



(51) International Patent Classification:

C09K 11/87 (2006.01) C07D 213/72 (2006.01)
 C09K 11/06 (2006.01) C07D 213/89 (2006.01)
 C07F 15/00 (2006.01) C07D 239/42 (2006.01)
 C07D 401/04 (2006.01) C07D 239/84 (2006.01)
 C07D 401/10 (2006.01) C07D 241/20 (2006.01)
 C07D 401/14 (2006.01) C07D 251/22 (2006.01)
 C07D 403/04 (2006.01) C07D 251/24 (2006.01)
 C07D 403/10 (2006.01) H01L 51/54 (2006.01)
 C07D 405/14 (2006.01) H05B 55/14 (2006.01)
 C07D 409/14 (2006.01) H05B 33/20 (2006.01)
 C07D 209/86 (2006.01)

(21) International Application Number:

PCT/KR20 13/006487

(22) International Filing Date:

19 July 2013 (19.07.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2012-0079339 20 July 2012 (20.07.2012) KR

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: A NOVEL COMBINATION OF A HOST COMPOUND AND A DOPANT COMPOUND AND AN ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

(57) Abstract: The present invention relates to a specific combination of a dopant compound and a host compound, and an organic electroluminescent device comprising the same. The organic electroluminescent device of the present invention emits yellow-green light; lowers the driving voltage of the device by improving the current characteristic of the device; and improves power efficiency and operational lifespan.



Description

Title of Invention: A NOVEL COMBINATION OF A HOST COMPOUND AND A DOPANT COMPOUND AND AN ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

Technical Field

- [1] The present invention relates to a novel combination of a host compound and a dopant compound and an organic electroluminescence device comprising the same.

Background Art

- [2] An electroluminescent (EL) device is a self-light-emitting device which has advantages in that it provides a wider viewing angle, a greater contrast ratio, and a faster response time compared to LCDs. An organic EL device was first developed by Eastman Kodak, by using small aromatic diamine molecules, and aluminum complexes as materials for forming a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].
- [3] The most important factor determining luminous efficiency in an organic EL device is the light-emitting material. The electroluminescent material includes a host material and a dopant material for purposes of functionality. Typically, a device that has very superior electroluminescent properties is known to have a structure in which a host is doped with a dopant to form an electroluminescent layer. Recently, the development of an organic EL device having high efficiency and long lifespan is being urgently called for. Particularly, taking into consideration the electroluminescent properties required of medium to large OLED panels, the development of materials very superior to conventional electroluminescent materials is urgent. In order to achieve such, a host material which functions as the solvent in a solid phase and plays a role in transferring energy should be of high purity and must have a molecular weight appropriate to enabling vacuum deposition. Also, the glass transition temperature and heat decomposition temperature should be high to ensure thermal stability, and high electrochemical stability is required to attain a long lifespan, and the formation of an amorphous thin film should become simple, and the force of adhesion to materials of other adjacent layers must be good but interlayer migration should not occur.
- [4] Until now, fluorescent materials have been widely used as a light-emitting material. However, in view of electroluminescent mechanisms, developing phosphorescent materials is one of the best methods to theoretically enhance luminous efficiency by four (4) times. Iridium(III) complexes have been widely known as dopant compounds of phosphorescent substances, including

bis(2-(2'-benzothienyl)-pyridinato-N,C3')iridium(acetylacetonate) $[(acac)Ir(btp)_2]$, tris(2-phenylpyridine)iridium $[Ir(ppy)_3]$ and bis(4,6-difluorophenylpyridinato-N,C2)picolinate iridium $[Firpic]$ as red, green and blue materials, respectively. Until now, 4,4'-N,N'-dicarbazol-biphenyl (CBP) was the most widely known host material for phosphorescent substances. Further, an organic EL device using bathocuproine (BCP) and aluminum(III)bis(2-methyl-8-quinolate)(4-phenylphenolate) (BALq) for a hole blocking layer is also known.

- [5] However, there were problems affecting power efficiency, operational life span, and luminous efficiency, when applying a light-emitting material comprising conventional dopant and host compounds to an organic EL device. Further, there were difficulties with obtaining a yellow-green light emitting luminous material having excellent performance.
- [6] Korean Patent Appln. Laying-Open Nos. KR 10-2005-0050489 A, and KR 10-2011-0065496 A disclose iridium complexes introducing an aryl group, etc., to an $Ir(ppy)_3$ structure, which is a conventional dopant compound, as a dopant compound comprised in a light-emitting material of an organic electroluminescent device. However, the above references do not disclose a combination with a specific host compound.
- [7] Korean Patent Appln. Laying-Open No. KR 10-2012-0012431 A discloses combinations of iridium complex dopant compounds, and various host compounds. However, this reference does not disclose a luminous material emitting yellow-green light.
- [8] The present inventors found that a specific combination of a luminous material containing a dopant compound and a host compound emits yellow-green light, and is suitable for manufacturing organic EL devices having high color purity, high luminance, and a long lifespan.

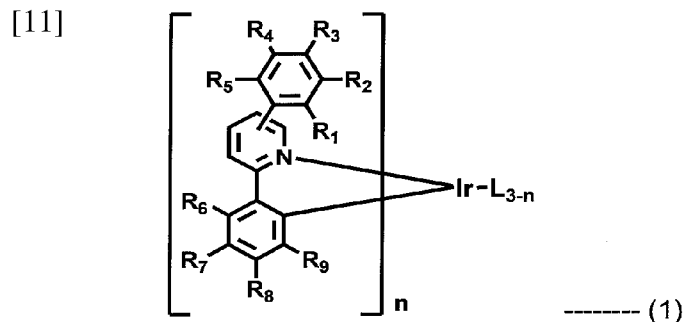
Disclosure of Invention

Technical Problem

- [9] The objective of the present invention is to provide a novel dopant and host combination and an organic electroluminescent device comprising the same which lowers the driving voltage of the device by improving the current characteristic of the device; improves power efficiency and operational lifespan; and emits yellow-green light.

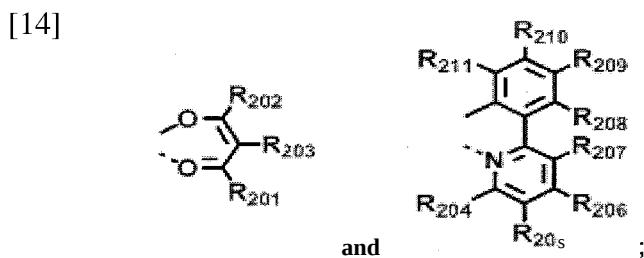
Solution to Problem

- [10] In order to achieve said purposes, the present invention provides a combination of one or more dopant compounds represented by the following formula 1, and one or more host compounds represented by the following formula 2:



[12] wherein

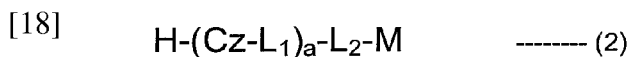
[13] L is selected from the following structures :



[15] R_1 to R_9 each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a cyano, or a substituted or unsubstituted (C1-C30)alkoxy;

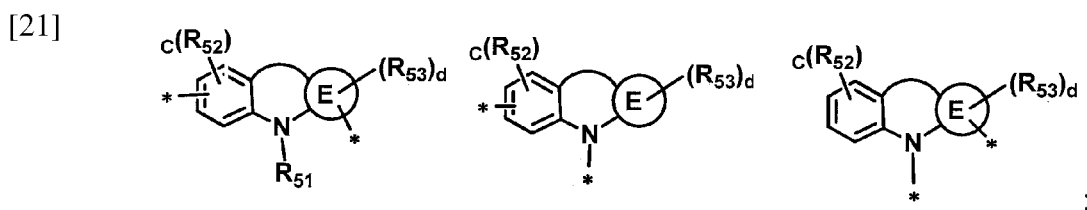
[16] R_{20i} to R_{211} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl; and

[17] n represents an integer of 1 to 3;



[19] wherein

[20] Cz is selected from the following structures:



[22] ring E represents a substituted or unsubstituted (C6-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30- membered heteroaryl;

[23] R_{51} to R_{53} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30- membered heteroaryl, a substituted or unsubstituted 5- to 7- membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl fused

- with at least one substituted or unsubstituted (C3-C30)alicyclic ring, a 5- to 7-membered heterocycloalkyl fused with at least one substituted or unsubstituted (C6-C30)aromatic ring, a substituted or unsubstituted (C3-C30)cycloalkyl, a (C3-C30)cycloalkyl fused with at least one substituted or unsubstituted (C6-C30)aromatic ring, or a substituted or unsubstituted (C6-C30)aryl(C1-C30)alkyl;
- [24] L_1 and L_2 each independently represent a single bond, a substituted or unsubstituted (C6-C40)arylene, a substituted or unsubstituted 3- to 30- membered heteroarylene, a substituted or unsubstituted 3- to 30- membered heteroarylene fused with a (C3-C30)cycloalkyl ring, or a substituted or unsubstituted (C6-C30)cycloalkylene;
- [25] M represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30- membered heteroaryl;
- [26] a represents 1 or 2; where a is 2, each of C_z may be same or different, and each of L_1 may be same or different;
- [27] c and d each independently represent an integer of 0 to 4; where c or d is an integer of 2 or more, each of R_{52} , and each of R_{53} may be same or different.

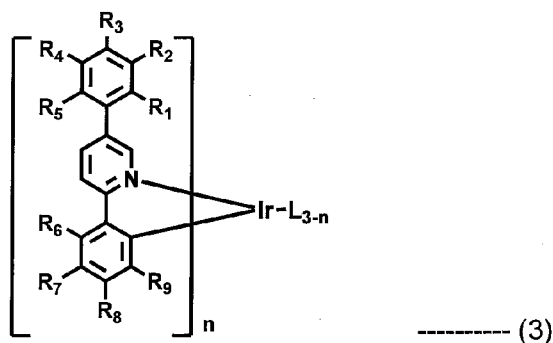
Advantageous Effects of Invention

- [28] The organic electroluminescent device comprising the dopant and host combination of the present invention emits yellow-green light; lowers the driving voltage of the device by improving the current characteristic of the device; and improves power efficiency and operational lifespan.

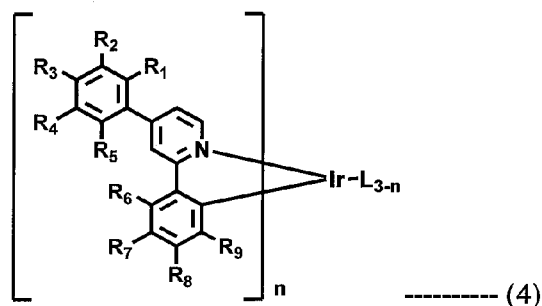
Mode for the Invention

- [29] Hereinafter, the present invention will be described in detail. However, the following description is intended to explain the invention, and is not meant in any way to restrict the scope of the invention.
- [30] The present invention relates to a combination of one or more dopant compounds represented by formula 1, and one or more host compounds represented by formula 2; and an organic electroluminescent device comprising the same.
- [31] The dopant compound represented by formula 1 is preferably represented by formula 3 or 4:

[32]



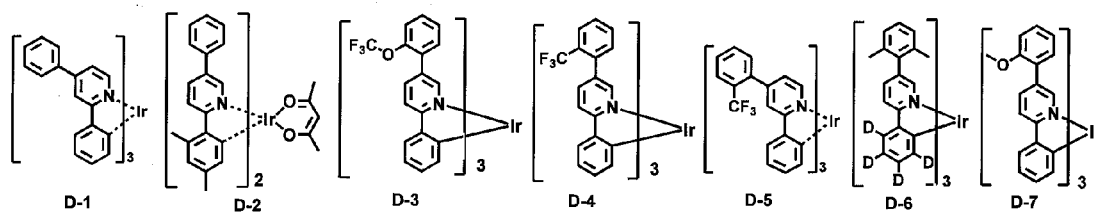
[33]

[34] wherein R_1 to R_9 , L, and n are as defined in formula 1.

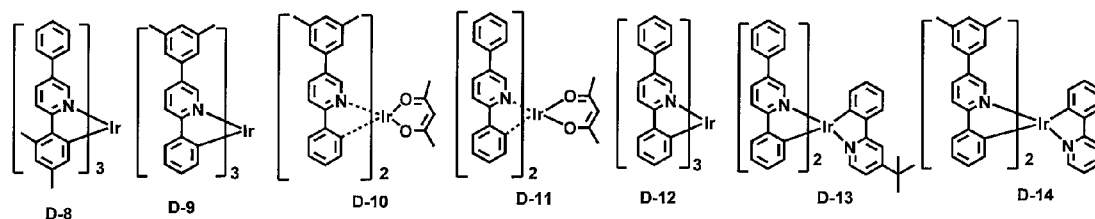
[35] In formulae 1, 3, and 4, R_1 to R_9 preferably each independently represent hydrogen, deuterium, a (Cl-C10)alkyl unsubstituted or substituted with a halogen, an unsubstituted (C3-C7)cycloalkyl, or a (Cl-C10)alkoxy unsubstituted or substituted with a halogen. R_{20} to R_{2n} preferably each independently represent hydrogen, or an unsubstituted (Cl-C10)alkyl.

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

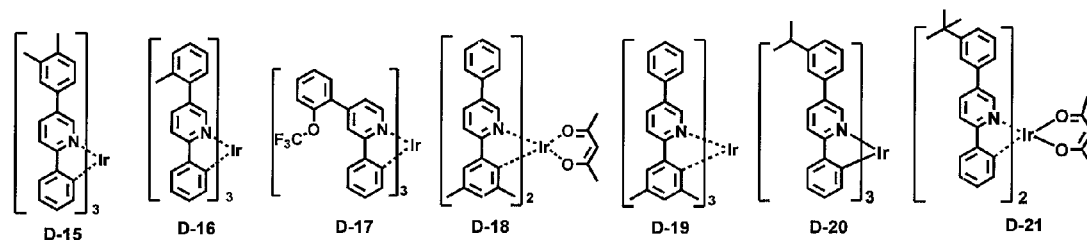
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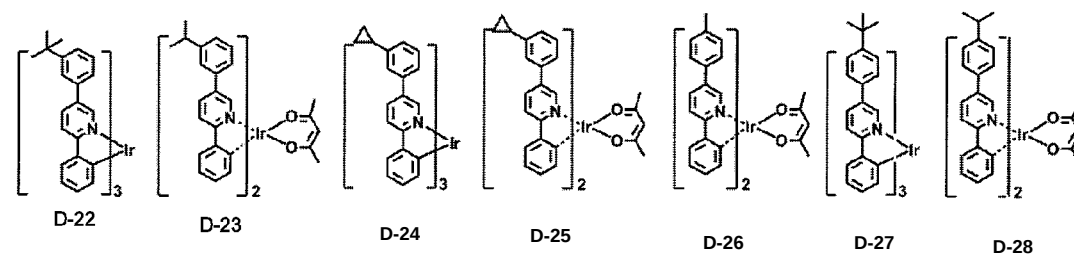
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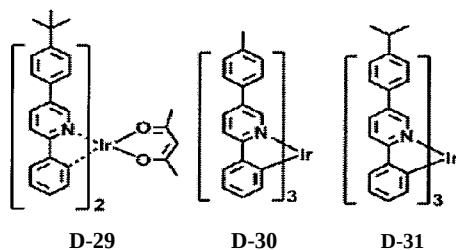
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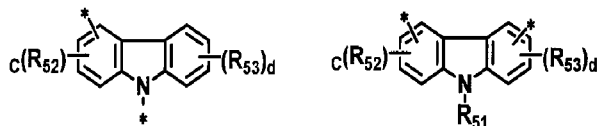


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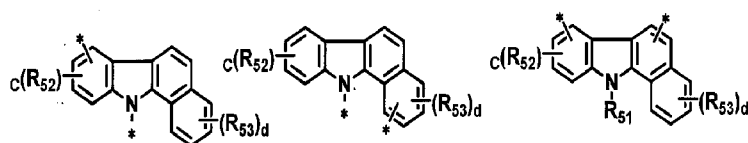


[42] In formulae 2, Cz is preferably selected from the following structures:

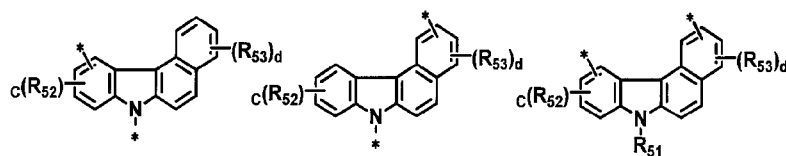
[43]



[44]



[45]



[46] wherein R_{51} , R_{52} , R_{53} , c, and d are as defined in formula 2.

