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(54) Title: A PLURALITY OF HOST MATERIALS AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

(57) Abstract: The present disclosure relates to a host material and an organic electroluminescent device comprising the same. By using a specific combination of two or more host compounds according to the present disclosure, the organic electroluminescent device of the present disclosure has luminous efficiency at least equivalent to or higher than conventional devices and has lifespan better than conventional devices.



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Description

Title of Invention: A PLURALITY OF HOST MATERIALS AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

Technical Field

- [1] The present disclosure relates to a plurality of host materials and an organic electroluminescent device comprising the same.

Background Art

- [2] An electroluminescent (EL) device is a self-light-emitting device which has advantages in that it provides a wider viewing angle, a greater contrast ratio, and a faster response time. An organic EL device was first developed by Eastman Kodak, by using small aromatic diamine molecules and aluminum complexes as materials to form a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].
- [3] The organic EL device(OLED) converts electric energy into light when electricity is applied to an organic light-emitting material(s). Generally, the organic EL device has a structure comprising an anode, a cathode, and an organic layer disposed between the anode and the cathode. The organic layer of the organic EL device comprises a hole injection layer, a hole transport layer, an electron blocking layer, a light-emitting layer (comprising a host material and a dopant material), an electron buffering layer, a hole blocking layer, an electron transport layer, an electron injection layer, etc. Depending on its function, materials for forming the organic layer can be classified as a hole injection material, a hole transport material, an electron blocking material, a light-emitting material, an electron buffering material, a hole blocking material, an electron transport material, an electron injection material, etc. When a voltage is applied to the organic EL device, holes and electrons are injected from an anode and a cathode, respectively, to the light-emitting layer. Excitons having high energy are formed by recombinations between the holes and the electrons, the energy puts the organic light-emitting compound in an excited state, and the decay of the excited state results in a relaxation of the energy level into a ground state, accompanied by light-emission.
- [4] The most important factor determining luminous efficiency in the organic EL device is light-emitting materials. The light-emitting material needs to have high quantum efficiency, high electron mobility, and high hole mobility. Furthermore, the light-emitting layer formed by the light-emitting material needs to be uniform and stable. Depending on the colors visualized by light-emission, the light-emitting materials can be classified as a blue-, green-, or red-emitting material, and can additionally include a yellow- or orange-emitting material. Furthermore, the light-emitting material can be

classified according to its function, as a host material and a dopant material. Recently, the development of an OLED providing high efficiency and a long lifespan is urgent. In particular, considering EL requirements for a middle or large-sized OLED panel, materials showing better performance than conventional ones must be urgently developed. In order to achieve the development, a host material which plays a role as a solvent in a solid state and transfers energy, should have high purity, and an appropriate molecular weight for being deposited under a vacuum. In addition, a host material should have high glass transition temperature and high thermal decomposition temperature to ensure thermal stability; high electrochemical stability to have a long lifespan; ease of preparation for amorphous thin film; and good adhesion to materials of adjacent layers. Furthermore, a host material should not move to an adjacent layer.

[5] The light-emitting material can be prepared by combining a host with a dopant to improve color purity, luminous efficiency, and stability. Generally, a device showing good EL performances comprises a light-emitting layer prepared by combining a host with a dopant. The host material greatly influences the efficiency and lifespan of the EL device when using a host/dopant system, and thus its selection is important.

[6] Korean Patent Application Laying-Open No. 10-2014-0096203 discloses an organic electroluminescent device using indole derivatives and biscarbazole compounds as a plurality of host materials. However, it does not specifically disclose an organic electroluminescent device comprising a compound having a structure wherein benzo-carbazole and triazinyl are connected via a pyridine linker, as a host material.

Disclosure of Invention

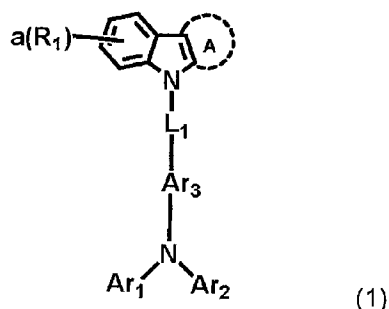
Technical Problem

[7] The objective of the present disclosure is to provide an organic electroluminescent device that has luminous efficiency at least equivalent to or higher than conventional devices and has lifespan longer than conventional devices.

Solution to Problem

[8] As a result of an earnest study for solving the above-described problems, the present inventors found that the above objective can be achieved by a host material that comprises one or more first host compounds and one or more second host compounds wherein the first host compound is represented by the following formula 1 and the second host compound is represented by the following formula 2.

[9]



[10] wherein

[11] L_1 represents a single bond or a substituted or unsubstituted (C6-C30)arylene,

[12] A represents hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted fluorenyl, a substituted or unsubstituted dibenzothiophenyl, or a substituted or unsubstituted dibenzofuranyl,

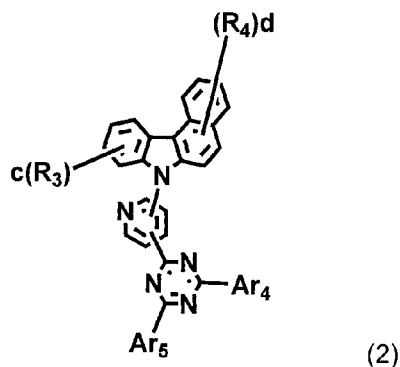
[13] Ar_1 , Ar_2 and Ar_3 , each independently, represent a substituted or unsubstituted (C6-C30)aryl(ene), or a substituted or unsubstituted 3- to 30-membered heteroaryl(ene); or Ar_2 and Ar_3 may be linked to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur,[14] R_1 represents 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-C30)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 R_1 may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring,

[15] wherein the heteroaryl(ene) contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P,

[16] a represents an integer of 0 to 4,

[17] and when a is an integer of 2 or more, each of R_1 may be the same or different;

[18]



[19] wherein

[20] Ar₄ and Ar₅, each independently, represent a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted 3- to 30-membered heteroaryl,

[21] R₃ and R₄, each independently, represent 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-C30)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,

[22] wherein the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P, and

[23] c represents an integer of 0 to 4; d represents an integer of 0 to 6; and when c or d is an integer of 2 or more, each of R₃ or R₄ may be the same or different.

Advantageous Effects of Invention

[24] The present disclosure provides an organic electroluminescent device that has luminous efficiency at least equivalent to or higher than conventional devices and has lifespan longer than conventional devices. Furthermore, a display system or a lighting system using the organic electroluminescent device of the present disclosure can be produced.

Mode for the Invention

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

[26] The host materials that comprise organic electroluminescent compounds represented by formula 1 above and represented by formula 2 above will be described in detail.

[27] In formula 1, L₁ may represent a single bond or a substituted or unsubstituted

(C6-C30)arylene, preferably a single bond or a substituted or unsubstituted (C6-C25)arylene, more preferably a single bond or a substituted or unsubstituted (C6-C18)arylene, and may include a single bond, an unsubstituted phenylene, an unsubstituted naphthylene, and an unsubstituted biphenylene.

[28] In formula 1, A may represent hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted fluorenyl, a substituted or unsubstituted dibenzothiophenyl, or a substituted or unsubstituted dibenzofuranyl, preferably hydrogen, an unsubstituted phenyl, a fluorenyl substituted with one or more methyl, an unsubstituted naphthyl, an unsubstituted dibenzothiophenyl, or an unsubstituted dibenzofuranyl; and the substituted fluorenyl may be a fluorenyl substituted with dimethyl.

[29] In formula 1, Ar₁ to Ar₃, each independently, may represent a substituted or unsubstituted (C6-C30)aryl(ene), or a substituted or unsubstituted 3 to 30-membered heteroaryl(ene); Ar₂ and Ar₃ may be linked to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; preferably, Ar₁ to Ar₃, each independently, may represent a substituted or unsubstituted (C6-C25)aryl(ene); Ar₂ and Ar₃ may be linked to form a substituted or unsubstituted 5 to 25-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; more preferably, Ar₁ to Ar₃, each independently, may represent a substituted or unsubstituted (C6-C20)aryl(ene); Ar₂ and Ar₃ may be linked to form a substituted or unsubstituted 5 to 20-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with nitrogen. For example, Ar₁ and Ar₂ may be a phenyl substituted or unsubstituted with naphthyl or phenanthrenyl, an unsubstituted biphenyl, an unsubstituted terphenyl, a fluorenyl substituted with dimethyl, or a benzofluorenyl substituted with dimethyl; Ar₃ may represent an unsubstituted phenylene, an unsubstituted naphthylene, or a fluorenylene substituted with dimethyl; and Ar₂ and Ar₃ may be linked to form an unsubstituted carbazole.

[30] In formula 1, R₁ may represent 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-C30)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

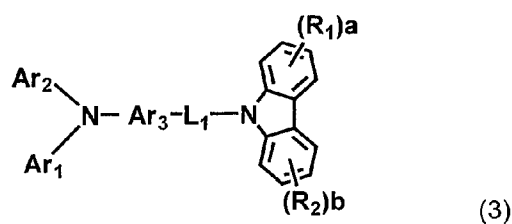
di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or R₁ may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring; preferably, R₁ may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 5 to 25-membered, mono- or polycyclic aromatic ring; more preferably, R₁ may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 5 to 18-membered, mono- or polycyclic, aromatic ring; specifically, the aromatic ring formed by linking the adjacent substituents may be selected from the group consisting of a benzene, an indole, an indene, a benzofuran and a benzothiophene, substituted or unsubstituted with a (C1-C10)alkyl or a (C6-C15)aryl; for example, the adjacent substituents may be linked to form an unsubstituted benzene, an indene substituted with dimethyl, an unsubstituted benzofuran or an unsubstituted benzothiophene.

- [31] In formula 1, a represents an integer of 0 to 4, preferably an integer of 0 to 2; and when a is an integer of 2 or more, each of R₁ may be the same or different.
- [32] In formula 2, Ar₄ and Ar₅, each independently, may represent a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted 3- to 30-membered heteroaryl; preferably, each independently, may represent a substituted or unsubstituted (C6-C25)aryl; more preferably, each independently, may represent an unsubstituted (C6-C18)aryl, such as, an unsubstituted phenyl, an unsubstituted naphthyl, or an unsubstituted biphenyl.
- [33] In formula 2, R₃ and R₄, each independently, may represent 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-C30)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; preferably, each independently, may represent a substituted or unsubstituted (C6-C25)aryl; or more preferably, each independently, may represent an unsubstituted (C6-C20)aryl, such as an unsubstituted phenyl, or an unsubstituted terphenyl.
- [34] In formula 2, c may represent an integer of 0 to 4; d may represent an integer of 0 to 6; preferably, c and d, each independently, may represent 0 or 2; more preferably, c and d, each independently, may represent 0 or 1. When each of c or d represents an integer of 2 or more, each of R₃ or R₄ may be the same or different.
- [35] In formulae 1 and 2, the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P; preferably, one or more heteroatoms

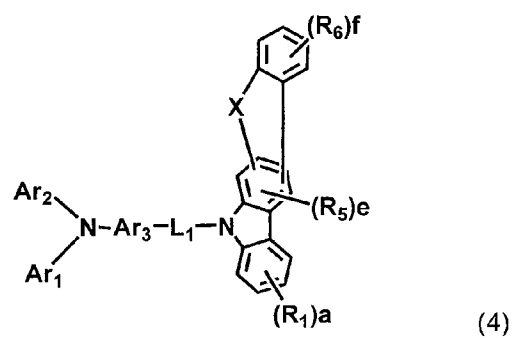
selected from the group consisting of N, O, and S.

[36] The compound of formula 1 of the present disclosure may be represented by any one of the following formulae 3 to 7:

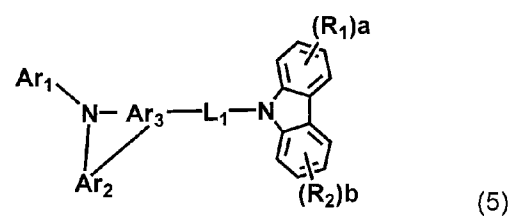
[37]



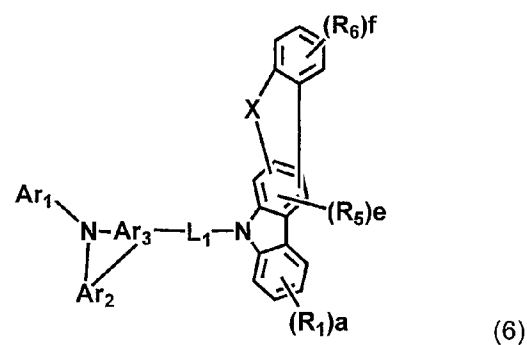
[38]



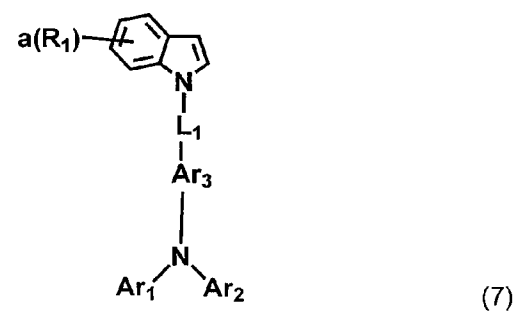
[39]



[40]



[41]



[42] In formulae 3 to 7, Ar₁ to Ar₃, each independently, may represent a substituted or un-

substituted (C6-C30)aryl(ene), or a substituted or unsubstituted 3 to 30-membered heteroaryl(ene); preferably, a substituted or unsubstituted (C6-C25)aryl(ene); more preferably a substituted or unsubstituted (C6-C20)aryl(ene); for example, Ar₁ and Ar₂, each independently, may represent a phenyl substituted or unsubstituted with naphthyl or phenanthrenyl, an unsubstituted biphenyl, an unsubstituted terphenyl, a fluorenyl substituted with dimethyl, or a benzofluorenyl substituted with dimethyl; and Ar₃ may represent an unsubstituted phenylene, an unsubstituted naphthylene, or a fluorenylene substituted with dimethyl.

[43] In formulae 4 and 6, X may represent S, O or CR₇R₈, preferably S or O.

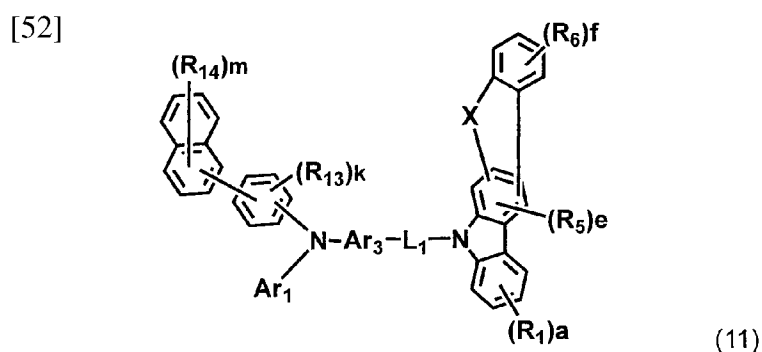
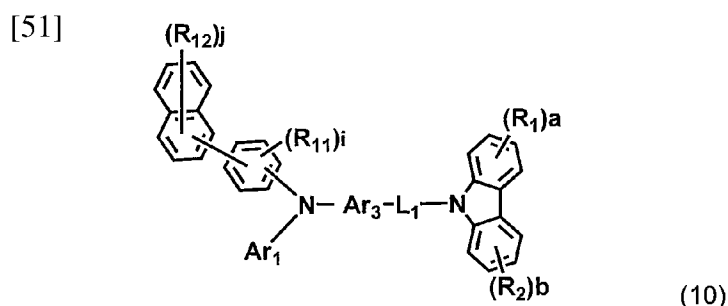
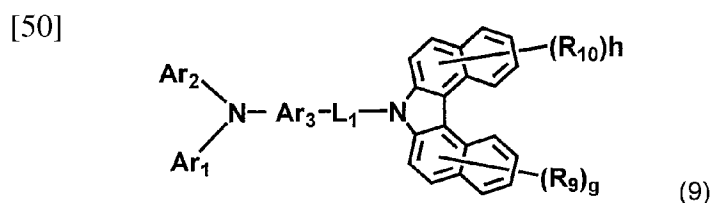
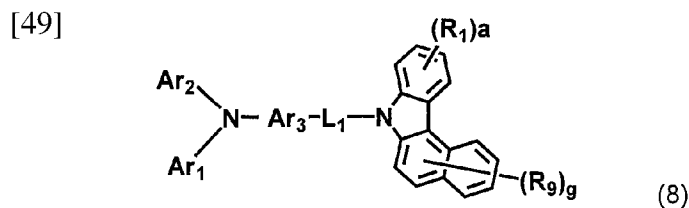
[44] In formulae 3 to 6, R₂ and R₅ to R₈, each independently, may represent deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)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 R₂ and R₅ to R₈, each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; or preferably, R₂ and R₅ to R₈, each independently, may represent a substituted or unsubstituted (C1-C20)alkyl; or R₂ and R₅ to R₈, each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 5 to 25-membered, mono- or polycyclic, aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; or more preferably, R₂ and R₅ to R₈, each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 5 to 18-membered, mono- or polycyclic, aromatic ring; for example, the adjacent substituents may be linked to form an unsubstituted benzene ring, or an indene ring substituted with dimethyl.

