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(71) Applicant: **ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.** [KR/KR]; 56, 3gongdan 1-ro, Seobuk-gu, Cheonan-si, Chungcheongnam-do 331-980 (KR).

(72) Inventors: **LEE, Mi-Ja**; 305-1503, 24, Yeongtong-ro 26beon-gil, Hwaseong-si, Gyeonggi-do 445-739 (KR). **MOON, Doo-Hyeon**; 906-1304, 117, Byeongjeom 3-ro, Hwaseong-si, Gyeonggi-do 445-768 (KR). **KANG, Hee-Ryong**; 31, Inheon 12na-gil, Gwanak-gu, Seoul 151-815 (KR). **KANG, Hyun-Ju**; 205-1001, 198, Haan-ro, Gwangmyeong-si, Gyeonggi-do 423-766 (KR). **KIM, Chi-Sik**; 441-1201, 71, Dongtanbanseok-ro, Hwaseong-si, Gyeonggi-do 445-752 (KR). **KIM, Nam-Kyun**; 302-1801, 219, Po Eun-daero, Suji-gu, Yongin-si, Gyeonggi-do 448-527 (KR). **CHO, Young-Jun**; 204-701, 393, Pangyo-ro, Bundang-gu, Seongnam-si, Gyeonggi-do 463-400 (KR). **KWON, Hyuck-Joo**; 105-2003, 29, Hakdong-ro 68-gil, Gangnam-gu, Seoul 135-877 (KR). **LEE, Kyung-Joo**;

210-1001, 72, Saechang-ro 8-gil, Mapo-gu, Seoul 121-773 (KR). **KIM, Bitnari**; 102-2401, 101, Dongan-ro, Dongan-gu, Anyang-si, Gyeonggi-do 431-774 (KR). **DOH, Yoo-Jin**; 408-204, 85, Byeoryang-ro, Gwacheon-si, Gyeonggi-do 427-731 (KR). **LEE, Su-Hyun**; 105-1102, 205, Suil-ro, Jangan-gu, Suwon-si, Gyeonggi-do 440-200 (KR).

(74) Agent: **CHANG, Hoon**; Central Intellectual Property & Law, Korean Re Bldg. 5F, 68, Jong-ro 5-gil, Jongno-gu, Seoul 110-733 (KR).

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(54) Title: ORGANIC ELECTROLUMINESCENT COMPOUND, AND MULTI-COMPONENT HOST MATERIAL AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

(57) Abstract: The present disclosure relates to an organic electroluminescent compound, and a multi-component host material and an organic electroluminescent device comprising the same. By using the organic electroluminescent compound according to the present disclosure, an organic electroluminescent device can have a remarkably improved lifespan, along with low driving voltage and good current and power efficiencies.



## Description

# Title of Invention: ORGANIC ELECTROLUMINESCENT COMPOUND, AND MULTI-COMPONENT HOST MATERIAL AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

### Technical Field

- [1] The present disclosure relates to an organic electroluminescent compound, and a multi-component host material and an organic electroluminescent device comprising the same.

### Background Art

- [2] An electroluminescent (EL) device is a self-light-emitting device which has advantages in that it provides a wider viewing angle, a greater contrast ratio, and a faster response time. An organic EL device was first developed by Eastman Kodak, by using small aromatic diamine molecules and aluminum complexes as materials to form a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].
- [3] The most important factor determining luminous efficiency in the organic EL device is light-emitting materials. Until now, fluorescent materials have been widely used as light-emitting materials. However, in view of electroluminescent mechanisms, since phosphorescent materials theoretically enhance luminous efficiency by four (4) times compared to fluorescent materials, phosphorescent light-emitting materials are widely being researched. Iridium(III) complexes have been widely known as phosphorescent materials, including bis(2-(2'-benzothienyl)-pyridinato-N,C3')iridium(acetylacetonate) ((acac)Ir(btp)<sub>2</sub>), tris(2-phenylpyridine)iridium (Ir(ppy)<sub>3</sub>) and bis(4,6-difluorophenylpyridinato-N,C2)picolate iridium (Firpic) as red-, green- and blue-emitting materials, respectively.
- [4] At present, 4,4'-N,N'-dicarbazol-biphenyl (CBP) is the most widely known host material for phosphorescent materials. Recently, Pioneer (Japan) et al., developed a high performance organic EL device using bathocuproine (BCP) and aluminum(III) bis(2-methyl-8-quinolate)(4-phenylphenolate) (BALq) etc., as host materials, which were known as hole blocking materials.
- [5] Although conventional materials provide good light-emitting characteristics, they have the following disadvantages: (1) Due to their low glass transition temperature and poor thermal stability, their degradation may occur during a high-temperature deposition process in a vacuum. (2) The power efficiency of the organic EL device is given by  $[(\pi/\text{voltage}) \times \text{current efficiency}]$ , and the power efficiency is inversely pro-

portional to the voltage. Although the organic EL device comprising phosphorescent host materials provides higher current efficiency (cd/A) than one comprising fluorescent materials, a significantly high driving voltage is necessary. Thus, there is no merit in terms of power efficiency (lm/W). (3) Furthermore, the operational lifespan of the organic EL device is short, and luminous efficiency is still required to be improved.

- [6] Korean Patent Appln. Laying-Open No. 10-2010-0105501 discloses a compound for an organic electroluminescent device, in which one of nitrogen atoms of biscarbazole is substituted, via phenylene, with quinoxaline. However, it does not disclose a compound in which one of the nitrogen atoms of biscarbazole is substituted, directly or via a linker, with naphthyridine or a compound in which one of nitrogen atoms of biscarbazole is substituted, directly or via a heteroarylene, with quinoxaline.

[7]

## Disclosure of Invention

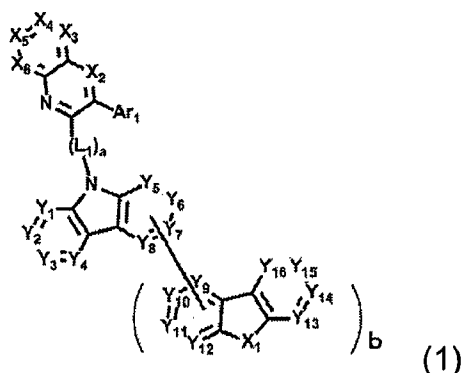
### Technical Problem

- [8] The objective of the present disclosure is to provide an organic electroluminescent compound, which can provide an organic electroluminescent device showing long lifespan, low driving voltage, and good current and power efficiencies, and a multi-component host material and an organic electroluminescent device comprising the same.

### Solution to Problem

- [9] The present inventors found that the above objective can be achieved by an organic electroluminescent compound represented by the following formula 1.

[10]



- [11] wherein  $L_1$  represents a single bond, a substituted or unsubstituted (3- to 30-membered)heteroarylene, or a substituted or unsubstituted (C6-C30)arylene;
- [12]  $X_1$  represents  $-NR_1-$ ,  $-CR_2R_3-$ ,  $-O-$ , or  $-S-$ ;
- [13]  $X_2$  to  $X_6$ , each independently, represent  $-CR_4-$  or  $-N-$ ;
- [14]  $Ar_1$  represents hydrogen, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (3- to 30-membered)heteroaryl;
- [15] with the proviso that when  $X_2$  is  $-N-$ ,  $L_1$  is not the substituted or unsubstituted

- (C6-C30)arylene and Ar<sub>i</sub> is not hydrogen;
- [16] Y<sub>1</sub> to Y<sub>4</sub> and Y<sub>13</sub> to Y<sub>16</sub>, each independently, represent -N- or -CR<sub>5</sub>-;
- [17] Y<sub>5</sub> to Y<sub>12</sub>, each independently, represent  $-\overset{\text{I}}{\underset{|}{\text{C}}}-$ , -N-, or -CR<sub>6</sub>-;
- [18] R<sub>1</sub> to R<sub>3</sub>, each independently, represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl;
- [19] R<sub>4</sub> to R<sub>6</sub>, each independently, represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, or a substituted or unsubstituted di(C6-C30)arylamino; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (3- to 30-membered), mono- or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;
- [20] the heteroaryl(ene) and the heterocycloalkyl, each independently, contain at least one hetero atom selected from B, N, O, S, P(=O), Si and P; and
- [21] a and b, each independently represent 0 or 1.
- [22]

### Advantageous Effects of Invention

- [23] An organic electroluminescent compound and a multi-component host material of the present disclosure can provide an organic electroluminescent device having low driving voltage, good current and power efficiencies, and remarkably improved lifespan.
- [24]

### Mode for the Invention

- [25] Hereinafter, the present disclosure will be described in detail. However, the following description is intended to explain the invention, and is not meant in any way to restrict the scope of the invention.
- [26] The present disclosure provides the organic electroluminescent compound of formula 1 above, an organic electroluminescent material comprising the same, and an organic electroluminescent device comprising the compound.
- [27] The details of the organic electroluminescent compound of formula 1 are as follows.
- [28] Herein, "alkyl" includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc. "Alkenyl" includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl,

3-butenyl, 2-methylbut-2-enyl, etc. “Alkynyl” includes ethynyl, 1-propynyl, 2-propynyl, 1-butyne, 2-butyne, 3-butyne, 1-methylpent-2-ynyl, etc. “Cycloalkyl” includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc. “(3- to 7-membered)heterocycloalkyl” indicates a cycloalkyl having 3 to 7 ring backbone atoms including at least one hetero atom selected from B, N, O, S, P(=O), Si, and P, preferably O, S, and N, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc. Furthermore, “aryl(ene)” indicates a monocyclic or fused ring derived from an aromatic hydrocarbon; may be a spiro compound in which two rings are connected via one atom; and includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenylnaphthyl, naphthylphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl, phenanthrenyl, phenylphenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, spirobifluorenyl, etc. “(3- to 30-membered)heteroaryl(ene)” indicates an aryl group having 3 to 30 ring backbone atoms including at least one, preferably 1 to 4, hetero atom selected from the group consisting of B, N, O, S, P(=O), Si, and P; may be a monocyclic ring, or a fused ring condensed with at least one benzene ring; may be partially saturated; may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); and includes a monocyclic ring-type heteroaryl such as furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl such as benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, naphthofuranyl, naphthothiophenyl, benzonaphthofuranyl, benzonaphthothiophenyl, benzimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, dihydroacridinyl, etc. Furthermore, “halogen” includes F, Cl, Br, and I.

- [29] Herein, “substituted” in the expression, “substituted or unsubstituted,” means that a hydrogen atom in a certain functional group is replaced with another atom or group, i.e. a substituent. The substituents of the substituted alkyl, the substituted cycloalkyl, the substituted cycloalkenyl, the substituted heterocycloalkyl, the substituted aryl(ene), the substituted heteroaryl(ene), the substituted diarylamino, the substituted alkoxy, and the substituted mono- or polycyclic, alicyclic or aromatic ring in L<sub>1</sub>, Ar<sub>1</sub>, R<sub>1</sub> to R<sub>6</sub>, R<sub>21</sub> to R<sub>27</sub>, R<sub>31</sub> to R<sub>33</sub>, R<sub>100</sub> to R<sub>109</sub>, R<sub>111</sub> to R<sub>127</sub>, L<sub>4</sub>, and M, each independently, are at least one selected from the group consisting of deuterium, a halogen, a cyano, a carboxy, a nitro, a hydroxy, a (C1-C30)alkyl, a halo(C1-C30)alkyl, a (C2-C30)alkenyl, a (C2-C30)alkynyl, a (C1-C30)alkoxy, a (C1-C30)alkylthio, a (C3-C30)cycloalkyl, a

(C3-C30)cycloalkenyl, a (3- to 7-membered)heterocycloalkyl, a (C6-C30)aryloxy, a (C6-C30)arylthio, a (3- to 30-membered)heteroaryl unsubstituted or substituted with a (C6-C30)aryl, a (C6-C30)aryl unsubstituted or substituted with a (3- to 30-membered)heteroaryl, a tri(C1-C30)alkylsilyl, a tri(C6-C30)arylsilyl, a di(C1-C30)alkyl(C6-C30)arylsilyl, a (C1-C30)alkyldi(C6-C30)arylsilyl, an amino, a mono- or di-(C1-C30)alkylamino, a mono- or di-(C6-C30)arylamino, a (C1-C30)alkyl(C6-C30)arylamino, a (C1-C30)alkylcarbonyl, a (C1-C30)alkoxycarbonyl, a (C6-C30)arylcarbonyl, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl and a (C1-C30)alkyl(C6-C30)aryl; and preferably, each independently, are at least one selected from the group consisting of a cyano, a halogen, a (C1-C10)alkyl, a (C3-C12)cycloalkyl, a (C5-C18)aryl, a (5- to 18-membered)heteroaryl, a di(C6-C12)arylamino, and a (C1-C10)alkyl(C5-C18)aryl.

[30]  $L_1$  represents a single bond, a substituted or unsubstituted (3- to 30-membered)heteroarylene, or a substituted or unsubstituted (C6-C30)arylene. Preferably,  $L_1$  may represent a single bond, a substituted or unsubstituted (5- to 21-membered)heteroarylene, or a substituted or unsubstituted (C6-C21)arylene. Specifically,  $L_1$  may represent a single bond.

[31]  $X_1$  represents  $-NR_1-$ ,  $-CR_2R_3-$ ,  $-O-$ , or  $-S-$ . Specifically,  $X_1$  may represent  $-NR_1-$ .

[32]  $X_2$  to  $X_6$ , each independently, represent  $-CR_4-$  or  $-N-$ . Preferably, all of  $X_2$  to  $X_6$  may represent  $-CR_4-$ ; or one of  $X_2$  to  $X_6$  may represent  $-N-$ , and the remainders of  $X_2$  to  $X_6$  may represent  $-CR_4-$ . When  $X_2$  represents  $-N-$ ,  $L_1$  is not a substituted or unsubstituted (C6-C30)arylene, and  $Ar_1$  is not hydrogen. Specifically, when  $X_2$  represents  $-N-$ ,  $L_1$  may represent a single bond.

[33]  $Ar_1$  represents hydrogen, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (3- to 30-membered)heteroaryl.  $Ar_1$  may represent, preferably hydrogen, or a substituted or unsubstituted (C6-C21)aryl; and more preferably hydrogen, or a (C6-C18)aryl unsubstituted or substituted with a (C1-C10)alkyl, a cyano, a (C6-C13)aryl or a (5- to 13-membered)heteroaryl. Specifically,  $Ar_1$  may represent hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted biphenyl, a substituted or unsubstituted terphenyl, a substituted or unsubstituted anthracenyl, a substituted or unsubstituted phenanthrenyl, a substituted or unsubstituted phenylnaphthyl, or a substituted or unsubstituted naphthylphenyl. More specifically,  $Ar_1$  may represent hydrogen; or a phenyl, biphenyl, naphthyl, terphenyl, anthracenyl, phenanthrenyl, phenylnaphthyl, or naphthylphenyl unsubstituted or substituted with a (C1-C4)alkyl, a cyano, or a pyridyl. Preferably, when  $Ar_1$  represents hydrogen, at least one of  $X_2$  to  $X_6$  may represent  $-CR_4-$  wherein  $R_4$  represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or

unsubstituted (3- to 30-membered)heteroaryl. More preferably, when Ar<sub>1</sub> represents hydrogen, at least one of X<sub>2</sub> to X<sub>6</sub> may represent -CR<sub>4</sub>- wherein R<sub>4</sub> represents a substituted or unsubstituted (C6-C21)aryl, or a substituted or unsubstituted (5- to 21-membered)heteroaryl; and even more preferably, one of X<sub>2</sub> to X<sub>6</sub> may represent -CR<sub>4</sub>- wherein R<sub>4</sub> represents a substituted or unsubstituted (C6-C18)aryl.

[34] Y<sub>1</sub> to Y<sub>4</sub> and Y<sub>13</sub> to Y<sub>16</sub>, each independently, represent -N- or -CR<sub>5</sub>-; and preferably -CR<sub>5</sub>-. Specifically, Y<sub>1</sub> to Y<sub>4</sub> may represent -CH-; or one of Y<sub>1</sub> to Y<sub>4</sub> may represent -CR<sub>5</sub>- (wherein R<sub>5</sub> is not hydrogen), the remainders of Y<sub>1</sub> to Y<sub>4</sub> may represent -CH-; or two of Y<sub>1</sub> to Y<sub>4</sub> may represent -CH-, the remainders of Y<sub>1</sub> to Y<sub>4</sub> may represent -CR<sub>5</sub>- (wherein R<sub>5</sub> is not hydrogen). Specifically, Y<sub>13</sub> to Y<sub>16</sub> may represent -CH-; or one of Y<sub>13</sub> to Y<sub>16</sub> may represent -CR<sub>5</sub>- (wherein R<sub>5</sub> is not hydrogen), the remainders of Y<sub>13</sub> to Y<sub>16</sub> may represent -CH-; or two of Y<sub>13</sub> to Y<sub>16</sub> may represent -CH-, the remainders of Y<sub>13</sub> to Y<sub>16</sub> may represent -CR<sub>5</sub>- (wherein R<sub>5</sub> is not hydrogen).

[35] Y<sub>5</sub> to Y<sub>12</sub>, each independently, represent  $\text{--}\overset{\text{I}}{\text{C}}\text{--}$ , -N-, or -CR<sub>6</sub>-. Preferably, Y<sub>5</sub> to Y<sub>12</sub>, each independently, represent  $\text{--}\overset{\text{I}}{\text{C}}\text{--}$  or -CR<sub>6</sub>-. Specifically, one of Y<sub>5</sub> to Y<sub>8</sub> may represent  $\text{--}\overset{\text{I}}{\text{C}}\text{--}$ , the remainders of Y<sub>5</sub> to Y<sub>8</sub> may represent -CH-. Specifically, one of Y<sub>9</sub> to Y<sub>12</sub> may represent  $\text{--}\overset{\text{I}}{\text{C}}\text{--}$ , the remainders of Y<sub>9</sub> to Y<sub>12</sub> may represent -CH-; or one of Y<sub>9</sub> to Y<sub>12</sub> may represent  $\text{--}\overset{\text{I}}{\text{C}}\text{--}$ , the two of Y<sub>9</sub> to Y<sub>12</sub> may represent -CR<sub>6</sub>- (wherein R<sub>6</sub> is not hydrogen), the remainder may represent -CH-.

[36] R<sub>1</sub> to R<sub>3</sub>, each independently, represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl. R<sub>1</sub> to R<sub>3</sub>, each independently, may represent preferably a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, a substituted or unsubstituted (C5-C21)cycloalkyl, or a substituted or unsubstituted (5- to 7-membered)heterocycloalkyl; more preferably a substituted or unsubstituted (C1-C10)alkyl, or a substituted or unsubstituted (C6-C18)aryl; and even more preferably, an unsubstituted (C1-C10)alkyl or an unsubstituted (C6-C18)aryl. Preferably, R<sub>2</sub> and R<sub>3</sub> are the same. Specifically, R<sub>1</sub> may represent phenyl, biphenyl, or naphthyl; R<sub>2</sub> may represent a (C1-C4)alkyl or phenyl; and R<sub>3</sub> may represent a (C1-C4)alkyl or phenyl.

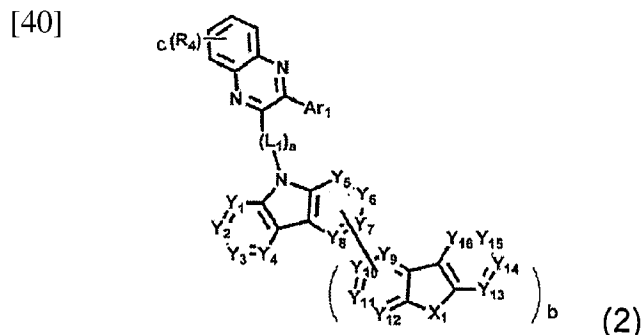
[37] R<sub>4</sub> to R<sub>6</sub>, each independently, represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted

(C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, or a substituted or unsubstituted di(C6-C30)arylamino; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (3- to 30-membered), mono- or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur.  $R_4$  to  $R_6$ , each independently, represent preferably, hydrogen, a halogen, a cyano, a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C5-C21)cycloalkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, or a substituted or unsubstituted di(C6-C21)arylamino; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (5- to 21-membered), mono- or polycyclic aromatic ring whose carbon atom(s) may be replaced with one or two hetero atoms selected from nitrogen, oxygen, and sulfur. More preferably,  $R_4$  represents hydrogen, or a substituted or unsubstituted (C6-C18)aryl. Specifically,  $R_4$  may represent hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted biphenyl, a substituted or unsubstituted terphenyl, a substituted or unsubstituted anthracenyl, a substituted or unsubstituted phenanthrenyl, a substituted or unsubstituted phenyl-naphthyl, or a substituted or unsubstituted naphthylphenyl. More preferably,  $R_5$  and  $R_6$  represent hydrogen, a cyano, a substituted or unsubstituted (C1-C10)alkyl, a substituted or unsubstituted (C5-C18)cycloalkyl, a substituted or unsubstituted (C6-C18)aryl, or a substituted or unsubstituted di(C6-C18)arylamino; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (5- to 18-membered), mono- or polycyclic aromatic ring whose carbon atom(s) may be replaced with a hetero atom(s) selected from nitrogen, oxygen, and sulfur. Specifically,  $R_5$  and  $R_6$ , each independently, may represent hydrogen, a cyano, a (C1-C4)alkyl, phenyl, cyclohexyl, or di(phenyl)amino, or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted benzene ring, a substituted or unsubstituted thiophene ring, a substituted or unsubstituted furan ring, a substituted or unsubstituted indole ring, a substituted or unsubstituted indene ring, a substituted or unsubstituted naphthalene ring, a substituted or unsubstituted benzothiophene ring, a substituted or unsubstituted benzofuran ring, or a substituted or unsubstituted benzindole ring.

- [38] According to one embodiment of the present disclosure,  $L_1$  represents a single bond, a substituted or unsubstituted (5- to 21-membered)heteroarylene, or a substituted or unsubstituted (C6-C21)arylene;  $X_1$  represents  $-NR_1-$ ,  $-CR_2R_3-$ ,  $-O-$ , or  $-S-$ ; all of  $X_2$  to  $X_6$  represent  $-CR_4-$ , or one of  $X_2$  to  $X_6$  represents  $-N-$ , and the remainders of  $X_2$  to  $X_6$

represent  $-\text{CR}_4-$ , wherein when  $\text{X}_2$  is  $-\text{N}-$ ,  $\text{L}_1$  is a single bond;  $\text{Ar}_1$  represents hydrogen, or a substituted or unsubstituted (C6-C21)aryl, wherein when  $\text{Ar}_1$  is hydrogen, at least one of  $\text{R}_4$  is a substituted or unsubstituted (C6-C21)aryl or a substituted or unsubstituted (5- to 21-membered)heteroaryl;  $\text{Y}_1$  to  $\text{Y}_4$  and  $\text{Y}_{13}$  to  $\text{Y}_{16}$ , each independently, represent  $-\text{CR}_5-$ ;  $\text{Y}_5$  to  $\text{Y}_{12}$ , each independently, represent  $-\text{C}-$  or  $-\text{CR}_6-$ ;  $\text{R}_1$  to  $\text{R}_3$ , each independently, represent a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, a substituted or unsubstituted (C5-C21)cycloalkyl, or a substituted or unsubstituted (5- to 7-membered)heterocycloalkyl;  $\text{R}_4$  to  $\text{R}_6$ , each independently, represent hydrogen, a halogen, a cyano, a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C5-C21)cycloalkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, or a substituted or unsubstituted di(C6-C21)arylamino, or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (5- to 21-membered), mono- or polycyclic, aromatic ring whose carbon atom(s) may be replaced with one or two hetero atom(s) selected from nitrogen, oxygen, and sulfur; the heteroaryl(ene) and the heterocycloalkyl, each independently, contain at least one hetero atom selected from N, O and S; and a and b, each independently represent 0 or 1.

