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(54) Title: ORGANIC ELECTROLUMINESCENCE COMPOUNDS AND ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

(57) Abstract: The present invention relates to an organic electroluminescence compound and an organic electroluminescence device containing the same. Using the organic electroluminescence compound according to the present invention, it is possible to manufacture an organic electroluminescence device having long lifespan and high luminous efficiency.

Description

Title of Invention: ORGANIC ELECTROLUMINESCENCE COMPOUNDS AND ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

Technical Field

[1] The present invention relates to organic electroluminescence compounds and organic electroluminescence device comprising the same.

Background Art

[2] An electroluminescent (EL) device is a self-light-emitting device which has advantages in that it provides a wider viewing angle, a greater contrast ratio, and a faster response time compared to LCDs. An organic EL device was first 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 the light-emitting material. The electroluminescent material includes a host material and a dopant material for purposes of functionality. Typically, a device that has much superior electroluminescent properties is known to have a structure in which a host is doped with a dopant to form an electroluminescent layer. Recently, the development of an organic EL device having high efficiency and long lifespan is being urgently called for. Particularly, taking into consideration the electroluminescent properties required of medium to large OLED panels, the development of materials much superior to conventional electroluminescent materials is urgent.

[4] A host material which functions as the solvent in a solid phase and plays a role in transferring energy should be of high purity and must have a molecular weight appropriate to enabling vacuum deposition. Also, the glass transition temperature and heat decomposition temperature should be high to ensure thermal stability, and high electrochemical stability is required to attain a long lifespan, and the formation of an amorphous thin film should become simple, and the force of adhesion to materials of other adjacent layers must be good but interlayer migration should not occur.

[5] Until now, fluorescent host materials have been widely used as a host material. For blue fluorescent host materials, many materials are researched and commercialized after the development of 4,4'-bis(2,2'-diphenylvinyl)-1,1'-biphenyl (DPVBi) from Idemitsu Kosan. Although the blue material system of Idemitsu Kosan and the dinaphthylanthracene, tetra(t-butyl)perylene system of Kodak are known, many researches are conducted until now to develop blue fluorescent host materials that can provide better characteristics in the device.

[6] Korean Patent No. KR 10-0987822 B, and Korean Patent Appln. Laying-Open Nos. KR 10-2010-0108903 A, KR 10-2010-0109050 A, KR 10-2012-0038402 A, etc., disclose many anthracene derivatives.

[7] The present inventors found that a specific structure of an anthracene derivative, which is not disclosed in the above references, is suitable for manufacturing an organic electroluminescent device having high luminous efficiency and a long lifespan.

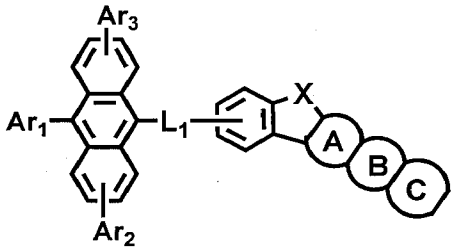
Disclosure of Invention

Technical Problem

[8] The objective of the present invention is to provide a specific structure of an anthracene derivative which can be used as a fluorescent host material of a light-emitting layer to realize an organic electroluminescent device having a long lifespan and high luminous efficiency.

Solution to Problem

[9] In order to achieve said purposes, the present invention provides an organic electroluminescence compound represented by the following formula 1:

[10] 

-------- (1)

[11] wherein

[12] L_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene group, or a substituted or unsubstituted 5- to 30-memebered heteroarylene group;

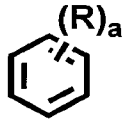
[13] Ar_1 represents a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group;

[14] Ar_2 and Ar_3 each independently represent hydrogen, deuterium, a halogen, a cyano group, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, a substituted or unsubstituted 5- to 30-membered heteroaryl group, or $-NR_1R_2$;

[15] R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group; or are linked to each other to form a mono- or polycyclic, 3- to 30-membered, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen and sulfur;

[16] ring A and ring C each independently represent an aromatic ring represented by the following formula 1a;

[17] ring B represents a 5-membered ring represented by the following formula 1b;

[18] 

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

[19] 

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

[20] X and Y each independently represent -O-, -S-, -N(R_{21})- or -C(R_{22})(R_{23})-; where X is -C(R_{22})(R_{23})-, Y is -O-, -S- or -N(R_{21})-, where X is -O- or -S-, Y is -N(R_{21})- or -C(R_{22})(R_{23})-, and where X is -N(R_{21})-, Y is -O-, -S- or -C(R_{22})(R_{23})-;

[21] R represents hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group;

[22] R_{21} to R_{23} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, 3- to 30-membered, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen and sulfur; and

[23] a represents 1 or 2; where a is 2, each of R is same or different.

Advantageous Effects of Invention

[24] Using the organic electroluminescence compound according to the present invention as a fluorescent host of a light-emitting layer, it is possible to manufacture an organic electroluminescence device having a long lifespan and high luminous efficiency.

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 represented by the above formula 1, an organic electroluminescent material comprising the compound, and an organic electroluminescence device comprising the material.

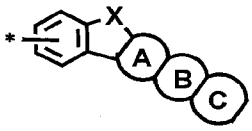
[27] The compound represented by the above formula 1 will be described in detail.

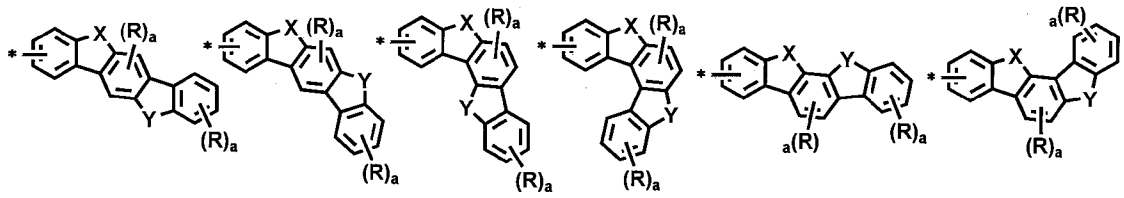
[28] Herein, “alkyl” includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc.; “alkenyl” includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, etc.; “alkynyl” includes ethynyl, 1-propynyl, 2-propynyl, 1-butynyl, 2-butynyl, 3-butynyl, 1-methylpent-2-ynyl, etc.; “cycloalkyl” includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc.; “5- to 7-membered het-

erocycloalkyl" is a cycloalkyl having at least one heteroatom selected from B, N, O, S, P(=O), Si and P, preferably O, S and N, and 5 to 7 ring backbone atoms, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc.; "aryl(ene)" is a monocyclic or fused ring derived from an aromatic hydrocarbon, 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.; "3- to 30-membered heteroaryl(ene)" is an aryl group having at least one, preferably 1 to 4 heteroatom selected from the group consisting of B, N, O, S, P(=O), Si and P, and 3 to 30 ring backbone atoms; 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 such as furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl such as benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, 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. The substituents of the substituted alkyl, the substituted aryl(ene), and the substituted heteroaryl(ene) in L_1, Ar_1 to Ar_3, R, R_1, R_2, and R_{21} to R_{23} in the above formula 1 each independently are at least one selected from the group consisting of deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen, a (C1-C30)alkoxy, a (C6-C30)aryl, a 3- to 30-membered heteroaryl unsubstituted or substituted with a (C6-C30)aryl, a (C3-C30)cycloalkyl, a 5- to 7-membered heterocycloalkyl, 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, a (C2-C30)alkenyl, a (C2-C30)alkynyl, a cyano, a carbazolyl, a di(C1-C30)alkylamino, a di(C6-C30)arylamino unsubstituted or substituted with a (C1-C30)alkyl, a (C1-C30)alkyl(C6-C30)arylamino, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, a (C1-C30)alkyl(C6-C30)aryl, a carboxyl, a nitro and a hydroxyl, and preferably each independently are at least one selected from the group

consisting of deuterium, a halogen, a (C1-C6)alkyl, a (C1-C6)alkoxy, a (C6-C21)aryl, a (C3-C21)cycloalkyl, a tri(C6-C12)arylsilyl, a cyano, a di(C6-C12)arylamino, and a hydroxyl.

[30] In formula 1, the moiety,  is preferably selected from the group consisting of the following structures:

[31] 

[32] wherein X, Y, R, and a are as defined in formula 1.

[33] In formula 1, L_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene group, or a substituted or unsubstituted 5- to 30-memebered heteroarylene group, preferably represents a single bond, a substituted or unsubstituted (C6-C21)arylene group, or a substituted or unsubstituted 5- to 21-memebered heteroarylene group, and more preferably represents a single bond; a (C6-C21)arylene group unsubstituted or substituted with a (C1-C6)alkyl; or an unsubstituted 5- to 21-memebered heteroarylene group.

[34] Ar_1 represents a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group, preferably represents a substituted or unsubstituted (C6-C21)aryl group, or a substituted or unsubstituted 5- to 21-membered heteroaryl group, and more preferably represents a (C6-C21)aryl group unsubstituted or substituted with deuterium, a halogen, a (C1-C6)alkyl, a (C1-C6)alkoxy, a (C6-C21)aryl, a (C3-C21)cycloalkyl, a tri(C6-C12)arylsilyl, a cyano, a di(C6-C12)arylamino, or a hydroxyl; or a 5- to 21-membered heteroaryl group unsubstituted or substituted with a (C6-C21)aryl.