[47] In formula 2, when L_2 is a single bond, formula 2 may be represented by formula 2', and when L_1 is a single bond, formula 2 may be represented by formula 2'':

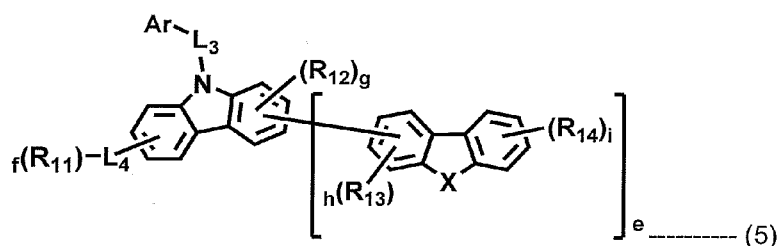
[48] $H-(Cz-L_1)_a-M$ ----- (2')

[49] $H-(Cz)_a-L_2-M$ ----- (2'')

[50] wherein Cz, L_1 , L_2 , M, and a are as defined in formula 2.

[51] The compound represented by formula 2 may be represented by formula 5:

[52]



[53] wherein

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

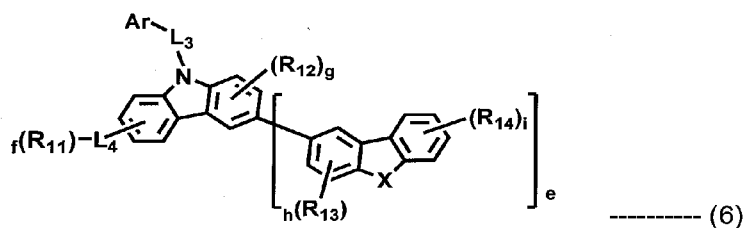
[55] X represents $-C(R_{16}R_{17})-$, $-N(R_{18})-$, $-S-$, or $-O-$;

[56] L_3 and L_4 each independently represent a single bond, a substituted or unsubstituted (C6-C40)arylene, a substituted or unsubstituted 5- to 30- membered heteroarylene, or a

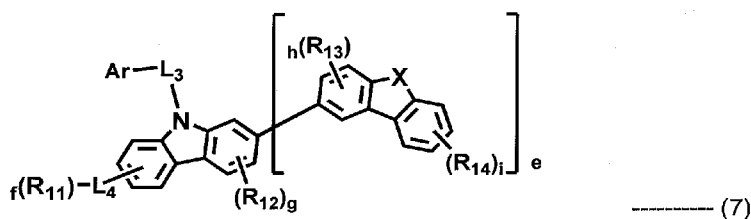
substituted or unsubstituted 5- to 30- membered heteroarylene fused with a (C3-C30)cycloalkyl ring;

- [57] R_{11} to R_{14} , and R_{16} to R_{18} each independently represent hydrogen, deuterium, a halogen, a cyano, a nitro, a hydroxyl, a substituted or unsubstituted amino, a substituted or unsubstituted silyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 5- to 30- membered heteroaryl, or are linked to each other to form a saturated or unsaturated ring;
- [58] e represents an integer of 0 to 1;
- [59] f and i each independently represent an integer of 1 to 4; where f or i is an integer of 2 or more, each of R_{11} , and each of R_{14} may be same or different; and
- [60] g and h each independently represent an integer of 1 to 3; where g or h is an integer of 2 or more, each of R_{12} , and each of R_{13} may be same or different.
- [61] The host compound represented by formula 5 is preferably selected from formulae 6 to 9:

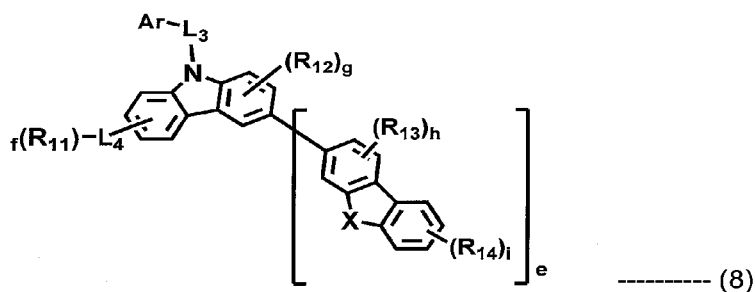
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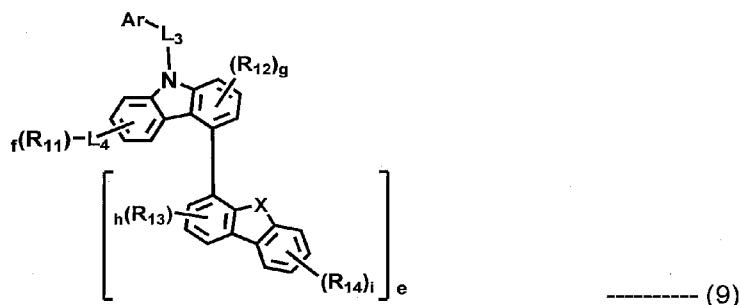
[63]



[64]



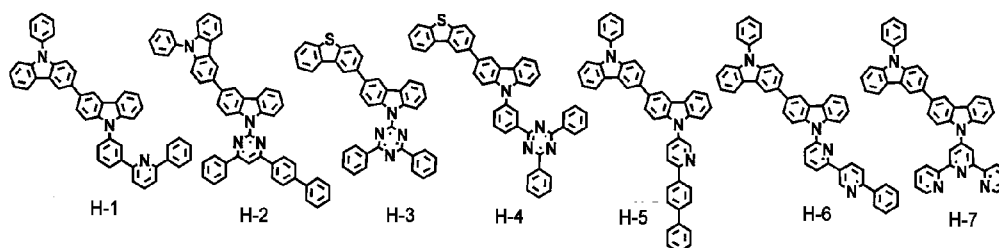
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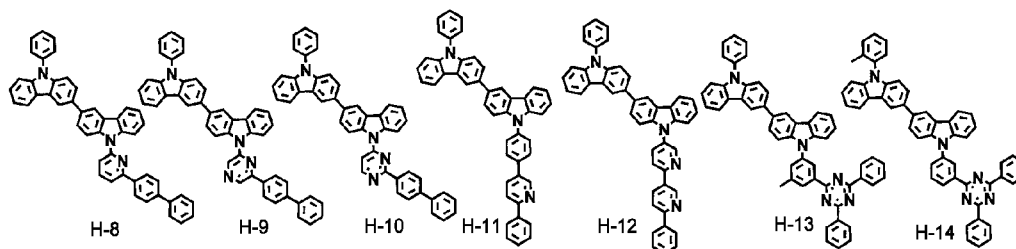
- [66] wherein Ar, X, L₃, L₄, R₁₁ to R₁₄, e, f, g, h, and i are as defined in formula 5.
- [67] In formulae 5 to 9, Ar preferably represents a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20- membered heteroaryl;
- [68] X preferably represents -C(Ri₆Rn)-, -N(Ri₈)-, -O-, or -S-, where R₁₆ to R₁₈ preferably each independently represent a substituted or unsubstituted silyl, a substituted or unsubstituted (Cl-C10)alkyl, a substituted or unsubstituted (C3-C10)cycloalkyl, a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20- membered heteroaryl, and more preferably each independently represent an unsubstituted tri(Cl-C6)alkylsilyl; an unsubstituted (Cl-C10)alkyl; an unsubstituted (C3-C10)cycloalkyl; a (C6-C20)aryl unsubstituted or substituted with a halogen or a (Cl-C6)alkyl; or an unsubstituted 5- to 20- membered heteroaryl.
- [69] L₃ and L₄ preferably each independently represent a single bond, a substituted or unsubstituted (C6-C20)arylene, a substituted or unsubstituted 5- to 20- membered heteroarylene, or a substituted or unsubstituted 5- to 20- membered heteroarylene fused with a (C3-C10)cycloalkyl ring, and more preferably each independently represent a single bond; a (C6-C20)arylene unsubstituted or substituted with a (Cl-C6)alkyl; a 5- to 20- membered heteroarylene unsubstituted or substituted with a (C6-C20)aryl, a (Cl-C6)alkyl(C6-C20)aryl, or a 5- to 20- membered heteroarylene; or an unsubstituted 5- to 20- membered heteroarylene fused with a (C3-C10)cycloalkyl ring.
- [70] R₁₁ to R₁₄ preferably each independently represent hydrogen, a halogen, a substituted or unsubstituted amino, a substituted or unsubstituted silyl, a substituted or unsubstituted (Cl-C10)alkyl, a substituted or unsubstituted 5- to 20- membered heteroaryl, or a substituted or unsubstituted (C6-C20)aryl; or are linked to each other to form a mono- or polycyclic, 5- to 30- membered alicyclic or aromatic ring, and more preferably each independently represent hydrogen; a halogen; an unsubstituted di(C6-C12)aryl amino; an unsubstituted di(C6-C12)aryl(Cl-C6)alkylsilyl; an unsubstituted tri(C6-C12)arylsilyl; an unsubstituted (Cl-C10)alkyl; a 5- to 20- membered heteroaryl unsubstituted or substituted with a (C6-C20)aryl; or a (C6-C20)aryl unsubstituted or substituted with a (Cl-C6)alkyl or a (C6-C20)aryl, or are linked to each other to form a monocyclic, 5- to 12- membered aromatic ring.
- [71] The representative compounds of formula 2 include the following compounds, but

are not limited thereto:

