



US 20180047919A1

(19) **United States**

(12) **Patent Application Publication**
JUNG et al.

(10) **Pub. No.: US 2018/0047919 A1**

(43) **Pub. Date: Feb. 15, 2018**

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

C09K 11/02 (2006.01)
C07F 7/08 (2006.01)

(52) **U.S. Cl.**
CPC *H01L 51/0094* (2013.01); *C07F 7/0812* (2013.01); *C09K 11/06* (2013.01); *C07F 7/0814* (2013.01); *H01L 51/009* (2013.01); *H01L 51/008* (2013.01); *H01L 51/0085* (2013.01); *C09K 11/025* (2013.01); *H01L 51/506* (2013.01)

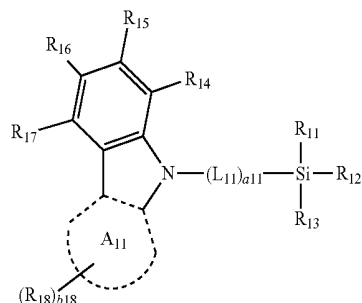
(71) Applicants: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR); **Samsung SDI Co., Ltd.**, Yongin-si (KR)

(72) Inventors: **Yongsik JUNG**, Yongin-si (KR); **Dalho HUH**, Suwon-si (KR); **Jhunmo SON**, Yongin-si (KR); **Eunsuk KWON**, Suwon-si (KR); **Sangmo KIM**, Hwaseong-si (KR); **Saeyoun LEE**, Suwon-si (KR); **Soonok JEON**, Seoul (KR); **Yeonsook CHUNG**, Seoul (KR); **Joonghyuk KIM**, Seoul (KR); **Myungsun SIM**, Suwon-si (KR)

(57) **ABSTRACT**

A silyl group-containing compound represented by Formula 1:

Formula 1



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

(21) Appl. No.: **15/400,253**

(22) Filed: **Jan. 6, 2017**

(30) **Foreign Application Priority Data**

Aug. 10, 2016 (KR) 10-2016-0101886

Publication Classification

(51) **Int. Cl.**
H01L 51/00 (2006.01)
C09K 11/06 (2006.01)

10
↙

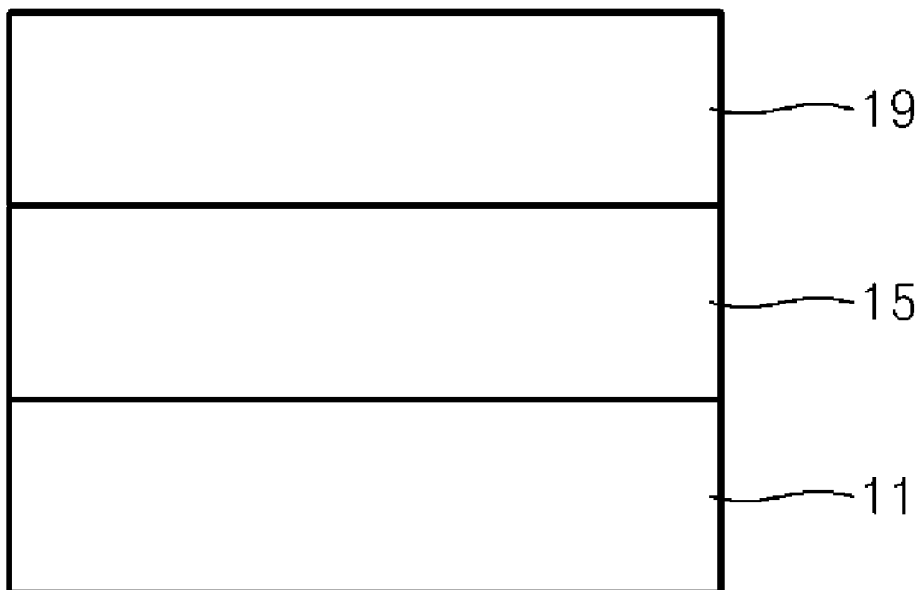
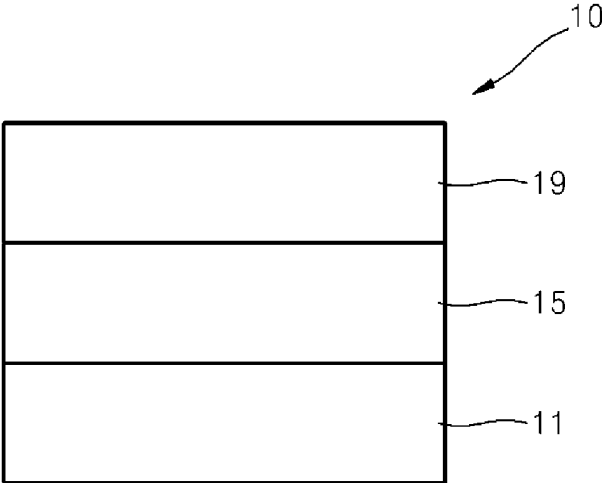


FIG. 1



**ORGANOMETALLIC COMPOUND AND
ORGANIC LIGHT-EMITTING DEVICE
INCLUDING THE SAME**

CROSS-REFERENCE TO RELATED
APPLICATION

[0001] This application claims priority to Korean Patent Application No. 10-2016-0101886, filed on Aug. 10, 2016, in the Korean Intellectual Property Office, and all the benefits accruing therefrom under 35 U.S.C. §119, the content of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

[0002] One or more exemplary embodiments relate to a silyl group-containing compound and an organic light-emitting device including the same.

2. Description of the Related Art

[0003] Organic light-emitting devices (OLEDs) are self-emission devices that produce full-color images and have wide viewing angles, high contrast ratios, and short response times, as well as excellent brightness, driving voltage, and response speed characteristics.

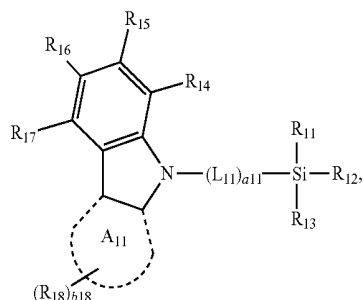
[0004] In an example, an organic light-emitting device includes an anode, a cathode, and an organic layer disposed between the anode and the cathode, wherein the organic layer includes an emission layer. A hole transport region may be disposed between the anode and the emission layer, and an electron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

SUMMARY

[0005] One or more exemplary embodiments include a silyl group-containing compound and an organic light-emitting device including the same.

[0006] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented exemplary embodiments.

[0007] According to one or more exemplary embodiments, a silyl group-containing compound is represented by Formula 1:

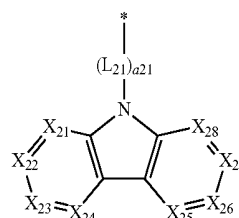


Formula 1

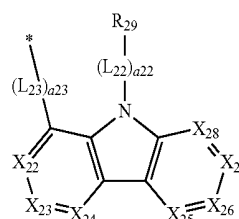
[0008] wherein, in Formula 1,

[0009] A₁₁ may be selected from a carbazole group, a fluorene group, a dibenzofuran group, and a dibenzothio-
phene group,

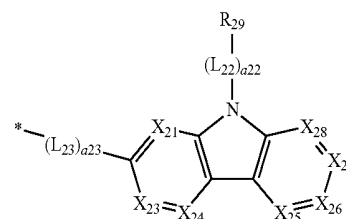
[0010] R₁₁ to R₁₃ may each independently be selected from groups represented by Formulae 2-1 to 2-6, provided that at least one selected from R₁₁ to R₁₃ is selected from groups represented by Formulae 2-1 to 2-5;



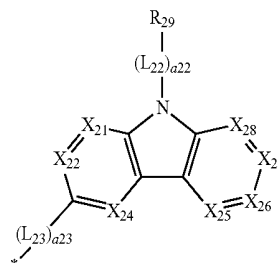
2-1



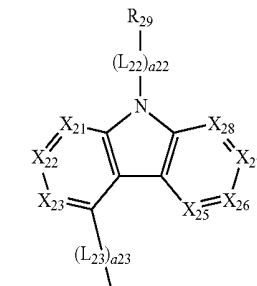
2-2



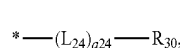
2-3



2-4



2-5



2-6

[0011] X₂₁ may be selected from N and CR₂₁, X₂₂ may be selected from N and CR₂₂, X₂₃ may be selected from N and CR₂₃, X₂₄ may be selected from N and CR₂₄, X₂₅ may be selected from N and CR₂₅, X₂₆ may be selected from N and CR₂₆, X₂₇ may be selected from N and CR₂₇, and X₂₈ may be selected from N and CR₂₈,

[0012] L₁₁ and L₂₁ to L₂₄ may each independently be selected from a substituted or unsubstituted C₃-C₁₀

cycloalkylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkylene group, a substituted or unsubstituted C₃-C₁₀ cycloalkenylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenylene group, a substituted or unsubstituted C₆-C₆₀ arylene group, a substituted or unsubstituted C₁-C₆₀ heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

[0013] a11 and a21 may each independently be selected from 1, 2, 3, and 4,

[0014] a22 to a24 may each independently be selected from 0, 1, 2, 3, and 4,

[0015] R₁₄ to R₁₈ and R₂₁ to R₂₉ may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₈-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —Si(Q₁)(Q₂)(Q₃), —N(Q₁)(Q₂), and —B(Q₁)(Q₂),

[0016] R₃₀ may be selected from a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,

[0017] b18 may be an integer selected from 1, 2, 4, 5, 6, 7, 8, 9, and 10,

[0018] Q₁ to Q₃ 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 C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group, and

[0019] indicates a binding site to a neighboring atom.

[0020] In one or more exemplary embodiments, an organic light-emitting device includes:

[0021] a first electrode,

[0022] a second electrode, and

[0023] an organic layer disposed between the first electrode and the second electrode,

[0024] wherein the organic layer includes an emission layer, and

[0025] wherein the organic layer includes at least one of the silyl group-containing compounds represented by Formula 1.

BRIEF DESCRIPTION OF THE DRAWING

[0026] These and/or other aspects will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with FIG. 1 which is a schematic view of an organic light-emitting device according to an exemplary embodiment.

DETAILED DESCRIPTION

[0027] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present disclosure. 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.

[0028] It will be understood that when an element is referred to as being “on” another element, it can be directly in contact with the other element or intervening elements may be present therebetween. In contrast, when an element is referred to as being “directly on” another element, there are no intervening elements present.

[0029] It will be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer, or section from another element, component, region, layer, or section. Thus, a first element, component, region, layer, or section discussed below could be termed a second element, component, region, layer, or section without departing from the teachings of the present embodiments.

[0030] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0031] The term “or” means “and/or.” It will be further understood that the terms “comprises” and/or “comprising,” or “includes” and/or “including” when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

[0032] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this general inventive concept belongs. It will

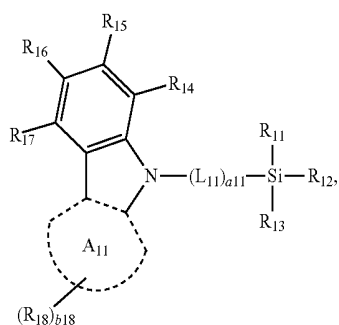
be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0033] Exemplary embodiments are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments described herein should not be construed as limited to the particular shapes of regions as illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present claims.

[0034] “About” or “approximately” as used herein is inclusive of the stated value and means within an acceptable range of deviation for the particular value as determined by one of ordinary skill in the art, considering the measurement in question and the error associated with measurement of the particular quantity (i.e., the limitations of the measurement system). For example, “about” can mean within one or more standard deviations, or within $\pm 30\%$, 20% , 10% , 5% of the stated value.

[0035] Hereinafter, with reference to attached drawings, a silyl group-containing compound and an organic light-emitting device including the same according to an exemplary embodiment will be described in detail. However, these are for illustrative purposes only and are not intended to limit the scope of this disclosure.

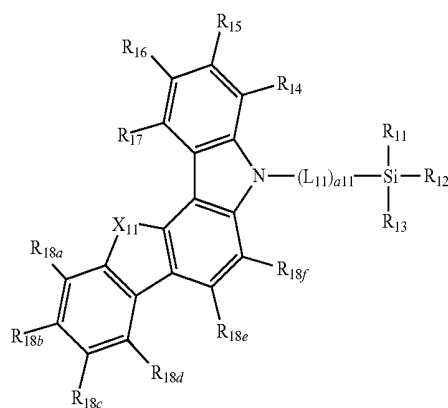
[0036] A silyl group-containing compound according to an exemplary embodiment may be represented by Formula 1:



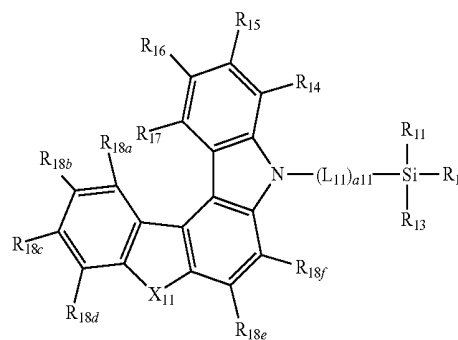
Formula 1

[0037] wherein A_{11} in Formula 1 may be selected from a carbazole group, a fluorene group, a dibenzofuran group, and a dibenzothiophene group,

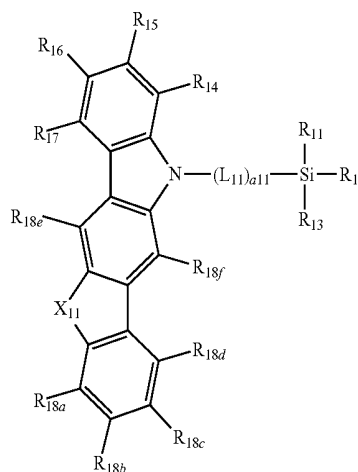
[0038] In one or more exemplary embodiments, the silyl group-containing compound represented by Formula 1 may be represented by one of Formulae 1-1 to 1-6, but exemplary embodiments of the present disclosure are not limited thereto:



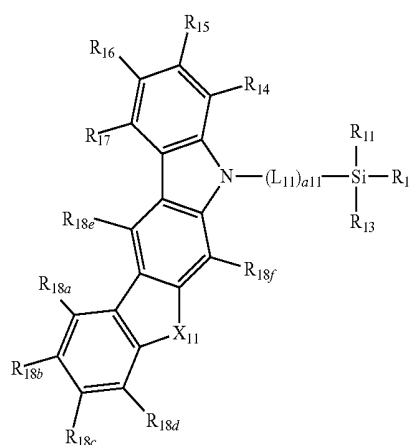
1-1



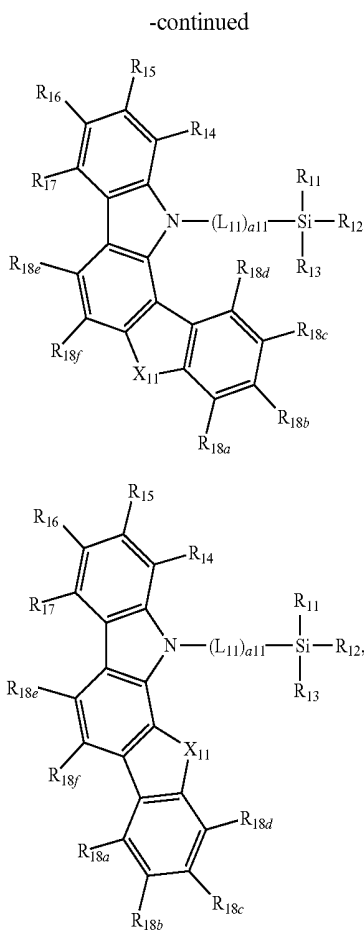
1-2



1-3

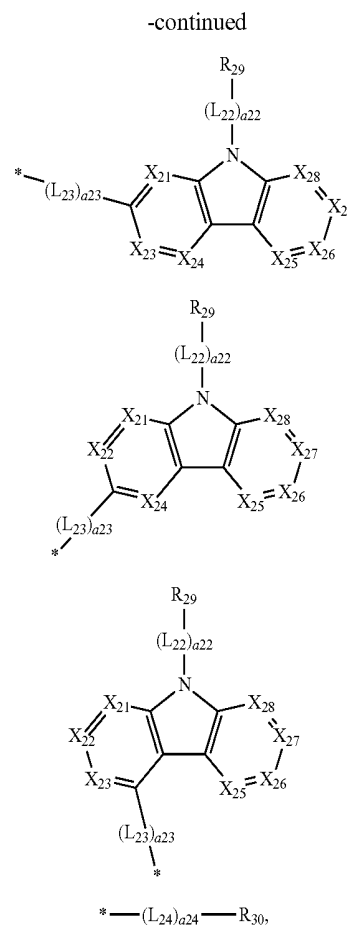


1-4



1-5

1-6



2-3

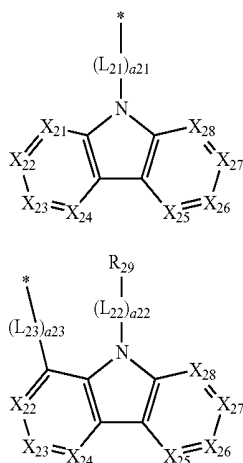
2-4

2-5

2-6

[0039] wherein, in Formulae 1-1 to 1-6,
 [0040] X_{11} may be selected from O, S, $N(R_{18g})$, and $C(R_{18g})(R_{18h})$,
 [0041] R_{11} to R_{17} , L_{11} , and a_{11} are the same as described below, and
 [0042] R_{18a} to R_{18h} are each independently the same as described below in connection with R_{18} .
 [0043] R_{11} to R_{13} in Formula 1 may each independently be selected from groups represented by Formulae 2-1 to 2-6, provided that at least one selected from R_{11} to R_{13} is selected from groups represented by Formulae 2-1 to 2-5;

[0044] wherein, in Formulae 2-1 to 2-6,
 [0045] X_{21} to X_{28} , L_{21} to L_{24} , a_{21} to a_{24} , R_{29} , and R_{30} are the same as described below, and
 [0046] * indicates a binding site to a neighboring atom.
 [0047] In one or more exemplary embodiments, in Formula 1, $R_{11} \neq R_{12} \neq R_{13}$;
 [0048] $R_{11} = R_{12}$ and $R_{12} \neq R_{13}$;
 [0049] $R_{12} = R_{13}$ and $R_{11} \neq R_{12}$;
 [0050] $R_{13} = R_{11}$ and $R_{12} \neq R_{13}$; or
 [0051] $R_{11} = R_{12} = R_{13}$, but exemplary embodiments of the present disclosure are not limited thereto.

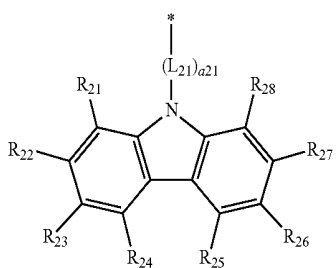


2-1

2-2

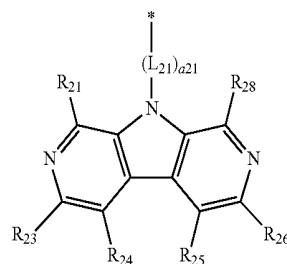
[0052] In one or more exemplary embodiments, in Formula 1, $R_{11} = R_{12}$ and $R_{12} \neq R_{13}$; or
 [0053] $R_{11} \neq R_{12}$ and $R_{12} = R_{13}$, but exemplary embodiments of the present disclosure are not limited thereto.
 [0054] In Formulae 2-1 to 2-5, X_{21} may be selected from N and CR_{21} , X_{22} may be selected from N and CR_{22} , X_{23} may be selected from N and CR_{23} , X_{24} may be selected from N and CR_{24} , X_{25} may be selected from N and CR_{25} , X_{26} may be selected from N and CR_{26} , X_{27} may be selected from N and CR_{27} , X_{28} may be selected from N and CR_{28} , and R_{21} to R_{28} are the same as described below.
 [0055] In one or more exemplary embodiments, in Formula 2-1, X_{21} may be CR_{21} , X_{22} may be CR_{22} , X_{23} may be CR_{23} , X_{24} may be CR_{24} , X_{25} may be CR_{25} , X_{26} may be CR_{26} , X_{27} may be CR_{27} , and X_{28} may be CR_{28} , but exemplary embodiments of the present disclosure are not limited thereto.
 [0056] In one or more exemplary embodiments, in Formula 2-2, X_{22} may be CR_{22} , X_{23} may be CR_{23} , X_{24} may be

-continued



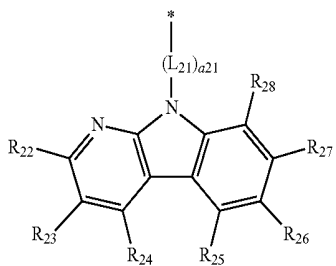
2-11

2-17



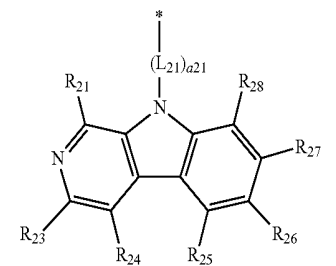
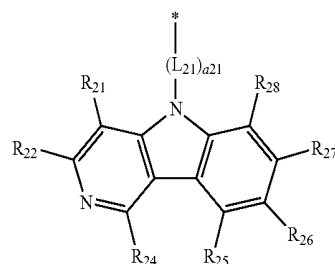
2-12

2-18



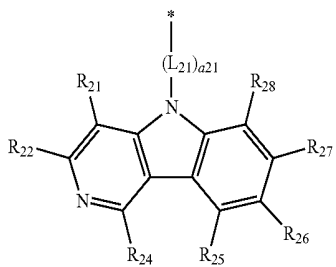
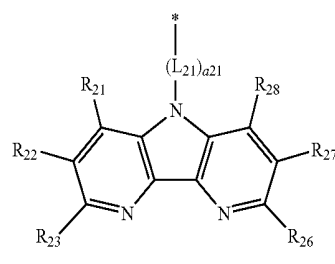
2-13

2-19



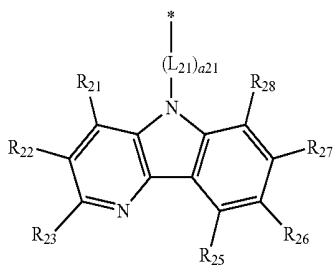
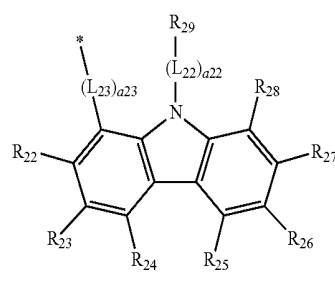
2-14

2-21



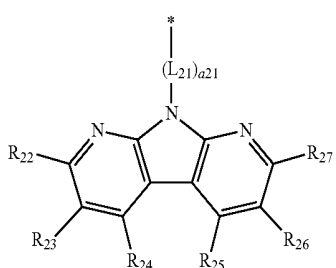
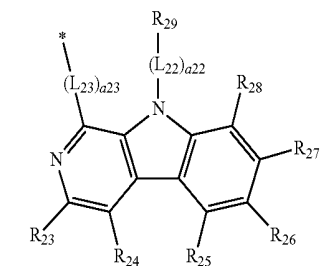
2-15

2-22

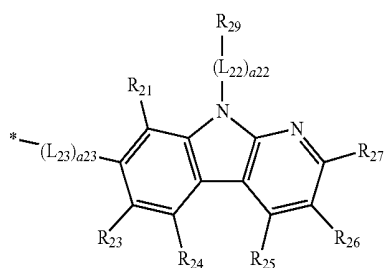


2-16

2-23

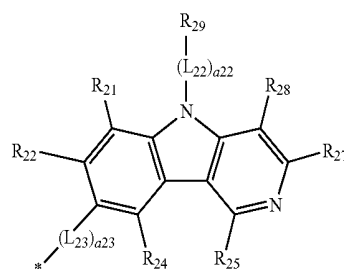


-continued

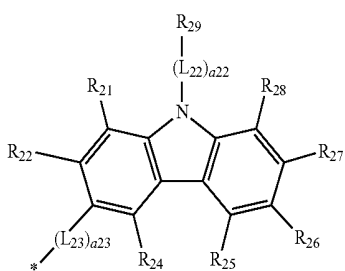


2-38

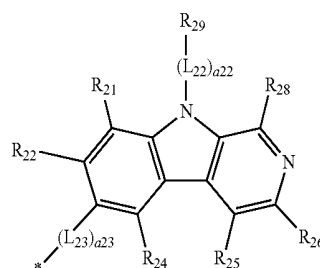
-continued



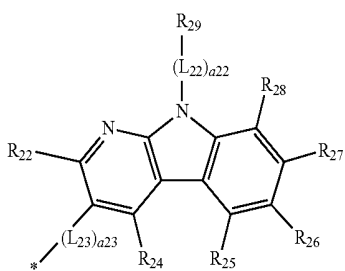
2-46



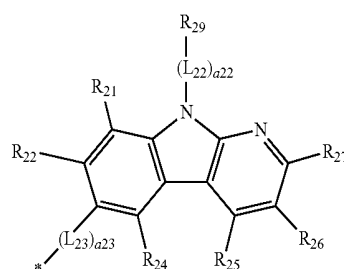
2-41



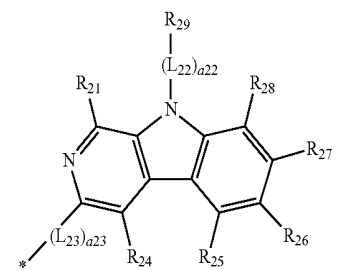
2-47



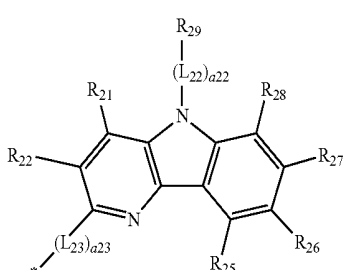
2-42



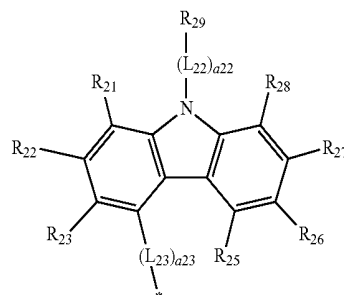
2-48



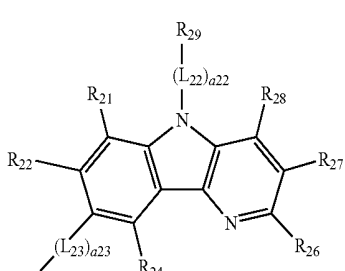
2-43



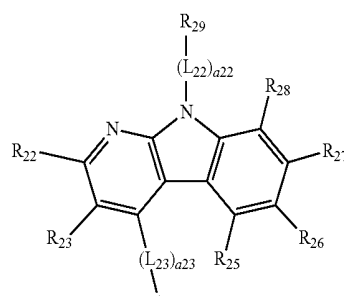
2-44



2-51

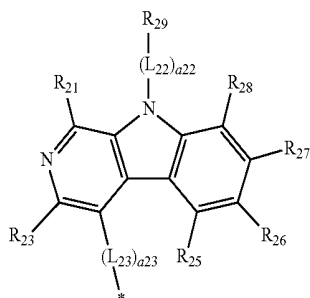


2-45



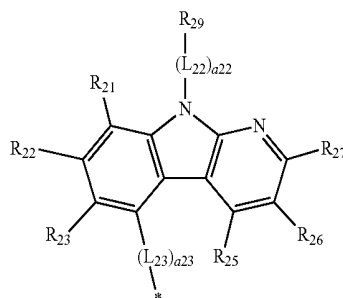
2-52

-continued

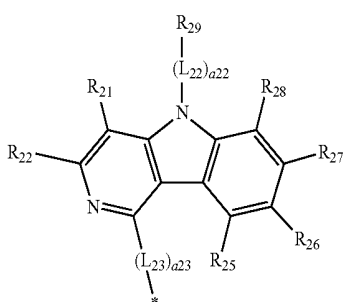


2-53

-continued



2-58



2-54

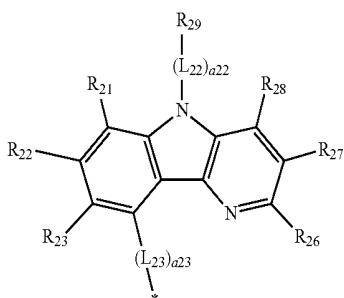
[0135] wherein, in Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, and 2-51 to 2-58,

[0136] L_{21} to L_{23} , a_{21} to a_{23} , and R_{21} to R_{29} are the same as described above in connection with Formulae 2-1 to 2-5, and

[0137] * indicates a binding site to a neighboring atom.

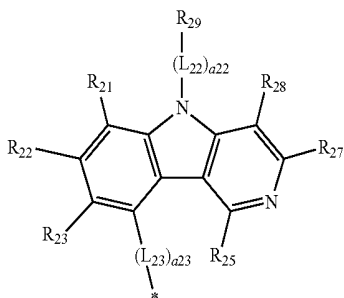
[0138] L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from a substituted or unsubstituted C_3 - C_{10} cycloalkylene group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3 - C_{10} cycloalkenylene group, a substituted or unsubstituted heterocycloalkenylene group, a substituted or unsubstituted C_6 - C_{60} arylene group, a substituted or unsubstituted heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group.

2-55



[0139] In one or more exemplary embodiments, L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from 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, but exemplary embodiments of the present disclosure are not limited thereto.

2-56

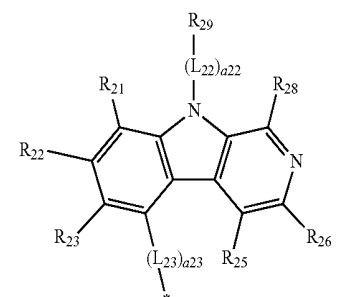


[0140] In one or more exemplary embodiments, L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from:

[0141] a phenylene group, a naphthylene group, a fluorenylene group, a phenanthrenylene group, an anthracenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylylene group, a pyrazinylylene group, a pyrimidinylene group, and a triazinylene group; and

[0142] a phenylene group, a naphthylene group, a fluorenylene group, a phenanthrenylene group, an anthracenylylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylylene group, a pyrazinylylene group, a pyrimidinylene group, and a triazinylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, and

2-57



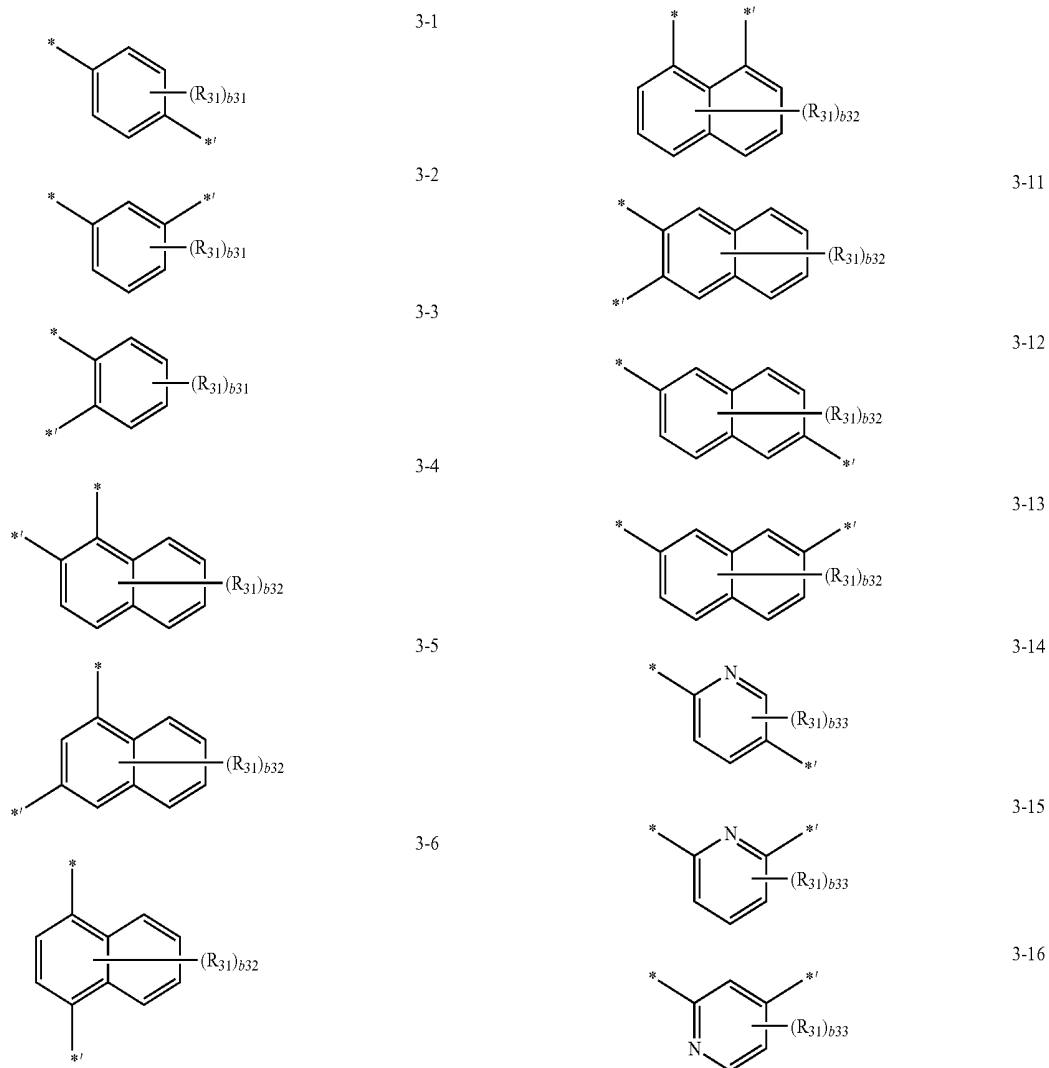
a triazinyl group, but exemplary embodiments of the present disclosure are not limited thereto.

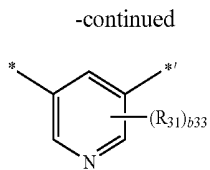
[0143] In one or more exemplary embodiments, L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from;

[0144] a phenylene group, a naphthylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, and a triazinylene group; and

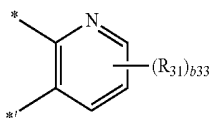
[0145] a phenylene group, a naphthylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, and a triazinylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, and a pyridinyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0146] In one or more exemplary embodiments, L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from groups represented by Formulae 3-1 to 3-28, but exemplary embodiments of the present disclosure are not limited thereto:

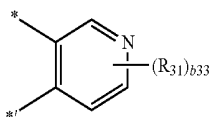




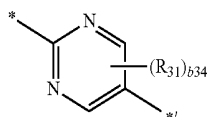
3-17



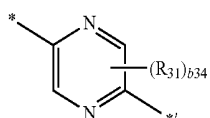
3-18



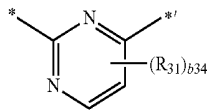
3-19



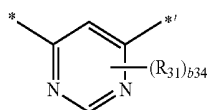
3-20



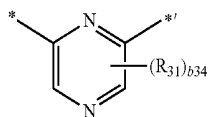
3-21



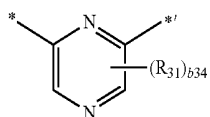
3-22



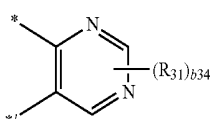
3-23



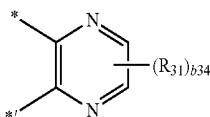
3-24



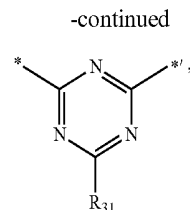
3-25



3-26



3-27



3-28

[0147] wherein, in Formulae 3-1 to 3-28,

[0148] R_{31} may be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, and a pyridinyl group,

[0149] b_{31} may be an integer selected from 1, 2, 3, and 4,

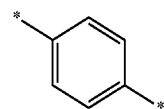
[0150] b_{32} may be an integer selected from 1, 2, 3, 4, 5, and 6,

[0151] b_{33} may be an integer selected from 1, 2, and 3,

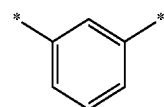
[0152] b_{34} may be an integer selected from 1 and 2, and

[0153] * and *' each indicate a binding site to a neighboring atom.

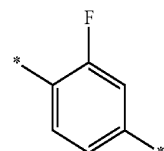
[0154] In one or more exemplary embodiments, L_{11} and L_{21} to L_{24} in Formulae 1 and 2-1 to 2-6 may each independently be selected from groups represented by Formulae 4-1 to 4-22, but exemplary embodiments of the present disclosure are not limited thereto:



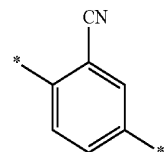
4-1



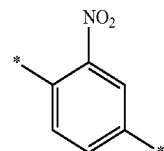
4-2



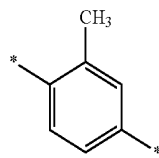
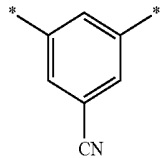
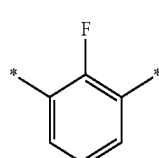
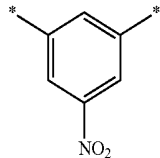
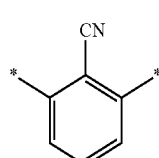
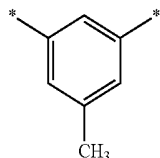
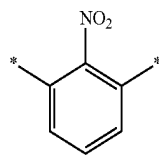
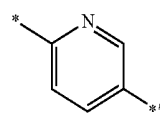
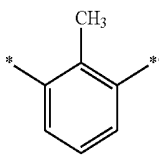
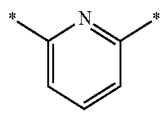
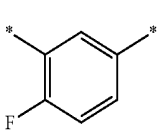
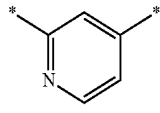
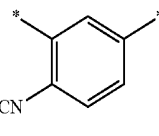
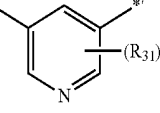
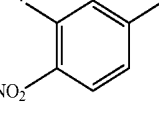
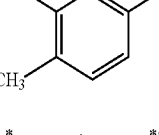
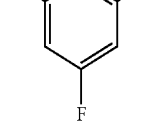
4-3



4-4



4-5

-continued		-continued	
	4-6		4-16
	4-7		4-17
	4-8		4-18
	4-9		4-19
	4-10		4-20
	4-11		4-21
	4-12		4-22
	4-13		
	4-14		
	4-15		

[0155] wherein, in Formulae 4-1 to 4-22,

[0156] * and *' each indicate a binding site to a neighboring atom.

[0157] a11 in Formula 1 indicates the repeating number of groups L₁₁ and may be selected from 1, 2, 3, and 4. When all is two or more, two or more groups L₁₁ may be identical to or different from each other.

[0158] a21 in Formula 2-1 indicates the repeating number of groups L₂₁ and may be selected from 1, 2, 3, and 4. When a21 is two or more, two or more groups L₂₁ may be identical to or different from each other.

[0159] In one or more exemplary embodiments, a11 and a21 in Formulae 1 and 2-1 may be 1, but exemplary embodiments of the present disclosure are not limited thereto.

[0160] a22, a23, and a24 in Formulae 2-2 to 2-6 respectively indicate the repeating number of groups L₂₂, L₂₃, and L₂₄ and may be selected from 0, 1, 2, 3, and 4. When a22 is zero, (L₂₂)_{a22} means a single bond. When a22 is two or more, two or more groups L₂₂ may be identical to or different from each other. When a23 is zero, (L₂₃)_{a23} means a single bond. When a23 is two or more, two or more groups L₂₃ may be identical to or different from each other. When

a₂₄ is two or more, two or more groups L₂₄ may be identical to or different from each other. When a₂₄ is zero, (L₂₄)_{a₂₄} means a single bond.

[0161] In one or more exemplary embodiments, a₂₂ to a₂₄ in Formulae 2-2 to 2-6 may each independently be selected from 0 and 1, but exemplary embodiments of the present disclosure are not limited thereto.

[0162] R₁₄ to R₁₈ and R₂₁ to R₂₉ in Formulae 1 and 2-1 to 2-5 may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₃-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₃ cycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —Si(Q₁)(Q₂)(Q₃), —N(Q₁)(Q₂), and —B(Q₁)(Q₂).

[0163] wherein Q₁ to Q₃ 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 hydrazone group, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0164] In one or more exemplary embodiments, R₁₄ to R₁₈ and R₂₁ to R₂₉ in Formulae 1 and 2-1 to 2-5 may each independently be selected from:

[0165] hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, and a C₁-C₂₀ alkoxy group;

[0166] a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a phenyl group, a pyridinyl group, a pyrimidinyl group, and a triazinyl group;

[0167] a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluo-

renyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

[0168] a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl 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 amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, —Si(Q₃₁)(Q₃₂)(Q₃₃), —N(Q₃₁)(Q₃₂), and —B(Q₃₁)(Q₃₂); and

[0169] —Si(Q₁)(Q₂)(Q₃), —N(Q₁)(Q₂), and —B(Q₁)(Q₂).

[0170] wherein Q₁ to Q₃ and Q₃₁ to Q₃₃ may each independently be selected from a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0171] In one or more exemplary embodiments, R₁₄ to R₁₈ and R₂₁ to R₂₉ in Formulae 1 and 2-1 to 2-5 may each independently be selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a pyridinyl group, and a pyrimidinyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0172] R₃₀ in Formula 2-6 may be selected from a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted heterocycloalkyl group, a substituted or unsubstituted cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₈-C₆₀ aryl group, a substituted or unsubsti-

tuted 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.

[0173] In one or more exemplary embodiments, R_{30} in Formula 2-6 may be selected from:

[0174] a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, 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 dibenzosilolyl group, a spiro-bifluorenyl 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 pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoxazolyl group, a benzimidazolyl group, a furanyl group, a benzofuranyl group, a thiophenyl group, a benzothiophenyl group, a thiazolyl group, an isothiazolyl group, a benzothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridimidinyl group, an imidazopyridinyl group, a pyridoindolyl group, a benzofuro-pyridinyl group, a benzothienopyridinyl group, a pyrimidoindolyl group, a benzofuopyrimidinyl group, a benzothienopyrimidinyl group, a phenoxazinyl group, a pyridobenzoaxazinyl group, and a pyridobenzothiazinyl group; and

[0175] a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, 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 dibenzosilolyl group, a spiro-bifluorenyl 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 pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoxazolyl group, a benzimidazolyl group, a furanyl group, a benzofuranyl group, a thiophenyl group, a benzothiophenyl group,

a thiazolyl group, an isothiazolyl group, a benzothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridimidinyl group, an imidazopyridinyl group, a pyridoindolyl group, a benzofuro-pyridinyl group, a benzothienopyridinyl group, a pyrimidoindolyl group, a benzofuopyrimidinyl group, a benzothienopyrimidinyl group, a phenoxazinyl group, a pyridobenzoaxazinyl group, and a pyridobenzothiazinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_2 - C_{20} alkenyl group, a C_2 - C_{20} alkynyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthracenyl group, a pyrenyl group, a phenanthrenyl group, a fluorenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a phthalazinyl group, a quinoxalinyl group, a cinnolinyl group, a quinazolinyl group, —Si(Q_{31})(Q_{32})(Q_{33}), —N(Q_{31})(Q_{32}), and —B(Q_{31})(Q_{32}),

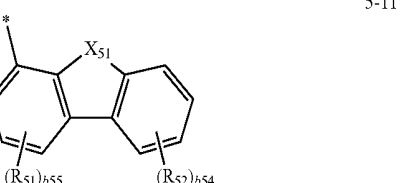
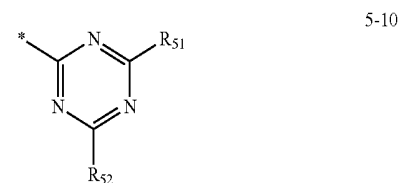
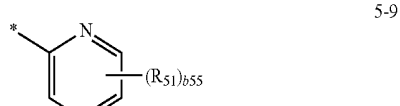
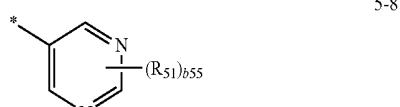
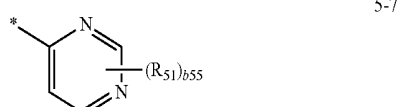
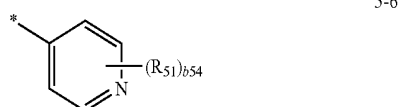
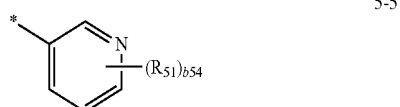
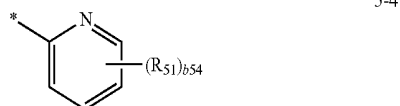
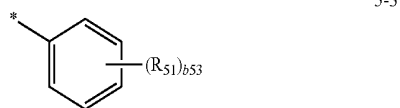
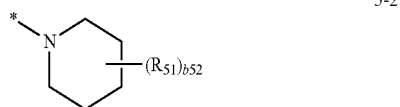
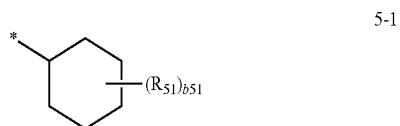
[0176] wherein Q_{31} to Q_{33} may each independently be selected from a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0177] In one or more exemplary embodiments, R_{33} in Formula 2-6 may be selected from:

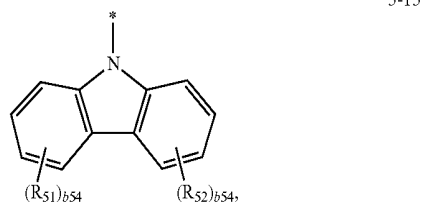
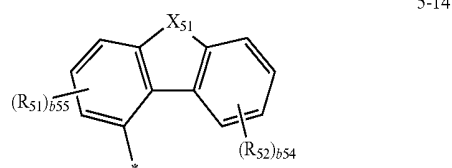
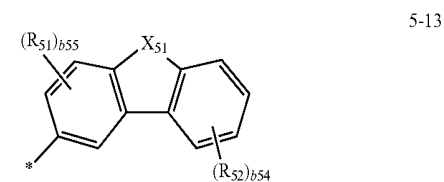
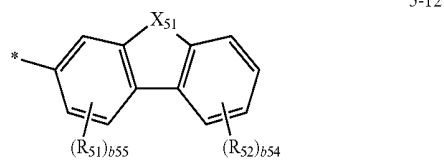
[0178] a cyclohexyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a furanyl group, a thiophenyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

[0179] a cyclohexyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a furanyl group, a thiophenyl group, a triazinyl 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 amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a carbazolyl group, a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, and a triazinyl group, but exemplary embodiments of the present disclosure are not limited thereto.

[0180] In one or more exemplary embodiments, R_{30} in Formula 2-6 may be one of the groups represented by Formulae 5-1 to 5-15, but exemplary embodiments of the present disclosure are not limited thereto:



-continued



[0181] wherein, in Formulae 5-1 to 5-15,

[0182] X_{51} may be selected from $C(R_{53})(R_{54})$, $Si(R_{53})(R_{54})$, $N(R_{53})$, O, and S,

[0183] R_{51} to R_{54} may each independently be selected from hydrogen, deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, and a triazinyl group,

[0184] b_{51} may be an integer selected from 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11,

[0185] b_{52} may be an integer selected from 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10,

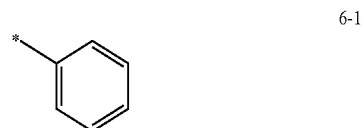
[0186] b_{53} may be an integer selected from 1, 2, 3, 4, and 5,

[0187] b_{54} may be an integer selected from 1, 2, 3, and 4,

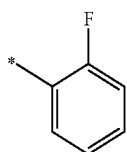
[0188] b_{55} may be an integer selected from 1, 2, and 3, and

[0189] * indicates a binding site to a neighboring atom.

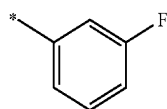
[0190] In one or more exemplary embodiments, R_{30} in Formula 2-6 may be one of the groups represented by Formulae 6-1 to 6-35, but exemplary embodiments of the present disclosure are not limited thereto:



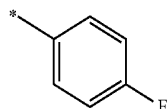
-continued



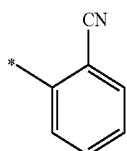
6-2



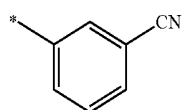
6-3



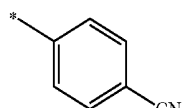
6-4



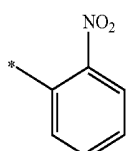
6-5



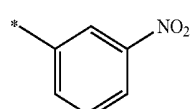
6-6



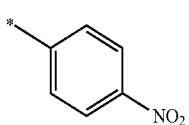
6-7



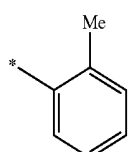
6-8



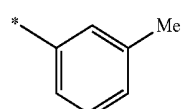
6-9



6-10

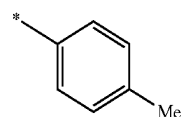


6-11

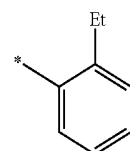


6-12

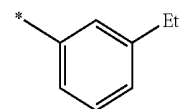
-continued



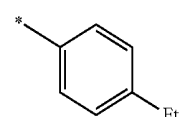
6-13



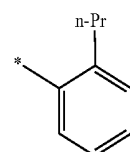
6-14



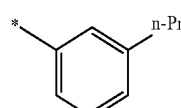
6-15



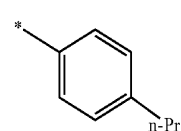
6-16



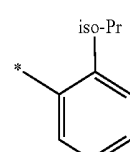
6-17



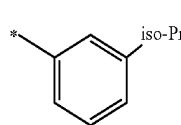
6-18



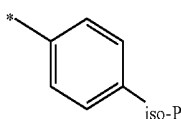
6-19



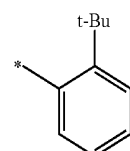
6-20



6-21

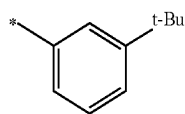


6-22

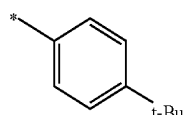


6-23

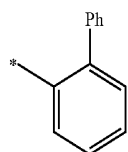
-continued



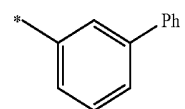
6-24



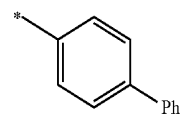
6-25



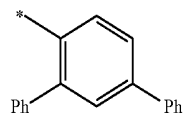
6-26



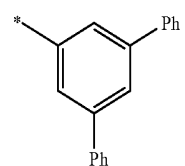
6-27



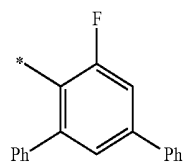
6-28



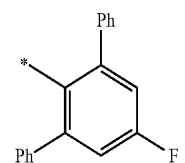
6-29



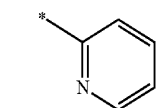
6-30



6-31

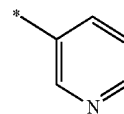


6-32

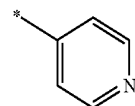


6-33

-continued



6-34



6-35

[0191] wherein, in Formulae 6-1 to 6-35,

[0192] Me is a methyl group,

[0193] Et is an ethyl group,

[0194] n-Pr is an n-propyl group,

[0195] iso-Pr is an iso-propyl group,

[0196] t-Bu is a tert-butyl group,

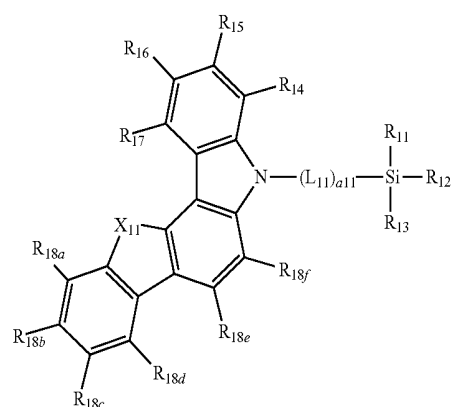
[0197] Ph is a phenyl group, and

[0198] * indicates a binding site to a neighboring atom.

[0199] b₁₈ in Formula 1 indicates the number of groups R₁₈ and may be selected from 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. When b₁₈ is two or more, two or more groups R₁₈ may be identical to or different from each other.

[0200] In one or more exemplary embodiments, the silyl group-containing compound represented by Formula 1 may be represented by Formulae 1-1 to 1-6, but exemplary embodiments of the present disclosure are not limited thereto:

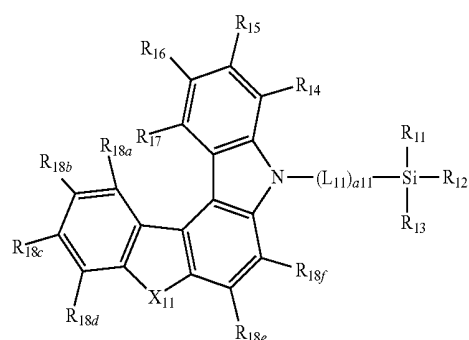
1-1



6-30

6-31

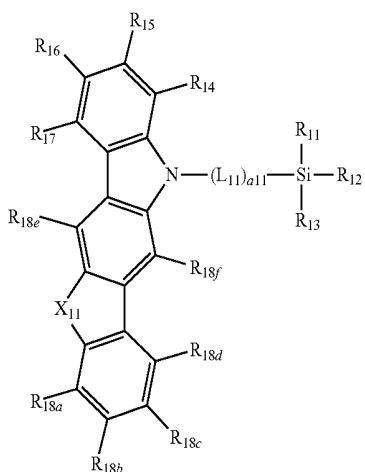
1-2



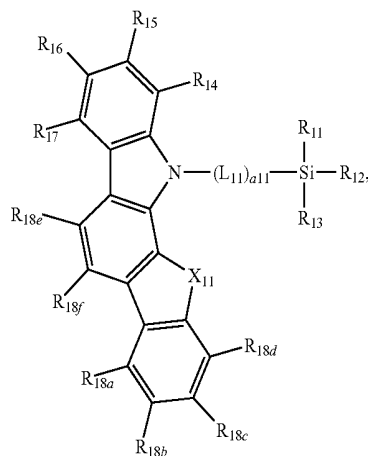
6-32

6-33

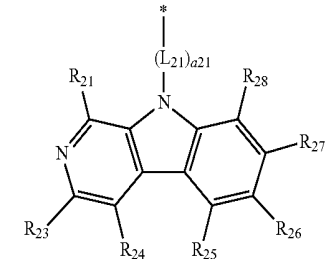
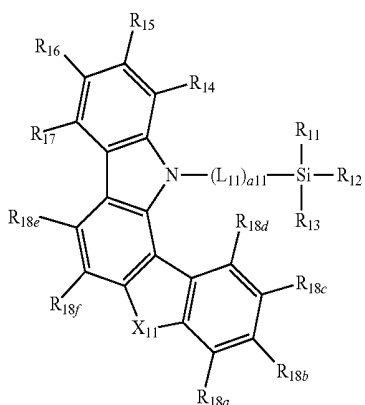
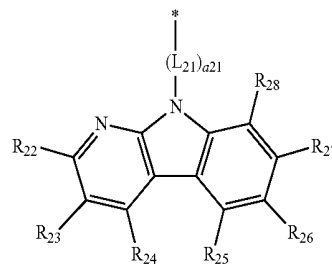
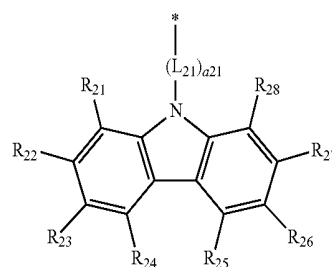
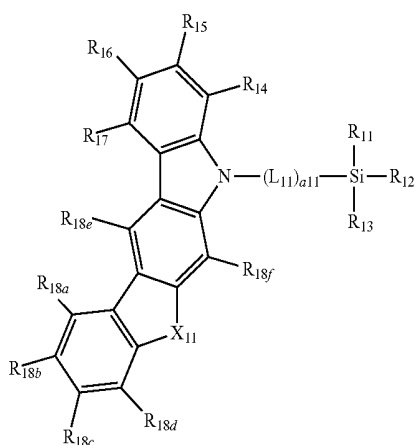
-continued



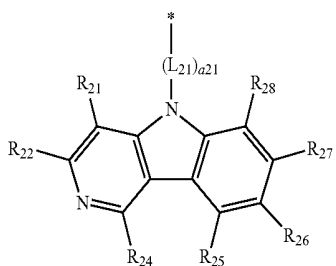
-continued



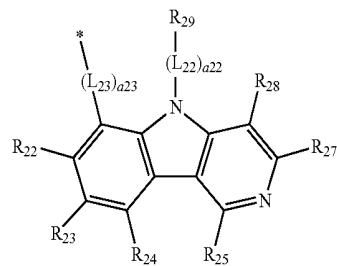
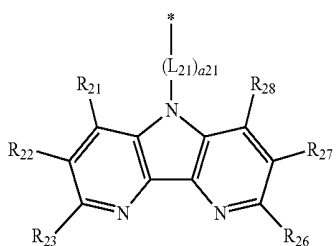
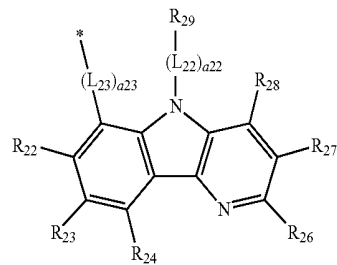
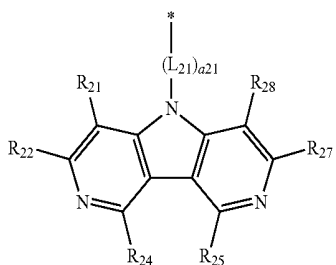
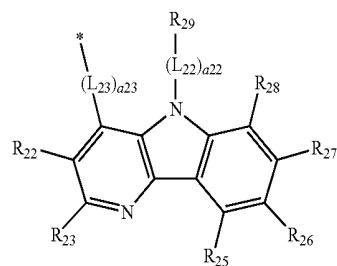
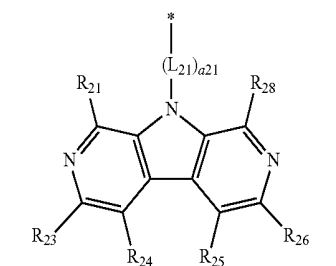
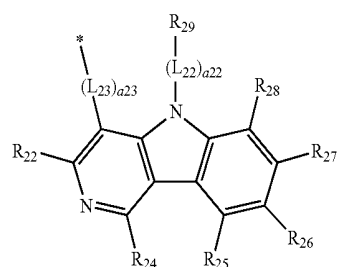
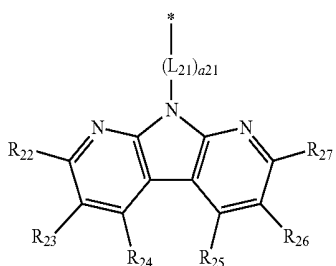
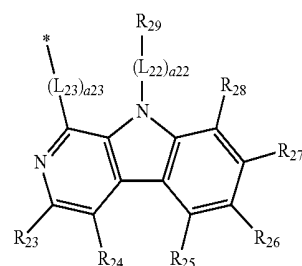
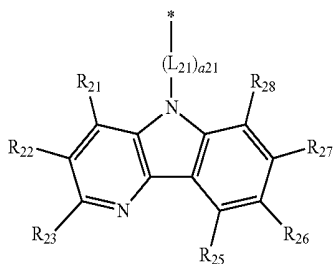
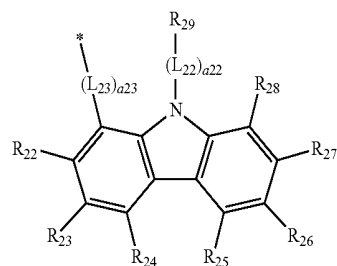
[0201] wherein, in Formulae 1-1 to 1-6,
 [0202] R_{11} to R_{13} may each independently be selected from groups represented by Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, 2-51 to 2-58, and 2-6, provided that at least one selected from R_{11} to R_{13} is selected from groups represented by Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, and 2-51 to 2-58,
 [0203] X_{11} may be selected from O, S, $N(R_{18g})$, and $C(R_{18g})(R_{18h})$,
 [0204] R_{11} to R_{17} , L_{11} , and a_{11} are the same as described above in connection with Formula 1, and
 [0205] R_{18a} to R_{18h} are each independently the same as described above in connection with R_{18} in Formula 1:



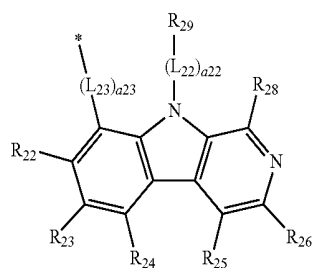
-continued



-continued

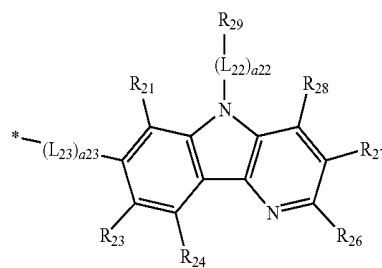


-continued

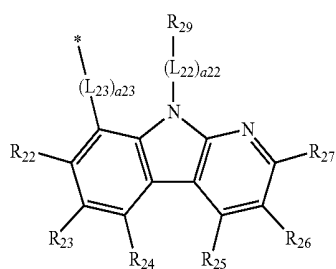


2-27

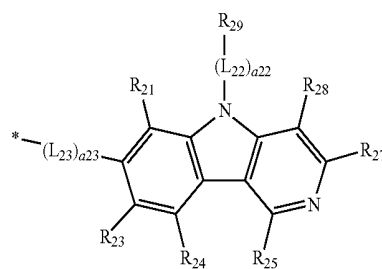
-continued



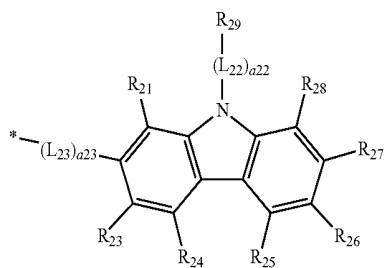
2-35



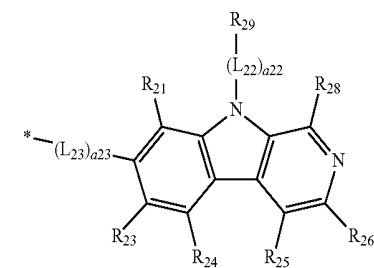
2-28



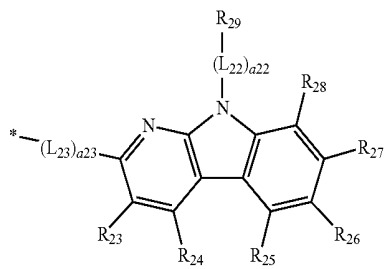
2-36



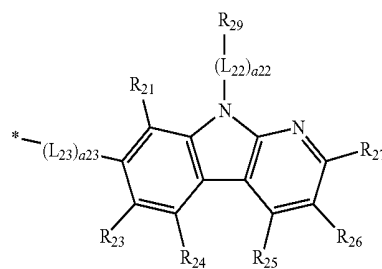
2-31



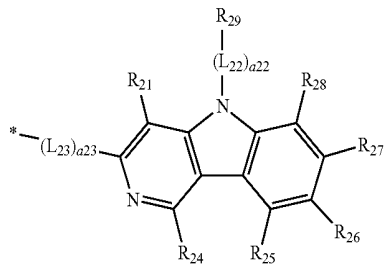
2-37



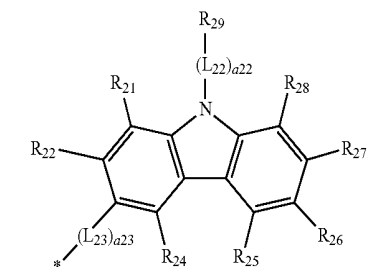
2-32



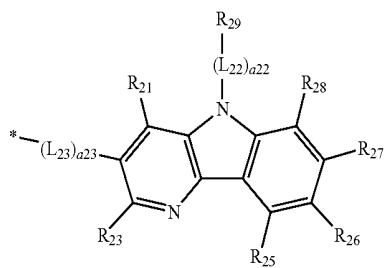
2-38



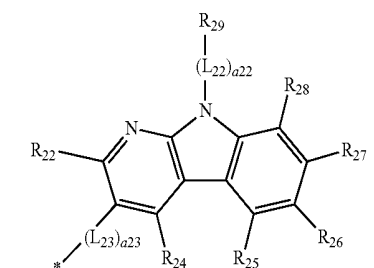
2-33



2-41

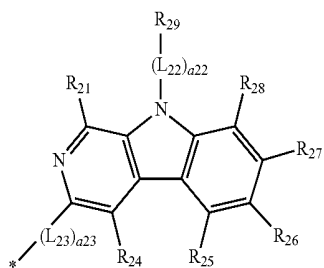


2-34

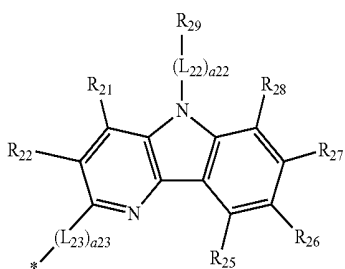


2-42

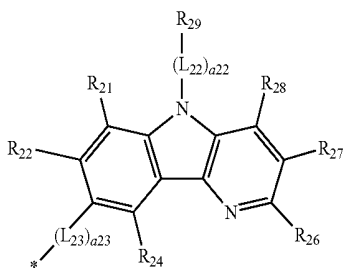
-continued



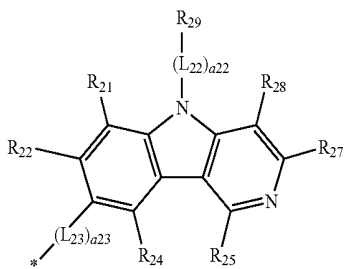
2-43



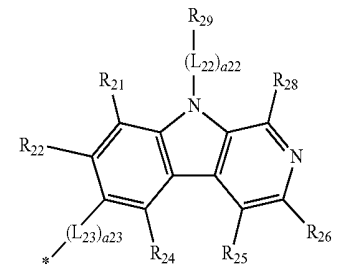
2-44



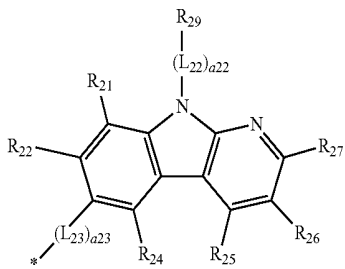
2-45



2-46

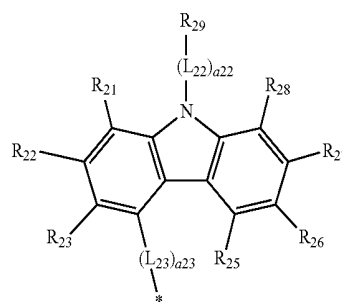


2-47

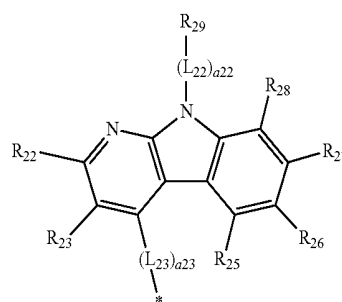


2-48

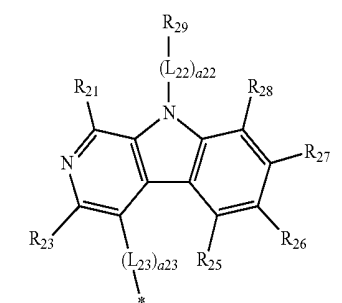
-continued



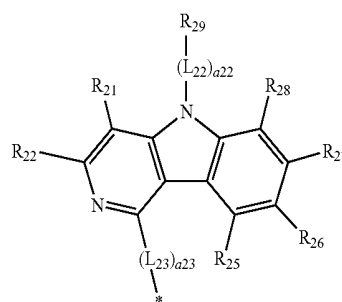
2-51



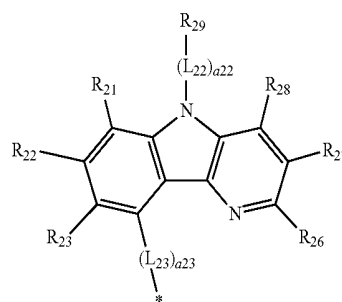
2-52



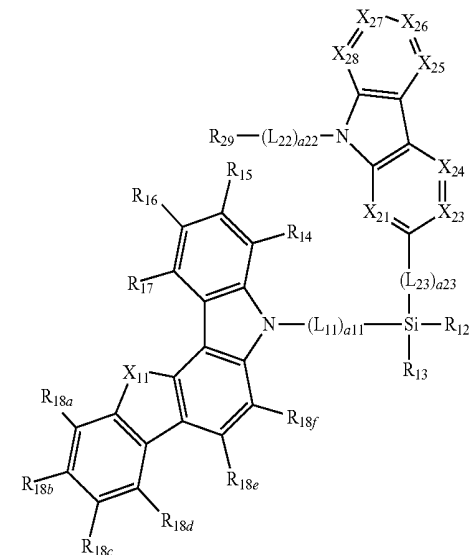
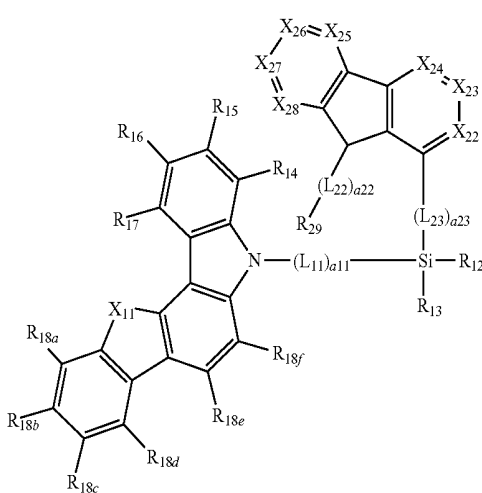
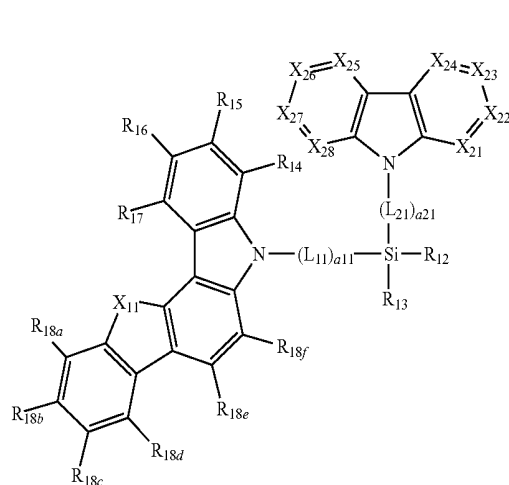
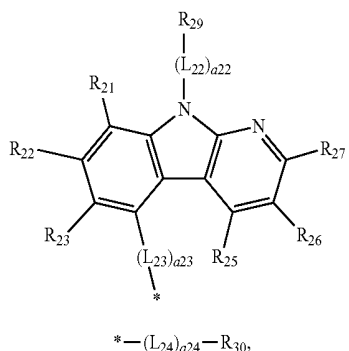
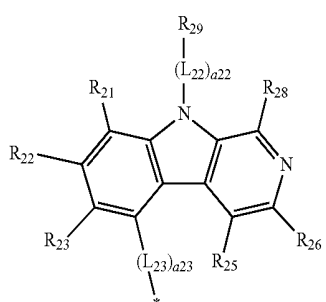
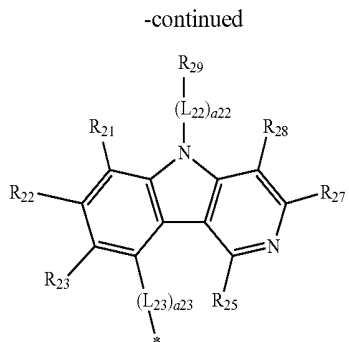
2-53



2-54



2-55



[0206] wherein, in Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, 2-51 to 2-58, and 2-6,

[0207] L_{21} to L_{24} , a_{21} to a_{24} , and R_{21} to R_{30} are the same as described above in connection with Formulae 2-1 to 2-6, and

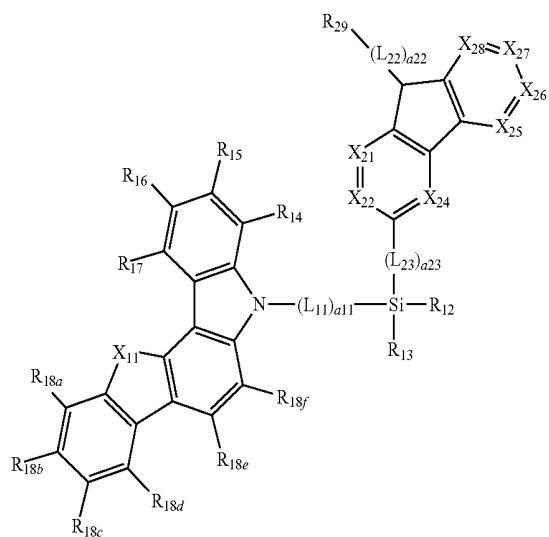
[0208] * indicates a binding site to a neighboring atom.

[0209] In one or more exemplary embodiments, R_{11} to R_{13} in Formulae 1-1 to 1-6 may each independently be selected from groups represented by Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, 2-51 to 2-58, and 2-6, provided that one or two of R_{11} to R_{13} are selected from groups represented by Formulae 2-11 to 2-19, 2-21 to 2-28, 2-31 to 2-38, 2-41 to 2-48, and 2-51 to 2-58, but exemplary embodiments of the present disclosure are not limited thereto.

[0210] In one or more exemplary embodiments, the silyl group-containing compound represented by Formula 1 may be represented by one of Formulae 1-11 to 1-40, but exemplary embodiments of the present disclosure are not limited thereto:

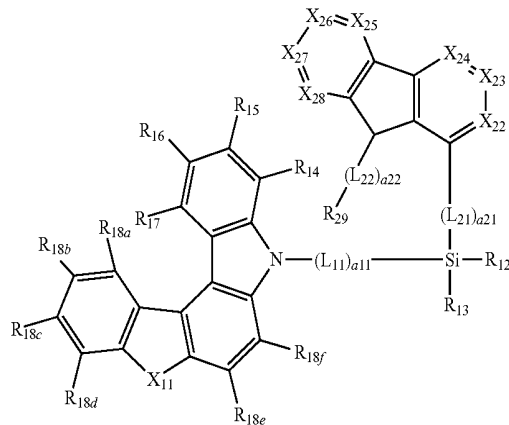
-continued

1-14



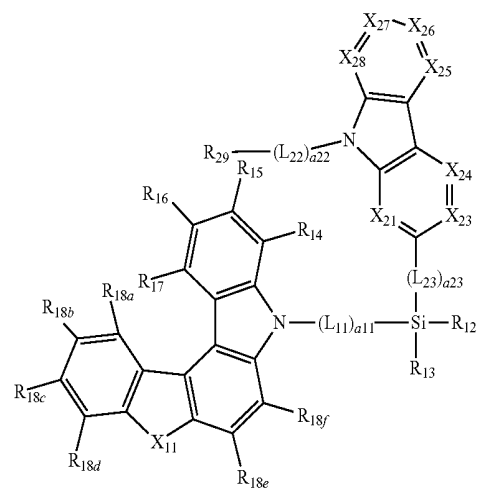
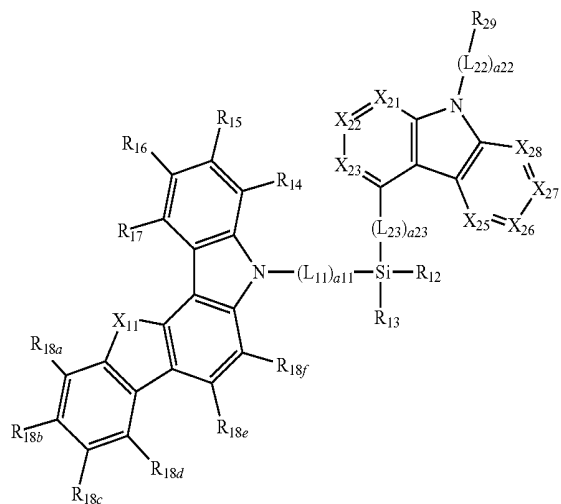
-continued

1-17



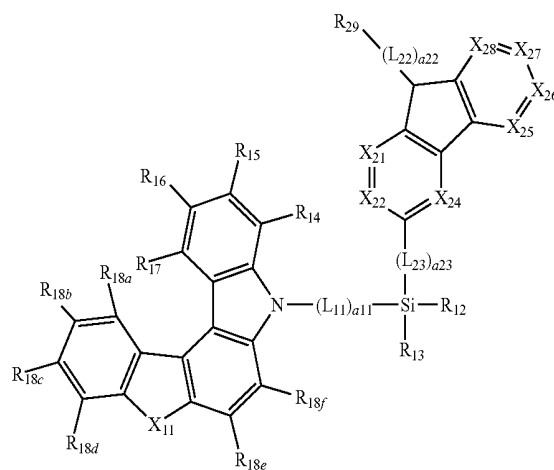
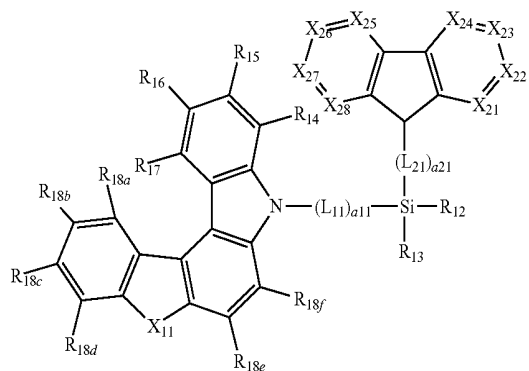
1-18

1-15



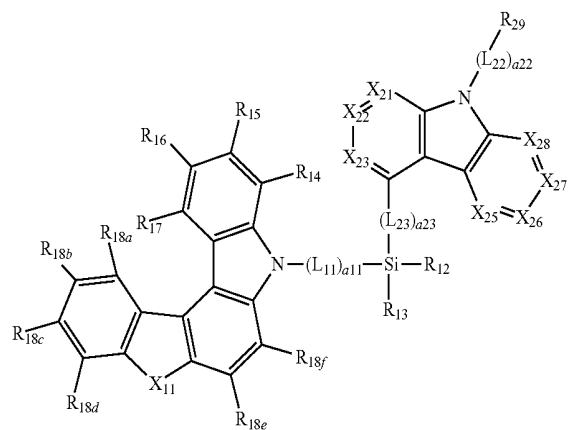
1-19

1-16



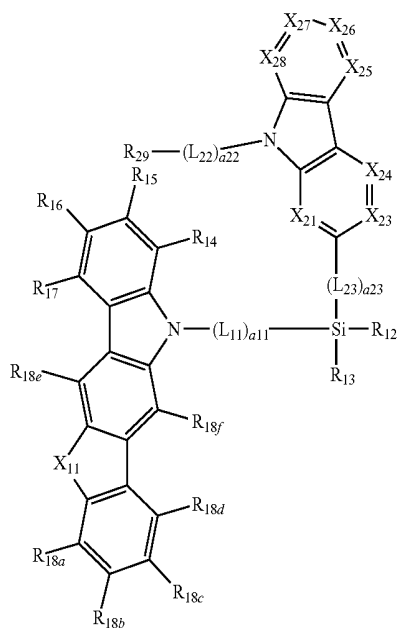
-continued

1-20

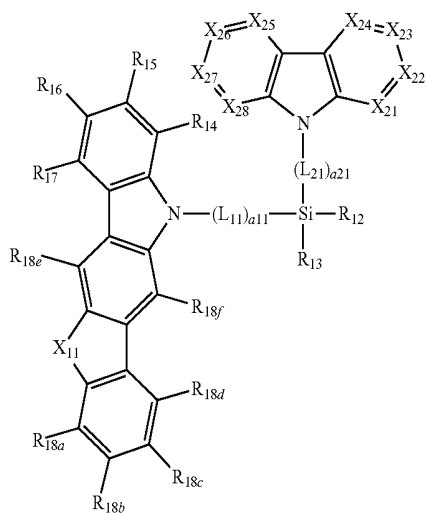


-continued

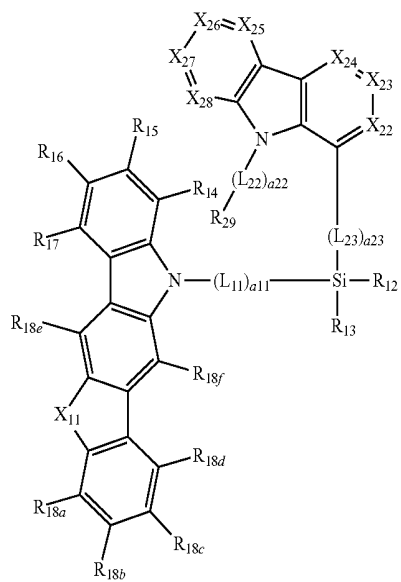
1-23



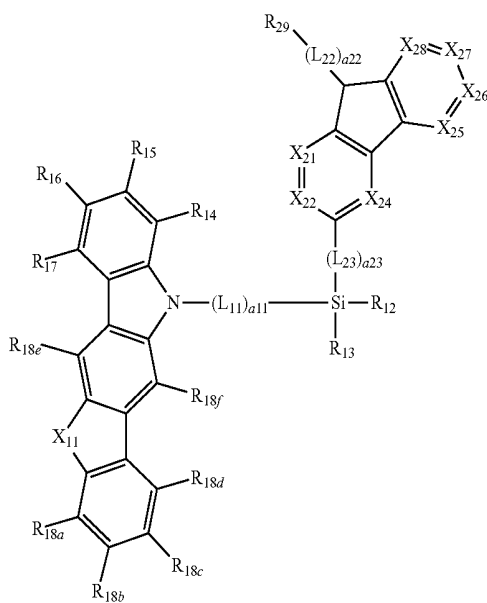
1-21



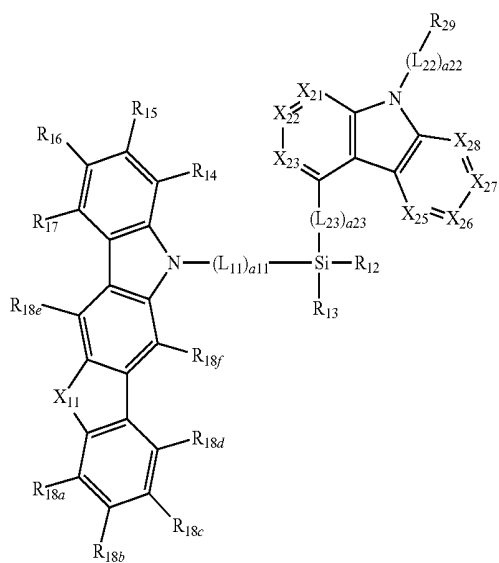
1-22



1-24

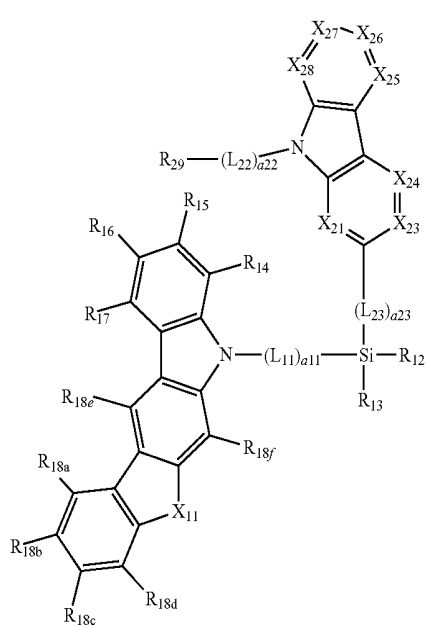


-continued



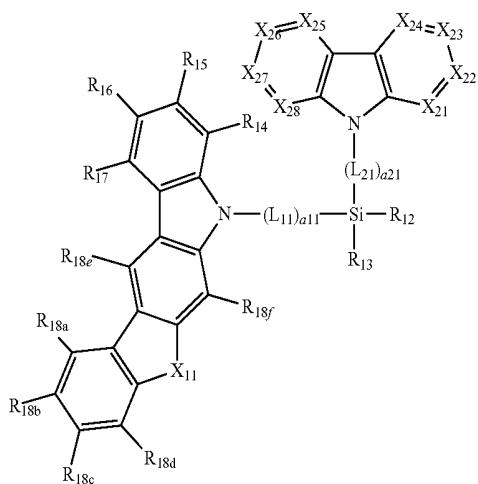
1-25

-continued



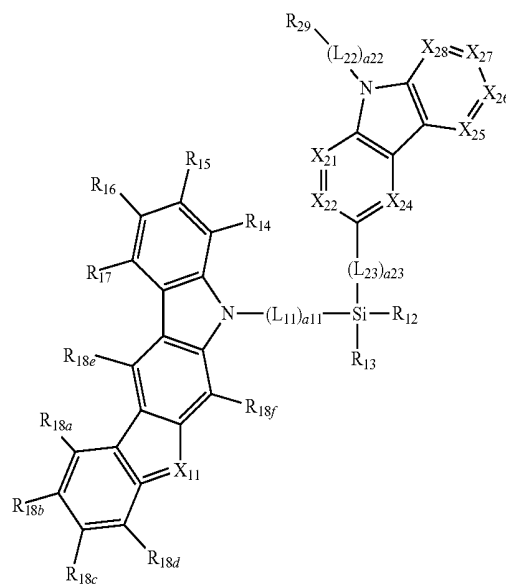
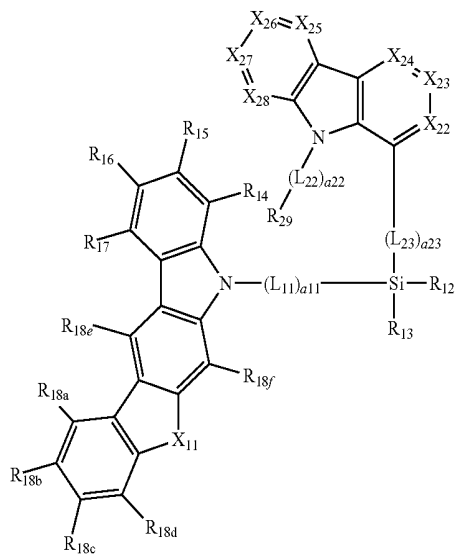
1-26

1-28



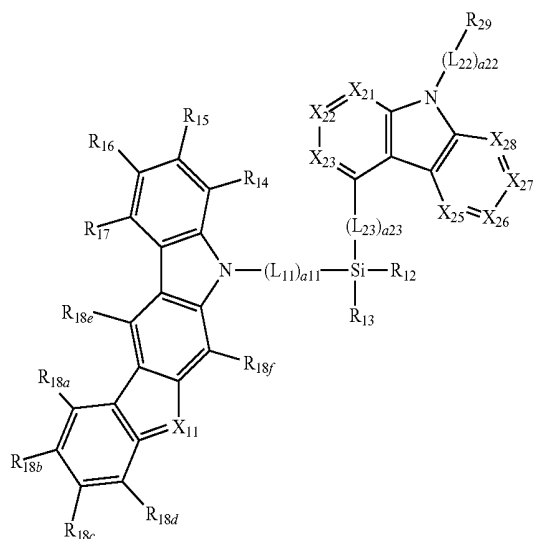
1-27

1-29



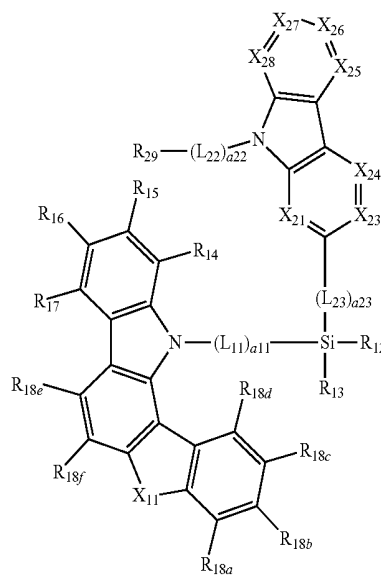
-continued

1-30



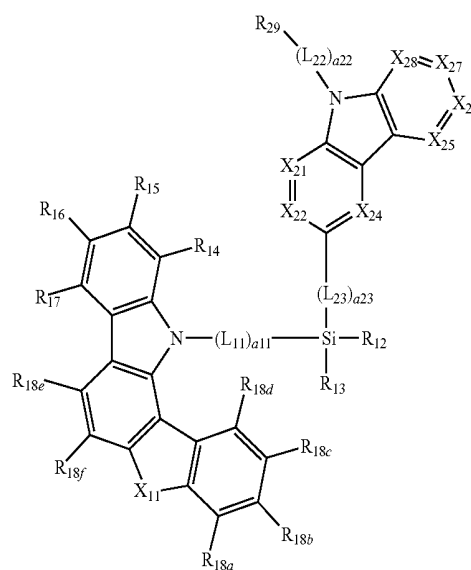
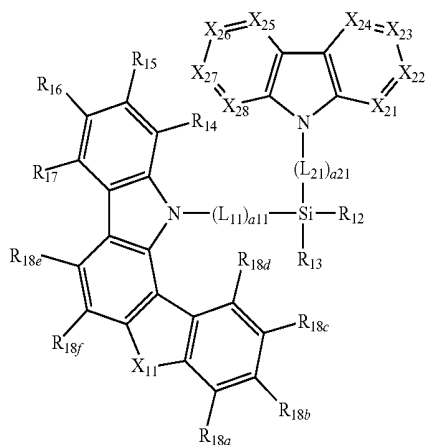
-continued

1-33



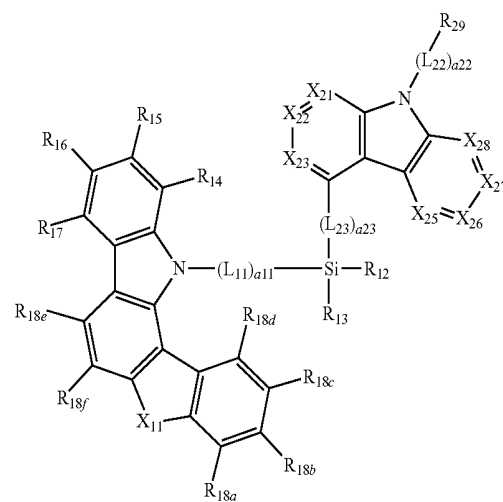
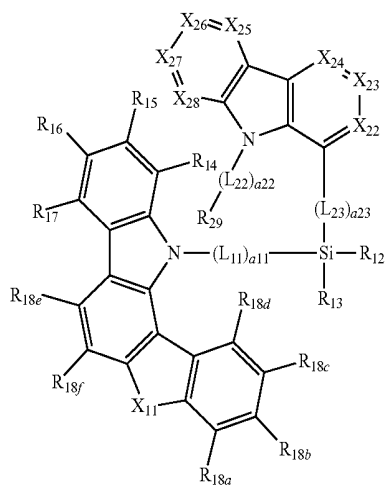
1-34

1-31

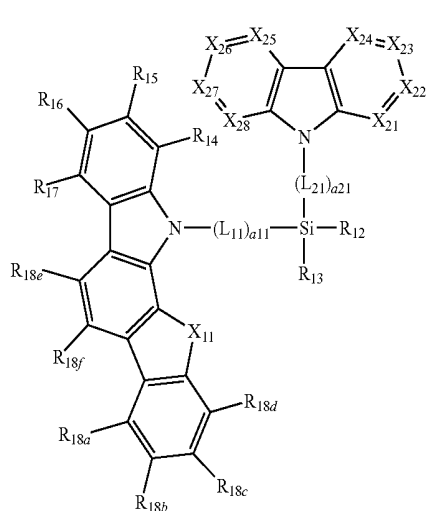


1-35

1-32

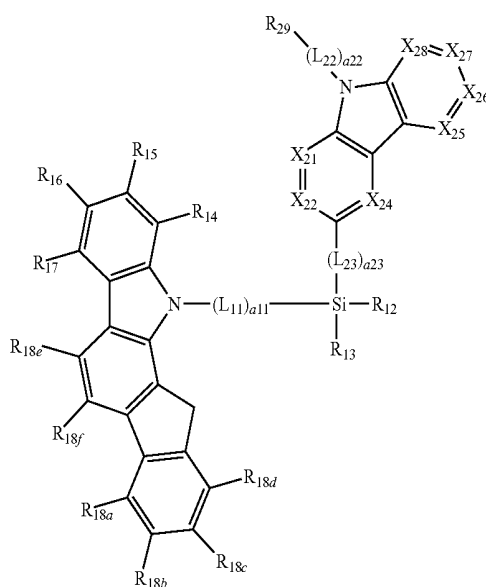


-continued



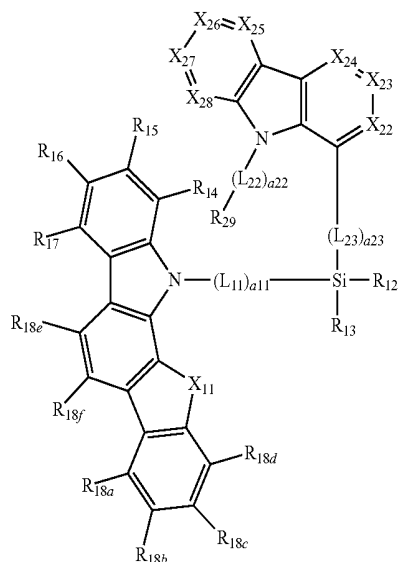
1-36

-continued



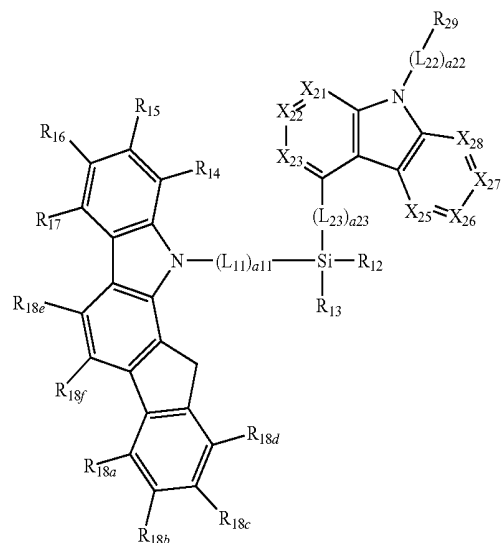
1-39

1-37



1-40

1-38



[0211] wherein, in Formulae 1-11 to 1-40,

[0212] X_{11} may be selected from O, S, $N(R_{18g})$, and $C(R_{18g})(R_{18h})$,

[0213] R_{12} to R_{17} , L_{11} , and a_{11} are the same as described above in connection with Formula 1,

[0214] X_{21} to X_{28} , L_{21} to L_{23} , a_{21} to a_{23} , and R_{29} are the same as described above in connection with Formulae 2-1 to 2-6, and

[0215] R_{18a} to R_{18h} are each independently the same as described above in connection with R_{18} in Formula 1.

[0216] In one or more exemplary embodiments, in Formulae 1-11 to 1-40, $R_{12} = R_{13}$ or $R_{12} \neq R_{13}$, but exemplary embodiments of the present disclosure are not limited thereto.

[0217] In one or more exemplary embodiments, in Formulae 1-11, 1-16, 1-21, 1-26, 1-31, and 1-36, for example, in Formula 2-1, X_{21} may be CR_{21} , X_{22} may be CR_{22} , X_{23} may be CR_{23} , X_{24} may be CR_{24} , X_{25} may be CR_{25} , X_{28} may be CR_{26} , X_{27} may be CR_{27} , and X_{28} may be CR_{28} ;

[0258] X₂₁ may be CR₂₁, X₂₃ may be CR₂₃, X₂₄ may be CR₂₄, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈;

[0259] X₂₁ may be CR₂₁, X₂₃ may be CR₂₃, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be N, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0260] X₂₁ may be N, X₂₃ may be CR₂₃, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0261] X₂₁ may be CR₂₁, X₂₃ may be N, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be N, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈; or

[0262] X₂₁ may be CR₂₁, X₂₃ may be CR₂₃, X₂₄ may be N, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈; but exemplary embodiments of the present disclosure are not limited thereto.

[0263] In one or more exemplary embodiments, in Formulae 1-14, 1-19, 1-24, 1-29, 1-34, and 1-39, X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0264] X₂₁ may be N, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0265] X₂₁ may be CR₂₁, X₂₂ may be N, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0266] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be N, X₂₅ may be CR₂₈, X₂₈ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0267] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be N, X₂₈ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0268] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₅ may be N, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0269] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₅ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈;

[0270] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₅ may be CR₂₈, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0271] X₂₁ may be CR₂₁, X₂₂ may be N, X₂₄ may be N, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0272] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈;

[0273] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be N, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0274] X₂₁ may be N, X₂₂ may be CR₂₂, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0275] X₂₁ may be CR₂₁, X₂₂ may be N, X₂₄ may be CR₂₄, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈; or

[0276] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₄ may be N, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈; but exemplary embodiments of the present disclosure are not limited thereto.

[0277] In one or more exemplary embodiments, in Formulae 1-15, 1-20, 1-25, 1-30, 1-35, and 1-40, X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅;

[0278] X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0279] X₂₁ may be N, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0280] X₂₁ may be CR₂₁, X₂₂ may be N, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₆ may be CR₂₈, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0281] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be N, X₂₅ may be CR₂₅, X₂₆ may be CR₂₈, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0282] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0283] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₆ may be N, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0284] X₂₁ may be CR₂₁, X₂₇ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₈ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈;

[0285] X₂₁ may be CR₂₁, X₂₇ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₈ may be CR₂₈, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0286] X₂₁ may be N, X₂₂ may be CR₂₂, X₂₃ may be N, X₂₅ may be CR₂₅, X₂₈ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈;

[0287] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be N, X₂₆ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈;

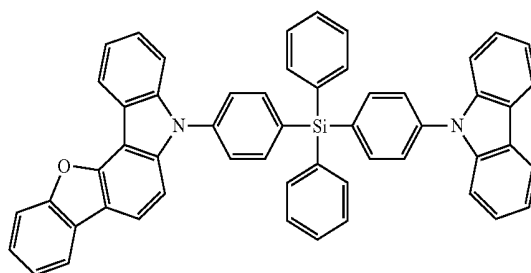
[0288] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₈ may be N, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0289] X₂₁ may be N, X₂₂ may be CR₂₂, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be CR₂₇, and X₂₈ may be N;

[0290] X₂₁ may be CR₂₁, X₂₂ may be N, X₂₃ may be CR₂₃, X₂₅ may be CR₂₅, X₂₆ may be CR₂₆, X₂₇ may be N, and X₂₈ may be CR₂₈; or

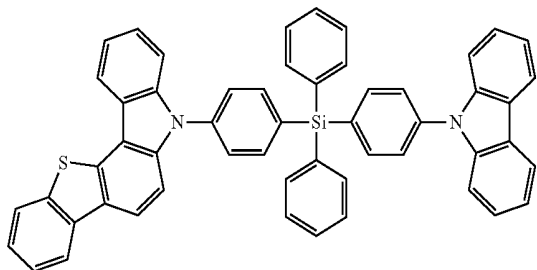
[0291] X₂₁ may be CR₂₁, X₂₂ may be CR₂₂, X₂₃ may be N, X₂₈ may be CR₂₅, X₂₆ may be N, X₂₇ may be CR₂₇, and X₂₈ may be CR₂₈; but exemplary embodiments of the present disclosure are not limited thereto.

