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(54) BIS-CARBAZOLE DERIVATIVE, MATERIAL FOR ORGANIC ELECTROLUMINESCENT ELEMENT AND ORGANIC ELECTROLUMINESCENT ELEMENT USING SAME

BISCARBAZOLDERIVAT, MATERIAL FÜR EIN ORGANISCHES ELEKTROLUMINESZENZELEMENT UND ORGANISCHES ELEKTROLUMINESZENZELEMENT DAMIT

DÉRIVÉ DE BIS-CARBAZOLE, MATÉRIAU POUR ÉLÉMENT ÉLECTROLUMINESCENT ORGANIQUE, ET ÉLÉMENT ÉLECTROLUMINESCENT ORGANIQUE L'UTILISANT

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JP-A- 2008 135 498 **US-A1- 2004 086 745**

- **QIN-DE LIU ET AL: "Design and Synthesis of Phosphorescent Iridium Containing Dendrimers for Potential Applications in Organic Light-Emitting Diodes", MACROMOLECULAR CHEMISTRY AND PHYSICS, vol. 209, no. 18, 12 August 2008 (2008-08-12), pages 1931-1941, XP055048970, ISSN: 1022-1352, DOI: 10.1002/macp.200800222**
- **V. VAITKEVICIENE ET AL.: SYNTHETIC METALS, vol. 158, 2008, pages 383-390, XP022732268,**
- **V. VAITKEVICIENE ET AL. SYNTHETIC METALS vol. 158, 2008, pages 383 - 390, XP022732268**

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Description

TECHNICAL FIELD

[0001] The present invention relates to a biscarbazole derivative, a material for an organic electroluminescence device, and an organic electroluminescence device using those.

BACKGROUND ART

[0002] A known organic electroluminescence device includes an organic thin-film layer between an anode and a cathode, the organic thin-film layer including an emitting layer, and emits light using exciton energy generated by a recombination of holes and electrons injected into the emitting layer (see Patent Literatures 1 to 7).

[0003] Such an organic electroluminescence device, which has the advantages as a self-emitting device, is expected to serve as an emitting device excellent in luminous efficiency, image quality, power consumption and thin design.

[0004] In forming the emitting layer, a doping method, according to which an emitting material (dopant) is doped to a host, has been known as a usable method.

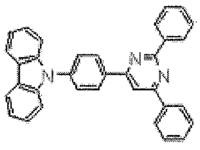
[0005] The emitting layer formed by the doping method can efficiently generate excitons from electric charges injected into the host. With the exciton energy generated by the excitons being transferred to the dopant, the dopant can emit light with high efficiency.

[0006] Recently, in order to improve performance of the organic electroluminescence device (hereinafter, occasionally referred to as an organic EL device), a doping method has been further studied to find a suitable host material.

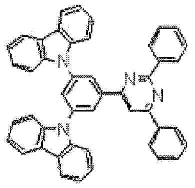
[0007] Such a host material is disclosed in, for instance, Patent Literatures 1 to 7. Patent Literatures 1 to 7 disclose a compound including a carbazole skeleton and a nitrogen-containing aromatic ring in the same molecule and a compound including a plurality of carbazole skeletons in the same molecule, as shown in the following compounds I to VIII.

[0008] The compounds I and II disclosed in Patent Literature 1 each have a structure in which a carbazole skeleton is bonded to a benzene ring and an electron-deficient nitrogen-containing hetero aromatic ring structure. A carbazole skeleton, which is represented by polyvinyl carbazole, has been known as a main skeleton of a hole transporting material. In contrast, the electron-deficient nitrogen-containing hetero aromatic ring structure has been known as a structure having a high electron transporting capability. In other words, the compounds I and II disclosed in Patent Literature 1 are materials for balancing charge transportation by combining a hole transporting skeleton and an electron transporting skeleton.

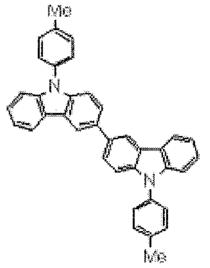
[Chemical Formula 1]



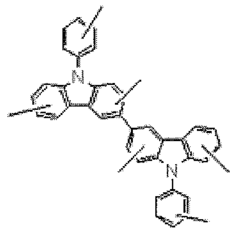
Compound I



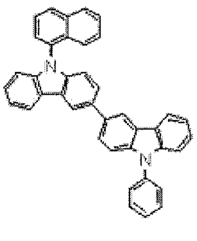
Compound II



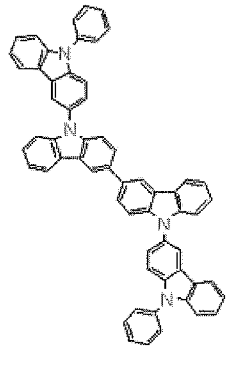
Compound III



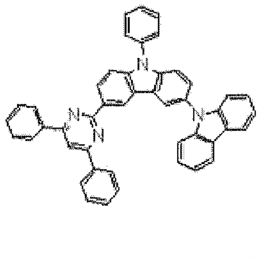
Compound IV



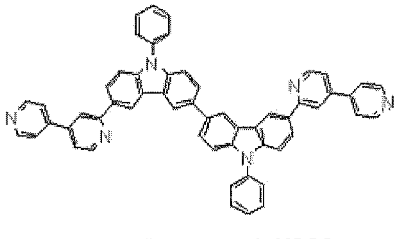
Compound V



Compound VI



Compound VII



Compound VIII

CITATION LIST

PATENT LITERATURE

[0009]

Patent Literature 1:	WO2003-080760
Patent Literature 2:	Japanese Patent No. 3139321
Patent Literature 3:	Japanese Patent No. 4357781
Patent Literature 4:	JP-A-2003-151774
Patent Literature 5:	JP-A-2008-135498
Patent Literature 6:	JP-A-2009-21336
Patent Literature 7:	JP-A-2008-214307

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010] The compound I has only a single carbazole skeleton and lacks a hole transporting capability, so that a favorable luminescence property cannot be obtained. The compound II has two carbazolyl groups that are branched to left and right relative to a bond axis of a pyrimidine ring and a benzene ring (two conjugated aromatic ring). Accordingly, an overlapping margin of the carbazole skeleton between molecules is impaired, so that a hole transporting capability is insufficient and a re-bonding position of charges is likely to be closer to the anode. Consequently, favorable luminescence property and lifetime property cannot be obtained.

[0011] In order to enlarge the overlapping margin between the molecules and exhibit a sufficient hole transporting capability, it has been proposed to incorporate a structure in which carbazole skeletons are linked in the molecules. For instance, the compounds III to VI disclosed in Patent Literatures 2 to 5 have a structure in which two carbazole skeletons are linked. However, since none of the compounds III to VI has an electron-deficient nitrogen-containing hetero aromatic ring structure, adjustment of carrier balance between holes and electrons is difficult, so that a favorable luminescence property cannot be obtained.

[0012] The compound VII disclosed in Patent Literature 6 has an electron-deficient nitrogen-containing hetero aromatic ring structure and a carbazole-linking structure. However, two carbazole skeletons are bonded to a carbon atom at 3-position by a nitrogen atom. In this structure, the two carbazole skeletons are twisted to each other to lose flatness. Accordingly, the overlapping margin between the molecules becomes small and a hole transporting capability becomes insufficient, so that favorable luminescence property and lifetime property cannot be obtained.

[0013] The compound VIII disclosed in Patent Literature 7 has a structure in which a bipyridyl group (a nitrogen-containing aromatic heterocyclic group) is bonded to a benzene ring of a carbazole skeleton. The compound is not disclosed as a phosphorescent host material although being used as a material for an electron transporting layer. However, since the compound is considered to exhibit a high electron transporting capability, when used as a host material, the compound provides a poor carrier balance within the emitting layer and fails to exhibit a favorable luminescence property.

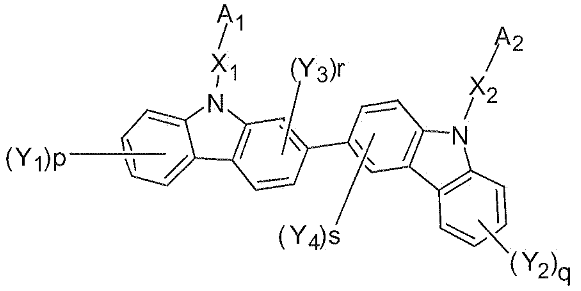
[0014] Accordingly, an object of the invention is to provide a novel biscarbazole derivative having a hole transporting capability and an electron transporting capability and exhibiting an excellent carrier balance, a material for an organic EL device and a phosphorescent and long-life organic EL device using those.

MEANS FOR SOLVING THE PROBLEMS

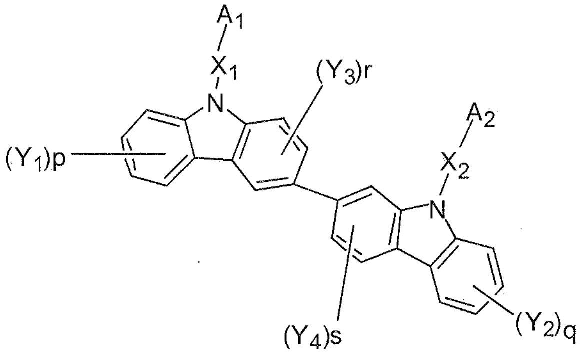
[0015] After dedicated study to achieve the above object, the inventors found that a compound including two carbazolyl groups and a nitrogen-containing heterocyclic group effectively works for optimizing a carrier balance in the emitting layer of an organic EL device, and achieved the invention.

[0016] Specifically, a biscarbazole derivative according to an aspect of the invention is represented by a formula (1A) or (1B) below. Herein, "hydrogen" is meant to also include deuterium.

[Chemical Formula 2]



··· (1A)



··· (1B)

[0017] In the formulae (1A) and (1B): A_1 is selected from the group consisting of a substituted or unsubstituted pyridine ring, a substituted or unsubstituted pyrimidine ring and a substituted or unsubstituted triazine ring;

A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

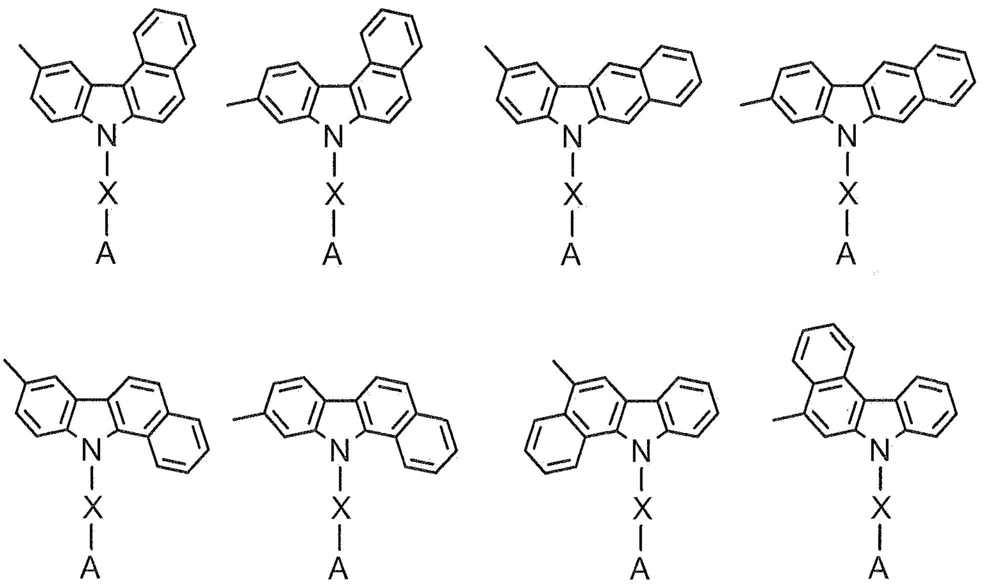
Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms; adjacent ones of Y_1 to Y_4 may be bonded to each other to form a ring structure;

p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and

when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 may be the same or different.

[0018] When Y_1 to Y_4 are bonded to each other to form a ring structure, the ring structure is exemplified by structures represented by the following formulae.

[Chemical Formula 3]



[0019] Moreover, in the biscarbazole derivative according to the above aspect of the invention, A_1 in the formula (1A) or (1B) is preferably selected from a substituted or unsubstituted pyrimidine ring or substituted or unsubstituted triazine ring, particularly preferably a substituted or unsubstituted pyrimidine ring.

[0020] Moreover, in the biscarbazole derivative according to the above aspect of the invention, A_1 in the formula (1A) or (1B) is preferably a substituted or unsubstituted quinazoline ring.

[0021] A material for an organic EL device (hereinafter, occasionally referred to as an organic-EL-device material) according another aspect of the invention contains the biscarbazole derivative.

[0022] The organic EL device according to still another aspect of the invention includes: a cathode; an anode; and a plurality of organic thin-film layers provided between the cathode and the anode, and the organic thin-film layer including an emitting layer, in which at least one layer of the organic thin-film layers includes the above-described organic-EL-device material.

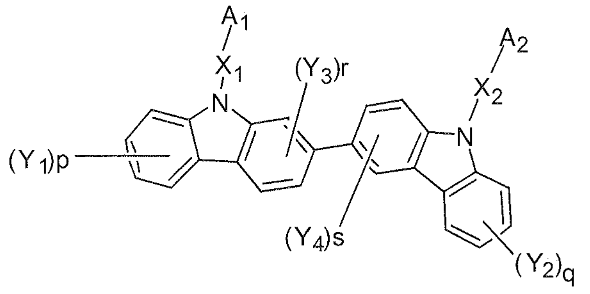
[0023] In the organic EL device according to the above aspect of the invention, the emitting layer preferably includes the organic-EL-device material according to the above aspect of the invention as a host material.

[0024] Also preferably in the above aspect of the invention, the emitting layer includes a phosphorescent material.

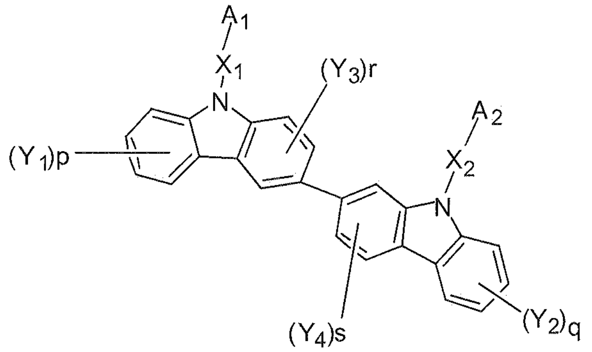
[0025] Further, the phosphorescent material is more preferably an ortho-metalated complex of a metal atom selected from iridium (Ir), osmium (Os) and platinum (Pt).

[0026] The organic EL device according to a further aspect of the invention includes: a cathode; an anode; and a plurality of organic thin-film layers provided between the cathode and the anode, and the organic thin-film layer includes an emitting layer, in which at least one of the organic thin-film layers is the emitting layer including a first host material, a second host material and a phosphorescent material providing phosphorescence, the first host material being a compound represented by a formula (5A) or (5B) below.

[Chemical Formula 4]



• • • (5A)



• • • (5B)

[0027] In the formulae (5A) and (5B): A_1 represents a substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;
A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;
X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;
Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;
adjacent ones of Y_1 to Y_4 may be bonded to each other to form a ring structure;
p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and.
when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 may be the same or different.

[0028] When Y_1 to Y_4 are bonded to each other to form a ring structure, the ring structure is exemplified by the same structures as ones listed when Y_1 to Y_4 are bonded to each other to form a ring structure in the formulae (1A) and (1B).

[0029] In the organic EL device according to the above aspect of the invention, the second host material is preferably represented by either one of a formula (6) or (7) below.

[0030] [Chemical Formula 5]

$$(Cz\text{-})_aA^3 \qquad (6)$$

$$Cz(\text{-}A^3)_b \qquad (7)$$

[0031] In the formulae (6) and (7): Cz represents a substituted or unsubstituted arylcarbazolyl group or carbazolylaryl group;
A^3 represents a group represented by a formula (8A) or (8B) below; and

a and b each represent an integer of 1 to 3.

[0032] [Chemical Formula 6]

$$(M^1)_c\text{-}(L^5)_d\text{-}(M^2)_e \qquad (8A)$$

[0033] In the formula (8A): M^1 and M^2 each independently represent a substituted or unsubstituted nitrogen-containing aromatic heterocyclic ring or nitrogen-containing fused aromatic heterocyclic ring having 2 to 40 ring carbon atoms; M^1 and M^2 may be the same or different;

[0034] L^5 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 carbon atoms;

c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0035] [Chemical Formula 7]

$$(M^3)_c\text{-}(L^6)_d\text{-}(M^4)_e \qquad (8B)$$

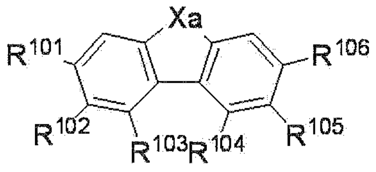
[0036] In the formula (8B): M^3 and M^4 each independently represent a substituted or unsubstituted aromatic hydrocarbon group having 6 to 40 ring carbon atoms; M^3 and M^4 may to be the same or different;

L^6 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, or substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms;

c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0037] In the organic EL device according to the above aspect of the invention, the second host material is preferably represented by a formula (9) below.

[Chemical Formula 8]



...(9)

[0038] In the formula (9): R^{101} to R^{106} each independently represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryl group having 10 to 18 carbon atoms, substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms or cyano group;

at least one of R^{101} to R^{106} is a substituted or unsubstituted 9-carbazolyl group, substituted or unsubstituted azacarbazolyl group having 2 to 5 nitrogen atoms, or -L-9-carbazolyl group;

L represents a substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, or substituted or unsubstituted halogenated

alkyl group having 1 to 40 carbon atoms;
Xa represents a sulfur atom, oxygen atom or N-R^{108}; and
R^{108} represents the same as R^{101} to R^{106}.

[0039] In the organic EL device according to the above aspect of the invention, the second host material is preferably a compound selected from the group consisting of polycyclic aromatic compounds represented by formulae (10A), (10B) and (10C) below.

$$\text{Ra-Ar}^{101}\text{-Rb} \qquad (10A)$$

$$\text{Ra-Ar}^{101}\text{-Ar}^{102}\text{-Rb} \qquad (10B)$$

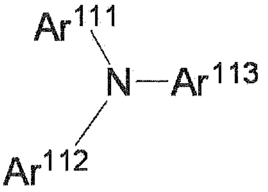
$$\text{Ra-Ar}^{101}\text{-Ar}^{102}\text{-Ar}^{103}\text{-Rb} \qquad (10C)$$

[0040] In formulae (10A) to (10C), Ar^{101}, Ar^{102}, Ar^{103}, Ra and Rb represent a polycyclic aromatic skeleton having 6 to 60 ring carbon atoms selected from a substituted or unsubstituted benzene ring, substituted or unsubstituted naphthalene ring, substituted or unsubstituted chrysene ring, substituted or unsubstituted fluoranthene ring, substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzophenanthrene ring, substituted or unsubstituted dibenzophenanthrene ring, substituted or unsubstituted triphenylene ring, substituted or unsubstituted benzo[a]triphenylene ring, substituted or unsubstituted benzochrysene ring, substituted or unsubstituted benzo[b]fluoranthene ring, substituted or unsubstituted fluorene ring and substituted or unsubstituted picene ring.

[0041] Moreover, in the organic EL device according to the above aspect of the invention, in the formulae (10A) to (10C), either one or both of Ra and Rb are preferably selected from the group consisting of a substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzo[c]phenanthrene ring and substituted or unsubstituted fluoranthene ring.

[0042] In the organic EL device according to the above aspect of the invention, the second host material is preferably a monoamine derivative represented by any one of formulae (11) to (13) below.

[Chemical Formula 9]

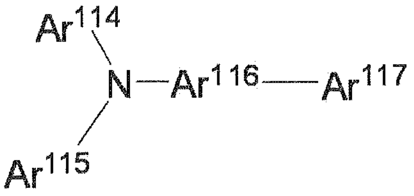


$$N(Ar^{111})(Ar^{112})-Ar^{113}$$

•••(11)

[0043] Ar^{111}, Ar^{112} and Ar^{113} are a substituted or unsubstituted aryl group or heteroaryl group.

[Chemical Formula 10]



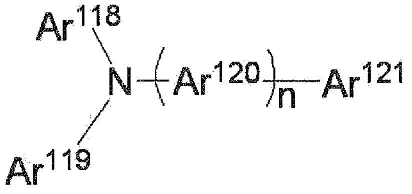
$$N(Ar^{114})(Ar^{115})-Ar^{116}-Ar^{117}$$

•••(12)

[0044] Ar^{111}, Ar^{112} and Ar^{113} are a substituted or unsubstituted aryl group or heteroaryl group.

[0045] Ar^{116} is a substituted or unsubstituted arylene group or heteroarylene group.

[Chemical Formula 11]



$\mathrm{N}(\mathrm{Ar}^{118})(\mathrm{Ar}^{119})\text{-}(\mathrm{Ar}^{120})_n\text{-}\mathrm{Ar}^{121}$ ···(13)

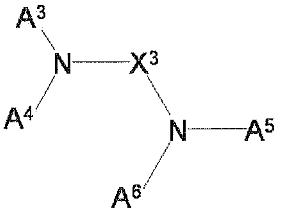
[0046] Ar^{118} Ar^{119} and Ar^{121} are a substituted or unsubstituted aryl group or heteroaryl group.

[0047] Ar^{120} is a substituted or unsubstituted arylene group or heteroarylene group.

[0048] n is an integer of 2 to 5: when n is 2 or more, Ar^{120} may be the same or different.

[0049] In the organic EL device according to the above aspect of the invention, the second host material is preferably represented by a formula (14) or (15) below.

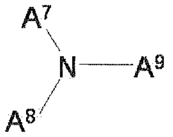
[Chemical Formula 12]



···(14)

[0050] In the formula (14): X^3 represents a substituted or unsubstituted arylene group having 10 to 40 ring carbon atoms; and A^3 to A^6 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 atoms forming a ring (hereinafter referred to as "ring atoms").

[Chemical Formula 13]

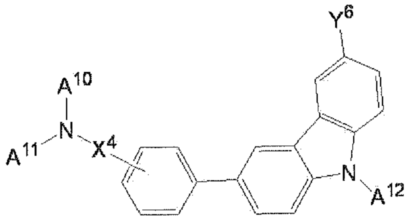


$\mathrm{N}(\mathrm{A}^{7})(\mathrm{A}^{8})\text{-}\mathrm{A}^{9}$ ···(15)

[0051] In the formula (15): A^7 to A^9 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 ring atoms.

[0052] In the organic EL device according to the above aspect of the invention, the second host material is more preferably represented by any one of formulae (16) to (20) below.

[Chemical Formula 14]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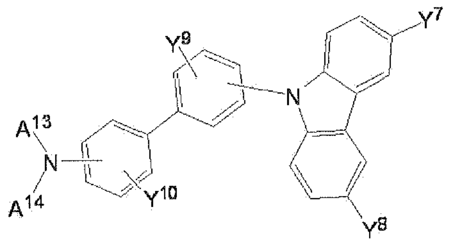
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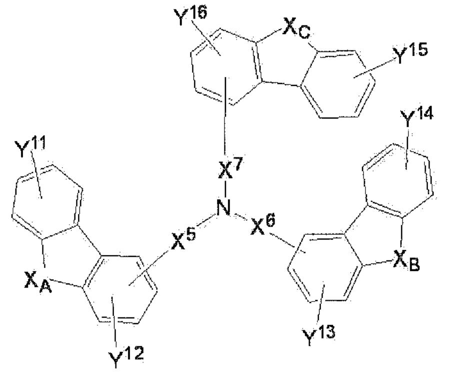
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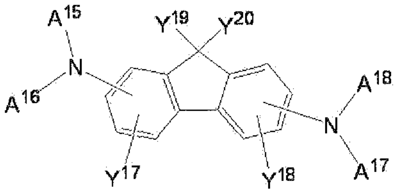
[Chemical Formula 15]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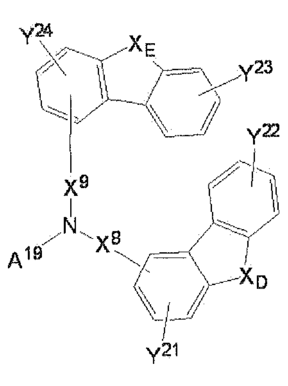

···(20)

[0053] In the formulae (16) to (20), A^{10} to A^{19} each represent a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 40 carbon atoms, substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic amino group, or substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic heterocyclic group;

A^{10}, A^{13}, A^{15} and A^{17} are adapted to be respectively bonded to A^{11}, A^{14}, A^{16} and A^{18} to form a ring;
X^4 to X^9 represent a single bond or a linking group having 1 to 30 carbon atoms;
Y^6 to Y^{24} represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted alkenyl group having 2 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted alkylsilyl group having 3 to 20 carbon atoms, substituted or unsubstituted arylsilyl group having 8 to 40 carbon atoms, substituted or unsubstituted aralkylsilyl group having 8 to 40 carbon atoms, or substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms; and
X_A, X_B, X_C, X_D, X_E each represent a sulfur atom, an oxygen atom or a monoaryl-substituted nitrogen atom.

[0054] In the organic EL device according to the above aspect of the invention, it is preferable that the emitting layer includes a host material and a phosphorescent material, the phosphorescent material being an ortho-metalated complex of a metal atom selected from iridium (Ir), osmium (Os) and platinum (Pt).

[0055] In the organic EL device according to the above aspect of the invention, it is preferable that an electron injecting layer is provided between the cathode and the emitting layer and includes a nitrogen-containing cyclic derivative.

[0056] In the organic EL device according to the above aspect of the invention, it is preferable that an electron transporting layer is provided between the cathode and the emitting layer and includes the above-described organic-EL-device material.

[0057] In the organic EL device according to the invention, a reduction-causing dopant may be preferably present at an interfacial region between the cathode and the organic thin-film layer.

[0058] According to the above aspect of the invention, since the biscarbazole derivative is used as the organic-EL-device material, a long-life organic electroluminescence device can be provided. Moreover, the organic-EL-device material is effective as an organic-electron-device material for an organic solar cell, an organic semiconductor laser, a sensor using an organic substance and an organic TFT.

BRIEF DESCRIPTION OF DRAWINGS

[0059] Fig. 1 schematically shows an exemplary arrangement of an organic electroluminescence device according to an exemplary embodiment of the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0060] The present invention will be described below in detail.

First Exemplary Embodiment

Arrangement of Organic EL Device

[0061] First of all, arrangement(s) of an organic EL device will be described below.

[0062] The followings are representative arrangement examples of an organic EL device:

(1) anode / emitting layer / cathode;
(2) anode / hole injecting layer / emitting layer / cathode;
(3) anode / emitting layer / electron injecting-transporting layer / cathode;
(4) anode / hole injecting layer / emitting layer / electron injecting-transporting layer / cathode;
(5) anode / organic semiconductor layer / emitting layer / cathode;
(6) anode / organic semiconductor layer / electron blocking layer / emitting layer / cathode;
(7) anode / organic semiconductor layer / emitting layer / adhesion improving layer / cathode;
(8) anode / hole injecting-transporting layer / emitting layer / electron injecting-transporting layer / cathode;
(9) anode / insulating layer / emitting layer / insulating layer / cathode;
(10) anode / inorganic semiconductor layer / insulating layer / emitting layer / insulating layer / cathode;
(11) anode / organic semiconductor layer / insulating layer / emitting layer / insulating layer / cathode;
(12) anode / insulating layer / hole injecting-transporting layer / emitting layer / insulating layer / cathode; and
(13) anode / insulating layer / hole injecting-transporting layer / emitting layer / electron injecting-transporting layer / cathode.

[0063] The arrangement (8) is suitably used among the above, but the arrangement of the invention is not limited to the above arrangements.

[0064] Fig. 1 schematically shows an exemplary arrangement of an organic EL device according to a first exemplary embodiment of the invention.

[0065] The organic EL device 1 includes a transparent substrate 2, an anode 3, a cathode 4 and an organic thin-film layer 10 positioned between the anode 3 and the cathode 4.

[0066] The organic thin-film layer 10 includes a phosphorescent-emitting layer 5 containing a phosphorescent host (a host material) and a phosphorescent dopant (a phosphorescent material). A layer such as a hole injecting/transporting layer 6 may be provided between the phosphorescent-emitting layer 5 and the anode 3 while a layer such as an electron injecting/transporting layer 7 may be provided between the phosphorescent-emitting layer 5 and the cathode 4.

[0067] In addition, an electron blocking layer may be provided to the phosphorescent-emitting layer 5 adjacent to the anode 3 while a hole blocking layer may be provided to the phosphorescent-emitting layer 5 adjacent to the cathode 4.

[0068] With this arrangement, electrons and holes can be trapped in the phosphorescent-emitting layer 5, thereby enhancing probability of exciton generation in the phosphorescent-emitting layer 5.

[0069] It should be noted that a "fluorescent host" and a "phosphorescent host" herein respectively mean a host combined with a fluorescent dopant and a host combined with a phosphorescent dopant, and that a distinction between the fluorescent host and phosphorescent host is not unambiguously derived only from a molecular structure of the host in a limited manner.

[0070] In other words, the fluorescent host herein means a material for forming a fluorescent-emitting layer containing a fluorescent dopant, and does not mean a host that is only usable as a host of a fluorescent material.

[0071] Likewise, the phosphorescent host herein means a material for forming a phosphorescent-emitting layer containing a phosphorescent dopant, and does not mean a host that is only usable as a host of a phosphorescent material.

[0072] It should be noted that the "hole injecting/transporting layer" herein means "at least either one of a hole injecting layer and a hole transporting layer" while the "electron injecting/transporting layer" herein means "at least either one of an electron injecting layer and an electron transporting layer."

Transparent Substrate

[0073] The organic EL device according to this exemplary embodiment is formed on a light-transmissive substrate. The light-transmissive plate, which supports the organic EL device, is preferably a smoothly-shaped substrate that transmits 50% or more of light in a visible region of 400 nm to 700 nm.

[0074] Specifically, a glass plate, a polymer plate, and the like are preferable.

[0075] For the glass plate, materials such as soda-lime glass, barium/strontium-containing glass, lead glass, aluminosilicate glass, borosilicate glass, barium borosilicate glass and quartz can be used.

[0076] For the polymer plate, materials such as polycarbonate, acryl, polyethylene terephthalate, polyether sulfide and polysulfone can be used.

Anode and Cathode

[0077] The anode of the organic EL device is used for injecting holes into the hole injecting layer, the hole transporting layer or the emitting layer. It is effective that the anode has a work function of 4.5 eV or more.

[0078] Exemplary materials for the anode are alloys of indium-tin oxide (ITO), tin oxide (NESA), indium zinc oxide, gold, silver, platinum and copper.

[0079] The anode may be made by forming a thin film from these electrode materials through methods such as vapor deposition and sputtering.

[0080] When light from the emitting layer is to be emitted through the anode as in this embodiment, the anode preferably transmits more than 10% of the light in the visible region. Sheet resistance of the anode is preferably several hundreds Ω/ square or lower. Although depending on the material of the anode, thickness of the anode is typically in a range of 10 nm to 1 μm, and preferably in a range of 10 to 200 nm.

[0081] The cathode is preferably formed of a material with smaller work function in order to inject electrons into the electron injecting layer, the electron transporting layer and the emitting layer.

[0082] Although a material for the cathode is subject to no specific limitation, examples of the material are indium, aluminum, magnesium, alloy of magnesium and indium, alloy of magnesium and aluminum, alloy of aluminum and lithium, alloy of aluminum, scandium and lithium, alloy of magnesium and silver and the like.

[0083] Like the anode, the cathode may be made by forming a thin film from the above materials through a method such as vapor deposition or sputtering. In addition, the light may be emitted through the cathode.

Emitting Layer

[0084] The emitting layer of the organic EL device is an organic thin-film layer having a function for providing conditions for recombination of the electrons and the holes to emit light.

[0085] Injectability of the holes may differ from that of the electrons and transporting capabilities of the hole and the electrons (represented by mobilities of the holes and the electrons) may differ from each other.

[0086] As a method of forming the emitting layer, known methods such as vapor deposition, spin coating and an LB method may be employed.

[0087] The emitting layer is preferably a molecular deposit film.

[0088] The molecular deposit film means a thin film formed by depositing a material compound in gas phase or a film formed by solidifying a material compound in a solution state or in liquid phase. The molecular deposit film is typically distinguished from a thin film formed by the LB method (molecular accumulation film) by differences in aggregation structures, higher order structures and functional differences arising therefrom.

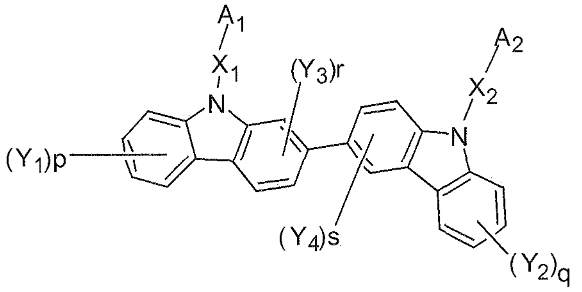
[0089] As disclosed in JP-A-57-51781, the emitting layer can be formed from a thin film formed by spin coating or the like, the thin film being formed from a solution prepared by dissolving a binder (e.g. a resin) and a material compound in a solvent.

[0090] An organic EL device according to this exemplary embodiment includes: a cathode; an anode; and a single or a plurality of organic thin-film layers provided between the cathode and the anode, in which the organic thin-film layer(s) includes at least one emitting layer, and at least one of the organic thin-film layers includes at least one phosphorescent material and, as an organic-EL-device material, at least one biscarbazole derivative according to this exemplary embodiment (described later). It is also preferable that at least one emitting layer includes the biscarbazole derivative according to this exemplary embodiment as the organic-EL-device material and at least one phosphorescent material.

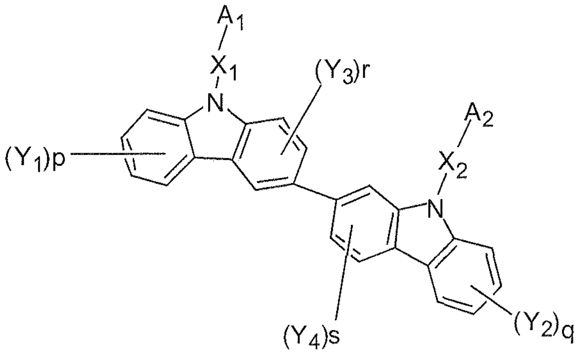
Biscarbazole Derivative

[0091] The biscarbazole derivative according to this exemplary embodiment is represented by a formula (1A) or (1B) below.

[Chemical Formula 16]



... (1A)



... (1B)

[0092] In the formula (1A) or (1B): A_1 represents a substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

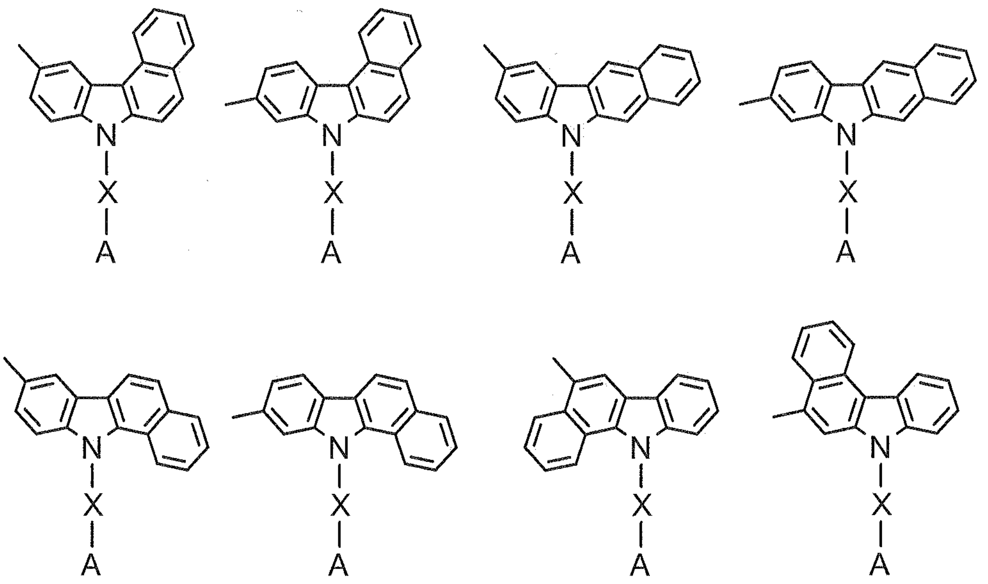
adjacent ones of Y_1 to Y_4 may be bonded to each other to form a ring structure;

p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and

when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 may be the same or different.

[0093] When Y_1 to Y_4 are bonded to each other to form a ring structure, the ring structure is exemplified by structures represented by the following formulae.

[Chemical Formula 17]



[0094] Moreover, A_1 in the formula (1A) or (1B) is preferably selected from the group consisting of a substituted or unsubstituted pyridine ring, substituted or unsubstituted pyrimidine ring and substituted or unsubstituted triazine ring, more preferably selected from a substituted or unsubstituted pyrimidine ring or substituted or unsubstituted triazine ring.

[0095] In the formula (1A) or (1B), A_1 is further preferably a substituted or unsubstituted pyrimidine ring.

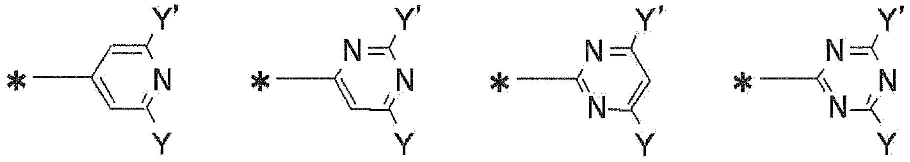
[0096] In the formula (1A) or (1B), A_1 is preferably a substituted or unsubstituted quinazoline ring.

[0097] In the formula (1A) or (1B), X_1 is preferably a single bond or substituted or unsubstituted divalent aromatic hydrocarbon group having 6 to 30 ring carbon atoms, particularly preferably a benzene ring.

[0098] In the formula (1A) or (1B), when X_1 is a substituted or unsubstituted benzene ring, A_1 and the carbazolyl group, which are bonded to X_1, are preferably in meta positions or para positions. Particularly preferably, X_1 is unsubstituted para-phenylene.

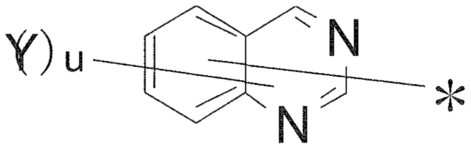
[0099] In the formula (1A) or (1B), the pyridine ring, pyrimidine ring and triazine ring are more preferably represented by the following formulae. In the formulae, Y and Y' represent a substituent. Examples of the substituent are the same groups as those represented by Y_1 to Y_4 as described above. Y and Y' may be the same or different. Preferred examples thereof are the substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, and the substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 ring carbon atoms. In the following formulae, * represents a bonding position to X_1 or X_2.

[Chemical Formula 18]



[0100] In the formula (1A) or (1B), the quinazoline ring is represented by the following formula. Y represents a substituent. u represents an integer of 1 to 5. When u is an integer of 2 to 5, a plurality of Y may be the same or different. As the substituent Y, the same groups as those for the above Y_1 to Y_4 are usable, among which preferred examples thereof are the substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, and the substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 ring carbon atoms. Also in the following formulae, * represents a bonding position to X_1 or X_2.

[Chemical Formula 19]



[0101] In the formulae (1A) to (1B), the alkyl group, alkoxy group, haloalkyl group, haloalkoxy group and alkylsilyl group, which are represented by Y_1 to Y_5, may be linear, branched or cyclic.

[0102] In the formulae (1A) to (2B), examples of the alkyl group having 1 to 20 carbon atoms are a methyl group, ethyl group, propyl group, isopropyl group, n-butyl group, s-butyl group, isobutyl group, t-butyl group, n-pentyl group, n-hexyl group, n-heptyl group, n-octyl group, n-nonyl group, n-decyl group, n-undecyl group, n-dodecyl group, n-tridecyl group, n-tetradecyl group, n-pentadecyl group, n-hexadecyl group, n-heptadecyl group, n-octadecyl group, neo-pentyl group, 1-methylpentyl group, 2-methylpentyl group, 1-pentylhexyl group, 1-butylpentyl group, 1-heptyloctyl group, 3-methylpentyl group, cyclopentyl group, cyclohexyl group, cycloheptyl group, cyclooctyl group and 3,5-tetramethylcyclohexyl group. An alkyl group having 1 to 10 carbon atoms is preferable, examples of which are a methyl group, ethyl group, propyl group, isopropyl group, n-butyl group, s-butyl group, isobutyl group, t-butyl group, cyclopentyl group, cyclohexyl group and cycloheptyl group.

[0103] As the alkoxy group having 1 to 20 carbon atoms, an alkoxy group having 1 to 6 carbon atoms is preferable and specific examples thereof are a methoxy group, ethoxy group, propoxy group, butoxy group, pentyloxy group, and hexyloxy group.

[0104] The haloalkyl group having 1 to 20 carbon atoms is exemplified by a haloalkyl group provided by substituting the alkyl group having 1 to 20 carbon atoms with one or more halogen atoms. Preferred one of the halogen atoms is fluorine. The haloalkyl group is exemplified by a trifluoromethyl group and a 2,2,2-trifluoroethyl group.

[0105] The haloalkoxy group having 1 to 20 carbon atoms is exemplified by a haloalkoxy group provided by substituting the alkoxy group having 1 to 20 carbon atoms with one or more halogen atoms. Preferred one of the halogen atoms is fluorine.

[0106] Examples of the alkylsilyl group having 1 to 10 carbon atoms are a trimethylsilyl group, triethylsilyl group, tributylsilyl group, dimethylethylsilyl group, dimethylisopropylsilyl group, dimethylpropylsilyl group, dimethylbutylsilyl group, dimethyl-tertiary-butylsilyl group and diethylisopropylsilyl group.

[0107] Examples of the arylsilyl group having 6 to 30 carbon atoms are a phenyldimethylsilyl group, diphenylmethylsilyl group, diphenyl-tertiary-butylsilyl group and triphenylsilyl group.

[0108] Examples of the aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 ring carbon atoms are a pyroryl group, pyrazinyl group, pyridinyl group, indolyl group, isoindolyl group, furyl group, benzofuranyl group, isobenzofuranyl group, dibenzofuranyl group, dibenzothiophenyl group, quinolyl group, isoquinolyl group, quinoxalinyl group, carbazolyl group, phenantridinyl group, acridinyl group, phenanthrolinyl group, thienyl group and a group formed from a pyridine ring, pyrazine ring, pyrimidine ring, pyridazine ring, triazine ring, indol ring, quinoline ring, acridine ring, pirrolidine ring, dioxane ring, piper idine ring, morpholine ring, piperadine ring, carbazole ring, furan ring, thiophene ring, oxazole ring, oxadiazole ring, benzooxazole ring, thiazole ring, thiadiazole ring, benzothiazole ring, triazole ring, imidazole ring, benzoimidazole ring, pyrane ring and dibenzofuran ring. Among the above, the aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 10 ring carbon atoms is preferable.

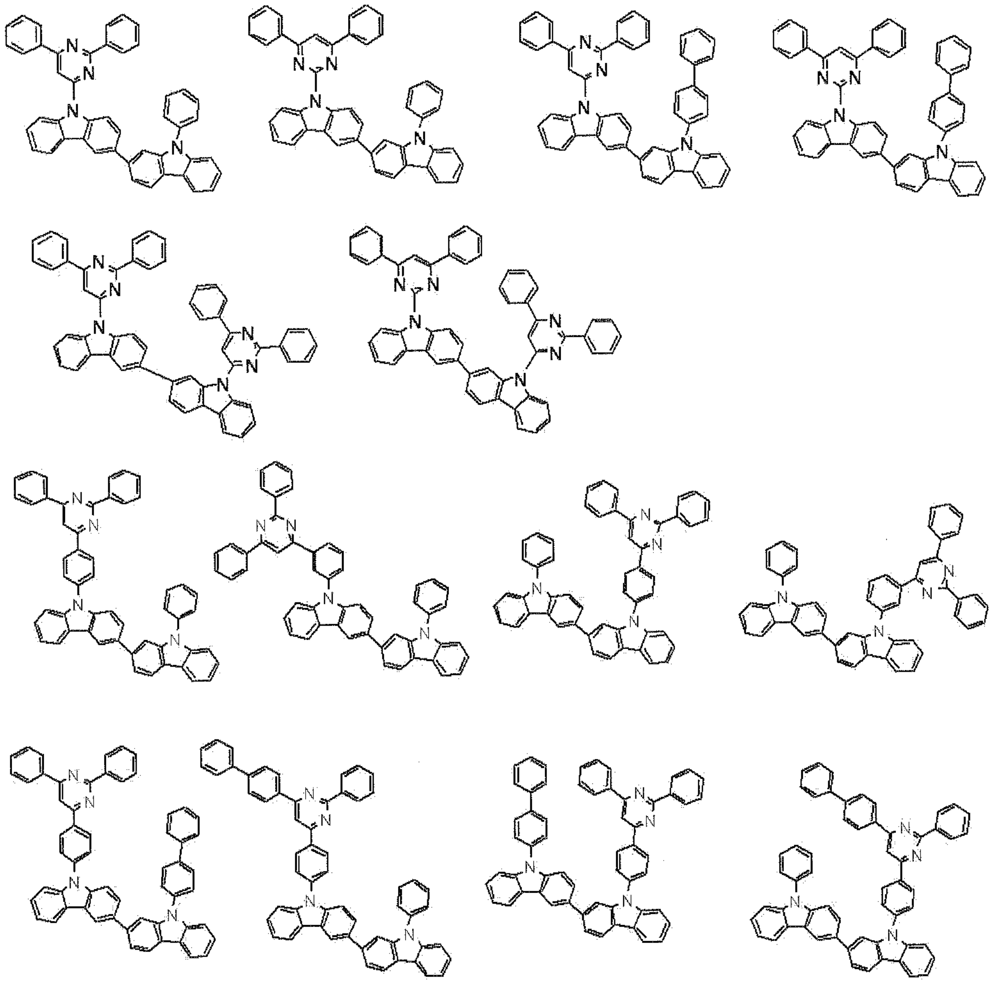
[0109] Examples of the aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms are a phenyl group, naphthyl group, phenanthryl group, biphenyl group, terphenyl group, quarterphenyl group, fluoranthenyl group, triphenylenyl group, phenanthrenyl group, pyrenyl group, chrysenyl group, fluorenyl group, and 9,9-dimethylfluorenyl group. Among the above, the aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 20 ring carbon atoms is preferable.

[0110] When A_1, A_2, X_1, X_2 and Y_1 to Y_5 in the formula (1A) or (1B) each have one or more substituents, the substituents are preferably a linear, branched or cyclic alkyl group having 1 to 20 carbon atoms; linear, branched or cyclic alkoxy group having 1 to 20 carbon atoms; linear, branched or cyclic haloalkyl group having 1 to 20 carbon atoms; linear, branched or cyclic alkylsilyl group having 1 to 10 carbon atoms; arylsilyl group having 6 to 30 ring carbon atoms; cyano group; halogen atom; aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms; or aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 ring carbon atoms.

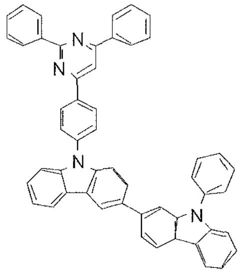
[0111] Examples of the linear, branched or cyclic alkyl group having 1 to 20 carbon atoms; linear, branched or cyclic alkoxy group having 1 to 20 carbon atoms; linear, branched or cyclic haloalkyl group having 1 to 20 carbon atoms; linear, branched or cyclic alkylsilyl group having 1 to 10 carbon atoms; arylsilyl group having 6 to 30 ring carbon atoms; aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms; and aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 ring carbon atoms are the above-described groups. The halogen atom is exemplified by a fluorine atom.

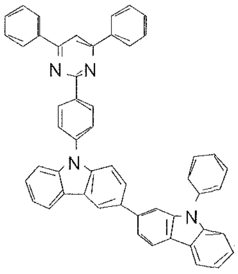
[0112] Examples of compounds for the biscarbazole derivative according to this exemplary embodiment represented by the formula (1A) or (1B) are as follows.