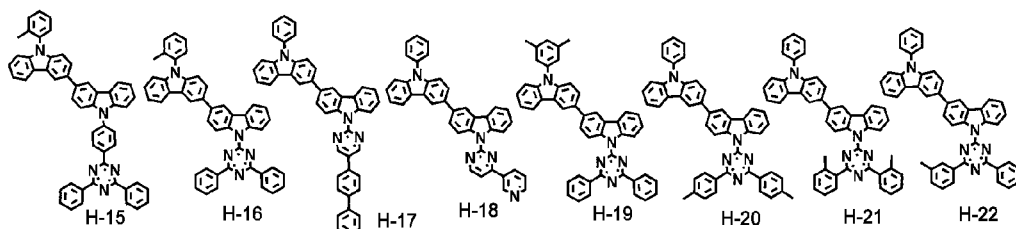
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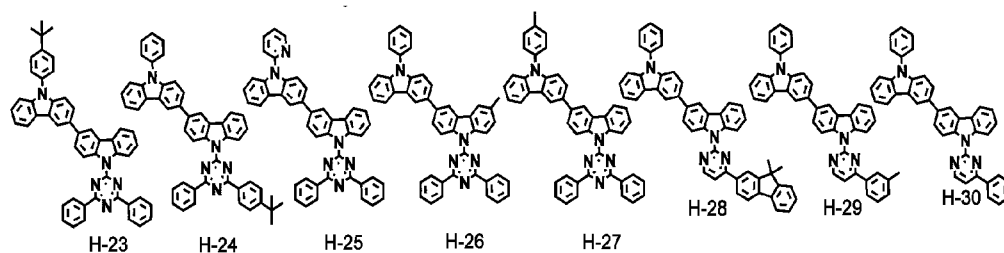
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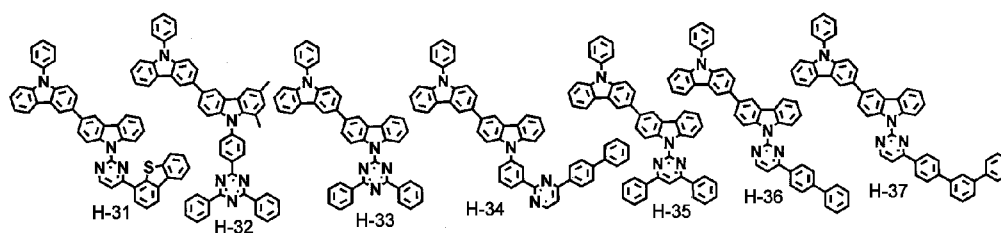
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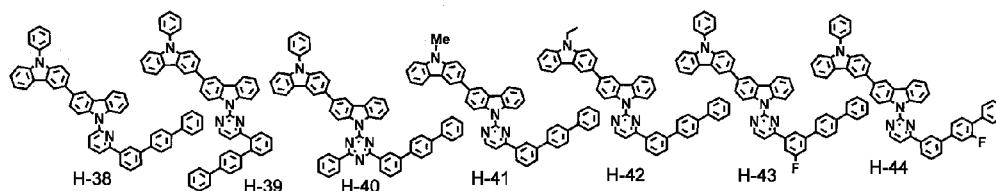
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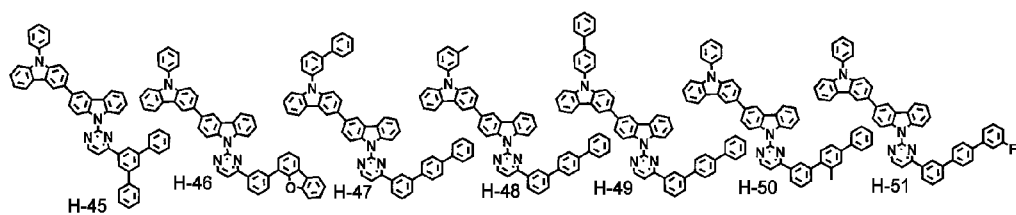
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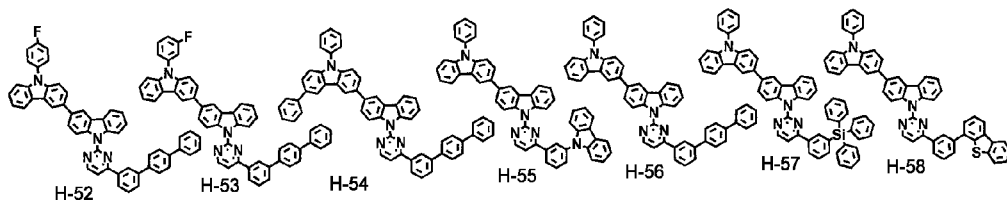
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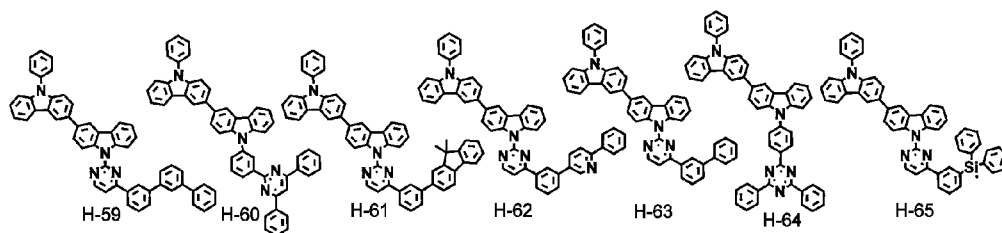
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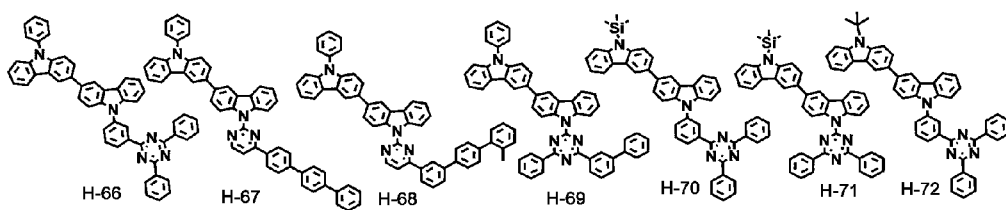
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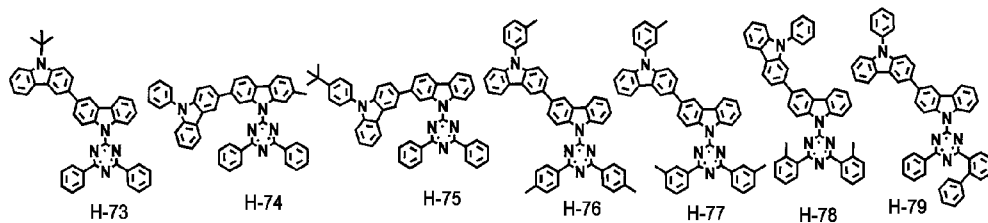
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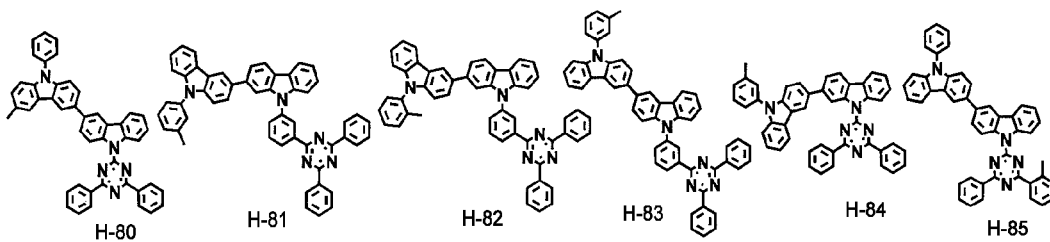
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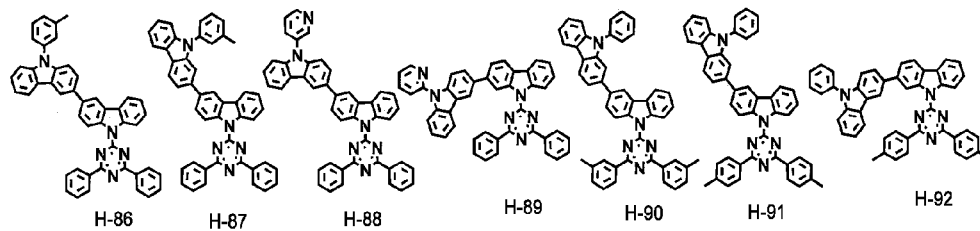
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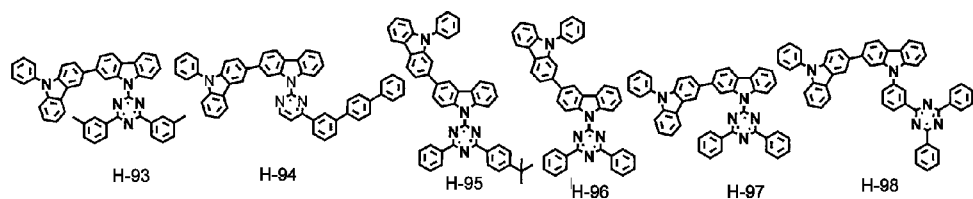
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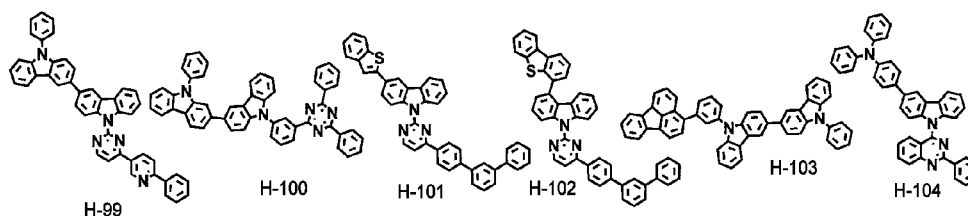
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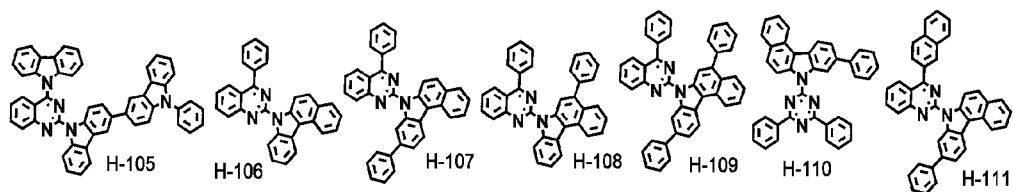
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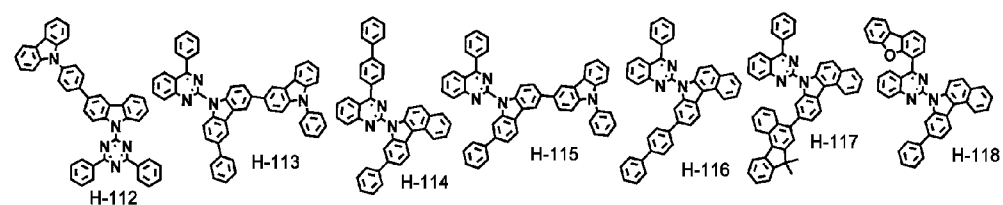
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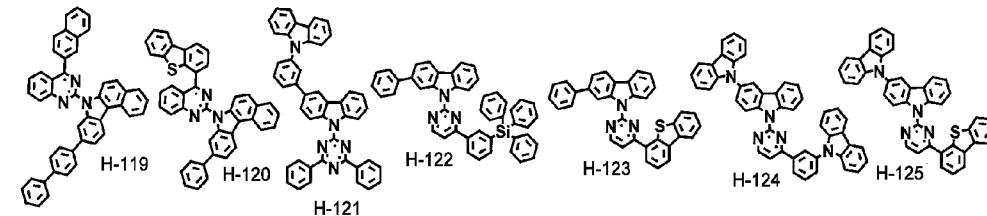
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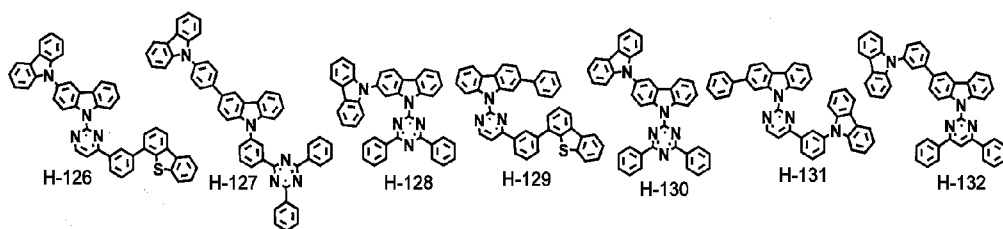
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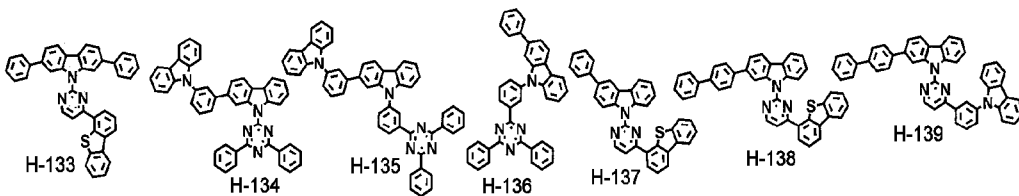
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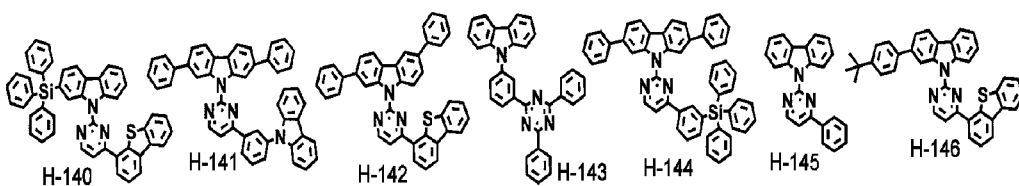
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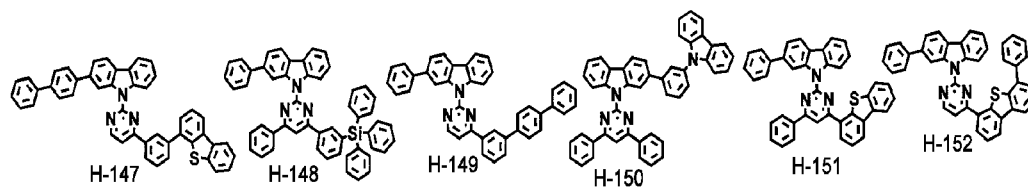
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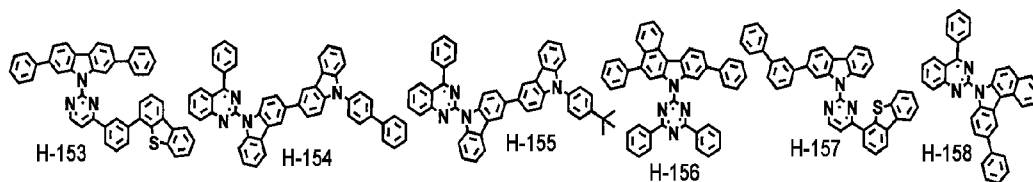
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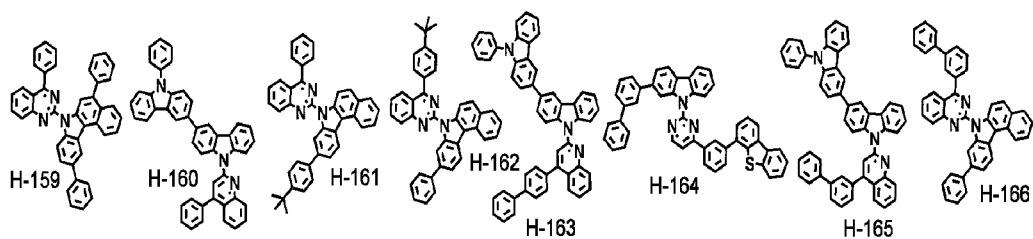
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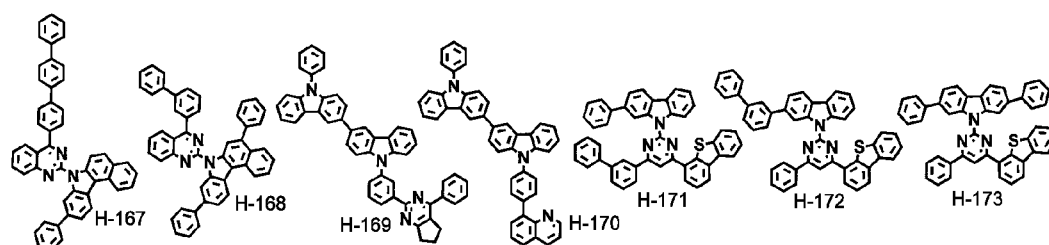
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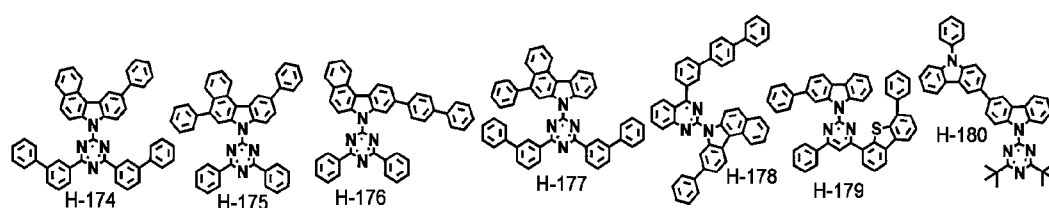
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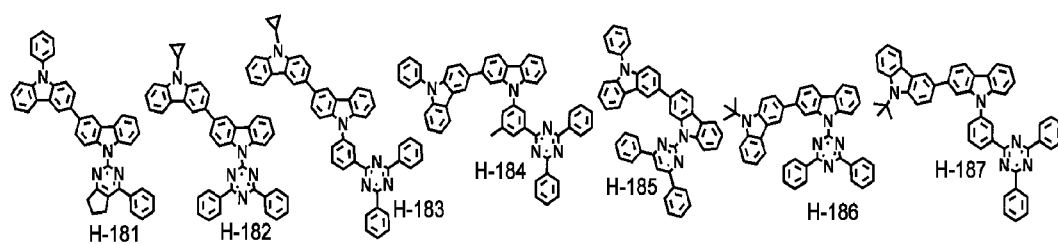
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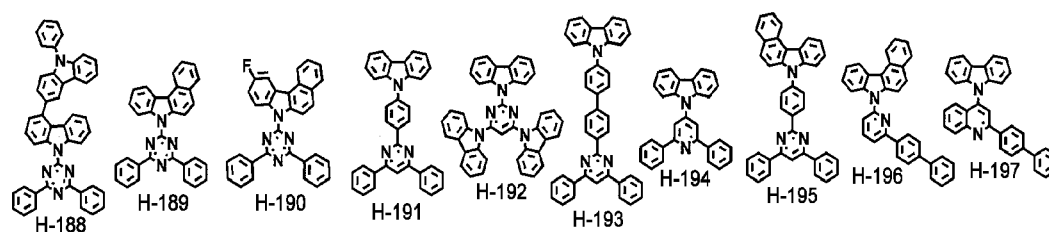
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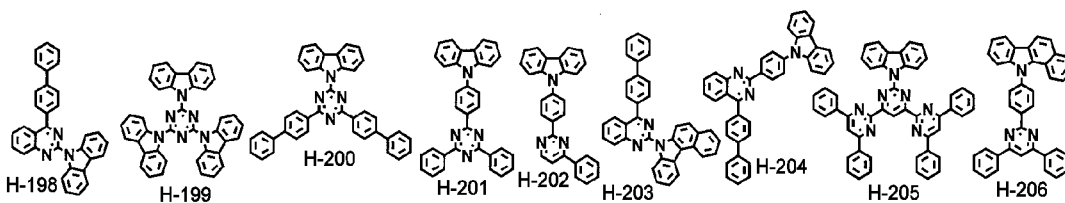
[98]



[99]



[100]



Chemical structures of compounds H-222, H-223, H-224, H-225, H-226, and H-227 are shown. These structures are complex organic molecules featuring various fused and linked aromatic systems, including indoles, quinolines, and benzimidazoles, with different substituents and linkages.

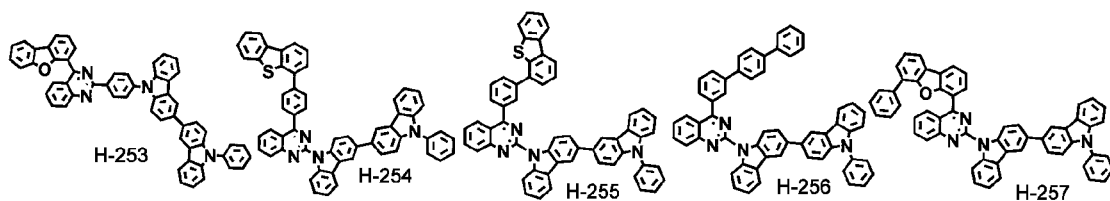
Chemical structures of compounds H-228, H-229, H-230, H-231, H-232, H-233, and H-234 are shown. These structures are variations of the H-227 core, featuring different substituents on the phenyl rings, including biphenyl, fluorenyl, and thiophenyl groups.

Chemical structures of compounds H-235, H-236, H-237, H-238, H-239, and H-240 are shown. These structures represent various substituted benzimidazole and benzoxazole derivatives, featuring different aromatic and heterocyclic substituents.

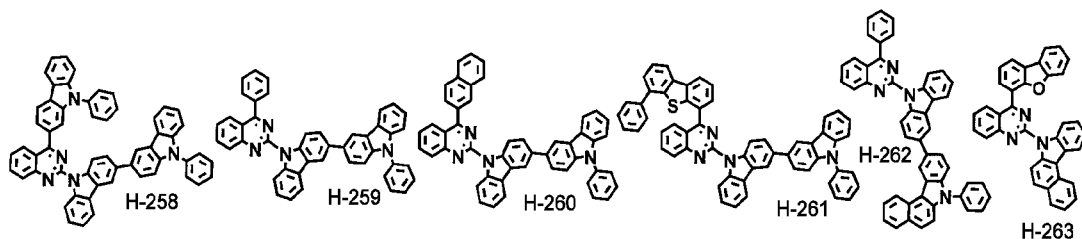
Chemical structures of H-241, H-242, H-243, H-244, H-245, and H-246 are shown. These structures are complex organic molecules featuring various fused and linked aromatic rings, including indoles, naphthalenes, and thiophenes, with multiple nitrogen and sulfur atoms. H-241 is a dicationic molecule with two positive charges on nitrogen atoms. H-242, H-243, H-244, H-245, and H-246 are also complex structures with various functional groups and ring systems.

Chemical structures of H-247, H-248, H-249, H-250, H-251, and H-252 are shown. These structures are complex organic molecules featuring various aromatic rings (phenyl, naphthalene, quinoline, indole, benzimidazole, benzoxazole, benzothiazole, benzofuran, and benzimidazole) and functional groups (nitro, fluoro, and various heterocyclic systems).

