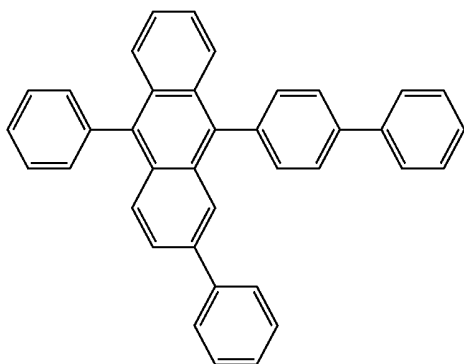
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H21

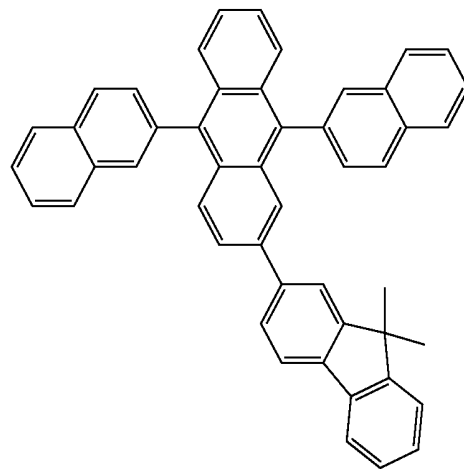


H22

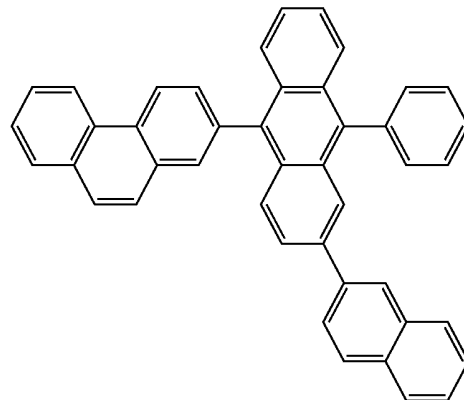


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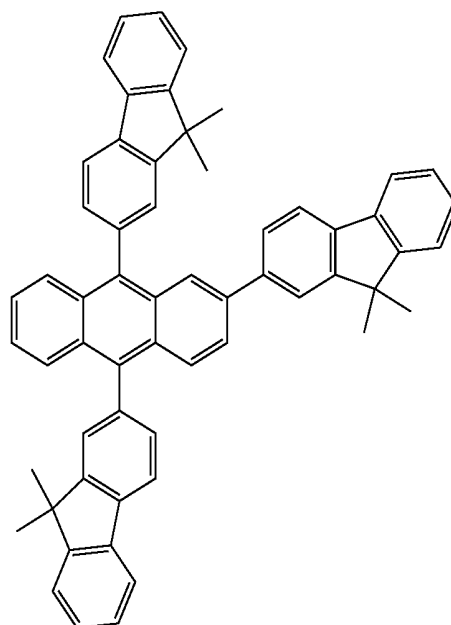
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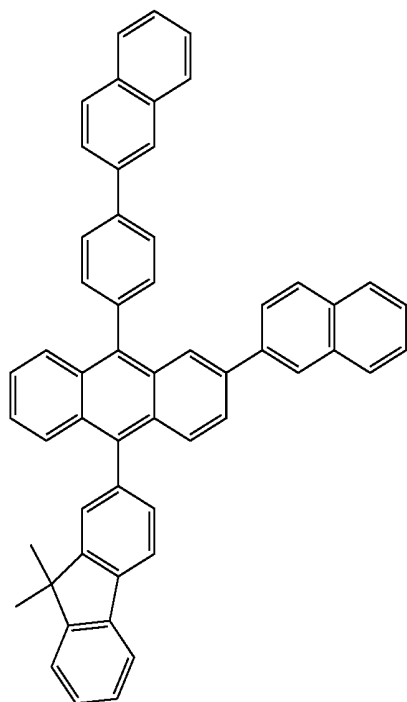
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H25

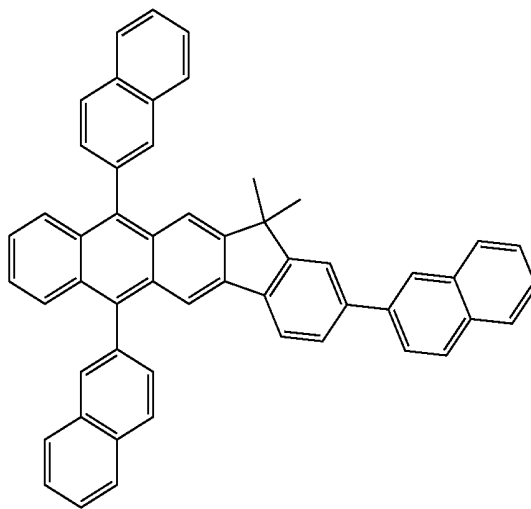


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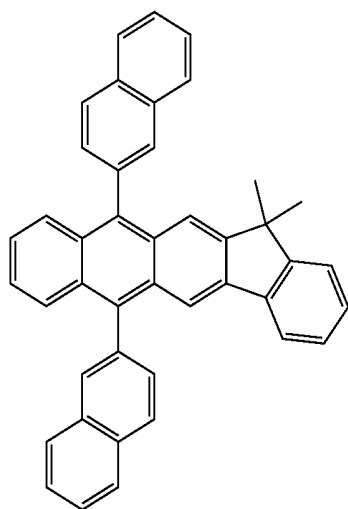


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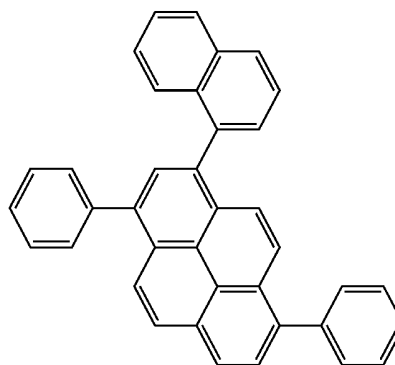
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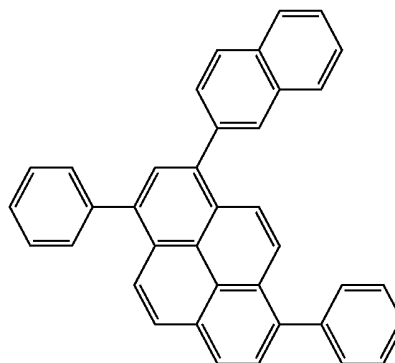
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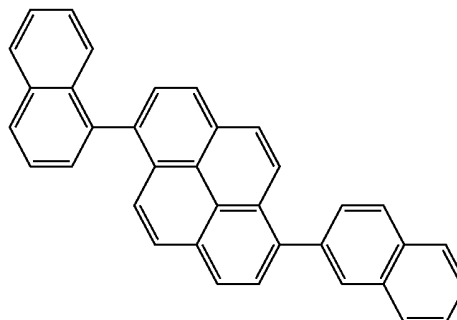
H27



H29



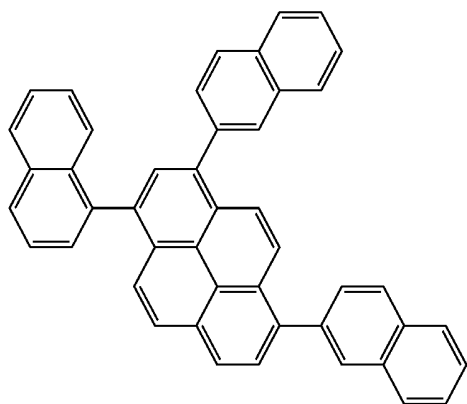
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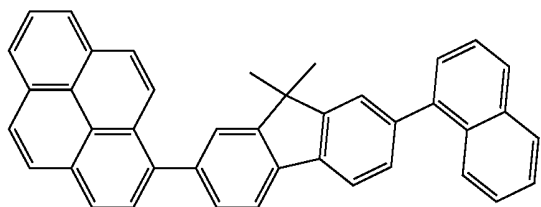
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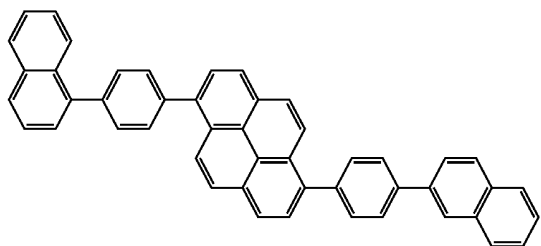
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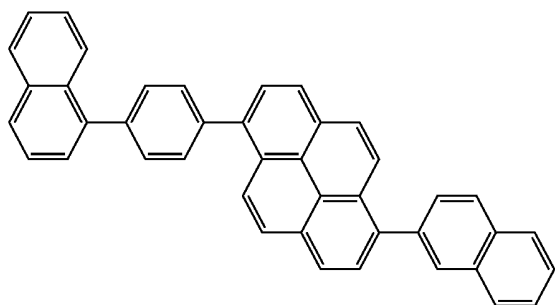
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H34

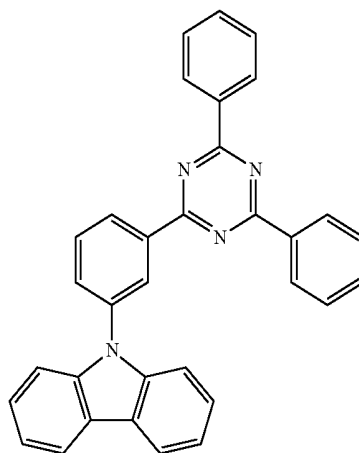


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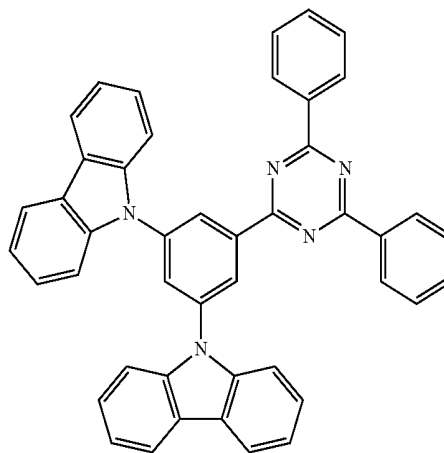


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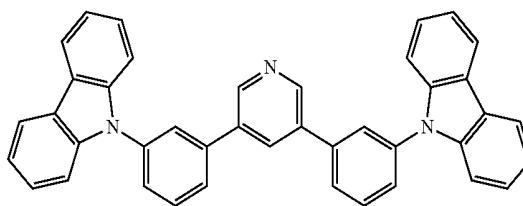
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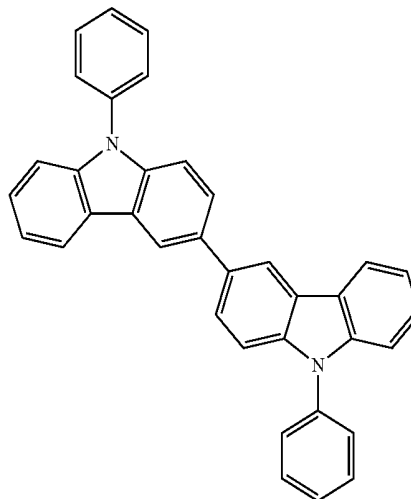
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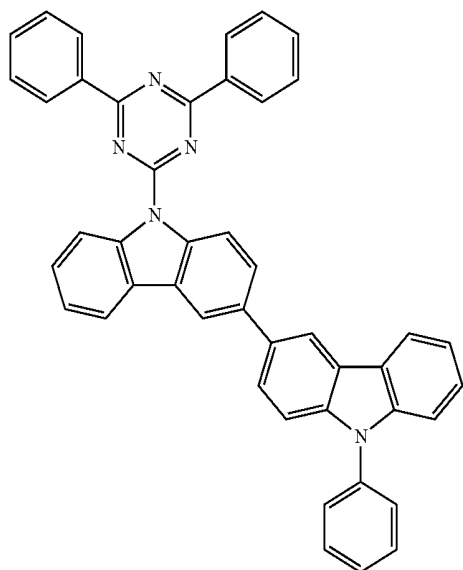
H38



H39

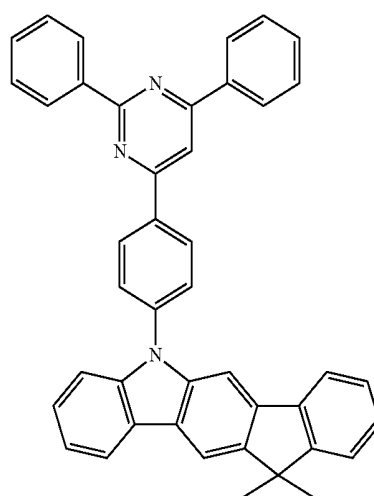


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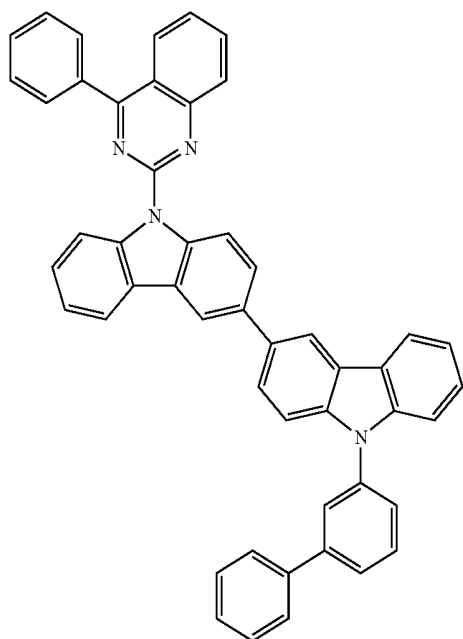


H40

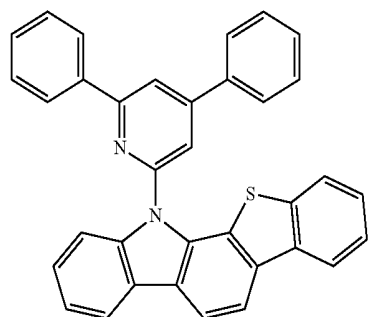
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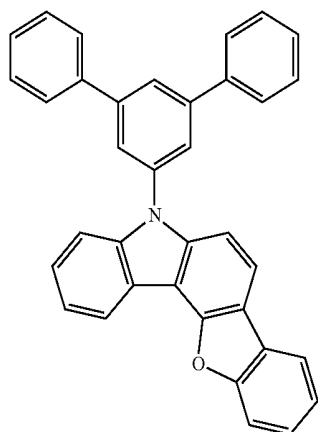
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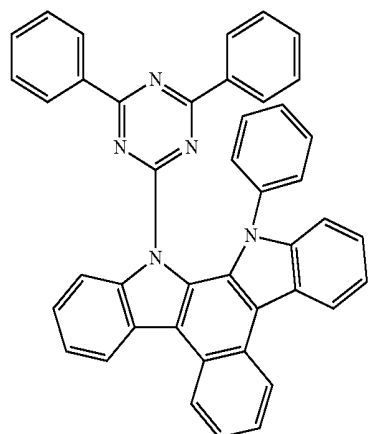
H41



H44



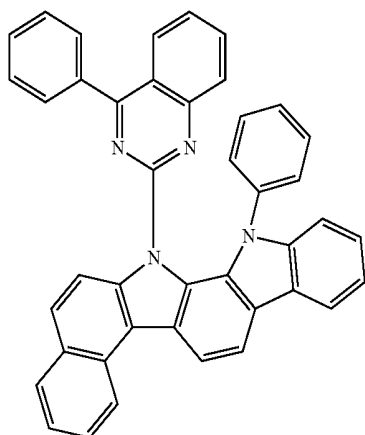
H42



H45

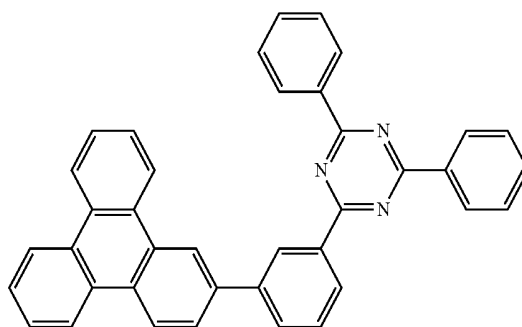
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H46



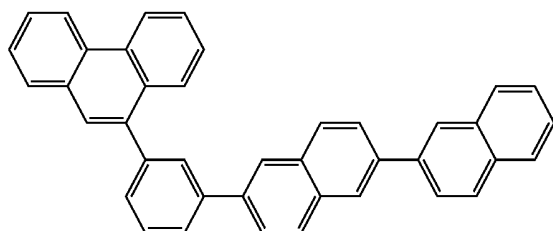
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H52

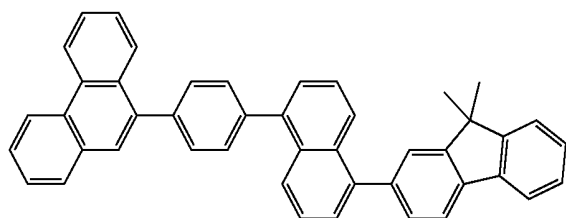


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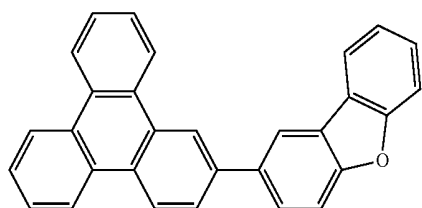
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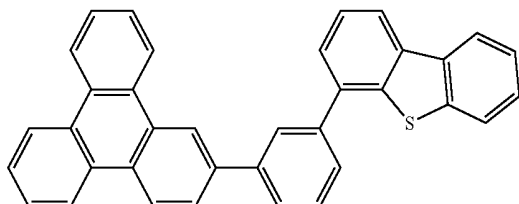
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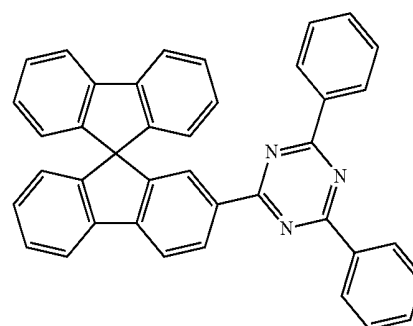
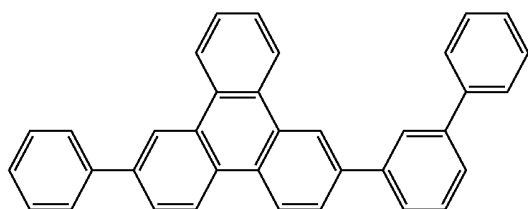
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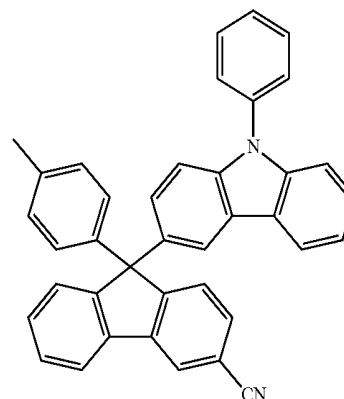
H50



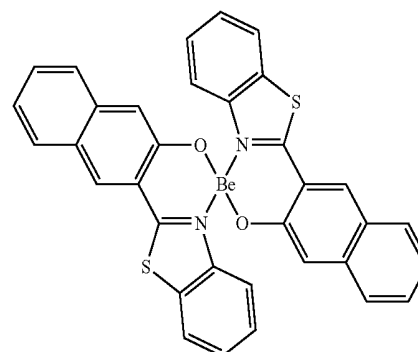
H51



H54



H55



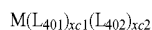
[0223] In one embodiment, the host may include at least one selected from a silicon-containing compound (for example, BCPDS used in the following examples or the like) and a phosphine oxide-containing compound (for example, POPCPA used in the following examples or the like).

[0224] However, embodiments of the present disclosure are not limited thereto. In one embodiment, the host may include only one compound, or two or more different

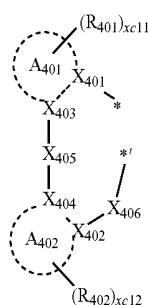
compounds (for example, a host used in the following examples includes BCPDS and POPCPA).

**[0225]** [Phosphorescent Dopant Included in Emission Layer in Organic Layer 150]

**[0226]** The phosphorescent dopant may include an organometallic complex represented by Formula 401 below:



Formula 401



Formula 402

**[0227]** In Formulae 401 and 402,

**[0228]** M may be selected from iridium (Ir), platinum (Pt), palladium (Pd), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), rhodium (Rh), and thulium (Tm),

**[0229]**  $L_{401}$  may be selected from ligands represented by Formula 402, and  $xc1$  may be 1, 2, or 3, wherein, when  $xc1$  is two or more, two or more  $L_{401}(s)$  may be identical to or different from each other,

**[0230]**  $L_{402}$  may be an organic ligand, and  $xc2$  may be an integer from 0 to 4, wherein, when  $xc2$  is two or more, two or more  $L_{402}(s)$  may be identical to or different from each other,

**[0231]**  $X_{401}$  to  $X_{404}$  may each independently be nitrogen or carbon,

**[0232]**  $X_{401}$  and  $X_{403}$  may be linked via a single bond or a double bond, and  $X_{402}$  and  $X_{404}$  may be linked via a single bond or a double bond,

**[0233]**  $A_{401}$  and  $A_{402}$  may each independently be selected from a  $C_5$ - $C_{60}$  carbocyclic group or a  $C_1$ - $C_{60}$  heterocyclic group,

**[0234]**  $X_{405}$  may be a single bond,  $*-O-*$ ,  $*-S-*$ ,  $*-C(=O)-*$ ,  $*-N(Q_{411})-*$ ,  $*-C(Q_{411})(Q_{412})-*$ ,  $*-C(Q_{411})=C(Q_{412})-*$ ,  $*-C(Q_{411})=*$ , or  $*=C=*$ , wherein  $Q_{411}$  and  $Q_{412}$  may each independently be hydrogen, deuterium, a  $C_1$ - $C_{20}$  alkyl group, a  $C_1$ - $C_{20}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, or a naphthyl group,

**[0235]**  $X_{406}$  may be a single bond, O, or S,

**[0236]**  $R_{401}$  and  $R_{402}$  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 hydrazino group, a hydrazono group, a substituted or unsubstituted  $C_1$ - $C_{20}$  alkyl group, a substituted or unsubstituted  $C_1$ - $C_{20}$  alkoxy group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryloxy group, a substituted or unsubstituted  $C_6$ - $C_{60}$

arylthio group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,  $-Si(Q_{401})(Q_{402})(Q_{403})$ ,  $-N(Q_{401})(Q_{402})$ ,  $-B(Q_{401})(Q_{402})$ ,  $-C(=O)(Q_{401})$ ,  $-S(=O)_2(Q_{401})$ , and  $-P(=O)(Q_{401})(Q_{402})$ , wherein  $Q_{401}$  to  $Q_{403}$  may each independently be selected from a  $C_1$ - $C_{10}$  alkyl group, a  $C_1$ - $C_{10}$  alkoxy group, a  $C_6$ - $C_{20}$  aryl group, and a  $C_1$ - $C_{20}$  heteroaryl group,

**[0237]**  $xc11$  and  $xc12$  may each independently be an integer from 0 to 10, and

**[0238]** \* and \*' in Formula 402 each indicate a binding site to M in Formula 401.

**[0239]** In one embodiment, in Formula 402,  $A_{401}$  and  $A_{402}$  may each independently be selected from a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, an indene group, a pyrrole group, a thiophene group, a furan group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a quinoxaline group, a quinazoline group, a carbazole group, a benzimidazole group, a benzofuran group, a benzothiophene group, an isobenzothiophene group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a dibenzofuran group, and a dibenzothiophene group.

**[0240]** In one or more embodiments, in Formula 402, i)  $X_{401}$  may be nitrogen, and  $X_{402}$  may be carbon, or ii)  $X_{401}$  and  $X_{402}$  may each be nitrogen concurrently (e.g., at the same time).

**[0241]** In one or more embodiments,  $R_{401}$  and  $R_{402}$  in Formula 401 may each independently be selected from:

**[0242]** hydrogen, deuterium,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ , a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $C_1$ - $C_{20}$  alkyl group, and a  $C_1$ - $C_{20}$  alkoxy group;

**[0243]** a  $C_1$ - $C_{20}$  alkyl group, and a  $C_1$ - $C_{20}$  alkoxy group, each substituted with at least one selected from deuterium,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ , a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a phenyl group, a naphthyl group, a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, and a norbornenyl group;

**[0244]** a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

**[0245]** a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from

deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

[0246] —Si(Q<sub>401</sub>)(Q<sub>402</sub>)(Q<sub>403</sub>), —N(Q<sub>401</sub>)(Q<sub>402</sub>), —B(Q<sub>401</sub>)(Q<sub>402</sub>), —C(=O)(Q<sub>401</sub>), —S(=O)<sub>2</sub>(Q<sub>401</sub>), and —P(=O)(Q<sub>401</sub>)(Q<sub>402</sub>), and

[0247] Q<sub>401</sub> to Q<sub>403</sub> may each independently be selected from a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>1</sub>-C<sub>10</sub> alkoxy group, a phenyl group, a biphenyl group, and a naphthyl group, but are not limited thereto.

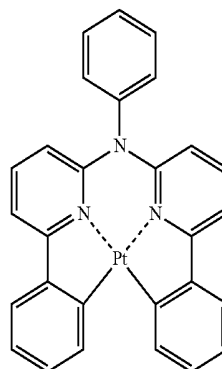
[0248] In one or more embodiments, when xc1 in Formula 401 is two or more, two A<sub>401</sub>(s) in two or more L<sub>401</sub>(s) may optionally be linked via X<sub>407</sub>, which is a linking group, or two A<sub>402</sub>(S) in two or more L<sub>401</sub>(s) may optionally be linked via X<sub>408</sub>, which is a linking group (see Compounds PD1 to PD4 and PD7). X<sub>407</sub> and X<sub>408</sub> may each independently be a single bond, \*—O—\*, \*—S—\*, \*—C(=O)—\*, \*—N(Q<sub>413</sub>)—\*, \*—C(Q<sub>413</sub>)(Q<sub>414</sub>)—\*, or \*—C(Q<sub>413</sub>)=C(Q<sub>414</sub>)—\* (wherein Q<sub>413</sub> and Q<sub>414</sub> may each independently be hydrogen, deuterium, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, or a naphthyl group), but embodiments of the present disclosure are not limited thereto.

[0249] L<sub>402</sub> in Formula 401 may be a monovalent, divalent, or trivalent organic ligand. For example, L<sub>402</sub> may be halogen, diketone (for example, acetylacetonate), carboxylic acid (for example, picolinate), —C(=O), isonitrile, —CN, and a phosphorus-containing material (For example, phosphine and phosphite), but embodiments of the present disclosure are not limited thereto.