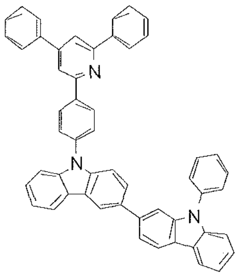
[Chemical Formula 20]

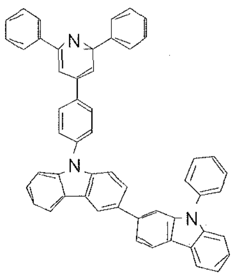


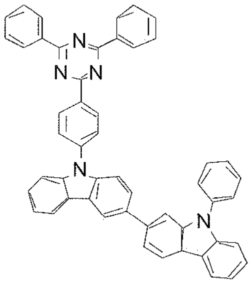
[Chemical Formula 21]

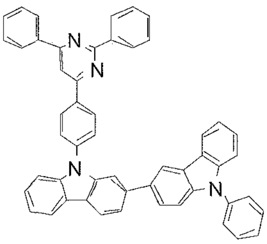


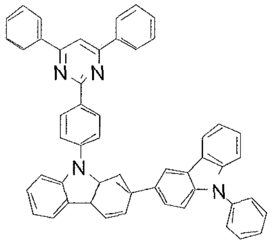


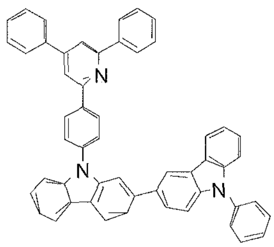


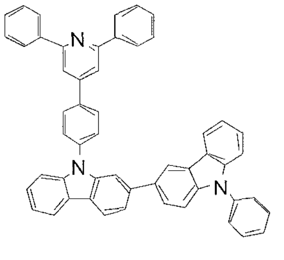


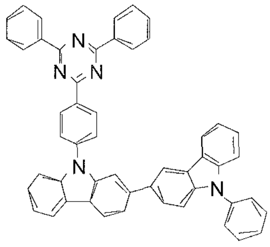




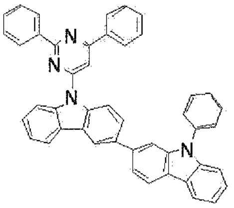


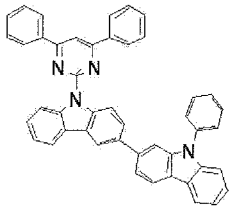


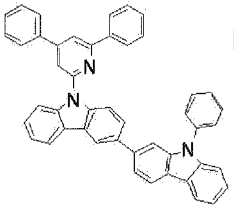


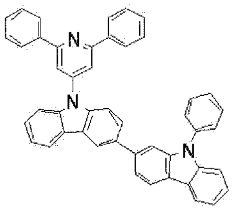


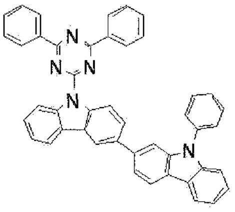
[Chemical Formula 22]

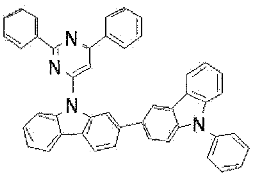


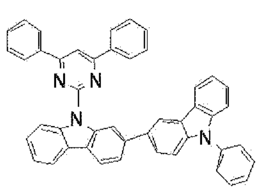


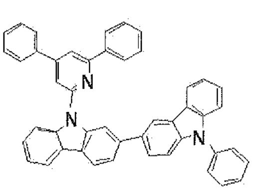


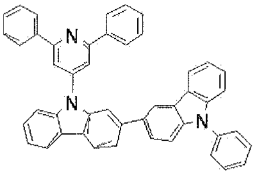


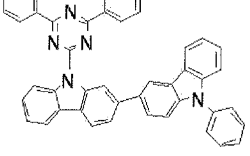




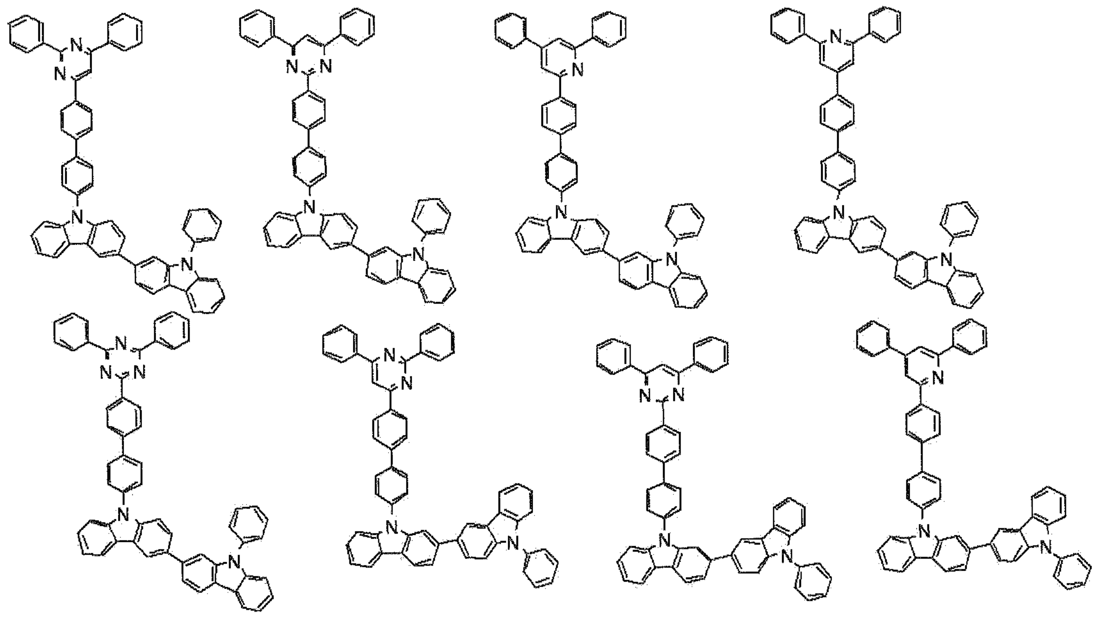




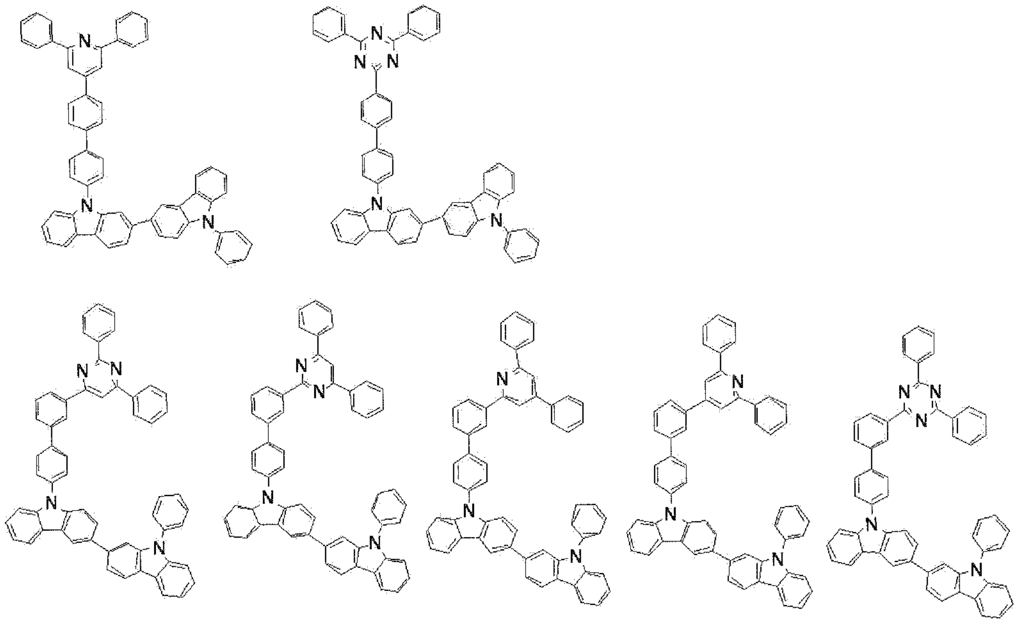




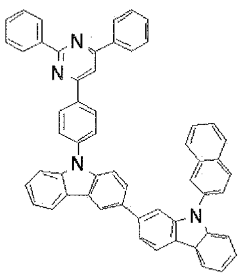
[Chemical Formula 23]

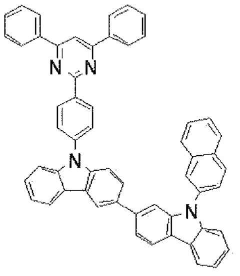


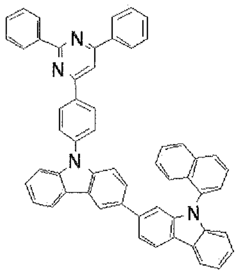
[Chemical Formula 24]

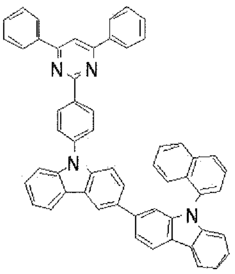


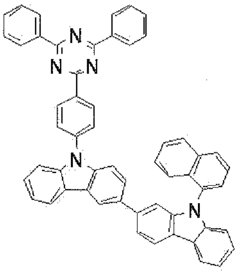
[Chemical Formula 25]

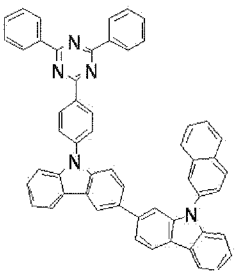




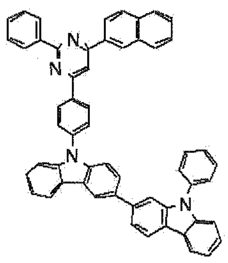


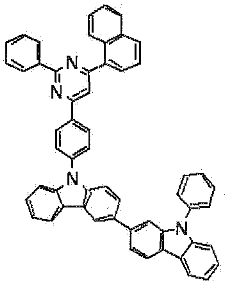


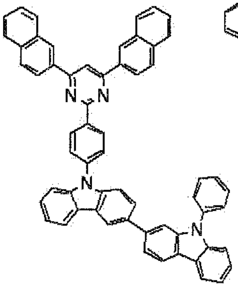


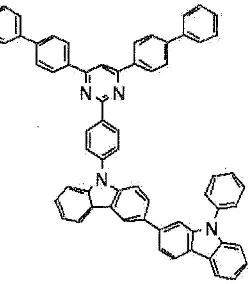


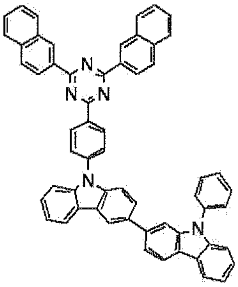
[Chemical Formula 26]

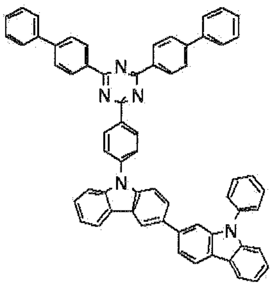


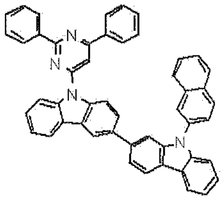


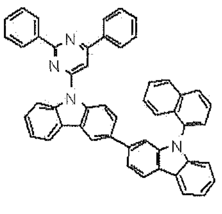


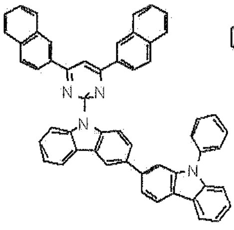


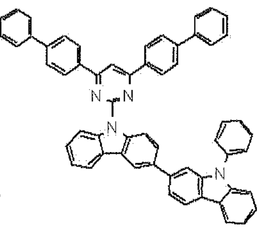




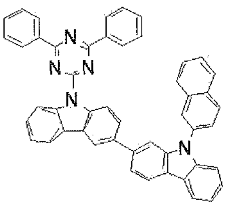
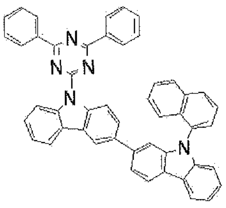
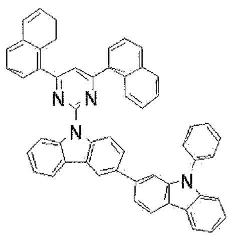
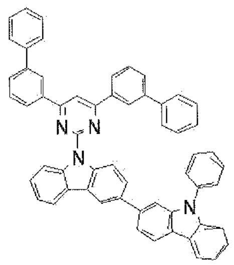


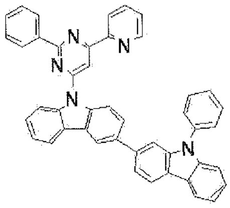
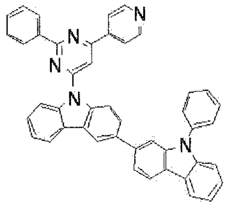
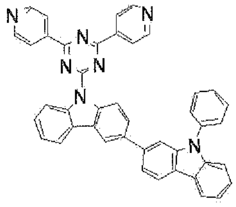
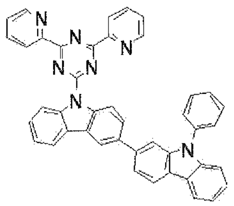




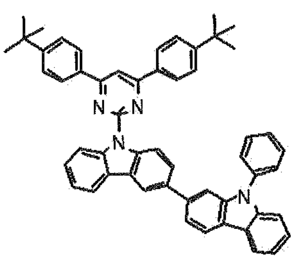
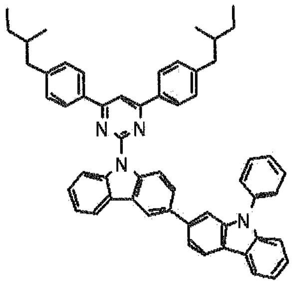
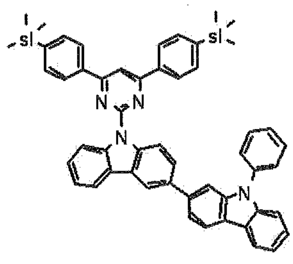


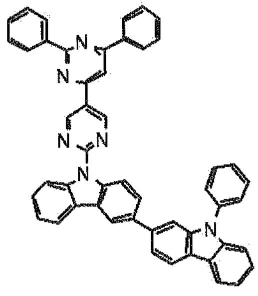
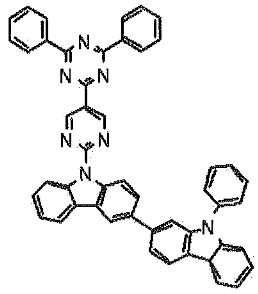
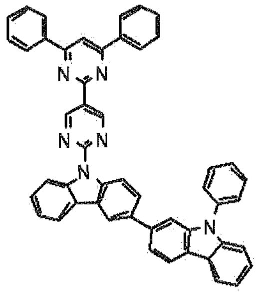
[Chemical Formula 27]

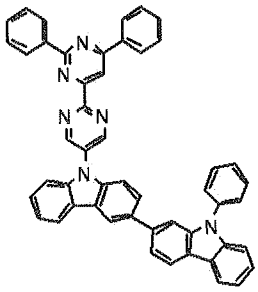
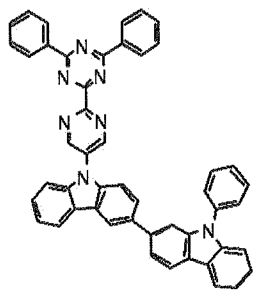
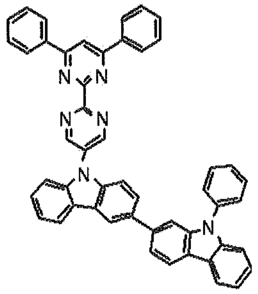





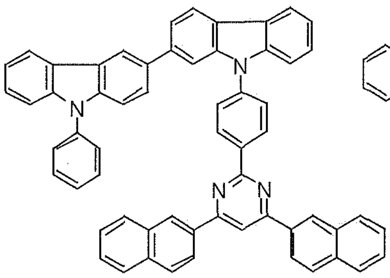
[Chemical Formula 28]

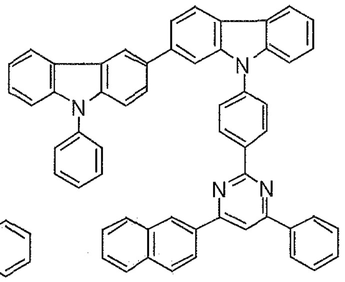




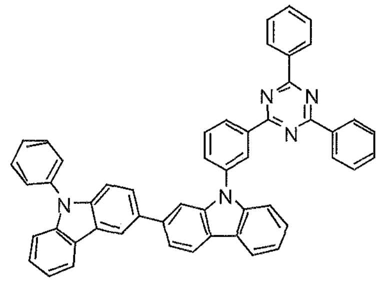




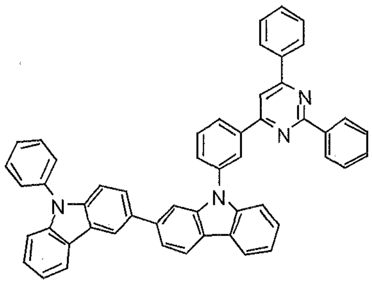




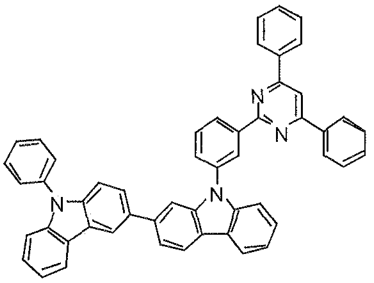
[Chemical Formula 29]

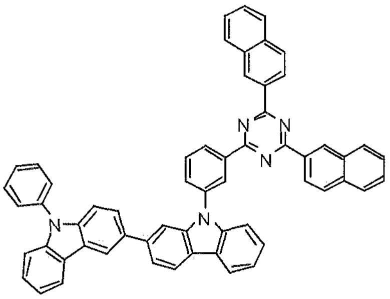


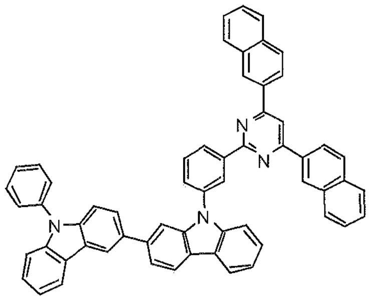




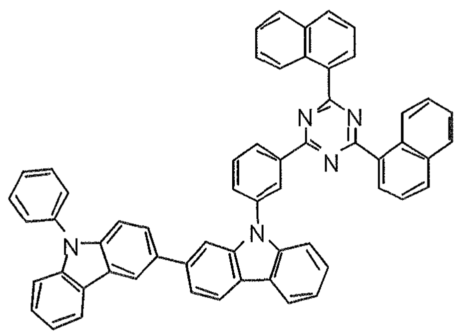


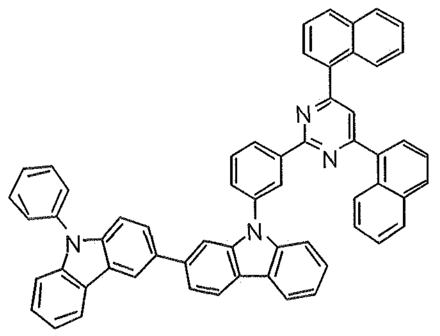


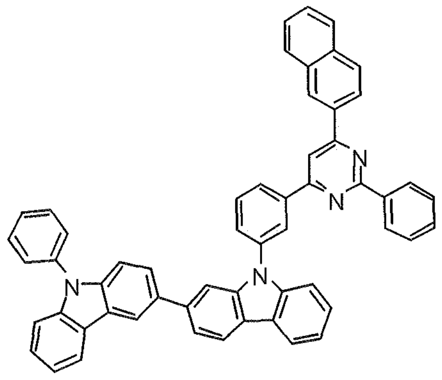


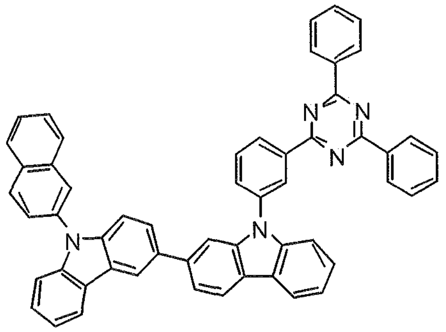


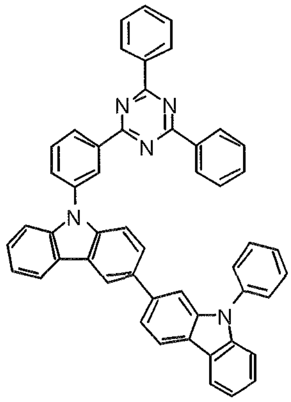
[Chemical Formula 30]

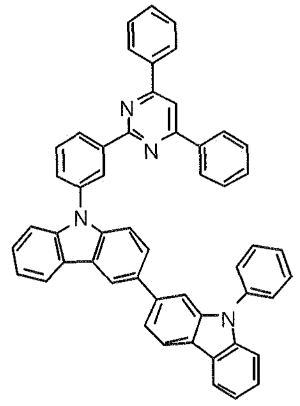


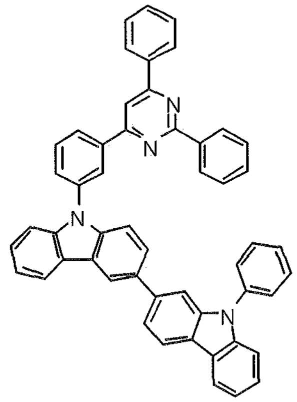




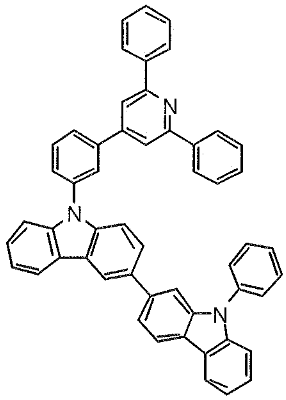


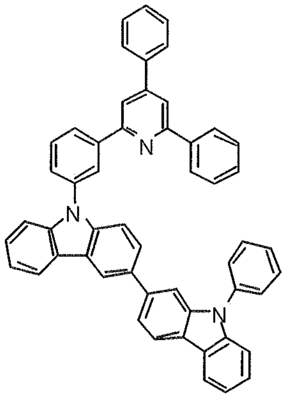


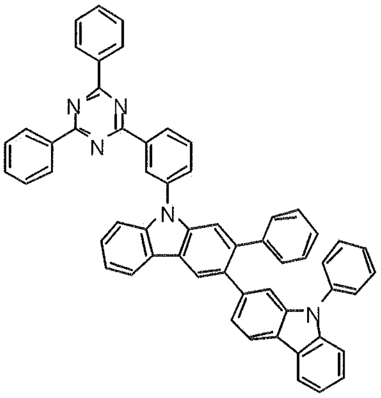


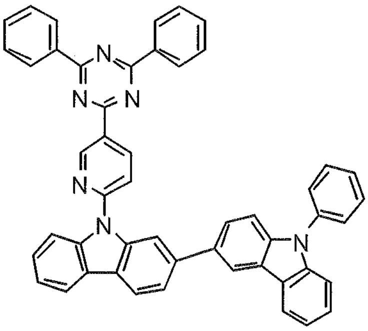


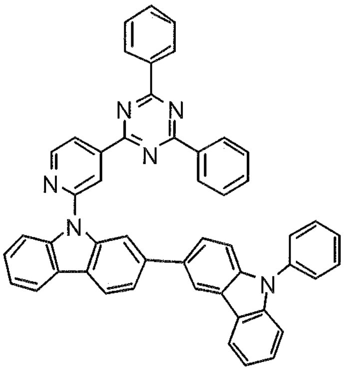
[Chemical Formula 31]



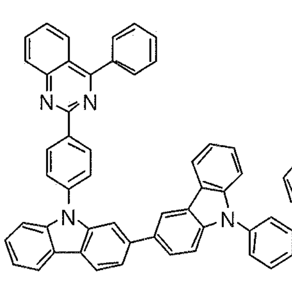


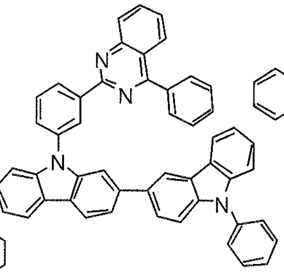


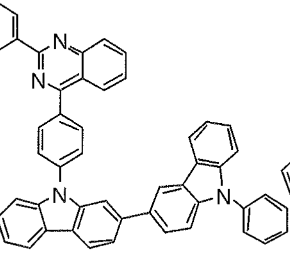


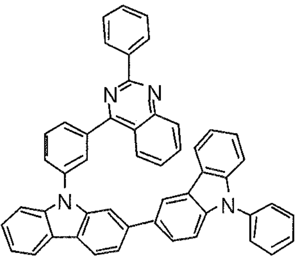


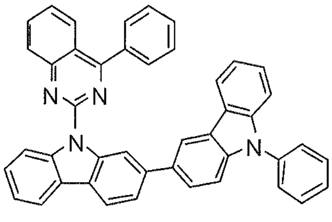
[Chemical Formula 32]

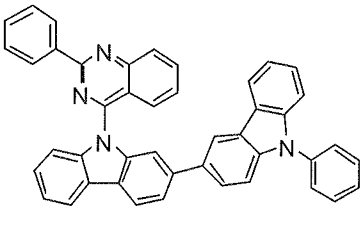




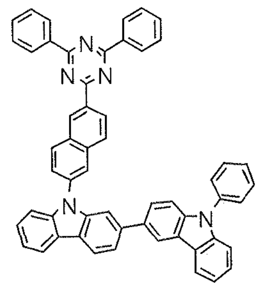
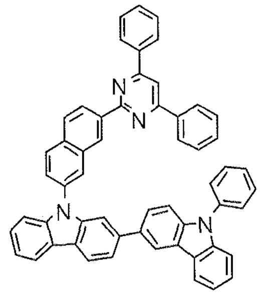
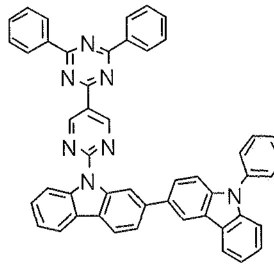
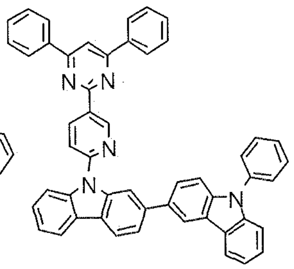
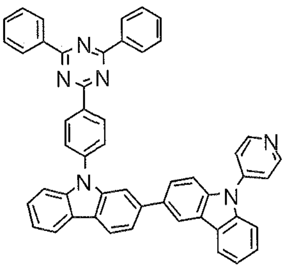
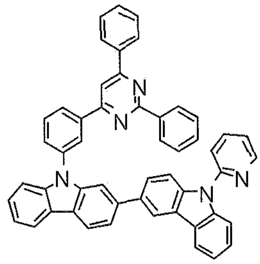
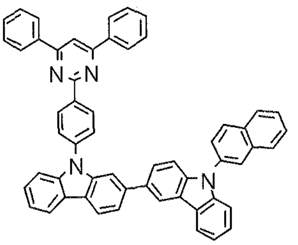
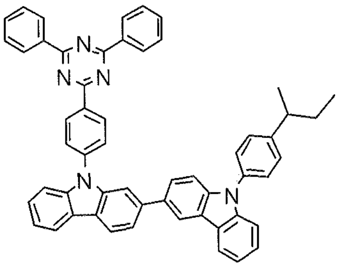
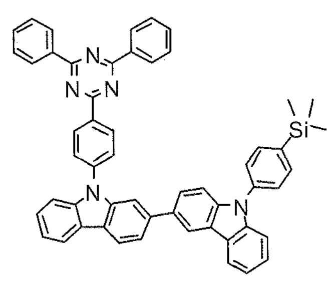
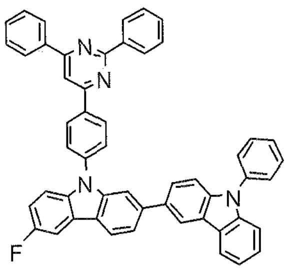
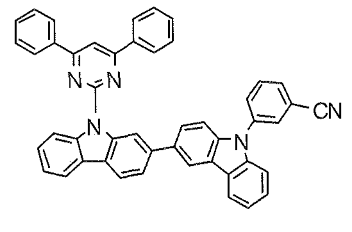
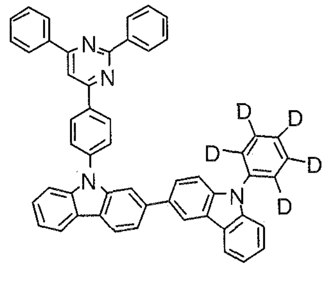
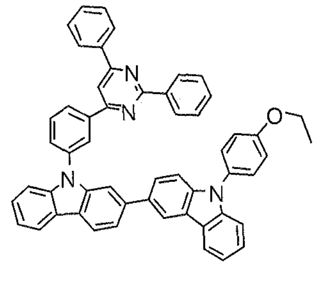
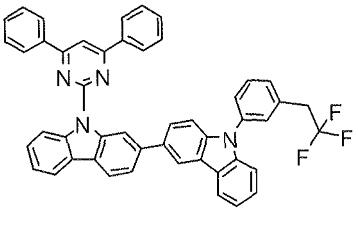
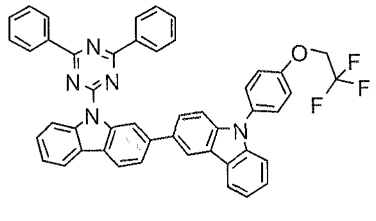
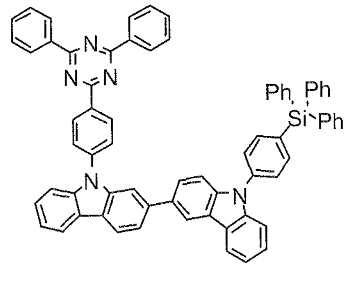




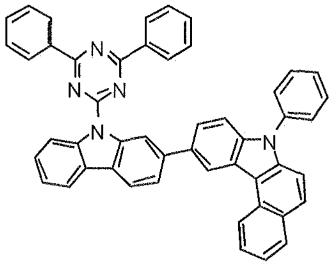


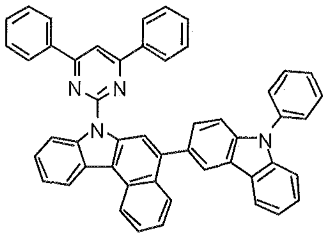


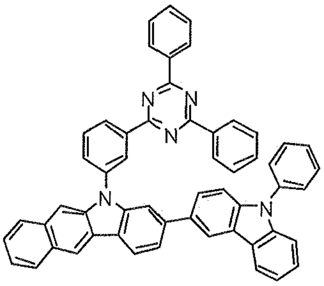
[Chemical Formula 33]

[Chemical Formula 34]







[0113] The biscarbazole derivative according to this exemplary embodiment represented by the formula (1A) or (1B) is a biscarbazole derivative in which carbazole skeletons are bonded to each other respectively at a second position and a third position. In general, a reaction active position of carbazole is a third position, not a second position. For this reason, synthesis of carbazole derivatives having a substituent at a second position is more difficult than synthesis of carbazole derivatives having a substituent at a third position, e.g., synthesis of a biscarbazole derivative in which carbazole skeletons are bonded to each other at their third positions. In this exemplary embodiment, these compounds are synthesized by a method described in Example described later.

[0114] The organic-EL-device material according to this exemplary embodiment includes the above biscarbazole derivative.

[0115] The organic-EL-device material according to this exemplary embodiment contains the biscarbazole derivative represented by the formula (1A) or (1B).

[0116] The organic EL device according to this exemplary embodiment includes a cathode, an anode, and an organic layer between the cathode and the anode, in which the organic layer includes a biscarbazole derivative of the formula (1A) or (1B).

[0117] In the organic EL device according to this exemplary embodiment, the emitting layer may preferably contain the organic-EL-device material according to this exemplary embodiment.

[0118] The organic EL device according to this exemplary embodiment may preferably contain the electron injecting / transporting layer that contains the organic-EL-device material according to this exemplary embodiment.

[0119] The organic EL device according to this exemplary embodiment may preferably contain at least one of the electron injecting / transporting layer and the hole blocking layer that contains the organic-EL-device material according to this exemplary embodiment.

[0120] The organic EL device according to this exemplary embodiment may preferably include the hole transporting layer (hole injecting layer) that contains the organic-EL-device material according to this exemplary embodiment.

[0121] The carbazole derivative represented by the formula (1A) or (B) according to this exemplary embodiment tends to have a smaller ionization potential (IP) than, for instance, a biscarbazole derivative in which carbazole skeletons are bonded to each other at their third positions. When the carbazole derivative according to this exemplary embodiment is used as an organic-EL-device material, the carbazole derivative is expected to have a higher hole injectivity.

[0122] Moreover, in the biscarbazole derivative, to change a bonding position between carbazoles means to change a conjugated system. For instance, when a biscarbazole derivative in which carbazole skeletons are bonded to each other at their third positions is changed to the carbazole derivative according to the exemplary embodiment of the invention in which carbazole skeletons are bonded to each other respectively at a second position and a third position, a conjugated system is cut off to increase a singlet energy gap (S1) and lower affinity (Af). Accordingly, it is expected that such a change of the bonding position from the third positions to the second and third positions enables control of electron injectability into the carbazole derivative.

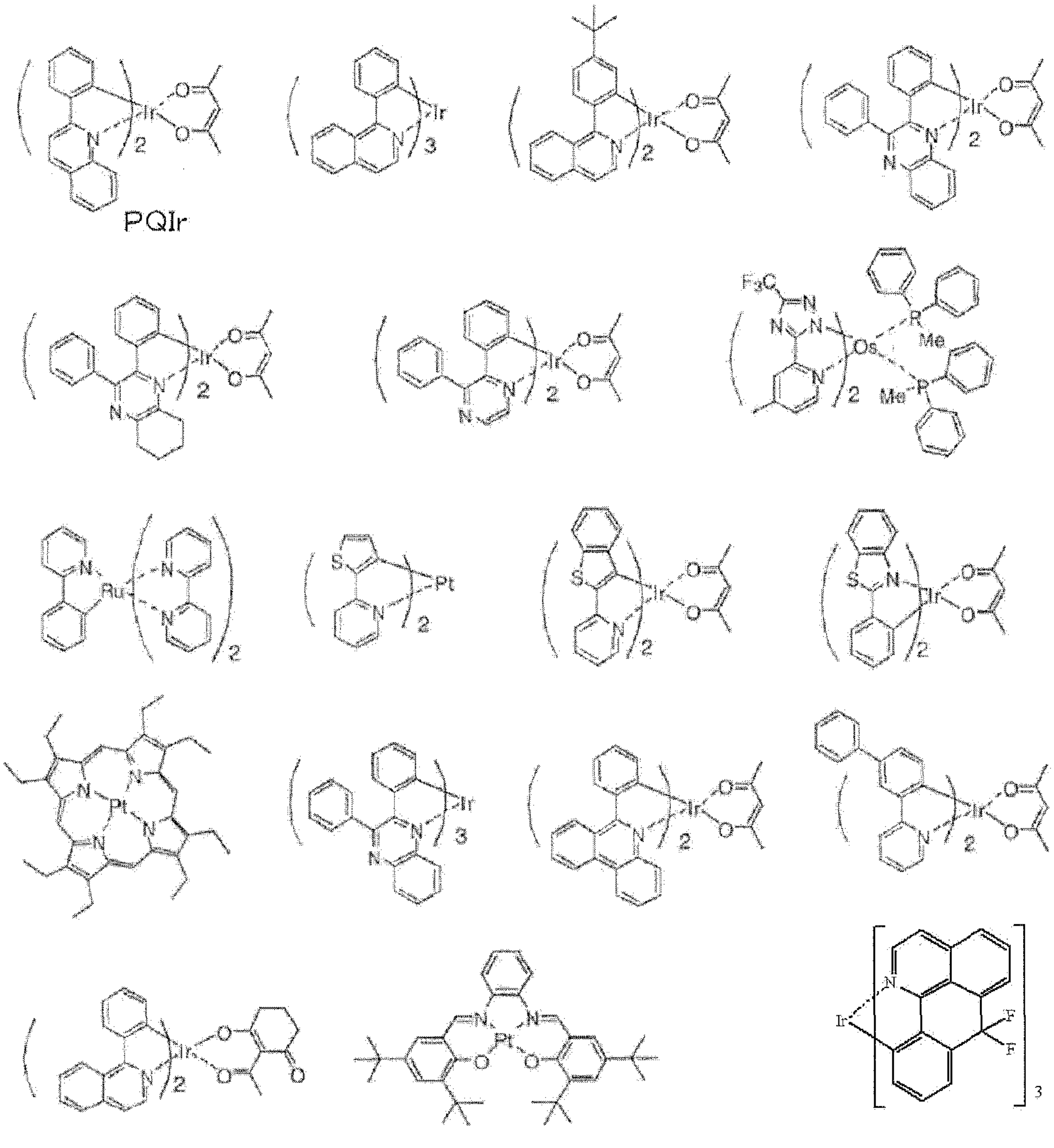
Phosphorescent Material

[0123] In the exemplary embodiment, the phosphorescent material preferably contains a metal complex, and the metal complex preferably has a metal atom selected from Ir, Pt, Os, Au, Cu, Re and Ru, and a ligand. Particularly, the ligand preferably has an ortho-metal bond.

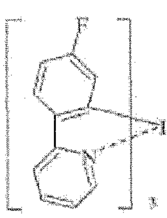
[0124] The phosphorescent material is preferably a compound containing a metal selected from iridium (Ir), osmium (Os) and platinum (Pt) because such a compound, which exhibits high phosphorescence quantum yield, can further enhance external quantum efficiency of the emitting device. The phosphorescent material is more preferably a metal complex such as an iridium complex, osmium complex or platinum complex, among which an iridium complex and platinum complex are more preferable and ortho metalation of an iridium complex is the most preferable.

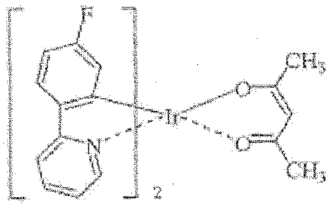
[0125] Examples of such a preferable metal complex are shown below.

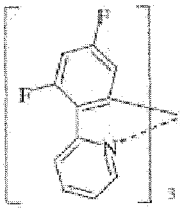
[Chemical Formula 35]

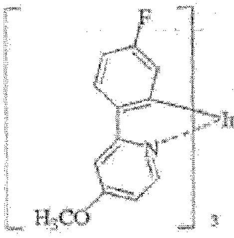


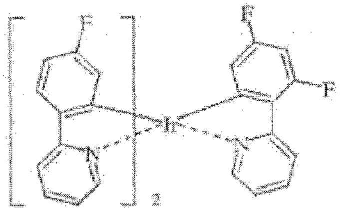
[Chemical Formula 36]

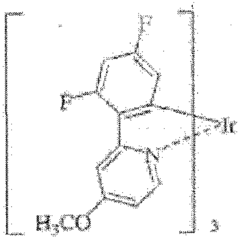


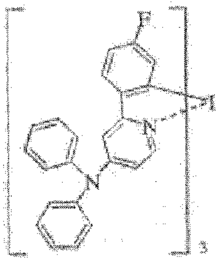


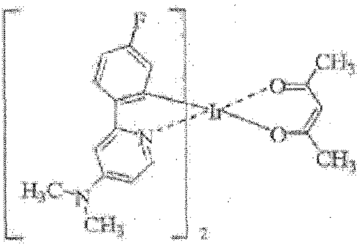


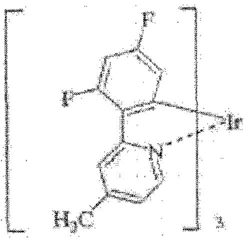


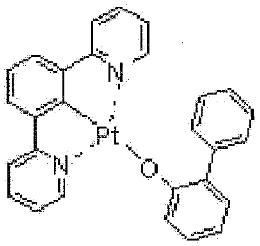


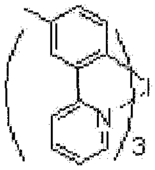


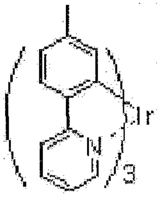


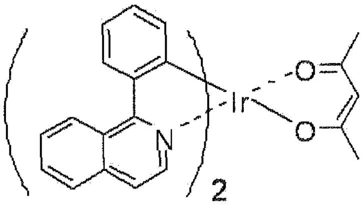


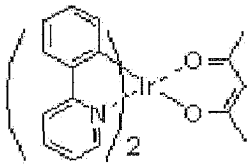


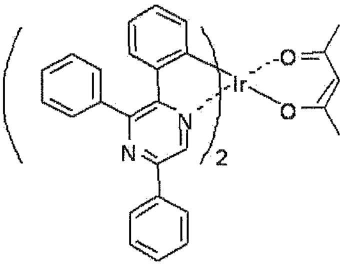




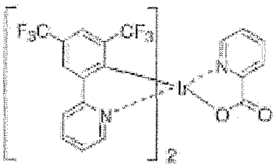


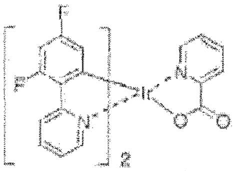


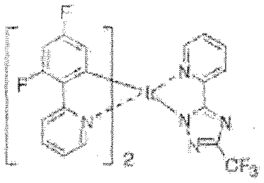


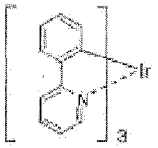


[Chemical Formula 37]

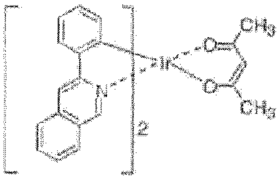


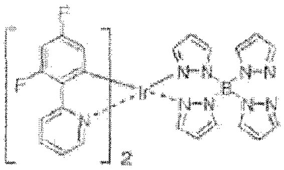


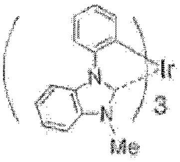


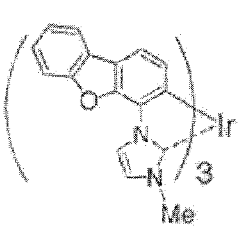


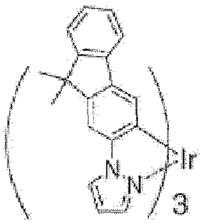
Ir(ppy)$_3$

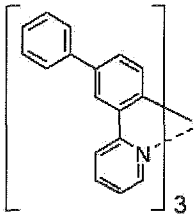


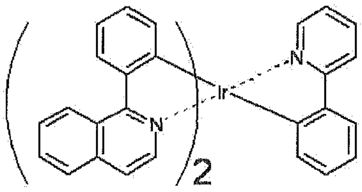


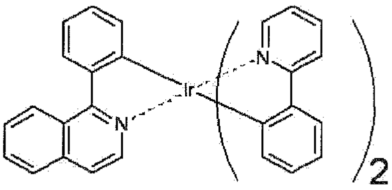












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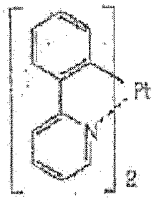
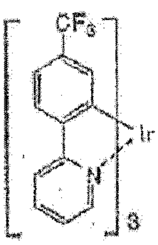
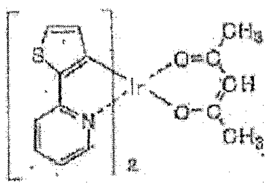
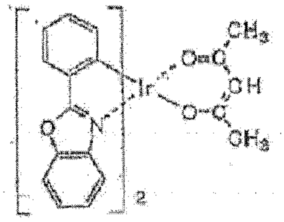
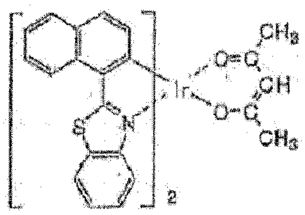
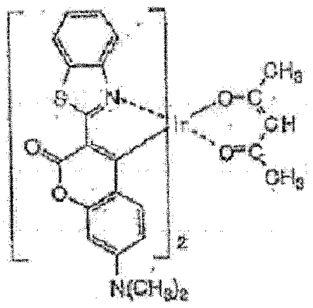


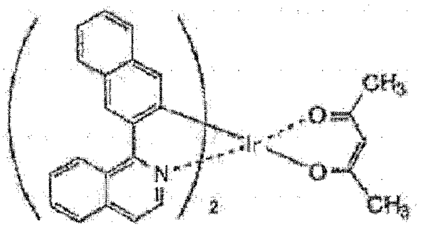


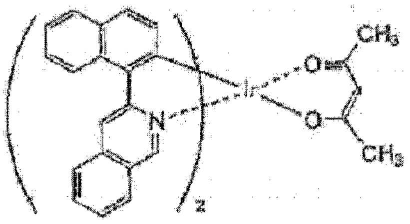


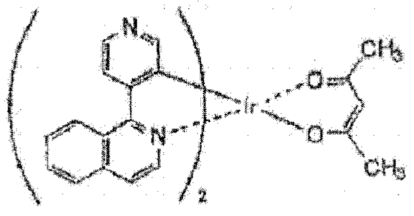


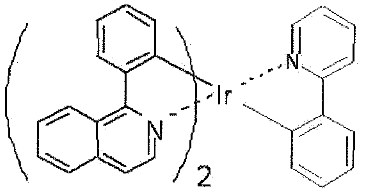


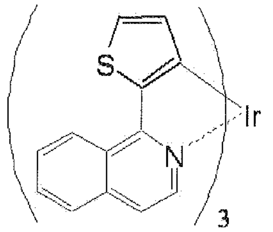












[0126] In the exemplary embodiment, at least one of the phosphorescent material contained in the emitting layer preferably emits light with the maximum wavelength of 450 nm to 720 nm.
By doping the phosphorescent material (phosphorescent dopant) having such an emission wavelength to the specific

host material used in this exemplary embodiment so as to form the emitting layer, the organic EL device can exhibit high efficiency.

Reduction-causing Dopant

[0127] In the organic EL device according to this exemplary embodiment, a reduction-causing dopant may be preferably contained in an interfacial region between the cathode and the organic thin-film layer.

[0128] With this arrangement, the organic EL device can emit light with enhanced luminance intensity and have a longer lifetime.

[0129] The reduction-causing dopant may be at least one compound selected from an alkali metal, alkali metal complex, alkali metal compound, alkali earth metal, alkali earth metal complex, alkali earth metal compound, rare-earth metal, rare-earth metal complex, rare-earth metal compound and the like.

[0130] Examples of the alkali metal are Na (work function: 2.36 eV), K (work function: 2.28 eV), Rb (work function: 2.16 eV), Cs (work function: 1.95 eV) and the like, among which a substance having a work function of 2.9 eV or less is particularly preferable. Among the above, the reduction-causing dopant is preferably K, Rb or Cs, more preferably Rb or Cs, the most preferably Cs.

[0131] Examples of the alkali earth metal are Ca (work function: 2.9 eV), Sr (work function: 2.0 to 2.5 eV), Ba (work function: 2.52 eV) and the like, among which a substance having a work function of 2.9 eV or less is particularly preferable.

[0132] Examples of the rare-earth metal are Sc, Y, Ce, Tb, Yb and the like, among which a substance having a work function of 2.9 eV or less is particularly preferable.

[0133] Since the above preferred metals have particularly high reducibility, addition of a relatively small amount of the metals to an electron injecting zone can enhance luminance intensity and lifetime of the organic EL device.

[0134] Examples of the alkali metal compound include an alkali oxide such as Li_2O, Cs_2O and K_2O, and an alkali halide such as LiF, NaF, CsF and KF, among which LiF, Li_2O, and NaF are preferable.

[0135] Examples of the alkali earth metal compound include BaO, SrO, CaO and their mixture such as $Ba_xSr_{1-x}O$ ($0<x<1$) and $Ba_xCa_{1-x}O$ ($0<x<1$). BaO, SrO, and CaO are preferable.

[0136] Examples of the rare earth metal compound include YbF_3, ScF_3, ScO_3, Y_2O_3, Ce_2O_3, GdF_3 and TbF_3. YbF_3, ScF_3, and TbF_3 are preferable.

[0137] The alkali metal complex, alkali earth metal complex and rare earth metal complex are not specifically limited as long as they contain at least one metal ion of an alkali metal ion, an alkali earth metal ion and a rare earth metal ion. A ligand for each of the complexes is preferably quinolinol, benzoquinolinol, acridinol, phenanthridinol, hydroxyphenyl oxazole, hydroxyphenyl thiazole, hydroxydiaryl oxadiazole, hydroxydiaryl thiadiazole, hydroxyphenyl pyridine, hydroxyphenyl benzoimidazole, hydroxybenzo triazole, hydroxy fluborane, bipyridyl, phenanthroline, phthalocyanine, porphyrin, cyclopentadiene, β-diketones, azomethines, or a derivative thereof, but the ligand is not limited thereto.

[0138] The reduction-causing dopant is added to preferably form a layer or an island pattern in the interfacial region. The layer of the reduction-causing dopant or the island pattern of the reduction-causing dopant is preferably formed by depositing the reduction-causing dopant by resistance heating deposition while an emitting material for forming the interfacial region or an organic substance as an electron-injecting material are simultaneously deposited, so that the reduction-causing dopant is dispersed in the organic substance. Dispersion concentration at which the reduction-causing dopant is dispersed in the organic substance is a mole ratio (organic substance to reduction-causing dopant) of 100:1 to 1:100, preferably 5:1 to 1:5.

[0139] When the reduction-causing dopant forms the layer, the emitting material or the electron injecting material for forming the organic layer of the interfacial region is initially layered, and the reduction-causing dopant is subsequently deposited singularly thereon by resistance heating deposition to form a preferably 0.1 nm- to 15 nm-thick layer.

[0140] When the reduction-causing dopant forms the island pattern, the emitting material or the electron injecting material for forming the organic layer of the interfacial region is initially formed in an island shape, and the reduction-causing dopant is subsequently deposited singularly thereon by resistance heating deposition to form a preferably 0.05 nm- to 1 nm-thick island shape.

[0141] A ratio of the main component to the reduction-causing dopant in the organic EL device according to this exemplary embodiment is preferably a mole ratio (main component to reduction-causing dopant) of 5:1 to 1:5, more preferably 2:1 to 1:2.

Electron Injecting Layer and Electron Transporting Layer

[0142] The electron injecting layer or the electron transporting layer, which aids injection of the electrons into the emitting layer, has a large electron mobility. The electron injecting layer is provided for adjusting energy level, by which, for instance, sudden changes of the energy level can be reduced.

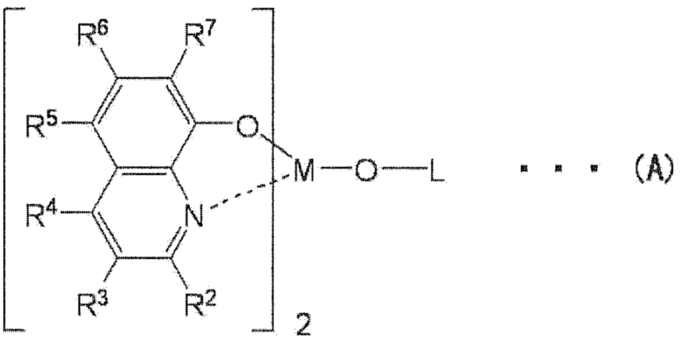
[0143] The organic EL device according to this exemplary embodiment preferably includes the electron injecting layer between the emitting layer and the cathode, and the electron injecting layer preferably contains a nitrogen-containing cyclic derivative as the main component. The electron injecting layer may serve as the electron transporting layer.

[0144] It should be noted that "as the main component" means that the nitrogen-containing cyclic derivative is contained in the electron injecting layer at a content of 50 mass% or more.

[0145] A preferable example of an electron transporting material for forming the electron injecting layer is an aromatic heterocyclic compound having in the molecule at least one heteroatom. Particularly, a nitrogen-containing cyclic derivative is preferable. The nitrogen-containing cyclic derivative is preferably an aromatic ring having a nitrogen-containing six-membered or five-membered ring skeleton, or a fused aromatic cyclic compound having a nitrogen-containing six-membered or five-membered ring skeleton.

[0146] The nitrogen-containing cyclic derivative is preferably exemplified by a nitrogen-containing cyclic metal chelate complex represented by the following formula (A).

[Chemical Formula 39]



[0147] R^2 to R^7 in the formula (A) each independently represent a hydrogen atom, a halogen atom, an oxy group, an amino group, a hydrocarbon group having 1 to 40 carbon atoms, an alkoxy group, an aryloxy group, an alkoxycarbonyl group, or an aromatic heterocyclic group. These groups may be substituted or unsubstituted.

[0148] Examples of the halogen atom include fluorine, chlorine, bromine, and iodine. In addition, examples of the substituted or unsubstituted amino group include an alkylamino group, an arylamino group, and an aralkylamino group.

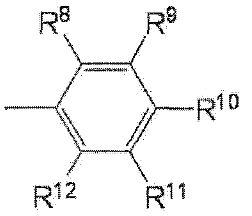
[0149] The alkoxycarbonyl group is represented by -COOY'. Examples of Y' are the same as the examples of the alkyl group. The alkylamino group and the aralkylamino group are represented by $-NQ^1Q^2$. Examples for each of Q^1 and Q^2 are the same as the examples described in relation to the alkyl group and the aralkyl group, and preferred examples for each of Q^1 and Q^2 are also the same as those described in relation to the alkyl group and the aralkyl group. Either one of Q^1 and Q^2 may be a hydrogen atom.

[0150] The arylamino group is represented by $-NAr^1Ar^2$. Examples for each of Ar^1 and Ar^2 are the same as the examples described in relation to the non-fused aromatic hydrocarbon group and the fused aromatic hydrocarbon group. Either one of Ar^1 and Ar^2 may be a hydrogen atom.

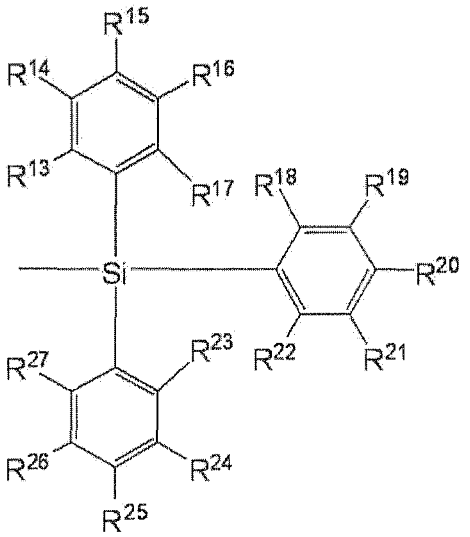
[0151] M represents aluminum (Al), gallium (Ga) or indium (In), among which In is preferable.

[0152] L in the formula (A) represents a group represented by a formula (A') or (A") below.

[Chemical Formula 40]



(A')



(A")

[0153] In the formula (A'), R^8 to R^{12} each independently represent a hydrogen atom or a substituted or unsubstituted hydrocarbon group having 1 to 40 carbon atoms. Adjacent groups may form a cyclic structure. In the formula (A"), R^{13} to R^{27} each independently represent a hydrogen atom or a substituted or unsubstituted hydrocarbon group having 1 to 40 carbon atoms. Adjacent groups may form a cyclic structure.

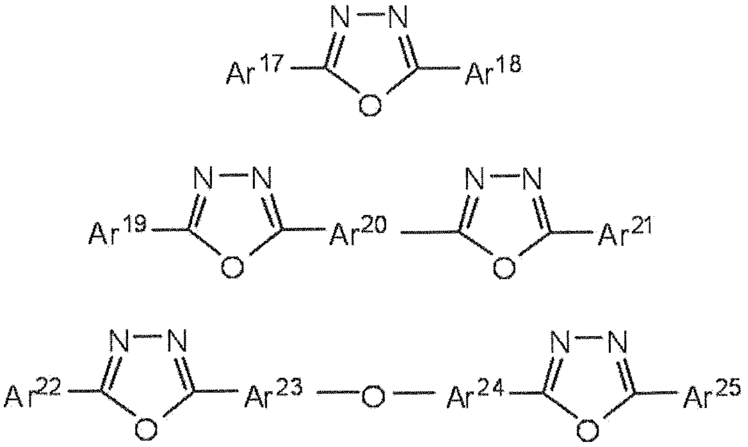
[0154] Examples of the hydrocarbon group having 1 to 40 carbon atoms represented by each of R^8 to R^{12} and R^{13} to R^{27} in the formulae (A') and (A") are the same as those of R^2 to R^7 in the formula (A).

[0155] Examples of a divalent group formed when an adjacent set of R^8 to R^{12} and R^{13} to R^{27} forms a cyclic structure are a tetramethylene group, a pentamethylene group, a hexamethylene group, a diphenylmethane-2,2'-diyl group, a diphenylethane-3,3'-diyl group, a diphenylpropane-4,4'-diyl group and the like.

[0156] Moreover, in this exemplary embodiment, the electron transporting layer may contain the biscarbazole derivatives represented by the formulae (1) to (3) (or the formulae (4) to (6)).

[0157] As an electron transporting compound for the electron injecting layer or the electron transporting layer, 8-hydroxyquinoline or a metal complex of its derivative, an oxadiazole derivative and a nitrogen-containing heterocyclic derivative are preferable. A specific example of the 8-hydroxyquinoline or the metal complex of its derivative is a metal chelate oxinoid compound containing a chelate of oxine (typically 8-quinolinol or 8-hydroxyquinoline). For instance, tris(8-quinolinol) aluminum can be used. Examples of the oxadiazole derivative are as follows.

[Chemical Formula 41]



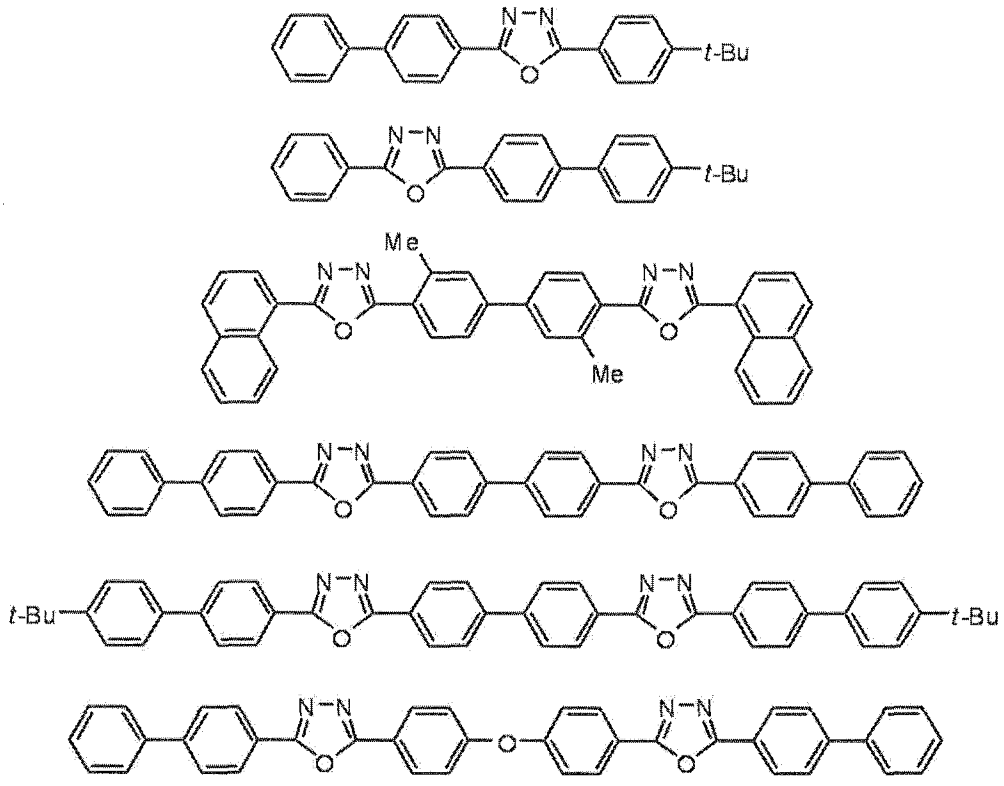
[0158] In the formula, Ar^{17}, Ar^{18}, Ar^{19}, Ar^{21}, Ar^{22} and Ar^{25} each represent a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms. Ar^{17}, Ar^{19} and Ar^{22} may be the same as or different from Ar^{18}, Ar^{21} and Ar^{25} respectively. Examples of the aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms are a phenyl group, biphenyl group, anthranil group, perylenyl group and pyrenyl group. Examples of the substituent therefor are an alkyl group having 1 to 10 carbon atoms, alkoxy group having 1 to 10 carbon atoms and cyano group.

