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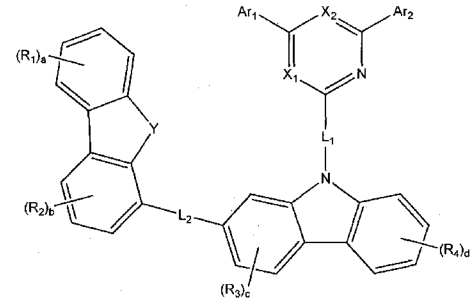
(54) Title: NOVEL ORGANIC ELECTROLUMINESCENT COMPOUNDS AND AN ORGANIC ELECTROLUMINESCENT DEVICE USING THE SAME



[Formula 1]

(57) Abstract: An organic electroluminescent compound of formula 1 and an organic electroluminescent device comprising the same is disclosed. The organic luminescent compound provides an organic electroluminescent device which has high luminous efficiency and a long operation lifetime and requires a low driving voltage, to thereby have improved power efficiency and power consumption.

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Description

Title of Invention: NOVEL ORGANIC ELECTROLUMINESCENT COMPOUNDS AND AN ORGANIC ELECTROLUMINESCENT DEVICE USING THE SAME

Technical Field

[1] The present invention relates to novel organic electroluminescent compounds and an organic electroluminescent device using the same.

Background Art

[2] An electroluminescent (EL) device is a self-light-emitting device which has advantages over other types of display devices in that it provides a wider viewing angle, a greater contrast ratio, and has a faster response time. An organic EL device was first developed by Eastman Kodak, by using small molecules which are aromatic diamines, and aluminum complexes as a material for forming a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].

[3] The most important factor to determine luminous efficiency in an organic EL device is a light-emitting material. Until now, fluorescent materials have been widely used as a light-emitting material. However, in view of electroluminescent mechanisms, phosphorescent materials theoretically show four (4) times higher luminous efficiency than fluorescent materials. Thus, recently, phosphorescent materials have been investigated. Iridium (III) complexes have been widely known as phosphorescent materials, including bis(2-(2'-benzothienyl)-pyridinato-N,C3')iridium (acetylacetonate) ((acac)Ir(btp)$_2$), tris(2-phenylpyridine)iridium (Ir(ppy)$_3$) and bis(4,6-difluorophenylpyridinato-N,C2)picolinate iridium (Firpic) as red, green and blue materials, respectively. In order to improve color purity, luminous efficiency and stability, light-emitting materials can be used as a system prepared by mixing a dopant with a host material. In the host material/dopant system, the host material has a great influence on the efficiency and performance of an EL device, and thus its selection is important. At present, 4,4'-bis(carbazol-9-yl)-biphenyl (CBP) is the most widely known host material for phosphorescent materials. Further, Pioneer (Japan) developed a high performance organic EL device employing, as a host material, bathocuproine (BCP) or aluminum(III)bis(2-methyl-8-quinolinate)(4-phenylphenolate) (BAlq), which had been a material used for a hole blocking layer.

[4] Though these phosphorous host materials provide good light-emitting characteristics, they have the following disadvantages: (1) Due to their low glass transition temperature and poor thermal stability, their degradation may occur during a high-temperature deposition process in a vacuum. (2) The power efficiency of an organic

EL device is given by [(π/voltage) × current efficiency], and thus the power efficiency is inversely proportional to the voltage. Though an organic EL device comprising phosphorescent materials provides higher current efficiency (cd/A) than one comprising fluorescent materials, a significantly high driving voltage is required to be applied to an organic EL device, thereby resulting in poor power efficiency (lm/W). (3) Further, the operation lifetime of an organic EL device is short and luminous efficiency is still required to be improved.

[5] Korean Patent No. 948700 discloses compounds for organic electroluminescent materials whose arylcarbazole backbone has a nitrogen-containing aryl. However, it does not disclose compounds whose carbazole backbone has both dibenzothiophene and a nitrogen-containing aryl. Further, an organic EL device comprising said compounds fails to provide satisfactory luminous efficiency, driving voltage and operation lifetime.

Disclosure of Invention

Technical Problem

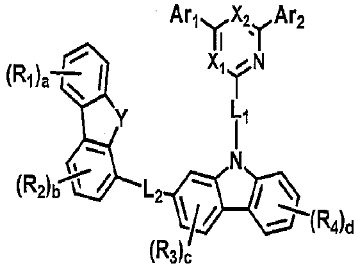
[6] An objective of the present invention is to provide organic electroluminescent compounds, which impart excellent luminous efficiency, a long operation lifetime and a low driving voltage to a device; and an organic electroluminescent device, which has high efficiency and a long operation lifetime, using said compounds.

Solution to Problem

[7] The present inventors found that the above objective can be achieved by a compound represented by the following formula 1:

[8] [Formula 1]

[9]



[10] wherein

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

[12] X_1 and X_2 each independently represent CR' or N;

[13] Y represents S, O or $-CR_{21}R_{22}$;

[14] Ar_1, Ar_2, R', R_{21} and R_{22} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsub-

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

[15] R_1 to R_4 each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, a substituted or unsubstituted 3- to 30-membered heteroaryl group, $-NR_{11}R_{12}$, $-SiR_{13}R_{14}R_{15}$, $-SR_{16}$, $-OR_{17}$, a cyano group, a nitro group or a hydroxyl group;

[16] R_{11} to R_{17} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group or a substituted or unsubstituted 3- to 30-membered heteroaryl group; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced by at least one atom selected from nitrogen, oxygen and sulfur;

[17] a and d each independently represent an integer of 1 to 4; where a or d is an integer of 2 or more, each of R_1 or each of R_4 is the same or different;

[18] b and c each independently represent an integer of 1 to 3; where b or c is an integer of 2 or more, each of R_2 or each of R_3 is the same or different; and the heteroaryl group and the heteroarylene group contain at least one atom selected from B, N, O, S, P(=O), Si and P.

[19] Substituents of the substituted groups in L_1, L_2, Ar_1, Ar_2, R', R_1 to R_4, R_{11} to R_{17}, R_{21} and R_{22} each independently are at least one selected from the group consisting of deuterium, a halogen, a (C1-C30)alkyl group, a (C1-C30)alkyl group substituted with a halogen, a (C6-C30)aryl group, a 3- to 30-membered heteroaryl group, a 3- to 30-membered heteroaryl group substituted with a (C6-C30)aryl group, a (C6-C30)aryl group substituted with a 3- to 30-membered heteroaryl group, a (C3-C30)cycloalkyl group, a 5- to 7-membered heterocycloalkyl group, a tri(C1-C30)alkylsilyl group, a tri(C6-C30)arylsilyl group, a di(C1-C30)alkyl(C6-C30)arylsilyl group, a (C1-C30)alkyldi(C6-C30)arylsilyl group, a (C2-C30)alkenyl group, a (C2-C30)alkynyl group, a cyano group, a di(C1-C30)alkylamino group, a di(C6-C30)arylamino group, a (C1-C30)alkyl(C6-C30)arylamino group, a di(C6-C30)arylboronyl group, a di(C1-C30)alkylboronyl group, a (C1-C30)alkyl(C6-C30)arylboronyl group, a (C6-C30)aryl(C1-C30)alkyl group, a (C1-C30)alkyl(C6-C30)aryl group, a carboxyl group, a nitro group and a hydroxyl group.

[20] Herein, the terms “alkyl,” “alkoxy” and any “alkyl” moiety which is comprised in substituents include both a linear structure and a branched structure; and the term “cycloalkyl” includes a mono- or polycyclic hydrocarbon such as a substituted or unsubstituted adamantyl group or a substituted or unsubstituted (C7-C30)bicycloalkyl group. The term “aryl” refers to an organic radical derived from an aromatic hydrocarbon by removing one hydrogen atom; includes a monocyclic ring or fused ring

each of whose rings has 4 to 7, preferably 5 or 6, ring backbone atoms; may be one formed by linking two or more aryl groups to one another via a single bond(s); and includes phenyl, biphenyl, terphenyl, naphthyl, anthryl, indenyl, fluorenyl, phenanthrenyl, triphenylenyl, pyrenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc., wherein said naphthyl includes 1-naphthyl and 2-naphthyl, said anthryl includes 1-anthryl, 2-anthryl and 9-anthryl and said fluorenyl includes 1-fluorenyl, 2-fluorenyl, 3-fluorenyl, 4-fluorenyl and 9-fluorenyl. The term "heteroaryl" refers to an aryl having 1 to 4 heteroatoms selected from the group consisting of B, N, O, S, P(=O), Si and P, and carbon atoms as remaining ring backbone atoms other than said heteroatom; is a monocyclic ring or fused ring condensed with at least one benzene ring; may be partially saturated; may be one formed by linking at least one heteroaryl group to other heteroaryl or aryl group via a single bond(s); may be a divalent aryl group whose ring backbone heteroatom is oxidized or quaternarized, for example, to form a N-oxide or a quaternary salt; and includes a monocyclic ring-type heteroaryl including furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., a fused ring-type heteroaryl including benzofuranyl, benzothiophenyl, isobenzofuranyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, carbazolyl, phenanthridinyl, benzodioxolyl, dibenzofuranyl, dibenzothiophenyl, etc., N-oxides thereof (for example, pyridyl N-oxide, quinolyl N-oxide) and quaternary salts thereof.

[21] Further, the "(C1-C30)alkyl(ene)" group is preferably a (C1-C20)alkyl(ene) group and more preferably a (C1-C10)alkyl(ene) group; the "(C6-C30)aryl(ene)" group is preferably a (C6-C20)aryl(ene) group and more preferably a (C6-C12)aryl(ene) group; the "3- to 30-membered heteroaryl(ene)" group is preferably a 3- to 20-membered heteroaryl(ene) group and more preferably a 5- to 13-membered heteroaryl(ene) group; the "(C3-C30)cycloalkyl" group is preferably a (C3-C20)cycloalkyl group and more preferably a (C3-C7)cycloalkyl group; and the "(C2-C30)alkenyl(ene) or alkynyl(ene)" group is preferably a (C2-C20)alkenyl(ene) or alkynyl(ene) group and more preferably a (C2-C10)alkenyl(ene) or alkynyl(ene) group.

[22] Preferably, L_1 and L_2 each independently represent a single bond; or a substituted or unsubstituted phenylene, biphenylene, terphenylene, indenylene, fluorenylene, triphenylenylene, pyrenylene, perylenylene, chrysenylene, naphthacenylene, fluoranthenylene, thiophenylene, pyrrolylene, pyrazolylene, thiazolylene, oxazolylene, oxadiazolylene, triazinylene, tetrazinylene, triazolylene, tetrazolylene, furazanylene, pyridylene, benzofuranylene, benzothiophenylene, indolene, benzoimidazolylene, ben-

zothiazolylene, benzoisothiazolylene, benzoisoxazolylene, benzoxazolylene, benzothiadiazolylene, dibenzofuranylene or dibenzothiophenylene;

[23] Ar_1, Ar_2, R', R_{21} and R_{22} each independently represent hydrogen; or a substituted or unsubstituted methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, terphenyl, pyrenyl, chrysenyl, naphthacenyl, perylene, pyridyl, pyrrolyl, furanyl, thiophenyl, imidazolyl, benzoimidazolyl, quinolyl, triazinyl, benzofuranyl, dibenzofuranyl, benzothiophenyl, dibenzothiophenyl, pyrazolyl, indolyl, carbazolyl, thiazolyl, oxazolyl, benzothiazolyl, benzoxazolyl, phenanthrolinyl, quinoxalinyl or N-carbazolyl; more preferably, R_{21} and R_{22} each independently represent hydrogen, methyl, ethyl, n-propyl or i-propyl;

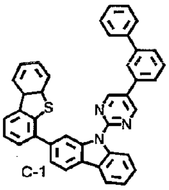
[24] R_1 to R_4 each independently represent hydrogen, deuterium, chloro, fluoro, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, triphenylenyl, pyrenyl, chrysenyl, naphthacenyl, perylenyl, pyridyl, pyrrolyl, furanyl, thiophenyl, imidazolyl, benzoimidazolyl, indenyl, pyrazinyl, pyrimidinyl, pyridazinyl, quinolyl, triazinyl, benzofuranyl, dibenzofuranyl, benzothiophenyl, dibenzothiophenyl, pyrazolyl, indolyl, carbazolyl, thiazolyl, oxazolyl, benzothiazolyl, benzoxazolyl, phenanthrolinyl or N-carbazolyl;

[25] a to d each independently represent an integer of 1 to 2, more preferably 1; and

[26] L_1, L_2, Ar_1, Ar_2, R', R_1 to R_4, R_{21} and R_{22} each independently may be further substituted with at least one selected from the group consisting of deuterium, chloro, fluoro, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, triphenylenyl, pyrenyl, chrysenyl, naphthacenyl, perylenyl, fluorotrimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyldimethylsilyl, dimethylphenylsilyl, carbazolyl and triphenylsilyl, and more preferably at least one selected from the group consisting of deuterium, chloro, fluoro, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ehtylhexyl, n-nonyl and decyl.