[0292] The silyl group-containing compound represented by Formula 1 may be selected from Compounds 1 to 432, but exemplary embodiments of the present disclosure are not limited thereto:

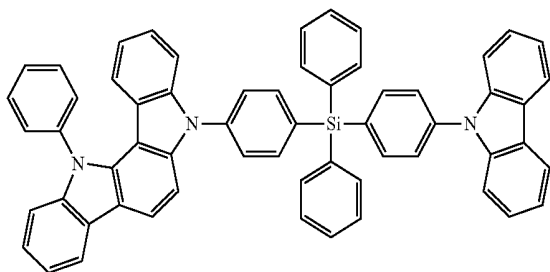


-continued

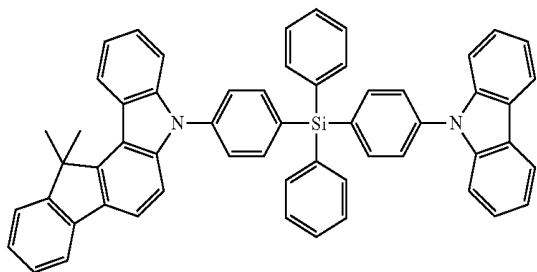
2



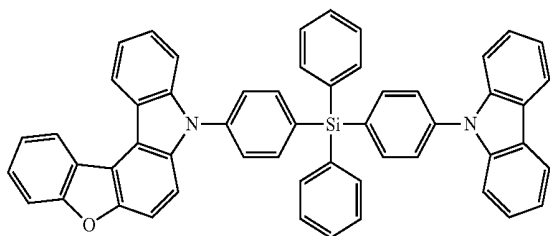
3



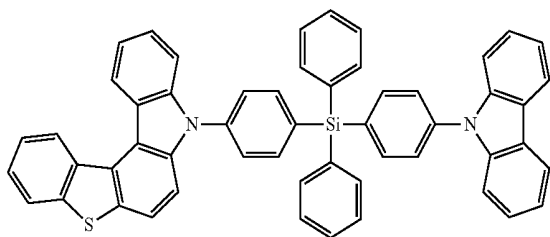
4



5

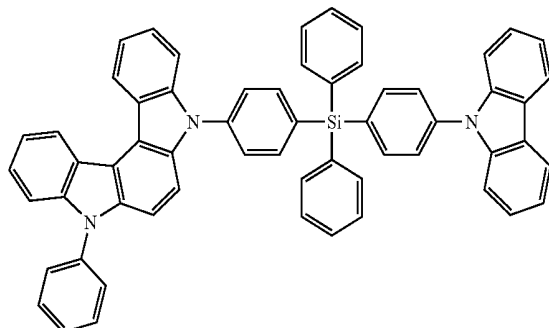


6

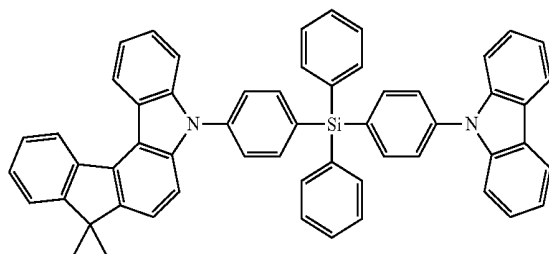


-continued

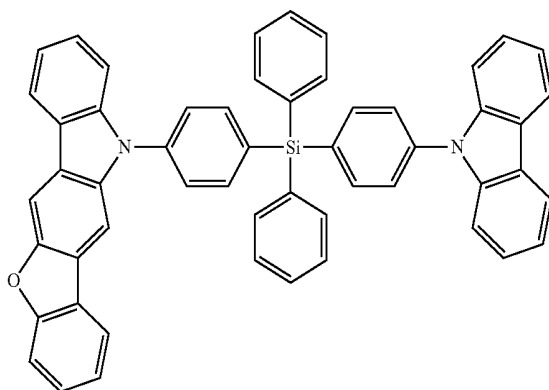
7



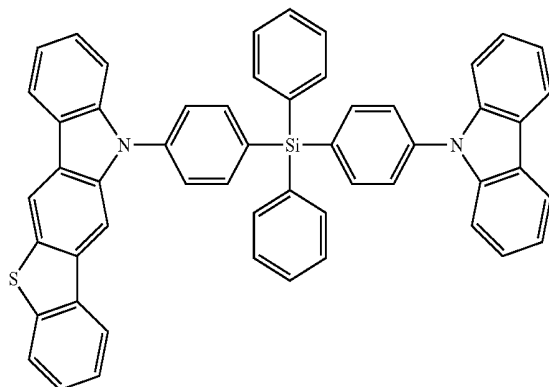
8



9

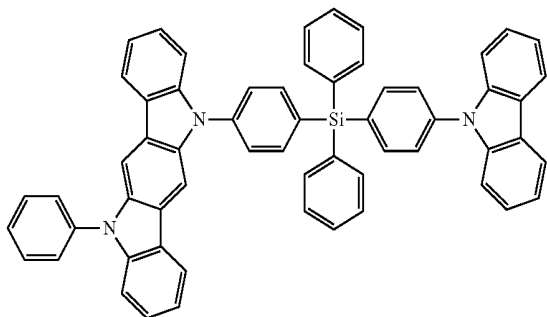


10



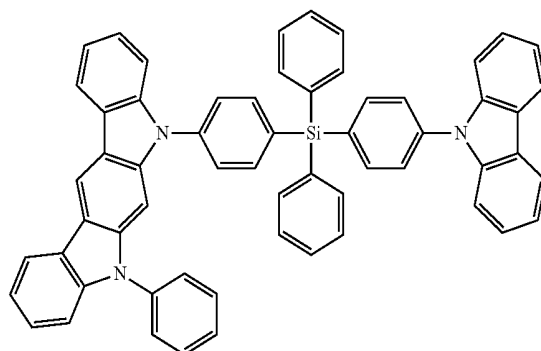
-continued

11

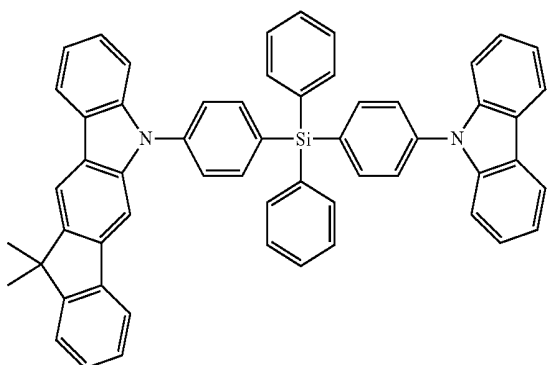


-continued

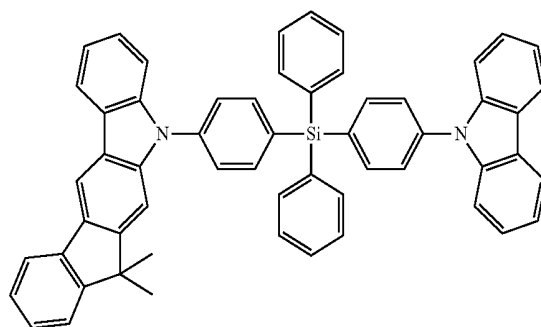
15



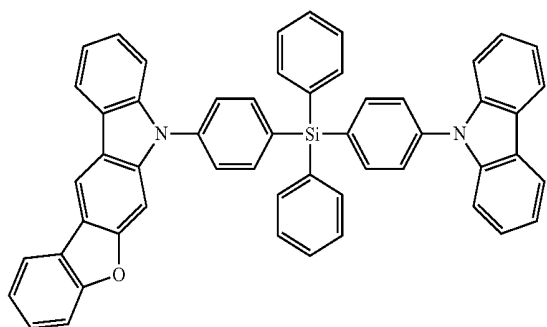
12



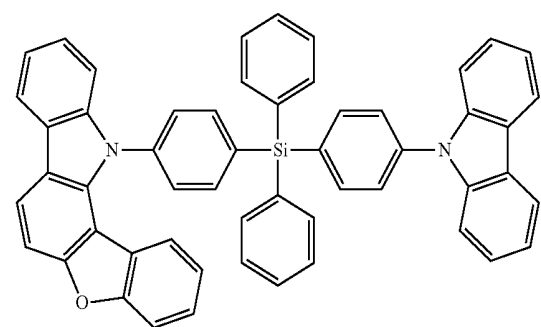
16



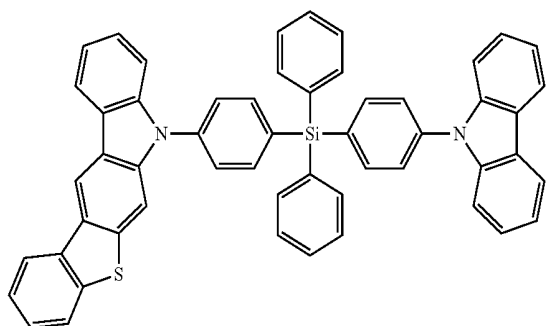
13



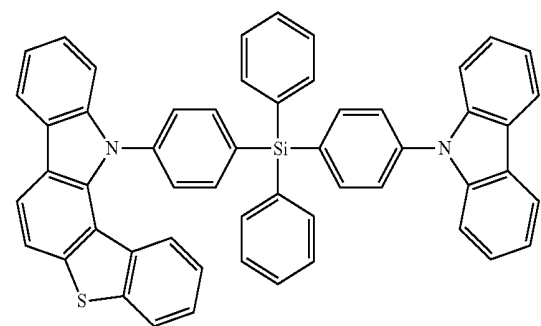
17



14

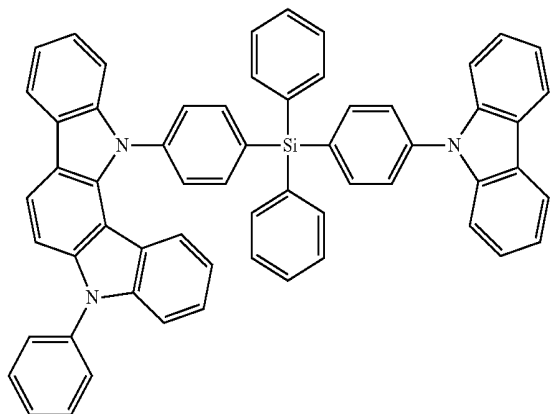


18

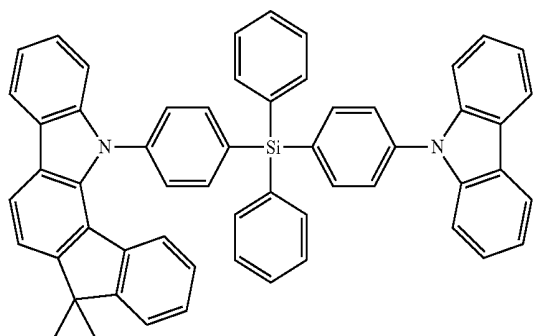


-continued

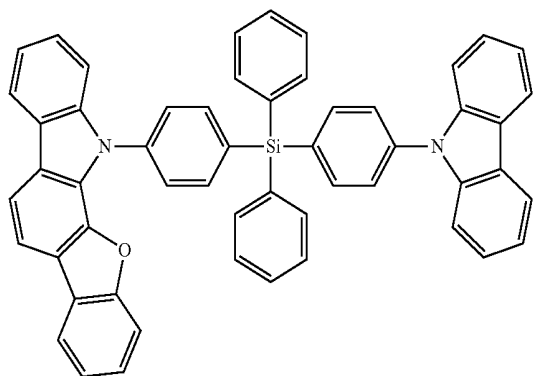
19



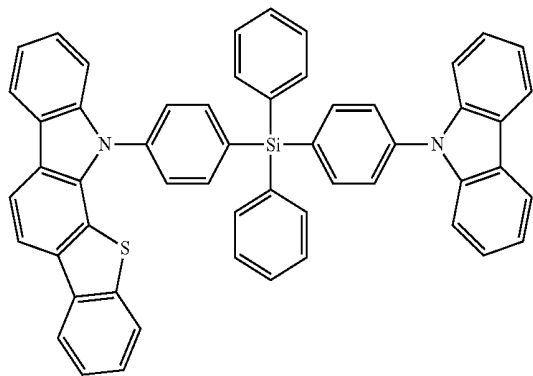
20



21

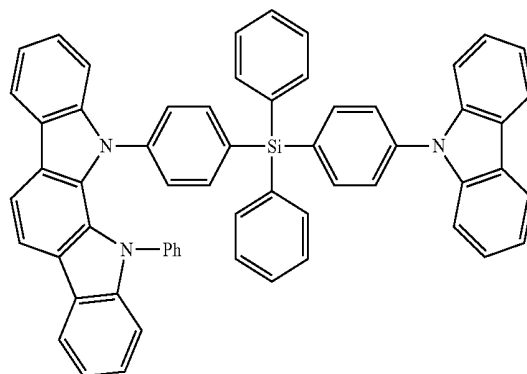


22

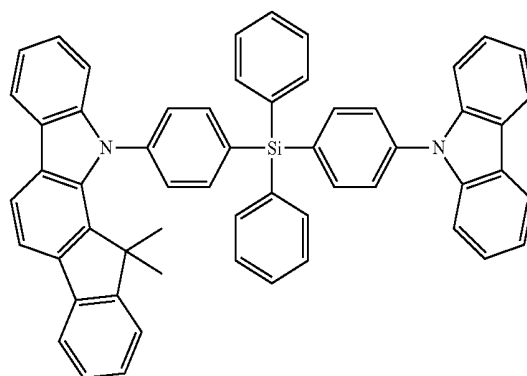


-continued

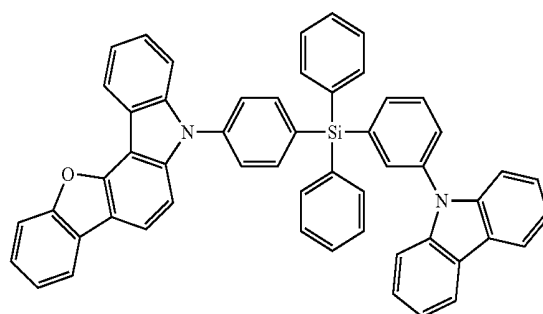
23



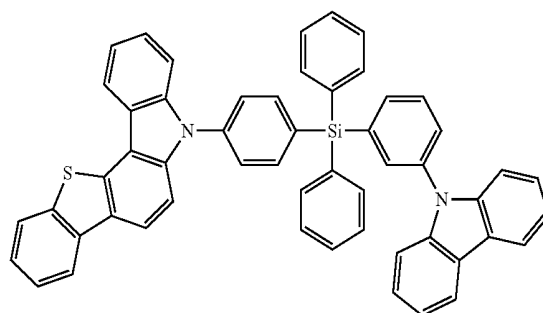
24



25

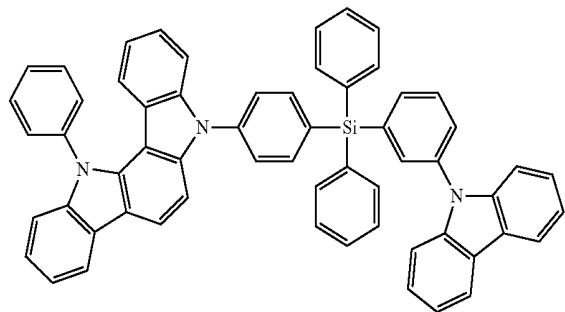


26



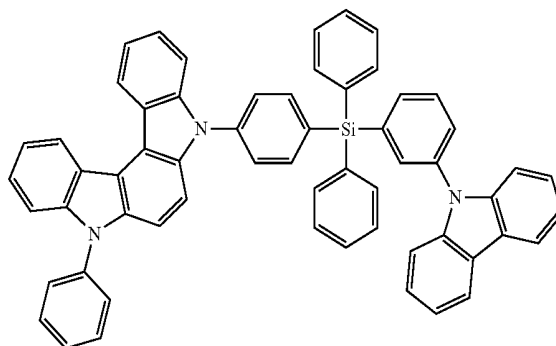
-continued

27

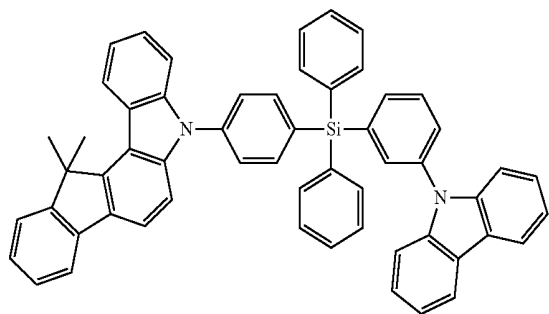


-continued

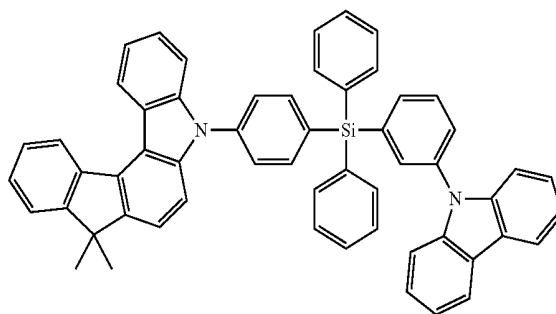
31



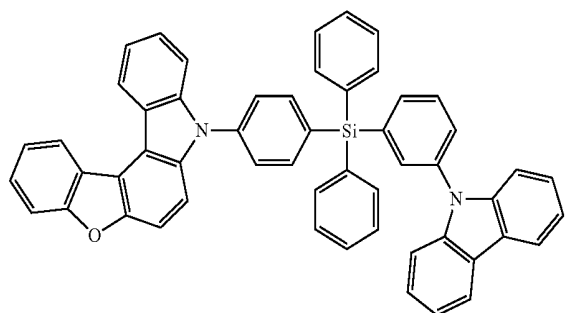
28



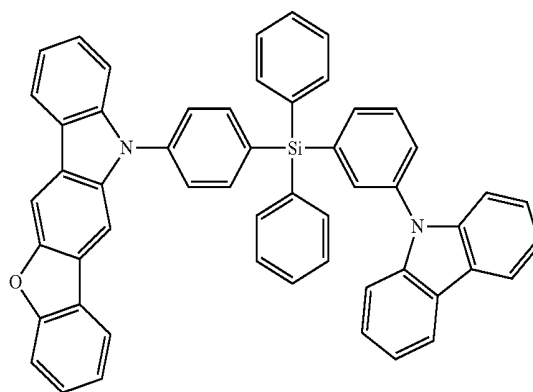
32



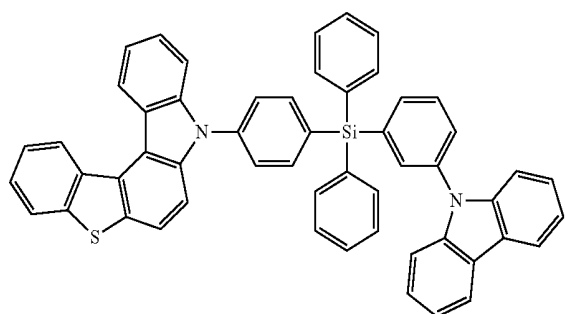
29



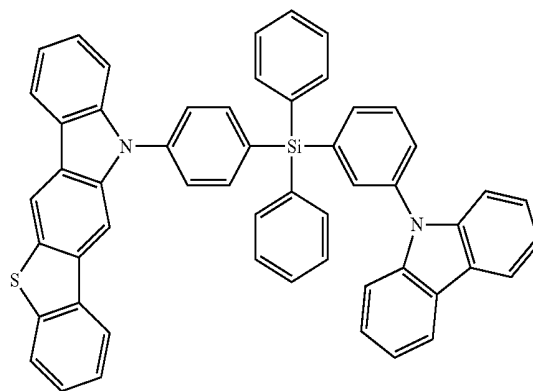
33



30

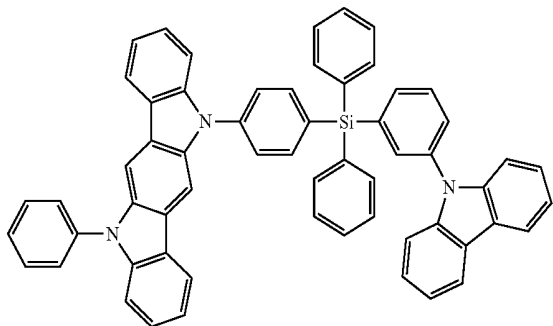


34

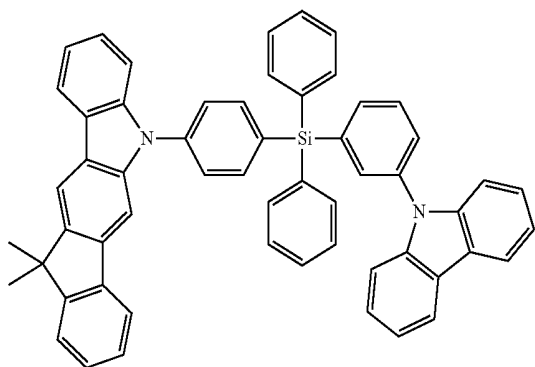


-continued

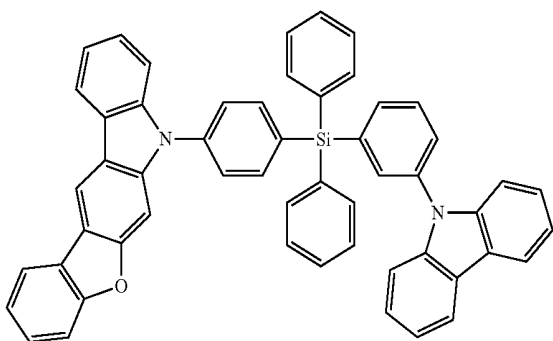
35



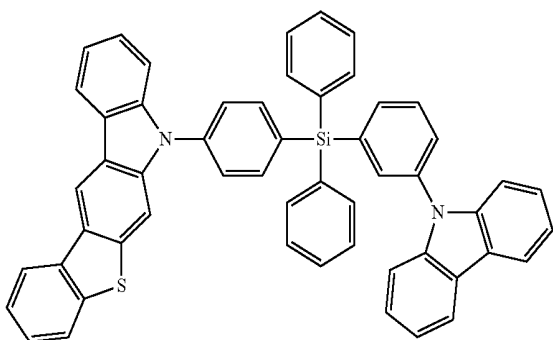
36



37

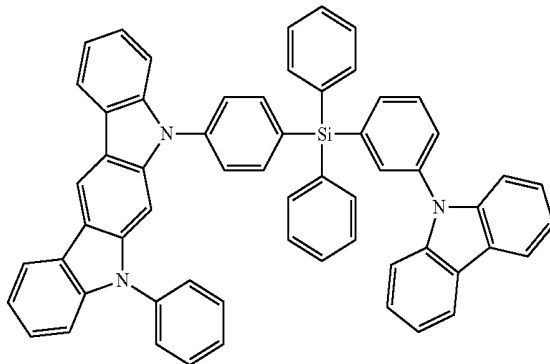


38

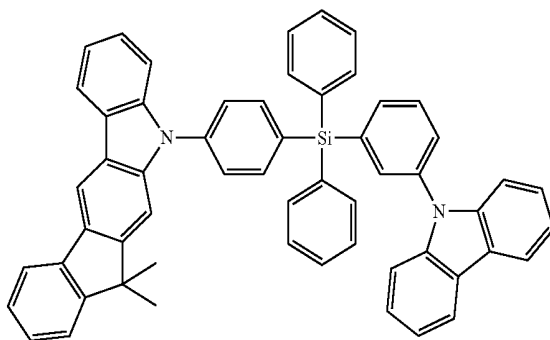


-continued

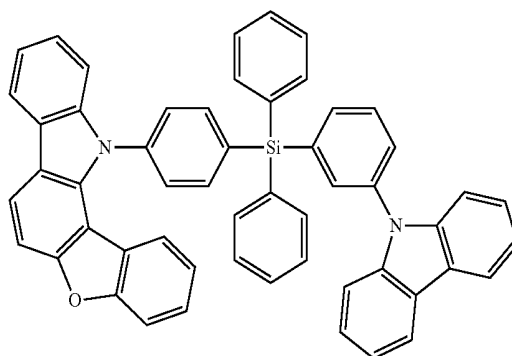
39



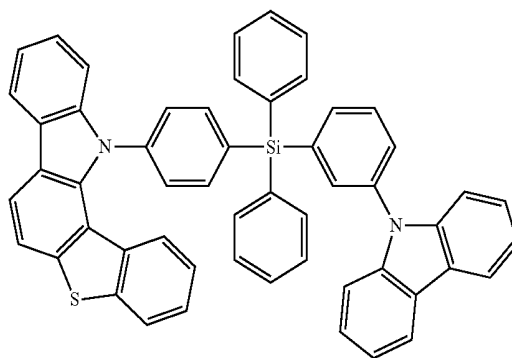
40



41

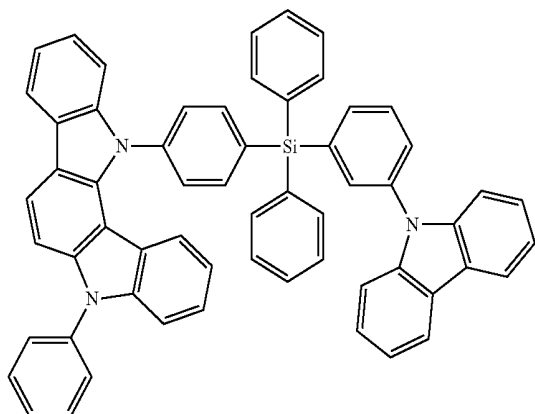


42



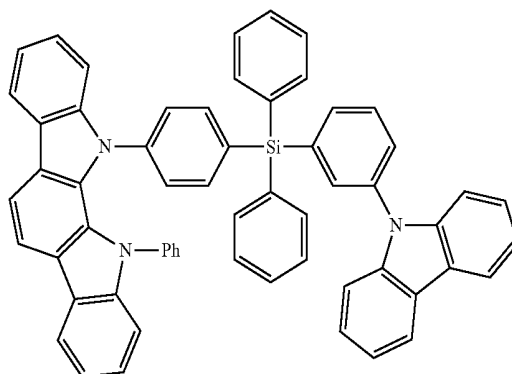
-continued

43

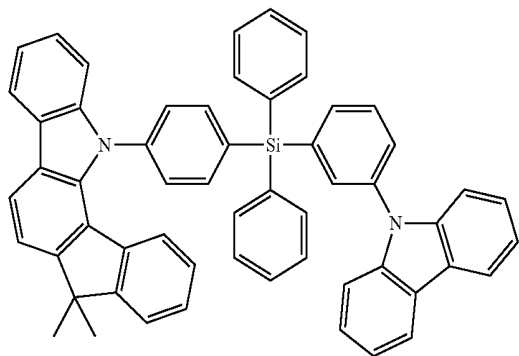


-continued

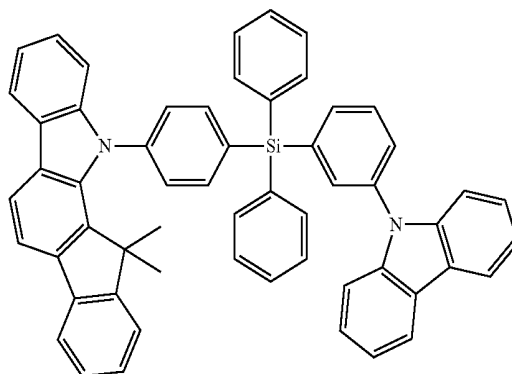
47



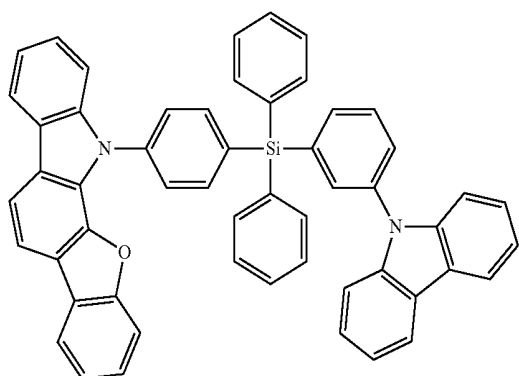
44



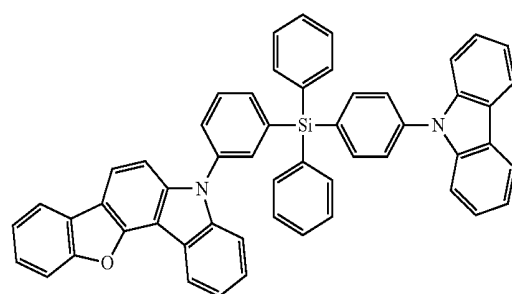
48



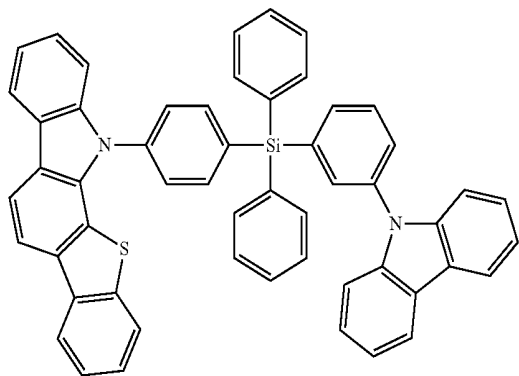
45



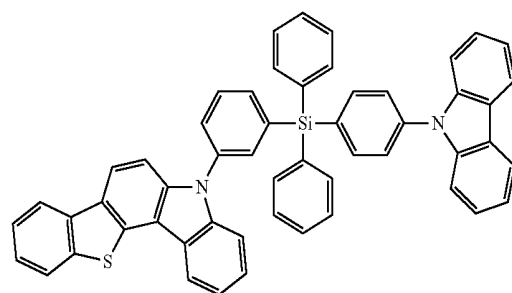
49



46

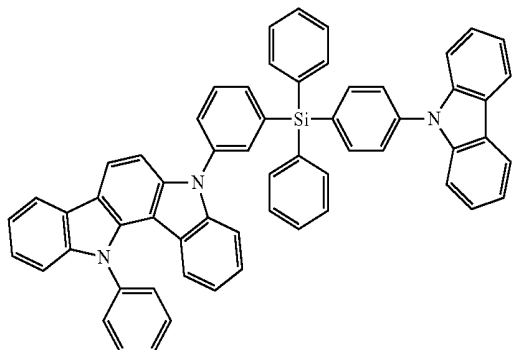


50



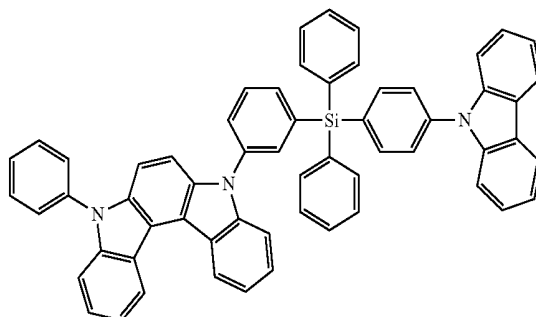
-continued

51

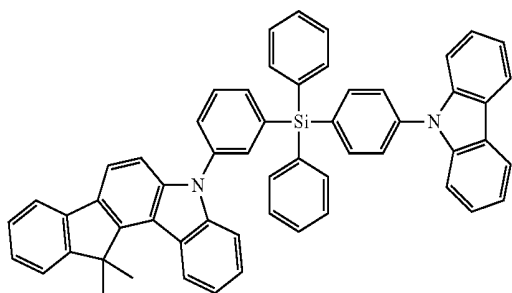


-continued

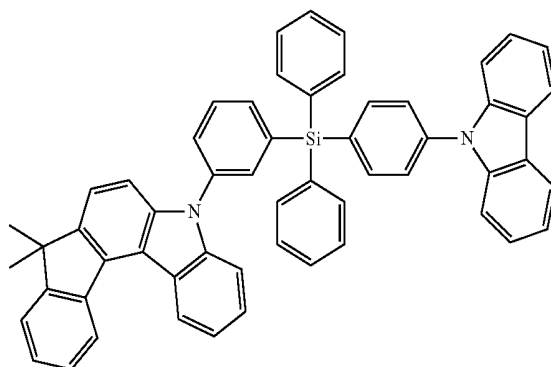
55



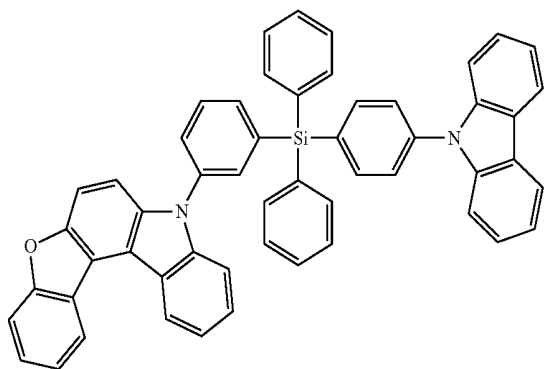
52



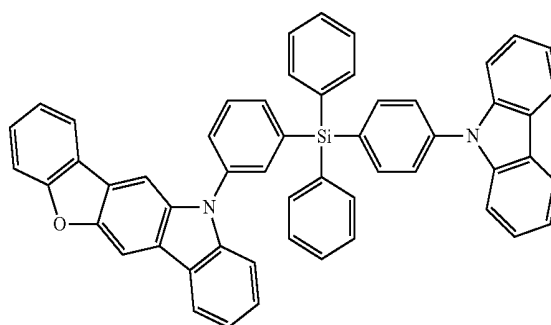
56



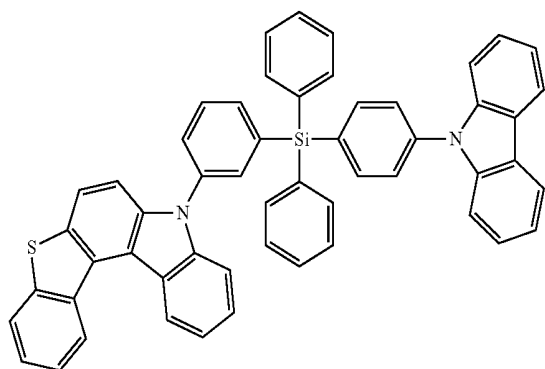
53



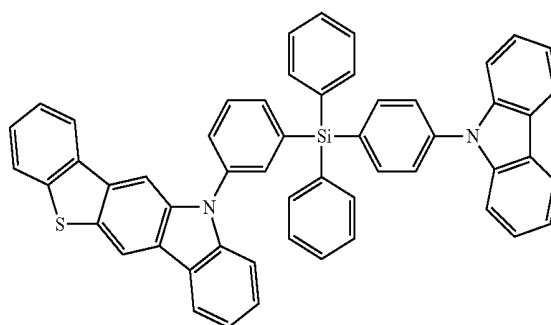
57



54

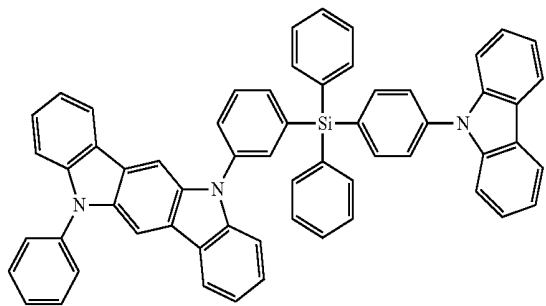


58

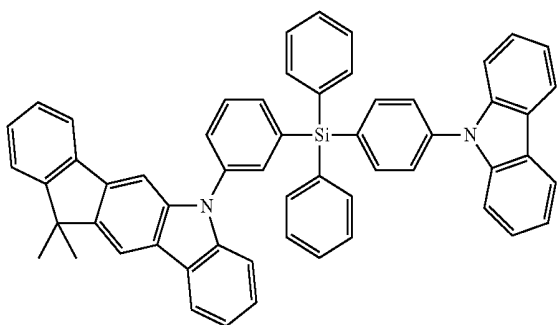


-continued

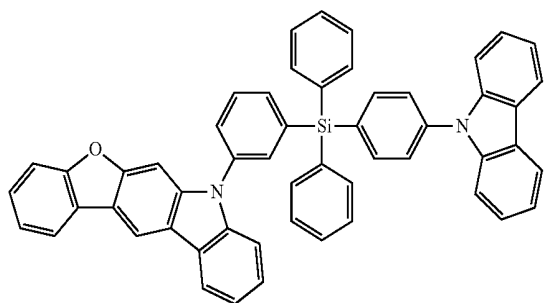
59



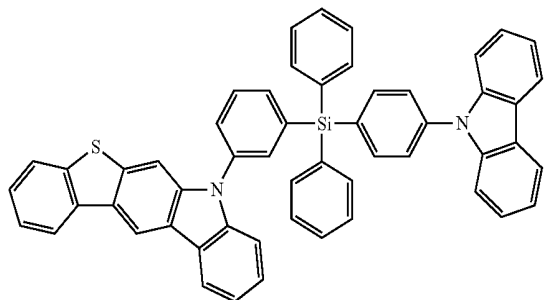
60



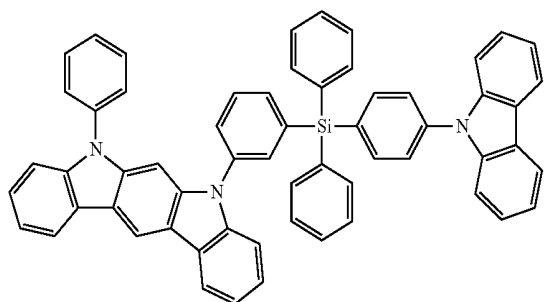
61



62

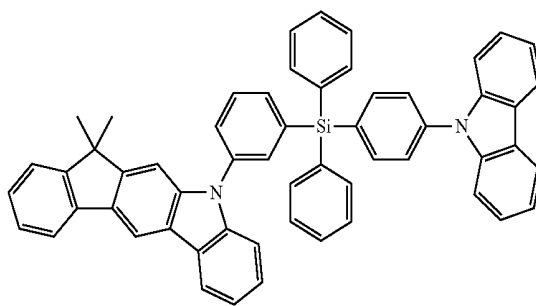


63

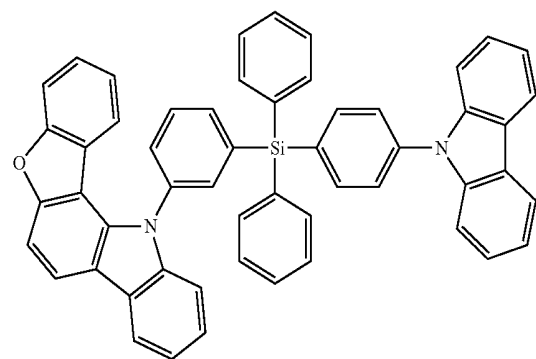


-continued

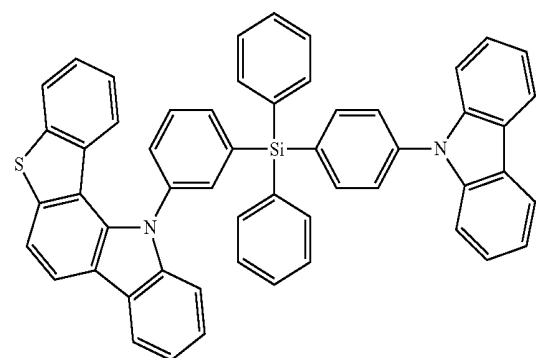
64



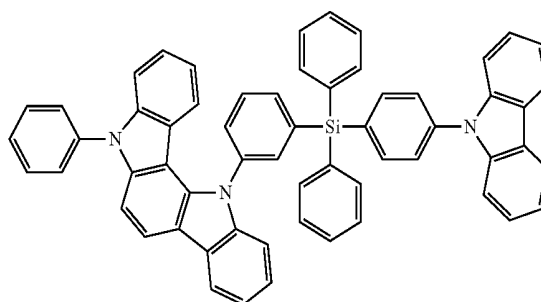
65



66

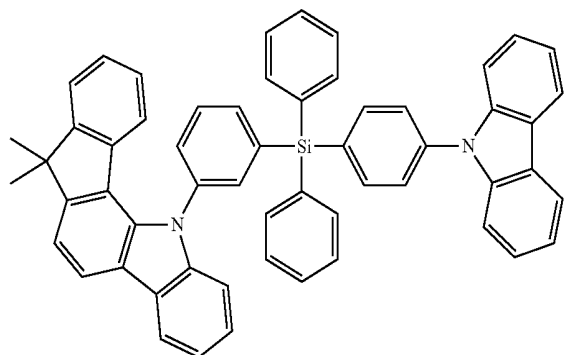


67



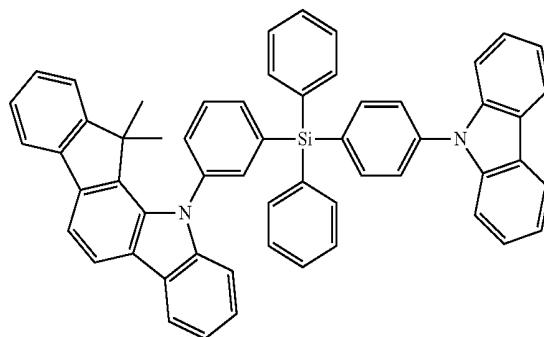
-continued

68

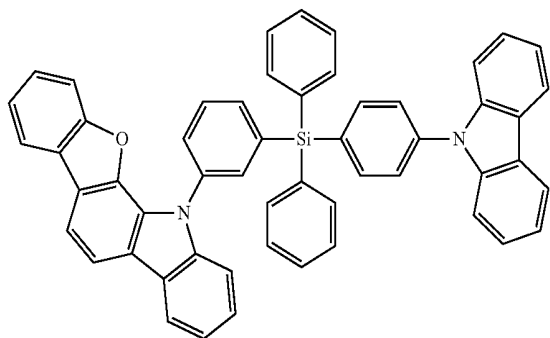


-continued

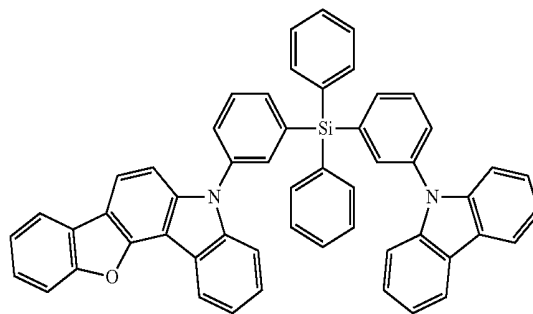
72



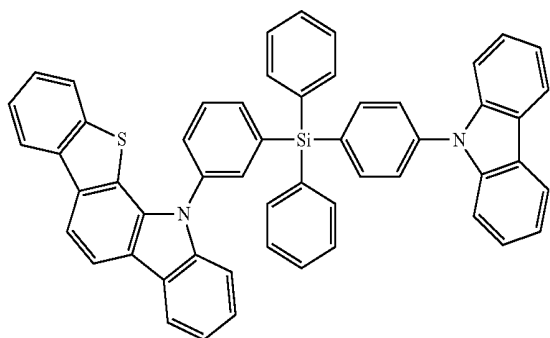
69



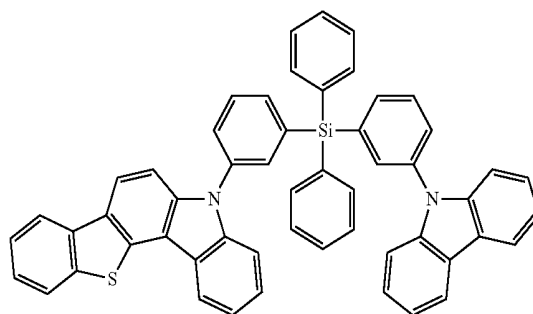
73



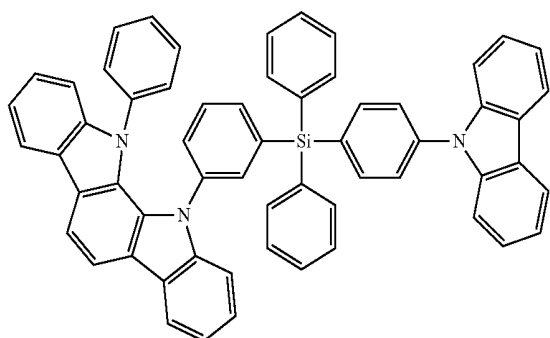
70



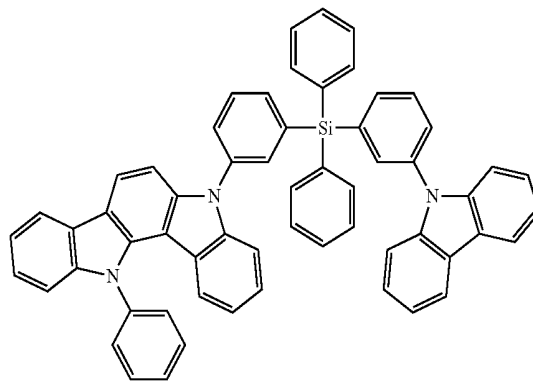
74



71

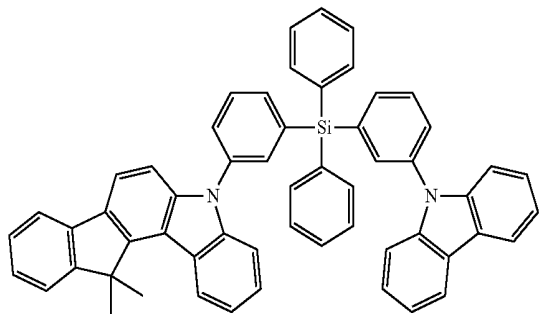


75

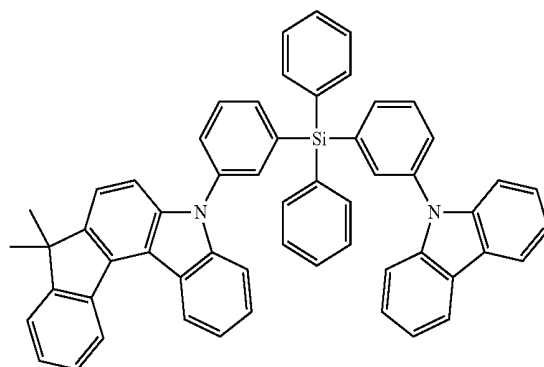


-continued

76



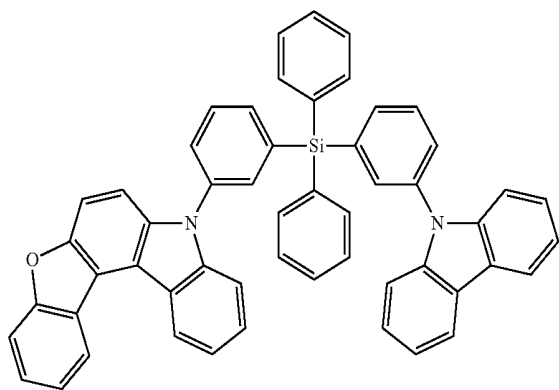
77



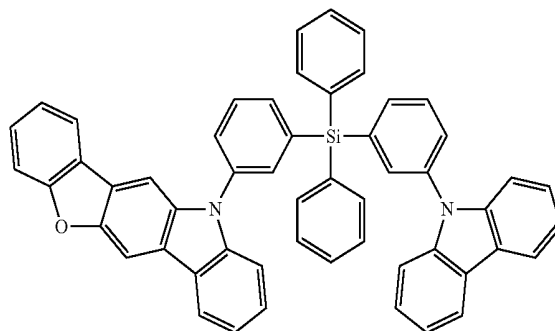
80

-continued

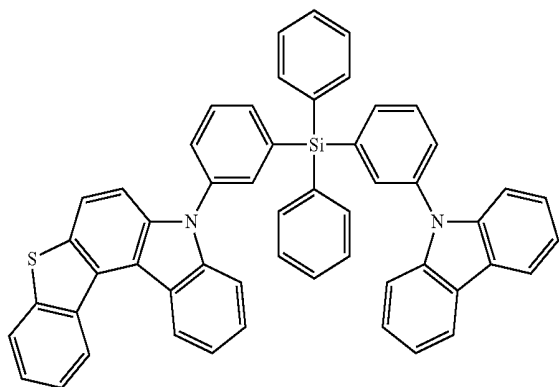
81



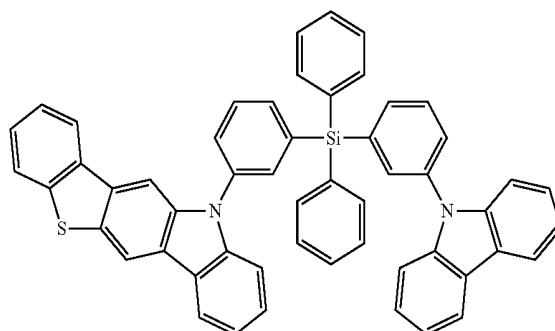
78



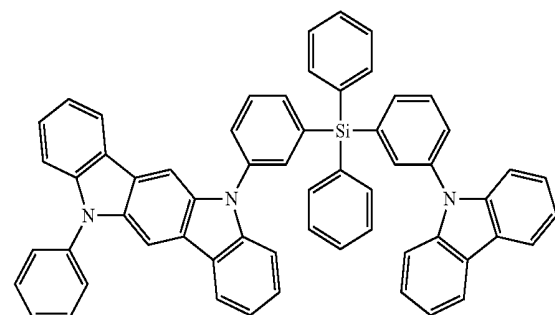
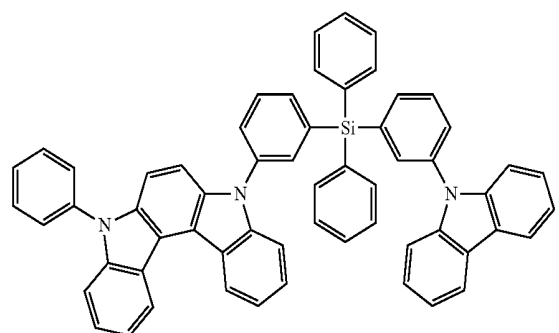
82



79

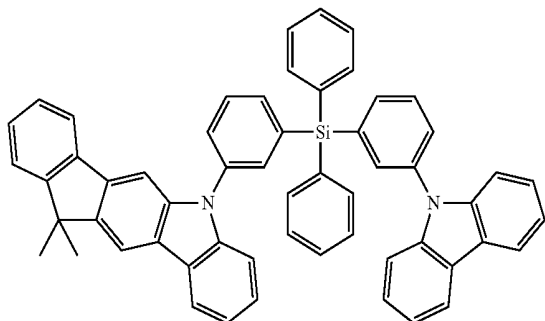


83



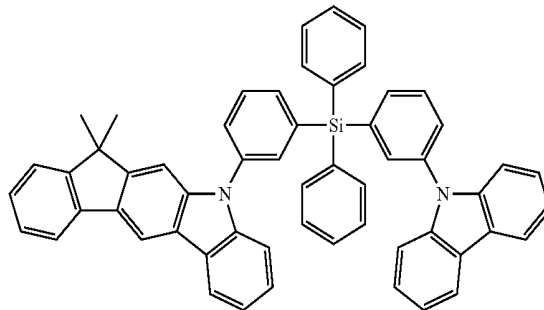
-continued

84

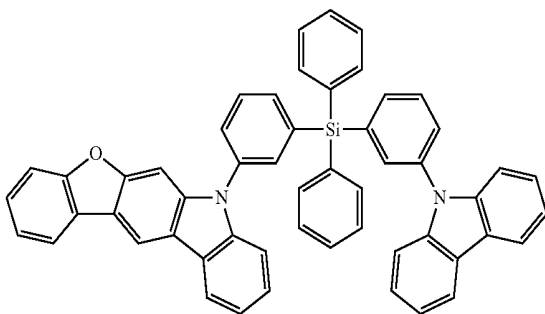


-continued

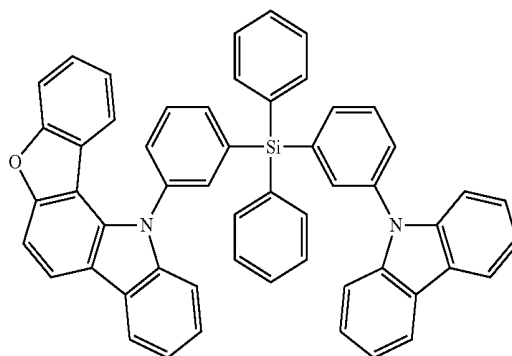
88



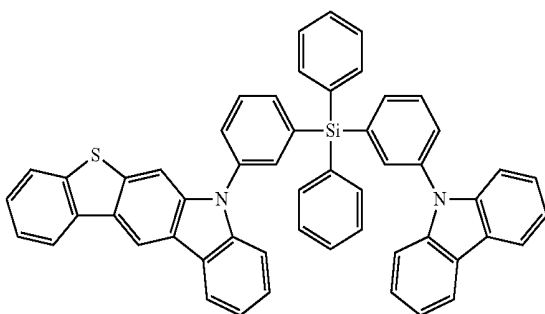
85



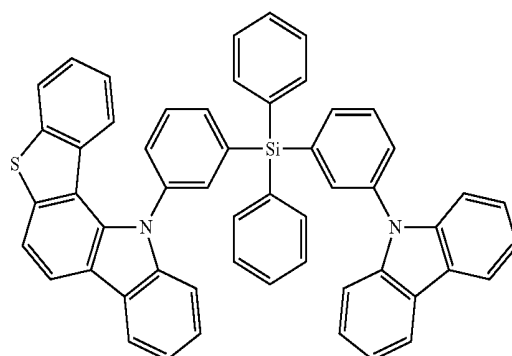
89



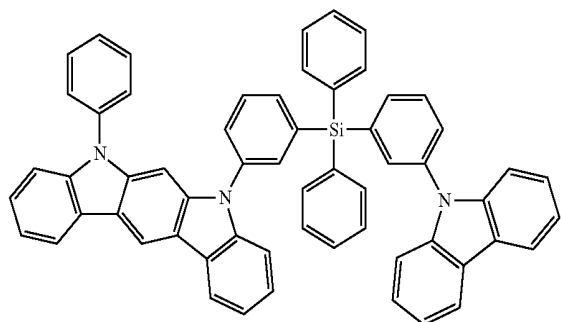
86



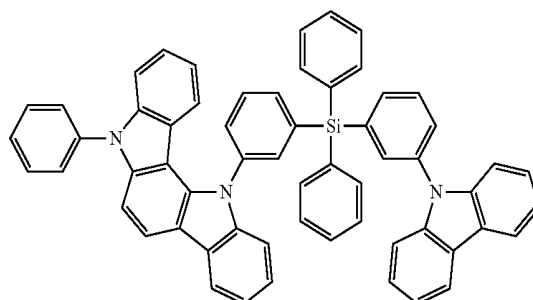
90



87

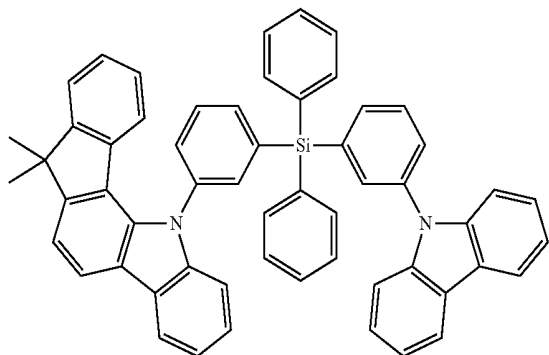


91

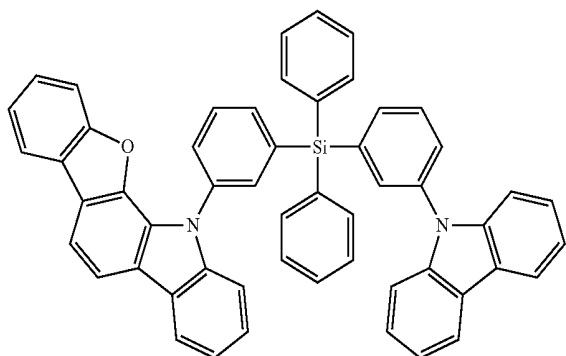


-continued

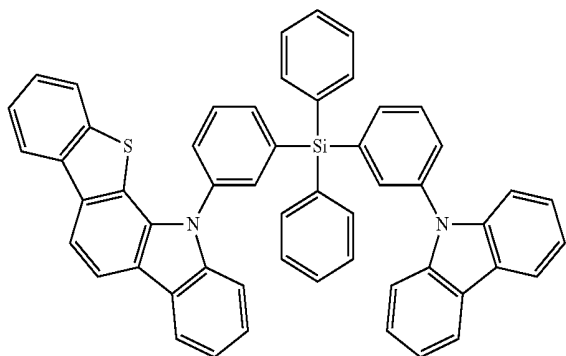
92



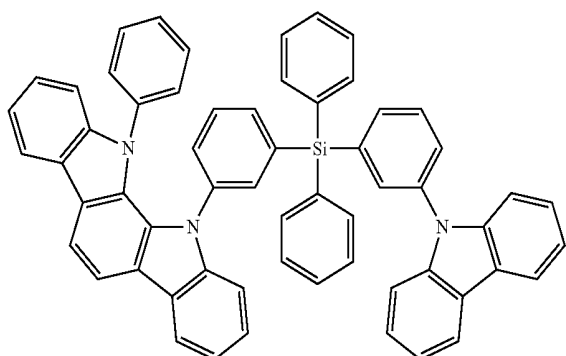
93



94

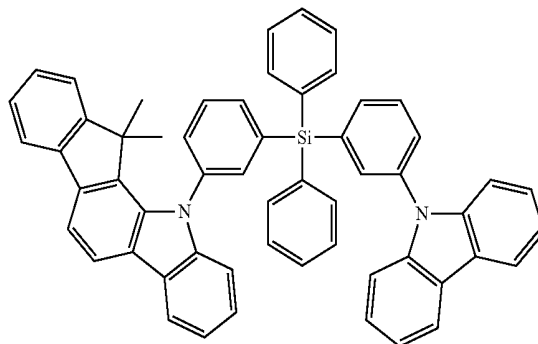


95

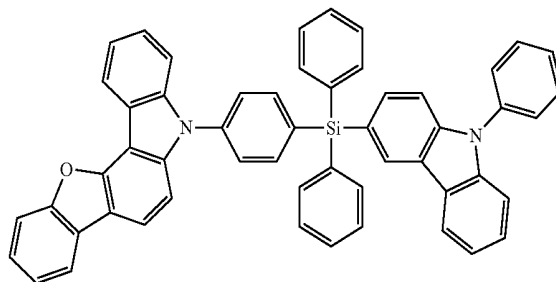


-continued

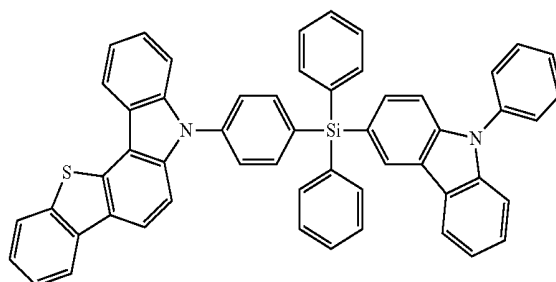
96



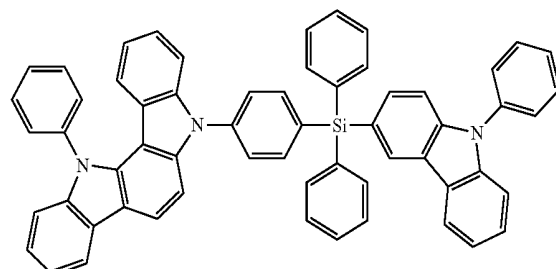
97



98

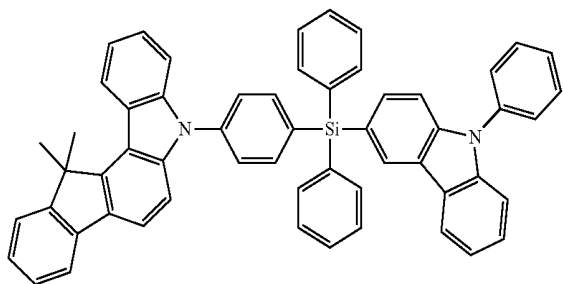


99

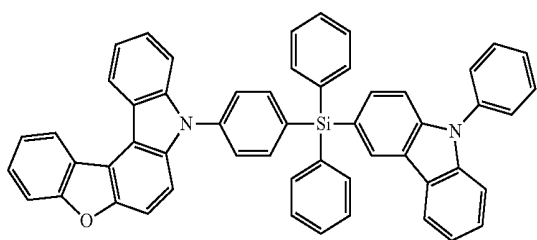


-continued

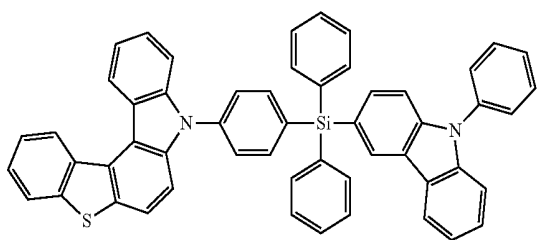
100



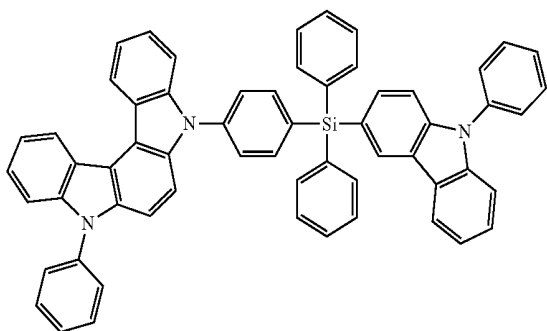
101



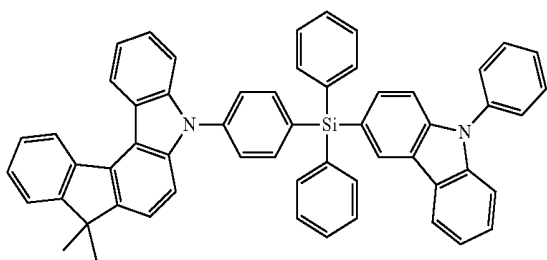
102



103

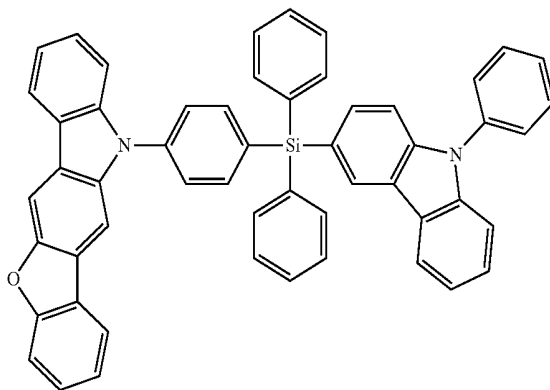


104

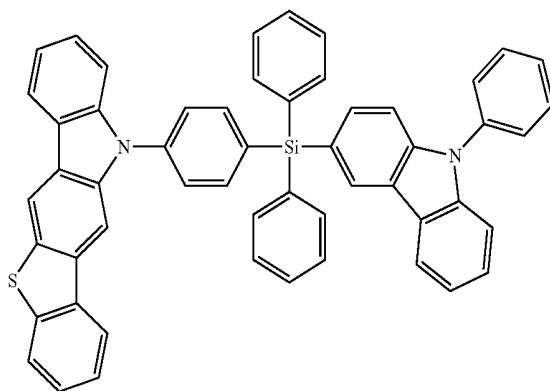


-continued

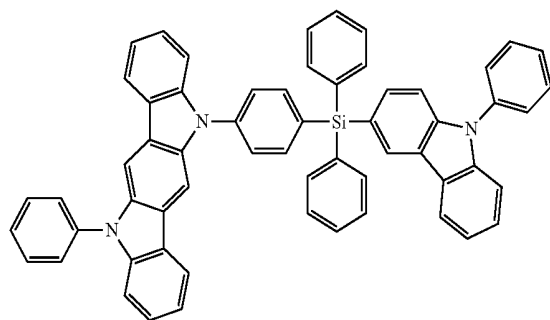
105



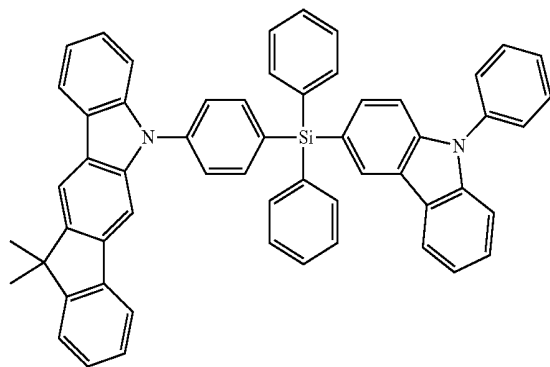
106



107

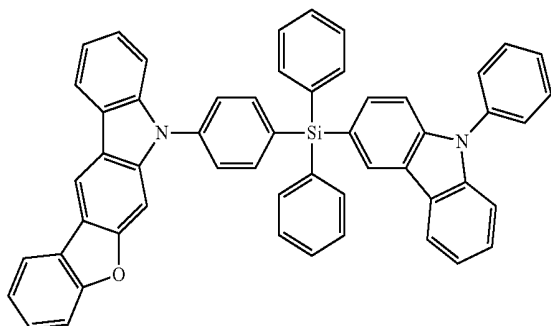


108



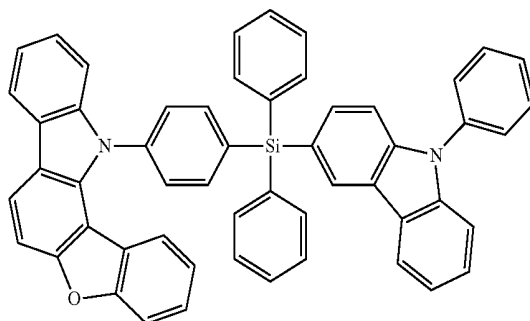
-continued

109

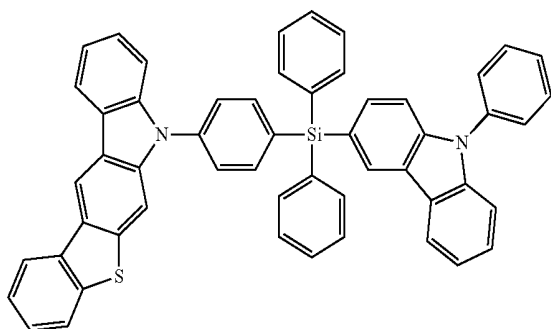


-continued

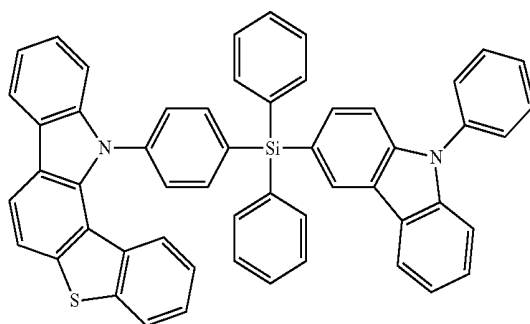
113



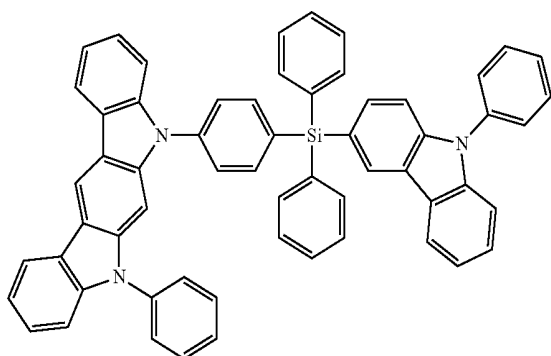
110



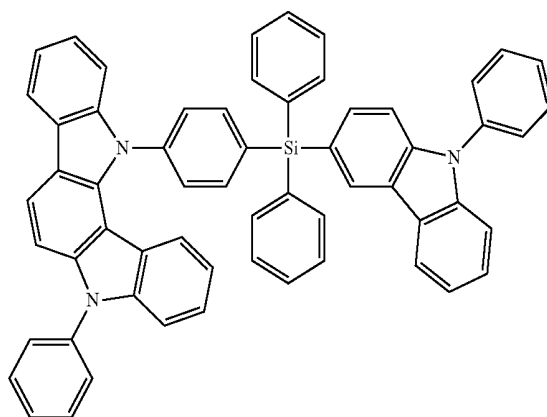
114



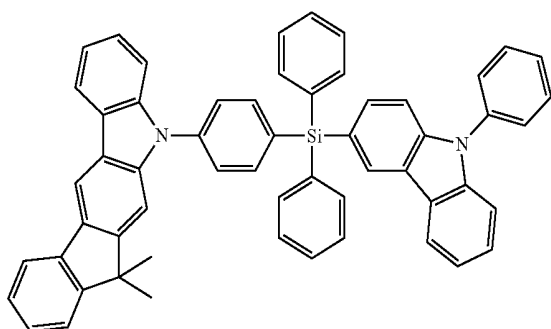
111



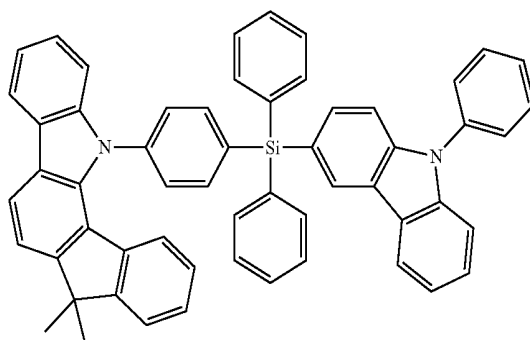
115



112

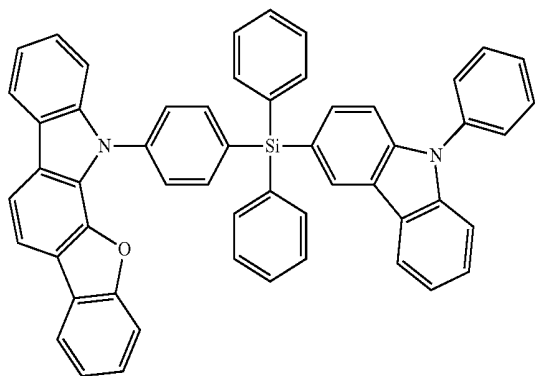


116



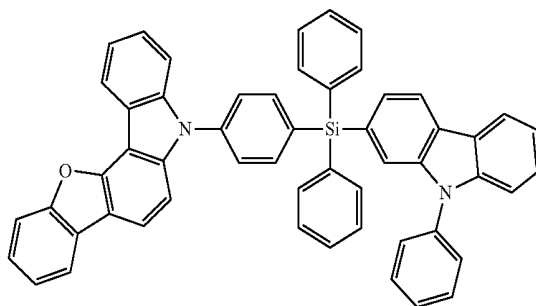
-continued

117



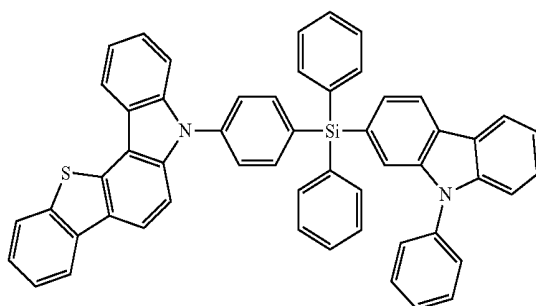
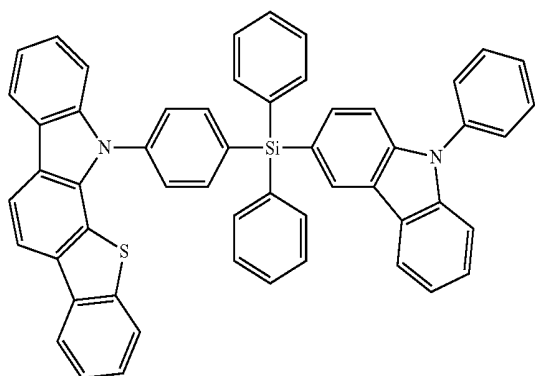
-continued

121



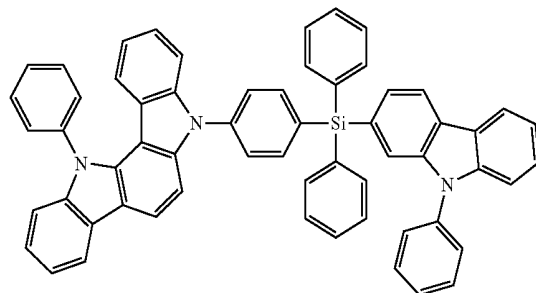
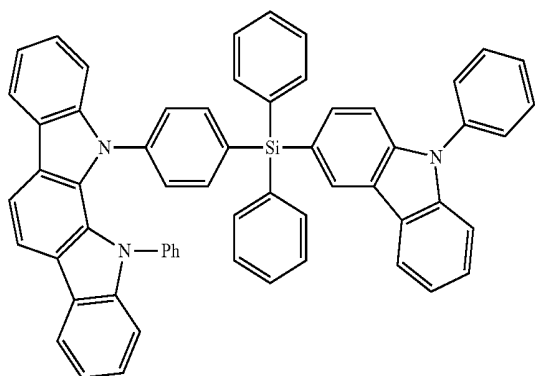
122

118



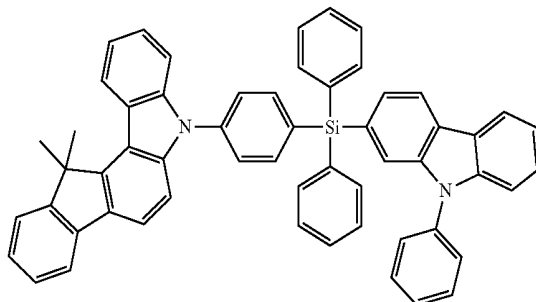
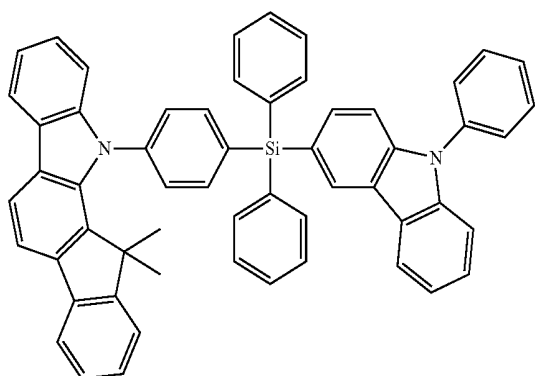
123

119



124

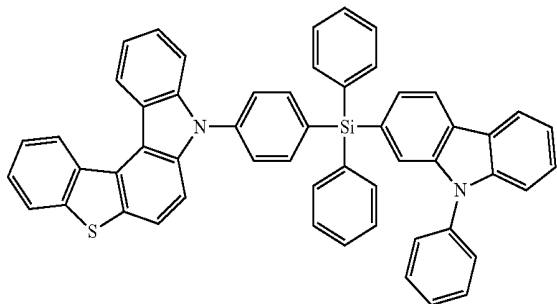
120



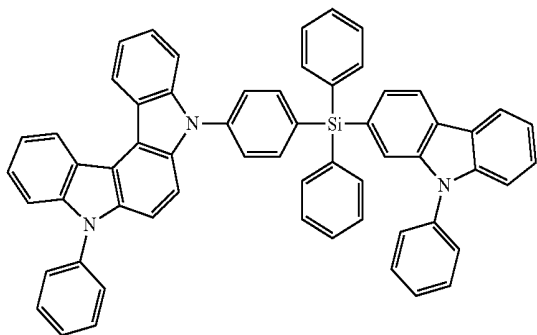
125

-continued

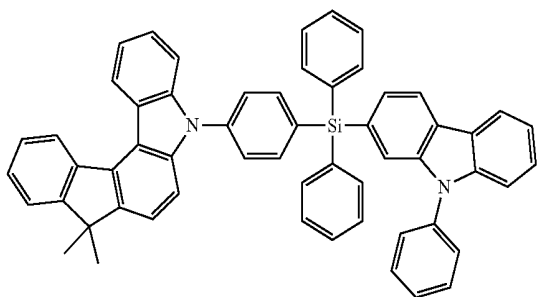
126



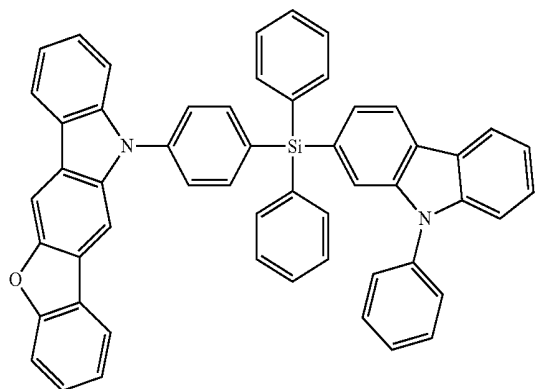
127



128

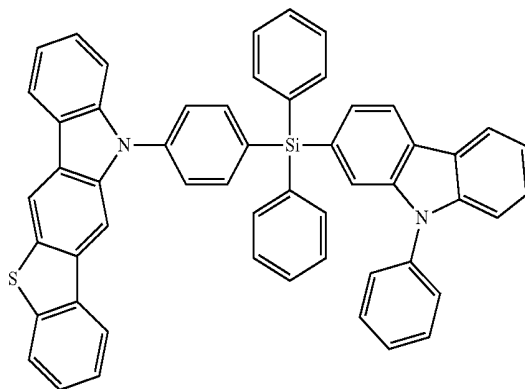


129

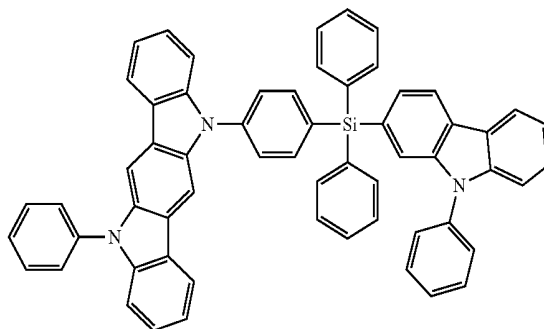


-continued

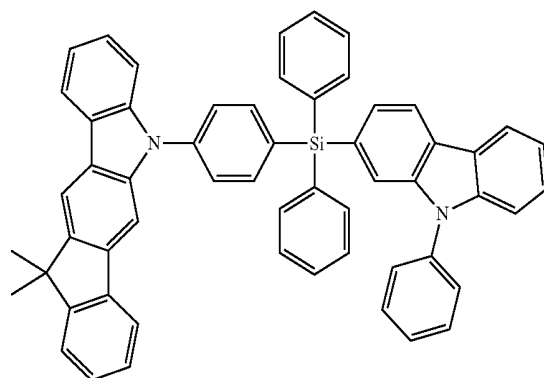
130



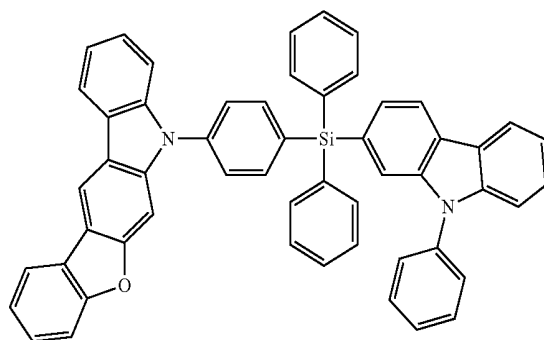
131



132

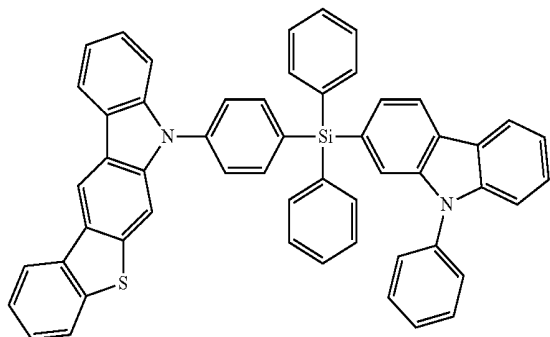


133



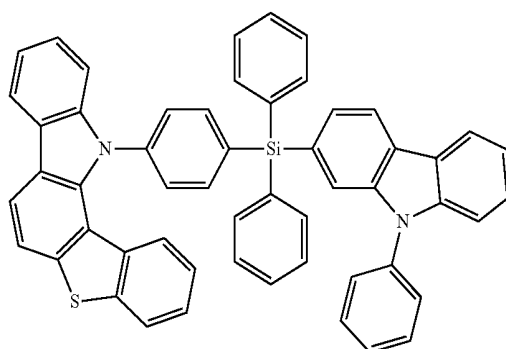
-continued

134

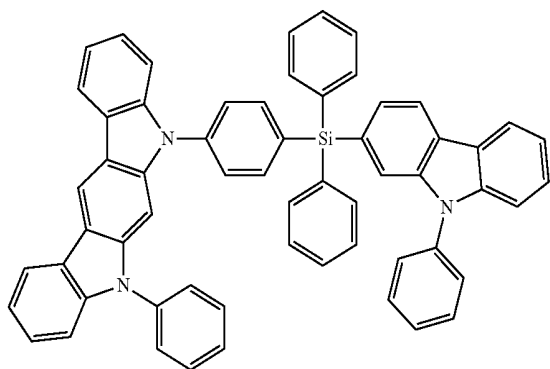


-continued

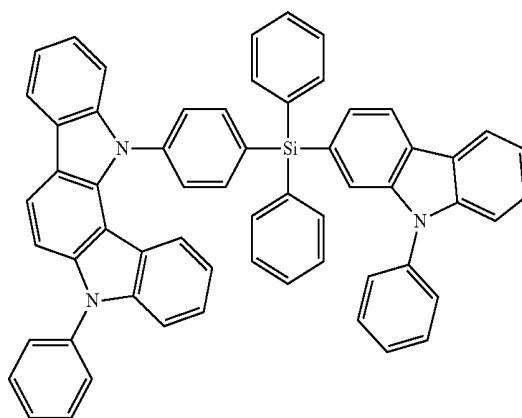
138



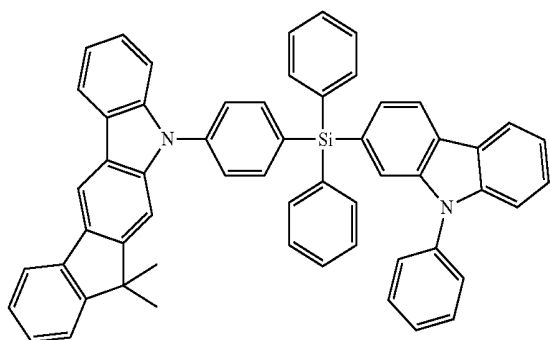
135



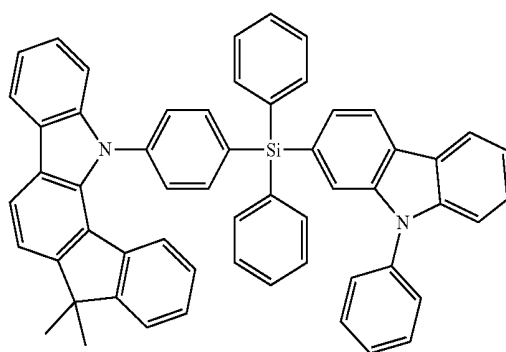
139



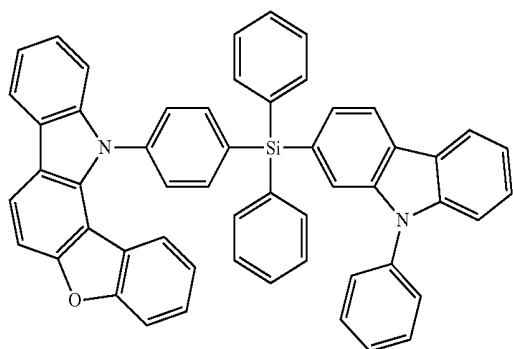
136



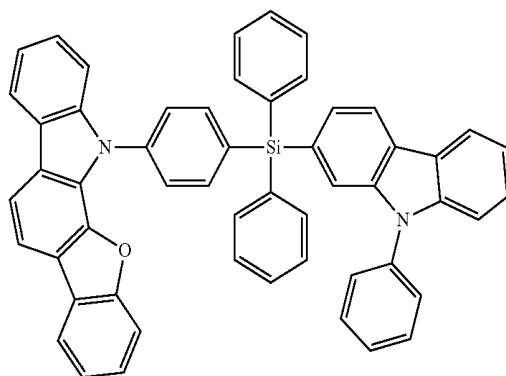
140



137

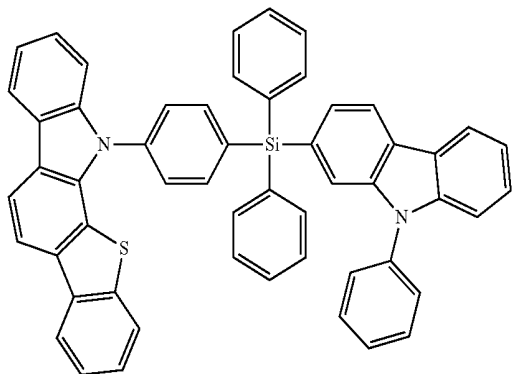


141



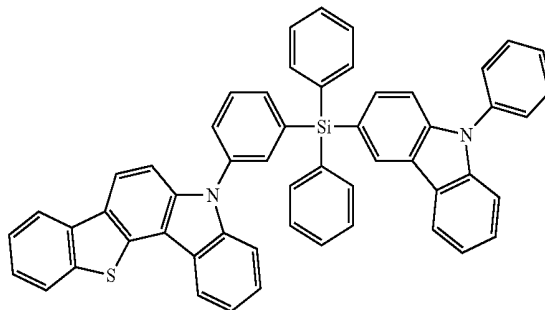
-continued

142

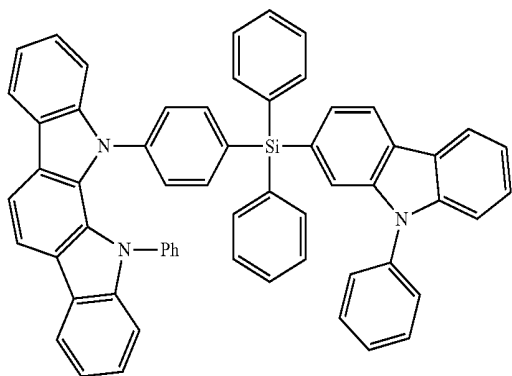


-continued

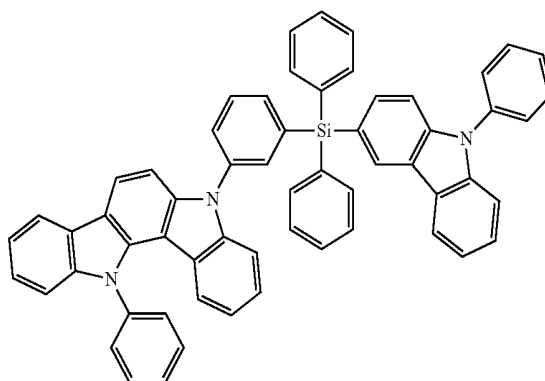
146



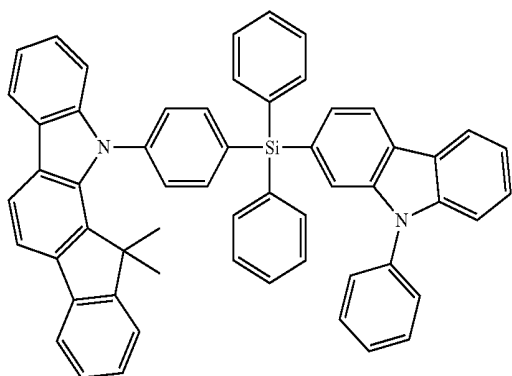
143



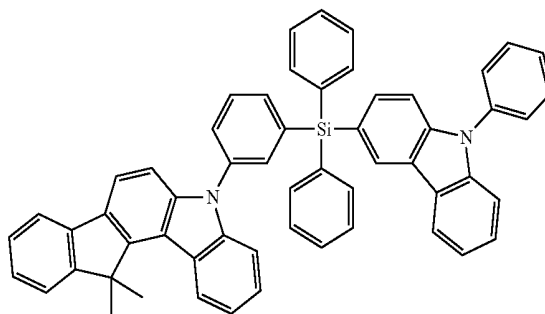
147



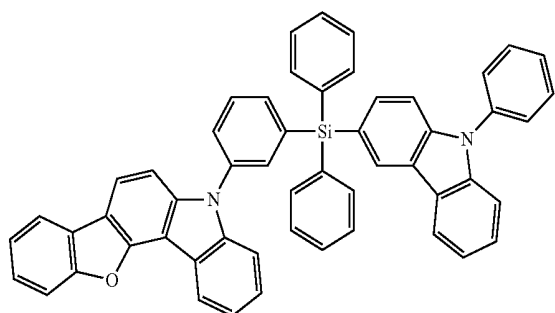
144



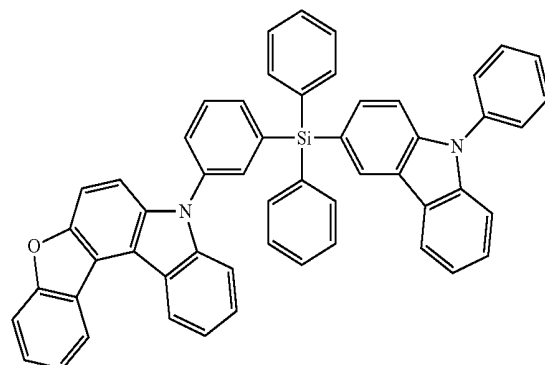
148



145

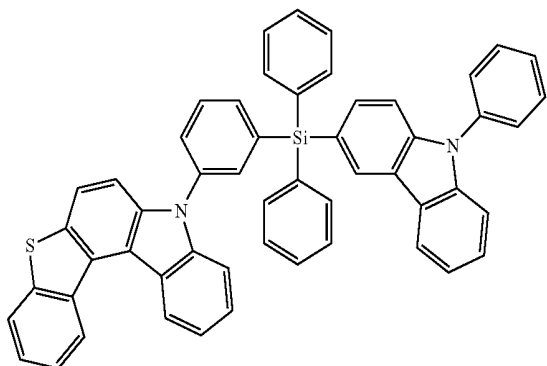


149



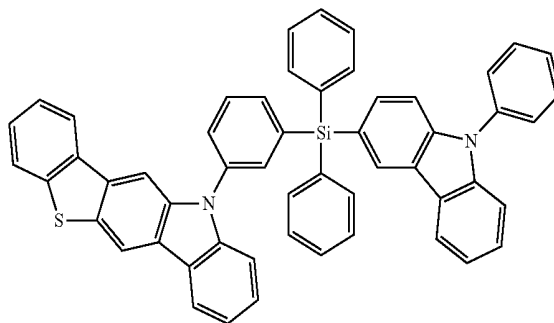
-continued

150



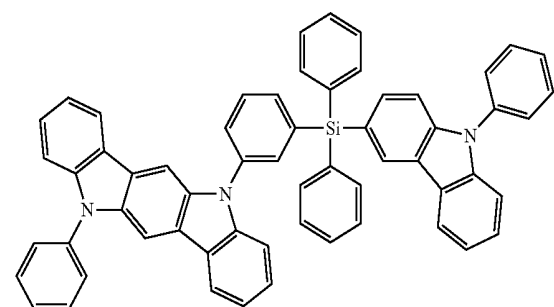
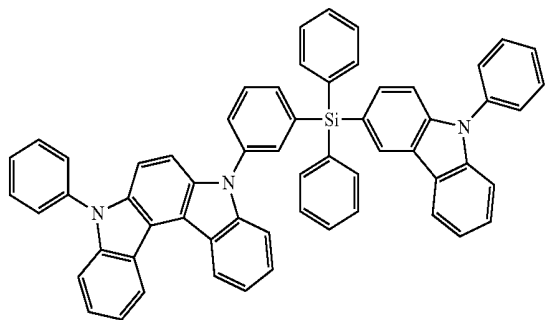
-continued

154



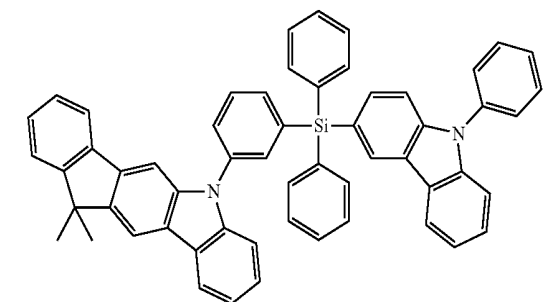
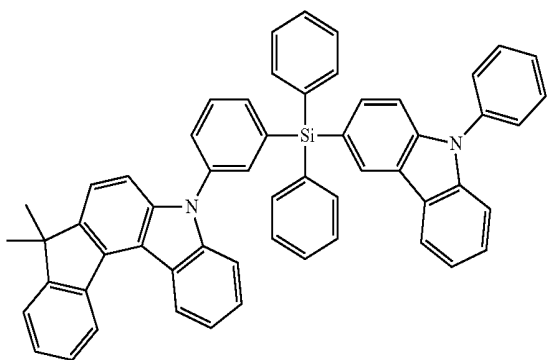
155

151



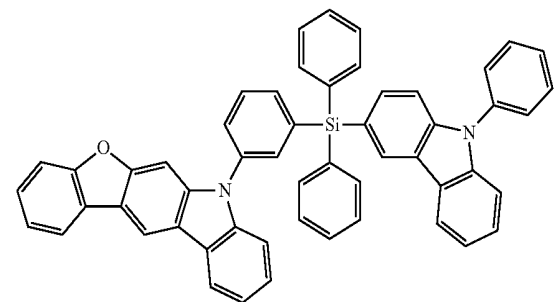
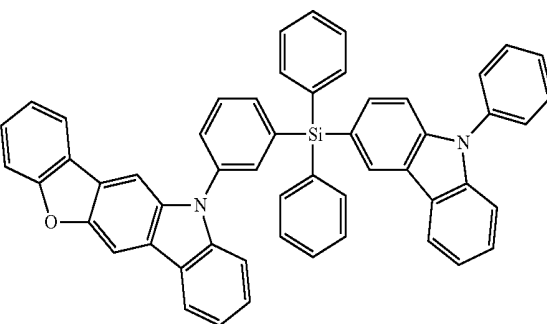
156

152

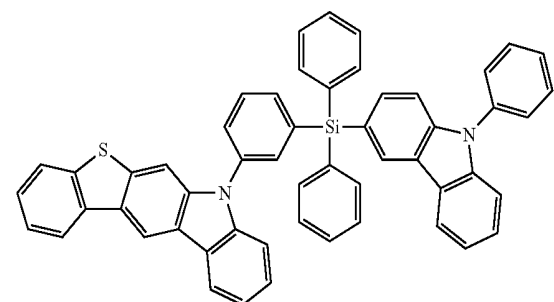


157

153

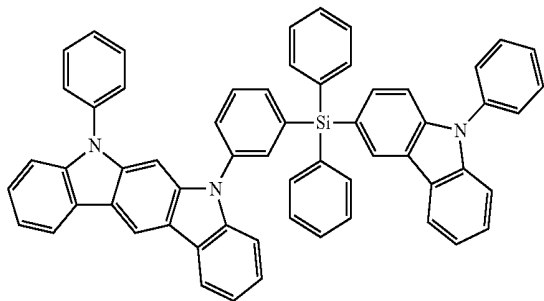


158



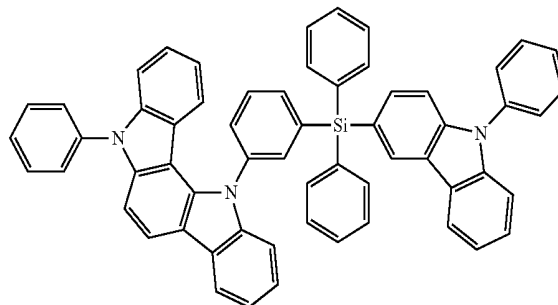
-continued

159

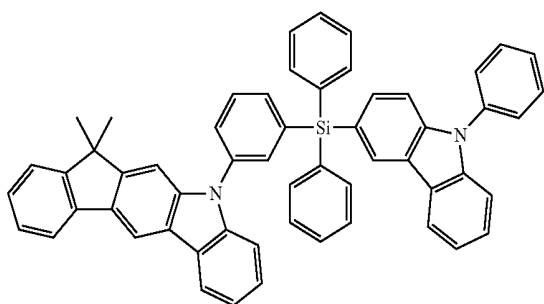


-continued

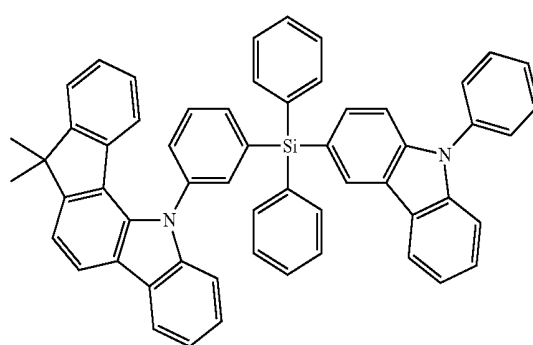
163



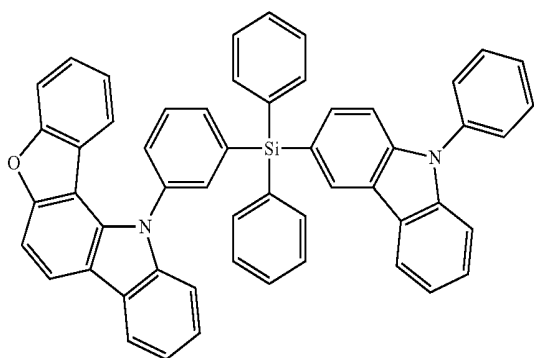
160



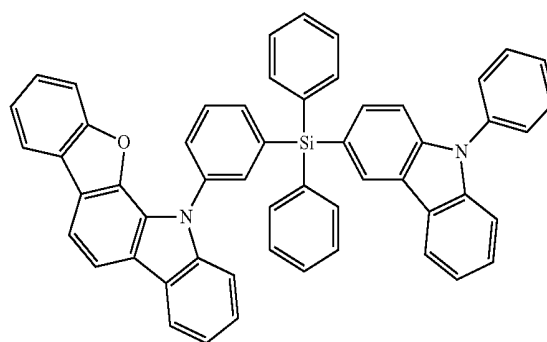
164



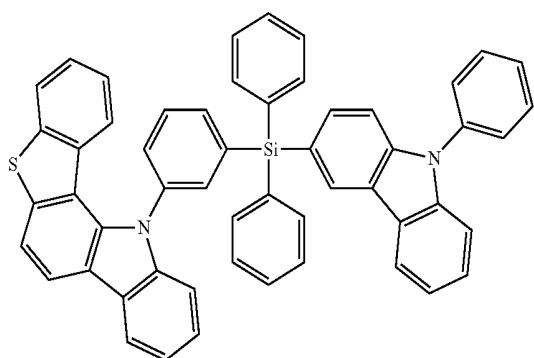
161



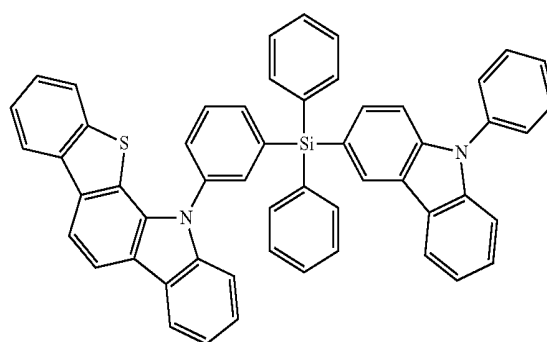
165



162

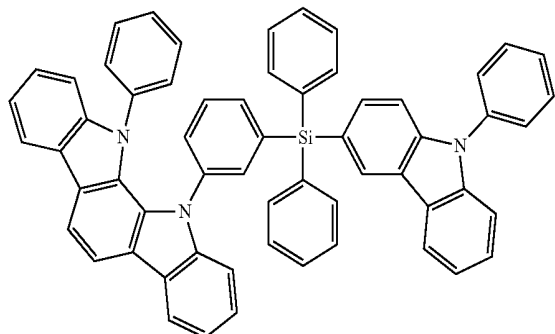


166



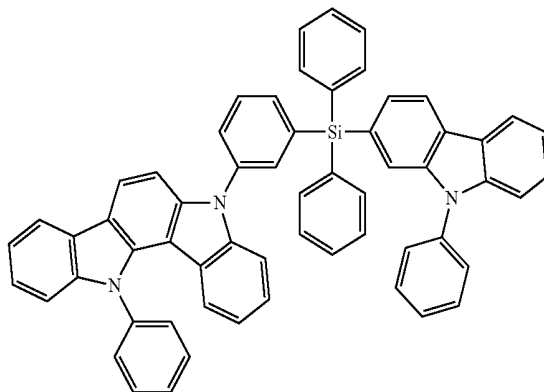
-continued

167

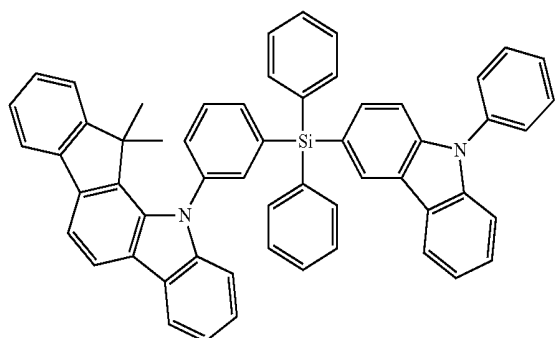


-continued

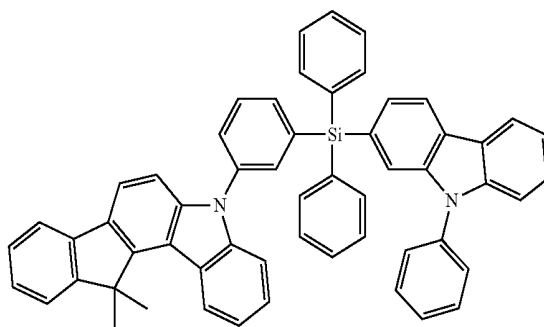
171



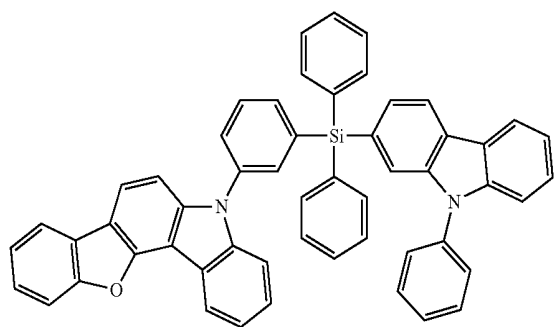
168



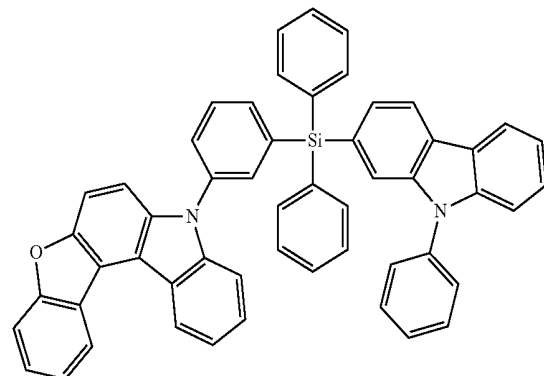
172



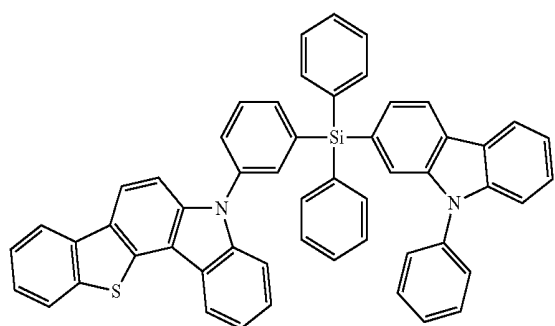
169



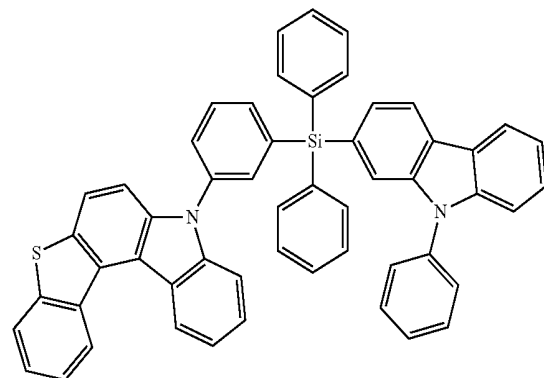
173



170

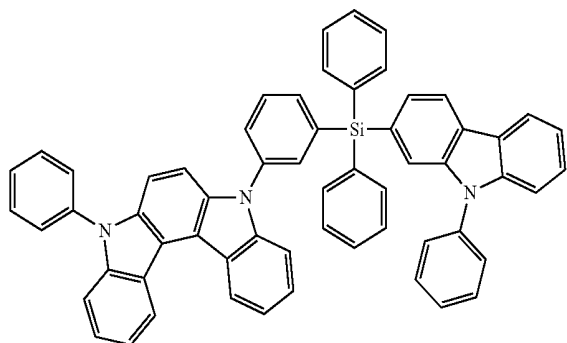


174



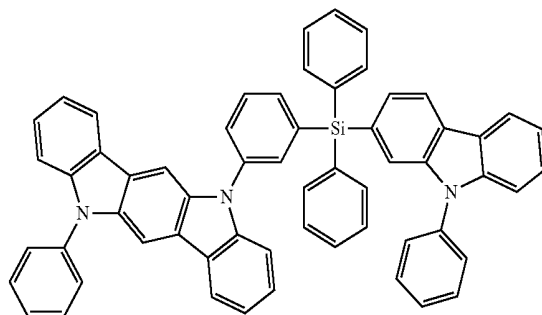
-continued

175

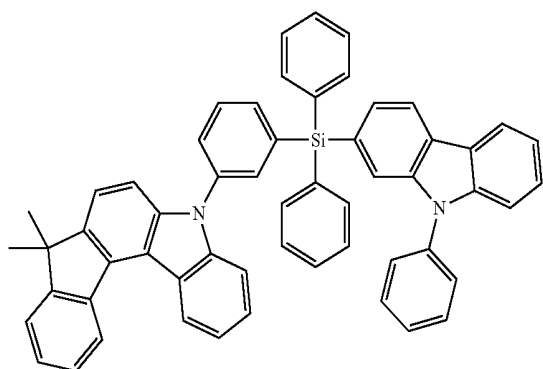


-continued

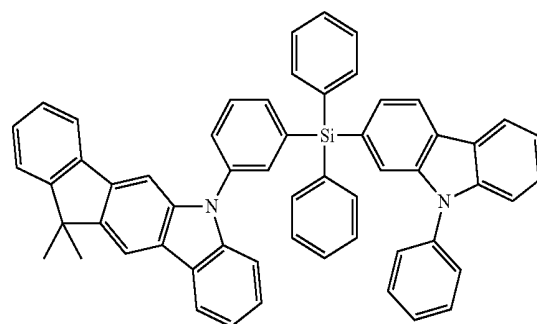
179



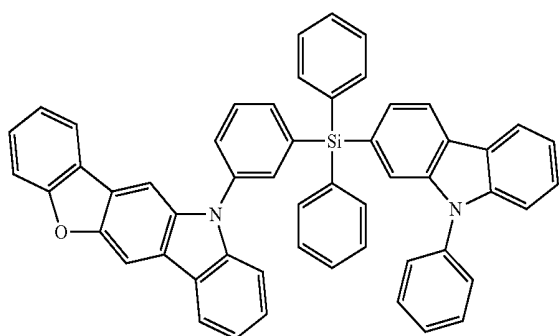
176



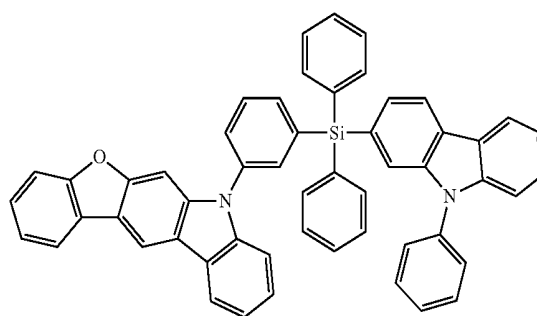
180



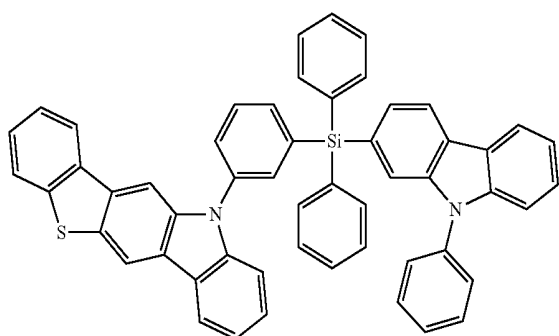
177



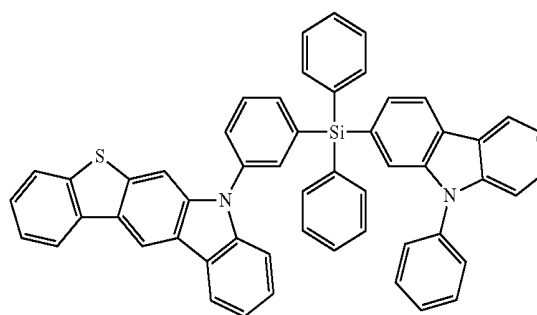
181



178

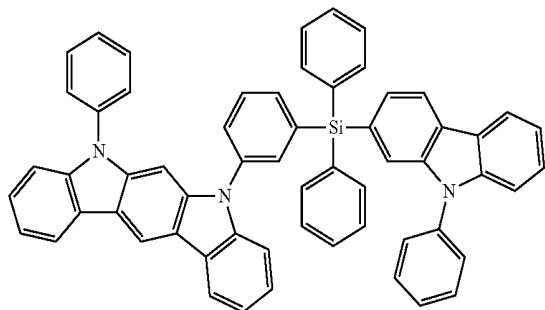


182



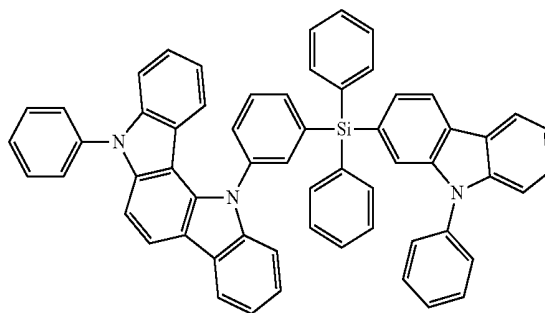
-continued

183

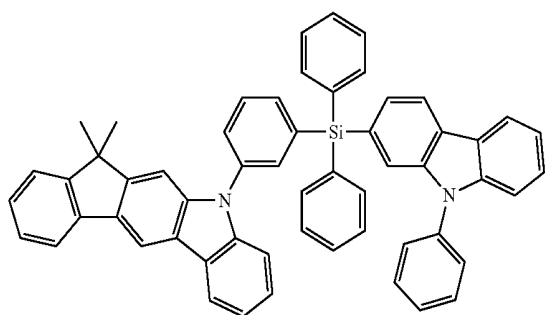


-continued

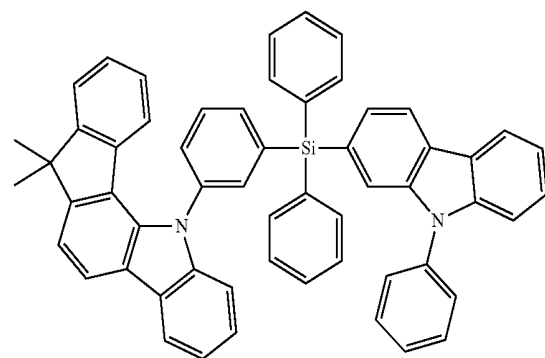
187



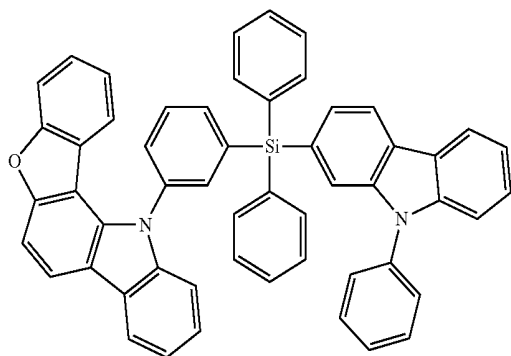
184



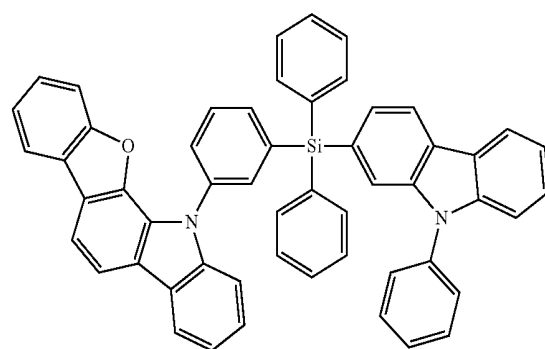
188



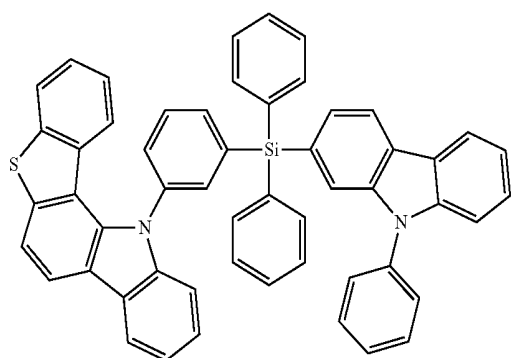
185



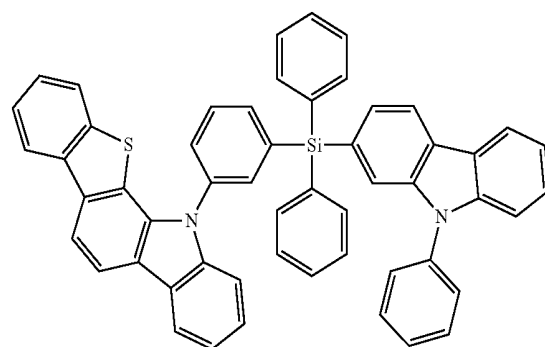
189



186

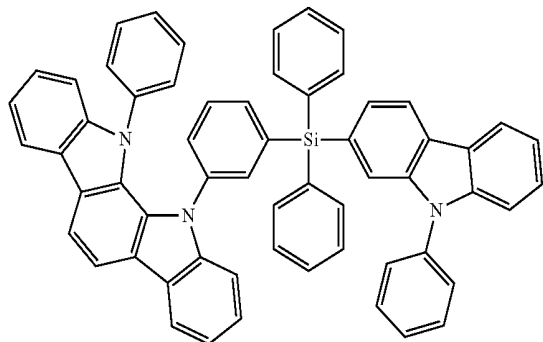


190



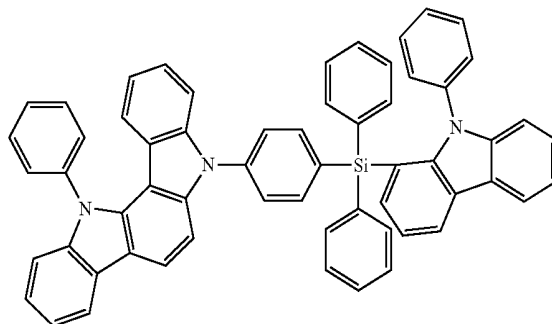
-continued

191

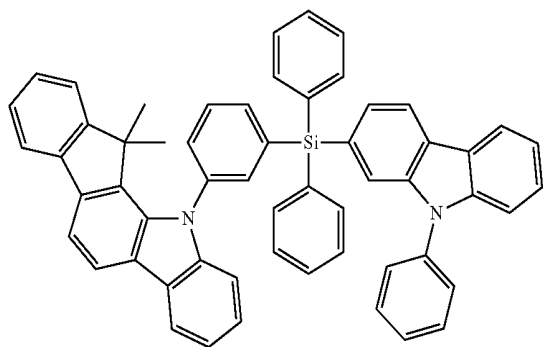


-continued

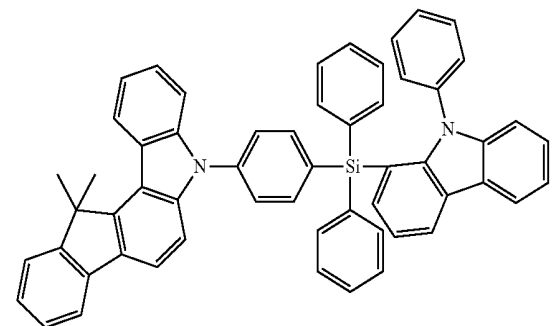
195



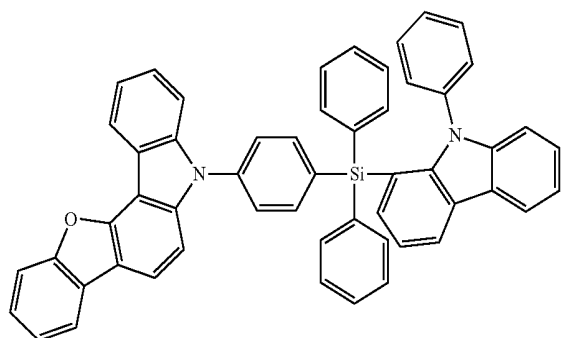
192



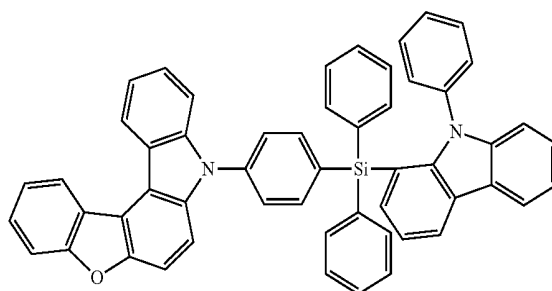
196



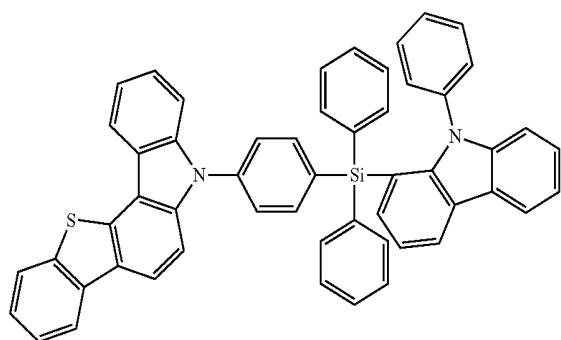
193



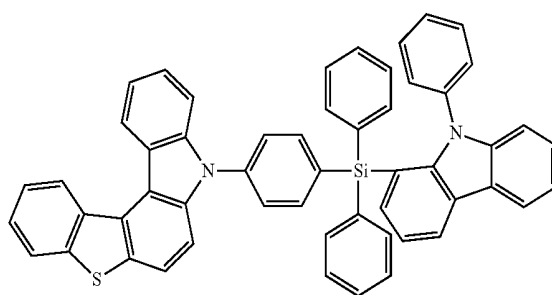
197



194

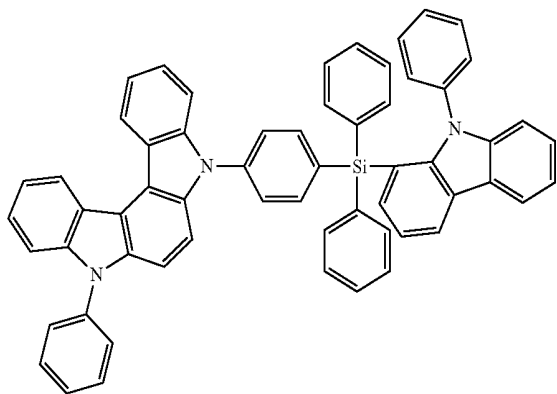


198

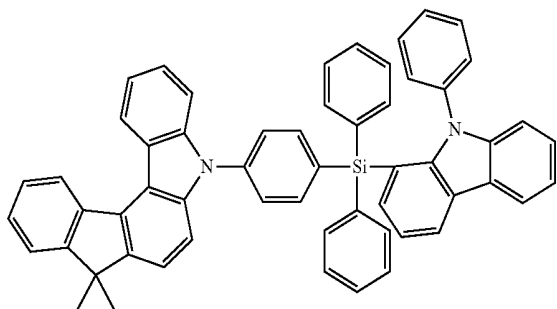


-continued

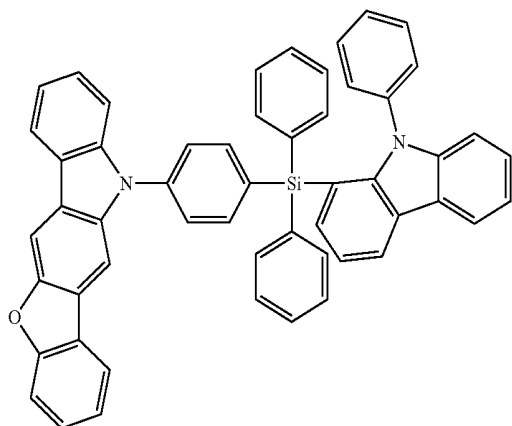
199



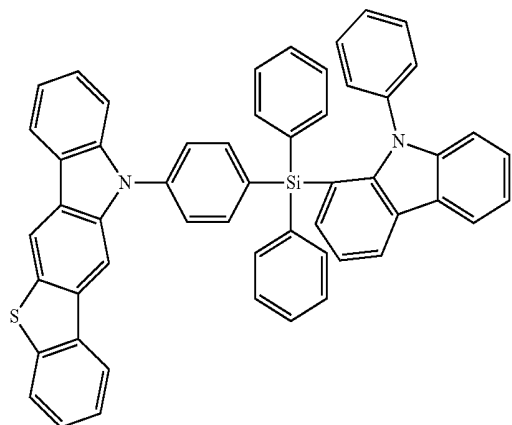
200



201

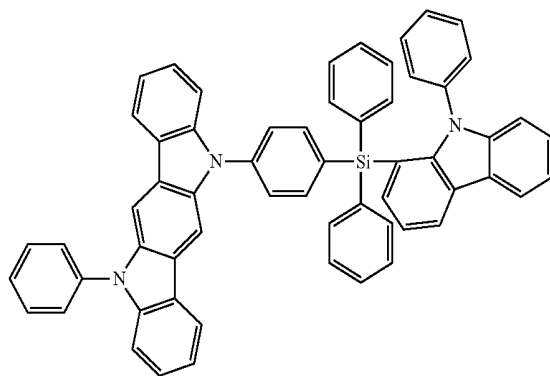


202

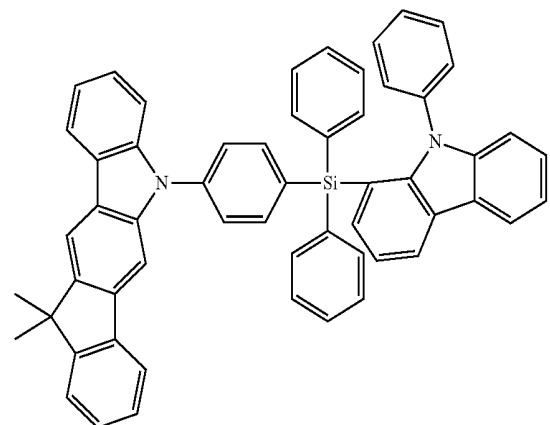


-continued

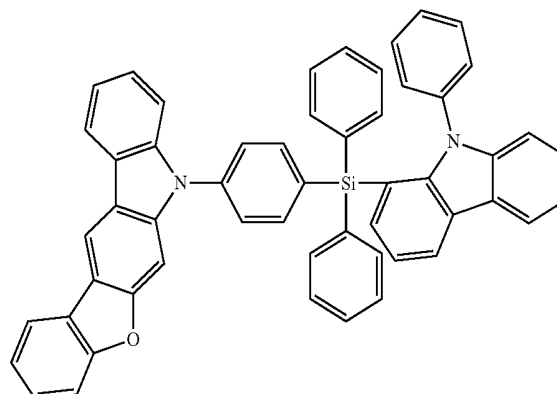
203



204

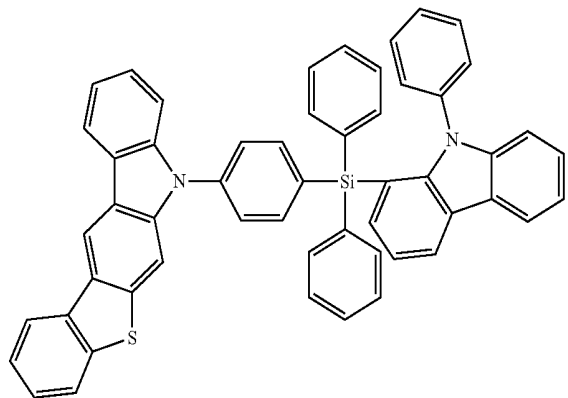


205

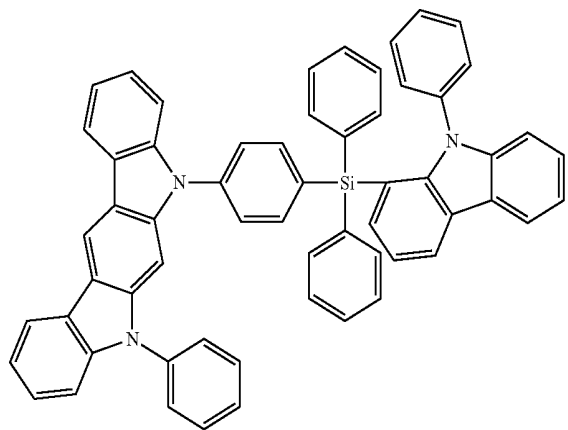


-continued

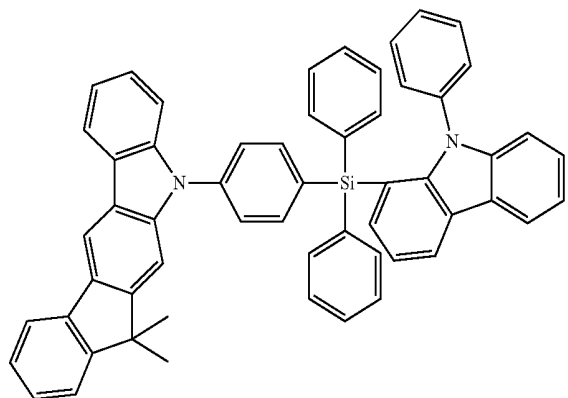
206



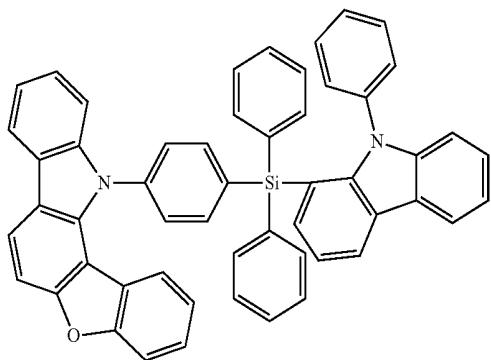
207



208

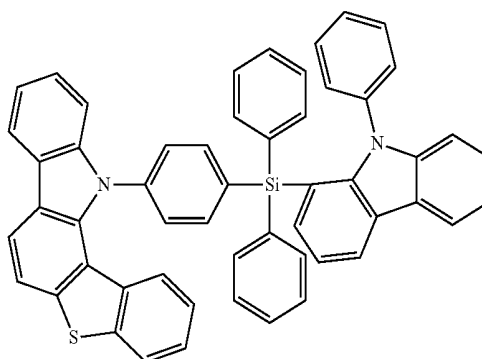


209

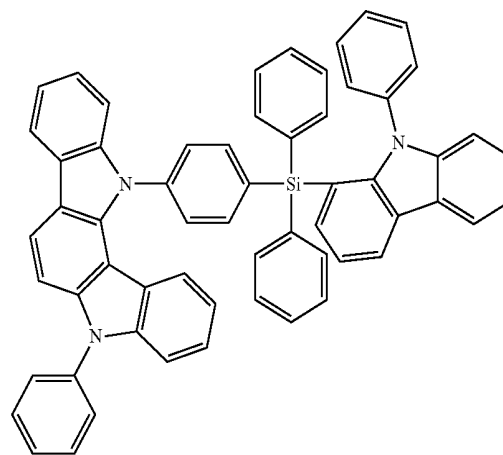


-continued

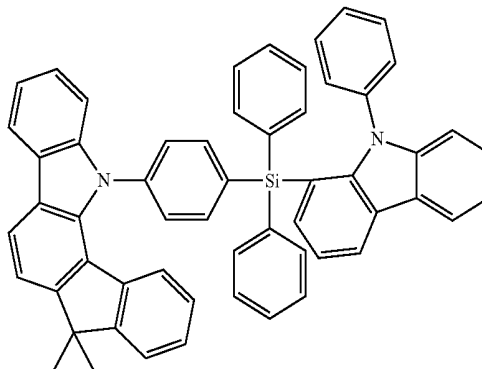
210



211

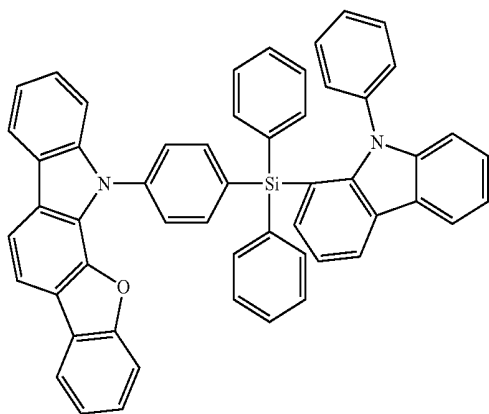


212



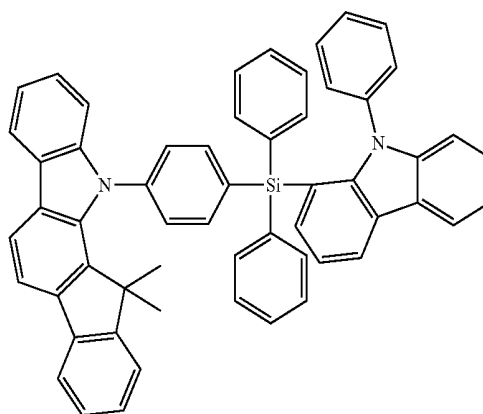
-continued

213



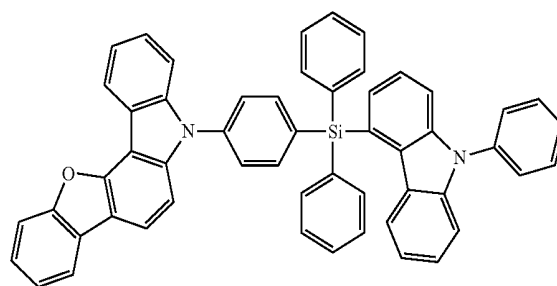
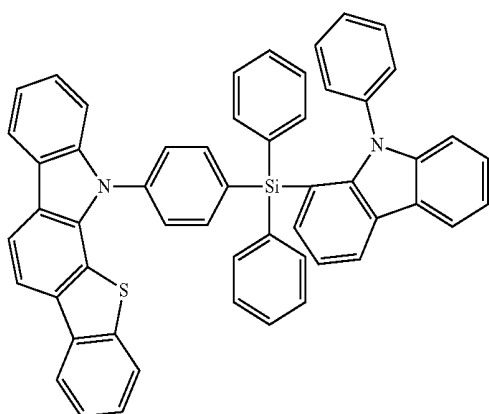
-continued

