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(54) Title: ORGANIC ELECTROLUMINESCENT COMPOUND AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

(57) Abstract: The present disclosure relates to an organic electroluminescent compound and an organic electroluminescent device comprising the same. By using the organic electroluminescent compound of the present disclosure, an organic electroluminescent device having low driving voltage, high luminous efficiency, and/or excellent lifespan characteristic can be produced.

Description

Title of Invention: ORGANIC ELECTROLUMINESCENT COMPOUND AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

Technical Field

[1] The present disclosure relates to an organic electroluminescent compound and an organic electroluminescent device comprising the same.

Background Art

[2] An electroluminescent device (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. The first organic EL device was developed by Eastman Kodak, by using small aromatic diamine molecules, and aluminum complexes as materials for forming a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].

[3] The most important factor determining luminous efficiency in an organic EL device is light-emitting materials. Until now, fluorescent materials have been widely used as a light-emitting material. However, in view of electroluminescent mechanisms, since phosphorescent materials theoretically enhance luminous efficiency by four (4) times compared to fluorescent materials, development of 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)$_2$), tris(2-phenylpyridine)iridium (Ir(ppy)$_3$) and bis(4,6-difluorophenylpyridinato-N,C2)picolinate iridium (Firpic) as red, green, and blue materials, respectively.

[4] At present, 4,4'-N,N'-dicarbazol-biphenyl (CBP) is the most widely known phosphorescent host material. Recently, Pioneer (Japan) et al. developed a high performance organic EL device using bathocuproine (BCP) and aluminum(III)bis(2-methyl-8-quinolinate)(4-phenylphenolate) (BAlq) etc., as host materials, which were known as hole blocking layer materials.

[5] Although these 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, and the lifespan of the device decreases. (2) The power efficiency of an organic EL device is given by [(π/voltage) × current efficiency], and the power efficiency is inversely proportional to the voltage. Although an 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) Further, the operational lifespan of an organic EL device is short and luminous efficiency is still required to be improved.

[6] Meanwhile, in order to enhance its efficiency and/or stability, an organic EL device has a structure of a multilayer comprising a hole injection layer, a hole transport layer, a light-emitting layer, an electron transport layer, and an electron injection layer. The selection of a compound comprised in the hole transport layer is known as a method for improving the characteristics of a device such as hole transport efficiency to the light-emitting layer, luminous efficiency, lifespan, etc.

[7] In this regard, copper phthalocyanine (CuPc), 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB), N,N'-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-biphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(3-methylphenylphenylamino)triphenylamine (MTDATA), etc., were used as a hole injection and transport material. However, an organic EL device using these materials is problematic in quantum efficiency and/or lifespan. It is because, when an organic EL device is driven under high current, thermal stress occurs between an anode and the hole injection layer. Thermal stress significantly reduces the operational lifespan of the device. Further, since the organic material used in the hole injection layer has very high hole mobility, the hole-electron charge balance may be broken and quantum yield (cd/A) may decrease.

[8] Therefore, a hole transport layer for improving durability of an organic EL device still needs to be developed.

[9] In addition, an electron buffer layer is equipped to improve a problem of light-emitting luminance modification which may occur due to the change of current properties in the device when the device is exposed to a high temperature during a process of producing panels. In order to retain stability when exposed to a high temperature together with similar current properties to a device without an electron buffer layer, the properties of the compounds comprised in the electron buffer layer are important.

[10] Further, an electron transport material actively transports electrons from a cathode to a light-emitting layer and inhibits transport of holes which are not recombined in the light-emitting layer to increase recombination opportunity of holes and electrons in the light-emitting layer. Thus, new electron transport materials, which are highly electron-affinitive, and quickly transport electrons in organic EL devices to provide organic EL devices having high luminous efficiency, are required.

[11] Japanese Patent Appln. Laying-Open No. JP 2014-110357 discloses a compound wherein two carbazoles are connected via a linker at each nitrogen atom position and

connected via a linker at each carbon atom position of a benzene ring as a compound for an organic electroluminescent device. However, in the compound of said reference, one or more of the linkers connecting the two carbazoles include a carbazole.

[12] Korean Patent Appln. Laying-Open No. KR 2015-0000967 discloses a compound wherein two carbazoles are connected via two linkers as a compound for an organic electroluminescent device, and Japanese Patent Appln. Laying-Open No. JP 2015-218110 discloses a compound wherein two indolines are connected via two linkers as a compound for an organic electroluminescent device. However, said references do not specifically disclose a compound wherein two carbazoles are connected via a linker at each nitrogen atom position and connected via a linker at each carbon atom position of a benzene ring.

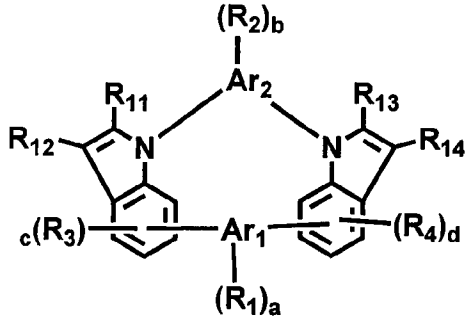
Disclosure of Invention

Technical Problem

[13] The objective of the present disclosure is to provide i) an organic electroluminescent compound which can produce an organic electroluminescent device having low driving voltage, high luminous efficiency, and/or excellent lifespan characteristic, and ii) an organic electroluminescent device comprising the compound.

Solution to Problem

[14] The compound of the present disclosure has a high glass transition temperature (Tg) for its molecular weight by forming a fused ring of a high-degree. In an organic electroluminescent device, a material having a high glass transition temperature can be advantageous. A thin film consisting of a material having a low glass transition temperature can be easily modified by heat generated from driving the device. Thus, the charge mobility within the thin film decreases, and this can affect the performance of the OLED. The present inventors found that the organic electroluminescent compound of the present disclosure can cause fast charge mobility by having a planar shaped main core which can help pi-pi stacking in the vacuum deposition layer and that the organic electroluminescent compound of the present disclosure can provide excellent morphological stability by having high glass transition temperature (Tg) in spite of having relatively low molecular weight. Specifically, the present inventors found that the above objective can be achieved by an organic electroluminescent compound represented by the following formula 1:

[15] 

----------(1)

[16] wherein

[17] Ar_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, with a proviso that Ar_1 is not a substituted or unsubstituted carbazolylene;

[18] Ar_2 represents a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, with a proviso that Ar_2 is not a substituted or unsubstituted carbazolylene;

[19] R_1 to R_4 each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino, with a proviso that R_1 and R_2 are not a substituted or unsubstituted carbazole;

[20] R_{11} to R_{14} each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted cyclohexane ring;

[21] a and b each independently represent an integer of 0 to 2, with a proviso that where Ar_1 is a single bond, a represents 0, and where a or b is 2, each of R_1 and each of R_2 may be the same or different;

[22] c and d each independently represent an integer of 0 to 3, where c or d is 2 or more, each of R_3 and each of R_4 may be the same or different; and

[23] the heteroaryl(ene) contains at least one hetero atom selected from B, N, O, S, Si, and P.

Advantageous Effects of Invention

[24] By using the organic electroluminescent compound according to the present disclosure, an organic electroluminescent device having low driving voltage, high luminous efficiency, and/or excellent lifespan characteristic can be produced.

Mode for the Invention

[25] Hereinafter, the present disclosure will be described in detail. However, the following description is intended to explain the disclosure, and is not meant in any way to restrict the scope of the disclosure.

[26] The present disclosure relates to an organic electroluminescent compound of formula 1, an organic electroluminescent material comprising the compound, and an organic electroluminescent device comprising the material.

[27] The term "organic electroluminescent compound" in the present disclosure means a compound that may be used in an organic electroluminescent device, and may be comprised in any layer constituting an organic electroluminescent device, as necessary.

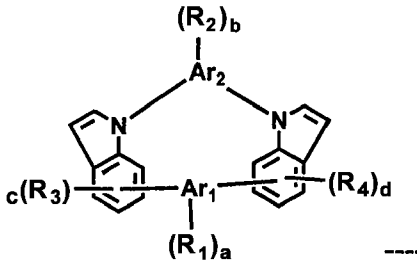
[28] The term "organic electroluminescent material" in the present disclosure means a material that may be used in an organic electroluminescent device, and may comprise at least one compound. The organic electroluminescent material may be comprised in any layer constituting an organic electroluminescent device, as necessary. For example, the organic electroluminescent material may be a hole injection material, a hole transport material, a hole auxiliary material, a light-emitting auxiliary material, an electron blocking material, a light-emitting material, an electron buffer material, a hole blocking material, an electron transport material, or an electron injection material.

[29] The organic electroluminescent material of the present disclosure may comprise at least one compound represented by formula 1. The compound represented by formula 1 may be comprised in at least one layer constituting an organic electroluminescent device, and may be comprised in a light-emitting layer, a hole transport layer, an electron buffer layer, and/or an electron transport layer, but is not limited thereto. When comprised in the light-emitting layer, it can be comprised as a phosphorescent host material; when comprised in the hole transport layer, it can be comprised as a hole transport material; when comprised in the electron buffer layer, it can be comprised as an electron buffer material; and when comprised in the electron transport layer, it can be comprised as an electron transport material.

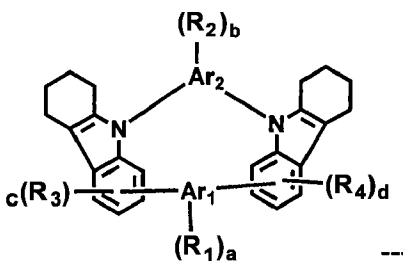
[30] Hereinafter, the organic electroluminescent compound represented by formula 1 will be described in detail.

[31] The compound of formula 1 may be represented by any one of the following formulas 2 to 10:

[32]

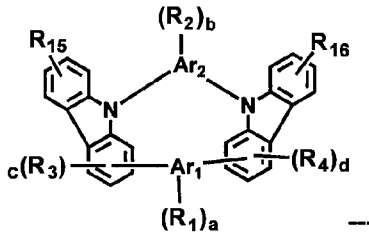


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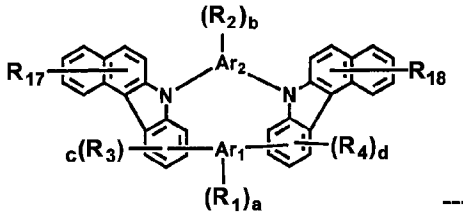


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[33]

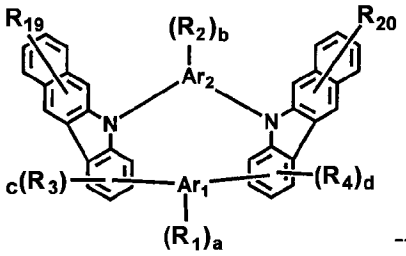


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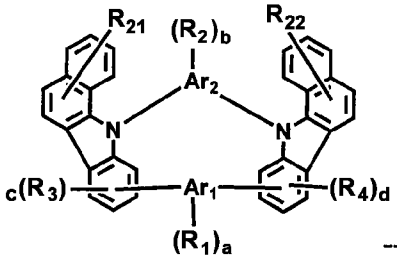


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[34]

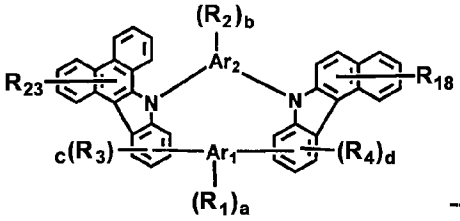


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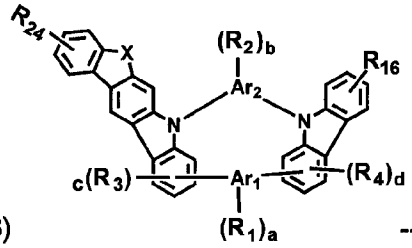


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[35]

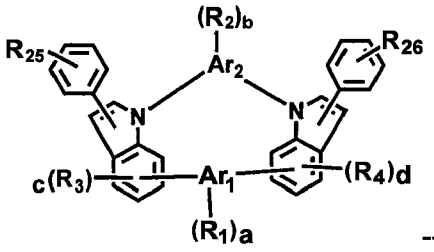


----------(8)



----------(9)

[36]



----------(10)

[37] wherein

[38] Ar_1, Ar_2, R_1 to R_4, and a to d are as defined in formula 1,

[39] X represents O, S, CR_5R_6, or NR_7;

[40] R_5 to R_7 each independently represent a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30-membered heteroaryl; or R_5 and R_6 are linked to each other to form a ring and form a spiro structure; and

[41] R_{15} to R_{26} each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino.

[42] Herein, "(C1-C30)alkyl" is meant to be a linear or branched alkyl having 1 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 1 to 10, more preferably 1 to 6, and includes methyl, ethyl, n-propyl, isopropyl, n-

butyl, isobutyl, tert-butyl, etc. "(C2-C30)alkenyl" is meant to be a linear or branched alkenyl having 2 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, etc. "(C2-C30)alkynyl" is a linear or branched alkynyl having 2 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes ethynyl, 1-propynyl, 2-propynyl, 1-butynyl, 2-butynyl, 3-butynyl, 1-methylpent-2-ynyl, etc. "(C3-C30)cycloalkyl" is a mono- or polycyclic hydrocarbon having 3 to 30 ring backbone carbon atoms, in which the number of carbon atoms is preferably 3 to 20, more preferably 3 to 7, and includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc. "3- to 7-membered heterocycloalkyl" is a cycloalkyl having at least one heteroatom selected from the group consisting of B, N, O, S, Si, and P, preferably O, S, and N, and 3 to 7 ring backbone atoms, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc. "(C6-C30)aryl(ene)" is a monocyclic or fused ring radical derived from an aromatic hydrocarbon having 6 to 30 ring backbone carbon atoms, in which the number of ring backbone carbon atoms is preferably 6 to 20, more preferably 6 to 15, and includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenylnaphthyl, naphthylphenyl, phenylterphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl, phenanthrenyl, phenylphenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc. "3- to 30-membered heteroaryl(ene)" is an aryl group having at least one, preferably 1 to 4 heteroatoms selected from the group consisting of B, N, O, S, Si, and P, and 3 to 30 ring backbone atoms, in which the number of ring backbone atoms is preferably 5 to 20, more preferably 5 to 15; is 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 including 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 including benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, benzimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc. "Halogen" includes F, Cl, Br, and I.

[43] Herein, "substituted" in the expression "substituted or unsubstituted" means that a hydrogen atom in a certain functional group is replaced with another atom or

functional group, i.e., a substituent. The substituents of the substituted (C1-C30)alkyl, the substituted cyclohexane, the substituted (C6-C30)aryl(ene), the substituted 3- to 30-membered heteroaryl(ene), and the substituted mono- or di- (C6-C30)arylamino in Ar_1, Ar_2, R_1 to R_4, and R_{11} to R_{14} in formula 1 each independently are at least one selected from the group consisting of deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, 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, a (C6-C30)aryl substituted with a 3- to 30-membered heteroaryl, a (C6-C30)aryl substituted with a di(C6-C30)arylamino, 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 (C1-C6)alkyl; a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl or a di(C6-C12)arylamino; a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl; and a di(C6-C12)arylamino.

[44] In formula 1 above, Ar_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, preferably represents a single bond, a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene, and more preferably represents a single bond, a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene. Ar_1 is not a substituted or unsubstituted carbazolylene.

[45] Ar_2 represents a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, preferably represents a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene, and more preferably represents a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene. Ar_2 is not a substituted or unsubstituted carbazolylene.

[46] R_1 to R_4 each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or

di- (C6-C30)arylamino, with a proviso that R_1 and R_2 are not a substituted or unsubstituted carbazole.

[47] Preferably, R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, a substituted or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino, and more preferably, R_1 and R_2 each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino.

[48] Preferably, R_3 and R_4 each independently represent hydrogen, a substituted or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino, and more preferably, R_3 and R_4 each independently represent hydrogen, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl or a 5- to 20-membered heteroaryl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino.

