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(54) **Organic electroluminescent material and electroluminescent device using the same**

Organisches Elektrolumineszenzmaterial und organische elektrolumineszente Vorrichtung

Matériau électroluminescent organique et dispositif organique électroluminescent

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- **SANDER R ET AL: "SYNTHESIS, PROPERTIES, AND GUEST-HOST SYSTEMS OF TRIPHENYLAMINE- BASED OLIGO (ARYLENEVINYLENE)S: ADVANCED MATERIALS FOR LED APPLICATIONS" MACROMOLECULES, AMERICAN CHEMICAL SOCIETY. EASTON, US, vol. 29, no. 24, 18 November 1996 (1996-11-18), pages 7705-7708, XP000631120 ISSN: 0024-9297**

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an organic-electroluminescence (EL) device used for planar light sources and displays, and the organic EL material therefor.

Description of the Related Art

[0002] An organic EL device has been attracting attention as a planar display element. The organic EL device with two or more organic layers has much improved light-emitting efficiency, emitting light of high brightness at a voltage of 10 V or less applied thereto (Applied Physics Letters, vol. 51, pp. 913, 1987 and vol. 56, pp. 799, 1990). It generally comprises an anode, hole transport region, EL light-emitting region, electron transport region and cathode as the basic structure. It may lack one of the hole and electron transport regions, or both. Each region may consist of one layer, or two or more layers.

[0003] Many of the conventional organic EL devices use a triphenylamine derivatives for the hole transport region. For example, 1,1-bis-(4-diparatolylaminophenyl)cyclohexane and N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine are preferably used, because of their good hole injection and film-making characteristics. It is reported, however, that the films of these compounds are uniform immediately after they are formed, but tend to suffer agglomeration in several days (Spring Meeting of the Japan Society of Applied Physics, 30a-SZK-1, 1993, Autumn Meeting of the Japan Society of Applied Physics, 29a-ZC-8, 1993), accelerating deterioration of brightness (Applied Physics Letters, vol. 68, pp. 1787, 1996).

[0004] On the other hand, Japanese Patent Publication No. SHO 64-7635 discloses use of a porphyrin compound for the hole transport layer. However, crystallization or agglomeration of the layer also occurs after the device is assembled, deteriorating its functions.

[0005] Japanese Patent Publication No. HEI 7-110940 (110940/1995 B) and Applied Physics Letters, vol. 65, pp. 807, 1994 disclose use of a starburst type tertiary amine derivatives for the hole transport material. However, it also fails to give the device which can continuously emit sufficiently bright light.

[0006] Japanese Patent No. 2597377 discloses an organic-EL device structure comprising two hole transport layers of hole injection type compounds, one being of a porphyrin compound and the other of an aromatic tertiary amine from the anode side, in order to reduce pinholes and thereby to improve device stability. However, even this structure shows insufficient improvement in device stability.

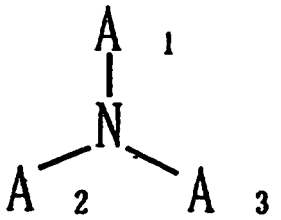
[0007] Moreover, the conventional organic EL device is insufficient in brightness, when it is to be used for light-emitting devices, e.g., full-color display, and is required to have higher brightness.

[0008] As described above, the organic EL device is less durable than other types of light-emitting devices, and insufficient in brightness-related properties, which have greatly retarded its commercialization.

[0009] The present invention has been developed to solve the above problems, and thereby to provide an organic EL device of longer serviceability and emitting light of high brightness.

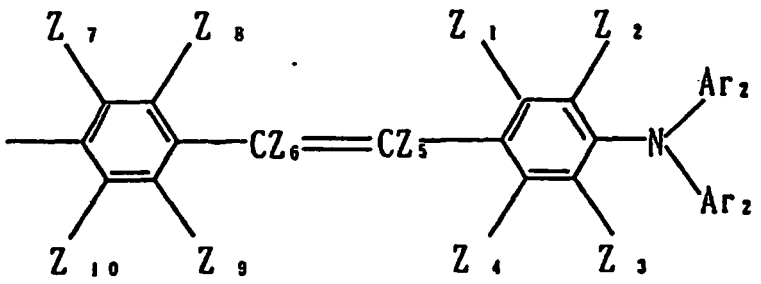
SUMMARY OF THE INVENTION

[0010] The organic electroluminescence material, characterized by containing a compound shown by the following general formula (A-I):



(A-I)

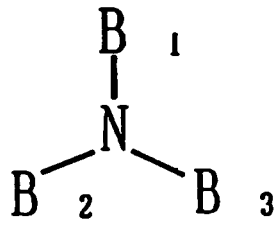
wherein, A_1 to A_3 are independently, each a substituent shown by the general formula (A-II). which may be the same or different.



(A-II)

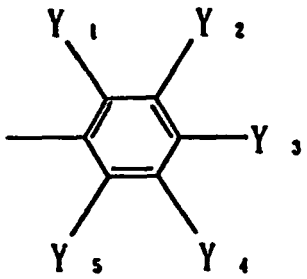
wherein, at least one of Z_1 to Z_4 and Z_7 to Z_{10} are independently, each a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (except styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group, and the others being a hydrogen atom;
Z_1 and Z_2, Z_3 and Z_4 and Z_7 to Z_{10} may form a ring by two adjacent atoms or groups;
Z_5 and Z_6 are independently, each a hydrogen atom, alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, or aromatic heterocyclic or substituted aromatic heterocyclic group; and
Ar_1 and Ar_2 are independently each an aryl gourp which may be substituted.

[0011] The organic electroluminescence material, characterized by containing a compound shown by the following general formula (A-III) (Except that the substituent shown by the general formula (A-V) is at the site of Y_3 and, at the same time, the substituent shown by the formula $-NAr_1Ar_2$ is at the site of Y_8.):



(A-III)

wherein, B_1 to B_3 are independently, each a substituent shown by the general formula (A-IV). which may be the same or different.

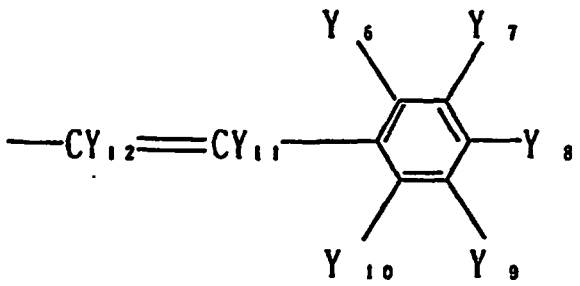


(A-IV)

wherein, at least one of Y_1 to Y_5 is a substituent shown by the general formula (A-V), the others being independently each a hydrogen atom, a halogen atom, or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (other than styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted

alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group; and

Y_1 to Y_5 may form a ring by two adjacent atoms or groups;



(A-V)

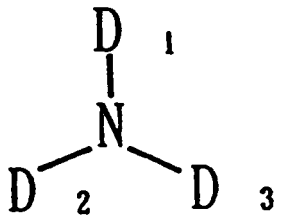
wherein, at least one of Y_6 to Y_{10} is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (other than styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group;

Y_6 to Y_{10} may form a ring by two adjacent atoms or groups;

Ar_1 and Ar_2 are independently each an aryl gourp which may be substituted; and

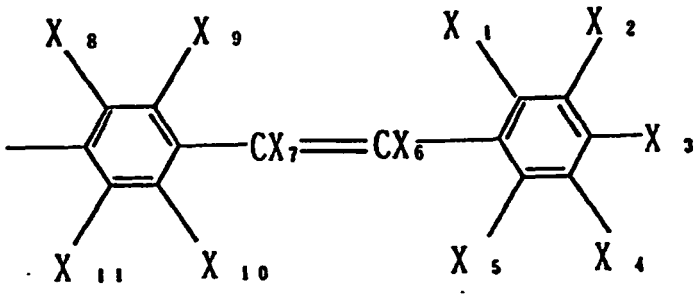
Y_{11} and Y_{12} are independently, each a hydrogen atom or alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic group.

[0012] The organic electroluminescence material, characterized by containing a compound shown by the following general formula (A-VI):



(A-VI)

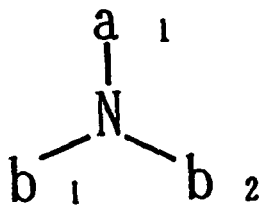
wherein, D_1 to D_3 are independently, each a substituent shown by the general formula (A-VII). They may be the same or different.



(A-VII)

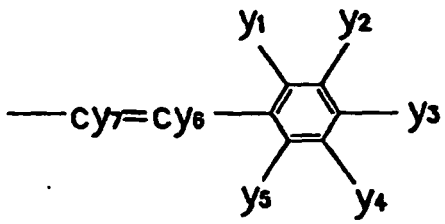
wherein, at least one of X_1 to X_5 is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (other than styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group;
Z_1 to Z_5 may form a ring by two adjacent atoms or groups;
Ar_1 and Ar_2 are independently, each an aryl group which may be substituted;
X_6 and X_7 are independently, each an alkyl group having 2 or more carbons, aromatic hydrocarbon group or aromatic heterocyclic group, all of which may be substituted; and
X_8 to X_{11} are independently, each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (except styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl carboxyl group and X_8 to X_{11} may form a ring by two adjacent atoms or groups.

[0013] The organic electroluminescence material, characterized by containing a compound shown by the following general formula (B-I):



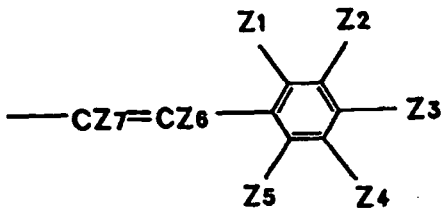
(B-I)

wherein, a_1, b_1 and b_2 are independently, each an aryl group which is substituted, a_1 having at least one substituent shown by the general formula (B-II), each of b_1 and b_2 having at least one substituent shown by the general formula (B-III), and b_1 and b_2 may be the same or different:



(B-II)

wherein, y_1 to y_5 are independently, each a hydrogen atom, a halogen atom or hydroxyl, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (except styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group; and
y_1 to y_5 may form a ring by two adjacent atoms or groups;
y_6 and y_7 are independently, each a hydrogen atom, alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, or aromatic heterocyclic or substituted aromatic heterocyclic group.



(B-III)

wherein, at least one of z_1 to z_5 is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently, each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl (except styryl), cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group;

z_1 to z_4 may form a ring by two adjacent atoms or groups;

Ar_1 and Ar_2 are independently, each an aryl group which may be substituted; and

z_6 and z_7 are independently, each a hydrogen atom or alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, or aromatic heterocyclic or substituted aromatic heterocyclic group.

[0014] In the present invention, it is preferable that organic electroluminescence material, wherein at least one material of said organic electroluminescence materials according to any one of claims 1 to 4, is dispersed in a polymer binder.

[0015] In the organic electroluminescence device comprising one or more layers of organic thin films put between the anode and cathode, wherein at least one of said layers is composed of at least one of the organic electroluminescence materials according to any one of claims 1 to 4.

[0016] In the organic electroluminescence device of claim 6, wherein at least one of said layers is composed of at least one of the organic electroluminescence materials according to any one of claims 1 to 4, and 2 to 500 nm thick.

[0017] It is preferable that the organic electroluminescence device of claims 6 to 7, wherein one of its hole transport, light-emitting and electron transport layers is composed of at least one of the organic electroluminescence materials according to any one of claims 1 to 4.

[0018] It is also preferable that the organic electroluminescence device of claim 6 or claim 8, wherein said light-emitting layer is doped with an organic luminescent agent as the dopant.

[0019] It is also preferable that the organic electroluminescence device of claim 6, wherein said hole transport layer contains a first and second hole transport layer facing the anode and light-emitting layer sides, respectively, and said first hole transport layer is composed of at least one of the organic electroluminescence materials according to any one of claims 1 to 4.

[0020] It is also preferable that organic electroluminescence device of claim 10, wherein said second hole transport layer contains an aromatic tertiary amine compound.

[0021] It is also preferable that organic electroluminescence device of claim 8, claim 10 or claim 11, wherein an anode interface layer is provided between said anode and said hole transport layer or between said anode and said first hole transport layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The objects and features of the present invention will become more apparent from the consideration of the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows an example of a sectional view of an organic EL device of the present invention;
Fig. 2 shows another example of the sectional view of the organic EL device of the present invention;
Fig. 3 shows still another example of the sectional view of the organic EL device of the present invention; and
Fig. 4 shows still another example of the sectional view of the organic EL device of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Preferred embodiments of the present invention will be described. Fig. 1 (a) shows a section of an organic EL device which uses an organic EL material of the present invention, where reference numeral 11 denotes a glass substrate;

reference numeral 12 denotes an anode; reference numeral 13 denotes a hole transport layer; reference numeral 14 denotes a light-emitting layer; reference numeral 15 denotes an electron transport layer; and reference numeral 16 denotes a cathode. The organic EL material of the present invention is used at least one of the hole transport layer 13, light-emitting layer 14, and electron transport layer 15.

[0024] The organic EL device of the present invention may dispense with the hole transport layer 13 and/or electron transport layer 15. Fig. 2 (a) shows the device which dispenses with the electron transport layer 15, and Fig. 3 shows the device which dispenses with both layers. The hole transport layer 13 may be divided into the first hole transport layer 13a on the anodic side and second hole transport layer 13b on the light-emitting device side, as shown in Figs. 1(b) and 2(b), where the former is made of the organic EL material of the present invention and the latter of a known organic material.

[0025] An anode interface layer may be provided between the anode 12 and hole tranport layer 13, or anode 12 and first hole transport layer 13a. Fig. 4 shows an example of the anode interface layer provided between the anode 12 and hole transport layer 13 for the organic EL device, shown in Fig. 2 (a).

[0026] The halogen atoms for the substituents shown by the general formula (A-II), (A-IV), (A-V), (A-VII), (B-II) or (B-III) include fluorine, chlorine, bromine and iodine.

[0027] The amino group or substituted amino group, is shown bfy the general formula $-NX^1X^2$, wherein X^1 and X^2 are independently, each hydrogen atom or methyl, ethyl, propyl, isopropyl, n-butyl, s-butyl, isobutyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl, 2-hydroxyisobutyl, 1, 2-dihydroxyethyl, 1,3-dihydroxyisopropyl, 2,3-dihydroxy-t-butyl, 1,2,3-trihydroxypropyl, chloromethyl, 1-chloroethyl, 2-chloroethyl, 2-chloroisobutyl, 1,2-dichloroethyl, 1,3-dichloroisopropyl, 2,3-dichloro-t-butyl, 1,2,3-trichloropropyl, bromomethyl, 1-bromoethyl, 2-bromoethyl, 2-bromoisobutyl, 1,2-dibromoethyl, 1,3-dibromoisopropyl, 2,3-dibromo-t-butyl, 1,2,3-tribromopropyl, iodomethyl, 1-iodoethyl, 2-iodoethyl, 2-iodoisobutyl, 1,2-diiodoethyl, 1,3-diiodoisopropyl, 2,3-diiodo-t-butyl, 1,2,3-triiodopropyl, aminomethyl, 1-aminoethyl, 2-aminoethyl, 2-aminoisobutyl, 1,2-diaminoethyl, 1,3-diaminoisopropyl, 2,3-diamino-t-butyl, 1,2,3-triaminopropyl, cyanomethyl, 1-cyanoethyl, 2-cyanoethyl, 2-cyanoisobutyl, 1,2-dicyanoethyl, 1,3-dicyanoisopropyl, 2,3-dicyano-t-butyl, 1,2,3-tricyanopropyl, nitromethyl, 1-nitroethyl, 2-nitroethyl, 2-nitroisobutyl, 1,2-dinitroethyl, 1,3-dinitroisopropyl, 2,3-dinitro-t-butyl, 1,2,3-trinitropropyl, phenyl, 1-naphthyl, 2-naphthyl, 1-anthryl, 2-anthryl, 9-anthryl, 1-phenanthryl, 2-phenanthryl, 3-phenanthryl, 4-phenanthryl, 9-phenanthryl, 1-naphthacenyl, 2-naphthacenyl, 9-naphthacenyl, 4-styrylphenyl, 1-pyrenyl, 2-pyrenyl, 4-pyrenyl, 2-biphenylyl, 3-biphenylyl, 4-biphenylyl, p-terphenyl-4-yl, p-terphenyl-3-yl, p-terphenyl-2-yl, m-terphenyl-4-yl, m-terphenyl-3-yl, m-terphenyl-2-yl, o-tolyl, m-tolyl, p-tolyl, p-t-butylphenyl, p-(2-phenylpropyl)phenyl, 3-methyl-2-naththyl, 4-methyl- 1-naththyl, 4-methyl-1-anthryl, 4'-methylbiphenylyl, 4''-t-butyl-p-terphenyl-4-yl, 2-pyrrolyl, 3-pyrrolyl, pyrazinyl, 2-pyridinyl, 3-pyridinyl, 4-pyridinyl, 2-indolyl, 3-indolyl, 4-indolyl, 5-indolyl, 6-indolyl, 7-indolyl, 1-isoindolyl, 3-isoindolyl, 4-isoindolyl, 5-isoindolyl, 6-isoindolyl, 7-isoindolyl, 2-furyl, 3-furyl, 2-benzofuranyl, 3-benzofuranyl, 4-benzofuranyl, 5-benzofuranyl, 6-benzofuranyl, 7-benzofuranyl, 1-isobenzofuranyl, 3-isobenzofuranyl, 4-isobenzofuranyl, 5-isobenzofuranyl, 6-isobenzofuranyl, 7-isobenzofuranyl, 2-quinolyl, 3-quinolyl, 4-quinolyl, 5-quinolyl, 6-quinolyl, 7-quinolyl, 8-quinolyl, 1-isoquinolyl, 3-isoquinolyl, 4-isoquinolyl, 5-isoquinolyl, 6-isoquinolyl, 7-isoquinolyl, 8-isoquinolyl, 2-quinoxalinyl, 5-quinoxalinyl, 6-quinoxalinyl, 1-carbazolyl, 2-carbazolyl, 3-carbazolyl, 4-carbazolyl, 1-phenanthridinyl, 2-phenanthridinyl, 3-phenanthridinyl, 4-phenanthridinyl, 6-phenanthridinyl, 7-phenanthridinyl, 8-phenanthridinyl, 9-phenanthridinyl, 10-phenanthridinyl, 1-acridinyl, 2-acridinyl, 3-acridinyl, 4-acridinyl, 9-acridinyl, 1,7-phenanthrolin-2-yl, 1,7-phenanthrolin-3-yl, 1,7-phenanthrolin-4-yl, 1,7-phenanthrolin-5-yl, 1,7-phenanthrolin-6-yl, 1,7-phenanthrolin-8-yl, 1,7-phenanthrolin-9-yl, 1,7-phenanthrolin-10-yl, 1,8-phenanthrolin-2-yl, 1,8-phenanthrolin-3-yl, 1,8-phenanthrolin-4-yl, 1,8-phenanthrolin-5-yl, 1,8-phenanthrolin-6-yl, 1,8-phenanthrolin-7-yl, 1,8-phenanthrolin-9-yl, 1,8-phenanthrolin-10-yl, 1,9-phenanthrolin-2-yl, 1,9-phenanthrolin-3-yl, 1,9-phenanthrolin-4-yl, 1,9-phenanthrolin-5-yl, 1,9-phenanthrolin-6-yl, 1,9-phenanthrolin-7-yl, 1,9-phenanthrolin-8-yl, 1,9-phenanthrolin-10-yl, 1,10-phenanthrolin-2-yl, 1,10-phenanthrolin-3-yl, 1,10-phenanthrolin-4-yl, 1,10-phenanthrolin-5-yl, 2,9-phenanthrolin-1-yl, 2,9-phenanthrolin-3-yl, 2,9-phenanthrolin-4-yl, 2,9-phenanthrolin-5-yl, 2,9-phenanthrolin-6-yl, 2,9-phenanthrolin-7-yl, 2,9-phenanthrolin-8-yl, 2,9-phenanthrolin-10-yl, 2,8-phenanthrolin-1-yl, 2,8-phenanthrolin-3-yl, 2,8-phenanthrolin-4-yl, 2,8-phenanthrolin-5-yl, 2,8-phenanthrolin-6-yl, 2,8-phenanthrolin-7-yl, 2,8-phenanthrolin-9-yl, 2,8-phenanthrolin-10-yl, 2,7-phenanthrolin-1-yl, 2,7-phenanthrolin-3-yl, 2,7-phenanthrolin-4-yl, 2,7-phenanthrolin-5-yl, 2,7-phenanthrolin-6-yl, 2,7-phenanthrolin-8-yl, 2,7-phenanthrolin-9-yl, 2,7-phenanthrolin-10-yl, 1-phenazinyl, 2-phenazinyl, 1-phenothiazinyl, 2-phenothiazinyl, 3-phenothiazinyl, 4-phenothiazinyl, 1-phenoxazinyl, 2-phenoxazinyl, 3-phenoxazinyl, 4-phenoxazinyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 2-oxadiazolyl, 5-oxadiazolyl, 3-furazanyl, 2-thienyl, 3-thienyl, 2-methylpyrrol-1-yl, 2-methylpyrrol-3-yl, 2-methylpyrrol-4-yl, 2-methylpyrrol-5-yl, 3-methylpyrrol-l-yl, 3-methylpyrrol-2-yl, 3-methylpyrrol-4-yl, 3-methylpyrrol-5-yl, 2-t-butylpyrrol-4-yl, 3-(2-phenylpropyl)pyrrol-1-yl, 2-methyl-1-indolyl, 4-methyl-1-indolyl, 2-methyl-3-indolyl, 4-methyl-3-indolyl, 2-t-butyl-1-indolyl, 4-t-butyl-1-indolyl, 2-t-butyl-3-indolyl, and 4-t-butyl-3-indolyl group.

