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(71) **Applicant** *(for all designated States except US)*: **CHEIL INDUSTRIES INC.** [KR/KR]; 290, Kongdan-dong, Kumi-city, Kyungsangbuk-do 730-030 (KR).

(72) **Inventors; and**
(75) **Inventors/Applicants** *(for US only)*: **KIM, Hyung-Sun** [KR/KR]; 301, 845-2, Tap-dong, Gwonseon-gu, Suwon-si, Gyeonggi-do 441-440 (KR). **LEE, Ho-Jae** [KR/KR]; 2101-1904, Baekhyeon Maeul Dongil, Hivill Apt., Jung-dong, Giheung-gu, Yongin-si, Gyeonggi-do 446-753 (KR). **YU, Eun-Sun** [KR/KR]; Bisan-dong, Dongan-gu, Anyang-si, Gyeonggi-do 431-050 (KR). **JUNG, Sung-Hyun** [KR/KR]; 1106-212, Jugong 11 Danji Apt., San-bon 2-dong, Gunpo-si, Gyeonggi-do 435-748 (KR). **KIM, Nam-Soo** [KR/KR]; 101-503, Obok Town, 565-3, Ojeong-dong, Ojeong-gu, Bucheon-si, Gyeonggi-do 421-815 (KR). **KIM, Young-Hoon** [KR/KR]; Anyang-dong, Manan-gu, Anyang-si, Gyeonggi-do 430-010 (KR). **CHAE, Mi-Young** [KR/KR]; 203-1803, Dongcheon Hyundai 2-cha, Hometown Apt., Dongcheon-dong, Suji-gu, Yongin-si, Gyeonggi-do 448-511 (KR).

(74) **Agent**: **PANKOREA PATENT AND LAW FIRM**; Seolim Bldg., 649-10, Yoksam-dong, Kangnam-ku, Seoul 135-080 (KR).

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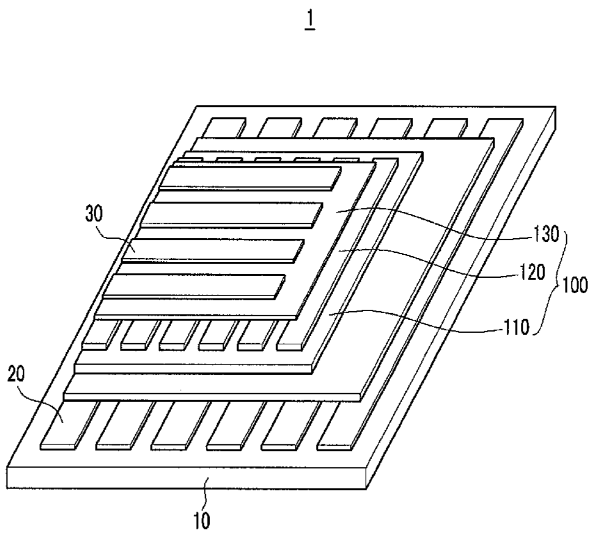
(54) **Title**: ORGANOMETALLIC COMPLEX COMPOUNDS FOR PHOTOELECTRIC DEVICE AND PHOTOELECTRIC DEVICE INCLUDING THE SAME

FIG. 1



(57) **Abstract**: Disclosed are an organic metallic complex compound for an organic photoelectric device represented by the specific Chemical Formula, and an organic photoelectric device including the same. The organic metallic complex compound for an organic photoelectric device includes a bulky substituent as a ligand, and thus suppresses intermolecular interaction resulting in improvement of luminous efficiency and solubility.

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TITLE OF THE INVENTION

ORGANOMETALLIC COMPLEX COMPOUNDS FOR PHOTOELECTRIC DEVICE AND PHOTOELECTRIC DEVICE INCLUDING THE SAME

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to an organic metallic complex compound for an organic photoelectric device and an organic photoelectric device including the same. More particularly, the present invention relates to an organic metallic complex compound for an organic photoelectric device having improved luminous efficiency and solubility, and an organic photoelectric device including the same.

(b) Description of the Related Art

An organic photoelectric device has been highlighted as a next generation display device. The organic photoelectric device can be driven at a low voltage, and can solve various problems of a liquid crystal display (LCD), such that is difficult to make it thinner and have a wide viewing angle and rapid response speed.

