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

(72) Inventors: **AHN, Hee-Choon**; 62, Yeongtong-ro 174beon-gil, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-400 (KR). **LEE, Tae-Jin**; 10-1, Seongnam-daero 1148beon-gil, Jungwon-gu, Seongnam-si, Gyeonggi-do 462-827 (KR).

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

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

(57) Abstract: The present invention relates to a novel organic electroluminescent compound and an organic electroluminescent device comprising the same. By using the organic electroluminescent compound of the present invention, an organic electroluminescent device having excellent luminous properties can be produced.

Description

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

Technical Field

[1] The present invention relates to organic electroluminescent compounds and 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 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 is 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 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 operational 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] Synthetic Metals Vol. 162 (2012) pp. 2059-2062 discloses a methyl compound substituted with phenyl, diphenylaniline, and dibenzofuran as an organic electroluminescent compound. However, the above reference does not specifically disclose an organic electroluminescent device using a compound in which at least either one of the two aryls of the diarylamine is not phenyl.

Disclosure of Invention

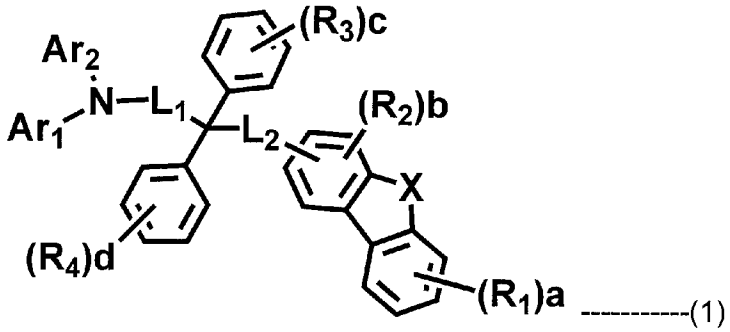
Technical Problem

[10] The objective of the present invention is to provide an organic electroluminescent compound having excellent luminous properties.

Solution to Problem

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

[12]



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

[13] wherein

[14] Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 5- to 30-membered heteroaryl;

[15] where Ar_1 and Ar_2 are not both phenyl;

[16] L_1 and L_2 each independently represent a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene;

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

[18] R_1 to R_7 each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, $-NR_8R_9$, or $-SiR_{10}R_{11}R_{12}$; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;

[19] R_8 to R_{12} each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30-membered heteroaryl;

[20] a represents an integer of 1 to 4, where a is an integer of 2 or more, each of R_1 may be the same or different;

[21] b represents an integer of 1 to 3, where b is an integer of 2 or more, each of R_2 may be the same or different;

[22] c and d each independently represent an integer of 1 to 5, where c or d is an integer of 2 or more, each of R_3 and each of R_4 may be the same or different; and

[23] the heteroaryl(ene) and heterocycloalkyl each independently contain 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 of the present invention, an organic electroluminescent device having excellent luminous properties can be produced.

Mode for the Invention

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

[26] The present invention 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] Hereinafter, the organic electroluminescent compound represented by formula 1 will be described in detail.

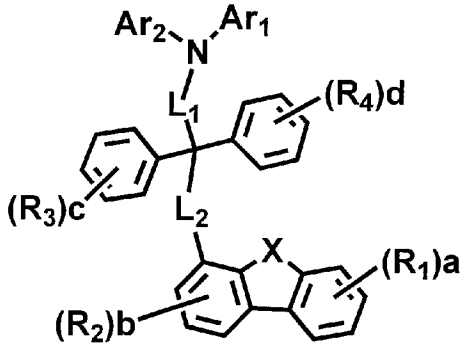
[28] Herein, "(C1-C30)alkyl" is meant to be a linear or branched alkyl having 1 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 1 to 10, more preferably 1 to 6, and includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc.; "(C2-C30)alkenyl" 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 meant to be 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 3 to 7 ring backbone atoms, including at least one heteroatom selected from B, N, O, S, Si, and P, preferably O, S, and N, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc.; "(C6-C30)aryl(ene)" is a monocyclic or fused ring derived from an aromatic hydrocarbon having 6 to 30 ring backbone carbon atoms, in which the number of carbon atoms is preferably 6 to 20, more preferably 6 to 15, and includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenylnaphthyl, naphthylphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl, phenanthrenyl, phenylphenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc.; "5- to 30-membered heteroaryl(ene)" is an aryl having 5 to 30 ring backbone atoms,

including at least one, preferably 1 to 4 heteroatoms selected from the group consisting of B, N, O, S, Si, and P; 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, benzonaphthothiophenyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc. Further, "halogen" includes F, Cl, Br, and I.

[29] Herein, "substituted" in the expression, "substituted or unsubstituted," means that a hydrogen atom in a certain functional group is replaced with another atom or group, i.e. a substituent. In the present invention, the substituents of the substituted alkyl, the substituted cycloalkyl, the substituted cycloalkenyl, the substituted heterocycloalkyl, the substituted aryl(ene), the substituted heteroaryl(ene), and the substituted mono- or polycyclic, alicyclic or aromatic ring in Ar_1, Ar_2, L_1, L_2, and R_1 to R_{12} 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 unsubstituted or substituted with a 3- to 30-membered heteroaryl, a tri(C1-C30)alkylsilyl, a tri(C6-C30)arylsilyl, a di(C1-C30)alkyl(C6-C30)arylsilyl, a (C1-C30)alkyldi(C6-C30)arylsilyl, an amino, a mono- or di- (C1-C30)alkylamino, a mono- or di- (C6-C30)arylamino, a (C1-C30)alkyl(C6-C30)arylamino, a (C1-C30)alkylcarbonyl, a (C1-C30)alkoxycarbonyl, a (C6-C30)arylcarbonyl, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, and a (C1-C30)alkyl(C6-C30)aryl, and preferably are at least one selected from the group consisting of a (C1-C6)alkyl, a (C6-C25)aryl, a tri(C6-C12)arylsilyl, and a (C1-C6)alkyl(C6-C15)aryl.

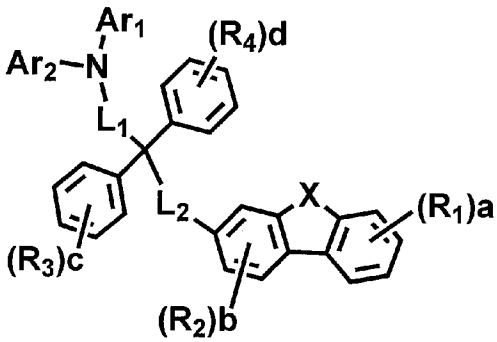
[30] The compound represented by formula 1 can be represented by one of the following formulas 2 and 3:

[31]



----------(2)

[32]



----------(3)

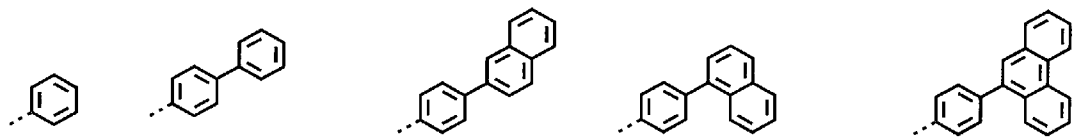
[33] wherein

[34] Ar_1, Ar_2, L_1, L_2, X, R_1 to R_4, and a to d are as defined in formula 1.

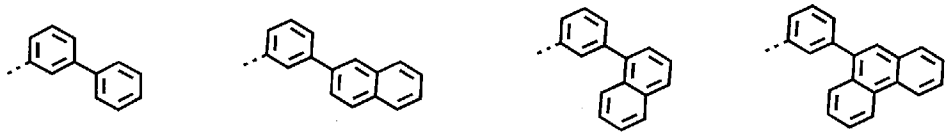
[35] In formula 1 above, Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 5- to 30-membered heteroaryl, where Ar_1 and Ar_2 are not both phenyl; preferably each independently represent a substituted or unsubstituted (C6-C20)aryl; and more preferably each independently represent a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a (C6-C25)aryl, a tri(C6-C12)arylsilyl, or a (C1-C6)alkyl(C6-C15)aryl.

[36] Specifically, Ar_1 and Ar_2 may each independently represent one of the following structures:

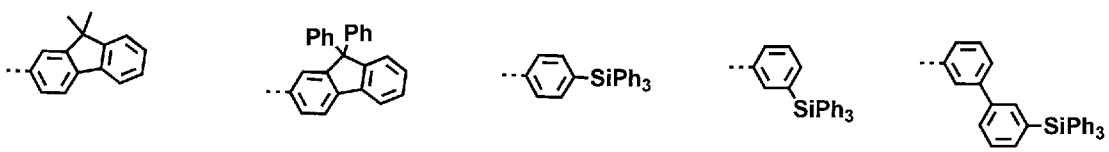
[37]

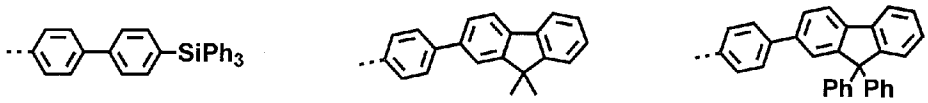


[38]



[39]



[40] 

[41] L_1 and L_2 each independently represent a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene; preferably each independently represent a single bond, or a substituted or unsubstituted (C6-C12)arylene; and more preferably each independently represent a single bond, or an unsubstituted (C6-C12)arylene.

[42] X represents O, S, CR_5R_6, or NR_7.

[43] R_1 to R_7 each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, $-NR_8R_9$, or $-SiR_{10}R_{11}R_{12}$; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur; preferably each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, or a substituted or unsubstituted (C6-C12)aryl; and more preferably each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, or an unsubstituted (C6-C12)aryl.

[44] R_8 to R_{12} each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30-membered heteroaryl; preferably each independently represent a substituted or unsubstituted (C6-C12)aryl; and more preferably each independently represent an unsubstituted (C6-C12)aryl.

[45] According to one embodiment of the present invention, in formula 1 above, Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C6-C20)aryl; L_1 and L_2 each independently represent a single bond, or a substituted or unsubstituted (C6-C12)arylene; X represents O, S, CR_5R_6, or NR_7; and R_1 to R_7 each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, or a substituted or unsubstituted (C6-C12)aryl.

[46] According to another embodiment of the present invention, in formula 1 above, Ar_1 and Ar_2 each independently represent (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a (C6-C25)aryl, a tri(C6-C12)arylsilyl, or a (C1-C6)alkyl(C6-C15)aryl;

L_1 and L_2 each independently represent a single bond, or an unsubstituted (C6-C12)arylene; X represents O, S, CR_5R_6, or NR_7; and R_1 to R_7 each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, or an unsubstituted (C6-C12)aryl.