[45] In formulae 3 to 7, the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P; preferably, one or more heteroatoms selected from the group consisting of N, O, and S.

[46] In formulae 3 to 7, b and f, each independently, may represent an integer of 0 to 4, and e may represent an integer of 0 to 2; when each of b or f represents an integer of 2 or more, or when e represents an integer of 2, each of R₂, R₅, or R₆ may be the same or different. Preferably, b and f, each independently, may represent an integer of 0 to 2, and e may represent an integer of 0.

[47] In formulae 3 to 7, L_1 , R_1 , and a are as defined in formula 1 above.

[48] The compound of formula 3 of the present disclosure may be represented by any one of the following formulae 8 to 10, and the compound of formula 4 of the present disclosure may be represented by the following formula 11:

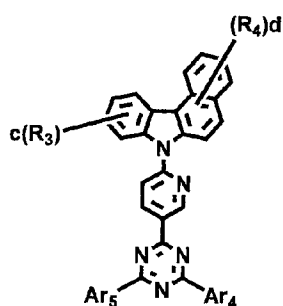


[53] In formulae 8 to 11, R_9 to R_{14} , each independently, may represent deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)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; R_9 to R_{14} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring

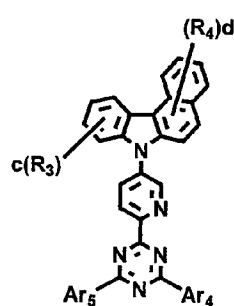
and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; preferably, R_9 to R_{14} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 5 to 25-membered, mono- or polycyclic, aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; or more preferably, R_9 to R_{14} , each independently, may be linked to an adjacent substituent(s) to form an unsubstituted 5 to 18-membered, mono- or polycyclic, aromatic ring; for example, R_9 to R_{14} , each independently, may be linked to an adjacent substituent(s) to form an unsubstituted benzene ring.

- [54] In formulae 8 to 11, the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P; preferably, one or more heteroatoms selected from the group consisting of N, O, and S.
- [55] In formulae 8 to 11, g and h, each independently, may represent an integer of 0 to 6; i and k, each independently, may represent an integer of 0 to 4; j and m, each independently, may represent an integer of 0 to 7; when each of g, h, i, j, k or m represents an integer of 2 or more, each of R_9 , R_{10} , R_{11} , R_{12} , R_{13} , or R_{14} may be the same or different. Preferably, g, h, i, and k, each independently, may represent 0, and, j and m, each independently, may represent 0 or 2.
- [56] In formulae 8 to 11, L_1 , R_1 , R_2 , R_5 , R_6 , Ar_1 to Ar_3 , a, b, e, and f are as defined in formulae 3 to 7.
- [57] According to one embodiment of the present disclosure, the compound of formula 2 of the present disclosure may be represented by any one of the following formulae 12 to 16:

[58]

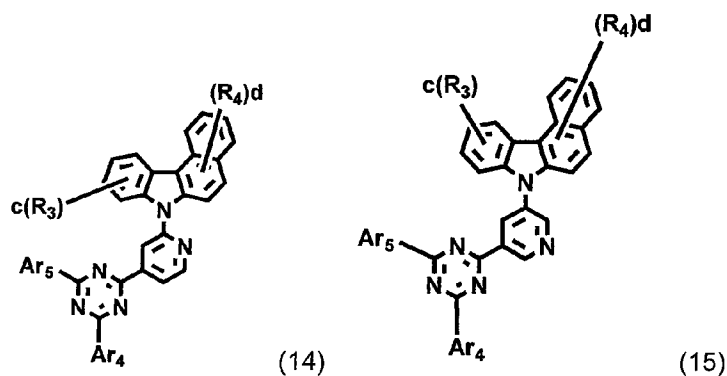


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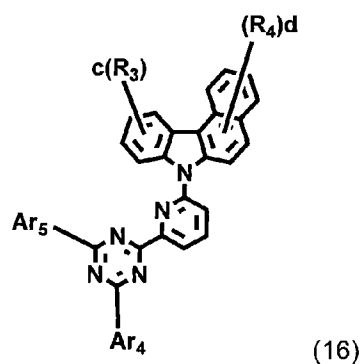


(13)

[59]



[60]



[61] In formulae 12 to 16, R₃, R₄, Ar₄, Ar₅, c, and d are as defined in formula 2.

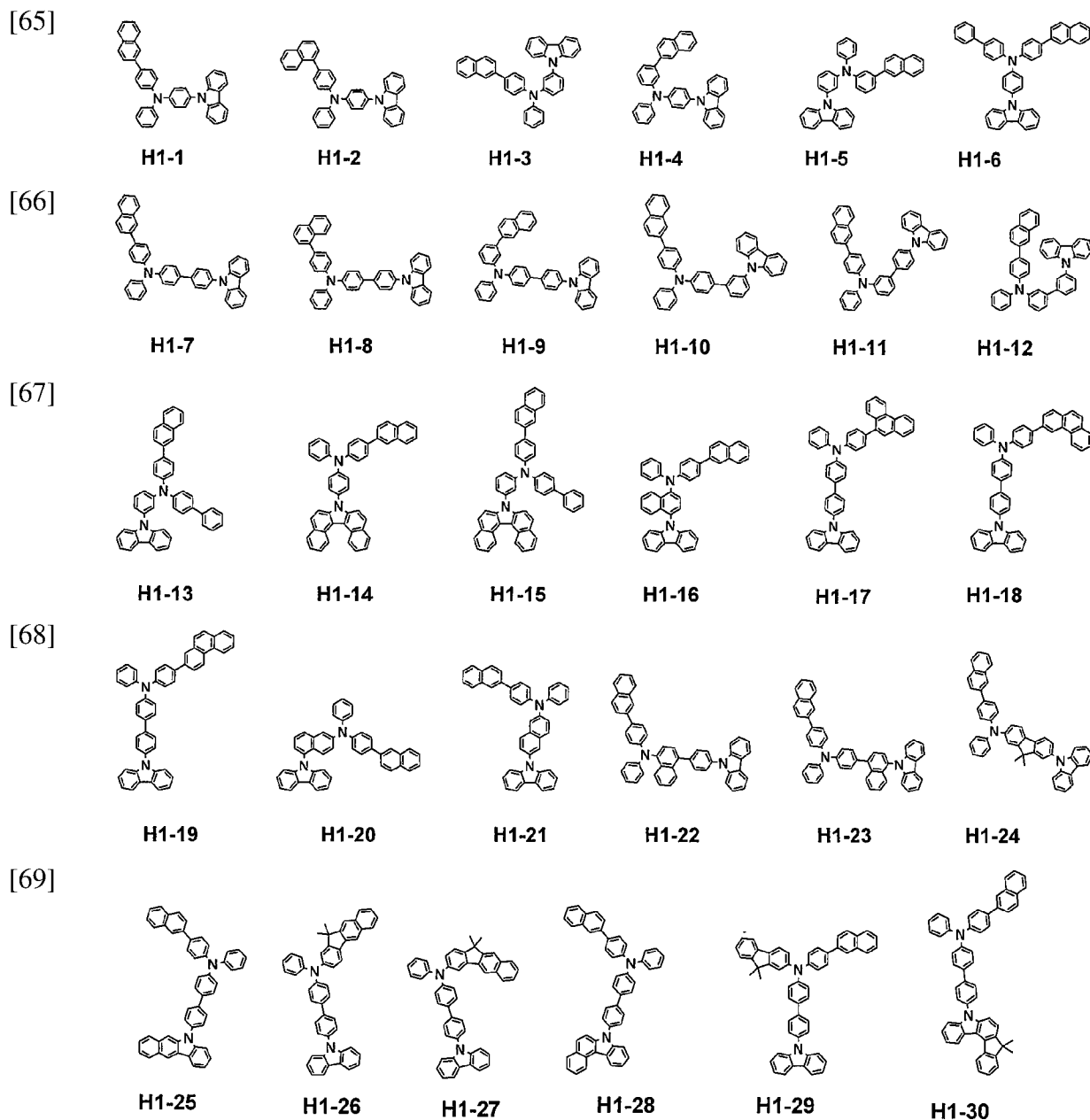
[62] Herein, “(C1-C30)alkyl” indicates a linear or branched alkyl having 1 to 30, preferably 1 to 20, and more preferably 1 to 10 carbon atoms, and includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc. “(C2-C30) alkenyl” indicates a linear or branched alkenyl having 2 to 30, preferably 2 to 20, and more preferably 2 to 10 carbon atoms and includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, etc. “(C2-C30)alkynyl” indicates a linear or branched alkynyl having 2 to 30, preferably 2 to 20, and more preferably 2 to 10 carbon atoms and includes ethynyl, 1-propynyl, 2-propynyl, 1-butyne, 2-butyne, 3-butyne, 1-methylpent-2-ynyl, etc. Herein, “(C3-C30)cycloalkyl” indicates a mono- or polycyclic hydrocarbon having 3 to 30, preferably 3 to 20, more preferably 3 to 7 ring backbone carbon atoms. The cycloalkyl includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc. Herein, “3 to 7-membered heterocycloalkyl” indicates a cycloalkyl having 3 to 7, preferably 5 to 7 ring backbone atoms including at least one heteroatom selected from B, N, O, S, Si, and P; preferably O, S, and N, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc. Herein, “(C6-C30)aryl(ene)” indicates a monocyclic ring-type or fused ring-type radical derived from aromatic hydrocarbon having 6 to 30, preferably 6 to 20 ring backbone carbon atoms wherein the (C6-C30)aryl(ene) may be partially saturated. The aryl includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenylnaphthyl, naphthylphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl,

phenanthrenyl, phenylphenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc. Herein, “3 to 30-membered heteroaryl(ene)” indicates an aryl group having 3 to 30 ring backbone atoms including at least one, preferably 1 to 4, heteroatoms selected from the group consisting of B, N, O, S, Si, and P; may be a monocyclic ring, or a fused ring condensed with at least one benzene ring; may be partially saturated; may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); and includes a monocyclic ring-type heteroaryl such as furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl such as benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, benzoindolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, naphthyridyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc. Further, “halogen” includes F, Cl, Br, and I.

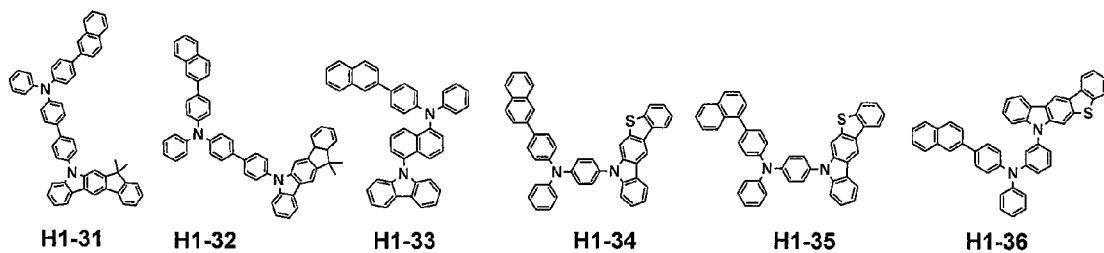
- [63] Furthermore, herein, “substituted” in the expression, “substituted or unsubstituted,” means that a hydrogen atom in a certain functional group is replaced with another atom or group, i.e. a substituent. The substituents of the substituted aryl(ene), the substituted heteroaryl(ene), the substituted alkyl, the substituted alkenyl, the substituted alkynyl, the substituted cycloalkyl, the substituted trialkylsilyl, the substituted triarylsilyl, the substituted dialkylarylsilyl, the substituted mono- or di-arylamino, the substituted phenyl, the substituted naphthyl, the substituted fluorenyl, the substituted dibenzothiophenyl, the substituted dibenzofuranyl, and the substituted, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring in L₁, A, Ar₁ to Ar₅, and R₁ to R₁₄ of formulae 1 to 11 of the present disclosure, each independently, are at least one selected from the group consisting of deuterium, a halogen; a cyano; a carboxy; 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 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 or di(C6-C30)arylamino; 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, each independently, are at least one selected from the group consisting of a (C1-C20)alkyl, and an unsubstituted (C6-C25)aryl; more preferably, each independently, are at least one selected from the group consisting of a (C1-C10)alkyl, and an unsubstituted (C6-C18)aryl; and the substituent may include methyl, an unsubstituted naphthyl or an unsubstituted phenanthrenyl.