216

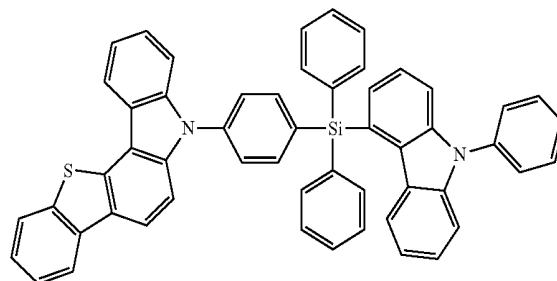


217

214

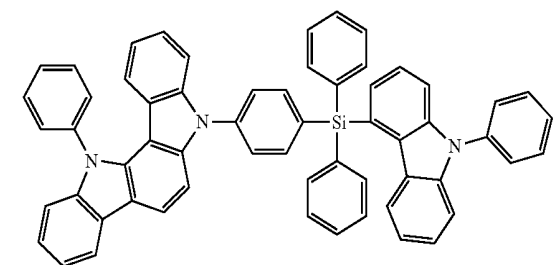
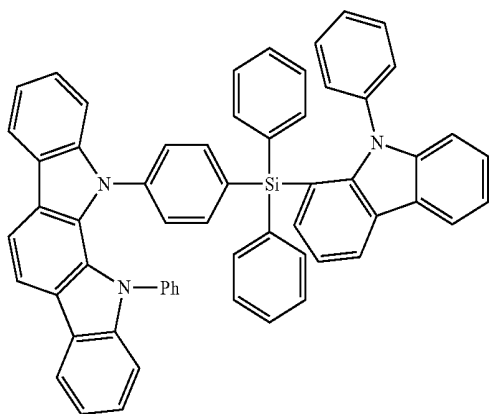


218

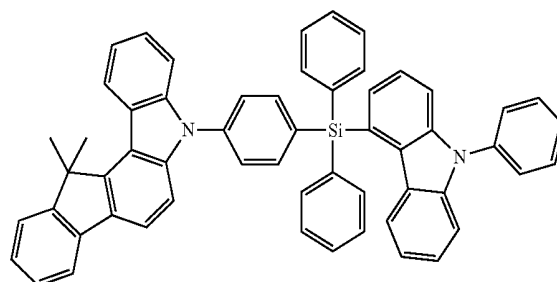


219

215

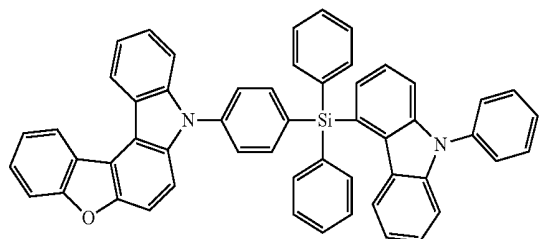


220

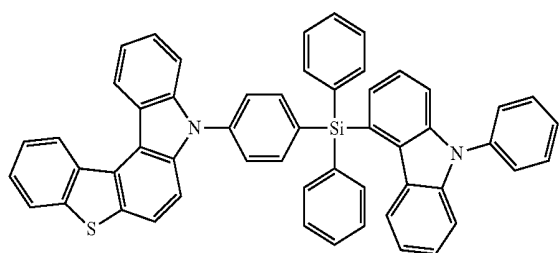


-continued

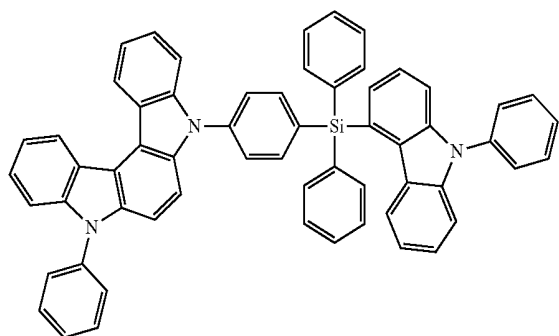
221



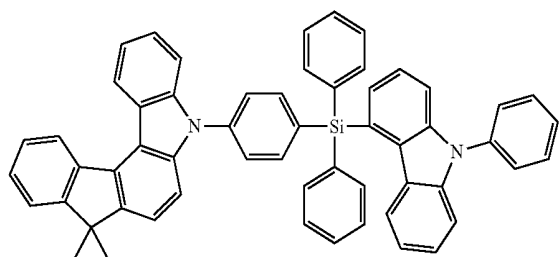
222



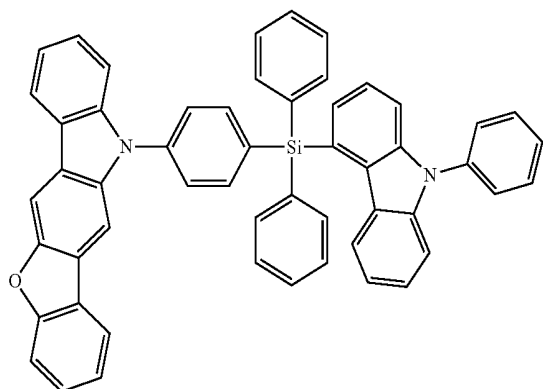
223



224

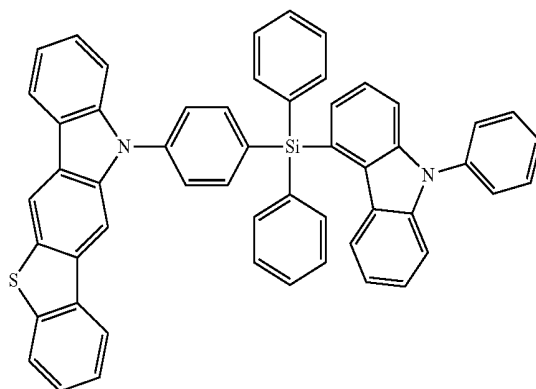


225

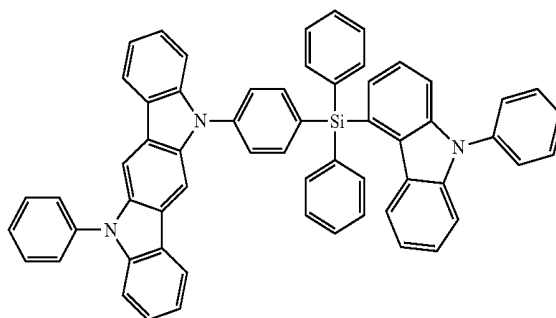


-continued

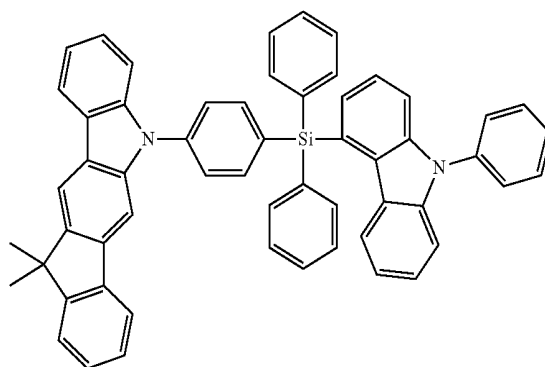
226



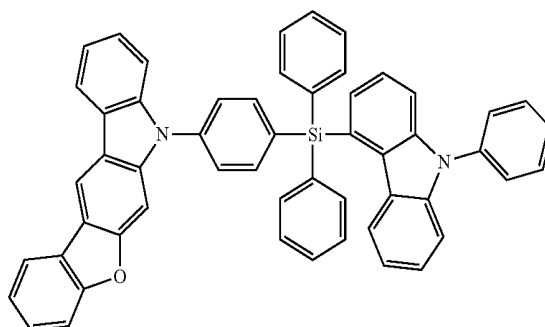
227



228

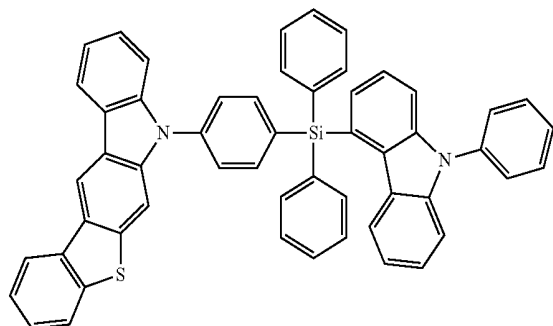


229



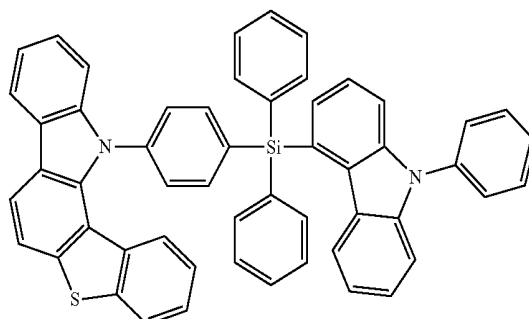
-continued

230



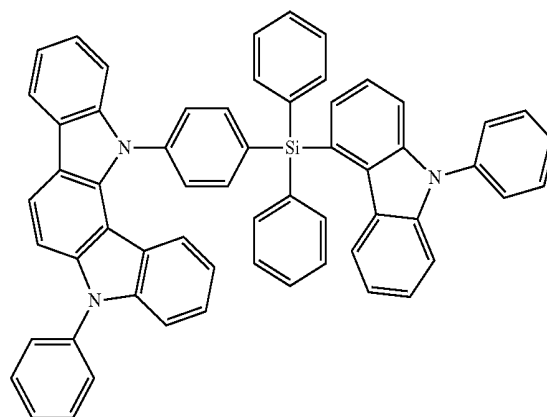
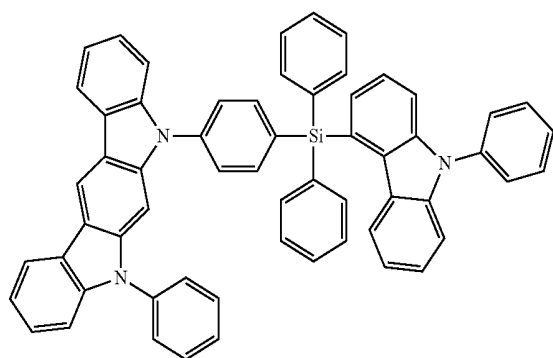
-continued

234

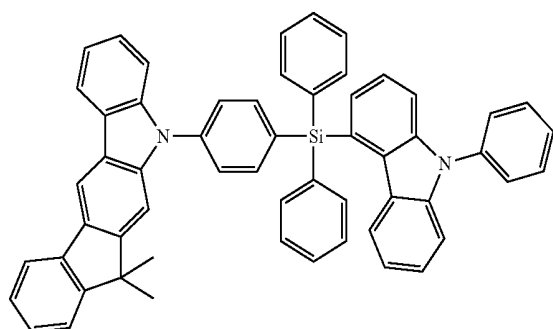


235

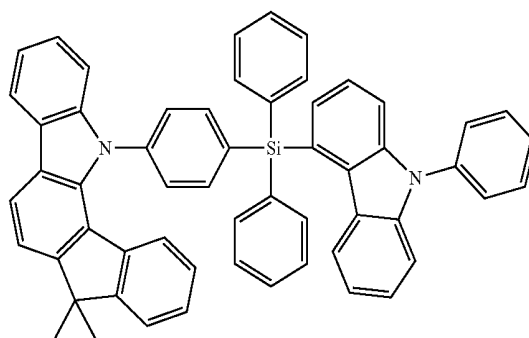
231



232

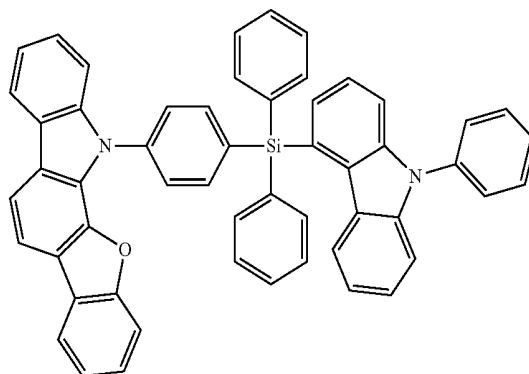
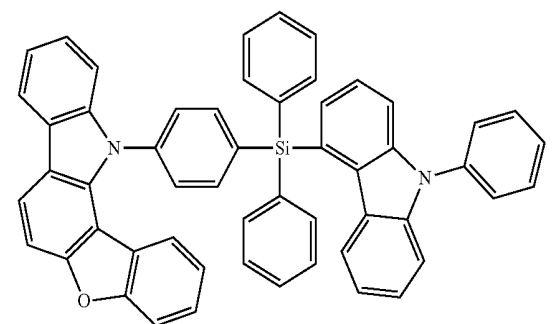


236



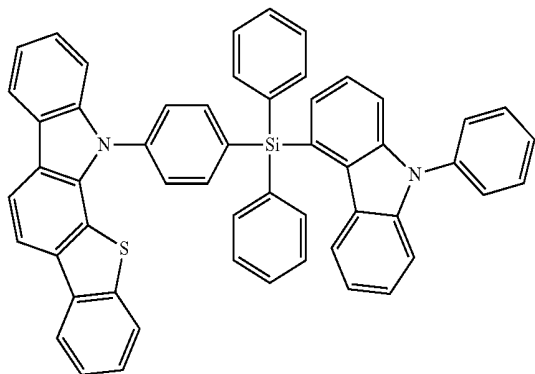
237

233

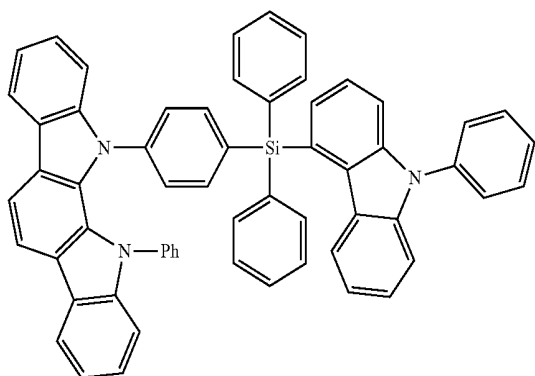


-continued

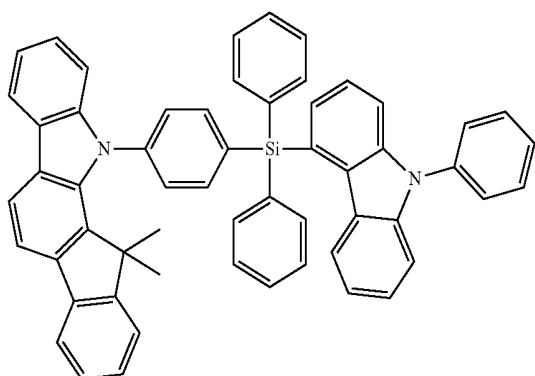
238



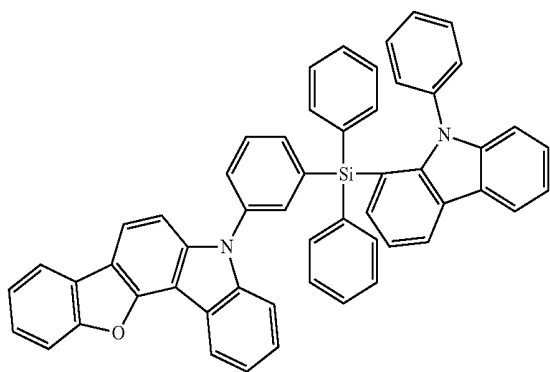
239



240

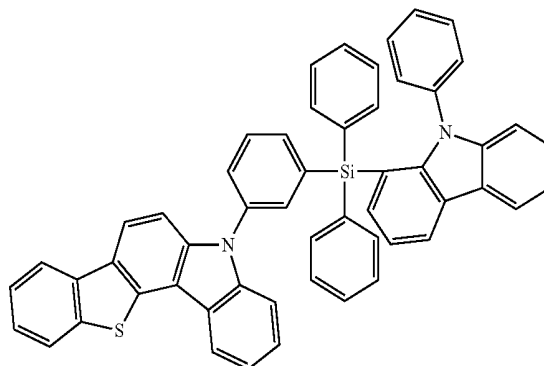


241

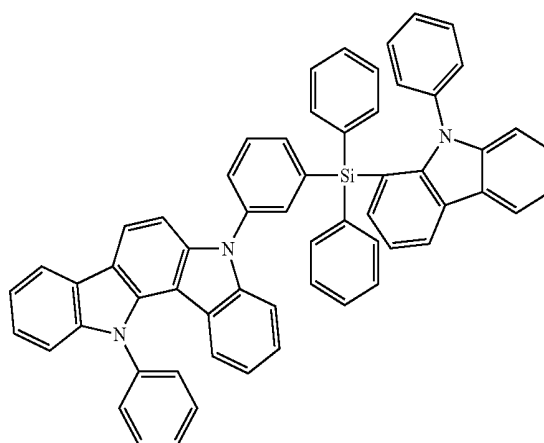


-continued

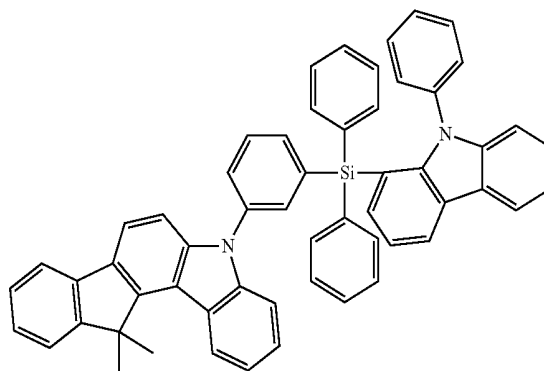
242



243

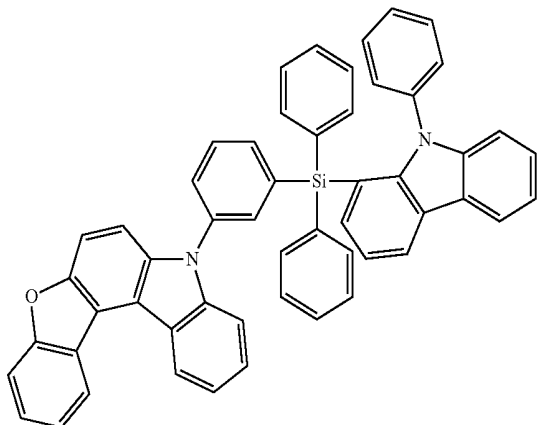


244



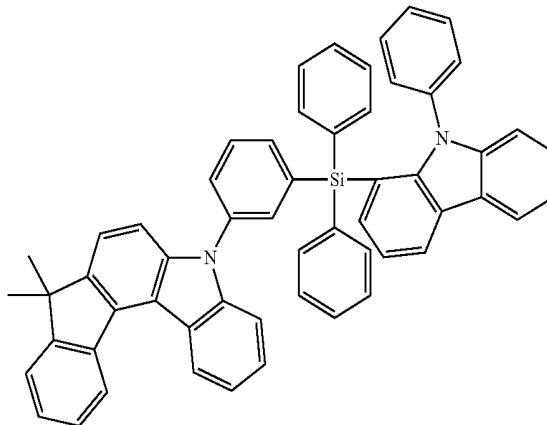
-continued

245



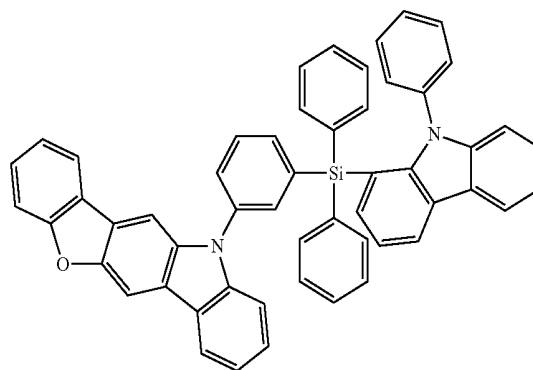
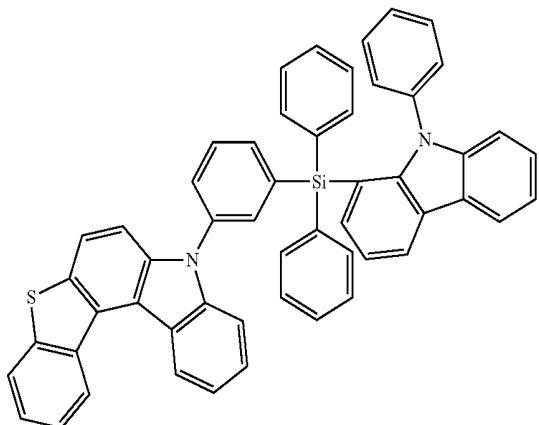
-continued

248



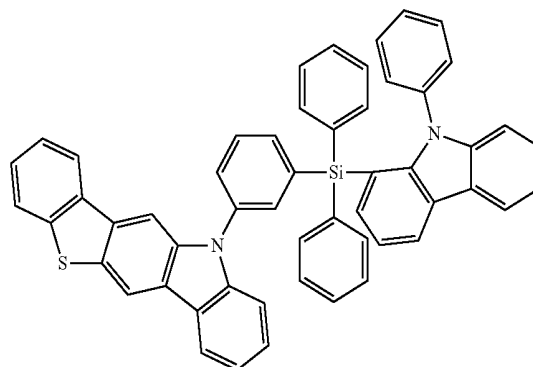
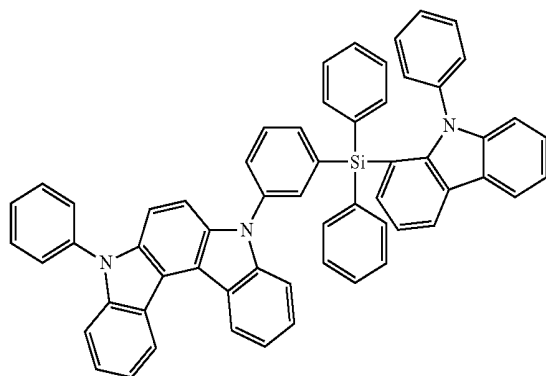
249

246

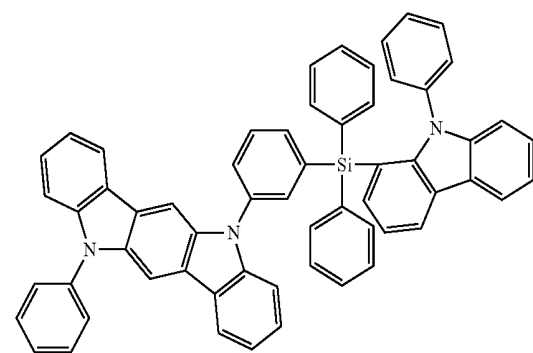


250

247

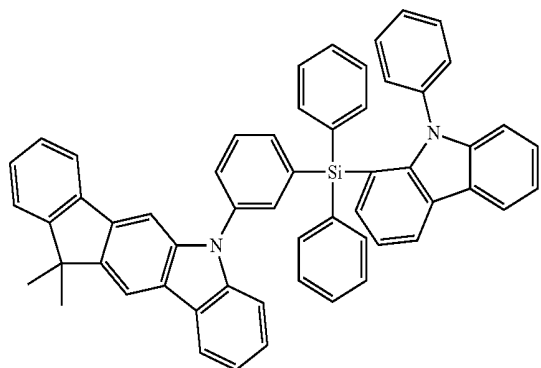


251



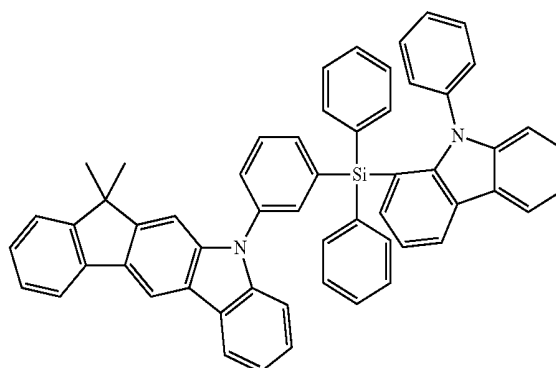
-continued

252

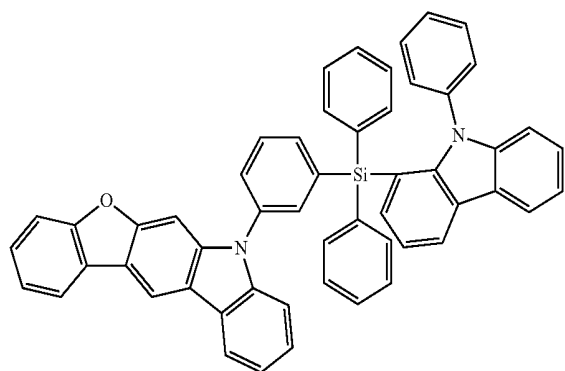


-continued

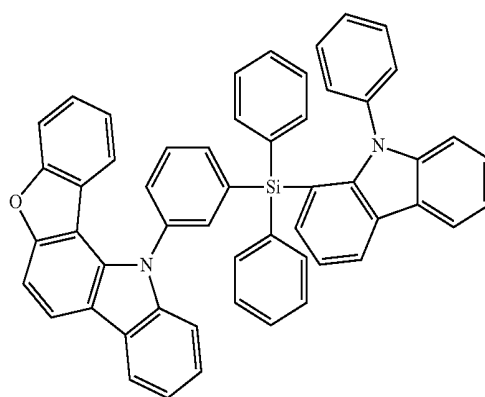
256



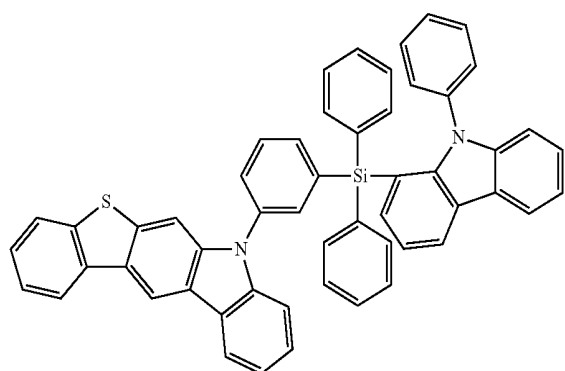
253



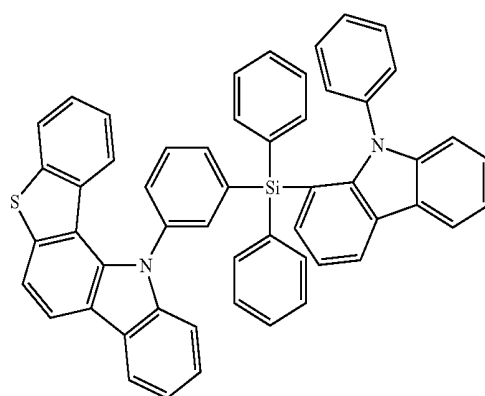
257



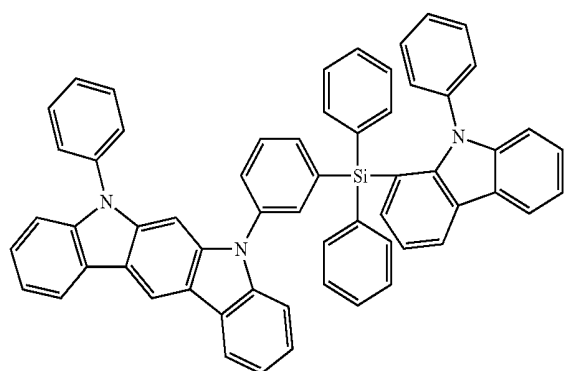
254



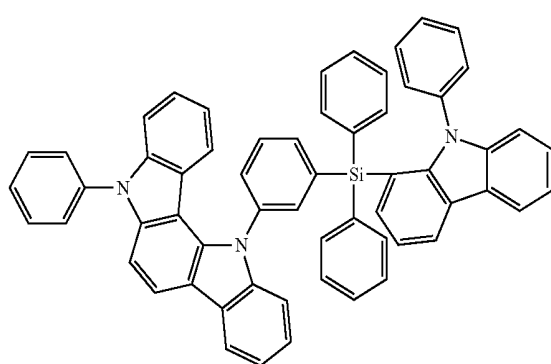
258



255

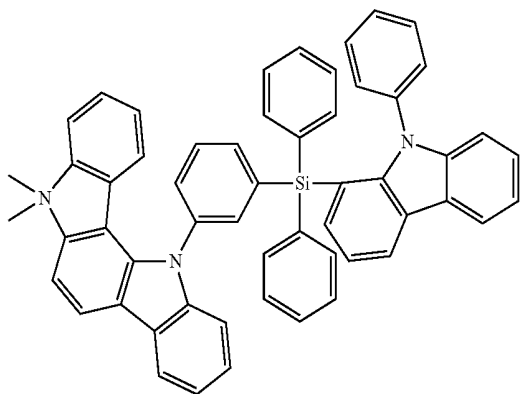


259

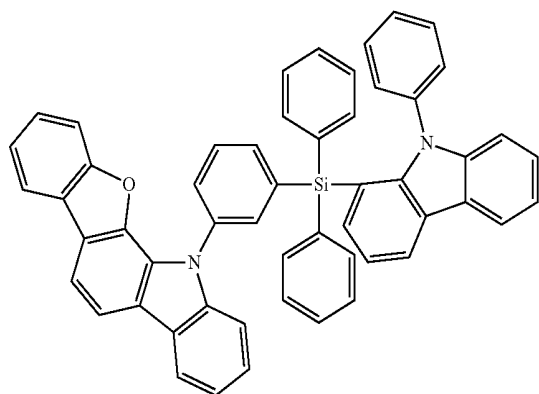


-continued

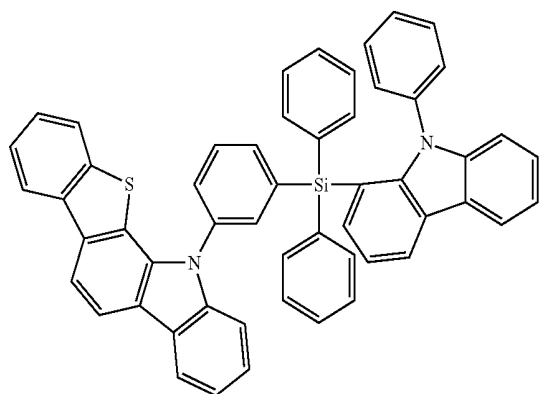
260



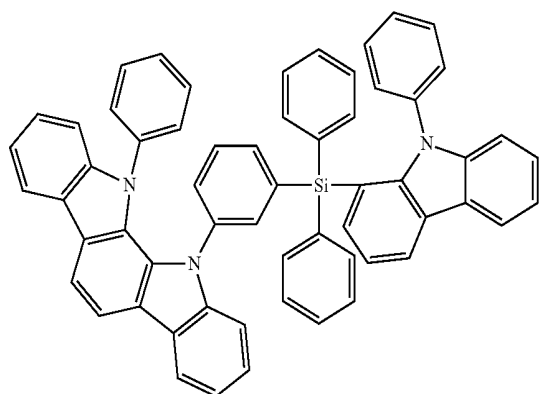
261



262

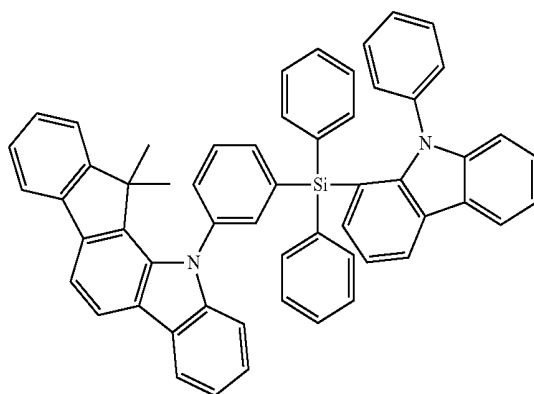


263

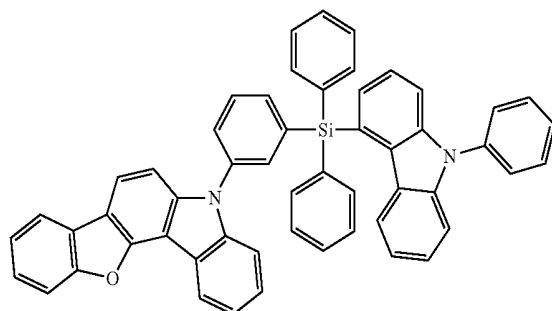


-continued

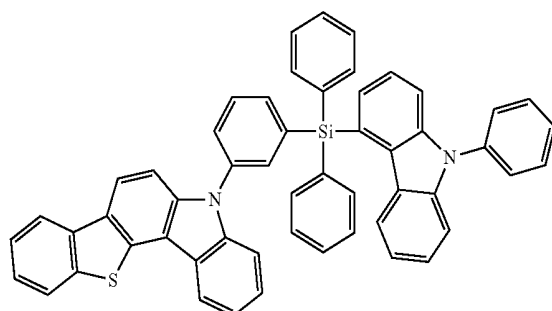
264



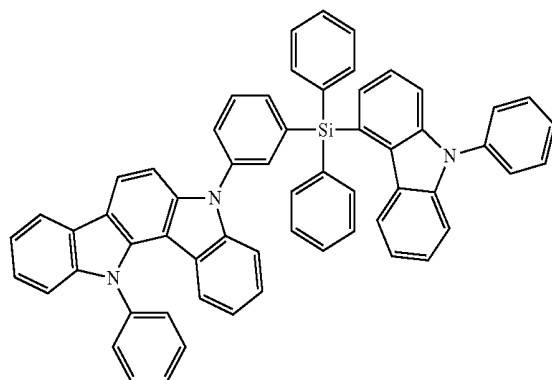
265



266

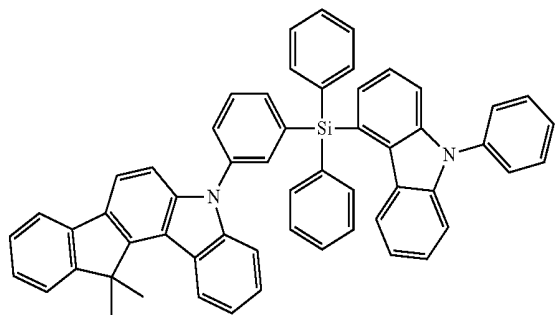


267



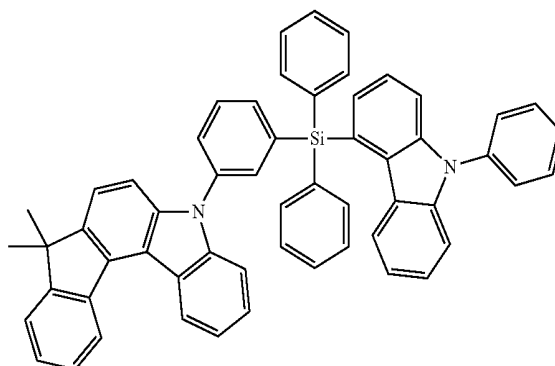
-continued

268

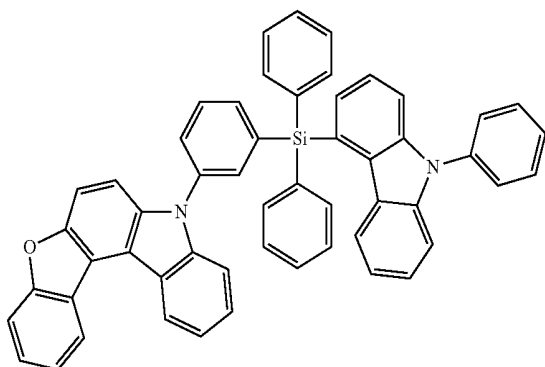


-continued

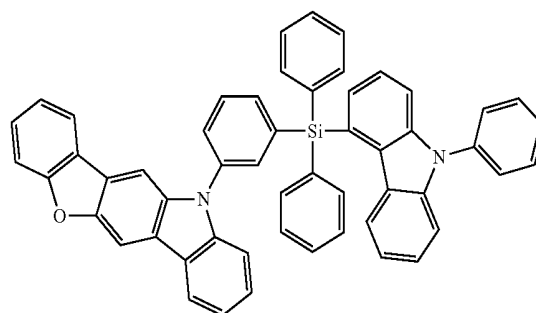
272



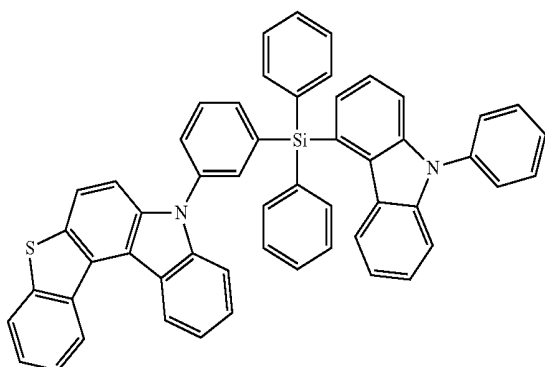
269



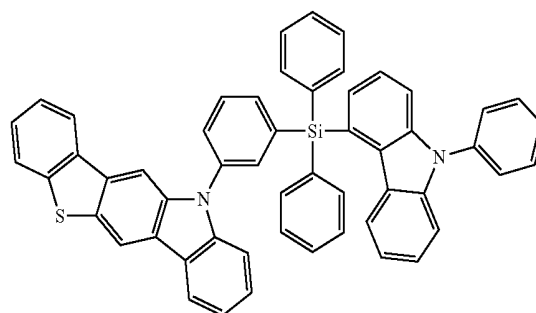
273



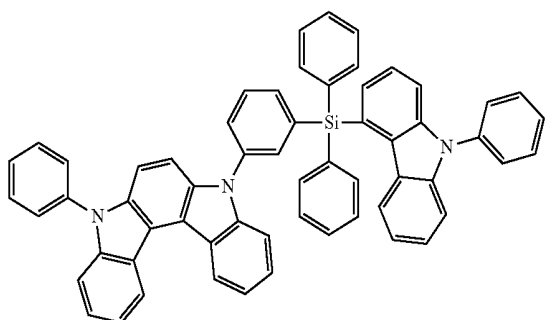
270



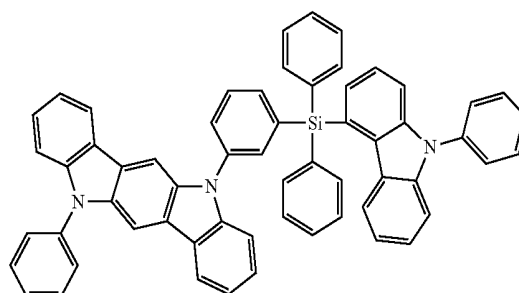
274



271

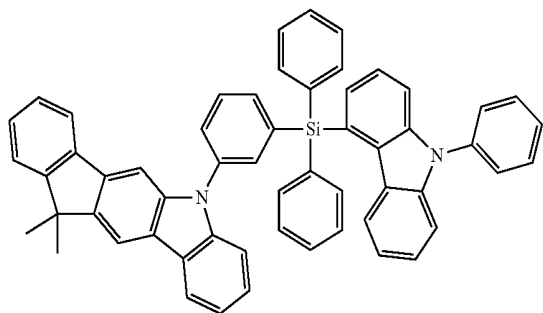


275



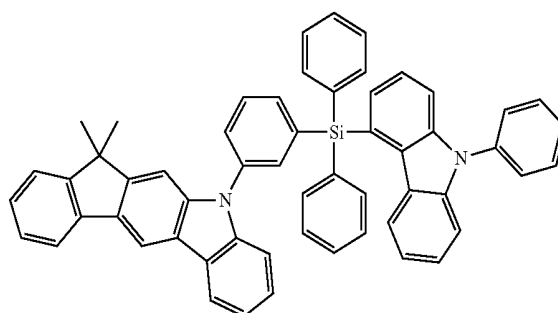
-continued

276

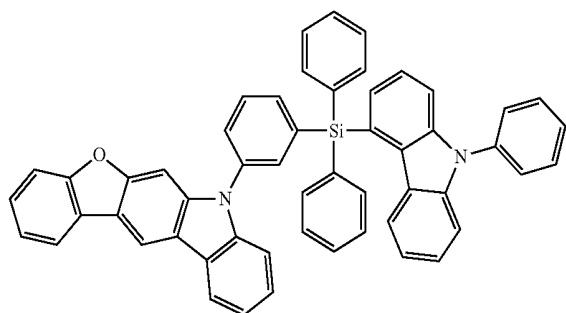


-continued

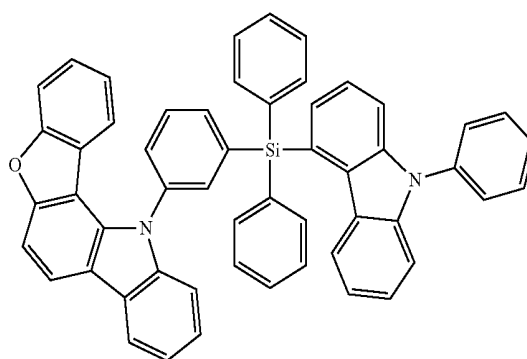
280



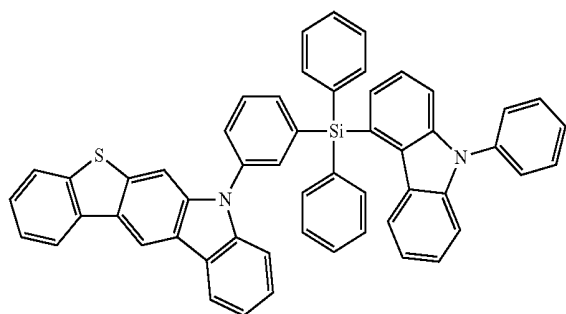
277



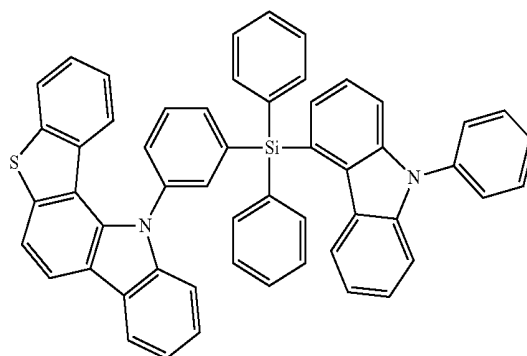
281



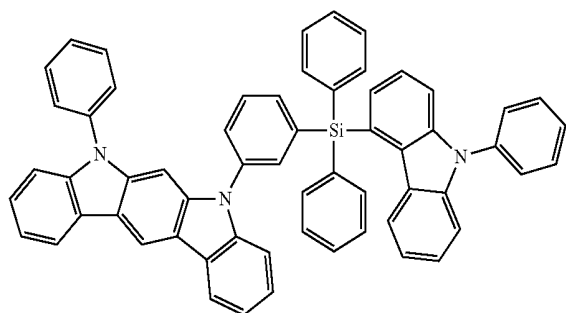
278



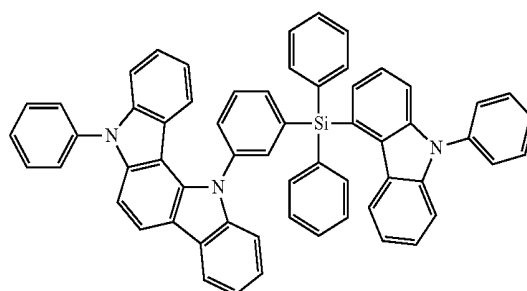
282



279

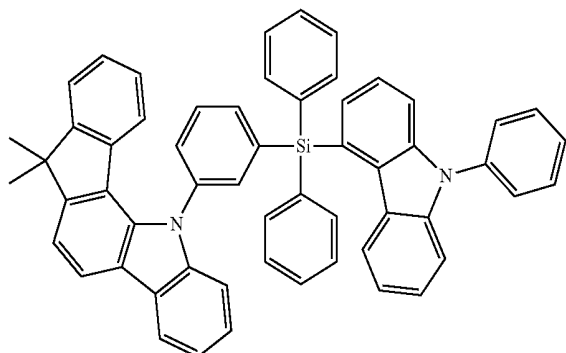


283



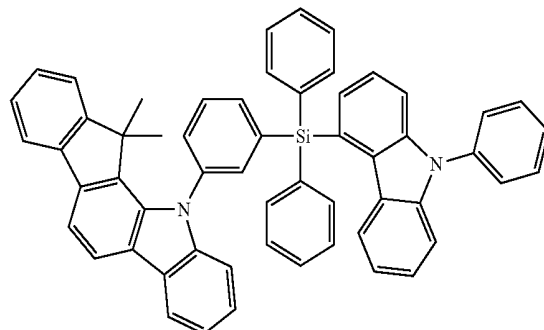
-continued

284



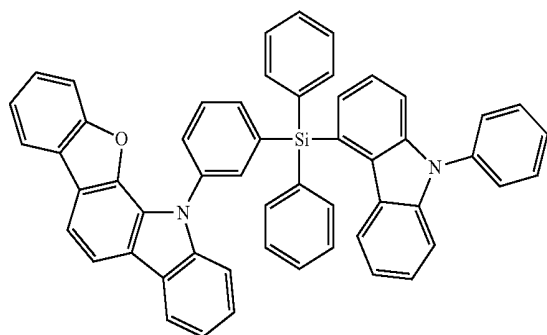
-continued

288

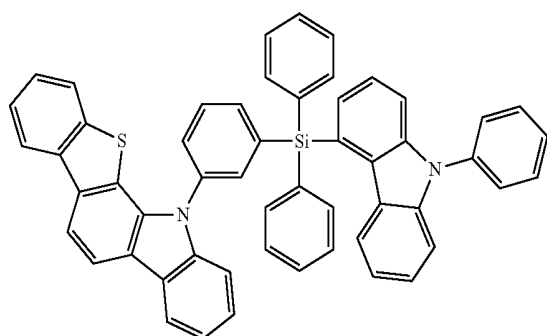


289

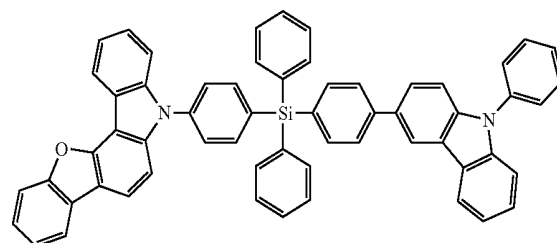
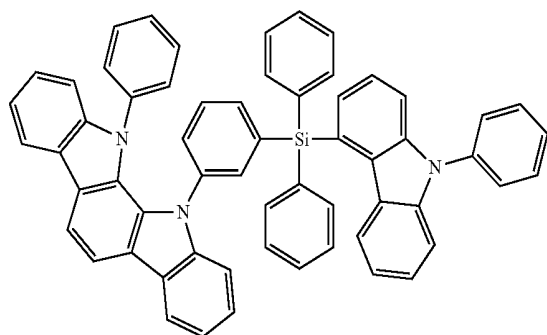
285



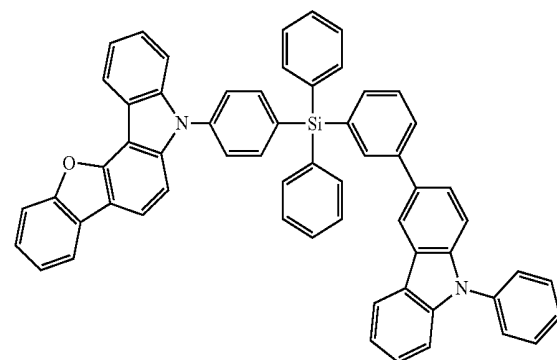
286



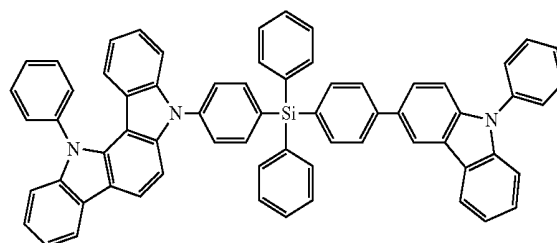
287



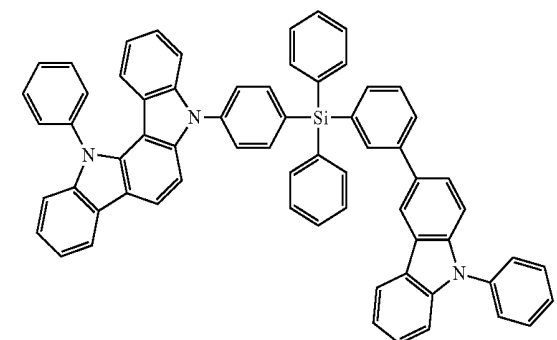
290



291

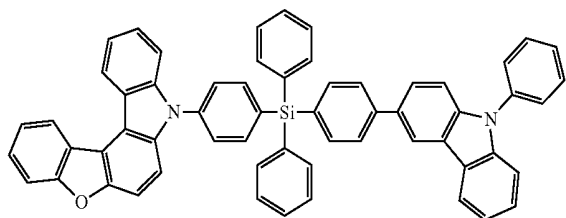


292

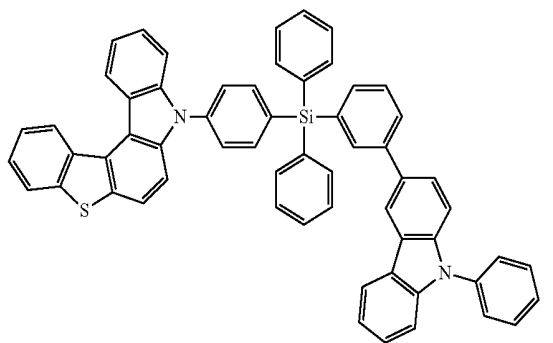


-continued

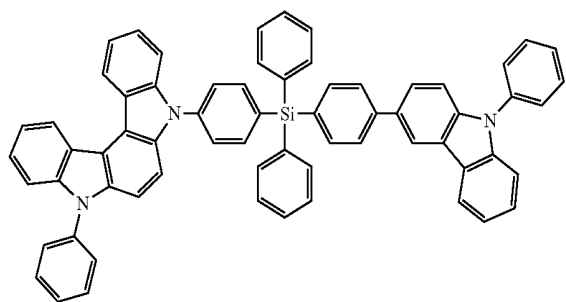
293



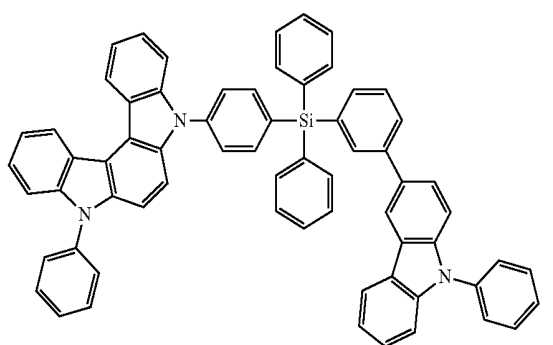
294



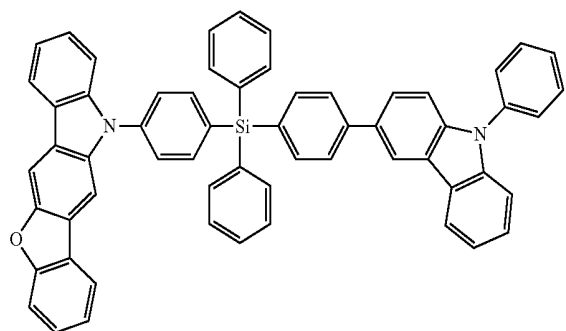
295



296

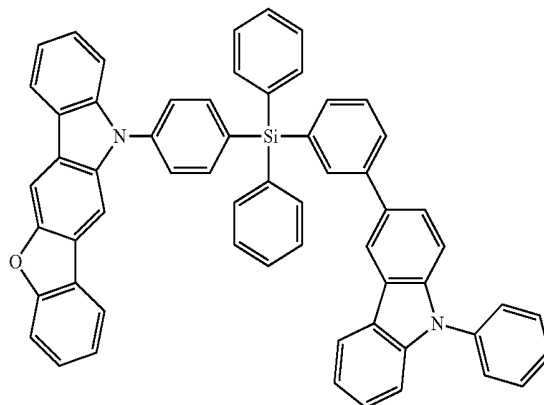


297

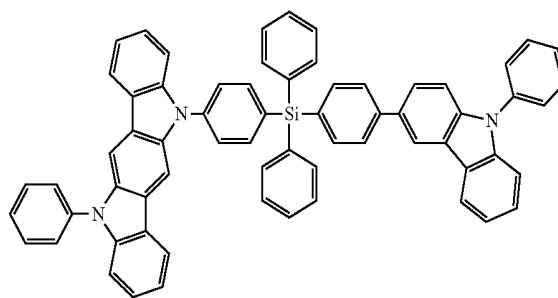


-continued

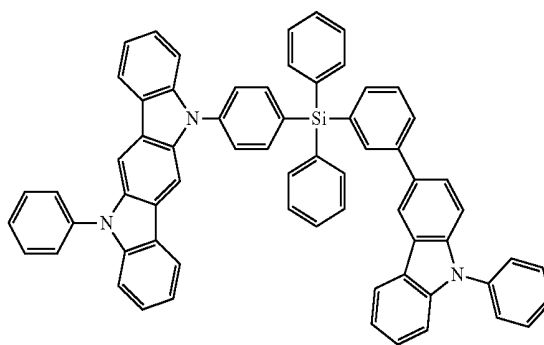
298



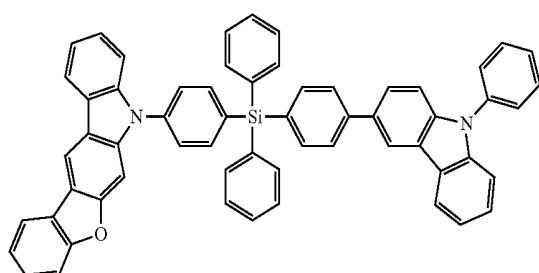
299



300

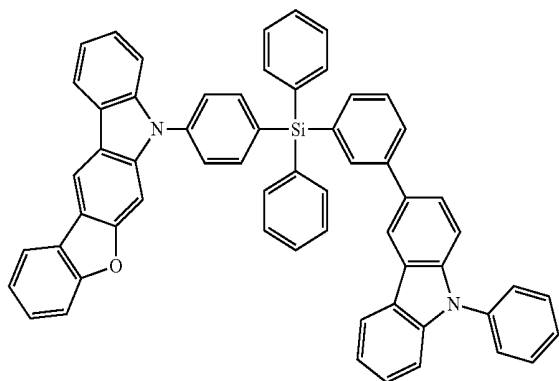


301



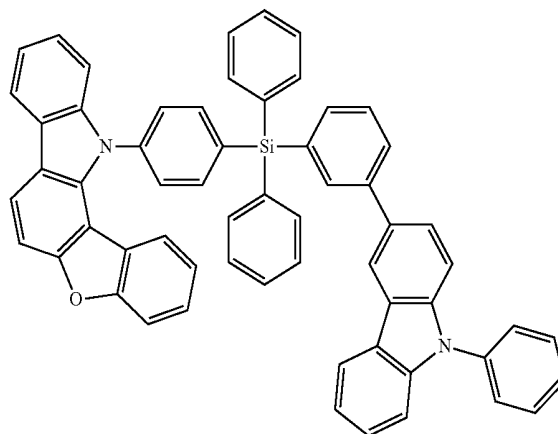
-continued

302

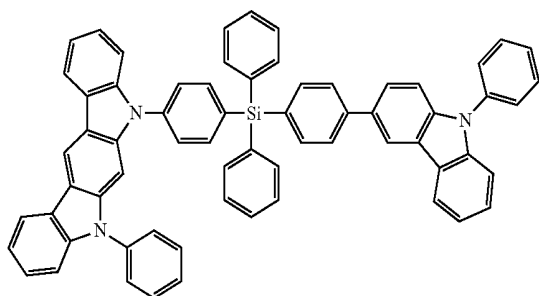


-continued

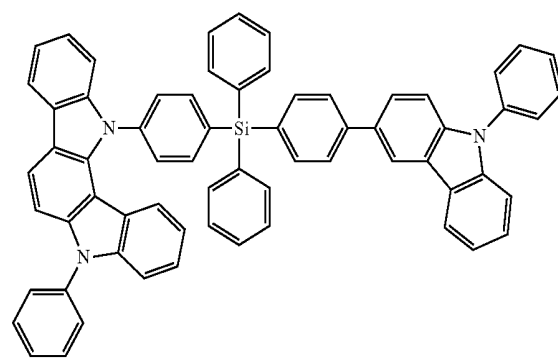
306



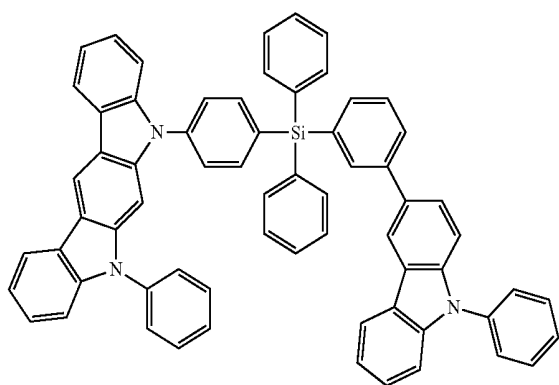
303



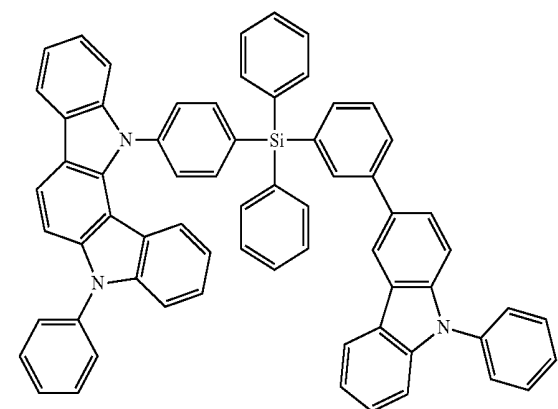
307



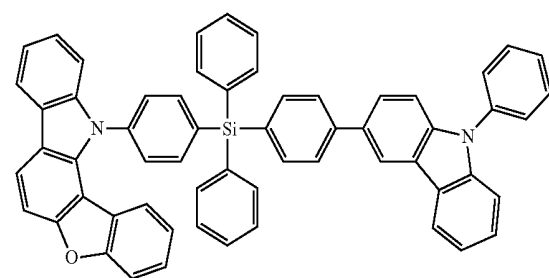
304



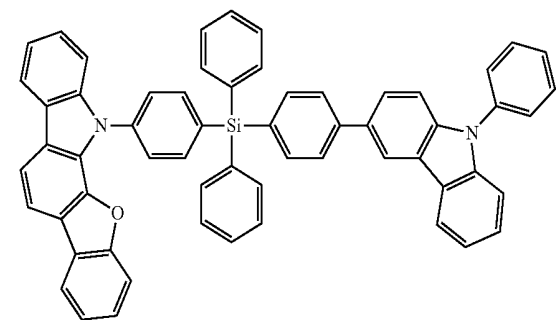
308



305

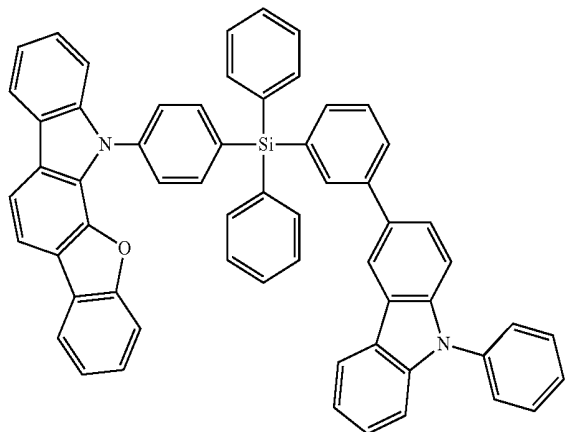


309



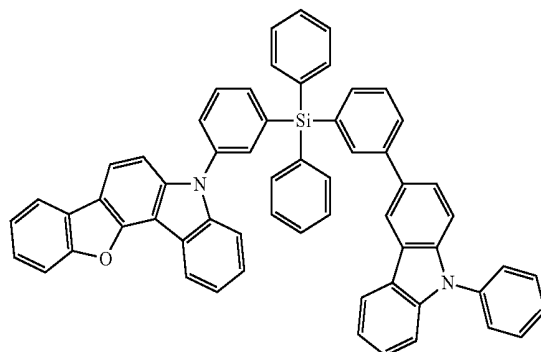
-continued

310

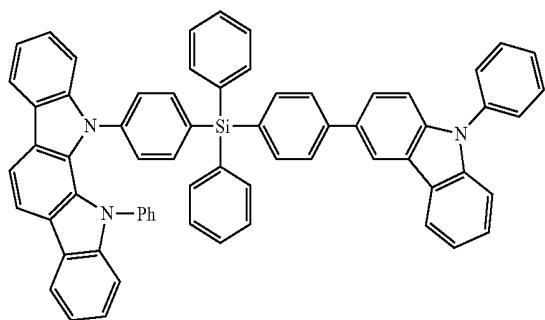


-continued

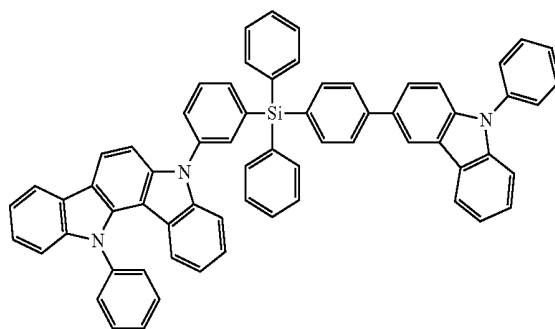
314



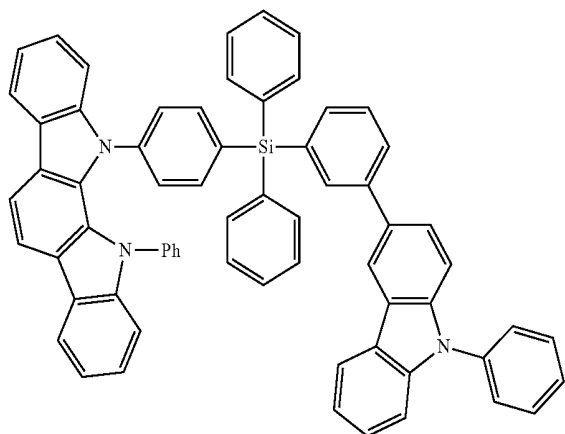
311



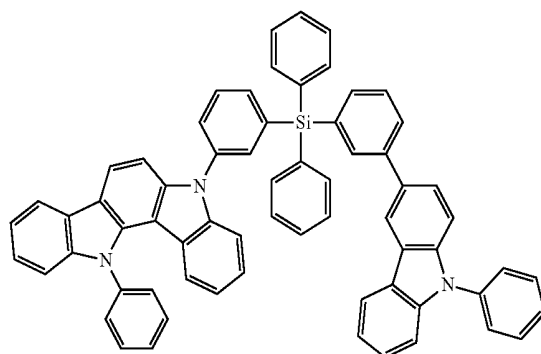
315



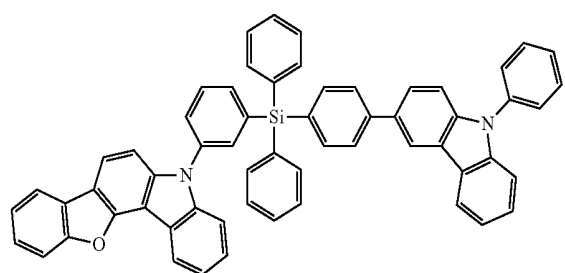
312



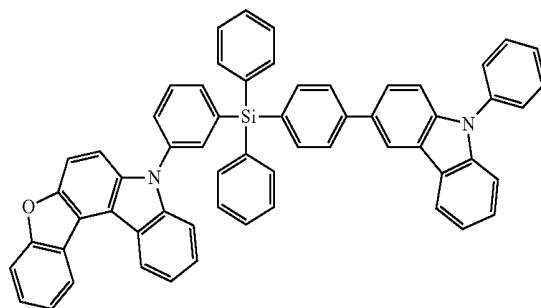
316



313

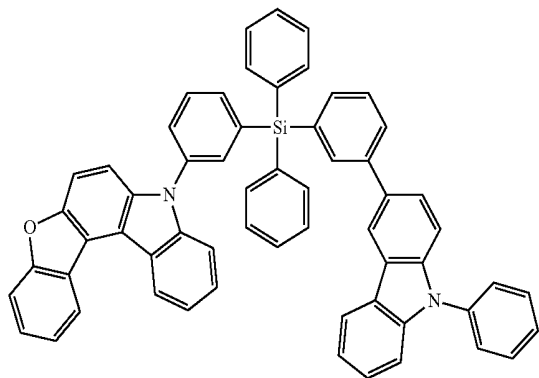


317



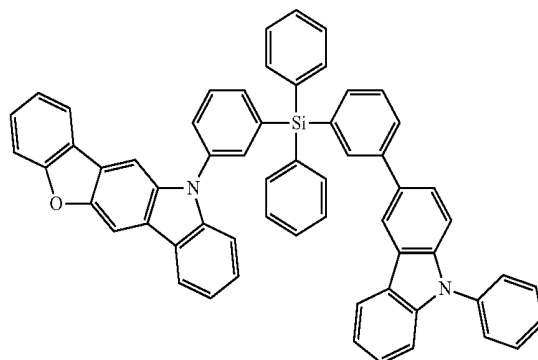
-continued

318

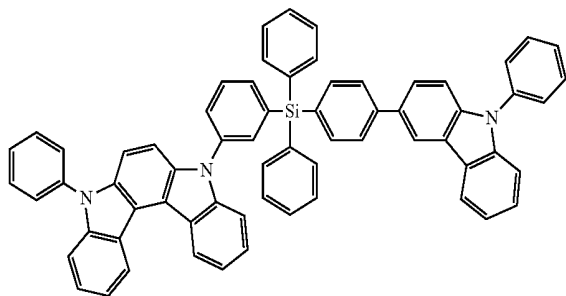


-continued

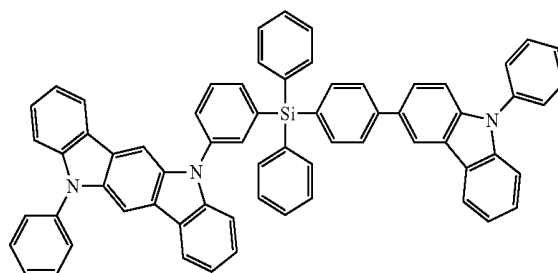
322



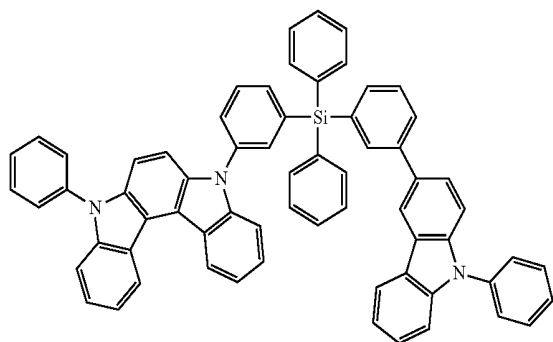
319



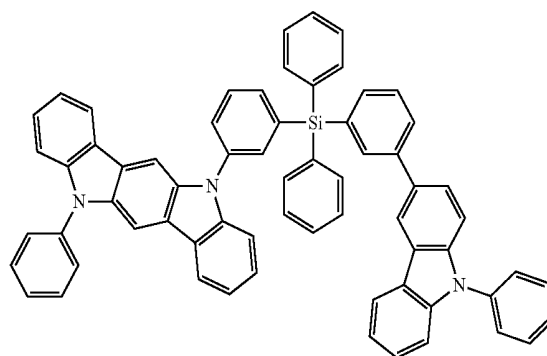
323



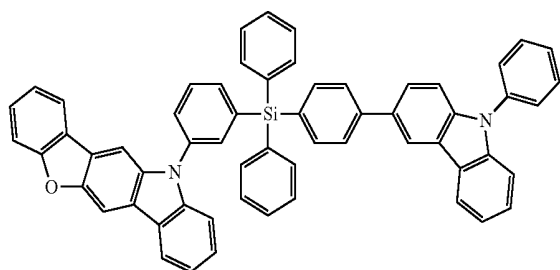
320



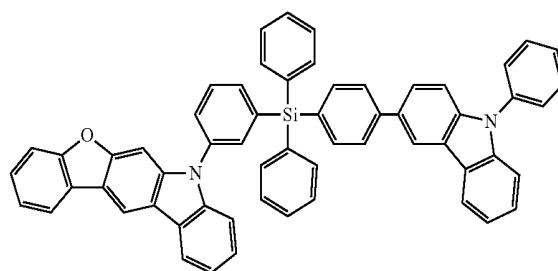
324



321

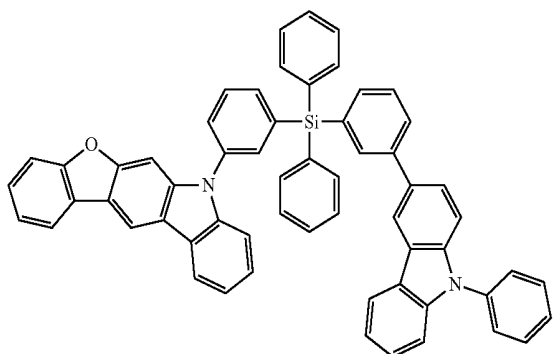


325



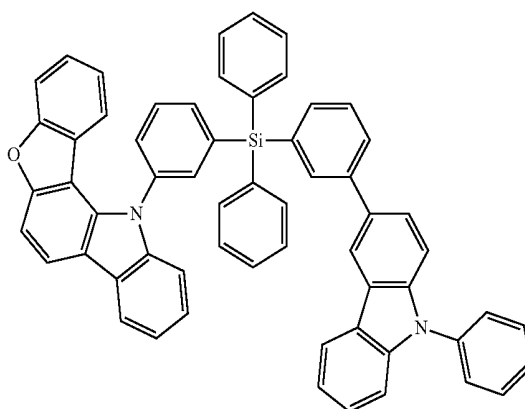
-continued

326

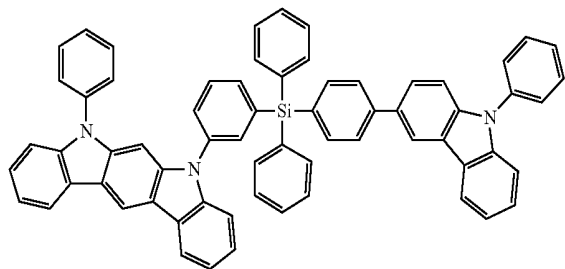


-continued

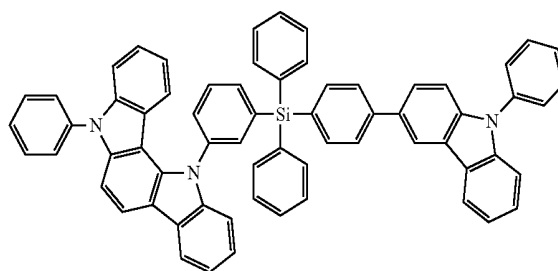
330



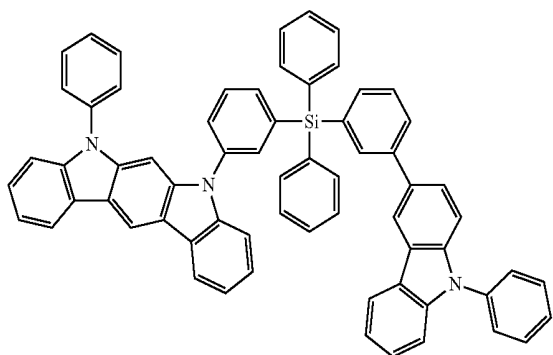
327



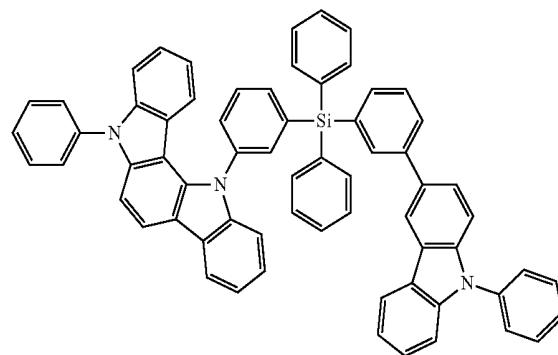
331



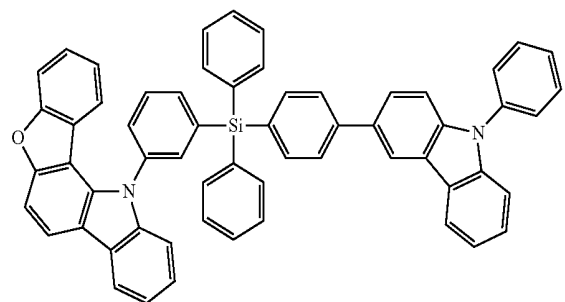
328



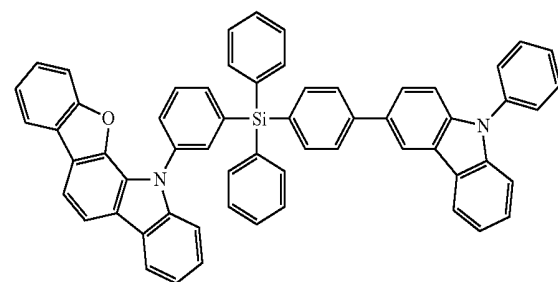
332



329

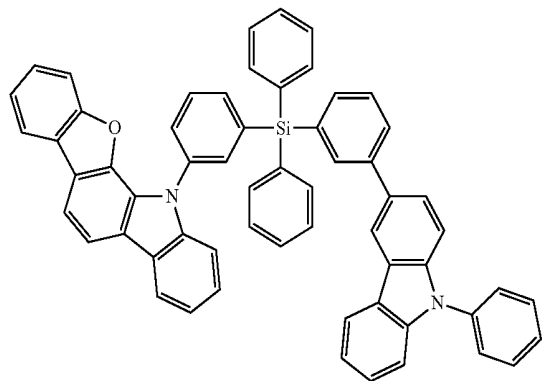


333



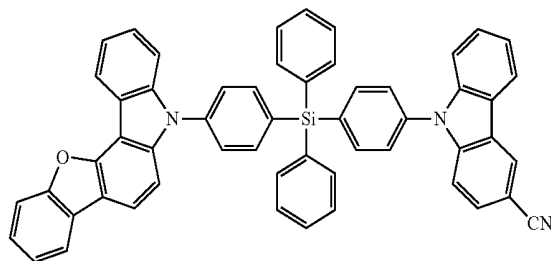
-continued

334

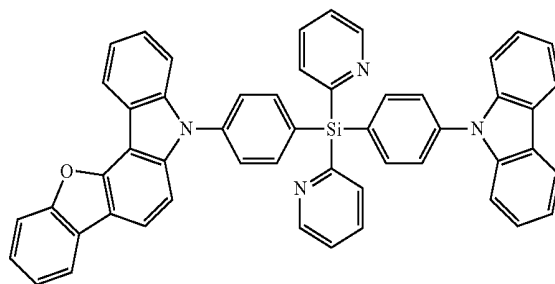


-continued

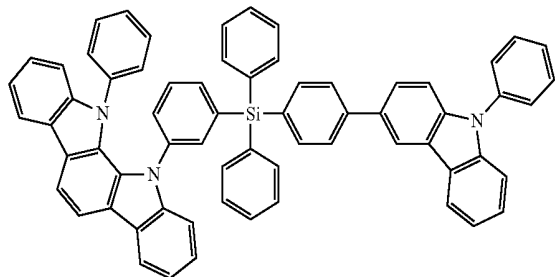
338



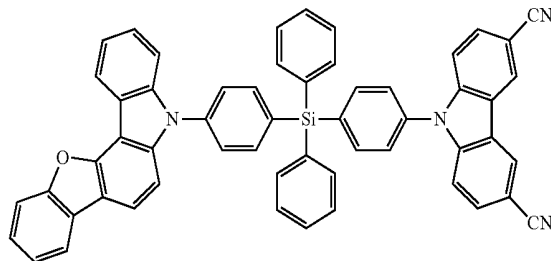
339



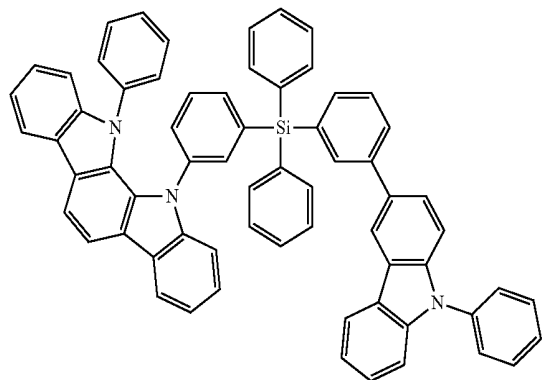
335



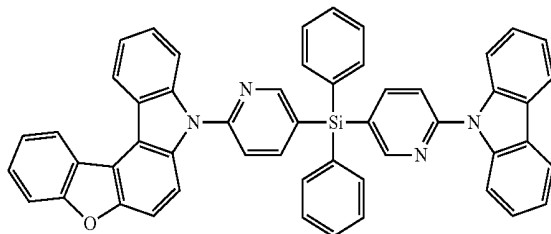
340



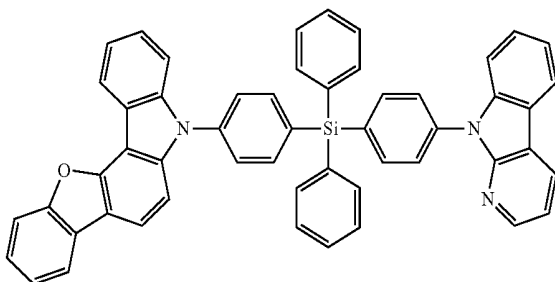
336



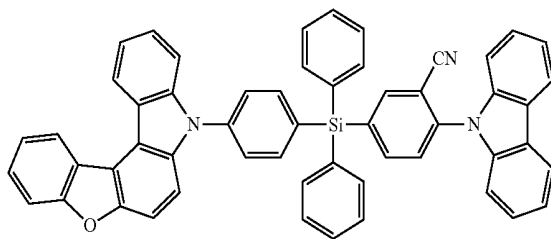
341



337

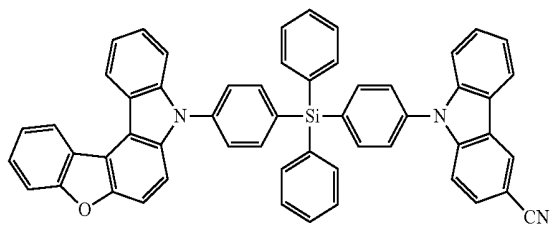


342

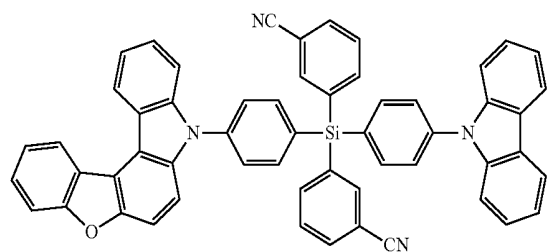


-continued

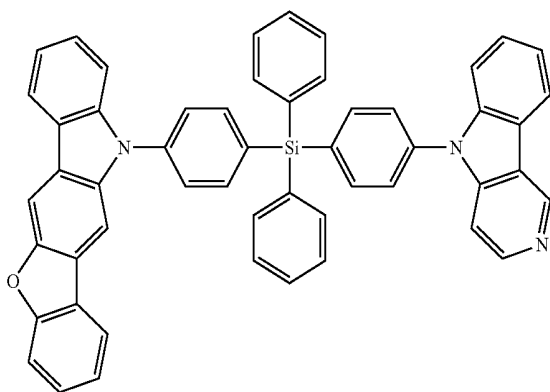
343



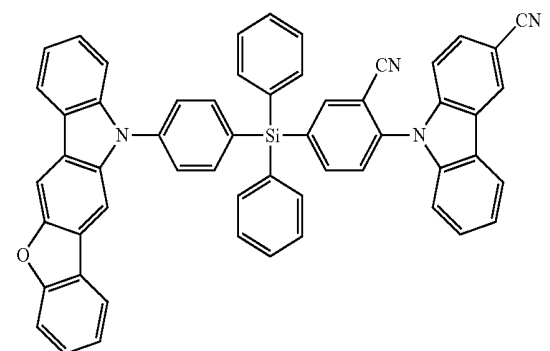
344



345

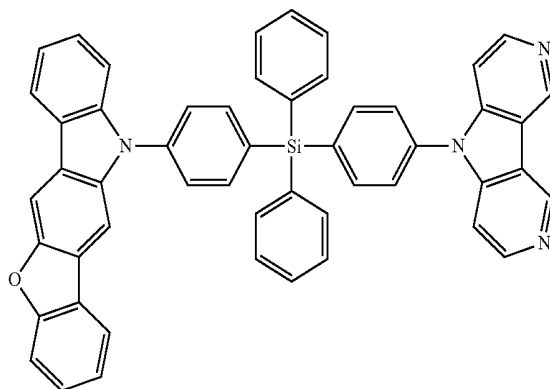


346

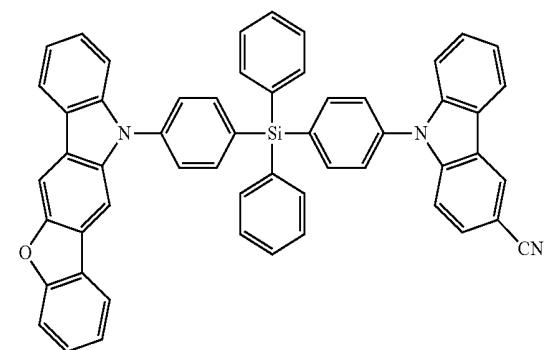


-continued

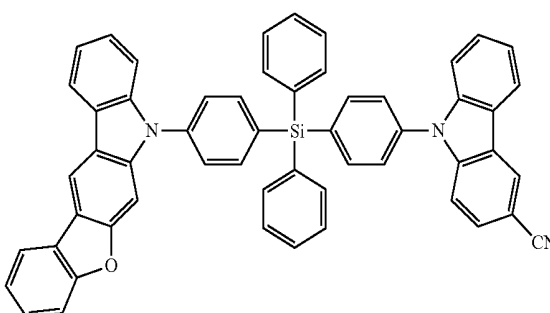
347



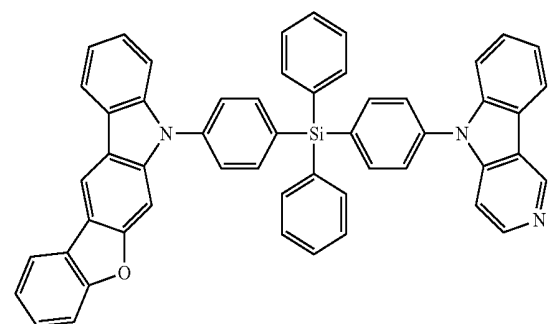
348



349

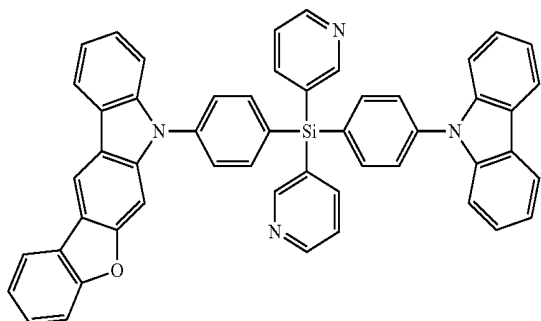


350



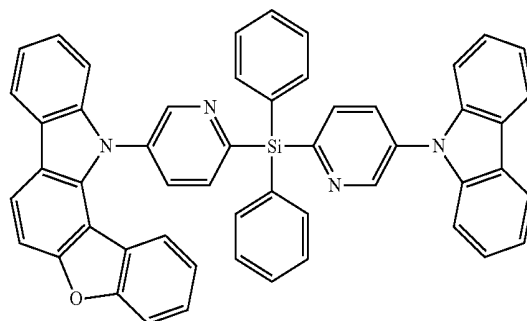
-continued

351

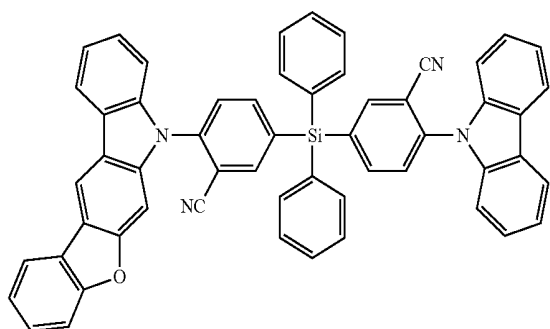


-continued

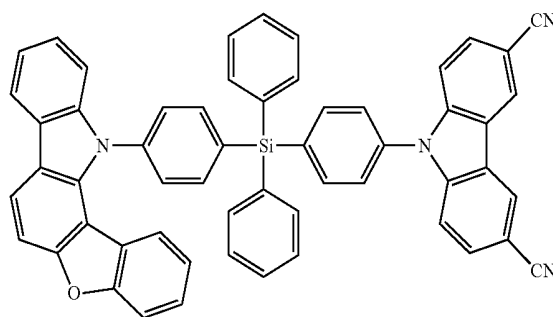
355



352

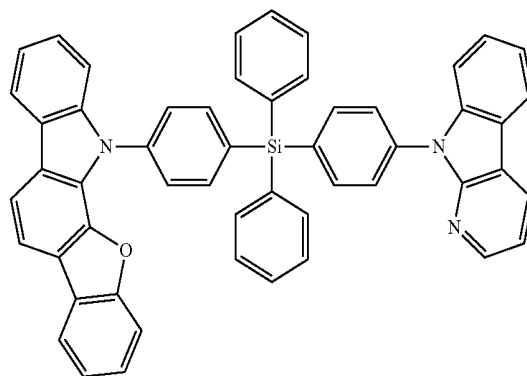
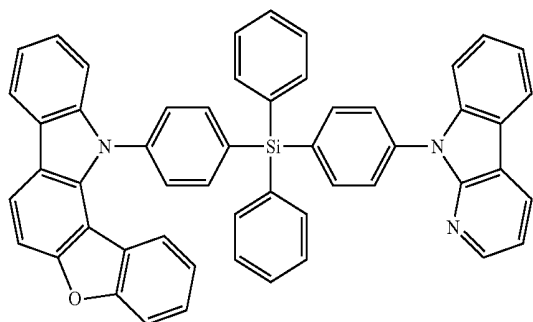


356



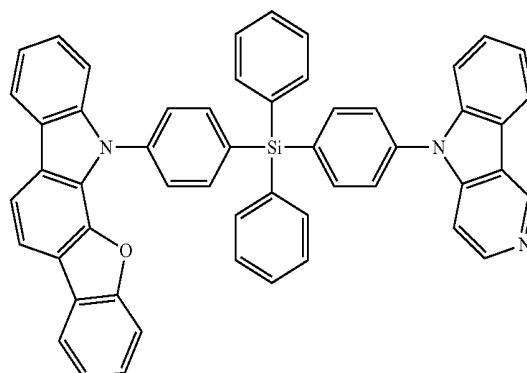
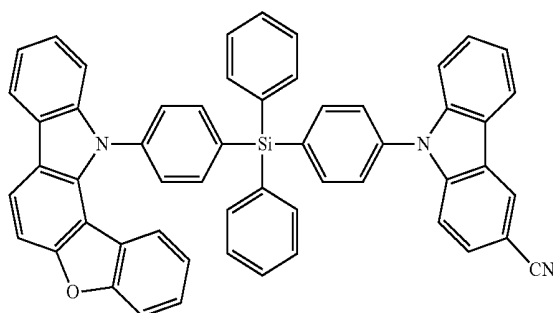
357

353



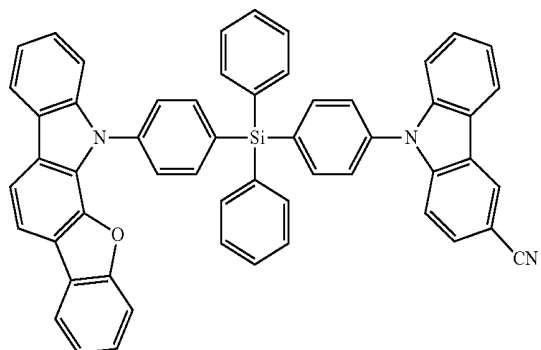
358

354



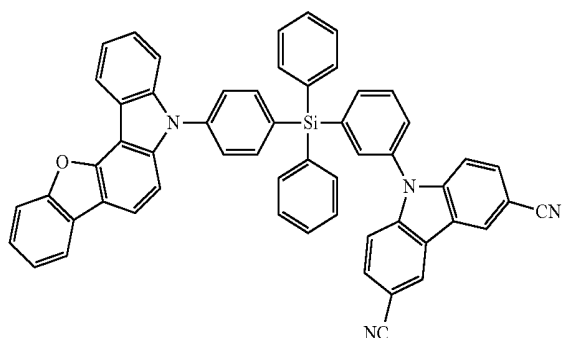
-continued

359



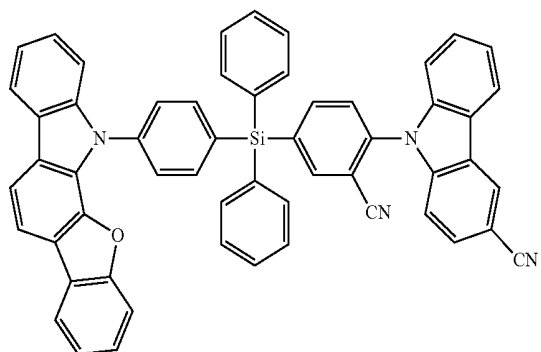
-continued

363

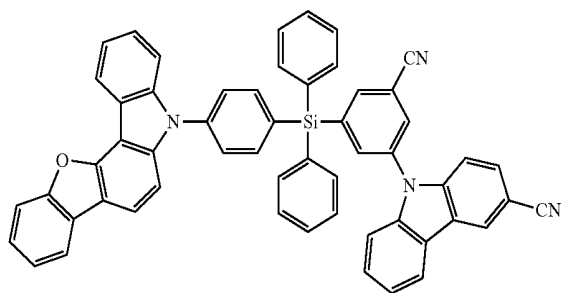


364

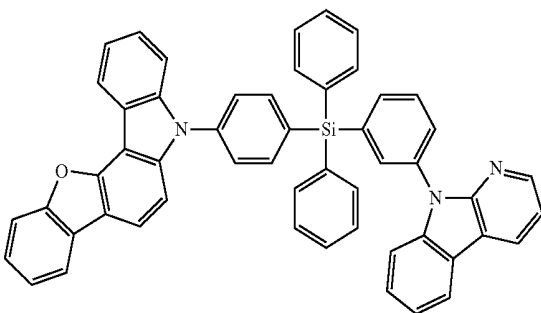
360



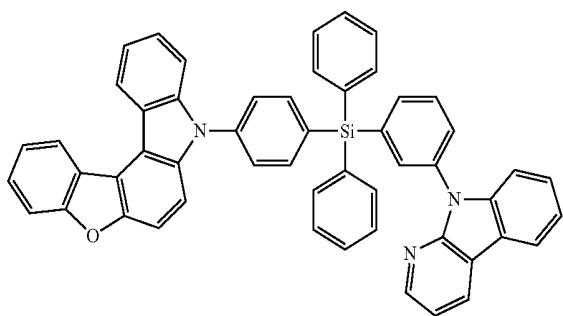
365



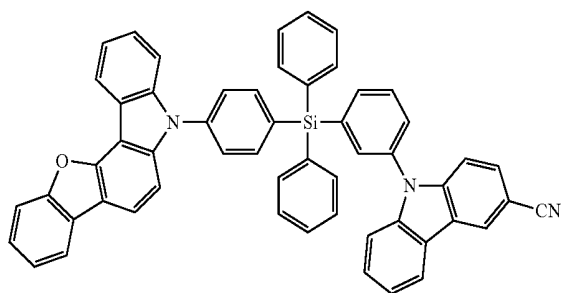
361



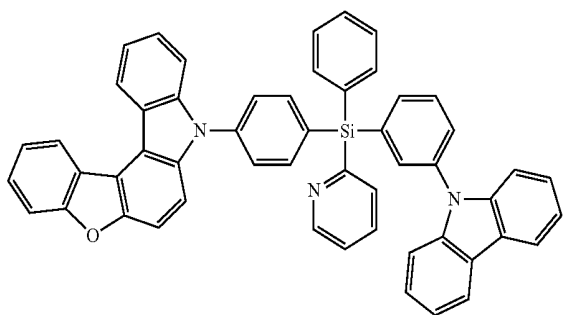
366



362

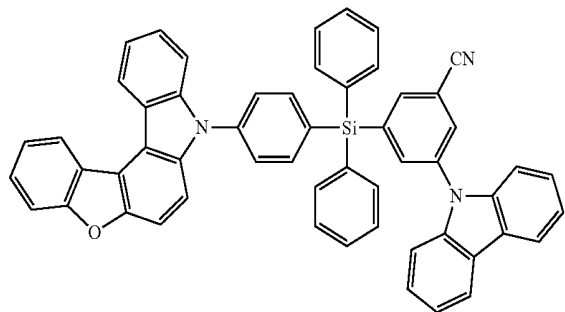


367

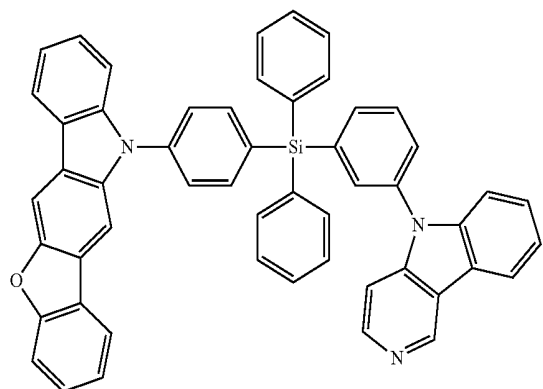
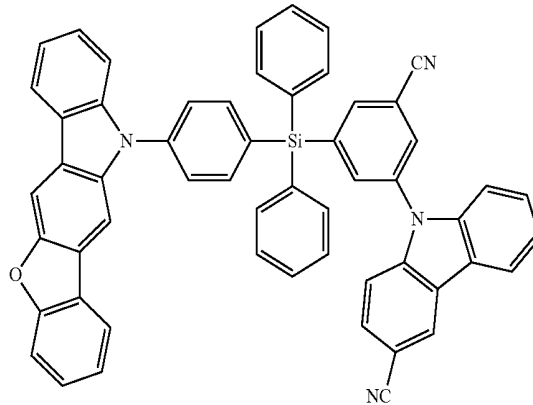


-continued

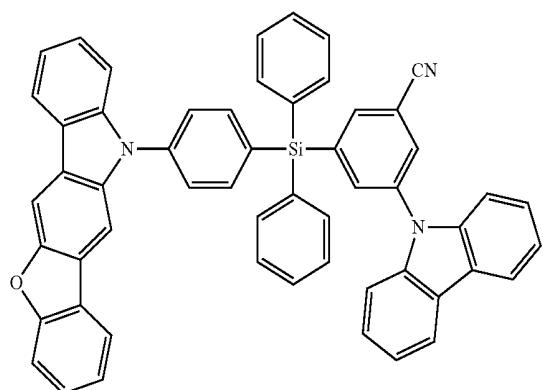
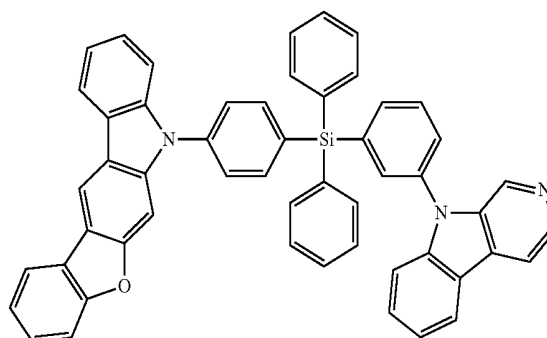
368



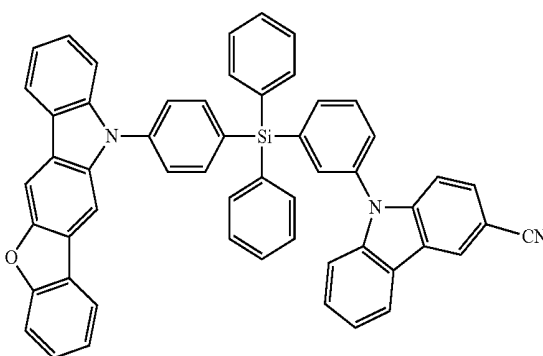
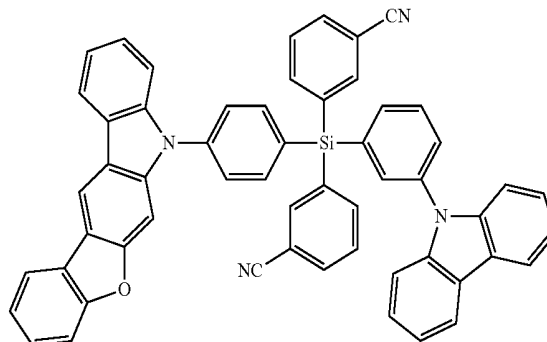
369



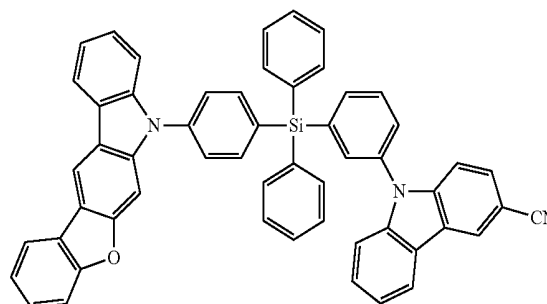
370



371



373



-continued

372

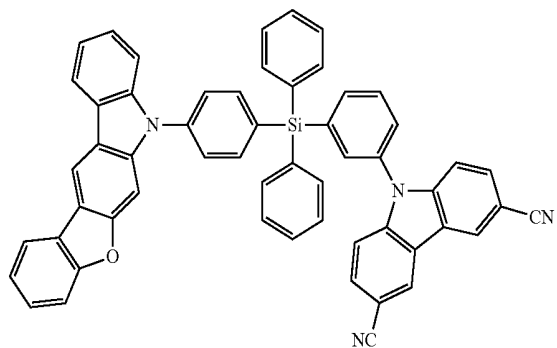
373

374

375

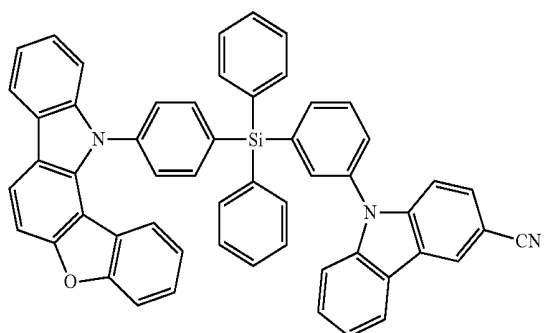
-continued

376



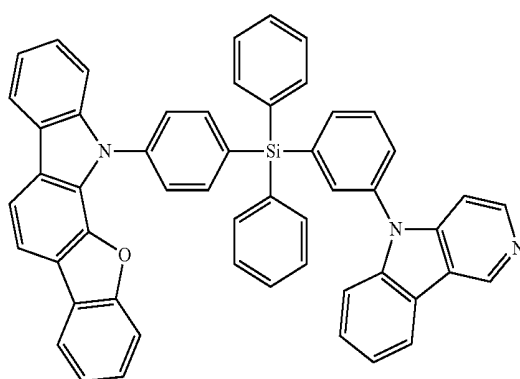
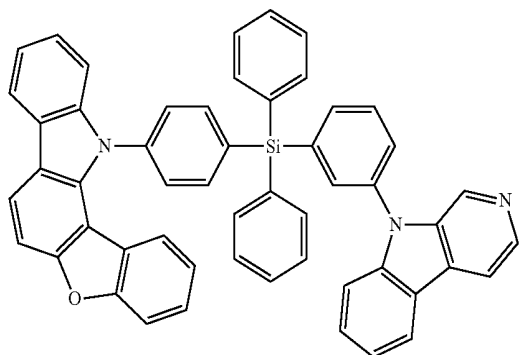
-continued

380



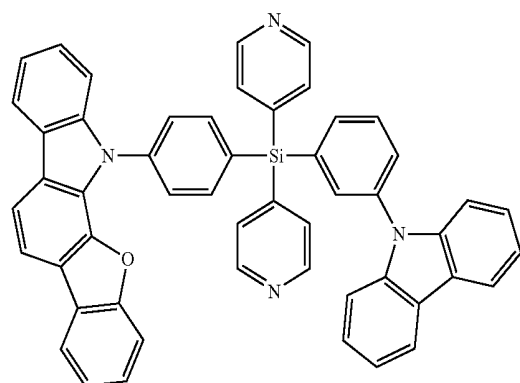
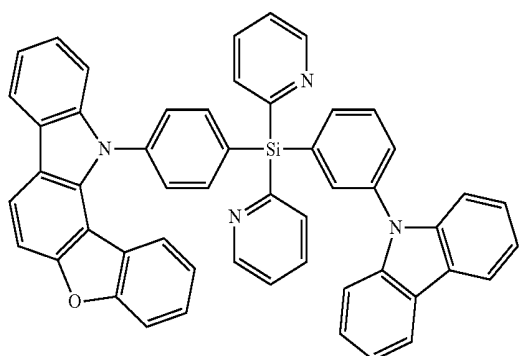
381

377



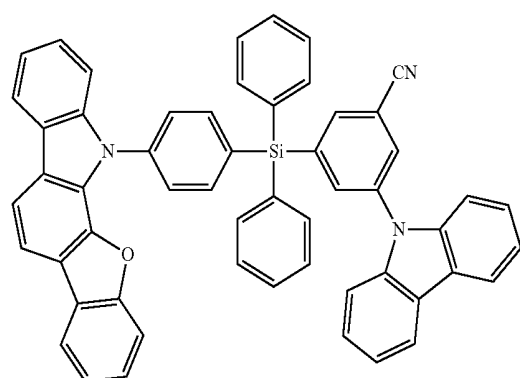
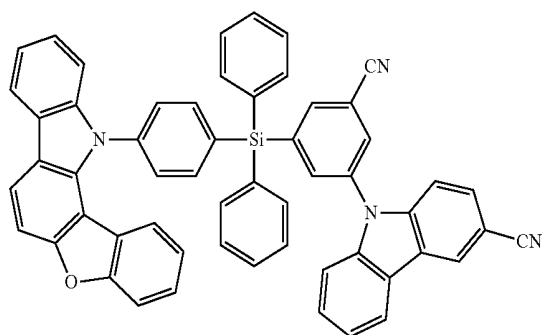
382

378



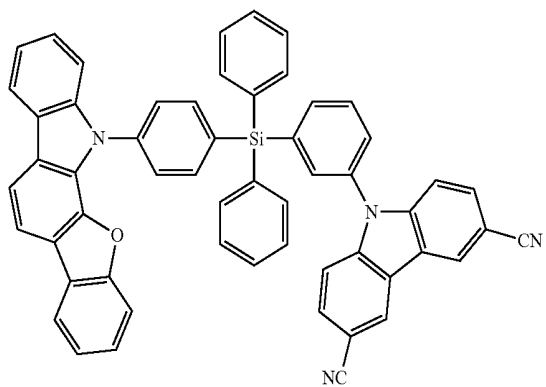
383

379



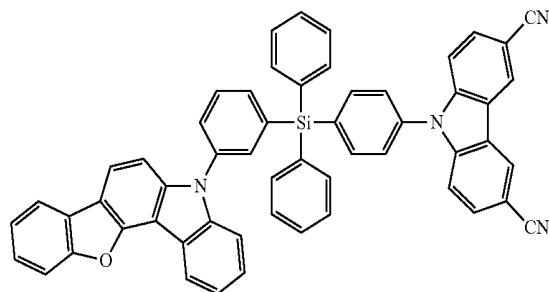
-continued

384



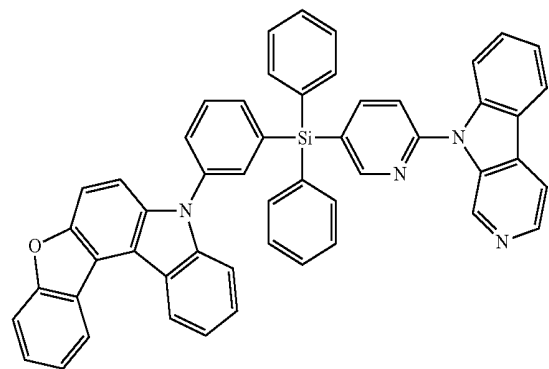
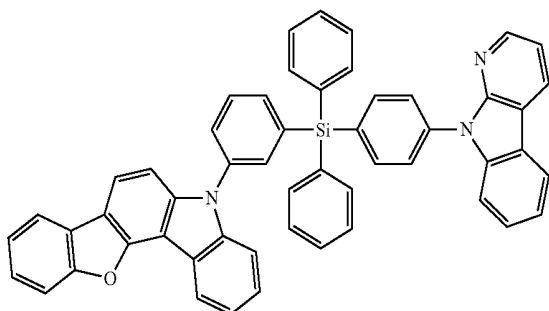
-continued

388



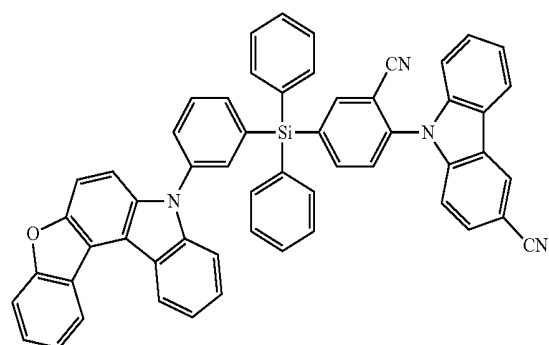
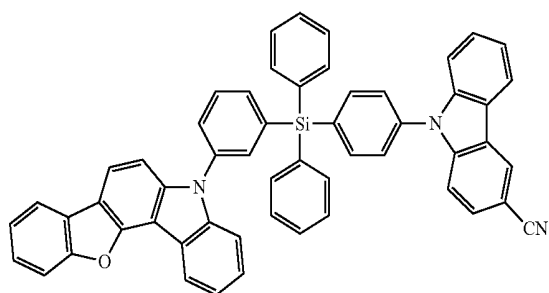
389