[0028] The alkyl or substituted alkyl group, useful for the present invention include(s) methyl, ethyl, propyl, isopropyl, n-butyl, s-butyl, isobutyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl, 2-hydroxyisobutyl, 1,2-dihydroxyethyl, 1,3-dihydroxyisopropyl, 2,3-dihydroxy-t-butyl, 1,2,3-trihydroxypropyl, chloromethyl, 1-chloroethyl, 2-chloroethyl, 2-chloroisobutyl, 1,2-dichloroethyl, 1,3-dichloroisopropyl, 2,3-dichloro-t-butyl, 1,2,3-trichloropropyl, bromomethyl, 1-bromoethyl, 2-bromoethyl, 2-bromoisobutyl, 1,2-dibromoethyl, 1,3-dibromoisopropyl, 2,3-di-

bromo-t-butyl, 1,2,3-tribromopropyl, iodomethyl, 1-iodoethyl, 2-iodoethyl, 2-iodoisobutyl, 1,2-diiodoethyl, 1,3-diiodoisopropyl, 2,3-diiodo-t-butyl, 1,2,3-triiodopropyl, aminomethyl, 1-aminoethyl, 2-aminoethyl, 2-aminoisobutyl, 1,2-diaminoethyl, 1,3-diaminoisopropyl, 2,3-diamino-t-butyl, 1,2,3-triaminopropyl, cyanomethyl, 1-cyanoethyl, 2-cyanoethyl, 2-cyanoisobutyl, 1,2-dicyanoethyl, 1,3-dicyanoisopropyl, 2,3-dicyano-t-butyl, 1,2,3-tricyanopropyl, nitromethyl, 1-nitroethyl, 2-nitroethyl, 2-nitroisobutyl, 1,2-dinitroethyl, 1,3-dinitroisopropyl, 2,3-dinitro-t-butyl, and 1,2,3-trinitropropyl group.

[0029] The alkenyl or substituted alkenyl group, useful for the present invention includes vinyl, allyl, 1-butenyl, 2-butenyl, 3-butenyl, 1,3-butanedienyl, 1-methylvinyl, 1-methylallyl, 1,1-dimethylallyl, 2-methylallyl, 1-phenylallyl, 2-phenylallyl, 3-phenylallyl, 3,3-diphenylallyl, 1,2-dimethylallyl, 1-phenyl-1-butenyl, and 3-phenyl-1-butenyl. The cycloalkyl or substituted cycloalkyl group, useful for the present invention include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, and 4-methylcyclohexyl group.

[0030] The alkoxy or substituted alkoxy group, is represented by the general formula -OY. The groups represented by Y useful for the present invention include methyl, ethyl, propyl, isopropyl, n-butyl, s-butyl, isobutyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl, 2-hydroxyisobutyl, 1,2-dihydroxyethyl, 1,3-dihydroxyisopropyl, 2,3-dihydroxy-t-butyl, 1,2,3-trihydroxypropyl, chloromethyl, 1-chloroethyl, 2-chloroethyl, 2-chloroisobutyl, 1,2-dichloroethyl, 1,3-dichloroisopropyl, 2,3-dichloro-t-butyl, 1,2,3-trichloropropyl, bromomethyl, 1-bromoethyl, 2-bromoethyl, 2-bromoisobutyl, 1,2-dibromoethyl, 1,3-dibromoisopropyl, 2,3-dibromo-t-butyl, 1,2,3-tribromopropyl, iodomethyl, 1-iodoethyl, 2-iodoethyl, 2-iodoisobutyl, 1,2-diiodoethyl, 1,3-diiodoisopropyl, 2,3-diiodo-t-butyl, 1,2,3-triiodopropyl, aminomethyl, 1-aminoethyl, 2-aminoethyl, 2-aminoisobutyl, 1,2-diaminoethyl, 1,3-diaminoisopropyl, 2,3-diamino-t-butyl, 1,2,3-triaminopropyl, cyanomethyl, 1-cyanoethyl, 2-cyanoethyl, 2-cyanoisobutyl, 1,2-dicyanoethyl, 1,3-dicyanoisopropyl, 2,3-dicyano-t-butyl, 1,2,3-tricyanopropyl, nitromethyl, 1-nitroethyl, 2-nitroethyl, 2-nitroisobutyl, 1,2-dinitroethyl, 1,3-dinitroisopropyl, 2,3-dinitro-t-butyl, and 1,2,3-trinitropropyl.

[0031] The aromatic hydrocarbon or substituted aromatic hydrocarbon group(s), useful for the present invention includes phenyl, 1-naphthyl, 2-naphthyl, 1-anthryl, 2-anthryl, 9-anthryl, 1-phenanthryl, 2-phenanthryl, 3-phenanthryl, 4-phenanthryl, 9-phenanthryl, 1-naphthacenyl, 2-naphthacenyl, 9-naphthacenyl, 1-pyrenyl, 2-pyrenyl, 4-pyrenyl, 2-biphenylyl, 3-biphenylyl, 4-biphenylyl, p-terphenyl-4-yl, p-terphenyl-3-yl, p-terphenyl-2-yl, m-terphenyl-4-yl, m-terphenyl-3-yl, m-terphenyl-2-yl, o-tolyl, m-tolyl, p-tolyl, p-t-butylphenyl, p-(2-phenylpropyl)phenyl, 3-methyl-2-naththyl, 4-methyl-1-naththyl, 4-methyl-1-anthryl, 4'-methylbiphenylyl, and 4"-t-butyl-p-terphenyl-4-yl group.

[0032] The aromatic heterocyclic or substituted aromatic heterocyclic group(s), useful for the present invention include 1-pyrrolyl, 2-pyrrolyl, 3-pyrrolyl, pyrazinyl, 2-pyridinyl, 3-pyridinyl, 4-pyridinyl, 1-indolyl, 2-indolyl, 3-indolyl, 4-indolyl, 5-indolyl, 6-indolyl, 7-indolyl, 1-isoindolyl, 2-isoindolyl, 3-isoindolyl, 4-isoindolyl, 5-isoindolyl, 6-isoindolyl, 7-isoindolyl, 2-furyl, 3-furyl, 2-benzofuranyl, 3-benzofuranyl, 4-benzofuranyl, 5-benzofuranyl, 6-benzofuranyl, 7-benzofuranyl, 1-isobenzofuranyl, 3-isobenzofuranyl, 4-isobenzofuranyl, 5-isobenzofuranyl, 6-isobenzofuranyl, 7-isobenzofuranyl, 2-quinolyl, 3-quinolyl, 4-quinolyl, 5-quinolyl, 6-quinolyl, 7-quinolyl, 8-quinolyl, 1-isoquinolyl, 3-isoquinolyl, 4-isoquinolyl, 5-isoquinolyl, 6-isoquinolyl, 7-isoquinolyl, 8-isoquinolyl, 2-quinoxalinyl, 5-quinoxalinyl, 6-quinoxalinyl, 1-carbazolyl, 2-carbazolyl, 3-carbazolyl, 4-carbazolyl, 9-carbazolyl, 1-phenanthridinyl, 2-phenanthridinyl, 3-phenanthridinyl, 4-phenanthridinyl, 6-phenanthridinyl, 7-phenanthridinyl, 8-phenanthridinyl, 9-phenanthridinyl, 10-phenanthridinyl, 1-acridinyl, 2-acridinyl, 3-acridinyl, 4-acridinyl, 9-acridinyl, 1,7-phenanthrolin-2-yl, 1,7-phenanthrolin-3-yl, 1,7-phenanthrolin-4-yl, 1,7-phenanthrolin-5-yl, 1,7-phenanthrolin-6-yl, 1,7-phenanthrolin-8-yl, 1,7-phenanthrolin-9-yl, 1,7-phenanthrolin-10-yl, 1,8-phenanthrolin-2-yl, 1,8-phenanthrolin-3-yl, 1,8-phenanthrolin-4-yl, 1,8-phenanthrolin-5-yl, 1,8-phenanthrolin-6-yl, 1,8-phenanthrolin-7-yl, 1,8-phenanthrolin-9-yl, 1,8-phenanthrolin-10-yl, 1,9-phenanthrolin-2-yl, 1,9-phenanthrolin-3-yl, 1,9-phenanthrolin-4-yl, 1,9-phenanthrolin-5-yl, 1,9-phenanthrolin-6-yl, 1,9-phenanthrolin-7-yl, 1,9-phenanthrolin-8-yl, 1,9-phenanthrolin-10-yl, 1,10-phenanthrolin-2-yl, 1,10-phenanthrolin-3-yl, 1,10-phenanthrolin-4-yl, 1,10-phenanthrolin-5-yl, 2,9-phenanthrolin-1-yl, 2,9-phenanthrolin-3-yl, 2,9-phenanthrolin-4-yl, 2,9-phenanthrolin-5-yl, 2,9-phenanthrolin-6-yl, 2,9-phenanthrolin-7-yl, 2,9-phenanthrolin-8-yl, 2,9-phenanthrolin-10-yl, 2,8-phenanthrolin-1-yl, 2,8-phenanthrolin-3-yl, 2,8-phenanthrolin-4-yl, 2,8-phenanthrolin-5-yl, 2,8-phenanthrolin-6-yl, 2,8-phenanthrolin-7-yl, 2,8-phenanthrolin-9-yl, 2,8-phenanthrolin-10-yl, 2,7-phenanthrolin-1-yl, 2,7-phenanthrolin-3-yl, 2,7-phenanthrolin-4-yl, 2,7-phenanthrolin-5-yl, 2,7-phenanthrolin-6-yl, 2,7-phenanthrolin-8-yl, 2,7-phenanthrolin-9-yl, 2,7-phenanthrolin-10-yl, 1-phenazinyl, 2-phenazinyl, 1-phenothiazinyl, 2-phenothiazinyl, 3-phenothiazinyl, 4-phenothiazinyl, 10-phenothiazinyl, 1-phenoxazinyl, 2-phenoxazinyl, 3-phenoxazinyl, 4-phenoxazinyl, 10-phenoxazinyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 2-oxadiazolyl, 5-oxadiazolyl, 3-furazanyl, 2-thienyl, 3-thienyl, 2-methylpyrrol-1-yl, 2-methylpyrrol-3-yl, 2-methylpyrrol-4-yl, 2-methylpyrrol-5-yl, 3-methylpyrrol-1-yl, 3-methylpyrrol-2-yl, 3-methylpyrrol-4-yl, 3-methylpyrrol-5-yl, 2-t-butylpyrrol-4-yl, 3-(2-phenylpropyl)pyrrol-1-yl, 2-methyl-1-indolyl, 4-methyl-1-indolyl, 2-methyl-3-indolyl, 4-methyl-3-indolyl, 2-t-butyl-1-indolyl, 4-t-butyl-1-indolyl, 2-t-butyl-3-indolyl, and 4-t-butyl-3-indolyl group.

[0033] The aralkyl or substituted aralkyl group(s), useful for the present invention include(s) benzyl, 1-phenylethyl, 2-phenylethyl, 1-phenylisopropyl, 2-phenylisopropyl, phenyl-t-butyl, a -naphthylmethyl, 1- a -naphthylethyl, 2- α -naphthylethyl, 1- a -naphthylisopropyl, 2- α - naphthylisopropyl, β -naphthylmethyl, 1- β -naphthylethyl, 2- β-naphthylethyl, 1- β -naphthylisopropyl, 2- β -naphthylisopropyl, 1-pyrrolylmethyl, 2-(1-pyrrolyl)ethyl, p-methylbenzyl, m-methylbenzyl, o-methylbenzyl, p-chlorobenzyl, m-chlorobenzyl, o-chlorobenzyl, p-bromobenzyl, m-bromobenzyl, o-bromobenzyl, p-io-

dobenzyl, m-iodobenzyl, o-iodobenzyl, p-hydroxybenzyl, m-hydroxybenzyl, o-hydroxybenzyl, p-aminobenzyl, m-aminobenzyl, o-aminobenzyl, p-aminobenzyl, m-aminobenzyl, o-aminobenzyl, p-nitrobenzyl, m-nitrobenzyl, o-nitrobenzyl, p-cyanobenzyl, m-cyanobenzyl, o-cyanobenzyl, 1-hydroxy-2-phenylisopropyl, and 1-chloro-2-phenylisopropyl.

[0034] The aryloxy or substituted aryloxy group(s), which may be substituted, is represented by the general formula -OZ. The groups represented by Z useful for the present invention include phenyl, 1-naphthyl, 2-naphthyl, 1-anthryl, 2-anthryl, 9-anthryl, 1-phenanthryl, 2-phenanthryl, 3-phenanthryl, 4-phenanthryl, 9-phenanthryl, 1-naphthacenyl, 2-naphthacenyl, 9-naphthacenyl, 1-pyrenyl, 2-pyrenyl, 4-pyrenyl, 2-biphenylyl, 3-biphenylyl, 4-biphenylyl, p-terphenyl-4-yl, p-terphenyl-3-yl, p-terphenyl-2-yl, m-terphenyl-4-yl, m-terphenyl-3-yl, m-terphenyl-2-yl, o-tolyl, m-tolyl, p-tolyl, p-t-butylphenyl, p-(2-phenylpropyl)phenyl, 3-methyl-2-naththyl, 4-methyl-1-naththyl, 4-methyl-1-anthryl, 4'-methylbiphenylyl, 4"-t-butyl-p-terphenyl-4-yl, 2-pyrrolyl, 3-pyrrolyl, pyrazinyl, 2-pyridinyl, 3-pyridinyl, 4-pyridinyl, 2-indolyl, 3-indolyl, 4-indolyl, 5-indolyl, 6-indolyl, 7-indolyl, 1-isoindolyl, 3-isoindolyl, 4-isoindolyl, 5-isoindolyl, 6-isoindolyl, 7-isoindolyl, 2-furyl, 3-furyl, 2-benzofuranyl, 3-benzofuranyl, 4-benzofuranyl, 5-benzofuranyl, 6-benzofuranyl, 7-benzofuranyl, 1-isobenzofuranyl, 3-isobenzofuranyl, 4-isobenzofuranyl, 5-isobenzofuranyl, 6-isobenzofuranyl, 7-isobenzofuranyl, 2-quinolyl, 3-quinolyl, 4-quinolyl, 5-quinolyl, 6-quinolyl, 7-quinolyl, 8-quinolyl, 1-isoquinolyl, 3-isoquinolyl, 4-isoquinolyl, 5-isoquinolyl, 6-isoquinolyl, 7-isoquinolyl, 8-isoquinolyl, 2-quinoxalinyl, 5-quinoxalinyl, 6-quinoxalinyl, 1-carbazolyl, 2-carbazolyl, 3-carbazolyl, 4-carbazolyl, 1-phenanthridinyl, 2-phenanthridinyl, 3-phenanthridinyl, 4-phenanthridinyl, 6-phenanthridinyl, 7-phenanthridinyl, 8-phenanthridinyl, 9-phenanthridinyl, 10-phenanthridinyl, 1-acridinyl, 2-acridinyl, 3-acridinyl, 4-acridinyl, 9-acridinyl, 1,7-phenanthrolin-2-yl, 1,7-phenanthrolin-3-yl, 1,7-phenanthrolin-4-yl, 1,7-phenanthrolin-5-yl, 1,7-phenanthrolin-6-yl, 1,7-phenanthrolin-8-yl, 1,7-phenanthrolin-9-yl, 1,7-phenanthrolin-10-yl, 1,8-phenanthrolin-2-yl, 1,8-phenanthrolin-3-yl, 1,8-phenanthrolin-4-yl, 1,8-phenanthrolin-5-yl, 1,8-phenanthrolin-6-yl, 1,8-phenahthrolin-7-yl, 1,8-phenanthrolin-9-yl, 1,8-phenanthrolin-10-yl, 1,9-phenanthrolin-2-yl, 1,9-phenanthrolin-3-yl, 1,9-phenanthrolin-4-yl, 1,9-phenanthrolin-5-yl, 1,9-phenanthrolin-6-yl, 1,9-phenanthrolin-7-yl, 1,9-phenanthrolin-8-yl, 1,9-phenanthrolin-10-yl, 1,10-phenanthrolin-2-yl, 1,10-phenanthrolin-3-yl, 1, 10-phenanthrolin-4-yl, 1,10-phenanthrolin-5-yl, 2,9-phenanthrolin-1-yl, 2,9-phenanthrolin-3-yl, 2,9-phenanthrolin-4-yl, 2,9-phenanthrolin-5-yl, 2,9-phenanthrolin-6-yl, 2,9-phenanthrolin-7-yl, 2,9-phenanthrolin-8-yl, 2,9-phenanthrolin-10-yl, 2,8-phenanthrolin-1-yl, 2,8-phenanthrolin-3-yl, 2,8-phenanthrolin-4-yl, 2,8-phenanthrolin-5-yl, 2,8-phenanthrolin-6-yl, 2,8-phenanthrolin-7-yl, 2,8-phenanthrolin-9-yl, 2,8-phenanthrolin-10-yl, 2,7-phenanthrolin-1-yl, 2,7-phenanthrolin-3-yl, 2,7-phenanthrolin-4-yl, 2,7-phenanthrolin-5-yl, 2,7-phenanthrolin-6-yl, 2,7-phenanthrolin-8-yl, 2,7-phenanthrolin-9-yl, 2,7-phenanthrolin-10-yl, 1-phenazinyl, 2-phenazinyl, 1-phenothiazinyl, 2-phenothiazinyl, 3-phenothiazinyl, 4-phenothiazinyl, 1-phenoxazinyl, 2-phenoxazinyl, 3-phenoxazinyl, 4-phenoxazinyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 2-oxadiazolyl, 5-oxadiazolyl, 3-furazanyl, 2-thienyl, 3-thienyl, 2-methylpyrrol-1-yl, 2-methylpyrrol-3-yl, 2-methylpyrrol-4-yl, 2-methylpyrrol-5-yl, 3-methylpyrrol-1-yl, 3-methylpyrrol-2-yl, 3-methylpyrrol-4-yl, 3-methylpyrrol-5-yl, 2-t-butylpyrrol-4-yl, 3-(2-phenylpropyl)pyrrol-1-yl, 2-methyl-1-indolyl, 4-methyl-1-indolyl, 2-methyl-3-indolyl, 4-methyl-3-indolyl, 2-t-butyl-1-indolyl, 4-t-butyl-1-indolyl, 2-t-butyl-3-indolyl, and 4-t-butyl-3-indolyl group.

[0035] The alkoxy carbonyl or substituted alkoxy carbonyl group(s), is represented by the general formula -COOY. The groups represented by Y useful for the present invention include methyl, ethyl, propyl, isopropyl, n-butyl, s-butyl, isobutyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl, 2-hydroxyisobutyl, 1,2-dihydroxyethyl, 1,3-dihydroxyisopropyl, 2,3-dihydroxy-t-butyl, 1,2,3-trihydroxypropyl, chloromethyl, 1-chloroethyl, 2-chloroethyl, 2-chloroisobutyl, 1,2-dichloroethyl, 1,3-dichloroisopropyl, 2,3-dichloro-t-butyl, 1,2,3-trichloropropyl, bromomethyl, 1-bromoethyl, 2-bromoethyl, 2-bromoisobutyl, 1,2-dibromoethyl, 1,3-dibromoisopropyl, 2,3-dibromo-t-butyl, 1,2,3-tribromopropyl, iodomethyl, 1-iodoethyl, 2-iodoethyl, 2-iodoisobutyl, 1,2-diiodoethyl, 1,3-diiodoisopropyl, 2,3-diiodo-t-butyl, 1,2,3-triiodopropyl, aminomethyl, 1-aminoethyl, 2-aminoethyl, 2-aminoisobutyl, 1,2-diaminoethyl, 1,3-diaminoisopropyl, 2,3-diamino-t-butyl, 1,2,3-triaminopropyl, cyanomethyl, 1-cyanoethyl, 2-cyanoethyl, 2-cyanoisobutyl, 1,2-dicyanoethyl, 1,3-dicyanoisopropyl, 2,3-dicyano-t-butyl, 1,2,3-tricyanopropyl, nitromethyl, 1-nitroethyl, 2-nitroethyl, 2-nitroisobutyl, 1,2-dinitroethyl, 1,3-dinitroisopropyl, 2,3-dinitro-t-butyl, and 1,2,3-trinitropropyl group.

[0036] The divalent groups which can form a ring include tetramethylene, pentamethylene, hexamethylene, diphenylmethane-2,2'-diyl, diphenylethane-3,3'-diyl, diphenylpropane-4,4'-diyl, and 1,3-butadiene-1,4-diyl.

[0037] The aryl groups represented by a_1, b_1, b_2, Ar_1 and Ar_2 include phenyl, naphthyl, anthryl, phenanthryl, naphthacenyl and pyrenyl.

[0038] These aryl group(s) may be substituted with a halogen atom, hydroxyl, the above described amino, nitro, cyano, the above described alkyl, the above described alkenyl (other than styryl), the above described cycloalkyl, the above described alkoxy, the above described aromatic hydrocarbon, the above described aromatic heterocyclic, the above described aralkyl, the above described aryloxy, the above described alkoxy carbonyl or carboxyl (of which amino, alkyl, alkenyl, cycloalkyl, alkoxy, aromatic hydrocarbon, aromatic heterocyclic, aralkyl, aryloxy, and alkoxy carbonyl may be substituted).

[0039] The inventors of the present invention have found, after having extensively studied to solve the problems involved in the conventional organic EL material, that the organic layer can be stabilized by containing a compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I), because they have excellent film-making properties and strongly amorphous to efficiently prevent agglomeration, with the result that the organic EL device of the present invention

is highly durable.

[0040] Japanese Patent Laid-Open No. HEI 10-140146 discloses an organic EL device which uses the compound shown by the general formula (A-I) with hydrogen atom for each of the substituents Z_1 to Z_4 and Z_7 to Z_{10}, and hydrogen atom or methyl group for each of the substituents of Z_5 and Z_6. The inventors of the present invention have found, after having further developed the concept, that introduction of a substituent other than hydrogen atom into one or more of the substituents of Z_1 to Z_4 and Z_7 to Z_{10} makes the molecular structure less planar, more distorted and more amorphous, to further stabilize the organic layer. It is also found that the similar effect is obtained to further stabilize the organic layer by introducing a bulky substituent in the ortho or meta position, like the compound shown by the general formula (A-III), rather than in the para position, and that the molecular structure is also distorted to stabilize the organic layer by introducing an alkyl group having 2 or more carbons, or aromatic hydrocarbon or aromatic heterocyclic group in the substituent X_6 or X_7, like the one shown by the general formula (A-VI), where the alkyl, aromatic hydrocarbon and aromatic heterocyclic groups may be substituted.

[0041] Moreover, it is possible to contain the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I) in the light-emitting region. The inventors of the present invention have found that the compounds shown by the general formula (A-I), (A-III), (A-VI) or (B-I) each have a very high fluorescence yield and thus the organic EL device emits EL light of higher brightness, when its light-emitting region contains one of the above compounds. The compound disclosed by Japanese Patent Laid-Open No. HEI 10-140146 exhibits light-emitting characteristics, but the inventors of the present invention have found, after having further developed the concept, that the compounds shown by the general formulae (A-I), (A-III), (A-VI) or (B-I) have better light-emitting characteristics.

