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(54) Title: MULTI-COMPONENT HOST MATERIAL AND AN ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

(57) Abstract: The present invention relates to a multi-component host material and an organic electroluminescent device comprising the same. By comprising a specific combination of the multi-component host compounds, the organic electroluminescent device according to the present invention can provide high luminous efficiency and excellent lifespan characteristics.

Description

Title of Invention: MULTI-COMPONENT HOST MATERIAL AND AN ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

Technical Field

[1] The present invention relates to a multi-component host material and an organic electroluminescence device comprising the same.

Background Art

[2] An electroluminescence 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] An organic EL device (OLED) is a device changing electronic energy to light by applying electricity to an organic electroluminescent material, and generally has a structure comprising an anode, a cathode, and an organic layer between the anode and the cathode. The organic layer of an organic EL device may be comprised of a hole injection layer, a hole transport layer, an electron blocking layer, a light-emitting layer (which comprises host and dopant materials), an electron buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, etc., and the materials used for the organic layer are categorized by their functions in hole injection material, hole transport material, electron blocking material, light-emitting material, electron buffer material, hole blocking material, electron transport material, electron injection material, etc. In the organic EL device, due to an application of a voltage, holes are injected from the anode to the light-emitting layer, electrons are injected from the cathode to the light-emitting layer, and excitons of high energies are formed by a recombination of the holes and the electrons. By this energy, luminescent organic compounds reach an excited state, and light emission occurs by emitting light from energy due to the excited state of the luminescent organic compounds returning to a ground state.

[4] The most important factor determining luminous efficiency in an organic EL device is light-emitting materials. A light-emitting material must have high quantum efficiency, high electron and hole mobility, and the formed light-emitting material layer must be uniform and stable. Light-emitting materials are categorized into blue, green, and red light-emitting materials dependent on the color of the light emission, additionally yellow or orange light-emitting materials. In addition, light-emitting materials

can also be categorized into host and dopant materials according to their functions. Recently, the development of an organic EL device providing high efficiency and long lifespan is an urgent issue. In particular, considering EL characteristic requirements for a middle or large-sized panel of OLED, materials showing better characteristics than conventional ones must be urgently developed. The host material which acts as a solvent in a solid state and transfers energy needs to have high purity and a molecular weight appropriate for vacuum deposition. Furthermore, the host material needs to have high glass transition temperature and high thermal degradation temperature to achieve thermal stability, high electro-chemical stability to achieve long lifespan, ease of forming amorphous thin film, good adhesion to materials of adjacent layers, and non-migration to other layers.

[5] A light-emitting material can be used as a combination of a host and a dopant to improve color purity, luminous efficiency, and stability. Generally, an EL device having excellent characteristics has a structure comprising a light-emitting layer formed by doping a dopant to a host. Since host materials greatly influence the efficiency and lifespan of the EL device when using a dopant/host material system as a light emitting material, their selection is important.

[6] Korean Patent Appln. Laying-Open No.10-2008-0080306 discloses an organic electroluminescent device using a compound wherein two carbazoles are linked via an arylene as a host material, and International Publication No. WO 2013/112557 A1 discloses an organic electroluminescent device using a compound wherein a biscarbazole is linked to a carbazole via an arylene as a host material. However, the references fail to disclose an organic electroluminescent device using a compound wherein a biscarbazole comprising an aryl is linked to a dibenzothiophene or dibenzofuran directly or via an arylene, and a compound wherein a carbazole is linked to a heteroaryl directly or via an arylene as a multi-component host.

[7]

Disclosure of Invention

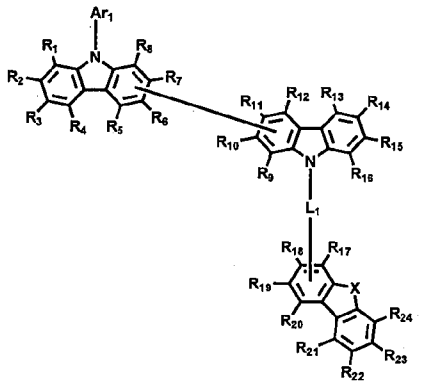
Technical Problem

[8] The objective of the present invention is to provide an organic electroluminescent device having improved lifespan characteristics.

Solution to Problem

[9] The present inventors found that the above objective can be achieved by an organic electroluminescent device comprising at least one light-emitting layer between an anode and a cathode, wherein the light-emitting layer comprises a host and a phosphorescent dopant, the host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by the

following formula 1, and a second host compound is represented by the following formula 2:

[10] 

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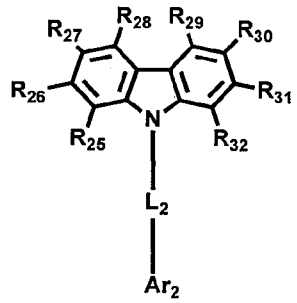
[11] 

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

[12] wherein

[13] Ar_1 represents a substituted or unsubstituted (C6-C30)aryl;

[14] L_1 and L_2 each independently represent a single bond, or a substituted or unsubstituted (C6-C30)arylene;

[15] X represents O or S;

[16] R_1 to R_{32} each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; 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;

[17] Ar_2 represents a substituted or unsubstituted 3- to 30-membered heteroaryl; and

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

[19]

Advantageous Effects of Invention

[20] According to the present invention, an organic electroluminescent device having high efficiency and long lifespan is provided, and it is possible to manufacture a display device or a lighting device using the organic electroluminescent device.

[21]

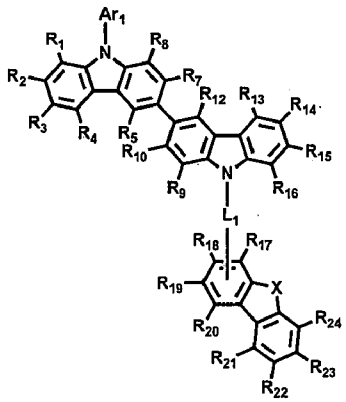
Mode for the Invention

[22] 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.

[23] Hereinafter, the organic electroluminescent device comprising the organic electroluminescent compounds of formulae 1 and 2 will be described in detail.

[24] The compound represented by formula 1 can be represented by formula 3, 4, 5, or 6:

[25]



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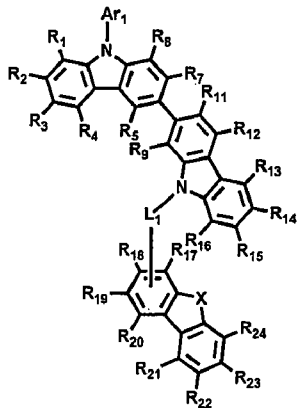
[26]



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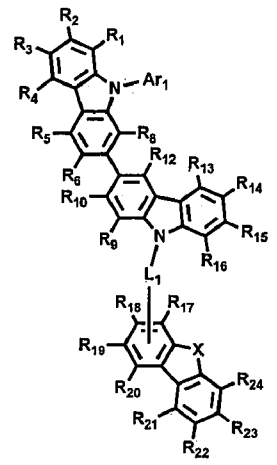
[27] 

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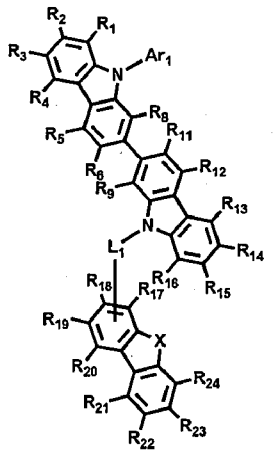
[28] 

----------(6)

[29] wherein

[30] Ar_1, L_1, X, and R_1 to R_{24} are as defined in formula 1.

[31] In formula 1 above, L_1 represents a single bond, or a substituted or unsubstituted (C6-C30)arylene, preferably represents a single bond, or a substituted or unsubstituted (C6-C15)arylene, and more preferably represents a single bond, or an unsubstituted (C6-C15)arylene.

[32] In formula 1 above, X represents O or S.

[33] In formula 1 above, Ar_1 represents a substituted or unsubstituted (C6-C30)aryl, preferably represents a substituted or unsubstituted (C6-C20)aryl, and more preferably represents a (C6-C20)aryl unsubstituted or substituted with a (C6-C20)aryl.

[34] In formula 1 above, R_1 to R_{24} each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsub-

stituted mono- or di- (C6-C30)arylamino; 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, and preferably, each independently represent hydrogen.

[35] In formula 2 above, L_2 represents a single bond, or a substituted or unsubstituted (C6-C30)arylene, preferably represents a single bond, or a substituted or unsubstituted (C6-C15)arylene, and more preferably represents a single bond, or a (C6-C15)arylene unsubstituted or substituted with a tri(C6-C15)arylsilyl.

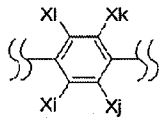
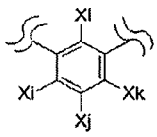
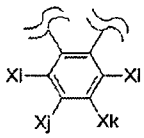
[36] In formula 2 above, Ar_2 represents a substituted or unsubstituted 3- to 30-membered heteroaryl, preferably represents a substituted or unsubstituted 5- to 11-membered nitrogen-containing heteroaryl, and more preferably represents a 6- to 10-membered nitrogen-containing heteroaryl unsubstituted or substituted with an unsubstituted (C6-C18)aryl, a (C6-C12)aryl substituted with a cyano, a (C6-C12)aryl substituted with a (C1-C6)alkyl, a (C6-C12)aryl substituted with a tri(C6-C12)arylsilyl, or a 6- to 15-membered heteroaryl.

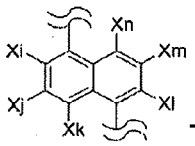
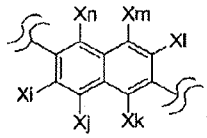
[37] In addition, Ar_2 may represent a monocyclic heteroaryl selected from the group consisting of pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, and pyridazinyl, or a fused heteroaryl selected from the group consisting of benzoimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, naphthyridinyl, quinoxalinyl, carbazolyl, and phenanthrydinyl, and preferably may represent triazinyl, pyrimidinyl, quinolyl, isoquinolyl, quinazolinyl, naphthyridinyl, or quinoxalinyl.

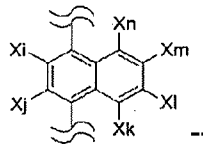
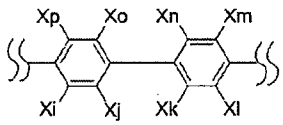
[38] In formula 2 above, R_{25} to R_{32} each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; 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, and preferably, each independently represent hydrogen, a cyano, a substituted or unsubstituted (C6-C15)aryl, a substituted or unsubstituted 10- to 20-membered heteroaryl, or a substituted or unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C6-C20) aromatic ring, and more preferably, each

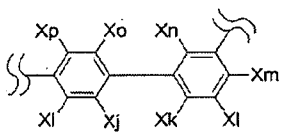
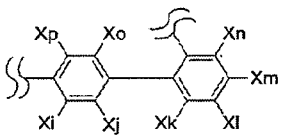
independently represent hydrogen, a cyano, a (C6-C15)aryl unsubstituted or substituted with a tri(C6-C10)arylsilyl, a 10- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted benzene, a substituted or unsubstituted indole, a substituted or unsubstituted benzoindole, a substituted or unsubstituted indene, a substituted or unsubstituted benzofuran, or a substituted or unsubstituted benzothiophene.

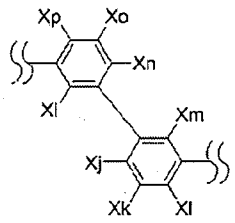
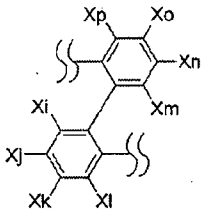
[39] In addition, L_1 and L_2 each independently can be represented by one of the following formulae 7 to 19:

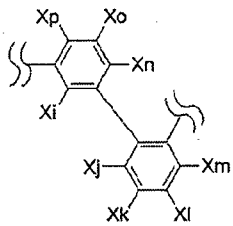
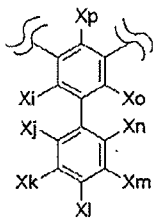
[40]  ----------(7)  ----------(8)  ----------(9)

[41]  ----------(10)  ----------(11)

[42]  ----------(12)  ----------(13)

[43]  ----------(14)  ----------(15)

[44]  ----------(16)  ----------(17)

[45]  ----------(18)  ----------(19)

[46] wherein

[47] Xi to Xp each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or un-

substituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; 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.

[48] Herein, "(C1-C30)alkyl" is meant to be a linear or branched alkyl having 1 to 30 carbon atoms, in which the number of carbon atoms is preferably 1 to 20, more preferably 1 to 10, 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, 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, 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 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, preferably 5 to 7, 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 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.; "3- to 30-membered heteroaryl" is an aryl having 3 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, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, benzoindolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc.; "nitrogen-containing 5- to 30-membered heteroaryl" is an aryl having 5 to 30 ring backbone atoms, preferably 5 to 20, and more preferably 5 to 15, including at least one heteroatom, N; 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 pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl including benzoimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenanthridinyl, etc. Further, "halogen" includes F, Cl, Br, and I.

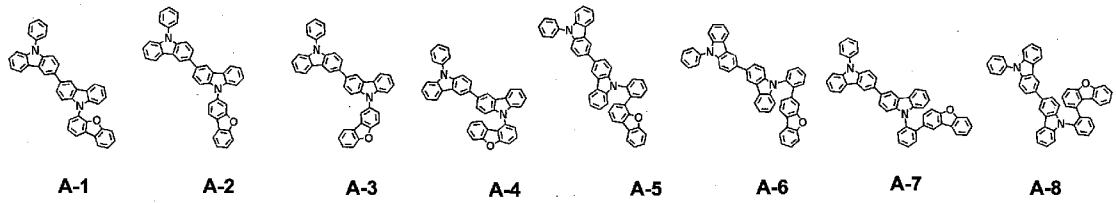
[49] Herein, "substituted" in the expression "substituted or unsubstituted" means that a hydrogen atom in a certain functional group is replaced with another atom or group, i.e. a substituent. The substituents of the substituted alkyl, the substituted alkenyl, the substituted alkynyl, the substituted cycloalkyl, the substituted aryl(ene), the substituted heteroaryl, the substituted trialkylsilyl, the substituted triarylsilyl, the substituted dialkylarylsilyl, the substituted mono- or di- arylamino, and the substituted mono- or polycyclic, alicyclic or aromatic ring in Ar_1, Ar_2, L_1, L_2, and R_1 to R_{32} in formulae 1 and 2 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 cyano, a 3- to 30-membered heteroaryl, or a tri(C6-C30)arylsilyl, 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 cyano, a (C1-C6)alkyl, a 5- to

15-membered heteroaryl, a (C6-C18)aryl, a (C6-C18)aryl substituted with a cyano, a (C6-C18)aryl substituted with a tri(C6-C12)arylsilyl, a tri(C6-C12)arylsilyl, and a (C1-C6)alkyl(C6-C18)aryl.

[50] In formulae 1 and 2, the triarylsilyl is preferably a triphenylsilyl.

[51] The first host compound represented by formula 1 includes the following compounds, but is not limited thereto:

[52]



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

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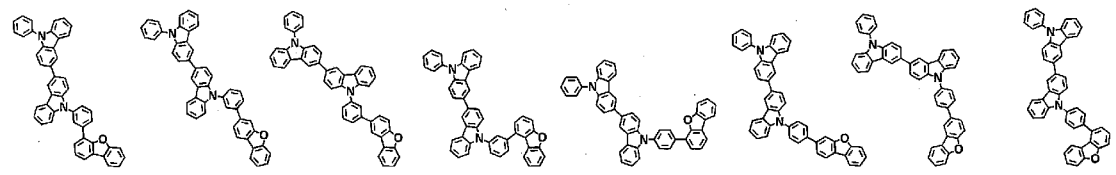

A-9 A-10 A-11 A-12 A-13 A-14 A-15 A-16

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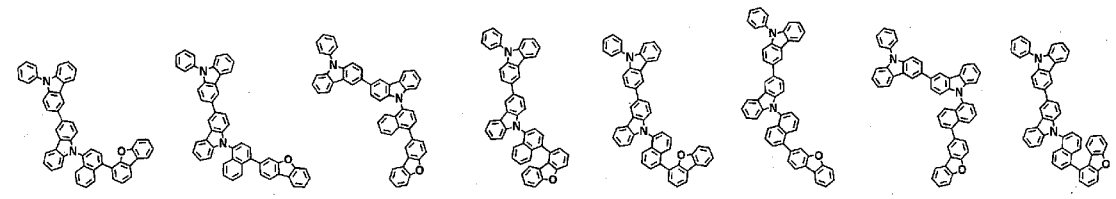

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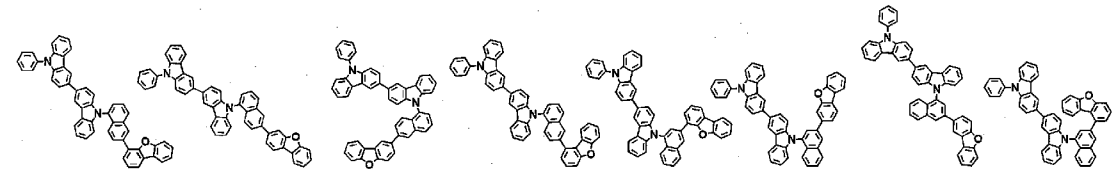

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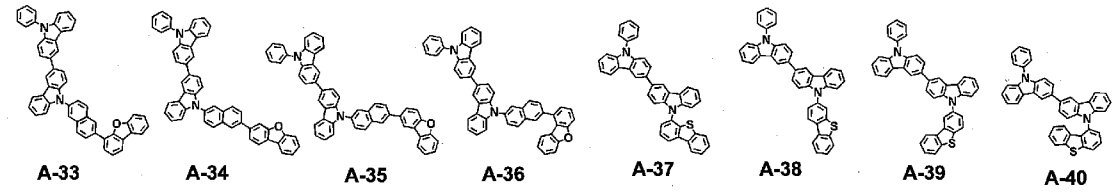

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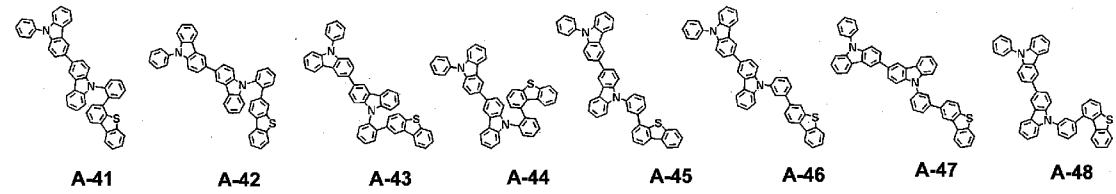

A-41 A-42 A-43 A-44 A-45 A-46 A-47 A-48

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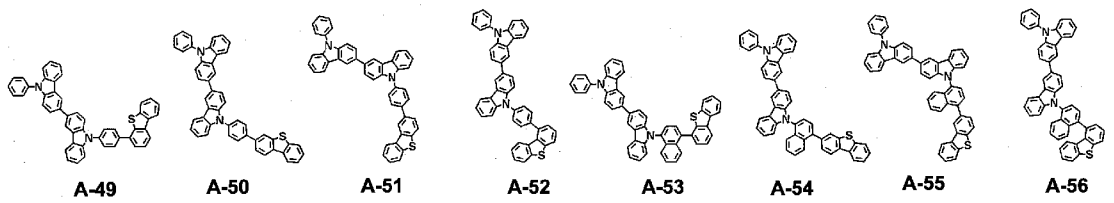

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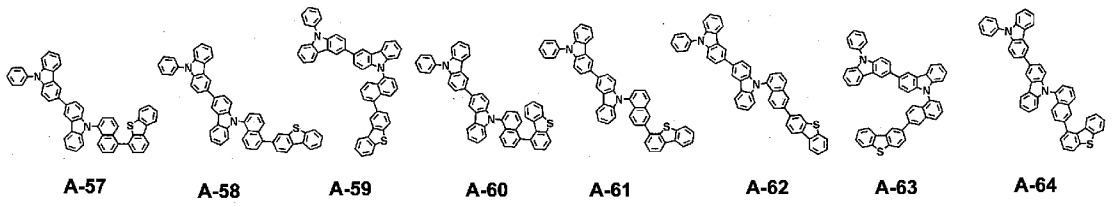