[0159] Ar^{20}, Ar^{23} and Ar^{24} each represent a substituted or unsubstituted divalent aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms. Ar^{23} and Ar^{24} may be mutually the same or different.

[0160] Examples of the divalent aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms are a phenylene group, naphthylene group, biphenylene group, anthranylene group, perylenylene group and pyrenylene group. Examples of the substituent therefor are an alkyl group having 1 to 10 carbon atoms, alkoxy group having 1 to 10 carbon atoms and cyano group.

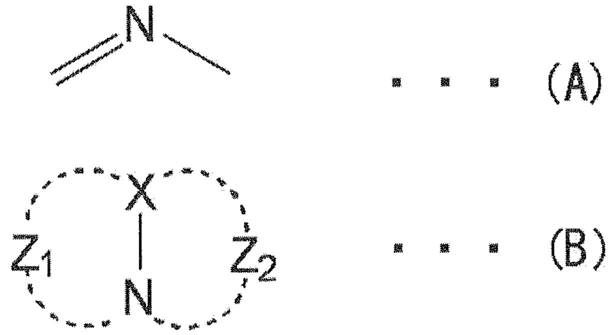
[0161] Such an electron transport compound is preferably an electron transport compound that can be favorably formed into a thin film(s). Examples of the electron transporting compounds are as follows.

[Chemical Formula 42]



[0162] An example of the nitrogen-containing heterocyclic derivative as the electron transporting compound is a nitrogen-containing compound that is not a metal complex, the derivative being formed of an organic compound represented by one of the following general formulae. Examples of the nitrogen-containing heterocyclic derivative are a five-membered ring or six-membered ring derivative having a skeleton represented by the following formula (A) and a derivative having a structure represented by the following formula (B).

[Chemical Formula 43]



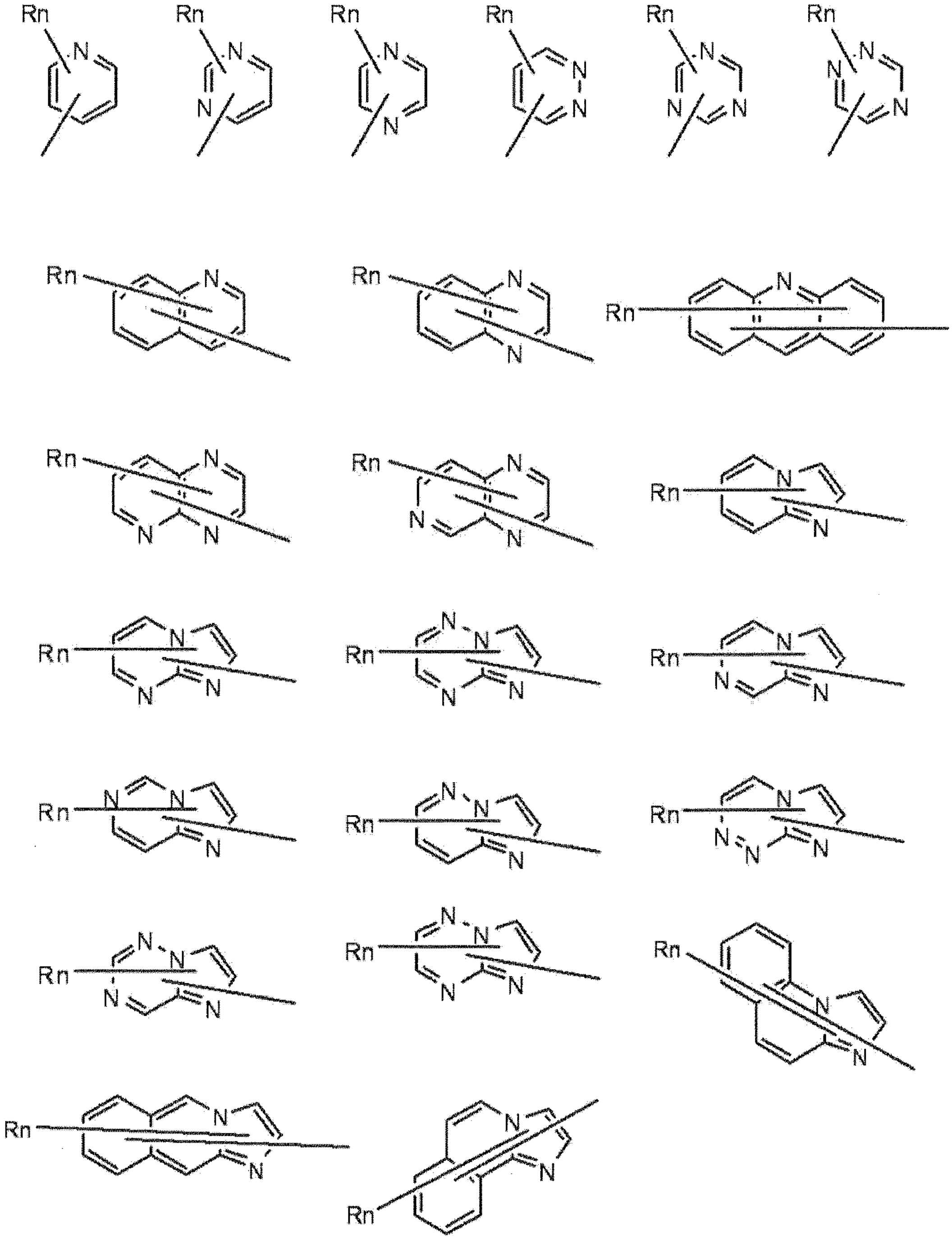
[0163] In the formula (B), X represents a carbon atom or a nitrogen atom. Z_1 and Z_2 each independently represent a group of atoms capable of forming a nitrogen-containing heterocycle.

[0164] Preferably, the nitrogen-containing heterocyclic derivative is an organic compound having a nitrogen-containing aromatic polycyclic group having a five-membered ring or six-membered ring. When the nitrogen-containing heterocyclic derivative includes such nitrogen-containing aromatic polycyclic series having plural nitrogen atoms, the nitrogen-containing heterocyclic derivative may be a nitrogen-containing aromatic polycyclic organic compound having a skeleton formed by a combination of the skeletons respectively represented by the formulae (A) and (B), or by a combination of the skeletons respectively represented by the formulae (A) and (C).

[Chemical Formula 44]

[0165] A nitrogen-containing group of the nitrogen-containing aromatic polycyclic organic compound is selected from nitrogen-containing heterocyclic groups respectively represented by the following general formulae.

[Chemical Formula 45]



[0166] In the formulae: R represents an aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms; aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms; alkyl group having 1 to 20 carbon atoms or alkoxy group having 1 to 20 carbon atoms; and n represents an integer in a range of 0 to 5. When n is an integer of 2 or more, plural R may be mutually the same or different.

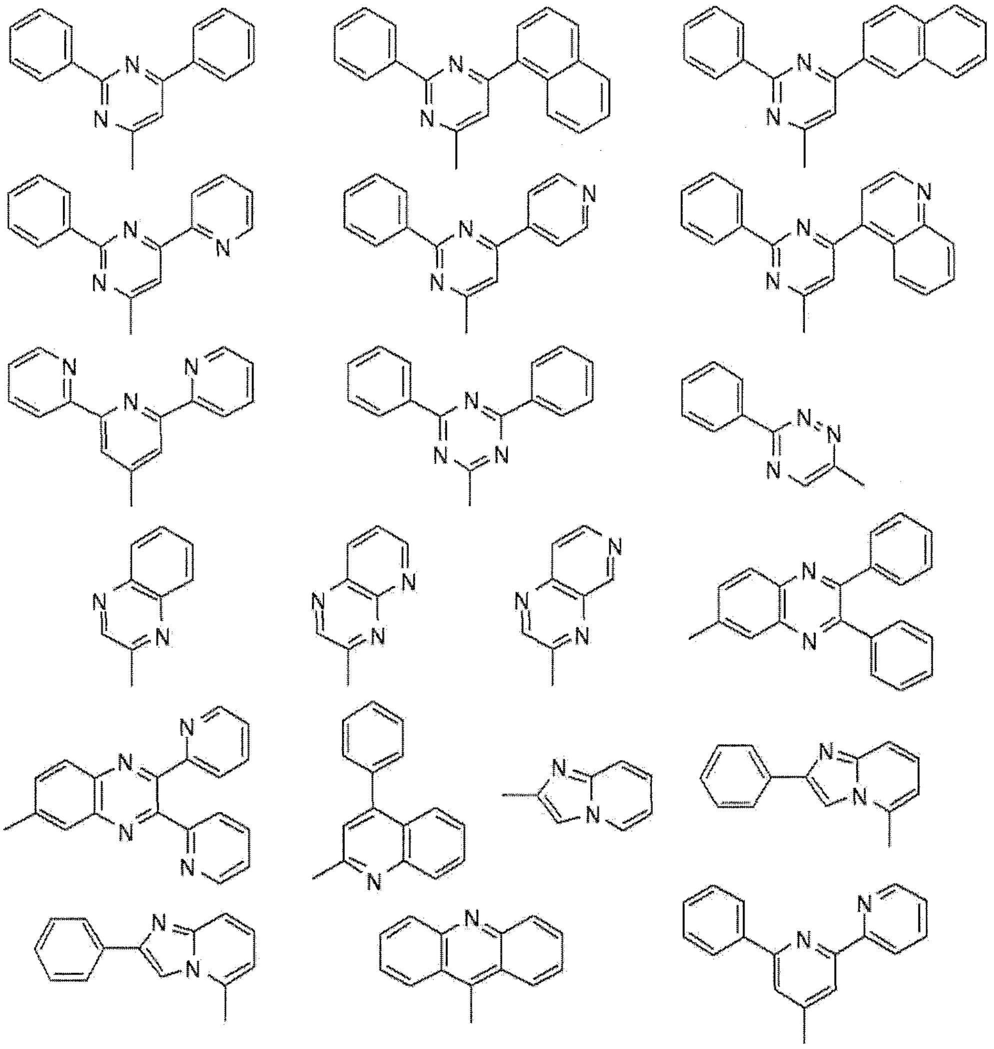
[0167] A preferable specific compound is a nitrogen-containing heterocyclic derivative represented by the following formula.

$$\mathrm{HAr\text{-}L^1\text{-}Ar^1\text{-}Ar^2}$$

[0168] In the formula: HAr represents a substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 40 ring carbon atoms; L^1 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms, or substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms; Ar^1 represents a substituted or unsubstituted divalent aromatic hydrocarbon group having 6 to 40 ring carbon atoms; and Ar^2 represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms, or substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms.

[0169] HAr is exemplarily selected from the following group.

[Chemical Formula 46]

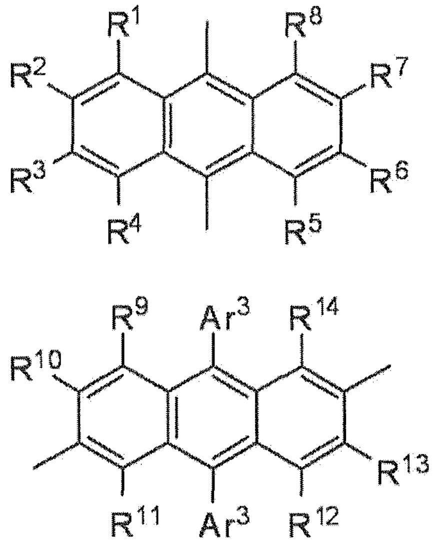


[0170] L^1 is exemplarily selected from the following group.

[Chemical Formula 47]

[0171] Ar^1 is exemplarily selected from the following arylanthranil groups.

[Chemical Formula 48]

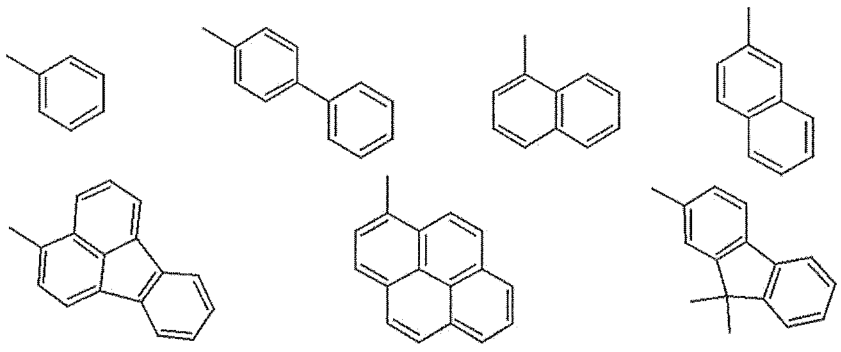


[0172] In the formulae, R^1 to R^{14} each independently represent a hydrogen atom, halogen atom, alkyl group having 1 to 20 carbon atoms, alkoxy group having 1 to 20 carbon atoms, aryloxy group having 6 to 40 ring carbon atoms, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms, or aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms; and Ar^3 represents aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 40 ring carbon atoms, or aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms.

[0173] All of R^1 to R^8 of a nitrogen-containing heterocyclic derivative may be hydrogen atoms.

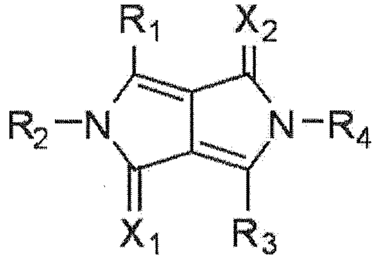
[0174] Ar^2 is exemplarily selected from the following group.

[Chemical Formula 49]



[0175] Other than the above, the following compound (see JP-A-9-3448) can be favorably used for the nitrogen-containing aromatic polycyclic organic compound as the electron transporting compound.

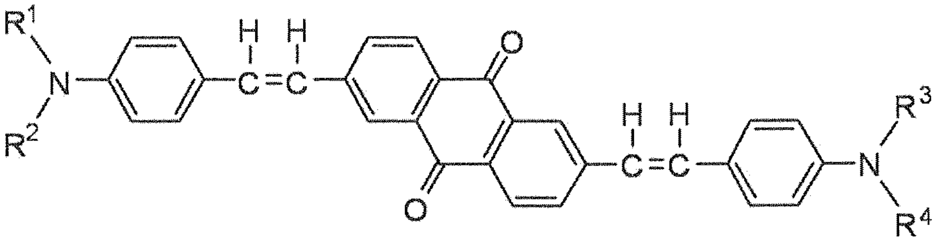
[Chemical Formula 50]



[0176] In the formula: R_1 to R_4 each independently represent a hydrogen atom, substituted or unsubstituted aliphatic group, substituted or unsubstituted alicyclic group, substituted or unsubstituted carbocyclic aromatic cyclic group or substituted or unsubstituted heterocyclic group; and X_1 and X_2 each independently represent an oxygen atom, sulfur atom or dicyanomethylene group.

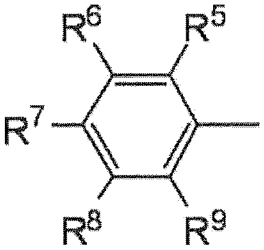
[0177] Alternatively, the following compound (see JP-A-2000-173774) can also be favorably used for the electron transporting compound.

[Chemical Formula 51]



[0178] In the formula, R^1, R^2, R^3 and R^4, which may be mutually the same or different, each represent an aromatic hydrocarbon group or fused aromatic hydrocarbon group represented by the following formula.

[Chemical Formula 52]

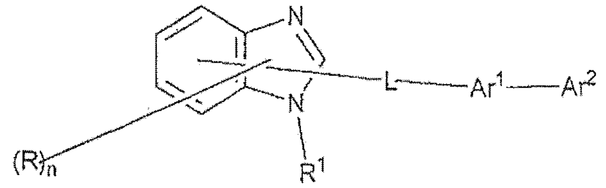


[0179] In the formula, R^5, R^6, R^7, R^8 and R^9, which may be mutually the same or different, each represent a hydrogen atom, a saturated or unsaturated alkoxyl group, alkyl group, amino group or alkylamino group. At least one of R^5, R^6, R^7, R^8 and R^9 represents a saturated or unsaturated alkoxyl group, alkyl group, amino group or alkylamino group.

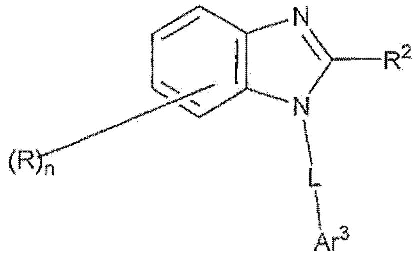
[0180] A polymer compound containing the nitrogen-containing heterocyclic group or a nitrogen-containing heterocyclic derivative may be used for the electron transporting compound.

[0181] The electron transporting layer preferably contains at least one of nitrogen-containing heterocycle derivatives respectively represented by the following formulae (201) to (203).

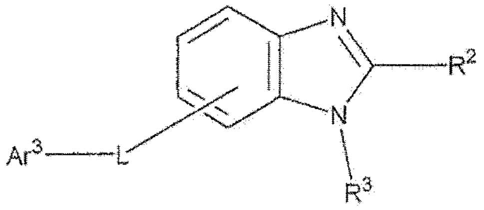
[Chemical Formula 53]



... (201)



... (202)



... (203)

[0182] In the formulae (201) to (203): R represents a hydrogen atom, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, or substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms; n is an integer in a range of 0 to 4;

R^1 represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, or alkoxy group having 1 to 20 carbon atoms;

R^2 and R^3 each independently represent a hydrogen atom, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, or a substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms;

L represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridinylene group, substituted or unsubstituted quinolylene group, or substituted or unsubstituted fluorenylene group;

Ar^1 represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridinylene group, substituted or unsubstituted quinolyl group.

Ar^2 represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, or substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms; and

[0183] Ar^3 represents a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms or group represented by $-Ar^1-Ar^2$ (Ar^1 and Ar^2 may be the same as the above).

[0184] In the formulae (201) to (203), R represents a hydrogen atom, a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 60 ring carbon atoms, substituted or unsubstituted pyridyl group, substituted or unsubstituted quinolyl group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, or substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms.

[0185] Although a thickness of the electron injecting layer or the electron transporting layer is not specifically limited, the thickness is preferably 1 nm to 100 nm.

[0186] The electron injecting layer preferably contains an inorganic compound such as an insulator or a semiconductor in addition to the nitrogen-containing cyclic derivative. Such an insulator or a semiconductor, when contained in the electron injecting layer, can effectively prevent a current leak, thereby enhancing electron capability of the electron injecting layer.

[0187] As the insulator, it is preferable to use at least one metal compound selected from the group consisting of an alkali metal chalcogenide, an alkali earth metal chalcogenide, a halogenide of alkali metal and a halogenide of alkali earth metal. By forming the electron injecting layer from the alkali metal chalcogenide or the like, the electron injecting capability can preferably be further enhanced. Specifically, preferred examples of the alkali metal chalcogenide are Li_2O, K_2O, Na_2S, Na_2Se and Na_2O, while preferable example of the alkali earth metal chalcogenide are CaO, BaO, SrO, BeO, BaS and CaSe. Preferred examples of the halogenide of the alkali metal are LiF, NaF, KF, LiCl, KCl and NaCl. Preferred examples of the halogenide of the alkali earth metal are fluorides such as CaF_2, BaF_2, SrF_2, MgF_2 and BeF_2, and halogenides other than the fluoride.

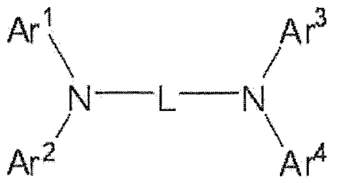
[0188] Examples of the semiconductor are one of or a combination of two or more of an oxide, a nitride or an oxidized nitride containing at least one element selected from Ba, Ca, Sr, Yb, Al, Ga, In, Li, Na, Cd, Mg, Si, Ta, Sb and Zn. An inorganic compound for forming the electron injecting layer is preferably a microcrystalline or amorphous semiconductor film. When the electron injecting layer is formed of such insulator film, more uniform thin film can be formed, thereby reducing pixel defects such as a dark spot. Examples of such an inorganic compound are the above-described alkali metal chalcogenide, alkali earth metal chalcogenide, halogenide of the alkali metal and halogenide of the alkali earth metal.

[0189] When the electron injecting layer contains such an insulator or such a semiconductor, a thickness thereof is preferably in a range of approximately 0.1 nm to 15nm. The electron injecting layer in this exemplary embodiment may preferably contain the above-described reduction-causing dopant.

Hole Injecting Layer and Hole Transporting Layer

[0190] The hole injecting layer or the hole transporting layer (including the hole injecting/transporting layer) may contain an aromatic amine compound such as an aromatic amine derivative represented by the following formula (I).

[Chemical Formula 54]

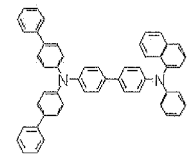
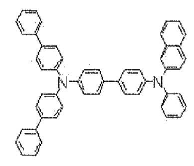
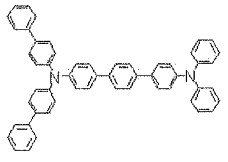
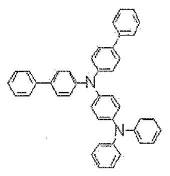


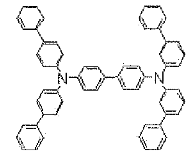
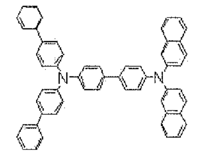
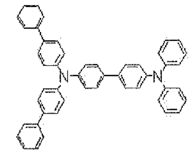
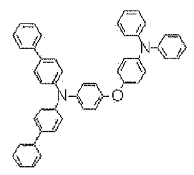
... (I)

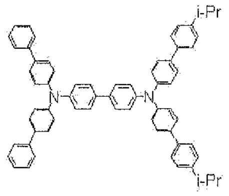
[0191] In the formula (I), Ar^1 to Ar^4 each represent a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 50 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 40 ring carbon atoms, or a group formed by combining the aromatic hydrocarbon group or the fused aromatic hydrocarbon group with the aromatic heterocyclic group or fused aromatic heterocyclic group.

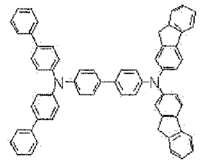
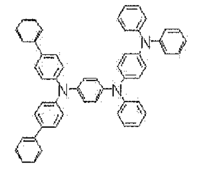
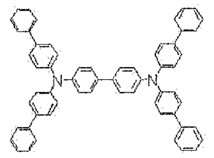
[0192] Examples of the compound represented by the formula (I) are shown below. However, the compound represented by the formula (I) is not limited thereto.

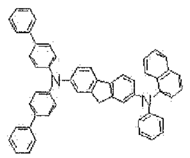
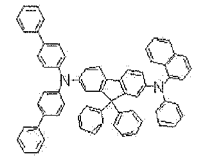
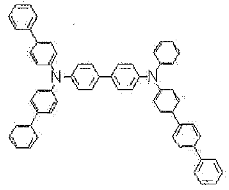
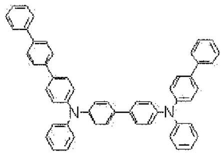
[Chemical Formula 55]

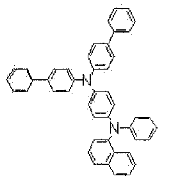
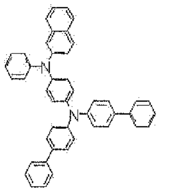
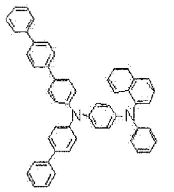
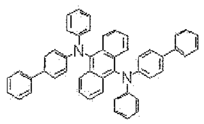





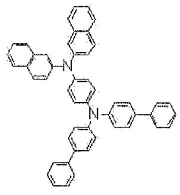
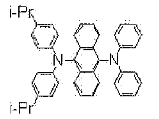





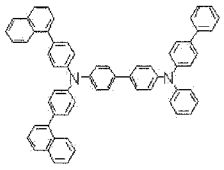
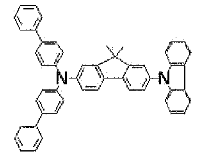


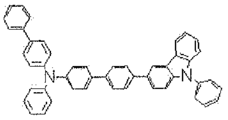
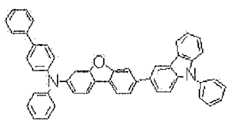




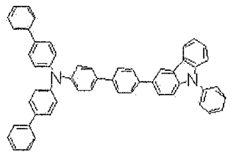
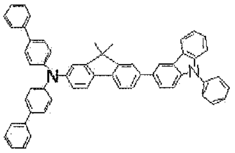





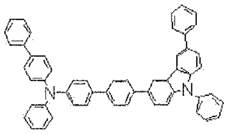
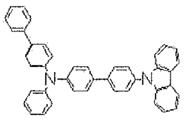
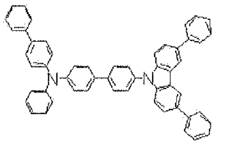
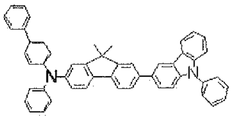





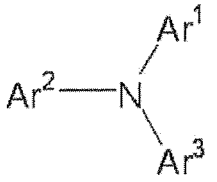



[0193] Aromatic amine represented by the following formula (II) can also be preferably used for forming the hole injecting layer or the hole transporting layer.

[Chemical Formula 56]

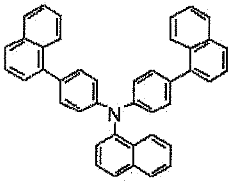
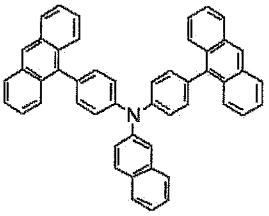
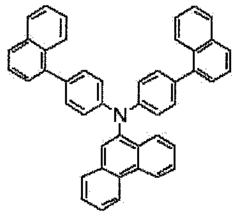
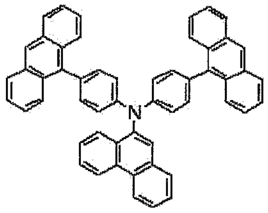
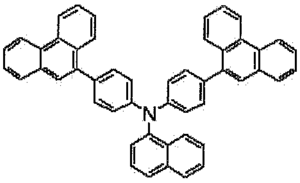
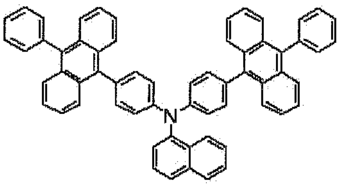
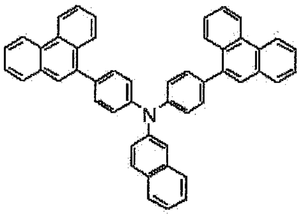
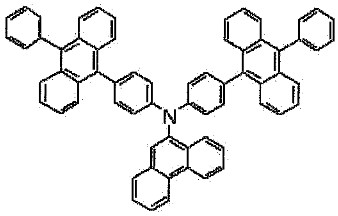
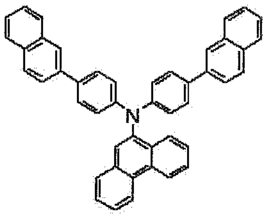
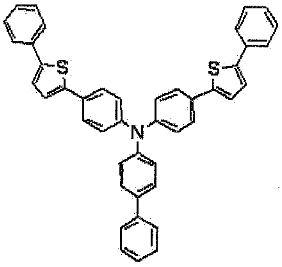
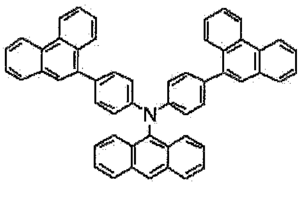
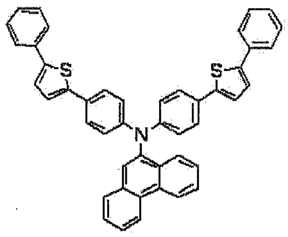
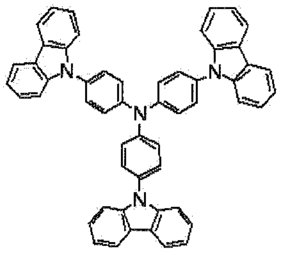
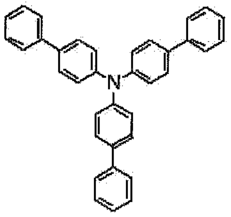
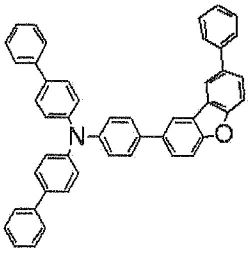
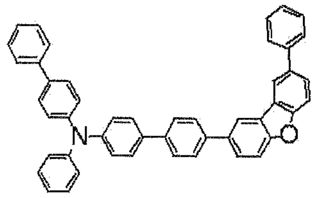
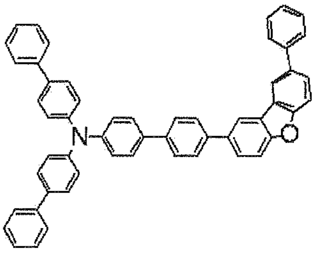


$$\mathrm{Ar^2{-}N(Ar^1)(Ar^3)}$$

· · · (II)

[0194] In the formula (II), Ar^1 to Ar^3 each represent the same as Ar^1 to Ar^4 of the above (I). Examples of the compound represented by the general formula (II) are shown below. However, the compound represented by the formula (II) is not limited thereto.

[Chemical Formula 57]

[0195] A method of forming each of the layers in the organic EL device according to this exemplary embodiment is not particularly limited. A conventionally-known methods such as vacuum deposition or spin coating may be employed for forming the layers. The organic thin-film layer containing the compound represented by the formula (1A) or (1B), which is used in the organic EL device according to this exemplary embodiment, may be formed by a conventional coating method such as vacuum deposition, molecular beam epitaxy (MBE method) and coating methods using a solution such as a dipping, spin coating, casting, bar coating, and roll coating.

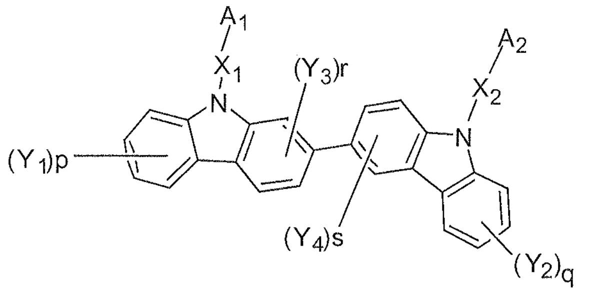
[0196] Although the thickness of each organic layer of the organic EL device according to this exemplary embodiment is not particularly limited, the thickness is generally preferably in a range of several nanometers to 1 μm because an excessively-thinned film likely entails defects such as a pin hole while an excessively-thickened film requires high voltage to be applied and deteriorates efficiency.

Second Exemplary Embodiment

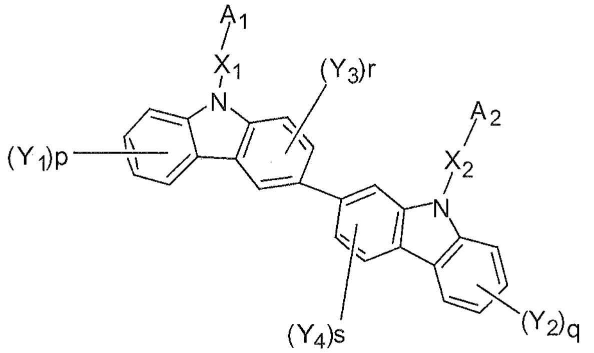
[0197] Next, an organic EL device according to a second exemplary embodiment will be described below.

[0198] The organic EL device according to the second exemplary embodiment is different in that the emitting layer includes the first host material, the second host material and the phosphorescent material. In this case, the first host material is the biscarbazole derivative according to the exemplary embodiment represented by the formulae (5A) and (5B).

[Chemical Formula 58]



• • • (5A)



• • • (5B)

[0199] In the formulae (5A) and (5B): A_1 represents a substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic

heterocyclic group having 2 to 30 ring carbon atoms;
adjacent ones of Y_1 to Y_4 may be bonded to each other to form a ring structure;
p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and
when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 may be the same or different.

[0200] When Y_1 to Y_4 are bonded to each other to form a ring structure, the ring structure is exemplified by the same structures as ones listed when Y_1 to Y_4 are bonded to each other to form a ring structure in the formulae (1A) and (1B). A substituted or unsubstituted nitrogen-containing heterocyclic group is preferably ones other than a substituted or unsubstituted carbazolyl group and a substituted or unsubstituted indolyl group.

[0201] The organic-EL-device material represented by the formulae (5A) and (5B) has a biscarbazole skeleton having an excellent hole transporting capability and a heterocyclic skeleton having an excellent electron transporting capability, which leads to a bi-polar performance sufficient for functioning as a single host. However, a luminous efficiency and a lifetime of the multilayered organic EL device depend on a carrier balance of an entire organic EL device. Main factors for controlling the carrier balance are carrier transporting capability of each of the organic layers and carrier injecting capability in the interfacial region of separate organic layers. In order to balance the carrier injecting capability to neighboring layers in the emitting layer (recombination region), it is preferable to adjust the carrier balance not by a single host material but by a plurality of host materials. Specifically, it is preferable that, in addition to the first host material, the second host material is suitably selected as a co-host and used in the emitting layer.

[0202] When a material having a poor electron injecting capability (e.g., metal chelate complex) is used as the cathode, a carrier balance in the emitting layer becomes shifted toward the cathode. For improving such a disadvantage, it is preferable to select a material having a high electron transporting capability as the second host material. Specifically, the host material of the exemplary embodiment is preferably represented by a formula (6) or (7).

[0203] [Chemical Formula 59]

$$(C_z\text{-})_a A^3 \qquad (6)$$

$$Cz(\text{-}A^3)_b \qquad (7)$$

[0204] In the formulae (6) and (7): Cz represents a substituted or unsubstituted arylcarbazolyl group or carbazolylaryl group;
A^3 represents a group represented by a formula (8A) below; and
a and b each represent an integer of 1 to 3.

[0205] [Chemical Formula 60]

$$(M^1)_c\text{-}(L^5)_d\text{-}(M^2)_e \qquad (8A)$$

[0206] In the formula (8A): M^1 and M^2 each independently represent a substituted or unsubstituted nitrogen-containing aromatic heterocyclic ring or nitrogen-containing fused aromatic heterocyclic ring having 2 to 40 ring carbon atoms; M^1 and M^2 may be the same or different;
L^5 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 carbon atoms;
c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

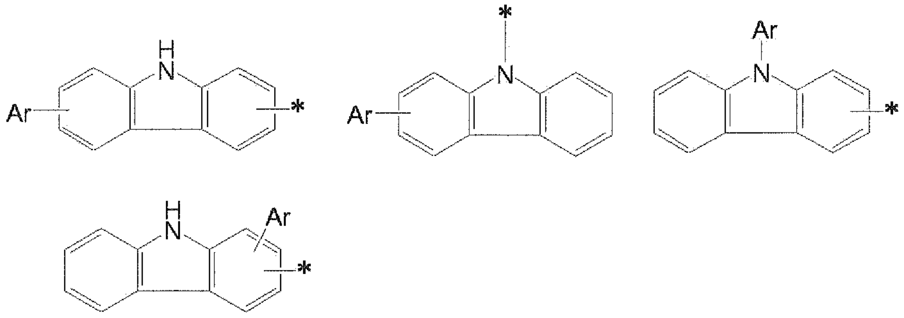
With Respect To Compounds Represented By Formulae (6) And (7)

[0207] Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0208] An arylcarbazolyl group means a carbazolyl group having at least one aryl group or heteroaryl group as a substituent, in which a position where the aryl group or heteroaryl group is substituted does not matter.

[0209] Specific examples are as follows. In the following chemical formulae, Ar represents an aryl group or heteroaryl group. * represents a position where another group is bonded.

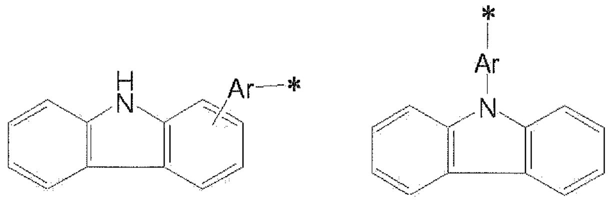
[Chemical Formula 61]



[0210] A carbazolylaryl group means an aryl group having at least one carbazolyl group as a substituent, in which a position where the aryl group is substituted does not matter.

[0211] Specific examples are as follows. In the following chemical formulae, Ar represents an aryl group. * represents a position where another group is bonded.

[Chemical Formula 62]



[0212] A substituted arylcarbazolyl group means the arylcarbazolyl group having at least one substituent irrespective of a substitution position. A substituted carbazolylaryl group means the carbazolylaryl group having at least one substituent irrespective of a substitution position.

[0213] In the formulae (6) and (7), a and b each represent an integer of 1 to 3.

[0214] An aryl group in the arylcarbazolyl group or carbazolylaryl group preferably has 6 to 30 carbon atoms. Examples of the aryl group are a phenyl group, naphthyl group, anthryl group, phenanthryl group, naphthacenyl group, pyrenyl group, fluorenyl group, biphenyl group and terphenyl group, among of which a phenyl group, naphthyl group, biphenyl group and terphenyl group are preferable.

[0215] Examples of the heteroaryl group in the arylcarbazolyl group are groups formed based on rings of pyridine, pyrimidine, pyrazine, triazine, aziridine, azaindolizine, indolizine, imidazoles, indole, isoindole, indazole, purine, pteridine, β-carboline, naphthyridine, quinoxaline, terpyridine, bipyridine, acridine, phenanthroline, phenazine and imidazopyridine, among which rings of pyridine, terpyridine, pyrimidine, imidazopyridine and triazine are preferable.

[0216] A in the formulae (6) and (7) represents the groups represented by the formula (8A).

[0217] In the formula (8A), M^1 and M^2 each independently represent a substituted or unsubstituted nitrogen-containing heterocyclic group having 2 to 40 ring carbon atoms. M^1 and M^2 may be the same or different.

[0218] Examples of the nitrogen-containing heterocyclic ring in the arylcarbazolyl group are groups formed based on rings of pyridine, pyrimidine, pyrazine, triazine, aziridine, azaindolizine, indolizine, imidazoles, indole, isoindole, indazole, purine, pteridine, β-carboline, naphthyridine, quinoxaline, terpyridine, bipyridine, acridine, phenanthroline, phenazine and imidazopyridine, among which rings of pyridine, terpyridine, pyrimidine, imidazopyridine and triazine are preferable.

[0219] L^5 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms, or substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

[0220] c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0221] Examples of the aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms are a phenyl group, biphenyl group, terphenyl group, naphthyl group, anthranil group, phenanthryl group, pyrenyl group, crycenyl group, fluoranthenyl group and perfluoroaryl group, fluorenyl group, and 9,9-dimethylfluorenyl group, among which a phenyl group, biphenyl group, terphenyl group and perfluoroaryl group are preferable.

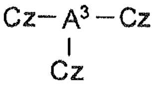
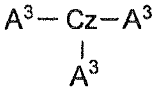
[0222] Examples of the cycloalkylene group having 5 to 30 carbon atoms are cyclopentyl group, cyclohexylene group, and cyclohepthylene group, among which a cyclohexylene group is preferable.

[0223] Examples of the aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms are 1-pyrrolyl group, 2-pyrrolyl group, 3-pyrrolyl group, pyrazinyl group, 2-pyridinyl group, 3-pyridinyl group, 4-pyridinyl group, 1-indolyl group, 2-indolyl group, 3-indolyl group, 4-indolyl group, 5-indolyl group, 6-indolyl group, 7-indolyl group, 1-isoindolyl group, 2-isoindolyl group, 3-isoindolyl group, 4-isoindolyl group, 5-isoindolyl group, 6-isoindolyl group, 7-isoindolyl group, 2-furyl group, 3-furyl group, 2-benzofuranyl group, 3-benzofuranyl group, 4-benzofuranyl group, 5-benzofuranyl group, 6-benzofuranyl group, 7-benzofuranyl group, 1-isobenzofuranyl group, 3-isobenzofuranyl group, 4-isobenzofuranyl group, 5-isobenzofuranyl group, 6-isobenzofuranyl group, 7-isobenzofuranyl group, 2-quinolyl group, 3-quinolyl group, 4-quinolyl group, 5-quinolyl group, 6-quinolyl group, 7-quinolyl group, 8-quinolyl group, 1-isoquinolyl group, 3-isoquinolyl group, 4-isoquinolyl group, 5-isoquinolyl group, 6-isoquinolyl group, 7-isoquinolyl group, 8-isoquinolyl group, 2-quinoxalinyl group, 5-quinoxalinyl group, 6-quinoxalinyl group, 1-carbazolyl group, 2-carbazolyl group, 3-carbazolyl group, 4-carbazolyl group, 9-carbazolyl group, 1-phenanthridinyl group, 2-phenanthridinyl group, 3-phenanthridinyl group, 4-phenanthridinyl group, 6-phenanthridinyl group, 7-phenanthridinyl group, 8-phenanthridinyl group, 9-phenanthridinyl group, 10-phenanthridinyl group, 1-acridinyl group, 2-acridinyl group, 3-acridinyl group, 4-acridinyl group, 9-acridinyl group, 1,7-phenanthrolin-2-yl group, 1,7-phenanthrolin-3-yl group, 1,7-phenanthrolin-4-yl group, 1,7-phenanthrolin-5-yl group, 1,7-phenanthrolin-6-yl group, 1,7-phenanthrolin-8-yl group, 1,7-phenanthrolin-9-yl group, 1,7-phenanthrolin-10-yl group, 1,8-phenanthrolin-2-yl group, 1,8-phenanthrolin-3-yl group, 1,8-phenanthrolin-4-yl group, 1,8-phenanthrolin-5-yl group, 1,8-phenanthrolin-6-yl group, 1,8-phenanthrolin-7-yl group, 1,8-phenanthrolin-9-yl group, 1,8-phenanthrolin-10-yl group, 1,9-phenanthrolin-2-yl group, 1,9-phenanthrolin-3-yl group, 1,9-phenanthrolin-4-yl group, 1,9-phenanthrolin-5-yl group, 1,9-phenanthrolin-6-yl group, 1,9-phenanthrolin-7-yl group, 1,9-phenanthrolin-8-yl group, 1,9-phenanthrolin-10-yl group, 1,10-phenanthrolin-2-yl group, 1,10-phenanthrolin-3-yl group, 1,10-phenanthrolin-4-yl group, 1,10-phenanthirolin-5-yl group, 2,9-phenanthrolin-1-yl group, 2,9-phenanthrolin-3-yl group, 2,9-phenanthrolin-4-yl group, 2,9-phenanthrolin-5-yl group, 2,9-phenanthrolin-6-yl group, 2,9-phenanthrolin-7-yl group, 2,9-phenanthrolin-8-yl group, 2,9-phenanthrolin-10-yl group, 2,8-phenanthrolin-1-yl group, 2,8-phenanthrolin-3-yl group, 2,8-phenanthrolin-4-yl group, 2,8-phenanthrolin-5-yl group, 2,8-phenanthrolin-6-yl group, 2,8-phenanthrolin-7-yl group, 2,8-phenanthrolin-9-yl group, 2,8-phenanthrolin-10-yl group, 2,7-phenanthrolin-1-yl group, 2,7-phenanthrolin-3-yl group, 2,7-phenanthrolin-4-yl group, 2,7-phenanthrolin-5-yl group, 2,7-phenanthrolin-6-yl group, 2,7-phenanthrolin-8-yl group, 2,7-phenanthrolin-9-yl group, 2,7-phenanthrolin-10-yl group, 1-phenazinyl group, 2-phenazinyl group, 1-phenothiazinyl group, 2-phenothiazinyl group, 3-phenothiazinyl group, 4-phenothiazinyl group, 10-phenothiazinyl group, 1-phenoxazinyl group, 2-phenoxazinyl group, 3-phenoxazinyl group, 4-phenoxazinyl group, 10-phenoxazinyl group, 2-oxazolyl group, 4-oxazolyl group, 5-oxazolyl group, 2-oxadiazolyl group, 5-oxadiazolyl group, 3-furazanyl group, 2-thienyl group, 3-thienyl group, 2-methylpyrrol-1-yl group, 2-methylpyrrol-3-yl group, 2-methylpyrrol-4-yl group, 2-methylpyrrol-5-yl group, 3-methylpyrrol-1-yl group, 3-methylpyrrol-2-yl group, 3-methylpyrrol-4-yl group, 3-methylpyrrol-5-yl group, 2-t-butylpyrrol-4-yl group, 3-(2-phenylpropyl)pyrrol-1-yl group, 2-methyl-1-indolyl group, 4-methyl-1-indolyl group, 2-methyl-3-indolyl group, 4-methyl-3-indolyl group, 2-t-butyl-1-indolyl group, 4-t-butyl-1-indolyl group, 2-t-butyl-3-indolyl group, and 4-t-butyl-3-indolyl group, among which a pyridinyl group and quinolyl group are preferable.

[0224] Examples of the substituents for Cz, M^1 and M^2 in the formulae (6), (7) and (8A) are a halogen atom such as chlorine, bromine and fluorine, carbazole group, hydroxyl group, substituted or unsubstituted amino group, nitro group, cyano group, silyl group, trifluoromethyl group, carbonyl group, carboxyl group, substituted or unsubstituted alkyl group, substituted or unsubstituted alkenyl group, substituted or unsubstituted arylalkyl group, substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group, substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group, substituted or unsubstituted aralkyl group, substituted or unsubstituted aryloxy group, and substituted or unsubstituted alkyloxy group. Among these, a fluorine atom, methyl group, perfluorophenylene group, phenyl group, naphthyl group, pyridyl group, pyrazil group, pyrimidyl group, adamantyl group, benzyl group, cyano group and silyl group are preferable.

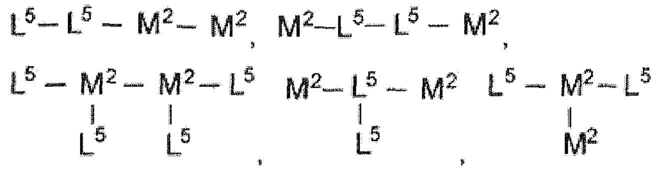
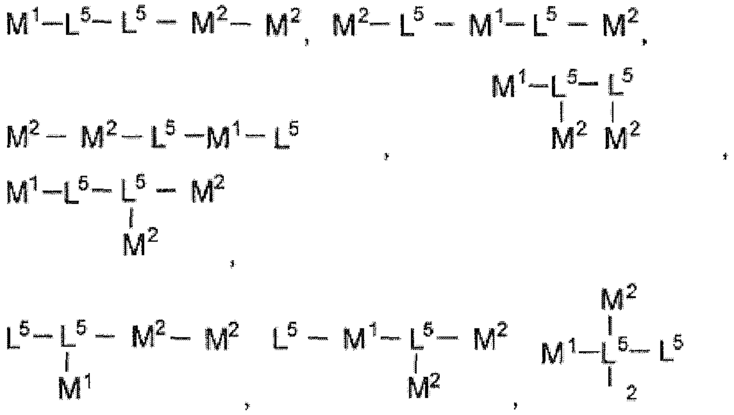
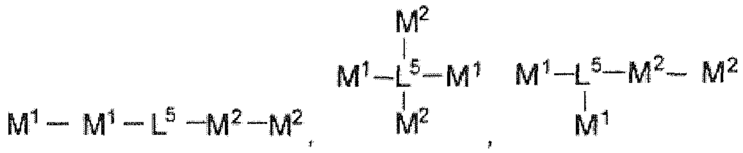
[0225] Bonding patterns of the compound represented by the formula (6) or (7) are shown in Table 1 below in accordance with values of a and b.

[Table 1]

a = b = 1	a = 2	a = 3	b = 2	b=3
Cz- A^3	Cz-A^3-Cz	 $\mathrm{Cz{-}}\underset{\mathrm{Cz}}{\underset{\vert}{\mathrm{A^3}}}\mathrm{{-}Cz}$	A^3- Cz-A^3	 $\mathrm{A^3{-}}\underset{\mathrm{A^3}}{\underset{\vert}{\mathrm{Cz}}}\mathrm{{-}A^3}$

[0226] Bonding patterns of the compound represented by the formula (8A) are shown in Tables 2 and 3 below in accordance with values of c, d and e.

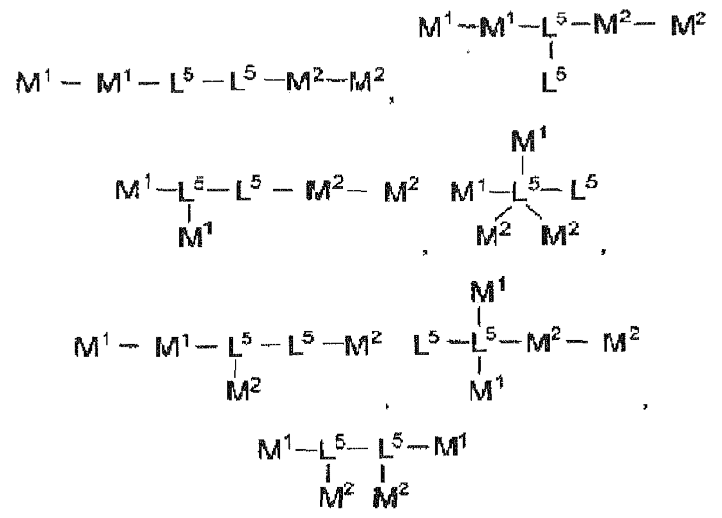
[Table 2]

No	c	d	e	Bonding Patterns
[1]	0	1	1	$L^5 - M^2$
[2]	0	1	2	$L^5 - M^2 - M^2$, $M^2 - L^5 - M^2$
[3]	0	2	1	$L^5 - L^5 - M^2$, $L^5 - M^2 - L^5$
[4]	0	2	2	 $L^5 - L^5 - M^2 - M^2$, $M^2 - L^5 - L^5 - M^2$, $L^5 - \underset{\overset{\vert}{L^5}}{M^2} - \underset{\overset{\vert}{L^5}}{M^2} - L^5$, $M^2 - \underset{\overset{\vert}{L^5}}{L^5} - M^2$, $L^5 - \underset{\overset{\vert}{M^2}}{M^2} - L^5$
[5]	1	1	0	the same as [1] (M^2 is replaced with M^1)
[6]	1	1	1	$M^1 - L^5 - M^2$
[7]	1	1	2	 $M^1 - L^5 - M^2 - M^2$, $M^1 - \underset{\overset{\vert}{M^2}}{L^5} - M^2$
[8]	1	2	0	the same as [3] (M^2 is replaced with M^1)
[9]	1	2	1	$M^1 - L^5 - L^5 - M^2$, $L^5 - M^1 - L^5 - M^2$,
				$L^5 - M^1 - L^5 - M^2$
[10]	1	2	2	 $M^1 - L^5 - L^5 - M^2 - M^2$, $M^2 - L^5 - M^1 - L^5 - M^2$, $M^2 - M^2 - L^5 - M^1 - L^5$, $M^1 - \underset{\overset{\vert}{M^2}}{L^5} - \underset{\overset{\vert}{M^2}}{L^5}$, $M^1 - L^5 - \underset{\overset{\vert}{M^2}}{L^5} - M^2$, $L^5 - \underset{\overset{\vert}{M^1}}{L^5} - M^2 - M^2$, $L^5 - M^1 - \underset{\overset{\vert}{M^2}}{L^5} - M^2$, $M^1 - \overset{\underset{\vert}{M^2}}{\underset{\overset{\vert}{2}}{L^5}} - L^5$
[11]	2	1	0	the same as [2] (M^2 is replaced with M^1)
[12]	2	1	1	the same as [7] (M^2 is replaced with M^1)
[13]	2	1	2	 $M^1 - M^1 - L^5 - M^2 - M^2$, $M^1 - \overset{\underset{\vert}{M^2}}{\underset{\overset{\vert}{M^2}}{L^5}} - M^1$, $M^1 - \underset{\overset{\vert}{M^1}}{L^5} - M^2 - M^2$

[Table 3]

No	c	d	c	Bonding Patterns
[14]	2	2	0	the same as [4] (M^2 is replaced with M^1)
[15]	2	2	1	the same as [10] (M^2 is replaced with M^1)

(continued)

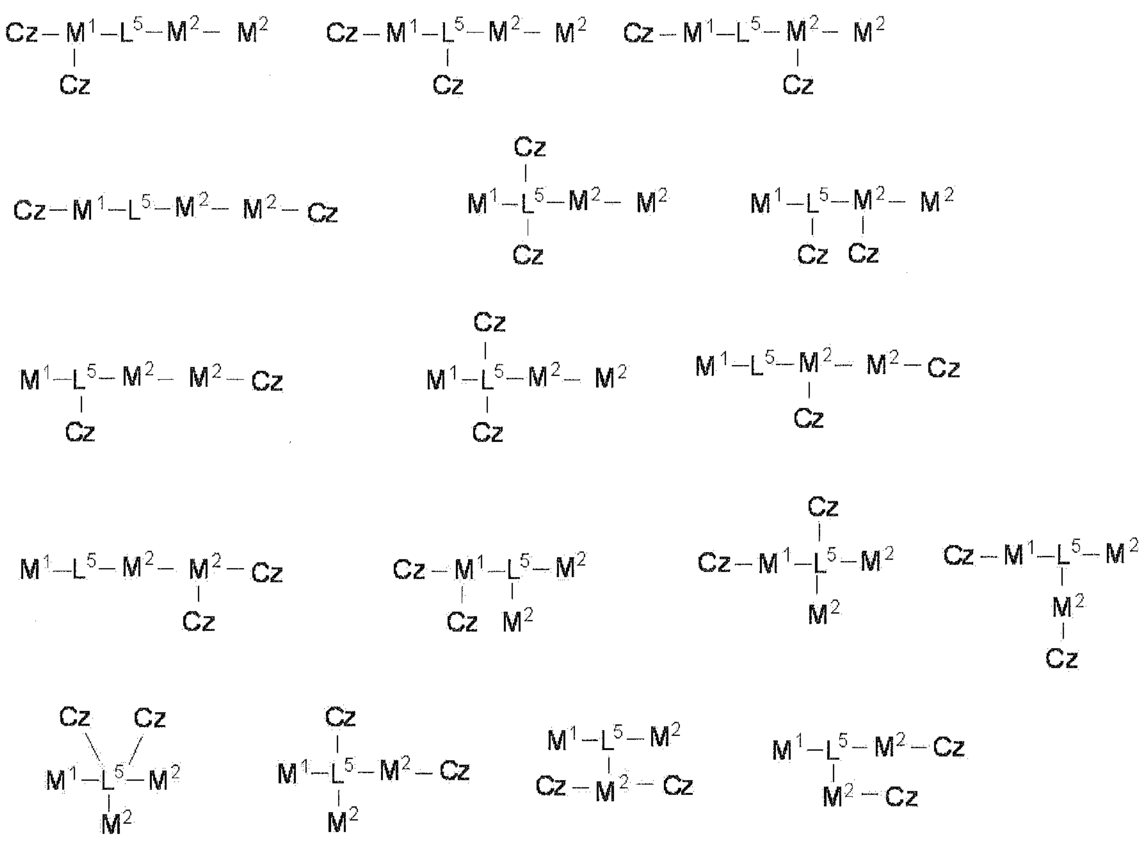
No	c	d	c	Bonding Patterns
[16]	2	2	2	

[0227] Cz bonded to A may be bonded to any one of M^1, L^5 and M^2 of the formula (8A) representing A.