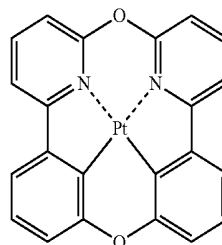
[0250] In one or more embodiments, the phosphorescent dopant may be selected from, for example, Compounds PD1 to PD25, but embodiments of the present disclosure are not limited thereto:

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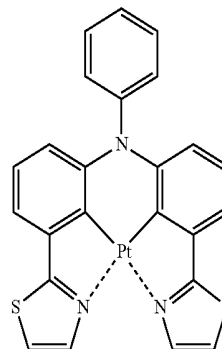
PD2



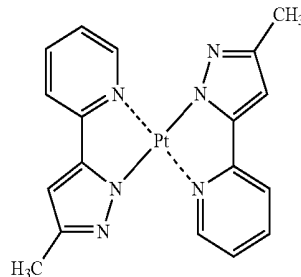
PD3



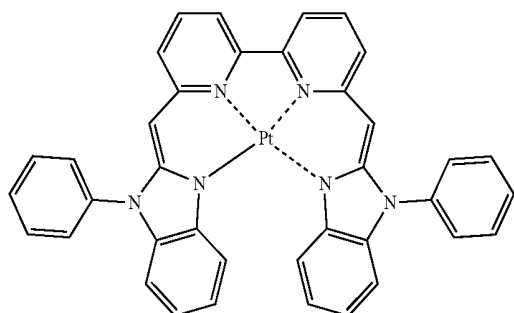
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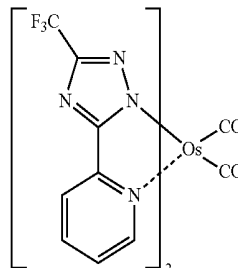
PD5



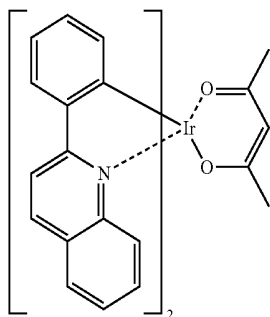
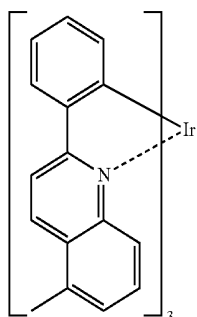
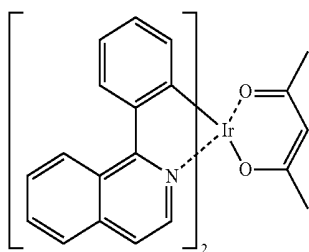
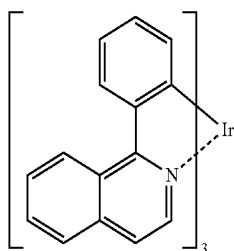
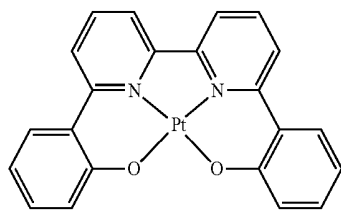
PD1



PD6

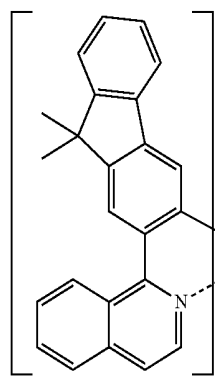


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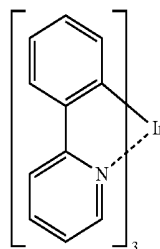
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PD7



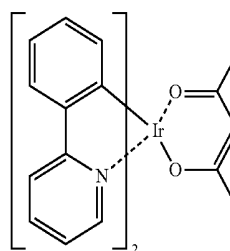
PD12

PD8



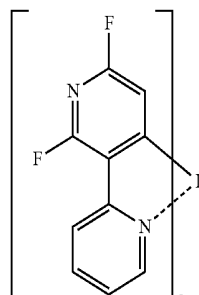
PD13

PD9



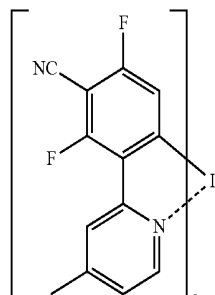
PD14

PD10



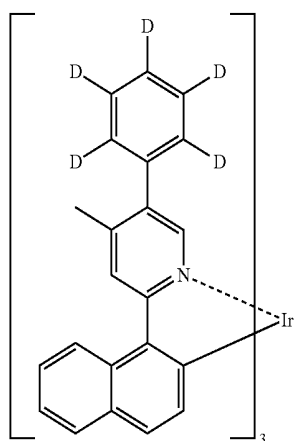
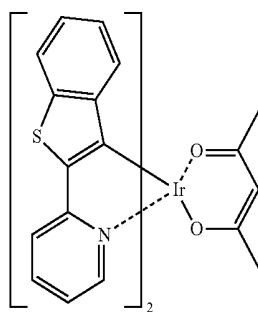
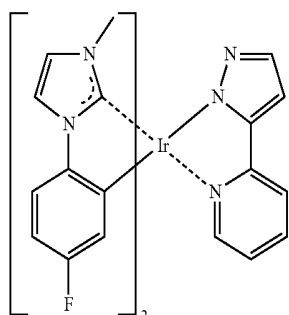
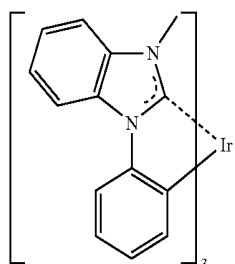
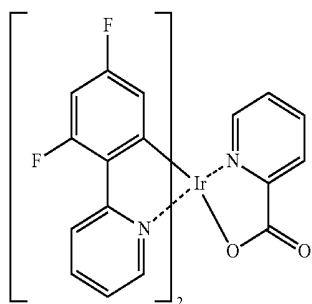
PD15

PD11



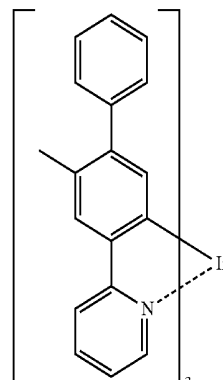
PD16

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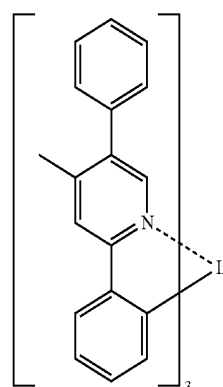
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PD17



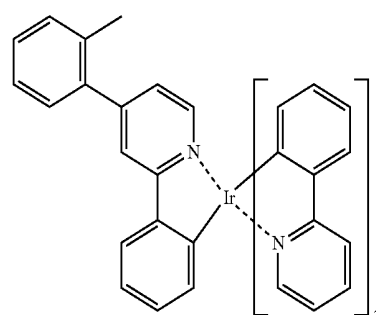
PD22

PD18



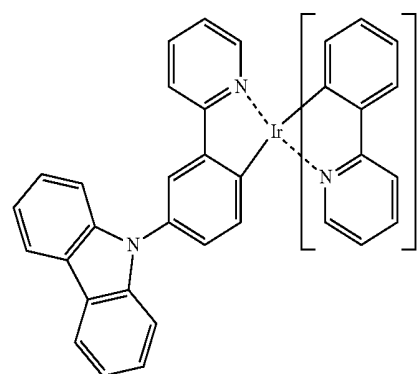
PD23

PD19



PD24

PD20



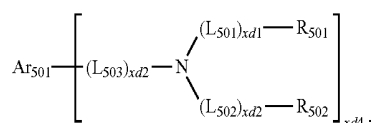
PD25

PD21

Fluorescent Dopant in Emission Layer

**[0251]** The fluorescent dopant may include an arylamine compound or a styrylamine compound.

**[0252]** The fluorescent dopant may include a compound represented by Formula 501 below.



Formula 501

[0253] In Formula 501,

[0254]  $\text{Ar}_{501}$  may be a substituted or unsubstituted  $\text{C}_5\text{-C}_{60}$  carbocyclic group or a substituted or unsubstituted  $\text{C}_1\text{-C}_{60}$  heterocyclic group,

[0255]  $\text{L}_{501}$  to  $\text{L}_{503}$  may each independently be selected from a substituted or unsubstituted  $\text{C}_3\text{-C}_{10}$  cycloalkylene group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $\text{C}_3\text{-C}_{10}$  cycloalkenylene group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $\text{C}_6\text{-C}_{60}$  arylene group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

[0256]  $x_{d1}$  to  $x_{d3}$  may each independently be an integer from 0 to 3,

[0257]  $\text{R}_{501}$  and  $\text{R}_{502}$  may each independently be selected from a substituted or unsubstituted  $\text{C}_3\text{-C}_{10}$  cycloalkyl group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $\text{C}_3\text{-C}_{10}$  cycloalkenyl group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $\text{C}_6\text{-C}_{60}$  aryl group, a substituted or unsubstituted  $\text{C}_6\text{-C}_{60}$  aryloxy group, a substituted or unsubstituted  $\text{C}_6\text{-C}_{60}$  arylthio group, a substituted or unsubstituted  $\text{C}_1\text{-C}_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, and

[0258]  $x_{d4}$  may be an integer from 1 to 6.

[0259] In one embodiment,  $\text{Ar}_{501}$  in Formula 501 may be selected from:

[0260] a naphthalene group, a heptalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, and an indenophenanthrene group; and

[0261] a naphthalene group, a heptalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, and an indenophenanthrene group, each substituted with at least one selected from deuterium,  $\text{-F}$ ,  $\text{-Cl}$ ,  $\text{-Br}$ ,  $\text{-I}$ , a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $\text{C}_1\text{-C}_{20}$  alkyl group, a  $\text{C}_1\text{-C}_{20}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0262] In one or more embodiments,  $\text{L}_{501}$  to  $\text{L}_{503}$  in Formula 501 may each independently be selected from:

[0263] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylylene group, a fluoranthenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylylene group, a thiophenylylene group, a furanylylene group, a carbazolylylene group, an indolylylene group, an isoindolylylene group, a benzofuranylylene group, a benzothiophenylylene group, a dibenzofuranylylene group, a dibenzothiophenylylene group, a benzocarbazolylylene group, a dibenzocarbazolylylene group, a dibenzosilolylylene group, and a pyridinylylene group; and

[0264] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylylene group, a fluoranthenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylylene group, a thiophenylylene group, a furanylylene group, a carbazolylylene group, an indolylylene group, an isoindolylylene group, a benzofuranylylene group, a benzothiophenylylene group, a dibenzofuranylylene group, a dibenzothiophenylylene group, a benzocarbazolylylene group, a dibenzocarbazolylylene group, a dibenzosilolylylene group, and a pyridinylylene group, each substituted with at least one selected from deuterium,  $\text{-F}$ ,  $\text{-Cl}$ ,  $\text{-Br}$ ,  $\text{-I}$ , a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a  $\text{C}_1\text{-C}_{20}$  alkyl group, a  $\text{C}_1\text{-C}_{20}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group.

[0265] In one or more embodiments,  $\text{R}_{501}$  and  $\text{R}_{502}$  in Formula 501 may each independently be selected from:

[0266] a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group; and

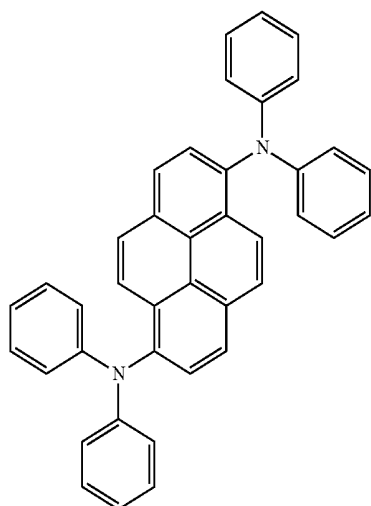
[0267] a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an

isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl 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 amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, and —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), and

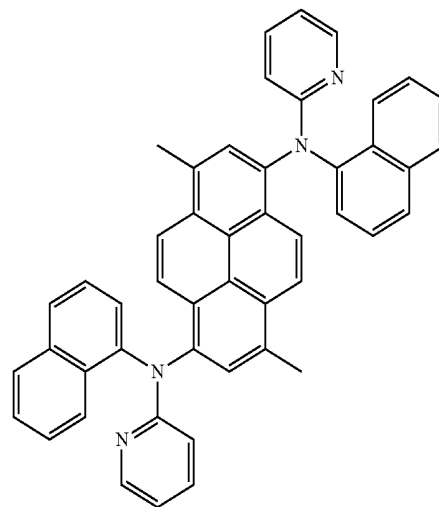
**[0268]** Q<sub>31</sub> to Q<sub>33</sub> may each independently be selected from a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>1</sub>-C<sub>10</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

**[0269]** In one or more embodiments, xd4 in Formula 501 may be 2, but embodiments of the present disclosure are not limited thereto.

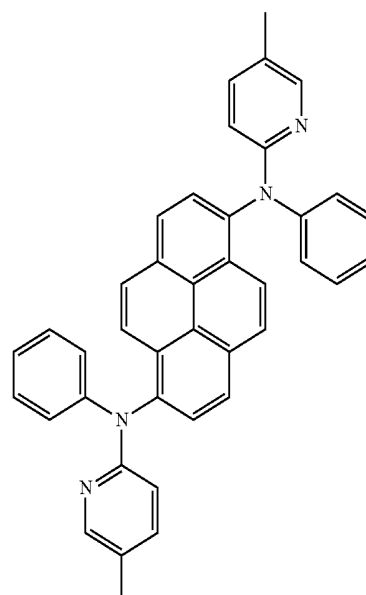
**[0270]** For example, the fluorescent dopant may be selected from Compounds FD1 to FD22:



-continued



FD2

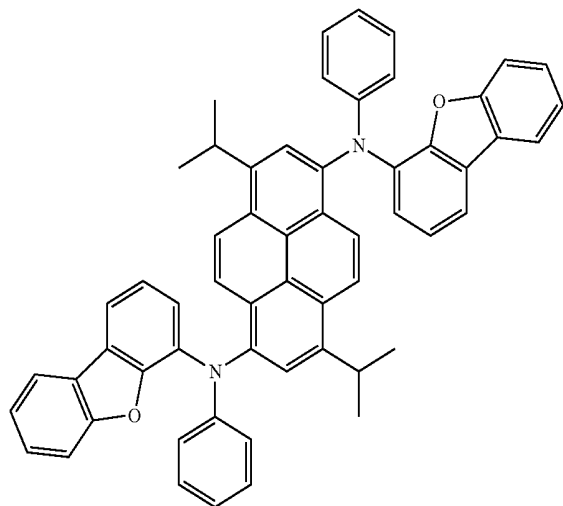


FD3

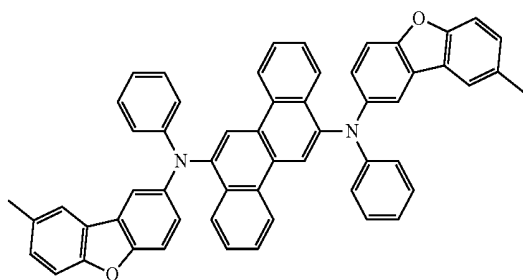


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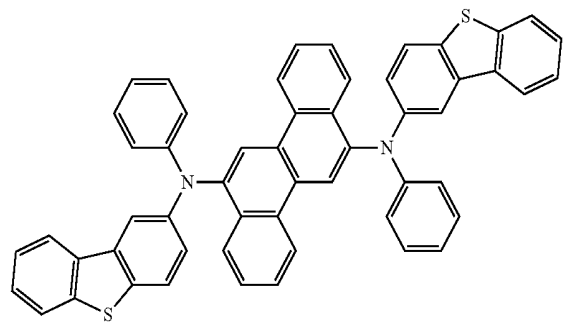
FD9



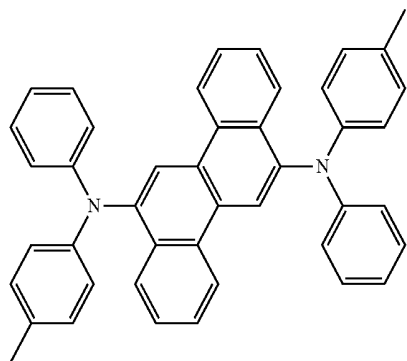
FD10



FD11

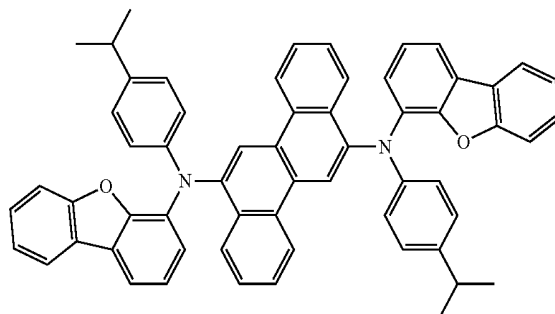


FD12

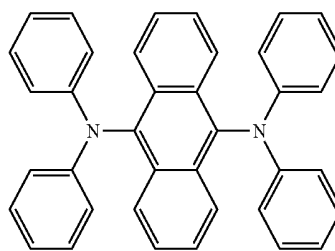


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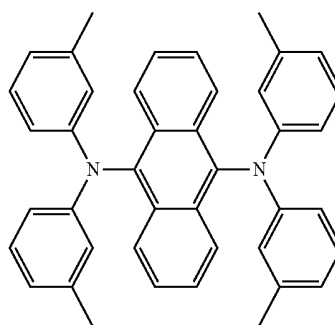
FD13



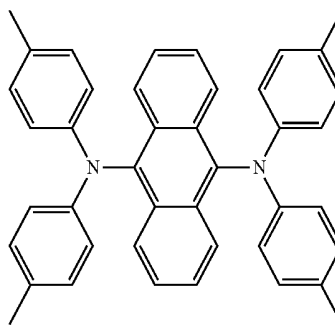
FD14



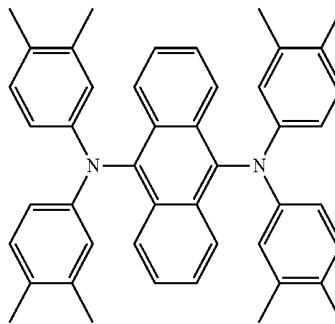
FD15



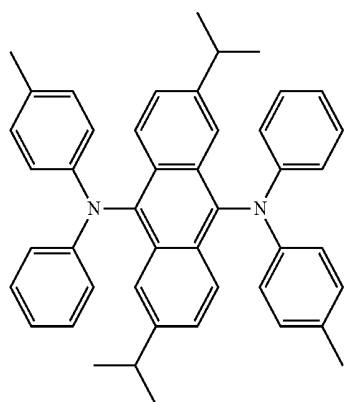
FD16



FD17

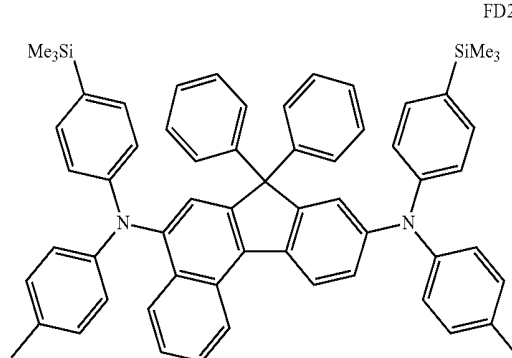


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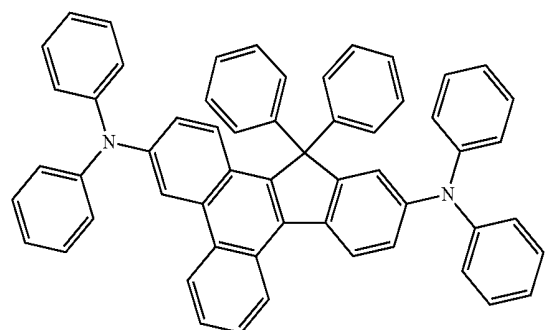
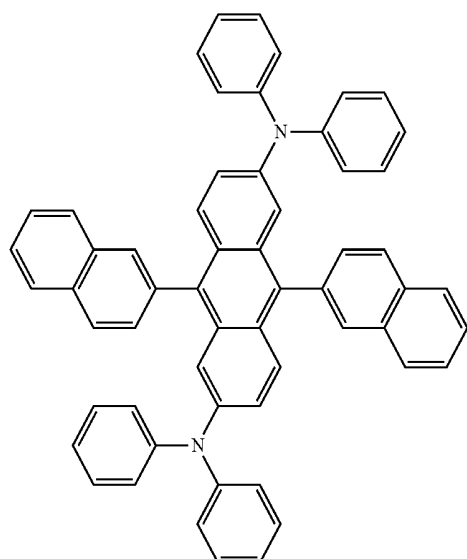
FD18

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FD21

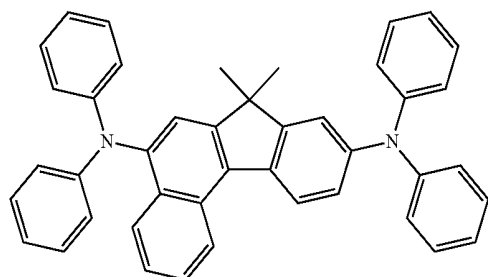
FD19

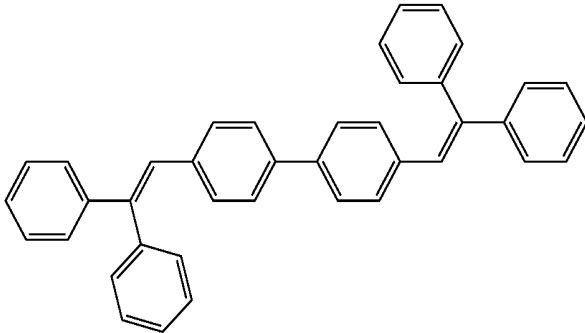


FD22

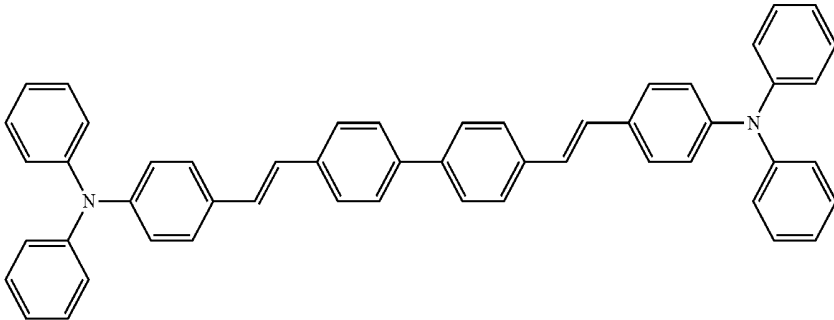
[0271] In one or more embodiments, the fluorescent dopant may be selected from the following compounds, but embodiments of the present disclosure are not limited thereto.

FD20

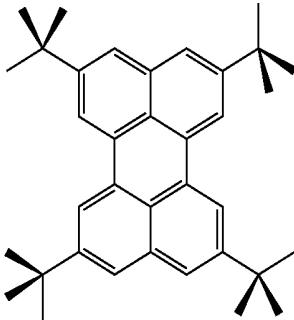




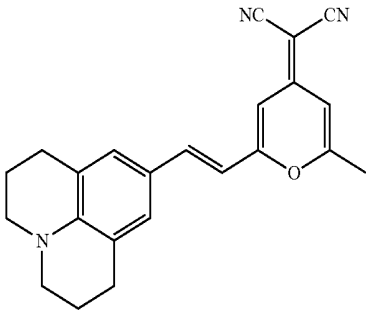
DPVBI



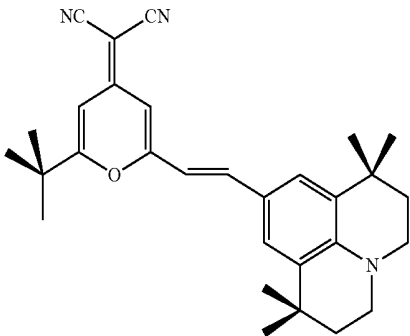
DPAVBI



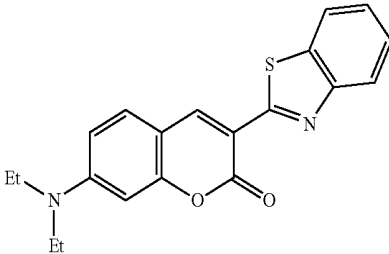
TBPe



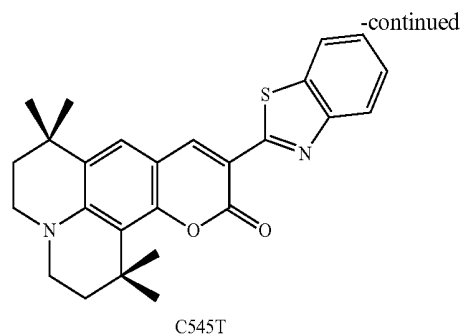
DCM



DCJTb



Coumarin 6



### Electron Transport Region in Organic Layer 150

**[0272]** The electron transport region may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

**[0273]** The electron transport region may include at least one selected from a buffer layer, a hole blocking layer, an electron control layer, an electron transport layer, and an electron injection layer, but embodiments of the present disclosure are not limited thereto.

**[0274]** For example, the electron transport region may have an electron transport layer/electron injection layer structure, a hole blocking layer/electron transport layer/electron injection layer structure, an electron control layer/electron transport layer/electron injection layer structure, or a buffer layer/electron transport layer/electron injection layer structure, wherein for each structure, constituting layers are sequentially stacked from an emission layer. However, embodiments of the structure of the electron transport region are not limited thereto.

**[0275]** The electron transport region (for example, a buffer layer, a hole blocking layer, an electron control layer, or an electron transport layer in the electron transport region) may include a metal-free compound containing at least one  $\pi$  electron-depleted nitrogen-containing ring.

**[0276]** As used herein, the term “ $\pi$  electron-depleted nitrogen-containing ring” indicates a  $C_1$ - $C_{60}$  heterocyclic group having at least one  $*-N=*$  moiety as a ring-forming moiety.

**[0277]** For example, the “ $\pi$  electron-depleted nitrogen-containing ring” may be i) a 60-membered to 7-membered heteromonocyclic group having at least one  $*-N=*$  moiety, ii) a heteropolycyclic group in which two or more 5-membered to 7-membered heteromonocyclic groups each having at least one  $*-N=*$  moiety are condensed with each other, or iii) a heteropolycyclic group in which at least one of 5-membered to 7-membered heteromonocyclic groups, each having at least one  $*-N=*$  moiety, is condensed with at least one  $C_5$ - $C_{60}$  carbocyclic group.

**[0278]** Examples of the  $\pi$  electron-depleted nitrogen-containing ring include an imidazole, a pyrazole, a thiazole, an isothiazole, an oxazole, an isoxazole, a pyridine, a pyrazine, a pyrimidine, a pyridazine, an indazole, a purine, a quinoline, an isoquinoline, a benzoquinoline, a phthalazine, a naphthyridine, a quinoxaline, a quinazoline, a cinnoline, a phenanthridine, an acridine, a phenanthroline, a phenazine, a benzimidazole, an isobenzothiazole, a benzoxazole, an

isobenzoxazole, a triazole, a tetrazole, an oxadiazole, a triazine, thiadiazol, an imidazopyridine, an imidazopyrimidine, and an azacarbazole, but are not limited thereto.

**[0279]** For example, the electron transport region may include a compound represented by Formula 601:



**[0280]** In Formula 601,

**[0281]**  $Ar_{601}$  may be a substituted or unsubstituted  $C_5$ - $C_{60}$  carbocyclic group or a substituted or unsubstituted  $C_1$ - $C_{60}$  heterocyclic group,

**[0282]**  $xe11$  may be 1, 2, or 3,

**[0283]**  $L_{601}$  may each independently be selected from a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylene group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group;

**[0284]**  $xe1$  may be an integer from 0 to 5,

**[0285]**  $R_{601}$  may be selected from a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkyl group, a substituted or unsubstituted  $C_3$ - $C_{10}$  cycloalkenyl group, a substituted or unsubstituted  $C_1$ - $C_{10}$  heterocycloalkenyl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryl group, a substituted or unsubstituted  $C_6$ - $C_{60}$  aryloxy group, a substituted or unsubstituted  $C_6$ - $C_{60}$  arylthio group, a substituted or unsubstituted  $C_1$ - $C_{60}$  heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,  $-\text{Si}(Q_{601})(Q_{602})(Q_{603})$ ,  $-\text{C}(=\text{O})(Q_{601})$ ,  $-\text{S}(=\text{O})_2(Q_{601})$ , and  $-\text{P}(=\text{O})(Q_{601})(Q_{602})$ ,

**[0286]**  $Q_{601}$  to  $Q_{603}$  may each independently be a  $C_1$ - $C_{10}$  alkyl group, a  $C_1$ - $C_{10}$  alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, or a naphthyl group, and

**[0287]**  $xe21$  may be an integer from 1 to 5.

**[0288]** In one embodiment, at least one of  $Ar_{601}(s)$  in the number of  $xe11$  and  $R_{601}(s)$  in the number of  $xe21$  may include the  $\pi$  electron-depleted nitrogen-containing ring.

**[0289]** In one embodiment, ring  $Ar_{601}$  in Formula 601 may be selected from:

**[0290]** a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triph-

enylene group, a pyrene group, a chrysene group, a naphthalene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group; and

[0291] a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthalene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), —S(=O)<sub>2</sub>(Q<sub>31</sub>), and —P(=O)(Q<sub>31</sub>)(Q<sub>32</sub>), and

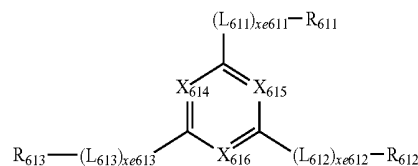
[0292] Q<sub>31</sub> to Q<sub>33</sub> may each independently be selected from a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>1</sub>-C<sub>10</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0293] When xe11 in Formula 601 is two or more, two or more Ar<sub>601</sub>(s) may be linked each other via a single bond.

[0294] In one or more embodiments, Ar<sub>601</sub> in Formula 601 may be an anthracene group.