An organic photoelectric device of a middle size or less also has equivalent or better image quality to a liquid crystal display (LCD) compared to other displays, and its manufacturing process is very simple. Therefore, it is evaluated to be advantageous in terms of cost in the future. An organic photoelectric device includes an organic light emitting material between a rear plate including ITO transparent electrode patterns as an anode on a transparent glass substrate and an upper plate including a metal electrode as a cathode on a substrate. When a predetermined voltage is applied between the transparent electrode and the metal electrode, current flows through the organic light emitting material to emit light.

Such an organic light emitting material for an organic photoelectric device was firstly developed by Eastman Kodak, Inc., in 1987. The material is a low molecular aromatic diamine and aluminum complex as an emission-layer-forming material (Applied Physics Letters. 51, 913, 1987). C. W. Tang et al. firstly disclosed a practicable device as an organic photoelectric device in 1987 (Applied Physics Letters, 51 12, 913-915, 1987).

According to the reference, the organic layer has a structure in which a thin film (hole transport layer (HTL)) of a diamine derivative and a thin film of tris(8-hydroxy-quinolate)aluminum (Alq_3) are laminated.

Generally, an organic photoelectric device is composed of an anode of a transparent electrode, an organic thin layer of a light emitting region, and a metal electrode (cathode) formed on a glass substrate, in that order.

The organic thin layer may include an emission layer, a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL), or an electron injection layer (EIL). It may further include an electron blocking layer or a hole blocking layer due to the emission characteristics of the emission layer.

When the organic light emitting diode is applied with an electric field, the holes and electrons are injected from the anode and the cathode, respectively. The injected holes and electrons are recombined on the emission layer though the hole transport layer (HTL) and the electron transport layer (ETL) to provide light emitting excitons. The provided light emitting excitons emit light by transiting to the ground state. A light emitting colorant (dopant) may be added in an emission layer (host) in order to increase the efficiency and stability in the emission state.

In the above-mentioned organic photoelectric device, the light emitting material may be classified as a fluorescent material singlet excitons and a phosphorescent material including triplet excitons according to the light emitting mechanism. It is has become known that a phosphorescent light emitting material can be used for a light emitting material of an organic photoelectric device as well as the fluorescent light emitting material (D. F. O'Brien et al., Applied Physics Letters, 74 3, 442-444, 1999; M. A. Baldo et al., Applied Physics letters, 75 1, 4-6, 1999).

Such a phosphorescent material emits light by transiting the electrons from a ground state to an excited state, non-radiance transiting of a singlet exciton to a triplet exciton through intersystem crossing, and transiting a triplet exciton to a ground state to emit light.

When the triplet exciton is transited, it cannot directly transit to the ground state. Therefore, the electron spin is flipped, and then it is transited to the ground state so that it provides a characteristic of extending the lifetime (emission duration) to more than that of fluorescent emission.

In other words, the duration of fluorescent emission is extremely short at several nanoseconds, but the duration of phosphorescent emission is relatively long such as at several microseconds.

In addition, evaluating quantum mechanically, when holes injected from the anode are recombined with electrons injected from the cathode to provide light emitting excitons, the singlet and the triplet are produced in a ratio of 1:3, in which the triplet light emitting excitons are produced at three times the amount of the singlet light emitting excitons in the organic photoelectric device.

Accordingly, the percentage of the singlet exited state is 25% (the triplet is 75%) in the case of a fluorescent material, so it has limits in luminous efficiency. On the other hand, in the case of a phosphorescent material, it can utilize 75% of the triplet exited state and 25% of the singlet exited state, so theoretically the internal quantum efficiency can reach up to 100%. When a phosphorescent light emitting material is used, it has advantages in an increase in luminous efficiency of around three times that of the fluorescent light emitting material.

A phosphorescent light emitting material has a molecule structure that is appropriate for intersystem crossing. The molecule structure includes heavy metals such as Ir, Pt, Rh, or Pd in an organic molecule, which incurs spin-orbital coupling and thus triplets and singlets are mixed. Thereby, inhibited transition is allowed and phosphorescent light emission at room temperature can effectively occur.