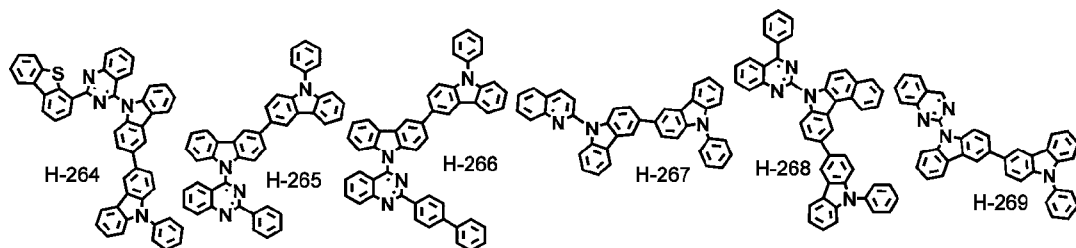
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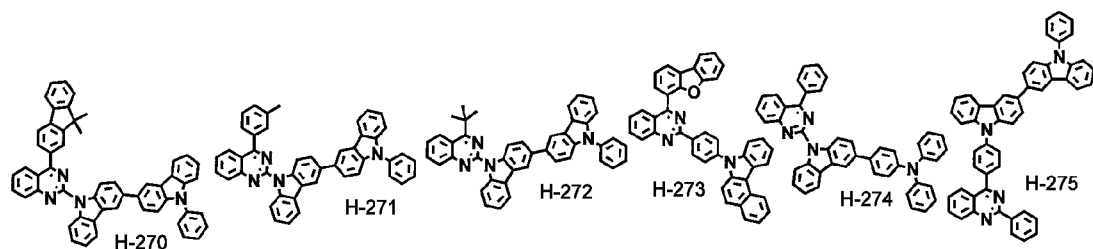
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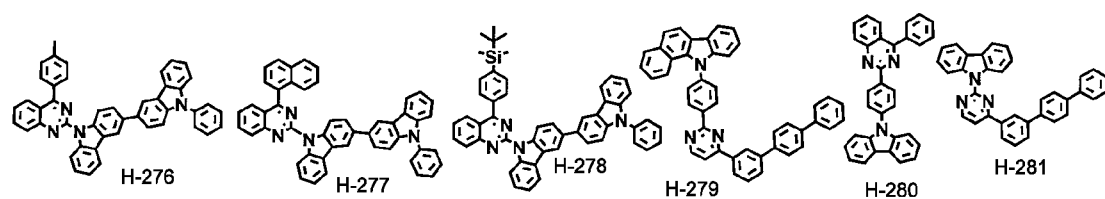
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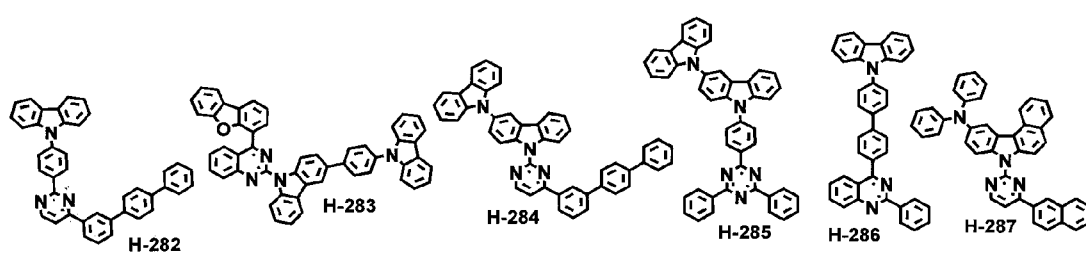
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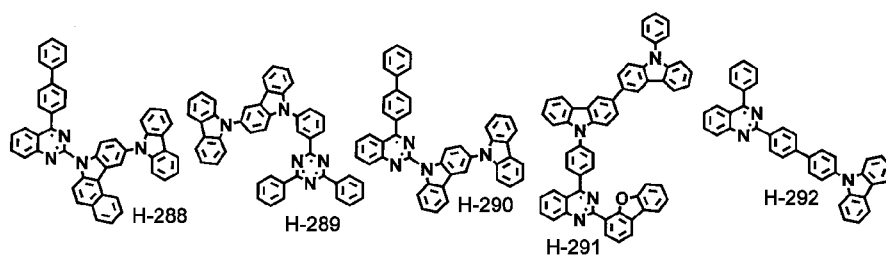
[112]



[113]



[114]



[115] Herein, "(Cl-C30)alkyl(ene)" is meant to be a linear or branched alkyl(ene) having 1

to 30 carbon atoms, in which the number of carbon atoms is preferably 1 to 20, more preferably 1 to 10, and includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc.; "(C2-C30) alkenyl" is meant to be a linear or branched alkenyl having 2 to 30 carbon atoms, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, etc.; "(C2-C30)alkynyl" is a linear or branched alkynyl having 2 to 30 carbon atoms, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes ethynyl, 1-propynyl, 2-propynyl, 1-butylnyl, 2-butylnyl, 3-butylnyl, 1-methylpent-2-ynyl, etc.; "(C3-C30)cycloalkyl" is a mono- or polycyclic hydrocarbon having 3 to 30 carbon atoms, in which the number of carbon atoms is preferably 3 to 20, more preferably 3 to 7, and includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc.; "3- to 7-membered heterocycloalkyl" is a cycloalkyl having at least one heteroatom selected from B, N, O, S, P(=O), Si and P, preferably O, S and N, and 3 to 7 ring backbone atoms, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc.; "(C6-C40)aryl(ene)" is a monocyclic or fused ring derived from an aromatic hydrocarbon having 6 to 40 carbon atoms, in which the number of carbon atoms is preferably 6 to 20, more preferably 6 to 15, and includes phenyl, biphenyl, terphenyl, naphthyl, fluorenyl, phenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc.; "3- to 30-membered heteroaryl(ene)" is an aryl group having at least one, preferably 1 to 4 heteroatom selected from the group consisting of B, N, O, S, P(=O), Si and P, and 3 to 30 ring backbone atoms; is a monocyclic ring, or a fused ring condensed with at least one benzene ring; has preferably 5 to 20, more preferably 5 to 15 ring backbone atoms; may be partially saturated; may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); and includes a monocyclic ring-type heteroaryl such as furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl such as benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc. Further, "halogen" includes F, Cl, Br and I.

[116] 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.

[117] The substituents of the substituted alkyl(ene), the substituted aryl(ene), the sub-

stituted heteroaryl(ene), the substituted cycloalkyl, and the substituted heterocycloalkyl in the above formulae each independently are preferably at least one selected from the group consisting of deuterium; a halogen; a (C1-C30)alkyl unsubstituted or substituted with a halogen; a (C6-C30)aryl; a 3- to 30- membered heteroaryl unsubstituted or substituted with a (C6-C30)aryl; a 5- to 7- membered heterocycloalkyl; a 5- to 7- membered heterocycloalkyl fused with at least one (C6-C30)aromatic ring; a (C3-C30)cycloalkyl; a (C6-C30)cycloalkyl fused with at least one (C6-C30)aromatic ring; $R_aR_bR_cSi-$; a (C2-C30)alkenyl; a (C2-C30)alkynyl; a cyano; a carbazolyl; $-NR_dR_e$; $-BR_fR_g$; $-PR_hR_i$; $-P(=O)R_jR_k$; a (C6-C30)aryl(C1-C30)alkyl; a (C1-C30)alkyl(C6-C30)aryl; $\frac{3}{4}Z-$; $R_mC(=O)-$; $R_mC(=O)O-$; a carboxyl; a nitro; and a hydroxyl, wherein R_a to R_l each independently represent a (C1-C30)alkyl, a (C6-C30)aryl, or a 3- to 30- membered heteroaryl; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, 5- to 30- membered alicyclic or aromatic ring whose carbon atom(s) may be replaced with at least one hetero atom selected from the group consisting of nitrogen, oxygen and sulfur; Z represents S or O; and R_m represents a (C1-C30)alkyl, a (C1-C30)alkoxy, a (C6-C30)aryl, or a (C6-C30)aryloxy.

- [118] Specifically, said organic electroluminescent device comprises a first electrode; a second electrode; and at least one organic layer between said first and second electrodes. Said organic layer comprises a light-emitting layer, and said light-emitting layer comprises a combination of one or more dopant compounds represented by formula 1, and one or more host compounds represented by formula 2.
- [119] Said light-emitting layer is a layer which emits light, and it may be a single layer, or it may be a multi layer of which two or more layers are laminated.
- [120] The doping concentration, the proportion of the dopant compound to the host compound may be preferably less than 20 wt%.
- [121] Another embodiment of the present invention provides a dopant and host combination of one or more dopant compounds represented by formula 1, and one or more host compounds represented by formula 2, and an organic EL device comprising the dopant and host combination .
- [122] Still another embodiment of the present invention provides an organic layer consisting of the combination of one or more dopant compounds represented by formula 1, and one or more host compounds represented by formula 2. Said organic layer comprises plural layers. Said dopant compound and said host compound can be comprised in the same layer, or can be comprised in different layers. In addition, the present invention provides an organic EL device comprising the organic layer.
- [123] In the organic electroluminescent device according to the present invention, a mixed region of an electron transport compound and an reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant may be placed on at least one

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

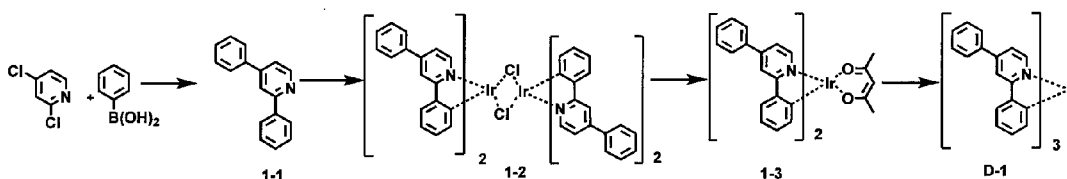
[124] In order to form each layer of the organic electroluminescent device according to the present invention, dry film-forming methods such as vacuum evaporation, sputtering, plasma and ion plating methods, or wet film-forming methods such as spin coating, dip coating, flow coating methods can be used.

[125] 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.

[126] Hereinafter, the compound, the preparation method of the compound, and the luminescent properties of the device will be explained in detail with reference to the following examples. However, these are just for exemplifying the embodiment of the present invention, so the scope of the present invention cannot be limited thereto.

[127] Example 1: Preparation of compound D-1

[128]



[129] Preparation of compound 1-1

[130] After adding 2,4-dichloropyridine 5 g (34 mmol), phenyl boronic acid 16 g (135 mmol), Pd(PPh₃)₄ 3.9 g (2.4 mmol), K₂CO₃ 23 g (135 mmol), toluene 100 mL, ethanol 50 mL, and H₂O 50 mL in a flask, the mixture was stirred at 120°C for 6 hours. Then, the reaction mixture was dried, and separated with a column to obtain compound 1-1 6.4 g (82 %).

[131] Preparation of compound 1-2

[132] After adding compound 1-1 4 g (17 mmol), IrCl₃ 2.3 g (7.8 mmol), 2-ethoxyethanol 60 mL, and H₂O 20 mL (2-ethoxyethanol/ H₂O=3/1) in a flask, the mixture was stirred

at 120°C for 24 hours under reflux. After completing the reaction, the mixture was washed using H₂O/MeOH/Hex, and dried to obtain compound 1-2 3.0 g (56 %).

[133] Preparation of compound 1-3

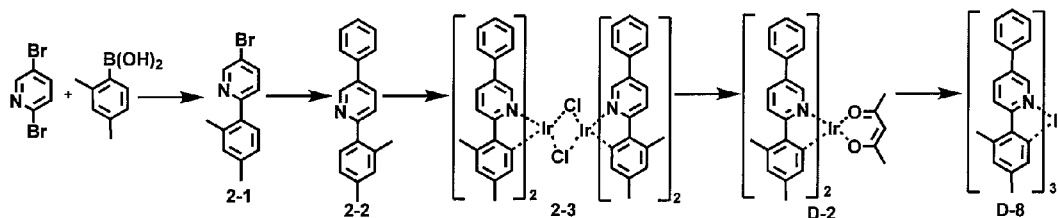
[134] After adding compound 1-2 3.0 g (2.2 mmol), 2,4-pentanedione 0.6 g (6.5 mmol), Na₂CO₃ 1.4 g (13 mmol), and 2-ethoxyethanol 10 mL in a flask, the mixture was stirred at 110°C for 12 hours. After completing the reaction, the produced solid was dried, and separated with a column to obtain compound 1-3 3 g (75 %).

[135] Preparation of compound D-1

[136] After adding compound 1-3 2.44 g (3.25 mmol), and compound 1-1 1.5 g (6.49 mmol) in a flask, glycerol was added to the mixture, and stirred for 16 hours under reflux. After the reaction, the produced solid was filtered, dried, and separated with a column to obtain compound D-1 2.5 g (87 %).

[137] Example 2: Preparation of compound D-2 and D-8

[138]



[139] Preparation of compound 2-1

[140] After adding 2,5-dibromopyridine 20 g (84 mmol), 2,4-dimethylbenzene boronic acid 15 g (101 mmol), Pd(PPh₃)₄ 4 g (3.4 mmol), Na₂CO₃ 27 g (253 mmol), toluene 240 mL, and H₂O 120 mL in a flask, the mixture was stirred at 100°C for 12 hours. Then, the reaction mixture was extracted with ethylacetate (EA), and the moisture was removed using MgSO₄, and distilled under reduced pressure. Then, the reaction mixture was dried, and separated with a column to obtain compound 2-1 18 g (70 %).

[141] Preparation of compound 2-2

[142] Compound 2-2 18 g (99 %) was prepared by using compound 2-1 18 g (70 mmol), and phenyl boronic acid 13 g (105 mmol) in a flask in the same manner as the synthetic method of compound 1-1.

[143] Preparation of compound 2-3

[144] Compound 2-3 13 g (72 %) was prepared by using compound 2-2 14 g (54 mmol), and IrCl₃ 7.5 g (24.3 mmol) in a flask in the same manner as the synthetic method of compound 1-2.

[145] Preparation of compound D-2

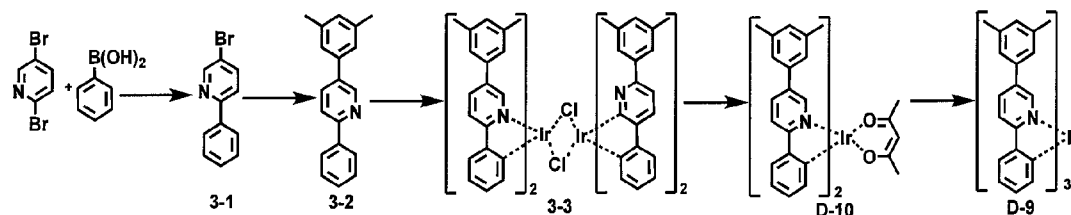
[146] Compound D-2 2.4 g (74 %) was prepared by using compound 2-3 3 g (2 mmol) in a flask in the same manner as the synthetic method of compound 1-3.

[147] Preparation of compound D-8

[148] Compound **D-8** 1.5 g (50 %) was prepared by using compound **D-2** 2.4 g (3 mmol) in a flask in the same manner as the synthetic method of compound **D-1**.

[149] Example 3: Preparation of compound **D-9** and **D-10**

[150]



[151] Preparation of compound 3-1

[152] Compound 3-1 16 g (79 %) was prepared by using 2,5-dibromopyridine 20 g (84 mmol), and phenyl boronic acid 12 g (101 mmol) in a flask in the same manner as the synthetic method of compound 2-1.

[153] Preparation of compound 3-2

[154] Compound 3-2 17 g (97 %) was prepared by using compound 3-1 16 g (67 mmol), and 3,5-dimethylphenyl boronic acid 15 g (101 mmol) in a flask in the same manner as the synthetic method of compound 2-2.

[155] Preparation of compound 3-3

[156] Compound 3-3 6 g (65 %) was prepared by using compound 3-2 7 g (27 mmol), and IrCl_3 3.7 g (12 mmol) in a flask in the same manner as the synthetic method of compound 2-3.