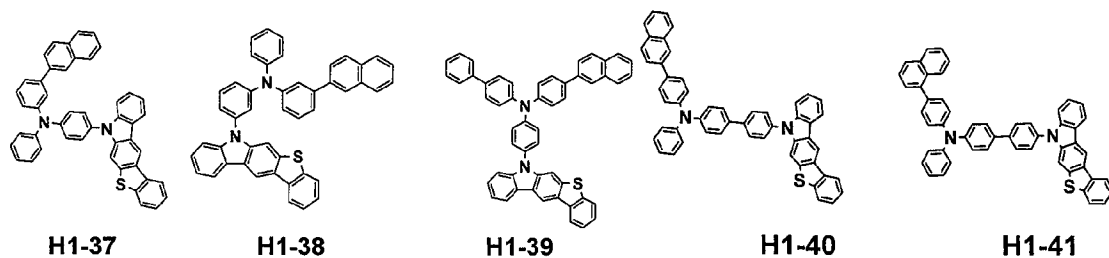
[64] The first host compound of formula 1 of the present disclosure includes the following, but is not limited thereto:



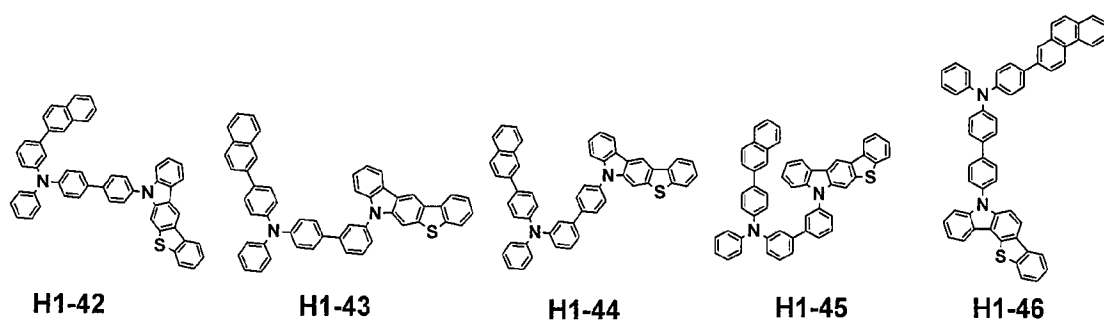
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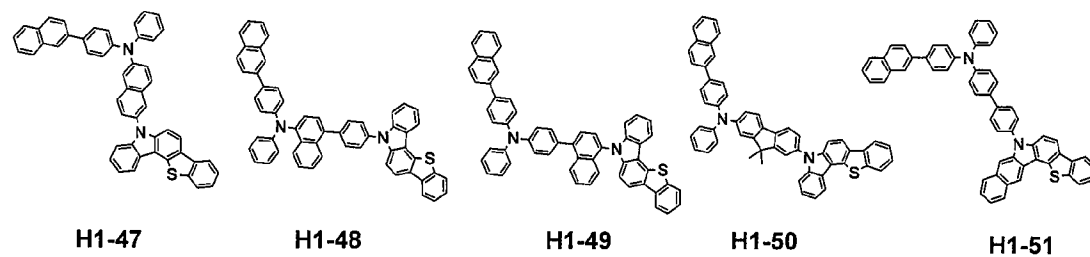
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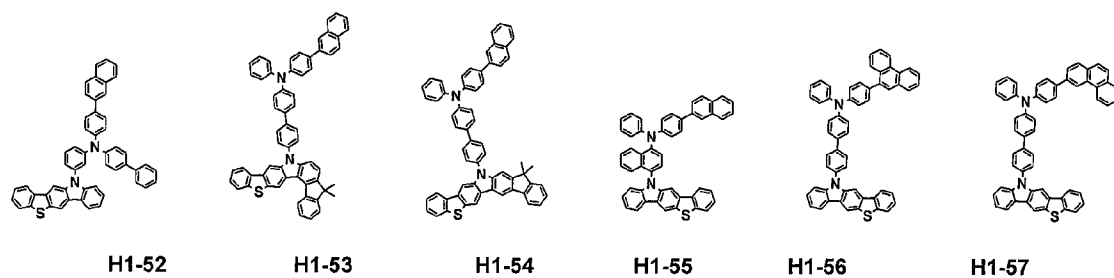
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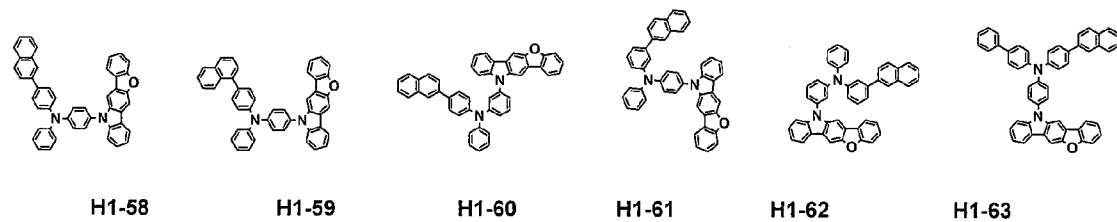
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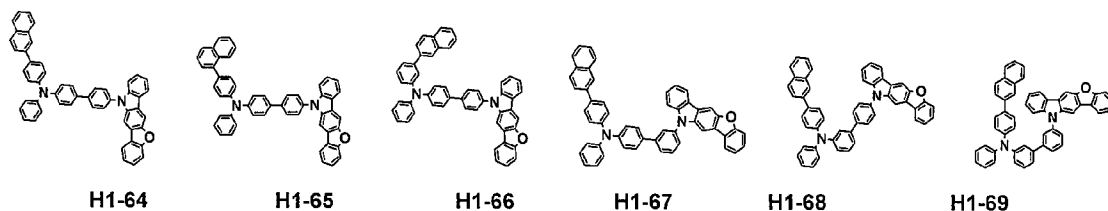
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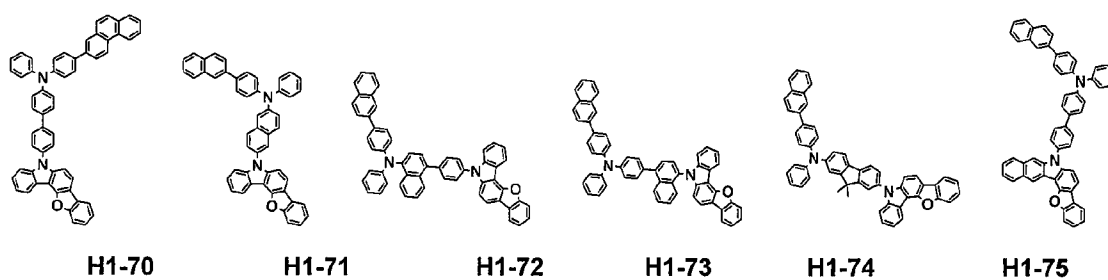
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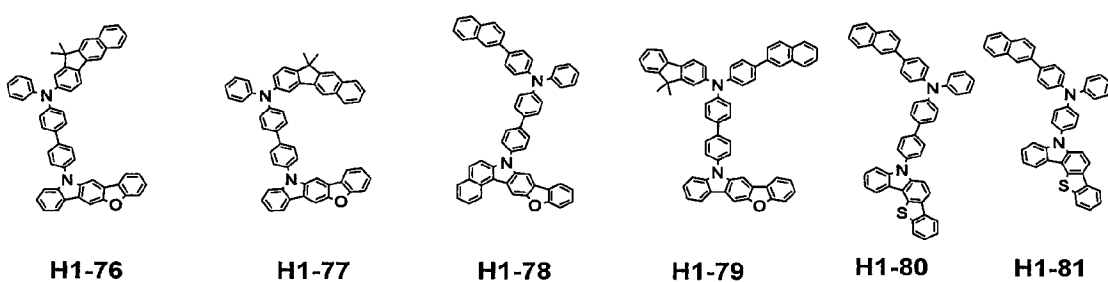
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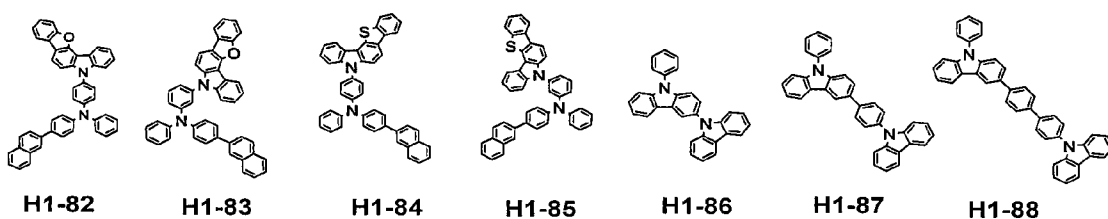
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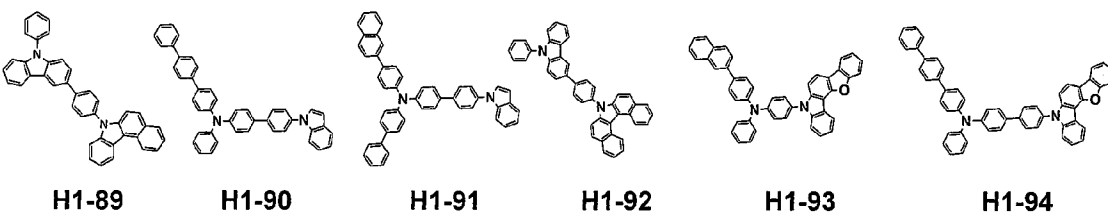
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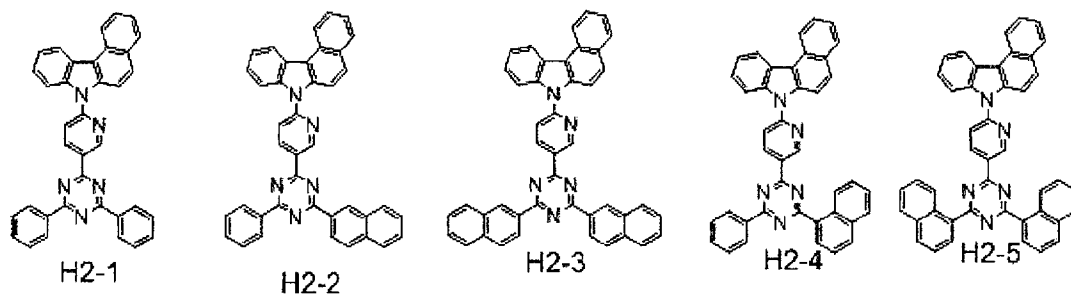


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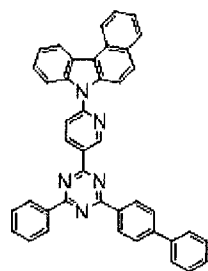


[81] The second host compound of formula 2 above of the present disclosure includes the following, but is not limited thereto:

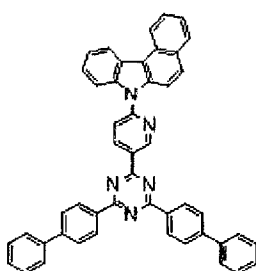
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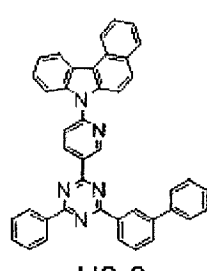
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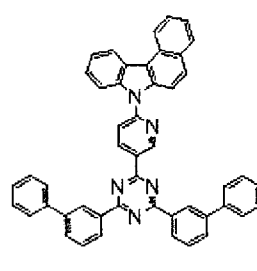
H2-6



H2-7

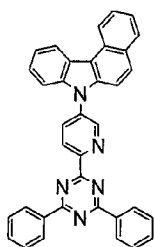


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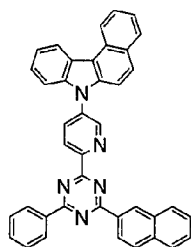


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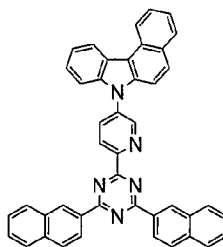
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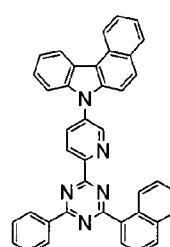
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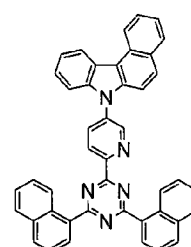
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H2-12

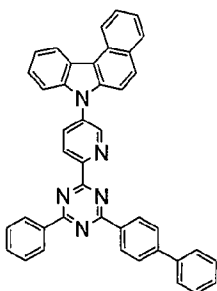


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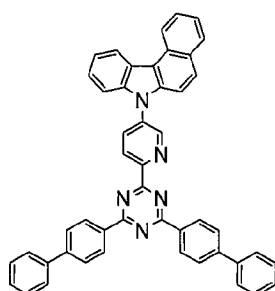


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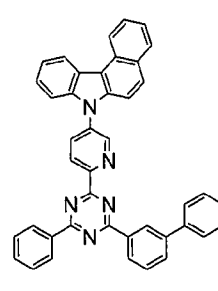
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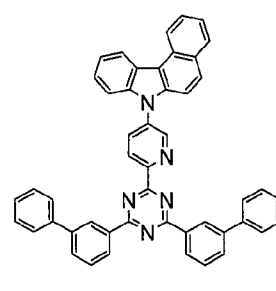
H2-15



H2-16

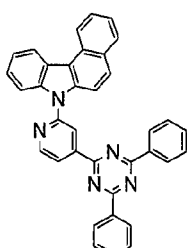


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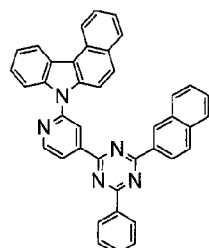


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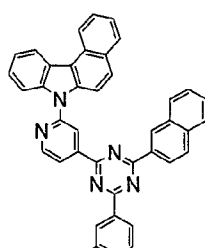
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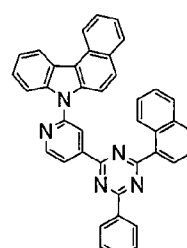
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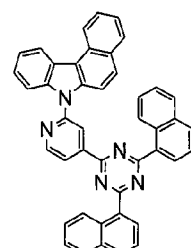
H2-20



H2-21

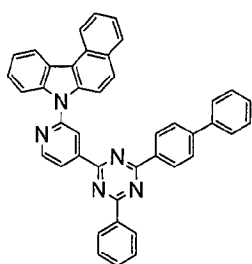


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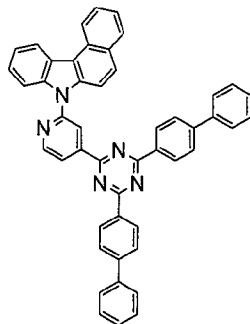


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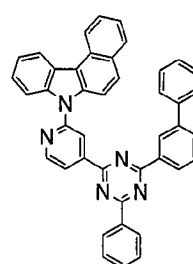
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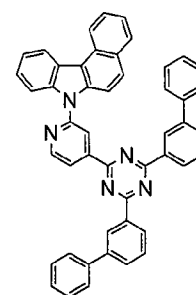
H2-24



H2-25

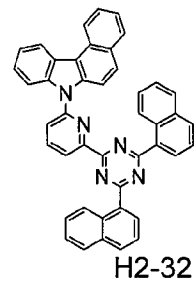
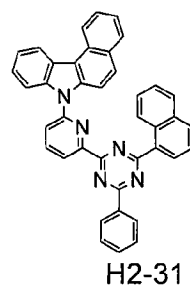
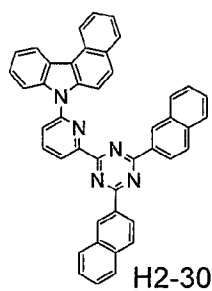
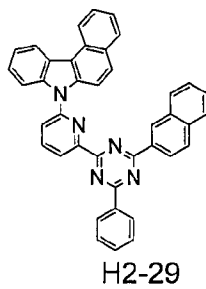
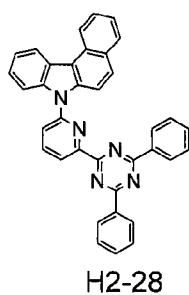


H2-26

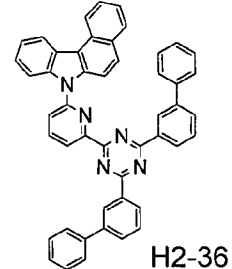
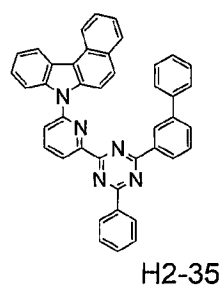
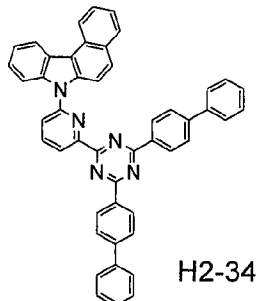
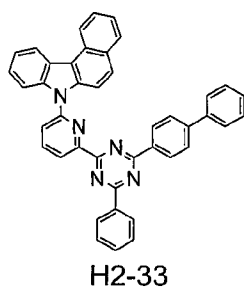