An iridium organic metallic complex has garnered interest due to excellent phosphorescent luminous efficiency, and phosphorescent light emitting materials including such a metallic complex have been reported [Sergey Lamansky et al. Inorg. Chem., 40, 1704-1711, 2001 & J. Am. Chem. Soc., 123, 4304-4312, 2001].

Such an organic metallic complex for phosphorescent light emission is a low molecular material that is applicable using a general dry process such as vacuum deposition. In the case of a polymer material, it can be applied to a device using a wet process such as spin coating, Inkjet printing, or casting.

The wet process using a polymer allows ease of device manufacture compared with a dry process such as vacuum deposition, and has merits in terms of costs and scalability. However, polymer materials have problems of lower life-span, luminous efficiency, color purity, and so on compared with low molecular materials.

Therefore, in order to solve the problems, development of a low material that is applicable to a wet process due to high solubility has been required.

SUMMARY OF THE INVENTION

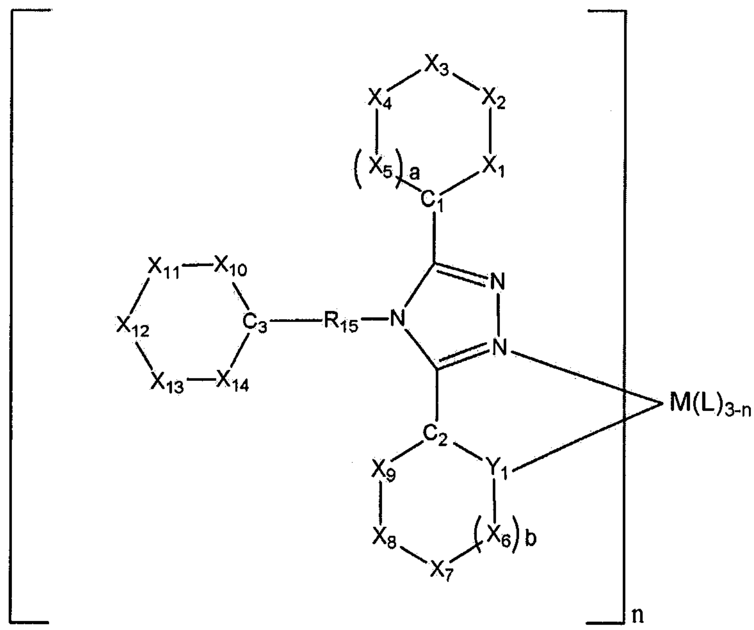
An exemplary embodiment of the present invention provides an organic metallic complex compound for an organic photoelectric device having improved luminous efficiency and solubility.

Another embodiment of the present invention provides the organic photoelectric device including the organic metallic complex compound for an organic photoelectric device.

The embodiments of the present invention are not limited to the above technical purposes, and a person of ordinary skill in the art can understand other technical purposes.

According to an embodiment of the present invention, an organic metallic complex compound for an organic photoelectric device represented by the following Chemical Formula 1 is provided.

[Chemical Formula 1]



In the above Chemical Formula 1,

n is an integer ranging from 1 to 3,

a and b are independently integers of 0 or 1,

a cyclic compound group including C_1 and X_1 to X_5, a cyclic compound group including C_2, Y_1, and X_6 to X_9, and a cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aliphatic cyclic compound, a hetero aliphatic cyclic compound, an aromatic cyclic compound, and a hetero aromatic cyclic compound,

M is a metal to form an octahedral complex,

L is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom, or a monovalent anionic didentate ligand of a monovalent anion bound to M through a coordinate covalent bond with two heteroatoms,

C_1 to C_3 are $-C(R_{17})_h-$, where h is an integer of 0 or 1,

Y_1 is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom,

X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, where i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2,

R_1 to R_5 and R_{17} are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_1 to R_5 are present as independent substituents, or are fused together to form a cycle bound to the X_1 to X_{14},

at least one of R_1 to R_5 is selected from the group consisting of a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, and a substituted or unsubstituted biarylphenyl,

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

R_{15} is selected from the group consisting of a halogen, a nitro, a substituted or unsubstituted C6 to C30 aryl, a substituted or unsubstituted C2 to C30 heteroaryl, a substituted or unsubstituted C1 to C20 alkyl, a substituted or unsubstituted C2 to C20 acyl, an amino, and a substituted or unsubstituted C1 to C20 alkoxy.