[49] R_{11} to R_{14} each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted cyclohexane ring, preferably each independently represent hydrogen, or a substituted or unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20-membered heteroaryl ring, and more preferably each independently represent hydrogen, or an unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a (C6-C20)aryl unsubstituted or substituted with a (C6-C12)aryl, a 5- to 20-membered heteroaryl, a di(C6-C12)arylamino, or a (C1-C6)alkyl(C6-C12)aryl; or an unsubstituted 5- to 20-membered heteroaryl ring.

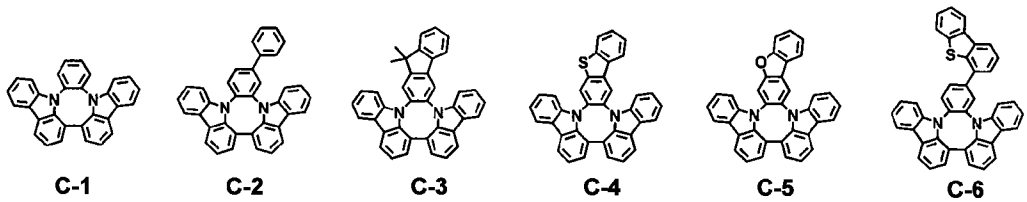
[50] According to one embodiment of the present disclosure, in formula 1 above, Ar_1 represents a single bond, a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene; Ar_2 represents a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene; R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, a substituted or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino; R_3 and R_4 each independently represent hydrogen, a substituted

or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino; and R_{11} to R_{14} each independently represent hydrogen, or a substituted or unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20-membered heteroaryl ring.

[51] According to another embodiment of the present disclosure, in formula 1 above, Ar_1 represents a single bond, a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene; Ar_2 represents a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene; R_1 and R_2 each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino; R_3 and R_4 each independently represent hydrogen, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl or a 5- to 20-membered heteroaryl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino; and R_{11} to R_{14} each independently represent hydrogen, or an unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a (C6-C20)aryl unsubstituted or substituted with a (C6-C12)aryl, a 5- to 20-membered heteroaryl, a di(C6-C12)arylamino, or a (C1-C6)alkyl(C6-C12)aryl; or an unsubstituted 5- to 20-membered heteroaryl ring.

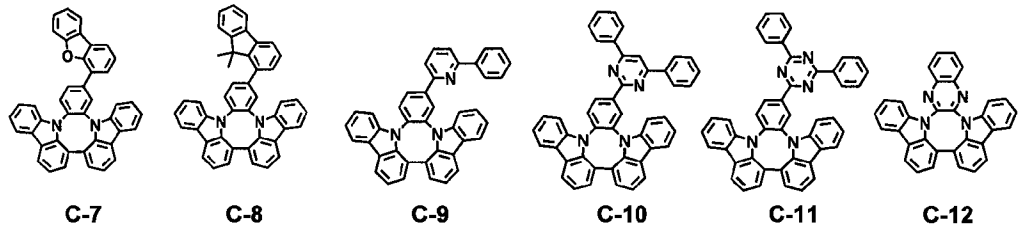
[52] The organic electroluminescent compound represented by formula 1 includes the following compounds, but is not limited thereto:

[53]



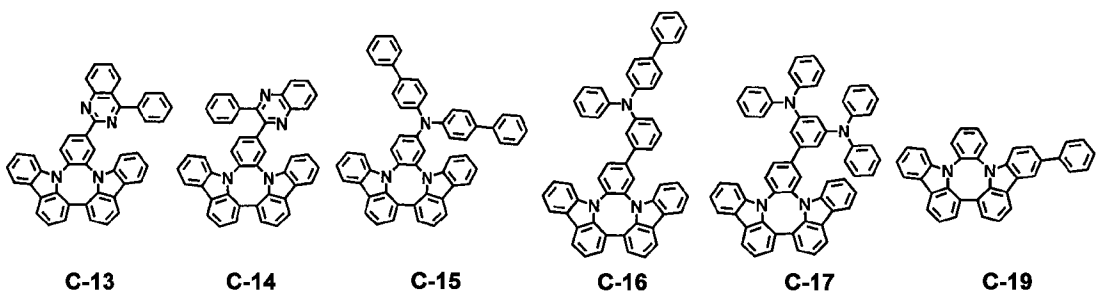
C-1 C-2 C-3 C-4 C-5 C-6

[54]



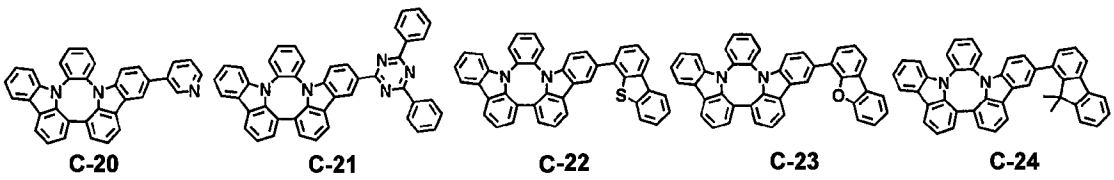
C-7 C-8 C-9 C-10 C-11 C-12

[55]



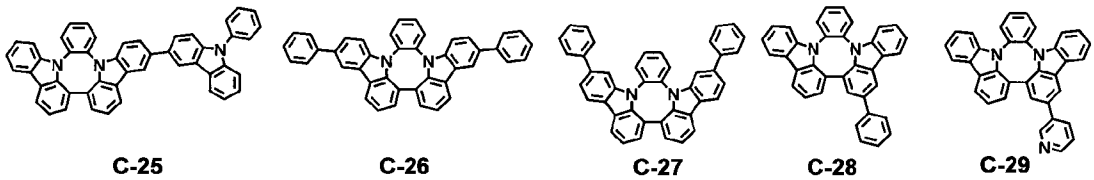
C-13 C-14 C-15 C-16 C-17 C-19

[56]



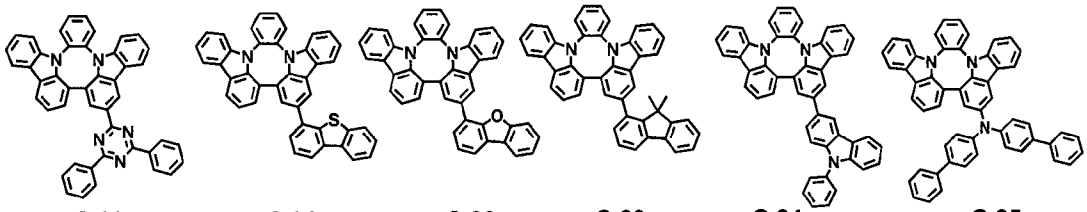
C-20 C-21 C-22 C-23 C-24

[57]



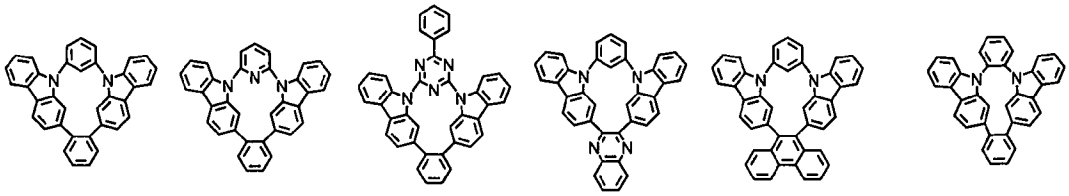
C-25 C-26 C-27 C-28 C-29

[58]



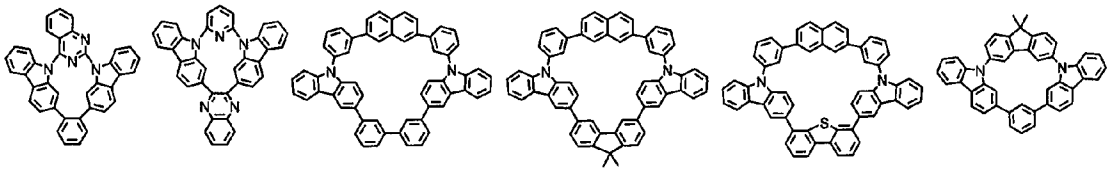
C-30 C-31 C-32 C-33 C-34 C-35

[59]



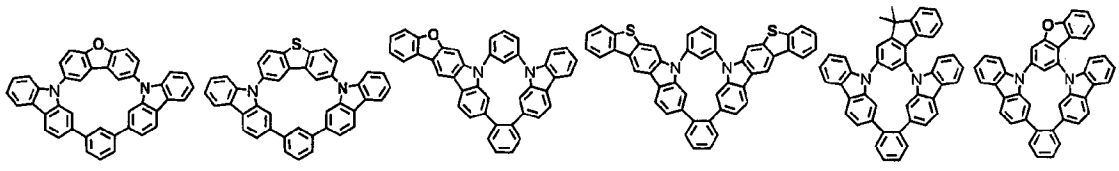
C-36 C-37 C-38 C-39 C-40 C-41

[60]



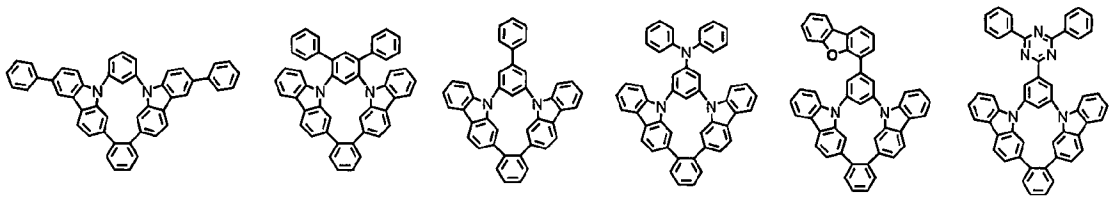
C-42 C-43 C-44 C-45 C-46 C-47

[61]



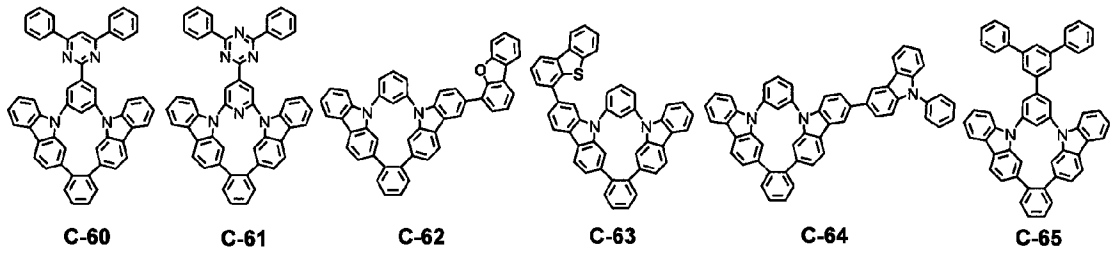
C-48 C-49 C-50 C-51 C-52 C-53

[62]



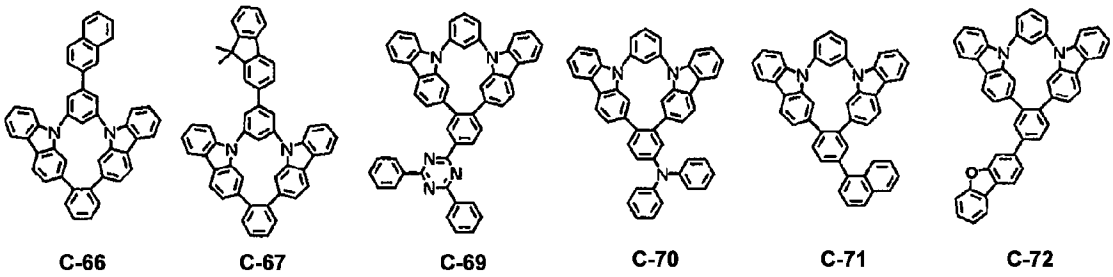
C-54 C-55 C-56 C-57 C-58 C-59

[63]



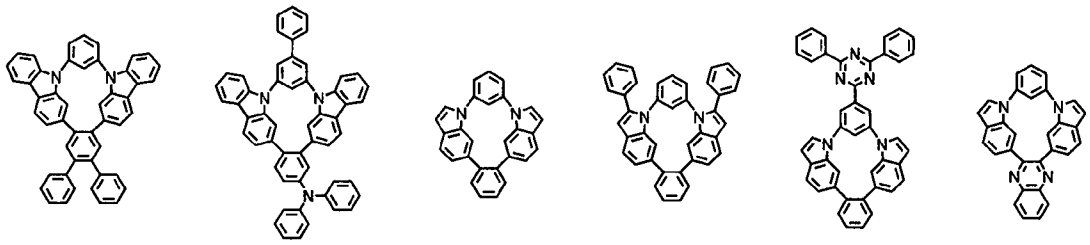
C-60 C-61 C-62 C-63 C-64 C-65

[64]



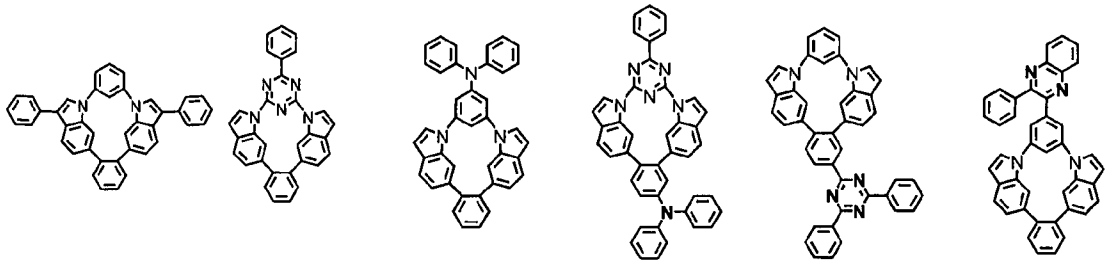
C-66 C-67 C-69 C-70 C-71 C-72

[65]



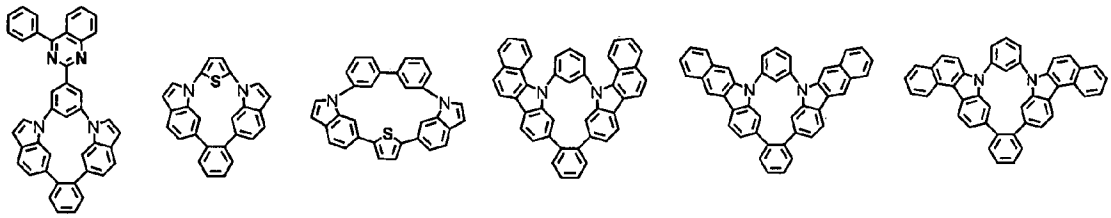
C-73 C-74 C-75 C-76 C-77 C-78

[66]



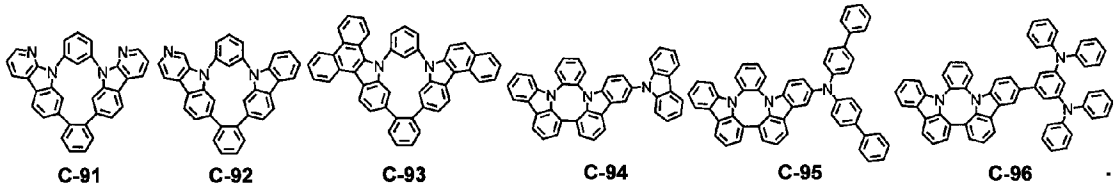
C-79 C-80 C-81 C-82 C-83 C-84

[67]



C-85 C-86 C-87 C-88 C-89 C-90

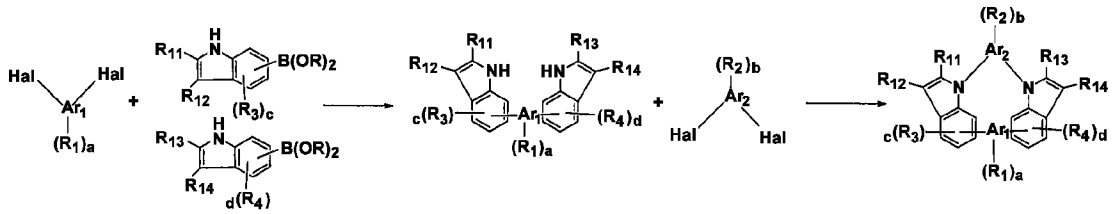
[68]



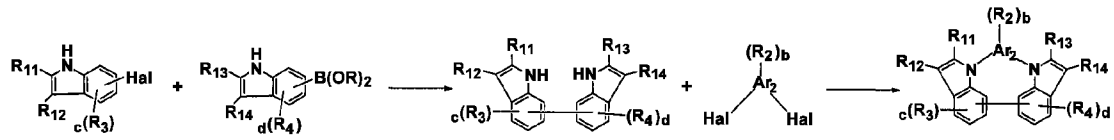
C-91 C-92 C-93 C-94 C-95 C-96

[69] The organic electroluminescent compound of the present disclosure can be prepared by a synthetic method known to a person skilled in the art. For example, it can be prepared according to the following reaction schemes.