H2-27

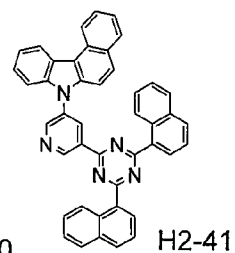
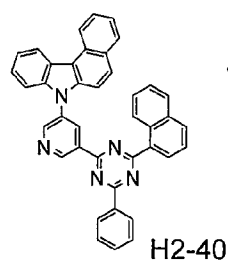
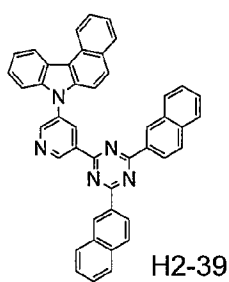
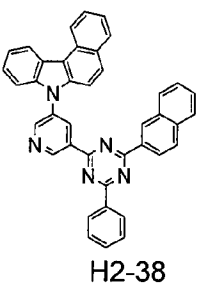
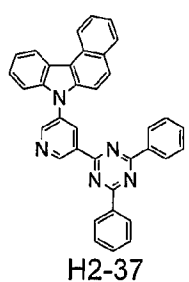
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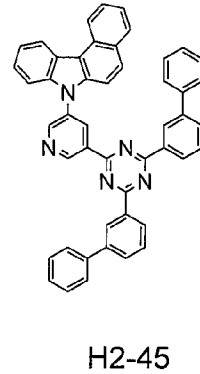
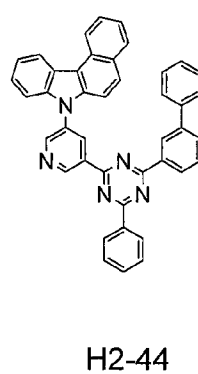
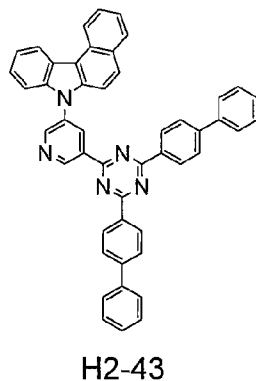
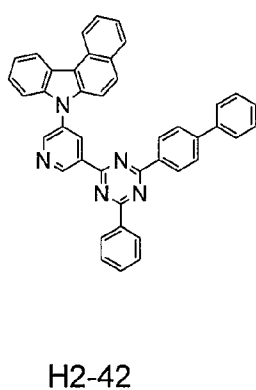
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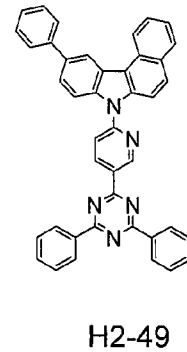
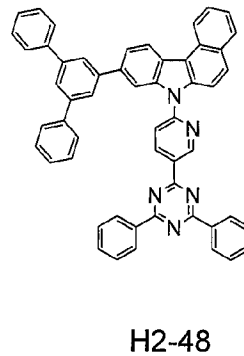
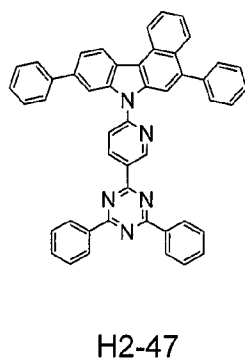
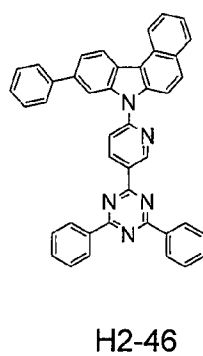
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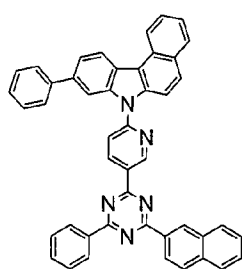
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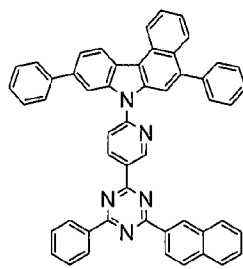
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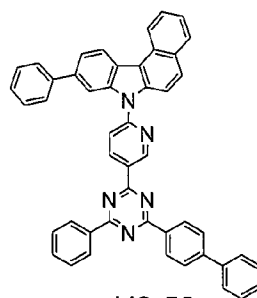
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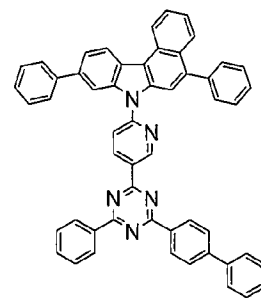
H2-50



H2-51

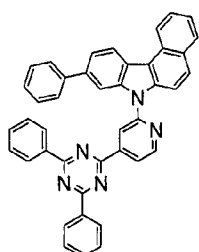


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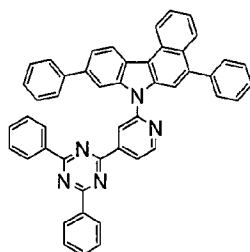


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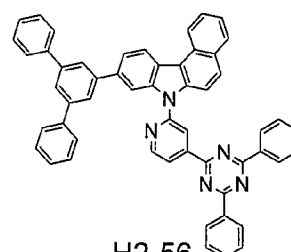
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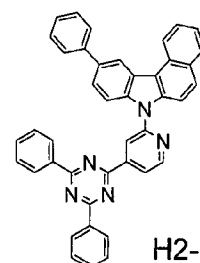
H2-54



H2-55

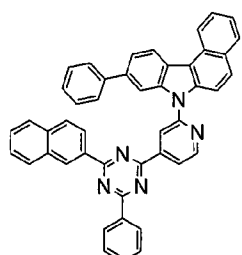


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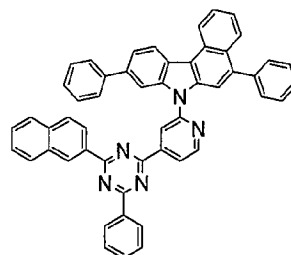


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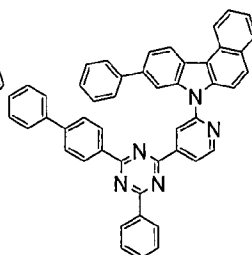
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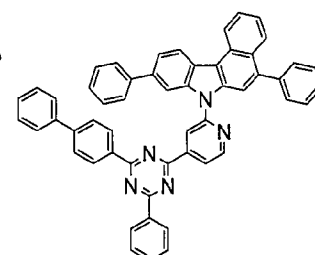
H2-58



H2-59

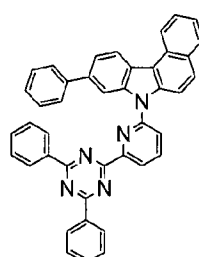


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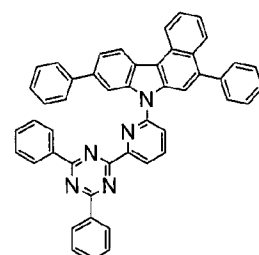


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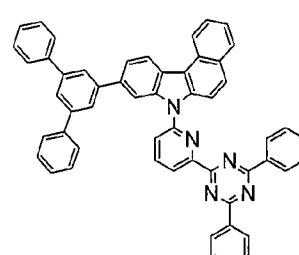
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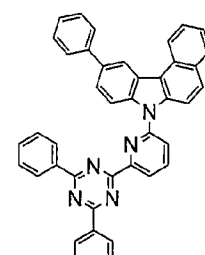
H2-62



H2-63

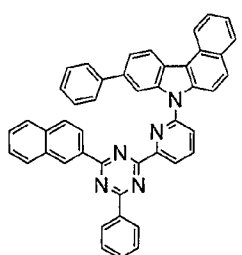


H2-64

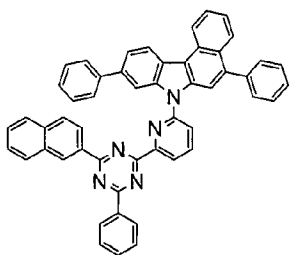


H2-65

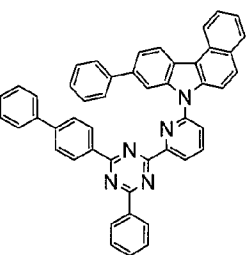
[97]



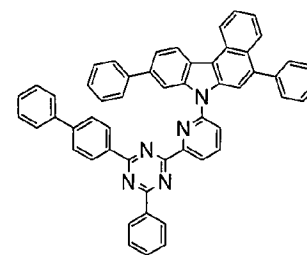
H2-66



H2-67



H2-68



H2-69

[98]

The compound of formula 1 and the compound of formula 2 of the present disclosure

can be prepared by a synthetic method known to one skilled in the art, e.g., bromination, Suzuki reaction, Buchwald-Hartwig reaction, Ullmann reaction, etc.

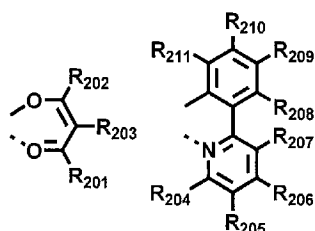
- [99] According to another embodiment of the present disclosure, a combination comprising the compound of formula 1 and the compound of formula 2 is provided. The combination above may be a combination that is comprised in a light-emitting layer of an organic electroluminescent device. In the combination of the present disclosure, the weight ratio in the light-emitting layer between the compound of formula 1 and the compound of formula 2 is in the range of 1:99 to 99:1, and preferably 30:70 to 70:30 in view of driving voltage, luminous efficiency, and lifespan.
- [100] The organic electroluminescent device of the present disclosure comprises an anode, a cathode, and one or more light-emitting layers disposed between the anode and cathode, wherein the light-emitting layers comprise a dopant and a host; the host comprises two or more host compounds; and a first host compound of the host compounds is represented by the formula 1 above; and a second host compound is represented by formula 2 above.
- [101] The light-emitting layer indicates a layer or plural layers consisting of two or more stacked layers, from which light is emitted. It is preferable that a doping amount of the dopant compound is less than 20 wt% based on the total amount of the host compound and the dopant compound. In the organic electroluminescent device of the present disclosure, the weight ratio in the light-emitting layer between the first host material and the second host material is in the range of 1:99 to 99:1, and preferably 30:70 to 70:30 in view of driving voltage, luminous efficiency, and lifespan.
- [102] The dopant for the organic electroluminescent device of the present disclosure is preferably one or more phosphorescent dopant compounds. The phosphorescent dopant compound for the organic electroluminescent device of the present disclosure is not limited, but may be preferably selected from metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu) or platinum (Pt), more preferably selected from ortho-metallated complex compounds of iridium (Ir), osmium (Os), copper (Cu) or platinum (Pt), and even more preferably ortho-metallated iridium complex compounds.
- [103] The phosphorescent dopant may be preferably selected from the compound of the following formulae 101 to 103:

$$\left[\begin{array}{c} \text{R}_{103} \\ \text{R}_{104} \quad \text{R}_{102} \\ \text{R}_{105} \quad \text{R}_{101} \\ \text{(R}_{100\text{)}}_r \text{---} \text{C}_5\text{H}_4\text{N} \text{---} \\ \text{R}_{106} \\ \text{R}_{107} \quad \text{R}_{109} \\ \text{R}_{108} \end{array} \right]_e \text{--- Ir-L}_{3-e} \quad (101)$$

(102)

$$\left[\begin{array}{c} \text{R}_{121} \\ \text{R}_{122} \quad \text{R}_{120} \\ \text{R}_{123} \quad \text{N} \\ \text{R}_{124} \\ \text{R}_{125} \quad \text{R}_{126} \quad \text{R}_{127} \end{array} \right] \text{Ir-L}_{3-e} \quad (103)$$

[108]

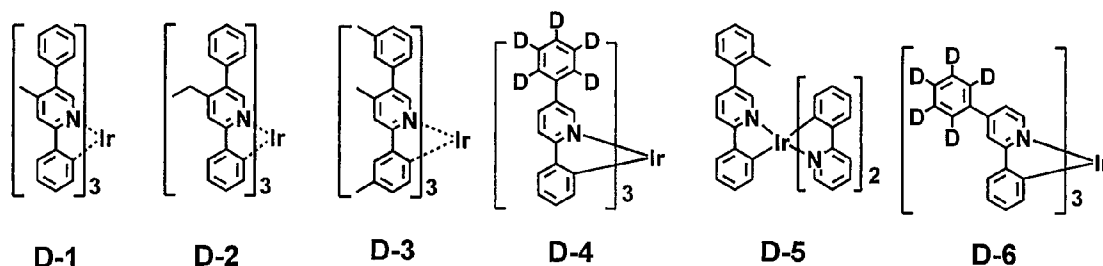


[110] R₁₀₁ to R₁₀₉ and R₁₁₁ to R₁₂₃, each independently, represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl substituted or unsubstituted with a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-C30)aryl; R₁₂₀ to R₁₂₃, each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, for example, a quinoline; R₁₂₄ to R₁₂₇, each independently, represent hydrogen, deuterium, a halogen, a substituted or

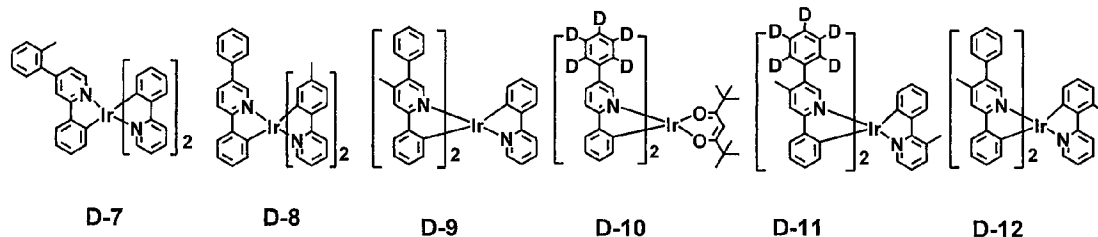
unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; when R_{124} to R_{127} , each independently, are an aryl, R_{124} to R_{127} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or (hetero)aromatic ring, or a combination of the alicyclic ring and the (hetero)aromatic ring, for example, a fluorene, a dibenzothiofene, a dibenzofuran; R_{201} to R_{211} , each independently, represent hydrogen, deuterium, a halogen, or a (C1-C30)alkyl substituted or unsubstituted with a halogen; R_{208} to R_{211} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic, aromatic, or heteroaromatic ring, or a combination of the alicyclic ring, the aromatic ring, and the heteroaromatic ring, for example, a fluorene, a dibenzothiofene, a dibenzofuran; r and s , each independently, represent an integer of 1 to 3; when r or s is an integer of 2 or more, each of R_{100} may be the same or different; and e represents an integer of 1 to 3.