[0042] Each of the compounds shown by the general formulae (A-I), (A-III), (A-VI) or (B-I) can form a light-emitting layer by itself, but can be doped with a light-emitting dopant to obtain the EL light emitted from the dopant. A known dopant can be used for the above purpose. It is also possible to use each of the compounds shown by the general formulae (A-I), (A-III), (A-VI) and (B-I) as the dopant. In this case, a known material can be used for the light-emitting host.

[0043] The layer containing the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I) preferably has a thickness of 1 to 1000 nm, more preferably 2 to 500 nm. An excessively thick film is undesirable, because it needs an excessively high driving voltage for the organic EL device. Because current flows into the organic EL device it will generate a large quantity of heat within the device, when its driving voltage is excessively high, to accelerate its aging.

[0044] The layer containing the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I) can be produced by a known method, e.g., vacuum deposition, more concretely, resistance heating, electron beam heating, sputtering, ion plating, MBE (molecular beam epitaxy), and so on.

[0045] It can be also produced by wet film-making methods, e.g., spin coating, spray coating, bar coating, dip coating, and roll coating.

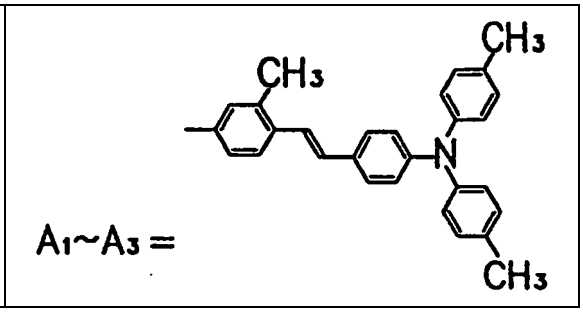
[0046] A known solvent can be adequately used for preparing the coating solution. The solvents include, for example, alcohols, aromatic hydrocarbons, ketones, esters, aliphatic halogenated hydrocarbons, ethers, amides, sulfoxides or the like.

[0047] A polymer binder dispersed with at least the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I) may be used to prepare the layer containing the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I). The polymer binder can be selected from known substances, e.g., resins (e.g., vinyl-based resin, acrylic-based resin, epoxy-based resin, silicon-based resin, styryl-based resin, polyimide, polysilylene, polyvinyl carbazole, polycarbonate, cellulosic resin, polyolefin-based resin), and natural resins (e.g., glue and gelatin).

[0048] The polymer binder dispersed with the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I) may be formed into a film by a known method, e.g., the wet film-making method. A combination of the wet film-making method and solvent may be adequately selected from the known ones above described.

[0049] Tables I-1 to I-4 show examples of the compound shown by the general formula (A-I), which by no means limit the compound.

[Table I-1]

1	

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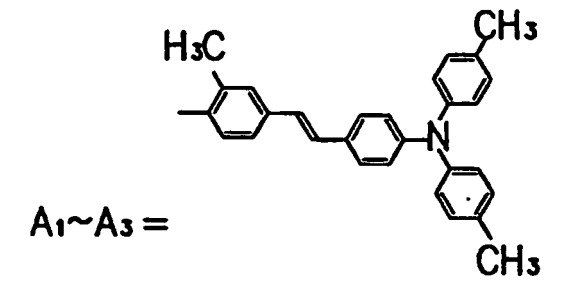
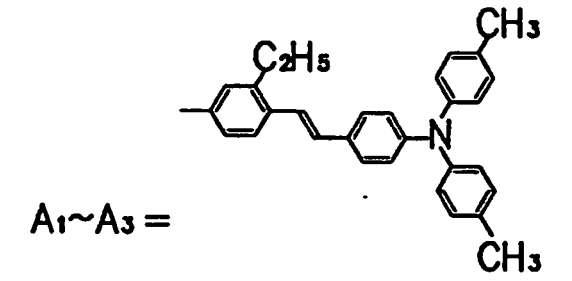
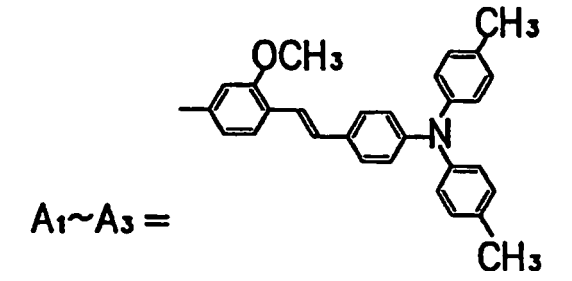
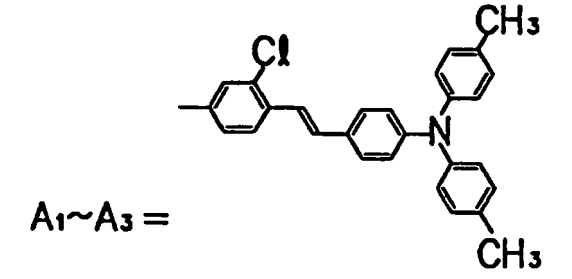
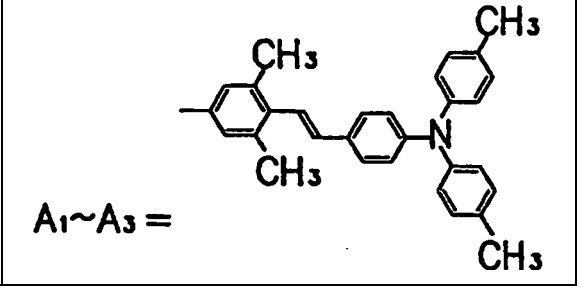
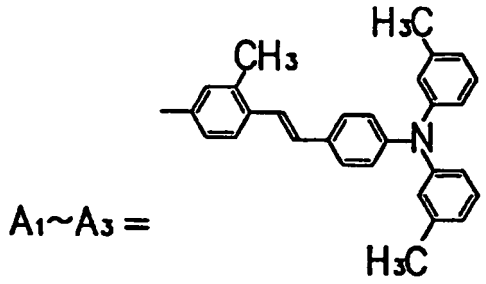
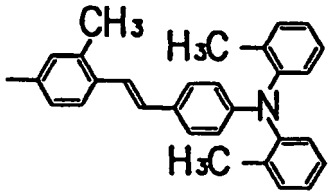
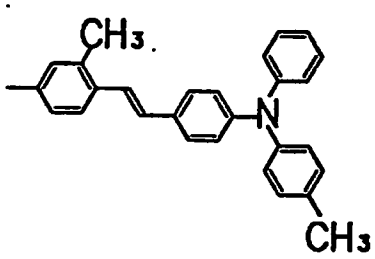
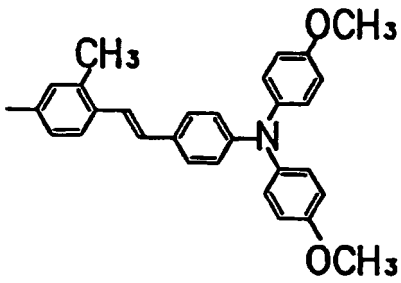
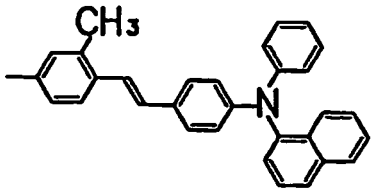
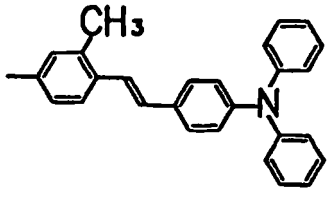
2	
3	
4	
5	
6	

[Table I-2]

7	 A1~A3 =
8	 A1~A3 =
9	 A1~A3 =
10	 A1~A3 =
11	 A1~A3 =
12	 A1~A3 =

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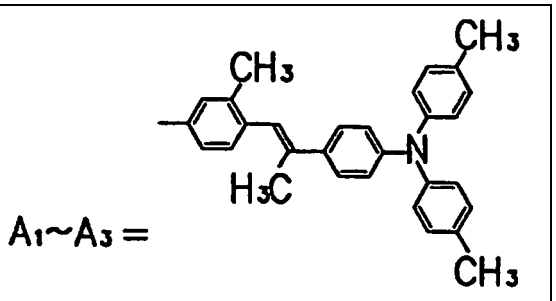
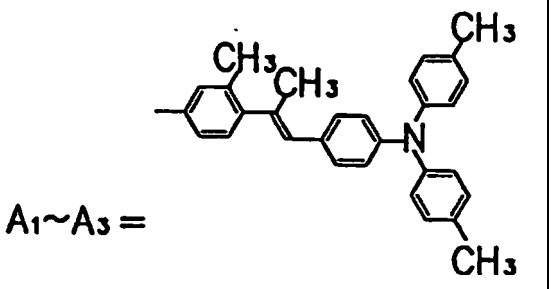
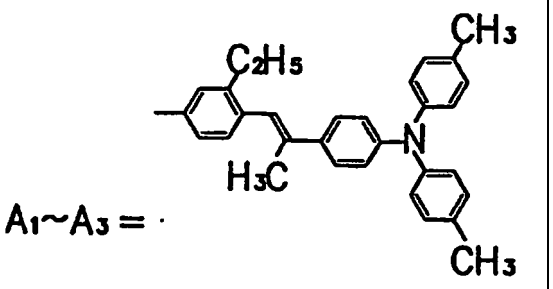
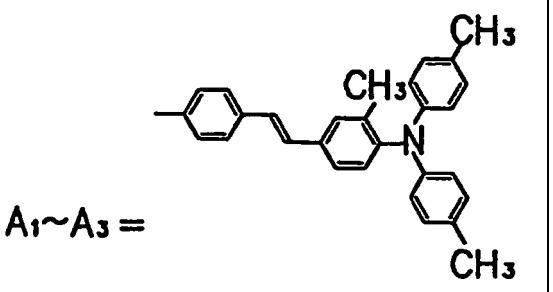
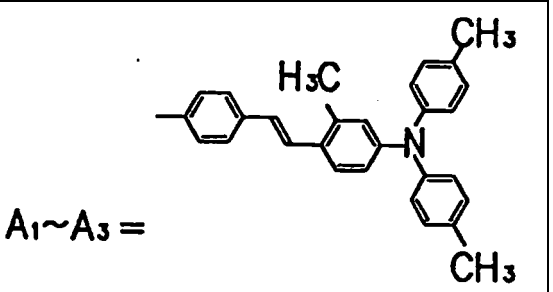
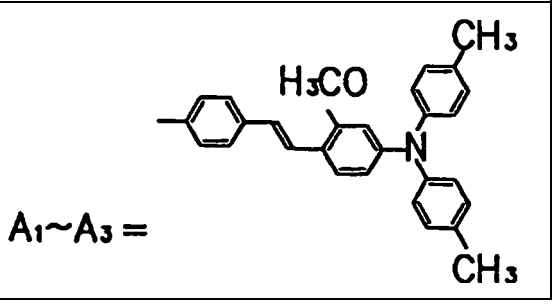
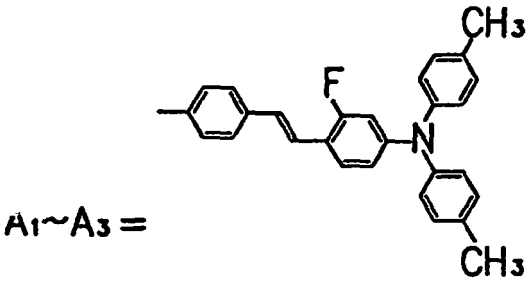
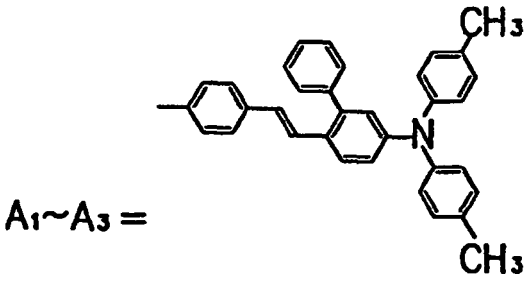
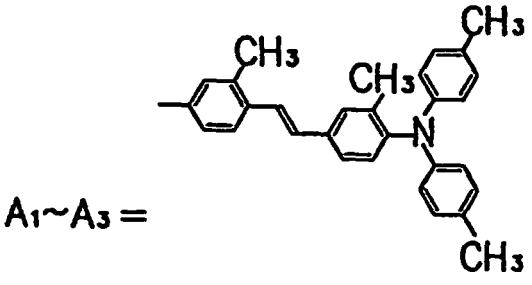
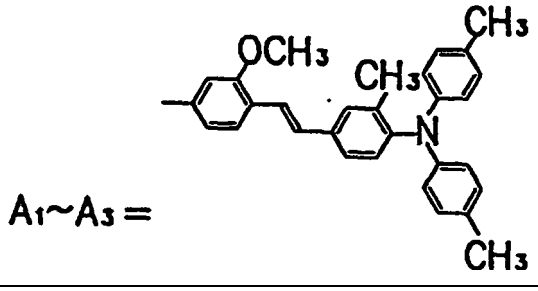
13	
14	
15	
16	
17	
18	

[Table I-4]

19	
20	
21	
22	

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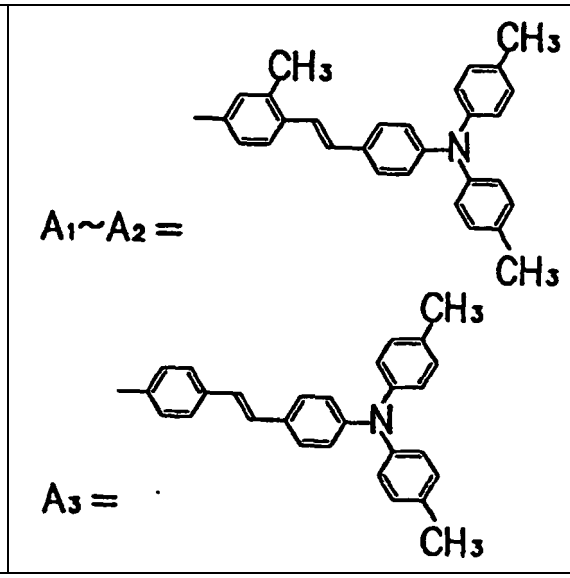
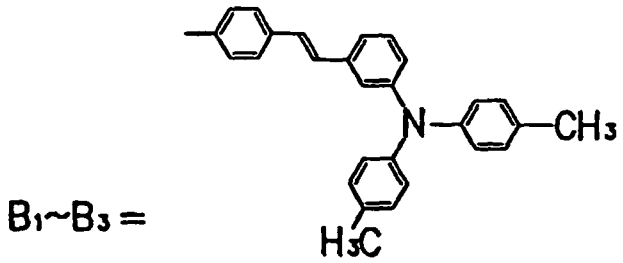
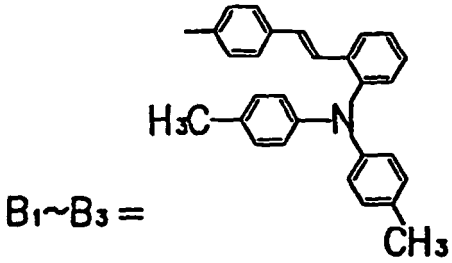
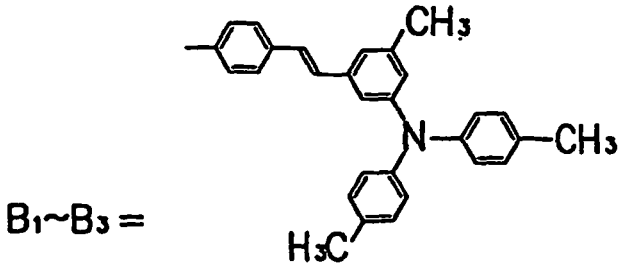
23	

[0050] Table I-5 shows examples of the compound shown by the general formula (A-III), which by no means limit the compound.

[Table I-5]

24	
25	
26	

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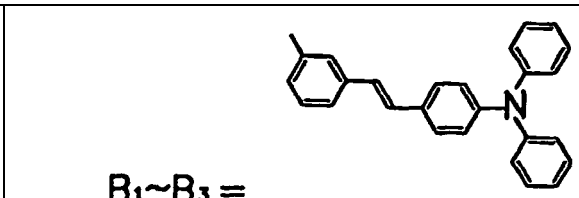
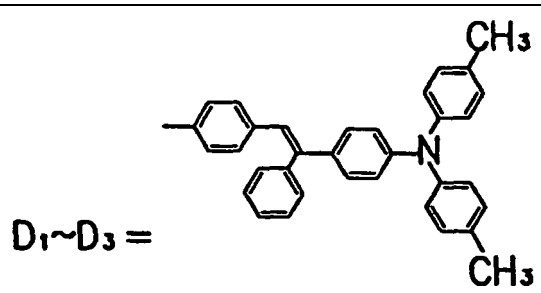
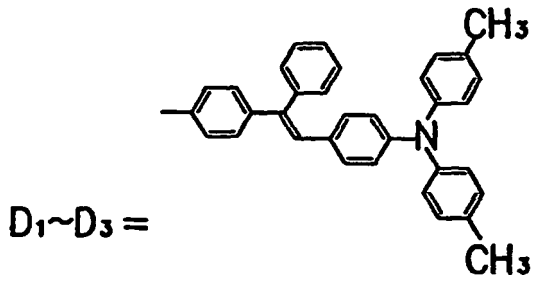
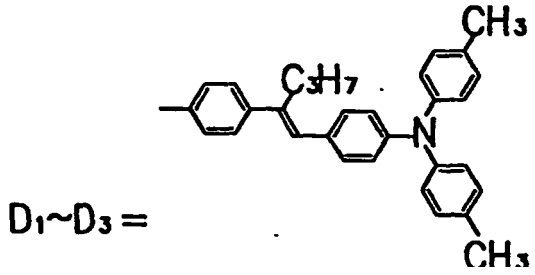
27	

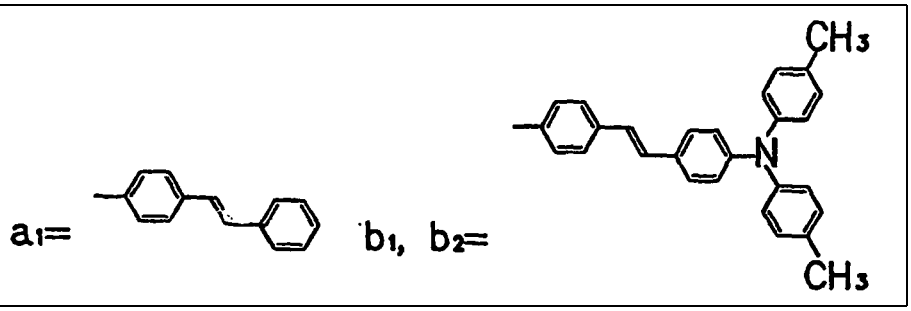
[0051] Table I-6 shows examples of the compound shown by the general formula (A-VI), which by no means limit the compound.

[Table I-6]

28	
29	
30	

[0052] Tables II -1 to II -6 show examples of the compound shown by the general formula (B-I), which by no means limit the compound.