[70] [Reaction Scheme 1]

[71] 

[72] [Reaction Scheme 2]

[73] 

[74] wherein Ar_1, Ar_2, R_1 to R_4, R_{11} to R_{14}, and a to d are as defined in formula 1, and Hal represents a halogen.

[75] The present disclosure provides an organic electroluminescent material comprising the organic electroluminescent compound of formula 1, and an organic electroluminescent device comprising the material.

[76] The above material can be comprised of the organic electroluminescent compound according to the present disclosure alone, or can further include conventional materials generally used in organic electroluminescent materials.

[77] The organic electroluminescent device according to the present disclosure comprises a first electrode; a second electrode; and at least one organic layer between the first and second electrodes. The organic layer may comprise at least one organic electroluminescent compound of formula 1.

[78] 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, a hole auxiliary layer, a light-emitting auxiliary layer, an electron transport layer, an electron buffer layer, an electron injection layer, an interlayer, a hole blocking layer, and an electron blocking layer.

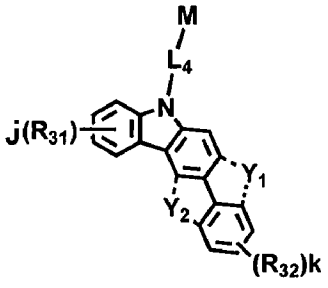
[79] The organic electroluminescent compound of formula 1 of the present disclosure may be comprised in at least one layer of the light-emitting layer, the hole injection layer, the hole transport layer, the hole auxiliary layer, the light-emitting auxiliary layer, the electron transport layer, the electron buffer layer, the electron injection layer, the interlayer, the hole blocking layer, and the electron blocking layer, preferably in the light-emitting layer, the hole transport layer, the electron buffer layer, or the hole transport layer. Where used in the light-emitting layer, the compound of formula 1 according to the present disclosure can be comprised as a phosphorescent host material. Further, it can be used as a co-host or pre-mixed host material. Preferably, the

light-emitting layer can further comprise one or more dopants. If necessary, a compound other than the compound of formula 1 (first host material) can be additionally comprised as a second host material in the phosphorescent host material of the present disclosure. Herein, the weight ratio of the first host material to the second host material is in the range of 1:99 to 99:1.

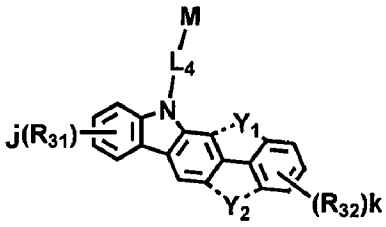
[80] The second host material can be any of the known hosts. The phosphorescent host selected from the group consisting of the compounds of formulas 11 to 16 below may be preferable in terms of luminous efficiency.

[81] $H\text{-}(Cz\text{-}L_4)_h\text{-}M$ ----------(11)

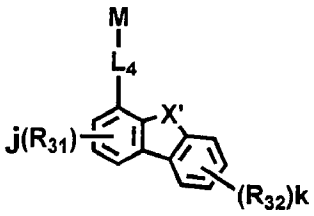
[82] $H\text{-}(Cz)_i\text{-}L_4\text{-}M$ ----------(12)

[83] 

----------(13)

[84] 

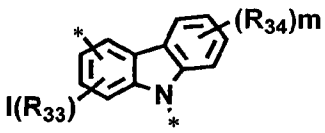
----------(14)

[85] 

----------(15)

[86] wherein

[87] Cz represents the following structure:

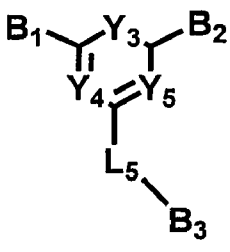
[88] 

[89] X' represents -O- or -S-; and

[90] R_{31} to R_{34}, 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 (5- to 30-membered)heteroaryl, or $-SiR_{35}R_{36}R_{37}$; in which

R_{35} to R_{37}, each independently, represent a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; L_4 represents 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; Y_1 and Y_2, each independently, represent -O-, -S-, -N(R_{41})- or -C(R_{42})(R_{43})-, with the proviso that Y_1 and Y_2 are not present simultaneously; R_{41} to R_{43}, each independently, represent 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_{42} and R_{43} may be the same or different; h and i, each independently, represent an integer of 1 to 3; j, k, l, and m, each independently, represent an integer of 0 to 4; where if h, i, j, k, l, or m represents an integer of 2 or more, each (Cz-L_4), each (Cz), each R_{31}, each R_{32}, each R_{33}, or each R_{34} may be the same or different;

[91]



----------(16)

[92] wherein

[93] Y_3 to Y_5, each independently, represent CR_{44} or N;

[94] R_{44} represents 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;

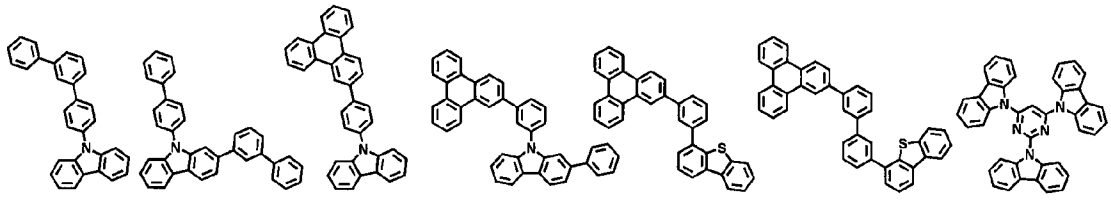
[95] B_1 and B_2, each independently, represent hydrogen, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl;

[96] B_3 represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl; and

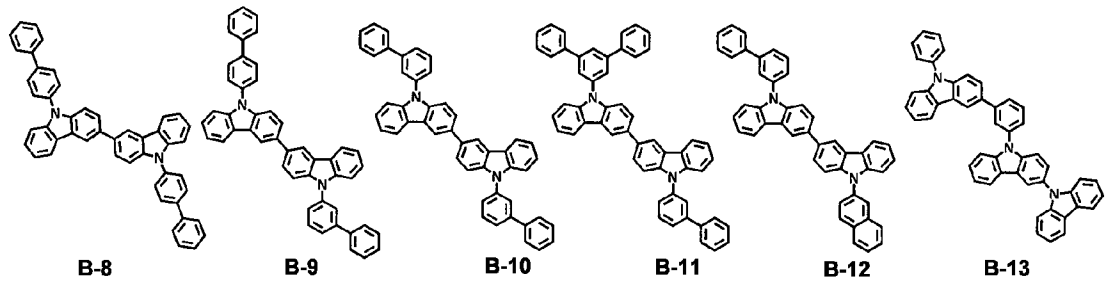
[97] L_5 represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted (5- to 30-membered)heteroarylene.

[98] Specifically, the examples of the second host material are as follows, but are not limited thereto.

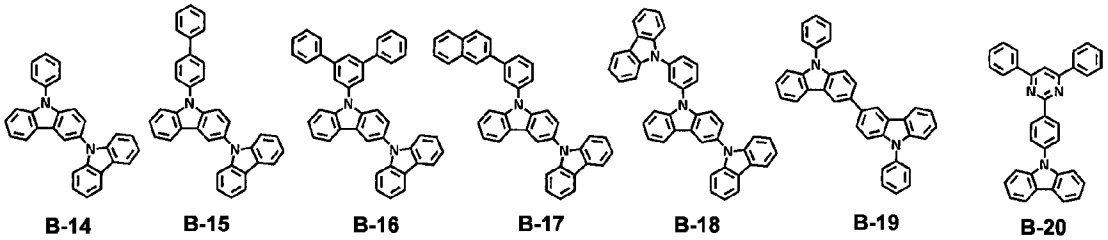
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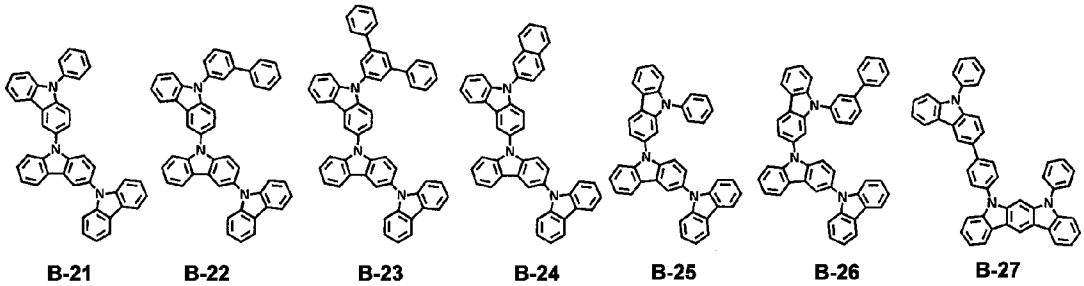
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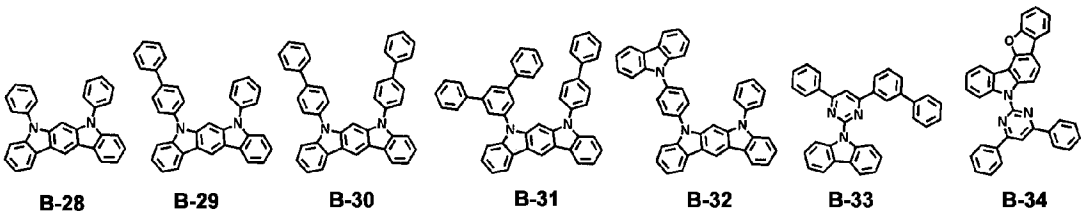
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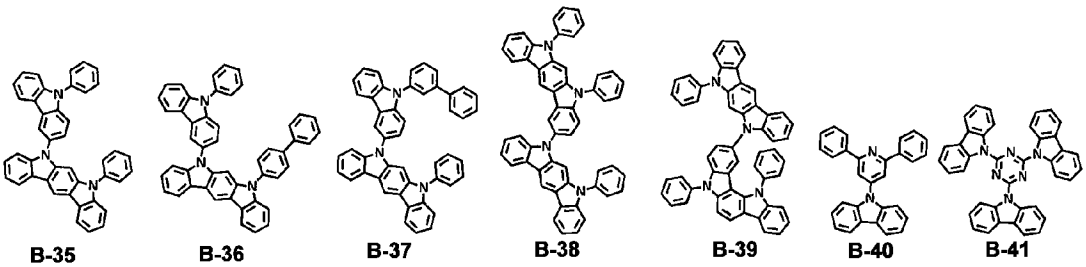
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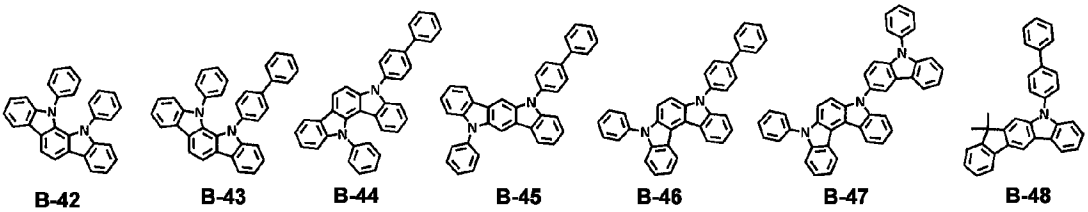
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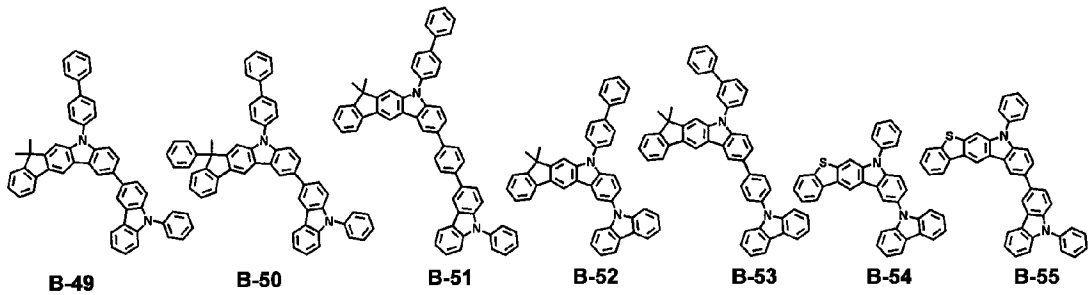
[104]



[105]

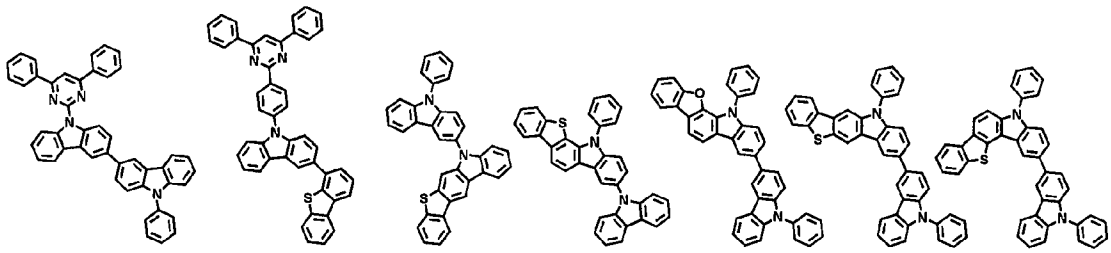


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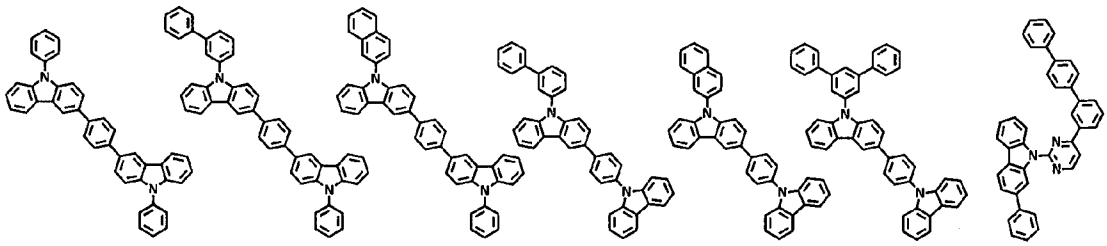
B-49 B-50 B-51 B-52 B-53 B-54 B-55

[107]



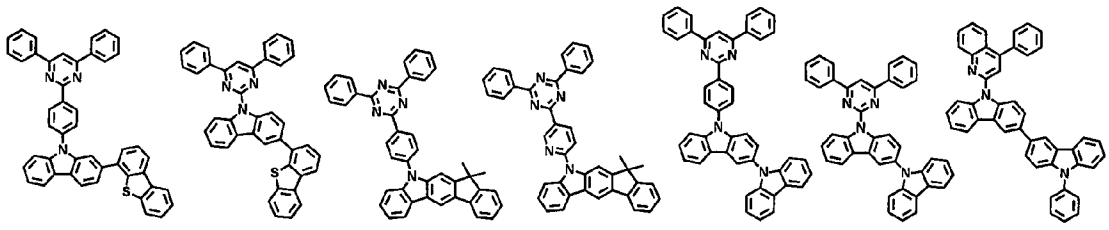
B-56 B-57 B-58 B-59 B-60 B-61 B-62

[108]