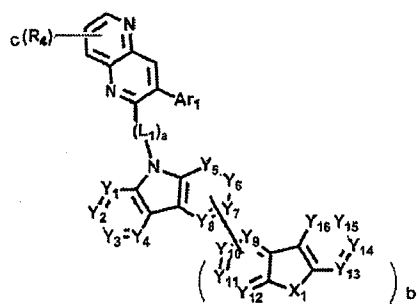
[39] According to another embodiment of the present disclosure, the compound of formula 1 may be represented by the following formula 2:



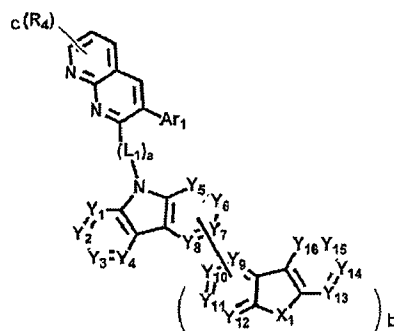
[41] wherein,  $\text{X}_1$ ,  $\text{Ar}_1$ ,  $\text{Y}_1$  to  $\text{Y}_{16}$ ,  $\text{R}_4$ ,  $\text{L}_1$ , a, and b are as defined in formula 1 above; c represents an integer of 1 to 4; and when c is 2 or more, each of  $\text{R}_4$  may be the same or different. Preferably, in formula 2,  $\text{L}_1$  represents a single bond;  $\text{Ar}_1$  represents a substituted or unsubstituted (C6-C21)aryl, or a substituted or unsubstituted (5- to 21-membered)heteroaryl, and  $\text{R}_4$  represents hydrogen.

[42] According to another embodiment of the present disclosure, the compound of formula 1 may be represented by any one of the following formulae 3 to 5:

[43]

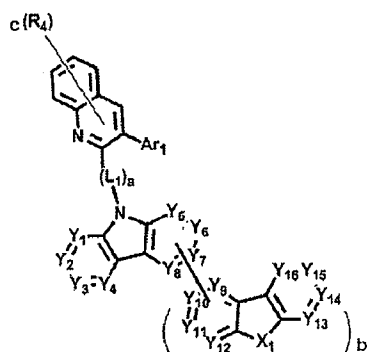


(3)



(4)

[44]

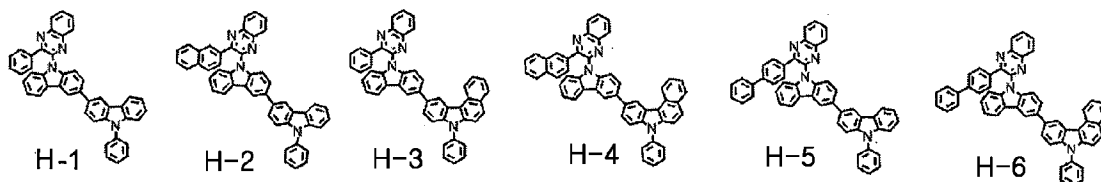


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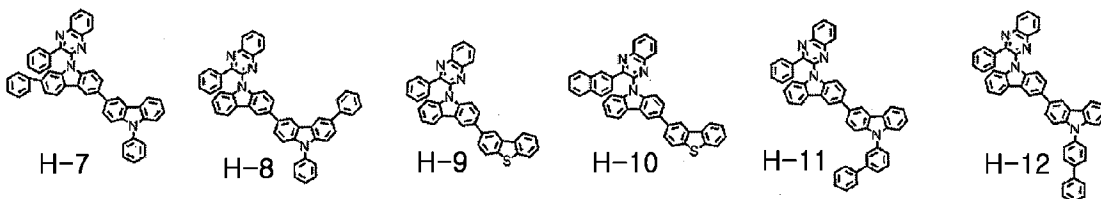
[45] wherein,  $X_1$ ,  $Ar_1$ ,  $Y_1$  to  $Y_{16}$ ,  $L_1$ ,  $R_4$ ,  $a$ , and  $b$  are as defined in formula 1;  $c$  represents an integer of 1 to 5; and when  $c$  is 2 or more, each of  $R_4$  is the same or different. In formulae 3 to 5, preferably, when  $Ar_1$  is hydrogen, at least one of  $R_4$  represents a substituted or unsubstituted (C6-C21)aryl, or a substituted or unsubstituted (5- to 21-membered)heteroaryl. More preferably,  $Ar_1$  represents hydrogen; one of  $R_4$  represents a substituted or unsubstituted (C6-C18)aryl, and the remainders of  $R_4$  represent hydrogen.

[46] More specifically, the organic electroluminescent compound of the present disclosure includes the following, but is not limited thereto:

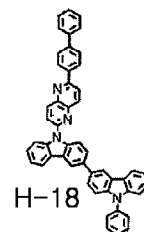
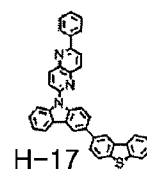
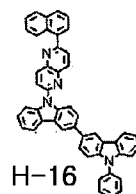
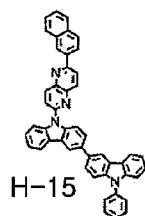
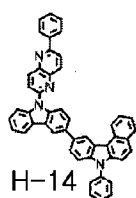
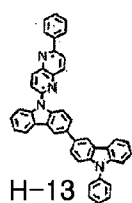
[47]



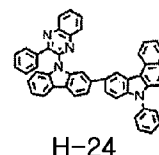
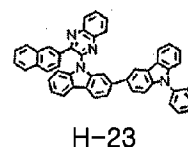
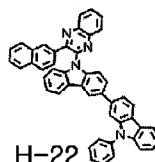
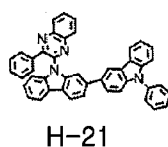
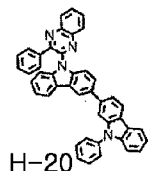
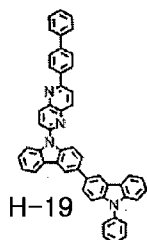
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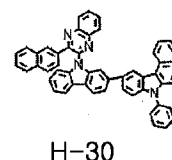
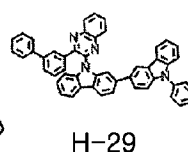
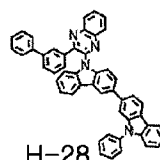
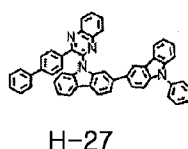
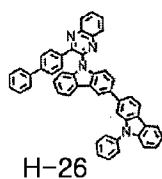
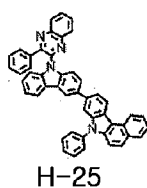
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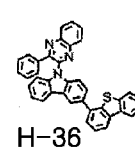
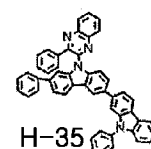
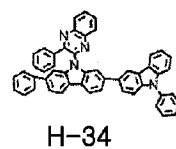
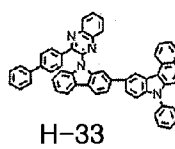
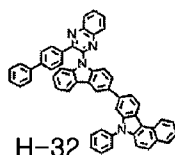
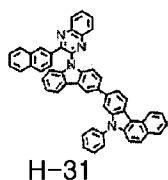
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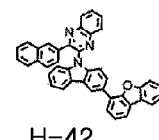
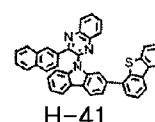
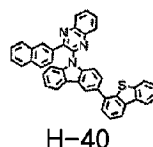
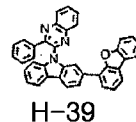
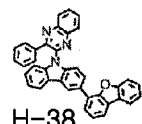
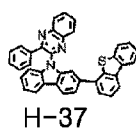
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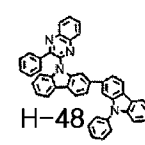
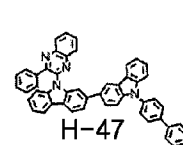
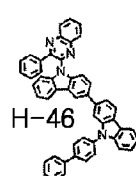
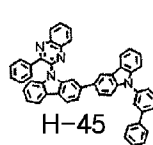
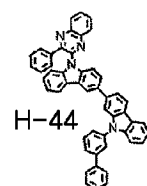
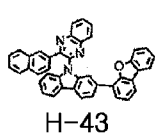
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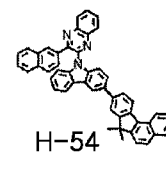
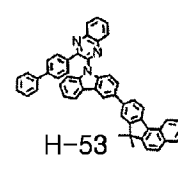
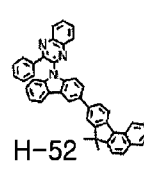
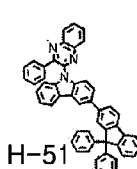
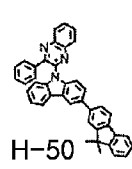
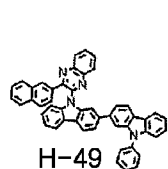
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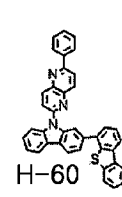
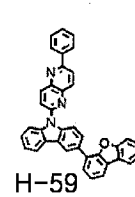
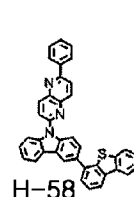
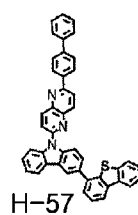
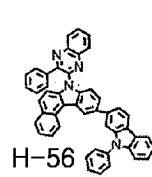
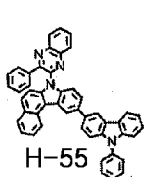
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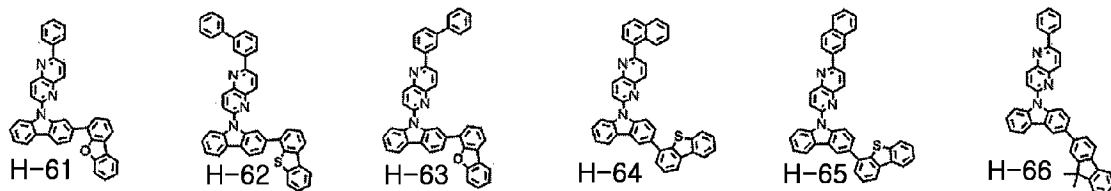
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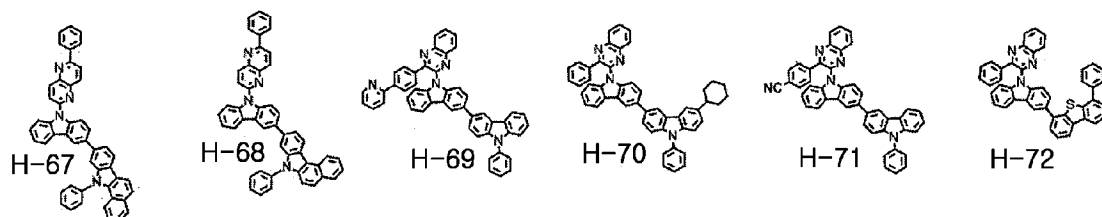
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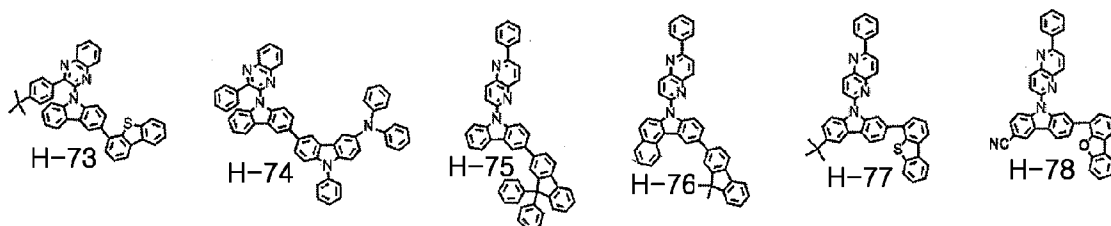
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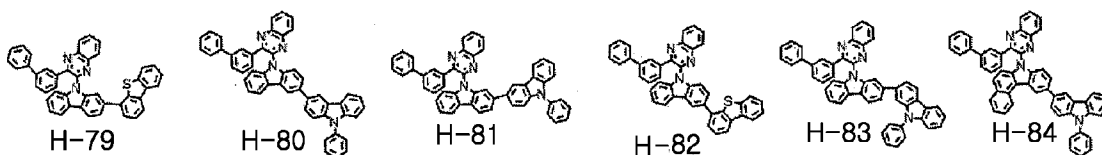
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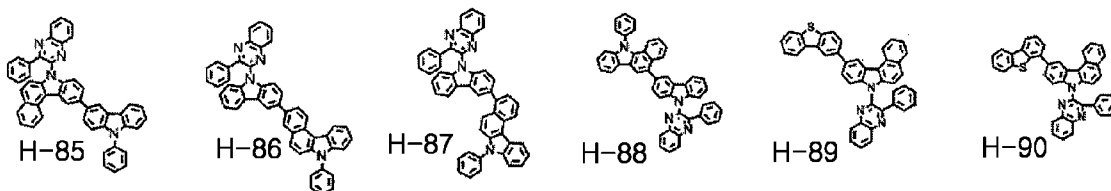
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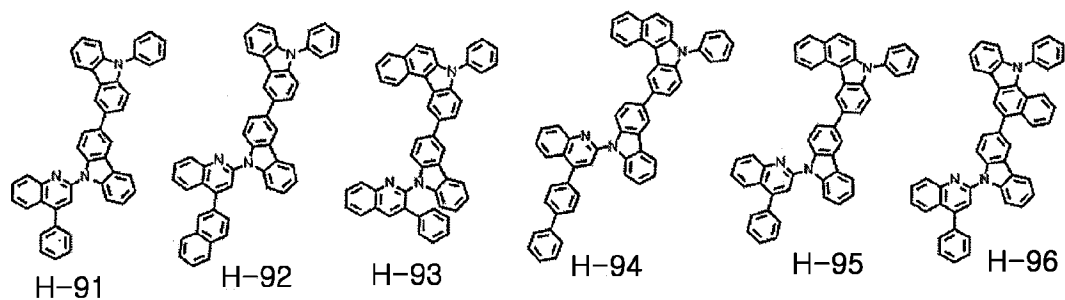
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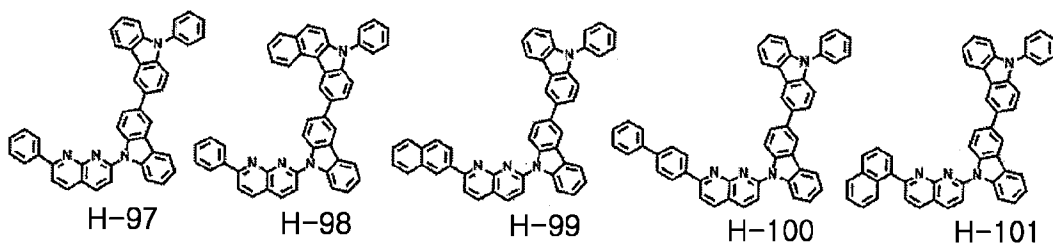
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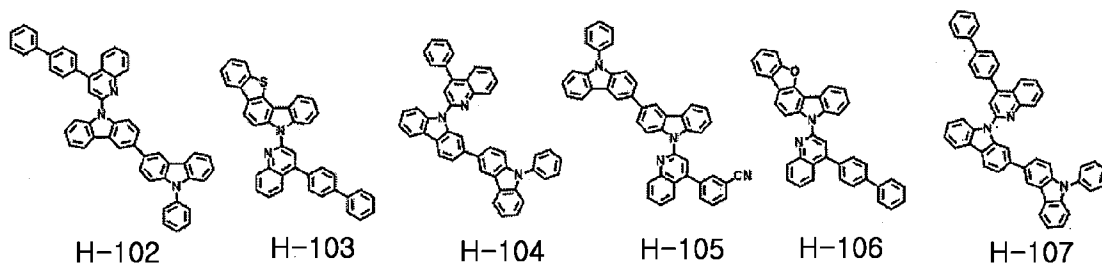
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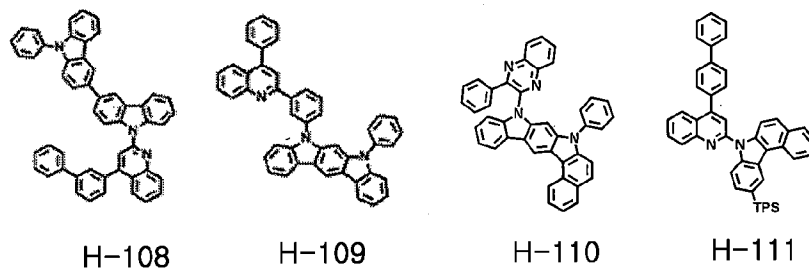
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[64]

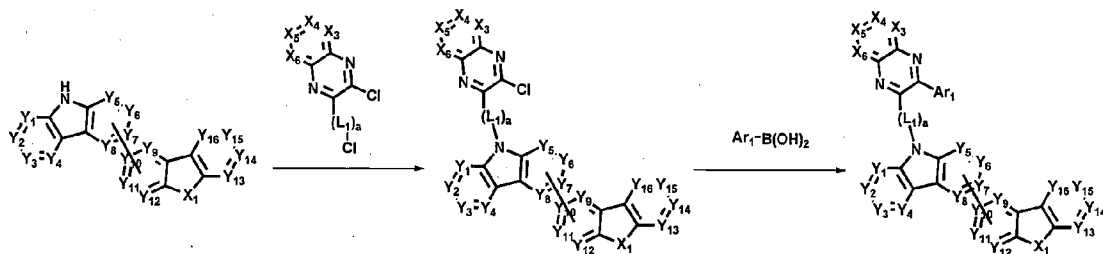


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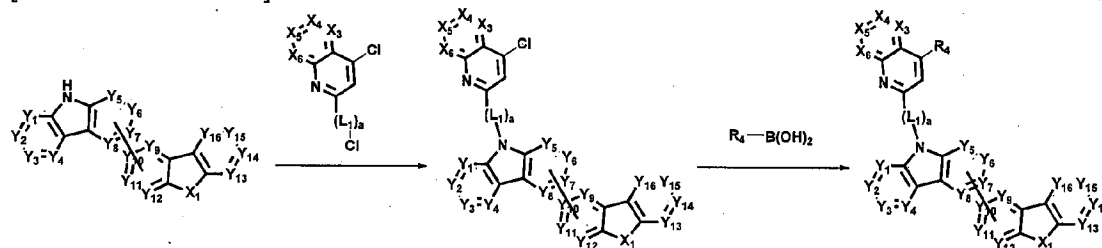


[66] The organic electroluminescent compound of formula 1 of the present disclosure can be prepared by a synthetic method known to one skilled in the art. For example, it can be prepared according to any one of the following reaction schemes 1 to 4.

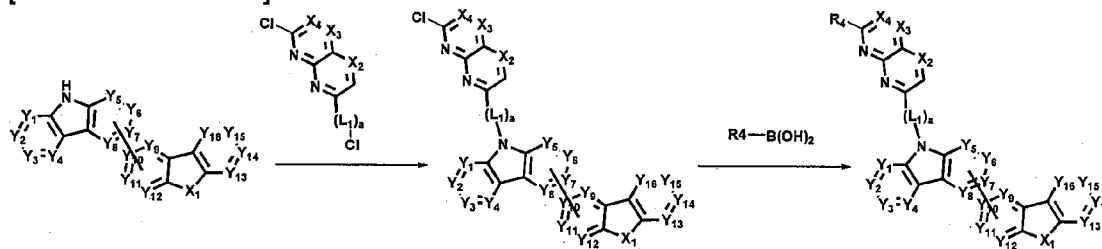
[67] [Reaction Scheme 1]



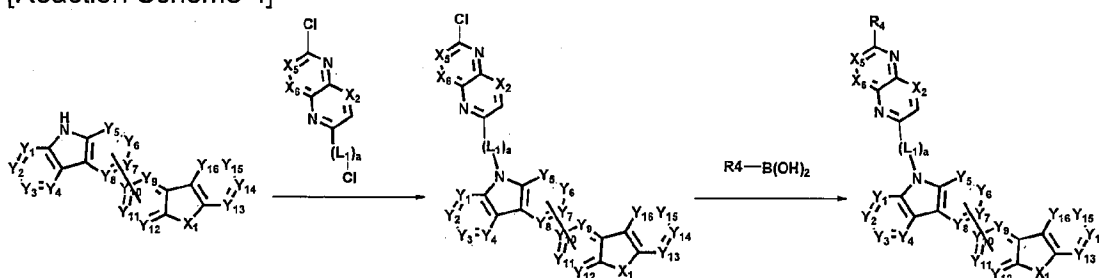
[68] [Reaction Scheme 2]



[69] [Reaction Scheme 3]



[70] [Reaction Scheme 4]



[71] In addition, the present disclosure provides an organic electroluminescent material comprising the organic electroluminescent compound of formula 1, and an organic electroluminescent device comprising the material.

[72] The material may comprise one or more compounds selected from the organic electroluminescent compound of formula 1. The material may further comprise a conventional compound(s) which has been comprised for an organic electroluminescent material.

[73] The organic electroluminescent device of the present disclosure may comprise a first electrode, a second electrode, and at least one organic layer disposed between the first and second electrodes, wherein the organic layer may comprise at least one compound of formula 1.

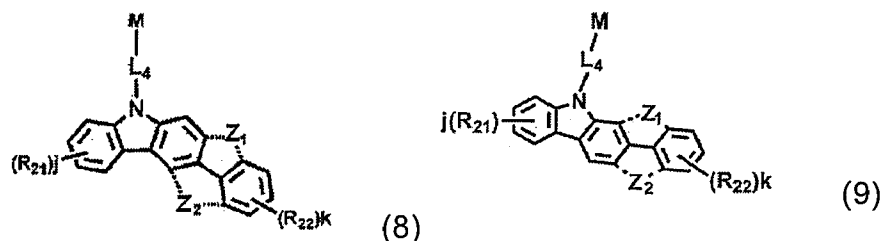
[74] One of the first and second electrodes may be an anode, and the other may be a cathode. The organic layer may comprise a light-emitting layer, and may further comprise at least one layer selected from a hole injection layer, a hole transport layer, an electron transport layer, an electron injection layer, an interlayer, a hole blocking layer, an electron buffer layer, and an electron blocking layer.

[75] The organic electroluminescent compound of the present disclosure may be comprised in the light-emitting layer. When used in the light-emitting layer, the organic electroluminescent compound of the present disclosure may be comprised as a host material. The light-emitting layer may further comprise at least one dopant. If necessary, the light-emitting layer may comprise two or more compounds selected from the organic electroluminescent compound of formula 1 of the present disclosure; or may further comprise a second host material other than the organic electroluminescent compound of formula 1 of the present disclosure.