385

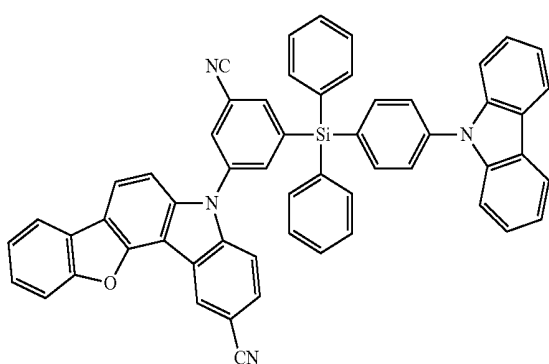


390

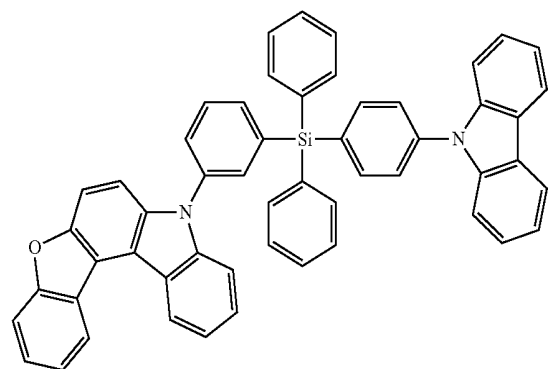
386



387

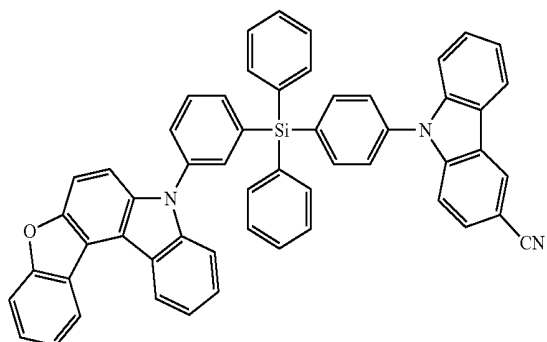


391



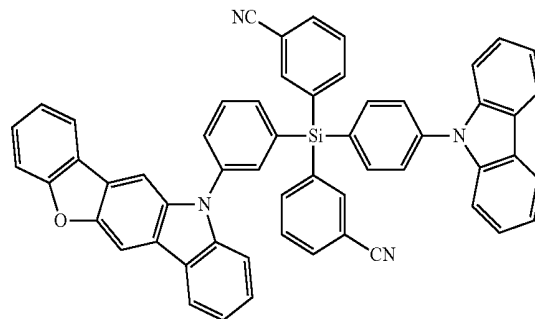
-continued

392

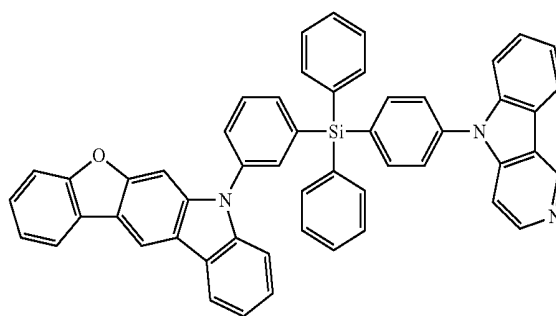


-continued

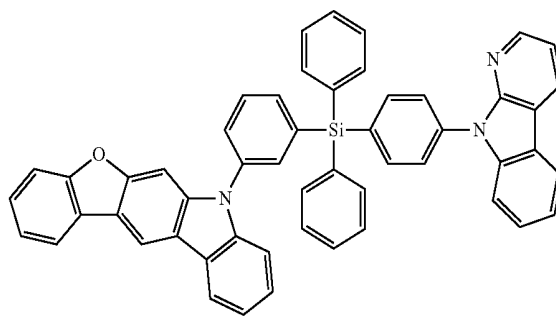
396



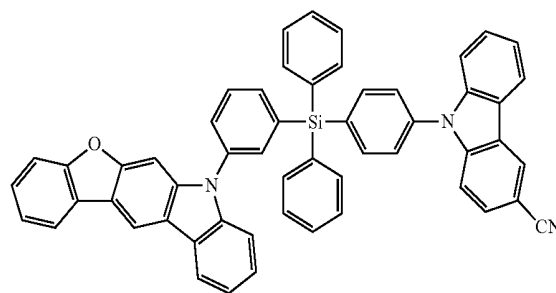
397



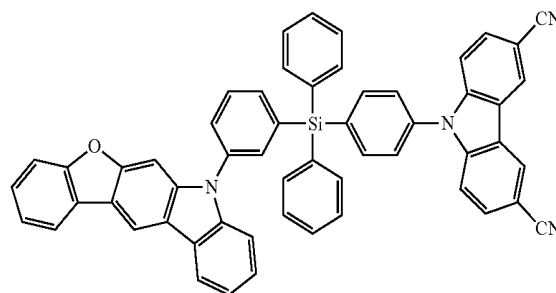
398



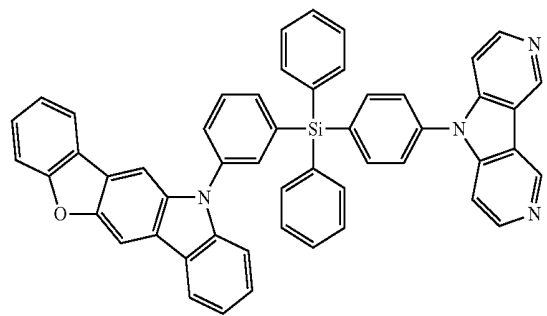
399



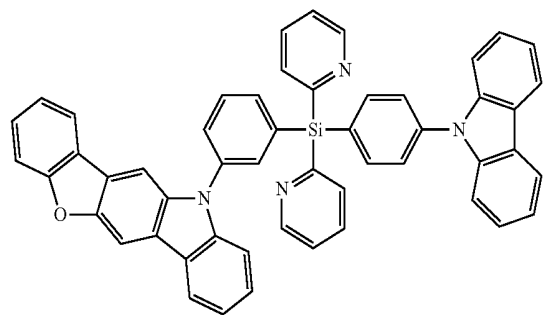
400



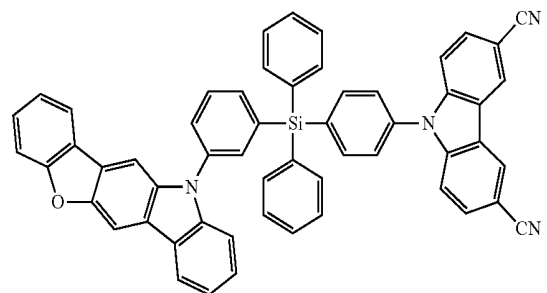
393



394

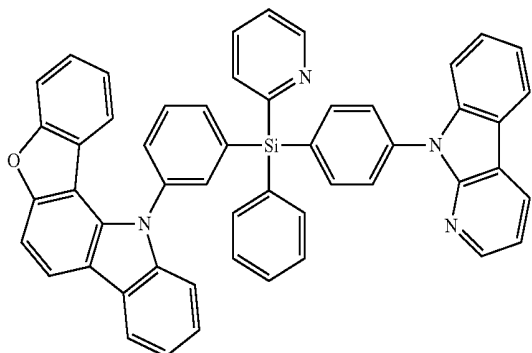


395



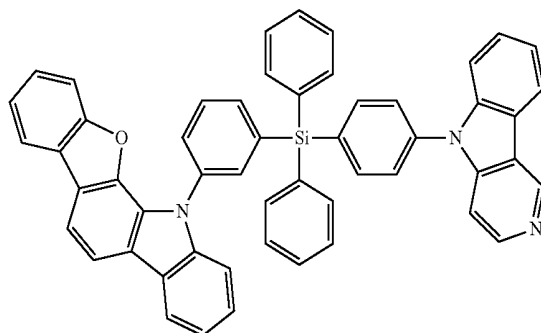
-continued

401

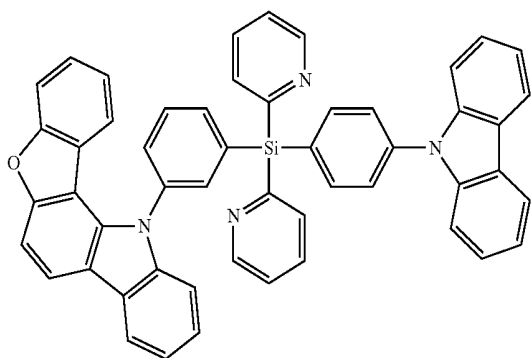


-continued

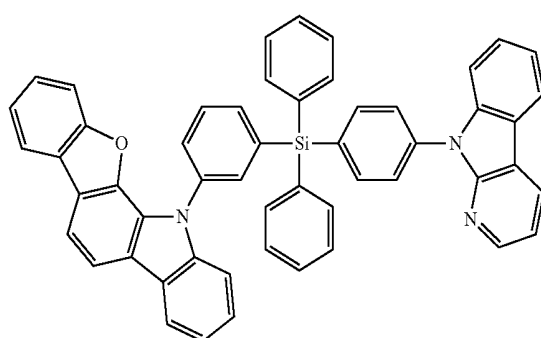
405



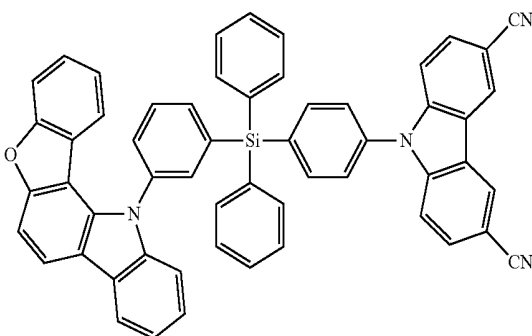
402



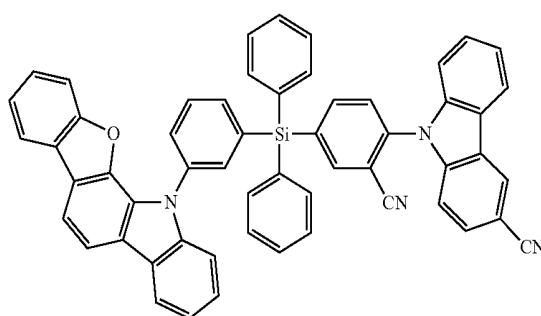
406



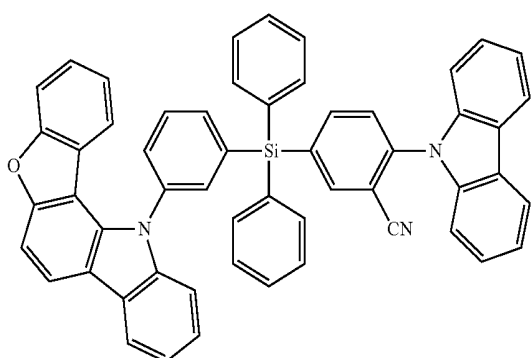
403



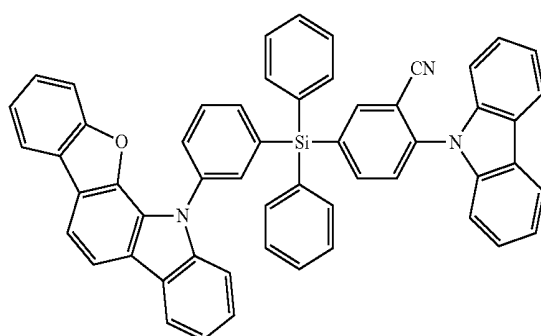
407



404

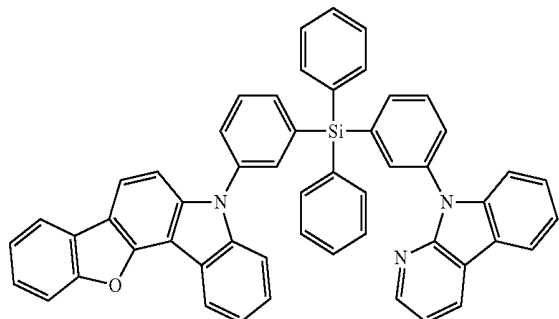


408



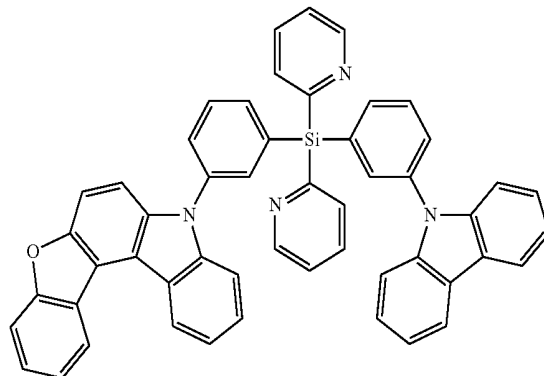
-continued

409

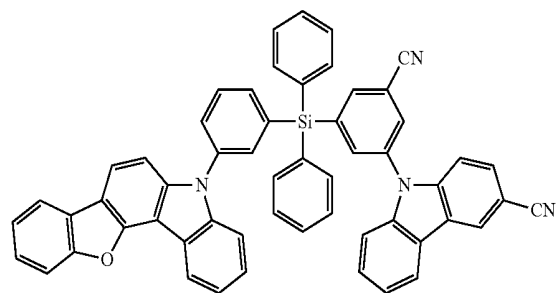


-continued

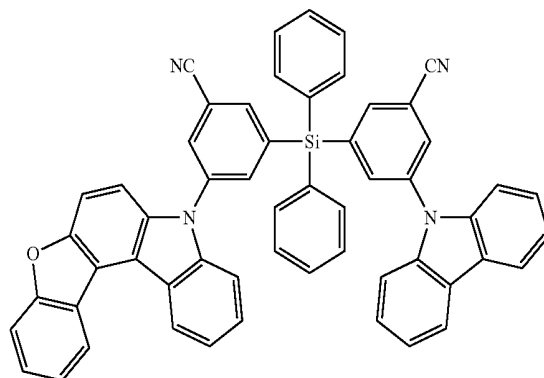
413



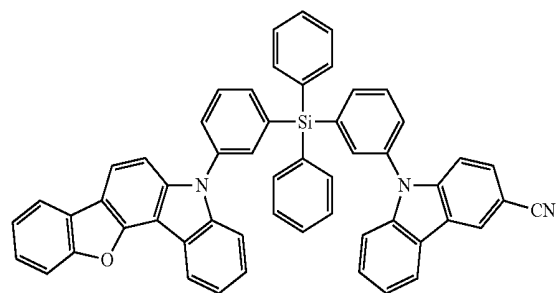
410



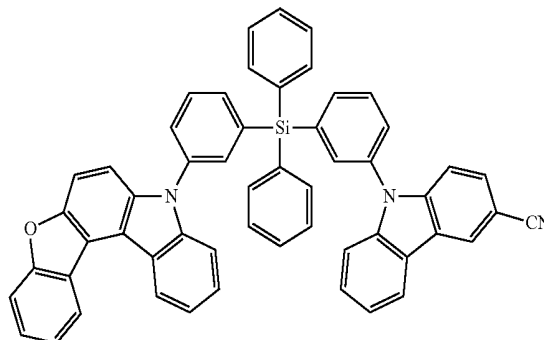
414



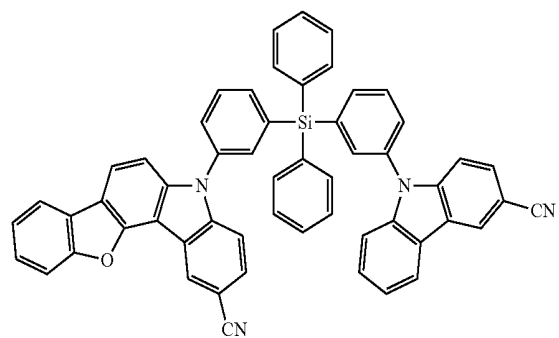
411



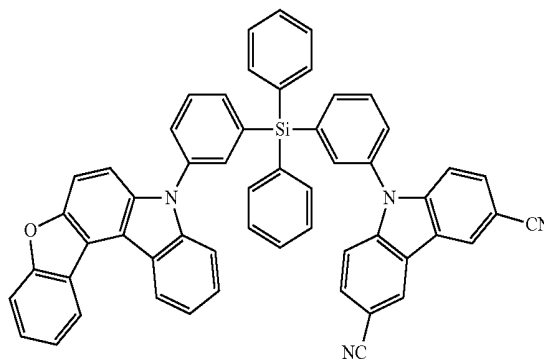
415



412

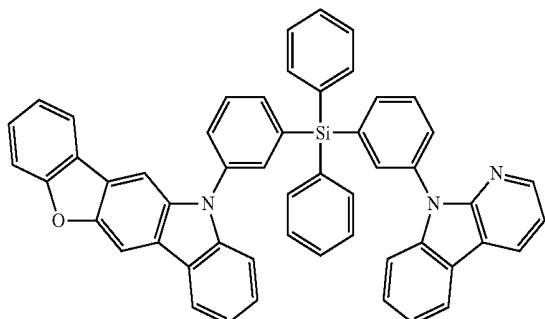


416



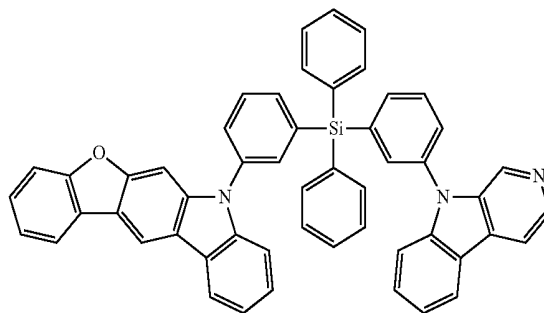
-continued

417

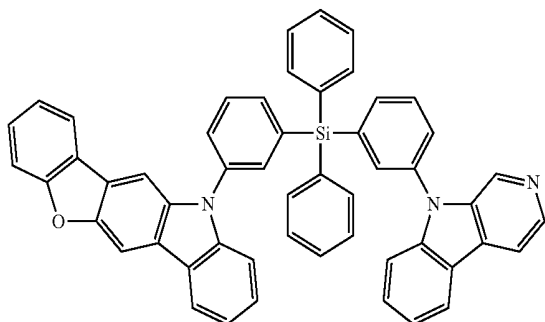


-continued

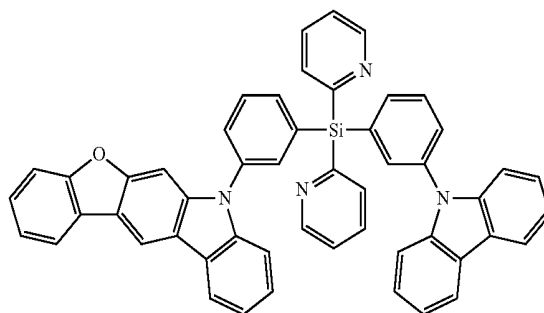
421



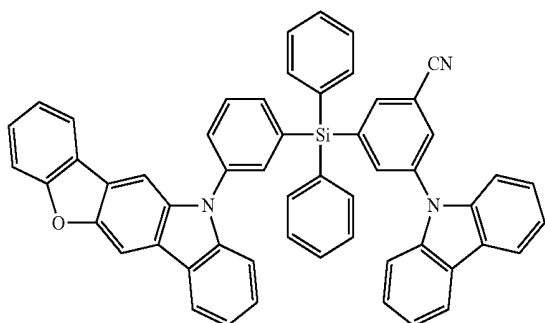
418



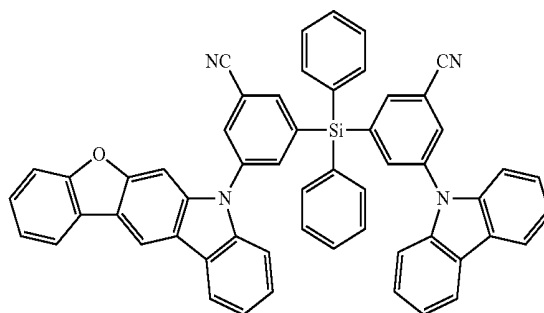
422



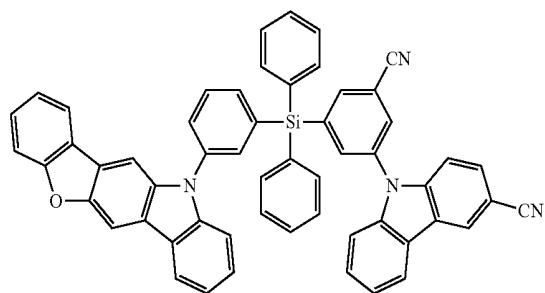
419



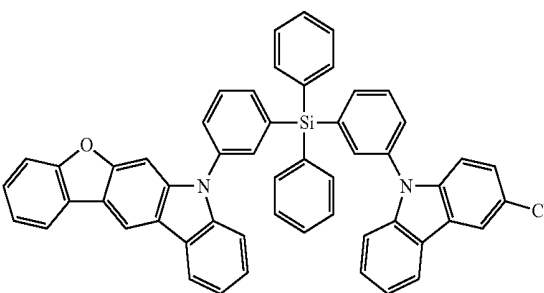
423



420

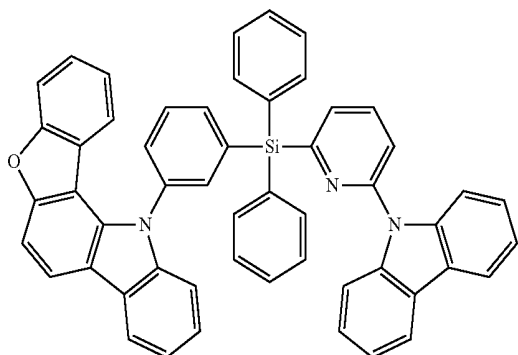


424



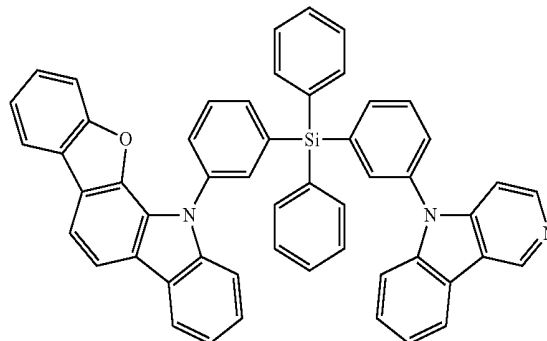
-continued

425



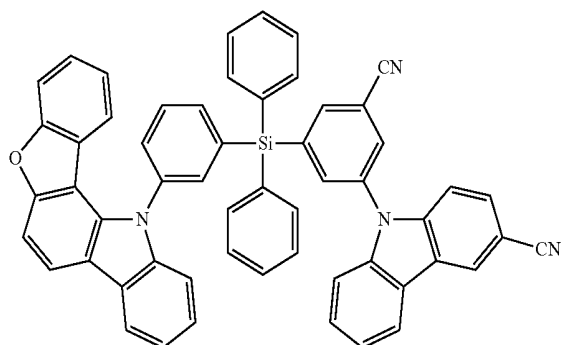
-continued

429

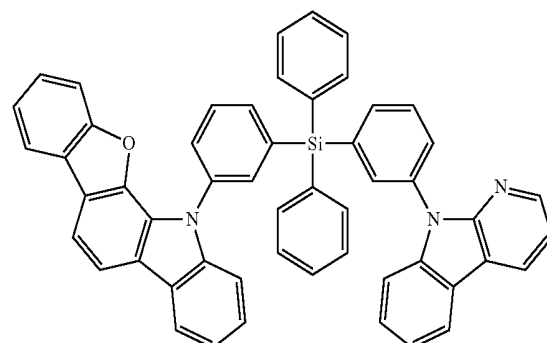


430

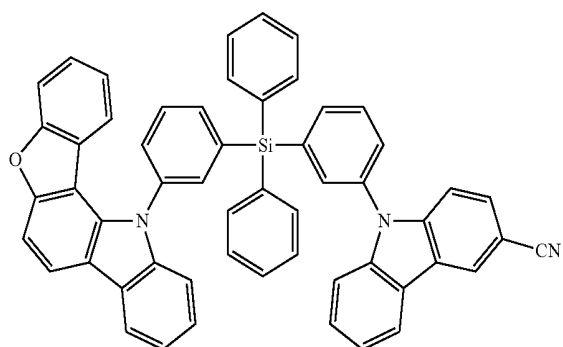
426



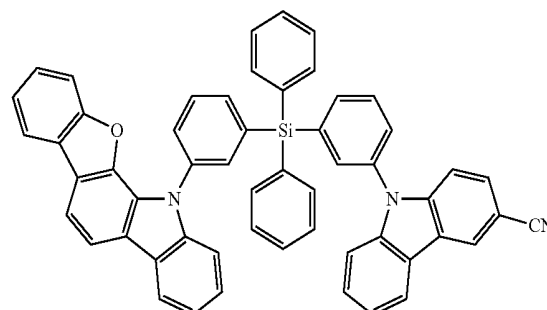
431



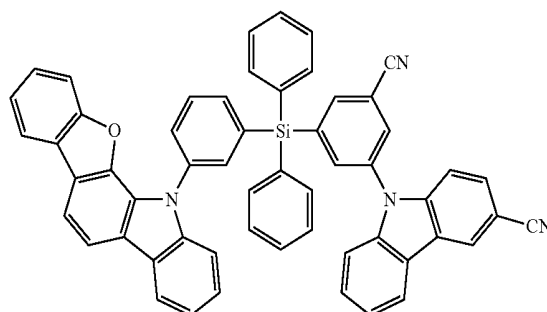
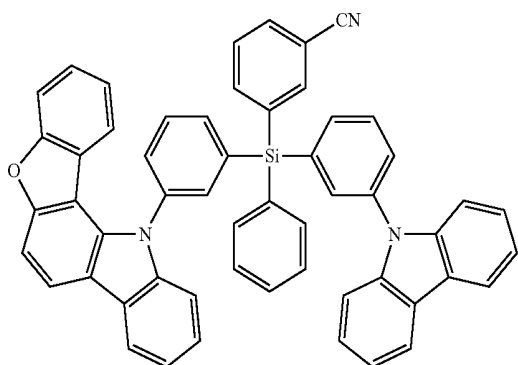
427



432



428



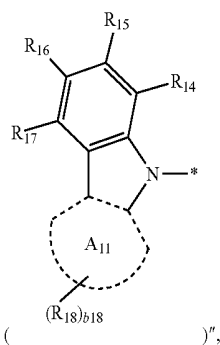
wherein, in Compounds 1 to 432,

[0293] Ph is a phenyl group.

[0294] The silyl group-containing compound represented by Formula 1 essentially includes "Si". Thus, a conjugation length of the silyl group-containing compound represented by Formula 1 may be adjusted and may have a high minimum excitation triplet energy level accordingly. For example, the silyl group-containing compound may have a minimum excitation triplet energy level of 2.8 electron volts

(eV) or higher. Therefore, the silyl group-containing compound represented by Formula 1 may have high efficiency and a long lifespan.

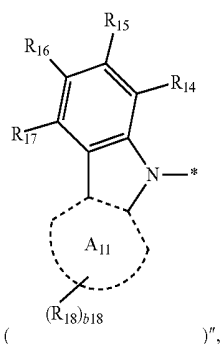
[0295] Since the silyl group-containing compound represented by Formula 1 essentially includes a “condensed ring



such as an indenocarbazole or an indolocarbazole, the silyl group-containing compound may have high thermal stability and high charge mobility. Therefore, the silyl group-containing compound represented by Formula 1 may have high efficiency and a long lifespan.

[0296] Since the silyl group-containing compound represented by Formula 1 may introduce various substituents into R₁₁ to R₁₃, it may allow to adjust the lowest unoccupied molecular orbital (LUMO) energy level and the highest occupied molecular orbital (HOMO) energy level of the silyl group-containing compound represented by Formula 1. Therefore, an organic light-emitting device including the silyl group-containing compound represented by Formula 1 may have high efficiency and a long lifespan.

[0297] Furthermore, since the silyl group-containing compound represented by Formula 1 essentially includes at least one “carbazole”, the silyl group-containing compound represented by Formula 1 may have improved hole mobility characteristics. Also, since the silyl group-containing compound represented by Formula 1 includes a “condensed ring

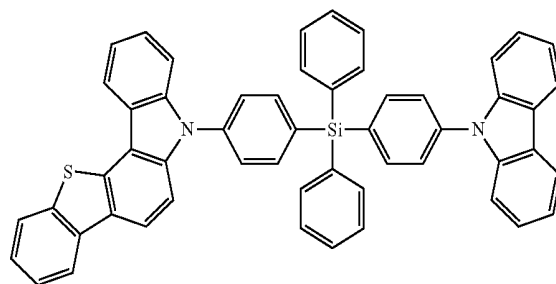
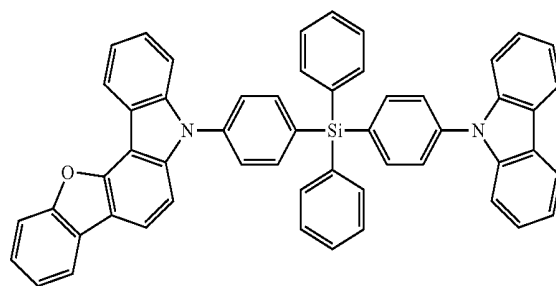


and a substituent, the silyl group-containing compound represented by Formula 1 may have improved electron mobility characteristics. That is, the silyl group-containing compound represented by Formula 1 may have improved hole mobility characteristics and may have bipolar characteristics. Therefore, an organic light-emitting device including the silyl group-containing compound represented by Formula 1 may have high efficiency and a long lifespan,

[0298] A HOMO energy level, a LUMO energy level, a minimum excitation triplet energy level (T₁), and a minimum excitation singlet energy level (S₁) of Compounds 1, 2, 17, 19, 21, 25, 26, 41, 43, 45, 49, 65, 69, 73, 97, 98, 113, 115, 117, 121, 338, 362, 386, A, and B were evaluated by a density functional theory (DFT) method of a Gaussian program (the structure was optimized at B3LYP/6-31G(d,p) level). Results thereof are shown in Table 1.

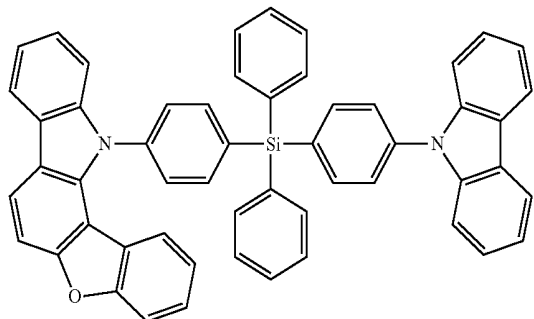
TABLE 1

Compound No.	HOMO (eV)	LUMO (eV)	T ₁ (eV)	S ₁ (eV)
1	-5.265	-0.987	3.002	3.743
2	-5.310	-0.999	2.968	3.764
17	-5.388	-1.015	2.981	3.777
19	-5.052	-0.903	2.963	3.652
21	-5.362	-1.062	2.958	3.757
25	-5.267	-0.982	3.003	3.740
26	-5.312	-0.992	2.968	3.764
41	-5.382	-1.010	2.981	3.768
43	-5.063	-0.883	2.963	3.653
45	-5.328	-1.069	2.958	3.757
49	-5.228	-0.972	3.005	3.748
65	-5.369	-1.015	2.978	3.786
69	-5.345	-1.019	2.960	3.766
73	-5.231	-0.946	3.005	3.773
97	-5.179	-0.897	3.003	3.783
98	-5.230	-0.876	2.969	3.796
113	-5.298	-0.918	2.980	3.828
115	-4.972	-0.838	2.963	3.688
117	-5.289	-0.974	2.961	3.757
121	-5.280	-0.946	3.004	3.805
338	-5.345	-1.225	3.002	3.700
362	-5.298	-1.190	3.002	3.681
386	-5.318	-1.238	3.005	3.679
A	-5.231	-1.065	2.972	3.792
B	-5.236	-0.852	2.971	3.810



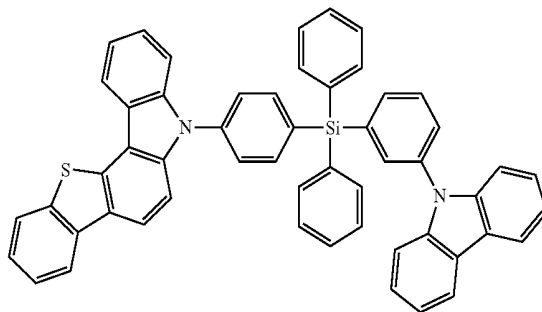
-continued

17

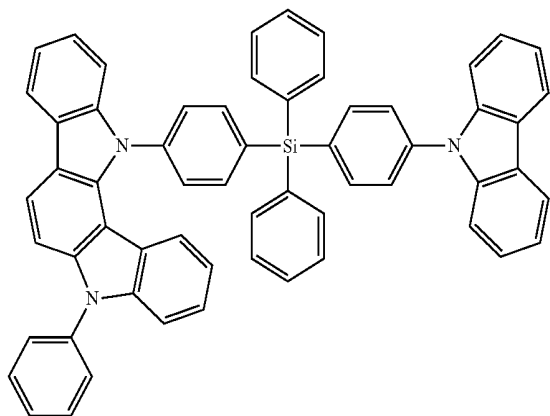


-continued

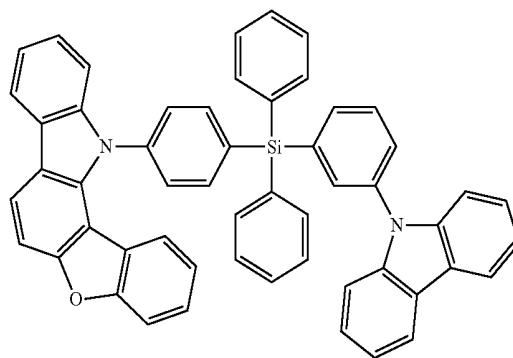
26



19

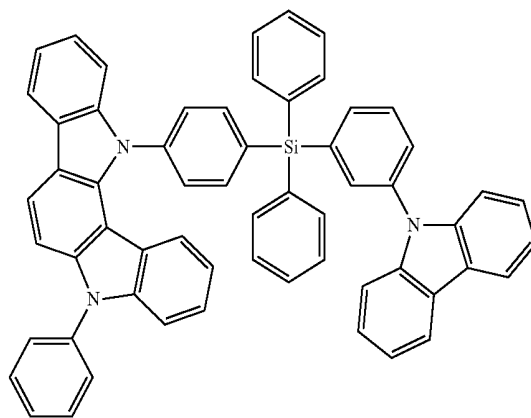
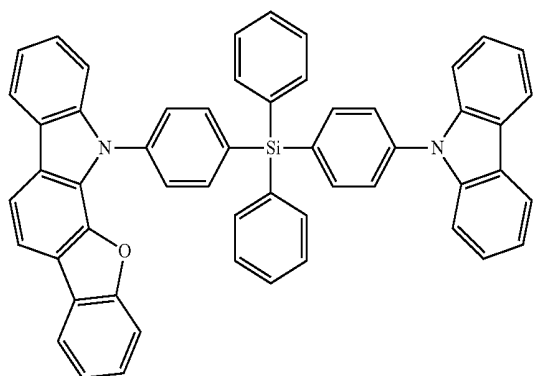


41



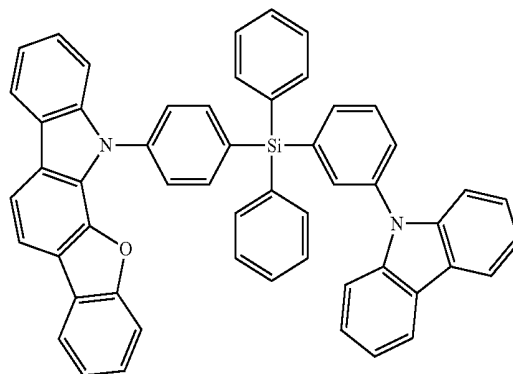
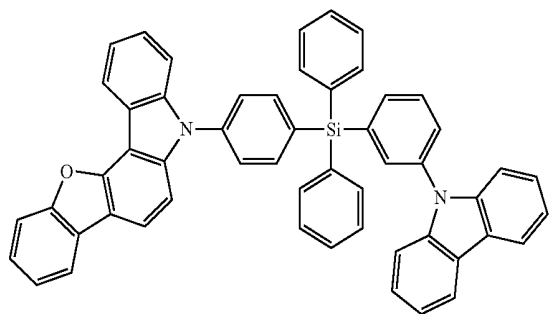
43

21



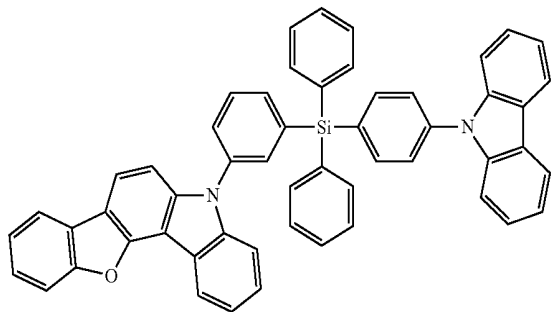
45

25



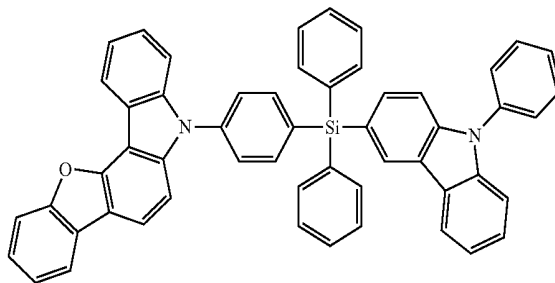
-continued

49

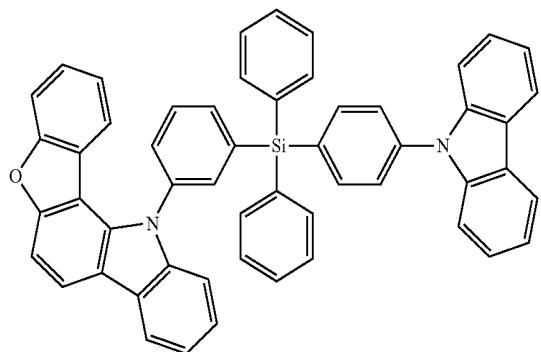


-continued

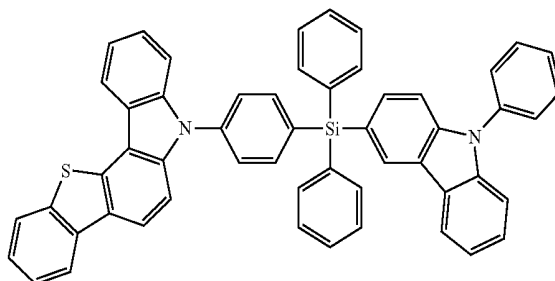
97



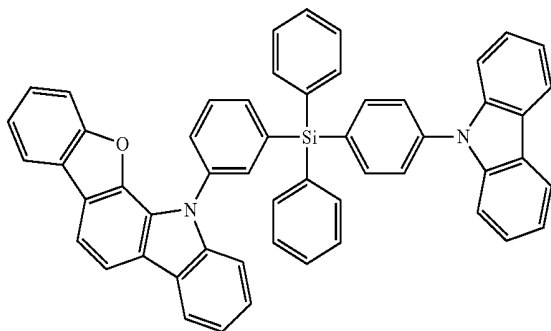
65



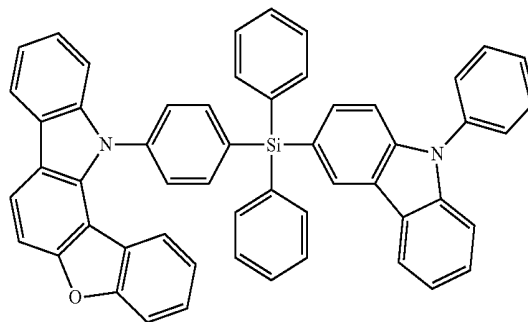
98



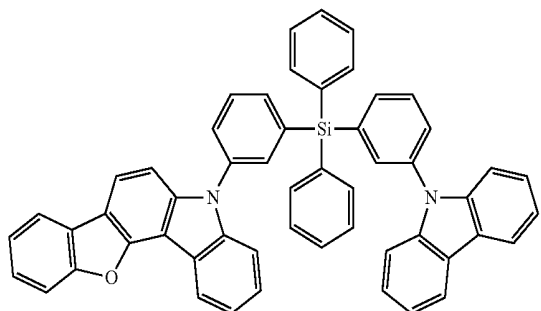
69



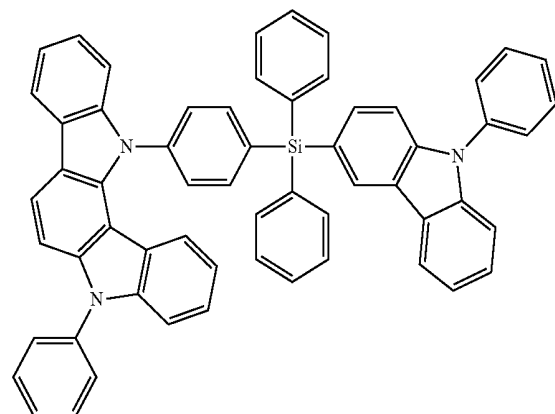
113



73

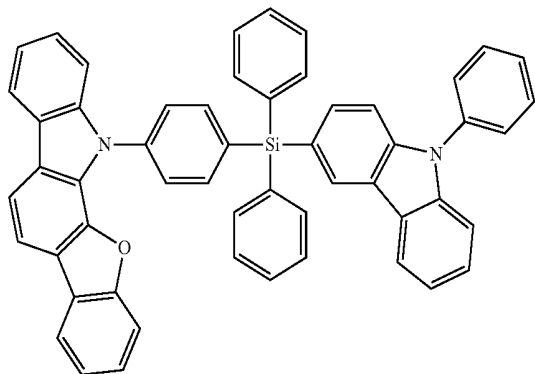


115



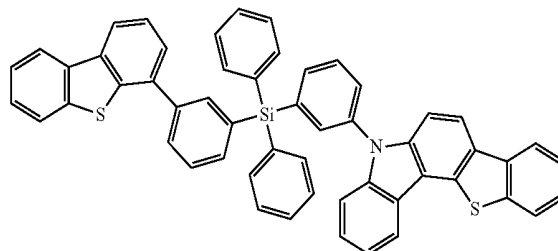
-continued

117

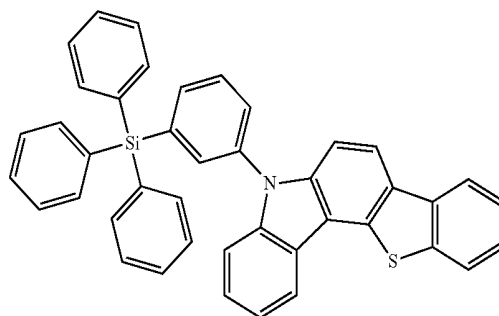


-continued

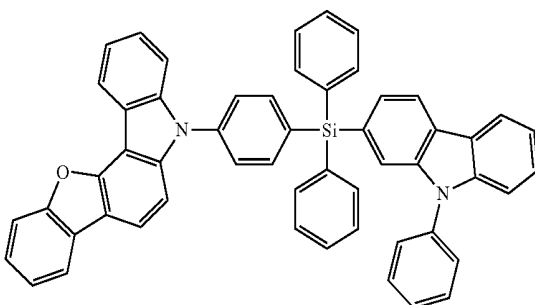
A



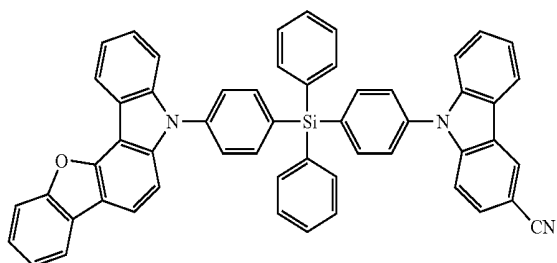
B



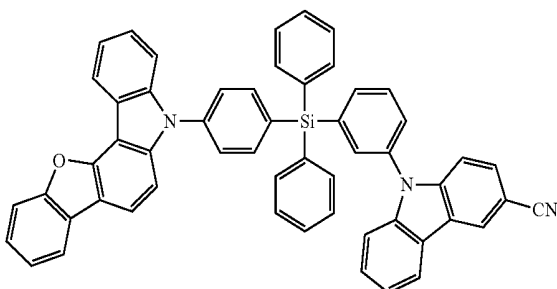
121



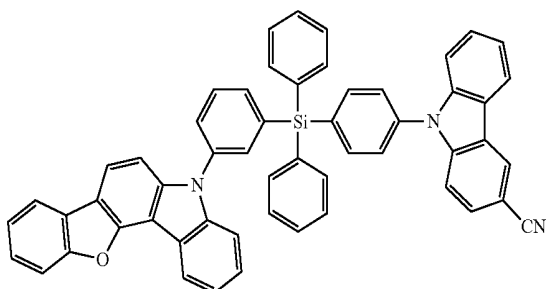
338



362



386



[0299] Synthesis methods of the silyl group-containing compound represented by Formula 1 may be recognizable by one of ordinary skill in the art by Synthesis Examples provided below.

[0300] Therefore, the silyl group-containing compound represented by Formula 1 is suitable for use in an organic layer of an organic light-emitting device, for example, for use as a material for a host or a hole transport region of an emission layer in the organic layer.

[0301] According to one or more exemplary embodiments, an organic light-emitting device may include:

[0302] a first electrode;

[0303] a second electrode; and

[0304] an organic layer disposed between the first electrode and the second electrode,

[0305] wherein the organic layer includes an emission layer, and

[0306] wherein the organic layer includes at least one of the silyl group-containing compounds represented by Formula 1.

[0307] The organic light-emitting device may have, due to the inclusion of an organic layer including the silyl group-containing compound represented by Formula 1, a low driving voltage, high efficiency, high luminance, high quantum emission efficiency, and a long lifespan.

[0308] The silyl group-containing compound represented by Formula 1 may be used between a pair of electrodes of the organic light-emitting device. For example, the silyl group-containing compound may be included in at least one of the emission layer, the hole transport region disposed between the first electrode and the emission layer (for example, the hole injection layer, the hole transport layer, the electron blocking layer, or any combination thereof), and the electron transport region disposed between the emission layer and the second electrode (for example, the hole blocking layer, the electron transport layer, the electron injection layer, or any combination thereof).

[0309] For example, the silyl group-containing compound represented by Formula 1 may be included in the emission layer. In this regard, the silyl group-containing compound included in the emission layer may act as a host, and the emission layer may further include a dopant (a fluorescent

dopant or a phosphorescent dopant). The emission layer may be a blue emission layer that emits blue light.

[0310] In one or more exemplary embodiments, the silyl group-containing compound represented by Formula 1 may be included in the emission layer, the emission layer may further include a phosphorescent dopant, and the emission layer may emit blue light.

[0311] In one or more exemplary embodiments, the emission layer may include a host and a dopant, and the host may include the silyl group-containing compound represented by Formula 1. An amount of the host is larger than an amount of the dopant.

[0312] In one or more exemplary embodiments, the silyl group-containing compound represented by Formula 1 may be included in the hole transport region.

[0313] In one or more exemplary embodiments, the hole transport region may include a hole transport layer, and the hole transport layer may include the silyl group-containing compound.

[0314] In one or more exemplary embodiments, the hole transport region may include a hole transport layer and an electron blocking layer, the electron blocking layer may be disposed between the hole transport layer and the emission layer, and the electron blocking layer may include the silyl group-containing compound represented by Formula 1.

[0315] In one or more exemplary embodiments, the hole transport region may include a hole transport layer and an electron blocking layer. The electron blocking layer may be disposed between the hole transport layer and the emission layer. Each of the electron blocking layer and the emission layer may include the silyl group-containing compound represented by Formula 1. The silyl group-containing compound represented by Formula 1 and included in the electron blocking layer, and the silyl group-containing compound represented by Formula 1 and included in the emission layer, may be identical to or different from each other.

[0316] The expression “(an organic layer) may include at least one of the silyl group-containing compounds” as used herein may include an embodiment in which (an organic layer) includes identical silyl group-containing compounds represented by Formula 1 and an embodiment in which (an organic layer) includes two or more different silyl group-containing compounds represented by Formula 1.

[0317] For example, the organic layer may include only Compound 1 as the silyl group-containing compound. In this regard, Compound 1 may be included only in the emission layer of the organic light-emitting device. In one or more exemplary embodiments, the organic layer may include, as the silyl group-containing compound, Compound 1 and Compound 2. In this regard, Compound 1 and Compound 2 may be included in an identical layer (for example, Compound 1 and Compound 2 all may be included in an emission layer), or may be included in different layers (for example, Compound 1 may be included in an emission layer and Compound 2 may be included in an electron blocking layer).

[0318] The first electrode may be an anode, which is a hole injection electrode, and the second electrode may be a cathode, which is an electron injection electrode; or the first electrode may be a cathode, which is an electron injection electrode, and the second electrode may be an anode, which is a hole injection electrode.

[0319] For example, the first electrode may be an anode, and the second electrode may be a cathode, and the organic layer may include: i) a hole transport region disposed between the first electrode and the emission layer, wherein the hole transport region may include at least one selected from a hole injection layer, a hole transport layer, and an

electron blocking layer, and ii) an electron transport region disposed between the emission layer and the second electrode, wherein the electron transport region may include at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

[0320] The term “organic layer” as used herein refers to a single layer and/or a plurality of layers disposed between the first electrode and the second electrode of the organic light-emitting device. The “organic layer” may include, in addition to an organic compound, an organometallic complex including metal.

[0321] FIG. 1 is a schematic view of an organic light-emitting device 10 according to an exemplary embodiment. Hereinafter, the structure of an organic light-emitting device according to an exemplary embodiment and a method of manufacturing an organic light-emitting device according to an exemplary embodiment will be described in connection with FIG. 1. The organic light-emitting device 10 includes a first electrode 11, an organic layer 15, and a second electrode 19, which are sequentially stacked in this stated order.

[0322] A substrate may be additionally disposed under the first electrode 11 or over the second electrode 19. For use as the substrate, any substrate that is used in general organic light-emitting devices may be used, and the substrate may be a glass substrate or a transparent plastic substrate, each having excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

[0323] In one or more exemplary embodiments, the first electrode 11 may be formed by depositing or sputtering a material for forming the first electrode 11 on the substrate. The first electrode 11 may be an anode. The material for forming the first electrode 11 may be selected from materials with a high work function to facilitate hole injection. The first electrode 11 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. The material for forming the first electrode 11 may be an indium tin oxide (ITO), an indium zinc oxide (IZO), tin oxide (SnO₂), or zinc oxide (ZnO). In one or more exemplary embodiments, the material for forming the first electrode 11 may be metal, such as magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag).

[0324] The first electrode 11 may have a single-layered structure or a multi-layered structure including two or more layers. For example, the first electrode 11 may have a three-layered structure of ITO/Ag/ITO, but the structure of the first electrode 11 is not limited thereto.

[0325] The organic layer 15 may be disposed on the first electrode 11.

[0326] The organic layer 15 may include a hole transport region, an emission layer, and an electron transport region.

[0327] The hole transport region may be disposed between the first electrode 11 and the emission layer.

[0328] The hole transport region may include a hole injection layer, a hole transport layer, an electron blocking layer, a buffer layer, or a combination thereof.

[0329] The hole transport region may include only either a hole injection layer or a hole transport layer. In one or more exemplary embodiments, the hole transport region may have a hole injection layer/hole transport layer structure or a hole injection layer/hole transport layer/electron blocking layer structure, or a hole transport layer/electron blocking layer structure, wherein, in each structure, constituting layers are sequentially stacked in this stated order from the first electrode 11.

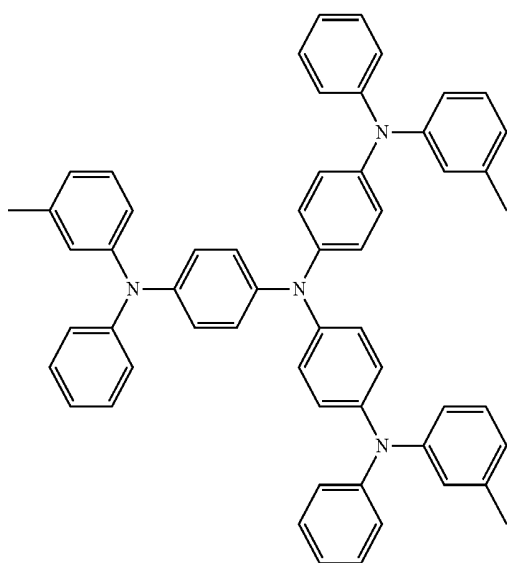
[0330] When the hole transport region includes a hole injection layer (HIL), the hole injection layer may be formed on the first electrode **11** by using one or more suitable methods, for example, vacuum deposition, spin coating, casting, and/or Langmuir-Blodgett (LB) deposition.

[0331] When a hole injection layer is formed by vacuum deposition, the deposition conditions may vary depending on a material used to form the hole injection layer, and the structure and thermal characteristics of the hole injection layer. For example, the deposition conditions may include a deposition temperature of about 100° C. to about 500° C., a vacuum pressure of about 10⁻⁸ torr to about 10⁻³ torr, and a deposition rate of about 0.01 Angstroms per second (Å/sec) to about 100 Å/sec. However, the deposition conditions are not limited thereto.

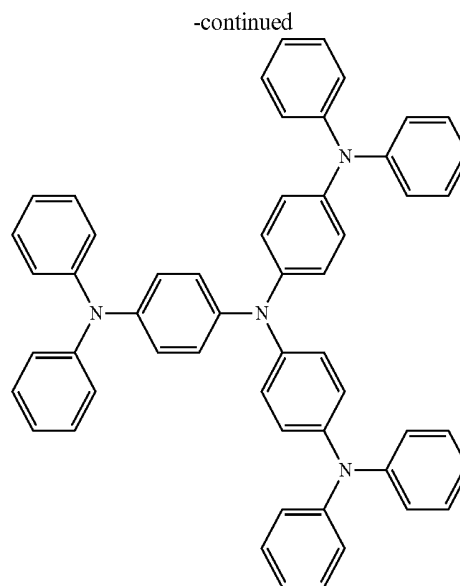
[0332] When the hole injection layer is formed using spin coating, coating conditions may vary depending on the material used to form the hole injection layer, and the structure and thermal properties of the hole injection layer. For example, a coating speed may be from about 2,000 revolutions per minute (rpm) to about 5,000 rpm, and a temperature at which a heat treatment is performed to remove a solvent after coating may be from about 80° C. to about 200° C. However, the coating conditions are not limited thereto.

[0333] Conditions for forming a hole transport layer and an electron blocking layer may be understood by referring to conditions for forming the hole injection layer.

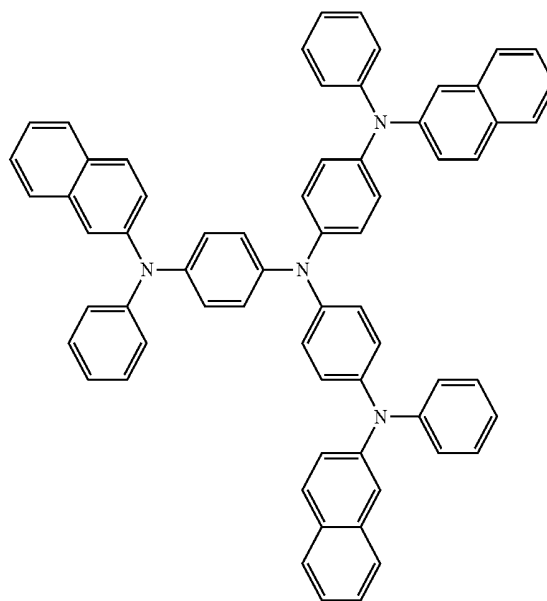
[0334] The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, Spiro-TPD, Spiro-NPB, methylated-NPB, TAPC, HMTPD, 4,4',4''-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzene sulfonic acid (PANI/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrene sulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (PANI/CSA), polyaniline/poly(4-styrene sulfonate) (PANT/PSS), a compound represented by Formula 201 below, and a compound represented by Formula 202:



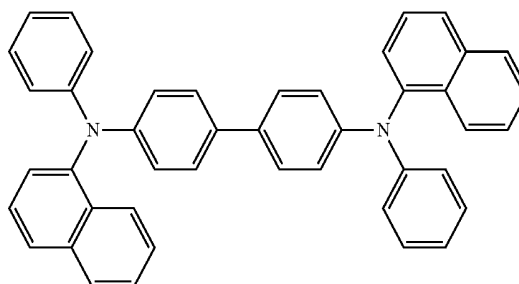
m-MTDATA



TDATA

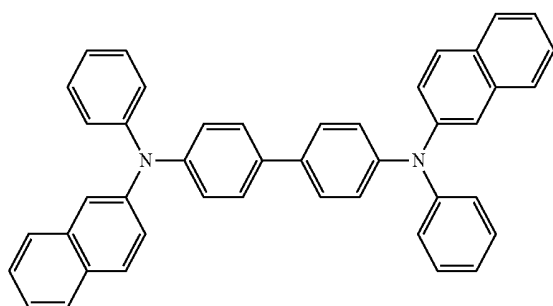
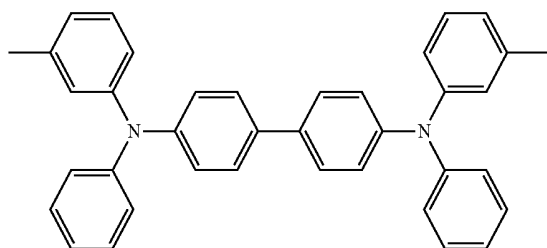


2-TNATA

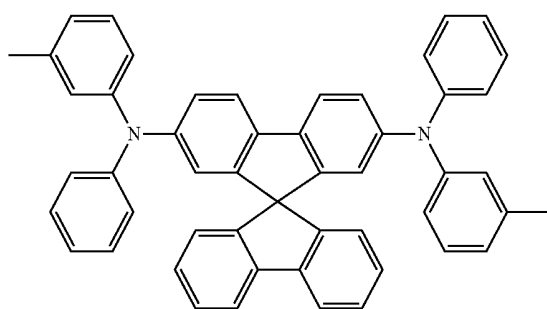


NPB

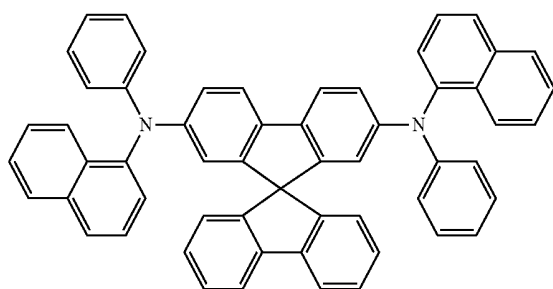
-continued

 β -NPB

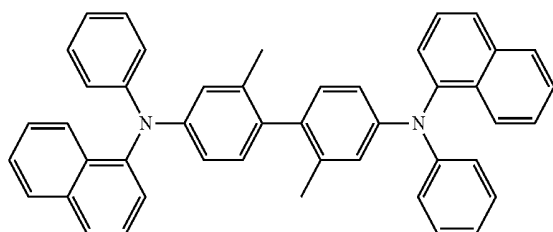
TPD



Spiro-TPD

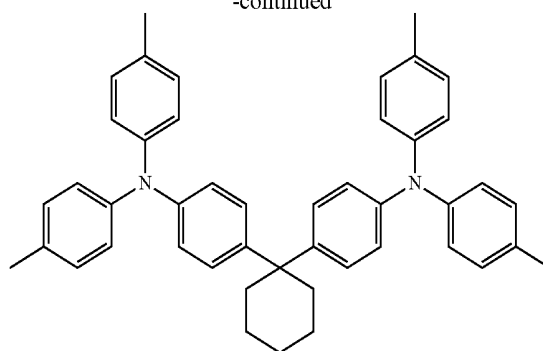


Spiro-NPB

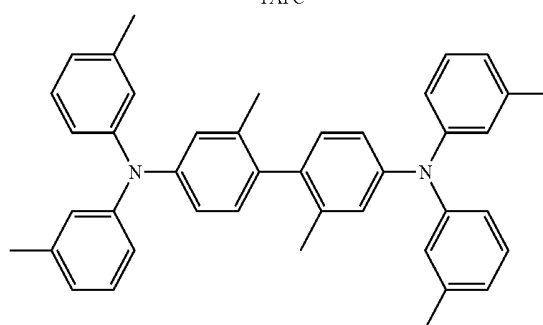


methylated NPB

-continued

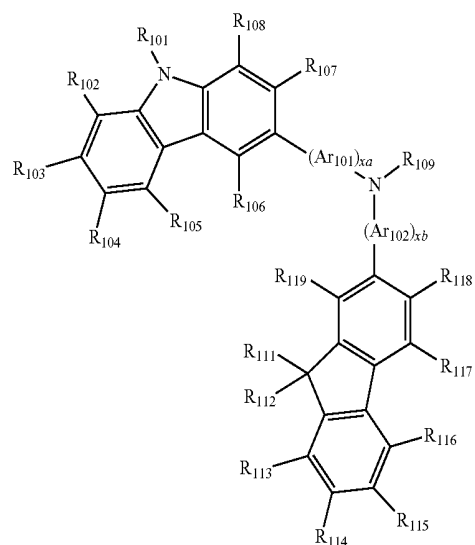


TAPC

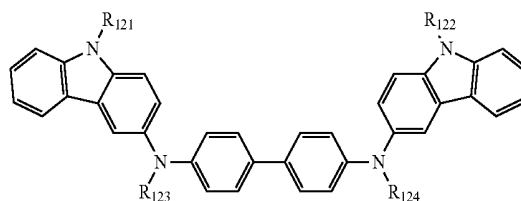


HMTPD

Formula 201



Formula 202



[0335] Ar_{101} and Ar_{102} in Formula 201 may each independently be selected from:

[0336] a phenylene group, a pentalenylene group, an indenylene group, a naphthylenylene group, an azulenylenylene group, a heptalenylene group, an acenaphthylenylene group, a fluore-

nylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylenylene group, a picenylene group, a perylenylene group, and a pentacenylene group; and

[0337] a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an acenaphthylene group, a fluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylenylene group, a picenylene group, a perylenylene group, and a pentacenylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0338] xa and xb in Formula 201 may each independently be an integer selected from 0 to 5, or 0, 1, or 2. For example, xa may be 1 and xb may be 0, but xa and xb are not limited thereto.

[0339] R₁₀₁ to R₁₀₈, R₁₁₁ to R₁₁₉, and R₁₂₁ to R₁₂₄ in Formulae 201 and 202 may each independently be selected from:

[0340] hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₁₀ alkyl group (for example, a methyl group, an ethyl group, a propyl group, a butyl group, a pentyl group, a hexyl group, and so on), or a C₁-C₁₀ alkoxy group (for example, a methoxy group, an ethoxy group, a propoxy group, a butoxy group, a pentoxy group, and so on);

[0341] a C₁-C₁₀ alkyl group or a C₁-C₁₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, and a phosphoric acid group or a salt thereof;

[0342] a phenyl group, a naphthyl group, an anthracenyl group, a fluorenyl group, or a pyrenyl group; or

[0343] a phenyl group, a naphthyl group, an anthracenyl group, a fluorenyl group, and a pyrenyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₁₀ alkyl group, and a C₁-C₁₀ alkoxy group,

[0344] but exemplary embodiments are not limited thereto,

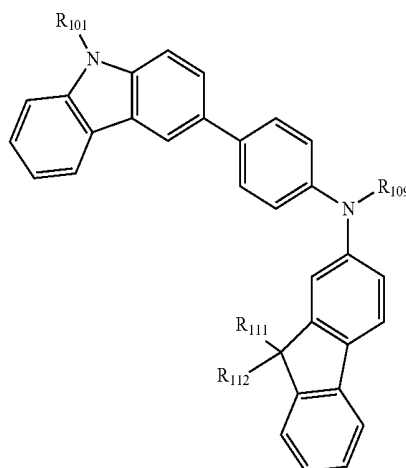
[0345] R₁₀₉ in Formula 201 may be selected from:

[0346] a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group; and

[0347] a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, an anthracenyl group, and a pyridinyl group.

[0348] According to an exemplary embodiment, the compound represented by Formula 201 may be represented by Formula 201A below, but is not limited thereto:

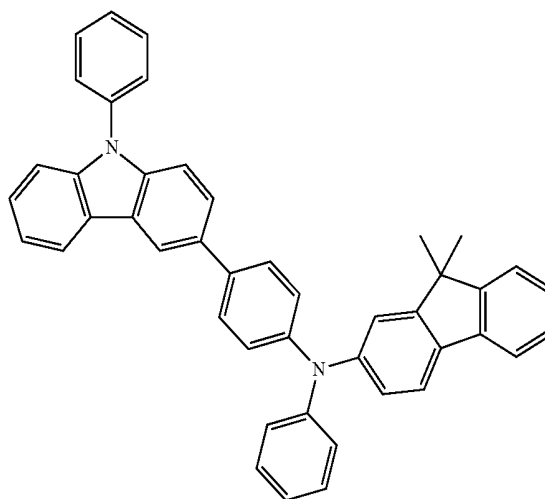
Formula 201A



[0349] R₁₀₁, R₁₁₁, R₁₁₂, and R₁₀₉ in Formula 201A may be understood by referring to the description provided herein.

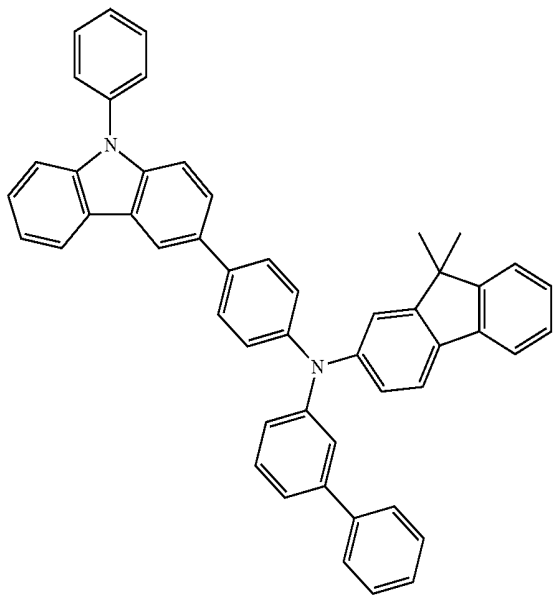
[0350] For example, the compound represented by Formula 201, and the compound represented by Formula 202 may include compounds HT1 to HT20 illustrated below, but are not limited thereto.

HT1



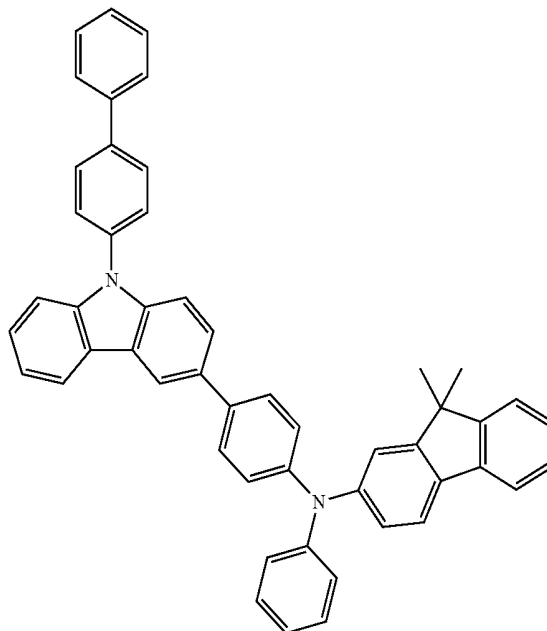
-continued

HT2

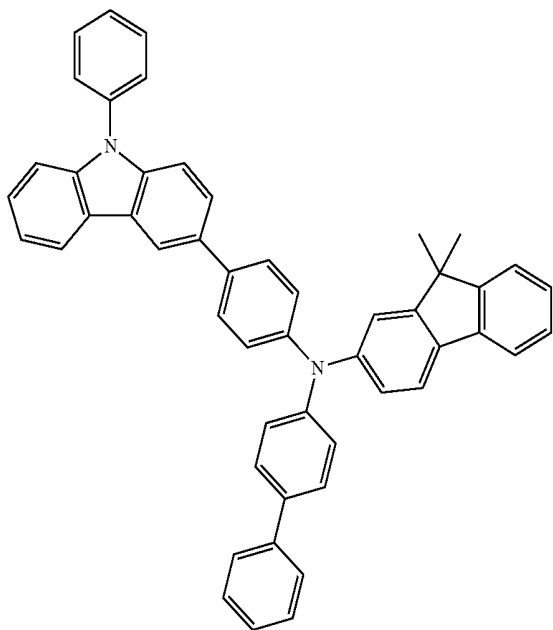


-continued

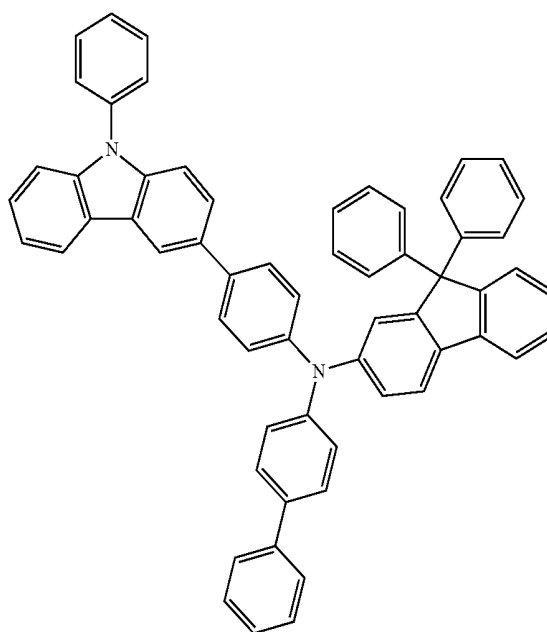
HT4



HT3

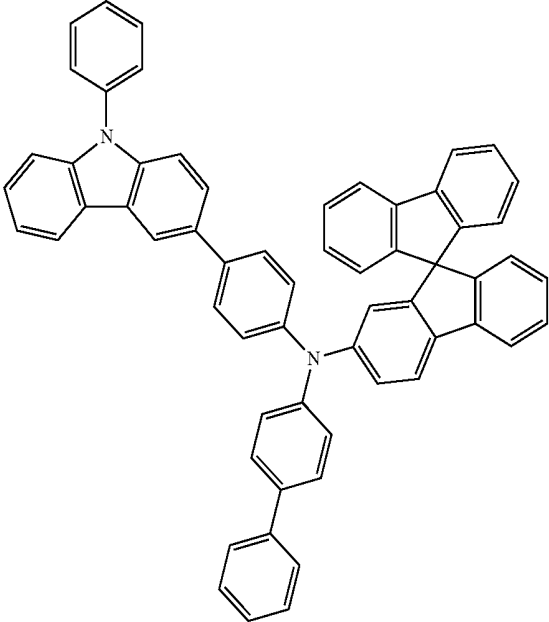


HT5



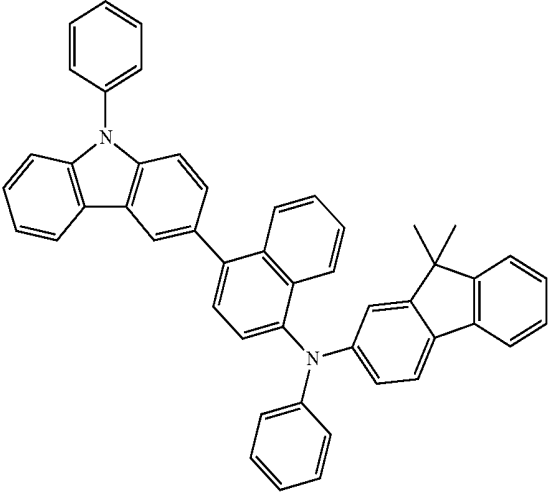
-continued

HT6



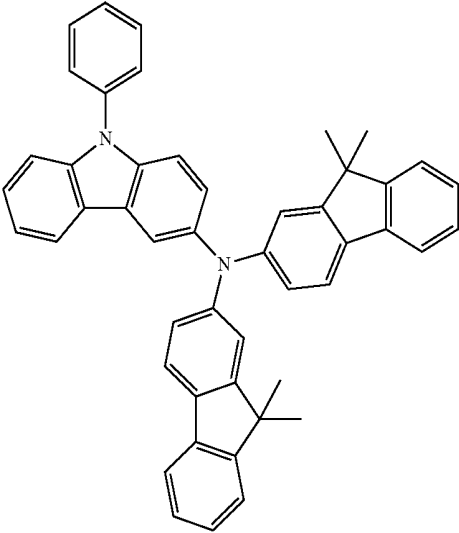
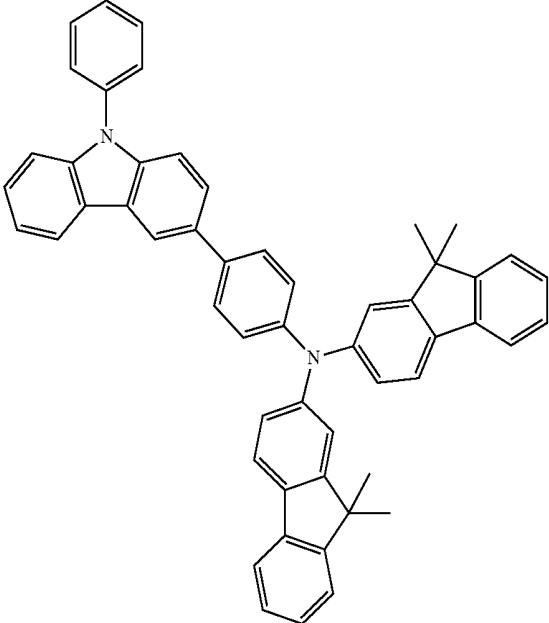
-continued

HT8



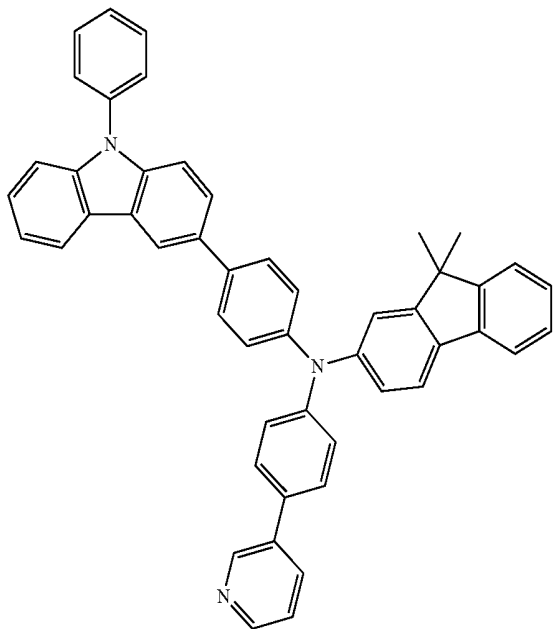
HT9

HT7



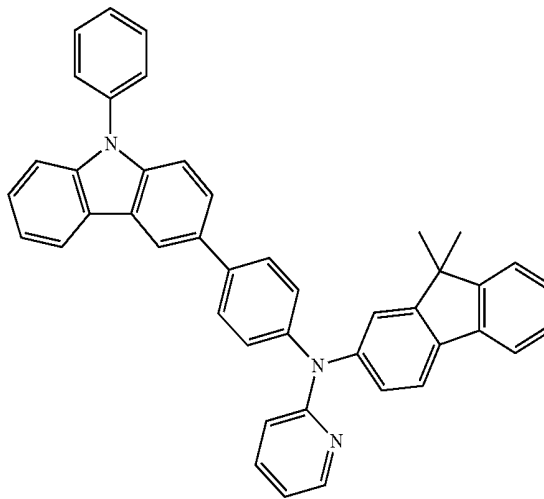
-continued

HT10

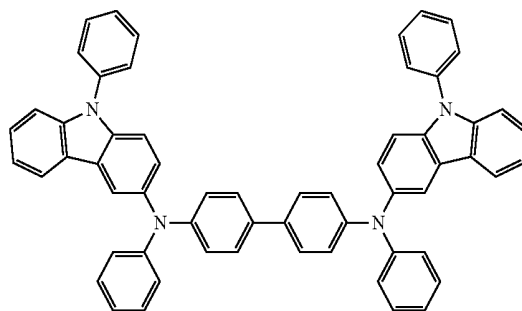


-continued

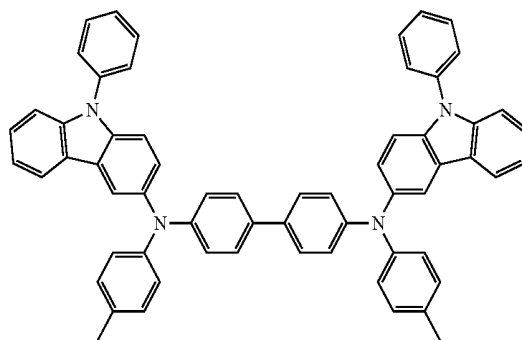
HT12



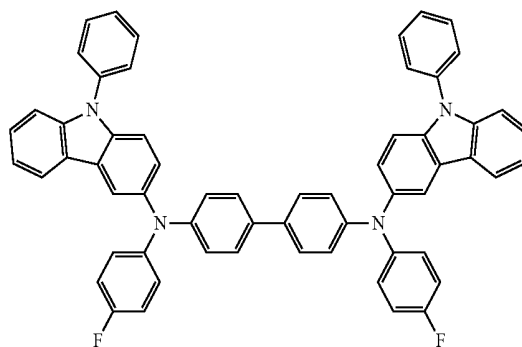
HT13



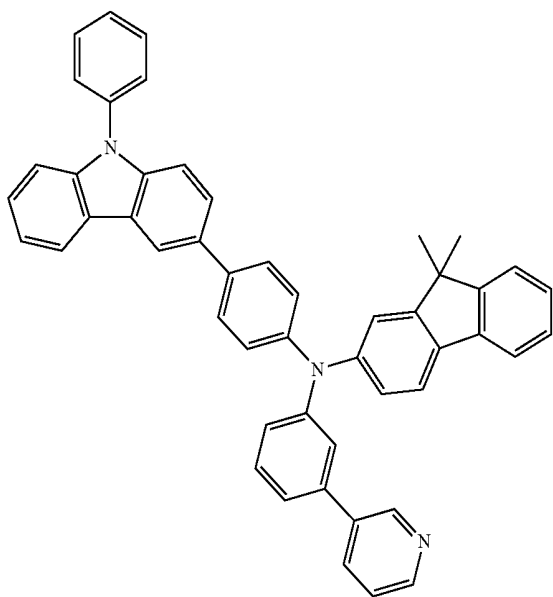
HT14



HT15

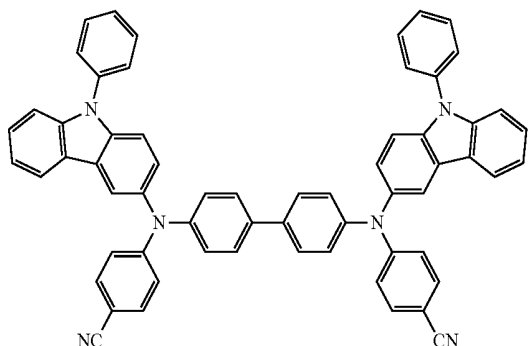


HT11



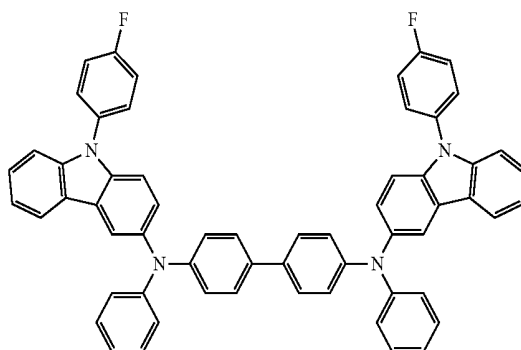
-continued

HT16

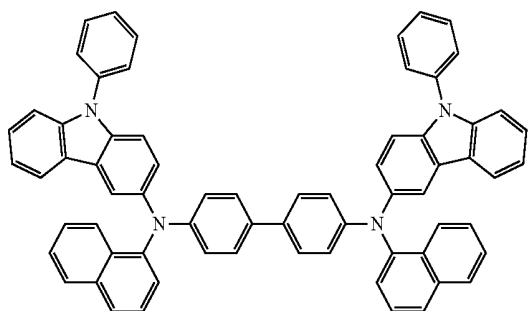


-continued

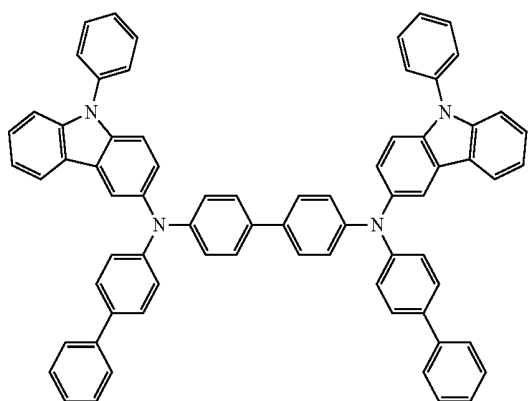
HT20



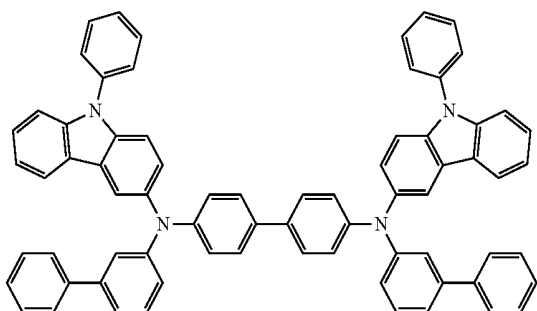
HT17



HT18



HT19

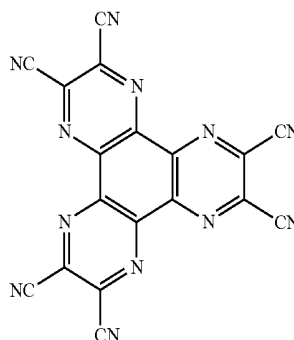


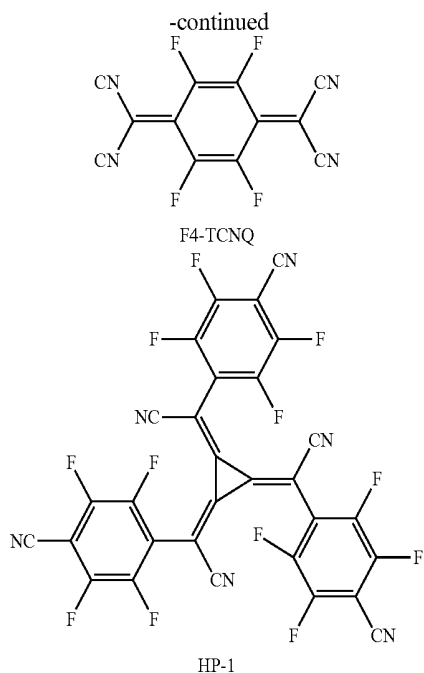
[0351] A thickness of the hole transport region may be in a range of about 100 Angstroms (Å) to about 10,000 Å, for example, about 100 Å to about 1,000 Å. When the hole transport region includes at least one of a hole injection layer and a hole transport layer, a thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 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. While not wishing to be bound by theory, it is understood that when the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within these ranges, satisfactory hole transporting characteristics may be obtained without a substantial increase in driving voltage.

[0352] The hole transport region may further include, in addition to these materials, a charge-generation material for improving conductive properties. The charge-generation material may be homogeneously or non-homogeneously dispersed in the hole transport region.

[0353] The charge-generation material may be, for example, a p-dopant. The p-dopant may be one selected from a quinone derivative, a metal oxide, and a cyano group-containing compound, but exemplary embodiments are not limited thereto. Non-limiting examples of the p-dopant are a quinone derivative, such as tetracyanoquinonodimethane (TCNQ) or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoguinonodimethane (F4-TCNQ); a metal oxide, such as a tungsten oxide or a molybdenum oxide; and a cyano group-containing compound, such as Compound HT-D1 or HP-1, but are not limited thereto.

Compound HT-D1



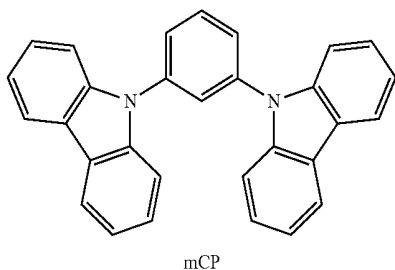


[0354] The hole transport region may include a buffer layer.

[0355] The buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, and thus, efficiency of a formed organic light-emitting device may be improved.

[0356] Then, an emission layer (BMW) may be formed on the hole transport region by vacuum deposition, spin coating, casting, LB deposition, or the like. When the emission layer is formed by vacuum deposition or spin coating, the deposition or coating conditions may be similar to those applied to form the hole injection layer, although the deposition or coating conditions may vary according to the material that is used to form the emission layer.

[0357] The electron transport region may further include an electron blocking layer. The electron blocking layer may include, for example, mCP, but a material included in the electron blocking layer is not limited thereto.



[0358] In one or more exemplary embodiments, the electron blocking layer may include the silyl group-containing compound represented by Formula 1, but exemplary embodiments of the present disclosure are not limited thereto.

[0359] When the organic light-emitting device is a full color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission

layer, and a blue emission layer. In one or more exemplary embodiments, due to a stack structure including a red emission layer, a green emission layer, and/or a blue emission layer, the emission layer may emit white light.

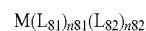
[0360] The emission layer may include the silyl group-containing compound represented by Formula 1. The emission layer may include a dopant. The dopant may include at least one selected from a phosphorescent dopant and a fluorescent dopant.

[0361] For example, a host in the emission layer may include the silyl group-containing compound represented by Formula 1.

[0362] In one or more exemplary embodiments, the host in the emission layer may include a first host and a second host, and the first host may be the silyl group-containing compound represented by Formula 1. In this regard, the first host may be different from the second host.

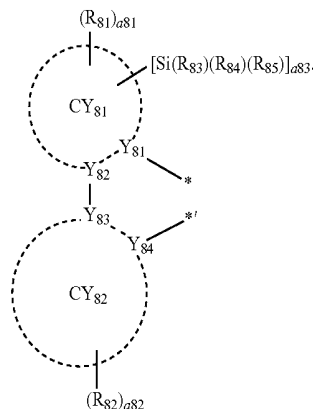
[0363] A dopant in the emission layer may be a fluorescent dopant that emits light according to a fluorescent emission mechanism or a phosphorescent dopant that emits light according to a phosphorescent emission mechanism.

[0364] In one or more exemplary embodiment, the dopant in the emission layer may be a phosphorescent dopant, and the phosphorescent dopant may include an organometallic compound represented by Formula 81 below:



Formula 81

Formula 81A



[0365] In Formulae 81 and 81A.

[0366] M may be selected from iridium (Ir), platinum (Pt), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), thulium (Tm), and rhodium (Rh).

[0367] L_{81} may be a ligand represented by Formula 81A, and $n81$ may be an integer from 1 to 3, wherein, when $n81$ is 2 or more, 2 or more groups L_{81} may be identical to or different from each other,

[0368] L_{82} may be an organic ligand, and $n82$ may be an integer from 0 to 4, wherein, when $n82$ is 2 or more, 2 or more groups L_{82} may be identical to or different from each other,

[0369] Y_{81} to Y_{84} may each independently be carbon (C) or nitrogen (N),

[0370] Y_{81} and Y_{82} , and Y_{83} and Y_{84} , may be each independently be linked to each other via a single bond or a double bond,

[0371] CY_{81} and CY_{82} may each independently be selected from a C_5 - C_{30} carbocyclic group and a C_3 - C_{30} heterocarbocyclic group,

[0372] CY_{81} and CY_{82} may optionally be linked via an organic linking group,

[0373] R_{81} to R_{85} may each independently be selected from hydrogen, deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, $-SF_5$, a 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 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, $-Si(Q_{81})(Q_{82})(Q_{83})$, $-N(Q_{84})(Q_{85})$, $-B(Q_{86})(Q_{87})$, and $-P(=O)(Q_{88})(Q_{89})$,

[0374] a_{81} to a_{83} may each independently be an integer from 0 to 5,

[0375] when a_{81} is two or more, two or more groups R_{81} may be identical to or different from each other,

[0376] a_{82} is two or more, and two or more groups R_{82} may be identical to or different from each other,

[0377] a_{81} is two or more, and neighboring groups R_{81} may optionally be linked to form a saturated or unsaturated ring,

[0378] a_{82} is two or more, and neighboring groups R_{82} may optionally be linked to form a saturated or unsaturated ring,

[0379] * and *' in Formula 81A each indicate a binding site to M in Formula 81,

[0380] at least one of substituents of the substituted C_1 - C_{60} alkyl group, the substituted C_2 - C_{60} alkenyl group, the substituted C_2 - C_{60} alkynyl group, 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 deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic

group, a monovalent non-aromatic condensed heteropolycyclic group, and $-Si(Q_{91})(Q_{92})(Q_{93})$,

[0381] wherein Q_{81} to Q_{89} and Q_{91} to Q_{93} may each independently be selected from hydrogen, deuterium, a C_1 - C_{60} alkyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0382] In one or more exemplary embodiments, in Formula 81A,

[0383] a_{83} may be 1 or 2,

[0384] R_{83} to R_{85} may each independently be selected from:

[0385] $-CH_3$, $-CD_3$, $-CD_2H_2$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCH_2H$, $-CHDCH_2H$, $-CHDCH_3$, $-CD_2CD_3$, and $-CD_2CD_2H$; and

[0386] an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

[0387] an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a C_1 - C_{10} alkyl group, and a phenyl group, but exemplary embodiments are not limited thereto.

[0388] In one or more exemplary embodiments, in Formula 81A,

[0389] Y_{81} may be nitrogen, Y_{82} and Y_{83} may each be carbon, Y_{84} may be nitrogen or carbon,

[0390] CY_{81} and CY_{82} may each independently be selected from a cyclopentadiene group, a benzene group, a heptalene group, an indene group, a naphthalene group, azulene group, a heptalene group, an indacene group, acenaphthylene 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, naphthacene group, a picene group, a perylene group, a pentacene group, a hexacene group, a rubicene group, a corozene group, an ovalene group, a pyrrole group, an iso-indole group, an indole group, an indazole group, a pyrazole group, an imidazole group, a triazole group, an oxazole group, an isoxazole group, an oxadiazole group, a thiazole group, an isothiazole group, thiadiazol group, a purine group, a furan group, a thiophene group, a pyridine group, a pyrimidine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phtalazine group, naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, phenanthroline group, phenazine group, a benzimidazole group, a benzofuran group, a benzothiophene group, an iso-benzothiazole group, a benzoxazole group, an isobenzoxazole group, benzocarbazole group, dibenzocarbazole group, an imidazopyridine group, an imidazopyrimidine group, a dibenzofuran group, a dibenzothiophene group, a dibenzothiophene sulfone group, a carbazole group, a dibenzosilole group, and a 2,3-dihydro-1H-imidazole.

[0391] In one or more exemplary embodiments, in Formula 81A, Y_{81} may be nitrogen, Y_{82} to Y_{84} may be carbon, CY_{81} may be a five-membered ring having two nitrogen atoms as a ring-forming atom, and CY_{82} may be selected from a benzene group, a naphthalene group, a fluorene group, a dibenzofuran group, and a dibenzothiophene group, but exemplary embodiments of the present disclosure are not limited thereto.

[0392] In one or more exemplary embodiments, in Formula 81A, Y_{81} may be nitrogen, Y_{82} to Y_{84} may each be carbon, CY_{81} may be an imidazole or a 2,3-dihydro-1H-imidazole, and CY_{82} may be selected from a benzene group, a naphthalene group, a fluorene group, a dibenzofuran group, and a dibenzothiophene group, but exemplary embodiments of the present disclosure are not limited thereto.

[0393] In one or more exemplary embodiments, in Formula 81A,

[0394] Y_{81} may be nitrogen, and Y_{82} to Y_{84} may be carbon,

[0395] CY_{81} may be selected from a pyrrole group, a pyrazole group, an imidazole group, a triazole group, an oxazole group, an isoxazole group, an oxadiazole group, a thiazole group, an isothiazole group, a thiadiazole group, a pyridine group, a pyrimidine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a benzimidazole group, an iso-benzothiazole group, a benzoxazole group, and an isobenzoxazole group,

[0396] CY_{82} may be selected from cyclopentadiene group, a benzene group, a naphthalene group, a fluorene group, a benzofluorene group, a dibenzofluorene group, a phenanthrene group, an anthracene group, a triphenylene group, a pyrene group, a chrysene group, a perylene group, a benzofuran group, a benzothiophene group, benzocarbazole group, dibenzocarbazole group, a dibenzofuran group, a dibenzothiophene group, a dibenzothiophene sulfone group, a carbazole group, and a dibenzosilole.

[0397] In one or more exemplary embodiments, in Formula 81A,

[0398] R_{81} and R_{82} may each independently be selected from:

[0399] hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, —SF₅, C₁-C₂₀ alkyl group, and a C₁-C₂₀ alkoxy group;

[0400] a C₁-C₂₀ alkyl group and a C₁-C₂₀ alkoxy group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, —CD₃, —CD₂H, —CDH₂, —CF₃, —CF₂H, —CFH₂, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₁₀ alkyl group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a pyridinyl group, and a pyrimidinyl group;

[0401] a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a Penzoquinolnnyl group, a quinoxalanyl group, a quinazolnnyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group,

[0402] a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, benzoquinolinyl group, a quinoxalanyl group, a quinazolnnyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, —CD₃, —CD₂H, —CDH₂, —CF₃, —CF₂H, —CFH₂, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group,

an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinoliny group, an isoquinoliny group, a benzoquinoliny group, a quinoxaliny group, a quinazoliny group, a cinnoliny group, a carbazolyl group, a phenanthroliny group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0403] $-B(Q_{86})(Q_{87})$ and $-P(=O)(Q_{88})(Q_{89})$,

[0404] wherein Q_{86} to Q_{89} may each independently be selected from:

[0405] $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, and $-CD_2CDH_2$;

[0406] an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

[0407] an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a C_1 - C_{10} alkyl group, and a phenyl group.

[0408] In one or more exemplary embodiments, R_{81} and R_{82} in Formula 81A may each independently be selected from:

[0409] hydrogen, deuterium, $-F$, a cyano group, a nitro group, $-SF_5$, a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, butoxy group, a pentoxy group, a cyclopentyl group, a cyclohexyl group, a cydoheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a pyridinyl group, and a pyrimidinyl group,

[0410] a methyl group, an ethyl group, an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, an n-hexyl group, an iso-hexyl group, a sec-hexyl group, a tert-hexyl group, an n-heptyl group, an iso-heptyl group, a sec-heptyl group, a tert-heptyl group, an n-octyl group, an iso-octyl group, a sec-octyl group, a tert-octyl group, an n-nonyl group, an iso-nonyl group, a sec-nonyl group, a tert-nonyl group, an n-decyl group, an iso-decyl group, a sec-decyl group, a tert-decyl group, a methoxy group, an ethoxy group, a propoxy group, butoxy group, a pentoxy

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

[0411] $-B(Q_{86})(Q_{87})$ and $-P(=O)(Q_{88})(Q_{89})$,

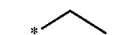
[0412] wherein Q_{86} to Q_{89} may each independently be selected from:

[0413] $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CH_2CH_3$, $-CH_2CD_3$, $-CH_2CD_2H$, $-CH_2CDH_2$, $-CHDCH_3$, $-CHDCD_2H$, $-CHDCDH_2$, $-CHDCD_3$, $-CD_2CD_3$, $-CD_2CD_2H$, and $-CD_2CDH_2$;

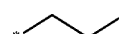
[0414] an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

[0415] an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a C_1 - C_{10} alkyl group, and a phenyl group.

[0416] In one or more exemplary embodiments, R_{81} and R_{82} in Formula 81A may each independently be selected from hydrogen, deuterium, $-F$, a cyano group, a nitro group, $-SF_5$, $-CH_3$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, a group represented by one of Formulae 9-1 to 9-19, and a group represented by one of Formulae 10-1 to 10-30, but exemplary embodiments of the present disclosure are not limited thereto:



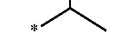
Formula 9-1



Formula 9-2



Formula 9-3



Formula 9-4

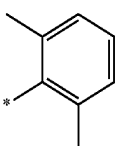
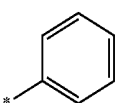
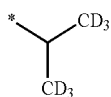
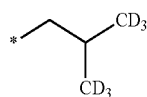
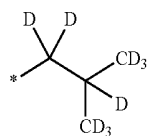
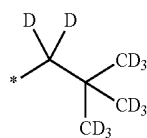
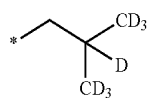
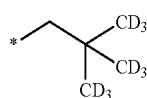
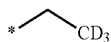
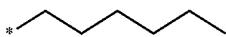
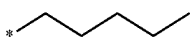
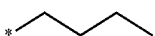
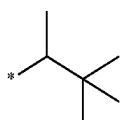
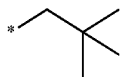
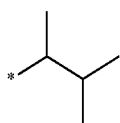


Formula 9-5



Formula 9-6

-continued



Formula 9-7

Formula 9-8

Formula 9-9

Formula 9-10

Formula 9-11

Formula 9-12

Formula 9-13

Formula 9-14

Formula 9-15

Formula 9-16

Formula 9-17

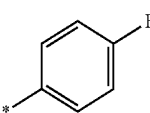
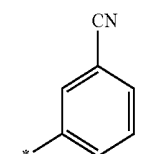
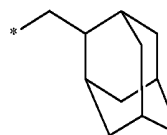
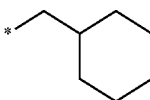
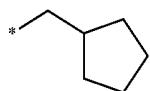
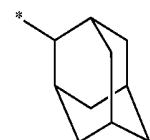
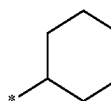
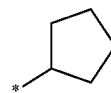
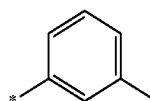
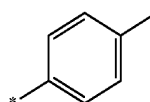
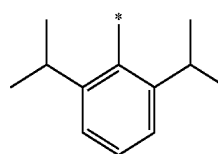
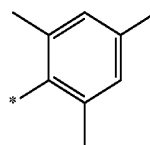
Formula 9-18

Formula 9-19

Formula 10-1

Formula 10-2

-continued



Formula 10-3

Formula 10-4

Formula 10-5

Formula 10-6

Formula 10-7

Formula 10-8

Formula 10-9

Formula 10-10

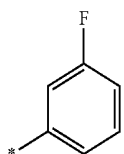
Formula 10-11

Formula 10-12

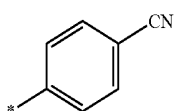
Formula 10-13

Formula 10-14

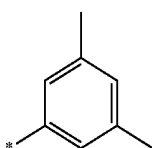
-continued



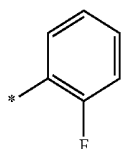
Formula 10-15



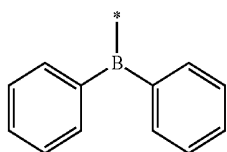
Formula 10-16



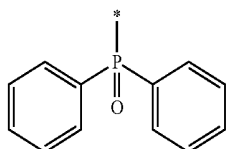
Formula 10-17



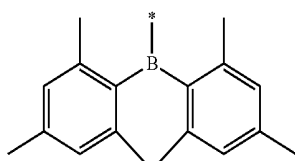
Formula 10-18



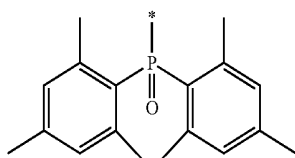
Formula 10-19



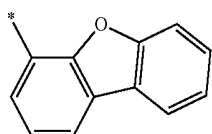
Formula 10-20



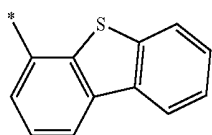
Formula 10-21



Formula 10-22

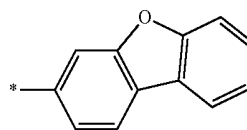


Formula 10-23

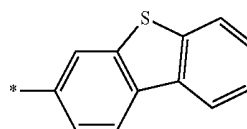


Formula 10-24

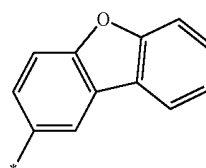
-continued



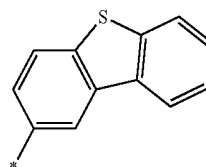
Formula 10-25



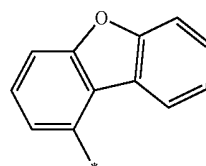
Formula 10-26



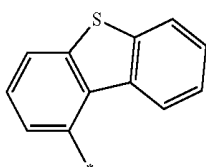
Formula 10-27



Formula 10-28



Formula 10-29



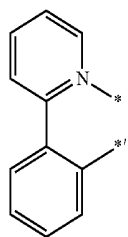
Formula 10-30

[0417] In Formulae 9-1 to 9-17 and 10-1 to 10-30, * indicates a binding site to a neighboring atom.

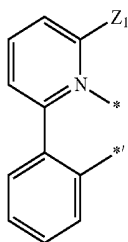
[0418] In one or more exemplary embodiments, in Formula 81A, the sum of a₈₁ and a₈₂ may be 1 or more, and at least one selected from groups R₈₁ in the number of a₈₁ and R₈₂ in the number of a₈₂ may be a cyano group.

[0419] In one or more exemplary embodiments, a₈₂ may be 1 or more, and at least one of groups R₈₂ in the number of a₈₂ may be a cyano group.

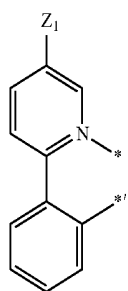
[0420] In one or more exemplary embodiments, at least one selected from groups R₈₁ in the number of a₈₁ and groups R₈₂ in the number of a₈₂ in Formula 81A may be deuterium. In one or more exemplary embodiments, L₈₂ in Formula 81 may be selected from ligands represented by Formulae 3-1(1) to 3-1(60), 3-1(61) to 3-1(69), 3-1(71) to 3-1(79), 3-1(81) to 3-1(88), 3-1(91) to 3-1(98), and 3-1(101) to 3-1(114):



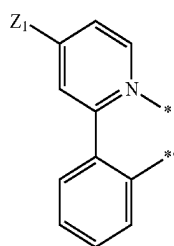
Formula 3-1(1)



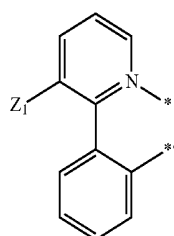
Formula 3-1(2)



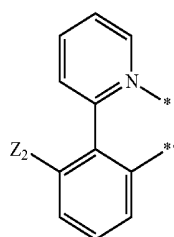
Formula 3-1(3)



Formula 3-1(4)

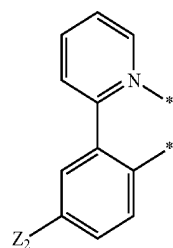


Formula 3-1(5)

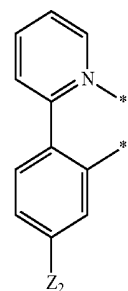


Formula 3-1(6)

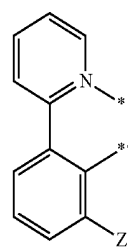
-continued



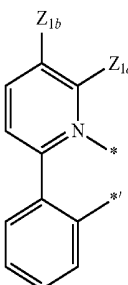
Formula 3-1(7)



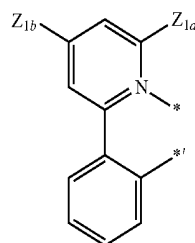
Formula 3-1(8)



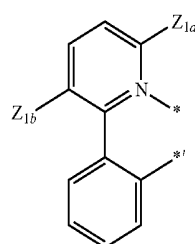
Formula 3-1(9)



Formula 3-1(10)

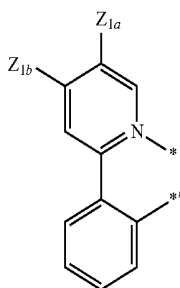


Formula 3-1(11)

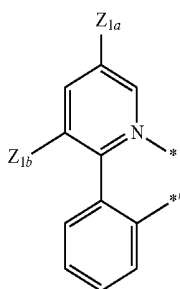


Formula 3-1(12)

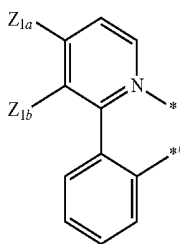
-continued



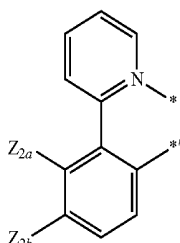
Formula 3-1(13)



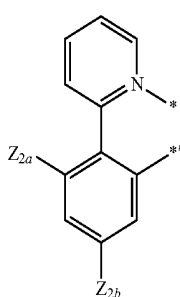
Formula 3-1(14)



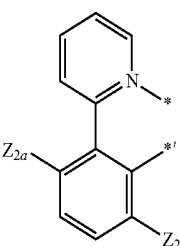
Formula 3-1(15)



Formula 3-1(16)

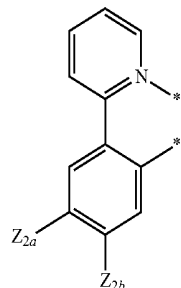


Formula 3-1(17)

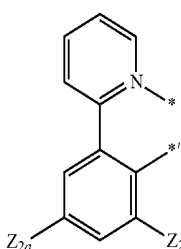


Formula 3-1(18)

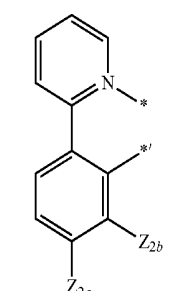
-continued



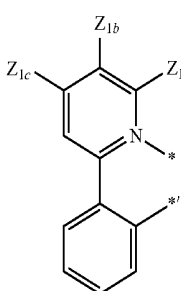
Formula 3-1(19)



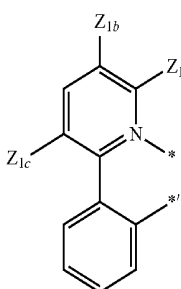
Formula 3-1(20)



Formula 3-1(21)

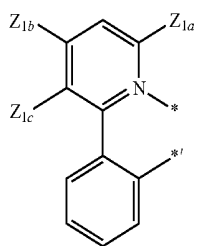


Formula 3-1(22)



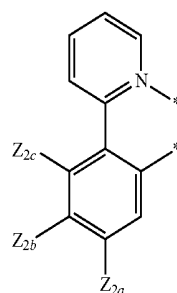
Formula 3-1(23)

-continued

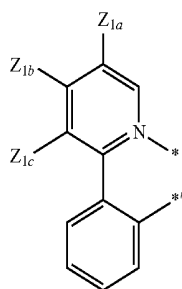


Formula 3-1(24)

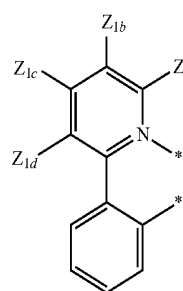
-continued



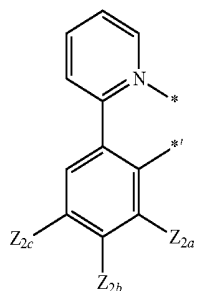
Formula 3-1(29)



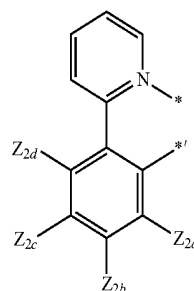
Formula 3-1(25)



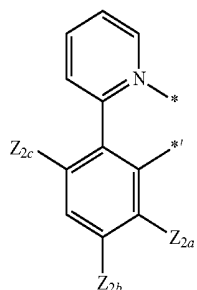
Formula 3-1(30)



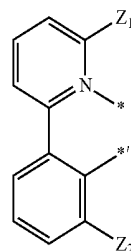
Formula 3-1(26)



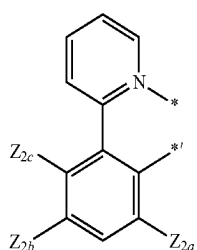
Formula 3-1(31)



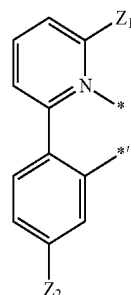
Formula 3-1(27)



Formula 3-1(32)

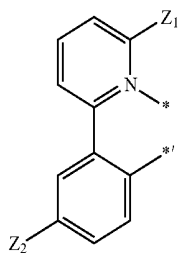


Formula 3-1(28)

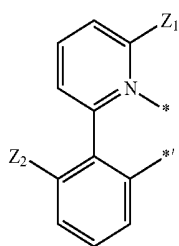


Formula 3-1(33)

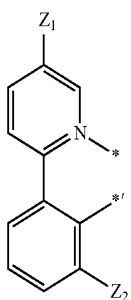
-continued



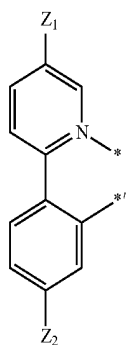
Formula 3-1(34)



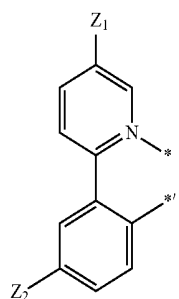
Formula 3-1(35)



Formula 3-1(36)

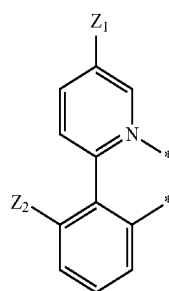


Formula 3-1(37)

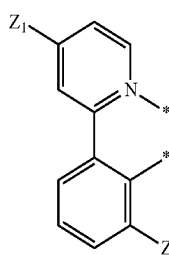


Formula 3-1(38)

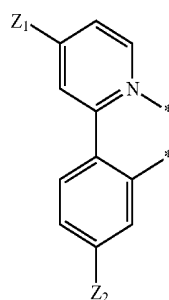
-continued



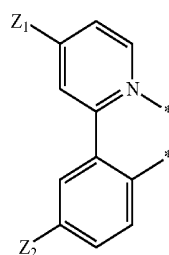
Formula 3-1(39)



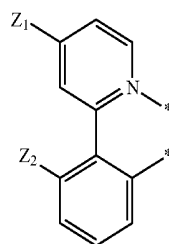
Formula 3-1(40)



Formula 3-1(41)

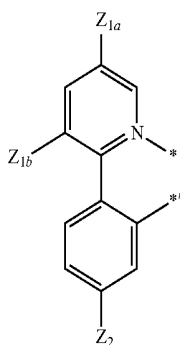


Formula 3-1(42)



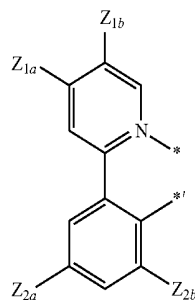
Formula 3-1(43)

-continued



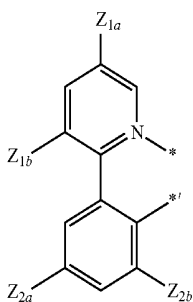
Formula 3-1(44)

-continued

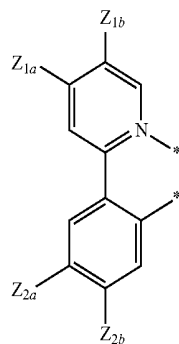


Formula 3-1(49)

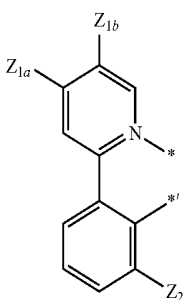
Formula 3-1(45)



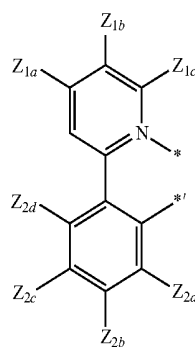
Formula 3-1(50)



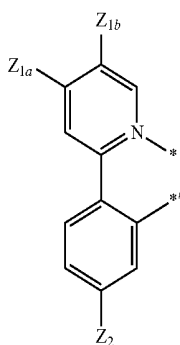
Formula 3-1(46)



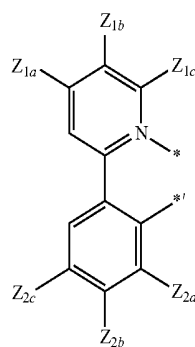
Formula 3-1(51)



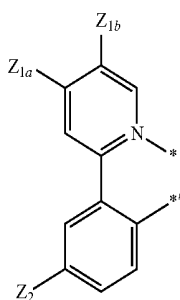
Formula 3-1(47)



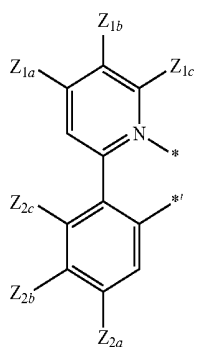
Formula 3-1(52)



Formula 3-1(48)

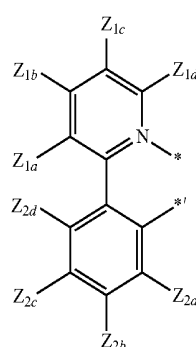


-continued



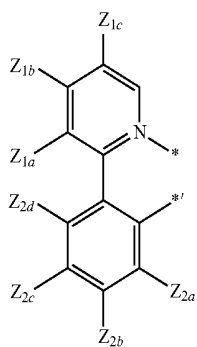
Formula 3-1(53)

-continued

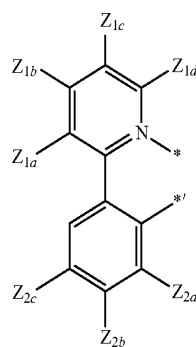


Formula 3-1(57)

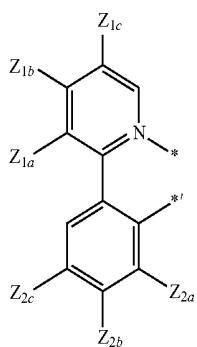
Formula 3-1(54)



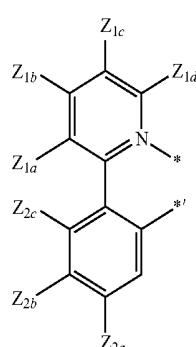
Formula 3-1(58)



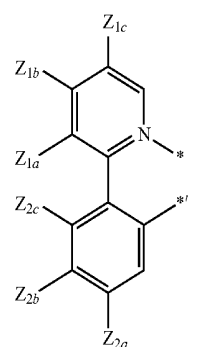
Formula 3-1(55)



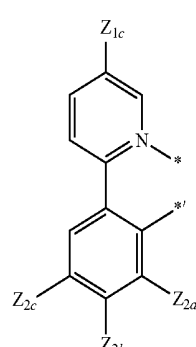
Formula 3-1(59)



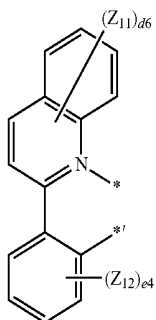
Formula 3-1(56)



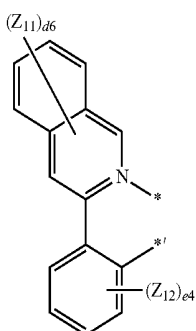
Formula 3-1(60)



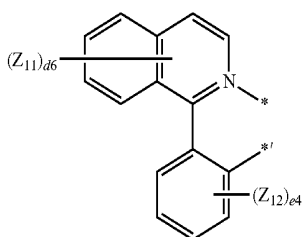
-continued



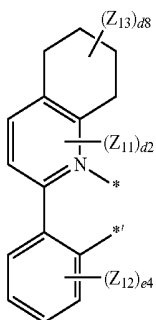
Formula 3-1(61)



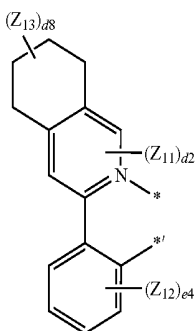
Formula 3-1(62)



Formula 3-1(63)

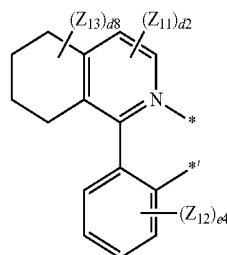


Formula 3-1(64)

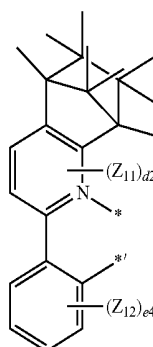


Formula 3-1(65)

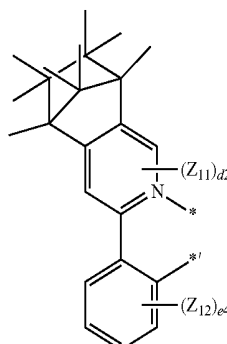
-continued



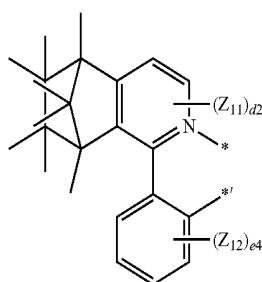
Formula 3-1(66)



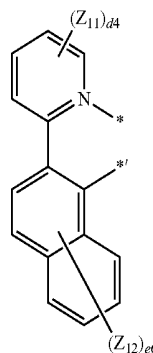
Formula 3-1(67)



Formula 3-1(68)

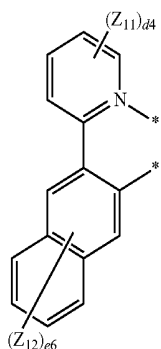


Formula 3-1(69)



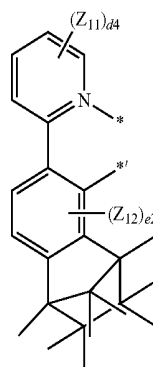
Formula 3-1(71)

-continued

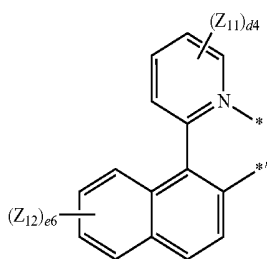


Formula 3-1(72)

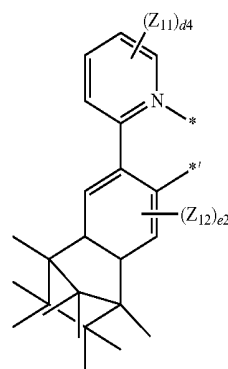
-continued



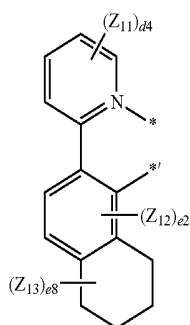
Formula 3-1(77)



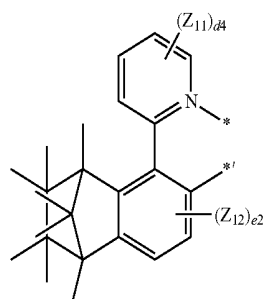
Formula 3-1(73)



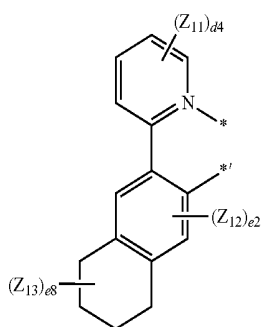
Formula 3-1(78)



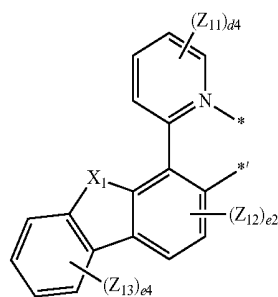
Formula 3-1(74)



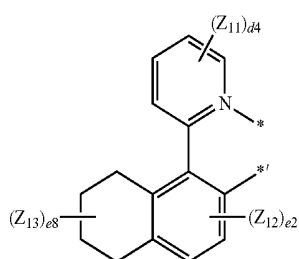
Formula 3-1(79)



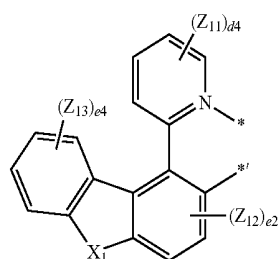
Formula 3-1(75)



Formula 3-1(81)

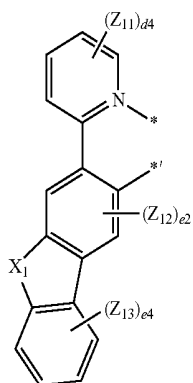


Formula 3-1(76)



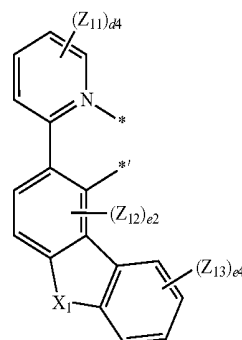
Formula 3-1(82)

-continued



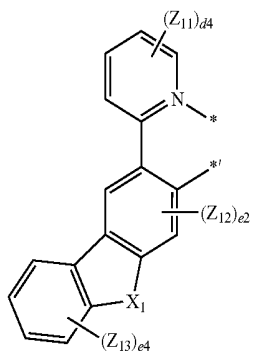
Formula 3-1(83)

-continued

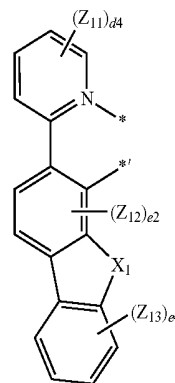


Formula 3-1(87)

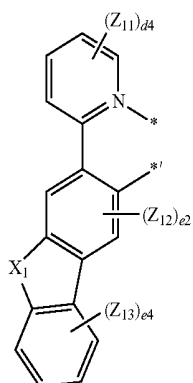
Formula 3-1(84)



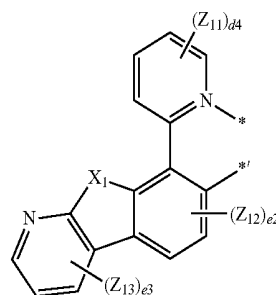
Formula 3-1(88)



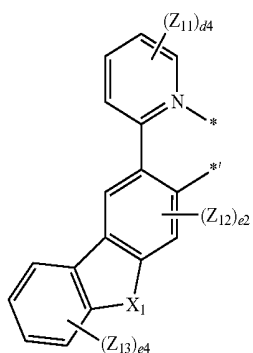
Formula 3-1(85)



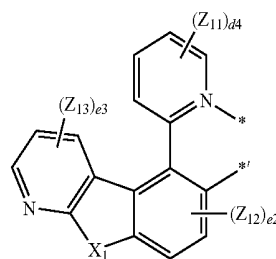
Formula 3-1(91)



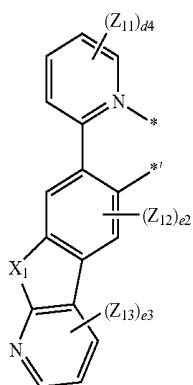
Formula 3-1(86)



Formula 3-1(92)

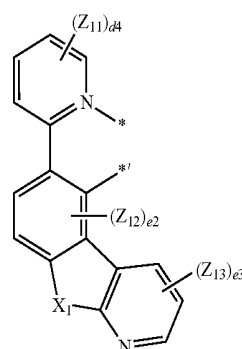


-continued

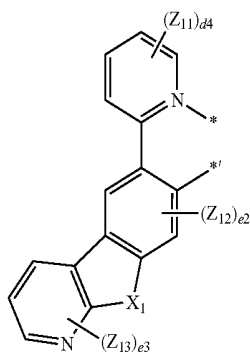


Formula 3-1(93)

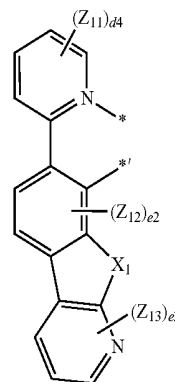
-continued



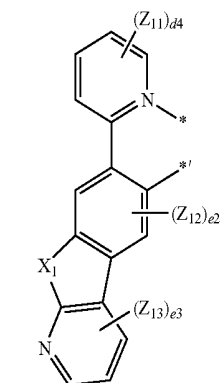
Formula 3-1(97)



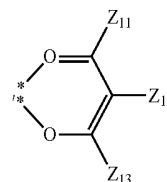
Formula 3-1(94)



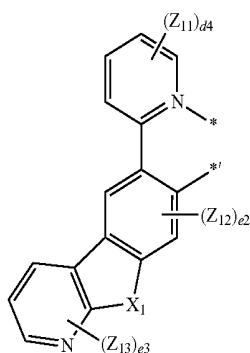
Formula 3-1(98)



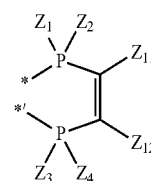
Formula 3-1(95)



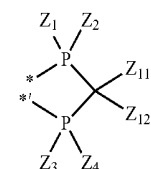
Formula 3-1(101)



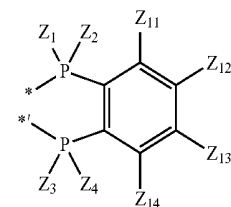
Formula 3-1(96)



Formula 3-1(102)

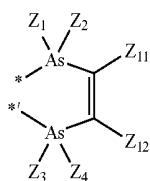


Formula 3-1(103)

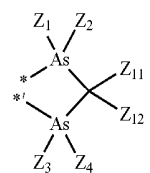


Formula 3-1(104)

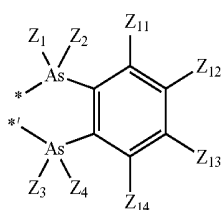
-continued



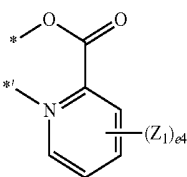
Formula 3-1(105)



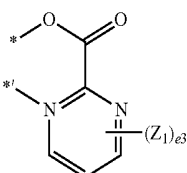
Formula 3-1(106)



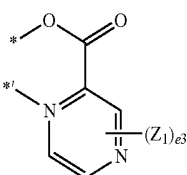
Formula 3-1(107)



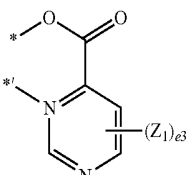
Formula 3-1(108)



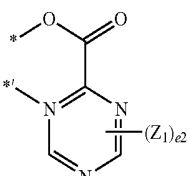
Formula 3-1(109)



Formula 3-1(110)

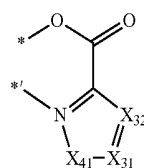


Formula 3-1(111)

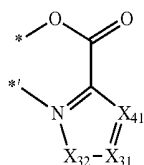


Formula 3-1(112)

-continued



Formula 3-1(113)



Formula 3-1(114)

[0421] In Formulae 3-1(1) to 3-1(60), 3-1(61) to 3-1(69), 3-1(71) to 3-1(79), 3-1(81) to 3-1(88), 3-1(91) to 3-1(98), and 3-1(101) to 3-1(114),

[0422] X_1 may be O, S, $C(Z_{21})(Z_{22})$, or $N(Z_{23})$,

[0423] X_{31} may be N or $C(Z_{1a})$, and X_{32} may be N or $C(Z_{1b})$,

[0424] X_{41} may be O, S, $N(Z_{1a})$ or $C(Z_{1a})(Z_{1b})$,

[0425] Z_1 to Z_4 , Z_{1a} , Z_{1b} , Z_{1c} , Z_{1d} , Z_{2b} , Z_{2c} , Z_{2d} , Z_{11} to Z_{14} , and Z_{21} to Z_{23} may each independently be selected from:

[0426] hydrogen, deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, $-SF_5$, C_1 - C_{20} alkyl group, and a C_1 - C_{20} alkoxy group;

[0427] a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group, each substituted with at least one selected from deuterium, $-F$, $-Cl$, $-Br$, $-I$, $-CD_3$, $-CD_2H$, $-CDH_2$, $-CF_3$, $-CF_2H$, $-CFH_2$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a pyridinyl group, and a pyrimidinyl group;

[0428] a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzimidazolyl group, a benzofuranlyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isoben-

zoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0429] a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from deuterium, —Cl, —Br, —I, —CD₃, —CD₂H, —CDH₂, —CF₃, —CF₂H, —CFH₂, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclooctyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a phenyl group, a naphthyl group, a fluorenyl group, phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0430] —B(Q₈₆)(Q₈₇) and —P(=O)(Q₈₈)(Q₈₉),

[0431] wherein Q₈₆ to Q₈₉ may each independently be selected from:

[0432] —CH₃, —CD₃, —CD₂H, —CDH₂, —CH₂CH₃, —CH₂CD₃, —CH₂CD₂H, —CH₂CDH₂, —CHDCH₃,

—CHDCD₂H, —CHDCDH₂, —CHDCD₃, —CD₂CD₃, —CD₂CD₂H, and —CD₂CDH₂,

[0433] an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group; and

[0434] an n-propyl group, an iso-propyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a sec-pentyl group, a tert-pentyl group, a phenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, a C₁-C₁₀ alkyl group, and a phenyl group,

[0435] d2 and e2 may each independently be 0 or 2,

[0436] e3 may be an integer from 0 to 3,

[0437] d4 and e4 may each independently be an integer from 0 to 4,

[0438] d6 and e6 may each independently be an integer from 0 to 6,

[0439] d8 and e8 may each independently be an integer from 0 to 8, and

[0440] * and *' each indicate a binding site to M in Formula 1.