[27] Organic electroluminescent compounds according to the present invention include the following, but are not limited thereto:

[28]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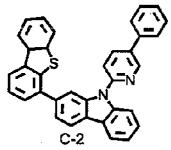
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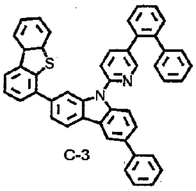
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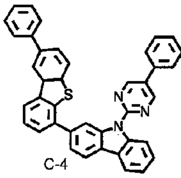
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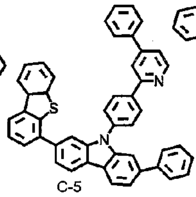
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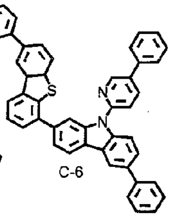
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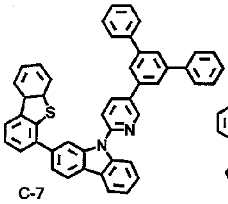
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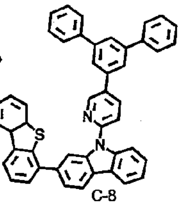
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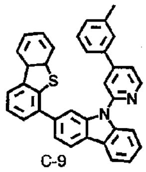
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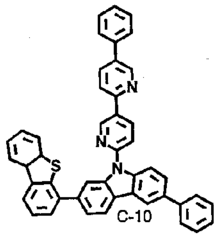
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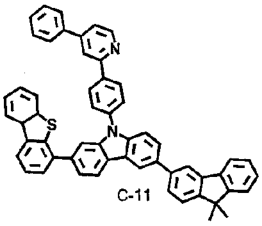
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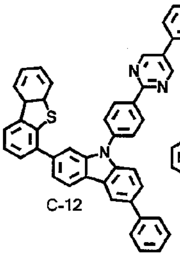
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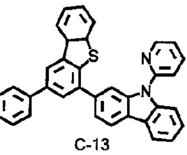
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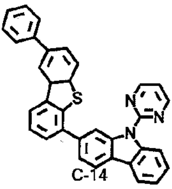
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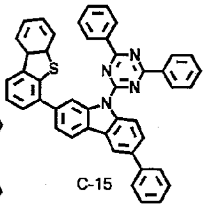
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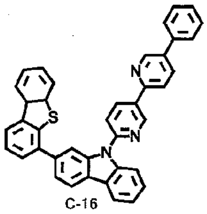
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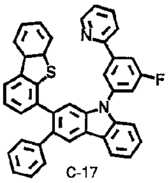
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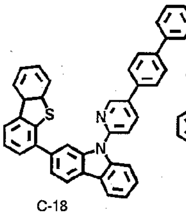
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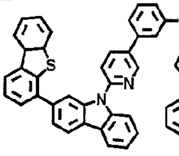
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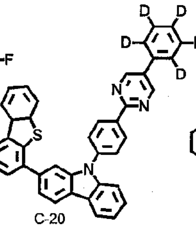
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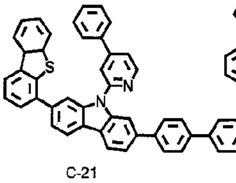
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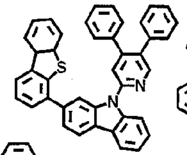
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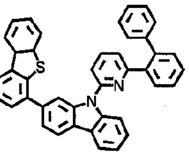
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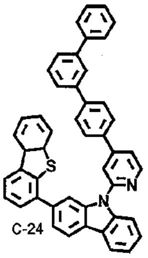
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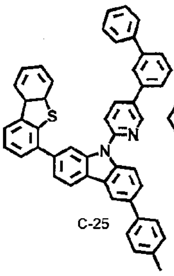
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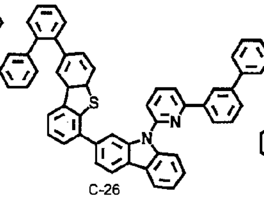
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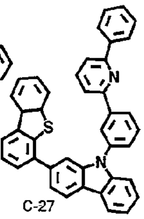
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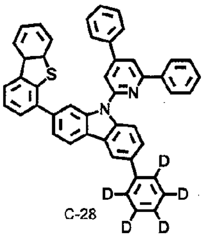
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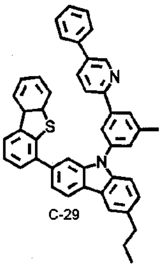
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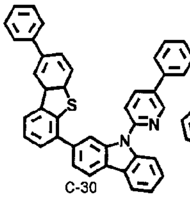
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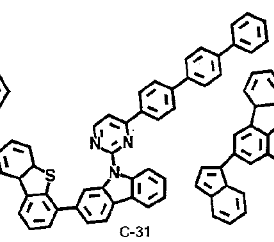
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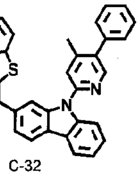
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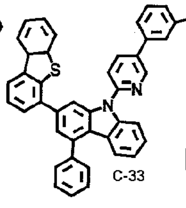
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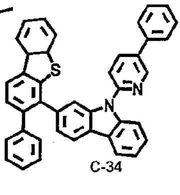
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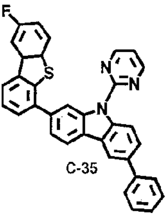
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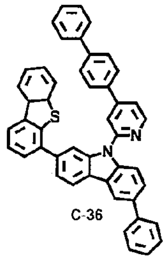
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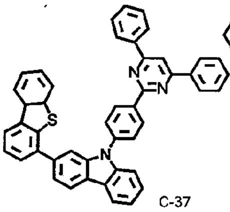
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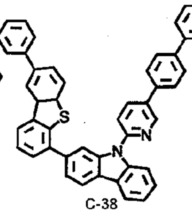
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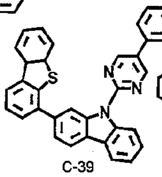
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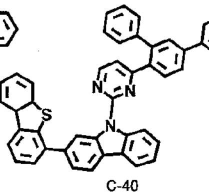
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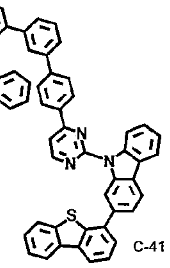
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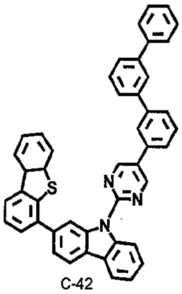
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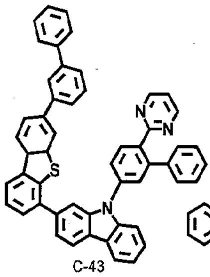
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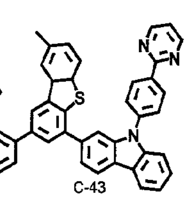
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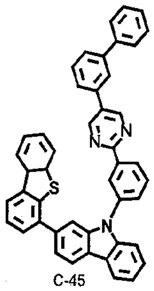
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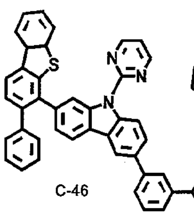
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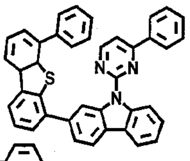
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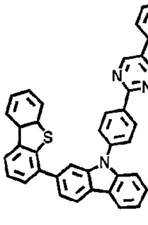
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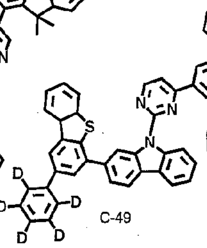
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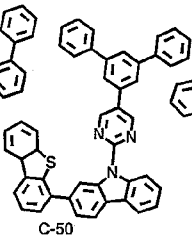
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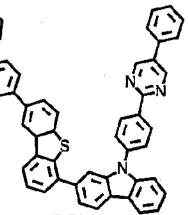
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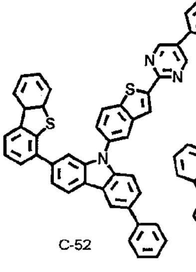
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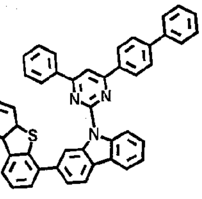
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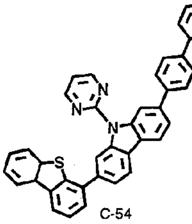
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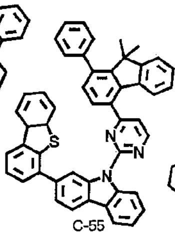
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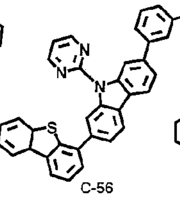
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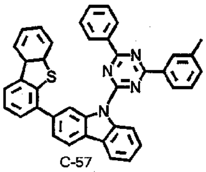
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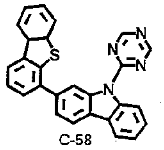
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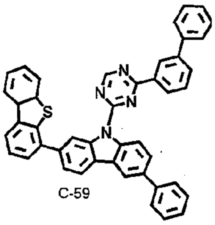
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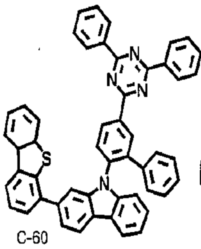
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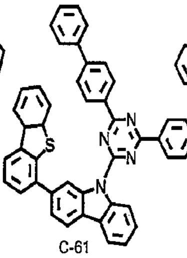
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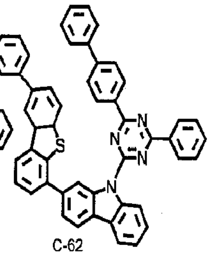
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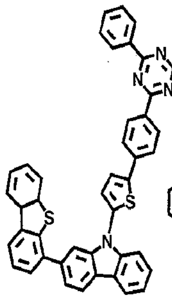
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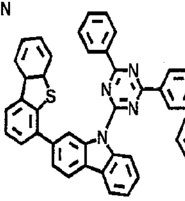
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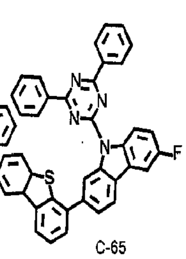
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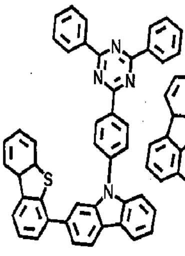
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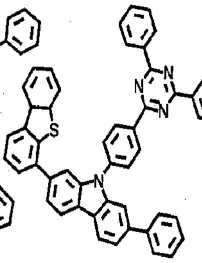
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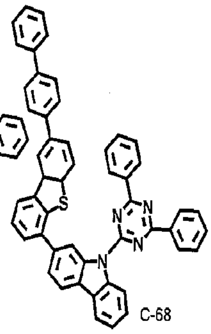
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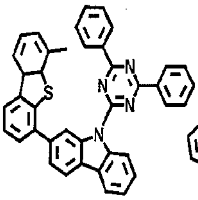
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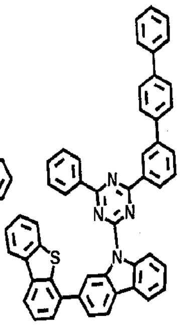
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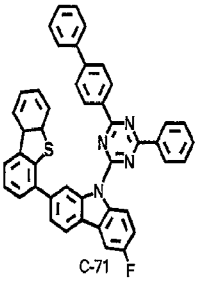
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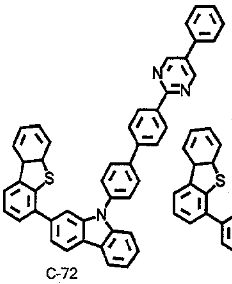
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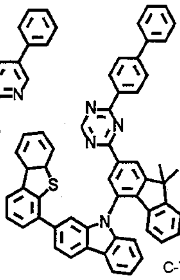
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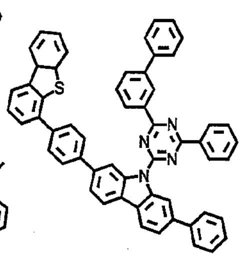
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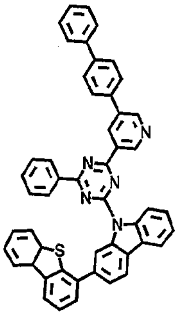
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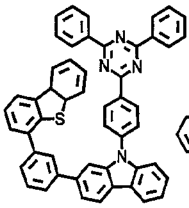
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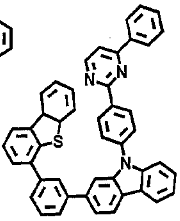