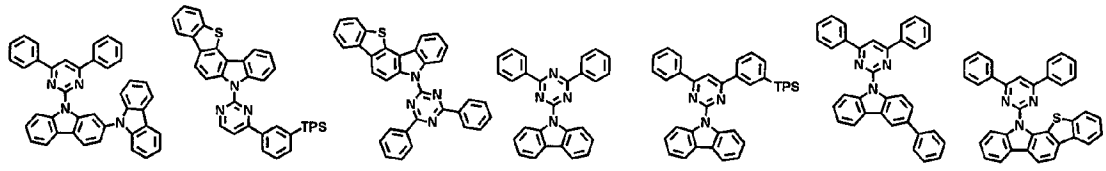
B-63 B-64 B-65 B-66 B-67 B-68 B-69

[109]



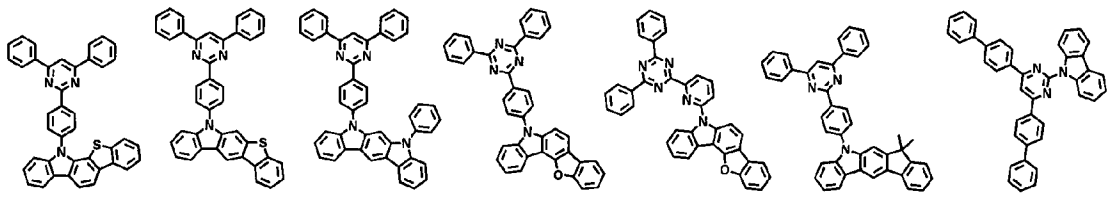
B-70 B-71 B-72 B-73 B-74 B-75 B-76

[110]



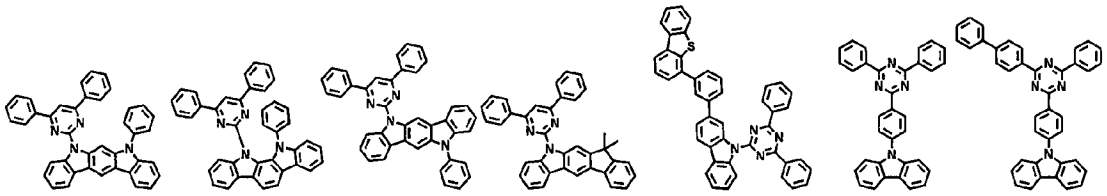
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[111]



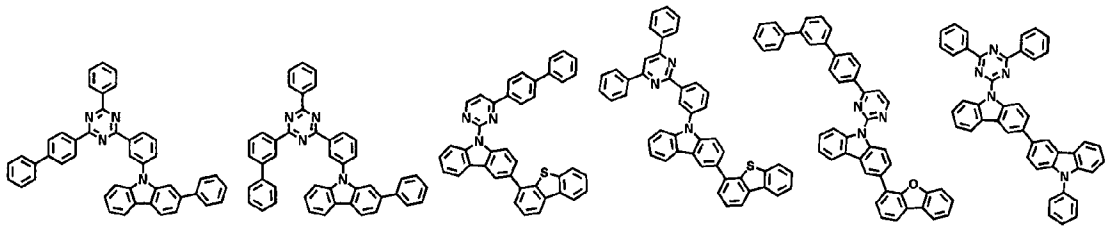
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[112]



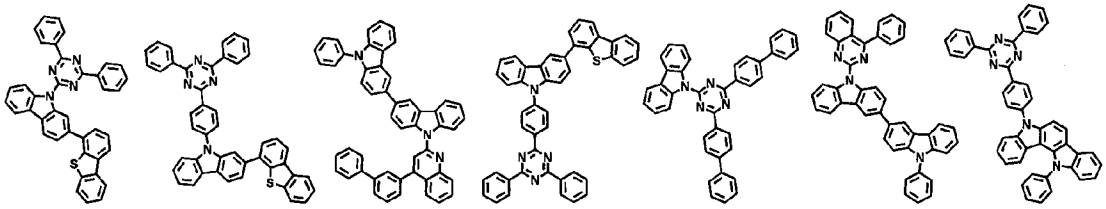
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[113]



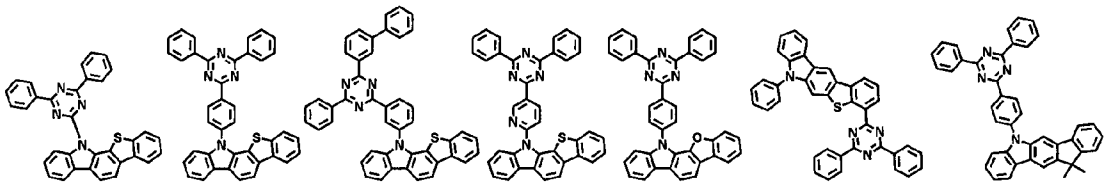
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[114]



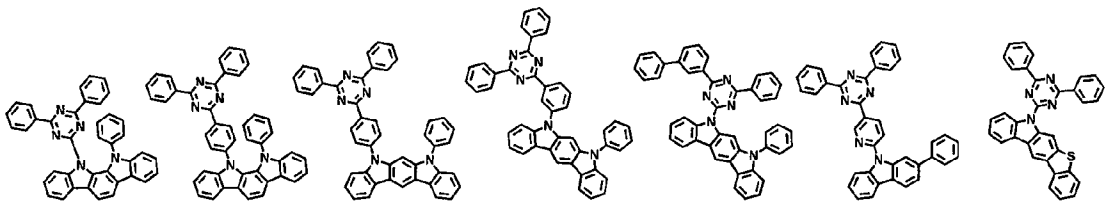
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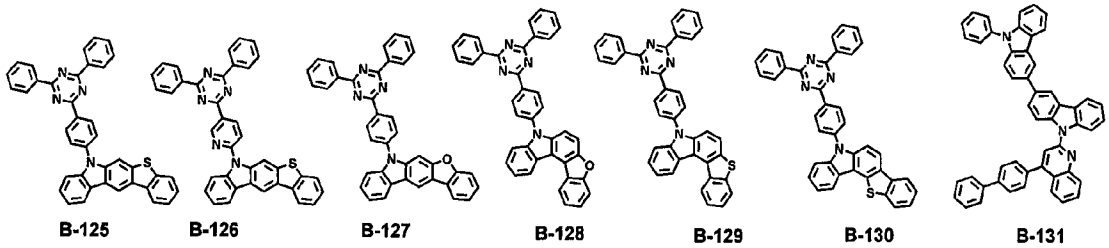
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[116]



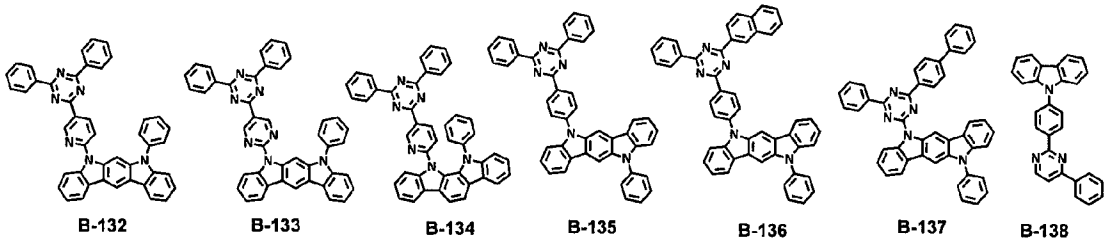
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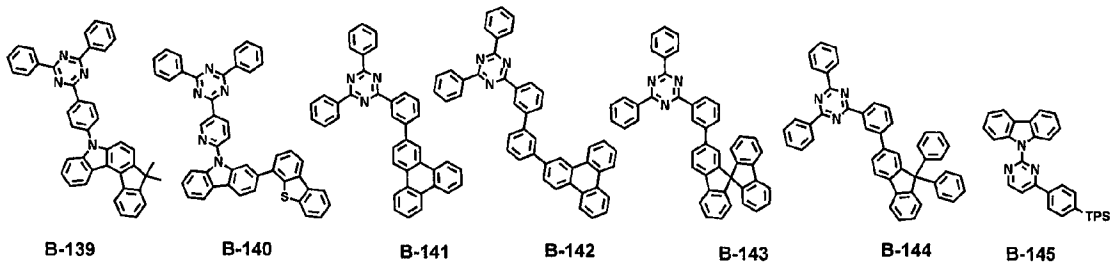


B-125 B-126 B-127 B-128 B-129 B-130 B-131

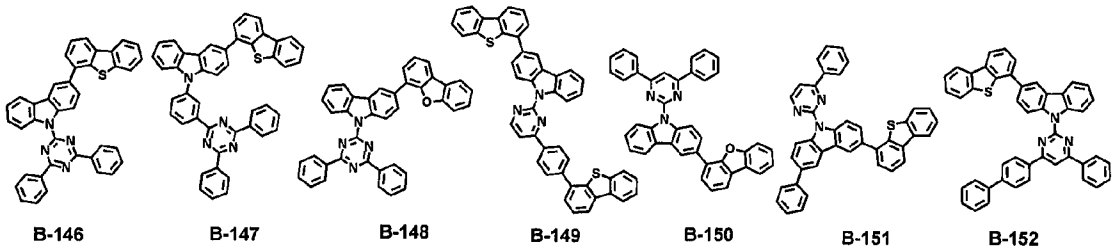
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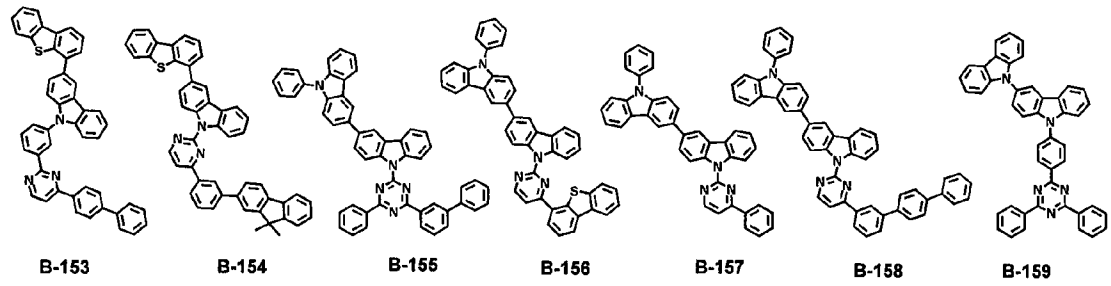
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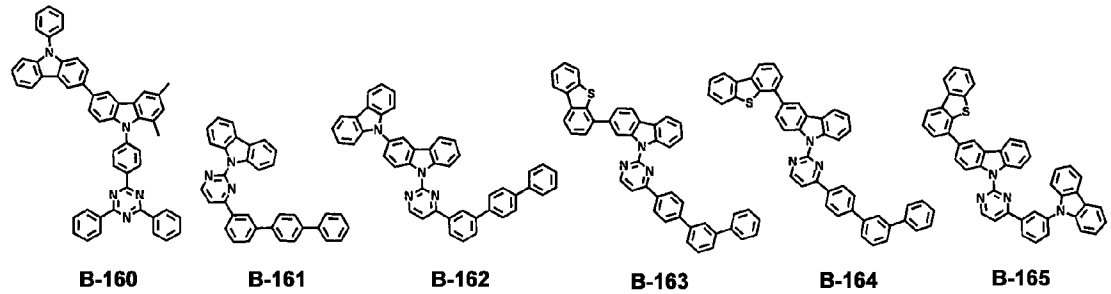
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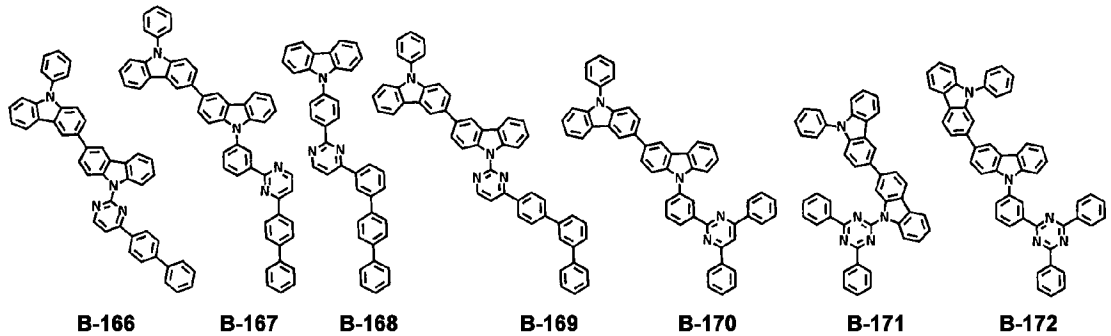
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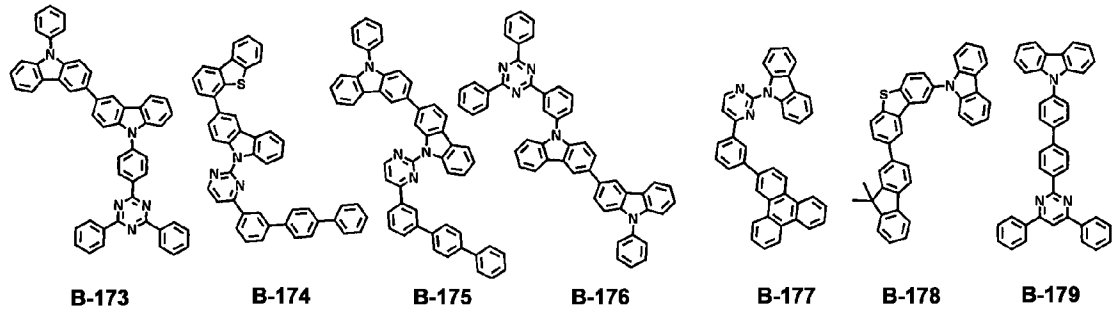
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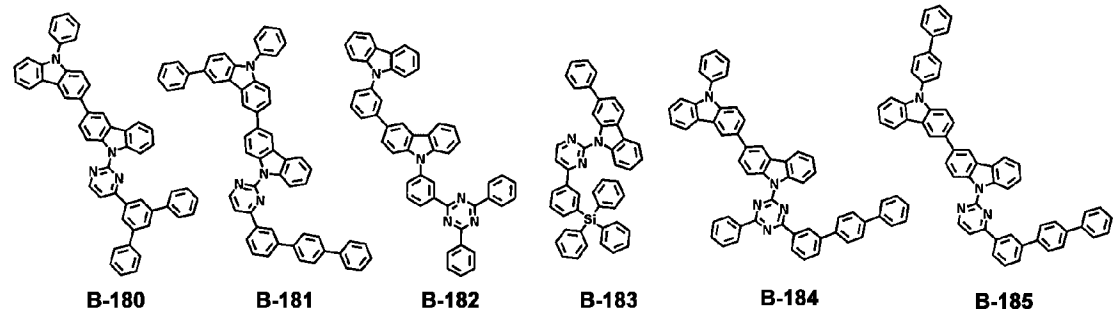
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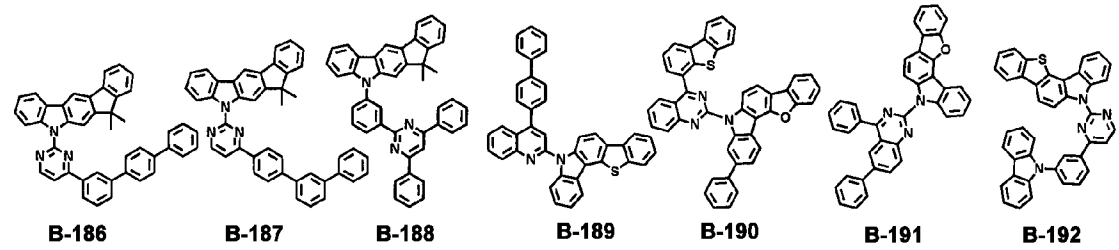
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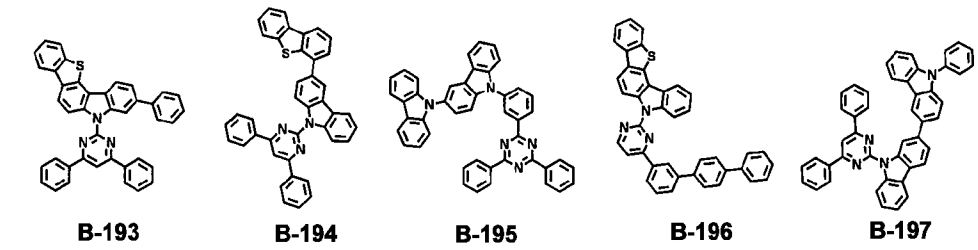
[125]



[126]



[127]

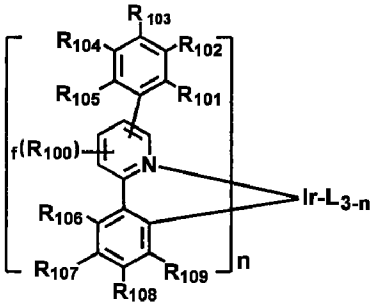


[128] [wherein TPS represents a triphenylsilyl group]

[129] The dopant comprised in the organic electroluminescent device according to the present disclosure may be preferably at least one phosphorescent dopant. The phosphorescent dopant materials applied to the organic electroluminescent device according to the present disclosure are not particularly limited, but may be preferably selected from metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu), and platinum (Pt), may be more preferably selected from ortho-metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu), and platinum (Pt), and may be even more preferably ortho-metallated iridium complex compounds.