[0295] In one or more embodiments, a compound represented by Formula 601 may be represented by Formula 601-1:

Formula 601-1



[0296] In Formula 601-1,

[0297] X<sub>614</sub> may be N or C(R<sub>614</sub>), X<sub>615</sub> may be N or C(R<sub>615</sub>), X<sub>616</sub> may be N or C(R<sub>616</sub>), and at least one selected from X<sub>614</sub> to X<sub>616</sub> may be N,

[0298] L<sub>611</sub> to L<sub>613</sub> may each independently be the same as described in connection with L<sub>601</sub>,

[0299] xe611 to xe613 may each independently be the same as described in connection with xe1,

[0300] R<sub>611</sub> to R<sub>613</sub> may each independently be the same as described in connection with R<sub>601</sub>,

[0301] R<sub>614</sub> to R<sub>616</sub> 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 hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0302] In one embodiment, L<sub>601</sub> and L<sub>611</sub> to L<sub>613</sub> in Formulae 601 and 601-1 may each independently be selected from:

[0303] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylylene group, a fluoranthenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylylene group, a thiophenylylene group, a furanylylene group, a carbazolylylene group, an indolylylene group, an isoindolylylene group, a benzofuranylylene group, a benzothiophenylylene group, a dibenzofuranylylene group, a dibenzothiophenylylene group, a benzocarbazolylylene group, a dibenzocarbazolylylene group, a dibenzosilolylylene group, a pyridinylylene group, an imidazololylylene group, a pyrazolylylene group, a thiazolylylene group, an isothiazolylylene group, an oxazololylylene group, an isoxazololylylene group, a thiadiazolylylene group, an oxadiazolylylene group, a pyrazinylylene group, a pyrimidinylylene group, a pyridazinylylene group, a triazinylylene group, a quinolinylylene group, an isoquinolinylylene group, a benzoquinolinylylene group, a phthalazinylylene group, a naphthyridinylylene group, a quinoxalinylylene group, a quinazolinylylene group, a cinnolinylylene group, a phenanthridinylylene group, an acridinylylene group, a phenanthrolinylylene group, a phenazinylylene group, a benzimidazololylylene group, an isobenzothiazolylylene group, a benzoxazololylylene group, an isobenzoxazololylylene group, a triazololylylene group, a tetrazolylylene group, an imidazopyridinylylene group, an imidazopyrimidinylylene group, and an azacarbazolylylene group; and

[0304] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylylene group, a benzofluorenylylene group, a dibenzofluorenylylene group, a phenanthrenylene group, an anthracenylylene group, a fluoranthenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylylene group, a

thiophenylene group, a furanylene group, a carbazolyene group, an indolyene group, an isoindolyene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolyene group, a dibenzocarbazolyene group, a dibenzosilolyene group, a pyridinylene group, an imidazolyene group, a pyrazolyene group, a thiazolyene group, an isothiazolyene group, an oxazolyene group, an isoxazolyene group, a thiadiazolyene group, an oxadiazolyene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolyene group, an isobenzothiazolyene group, a benzoxazolyene group, an isobenzoxazolyene group, a triazolylene group, a tetazolylene group, an imidazopyrimidinylene group, an imidazopyrimidinylene group, and an azacarbazolyene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinylyl group, a quinazolinylyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group,

[0305] but embodiments of the present disclosure are not limited thereto.

[0306] In one or more embodiments, xe1 and xe611 to xe613 in Formulae 601 and 601-1 may each independently be 0, 1, or 2.

[0307] In one or more embodiments, in Formulae 601 and 601-1, R<sub>601</sub> and R<sub>611</sub> to R<sub>613</sub> may each independently be selected from:

[0308] a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group,

a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinylyl group, a quinazolinylyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;

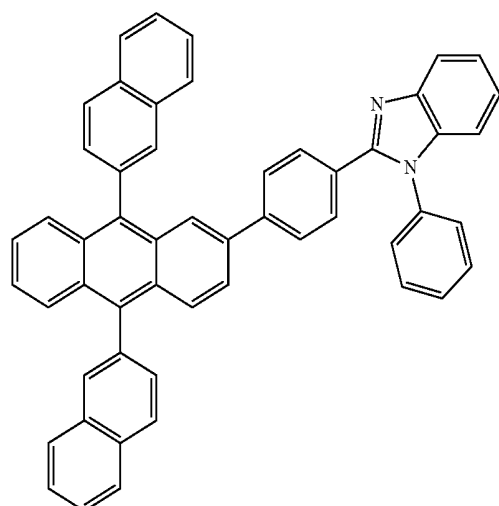
[0309] a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinylyl group, a quinazolinylyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenylyl group, a pentacenylyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthy-

ridinyl group, a quinoxaliny group, a quinazoliny group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group; and

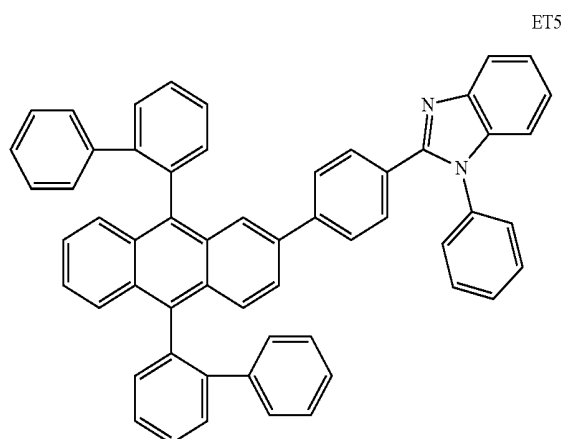
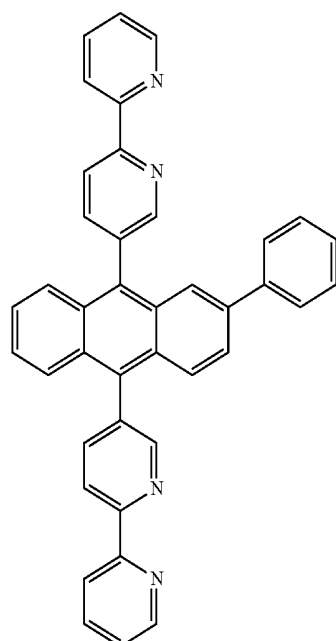
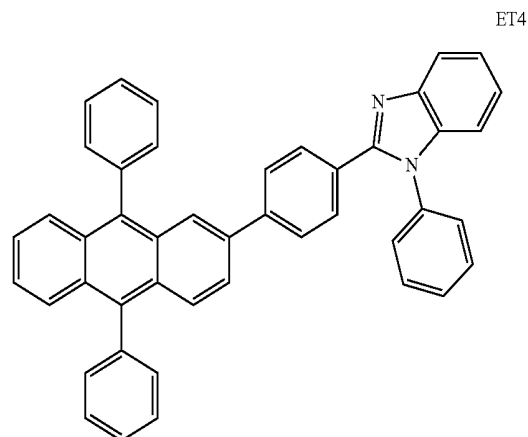
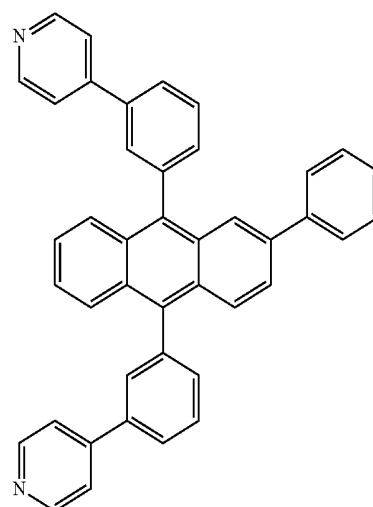
[0310]  $-S(=O)_2(Q_{601})$  and  $-P(=O)(Q_{601})(Q_{602})$ , and

[0311]  $Q_{601}$  and  $Q_{602}$  may respectively be the same as described above.

[0312] The electron transport region may include at least one compound selected from Compounds ET1 to ET36, but embodiments of the present disclosure are not limited thereto:

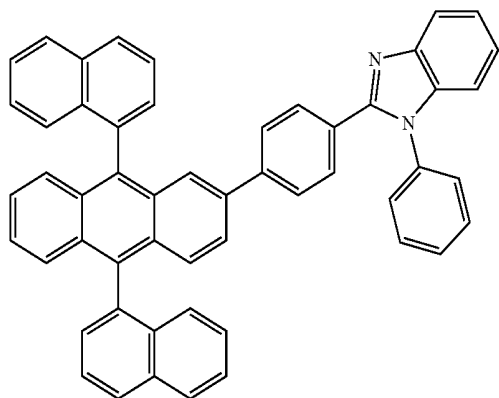


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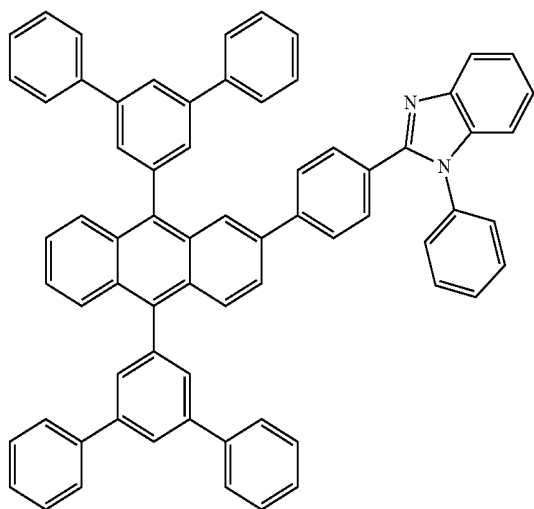


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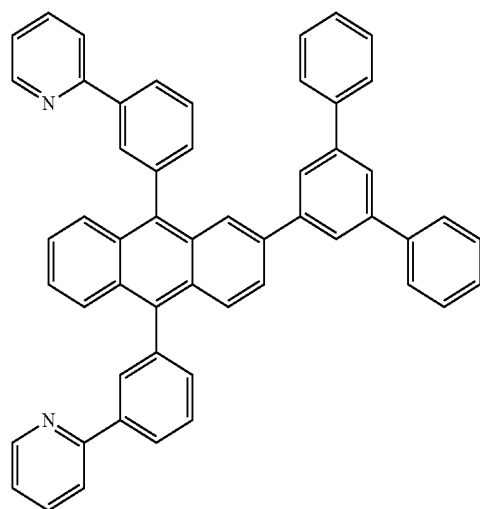
ET6



ET7

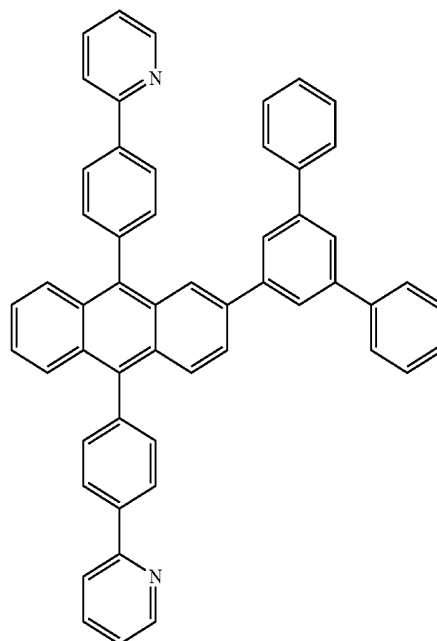


ET8

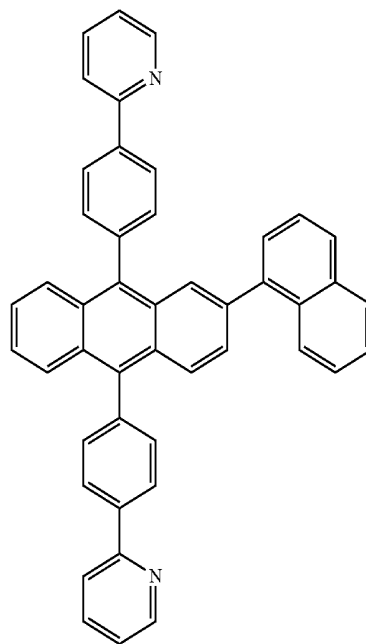


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ET9

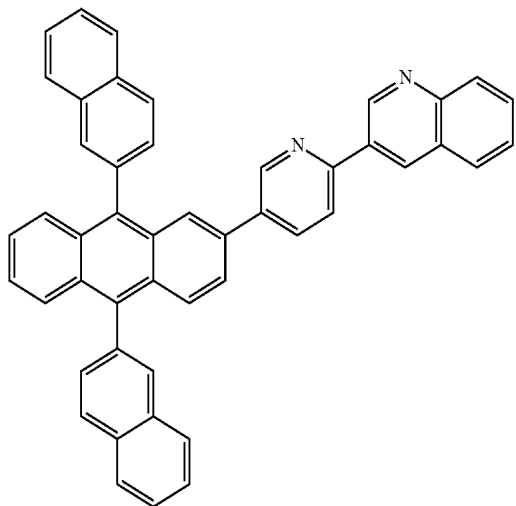


ET10



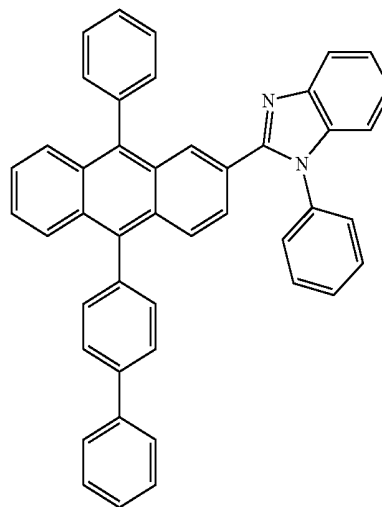
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ET11

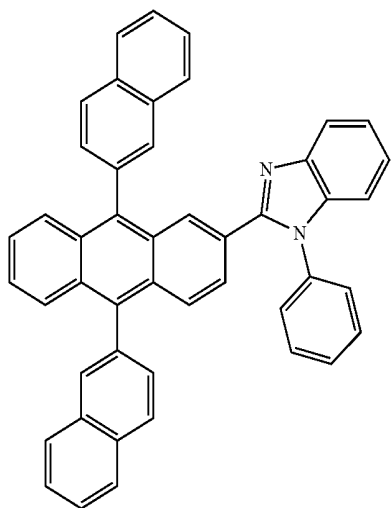


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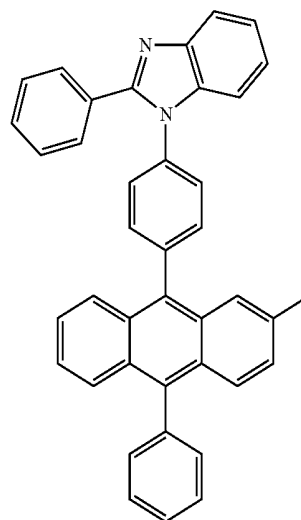
ET14



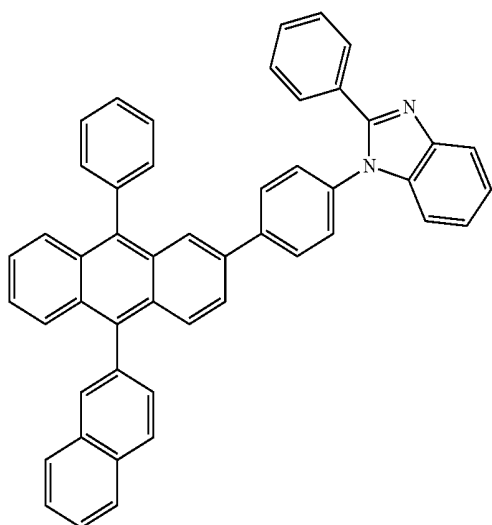
ET12



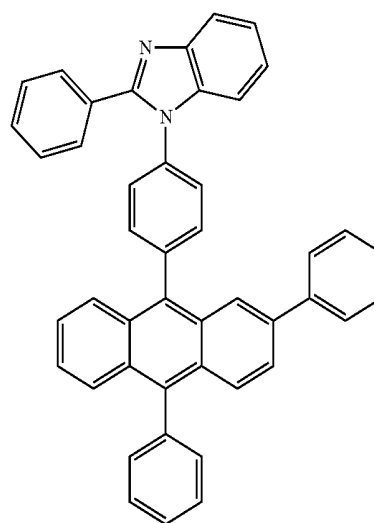
ET15



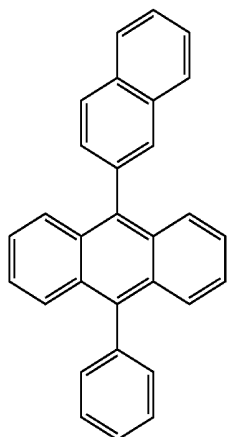
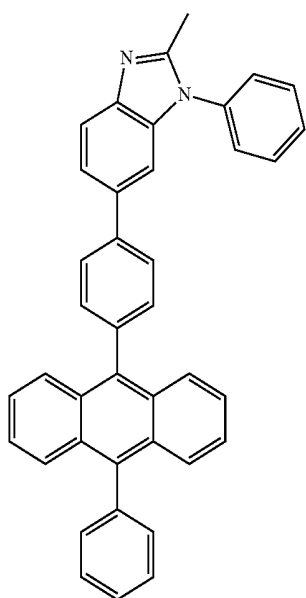
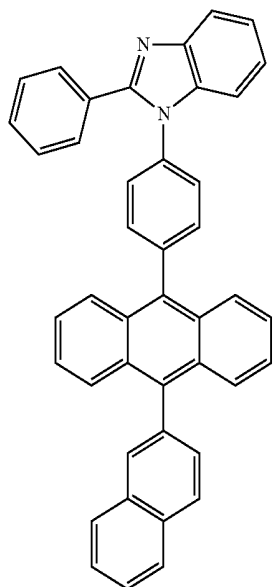
ET13



ET16

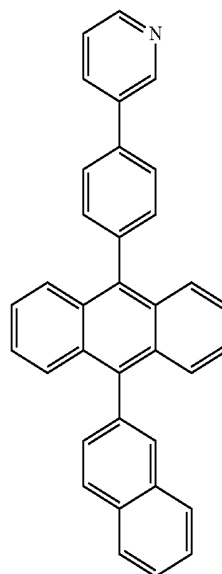


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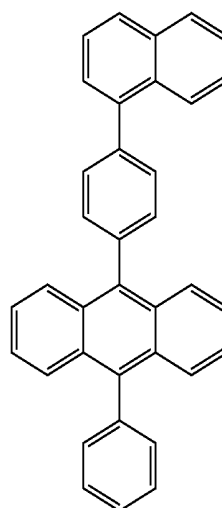
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ET17



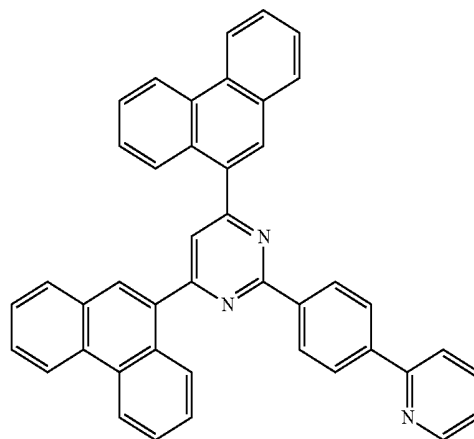
ET20

ET18



ET21

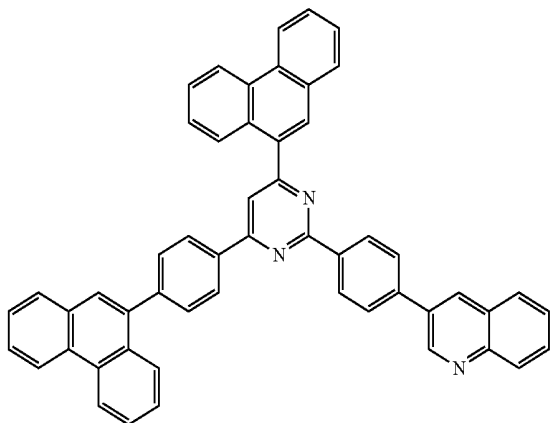
ET19



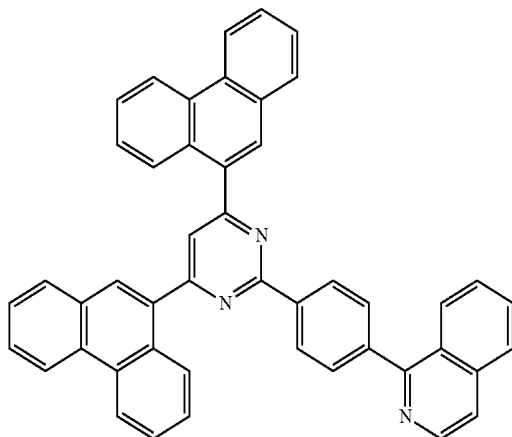
ET22

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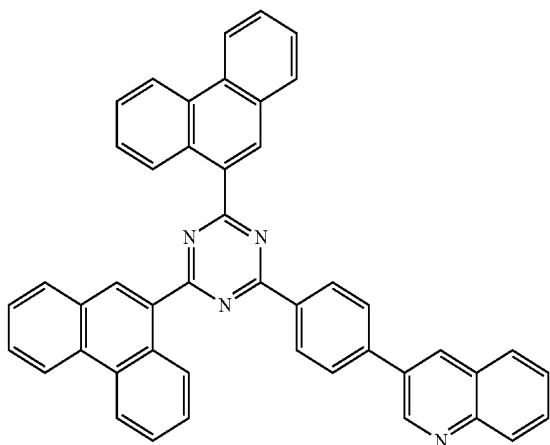
ET23



ET24

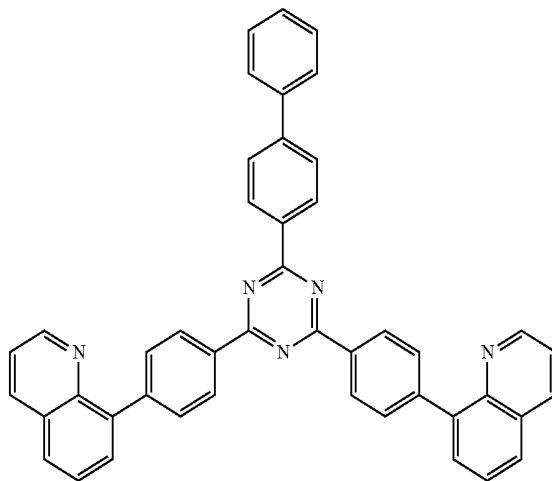


ET25

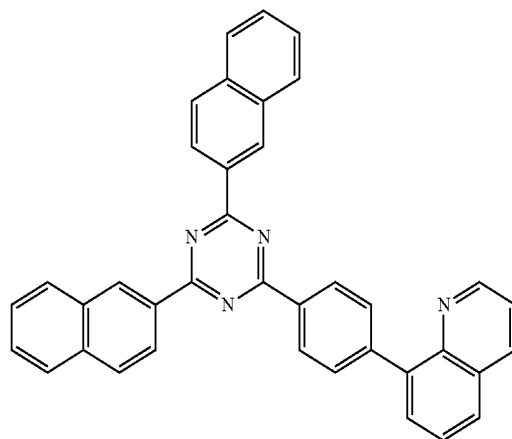


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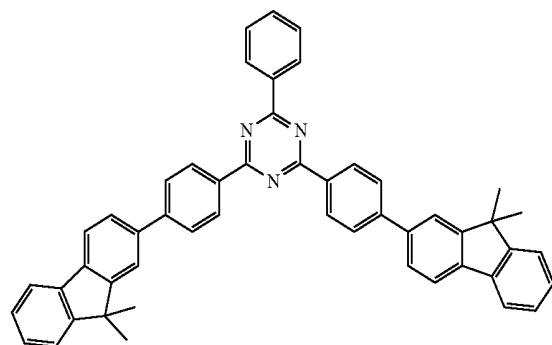
ET26



ET27

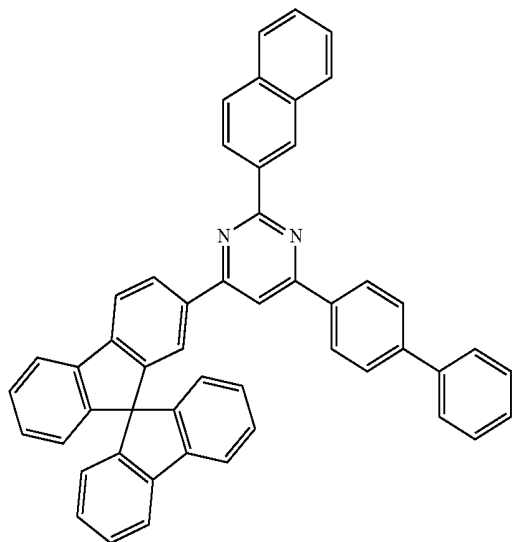


ET28



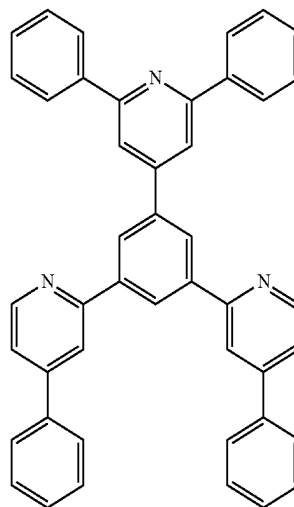
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ET29

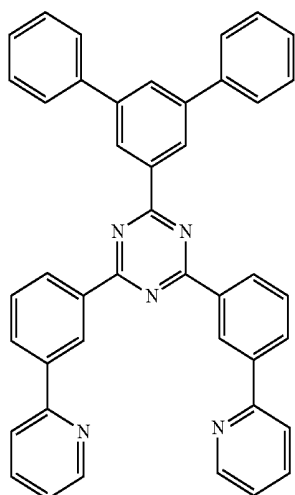


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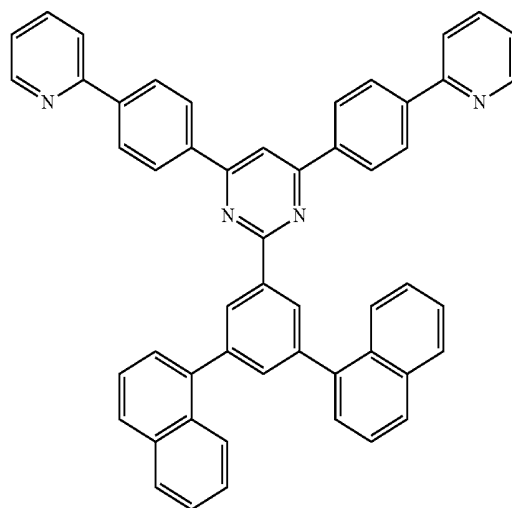
ET32



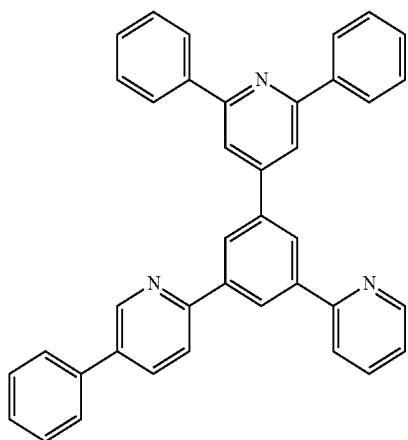
ET30



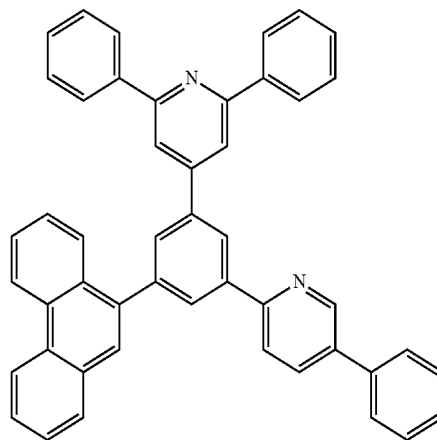
ET33



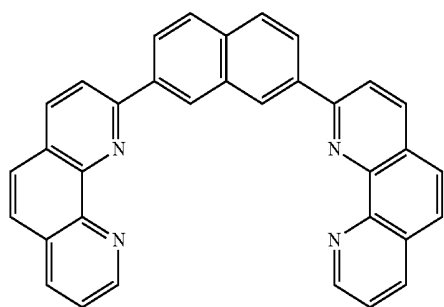
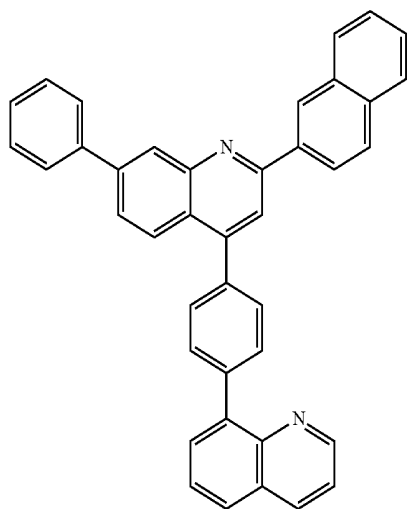
ET31



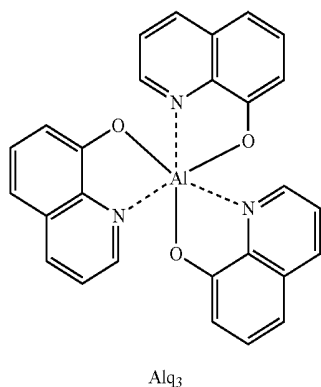
ET34



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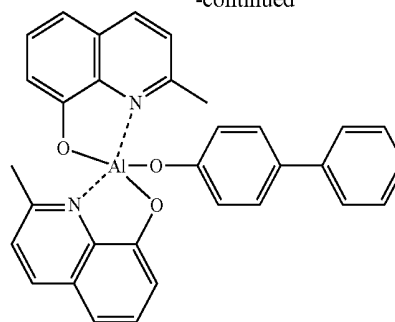


[0313] In one or more embodiments, the electron transport region may include at least one compound selected from 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP), 4,7-diphenyl-1,10-phenanthroline (Bphen), Alq<sub>3</sub>, BAlq, 3-(biphenyl-4-yl)-5-(4-tert-butylphenyl)-4-phenyl-4H-1,2,4-triazole (TAZ), and NTAZ:

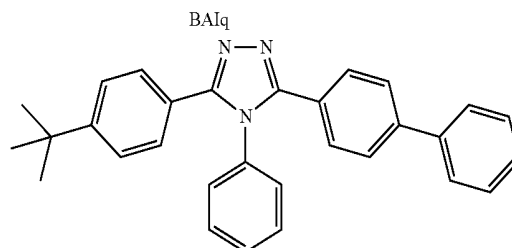


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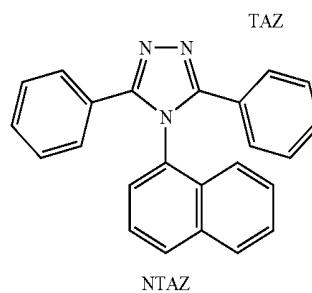
ET35



BAlq



ET36



[0314] In one embodiment, the electron transport region may include a phosphine oxide-containing compound (for example, TSPO1 used in the following examples or the like), but embodiments of the present disclosure are not limited thereto. In one embodiment, the phosphine oxide-containing compound may be used in a hole blocking layer in the electron transport region, but embodiments of the present disclosure are not limited thereto.