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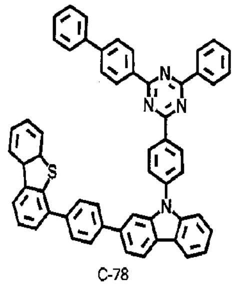
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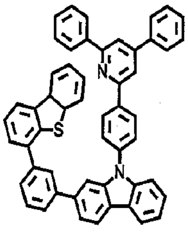
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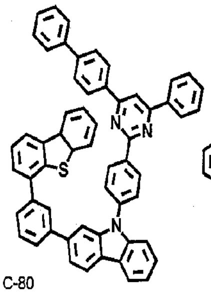
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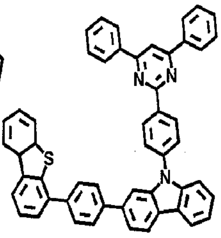
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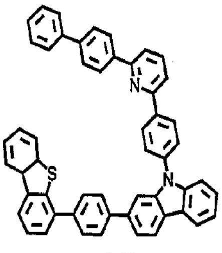
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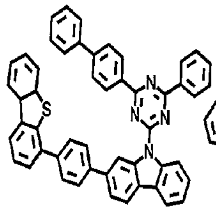
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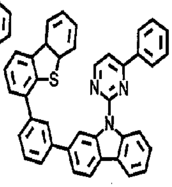
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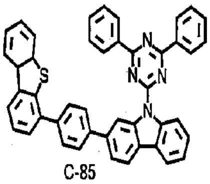
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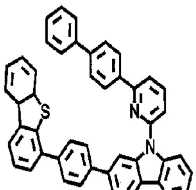
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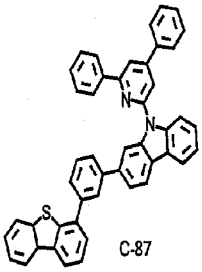
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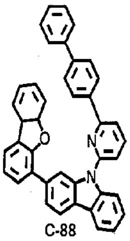
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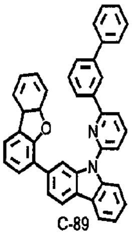
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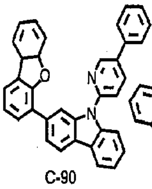
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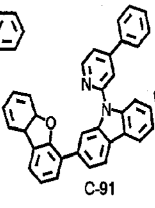
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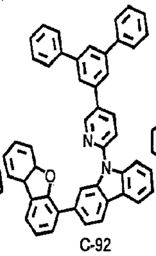
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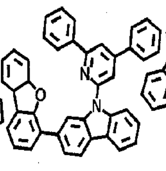
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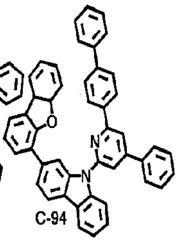
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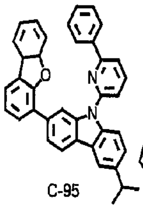
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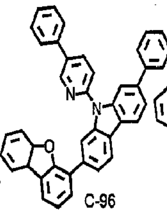
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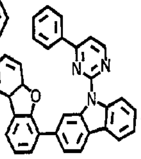
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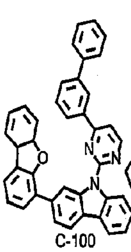
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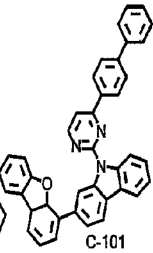
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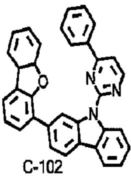
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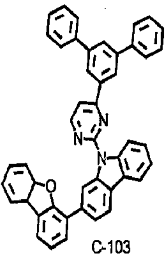
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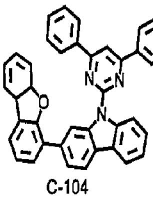
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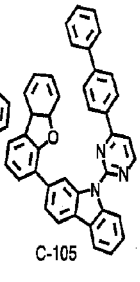
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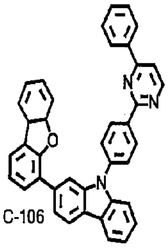
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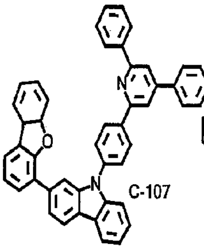
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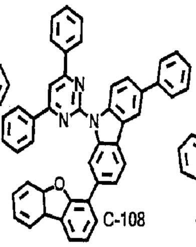
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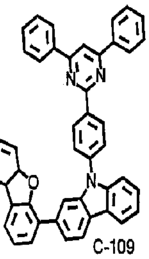
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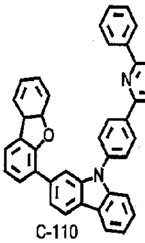
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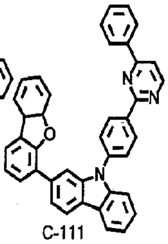
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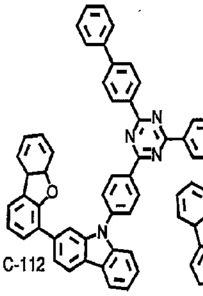
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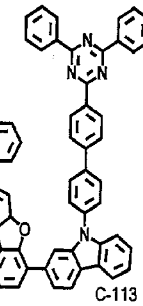
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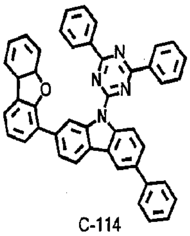
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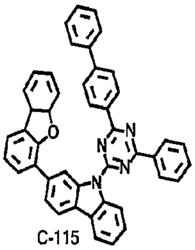
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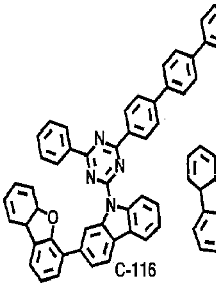
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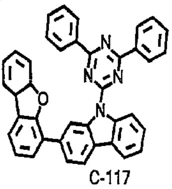
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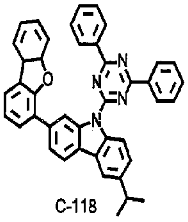
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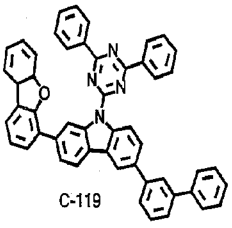
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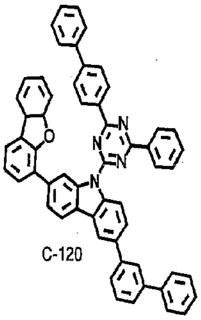
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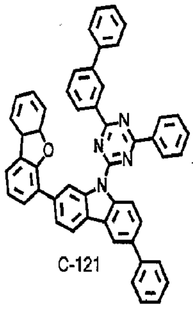
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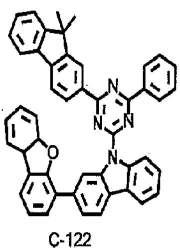
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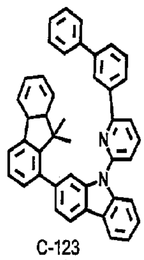
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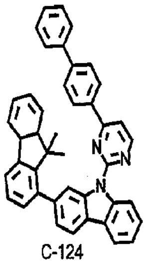
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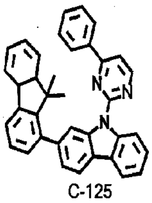
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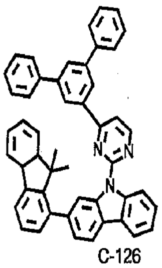
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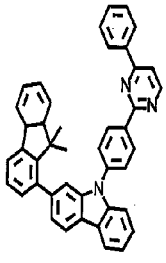
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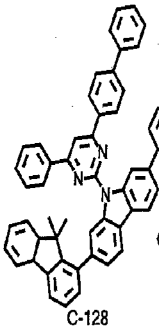
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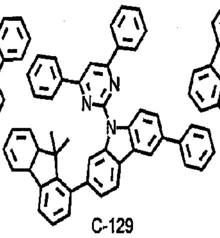
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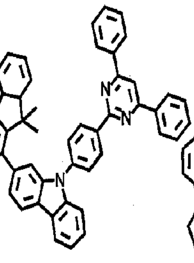
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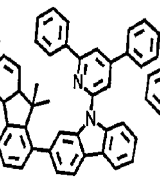
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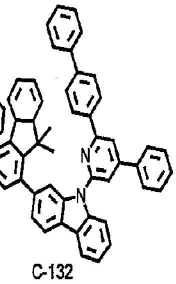
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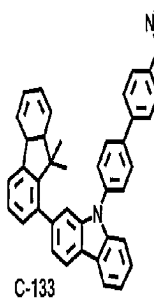
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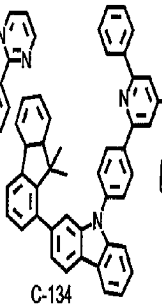
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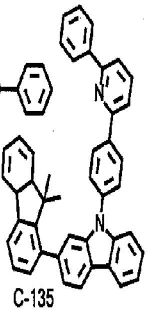
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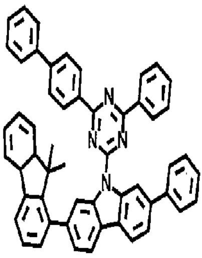
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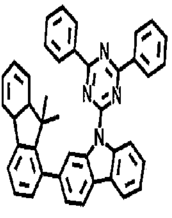
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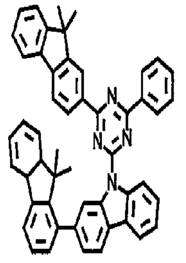
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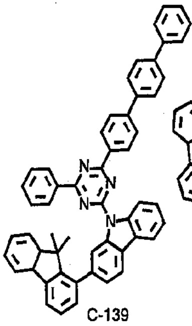
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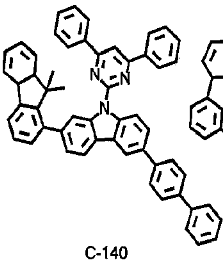
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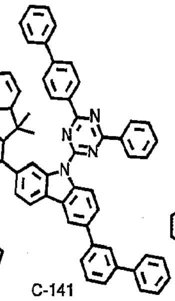
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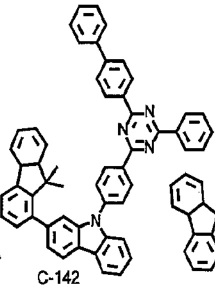
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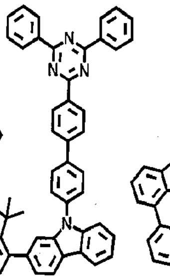
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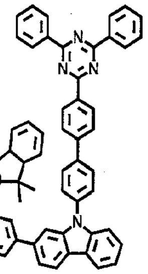
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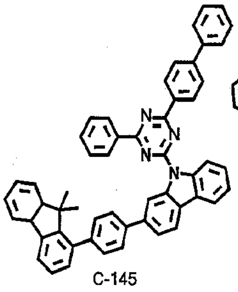
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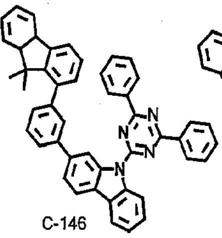
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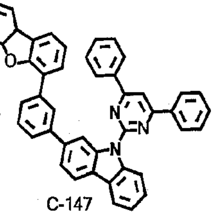
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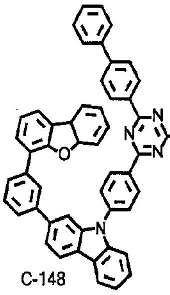
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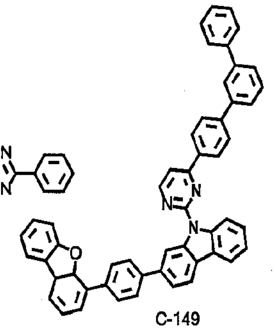
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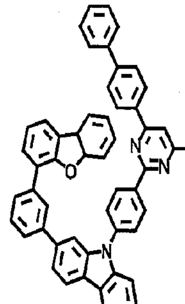
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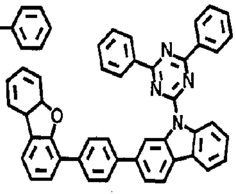
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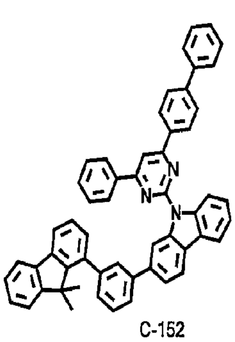
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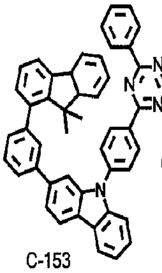
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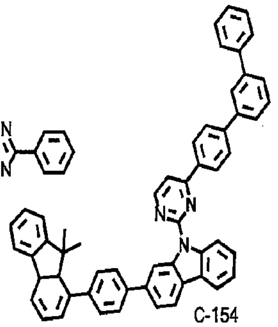
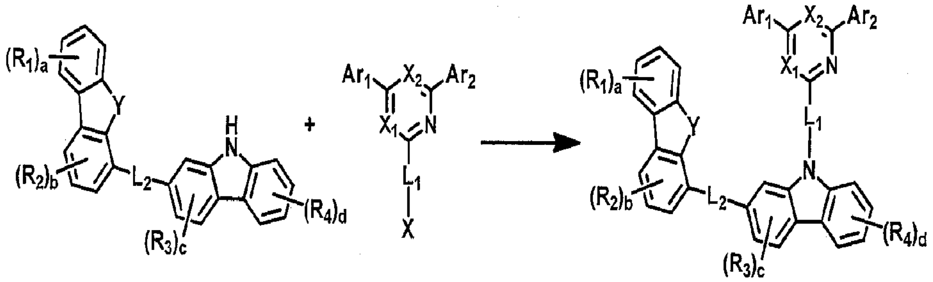

C-154

[54] Organic electroluminescent compounds according to the present invention can be prepared according to the following reaction scheme 1.