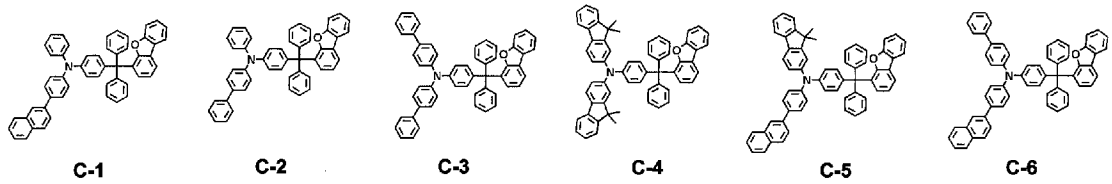
[47] In formula 1 above, a compound where Ar_1 and Ar_2 are both phenyl is excluded. If the conjugation length is too short, side reactions such as cyclization occur when the compound of formula 1 becomes an exciton, and charges are not efficiently migrated.

[48] In addition, since the three-dimensional shape changes according to how the substituents are bonded to diphenylmethyl in formula 1, it highly affects the efficiency of the device, etc. This is because when a molecule such as dibenzofuran is bonded via 3- or 4-position carbon thereof (1- or 2- position of carbazole), it will be placed at a position near to the phenyl of the substituent, and an atom having high polarity such as oxygen will be less exposed to the space compared to when the molecule is bonded via 2-position carbon thereof (3- position of carbazole). This affects the charge transportation of materials and properties of device in a preferable way. When an atom having high polarity is highly exposed to the space, it interacts with charges in the device and can operate as a disturbing factor for efficient transportation.

[49] Meanwhile, in case of a molecule having no polar atom such as fluorene, the most ordinary form of bondage via 3-position carbon thereof is the most preferable embodiment.

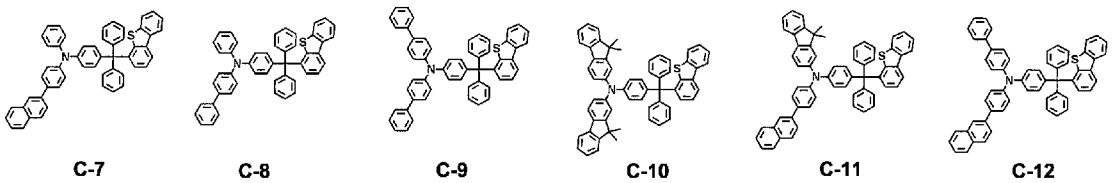
[50] The organic electroluminescent compound represented by formula 1 includes the following compounds, but is not limited thereto:

[51]



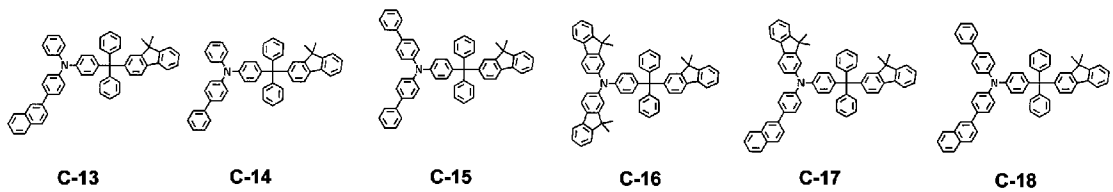
C-1 C-2 C-3 C-4 C-5 C-6

[52]



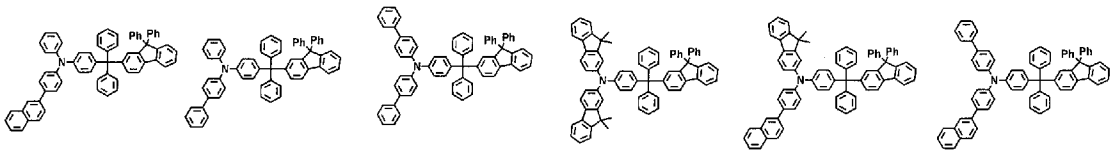
C-7 C-8 C-9 C-10 C-11 C-12

[53]



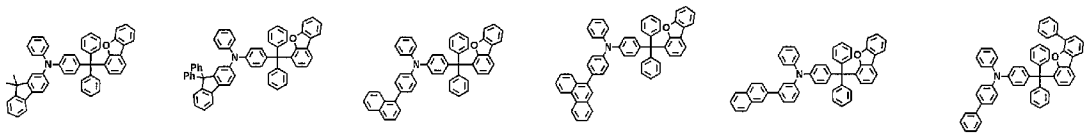
C-13 C-14 C-15 C-16 C-17 C-18

[54]



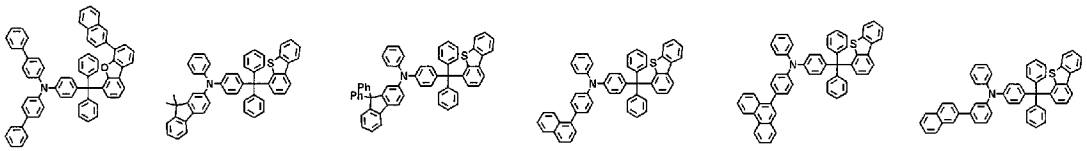
C-19 C-20 C-21 C-22 C-23 C-24

[55]



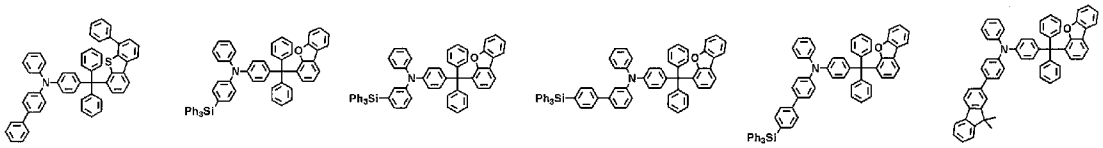
C-25 C-26 C-27 C-28 C-29 C-30

[56]



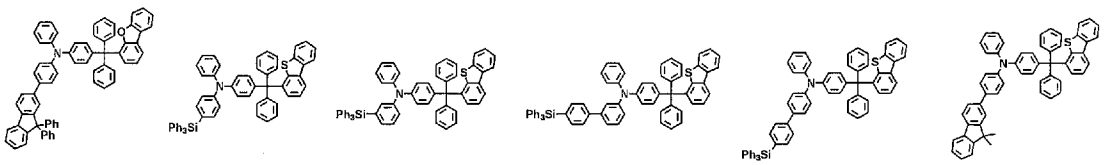
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[57]



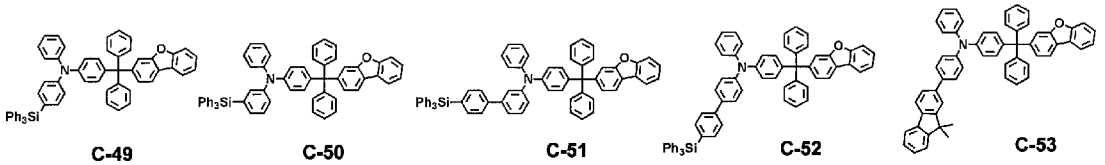
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[58]



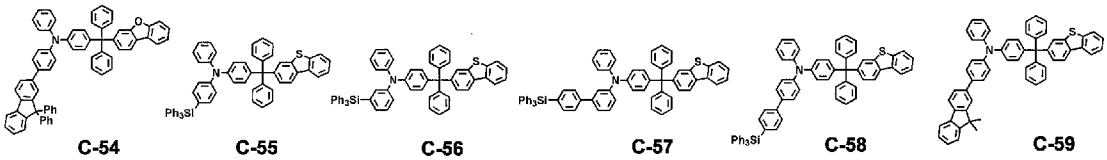
C-43 C-44 C-45 C-46 C-47 C-48

[59]



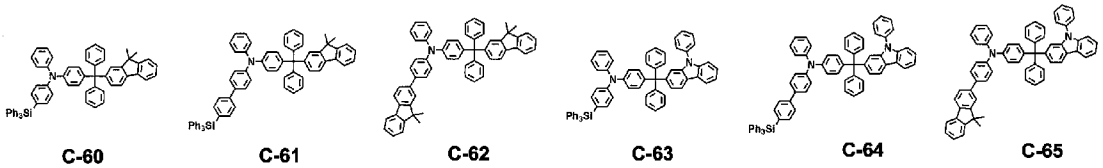
C-49 C-50 C-51 C-52 C-53

[60]



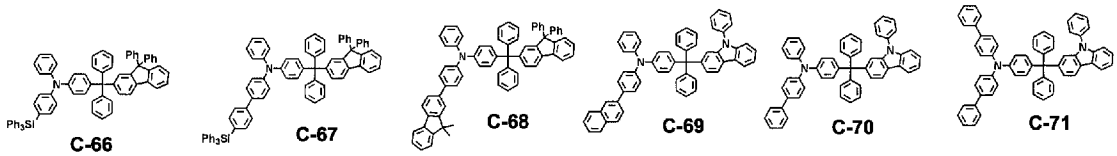
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[61]

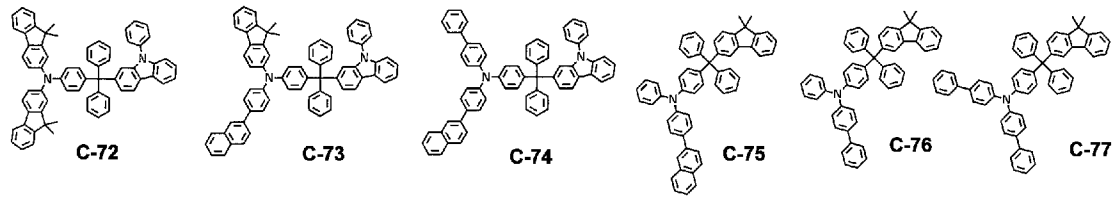


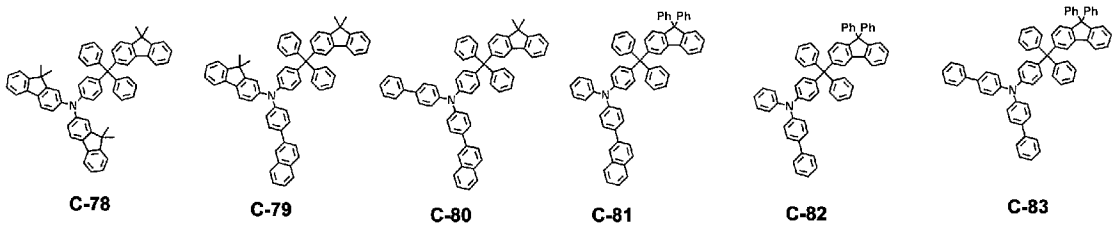
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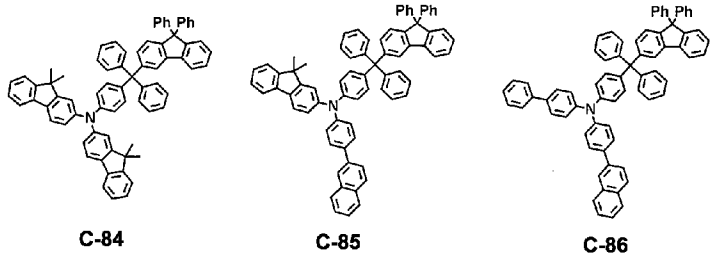
[62]