[0315] A thickness of the buffer layer, the hole blocking layer, or the electron control layer may be in a range of about 20 Å to about 1,000 Å, for example, about 30 Å to about 300 Å. When the thicknesses of the buffer layer, the hole blocking layer, and the electron control layer are within these ranges, the electron blocking layer may have excellent electron blocking characteristics or electron control characteristics without a substantial increase in driving voltage.

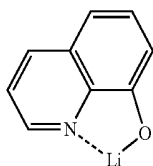
[0316] A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, for example, about 150 Å to about 500 Å. When the thickness of the electron transport layer is within the range described above, the electron transport layer may have suitable or satisfactory electron transport characteristics without a substantial increase in driving voltage.

[0317] The electron transport region (for example, the electron transport layer in the electron transport region) may further include, in addition to the materials described above, a metal-containing material.

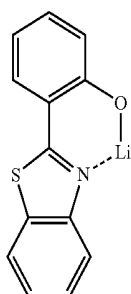
[0318] The metal-containing material may include at least one selected from alkali metal complex and alkaline earth-metal complex. The alkali metal complex may include a

metal ion selected from a Li ion, a Na ion, a K ion, a Rb ion, and a Cs ion, and the alkaline earth-metal complex may include a metal ion selected from a Be ion, a Mg ion, a Ca ion, a Sr ion, and a Ba ion. A ligand coordinated with the metal ion of the alkali metal complex or the alkaline earth-metal complex may be selected from a hydroxy quinoline, a hydroxy isoquinoline, a hydroxy benzoquinoline, a hydroxy acridine, a hydroxy phenanthridine, a hydroxy phenyloxazole, a hydroxy phenylthiazole, a hydroxy diphenyloxadiazole, a hydroxy diphenylthiadiazol, a hydroxy phenylpyridine, a hydroxy phenylbenzimidazole, a hydroxy phenylbenzothiazole, a bipyridine, a phenanthroline, and a cyclopentadiene, but embodiments of the present disclosure are not limited thereto.

[0319] For example, 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

[0320] The electron transport region may include an electron injection layer that facilitates injection of electrons from the second electrode **190**. The electron injection layer may directly contact the second electrode **190**.

[0321] The electron injection layer may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

[0322] The electron injection layer may include an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof.

[0323] The alkali metal may be selected from Li, Na, K, Rb, and Cs. In one embodiment, the alkali metal may be Li, Na, or Cs. In one or more embodiments, the alkali metal may be Li or Cs, but embodiments of the present disclosure are not limited thereto.

[0324] The alkaline earth metal may be selected from Mg, Ca, Sr, and Ba.

[0325] The rare earth metal may be selected from Sc, Y, Ce, Tb, Yb, and Gd.

[0326] The alkali metal compound, the alkaline earth-metal compound, and the rare earth metal compound may be selected from oxides and halides (for example, fluorides, chlorides, bromides, or iodides) of the alkali metal, the alkaline earth-metal, and the rare earth metal.

[0327] The alkali metal compound may be selected from alkali metal oxides, such as  $\text{Li}_2\text{O}$ ,  $\text{Cs}_2\text{O}$ , or  $\text{K}_2\text{O}$ , and alkali metal halides, such as LiF, NaF, CsF, KF, LiI, NaI, CsI, or KI. In one embodiment, the alkali metal compound may be selected from LiF,  $\text{Li}_2\text{O}$ , NaF, LiI, NaI, CsI, and KI, but embodiments of the present disclosure are not limited thereto.

[0328] The alkaline earth-metal compound may be selected from alkaline earth-metal oxides, such as BaO, SrO, CaO,  $\text{Ba}_x\text{Sr}_{1-x}\text{O}$  ( $0 < x < 1$ ), or  $\text{Ba}_x\text{Ca}_{1-x}\text{O}$  ( $0 < x < 1$ ). In one embodiment, the alkaline earth-metal compound may be selected from BaO, SrO, and CaO, but embodiments of the present disclosure are not limited thereto.

[0329] The rare earth metal compound may be selected from  $\text{YbF}_3$ ,  $\text{ScF}_3$ ,  $\text{ScO}_3$ ,  $\text{Y}_2\text{O}_3$ ,  $\text{Ce}_2\text{O}_3$ ,  $\text{GdF}_3$ , and  $\text{TbF}_3$ . In one embodiment, the rare earth metal compound may be selected from  $\text{YbF}_3$ ,  $\text{ScF}_3$ ,  $\text{TbF}_3$ ,  $\text{YbI}_3$ ,  $\text{ScI}_3$ , and  $\text{TbI}_3$ , but embodiments of the present disclosure are not limited thereto.

[0330] The alkali metal complex, the alkaline earth-metal complex, and the rare earth metal complex may include an ion of alkali metal, alkaline earth-metal, and rare earth metal as described above, and a ligand coordinated with a metal ion of the alkali metal complex, the alkaline earth-metal complex, or the rare earth metal complex may be selected from hydroxy quinoline, hydroxy isoquinoline, hydroxy benzoquinoline, hydroxy acridine, hydroxy phenanthridine, hydroxy phenyloxazole, hydroxy phenylthiazole, hydroxy diphenyloxadiazole, hydroxy diphenylthiadiazol, hydroxy phenylpyridine, hydroxy phenylbenzimidazole, hydroxy phenylbenzothiazole, bipyridine, phenanthroline, and cyclopentadiene, but embodiments of the present disclosure are not limited thereto.

[0331] The electron injection layer may consist of an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof, as described above. In one or more embodiments, the electron injection layer may further include an organic material. When the electron injection layer further includes an organic material, an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof may be homogeneously or non-homogeneously dispersed in a matrix including the organic material.

[0332] A thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, for example, about 3 Å to about 90 Å. When the thickness of the electron injection layer is within the range described above, the electron injection layer may have suitable or satisfactory electron injection characteristics without a substantial increase in driving voltage.

### Second Electrode 190

[0333] The second electrode 190 may be disposed on the organic layer 150 having such a structure. The second electrode 190 may be a cathode which is an electron injection electrode, and in this regard, a material for forming the second electrode 190 may be selected from metal, an alloy, an electrically conductive compound, and a combination thereof, which have a relatively low work function.

[0334] The second electrode 190 may include at least one selected from lithium (Li), silver (Ag), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), magnesium-silver (Mg—Ag), ITO, and IZO, but embodiments of the present disclosure are not limited thereto. The second electrode 190 may be a transmissive electrode, a semi-transmissive electrode, or a reflective electrode.

[0335] The second electrode 190 may have a single-layered structure, or a multi-layered structure including two or more layers.

[0336] Layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region may be formed in a certain region by using one or more suitable methods selected from vacuum deposition, spin coating, casting, Langmuir-Blodgett (LB) deposition, ink-jet printing, laser-printing, and laser-induced thermal imaging.

[0337] When layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region are formed by vacuum deposition, the deposition may be performed at a deposition temperature of about 100° C. to about 500° C., a vacuum degree of about  $10^{-8}$  torr to about  $10^{-3}$  torr, and a deposition speed of about 0.01 Å/sec to about 100 Å/sec by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

[0338] When layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region are formed by spin coating, the spin coating may be performed at a coating speed of about 2,000 rpm to about 5,000 rpm and at a heat treatment temperature of about 80° C. to about 200° C. by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

### Apparatus

[0339] The organic light-emitting device may be included in various suitable apparatuses. For example, a light-emitting apparatus, an authentication apparatus, or an electronic apparatus, which includes the organic light-emitting device, may be provided.

[0340] The light-emitting apparatus may further include, in addition to the organic light-emitting device, a thin film transistor including a source electrode and a drain electrode. One of the source electrode and the drain electrode of the thin film transistor may be electrically coupled to (e.g., electrically connected to) one of the first electrode and the second electrode of the organic light-emitting device. The light-emitting apparatus may be used as various suitable displays, light sources, and the like.

[0341] The authentication apparatus may be, for example, a biometric authentication apparatus for authenticating an individual by using biometric information of a biometric body (for example, a finger tip, a pupil, or the like).

[0342] The authentication apparatus may further include, in addition to the organic light-emitting device, a biometric information collector.

[0343] The electronic apparatus may be applied to personal computers (for example, a mobile personal computer), mobile phones, digital cameras, electronic organizers, electronic dictionaries, electronic game machines, medical instruments (for example, electronic thermometers, sphygmomanometers, blood glucose meters, pulse measurement devices, pulse wave measurement devices, electrocardiogram (ECG) displays, ultrasonic diagnostic devices, or endoscope displays), fish finders, various suitable measuring instruments, meters (for example, meters for a vehicle, an aircraft, and a vessel), projectors, and the like, but embodiments of the present disclosure are not limited thereto.

### Description of FIGS. 2-4

[0344] An organic light-emitting device 20 of FIG. 2 includes a first capping layer 210, a first electrode 110, an organic layer 150, and a second electrode 190 which are sequentially stacked in this stated order, an organic light-emitting device 30 of FIG. 3 includes a first electrode 110, an organic layer 150, a second electrode 190, and a second capping layer 220 which are sequentially stacked in this stated order, and an organic light-emitting device 40 of FIG. 4 includes a first capping layer 210, a first electrode 110, an organic layer 150, a second electrode 190, and a second capping layer 220.

[0345] Regarding FIGS. 2-4, the first electrode 110, the organic layer 150, and the second electrode 190 may be understood by referring to the description presented in connection with FIG. 1.

[0346] In the organic layer 150 of each of the organic light-emitting devices 20 and 40, light generated in an emission layer may pass through the first electrode 110, which is a semi-transmissive electrode or a transmissive electrode, and the first capping layer 210 toward the outside, and in the organic layer 150 of each of the organic light-emitting devices 30 and 40, light generated in an emission layer may pass through the second electrode 190, which is a semi-transmissive electrode or a transmissive electrode, and the second capping layer 220 toward the outside.

[0347] The first capping layer 210 and the second capping layer 220 may increase external luminescent efficiency according to the principle of constructive interference.

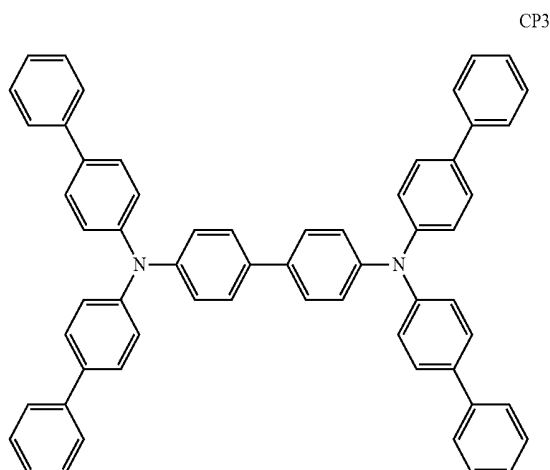
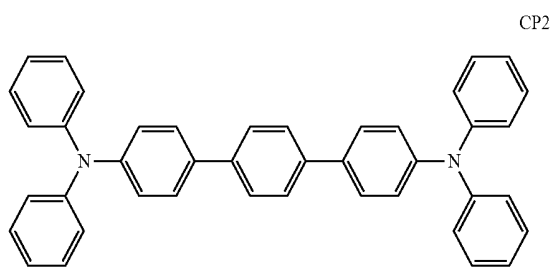
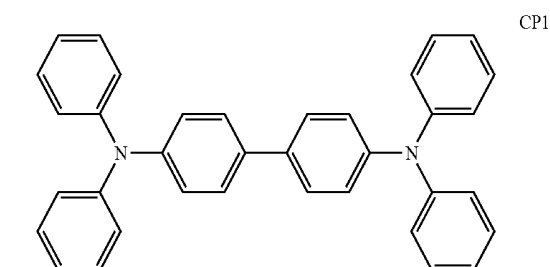
[0348] The first capping layer 210 and the second capping layer 220 may each independently be an organic capping layer including an organic material, an inorganic capping layer including an inorganic material, or a composite capping layer including an organic material and an inorganic material.

[0349] At least one selected from the first capping layer 210 and the second capping layer 220 may each independently include at least one material selected from carbocyclic compounds, heterocyclic compounds, amine-based compounds, porphyrine derivatives, phthalocyanine derivatives, a naphthalocyanine derivatives, alkali metal complexes, and alkaline earth-based complexes. The carbocyclic compound, the heterocyclic compound, and the amine-based compound may be optionally substituted with a substituent containing at least one element selected from O, N, S, Se, Si, F, Cl, Br, and I. In one embodiment, at least one selected

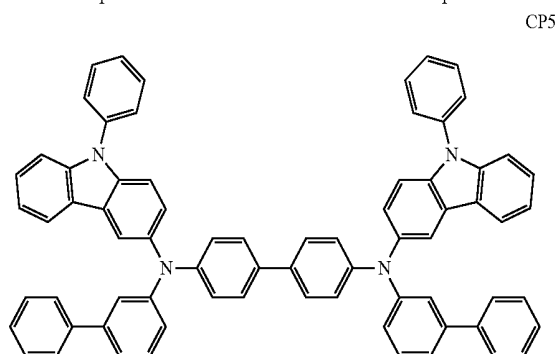
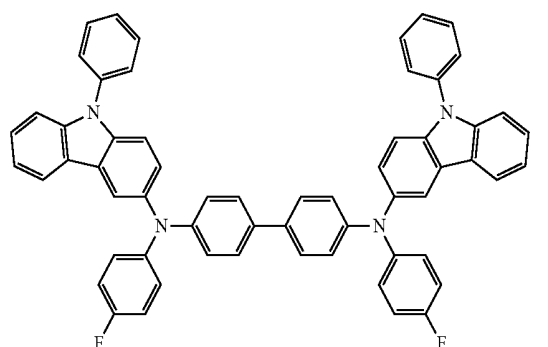
from the first capping layer 210 and the second capping layer 220 may each independently include an amine-based compound.

[0350] In one embodiment, at least one selected from the first capping layer 210 and the second capping layer 220 may each independently include the compound represented by Formula 201 or the compound represented by Formula 202.

[0351] In one or more embodiments, at least one selected from the first capping layer 210 and the second capping layer 220 may each independently include a compound selected from Compounds HT28 to HT33 and Compounds CP1 to CP5, but embodiments of the present disclosure are not limited thereto.



-continued



[0352] Hereinbefore, the organic light-emitting device according to an embodiment has been described in connection with FIGS. 1-4. However, embodiments of the present disclosure are not limited thereto.

[0353] Layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region may be formed in a certain region by using one or more suitable methods selected from vacuum deposition, spin coating, casting, Langmuir-Blodgett (LB) deposition, ink-jet printing, laser-printing, and laser-induced thermal imaging.

[0354] When layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region are formed by vacuum deposition, the deposition may be performed at a deposition temperature of about 100° C. to about 500° C., a vacuum degree of about 10<sup>-8</sup> torr to about 10<sup>-3</sup> torr, and a deposition speed of about 0.01 Å/sec to about 100 Å/sec by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

[0355] When layers constituting the hole transport region, an emission layer, and layers constituting the electron transport region are formed by spin coating, the spin coating may be performed at a coating speed of about 2,000 rpm to about 5,000 rpm and at a heat treatment temperature of about 80° C. to about 200° C. by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

#### General Definition of Some of the Substituents

[0356] The term “C<sub>1</sub>-C<sub>60</sub> alkyl group,” as used herein, refers to a linear or branched aliphatic saturated hydrocarbon monovalent group having 1 to 60 carbon atoms, and examples thereof include a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a tert-

butyl group, a pentyl group, an isoamyl group, and a hexyl group. The term “C<sub>1</sub>-C<sub>60</sub> alkylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>1</sub>-C<sub>60</sub> alkyl group.

**[0357]** The term “C<sub>2</sub>-C<sub>60</sub> alkenyl group,” as used herein, refers to a hydrocarbon group having at least one carbon-carbon double bond at a main chain (e.g., in the middle) or at a terminus of the C<sub>2</sub>-C<sub>60</sub> alkyl group, and examples thereof include an ethenyl group, a propenyl group, and a butenyl group. The term “C<sub>2</sub>-C<sub>60</sub> alkenylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>2</sub>-C<sub>60</sub> alkenyl group.

**[0358]** The term “C<sub>2</sub>-C<sub>60</sub> alkynyl group,” as used herein, refers to a hydrocarbon group having at least one carbon-carbon triple bond at a main chain (e.g., in the middle) or at a terminus of the C<sub>2</sub>-C<sub>60</sub> alkyl group, and examples thereof include an ethynyl group, and a propynyl group. The term “C<sub>2</sub>-C<sub>60</sub> alkynylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>2</sub>-C<sub>60</sub> alkynyl group.

**[0359]** The term “C<sub>1</sub>-C<sub>60</sub> alkoxy group,” as used herein, refers to a monovalent group represented by —OA<sub>101</sub> (wherein A<sub>101</sub> is the C<sub>1</sub>-C<sub>60</sub> alkyl group), and examples thereof include a methoxy group, an ethoxy group, and an isopropoxy group.

**[0360]** The term “C<sub>3</sub>-C<sub>10</sub> cycloalkyl group,” as used herein, refers to a monovalent saturated hydrocarbon monocyclic group having 3 to 10 carbon atoms, and examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. The term “C<sub>3</sub>-C<sub>10</sub> cycloalkylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>3</sub>-C<sub>10</sub> cycloalkyl group.

**[0361]** The term “C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group,” as used herein, refers to a monovalent monocyclic group having at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom and 1 to 10 carbon atoms, and examples thereof include a 1,2,3,4-oxatriazolidinyl group, a tetrahydrofuran group, and a tetrahydrothiophenyl group. The term “C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group.

**[0362]** The term “C<sub>3</sub>-C<sub>10</sub> 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 no aromaticity (e.g., the entire ring, group and/or molecule is not aromatic), and examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. The term “C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group.

**[0363]** The term “C<sub>1</sub>-C<sub>0</sub> heterocycloalkenyl group,” as used herein, refers to a monovalent monocyclic group that has at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom, 1 to 10 carbon atoms, and at least one carbon-carbon double bond in its ring. Non-limiting examples of the C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group include a 4,5-dihydro-1,2,3,4-oxatriazolyl group, a 2,3-dihydrofuran group, and a 2,3-dihydrothiophenyl group. The term “C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group,” as used herein, refers to a divalent group having substantially the same structure as the C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group.

**[0364]** The term “C<sub>6</sub>-C<sub>60</sub> aryl group,” as used herein, refers to a monovalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms, and a C<sub>6</sub>-C<sub>60</sub> arylene group used herein refers to a divalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms. Non-limiting examples of the C<sub>6</sub>-C<sub>60</sub> 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<sub>6</sub>-C<sub>60</sub> aryl group and the C<sub>6</sub>-C<sub>60</sub> arylene group each include two or more rings, the rings may be fused to each other (e.g., combined together).

**[0365]** The term “C<sub>1</sub>-C<sub>60</sub> 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, Si, P, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. The term “C<sub>1</sub>-C<sub>60</sub> 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, Si, P, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. Non-limiting examples of the C<sub>1</sub>-C<sub>60</sub> 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<sub>1</sub>-C<sub>60</sub> heteroaryl group and the C<sub>1</sub>-C<sub>60</sub> heteroarylene group each include two or more rings, the rings may be condensed with each other (e.g., combined together).

**[0366]** The term “C<sub>6</sub>-C<sub>60</sub> aryloxy group,” as used herein, refers to —OA<sub>102</sub> (wherein A<sub>102</sub> is the C<sub>6</sub>-C<sub>60</sub> aryl group), and the term “C<sub>6</sub>-C<sub>60</sub> arylthio group,” as used herein, refers to —SA<sub>103</sub> (wherein A<sub>103</sub> is the C<sub>6</sub>-C<sub>60</sub> aryl group).

**[0367]** 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 with each other (e.g., combined together), only carbon atoms as ring-forming atoms, and no aromaticity in its entire molecular structure (e.g., the entire group and/or molecule is not aromatic). An example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. The term “divalent non-aromatic condensed polycyclic group,” as used herein, refers to a divalent group having substantially the same structure as the monovalent non-aromatic condensed polycyclic group.

**[0368]** The term “monovalent non-aromatic condensed heteropolycyclic group,” as used herein, refers to a monovalent group (for example, having 1 to 60 carbon atoms) having two or more rings condensed to each other (e.g., combined together), at least one heteroatom selected from N, O, Si, P, and S, other than carbon atoms, as a ring-forming atom, and no aromaticity in its entire molecular structure (e.g., the entire group and/or molecule is not aromatic). An example of the monovalent non-aromatic condensed heteropolycyclic group is a carbazolyl group. The term “divalent non-aromatic condensed heteropolycyclic group,” as used herein refers to a divalent group having substantially the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

**[0369]** The term “C<sub>4</sub>-C<sub>60</sub> carbocyclic group,” as used herein, refers to a monocyclic or polycyclic group having 4 to 60 carbon atoms in which a ring-forming atom is a carbon atom only. The C<sub>4</sub>-C<sub>60</sub> carbocyclic group may be an aromatic carbocyclic group or a non-aromatic carbocyclic group. The C<sub>4</sub>-C<sub>60</sub> carbocyclic group may be a ring, such as benzene, a monovalent group, such as a phenyl group, or a

divalent group, such as a phenylene group. In one or more embodiments, depending on the number of substituents connected to the C<sub>4</sub>-C<sub>60</sub> carbocyclic group, the C<sub>4</sub>-C<sub>60</sub> carbocyclic group may be a trivalent group or a quadrivalent group.

**[0370]** The term “C<sub>1</sub>-C<sub>60</sub> heterocyclic group,” as used herein, refers to a group having substantially the same structure as the C<sub>4</sub>-C<sub>60</sub> carbocyclic group, except that as a ring-forming atom, at least one heteroatom selected from N, O, Si, P, and S is used in addition to carbon (the number of carbon atoms may be in a range of 1 to 60).

**[0371]** At least one substituent of the substituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group, the substituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic, substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, the substituted C<sub>6</sub>-C<sub>60</sub> arylthio group, the substituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

**[0372]** deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> alkoxy group;

**[0373]** a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> 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 amidino group, a hydrazino group, a hydrazono group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>), —N(Q<sub>11</sub>)(Q<sub>12</sub>), —B(Q<sub>11</sub>)(Q<sub>12</sub>), —C(=O)(Q<sub>11</sub>), —S(=O)<sub>2</sub>(Q<sub>11</sub>), and —P(=O)(Q<sub>11</sub>)(Q<sub>12</sub>);

**[0374]** a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;

**[0375]** a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heterop-

lycyclic group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>), —N(Q<sub>21</sub>)(Q<sub>22</sub>), —B(Q<sub>21</sub>)(Q<sub>22</sub>), —C(=O)(Q<sub>21</sub>), —S(=O)<sub>2</sub>(Q<sub>21</sub>), and —P(=O)(Q<sub>21</sub>)(Q<sub>22</sub>); and

**[0376]** —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), —N(Q<sub>31</sub>)(Q<sub>32</sub>), —B(Q<sub>31</sub>)(Q<sub>32</sub>), —C(=O)(Q<sub>31</sub>), —S(=O)<sub>2</sub>(Q<sub>31</sub>), and —P(=O)(Q<sub>31</sub>)(Q<sub>32</sub>), and

**[0377]** Q<sub>11</sub> to Q<sub>13</sub>, Q<sub>21</sub> to Q<sub>23</sub>, Q<sub>31</sub> to Q<sub>33</sub>, and Q<sub>41</sub> to Q<sub>42</sub> 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 hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group.

**[0378]** The term “Ph,” as used herein, represents a phenyl group, the term “Me,” as used herein, represents a methyl group, the term “Et,” as used herein, represents an ethyl group, the term “ter-Bu” or “Bu<sup>t</sup>,” as used herein, represents a tert-butyl group, and the term “OMe,” as used herein, represents a methoxy group.

**[0379]** The term “biphenyl group,” as used herein, refers to a phenyl group substituted with a phenyl group. The “biphenyl group” is a “substituted phenyl group” having a “C<sub>6</sub>-C<sub>60</sub> aryl group” as a substituent.

**[0380]** The term “terphenyl group,” as used herein, refers to a phenyl group substituted with a biphenyl group. The “terphenyl group” is a “phenyl group” having, as a substituent, a “C<sub>6</sub>-C<sub>60</sub> aryl group substituted with a C<sub>6</sub>-C<sub>60</sub> aryl group.”

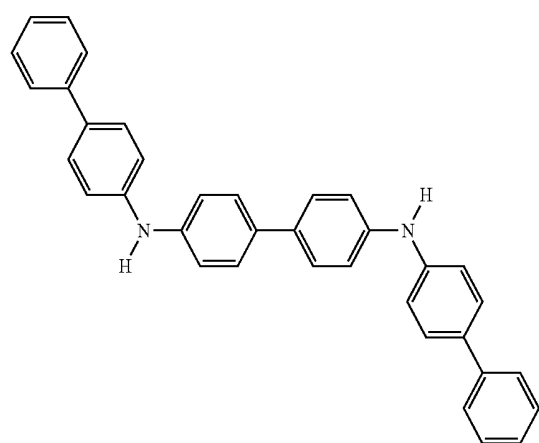
**[0381]** \* and \*<sup>t</sup> used herein, unless defined otherwise, each refer to a binding site to a neighboring atom in a corresponding formula.

**[0382]** Hereinafter, a compound according to embodiments and an organic light-emitting device according to embodiments will be described in more detail with reference to Synthesis Examples and Examples. The expression “B was used instead of A” used in describing Synthesis Examples means that an identical number of molar equivalents of A was used in place of molar equivalents of B.