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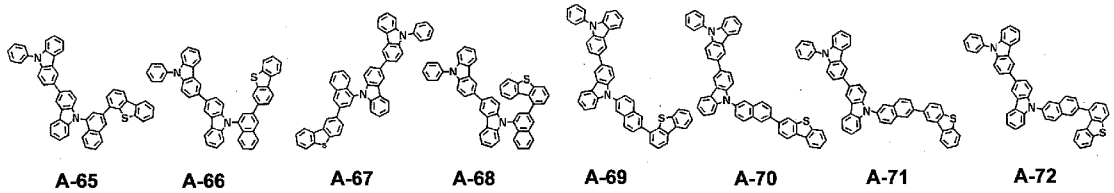

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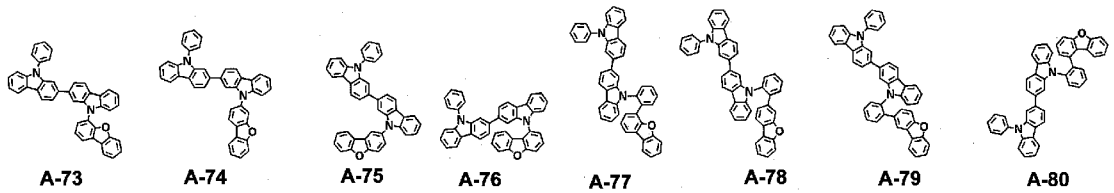

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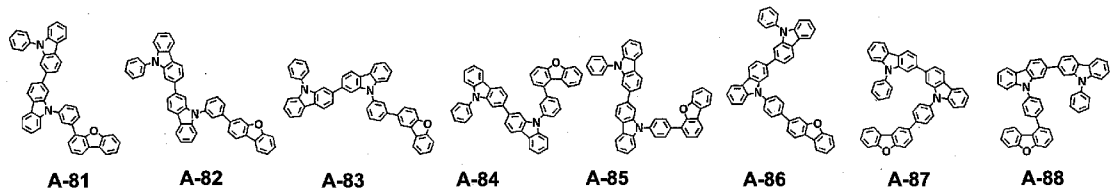

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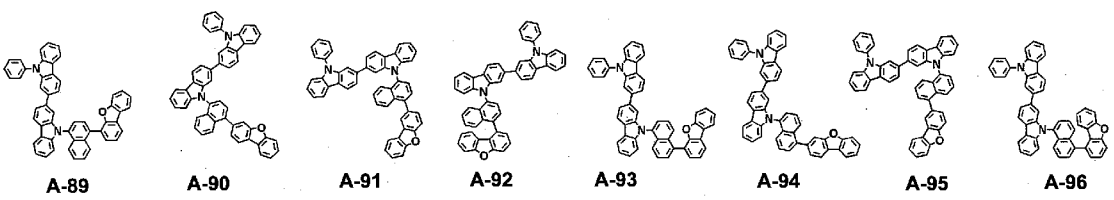

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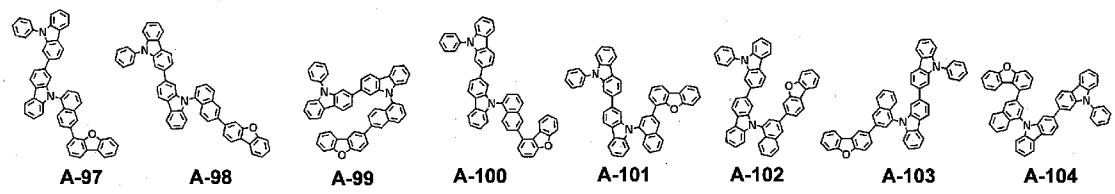

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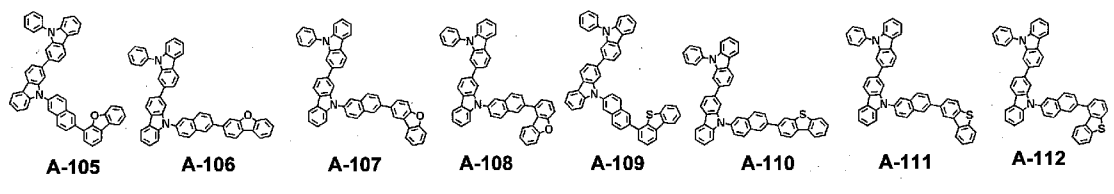

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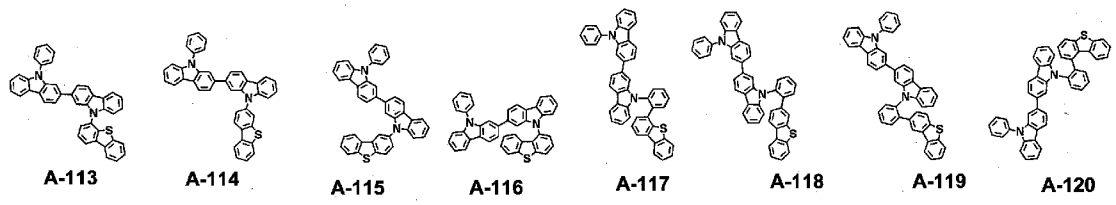

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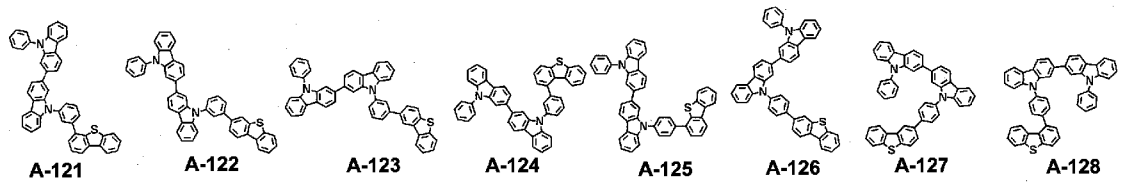

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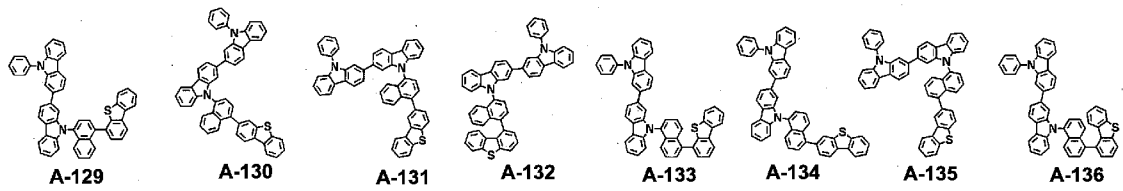

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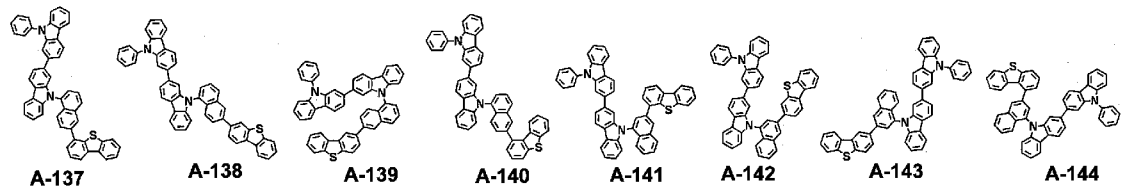

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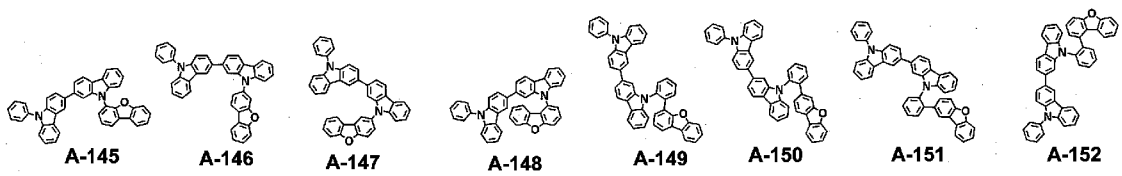

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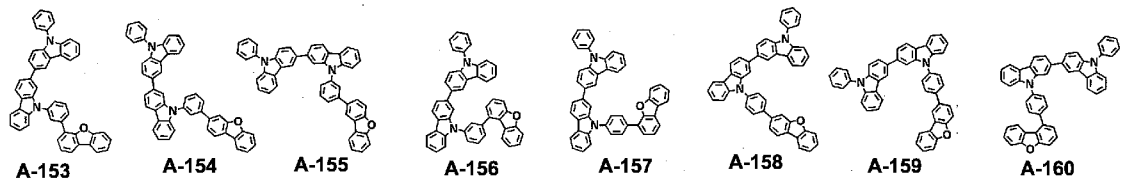

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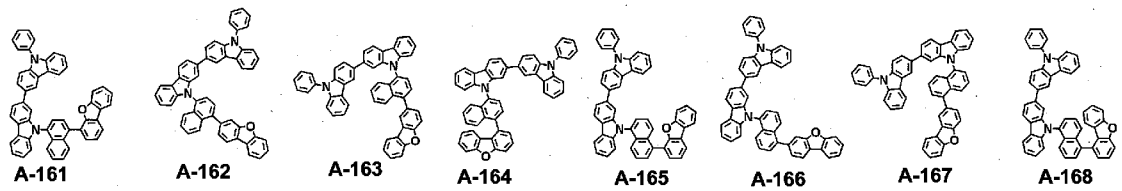

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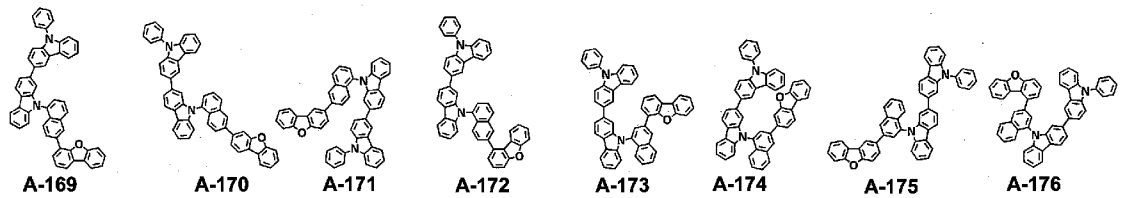

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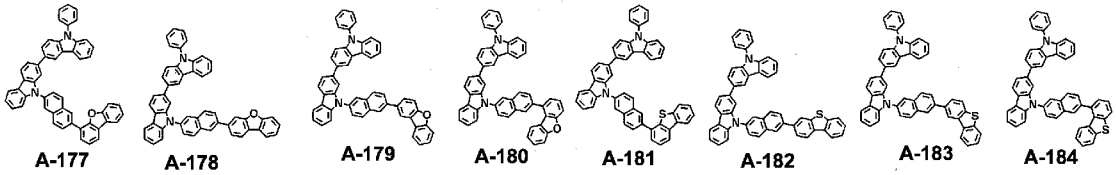

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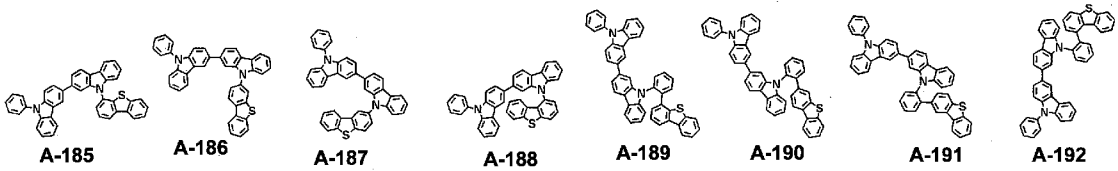

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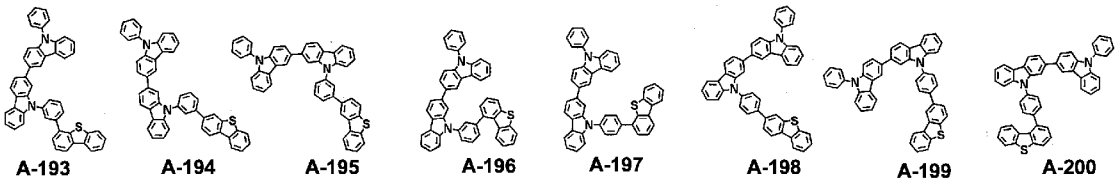

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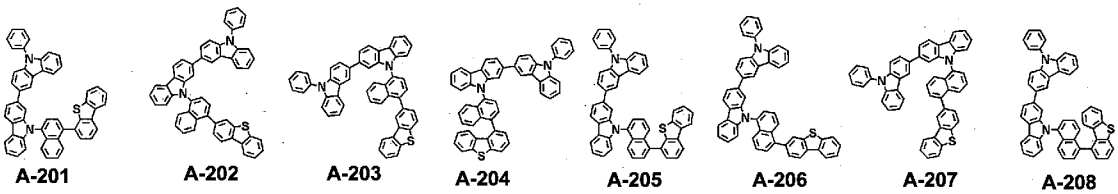

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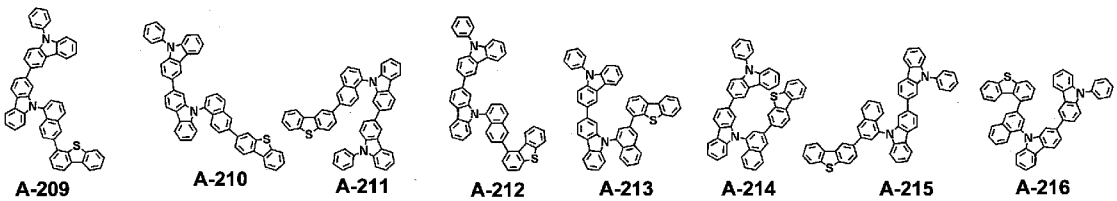

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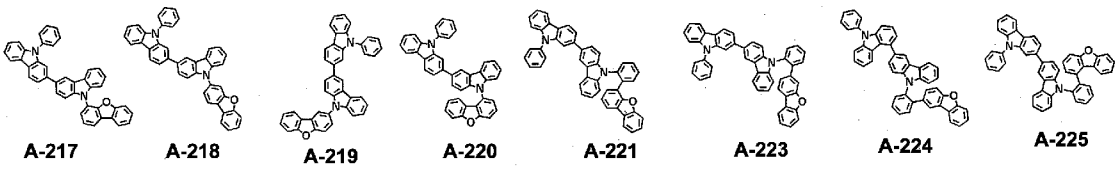

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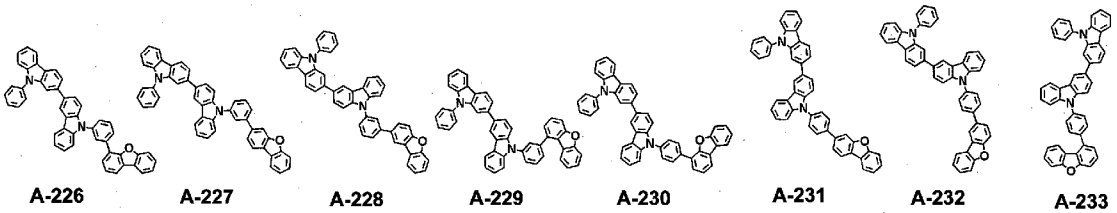

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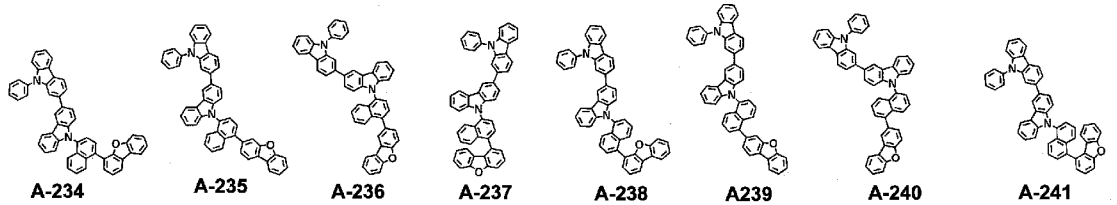

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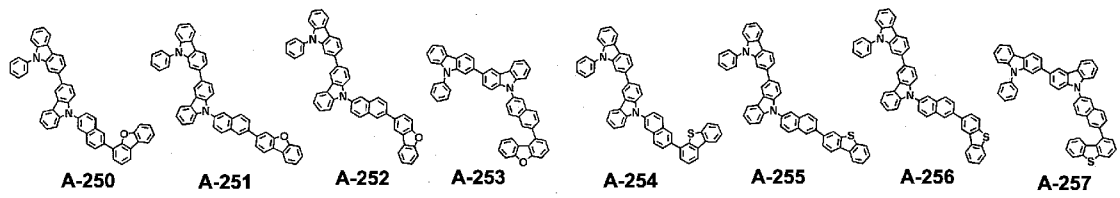

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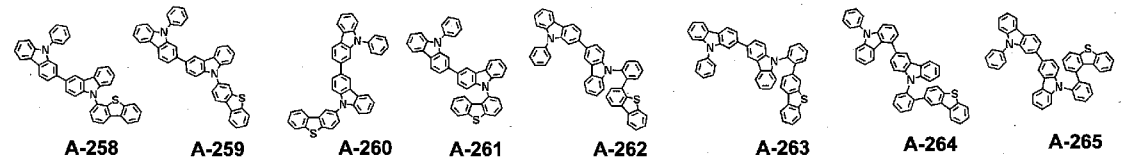

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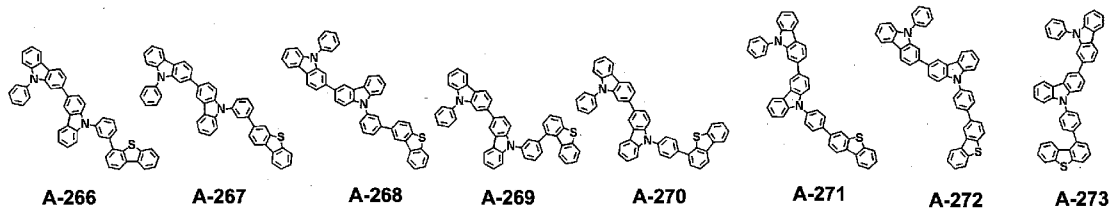

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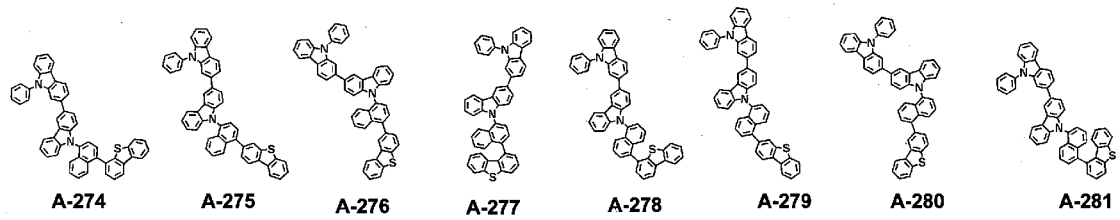

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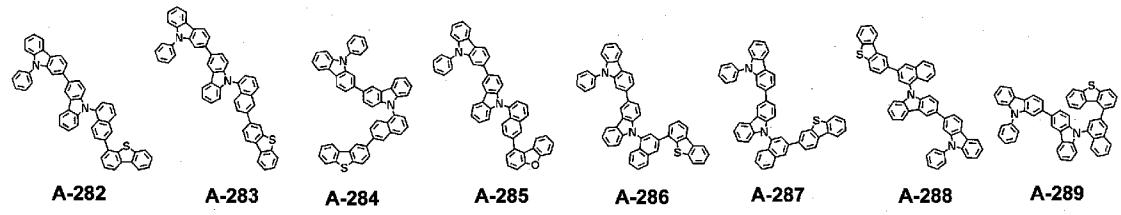

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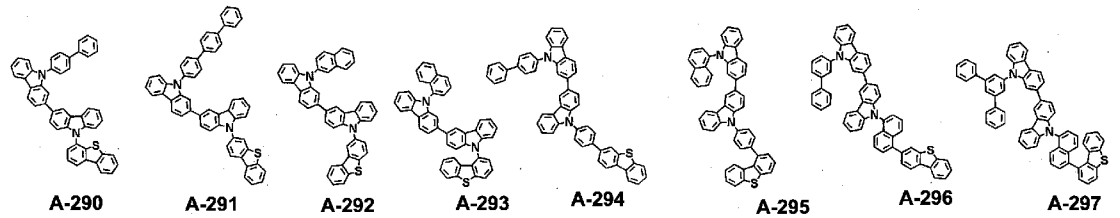