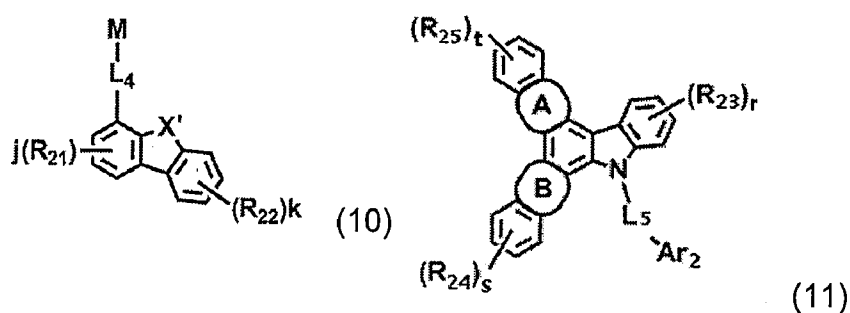
[76] A phosphorescent host material known in the art may be used as the second host material. The compound selected from the group consisting of the compounds of formulae 6 to 11 below is preferable as the second host material in view of driving voltage, lifespan, and luminous efficiency.

[77] 
$$\text{H}-(\text{Cz}-\text{L}_4)_n-\text{M} \quad (6) \quad \text{H}-(\text{Cz})_l-\text{L}_4-\text{M} \quad (7)$$

[78]

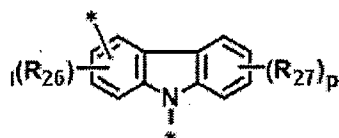


[79]



[80] wherein, Cz represents the following structure:

[81]

[82]  $L_4$  and  $L_5$ , each independently, represent a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted (5- to 30-membered)heteroarylene;

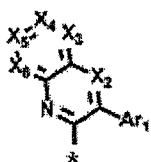
[83] M represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, provided that when h of formula 6 is 1, or i of formula 7 is 1, M is not

[84] , and M of formulae 8 and 9 are not

[85] (wherein  $X_2$  to  $X_6$ , and  $Ar_1$  are as defined in formula 1, and \* represents a bonding site.);[86]  $Z_1$  and  $Z_2$ , each independently, represent -O-, -S-, -N( $R_{31}$ )-, or -C( $R_{32}$ )( $R_{33}$ )-, provided that  $Z_1$  and  $Z_2$  do not simultaneously exist;[87]  $X'$  represents -O- or -S-;

[88] ring A represents ; ring B represents ;

[89] D and E, each independently, represent -O-, -S-, -N( $R_{34}$ )-, or -C( $R_{35}$ )( $R_{36}$ )-;[90]  $Ar_2$  represents a substituted or unsubstituted (3- to 30-membered)heteroaryl, or a sub-



(wherein  $X_2$  to  $X_6$  and  $Ar_1$  are as defined in formula 1, and \* represents a

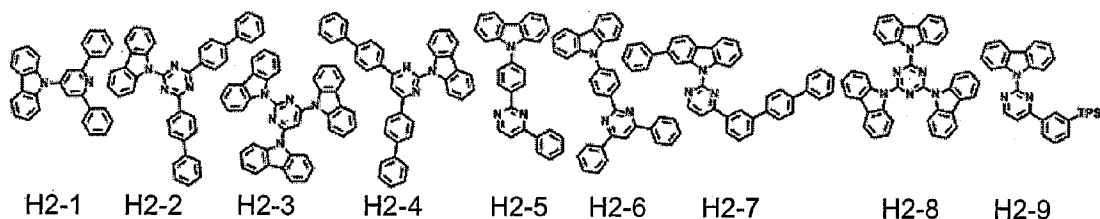
bonding site.);

- [91]  $R_{21}$  to  $R_{27}$ , each independently, represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, or  $R_{28}R_{29}R_{30}Si-$ ; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (C3-C30), monocyclic or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur; provided that when  $h$  of formula 6 or  $i$  of formula 7 is 1,  $R_{26}$  or  $R_{27}$  does not form the ring containing  $Z_1$ ,  $Z_2$ ,  $D$ , or  $E$  of formulae 8, 9, and 11,  $R_{22}$  of formula 10 does not form the indole ring connected to  $R_{21}$  of formulae 8 and 9 and the indole ring connected to  $R_{23}$  of formula 11;
- [92]  $R_{28}$  to  $R_{30}$ , each independently, represent a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl;
- [93]  $R_{31}$  to  $R_{36}$ , each independently, represent hydrogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl;  $R_{32}$  and  $R_{33}$  may be the same or different;  $R_{35}$  and  $R_{36}$  may be the same or different;
- [94] the heteroaryl(ene) contains one or more hetero atoms selected from B, N, O, S, P(=O), Si, and P;
- [95]  $h$  and  $i$ , each independently, represent an integer of 1 to 3;  $j$ ,  $k$ ,  $l$  and  $p$ , each independently, represent an integer of 0 to 4;  $r$ ,  $s$ , and  $t$ , each independently, represent an integer of 1 to 4; and when  $h$ ,  $i$ ,  $j$ ,  $k$ ,  $l$ ,  $p$ ,  $r$ ,  $s$ , or  $t$  is an integer of 2 or more, each of (Cz- $L_4$ ), each of (Cz), each of  $R_{21}$ , each of  $R_{22}$ , each of  $R_{23}$ , each of  $R_{24}$ , each of  $R_{25}$ , each of  $R_{26}$ , or each of  $R_{27}$  may be the same or different.
- [96] Preferably, in formulae 6 to 10,  $M$  may represent a substituted or unsubstituted nitrogen-containing (6- to 20-membered)heteroaryl. Preferably, the substituent of  $M$  may be a (C1-C20)alkyl; a (C6-C24)aryl unsubstituted or substituted with a (C1-C10)alkyl, a tri(C6-C13)arylsilyl, or a (6- to 13-membered)heteroaryl; a (6- to 20-membered)heteroaryl unsubstituted or substituted with a (C1-C10)alkyl, a tri(C6-C13)arylsilyl, or a (C6-C24)aryl; or a tri(C6-C20)arylsilyl. Specifically,  $M$  may represent a substituted or unsubstituted pyridyl, a substituted or unsubstituted pyrimidinyl, a substituted or unsubstituted triazinyl, a substituted or unsubstituted pyrazinyl, a substituted or unsubstituted quinazolinyl, or a substituted or unsubstituted

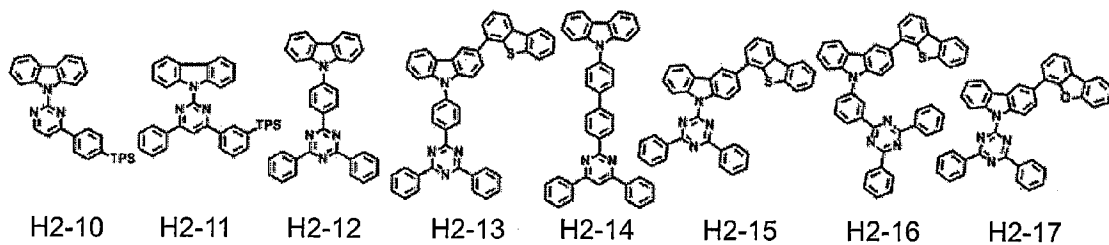
phenanthrolinyl.

- [97] At least one of  $R_{26}$  and  $R_{27}$  of formulae 6 and 7, or at least one of  $R_{21}$  and  $R_{22}$  of formulae 8 to 10 may be a substituted or unsubstituted carbazolyl, a substituted or unsubstituted benzocarbazolyl, a substituted or unsubstituted dibenzothiophenyl, a substituted or unsubstituted naphthobenzothiophenyl, a substituted or unsubstituted dibenzofuranyl, a substituted or unsubstituted naphthobenzofuranyl, a (C6-C18)aryl substituted with a substituted or unsubstituted carbazolyl, a (C6-C18)aryl substituted with a substituted or unsubstituted benzocarbazolyl, a (C6-C18)aryl substituted with a substituted or unsubstituted dibenzothiophenyl, a (C6-C18)aryl substituted with a substituted or unsubstituted naphthobenzothiophenyl, a (C6-C18)aryl substituted with a substituted or unsubstituted dibenzofuranyl, or a (C6-C18)aryl substituted with a substituted or unsubstituted naphthobenzofuranyl. When M is aryl, at least one of  $R_{26}$  and  $R_{27}$ , or at least one of  $R_{21}$  and  $R_{22}$  may represent a substituted or unsubstituted nitrogen-containing (6- to 20-membered)heteroaryl; or may have, as a substituent, a substituted or unsubstituted nitrogen-containing (6- to 20-membered)heteroaryl. Specifically, the substituted or unsubstituted nitrogen-containing heteroaryl may represent a substituted or unsubstituted pyridyl, a substituted or unsubstituted pyrimidinyl, a substituted or unsubstituted triazinyl, a substituted or unsubstituted pyrazinyl, a substituted or unsubstituted quinazolinyl, or a substituted or unsubstituted phenanthrolinyl.
- [98] D and E, each independently, may be preferably selected from -O-, -S-, and -N( $R_{34}$ )-, provided that both X and Y are not -N( $R_{34}$ )-, simultaneously. According to one embodiment of the present disclosure, X and Y, each independently, may be selected from -O- and -S-. According to another embodiment of the present disclosure, X and Y, each independently, may be selected from -O- and -S-; and at least one of X and Y may be -S-.  $R_{34}$  may represent preferably, a substituted or unsubstituted (C6-C30)aryl, and specifically, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, or a substituted or unsubstituted biphenyl.
- [99]  $Ar_2$  may represent preferably, a substituted or unsubstituted (6- to 20-membered)heteroaryl, or a substituted or unsubstituted (C6-C20)aryl; and more preferably a substituted or unsubstituted nitrogen-containing (6- to 20-membered)heteroaryl. Specifically,  $Ar_2$  may represent a substituted or unsubstituted triazinyl, a substituted or unsubstituted pyrimidinyl, a substituted or unsubstituted pyridyl, a substituted or unsubstituted pyrazinyl, a substituted or unsubstituted quinazolinyl, or a substituted or unsubstituted phenanthrolinyl.
- [100] Specifically, the preferable example of the second host material includes the following, but is not limited thereto:

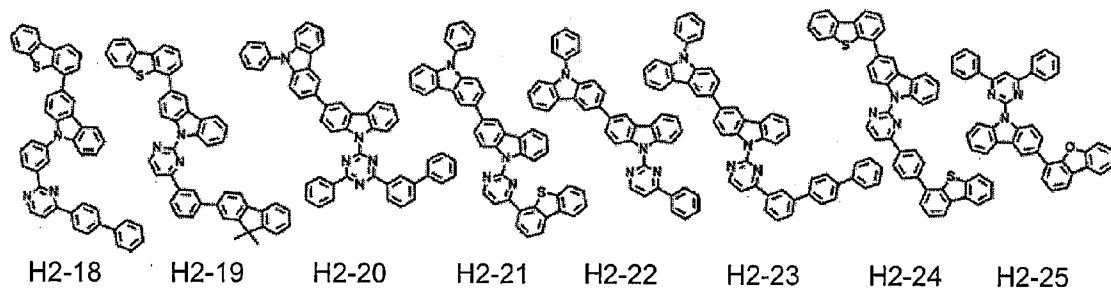
[101]



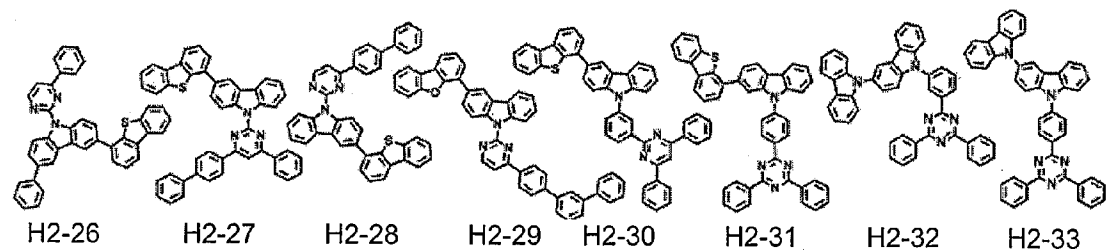
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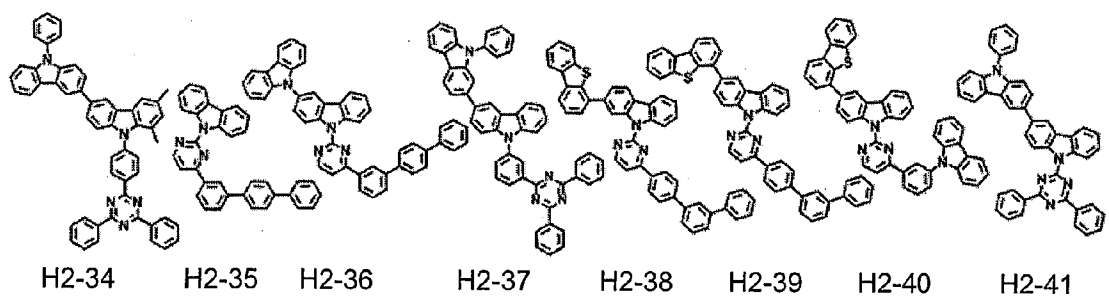
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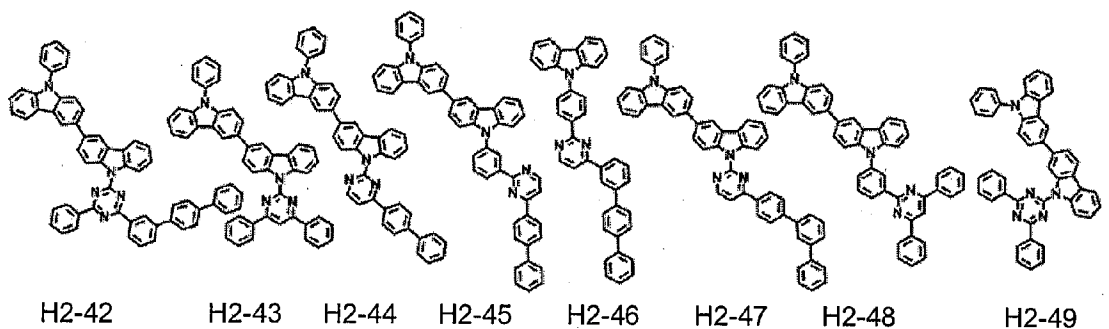
[104]



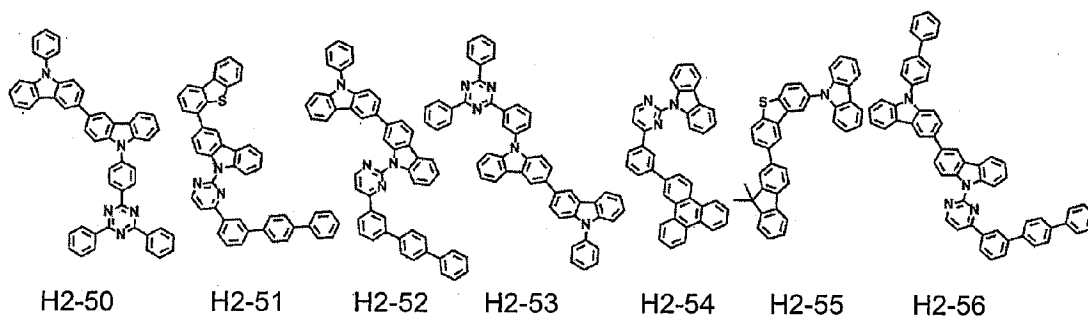
[105]



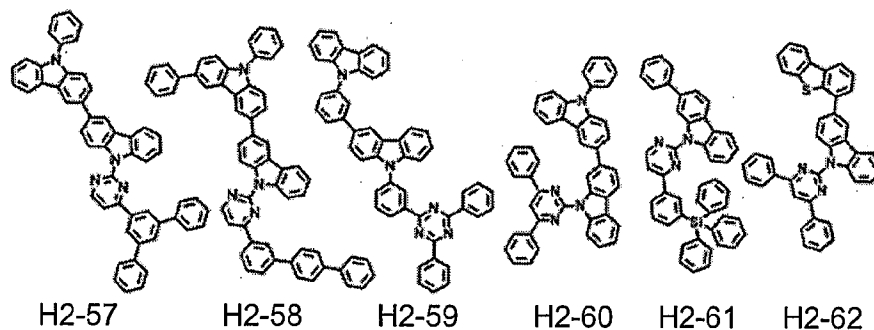
[106]



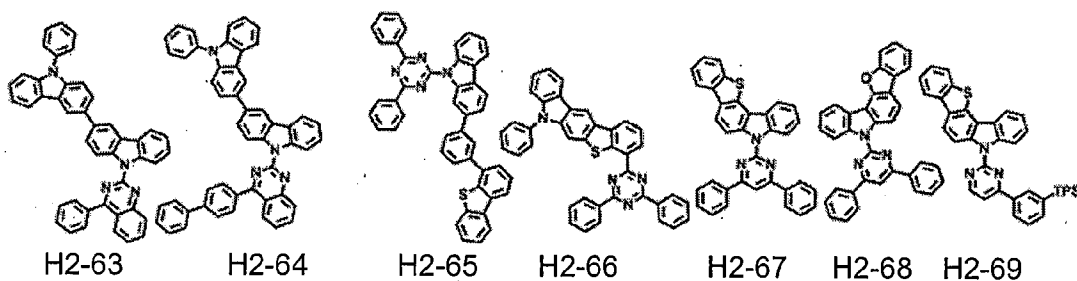
[107]



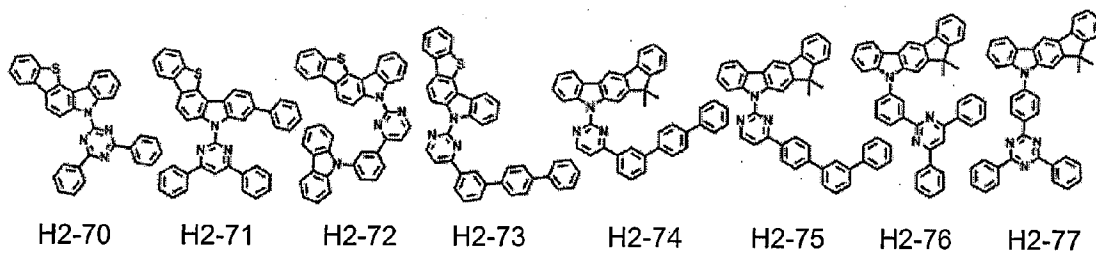
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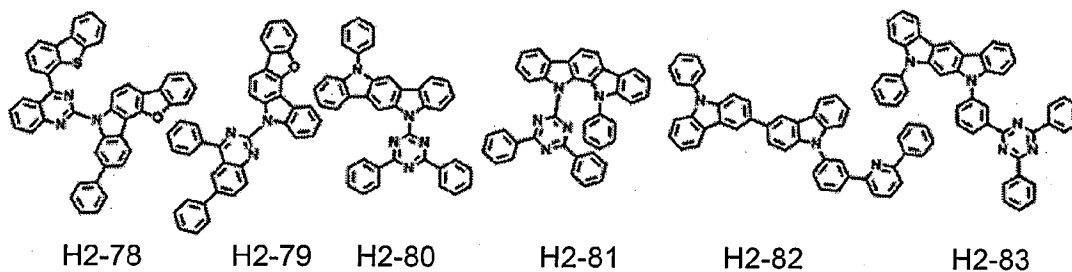
[109]



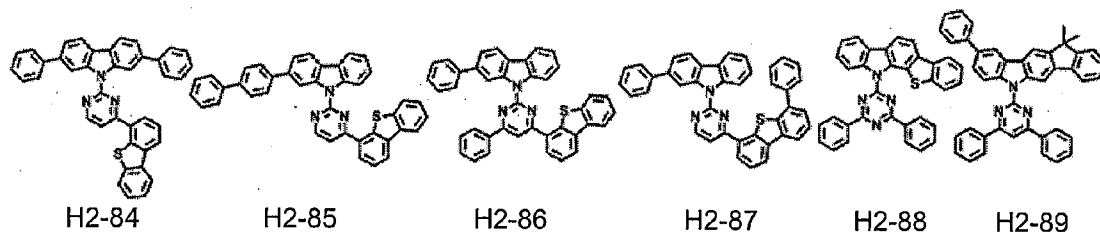
[110]



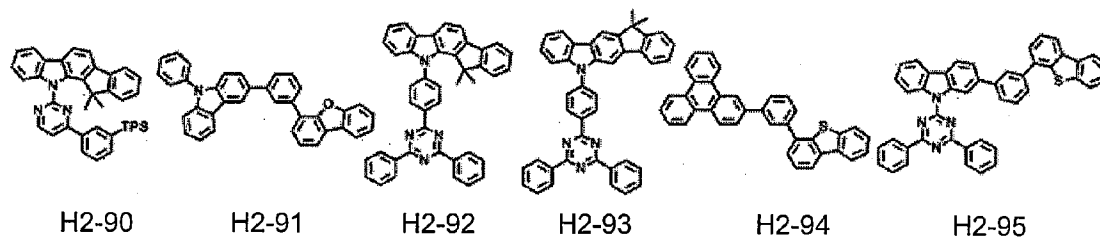
[111]



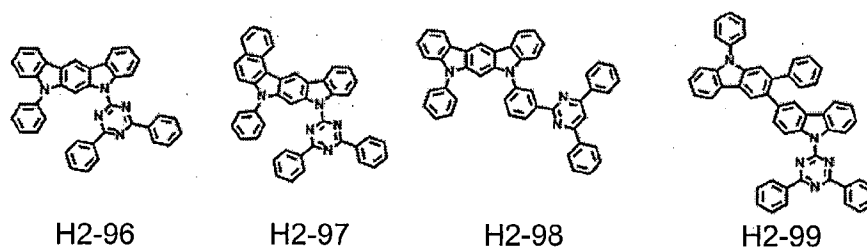
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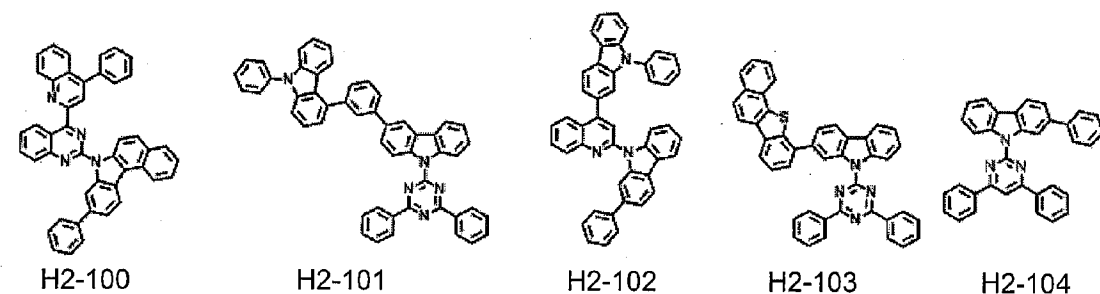
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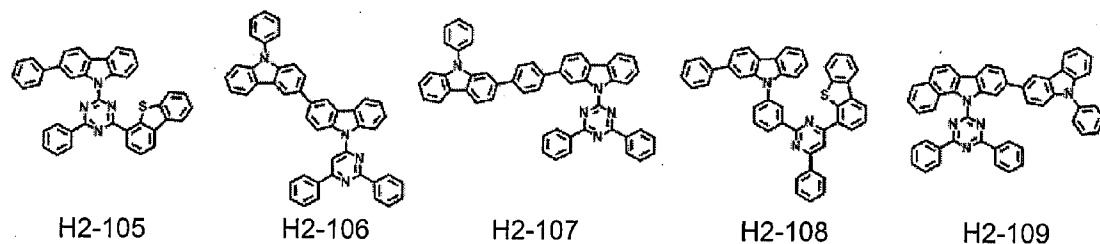
[114]



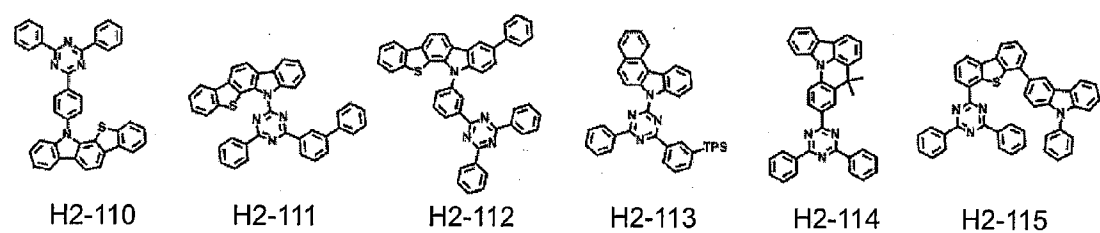
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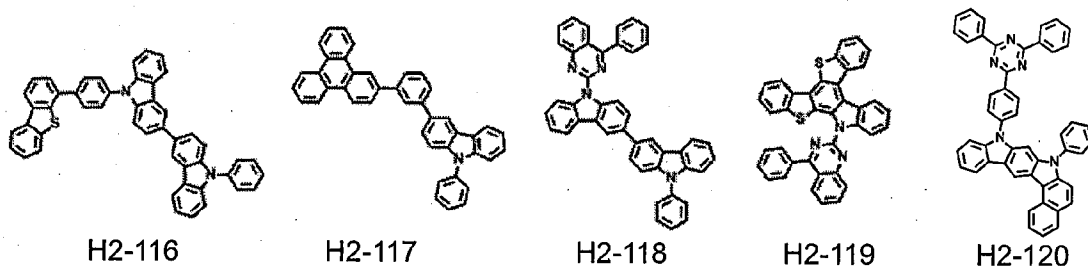
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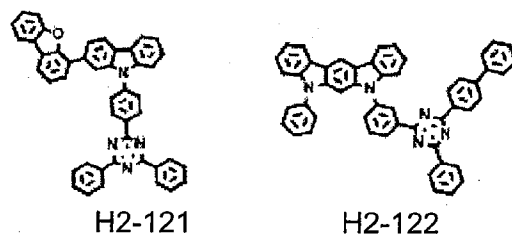
[117]



[118]



[119]

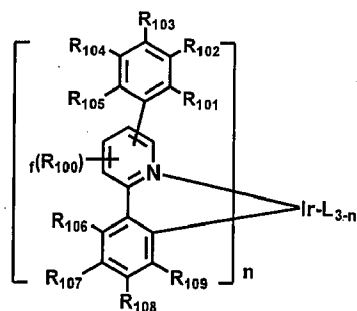


[120] [Wherein, TPS represents triphenylsilyl.]