[157] Preparation of compound **D-10**

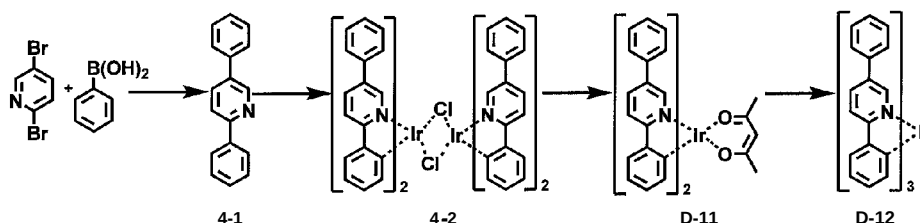
[158] Compound **D-10** 5 g (81 %) was prepared by using compound 3-3 6 g (4 mmol), and 2,4-pentanedione 1.2 g (12 mmol) in a flask in the same manner as the synthetic method of compound **D-2**.

[159] Preparation of compound **D-9**

[160] Compound **D-9** 1.6 g (45 %) was prepared by using compound **D-10** 3 g (3.7 mmol), and compound 3-2 2 g (7.4 mmol) in a flask in the same manner as the synthetic method of compound **D-8**.

[161] Example 4: Preparation of compound **D-11** and **D-12**

[162]



[163] Preparation of compound 4-1

[164] Compound 4-1 60 g (87 %) was prepared by using 2,5-dibromopyridine 70 g (295.5 mmol), and phenyl boronic acid 83 g (679.6 mmol) in a flask in the same manner as the synthetic method of compound 1-1.

[165] Preparation of compound 4-2

[166] Compound 4-2 44 g (92 %) was prepared by using compound 4-1 40 g (380.5 mmol), and IrCl_3 23.5 g (173 mmol) in a flask in the same manner as the synthetic method of compound 1-2.

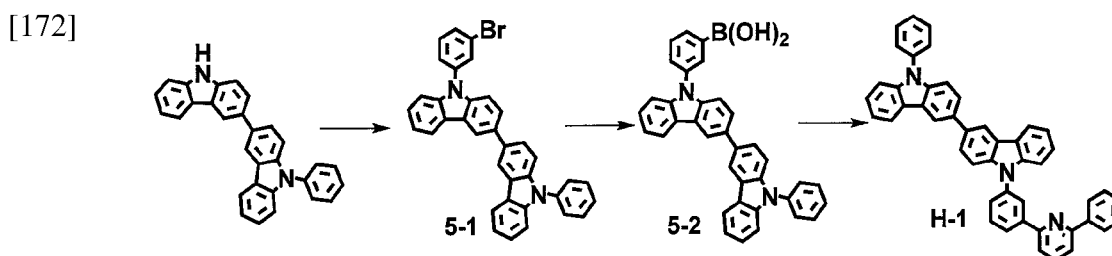
[167] Preparation of compound D-II

[168] Compound **D-II** 42 g (87.4 %) was prepared by using compound 4-2 44 g (48 mmol), and 2,4-pentanedione 9.6 g (96 mmol) in a flask in the same manner as the synthetic method of compound 1-3.

[169] Preparation of compound D-12

[170] Compound **D-12** 20 g (38 %) was prepared by using compound **D-II** 42 g (80.5 mmol), and compound 4-1 20 g (161 mmol) in a flask in the same manner as the synthetic method of compound **D-I**.

[171] Example 5: Preparation of compound H-1



[173] Preparation of compound 5-1

[174] After adding 9-phenyl-9H,9'H-3,3'-bicarbazole 20 g (0.049 mol), 1-bromo-3-iodobenzene 28 g (0.098 mol), CuI 9.32 g (0.049 mol), K_3PO_4 26 g (0.12 mol), ethylenediamine 3.3 mL, and toluene 300 mL in a flask, the mixture was stirred at 120°C for 12 hours. After completing the reaction, the mixture was filtered, washed with methanol, and filtered using a column. Then, the solvent was removed under reduced pressure, and recrystallized with EA/methanol to obtain compound 5-1 14 g (52 %).

[175] Preparation of compound 5-2

[176] After adding compound 5-1 20 g (0.035 mol), and tetrahydrofuran (THF) 190 mL in a flask, $n\text{-BuLi}$ 15 mL (2.25 M in hexane) was slowly added to the mixture at -78°C . After stirring the mixture at -78°C for 1 hour, B(OMe)_3 16 mL (0.07 mol) was slowly added to the mixture at -78°C , and heated to room temperature to react for 12 hours. After completing the reaction, the mixture was extracted with ethylacetate, the organic layer was dried with MgSO_4 , filtered, and the solvent was removed under reduced pressure. Then, the remaining product was recrystallized to obtain compound 5-2 10 g (75 %).

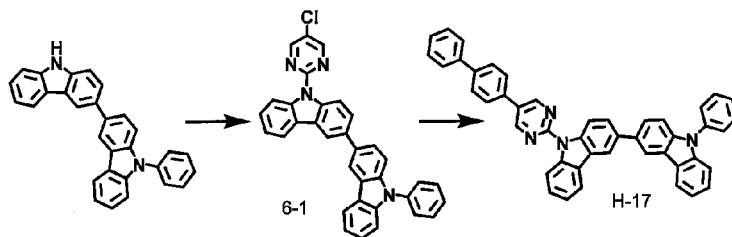
[177] Preparation of compound H-1

[178] After adding 2-bromo-6-phenylpyridine 6.5 g (0.03 mol), compound 5-2 19.2 g

(0.036 mol), $\text{Pd(PPh}_3)_4$ 1.6 g (0.001 mol), K_2CO_3 11 g (0.08 mol), toluene 140 mL, EtOH 35 mL, and H_2O 40 mL in a flask, the mixture was stirred at 120°C for 12 hours. After completing the reaction, the mixture was extracted with ethylacetate, the organic layer was dried with MgSO_4 , filtered, and the solvent was removed under reduced pressure. Then, the remaining product was separated with a column to obtain compound **H-1** 8.7 g (49 %).

[179] Example 6: Preparation of compound **H-17**

[180]



[181] Preparation of compound 6-1

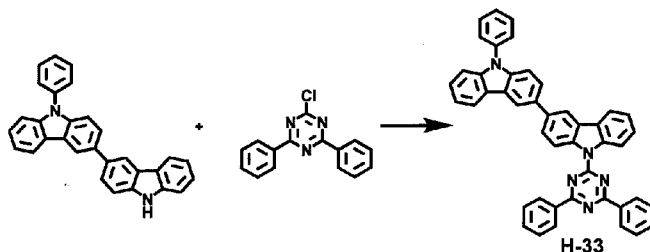
[182] After adding 9-phenyl-9H,9'H-3,3'-bicarbazole 12.5 g (30.51 mmol) in a flask, it was dissolved using dimethylformamide (DMF) 150 mL, and NaH 1.8 g (45.77 mmol) was added to the mixture. After 30 minutes, 2,5-dichloropyrimidine 5 g (33.56 mmol) was added to the reaction mixture. After stirring the mixture for 4 hours at room temperature, methanol was added to the mixture. Then, the produced solid was filtered under reduced pressure, and separated with a column to obtain compound 6-1 13.3 g (84 %).

[183] Preparation of compound **H-17**

[184] After adding compound 6-1 6.5 g (12.48 mmol), 4-phenyl boronic acid 3 g (14.97 mmol), 2-dicyclohexylphosphino-2',6'-dimethoxybiphenyl (S-phos) 0.51 g (1.25 mmol), Pd(OAc)_2 0.28 g (1.25 mmol), Cs_2CO_3 12.2 g (37.44 mmol), o-xylene 65 mL, ethanol 30 mL, and distilled water 30 mL in a flask, the mixture was stirred under reflux. After 4 hours, the mixture was cooled to room temperature, and methanol was added. Then, the produced solid was filtered under reduced pressure, and separated with a column to obtain compound **H-17** 3.5 g (44 %).

[185] Example 7: Preparation of compound **H-33**

[186]

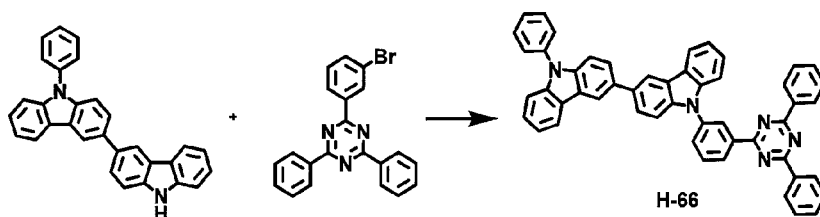


[187] Compound **H-33** 6.5 g (54 %) was prepared by using 9-phenyl-9H,9'H-3,3'-bicarbazole 10 g (22.4 mmol), and

2-chloro-4,6-diphenyl-1,3,5-triazine 5 g (18.6 mmol) in a flask in the same manner as the synthetic method of compound 6-1.

[188] Example 8: Preparation of compound H-66

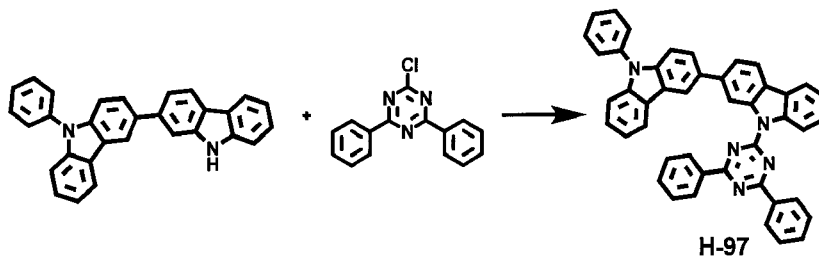
[189]



[190] After adding 9-phenyl-9H,9'H-3,3'-bicarbazole 36.2 g (93.2 mmol), 2-(3-bromophenyl)-4,6-diphenyl-1,3,5-triazine 40 g (97.9 mmol), Pd(OAc)₂ 1.25 g (5.59 mmol), S-phos 4.6 g (11.18 mmol), NaOt-bu 26.8 g (279.7 mmol), and o-xylene 450 mL in a flask, the mixture was stirred under reflux. After 6 hours, the mixture was cooled to room temperature, and the produced solid was filtered under reduced pressure. Then, the remaining product was separated with a column to obtain compound **H-66** 34.8 g (52.1 %).

[191] Example 9: Preparation of compound H-97

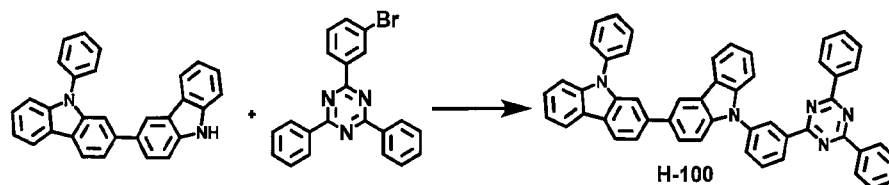
[192]



[193] Compound **H-97** 9.5 g (86 %) was prepared by using 9-phenyl-9H,9'H-2,3'-bicarbazole 7 g (17.14 mmol), and 2-chloro-4,6-diphenyl-1,3,5-triazine 5.1 g (18.85 mmol) in a flask in the same manner as the synthetic method of compound 6-1.

[194] Example 10: Preparation of compound H-100

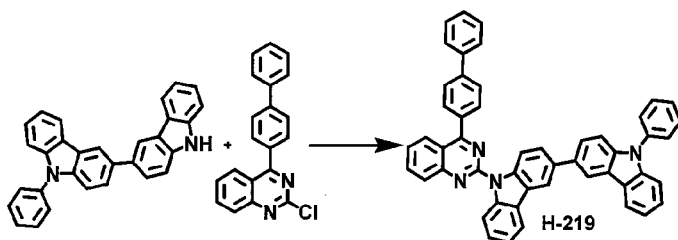
[195]



[196] Compound **H-100** 4 g (28.5 %) was prepared by using 9-phenyl-9H,9'H-2,3'-bicarbazole 4 g (9.8 mmol), and 2-(3-bromophenyl)-4,6-diphenyl-1,3,5-triazine 4.6 g (11.75 mmol) in a flask in the same manner as the synthetic method of compound **H-66**.

[197] Example 11: Preparation of compound H-219

[198]



[199] Compound **H-219** 4 g (47.4 %) was prepared by using 4-(biphenyl-4-yl)-2-chloroquinazoline 4.6 g (14.7 mmol), and 9-phenyl-9H,9'H-2,3'-bicarbazole 5 g (12.2 mmol) in a flask in the same manner as the synthetic method of compound 6-1.

[200] The detailed data of the dopant compounds prepared in Examples 1 to 4, and the dopant compounds easily prepared using Examples 1 to 4 are shown in table 1 below.

[201] [Table 1]

[202]

Compound	Yield (%)	Melting Point (°C)	UV (nm)	PL (nm)
D-1	87	273	308	459
D-2	82	360	334	550
D-3	81	154	308	541
D-5	62	265	312	534
D-7	35	297	298	568
D-8	34	over 400	320	556
D-9	81	360	326	541
D-10	45	N/A	N/A	N/A
D-11	92	N/A	N/A	N/A
D-12	61	360	326	541
D-18	36	360	334	550

[203] The detailed data of the host compounds prepared in Examples 5 to 11, and the host compounds easily prepared using Examples 5 to 11 are shown in table 2 below.

[204] [Table 2]

[205]

Compound	Yield (%)	Melting Point (°C)	UV (nm)	PL (nm)	Mass
H-1	49	140	326	407	638.77
H-2	21	290	352	500	715.8
H-3	24	285	356	485	581.7
H-4	41	300	308	459	658
H-5	12	233.7	294	412.9	638.7
H-6	29	192	360	433	640
H-9	32	170	344	465	640
H-10	36	143	307	435	639.7
H-13	38	212	304	479	730.8
H-17	44	265	372	423	639.76
H-18	82	219	350	499	565
H-20	66	180	296	385	668.8
H-21	54	215	322	403	668.8
H-28	51	212	354	479	679.82
H-29	64	180	306	477	577.7
H-30	42	132	340	477	563.66
H-31	55	220	334	495	669.81
H-33	54	237	318	512	640.24
H-35	78	215	362	492	639.25
H-36	23	175	340	483	639.76
H-37	22	198	348	489	715.85
H-38	23	219	345	404	714.8
H-39	36	243	308	472	715.9
H-40	11	260	338	511	792.9
H-42	46	230	304	479	667.2
H-43	62	222	331	477	733.84
H-45	38	214	342	475	715.85
H-47	45	195	338	485	792
H-48	13	169	304	478	729.9
H-50	21	138	304	478	729.9

H-51	15	223	304	471	733.8
H-58	42	199	344	481	745.9
H-60	51	251	362	434	715.8
H-63	52	206	358	482	639.7
H-66	52	282	366	478	716.8
H-67	31	254	348	493	715.85
H-68	25	130	324	482	729.9
H-74	71	292	334	414	654.77
H-75	84	244	368	487	696.88
H-81	17	160	324	374	730.87
H-82	17	250	324	374	730.87
H-85	71	207	302	385	654.77
H-87	66	264	372	493	654.77
H-90	49	245	356	493	668.8
H-94	48	145	335	463	715.85
H-97	86	280	381	481	640.75
H-98	57	230	324	461	716.8
H-100	29	250	345	466	716.84
H-105	15	281	340	513	701
H-113	14	228	356	515	689
H-115	65	292	310	513	689
H-154	33	250	332	513	689
H-155	22	235	336	521	668
H-160	39	304	457	244	612.7
H-163	59	304	467	181	688.8
H-165	20	196	391	451	689
H-219	47	264	342	523	689
H-222	76	311	340	488	689
H-223	17	282	346	497	778
H-224	60	234	308	381	703

[207]

H-239	37	168	304	446	689
H-240	20	262	342	531	739
H-241	32	168	304	383	689
H-242	66	204	304	517	689
H-243	35	187	305	448	765
H-244	65	264	306	384	719
H-245	60	235	340	488	815
H-246	75	208	344	468	795
H-248	38	221	310	522	765
H-250	41	237	310	517	779
H-251	40	307	326	520	779
H-252	53	197	306	465	739
H-255	23	215	358	521	795
H-256	71	227	304	517	765
H-257	44	187	334	516	779
H-258	39	267	282	515	778
H-259	40	219	306	516	613
H-260	19	234	324	525	663
H-261	51	211	352	537	795
H-264	48	243	296	502	719
H-265	32	248	296	492	613
H-266	37	234	300	494	689
H-267	71	131	304	427	536
H-269	19	196	332	491	537
H-270	61	248	308	511	729
H-271	43	196	306	508	617
H-272	49	210	306	467	593
H-275	22	177	304	470	689
H-276	58	235	308	515	627
H-277	58	245	356	513	663
H-283	56	250	334	486	703
H-290	59	283	296	513	613
H-291	32	270	304	470	779

[208] DeviceExample 1: ProductionofanOLEDdeviceusingtheorganic
 [209] electroluminescent compoundaccordingtothepresentinvention

[210] An OLED device was produced using the light emitting material according to the present invention. A transparent electrode indium tin oxide (ITO) thin film (15 Ω /sq) on a glass substrate for an organic light-emitting diode (OLED) device (Samsung

Corning, Republic of Korea) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol and distilled water, sequentially, and then was stored in isopropanol. Then, the ITO substrate was mounted on a substrate holder of a vacuum vapor depositing apparatus. $N^1,N^{1'}-([1,1'\text{-biphenyl}]\text{-}4,4'\text{-diyl})\text{bis}(N^{1'}\text{-}(\text{naphthalen-1-yl})\text{-}N^4,N^4\text{-diphenylbenzen-1,4-diamine})$ was introduced into a cell of said vacuum vapor depositing apparatus, and then the pressure in the chamber of said apparatus was controlled to 10^{-6} torr. Thereafter, an electric current was applied to the cell to evaporate the above introduced material, thereby forming a hole injection layer having a thickness of 120 nm on the ITO substrate. Then, $N^4,N^4,N^4',N^4'\text{-tetra}([1,1'\text{-biphenyl}]\text{-}4\text{-yl})\text{-}[1,1'\text{-biphenyl}]\text{-}4,4'\text{-diamine}$ was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a hole transport layer having a thickness of 20 nm on the hole injection layer. Thereafter, compound **H-56** was introduced into one cell of the vacuum vapor depositing apparatus, as a host material, and compound **D-I** was introduced into another cell as a dopant. The two materials were evaporated at different rates and were deposited in a doping amount of 12 wt% based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 40 nm on the hole transport layer. Then, 2-(4-(9,10-di(naphthalen-2-yl)anthracen-2-yl)phenyl)-1-phenyl-1H-benzo[*c*]imidazole was introduced into one cell and lithium quinolate was introduced into another cell. The two materials were evaporated at the same rate and were deposited in a doping amount of 50 wt% each to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. Then, after depositing lithium quinolate as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 150 nm was deposited by another vacuum vapor deposition apparatus on the electron injection layer. Thus, an OLED device was produced. All the materials used for producing the OLED device were purified by vacuum sublimation at 10^{-6} torr prior to use.