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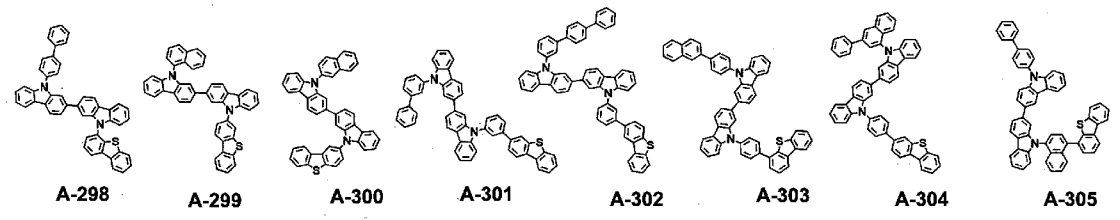

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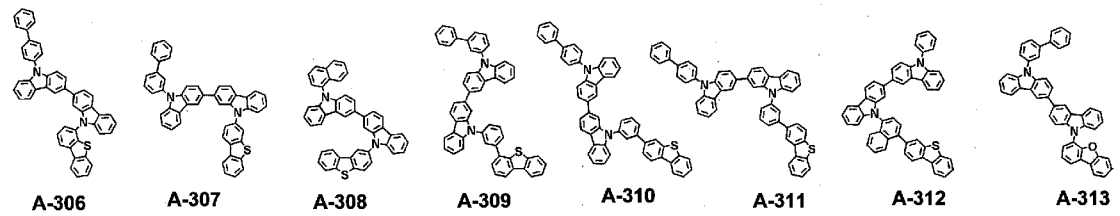

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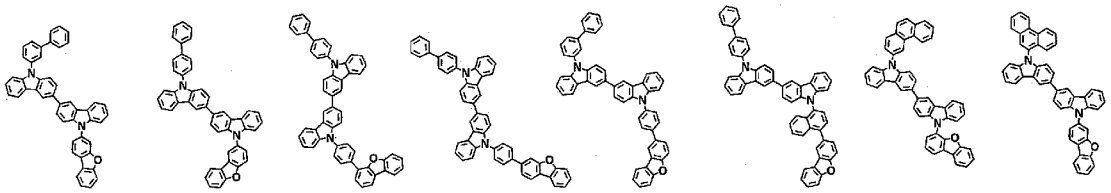
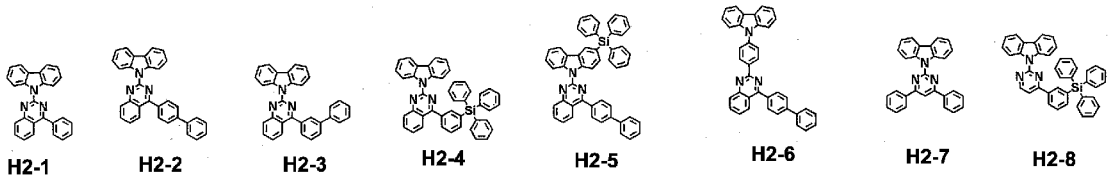


[91] The second host compound represented by formula 2 includes the following compounds, but is not limited thereto:

[92]



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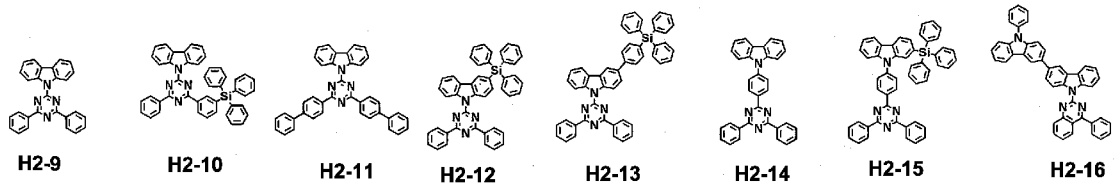

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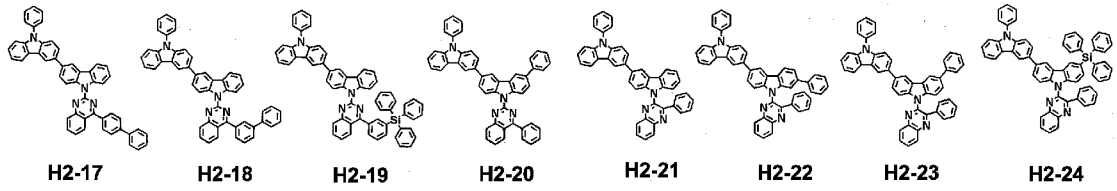

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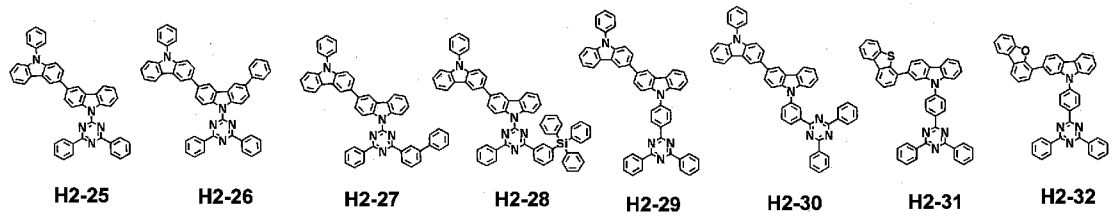

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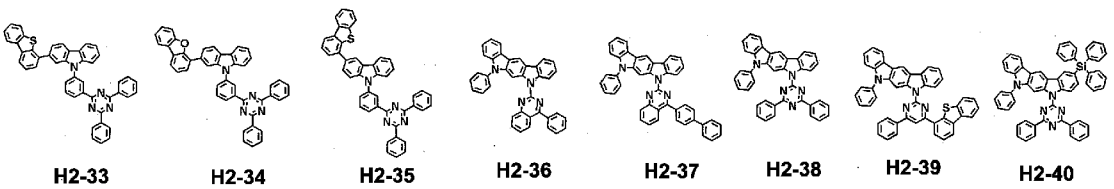

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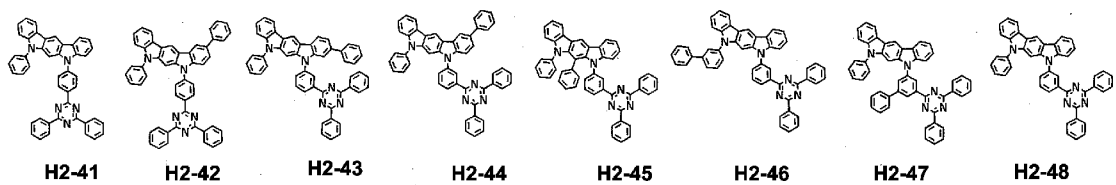

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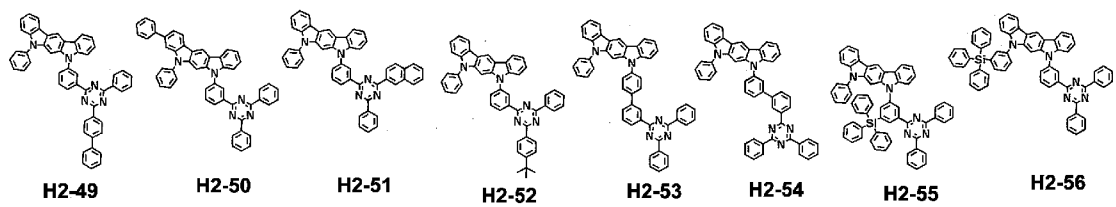

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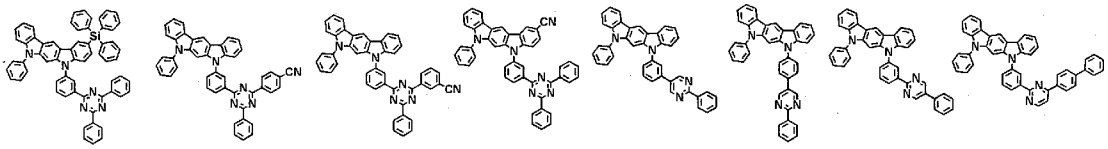
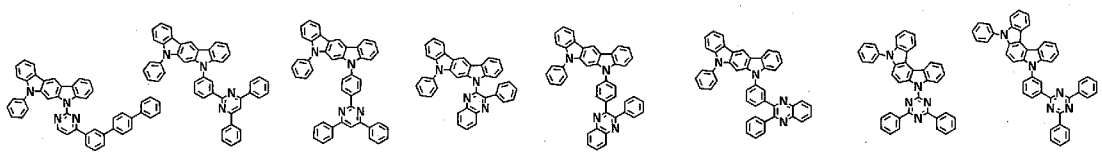


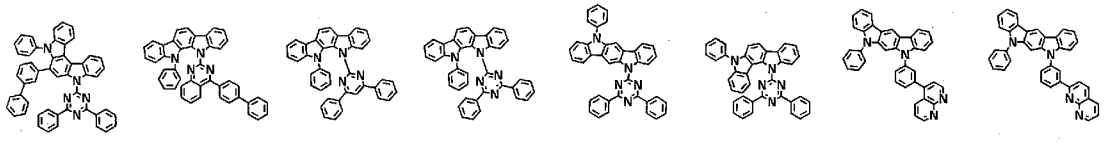
H2-57 H2-58 H2-59 H2-60 H2-61 H2-62 H2-63 H2-64

[100]



H2-65 H2-66 H2-67 H2-68 H2-69 H2-70 H2-71 H2-72

[101]



H2-73 H2-74 H2-75 H2-76 H2-77 H2-78 H2-79 H2-80

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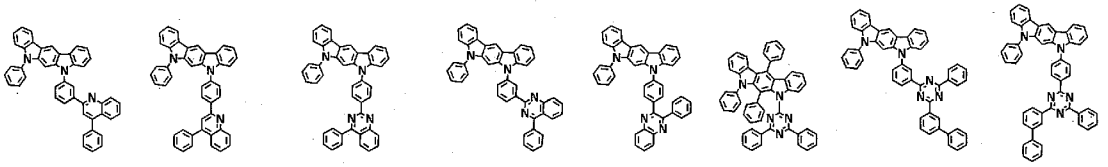

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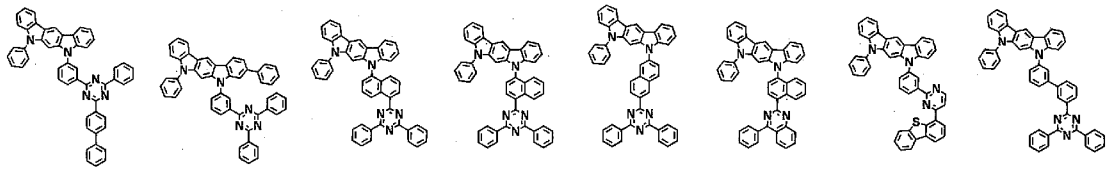
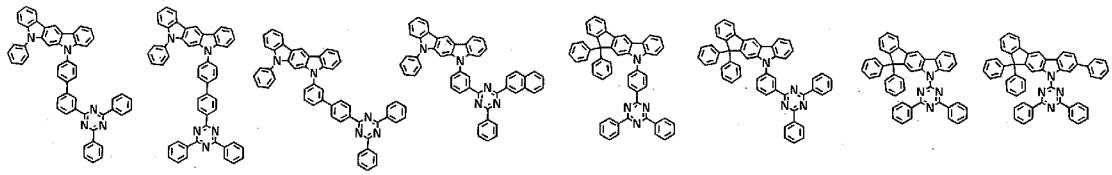


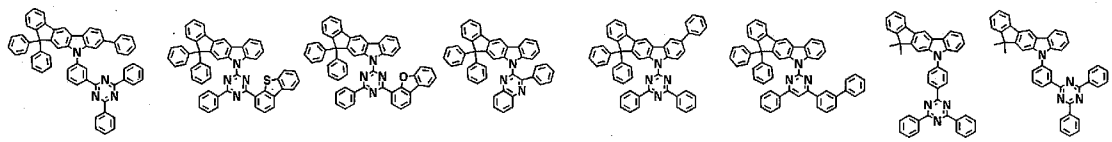
H2-89 H2-90 H2-91 H2-92 H2-93 H2-94 H2-95 H2-96

[104]



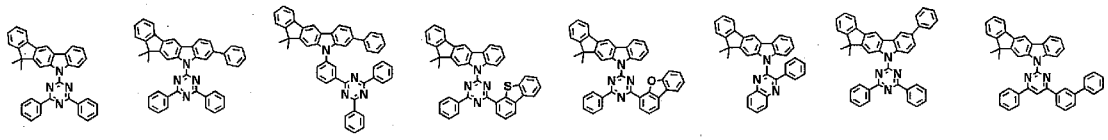
H2-97 H2-98 H2-99 H2-100 H2-101 H2-102 H2-103 H2-104

[105]



H2-105 H2-106 H2-107 H2-108 H2-109 H2-110 H2-111 H2-112

[106]



H2-113 H2-114 H2-115 H2-116 H2-117 H-118 H-119 H2-120

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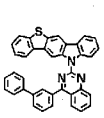
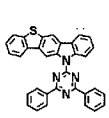
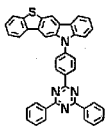
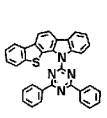
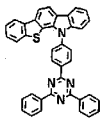

H2-121


H2-122


H2-123


H2-124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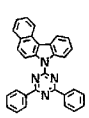
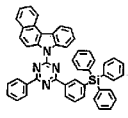

H2-126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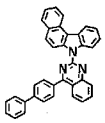
H2-128

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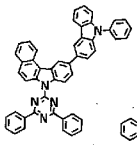
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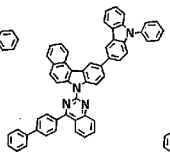
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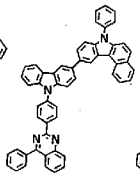
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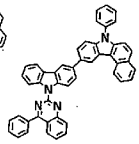
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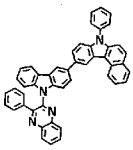
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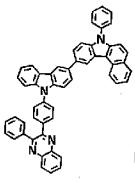
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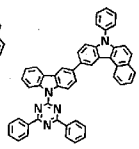
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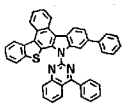
H2-136

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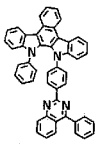
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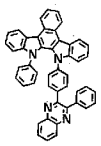
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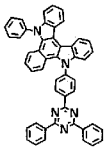
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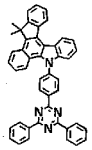
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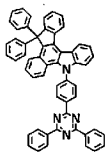
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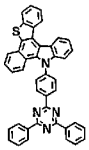
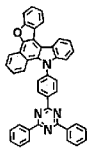

H2-142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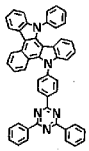
H2-144

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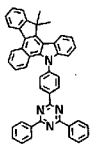
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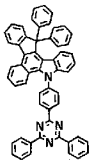
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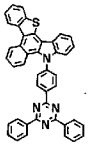
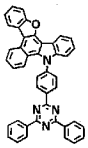
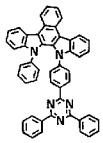

H2-147


H2-148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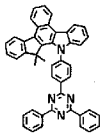
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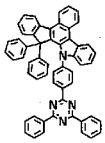
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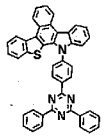
H-152

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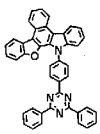
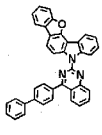
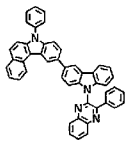
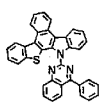
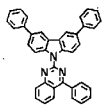
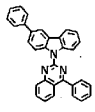

H2-153

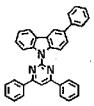

H2-154

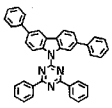

H2-155


H2-156


H2-157


H2-158


H2-159


H2-160

[112]

H2-161

H2-162

H2 - 163

H2-164

H2-165

H2-166

H2-167

H2-168

[113]

H2-169

H2-170

H2-171

H2-172

H2-173

H2-174

H2-175

H2-176

[114]

H2-177

H2-178

H2-179

H2-180

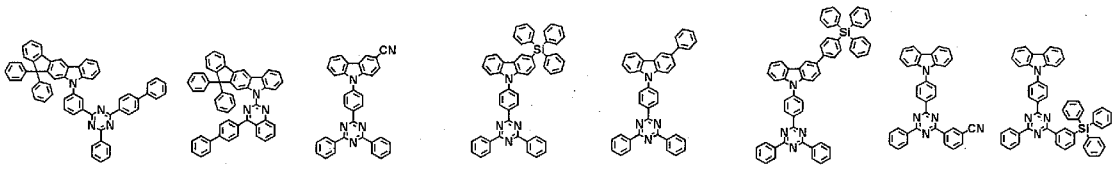
H2-181

H2-182

H2-183

H2-184

[115]



H2-185 H2-186 H2-187 H2-188 H2 -189 H2-190 H2-191 H2-192

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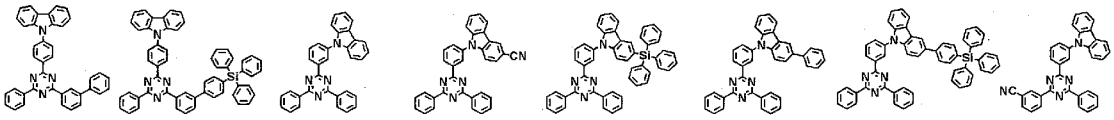

H2-193 H2-194 H2-195 H2-196 H2-197 H2-198 H2-199 H2-200

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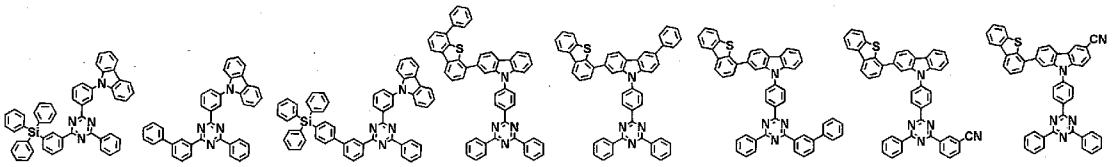
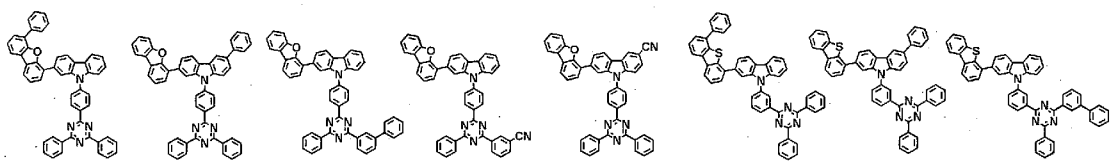


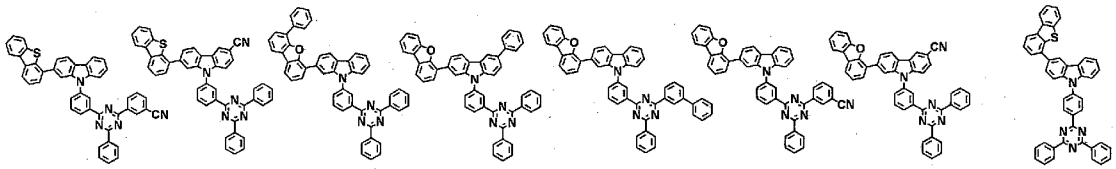
H2-201 H2-202 H2-203 H2-204 H2-205 H2-206 H2-207 H2-208

[118]



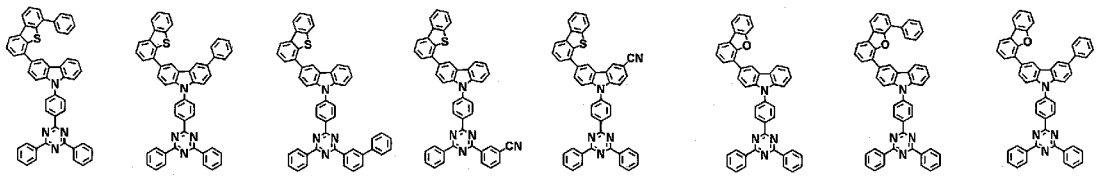
H2-209 H2-210 H2-211 H2-212 H2-213 H2-214 H2-215 H2-216