According to a further embodiment of the present invention, an organic photoelectric device is provided that includes an organic thin layer disposed between a pair of electrodes. The organic thin layer includes the above organic metallic complex compound.

Hereinafter, further embodiments of the present invention will be described in detail.

The organic metallic complex compound for an organic photoelectric device suppresses molecular interaction and thus improves luminous efficiency and solubility.

The organic metallic complex compound can be applicable to a wet process such as spin coating, Inkjet printing, casting, and so on due to excellent solubility during fabrication of an organic photoelectric device, resulting in a fabrication cost reduction of an organic photoelectric device.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded perspective view showing an organic photoelectric device according to one embodiment of the present invention.

<Description of Reference Numerals Indicating Primary Elements in the Drawings>

1: organic photoelectric device 10: substrate

20: first electrode 30: second electrode

100: organic thin layer 110: first buffer layer

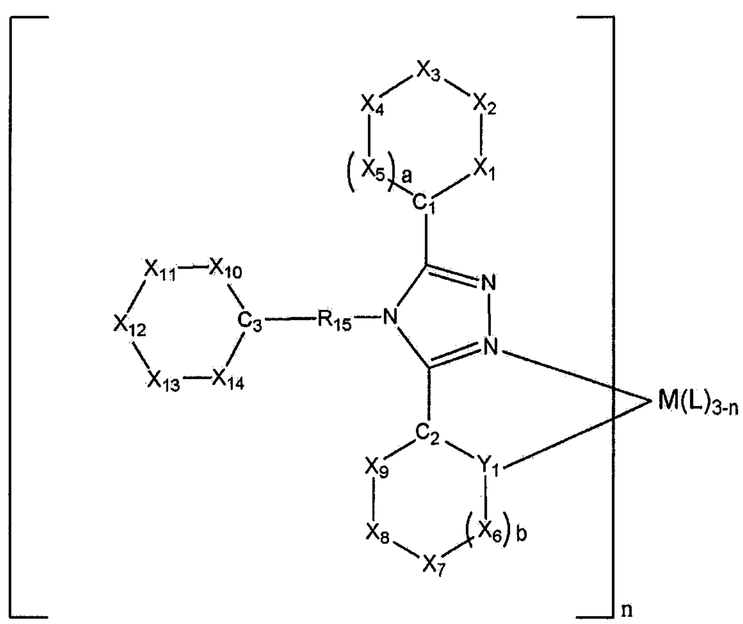
120: emission layer 130: second buffer layer

DETAILED DESCRIPTION OF THE INVENTION

Exemplary embodiments of the present invention will hereinafter be described in detail. However, these embodiments are only exemplary, and the present invention is not limited thereto but rather is defined by the scope of the appended claims.

According to an embodiment of the present invention, an organic metallic complex compound for an organic photoelectric device represented by the following Chemical Formula 1 is provided.

[Chemical Formula 1]



In the above Chemical Formula 1,

n is an integer ranging from 1 to 3,

a and b are independently integers of 0 or 1,

a cyclic compound group including C_1 and X_1 to X_5, a cyclic compound group including C_2, Y_1, and X_6 to X_9, and a cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aliphatic cyclic compound, an hetero aliphatic cyclic compound, an aromatic cyclic compound, and a hetero aromatic cyclic compound,

M is a metal to form an octahedral complex,

L is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom, or a monovalent anionic didentate ligand of a monovalent anion bound to M through a coordinate covalent bond with two heteroatoms,

C_1 to C_3 are $-C(R_{17})_h-$, where h is an integer of 0 or 1,

Y_1 is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom,

X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, where i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2,

R_1 to R_5, and R_{17} are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_1 to R_5 are present as independent substituents, or are fused together to form a cycle bound to the X_1 to X_{14},

at least one of R_1 to R_5 is selected from the group consisting of a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, and a substituted or unsubstituted biarylphenyl,

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

R_{15} is selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene.