- [211] The produced OLED device showed a yellow-green emission having a luminance of 1020 cd/m² and a current density of 3.0 mA/cm².
- [212] Device Example 2: Production of an OLED device using the organic
- [213] electroluminescent compound according to the present invention
- [214] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-97** as a host, and using compound **D-3** as a dopant of the light emitting material.
- [215] The produced OLED device showed a yellow-green emission having a luminance of 2540 cd/m² and a current density of 5.34 mA/cm².
- [216] Device Example 3: Production of an OLED device using the organic

- [217] electroluminescent compound according to the present invention
- [218] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-98** as a host, and using compound **D-4** as a dopant of the light emitting material.
- [219] The produced OLED device showed a yellow-green emission having a luminance of 520 cd/m² and a current density of 1.02 mA/cm².
- [220] Device Example 4: Production of an OLED device using the organic
- [221] electroluminescent compound according to the present invention
- [222] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-56** as a host, and using compound **D-5** as a dopant of the light emitting material.
- [223] The produced OLED device showed a yellow-green emission having a luminance of 1895 cd/m² and a current density of 6.86 mA/cm².
- [224] Device Example 5: Production of an OLED device using the organic
- [225] electroluminescent compound according to the present invention
- [226] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-35** as a host, and using compound **D-12** as a dopant of the light emitting material.
- [227] The produced OLED device showed a yellow-green emission having a luminance of 3030 cd/m² and a current density of 19.2 mA/cm².
- [228] Device Example 6: Production of an OLED device using the organic
- [229] electroluminescent compound according to the present invention
- [230] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-100** as a host, and using compound **D-9** as a dopant of the light emitting material.
- [231] The produced OLED device showed a yellow-green emission having a luminance of 760 cd/m² and a current density of 1.62 mA/cm².
- [232] Device Example 7: Production of an OLED device using the organic
- [233] electroluminescent compound according to the present invention
- [234] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-66** as a host, and using compound **D-9** as a dopant of the light emitting material.
- [235] The produced OLED device showed a yellow-green emission having a luminance of 920 cd/m² and a current density of 2.38 mA/cm².
- [236] Device Example 8: Production of an OLED device using the organic
- [237] electroluminescent compound according to the present invention
- [238] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-66** as a host, and using compound **D-12** as a dopant of the light

emitting material.

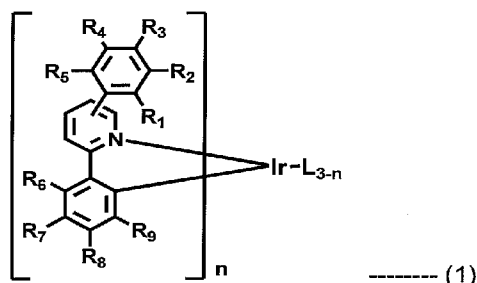
- [239] The produced OLED device showed a yellow-green emission having a luminance of 1110 cd/m² and a current density of 2.57 mA/cm².
- [240] Device Example 9: Production of an OLED device using the organic
- [241] electroluminescent compound according to the present invention
- [242] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-33** as a host, and using compound **D-9** as a dopant of the light emitting material.
- [243] The produced OLED device showed a yellow-green emission having a luminance of 1915 cd/m² and a current density of 4.34 mA/cm².
- [244] Device Example 10: Production of an OLED device using the organic
- [245] electroluminescent compound according to the present invention
- [246] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-33** as a host, and using compound **D-12** as a dopant of the light emitting material.
- [247] The produced OLED device showed a yellow-green emission having a luminance of 4010 cd/m² and a current density of 8.91 mA/cm².
- [248] Device Example 11: Production of an OLED device using the organic
- [249] electroluminescent compound according to the present invention
- [250] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-156** as a host, and using compound **D-18** as a dopant of the light emitting material.
- [251] The produced OLED device showed a yellow-green emission having a luminance of 520 cd/m² and a current density of 4.73 mA/cm².
- [252] Device Example 12: Production of an OLED device using the organic
- [253] electroluminescent compound according to the present invention
- [254] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-160** as a host, and using compound **D-9** as a dopant of the light emitting material.
- [255] The produced OLED device showed a yellow-green emission having a luminance of 882 cd/m² and a current density of 2.15 mA/cm².
- [256] Device Example 13: Production of an OLED device using the organic
- [257] electroluminescent compound according to the present invention
- [258] An OLED device was produced in the same manner as in Device Example 1, except for using compound **H-259** as a host, and using compound **D-18** as a dopant of the light emitting material.
- [259] The produced OLED device showed a yellow-green emission having a luminance of 4055 cd/m² and a current density of 7.51 mA/cm².

[260] As shown above, the organic EL device of the present invention contains a specific combination of a dopant compound and a host compound, and thus emits yellow-green light, and provides excellent current efficiency. In general, an organic EL device can emit white light by mixing 3 colors, i.e., red, green, and blue. On the other hand, when using the dopant compound and the host compound according to the present invention, the CIE X value appears to be 0.45, which is a yellow-green light. Thus, it is possible to emit white color by bicolor combination with blue light when using the organic EL device comprising the dopant and host combination according to the present invention.

Claims

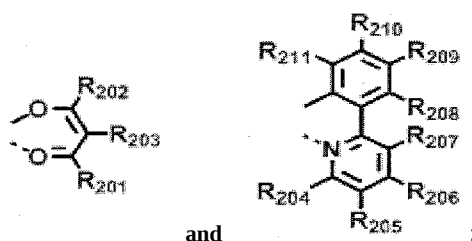
[Claim 1]

A combination of one or more dopant compound represented by the following formula 1, and one or more host compound represented by the following formula 2:



wherein

L is selected from the following structures:



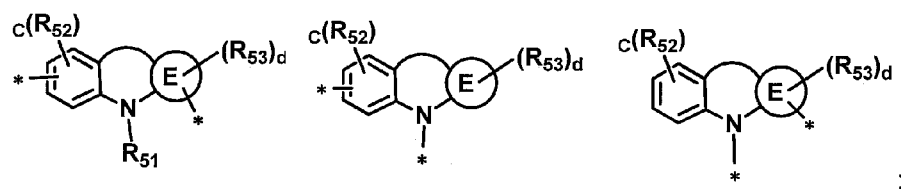
R_i to R₉, each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a cyano, or a substituted or unsubstituted (C1-C30)alkoxy;

R₂₀₁ to R₂₁₀ each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl; and
n represents an integer of 1 to 3;



wherein

Cz is selected from the following structures:



ring E represents a substituted or unsubstituted (C6-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30- membered heteroaryl;

R_{51} to R_{53} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted 5- to 7-membered heterocycloalkyl, a substituted or unsubstituted (C6-C30)aryl fused with at least one substituted or unsubstituted (C3-C30)alicyclic ring, a 5- to 7-membered heterocycloalkyl fused with at least one substituted or unsubstituted (C6-C30)aromatic ring, a substituted or unsubstituted (C3-C30)cycloalkyl, a (C3-C30)cycloalkyl fused with at least one substituted or unsubstituted (C6-C30)aromatic ring, or a substituted or unsubstituted (C6-C30)aryl(C1-C30)alkyl;

L_1 and L_2 each independently represent a single bond, a substituted or unsubstituted (C6-C40)arylene, a substituted or unsubstituted 3- to 30-membered heteroarylene, a substituted or unsubstituted 3- to 30-membered heteroarylene fused with a (C3-C30)cycloalkyl ring, or a substituted or unsubstituted (C6-C30)cycloalkylene;

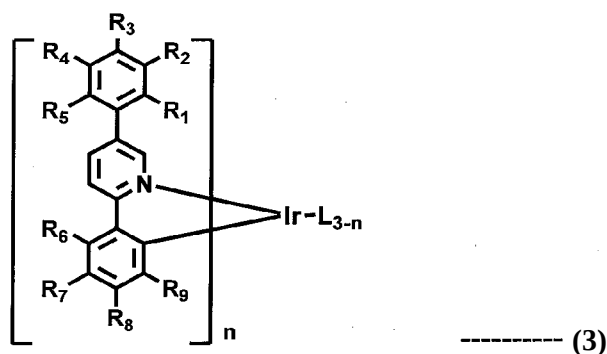
M represents a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 3- to 30-membered heteroaryl;

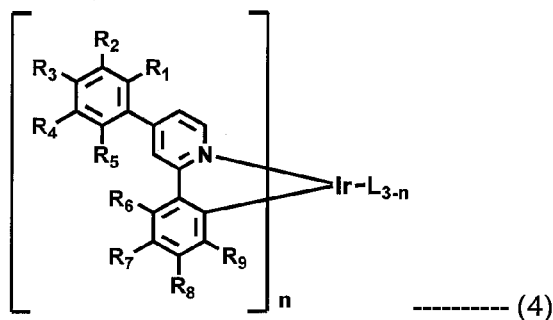
a represents 1 or 2; where a is 2, each of Cz may be same or different, and each of L_1 may be same or different;

c and d each independently represent an integer of 0 to 4; where c or d is an integer of 2 or more, each of R_{52} , and each of R_{53} may be same or different.

[Claim 2]

The combination according to claim 1, wherein the compound represented by formula 1 is represented by formula 3 or 4:

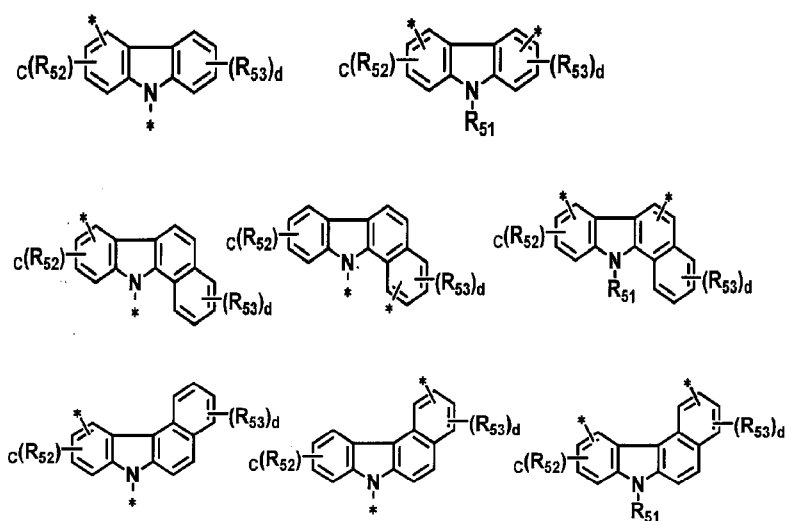




wherein R_1 to R_9 , L , and n are as defined in claim 1.

[Claim 3]

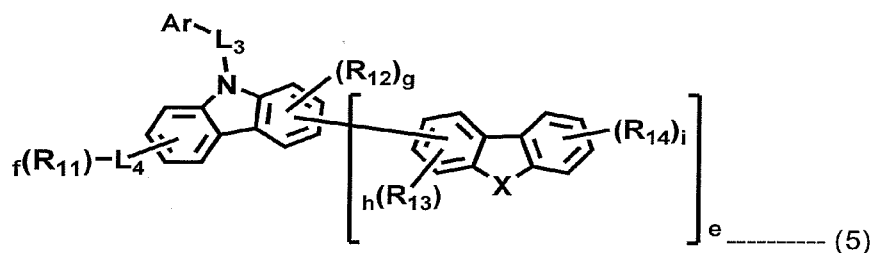
The combination according to claim 1, wherein in formula 2, Cz is selected from the following structures:



wherein R_{51} , R_{52} , R_{53} , c , and d are as defined in claim 1.

[Claim 4]

The combination according to claim 1, wherein the compound represented by formula 2 is represented by formula 5:



wherein

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

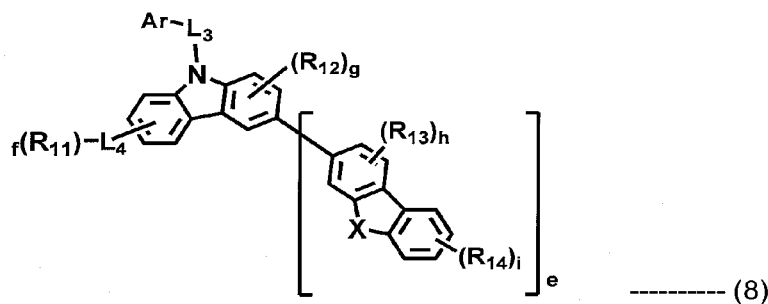
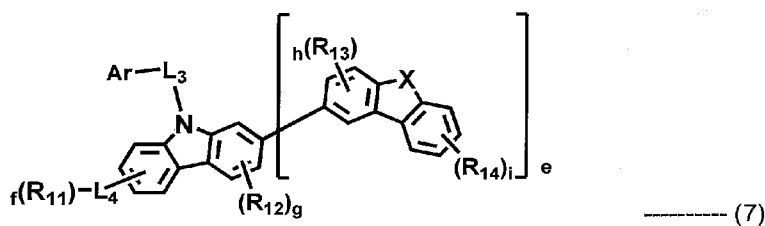
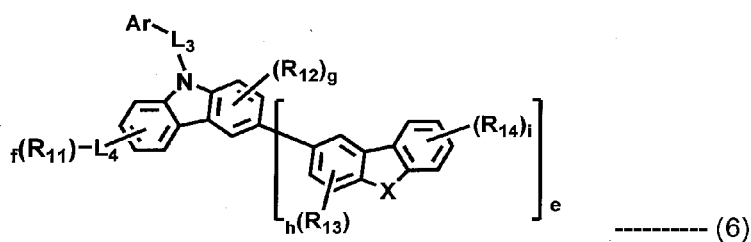
X represents $-\text{C}(\text{R}_{16}\text{R}_{17})-$, $-\text{N}(\text{R}_{18})-$, $-\text{S}-$, or $-\text{O}-$;

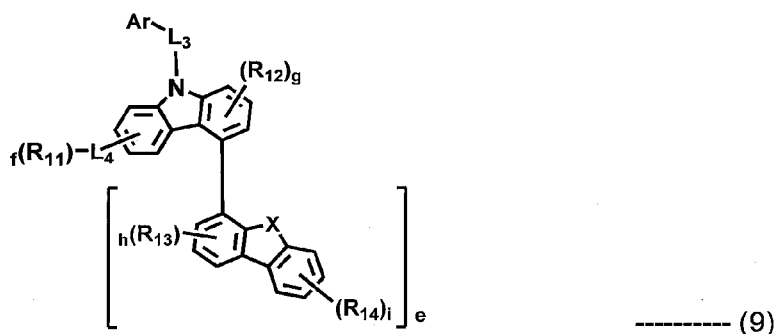
L_3 and L_4 each independently represent a single bond, a substituted or unsubstituted (C6-C40)arylene, a substituted or unsubstituted 5- to 30- membered heteroarylene, or a substituted or unsubstituted 5- to 30-

membered heteroarylene fused with a (C3-C30)cycloalkyl ring;
 R_{11} to R_{14} , and R_{16} to R_{18} each independently represent hydrogen, deuterium, a halogen, a cyano, a nitro, a hydroxyl, a substituted or unsubstituted amino, a substituted or unsubstituted silyl, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted 5- to 30- membered heteroaryl, or are linked to each other to form a saturated or unsaturated ring;
 e represents an integer of 0 to 1;
 f and i each independently represent an integer of 1 to 4; where f or i is an integer of 2 or more, each of R_{11} , and each of R_{14} may be same or different; and
 g and h each independently represent an integer of 1 to 3; where g or h is an integer of 2 or more, each of R_{12} , and each of R_{13} may be same or different.