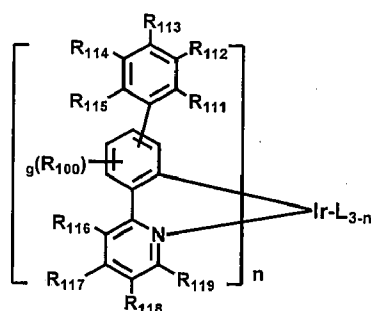
[121] The dopant is preferably at least one phosphorescent dopant. The phosphorescent dopant material for the organic electroluminescent device of the present disclosure is not limited, but may be preferably selected from metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu) or platinum (Pt), more preferably selected from ortho-metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu) or platinum (Pt), and even more preferably ortho-metallated iridium complex compounds.

[122] The dopant to be comprised in the organic electroluminescent device of the present disclosure may be selected from the group consisting of compounds represented by the following formulae 12 to 14.

[123]

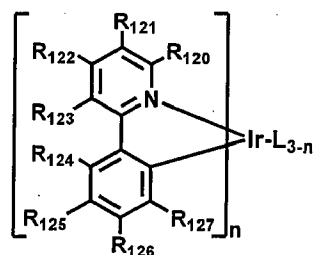


(12)



(13)

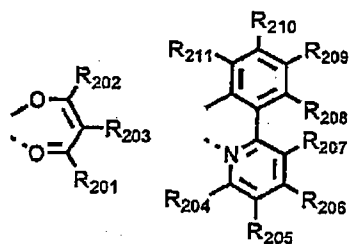
[124]



(14)

[125] wherein L is selected from the following structures:

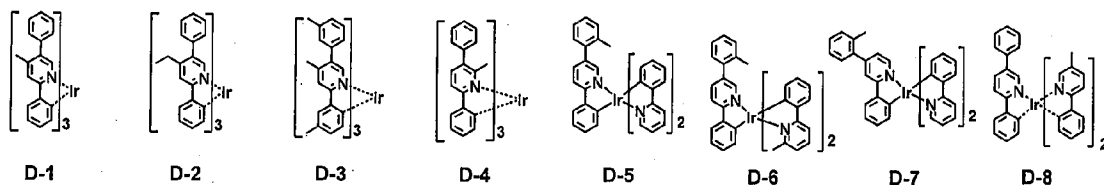
[126]



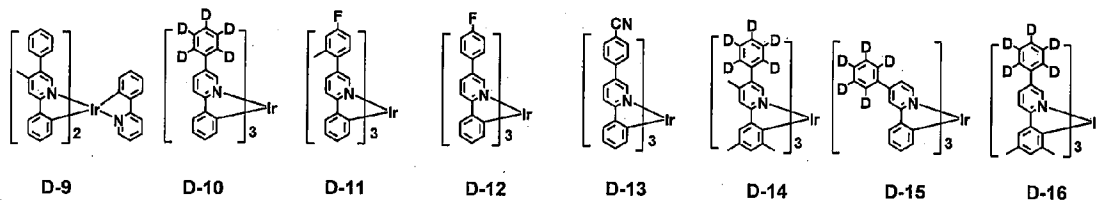
[127]  $R_{100}$  represents hydrogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl;  $R_{101}$  to  $R_{109}$ , and  $R_{111}$  to  $R_{123}$ , each independently, represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen, a substituted or unsubstituted (C3-C30)cycloalkyl, a cyano, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (C1-C30)alkoxy;  $R_{106}$  to  $R_{109}$  may be linked to an adjacent substituent(s) to form a substituted or unsubstituted fused ring, for example, a substituted or unsubstituted fluorene, a substituted or unsubstituted dibenzothiophene, or a substituted or unsubstituted dibenzofuran;  $R_{120}$  to  $R_{123}$  may be linked to an adjacent substituent(s) to form a substituted or unsubstituted fused ring, for example, a substituted or unsubstituted quinoline;  $R_{124}$  to  $R_{127}$ , each independently, represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; when any one of  $R_{124}$  to  $R_{127}$  is aryl, it may be linked to an adjacent substituent(s) to form a substituted or unsubstituted fused ring, for example, a substituted or unsubstituted fluorene, a substituted or unsubstituted dibenzothiophene, or a substituted or unsubstituted dibenzofuran;  $R_{201}$  to  $R_{211}$ , each independently, represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-30)aryl,  $R_{208}$  to  $R_{211}$  may be linked to an adjacent substituent(s) to form a substituted or unsubstituted fused ring, for example, a substituted or unsubstituted fluorene, a substituted or unsubstituted dibenzothiophene, or a substituted or unsubstituted dibenzofuran;  $f$  and  $g$ , each independently, represent an integer of 1 to 3; when  $f$  or  $g$  is an integer of 2 or more, each of  $R_{100}$  may be the same or different; and  $n$  represents an integer of 1 to 3.

[128] Specifically, the dopant material includes the following:

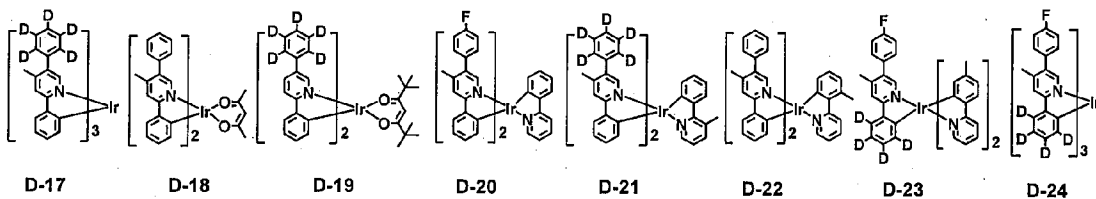
[129]



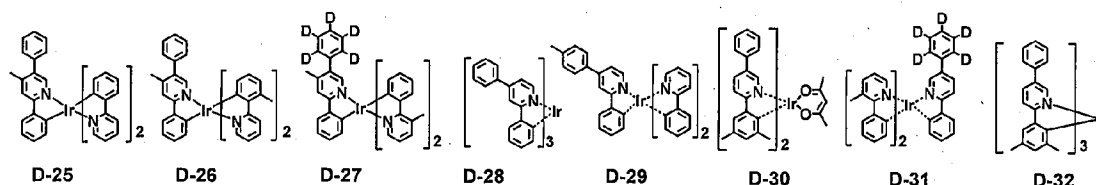
[130]



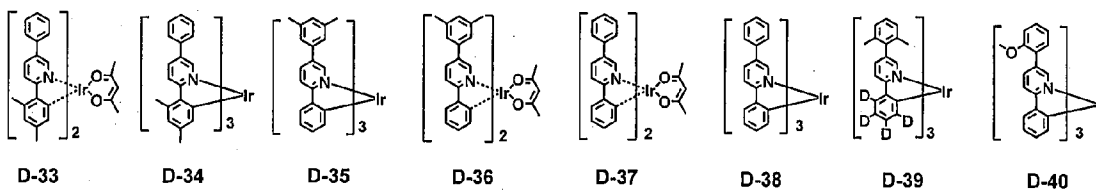
[131]



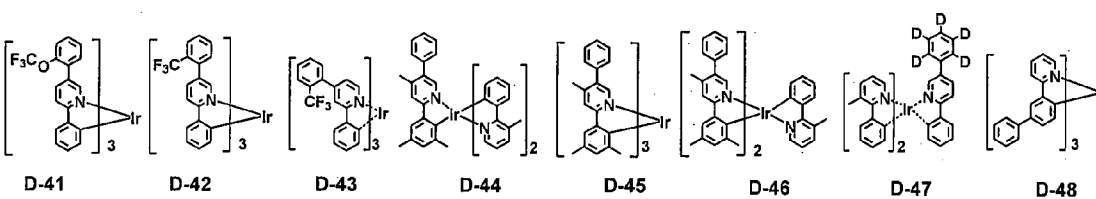
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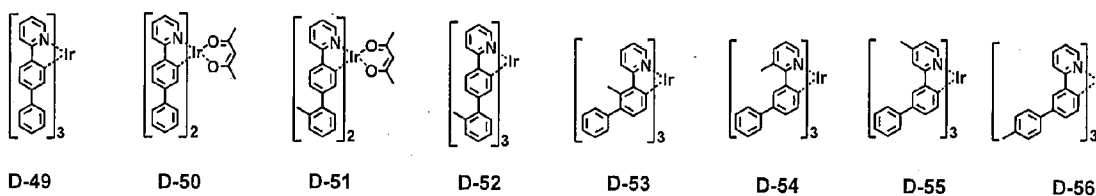
[133]



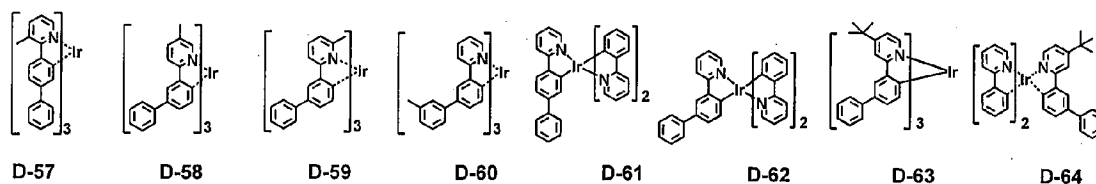
[134]



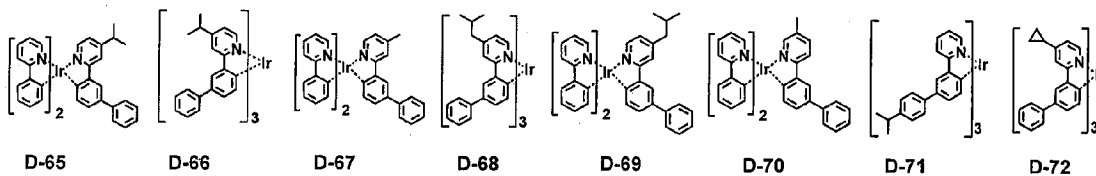
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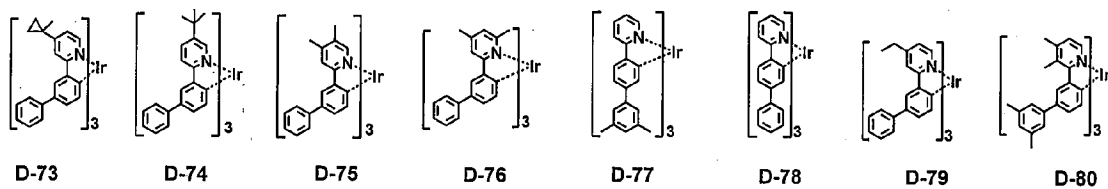
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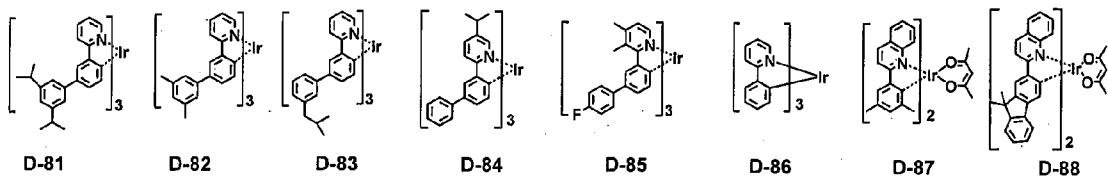
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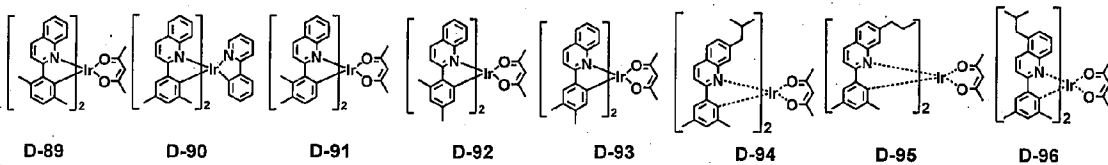
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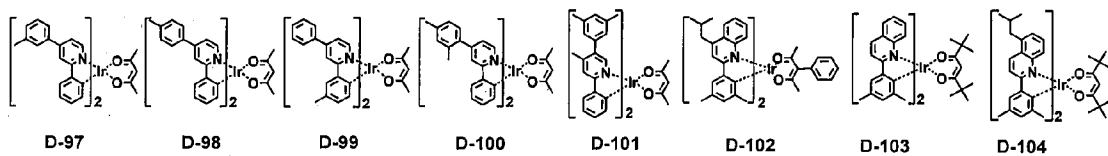
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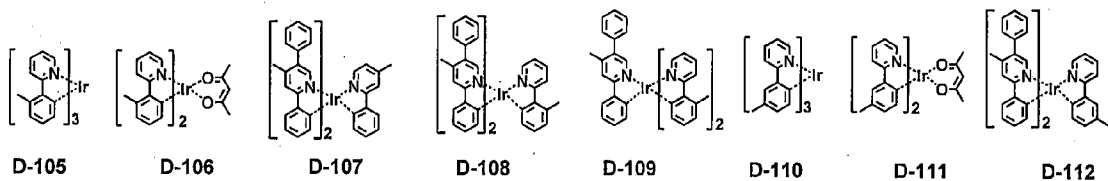
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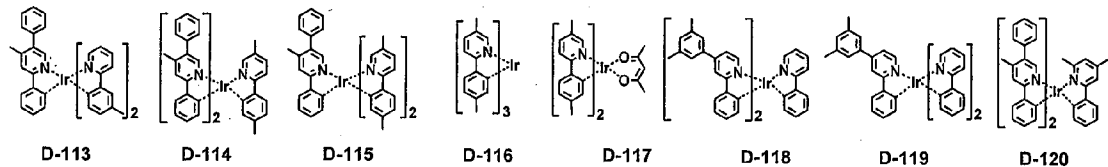
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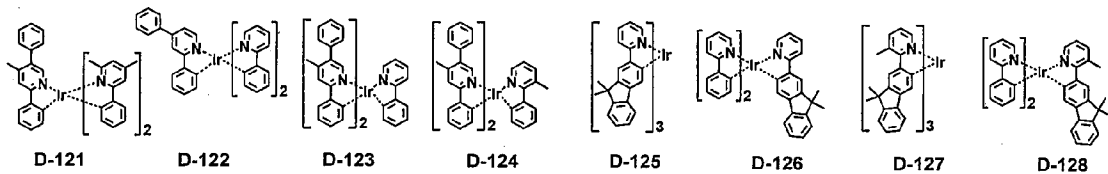
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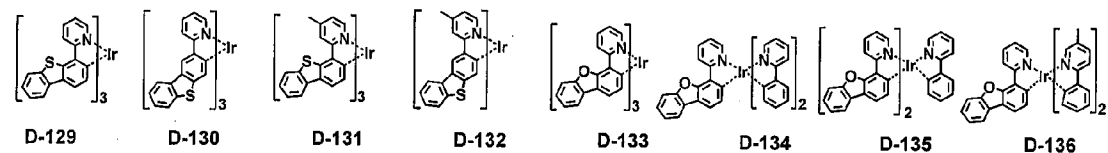
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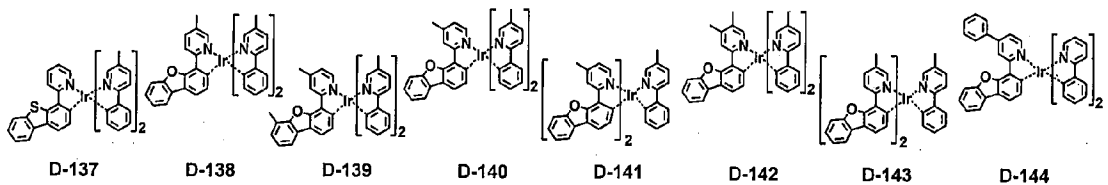
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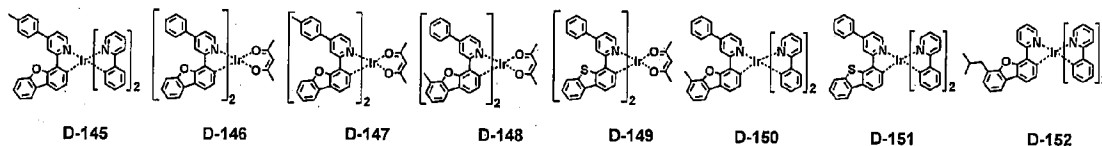
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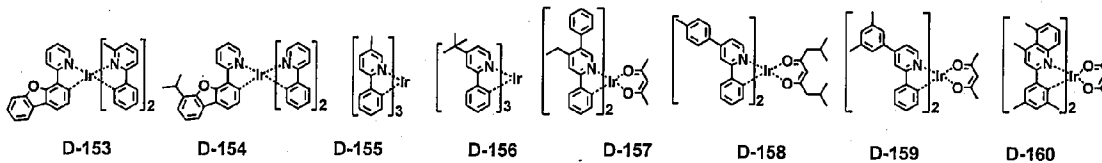
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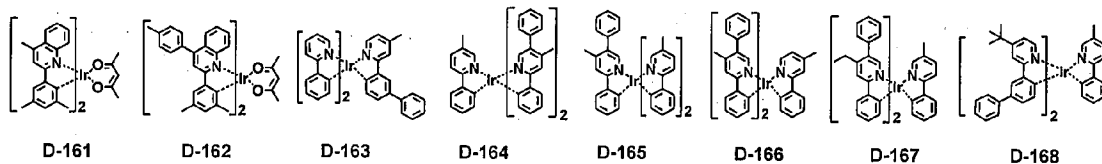
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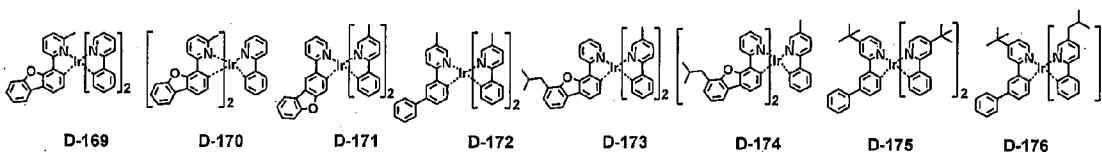
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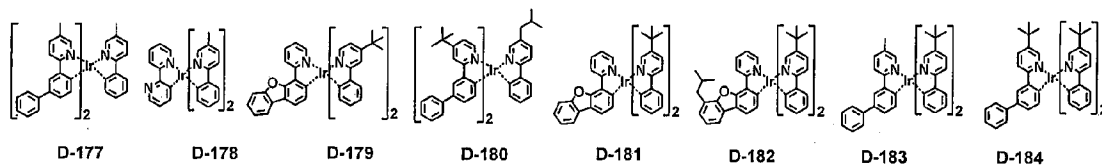
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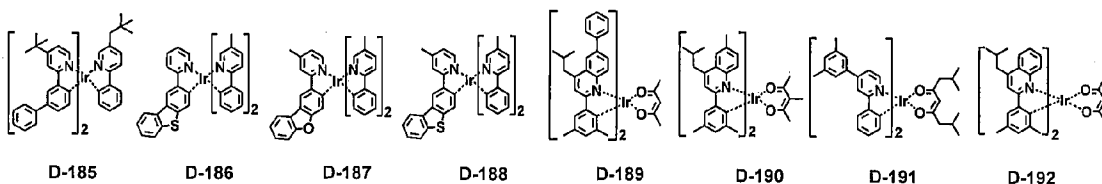
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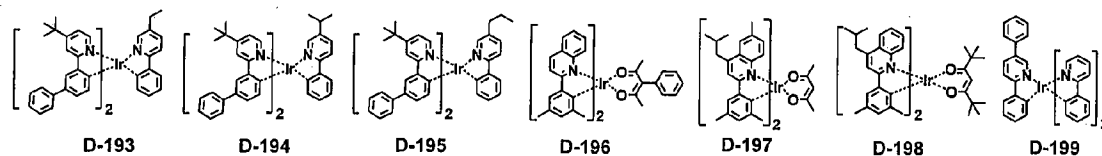
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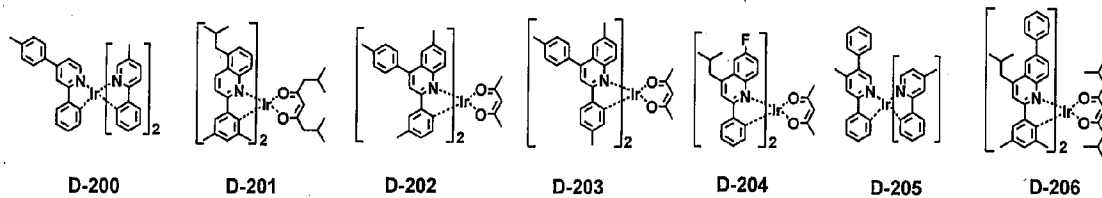
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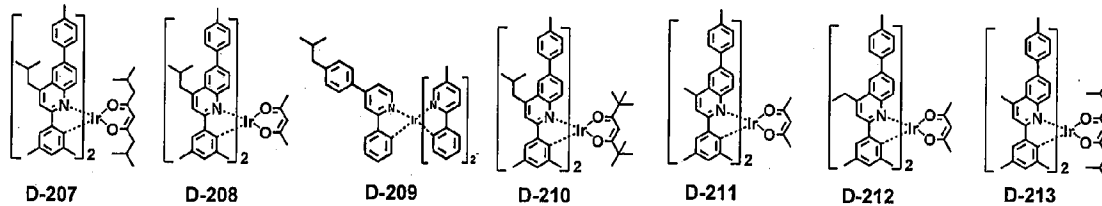
[153]



[154]



[155]



[156]

According to another aspect of the present disclosure, a material for preparing an

organic electroluminescent device is provided. The material may be a material for preparing a light-emitting layer or an electron transport layer of an organic electroluminescent device. When the compound of the present disclosure is comprised in the material for preparing a light-emitting layer of an organic electroluminescent device, the compound of the present disclosure may be comprised as a host material. When the compound of the present disclosure is comprised as a host material, the material may comprise two or more compounds selected from the organic electroluminescent compound of formula 1 of the present disclosure; or may comprise, in addition to an organic electroluminescent compound of formula 1 of the present disclosure (a first host material), a second host material, for example, a material selected from the compound represented by formulae 6 to 11. The weight ratio between the first host material and the second host material is in the range of 1:99 to 99:1, and preferably 30:70 to 70:30 in view of driving voltage, lifespan, and luminous efficiency. When the compound of the present disclosure is comprised in the material for preparing an electron transport layer of an organic electroluminescent device, the compound of the present disclosure may be comprised as an electron transport material. The material may be a composition or a mixture. The material may further comprise a conventional compound(s) which has been comprised for an organic electroluminescent material.