As used herein, the term “heteroatom” refers to an atom selected from the group consisting of nitrogen (N), oxygen (O), sulfur (S), and phosphorus (P). The terms “hetero aliphatic cyclic compound”, “hetero aromatic cyclic compound”, “heteroalkyl”, and “heteroaryl” respectively refer to an aliphatic cyclic compound, an aromatic cyclic compound, an alkyl, and an aryl including 1 to 3 heteroatoms selected from the group consisting of nitrogen (N), oxygen (O), sulfur (S), and phosphorus (P), and the remainder being carbon.

In the present specification, when specific definition is not provided, the term “substituted” refers to one substituted with at least a substituent selected from the group consisting of a halogen, a cyano, a hydroxy, an amino, a substituted or unsubstituted C6 to C30 aryl, and a substituted or unsubstituted C2 to C30 heteroaryl instead of hydrogen.

When the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} independently form an aliphatic cyclic compound, or a hetero aliphatic cyclic compound, X_1 to X_{14} are independently $C(R_1)(R_2)$, $N(R_3)$, $Si(R_5)(R_6)$, O, or S, and C_1 to C_3 are $C(R_{17})$. In the case, h, i, j, k, o, and p are 1.

When the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} independently form an aromatic cyclic compound or a hetero aromatic cyclic compound, X_1 to X_{14} are independently $C(R_1)$, $N(R_3)$, $Si(R_5)(R_6)$, O, or S, and C_1 to C_3 are C. In the case, h, j, k, o, and p are 0, and I is 1.

When X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2.

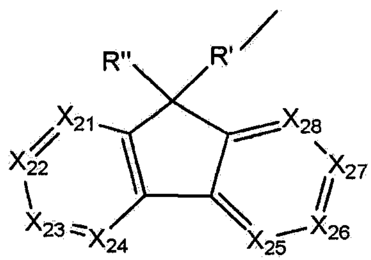
C_1 and X_1 to X_4 form a pentacyclic compound if a is 0 in the above Chemical Formula 1, and C_1 and X_1 to X_4 are a hexacyclic compound if a is 1 in the above Chemical Formula 1.

C_2, Y_1, and X_7 to X_9 form a pentacyclic compound if b is 0, and C_2, Y_1, and X_7 to X_9 form a hexacyclic compound if b is 1.

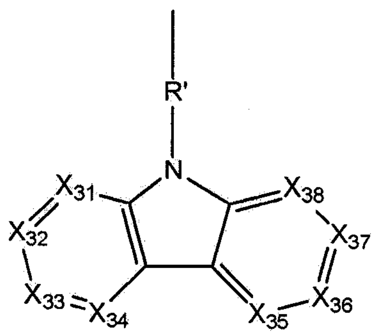
It is preferable that the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aromatic cyclic compound and a hetero aromatic cyclic compound.

R_1 to R_5 are preferably selected from the group consisting of substituents represented by the following Chemical Formulae 2 to 6.

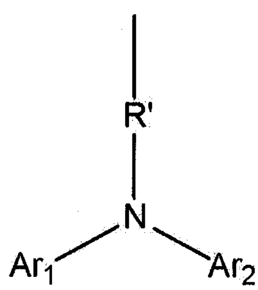
[Chemical Formula 2]



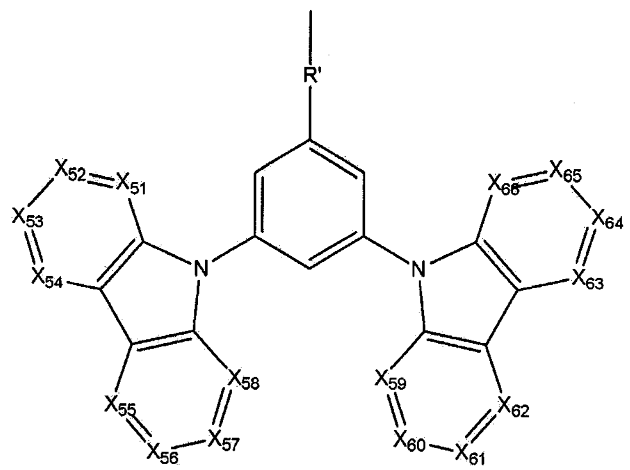
[Chemical Formula 3]