[119]



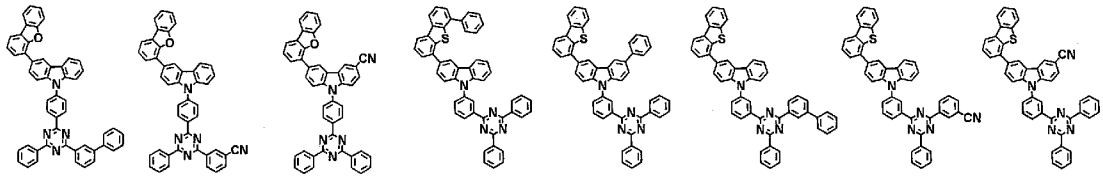
H2 -217 H2-218 H2-219 H2-220 H2-221 H2-222 H2-223 H2-224

[120]



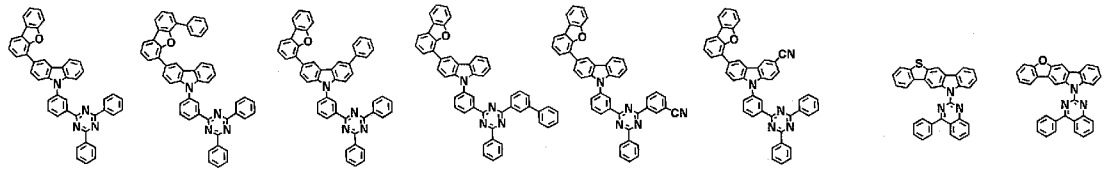
H2-225 H2-226 H2-227 H2-228 H2-229 H2-230 H2-231 H2-232

[121]



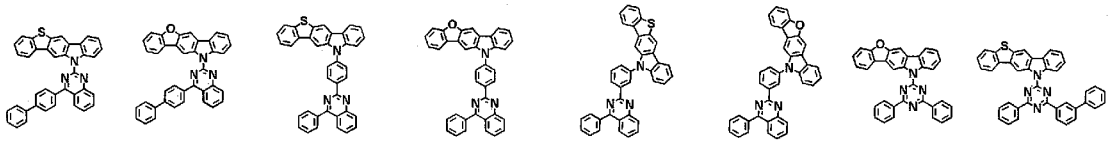
H2-233 H2-234 H2-235 H2-236 H2-237 H2-238 H2-239 H2-240

[122]



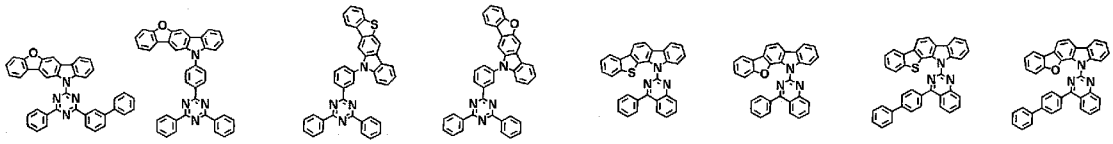
H2-241 H2-242 H2-243 H2-244 H2-245 H2-246 H2-247 H2-248

[123]



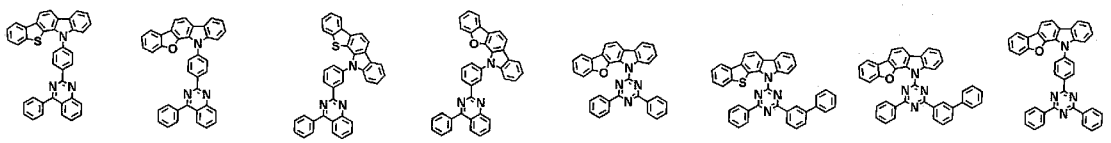
H2-249 H2-250 H2-251 H2-252 H2-253 H2-254 H2-255 H2-256

[124]



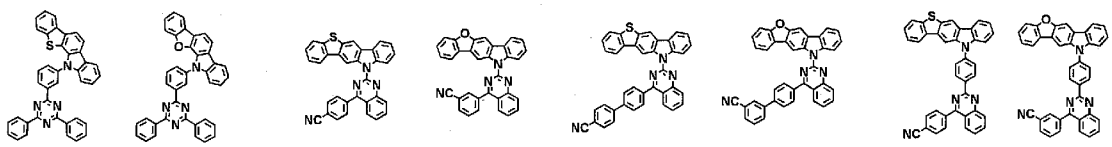
H2-257 H2-258 H2-259 H2-260 H2-261 H2-262 H2-263 H2-264

[125]



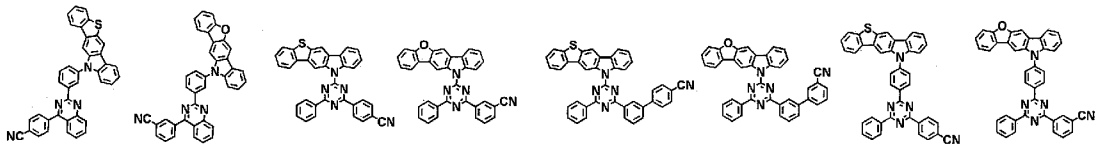
H2-265 H2-266 H2-267 H2-268 H2-269 H2-270 H2-271 H2-272

[126]



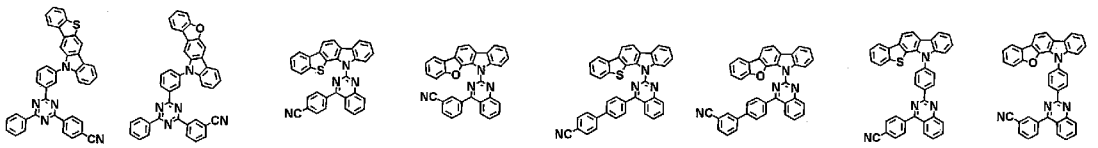
H2-273 H2-274 H2-275 H2-276 H2-277 H2-278 H2-279 H2-280

[127]



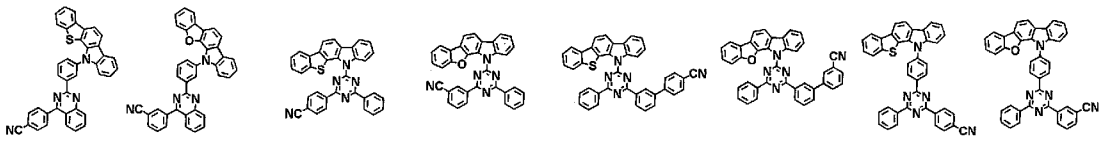
H2-281 H2-282 H2-283 H2-284 H2-285 H2-286 H2-287 H2-288

[128]



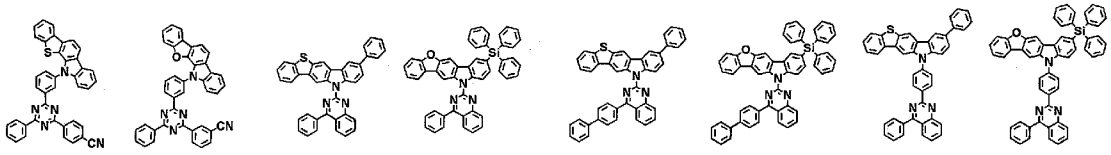
H2-289 H2-290 H2-291 H2-292 H2-293 H2-294 H2-295 H2-296

[129]



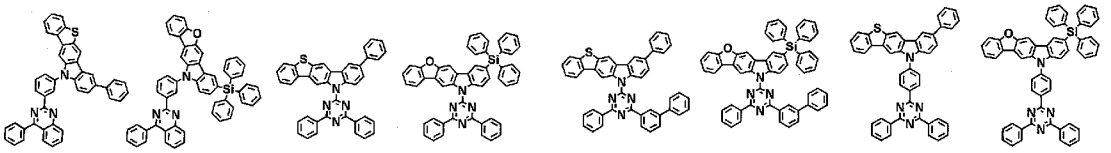
H2-297 H2-298 H2-299 H2-300 H2-301 H2-302 H2-303 H2-304

[130]



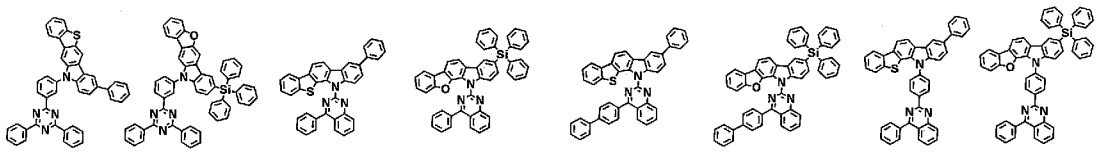
H2-305 H2-306 H2-307 H2-308 H2-309 H2-310 H2-311 H2-312

[131]



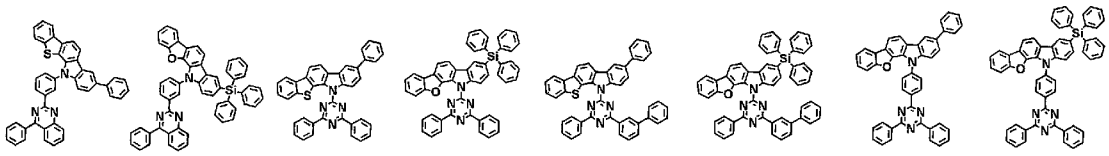
H2-313 H2-314 H2-315 H2-316 H2-317 H2-318 H2-319 H2-320

[132]



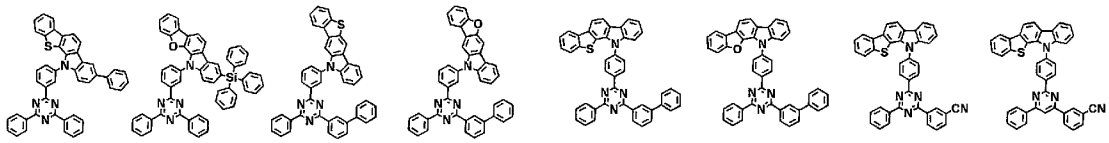
H2-321 H2-322 H2-323 H2-324 H2-325 H2-326 H2-327 H2-328

[133]



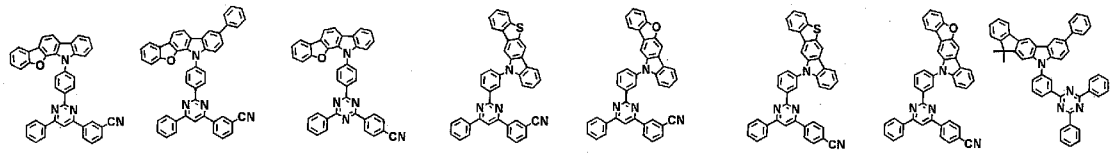
H2-329 H2-330 H2-331 H2-332 H2-333 H2-334 H2-335 H2-336

[134]



H2-337 H2-338 H2-339 H2-340 H2-341 H2-342 H2-343 H2-344

[135]



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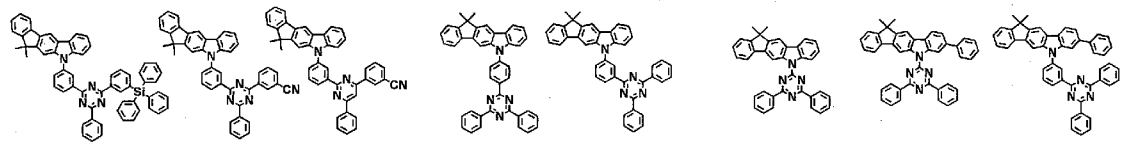
[136]



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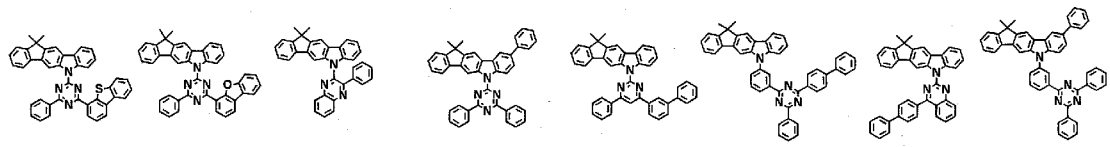
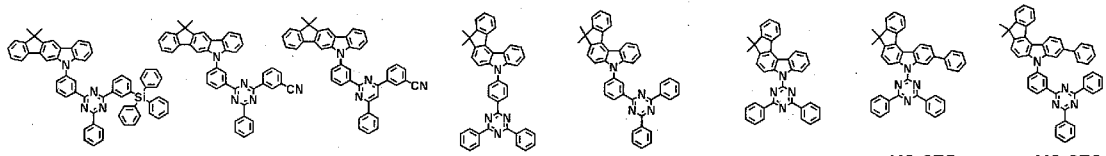
[137]



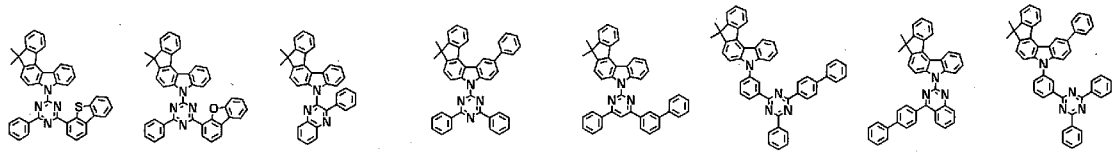
H2-361 H2-362 H2-363 H2-364 H2-365 H2-366 H2-367 H2-368

[138]



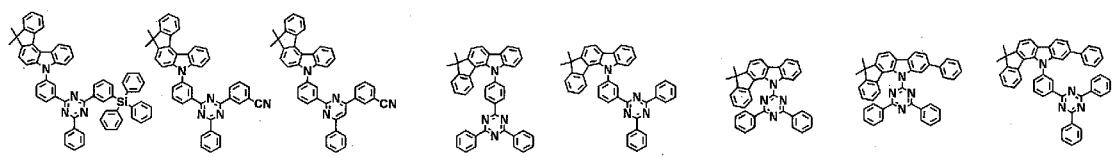
H2-369 H2-370 H2-371 H2-372 H2-373 H2-374 H2-375 H2-376

[139]



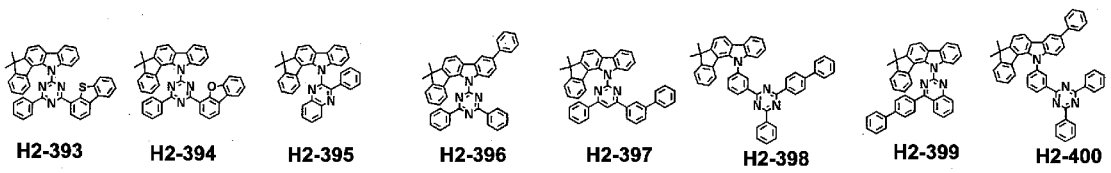
H2-377 H2-378 H2-379 H2-380 H2-381 H2-382 H2-383 H2-384

[140]



H2-385 H2-386 H2-387 H2-388 H2-389 H2-390 H2-391 H2-392

[141]



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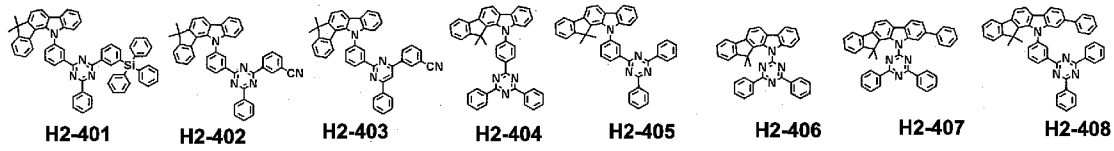

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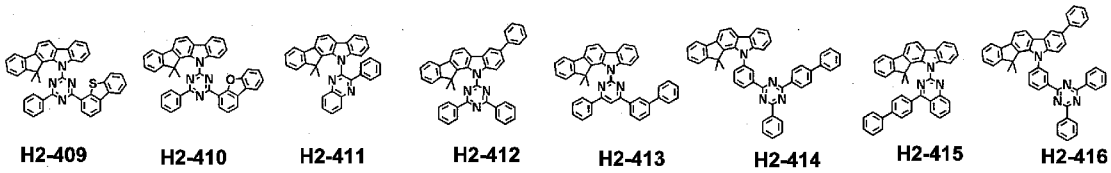

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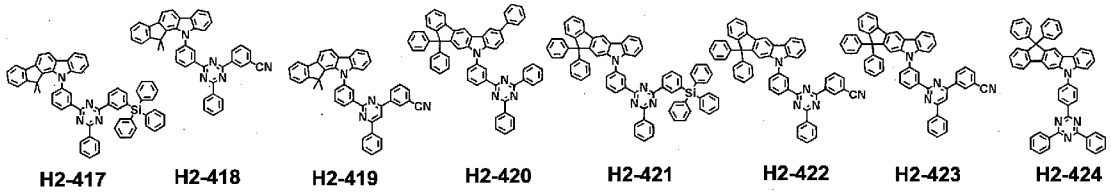

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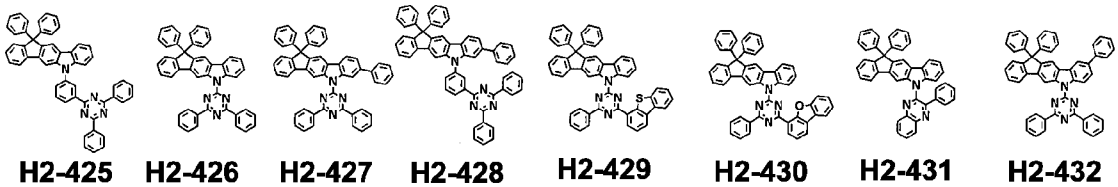

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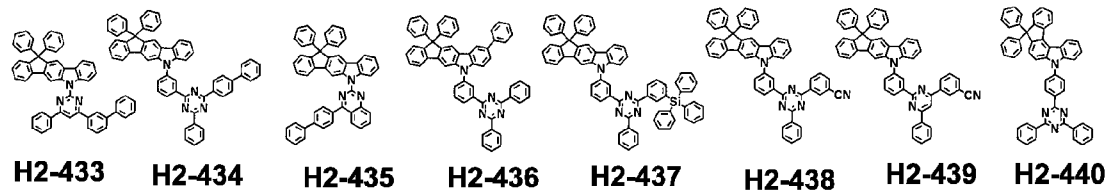

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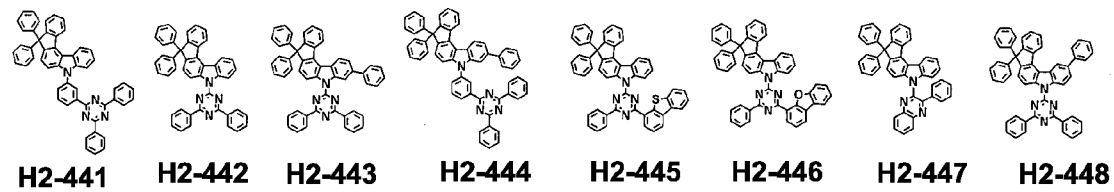

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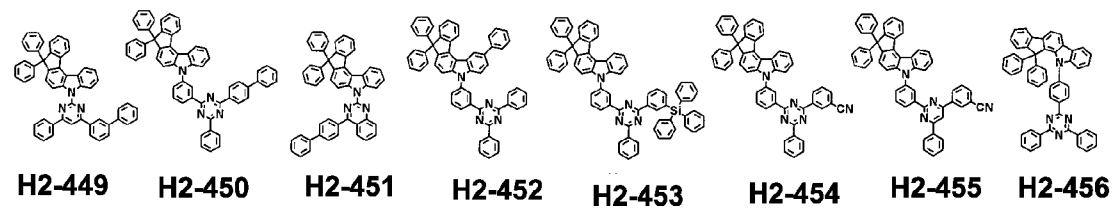
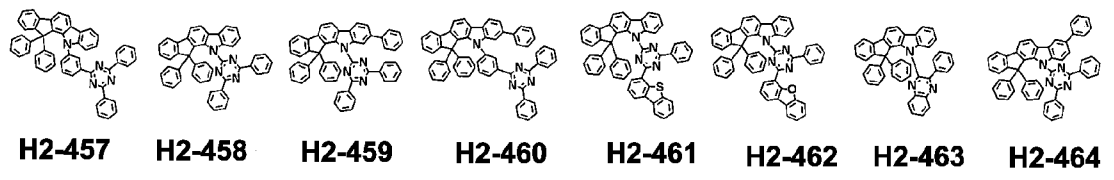
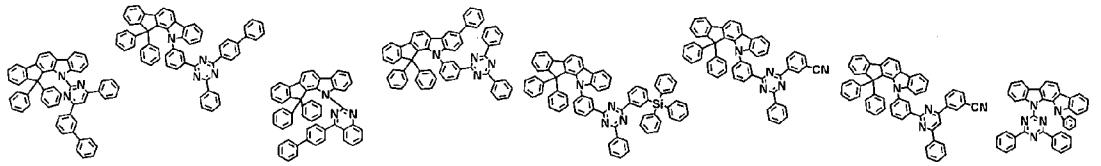
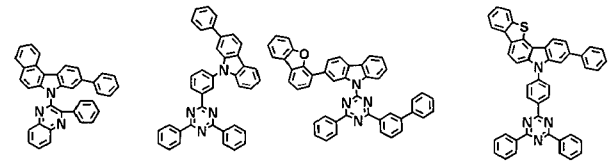


[149]



[150] 

[151] 

[152] The organic electroluminescent device according to the present invention comprises an anode; a cathode; and at least one organic layer between the anode and the cathode. The organic layer comprises a light-emitting layer, and the light-emitting layer comprises a host and a phosphorescent dopant. The host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by formula 1, and a second host compound is represented by formula 2.