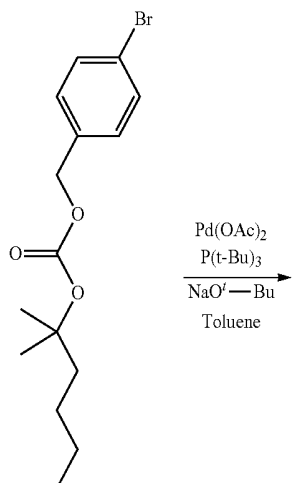
## EXAMPLES

## Synthesis Example 1: Synthesis of Compound 4

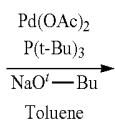
[0383]



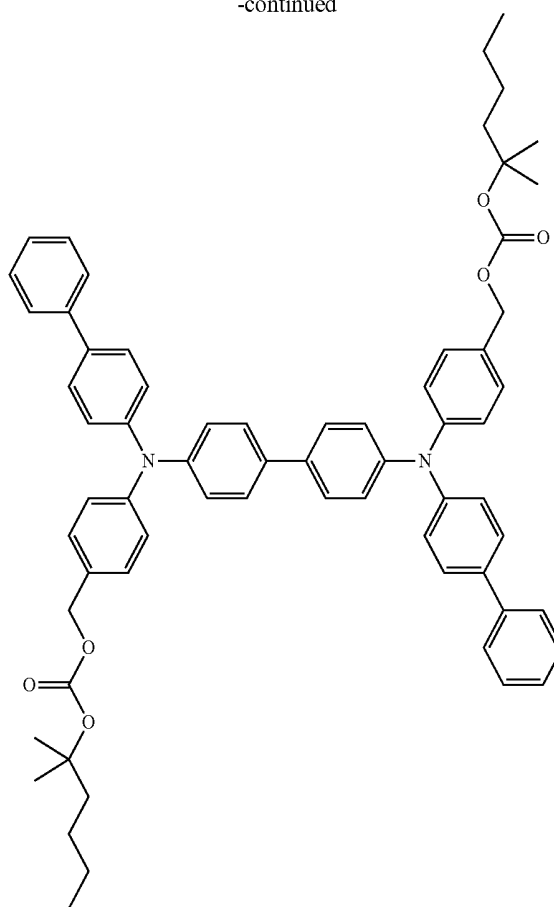
Intermediate A



Intermediate B



+



Compound 4

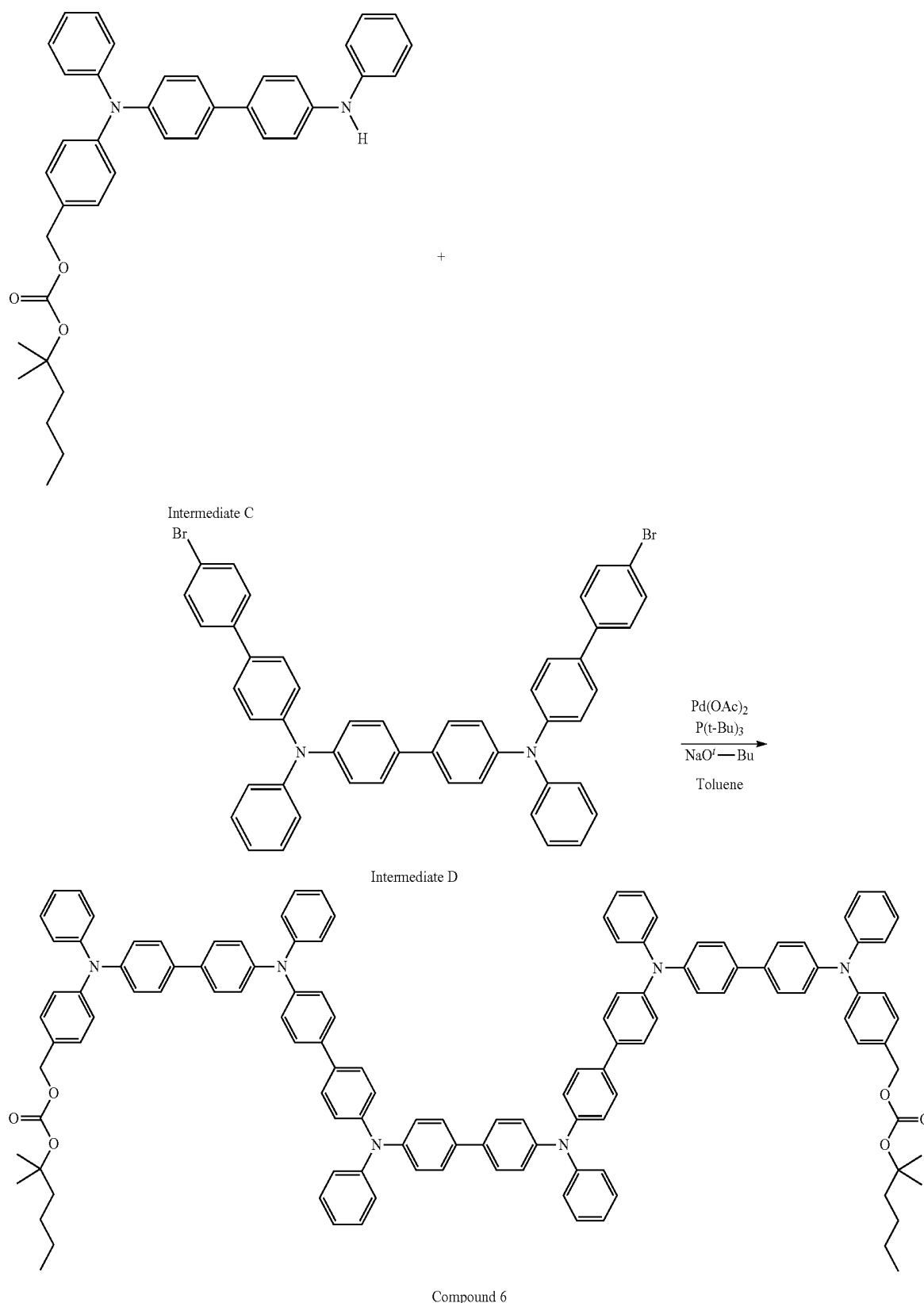
-continued

**[0384]** 1.95 g (4 mmol) of Intermediate A, 2.6 g (8 mmol) of Intermediate B, 180 mg (0.20 eq.) of palladium acetate, 480 mg (0.60 eq.) of tri-*t*-butyl phosphine, and 2.4 g (24 mmol) of sodium *t*-butoxide were added to 80 ml of toluene in a nitrogen atmosphere and refluxed at a temperature of 120° C. for 24 hours. After the reaction was completed, the mixture passed through a silica gel pad and was rinsed with toluene. A solvent of a solution obtained therefrom was evaporated, recrystallized, and separated by silica gel chromatography to obtain 1.4 g (yield of 36%) of Compound 4.

**[0385]** MS (MALDI-TOF) *m/z*: 984 [M]<sup>+</sup>.

## Synthesis Example 2: Synthesis of Compound 6

[0386]



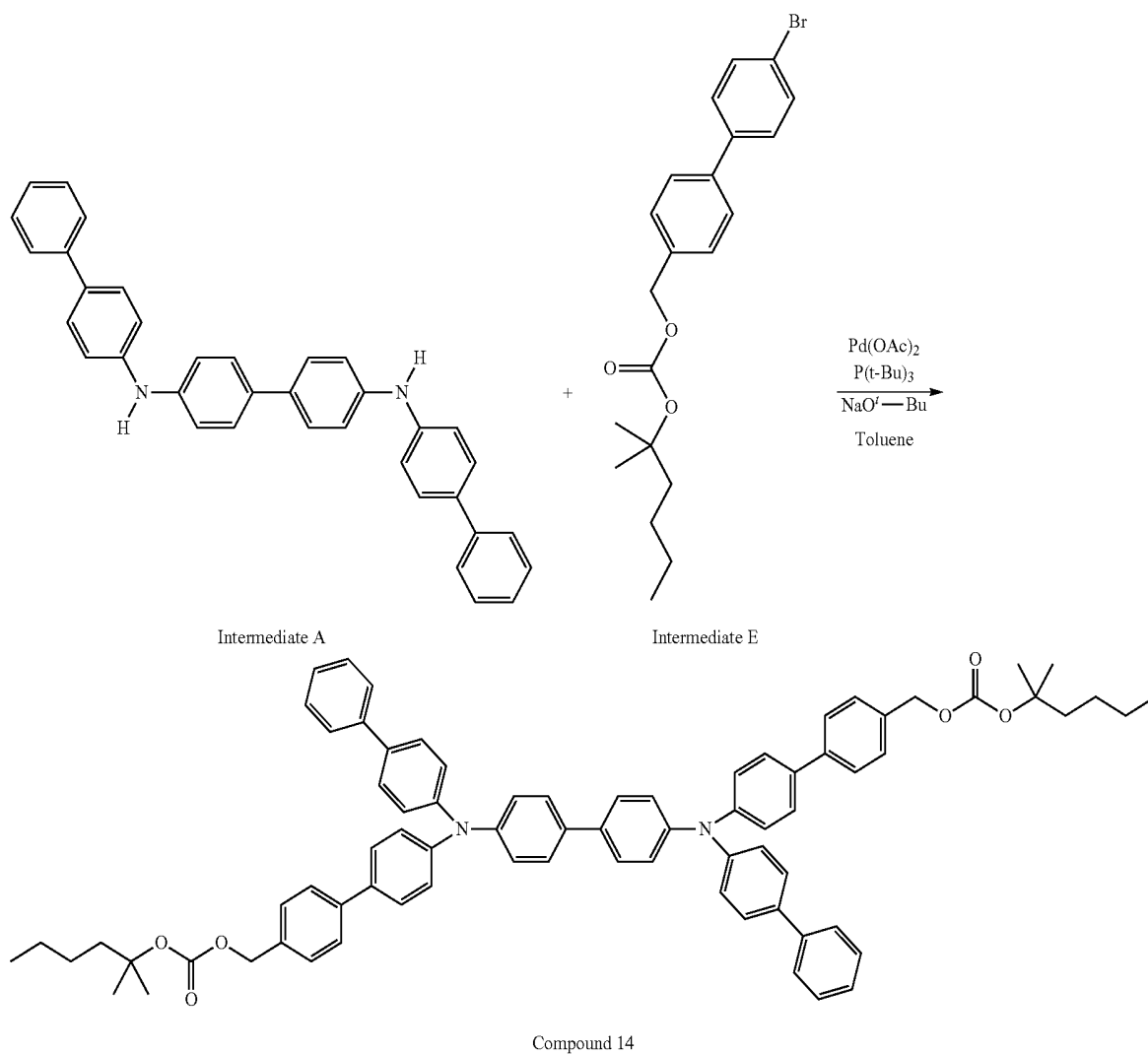
[0387] 0.790 g (yield of 11%) of Compound 6 was synthesized in substantially the same manner as in Synthesis of

Compound 4, except that Intermediate C was used instead of Intermediate A, and Intermediate D was used instead of Intermediate B

[0388] MS (MALDI-TOF) m/z: 1804 [M]<sup>+</sup>.

Synthesis Example 3: Synthesis of Compound 14

[0389]

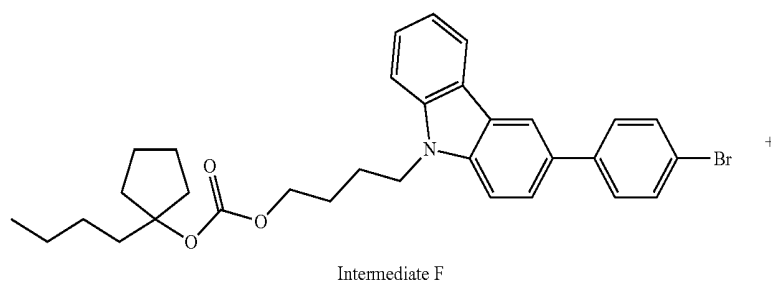


[0390] 1.5 g (yield of 33%) of Compound 14 was synthesized in substantially the same manner as in Synthesis of Compound 4, except that Intermediate E was used instead of Intermediate B.

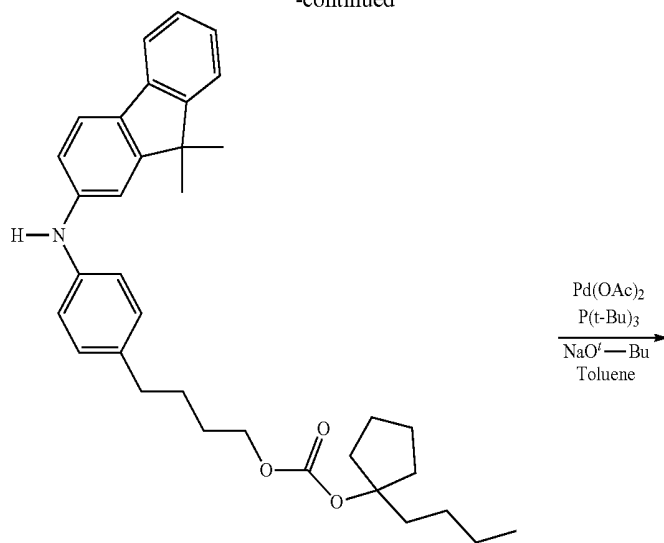
[0391] MS (MALDI-TOF) m/z: 1136 [M]<sup>+</sup>.

Synthesis Example 4: Synthesis of Compound 20

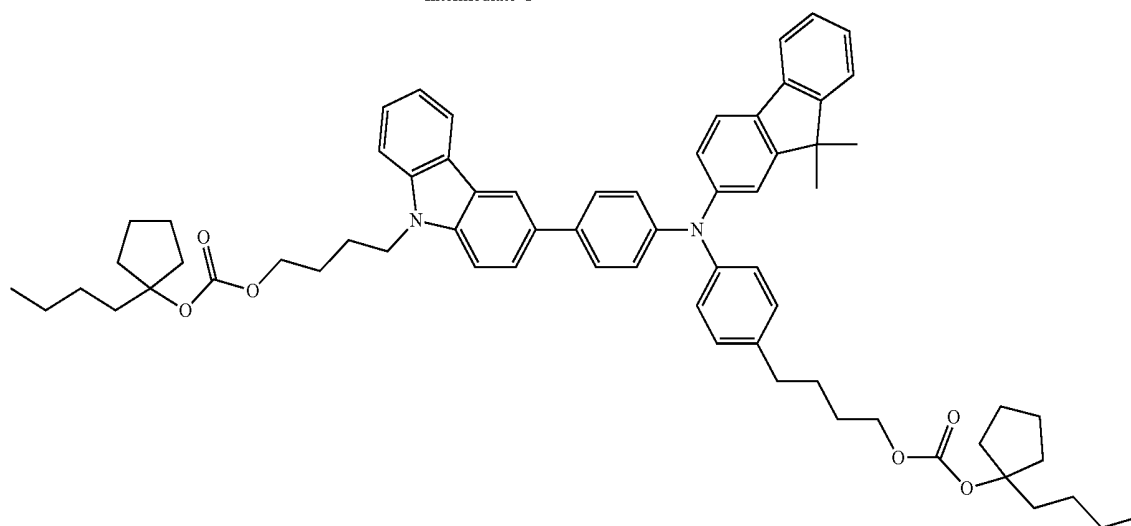
[0392]



-continued



Intermediate G



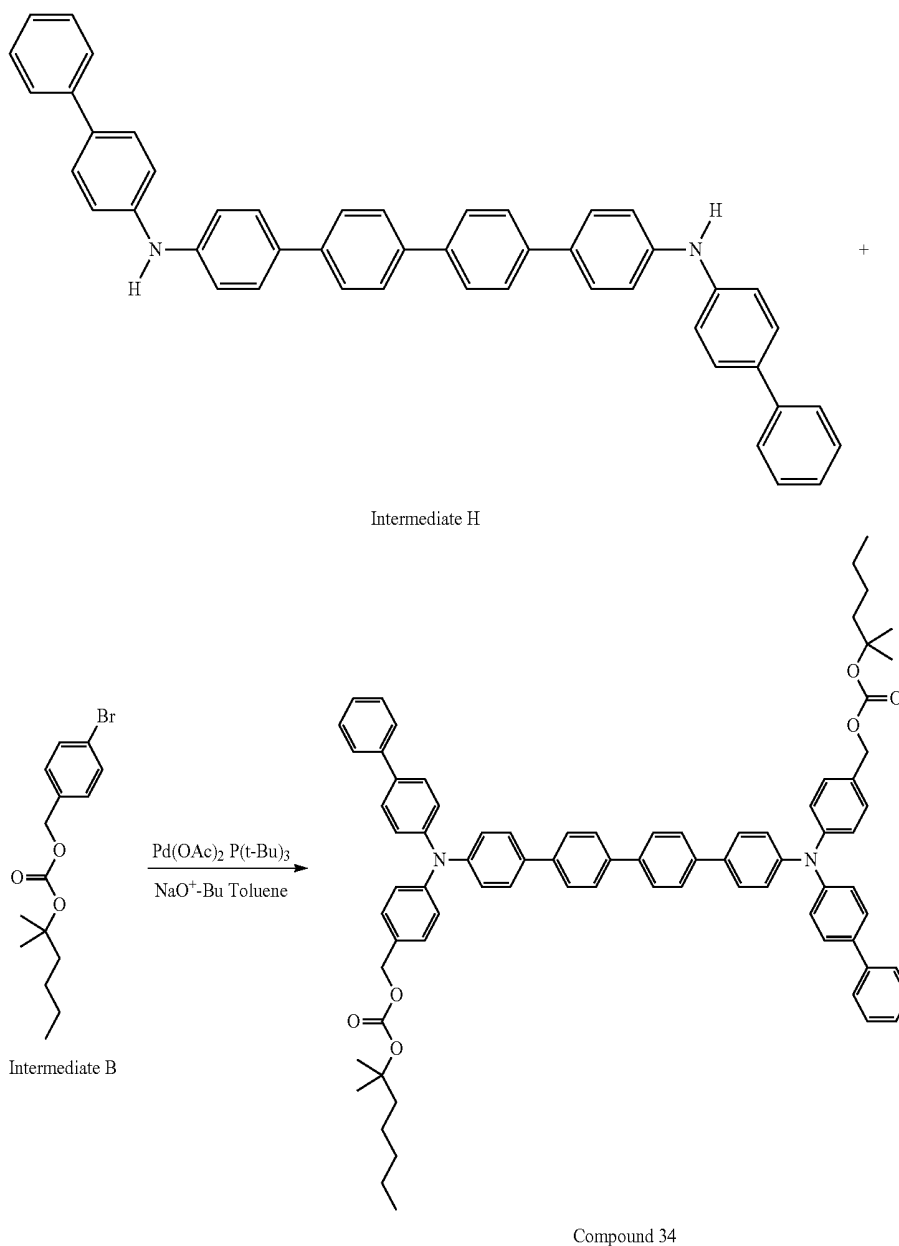
Compound 20

**[0393]** 1 g (yield of 25%) of Compound 20 was synthesized in substantially the same manner as in Synthesis of Compound 4, except that Intermediate F was used instead of Intermediate A, and Intermediate G was used instead of Intermediate B.

**[0394]** MS (MALDI-TOF)  $m/z$ : 1006 [M]<sup>+</sup>.

Synthesis Example 5: Synthesis of Compound 34

**[0395]**



**[0396]** 1 g (yield of 24%) of Compound 34 was synthesized in substantially the same manner as in Synthesis of Compound 4, except that Intermediate H was used instead of Intermediate A.

**[0397]** MS (MALDI-TOF)  $m/z$ : 1150 [M]<sup>+</sup>.

**[0398]** Methods of synthesizing compounds other than the compounds shown in Table 1 should be readily recognizable by those of ordinary skill in the art by referring to the synthesis path and source materials described herein above.

#### Example 1

**[0399]** As an anode, a Corning 15  $\Omega/\text{cm}^2$  (120 nm) ITO glass substrate was cut to a size of 50 mm $\times$ 50 mm $\times$ 0.7 mm, sonicated with isopropyl alcohol and pure water each for 5 minutes, and then cleaned by exposure to ultraviolet rays for 30 minutes.

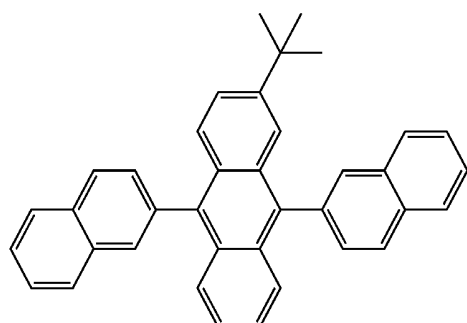
**[0400]** PEDOT-PSS (A14083) manufactured by Bayer was coated on the glass substrate and heat-treated at a temperature of 150° C. for 30 minutes to form a hole injection layer having a thickness of 500 Å. A mixture of 2 g of a xylene solution and 0.1 g of Compound 4 was spin-coated on the hole injection layer, dried at a temperature of 100° C. for 10 minutes, and thermally crosslinked at a temperature of 200° C. for 30 minutes to form a hole transport layer having a thickness of 700 Å.

**[0401]** A solution in which Compound A (host) and Compound B (dopant) (host ratio: 5%) were dissolved in a xylene solution was spin-coated on the hole transport layer and dried at a temperature of 100° C. for 10 minutes to form an emission layer having a thickness of 350 Å.

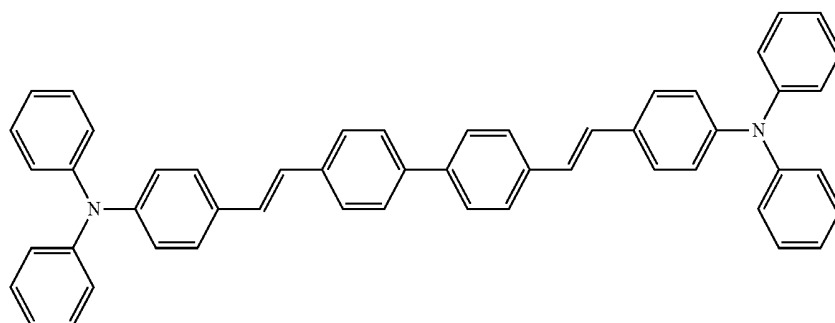
**[0402]** Then, Compound C and LiQ (8-hydroxyquinolino-lithium) were vacuum-deposited on the emission layer at a ratio of 5:5 to form an electron transport layer having a

thickness of 200 Å. 10 Å of LiQ (electron injection layer) and 2,000 Å of Al (cathode) were sequentially vacuum-

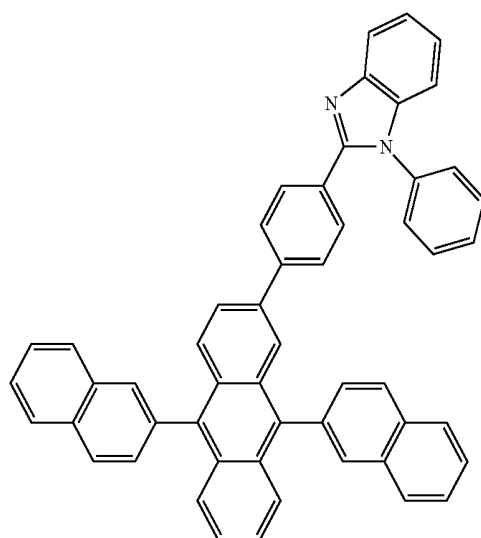
deposited on the electron transport layer, thereby completing the manufacture of an organic light-emitting device.



Compound A



Compound B



Compound C

Examples 2 to 5 and Comparative Examples 1 to 4

**[0403]** Examples 2 to 5 were prepared by manufacturing organic light-emitting devices in substantially the same manner as in Example 1, except that Compounds 6, 14, 20, and 34 were used instead of Compound 4 in forming a hole transport layer of Examples 2 to 5, respectively. Compara-

tive Examples 1 to 4 were prepared by manufacturing organic light-emitting devices in substantially the same manner as in Example 1, except that Comparative Compounds A-1 to A-4 were used instead of Compound 4 in forming a hole transport layer of Comparative Examples 1 to 4, respectively.

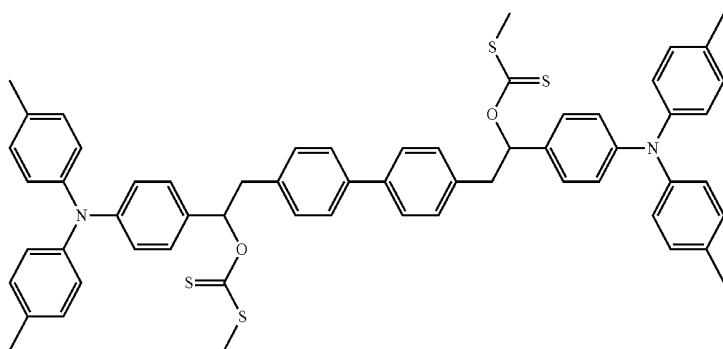
TABLE 1

	Hole transport layer	Driving voltage (@700 nit)	Current efficiency (cd/A)	Lifespan (T90)
Example 1	4	7.4	5.3	45

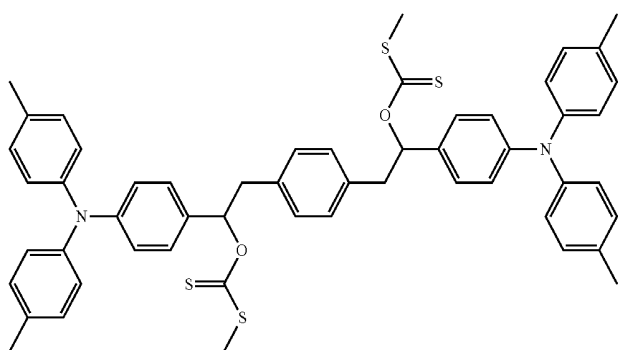
TABLE 1-continued

	Hole transport layer	Driving voltage (@700 nit)	Current efficiency (cd/A)	Lifespan (T90)
Example 2	6	7.5	5.4	30
Example 3	14	7.9	5.9	46
Example 4	20	7.8	6.0	55
Example 5	34	7.7	6.1	61
Comparative Example 1	A-1	12	2	2
Comparative Example 2	A-2	12	2	1
Comparative Example 3	A-3	14	1	1
Comparative Example 4	A-4	9	4.2	11

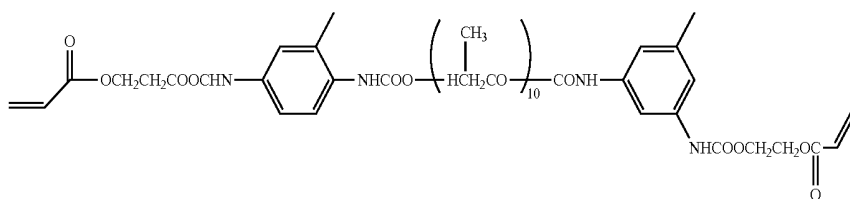
Compound A-1



Compound A-2



Compound A-3



Compound A-4

TABLE 1-continued

Hole transport layer	Driving voltage (@700 nit)	Current efficiency (cd/A)	Lifespan (T90)

[0404] Referring to Table 1, it is confirmed that the organic light-emitting devices of Examples 1 to 5 have low driving voltage, high efficiency, and excellent lifespan characteristics, as compared with those of the organic light-emitting devices of Comparative Examples 1 to 4.

[0405] The organic light-emitting device may have improved device characteristics, including a low driving voltage, high efficiency, and a long lifespan.

[0406] 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.

[0407] 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 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 described below could be termed a second element, component, region, layer or section, without departing from the spirit and scope of the present disclosure.

[0408] Spatially relative terms, such as “beneath,” “below,” “lower,” “under,” “above,” “upper,” and the like, may be used herein for ease of explanation to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or in operation, in

addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” or “under” other elements or features would then be oriented “above” the other elements or features. Thus, the example terms “below” and “under” can encompass both an orientation of above and below. The device may be otherwise oriented (e.g., rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein should be interpreted accordingly.

[0409] It will be understood that when an element or layer is referred to as being “on,” “connected to,” or “coupled to” another element or layer, it can be directly on, connected to, or coupled to the other element or layer, or one or more intervening elements or layers may be present. In addition, it will also be understood that when an element or layer is referred to as being “between” two elements or layers, it can be the only element or layer between the two elements or layers, or one or more intervening elements or layers may also be present.

[0410] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes,” and “including,” when used in this specification, specify the presence of the stated features, integers, acts, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, acts, operations, elements, components, and/or groups thereof.

[0411] As used herein, the terms “substantially,” “about,” and similar terms are used as terms of approximation and not

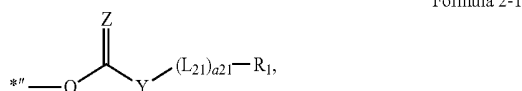
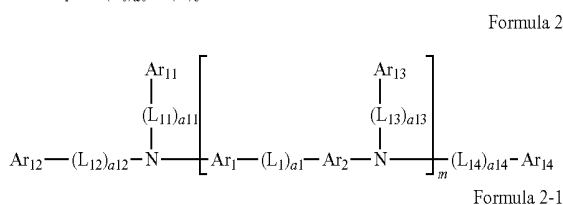
as terms of degree, and are intended to account for the inherent deviations in measured or calculated values that would be recognized by those of ordinary skill in the art. Further, the use of "may" when describing embodiments of the present disclosure refers to "one or more embodiments of the present disclosure." As used herein, the terms "use," "using," and "used" may be considered synonymous with the terms "utilize," "utilizing," and "utilized," respectively. Also, the term "exemplary" is intended to refer to an example or illustration.

[0412] Also, any numerical range recited herein is intended to include all subranges of the same numerical precision subsumed within the recited range. For example, a range of "1.0 to 10.0" is intended to include all subranges between (and including) the recited minimum value of 1.0 and the recited maximum value of 10.0, that is, having a minimum value equal to or greater than 1.0 and a maximum value equal to or less than 10.0, such as, for example, 2.4 to 7.6. Any maximum numerical limitation recited herein is intended to include all lower numerical limitations subsumed therein, and any minimum numerical limitation recited in this specification is intended to include all higher numerical limitations subsumed therein. Accordingly, Applicant reserves the right to amend this specification, including the claims, to expressly recite any sub-range subsumed within the ranges expressly recited herein.