[55] [Reaction Scheme 1]

[56]



[57] wherein Ar_1, Ar_2, L_1, L_2, Y, X_1, X_2, R_1 to R_4, a, b, c and d are as defined in formula 1 above, and X represents a halogen.

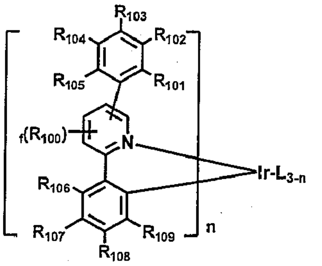
[58] In addition, the present invention provides an organic electroluminescent device comprising the compound of formula 1. The organic electroluminescent device comprises a first electrode, a second electrode and at least one organic layer between the first and second electrodes. The organic layer comprises at least one compound of formula 1 according to the present invention. One of the first electrode and the second electrode is an anode and the other is a cathode. The organic layer comprises a light-emitting layerand may further comprise at least one layer selected from a hole injection layer, a hole transport layer, an electron transport layer, an electron injection layer, an interlayer and a hole blocking layer.

[59] The compound of formula 1 is comprised in at least one of the light-emitting layer and the hole transport layer. Where the hole transport layer comprises the compound of formula 1, the compound may be used as a hole transport material. Where the light-emitting layer comprises the compound of formula 1, the compound may be used as a host material; preferably, the light-emitting layer may further comprise at least one dopant; and if necessary, the light-emitting layer may further comprise another host material in addition to the compound of formula 1.

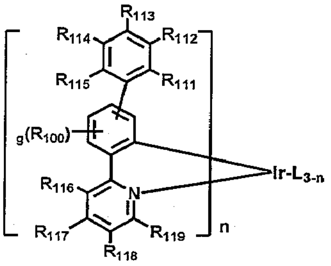
[60] As the dopant, at least one phosphorescent dopant is preferable. In the organic electroluminescent device of the present invention, the phosphorescent dopant is not particularly limited; however, preferably, a complex compound comprising a metal atom selected from iridium (Ir), osmium (Os), copper (Cu) and platinum (Pt), more preferably an ortho-metalated complex compound comprising a metal atom selected from Ir, Os, Cu and Pt, and even more preferably, an ortho-metalated complex compound comprising Ir is comprised.

[61] Further, it is preferable to select the phosphorescent dopant from the group consisting of compounds represented by the following formulae 2 to 4:

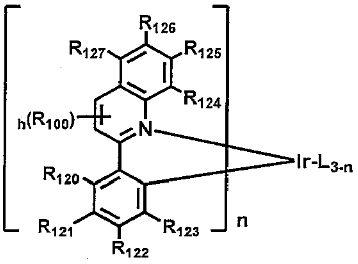
[62] [Formula 2]

[63] 

[64] [Formula 3]

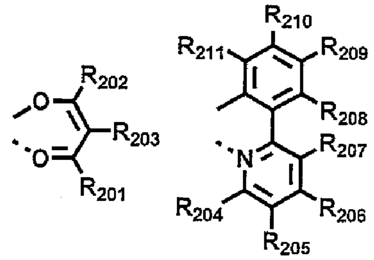
[65] 

[66] [Formula 4]

[67] 

[68] wherein

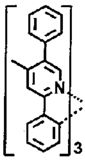
[69] L is selected from the following structure:

[70] 

[71] R_{100} represents hydrogen or a substituted or unsubstituted (C1-C30)alkyl group; R_{101} to R_{109} and R_{111} to R_{127} each independently represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl group substituted or unsubstituted with a halogen, a cyano group, or a substituted or unsubstituted (C1-C30)alkoxy group; R_{201} to R_{211} each independently represent hydrogen, deuterium, a halogen, or a (C1-C30)alkyl group substituted or unsubstituted with a halogen; f and g each independently represent an integer of 1 to 3; h represents an integer of 1 to 2; where f, g, or h are integers of 2 or more, each of R_{100} is the same or different; and n represents an integer of 1 to 3.

[72] The phosphorescent dopant includes the following

[73]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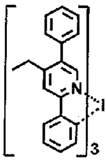
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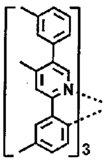
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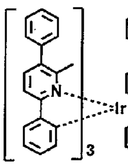
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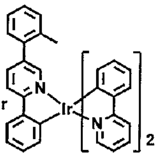
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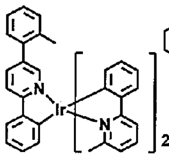
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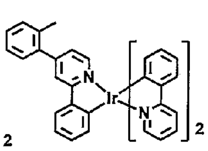
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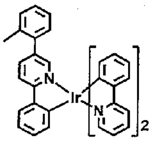
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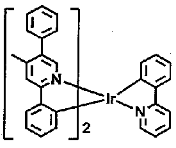
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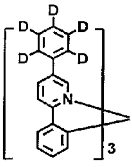
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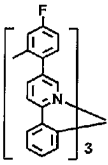
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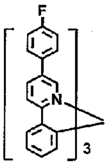
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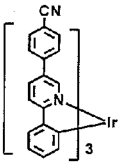
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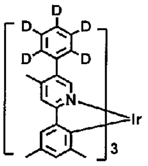
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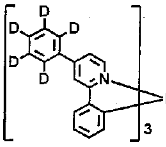
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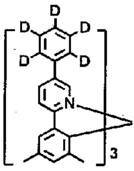
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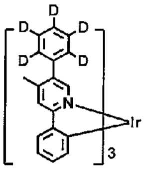
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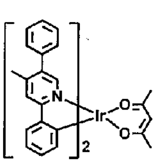
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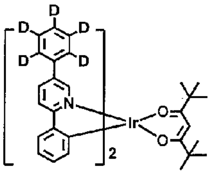
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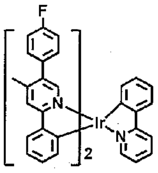
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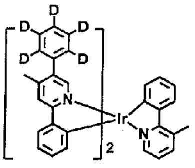
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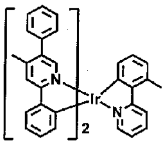
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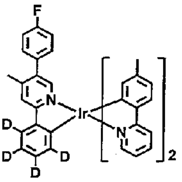
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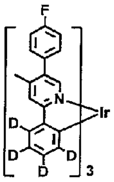
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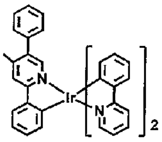
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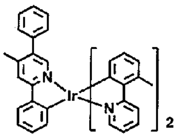
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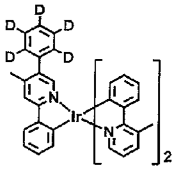
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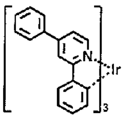
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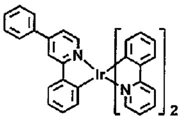
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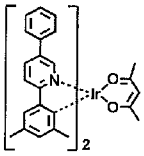
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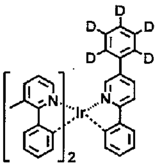
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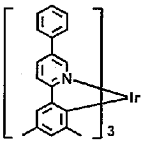
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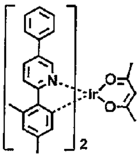
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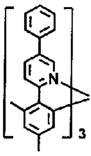
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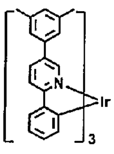
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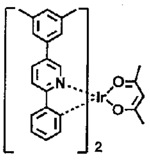
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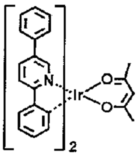
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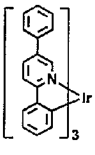
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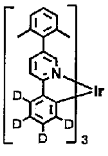
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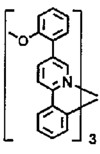
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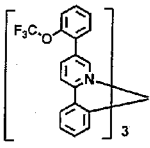
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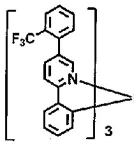
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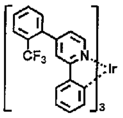
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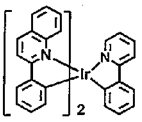
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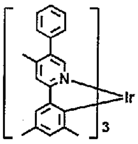
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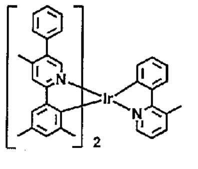
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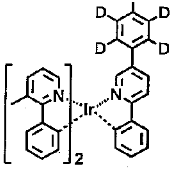
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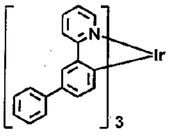
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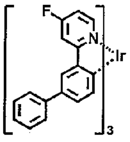
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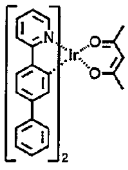
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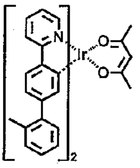
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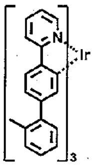
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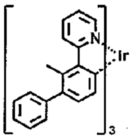
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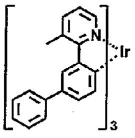
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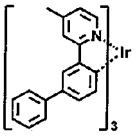
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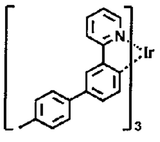
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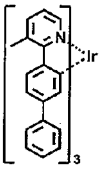
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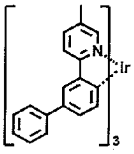
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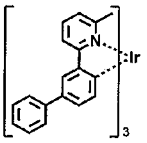
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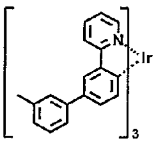
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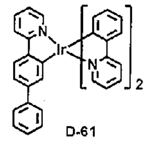
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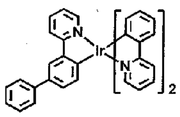
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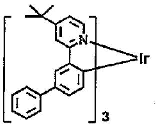
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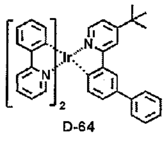
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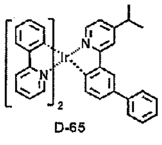
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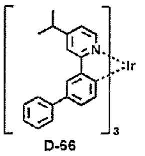
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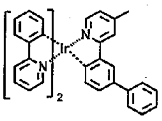
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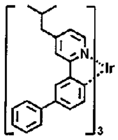
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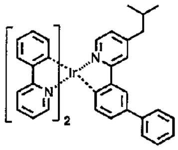
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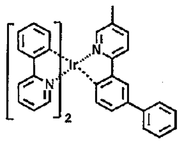
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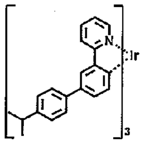
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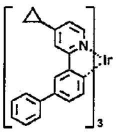
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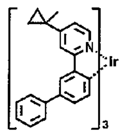
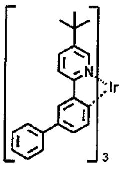

D-73

[84]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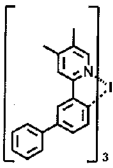
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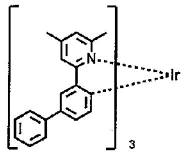
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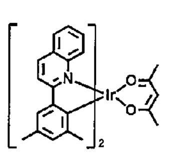
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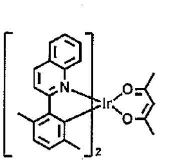
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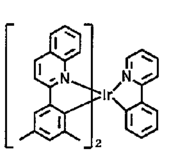

D-79

[85] The organic electroluminescent device of the present invention comprises a first electrode, a second electrode and at least one organic layer between the first electrode and the second electrode; the organic layer comprises a light-emitting layer; the light-emitting layer comprises a composition for the organic electroluminescent device of the present invention and a phosphorous dopant; and the composition for the organic electroluminescent device is used as a host material.