[35] Ar_2 and Ar_3 each independently represent hydrogen, deuterium, a halogen, a cyano group, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, a substituted or unsubstituted 5- to 30-membered heteroaryl group, or $-NR_1R_2$, preferably each independently represent hydrogen, a substituted or unsubstituted (C6-C21)aryl group, a substituted or unsubstituted 5- to 21-membered heteroaryl group, or $-NR_1R_2$, and more preferably each independently represent hydrogen, an unsubstituted (C6-C21)aryl group, an unsubstituted 5- to 21-membered heteroaryl group, or $-NR_1R_2$.

[36] R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl

group; or are linked to each other to form a mono- or polycyclic, 3- to 30-membered, 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, or a substituted or unsubstituted (C6-C21)aryl group, and more preferably each independently represent hydrogen, or a (C6-C21)aryl group unsubstituted or substituted with a (C1-C6)alkyl.

[37] X and Y each independently represent -O-, -S-, -N(R_{21})- or -C(R_{22})(R_{23})-; where X is -C(R_{22})(R_{23})-, Y is -O-, -S- or -N(R_{21})-, where X is -O- or -S-, Y is -N(R_{21})- or -C(R_{22})(R_{23})-, and where X is -N(R_{21})-, Y is -O-, -S- or -C(R_{22})(R_{23})-.

[38] R represents hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group, and preferably represents hydrogen.

[39] R_{21} to R_{23} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, 3- to 30-membered, 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 a substituted or unsubstituted (C1-C6)alkyl group, or a substituted or unsubstituted (C6-C21)aryl group, and more preferably each independently represent an unsubstituted (C1-C6)alkyl group, or an unsubstituted (C6-C21)aryl group.

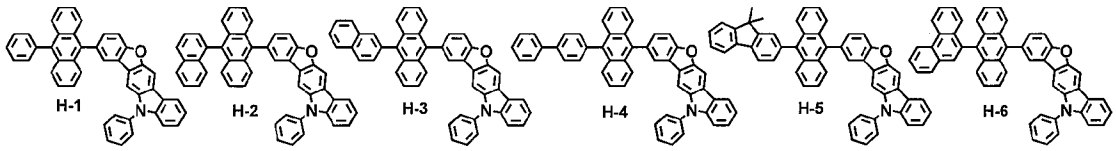
[40] According to one embodiment of the present invention, in formula 1, L_1 represents a single bond, a substituted or unsubstituted (C6-C21)arylene group, or a substituted or unsubstituted 5- to 21-memebered heteroarylene group; Ar_1 represents a substituted or unsubstituted (C6-C21)aryl group, or a substituted or unsubstituted 5- to 21-membered heteroaryl group; Ar_2 and Ar_3 each independently represent hydrogen, a substituted or unsubstituted (C6-C21)aryl group, a substituted or unsubstituted 5- to 21-membered heteroaryl group, or -NR_1R_2; R_1 and R_2 each independently represent hydrogen, or a substituted or unsubstituted (C6-C21)aryl group; X and Y each independently represent -O-, -S-, -N(R_{21})- or -C(R_{22})(R_{23})-; where X is -C(R_{22})(R_{23})-, Y is -O-, -S- or -N(R_{21})-, where X is -O- or -S-, Y is -N(R_{21})- or -C(R_{22})(R_{23})-, and where X is -N(R_{21})-, Y is -O-, -S- or -C(R_{22})(R_{23})-; R represents hydrogen: and R_{21} to R_{23} each independently represent a substituted or unsubstituted (C1-C6)alkyl group, or a substituted or unsubstituted (C6-C21)aryl group.

[41] According to another embodiment of the present invention, in formula 1, L_1 represents a single bond; a (C6-C21)arylene group unsubstituted or substituted with a (C1-C6)alkyl; or an unsubstituted 5- to 21-memebered heteroarylene group; Ar_1

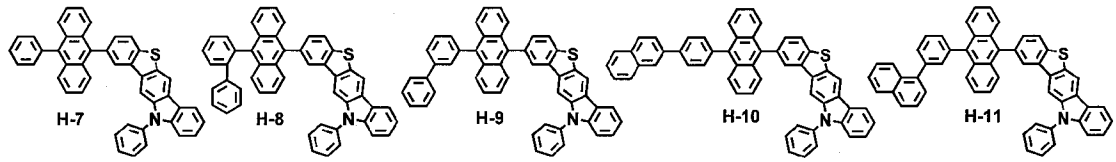
represents a (C6-C21)aryl group unsubstituted or substituted with deuterium, a halogen, a (C1-C6)alkyl, a (C1-C6)alkoxy, a (C6-C21)aryl, a (C3-C21)cycloalkyl, a tri(C6-C12)arylsilyl, a cyano, a di(C6-C12)arylamino, or a hydroxyl; or a 5- to 21-memebered heteroaryl group unsubstituted or substituted with a (C6-C21)aryl; Ar_2 and Ar_3 each independently represent hydrogen; an unsubstituted (C6-C21)aryl group; an unsubstituted 5- to 21-membered heteroaryl group; or $-NR_1R_2$; R_1 and R_2 each independently represent hydrogen, or a (C6-C21)aryl group unsubstituted or substituted with a (C1-C6)alkyl; X and Y each independently represent -O-, -S-, $-N(R_{21})-$ or $-C(R_{22})(R_{23})-$; where X is $-C(R_{22})(R_{23})-$, Y is -O-, -S- or $-N(R_{21})-$, where X is -O- or -S-, Y is $-N(R_{21})-$ or $-C(R_{22})(R_{23})-$, and where X is $-N(R_{21})-$, Y is -O-, -S- or $-C(R_{22})(R_{23})-$; R represents hydrogen: and R_{21} to R_{23} each independently represent an unsubstituted (C1-C6)alkyl group, or an unsubstituted (C6-C21)aryl group.

[42] The representative compounds of formula 1 include the following compounds, but are not limited thereto:

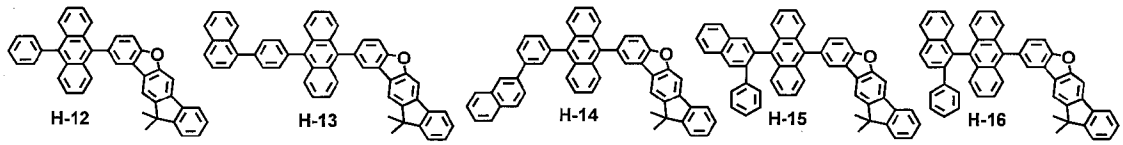
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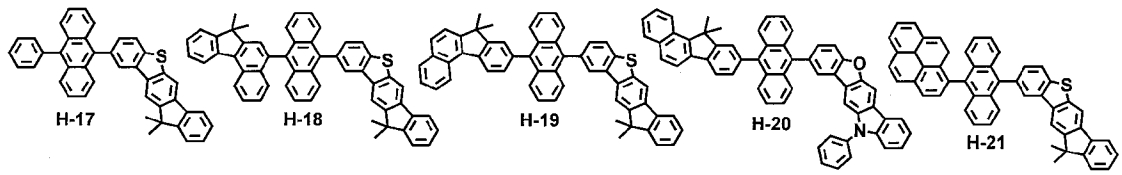
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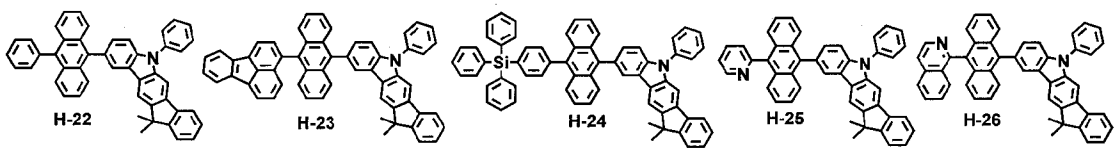
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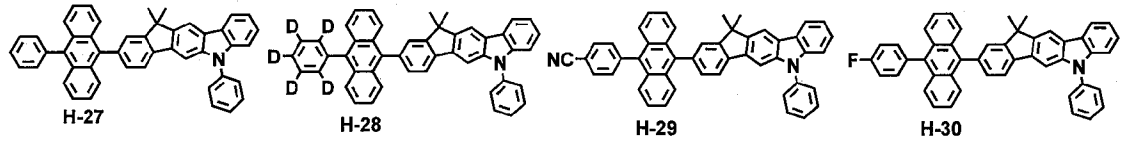
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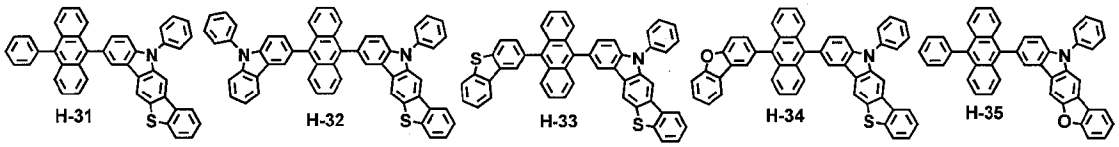
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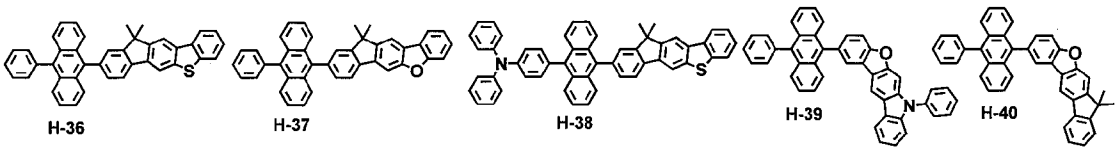
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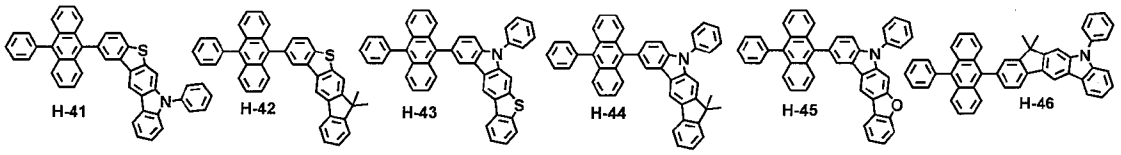
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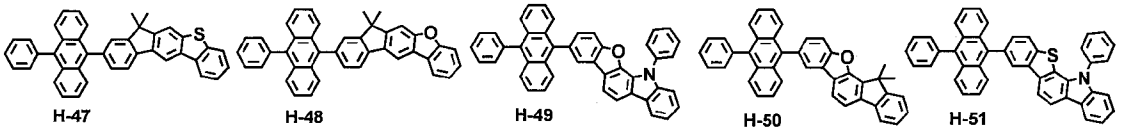
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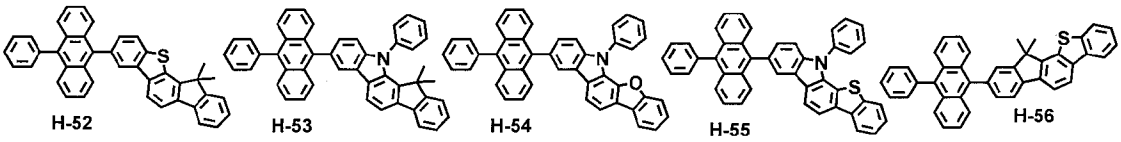
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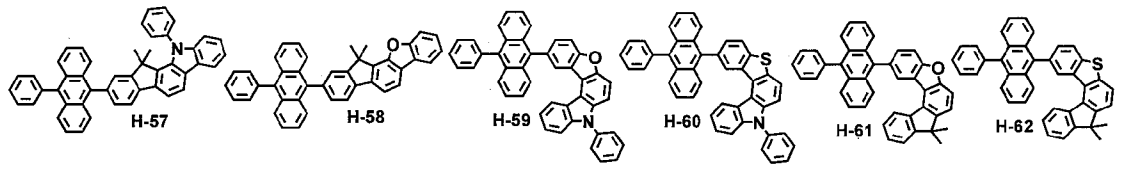
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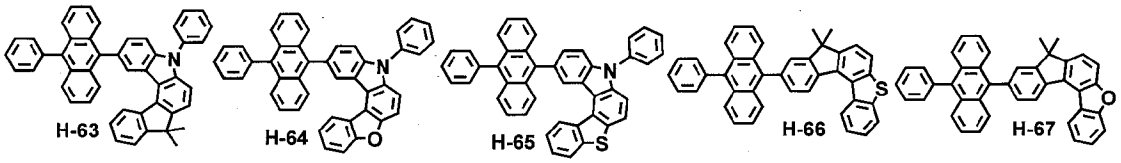
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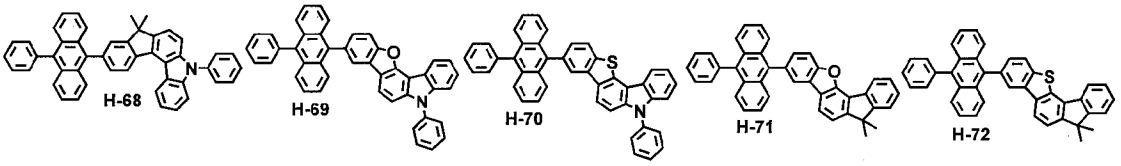
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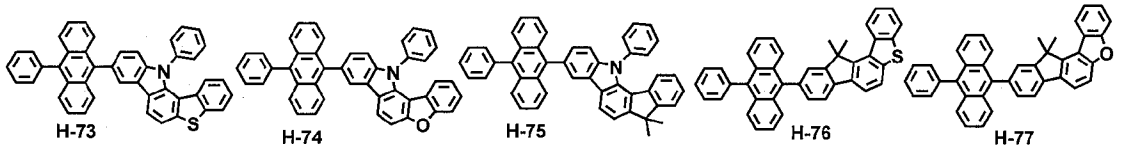
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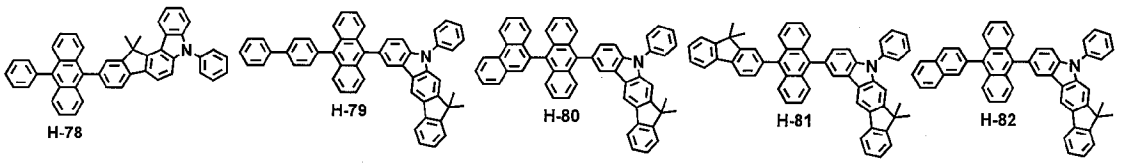
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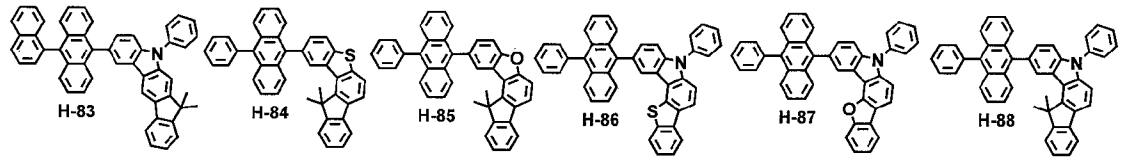
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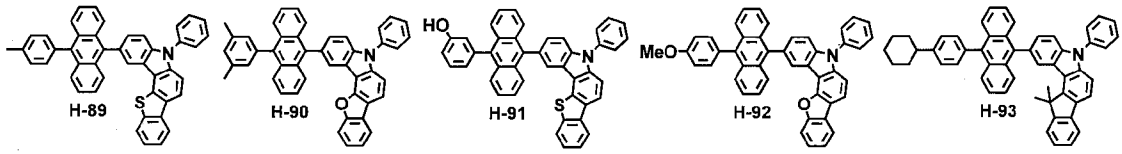
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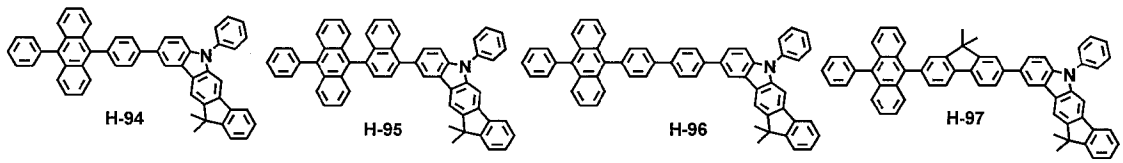
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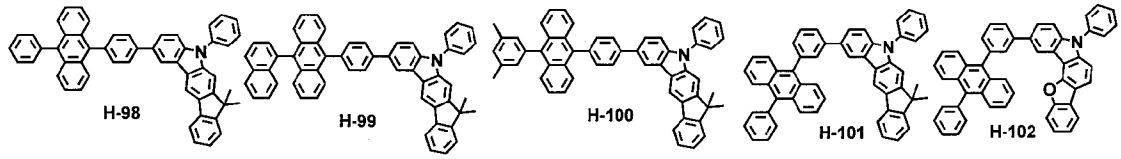
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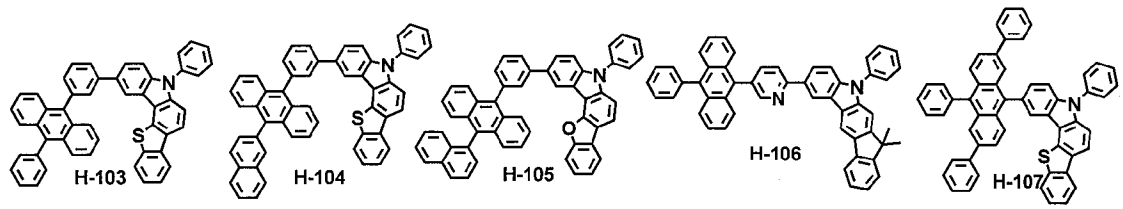
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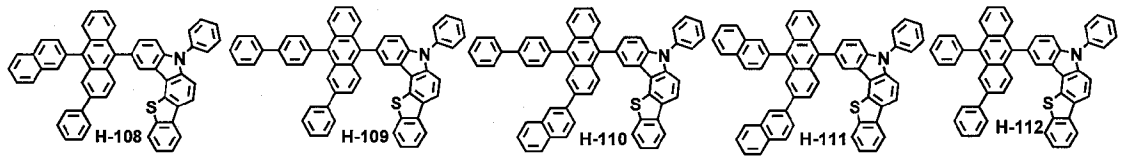
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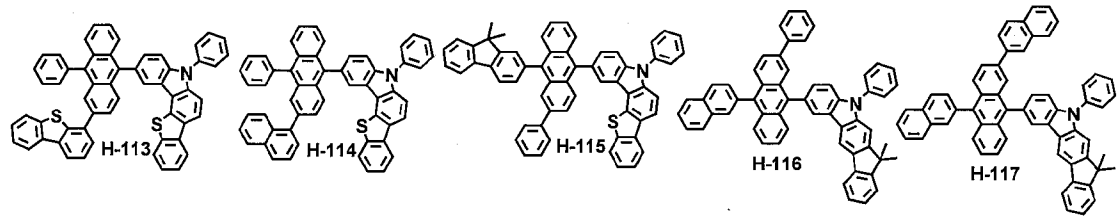
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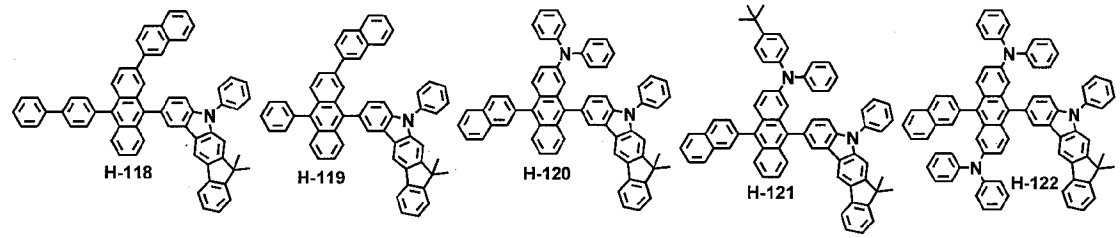
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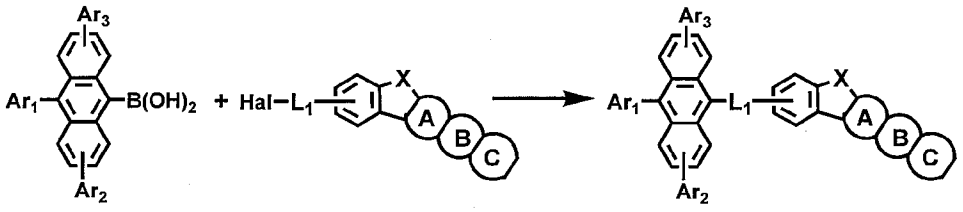