[0413] 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 as defined by the following claims, and equivalents thereof.

What is claimed is:

1. An organic light-emitting device comprising: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode, wherein the organic layer comprises an arylamine-based compound in which a thermally decomposable group has been decomposed and removed by performing heat treatment on the arylamine-based compound comprising a thermally decomposable group and represented by Formula 1:



wherein, in Formula 1,

$A_1$  is a group represented by Formula 2,

$L_0$  is a single bond,  $*(CH_2)_p-*$ ,  $*(CH_2)_p-O-*$ ,  $*-O-(CH_2)_q-*$ ,  $*(CH_2)_p-O-(CH_2)_q-*$ ,  $*-(CH_2)_p-O-(CH_2)_q-O-(CH_2)_r-*$ ,  $*(CH_2)_p-S-*$ ,  $*-S-(CH_2)_q-*$ , or  $*(CH_2)_p-S-(CH_2)_q-*$ , and  $*$  and  $*$  each indicate a binding site to a neighboring atom,

$p$ ,  $q$ , and  $r$  are each independently an integer from 1 to 5,  $a_0$  is an integer from 1 to 100, and when  $n_1$  is two or more, two or more  $L_0(s)$  are identical to or different from each other,

$X$  is a thermally decomposable group represented by Formula 2-1, and when  $L_0$  is a single bond,  $*$  is a binding site to  $A_1$ , and when  $L_0$  is not a single bond,  $*$  is a binding site to  $L_0$ ,

$b$  is an integer from 1 to 100, wherein, when  $b$  is two or more, two or more  $X(s)$  are identical to or different from each other,

in Formula 2,

$m$  is an integer from 0 to 100, when  $m$  is 0,  $-Ar_1-(L_1)_{a1}-Ar_2-N[(L_{13})_{a13}-Ar_{13}]$  is a single bond, and when  $m$  is two or more, two or more  $-Ar_1-(L_1)_{a1}-Ar_2-N[(L_{13})_{a13}-Ar_{13}](s)$  are identical to or different from each other,

$L_1$  and  $L_{11}$  to  $L_{14}$  are each independently selected from a single bond, a substituted or unsubstituted  $C_5-C_{60}$  carbocyclic group, and a substituted or unsubstituted  $C_1-C_{60}$  heterocyclic group,

$a_1$  and  $a_{11}$  to  $a_{14}$  are each independently an integer from 1 to 5,

when  $a_1$  is two or more, two or more  $L_1(s)$  are identical to or different from each other, when  $a_{11}$  is two or more, two or more  $L_{11}(s)$  are identical to or different from each other, when  $a_{12}$  is two or more, two or more  $L_{12}(s)$  are identical to or different from each other, when  $a_{13}$  is two or more, two or more  $L_{13}(s)$  are identical to or different from each other, and when  $a_{14}$  is two or more, two or more  $L_{14}(s)$  are identical to or different from each other,

$Ar_1$ ,  $Ar_2$ , and  $Ar_{11}$  to  $Ar_{14}$  are each independently selected from a substituted or unsubstituted  $C_5-C_{60}$  carbocyclic group and a substituted or unsubstituted  $C_1-C_{60}$  heterocyclic group, wherein at least one of  $Ar_1$ ,  $Ar_2$ , and  $Ar_{11}$  to  $Ar_{14}$  is linked to  $-(L_0)_{a0}-(X)_b$  in Formula 1, two groups selected from  $Ar_1$ ,  $Ar_2$ , and  $Ar_{11}$  to  $Ar_{14}$  are optionally linked via a single bond to form a condensed polycyclic group,

in Formula 2-1,

$Y$  is sulfur (S), nitrogen (N), or oxygen (O),

$Z$  is sulfur (S) or oxygen (O),

$L_{21}$  is selected from a single bond, a substituted or unsubstituted  $C_1-C_{20}$  alkylene group, a substituted or unsubstituted  $C_2-C_{20}$  alkenylene group, a substituted or unsubstituted  $C_3-C_{10}$  cycloalkylene group, a substituted or unsubstituted  $C_1-C_{10}$  heterocycloalkylene group, a substituted or unsubstituted  $C_3-C_{10}$  cycloalkenylene group, a substituted or unsubstituted  $C_1-C_{10}$  heterocycloalkenylene group, a substituted or unsubstituted  $C_6-C_{60}$  arylene group, a substituted or unsubstituted  $C_1-C_{60}$  heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

$a_{21}$  is an integer from 1 to 3, wherein, when  $a_{21}$  is two or more, two or more  $L_{21}(s)$  are identical to or different from each other,

$R_1$  is selected from hydrogen, deuterium (-D), -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro

- group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkoxy group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylthio group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,
- at least one substituent of the substituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group, the substituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group, the substituted C<sub>1</sub>-C<sub>20</sub> alkylene group, the substituted C<sub>2</sub>-C<sub>20</sub> alkenylene group, the substituted C<sub>2</sub>-C<sub>20</sub> alkynylene group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group, the substituted C<sub>6</sub>-C<sub>60</sub> arylene group, the substituted C<sub>1</sub>-C<sub>60</sub> heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C<sub>1</sub>-C<sub>60</sub> alkyl group, the substituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, the substituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, the substituted C<sub>1</sub>-C<sub>60</sub> alkoxy group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, the substituted C<sub>6</sub>-C<sub>60</sub> arylthio group, the substituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:
- deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> alkoxy group;
- a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> 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 amidino group, a hydrazino group, a hydrazono group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>), —N(Q<sub>11</sub>)(Q<sub>12</sub>), —B(Q<sub>11</sub>)(Q<sub>12</sub>), —C(=O)(Q<sub>11</sub>), —S(=O)<sub>2</sub>(Q<sub>11</sub>), and —P(=O)(Q<sub>11</sub>)(Q<sub>12</sub>);
- a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;
- a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> 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, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>), —N(Q<sub>21</sub>)(Q<sub>22</sub>), —B(Q<sub>21</sub>)(Q<sub>22</sub>), —C(=O)(Q<sub>21</sub>), —S(=O)<sub>2</sub>(Q<sub>21</sub>), and —P(=O)(Q<sub>21</sub>)(Q<sub>22</sub>); and —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), —N(Q<sub>31</sub>)(Q<sub>32</sub>), —B(Q<sub>31</sub>)(Q<sub>32</sub>), —C(=O)(Q<sub>31</sub>), —S(=O)<sub>2</sub>(Q<sub>31</sub>), and —P(=O)(Q<sub>31</sub>)(Q<sub>32</sub>); and
- Q<sub>11</sub> to Q<sub>13</sub>, Q<sub>21</sub> to Q<sub>23</sub>, Q<sub>31</sub> to Q<sub>33</sub>, and Q<sub>41</sub> to Q<sub>42</sub> are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group.
- The organic light-emitting device of claim 1, wherein: the first electrode is an anode, the second electrode is a cathode, and the organic layer comprises i) a hole transport region between the first electrode and the emission layer and comprising a hole injection layer, a hole transport layer, an emission auxiliary layer, an electron blocking layer, or any combination thereof ii) an electron transport region between the emission layer and the second electrode and comprising a buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, or any combination thereof.
  - The organic light-emitting device of claim 2, wherein: the hole transport region comprises at least one of the arylamine-based compound.
  - The organic light-emitting device of claim 3, wherein: the hole transport region comprises a hole transport layer and a hole injection layer, and the hole transport layer comprises at least one of the arylamine-based compound.
  - The organic light-emitting device of claim 2, wherein:

the emission layer is a first color light emission layer, the organic light-emitting device further comprises i) at least one second color light emission layer or ii) at least one second color light emission layer and at least one third color light emission layer, between the first electrode and the second electrode,

a maximum emission wavelength of first color light, a maximum emission wavelength of second color light, and a maximum emission wavelength of third color light are identical to or different from each other, and the first color light and the second color light are emitted in the form of mixed light, or the first color light, the second color light, and the third color light are emitted in the form of mixed light.

6. An electronic apparatus comprising:

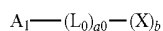
a thin film transistor; and

the organic light-emitting device of claim 1,

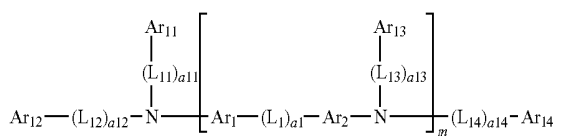
wherein the thin film transistor comprises a source electrode, a drain electrode, an active layer, and a gate electrode, and

the first electrode of the organic light-emitting device is electrically coupled to one of the source electrode and the drain electrode of the thin film transistor.

7. An arylamine-based compound comprising a thermally decomposable group and represented by Formula 1:

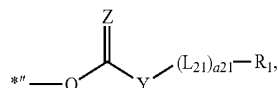


Formula 1



Formula 2

Formula 2-1



wherein, in Formula 1,

A<sub>1</sub> is a group represented by Formula 2,

L<sub>0</sub> is a single bond, \*(CH<sub>2</sub>)<sub>p</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—O—\*, \*—O—(CH<sub>2</sub>)<sub>q</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—O—(CH<sub>2</sub>)<sub>q</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—O—(CH<sub>2</sub>)<sub>q</sub>—O—(CH<sub>2</sub>)<sub>r</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—S—\*, \*—S—(CH<sub>2</sub>)<sub>q</sub>—\*, or \*(CH<sub>2</sub>)<sub>p</sub>—S—(CH<sub>2</sub>)<sub>q</sub>—\*, and \* and \*<sup>1</sup> each indicate a binding site to a neighboring atom,

p, q, and r are each independently an integer from 1 to 5, a<sub>0</sub> is an integer from 1 to 100, and when n<sub>1</sub> is two or more, two or more L<sub>0</sub>(s) are identical to or different from each other,

X is a thermally decomposable group represented by Formula 2-1, and when L<sub>0</sub> is a single bond, \*\* is a binding site to A<sub>1</sub>, and when L<sub>0</sub> is not a single bond, \*\* is a binding site to L<sub>0</sub>,

b is an integer from 1 to 100, wherein, when b is two or more, two or more X(s) are identical to or different from each other,

in Formula 2,

m is an integer from 0 to 100,

when m is 0, —Ar<sub>1</sub>—(L<sub>1</sub>)<sub>a1</sub>—Ar<sub>2</sub>—N[(L<sub>13</sub>)<sub>a13</sub>—Ar<sub>13</sub>]— is a single bond, and when m is two or more, two or more

—Ar<sub>1</sub>—(L<sub>1</sub>)<sub>a1</sub>—Ar<sub>2</sub>—N[(L<sub>13</sub>)<sub>a13</sub>—Ar<sub>13</sub>](s) are identical to or different from each other,

L<sub>1</sub> and L<sub>11</sub> to L<sub>14</sub> are each independently selected from a single bond, a substituted or unsubstituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group, and a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group,

a<sub>1</sub> and a<sub>11</sub> to a<sub>14</sub> are each independently an integer from 1 to 5,

when a<sub>1</sub> is two or more, two or more L<sub>1</sub>(s) are identical to or different from each other, when a<sub>11</sub> is two or more, two or more L<sub>11</sub>(s) are identical to or different from each other, when a<sub>12</sub> is two or more, two or more L<sub>12</sub>(s) are identical to or different from each other, when a<sub>13</sub> is two or more, two or more L<sub>13</sub>(s) are identical to or different from each other, and when a<sub>14</sub> is two or more, two or more L<sub>14</sub>(s) are identical to or different from each other,

Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> are each independently selected from a substituted or unsubstituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group and a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group, wherein at least one of Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> is linked to —[(L<sub>0</sub>)<sub>a0</sub>—(X)<sub>b</sub>] in Formula 1, two groups selected from Ar<sub>1</sub>, Ar<sub>2</sub>, and Ar<sub>11</sub> to Ar<sub>14</sub> are optionally linked via a single bond to form a condensed polycyclic group,

in Formula 2-1,

Y is sulfur (S), nitrogen (N), or oxygen (O),

Z is sulfur (S) or oxygen (O),

L<sub>21</sub> is selected from a single bond, a substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkylene group, a substituted or unsubstituted C<sub>2</sub>-C<sub>20</sub> alkenylene group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylene group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

a<sub>21</sub> is an integer from 1 to 3, wherein, when a<sub>21</sub> is two or more, two or more L<sub>21</sub>(s) are identical to or different from each other,

R<sub>1</sub> is selected from a hydrogen, deuterium (-D), —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkoxy group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a substituted or unsubstituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryl group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, a substituted or unsubstituted C<sub>6</sub>-C<sub>60</sub> arylthio group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,

at least one substituent of the substituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group, the substituted C<sub>1</sub>-C<sub>60</sub> heterocyclic group, the substituted C<sub>1</sub>-C<sub>20</sub> alkylene group, the substituted C<sub>2</sub>-C<sub>20</sub> alkenylene group, the substituted C<sub>2</sub>-C<sub>20</sub> alkynylene group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkylene group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkenylene group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenylene group, the substituted C<sub>6</sub>-C<sub>60</sub> arylene group, the substituted C<sub>1</sub>-C<sub>60</sub> heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C<sub>1</sub>-C<sub>60</sub> alkyl group, the substituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, the substituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, the substituted C<sub>1</sub>-C<sub>60</sub> alkoxy group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, the substituted C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, the substituted C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryl group, the substituted C<sub>6</sub>-C<sub>60</sub> aryloxy group, the substituted C<sub>6</sub>-C<sub>60</sub> arylthio group, the substituted C<sub>1</sub>-C<sub>60</sub> heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> alkoxy group;

a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, and a C<sub>1</sub>-C<sub>60</sub> 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 amidino group, a hydrazino group, a hydrazono group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>), —N(Q<sub>11</sub>)(Q<sub>12</sub>), —B(Q<sub>11</sub>)(Q<sub>12</sub>), —C(=O)(Q<sub>11</sub>), —S(=O)<sub>2</sub>(Q<sub>11</sub>), and —P(=O)(Q<sub>11</sub>)(Q<sub>12</sub>);

a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;

a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> 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, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub>

cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>6</sub>-C<sub>60</sub> aryloxy group, a C<sub>6</sub>-C<sub>60</sub> arylthio group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>), —N(Q<sub>21</sub>)(Q<sub>22</sub>), —B(Q<sub>21</sub>)(Q<sub>22</sub>), —C(=O)(Q<sub>21</sub>), —S(=O)<sub>2</sub>(Q<sub>21</sub>), and —P(=O)(Q<sub>21</sub>)(Q<sub>22</sub>); and —Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>), —N(Q<sub>31</sub>)(Q<sub>32</sub>), —B(Q<sub>31</sub>)(Q<sub>32</sub>), —C(=O)(Q<sub>31</sub>), —S(=O)<sub>2</sub>(Q<sub>31</sub>), and —P(=O)(Q<sub>31</sub>)(Q<sub>32</sub>), and

Q<sub>11</sub> to Q<sub>13</sub>, Q<sub>21</sub> to Q<sub>23</sub>, Q<sub>31</sub> to Q<sub>33</sub>, and Q<sub>41</sub> to Q<sub>42</sub> are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>60</sub> alkyl group, a C<sub>2</sub>-C<sub>60</sub> alkenyl group, a C<sub>2</sub>-C<sub>60</sub> alkynyl group, a C<sub>1</sub>-C<sub>60</sub> alkoxy group, a C<sub>3</sub>-C<sub>10</sub> cycloalkyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkyl group, a C<sub>3</sub>-C<sub>10</sub> cycloalkenyl group, a C<sub>1</sub>-C<sub>10</sub> heterocycloalkenyl group, a C<sub>6</sub>-C<sub>60</sub> aryl group, a C<sub>1</sub>-C<sub>60</sub> heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group.

8. The arylamine-based compound of claim 7, wherein: L<sub>0</sub> is selected from \*(CH<sub>2</sub>)<sub>p</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—O—\*, \*—O—(CH<sub>2</sub>)<sub>q</sub>—\*, \*(CH<sub>2</sub>)<sub>p</sub>—O—(CH<sub>2</sub>)<sub>q</sub>—\*, and \*(CH<sub>2</sub>)<sub>p</sub>—O—(CH<sub>2</sub>)<sub>q</sub>—O—(CH<sub>2</sub>)<sub>r</sub>—\*.

9. The arylamine-based compound of claim 7, wherein: m is an integer from 1 to 100.

10. The arylamine-based compound of claim 7, wherein: L<sub>1</sub> and L<sub>11</sub> to L<sub>14</sub> are each independently selected from: a single bond;

a benzene group, a naphthalene group, a fluorene group, a phenalene group, a phenanthrene group, an anthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group; and

a benzene group, a naphthalene group, a fluorene group, a phenalene group, a phenanthrene group, an anthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthro-

line group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

11. The arylamine-based compound of claim 7, wherein: Ar<sub>11</sub> to Ar<sub>14</sub> are each independently selected from:

a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinoxalinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;

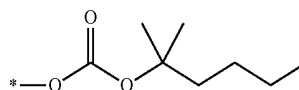
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinoxalinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isoben-

zothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthrenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinoxalinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group.

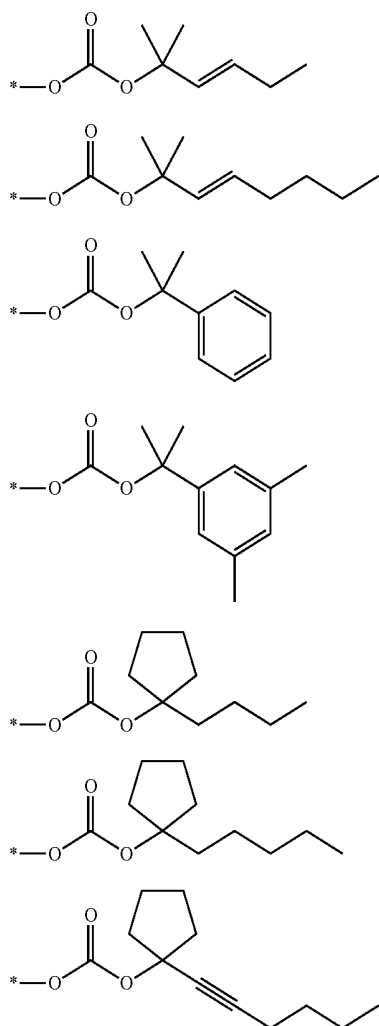
12. The arylamine-based compound of claim 7, wherein: Ar<sub>1</sub> and Ar<sub>2</sub> are each independently selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a fluoranthrenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylenylene group, a hexacenylenylene group, a pentacenylenylene group, a thiophenylenylene group, a furanylene group, a carbazolylene group, an indolylenylene group, an isoindolylenylene group, a benzofuranylene group, a benzothiophenylenylene group, a dibenzofuranylene group, a dibenzothiophenylenylene group, a benzocarbazolylenylene group, a dibenzocarbazolylenylene group, a dibenzosilolylenylene group, a pyridinylenylene group, an imidazolylene group, a pyrazolylenylene group, a thiazolylenylene group, an isothiazolylenylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylenylene group, an oxadiazolylenylene group, a pyrazinylenylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylenylene group, a quinoxalinylenylene group, a quinoxalinylenylene group, a cinnolinylenylene group, a phenanthridinylenylene group, an acridinylenylene group, a phenanthrolinylenylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylenylene group, a benzoxazolylene group,

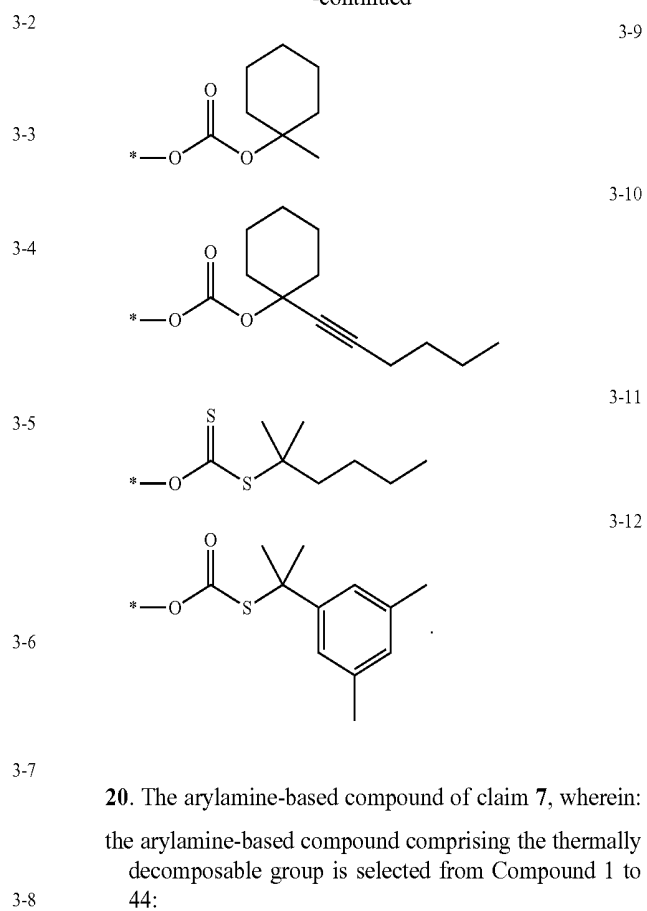
- an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group; and
- a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, a pyridinylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylene group, an oxadiazolylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C<sub>1</sub>-C<sub>20</sub> alkyl group, a C<sub>1</sub>-C<sub>20</sub> alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group.
13. The arylamine-based compound of claim 7, wherein: Ar<sub>1</sub> and Ar<sub>2</sub> are the same group.
14. The arylamine-based compound of claim 7, wherein: Y in Formula 2-1 is sulfur (S) or oxygen (O).
15. The arylamine-based compound of claim 7, wherein: in Formula 2-1,  
Y is sulfur (S), and Z is sulfur (S);  
Y is sulfur (S), and Z is oxygen (O);  
Y is oxygen (O), and Z is sulfur (S); or  
Y is oxygen (O), and Z is oxygen (O).
16. The arylamine-based compound of claim 7, wherein: L<sub>21</sub> in Formula 2-1 is a linear or branched substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkylene group, or a linear or branched substituted or unsubstituted C<sub>3</sub>-C<sub>10</sub> cycloalkylene group.
17. The arylamine-based compound of claim 7, wherein: in Formula 2-1, a  $^{*}-(L_{21})_{a21}-^{*}$  moiety is  $^{*}-C(R_2)(R_3)-^{*}$ ,  
wherein R<sub>2</sub> and R<sub>3</sub> are each independently selected from hydrogen, deuterium (-D), —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C<sub>1</sub>-C<sub>60</sub> alkyl group, a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkenyl group, and a substituted or unsubstituted C<sub>2</sub>-C<sub>60</sub> alkynyl group, and  
R<sub>2</sub> and R<sub>3</sub> are optionally linked to form a substituted or unsubstituted C<sub>5</sub>-C<sub>60</sub> carbocyclic group.
18. The arylamine-based compound of claim 7, wherein: in Formula 2-1,  
R<sub>1</sub> is selected from:  
a methyl group, an ethyl group, a propyl group, a butyl group, an ethenyl group and an ethynyl group;  
a methyl group, an ethyl group, a propyl group, a butyl group, an ethenyl group, and an ethynyl group, each substituted with at least one selected from a methyl group, an ethyl group, a propyl group, and a butyl group;  
a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group; and  
a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from a methyl group, an ethyl group, a propyl group, a butyl group, a cyclopentyl group, a cyclohexyl group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.
19. The arylamine-based compound of claim 7, wherein: the thermally decomposable group represented by Formula 2-1 is selected from groups represented by Formulae 3-1 to 3-12:

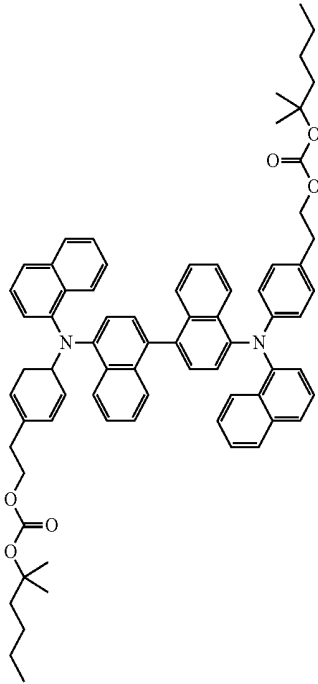


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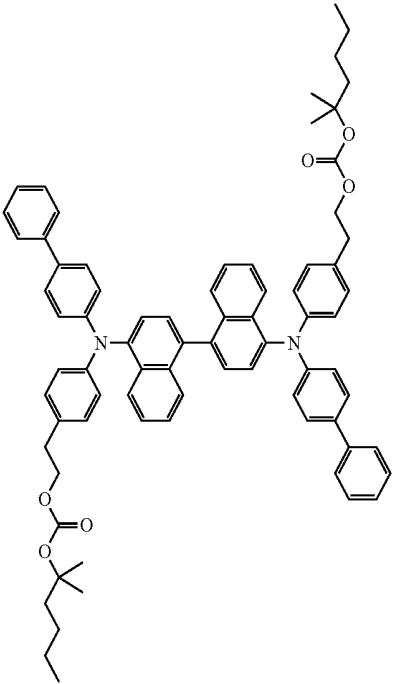


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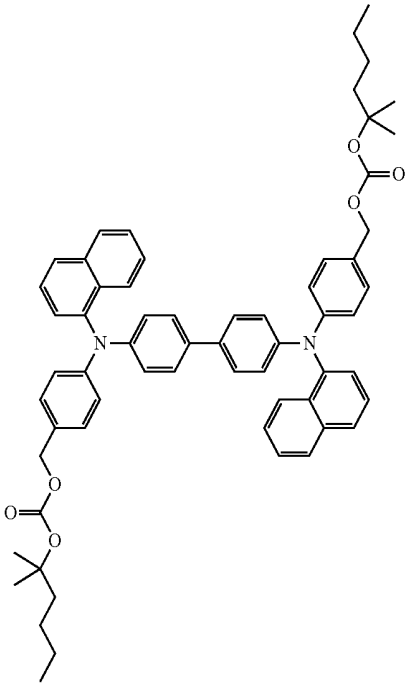