[86] The organic electroluminescent device of the present invention may further comprise, in addition to the compound of formula 1, at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds in the organic layer.

[87] In the organic electroluminescent device of the present invention, the organic layer may further comprise, in addition to the compound of formula 1, at least one metal selected from the group consisting of metals of Group 1, metals of Group 2, transition metals of the 4th period, transition metals of the 5th period, lanthanides and organic metals of d-transition elements of the Periodic Table, or at least one complex compound comprising said metal. Further, the organic layer may comprise a light-emitting layer and a charge generating layer.

[88] The organic electroluminescent device of the present invention may emit a white light by further comprising at least one light-emitting layer which comprises a blue electroluminescent compound, a red electroluminescent compound or a green electroluminescent compound, in addition to the compound of the present invention. If

necessary, the organic electroluminescent device may further comprise a yellow light-emitting layer or an orange light-emitting layer.

[89] Preferably, in the organic electroluminescent device of the present invention, at least one layer (hereinafter, "a surface layer") selected from a chalcogenide layer, a metal halide layer and a metal oxide layer may be placed on an inner surface(s) of one or both electrode(s). Specifically, it is preferred that the chalcogenide (includes oxides) layer of silicon or aluminum is placed on an anode surface of an electroluminescent medium layer, and the metal halide layer or metal oxide layer is placed on a cathode surface of an electroluminescent medium layer. Such a surface layer provides operation stability for the organic electroluminescent device. Preferably, said chalcogenide includes $SiO_X(1 \leq X \leq 2)$, $AlO_X(1 \leq X \leq 1.5)$, SiON, SiAlON, etc.; said metal halide includes LiF, MgF_2, CaF_2, a rare earth metal fluoride, etc.; and said metal oxide includes Cs_2O, Li_2O, MgO, SrO, BaO, CaO, etc.

[90] Preferably, in the organic electroluminescent device of the present invention, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant may be placed on at least one surface of a pair of electrodes. In that 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 the 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 a white light.

Advantageous Effects of Invention

[91] The organic electroluminescent compound of the present invention provides an organic electroluminescent device which has high luminous efficiency and a long operation lifetime and requires a low driving voltage, to thereby have improved power efficiency and power consumption.

Mode for the Invention

[92] Hereinafter, the preparation method of the organic electroluminescent compound, and the luminescent properties of the organic electroluminescent devices using the compound of the present invention will be explained in detail with reference to the following examples.

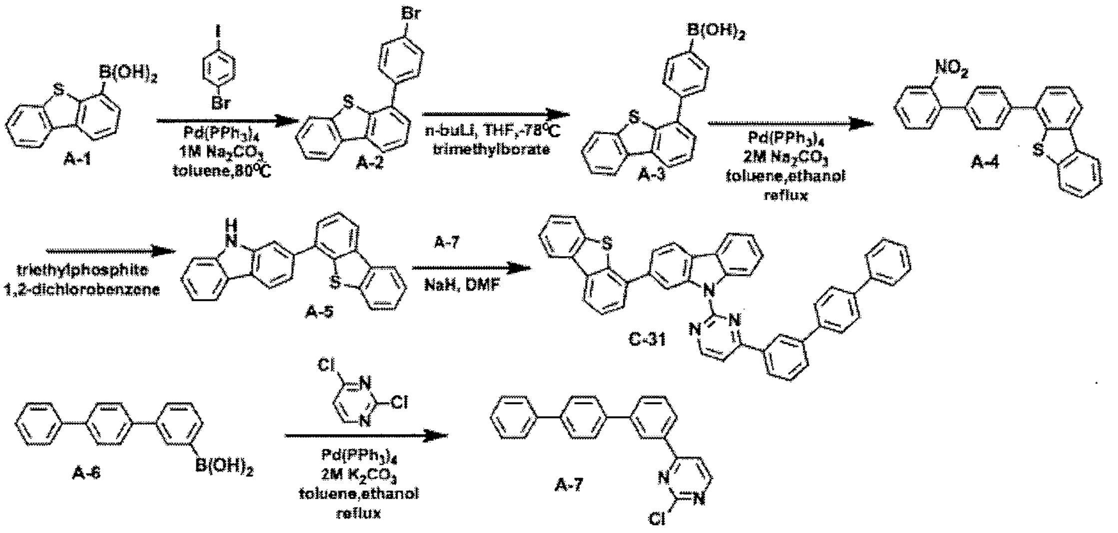
[93] The abbreviations used in the examples have the following meanings:

[94] EA: ethyl acetate, THF: tetrahydrofuran, MC: methylene chloride, n-Bu: normal-butyl,

[95] DMF: dimethylformamide, DME: dimethylether, i-Pr: isopropyl, and EtOH: ethanol

[96] [Preparation Example 1] Preparation of compound **C-31**

[97]



[98] Preparation of compound **A-2**

[99] Compound **A-1** 20 g (0.087 mol), 4-bromoiodobenzene 49.6 g (0.175 mol), $Pd(PPh_3)_4$ 3.039g (0.0026 mol), 1 M Na_2CO_3 and toluene 400 mL were mixed and stirred under reflux. After 3 hours, the mixture was cooled to room temperature, and then distilled water was added thereto. The mixture was extracted with EA and was dried with $MgSO_4$. The obtained solid was distilled under reduced pressure and was purified by column chromatography to obtain compound **A-2** (23 g, 0.065 mol, 75.6%).

[100] Preparation of compound **A-3**

[101] Compound **A-2** 23 g (0.065 mol) was dissolved in THF 700 mL. n-BuLi 39 mL (0.098 mol, 2.5 M in hexane) was slowly added at -78°C to the mixture. After 1 hour, triisopropylborate 30.2 mL (0.131 mol) was added thereto. After stirring the mixture at room temperature for 12 hours and adding distilled water thereto, the mixture was extracted with EA, was dried with $MgSO_4$, and was distilled under reduced pressure. The resultant was recrystallized with MC and hexane to obtain compound **A-3** (15 g, 0.049 mol, 75.38%).

[102] Preparation of compound **A-4**

[103] Compound **A-3** 15 g (49.31 mmol), 2-bromonitrobenzene 12.9 g (64.10 mmol), $Pd(PPh_3)_4$ 1.13 g (0.98 mmol), 2 M Na_2CO_3 60 mL, toluene 150 mL and ethanol 50 mL were mixed and were stirred under reflux. After 4 hours, the mixture was cooled to room temperature. After adding distilled water to the mixture, it was extracted with EA and was dried with $MgSO_4$. The resultant was distilled under reduced pressure and was recrystallized with MC and hexane to obtain compound **A-4** (13.5 g, 35.39 mmol,

71.77%).

[104] Preparation of compound **A-5**

[105] Compound **A-4** 13.5 g, triethylphosphite 150 mL and 1,2-dichlorobenzene 150 mL were mixed and were stirred at 150°C for 10 hours. The mixture was cooled to room temperature, was distilled under reduced pressure, and was purified by column chromatography to obtain compound **A-5** (8 g, 22.89 mmol, 65.4%).

[106] Preparation of compound **A-7**

[107] Compound **A-6** 20 g (72.96 mmol), 2,4-dichloropyrimidine 9.8 g (66.32 mmol), $Pd(PPh_3)_4$ 2.28 g (1.97 mmol), 2 M Na_2CO_3 80 mL and DME 200 mL were mixed and were stirred under reflux for 12 hours. The mixture was cooled to room temperature and distilled water was added thereto. The resultant was extracted with EA, was dried with $MgSO_4$ and was distilled under reduced pressure. Compound **A-7** (9 g, 26.25 mmol, 39.77%) was obtained via column chromatography.

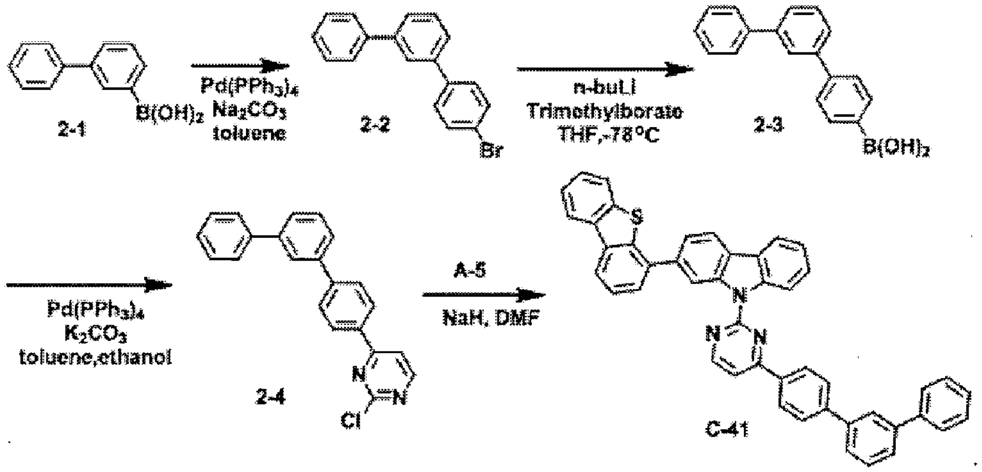
[108] Preparation of compound **C-31**

[109] Compound **A-7** 5 g (14.58 mmol) and compound **A-5** 6.11 g (17.50 mmol) were dissolved in DMF 120 mL, and then NaH 0.52 g (21.87 mmol) was added thereto. The mixture was stirred at room temperature for 12 hours and methanol was added thereto. The obtained solid was filtered under reduced pressure and was recrystallized with EA and $CHCl_3$ to obtain compound **C-31** (6.5 g, 9.91 mmol, 67.97%).

[110] MS/FAB Found **656**; Calculated **655.21**

[111] [Preparation Example 2] Preparation of compound **C-41**

[112]



[113] Preparation of compound **2-2**

[114] Compound **2-1** 25 g (0.126 mol), 4-bromoiodobenzene 89.3 g (0.316 mol), $PdCl_2(PPh_3)_2$ 2.66 g (0.0038 mol), 2M Na_2CO_3 150 mL, toluene 150 mL and ethanol 30 mL were mixed, were stirred at 110°C for 3 hours, and then distilled water was added thereto. The mixture was extracted with EA, was dried with $MgSO_4$, and was distilled under reduced pressure. Compound **2-2** 31 g (0.100 mol, 80%) was obtained by

purifying via column chromatography.

[115] Preparation of compound **2-3**

[116] Compound **2-2** 31 g (0.100 mol) was dissolved in THF 750 mL, and then n-BuLi 60 mL (0.150 mol, 2.5 M in hexane) was slowly added at -78°C. After 1 hour, triisopropylborate 46 mL (0.200 mol) was added to the mixture. The mixture was stirred at room temperature for 12 hours, and distilled water was added thereto. Then, the mixture was extracted with EA, was dried with $MgSO_4$, and was distilled under reduced pressure. After recrystallizing with MC and hexane, compound **2-3** 21 g (0.076 mol, 76.6%) was obtained.

[117] Preparation of compound **2-4**

[118] 2,4-dichloropyrimidine 7 g (0.047 mol), compound **2-3** 10 g (0.036 mol), 2M Na_2CO_3 45 mL, toluene 182 mL and ethanol 45 mL were mixed. The mixture was stirred under reflux for 12 hours, and then was cooled to room temperature. After adding distilled water thereto, the mixture was extracted with EA, was dried with $MgSO_4$, and was distilled under reduced pressure. Compound **2-4** 9 g (0.026 mol, 72.9%) was obtained by purifying via column chromatography.