[0228] For instance, when a=b=1 and Cz-A^3-Cz are given in the formula (6) or (7) and [6] (c=d=e=1) of Table 2 is given in the formula (8A), three bonding patterns of Cz-M^1-L^5M^2, M^1-L^5(Cz)-M^2, and M^1-L^5-M^2-Cz are listed.

[0229] Moreover, for instance, when a=2 and Cz-A^3-Cz are given in the formula (6) and [7] (c=d=1,e=2) Table 2 is given in the formula (8A), the following bonding patterns are listed.

[Chemical Formula 63]



[0230] In the bonding patterns of the formulae (6), (7) and (8A) and exemplary combinations of the groups as described above, compounds represented by [1] to [4] below are preferable.

a=1 is given in the formula (6) and c=1 and d=0 are given in the formula (8A).

[0231] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0232] In the formula (8A): M^1 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^5 is a substituted or unsubstituted aryl group or aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

a=2 is given in the formula (6) and c=1 and e=0 are given in the formula (8A).

[0233] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0234] In the formula (8A): M^1 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^5 is a substituted or unsubstituted aryl group or aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

[0235] [3] a=1 is given in the formula (6) and c=2 and e=0 are given in the formula (8A).

[0236] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0237] In the formula (8A): M^1 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^5 is a substituted or unsubstituted aryl group or aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

b=2 is given in the formula (7) and c=d=1 is given in the formula (8A).

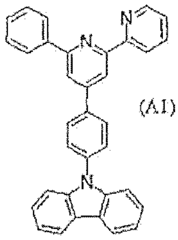
[0238] In the formula (7), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0239] In the formula (8A): M^1 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^5 is a substituted or unsubstituted aryl group or aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

[0240] In the formulae (6) and (7), Cz is preferably a substituted or unsubstituted arylcarbazolyl group, more preferably phenylcarbozolyl group. Moreover, an aryl site of the arylcarbazolyl group is preferably substituted by a carbazolyl group.

[0241] Specific examples of the compound represented by the formula (6) according to this exemplary embodiment are shown below, but the compound represented by the formula (6) is not limited thereto.

[Chemical Formula 64]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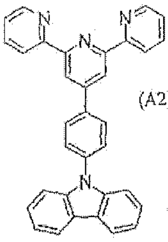
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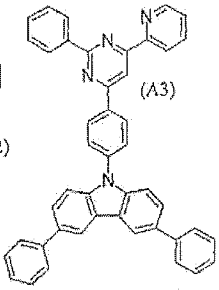
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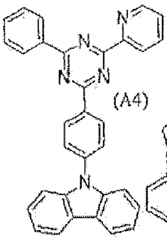
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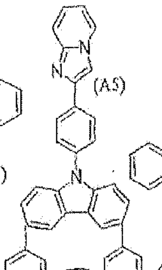
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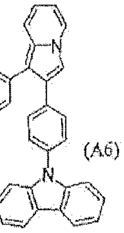
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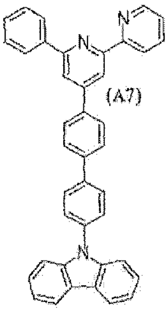
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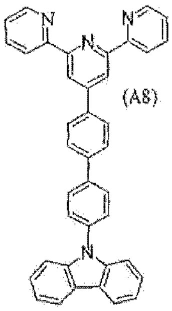
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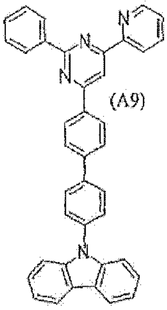
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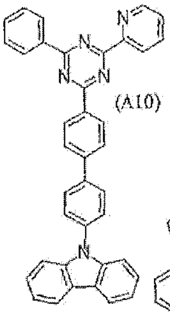
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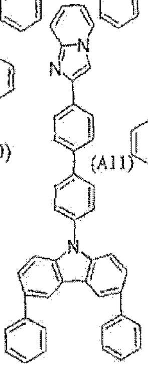
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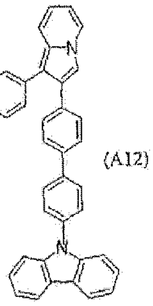
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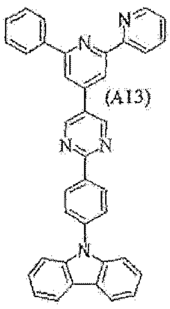
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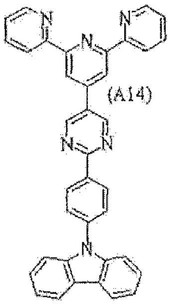
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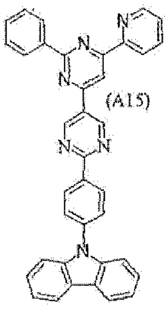
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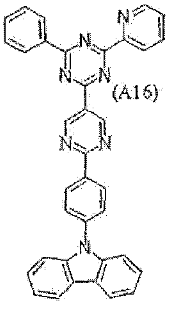
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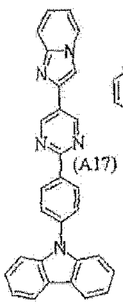
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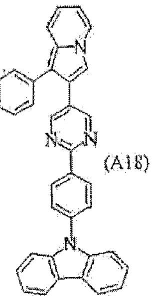
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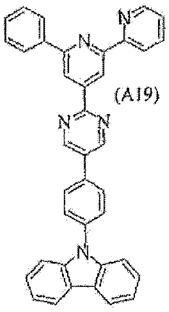
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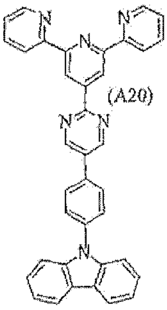
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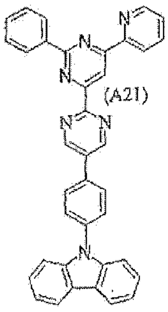
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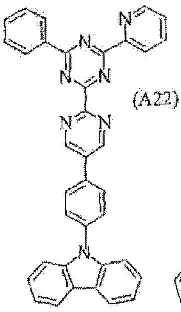
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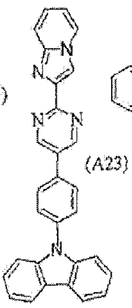
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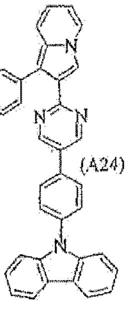
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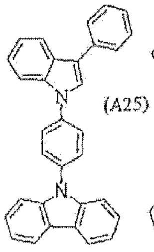
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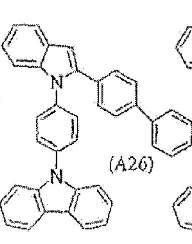
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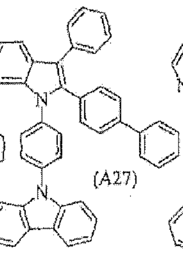
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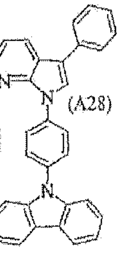
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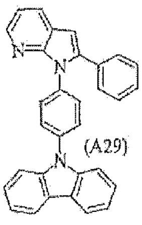
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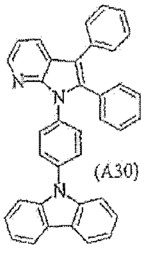
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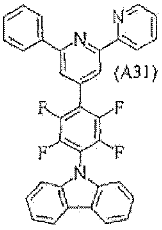
[Chemical Formula 65]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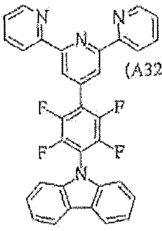
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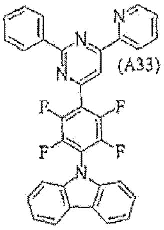
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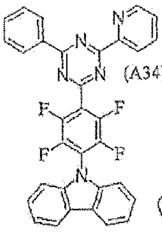
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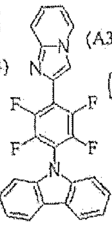
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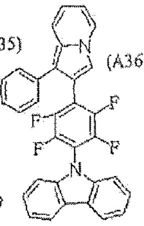
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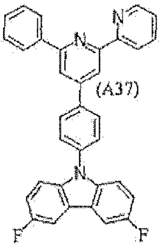
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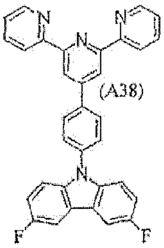
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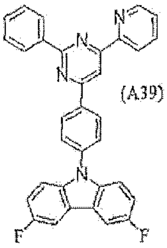
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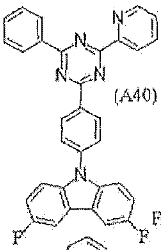
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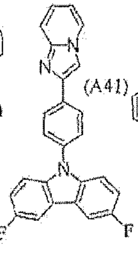
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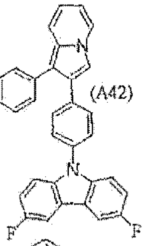
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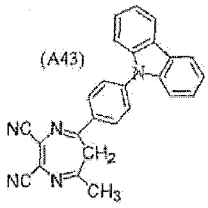
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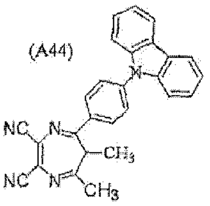
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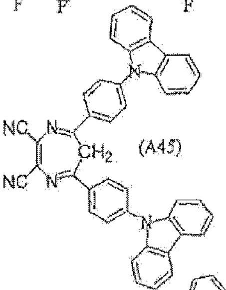
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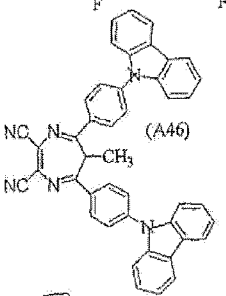
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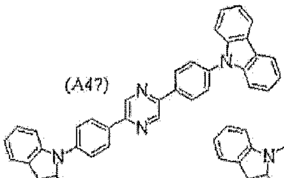
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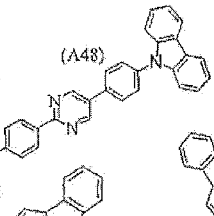
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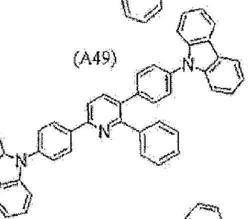
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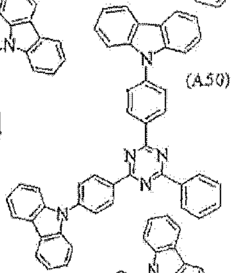
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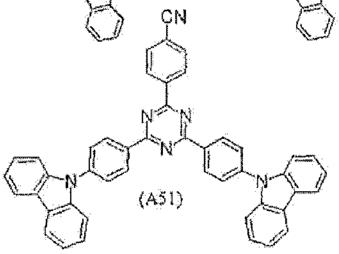
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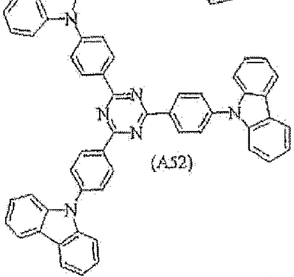
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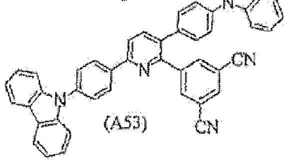
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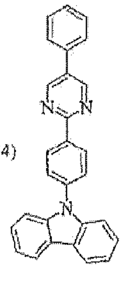
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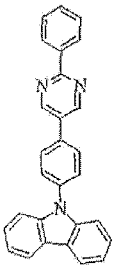
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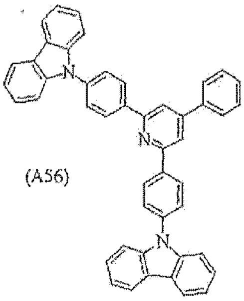
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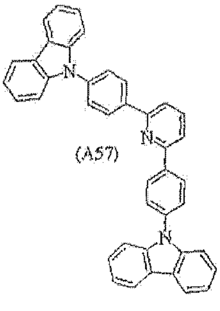
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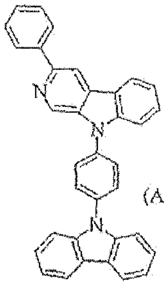
[Chemical Formula 66]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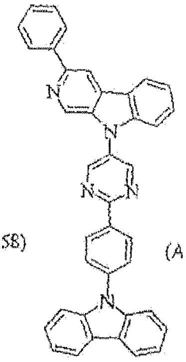
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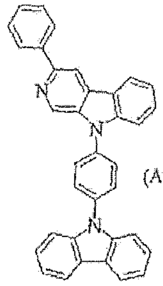
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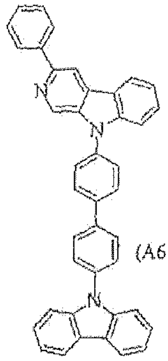
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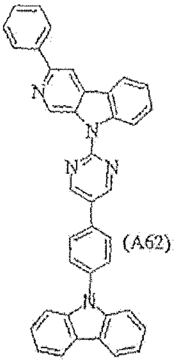
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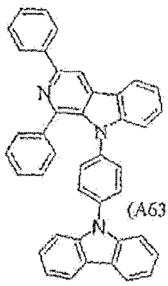
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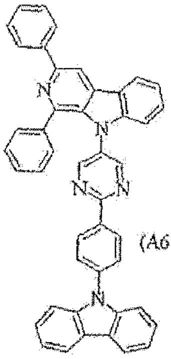
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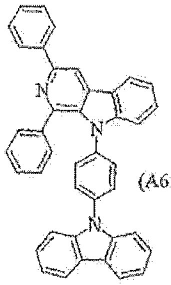
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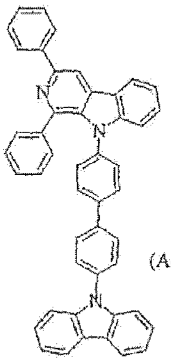
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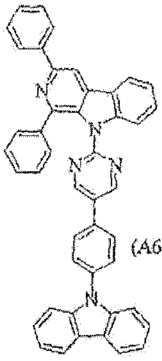
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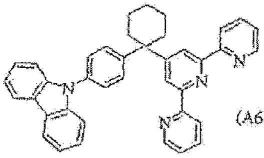
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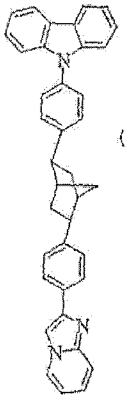
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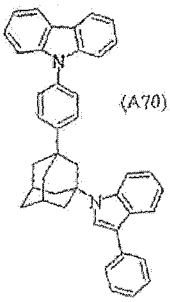
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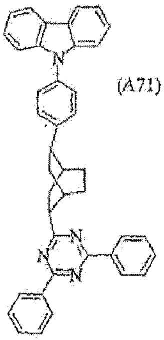
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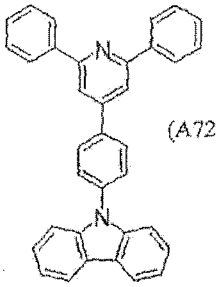
[Chemical Formula 67]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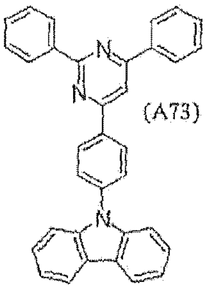
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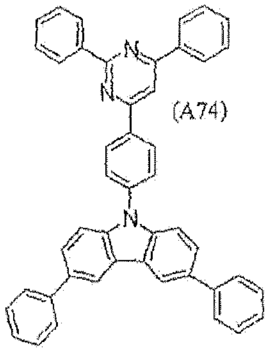
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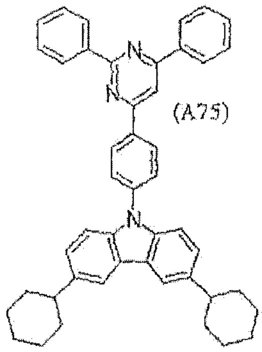
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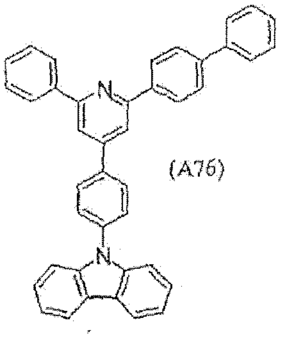
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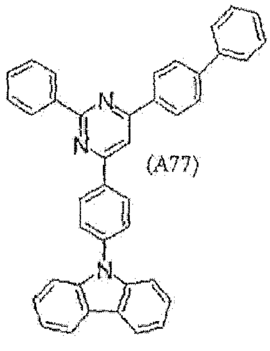
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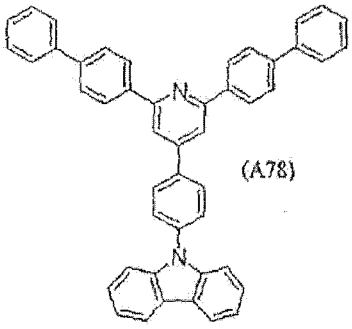
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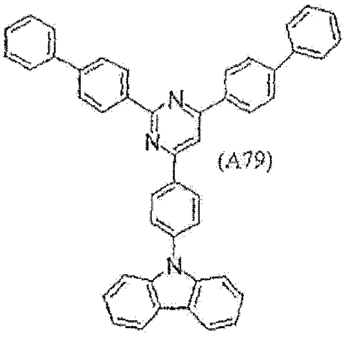
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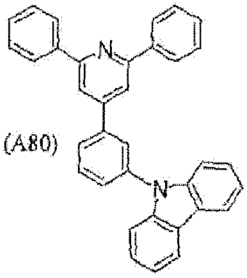
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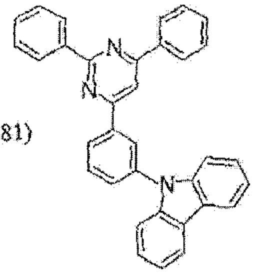
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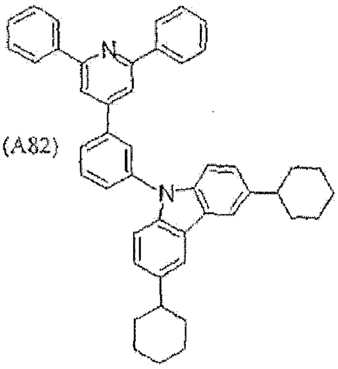
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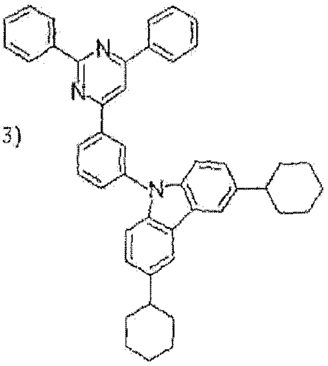
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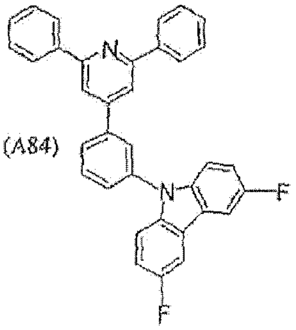
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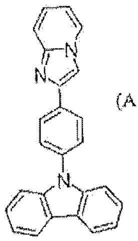
[Chemical Formula 68]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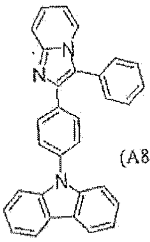
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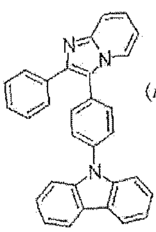
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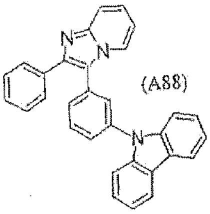
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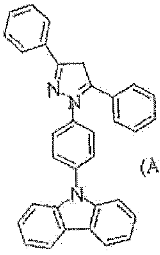
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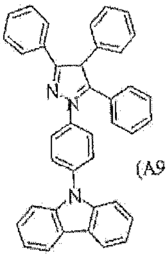
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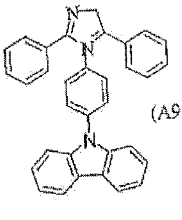
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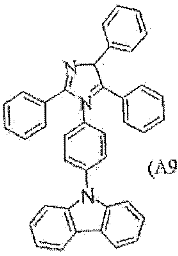
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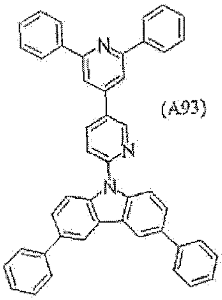
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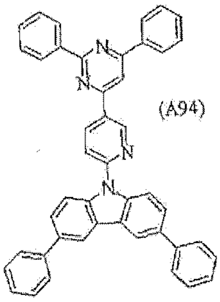
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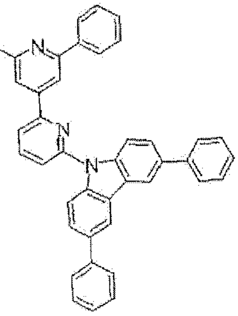
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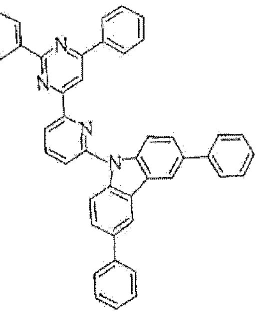
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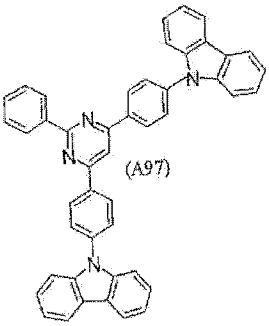
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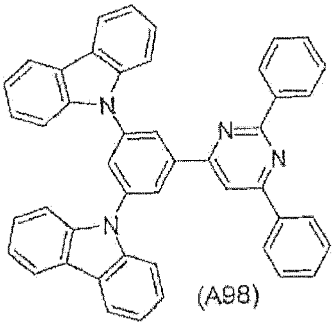
[Chemical Formula 69]



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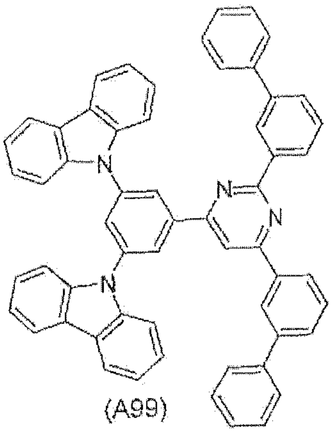
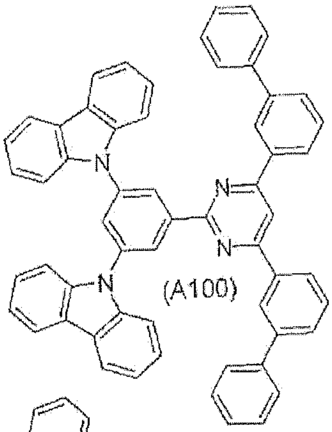


(A99)



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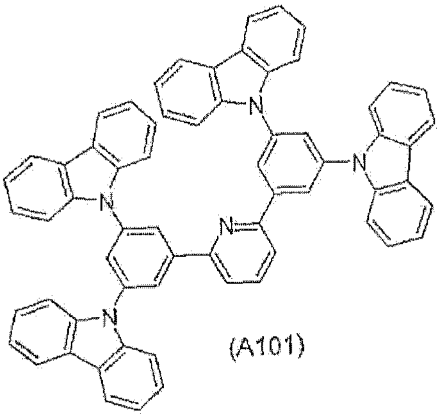
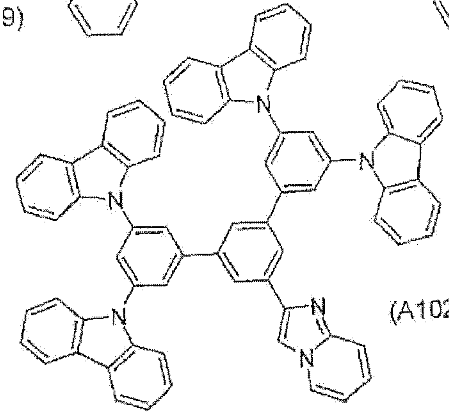
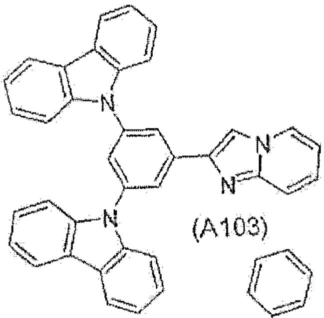


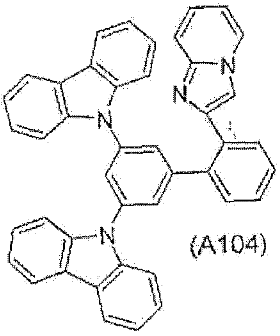
(A101)



(A102)



(A103)



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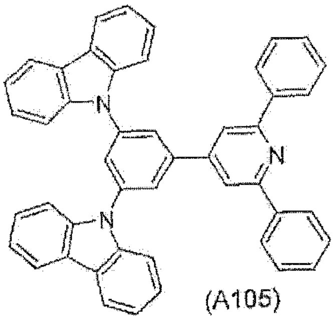

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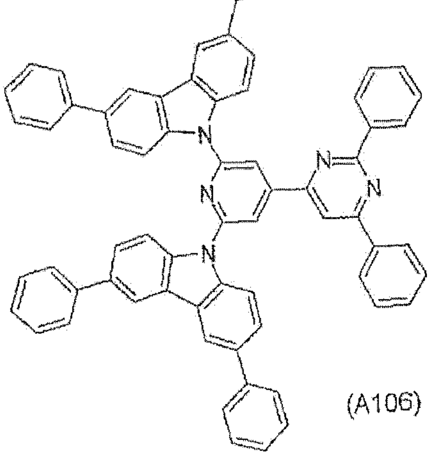
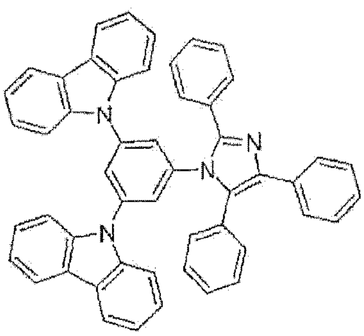
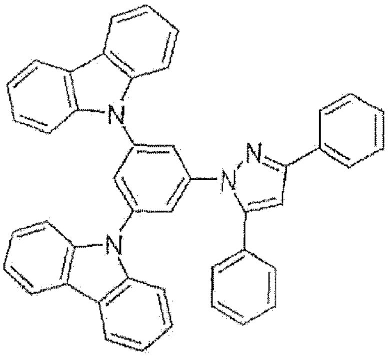


(A106)

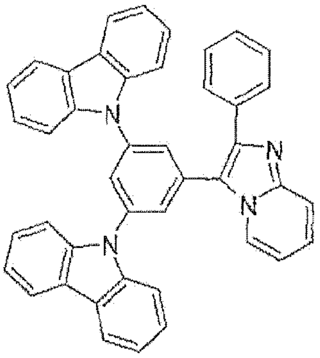


(A107)

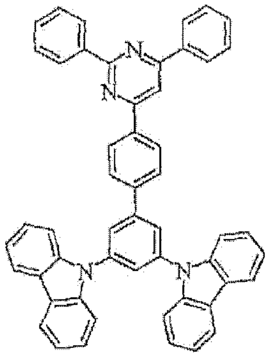
[Chemical Formula 70]



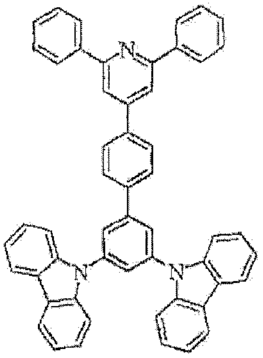
(A108)



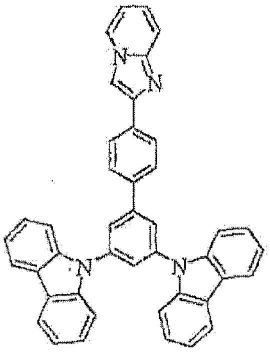
(A109)



(A110)



(A111)



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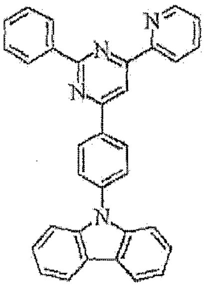

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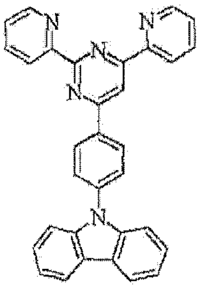
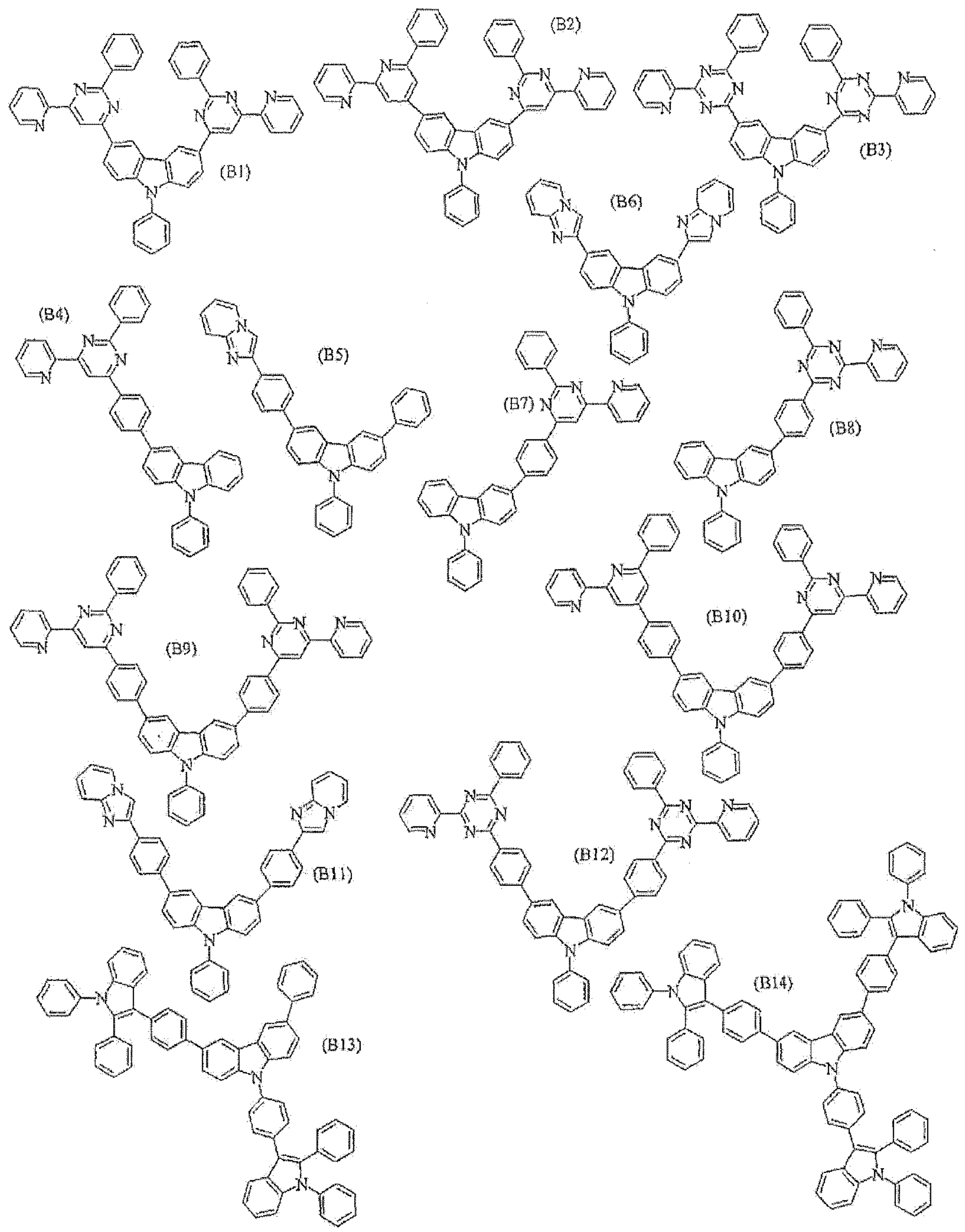


(A114)

[0242] Specific examples of the compound represented by the formula (7) are shown below, but the compound represented by the formula (7) is not limited thereto.

[Chemical Formula 71]



[0243] The compound represented by the formula (6) or (7) in this exemplary embodiment has triplet energy gap of 2.5 eV to 3.3 eV, preferably 2.5 eV to 3.2 eV.

[0244] The compound represented by the formula (6) or (7) in this exemplary embodiment has singlet energy gap of 2.8 eV to 3.8 eV, preferably 2.9 eV to 3.7 eV.

Third Exemplary Embodiment

[0245] An organic EL device according to a third exemplary embodiment is different from the organic EL device according to the second exemplary embodiment in that a material having a poor electron capability is used as the second material.

[0246] When a material having an excellent electron injecting capability from the electrode (e.g., LiF) is used as the cathode, a carrier balance in the emitting layer becomes shifted toward the anode. For improving such a disadvantage, it is preferable to select a material having a poor electron injecting capability as the second host material. Specifically, the second host material of this exemplary embodiment is preferably a compound in which A^3 is a group represented by the following formula (8B) in the formula (6) or (7).

[0247] [Chemical Formula 72]

$$(M^3)_c\text{-}(L^6)_d\text{-}(M^4)_e \qquad (8B)$$

[0248] In the formula (8B): M^3 and M^4 each independently represent a substituted or unsubstituted aromatic hydrocarbon group having 6 to 40 ring carbon atoms; M^3 and M^4 may be the same or different;
L^6 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, or substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms;
c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0249] In the formula (8B), as the aromatic hydrocarbon group for M^3 and M^4 and the the aromatic hydrocarbon group, fused aromatic hydrocarbon group and cycloalkylene group for L^6, those represented by the formula (8A) can be used. As bonding patterns of the groups represented by the formula (8B), the same bonding patterns as those of the formula (8A) can be used. Specifically, in the bonding patterns of the formula (8A), M^1, L^5 and M^2 may be respectively replaced with M^3, L^6 and M^4.

[0250] In the bonding patterns of the formulae (6), (7) and (8B) and exemplary combinations of the groups as described above, compounds represented by [5] to [8] below are preferable.
a=1 is given in the formula (6) and c=1 and d=0 are given in the formula (8B).

[0251] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0252] In the formula (8B): M^3 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^6 is a substituted or unsubstituted aryl group or aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.
a=2 is given in the formula (6) and c=1 and e=0 are given in the formula (8B).

[0253] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0254] In the formula (8B): M^3 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^6 is a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

[0255] [7] a=1 is given in the formula (6) and c=2 and e=0 are given in the formula (8B).

[0256] In the formula (6), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

[0257] In the formula (8B): M^3 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^6 is a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.
b=2 is given in the formula (7) and c=d=1 is given in the formula (8B).

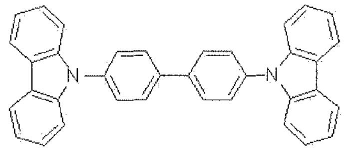
[0258] In the formula (7), Cz is a substituted or unsubstituted arylcarbazolyl group or substituted or unsubstituted carbazolylaryl group.

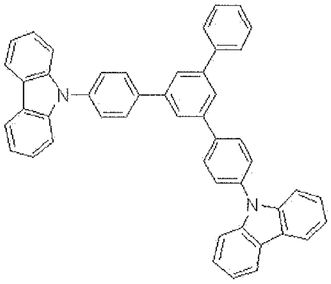
[0259] In the formula (8B): M^3 is a substituted or unsubstituted nitrogen-containing six-membered or seven-membered hetero ring having 4 to 5 ring carbon atoms, substituted or unsubstituted nitrogen-containing five-membered hetero ring having 2 to 4 ring carbon atoms, substituted or unsubstituted nitrogen-containing hetero ring having 8 to 11 ring carbon atoms, substituted or unsubstituted imidazopyridinyl ring; and L^6 is a substituted or unsubstituted aromatic hydrocarbon group or fused aromatic hydrocarbon group having 6 to 30 carbon atoms and substituted or unsubstituted aromatic heterocyclic group or fused aromatic heterocyclic group having 2 to 30 carbon atoms.

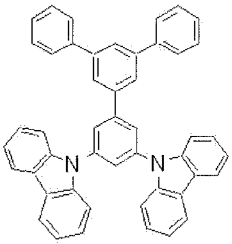
[0260] In the formulae (6) and (7), Cz is preferably a substituted or unsubstituted arylcarbazolyl group, more preferably phenylcarbozolyl group. Moreover, an aryl site of the arylcarbazolyl group is preferably substituted by a carbazolyl group.

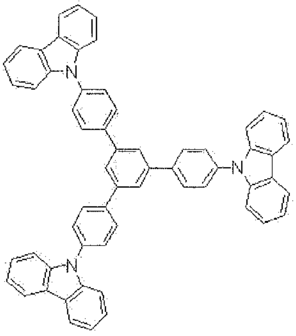
[0261] Examples of the compound in which A^3 is a group represented by the following formula (8B) in the formula (6) or (7) are listed below.

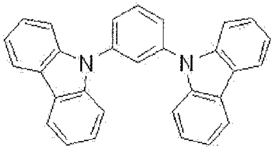
[Chemical Formula 73]

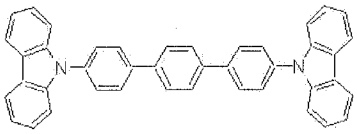


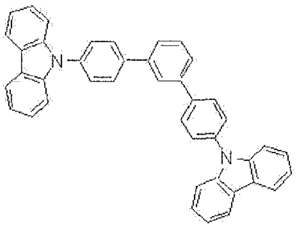


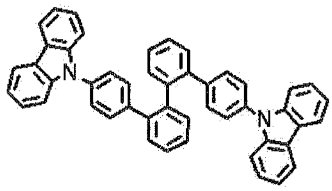


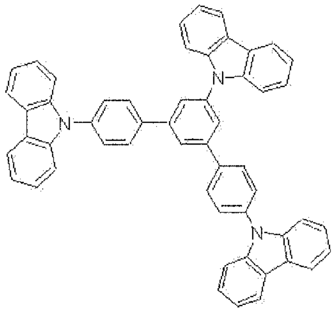




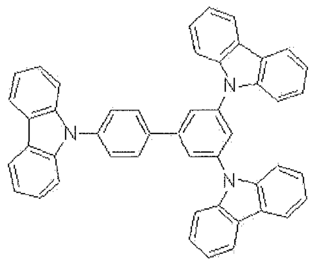


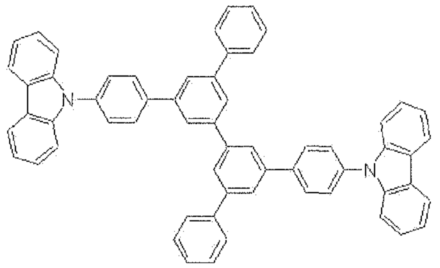


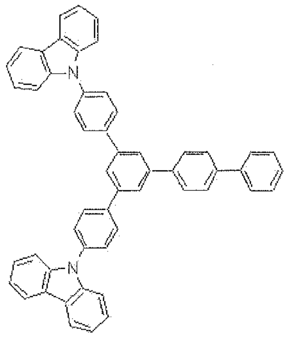


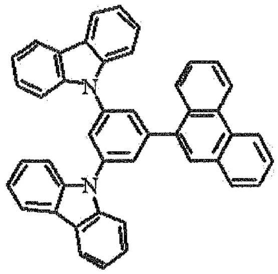


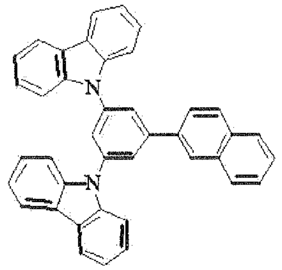
[Chemical Formula 74]

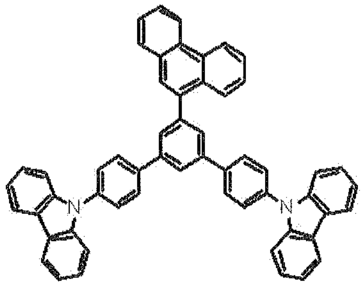


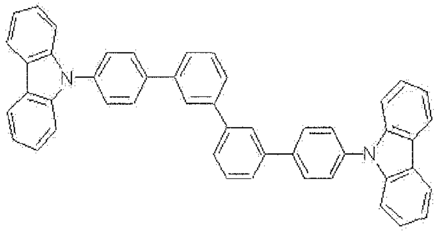


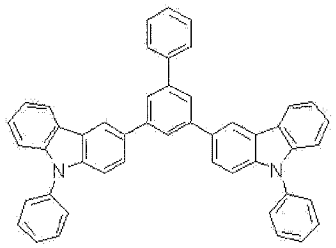






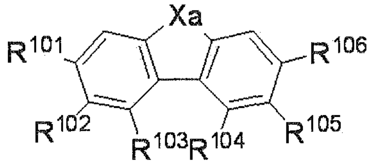






[0262] As the second host material of this exemplary embodiment, a compound represented by a formula (9) below may be used.

[Chemical Formula 75]



···(9)

[0263] In the formula (9): R^{101} to R^{106} each independently represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms or cyano group;
at least one of R^{101} to R^{106} represents a substituted or unsubstituted 9-carbazolyl group, substituted or unsubstituted azacarbazolyl group having 2 to 5 nitrogen atoms, or - L-9-carbazolyl group; L represents an alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryloxy group having

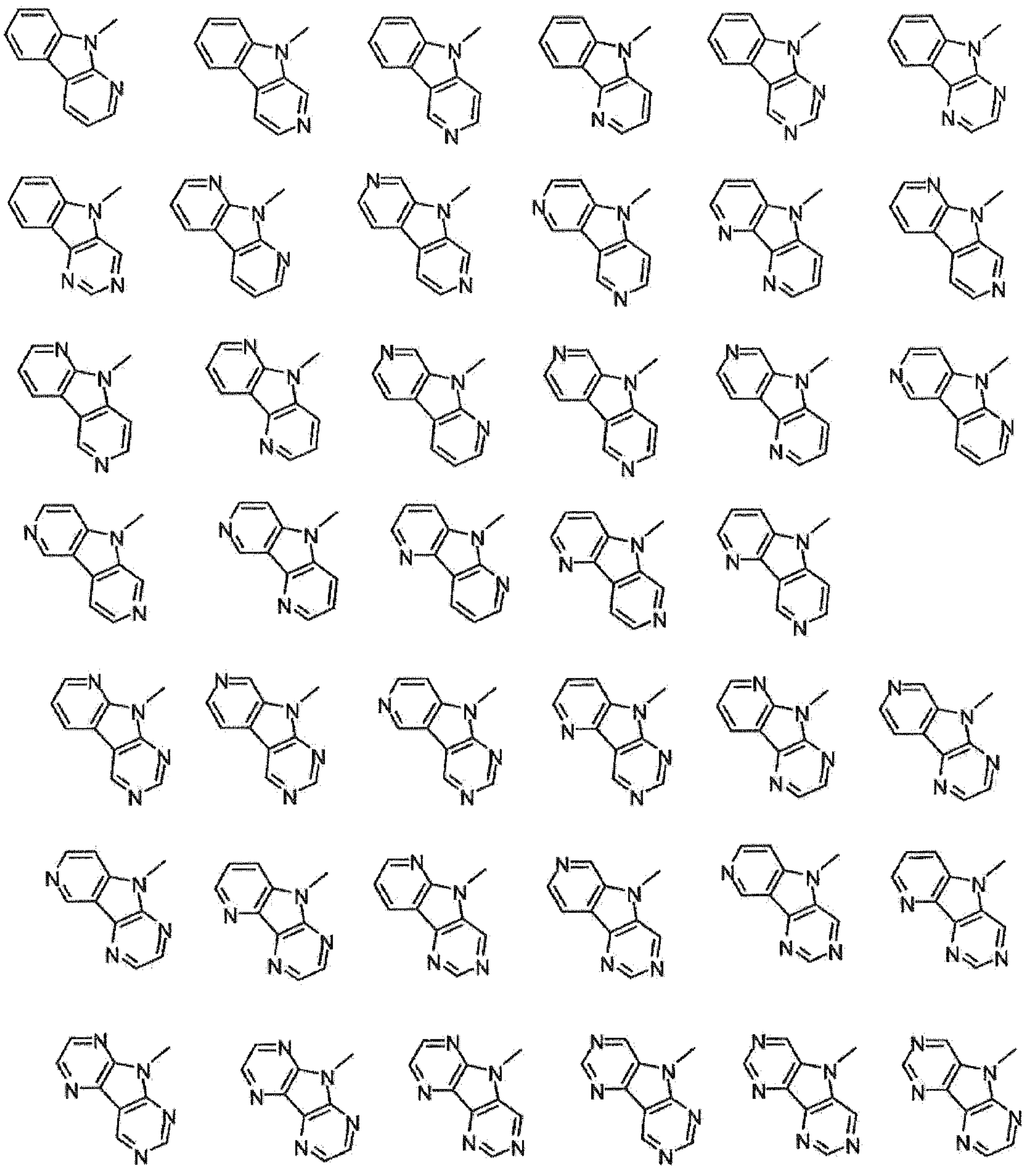
6 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms or cyano group;

Xa represents a sulfur atom, oxygen atom or N-R^{108}; and

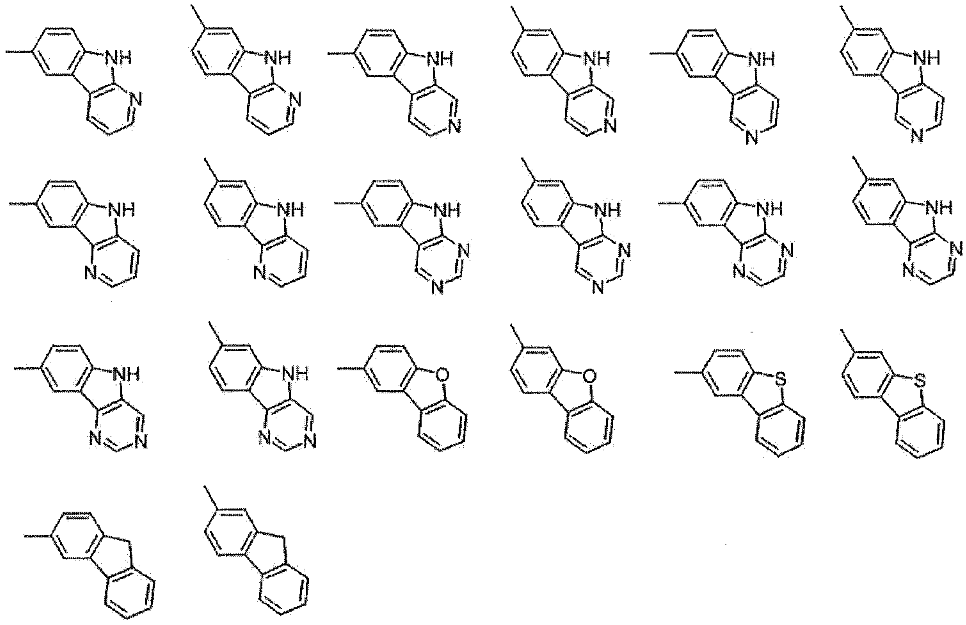
R^{108} represents the same as R^{101} to R^{106}.

[0264] Specific examples of the substituted or unsubstituted azacarbazolyl group having 2 to 5 nitrogen atoms are shown below (in which any substituent is omitted), but the substituted or unsubstituted azacarbazolyl group is not limited thereto.

[Chemical Formula 76]



[Chemical Formula 77]



[0265] Examples of the halogen atom include fluorine, chlorine, bromine, and iodine.

[0266] Examples of the substituted or unsubstituted alkyl group having 1 to 40 carbon atoms include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-nonyl group, an n-decyl group, an n-undecyl group, an n-dodecyl group, an n-tridecyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, a neopentyl group, a 1-methylpentyl group, a 2-methylpentyl group, a 1-pentylhexyl group, a 1-butylpentyl group, a 1-heptyloctyl group, a 3-methylpentyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 1,2-dinitroethyl group, a 2,3-dinitro-t-butyl group, and a 1,2,3-trinitropropyl group, among of which a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-nonyl group, an n-decyl group, an n-undecyl group, an n-dodecyl group, an n-tridecyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, a neopentyl group, a 1-methylpentyl group, a 1-pentylhexyl group, a 1-butylpentyl group, a 1-heptyloctyl group are preferable. The alkyl group (excluding a substituent) preferably has 1 to 10 carbon atoms.

[0267] Examples of the substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms include a cyclopentyl group, cyclohexyl group, cyclooctyl group, and 3,5,5,5-tetramethylcyclohexyl group. A cyclohexyl group, cyclooctyl group, and 3,5-tetramethylcyclohexyl group are preferable. The cycloalkyl group (excluding a substituent) preferably has 3 to 12 carbon atoms.

[0268] Examples of the substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms are a 1-pyroryl group, 2-pyroryl group, 3-pyroryl group, pyrazinyl group, 2-pyridinyl group, 1-imidazolyl, 2-imidazolyl, 1-pyrazolyl, 1-indolidinyl, 2-indolidinyl, 3-indolidinyl, 5-indolidinyl, 6-indolidinyl, 7-indolidinyl, 8-indolidinyl, 2-imidazopyridinyl, 3-imidazopyridinyl, 5-imidazopyridinyl, 6-imidazopyridinyl, 7-imidazopyridinyl, 8-imidazopyridinyl, 3-pyridinyl group, 4-pyridinyl group, 1-indolyl group, 2-indolyl group, 3-indolyl group, 4-indolyl group, 5-indolyl group, 6-indolyl group, 7-indolyl group, 1-isoindolyl group, 2-isoindolyl group, 3-isoindolyl group, 4-isoindolyl group, 5-isoindolyl group, 6-isoindolyl group, 7-isoindolyl group, 2-furyl group, 3-furyl group, 2-benzofuranyl group, 3-benzofuranyl group, 4-benzofuranyl group, 5-benzofuranyl group, 6-benzofuranyl group, 7-benzofuranyl group, 1-isobenzofuranyl group, 3-isobenzofuranyl group, 4-isobenzofuranyl group, 5-isobenzofuranyl group, 6-isobenzofuranyl group, 7-isobenzofuranyl group, 2-quinolyl group, 3-quinolyl group, 4-quinolyl group, 5-quinolyl group, 6-quinolyl group, 7-quinolyl group, 8-quinolyl group, 1-isoquinolyl group, 3-isoquinolyl group, 4-isoquinolyl group, 5-isoquinolyl group, 6-isoquinolyl group, 7-isoquinolyl group, 8-isoquinolyl group, 2-quinoxalinyl group, 5-quinoxalinyl group, 6-quinoxalinyl group, 1-carbazolyl group, 2-carbazolyl group, 3-carbazolyl group, 4-carbazolyl group, 9-carbazolyl group, azacarbazolyl-1-yl, azacarbazolyl-2-yl, azacarbazolyl-3-yl, azacarbazolyl-4-yl, azacarbazolyl-5-yl, azacarbazolyl-6-yl, azacarbazolyl-7-yl, azacarbazolyl-8-yl, azacarbazolyl-9-yl, 1-phenanthrydinyl group, 2-phenanthrydinyl group, 3-phenanthrydinyl group, 4-phenanthrydinyl group, 6-phenanthrydinyl group, 7-phenanthrydinyl group, 8-phenanthrydinyl group, 9-phenanthrydinyl group, 10-phenanthrydinyl group, 1-acridinyl group, 2-acridinyl group, 3-acridinyl group, 4-acridinyl group, 9-acridinyl group, 1,7-phenanthroline-2-yl group, 1,7-phenanthroline-3-yl group, 1,7-phenanthroline-4-yl group, 1,7-phenanthroline-5-yl group, 1,7-phenanthroline-6-yl group, 1,7-phenanthroline-8-yl group, 1,7-phenanthroline-9-yl group, 1,7-phenanthroline-10-yl group, 1,8-phenanthroline-2-yl group, 1,8-phenanthroline-3-yl group, 1,8-phenanthroline-4-yl group, 1,8-phenanthroline-5-yl group, 1,8-phenanthroline-6-yl group, 1,8-phenanthroline-7-yl group, 1,8-phenanthroline-9-yl group, 1,8-phenanthroline-10-yl group, 1,9-phenanthroline-2-yl group, 1,9-phenanthroline-3-yl group, 1,9-phenanthroline-4-yl group, 1,9-phenanthroline-5-yl group, 1,9-phenanthroline-6-yl group, 1,9-phenanthroline-7-yl group, 1,9-phenanthroline-8-yl group, 1,9-phenanthroline-10-yl group, 1,10-phenanthroline-2-yl group, 1,10-phenanthroline-3-yl group, 1,10-phenanthroline-4-yl group, 1,10-phenanthroline-5-yl group, 2,9-phenanthroline-1-yl group, 2,9-phenanthroline-3-yl group, 2,9-phenanthroline-4-yl group, 2,9-phenanthroline-5-yl group, 2,9-phenanthroline-6-yl group, 2,9-phenanthroline-7-yl group, 2,9-phenanthroline-8-yl group, 2,9-phenanthroline-10-yl group, 2,8-phenanthroline-1-yl group, 2,8-phenanthroline-3-yl group, 2,8-phenanthroline-4-yl group, 2,8-phenanthroline-5-yl group, 2,8-phenanthroline-6-yl group, 2,8-phenanthroline-7-yl group, 2,8-phenanthroline-9-yl group, 2,8-phenanthroline-10-yl group, 2,7-phenanthroline-1-yl group, 2,7-phenanthroline-3-yl group, 2,7-phenanthroline-4-yl group, 2,7-phenanthroline-5-yl group, 2,7-phenanthroline-6-yl group, 2,7-phenanthroline-8-yl group, 2,7-phenanthroline-9-yl group, 2,7-phenanthroline-10-yl group, 1-phenazinyl group, 2-phenazinyl group, 1-phenothiazinyl group, 2-phenothiazinyl group, 3-phenothiazinyl group, 4-phenothiazinyl group, 10-phenothiazinyl group, 1-phenoxazinyl group, 2-phenoxazinyl group, 3-phenoxazinyl group, 4-phenoxazinyl group, 10-phenoxazinyl group, 2-oxazolyl group, 4-oxazolyl group, 5-oxazolyl group, 2-oxadiazolyl group, 5-oxadiazolyl group, 3-furazanyl group, 2-thienyl group, 3-thienyl group, 2-methylpyrrole-1-yl group, 2-methylpyrrole-3-yl group, 2-methylpyrrole-4-yl group, 2-methylpyrrole-5-yl group, 3-methylpyrrole-1-yl group, 3-methylpyrrole-2-yl group, 3-methylpyrrole-4-yl group, 3-methylpyrrole-5-yl group, 2-t-butylpyrrole-4-yl group, 3-(2-phenylpropyl)pyrrole-1-yl group, 2-methyl-1-indolyl group, 4-methyl-1-indolyl group, 2-methyl-3-indolyl group, 4-methyl-3-indolyl group, 2-t-butyl-1-indolyl group, 4-t-butyl-1-indolyl group, 2-t-butyl-3-indolyl group, 4-t-butyl-3-indolyl group, 1-dibenzofuranyl group, 2-dibenzofuranyl group, 3-dibenzofuranyl group, 4-dibenzofuranyl group, 1-dibenzothiophenyl group, 2-dibenzothiophenyl group, 3-dibenzothiophenyl group, 4-dibenzothiophenyl group, 1-silafluorenyl group, 2-silafluorenyl group, 3-silafluorenyl group, 4-silafluorenyl group, 1-germafluorenyl group, 2-germafluorenyl group, 3-germafluorenyl group and 4-germafluorenyl group.