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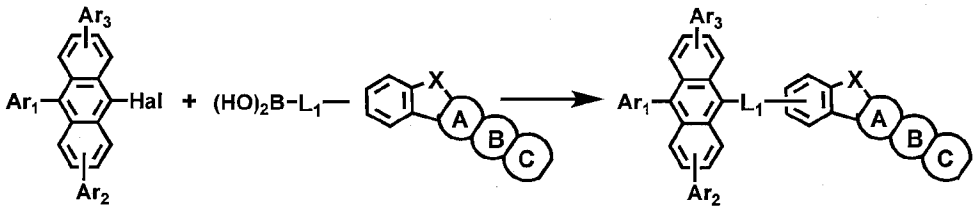


[67] The organic electroluminescent compounds of the present invention can be prepared by a synthetic method known to a person skilled in the art. For example, they can be prepared according to the following reaction scheme 1 or 2.

[68] [Reaction Scheme 1]

[69] 

[70] [Reaction Scheme 2]

[71] 

[72] wherein Ar_1, Ar_2, Ar_3, L_1, X, ring A, ring B, and ring C are as defined in formula 1 above, and Hal represents a halogen.

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

[74] Said material can be comprised of the organic electroluminescent compound according to the present invention alone, or can additionally comprise conventional materials comprised in organic electroluminescent materials.

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

[76] One of the first and second electrodes is an anode, and the other is a cathode. The organic layer comprises a light-emitting layer, and 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 a electron blocking layer.

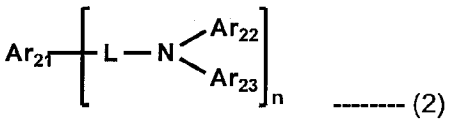
[77] Also, said organic layer comprises a light-emitting layer, and the organic electroluminescent compound of formula 1 can be used as a host material in the light-emitting layer.

[78] In addition, said light-emitting layer can comprise a fluorescent dopant material with the host material of the present invention.

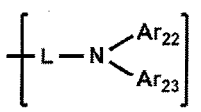
[79] A fluorescent dopant is a compound which can emit light from a single exciton. The fluorescent dopant is preferably a compound which is selected according to a required emission color from an amine-based compound, an aromatic compound, a chelate complex such as a tris(8-quinolinolate)aluminum complex, a coumarin derivative, a tetraphenylbutadiene derivative, a bisstyrylarylene derivative, an oxadiazole derivative,

or the like. A styrylamine compound, a styryldiamine compound, an arylamine compound, and an aryldiamine compound are more preferable, with a fused polycyclic amine derivative being even more preferable. These fluorescent dopants may be used either singly or in combination of two or more.

[80] As the fused polycyclic amine derivative comprised as a fluorescent dopant of the organic electroluminescent device according to the present invention, a compound represented by the following formula 2 can be used.

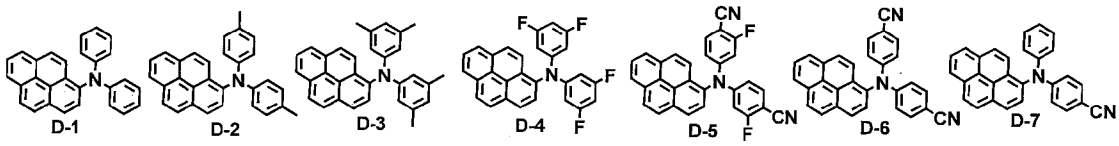
[81]  -------- (2)

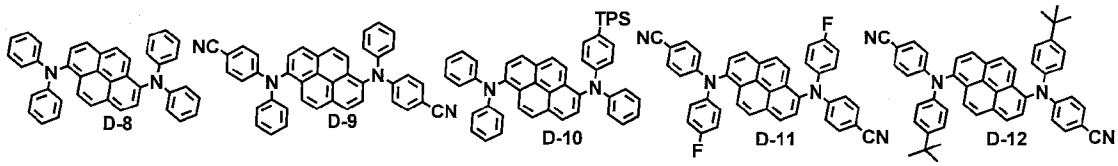
[82] wherein

[83] Ar_{21} represents a substituted or unsubstituted (C6-C50)aryl or a styryl; L represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted 3- to 30-memebered heteroarylene; Ar_{22} and Ar_{23} each independently represent hydrogen, deuterium, a halogen, 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 are linked to an adjacent substituent(s) to form a mono- or polycyclic, 3- to 30- membered, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen and sulfur; n represents 1 or 2, where n is 2, each of  are same or different.

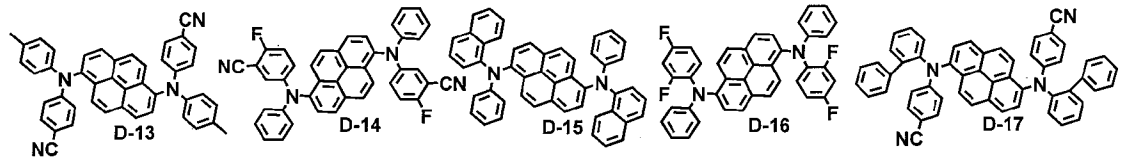
[84] The preferable aryl groups of Ar_{21} are a substituted or unsubstituted phenyl, a substituted or unsubstituted fluorenyl group, a substituted or unsubstituted anthryl group, a substituted or unsubstituted pyrenyl group, a substituted or unsubstituted chrysenyl group, and a substituted or unsubstituted benzofluorenyl group, etc.

[85] The representative compounds of formula 2 include the following compounds, but are not limited thereto:

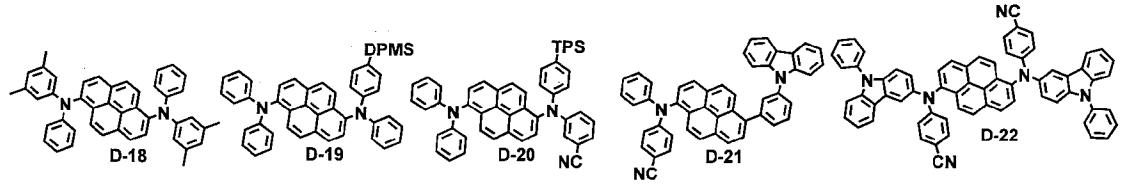
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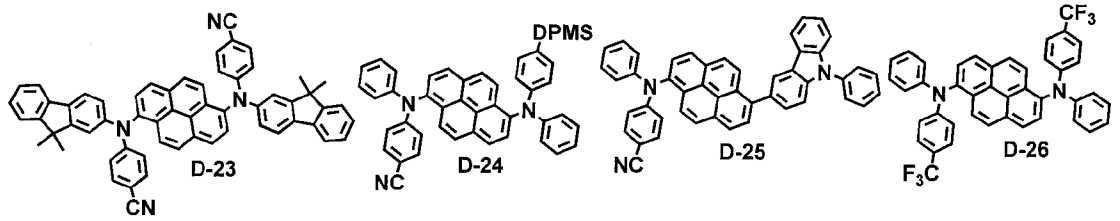
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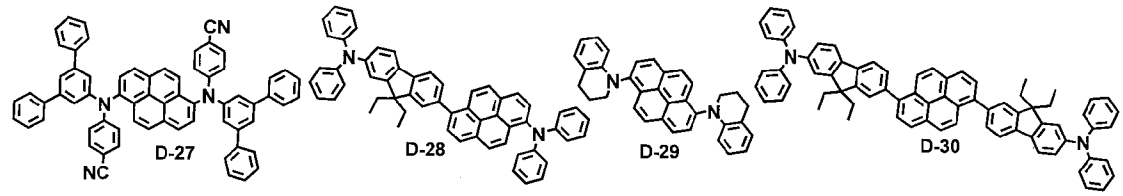
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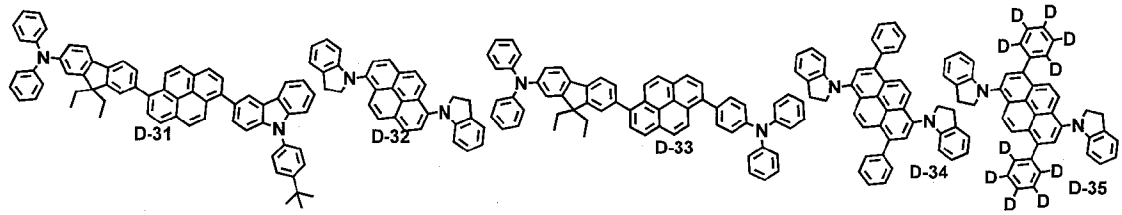
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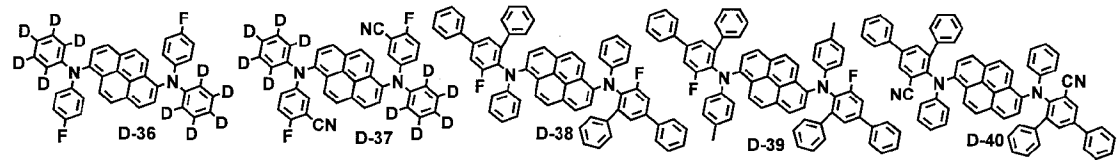
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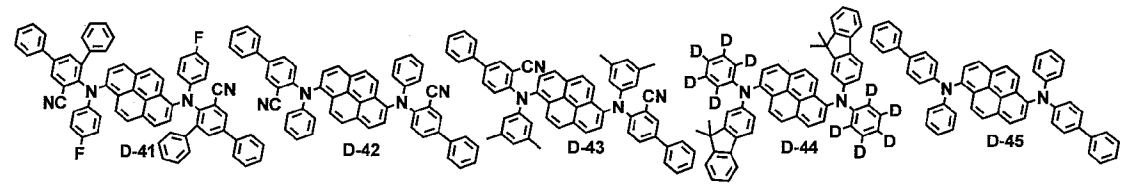
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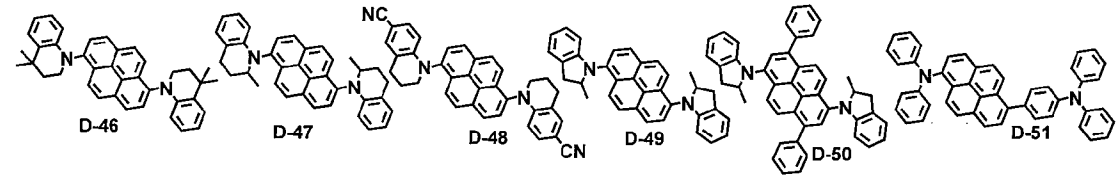
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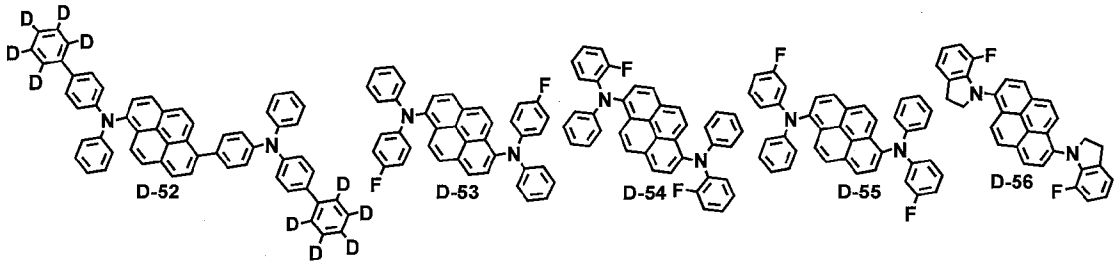
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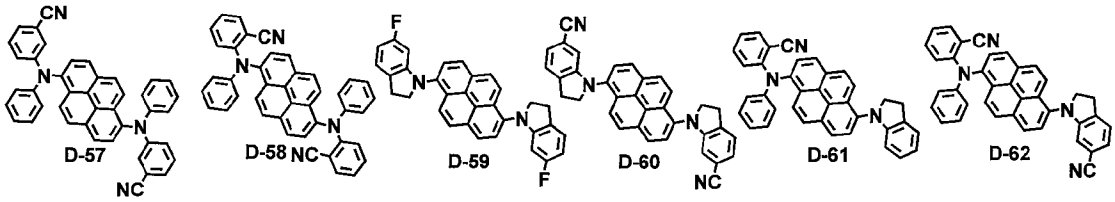
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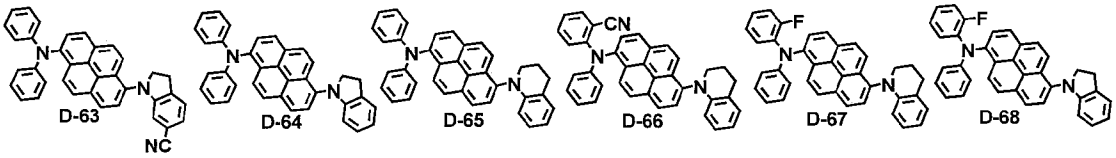
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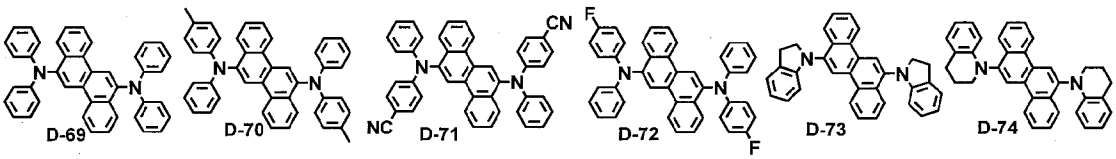
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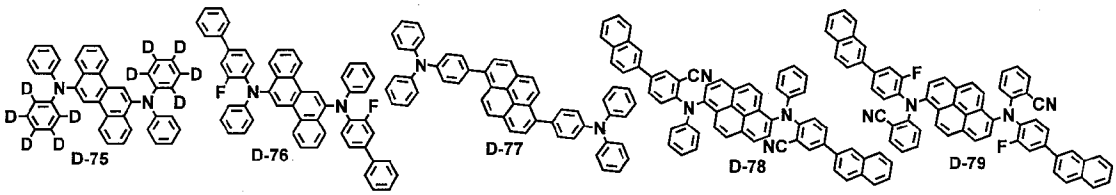
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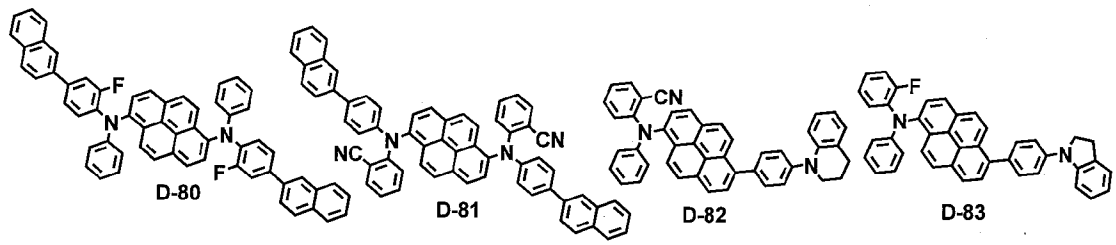
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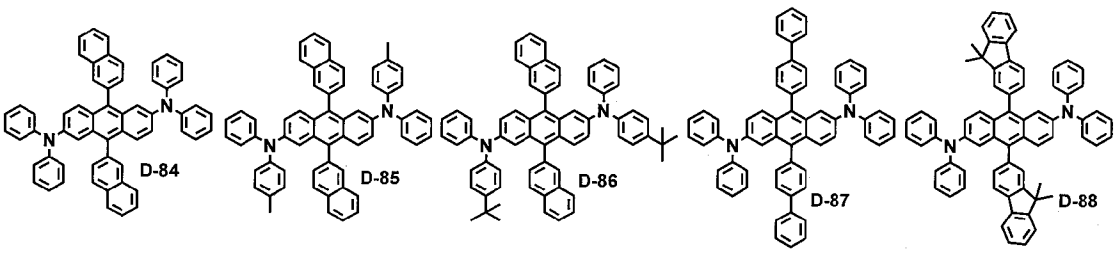
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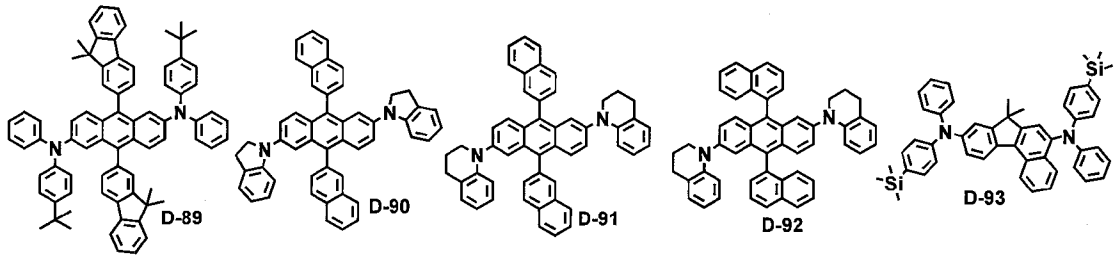
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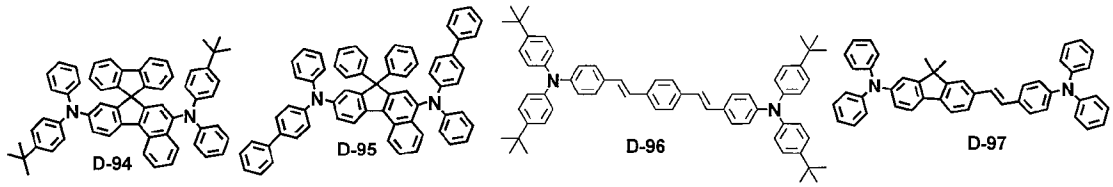
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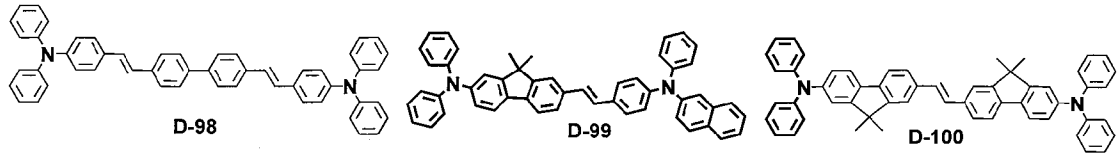
[103]