C-66 C-67 C-68 C-69 C-70 C-71

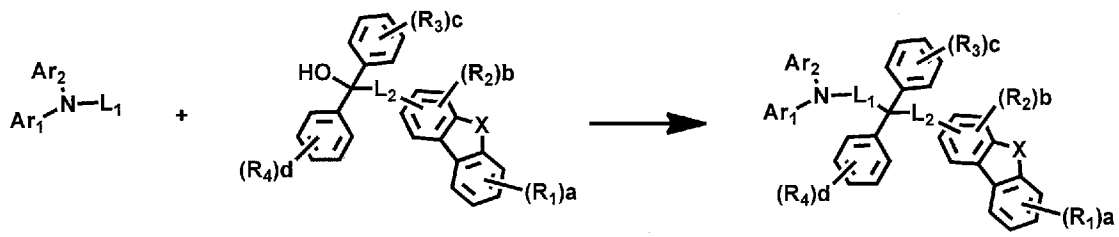
[63] 

[64] 

[65] 

[66] The organic electroluminescent compound of the present invention 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 scheme.

[67] [Reaction Scheme 1]

[68] 

[69] wherein Ar_1, Ar_2, L_1, L_2, X, R_1 to R_4, and a to d are as defined in formula 1.

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

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

[72] The organic electroluminescent device 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.

[73] One of the first and second electrodes can be an anode, and the other can be a

cathode. The organic layer comprises a light-emitting layer, and may further comprise at least one layer selected from the group consisting of a hole injection layer, a hole transport layer, an electron transport layer, an electron injection layer, an interlayer, a hole blocking layer, and an electron blocking layer.

[74] The organic electroluminescent compound of the present invention can be comprised in at least one of the light-emitting layer and the hole transport layer. Where used in the hole transport layer, the organic electroluminescent compound of the present invention can be comprised as a hole transport material. Where used in the light-emitting layer, the organic electroluminescent compound of the present invention can be comprised as a host material.

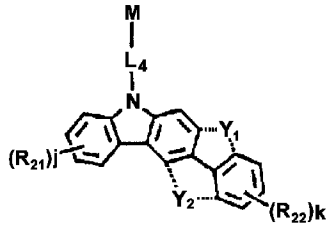
[75] The organic electroluminescent device comprising the organic electroluminescent compound of the present invention can further comprise one or more host compounds, and can further comprise one or more dopants.

[76] When the organic electroluminescent compound of the present invention is comprised as a host material (first host material) of the light-emitting layer, another compound can be comprised as a second host material. Herein, the weight ratio of the first host material to the second host material is in the range of 1:99 to 99:1.

[77] The host material of a compound other than the organic electroluminescent compound of the present invention can be any of the known phosphorescent hosts. Specifically, the compound selected from the group consisting of the compounds of formulae 11 to 13 below is preferable in terms of luminous efficiency.

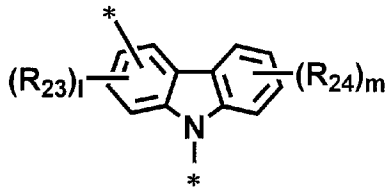
[78] $H\text{-}(Cz\text{-}L_4)_h\text{-}M$ ---------- (11)

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

[79] 

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

[80] wherein Cz represents the following structure;

[81] 

[82] R_{21} to R_{24} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted of unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, or $-SiR_{25}R_{26}R_{27}$, R_{25} to R_{27} each

independently represent a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl;

[83] L_4 represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 5- to 30-membered heteroarylene;

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

[85] Y_1 and Y_2 each independently represent -O-, -S-, -N(R_{31})-, or -C(R_{32})(R_{33})-, provided that Y_1 and Y_2 do not simultaneously exist;

[86] R_{31} to R_{33} 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, and R_{32} and R_{33} may be the same or different;

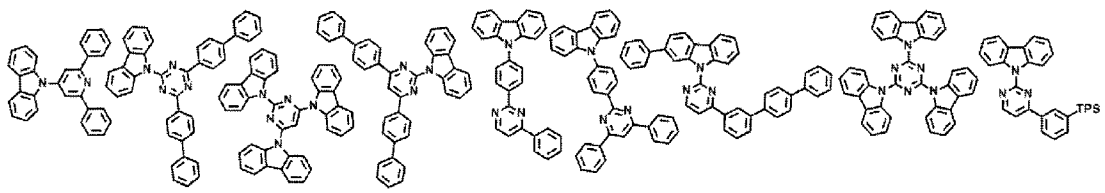
[87] h and i each independently represent an integer of 1 to 3;

[88] j, k, l, and m each independently represent an integer of 0 to 4; and

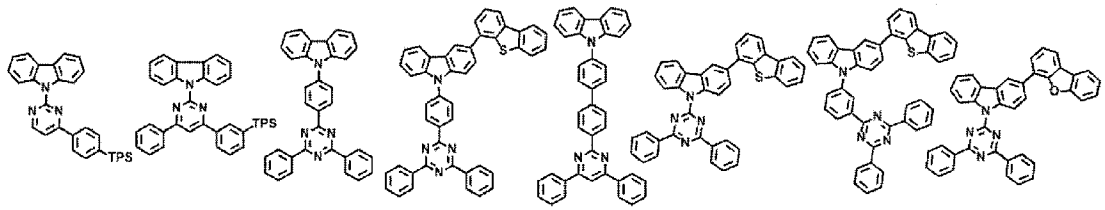
[89] where h, i, j, k, l, or m is an integer of 2 or more, each of (Cz-L_4), each of (Cz), each of R_{21}, each of R_{22}, each of R_{23}, or each of R_{24} may be the same or different.

[90] Specifically, preferable examples of the host material are as follows:

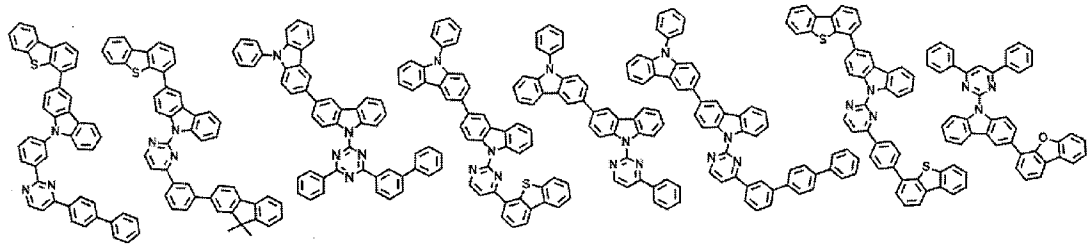
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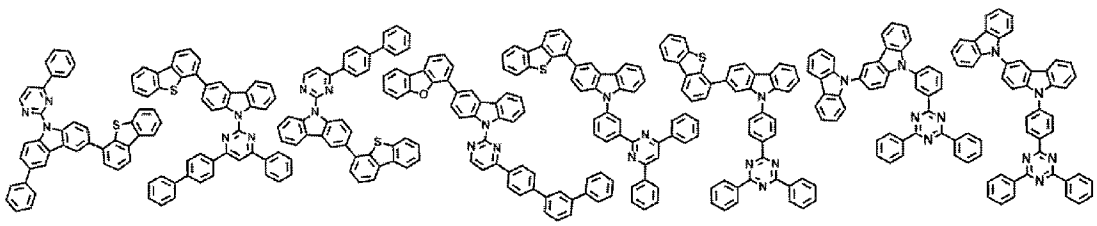
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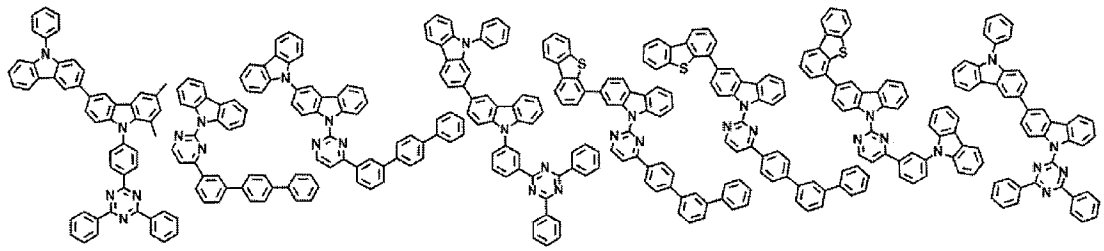
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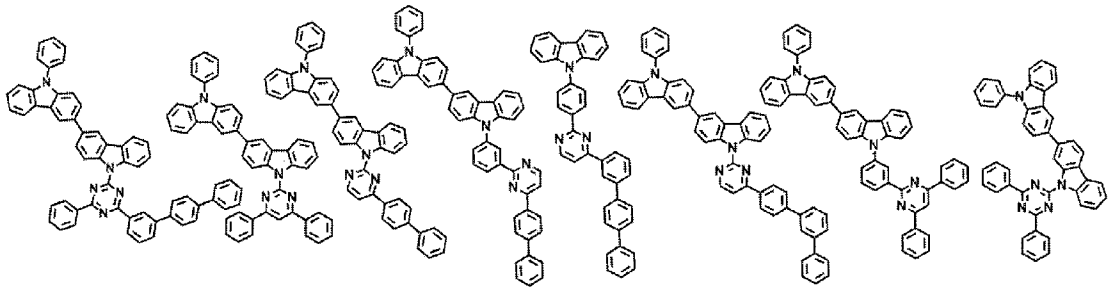
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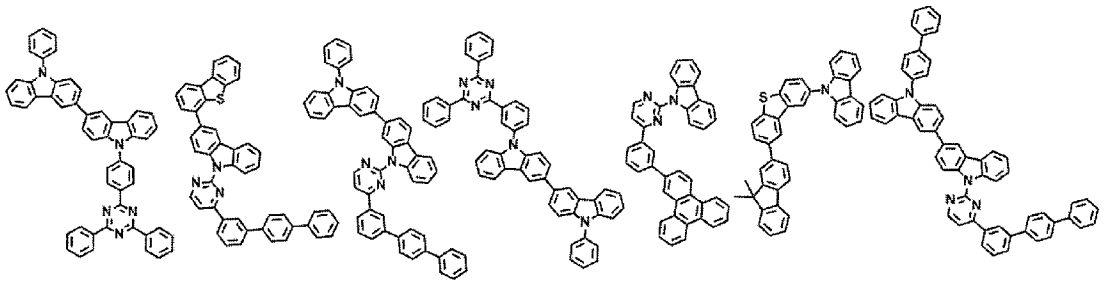
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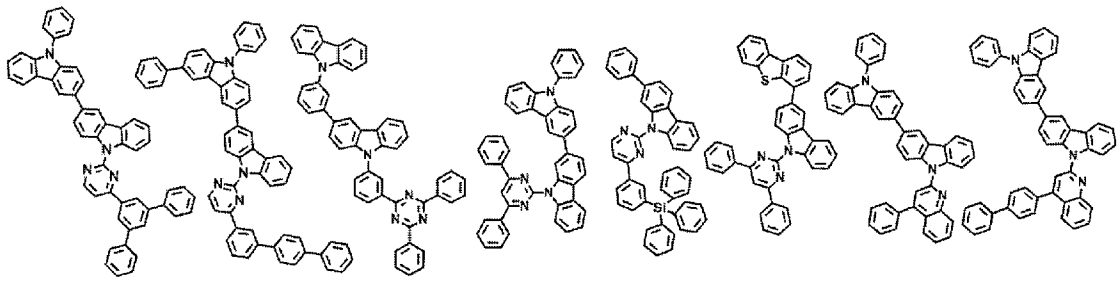
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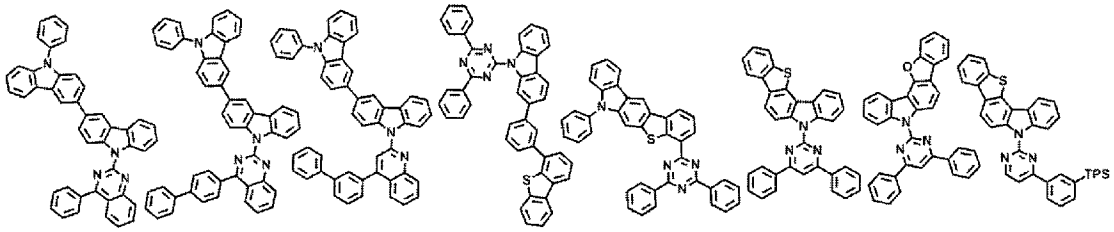
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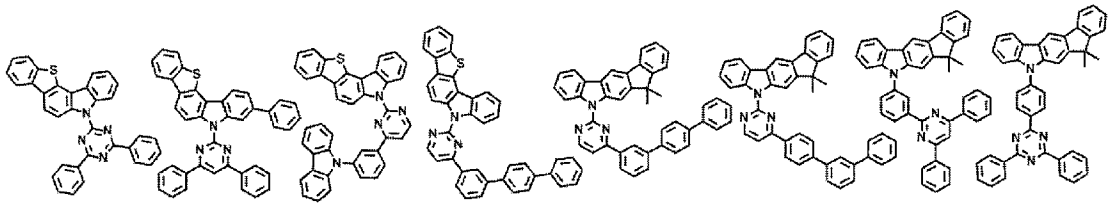
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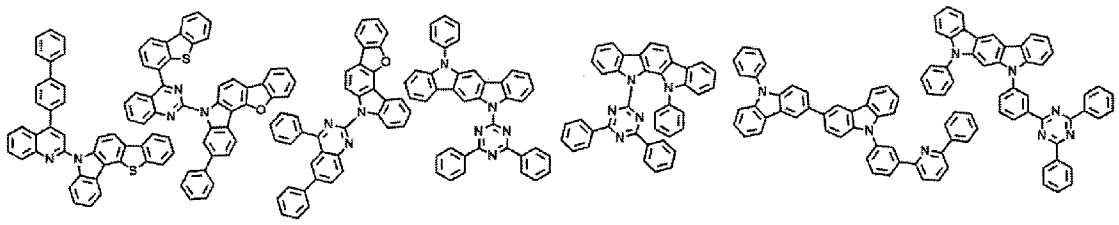


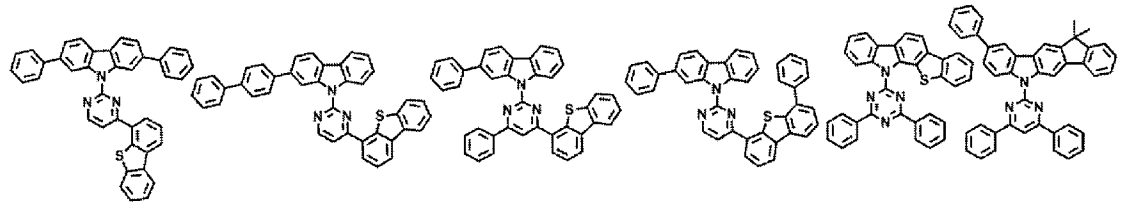
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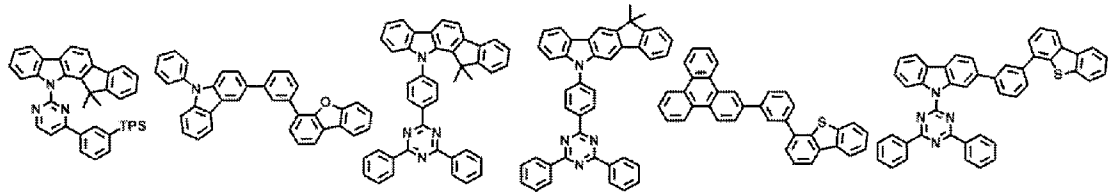


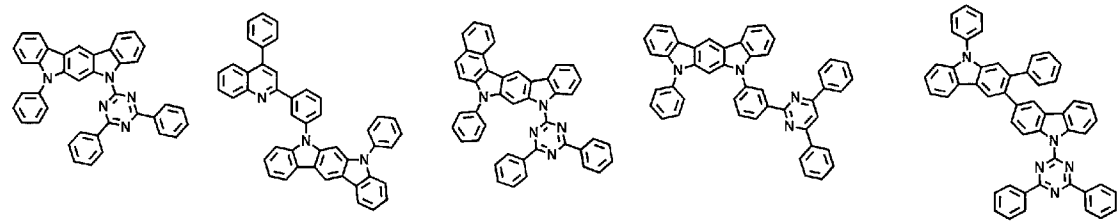
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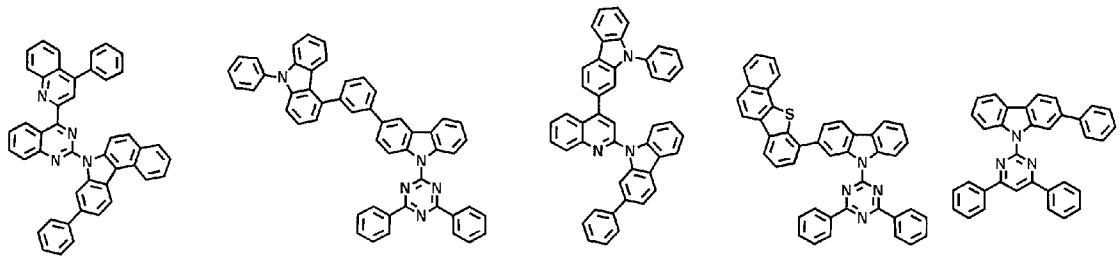


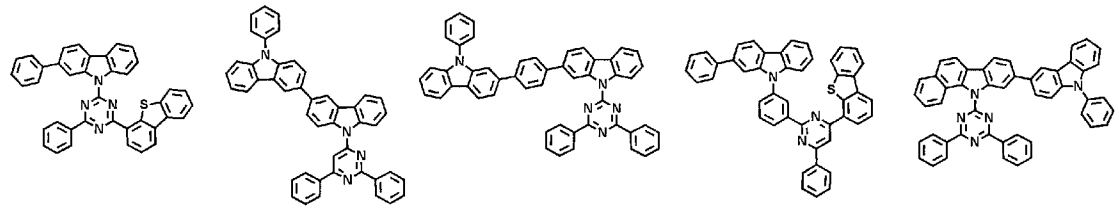
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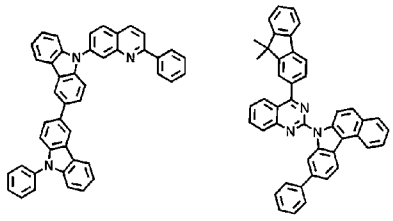
[102] 

[103] 

[104] 

[105] 

[106] 

[107] 

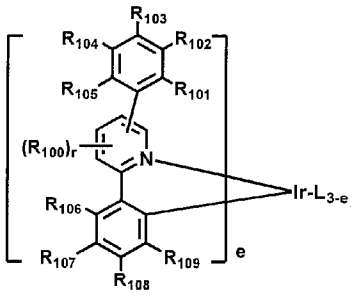
[108] [wherein TPS represents a triphenylsilyl group]

[109] The dopant comprised in the organic electroluminescent device according to the present invention is preferably at least one phosphorescent dopant. The dopant

materials applied to the organic electroluminescent device according to the present invention are not limited, but may be preferably selected from metallated complex compounds of iridium, osmium, copper, and platinum, more preferably selected from ortho-metallated complex compounds of iridium, osmium, copper, and platinum, and even more preferably ortho-metallated iridium complex compounds.

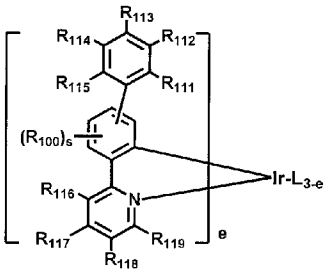
[110] The phosphorescent dopant is preferably selected from the group consisting of the compounds of formulae 101 to 103 below.