[Claim 5]

The combination according to claim 4, wherein the compound represented by formula 5 is selected from formulae 6 to 9:



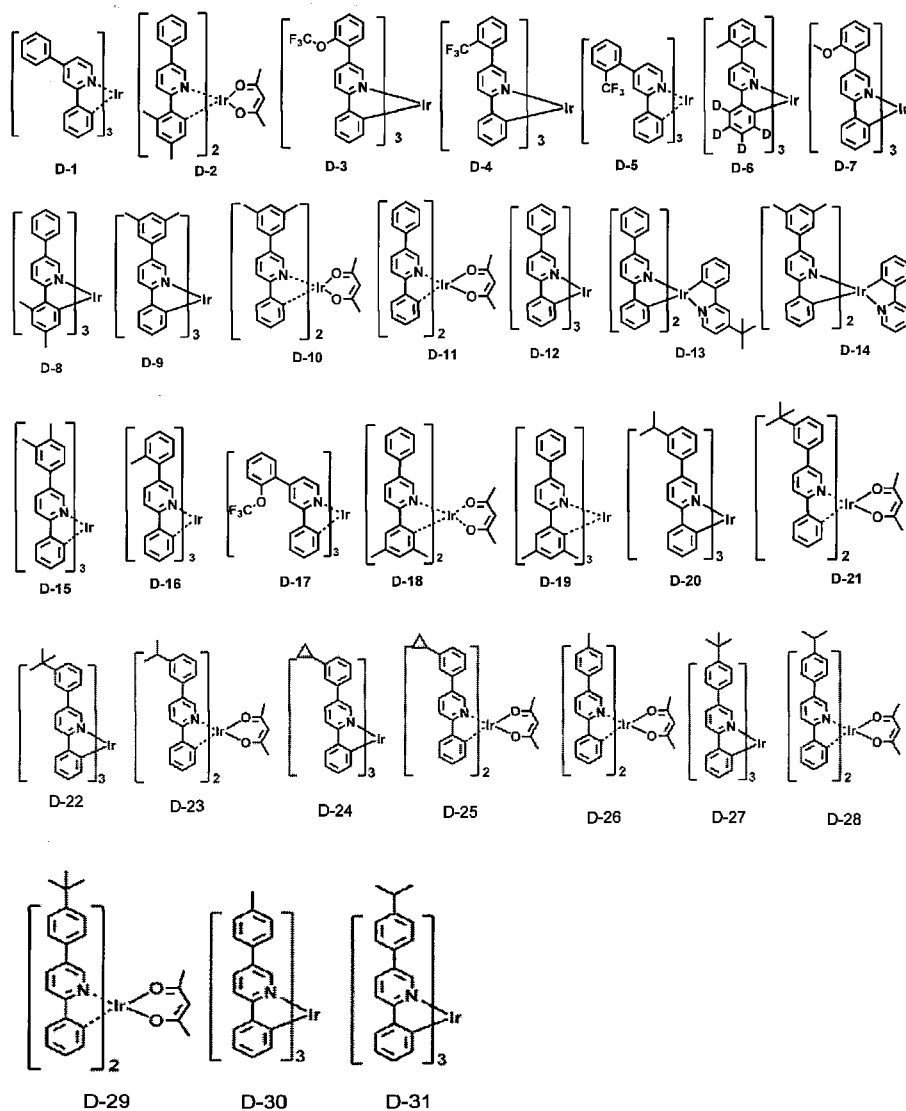


wherein Ar, X, L₃, L₄, R₁₁ to R₁₄, e, f, g, h, and i are as defined in claim 4.

[Claim 6] The combination according to claim 1, wherein in formula 1, R_i to R₉ each independently represent hydrogen, deuterium, a (Cl-CIO)alkyl unsubstituted or substituted with a halogen, an unsubstituted (C3-C7)cycloalkyl, or a (Cl-CIO)alkoxy unsubstituted or substituted with a halogen; and
R_{20i} to R₂₁₁ each independently represent hydrogen, or an unsubstituted (Cl-CIO)alkyl.

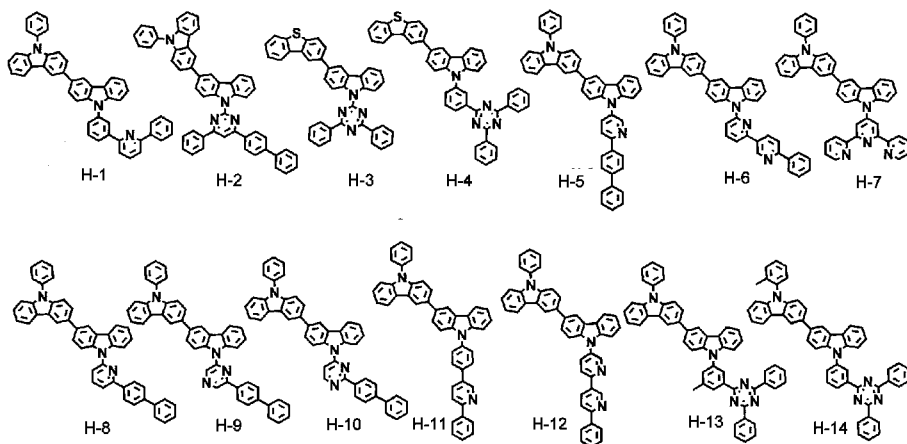
[Claim 7] The combination according to claim 4, wherein in formula 5, Ar represents a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20- membered heteroaryl;
X represents -C(R₁₆R_n)-, -N(R₁₈)-, -O-, or -S-, where R₁₆ to R₁₈ each independently represent a substituted or unsubstituted silyl, a substituted or unsubstituted (Cl-CIO)alkyl, a substituted or unsubstituted (C3-C10)cycloalkyl, a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted 5- to 20- membered heteroaryl;
L₃ and L₄ each independently represent a single bond, a substituted or unsubstituted (C6-C20)arylene, a substituted or unsubstituted 5- to 20- membered heteroarylene, or a substituted or unsubstituted 5- to 20- membered heteroarylene fused with a (C3-C10)cycloalkyl ring;
R_n to R₁₄ each independently represent hydrogen, a halogen, a substituted or unsubstituted amino, a substituted or unsubstituted silyl, a substituted or unsubstituted (Cl-CIO)alkyl, a substituted or unsubstituted 5- to 20- membered heteroaryl, or a substituted or unsubstituted (C6-C20)aryl; or are linked to each other to form a mono- or polycyclic, 5- to 30- membered alicyclic or aromatic ring.

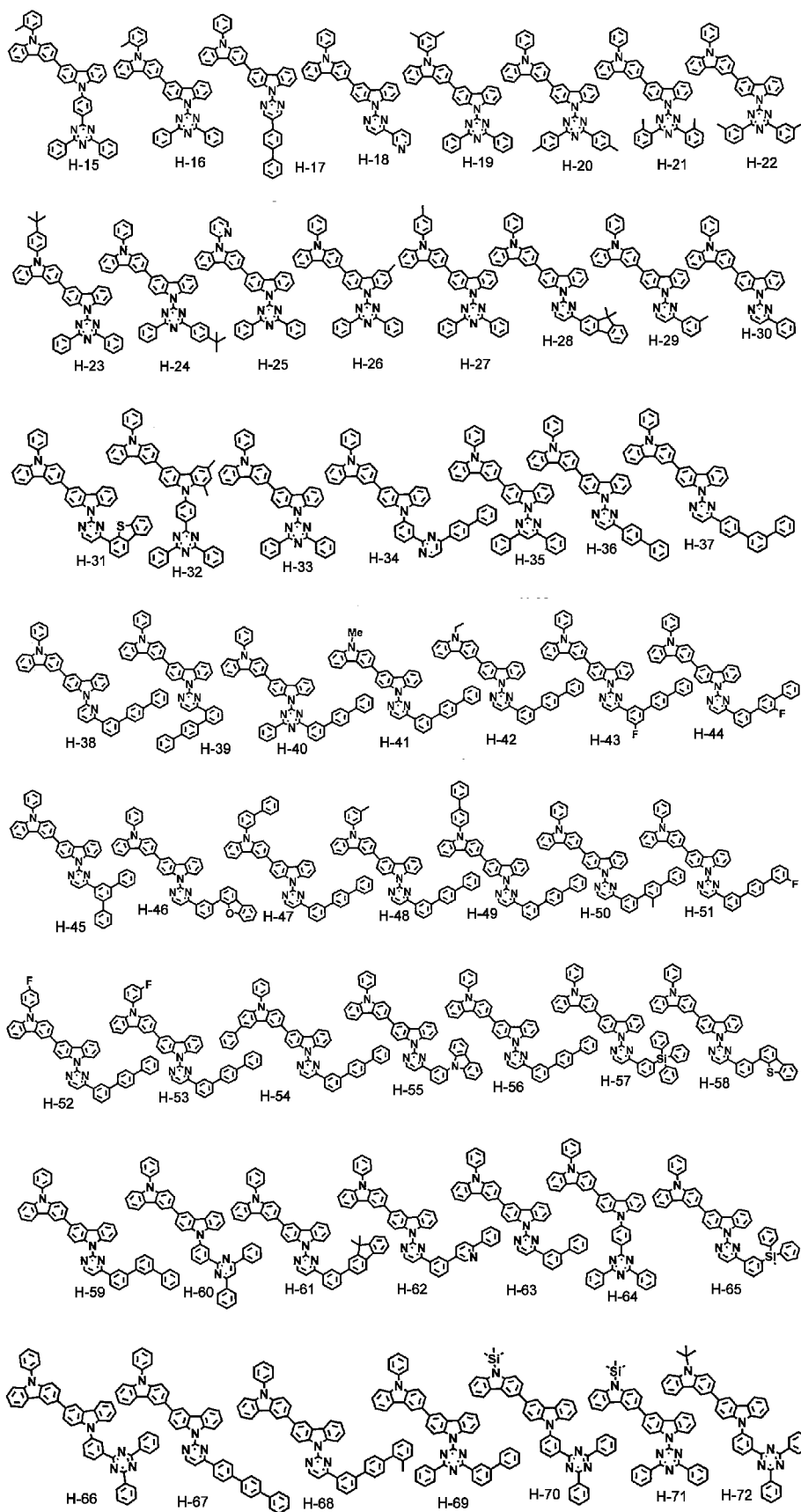
[Claim 8] The combination according to claim 1, wherein the compound represented by formula 1 is selected from the group consisting of:

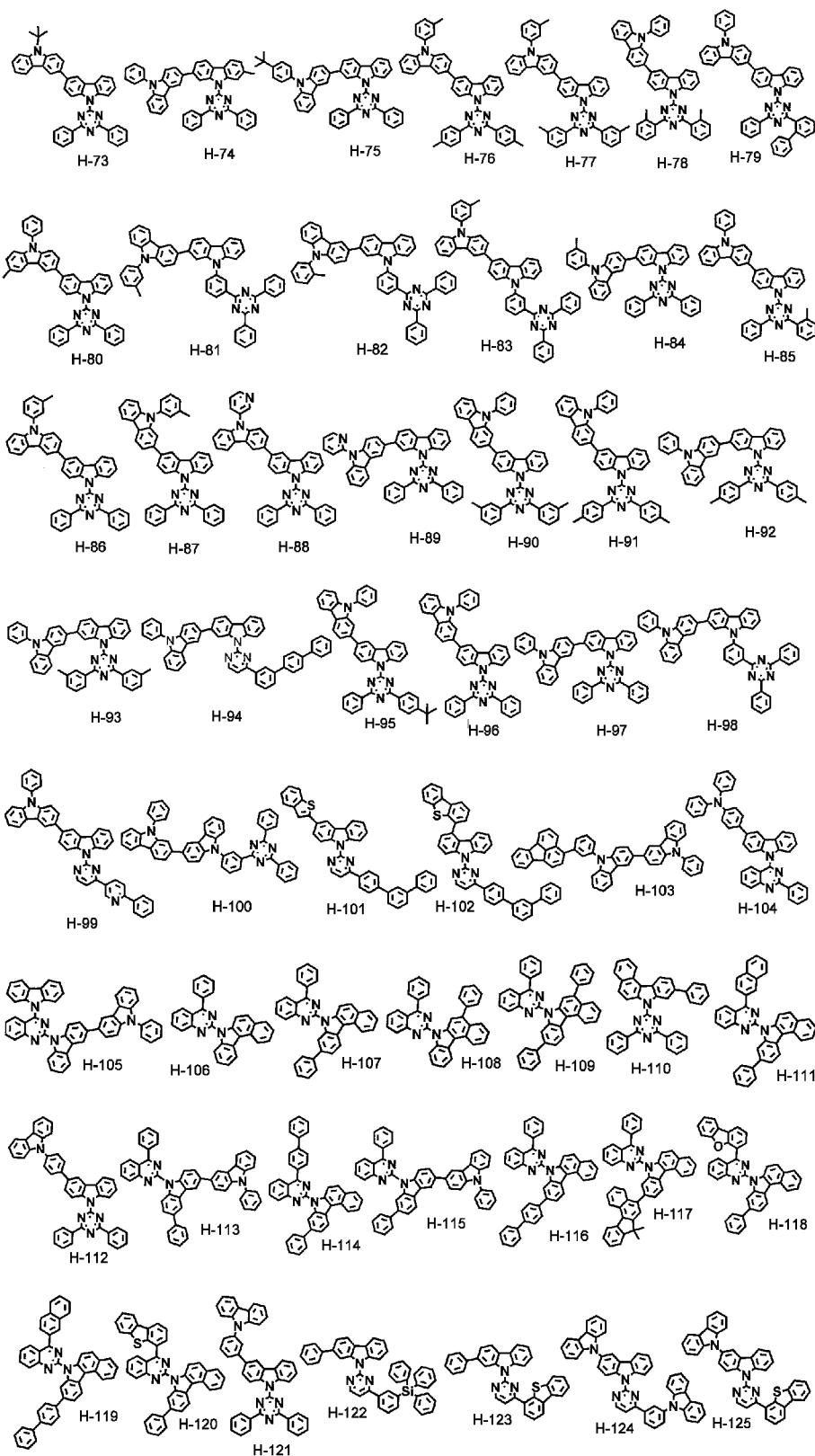


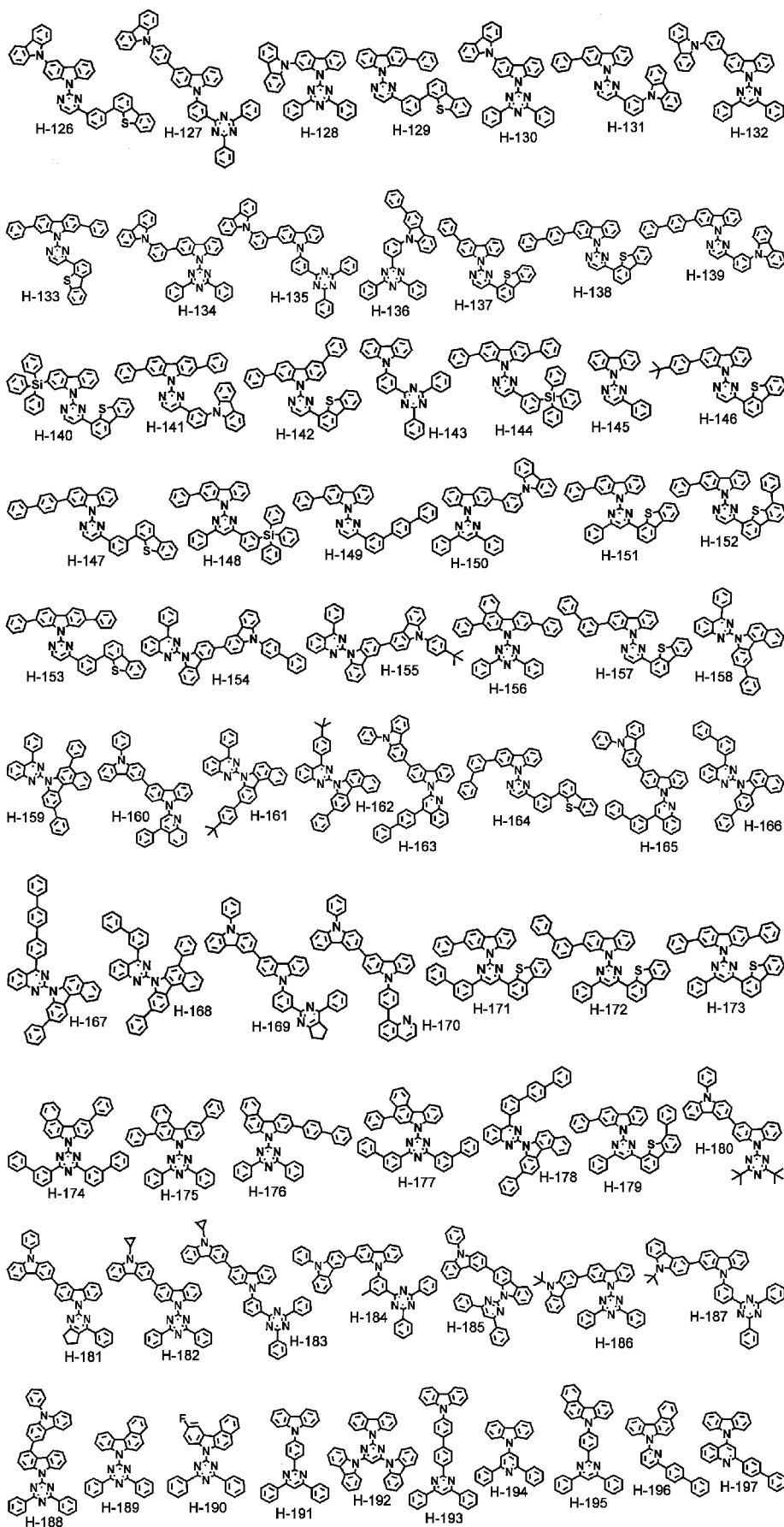
[Claim 9]

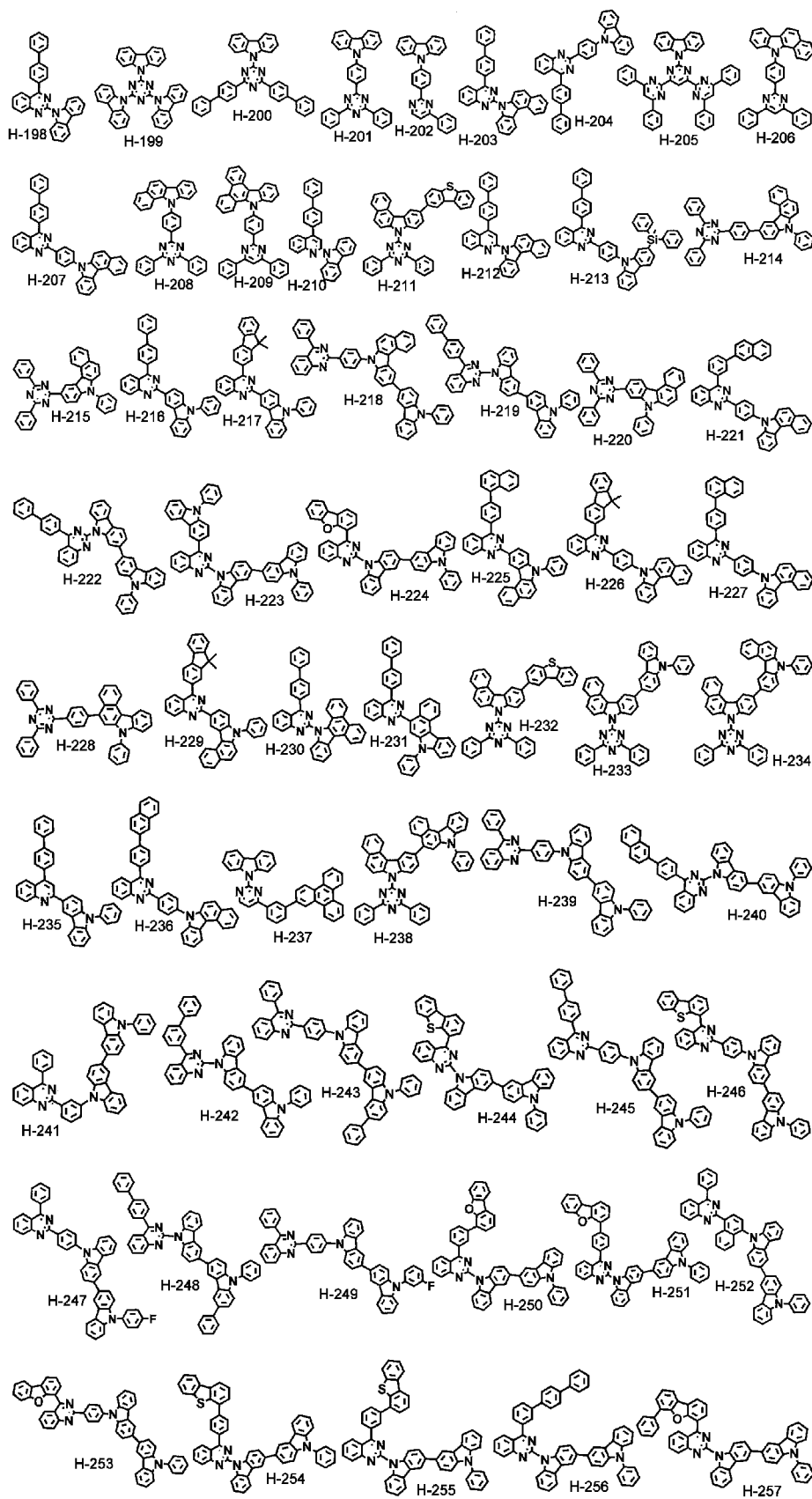
The combination according to claim 1, wherein the compound represented by formula 2 is selected from the group consisting of:

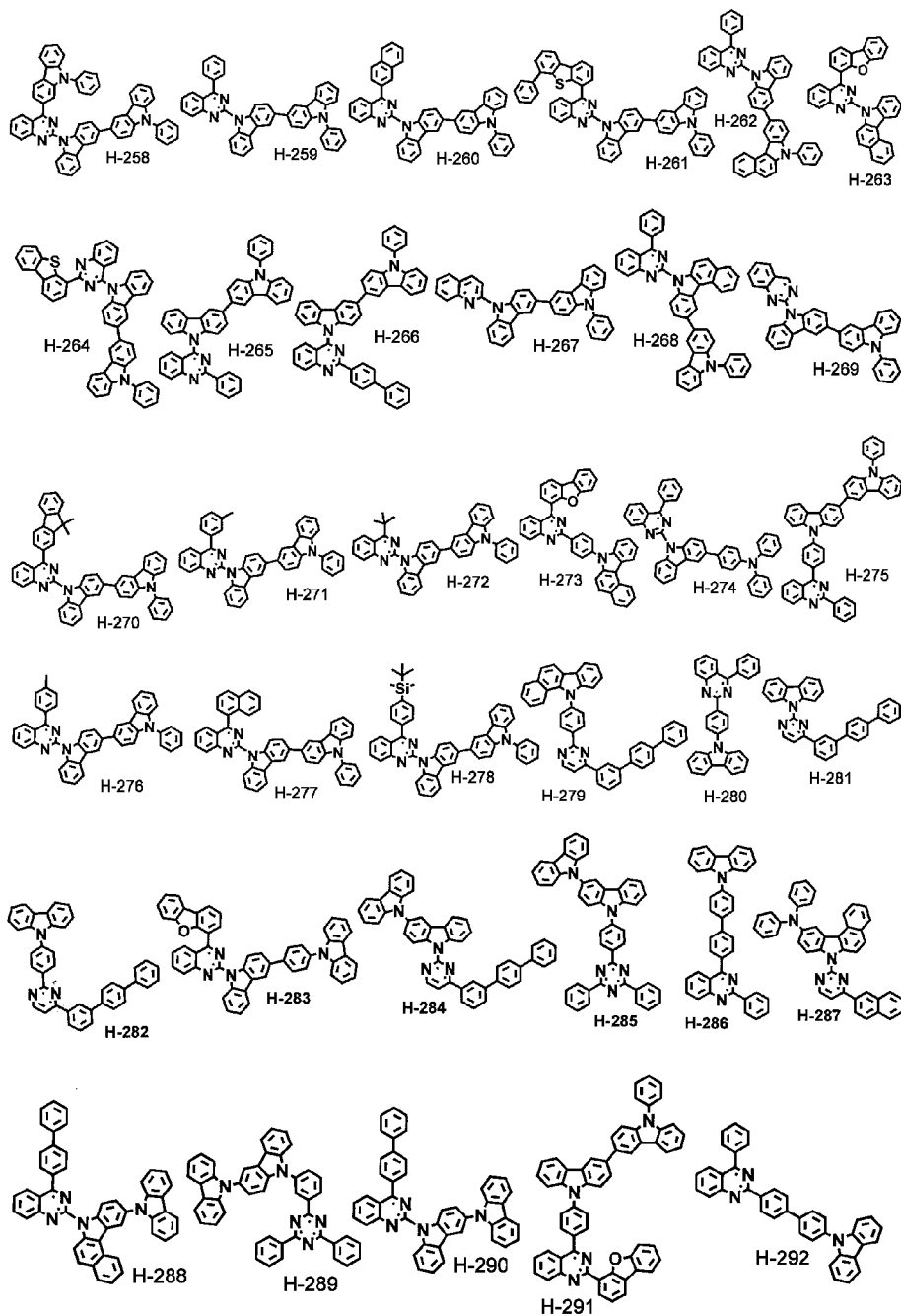












[Claim 10]

An organic electroluminescent device which comprises the combination according to claim 1, and emits yellow-green light.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2013/006487

A. CLASSIFICATION OF SUBJECT MATTER

[See Supplemental Sheet]

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)

Chemical Abstracts, Registry
Structure search based on claim 1

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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



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 28 October 2013	Date of mailing of the international search report 28 October 2013
Name and mailing address of the ISA/All AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au Facsimile No.: +61 2 6283 7999	Authorised officer Matthew Francis AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832424

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. PCT/KR2013/006487
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 201 1/0227049 A1 (XIA ET AL) 22 September 2011 page 85, para [0279] and compounds E3 and CBP	1-8, 10
X	EP 1535981 A2 (SAMSUNG SDI CO., LTD.) 01 June 2005 pages 12, 14 and 15	1-8, 10
X	WO 2012/023947 A1 (UNIVERSAL DISPLAY CORPORATION) 23 February 2012 See page 5, compound 1; page 27, compound 91, pages 51-56	1-7, 9, 10
X	WO 2009/030981 A2 (UNIVERSAL DISPLAY CORPORATION) 12 March 2009 page 17, compound J; page 18, compounds P, R; page 49, table 7	1-8, 10
X	US 20060240279 A1 (ADAMOVICH ET AL) 26 October 2006 Paragraphs [0083], [0093], [0114]; examples 1-4	1-8, 10
X	US 20060088728 A1 (KWONG ET AL) 27 April 2006 paragraphs [0071]-[0080], [0107]; Example 5, 6 and 13-15	1-8, 10
X	US 20050194892 A1 (LU ET AL) 08 September 2005 See examples 1-5	1-8, 10
X	WO 2010/028262 A1 (UNIVERSAL DISPLAY CORPORATION) 11 March 2010 See whole document	1-8, 10

Supplemental Box - IPC Marks*C09K 11/87 (2006.01)**C09K 11/06 (2006.01)**C07F 15/00 (2006.01)**C07D 401/04 (2006.01)**C07D 401/10 (2006.01)**C07D 401/14 (2006.01)**C07D 403/04 (2006.01)**C07D 403/10 (2006.01)**C07D 405/14 (2006.01)**C07D 409/14 (2006.01)**C07D 209/86 (2006.01)**C07D 213/72 (2006.01)**C07D 213/89 (2006.01)**C07D 239/42 (2006.01)**C07D 239/84 (2006.01)**C07D 241/20 (2006.01)**C07D 251/22 (2006.01)**C07D 251/24 (2006.01)**H01L 51/54 (2006.01)**H05B 33/14 (2006.01)**H05B 33/20 (2006.01)*

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2013/006487	
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
US 2011/0227049 A1	22 Sep 2011	None	
EP 1535981 A2	01 Jun 2005	EP 1535981 A2	01 Jun 2005
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		KR 20090106566 A	09 Oct 2009
		KR 101 118808 B1	22 Mar 2012
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		KR 20100099327 A	10 Sep 2010
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TW 200927742 A	01 Jul 2009		
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US 2009167162 A1	02 Jul 2009		
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/KR2013/006487	
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 2009134784 A1	28 May 2009
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		US 2011215309 A1	08 Sep 2011
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		WO 2010028262 A1	11 Mar 2010
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

专利名称(译)	主体化合物和掺合物化合物以及包含该化合物的有机电致发光装置的新组合		
公开(公告)号	EP2875094A1	公开(公告)日	2015-05-27
申请号	EP2013820023	申请日	2013-07-19
[标]申请(专利权)人(译)	罗门哈斯电子材料有限公司		
申请(专利权)人(译)	罗门哈斯电子材料KOREA LTD.		
当前申请(专利权)人(译)	罗门哈斯电子材料KOREA LTD.		
[标]发明人	KIM CHI SIK YOON SEOK KEUN KIM HYUN JUNG SO YOUNG KANG HYUN JU LEE KYUNG JOO SHIN HYO NIM KIM NAM KYUN CHO YOUNG JUN KWON HYUCK JOO KIM BONG OK		
发明人	KIM, CHI-SIK YOON, SEOK-KEUN KIM, HYUN JUNG, SO-YOUNG KANG, HYUN-JU LEE, KYUNG-JOO SHIN, HYO-NIM KIM, NAM-KYUN CHO, YOUNG-JUN KWON, HYUCK-JOO KIM, BONG-OK		
IPC分类号	C09K11/87 C09K11/06 C07F15/00 C07D401/04 C07D401/10 C07D401/14 C07D403/04 C07D403/10 C07D405/14 C07D409/14 C07D209/86 C07D213/72 C07D213/89 C07D239/42 C07D239/84 C07D241 /20 C07D251/22 C07D251/24 H01L51/54 H05B33/14 H05B33/20		
CPC分类号	C07D209/86 C07D213/72 C07D213/89 C07D239/42 C07D239/84 C07D241/20 C07D251/22 C07D251 /24 C07D401/04 C07D401/10 C07D401/14 C07D403/04 C07D403/10 C07D405/14 C07D409/14 C07F15/0033 C09K11/06 C09K2211/1007 C09K2211/1029 C09K2211/1425 H01L51/0072 H01L51 /0085 H01L51/5016 H05B33/14 H05B33/20 C07F15/00 C09K2211/185 H01L51/0067 H01L51/0073 H01L51/0074 H01L51/0094 H01L51/5024		
代理机构(译)	霍顿MARK PHILLIP		
优先权	1020120079339 2012-07-20 KR		
外部链接	Espacenet		

摘要(译)

本发明涉及掺杂剂化合物和主体化合物的特定组合，以及包含该化合物的有机电致发光器件。本发明的有机电致发光器件发出黄绿色光;通过改善器件的电流特性来降低器件的驱动电压;并提高电源效率和运行寿命。