[104]



[105]



[106] 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.

[107] 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.

[108] In addition, the organic layer may form an organic electroluminescent device which emits white light by further comprising at least one organic light-emitting layer which comprises a blue electroluminescent compound, a red electroluminescent compound or a green electroluminescent compound, besides said organic electroluminescent compound.

[109] According to the present invention, at least one layer (hereinafter, "a surface layer") may be 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(includes oxides) layer of silicon or aluminum is preferably placed on an anode surface of an electroluminescent medium layer, and a metal halide layer or a metal oxide layer is preferably placed on a cathode surface of an electroluminescent medium layer. Such a surface layer provides operation stability for the organic electroluminescent device. Preferably, 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.

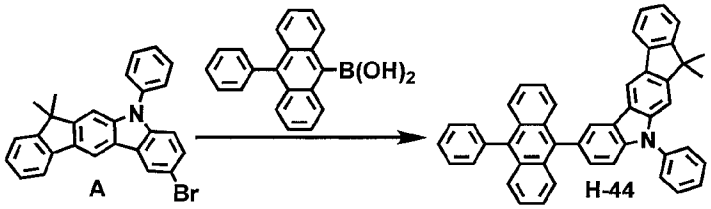
[110] In the organic electroluminescent device according to the present invention, a mixed region of an electron transport compound and an reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant may be preferably placed on at least one surface of a pair of electrodes. 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.

[111] 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, flow coating methods can be used.

[112] 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.

[113] 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.

[114] **Example 1: Preparation of compound H-44**

[115] 

[116] After mixing compound A 5 g (15 mmol), 10-phenylanthracen-9-yl boronic acid 6.6 g (16.5 mmol), $Pd(PPh_3)_4$ 1.0 g (0.9 mmol), K_2CO_3 (2 M) 22 mL, ethanol 22 mL, and toluene 44 mL in a flask, the mixture was stirred under reflux at 120°C for 4 hours. After the reaction was completed, the mixture was washed with distilled water,

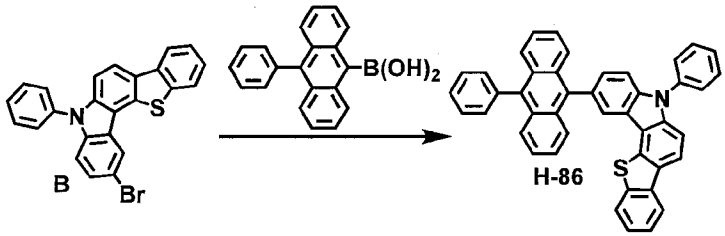
extracted with ethylacetate (EA), the organic layer was dried with $MgSO_4$, the solvent was removed using a rotary evaporator, and the remaining product was separated using a column to obtain compound **H-44**, 4.4 g (48%).

[117] Melting point 332°C, UV 312 nm (in toluene), PL 426 nm (in toluene), Molecular weight 611.26

[118]

[119] **Example 2: Preparation of compound H-86**

[120]



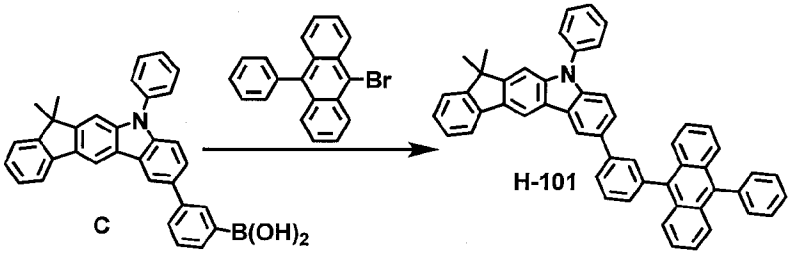
[121] After mixing compound B 3.5 g (8.2 mmol), 10-phenylanthracen-9-yl boronic acid 2.3 g (8.6 mmol), $Pd(PPh_3)_4$ 568 mg (0.5 mmol), K_2CO_3 (2 M) 12 mL, ethanol 12 mL, and toluene 24 mL in a flask, the mixture was washed with distilled water, extracted with EA, the organic layer was dried with $MgSO_4$, the solvent was removed using a rotary evaporator, and the remaining product was separated using a column to obtain compound **H-86**, 3.6 g (72%).

[122] Melting point 374°C, UV 292 nm (in toluene), PL 426 nm (in toluene), Molecular weight 601.19

[123]

[124] **Example 3: Preparation of compound H-101**

[125]



[126] Compound **H-101**, 3.9 g (48.7%) was prepared in the same manner as the synthetic method of compound **H-44** using compound C 6.7 g (13.9 mmol), and 9-bromo-10-phenylanthracene 3.9 g (11.6 mmol).

[127] Melting point 358°C, UV 257 nm (in methylene chloride (MC)), PL 412 nm (in MC), Molecular weight 687.29

[128]

[129] **Device Example 1: Production of an OLED device using the**

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

[131] An OLED device was produced using the light emitting material according to the present invention. A transparent electrode indium tin oxide (ITO) thin film (15 Ω/sq)

on a glass substrate for an organic light-emitting diode (OLED) device (Samsung Corning, Republic of Korea) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol and distilled water, sequentially, and then was stored in isopropanol. Next, the ITO substrate was mounted on a substrate holder of a vacuum vapor depositing apparatus.

4,4',4"-tris(N,N-(2-naphthyl)-phenylamino)triphenylamine 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 hole injection layer having a thickness of 60 nm on the ITO substrate. Then, N,N'-bis(α-naphthyl)-N,N'-diphenyl-4,4'-diamine 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 hole transport layer having a thickness of 20 nm on the hole injection layer. Thereafter, compound **H-44** according to the present invention was introduced into one cell of the vacuum vapor depositing apparatus, as a host material, and compound **D-55** was introduced into another cell as a dopant. The two materials were evaporated at different rates and were deposited in a doping amount of 3 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 30 nm on the hole transport layer. Next, tris(8-hydroxyquinoline)-aluminum (III) was introduced into one cell to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. Thereafter, after depositing lithium quinolate as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 150 nm was 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.

[132] The produced OLED device showed a blue emission having a luminance of 590 cd/m^2 and a current density of 23.6 mA/cm^2.

[133]

[134] **Device Example 2: Production of an OLED device using the**

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

[136] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-86** as a host, and using compound **D-99** as a dopant of the light emitting material.

[137] The produced OLED device showed a blue emission having a luminance of 1080 cd/m^2 and a current density of 15.7 mA/cm^2.

[138]

[139] **Device Example 3: Production of an OLED device using the**

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

[141] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-101** as a host, and using compound **D-9** as a dopant of the light emitting material.

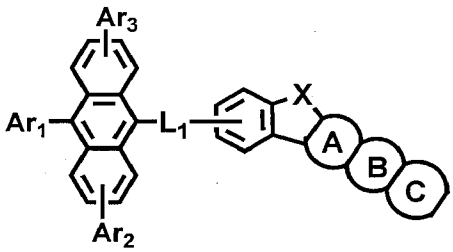
[142] The produced OLED device showed a blue emission having a luminance of 630 cd/m ^{2} and a current density of 22.5 mA/cm^2.

[143]

[144] It is verified that the organic electroluminescent compound according to the present invention is efficient for blue emission as a fluorescent host of a light-emitting layer.