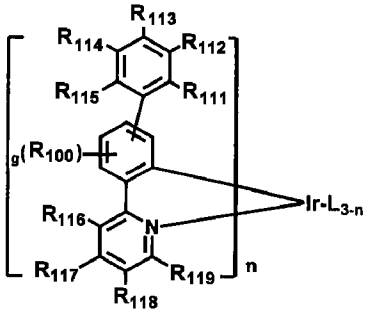
[130] The dopant comprised in the organic electroluminescent device of the present disclosure may be preferably selected from the group consisting of the compounds of formulas 101 to 104 below, but is not limited thereto.

[131]



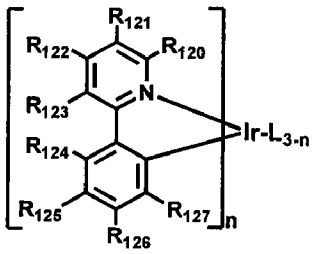
---------- (101)

[132]



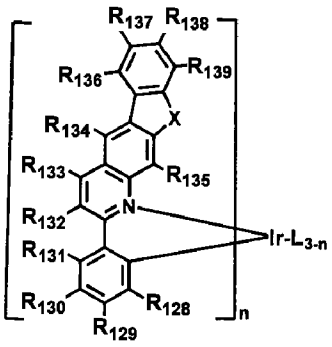
---------- (102)

[133]



---------- (103)

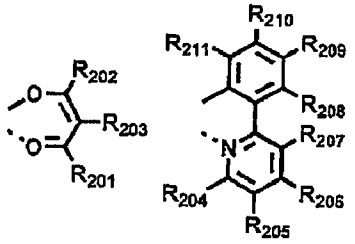
[134]



---------- (104)

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

[136]



[137] R_{100}, R_{134}, and R_{135}, each independently, represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl;

[138] 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 substituted or unsubstituted (C6-C30)aryl, a cyano, or a substituted or unsubstituted (C1-C30)alkoxy; adjacent substituents of R_{106} to R_{109} may be linked to each other to form a substituted or unsubstituted fused ring, e.g., a fluorene unsubstituted or substituted with an alkyl, a dibenzothiophene unsubstituted or substituted with an alkyl, or a dibenzofuran unsubstituted or substituted with an alkyl; and adjacent substituents of R_{120} to R_{123} may be linked to each other to form a substituted or unsubstituted fused ring, e.g., a quinoline unsubstituted or substituted with an alkyl or an aryl;

[139] R_{124} to R_{133} and R_{136} to R_{139}, each independently, represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; and adjacent substituents of R_{124} to R_{127} may be linked to each other to form a substituted or unsubstituted fused ring, e.g., a fluorene unsubstituted or substituted with an alkyl, a dibenzothiophene unsubstituted or substituted with an alkyl, or a dibenzofuran unsubstituted or substituted with an alkyl;

[140] X represents CR_aR_b, O, or S;

[141] R_a and R_b, each independently, represent a substituted or unsubstituted (C1-C10)alkyl, or a substituted or unsubstituted (C6-C30)aryl;

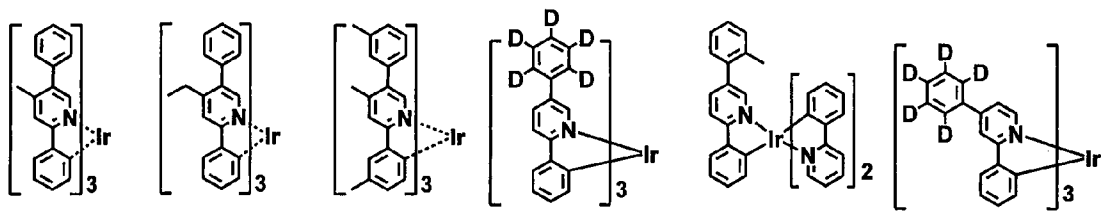
[142] R_{201} to R_{211}, each independently, represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-C30)aryl; and adjacent substituents of R_{208} to R_{211} may be linked to each other to form a substituted or unsubstituted fused ring, e.g., a fluorene unsubstituted or substituted with an alkyl, a dibenzothiophene unsubstituted or substituted with an alkyl, or a dibenzofuran unsubstituted or substituted with an alkyl;

[143] f and g, each independently, represent an integer of 1 to 3; where f or g is an integer of 2 or more, each R_{100} may be the same or different; and

[144] n represents an integer of 1 to 3.

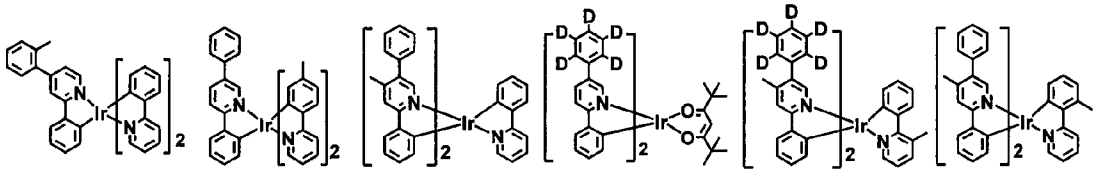
[145] The specific examples of the dopant compound are as follows:

[146]



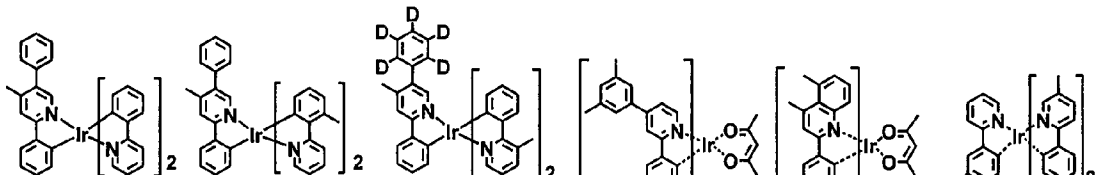
D-1 D-2 D-3 D-4 D-5 D-6

[147]



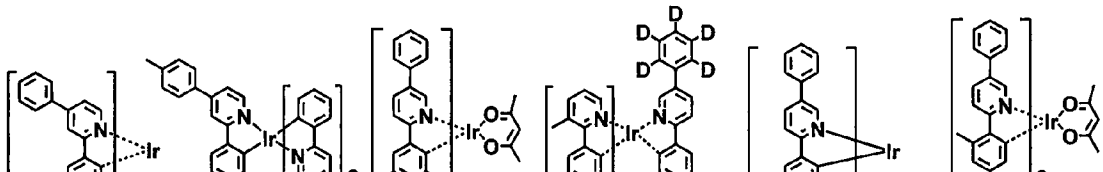
D-7 D-8 D-9 D-10 D-11 D-12

[148]



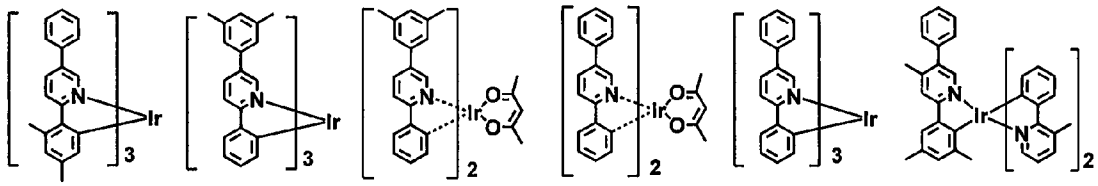
D-13 D-14 D-15 D-16 D-17 D-18

[149]



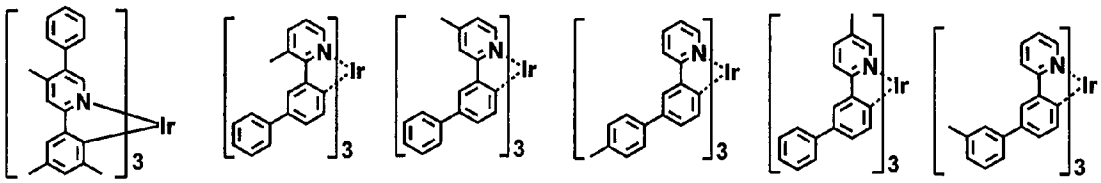
D-19 D-20 D-21 D-22 D-23 D-24

[150]



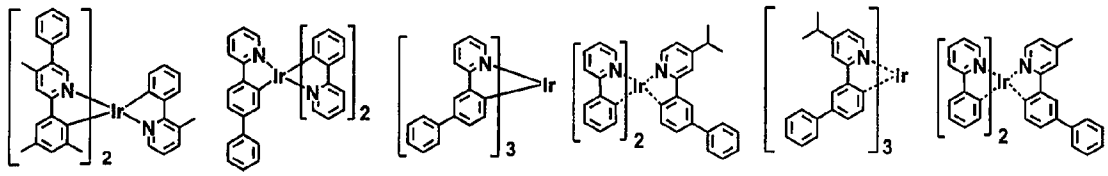
D-25 D-26 D-27 D-28 D-29 D-30

[151]



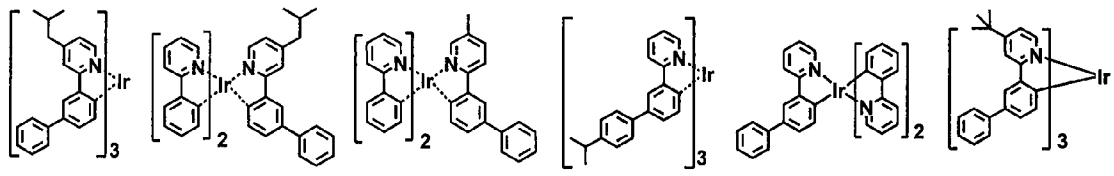
D-31 D-32 D-33 D-34 D-35 D-36

[152]



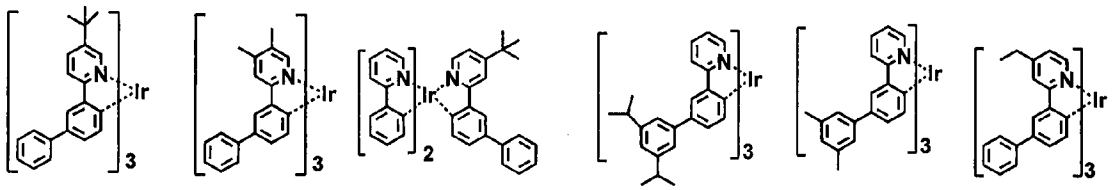
D-37 D-38 D-39 D-40 D-41 D-42

[153]



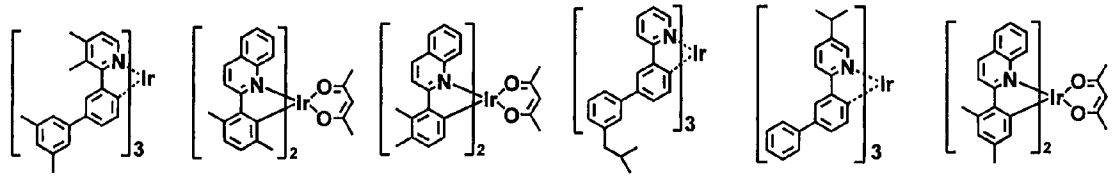
D-43 D-44 D-45 D-46 D-47 D-48

[154]



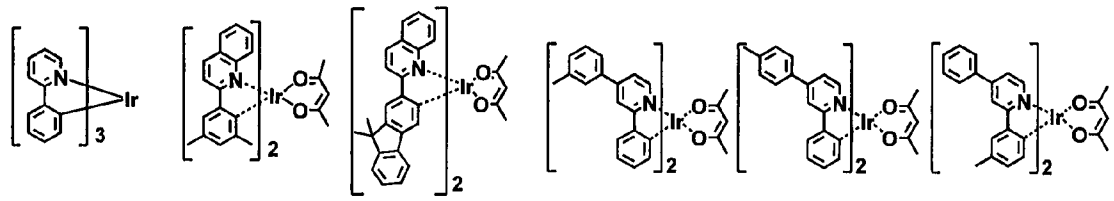
D-49 D-50 D-51 D-52 D-53 D-54

[155]



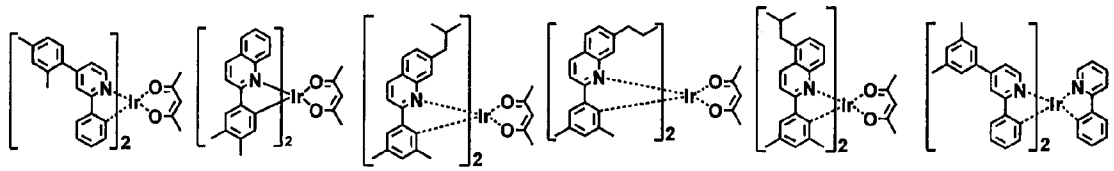
D-55 D-56 D-57 D-58 D-59 D-60

[156]



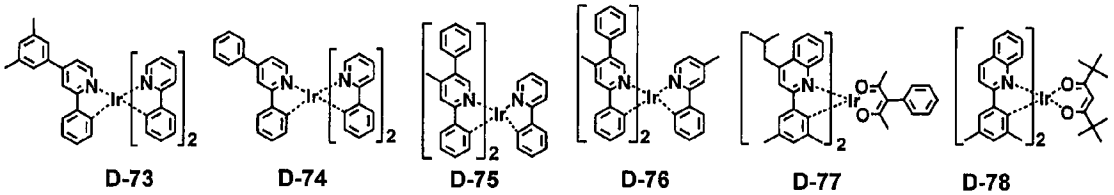
D-61 D-62 D-63 D-64 D-65 D-66

[157]



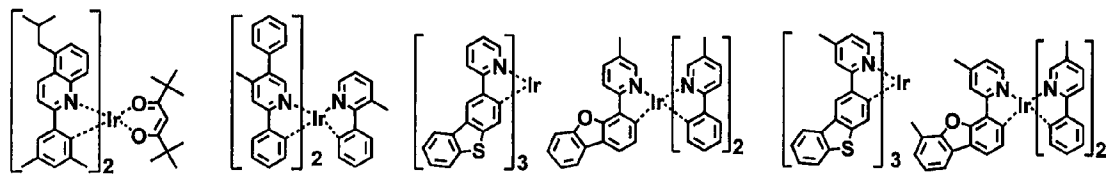
D-67 D-68 D-69 D-70 D-71 D-72

[158]