[111]



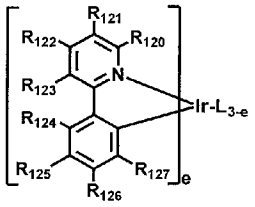
---------- (101)

[112]



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

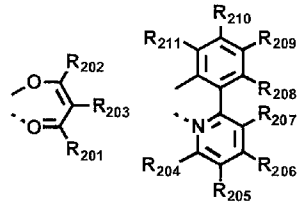
[113]



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

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

[115]



[116] R_{100} represents hydrogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl;

[117] 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(s), a cyano, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (C3-C30)cycloalkyl; adjacent sub-

stituents of R_{106} to R_{109} may be linked to each other to form a substituted or unsubstituted fused ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with 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., quinoline unsubstituted or substituted with alkyl or aryl;

[118] R_{124} to R_{127} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; 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., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl;

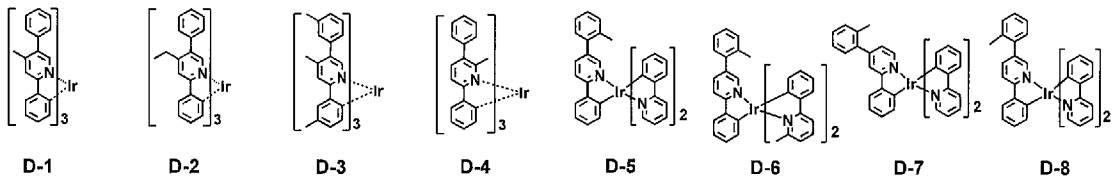
[119] R_{201} to R_{211} each independently represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen(s), a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-C30)aryl, and adjacent substituents of R_{208} to R_{211} may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

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

[121] e represents an integer of 1 to 3.

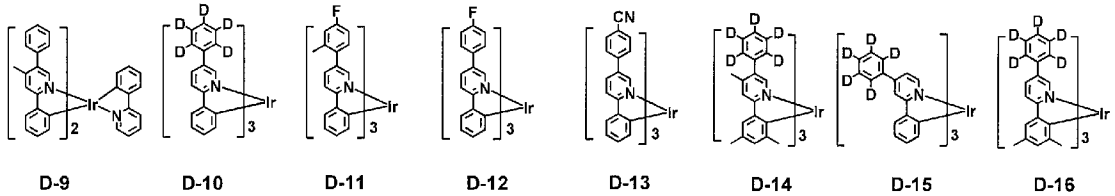
[122] Specifically, the phosphorescent dopant compounds include the following:

[123]



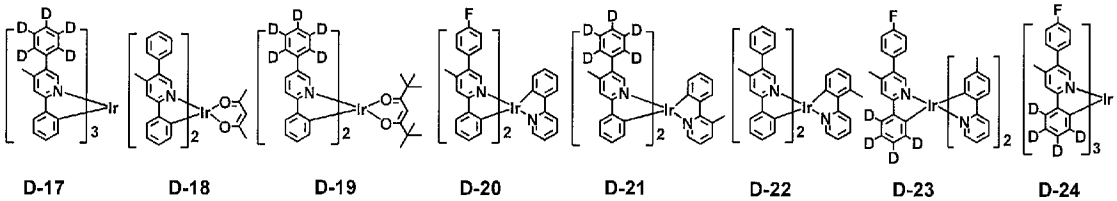
D-1 D-2 D-3 D-4 D-5 D-6 D-7 D-8

[124]



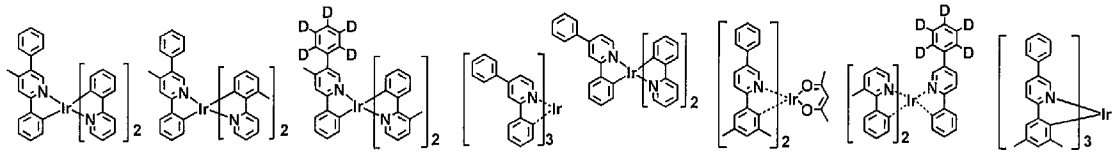
D-9 D-10 D-11 D-12 D-13 D-14 D-15 D-16

[125]



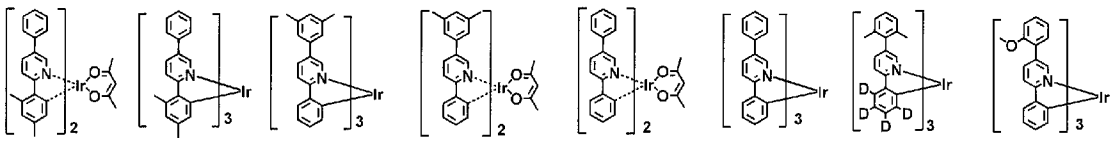
D-17 D-18 D-19 D-20 D-21 D-22 D-23 D-24

[126]



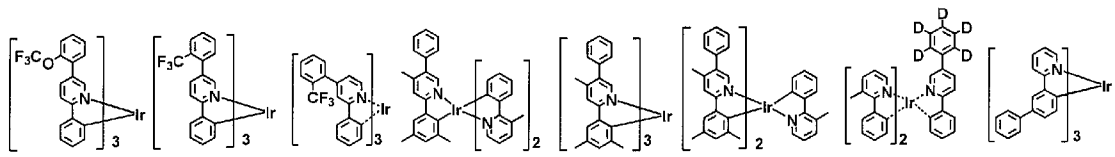
D-25 D-26 D-27 D-28 D-29 D-30 D-31 D-32

[127]



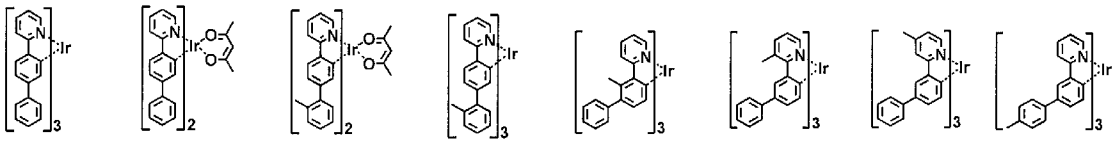
D-33 D-34 D-35 D-36 D-37 D-38 D-39 D-40

[128]



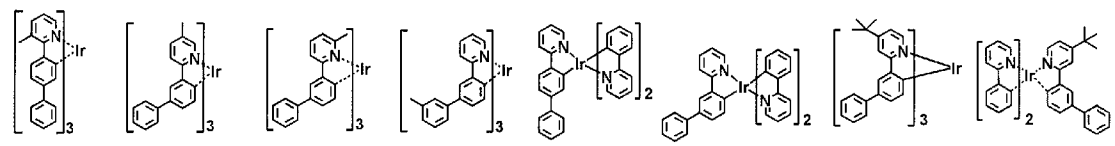
D-41 D-42 D-43 D-44 D-45 D-46 D-47 D-48

[129]



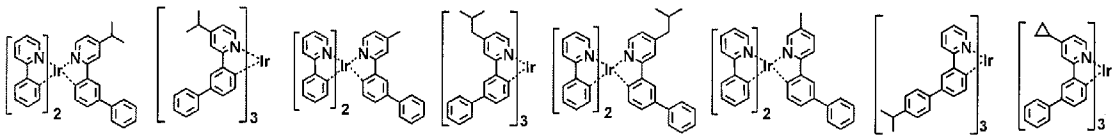
D-49 D-50 D-51 D-52 D-53 D-54 D-55 D-56

[130]



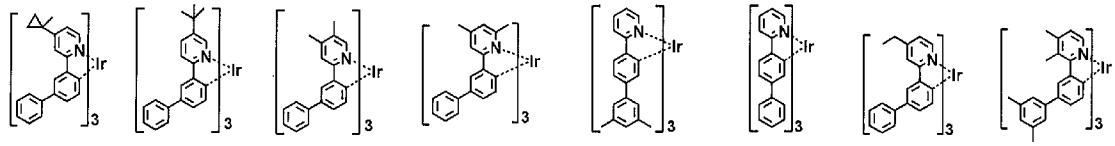
D-57 D-58 D-59 D-60 D-61 D-62 D-63 D-64

[131]



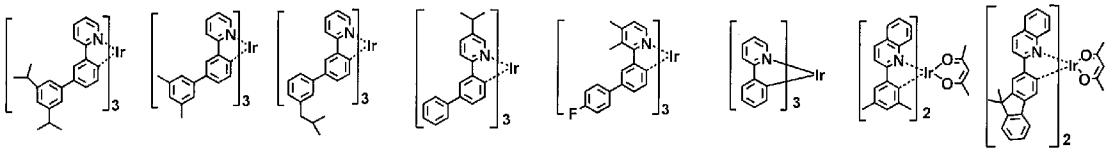
D-65 D-66 D-67 D-68 D-69 D-70 D-71 D-72

[132]



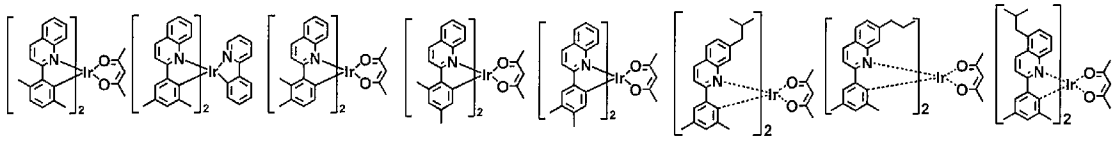
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[133]



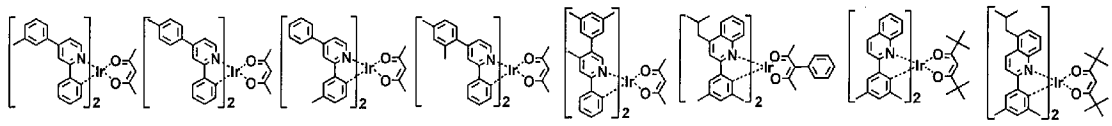
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[134]



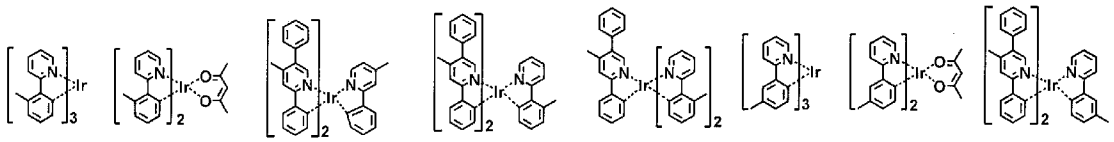
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[135]