[157] According to another aspect of the present disclosure, an organic electroluminescent device comprising a first electrode, a second electrode, and at least one organic layer disposed between the first and second electrodes, wherein the organic layer comprises the material of the present disclosure for preparing an organic electroluminescent device, is provided.

[158] According to another aspect of the present disclosure, an organic electroluminescent device comprising an anode, a cathode, and an organic layer disposed between the anode and cathode, wherein the organic layer comprises one or more light-emitting layers; at least one light-emitting layer comprises one or more dopant compounds and two or more host compounds; and at least one of the two or more host compounds is represented by formula 1 is provided.

[159] According to one embodiment of the present disclosure, in the organic electroluminescent device, a first host compound of the two or more host compounds may be selected from the compound represented by formulae 2 and 5.

[160] According to another embodiment of the present disclosure, in the organic electroluminescent device, at least two of the two or more host compounds, each independently, may be selected from the compound represented by formula 1.

[161] According to another embodiment of the present disclosure, in the organic electroluminescent device, a first host compound of the two or more host compounds may be represented by formula 1, and a second host compound may be selected from the

compound represented by formulae 6 to 11.

[162] According to another embodiment of the present disclosure, in the organic electroluminescent device, the one or more dopant compounds may be selected from the compound represented by formulae 12 to 14.

[163] The organic electroluminescent device of the present disclosure comprises the compound of formula 1 in the organic layer. The organic electroluminescent device of the present disclosure may further comprise at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds.

[164] In the organic electroluminescent device of the present disclosure, the organic layer may further comprise, in addition to the compound of formula 1, at least one metal selected from the group consisting of metals of Group 1, metals of Group 2, transition metals of the 4<sup>th</sup> period, transition metals of the 5<sup>th</sup> period, lanthanides and organic metals of the d-transition elements of the Periodic Table, or at least one complex compound comprising the metal.

[165] In addition, the organic electroluminescent device of the present disclosure may emit white light by further comprising at least one light-emitting layer, which comprises a blue electroluminescent compound, a red electroluminescent compound or a green electroluminescent compound known in the field, besides the compound of the present disclosure. If necessary, it may further comprise an orange light-emitting layer or a yellow light-emitting layer.

[166] In the organic electroluminescent device of the present disclosure, preferably, at least one layer (hereinafter, "a surface layer") may be placed on an inner surface(s) of one or both electrode(s), selected from a chalcogenide layer, a metal halide layer and a metal oxide layer. Specifically, a chalcogenide (includes oxides) layer of silicon or aluminum is preferably placed on an anode surface of an electroluminescent medium layer, and a metal halide layer or a metal oxide layer is preferably placed on a cathode surface of an electroluminescent medium layer. Such a surface layer provides operation stability for the organic electroluminescent device. Preferably, the chalcogenide includes  $\text{SiO}_x$  ( $1 \leq x \leq 2$ ),  $\text{AlO}_x$  ( $1 \leq x \leq 1.5$ ),  $\text{SiON}$ ,  $\text{SiAlON}$ , etc.; the metal halide includes  $\text{LiF}$ ,  $\text{MgF}_2$ ,  $\text{CaF}_2$ , a rare earth metal fluoride, etc.; and the metal oxide includes  $\text{Cs}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{MgO}$ ,  $\text{SrO}$ ,  $\text{BaO}$ ,  $\text{CaO}$ , etc.

[167] In the organic electroluminescent device of the present disclosure, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant may be placed on at least one surface of a pair of electrodes. In this case, the electron transport compound is reduced to an anion, and thus it becomes easier to inject and transport electrons from the mixed region to an electroluminescent medium. Furthermore, the hole transport compound is oxidized to a

cation, and thus it becomes easier to inject and transport holes from the mixed region to the electroluminescent medium. Preferably, the oxidative dopant includes various Lewis acids and acceptor compounds, and the reductive dopant includes alkali metals, alkali metal compounds, alkaline earth metals, rare-earth metals, and mixtures thereof. A reductive dopant layer may be employed as a charge generating layer to prepare an electroluminescent device having two or more light-emitting layers and emitting white light.

[168] In order to form each layer of the organic electroluminescent device of the present disclosure, dry film-forming methods such as vacuum evaporation, sputtering, plasma and ion plating methods, or wet film-forming methods such as inkjet printing, nozzle printing, slot coating, spin coating, dip coating, and flow coating methods can be used.

[169] When using a wet film-forming method, a thin film can be formed by dissolving or diffusing materials forming each layer into any suitable solvent such as ethanol, chloroform, tetrahydrofuran, dioxane, etc. The solvent can be any solvent where the materials forming each layer can be dissolved or diffused, and where there are no problems in film-formation capability.

[170] In the organic electroluminescent device of the present disclosure, two or more host compounds for a light-emitting layer may be co-evaporated or mixture-evaporated. Herein, a co-evaporation indicates a process for two or more materials to be deposited as a mixture, by introducing each of the two or more materials into respective crucible cells, and applying electric current to the cells for each of the materials to be evaporated. Herein, a mixture-evaporation indicates a process for two or more materials to be deposited as a mixture, by mixing the two or more materials in one crucible cell before the deposition, and applying electric current to the cell for the mixture to be evaporated.

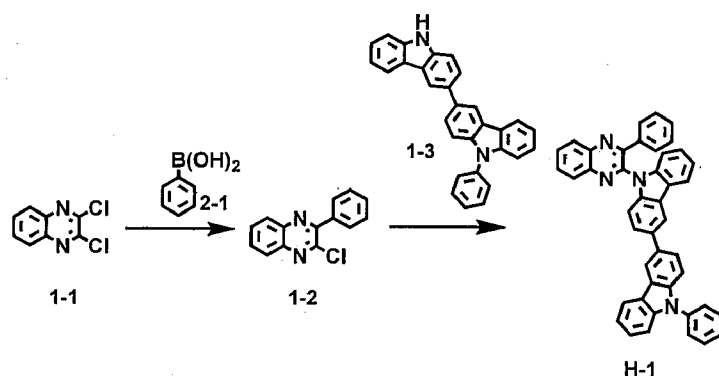
[171] By using the organic electroluminescent device of the present disclosure, a display system or a lighting system can be produced.

[172] Hereinafter, the organic electroluminescent compound of the present disclosure, the preparation method of the compound, and the luminescent properties of the device will be explained in detail with reference to the following examples.

[173]

[174] **[Example 1]**

[175]

[176] Preparation of compound 1-2

[177] After adding compound 1-1 (20 g, 100.5 mmol), compound 2-1 (19 g, 150 mmol), palladium(0) tetrakis(triphenylphosphine) [Pd(PPh<sub>3</sub>)<sub>4</sub>] (5.7 g, 5.0 mmol), and Na<sub>2</sub>CO<sub>3</sub> (31 g, 300 mmol) to toluene (500 mL), ethanol (250 mL), and purified water 250 mL, the mixture was stirred at 120°C for 15 hours. After the completion of the reaction, the mixture was standed to remove the water layer, and the organic layer was then concentrated. The mixture was purified by column chromatography to obtain compound 1-2 (20 g, 83%).

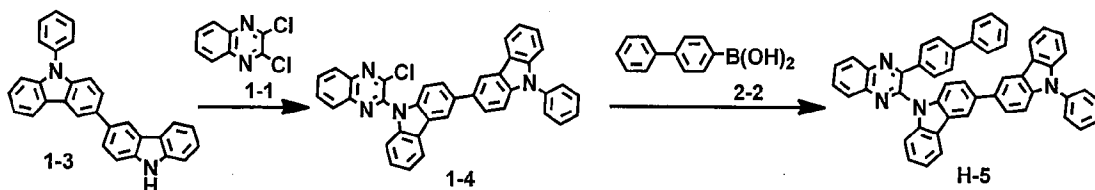
[178] Preparation of compound H-1

[179] After dissolving compound 1-2 (20 g, 83 mmol), compound 1-3 (50 g, 99 mmol), and NaH (4 g, 166 mmol) into dimethylformamide (DMF), the mixture was stirred for 15 hours. After the completion of the reaction, the solid was filtered, and purified by column chromatography to obtain compound H-1 (50 g, 82%).

[180]

[181] [Example 2]

[182]

[183] Preparation of compound 1-4

[184] After dissolving compound 1-3 (30g, 73.44mmol) in dimethylformamide (370mL), sodium hydride (4.4g, 110.16mmol) was slowly added to the mixture, and the mixture was then stirred for 30 minutes. Compound 1-1 (17.5g, 88.13mmol) was added to the mixture, and the mixture was then stirred for 4 hours. After slowly adding the mixture to distilled water (500mL), the mixture was stirred for 30 minutes. The obtained solid was purified by column chromatography and recrystallization to obtain compound 1-4 (30g, 71%).

[185] Preparation of compound H-5

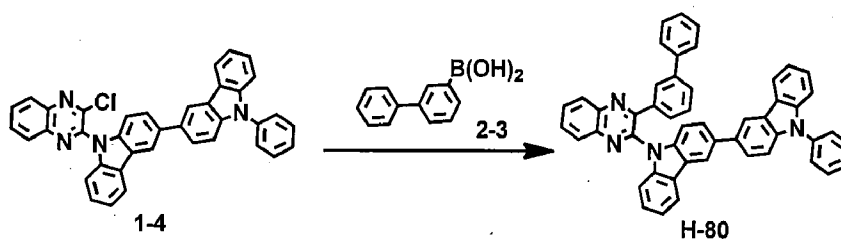
[186] After introducing compound 1-4 (10g, 17.51 mmol), compound 2-2 (4.2g, 21.01

mmol), palladium(0) tetrakis(triphenylphosphine) [Pd(PPh<sub>3</sub>)<sub>4</sub>] (0.6g, 0.53 mmol), sodium carbonate (4.6g, 43.78 mmol), toluene (90mL), and ethanol (22mL) into a reaction vessel, distilled water (22mL) was added to the mixture. The mixture was stirred at 120°C for 4 hours. After the completion of the reaction, the mixture was washed with distilled water, and extracted with ethyl acetate. The obtained organic layer was dried with magnesium sulfate, and the solvent was removed therefrom by a rotary evaporator. The products were purified by column chromatography to obtain compound **H-5** (5.5g, 46%).

[187]

[188] [Example 3]

[189]

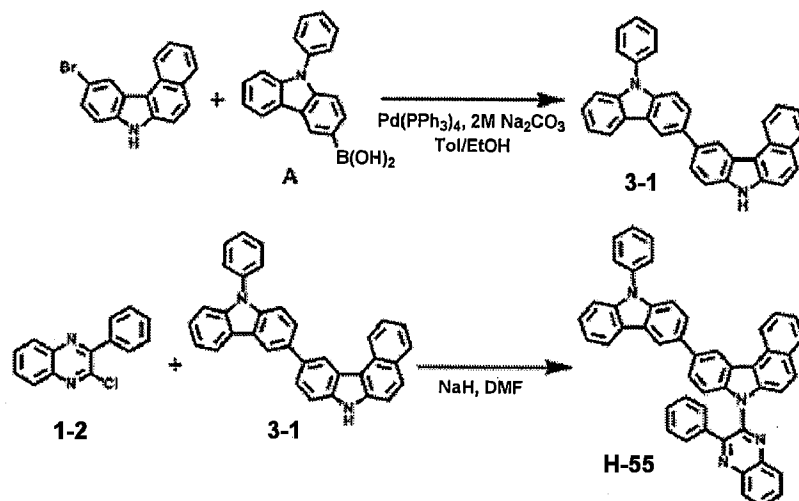
[190] Preparation of compound **H-80**

[191] After introducing compound 1-4 (10g, 17.51 mmol), compound 2-3 (4.2g, 21.01 mmol), palladium(0) tetrakis(triphenylphosphine) [Pd(PPh<sub>3</sub>)<sub>4</sub>] (0.6g, 0.53 mmol), sodium carbonate (4.6g, 43.78 mmol), toluene (90mL), and ethanol (22mL) into a reaction vessel, distilled water (22mL) was added to the mixture, and the mixture was then stirred at 120°C for 4 hours. After the completion of the reaction, the mixture was washed with distilled water, and extracted with ethyl acetate. The obtained organic layer was dried with magnesium sulfate, and the solvent was removed therefrom by a rotary evaporator. The products were purified by column chromatography to obtain compound **H-80** (7.7g, 64%).

[192]

[193] [Example 4]

[194]

[195] Preparation of compound **3-1**

[196] After dissolving compound 10-bromo-7H-benzo[c]carbazole (15.5g, 41.64 mmol), compound **A** (13.1g, 45.80 mmol),  $\text{Pd(PPh}_3)_4$  (2.4g, 2.08 mmol), and  $2\text{M Na}_2\text{CO}_3$  (110mL) in toluene (220mL) and ethanol (110mL), the mixture was under reflux at  $120^\circ\text{C}$  for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed therefrom with magnesium sulfate, and then the mixture was dried. The products were purified by column chromatography to obtain compound **3-1** (15.4g, yield: 81%).

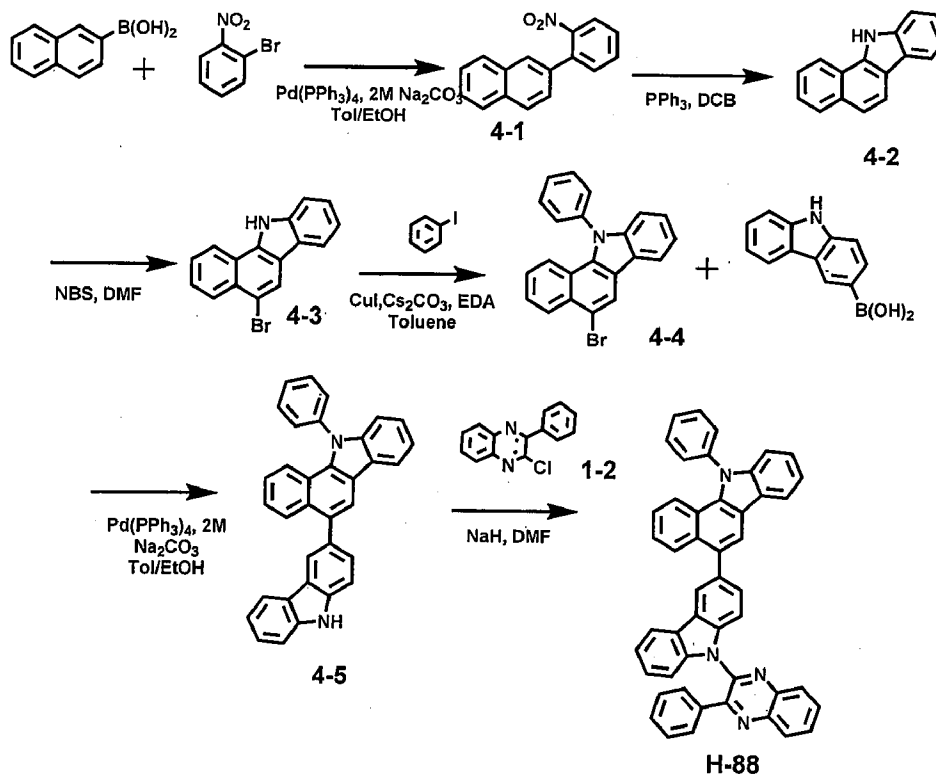
[197] Preparation of compound **H-55**

[198] After dissolving compound **1-2** (6.3g, 26.17 mmol), and compound **3-1** (10g, 21.81 mmol) in DMF (110mL),  $\text{NaH}$  (0.5g, 14.54 mmol, 60% in mineral oil) was added to the mixture. The mixture was stirred at room temperature for 12 hours, and methanol and distilled water were added thereto. The obtained solid was filtered under reduced pressure, and then purified by column chromatography to obtain compound **H-55** (2.5g, yield: 18%).

[199]

[200] [Example 5]

[201]

[202] Preparation of compound 4-1

[203] After dissolving naphthalene-2-yl boronic acid (30g, 174.35 mmol), 2-bromonitrobenzene (42g, 209.22 mmol),  $\text{Pd(PPh}_3)_4$  (10g, 8.71 mmol), and  $2\text{M Na}_2\text{CO}_3$  (425mL) in toluene (850mL) and ethanol (425mL) of a flask, the mixture was under reflux at  $120^\circ\text{C}$  for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 4-1 (40g, yield: 93%).

[204] Preparation of compound 4-2

[205] After dissolving compound 4-1 (40g, 160.34 mmol), and  $\text{PPh}_3$  (105.1g, 400.86 mmol) in dichlorobenzene (DCB) (1000mL), the mixture was under reflux at  $150^\circ\text{C}$  for 6 hours. After the completion of the reaction, the mixture was distilled, and was triturated with methanol. As a result, compound 4-2 (24g, yield: 50%) was obtained.

[206] Preparation of compound 4-3

[207] After dissolving compound 1-2 (24g, 110.46 mmol) in DMF (570mL), N-bromosuccinimide (NBS) (17g, 99.42 mmol) was added thereto at  $0^\circ\text{C}$ . The mixture was stirred for 5 hours, and distilled water was then added thereto. The obtained solid was filtered under reduced pressure, added to methanol, stirred, and then filtered under reduced pressure. After the solid was added to ethyl acetate and methanol, the mixture was stirred, and filtered under reduced pressure to obtain compound 4-3 (23g, yield:

73%).

[208] Preparation of compound 4-4

[209] After dissolving compound 4-3 (23.4g, 79.01 mmol), iodobenzene (18mL, 158.02 mmol), CuI (7.5g, 39.50 mmol), ethylene diamine (EDA) (2.6mL, 39.50 mmol), and Cs<sub>2</sub>CO<sub>3</sub> (77g, 237.03 mmol) in toluene (400mL), the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 4-4 (21.5g, yield: 74%).

[210] Preparation of compound 4-5

[211] After dissolving compound 4-4 (21.5g, 57.75 mmol), (9H-carbazol-3-yl)boronic acid (15g, 69.31 mmol), Pd(PPh<sub>3</sub>)<sub>4</sub> (3.4g, 2.88 mmol) and 2M Na<sub>2</sub>CO<sub>3</sub> (150mL) in toluene (300mL) and ethanol (150mL), the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 4-5 (4.2g, yield: 17%).

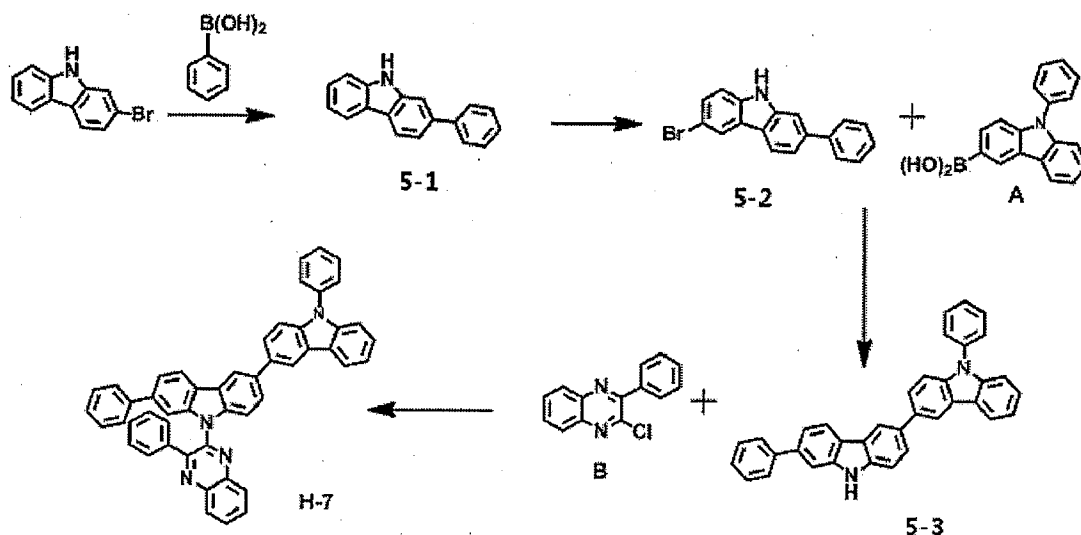
[212] Preparation of compound H-88

[213] After introducing compound 1-2 (2.6g, 10.99 mmol), compound 4-5 (4.2g, 9.16 mmol), K<sub>2</sub>CO<sub>3</sub> (1.2g, 9.16 mmol), 4-dimethylaminopyridine(DMAP) (0.6g, 4.58 mmol), and dimethylacetamide (DMA) (50mL) in a reaction vessel, the mixture was stirred under reflux for 4 hours. The mixture was cooled to room temperature, and distilled water was then added thereto. The mixture was extracted with methylene chloride (MC), dried with magnesium sulfate, distilled under reduced pressure, and purified by column chromatography to obtain compound H-88 (1.7 g, 28%).