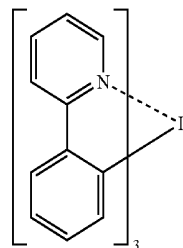
[0441] For example, Z₁ to Z₄, Z_{1a}, Z_{1b}, Z_{1c}, Z_{1d}, Z_{2a}, Z_{2b}, Z_{2c}, Z_{2d}, Z₁₁ to Z₁₄, and Z₂₁ to Z₂₃ may each independently be selected from hydrogen, deuterium, —F, a cyano group, a nitro group, —SF₅, —CH₃, —CD₃, —CD₂H, —CDH₂, —CF₃, —CF₂H, —CFH₂, a group represented by one of Formulae 9-1 to 9-19, and a group represented by one of Formulae 10-1 to 10-30, but exemplary embodiments of the present disclosure are not limited thereto.

[0442] In one or more exemplary embodiments, M in Formula 81 may be Ir, and the sum of n81 and n82 may be 3; or M may be Pt, and the sum of n81 and n82 may be 2.

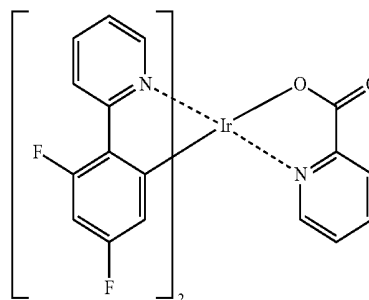
[0443] In one or more exemplary embodiments, the organometallic compound represented by Formula 81 may not be a salt consisting of a cation and an anion, but may be neutral.

[0444] The phosphorescent dopant may include at least one selected from Compounds PD1 to PD78 and FIr6, but exemplary embodiments of the present disclosure are not limited thereto:

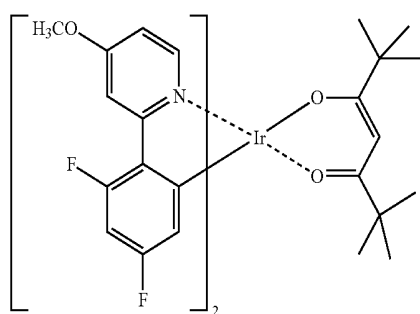
PD1



PD2

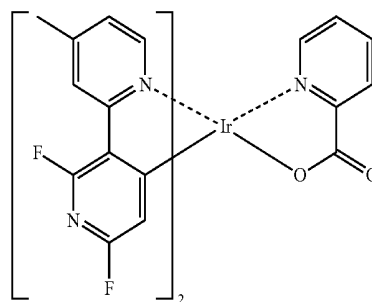


-continued

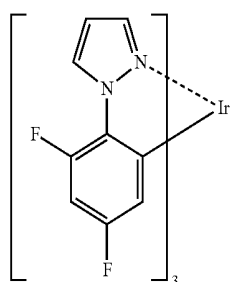


PD3

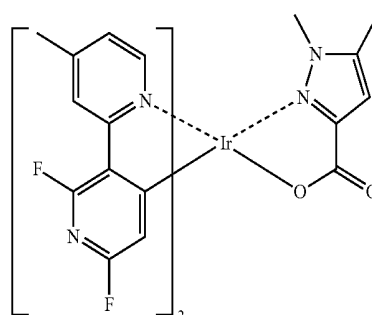
-continued



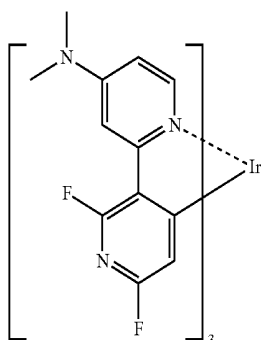
PD8



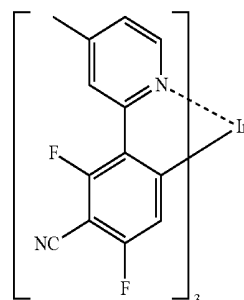
PD4



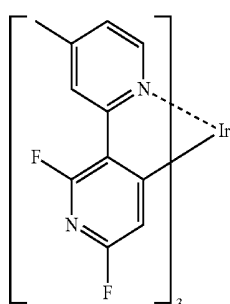
PD9



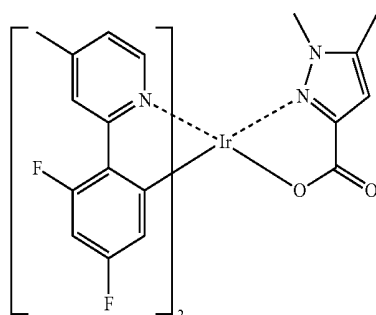
PD5



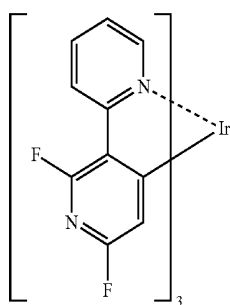
PD10



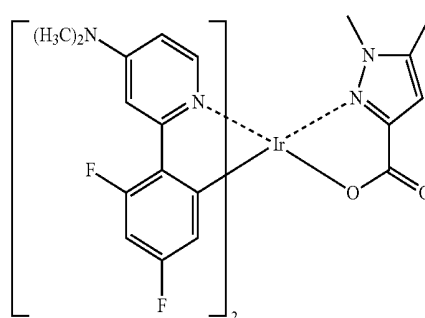
PD6



PD11

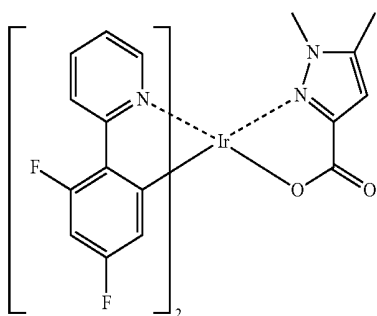


PD7



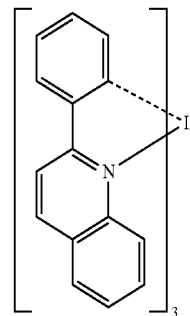
PD12

-continued

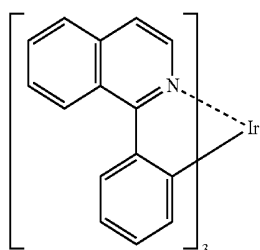


PD13

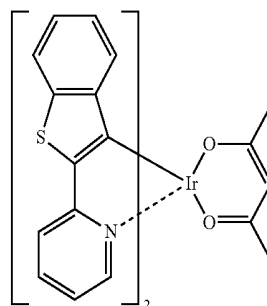
-continued



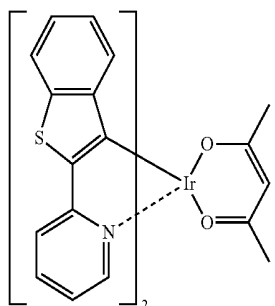
PD18



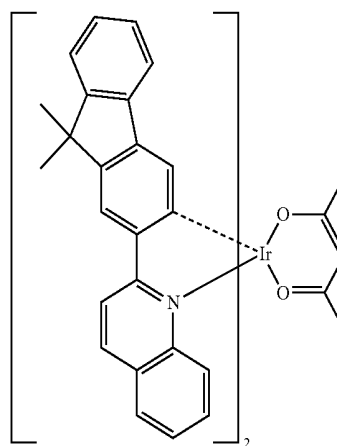
PD14



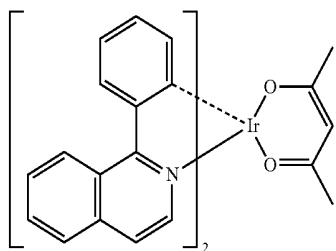
PD19



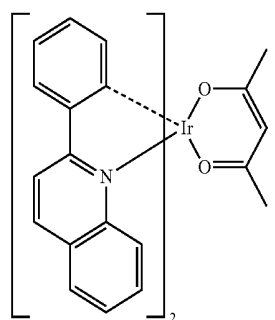
PD15



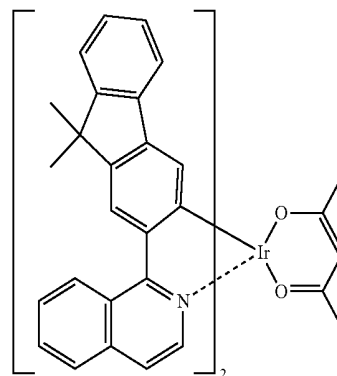
PD20



PD16

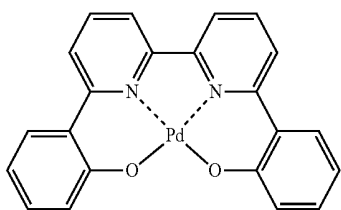


PD17

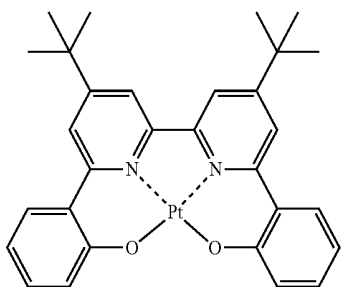


PD21

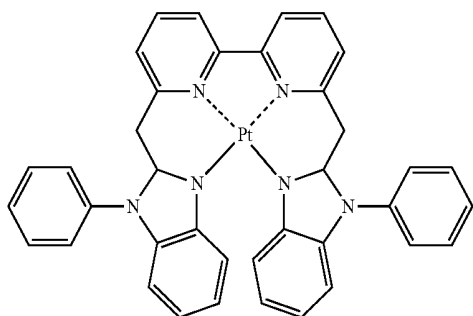
-continued



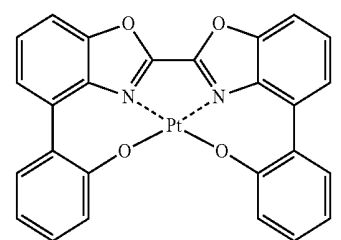
PD22



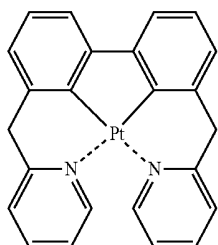
PD23



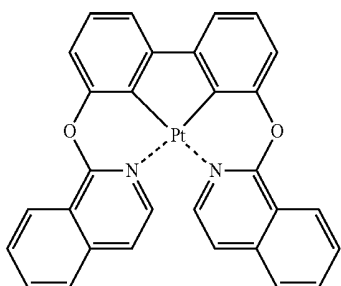
PD24



PD25

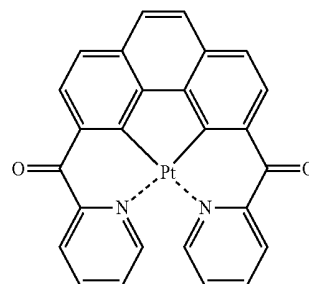


PD26

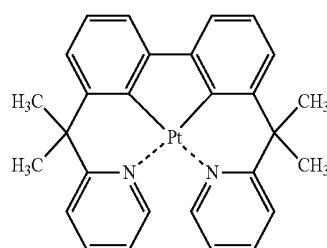


PD27

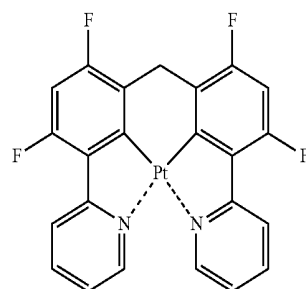
-continued



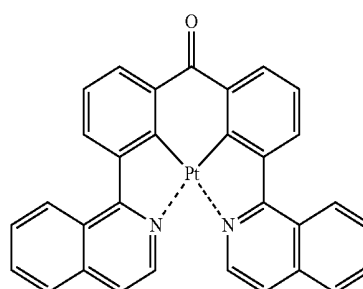
PD28



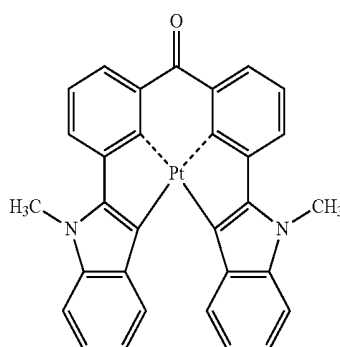
PD29



PD30

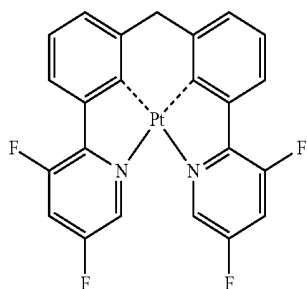


PD31



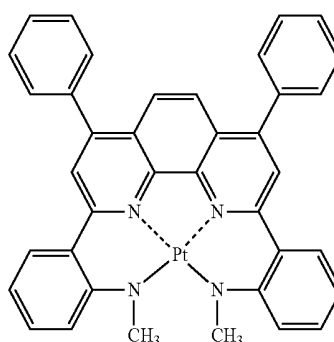
PD32

-continued



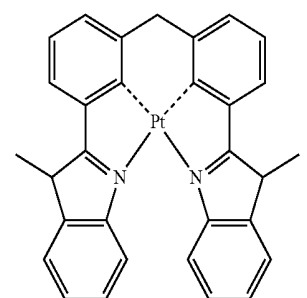
PD33

-continued



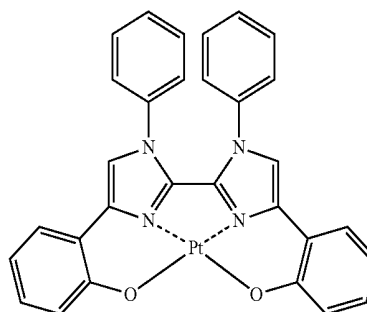
PD38

PD34

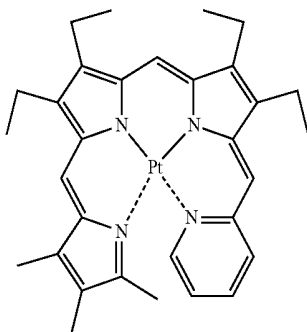


PD39

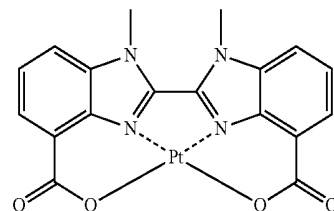
PD35



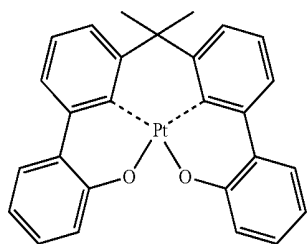
PD40



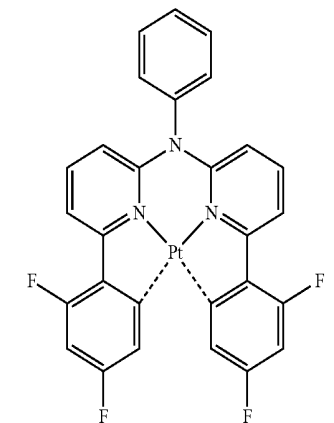
PD36



PD41

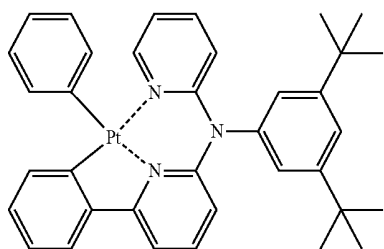
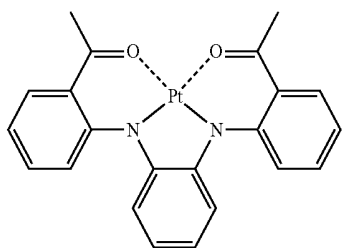
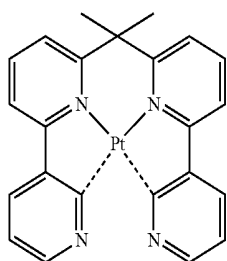
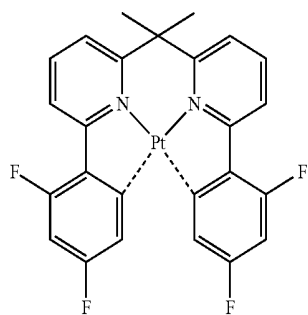
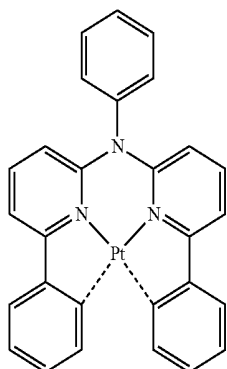


PD37



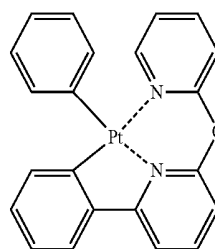
PD42

-continued



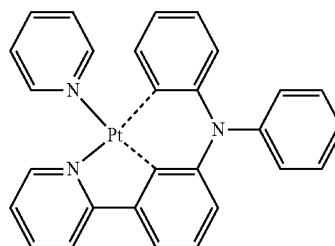
-continued

PD43



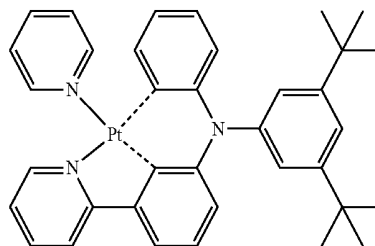
PD48

PD44



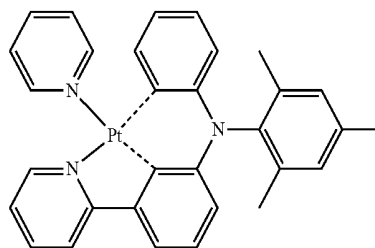
PD49

PD45



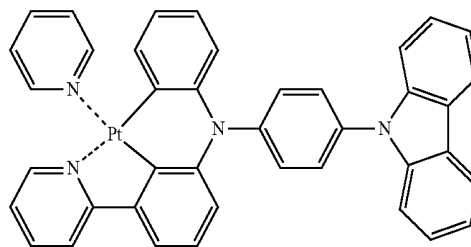
PD50

PD46

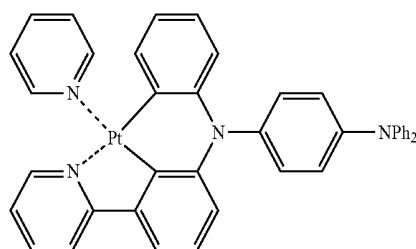


PD51

PD47

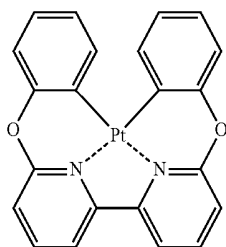


PD52



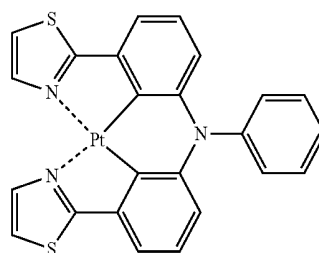
PD53

-continued

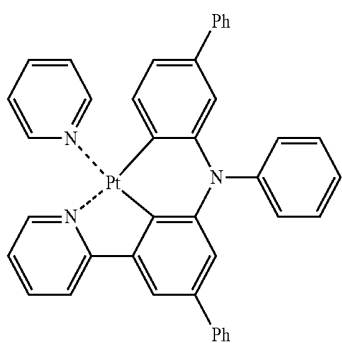


PD54

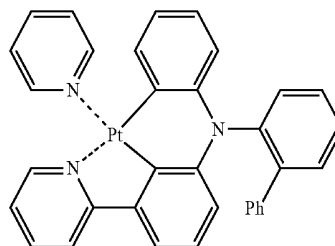
-continued



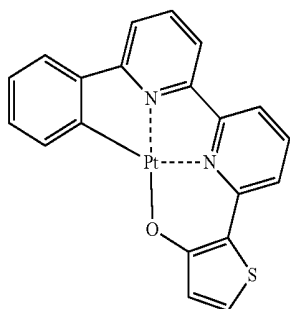
PD59



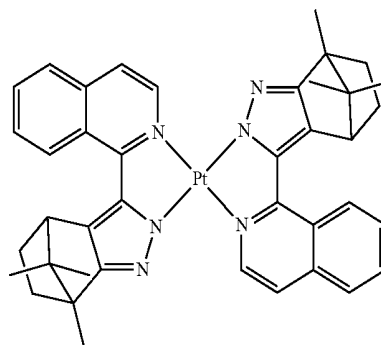
PD55



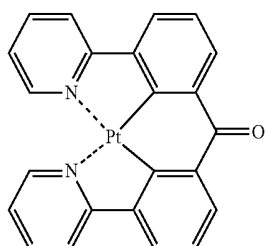
PD60



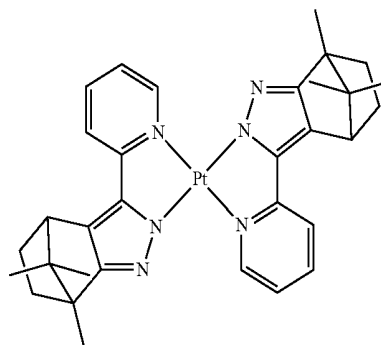
PD56



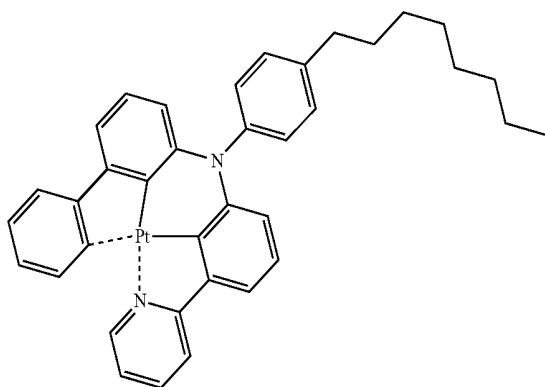
PD61



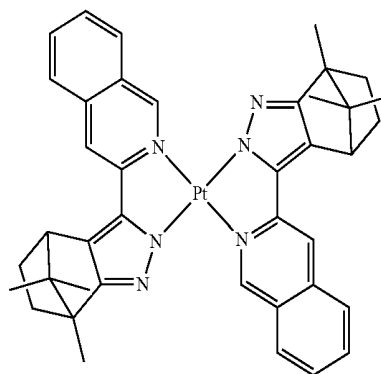
PD57



PD62

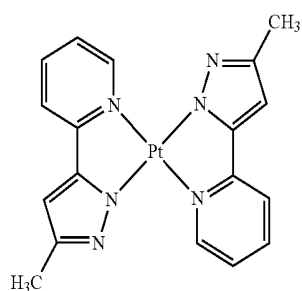


PD58



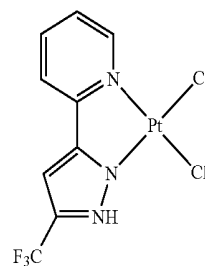
PD63

-continued

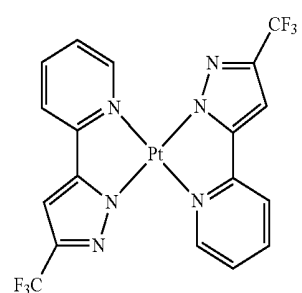


PD64

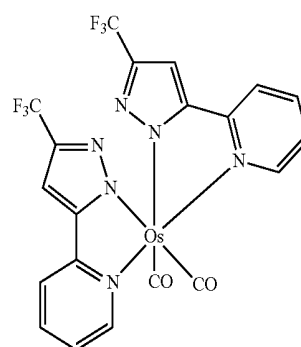
-continued



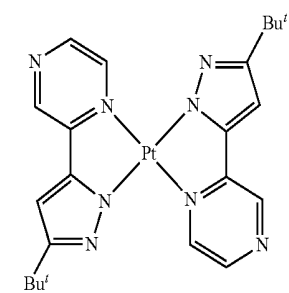
PD69



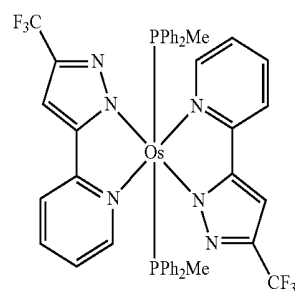
PD65



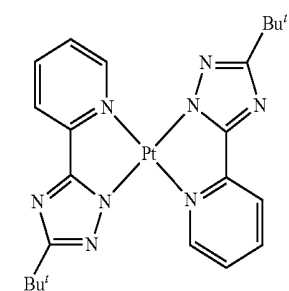
PD70



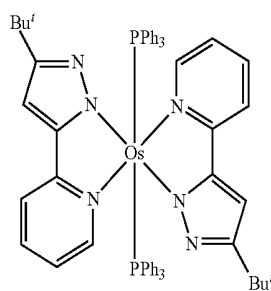
PD66



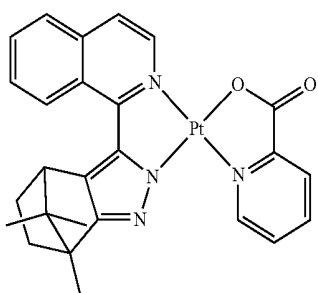
PD71



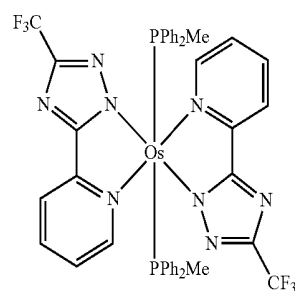
PD67



PD72

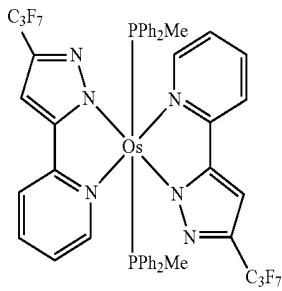


PD68



PD73

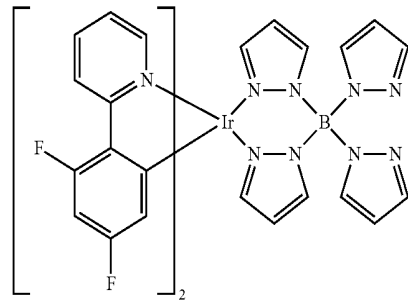
-continued



PD74

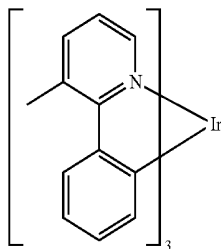
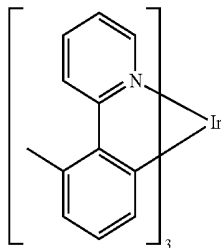
-continued

Flr6

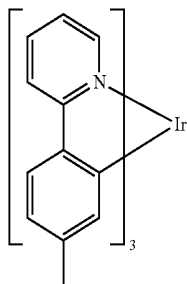
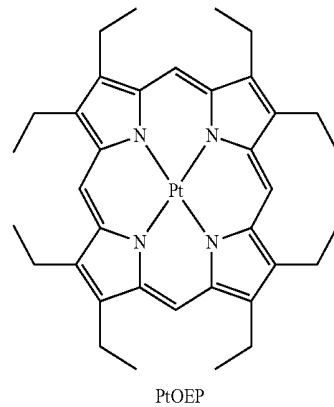


PD75

[0445] In one or more exemplary embodiments, the phosphorescent dopant may include PtOEP:



PD76



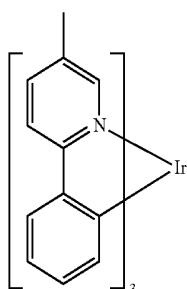
PD77

[0446] When the emission layer includes a host and a dopant, an amount of the dopant may be in a range of about 0.01 parts to about 20 parts by weight based on 100 parts by weight of the host, but is not limited thereto.

[0447] 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. While not wishing to be bound by theory, it is understood that 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.

[0448] Then, an electron transport region may be disposed on the emission layer.

[0449] The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

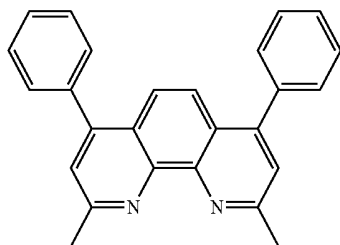


PD78

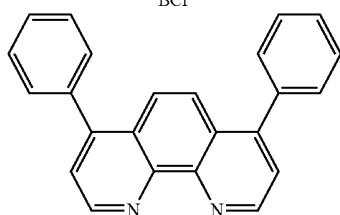
[0450] For example, the electron transport region may have a hole blocking layer/electron transport layer/electron injection layer structure or an electron transport layer/electron injection layer structure, but the structure of the electron transport region is not limited thereto. The electron transport layer may have a single-layered structure or a multi-layered structure including two or more different materials.

[0451] Conditions for forming the hole blocking layer, the electron transport layer, and the electron injection layer which constitute the electron transport region may be understood by referring to the conditions for forming the hole injection layer.

[0452] When the electron transport region includes a hole blocking layer, the hole blocking layer may include, for example, at least one of BCP and Bphen, but may also include other materials.



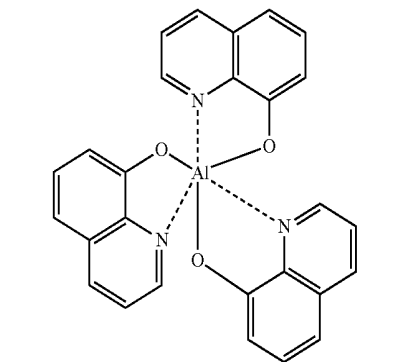
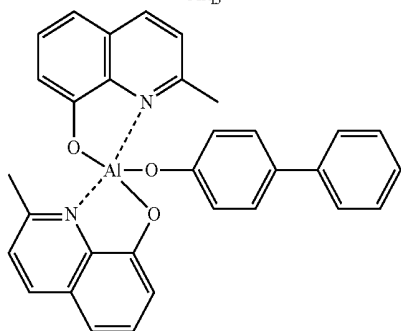
BCP



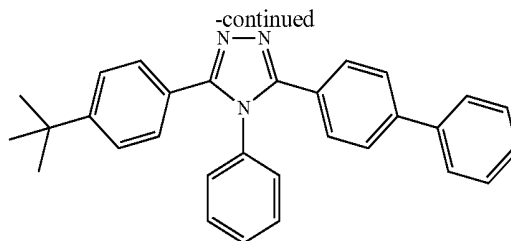
Bphen

[0453] A thickness of the hole blocking layer may be in a range of about 20 Å to about 1,000 Å, for example, about 30 Å to about 300 Å. While not wishing to be bound by theory, it is understood that when the thickness of the hole blocking layer is within these ranges, the hole blocking layer may have excellent hole blocking characteristics without a substantial increase in driving voltage.

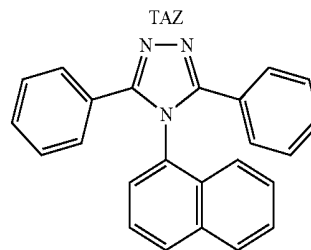
[0454] The electron transport layer may further include, in addition to the organometallic compound represented by Formula 1, at least one selected from BCP, Bphen, Alq₃, BAlq, TAZ, and NTAZ.

Alq₃

BAlq



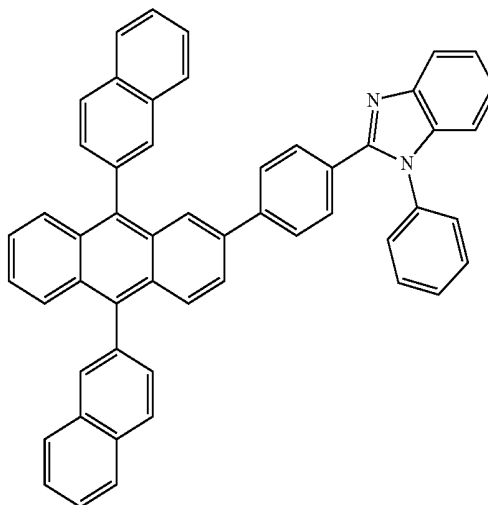
TAZ



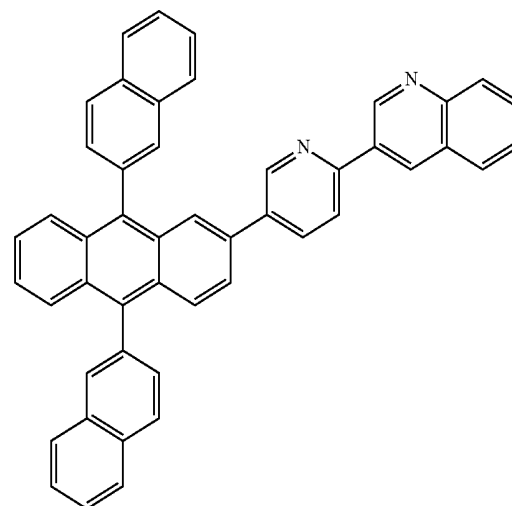
NTAZ

[0455] In one or more exemplary embodiments, the electron transport layer may include at least one of ET1 to ET19, but is not limited thereto:

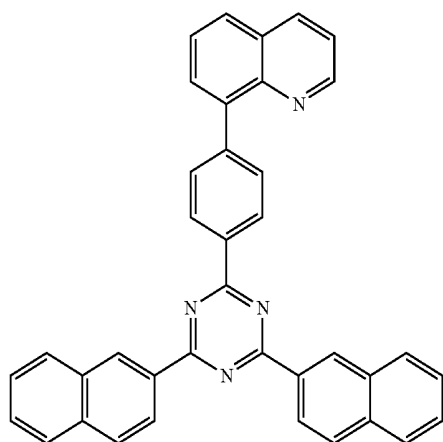
ET1



ET2

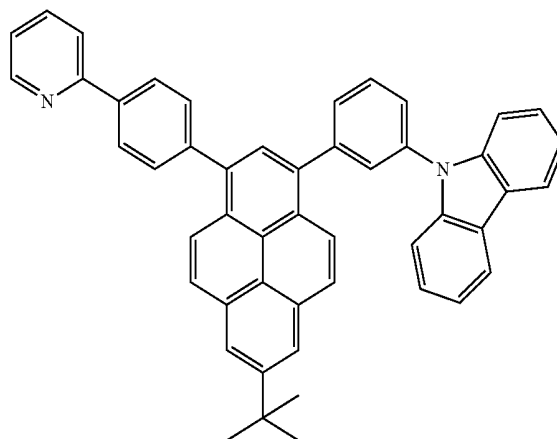


-continued



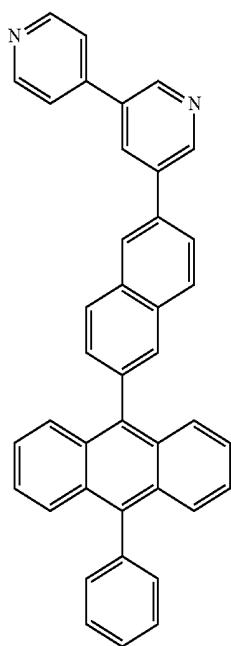
ET3

-continued

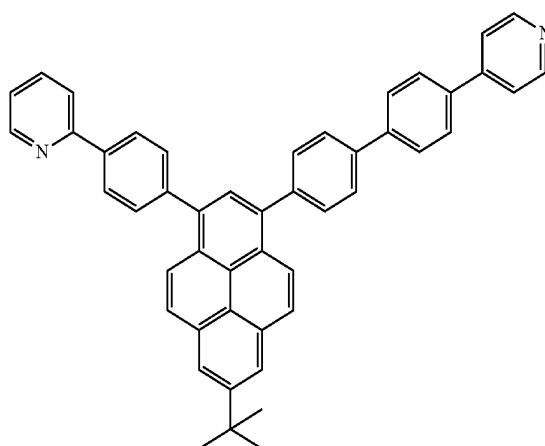


ET6

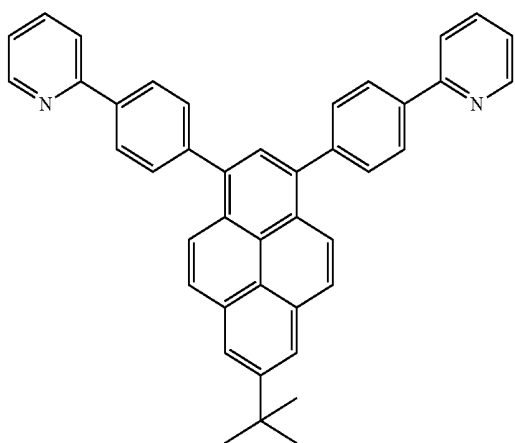
ET4



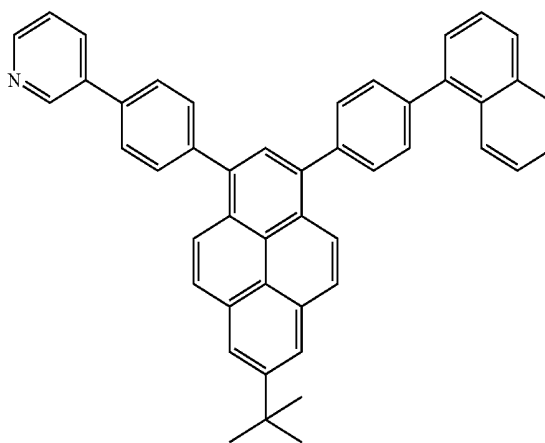
ET7



ET5

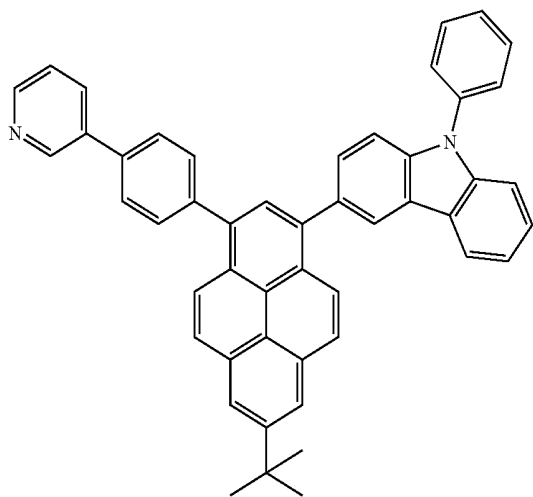


ET8

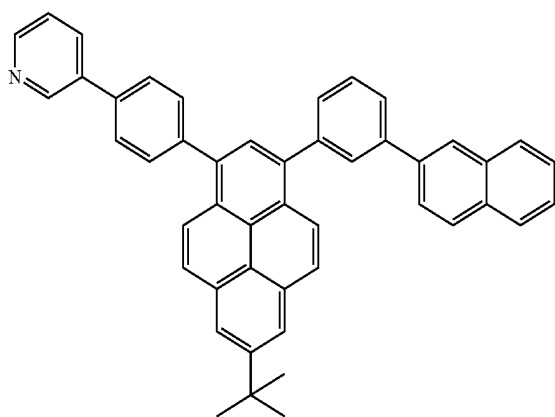


-continued

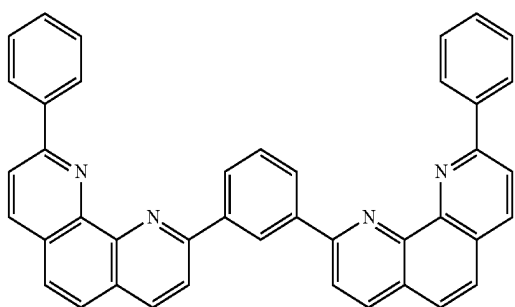
ET9



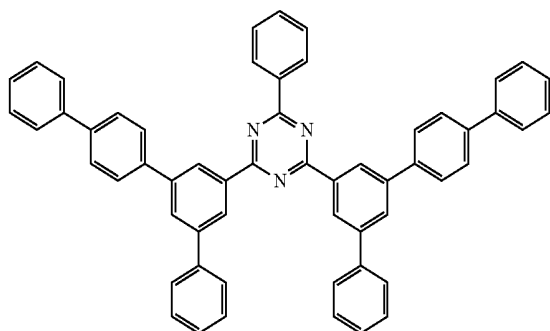
ET10



ET11

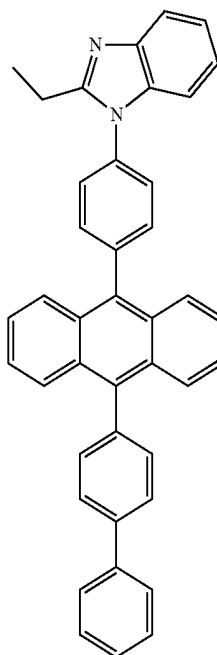


ET12

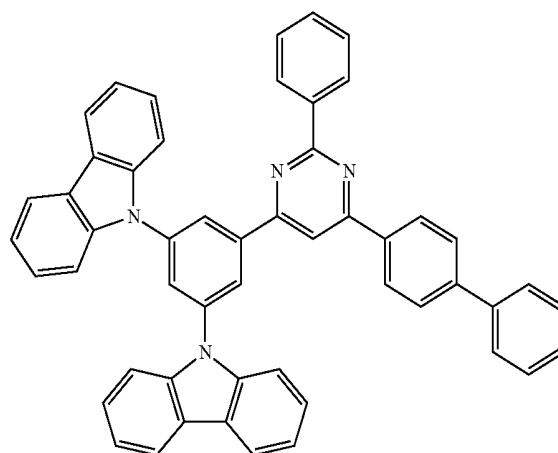


-continued

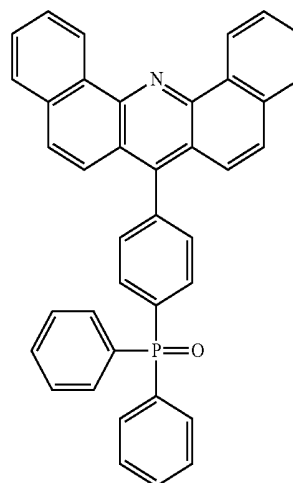
ET13



ET14



ET15



electron injection layer may have satisfactory electron injection characteristics without a substantial increase in driving voltage.

[0462] The second electrode **19** is disposed on the organic layer **15**. The second electrode **19** may be a cathode. A material for forming the second electrode **19** may be metal, an alloy, an electrically conductive compound, or a combination thereof, which have a relatively low work function. For example, lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), or magnesium-silver (Mg—Ag) may be formed as the material for forming the second electrode **19**. To manufacture a top-emission type light-emitting device, a transmissive electrode formed using ITO or IZO may be used as the second electrode **19**.

[0463] Hereinbefore, the organic light-emitting device has been described with reference to FIG. **1**, but is not limited thereto.

[0464] The term “C₁-C₆₀ alkyl group” as used herein refers to a linear or branched saturated aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms. 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 iso-amyl group, and a hexyl group. The term “C₁-C₆₀ alkylene group” as used herein refers to a divalent group having the same structure as the C₁-C₆₀ alkyl group.

[0465] The term “C₁-C₆₀ alkoxy group” as used herein refers to a monovalent group represented by —OA₁₀₁ (wherein A₁₀₁ is the C₁-C₆₀ alkyl group). Examples thereof include a methoxy group, an ethoxy group, and an isopropoxy group.

[0466] The term “C₂-C₆₀ alkenyl group” as used herein refers to a hydrocarbon group having at least one carbon-carbon double bond in the middle or at the terminus of the C₂-C₆₀ alkyl group. Examples thereof include an ethenyl group, a propenyl group and a butenyl group. The term “C₂-C₆₀ alkenylene group” as used herein refers to a divalent group having the same structure as the C₂-C₆₀ alkenyl group.

[0467] The term “C₂-C₆₀ alkynyl group” as used herein refers to a hydrocarbon group having at least one carbon-carbon triple bond in the middle or at the terminus of the C₂-C₆₀ alkyl group. Examples thereof include an ethynyl group and a propynyl group. The term “C₂-C₆₀ alkynylene group” as used herein refers to a divalent group having the same structure as the C₂-C₆₀ alkynyl group.

[0468] The term “C₃-C₁₀ cycloalkyl group” as used herein refers to a monovalent hydrocarbon monocyclic group having 3 to 10 carbon atoms. Examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. The term “C₃-C₁₀ cycloalkylene group” as used herein refers to a divalent group having the same structure as the C₃-C₁₀ cycloalkyl group.

[0469] The term “C₁-C₁₀ heterocycloalkyl group” as used herein refers to a monovalent saturated monocyclic group having at least one heteroatom selected from N, O, P, Si and S as a ring-forming atom and 1 to 10 carbon atoms. Examples thereof include a tetrahydrofuranlyl group and a tetrahydrothiophenyl group. The term “C₁-C₁₀ heterocycloalkylene group,” as used herein, refers to a divalent group having the same structure as the C₁-C₁₀ heterocycloalkyl group.

[0470] The term “C₃-C₁₀ 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 which is not aromatic. Examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. The term “C₃-C₁₀ cycloalkenylene group,” as used herein, refers to a divalent group having the same structure as the C₃-C₁₀ cycloalkenyl group.

[0471] The term “C₁-C₁₀ heterocycloalkenyl group” as used herein refers to a monovalent monocyclic group that has at least one heteroatom selected from N, O, P, Si, and S as a ring-forming atom, 1 to 10 carbon atoms, and at least one carbon-carbon double bond in its ring. Examples of the C₂-C₁₀ heterocycloalkenyl group include a 2,3-dihydrofuranlyl group and a 2,3-dihydrothiophenyl group. The term “C₁-C₁₀ heterocycloalkenylene group,” as used herein, refers to a divalent group having the same structure as the C₁-C₁₀ heterocycloalkenyl group.

[0472] The term “C₆-C₆₀ aryl group” as used herein refers to a monovalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms, and the term “C₆-C₆₀ arylene group” as used herein refers to a divalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms. Examples of the C₆-C₆₀ aryl group are a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C₆-C₆₀ aryl group and the C₆-C₆₀ arylene group each include two or more rings, the rings may be fused to each other.

[0473] The term “C₁-C₆₀ heteroaryl group” as used herein refers to a monovalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, P, Si, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. The term “C₁-C₆₀ heteroarylene group” as used herein refers to a divalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, P, Si, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. Examples of the C₁-C₆₀ heteroaryl group are a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinoxalyl group, and an isoquinolinyl group. When the C₁-C₆₀ heteroaryl group and the C₁-C₆₀ heteroarylene group each include two or more rings, the rings may be fused to each other.

[0474] The term “C₆-C₆₀ aryloxy group,” as used herein, indicates —OA₁₀₂ (wherein A₁₀₂ is the C₆-C₆₀ aryl group), and the term “C₆-C₆₀ arylthio group” as used herein indicates —SA₁₀₃ (wherein A₁₀₃ is the C₆-C₆₀ aryl group).

[0475] The term “monovalent non-aromatic condensed polycyclic group” as used herein refers to a monovalent group that has two or more rings condensed to each other, that includes only carbon atoms (for example, the number of carbon atoms may be in a range of 8 to 60) as ring-forming atoms, and that is non-aromatic in the entire molecular structure. Examples of the monovalent non-aromatic condensed polycyclic group include a fluorenyl group. The term “divalent non-aromatic condensed polycyclic group,” as used herein, refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

[0476] The term “monovalent non-aromatic condensed heteropolycyclic group” as used herein refers to a monovalent group that has two or more rings condensed to each other, has a heteroatom selected from N, O, P, Si, and S,

other than carbon atoms (for example, the number of carbon atoms may be in a range of 2 to 60), as a ring-forming atom, and which is non-aromaticity in the entire molecular structure. Examples of the monovalent non-aromatic condensed heteropolycyclic group include a carbazoyl group. The term “divalent non-aromatic condensed heteropolycyclic group,” as used herein, refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

[0477] The term “biphenyl group” refers to a monovalent group in which two benzene groups are linked via a single bond.

[0478] The term “terphenyl group” refers to a monovalent group in which three benzene groups are linked via a single bond.

[0479] At least one substituent of 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} alkyne group, the substituted C_1 - C_{60} alkoxy group, the substituted C_3 - C_{60} 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:

[0480] deuterium, $—CD_3$, $—CD_2H$, $—CDH_2$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkyne group, and a C_1 - C_{60} alkoxy group;

[0481] a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkyne group, and a C_1 - C_{60} alkoxy group, each substituted with at least one selected from deuterium, $—CD_3$, $—CD_2H$, $—CDH_2$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_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, $—Si(Q_{11})(Q_{12})(Q_{13})$, $—N(Q_{11})(Q_{12})$, and $—B(Q_{11})(Q_{12})$;

[0482] 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;

[0483] 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, $—CD_3$, $—CD_2H$, $—CDH_2$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkyne 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, $—Si(Q_{21})(Q_{22})(Q_{23})$, $—N(Q_{21})(Q_{22})$, and $—B(Q_{21})(Q_{22})$; and $—Si(Q_{31})(Q_{32})(Q_{33})$, $—N(Q_{31})(Q_{32})$ and $—B(Q_{31})(Q_{32})$, wherein Q_{11} to Q_{13} , Q_{21} to Q_{23} , and Q_{31} to Q_{33} may each independently be selected from hydrogen, deuterium, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkyne 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.

[0484] When a group containing a specified number of carbon atoms is substituted with any of the groups listed in the preceding paragraph, the number of carbon atoms in the resulting “substituted” group is defined as the sum of the carbon atoms contained in the original (unsubstituted) group and the carbon atoms (if any) contained in the substituent. For example, when the term “substituted C_1 - C_{30} alkyl” refers to a C_1 - C_{30} alkyl group substituted with C_6 - C_{30} aryl group, the total number of carbon atoms in the resulting aryl substituted alkyl group is C_7 - C_{60} .

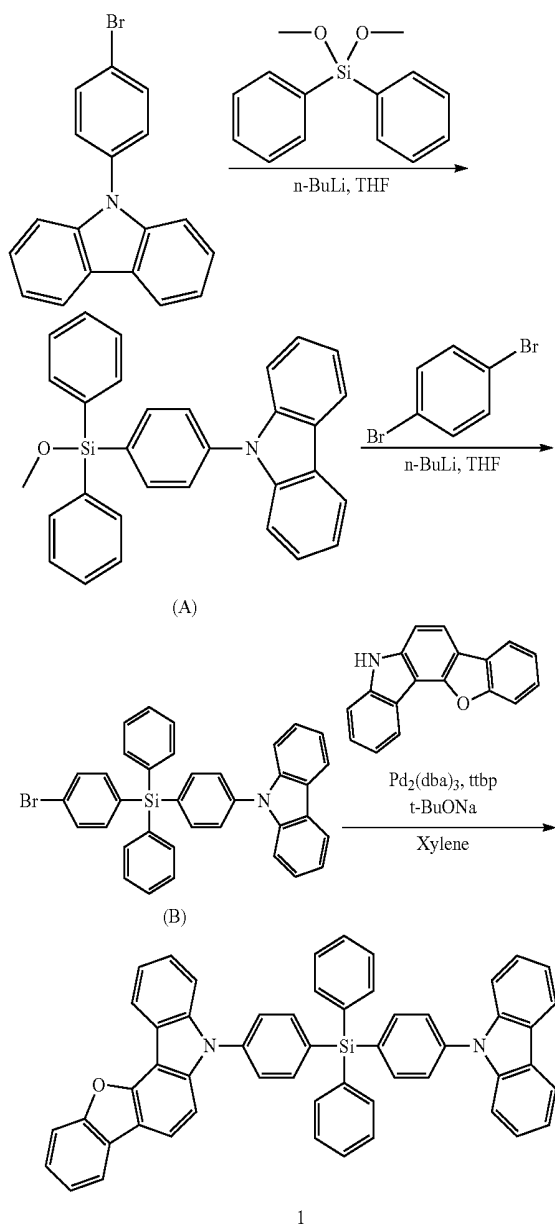
[0485] Hereinafter, a compound and an organic light-emitting device according to exemplary embodiments are described in detail with reference to Synthesis Examples and Examples. However, the compound and the organic light-emitting device are not limited thereto. The wording “B was used instead of A” used in describing Synthesis Examples means that an amount in molar equivalents of A used was identical to an amount in molar equivalents of B used.

EXAMPLES

Synthesis Example 1

Synthesis of Compound 1

[0486] Compound 1 was synthesized according to the Reaction Scheme below:



[0487] (1) Synthesis of Intermediate (A)

[0488] 50.0 grams (g) (155 millimoles, mmol) of 9-(4-bromophenyl)-9H-carbazole was dissolved in 500 milliliters (mL) of tetrahydrofuran (THF) and the solution was cooled to a temperature of -78°C . Then, 97.0 mL (155.0 mmol, 1.6 molar (M) solution in n-hexane) of n-butyllithium was slowly added thereto for 30 minutes and the resultant mixture was stirred at a temperature of -78°C . for 1 hour. To the resultant mixture, 45.5 g (186 mmol) of dimethoxydiphenylsilane dissolved in 250 mL of THF was slowly added for 30 minutes. The reaction temperature was raised slowly to room temperature for 1 hour, and the reaction was

additionally stirred at room temperature for 15 hours. After the reaction was complete, a saturated ammonium chloride (NH_4Cl) aqueous solution was added thereto. The reaction mixture was extracted and the organic layer was separated. Water was removed from the separated organic layer by using anhydrous magnesium sulfate (MgSO_4) as a drying agent, and the dried solution was filtered and concentrated. The product was purified by silica gel column chromatography, thereby completing the preparation of 45.2 g (64%) of Intermediate (A).

[0489] LC-Mass (cal.: 455.17 g/mol, found: $[\text{M}+\text{H}]^+=456$ g/mol)

[0490] (2) Synthesis of Intermediate (B)

[0491] 22.2 g (45%) of Intermediate (B) was synthesized in the same manner as in Synthesis of Intermediate (A), except that, in synthesizing Intermediate (B), 20.0 g (84.8 mmol) of 1,4-dibromobenzene was used instead of 9-(4-bromophenyl)-9H-carbazole, and 38.6 g (84.8 mmol) of Intermediate (A) was used instead of dimethoxydiphenylsilane.

[0492] LC-Mass (cal.: 579.10 grams per mole (g/mol), found: $[\text{M}+\text{H}]^+=580$ g/mol)

[0493] (3) Synthesis of Compound 1

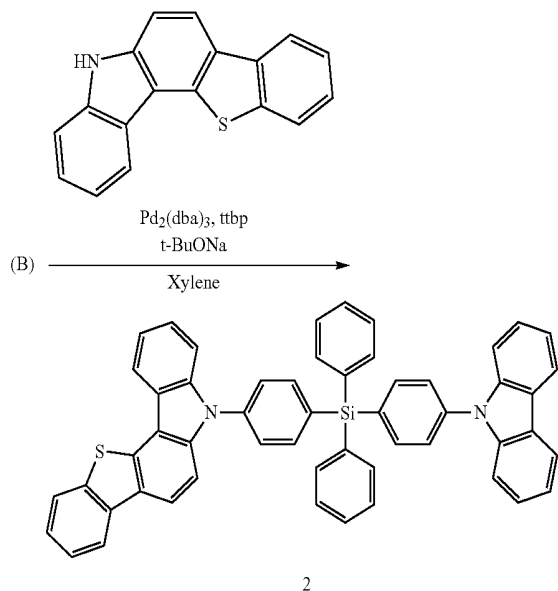
[0494] 10.0 g (17.2 mmol) of Intermediate (B), 4.88 g (19.0 mmol) of 5H-benzofuro[3,2-c]carbazole, 0.99 g (1.72 mmol) of $\text{Pd}(\text{dba})_2$, 1.72 mL (50% in xylene, 3.44 mmol) of tri-tert-butylphosphine (ttpb), and 3.31 g (34.5 mmol) of sodium tert-butoxide were added to 60 mL of xylene, and the resultant mixture was heated and stirred at a temperature of 120°C . When the reaction was complete, the reaction product was cooled to room temperature and filtered through a plug of silica gel under reduced pressure. The filtered solution was concentrated under vacuum. The product was purified by silica gel column chromatography, thereby completing the preparation of 9.91 g (76%) of Compound 1.

[0495] LC-Mass (cal.: 756.26 g/mol, found: $[\text{M}+\text{H}]^+=757$ g/mol)

Synthesis Example 2

Synthesis of Compound 2

[0496] Compound 2 was synthesized according to the Reaction Scheme below:



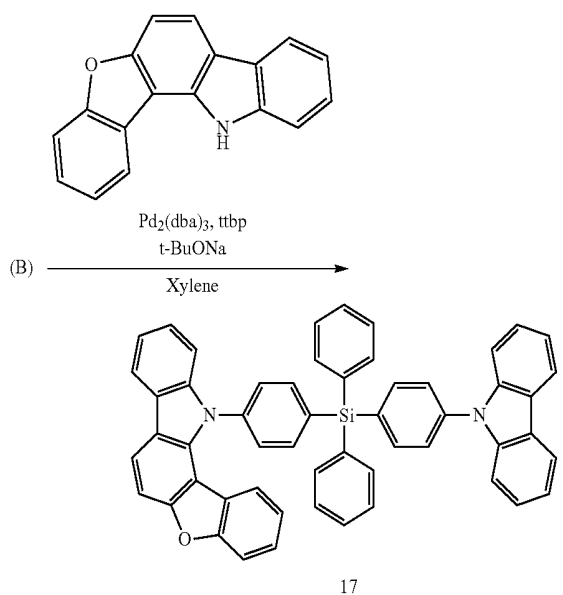
[0497] 9.05 g (68%) of Compound 2 was synthesized in the same manner as in Synthesis of Compound 1, except that 5.18 g (19.0 mmol) of 5H-benzo[4,5]thieno[3,2-c]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 2.

[0498] LC-Mass (cal.: 772.24 g/mol, found: $[M+H]^+=773$ g/mol)

Synthesis Example 3

Synthesis of Compound 17

[0499] Compound 17 was synthesized according to the Reaction Scheme below:



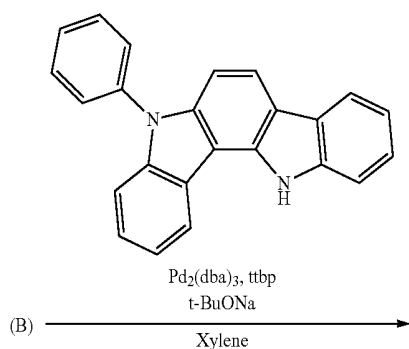
[0500] 7.95 g (61%) of Compound 17 was synthesized in the same manner as in Synthesis of Compound 1, except that 4.88 g (19.0 mmol) of 12H-benzofuro[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 17.

[0501] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

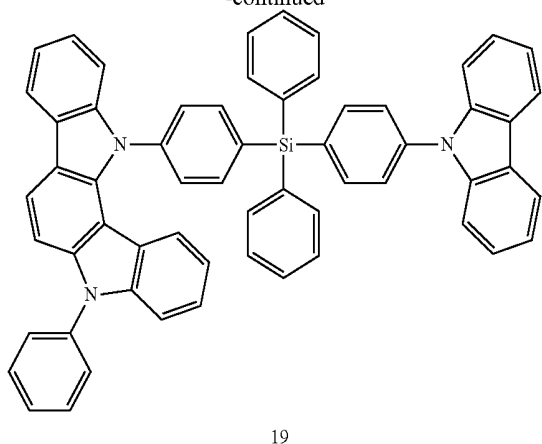
Synthesis Example 4

Synthesis of Compound 19

[0502] Compound 19 was synthesized according to the Reaction Scheme below:



-continued



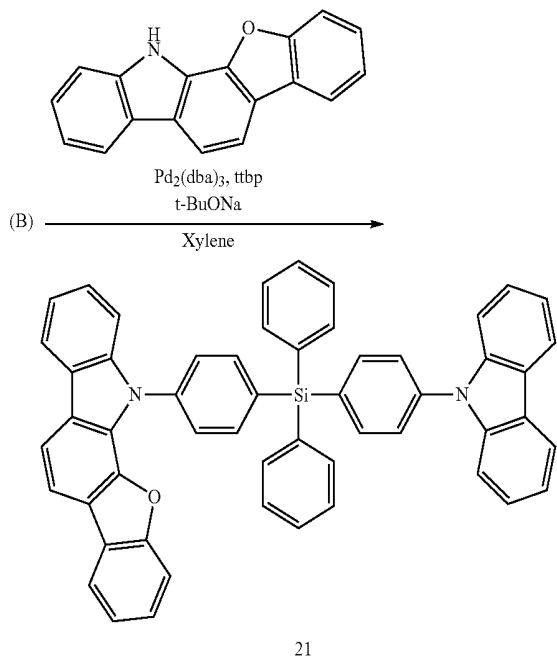
[0503] 6.16 g (43%) of Compound 19 was synthesized in the same manner as in Synthesis of Compound 1, except that 6.30 g (19.0 mmol) of 5-phenyl-5,12-dihydroindolo[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole.

[0504] LC-Mass (cal.: 831.31 g/mol, found: $[M+H]^+=832$ g/mol)

Synthesis Example 5

Synthesis of Compound 21

[0505] Compound 21 was synthesized according to the Reaction Scheme below:



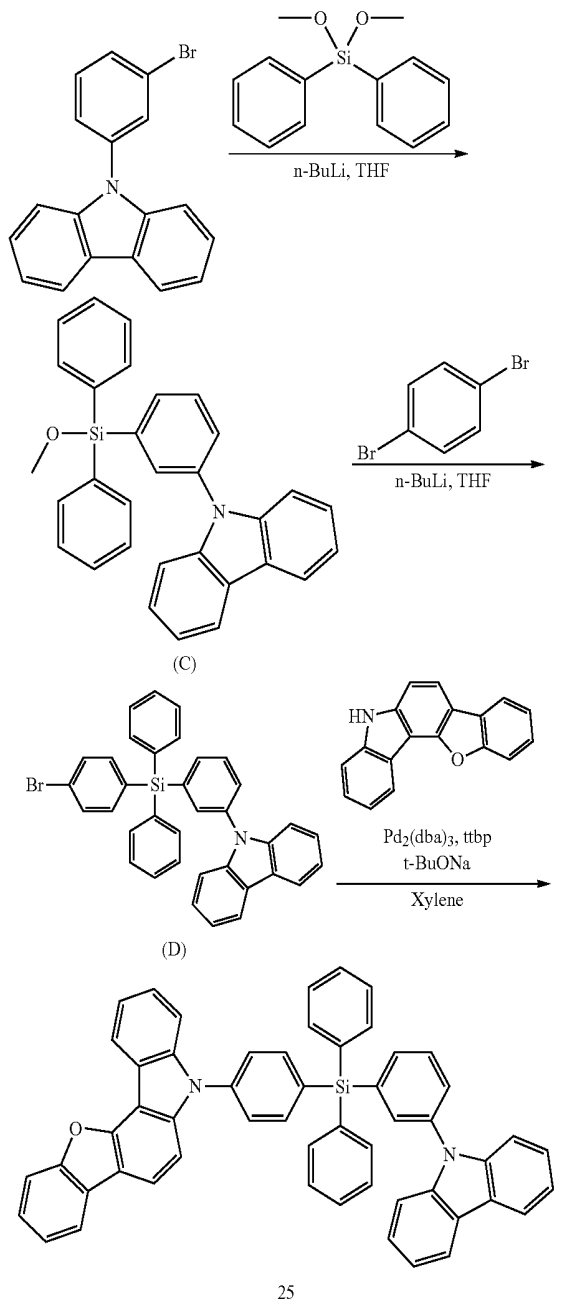
[0506] 6.13 g (47%) of Compound 21 was synthesized in the same manner as in Synthesis of Compound 1, except that 4.88 g (19.0 mmol) of 12H-benzofuro[2,3-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 21.

[0507] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 6

Synthesis of Compound 25

[0508] Compound 25 was synthesized according to the Reaction Scheme below:



[0509] (1) Synthesis of Intermediate (C)

[0510] 43.1 g (61%) of Intermediate (C) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (155 mmol) of 9-(3-bromophenyl)-9H-carbazole was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (C).

[0511] LC-Mass (cal.: 455.17 g/mol, found: $[M+H]^+=456$ g/mol)

[0512] (2) Synthesis of Intermediate (D)

[0513] 26.1 g (53%) of Intermediate (D) was synthesized in the same manner as in Synthesis of Intermediate (B),

except that 38.6 g (84.8 mmol) of Intermediate (C) was used instead of Intermediate (A) in synthesizing Intermediate (D).

[0514] LC-Mass (cal.: 579.10 g/mol, found: $[M+H]^+=580$ g/mol)

[0515] (3) Synthesis of Compound 25

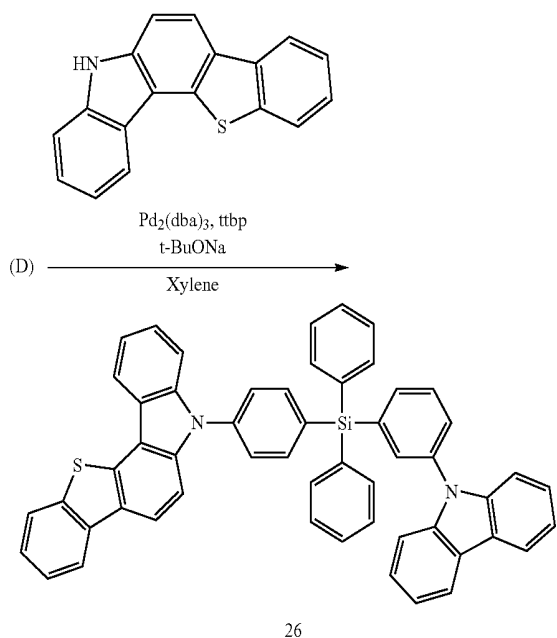
[0516] 9.39 g (72%) of Compound 25 was synthesized in the same manner as in Synthesis of Compound 1, except that 10.0 g (17.2 mmol) of Intermediate (D) was used instead of Intermediate (B) in synthesizing Compound 25.

[0517] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 7

Synthesis of Compound 26

[0518] Compound 26 was synthesized according to the Reaction Scheme below:



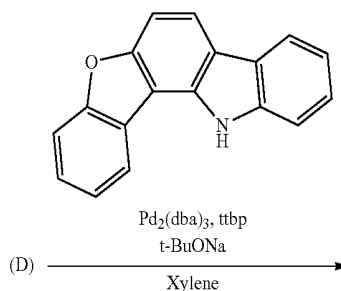
[0519] 9.32 g (70%) of Compound 26 was synthesized in the same manner as in Synthesis of Compound 25, except that 5.18 g (19.0 mmol) of 5H-benzo[4,5]thieno[3,2-c]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 26.

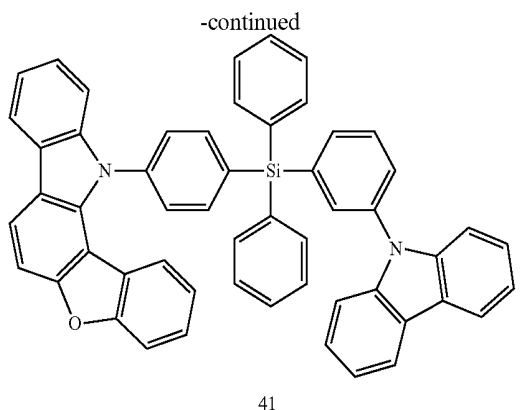
[0520] LC-Mass (cal.: 772.24 g/mol, found: $[M+H]^+=773$ g/mol)

Synthesis Example 8

Synthesis of Compound 41

[0521] Compound 41 was synthesized according to the Reaction Scheme below:





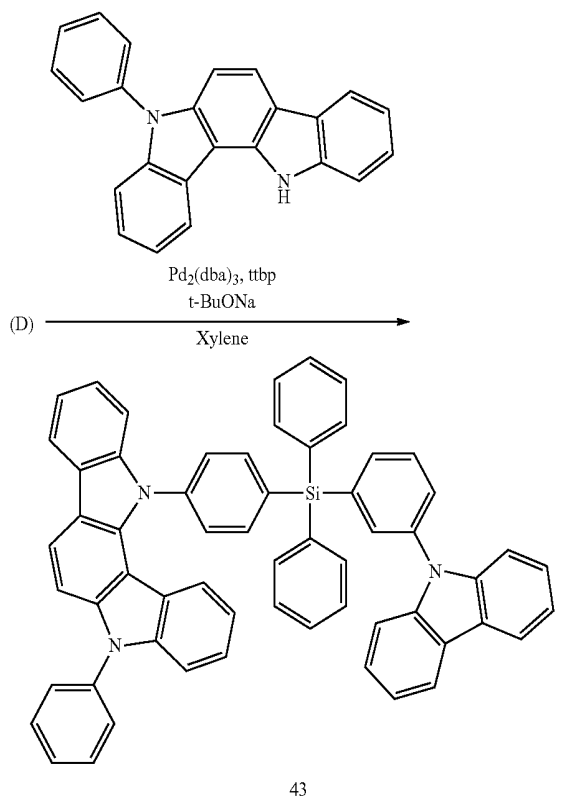
[0522] 7.56 g (58%) of Compound 41 was synthesized in the same manner as in Synthesis of Compound 25, except that 4.88 g (19.0 mmol) of 12H-benzofuro[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 41.

[0523] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 9

Synthesis of Compound 43

[0524] Compound 43 was synthesized according to the Reaction Scheme below:



[0525] 7.88 g (55%) of Compound 43 was synthesized in the same manner as in Synthesis of Compound 25, except that 6.30 g (19.0 mmol) of 5-phenyl-5,12-dihydroindolo[3,

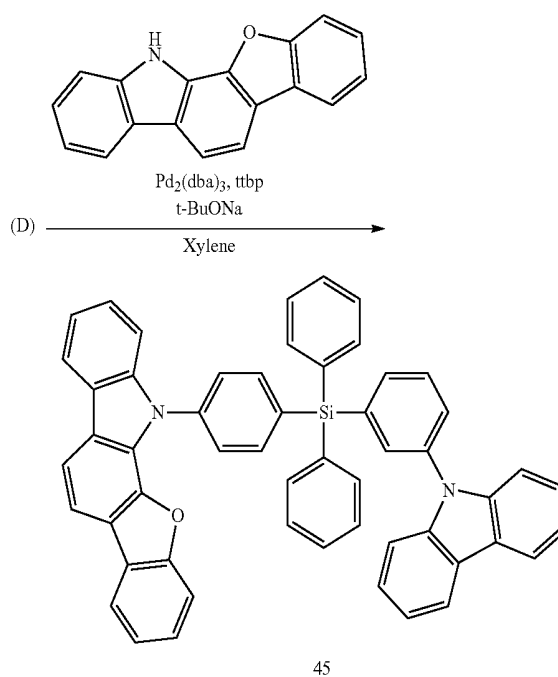
2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 43.

[0526] LC-Mass (cal.: 831.31 g/mol, found: $[M+H]^+=832$ g/mol)

Synthesis Example 10

Synthesis of Compound 45

[0527] Compound 45 was synthesized according to the Reaction Scheme below:



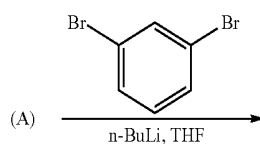
[0528] 5.48 g (42%) of Compound 45 was synthesized in the same manner as in Synthesis of Compound 25, except that 4.88 g (19.0 mmol) of 12H-benzofuro[2,3-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 45.

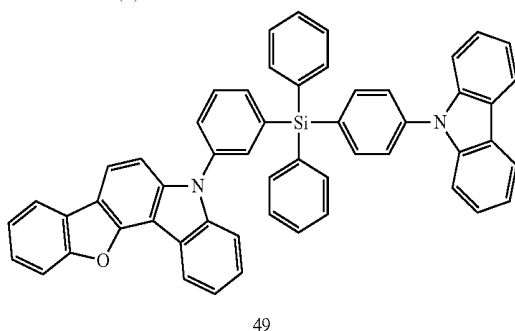
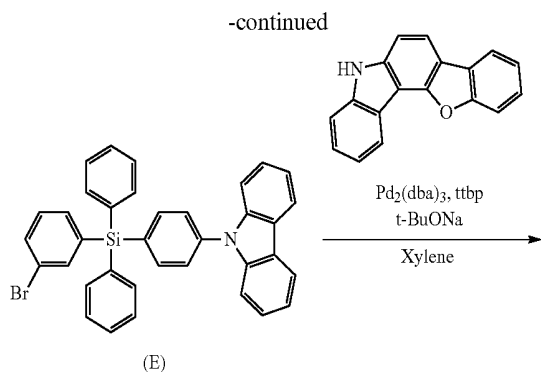
[0529] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 11

Synthesis of Compound 49

[0530] Compound 4 was synthesized according to the Reaction Scheme below:





[0531] (1) Synthesis of Intermediate (E)

[0532] 24.7 g (50%) of Intermediate (E) was synthesized in the same manner as in Synthesis of Intermediate (B), except that 20.0 g (84.8 mmol) of 1,3-dibromobenzene was used instead of Intermediate 1,4-dibromobenzene in synthesizing Intermediate (E).

[0533] LC-Mass (cal.: 579.10 g/mol, found: $[M+H]^+=580$ g/mol)

[0534] (2) Synthesis of Compound 49

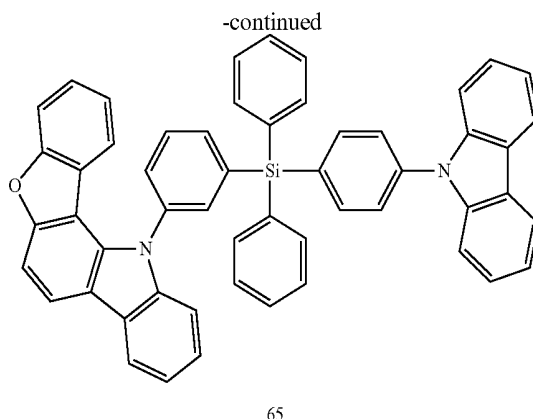
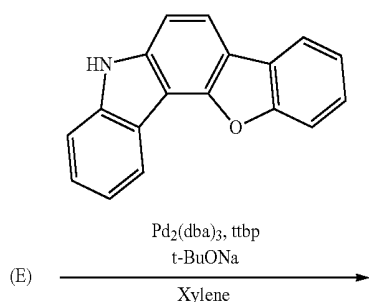
[0535] 8.22 g (63%) of Compound 49 was synthesized in the same manner as in Synthesis of Compound 1, except that 10.0 g (17.2 mmol) of Intermediate (E) was used instead of Intermediate (B) in synthesizing Compound 49.

[0536] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 12

Synthesis of Compound 65

[0537] Compound 65 was synthesized according to the Reaction Scheme below:



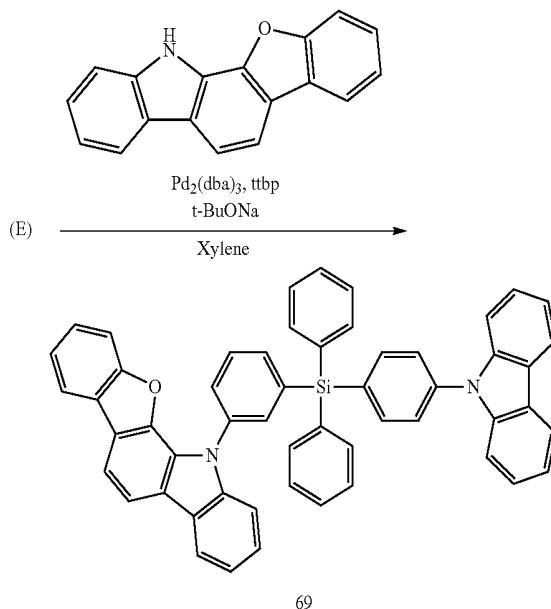
[0538] 6.26 g (48%) of Compound 65 was synthesized in the same manner as in Synthesis of Compound 49, except that 4.88 g (19.0 mmol) of 12H-benzofuro[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 65.

[0539] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 13

Synthesis of Compound 69

[0540] Compound 69 was synthesized according to the Reaction Scheme below:



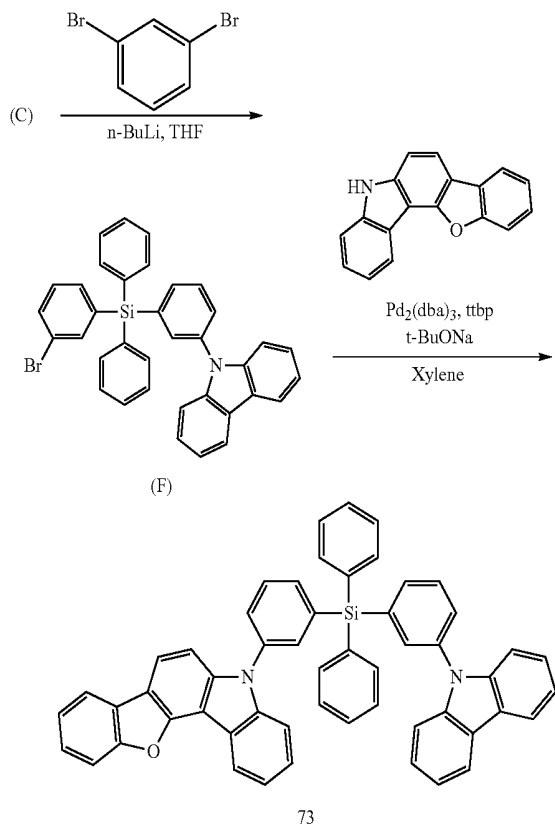
[0541] 5.61 g (43%) of Compound 69 was synthesized in the same manner as in Synthesis of Compound 49, except that 4.88 g (19.0 mmol) of 12H-benzofuro[2,3-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 69.

[0542] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 14

Synthesis of Compound 73

[0543] Compound 73 was synthesized according to the Reaction Scheme below:



[0544] (1) Synthesis of Intermediate (F)

[0545] 20.3 g (41%) of Intermediate (F) was synthesized in the same manner as in Synthesis of Intermediate (D), except that 20.0 g (84.8 mmol) of 1,3-dibromobenzene was used instead of Intermediate 1,4-dibromobenzene in synthesizing Intermediate (F).

[0546] LC-Mass (cal.: 579.10 g/mol, found: $[M+H]^+=580$ g/mol)

[0547] (2) Synthesis of Compound 73

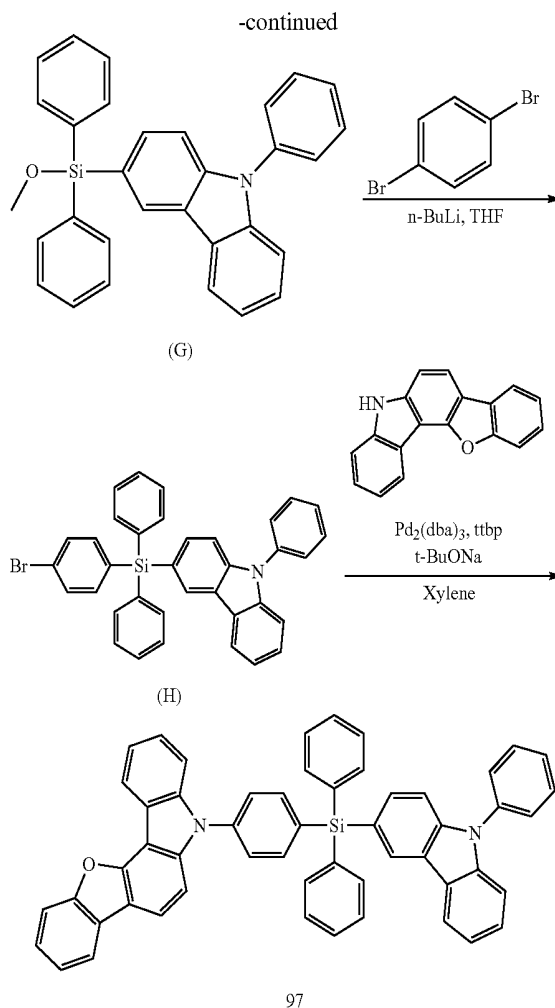
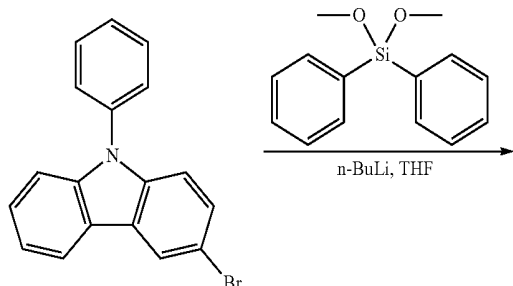
[0548] 8.35 g (64%) of Compound 73 was synthesized in the same manner as in Synthesis of Compound 1, except that 10.0 g (17.2 mmol) of Intermediate (F) was used instead of Intermediate (B) in synthesizing Compound 73.

[0549] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 15

Synthesis of Compound 97

[0550] Compound 97 was synthesized according to the Reaction Scheme below:



[0551] (1) Synthesis of Intermediate (G)

[0552] 45.9 g (65%) of Intermediate (G) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (155 mmol) of 3-bromo-9-phenyl-9H-carbazole was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (G).

[0553] LC-Mass (cal.: 455.17 g/mol, found: $[M+H]^+=456$ g/mol)

[0554] (2) Synthesis of Intermediate (H)

[0555] 27.1 g (55%) of Intermediate (H) was synthesized in the same manner as in Synthesis of Intermediate (B), except that 38.6 g (84.8 mmol) of Intermediate (G) was used instead of Intermediate (A) in synthesizing Intermediate (H).

[0556] LC-Mass (cal.: 579.10 g/mol, found: $[M+H]^+=580$ g/mol)

[0557] (3) Synthesis of Compound 97

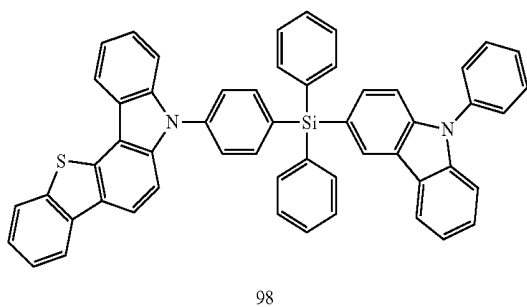
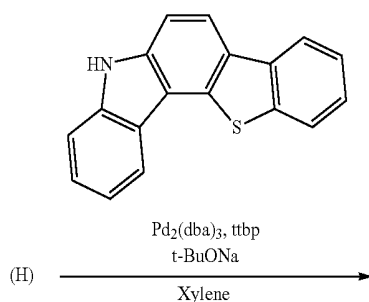
[0558] 7.96 g (61%) of Compound 97 was synthesized in the same manner as in Synthesis of Compound 1, except that 10.0 g (17.2 mmol) of Intermediate (H) was used instead of Intermediate (B) in synthesizing Compound 97.

[0559] LC-Mass (cal.: 756.26 g/mol, found: $[M+H]^+=757$ g/mol)

Synthesis Example 16

Synthesis of Compound 98

[0560] Compound 98 was synthesized according to the Reaction Scheme below:



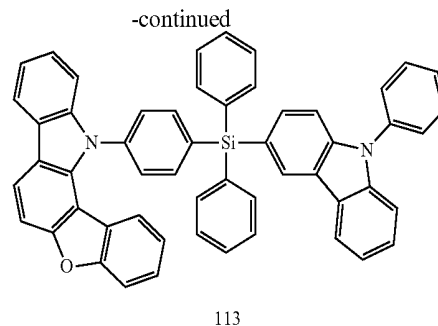
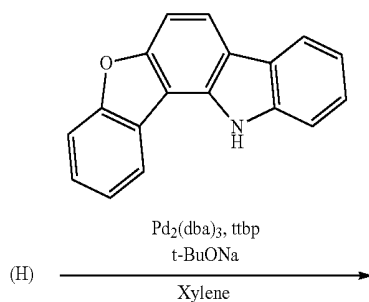
[0561] 8.39 g (63%) of Compound 98 was synthesized in the same manner as in Synthesis of Compound 97, except that 5.18 g (19.0 mmol) of 5H-benzo[4,5]thieno[3,2-c]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 98.

[0562] LC-Mass (cal.: 772.24 g/mol, found: $[\text{M}+\text{H}]^+=773$ g/mol)

Synthesis Example 17

Synthesis of Compound 113

[0563] Compound 113 was synthesized according to the Reaction Scheme below:



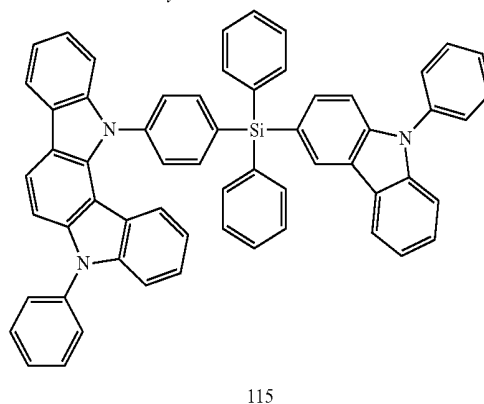
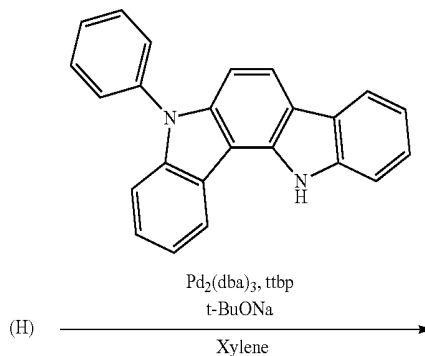
[0564] 8.21 g (63%) of Compound 113 was synthesized in the same manner as in Synthesis of Compound 97, except that 4.88 g (19.0 mmol) of 12H-benzofuro[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 113.

[0565] LC-Mass (cal.: 756.26 g/mol, found: $[\text{M}+\text{H}]^+=757$ g/mol)

Synthesis Example 18

Synthesis of Compound 115

[0566] Compound 115 was synthesized according to the Reaction Scheme below:



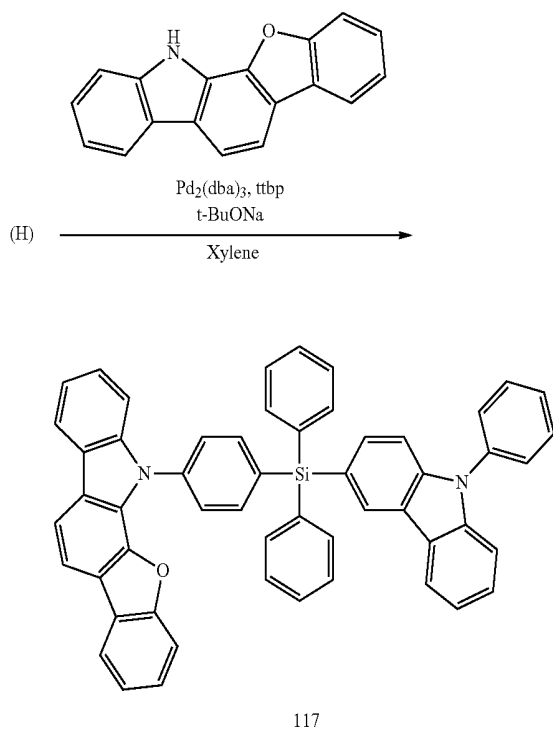
[0567] 5.87 g (41%) of Compound 115 was synthesized in the same manner as in Compound 97, except that 6.30 g (19.0 mmol) of 5-phenyl-5,12-dihydroindolo[3,2-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 115.

[0568] LC-Mass (cal.: 831 g/mol, found: $[\text{M}+\text{H}]^+=832$ g/mol)

Synthesis Example 19

Synthesis of Compound 117

[0569] Compound 117 was synthesized according to the Reaction Scheme below:



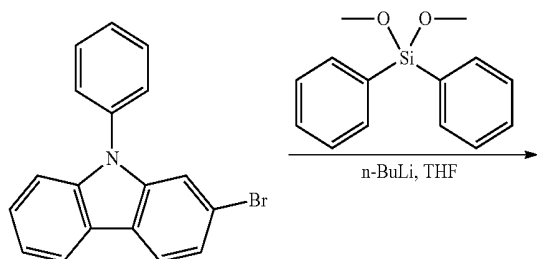
[0570] 5.87 g (45%) of Compound 117 was synthesized in the same manner as in Synthesis of Compound 97, except that 4.88 g (19.0 mmol) of 12H-benzofuro[2,3-a]carbazole was used instead of 5H-benzofuro[3,2-c]carbazole in synthesizing Compound 117.

[0571] LC-Mass (cal.: 756.26 g/mol, found: $[\text{M}+\text{H}]^+=757$ g/mol)

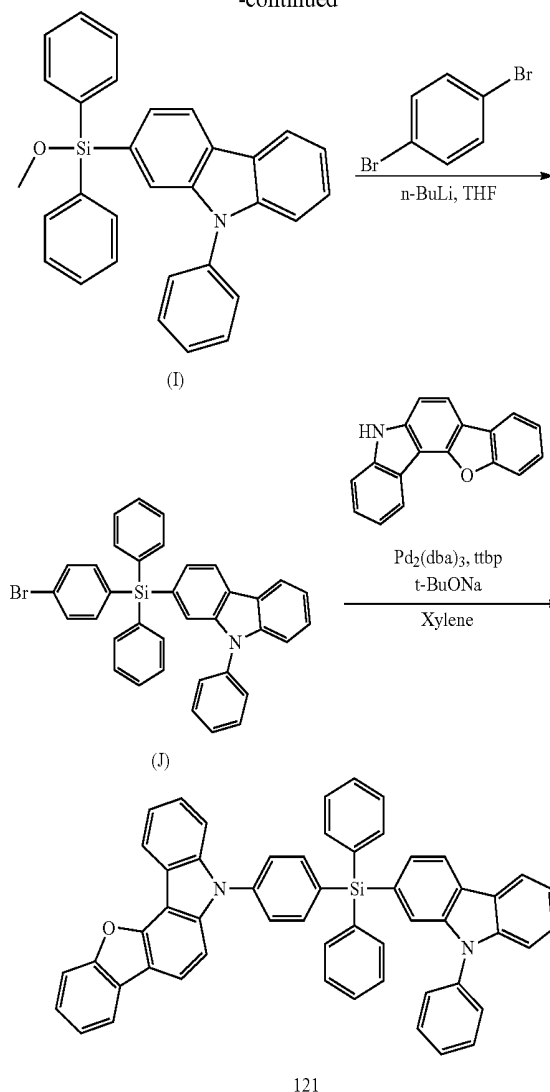
Synthesis Example 20

Synthesis of Compound 121

[0572] Compound 121 was synthesized according to the Reaction Scheme below:



-continued



[0573] (1) Synthesis of Intermediate (I)

[0574] 42.4 g (60%) of Intermediate (I) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (155 mmol) of 2-bromo-9-phenyl-9H-carbazole was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (I).

[0575] LC-Mass (cal.: 455.17 g/mol, found: $[\text{M}+\text{H}]^+=456$ g/mol)

[0576] (2) Synthesis of Intermediate (J)

[0577] 23.7 g (48%) of Intermediate (J) was synthesized in the same manner as in Synthesis of Intermediate (B), except that 38.6 g (84.8 mmol) of Intermediate (I) was used instead of Intermediate (A) in synthesizing Intermediate (J).

[0578] LC-Mass (cal.: 579.10 g/mol, found: $[\text{M}+\text{H}]^+=580$ g/mol)

[0579] (3) Synthesis of Compound 121

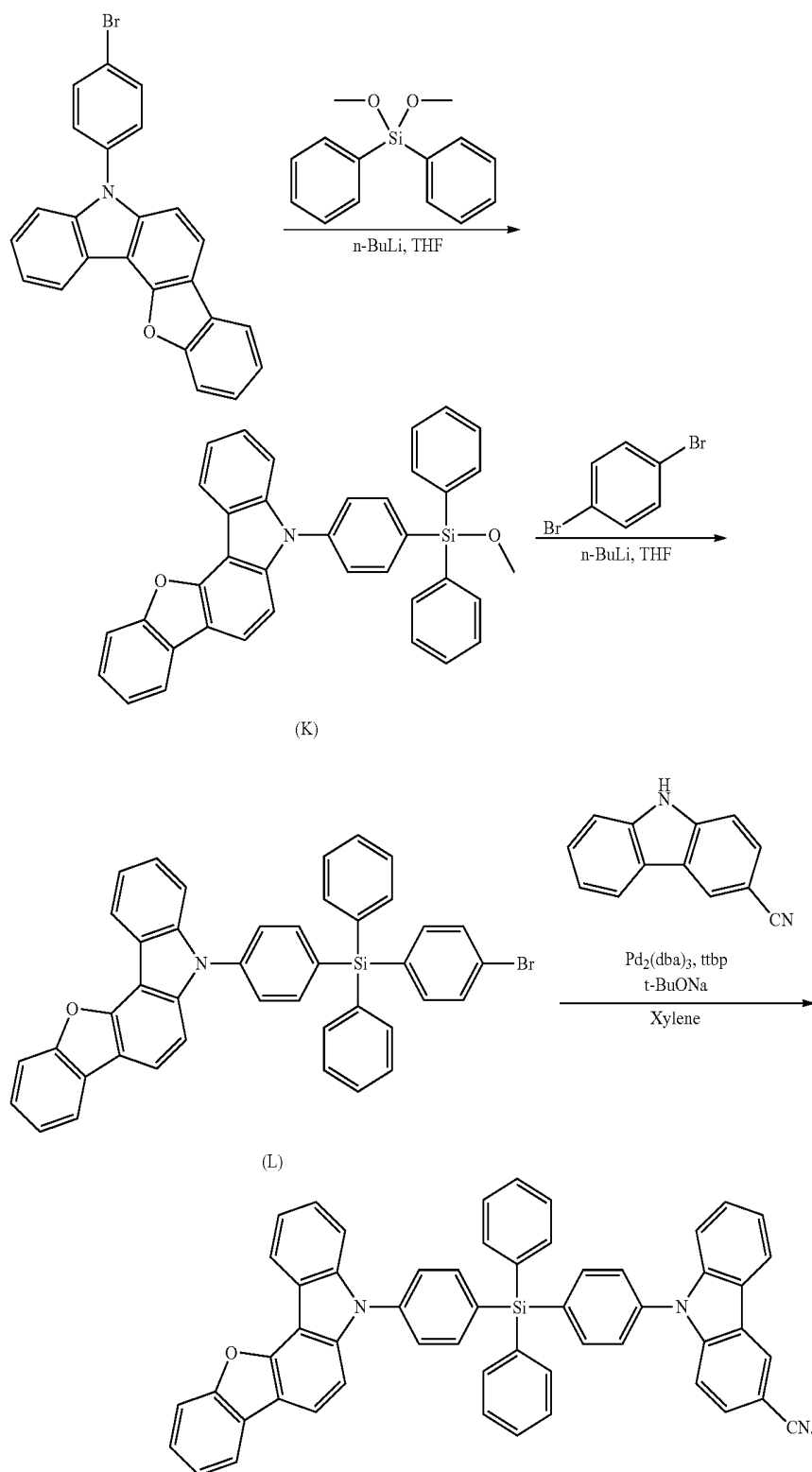
[0580] 5.74 g (44%) of Compound 121 was synthesized in the same manner as in Synthesis of Compound 1, except that 10.0 g (17.2 mmol) of Intermediate (J) was used instead of Intermediate (B) in synthesizing Compound 121.

[0581] LC-Mass (cal.: 756.26 g/mol, found: $[\text{M}+\text{H}]^+=757$ g/mol)

Synthesis Example 21

Synthesis of Compound 338

[0582] Compound 338 was synthesized according to the Reaction Scheme below:



[0583] (1) Synthesis of Intermediate (K)

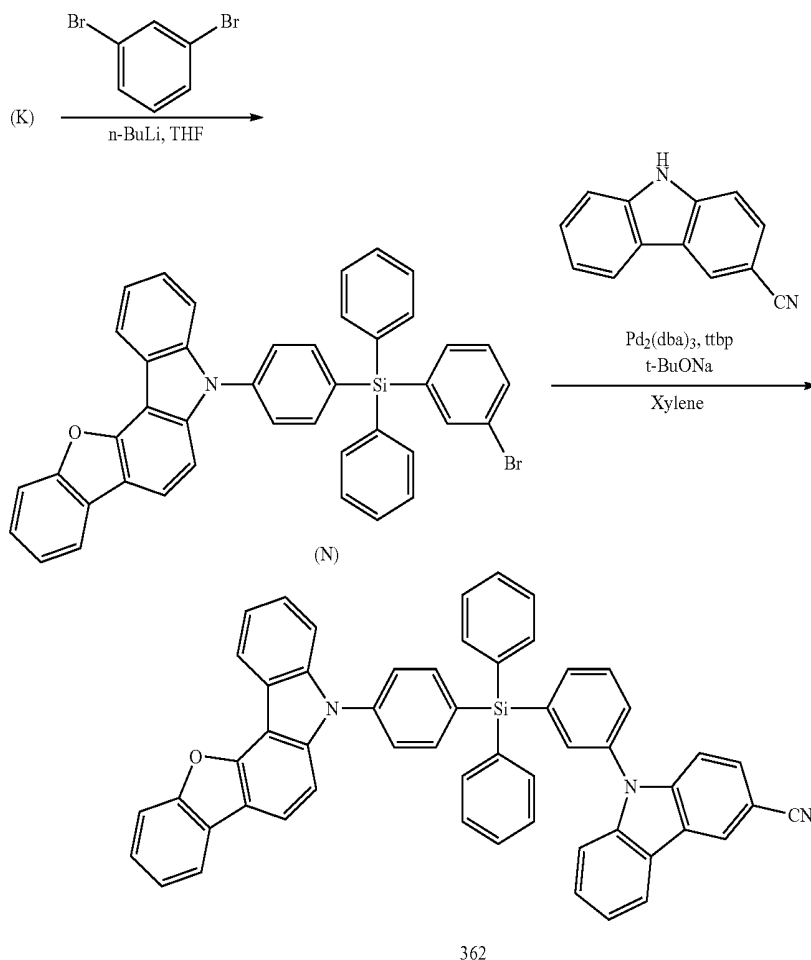
[0584] 37.7 g (57%) of Intermediate (K) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (121 mmol) of 5-(4-bromophenyl)-5H-benzofuro[3,2-c]carbazole was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (K).

[0585] LC-Mass (cal.: 545.18 g/mol, found: $[M+H]^+=546$ g/mol)

Synthesis Example 22

Synthesis of Compound 362

[0592] Compound 362 was synthesized according to the Reaction Scheme below:

**[0586]** (2) Synthesis of Intermediate (L)

[0587] 19.2 g (45%) of Intermediate (L) was synthesized in the same manner as in Synthesis of Intermediate (B), except that 34.7 g (63.6 mmol) of Intermediate (K) was used instead of Intermediate (A) in synthesizing Intermediate (L).

[0588] LC-Mass (cal.: 669.11 g/mol, found: $[M+H]^+=670$ g/mol)

[0589] (3) Synthesis of Compound 338

[0590] 5.25 g (45%) of Compound 338 was synthesized in the same manner as in Synthesis of Compound 1, except that, in synthesizing Compound 338, 10.0 g (14.9 mmol) of Intermediate (L) was used instead of Intermediate (B), and 3.15 g (16.4 mmol) of 9H-carbazole-3-carbonitrile was used instead of 5H-benzofuro[3,2-c]carbazole.

[0591] LC-Mass (cal.: 781.25 g/mol, found: $[M+H]^+=782$ g/mol)

[0593] (1) Synthesis of Intermediate (N)

[0594] 17.5 g (41%) of Intermediate (N) was synthesized in the same manner as in Synthesis of Intermediate (L), except that 15.0 g (63.6 mmol) of 1,3-dibromobenzene was used instead of Intermediate 1,4-dibromobenzene in synthesizing Intermediate (N).

[0595] LC-Mass (cal.: 669.11 g/mol, found: $[M+H]^+=670$ g/mol)

[0596] (2) Synthesis of Compound 362

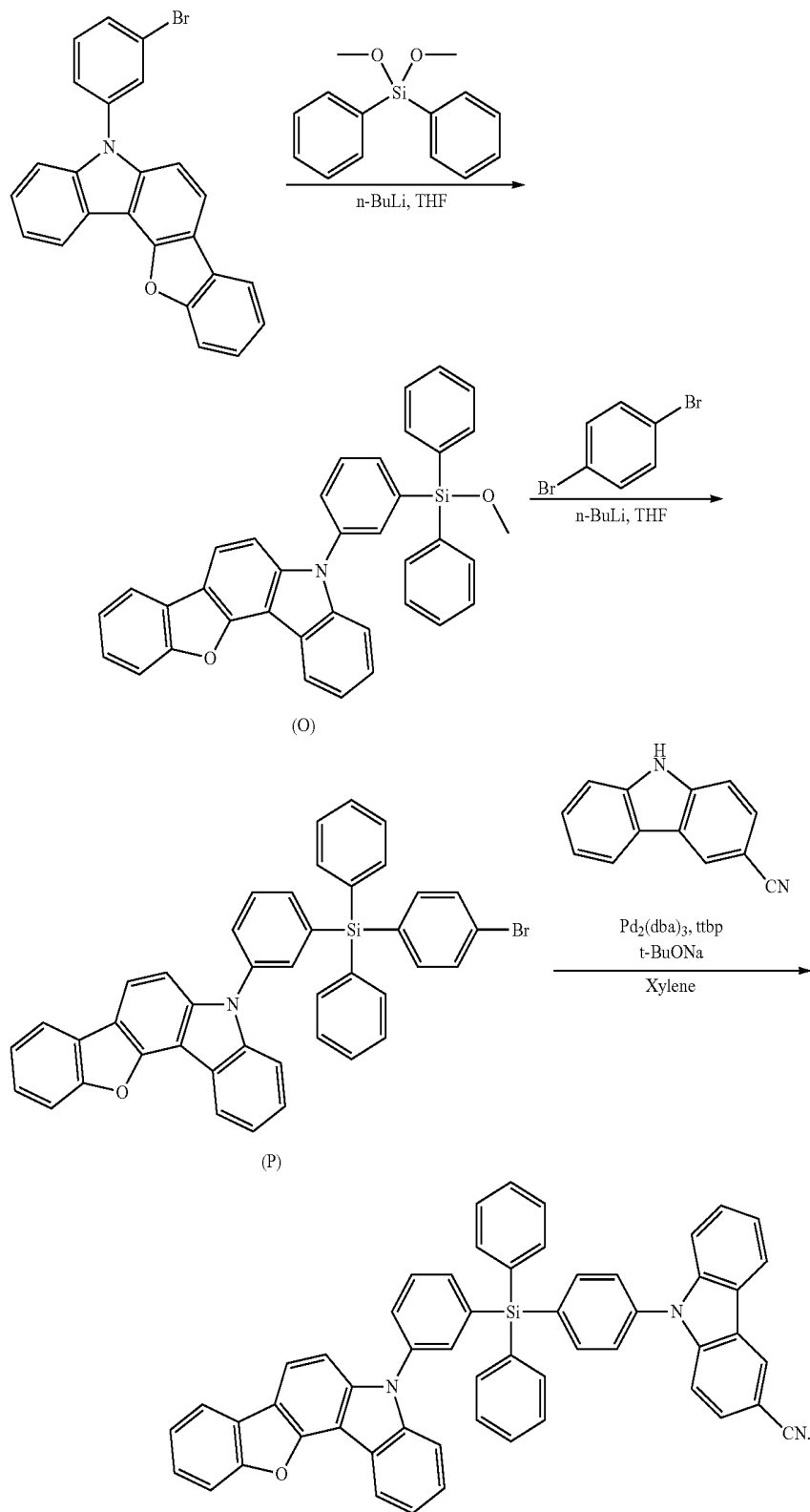
[0597] 4.43 g (38%) of Compound 362 was synthesized in the same manner as in Synthesis of Compound 338, except that 10.0 g (14.9 mmol) of Intermediate (N) was used instead of Intermediate (L) in synthesizing Compound 362.