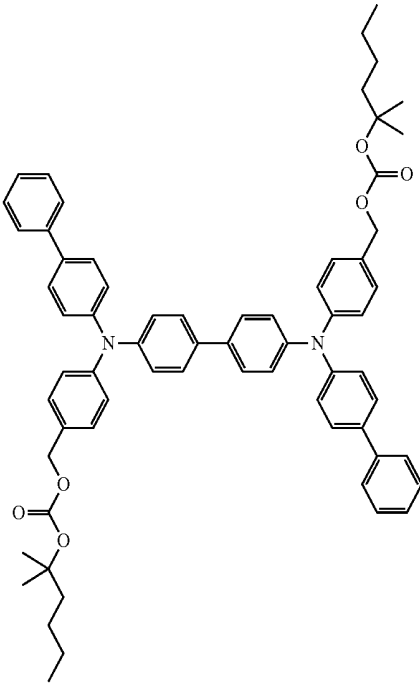
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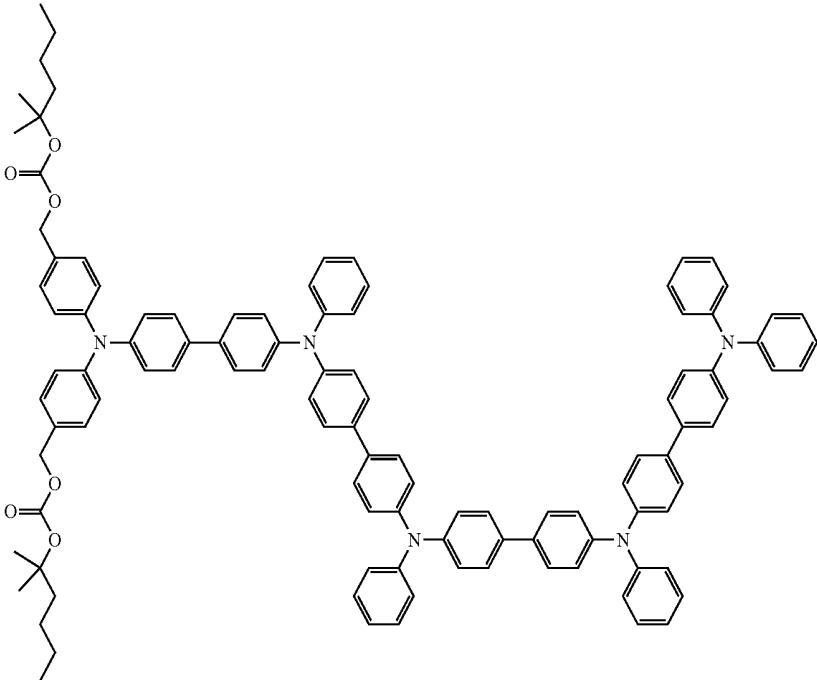
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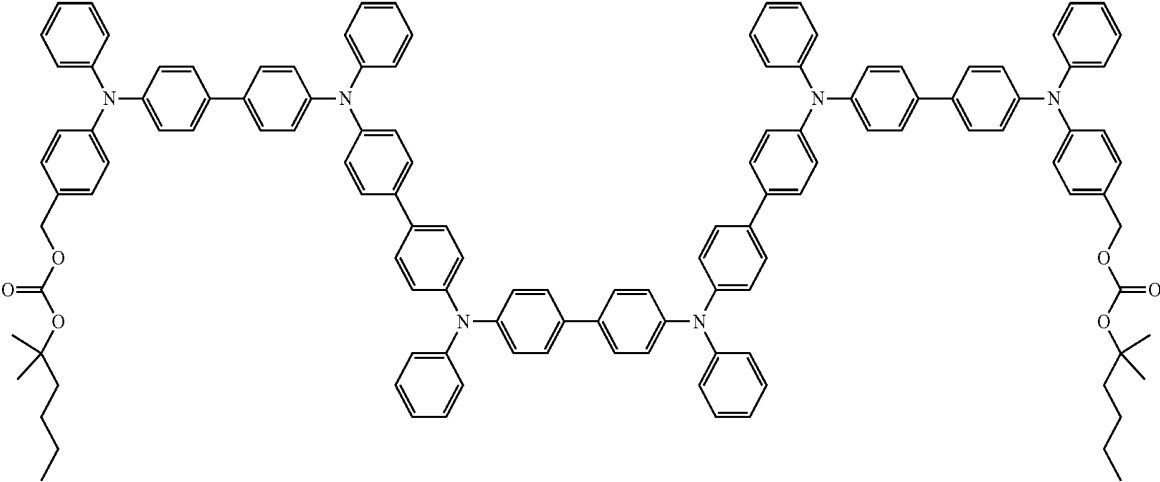
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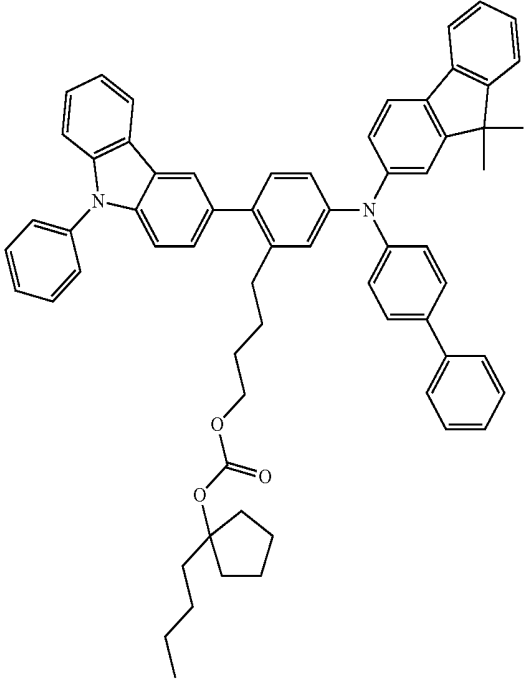


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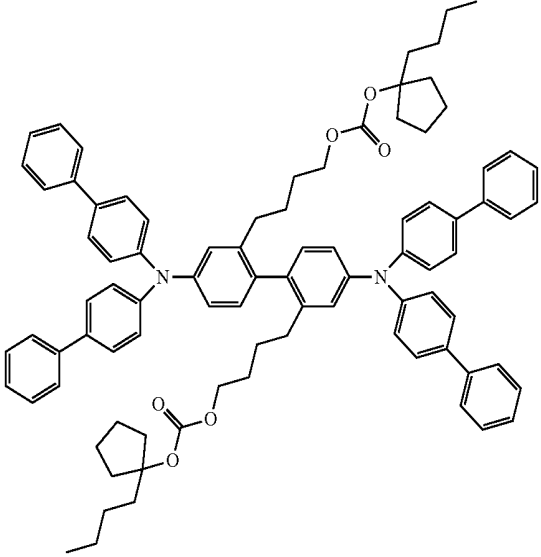


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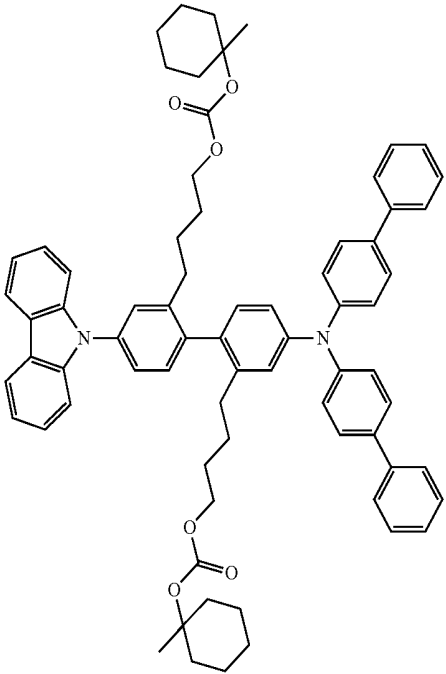
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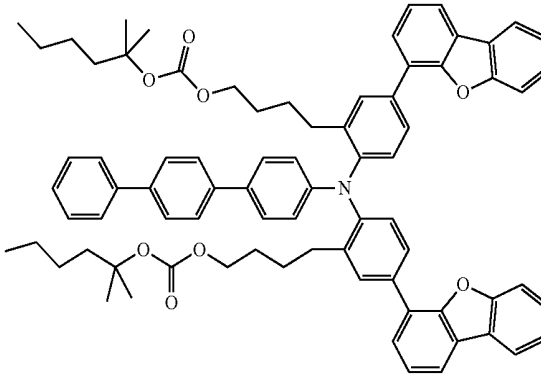
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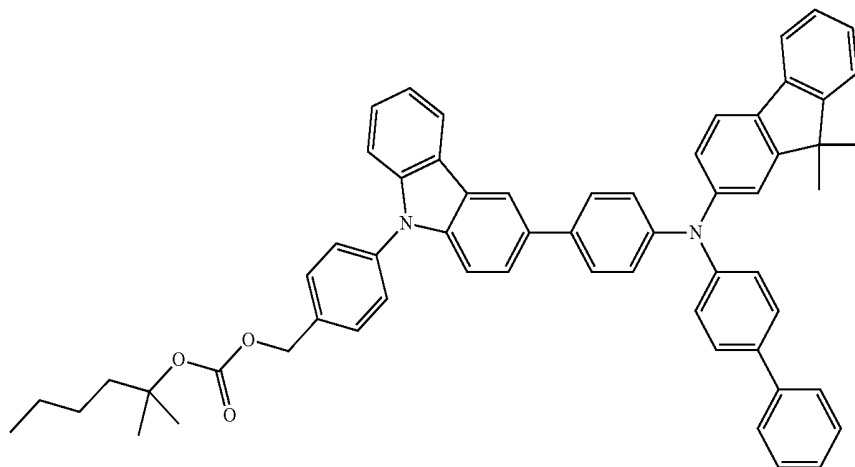


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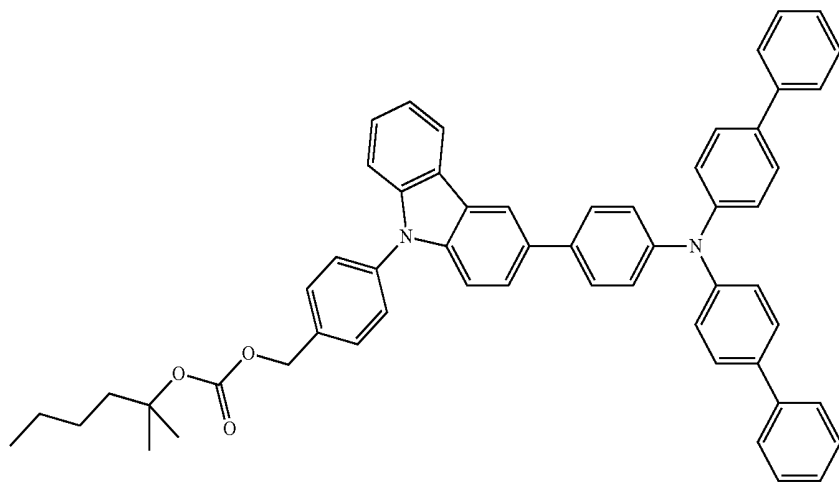


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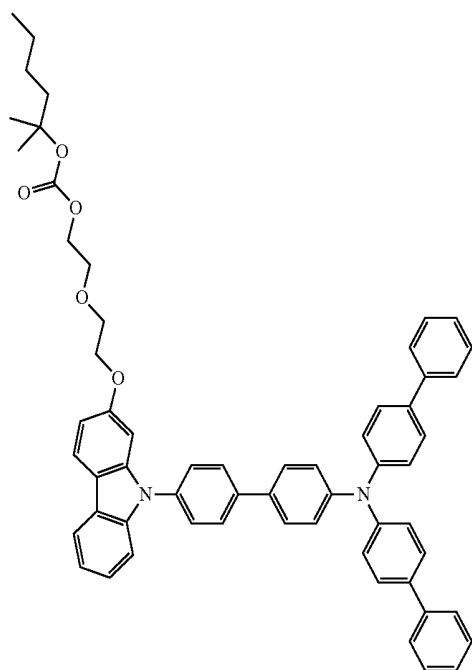
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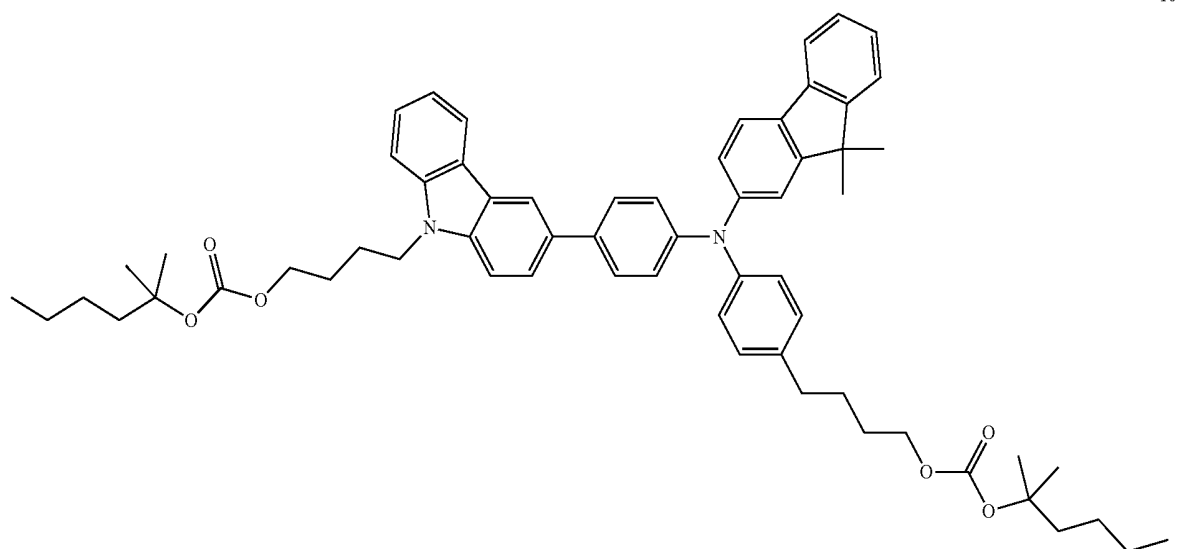
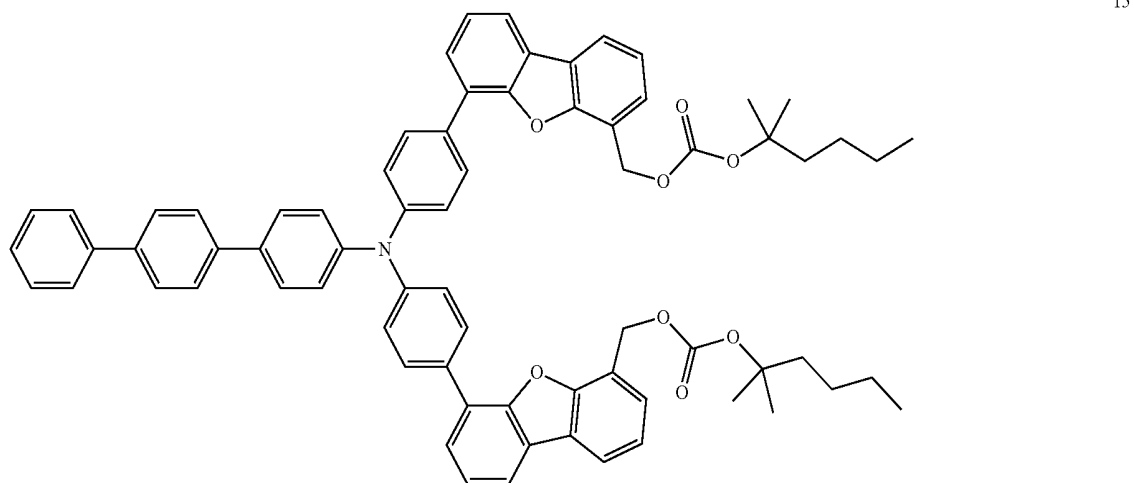
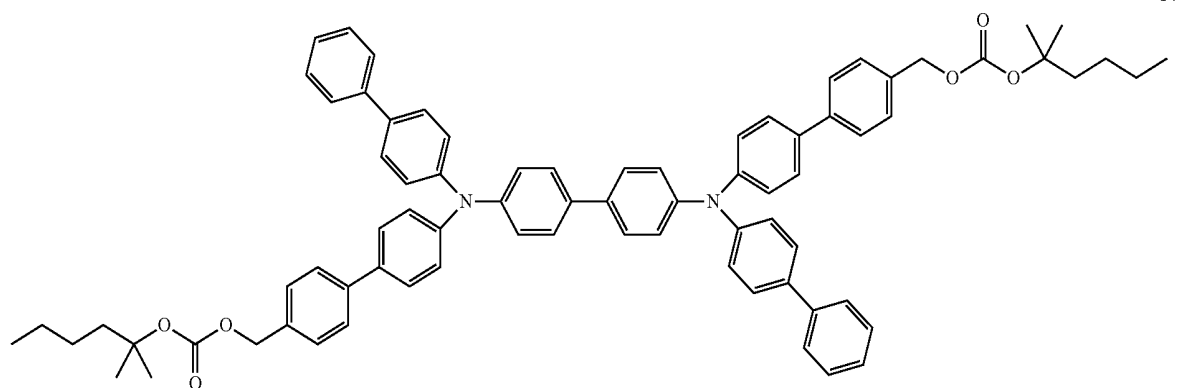
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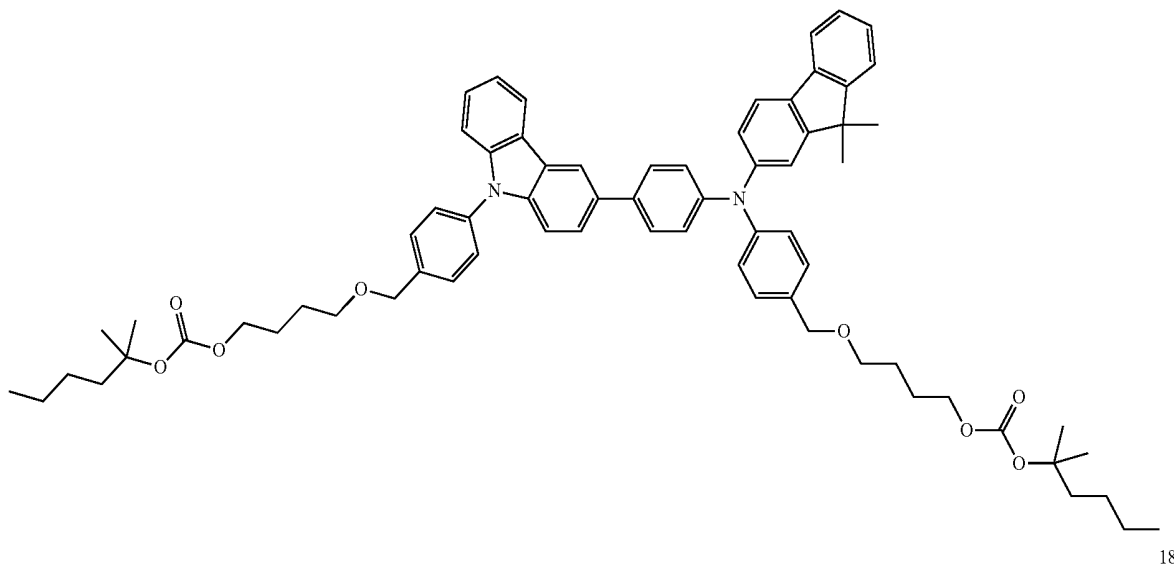


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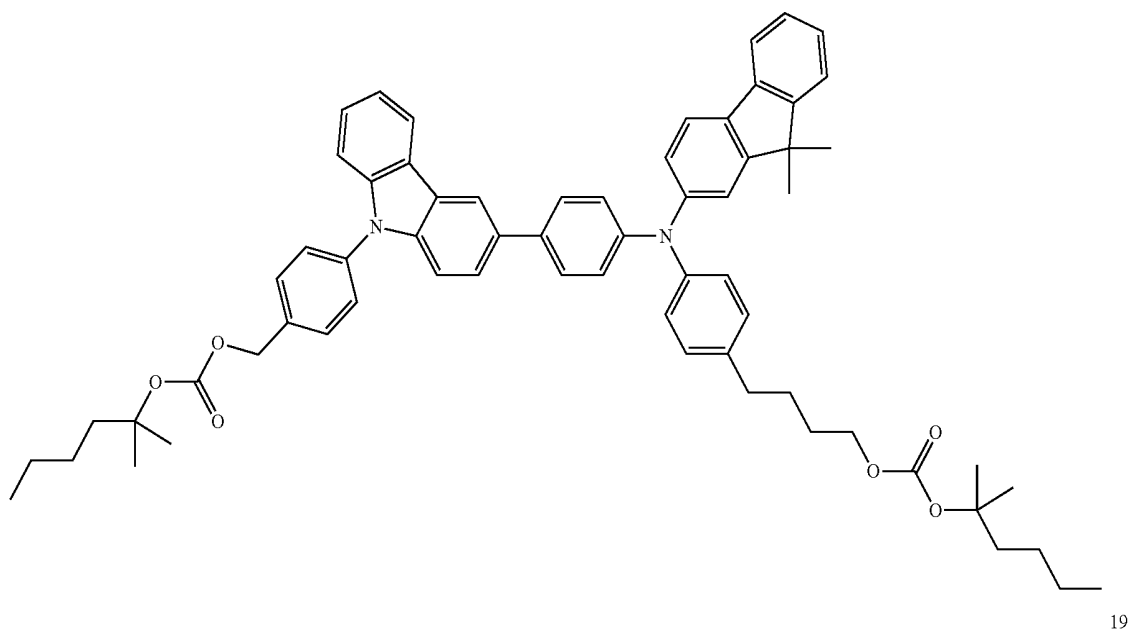


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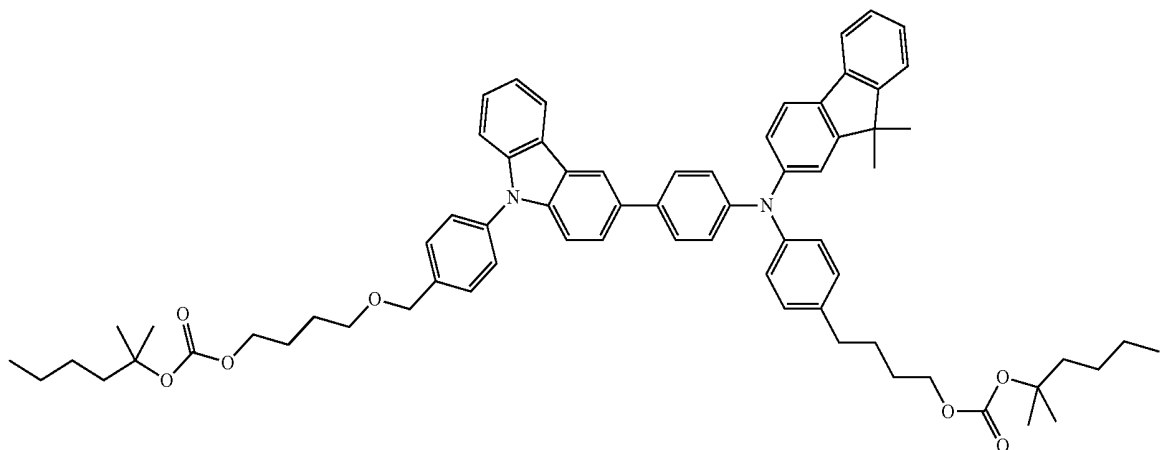
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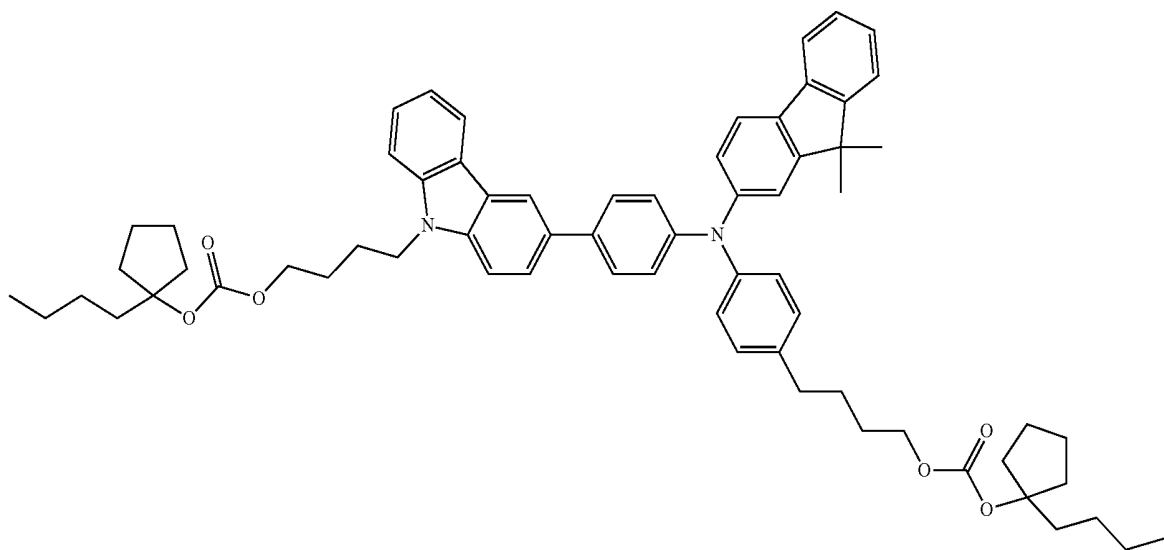


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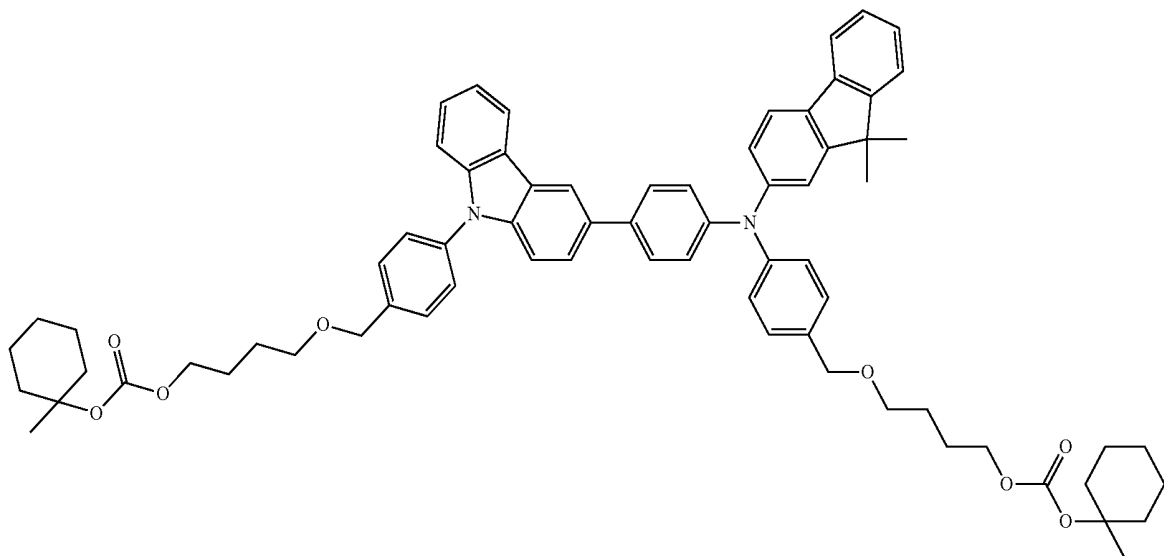


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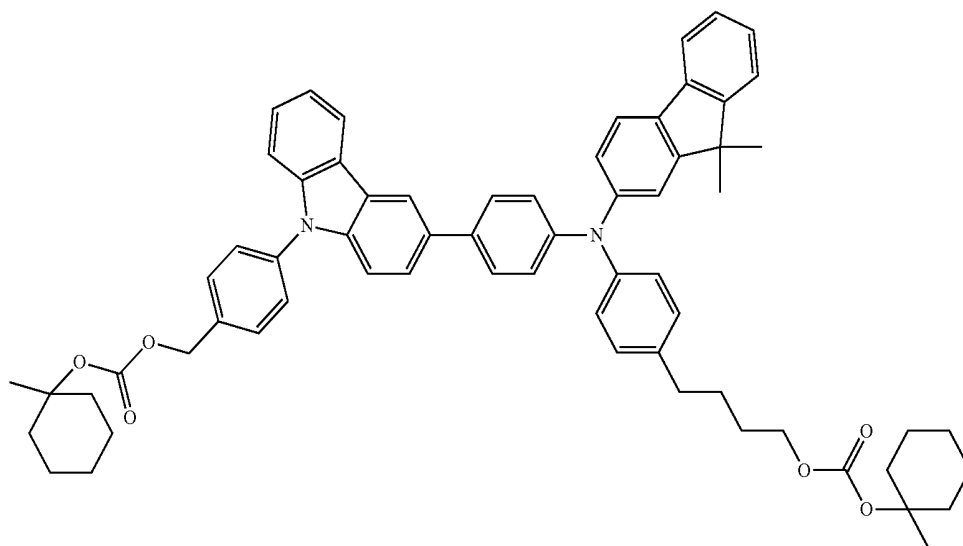
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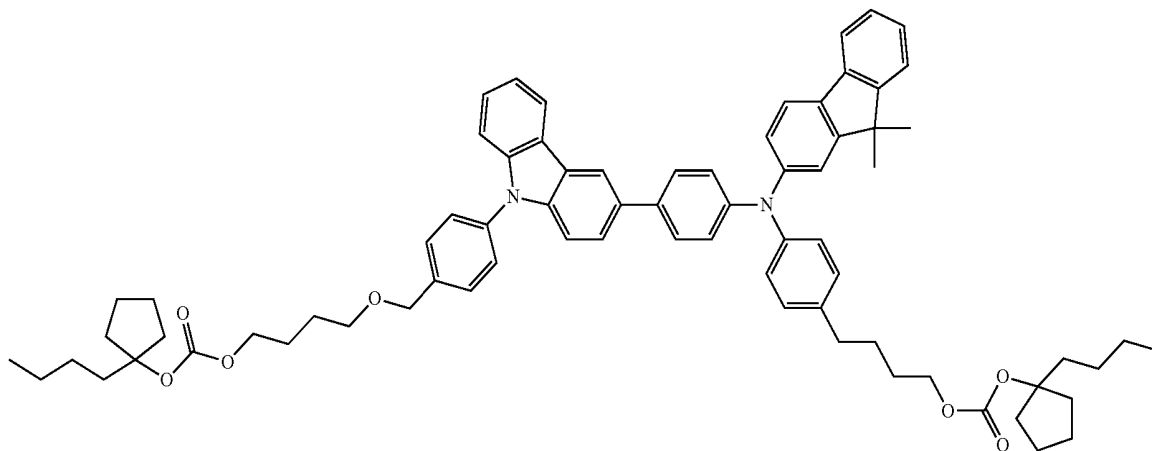