[Table II-1]

1	

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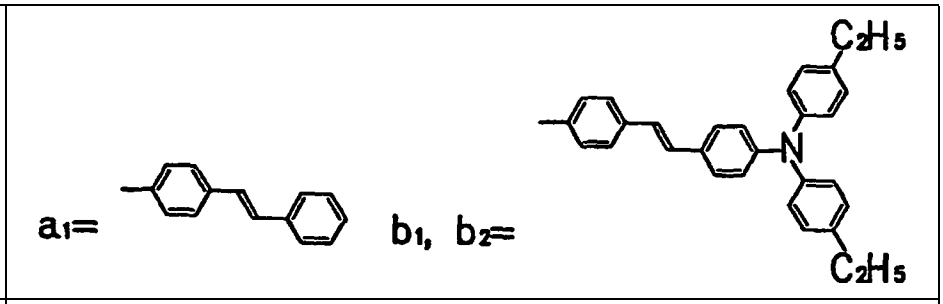
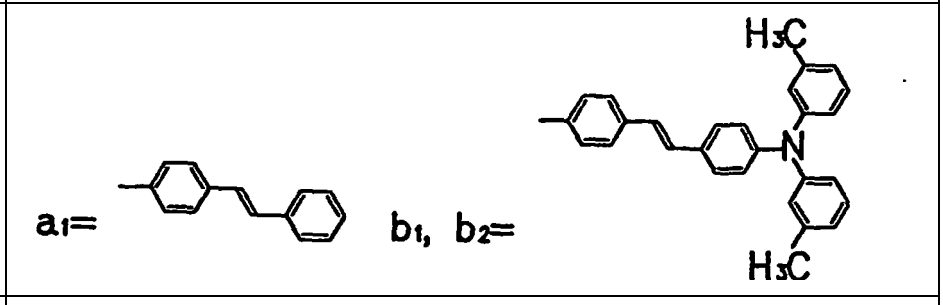
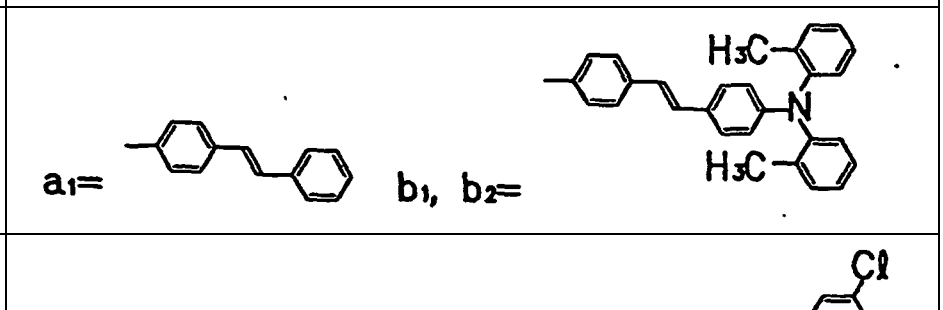
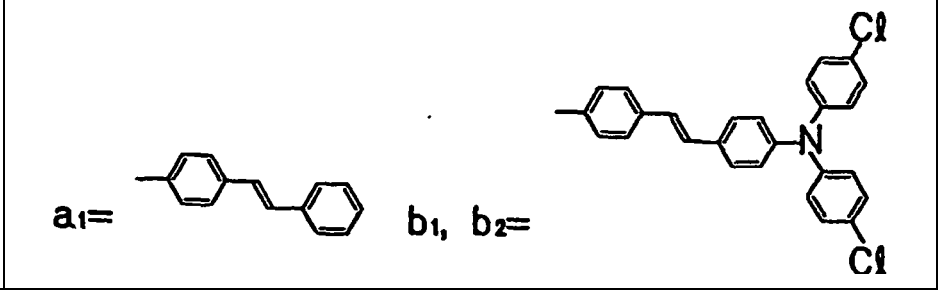
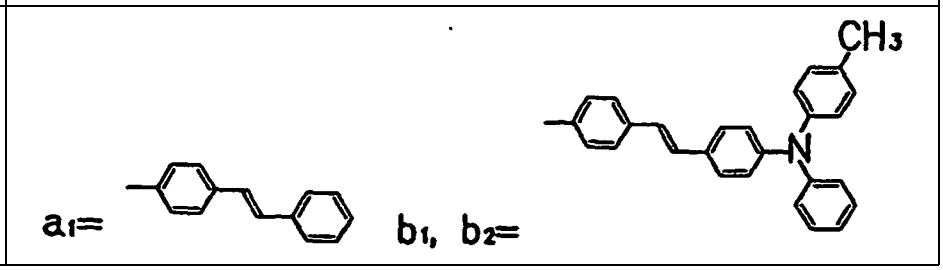
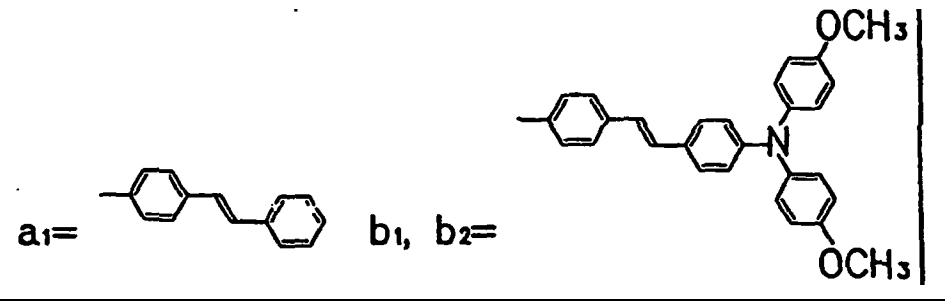
2	
3	
4	
5	
6	

[Table II -2]

7	

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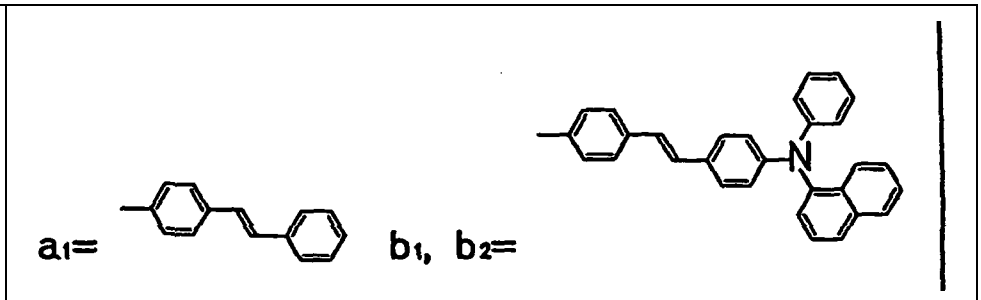
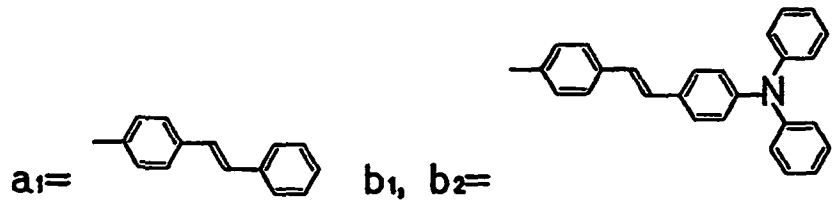
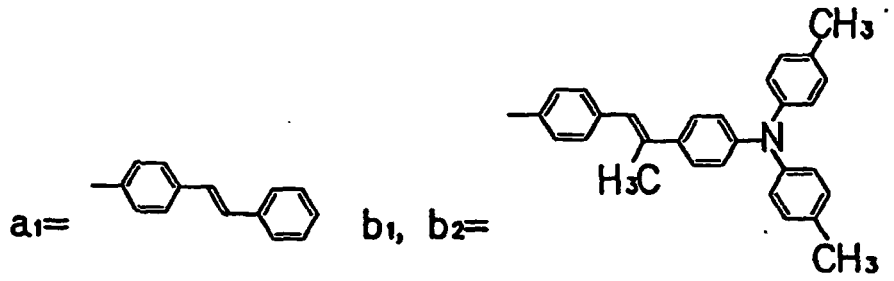
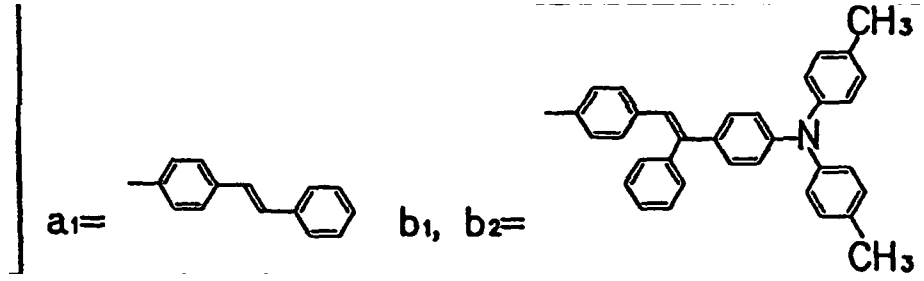
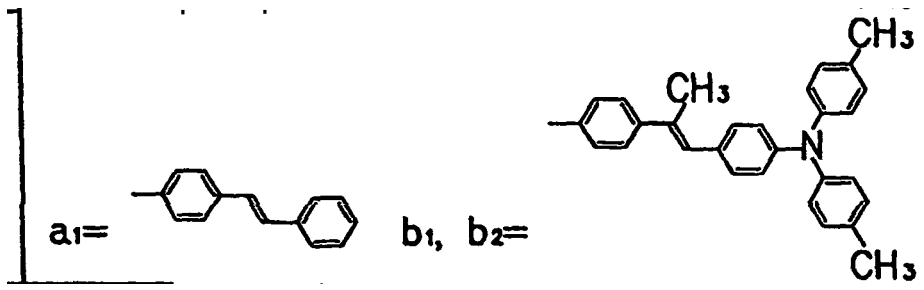
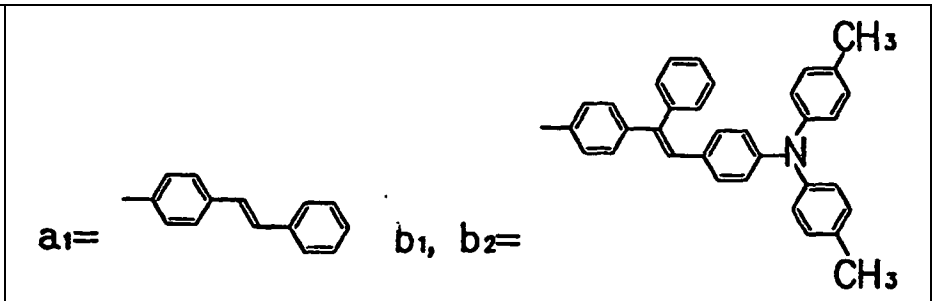
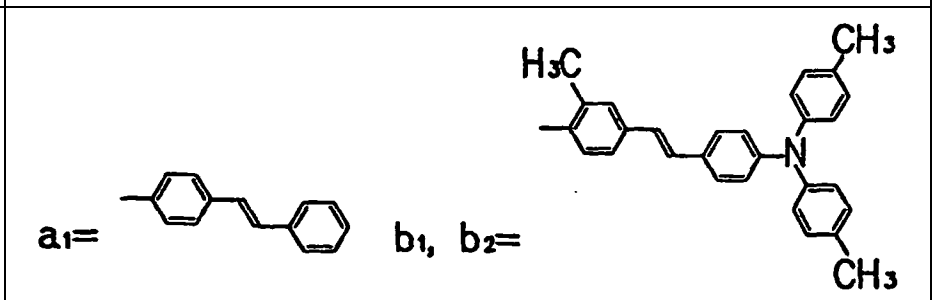
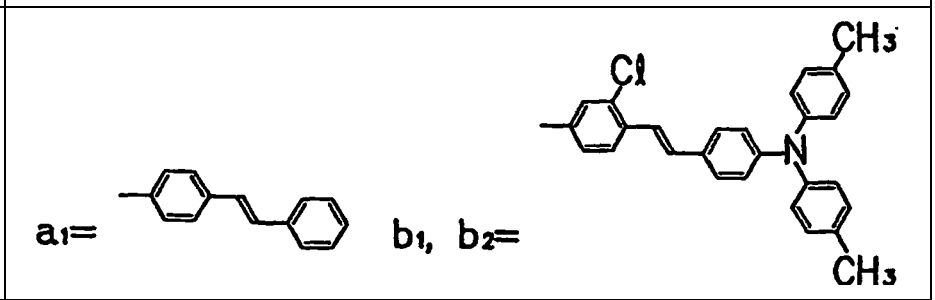
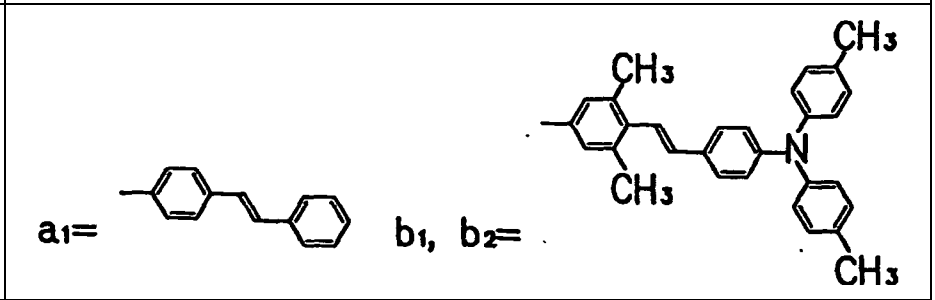
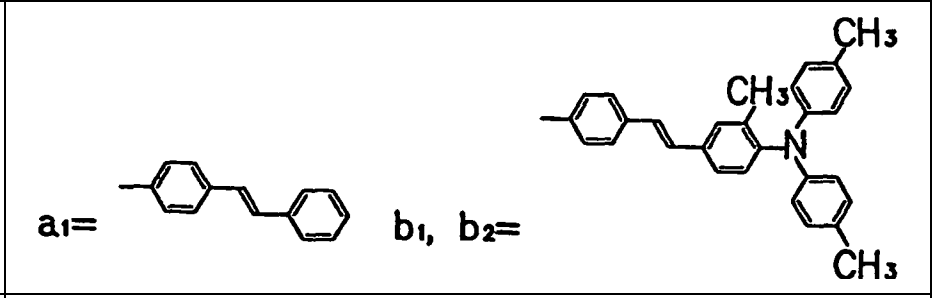
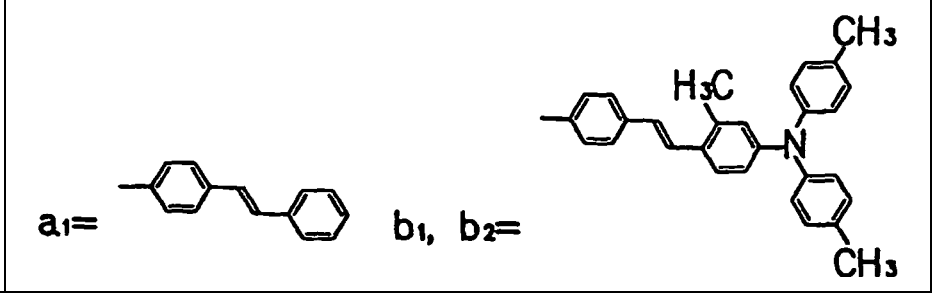
8	
9	
10	
11	
12	

[Table II -3]

13	
14	
15	
16	
17	
18	

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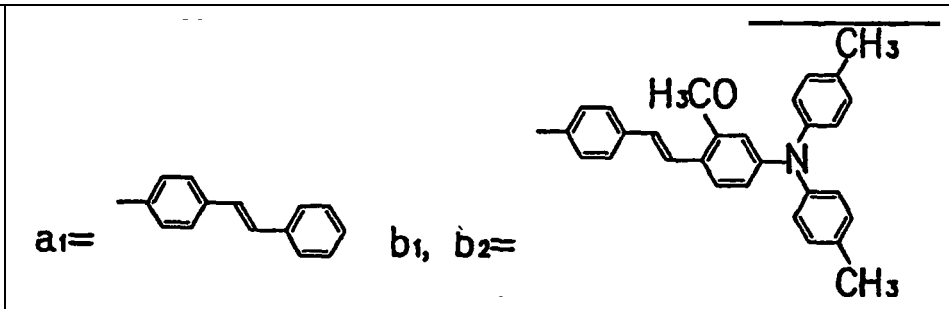
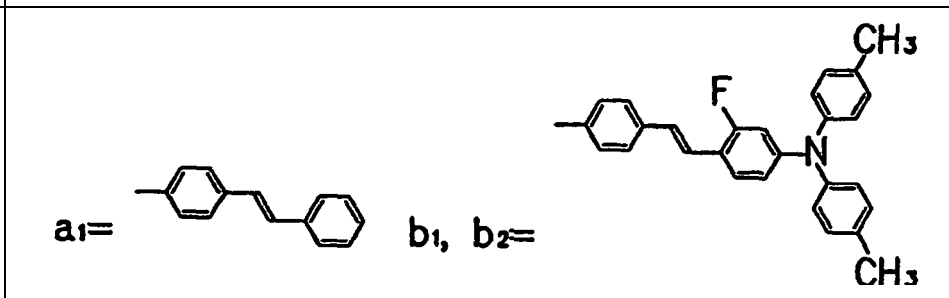
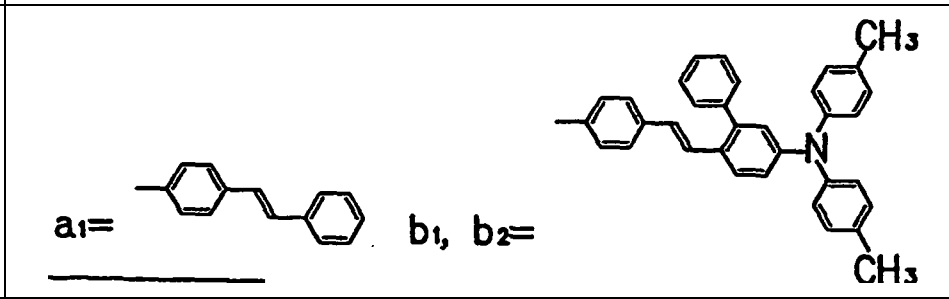
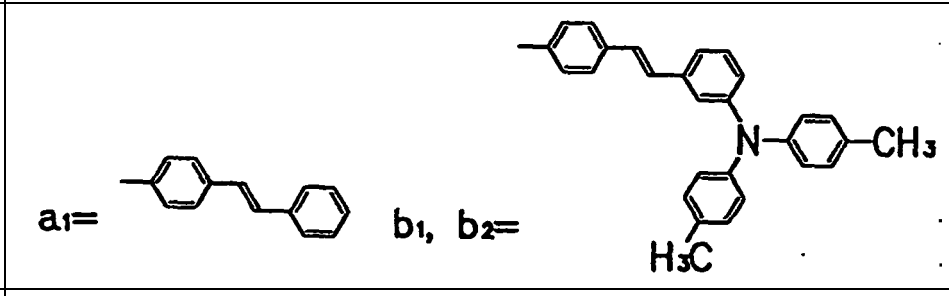
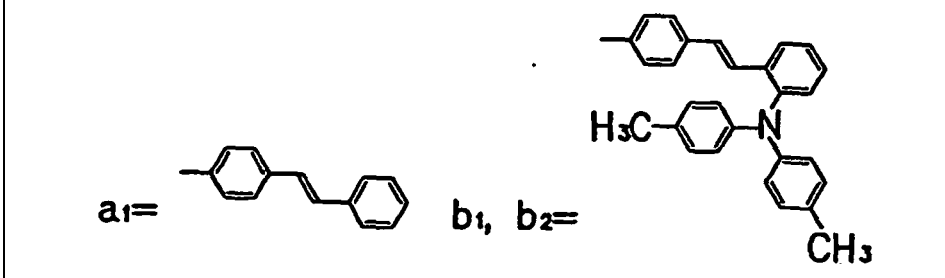
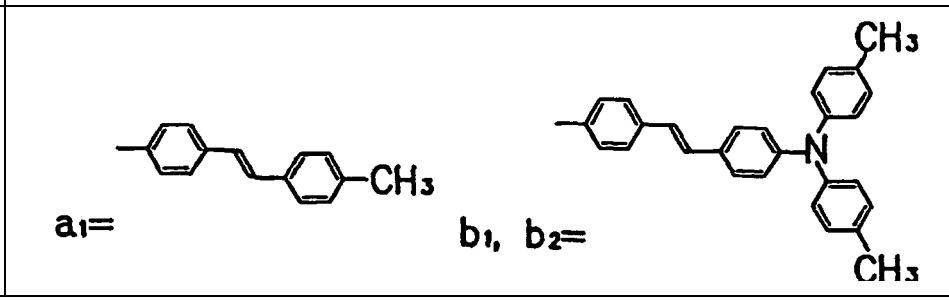
19	
20	
21	
22	
23	
24	

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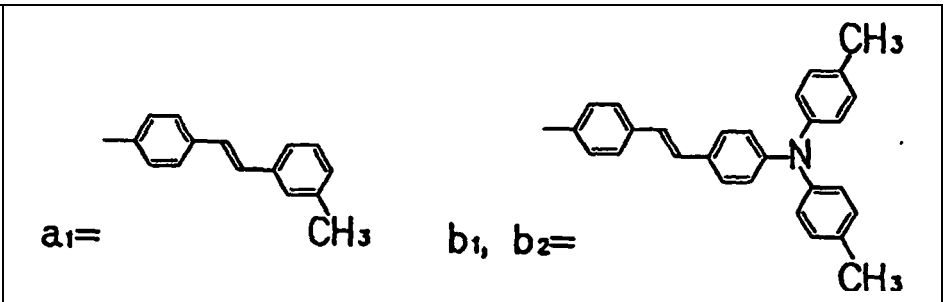
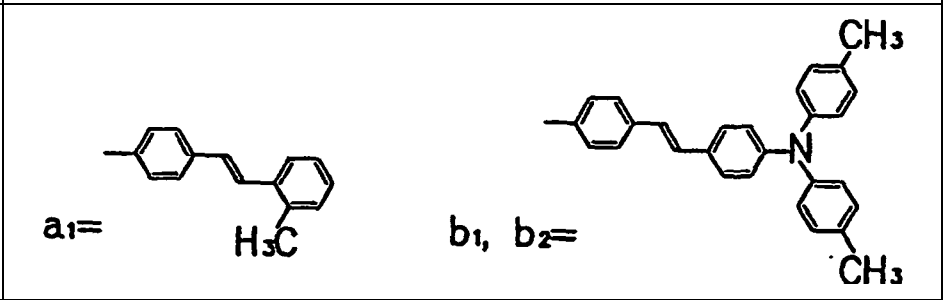
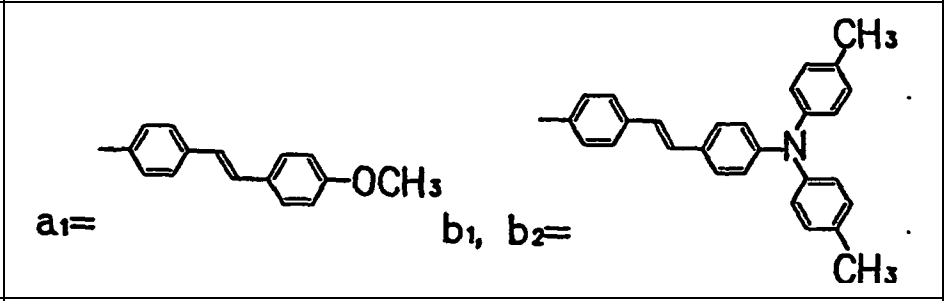
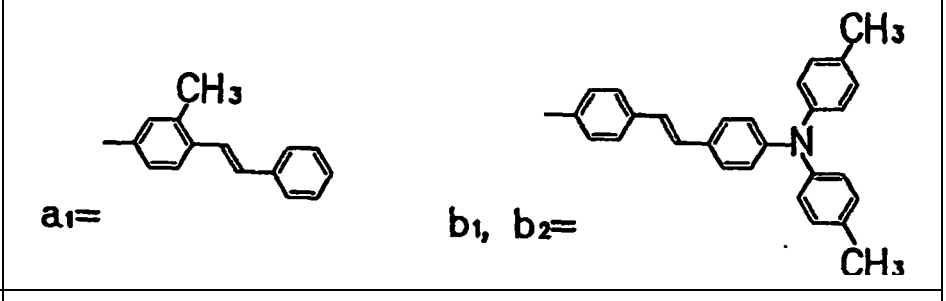
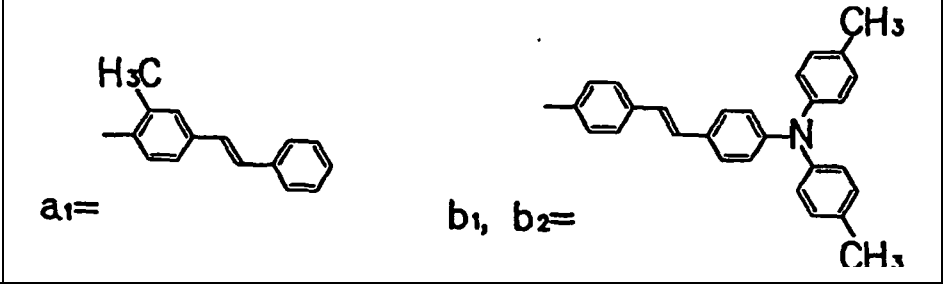
25	
26	
27	
28	
29	