[119] Preparation of compound **C-41**

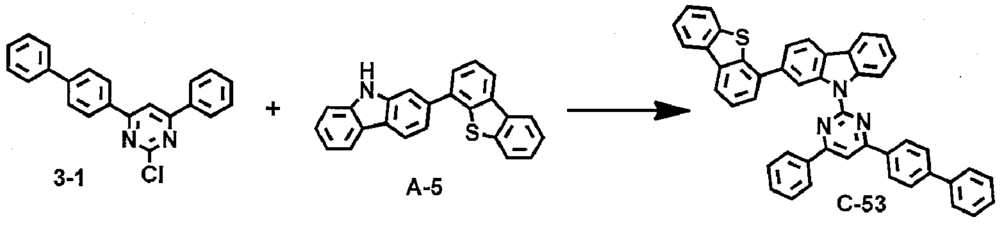
[120] Compound **2-4** 5 g (14.58 mmol) and compound **A-5** 6.11 g (17.50 mmol) were dissolved in DMF 120 mL, and then NaH 0.52 g (21.87 mmol) was added thereto. The mixture was stirred at room temperature for 12 hours, and then methanol was added thereto. The obtained solid was filtered under reduced pressure and was recrystallized with EA and $CHCl_3$ to obtain compound **C-41** 6.0 g (0.009 mol, 62.75%).

[121] MS/FAB Found **658**; Calculated **657.22**

[122]

[123] [Preparation Example 3] Preparation of compound **C-53**

[124]



[125] Preparation of compound **C-53**

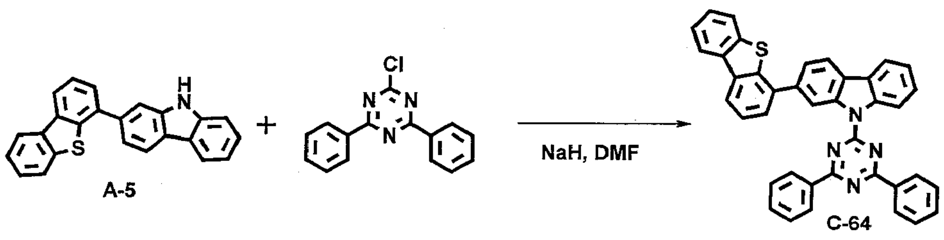
[126] Compound **3-1**, 4-([1,1'-biphenyl]-4-yl)-2-chloro-6-phenylpyrimidine (5 g, 14.58 mmol) and compound A-5 (5.6 g, 16.04 mmol) were dissolved in DMF 100 mL, and then NaH (0.87 g, 60% in mineral oil, 21.87 mmol) was added thereto. The mixture was stirred at room temperature for 12 hours. After adding methanol, the mixture was filtered under reduced pressure. Compound **C-53** (7 g, 10.67 mmol, 73.2%) was obtained by purifying the obtained solid via column chromatography.

[127] MS/FAB Found **655.8**; Calculated **655.21**

[128]

[129] [Preparation Example 4] Preparation of compound **C-64**

[130]



[131] Preparation of compound **C-64**

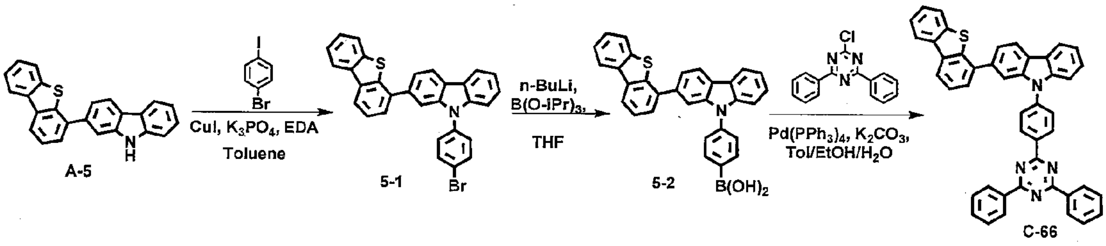
[132] 2-chloro-4,6-diphenyl-1,3,5-triazine (3.1 g, 11.4 mmol) and compound A-5 (4 g, 11.4 mmol) was suspended in DMF 57 mL, and then 60% NaH (684 mg, 17.1 mmol) was added thereto at room temperature. The mixture was stirred for 12 hours. After adding distilled water (1L), the mixture was filtered under reduced pressure. The obtained solid was purified via column chromatography to obtain compound **C-64** (2.4 g, 36.4%).

[133] MS/FAB Found **580.7**; Calculated **580.17**

[134]

[135] [Preparation Example 5] Preparation of compound **C-66**

[136]



[137] Preparation of compound **5-1**

[138] Compound A-5 (10 g, 0.03 mol), 1-bromo-4-iodobenzene (16 g, 0.06 mol), CuI (2.7 g, 0.01 mol), ethylenediamine (1.9 mL, 0.03 mol), K_3PO_4 (15 g, 0.07 mol) and toluene (150 mL) were mixed. The mixture was stirred at 120°C for 12 hours, and then was extracted with EA. The obtained organic layer was dried with $MgSO_4$ and then was filtered. After removing solvents under reduced pressure, the obtained solid was purified via column chromatography to obtain compound **5-1** (13 g, 91%).

[139] Preparation of compound **5-2**

[140] Dry THF (200 mL) and compound **5-1** (13 g, 0.03 mol) were mixed. While stirring under nitrogen atmosphere, n-BuLi (16 mL, 2.25 M solution in hexane) was slowly added to the mixture at -78°C. The mixture was stirred at -78°C for 1 hour and $B(O\text{-}iPr)_3$ (12 mL, 0.05 mol) was slowly added thereto at -78°C. Then, the mixture was warmed to room temperature and was reacted together for 12 hours. After completing the reaction, the resultant was extracted with EA. The obtained organic layer was dried

with $MgSO_4$ and was filtered. After removing solvents under reduced pressure, the obtained solid was recrystallized to obtain compound **5-2** (11g, 90%).

[141] Preparation of compound **C-66**

[142] Compound **5-2** (11 g, 0.02 mol), 2-chloro-4,6-diphenyl-1,3,5-triazine (8.2 g, 0.03 mol), $Pd(PPh_3)_4$ (1.35 g, 0.001 mol), K_2CO_3 (9.7 g, 0.07 mol), toluene (120 mL), EtOH (30 mL) and H_2O (35 mL) were mixed. The mixture was stirred at 120°C for 12 hours. After completing the reaction, the resultant was extracted with EA. The obtained organic layer was dried with $MgSO_4$ and was filtered. After removing solvents under reduced pressure, the obtained solid was recrystallized to obtain compound C-66 (8.3 g, 54%).

[143] MS/FAB Found **656.8**; Calculated **656.2**

[144]

[145] [Example 1] Production of an OLED device using the compound of the present invention

[146] A transparent electrode indium tin oxide (ITO) thin film (15 Ω/sq) on a glass substrate for an 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. 2-TNATA [4,4',4''-tris(N,N-(2-naphthyl)phenylamino)triphenylamine] was introduced into a cell of said vacuum vapor depositing apparatus, and then the pressure in the chamber of said apparatus was controlled to 10^{-6} torr. Thereafter, an electric current was applied to the cell to evaporate 2-TNATA, thereby forming a hole injection layer having a thickness of 60 nm on the ITO substrate. Then, NPB [N,N'-bis(α-naphthyl)-N,N'-diphenyl-4,4'-diamine] was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying electric current to the cell, thereby forming a hole transport layer having a thickness of 20 nm on the hole injection layer. Thereafter, compound **C-31** was introduced into one cell of the vacuum vapor depositing apparatus, as a host material, and compound **D-1** was introduced into another cell as a dopant. The two materials were evaporated at different rates and was deposited in a doping amount of 4 to 20 wt% to form a light-emitting layer having a thickness of 30 nm on the hole transport layer. Then, 9,10-di(1-naphthyl)-2-(4-phenyl-1-phenyl-1H-benzo[d]imidazole)anthracene was introduced into one cell and lithium quinolate was introduced into another cell. The two materials were evaporated at different rates and were deposited in a doping amount of 30 to 70 wt% 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 1 to 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 those purified by vacuum sublimation at 10^{-6} torr.

[147] The produced OLED device showed green-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.41 mA/cm^2 at a driving voltage of 3.2 V.

[148]

[149] [Example 2] Production of an OLED device using the compound of the present invention

[150] An OLED device was produced in the same manner as one of Example 1, except for using compound **C-31** and compound **D-28** as a host material and a dopant, respectively. The produced OLED device showed orange-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.55 mA/cm^2 at a driving voltage of 3.7 V.

[151]

[152] [Example 3] Production of an OLED device using the compound of the present invention

[153] An OLED device was produced in the same manner as one of Example 1, except for using compound **C-31** and compound **D-44** as a host material and a dopant, respectively. The produced OLED device showed dark orange-light emission having a luminance of 1,000 cd/m^2 and a current density of 6.67 mA/cm^2 at a driving voltage of 4.0 V.

[154]

[155] [Example 4] Production of an OLED device using the compound of the present invention

[156] An OLED device was produced in the same manner as one of Example 1, except for using compound **C-41** and compound **D-1** as a host material and a dopant, respectively. The produced OLED device showed green-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.46 mA/cm^2 at a driving voltage of 3.1 V.

[157]

[158] [Example 5] Production of an OLED device using the compound of the present invention

[159] An OLED device was produced in the same manner as one of Example 1, except for using compound **C-66** and compound **D-1** as a host material and a dopant, respectively. The produced OLED device showed green-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.65 mA/cm^2 at a driving voltage of 3.0 V.

[160]

[161] [Example 6] Production of an OLED device using the compound of the present invention

[162] An OLED device was produced in the same manner as one of Example 1, except for using compound **C-53** and compound **D-1** as a host material and a dopant, respectively. The produced OLED device showed green-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.56 mA/cm^2 at a driving voltage of 3.0 V.

[163]

[164] [Comparative Example 1] Production of an OLED device using a conventional electroluminescent compound

[165] An OLED device was produced in the same manner as one of Example 1, except for depositing a light-emitting layer having a thickness of 30 nm on the hole transport layer by using CBP as a host material and compound **D-1** as a dopant and depositing a hole blocking layer having a thickness of 10 nm by using BAlq.

[166] The produced OLED device showed green-light emission having a luminance of 1,000 cd/m^2 and a current density of 2.86 mA/cm^2 at a driving voltage of 4.9 V.

[167]

[168] [Comparative Example 2] Production of an OLED device using a conventional electroluminescent compound

[169] An OLED device was produced in the same manner as one of Example 1, except for depositing a light-emitting layer having a thickness of 30 nm on the hole transport layer by using CBP as a host material and compound **D-28** as a dopant and depositing a hole blocking layer having a thickness of 10 nm by using BAlq.

[170] The produced OLED device showed orange-light emission having a luminance of 1,000 cd/m^2 and a current density of 3.05 mA/cm^2 at a driving voltage of 4.6 V.

[171]

[172] [Comparative Example 3] Production of an OLED device using a conventional electroluminescent compound

[173] An OLED device was produced in the same manner as one of Comparative Example 1, except for using compound **D-44** as a dopant.

[174] The produced OLED device showed dark orange-light emission having a luminance of 1,000 cd/m^2 and a current density of 8.2 mA/cm^2 at a driving voltage of 5.2 V.

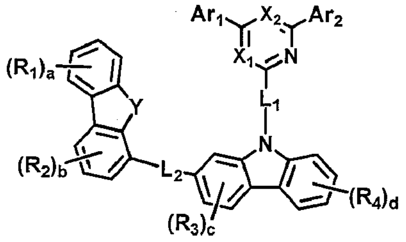
[175]

[176] As shown above, the compounds of the present invention have superior luminescent properties than conventional compounds, and thus provide an organic electroluminescent device which has high luminous efficiency and requires a low driving voltage, to thereby have improved power efficiency and power consumption.

Claims

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

[Formula 1]



wherein

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

X_1 and X_2 each independently represent CR' or N;

Y represents S, O or $-CR_{21}R_{22}$;

Ar_1, Ar_2, R', R_{21} and R_{22} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, or a substituted or unsubstituted 3- to 30-membered heteroaryl group;

R_1 to R_4 each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group, a substituted or unsubstituted 3- to 30-membered heteroaryl group, $-NR_{11}R_{12}$, $-SiR_{13}R_{14}R_{15}$, $-SR_{16}$, $-OR_{17}$, a cyano group, a nitro group or a hydroxyl group;

R_{11} to R_{17} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl group, a substituted or unsubstituted (C6-C30)aryl group or a substituted or unsubstituted 3- to 30-membered heteroaryl group; or are linked to an adjacent substituent(s) to form a mono- or polycyclic, alicyclic or aromatic ring whose carbon atom(s) may be replaced by at least one atom selected from nitrogen, oxygen and sulfur;

a and d each independently represent an integer of 1 to 4; where a or d is an integer of 2 or more, each of R_1 or each of R_4 is the same or different;

b and c each independently represent an integer of 1 to 3; where b or c is an integer of 2 or more, each of R_2 or each of R_3 is the same or different; and the heteroaryl group and the heteroarylene group contain at least one heteroatom selected from B, N, O, S, P(=O), Si and P.