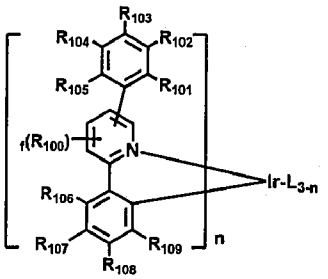
[153] The light-emitting layer is a layer from which light is emitted, and can be a single layer or a multi layer of which two or more layers are stacked. In the light-emitting layer, it is preferable that the doping concentration of the dopant compound based on the host compound is less than 20 wt%.

[154] 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.

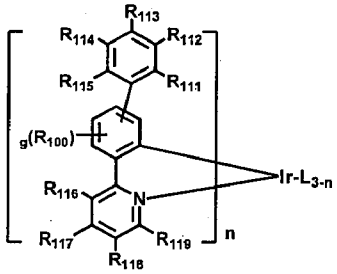
[155] According to the organic electroluminescent device of the present invention, the weight ratio of the first host material to the second host material is in the range of 1:99 to 99:1.

[156] The dopant 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.

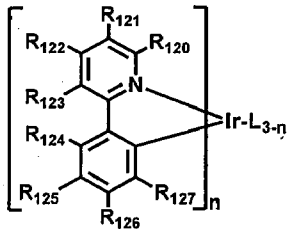
[157] The phosphorescent dopant is preferably selected from compounds represented by the following formulae 101 to 103.

[158] 

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

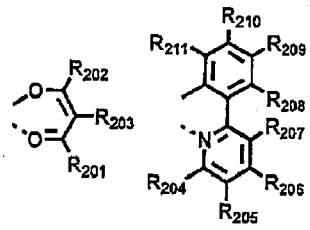
[159] 

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

[160] 

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

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

[162] 

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

[164] 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 deuterium or a halogen(s), a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a cyano, or a substituted or unsubstituted (C1-C30)alkoxy; adjacent substituents of R_{106} to R_{109} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic 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, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic

ring, e.g., quinoline unsubstituted or substituted with halogen, alkyl, or aryl;

[165] 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, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl;

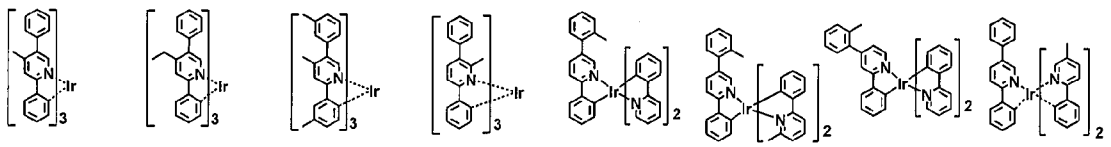
[166] R_{201} to R_{211} each independently represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with deuterium or a halogen(s), a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-C30)aryl; and adjacent substituents of R_{208} to R_{211} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl;

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

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

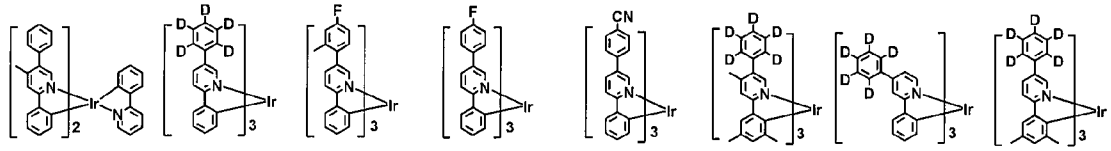
[169] Specifically, the phosphorescent dopant materials include the following:

[170]



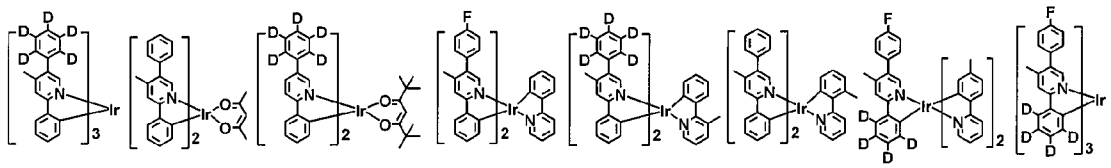
D-1 D-2 D-3 D-4 D-5 D-6 D-7 D-8

[171]



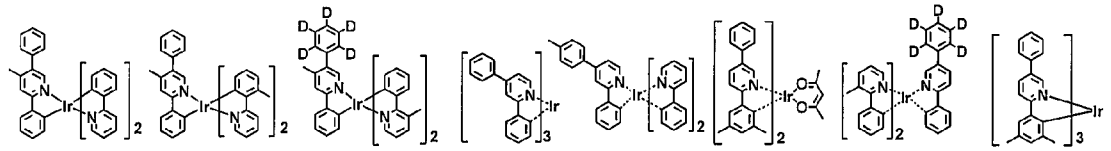
D-9 D-10 D-11 D-12 D-13 D-14 D-15 D-16

[172]



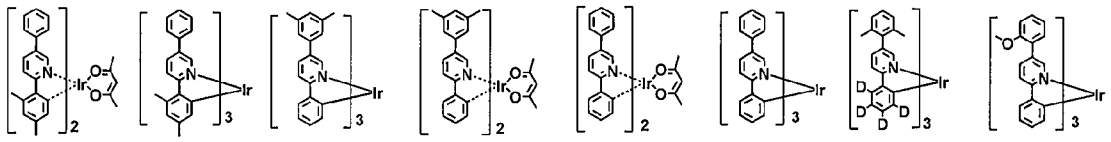
D-17 D-18 D-19 D-20 D-21 D-22 D-23 D-24

[173]



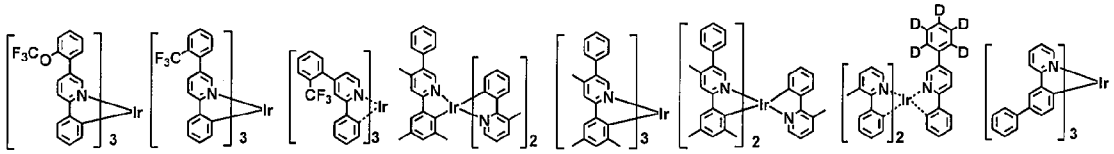
D-25 D-26 D-27 D-28 D-29 D-30 D-31 D-32

[174]



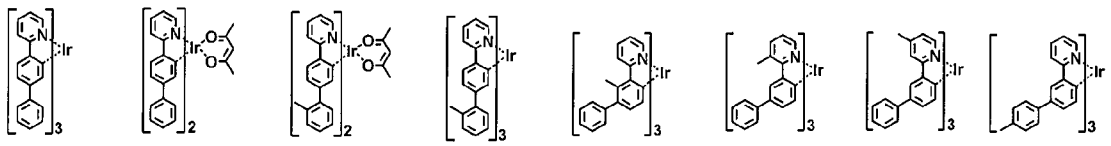
D-33 D-34 D-35 D-36 D-37 D-38 D-39 D-40

[175]



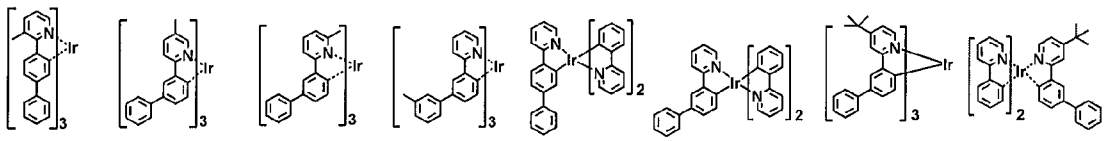
D-41 D-42 D-43 D-44 D-45 D-46 D-47 D-48

[176]



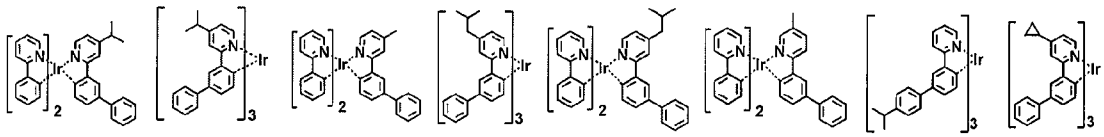
D-49 D-50 D-51 D-52 D-53 D-54 D-55 D-56

[177]



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

[178]



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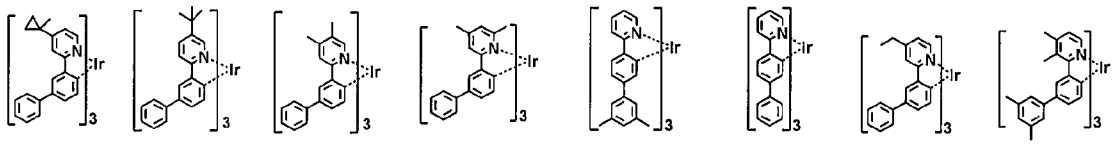

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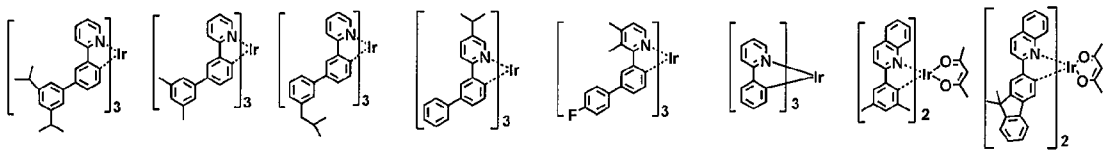

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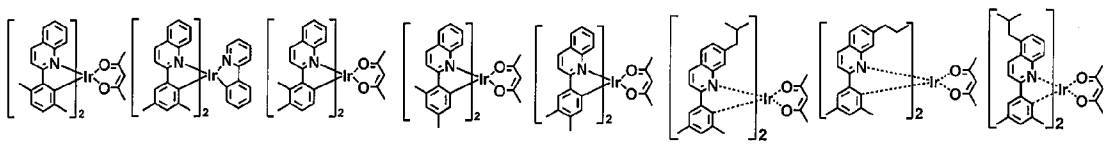

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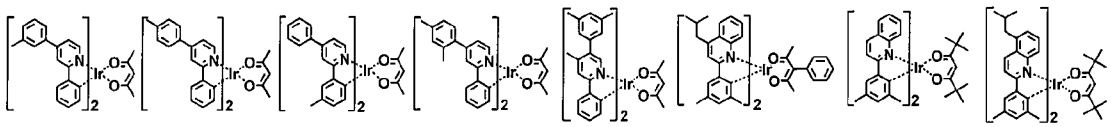

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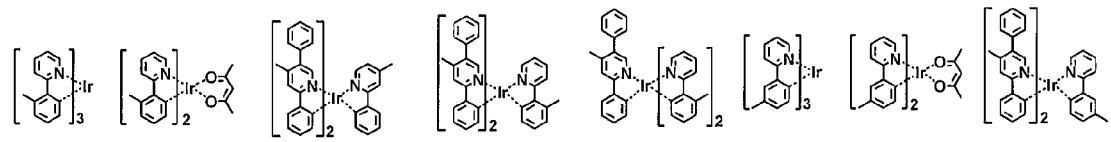

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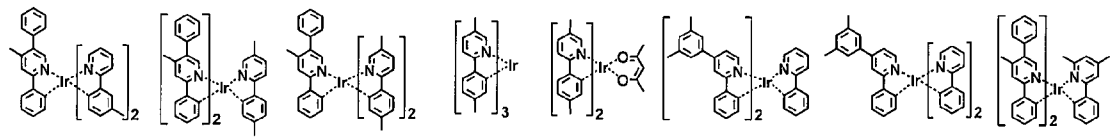

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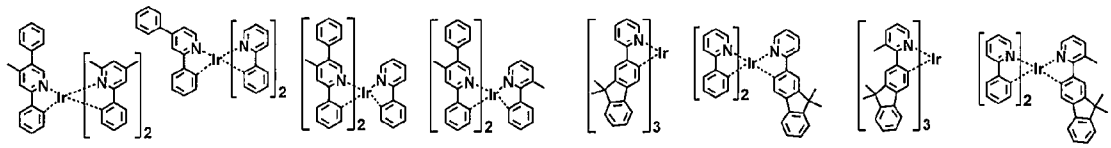

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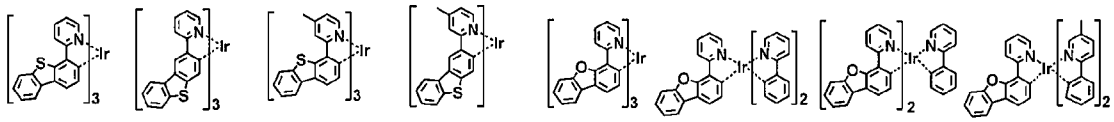

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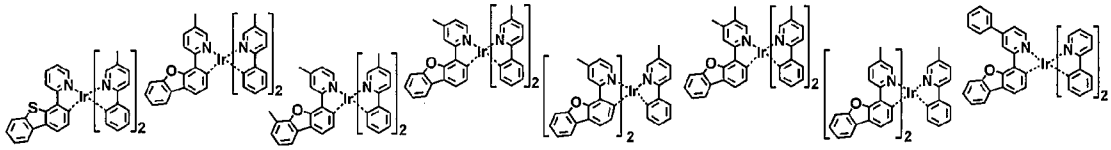

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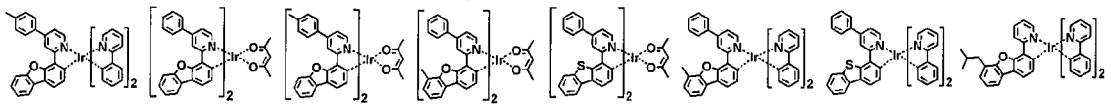

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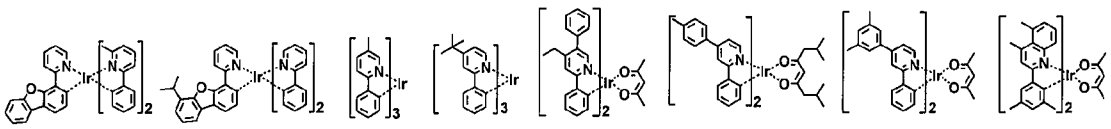

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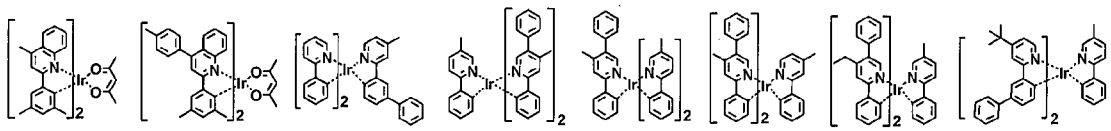

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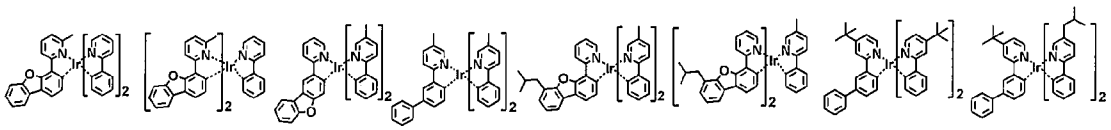

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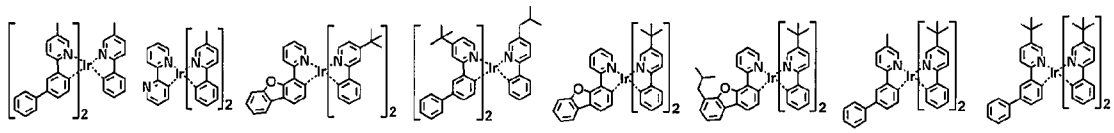

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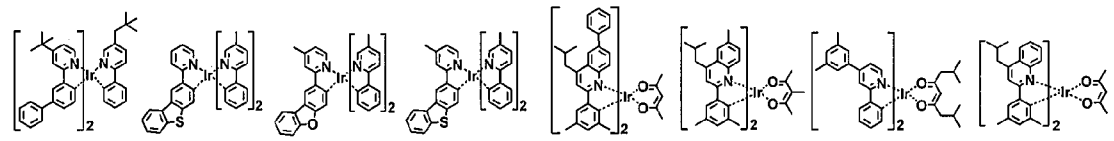

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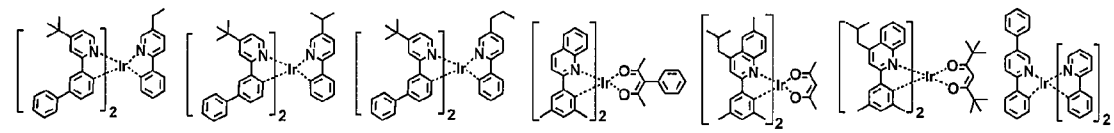

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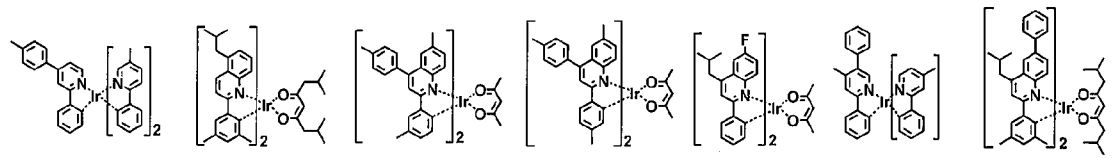

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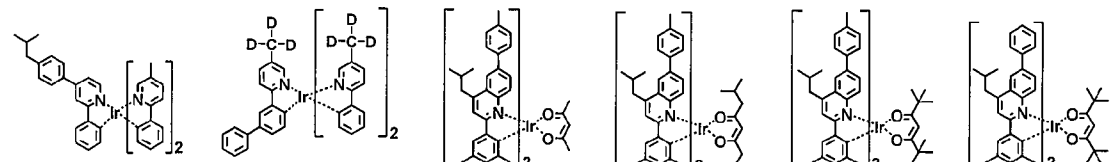


D-207 D-208 D-209 D-210 D-211 D-212

[197] The organic electroluminescent device according to the present invention may further comprise at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds in the organic layer.

[198] In addition, 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.

[199] 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.

[200] Between the anode and the light-emitting layer, a layer selected from a hole injection layer, a hole transport layer, or an electron blocking layer, or formed by a combination thereof can be used. Multi layers can be used for the hole injection layer in order to lower the hole injection barrier (or hole injection voltage) from the anode to the hole transport layer or the electron blocking layer. Two compounds can be simultaneously used in each layer. The hole transport layer and the electron blocking layer can also be formed of multi layers.