[0598] LC-Mass (cal.: 781.25 g/mol, found: $[M+H]^+=782$ g/mol)

Synthesis Example 23

Synthesis of Compound 386

[0599] Compound 386 was synthesized according to the Reaction Scheme below:



[0600] (1) Synthesis of Intermediate (O)

[0601] 38.4 g (58%) of Intermediate (O) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (121 mmol) of 5-(3-bromophenyl)-5H-benzofuro[3,2-c]carbazole was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (O).

[0602] LC-Mass (cal.: 545.18 g/mol, found: $[M+H]^+=546$ g/mol)

[0603] (2) Synthesis of Intermediate (P)

[0604] 18.8 g (44%) of Intermediate (P) was synthesized in the same manner as in Synthesis of Intermediate (B), except that 34.7 g (63.6 mmol) of Intermediate (O) was used instead of Intermediate (A) in synthesizing Intermediate (P).

[0605] LC-Mass (cal.: 669.11 g/mol, found: $[M+H]^+=670$ g/mol)

[0606] (3) Synthesis of Compound 386

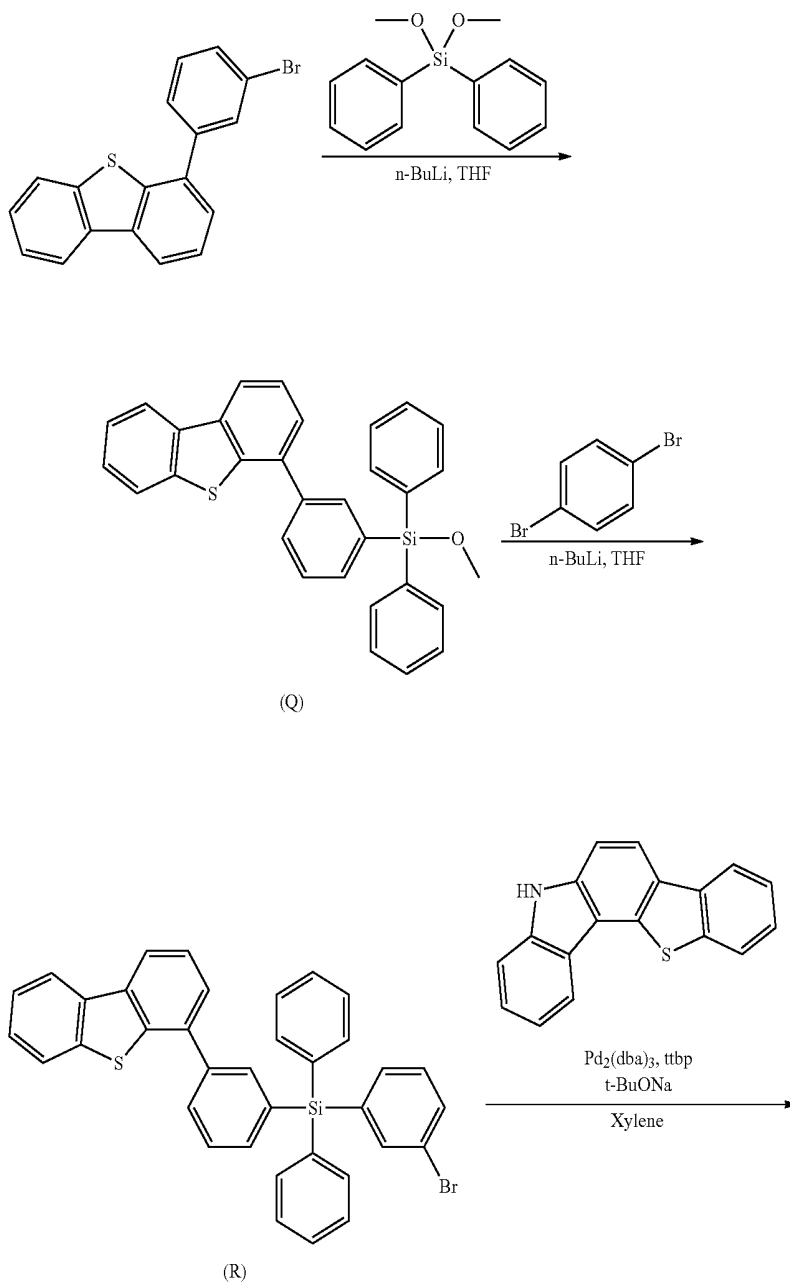
[0607] 4.66 g (40%) of Compound 386 was synthesized in the same manner as in Synthesis of Compound 338, except that 10.0 g (14.9 mmol) of Intermediate (P) was used instead of Intermediate (L) in synthesizing Compound 386.

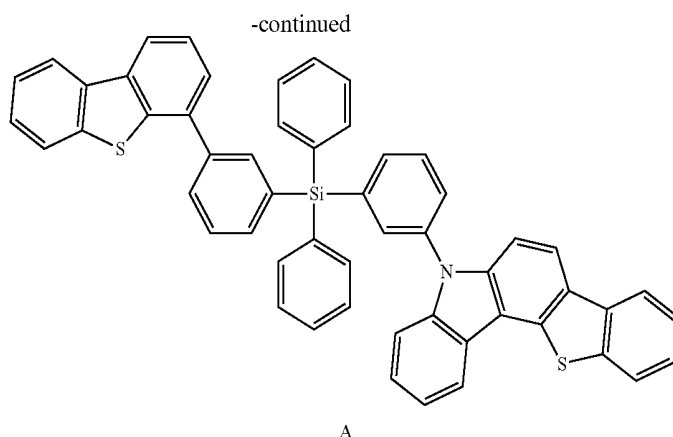
[0608] LC-Mass (cal.: 781.25 g/mol, found: $[M+H]^+=782$ g/mol)

Synthesis Example 24

Synthesis of Compound A

[0609] Compound A was synthesized according to the Reaction Scheme below:





[0610] (1) Synthesis of Intermediate (Q)

[0611] 39.7 g (57%) of Intermediate (Q) was synthesized in the same manner as in Synthesis of Intermediate (A), except that 50.0 g (147 mmol) of 4-(3-bromophenyl)dibenzo [b,d]thiophene was used instead of 9-(4-bromophenyl)-9H-carbazole in synthesizing Intermediate (Q).

[0612] LC-Mass (cal.: 472.13 g/mol, found: $[M+H]^+ = 473$ g/mol)

[0613] (2) Synthesis of Intermediate (R)

[0614] 21.0 g (46%) of Intermediate (R) was synthesized in the same manner as in Intermediate (B), except that 36.1 g (76.3 mmol) of Intermediate (Q) was used instead of Intermediate (A) in synthesizing Intermediate (R).

[0615] LC-Mass (cal.: 596.06 g/mol, found: $[M+H]^+ = 597$ g/mol)

[0616] (3) Synthesis of Compound A

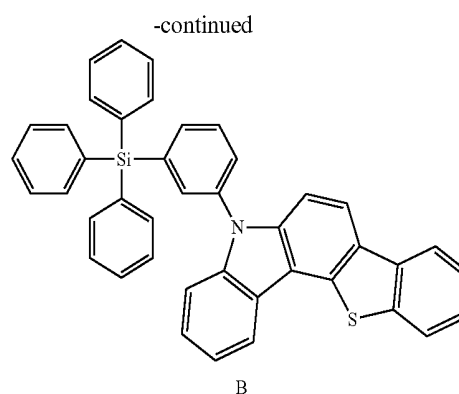
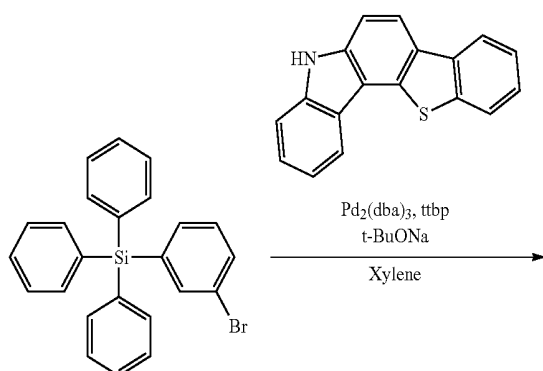
[0617] 7.01 g (53%) of Compound A was synthesized in the same manner as in Synthesis of Compound 2, except that 10.0 g (16.7 mmol) of Intermediate (R) was used instead of Intermediate (B) in synthesizing Compound A.

[0618] LC-Mass (cal.: 789.20 g/mol, found: $[M+H]^+ = 790$ g/mol)

Synthesis Example 25

Synthesis of Compound B

[0619] Compound B was synthesized according to the Reaction Scheme below:



[0620] 5.27 g (72%) of Compound B was synthesized in the same manner as in Synthesis of Compound 2, except that 5.00 g (12.0 mmol) of (3-bromophenyl)triphenylsilane was used instead of Intermediate (B) in synthesizing Compound B.

[0621] LC-Mass (cal.: 607.18 g/mol, found: $[M+H]^+ = 608$ g/mol)

Example 1

[0622] A glass substrate with an 1,500 Angstrom-thick (Å-thick) ITO electrode (first electrode, anode) formed thereon was washed by using distilled water and ultrasonic waves. When the washing with distilled water was completed, sonification washing was performed using a solvent, such as iso-propyl alcohol, acetone, or methanol. The resultant washed substrate was dried and transferred to a plasma washer where the substrate was washed with oxygen plasma for 5 minutes and transferred to a vacuum deposition apparatus.

[0623] Compound HT3 and Compound HP-1 were co-deposited on the ITO electrode of the glass substrate to form a hole injection layer having a thickness of 100 Angstroms (Å), Compound HT3 was deposited on the hole injection layer to form a hole transport layer having a thickness of 1,300 Å, and mCP was deposited on the hole transport layer to form an electron blocking layer having a thickness of 100 Å, thereby forming a hole transport region.

[0624] Compound 1 (host) and Flr6 (dopant, 10 percent by weight, wt %) were co-deposited on the hole transport region to form an emission layer having a thickness of 400 Å.

[0625] Compound BCP was vacuum-deposited on the emission layer to form a hole blocking layer having a thickness of 100 Å, Compound ET3 and LiQ were vacuum-deposited on the hole blocking layer to form an electron transport layer having a thickness of 300 Å, LiQ was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was deposited on the electron injection layer to form a second electrode (cathode) having a thickness of 1,200 Å, thereby completing the manufacture of an organic light-emitting device.

Examples 2 to 23

[0626] Organic light-emitting devices of Examples 2 to 23 were manufactured in the same manner as in Example 1, except that Compounds shown in Table 2 were each used instead of Compound 1 as a host in forming an emission layer.

Comparative Examples 1 and 2

[0627] Organic light-emitting devices of Comparative Examples 1 and 2 were manufactured in the same manner as in Example 1, except that Compound A and Compound B were used instead of Compound 1 as a host in forming an emission layer.

Evaluation Example 1

Evaluation of Characteristics of Organic Light-Emitting Devices

[0628] The change in current density based on a voltage, the change in luminance according to a voltage, and the luminescent efficiency of the organic light-emitting devices manufactured according to Examples 1 to 23 and Comparative Examples 1 and 2 were measured. Specific measuring methods are as follows, and results thereof are shown in Table 2.

[0629] (1) Change in Current Density According to Voltage

[0630] A value of current flowing through a unit element of the manufactured organic light-emitting device was measured by using an ammeter-voltmeter (Keithley 2400), while increasing a voltage from 0 volts (V) to 10 V, and the result was obtained by dividing the measured value of current by an area of the unit element.

[0631] (2) Change in Brightness According to Voltage

[0632] Luminance of the manufactured organic light-emitting device was measured by using a luminance meter (Minolta Cs-1000A), while increasing a voltage from 0 V to 10 V, and the result was obtained.

[0633] (3) Measurement of Luminescent Efficiency

[0634] The current efficiency (candelas per ampere, cd/A) at the same current density (10 milliamperes per square centimeter, mA/cm²) was calculated by using the luminance, the current density, and the voltage, which were measured in (1) and (2).

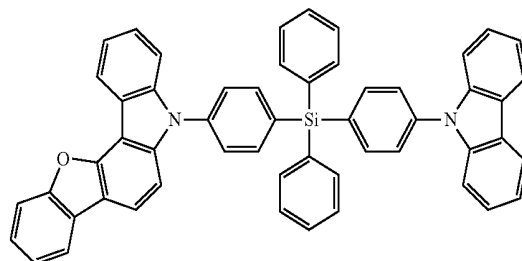
[0635] (4) Measurement of Durability

[0636] An amount of time that lapsed when luminance was 95% of initial luminance (100%) was evaluated.

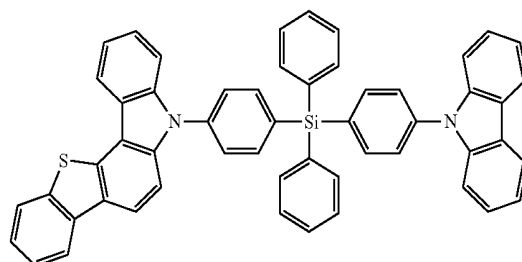
[0637] The driving voltage, current efficiency, and durability in Table 2 are relative values when the driving voltage, current efficiency, and durability of the organic light-emitting device manufactured according to Comparative Example 1 are at 100%.

TABLE 2

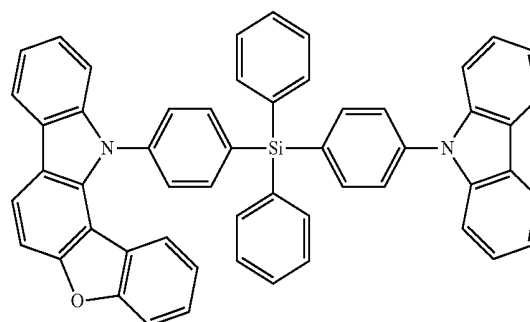
	Host	Driving voltage (%)	Current efficiency (%)	Durability (%)	Color
Example 1	Compound 1	84	124	135	Blue
Example 2	Compound 2	95	110	108	Blue
Example 3	Compound 17	87	120	114	Blue
Example 4	Compound 19	81	108	109	Blue
Example 5	Compound 21	87	114	120	Blue
Example 6	Compound 25	78	135	140	Blue
Example 7	Compound 26	91	115	110	Blue
Example 8	Compound 41	82	120	118	Blue
Example 9	Compound 43	78	125	114	Blue
Example 10	Compound 45	88	128	130	Blue
Example 11	Compound 49	80	130	138	Blue
Example 12	Compound 65	84	114	120	Blue
Example 13	Compound 69	84	105	131	Blue
Example 14	Compound 73	80	121	133	Blue
Example 15	Compound 97	84	134	145	Blue
Example 16	Compound 98	94	108	105	Blue
Example 17	Compound 113	84	106	124	Blue
Example 18	Compound 115	77	131	111	Blue
Example 19	Compound 117	81	124	130	Blue
Example 20	Compound 121	94	104	122	Blue
Example 21	Compound 338	64	158	245	Blue
Example 22	Compound 362	70	160	210	Blue
Example 23	Compound 386	68	155	234	Blue
Comparative Example 1	Compound A	100	100	100	Blue
Comparative Example 2	Compound B	135	76	42	Blue



1



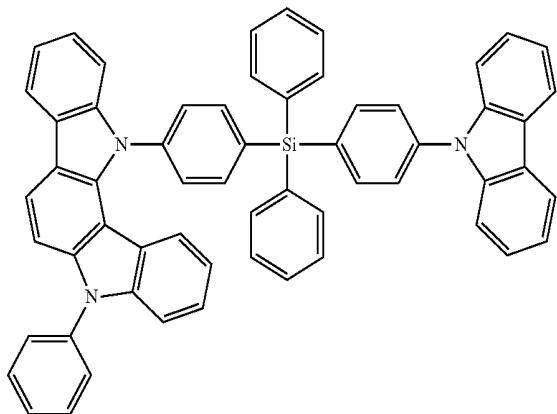
2



17

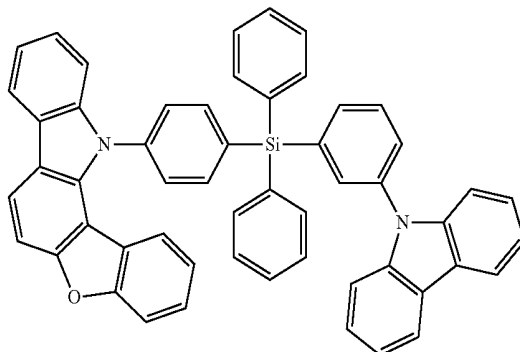
-continued

19



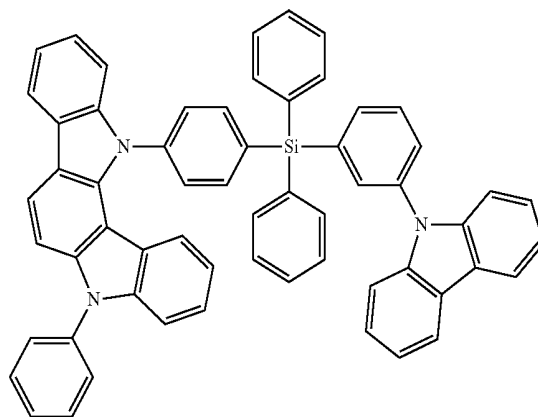
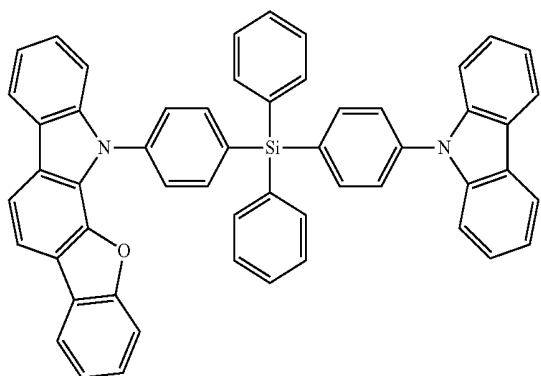
-continued

41



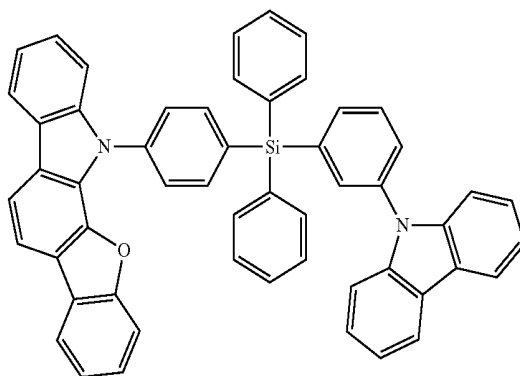
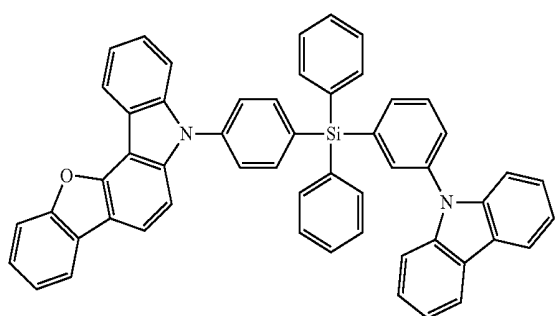
43

21



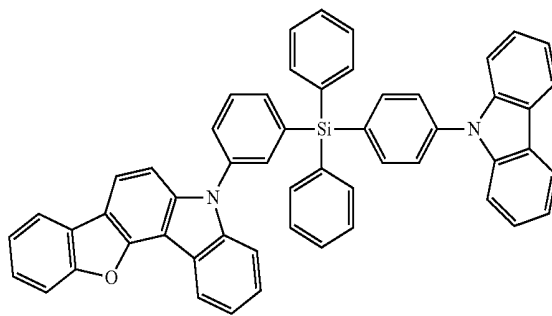
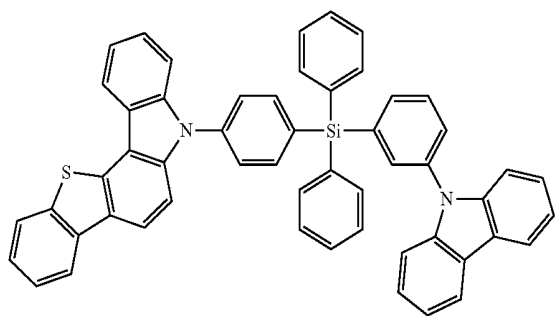
45

25



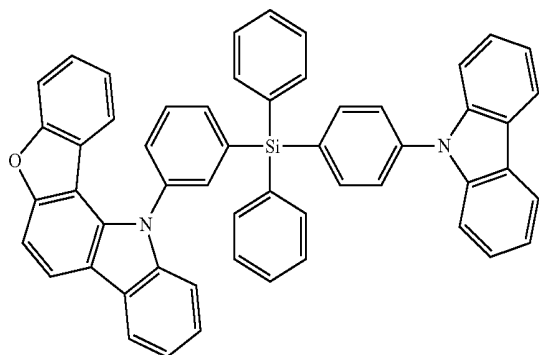
26

49

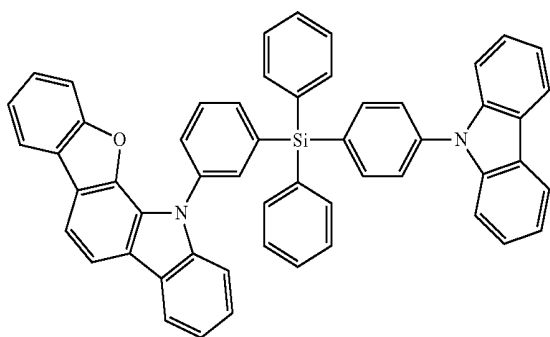


-continued

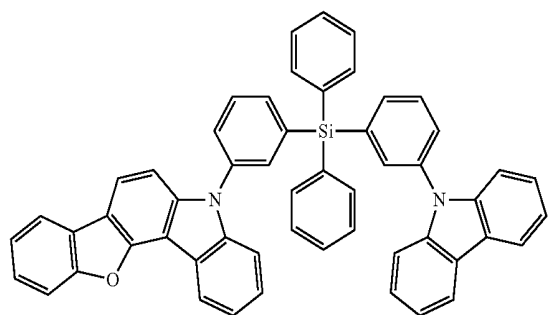
65



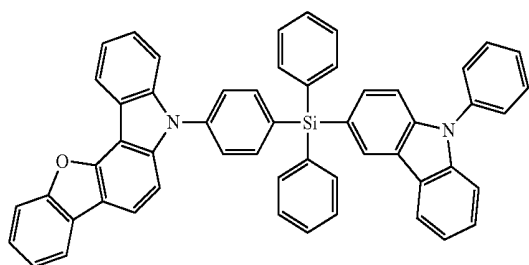
69



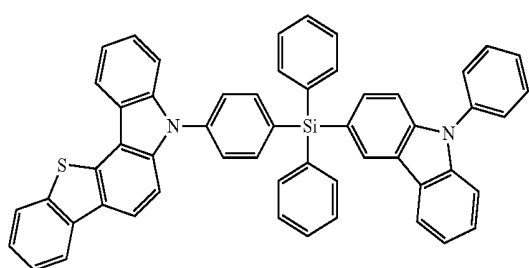
73



97

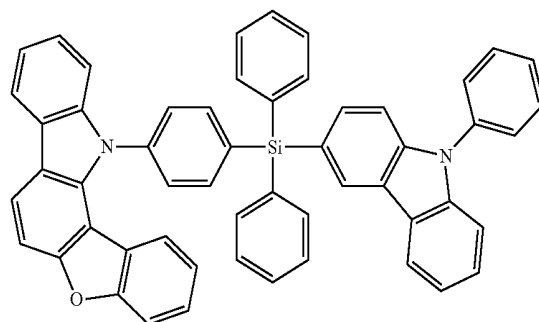


98

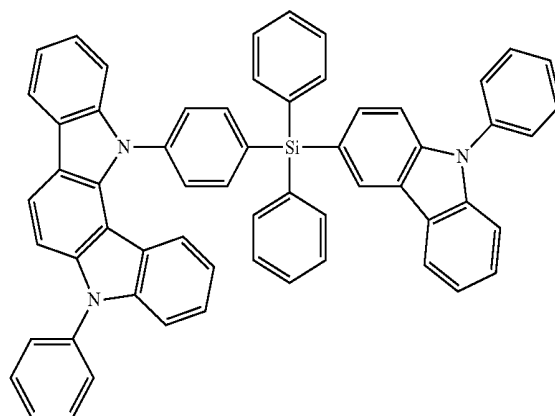


-continued

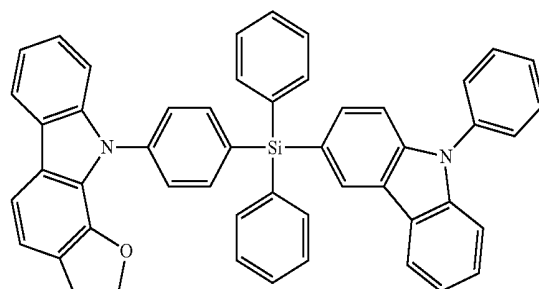
113



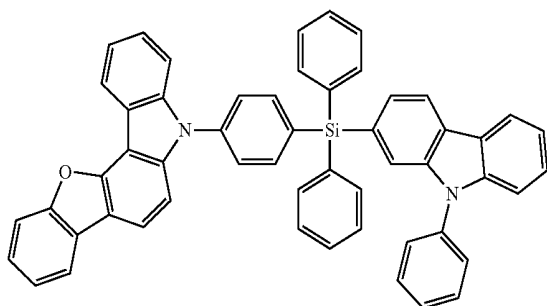
115



117

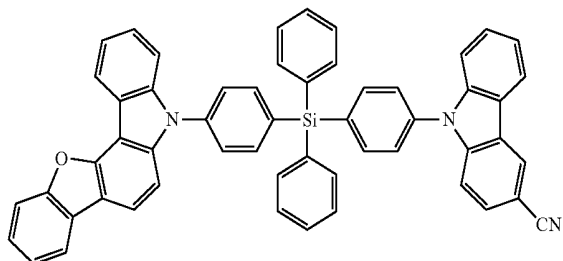


121

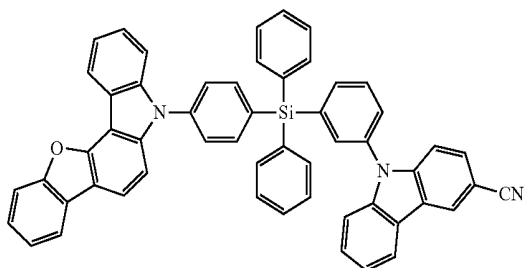


-continued

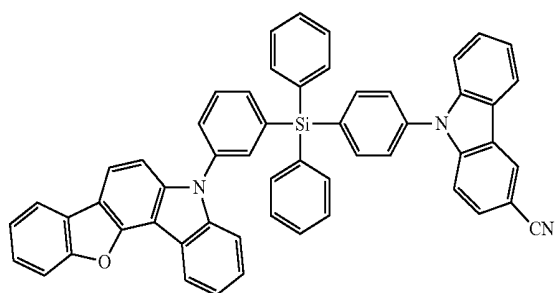
338



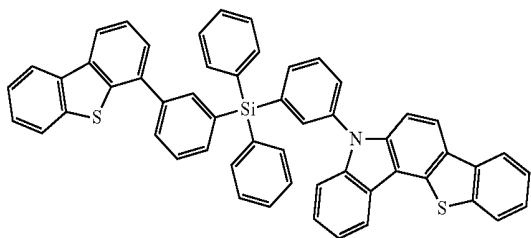
362



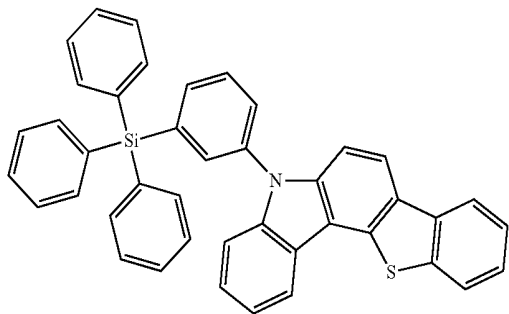
386



A



B



[0638] Referring to Table 2, it was found that the organic light-emitting devices of Examples 1 to 23 had a low driving voltage, high efficiency, and high durability, compared to those of Comparative Examples 1 and 2.

[0639] According to one or more exemplary embodiments, since the silyl group-containing compound has excel-

lent electric characteristics and thermal stability, an organic light-emitting device including the silyl group-containing compound may have low driving voltage, high efficiency, high power, high quantum emission efficiency, and long lifespan characteristics.

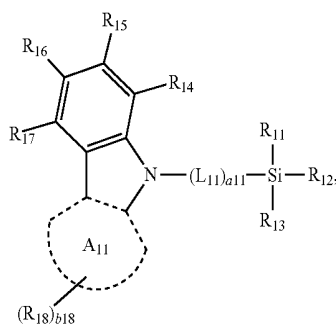
[0640] It should be understood that exemplary embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each exemplary embodiment should typically be considered as available for other similar features or aspects in other exemplary embodiments.

[0641] While one or more exemplary embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present disclosure as defined by the following claims.

What is claimed is:

1. A silyl group-containing compound represented by Formula 1:

Formula 1

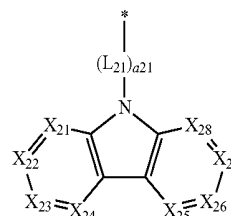


wherein, in Formula 1,

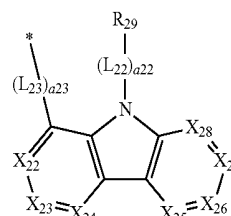
A_{11} is selected from a carbazole group, a fluorene group, a dibenzofuran group, and a dibenzothiophene group,

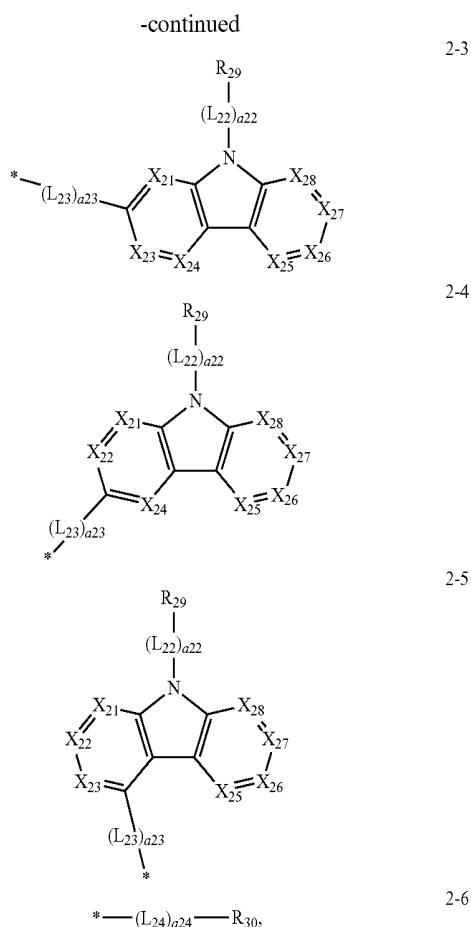
R_{11} to R_{13} are each independently selected from groups represented by Formulae 2-1 to 2-6, provided that at least one selected from R_{11} to R_{13} is selected from groups represented by Formulae 2-1 to 2-5:

2-1



2-2





wherein, in Formulae 2-1 to 2-6,

X₂₁ is selected from N and CR₂₁, X₂₂ is selected from N and CR₂₂, X₂₃ is selected from N and CR₂₃, X₂₄ is selected from N and CR₂₄, X₂₅ is selected from N and CR₂₅, X₂₆ is selected from N and CR₂₆, X₂₇ is selected from N and CR₂₇, and X₂₈ is selected from N and CR₂₈, L₁₁ and L₂₁ to L₂₄ are each independently selected from a substituted or unsubstituted C₃-C₁₀ cycloalkylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkylene group, a substituted or unsubstituted C₃-C₁₀ cycloalkenylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenylene group, a substituted or unsubstituted C₆-C₆₀ arylene group, a substituted or unsubstituted C₁-C₆₀ heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

a₁₁ and a₂₁ are each independently an integer selected from 1, 2, 3, and 4,

a₂₂ to a₂₄ are each independently an integer selected from 0, 1, 2, 3, and 4,

R₁₄ to R₁₈ and R₂₁ to R₂₉ are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted

C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —Si(Q₁)(Q₂)(Q₃), —N(Q₁)(Q₂), and —B(Q₁)(Q₂).

R₃₀ is selected from a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,

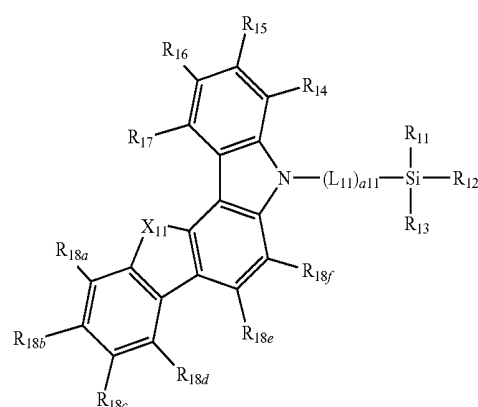
b₁₈ is an integer selected from 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10,

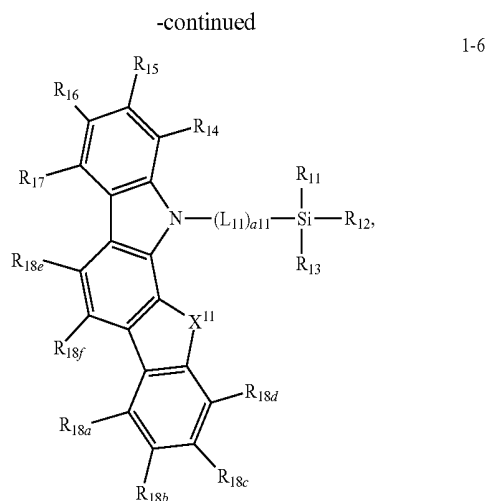
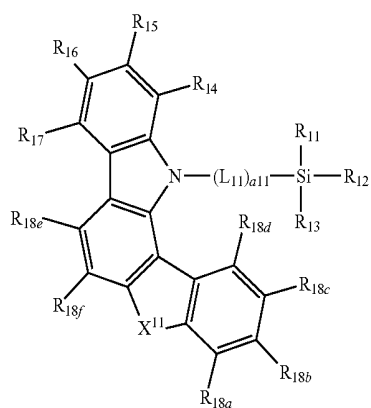
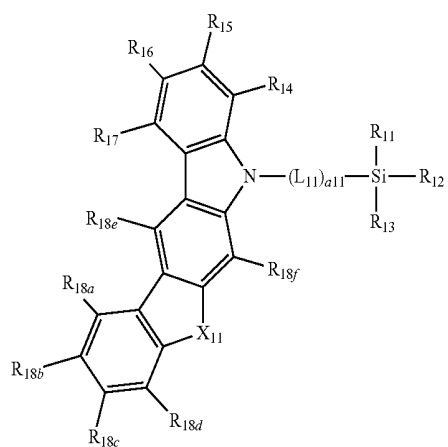
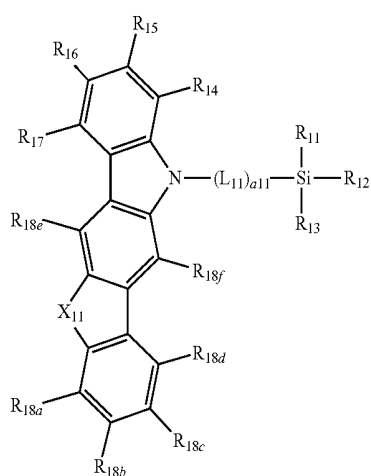
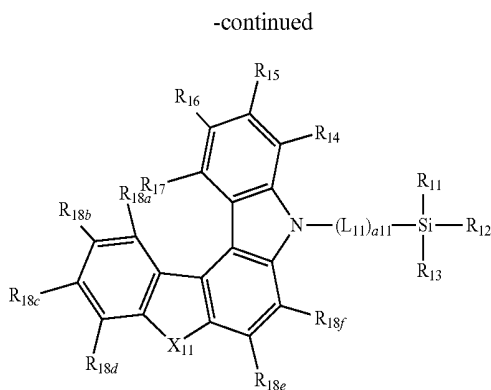
Q₁ to Q₃ are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazine group, a hydrazone group, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group, and

* indicates a binding site to a neighboring atom.

2. The silyl group-containing compound of claim 1, wherein

the silyl group-containing compound represented by Formula 1 is represented by one of Formulae 1-1 to 1-6:





wherein, in Formulae 1-1 to 1-6,
 X_{11} is selected from O, S, N(R_{18g}), and C(R_{18g})(R_{18h}),
 R_{11} to R_{17} , L_{11} , and a_{11} are the same as described in
 connection with Formula 1, and
 R_{18a} to R_{18h} are each independently the same as described
 in connection with R_{18} in Formula 1.

3. The silyl group-containing compound of claim 1,
 wherein

- $R_{11} \neq R_{12} \neq R_{13}$;
- $R_{11} = R_{12}$, $R_{12} \neq R_{13}$;
- $R_{12} = R_{13}$, $R_{11} \neq R_{12}$;
- $R_{13} = R_{11}$, $R_{12} \neq R_{13}$; or
- $R_{11} = R_{12} = R_{13}$.

4. The silyl group-containing compound of claim 1,
 wherein

- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is N, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is N, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is N, X_{24} is CR₂₄, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is N, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is N, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is CR₂₅, X_{26} is N, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is CR₂₅, X_{26} is CR₂₆, X_{27} is N, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is CR₂₅, X_{26} is CR₂₆, X_{27} is and CR₂₇, X_{28} is N;
- X_{21} is N, X_{22} is CR₂₂, X_{23} is N, X_{24} is CR₂₄, X_{25} is CR₂₅,
 X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is N, X_{23} is CR₂₃, X_{24} is N, X_{25} is CR₂₅,
 X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is N, X_{26} is CR₂₆, X_{27} is N, and X_{28} is CR₂₈;
- X_{21} is CR₂₁, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25}
 is CR₂₅, X_{26} is N, X_{27} is CR₂₇, and X_{28} is N;
- X_{21} is N, X_{22} is CR₂₂, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is CR₂₇, and X_{28} is N;
- X_{21} is CR₂₁, X_{22} is N, X_{23} is CR₂₃, X_{24} is CR₂₄, X_{25} is
 CR₂₅, X_{26} is CR₂₆, X_{27} is N, and X_{28} is CR₂₈;

X_{21} is CR_{21} , X_{22} is CR_{22} , X_{23} is N, X_{24} is CR_{24} , X_{25} is CR_{25} , X_{26} is N, X_{27} is CR_{27} , and X_{28} is CR_{28} ; or

X_{21} is CR_{21} , X_{22} is CR_{22} , X_{23} is CR_{23} , X_{24} is N, X_{25} is N, X_{26} is CR_{26} , X_{27} is CR_{27} , and X_{28} is CR_{28} .

5. The silyl group-containing compound of claim 1, wherein

L_{11} and L_{21} to L_{24} are each independently selected from 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.

6. The silyl group-containing compound of claim 1, wherein

L_{11} and L_{21} to L_{24} are each independently selected from: a phenylene group, a naphthylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, and a triazinylene group; and

a phenylene group, a naphthylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, and a triazinylene group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, and a pyridinyl group.

7. The silyl group-containing compound of claim 1, wherein

R_{14} to R_{18} and R_{21} to R_{29} are each independently selected from:

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

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

a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranlyl group, and a dibenzothiophenyl group;

a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranlyl 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 amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, a furanyl group, a thiophenyl group, a thiazolyl group, an isothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranlyl group, a dibenzothiophenyl group, —Si(Q_{31})(Q_{32})(Q_{33}), —N(Q_{31})(Q_{32}), and —B(Q_{31})(Q_{32}); and

—Si(Q_1)(Q_2)(Q_3), —N(Q_1)(Q_2), and —B(Q_1)(Q_2),

wherein Q_1 to Q_3 and Q_{31} to Q_{33} are each independently selected from 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, a fluorenyl group, a carbazolyl group, a dibenzofuranlyl group, and a dibenzothiophenyl group.

8. The silyl group-containing compound of claim 1, wherein

R_{14} to R_{18} and R_{21} to R_{29} are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a pyridinyl group, and a pyrimidinyl group.

9. The silyl group-containing compound of claim 1, wherein

R_{30} is selected from:

a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, 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 dibenzosilolyl group, a spiro-bifluorenyl 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 pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl

group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthroline group, a phenazinyl group, a benzoxazolyl group, a benzimidazolyl group, a furanyl group, a benzofuranyl group, a thiophenyl group, a benzothiophenyl group, a thiazolyl group, an isothiazolyl group, a benzothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridimidinyl group, an imidazopyridinyl group, a pyridoindolyl group, a benzofuropridinyl group, a benzothienopyridinyl group, a pyrimidoindolyl group, a benzofuroprymidinyl group, a benzothienopyrimidinyl group, a phenoxazinyl group, a pyridobenzoxazinyl group, and a pyridobenzothiazinyl group; and

a cyclopentyl group, a cyclohexyl group, a cyclopentenyl group, a cyclohexenyl group, a cycloheptenyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, 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 dibenzosilolyl group, a spiro-bifluorenyl 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 pyrrolyl group, an imidazolyl group, a pyrazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthroline group, a phenazinyl group, a benzoxazolyl group, a benzimidazolyl group, a furanyl group, a benzofuranyl group, a thiophenyl group, a benzothiophenyl group, a thiazolyl group, an isothiazolyl group, a benzothiazolyl group, an isoxazolyl group, an oxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, an imidazopyridimidinyl group, an imidazopyridinyl group, a pyridoindolyl group, a benzofuropridinyl group, a benzothienopyridinyl group, a pyrimidoindolyl group, a benzofuroprymidinyl group, a benzothienopyrimidinyl group, a phenoxazinyl group, a pyridobenzoxazinyl group, and a pyridobenzothiazinyl group, each substituted with at least one selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₂-C₂₀ alkenyl group, a C₂-C₂₀ alkynyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthracenyl group, a pyrenyl group, a phenanthrenyl group, a fluorenyl group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a pyridinyl group, a

pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a phthalazinyl group, a quinoxalinyl group, a cinnolinyl group, a quinazolinyl group, —Si(Q₃₁)(Q₃₂)(Q₃₃), —N(Q₃₁)(Q₃₂), and —B(Q₃₁)(Q₃₂), wherein Q₃₁ to Q₃₃ are each independently selected from a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group.

10. The silyl group-containing compound of claim 1, wherein

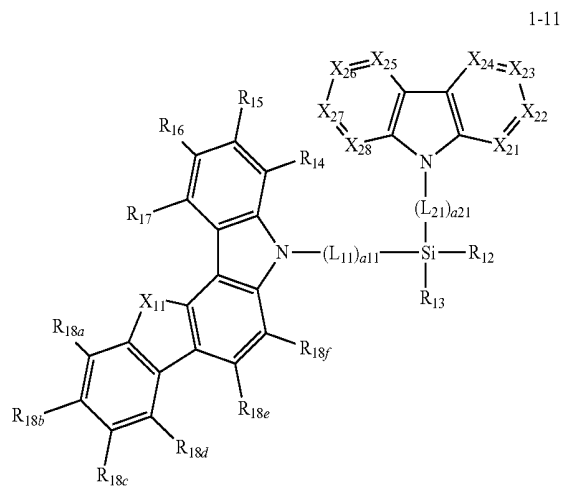
R₃₀ is selected from:

a cyclohexyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a furanyl group, a thiophenyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

a cyclohexyl group, a piperidinyl group, a tetrahydro-2H-pyranyl group, a tetrahydro-2H-thiopyranyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a dibenzosilolyl group, a pyrrolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a furanyl group, a thiophenyl group, a triazinyl 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 amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a carbazolyl group, a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, and a triazinyl group.

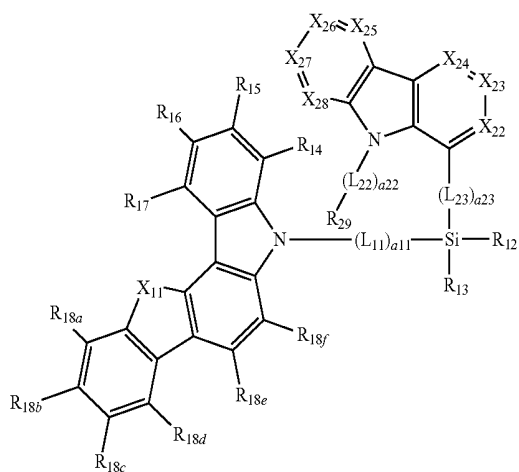
11. The silyl group-containing compound of claim 1, wherein

the silyl group-containing compound is represented by one of Formulae 1-11 to 1-40:



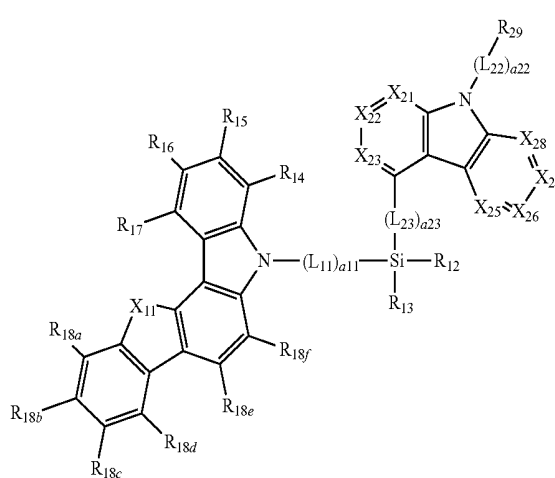
-continued

1-12

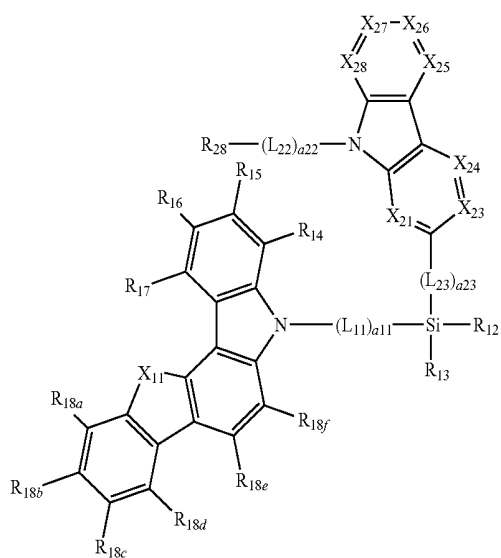


-continued

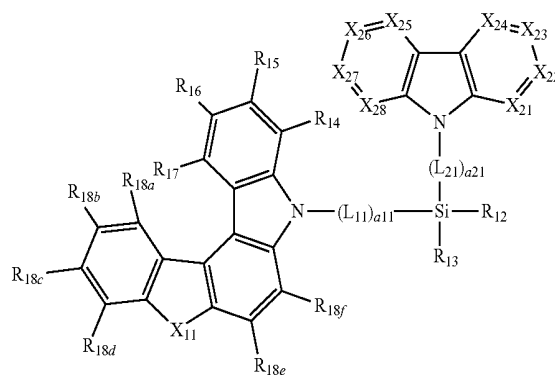
1-15



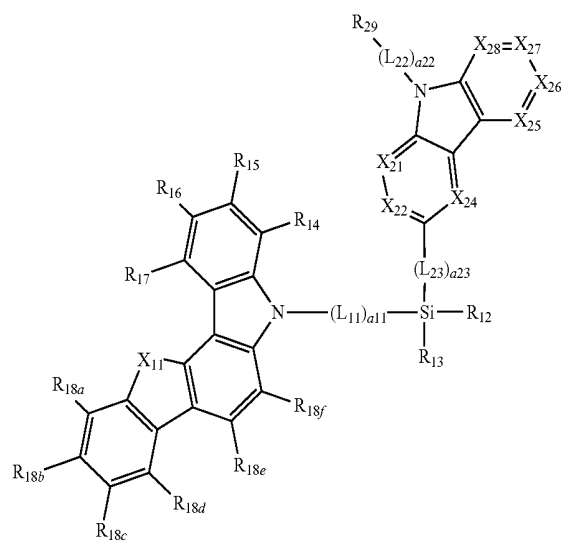
1-13



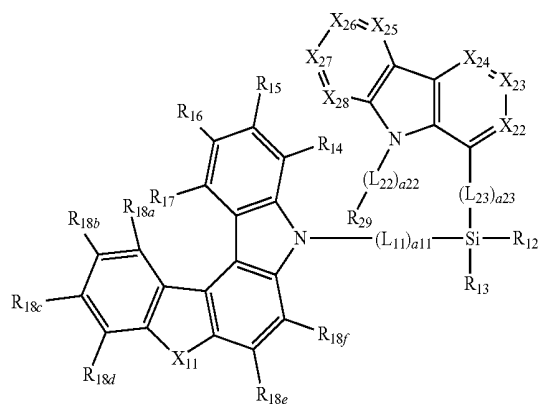
1-16



1-14

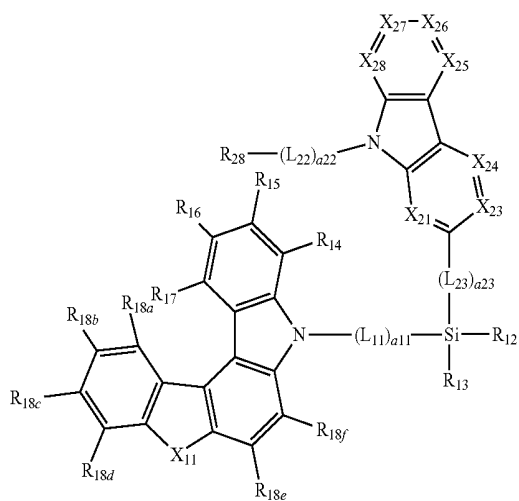


1-17



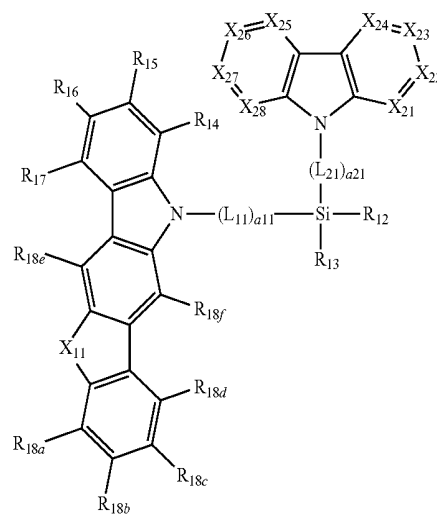
-continued

1-18

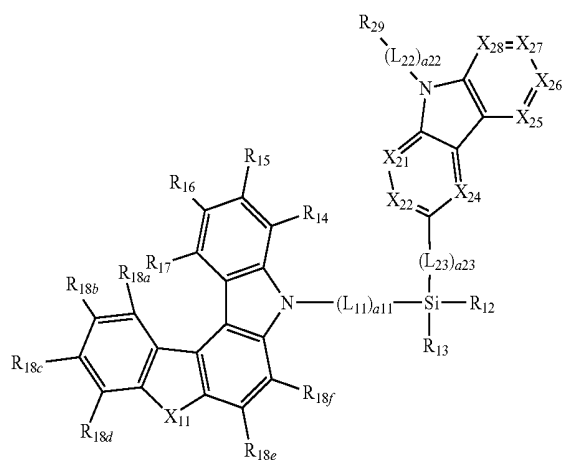


-continued

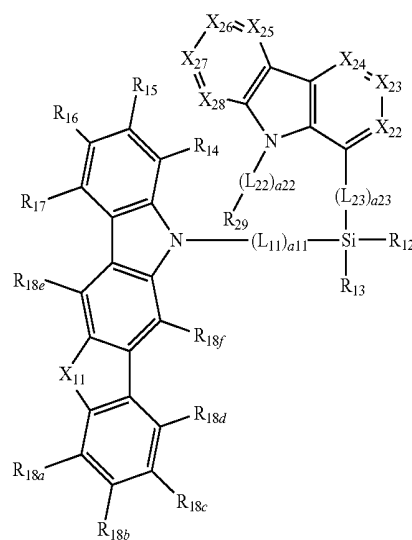
1-21



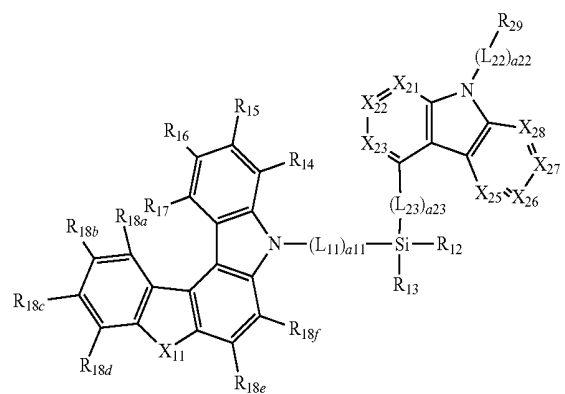
1-19



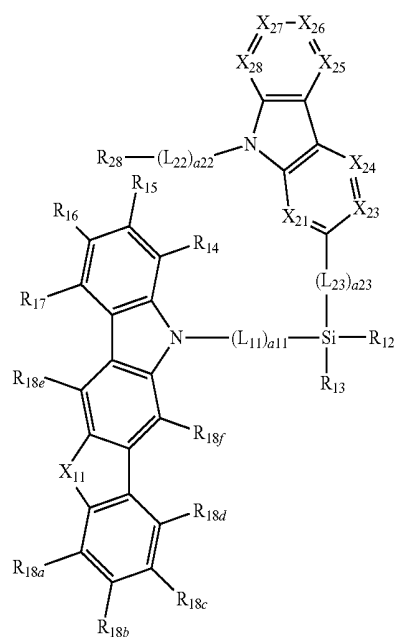
1-22



1-20

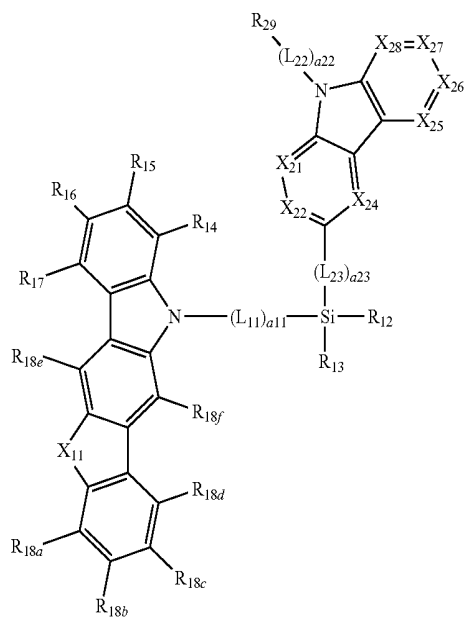


1-23



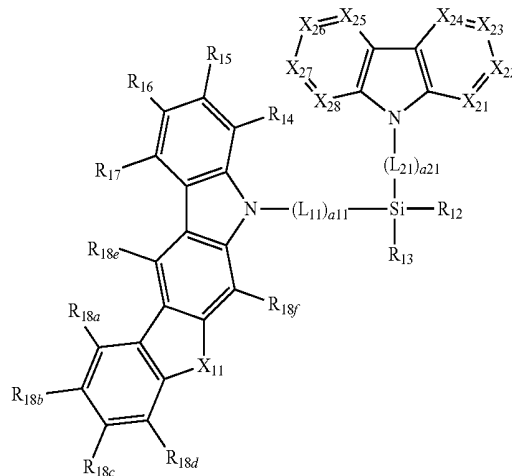
-continued

1-24

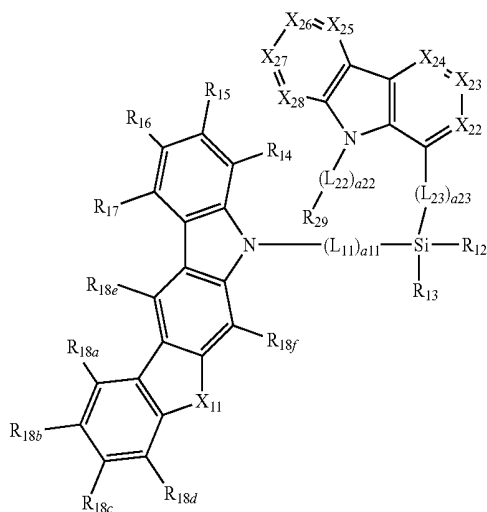


-continued

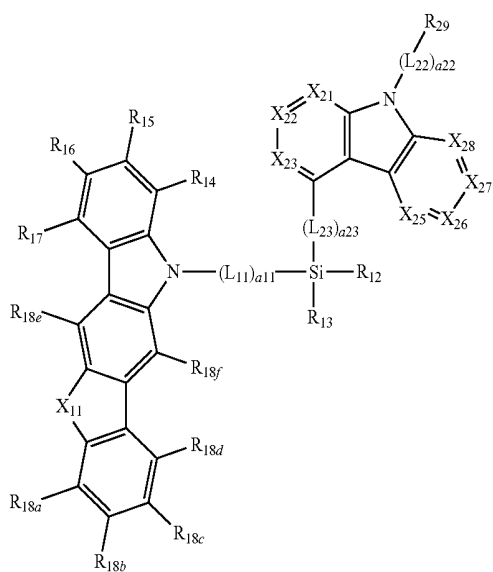
1-26



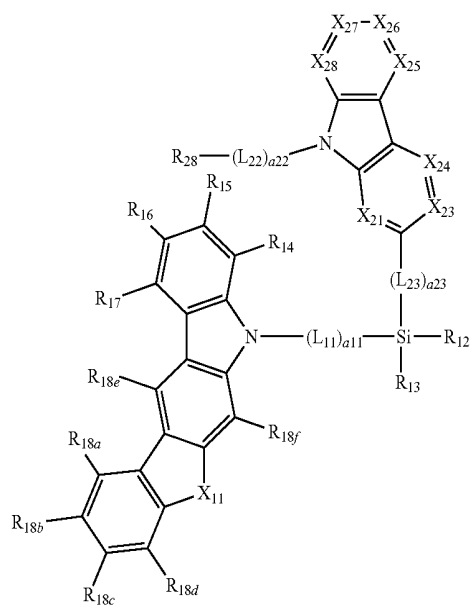
1-27



1-25

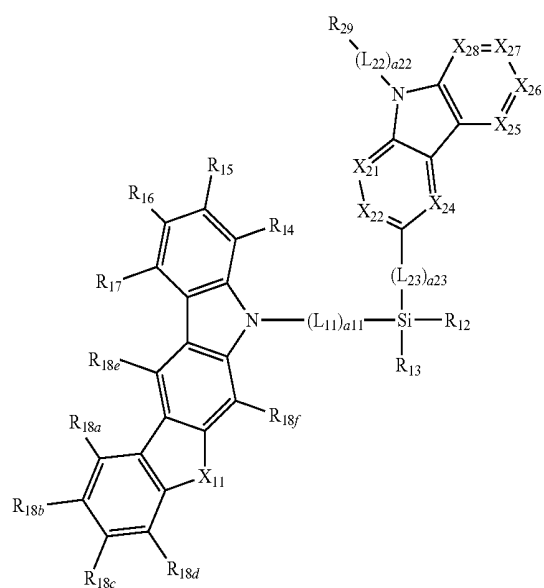


1-28



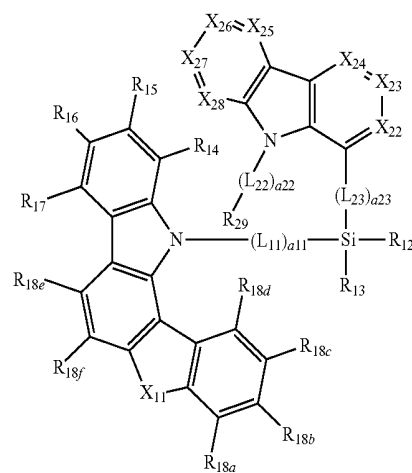
-continued

1-29



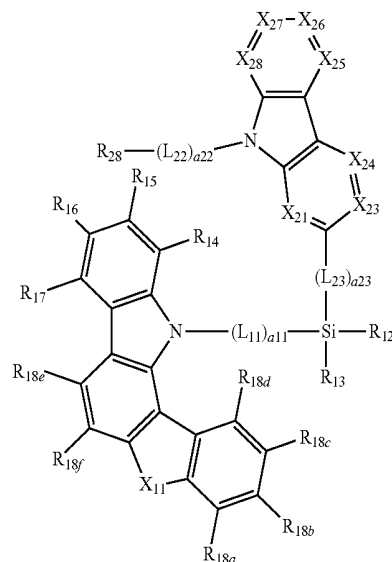
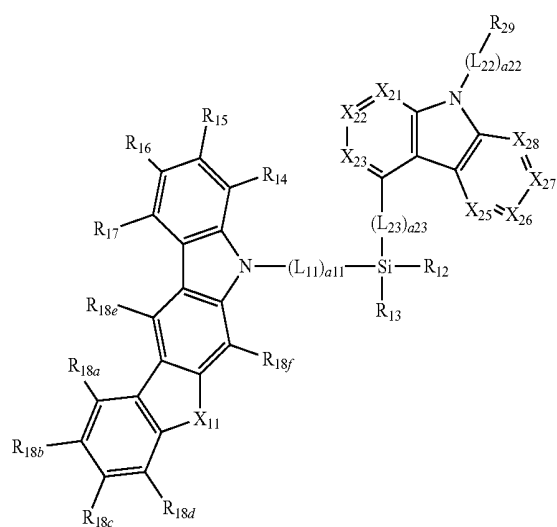
-continued

1-32



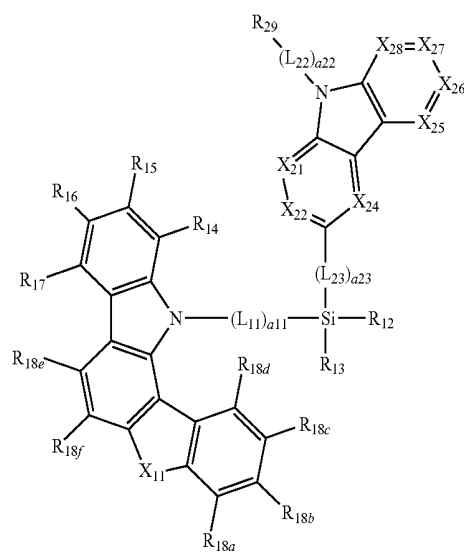
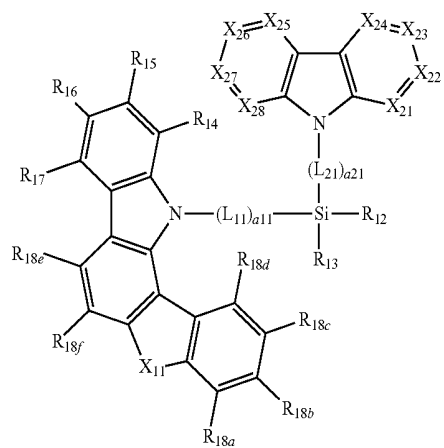
1-33

1-30

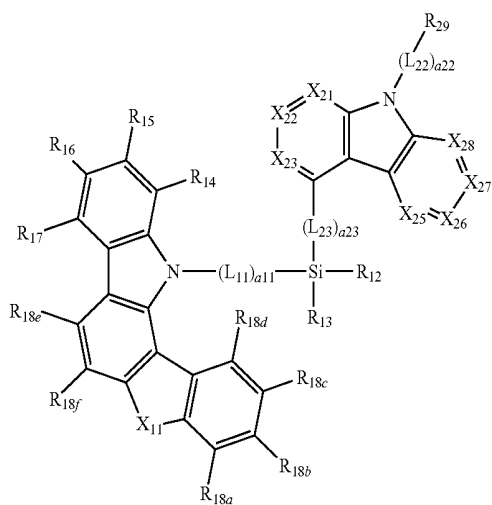


1-34

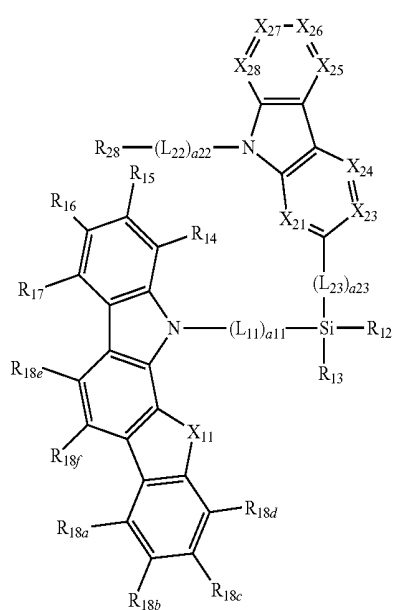
1-31



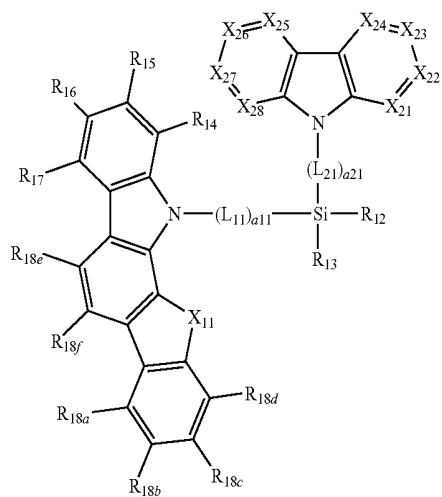
-continued



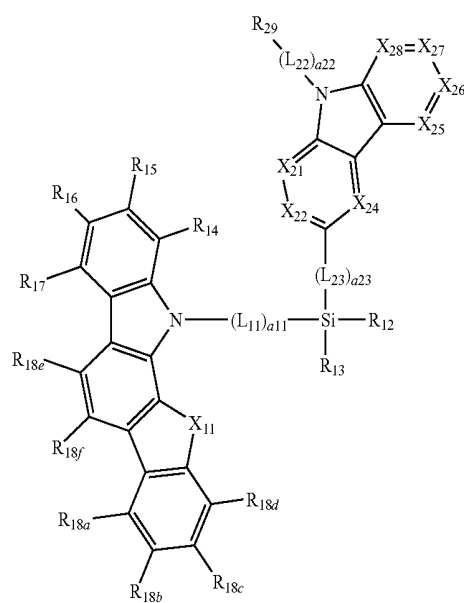
-continued



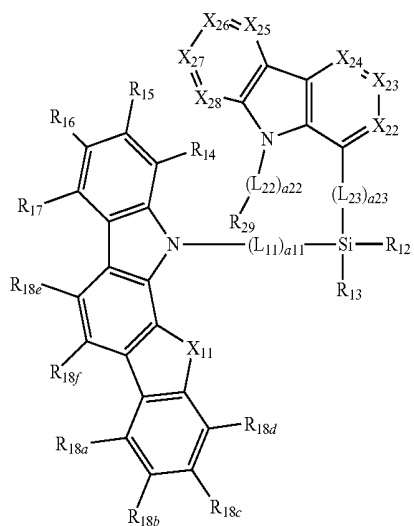
1-36



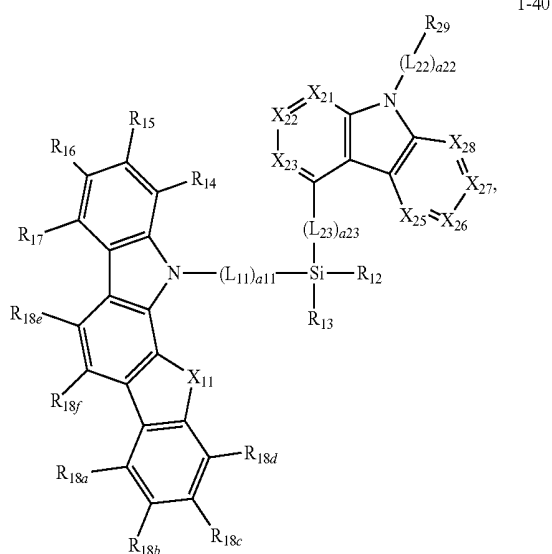
1-39



1-37



-continued



wherein, in Formulae 1-11 to 1-40,

X₁₁ is selected from O, S, N(R_{18g}), and C(R_{18g})(R_{18h}),

R₁₂ to R₁₇, L₁₁, and all are the same as described in connection with Formula 1,

X₂₁ to X₂₈, L₂₁ to L₂₃, a₂₁ to a₂₃, and R₂₉ are the same as described in connection with Formulae 2-1 to 2-6, and

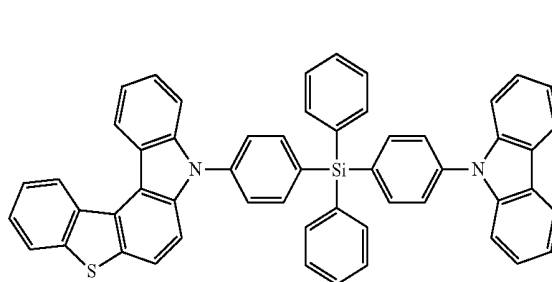
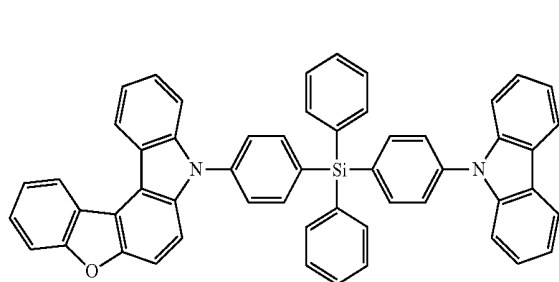
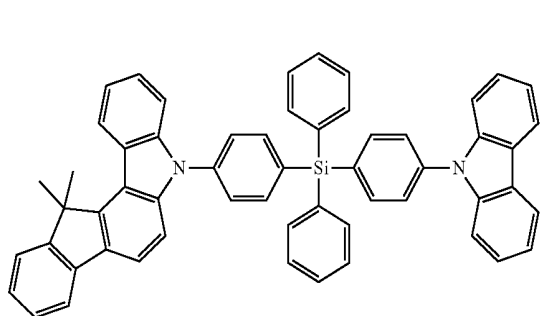
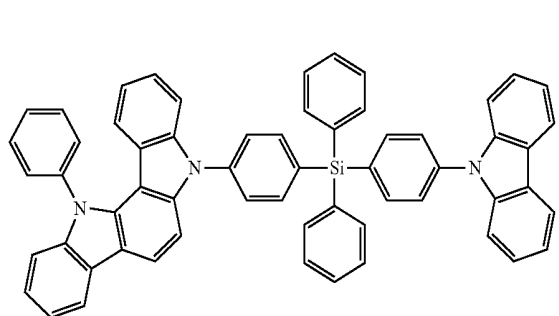
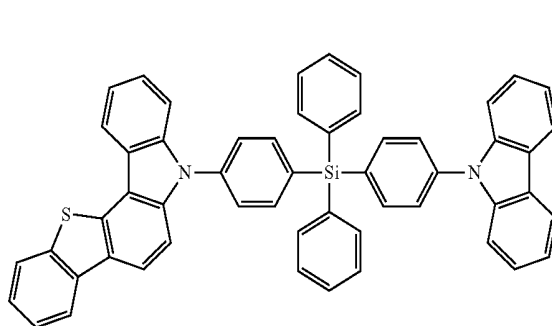
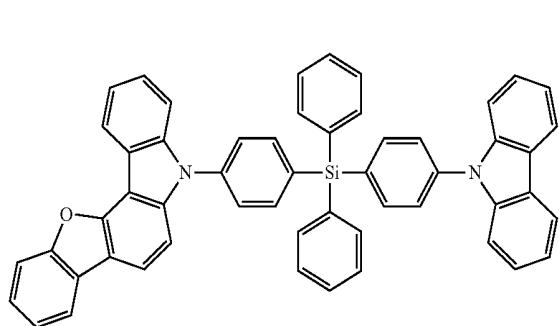
R_{18a} to R_{18h} are each independently the same as described in connection with R₁₈ in Formula 1.

12. The silyl group-containing compound of claim 1, wherein

the silyl group-containing compound has a triplet energy level of 2.8 electron volts or higher.

13. The silyl group-containing compound of claim 1, wherein

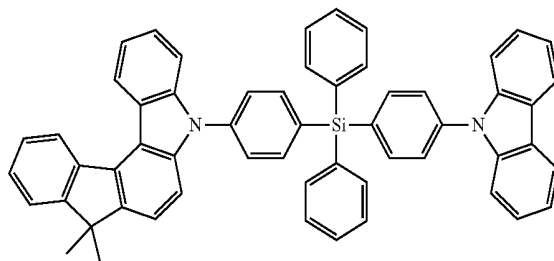
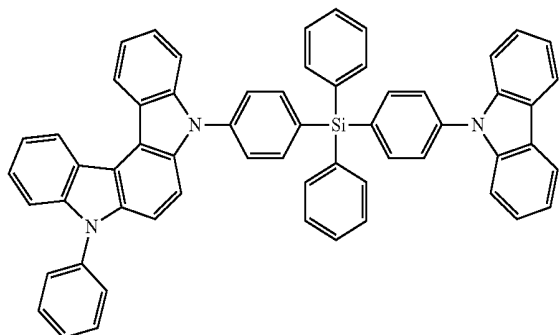
the silyl group-containing compound represented by Formula 1 is selected from Compounds 1 to 432:



-continued

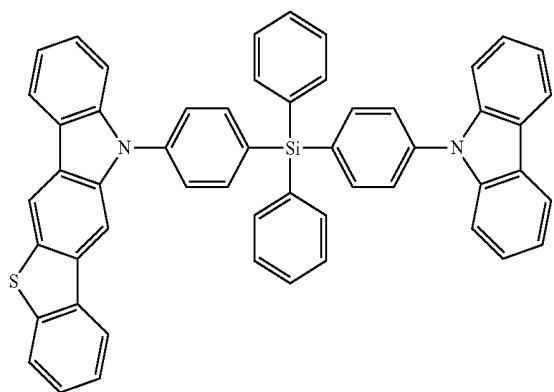
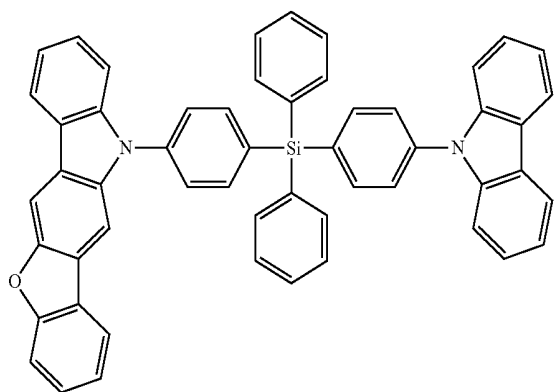
7

8



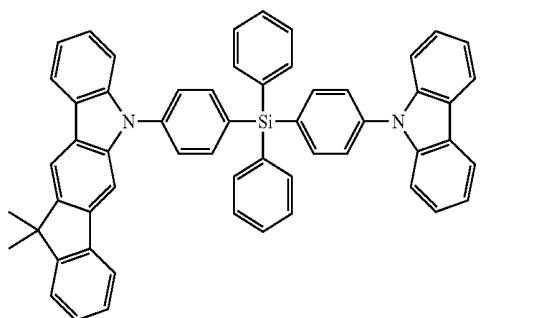
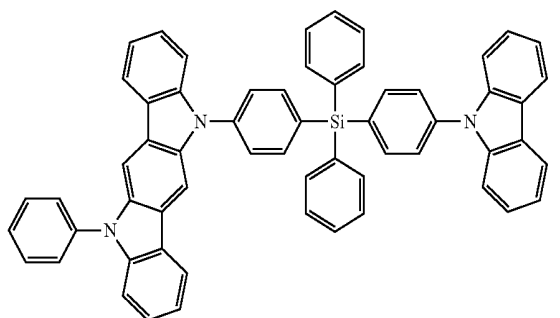
9

10



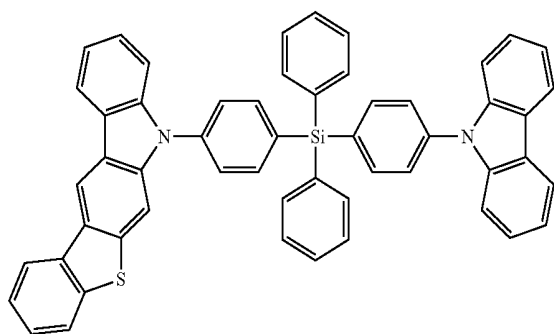
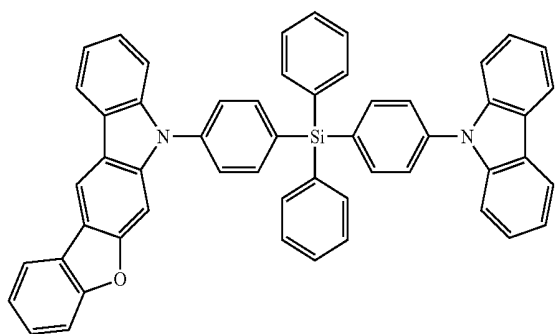
11

12



13

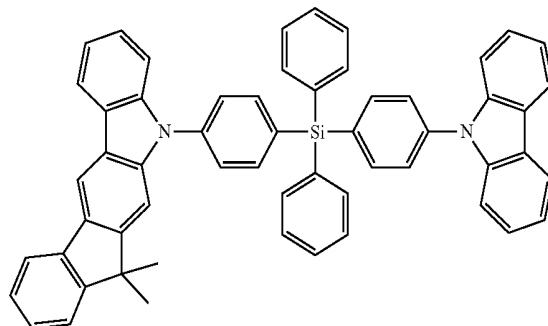
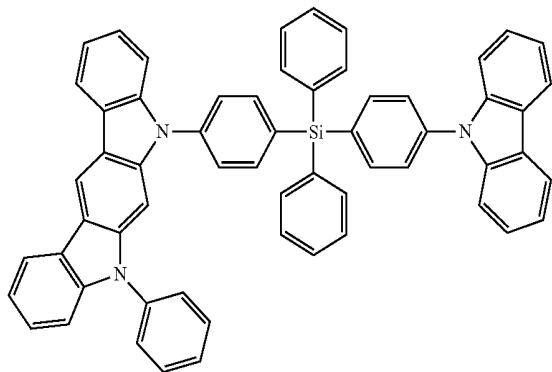
14



-continued

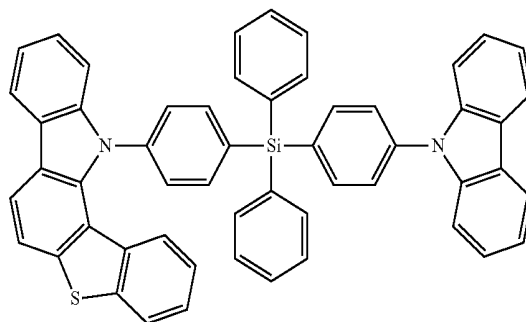
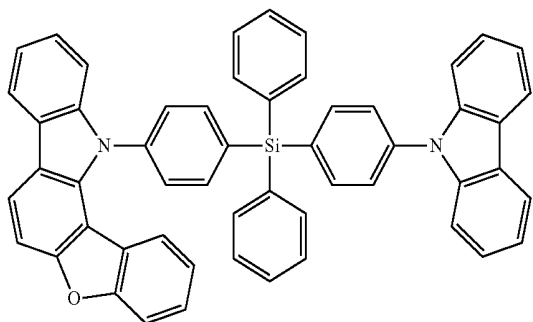
15

16



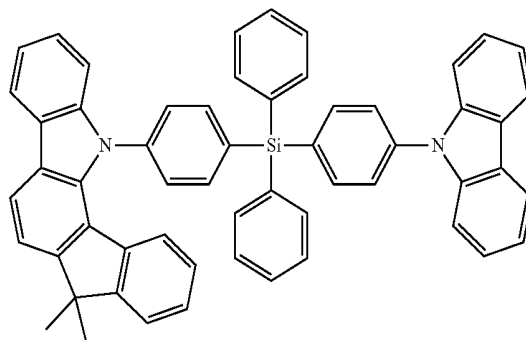
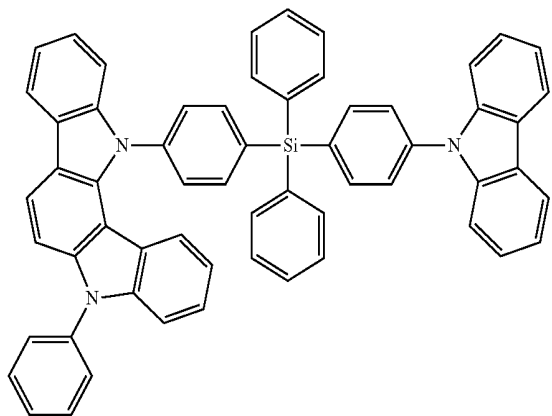
17

18



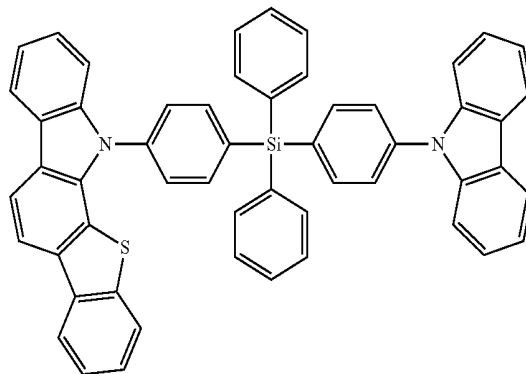
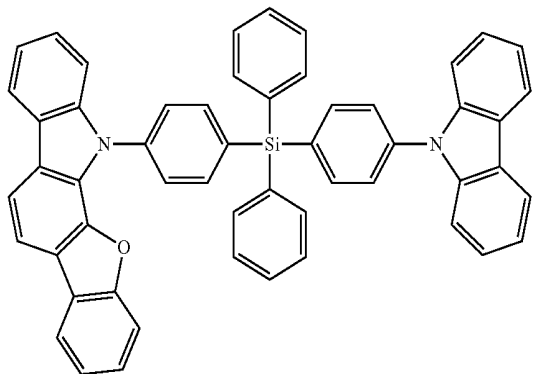
19

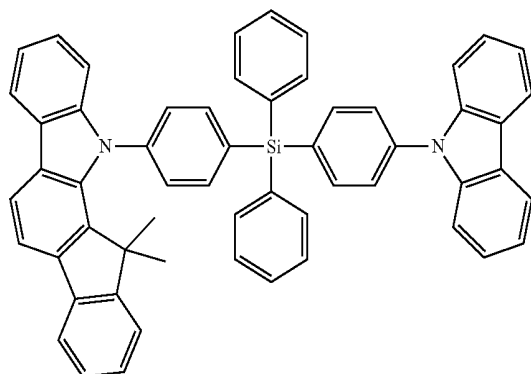
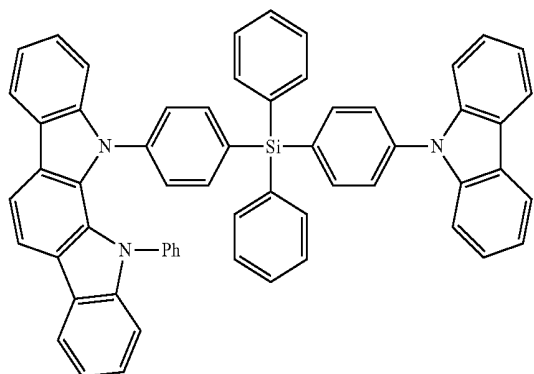
20



21

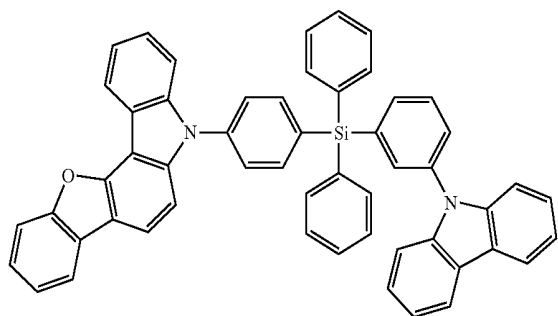
22



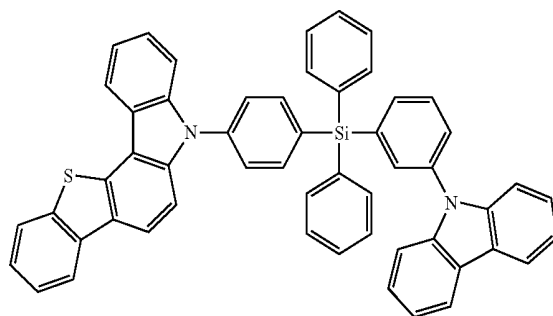
-continued
23

24

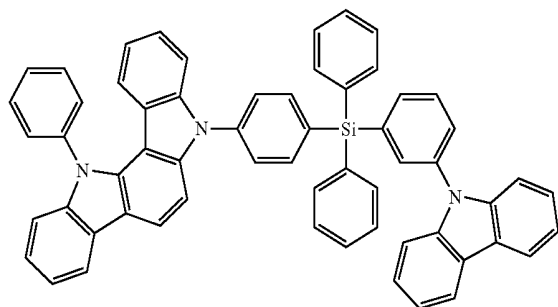
25



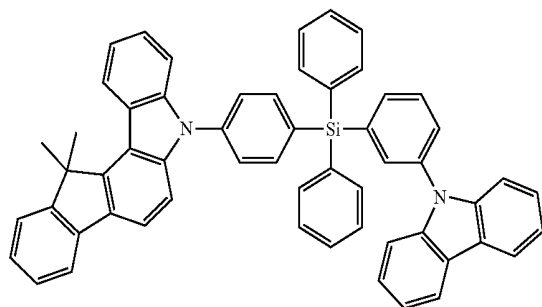
26



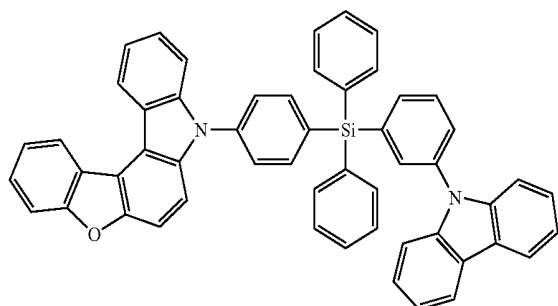
27



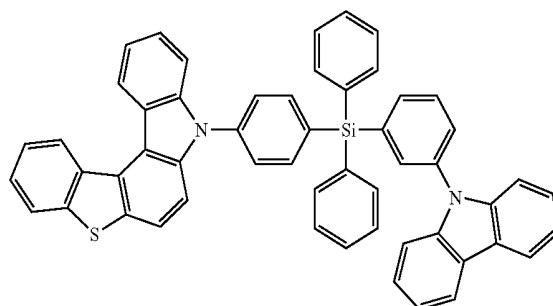
28



29



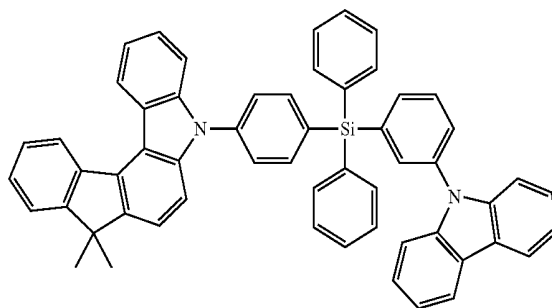
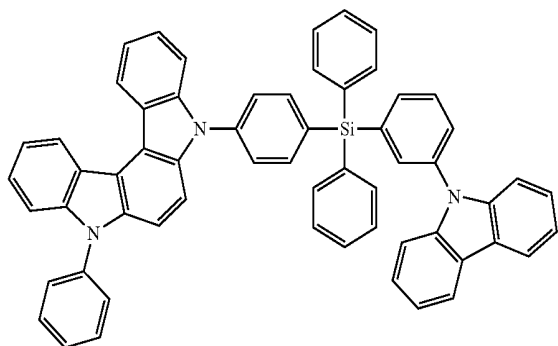
30



-continued

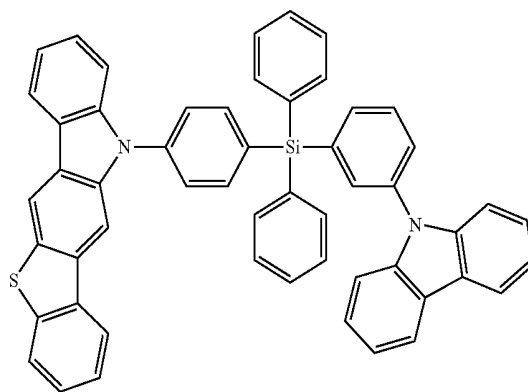
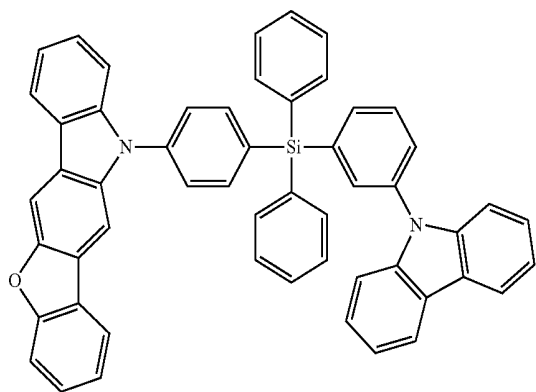
31

32



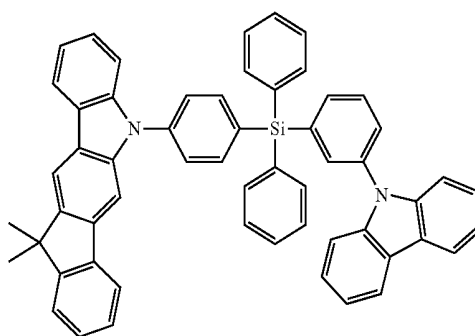
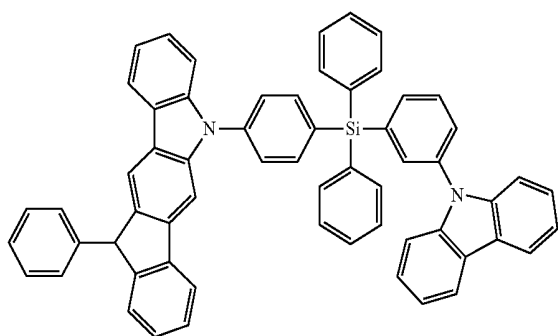
33

34



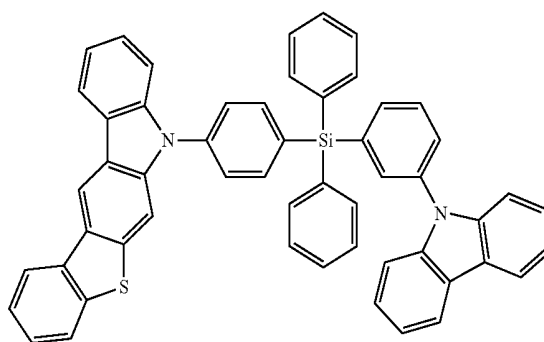
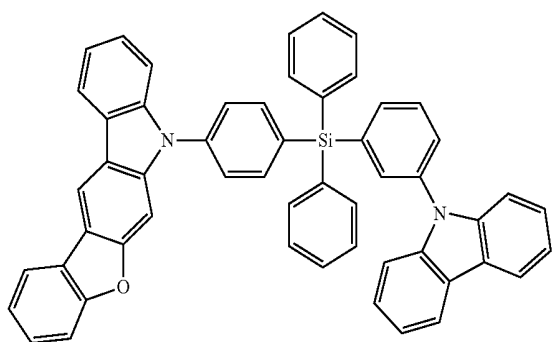
35

36



37

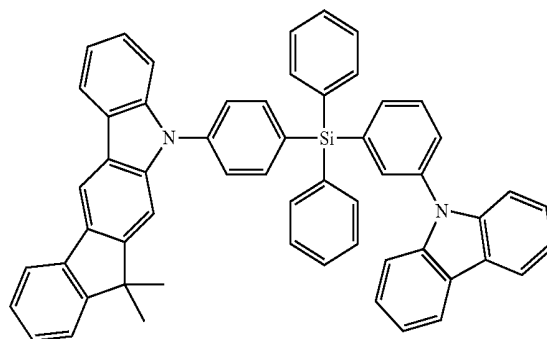
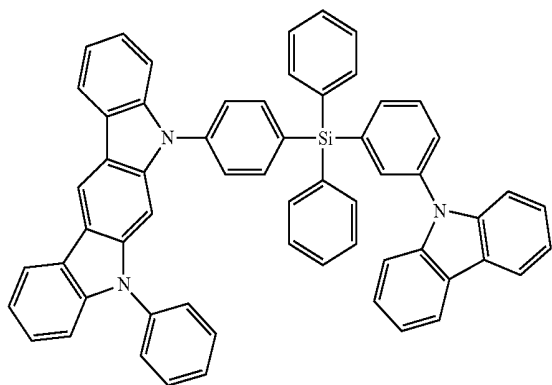
38



-continued

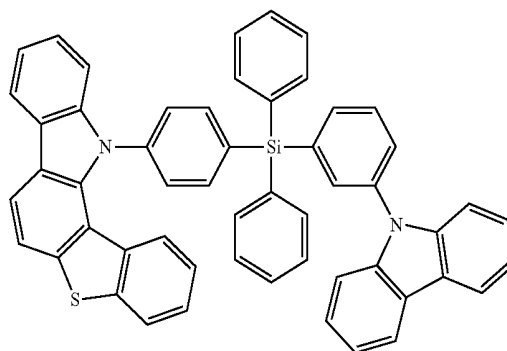
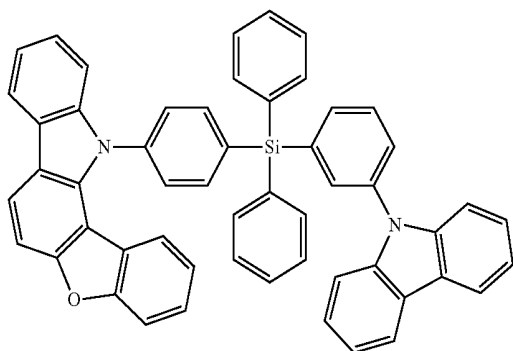
39

40



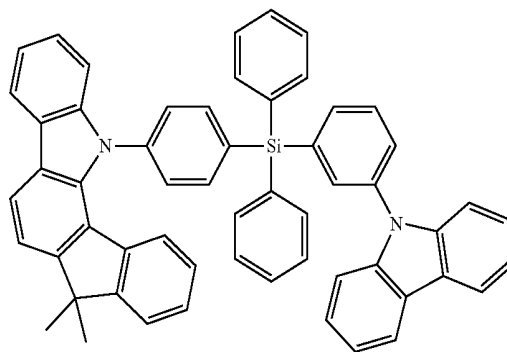
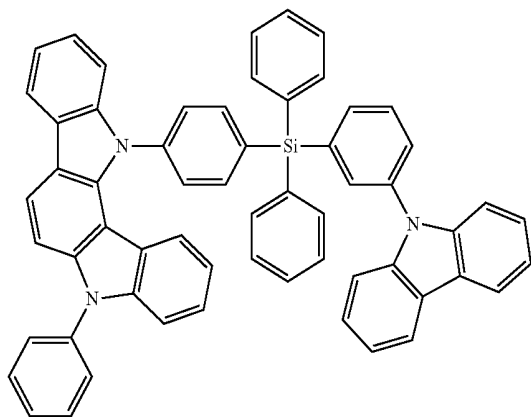
41

42



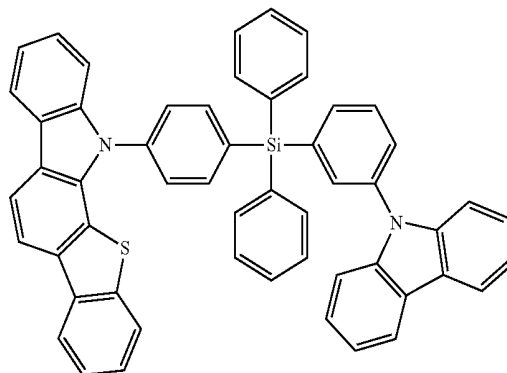
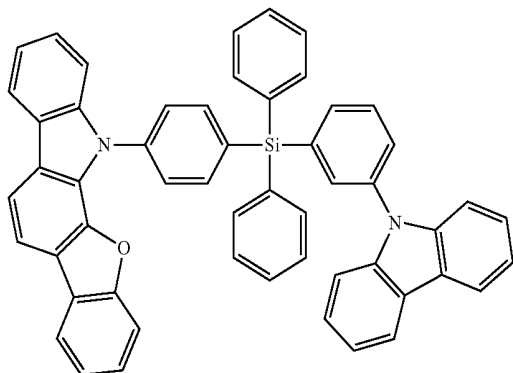
43

44



45

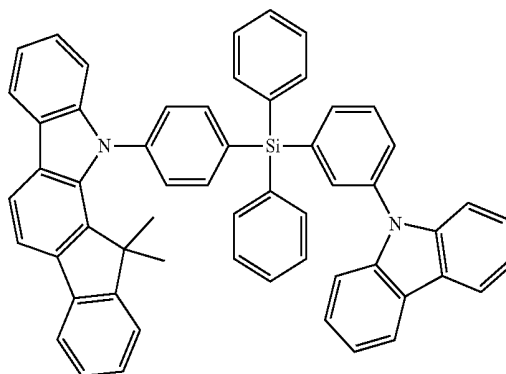
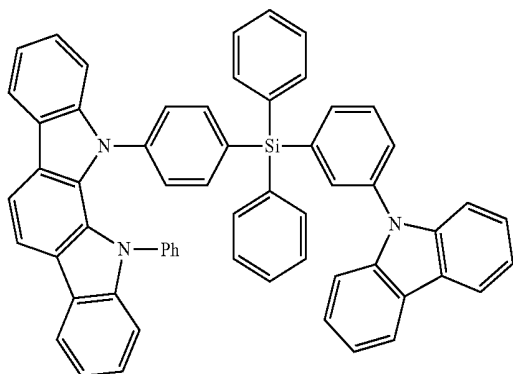
46



-continued

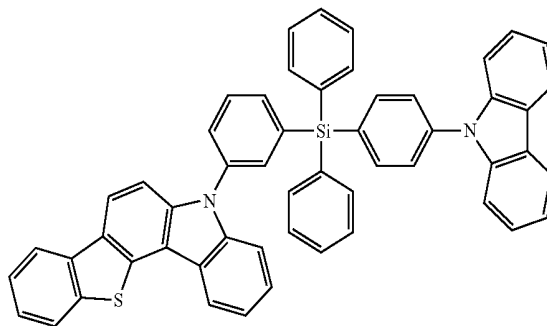
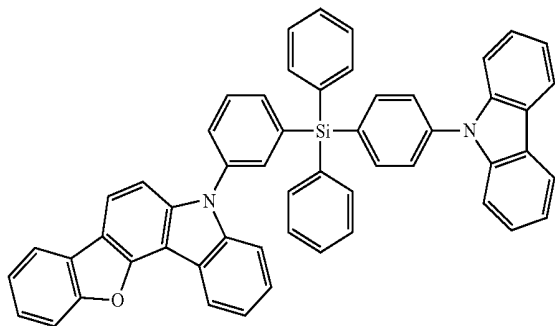
47

48



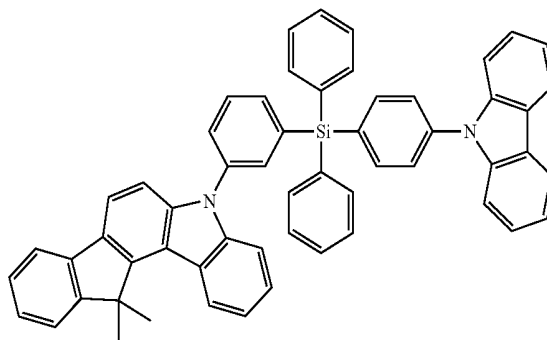
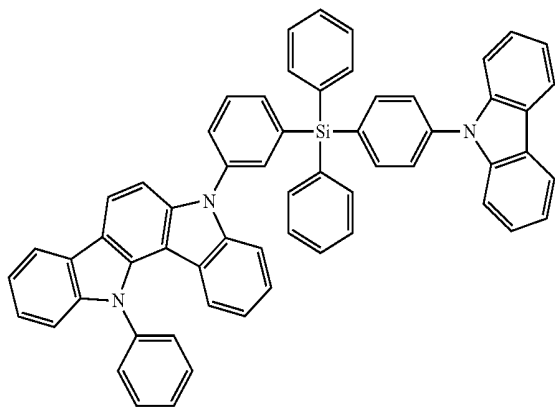
49

50



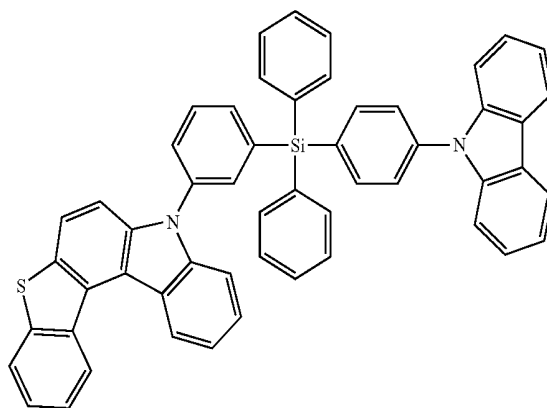
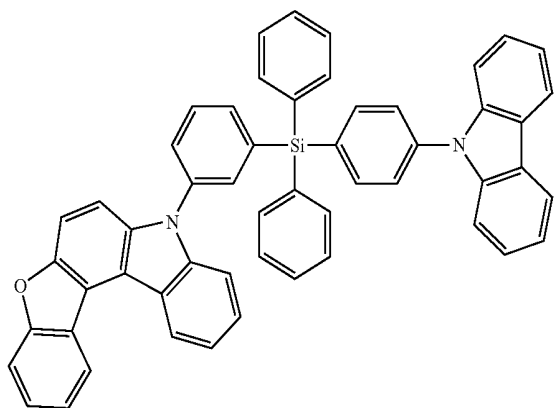
51

52



53

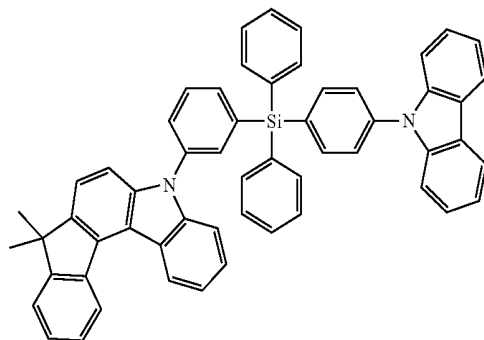
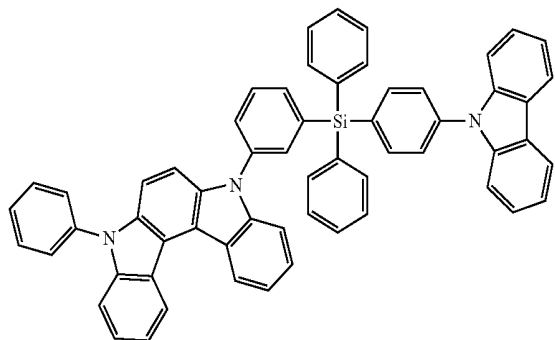
54



-continued

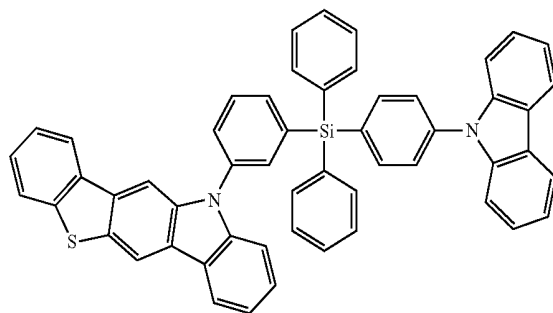
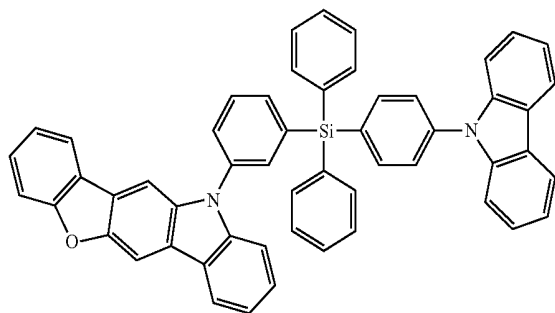
55

56



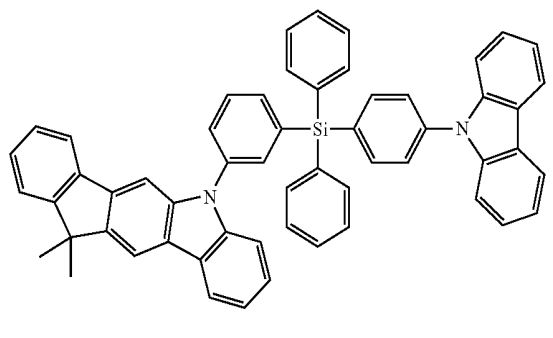
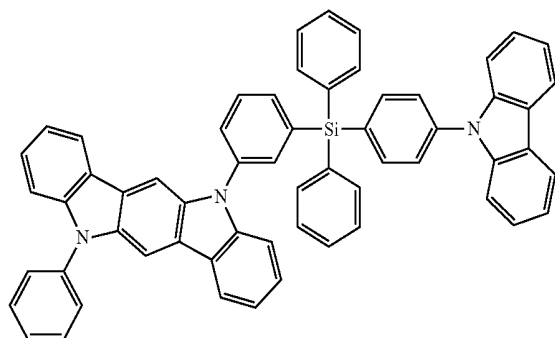
57

58



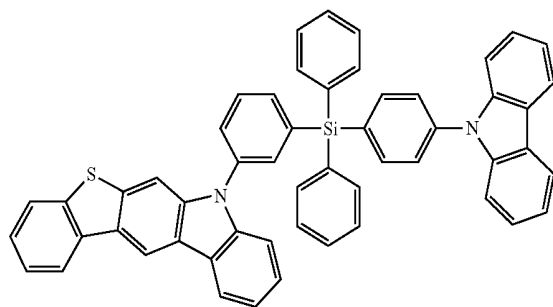
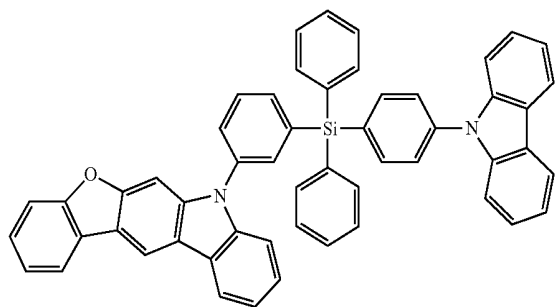
59

60



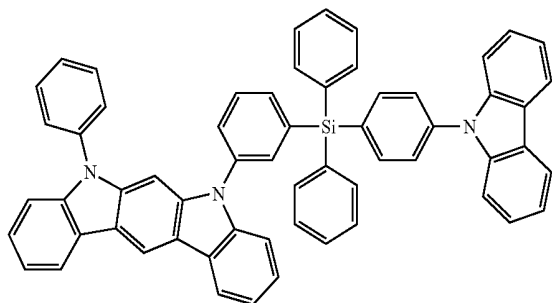
61

62

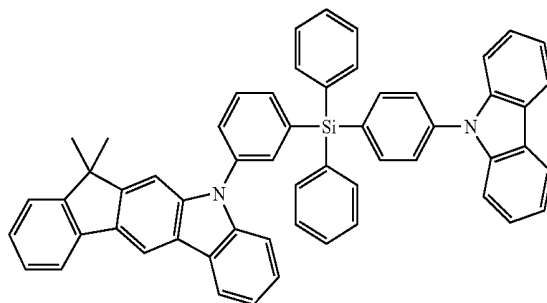


-continued

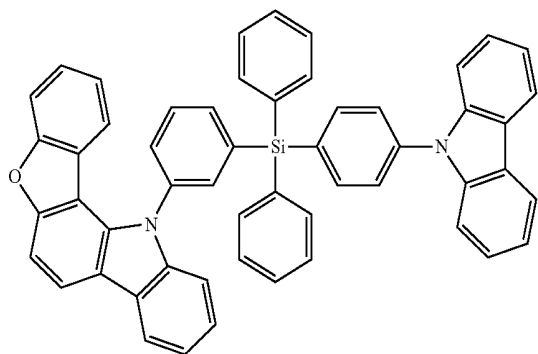
63



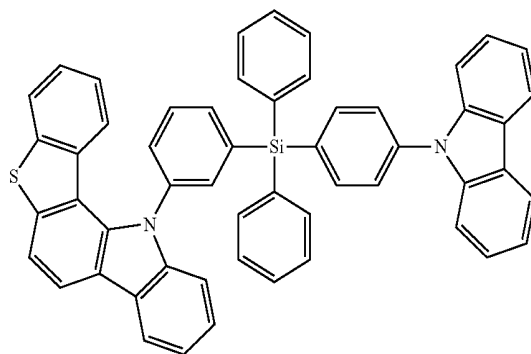
64



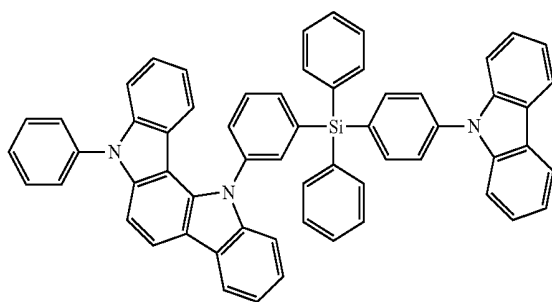
65



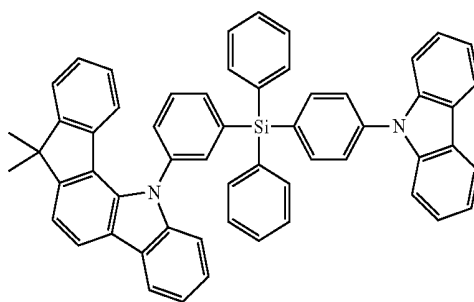
66



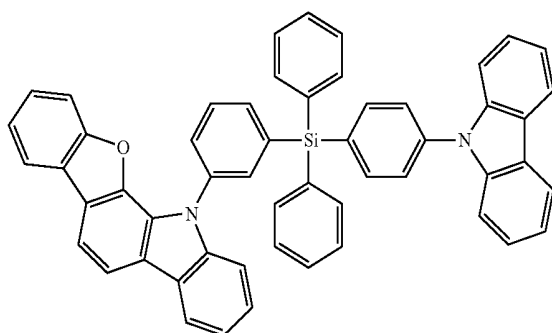
67



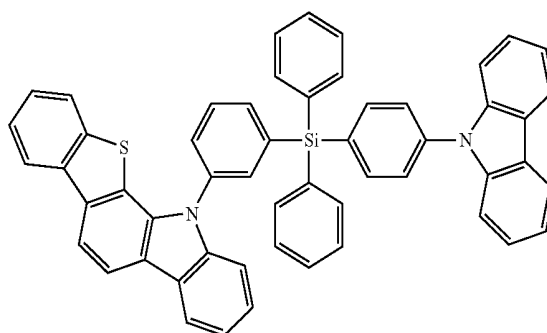
68



69



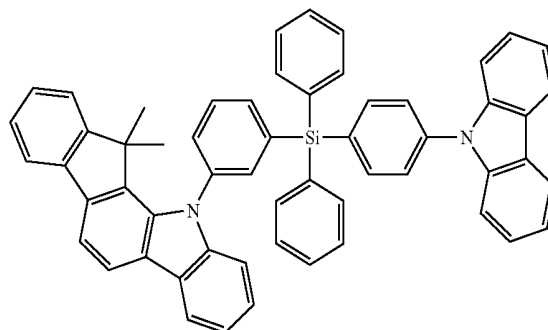
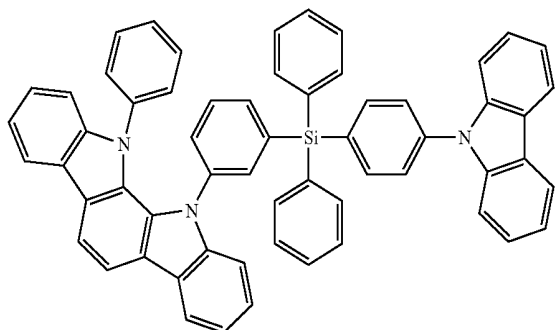
70



-continued

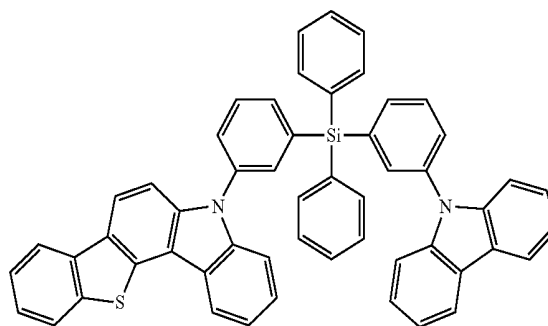
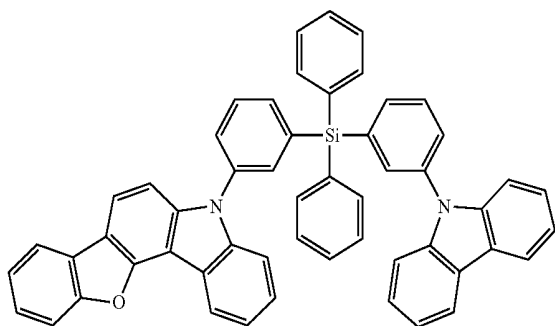
71