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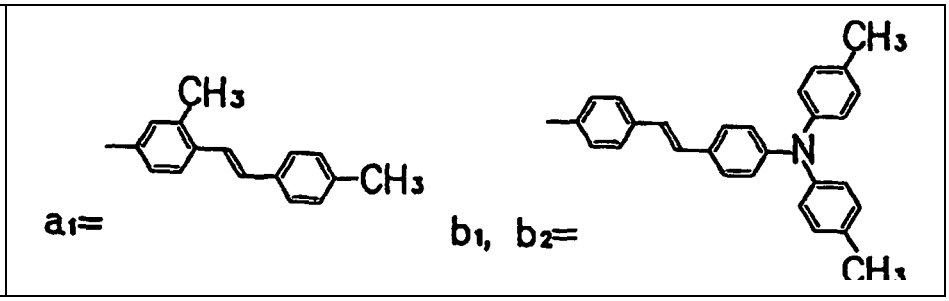
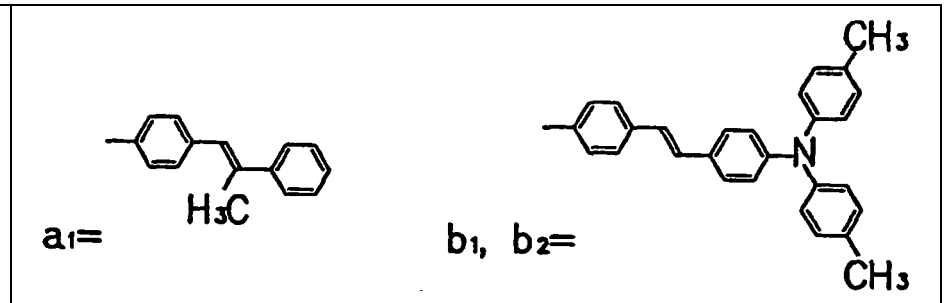
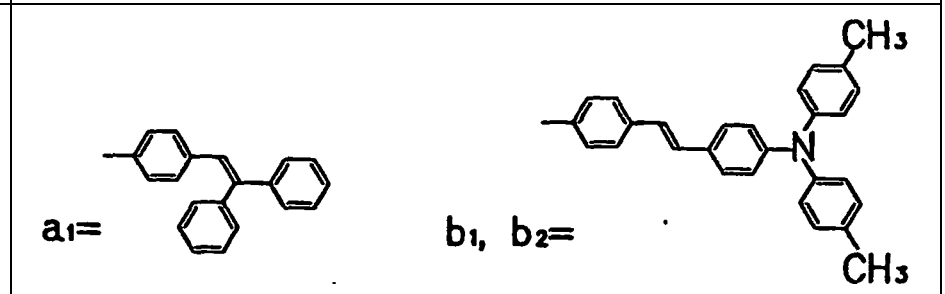
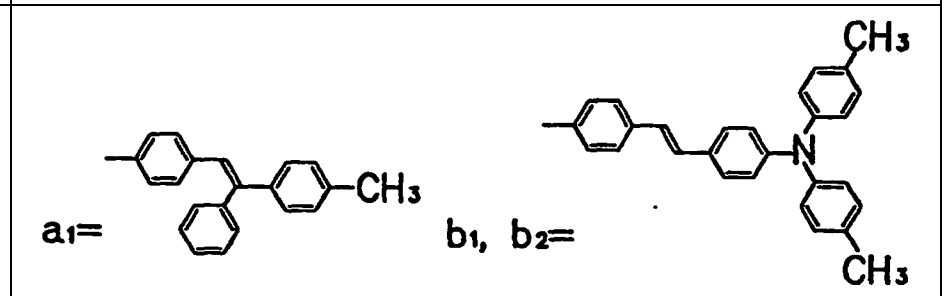
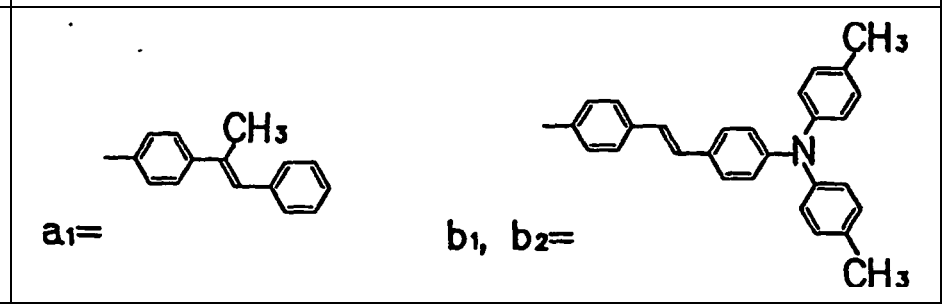
30	

[Table II -6]

31	
32	
33	
34	

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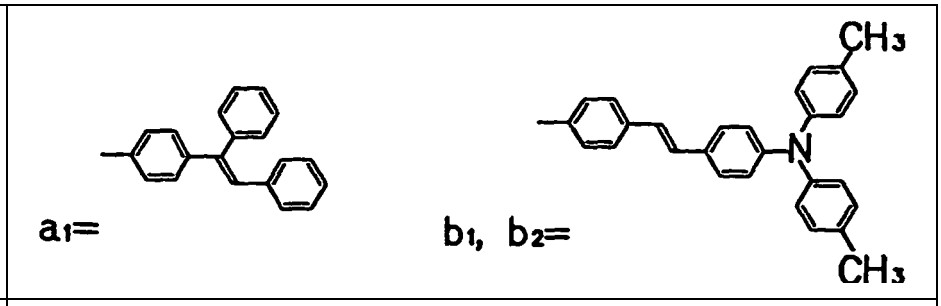
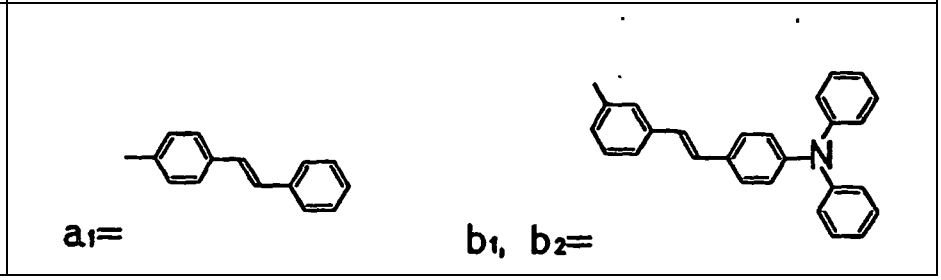
35	
36	

[0053] When the organic EL device of the present invention has the first hole transport layer of anode side containing the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I), and the second hole transport layer of light-emitting layer side containing an aromatic tertiary amine, the aromatic tertiary amine can be a known one. For example, those disclosed by Japanese Patent Publication No. HEI 6-32307, Japanese Patent Laid-Open No. HEI 5-234681, Japanese Patent Publication No. HEI 7-110940, and Japanese Patent Laid-Open Nos. HEI 5-239455 and HEI 6-312982 may be used for the present invention.

[0054] When the organic EL device of the present invention has an anode interface layer in contact with the anode, the anode interface layer may include a known compound. For example, a porphyrin-based compound disclosed by Japanese Patent Publication No. SHO 64-7635 may be used. The other compounds which can be used for the present invention include spiro, perylene, azo, quinone, indigo, polymethine, acridine or quinacridon compounds or the like.

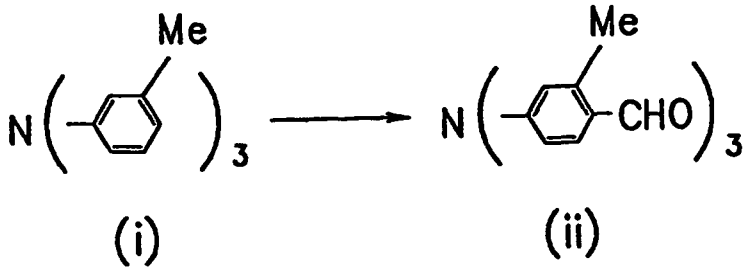
[0055] A known organic fluorescent agent may be used for the EL light-emitting material. For example, those agents useful for the present invention include an anthracene-based compound, to begin with, metal complex of 8-quinolinol (Japanese Patent Laid-Open No. SHO 59-194393), and distyrylarylene derivative (Japanese Patent Laid-Open Nos. HEI 2-247278 and HEI 5-17765),which may be applicable as the light-emitting materials. The light-emitting host may be also doped with an organic fluorescent agent. The light-emitting dopants useful for the present invention include derivatives of cumarin, dicyanomethylenepiran, perylene (Japanese Patent Laid-Open No. SHO 63-264692), and quinacridon (Japanese Patent Laid-Open No. HEI 5-70773). They can be formed into a film by a known film-making method, e.g., vacuum deposition or coating.

[0056] Any layer for the present invention, except that containing the compound shown by the general formula (A-I), (A-III), (A-VI) or (B-I), may have any known composition. The electron transport region may be dispensed with. The materials for the anode and cathode may be selected from known ones.

Examples

[0057] The present invention is described more concretely by Examples.

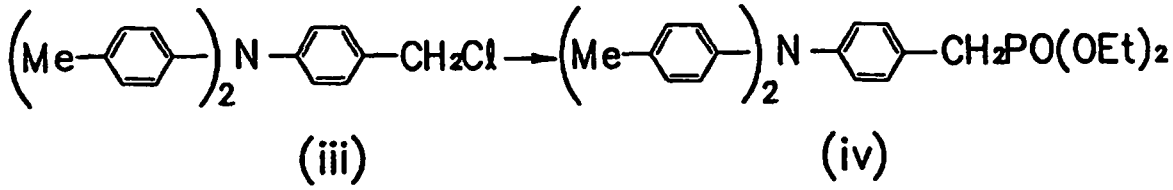
[Synthesis Example 1]



(i) (ii)

[0058] N,N-dimethylformamide and 3,3',3''-trimethyltriphenylamine (shown by the formula (i)) were put in an ice-cooled three-necked flask equipped with a drop funnel, a nitrogen gas leading pipe and a reflux condenser, and stirred in a nitrogen atmosphere, to which phosphorus oxychloride was slowly added dropwise by the drop funnel. On completion of the addition, the temperature of the mixture was raised upto 80° C slowly and kept 80° C for 10 hours with stirring. After on completion of the reactions water was added thereto, the mixture was stirred for 15 min. The mixture was purified by the common method, to obtain 3,3',3''-trimethyl-4,4',4''-triformyltriphenylamine (shown by the formula (ii)).

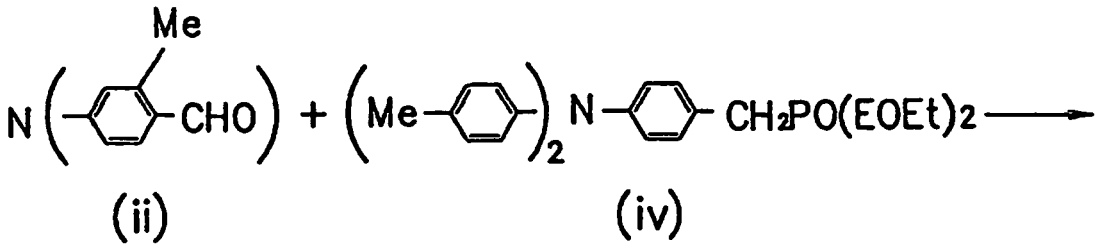
[Formula 16]



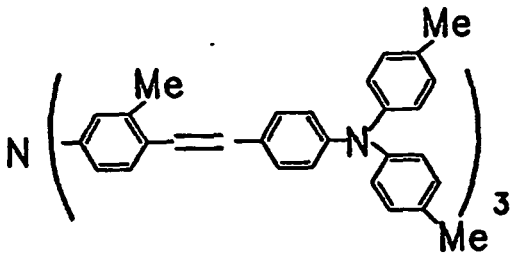
(iii) (iv)

[0059] 4-chloromethyl-4',4''-dimethyltriphenylamine (shown by the formula (iii)) and triethyl phosphite were put in a three-necked flask equipped with a reflux condenser, to which toluene was added and heated with stirring for 8 hours under reflux. The mixture was purified by the common method, to obtain 4-(4',4"-dimethyldiphenylamino)benzyl diethyl phosphonate (shown by the formula (iv)).

[Formula 17]



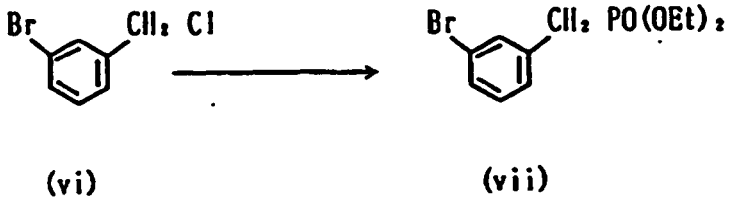
(ii) (iv)



(v)

[0060] 3,3',3"-trimethyl-4,4',4"-triformyltriphenylamine (shown by the formula (ii)) was reacted with 4-(4',4''-dimethyl-diphenylamino)benzyl diethyl phosphonate (shown by the formula (iv))in a solution of N,N-dimethylformamide suspended with hydrogenated sodium at 40°C for 40 hours. The mixture was purified by common method, to obtain 3,3',3"-trimethyl-4,4',4"-tris(4-(N,N-ditolylamino)styryl)triphenylamine (shown by the formula (v)).

[Synthesis Example 2]

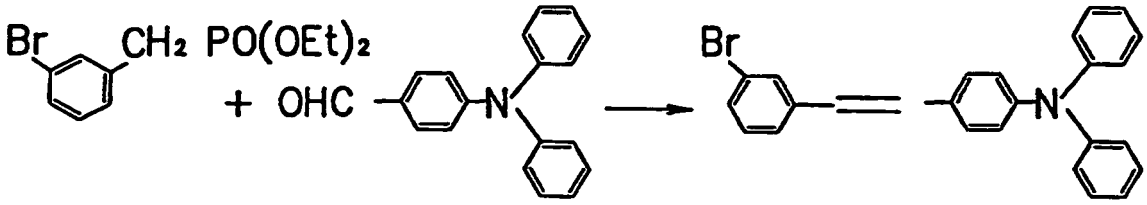


(vi) (vii)

[0061] 3-bromobenzyl chloride shown by the formula (vi) and triethyl phosphite were put in a three-necked flask equipped with a reflux condenser, to which toluene was added and heated with stirring for 8 hours under reflux. The mixture was purified by common method, to obtain diethyl 3-bromobenzylphosphonate shown by the formula (vii).

[0062] Diethyl 3-bromobenzylphosphonate shown by the formula (vii) was reacted with 4-formyltriphenylamine shown by the formula (viii) in a solution of N,N-dimethylformamide suspended with hydrogenated sodium at 40°C for 40 hours. The mixture was purified by the common method, to obtain 4-(3-bromostyryl)triphenylamine shown by the formula (ix).

[Formula 20]



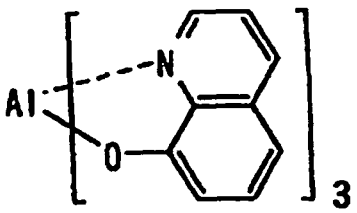
(vii) (viii) (ix)

[0063] 4-(3-bromostyryl)triphenylamine (shown by the formula (ix)) and tetrahydrofuran were put in a three-necked flask equipped with a drop funnel and dryer tube, and stirred. The mixture was cooled to -78°C, to which a hexane solution of butyl lithium was added dropwise by a drop funnel. The temperature of the mixture was kept at -78°C for 1 hour and then raised upto -20°C with stirring. A toluene solution of nitrogen chloride was slowly added dropwise by a drop funnel. On completion of the addition, it was further stirred for two hours. The mixture was purified by common method, to obtain 3,3',3"-tris-(4-diphenylaminostyryl)triphenylamine (shown by the formula (x)).

[Example 1]

[0064] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω/□, by sputtering, the compound 1 shown by Table I-1 to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 60 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio; 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

Compound (a)



[0065] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 203 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 147 cd/m^2 after 1000 hours drive, by which is meant that this organic EL device of the present invention is more durable than those prepared by Comparative Examples 1 and 2.

[Examples 2 to 6]

[0066] The same procedure as used for Example 1 was repeated, except that the material applied to the hole transport layer was replaced by the compound shown by Table I-7, to prepare the organic EL devices. They emitted very bright green color emission from the light-emitting layers of tris-(8-hydroxyquinolinol) aluminum. Brightness of the emitted light, initial and after 1000 hours drive, is given in Table I-7 for each device, at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere.

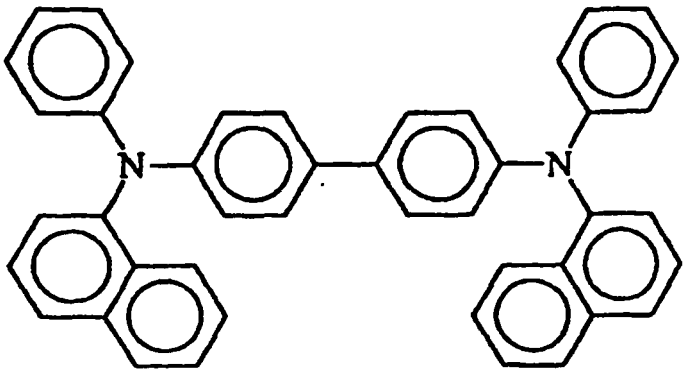
Table I-7

Examples	Hole transport layer	Initial brightness (cd/m^2)	Brightness after 1000 hours drive (cd/m^2)
2	Compound 10 shown by Table I-2	221	150
3	Compound 16 shown by Table I-3	216	179
4	Compound 24 shown by Table I-5	205	151
5	Compound 27 shown by Table I-5	210	161
6	Compound 28 shown by Table I-6	237	177

[Example 7]

[0067] Referring to Fig. 2(b), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □, by sputtering, the compound 1 shown by Table I-1 to a thickness of 40 nm as the first hole transport layer 13a by resistance heating vacuum deposition, compound (b) to a thickness of 20 nm as the second hole transport layer 13b also by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio; 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

Compound (b)



[0068] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 273 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 225 cd/m^2 after 1000 hours drive.

[Examples 8 to 12]

[0069] The same procedure as used for Example 7 was repeated, except that the material applied to the first hole transport layer was replaced by the compound shown by Table I-8, to prepare the organic EL devices. They emitted

very bright green color emission from the light-emitting layers of tris-(8-hydroxyquinolinol) aluminum. Brightness of the emitted light, initial and after 1000 hours drive, is given in Table I-8 for each device, at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere.

Table I-8

Examples	First hole transport layer	Initial brightness (cd/m^2)	Brightness after 1000 hours drive (cd/m^2)
8	Compound 10 shown by Table I-2	291	232
9	Compound 16 shown by Table I-3	253	199
10	Compound 24 shown by Table I-5	256	194
11	Compound 27 shown by Table I-5	280	241
12	Compound 28 shown by Table I-6	266	217

[Example 13]

[0070] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □ , by sputtering. The anode 12 was coated with a solution, which was a mixture of the compound 1 of Table I-1 and polycarbonate (Mitubishi Chemical, Z200) (1:1 by weight) dissolved in tetrahydrofuran at 1.5 wt.%, by dip coating to a thickness of 50 nm, and dried at 80°C for 1 hour, to form the hole transport layer 13. It was then coated with tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio; 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

[0071] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 212 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 180 cd/m^2 after 1000 hours drive.

[Example 14]

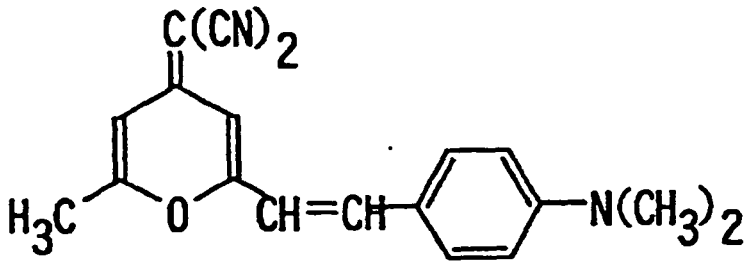
[0072] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □, by sputtering. The anode 12 was coated with the compound 1 of Table I-1 and compound (b) by resistance heating vacuum deposition to a thickness of 50 nm (codeposition at a rate ratio of 7:3), to form the hole transport layer 13. It was then coated with tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio; 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

[0073] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 276 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 212 cd/m^2 after 1000 hours drive.

[Example 15]

[0074] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □, by sputtering, the compound 1 of Table I-1 to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) and DCM (compound (c)) to a thickness of 30 nm as the light-emitting layer 14 also by resistance heating vacuum deposition (codeposition at a rate ratio of 100:2), tris-(8-hydroxyquinolinol) aluminum to a thickness of 30 nm as the electron transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

Compound (c)



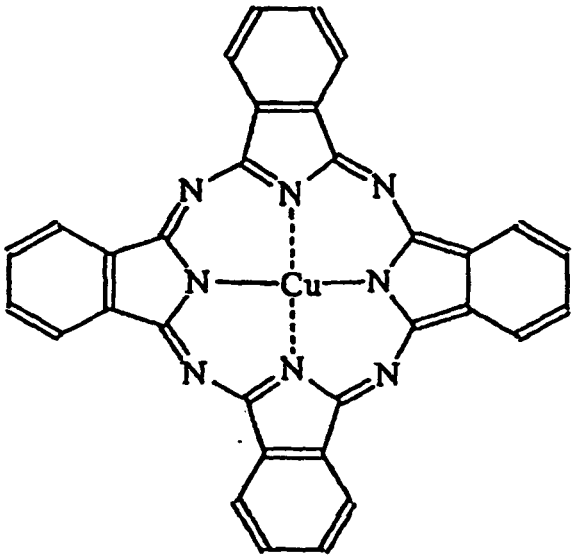
[0075] Very bright orange color planar-emission was performed from the light-emitting layer of DCM. Brightness of the light was 479 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 387 cd/m^2 after 1000 hours drive.

[Example 16]

[0076] Referring to Fig. 4, a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □ , by sputtering, copper phthalocyanine (compound (d)) to a thickness of 10 nm as the anode interface layer 17 by resistance heating vacuum deposition, the compound 1 of Table I-1 to a thickness of 50 nm as the hole transport layer 13 also by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0077] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 223 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 185 cd/m^2 after 1000 hours drive.