Claims

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



-------- (1)

wherein

L_1 represents a single bond, a substituted or unsubstituted (C6-C30)arylene group, or a substituted or unsubstituted 5- to 30-memebered heteroarylene group;

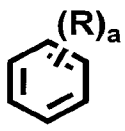
Ar_1 represents a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group;

Ar_2 and Ar_3 each independently represent hydrogen, deuterium, a halogen, a cyano group, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, a substituted or unsubstituted 5- to 30-membered heteroaryl group, or $-NR_1R_2$;

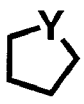
R_1 and R_2 each independently represent hydrogen, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group; or are linked to each other to form a mono- or polycyclic, 3- to 30-membered, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen and sulfur;

ring A and ring C each independently represent an aromatic ring represented by the following formula 1a;

ring B represents a 5-membered ring represented by the following formula 1b;



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



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

X and Y each independently represent -O-, -S-, $-N(R_{21})-$ or $-C(R_{22})(R_{23})-$; where X is $-C(R_{22})(R_{23})-$, Y is -O-, -S- or $-N(R_{21})-$, where X is -O- or

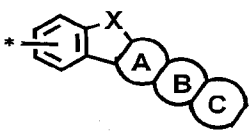
-S-, Y is -N(R_{21})- or -C(R_{22})(R_{23})-, and where X is -N(R_{21})-, Y is -O-, -S- or -C(R_{22})(R_{23})-;

R represents hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group;

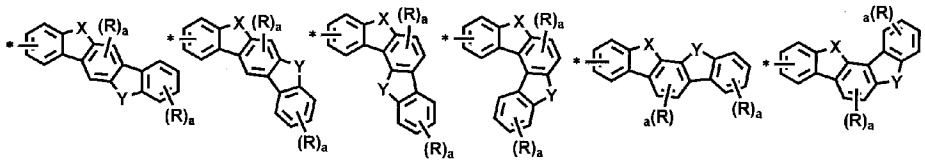
R_{21} to R_{23} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 5- to 30-membered heteroaryl group; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, 3- to 30-membered, alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen and sulfur; and

a represents 1 or 2; where a is 2, each of R is same or different.

[Claim 2] The organic electroluminescence compound according to claim 1, wherein the substituents of the substituted alkyl, the substituted aryl(ene), and the substituted heteroaryl(ene) in L_1, Ar_1 to Ar_3, R, R_1, R_2, and R_{21} to R_{23} each independently are at least one selected from the group consisting of deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with a halogen, a (C1-C30)alkoxy, a (C6-C30)aryl, a 3- to 30-membered heteroaryl unsubstituted or substituted with a (C6-C30)aryl, a (C3-C30)cycloalkyl, a 5- to 7-membered heterocycloalkyl, 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, a (C2-C30)alkenyl, a (C2-C30)alkynyl, a cyano, a carbazolyl, a di(C1-C30)alkylamino, a di(C6-C30)arylamino unsubstituted or substituted with a (C1-C30)alkyl, a (C1-C30)alkyl(C6-C30)arylamino, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, a (C1-C30)alkyl(C6-C30)aryl, a carboxyl, a nitro and a hydroxyl.

[Claim 3] The organic electroluminescence compound according to claim 1, wherein the moiety, 

is selected from the group consisting of the following structures:



wherein X, Y, R and a are as defined in claim 1.

[Claim 4] The organic electroluminescence compound according to claim 1, wherein L_1 represents a single bond, a substituted or unsubstituted (C6-C21)arylene group, or a substituted or unsubstituted 5- to 21-memebered heteroarylene group;

Ar_1 represents a substituted or unsubstituted (C6-C21)aryl group, or a substituted or unsubstituted 5- to 21-membered heteroaryl group;

Ar_2 and Ar_3 each independently represent hydrogen, a substituted or unsubstituted (C6-C21)aryl group, a substituted or unsubstituted 5- to 21-membered heteroaryl group, or $-NR_1R_2$;

R_1 and R_2 each independently represent hydrogen, or a substituted or unsubstituted (C6-C21)aryl group;

X and Y each independently represent -O-, -S-, $-N(R_{21})-$ or $-C(R_{22})(R_{23})-$; where X is $-C(R_{22})(R_{23})-$, Y is -O-, -S- or $-N(R_{21})-$, where X is -O- or -S-, Y is $-N(R_{21})-$ or $-C(R_{22})(R_{23})-$, and where X is $-N(R_{21})-$, Y is -O-, -S- or $-C(R_{22})(R_{23})-$;

R represents hydrogen: and

R_{21} to R_{23} each independently represent a substituted or unsubstituted (C1-C6)alkyl group, or a substituted or unsubstituted (C6-C21)aryl group.

[Claim 5] The organic electroluminescence compound according to claim 1, wherein L_1 represents a single bond; a (C6-C21)arylene group unsubstituted or substituted with a (C1-C6)alkyl; or an unsubstituted 5- to 21-memebered heteroarylene group;

Ar_1 represents a (C6-C21)aryl group unsubstituted or substituted with deuterium, a halogen, a (C1-C6)alkyl, a (C1-C6)alkoxy, a (C6-C21)aryl, a (C3-C21)cycloalkyl, a tri(C6-C12)arylsilyl, a cyano, a di(C6-C12)arylamino, or a hydroxyl; or a 5- to 21-memebered heteroaryl group unsubstituted or substituted with a (C6-C21)aryl;

Ar_2 and Ar_3 each independently represent hydrogen; an unsubstituted (C6-C21)aryl group; an unsubstituted 5- to 21-membered heteroaryl group; or $-NR_1R_2$;

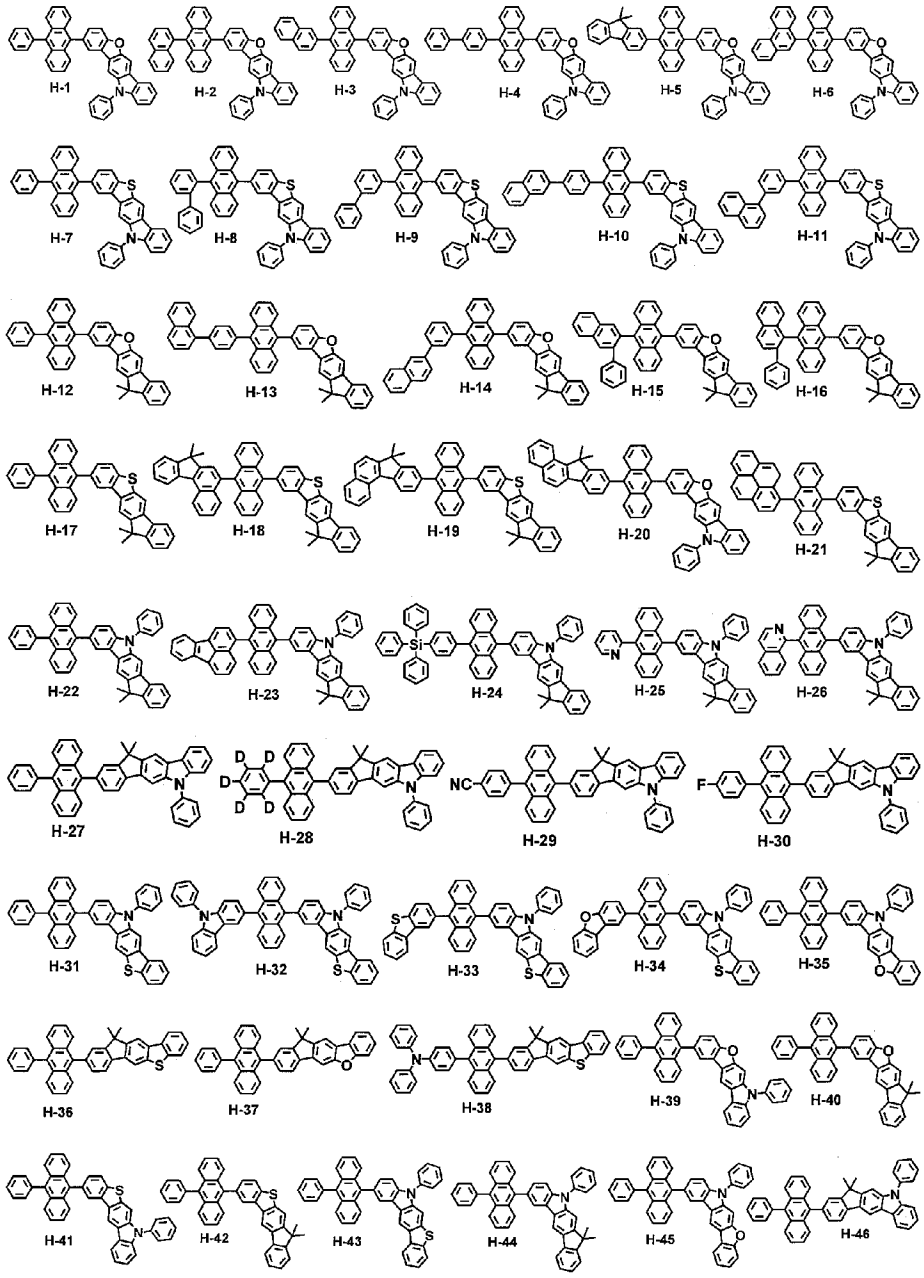
R_1 and R_2 each independently represent hydrogen, or a (C6-C21)aryl group unsubstituted or substituted with a (C1-C6)alkyl;