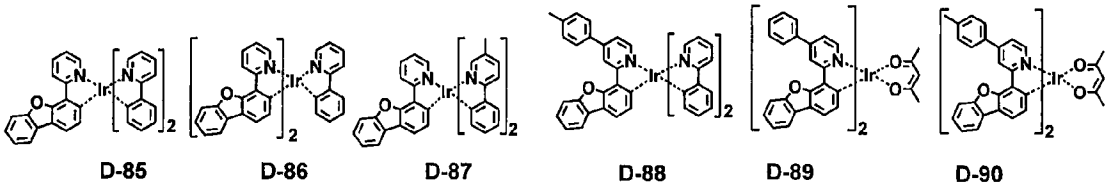
D-73 D-74 D-75 D-76 D-77 D-78

[159]



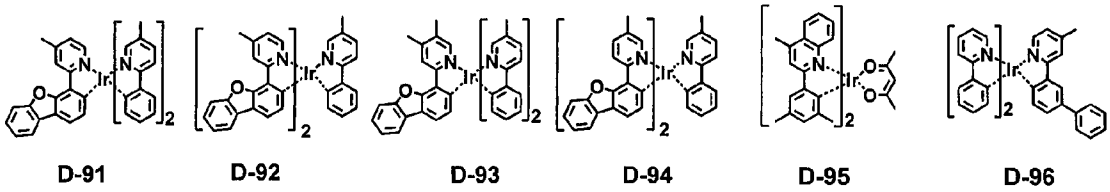
D-79 D-80 D-81 D-82 D-83 D-84

[160]



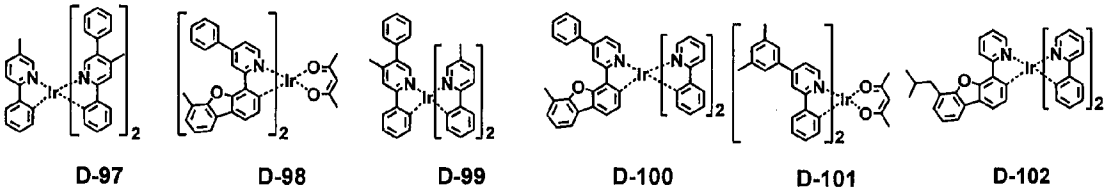
D-85 D-86 D-87 D-88 D-89 D-90

[161]



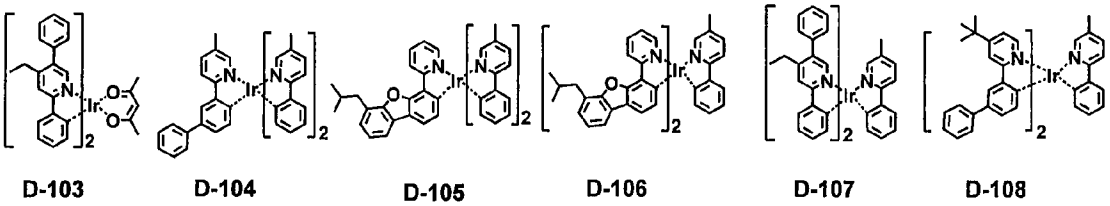
D-91 D-92 D-93 D-94 D-95 D-96

[162]



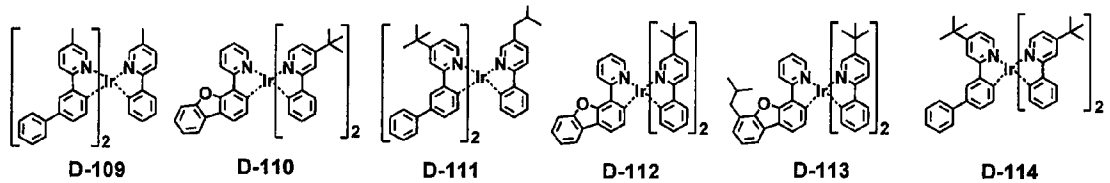
D-97 D-98 D-99 D-100 D-101 D-102

[163]



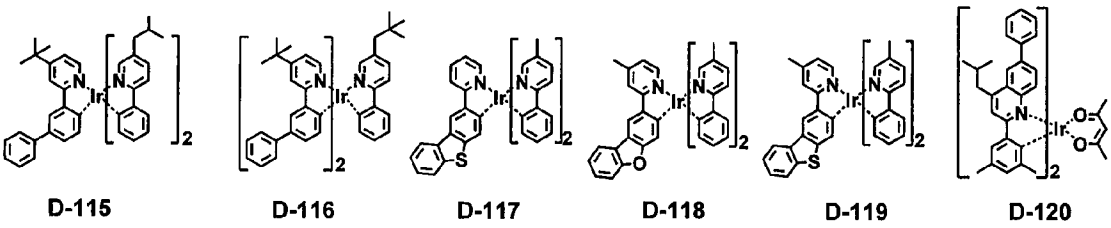
D-103 D-104 D-105 D-106 D-107 D-108

[164]



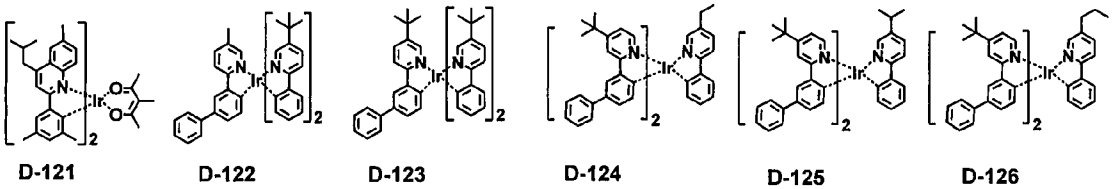
D-109 D-110 D-111 D-112 D-113 D-114

[165]



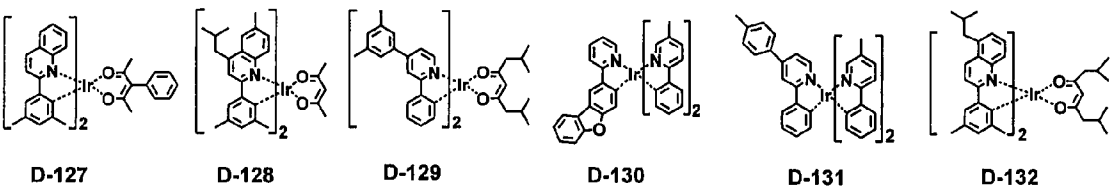
D-115 D-116 D-117 D-118 D-119 D-120

[166]



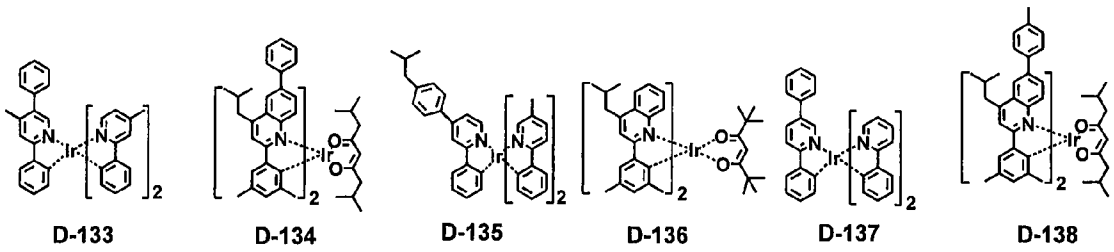
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[167]



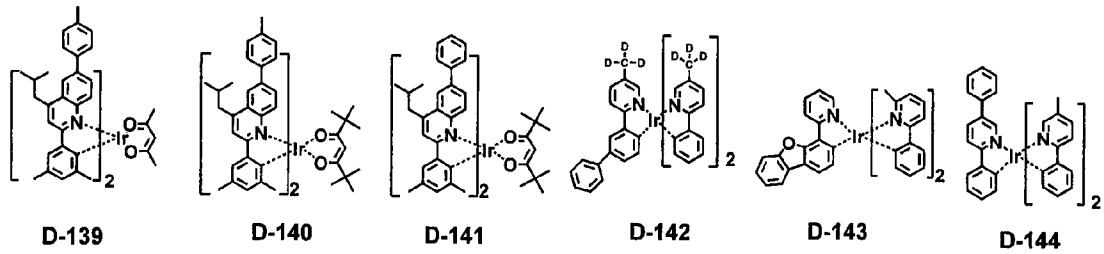
D-127 D-128 D-129 D-130 D-131 D-132

[168]



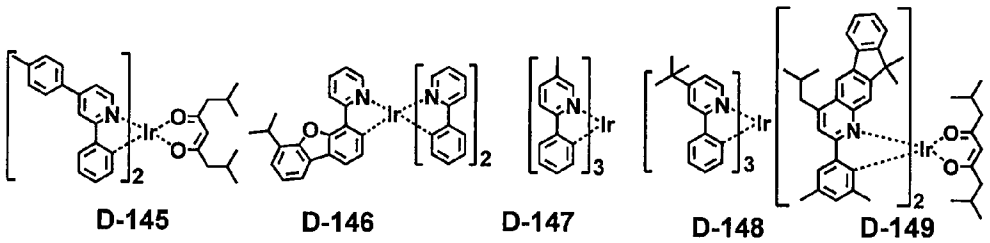
D-133 D-134 D-135 D-136 D-137 D-138

[169]



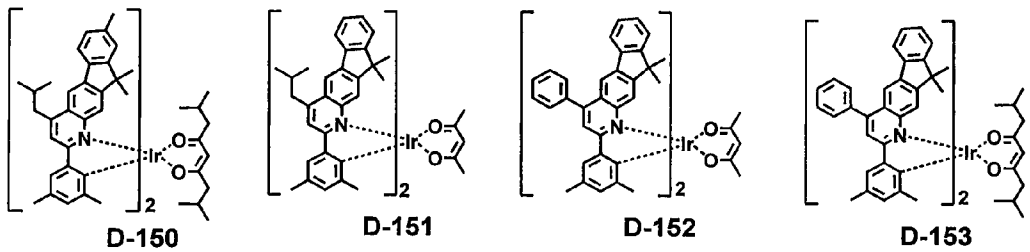
D-139 D-140 D-141 D-142 D-143 D-144

[170]



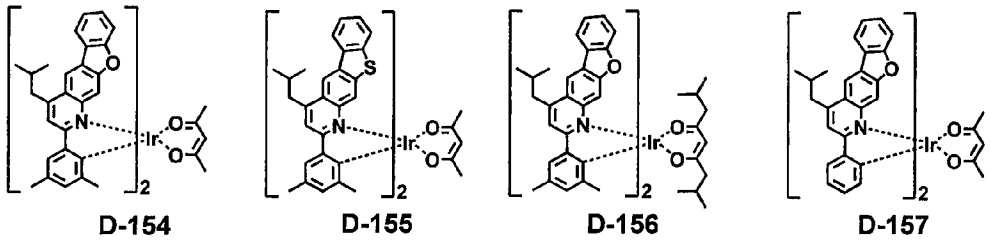
D-145 D-146 D-147 D-148 D-149

[171]



D-150 D-151 D-152 D-153

[172]



D-154 D-155 D-156 D-157

[173] In another embodiment of the present disclosure, a plurality of host materials is provided. The plurality of host materials can comprise the compound represented by formula 1 and the compound represented by any one of formulas 11 to 16.

[174] Further, the organic electroluminescent device according to the present disclosure may have a first electrode; a second electrode; and an organic layer between the first and second electrodes, and the organic layer may comprise the plurality of host materials.

[175] In another embodiment of the present disclosure, a composition for preparing an organic electroluminescent device is provided. The composition comprises the

compound according to the present disclosure as a host material, a hole transport material, an electron buffer material, or an electron transport material.

[176] In addition, the organic electroluminescent device according to the present disclosure comprises a first electrode; a second electrode; and at least one organic layer between the first and second electrodes. The organic layer comprises a light-emitting layer, and the light-emitting layer may comprise the composition for preparing the organic electroluminescent device according to the present disclosure.

[177] The organic electroluminescent device according to the present disclosure may further comprise, in addition to the organic electroluminescent compound represented by formula 1, at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds.

[178] In the organic electroluminescent device according to the present disclosure, the organic layer may further comprise at least one metal selected from the group consisting of metals of Group 1, metals of Group 2, transition metals of the 4^{th} period, transition metals of the 5^{th} period, lanthanides and organic metals of d-transition elements of the Periodic Table, or at least one complex compound comprising said metal. The organic layer may further comprise a light-emitting layer and a charge generating layer.

[179] In addition, the organic electroluminescent device according to 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 according to the present disclosure. Also, if necessary, a yellow or orange light-emitting layer can be comprised in the device.

[180] According to the present disclosure, at least one layer (hereinafter, "a surface layer") is preferably 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 (including 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, said chalcogenide includes $SiO_X(1\leq X\leq 2)$, AlO_X $(1\leq X\leq 1.5)$, SiON, SiAlON, etc.; said metal halide includes LiF, MgF_2, CaF_2, a rare earth metal fluoride, etc.; and said metal oxide includes Cs_2O, Li_2O, MgO, SrO, BaO, CaO, etc.

[181] A hole injection layer, a hole transport layer, an electron blocking layer, or a combination thereof can be used between the anode and the light-emitting layer. The hole injection layer may be multi-layers in order to lower the hole injection barrier (or hole

injection voltage) from the anode to the hole transport layer or the electron blocking layer, wherein each of the multi-layers may use two compounds simultaneously. The hole transport layer or the electron blocking layer may also be multi-layers.

[182] An electron buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, or a combination thereof can be used between the light-emitting layer and the cathode. The electron buffer layer may be multi-layers in order to control the injection of the electron and improve the interfacial properties between the light-emitting layer and the electron injection layer, wherein each of the multi-layers may use two compounds simultaneously. The hole blocking layer or the electron transport layer may also be multi-layers, wherein each of the multi-layers may use a plurality of compounds.

[183] The light-emitting auxiliary layer may be placed between the anode and the light-emitting layer, or between the cathode and the light-emitting layer. When the light-emitting auxiliary layer is placed between the anode and the light-emitting layer, it can be used for promoting the hole injection and/or hole transport, or for preventing the overflow of electrons. When the light-emitting auxiliary layer is placed between the cathode and the light-emitting layer, it can be used for promoting the electron injection and/or electron transport, or for preventing the overflow of holes. Also, the hole auxiliary layer may be placed between the hole transport layer (or hole injection layer) and the light-emitting layer, and may be effective to promote or block the hole transport rate (or hole injection rate), thereby enabling the charge balance to be controlled. Further, the electron blocking layer may be placed between the hole transport layer (or hole injection layer) and the light-emitting layer, and can confine the excitons within the light-emitting layer by blocking the overflow of electrons from the light-emitting layer to prevent a light-emitting leakage. When an organic electroluminescent device includes two or more hole transport layers, the hole transport layer, which is further included, may be used as a hole auxiliary layer or an electron blocking layer. The hole auxiliary layer and the electron blocking layer may have an effect of improving the efficiency and/or the lifespan of the organic electroluminescent device.

[184] Preferably, 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 the light-emitting 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 light-emitting 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. The reductive dopant layer may be employed as a charge-generating layer to prepare an organic EL device having two or more light-emitting layers and emitting white light.

[185] In order to form each layer constituting the organic EL device of the present disclosure, dry film-forming methods such as vacuum deposition, sputtering, plasma, ion plating methods, etc., or wet film-forming methods such as spin coating, dip coating, flow coating methods, etc., can be used. When forming the film of the first and second host compounds of the present disclosure, a co-evaporation or a mixed evaporation method is used.

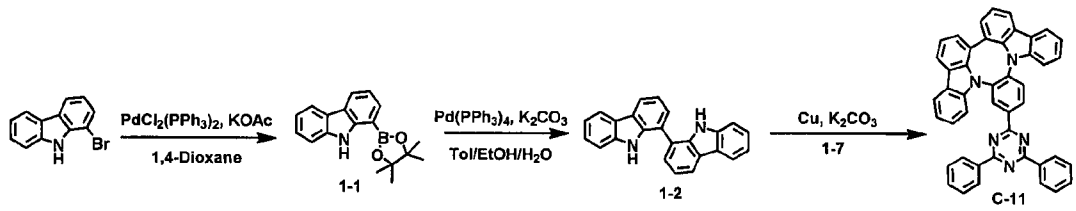
[186] When using a wet film-forming method, a thin film is formed by dissolving or dispersing the material constituting each layer in suitable solvents, such as ethanol, chloroform, tetrahydrofuran, dioxane, etc. The solvents are not specifically limited as long as the material constituting each layer is soluble or dispersible in the solvents, which do not cause any problems in forming a film.