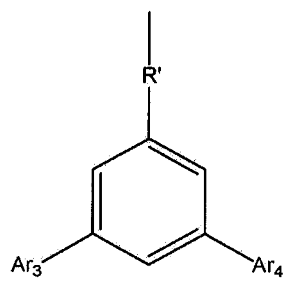
[Chemical Formula 4]



[Chemical Formula 5]



[Chemical Formula 6]



In the above Chemical Formulae 2 to 6,

X_{21} to X_{28}, X_{31} to X_{38}, and X_{51} to X_{66} are independently selected from the group consisting of CR_{18} and N,

R_{18} and R" are independently selected from the group consisting of hydrogen, a halogen, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted

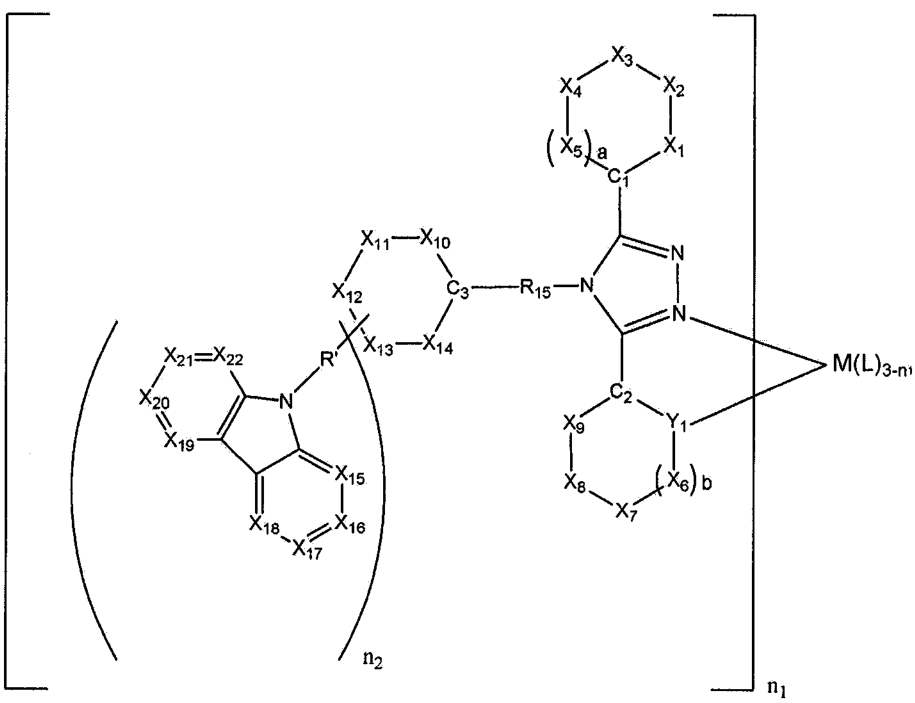
C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl,

R' is selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene, and

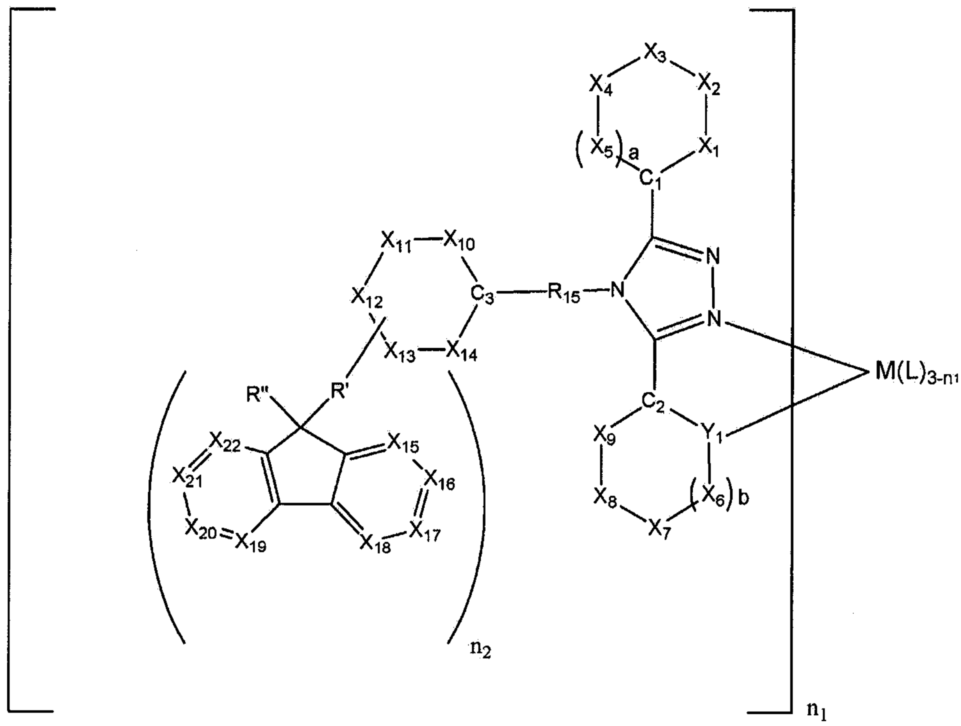
Ar_1 to Ar_4 are selected from the group consisting of a substituted or unsubstituted C6 to C30 aryl and a substituted or unsubstituted C2 to C30 heteroaryl.