[201] Between the light-emitting layer and the cathode, a layer selected from an electron buffer layer, a hole blocking layer, an electron transport layer, or an electron injection layer, or formed by a combination thereof can be used. Multi layers can be used for the electron buffer layer in order to control the injection of the electrons and enhance the interfacial characteristics between the light-emitting layer and the electron injection layer. Two compounds can be simultaneously used in each layer. The hole blocking layer and the electron transport layer can also be formed of multi layers, and each layer can comprise two or more compounds.

[202] In the organic electroluminescent device according to the present invention, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant 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.

[203] In order to form each layer of the organic electroluminescent device of 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. The first and second host compounds of the present invention may be co-evaporated or mixture-evaporated.

[204] 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.

[205] The first and second host compounds of the present invention can be used to form a film by a co-evaporation of mixture-evaporation process.

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

[207] Hereinafter, the luminescent properties of the device comprising the host compound of the present invention will be explained in detail with reference to the following examples.

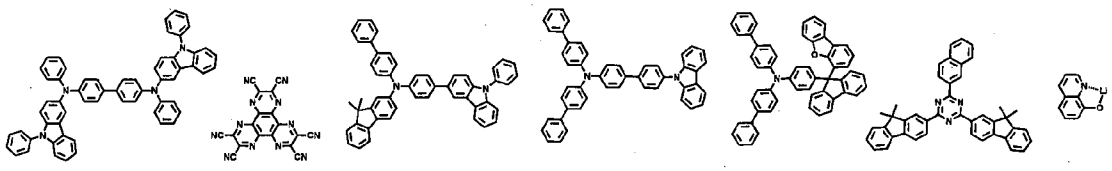
[208]

[209] **Device Example 1-1: Preparation of an OLED device by co-evaporating the**

[210] **first host compound and the second host compound of the present invention**

[211] An OLED device was produced using 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) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol, and distilled water, sequentially, and then was stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing 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. Next, 1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (compound HI-2) was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. N-([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluorene-2-amine (compound HT-1) 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 first hole transport layer having a thickness of 70 nm on the

second hole injection layer. As a host material, a first host compound and a second host compound were introduced into two cells of the vacuum vapor depositing apparatus, respectively. A dopant compound D-96 was introduced into another cell. The two host materials were evaporated at 1:1 rate, while the dopant was evaporated at a different rate from the host materials, so that the dopant was deposited in a doping amount of 3 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 40 nm on the hole transport layer. 2,4-bis(9,9-dimethyl-9H-fluoren-2-yl)-6-(naphthalen-2-yl)-1,3,5-triazine (compound ET-1) and lithium quinolate (compound EI-1) were then introduced into two cells of the vacuum vapor depositing apparatus, respectively, and evaporated at 1:1 rate to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. After depositing lithium quinolate (compound EI-1) as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was deposited by another vacuum vapor deposition apparatus. Thus, an OLED device was produced.

[212] 

[213]

[214] **Device Examples 2-1 to 2-3: Preparation of an OLED device by**

[215] **co-evaporating the first host compound and the second host compound of the present invention**

[216] An OLED device was produced in the same manner as in Device Example 1-1, except for evaporating the first hole transport layer (compound HT-1) of 10 nm thickness, introducing N,N-di([1,1'-biphenyl]-4-yl)-4'-(9H-carbazol-9-yl)-[1,1'-biphenyl]-4-amine (compound HT-2) into another cell of said vacuum vapor depositing apparatus, evaporating 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, and using the first and second host compounds listed in Table 1 as a host.

[217]

[218] **Comparative Example 1-1: Preparation of an OLED device using only the**

[219] **first host compound as a host**

[220] An OLED device was produced in the same manner as in Device Example 1-1, except for using only the first host compound listed in Table 1 as a host of the light-emitting layer.

[221]

[222] **Comparative Examples 2-1 to 2-3: Preparation of an OLED device using**

[223] **only the second host compound as a host**

[224] An OLED device was produced in the same manner as in Device Examples 2-1 to 2-3, except for using only the second host compound listed in Table 1 as a host of the light-emitting layer.

[225]

[226] The driving voltage at 1,000 nit, luminous efficiency, CIE color coordinate, and the time taken for the luminance at 5,000 nit to be reduced from 100% to 90% at a constant current of the OLEDs produced as above were measured.

[227] Table 1 below shows the luminous characteristics of the organic electroluminescent devices produced as in Device Example 1-1, Comparative Example 1-1, Device Examples 2-1 to 2-3, and Comparative Examples 2-1 to 2-3.

[228] [Table 1]

Device No.	HTL	Host	Dopant	Voltage [V]	Efficiency [cd/A]	Color Coordinate (x,y)	Lifespan [hr]
Device Ex. 1-1	HT-1	A-49 : H2-31	D-96	4	27.8	0.667, 0.332	70
Device Ex. 2-1	HT-1 / HT-2	A-49: H2-473	D-96	4.4	28.6	0.655, 0.334	215
Device Ex. 2-2	HT-1 / HT-2	A-49: H2-2	D-96	4.3	27.6	0.664, 0.335	300
Device Ex. 2-3	HT-1 / HT-2	A-49: H2-155	D-96	4.6	27.1	0.663, 0.336	250
Comp. Ex. 1-1	HT-1	A-49	D-96	8.1	3.7	0.651, 0.338	2
Comp. Ex. 2-1	HT-1 / HT-2	H2-473	D-96	3.9	29.2	0.664, 0.335	42
Comp. Ex. 2-2	HT-1 / HT-2	H2-2	D-96	4.1	28.2	0.662, 0.337	100
Comp. Ex. 2-3	HT-1 / HT-2	H2-155	D-96	4.4	28.3	0.666, 0.334	195

[229]

[230] **Device Examples 3-1 to 3-13: Preparation of an OLED device by**

[231] **co-evaporating the first host compound and the second host compound of the present invention**

[232] An OLED device was produced in the same manner as in Device Example 1-1, except for evaporating the second hole injection layer of 3 nm thickness, evaporating the first hole transport layer of 40 nm thickness, not evaporating the second hole transport layer, using compound D-1 or D-25 for the dopant of the light-emitting layer, evaporating the electron transport layer of 35 nm thickness at a rate of 4:6, and using the first and second host compounds combination listed in Table 2 as a host of the light-emitting layer.

[233]

[234] **Device Example 4-1: Preparation of an OLED device by co-evaporating the**

[235] **first host compound and the second host compound of the present invention**

[236] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for evaporating the first hole transport layer of 10 nm thickness, evaporating the second hole transport layer of 30 nm thickness by using compound HT-3, using compound D-136 for the dopant of the light-emitting layer, and using the first and second host compounds combination listed in Table 2 as a host of the light-emitting layer.

[237]

[238] **Comparative Example 3-1: Preparation of an OLED device using only the**

[239] **first host compound as a host**

[240] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for using only the first host compound listed in Table 2 as a host of the light-emitting layer.

[241]

[242] **Comparative Examples 4-1 to 4-12: Preparation of an OLED device using**

[243] **only the second host compound as a host**

[244] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for using only the second host compound listed in Table 2 as a host of the light-emitting layer.

[245]

[246] **Comparative Example 5-1: Preparation of an OLED device using only the**

[247] **second host compound as a host**

[248] An OLED device was produced in the same manner as in Device Example 4-1, except for using only the second host compound listed in Table 2 as a host of the light-emitting layer.

[249]

[250] The driving voltage at 1,000 nit, luminous efficiency, CIE color coordinate, and the time taken for the luminance at 15,000 nit to be reduced from 100% to 90% at a constant current of the OLEDs produced as above were measured.

[251] Table 2 below shows the luminous characteristics of the organic electroluminescent devices produced as in Device Examples 3-1 to 3-13, Device Example 4-1, Comparative Example 3-1, Comparative Examples 4-1 to 4-12, and Comparative Example 5-1.

[252] [Table 2]

Device No.	HTL	Host	Dopant	Voltage [V]	Efficiency [cd/A]	Color Coordinate (x,y)	Lifespan [hr]
Device Ex. 3-1	HT-1	A-49: H2-474	D-25	2.9	56	0.309, 0.652	97
Device Ex. 3-2	HT-1	A-49 : H2-101	D-25	2.9	52.1	0.311, 0.652	42
Device Ex. 3-3	HT-1	A-49 : H2-475	D-25	3.1	48.4	0.302, 0.659	52
Device Ex. 3-4	HT-1	A-49 : H2-472	D-25	2.8	54.3	0.304, 0.657	89
Device Ex. 3-5	HT-1	A-49 : H2-48	D-25	2.8	53.4	0.307, 0.656	121
Device Ex. 3-6	HT-1	A-49 : H2-25	D-25	3.2	47.9	0.299, 0.659	98
Device Ex. 3-7	HT-1	A-49 : H2-125	D-25	2.9	54	0.310, 0.653	158
Device Ex. 3-8	HT-1	A-49 : H2-31	D-25	2.9	51.7	0.302, 0.657	144
Device Ex. 3-9	HT-1	A-49 : H2-101	D-1	2.7	51.7	0.320, 0.655	211
Device Ex. 3-10	HT-1	A-49 : H2-32	D-1	2.8	51.6	0.322, 0.655	359
Device Ex. 3-11	HT-1	A-49 : H2-474	D-1	2.8	54.2	0.320, 0.656	260
Device Ex. 3-12	HT-1	A-49 : H2-31	D-1	2.9	52.5	0.322, 0.655	205
Device Ex. 3-13	HT-1	A-49 : H2-48	D-1	2.7	54.2	0.322, 0.655	199

[253]

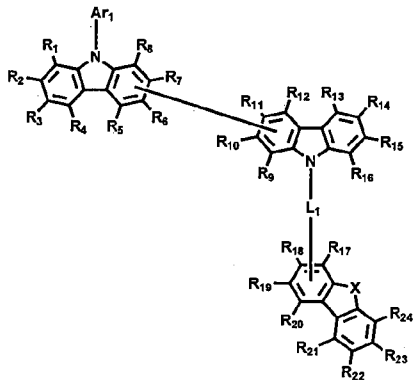
Device Ex. 4-1	HT-1 / HT-3	A-49 : H2-31	D-136	3.1	68.4	0.329, 0.656	270
Comp. Ex. 3-1	HT-1	A-49	D-25	5.7	3.6	0.302, 0.653	X
Comp. Ex. 4-1	HT-1	H2-474	D-25	2.7	56.3	0.310, 0.651	22
Comp. Ex. 4-2	HT-1	H2-101	D-25	2.8	50.3	0.315,0.651	24
Comp. Ex. 4-3	HT-1	H2-475	D-25	3.2	58.8	0.307, 0.656	32
Comp. Ex. 4-4	HT-1	H2-472	D-25	2.6	38.8	0.305, 0.653	53
Comp. Ex. 4-5	HT-1	H2-48	D-25	2.6	49.6	0.314, 0.652	67
Comp. Ex. 4-6	HT-1	H2-25	D-25	3.1	54.2	0.308, 0.655	45
Comp. Ex. 4-7	HT-1	H2-31	D-25	2.9	42.8	0.314, 0.652	39
Comp. Ex. 4-8	HT-1	H2-101	D-1	2.8	38	0.330, 0.650	18
Comp. Ex. 4-9	HT-1	H2-32	D-1	3.1	30.1	0.328, 0.651	119
Comp. Ex. 4-10	HT-1	H2-474	D-1	2.6	45.7	0.332, 0.635	105
Comp. Ex. 4-11	HT-1	H2-31	D-1	2.9	33.5	0.323, 0.653	130
Comp. Ex. 4-12	HT-1	H2-48	D-1	2.6	41.2	0.325, 0.653	124
Comp. Ex. 5-1	HT-1 / HT-3	H2-125	D-136	3	64.9	0.337, 0.649	124

[254] The organic electroluminescent device of the present invention comprises a light-

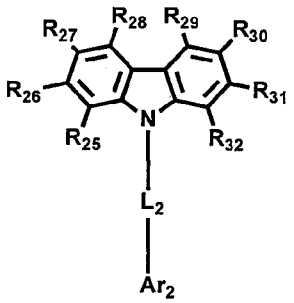
emitting layer comprising a host and a phosphorus dopant, and the host consists of a specific combination of multi-component host compounds. The device of the present invention provides superior lifespan characteristics to conventional devices.

Claims

[Claim 1] An organic electroluminescent device comprising at least one light-emitting layer between an anode and a cathode, wherein the light-emitting layer comprises a host and a phosphorescent dopant, the host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by the following formula 1, and a second host compound is represented by the following formula 2.



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



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

wherein

Ar_1 represents a substituted or unsubstituted (C6-C30)aryl;

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

X represents O or S;

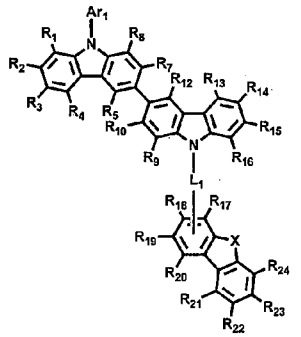
R_1 to R_{32} each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted

di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; 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;

Ar_2 represents a substituted or unsubstituted 3- to 30-membered heteroaryl; and

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

[Claim 2] The organic electroluminescent device according to claim 1, wherein formula 1 is represented by one of the following formulae 3 to 6:



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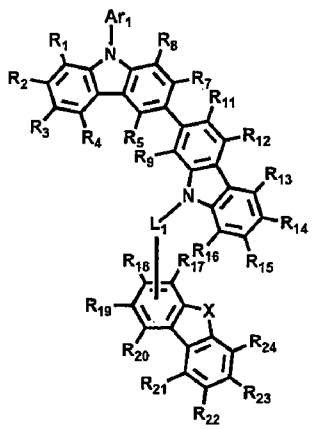

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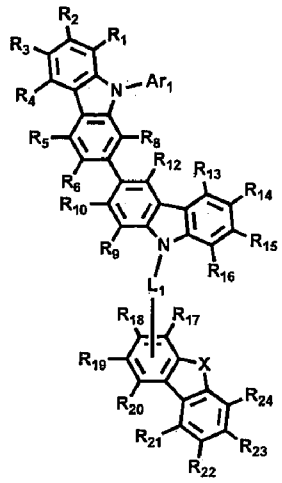

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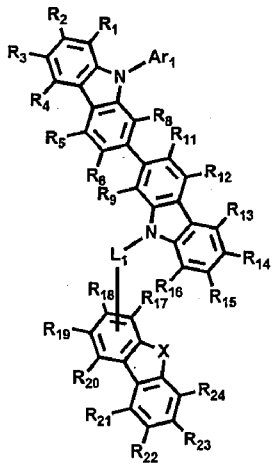


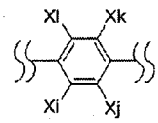
----------(6)

wherein

Ar_1, L_1, X, and R_1 to R_{24} are as defined in claim 1.

[Claim 3] The organic electroluminescent device according to claim 1, wherein in formulae 1 and 2,

L_1 and L_2 each independently are represented by one of the following formulae 7 to 19:



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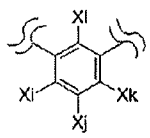

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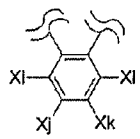

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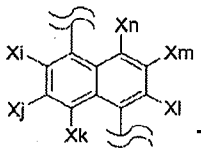

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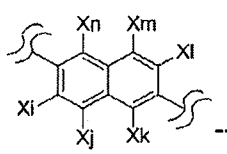

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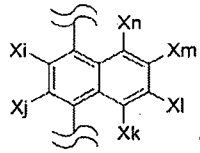

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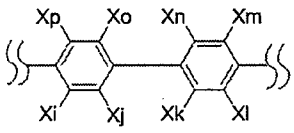

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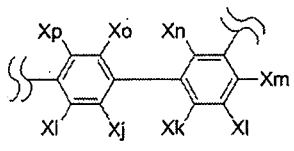

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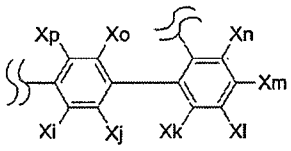

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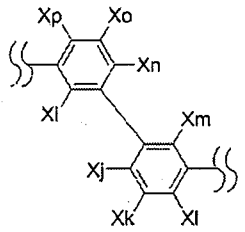

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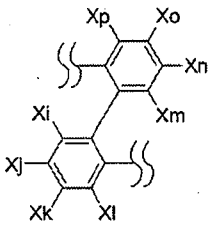

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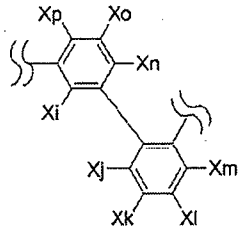

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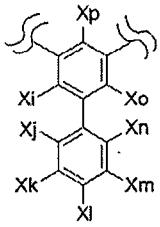


----------(19)

wherein

Xi to Xp each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di- (C6-C30)arylamino; 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.

[Claim 4] The organic electroluminescent device according to claim 1, wherein in formula 2,

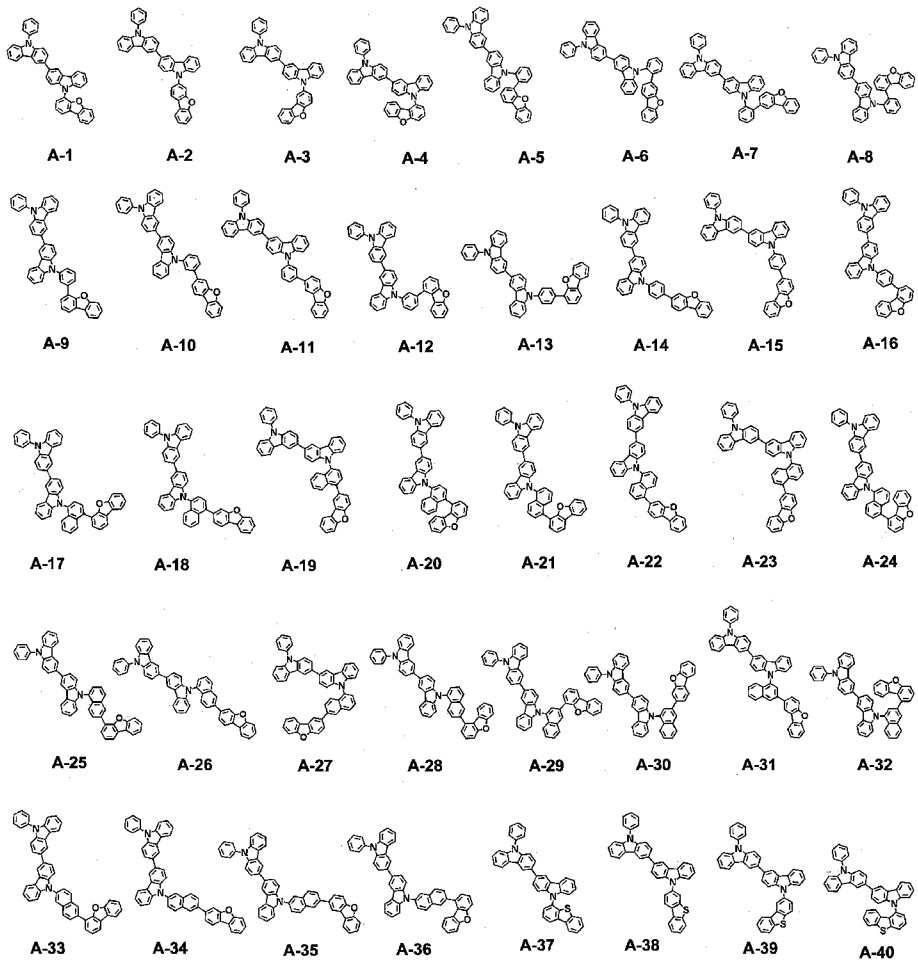
Ar_2 represents a monocyclic heteroaryl selected from the group consisting of pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, and pyridazinyl, or a fused heteroaryl selected from the group consisting of benzoimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, naphthyridinyl, quinoxalinyl,