72



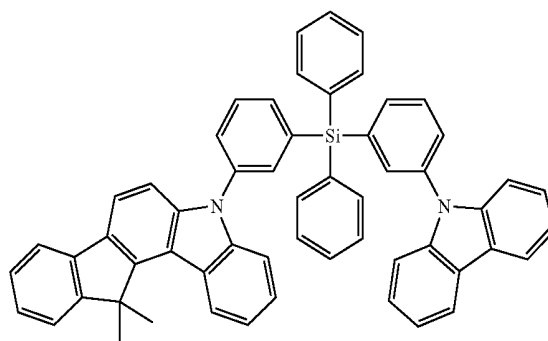
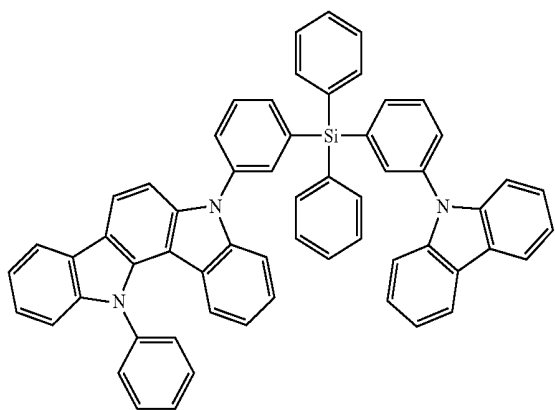
73

74



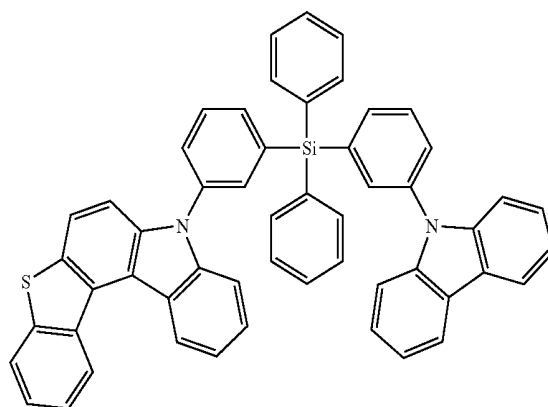
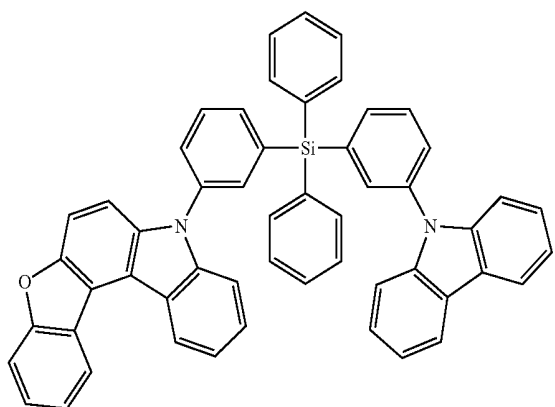
75

76



77

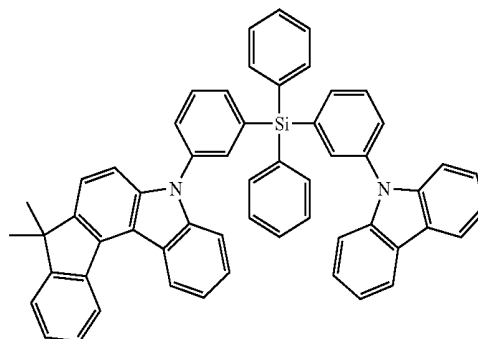
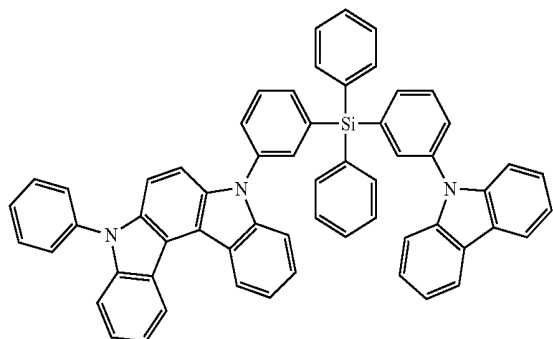
78



-continued

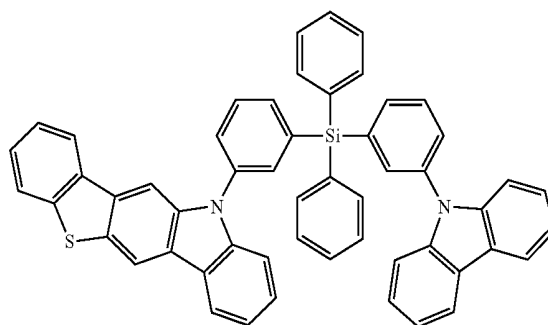
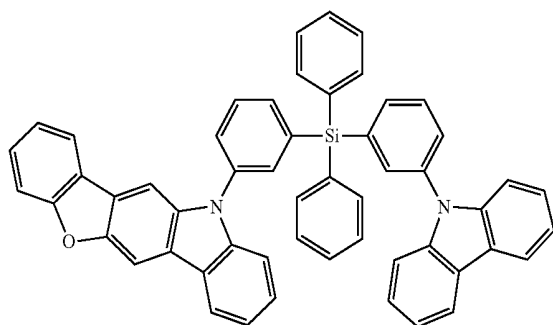
79

80



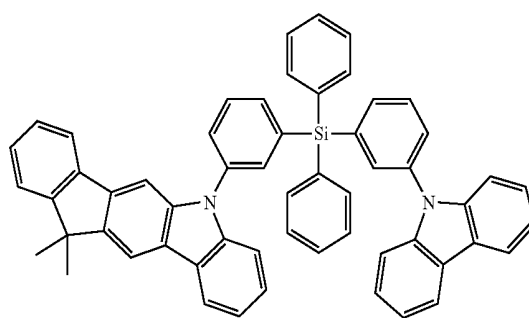
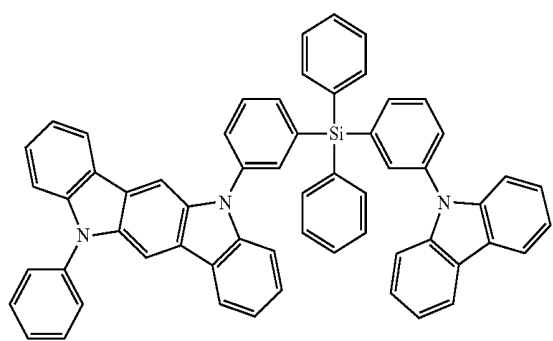
81

82



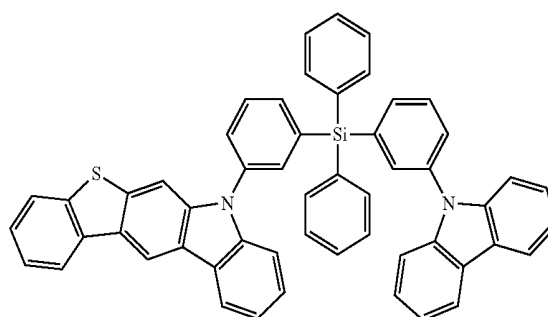
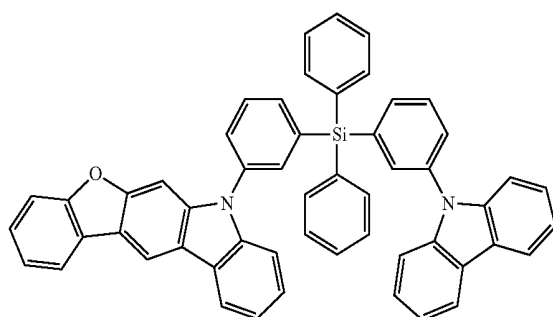
83

84



85

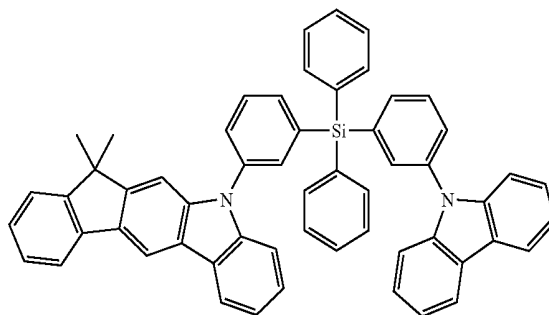
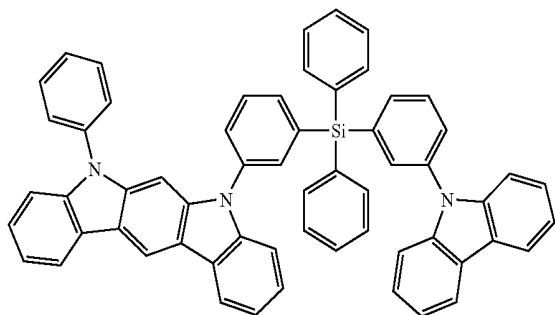
86



-continued

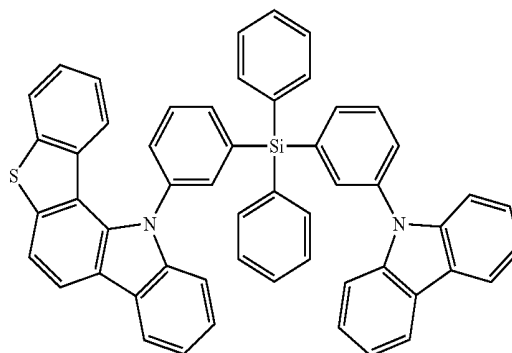
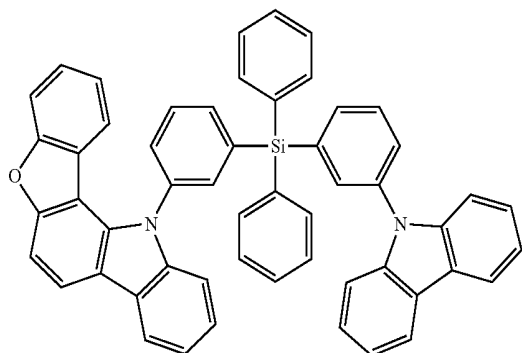
87

88



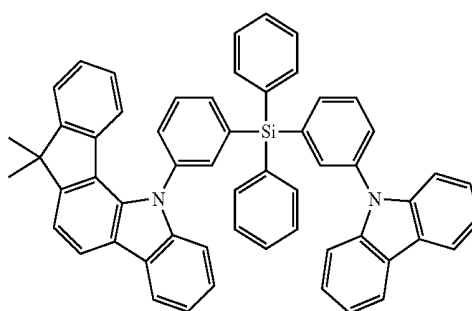
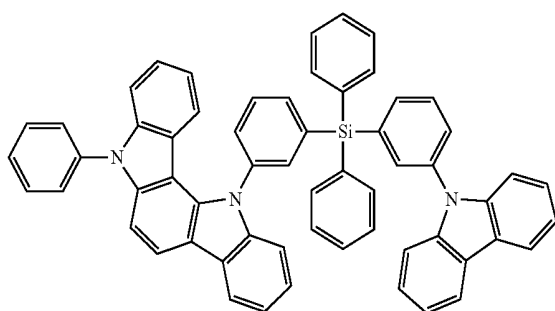
89

90



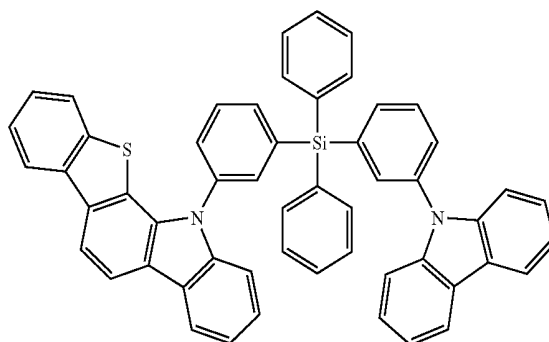
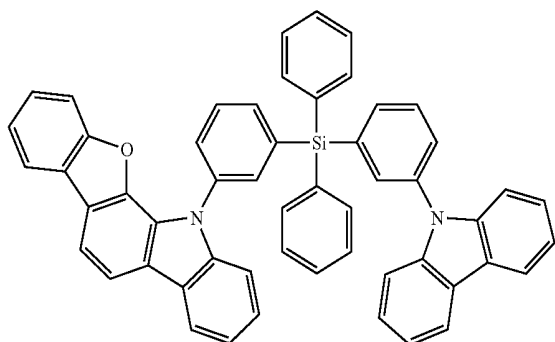
91

92



93

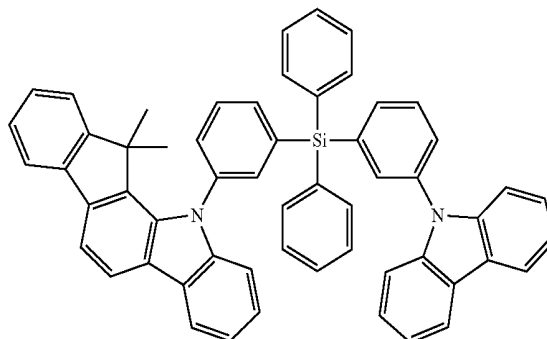
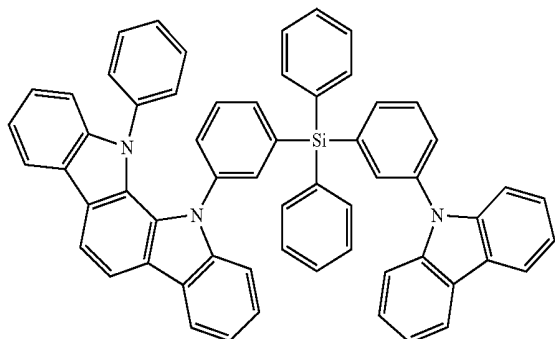
94



-continued

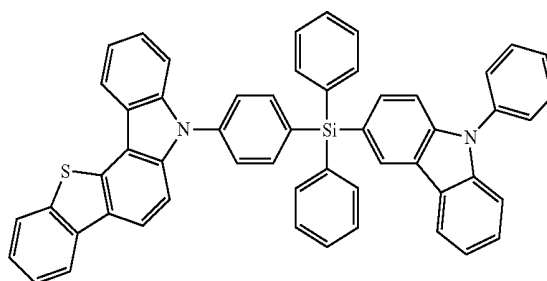
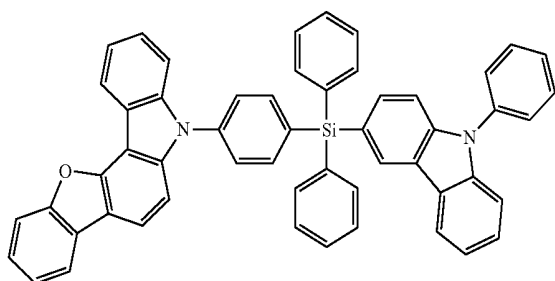
95

96



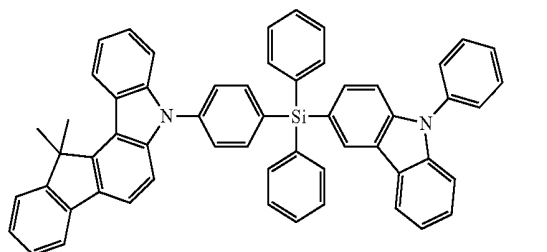
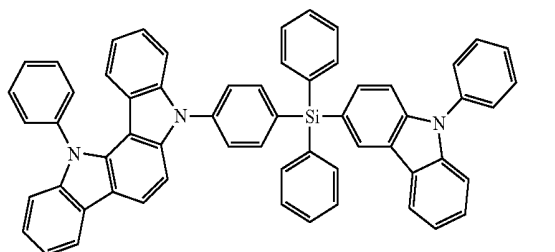
97

98



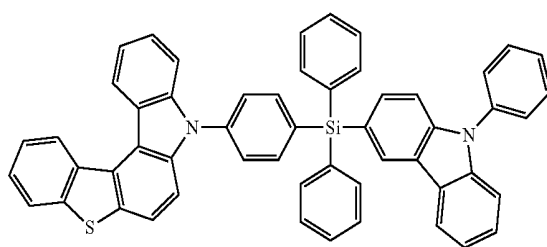
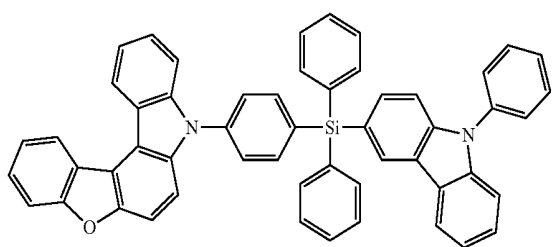
99

100



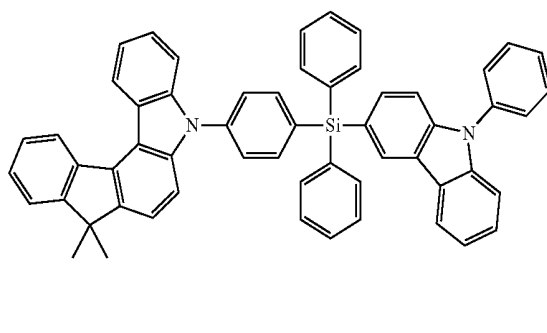
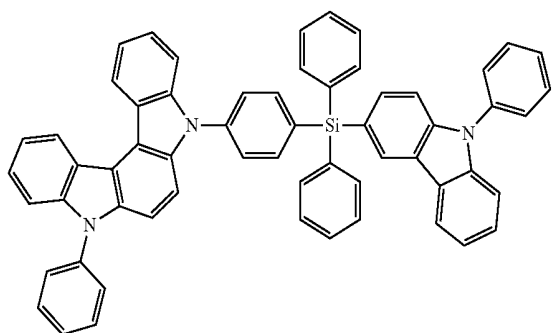
101

102



103

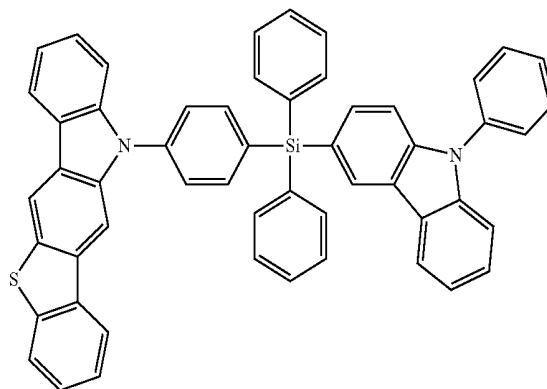
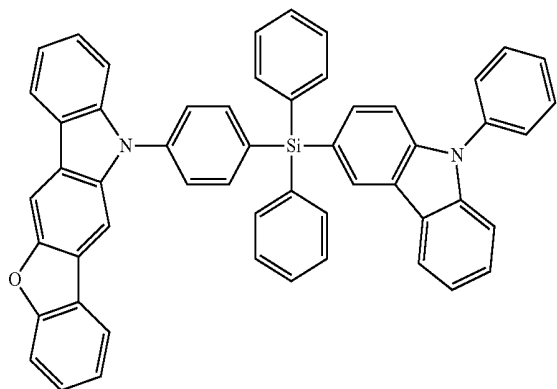
104



-continued

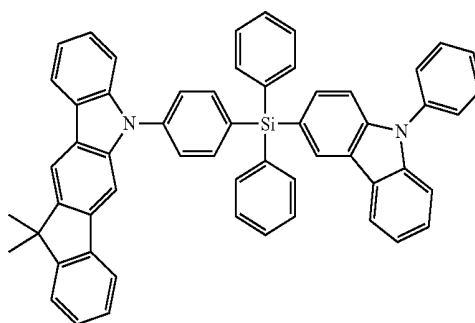
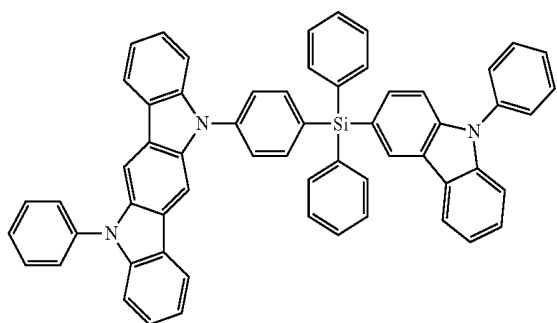
105

106



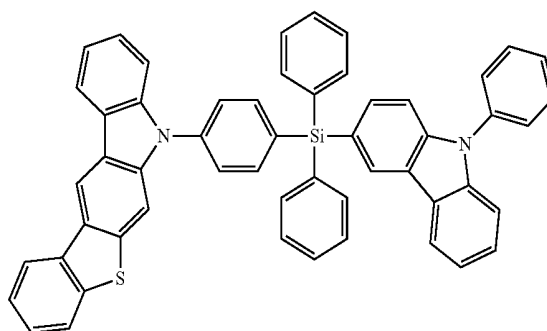
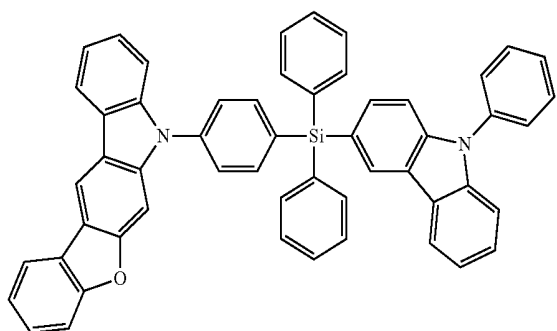
107

108



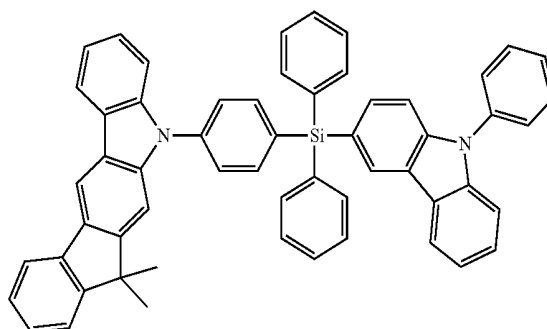
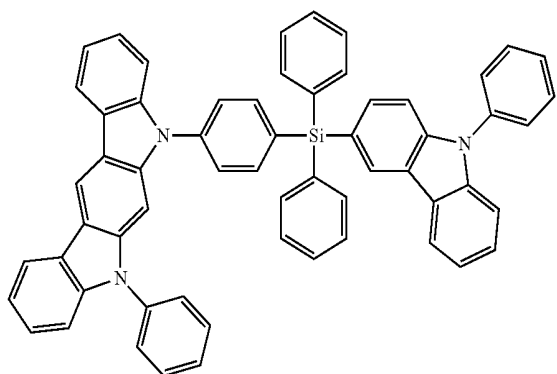
109

110



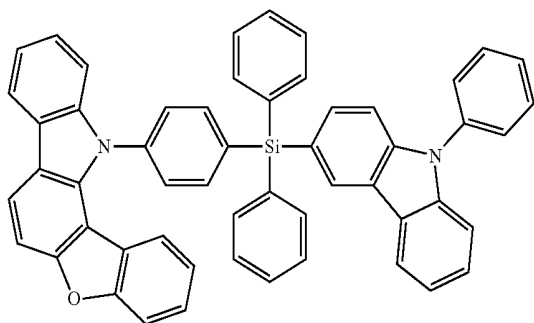
111

112

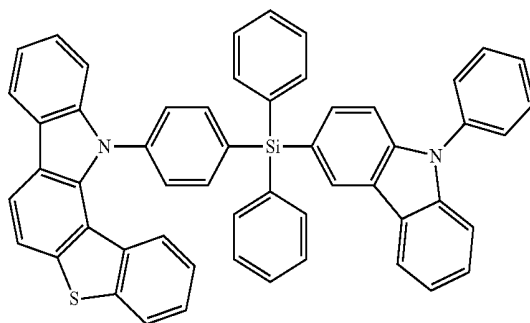


-continued

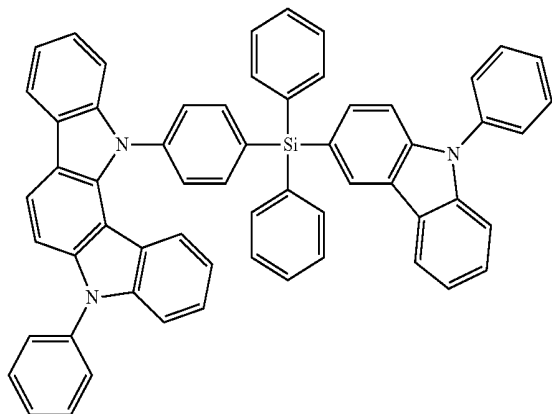
113



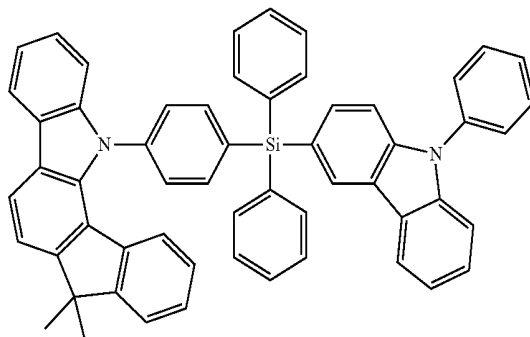
114



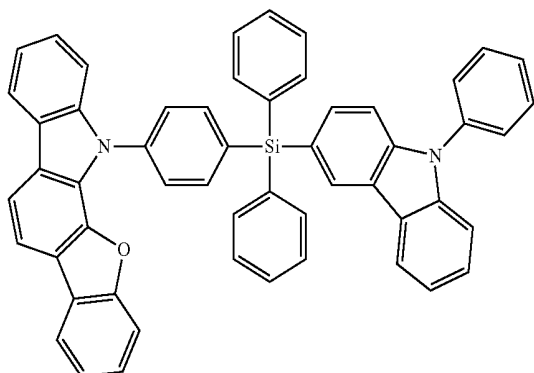
115



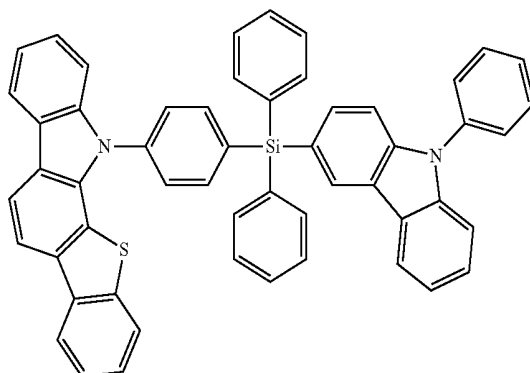
116



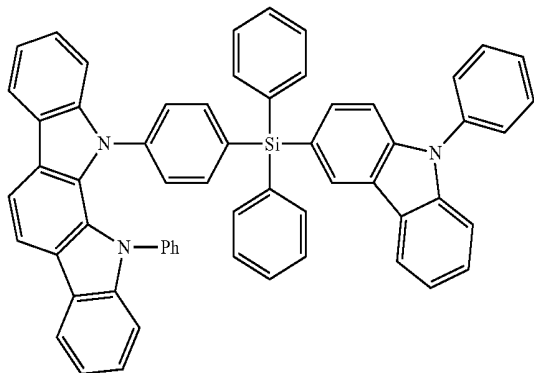
117



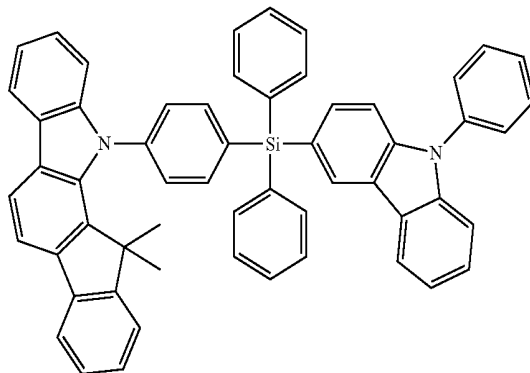
118



119



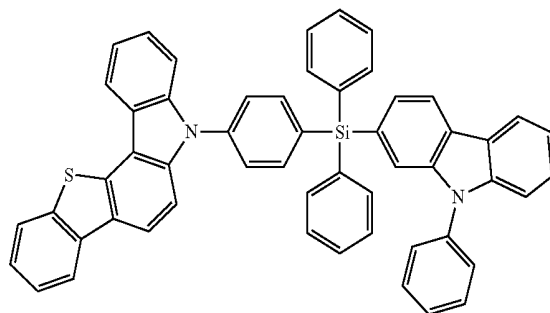
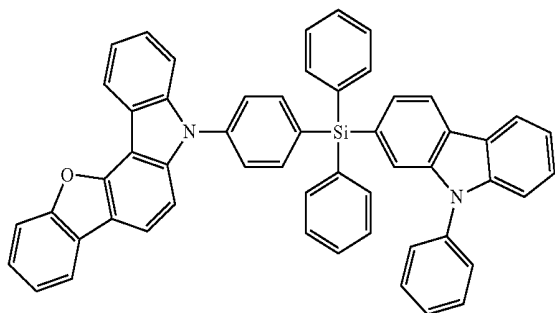
120



-continued

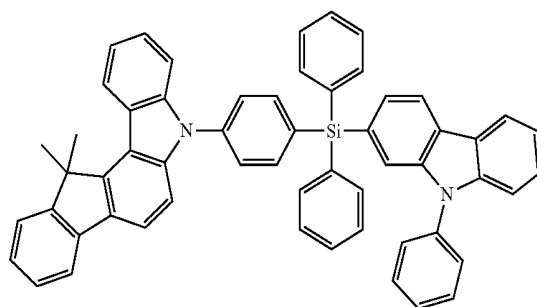
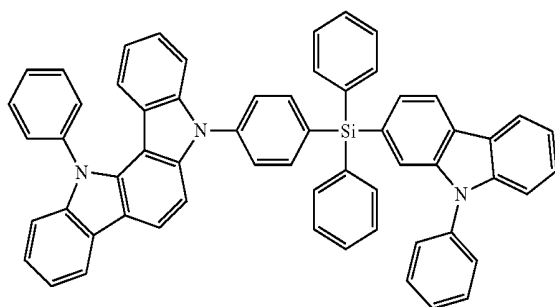
121

122



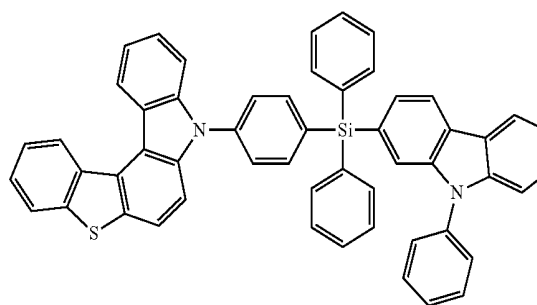
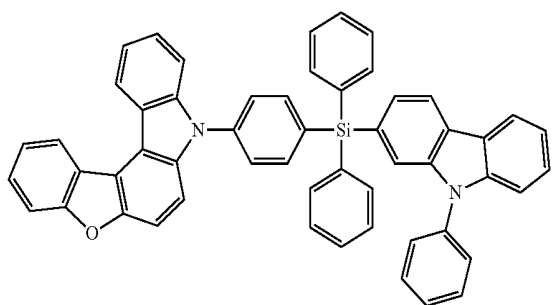
123

124



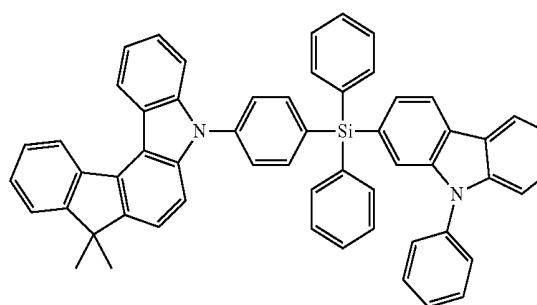
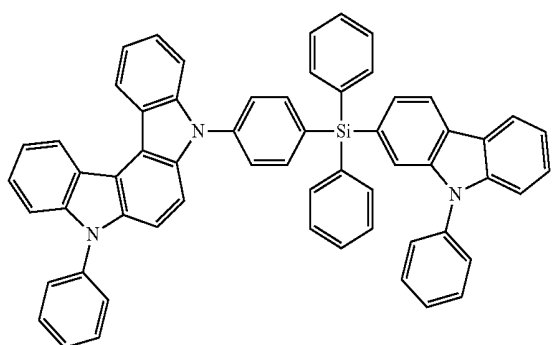
125

126



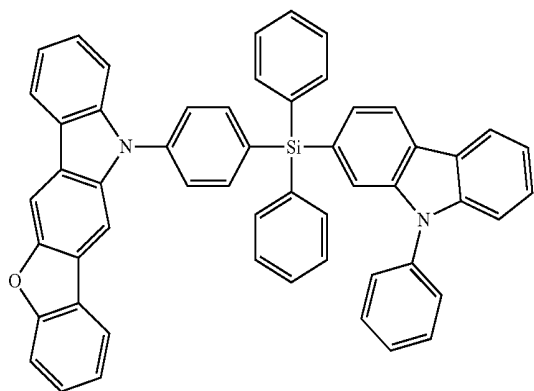
127

128

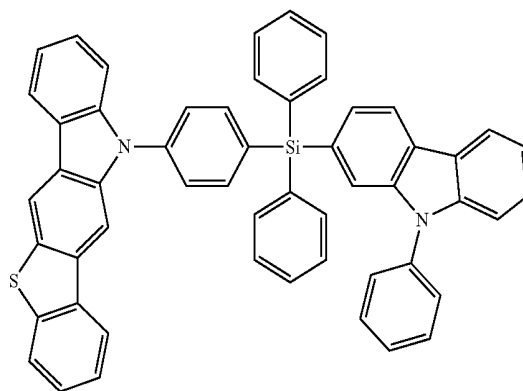


-continued

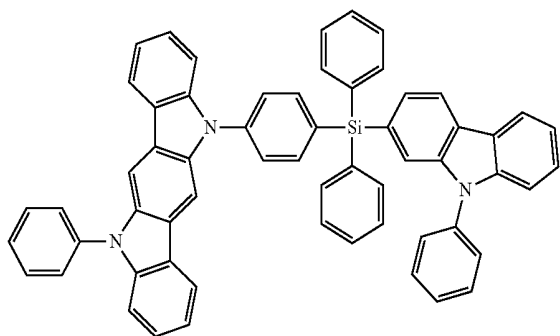
129



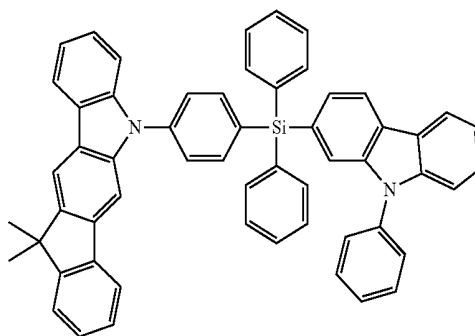
130



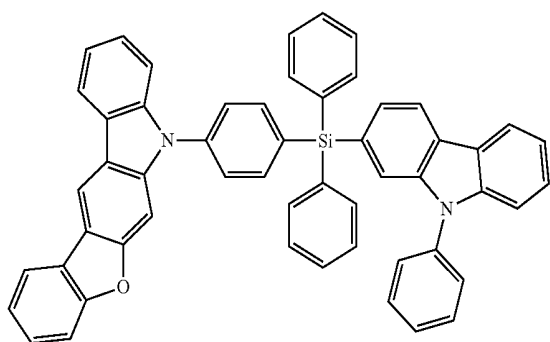
131



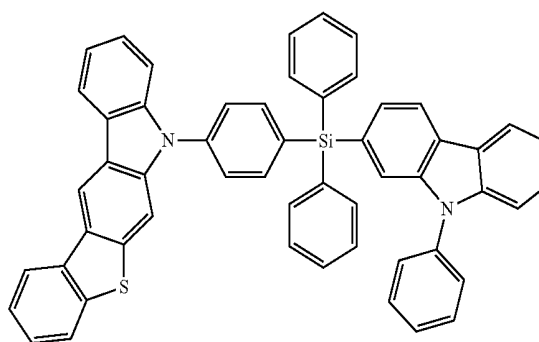
132



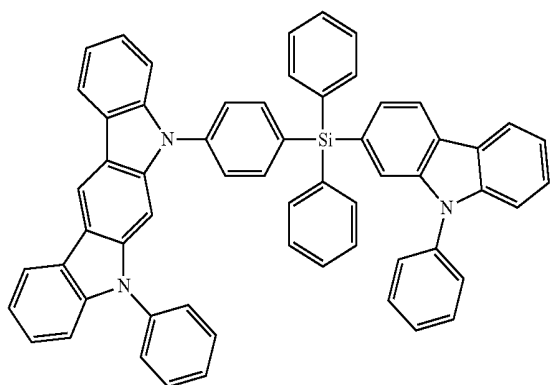
133



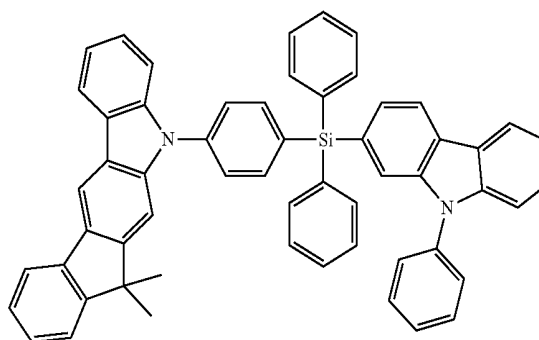
134



135



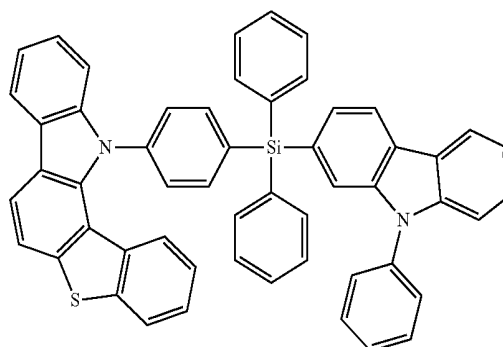
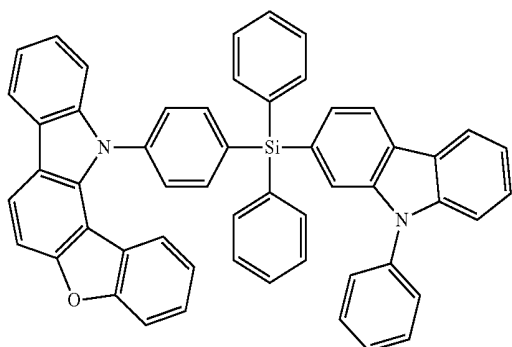
136



-continued

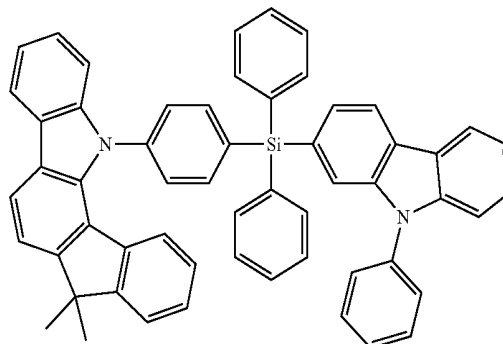
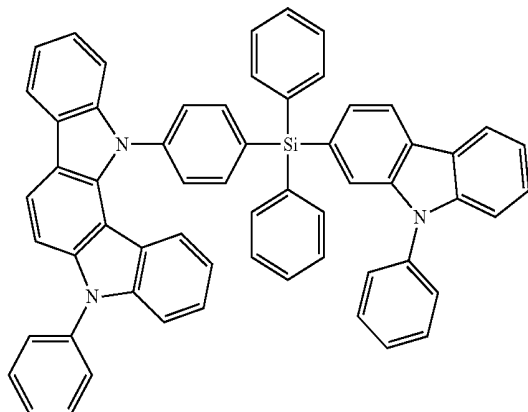
137

138



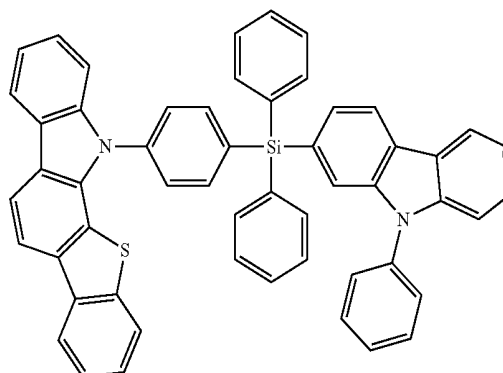
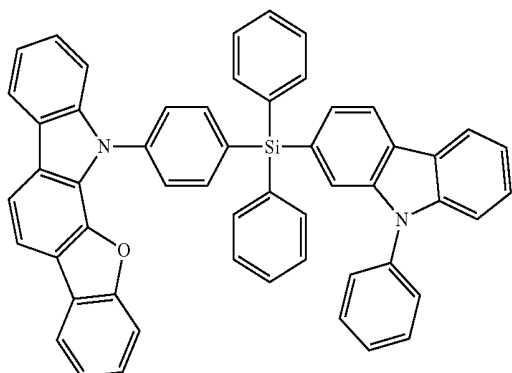
139

140



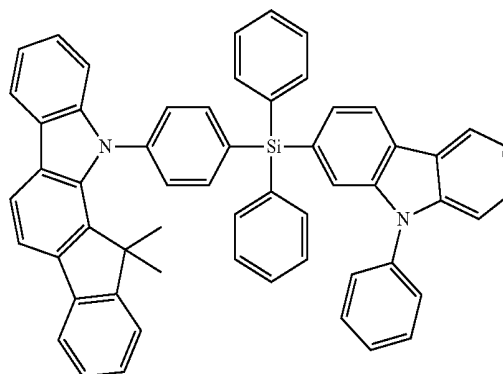
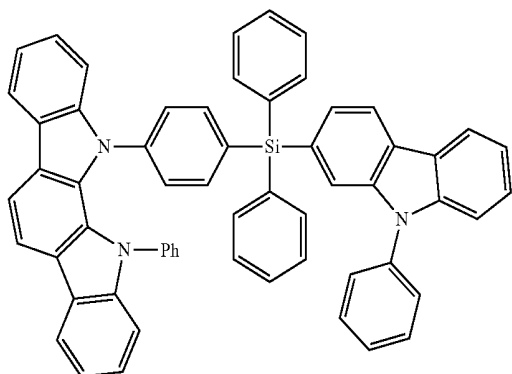
141

142



143

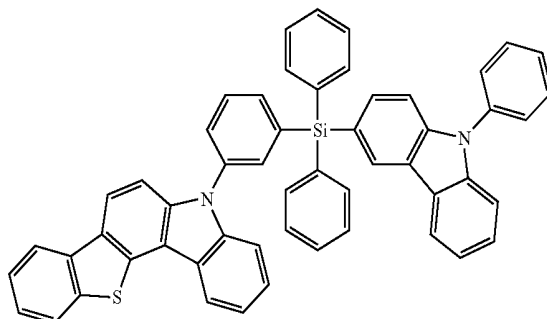
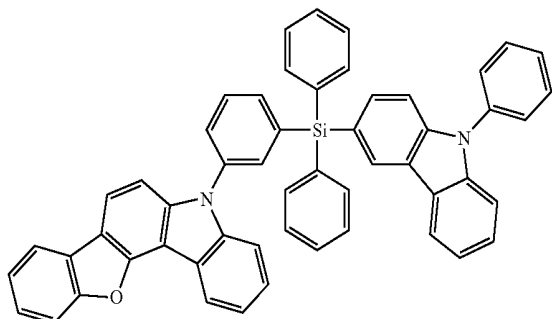
144



-continued

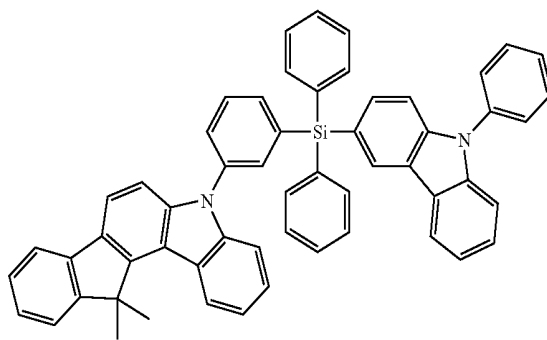
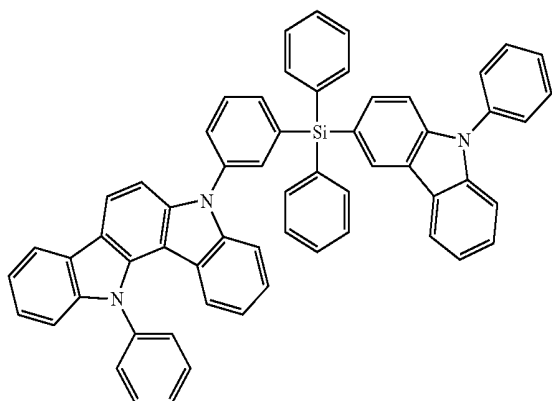
145

146



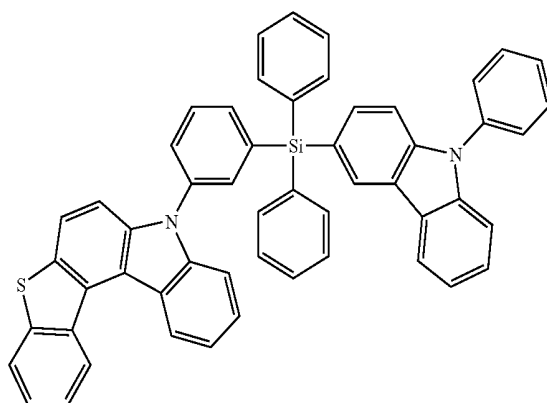
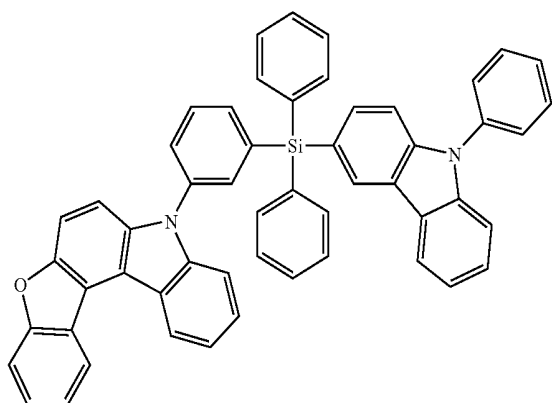
147

148



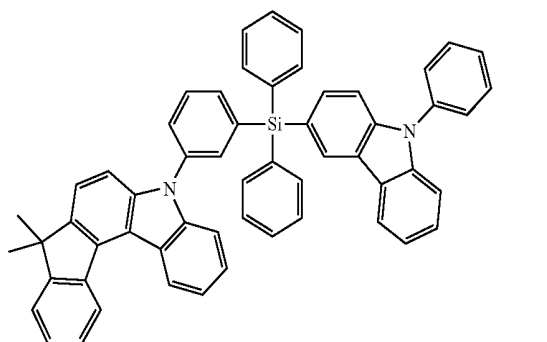
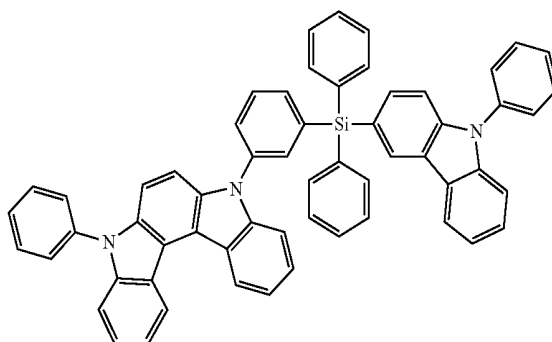
149

150



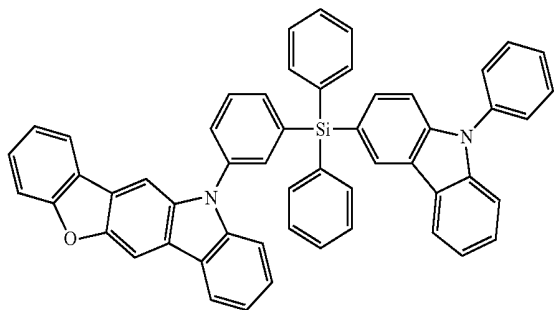
151

152

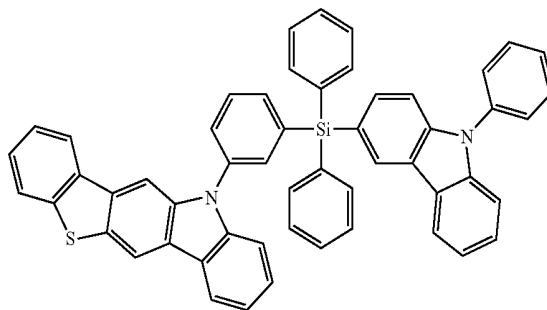


-continued

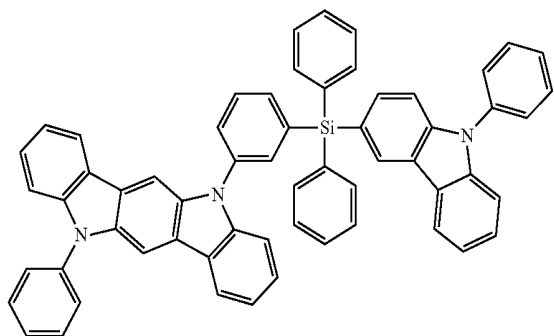
153



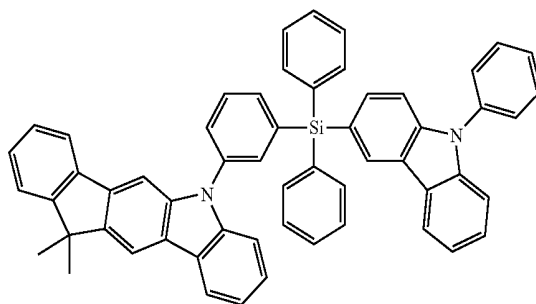
154



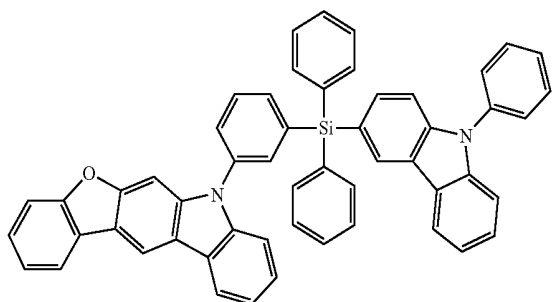
155



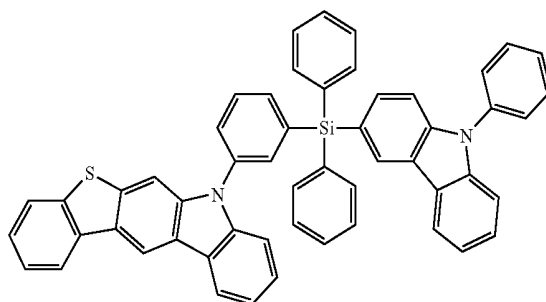
156



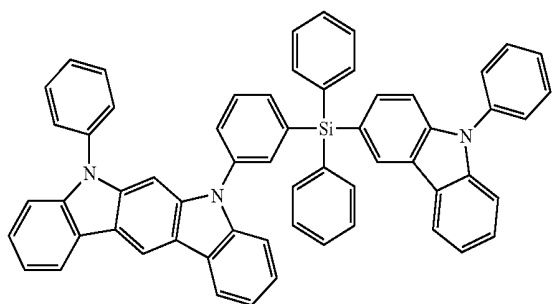
157



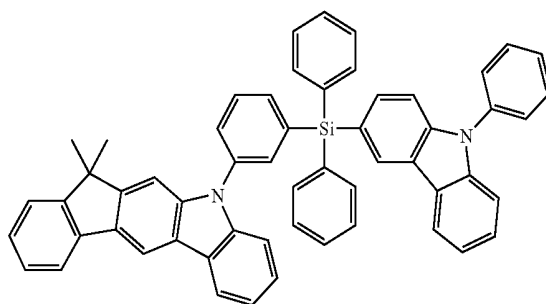
158



159



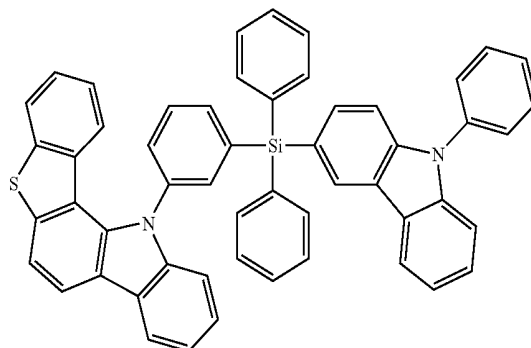
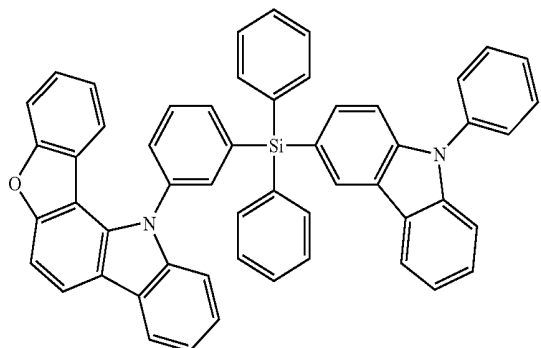
160



-continued

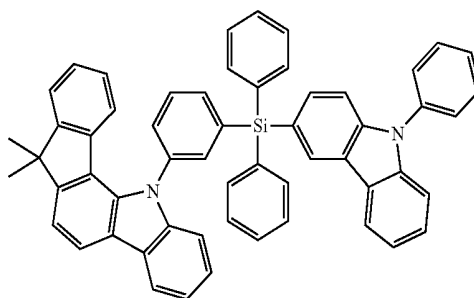
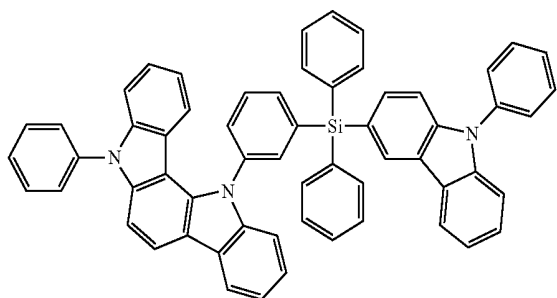
161

162



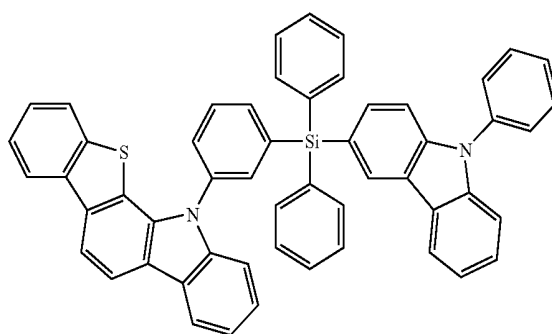
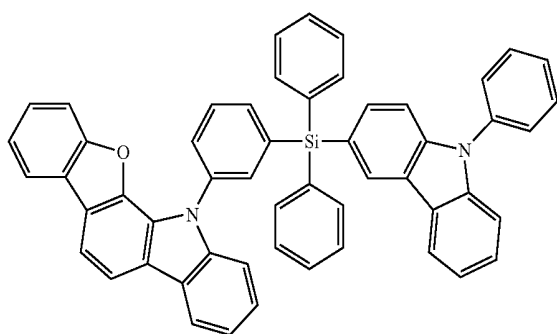
163

164



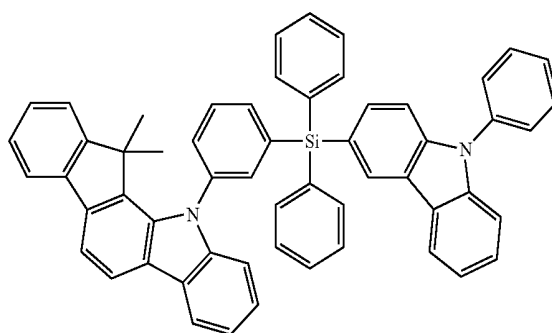
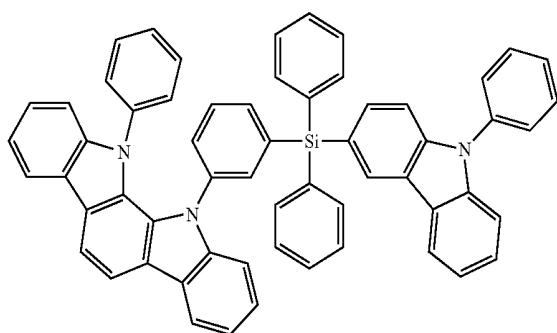
165

166



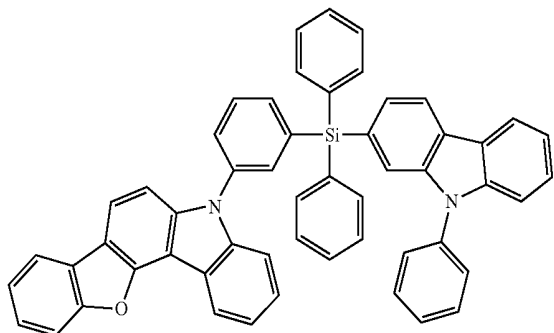
167

168

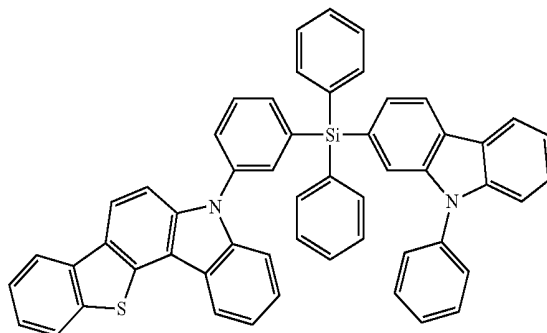


-continued
169

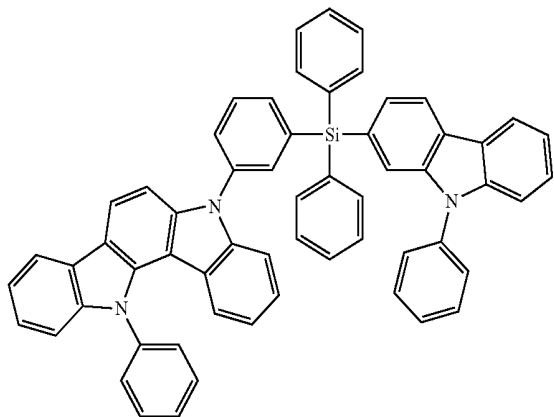
170



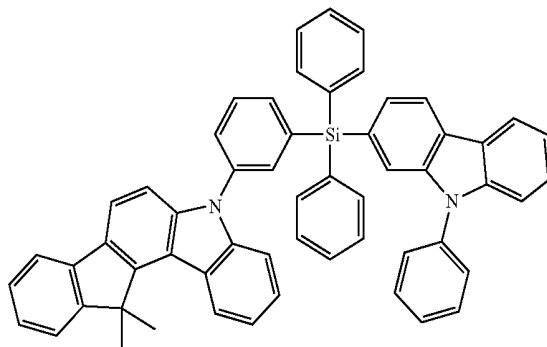
171



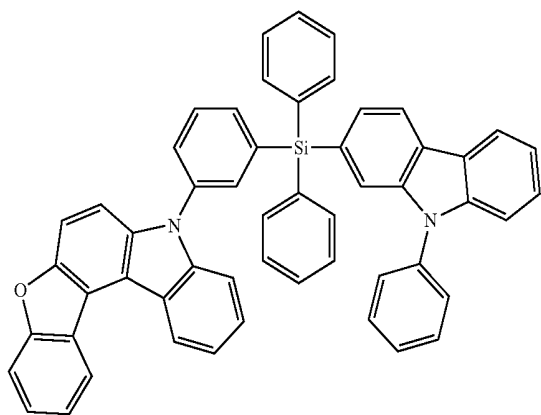
172



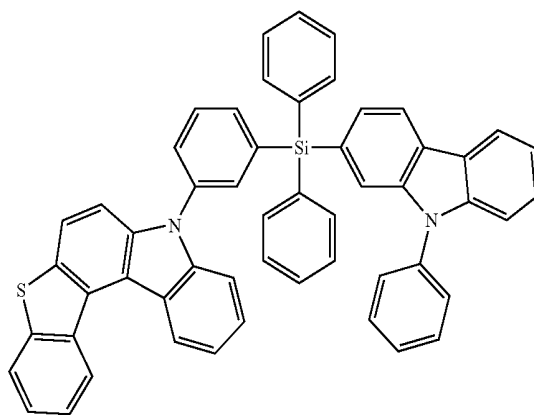
173



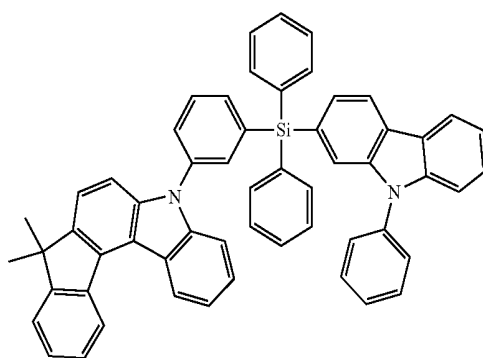
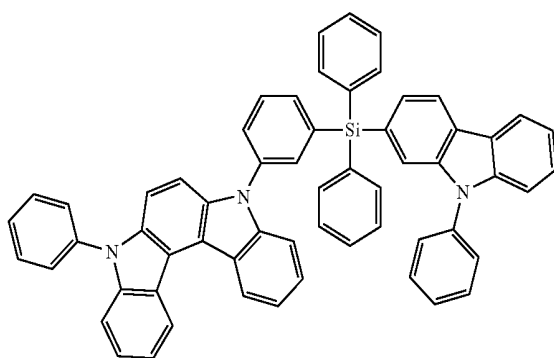
174



175



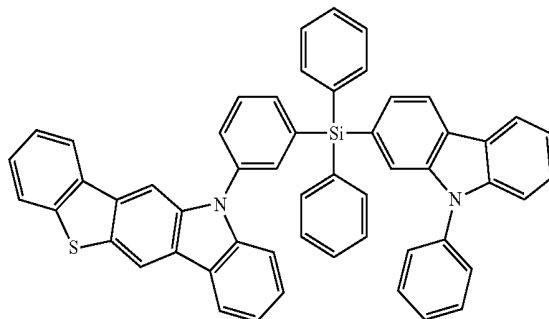
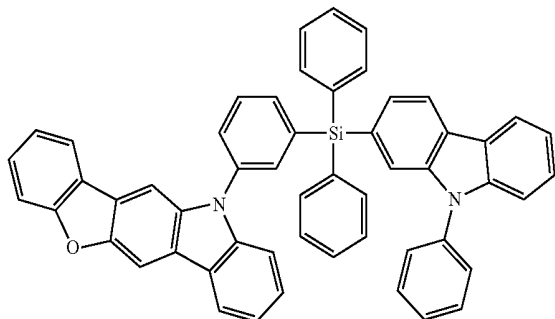
176



-continued

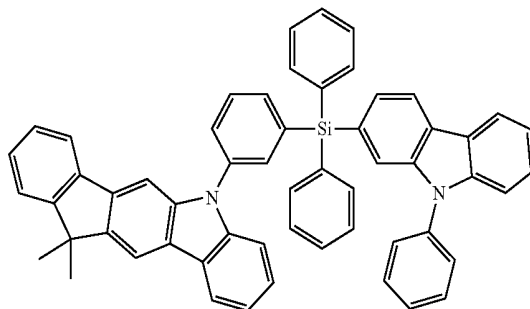
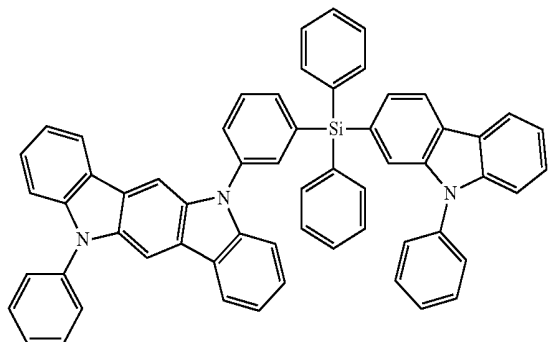
177

178



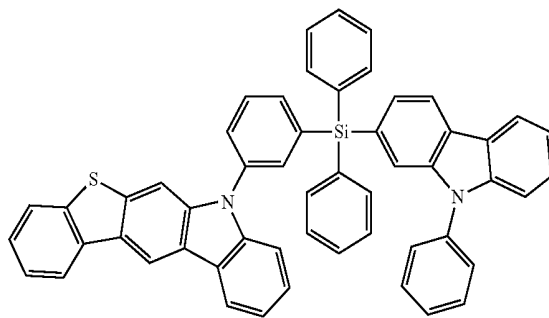
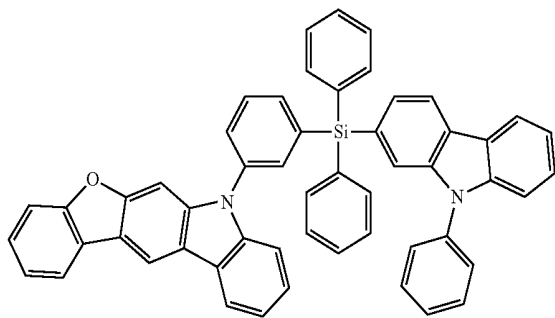
179

180



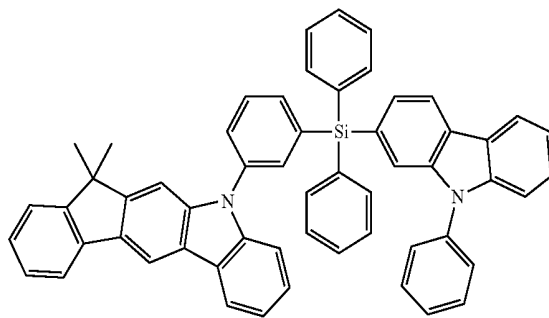
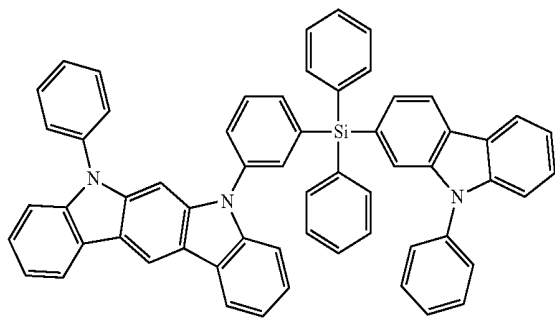
181

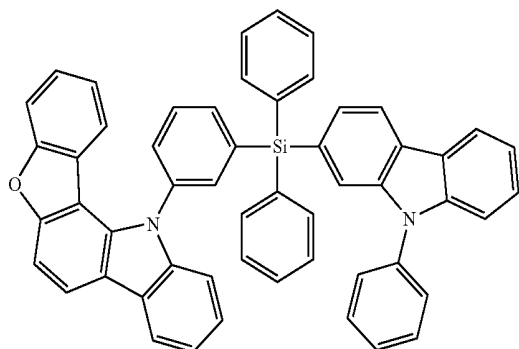
182



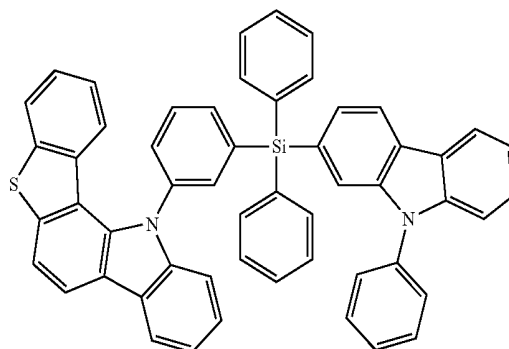
183

184



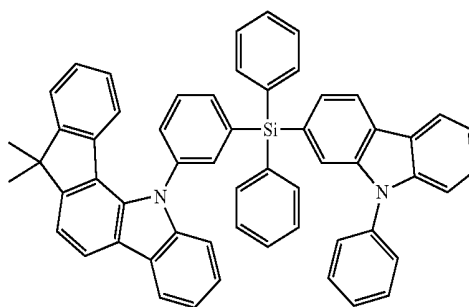
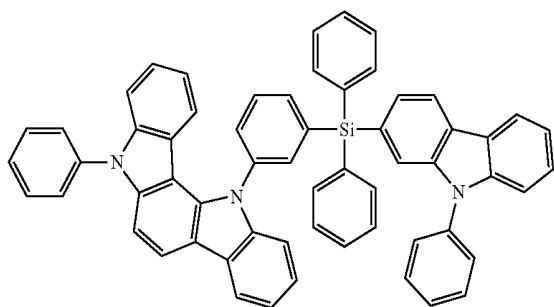
-continued
185

186



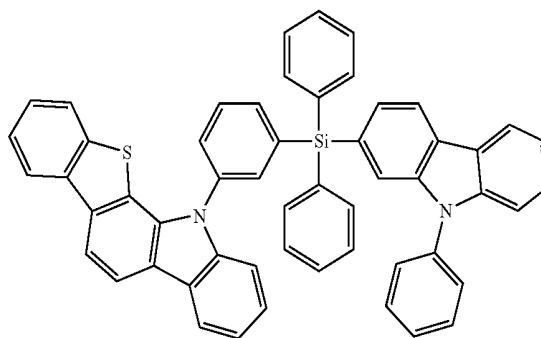
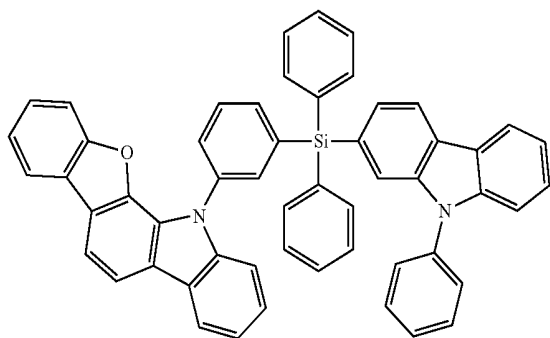
187

188



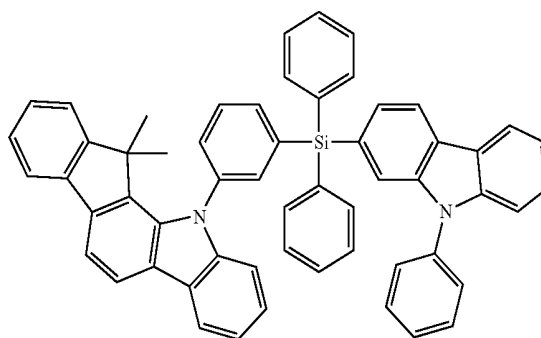
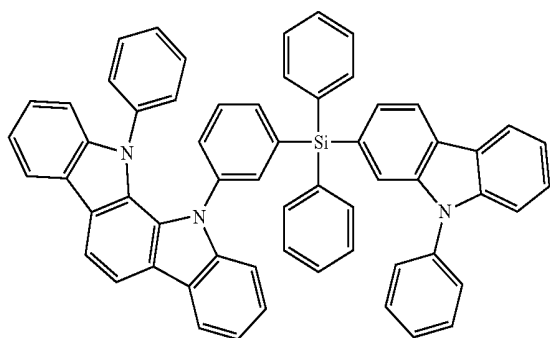
189

190



191

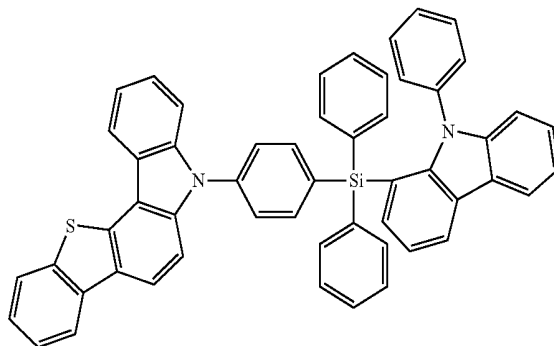
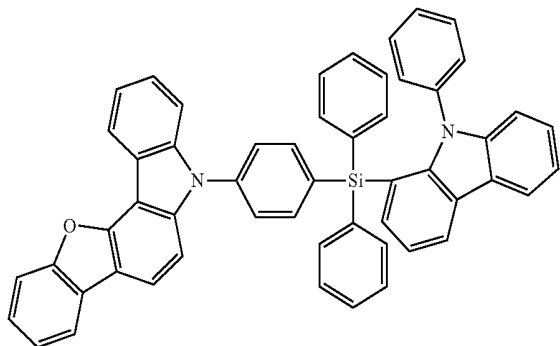
192



-continued

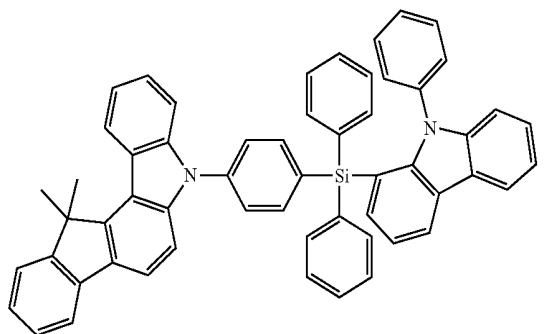
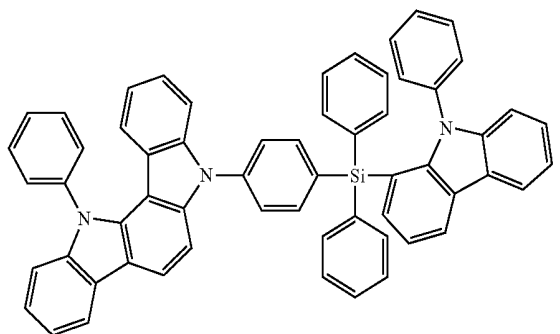
193

194



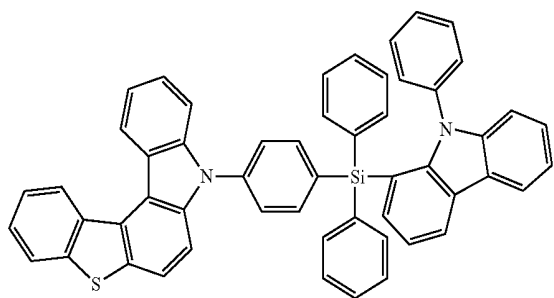
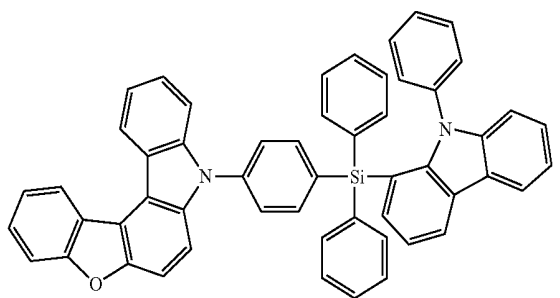
195

196



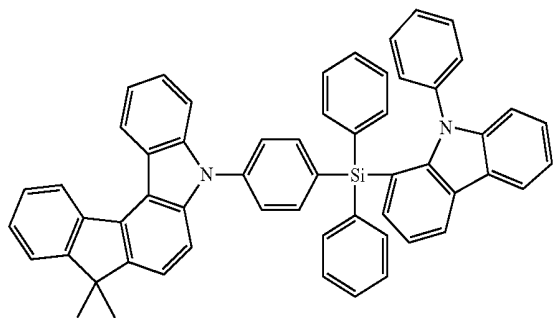
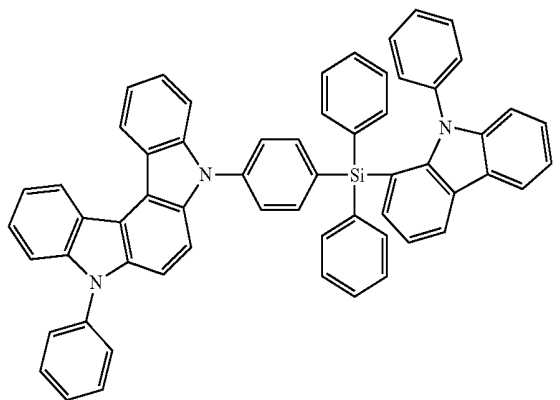
197

198

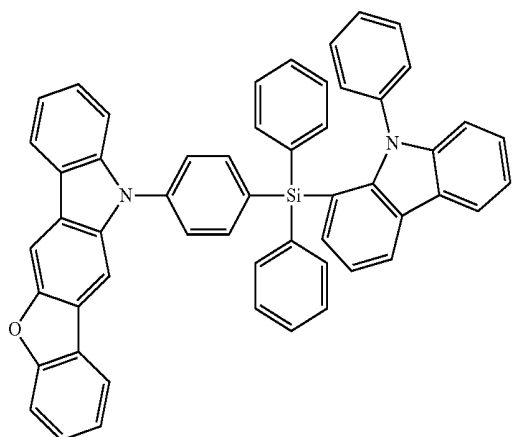


199

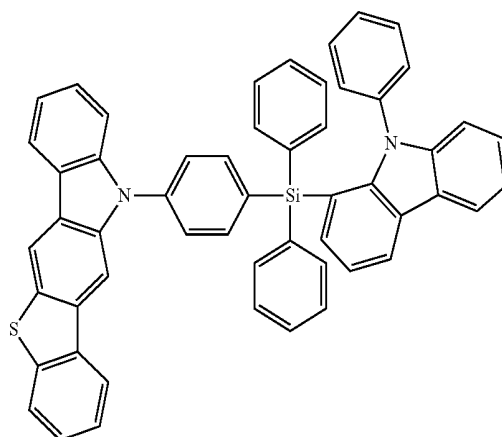
200



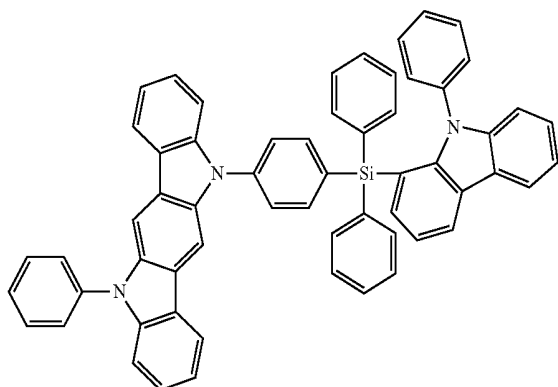
-continued
201



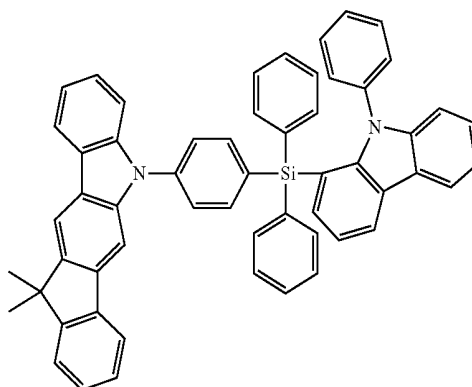
202



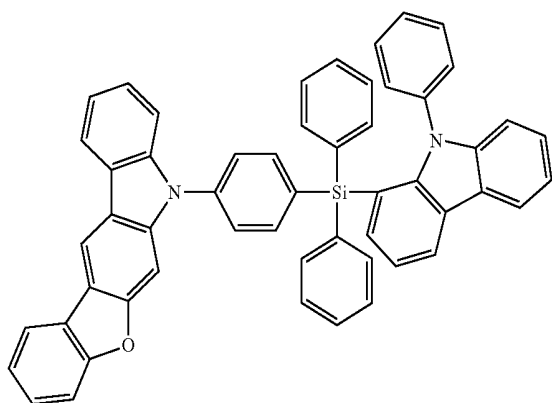
203



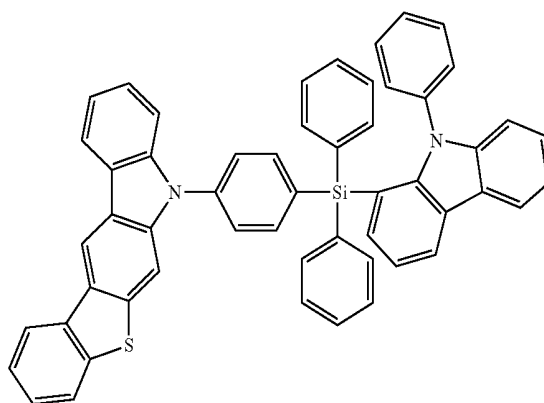
204



205

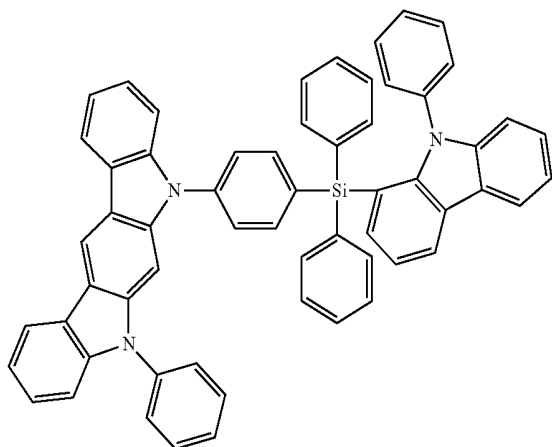


206

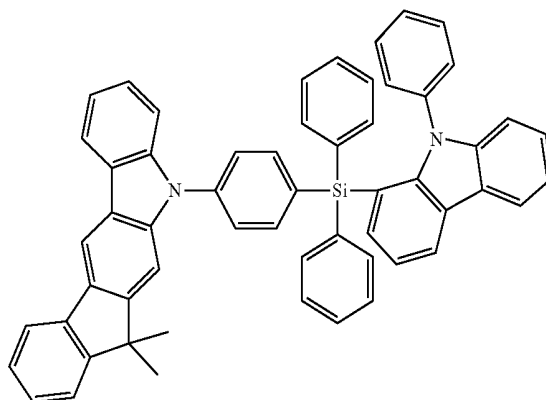


-continued

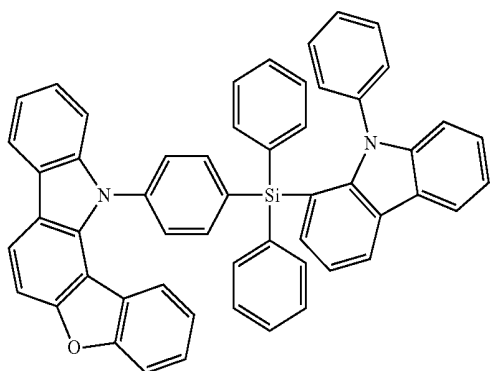
207



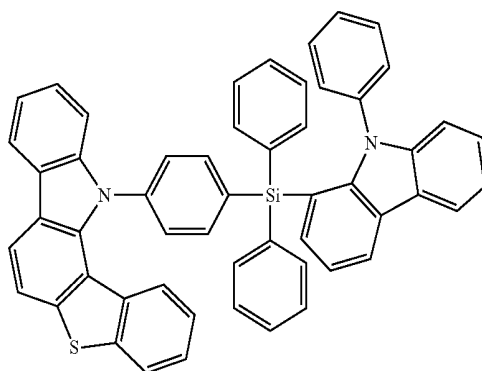
208



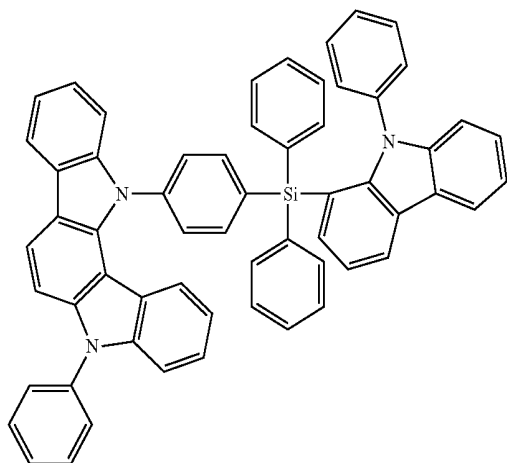
209



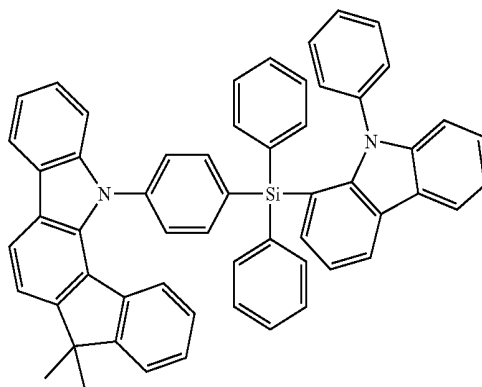
210



211



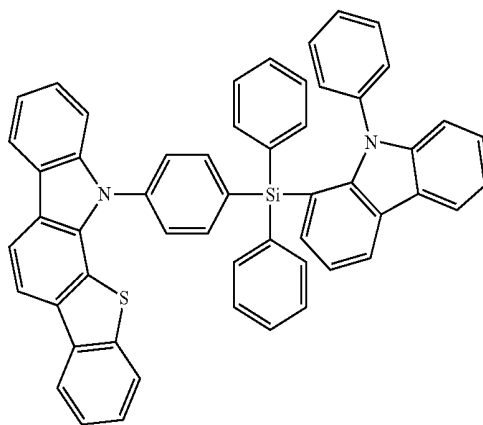
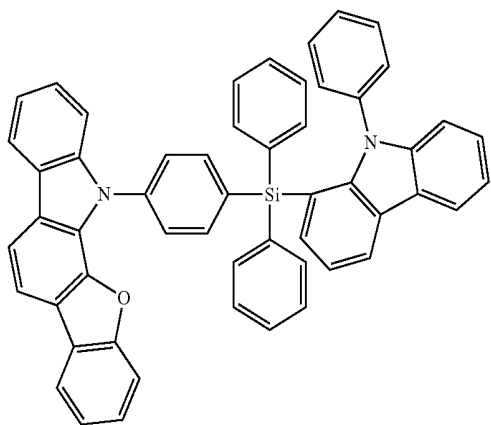
212



-continued

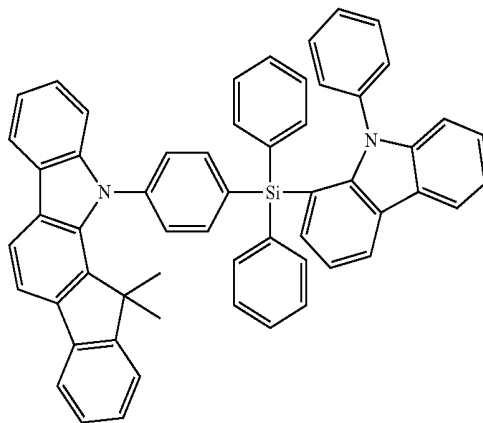
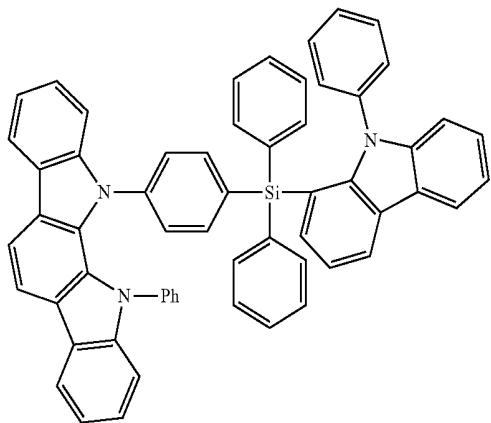
213

214



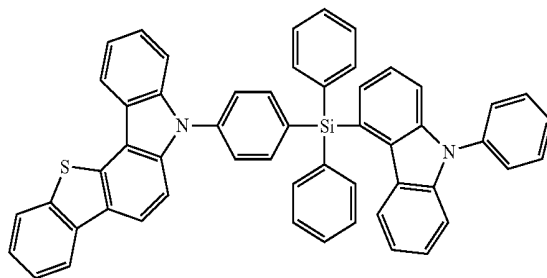
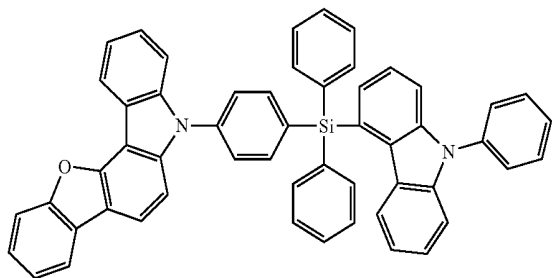
215

216



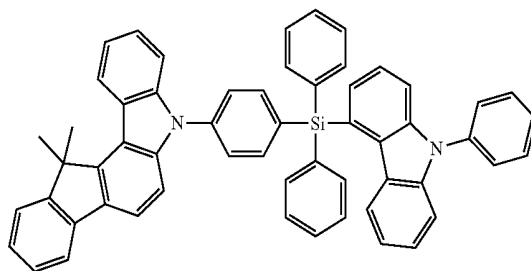
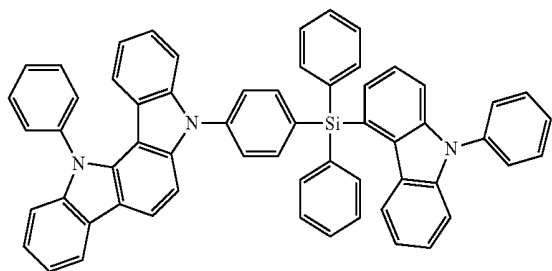
217

218



219

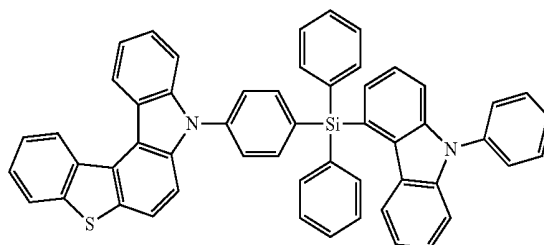
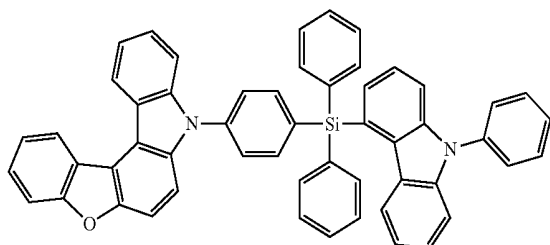
220



-continued

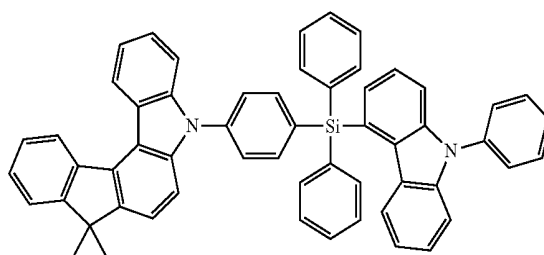
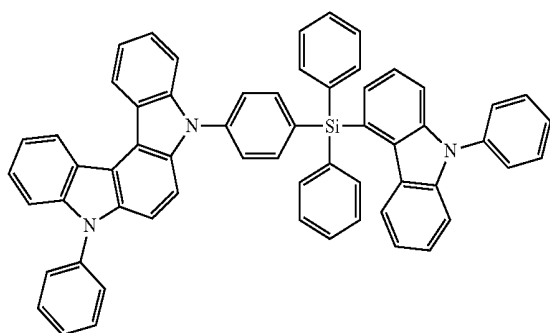
221

222



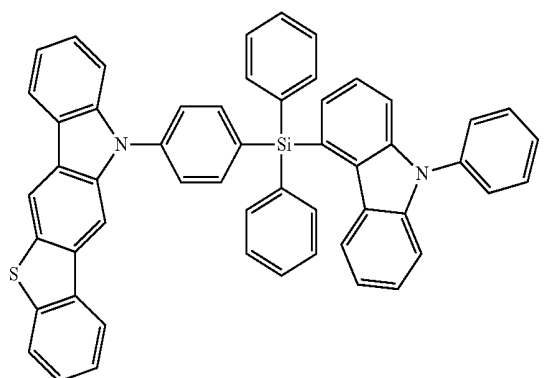
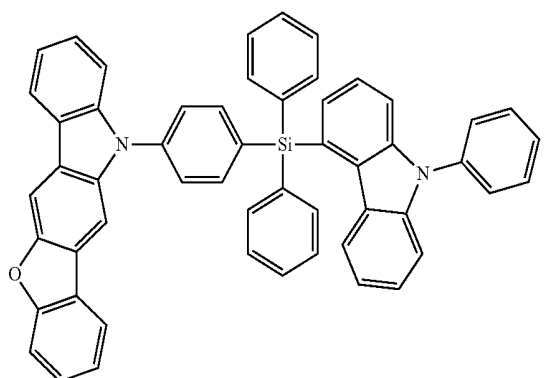
223

224



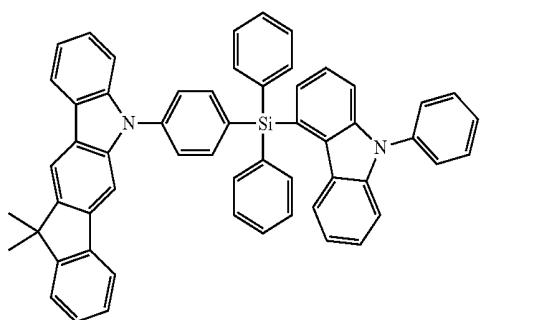
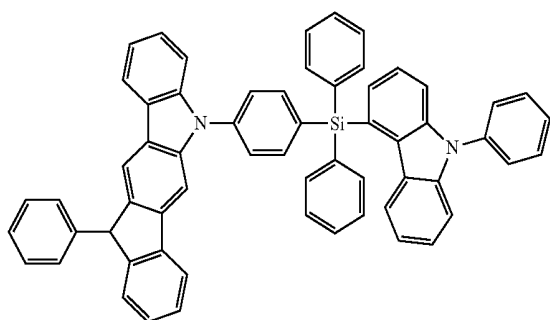
225

226



227

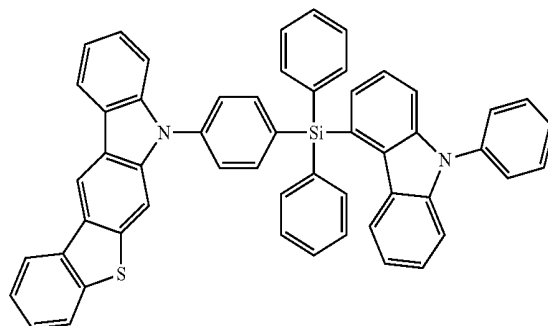
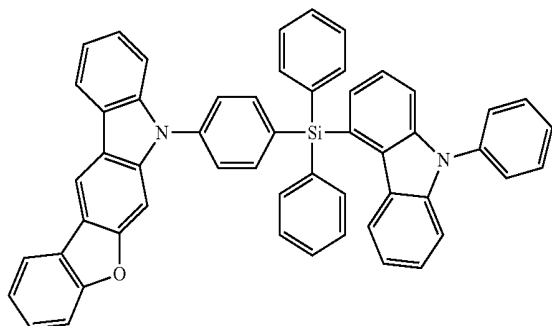
228



-continued

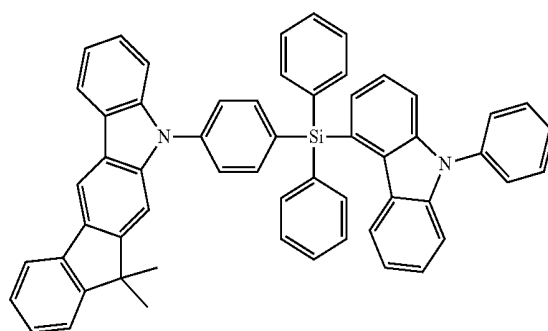
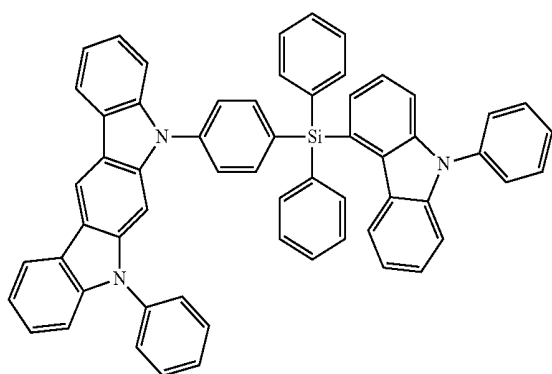
229

230



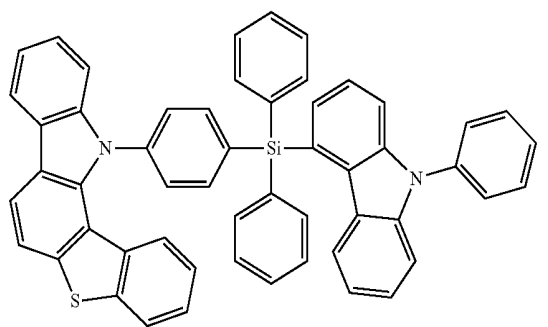
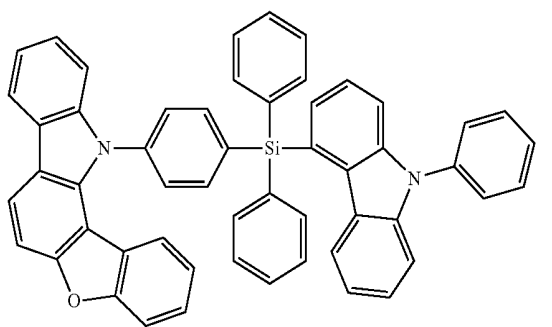
231

232



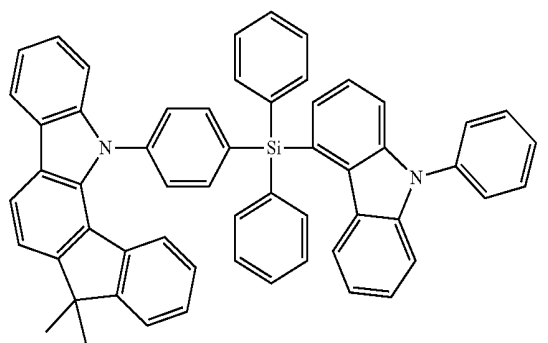
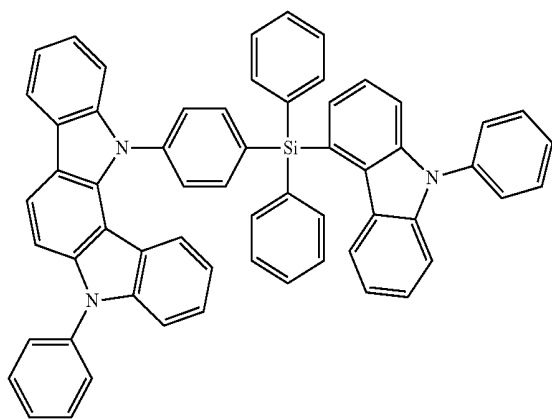
233

234



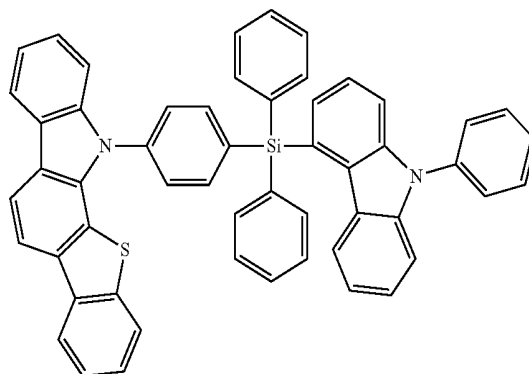
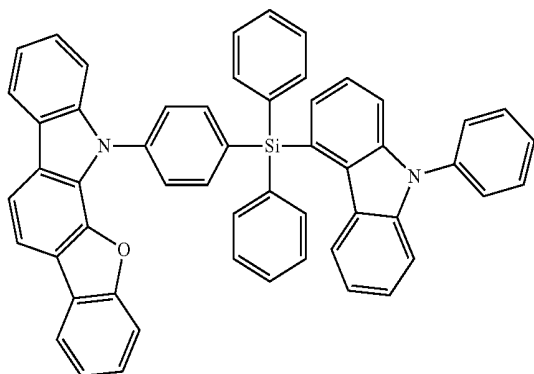
235

236



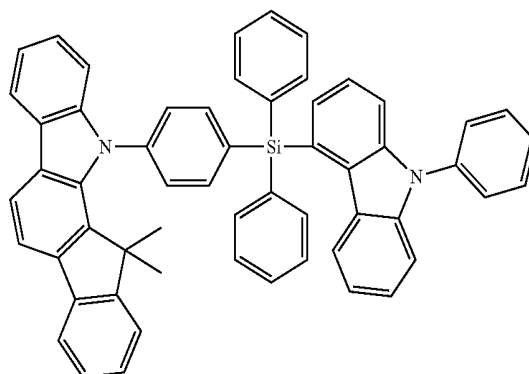
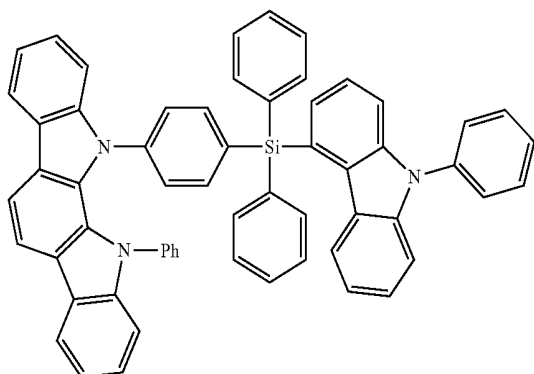
-continued
237

238



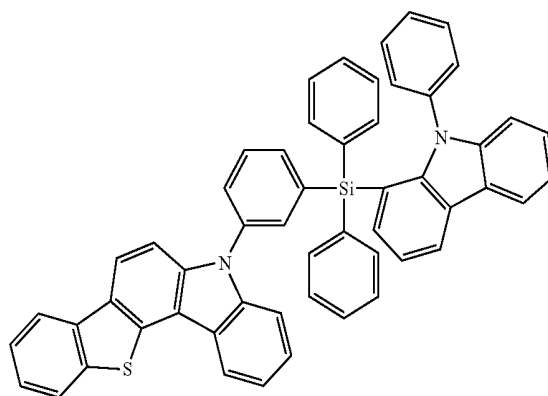
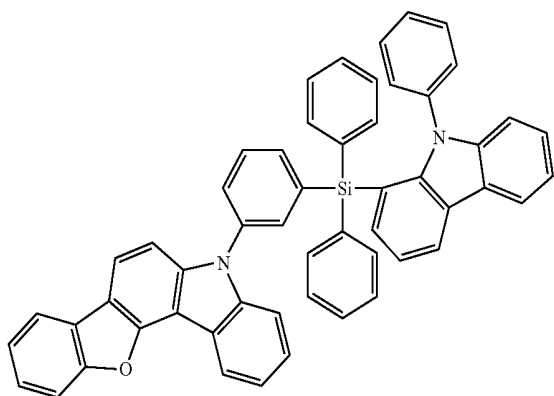
239

240



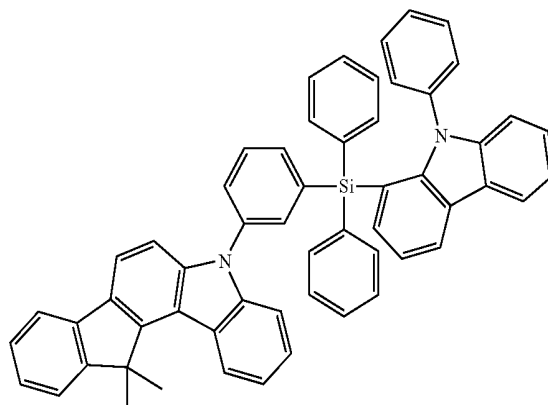
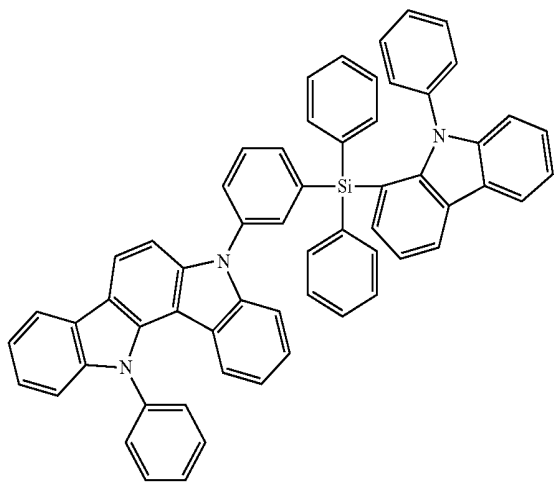
241

242



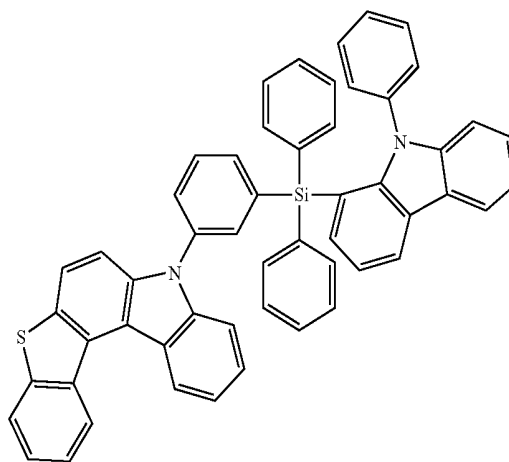
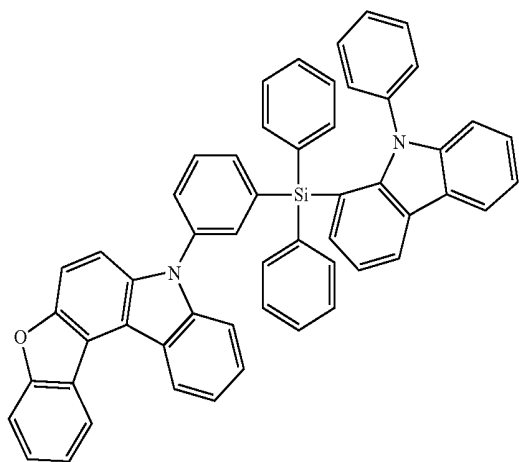
243

244



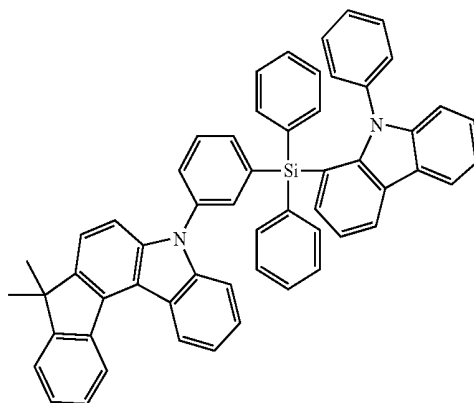
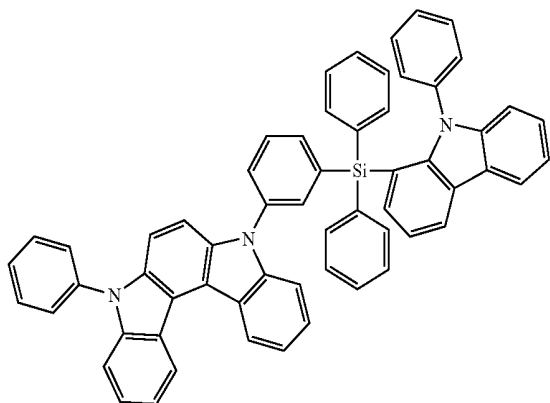
-continued
245

246



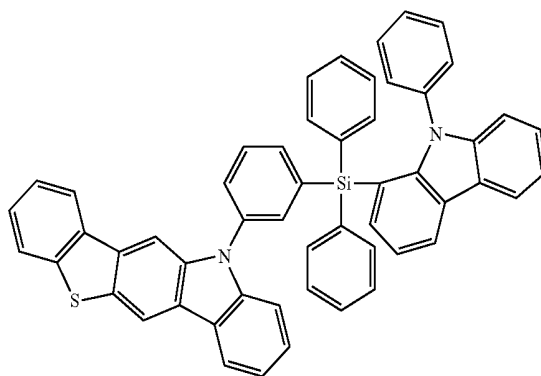
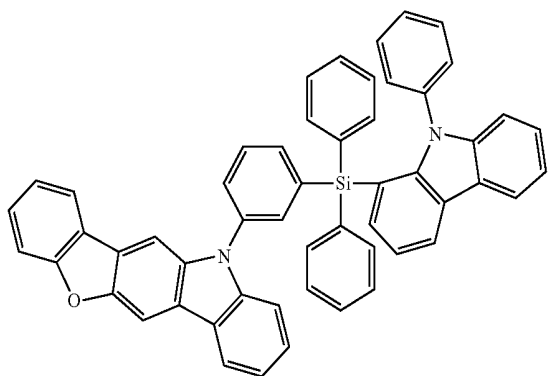
247

248



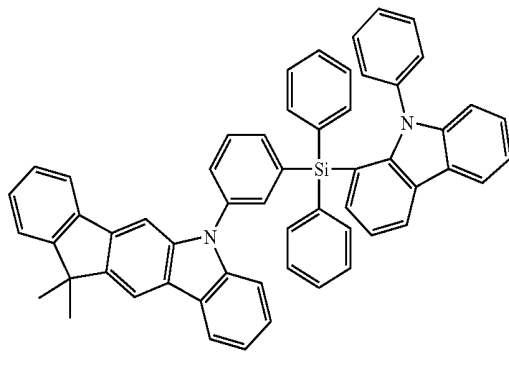
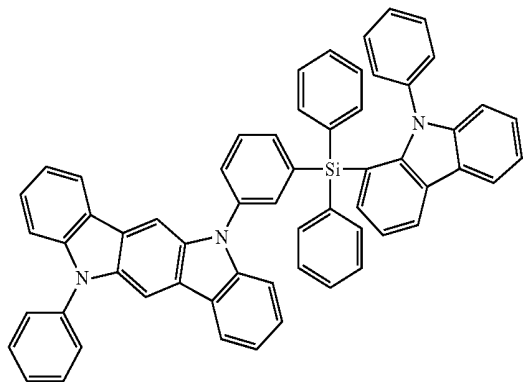
249

250



251

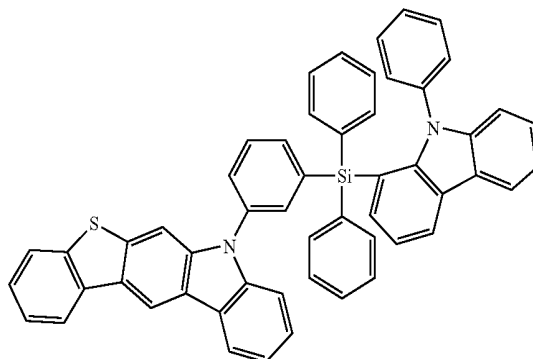
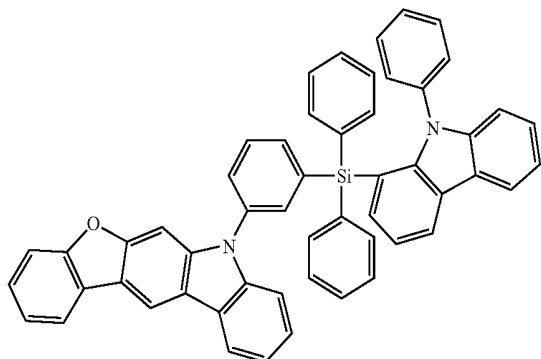
252



-continued

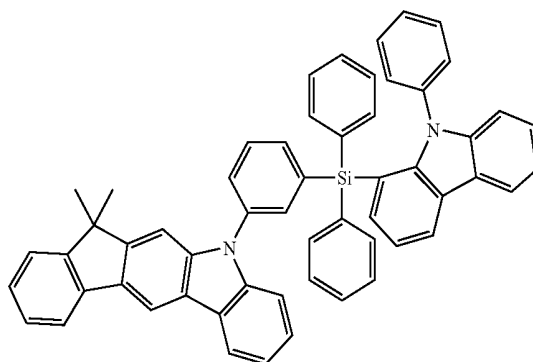
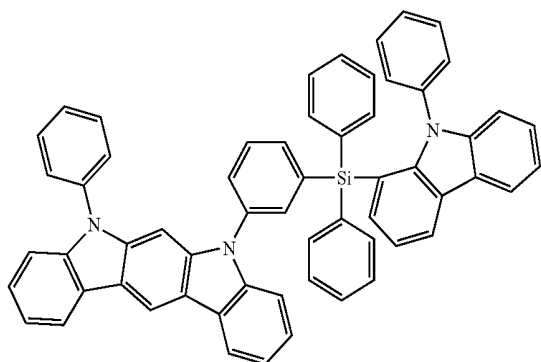
253

254



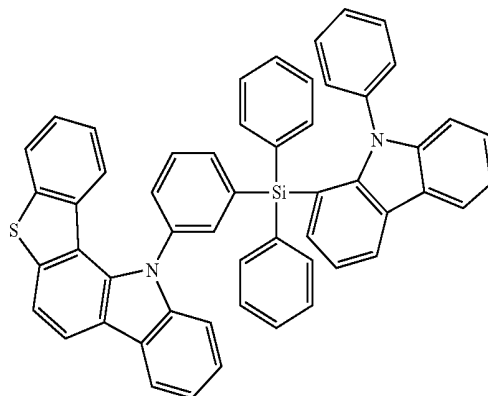
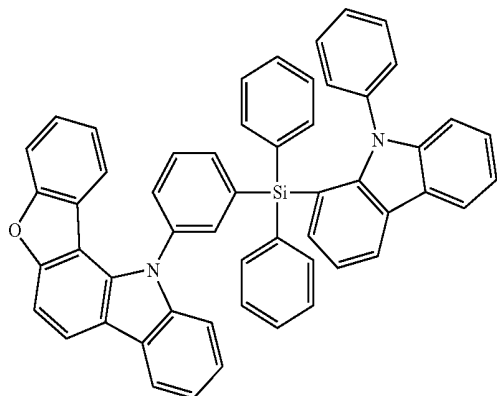
255