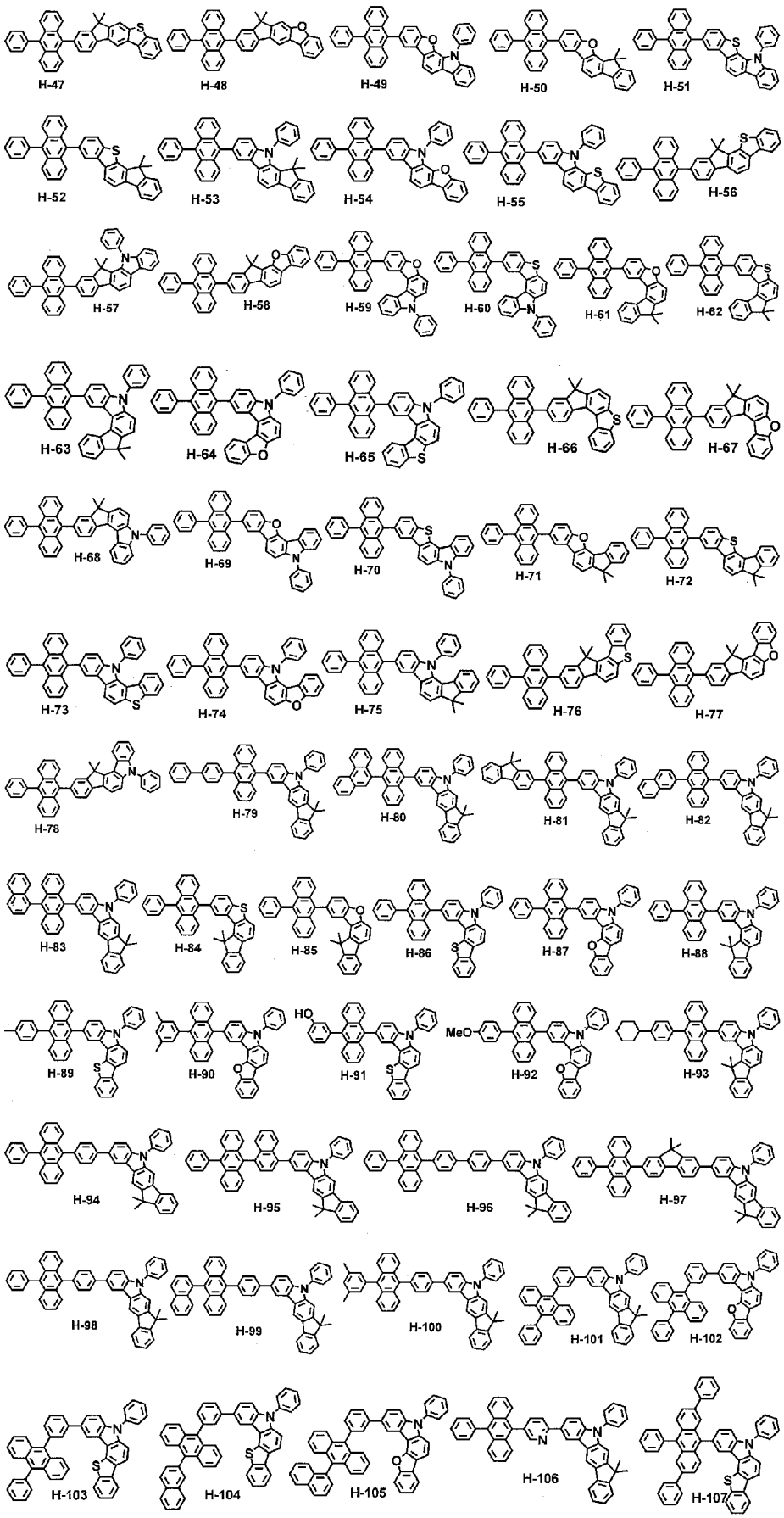
X and Y each independently represent -O-, -S-, -N(R_{21})- or -C(R_{22})(R_{23})-; where X is -C(R_{22})(R_{23})-, Y is -O-, -S- or -N(R_{21})-, where X is -O- or -S-, Y is -N(R_{21})- or -C(R_{22})(R_{23})-, and where X is -N(R_{21})-, Y is -O-, -S- or -C(R_{22})(R_{23})-;

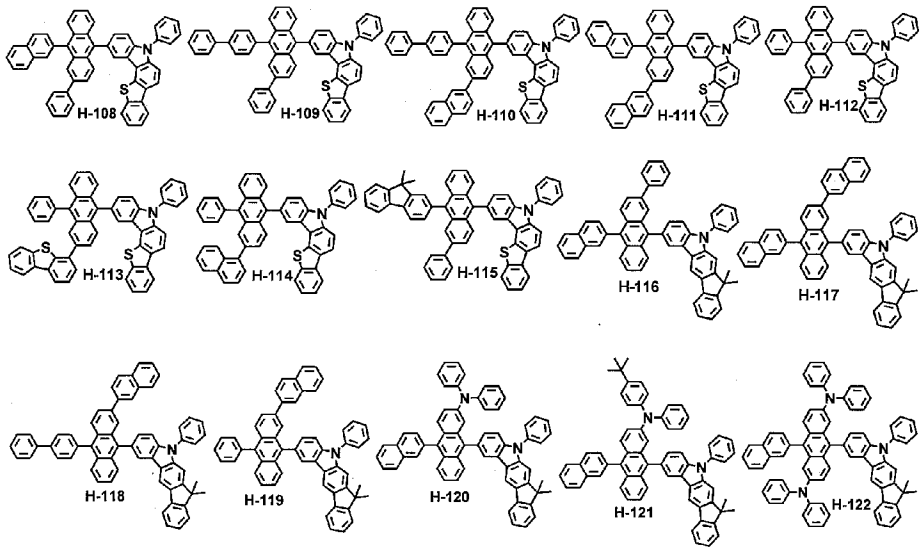
R represents hydrogen: and

R_{21} to R_{23} each independently represent an unsubstituted (C1-C6)alkyl group, or an unsubstituted (C6-C21)aryl group.

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




H-47
H-48
H-49
H-50
H-51
H-52
H-53
H-54
H-55
H-56
H-57
H-58
H-59
H-60
H-61
H-62
H-63
H-64
H-65
H-66
H-67
H-68
H-69
H-70
H-71
H-72
H-73
H-74
H-75
H-76
H-77
H-78
H-79
H-80
H-81
H-82
H-83
H-84
H-85
H-86
H-87
H-88
H-89
H-90
HO
H-91
MeO
H-92
H-93
H-94
H-95
H-96
H-97
H-98
H-99
H-100
H-101
H-102
H-103
H-104
H-105
H-106
H-107



[Claim 7] An organic electroluminescence device comprising the organic electroluminescence compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2013/009197

A. CLASSIFICATION OF SUBJECT MATTER

C07D 491/02 (2006.01) ***C07D 495/02 (2006.01)*** ***C07D 307/91 (2006.01)*** ***C07D 333/76 (2006.01)*** ***C07D 209/86 (2006.01)***
C07D 401/10 (2006.01) ***C07F 7/10 (2006.01)*** ***C09K 11/06 (2006.01)*** ***H01L 27/32 (2006.01)*** ***H01L 51/54 (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: databases Registry and CAplus, structure search based on claim 1.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

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

* Special categories of cited documents:
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"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
13 January 2014	13 January 2014
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 Facsimile No.: +61 2 6283 7999	Chetan Makani AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832896

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/KR2013/009197**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2141214 A2 (GRACEL DISPLAY INC.) 06 January 2010 See examples 55 and 56 on page 16, title, abstract, claims	1–7
X	WO 2010/114243 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 07 October 2010 See examples 14 and 20 on page 11 and example 37 on page 12,title, abstract, claims	1–7
X	WO 2010/114256 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 07 October 2010 See examples 56 and 57 page 10, title, abstract, claims	1–7
X	WO 2010/114263 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 07 October 2010 See examples 199 and 200 on page 17, title, abstract, claims	1–7
X	WO 2010/114266 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 07 October 2010 See examples 62 and 67 page 10, title, abstract, claims	1–7
X	WO 2010/137285 A1 (IDEMITSU KOSAN CO., LTD.) 02 February 2010 & EP 2436679 A1 (IDEMITSU KOSAN CO., LTD.) 4 April 2012 See many compounds see for instance all compounds on page 15 inter alia, title, abstract, claims	1–7
X	WO 2011/115378 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 22 September 2011 See compound 33 on page 10, title, abstract, claims	1–7
X	US 2012/0097932 A1 (KIM et al) 26 April 2012 See compound 12 on page 13, title, abstract, claims	1–7
X	EP 2189508 A2 (GRACEL DISPLAY INC.) 26 May 2010 See compound H-111 on page 77, title, abstract, claims	1–7
P,X	KR 10-2012-0120886 A (CS ELSOLAR CO., LTD.) 02 November 2012 See compounds 4, 18, 32, 46, 70 and 79 from pages 6 to 10, title, abstract, claims	1–5, 7
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INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/KR2013/009197**

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.

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		EP 2256176 A1	01 Dec 2010
		JP 2010059144 A	18 Mar 2010
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		WO 2011115378 A1	22 Sep 2011

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

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/KR2013/009197**

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**
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		WO 2010058995 A1	27 May 2010
KR 10-2012-0120886 A	02 Nov 2012	None	
CN 103187531 A	03 Jul 2013	None	
KR 10-2013-0098228 A	04 Sep 2013	None	

End of Annex

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