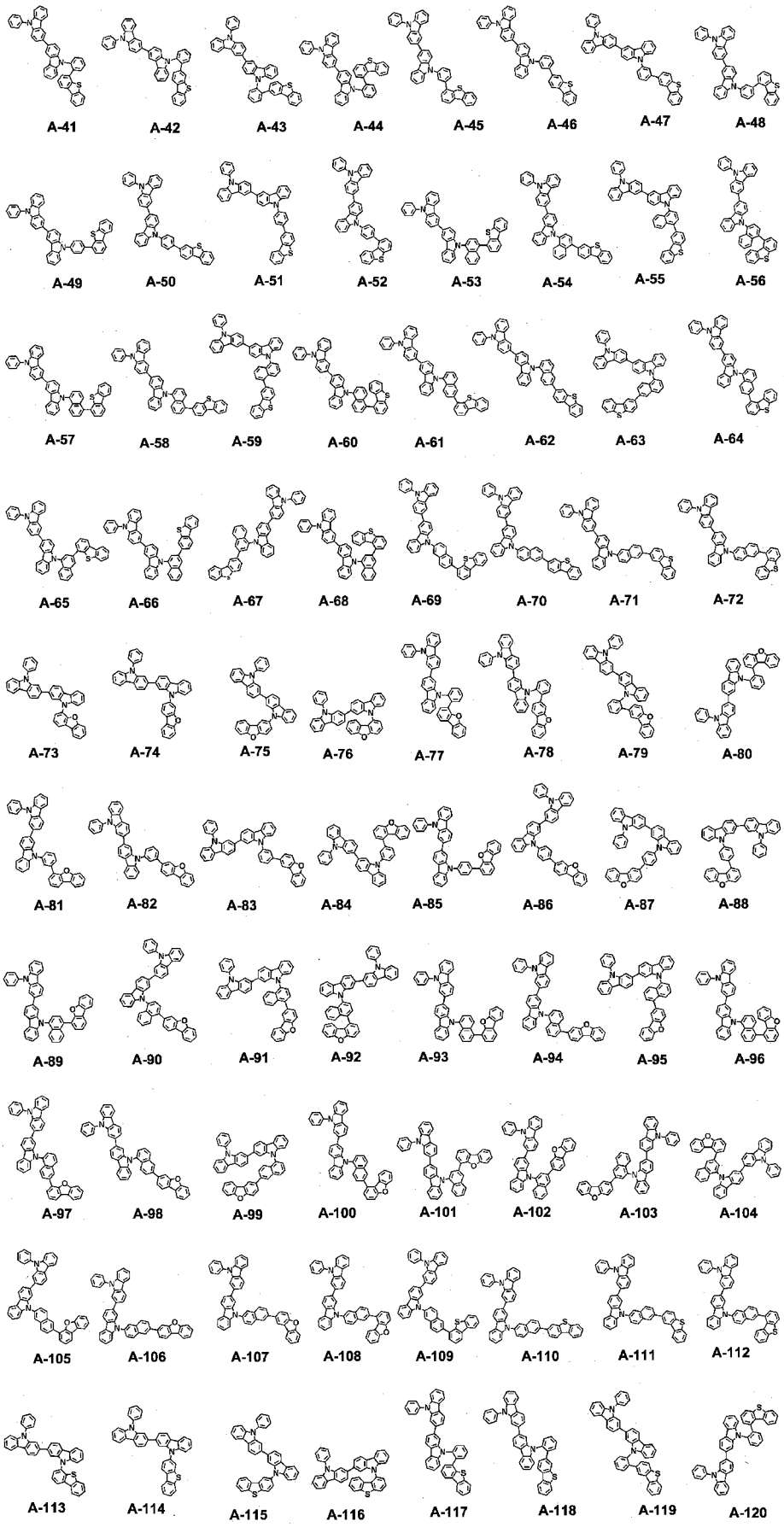
carbazolyl, and phenanthrydinyl.

[Claim 5] The organic electroluminescent device according to claim 1, wherein in formula 2,

R_{25} to R_{32} each independently represent hydrogen, a cyano, a (C6-C15)aryl unsubstituted or substituted with a tri(C6-C10)arylsilyl, a 10- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted benzene, a substituted or unsubstituted indole, a substituted or unsubstituted benzoindole, a substituted or unsubstituted indene, a substituted or unsubstituted benzofuran, or a substituted or unsubstituted benzothiophene.

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

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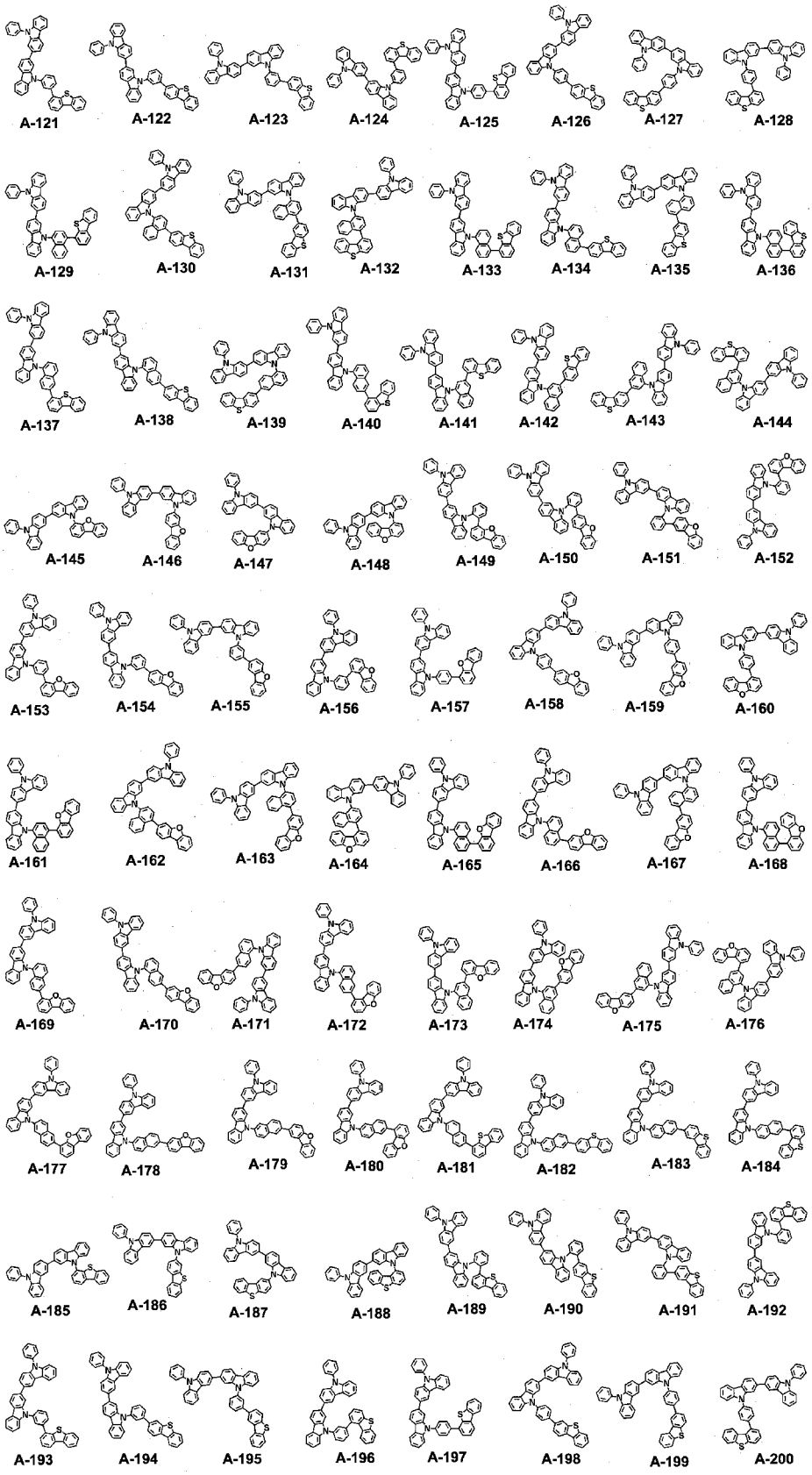
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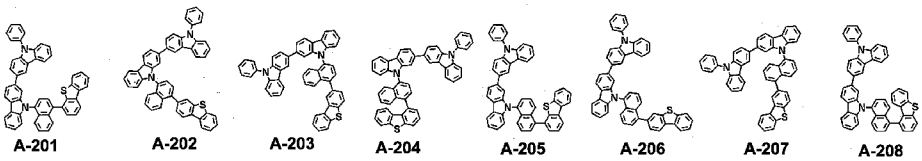
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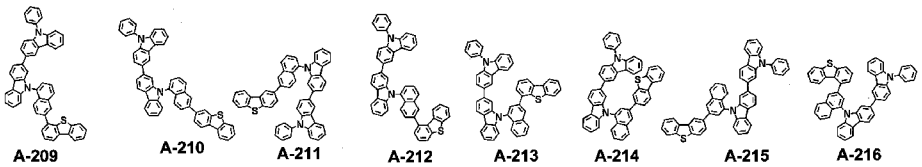
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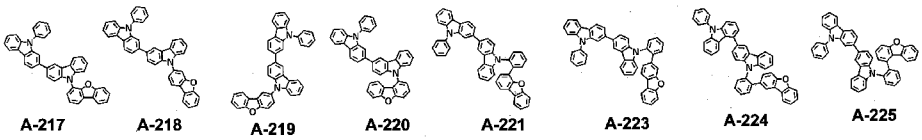
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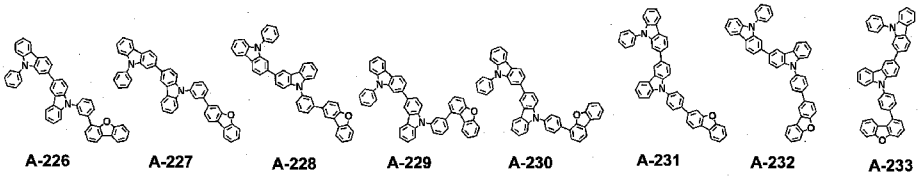
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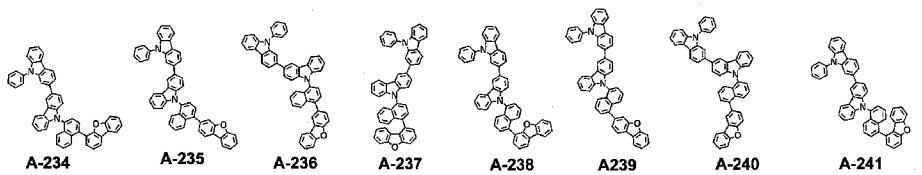
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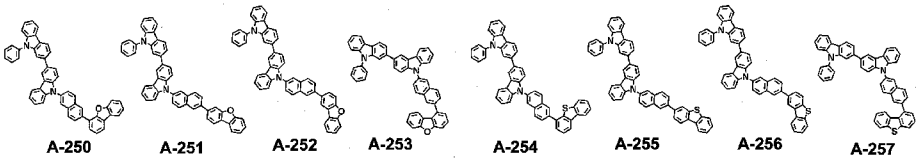
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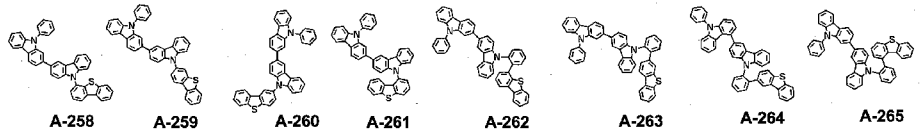
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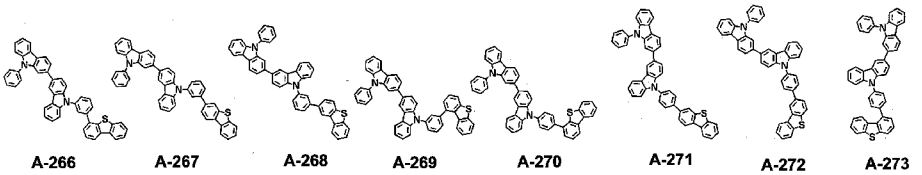
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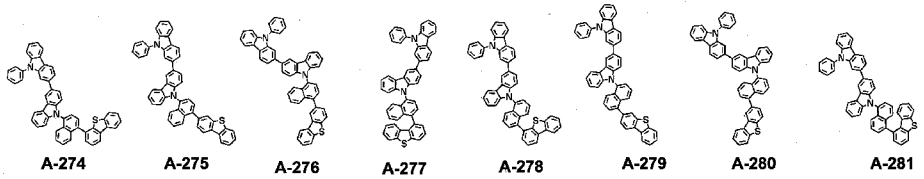
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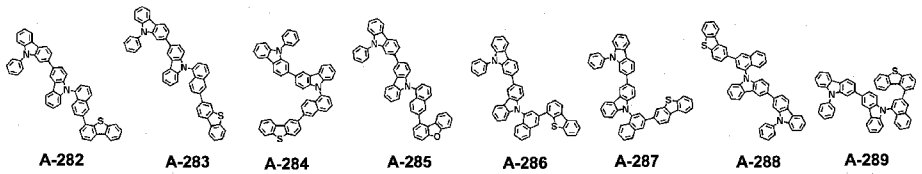
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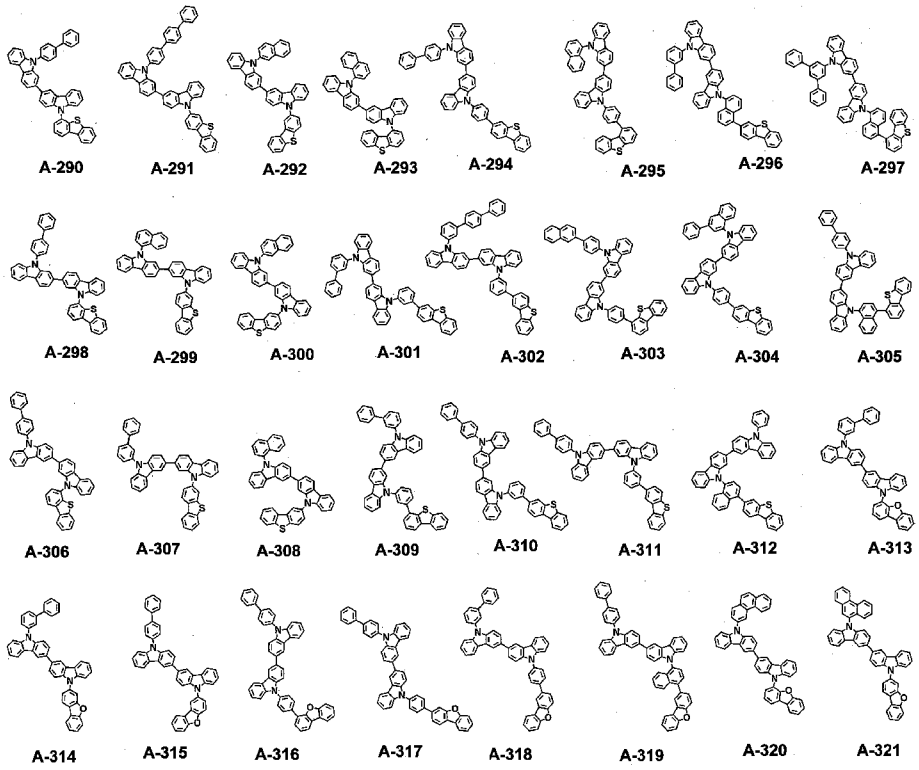
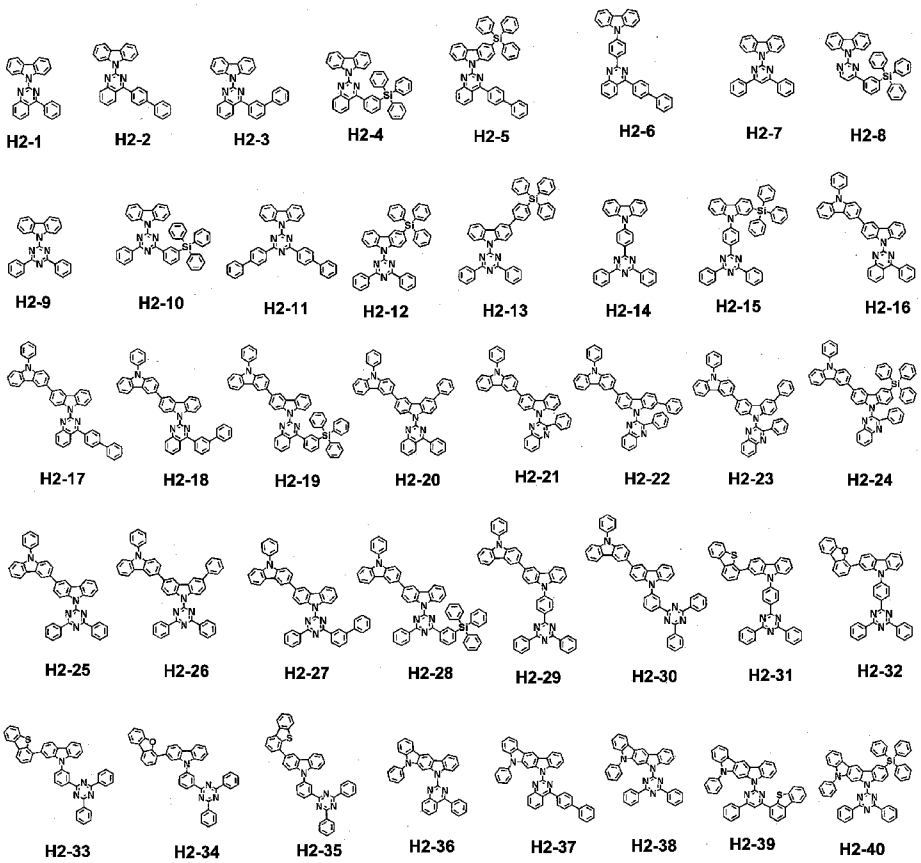
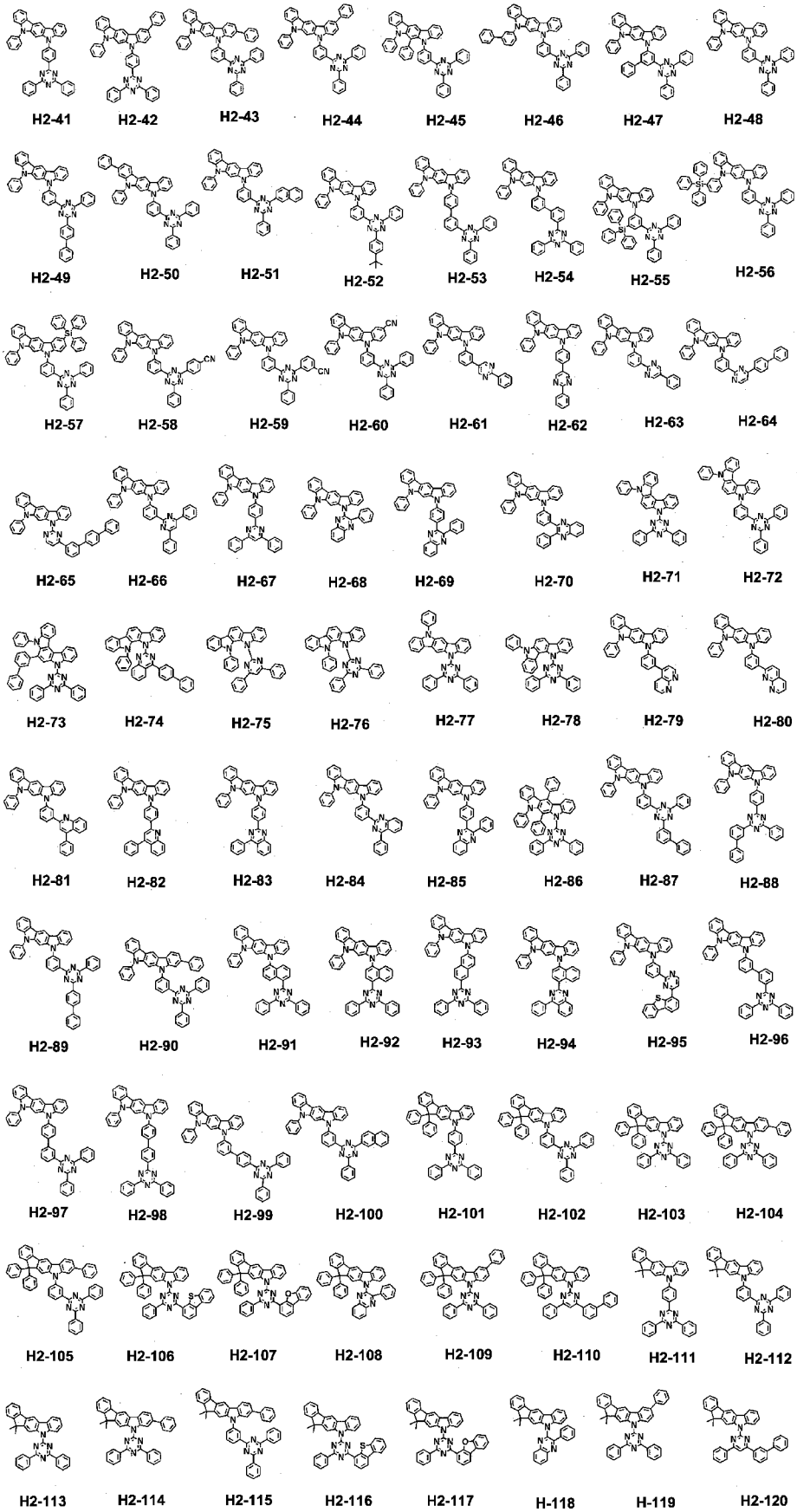