[0269] Among the above, the heterocyclic group is preferably a 2-pyridinyl group, 1-indolidinyl, 2-indolidinyl, 3-indolidinyl, 5-indolidinyl, 6-indolidinyl, 7-indolidinyl, 8-indolidinyl, 2-imidazopyridinyl, 3-imidazopyridinyl, 5-imidazopyridinyl, 6-imidazopyridinyl, 7-imidazopyridinyl, 8-imidazopyridinyl, 3-pyridinyl group, 4-pyridinyl group, 1-indolyl group, 2-indolyl group, 3-indolyl group, 4-indolyl group, 5-indolyl group, 6-indolyl group, 7-indolyl group, 1-isoindolyl group, 2-isoindolyl group, 3-isoindolyl group, 4-isoindolyl group, 5-isoindolyl group, 6-isoindolyl group, 7-isoindolyl group, 9-carbazolyl group, 1-dibenzofuranyl group, 2-dibenzofuranyl group, 3-dibenzofuranyl group, 4-dibenzofuranyl group, 1-dibenzothiophenyl group, 2-dibenzothiophenyl group, 3-dibenzothiophenyl group, 4-dibenzothiophenyl group, 1-silafluorenyl group, 2-silafluorenyl group, 3-silafluorenyl group, 4-silafluorenyl group, 1-germafluorenyl group, 2-germafluorenyl group, 3-germafluorenyl group, 4-germafluorenyl group, azacarbazolyl-1-yl group, azacarbazolyl-2-yl group, azacarbazolyl-3-yl group, azacarbazolyl-4-yl group, azacarbazolyl-5-yl group, azacarbazolyl-6-yl group, azacarbazolyl-7-yl group, azacarbazolyl-8-yl group, and azacarbazolyl-9-yl group. The heterocyclic group (excluding a substituent) preferably has 3 to 14 carbon atoms.

[0270] The substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms is a group represented by -OY. Examples of Y are the same as those described in relation to the alkyl group. Preferred examples are also the same.

[0271] Examples of the substituted or unsubstituted aryl group having 6 to 40 carbon atoms (including a fused aromatic hydrocarbon group and a ring assembly aromatic hydrocarbon group) are a phenyl group, 2-biphenylyl group, 3-biphenylyl group, 4-biphenylyl group, p-terphenyl-4-yl group, p-terphenyl-3-yl group, p-terphenyl-2-yl group, m-terphenyl-4-yl group, m-terphenyl-3-yl group, m-terphenyl-2-yl group, o-tolyl group, m-tolyl group, p-tolyl group, p-t-butylphenyl group, p-(2-phenylpropyl)phenyl group, 4'-methylbiphenylyl group, 4"-t-butyl-p-terphenyl-4-yl group, o-cumenyl group, m-cumenyl group, p-cumenyl group, 2,3-xylyl group, 3,4-xylyl group, 2,5-xylyl group, mesityl group and m-quarter-phenyl group. Among the above, the substituted or unsubstituted aryl group is preferably a phenyl group, 2-biphenylyl group, 3-biphenylyl group, 4-biphenylyl group, m-terphenyl-4-yl group, m-terphenyl-3-yl group, m-terphenyl-2-yl group, p-tolyl group, 3,4-xylyl group, m-quarter-phenyl-2-yl group, 1-naphtyl group, 2-naphtyl group, 1-phenanthrenyl group, 2-phenanthrenyl group, 3-phenanthrenyl group, 4-phenanthrenyl group, 9-phenanthrenyl group, 1-triphenylenyl group, 2-triphenylenyl group, 3-triphenylenyl group, 4-triphenylenyl group, 1-chrysenyl group, 2-chrysenyl group, 3-chrysenyl group, 4-chrysenyl group, 5-chrysenyl group, and 6-chrysenyl group. The aryl group (excluding a substituent) preferably has 6 to 24 carbon atoms. The aryl group preferably further includes a 9-carbazolyl group as a substituent.

[0272] The substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms is a group represented by -OAr. Examples of Ar are the same as those described in relation to the aryl group. Preferred examples are also the same.

[0273] Examples of the substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms are a benzyl group, 1-phenylethyl group, 2-phenylethyl group, 1-phenylisopropyl group, 2-phenylisopropyl group, phenyl-t-butyl group, α-naphthylmethyl group, 1-α-naphthylethyl group, 2-α-naphthylethyl group, 1-α-naphthylisopropyl group, 2-α-naphthylisopropyl group, β-naphthylmethyl group, 1-β-naphthylethyl group, 2-β-naphthylethyl group, 1-β-naphthylisopropyl group, 2-β-naphthylisopropyl group, 1-pyrorylmethyl group, 2-(1-pyroryl)ethyl group, p-methylbenzyl group, m-methylbenzyl group, o-methylbenzyl group, p-chlorobenzyl group, m-chlorobenzyl group, o-chlorobenzyl group, p-bromobenzyl group, m-bromobenzyl group, o-bromobenzyl group, p-iodobenzyl group, m-iodobenzyl group, o-iodobenzyl group, p-hydroxybenzyl group, m-hydroxybenzyl group, o-hydroxybenzyl group, p-aminobenzyl group, m-aminobenzyl group, o-aminobenzyl group, p-nitrobenzyl group, m-nitrobenzyl group, o-nitrobenzyl group, p-cyanobenzyl group, m-cyanobenzyl group, o-cyanobenzyl group, 1-hydroxy-2-phenylisopropyl group, 1-chloro-2-phenylisopropyl group and the like. Among these, preferred are a benzyl group, a p-cyanobenzyl group, m-cyanobenzyl group, o-cyanobenzyl group, 1-phenylethyl group, 2-phenylethyl group, 1-phenylisopropyl group, and 2-phenylisopropyl group. An alkyl portion of the aralkyl group preferably has 1 to 8 carbon atoms. An aryl portion thereof (including heteroaryl) preferably has 6 to 18 carbon atoms.

[0274] The substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, the substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, and the substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms each are represented by $-NQ^1Q^2$. Examples of Q^1 and Q^2 each are independently the same as those described in relation to the alkyl group, aryl group and aralkyl group. Preferred examples are also the same.

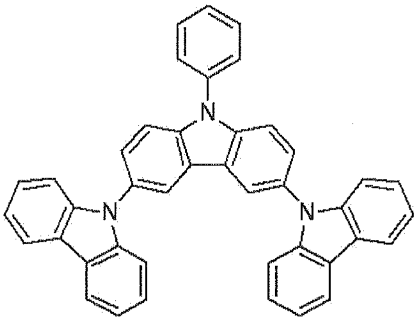
[0275] The substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms is represented by $-COAr^2$. Examples of Ar^2 are the same as those described in relation to the aryl group. Preferred examples are also the same.

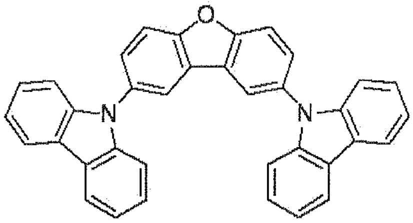
[0276] The substituted or unsubstituted arylthio group having 6 to 20 carbon atoms is exemplified by a group obtained by replacing an oxygen atom of the aryloxy group represented by -OAr with a sulfur atom. Preferred examples are also the same.

[0277] The substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms is exemplified by a halogenated alkyl group in which at least one hydrogen atom of the alkyl group is substituted by a halogen atom. Preferred examples are also the same.

[0278] The compound represented by the general formula (9) preferably has triplet energy gap of 2.2 eV to 3.2 eV. Specific examples of the formula (9) are shown below.

[Chemical Formula 78]





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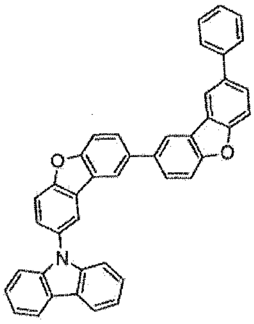

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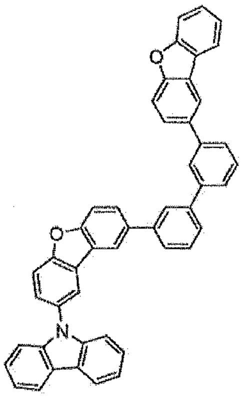

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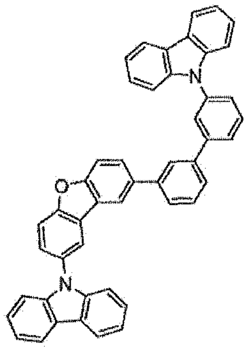

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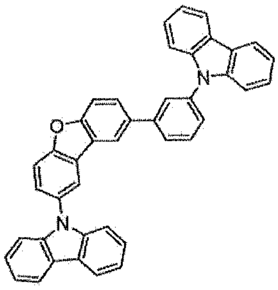

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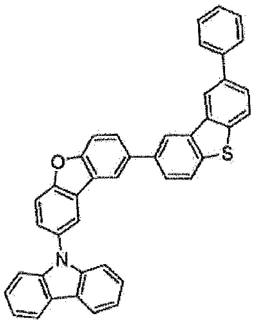

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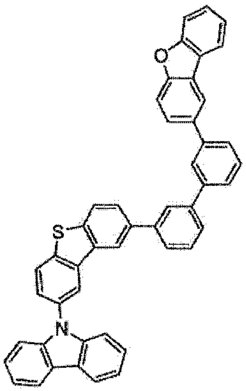

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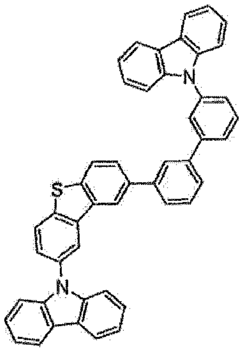

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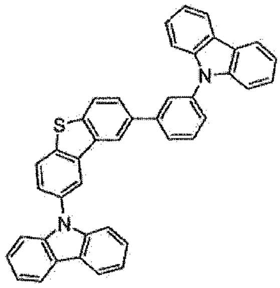

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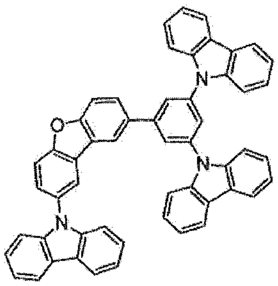

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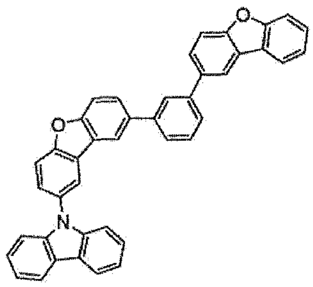

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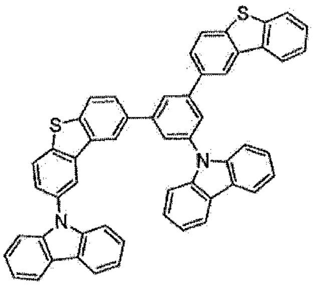

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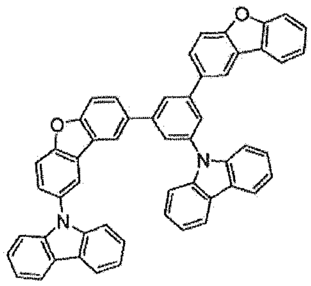

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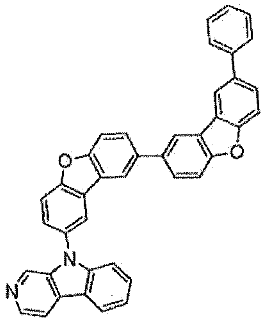
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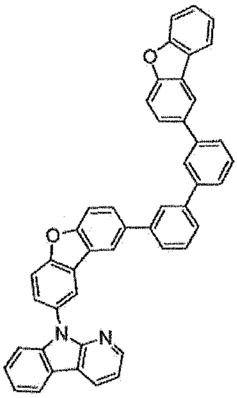
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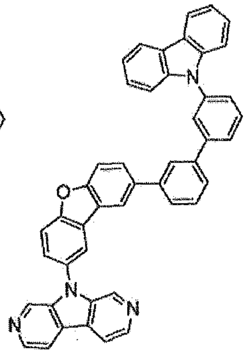
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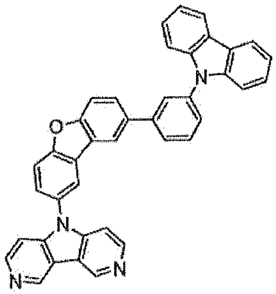
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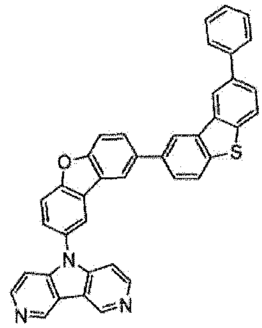
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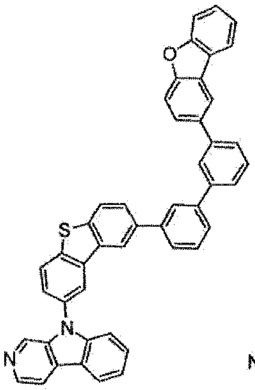
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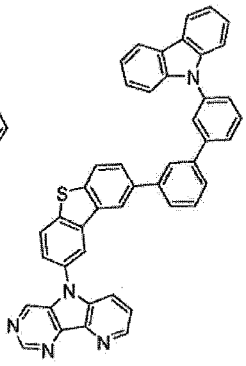
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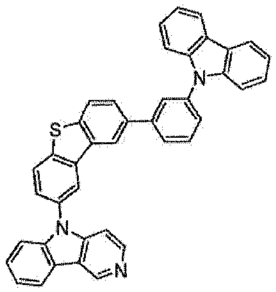
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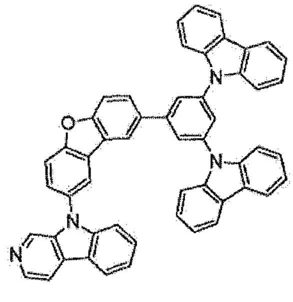
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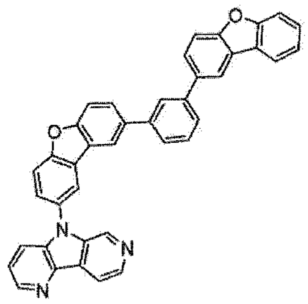
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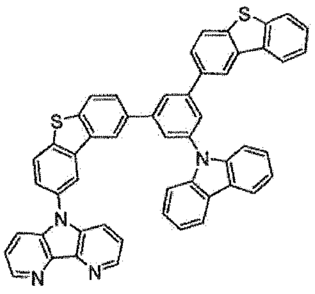
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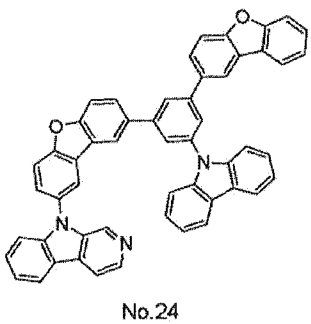
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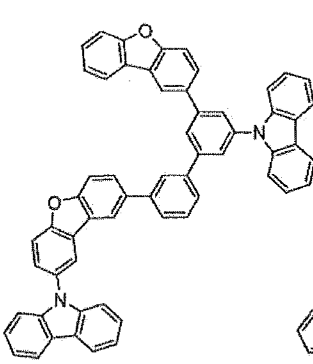

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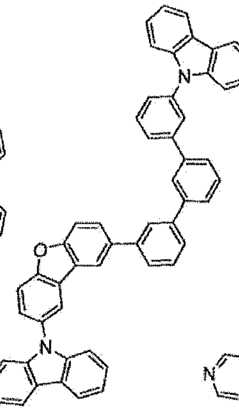

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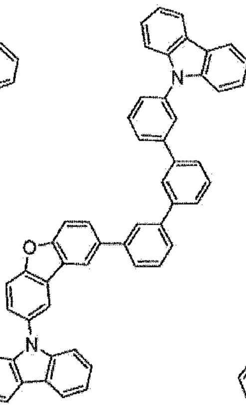

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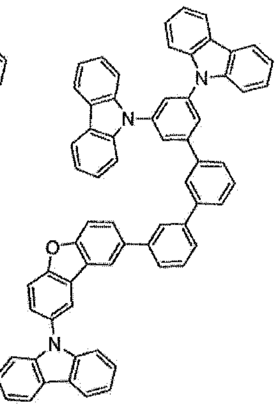

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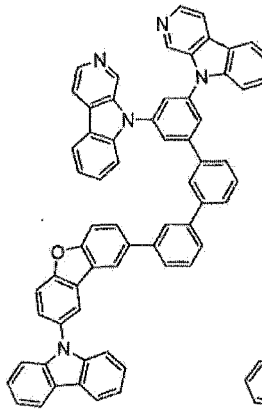

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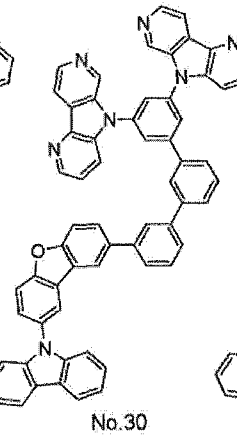

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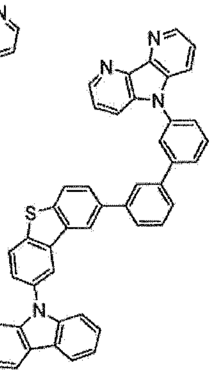

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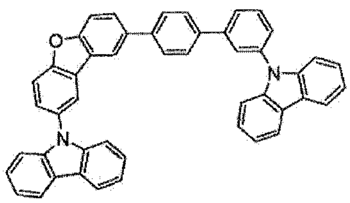

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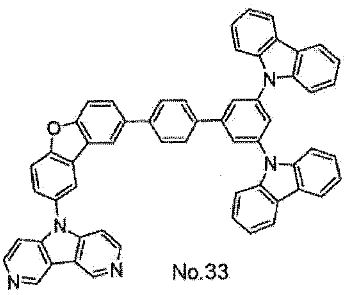

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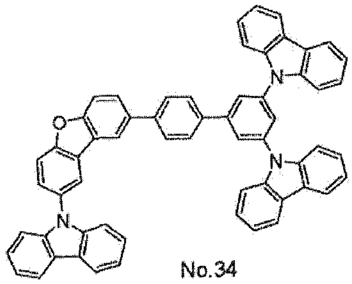

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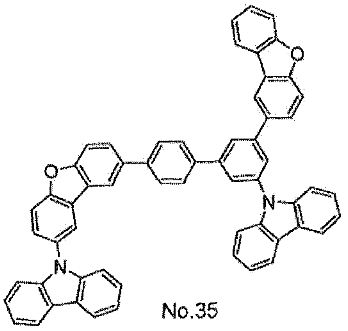

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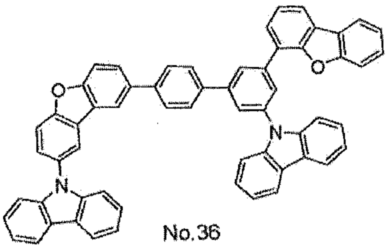

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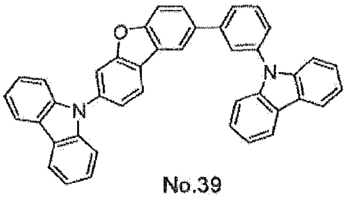
[Chemical Formula 82]



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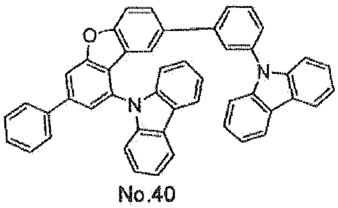

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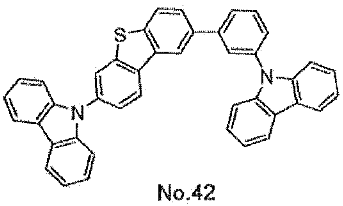

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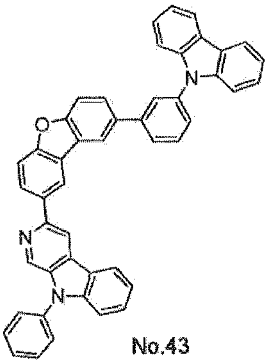

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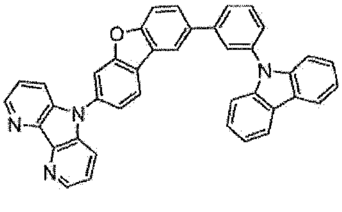

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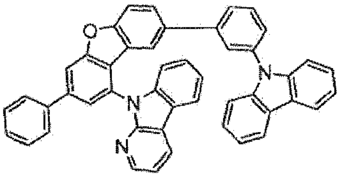

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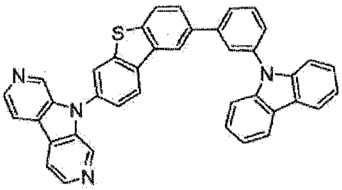

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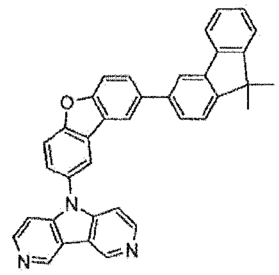
[Chemical Formula 83]



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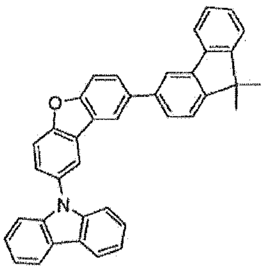

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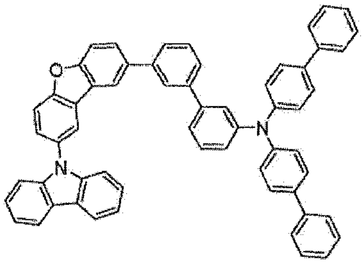

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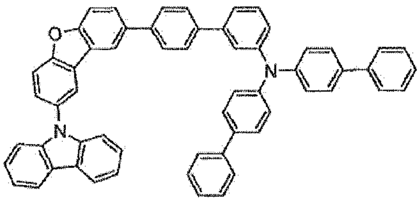

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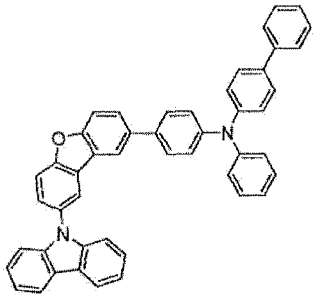

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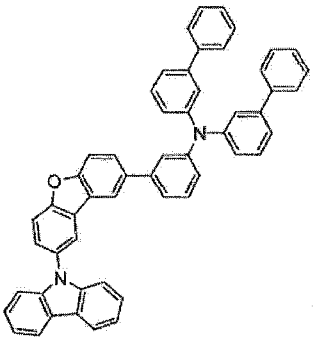

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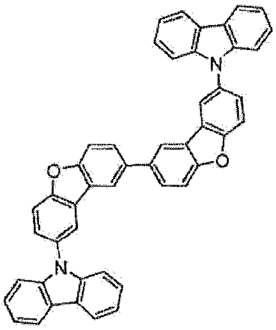

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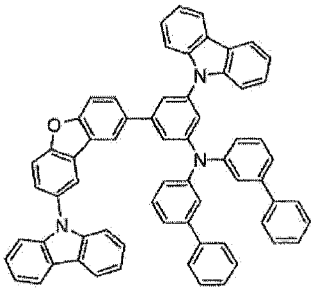

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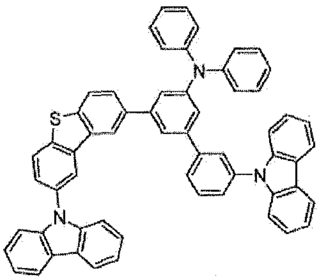

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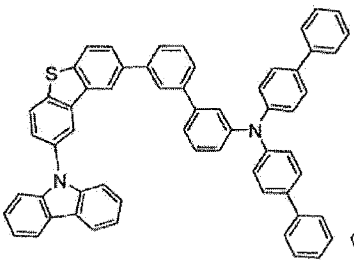

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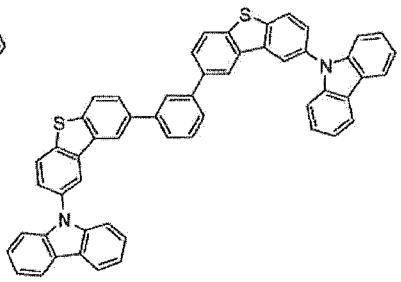
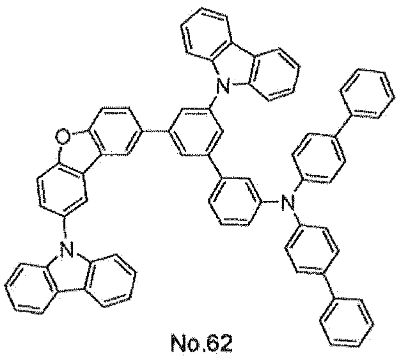


No.59

[Chemical Formula 84]



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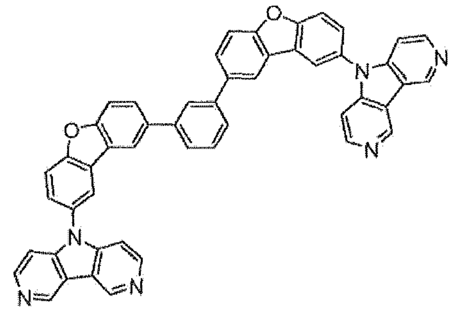

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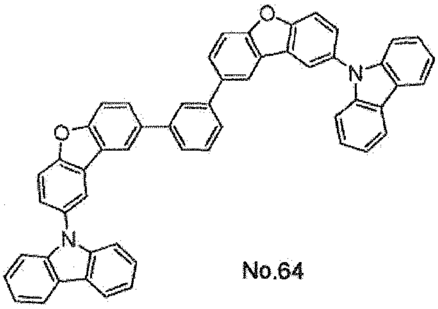

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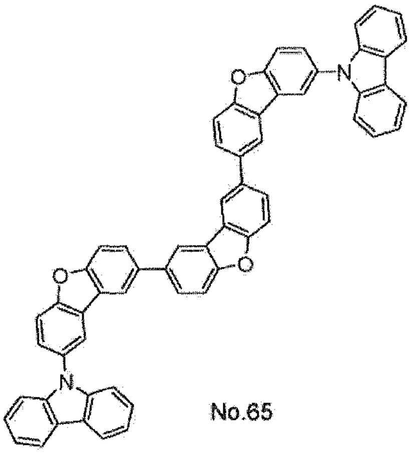

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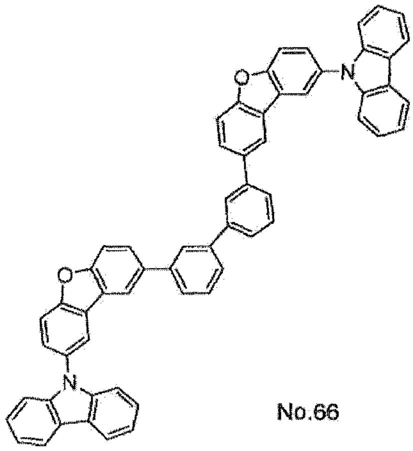

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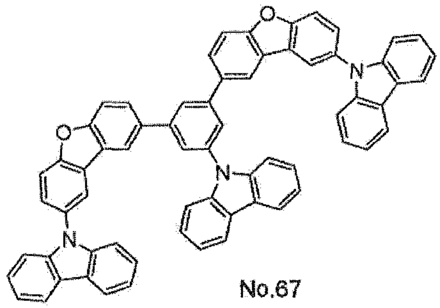


No.67

Fourth Exemplary Embodiment

[0279] An organic EL device according to a fourth exemplary embodiment is different from the organic EL devices according to the second and third exemplary embodiments in being a red phosphorescent device.

[0280] The compound according to this exemplary embodiment is not disclosed as a phosphorescent host material of which color is specified. However, since having a high resistance against oxidation and reduction, the compound is also applicable to a red phosphorescent device. As a red phosphorescent device, a hydrocarbon material, which exhibits a small triplet energy and broad π electron clouds compared with a green phosphorescent material, can be used. Although the hydrocarbon material is difficult to be used as a green phosphorescent material because of its small triplet energy, the hydrocarbon material is highly appropriate as a red phosphorescent host material because of its high oxidation and reduction. Accordingly, by using the hydrocarbon material as the second host material, a red phosphorescent device can become highly efficient.

[0281] The second host material is preferably a compound selected from the group consisting of polycyclic aromatic compounds represented by formulae (10A), (10B) and (10C) below.

$$Ra\text{-}Ar^{101}\text{-}Rb \qquad (10A)$$

$$Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Rb \qquad (10B)$$

$$Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Ar^{103}\text{-}Rb \qquad (10C)$$

[0282] In the formulae (10A) to (10C), Ar^{101}, Ar^{102}, Ar^{103}, Ra and Rb represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms.
Ar^{101}, Ar^{102}, Ar^{103}, Ra and Rb preferably represent a polycyclic aromatic skeleton selected from a substituted or unsubstituted benzene ring, substituted or unsubstituted naphthalene ring, substituted or unsubstituted chrysene ring, substituted or unsubstituted fluoranthene ring, substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzophenanthrene ring, substituted or unsubstituted dibenzophenanthrene ring, substituted or unsubstituted triphenylene ring, substituted or unsubstituted benzo[a]triphenylene ring, substituted or unsubstituted benzochrysene ring, substituted or unsubstituted benzo[b]fluoranthene ring, substituted or unsubstituted fluorene ring and substituted or unsubstituted picene ring.

[0283] Further, it is preferable that a substituent for each of Ra and Rb is not an aryl group and that Ar^{101}, Ar^{102}, Ar^{103}, Ra and Rb are not substituted or unsubstituted benzene ring at the same time.

[0284] Moreover, in the formulae (10A) to (10C), either one or both of Ra and Rb are preferably selected from the group consisting of a substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzo[c]phenanthrene ring and substituted or unsubstituted fluoranthene ring.

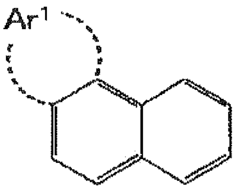
[0285] The polycyclic aromatic skeleton of the polycyclic aromatic compound may be substituted.

[0286] Examples of the substituent for the polycyclic aromatic skeleton are a halogen atom, hydroxyl group, substituted or unsubstituted amino group, nitro group, cyano group, substituted or unsubstituted alkyl group, substituted or unsubstituted alkenyl group, substituted or unsubstituted cycloalkyl group, substituted or unsubstituted alkoxy group, substituted or unsubstituted aromatic hydrocarbon group, substituted or unsubstituted aromatic heterocyclic group, substituted or unsubstituted aralkyl group, substituted or unsubstituted aryloxy group, substituted or unsubstituted alkoxycarbonyl group, and carboxyl group. Preferred examples of the aromatic hydrocarbon group are naphthalene, phenanthrene, fluorene, chrysene, fluoranthene and triphenylene.

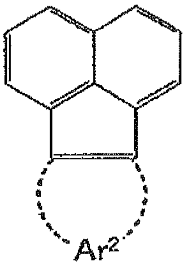
[0287] When the polycyclic aromatic skeleton has a plurality of substituents, the substituents may form a ring.

[0288] The polycyclic aromatic skeleton is preferably any one selected from the group consisting of compounds represented by formulae (10-1) to (10-4) below.

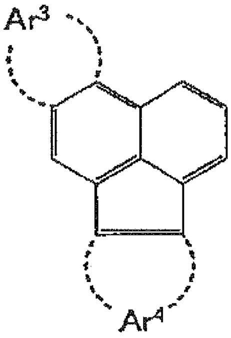
[Chemical Formula 85]



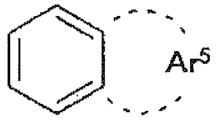
··· (10-1)



··· (10-2)



··· (10-3)



··· (10-4)

[0289] In the formulae (10-1) to (10-4), Ar^1 to Ar^5 each represent a substituted or unsubstituted fused ring structure having 4 to 16 ring carbon atoms.

[0290] Examples of the compound represented by the formula (10-1) are elementary substances or derivatives of substituted or unsubstituted phenanthrene and chrysene.

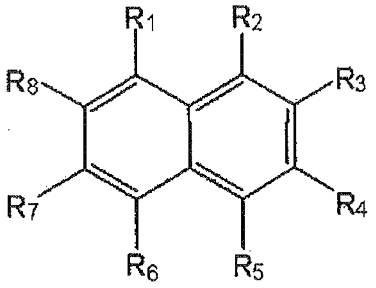
[0291] Examples of the compound represented by the formula (10-2) are elementary substances or derivatives of substituted or unsubstituted acenaphthylene, acenaphthene and fluoranthene.

[0292] Examples of the compound represented by the formula (10-3) are elementary substances or derivatives of substituted or unsubstituted benzofluoranthene.

[0293] Examples of the compound represented by the formula (10-4) are elementary substances or derivatives of substituted or unsubstituted benzofluoranthene.

[0294] The naphthalene derivative is exemplified by a formula (10-5) below.

[Chemical Formula 86]

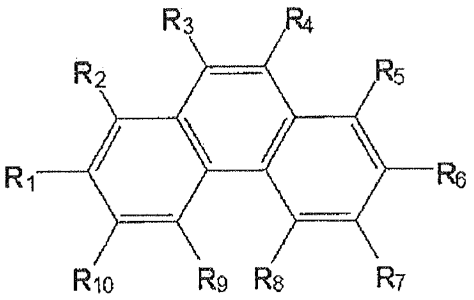


··· (10-5)

[0295] In the formula (10-5), R_1 to R_8 each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0296] The naphthalene derivative is exemplified by a formula (10-6) below.

[Chemical Formula 87]

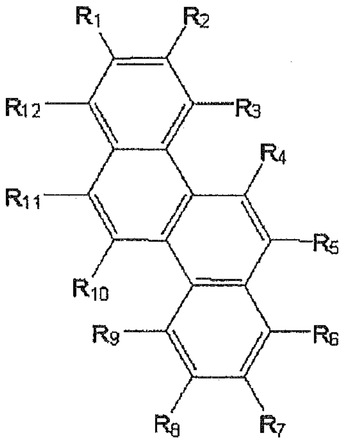


··· (10-6)

[0297] In the formula (10-6), R_1 to R_{10} each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0298] The chrysene derivative is exemplified by a formula (10-7) below.

[Chemical Formula 88]

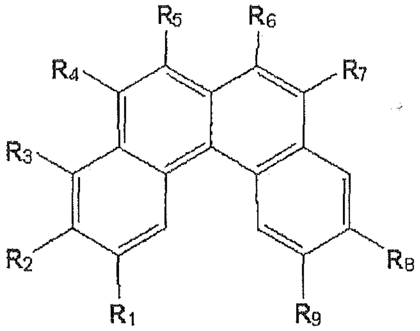


··· (10-7)

[0299] In the formula (10-7), R_1 to R_{12} each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0300] The polyaromatic skeleton is preferably benzo[c]phenanthrene or its derivative. The benzo[c]phenanthrene derivative is exemplified by a formula (10-8) below.

[Chemical Formula 89]

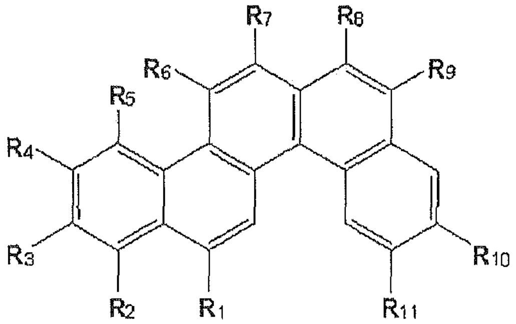


··· (10– 8)

[0301] In the formula (10-8), R_1 to R_9 each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0302] The polycyclic aromatic skeleton is preferably benzo[c]chrysene or its derivative. The benzo[c]phenanthrene derivative is exemplified by a formula (10-9) below.

[Chemical Formula 90]

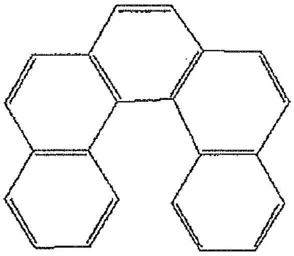


··· (10– 9)

[0303] In the formula (10-9), R_1 to R_{11} each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0304] The polycyclic aromatic skeleton is preferably dibenzo[c,g]phenanthrene represented by a formula (10-10) below or its derivative.

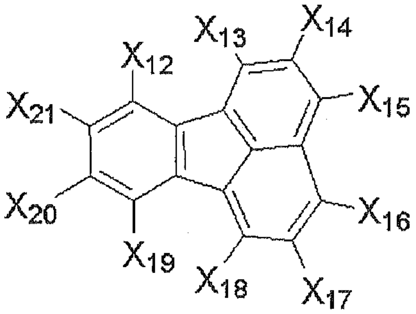
[Chemical Formula 91]



(10-10)

[0305] The polycyclic aromatic skeleton is preferably fluoranthene or its derivative. The fluoranthene derivative is exemplified by a formula (10-11) below.

[Chemical Formula 92]

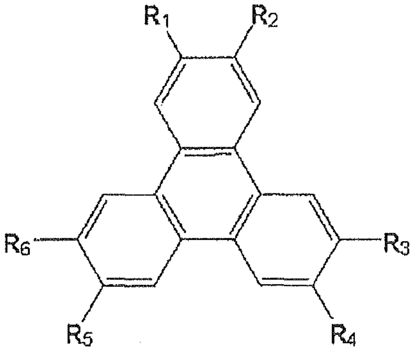


(10-11)

[0306] In the formula (10-11), X_{12} to X_{21} each represent a hydrogen atom; halogen atom; linear, branched or cyclic alkyl group; linear, branched or cyclic alkoxy group; substituted or unsubstituted aryl group; or substituted or unsubstituted heteroaryl group.

[0307] The polycyclic aromatic skeleton is preferably triphenylene or its derivative. The triphenylene derivative is exemplified by a formula (10-12) below.

[Chemical Formula 93]

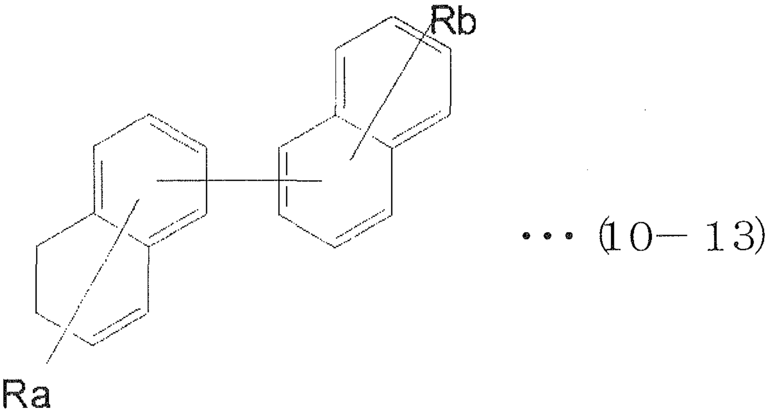


(10-12)

[0308] In the formula (10-12), R_1 to R_6 each independently represent a hydrogen atom, or a substituent consisting of one of or a combination of two or more of substituted or unsubstituted aryl group having 5 to 30 ring carbon atoms, branched or linear alkyl group having 1 to 30 carbon atoms and substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms.

[0309] The polycyclic aromatic compound may be represented by a formula (10-13) below.

[Chemical Formula 94]



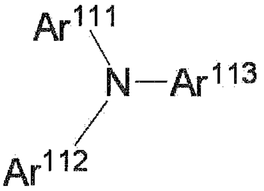
[0310] In the formula (10-13), Ra and Rb represent the same as Ra and Rb in the formulae (10A) to (10C). When Ra, Rb and the naphthalene ring have a single or plural substituent(s), the single or plural substituent(s) are an alkyl group having 1 to 20 carbon atoms, haloalkyl group having 1 to 20 carbon atoms, cycloalkyl group having 5 to 18 carbon atoms, silyl group having 3 to 20 carbon atoms, cyano group or halogen atom, while substituents for the naphthalene rings other than Ra and Rb are further allowed to be an aryl group having 6 to 22 carbon atoms.

[0311] In the formula (10-13), Ra and Rb each preferably represent a group selected from fluorene ring, phenanthrene ring, triphenylene ring, benzophenanthrene ring, dibenzophenanthrene ring, benzotriphenylene ring, fluoranthene ring, benzochrysene ring, benzo[b]fluoranthene ring and picene ring.

Fifth Exemplary Embodiment

[0312] The second host material is preferably a monoamine derivative represented by any one of formulae (11) to (13) below.

[Chemical Formula 95]



$$\mathrm{N}(\mathrm{Ar}^{111})(\mathrm{Ar}^{112})-\mathrm{Ar}^{113} \quad \cdots (11)$$

[0313] In the formula (11), Ar^{111}, Ar^{112} and Ar^{113} each are a substituted or unsubstituted aryl group or heteroaryl group.

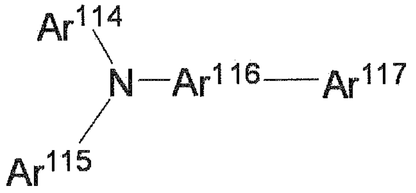
[0314] The aryl group has 6 to 50 ring carbon atoms (preferably 6 to 30 ring carbon atoms, more preferably 6 to 20 ring carbon atoms). Examples of the aryl group are a phenyl group, naphthyl group, phenanthrenyl group, benzophenanthrenyl group, dibenzophenanthrenyl group, benzochrysenyl group, dibenzochrysenyl group, fluoranthenyl group, benzofluoranthenyl group, triphenylenyl group, benzotriphenylenyl group, dibenzotriphenylenyl group, picenyl group, benzopicenyl group, dibenzopicenyl group, phenalenyl group, acenaphthenyl group, and diazaphenanthrenyl group. Among the above, a phenyl group or naphthyl group is preferable.

[0315] The heteroaryl group has 5 to 50 ring atoms (preferably 6 to 30 ring atoms, more preferably 6 to 20 ring atoms). Examples of the heteroaryl group are a pyrimidyl group and diazaphenanthrenyl group.

[0316] At least one of Ar^{111}, Ar^{112} and Ar^{113} is preferably a fused aromatic hydrocarbon group selected from a phenanthrenyl group, benzophenanthrenyl group, dibenzophenanthrenyl group, benzochrysenyl group, dibenzochrysenyl group, fluoranthenyl group, benzofluoranthenyl group, triphenylenyl group, benzotriphenylenyl group, dibenzotriphenylenyl group, picenyl group, benzopicenyl group, dibenzopicenyl group, phenalenyl group, and diazaphenanthrenyl group. Among the above, a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group is more preferable. Preferably, the fused aromatic hydrocarbon is unsubstituted.

[0317] In the monoamine derivative represented by the formula (11), Ar^{111} and Ar^{112} each are preferably a phenyl group or naphthyl group, and Ar^{113} is preferably a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group.

[Chemical Formula 96]



$$\begin{matrix} Ar^{114} & & \\ & N - Ar^{116} - Ar^{117} & \cdots (12) \\ Ar^{115} & & \end{matrix}$$

[0318] In the formula (12), Ar^{114}, Ar^{115} and Ar^{117} each are a substituted or unsubstituted aryl group or heteroaryl group.

[0319] Examples of the aryl group or heteroaryl group are the same as those defined as the aryl group or heteroaryl group for Ar^{111}, among which a phenyl group or naphthyl group is preferable.

[0320] Ar^{116} is a substituted or unsubstituted arylene group or heteroarylene group.

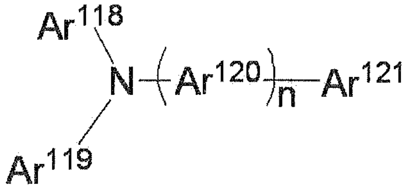
[0321] The arylene group has 6 to 50 ring carbon atoms (preferably 6 to 30 ring carbon atoms, more preferably 6 to 20 ring carbon atoms). Examples of the arylene group are a phenylene group, naphthylene group, phenanthrenylene group, naphthacenylene group, pyrenylene group, biphenylene group, terphenylenylene group, benzophenanthrenylene group, dibenzophenanthrenylene group, benzochrysenylene group, dibenzochrysenylene group, fluoranthenylene group, benzofluoranthenylene group, triphenylenylene group, benzotriphenylenylene group, dibenzotriphenylenylene group, picenylene group, benzopicenylene group, and dibenzopicenylene group. Among the above, a phenylene group or naphthylene group is preferable.

[0322] The heteroaryl group has 5 to 50 ring atoms (preferably 6 to 30 ring atoms, more preferably 6 to 20 ring atoms). Examples of the heteroaryl group are a pyridylene group, pyrimidylene group, dibenzofuranylene group, and dibenzothiophenylene group.

[0323] Ar^{117} is preferably a fused aromatic hydrocarbon group selected from a phenanthrenyl group, benzophenanthrenyl group, dibenzophenanthrenyl group, benzochrysenyl group, dibenzochrysenyl group, fluoranthenyl group, benzofluoranthenyl group, triphenylenyl group, benzotriphenylenyl group, dibenzotriphenylenyl group, picenyl group, benzopicenyl group, and dibenzopicenyl group.] Among the above, a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group is more preferable. Preferably, the fused aromatic hydrocarbon is unsubstituted.

[0324] In the monoamine derivative of the formula (12), more preferably, Ar^{114} and Ar^{115} each are a phenyl group or naphthyl group, Ar^{116} is a phenyl group or naphthyl group, and Ar^{117} is a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group.

[Chemical Formula 97]



$$\begin{matrix} Ar^{118} & & \\ & N \left(Ar^{120} \right)_n Ar^{121} & \cdots (13) \\ Ar^{119} & & \end{matrix}$$

[0325] In the formula (13), Ar^{118}, Ar^{119} and Ar^{121} are a substituted or unsubstituted aryl group or heteroaryl group.

[0326] Examples of the aryl group or heteroaryl group are the same as those defined as the aryl group or heteroaryl group for Ar^{111} and are preferably a phenyl group.

[0327] Ar^{120} is a substituted or unsubstituted arylene group or heteroarylene group and the same as those defined as the arylene group or heteroarylene group for Ar^{116}.

[0328] Ar^{120} is preferably a phenylene group or naphthylene group.

[0329] n is an integer of 2 to 5, preferably 2 to 4, more preferably 2 to 3. When n is 2 or more, Ar^{120} may be mutually the same or different.

[0330] Ar^{121} is preferably a fused aromatic hydrocarbon group selected from a phenyl group, naphthyl group, phenanthrenyl group, benzophenanthrenyl group, dibenzophenanthrenyl group, benzochrysenyl group, dibenzochrysenyl group, fluoranthenyl group, benzofluoranthenyl group, triphenylenyl group, benzotriphenylenyl group, dibenzotriphenylenyl group, picenyl group, benzopicenyl group, dibenzopicenyl group, phenalenyl group, and diazaphenanthrenyl group. Among the above, a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group is more preferable.

[0331] In this exemplary embodiment, for the second host material in the formula (13), Ar^{118} and Ar^{119} each are preferably a phenyl group or naphthyl group; Ar^{120} is preferably a phenylene group or naphthylene group; and Ar^{121} is preferably a benzochrysenyl group, triphenylenyl group, or phenanthrenyl group.

[0332] When Ar^{101} to Ar^{121} have substituent(s), the substituent(s) is preferably an alkyl group having 1 to 20 carbon atoms, haloalkyl group having 1 to 20 carbon atoms, cycloalkyl group having 3 to 18 carbon atoms, aryl group having 6 to 30 ring carbon atoms, silyl group having 3 to 20 carbon atoms, cyano group, and halogen atom.

[0333] Examples of the alkyl group are a methyl group, ethyl group, propyl group, isopropyl group, n-butyl group, 1-methylpropyl group and 1-propylbutyl group.

[0334] Examples of the aryl group are the same as those for Ar^{101}.

[0335] The haloalkyl group is exemplified by a 2,2,2-trifluoroethyl group.

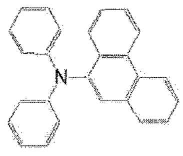
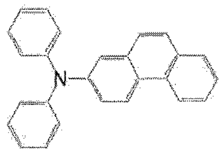
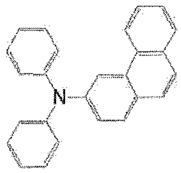
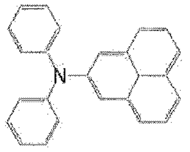
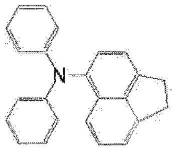
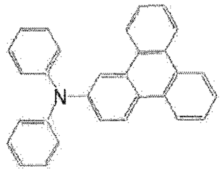
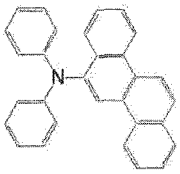
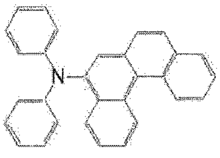
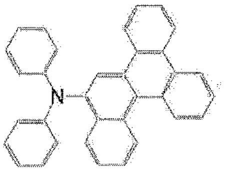
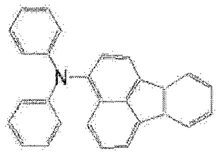
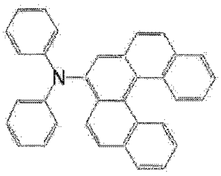
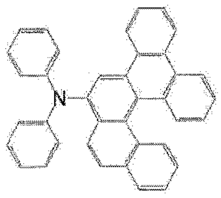
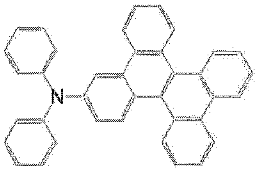
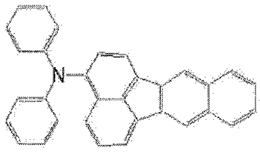
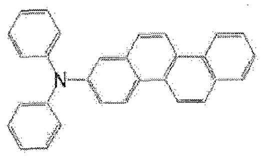
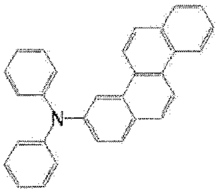
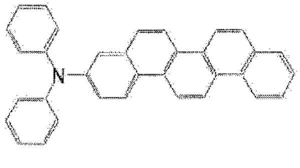
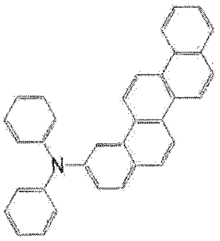
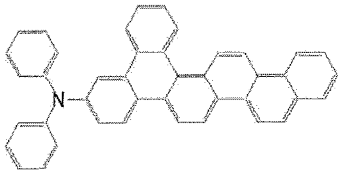
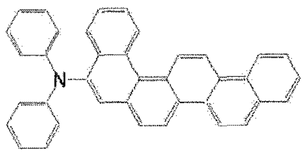
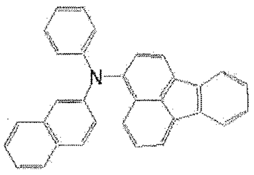
[0336] Examples of the cycloalkyl group are a cyclopropyl group, cyclobutyl group, cyclopentyl group, cyclohexyl group and cyclooctyl group.

[0337] Examples of the silyl group are a trimethylsilyl group and triethylsilyl group. Examples of the halogen atom are fluorine, chlorine, bromine, and iodine.

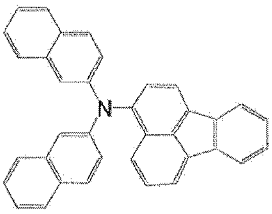
[0338] When the monoamine derivatives represented by the formulae (11) to (13) are not substituted, it is meant that a hydrogen atom is substituted. The hydrogen atom of the monoamine derivatives represented by the formulae (11) to (13) includes light hydrogen and deuterium. "Carbon atoms forming a ring (ring carbon atoms)" mean carbon atoms forming a saturated ring, unsaturated ring, or aromatic ring. "Atoms forming a ring (ring atoms)" mean carbon atoms and hetero atoms forming a ring including a saturated ring, unsaturated ring, or aromatic ring.