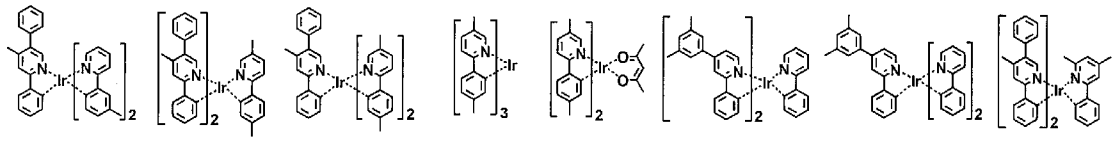
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[136]



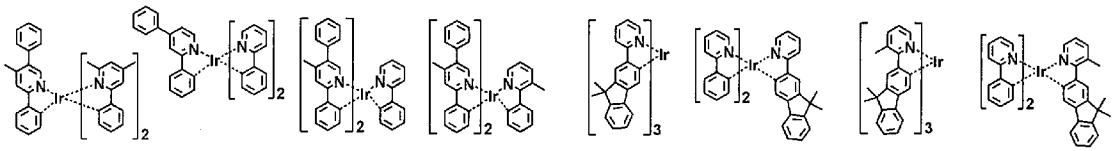
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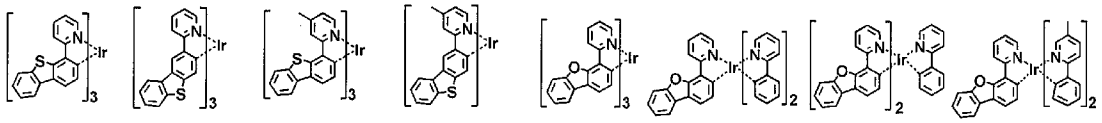
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[138]



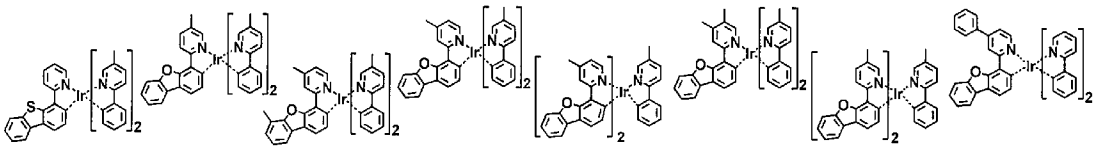
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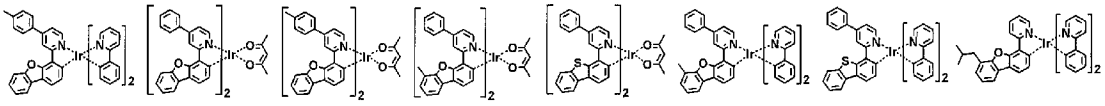
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[140]



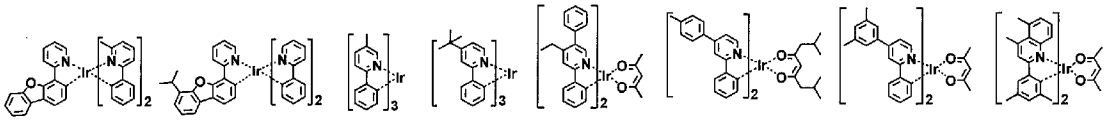
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[141]



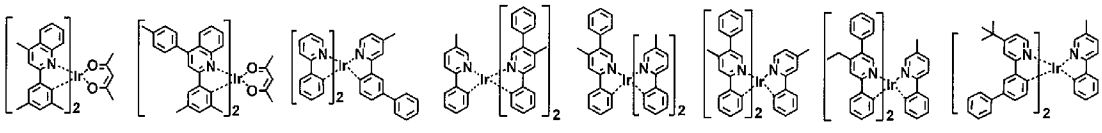
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[142]



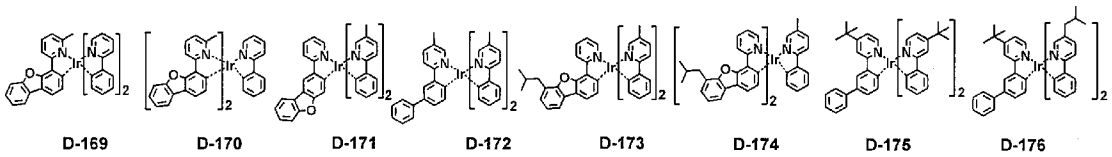
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[143]



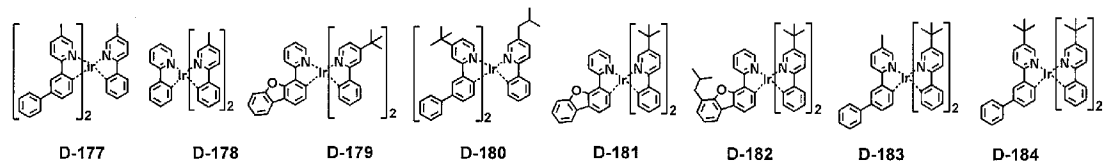
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[144]



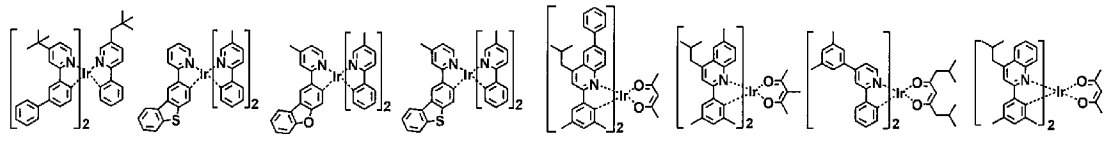
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[145]



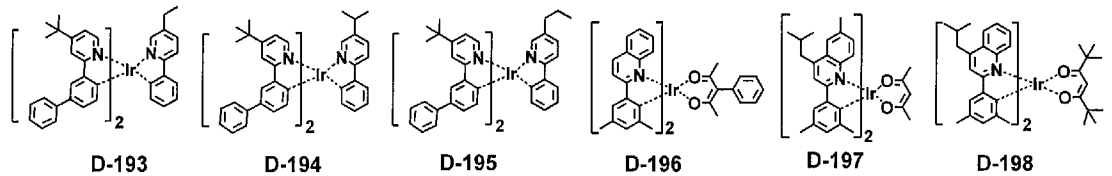
D-177 D-178 D-179 D-180 D-181 D-182 D-183 D-184

[146]



D-185 D-186 D-187 D-188 D-189 D-190 D-191 D-192

[147]



D-193 D-194 D-195 D-196 D-197 D-198

[148] In another embodiment of the present invention, a composition for preparing an organic electroluminescent device is provided. The composition comprises the compound according to the present invention as a host material or a hole transport material.

[149] In addition, the organic electroluminescent device according to the present invention 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 invention.

[150] The organic electroluminescent device according to the present invention 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.

[151] In the organic electroluminescent device according to the present invention, 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 4th period, transition metals of the 5th 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.

[152] In addition, the organic electroluminescent device according to the present invention

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 invention. Also, if necessary, a yellow or orange light-emitting layer can be comprised in the device.

[153] According to the present invention, 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.

[154] In the organic electroluminescent device according to the present invention, a mixed region of an electron transport compound and reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant is preferably placed on at least one surface of a pair of electrodes. In this case, the electron transport compound is reduced to an anion, and thus it becomes easier to inject and transport electrons from the mixed region to an electroluminescent medium. Further, the hole transport compound is oxidized to a cation, and thus it becomes easier to inject and transport holes from the mixed region to the electroluminescent medium. Preferably, the oxidative dopant includes various Lewis acids and acceptor compounds; and the reductive dopant includes alkali metals, alkali metal compounds, alkaline earth metals, rare-earth metals, and mixtures thereof. A reductive dopant layer may be employed as a charge generating layer to prepare an electroluminescent device having two or more electroluminescent layers and emitting white light.

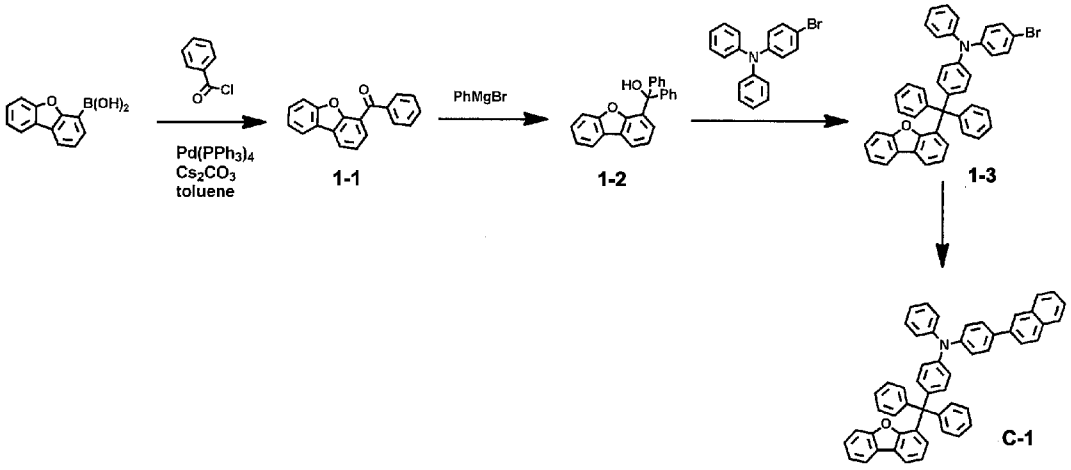
[155] In order to form each layer of the organic electroluminescent device according to the present invention, dry film-forming methods such as vacuum evaporation, sputtering, plasma and ion plating methods, or wet film-forming methods such as spin coating, dip coating, and flow coating methods can be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

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

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

[158] **Example 1: Preparation of compound C-1**

[159]



[160] Preparation of compound 1-1

[161] After introducing benzoyl chloride (45 mL, 376 mmol), 4-dibenzofuryl-boronic acid (40 g, 188.7 mmol), tetrakis(triphenylphosphine)palladium (6.5 g, 5.66 mmol), cesium carbonate (92 g, 283 mmol), and toluene 1 L in a reaction vessel, the mixture was stirred at 120°C for 2 hours. After the reaction is completed, the mixture was washed with distilled water, and an organic layer was extracted with ethyl acetate. The extracted organic layer was dried with magnesium sulfate, and the solvent was removed using a rotary evaporator. The remaining product was then purified with column chromatography to obtain compound 1-1 (46 g, 90%).