The organic metallic complex compound represented by the above Chemical Formula 1 is preferably selected from the group consisting of the following Chemical Formulae 7 to 9.

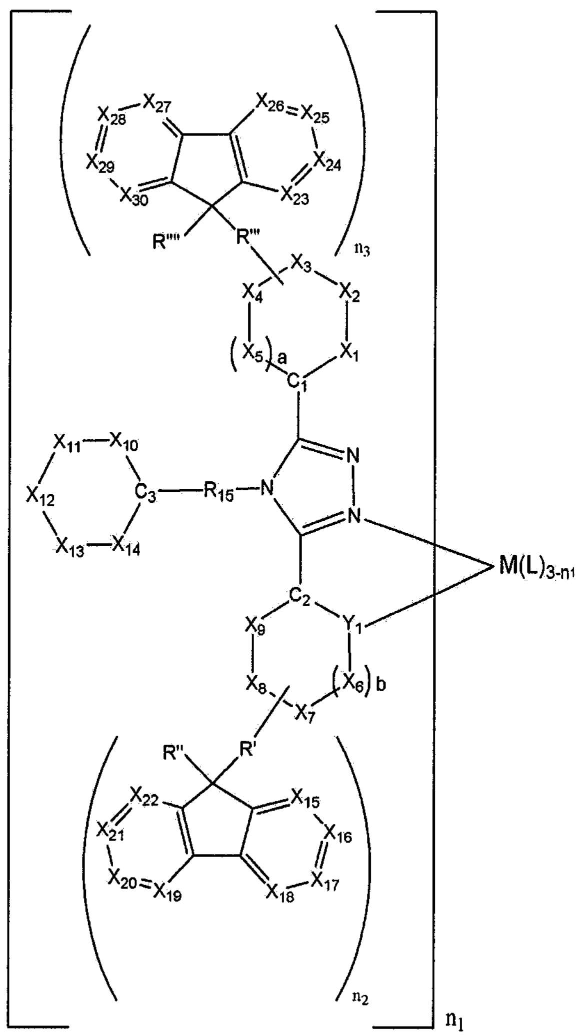
[Chemical Formula 7]



[Chemical Formula 8]



[Chemical Formula 9]



In the above Chemical Formulae 7 to 9,

n_1 is an integer ranging from 1 to 3, n_2 and n_3 are independently integers ranging from 1 to 5,

a and b are independently integers of 0 or 1,

the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aliphatic cyclic compound, a hetero aliphatic cyclic compound, an aromatic cyclic compound, and a hetero aromatic cyclic compound,

M is a metal to form an octahedral complex,

L is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom, or a monovalent anionic didentate ligand of a monovalent anion bound to M through a coordinate covalent bond with two heteroatoms,

C_1 to C_3 are $-C(R_{17})_h-$, where h is an integer of 0 or 1,

Y_1 is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom,

X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, where i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2,

X_{15} to X_{30} are independently selected from the group consisting of CR_{18} and N,

R_1 to R_5, R_{17}, R_{18}, R'', and R'''' are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, N R_{162}, P R_{162}, P OR_{162}, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, Si R_{163}, Si $CH_{32}R_{16}$, Si $(Ph)_2R_{16}$, B R_{162}, B OR_{162}, C $(O)R_{16}$, $C(O)OR_{16}$, C(O)N R_{162}, CN, NO_2, SO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