[111] Specifically, the phosphorescent dopant includes the following:

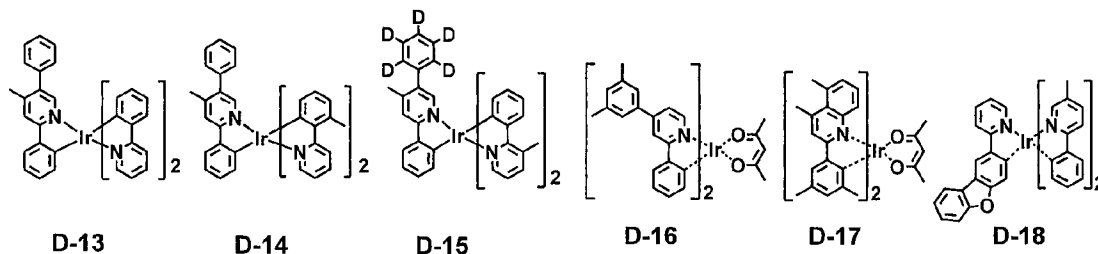
[112]



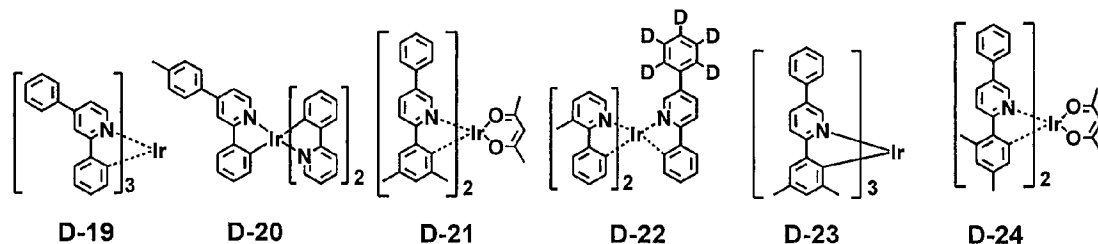
[113]



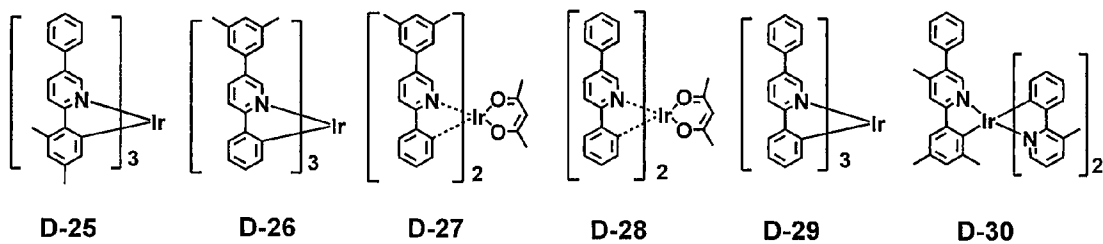
[114]



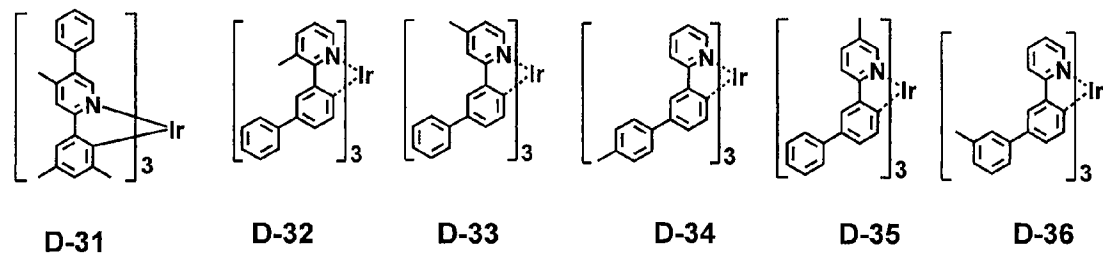
[115]



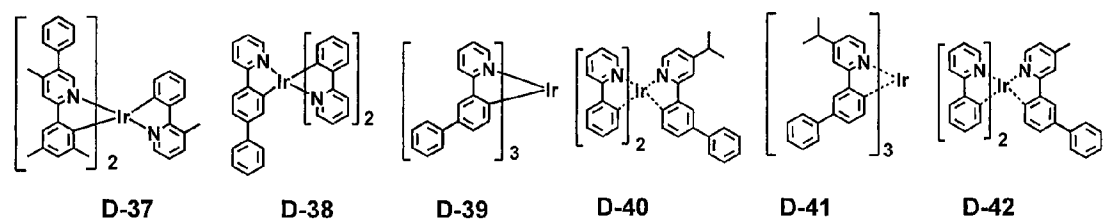
[116]



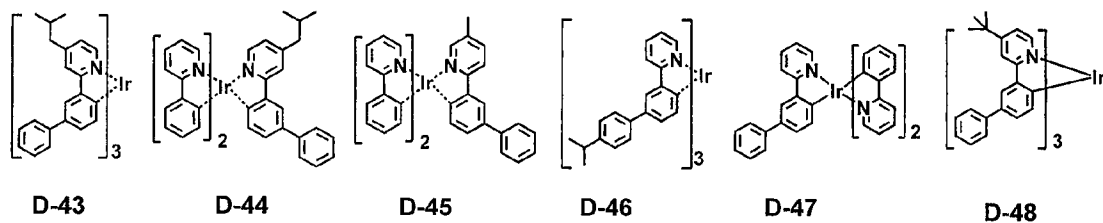
[117]



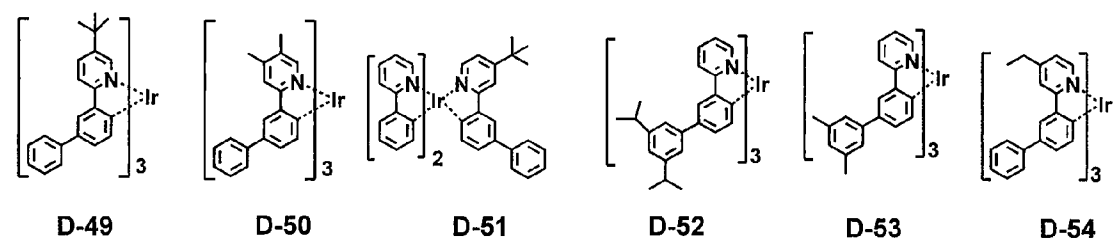
[118]



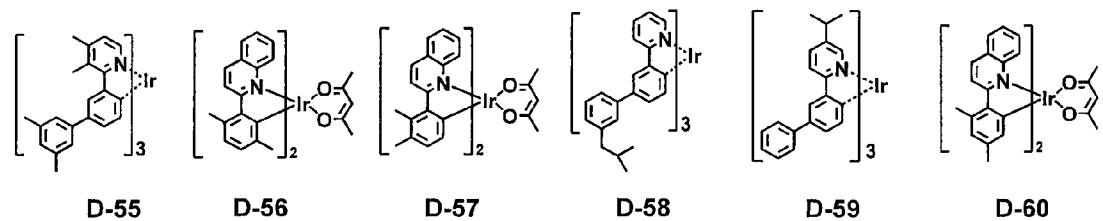
[119]



[120]



[121]



[illegible]

The figure displays six chemical structures of Ir(III) complexes, labeled D-67 through D-72. Each complex consists of an iridium center coordinated by two bipyridine-type ligands and two acetylacetonate (acac) ligands. The ligands are defined as follows:

- D-67:** Two equivalents of 2,2'-bis(4-methylphenyl)-5,5'-bibenzimidazole.
- D-68:** Two equivalents of 2,2'-bis(4-methylphenyl)-5,5'-bibenzimidazole.
- D-69:** Two equivalents of 2,2'-bis(4-isopropylphenyl)-5,5'-bibenzimidazole.
- D-70:** Two equivalents of 2,2'-bis(4-(propylthio)phenyl)-5,5'-bibenzimidazole.
- D-71:** Two equivalents of 2,2'-bis(4-isopropylphenyl)-5,5'-bibenzimidazole.
- D-72:** Two equivalents of 2,2'-bis(4-methylphenyl)-5,5'-bibenzimidazole.

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

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

[illegible][illegible]



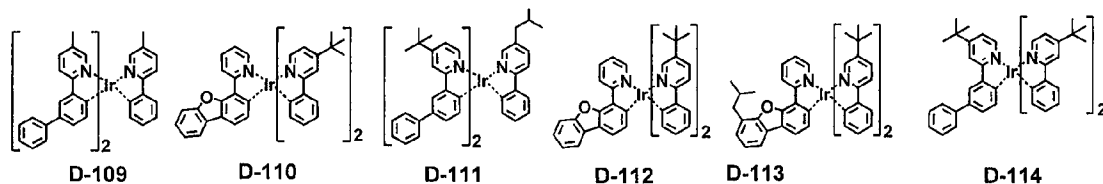




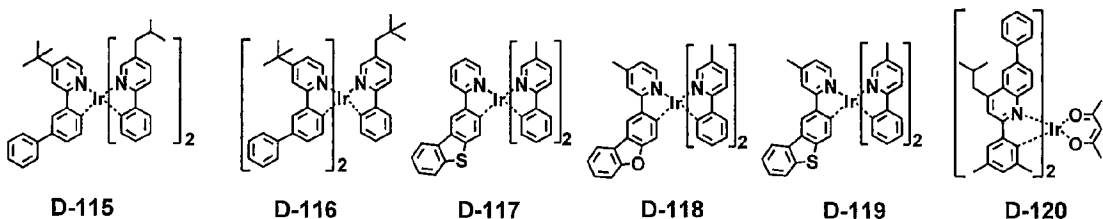

D-97 **D-98** **D-99** **D-100** **D-101** **D-102**

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

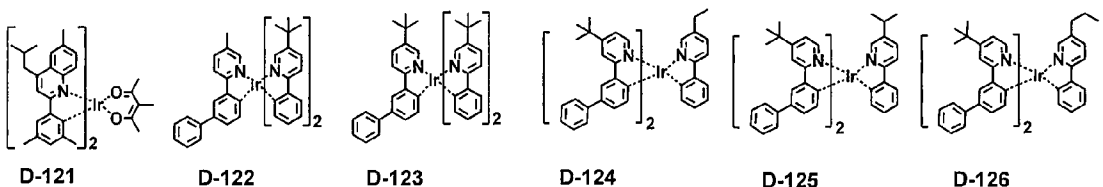
[130]



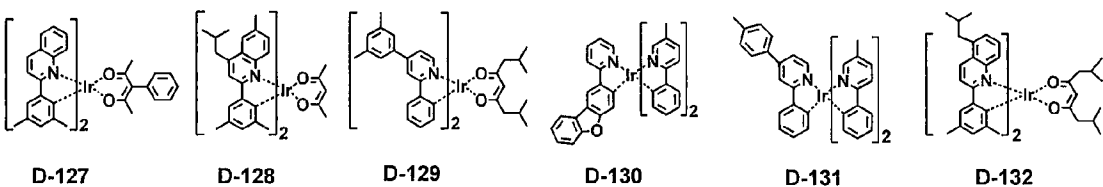
[131]



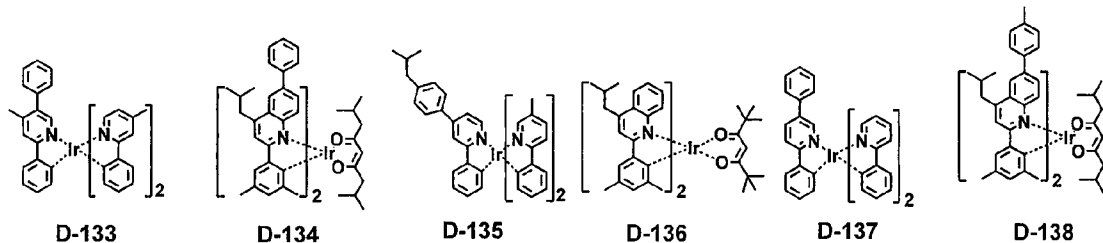
[132]



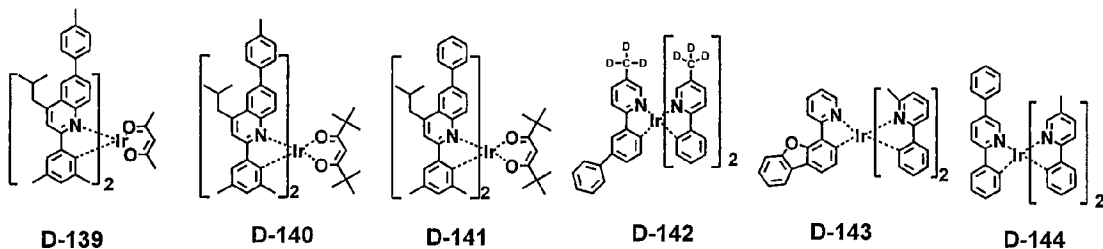
[133]



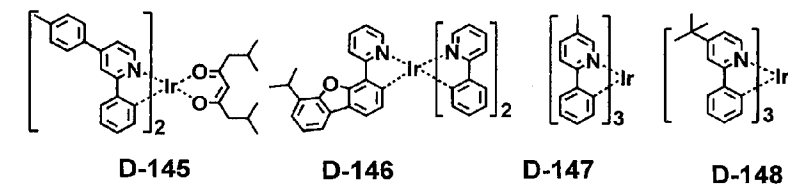
[134]



[135]



[136]



[137]

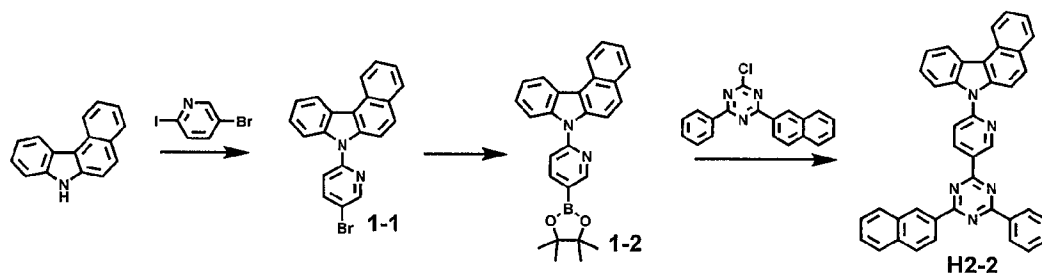
The organic electroluminescent device of the present disclosure may further comprise at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds in the organic layer.

- [138] In the organic electroluminescent device of the present disclosure, the organic layer may further comprise at least one metal selected from the group consisting of metals of Group 1, metals of Group 2, transition metals of the 4th period, transition metals of the 5th period, lanthanides and organic metals of the d-transition elements of the Periodic Table, or at least one complex compound comprising the metal.
- [139] In the organic electroluminescent device of the present disclosure, preferably, at least one layer (hereinafter, "a surface layer") may be placed on an inner surface(s) of one or both electrode(s), selected from a chalcogenide layer, a metal halide layer and a metal oxide layer. Specifically, a chalcogenide (includes oxides) layer of silicon or aluminum is preferably placed on an anode surface of an electroluminescent medium layer, and a metal halide layer or a metal oxide layer is preferably placed on a cathode surface of an electroluminescent medium layer. Such a surface layer provides operation stability for the organic electroluminescent device. Preferably, the chalcogenide includes SiO_x ($1 \leq x \leq 2$), AlO_x ($1 \leq x \leq 1.5$), SiON , SiAlON , etc.; the metal halide includes LiF , MgF_2 , CaF_2 , a rare earth metal fluoride, etc.; and the metal oxide includes Cs_2O , Li_2O , MgO , SrO , BaO , CaO , etc.
- [140] In the organic electroluminescent device of the present disclosure, a hole injection layer, a hole transport layer, a hole auxiliary layer, an auxiliary light-emitting layer, or an electron blocking layer, or a combination thereof may be disposed between the anode and the light-emitting layer. The hole injection layer may be composed of two or more layers in order to lower an energy barrier for injecting holes from the anode to a hole transport layer or an electron blocking layer (or a voltage for injecting a hole). Each of the layers may comprise two or more compounds. The hole transport layer or electron blocking layer may be composed of two or more layers. Wherein the hole auxiliary layer or the auxiliary light-emitting layer is disposed between the hole transport layer and the light-emitting layer, and modulates hole mobility. The hole auxiliary layer or the auxiliary light-emitting layer has the effects to provide improved efficiency and lifespan of the organic electroluminescent device.
- [141] An electron buffering layer, a hole blocking layer, an electron transport layer, an electron injection layer, or a combination thereof may be disposed between the light-emitting layer and the cathode. The electron buffering layer may be composed of two or more layers in order to control the electron injection and improve characteristics of interface between the light-emitting layer and the electron injection layer. Each of the layers may comprise two or more compounds. The hole blocking layer or electron transport layer may be composed of two or more layers, and each of the layers may comprise two or more compounds.
- [142] In the organic electroluminescent device of the present disclosure, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole

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

- [143] In order to form each layer of the organic electroluminescent device of the present disclosure, any of 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. A co-evaporation or a mixture-evaporation is used for forming a film of the first host material and a film of the second host material. The co-evaporation indicates a process for two or more materials to be deposited as a mixture, by introducing each of the two or more materials into respective crucible cells, and applying electric current to the cells for each of the materials to be evaporated. Herein, a mixture-evaporation indicates a process for two or more materials to be deposited as a mixture, by mixing the two or more materials in one crucible cell before the deposition, and applying electric current to the cell for the mixture to be evaporated.
- [144] 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.
- [145] A display system or a lighting system using the organic electroluminescent device of the present disclosure can be produced.
- [146] Hereinafter, for a more in-depth understanding of the present disclosure, the luminescent properties of the organic electroluminescent device comprising the host compound of the present disclosure will be explained.
- [147] Hereinafter, the organic electroluminescent compound of the present disclosure, the preparation method and the physical properties of the compound, and the luminescent properties of the organic electroluminescent device comprising the compound will be explained in detail with reference to the following examples.
- [148] **[Example 1] Preparation of compound H2-2**

[149]

[150] 1) Preparation of compound 1-1

[151] After introducing a compound 7H-benzo[c]carbazole (30 g, 138.1 mmol), 5-bromo-2-iodopyridine (58.8 g, 207.1 mmol), CuI (12.5 g, 65.4 mmol), K₃PO₄ (73 g, 345.2 mmol), ethylene diamine (8.3 g, 138.1 mmol), and toluene (600 mL) into a flask, the mixture was stirred under reflux at 120°C for 4 hours. After completion of the reaction, the mixture was extracted with ethyl acetate and purified water, and the obtained organic layer was concentrated under reduced pressure. The organic layer was subjected to silica gel column chromatography (methylene chloride(MC):hexane(Hex)) to obtain compound **1-1** (16 g, yield: 31%).