[Claim 2] The organic electroluminescent compound according to claim 1, wherein the substituents of the substituted groups in L_1, L_2, Ar_1, Ar_2, R', R_1 to R_4, R_{11} to R_{17}, R_{21} and R_{22} each independently are at least one selected from the group consisting of deuterium, a halogen, a (C1-C30)alkyl group, a (C1-C30)alkyl group substituted with a halogen, a (C6-C30)aryl group, a 3- to 30-membered heteroaryl group, a 3- to 30-membered heteroaryl group substituted with a (C6-C30)aryl group, a (C6-C30)aryl group substituted with a 3- to 30-membered heteroaryl group, a (C3-C30)cycloalkyl group, a 5- to 7-membered heterocycloalkyl group, a tri(C1-C30)alkylsilyl group, a tri(C6-C30)arylsilyl group, a di(C1-C30)alkyl(C6-C30)arylsilyl group, a (C1-C30)alkyldi(C6-C30)arylsilyl group, a (C2-C30)alkenyl group, a (C2-C30)alkynyl group, a cyano group, a di(C1-C30)alkylamino group, a di(C6-C30)arylamino group, a (C1-C30)alkyl(C6-C30)arylamino group, a di(C6-C30)arylboronyl group, a di(C1-C30)alkylboronyl group, a (C1-C30)alkyl(C6-C30)arylboronyl group, a (C6-C30)aryl(C1-C30)alkyl group, a (C1-C30)alkyl(C6-C30)aryl group, a carboxyl group, a nitro group and a hydroxyl group.

[Claim 3] The organic electroluminescent compound according to claim 1, wherein L_1 and L_2 each independently represent a single bond; or a substituted or unsubstituted phenylene, biphenylene, terphenylene, indenylene, fluorenylene, triphenylenylene, pyrenylene, perylenylene, chrysenylene, naphthacenylene, fluoranthenylene, thiophenylene, pyrrolylene, pyrazolylene, thiazolylene, oxazolylene, oxadiazolylene, triazinylene, tetrazinylene, triazolylene, tetrazolylene, furazanylene, pyridylene, benzofuranylene, benzothiophenylene, indolene, benzoimidazolylene, benzothiazolylene, benzoisothiazolylene, benzoisoxazolylene, benzoxazolylene, benzothiadiazolylene, dibenzofuranylene or dibenzothiophenylene;

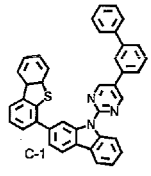
Ar_1, Ar_2, R', R_{21} and R_{22} each independently represent hydrogen; or a substituted or unsubstituted methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, terphenyl, pyrenyl, chrysenyl, naphthacenyl, perylene, pyridyl, pyrrolyl, furanyl, thiophenyl, imidazolyl, benzoimidazolyl, quinolyl, triazinyl, benzofuranyl, dibenzofuranyl, benzothiophenyl, dibenzothiophenyl, pyrazolyl, indolyl, carbazolyl, thiazolyl, oxazolyl, benzothiazolyl, benzoxazolyl, phenanthrolinyl, quinoxalinyl or N-carbazolyl;

R_1 to R_4 each independently represent hydrogen, deuterium, chloro, fluoro, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, triphenylenyl, pyrenyl, chrysenyl, naphthacenyl, perylenyl, pyridyl, pyrrolyl, furanyl, thiophenyl, imidazolyl, benzoimidazolyl, indenyl, pyrazinyl, pyrimidinyl, pyridazinyl, quinolyl, triazinyl, benzofuranyl, dibenzofuranyl, benzothiophenyl, dibenzothiophenyl, pyrazolyl, indolyl, carbazolyl, thiazolyl, oxazolyl, benzothiazolyl, benzoxazolyl, phenanthrolinyl or N-carbazolyl;

a to d each independently represent an integer of 1 to 2; and

L_1, L_2, Ar_1, Ar_2, R’, R_1 to R_4, R_{21} and R_{22} each independently may be further substituted with at least one selected from the group consisting of deuterium, chloro, fluoro, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, phenyl, biphenyl, fluorenyl, fluoranthenyl, triphenylenyl, pyrenyl, chrysenyl, naphthacenyl, perylenyl, fluorotrimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyldimethylsilyl, dimethylphenylsilyl, carbazolyl and triphenylsilyl.