[187] By using the organic electroluminescent device of the present disclosure, a display system, for example, for smartphones, tablets, notebooks, PCs, TVs, or vehicles, or a lighting system, for example, an indoor or outdoor lighting system, can be produced.

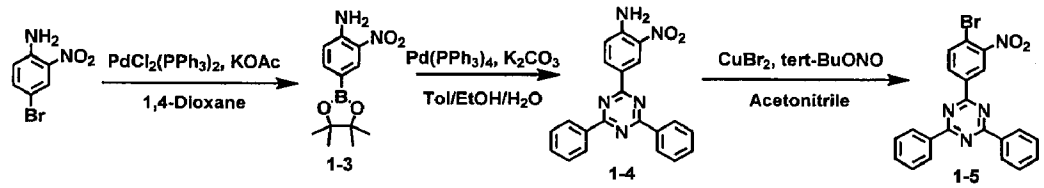
[188] Hereinafter, the preparation method of the organic electroluminescent compounds of the present disclosure, the physical properties of the compounds, and the luminous properties of the organic electroluminescent device comprising the compounds will be explained in detail with reference to the representative compounds of the present disclosure.

[189] **Example 1: Preparation of compound C-11**

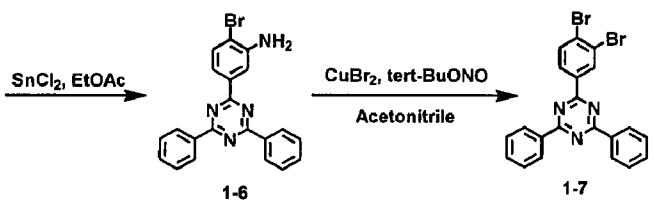
[190]



[191]



[192]



[193] Preparation of compound 1-1

[194] 20 g of 1-bromo-9H-carbazole (81.2 mmol), 26.8 g of bis(pinacolato)diborane (105 mmol), 2.8 g of bis(triphenylphosphine)palladium(II) (4 mmol), 16 g of potassium acetate (162 mmol), and 400 mL of 1,4-dioxane were introduced into a reaction vessel, and the mixture was stirred at 120°C for 12 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 16.7 g of compound **1-1** (yield: 71%).

[195] Preparation of compound 1-2

[196] 16.4 g of compound **1-1** (56 mmol), 12.5 g of 1-bromo carbazole (51 mmol), 2.9 g of tetrakis(triphenylphosphine)palladium (2.5 mmol), 17.5 g of potassium carbonate (127 mmol), 300 mL of toluene, 75 mL of ethanol, and 75 mL of distilled water were introduced into a reaction vessel, and the mixture was stirred under reflux for 5 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 13.8 g of compound **1-2** (yield: 82%).

[197] Preparation of compound 1-3

[198] 30 g of 4-bromo-2-nitroaniline (138 mmol), 42 g of bis(pinacolato)diborane (166 mmol), 4.9 g of bis(triphenylphosphine)palladium(II) (6.9 mmol), 34 g of potassium acetate (345 mmol), and 690 mL of 1,4-dioxane were introduced into a reaction vessel, and the mixture was stirred at 120°C for 5 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 28 g of compound **1-3** (yield: 77%).

[199] Preparation of compound 1-4

[200] 13 g of compound **1-3** (49 mmol), 14.5 g of 2-chloro-4,6-diphenyl-1,3,5-triazine (54 mmol), 2.8 g of tetrakis(triphenylphosphine)palladium (2.4 mmol), 17 g of potassium carbonate (123 mmol), 240 mL of toluene, 30 mL of ethanol, and 60 mL of distilled water were introduced into a reaction vessel, and the mixture was stirred under reflux for 12 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 18 g of compound **1-4** (yield: 100%).

[201] Preparation of compound 1-5

[202] 15 g of compound **1-4** (40.6 mmol), 13.6 g of cupric bromide (61 mmol), 7.3 mL of tert-butyl nitrite (61 mmol), and 140 mL of acetonitrile were introduced into a reaction vessel, and the mixture was stirred for 3 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 10 g of compound **1-5** (yield: 57%).

[203] Preparation of compound 1-6

[204] 10 g of compound **1-5** (23 mmol), 15.6 g of stannous chloride dihydrate (69 mmol), and 150 mL of ethyl acetate were introduced into a reaction vessel, and the mixture was stirred for 12 hours. After completion of the reaction, the mixture was neutralized with potassium hydroxide solution. The mixture was then washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 7 g of compound **1-6** (yield: 75%).

[205] Preparation of compound 1-7

[206] 6.5 g of compound **1-6** (16 mmol), 4 g of cupric bromide (18 mmol), 2.9 mL of tert-butyl nitrite (24 mmol), and 550 mL of acetonitrile were introduced into a reaction vessel, and the mixture was stirred for 12 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 4.4 g of compound **1-7** (yield: 59%).

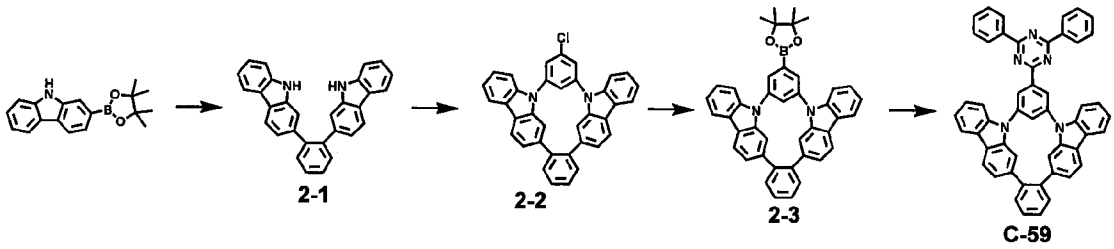
[207] Preparation of compound C-11

[208] 3.1 g of compound **1-2** (9.4 mmol), 2.2 g of compound **1-7** (4.7 mmol), 0.3 g of copper (4.7 mmol), 2.6 g of potassium carbonate (18.8 mmol), and 24 mL of 1,2-dichlorobenzene were introduced into a reaction vessel, and the mixture was stirred under reflux for 12 hours. After completion of the reaction, the mixture was washed with distilled water, extracted with ethyl acetate, and the extracted organic layer was dried with magnesium sulfate. The solvent was removed with a rotary evaporator, and the resulting product was purified by column chromatography to obtain 1 g of compound **C-11** (yield: 33%).

[209]

	MW	UV	PL	M.P.
C-11	637.73	344 nm	465 nm	330℃

[210] **Example 2: Preparation of compound C-59**

[211] 

[212] Preparation of compound 2-1

[213] 41 g of 2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-9H-carbazole (140 mmol), 19.8 g of 1-bromo-2-iodobenzene (70 mmol), 1.5 g of palladium acetate (7 mmol), 48 g of 2 M potassium carbonate (350 mmol), 5.7 g of 2-dichlorohexylphosphine-2',6'-dimethoxybiphenyl (14 mmol), 530 mL of toluene, and 170 mL of acetonitrile were introduced into a flask, and the mixture was refluxed for 12 hours. After completion of the reaction, the obtained solid was filtered and the filtrate was separated by column chromatography to obtain 14 g of compound **2-1** (yield: 50%).

[214] Preparation of compound 2-2

[215] 14 g of compound **2-1** (35 mmol), 10 g of 1,3-dibromo-5-chlorobenzene (39 mmol), 2.2 g of copper powder (35 mmol), 14 g of potassium carbonate (106 mmol), and 180 mL of nitrobenzene were introduced into a flask, and the mixture was refluxed for 12 hours. After completion of the reaction, an organic layer was extracted with methylene chloride, and the remaining moisture was removed by using magnesium sulfate. The resulting product was then dried, and separated by column chromatography to obtain 5.3 g of compound **2-2** (yield: 30%).

[216] Preparation of compound 2-3

[217] 5.3 g of compound **2-2** (10 mmol), 3.1 g of bis(pinacolato)diborone (12 mmol), 0.2 g of tris(dibenzylideneacetone)dipalladium (0.3 mmol), 0.4 g of 2-dichlorohexylphosphine-2',6'-dimethoxybiphenyl (1 mmol), 2.5 g of potassium acetate (26 mmol), and 75 mL of 1,4-dioxane were introduced into a flask, and the mixture was refluxed for 4 hours. After completion of the reaction, an organic layer was extracted with methylene chloride, and the remaining moisture was removed by using magnesium sulfate. The resulting product was then dried, and separated by column chromatography to obtain 5.9 g of compound **2-3** (yield: 95%).

[218] Preparation of compound C-59

[219] 5.9 g of compound **2-3** (10 mmol), 2.6 g of 2-chloro-4,6-diphenyl-1,3,5-triazine (10 mmol), 0.5 g of tetrakis(triphenylphosphine)palladium(0) (0.48 mmol), 3.3 g of 2 M potassium carbonate (24 mmol), 48 mL of toluene, and 12 mL of ethanol were introduced into a flask, and the mixture was refluxed for 2 hours. After completion of the reaction, the obtained solid was filtered and the filtrate was separated by column chro-

matography to obtain 5.1 g of compound **C-59** (yield: 73%).

[220]

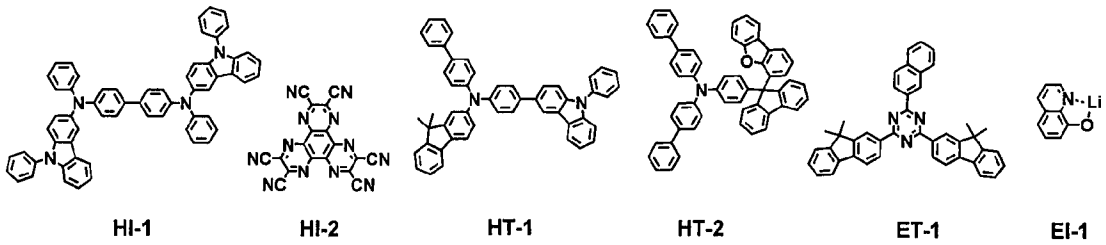
	MW	UV	PL	M.P.
C-59	713.84	354 nm	488 nm	465℃

[221] **Device Example 1-1: Production of an OLED device using the organic**

[222] **electroluminescent compound according to the present disclosure**

[223] An OLED device was produced using the organic electroluminescent compound of the present disclosure. A transparent electrode indium tin oxide (ITO) thin film (10 Ω/sq) on a glass substrate for an organic light-emitting diode (OLED) device (Geomatec, Japan) was subjected to an ultrasonic washing with acetone, ethanol, and distilled water, sequentially, and was then stored in isopropanol. Next, the ITO substrate was mounted on a substrate holder of a vacuum vapor depositing apparatus. Compound HI-1 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^{-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 80 nm on the ITO substrate. Compound HI-2 was then introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. Compound HT-1 was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a first hole transport layer having a thickness of 10 nm on the second hole injection layer. Compound HT-2 was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a second hole transport layer having a thickness of 30 nm on the first hole transport layer. After forming the hole injection layers and the hole transport layers, a light-emitting layer was then deposited as follows. Compound C-59 was introduced into one cell of the vacuum vapor depositing apparatus as a host, and compound D-74 was introduced into another cell as a dopant. The two materials were evaporated at different rates and were deposited in a doping amount of 10 wt% (the amount of dopant) based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 40 nm on the second hole transport layer. Compound ET-1 and compound EI-1 were then introduced into other two cells, evaporated at the rate of 4:6, and deposited to form an electron transport layer having a thickness of 35 nm on the light-emitting layer. Next, after depositing 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 deposited by another vacuum vapor deposition apparatus on the electron injection layer. Thus, an OLED device was

produced. All the materials used for producing the OLED device were purified by vacuum sublimation at 10^{-6} torr prior to use.

[224] 

[225] **Device Example 1-2: Production of an OLED device by co-evaporating the**

[226] **organic electroluminescent compound according to the present disclosure**

[227] An OLED device was produced in the same manner as in Device Example 1-1, except that compounds B-63 and C-59 were respectively introduced into two cells of the vacuum vapor depositing apparatus as hosts and the two host materials were evaporated at the same rate of 1:1, and the dopant material was evaporated at a different rate (10 wt% based on the total amount of the host and dopant).

[228] **Comparative Example 1-1: Production of an OLED device using a**

[229] **conventional organic electroluminescent compound**

[230] An OLED device was produced in the same manner as in Device Example 1-1, except that CBP was used as a host, compound D-74 was used as a dopant, Balq as a hole blocking layer was deposited in a thickness of 10 nm, and Compound ET-1 and compound EI-1 were evaporated at the rate of 4:6 to form an electron transport layer having a thickness of 25 nm on the hole blocking layer.

[231] The driving voltage, luminous efficiency, and CIE color coordinates at 10 mA/cm^2, and the lifespan result at 10,000 nit of the produced OLED devices are provided in Table 1 below.

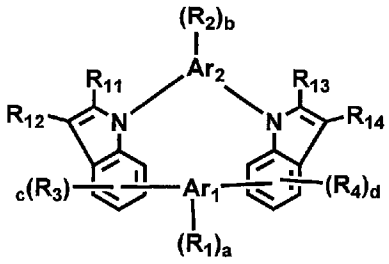
[232] [Table 1]

	Host	Voltage [V]	Luminous efficiency [cd/A]	Lifespan (T%)		Color coordinates (x, y)
Device Example 1-1	C-59	4.6	70.6	36	T90	428, 558
Device Example 1-2	B-63:C-59	4.6	75.9	21	T98.5	424, 562
Comparative Example 1-1	CBP	7.7	66.1	18	T90	422, 563

[233] It can be seen that the organic electroluminescent compounds according to the present disclosure provide low driving voltage and excellent luminous efficiency and lifespan characteristics compared to the conventional material.

Claims

[Claim 1] An organic electroluminescent compound represented by the following formula 1:



----------(1)

wherein

Ar_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, with a proviso that Ar_1 is not a substituted or unsubstituted carbazolylene;

Ar_2 represents a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene, with a proviso that Ar_2 is not a substituted or unsubstituted carbazolylene;

R_1 to R_4 each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino, with a proviso that R_1 and R_2 are not a substituted or unsubstituted carbazole;

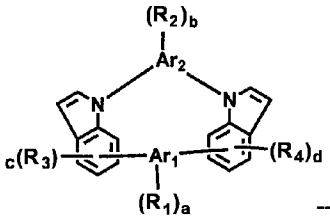
R_{11} to R_{14} each independently represent hydrogen, deuterium, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted cyclohexane ring;

a and b each independently represent an integer of 0 to 2, with a proviso that where Ar_1 is a single bond, a represents 0, and where a or b is 2, each of R_1 and each of R_2 may be the same or different;

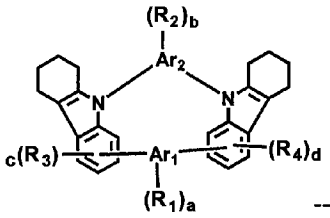
c and d each independently represent an integer of 0 to 3, where c or d is 2 or more, each of R_3 and each of R_4 may be the same or different; and

the heteroaryl(ene) contains at least one hetero atom selected from B, N, O, S, Si, and P.