[214]

[215] [Example 6]

[216]

[217] Preparation of compound 5-1

[218] After dissolving 2-bromo-carbazole (30g, 121.90 mmol), phenylboronic acid (18g, 146.28 mmol),  $\text{Pd(PPh}_3)_4$  (7g, 6.09 mmol), and 2M  $\text{Na}_2\text{CO}_3$  (250mL) in toluene (500mL) and ethanol (250mL) in a flask, the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed therefrom with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 5-1 (15g, yield: 52%).

[219] Preparation of compound 5-2

[220] After dissolving compound 5-1 (14.4g, 59.19 mmol) in DMF (200mL) in a flask, NBS (11 g, 59.19 mmol) was added thereto at 0°C. The mixture was stirred for 12 hours, and distilled water was then added thereto. The obtained solid was filtered under reduced pressure, added to methanol, stirred, and then filtered under reduced pressure. The solid was added to ethyl acetate and methanol. The mixture was stirred and filtered under reduced pressure. As a result, compound 5-2 (15.8g, yield: 83%) was obtained.

[221] Preparation of compound 5-3

[222] After dissolving compound 5-2 (15.8g, 49.04 mmol), compound A (15.5g, 53.94 mmol),  $\text{Pd(PPh}_3)_4$  (3g, 2.452 mmol), and 2M  $\text{Na}_2\text{CO}_3$  (150mL) in toluene (300mL) and ethanol (150mL) in a flask, the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 5-3 (4g, yield: 17%).

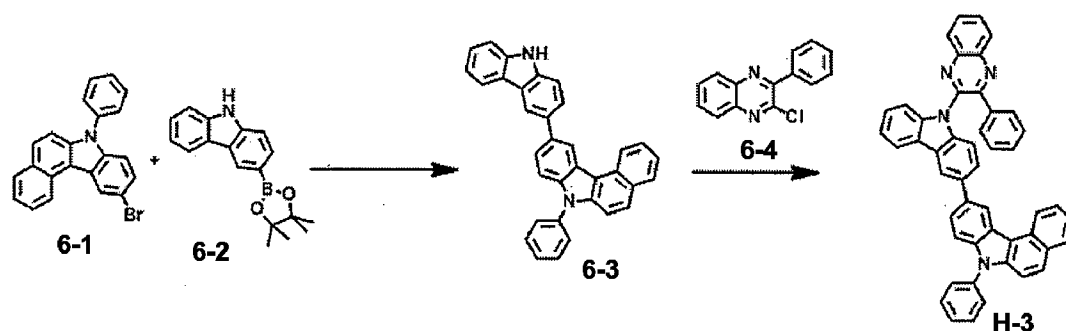
[223] Preparation of compound H-7

[224] After dissolving compound **5-3** (4 g, 8.254 mmol), compound B (2.4g, 9.905 mmol),  $K_2CO_3$  (1.15g, 8.254 mmol), and DMAP (0.5g, 4.127 mmol) in DMF (40mL) in a flask, the mixture was under reflux at 220°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound **H-7** (2.8g, yield: 50%).

[225]

[226] [Example 7]

[227]



[228] Preparation of compound 6-3

[229] After dissolving compound 6-1 (25.4g, 68.22 mmol), compound 6-2 (20g, 68.22 mmol),  $Pd(PPh_3)_4$  (4g, 3.41 mmol), and 2M  $K_2CO_3$  (100mL) in toluene (340mL) and ethanol (100mL) in a flask, the mixture was under reflux at 120°C for 3 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 6-3 (8g, yield: 25%).

[230] Preparation of compound H-3

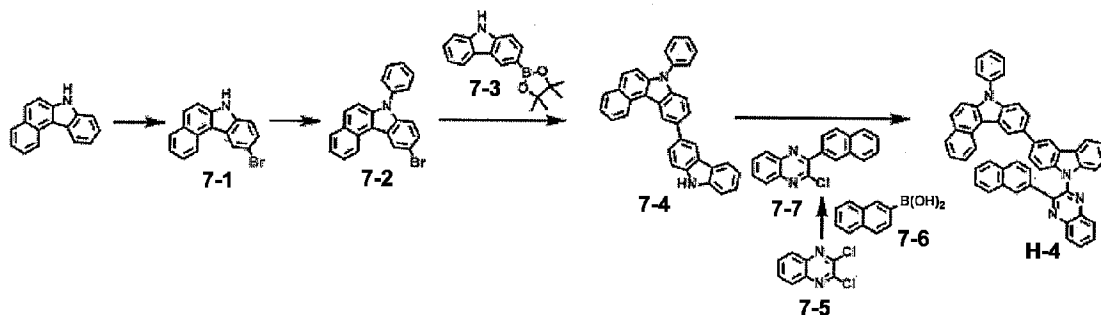
[231] After dissolving compound 6-3 (11 g, 23.99 mmol), compound 6-4 (9g, 35.98 mmol), and NaH (60% in mineral oil) (2.8g, 71.97 mmol) in DMF (230mL) in a flask, the mixture was stirred at room temperature for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound **H-3** (4g, yield: 25%).

[232]

	MW	UV	PL	Melting point
<b>H-3</b>	<b>662.78</b>	<b>296 nm</b>	<b>517 nm</b>	<b>234 °C</b>

[233] [Example 8]

[234]

[235] Preparation of compound 7-1

[236] After dissolving 7H-benzo[c]carbazole (50g, 230.12 mmol), and N-bromosuccinimide (41g, 230.12 mmol) in DMF (500mL) in a flask, the mixture was stirred at room temperature for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 7-1 (50g, yield: 73%).

[237] Preparation of compound 7-2

[238] After dissolving 10-bromo-7H-benzo[c]carbazole (compound 7-1) (15g, 61.00 mmol), iodobenzene (14ml, 123.00mmol), CuI (6.0g, 30.00 mmol), EDA (4ml, 61.00 mmol), and K<sub>3</sub>PO<sub>4</sub> (40g, 183.00 mmol) in toluene (500mL) in a flask, the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 7-2 (13g, yield: 73%).

[239] Preparation of compound 7-4

[240] After dissolving compound 10-bromo-7-phenyl-7H-benzo[c]carbazole (compound 7-2) (10g, 34.10 mmol), and compound 7-3 (10g, 40.92 mmol) in toluene (100 mL), ethanol (50 mL), and H<sub>2</sub>O (50 mL), the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 7-4 (9g, yield: 57%).

[241] Preparation of compound 7-7

[242] After dissolving compound 2,3-dichloroquinoxaline (compound 7-5) (28g, 140.67 mmol), and compound 7-6 (24g, 140.67 mmol) in toluene 100 mL, ethanol 50 mL, H<sub>2</sub>O 50 mL, the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was

removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound 7-7 (30g, yield: 73%).

[243] Preparation of compound H-4

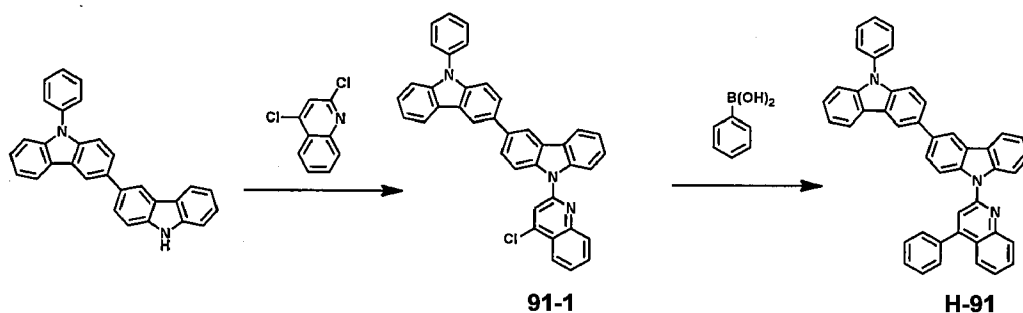
[244] After introducing compound 10-(9H-carbazol-3-yl)-7-phenyl-7H-benzo[c]carbazole (compound 7-4) (9.1 g, 19.80 mmol), compound 7-7 (9g, 29.7 mmol), K<sub>2</sub>CO<sub>3</sub> (5.5 g, 39.6 mmol), DMAP (1.2 g, 9.9 mmol), and DMF (100 mL) in a reaction vessel, the mixture was stirred under reflux for 1 hour, cooled to room temperature, and distilled water was then added thereto. The mixture was extracted with methylene chloride, dried with magnesium sulfate, distilled under reduced pressure, and purified by column chromatography to obtain compound H-4 (5 g, yield: 35 %).

[245]

	MW	UV	PL	Melting point
H-4	712.84	334nm	516nm	298.0 °C

[246] [Example 9]

[247]



[248] Preparation of compound 91-1

[249] After dissolving 9-phenyl-9H,9'H-3,3'-bicarbazole (33.8g, 82.7mmol), 2,4-dichloroquinoline (17.2g, 86.9mmol), CuI (31.5g, 165.4mmol), and trans-1,2-diaminocyclohexane (6mL, 49.63mmol) in o-DCB 550mL in a flask, the mixture was stirred under reflux at 200°C for 6 hours. After the completion of the reaction, the mixture was extracted with methylene chloride, dried with MgSO<sub>4</sub>, subjected to column chromatography, and methanol was then added to the separated material. The obtained solid was filtered under reduced pressure to obtain compound 91-1 (32.5g, yield: 69%).

[250] Preparation of compound H-91

[251] After dissolving compound 91-1

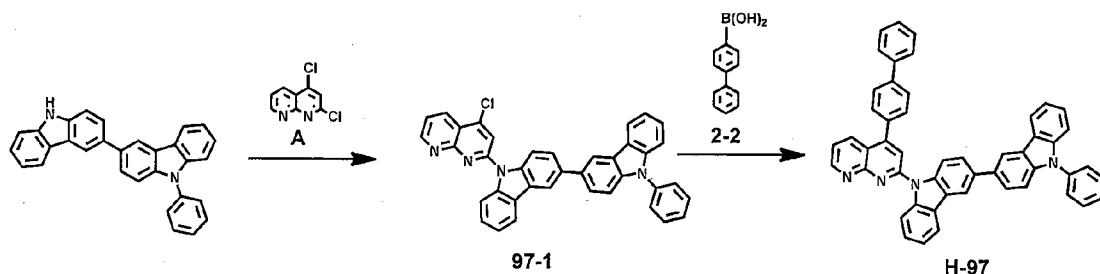
[9-(4-chloroquinolin-2-yl)-9'-phenyl-9H,9'H-3,3'-bicarbazole] (32g, 56.13mmol), phenylboronic acid (13.7g, 112.3mmol), Pd(PPh<sub>3</sub>)<sub>4</sub> (6.5g, 5.7mmol), and K<sub>2</sub>CO<sub>3</sub> (19.4g, 140.33mmol) in toluene (560mL), ethanol (35mL), and H<sub>2</sub>O (70mL), the mixture was under reflux at 120°C for 12 hours. After the completion of the reaction, the mixture was extracted with methylene chloride, dried with MgSO<sub>4</sub>, subjected to

column chromatography, and hexane was then added to the separated material. The obtained solid was filtered under reduced pressure to obtain compound **H-91** (23g, yield: 67%).

[252]

[253] [Example 10]

[254]

[255] Preparation of compound 97-1

[256] After dissolving compound 9-phenyl-9H,9'H-3,3'-bicarbazole (20.5g, 50.24 mmol), and compound A (12g, 60.29 mmol) in DMF (50mL) in a flask, NaH (2.6g, 62.31 mmol, 60% in mineral oil) was added thereto. The mixture was stirred at room temperature for 12 hours, and methanol and distilled water were added thereto. The produced solid was filtered under reduced pressure, and purified by column chromatography to obtain compound 97-1 (10g, yield: 35%).

[257] Preparation of compound H-97

[258] After dissolving compound 97-1 (10g, 17.51 mmol), compound 2-2 (4.5g, 22.76 mmol), Pd<sub>2</sub>dba<sub>3</sub> (0.96g, 1.05 mmol), S-phos (0.6g, 1.40 mmol), and K<sub>3</sub>PO<sub>4</sub> (12g, 52.53 mmol) in toluene (200mL) in a flask, the mixture was under reflux at 120°C for 5 hours. After the completion of the reaction, the mixture was extracted with ethyl acetate, the remaining moisture was removed from the obtained organic layer with magnesium sulfate, and then the organic layer was dried. The products were purified by column chromatography to obtain compound **H-97** (3g, yield: 25%).

[259]

[260] [Device Example 1] OLED using the compound of the present disclosure

[261] OLED was produced using the compound of the present disclosure as follows. A transparent electrode indium tin oxide (ITO) thin film (15 Ω/sq) on a glass substrate for an organic light-emitting diode (OLED) (Geomatec) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol, and distilled water sequentially, and was then stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing apparatus. N<sup>1</sup>,N<sup>1'</sup>-([1,1'-biphenyl]-4,4'-diyl)bis(N<sup>1</sup>-(naphthalene-1-yl)-N<sup>4</sup>,N<sup>4'</sup>-diphenylbenzene-1,4-diamine) was introduced into a cell of said vacuum vapor depositing apparatus, and then the pressure in the chamber of said apparatus was controlled to 10<sup>-6</sup> torr. Thereafter, an electric current was applied to the

cell to evaporate the above introduced material, thereby forming a hole injection layer having a thickness of 60 nm on the ITO substrate.

N,N'-di(4-biphenyl)-N,N'-di(4-biphenyl)-4,4'-diaminobiphenyl was then introduced into another cell of said vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a hole transport layer having a thickness of 20 nm on the hole injection layer. Thereafter compound **H-1** was introduced into one cell of the vacuum vapor depositing apparatus as a host, and compound **D-88** was introduced into another cell as a dopant. The two materials were evaporated at different rates so that the dopant was deposited in a doping amount of 4 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 30 nm on the hole transport layer.

2-(4-(9,10-di(naphthalene-2-yl)anthracen-2-yl)phenyl)-1-phenyl-1H-benzo[d]imidazole was then introduced into one cell, and lithium quinolate was introduced into another cell. The two materials were evaporated at the same rate, so that they were respectively deposited in a doping amount of 50 wt% to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. After depositing lithium quinolate as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 150 nm was then deposited by another vacuum vapor deposition apparatus on the electron injection layer. Accordingly, an OLED was produced. All the materials used for producing the OLED were those purified by vacuum sublimation at  $10^{-6}$  torr. The produced OLED showed a red emission having a luminance of 1,050 cd/m<sup>2</sup> and a current density of 11.1 mA/cm<sup>2</sup> at a driving voltage of 4.1 V. The minimum time taken to be reduced to 90% of the luminance at 5,000 nit was 90 hours.

[262]

[263] **[Device Examples 2 to 8] OLED using the compound of the present disclosure**

[264] OLED was produced in the same manner as in Device Example 1, except that a host and a dopant shown in Table 2 below were used as a light-emitting material. Driving voltage (V), current density (mA/cm<sup>2</sup>), luminance (cd/m<sup>2</sup>), color, and minimum time taken to be reduced to 90% of the luminance at 5000 nit (lifespan), of the produced OLEDs are shown in Table 2 below.

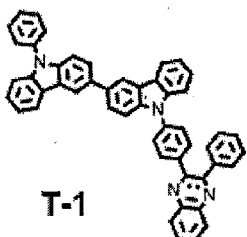
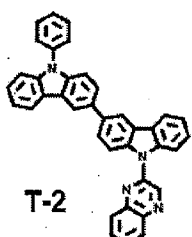
[265]

[266] **[Comparative Examples 1 and 2] OLED using conventional light-emitting materials**

[267] OLED was produced in the same manner as in Device Example 1, except that compound T-1 or T-2 shown in Table 1 below was used as a host, and a dopant shown in Table 2 below was used. A driving voltage (V), current density (mA/cm<sup>2</sup>), luminance (cd/m<sup>2</sup>), color, and minimum time taken to be reduced to 90% of the luminance at 5000 nit (lifespan), of the produced OLEDs are shown in Table 2 below.

[268] [Table 1]

[269]

Compound for comparative example 1	Compound for comparative example 2
 <p style="text-align: center;">T-1</p>	 <p style="text-align: center;">T-2</p>

[270] [Table 2]

[271]

Device Example No.	Host	Dopant	Voltage (V)	Current density (mA/cm <sup>2</sup> )	Luminance (cd/m <sup>2</sup> ) / Color	Minimum time taken to be reduced to 90% of the luminance at 5000nit
1	H-1	D-88	4.1	11.1	1050 / red	90 hours
2	H-2	D-88	4.1	11.8	1020 / red	100 hours
3	H-3	D-87	4.0	6.4	1100 / red	120 hours
4	H-5	D-88	4.1	12.2	1150 / red	100 hours
5	H-80	D-87	3.9	6.7	1120 / red	80 hours
6	H-88	D-88	3.7	12.9	1200 / red	100 hours
7	H-55	D-87	3.8	7.1	1100 / red	120 hours
8	H-4	D-88	4.3	11.4	1050 / red	95 hours
Comparative Example 1	T-1	D-87	3.5	6.8	1000 / red	20 hours
Comparative Example 2	T-2	D-88	4.4	11.8	1000 / red	40 hours

[272] As shown in Table 2, organic electroluminescent devices using the organic electroluminescent compound of the present disclosure show lifespan remarkably improved up to 600% better than those using conventional compounds, while maintaining good driving voltage, and good current and power efficiencies.

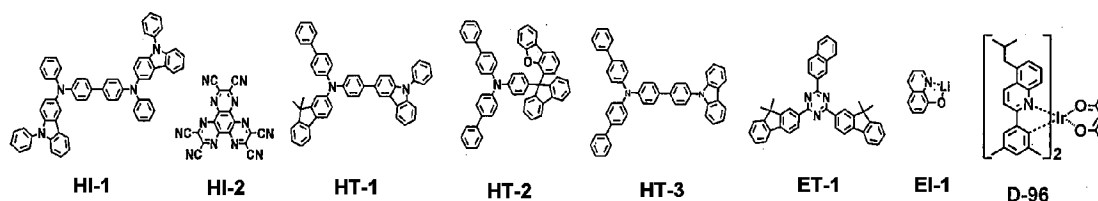
[273]

[274] **[Device Example 9] OLED in which a first host compound and a second host compound of the present disclosure were co-evaporated**

[275] OLED was produced using the compound of the present disclosure as follows. A transparent electrode indium tin oxide (ITO) thin film (10 Ω/sq) on a glass substrate for an organic light-emitting diode (OLED) (Geomatec) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol, and distilled water sequentially, and was then stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing apparatus. N<sup>4</sup>,N<sup>4'</sup>-diphenyl-N<sup>4</sup>,N<sup>4'</sup>-bis(9-phenyl-9H-carbazole-3-yl)-[1,1'-biphenyl]-4,4'-diamine (compound **HI-1**) was introduced into a cell of the vacuum vapor depositing apparatus, and then the pressure in the chamber of the apparatus was controlled to 10<sup>-6</sup> torr. Thereafter, an electric

current was applied to the cell to evaporate the above introduced material, thereby forming a first hole injection layer having a thickness of 80 nm on the ITO substrate. 1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (compound **HI-2**) was introduced into another cell of the vacuum vapor depositing apparatus, and then an electric current was applied to the cell to evaporate the above introduced material, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. N-([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazole-3-yl)phenyl)-9H-fluoren-2-amine (compound **HT-1**) was introduced into a cell of the vacuum vapor depositing apparatus, and then an electric current was applied to the cell to evaporate the above introduced material, thereby forming a first hole transport layer having a thickness of 10 nm on the second hole injection layer. Thereafter, N,N-di([1,1'-biphenyl]-4-yl)-4'-(9H-carbazole-9-yl)-[1,1'-biphenyl]-4-amine (compound **HT-3**) was introduced into another cell of the vacuum vapor depositing apparatus, and then an electric current was applied to the cell to evaporate the above introduced material, thereby forming a second hole transport layer having a thickness of 60 nm on the first hole transport layer. As a host material, compound **H-1** and compound **H2-116** were introduced into two cells of the vacuum vapor depositing apparatus, respectively. Compound **D-96** was introduced into another cell as a dopant. The two host materials were evaporated at the same rate, while the dopant was evaporated at a different rate from the host material so that the dopant was deposited in a doping amount of 3 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 40 nm on the hole transport layer. 2,4-bis(9,9-dimethyl-9H-fluoren-2-yl)-6-(naphthalene-2-yl)-1,3,5-triazine (compound **ET-1**) was then introduced into one cell, and lithium quinolate (compound **EI-1**) was introduced into another cell. The two materials were evaporated at 1:1 rate to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. After depositing lithium quinolate (compound **EI-1**) as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was then deposited by another vacuum vapor deposition apparatus on the electron injection layer. The minimum time taken to be reduced to 80% of the luminance at 5,000 nit was 195 hours.

[276]



[277]

**[Device Examples 10 to 16] OLED using a multi-component host material of the present disclosure**

[278] OLED was produced in the same manner as in Device Example 9, except that compounds shown in Table 3 below were used as a first host and a second host for preparing a light-emitting layer. The minimum time taken to be reduced to 80% of the luminance at 5000 nit of the produced OLEDs is shown in Table 3 below.

[279]

[280] **[Comparative Examples 3 to 4] OLED using only a first host compound as a host**

[281] OLED was produced in the same manner as in Device Example 9, except that only a first host compound shown in Table 3 below was used as a host for a light-emitting layer. The minimum time taken to be reduced to 80% of the luminance at 5000 nit of the produced OLEDs is shown in Table 3 below.

[282]

[283] [Table 3]

[284]

Device Example No.	Host	Dopant	Minimum time taken to be reduced to 80% of the luminance at 5000nit
9	H-1 : H2-116	D-96	195 hours
10	H-3 : H2-94	D-96	490 hours
11	H-3 : H2-117	D-96	517 hours
12	H-3 : H2-116	D-96	378 hours
13	H-3 : H2-118	D-96	480 hours
14	H-3 : H-110	D-96	1,422 hours
15	H-3 : H2-119	D-96	1,080 hours
16	H-3 : H2-120	D-96	1,250 hours
Comparative Example 3	H-1	D-96	168 hours
Comparative Example 4	H-3	D-96	295 hours

[285] As shown above, although organic electroluminescent devices using the organic electroluminescent compound of the present disclosure as a sole host show excellent lifespan, a multi-component host material comprising an organic electroluminescent compound of the present disclosure can provide an organic electroluminescent device having more improvement in lifespan.

[286]

[287] **[Device Examples 17-1 to 17-5, 18-1 to 18-6] OLED in which a first host compound and a second host compound according to the present disclosure were co-evaporated**

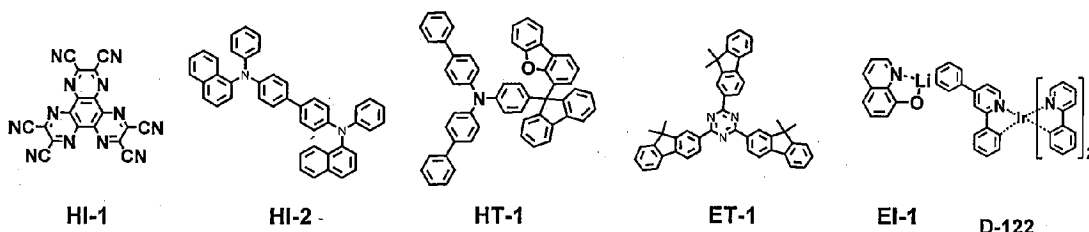
[289] OLED was produced using the compound of the present disclosure as follows. A transparent electrode indium tin oxide (ITO) thin film (10  $\Omega$ /sq) on a glass substrate for an organic light-emitting diode (OLED) (Geomatec) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol, and distilled water sequentially, and

was then stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing apparatus.