Compound (d)



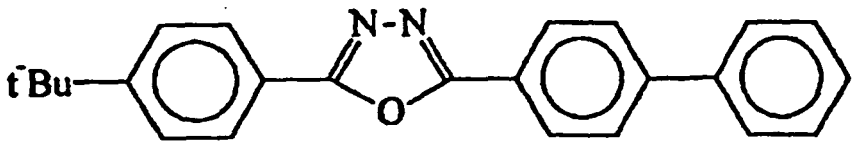
[Example 17]

[0078] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □, by sputtering, the compound (b) to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, compound 1 of Table I-1 to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, t-Bu-PBD (compound (e)) to a thickness of 30 nm as the electron

transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0079] Very bright blue color planar-emission was performed from the light-emitting layer of the compound 1 of TableI-1. Brightness of the light was 711 cd/m^2 at a voltage of 8 V, by which is meant that this device has improved brightness characteristics over the one prepared by Comparative Example 3.

Compound (e)



[Examples 18 to 22]

[0080] The same procedure as used for Example 17 was repeated, except that the material applied to the light-emitting layer was replaced by the compound shown by Table I-9, to prepare the organic EL devices. They emitted very bright emission from the light-emitting layers. Brightness of the emitted light at a voltage of 8 V is given in Table I-9 for each device.

Table I-9

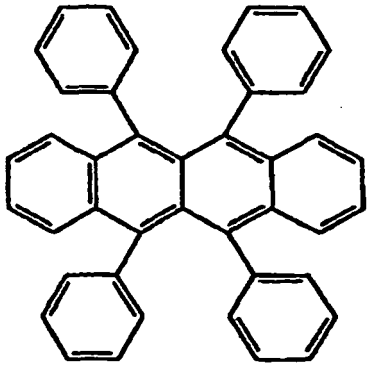
Examples	Light-emitting layer	Brightness at 8 V (cd/m^2)
18	Compound 10 shown by Table I-2	808
19	Compound 16 shown by Table I-3	537
20	Compound 24 shown by Table I-5	726
21	Compound 27 shown by Table I-5	652
22	Compound 28 of Table I-6	616

[Example 23]

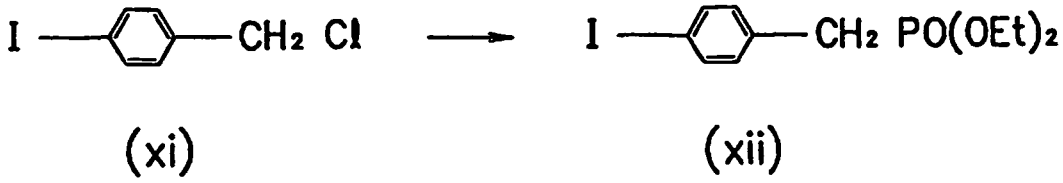
[0081] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □ , by sputtering, and the compound (b) to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, in this order. The hole transport layer 13 was coated with the compound 1 of Table I-1 and rubrene (compound (f)) to a thickness of 50 nm also by resistance heating vacuum deposition (codeposition at a rate ratio of 100:2), to form the light-emitting layer 14. It was then coated with t-Bu-PBD (compound (e)) to a thickness of 30 nm as the electron transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0082] It emitted very bright yellow color emission from the light-emitting layer of the compound (f). Brightness of the light was 1835 cd/m^2 at a voltage of 8 V.

Compound (f)

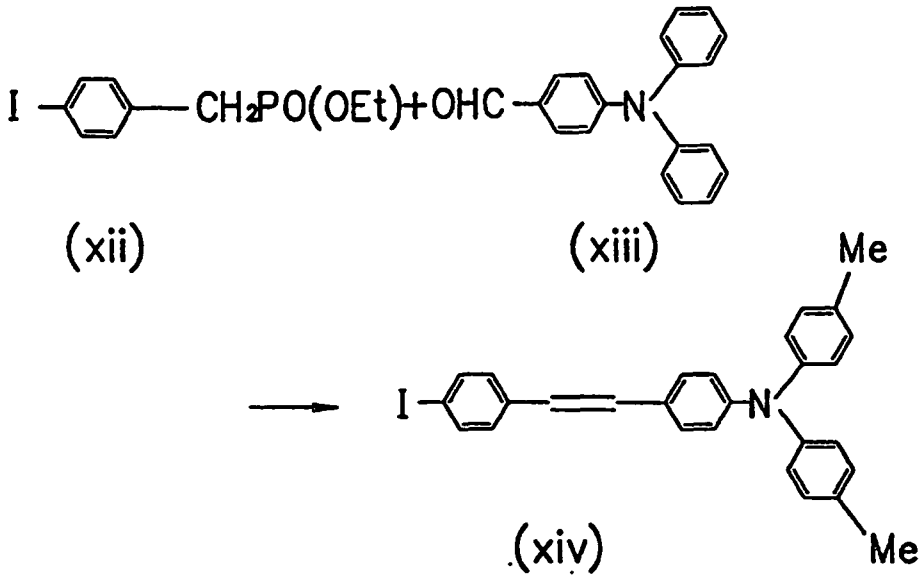


[Synthesis Example 3]



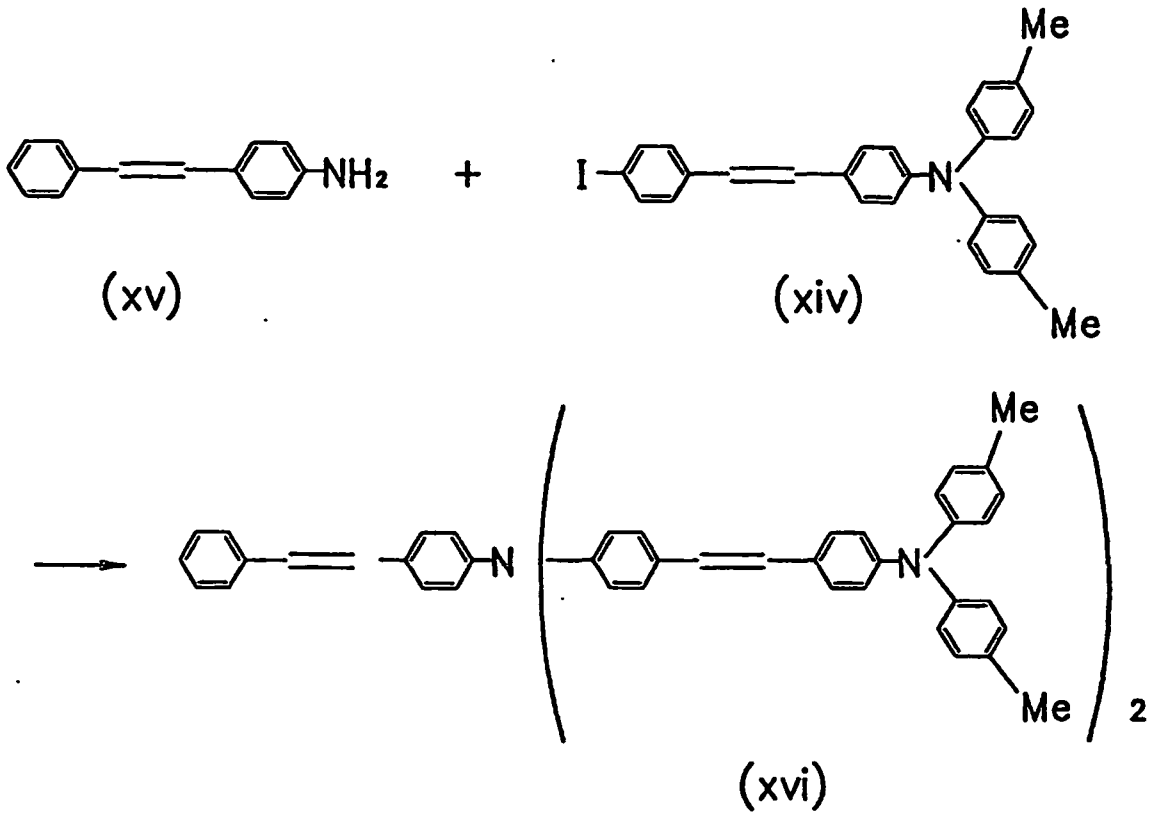
(xi) (xii)

[0083] 4-iodobenzyl chloride and triethyl phosphite were put in a three-necked flask equipped with a reflux condenser, to which toluene was added and heated with stirring for 8 hours under reflux. The mixture was purified by the common method, to obtain diethyl 4-iodobenzylphosphonate.



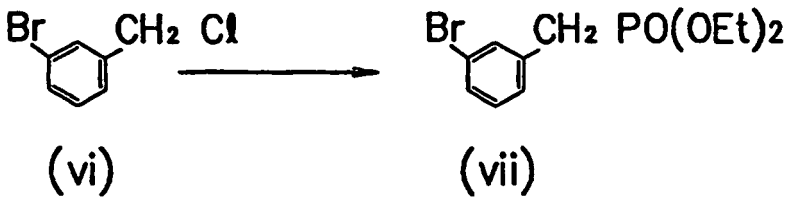
(xii) (xiii) (xiv)

[0084] Diethyl 4-iodobenzylphosphonate (shown by the formula (xii)) was reacted with 4-formyl-4',4''-dimethyltriphenylamine (shown by the formula (viii)) in a solution of N,N-dimethylformamide suspended with hydrogenated sodium at 40°C for 40 hours. The mixture was purified by the common method, to obtain 4-(4-iodostyryl)-4',4''-dimethyltriphenylamine (shown by the formula (xiv)).

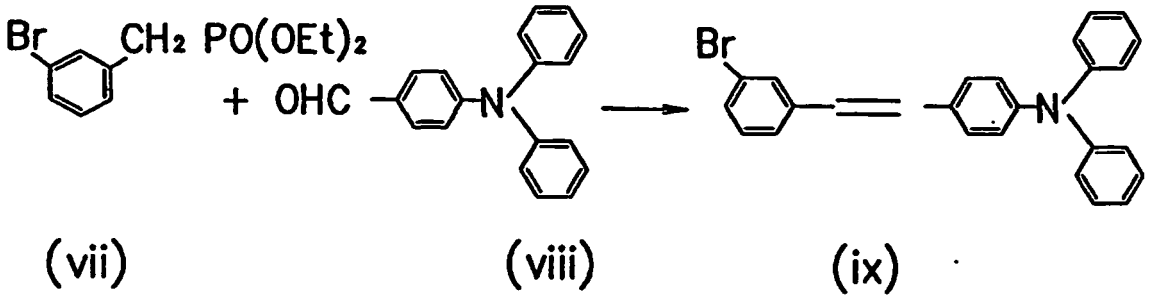


[0085] 4-styrylaniline (shown by the formula (xv)), 4-(4-iodostyryl)-4',4''-dimethyltriphenylamine (shown by the formula (xiv)), copper powder and potassium carbonate were added to nitrobenzene, and they were allowed to react with one another at 200°C for 40 hours. The mixture was purified by the common method, to obtain 4-styryl-4',4''-bis(4-(N,N-ditolylamino)styryl)triphenylamine (shown by the formula (xvi)).

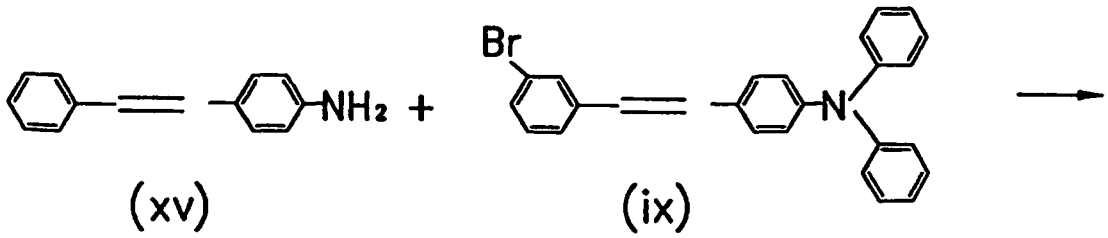
[Synthesis Example 4]



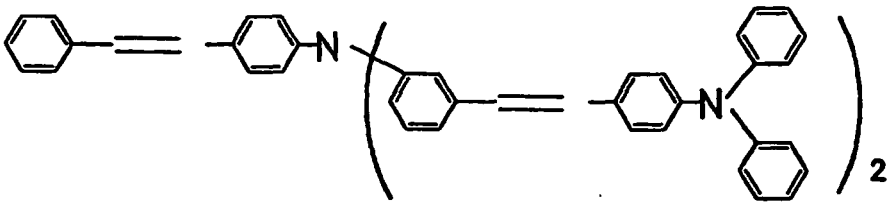
[0086] 3-bromobenzyl chloride (shown by the formula (vi)) and triethyl phosphite were put in a three-necked flask equipped with a reflux condenser, to which toluene was added and heated with stirring for 8 hours under reflux. The mixture was purified by the common method, to obtain diethyl 3-bromobenzylphosphonate (shown by the formula (vii)).



[0087] Diethyl 3-bromobenzylphosphonate (shown by the formula (vii)) was reacted with 4-formyltriphenylamine (shown by the formula (viii)) in a solution of N,N-dimethylformamide suspended with hydrogenated sodium at 40°C for 40 hours. The mixture was purified by common method, to obtain 4-(3-bromostyryl)triphenylamine (shown by the formula (ix)).



(xv) (ix)



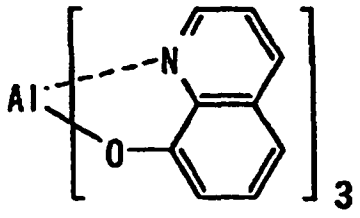
(xvii)

[0088] 4-styrylaniline (shown by the formula (xv)), 4-(3-bromostyryl)triphenylamine (shown by the formula (ix)), copper powder and potassium carbonate were added to nitrobenzene, and they were allowed to react with one another at 200°C for 40 hours. The mixture was purified by common method, to obtain 4-styryl-3',3''-bis-(4-diphenylaminostyryl)triphenylamine (shown by the formula (xvii)).

[Example 24]

[0089] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □, by sputtering, the compound 1 shown by Table II -1 to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 60 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio; 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

Compound (a)



[0090] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 241 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 160 cd/m^2 after 1000 hours drive, by which is meant that this organic EL device of the present invention is more durable than those prepared by Comparative Examples 1 and 2.

[Examples 25 to 29]

[0091] The same procedure as used for Example 24 was repeated, except that the material applied to the hole transport layer was replaced by the compound shown by Table II -7, to prepare the organic EL devices. They emitted very bright green color emission from the light-emitting layers of tris-(8-hydroxyquinolinol) aluminum. Brightness of the emitted light, initial and after 1000 hours drive, is given in Table II -7 for each device, at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere.

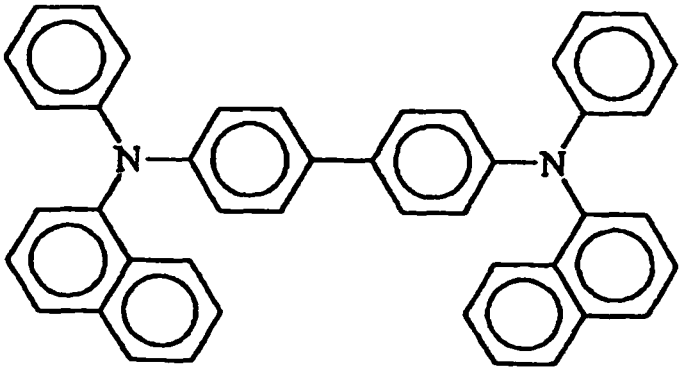
Table II -7

Examples	Hole transport layer	Initial brightness (cd/m^2)	Brightness after 1000 hours drive (cd/m^2)
25	Compound 3 shown by Table II-1	232	166
26	Compound 11 shown by Table II-2	237	175
27	Compound 24 shown by Table II-4	254	192
28	Compound 32 shown by Table II-5	261	190
29	Compound 36 shown by Table II-5	225	169

[Example 30]

[0092] Referring to Fig. 2(b), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □, by sputtering, the compound 1 of Table II-1 to a thickness of 40 nm as the first hole transport layer 13a by resistance heating vacuum deposition, compound (b) to a thickness of 20 nm as the second hole transport layer 13b also by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

Compound (b)



[0093] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 294 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 231 cd/m^2 after 1000 hours drive.

[Examples 31 to 35]

[0094] The same procedure as used for Example 30 was repeated, except that the material applied to the first hole transport layer was replaced by the compound shown by Table II -8, to prepare the organic EL devices. They emitted very bright green color emission from the light-emitting layers of tris-(8-hydroxyquinolinol) aluminum. Brightness of the

emitted light, initial and after 1000 hours drive, is given in Table II -8 for each device, at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere.

Table II-8

Examples	First hole transport layer	Initial brightness (cd/m^2)	Brightness after 1000 hours drive (cd/m^2)
8	Compound 3 shown by Table II-1	270	219
9	Compound 11 shown by Table II-2	279	238
10	Compound 24 shown by Table II-4	299	255
11	Compound 32 shown by Table II-6	303	247
12	Compound 36 shown by Table II-6	273	231

[Example 36]

[0095] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20Ω/□, by sputtering. The anode 12 was coated with a solution, which was a mixture of the compound 1 of Table II -1 and polycarbonate (Mitubishi Chemical, Z200) (1:1 by weight) dissolved in tetrahydrofuran at 1.5 wt.%, by dip coating to a thickness of 50 nm, and dried at 80°C for 1 hour, to form the hole transport layer 13. It was then coated with tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

[0096] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 222 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 175 cd/m^2 after 1000 hours drive.

[Example 37]

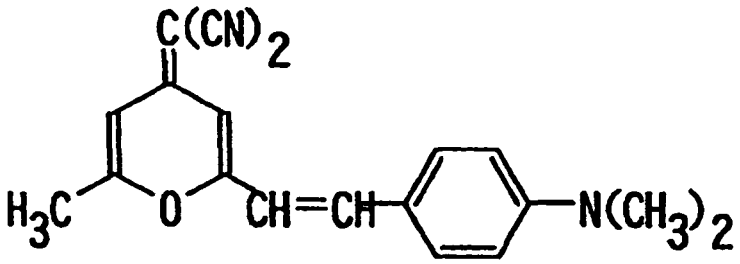
[0097] Referring to Fig. 2(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / Ω, by sputtering. The anode 12 was coated with the compound 1 of Table II -1 and compound (b) by resistance heating vacuum deposition to a thickness of 50 nm (codeposition at a rate ratio of 7:3), to form the hole transport layer 13. It was then coated with tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition.

[0098] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 262 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 206 cd/m^2 after 1000 hours drive.

[Example 38]

[0099] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □ , by sputtering, the compound 1 shown by Table II -1 to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) and DCM (compound (c)) to a thickness of 30 nm as the light-emitting layer 14 also by resistance heating vacuum deposition (codeposition at a rate ratio of 100:2), tris-(8-hydroxyquinolinol) aluminum to a thickness of 30 nm as the electron transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

Compound (c)



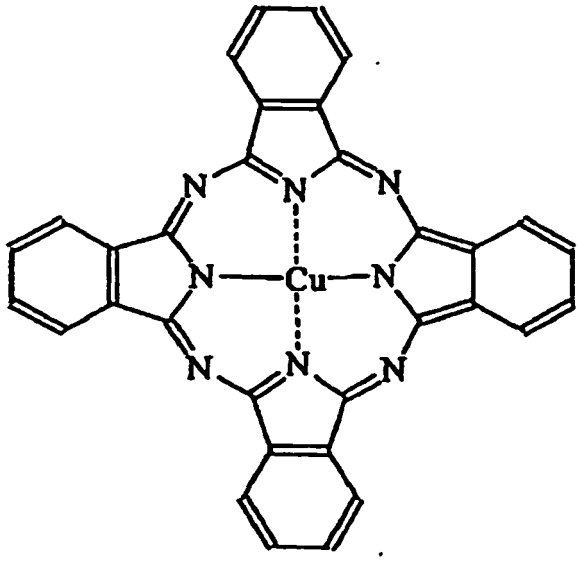
[0100] Very bright orange color planar-emission was performed from the light-emitting layer of DCM. Brightness of the light was 456 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 324 cd/m^2 after 1000 hours drive.

[Example 39]

[0101] Referring to Fig. 4, a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω / □, by sputtering, copper phthalocyanine (compound d) to a thickness of 10 nm as the anode interface layer 17 by resistance heating vacuum deposition, the compound 1 of Table II-1 to a thickness of 50 nm as the hole transport layer 13 also by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 50 nm as the light-emitting layer 14 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0102] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 252 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 201 cd/m^2 after 1000 hours drive.

Compound (d)



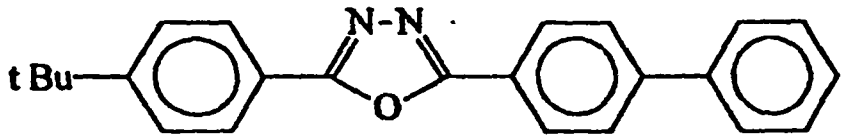
[Example 40]

[0103] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO (indium tin oxide) as the anode 12, having a resistivity of 20 Ω/□, by sputtering, the compound (b) to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, compound 1 of Table II -1 to a thickness of 50 nm as the light-emitting

layer 14 also by resistance heating vacuum deposition, t-Bu-PBD (compound (e)) to a thickness of 30 nm as the electron transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0104] Very bright blue color planar-emission was performed from the light-emitting layer of the compound 1 shown by Table II -1. Brightness of the light was 903 cd/m^2 at a voltage of 8 V, by which is meant that this device has improved brightness characteristics over the one prepared by Comparative Example 3.

Compound (e)



[Examples 41 to 45]

[0105] The same procedure as used for Example 40 was repeated, except that the material applied to the light-emitting layer was replaced by the compound shown by Table II -9, to prepare the organic EL devices. They emitted very bright emission from the light-emitting layers. Brightness of the emitted light at a voltage of 8 V is given in Table II -9 for each device.

Table II-9

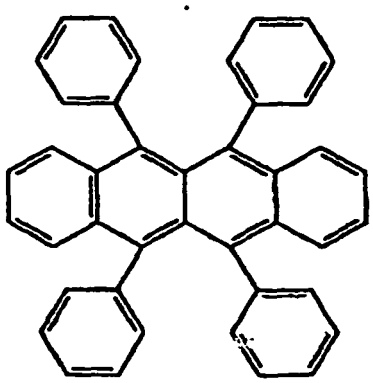
Examples	Light-emitting layer	Brightness at 8 V (cd/m^2)
18	Compound 3 shown by Table II-1	584
19	Compound 11 shown by Table II-2	885
20	Compound 24 shown by Table II-4	967
21	Compound 32 shown by Table II-6	1002
22	Compound 36 shown by Table II-6	627

[Example 46]

[0106] Referring to Fig. 1(a), a glass substrate 11 was coated with a thin film of ITO as the anode 12, having a resistivity of 20 Ω / □, by sputtering, and the compound (b) to a thickness of 50 nm as the hole transport layer 13 by resistance heating vacuum deposition, in this order. The hole transport layer 13 was coated with the compound 1 shown by Table II -1 and rubrene (compound (f)) to a thickness of 50 nm also by resistance heating vacuum deposition (codeposition at a rate ratio of 100:2), to form the light-emitting layer 14. It was then coated with t-Bu-PBD (compound (e)) to a thickness of 30 nm as the electron transport layer 15 also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode 16 also by resistance heating vacuum deposition, in this order.