[162] Preparation of compound 1-2

[163] After introducing compound 1-1 (38 g, 140 mmol) and tetrahydrofuran 500 mL in a reaction vessel, the mixture was subjected to nitrogen atmosphere and cooled to 0°C. Phenylmagnesium bromide solution 60 mL (3 M, 182 mmol) was then slowly added dropwise to the mixture. The temperature was slowly increased and the mixture was stirred under reflux for 3 hours. Ammonium chloride aqueous solution was added to the reactant solution to complete the reaction, and extracted with ethyl acetate. The extracted organic layer was dried with magnesium sulfate, and the solvent was removed using a rotary evaporator. The remaining product was then purified with column chromatography to obtain compound 1-2 (29 g, 59%).

[164] Preparation of compound 1-3

[165] After introducing compound 1-2 (28.5 g, 81 mmol), 4-bromotriphenylamine (53 g, 162 mmol), and methylene chloride (MC) 400 mL in a reaction vessel, the mixture was subjected to nitrogen atmosphere. Eaton's reagent 2.5 mL was then slowly added

dropwise to the mixture. After stirring the mixture at room temperature for 2 hours, ethanol and distilled water were added to the mixture to complete the reaction, and extracted with methylene chloride. The extracted organic layer was dried with magnesium sulfate, and the solvent was removed using a rotary evaporator. The remaining product was then purified with column chromatography to obtain compound 1-3 (28.5 g, 54%).

[166] Preparation of compound C-1

[167] After introducing compound 1-3 (10 g, 15.2 mmol), 2-naphthylboronic acid (3.1 g, 18.2 mmol), tetrakis(triphenylphosphine)palladium (0.7 g, 0.61 mmol), potassium carbonate (5.2 g, 38 mmol), toluene 60 mL, and ethanol 20 mL in a reaction vessel, distilled water 20 mL was added thereto and the mixture was stirred at 120°C for 3 hours. After the reaction is completed, the mixture was washed with distilled water, and an organic layer was extracted with ethyl acetate. The extracted organic layer was dried with magnesium sulfate, and the solvent was removed using a rotary evaporator. The remaining product was then purified with column chromatography to obtain compound C-1 (8.7 g, 81%).

[168]

MW	UV	PL	M.P
703.87	324 nm	402 nm	251℃

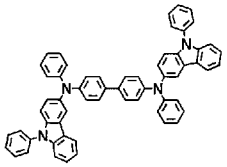
[169] **Device Example 1: Production of an OLED device comprising the**

[170] **organic electroluminescent compound according to the present invention**

[171] An OLED device was produced comprising the organic electroluminescent compound according to the present invention. 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 deositing apparatus. $N^4,N^{4'}$-diphenyl-$N^4,N^{4'}$-bis(9-phenyl-9H-carbazol-3-yl)-[1,1'-biphenyl]-4,4'-diamine (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. 1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (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 3 nm on the first hole injection layer. N-([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluor

ene-2-amine (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 C-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 second hole transport layer having a thickness of 60 nm on the first hole transport layer. Thereafter, compound H-1 as below was introduced into one cell of the vacuum vapor depositing apparatus as a host, and compound D-96 was introduced into another cell as a dopant. The two materials were evaporated at different rates and were deposited in a doping amount of 2 wt% (the amount of dopant) based on the total amount of the dopant and host to form a light-emitting layer having a thickness of 40 nm on the second hole transport layer.

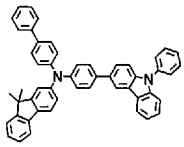
2,4-bis(9,9-dimethyl-9H-fluoren-2-yl)-6-(naphthalen-2-yl)-1,3,5-triazine (compound ET-1) and lithium quinolate (compound EI-1) were then introduced into another two cells, evaporated at the rate of 1:1, and deposited to form an electron transport layer having a thickness of 35 nm on the light-emitting layer. Next, after depositing lithium quinolate (compound EI-1) as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was deposited by another vacuum vapor deposition apparatus on the electron injection layer. Thus, an OLED device was produced.

[172] 

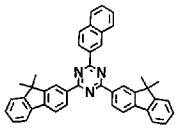
HI-1



HI-2



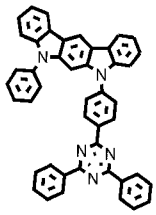
HT-1



ET-1



EI-1

[173] 

H-1

[174] The produced OLED device showed a red emission having a luminance of 1000 cd/m^2 and a current density of 3.67 mA/cm^2.

[175]

[176] **Comparative Example 1: Production of an OLED device comprising**

[177] **a conventional organic electroluminescent compound**

[178] An OLED device was produced in the same manner as in Device Example 1, except for depositing N-

([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluorene-2-amine (compound HT-1) at a thickness of 60 nm for the second hole transport layer.

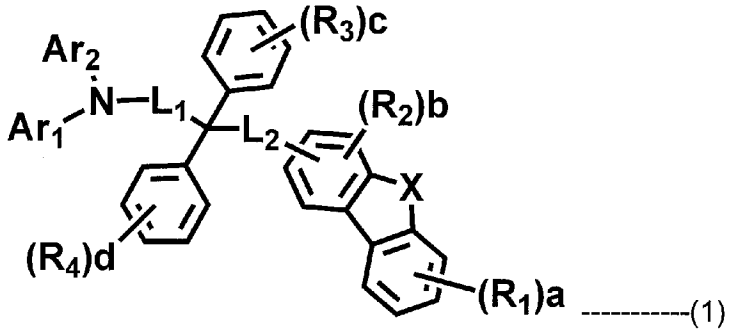
[179] The produced OLED device showed a red emission having a luminance of 1000 cd/m^2 and a current density of 7.5 mA/cm^2.

[180]

[181] Compared to the conventional materials, the organic electroluminescent compound according to the present invention showed excellent luminous characteristics. In addition, the device using the organic electroluminescent compound of the present invention has excellent luminous characteristics.

Claims

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



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

wherein

Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 5- to 30-membered heteroaryl;

where Ar_1 and Ar_2 are not both phenyl;

L_1 and L_2 each independently represent a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-membered heteroarylene;

X represents O, S, CR_5R_6, or NR_7;

R_1 to R_7 each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, $-NR_8R_9$, or $-SiR_{10}R_{11}R_{12}$; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;

R_8 to R_{12} each independently represent hydrogen, deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C3-C30)cycloalkenyl, a substituted or unsubstituted 3- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to

30-membered heteroaryl;

a represents an integer of 1 to 4, where a is an integer of 2 or more, each of R_1 may be the same or different;

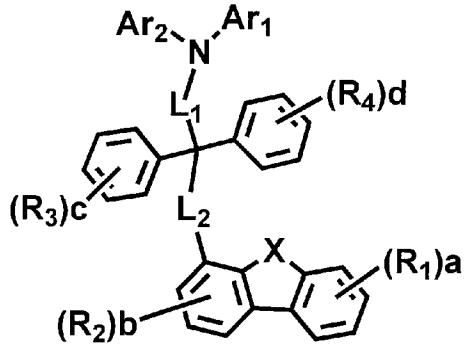
b represents an integer of 1 to 3, where b is an integer of 2 or more, each of R_2 may be the same or different;

c and d each independently represent an integer of 1 to 5, where c or d is an integer of 2 or more, each of R_3 and each of R_4 may be the same or different; and

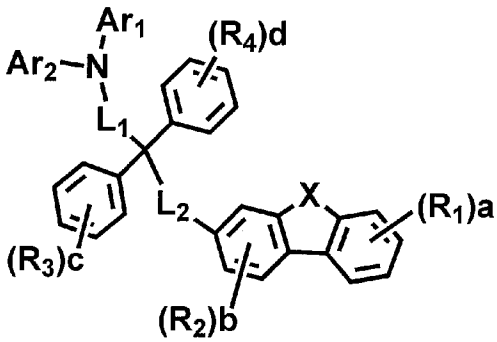
the heteroaryl(ene) and heterocycloalkyl each independently contain at least one hetero atom selected from B, N, O, S, Si, and P.

[Claim 2] The organic electroluminescent compound according to claim 1, wherein the substituents of the substituted alkyl, the substituted cycloalkyl, the substituted cycloalkenyl, the substituted heterocycloalkyl, the substituted aryl(ene), the substituted heteroaryl(ene), and the substituted mono- or polycyclic, alicyclic or aromatic ring in Ar_1, Ar_2, L_1, L_2, and R_1 to R_{12} 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 unsubstituted or substituted with a 3- to 30-membered heteroaryl, a tri(C1-C30)alkylsilyl, a tri(C6-C30)arylsilyl, a di(C1-C30)alkyl(C6-C30)arylsilyl, a (C1-C30)alkyldi(C6-C30)arylsilyl, an amino, a mono- or di-(C1-C30)alkylamino, a mono- or di- (C6-C30)arylamino, a (C1-C30)alkyl(C6-C30)arylamino, a (C1-C30)alkylcarbonyl, a (C1-C30)alkoxycarbonyl, a (C6-C30)arylcarbonyl, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, and a (C1-C30)alkyl(C6-C30)aryl.

[Claim 3] The organic electroluminescent compound according to claim 1, wherein the compound represented by formula 1 is represented by one of the following formulas 2 and 3:



----------(2)

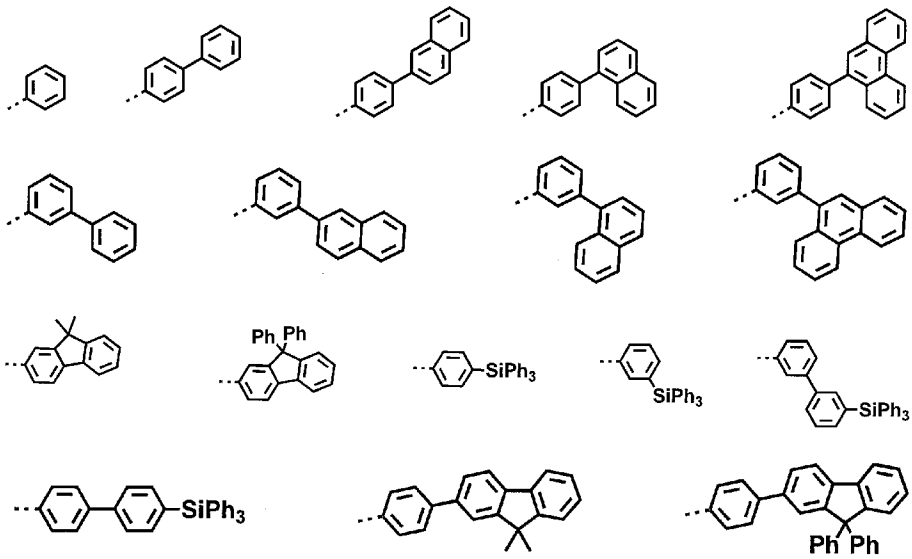


----------(3)

wherein

Ar_1, Ar_2, L_1, L_2, X, R_1 to R_4, and a to d are as defined in claim 1.