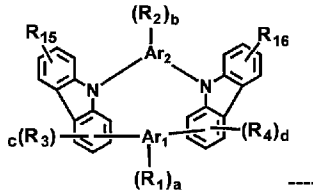
[Claim 2] The organic electroluminescent compound according to claim 1, wherein the compound represented by formula 1 is represented by any one of the following formulas 2 to 10:



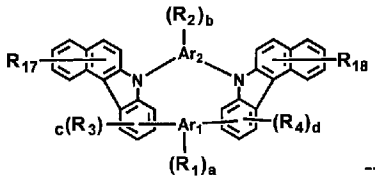
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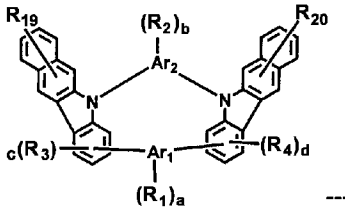
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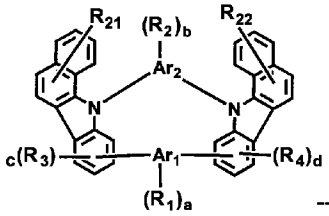
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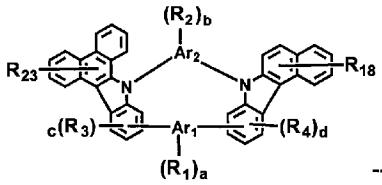
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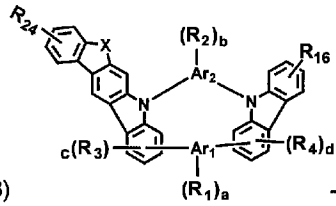
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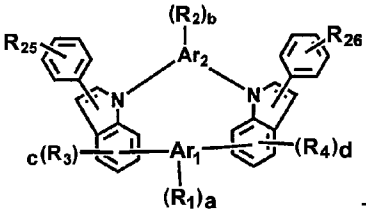
----------(7)



----------(8)



----------(9)



----------(10)

wherein

Ar_1, Ar_2, R_1 to R_4, and a to d are as defined in claim 1,

X represents O, S, CR_5R_6, or NR_7;

R_5 to R_7 each independently represent a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30-membered heteroaryl; or R_5 and R_6 are linked to each other to form a ring and form a spiro structure; and

R_{15} to R_{26} each independently represent hydrogen, deuterium, a sub-

stituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino.

[Claim 3] The organic electroluminescent compound according to claim 1, wherein the substituents of the substituted (C1-C30)alkyl, the substituted cyclohexane, the substituted (C6-C30)aryl(ene), the substituted 3- to 30-membered heteroaryl(ene), and the substituted mono- or di-(C6-C30)arylamino in Ar_1, Ar_2, R_1 to R_4, and R_{11} to R_{14} each independently are at least one selected from the group consisting of deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, 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, a (C6-C30)aryl substituted with a 3- to 30-membered heteroaryl, a (C6-C30)aryl substituted with a di(C6-C30)arylamino, 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 4] The organic electroluminescent compound according to claim 1, wherein

Ar_1 represents a single bond, a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene;

Ar_2 represents a substituted or unsubstituted (C6-C25)arylene, or a substituted or unsubstituted 5- to 20-membered heteroarylene;

R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, a substituted or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino;

R_3 and R_4 each independently represent hydrogen, a substituted or unsubstituted (C6-C20)aryl, a substituted or unsubstituted 5- to 20-membered heteroaryl, or a substituted or unsubstituted di(C6-C12)arylamino; and

R_{11} to R_{14} each independently represent hydrogen, or a substituted or unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20-membered heteroaryl ring.

[Claim 5] The organic electroluminescent compound according to claim 1, wherein

Ar_1 represents a single bond, a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene;

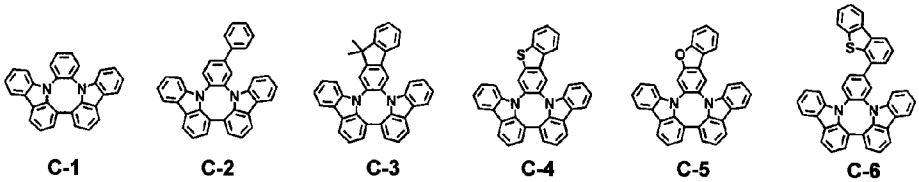
Ar_2 represents a (C6-C25)arylene unsubstituted or substituted with a (C1-C6)alkyl, or an unsubstituted 5- to 20-membered heteroarylene;

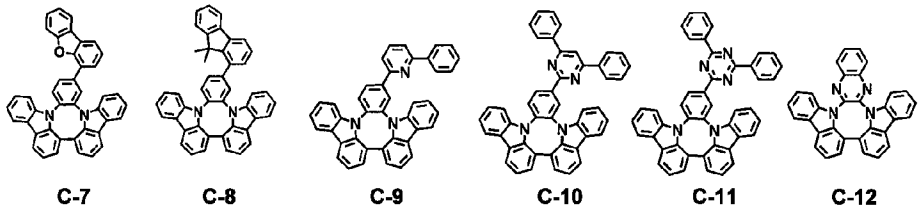
R_1 and R_2 each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino;

R_3 and R_4 each independently represent hydrogen, a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl or a 5- to 20-membered heteroaryl, a 5- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted di(C6-C12)arylamino; and

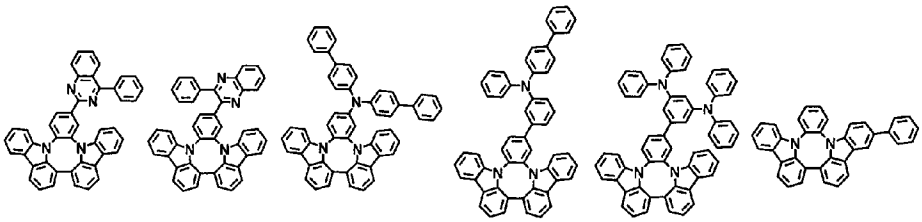
R_{11} to R_{14} each independently represent hydrogen, or an unsubstituted (C6-C12)aryl; or R_{11} and R_{12}, or R_{13} and R_{14} are linked to each other to form a (C6-C20)aryl unsubstituted or substituted with a (C6-C12)aryl, a 5- to 20-membered heteroaryl, a di(C6-C12)arylamino, or a (C1-C6)alkyl(C6-C12)aryl; or an unsubstituted 5- to 20-membered heteroaryl ring.

[Claim 6] The organic electroluminescent compound according to claim 1, wherein the compound represented by formula 1 is selected from the group consisting of:

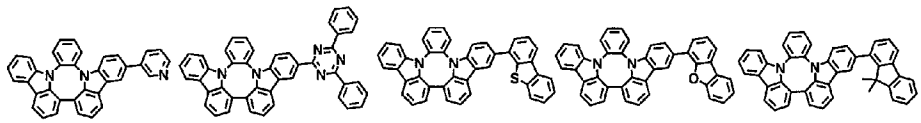




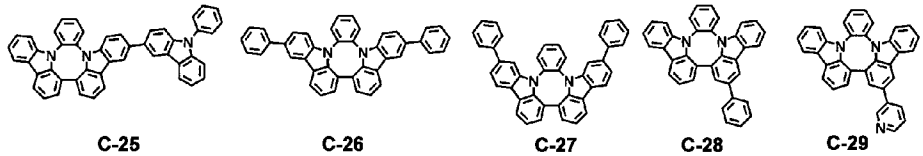
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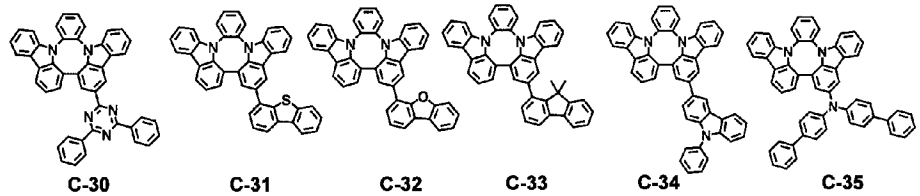
C-13 C-14 C-15 C-16 C-17 C-19



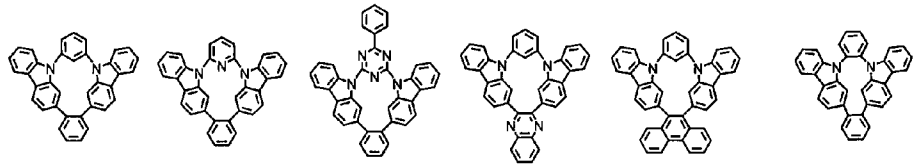
C-20 C-21 C-22 C-23 C-24



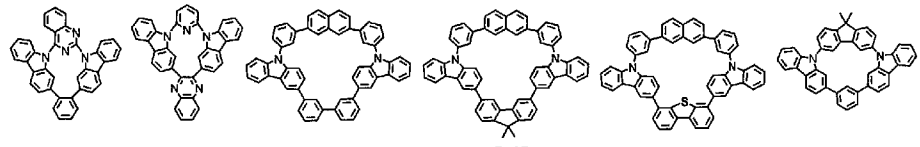
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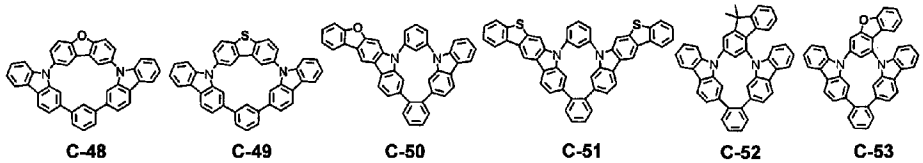
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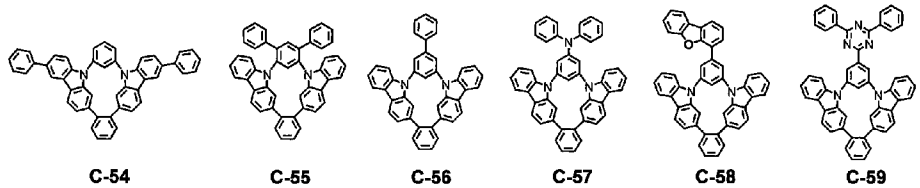
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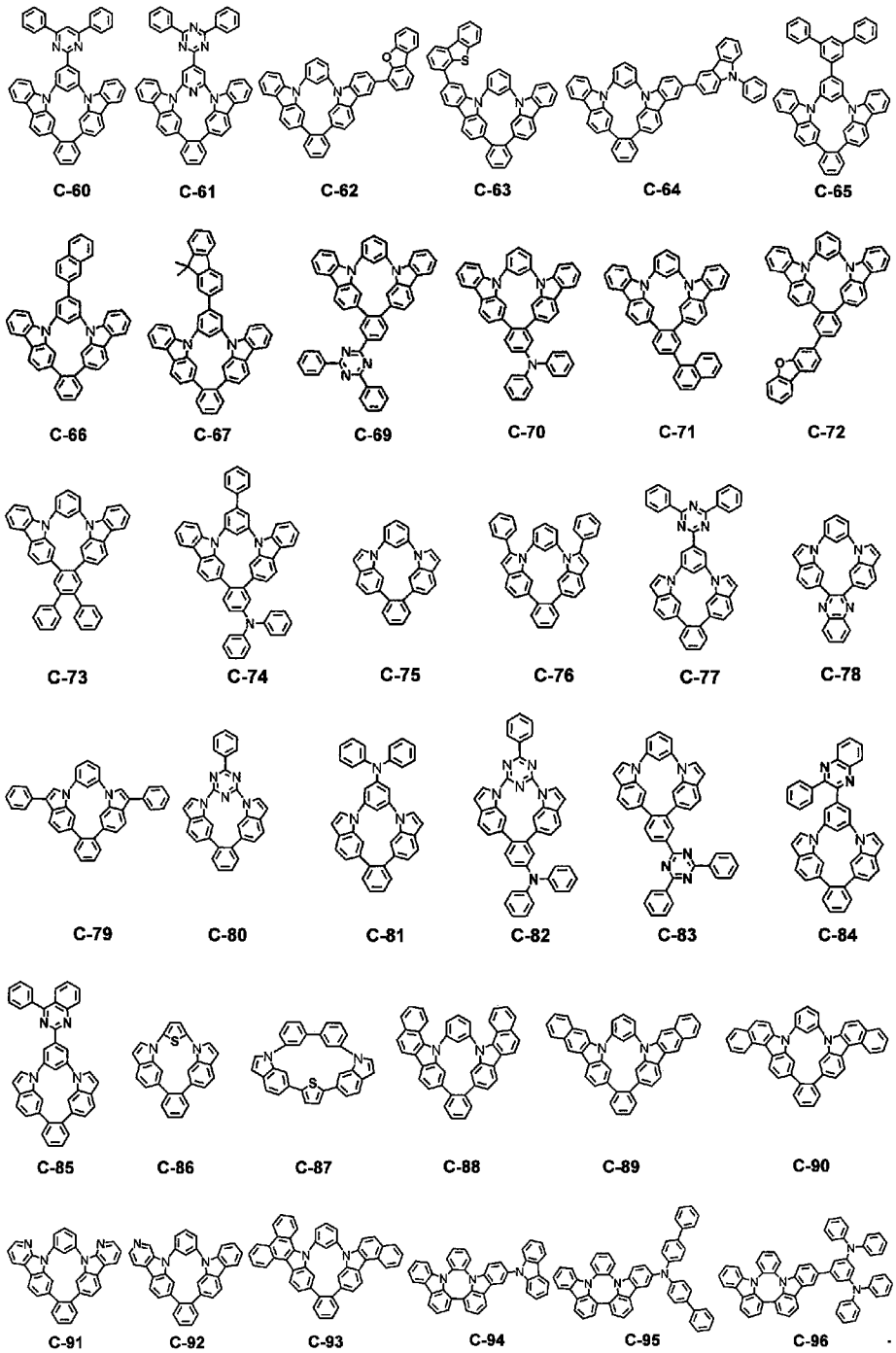
C-42 C-43 C-44 C-45 C-46 C-47



C-48 C-49 C-50 C-51 C-52 C-53



C-54 C-55 C-56 C-57 C-58 C-59



[Claim 7] An organic electroluminescent material comprising the organic electroluminescent compound according to claim 1.

[Claim 8] An organic electroluminescent device comprising the organic electroluminescent compound according to claim 1.

[Claim 9] The organic electroluminescent device according to claim 8, wherein the organic electroluminescent compound is comprised in at least one layer of a light-emitting layer, a hole transport layer, an electron buffer layer, and an electron transport layer.

[Claim 10] A display device comprising the organic electroluminescent compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/004310

A. CLASSIFICATION OF SUBJECT MATTER

C07D 487/14 (2006.01) ***C07D 487/22 (2006.01)*** ***C07D 471/22 (2006.01)*** ***C07D 491/22 (2006.01)*** ***C07D 495/22 (2006.01)***
C09K 11/06 (2006.01) ***H01L 27/32 (2006.01)*** ***H01L 51/54 (2006.01)*** ***H05B 33/14 (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)

STN REGISTRY, CAPLUS: Structure search based on compounds of Formula (1).

ESPACENET: Keyword search using Applicant and Inventor names, "Electroluminescent," "OLED" etc.

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	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 May 2017	25 May 2017
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Richard Cordiner AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832162

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/KR2017/004310**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015/125571 A1 (KONICA MINOLTA, INC.) 27 August 2015 Abstract; compounds D1-D10.	1-10
A	WO 2015/093813 A2 (DOOSAN CORPORATION) 25 June 2015 Abstract; pages 16-19.	1-10
A	JP 2014-110357 A (SAMSUNG R&D INSTITUTE JAPAN CO., LTD.) 12 June 2014 Abstract; pages 7-13.	1-10
P,X	US 2016/0285009 A1 (UNIVERSAL DISPLAY CORPORATION) 29 September 2016 Abstract; compounds 22 and 23, page 13; paragraphs [0017]-[0024]; Claims 10-16.	1-10

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/KR2017/004310**

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 2015/125571 A1	27 August 2015	WO 2015125571 A1	27 Aug 2015
		JP WO2015125571 A1	30 Mar 2017
		KR 20160108535 A	19 Sep 2016
		US 2016336522 A1	17 Nov 2016
WO 2015/093813 A2	25 June 2015	WO 2015093813 A2	25 Jun 2015
		KR 20150070827 A	25 Jun 2015
		KR 101622811 B1	19 May 2016
JP 2014-110357 A	12 June 2014	JP 2014110357 A	12 Jun 2014
US 2016/0285009 A1	29 September 2016	US 2016285009 A1	29 Sep 2016

End of Annex

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