[0107] Very bright yellow color planar-emission was performed from the light-emitting layer of the compound (f). Brightness of the light was 2310 cd/m^2 at a voltage of 8 V.

Compound (f)



[Comparative Example 1]

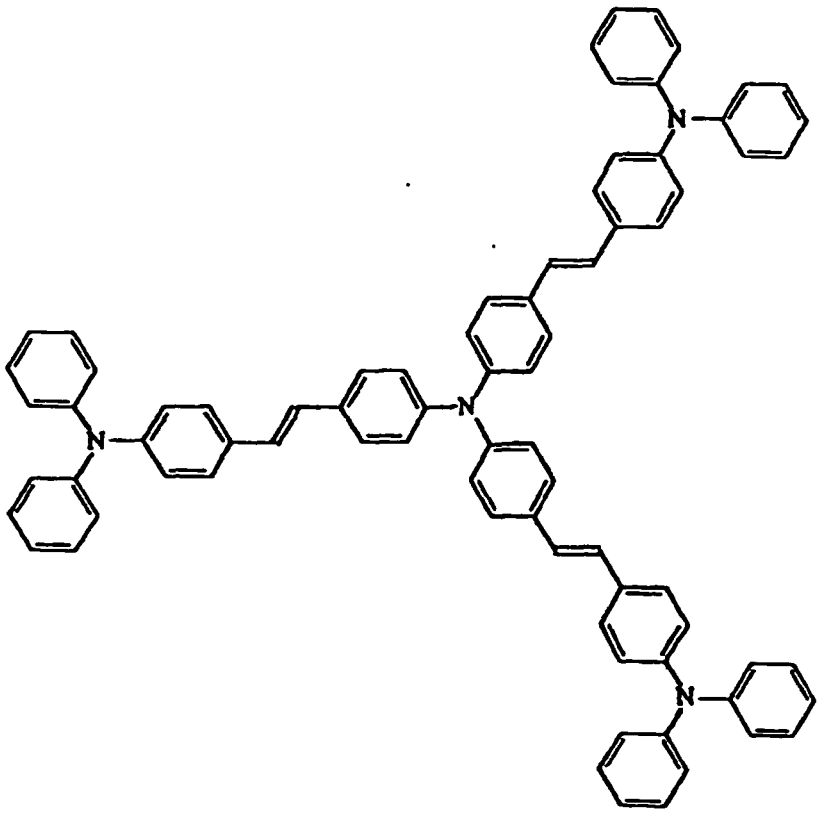
[0108] A glass substrate was coated with a thin film of ITO (indium tin oxide) as the anode, having a resistivity of 20 Ω / □ , N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine to a thickness of 50 nm as the hole transport layer, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 60 nm as the light-emitting layer by vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode also by vacuum deposition, in this order.

[0109] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 212 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, but declined to 51 cd/m^2 after 630 hours drive, at which it was broken.

[Comparative Example 2]

[0110] A glass substrate was coated with a thin film of ITO (indium tin oxide) as the anode, having a resistivity of 20 Ω / □ , by sputtering, the compound (g) to a thickness of 50 nm as the hole transport layer by resistance heating vacuum deposition, tris-(8-hydroxyquinolinol) aluminum (compound (a)) to a thickness of 60 nm as the light-emitting layer also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode also by resistance heating vacuum deposition, in this order.

Compound (g)



[0111] Very bright green color planar-emission was performed from the light-emitting layer of tris-(8-hydroxyquinolinol) aluminum. Brightness of the light was 223 cd/m^2 initially at a constant current density of 10 mA/cm^2 in a dried nitrogen atmosphere, and 125 cd/m^2 after 1000 hours drive.

[Comparative Example 3]

[0112] A glass substrate was coated with a thin film of ITO (indium tin oxide) as the anode, having a resistivity of 20 Ω / □ , by sputtering, the compound (b) to a thickness of 50 nm as the hole transport layer by resistance heating vacuum deposition, compound (g) to a thickness of 50 nm as the light-emitting layer also by resistance heating vacuum deposition, t-Bu-PBD (compound (e)) to a thickness of 30 nm as the electron transport layer also by resistance heating vacuum deposition, and finally MgAg (deposition rate ratio: 10:1) to a thickness of 150 nm as the cathode also by resistance heating vacuum deposition, in this order.

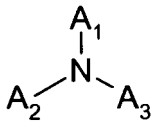
[0113] Blue color plane-emission was performed from the light-emitting layer of the compound g. Brightness of the light was 184 cd/m^2 at a voltage of 8 V.

[0114] As described above, the present invention provides a durable, organic EL device emitting light of high brightness. Therefore, the present invention can provide an excellent EL material and EL device for full-color EL displays.

Claims

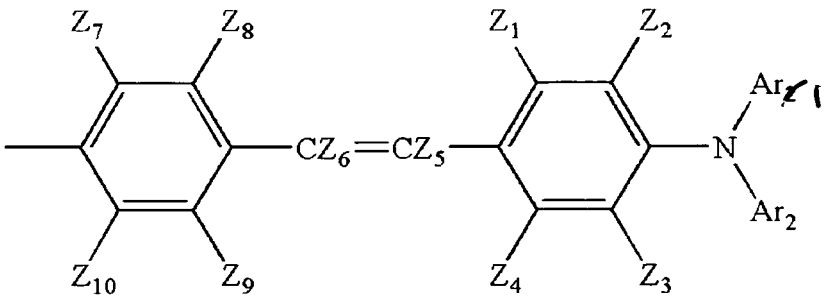
1. An organic electroluminescence material, **characterized by**

(i) containing a compound shown by the following general formula (A-I)



(A-I)

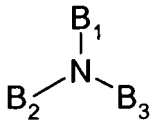
wherein A_1 to A_3 are independently, each a substituent shown by the general formula (A-II), which may be the same or different:



(A-II)

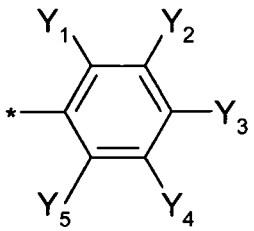
wherein, at least one of Z_1 to Z_4 and Z_7 to Z_{10} are independently, each a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl except styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group, and the others being a hydrogen atom;
Z_1 and Z_2, Z_3 and Z_4 and Z_7 to Z_{10} may from a ring by two adjacent atoms or groups;
Z_5 and Z_6 are independently, each a hydrogen atom or alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, or aromatic heterocyclic or substituted aromatic heterocyclic group; and
Ar_1 and Ar_2 are independently each an aryl group which may be substituted; or

(ii) containing a compound shown by the following general formula (A-III):



(A-III)

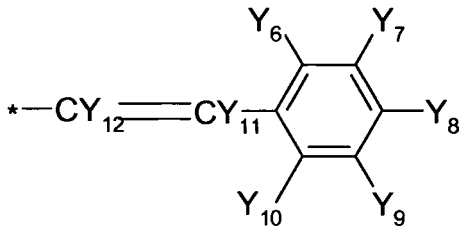
wherein B_1 to B_3 are independently, each a substituent shown by the general formula (A-IV), which may be the same or different:



(A-IV)

wherein, at least one of Y_1 to Y_5 is a substituent shown by the general formula (A-V), the others being independently each a hydrogen atom, a halogen atom, or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl other than styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy,

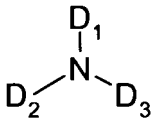
alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group; and
Y_1 to Y_5 may from a ring by two adjacent atoms or groups;



(A-V)

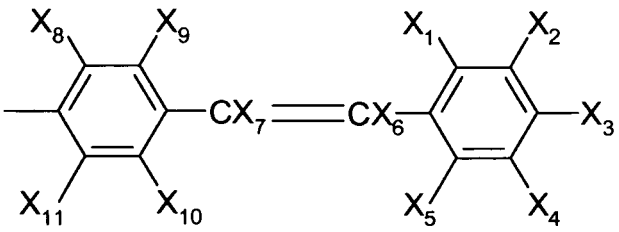
wherein, at least one of Y_6 to Y_{10} is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl other than styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group;
Y_6 to Y_{10} may form a ring by two adjacent atoms or groups;
Ar_1 and Ar_2 are independently each an aryl group which may be substituted; and
Y_{11} and Y_{12} are independently, each a hydrogen atom or alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic;
excluding the compounds where the substituent shown in general Formula (A-V) is at the site of Y_3 and, at the same time, the substituent shown by formula $-NAr_1Ar_2$ is at the site of Y_8; or

(iii) containing a compound shown by the following general formula (A-VI)



(A-VI)

wherein D_1 to D_3 are independently, each a substituent shown by the general formula (A-VII):

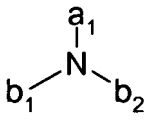


(A-VII)

wherein, at least one of X_1 to X_5 is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl other than styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group;
X_1 to X_5 may from a ring by two adjacent atoms or groups;
Ar_1 and Ar_2 are independently, each an aryl group which may be substituted;
X_6 and X_7 are independently, each an alkyl group having 2 or more carbons, aromatic hydrocarbon group or aromatic heterocyclic group, all of which may be substituted; and
X_8 to X_{11} are independently each a hydrogen atom, a halogen atom or hydroxyl, amino or substituted amino, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl except styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aro-

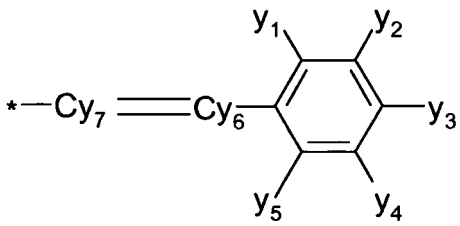
matic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group and X_8 to X_{11} may from a ring by two adjacent atoms or groups; or

(iv) containing a compound shown by the following general formula (B-I)



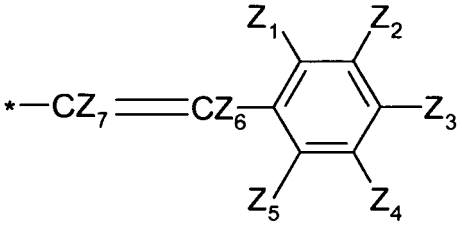
(B-I)

wherein, a_1, b_1 and b_2 are independently, each an aryl group which is substituted, a_1 having at least one substituent shown by the general formula (B-II), each of b_1 and b_2 having at least one substituent shown by the general formula (B-III), and b_1 and b_2 may be the same or different:



(B-II)

wherein, y_1 to y_5 are independently, each a hydrogen atom, a halogen atom or hydroxyl, nitro, cyano, alkyl or substituted alkyl, alkenyl or substituted alkenyl except styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group; and
y_1 to y_5 may form a ring by two adjacent atoms or groups;
y_6 and y_7 are independently, each a hydrogen atom, alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic group;



(B-III)

wherein, at least one of Z_1 to Z_5 is a substituent shown by the formula $-NAr_1Ar_2$, the others being independently, each a hydrogen atom, a halogen atom or hydroxyl, nitro, cyano, alkyl or substituted alkyl alkenyl or substituted alkenyl except styryl, cycloalkyl or substituted cycloalkyl, alkoxy or substituted alkoxy, aromatic hydrocarbon or substituted aromatic hydrocarbon, aromatic heterocyclic or substituted aromatic heterocyclic, aralkyl or substituted aralkyl, aryloxy or substituted aryloxy, alkoxy carbonyl or substituted alkoxy carbonyl or carboxyl group; and
Z_1 to Z_4 may form a ring by two adjacent atoms or groups;
Ar_1 and Ar_2 are independently, each an aryl group which may be substituted; and
Z_6 and Z_7 are independently, each a hydrogen atom or alkyl or substituted alkyl, aromatic hydrocarbon or substituted aromatic hydrocarbon, or aromatic heterocyclic or substituted aromatic heterocyclic group.

2. An organic electroluminescence device comprising one or more layers of organic thin films put between the anode and cathode, wherein at least one of said layers is composed of at least one of the organic electroluminescence materials according to claim 1.

3. The organic electroluminescence device of claim 2, wherein at least one of said layers has a thickness of 2 to 500 nm.

4. The organic electroluminescence device of any of claims 2 or 3, wherein the layers include a hole transport layer, a light-emitting layer and an electron transport layer and wherein one of these layers is composed of at least one of the organic electroluminescence materials according to claim 1.

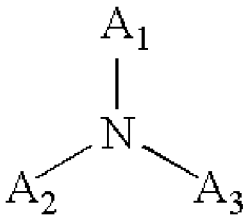
5. The organic electroluminescence device of claim 4, wherein said light-emitting layer is doped with an organic luminescent agent as a dopant.

6. A composition comprising the organic electroluminescence material of claim 1 dispersed in a polymer binder.

Patentansprüche

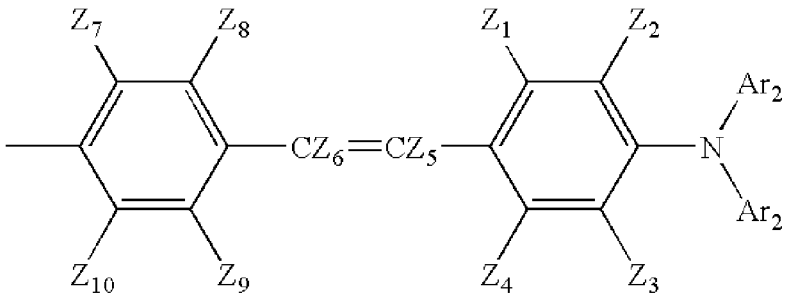
1. Organisches Elektrolumineszenzmaterial, **gekennzeichnet durch**

(i) Enthalten einer Verbindung, die **durch** die folgende allgemeine Formel (A-I) dargestellt ist:



(A-I)

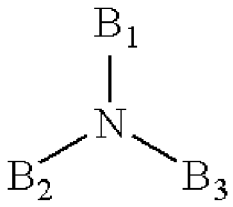
wobei A_1 bis A_3 unabhängig voneinander jeweils ein **durch** die allgemeine Formel (A-II) dargestellter Substituent sind, wobei sie gleich oder verschieden sein können:



(A-II)

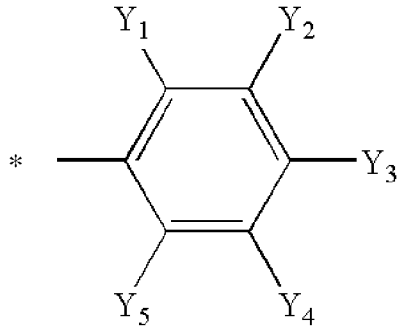
wobei zumindest eines von Z_1 bis Z_4 und Z_7 bis Z_{10} unabhängig voneinander jeweils ein Halogenatom oder eine Hydroxy-, Amino- oder substituierte Amino-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenyl- außer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe ist; und die anderen ein Wasserstoffatom sind;
Z_1 und Z_2, Z_3 und Z_4 und Z_7 bis Z_{10} einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können;
Z_5 und Z_6 unabhängig voneinander jeweils ein Wasserstoffatom oder eine Alkyl- oder substituierte Alkyl-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff- oder aromatische heterocyclische oder substituierte aromatische heterocyclische Gruppe sind; und
Ar_1 und Ar_2 unabhängig voneinander jeweils eine Arylgruppe, die substituiert werden kann, sind; oder

(ii) Enthalten einer Verbindung, die **durch** die folgende allgemeine Formel (A-III) dargestellt ist



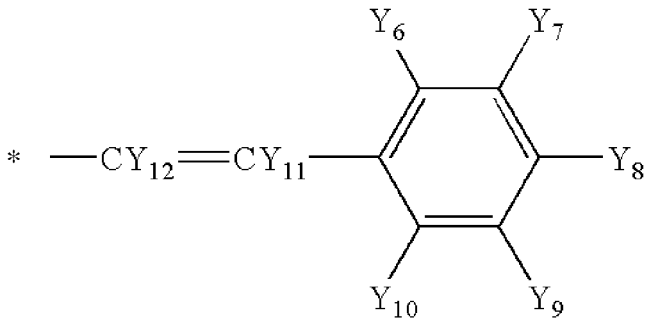
(A-III)

wobei B_1 bis B_3 unabhängig voneinander jeweils ein **durch** die allgemeine Formel (A-IV) dargestellter Substituent sind, wobei sie gleich oder verschieden sein können:



(A-IV)

wobei zumindest eines von Y_1 bis Y_5 ein Substituent ist, der **durch** die allgemeine Formel (A-V) dargestellt ist, während die anderen unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Amino- oder substituierte Amino-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenyl- außer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe sind; und
Y_1 bis Y_5 einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können;

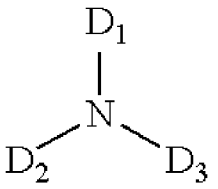


(A-V)

wobei zumindest eines von Y_6 bis Y_{10} ein Substituent ist, der **durch** die Formel $-NAr_1Ar_2$ dargestellt ist, während die anderen unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Amino- oder substituierte Amino-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenyl- außer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkocycarbonyl- oder Carboxylgruppe sind;
Y_6 bis Y_{10} einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können;
Ar_1 und Ar_2 unabhängig voneinander jeweils eine Arylgruppe, die substituiert werden kann, sind; und
Y_{11} und Y_{12} unabhängig voneinander jeweils ein Wasserstoffatom oder eine Alkyl- oder substituierte Alkyl-,

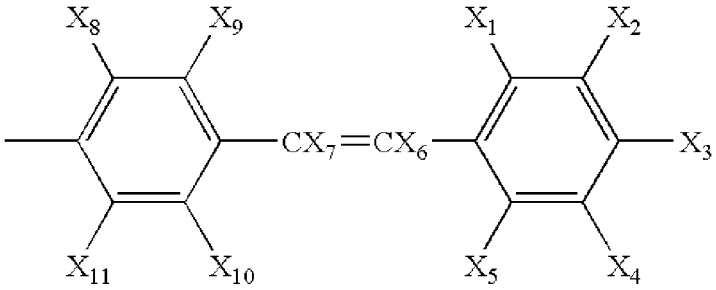
aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische Gruppe sind, mit Ausnahme der Verbindungen, bei denen der in der allgemeinen Formel (A-V) dargestellte Substituent an der Stelle von Y_3 ist und zugleich der **durch** die Formel $-NAr_1Ar_2$ dargestellte Substituent an der Stelle von Y_8 ist; oder

(iii) Enthalten einer Verbindung, die **durch** die folgende allgemeine Formel (A-VI) dargestellt ist



(A-VI)

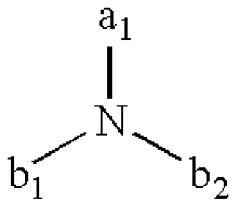
wobei D_1 bis D_3 unabhängig voneinander jeweils ein **durch** die allgemeine Formel (A-VII) dargestellter Substituent sind:



(A-VII)

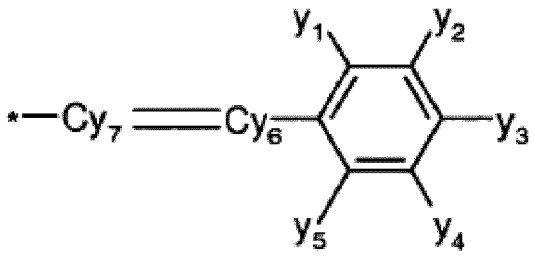
wobei zumindest eines von X_1 bis X_5 ein Substituent ist, der **durch** die Formel $-Nar_1Ar_2$ dargestellt ist, während die anderen unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Amino- oder substituierte Amino-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenyl- außer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe sind;
X_1 bis X_5 einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können;
Ar_1 und Ar_2 unabhängig voneinander jeweils eine Arylgruppe, die substituiert werden kann, sind;
X_6 und X_7 unabhängig voneinander jeweils eine Alkylgruppe, die zwei oder mehr Kohlenstoffe aufweist, eine aromatische Kohlenwasserstoffgruppe oder aromatische heterocyclische Gruppe sind, von denen alle substituiert werden können; und
X_8 bis X_{11} unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Amino- oder substituierte Amino-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenylaußer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe sind, und X_8 bis X_{11} einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können; oder

(iv) Enthalten einer Verbindung, die **durch** die folgende allgemeine Formel (B-I) dargestellt ist



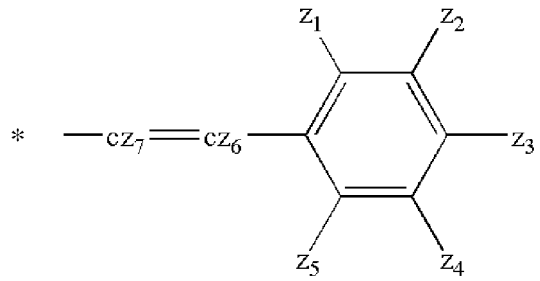
(B-I)

wobei a_1, b_1 und b_2 unabhängig voneinander jeweils eine Arylgruppe, die substituiert ist, sind, wobei a_1 zumindest einen **durch** die allgemeine Formel (B-II) dargestellten Substituenten aufweist, wobei b_1 und b_2 jeweils zumindest einen durch die allgemeine Formel (B-III) dargestellten Substituenten aufweisen, und wobei b_1 und b_2 gleich oder verschieden sein können:



(B-II)

wobei y_1 bis y_5 unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenyl- außer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituierte Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe sind; und
y_1 bis y_5 einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können; y_6 und y_7 unabhängig voneinander jeweils ein Wasserstoffatom, eine Alkyl- oder substituierte Alkyl-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische Gruppe sind;



(B-III)

wobei zumindest eines von Z_1 bis Z_5 ein Substituent ist, der **durch** die Formel $-Nar_1Ar_2$ dargestellt ist, während die anderen unabhängig voneinander jeweils ein Wasserstoffatom, ein Halogenatom oder eine Hydroxy-, Nitro-, Cyano-, Alkyl- oder substituierte Alkyl-, Alkenyl- oder substituierte Alkenylaußer Styryl-, Cycloalkyl- oder substituierte Cycloalkyl-, Alkoxy- oder substituierte Alkoxy-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff-, aromatische heterocyclische oder substituierte aromatische heterocyclische, Aralkyl- oder substituierte Aralkyl-, Aryloxy- oder substituiere Aryloxy-, Alkoxycarbonyl- oder substituierte Alkoxycarbonyl- oder Carboxylgruppe sind; und
Z_1 bis Z_4 einen Ring **durch** zwei benachbarte Atome oder Gruppen bilden können; Ar_1 und Ar_2 unabhängig voneinander jeweils eine Arylgruppe, die substituiert werden kann, sind; und

Z_6 und Z_7 unabhängig voneinander jeweils ein Wasserstoffatom oder eine Alkyl- oder substituierte Alkyl-, aromatische Kohlenwasserstoff- oder substituierte aromatische Kohlenwasserstoff- oder aromatische heterocyclische oder substituierte aromatische heterocyclische Gruppe sind.