1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (compound **HI-1**) was introduced into a cell of the vacuum vapor depositing apparatus, and then the pressure in the chamber of the apparatus was controlled to  $10^{-6}$  torr. Thereafter, an electric current was applied to the cell to evaporate the above introduced material, thereby forming a first hole injection layer having a thickness of 5 nm on the ITO substrate. N,N' - bis(naphthalene-1-yl)-N,N' -bis(phenyl)benzidine (compound **HI-2**) was then introduced into another cell of the vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a second hole injection layer having a thickness of 95 nm on the first hole injection layer. N-([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluorene-2-amine (compound **HT-1**) was introduced into one cell of the vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a hole transport layer having a thickness of 20 nm on the second hole transport layer. As a host material, two compounds shown in Table 4 below were introduced into two cells of the vacuum vapor depositing apparatus, respectively. Compound **D-122** was introduced into another cell as a dopant. The two host materials were evaporated at the same rate of 1:1, while the dopant was evaporated at a different rate from the host material so that the dopant was deposited in a doping amount of 12 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 30 nm on the hole transport layer.

2,4,6-tris(9,9-dimethyl-9H-fluorene-2-yl)-1,3,5-triazine (compound **ET-1**) was then introduced into another cell, and evaporated to be deposited as an electron transport layer having a thickness of 35 nm on the light-emitting layer. After depositing lithium quinolate (compound **EI-1**) as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was then deposited by another vacuum vapor deposition apparatus on the electron injection layer.

[290]



[291]

**[Comparative Device Examples 5-1 to 5-3] OLED using conventional compounds**

[292]

OLED was produced in the same manner as in Device Example 17-1, except that the

conventional compounds shown in Tables 4 and 5 below were used as a first host compound and a second host compound.

[293]

[294] A driving voltage, luminous efficiency, CIE color coordinate, and the minimum time taken to be reduced from 100% to 95% of the luminance at 10,000 nit and a constant current, of OLEDs produced in Device Examples 17-1 to 17-5, Device Examples 18-1 to 18-6, and Comparative Device Examples 5-1 to 5-3 are shown in Table 4 below.

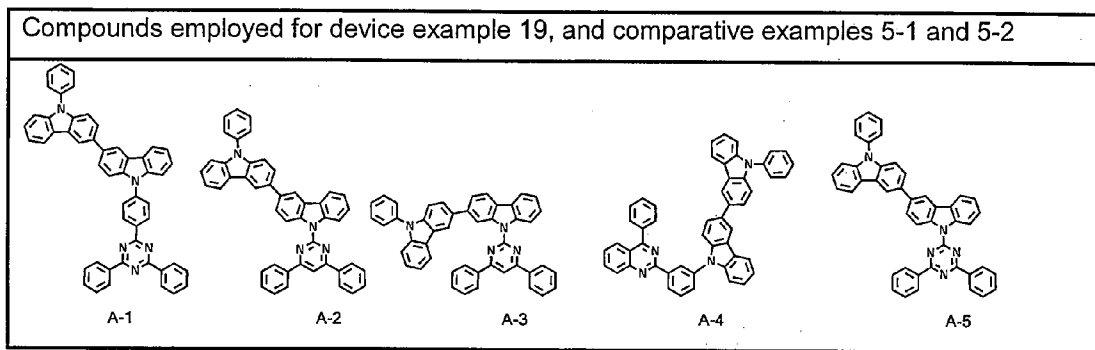
[295] [Table 4]

[296]

Device Example No.	Host	Dopant	Voltage [V]	Current Efficiency [cd/A]	Color coordinate (x, y)	Minimum time taken to be reduced to 95% of the luminance at 10,000nit
17-1	H-91 : H2-110	D-122	3.7	74.6	0.430, 0.557	328 hours
17-2	H-102 : H2-110	D-122	4	70	0.429, 0.558	206 hours
17-3	H-103 : H2-110	D-122	3.6	-	0.429, 0.557	97 hours
17-4	H-105 : H2-110	D-122	4	74.4	0.429, 0.558	126 hours
17-5	H-104 : H2-110	D-122	3.6	-	0.429, 0.558	157 hours
18-1	H-91 : H2-31	D-122	3.7	73.6	0.426, 0.560	165 hours
18-2	H-91 : H2-111	D-122	3.6	72.2	0.419, 0.570	172 hours
18-3	H-91 : H2-112	D-122	3.5	-	0.420, 0.569	87 hours
18-4	H-91 : H2-113	D-122	3.9	-	0.428, 0.559	105 hours
18-5	H-91 : H2-115	D-122	3.8	72.9	0.428, 0.558	138 hours
18-6	H-91 : H2-114	D-122	3.9	75.1	0.425, 0.561	111 hours
Comparative Example 5-1	A-5: A-1	D-122	3.8	73.9	0.429, 0.558	83 hours
Comparative Example 5-2	A-2 : A-3	D-122	3.8	70.8	0.425, 0.561	42 hours
Comparative Example 5-3	A-4 : A-5	D-122	3.7	72.4	0.428, 0.558	66 hours

[297] [Table 5]

[298]

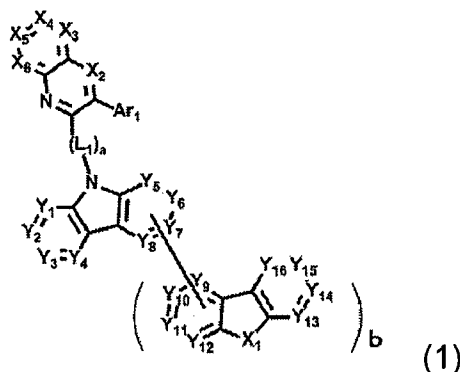


[299]

## Claims

[Claim 1]

An organic electroluminescent compound represented by the following formula 1:



wherein  $L_1$  represents a single bond, a substituted or unsubstituted (3- to 30-membered)heteroarylene, or a substituted or unsubstituted (C6-C30)arylene;

$X_1$  represents  $-NR_1-$ ,  $-CR_2R_3-$ ,  $-O-$ , or  $-S-$ ;

$X_2$  to  $X_6$ , each independently, represent  $-CR_4-$  or  $-N-$ ;

$Ar_1$  represents hydrogen, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (3- to 30-membered)heteroaryl;

with the proviso that when  $X_2$  is  $-N-$ ,  $L_1$  is not the substituted or unsubstituted (C6-C30)arylene and  $Ar_1$  is not hydrogen;

$Y_1$  to  $Y_4$  and  $Y_{13}$  to  $Y_{16}$ , each independently, represent  $-N-$  or  $-CR_5-$ ;

$Y_5$  to  $Y_{12}$ , each independently, represent  $-\overset{\text{I}}{\underset{\text{I}}{\text{C}}}-$ ,  $-N-$ , or  $-CR_6-$ ;

$R_1$  to  $R_3$ , each independently, represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl;

$R_4$  to  $R_6$ , each independently, represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted (3- to 7-membered)heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (3- to 30-membered)heteroaryl, or a substituted or unsubstituted di(C6-C30)arylamino; or may be fused with an adjacent substituent(s)

to form a substituted or unsubstituted (3- to 30-membered), mono- or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;

the heteroaryl(ene) and the heterocycloalkyl, each independently, contain at least one hetero atom selected from B, N, O, S, P(=O), Si and P; and

a and b, each independently represent 0 or 1.

[Claim 2]

The organic electroluminescent compound according to claim 1, wherein the substituents of the substituted alkyl, the substituted cycloalkyl, the substituted cycloalkenyl, the substituted heterocycloalkyl, the substituted aryl(ene), the substituted heteroaryl(ene), the substituted diarylamino and the substituted mono- or polycyclic, alicyclic or aromatic ring in  $L_1$ ,  $Ar_1$ , and  $R_1$  to  $R_6$ , each independently, are at least one selected from the group consisting of deuterium, a halogen, a cyano, a carboxy, a nitro, a hydroxy, a (C1-C30)alkyl, a halo(C1-C30)alkyl, a (C2-C30)alkenyl, a (C2-C30)alkynyl, a (C1-C30)alkoxy, a (C1-C30)alkylthio, a (C3-C30)cycloalkyl, a (C3-C30)cycloalkenyl, a (3- to 7-membered)heterocycloalkyl, a (C6-C30)aryloxy, a (C6-C30)arylthio, a (3- to 30-membered)heteroaryl unsubstituted or substituted with a (C6-C30)aryl, a (C6-C30)aryl unsubstituted or substituted with a (3- to 30-membered)heteroaryl, a tri(C1-C30)alkylsilyl, a tri(C6-C30)arylsilyl, a di(C1-C30)alkyl(C6-C30)arylsilyl, a (C1-C30)alkyldi(C6-C30)arylsilyl, an amino, a mono- or di-(C1-C30)alkylamino, a mono- or di-(C6-C30)arylamino, a (C1-C30)alkyl(C6-C30)arylamino, a (C1-C30)alkylcarbonyl, a (C1-C30)alkoxycarbonyl, a (C6-C30)arylcarbonyl, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, and a (C1-C30)alkyl(C6-C30)aryl.

[Claim 3]

The organic electroluminescent compound according to claim 1, wherein

$L_1$  represents a single bond, a substituted or unsubstituted (5- to 21-membered)heteroarylene, or a substituted or unsubstituted (C6-C21)arylene;

$X_1$  represents  $-NR_1-$ ,  $-CR_2R_3-$ ,  $-O-$ , or  $-S-$ ;

all of  $X_2$  to  $X_6$  represent  $-CR_4-$ , or one of  $X_2$  to  $X_6$  represents  $-N-$ , and

the remainders of  $X_2$  to  $X_6$  represent  $-CR_4-$ , wherein when  $X_2$  is  $-N-$ ,  $L_1$  is a single bond;

$Ar_1$  represents hydrogen, or a substituted or unsubstituted (C6-C21)aryl, wherein when  $Ar_1$  is hydrogen, at least one of  $R_4$  is a substituted or unsubstituted (C6-C21)aryl or a substituted or unsubstituted (5- to 21-membered)heteroaryl;

$Y_1$  to  $Y_4$  and  $Y_{13}$  to  $Y_{16}$ , each independently, represent  $-CR_5-$ ;

$Y_5$  to  $Y_{12}$ , each independently, represent  $-\overset{!}{C}-$  or  $-CR_6-$ ;

$R_1$  to  $R_3$ , each independently, represent a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, a substituted or unsubstituted (C5-C21)cycloalkyl, or a substituted or unsubstituted (5- to 7-membered)heterocycloalkyl;

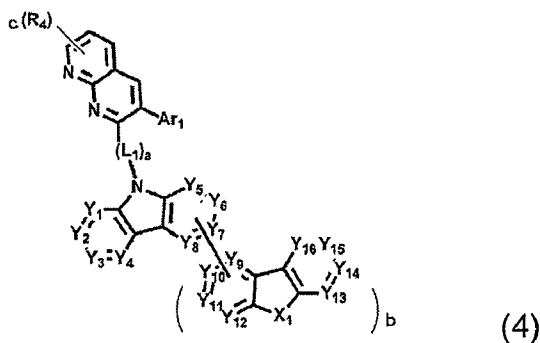
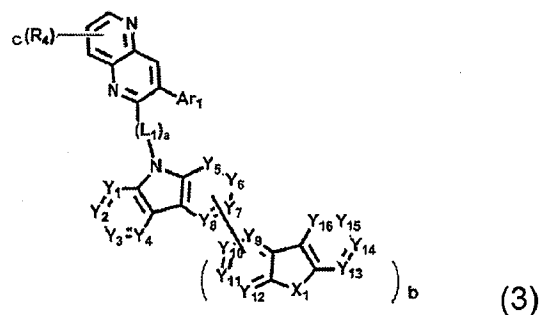
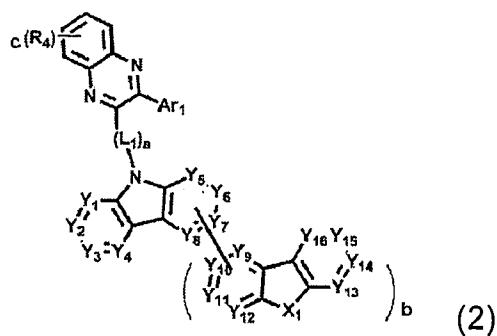
$R_4$  to  $R_6$ , each independently, represent hydrogen, a halogen, a cyano, a substituted or unsubstituted (C1-C20)alkyl, a substituted or unsubstituted (C5-C21)cycloalkyl, a substituted or unsubstituted (C6-C21)aryl, a substituted or unsubstituted (5- to 21-membered)heteroaryl, or a substituted or unsubstituted di(C6-C21)arylamino; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (5- to 21-membered), mono- or polycyclic, aromatic ring whose carbon atom(s) may be replaced with one or two hetero atom(s) selected from nitrogen, oxygen, and sulfur; the heteroaryl(ene) and the heterocycloalkyl, each independently, contain at least one hetero atom selected from N, O and S; and a and b, each independently represent 0 or 1.

[Claim 4]

The organic electroluminescent compound according to claim 3, wherein  $Ar_1$  represents hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted biphenyl, a substituted or unsubstituted terphenyl, a substituted or unsubstituted anthracenyl, a substituted or unsubstituted phenanthrenyl, a substituted or unsubstituted phenylnaphthyl, or a substituted or unsubstituted naphthylphenyl.

[Claim 5]

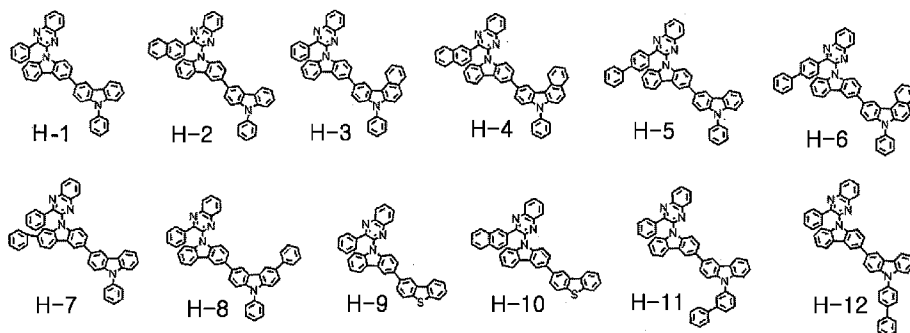
The organic electroluminescent compound according to claim 1, wherein the compound is represented by any one of the following formulae 2 to 4:

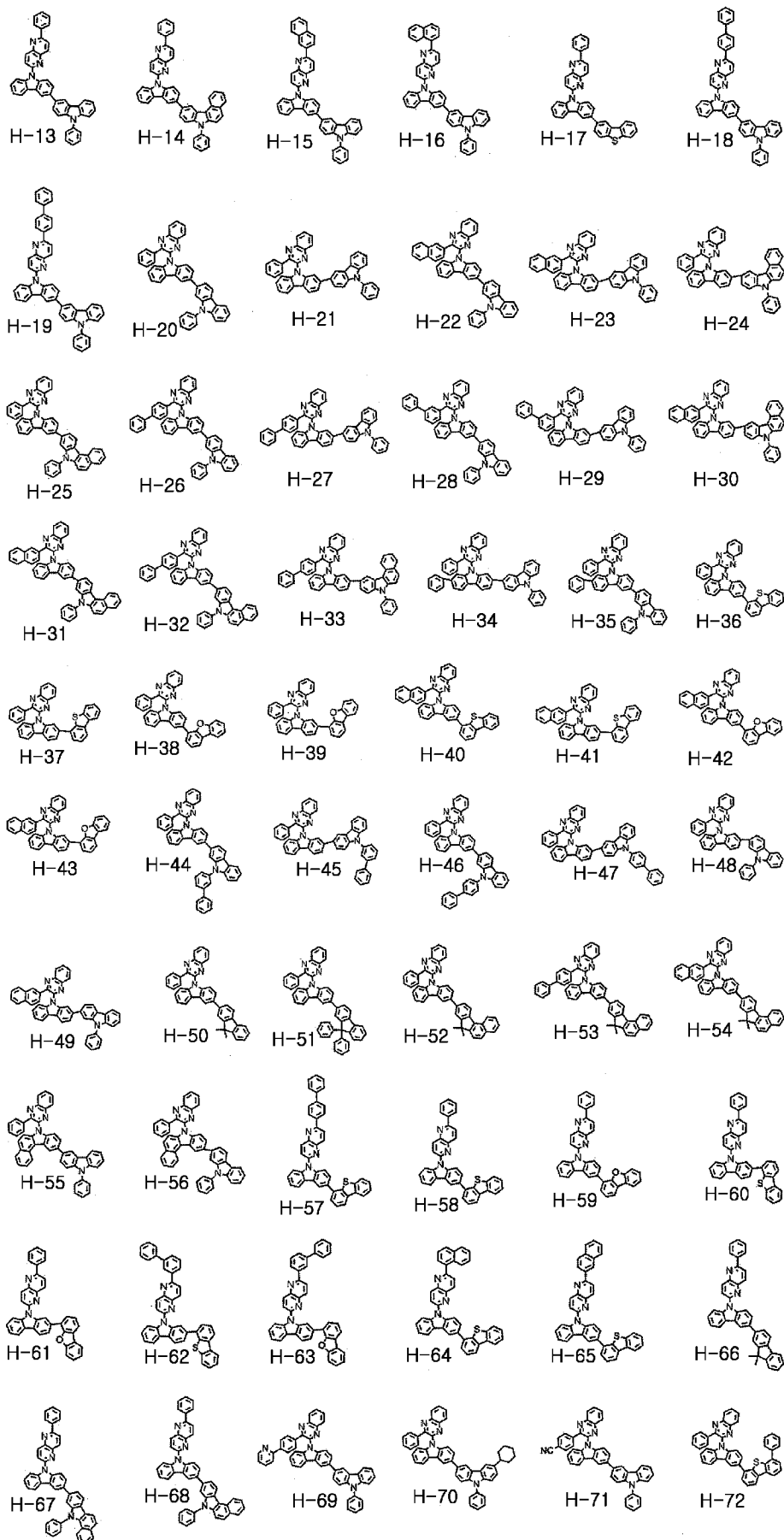


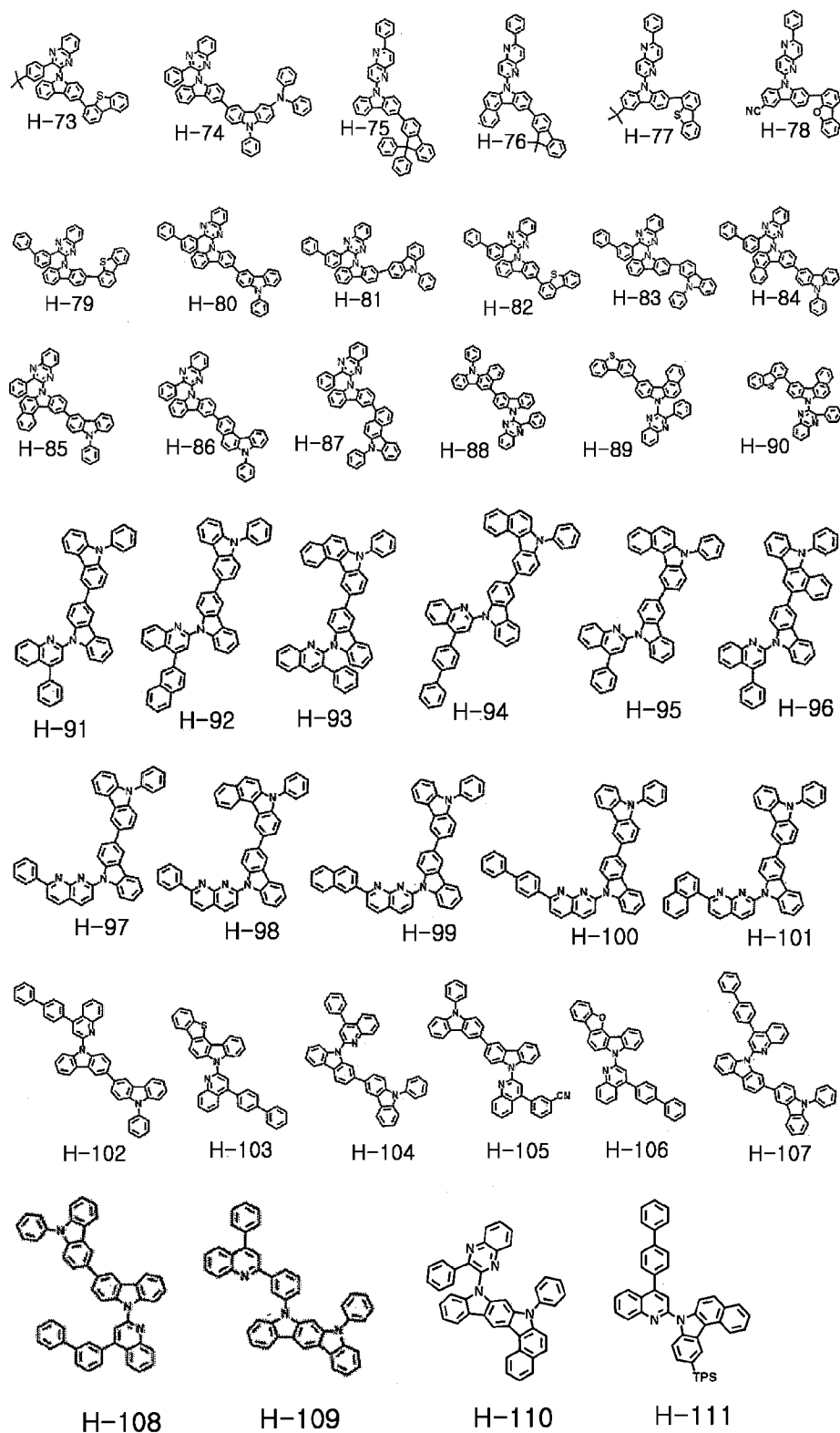
wherein  $X_1$ ,  $Ar_1$ ,  $Y_1$  to  $Y_{16}$ ,  $R_4$ ,  $L_1$ ,  $a$ , and  $b$  are as defined in claim 1;  $c$  represents an integer of 1 to 4; and when  $c$  is an integer of 2 or more, each of  $R_4$  is the same or different.

[Claim 6]

The organic electroluminescent compound according to claim 1, wherein the compound is selected from the group consisting of:







[Claim 7]

An organic electroluminescent device comprising the compound according to claim 1.