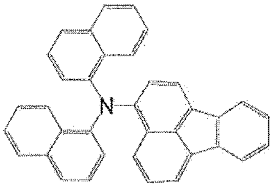
[0339] Specific examples of the monoamine derivatives represented by the formula (11) are shown below.

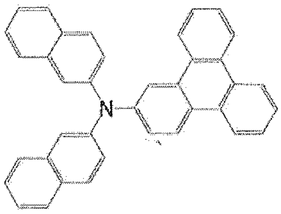
[Chemical Formula 98]

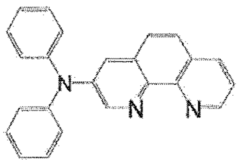






















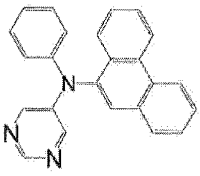
[Chemical Formula 99]

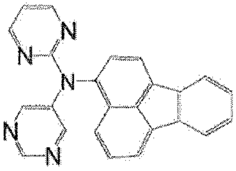


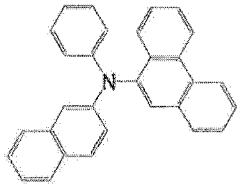


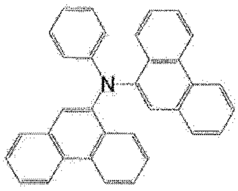


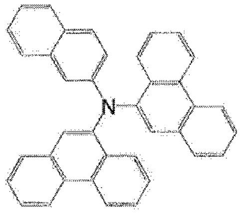


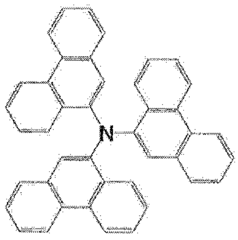


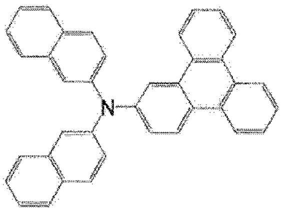


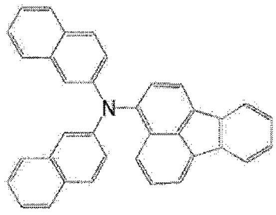












[0340] Specific examples of the monoamine derivatives represented by the formula (12) are shown below.

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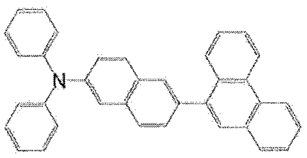

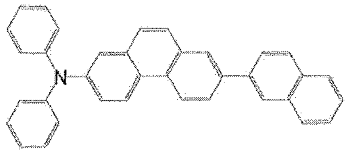

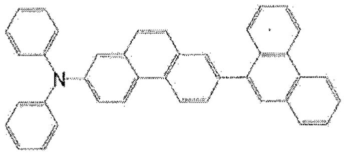

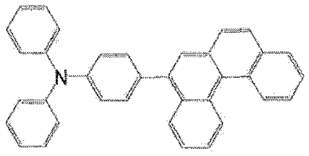

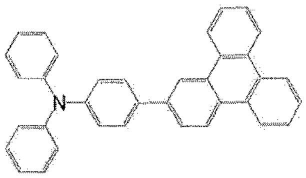

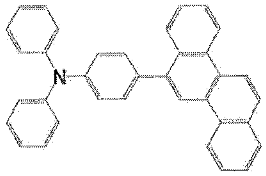

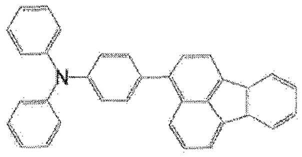

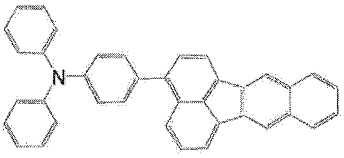

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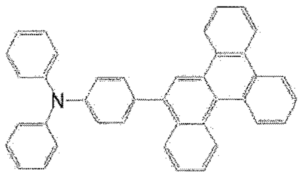
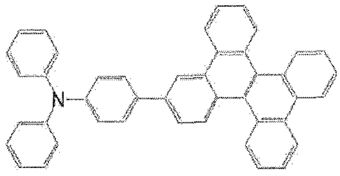
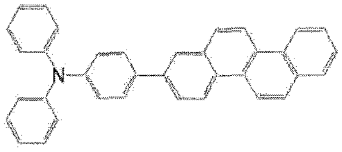
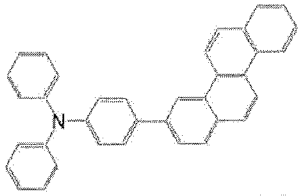
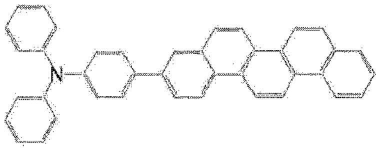
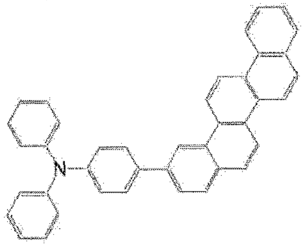


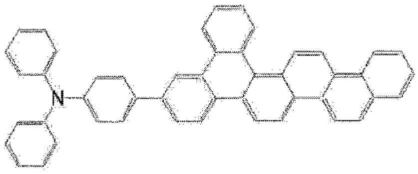


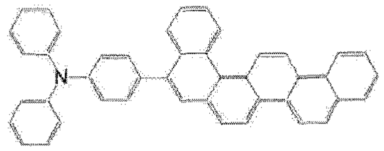


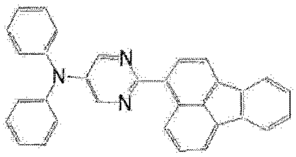


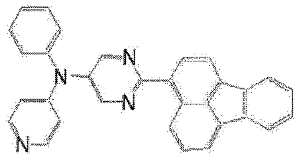


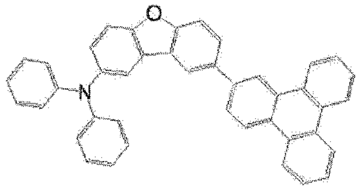


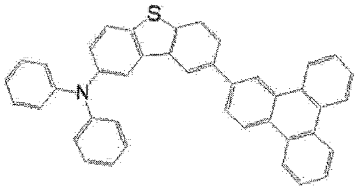


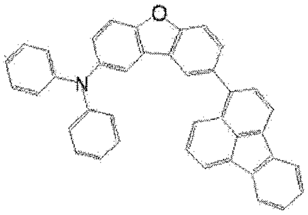


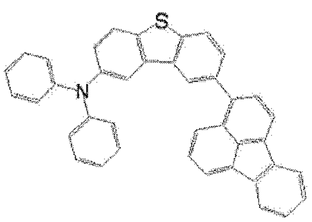




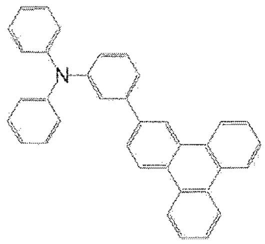


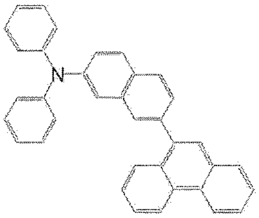


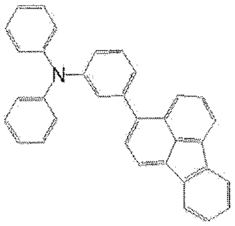


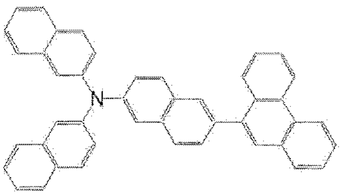


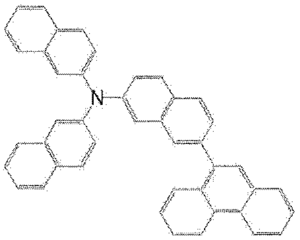
[Chemical Formula 102]





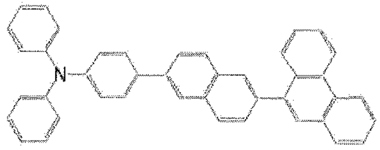


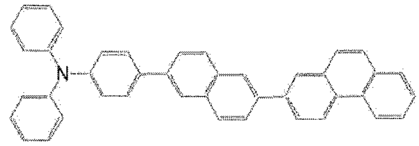


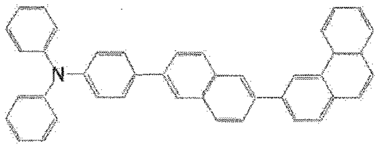


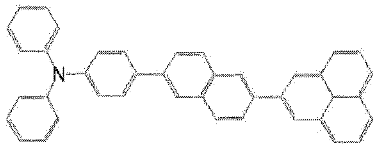
[0341] Specific examples of the monoamine derivatives represented by the formula (13) are shown below.

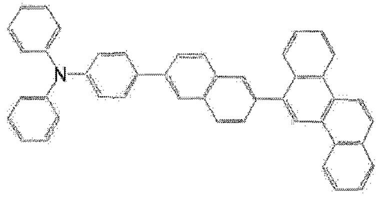
[Chemical Formula 103]

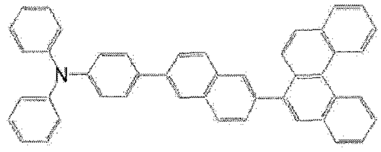


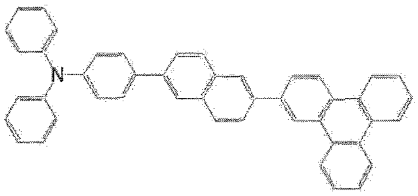


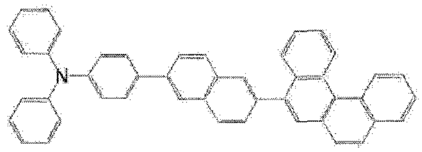


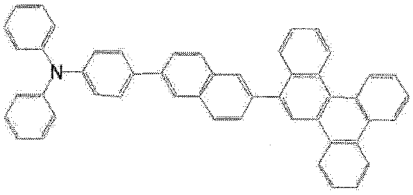


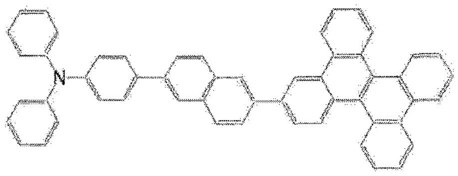


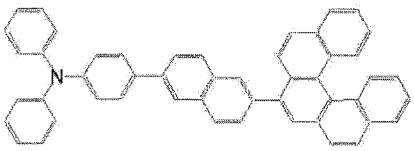


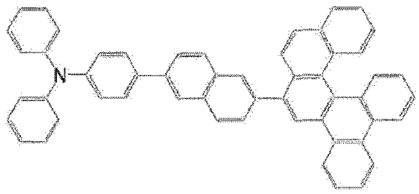


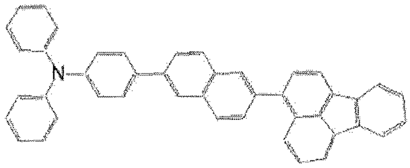


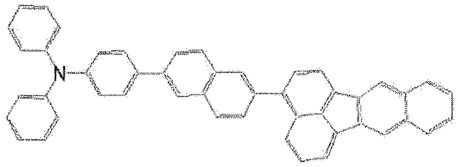




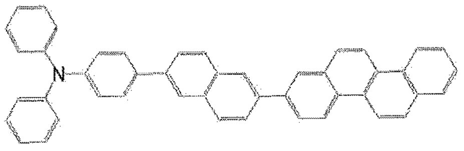


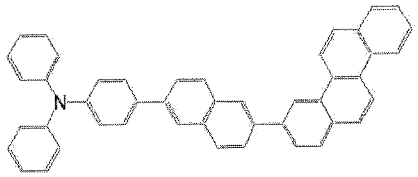


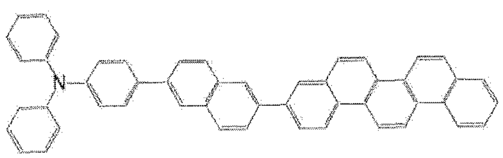


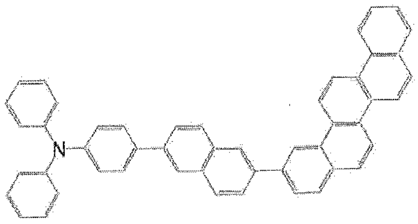


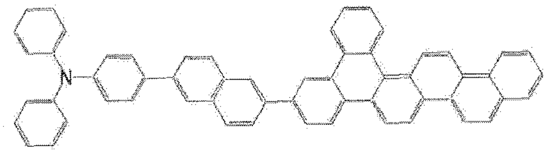
[Chemical Formula 104]

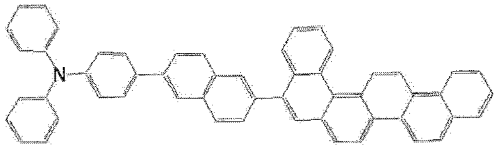


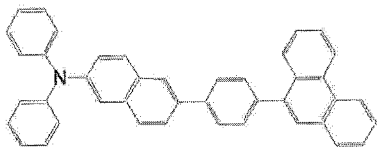


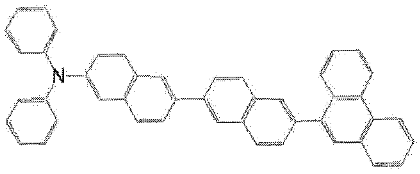


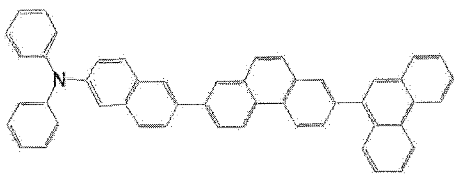


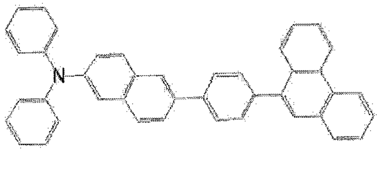


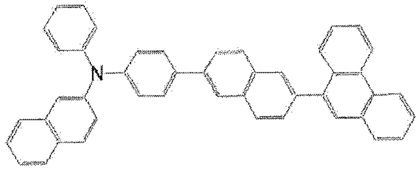


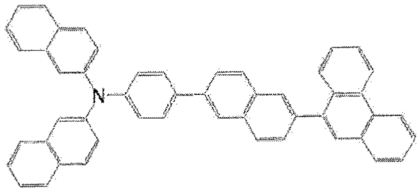




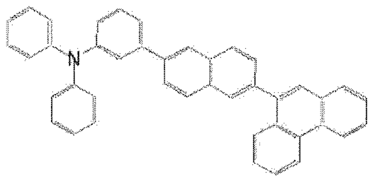


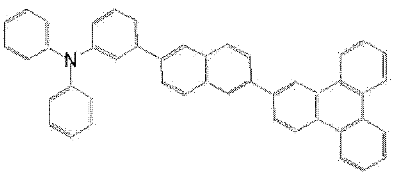


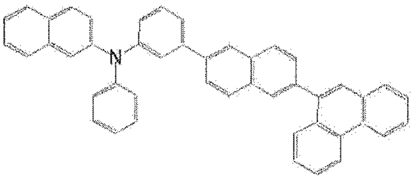


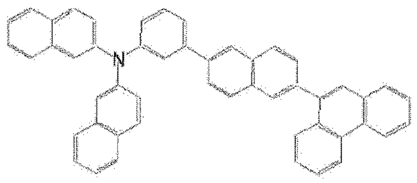


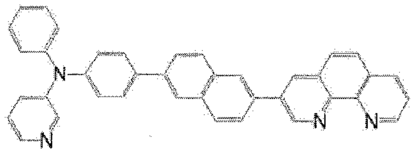
[Chemical Formula 105]

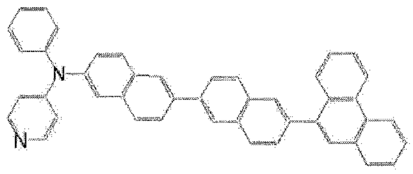


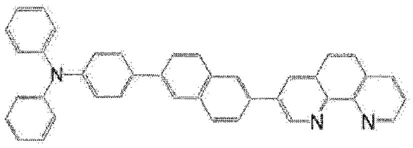


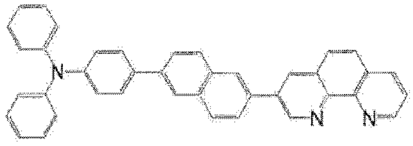


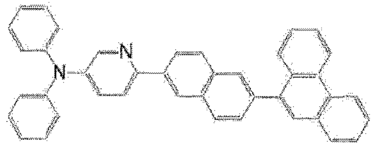


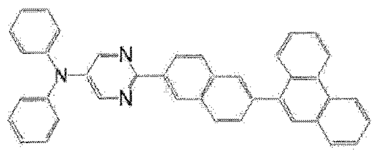


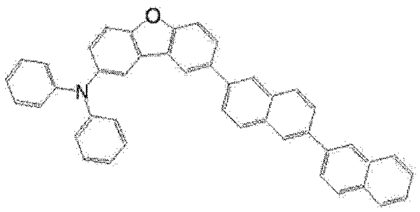


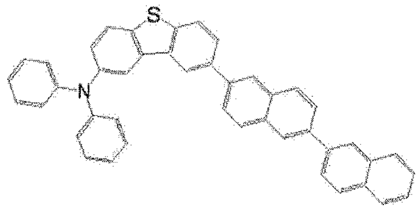


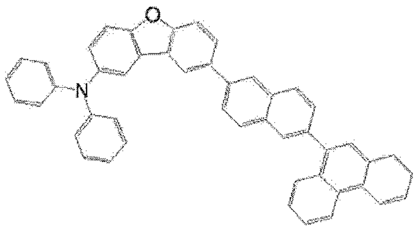


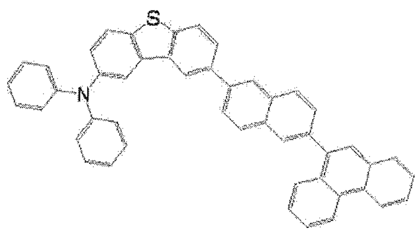




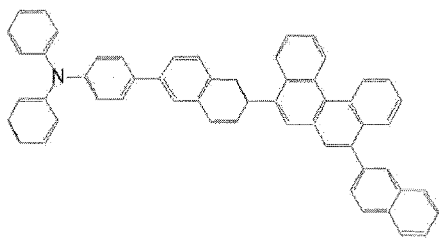


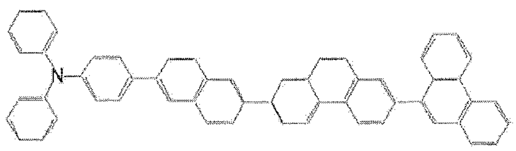


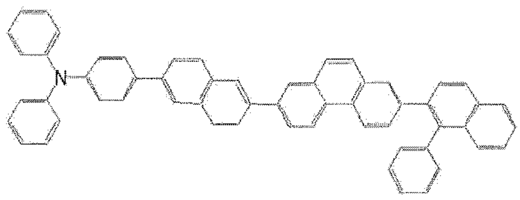


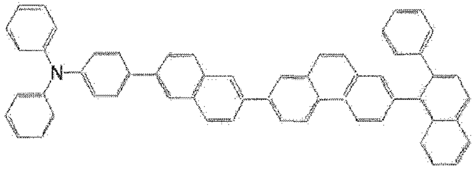


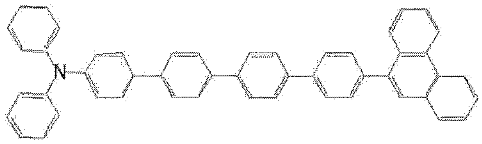
[Chemical Formula 106]

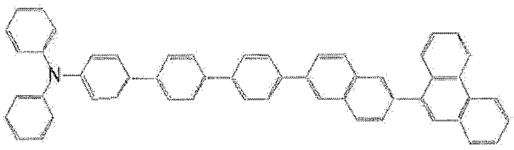


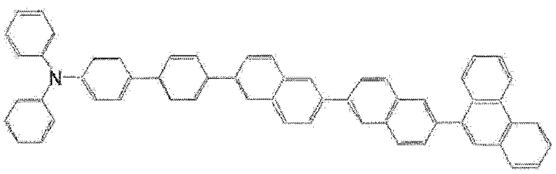


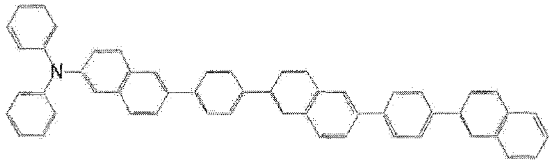


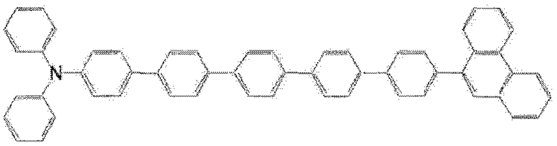


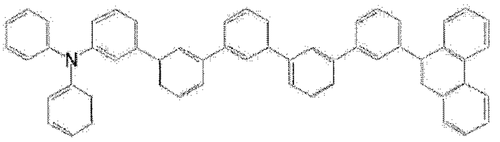










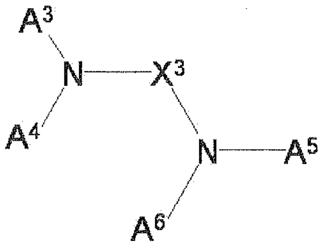


Sixth Exemplary Embodiment

[0342] In an organic EL device according to a sixth exemplary embodiment, an aromatic amine compound is used as the second host material.

[0343] An example of the aromatic amine compound is preferably a compound represented by a formula (14) or (15) below.

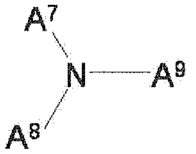
[Chemical Formula 107]



$$(A^3)(A^4)N-X^3-N(A^5)(A^6) \quad \cdots (14)$$

[0344] In the formula (14): X^3 represents a substituted or unsubstituted arylene group having 10 to 40 ring carbon atoms; and A^3 to A^6 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 ring atoms.

[Chemical Formula 108]

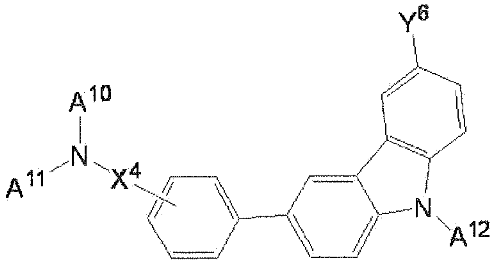


•••(15)

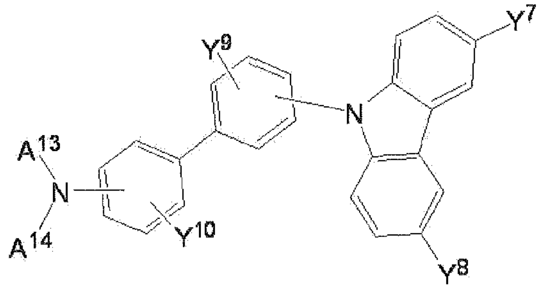
[0345] In the formula (15), A^7 to A^9 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 ring atoms.

[0346] The second host material represented by the formula (14) or (15) is preferably represented by formulae (16) to (20).

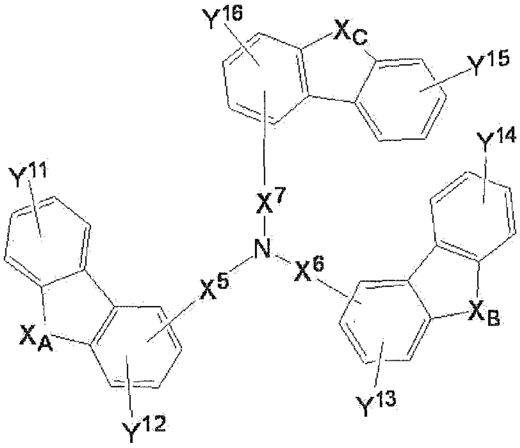
[Chemical Formula 109]



•••(16)

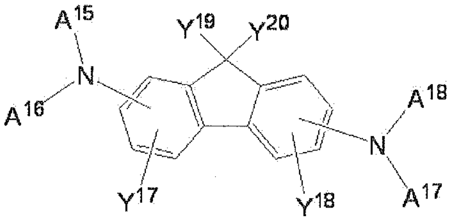


•••(17)

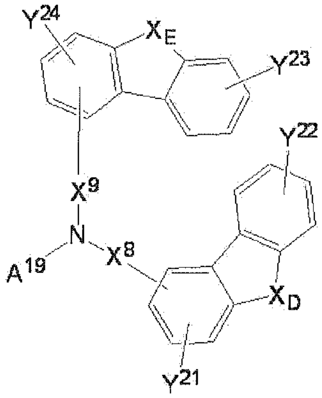


•••(18)

[Chemical Formula 110]



···(19)

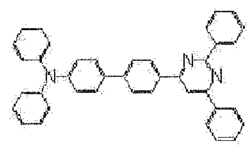


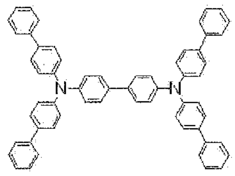
···(20)

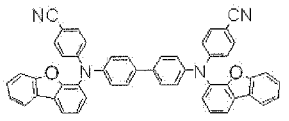
[0347] In the formulae (16) to (20): A^{10} to A^{19} each represent a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 40 carbon atoms, substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic amino group, or substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic heterocyclic group;
A^{10}, A^{13}, A^{15} and A^{17} are adapted to be respectively bonded to A^{11}, A^{14}, A^{16} and A^{18} to form a ring;
X^4 to X^9 represent a single bond or a linking group having 1 to 30 carbon atoms;
Y^6 to Y^{24} represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted alkenyl group having 2 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted alkylsilyl group having 3 to 20 carbon atoms, substituted or unsubstituted arylsilyl group having 8 to 40 carbon atoms, substituted or unsubstituted aralkylsilyl group having 8 to 40 carbon atoms, or substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms; and
X_A, X_B, X_C, X_D, X_E each represent a sulfur atom, an oxygen atom or a monoaryl-substituted nitrogen atom.

[0348] Examples of compounds represented by the formulae (14), (15), and (16) to (20) are as follows.

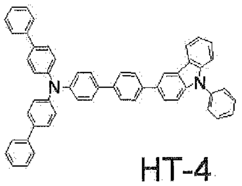
[Chemical Formula 111]


HT-1


HT-2



HT-3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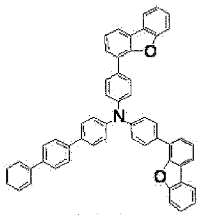
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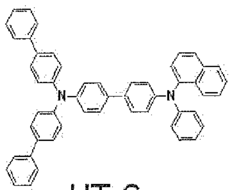
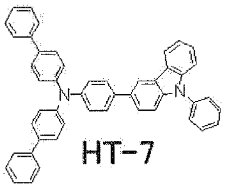

HT-6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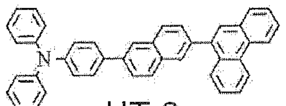
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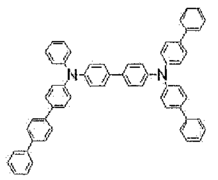
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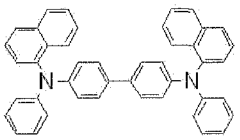

HT-10

Seventh Exemplary Embodiment

[0349] An organic EL device according to a seventh exemplary embodiment preferably contains a metal complex as the second host material.

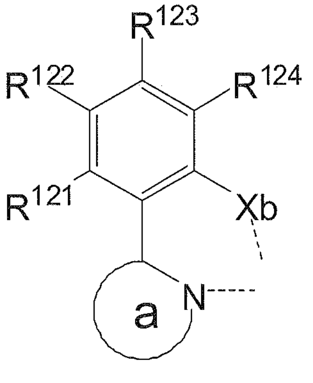
[0350] The metal complex is preferably represented by a formula (21) below.

[0351] [Chemical Formula 112]

$$L^{11}L^{12}L^{13}M^{11}{}_2Q^{11} \qquad (21)$$

[0352] In the formula: ligands L^{11}, L^{12} and L^{13} are independently selected from a structure represented by a formula (22) below; M^{11} is a divalent metal; and Q^{11} is a monovalent anion induced from inorganic or organic acids.

[Chemical Formula 113]



··· (22)

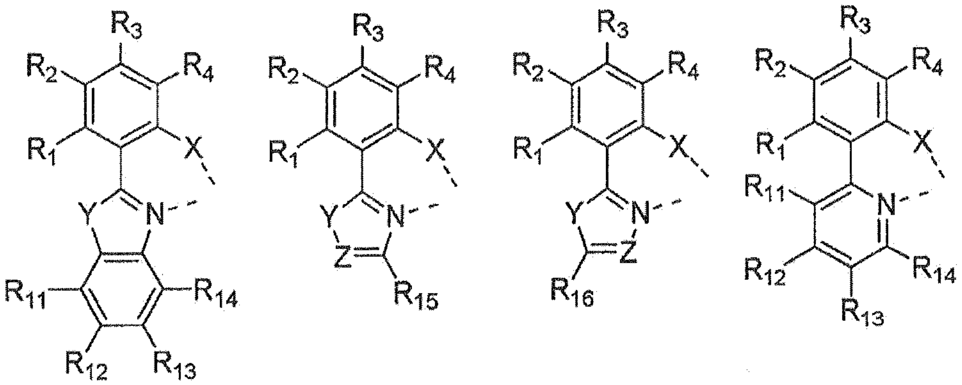
[0353] In the ligands: Xb is O, S or Se; a-ring is oxazole, thiazole, imidazoles, oxadiazole, thiadiazole, benzooxazole, benzothiazole, benzoimidazole, pyridine, or quinoline; and R^{121} to R^{124} are independently hydrogen, an alkyl group having 1 to 5 carbon atoms, halogen, silyl group or aryl group having 6 to 20 carbon atoms, which may be bonded to an adjacent substituent via alkylene or alkenylene to form a fused ring.

The pyridine and quinoline may be bonded to R1 to form a fused ring.

The a-ring and the aryl group for R^{121} to R^{124} may be further substituted by a C1-C5 alkyl group, halogen, C1-C5 alkyl group having a halogen substituent, phenyl group, naphthyl group, silyl group, or amino group.

[0354] The ligands L^{11}, L^{12} and L^{13} are independently selected from the following structures.

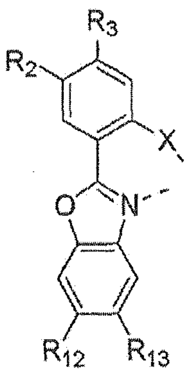
[Chemical Formula 114]

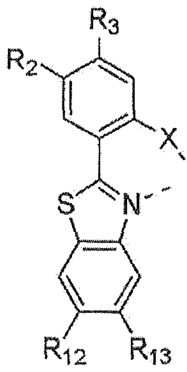


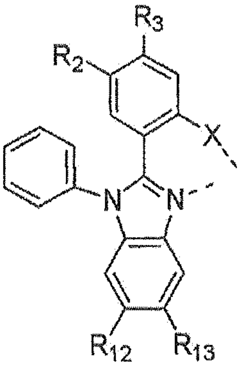
[0355] In the ligands: X and R_1 to R_4 represent the same as Xb and R^{121} to R^{124} in the formula (22); Y is O, S or NR_{21}; Z is CH or N; R_{11} to R_{16} are independently hydrogen, a C1-C5 alkyl group, halogen, C1-C5 alkyl group having a halogen substituent, phenyl group, naphthyl group, silyl group, or amino group; and R_{11} to R_{14} may be bonded to an adjacent substituent via alkylene or alkenylene to form a fused ring.

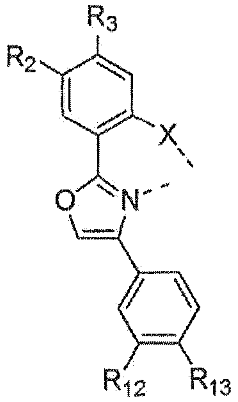
[0356] The ligands L^{11}, L^{12} and L^{13} of the compound may be the same and can be selected from the following structures.

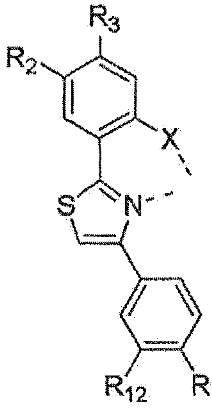
[Chemical Formula11 5]

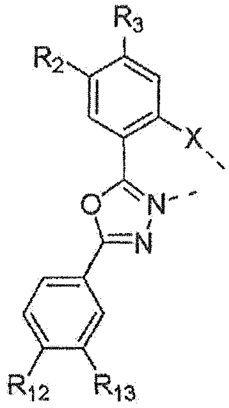


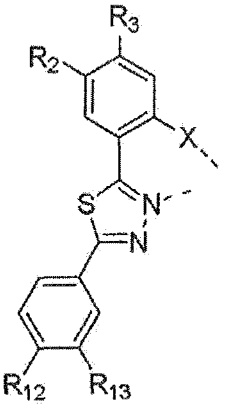










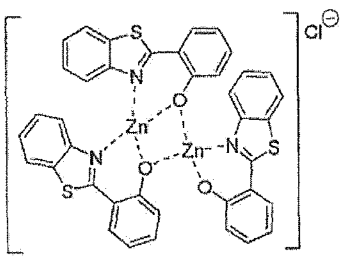


[0357] In the ligands: X is O, S or Se; R_2, R_3, R_{12} and R_{13} are independently hydrogen, methyl, ethyl, n-propyl, isopropyl, fluorine, chlorine, trifluoromethyl, phenyl, naphthyl, fluorenyl, trimethylsilyl, triphenylsilyl, t-butyldimethylsilyl, dimethylamine, diethylamine, or diphenylamine.

[0358] The phenyl, naphthyl, fluorenyl are further substituted by fluorine, chlorine, trimethylsilyl, triphenylsilyl, t-butyldimethylsilyl, dimethylamine, diethylamine, or diphenylamine.

[0359] Furthermore, in this exemplary embodiment, the metal complex is preferably a zinc complex. Examples of such a preferable zinc complex are shown below.

[Chemical Formula 116]



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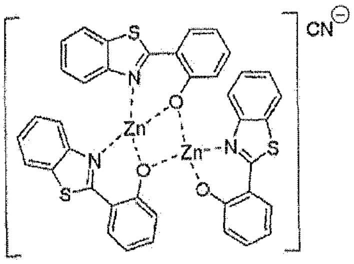

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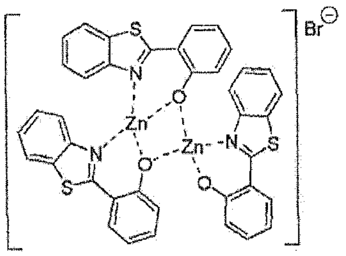

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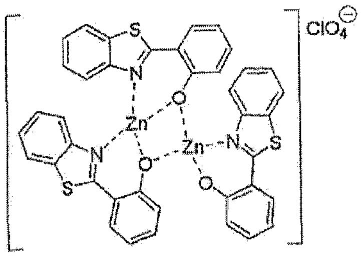

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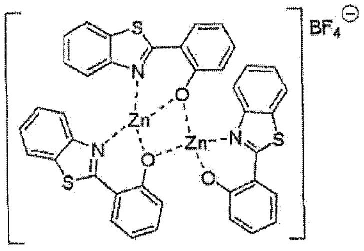

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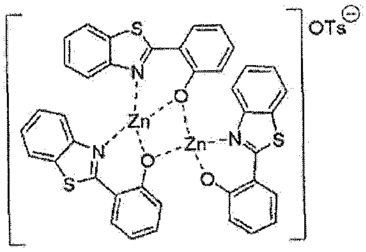

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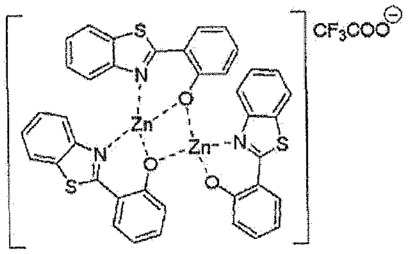

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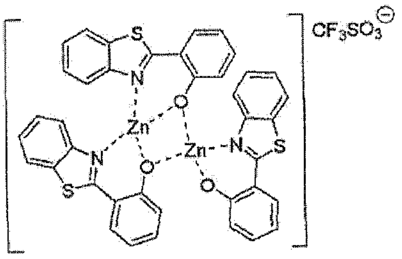

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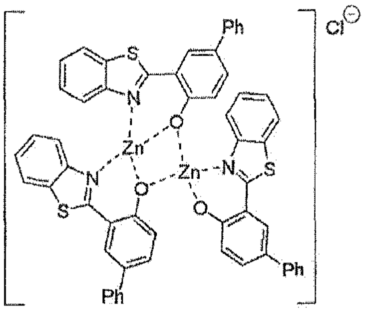
[Chemical Formula 117]



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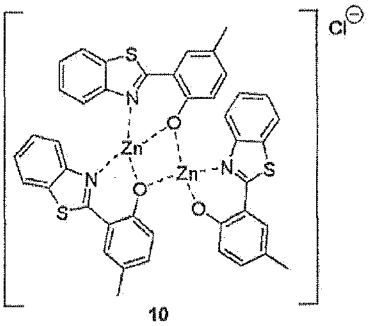

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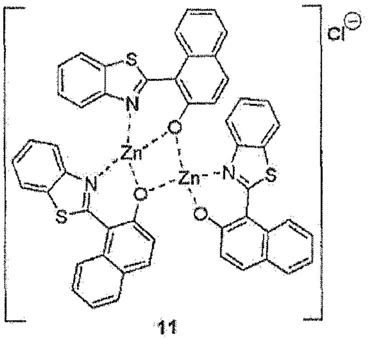

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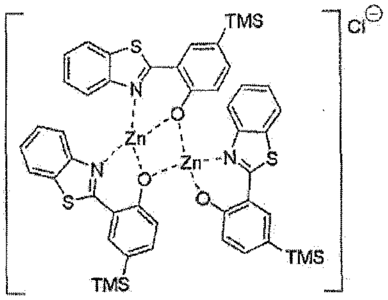

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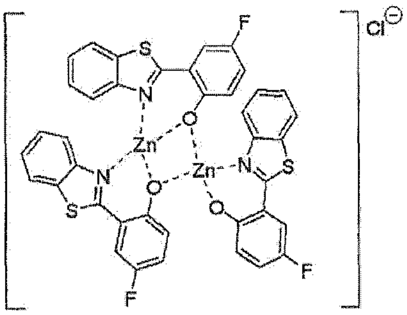

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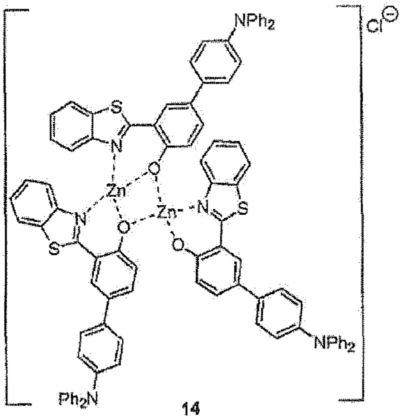

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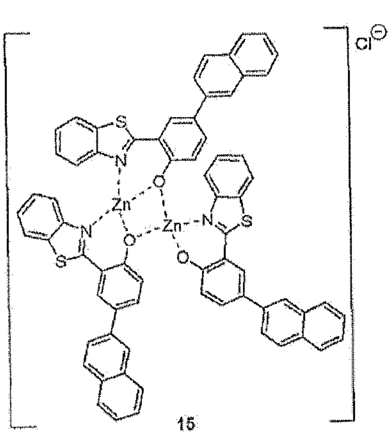
[Chemical Formula 118]



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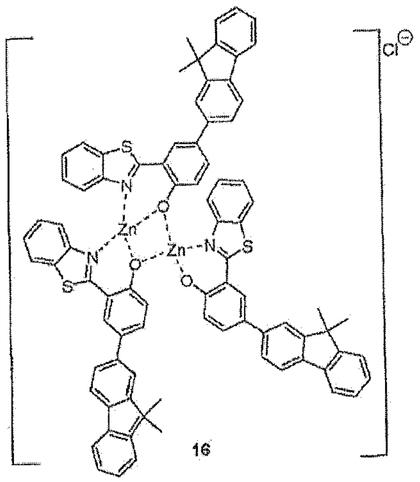

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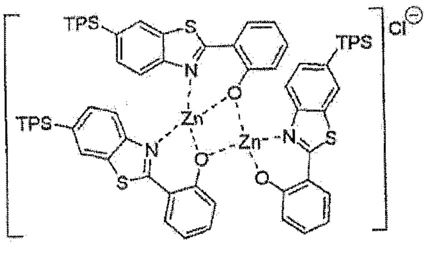

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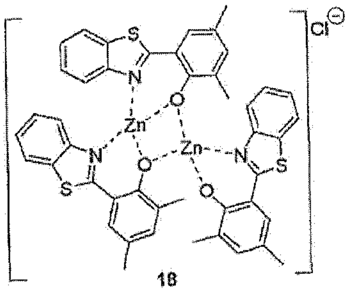

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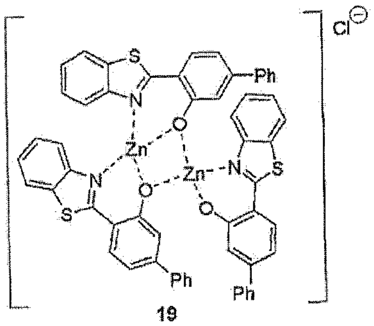

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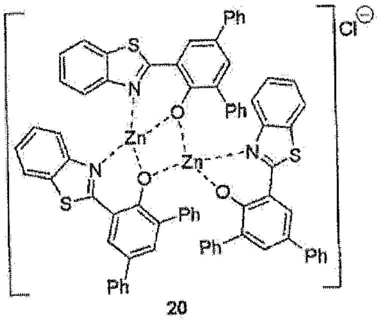

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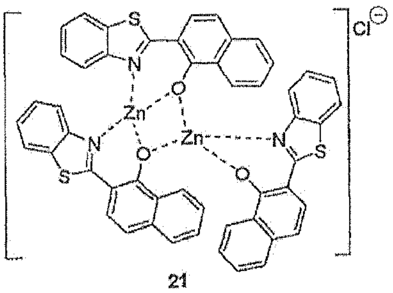
[Chemical Formula 119]



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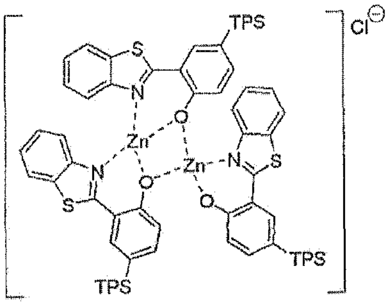

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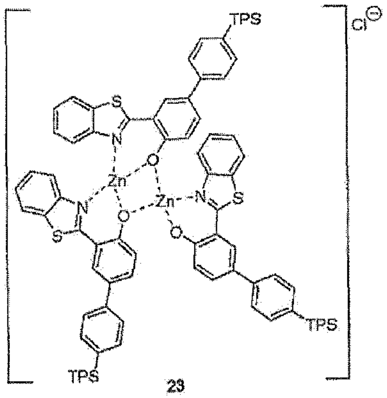

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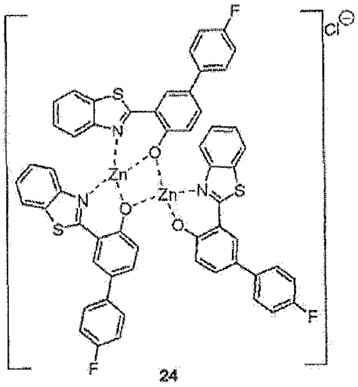

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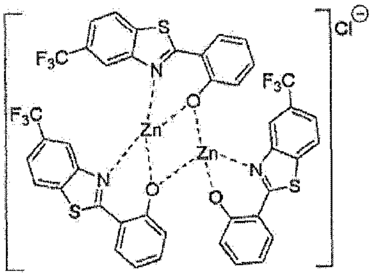

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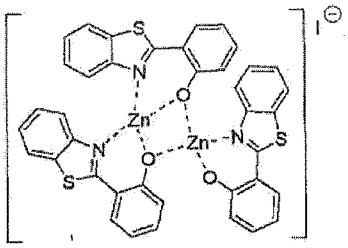

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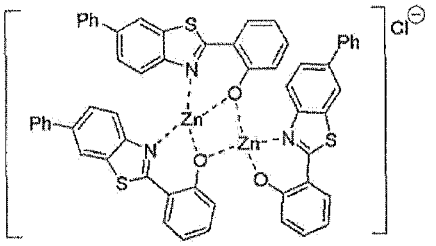
[Chemical Formula 120]



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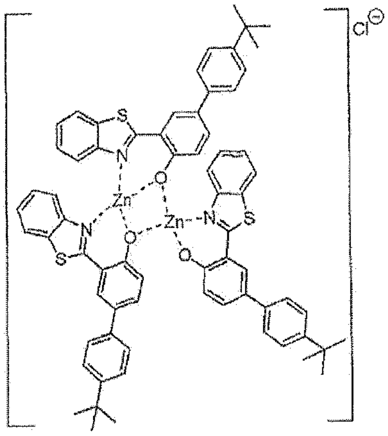

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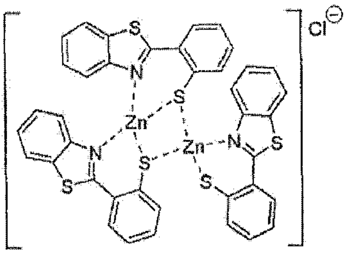

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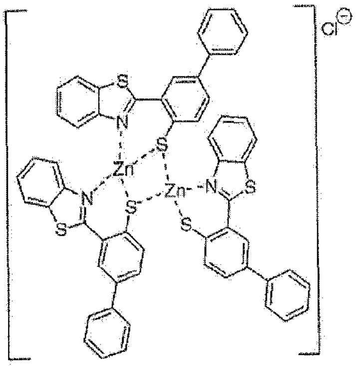

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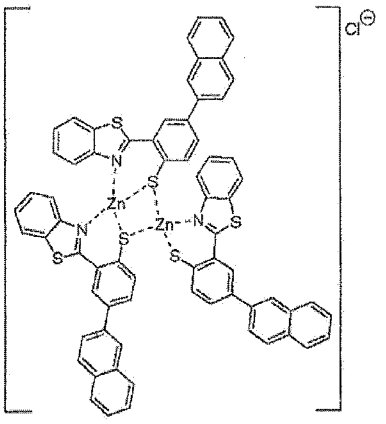
[Chemical Formula 121]



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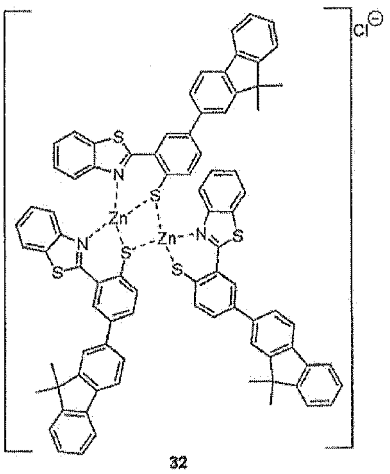

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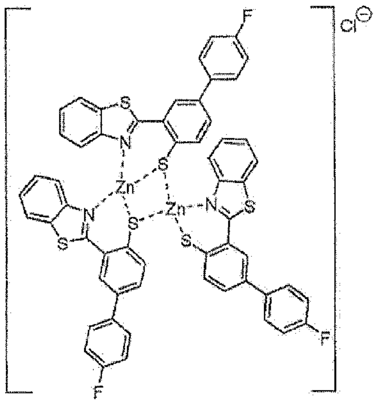

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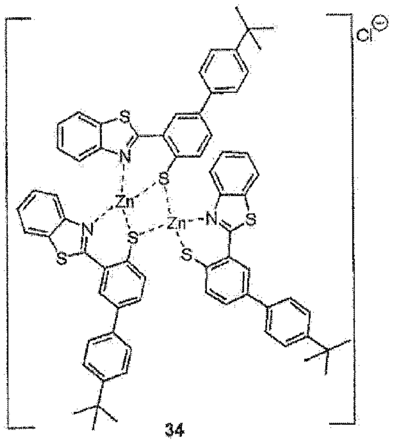

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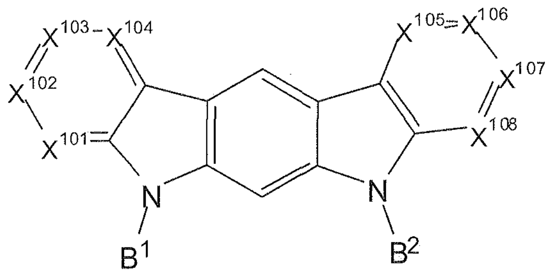
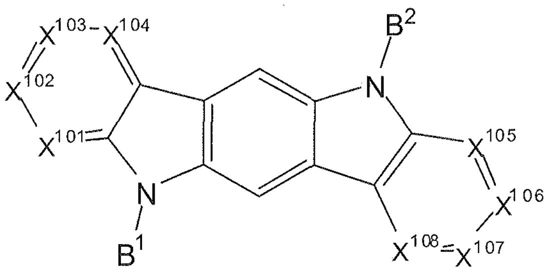
Eighth Exemplary Embodiment

[0360] The second host material may be compounds represented by formulae (23) to (25) below.

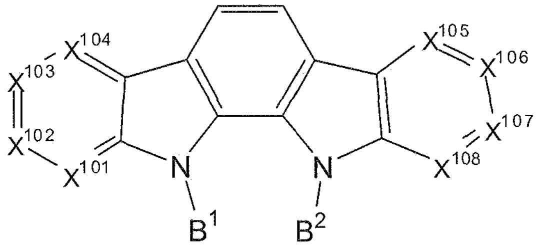
[Chemical Formula 122]



... (23)



... (24)



... (25)

[0361] In the formulae (23) to (25): X^{101} to X^{108} are a nitrogen atom or C-Ar^{131}.

[0362] Ar^{131} represent a hydrogen atom, a fluorine atom, a cyano group, a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms.

[0363] Adjacent ones of X^{101} to X^{108} may be bonded to each other to form a ring structure.

[0364] B^1 and B^2 represent a group represented by a formula (26A) or (26B) below.

[0365] [Chemical Formula 123]

$$(M^1)_c\text{-}(L^5)_d\text{-}(M^2)_e \qquad (26A)$$

[0366] In the formula (26A): M^1 and M^2 each independently represent a substituted or unsubstituted nitrogen-containing aromatic heterocyclic ring or nitrogen-containing fused aromatic heterocyclic ring having 2 to 40 ring carbon atoms; M^1 and M^2 may be the same or different;
L^5 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 carbon atoms;
c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0367] [Chemical Formula 124]

$$(M^3)_c\text{-}(L^6)_d\text{-}(M^4)_e \qquad (26B)$$

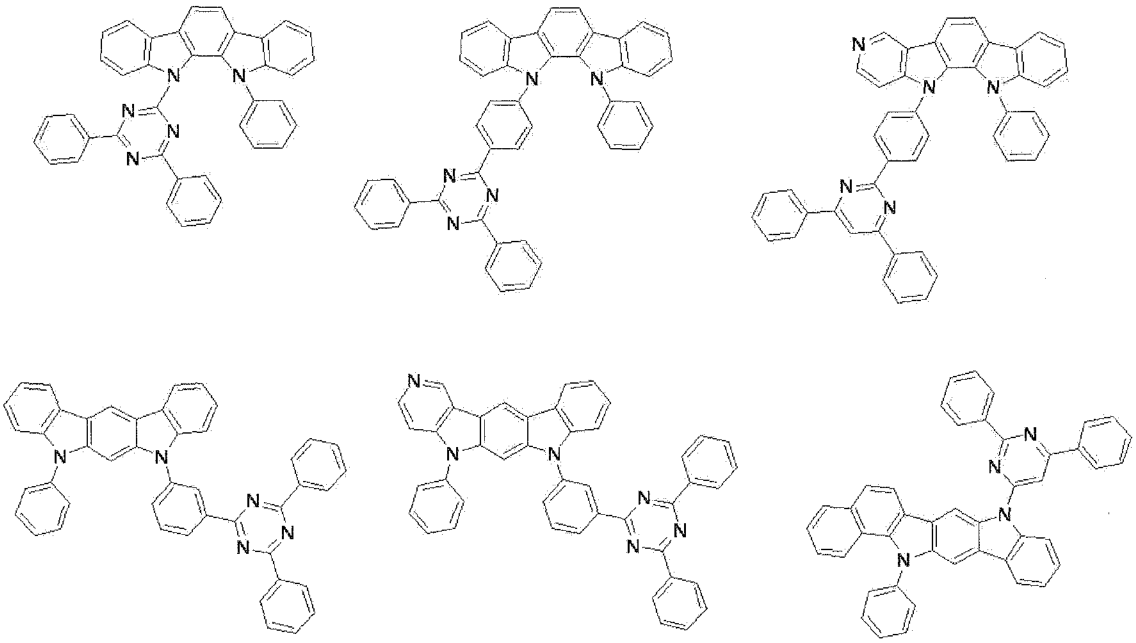
[0368] In the formula (26B): M^3 and M^4 each independently represent a substituted or unsubstituted aromatic hydrocarbon group having 2 to 40 ring carbon atoms; M^3 and M^4 may be the same or different; L^6 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, or substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms;

c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

[0369] The formulae (26A) and (8A) are respectively the same as the formulae (26B) and (8B). M^1 to M^4 and L^5 to L^6 are the same as those described in relation to the formulae (8A) and (8B).

[0370] Specific examples of compounds represented by the formulae (23) to (25) are shown.