[Claim 4] The organic electroluminescent compound according to claim 1, wherein the compound is selected from the group consisting of: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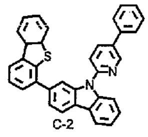
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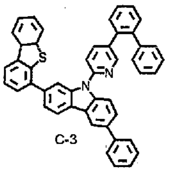
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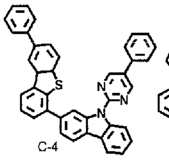
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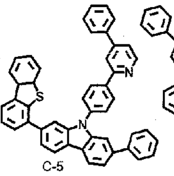
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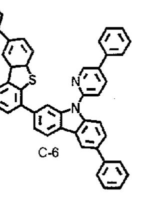
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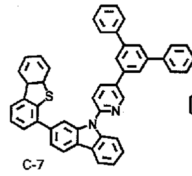
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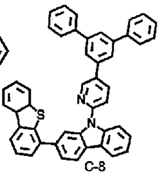
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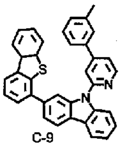
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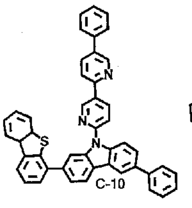
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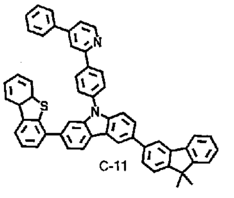
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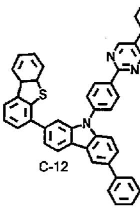
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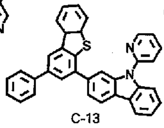
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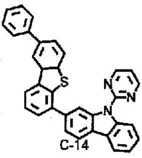
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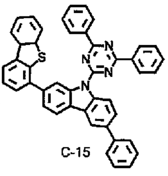
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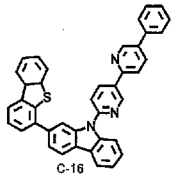
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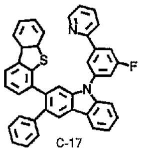
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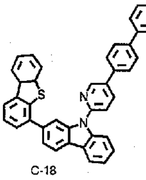
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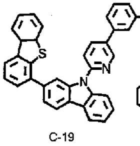
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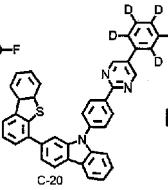
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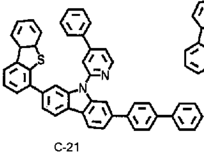
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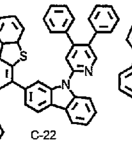
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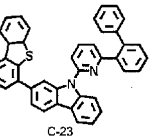
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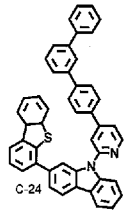
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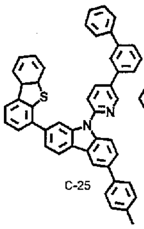
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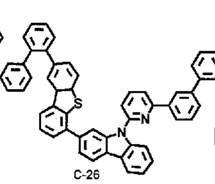
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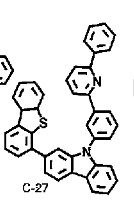
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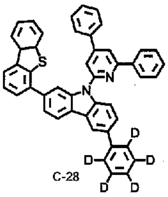
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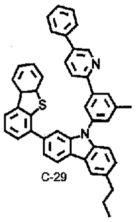
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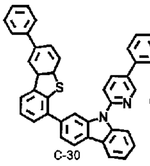
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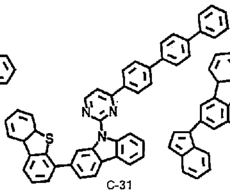
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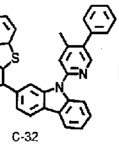
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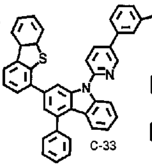
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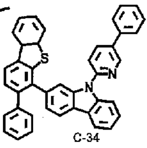
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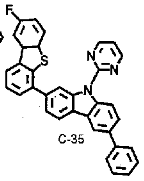
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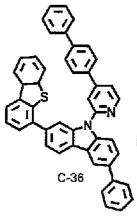
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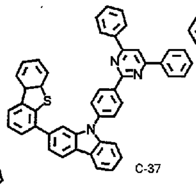
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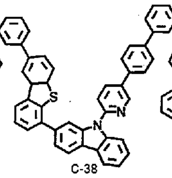
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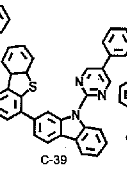
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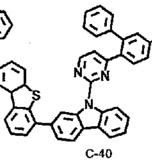
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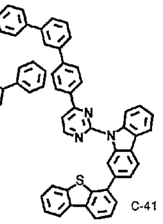
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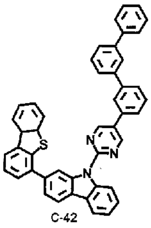
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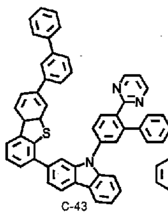
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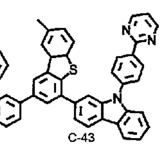
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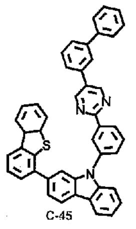
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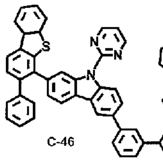
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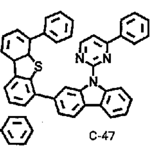
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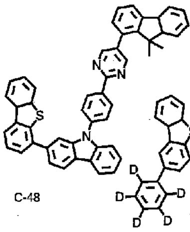
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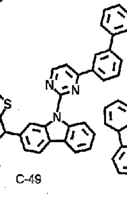
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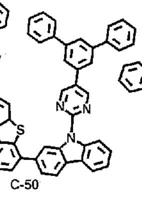
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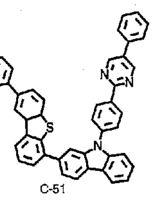
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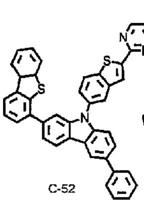
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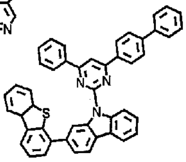
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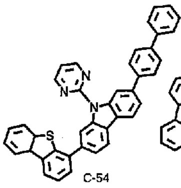
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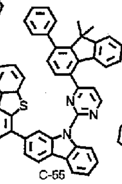
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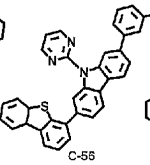
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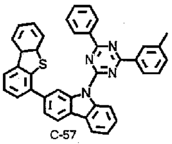
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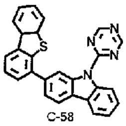
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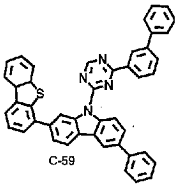
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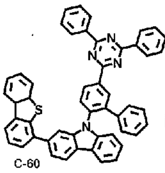
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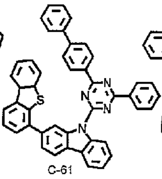
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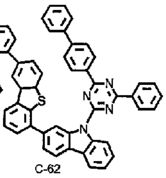
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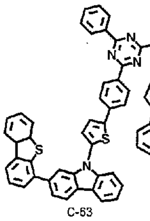
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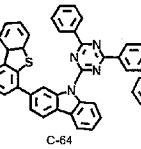
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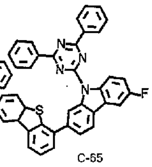
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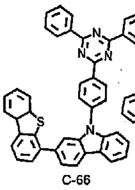
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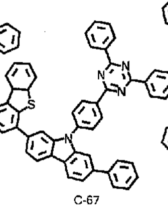
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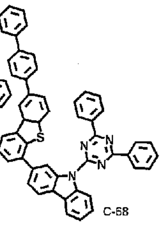
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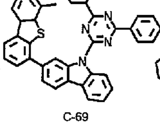
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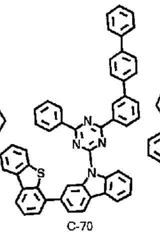
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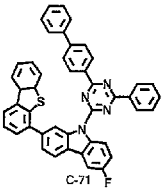
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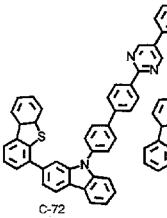
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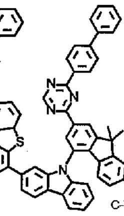
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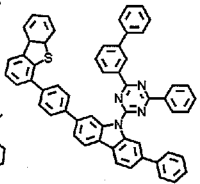
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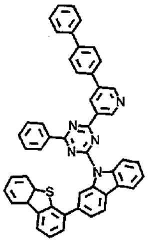
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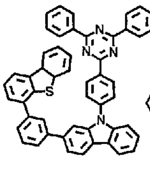
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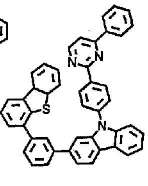
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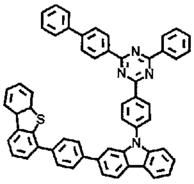
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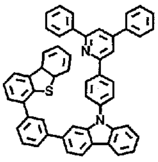
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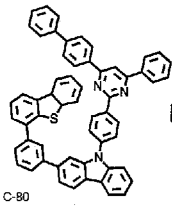
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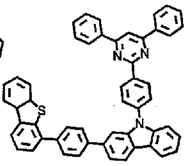
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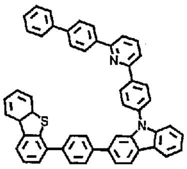
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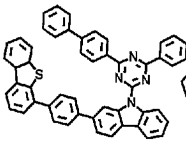
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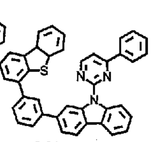
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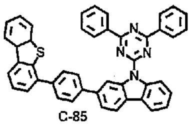
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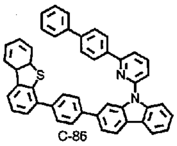
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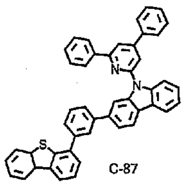
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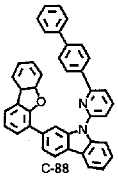
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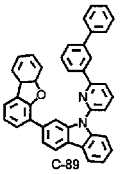
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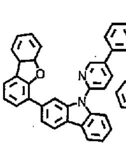
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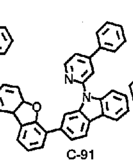
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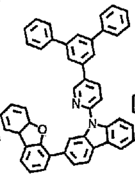
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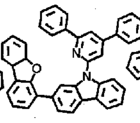
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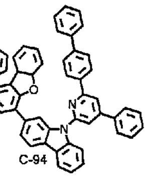
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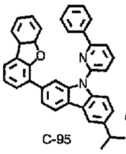
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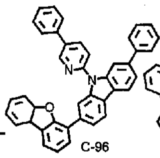
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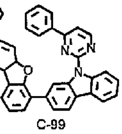
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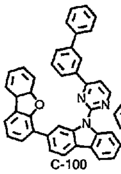
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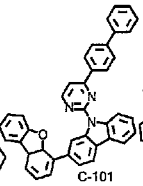
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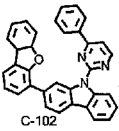
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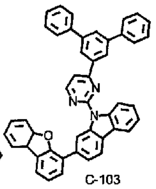
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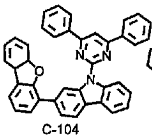
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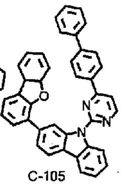
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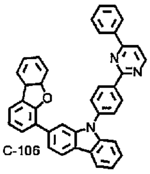
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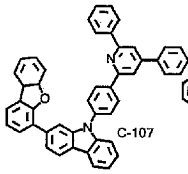
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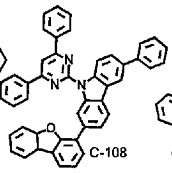
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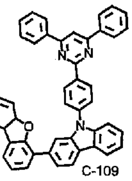
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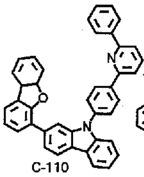
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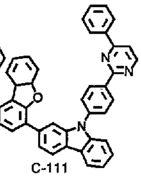
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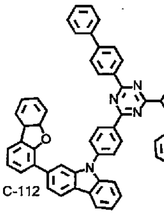
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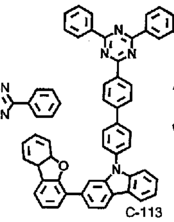
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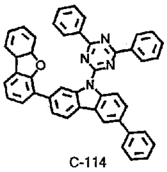
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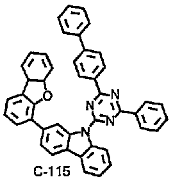
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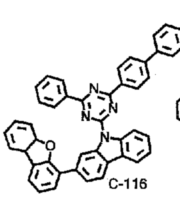
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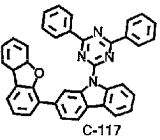
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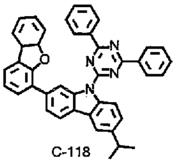
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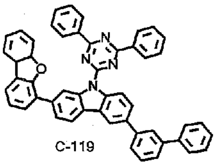
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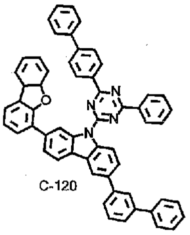
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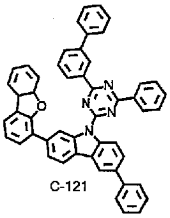
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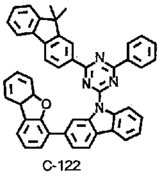
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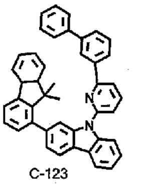
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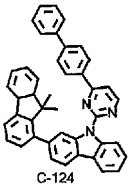
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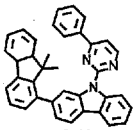
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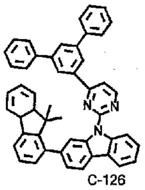
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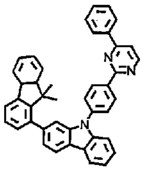
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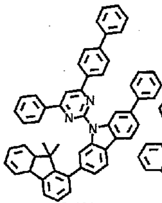
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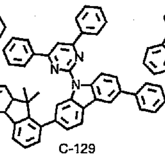
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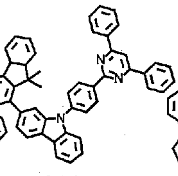
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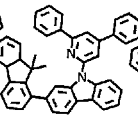
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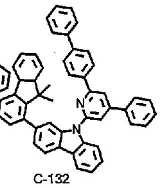
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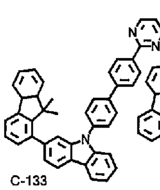
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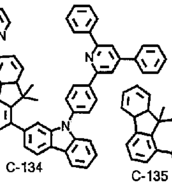
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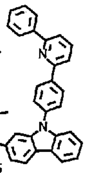
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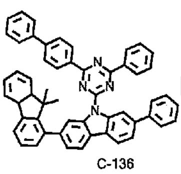
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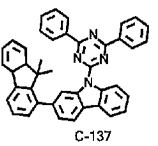
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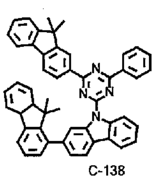
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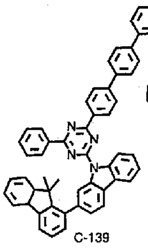
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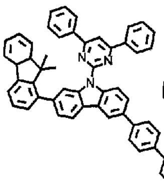
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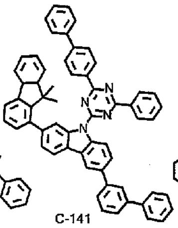
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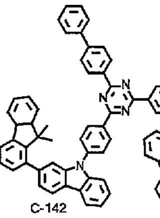
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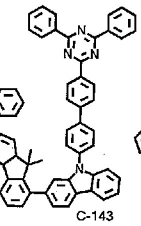
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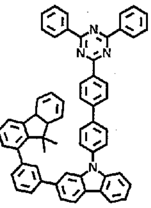
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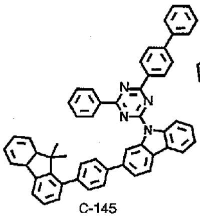
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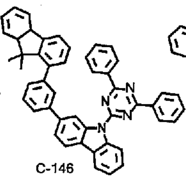
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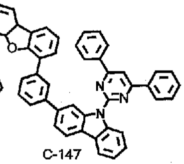
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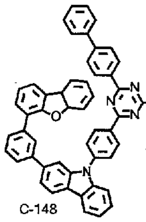
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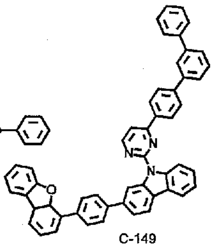
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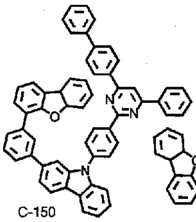
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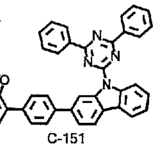
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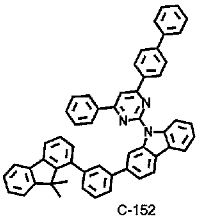
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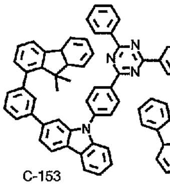
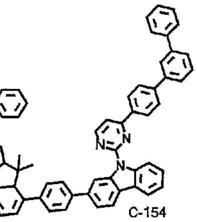

C-153


C-154

[Claim 5] An organic electroluminescent device comprising the organic electroluminescent compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/003472

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C09K 11/06 (2006.01)	***C07D 407/14*** (2006.01)	***H01L 51/54*** (2006.01)
C07D 403/04 (2006.01)	***C07D 409/14*** (2006.01)	
C07D 403/10 (2006.01)	***H01L 27/32*** (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)
CAplus, Registry: Structure search based on formula 1 defined in claim 1
EPODOC, WPIDS: C09K 11/06, C07D 403/04, C07D 403/10, C07D 407/14, C07D 409/14, carbazole

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/010840 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 27 January 2011 See Chemical Formula 1, claim 1; pages 7-9; claims 3, 6-10	1-3, 5
P,X	WO 2012/033108 A1 (SEMI-CONDUCTOR ENERGY LABORATORY CO., LTD.) 15 March 2012 See formula G1, paragraphs [0018]-[0023] and formula G4 (paragraphs [0054]-[0055]; paragraph [0056]; Synthesis Example 8, pages 121-122	1-5
A	WO 2010/114264 A2 (DOW ADVANCED DISPLAY MATERIALS, LTD.) 7 October 2010 See claim 1; example compounds pages 11-14	

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex

*	Special categories of cited documents:		
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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 25 May 2012	Date of mailing of the international search report 12 June 2012
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **SARAH SMITH** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2713

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 2012/036482 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 22 March 2012 See claim 1; example compounds page 11-22	

This Annex lists the known "A" publication level 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 Cited in Search Report		Patent Family Member			
WO	2011010840	KR	20110008723	TW	201111472
WO	2012033108	US	2012074390		
WO	2010114264	KR	20100108924	TW	201105774
WO	2012036482	NONE			

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

END OF ANNEX

专利名称(译)	新型有机电致发光化合物和使用其的有机电致发光器件		
公开(公告)号	EP2694619A1	公开(公告)日	2014-02-12
申请号	EP2012779767	申请日	2012-05-03
[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 YANG SOO JIN KIM HEE SOOK PARK KYOUNG JIN KIM SEUNG AE LEE KYUNG JOO KWON HYUCK JOO KIM BONG OK		
发明人	KIM, CHI-SIK YANG, SOO-JIN KIM, HEE-SOOK PARK, KYOUNG-JIN KIM, SEUNG-AE LEE, KYUNG-JOO KWON, HYUCK-JOO KIM, BONG-OK		
IPC分类号	C09K11/06 C07D407/14 H01L51/54 C07D403/04 C07D409/14 C07D403/10 H01L27/32 C07D401/04 C07D401/10 C07D405/14		
CPC分类号	H01L51/0074 C07D401/04 C07D401/10 C07D403/04 C07D403/10 C07D405/14 C07D409/14 C09K11/06 C09K2211/1007 C09K2211/1029 C09K2211/185 H01L51/0067 H01L51/0072 H01L51/0085 H01L51/5016 H05B33/14 H05B33/20		
优先权	1020120046340 2012-05-02 KR 1020110041819 2011-05-03 KR		
其他公开文献	EP2694619A4		
外部链接	Espacenet		

摘要(译)

公开了一种式1的有机电致发光化合物和包含该化合物的有机电致发光器件。有机发光化合物提供有机电致发光器件，其具有高发光效率和长操作寿命并且需要低驱动电压，从而具有改善的功率效率和功耗。