256



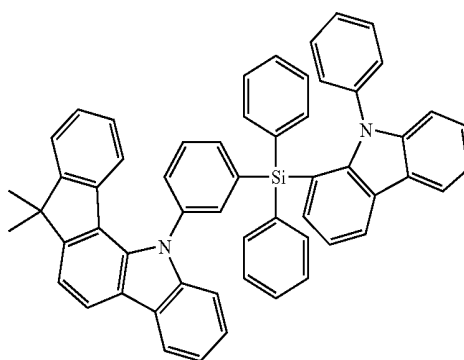
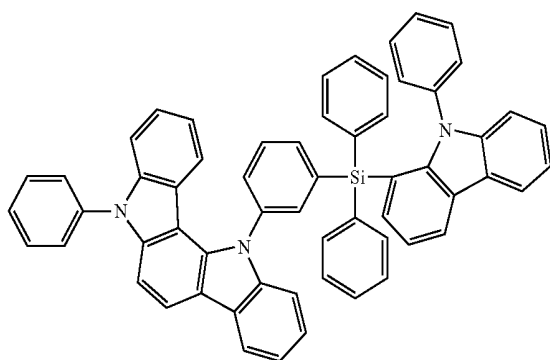
257

258



259

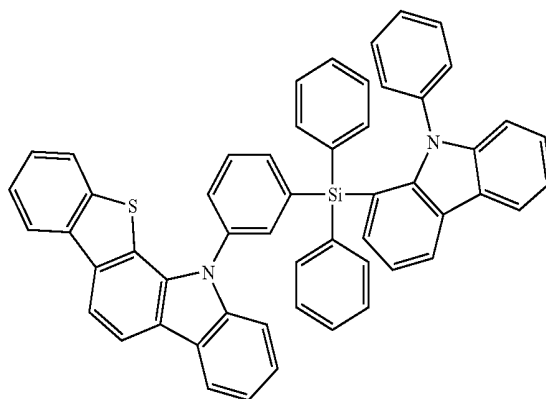
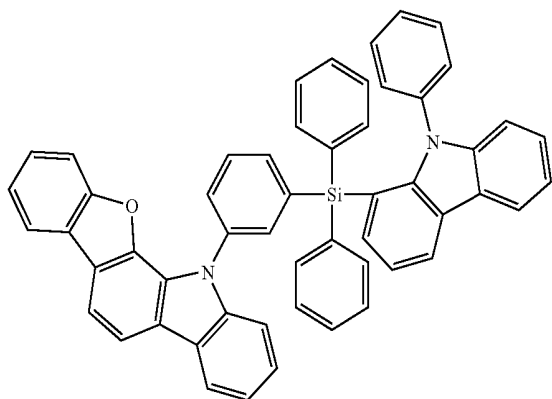
260



-continued

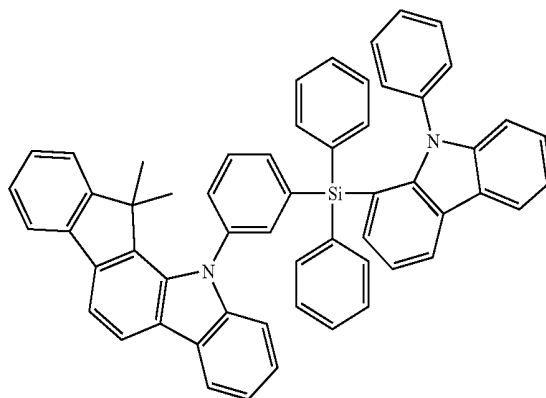
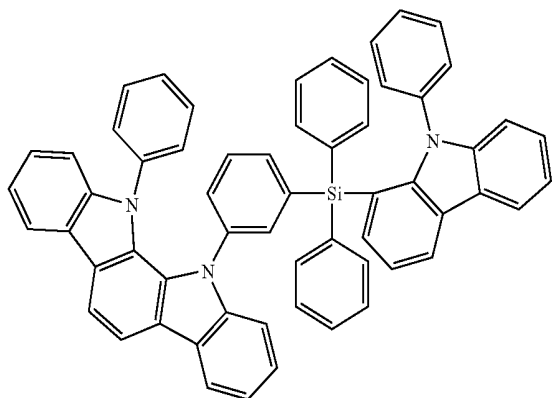
261

262



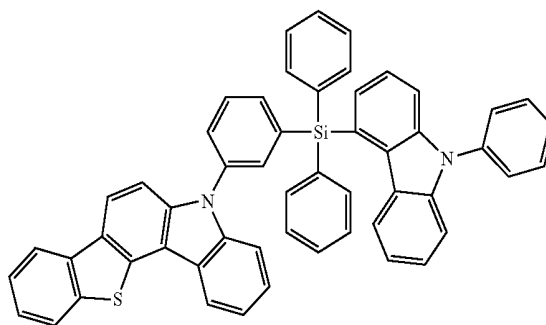
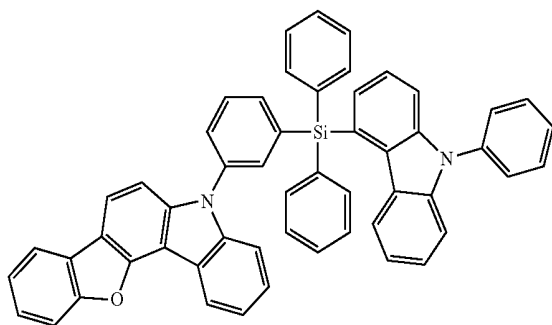
263

264



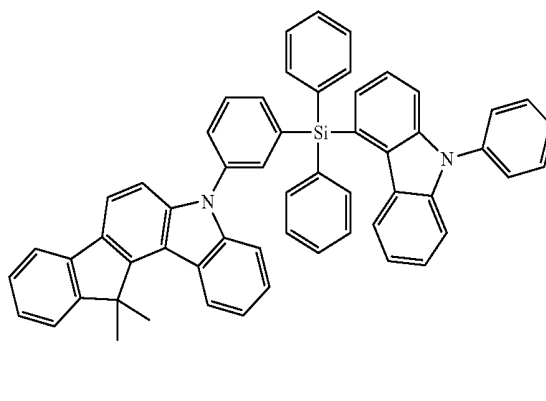
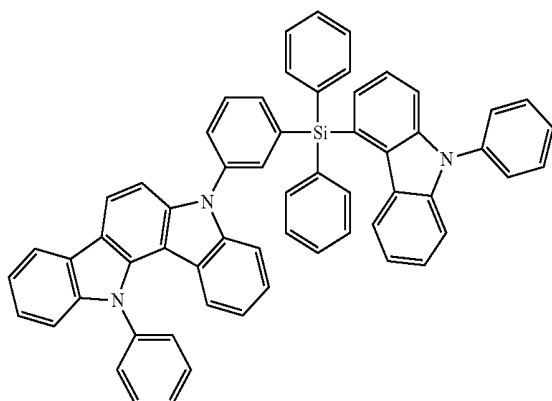
265

266



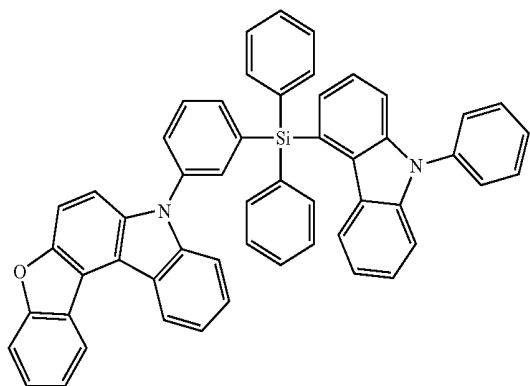
267

268

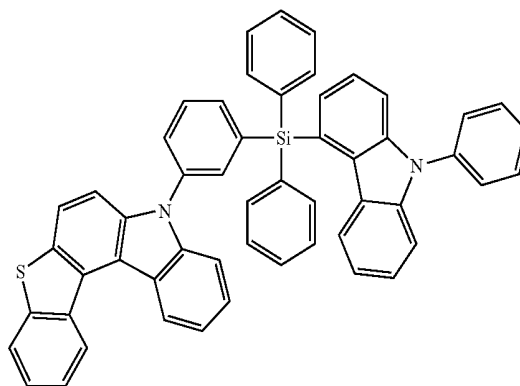


-continued

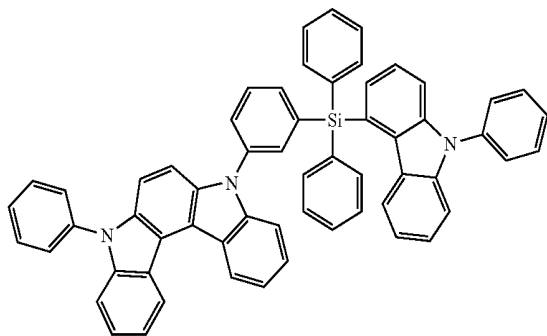
269



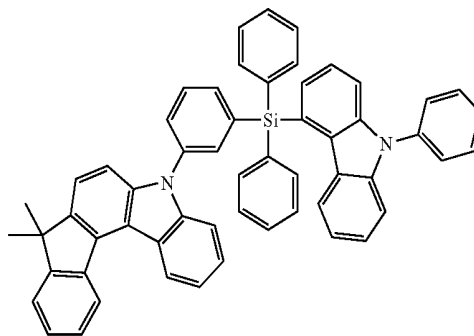
270



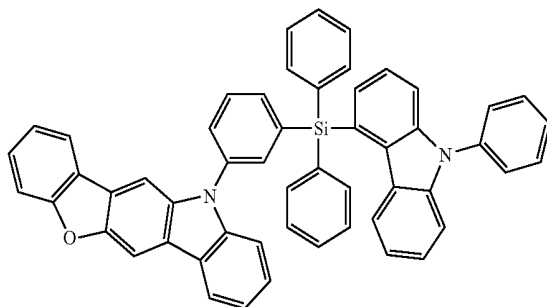
271



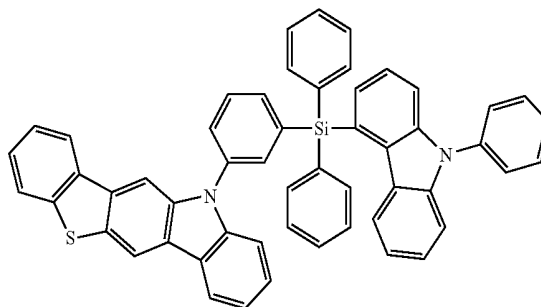
272



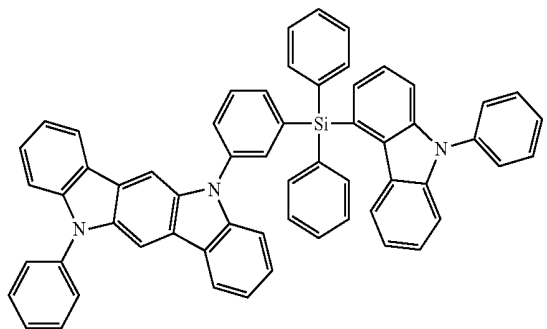
273



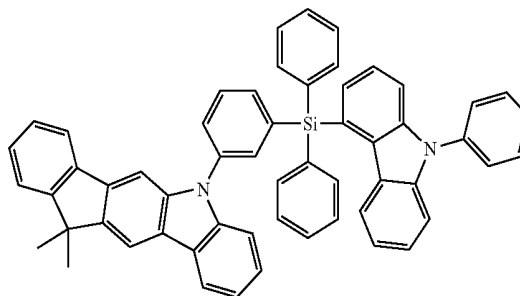
274



275



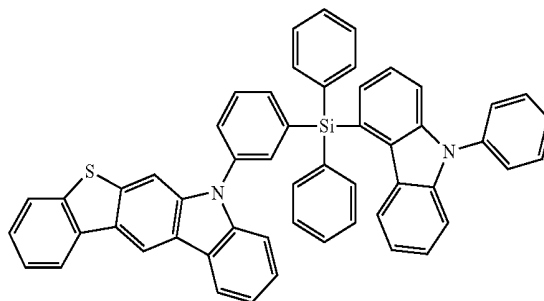
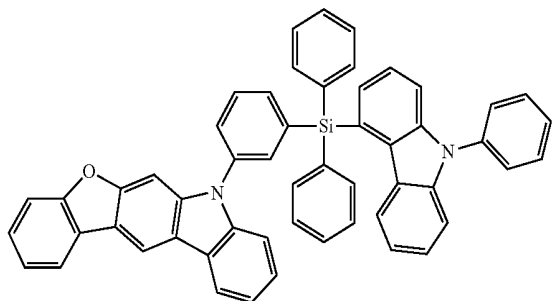
276



-continued

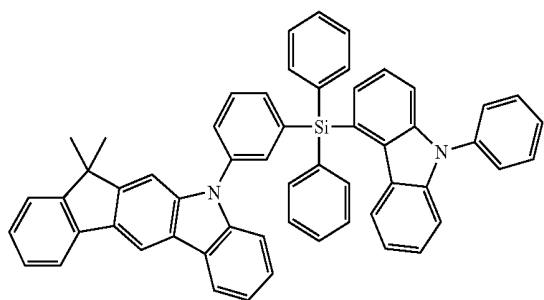
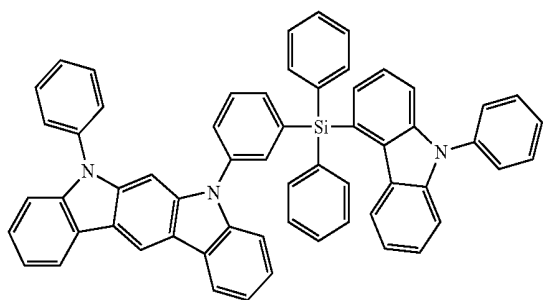
277

278



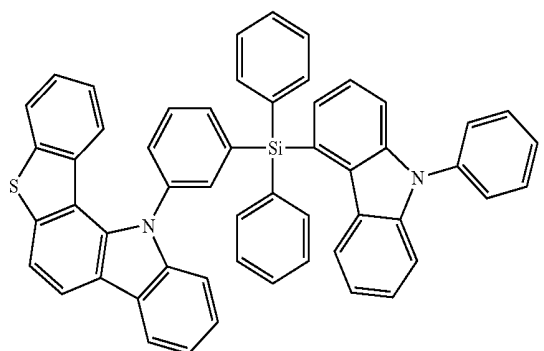
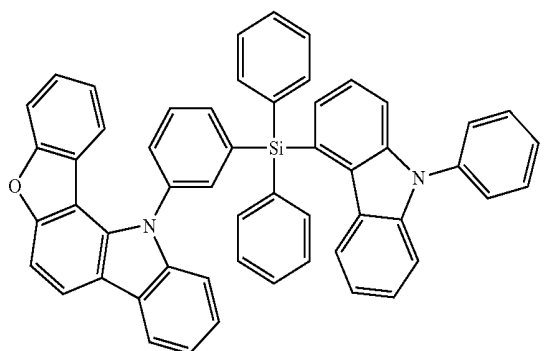
279

280



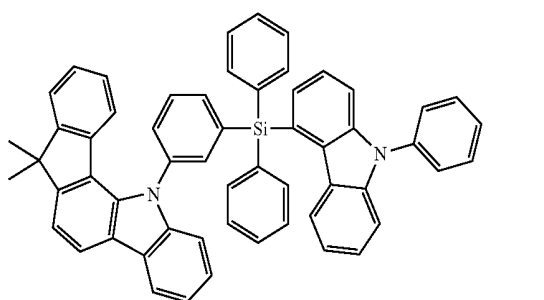
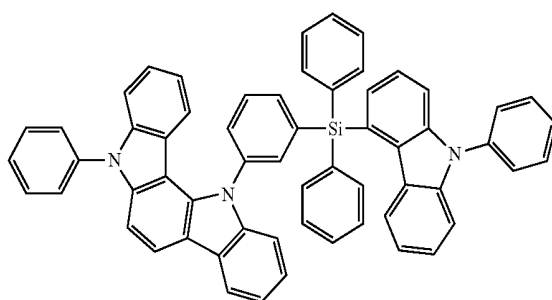
281

282



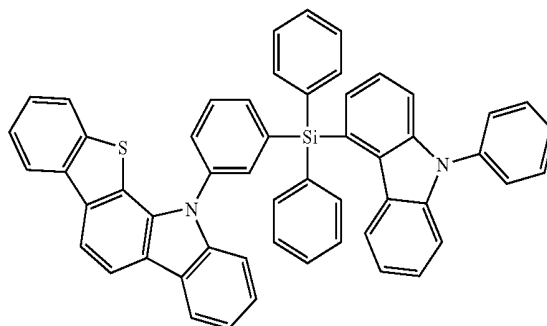
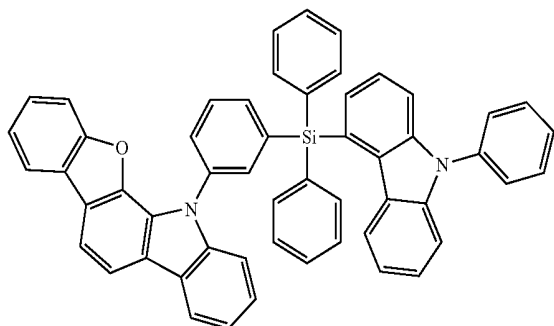
283

284



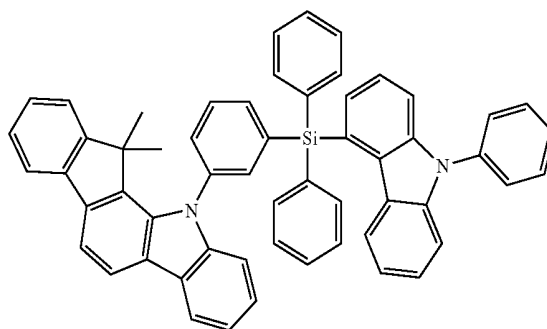
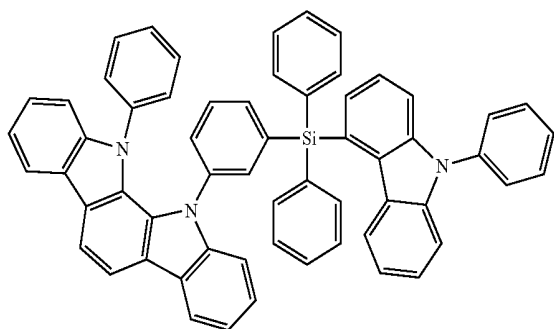
-continued
285

286

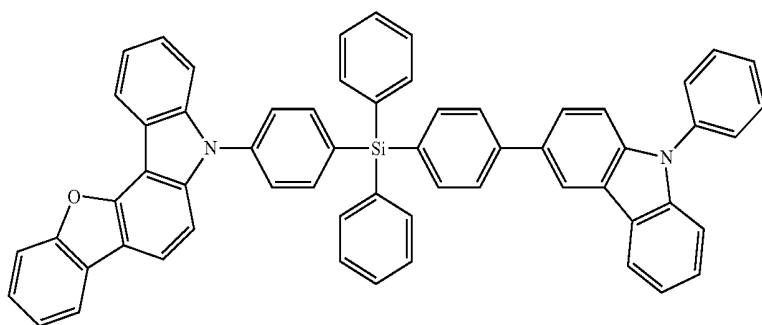


287

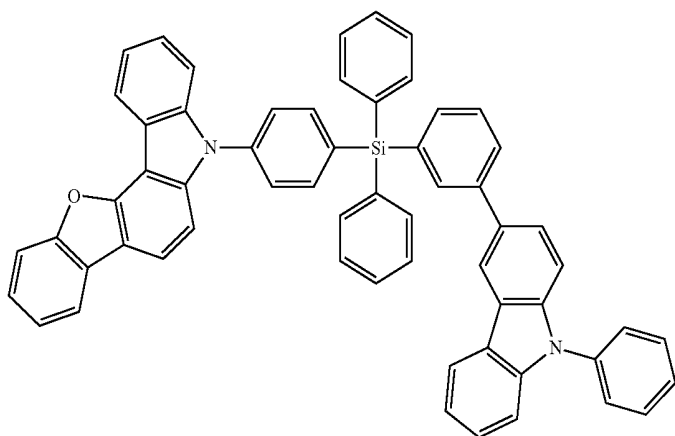
288



289

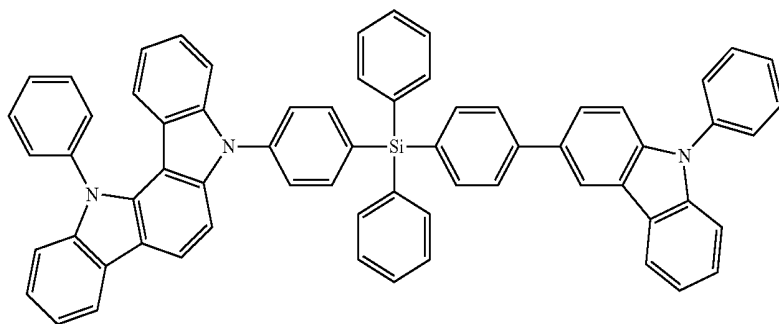


290

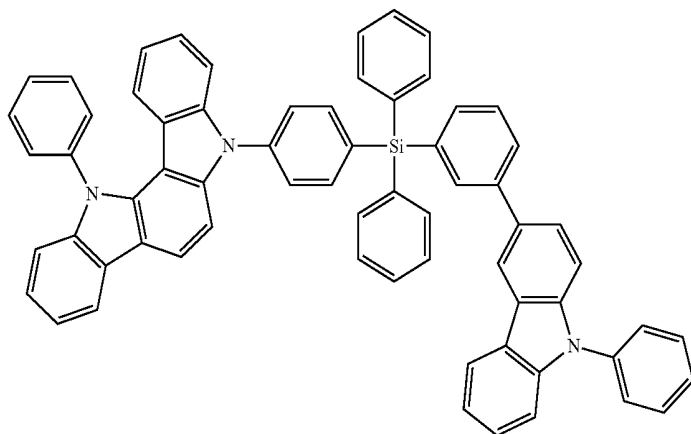


-continued

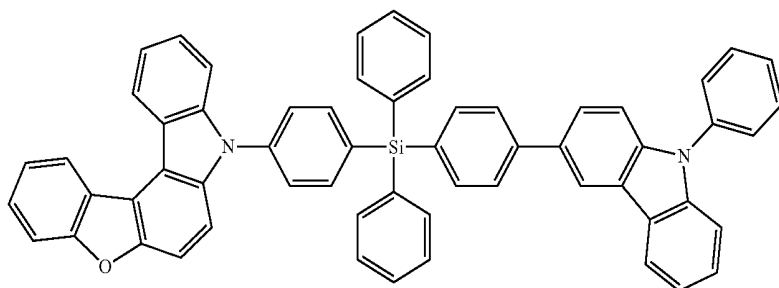
291



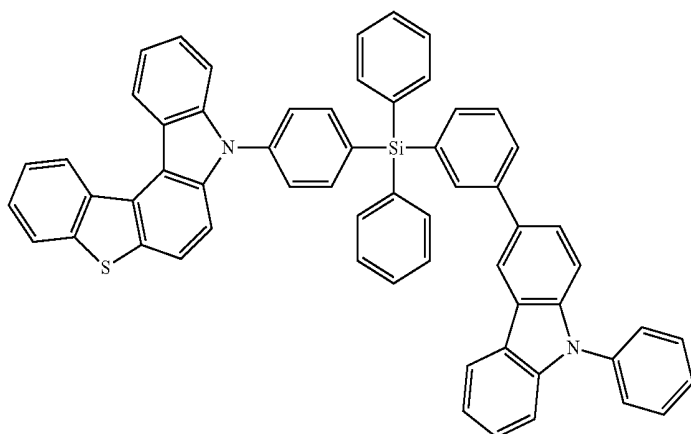
292



293

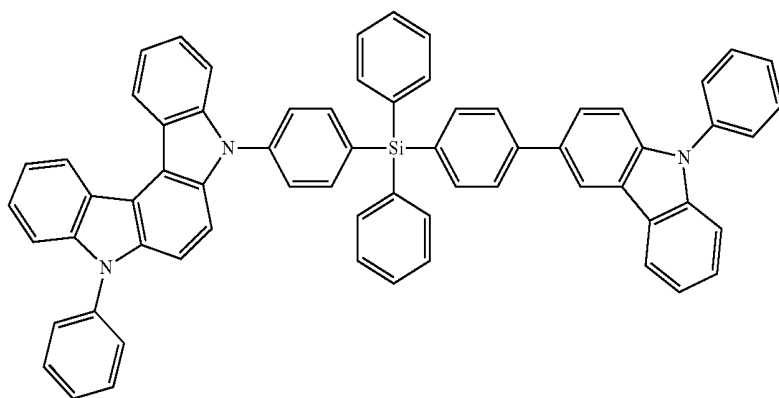


294

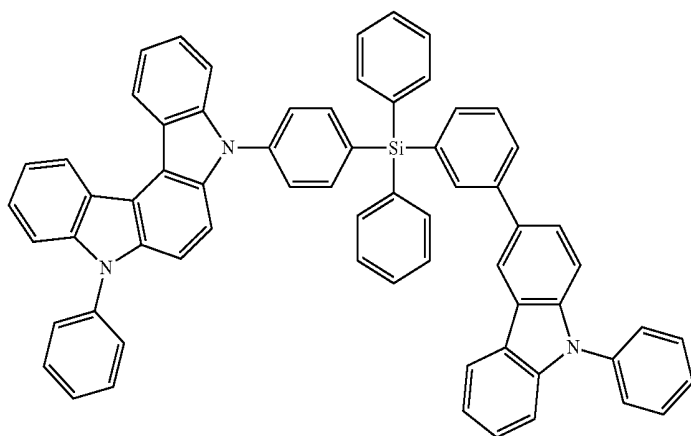


-continued

295

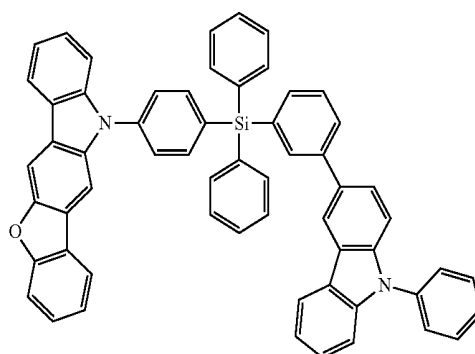
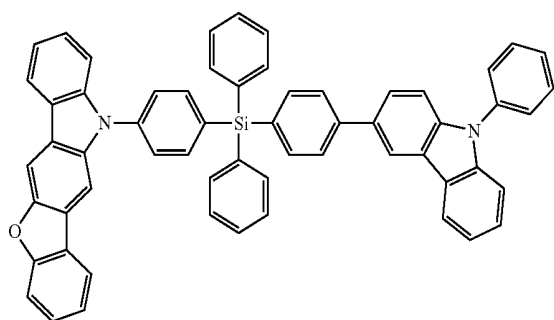


296

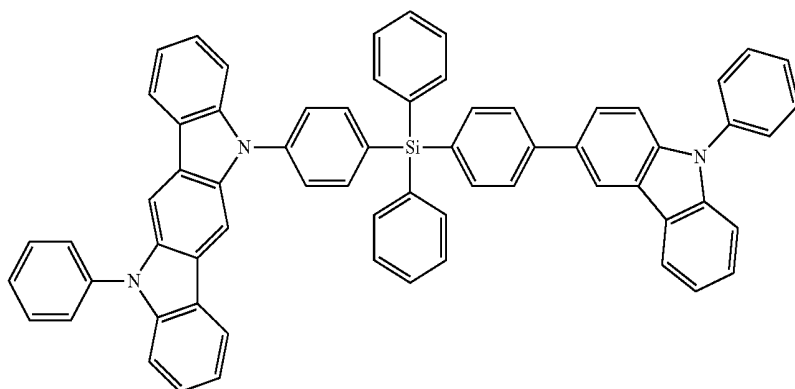


297

298

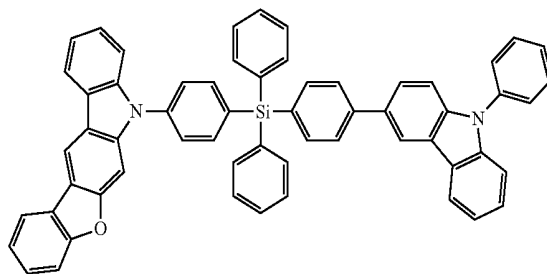
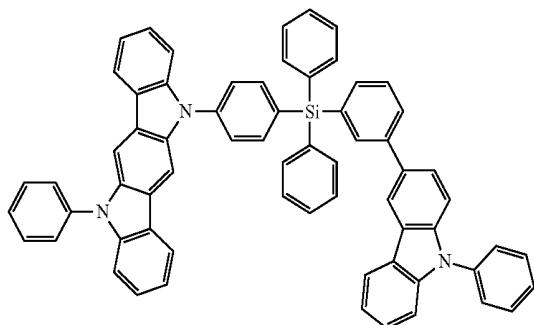


299



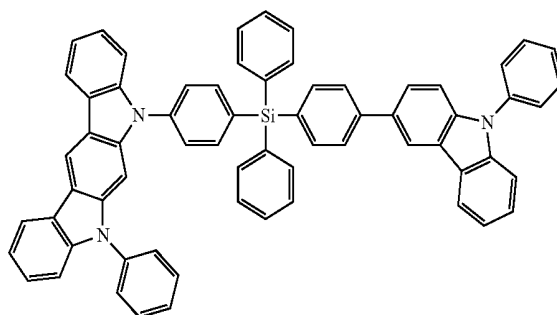
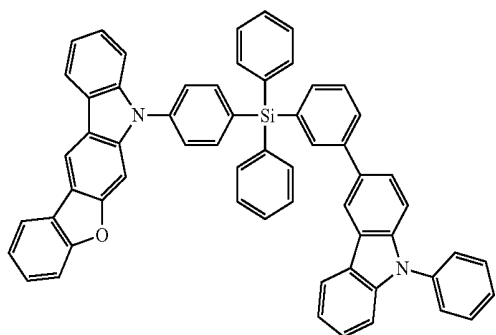
-continued
300

301



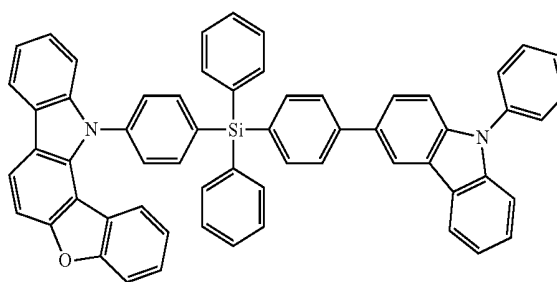
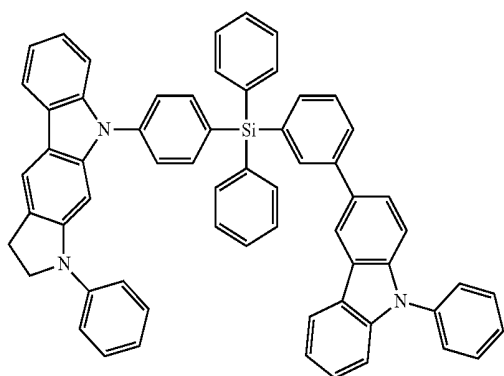
302

303



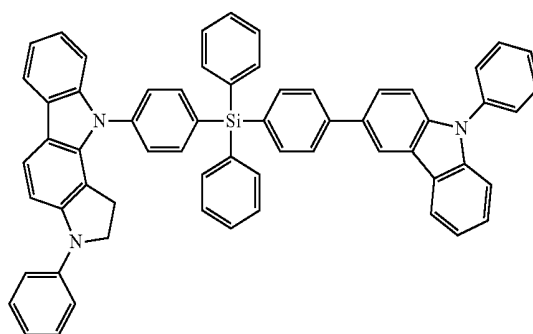
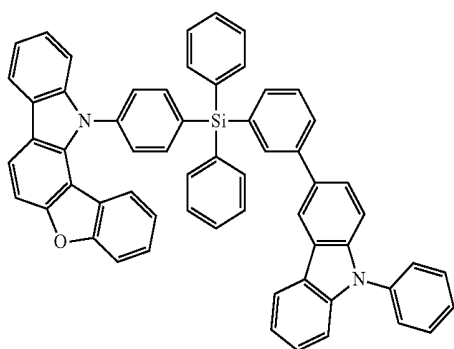
304

305



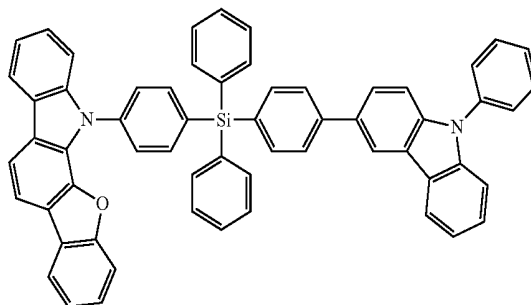
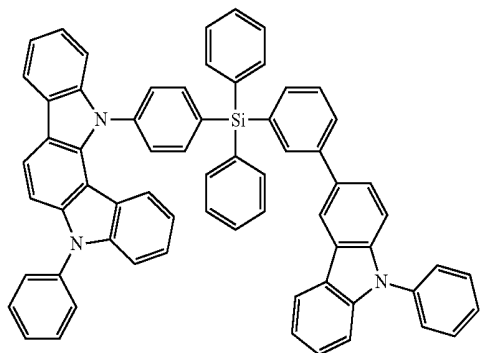
306

307



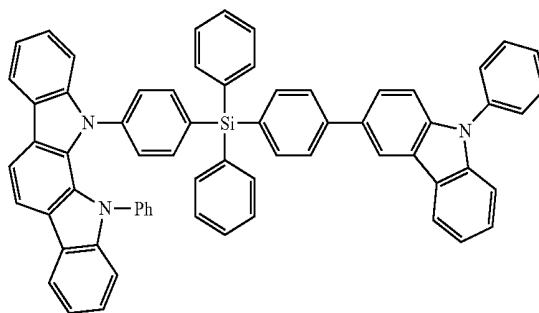
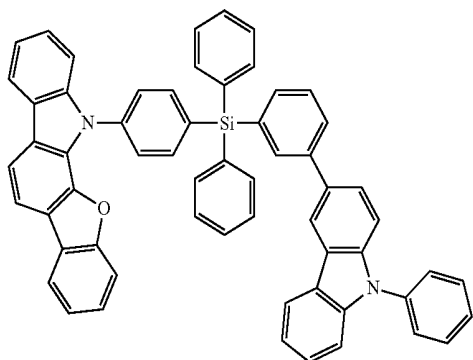
-continued
308

309



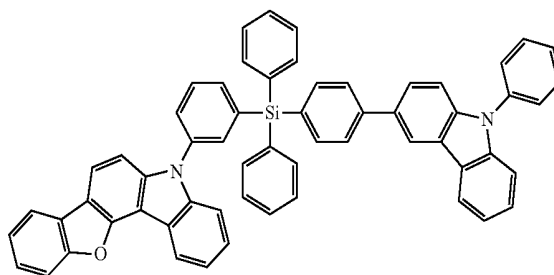
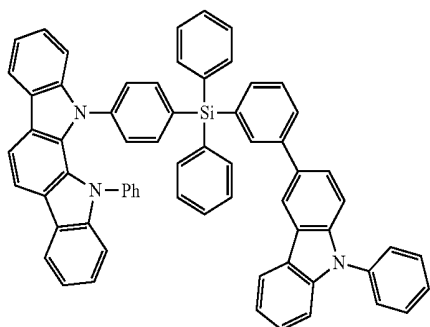
310

311



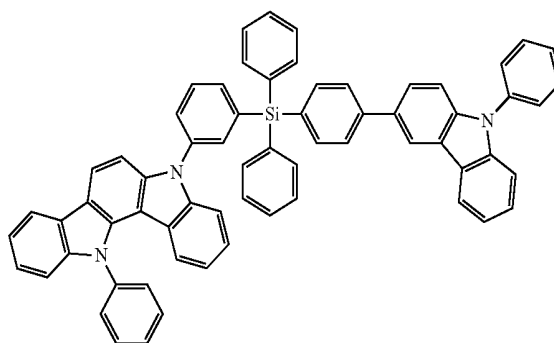
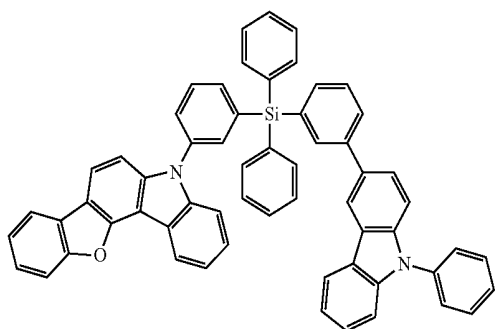
312

313



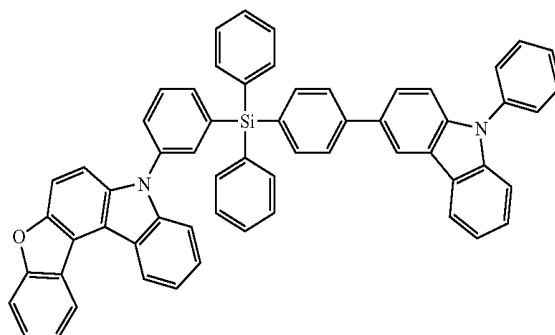
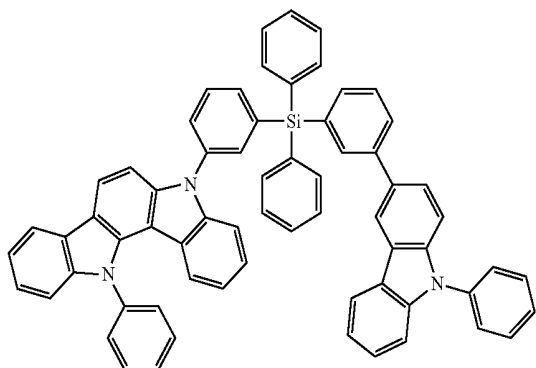
314

315

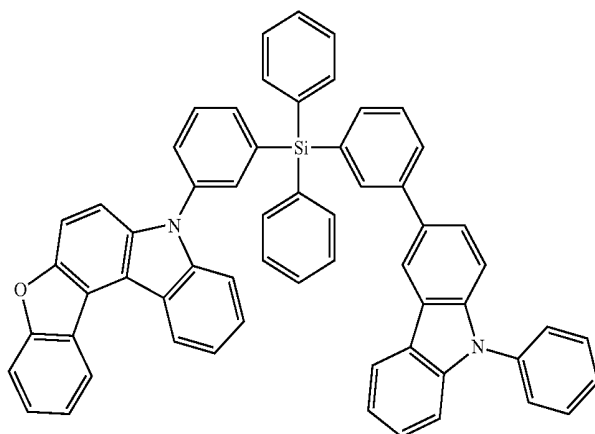


-continued
316

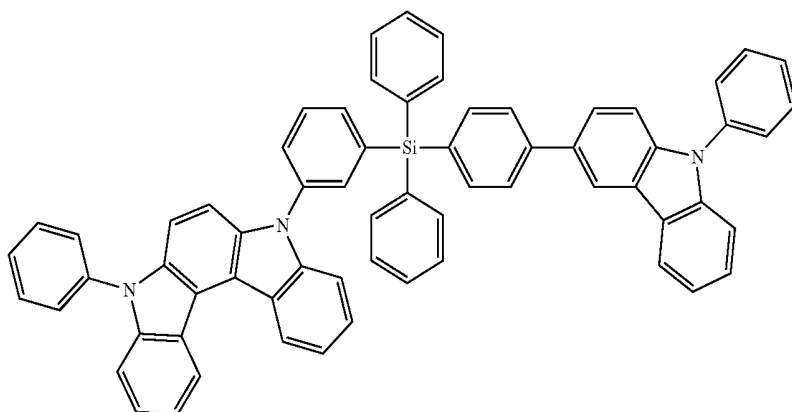
317



318

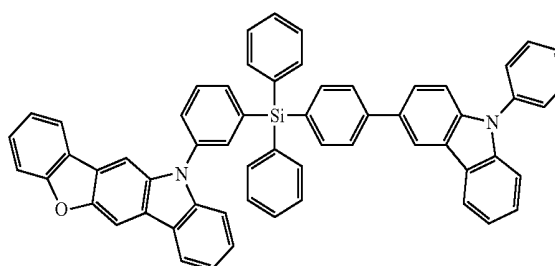
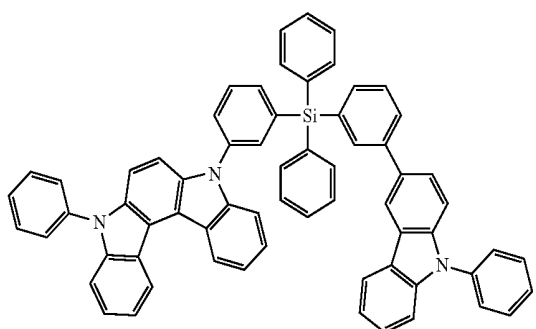


319



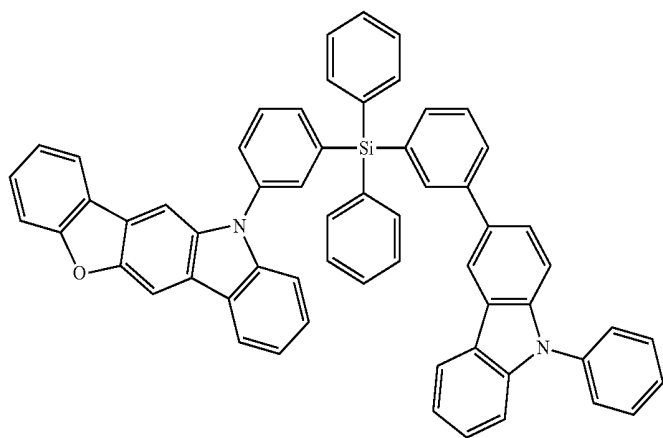
320

321

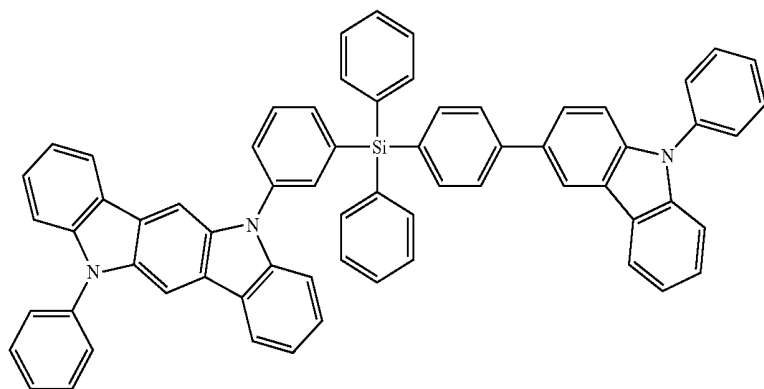


-continued

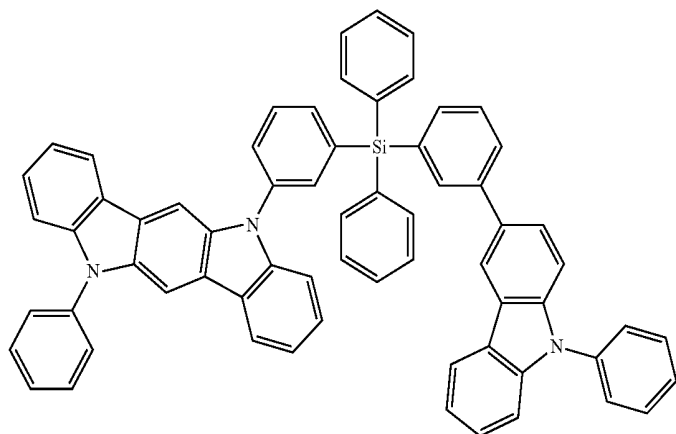
322



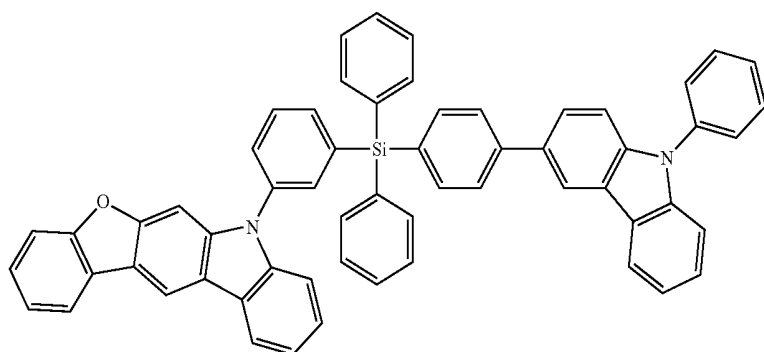
323



324

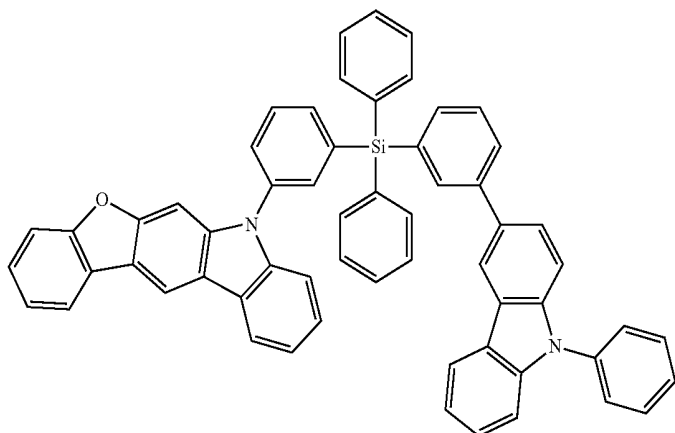


325

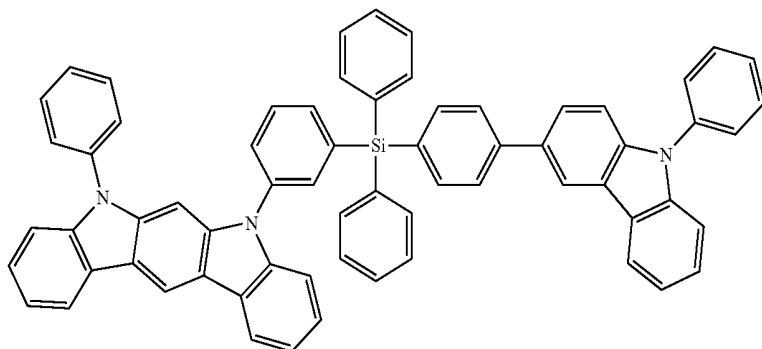


-continued

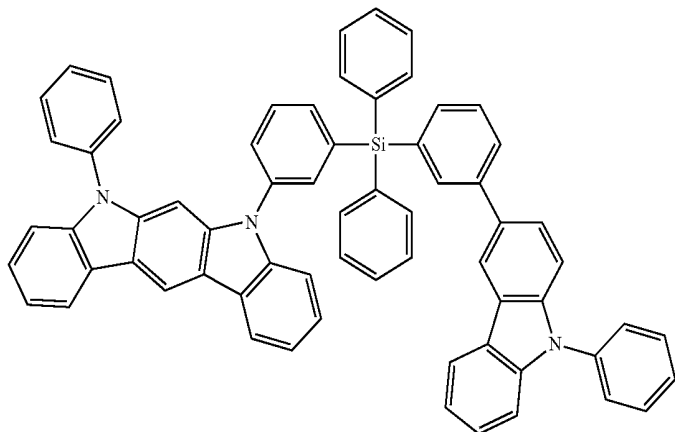
326



327

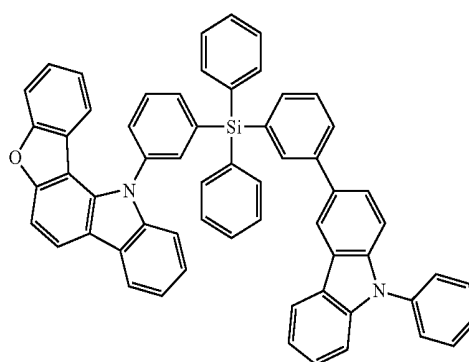
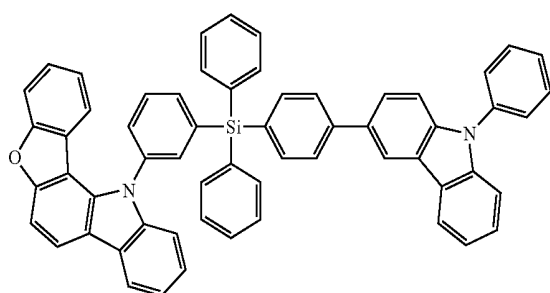


328



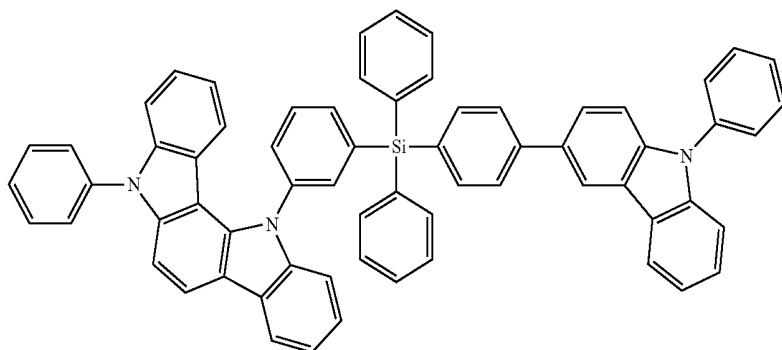
329

330

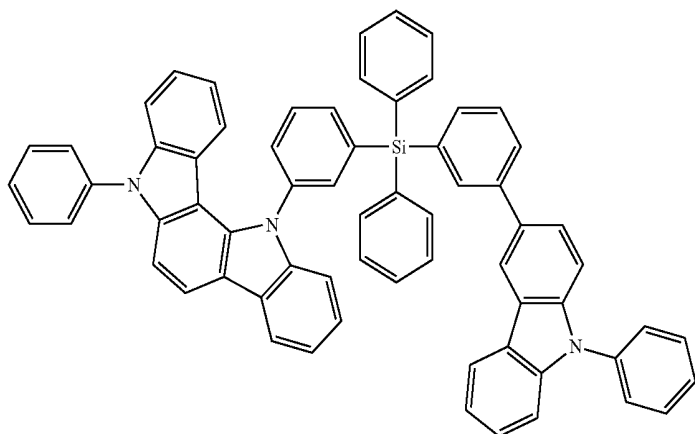


-continued

331

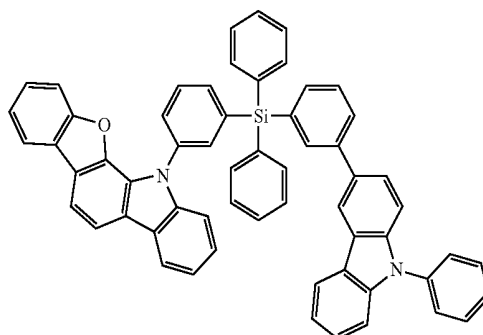
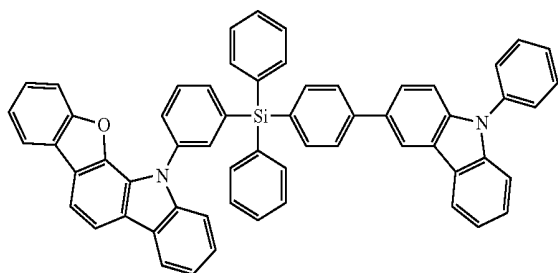


332



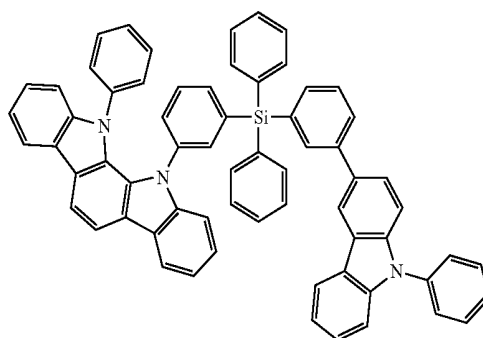
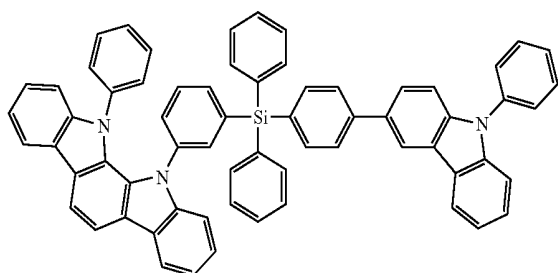
333

334



335

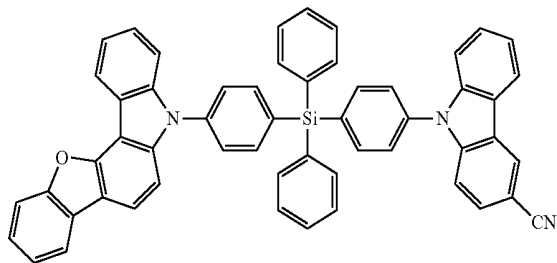
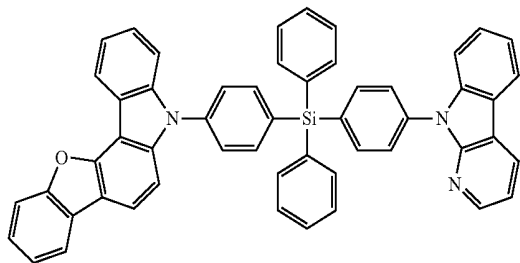
336



-continued

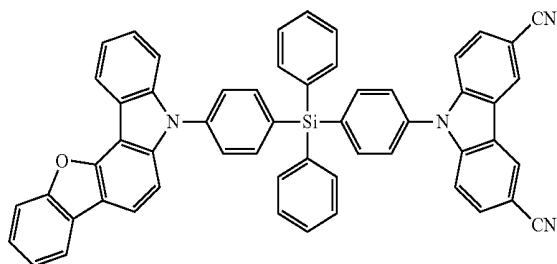
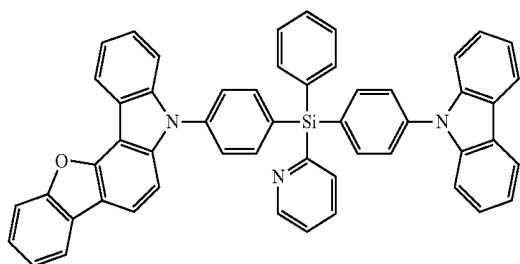
337

338



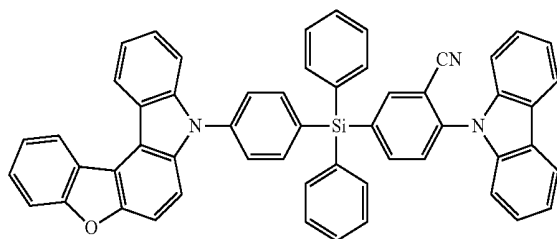
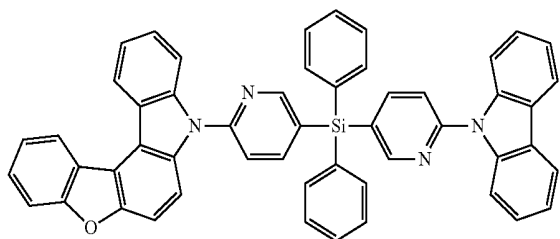
339

340



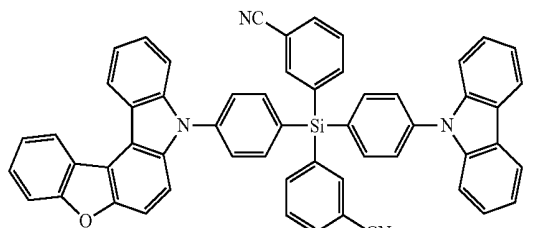
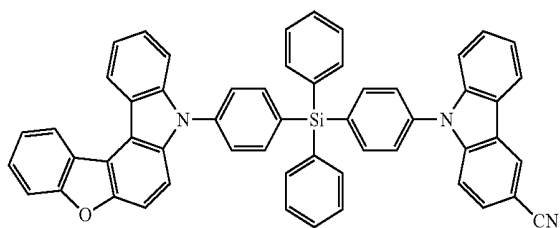
341

342



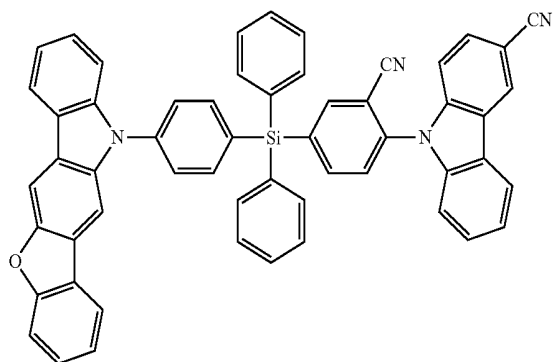
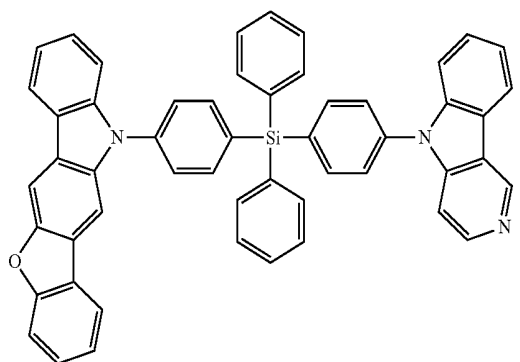
343

344



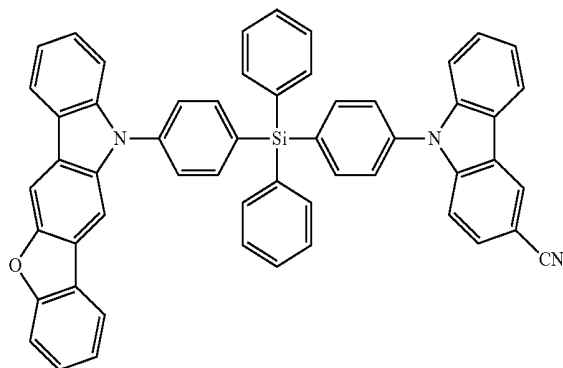
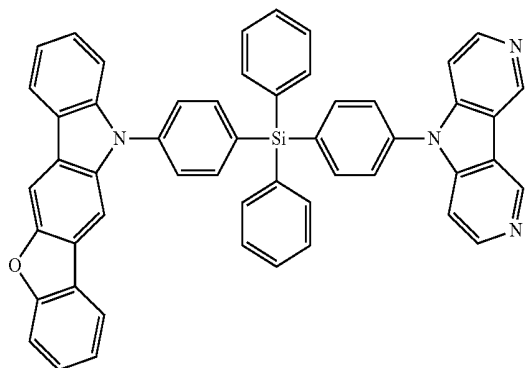
345

346



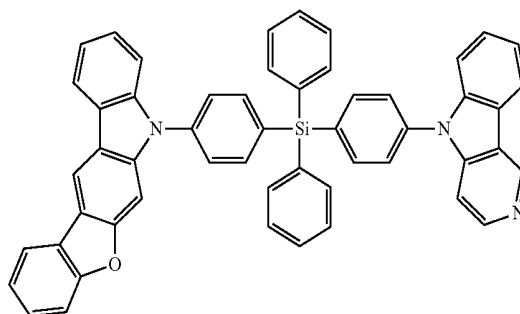
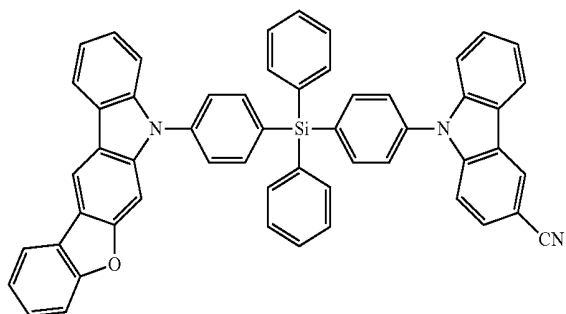
-continued
347

348



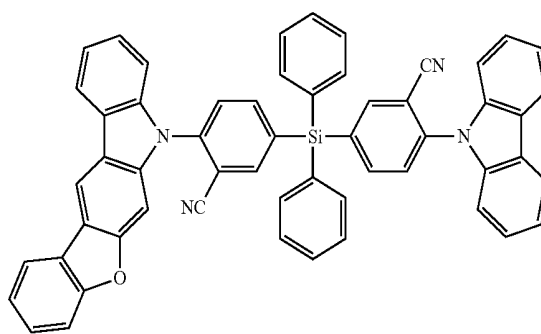
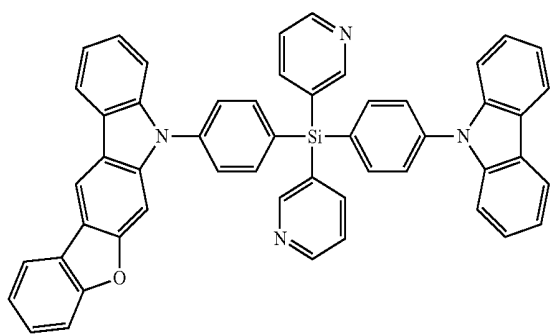
349

350



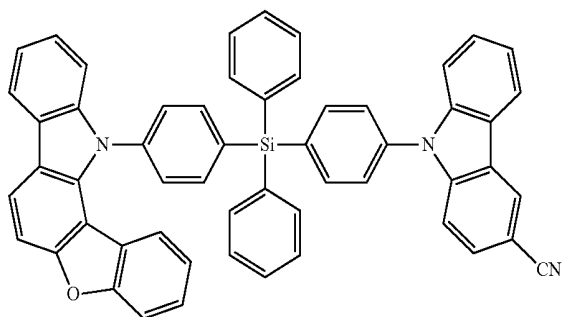
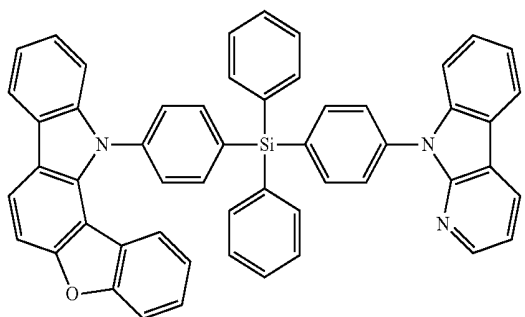
351

352



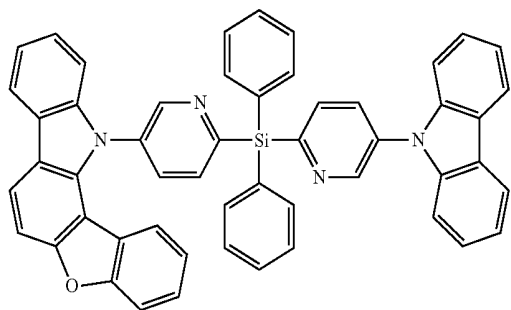
353

354

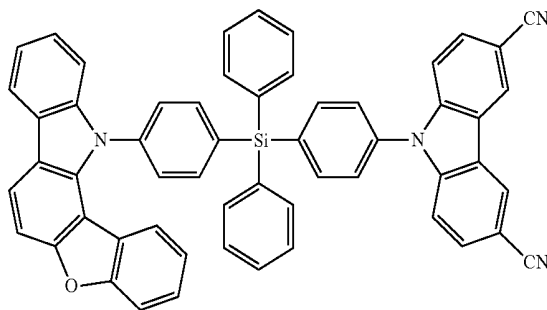


-continued

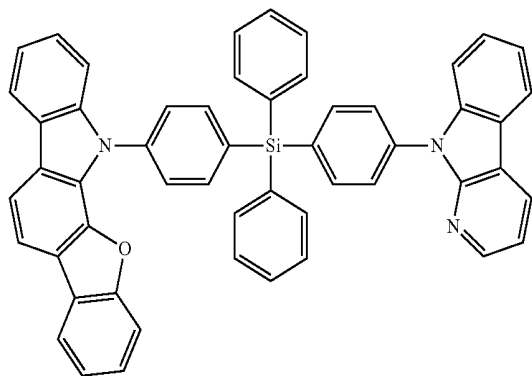
355



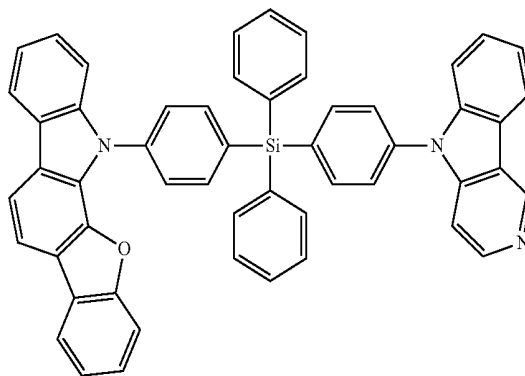
356



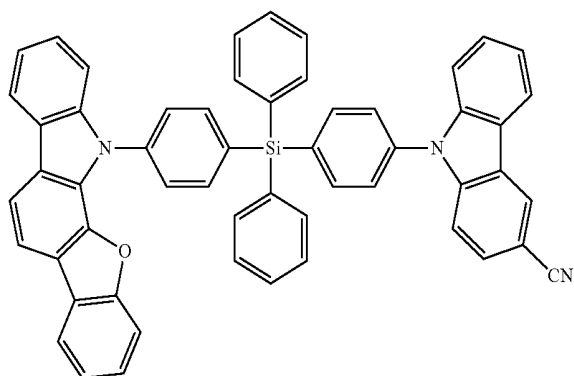
357



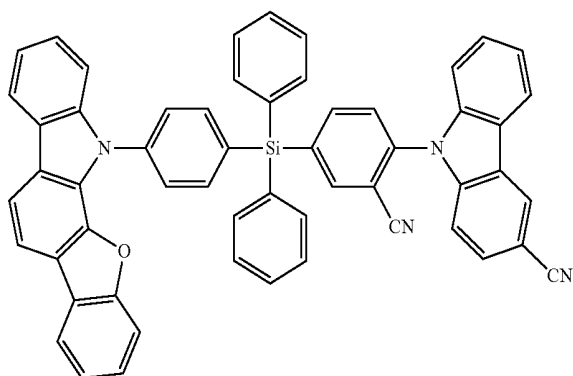
358



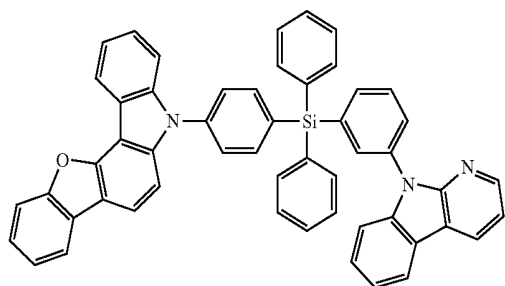
359



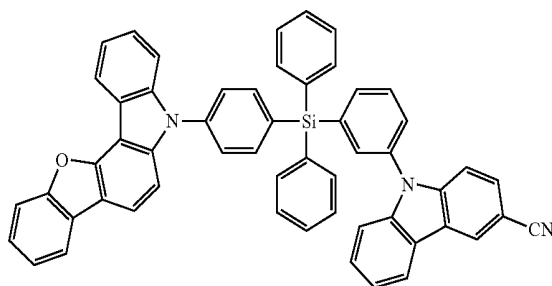
360



361

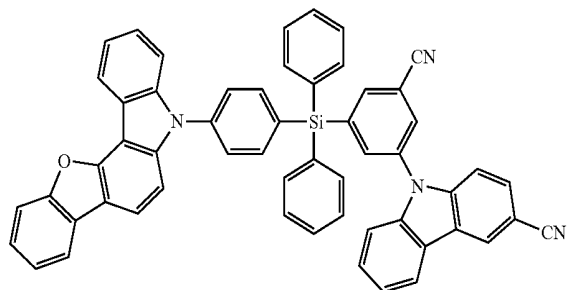
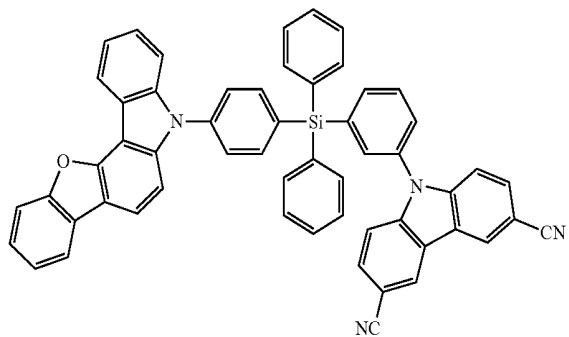


362



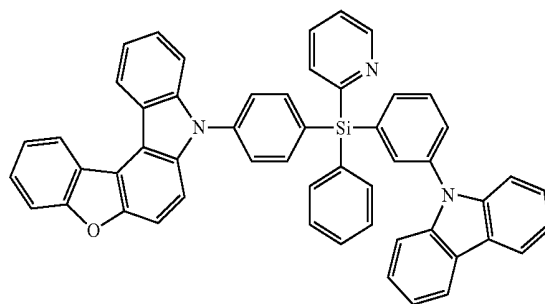
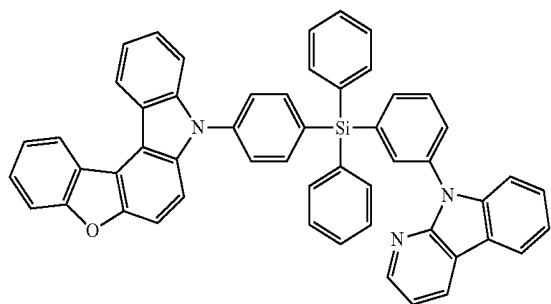
-continued
363

364



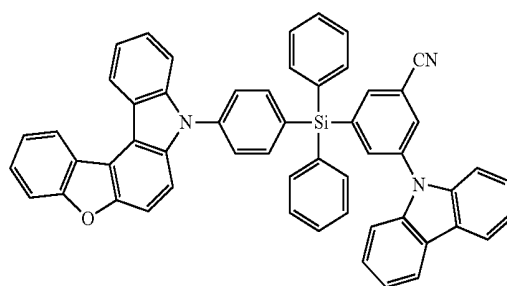
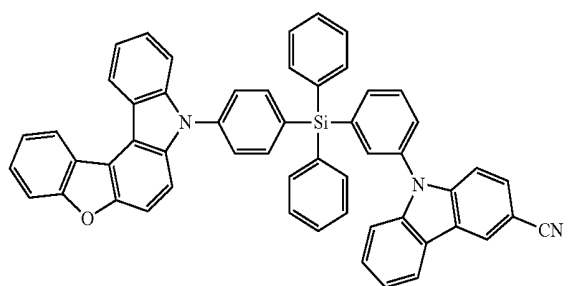
365

366



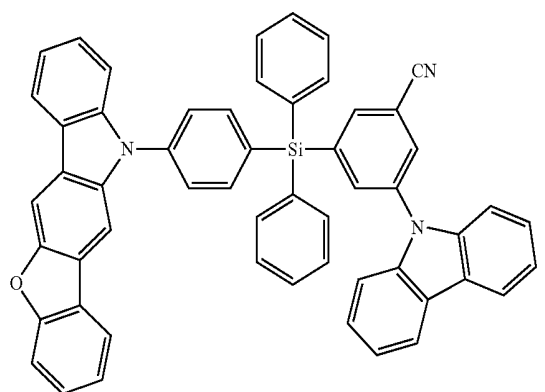
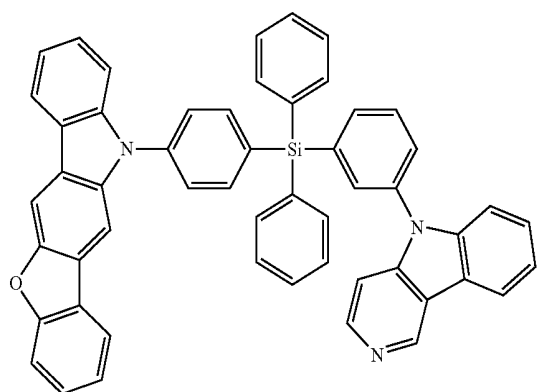
367

368



369

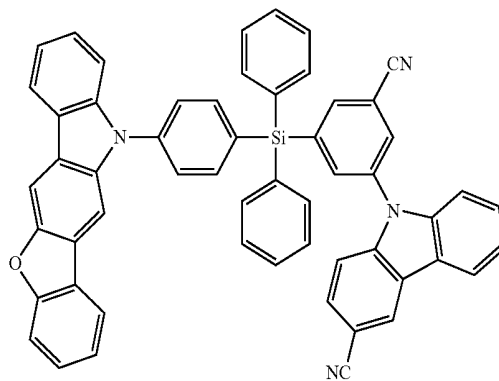
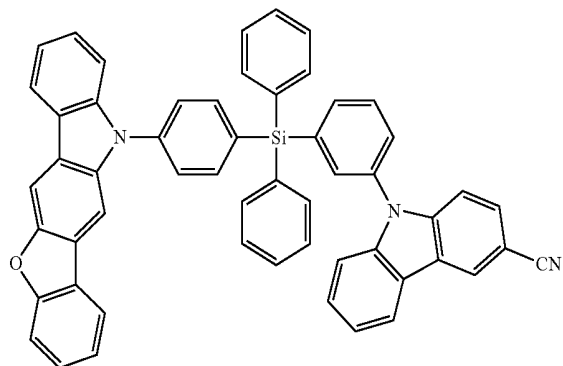
370



-continued

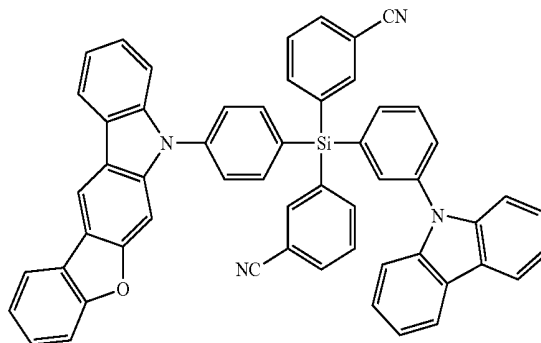
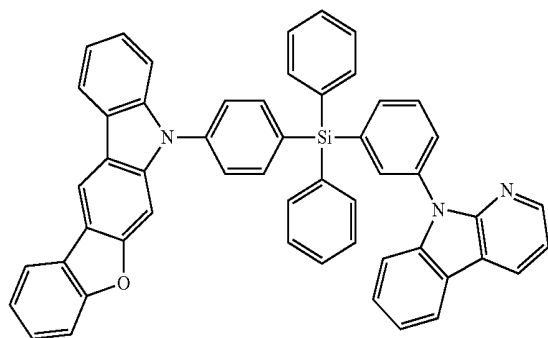
371

372



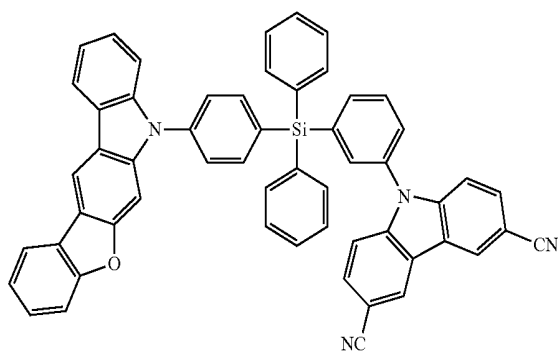
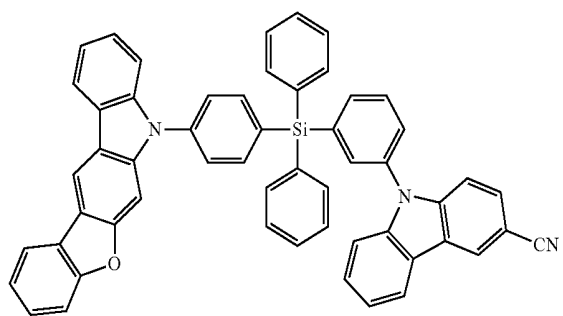
373

374



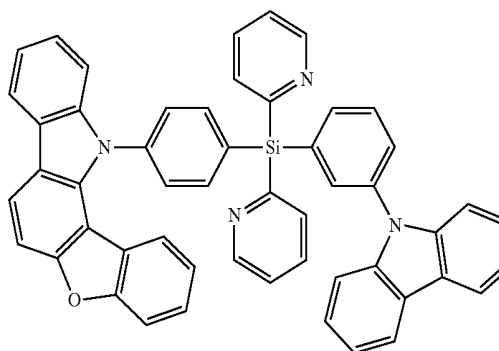
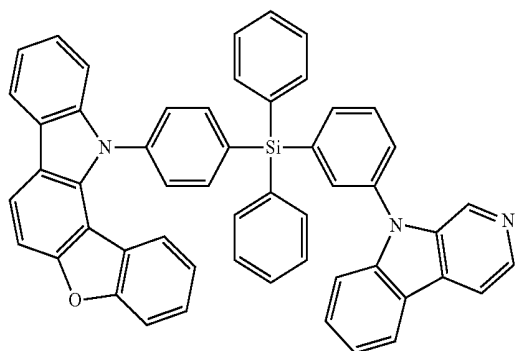
375

376



377

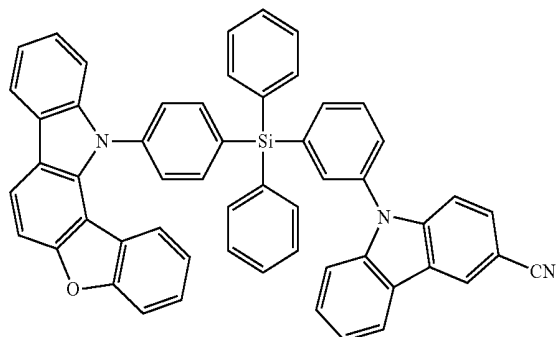
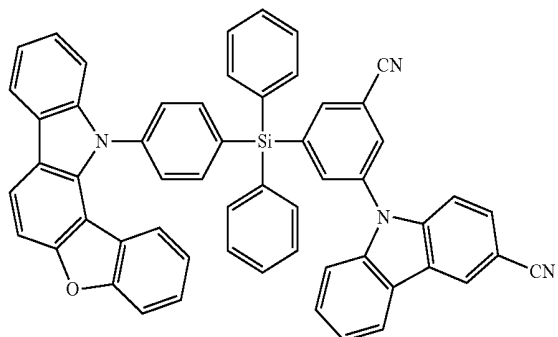
378



-continued

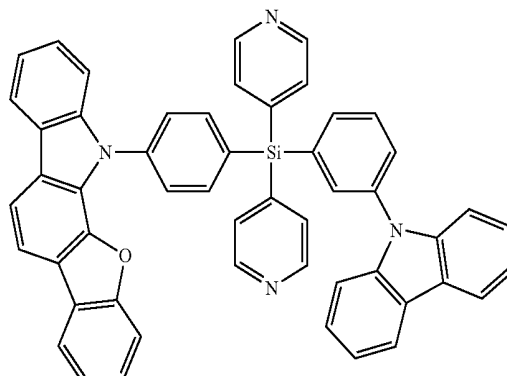
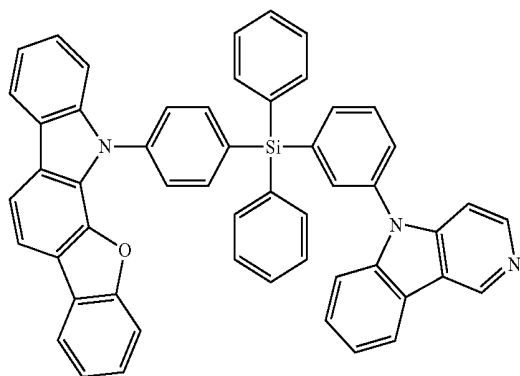
379

380



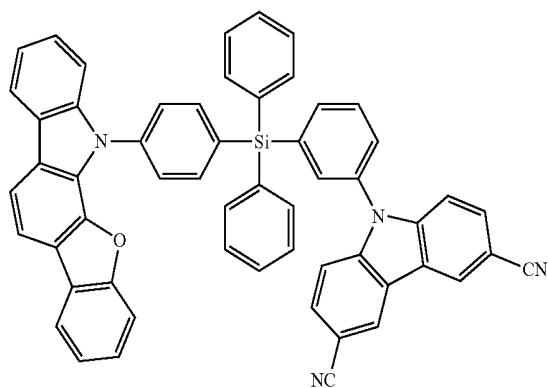
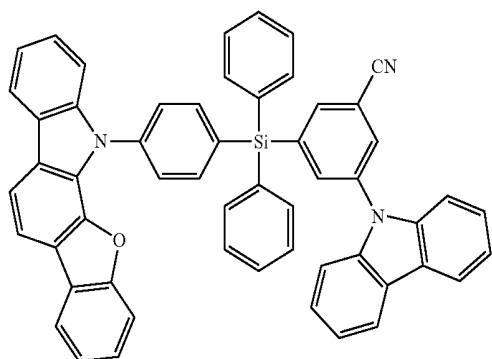
381

382



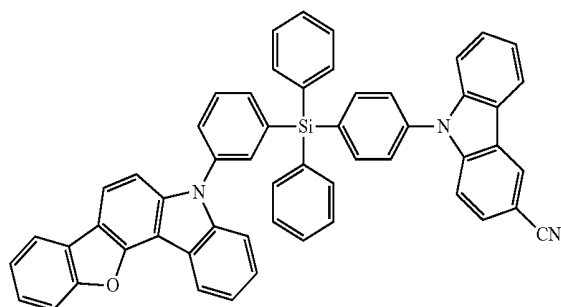
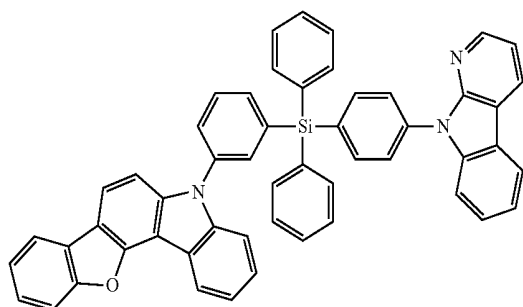
383

384



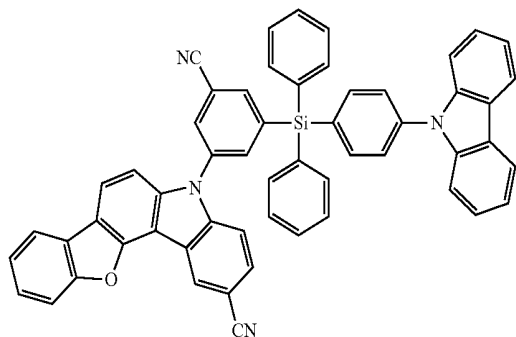
385

386

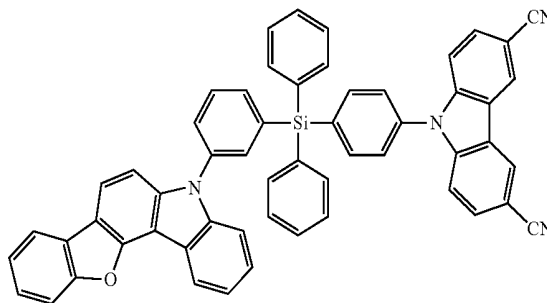


-continued

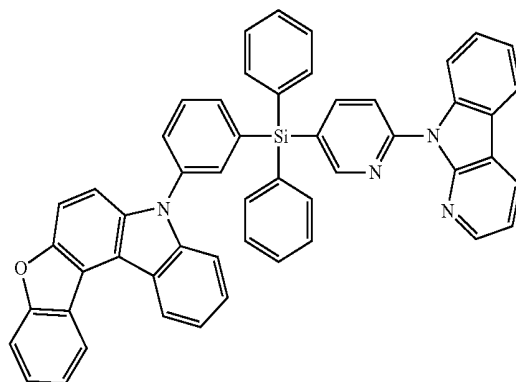
387



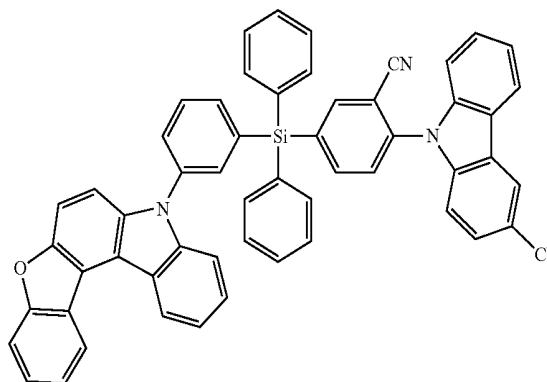
388



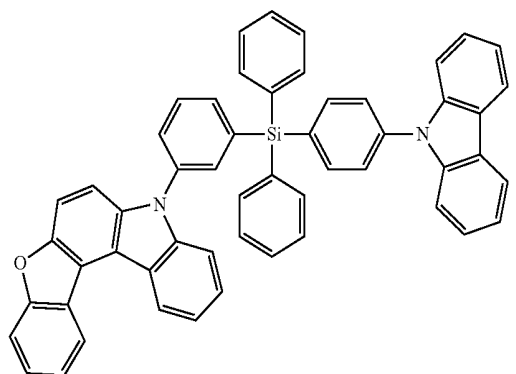
389



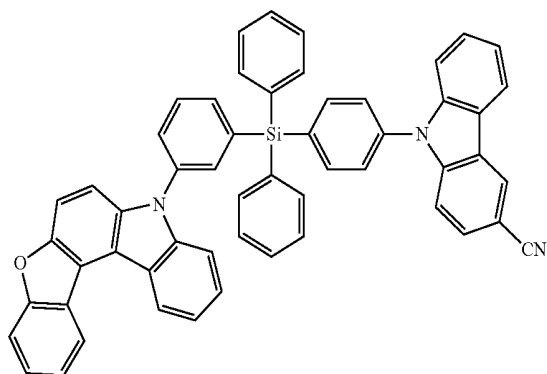
390



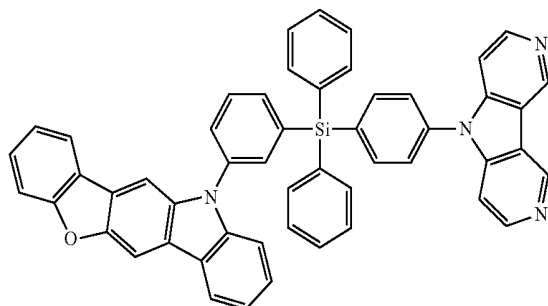
391



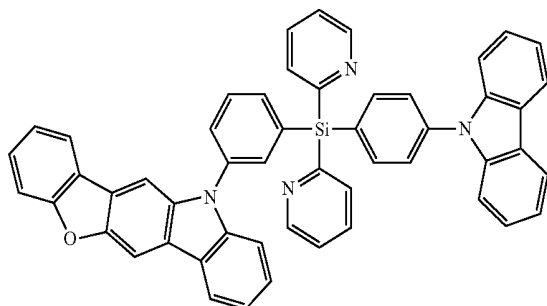
392



393



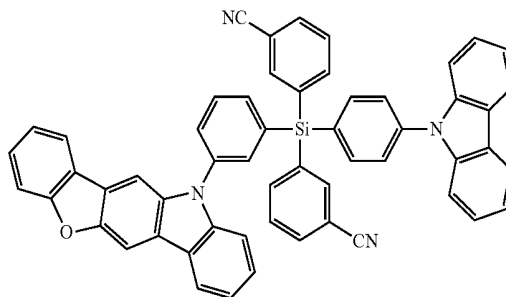
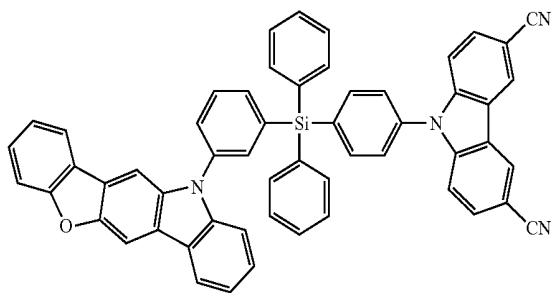
394



-continued

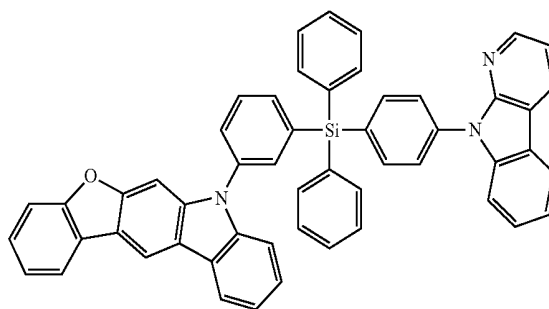
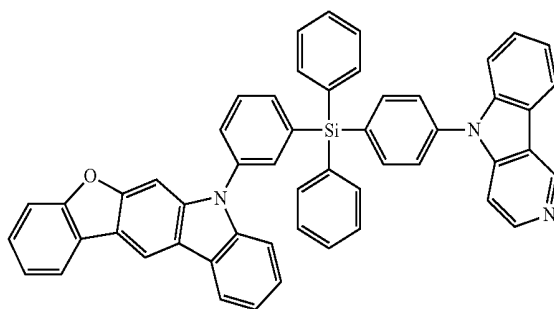
395

396



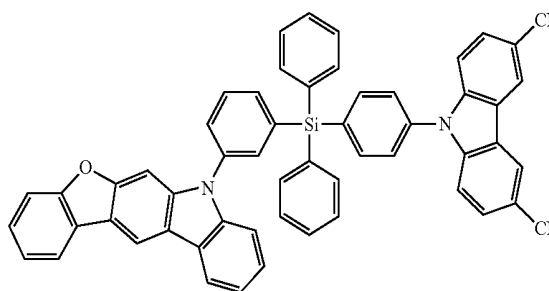
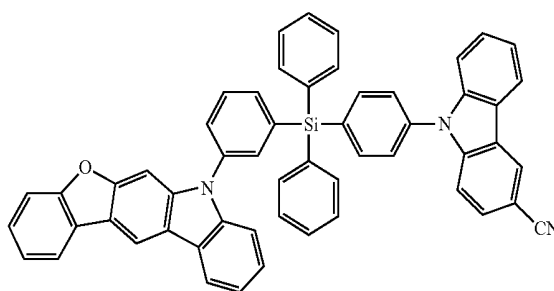
397

398



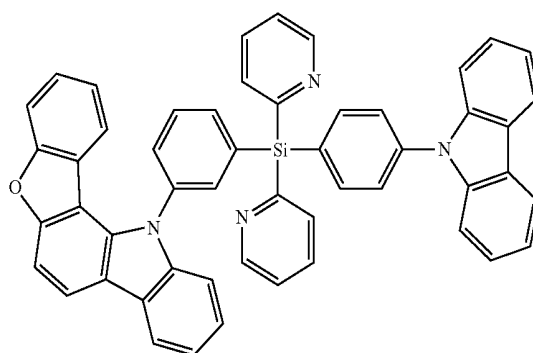
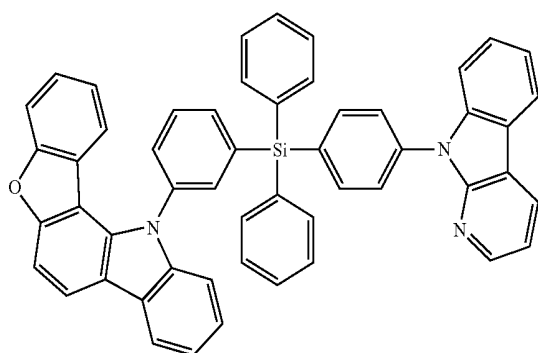
399

400



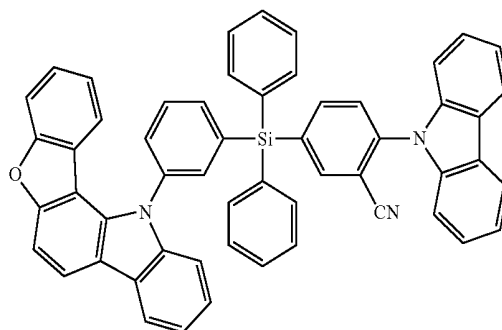
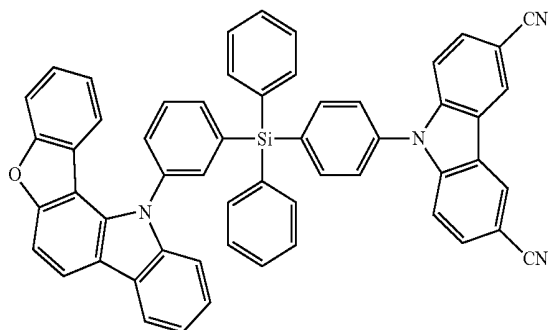
401

402



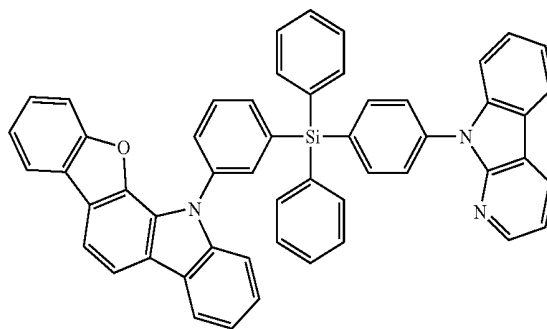
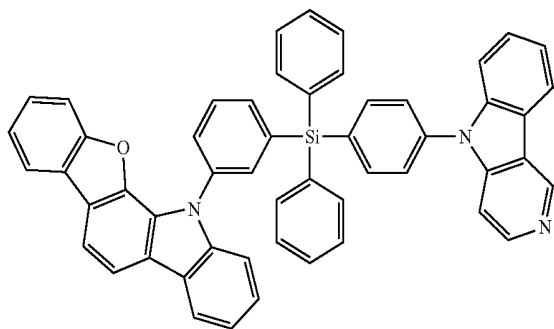
-continued
403

404



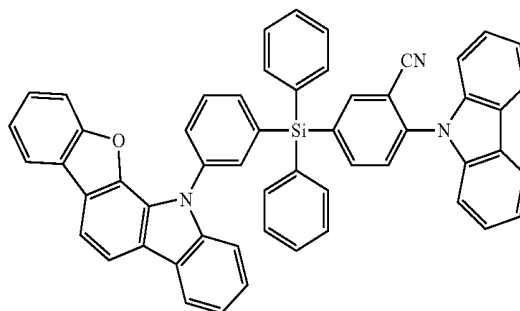
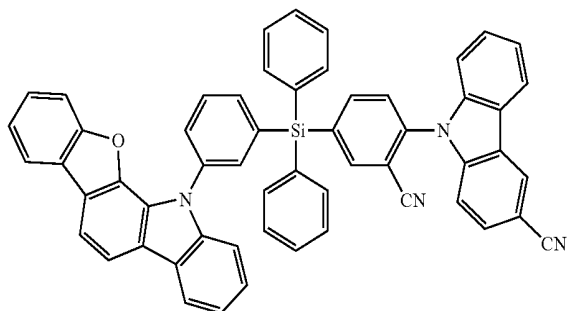
405

406



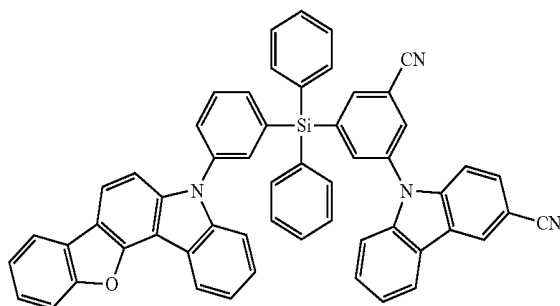
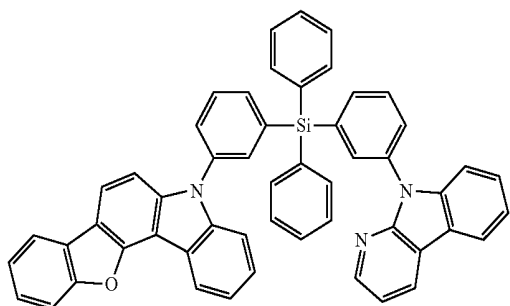
407

408



409

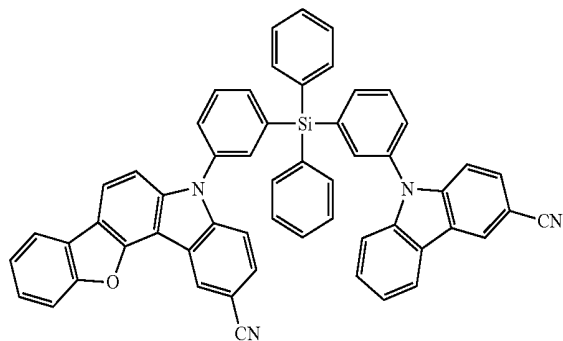
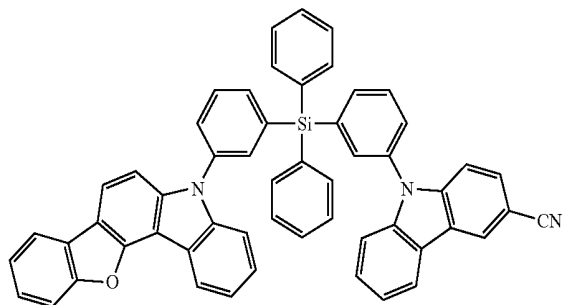
410



-continued

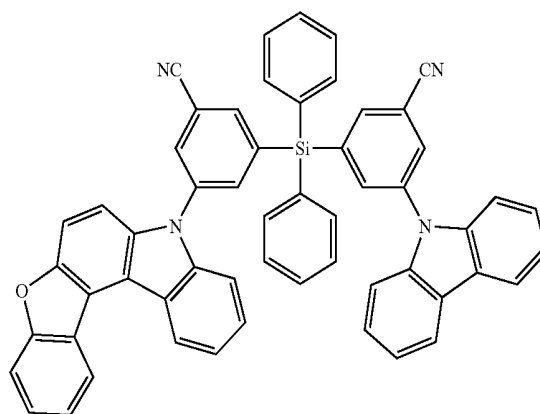
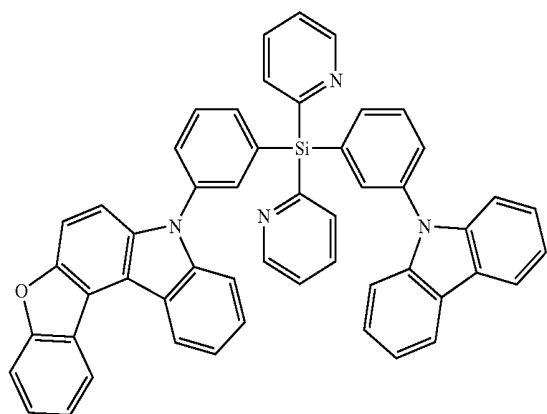
411

412



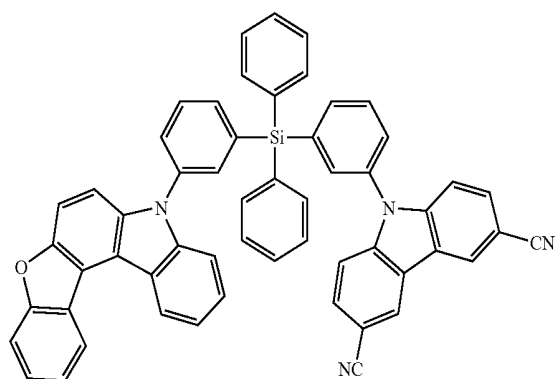
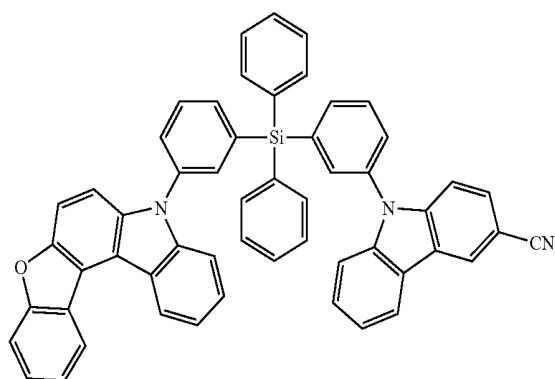
413

414



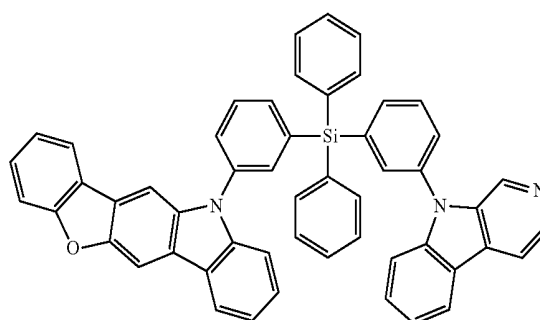
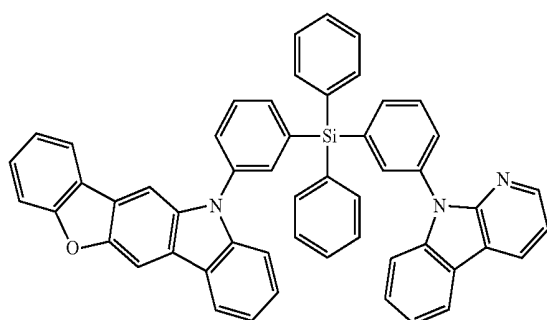
415

416



417

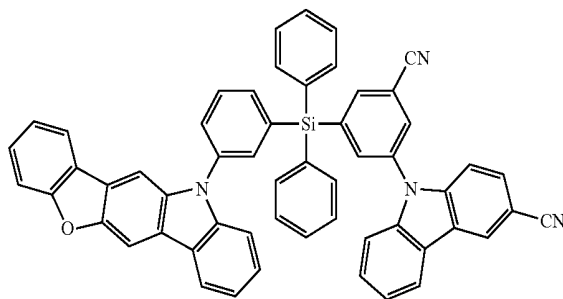
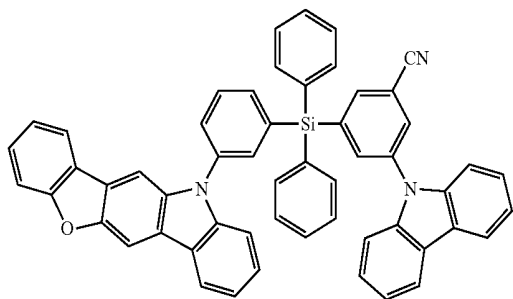
418



-continued

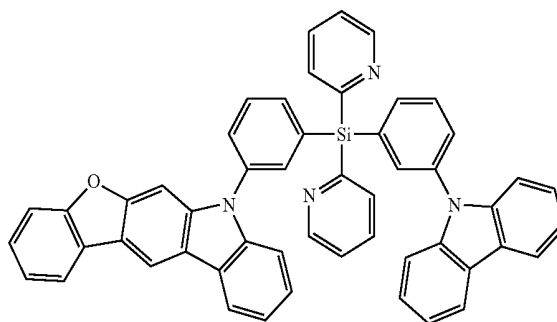
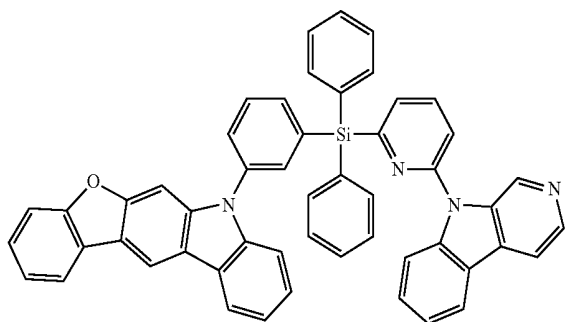
419

420



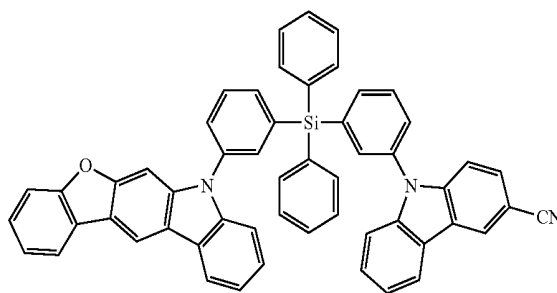
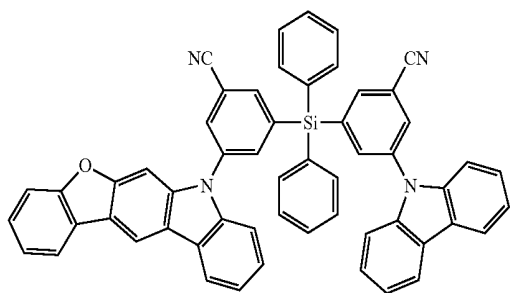
421

422



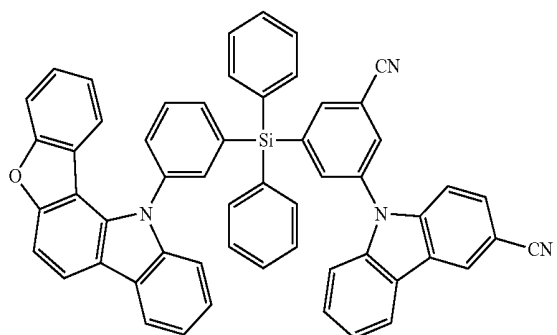
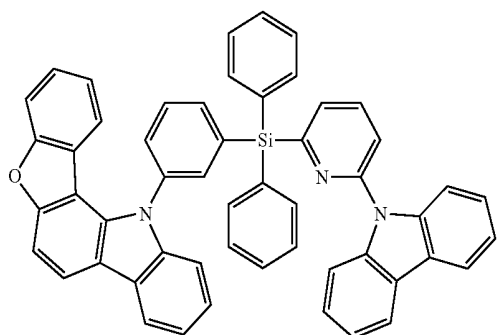
423

424



425

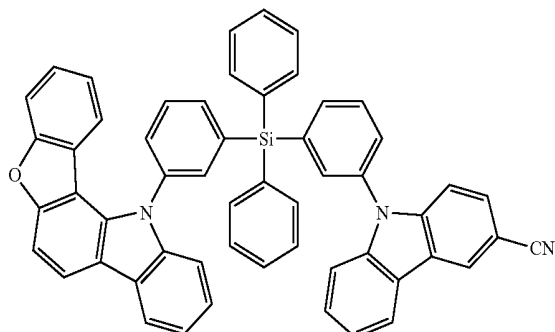
426



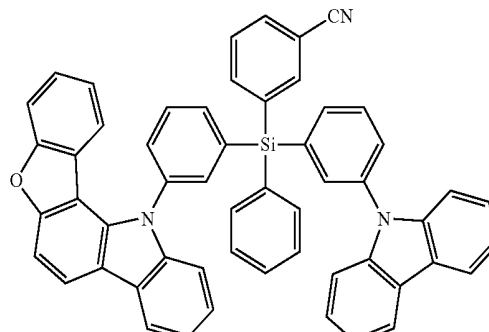
-continued

427

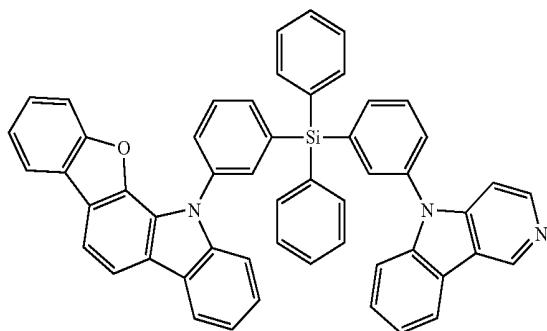
428



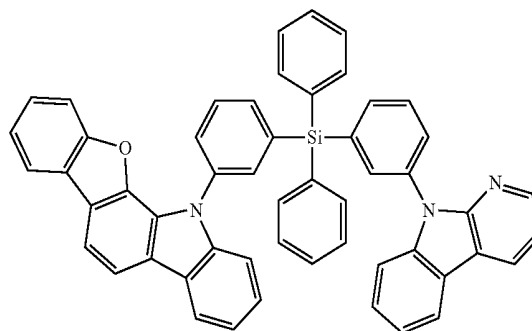
429



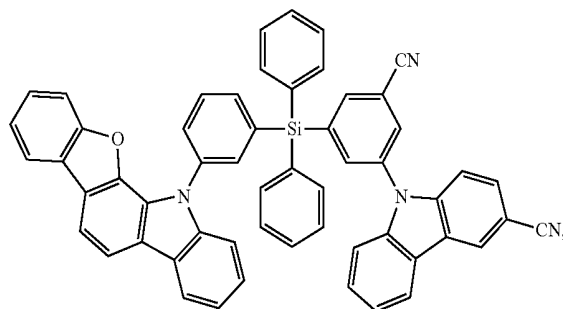
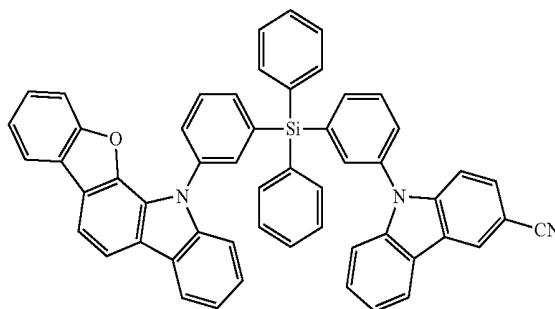
430



431



432



wherein, in Compounds 1 to 432,
Ph is a phenyl group.

14. An organic light-emitting device comprising:
a first electrode;
a second electrode; and
an organic layer disposed between the first electrode and the second electrode,
wherein the organic layer comprises an emission layer,
and
wherein the organic layer comprises at least one of the silyl group-containing compounds represented by Formula 1 of claim 1.

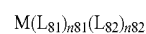
15. The organic light-emitting device of claim 14, wherein the first electrode is an anode,
the second electrode is a cathode, and
the organic layer further comprises a hole transport region disposed between the first electrode and the emission layer, and an electron transport region disposed between the emission layer and the second electrode,

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

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

16. The organic light-emitting device of claim 14, wherein the emission layer comprises the at least one of the silyl group-containing compounds represented by Formula 1 of claim 1.

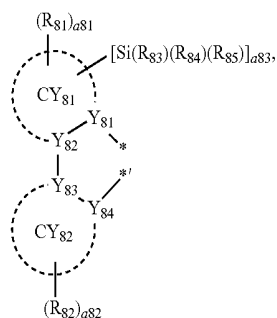
17. The organic light-emitting device of claim 16, wherein the emission layer further comprises a phosphorescent dopant represented by Formula 81:



Formula 81

-continued

Formula 81A



wherein, in Formulae 81 and 81A,

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

L_{81} is a ligand represented by Formula 81A, and n_{81} is an integer from 1 to 3, wherein when n_{81} is two or more, two or more groups L_{81} are identical to or different from each other,

L_{82} is an organic ligand, and n_{82} is an integer from 0 to 4, wherein when n_{82} is two or more, two or more groups L_{82} are identical to or different from each other, Y_{81} to Y_{84} are each independently carbon (C) or nitrogen (N),

Y_{81} and Y_{82} are linked to each other via a single bond or a double bond, and Y_{83} and Y_{84} are linked to each other via a single bond or a double bond,

CY_{81} and CY_{82} are each independently selected from a C_5 - C_{30} carbocyclic group and a C_3 - C_{30} heterocarbocyclic group,

CY_{81} and CY_{82} are further optionally linked to each other via an organic linking group,

R_{81} to R_{85} are each independently selected from hydrogen, deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, — SF_5 , a 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} alkyne 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, — $Si(Q_{81})(Q_{82})(Q_{83})$, — $N(Q_{84})(Q_{85})$, — $B(Q_{88})(Q_{87})$, and — $P(=O)(Q_{88})(Q_{89})$,

a_{81} to a_{83} are each independently an integer from 0 to 5, when a_{81} is two or more, two or more groups R_{81} are identical to or different from each other,

when a_{82} is two or more, two or more groups R_{82} are identical to or different from each other,

when a_{81} is two or more, neighboring groups R_{81} are optionally linked to each other to form a saturated or unsaturated ring,

when a_{82} is two or more, neighboring groups R_{82} are optionally linked to each other to form a saturated or unsaturated ring,

* and *' in Formula 81A each indicate a binding site to M in Formula 81, and

at least one substituent selected from a substituent(s) of the substituted C_1 - C_{60} alkyl group, the substituted C_2 - C_{60} alkenyl group, the substituted C_2 - C_{60} alkyne 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 is selected from deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkyne group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, and — $Si(Q_{91})(Q_{92})(Q_{93})$,

wherein Q_{81} to Q_{89} and Q_{91} to Q_{93} are each independently selected from hydrogen, deuterium, a C_1 - C_{60} alkyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

18. The organic light-emitting device of claim 17, wherein,

at least one selected from groups R_{81} in the number of a_{81} and groups R_{83} in the number of a_{82} in Formula 81A is a cyano group or deuterium.

19. The organic light-emitting device of claim 16, wherein the emission layer emits blue light.

20. The organic light-emitting device of claim 15, wherein the hole transport region comprises an electron blocking layer, and

the electron blocking layer comprises the at least one of the silyl group-containing compounds represented by Formula 1.

* * * * *

专利名称(译)	有机金属化合物和包括其的有机发光器件		
公开(公告)号	US20180047919A1	公开(公告)日	2018-02-15
申请号	US15/400253	申请日	2017-01-06
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO. , LTD. 三星SDI CO. , LTD.		
当前申请(专利权)人(译)	SAMSUNG ELECTRONICS CO. , LTD. 三星SDI CO. , LTD.		
[标]发明人	JUNG YONGSIK HUH DALHO SON JHUNMO KWON EUNSUK KIM SANGMO LEE SAEYOUN JEON SOONOK CHUNG YEONSOOK KIM JOONGHYUK SIM MYUNGSUN		
发明人	JUNG, YONGSIK HUH, DALHO SON, JHUNMO KWON, EUNSUK KIM, SANGMO LEE, SAEYOUN JEON, SOONOK CHUNG, YEONSOOK KIM, JOONGHYUK SIM, MYUNGSUN		
IPC分类号	H01L51/00 C09K11/06 C09K11/02 C07F7/08		
CPC分类号	C07F7/0814 C09K11/06 H01L51/008 H01L51/0085 C09K11/025 H01L51/506 H01L51/5016 H01L51/5096 C09K2211/185 C09K2211/1044 C09K2211/1029 C09K2211/1022 C09K2211/1007 H01L51/0094 C07F7/0812 H01L51/009 H01L51/0072 H01L51/0074		
优先权	1020160101886 2016-08-10 KR		
其他公开文献	US10199584		
外部链接	Espacenet USPTO		

摘要(译)

由式1表示的含甲硅烷基的化合物：其中，在公式1中，组和变量与规范中描述的相同。