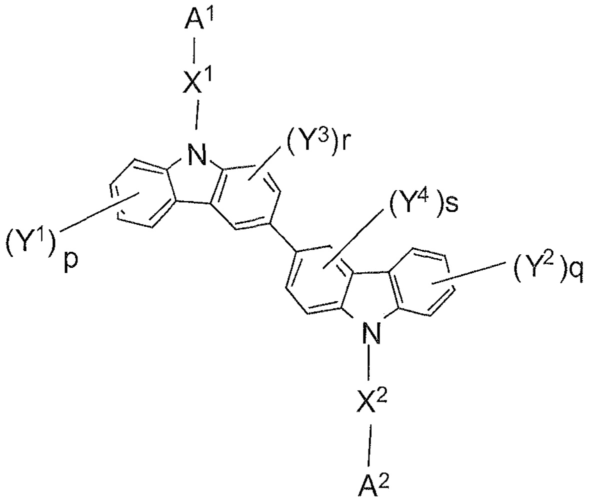
[Chemical Formula 125]



Ninth Exemplary Embodiment

[0371] The second host material may be compounds represented by a formula (27) below.

[Chemical Formula 126]



... (27)

[0372] In the formula (27), A^1, A^2, X^1, X^2, Y^1 to Y^4, p, q, r and s represent the same as A_1, A_2, X_1, X_2, Y_1 to Y_4, p, q, r and s in the formulae (1A) and (1B).

[0373] In the formula (27), examples of A^1, A^2, X^1, X^2, Y^1 to Y^4 are the same as those of A_1, A_2, X_1 X_2, Y_1 to Y_4, in the formulae (1A) and (1B).

[0374] It should be noted that the invention is not limited to the above description but may include any modification as long as such modification stays within a scope and a spirit of the invention.

[0375] For instance, the following is a preferable example of such modification made to the invention.

[0376] In the invention, the emitting layer may also preferably contain an assistance material for assisting injection of charges.

[0377] When the emitting layer is formed of a host material that exhibits a wide energy gap, a difference in ionization potential (Ip) between the host material and the hole injecting/transporting layer etc. becomes so large that injection of the holes into the emitting layer becomes difficult, which may cause a rise in a driving voltage required for providing sufficient luminance.

[0378] In the above instance, introducing a hole-injectable/transportable assistance material for assisting injection of charges in the emitting layer can contribute to facilitation of the injection of the holes into the emitting layer and to reduction of the driving voltage.

[0379] As the assistance material for assisting the injection of charges, for instance, a typical hole injecting/transporting material or the like can be used.

[0380] Specific examples of the assistance material for assisting the injection of charges are a triazole derivative, oxadiazole derivative, imidazoles derivative, polyarylalkane derivative, pyrazoline derivative, pyrazolone derivative, phenylenediamine derivative, arylamine derivative, amino-substituted chalcone derivative, oxazole derivative, styrylanthracene derivative, fluorenone derivative, hydrazone derivative, silazane derivative, polysilane copolymer, aniline copolymer, and conductive polymer oligomer (particularly, a thiophene oligomer).

[0381] The hole injecting material is exemplified by the above. The hole injecting material is preferably a porphyrin compound, aromatic tertiary amine compound and styryl amine compound, particularly preferably aromatic tertiary amine compound.

[0382] In addition, 4,4'-bis(N-(1-naphthyl)-N-phenylamino)biphenyl (hereinafter, abbreviated as NPD) having two fused aromatic rings in a molecule, or 4,4',4"-tris(N-(3-methylphenyl)-N-phenylamino)triphenylamine (hereinafter, abbreviated as MTDATA) in which three triphenylamine units are bonded in a starburst form as disclosed and the like may also be used.

[0383] Moreover, a hexaazatriphenylene derivative and the like may be also preferably used as the hole injecting material.

[0384] Alternatively, inorganic compounds such as p-type Si and p-type SiC may also be used as the hole-injecting material.

Examples

[0385] Next, the invention will be described in further detail by exemplifying Example(s) and Comparison(s). However, the invention is not limited by the description of Example(s).

Synthesis Example 1 (Synthesis of Compound 1)

[0386] Under a nitrogen atmosphere, trichloropyrimidine (10 g, 54.5 mmol), phenylboronic acid (13.3 g, 109 mmol), palladium acetate (0.3 g, 1.37 mmol), triphenylphosphine (0.72 g, 2.73 mmol), dimethoxyethane (150 mL) and an aqueous solution of 2M sodium carbonate (170 mL) were added together in sequential order, and heated to reflux for 8 hours.

[0387] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 1-1 (9.2g, a yield of 63%) was obtained.

[0388] Under a nitrogen atmosphere, 2-nitro-1,4-dibromobenzene (11.2 g, 40 mmol), phenylboronic acid (4.9 g, 40 mmol), tetrakis(triphenylphosphine)palladium (1.39 g, 1.2 mmol), toluene (120 mL) and an aqueous solution of 2M sodium carbonate (60 mL) were added together in sequential order, and heated to reflux for 8 hours.

[0389] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 1-2 (6.6 g, a yield of 59%) was obtained.

[0390] Subsequently, under an argon gas atmosphere, the intermediate body 7-2 (6.6 g, 23.7 mmol), triphenylphosphine (15.6 g, 59.3 mmol), and o-dichlorobenzene (24 mL) were added together in sequential order, and heated to reflux at 180 degrees C for 8 hours.

[0391] After cooled down to the room temperature, the reaction solution was refined by silica-gel column chromatography, whereby an intermediate body 1-3 (4 g, a yield of 68%) was obtained.

[0392] Under a nitrogen atmosphere, the intermediate body 1-3 (4 g, 16 mmol), N-phenylcarbazolyl-3-boronic acid (5.1 g, 17.8 mmol), tetrakis(triphenylphosphine)palladium (0.56 g, 0.48 mmol), toluene (50 mL) and an aqueous solution of 2M sodium carbonate (24 mL) were added together in sequential order, and heated to reflux for 8 hours.

[0393] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 1-4 (3.2 g, a yield of 49%) was obtained.

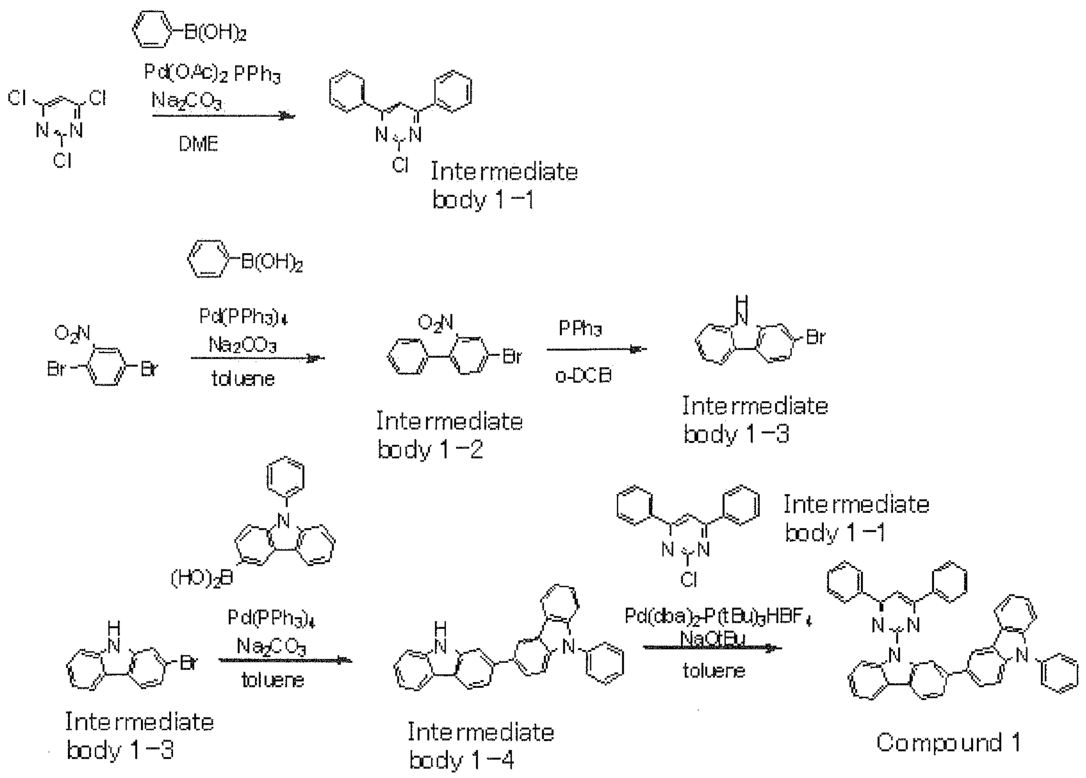
[0394] Under an argon gas atmosphere, the intermediate body 1-4 (1.6 g, 3.9 mmol), the intermediate body 1-1 (1.0 g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours.

[0395] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 1 (2.4 g, a yield of 95%) was obtained.

[0396] FD-MS analysis consequently showed that m/e was equal to 638 while a calculated molecular weight was 638.

[0397] A synthesis scheme of the compound 1 is shown below.

[Chemical Formula 127]



Synthesis Example 2 (Synthesis of Compound 2)

[0398] 4-bromobenzaldehyde (25 g, 135 mmol) and acetophenone (16.2 g, 135 mmol) were added to ethanole (200 mL). An aqueous solution of 3M potassium hydrate (60 mL) was further added thereto and stirred at room temperature for 7 hours. A precipitated solid was separated by filtration. Then, the obtained solid was washed with methanol. A white solid intermediate body 2-1 (28.3g, a yield rate 73%) was obtained.

[0399] The intermediate body 2-1 (20 g, 69.7 mmol) and benzamidine hydrochloride (10.8 g, 69.7 mmol) were added to ethanole (300 mL). Sodium hydroxide (5.6 g, 140 mmol) was further added thereto and heated to reflux at room temperature for 8 hours. A precipitated solid was separated by filtration. Then, the obtained solid was washed with hexane. A white solid intermediate body 2-2 (10.3g, a yield rate 38%) was obtained.

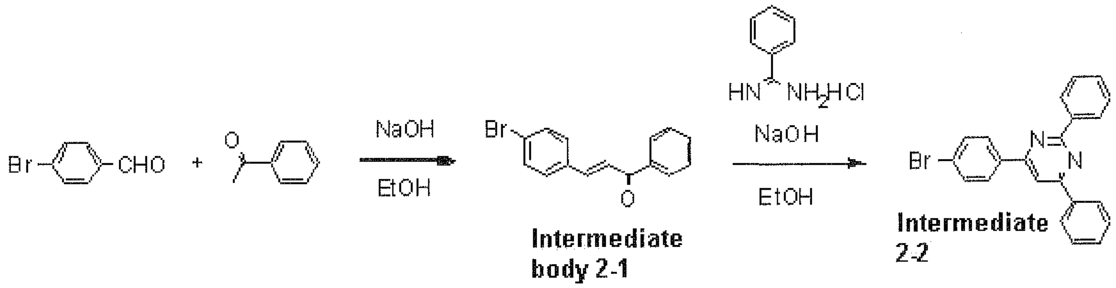
[0400] Under an argon gas atmosphere, the intermediate body 1-4 (1.6 g, 3.9 mmol), the intermediate body 2-2 (1.5g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours.

[0401] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 2 (2.2g, a yield of 80%) was obtained.

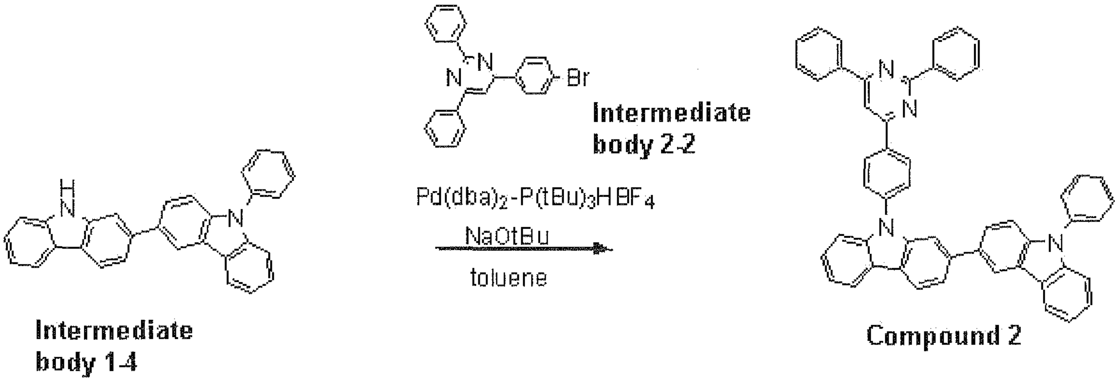
[0402] FD-MS analysis consequently showed that m/e was equal to 714 while a calculated molecular weight was 714.

[0403] A synthesis scheme of the compound 2 is shown below.

[Chemical Formula 128]



[Chemical Formula 129]



Synthesis Example 3 (Synthesis of Compound 3)

[0404] Under a nitrogen atmosphere, trichloropyrimidine (8 g, 43.4 mmol), phenylboronic acid (11.6 g, 95.4 mmol), tetrakis(triphenylphosphine)palladium (1.83 g, 1.74 mmol), toluene (300 mL) and an aqueous solution of 2M sodium carbonate (130 mL) were added together in sequential order, and heated to reflux for 8 hours.

After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 3-1 (8.2g, a yield of 71%) was obtained.

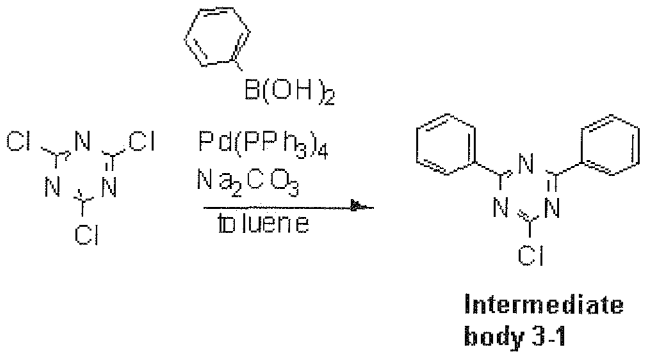
[0405] Under an argon gas atmosphere, the intermediate body 1-4 (1.6 g, 3.9 mmol), the intermediate body 3-1 (1.5g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours.

After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 3 (2.2g, a yield of 80%) was obtained.

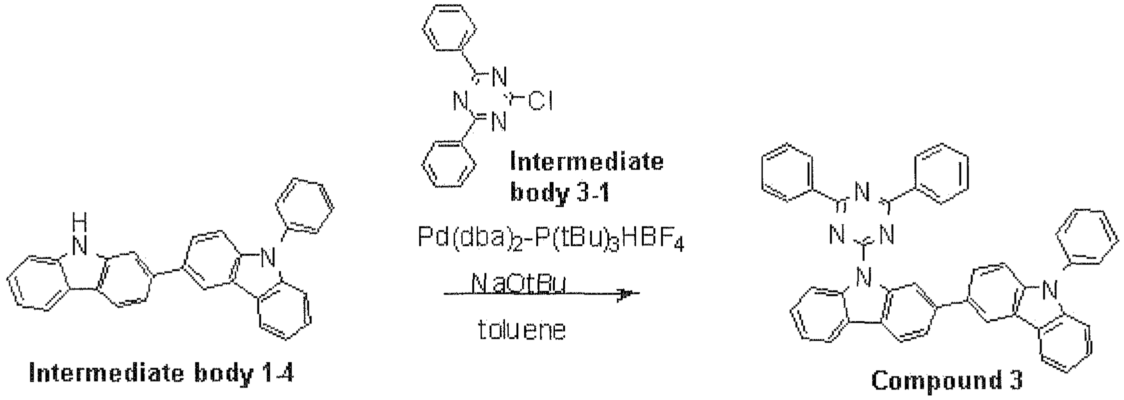
[0406] FD-MS analysis consequently showed that m/e was equal to 639 while a calculated molecular weight was 639.

[0407] A synthesis scheme of the compound 3 is shown below.

[Chemical Formula 130]



[Chemical Formula 131]



Synthesis Example 4 (Synthesis of Compound 4)

[0408] Under a nitrogen atmosphere, intermediate body 3-1 (8 g, 29.9 mmol), p-chlorophenylboronic acid (5.1g, 32.9 mmol), tetrakis(triphenylphosphine)palladium (0.63g, 0.6 mmol), toluene (60 mL) and an aqueous solution of 2M sodium carbonate (30 mL) were added together in sequential order, and heated to reflux for 8 hours.

[0409] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 4-1 (7.0g, a yield of 68%) was obtained.

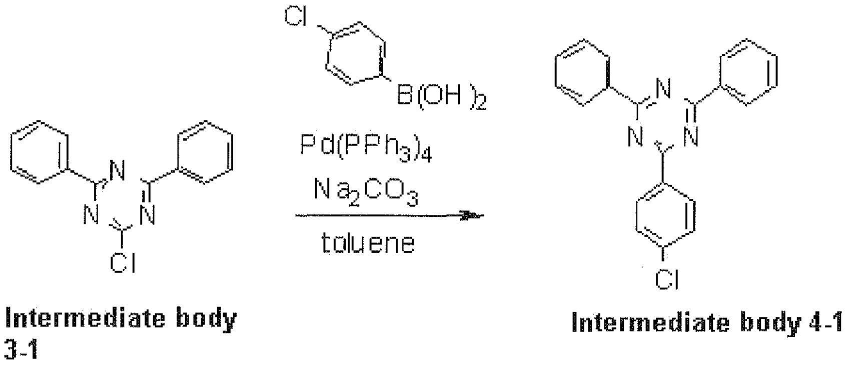
[0410] Under an argon gas atmosphere, the intermediate body 1-4 (1.6 g, 3.9 mmol), the intermediate body 4-1 (1.3g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours.

[0411] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 4 (2.3g, a yield of 82%) was obtained.

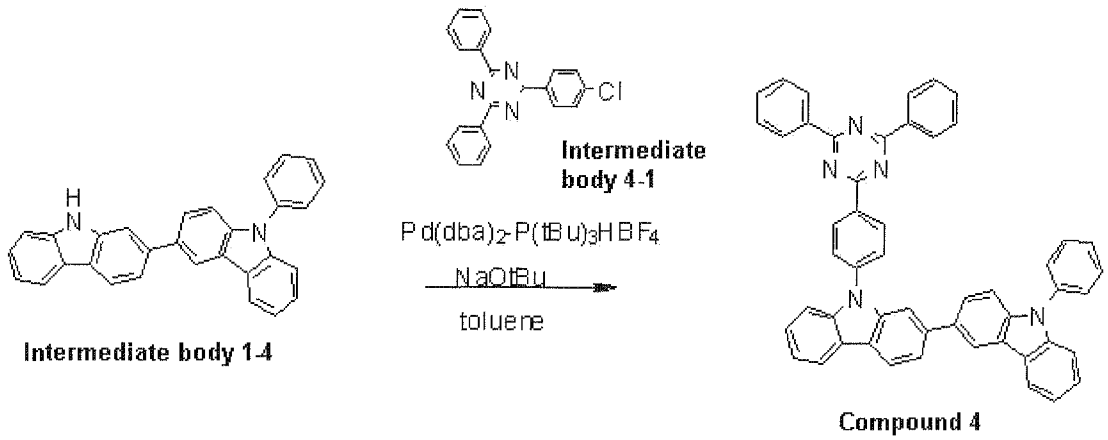
[0412] FD-MS analysis consequently showed that m/e was equal to 715 while a calculated molecular weight was 715.

[0413] A synthesis scheme of the compound 4 is shown below.

[Chemical Formula 132]



[Chemical Formula 133]



Synthesis Example 5 (Synthesis of Compound 5)

[0414] 3-bromobenzaldehydo (100 g, 54 mmol) and aniline (50 g, 54 mmol) were added to toluene (1L) and heated to reflux for 8 hours. After the reaction solution was cooled down, a solvent was concentrated under reduced pressure to obtain an intermediate body 5-1 (130g, a yield of 93%).

[0415] Subsequently, under an argon gas atmosphere, the intermediate body 5-1 (130g, 50 mmol), benzamidine hydrochloride (152g, 100 mmol), anhydrous ethanol (1 L), and sodium hydroxide (42 g) were added together in sequential order, and stirred at 80 degrees C for 16 hours. Subsequently, sodium-t-butoxide (20 g, 208 mmol) were further added and heated at 80 degrees C for 16 hours with stirring. After the reaction solution was cooled down, a solid was separated by filtration and washed with methanol to obtain an intermediate body 5-2 (67g, a yield of 37%).

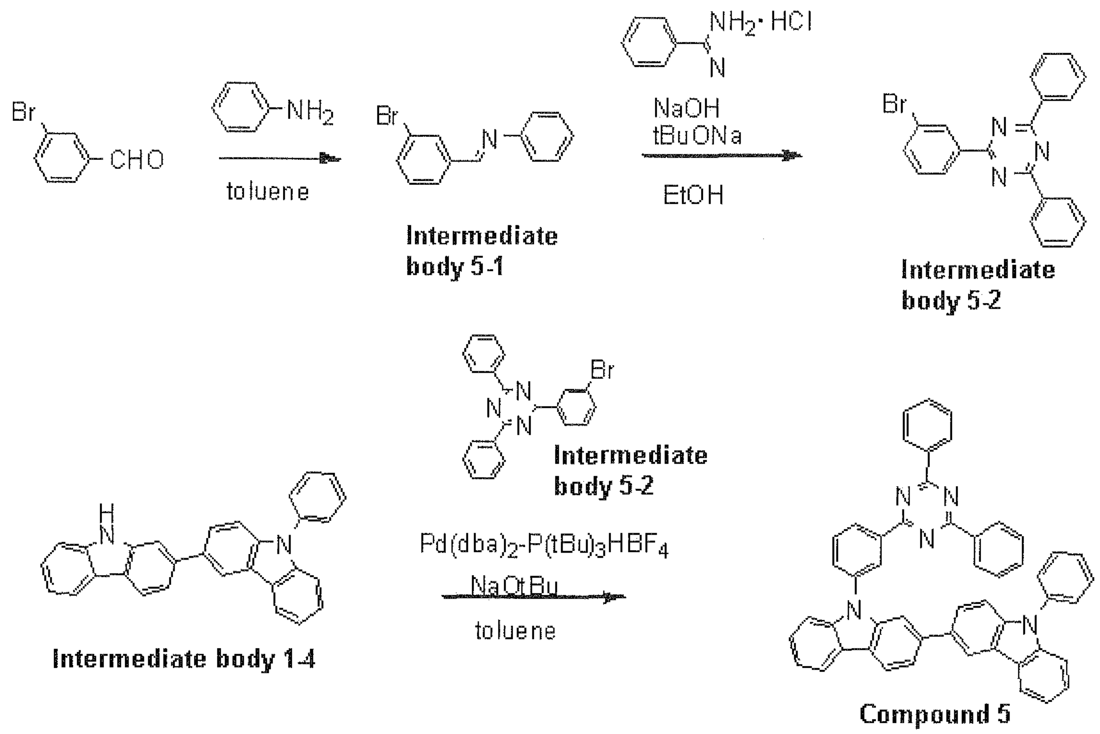
[0416] Under an argon gas atmosphere, the intermediate body 1-4 (1.6 g, 3.9 mmol), the intermediate body 5-2 (1.5g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours.

[0417] After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 5 (2.3g, a yield of 82%) was obtained.

[0418] FD-MS analysis consequently showed that m/e was equal to 715 while a calculated molecular weight was 715.

[0419] A synthesis scheme of the compound 5 is shown below.

[Chemical Formula 134]



Synthesis Example 6 (Synthesis of Compound 6)

[0420] Under a nitrogen atmosphere, the intermediate body 3-1 (15.5 g, 58 mmol), 3-bromocarbazole (14.2 g, 58 mmol), and potassium carbonate (16g, 116 mmol) were added to dimethylformamide (100 mL), and heated at 100 degrees C for 16 hours with stirring. A precipitated solid was separated by filtration. Then, the obtained solid was washed with methanol to obtain an intermediate body 6-1 (25g, a yield of 90%).

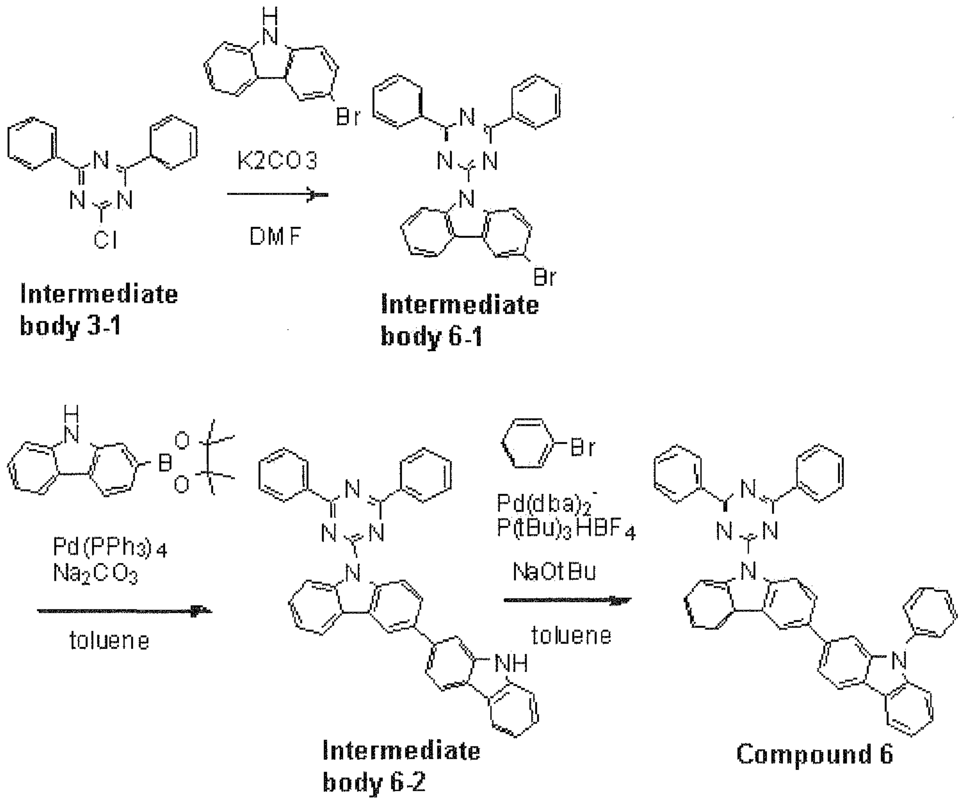
[0421] Subsequently, under a nitrogen atmosphere, the intermediate body 6-1 (8.1g, 17 mmol), 9H-carbazole-2-boronic acid pinacol ester (5g, 17 mmol), tetrakis(triphenylphosphine)palladium (0.39g, 0.34 mmol), toluene (50 mL) and an aqueous solution of 2M sodium carbonate (26 mL) were added together, and stirred at 80 degrees C for 8 hours. After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was concentrated under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby an intermediate body 6-2 (6.2g, a yield of 65%) was obtained.

[0422] Under a nitrogen atmosphere, the intermediate body 6-2 (2.2g, 3.9 mmol), bromobenzene (0.61 g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours. After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 6 (1.8g, a yield of 72%) was obtained.

[0423] FD-MS analysis consequently showed that m/e was equal to 639 while a calculated molecular weight was 639.

[0424] A synthesis scheme of the compound 6 is shown below.

[Chemical Formula 135]



Synthesis Example 7 (Synthesis of Compound 7)

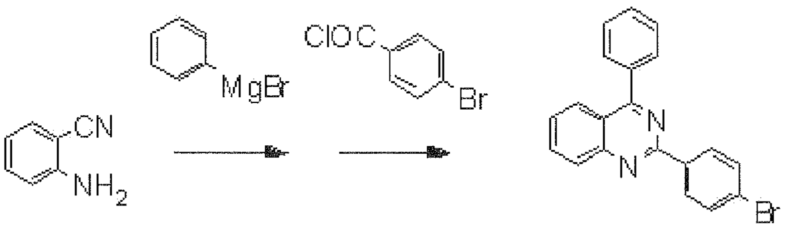
[0425] An intermediate body 7-1 was synthesized by applying a method described in a document (J. Bergman, A. Brynolf, B. Elman and E. Vuorinen, Tetrahedron, 42,3697-3706(1986)). Specifically, to a three-necked flask (500 ml), a 1M tetrahydrofuran solution of phenylmagnesium bromide (100 ml, 100 mmol) was added. Dry ether (100 ml) was further added and heated to reflux in a 45-degree-C oil bath. A dry ether solution (50 ml) of 2-cyanoaniline (5.91 g, 50 mmol) was dropped in the reaction solution for 30 minutes After refluxed for another 1.5 hours, the reaction solution was cooled down to 0 degree C in an ice water bath. Subsequently, a dry ether solution (100ml) of 4-bromobenzoate chloride (13.2g, 60 mmol) was dropped in the reaction solution for 10 minutes and heated to reflux for 2 hours in a 45-degree-C oil bath. After the reaction, the reaction solution was cooled down to 0 degree C in an ice water bath and a saturated ammonium chloride aqueous solution was added. A precipitated solid was separated by filtration. Then, the obtained solid was washed with a small amount of methanol and vacuum-dried to obtain an intermediate body 7-1 (10.8 g, a yield of 60%).

[0426] Subsequently, under a nitrogen atmosphere, the intermediate body 7-1 (1.4g, 3.9 mmol), the intermediate body 1-4 (1.6 g, 3.9 mmol), tris(dibenzylideneacetone)dipalladium (0.071 g, 0.078 mmol), tri-t-butylphosphonium tetrafluoroborate (0.091 g, 0.31 mmol), sodium t-butoxide (0.53g, 5.5 mmol), and anhydrous toluene (20 mL) were sequentially mixed, and heated to reflux for 8 hours. After the reaction solution was cooled down to the room temperature, an organic layer was removed and an organic solvent was distilled away under reduced pressure. The obtained residue was refined by silica-gel column chromatography, whereby a compound 7 (2.2g, a yield of 82%) was obtained.

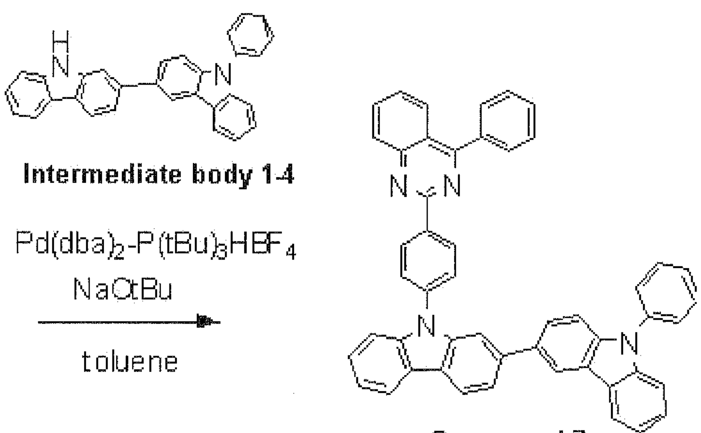
[0427] FD-MS analysis consequently showed that m/e was equal to 688 while a calculated molecular weight was 688.

[0428] A synthesis scheme of the compound 7 is shown below.

[Chemical Formula 136]



Intermediate body 7-1



Intermediate body 1-4

Compound 7

Example 1 (Manufacture of Organic EL Device)

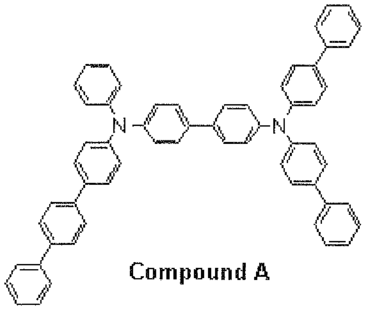
[0429] A glass substrate (size: 25 mm × 75 mm × 1.1 mm) having an ITO transparent electrode (manufactured by GEOMATEC Co., Ltd.) was ultrasonic-cleaned in isopropyl alcohol for five minutes, and then UV (Ultraviolet)/ozone-cleaned for 30 minutes.

[0430] After the glass substrate having the transparent electrode was cleaned, the glass substrate was mounted on a substrate holder of a vacuum deposition apparatus, and a hole injecting layer was initially formed by depositing a compound A onto the substrate to be 40 nm thick to cover a surface of the glass substrate where a transparent electrode line was provided. Next, a compound B was deposited onto the hole injecting layer to be 20 nm thick to obtain a hole transporting layer.

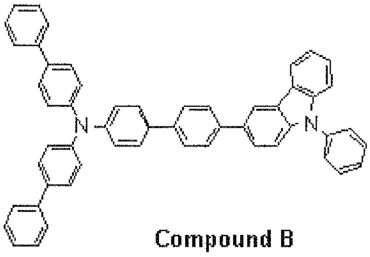
[0431] A phosphorescent-emitting layer was obtained by co-depositing the compound 1 used as a phosphorescent host material and $Ir(Ph\text{-}ppy)_3$ used as a phosphorescent dopant material onto the hole transporting layer to be 40 nm thick. The concentration of $Ir(Ph\text{-}ppy)_3$ was 20 mass%.

[0432] Subsequently, a 30-nm-thick compound C, 1-nm-thick LiF and 80-nm-thick metal Al are sequentially layered to obtain a cathode. LiF, which is an electron injectable electrode, was formed at a speed of 1 Å/min.

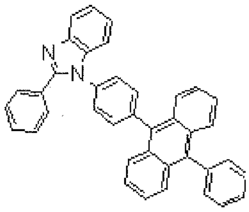
[Chemical Formula 137]



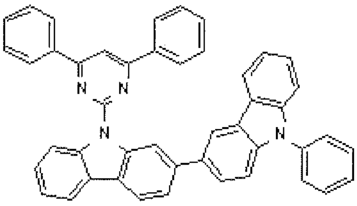
Compound A



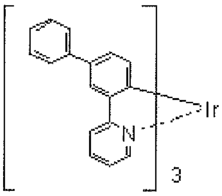
Compound B



Compound C



Compound 1

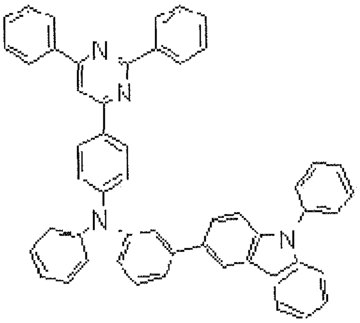


Ir(Ph-ppy)$_3$ (facial body)

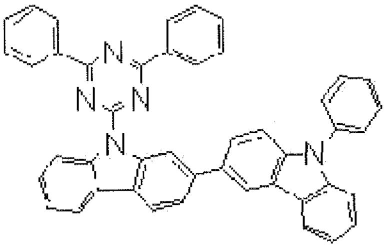
Examples 2 to 5 (Manufacture of Organic EL Devices 2 to 5)

[0433] In Example 1, the compounds 2 to 5 below were used in place of the compound 1 to manufacture organic EL devices 2 to 5.

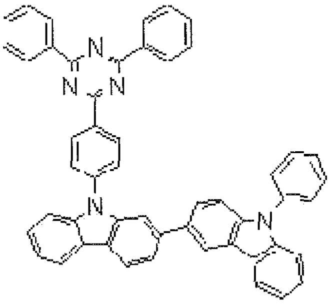
[Chemical Formula 138]



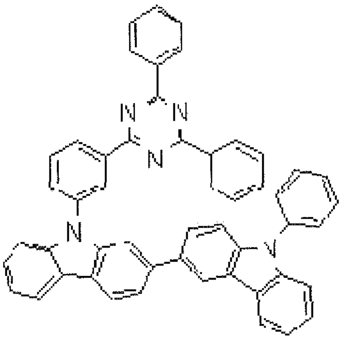
Compound 2



Compound 3



Compound 4



Compound 5

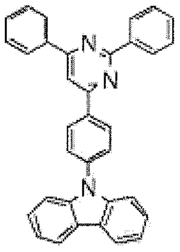
Comparisons 1 to 4

[0434] The organic EL devices according respectively to Comparisons 1 to 4 were formed in the same manner as in Example 1 except that the following comparative compounds D to G were respectively used as a host material in place of the compound 1 in Example 1.

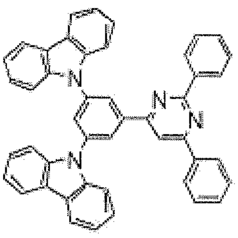
Evaluation of Organic EL Device

[0435] The organic EL devices manufactured in Examples 1 to 5 and Comparisons 1 to 4 were driven by direct-current electricity to emit light, where luminescent performance was evaluated and time elapsed until an initial luminescence intensity of 20,000cd/m^2 was reduced to the half and luminous efficiency were measured. The results are shown in Table 4.

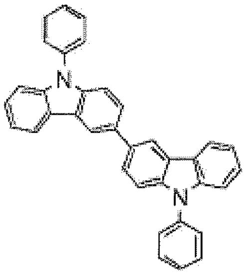
[Chemical Formula 139]



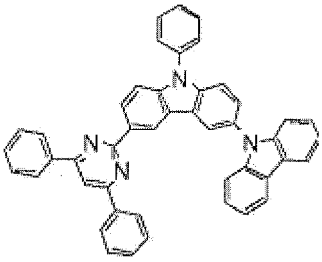
Compound D



Compound E



Compound F



Compound G

[Table 4]

	Host Material	Voltage (V) @1mA/cm^2	Luminous Efficiency (cd/A) @1mA/cm^2	Luminance half-life (hrs)
Example 1	Compound 1	4.2	60	600
Example 2	Compound 2	4.1	62	600
Example 3	Compound 3	4.3	61	700
Example 4	Compound 4	4.2	60	630
Example 5	Compound 5	4.2	61	800
Comparison 1	Compound D	4.2	38	310
Comparison 2	Compound E	4.5	54	450
Comparison 3	Compound F	5.1	50	210
Comparison 4	Compound G	4.6	48	350

[0436] Table 4 shows that the compounds of the invention used in Examples 1 to 5 have a significantly long luminance half-life and a high luminous efficiency while being capable of low-voltage drive, as compared with those of Comparisons 1 to 4.

[0437] In Comparison 1, since the compound D has a single carbazolyl group and is poor in hole transporting performance, luminance half-life is short. In Comparison 2, although having two carbazolyl groups, the compound E has a poor hole transporting performance and a short luminance half-life, presumably because of small overlapping margin between the molecules. In Comparison 3, since the compound F has a nitrogen-containing heterocyclic group only in a carbazolyl group, electrons are difficult to be injected, so that the compound F has a low luminous efficiency and a short luminance half-life. In Comparison 4, although having two carbazolyl groups, the compound G has a poor hole transporting capability and a short luminance half-life, presumably because of small overlapping margin between the molecules.

[0438] Table 5 shows physical properties of the host materials used in Examples 1 to 5.

[0439] A method for measuring each of the physical properties is as follows.

(1) Ionization Potential (Ip)

[0440] Ionization potential was measured in the atmosphere by using a photoelectron spectrometer (AC-1 manufactured by Riken Keiki Co., Ltd.). Specifically, ionization potential was measured by irradiating the materials with light and measuring the amount of electrons generated by charge separation at that time.

(2) Affinity (Af)

[0441] Affinity was calculated based on measurement values of ionization potential Ip and energy gap Eg. A calculation equitation is as follows.

$$Af=Ip-Eg$$

[0442] The energy gap was measured from an absorption end of absorption spectrum of benzene. Specifically, the absorption spectrum is measured with a commercially available ultraviolet-visible spectrophotometer, and the energy gap is calculated from a wavelength at which the absorption spectrum appears.

(3) Singlet Energy (S1) and Triplet Energy (T1)

[0443] The optical energy gap S1 (also referred to as singlet energy) is a difference between a conduction level and a valence level. The optical energy gap was obtained by converting into energy a wavelength value at an intersection of a long-wavelength-side tangent line in an absorbing spectrum of a toluene-diluted solution of each material and a base line in the absorbing spectrum (zero absorption).

[0444] The triplet energy gap T1 of the material may be exemplarily defined based on the phosphorescence spectrum.

The triplet energy gap T1 was defined as follows in Examples.

[0445] Specifically, each material was dissolved in an EPA solvent (diethylether:isopentane:ethanol = 5:5:2 in volume ratio) with a concentration of 10 μmol/L, thereby forming a sample for phosphorescence measurement.

[0446] Then, the sample for phosphorescence measurement was put into a quartz cell, cooled to 77K and irradiated with exciting light, so that a wavelength of phosphorescence radiated therefrom was measured.

[0447] A tangent line is drawn to be tangent to a rising section adjacent to short-wavelength of the obtained phosphorescence spectrum, a wavelength value at an intersection of the tangent line and a base line is converted into energy value, and the converted energy value is defined as the triplet energy gap T1.

[0448] For the measurement, a measurement machine F-4500 (manufactured by Hitachi) was used.

[Table 5]

	IP (eV)	Af(eV)	S1 (eV)	T1 (eV)
Compound 1	5.5	2.1	3.4	2.7
Compound 2	5.8	2.3	3.4	2.8
Compound 3	5.6	2.2	3.4	2.7
Compound 4	5.7	2.6	3.1	2.7
Compound 5	5.6	2.2	3.4	2.7

Example 6 (Manufacture of Organic EL Device 6)

[0449] A glass substrate (size: 25 mm × 75 mm × 1.1mm thick) having an ITO transparent electrode (manufactured by GEOMATEC Co., Ltd.) was ultrasonic-cleaned in isopropyl alcohol for five minutes, and then UV/ozone-cleaned for 30 minutes.

[0450] After the glass substrate having the transparent electrode line was cleaned, the glass substrate was mounted on a substrate holder of a vacuum deposition apparatus, so that the following electron accepting compound (C-1) was deposited to form a 5-nm thick C-1 film on a surface of the glass substrate where the transparent electrode line was provided so as to cover the transparent electrode. On the C-1 film, the following aromatic amine derivative (X1) was deposited as a first hole transporting material to form a 50-nm thick first hole transporting layer. After film formation of the first hole transporting layer, the following aromatic amine derivative (X2) was deposited as a second hole transporting material to form a 60-nm thick second hole transporting layer.

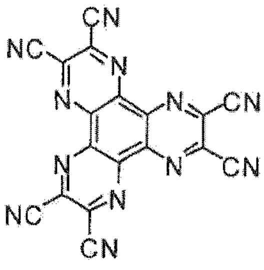
[0451] Further on the second hole transporting layer, the compound 1 obtained in Synthesis Example 1 was deposited to form a 45-nm thick emitting layer. Simultaneously, the following compound (D3) was co-deposited as a phosphorescent material. A concentration of the compound D3 was 8.0 mass%. This co-deposited film serves as the emitting layer.

[0452] After the film formation of the emitting layer, a 30-nm thick film of the following compound (ET1) was formed. The ET1 film serves as the electron transporting layer.

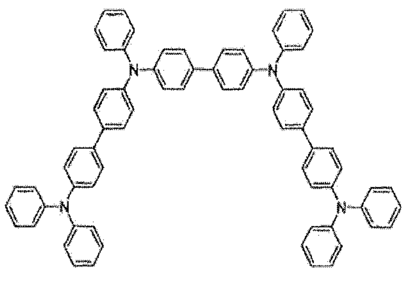
[0453] Next, a 1-nm thick film of LiF was formed as an electron-injecting electrode (cathode) at a film-forming speed of 0.1 Å/min. Metal (Al) was deposited on the LiF film to form an 80-nm thick metal cathode, thereby providing an organic electroluminescence device.

[0454] For each of the obtained organic EL devices, luminous efficiency was measured when the device was driven by DC constant current at the initial luminescence of 2000 cd/m^2 at the room temperature, and the time elapsed until a half-life of emission was measured when the device was driven by DC constant current at the initial luminescence of 5000 cd/m^2 at the room temperature. The results are shown in Table 6.

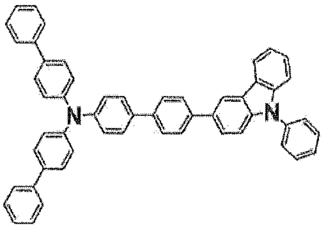
[Chemical Formula 140]



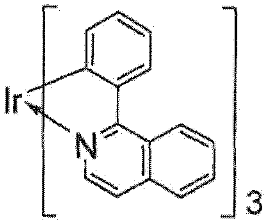
C－1



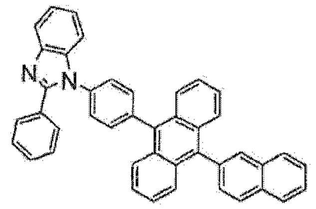
X1



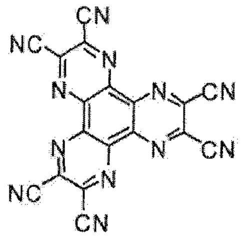
X2



D3



ET1



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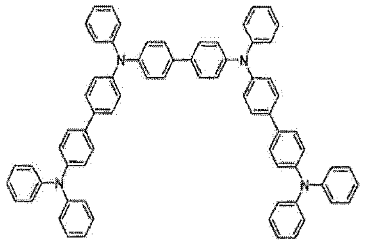
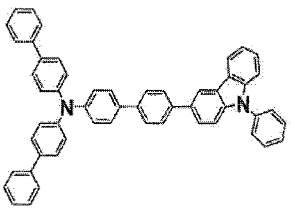
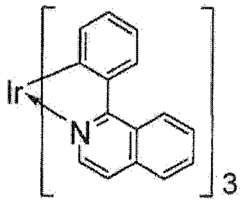


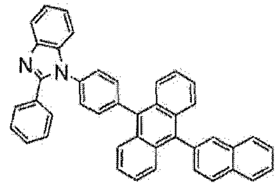
~~X1~~



~~X2~~



D3



ET2

Examples 7 to 11 (Manufacture of Organic EL Devices 7 to 11)

[0455] The organic EL devices according to Examples 9 to 14 were manufactured in the same manner as that in Example 6 except that the compounds 2 to 5 and 7 were used in place of the compound 1 as materials for the emitting layer. For each of the obtained organic EL devices, luminous efficiency was measured when the device was driven by DC constant current at the initial luminescence of 2000 cd/m^2 at the room temperature, and the time elapsed until a half-life of emission was measured when the device was driven by DC constant current at the initial luminescence of 5000 cd/m^2 at the room temperature. The results are shown in Table 6.

Comparisons 5 and 6

[0456] The organic EL devices according to Comparisons 5 and 6 were manufactured in the same manner as that in Example 6 except that the comparative compounds D and F were used in place of the compound 1 as materials for the emitting layer. For each of the obtained organic EL devices, luminous efficiency was measured when the device was driven by DC constant current at the initial luminescence of 2000 cd/m^2 at the room temperature, and the time elapsed until a half-life of emission was measured when the device was driven by DC constant current at the initial luminescence of 5000 cd/m^2 at the room temperature.

[0457] The results are shown in Table 6.

[Table 6]

	Host Material	Voltage (V)	Luminous Efficiency (cd/A)	Luminance half-life (hrs)
Example 6	Compound 1	4.1	9	400
Example 7	Compound 2	4.2	11	400
Example 8	Compound 3	4.1	10	350
Example 9	Compound 4	4.1	12	440
Example 10	Compound 5	4.4	12	350
Example 11	Compound 7	4.1	12	450
Comparison 5	Compound D	4.1	7	200
Comparison 6	Compound F	5.2	6.5	220

[0458] The table 6 shows that the compounds of the invention also function as a red phosphorescent host material.

INDUSTRIAL APPLICABILITY

[0459] The invention is applicable to an organic EL device and an organic-EL-device material capable of a long lifetime, high luminous efficiency, and reducing driving voltage and exhibiting high efficiency.

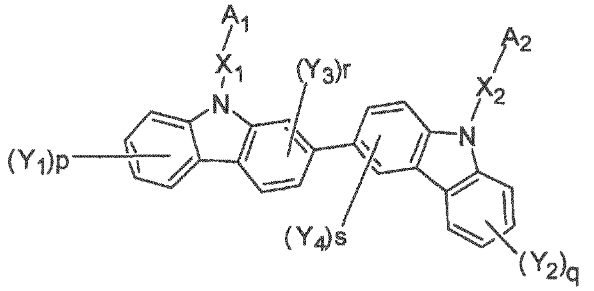
EXPLANATION OF CODES

[0460]

1	organic EL device
2	substrate
3	anode
4	cathode
5	phosphorescent-emitting layer
6	hole injecting/transporting layer
7	electron injecting/transporting layer
10	organic thin-film layer

Claims

1. A biscarbazole derivative represented by a formula (1A) or (1B) below.



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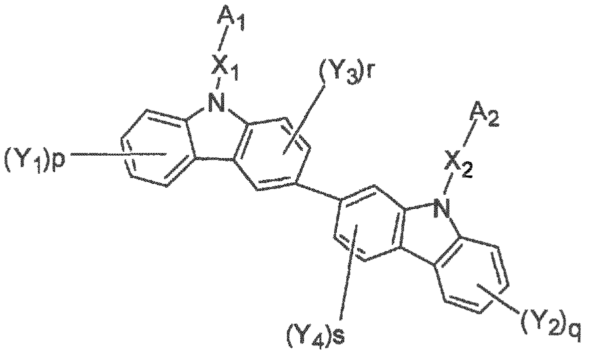


···(1B)

where: A_1 is selected from the group consisting of a substituted or unsubstituted pyridine ring, a substituted or unsubstituted pyrimidine ring and a substituted or unsubstituted triazine ring;
A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;
X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;
Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;
adjacent ones of Y_1 to Y_4 are allowed to be bonded to each other to form a ring structure;
p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and
when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 are allowed to be the same or different.

2. The biscarbazole derivative according to claim 1, wherein
A_1 is selected from a substituted or unsubstituted pyrimidine ring or substituted or unsubstituted triazine ring.

3. The biscarbazole derivative according to claim 1 or 2, wherein A_1 is a substituted or unsubstituted pyrimidine ring.

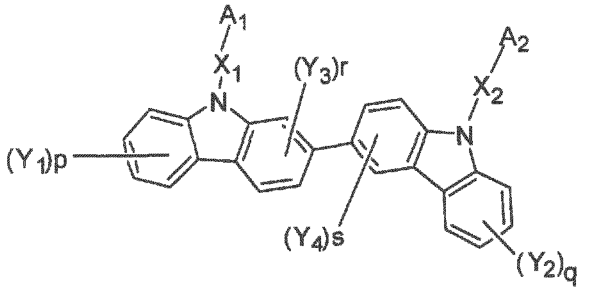
4. An organic-EL-device material comprising the biscarbazole derivative according to any one of claims 1 to 3.

5. An organic electroluminescence device comprising: a cathode; an anode; and a plurality of organic thin-film layers provided between the cathode and the anode, the organic thin-film layers comprising an emitting layer, wherein at least one of the organic thin-film layers comprises the organic-EL-device material according to claim 4.

6. The organic electroluminescence device according to claim 5, wherein
the emitting layer comprises the organic-EL-device material as a host material.

7. The organic electroluminescence device according to claim 5 or 6, wherein the emitting layer comprises a phosphorescent material.

8. An organic electroluminescence device comprising: a cathode; an anode; and a plurality of organic thin-film layers provided between the cathode and the anode, the organic thin-film layers comprising an emitting layer, wherein at least one of the organic thin-film layers is the emitting layer comprising a first host material, a second host material and a phosphorescent material providing phosphorescence,
the first host material being a compound represented by a formula (5A) or (5B) below.



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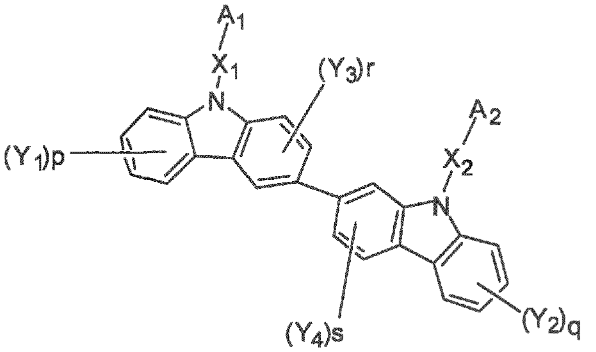


···(5B)

where: A_1 is selected from the group consisting of a substituted or unsubstituted pyridine ring, a substituted or unsubstituted pyrimidine ring and a substituted or unsubstituted triazine ring;

A_2 represents a substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, or substituted or unsubstituted nitrogen-containing heterocyclic group having 1 to 30 ring carbon atoms;

X_1 and X_2 each are a linking group and independently represent a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

Y_1 to Y_4 independently represent a hydrogen atom, fluorine atom, cyano group, substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkyl group having 1 to 20 carbon atoms, substituted or unsubstituted haloalkoxy group having 1 to 20 carbon atoms, substituted or unsubstituted alkylsilyl having 1 to 10 carbon atoms, substituted or unsubstituted arylsilyl having 6 to 30 carbon atoms, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 ring carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 ring carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 ring carbon atoms;

adjacent ones of Y_1 to Y_4 are allowed to be bonded to each other to form a ring structure;

p and q represent an integer of 1 to 4; r and s represent an integer of 1 to 3; and

when p and q are an integer of 2 to 4 and r and s are an integer of 2 to 3, a plurality of Y_1 to Y_4 are allowed to be the same or different.

9. The organic electroluminescence device according to claim 8, wherein the second host material is represented by either one of a formula (6) or (7) below.

$$(Cz\text{-})_aA^3 \qquad (6)$$

$$Cz(\text{-}_{A}{}^{3})_b \qquad (7)$$

where: Cz represents a substituted or unsubstituted arylcarbazolyl group or carbazolylaryl group;

A^3 represents a group represented by a formula (8A) or (8B) below; and

a and b each represent an integer of 1 to 3.

$$(M^1)_c\text{-}(L^5)_d\text{-}(M^2)_e \qquad (8A)$$

where: M^1 and M^2 each independently represent a substituted or unsubstituted nitrogen-containing aromatic heterocyclic ring or nitrogen-containing fused aromatic heterocyclic ring having 2 to 40 ring carbon atoms; M^1 and M^2 are allowed to be the same or different;

L^5 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 30 carbon atoms, or substituted or unsubstituted fused aromatic heterocyclic group having 2 to 30 carbon atoms;

c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

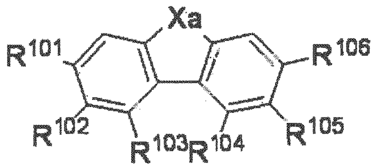
$$(M^3)_c\text{-}(L^6)_d\text{-}(M^4)_e \qquad (8B)$$

where: M^3 and M^4 each independently represent a substituted or unsubstituted aromatic hydrocarbon group having 6 to 40 ring carbon atoms; M^3 and M^4 are allowed to be the same or different;

L^6 represents a single bond, substituted or unsubstituted aromatic hydrocarbon group having 6 to 30 carbon atoms, substituted or unsubstituted fused aromatic hydrocarbon group having 6 to 30 carbon atoms, or substituted or unsubstituted cycloalkylene group having 5 to 30 carbon atoms;

c represents an integer of 0 to 2; d represents an integer of 1 to 2; e represents an integer of 0 to 2; and c+e represents 1 or more.