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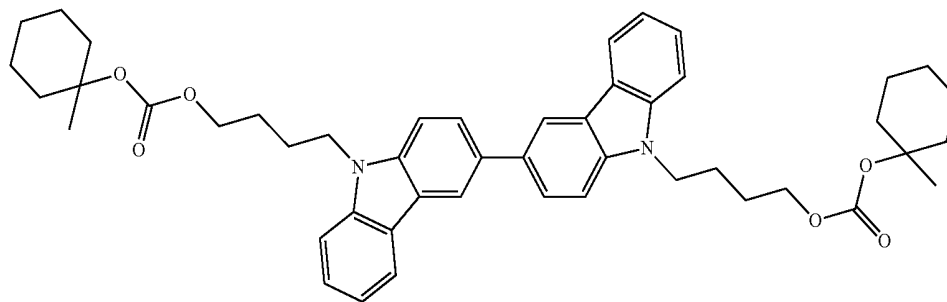


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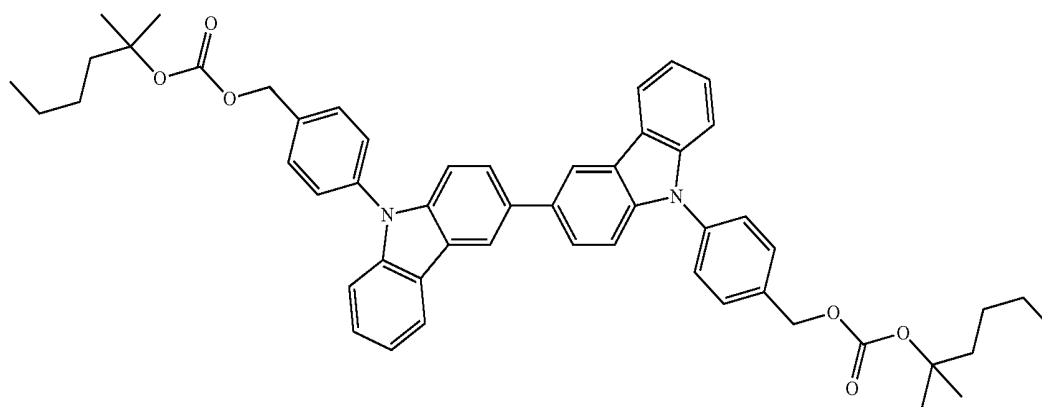
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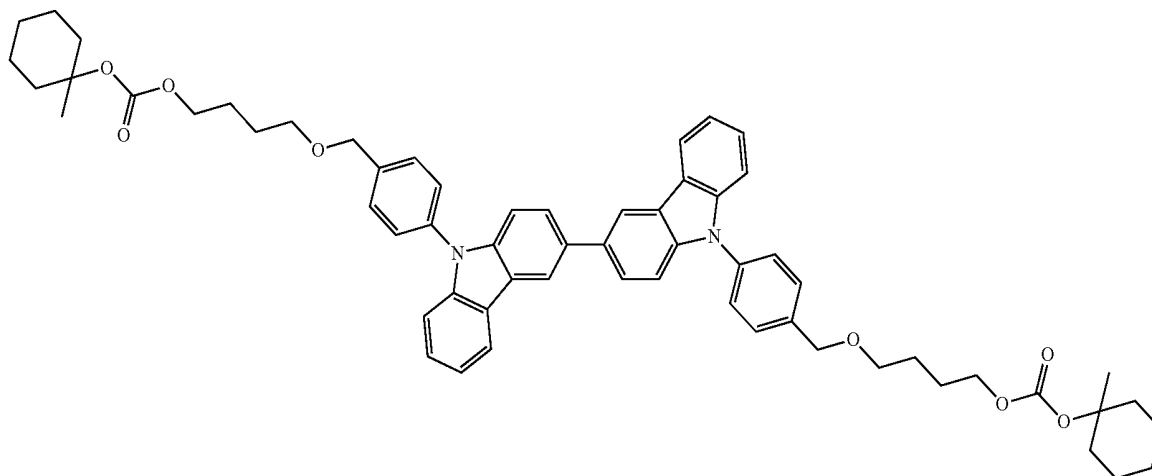
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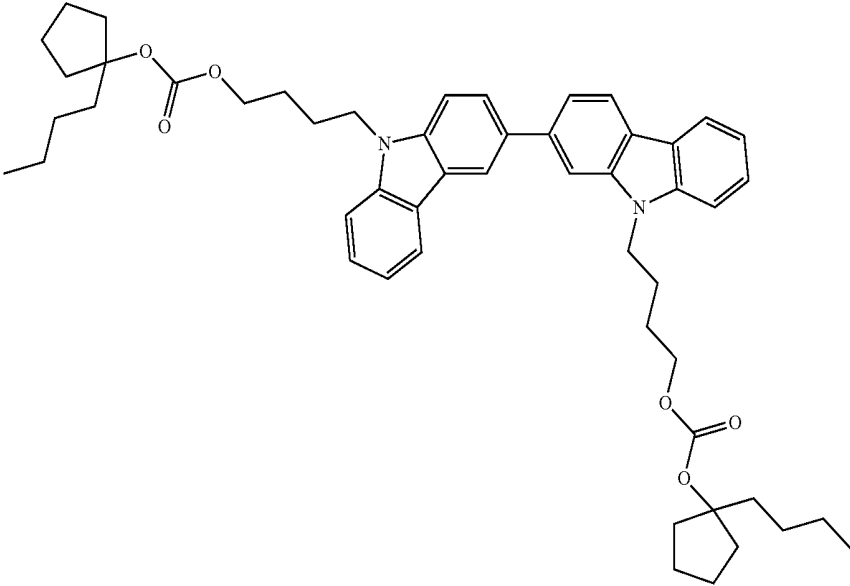


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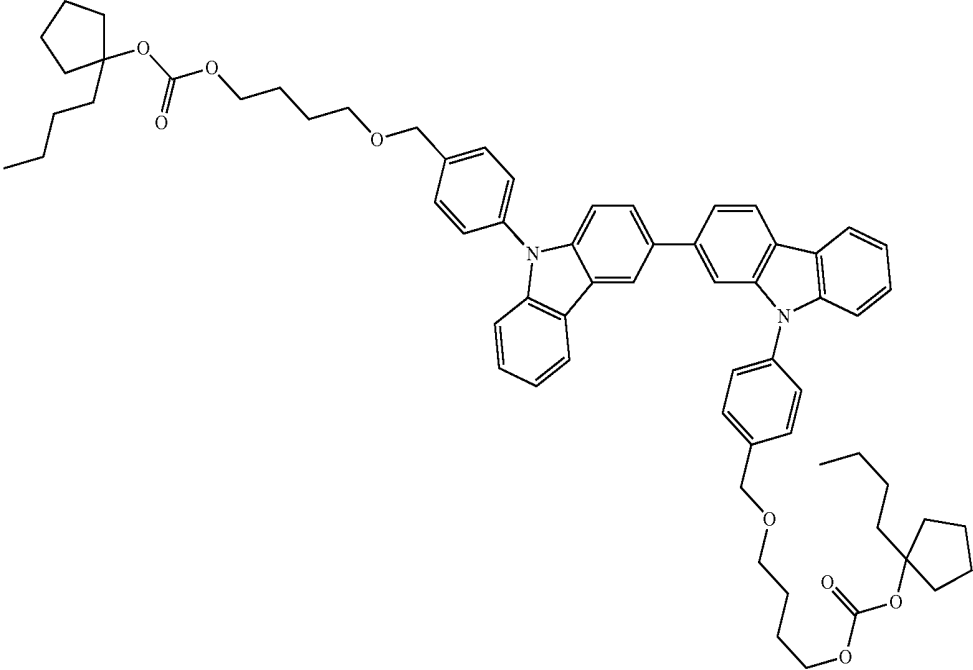


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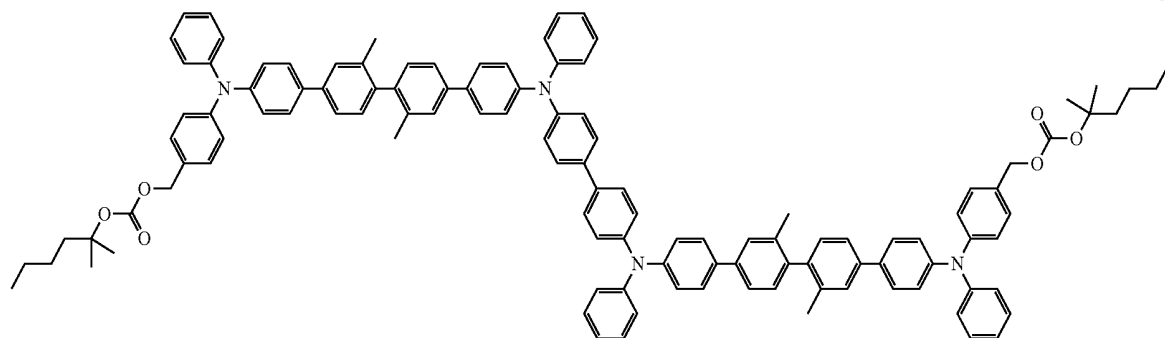
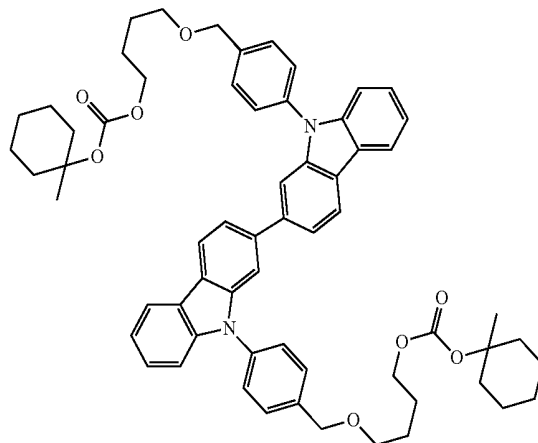
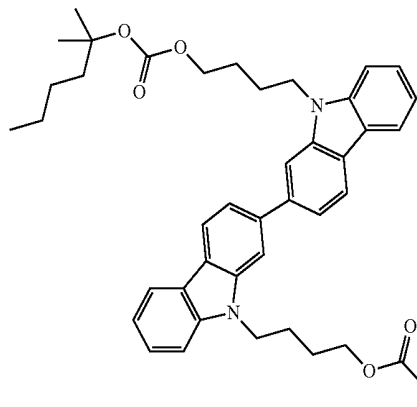
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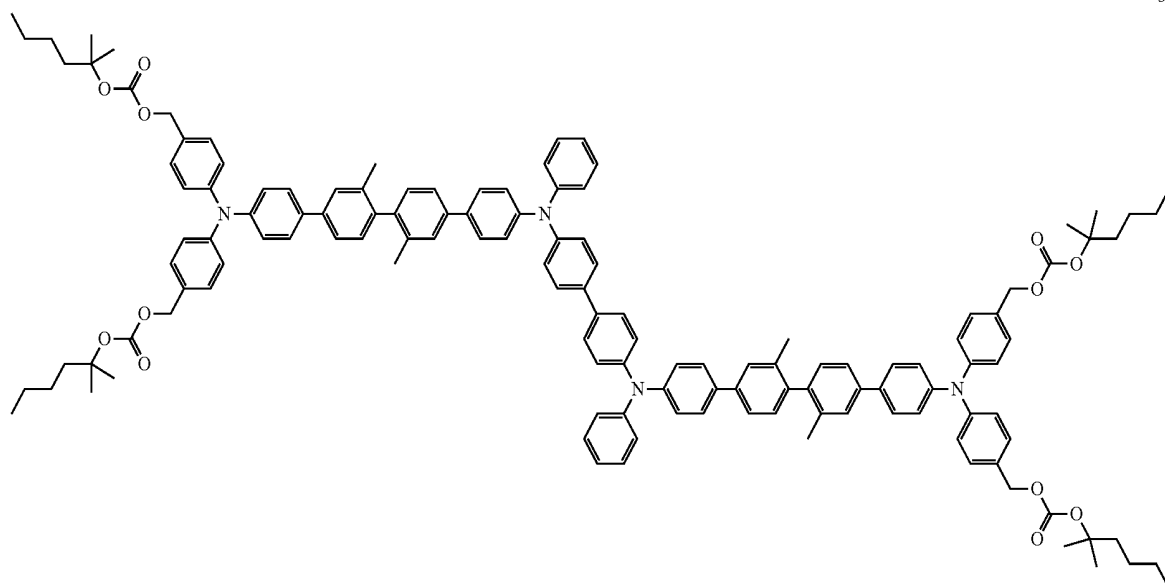
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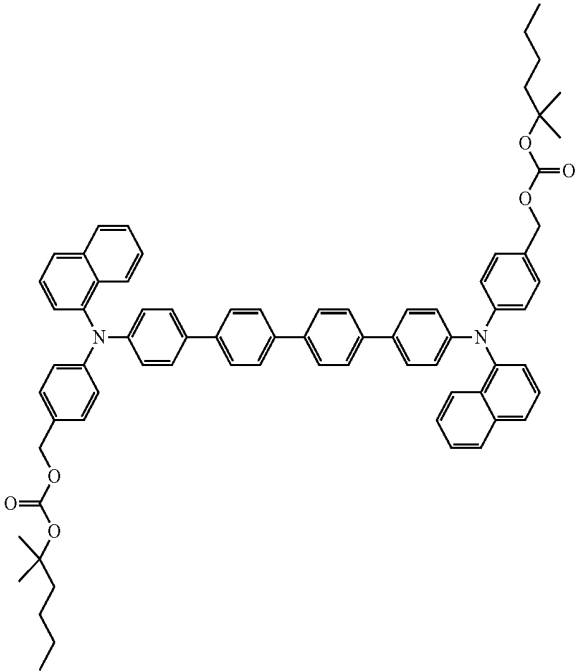
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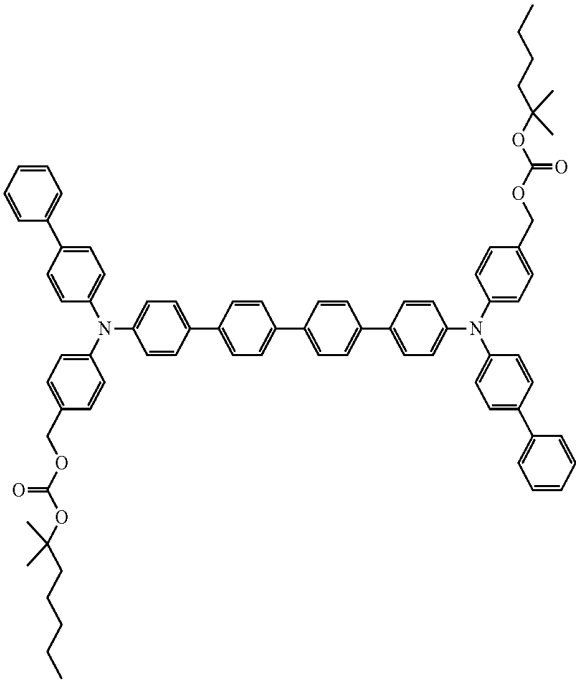
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33



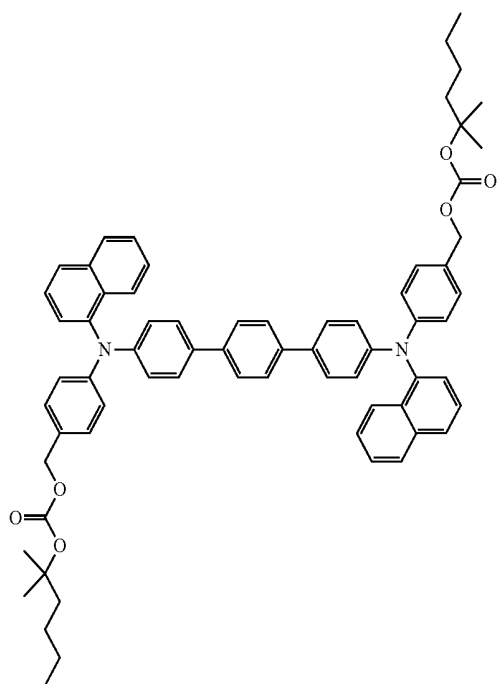
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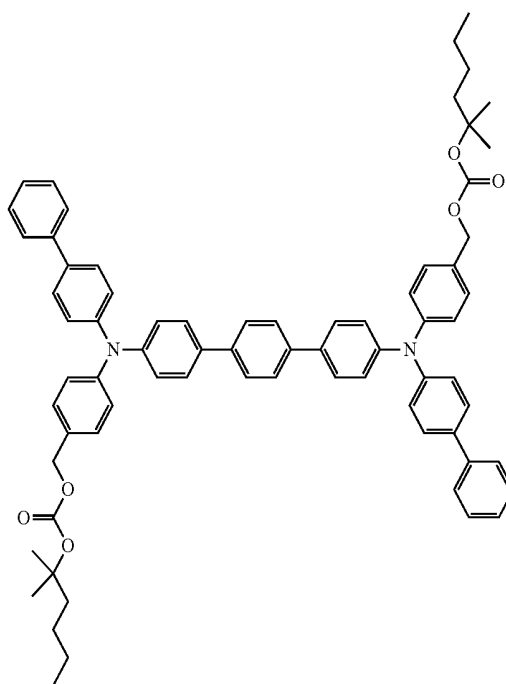


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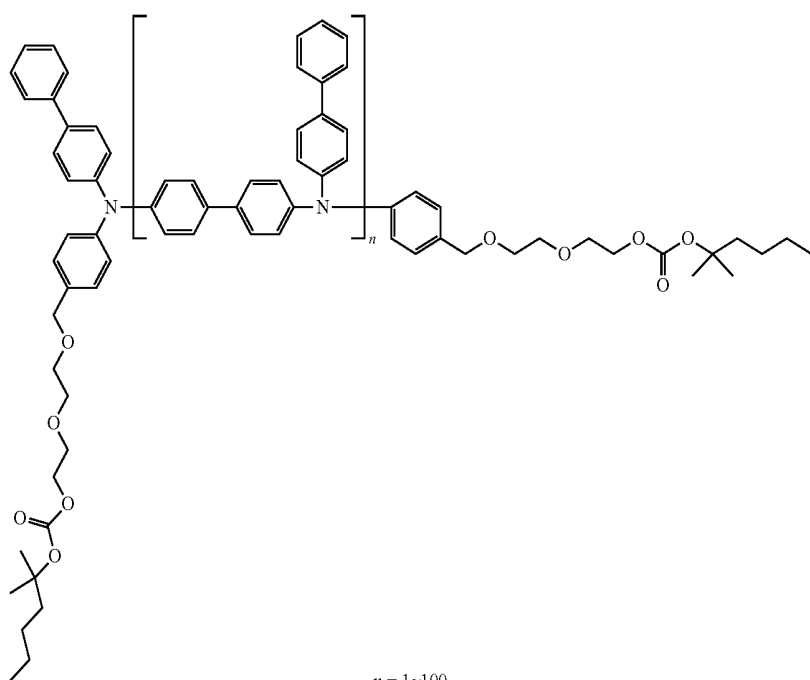
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38

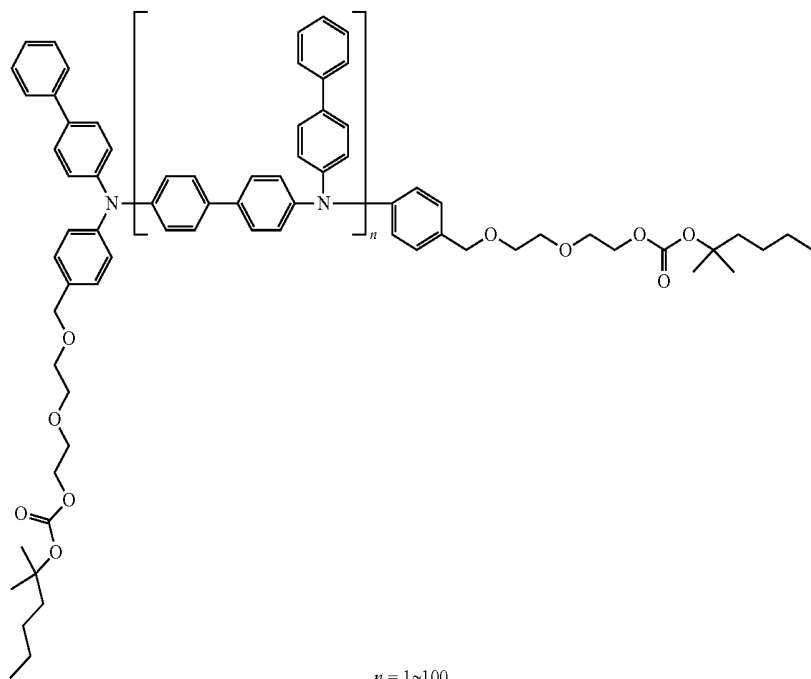


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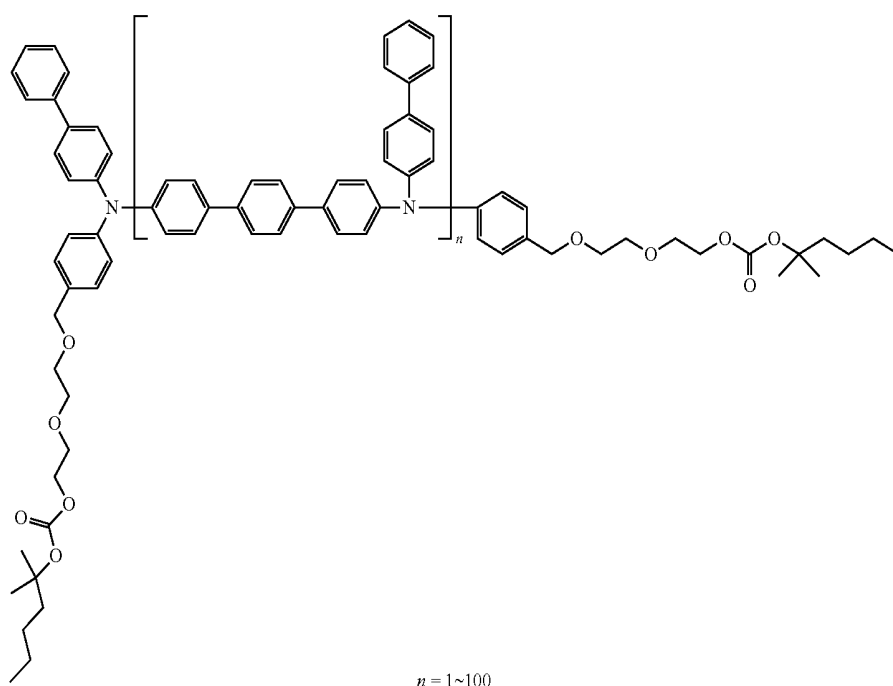


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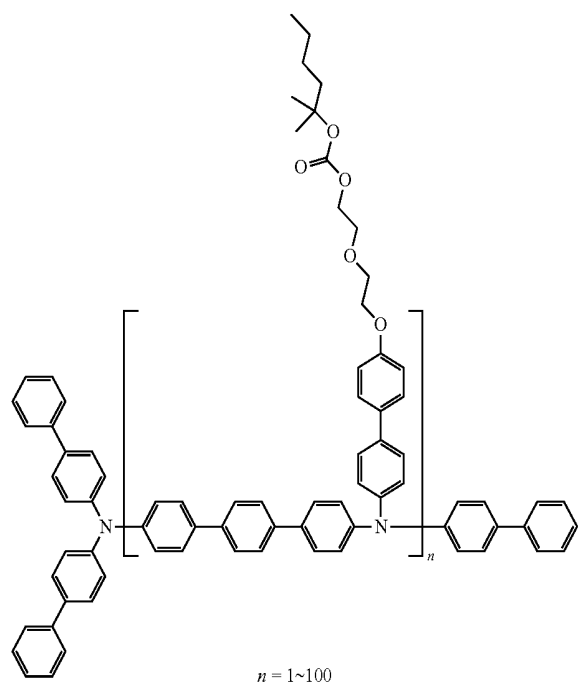
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41

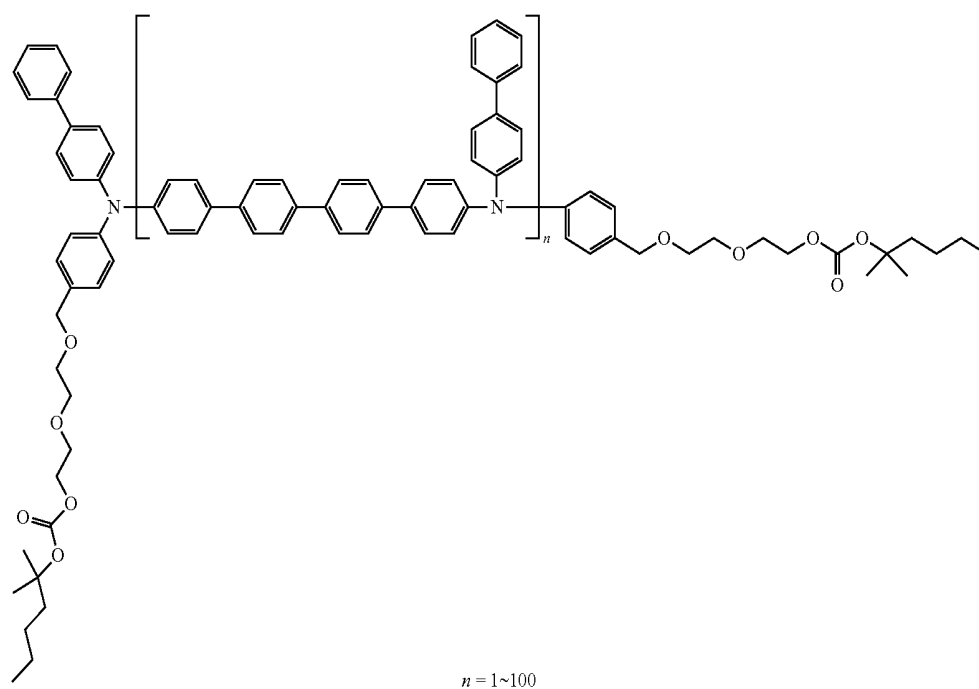
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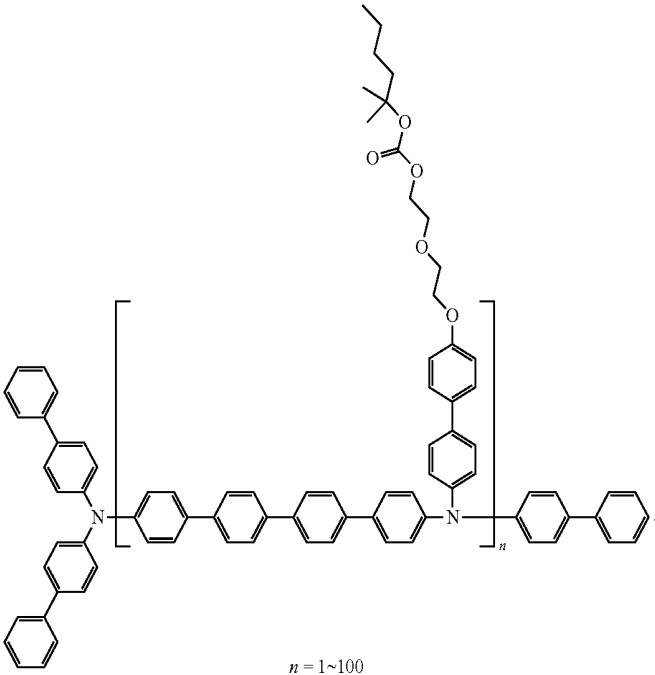
42



43



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专利名称(译)	包括热分解基团的芳胺基化合物和包括该化合物的有机发光装置		
公开(公告)号	<a href="#">US20190326519A1</a>	公开(公告)日	2019-10-24
申请号	US16/375806	申请日	2019-04-04
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	SHIN DONGWOO KIM DUKKI KIM SEHUN KIM JAEYUN PARK JONGWON HA JAEKOOK		
发明人	SHIN, DONGWOO KIM, DUKKI KIM, SEHUN KIM, JAEYUN PARK, JONGWON LEE, SEUNGMOOK HA, JAEKOOK		
IPC分类号	H01L51/00 C07D209/86 C07D307/91		
CPC分类号	C07D209/86 H01L51/5036 C07D307/91 H01L51/5064 H01L51/006 H01L51/0072 H01L51/0073 H01L51/0052 H01L51/0059 H01L51/0061 H01L51/5056		
优先权	1020180046984 2018-04-23 KR		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

摘要(译)

提供一种有机发光装置，其包括具有热分解性基团的芳基胺基化合物和具有热分解性基团的芳基胺基化合物。该有机发光装置包括：第一电极；以及第二电极。面对第一电极的第二电极；第一电极和第二电极之间的有机层包括发光层，该有机层包括其中热分解基团已经热分解并从包括热分解基团的芳胺基化合物中除去的芳基胺基化合物。

**10**

<b>190</b>
<b>150</b>
<b>110</b>