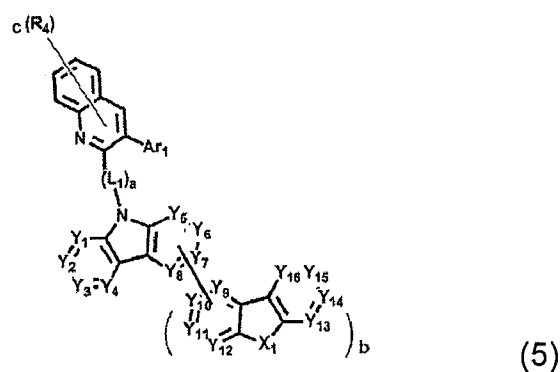
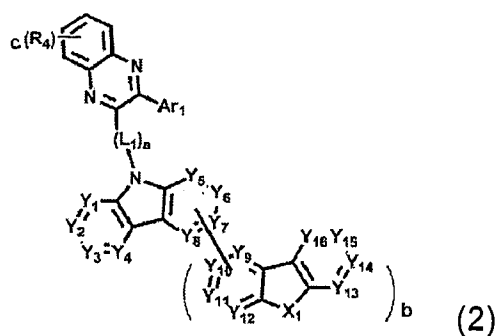
[Claim 8]

An organic electroluminescent device comprising an anode, a cathode, and an organic layer disposed between the anode and cathode, wherein

the organic layer comprises one or more light-emitting layers; at least one light-emitting layer comprises one or more dopant compounds and two or more host compounds; and at least one of the two or more host compounds is the organic electroluminescent compound represented by formula 1 according to claim 1.

[Claim 9]

The organic electroluminescent device according to claim 8, wherein a first host compound of the two or more host compounds is selected from the organic electroluminescent compound represented by the following formulae 2 and 5.



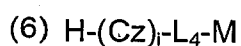
wherein,  $X_1$ ,  $Ar_1$ ,  $Y_1$  to  $Y_{16}$ ,  $R_4$ ,  $L_1$ ,  $a$ , and  $b$  are as defined in claim 1;  $c$  represents an integer of 1 to 5; and where  $c$  is 2 or more, each of  $R_4$  may be the same or different.

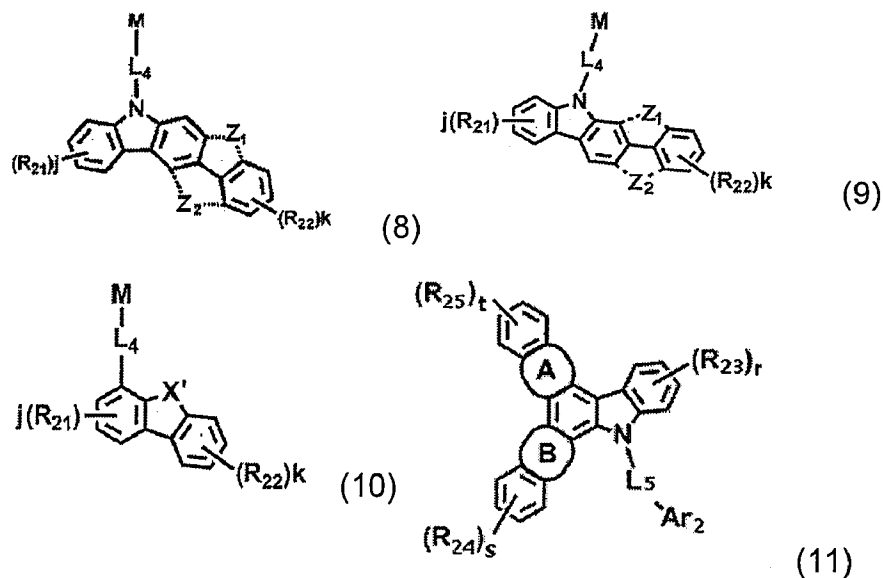
[Claim 10]

The organic electroluminescent device according to claim 8, wherein at least two of the two or more host compounds, each independently, are selected from the organic electroluminescent compound represented by formula 1.

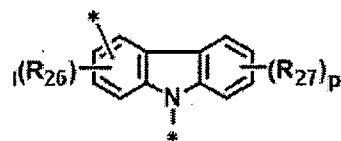
[Claim 11]

The organic electroluminescent device according to claim 8, wherein a first host compound of the two or more host compounds is the organic electroluminescent compound represented by formula 1, and a second host compound is selected from the compound represented by the following formulae 6 to 11.



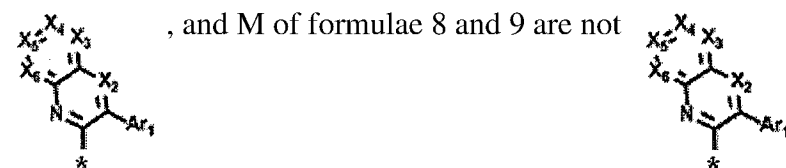


wherein Cz represents the following structure:



$L_4$  and  $L_5$ , each independently, represent a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted (5- to 30-membered)heteroarylene;

$M$  represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, provided that where  $h$  of formula 6 is 1, or  $i$  of formulae 7 is 1,  $M$  is not



(wherein  $X_2$  to  $X_6$ , and  $Ar_1$  are as defined in formula 1, and  $*$  represents a bonding site.);

$Z_1$  and  $Z_2$ , each independently, represent -O-, -S-, -N( $R_{31}$ )-, or -C( $R_{32}$ )( $R_{33}$ )-, provided that  $Z_1$  and  $Z_2$  do not simultaneously exist;

$X'$  represents -O- or -S-;

ring A represents



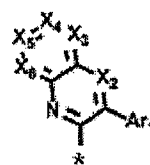
ring B represents



D and E, each independently, represent -O-, -S-, -N( $R_{34}$ )-, or -C( $R_{35}$ )( $R_{36}$ )-;

$Ar_2$  represents a substituted or unsubstituted (3- to

30-membered)heteroaryl, or a substituted or unsubstituted (C6-C30)aryl, provided that Ar<sub>2</sub> is not



and Ar<sub>1</sub> are as defined in formula 1, and \* represents a bonding site.); R<sub>21</sub> to R<sub>27</sub>, each independently, represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, or R<sub>28</sub>R<sub>29</sub>R<sub>30</sub>Si-; or may be fused with an adjacent substituent(s) to form a substituted or unsubstituted (C3-C30), monocyclic or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur; provided that where h of formula 6 or i of formula 7 is 1, R<sub>26</sub> or R<sub>27</sub> does not form the ring containing Z<sub>1</sub>, Z<sub>2</sub>, D, or E of formulae 8, 9, and 11, R<sub>22</sub> of formula 10 does not form the indole ring connected to R<sub>21</sub> of formulae 8 and 9 and the indole ring connected to R<sub>23</sub> of formula 11;

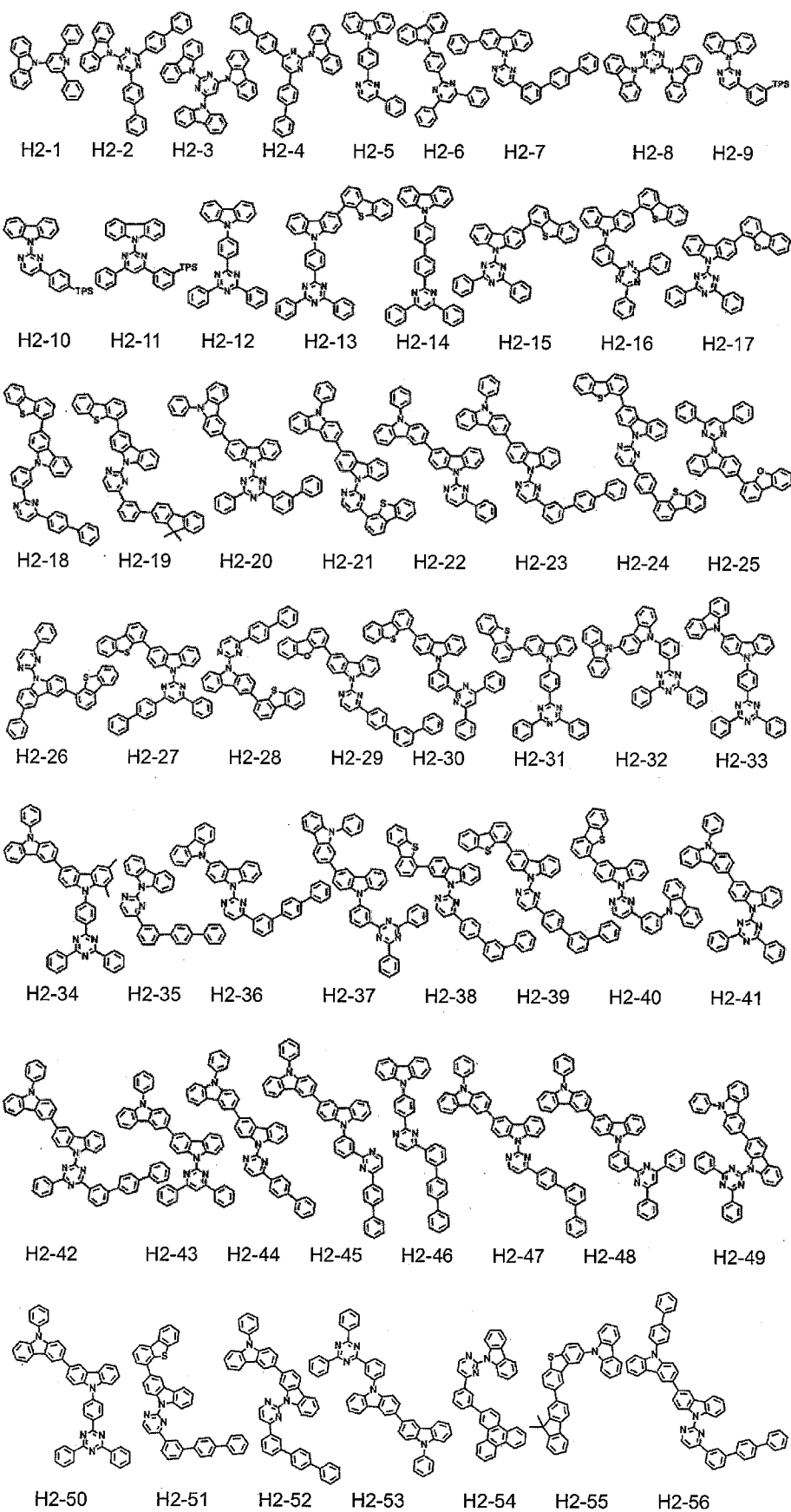
R<sub>28</sub> to R<sub>30</sub>, each independently, represent a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl;

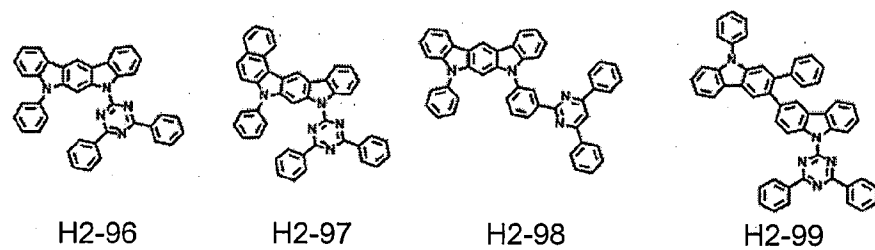
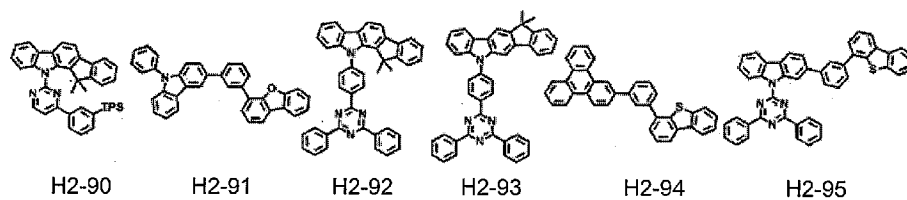
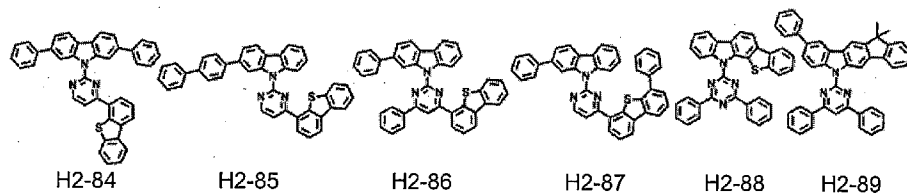
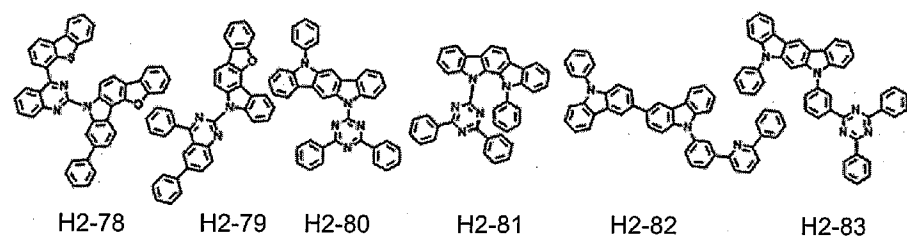
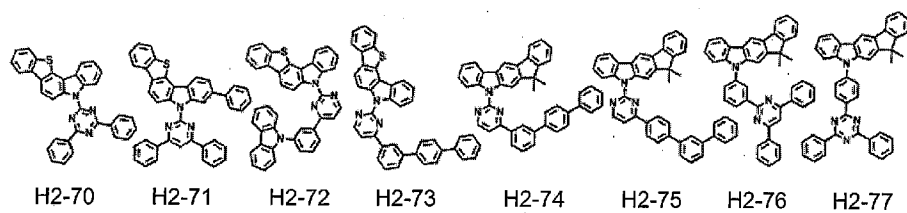
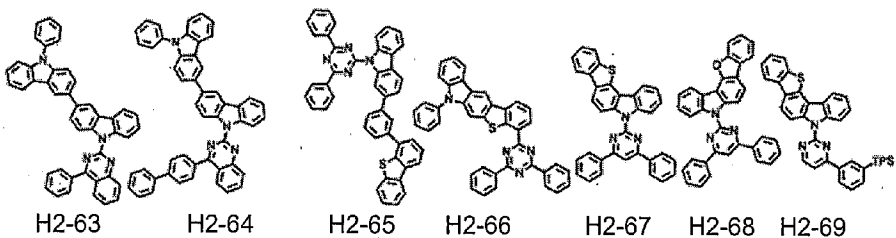
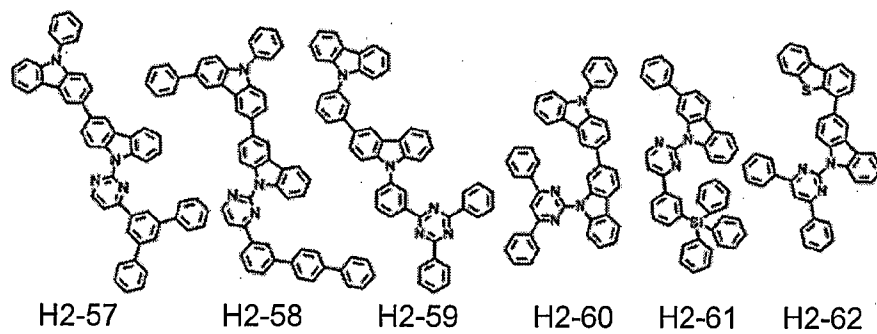
R<sub>31</sub> to R<sub>36</sub>, each independently, represent hydrogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl; R<sub>32</sub> and R<sub>33</sub> may be the same or different; R<sub>35</sub> and R<sub>36</sub> may be the same or different; the heteroaryl(ene) contains one or more hetero atoms selected from B, N, O, S, P(=O), Si, and P;

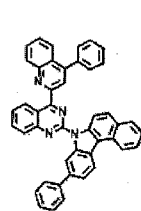
h and i, each independently, represent an integer of 1 to 3; j, k, l and p, each independently, represent an integer of 0 to 4; r, s, and t, each independently, represent an integer of 1 to 4; and where h, i, j, k, l, p, r, s, or t is an integer of 2 or more, each of (Cz-L<sub>4</sub>), each of (Cz), each of R<sub>21</sub>, each of R<sub>22</sub>, each of R<sub>23</sub>, each of R<sub>24</sub>, each of R<sub>25</sub>, each of R<sub>26</sub>, or each of R<sub>27</sub> may be the same or different.

[Claim 12]

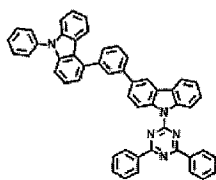
The organic electroluminescent device according to claim 11, wherein the compound represented by formulae 6 to 11 is selected from the group consisting of:



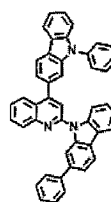




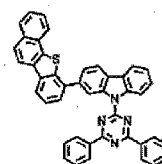
H2-100



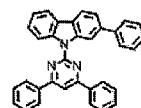
H2-101



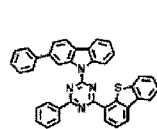
H2-102



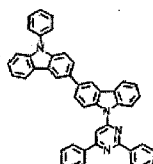
H2-103



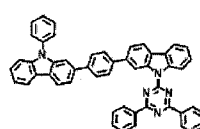
H2-104



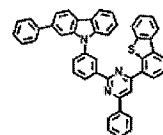
H2-105



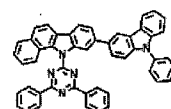
H2-106



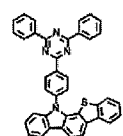
H2-107



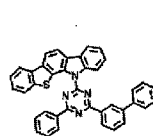
H2-108



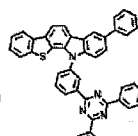
H2-109



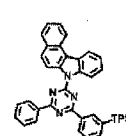
H2-110



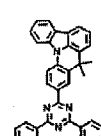
H2-111



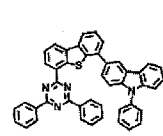
H2-112



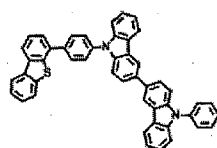
H2-113



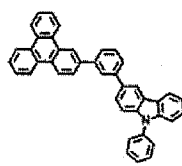
H2-114



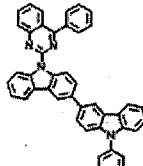
H2-115



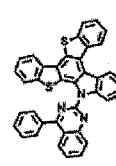
H2-116



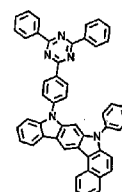
H2-117



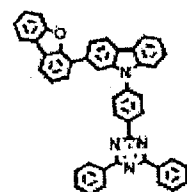
H2-118



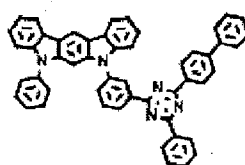
H2-119



H2-120



H2-121



H2-122

## INTERNATIONAL SEARCH REPORT

 International application No.  
**PCT/KR2014/012547**

## A. CLASSIFICATION OF SUBJECT MATTER

*H01L 51/00 (2006.01)*    *H01L 27/32 (2006.01)*    *C07D 209/82 (2006.01)*    *C07D 401/02 (2006.01)*    *C07D 401/04 (2006.01)*  
*C07D 401/14 (2006.01)*    *C07D 403/02 (2006.01)*    *C07D 403/04 (2006.01)*    *C07D 403/14 (2006.01)*    *C07D 405/10 (2006.01)*  
*C07D 409/14 (2006.01)*    *C09K 11/06 (2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Inventor and Applicant search:

Patentscope &amp; Google: LEE, Mi-Ja; LEE, Kyung-Joo; LEE, Su-Hyun; ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.

STN Registry and CAplus: Substructure search based on compounds of formula (1)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed	

 Date of the actual completion of the international search  
 27 April 2015

 Date of mailing of the international search report  
 27 April 2015

## Name and mailing address of the ISA/AU

 AUSTRALIAN PATENT OFFICE  
 PO BOX 200, WODEN ACT 2606, AUSTRALIA  
 Email address: pct@ipaustalia.gov.au

## Authorised officer

 Pina Potenza  
 AUSTRALIAN PATENT OFFICE  
 (ISO 9001 Quality Certified Service)  
 Telephone No. 0399359614

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/KR2014/012547
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/019156 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD. ) 17 February 2011 Abstract; Chemical Formula 1, Claim 1 for generic definition; Claim 5 compounds 26-27 on page 29, compounds 60-62 on page 30; Claims 6 and 7	1-12
X	WO 2012/121561 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD. ) 13 September 2012 Abstract; Paragraphs [45]-[61]; Claim 1 for generic definition; Claim 5 compounds C-1, C-10, C-24, C-25, C-26, C-66, C-68 and C-72; Claim 6	1-4, 7-12
X	WO 2012/134124 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD. ) 04 October 2012 see Abstract; Paragraphs [72]-[92]; Claim 1 for generic definition; Claim 5 compounds C-40, C-78, C-80, C-81 and C-83; Claim 6	1-4, 6-10
X	WO 2012/036482 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD. ) 22 March 2012 Abstract; pages 12-22; compounds 47-48, page 14; compounds 69, 71, 73, page 16; compounds 139, 142-144, page 21; Claim 1 for generic definition; Claims 4 and 6-7	1-4, 7-11
X	US 2011/0062429 A1 (KAI et al) 17 March 2011 Abstract; compounds (5)-(6), (11)-(14), (23)-(24), (26)-(27), (31)-(32) and (36)-(37); Claims 3-6	1-5, 7-10
X	WO 2010/107244 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 23 September 2010 Abstract; compounds associated with CAS Registry Numbers RN 1246309-55-6, RN 1246309-70-5, RN 1246310-04-2; Claims 1-6	1-5, 7-10
X	WO 2011/010840 A1 ( ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 27 January 2011 Abstract; Claim 1 for generic definition; Claim 5 compounds 30 and 33; Claims 6-7	1-5, 7-10
X	US 8564190 B2 (SEO et al) 22 October 2013 Abstract; column 18, compound Cz1PQIII; Claim 1	1-5, 7-10
X	US 8247575 B2 (NOMURA et al ) 21 August 2012 Abstract; compounds (35)-(66)	1-5
X	KR 2013-0102673 A (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 23 September 2013 page 5, compound C-25	1-4, 6-7
P,X	WO 2014/088290 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD. ) 12 June 2014 Abstract; Examples and compounds C-1 to C-68	1-12
P,X	KR 2014-0108778 A (SFC LTD.) 15 September 2014 Abstract; pages 5-13, compounds 1-163	1-12
Form PCT/ISA/210 (fifth sheet) (July 2009)		

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2014/012547	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2011/019156 A1	17 February 2011	CN 102918134 A	06 Feb 2013
		CN 104193732 A	10 Dec 2014
		KR 20110015836 A	17 Feb 2011
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		KR 20120102374 A	18 Sep 2012
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		CN 103534251 A	22 Jan 2014
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		JP 2014515738 A	03 Jul 2014
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		EP 2284920 A1	16 Feb 2011
		JP 4819181 B2	24 Nov 2011
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2014/012547	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2011/010840 A1	27 January 2011	CN 103524510 A	22 Jan 2014
		CN 103555322 A	05 Feb 2014
		CN 103641830 A	19 Mar 2014
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		CN 103641832 A	19 Mar 2014
		JP 2012520872 A	10 Sep 2012
		KR 20100105099 A	29 Sep 2010
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US 8564190 B2	22 October 2013	TW 201111472 A	01 Apr 2011
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