10. The organic electroluminescence device according to claim 8, wherein the second host material is represented by a formula (9) below.



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where: R^{101} to R^{106} each independently represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms or cyano group;

at least one of R^{101} to R^{106} is a substituted or unsubstituted 9-carbazolyl group, substituted or unsubstituted azacarbazolyl group having 2 to 5 nitrogen atoms, or -L-9-carbazolyl group;

L represents a substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted cycloalkyl group having 3 to 15 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted alkoxy group having 1 to 40 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aryloxy group having 6 to 20 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted arylamino group having 6 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted arylcarbonyl group having 7 to 40 carbon atoms, substituted or unsubstituted arylthio group having 6 to 20 carbon atoms, or substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms;

Xa represents a sulfur atom, oxygen atom or N-R^{108}; and

R^{108} represents the same as R^{101} to R^{106}.

11. The organic electroluminescence device according to claim 8, wherein the second host material is a compound selected from the group consisting of polycyclic aromatic compounds represented by formulae (10A), (10B) and (10C) below.

$\mathrm{Ra\text{-}Ar^{101}\text{-}Rb}$ (10A)

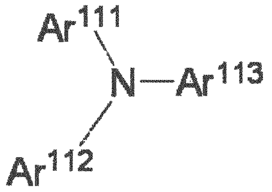
$\mathrm{Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Rb}$ (10B)

$\mathrm{Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Ar^{103}\text{-}Rb}$ (10C)

where: Ar^{101}, Ar^{102}, Ar^{103}, Ra and Rb represent a polycyclic aromatic skeleton having 6 to 60 ring carbon atoms selected from a substituted or unsubstituted benzene ring, substituted or unsubstituted naphthalene ring, substituted or unsubstituted chrysene ring, substituted or unsubstituted fluoranthene ring, substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzophenanthrene ring, substituted or unsubstituted dibenzophenanthrene ring, substituted or unsubstituted triphenylene ring, substituted or unsubstituted benzo[a]triphenylene ring, substituted or unsubstituted benzochrysene ring, substituted or unsubstituted benzo[b]fluoranthene ring, substituted or unsubstituted fluorene ring and substituted or unsubstituted picene ring.

12. The organic electroluminescence device according to claim 11, wherein either one or both of Ra and Rb in the formulae (10A) to (10C) are selected from the group consisting of a substituted or unsubstituted phenanthrene ring, substituted or unsubstituted benzo[c]phenanthrene ring and substituted or unsubstituted fluoranthene ring.

13. The organic electroluminescence device according to claim 8, wherein the second host material is a monoamine derivative represented by any one of formulae (11) to (13) below.



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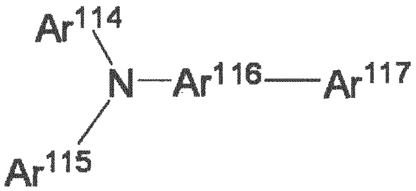
[where: Ar^{111}, Ar^{112} and Ar^{113} are a substituted or unsubstituted aryl group or heteroaryl group.]



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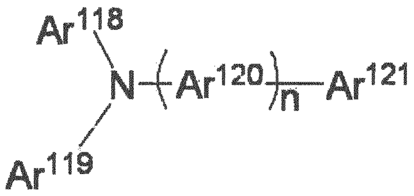
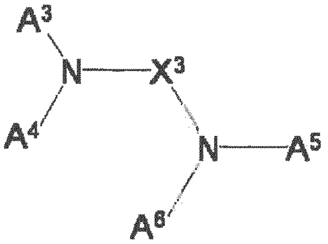
[where: Ar^{114}, Ar^{115} and Ar^{117} are a substituted or unsubstituted aryl group or heteroaryl group; and Ar^{116} is a substituted or unsubstituted arylene group or heteroarylene group.]



•••(13)

where: Ar^{118}, Ar^{119} and Ar^{121} are a substituted or unsubstituted aryl group or heteroaryl group;
Ar^{120} is a substituted or unsubstituted arylene group or heteroarylene group;
n is an integer of 2 to 5; and
when n is 2 or more, Ar^{120} are allowed to be the same or different.

14. The organic electroluminescence device according to claim 8, wherein the second host material is represented by either one of a formula (14) or (15) below.



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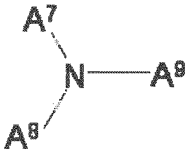
where: X^3 represents a substituted or unsubstituted arylene group having 10 to 40 ring carbon atoms; and A^3 to A^6 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 ring atoms.



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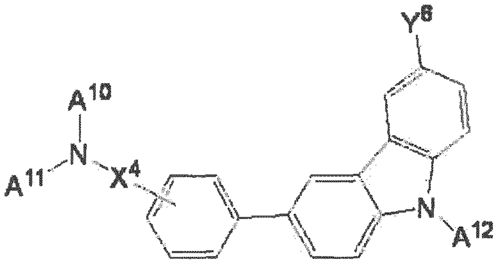
where: A^7 to A^9 represent a substituted or unsubstituted aryl group having 6 to 60 ring carbon atoms, or heteroaryl group having 6 to 60 ring atoms.

15. The organic electroluminescence device according to claim 8, wherein the second host material is represented by any one of formulae (16) to (20) below.



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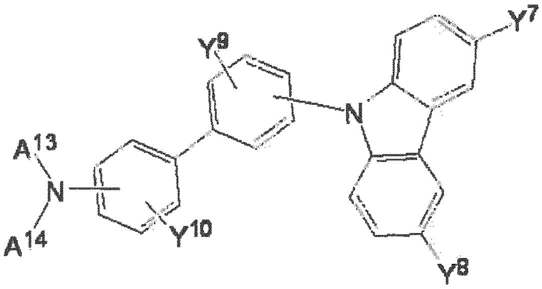

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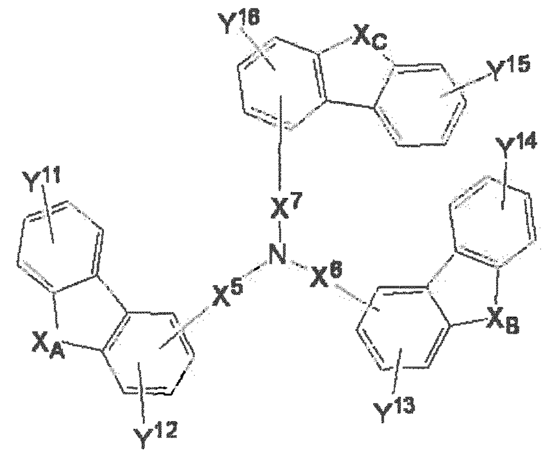

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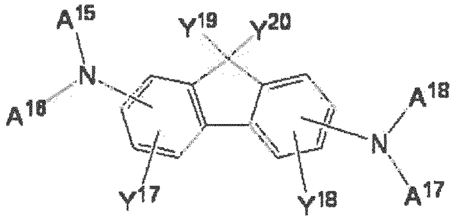

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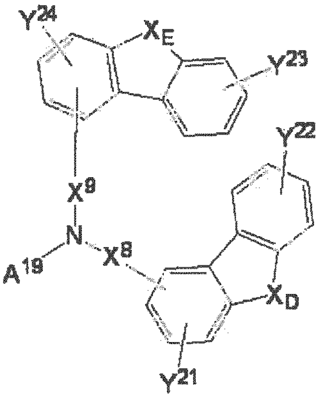

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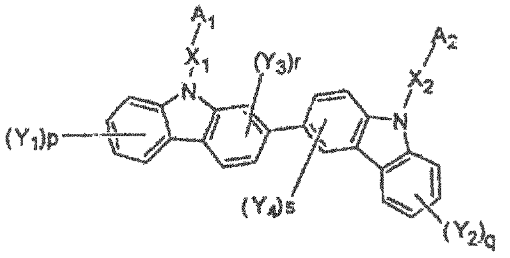
where: A^{10} to A^{19} each represent a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aromatic heterocyclic group having 2 to 40 carbon atoms, substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic amino group, or substituted or unsubstituted aryl group having 8 to 40 carbon atoms bonded with an aromatic heterocyclic group;
A^{10}, A^{13}, A^{15} and A^{17} are adapted to be respectively bonded to A^{11}, A^{14}, A^{16} and A^{18} to form a ring;
X^4 to X^9 represent a single bond or a linking group having 1 to 30 carbon atoms;
Y^6 to Y^{24} represent a hydrogen atom, halogen atom, substituted or unsubstituted alkyl group having 1 to 40 carbon atoms, substituted or unsubstituted heterocyclic group having 3 to 20 carbon atoms, substituted or unsubstituted aryl group having 6 to 40 carbon atoms, substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms, substituted or unsubstituted alkenyl group having 2 to 40 carbon atoms, substituted or unsubstituted alkylamino group having 1 to 40 carbon atoms, substituted or unsubstituted aralkylamino group having 7 to 60 carbon atoms, substituted or unsubstituted alkylsilyl group having 3 to 20 carbon atoms, substituted or unsubstituted arylsilyl group having 8 to 40 carbon atoms, substituted or unsubstituted aralkylsilyl group having 8 to 40 carbon atoms, or substituted or unsubstituted halogenated alkyl group having 1 to 40 carbon atoms; and
X_A, X_B, X_C, X_D, X_E each represent a sulfur atom, an oxygen atom or a monoaryl-substituted nitrogen atom.

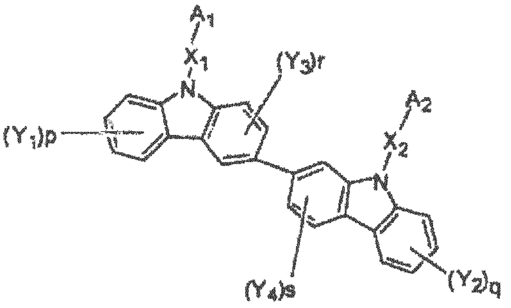
16. The organic electroluminescence device according to any one of claims 8 to 15, wherein
the emitting layer comprises a host material and a phosphorescent material, the phosphorescent material being an ortho-metalated complex of a metal atom selected from iridium (Ir), osmium (Os) and platinum (Pt).

Patentansprüche

1. Durch eine der folgenden Formeln (1A) oder (1B) dargestelltes Biscarbazol-Derivat,



···(1A)



···(1B)

wobei: A_1 aus der Gruppe ausgewählt wird, die aus einem substituierten oder unsubstituierten Pyridinring, einem substituierten oder unsubstituierten Pyrimidinring und einem substituierten oder unsubstituierten Triazinring besteht;
A_2 eine substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, oder eine substituierte oder unsubstituierte stickstoffhaltige heterocyclische Gruppe mit 1 bis 30 Ring-Kohlenstoffatomen darstellt;
X_1 und X_2 jeweils eine Bindungsgruppe sind und unabhängig voneinander eine Einfachbindung, substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenwasserstoffatomen, substituierte oder unsubstituierte kondensierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen, oder substituierte oder unsubstituierte kondensierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen darstellen;
Y_1 bis Y_4 unabhängig voneinander ein Wasserstoffatom, Fluoratom, Cyanogruppe, substituierte oder unsubstituierte Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Alkoxygruppe mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Haloalkylgruppe mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Haloalkoxygruppe mit 1 bis 20 Kohlenstoffatomen, substituiertes oder unsubstituiertes Alkylsilyl mit 1 bis 10 Kohlenstoffatomen, substituiertes oder unsubstituiertes Arylsilyl mit 6 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder unsubstituierte kondensierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen, oder substituierte oder unsubstituierte kondensierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen darstellen;
benachbarte Y_1 bis Y_4 aneinander gebunden sein können, um eine Ringstruktur zu bilden;
p und q eine ganze Zahl von 1 bis 4 darstellen; r und s eine ganze Zahl von 1 bis 3 darstellen; und
wenn p und q eine ganze Zahl von 2 bis 4 sind und r und s eine ganze Zahl von 2 bis 3 sind, mehrere Y_1 bis Y_4 gleich oder verschieden sein können.

2. Biscarbazol-Derivat nach Anspruch 1, wobei A_1 aus einem substituierten oder unsubstituierten Pyrimidinring oder einem substituierten oder unsubstituierten Triazinring ausgewählt wird.

3. Biscarbazol-Derivat nach Anspruch 1 oder 2, wobei A_1 ein substituierter oder unsubstituierter Pyrimidinring ist.

4. Organisches Elektrolumineszenz-Vorrichtungsmaterial, umfassend das Biscarbazol-Derivat nach einem der An-

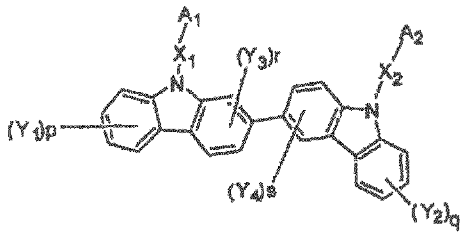
sprüche 1 bis 3.

5. Organische Elektrolumineszenz-Vorrichtung, umfassend: eine Kathode; eine Anode; und eine Mehrzahl von organischen Dünnfilm-Schichten, die zwischen der Kathode und der Anode vorgesehen sind, wobei die organischen Dünnfilm-Schichten eine emittierende Schicht umfassen, wobei
mindestens eine der organischen Dünnfilm-Schichten das organische Elektrolumineszenz-Vorrichtungsmaterial nach Anspruch 4 umfasst.

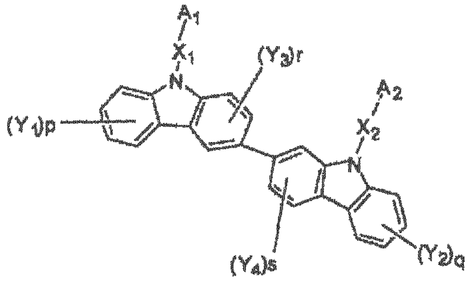
6. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 5, wobei die emittierende Schicht das organische Elektrolumineszenz-Vorrichtungsmaterial als Wirtsmaterial umfasst.

7. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 5 oder 6, wobei die emittierende Schicht ein phosphoreszierendes Material umfasst.

8. Organische Elektrolumineszenz-Vorrichtung, umfassend: eine Kathode; eine Anode; und eine Mehrzahl von organischen Dünnfilm-Schichten, die zwischen der Kathode und der Anode vorgesehen sind, wobei die organischen Dünnfilm-Schichten eine emittierende Schicht umfassen, wobei
mindestens eine der organischen Dünnfilm-Schichten die emittierende Schicht ist, die ein erstes Wirtsmaterial, ein zweites Wirtsmaterial, und ein phosphoreszierendes Material umfasst, das Phosphoreszenz gewährleistet,
wobei das erste Wirtsmaterial eine durch die folgende Formel (5A) oder (5B) dargestellte Verbindung ist,



··· (5A)



··· (5B)

wobei: A_1 ausgewählt wird aus der Gruppe, die aus einem substituierten oder unsubstituierten Pyridinring, einem substituierten oder unsubstituierten Pyrimidinring und einem substituierten oder unsubstituierten Triazinring besteht;
A_2 eine substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, eine substituierte oder unsubstituierte stickstoffhaltige heterocyclische Gruppe mit 1 bis 30 Ring-Kohlenstoffatomen darstellt;
X_1 und X_2 jeweils eine Bindungsgruppe sind und unabhängig voneinander eine Einfachbindung, substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenwasserstoffatomen, substituierte oder unsubstituierte kondensierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen, oder substituierte oder unsubstituierte kondensierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen darstellen;
Y_1 bis Y_4 unabhängig voneinander ein Wasserstoffatom, Fluoratom, Cyanogruppe, substituierte oder unsubstituierte Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Alkoxygruppen mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Haloalkylgruppe mit 1 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Haloalkoxygruppe mit 1 bis 20 Kohlenstoffatomen, substituiertes oder unsubstituiertes Alkylsilyl mit 1 bis 10 Kohlenstoffatomen, substituiertes oder unsubstituiertes Arylsilyl mit 6 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder

unsubstituierte kondensierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Ring-Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen, oder substituierte oder unsubstituierte kondensierte aromatische heterocyclische Gruppe mit 2 bis 30 Ring-Kohlenstoffatomen darstellen;
benachbarte Y_1 bis Y_4 aneinander unter Bildung einer Ringstruktur gebunden sein können;
p und q eine ganze Zahl von 1 bis 4 darstellen; r und s eine ganze Zahl von 1 bis 3 darstellen; und
wenn p und q eine ganze Zahl von 2 bis 4 sind und r und s eine ganze Zahl von 2 bis 3 sind, mehrere Y_1 bis Y_4 gleich oder verschieden sein können.

9. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial entweder durch die folgenden Formeln (6) oder (7) dargestellt wird

$$(Cz\text{-})_aA^3 \qquad (6)$$

$$Cz(\text{-}A^3)_b \qquad (7)$$

wobei Cz eine substituierte oder unsubstituierte Arylcarbazolylgruppe oder Carbazolylarylgruppe darstellt;
A^3 eine durch die folgenden Formeln (8A) oder (8B) dargestellte Gruppe darstellt; und
a und b jeweils eine ganze Zahl von 1 bis 3 darstellen,

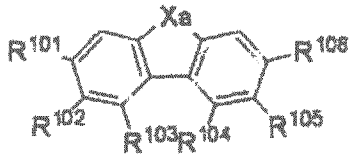
$$(M^1)_c\text{-}(L^5)_d\text{-}(M^2)_e \qquad (8A)$$

wobei: M^1 und M^2 jeweils unabhängig voneinander einen substituierten oder unsubstituierten stickstoffhaltigen aromatischen heterocyclischen Ring oder einen stickstoffhaltigen kondensierten aromatischen heterocyclischen Ring mit 2 bis 40 Ring-Kohlenstoffatomen darstellen; M^1 und M^2 gleich oder verschieden sein können;
L^5 eine Einfachbindung, eine substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte kondensierte aromatische Kohlenwasserstoffatome mit 6 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte Cycloalkylengruppe mit 5 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 30 Kohlenstoffatomen, oder substituierte oder unsubstituierte kondensierte aromatische heterocyclische Gruppe mit 2 bis 30 Kohlenstoffatomen darstellen;
c eine ganze Zahl von 0 bis 2 darstellt; d eine ganze Zahl von 1 bis 2 darstellt; e eine ganze Zahl von 0 bis 2 darstellt; und c + e 1 oder mehr darstellt

$$(M^3)_c\text{-}(L^6)_d\text{-}(M^4)_e \qquad (8B)$$

wobei M^3 und M^4 jeweils unabhängig voneinander eine substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 40 Ring-Kohlenstoffatomen darstellen; M^3 und M^4 gleich oder verschieden sein können;
L_6 eine Einfachbindung, substituierte oder unsubstituierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Kohlenstoffatomen, substituierte oder unsubstituierte kondensierte aromatische Kohlenwasserstoffgruppe mit 6 bis 30 Kohlenstoffatomen, oder substituierte oder unsubstituierte Cycloalkylengruppe mit 5 bis 30 Kohlenstoffatomen darstellt;
c eine ganze Zahl von 0 bis 2 darstellt; d eine ganze Zahl von 1 bis 2 darstellt; e eine ganze Zahl von 0 bis 2 darstellt; und c + e 1 oder mehr darstellt.

10. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial durch die folgende Formel (9) dargestellt wird



…(9)

wobei R^{101} bis R^{106} jeweils unabhängig voneinander ein Wasserstoffatom, Halogenatom, substituierte oder unsubstituierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Cycloalkylgruppe mit 3 bis 15 Kohlenstoffatomen, substituierte oder unsubstituierte heterocyclische Gruppe mit 3 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Alkoxygruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte

Arylgruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aryloxygruppe mit 6 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Arylaminogruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Alkylaminogruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylaminogruppe mit 7 bis 60 Kohlenstoffatomen, substituierte oder unsubstituierte Arylcarbonylgruppe mit 7 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Arylthiogruppe mit 6 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte halogenierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen oder Cyanogruppe darstellen;

mindestens einer von R^{101} bis R^{106} eine substituierte oder unsubstituierte 9-Carbazolylgruppe, substituierte oder unsubstituierte Azacarbazolylgruppe mit 2 bis 5 Stickstoffatomen, oder -L-9-Carbazolylgruppe ist;

L eine substituierte oder unsubstituierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Cycloalkylgruppe mit 3 bis 15 Kohlenstoffatomen, substituierte oder unsubstituierte heterocyclische Gruppe mit 3 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Alkoxygruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Arylgruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aryloxygruppe mit 6 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Arylaminogruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Alkylaminogruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylaminogruppe mit 7 bis 60 Kohlenstoffatomen, substituierte oder unsubstituierte Arylcarbonylgruppe mit 7 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Arylthiogruppe mit 6 bis 20 Kohlenstoffatomen, oder substituierte oder unsubstituierte halogenierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen darstellt;

Xa ein Schwefelatom, Sauerstoffatom oder N-R^{108} darstellt; und R^{108} dasselbe darstellt wie R^{101} bis R^{106}.

11. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial eine Verbindung ist, die ausgewählt wird aus der durch die folgenden Formeln (10A), (10B) und (10C) dargestellten polycyclischen aromatischen Verbindungen

$$Ra\text{-}Ar^{101}\text{-}Rb \qquad (10A)$$

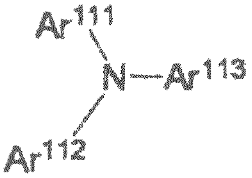
$$Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Rb \qquad (10B)$$

$$Ra\text{-}Ar^{101}\text{-}Ar^{102}\text{-}Ar^{105}\text{-}Rb \qquad (10C)$$

wobei: Ar^{101}, Ar^{102}, Ar^{103}, Ra und Rb ein polycyclisches aromatisches Gerüst mit 6 bis 60 Ring-Kohlenstoffatomen darstellen, ausgewählt aus einem substituierten oder unsubstituierten Benzolring, substituierten oder unsubstituierten Naphthalinring, substituierten oder unsubstituierten Chrysenring, substituierten oder unsubstituierten Fluoranthenring, substituierten oder unsubstituierten Phenanthrenring, substituierten oder unsubstituierten Benzophenanthrenring, substituierten oder unsubstituierten Dibenzophenanthrenring, substituierten oder unsubstituierten Triphenylenring, substituierten oder unsubstituierten Benzo[a]triphenylenring, substituierten oder unsubstituierten Benzochrysenring, substituierten oder unsubstituierten Benzo[b]fluoranthenring, substituierten oder unsubstituierten Flourenring und substituierten oder unsubstituierten Picenring.

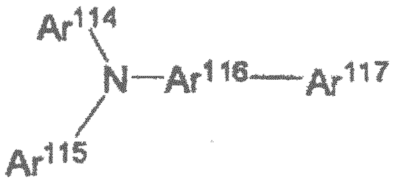
12. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 11, wobei entweder einer oder beide von Ra und Rb in Formeln (10A) bis (10c) ausgewählt werden aus der Gruppe, die aus einem substituierten oder unsubstituierten Phenanthrenring, substituierten oder unsubstituierten Benzo[c]phenanthrenring und substituierten oder unsubstituierten Flouranthenring besteht.

13. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial ein durch eine beliebige der folgenden Formeln (11) bis (13) dargestelltes Monoamin-Derivat ist



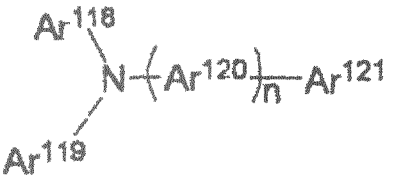
···(11)

[wobei: Ar^{111}, Ar^{112} und Ar^{113} eine substituierte oder unsubstituierte Arylgruppe oder Heteroarylgruppe sind]



···(12)

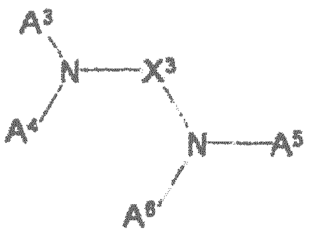
[wobei: Ar^{114}, Ar^{115} und Ar^{117} eine substituierte oder unsubstituierte Arylgruppe oder Heteroarylgruppe sind]; und Ar^{116} eine substituierte oder unsubstituierte Arylengruppe oder Heteroarylengruppe ist].



···(13)

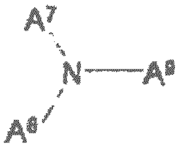
wobei: Ar^{118}, Ar^{119} und Ar^{121} eine substituierte oder unsubstituierte Arylgruppe oder Heteroarylgruppe sind;
Ar^{120} eine substituierte oder unsubstituierte Arylengruppe oder Heteroarylengruppe ist;
n eine ganze Zahl von 2 bis 5 ist; und
wenn n 2 oder mehr ist, Ar^{120} gleich oder verschieden sein können.

14. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial entweder durch die folgende Formel (14) oder (15) dargestellt wird



···(14)

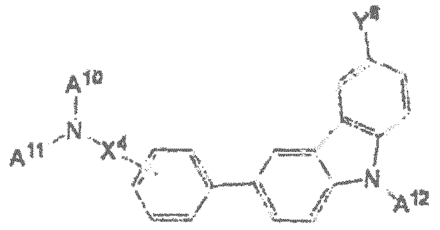
wobei: X^3 eine substituierte oder unsubstituierte Arylengruppe mit 10 bis 40 Ring-Kohlenstoffatomen darstellt; und A^3 bis A^6 eine substituierte oder unsubstituierte Arylgruppe mit 6 bis 60 Ring-Kohlenstoffatomen, oder Heteroarylgruppe mit 6 bis 60
Ringatomen darstellen,



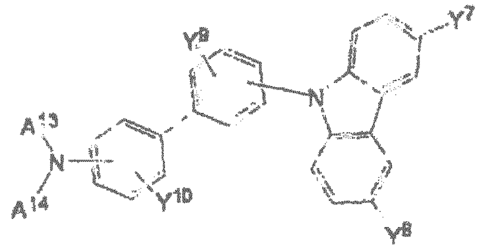
···(15)

wobei: A^7 bis A^9 eine substituierte oder unsubstituierte Arylgruppe mit 6 bis 60 Ring-Kohlenstoffatomen oder Heteroarylgruppe mit 6 bis 60 Ringatomen darstellen.

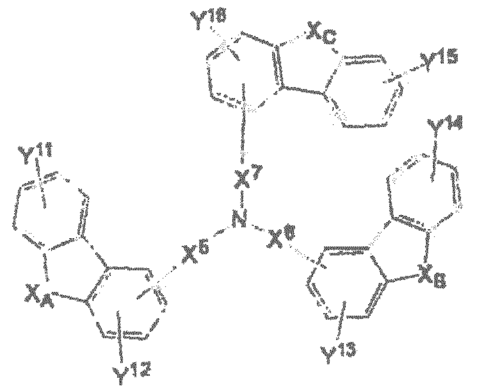
15. Organische Elektrolumineszenz-Vorrichtung nach Anspruch 8, wobei das zweite Wirtsmaterial durch eine der folgenden Formeln (16) bis (20) dargestellt wird



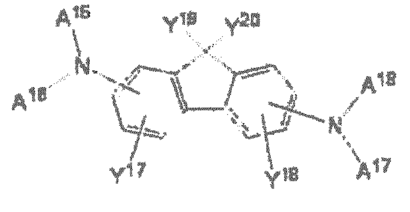
···(16)



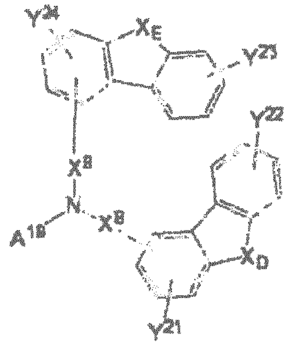
···(17)



···(18)



···(19)



···(20)

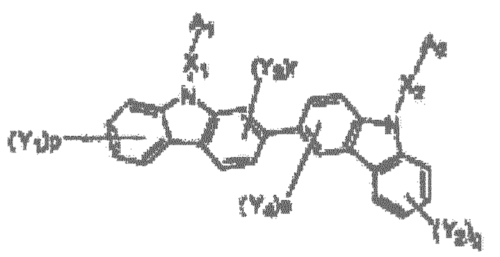
wobei: A^{10} bis A^{19} jeweils eine substituierte oder unsubstituierte Arylgruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte aromatische heterocyclische Gruppe mit 2 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Arylgruppe mit 8 bis 40 Kohlenstoffatomen, die an eine aromatische Aminogruppe gebunden ist, oder substituierte oder unsubstituierte Arylgruppe mit 8 bis 40 Kohlenstoffatomen, die an eine aromatische

heterocyclische Gruppe gebunden ist darstellen,
A^{10}, A^{13}, A^{15} und A^{17} so angepasst sind, dass sie jeweils unter Bildung eines Rings an A^{11}, A^{14}, A^{16} und A^{18} gebunden sind;
X^4 bis X^9 eine Einfachbindung oder eine bindende Gruppe mit 1 bis 30 Kohlenstoffatomen darstellen;
Y^6 bis Y^{24} ein Wasserstoffatom, Halogenatom, substituierte oder unsubstituierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte heterocyclische Gruppe mit 3 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Arylgruppe mit 6 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Alkenylgruppe mit 2 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Alkylaminogruppe mit 1 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylaminogruppe mit 7 bis 60 Kohlenstoffatomen, substituierte oder unsubstituierte Alkylsilylgruppe mit 3 bis 20 Kohlenstoffatomen, substituierte oder unsubstituierte Arylsilylgruppe mit 8 bis 40 Kohlenstoffatomen, substituierte oder unsubstituierte Aralkylsilylgruppe mit 8 bis 40 Kohlenstoffatomen, oder substituierte oder unsubstituierte halogenierte Alkylgruppe mit 1 bis 40 Kohlenstoffatomen darstellen; und
X_A, X_B, X_C, X_D, X_E jeweils ein Schwefelatom, ein Sauerstoffatom oder ein Monoarylsubstituiertes Stickstoffatom darstellen.

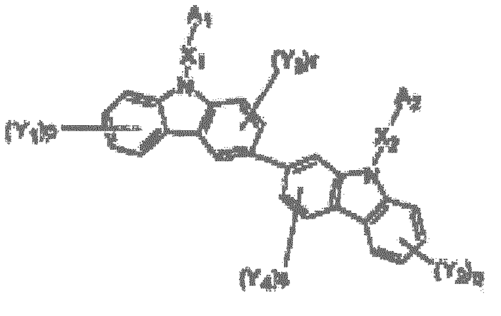
16. Organische Elektrolumineszenz-Vorrichtung nach einem der Ansprüche 8 bis 15, wobei
die emittierende Schicht ein Wirtsmaterial und ein phosphoreszierendes Material umfasst, wobei das phosphoreszierende Material ein ortho-metallierter Komplex eines Metallatoms ist, das ausgewählt wird aus Iridium (Ir), Osmium (Os) und Platin (Pt).

Revendications

1. Dérivé de biscarbazole représenté par une formule (1A) ou (1 B) ci-dessous,



•••(1A)



•••(1B)

où : A_1 est sélectionné parmi le groupe consistant en un anneau pyridine substitué ou non substitué, un anneau pyrimidine substitué ou non substitué et un anneau triazine substitué ou non substitué ;
A_2 représente un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, ou un groupe hétérocyclique contenant de l'azote substitué ou non substitué ayant 1 à 30 atomes de carbone de anneau ;
X_1 et X_2 sont chacun un groupe de liaison et représentent indépendamment une simple liaison, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ou un groupe hétérocyclique aromatique condensé substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ;
Y_1 à Y_4 représentent indépendamment un atome d'hydrogène, un atome de fluor, un groupe cyano, un groupe

alkyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe alcoxy substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe halogénoalkyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe halogénoalcoxy substitué ou non substitué ayant de 1 à 20 atomes de carbone, un alkylsilyle substitué ou non substitué ayant de 1 à 10 atomes de carbone, un arylsilyle substitué ou non substitué ayant de 6 à 30 atomes de carbone, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ou un groupe hétérocyclique aromatique condensé substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ;
ceux qui sont adjacents à Y_1 à Y_4 sont laissés être liés l'un à l'autre pour former une structure cyclique ;
p et q représentent un nombre entier de 1 à 4 ; r et s représentent un nombre entier de 1 à 3 ; et
quand p et q sont un nombre entier de 2 à 4 et r et s sont un nombre entier de 2 à 3, une pluralité de Y1 à Y4 sont laissés être identiques ou différents.

2. Dérivé de biscarbazole selon la revendication 1, dans lequel A_1 est sélectionné parmi un anneau pyrimidine substitué ou non substitué ou un anneau triazine substitué ou non substitué.

3. Dérivé de biscarbazole selon la revendication 1 ou 2, dans lequel A_1 est un anneau pyrimidine substitué ou non substitué.

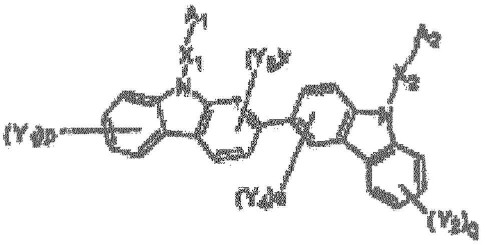
4. Matériau de dispositif-EL-organique comprenant le dérivé de biscarbazole selon l'une quelconque des revendications 1 à 3.

5. Dispositif d'électroluminescence organique comprenant une cathode ; une anode ; et une pluralité de couches de film mince organique fournies entre la cathode et l'anode, les couches de film mince organique comprenant une couche émettrice, dans lequel
au moins une des couches de film mince organique comprend le matériau dispositif-EL-organique selon la revendication 4.

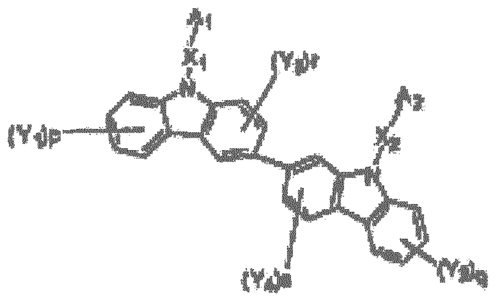
6. Dispositif d'électroluminescence organique selon la revendication 5, dans lequel l couche émettrice comprend le matériau dispositif-EL-organique comme matériau hôte.

7. Dispositif d'électroluminescence organique selon la revendication 5 ou 6, dans lequel la couche émettrice comprend un matériau phosphorescent.

8. Dispositif ’électroluminescence organique comprenant : une cathode ; une anode ; et une pluralité de couches de film mince organique fournies entre la cathode et l'anode, les couches de film mince organique comprenant une couche émettrice, dans lequel
au moins une des couches de film mince organique est la couche émettrice comprenant un premier matériau hôte, un deuxième matériau hôte et un matériau phosphorescent fournissant de la phosphorescence,
le premier matériau hôte étant un composé représenté par la formule (5A) ou (5B) ci-dessous,



···(5A)



···(5B)

où : A_1 est sélectionné parmi le groupe consistant en un anneau pyridine substitué ou non substitué, un anneau pyrimidine substitué ou non substitué et un anneau triazine substitué ou non substitué ;

A_2 représente un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau ou un groupe hétérocyclique contenant de l'azote substitué ou non substitué ayant 1 à 30 atomes de carbone de anneau ;

X_1 et X_2 sont chacun un groupe de liaison et représentent indépendamment une simple liaison, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ou un groupe hétérocyclique aromatique condensé substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ;

Y_1 à Y_4 représentent indépendamment un atome d'hydrogène, un atome de fluor, un groupe cyano, un groupe alkyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe alcoxy substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe halogénoalkyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe halogénoalcoxy substitué ou non substitué ayant de 1 à 20 atomes de carbone, un alkylsilyle substitué ou non substitué ayant de 1 à 10 atomes de carbone, un arylsilyle substitué ou non substitué ayant de 6 à 30 atomes de carbone, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone de anneau, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ou un groupe hétérocyclique aromatique condensé substitué ou non substitué ayant de 2 à 30 atomes de carbone de anneau ;

ceux qui sont adjacents à Y_1 à Y_4 sont laissés être liés l'un à l'autre pour former une structure cyclique ;

p et q représentent un nombre entier de 1 à 4 ; r et s représentent un nombre entier de 1 à 3 ; et

quand p et q sont un nombre entier de 2 à 4 et r et s sont un nombre entier de 2 à 3, une pluralité de Y_1 à Y_4 sont laissés être identiques ou différents.

9. Dispositif d'électroluminescence organique selon la revendication 8, dans lequel le deuxième matériau hôte est représenté par l'une des formules (6) ou (7) ci-dessous,

$$(Cz-)_aA^3 \qquad (6)$$

$$Cz(-A^3)_b \qquad (7)$$

où : Cz représente un groupe arylcarbazolyle ou carbazolylaryle substitué ou non substitué ;

A3 représente un groupe représenté par la formule (8A) ou (8B) ci-dessous ; et a et b représentent chacun un nombre entier de 1 à 3,

$$(M^1)_c-(L^5)_d-(M^2)_e \qquad (8A)$$

où : M^1 et M^2 représentent chacun indépendamment un anneau hétérocyclique aromatique contenant de l'azote substitué ou non substitué ou un anneau hétérocyclique condensé contenant de l'azote ayant de 2 à 40 atomes de carbone de anneau ; M1 et M2 sont laissés être identiques ou différents ;

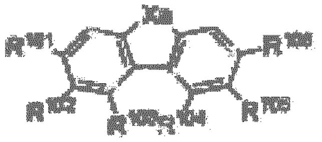
L^5 représente une simple liaison, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone, un groupe cycloalkylène substitué ou non substitué ayant de 5 à 30 atomes de carbone, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 30 atomes de carbone, ou un groupe hétérocyclique aromatique condensé substitué ou non substitué ayant de 2 à 30 atomes de carbone ;

c représente un nombre entier de 0 à 2 ; d représente un nombre entier de 1 à 2 ; e représente un nombre entier de 0 à 2 ; et c + e représente 1 ou plus,

$(M^3)_c$-$(L^6)_d$-$(M^4)_e$ (8B)

où : M^3 et M^4 représentent chacun indépendamment un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 40 atomes de carbone de anneau ; M^3 et M^4 sont laissés être identiques ou différents ;
L^6 représente une simple liaison, un groupe hydrocarbure aromatique substitué ou non substitué ayant de 6 à 30 atomes de carbone, un groupe hydrocarbure aromatique condensé substitué ou non substitué ayant de 6 à 30 atomes de carbone ou un groupe cycloalkylène substitué ou non substitué ayant de 5 à 30 atomes de carbone ;
c représente un nombre entier de 0 à 2 ; d représente un nombre entier de 1 à 2 ; e représente un nombre entier de 0 à 2 ; et c + e représente 1 ou plus.

10. Dispositif d'électroluminescence organique selon la revendication 8, das lequel le deuxième matériau hôte est représenté par une formule (9) ci-dessous,



···(9)

où : R^{101} à R^{106} représentent chacun indépendamment un atome d'hydrogène, un atome d'halogène, un groupe alkyle substitué à non substitué ayant de 1 à 40 atomes de carbone, un groupe cycloalkyle substitué ou non substitué ayant de 3 à 15 atomes de carbone, un groupe hétérocyclique substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe alcoxy substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe aryle substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe aryloxy substitué ou non substitué ayant de 6 à 20 atomes de carbone, un groupe aralkyle substitué ou non substitué ayant de 7 à 20 atomes de carbone, un groupe arylamino substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe alkylamino substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe aralkyamino substitué ou non substitué ayant de 7 à 60 atomes de carbone, un groupe arylcarbonyle substitué ou non substitué ayant de 7 à 40 atomes de carbone, un groupe arylthio substitué ou non substitué ayant de 6 à 20 atomes de carbone, un groupe alkyle halogéné substitué ou non substitué ayant de 1 à 40 atomes de carbone ou un groupe cyano ;
au moins un de R^{101} à R^{106} est un groupe 9-carbazolyle substitué ou non substitué, un groupe azacarbazolyle substitué ou non substitué ayant de 2 à 5 atomes d'azote, ou un groupe L-9-carbazolyle ;
L représente un groupe alkyle substitué à non substitué ayant de 1 à 40 atomes de carbone, un groupe cycloalkyle substitué ou non substitué ayant 3 à 15 atomes de carbone, un groupe hétérocyclique substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe alcoxy substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe aryle substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe aryloxy substitué ou non substitué ayant de 6 à 20 atomes de carbone, un groupe aralkyle substitué ou non substitué ayant de 7 à 20 atomes de carbone, un groupe arylamino substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe alkylamino substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe aralkyamino substitué ou non substitué ayant de 7 à 60 atomes de carbone, un groupe arylcarbonyle substitué ou non substitué ayant de 7 à 40 atomes de carbone, un groupe arylthio substitué ou non substitué ayant de 6 à 20 atomes de carbone ou un groupe alkyle halogéné substitué ou non substitué ayant de 1 à 40 atomes de carbone ;
Xa représente un atome de soufre, un atome d'oxygène ou N-R^{108} ; et
R^{108} représente le même que R^{101} à R^{106}.

11. Dispositif d'électroluminescence organique selon la revendication 8, dans lequel le deuxième matériau hôte est un composé sélectionné parmi le groupe consistant en les composés aromatiques polycycliques représentés par les formules (10A), (10B) et (10C) ci-dessous,

Ra-Ar^{101}-Rb (10A)

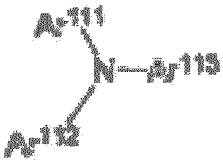
Ra-Ar^{101}-Ar^{102}-Rb (10B)

Ra-Ar^{101}-Ar^{102}-Ar^{103}-Rb (10C)

où : Ar^{101}, Ar^{102}, Ar^{103}, Ra et Rb représentent un squelette aromatique polycyclique ayant de 6 à 60 atomes de carbone de anneau sélectionnés parmi un anneau benzène substitué ou non substitué, un anneau naphtalène substitué ou non substitué, un anneau chrysène substitué ou non substitué, un anneau fluoranthène substitué ou non substitué, un anneau phénanthrène substitué ou non substitué, un anneau benzophénanthrène substitué ou non substitué, un anneau dibenzophénanthrène substitué ou non substitué, un anneau triphénylène substitué ou non substitué, un anneau benzo[a]triphénylène substitué ou non substitué, un anneau benzochrysène substitué ou non substitué, un anneau benzo[b]fluoranthène substitué ou non substitué, un anneau fluorène substitué ou non substitué et un anneau picène substitué ou non substitué.

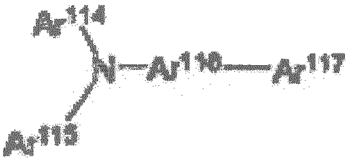
12. Dispositif d'électroluminescence organique selon la revendication 11, dans lequel l'un ou les deux de Ra et Rb dans les formules (10A) à (10C) sont sélectionnés dans le groupe constitué par un anneau phénanthrène substitué ou non substitué, un anneau benzo[c]phénanthrène substitué ou non substitué ou un anneau fluoranthène substitué ou non substitué.

13. Dispositif d'électroluminescence organique selon la revendication 8, dans lequel le deuxième matériau hôte est un dérivé de monoamine représenté par l'une quelconque des formules 11 à 13 ci-dessous,



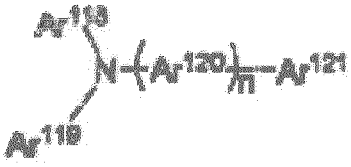
···(11)

[où : Ar^{111}, Ar^{112} et Ar^{113} sont un groupe aryle ou un groupe hétéroaryle substitué ou non substitué.]



···(12)

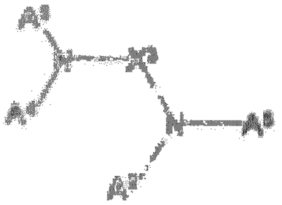
[où : Ar^{114}, Ar^{115} et Ar^{117} sont un groupe aryle ou un groupe hétéroaryle substitué ou non substitué ; et
Ar^{116} est un groupe arylène ou un groupe hétéroarylène substitué ou non substitué.]



···(13)

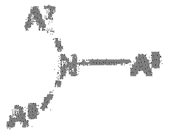
où : Ar^{118}, Ar^{119} et Ar^{121} sont un groupe aryle ou un groupe hétéroaryle substitué ou non substitué ; et
Ar^{120} est un groupe arylène ou un groupe hétéroarylène substitué ou non substitué ;
n est un nombre entier de 2 à 5 ; et
quand n vaut 2 ou plus, les Ar^{120} sont laissés être identiques ou différents.

14. Dispositif d'électroluminescence organique selon la revendication 8, dans lequel le deuxième matériau hôte est représenté par la formule (14) ou (15) ci-dessous,



···(14)

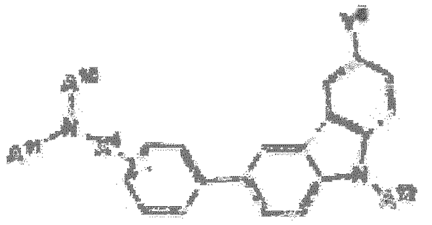
où : X^3 représente un groupe arylène substitué ou non substitué ayant de 10 à 40 atomes de carbone de anneau ; et A^3 à A^6 représentent un groupe aryle substitué ou non substitué ayant de 6 à 60 atomes de carbone de anneau ou un groupe hétéroaryle ayant de 6 à 60 atomes annulaires,



···(15)

où : A^7 à A^9 représentent un groupe aryle substitué ou non substitué ayant de 6 à 60 atomes de carbone de anneau, ou un groupe hétéroaryle ayant de 6 à 60 atomes annulaires.

15. Dispositif d'électroluminescence organique selon la revendication 8, dans lequel le deuxième matériau hôte est représenté par l'une quelconque des formules (16) à (20) ci-dessous,



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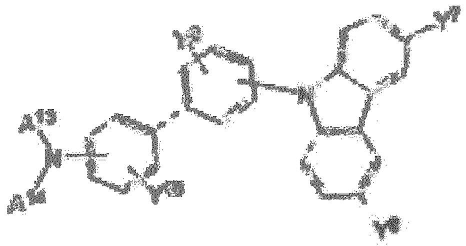

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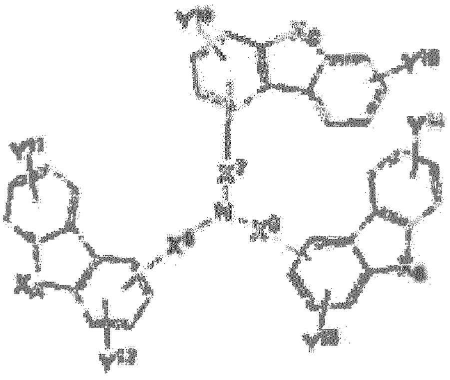

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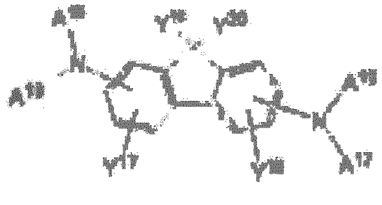

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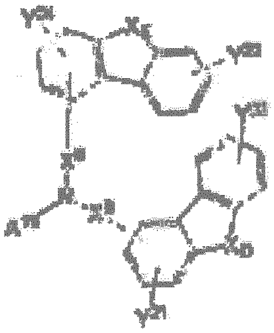


···(20)

où : A^{10} à A^{19} représentent chacun un groupe aryle substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe hétérocyclique aromatique substitué ou non substitué ayant de 2 à 40 atomes de carbone, un groupe aryle substitué ou non substitué ayant de 8 à 40 atomes de carbone lié avec un groupe amino aromatique, ou un groupe aryle substitué ou non substitué ayant de 8 à 40 atomes de carbone lié avec un groupe hétérocyclique aromatique ;

A^{10}, A^{13}, A^{15} et A^{17} sont adaptés pour être liés respectivement à A^{11}, A^{14}, A^{16} et A^{18} pour former un anneau ;

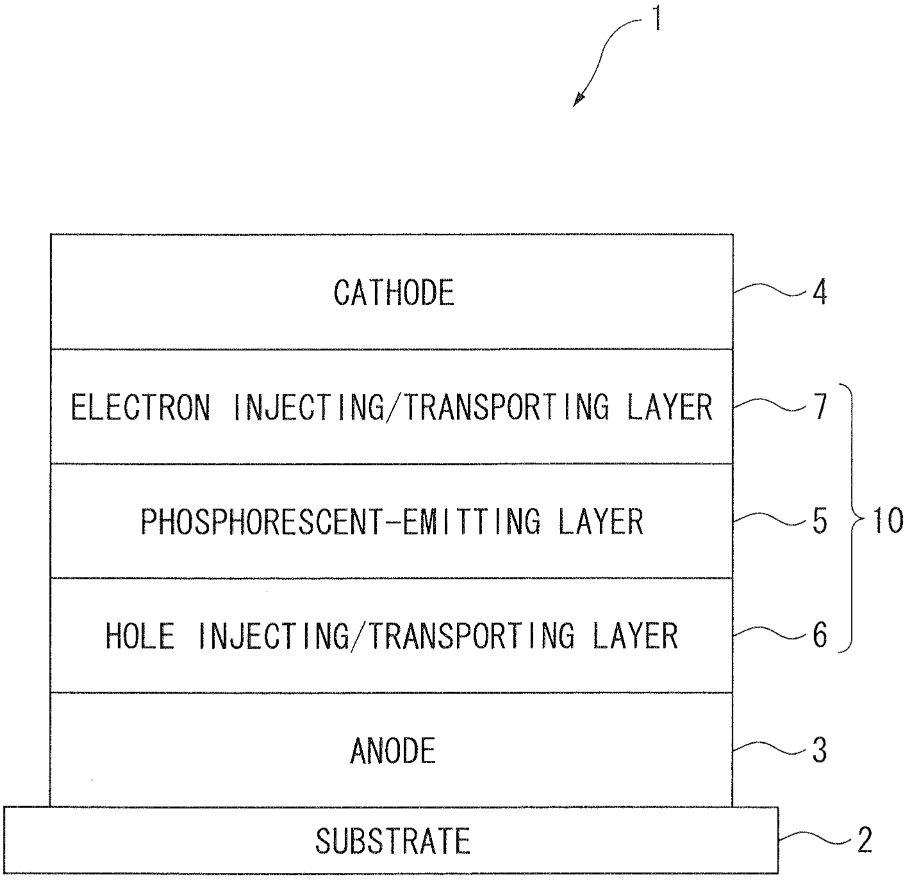
X^4 à X^9 représentent une simple liaison ou un groupe de liaison ayant de 1 à 30 atomes de carbone ;

Y^6 à Y^{24} représentent un atome d'hydrogène, un atome d'halogène, un groupe alkyle substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe hétérocyclique substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe aryle substitué ou non substitué ayant de 6 à 40 atomes de carbone, un groupe aralkyle substitué ou non substitué ayant de 7 à 20 atomes de carbone, un groupe alkényle substitué ou non substitué ayant de 2 à 40 atomes de carbone, un groupe alkylamino substitué ou non substitué ayant de 1 à 40 atomes de carbone, un groupe aralkylamino substitué ou non substitué ayant de 7 à 60 atomes de carbone, un groupe alkylsilyle substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe arylsilyle substitué ou non substitué ayant de 8 à 40 atomes de carbone, un groupe aralkylsilyle substitué ou non substitué ayant de 8 à 40 atomes de carbone ou un groupe alkyle halogéné substitué ou non substitué ayant de 1 à 40 atomes de carbone ; et

X_A, X_B, X_C, X_D, X_E représentent chacun un atome de soufre, un atome d'oxygène ou un atome d'azote substitué par un monoaryle.

16. Dispositif d'électroluminescence organique selon l'une quelconque des revendications 8 à 15, dans lequel la couche émettrice comprend un matériau hôte et un matériau phosphorescent, le matériau phosphorescent étant un complexe ortho-métallique d'un atome de métal sélectionné parmi l'iridium (Ir), l'osmium (Os) et le platine (Pt).

FIG.1


1
CATHODE
4
ELECTRON INJECTING/TRANSPORTING LAYER
7
PHOSPHORESCENT-EMITTING LAYER
5
10
HOLE INJECTING/TRANSPORTING LAYER
6
ANODE
3
SUBSTRATE
2

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专利名称(译)	双咔唑衍生物，有机电致发光元件用材料和使用它的有机电致发光元件		
公开(公告)号	EP2415769B1	公开(公告)日	2015-10-28
申请号	EP2011763575	申请日	2011-04-19
[标]申请(专利权)人(译)	出光兴产株式会社		
申请(专利权)人(译)	出光兴产股份有限公司.		
当前申请(专利权)人(译)	出光兴产股份有限公司.		
[标]发明人	INOUE TETSUYA ITO MITSUNORI YOSHIDA KEI HIBINO KUMIKO NISHIMURA KAZUKI OGIWARA TOSHINARI IKEDA KIYOSHI		
发明人	INOUE TETSUYA ITO MITSUNORI YOSHIDA KEI HIBINO KUMIKO NISHIMURA KAZUKI OGIWARA TOSHINARI IKEDA KIYOSHI		
IPC分类号	H01L51/30 C07D401/14 C07D403/14 C09K11/06 H01L51/50		
CPC分类号	C07D209/82 C07D401/14 C07D403/14 C09B57/00 C09K11/06 C09K2211/1007 C09K2211/1029 C09K2211/1044 C09K2211/1059 H01L51/0072 H01L51/5016 H01L2251/5384 H05B33/20 Y10S428/917 H01L51/0067 H01L51/0085 H01L51/5072 H01L51/5012 H01L51/5024 H01L51/5076 H01L51/5092		
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其他公开文献	EP2415769A4 EP2415769A1		
外部链接	Espacenet		

摘要(译)

本发明的双咔唑衍生物由下式（1A或（1B）表示：式（1A）或（1B）中：A1表示取代或未取代的含有1至30个环碳原子的含氮杂环基; A2 “取代或未取代的”具有6至30个环碳原子的芳族烃基，或具有1至30个环碳原子的取代或未取代的含氮杂环基; X 1和X 2各自为连接基团; Y 1至Y 4各自表示取代基; p和q表示1至4的整数;并且r和s表示1至3的整数。

[Chemical Formula 1]