[152] 2) Preparation of compound 1-2

[153] After introducing compound 1-1 (16 g, 42.86 mmol), pinacolatodiboron (13.1 g, 51.44 mmol), PdCl₂(PPh₃)₂ (3 g, 4.3 mmol), potassium acetate (KOAc) (10.5 g, 107 mmol), and 1,4-dioxane (200 mL) into a flask, the mixture was stirred under reflux at 120°C for 2 hours. After completion of the reaction, the mixture was extracted with ethyl acetate and purified water, and the obtained organic layer was dried under reduced pressure. The organic layer was subjected to silica gel column chromatography (MC:Hex) to obtain compound **1-2** (11 g, yield: 61%).

[154] 3) Preparation of compound H2-2

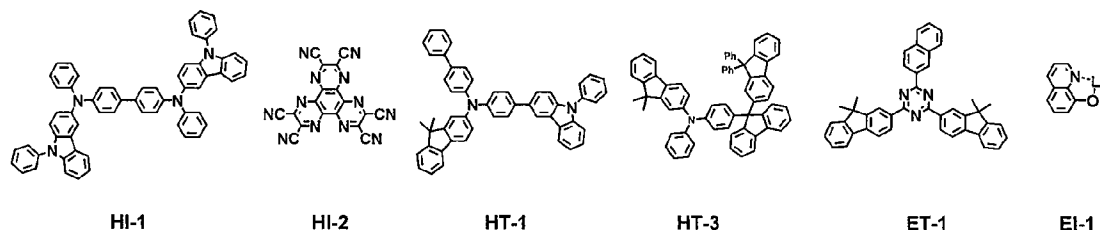
[155] After introducing compound 1-2 (11 g, 26.17 mmol), 2-chloro-4-(naphthalen-2-yl)-6-phenyl-1,3,5-triazine (8.3 g, 26.17 mmol), Na₂CO₃ (6.9 g, 65.42 mmol), Pd(PPh₃)₄ (1.5 g, 1.3 mmol), tetrahydrofuran (THF) (100 mL), and purified water (30 mL) into a flask, the mixture was stirred under reflux at 120°C for 4 hours. After completion of the reaction, the mixture was extracted with ethyl acetate and purified water, and the obtained organic layer was concentrated under reduced pressure. The organic layer was subjected to silica gel column chromatography (MC:Hex) to obtain compound **H2-2** (6.54 g, yield: 43.1 %).

[156] [Device Examples 1 to 4] OLED comprising a first host compound and a
 [157] second host compound of the present disclosure as a host

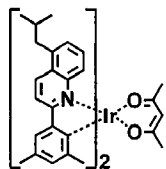
[158] An OLED was produced using the organic electroluminescent compound of the present disclosure as follows. A transparent electrode indium tin oxide (ITO) thin film (10 Ω/sq) on a glass substrate for an OLED (Geomatec) was subjected to an ultrasonic

washing with acetone, ethanol, and distilled water sequentially, and was then stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing apparatus. **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. **HI-2** was then introduced into another cell of said vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. **HT-1** was introduced into one cell of the vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a first hole transport layer having a thickness of 10 nm on the second hole injection layer. **HT-3** was introduced into another cell of the vacuum vapor depositing apparatus, and evaporated by applying electric current to the cell, thereby forming a second hole transport layer having a thickness of 60 nm on the first hole transport layer. After forming the hole injection layer and the hole transport layer, a light-emitting layer was deposited thereon as follows. A first host material and a second host material shown in Table 1 below were introduced, as host materials, into a cell of the vacuum vapor depositing apparatus, and compound **D-71** was introduced, as a dopant, into another cell. The two host compounds were then evaporated at the same rate of 1:1, 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 40nm on the second hole transport layer. Compounds **ET-1** and **EI-1** were then introduced into another two cells of the vacuum vapor depositing apparatus, respectively, and evaporated at the same rate of 1:1, thereby forming an electron transport layer having a thickness of 30nm on the light-emitting layer. After depositing compound **EI-1** as an electron injection layer having a thickness of 2nm on the electron transport layer, an A₁ cathode having a thickness of 80nm was then deposited by another vacuum vapor deposition apparatus on the electron injection layer to produce an OLED. Evaluation results of the devices produced in Device Examples 1 to 4 are shown in Table 1 below.

[159]



[160]



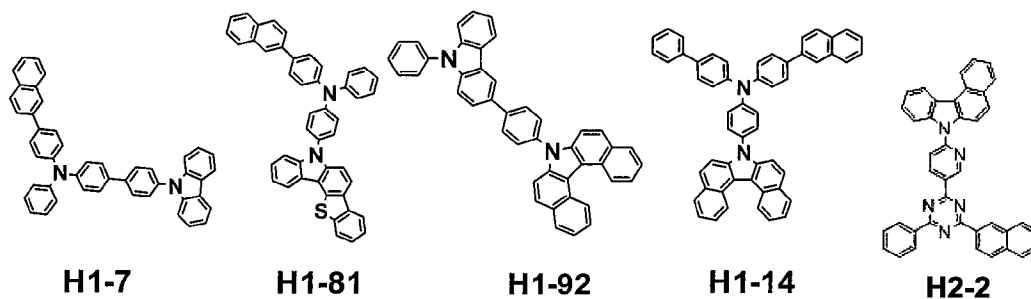
D-71

[161]

[Table 1]

Device Example No.	The 1 st Host	The 2 nd Host	Driving Voltage (V)	Efficiency (cd/A)	The Emission Color	T98 Lifespan (hr)
Device Example 1	H1-7	H2-2	3.4	29.3	Red	76
Device Example 2	H1-81	H2-2	3.8	27.8	Red	153
Device Example 3	H1-92	H2-2	3.5	27.7	Red	56
Device Example 4	H1-14	H2-2	3.4	29.1	Red	62

[162]



[163]

[164]

[165]

[Device Examples 5 to 8] OLED comprising a first host compound and a second host compound of the present disclosure as a host

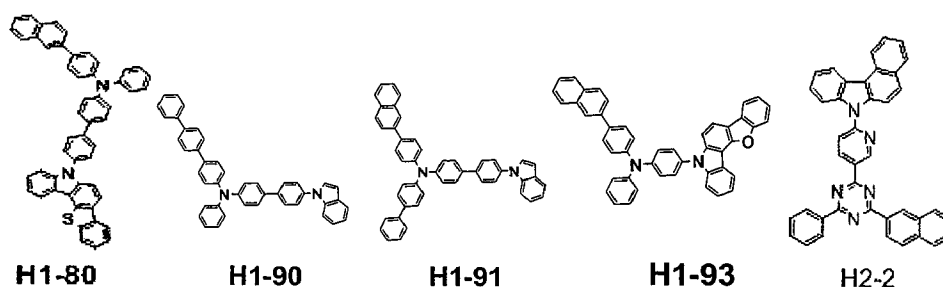
In Device Examples 5 to 8, OLEDs were produced in the same manner as in Device Examples 1 to 4, except that a first hole injection layer having a thickness of 90nm was formed, the doping amount of the dopant was 2 wt%, an electron transport layer having a thickness of 35 nm was deposited, and the first host was changed as shown in Table 2 below. Evaluation results of the devices produced in Device Examples 5 to 8 are shown in Table 2 below.

[166]

[Table 2]

Device Example No.	The 1 st Host	The 2 nd Host	Driving Voltage (V)	Efficiency (cd/A)	The Emission Color	T98 Lifespan (hr)
Device Example 5	H1-80	H2-2	3.5	28.7	Red	100
Device Example 6	H1-90	H2-2	3.6	30.3	Red	85
Device Example 7	H1-93	H2-2	3.5	29.9	Red	82
Device Example 8	H1-91	H2-2	3.6	30.0	Red	64

[167]



[168] **[Comparative Device Example 1] OLED comprising a conventional organic**
 [169] **electroluminescent compound**

[170] An OLED was produced in the same manner as in Device Examples 1 to 4, except that the first host shown in Table 3 below was employed as a host for a light-emitting layer and the second host was not employed.

[171]

[Table 3]

Device Example No.	The 1 st Host	The 2 nd Host	Driving Voltage (V)	Efficiency (cd/A)	The Emission Color	T98 Lifespan (hr)
Comparative Device Example 1	H1-92	-	8.1	13.6	Red	X

* X indicates that lifespan of a device was too short to be measured.

[172] **[Comparative Device Example 2] OLED comprising a conventional organic**
 [173] **electroluminescent compound**

[174] An OLED was produced in the same manner as in Device Examples 1 to 4, except that the second host shown in Table 4 below was employed as a host for a light-emitting layer and the first host was not employed.

[175]

[Table 4]

Device Example No.	The 1 st Host	The 2 nd Host	Driving Voltage (V)	Efficiency (cd/A)	The Emission Color	T98 Lifespan (hr)
Comparative Device Example 2	-	H2-2	3.3	24.9	Red	7

[176]

[177]

[178]

[Comparative Device Example 3] OLED comprising a conventional organic electroluminescent compound

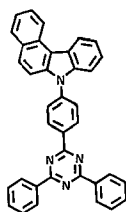
An OLED was produced in the same manner as in Device Examples 1 to 4, except that the first host and the second host shown in Table 5 below were employed as a host for a light-emitting layer.

[179]

[Table 5]

Device Example No.	The 1 st Host	The 2 nd Host	Driving Voltage (V)	Efficiency (cd/A)	The Emission Color	T98 Lifespan (hr)
Comparative Device Example 3	H1-7	Compound A	3.5	31.1	Red	40

[180]



Compound A

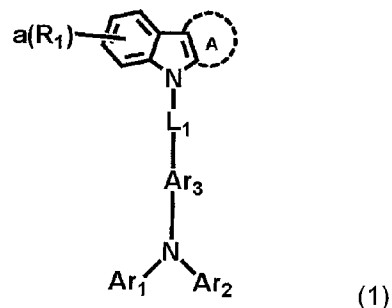
[181]

By using a specific combination of two or more host compounds according to the present disclosure, the organic electroluminescent device of the present disclosure has luminous efficiency at least equivalent to or higher than conventional devices and has lifespan longer than conventional devices.

Claims

[Claim 1]

A host material that comprises one or more first host compounds and one or more second host compounds wherein the first host compound is represented by the following formula 1 and the second host compound is represented by the following formula 2:



wherein

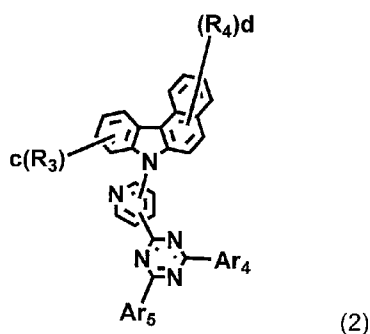
L_1 represents a single bond or a substituted or unsubstituted (C6-C30)arylene,

A represents hydrogen, a substituted or unsubstituted phenyl, a substituted or unsubstituted naphthyl, a substituted or unsubstituted fluorenyl, a substituted or unsubstituted dibenzothiophenyl, or a substituted or unsubstituted dibenzofuranyl,

Ar_1 , Ar_2 , and Ar_3 , each independently, represent a substituted or unsubstituted (C6-C30)aryl(ene), or a substituted or unsubstituted 3- to 30-membered heteroaryl(ene); or Ar_2 and Ar_3 may be linked to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur,

R_1 represents 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-C30)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 R_1 may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to

30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, wherein the heteroaryl(ene) contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P, a represents an integer of 0 to 4, and when a is an integer of 2 or more, each of R_1 may be the same or different;



wherein

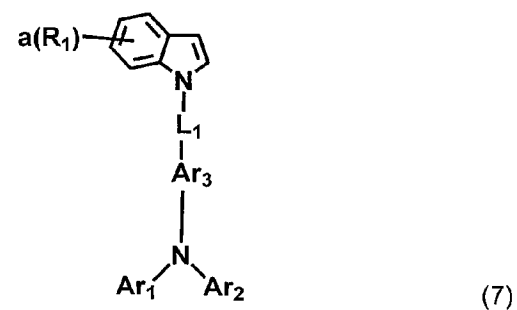
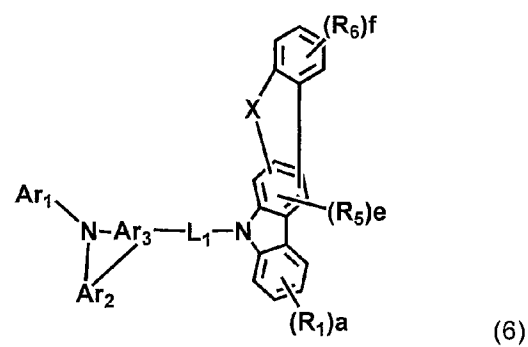
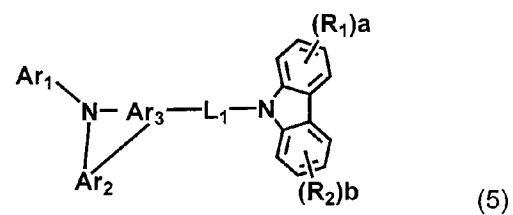
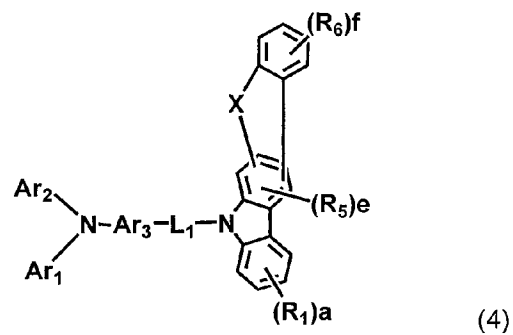
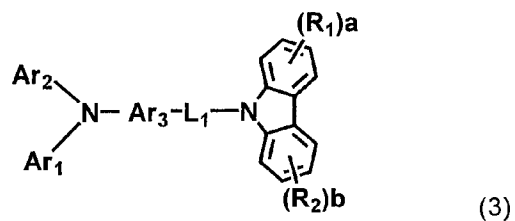
Ar_4 and Ar_5 , each independently, represent a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted 3- to 30-membered heteroaryl,

R_3 and R_4 , each independently, represent 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-C30)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,

wherein the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P, and c represents an integer of 0 to 4; d represents an integer of 0 to 6; and when c or d is an integer of 2 or more, each of R_3 or R_4 may be the same or different.