[Claim 4] The organic electroluminescent compound according to claim 1, wherein Ar_1 and Ar_2 each independently represent one of the following structures:



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

Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C6-C20)aryl;

L_1 and L_2 each independently represent a single bond, or a substituted or unsubstituted (C6-C12)arylene;

X represents O, S, CR_5R_6, or NR_7; and

R_1 to R_7 each independently represent hydrogen, a substituted or unsubstituted (C1-C6)alkyl, or a substituted or unsubstituted (C6-C12)aryl.

[Claim 6] The organic electroluminescent compound according to claim 1, wherein

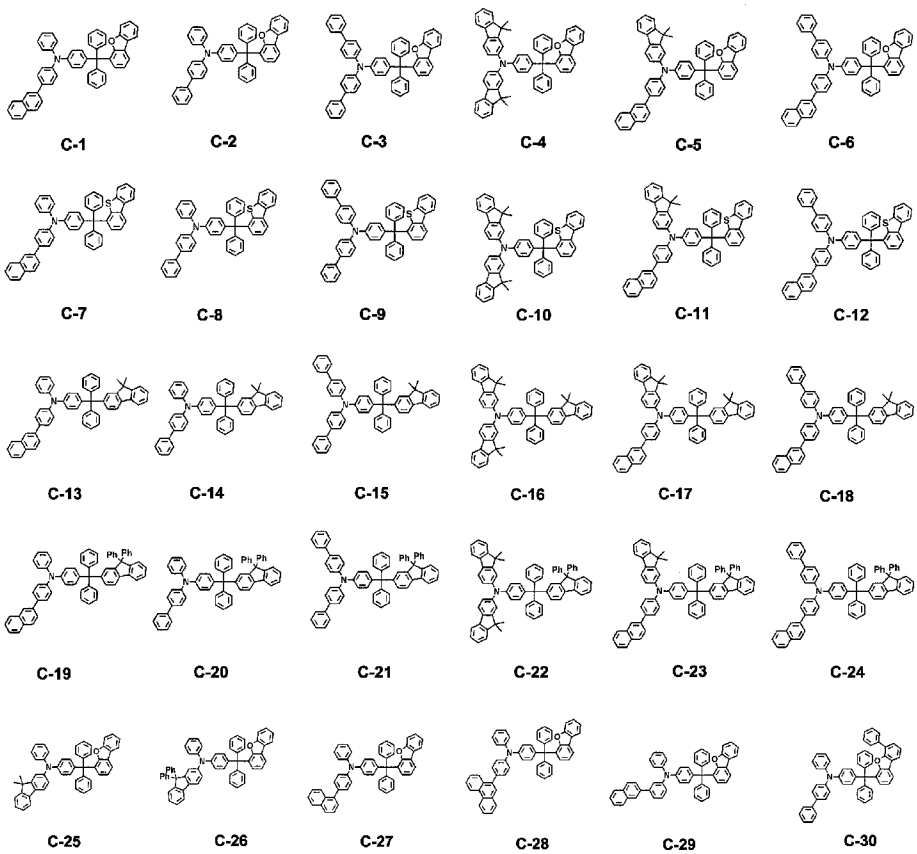
Ar_1 and Ar_2 each independently represent a (C6-C20)aryl unsubstituted or substituted with a (C1-C6)alkyl, a (C6-C25)aryl, a tri(C6-C12)arylsilyl, or a (C1-C6)alkyl(C6-C15)aryl;

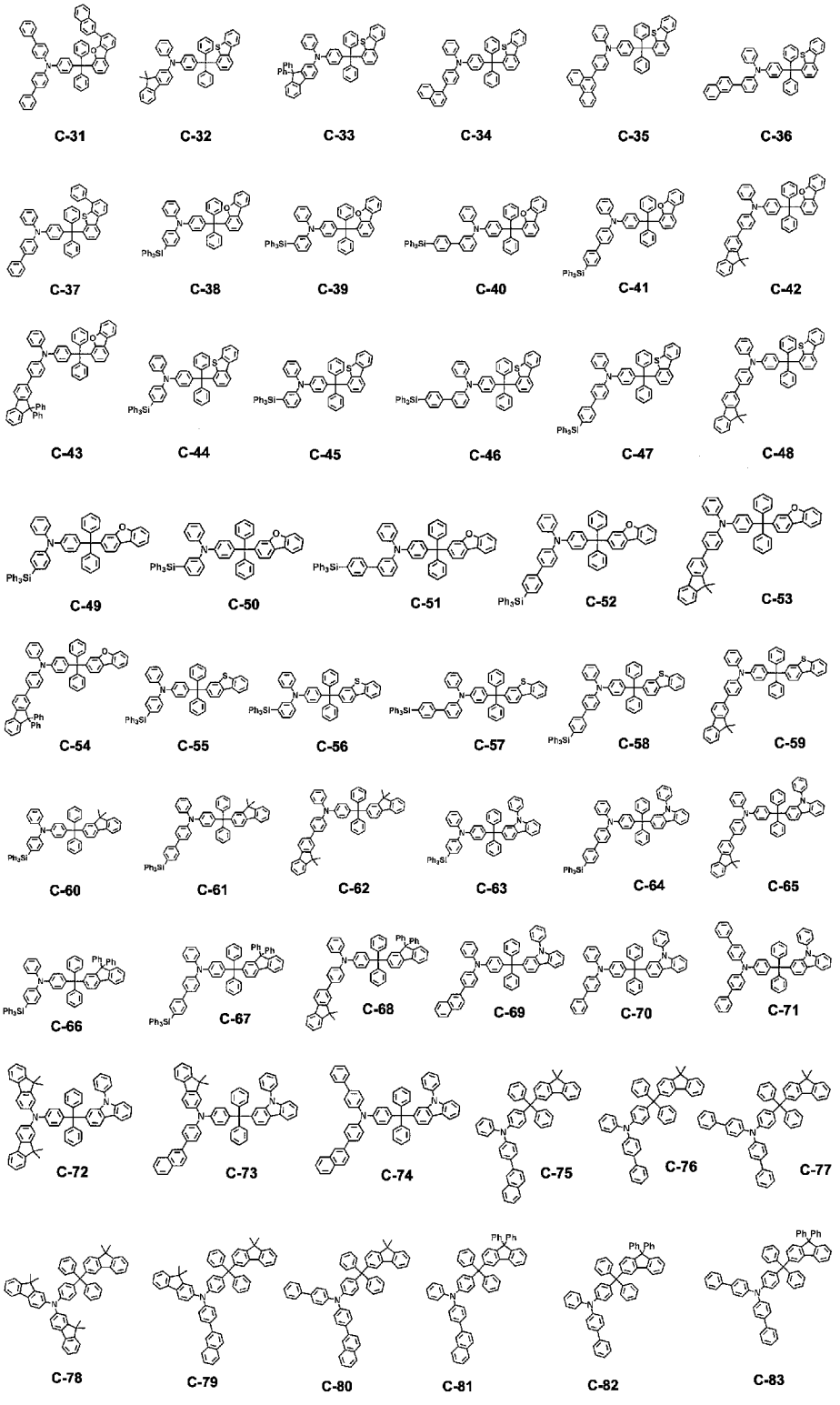
L_1 and L_2 each independently represent a single bond, or an unsubstituted (C6-C12)arylene;

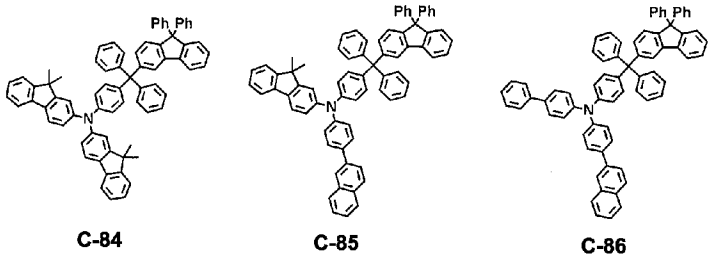
X represents O, S, CR_5R_6, or NR_7; and

R_1 to R_7 each independently represent hydrogen, an unsubstituted (C1-C6)alkyl, or an unsubstituted (C6-C12)aryl.

[Claim 7] The organic electroluminescent compound according to claim 1, wherein the compound represented by formula 1 is selected from the group consisting of:




C-31
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C-34
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C-44
C-45
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C-65
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C-68
C-69
C-70
C-71
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C-74
C-75
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C-80
C-81
C-82
C-83



C-84 C-85 C-86

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/013231

A. CLASSIFICATION OF SUBJECT MATTER

C07D 333/76 (2006.01) C07D 209/82 (2006.01) C07D 307/91 (2006.01) C07C 211/55 (2006.01) C07C 211/57 (2006.01) C07F 7/08 (2006.01) C09K 11/06 (2006.01) H01L 51/50 (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: CAplus, Registry: Substructure search of formula 1.

Google: Inventor/Applicant and Keywords: electroluminescent; and/or OLED; and/or device; and/or light; and/or emit.

Espacenet: Inventor/Applicant and Keywords: electroluminescent and/or OLED.

Applicant(s)/Inventor(s) name searched in internal databases provided by IP Australia.

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
7 March 2016	07 March 2016

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	Marica Nikac AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61 2 62832087

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/KR2015/013231**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LEE, C.W. et al., "Synthesis and photophysical properties of host materials with high triplet energy based on dibenzofuran and triphenylamine functionalities", Synthetic Metals, 2012, Vol. 162, pages 2059-2062. Whole document; Abstract; "Introduction", page 2059; Scheme 1, page 2060; compound DBFDPA	1-8
X	JP 2009-170816 A (MITSUI CHEMICALS INC) 30 July 2009 Abstract; Examples, pages 28-36; Formulae 1-1A, 1-2A and 1-3A; paragraphs [0047], [0048], [0051], [0053], [0054], [0056], pages 12-14; compounds A-3, A-6 and A-8, paragraphs [0168], [0178], [0188], pages 31, 33, 34	1-8

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/KR2015/013231**

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**
JP 2009-170816 A	30 July 2009	JP 2009170816 A	30 Jul 2009
		JP 4832451 B2	07 Dec 2011

End of Annex

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