2. Organische elektrolumineszente Vorrichtung, aufweisend eine oder mehrere Schichten aus organischen Dünnfilmen, die zwischen der Anode und der Kathode angeordnet sind, wobei zumindest eine der besagten Schichten aus zumindest einem der organischen Elektrolumineszenzmaterialien nach Anspruch 1 zusammengesetzt ist.

3. Organische elektrolumineszente Vorrichtung nach Anspruch 2, wobei zumindest eine der besagten Schichten eine Dicke von 2 bis 500 nm aufweist.

4. Organische elektrolumineszente Vorrichtung nach einem der Ansprüche 2 oder 3, wobei die Schichten eine Lochtransportschicht, eine lichtemittierende Schicht und eine Elektronentransportschicht aufweisen und wobei eine dieser Schichten aus zumindest einem der organischen Elektrolumineszenzmaterialien nach Anspruch 1 zusammengesetzt ist.

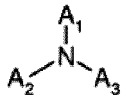
5. Organische elektrolumineszente Vorrichtung nach Anspruch 4, wobei die besagte lichtemittierende Schicht mit einem organischen lumineszierenden Mittel als Dotiersubstanz dotiert ist.

6. Zusammensetzung, aufweisend das organische Elektrolumineszenzmaterial nach Anspruch 1, das in einem Polymer-Bindemittel dispergiert ist.

Revendications

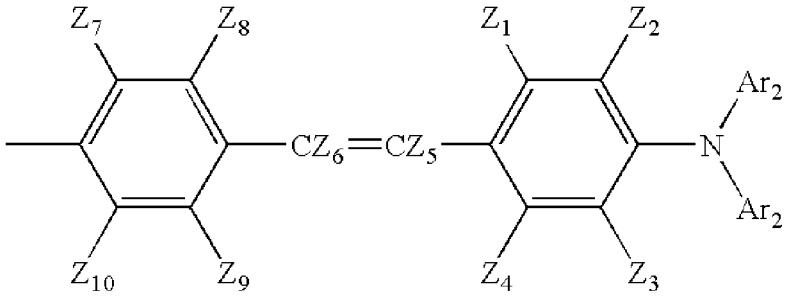
1. Matériau électroluminescent organique, **caractérisé par** le fait :

(i) de contenir un composé représenté par la formule générale suivante (A-I)



(A-I)

dans laquelle A_1 à A_3 représentent, indépendamment, chacun un substituant représenté par la formule générale (A-II), qui peuvent être identiques ou différents :

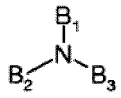


(A-II)

dans laquelle au moins l'un de Z_1 à Z_4 et Z_7 à Z_{10} représente chacun, indépendamment, un atome d'halogène ou un groupe hydroxyle, un groupe amino ou amino substitué, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué à l'exception du groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxycarbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ; et les autres représentant un atome d'hydrogène ;
Z_1 et Z_2, Z_3 et Z_4 et Z_7 à Z_{10} peuvent former un noyau par deux atomes ou groupes adjacents ;

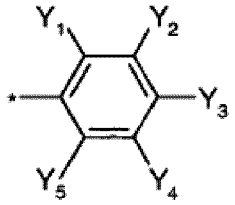
Z_5 et Z_6 représentent, indépendamment, chacun un atome d'hydrogène ou un groupe alkyle ou alkyle substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, ou un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué ; et
Ar_1 et Ar_2 représentent, indépendamment, chacun un groupe aryle qui peut être substitué ; ou

(ii) de contenir un composé représenté par la formule générale suivante (A-III),



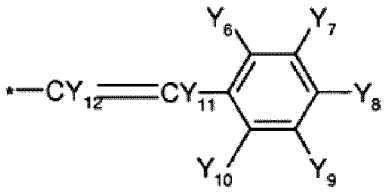
(A-III)

dans laquelle B_1 à B_3 représentent, indépendamment, chacun un substituant représenté par la formule générale (A-IV), qui peuvent être identiques ou différents :



(A-IV)

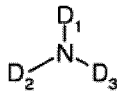
dans laquelle, au moins l'un de Y_1 à Y_5 représente un substituant représenté par la formule générale (A-V), les autres représentant, indépendamment, chacun un atome d'hydrogène, un atome d'halogène, ou un groupe hydroxyle, un groupe amino ou amino substitué, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué autre qu'un groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxycarbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ; et
Y_1 à Y_5 peuvent former un noyau par deux atomes ou groupes adjacents ;



(A-V)

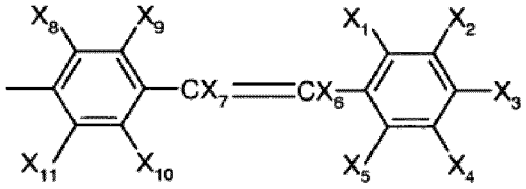
dans laquelle, au moins l'un de Y_6 à Y_{10} représente un substituant représenté par la formule $-NAr_1Ar_2$, les autres représentant, indépendamment, chacun un atome d'hydrogène, un atome d'halogène ou un groupe hydroxyle, un groupe amino ou amino substitué, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué autre qu'un groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxy-carbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ;
Y_6 à Y_{10} peuvent former un noyau par deux atomes ou groupes adjacents ;
Ar_1 et Ar_2 représentent, indépendamment, chacun un groupe aryle qui peut être substitué ; et
Y_{11} et Y_{12} représentent, indépendamment, chacun un atome d' hydrogène ou un groupe alkyle ou alkyle substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, à l'exclusion des composés où le substituant représenté dans la formule générale (A-V) se trouve au niveau du site de Y_3 et, en même temps, le substituant représenté par la formule $-NAr_1Ar_2$ se trouve au niveau du site de Y_8 ; ou

(iii) de contenir un composé représenté par la formule générale suivante (A-VI)



(A-VI)

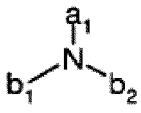
dans laquelle D_1 à D_3 représentent, indépendamment, chacun un substituant représenté par la formule générale (A-VII) :



(A-VII)

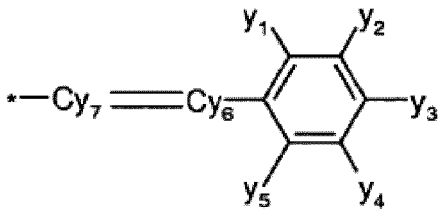
dans laquelle, au moins l'un de X_1 à X_5 représente un substituant représenté par la formule $-NAr_1Ar_2$, les autres représentant, indépendamment, chacun un atome d'hydrogène, un atome d'halogène ou un groupe hydroxyle, un groupe amino ou amino substitué, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué autre qu'un groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxy-carbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ;
X_1 à X_5 peuvent former un noyau par deux atomes ou groupes adjacents ;
Ar_1 et Ar_2 représentent, indépendamment, chacun un groupe aryle qui peut être substitué ;
X_6 et X_7 représentent, indépendamment, chacun un groupe alkyle ayant 2 ou plus de deux atomes de carbone, un groupe hydrocarboné aromatique ou un groupe hétérocyclique aromatique, qui peuvent tous être substitués ; et
X_8 à X_{11} représentent, indépendamment, chacun un atome d'hydrogène, un atome d'halogène ou un groupe hydroxyle, un groupe amino ou amino substitué, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué à l'exception du groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxycarbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle et X_8 à X_{11} peuvent former un noyau par deux atomes ou groupes adjacents ; ou

(iv) de contenir un composé représenté par la formule générale suivante (B-I)



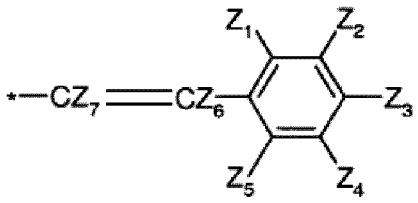
(B-I)

dans laquelle, a_1, b_1 et b_2 représentent, indépendamment, chacun un groupe aryle qui est substitué, a_1 ayant au moins un substituant représenté par la formule générale (B-II), chacun de b_1 et b_2 ayant au moins un substituant représenté par la formule générale (B-III), et b_1 et b_2 peuvent être identiques ou différents :



(B-II)

dans laquelle, y_1 à y_5 représentent, indépendamment, chacun un atome d'hydrogène, un atome d'halogène ou un groupe hydroxyle, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué à l'exception du groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxycarbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ; et
y_1 à y_5 peuvent former un noyau par deux atomes ou groupes adjacents ;
y_6 et y_7 représentent, indépendamment, chacun un atome d'hydrogène, un groupe alkyle ou alkyle substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué ;



(B-III)

dans laquelle, au moins l'un de Z_1 à Z_5 représente un substituant représenté par la formule $-NAr_1Ar_2$, les autres représentant, indépendamment, chacun un atome d'hydrogène, un atome d'halogène ou un groupe hydroxyle, un groupe nitro, un groupe cyano, un groupe alkyle ou alkyle substitué, un groupe alcényle ou alcényle substitué à l'exception du groupe styryle, un groupe cycloalkyle ou cycloalkyle substitué, un groupe alkoxy ou alkoxy substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué, un groupe aralkyle ou aralkyle substitué, un groupe aryloxy ou aryloxy substitué, un groupe alkoxycarbonyle ou alkoxycarbonyle substitué, ou un groupe carboxyle ; et
Z_1 à Z_4 peuvent former un noyau par deux atomes ou groupes adjacents ;
Ar_1 et Ar_2 représentent, indépendamment, chacun un groupe aryle qui peut être substitué ; et
Z_6 et Z_7 représentent, indépendamment, chacun un atome d'hydrogène ou un groupe alkyle ou alkyle substitué, un groupe hydrocarboné aromatique ou hydrocarboné aromatique substitué, ou un groupe hétérocyclique aromatique ou hétérocyclique aromatique substitué.

2. Dispositif électroluminescent organique comprenant une ou plusieurs couches de films minces organiques placées entre l'anode et la cathode, dans lequel au moins l'une desdites couches est composée d'au moins l'un des matériaux électroluminescents organiques selon la revendication 1.

3. Dispositif électroluminescent organique de la revendication 2, dans lequel au moins l'une desdites couches a une épaisseur allant de 2 à 500 nm.

4. Dispositif électroluminescent organique de l'une des revendications 2 ou 3, dans lequel les couches comportent une couche de transport de trous, une couche électroluminescente et une couche de transport d'électrons et dans lequel l'une de ces couches est composée d'au moins l'un des matériaux électroluminescents organiques selon la revendication 1.

5. Dispositif électroluminescent organique de la revendication 4, dans lequel ladite couche électroluminescente est dopée avec un agent organique luminescent comme dopant.

6. Composition comprenant le matériau électroluminescent organique de la revendication 1 dispersé dans un liant polymère.

Fig. 1A

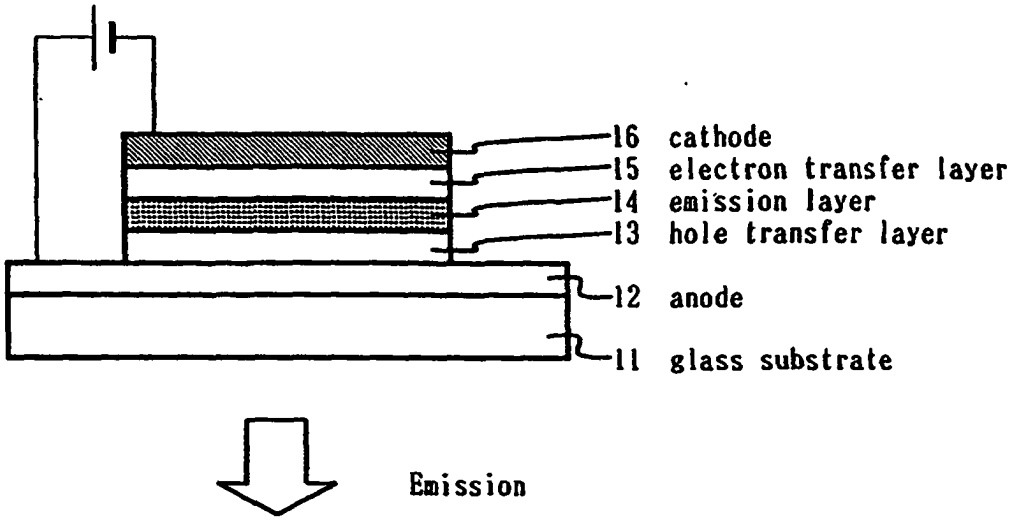

16 cathode
15 electron transfer layer
14 emission layer
13 hole transfer layer
12 anode
11 glass substrate
Emission

Fig. 1B

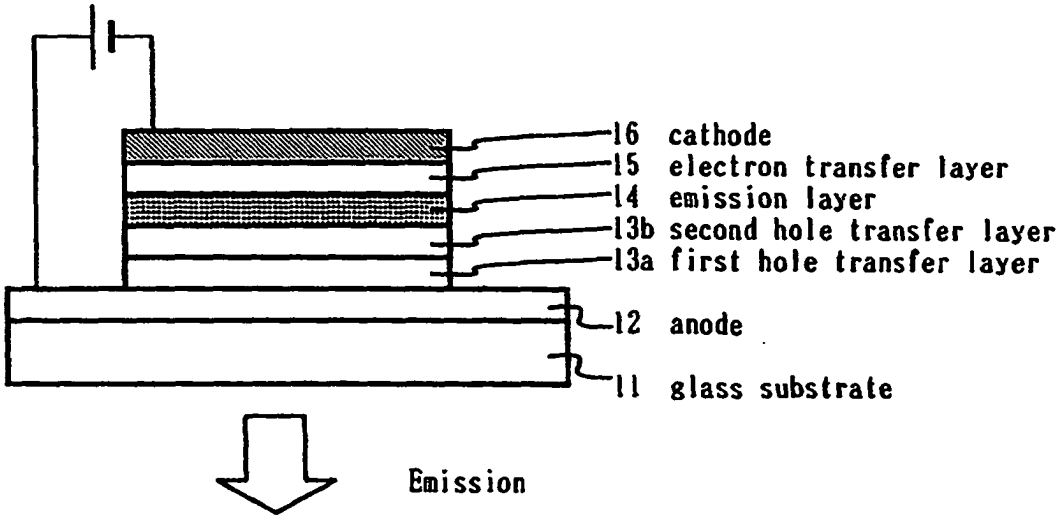

16 cathode
15 electron transfer layer
14 emission layer
13b second hole transfer layer
13a first hole transfer layer
12 anode
11 glass substrate
Emission

Fig. 2A

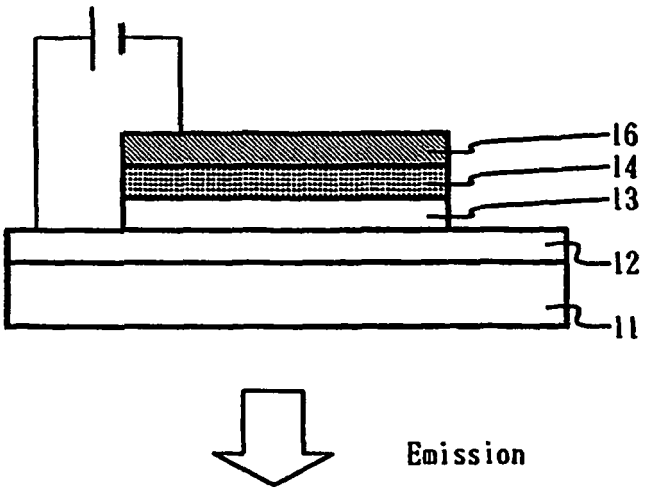


Fig. 2B

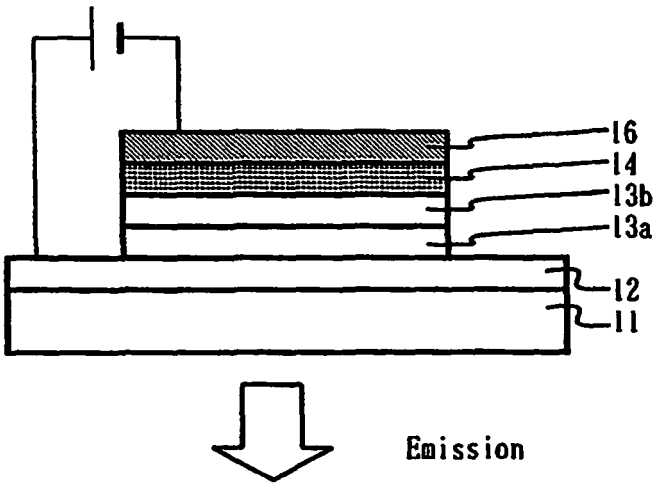


Fig. 3

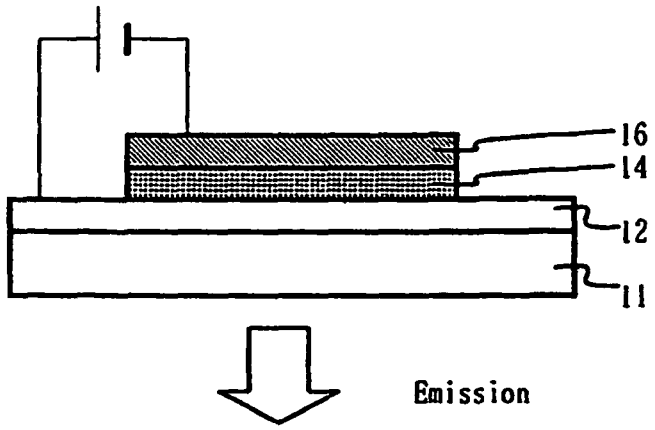
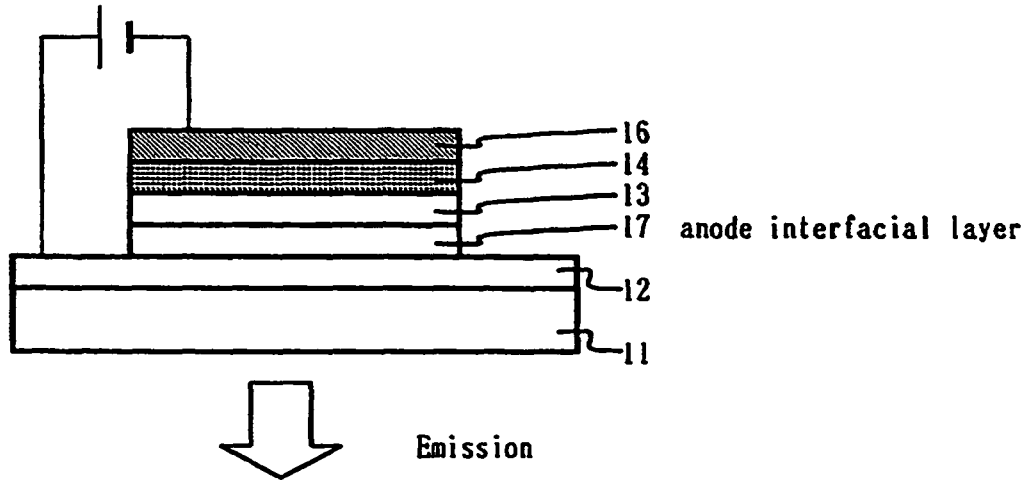

16
14
12
11
Emission

Fig. 4


16
14
13
17
anode interfacial layer
12
11
Emission

REFERENCES CITED IN THE DESCRIPTION

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- *APPLIED PHYSICS LETTERS,* 1990, vol. 56, 799 **[0002]**
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- *Applied Physics Letters,* 1996, vol. 68, 1787 **[0003]**
- *Applied Physics Letters,* 1994, vol. 65, 807 **[0005]**

专利名称(译)	有机电致发光材料和使用其的电致发光器件		
公开(公告)号	EP1074601B1	公开(公告)日	2014-11-05
申请号	EP2000116726	申请日	2000-08-02
申请(专利权)人(译)	NEC公司		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	ISHIKAWA HITOSHI C O NEC CORPORATION TOGUCHI SATORU C O NEC CORPORATION MORIOKA YUKIKO C O NEC CORPORATION		
发明人	TADA, HIROSHI, C/O NEC CORPORATION ODA, ATSUSHI, C/O NEC CORPORATION ISHIKAWA, HITOSHI, C/O NEC CORPORATION TOGUCHI, SATORU, C/O NEC CORPORATION MORIOKA, YUKIKO, C/O NEC CORPORATION		
IPC分类号	H01L51/30 C07C211/54 C07C211/56 C07C211/57 C07C217/80 C07C217/92 C09K11/06 H01L51/00 H01L51/50 H05B33/14		
CPC分类号	C09K11/06 C07C211/54 C07C211/56 C07C211/57 C07C217/80 C07C217/92 C09K2211/1014 H01L51/0059 H01L51/006 H01L51/0081 H01L51/5012 H01L51/5048 H01L2251/308 H05B33/14 Y10S428/917		
优先权	1999218337 1999-08-02 JP 1999218336 1999-08-02 JP		
其他公开文献	EP1074601A3 EP1074601A2		
外部链接	Espacenet		

摘要(译)

本发明的有机电致发光材料包括，为了提供发射高亮度光的耐用有机EL器件，由下列通式（AI）或（BI）表示的化合物，其中，A1至A3，其可以是相同或不同的，各自独立地为通式（A-II）所示的取代基：和a1，b1和b2各自独立地为可被取代的芳基，a1具有至少一个由通式（B）表示的取代基-II），和b1和b2各自具有通式（B-III）所示的至少一个取代基，并且b1和b2可以相同或不同。