[Claim 2]

The host material according to claim 1, wherein formula 1 is represented by any one of the following formulae 3 to 7:



wherein

Ar₁, Ar₂, and Ar₃, each independently, represent a substituted or unsubstituted (C₆-C₃₀)aryl(ene), or a substituted or unsubstituted 3 to 30-membered heteroaryl(ene);

X represents S, O or CR₇R₈;

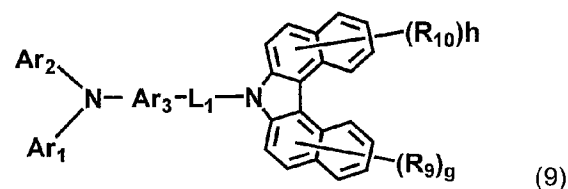
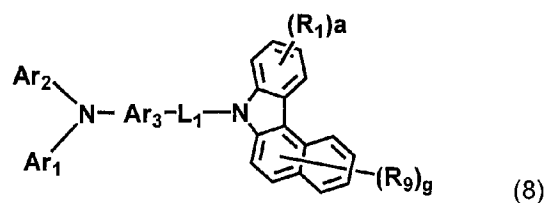
R₂ and R₅ to R₈, each independently, represent deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)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 R₂ and R₅ to R₈, each independently, are linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur;

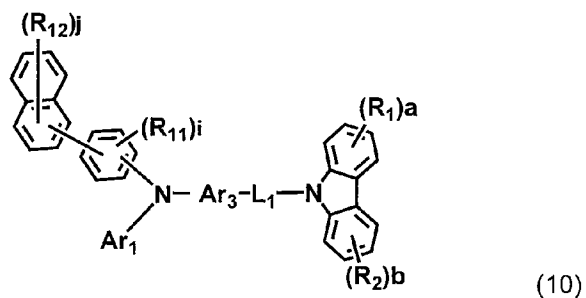
b and f, each independently, represent an integer of 0 to 4, and e represents an integer of 0 to 2; when each of b or f represents an integer of 2 or more, or when e represents an integer of 2, each of R₂, R₅, or R₆ may be the same or different; and

L₁, R₁, and a are as defined in claim 1.

[Claim 3]

The host material according to claim 2, wherein formula 3 is represented by any one of the following formulae 8 to 10:





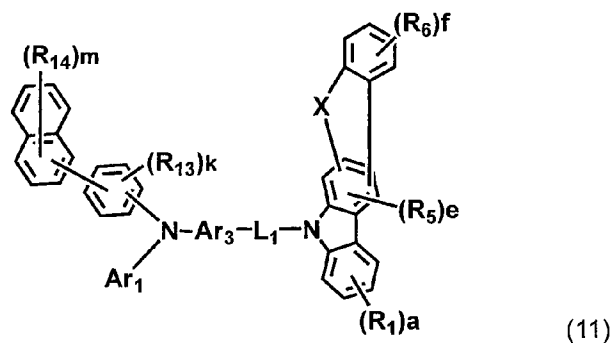
wherein

R_9 to R_{12} , each independently, represent 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-C30)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 R_9 to R_{12} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur; the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P; g and h , each independently, represent an integer of 0 to 6; i represents an integer of 0 to 4; j represents an integer of 0 to 7; when each of g , h , i or j represents an integer of 2 or more, each of R_9 , R_{10} , R_{11} or R_{12} may be the same or different; and

L_1 , R_1 , R_2 , Ar_1 , Ar_2 , Ar_3 , a , and b are as defined in claim 2.

[Claim 4]

The host material according to claim 2, wherein formula 4 is represented by the following formula 11:



wherein

R_{13} and R_{14} , each independently, represent 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-C30)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 R_{13} and R_{14} , each independently, may be linked to an adjacent substituent(s) to form a substituted or unsubstituted 3 to 30-membered, mono- or polycyclic, alicyclic or aromatic ring, or a combination of the alicyclic ring and the aromatic ring, whose carbon atom(s) may be replaced with at least one heteroatom selected from the group consisting of nitrogen, oxygen, and sulfur;

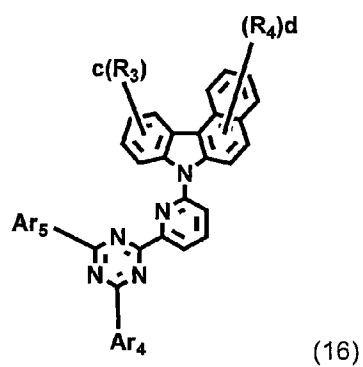
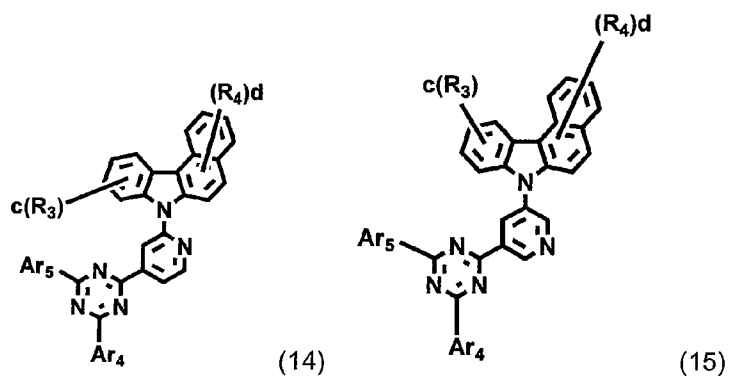
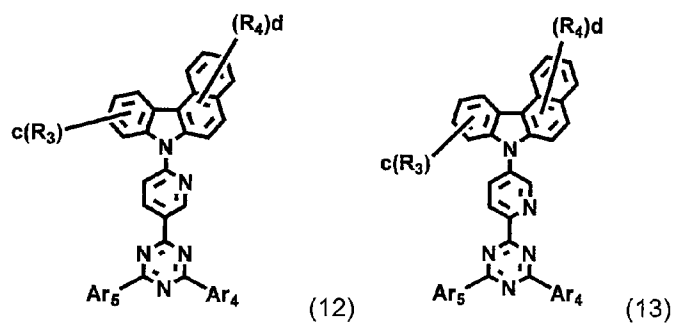
the heteroaryl contains one or more heteroatoms selected from the group consisting of B, N, O, S, Si, and P;

k represents an integer of 0 to 4, and m represents an integer of 0 to 7; when each of k or m represents an integer of 2 or more, each of R_{13} or R_{14} may be the same or different; and

L_1 , R_1 , R_5 , R_6 , Ar_1 , Ar_3 , a , e , and f are as defined in claim 2.

[Claim 5]

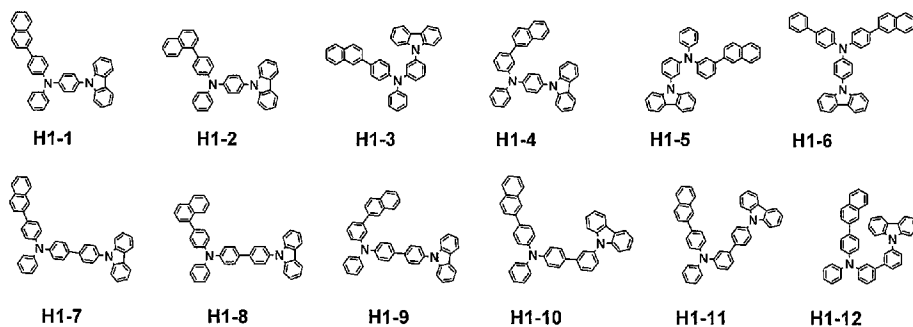
The host material according to claim 1, wherein formula 2 is represented by any one of the following formulae 12 to 16:

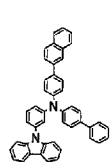


wherein Ar₄, Ar₅, R₃, R₄, c, and d are as defined in claim 1.

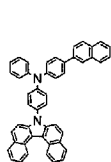
[Claim 6]

The host material according to claim 1, wherein the first host compound of formula 1 is selected from the group consisting of:

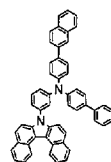




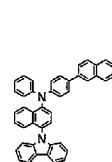
H1-13



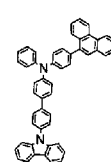
H1-14



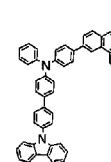
H1-15



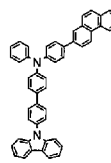
H1-16



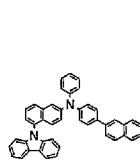
H1-17



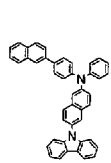
H1-18



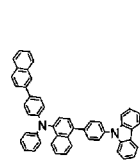
H1-19



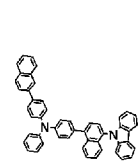
H1-20



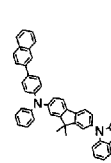
H1-21



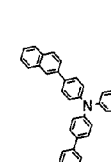
H1-22



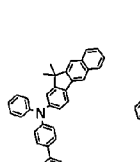
H1-23



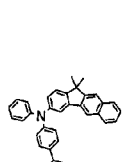
H1-24



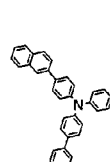
H1-25



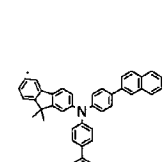
H1-26



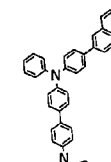
H1-27



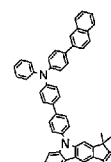
H1-28



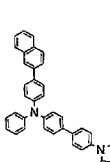
H1-29



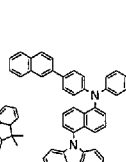
H1-30



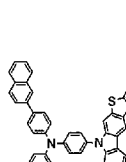
H1-31



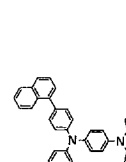
H1-32



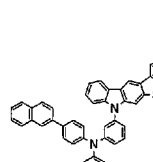
H1-33



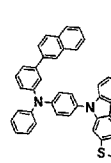
H1-34



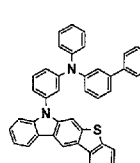
H1-35



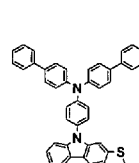
H1-36



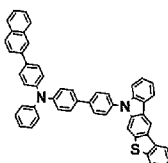
H1-37



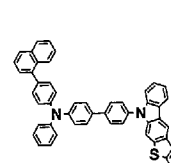
H1-38



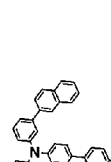
H1-39



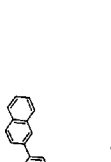
H1-40



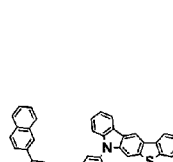
H1-41



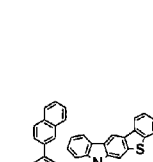
H1-42



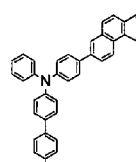
H1-43



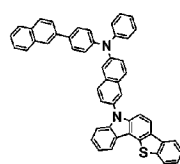
H1-44



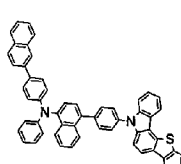
H1-45



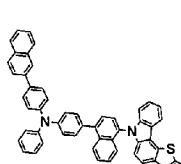
H1-46



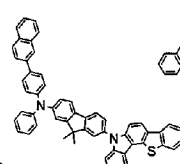
H1-47



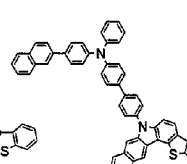
H1-48



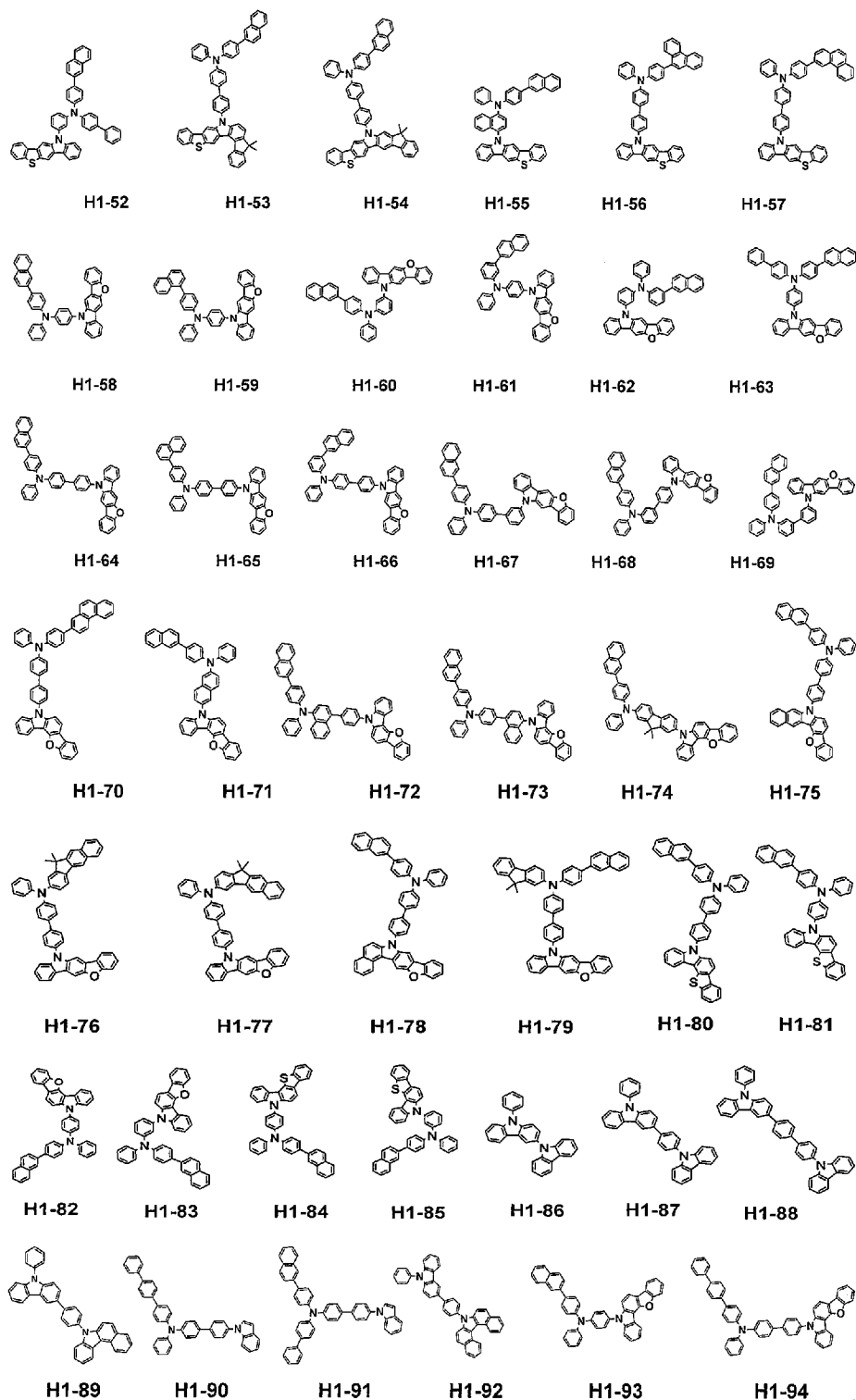
H1-49



H1-50

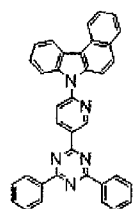


H1-51

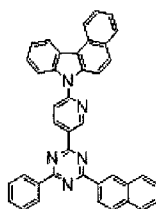


[Claim 7]