[Claim 7] The organic electroluminescent device according to claim 1, wherein the compound represented by formula 2 is selected from the group consisting of:

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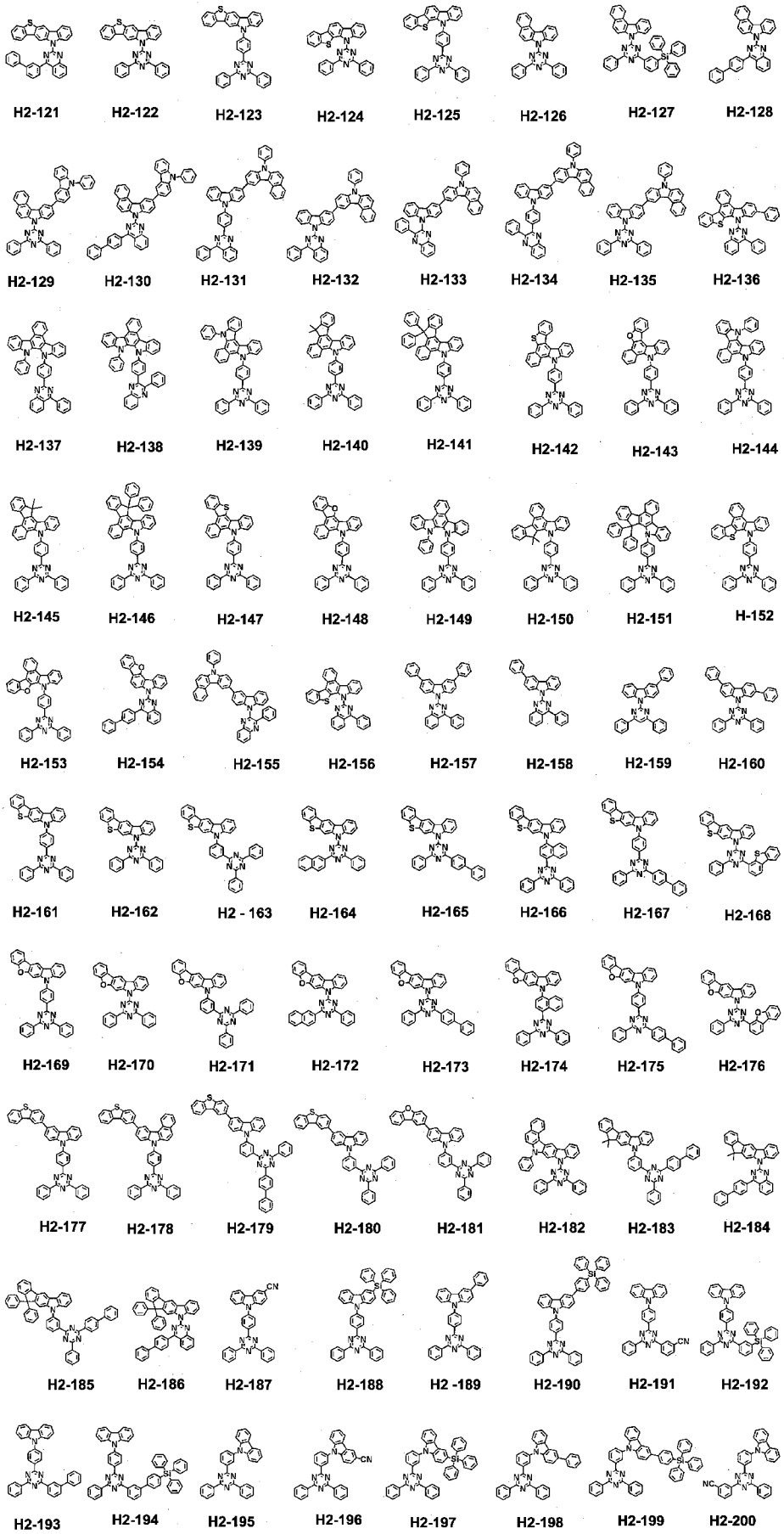
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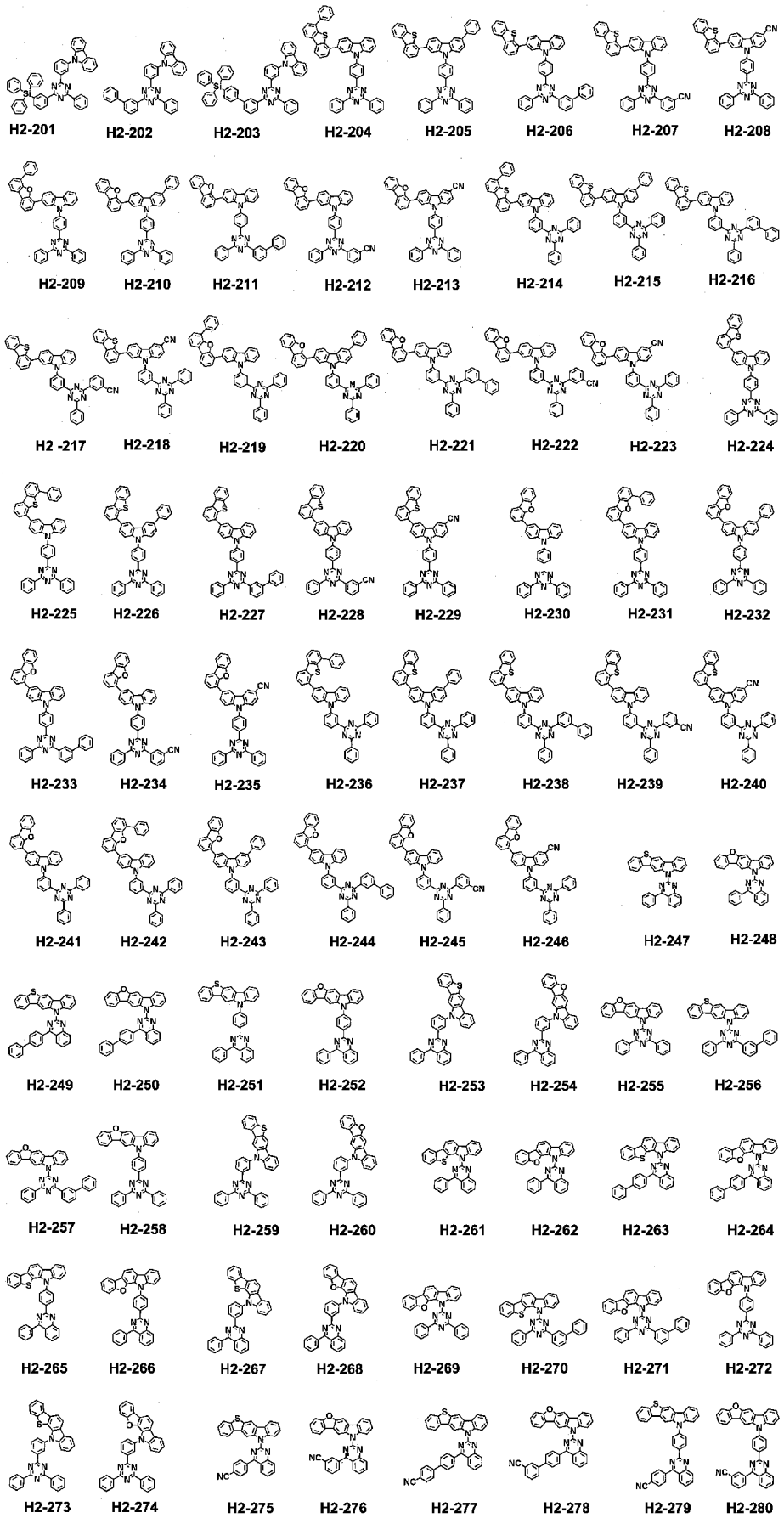
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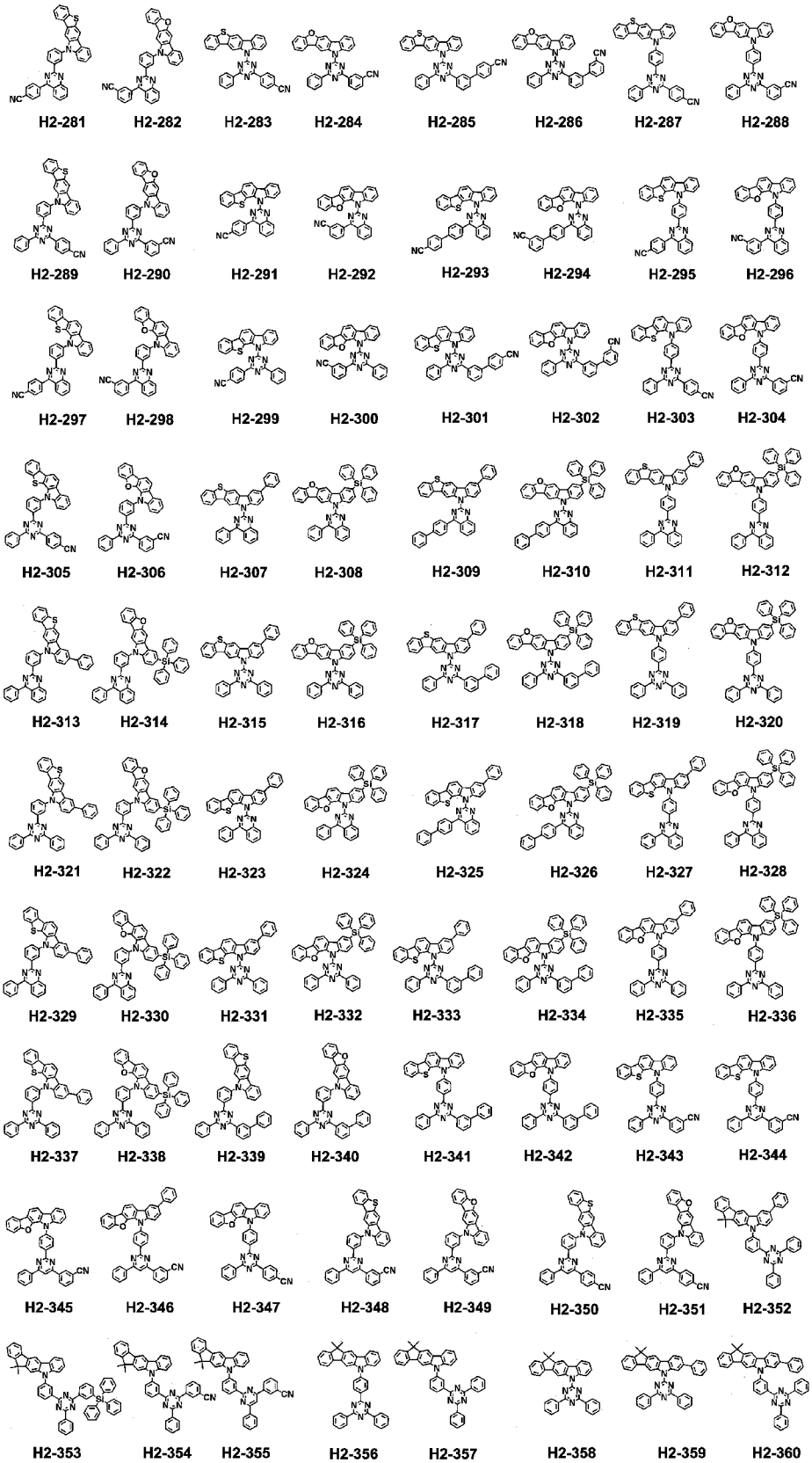
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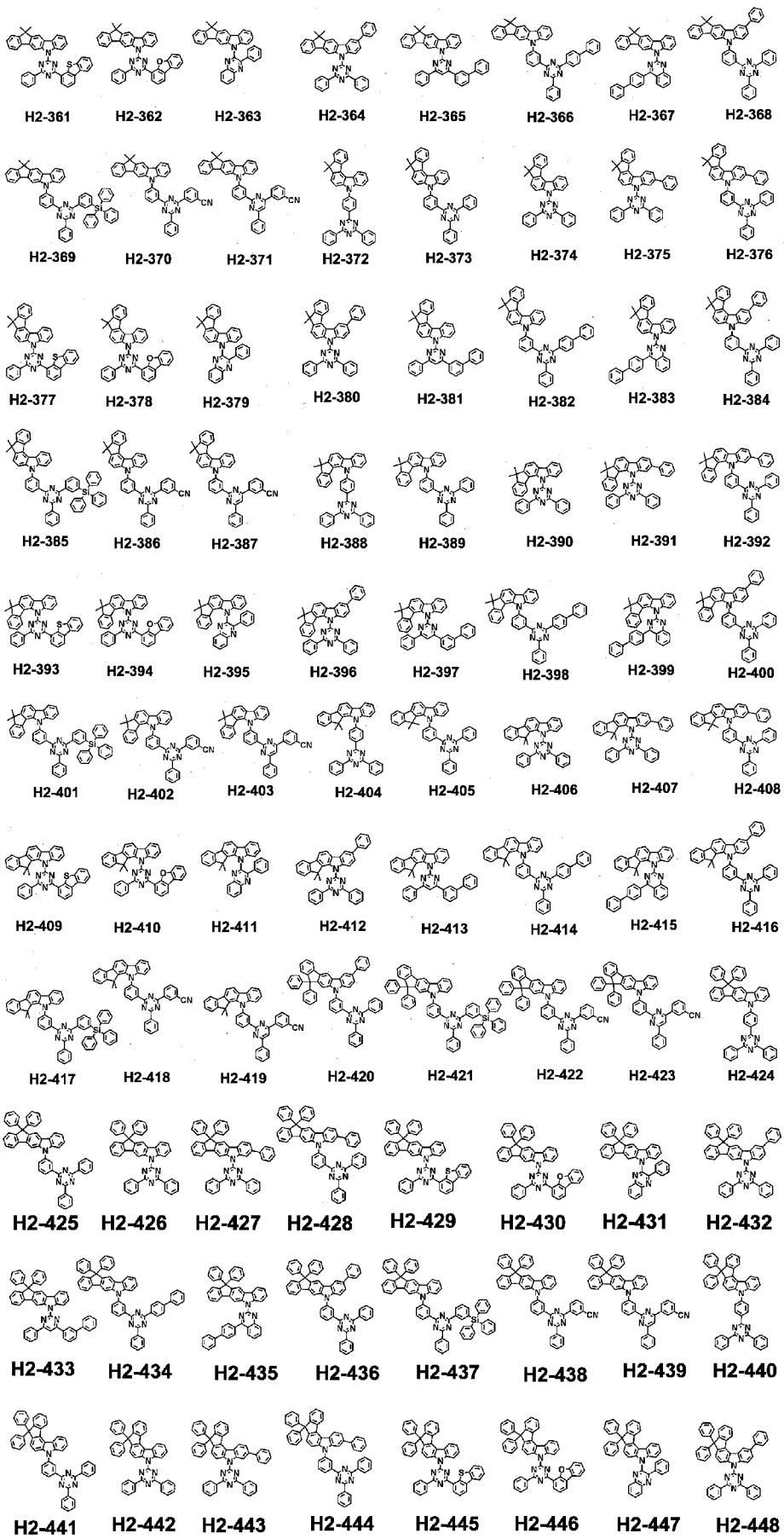
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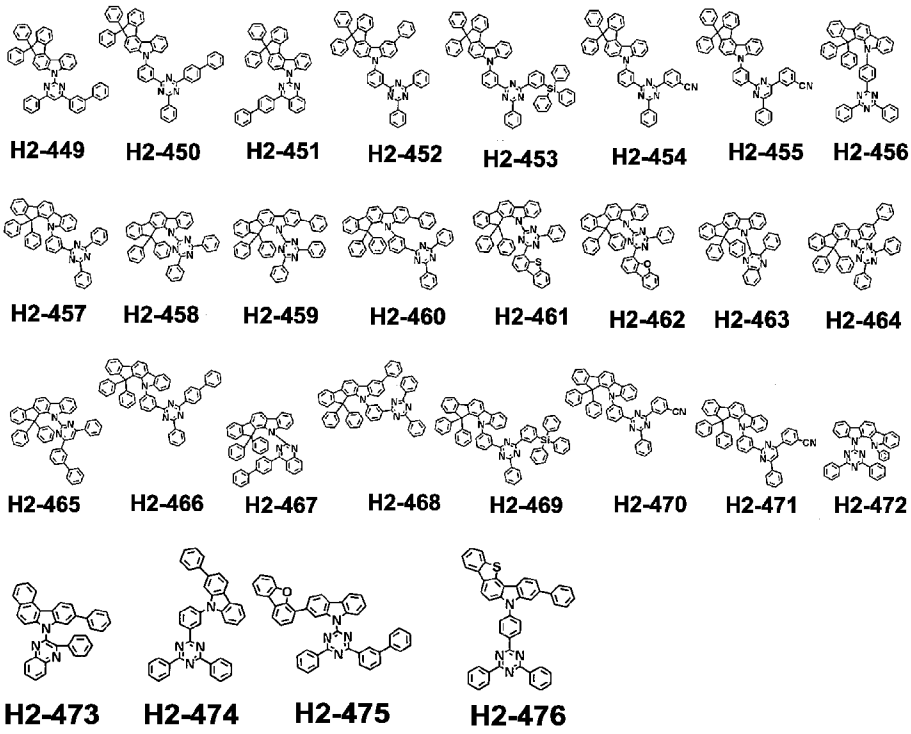
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/005194

A. CLASSIFICATION OF SUBJECT MATTER

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 formulae 1 and 2 of claim 1

Inventor names searched along with "HAAS" keyword in applicant field in Patent Scope.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 August 2015	25 August 2015
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	Chetan Makani AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832896

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/KR2015/005194**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013/172835 A1 (UNIVERSAL DISPLAY CORPORATION) 21 November 2013 See table 1, on page 66, and example device 4	1 to 7
X	US 2013/0234119 A1 (IDEMITSU KOSAN CO., LTD.) 12 September 2013 See table 2, page 191, example 13; table 4, page 192, examples 26 to 28	1 to 7
X	WO 2013/062075 A1 (IDEMITSU KOSAN CO., LTD.) 16 October 2014 & US 2014/0306207 A1 (IDEMITSU KOSAN CO., LTD.) 16 October 2014 See table 2, on page 299, and example 4	1 to 7
A	US 2014/0001446 A1 (MIZUKI et al) 02 January 2014 See table 2, page 87	
P,X	WO 2014/129869 A1 (DOOSAN CORPORATION) 28 August 2014 See example devices in table 2, compounds H36, H37, H40, H41	1 to 7

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/KR2015/005194**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2013/172835 A1	21 November 2013	WO 2013172835 A1	21 Nov 2013
		US 2015194621 A1	09 Jul 2015
US 2013/0234119 A1	12 September 2013	US 2013234119 A1	12 Sep 2013
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		EP 2790239 A1	15 Oct 2014
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		TW 201326121 A	01 Jul 2013
		TW 201332970 A	16 Aug 2013
		US 2014001446 A1	02 Jan 2014
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		WO 2013145923 A1	03 Oct 2013
WO 2014/129869 A1	28 August 2014	WO 2014129869 A1	28 Aug 2014
		KR 20140105913 A	03 Sep 2014

End of Annex

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/KR2015/005194**

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Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**

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