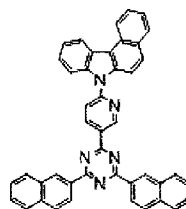
The host material according to claim 1, wherein the second host compound of formula 2 is selected from the group consisting of:



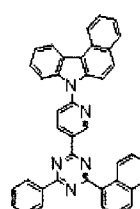
H2-1



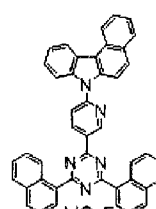
H2-2



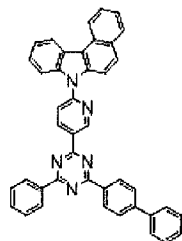
H2-3



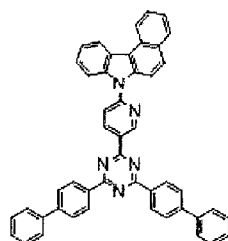
H2-4



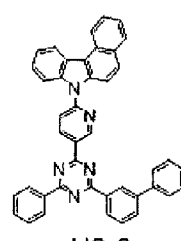
H2-5



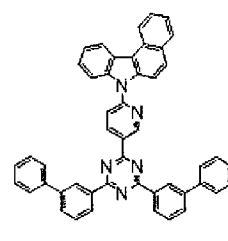
H2-6



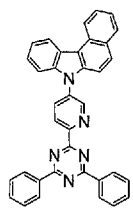
H2-7



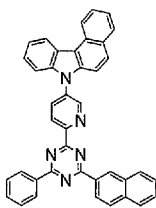
H2-8



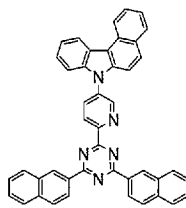
H2-9



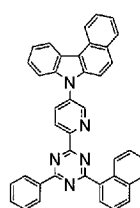
H2-10



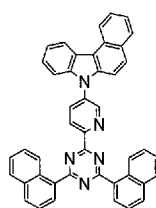
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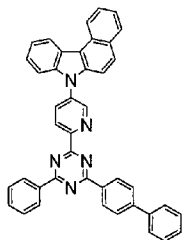
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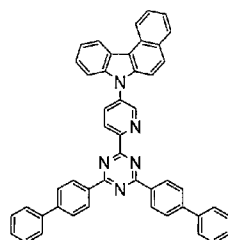
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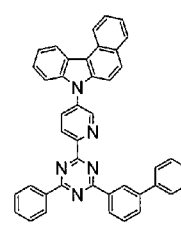
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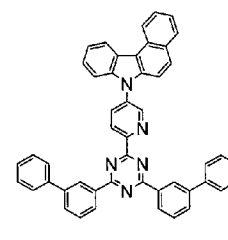
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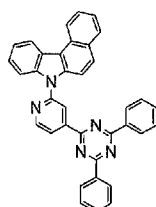
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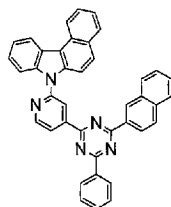
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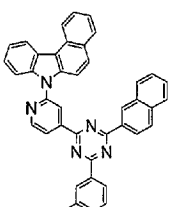
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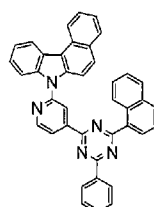
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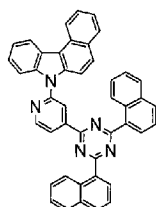
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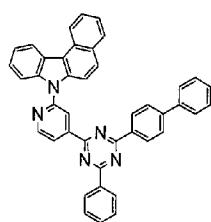
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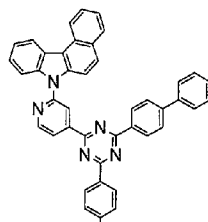
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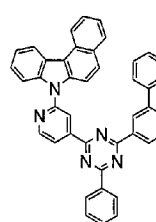
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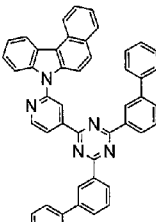
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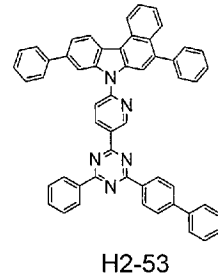
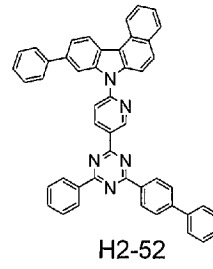
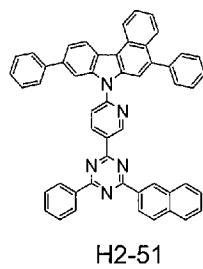
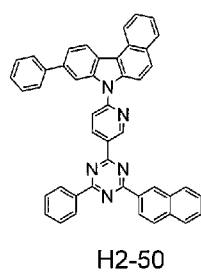
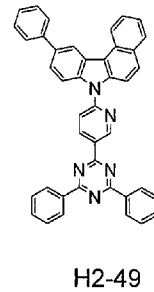
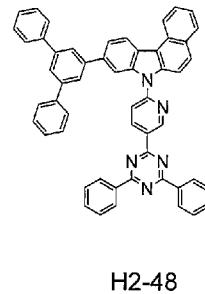
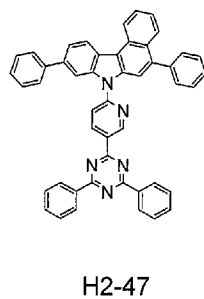
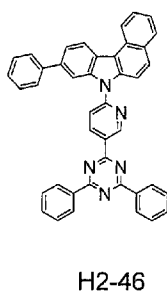
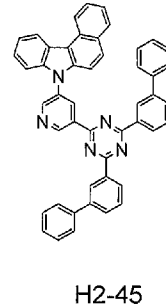
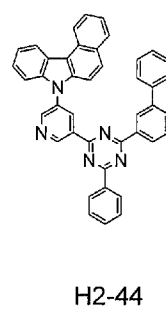
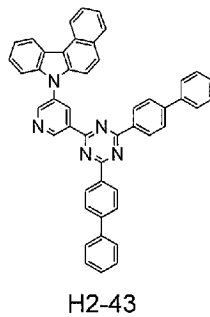
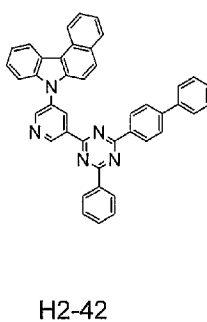
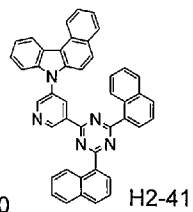
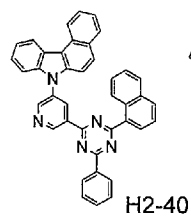
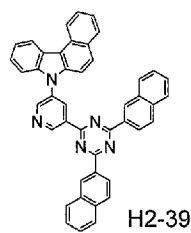
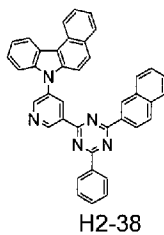
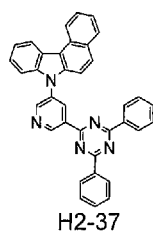
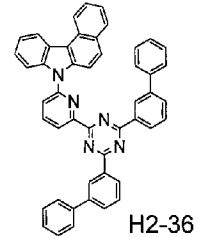
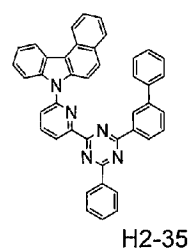
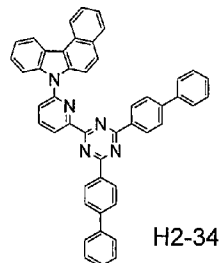
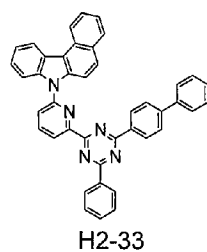
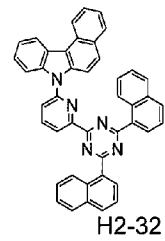
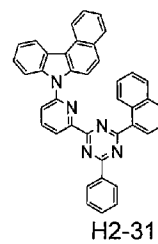
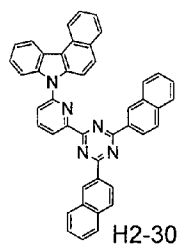
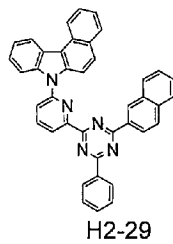
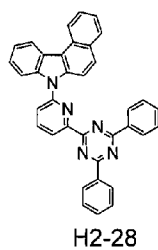
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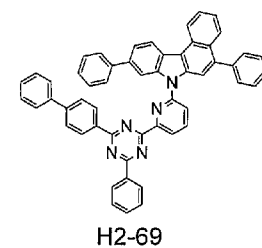
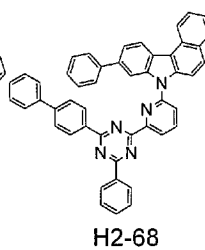
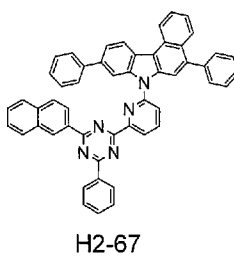
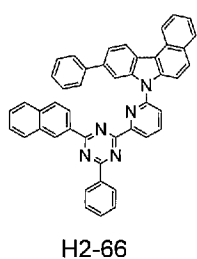
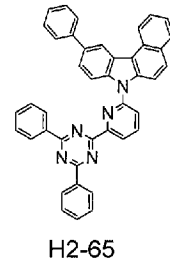
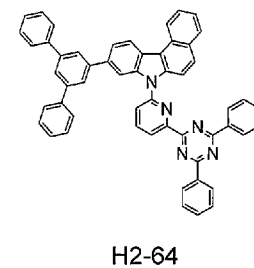
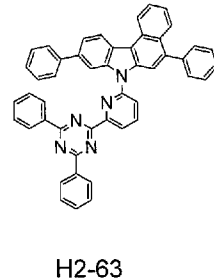
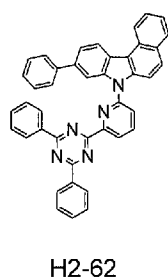
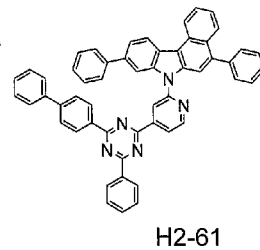
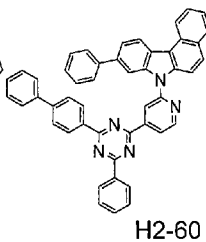
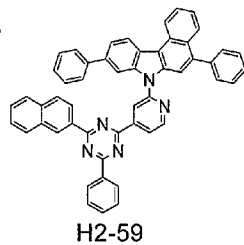
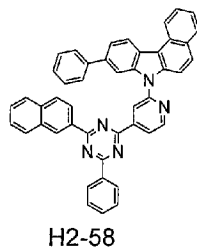
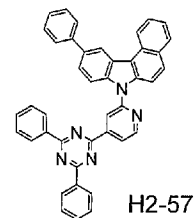
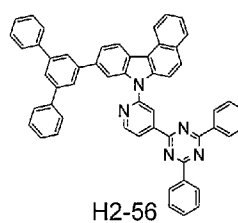
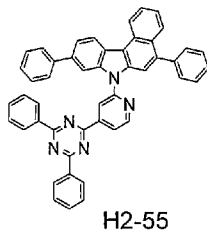
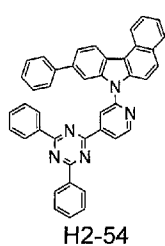


H2-26



H2-27





[Claim 8]

An organic electroluminescent device comprising an anode, a cathode, and at least one light-emitting layer disposed between the anode and cathode, wherein the light-emitting layer comprises a host and a dopant, and the host comprises the host material according to claim 1.

INTERNATIONAL SEARCH REPORT

 International application No.
PCT/KR2016/012455

A. CLASSIFICATION OF SUBJECT MATTER

C09K 11/06 (2006.01) **H01L 27/32 (2006.01)** **H01L 51/54 (2006.01)** **C07D 403/14 (2006.01)** **C07D 209/86 (2006.01)**
C07D 495/04 (2006.01) **C07D 491/048 (2006.01)** **C07D 209/08 (2006.01)** **C07F 15/00 (2006.01)**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

STN (REGISTRY AND CAPLUS). Structure search based on the compounds of formula 1 and 2. Broader structure search based on the compound of formula 2 and compound of formula 1 with control terms "organic electroluminescent devices" or "electroluminescent substances", with IPC H01L and with keywords "multi?" or "plural".

Espacenet. Applicant and Inventor search, "Rohm and Haas" and "LIM, Young-Mook" or "KIM, Bitnari"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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



Further documents are listed in the continuation of Box C



See patent family annex

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

Date of the actual completion of the international search 3 February 2017	Date of mailing of the international search report 03 February 2017
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au	Authorised officer Maree Staples AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262223634

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/KR2016/012455
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0200373 A1 (SAMSUNG DISPLAY CO., LTD.) 16 July 2015 Abstract; pages 1-2, paragraphs [0009]-[0026]; page 92, compounds 113B-120B; page 93, compound 127B; page 94, compound 130B; page 96, compound 142B; page 102, compounds 189B-191B; page 70, compound 134A; page 1, paragraph [0011]; pages 23-26; page 24, moiety 5-21; page 26, paragraph [0162]); page 17, moieties 4-7 to 4-12.	1-8
X	EP 2423209 A1 (IDEMITSU KOSAN CO., LTD.) 29 February 2012 Page 5, Chemical Formula 2; page 7, paragraphs [0024]-[0025]; page 7, paragraph [0026]; page 6, paragraph [0015], first moiety; page 6, paragraph [0019]; page 12, 2nd compound; pages 124-125; page 130, 4th compound.	1-8
X	EP 2415769 A1 (IDEMITSU KOSAN CO., LTD.) 08 February 2012 Page 5, Chemical Formula 2; , page 6, paragraphs [0018]-[0019]; , pages 6-7, paragraph [0020]; page 6, paragraph [0015], first moiety; page 6, paragraph [0016]; page 11, second compound; page 26, 4th compound and page 28, 3rd compound; page 22, 5th and 6th compounds; page 24, 3rd and 6th compounds; page 25, 1st, 4th and 5th compounds; page 26, 3rd compound; page 27, 1st, 3rd, 5th, 8th, 9th and 16th compounds; and page 28, 3rd compound; page 66, last two compounds; page 124, 4th compound.	1-8

Form PCT/ISA/210 (fifth sheet) (July 2009)

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2016/012455	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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Publication Number	Publication Date	Publication Number	Publication Date
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		CN 104795503 A	22 Jul 2015
		KR 20150085772 A	24 Jul 2015
		TW 201533024 A	01 Sep 2015
EP 2423209 A1	29 February 2012	EP 2423209 A1	29 Feb 2012
		EP 2423209 B1	05 Aug 2015
		CN 102421772 A	18 Apr 2012
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		CN 102439004 A	02 May 2012
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		EP 2415769 A1	08 Feb 2012
		EP 2415769 B1	28 Oct 2015
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		JP 5562970 B2	30 Jul 2014
		KR 20120127746 A	23 Nov 2012
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		US 2012138912 A1	07 Jun 2012
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		US 2011278555 A1	17 Nov 2011
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		US 2015008423 A1	08 Jan 2015
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			
Form PCT/ISA/210 (Family Annex)(July 2009)			

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2016/012455	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
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		US 8940414 B2	27 Jan 2015
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		US 2015228912 A1	13 Aug 2015
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		WO 2011132684 A1	27 Oct 2011
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			
Form PCT/ISA/210 (Family Annex)(July 2009)			

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/KR2016/012455	
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
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			