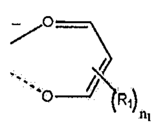
R_1 to R_5 are present as independent substituents, or are fused together to form a cycle bound to the X_1 to X_{14},

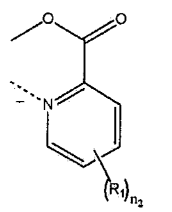
R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

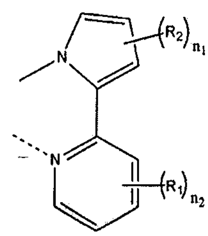
R_{15}, R', and R''' are independently selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene.

The L is preferably selected from the group consisting of ligands represented by the following Chemical Formulae 10 to 16.

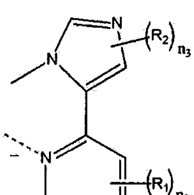
[Chemical Formula 10] [Chemical Formula 11] [Chemical Formula 12]

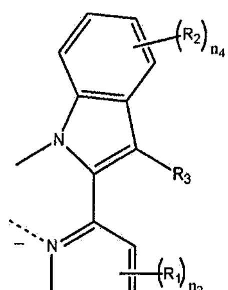


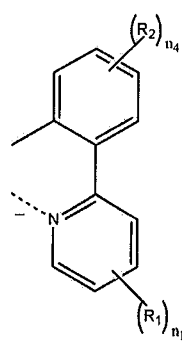




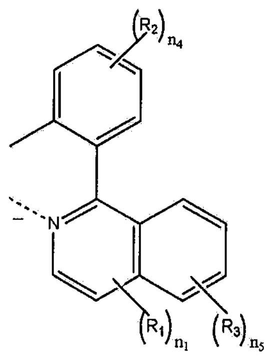
[Chemical Formula 13] [Chemical Formula 14] [Chemical Formula 15]







[Chemical Formula 16]



In the above Chemical Formulae 10 to 16,

R_1 to R_3 are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl,

n_1 is an integer ranging from 1 to 3, n_2, n_4, and n_5 are integers ranging from 1 to 4, and n_3 is an integer of 1 or 2.

M is preferably selected from the group consisting of a Group 8 element and a Group 10 element of the periodic table that is capable of forming an octahedral complex. An element selected from the group consisting of Ir, Pt, Rh, and Pd is more preferable, and Ir is still more preferable.

According to a further embodiment of the present invention, an organic photoelectric device that includes an organic thin layer disposed between a pair of electrodes is provided. The organic thin layer includes the above polymer. In one embodiment, the organic photoelectric device may be an organic light emitting diode.

The organic photoelectric device includes a first electrode disposed on a substrate, an organic thin layer including the organic metallic complex compound disposed on the first electrode, and a second electrode disposed on the organic thin layer.

The first electrode may include transparent and highly conductive indium tin oxide (ITO), indium-zinc-oxide (IZO), or so on.

The substrate may be a glass substrate or a flexible substrate.

The organic thin layer includes at least one of a first buffer layer for hole injection or transport, disposed on the first electrode, an emission layer disposed on the first buffer layer, and a second buffer layer for electron injection or transport, disposed on the emission layer. At least one layer of the organic thin layer includes the organic metallic complex compound according to one embodiment of the present invention.

The first buffer layer may include at least one selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), a hole blocking layer, and combinations thereof. The second buffer layer may include at least one selected from the group consisting of an electron injection layer (EIL), an electron transport layer (ETL), an electron blocking layer, and combinations thereof.

The organic metallic complex compound can be applicable to a wet process such as spin coating, Inkjet printing, casting, and the like during fabrication of an organic thin layer due to excellent solubility.

FIG. 1 is an exploded perspective view of an organic photoelectric device according to one embodiment of the present invention.

Referring to FIG. 1, the organic photoelectric device 1 includes a first electrode (anode, 20) including a transparent conductive metal oxide, an organic thin layer 100 including a light emitting region, and a second electrode (cathode, 30) that are sequentially disposed on a substrate 10.

The substrate 10 may be a glass substrate or a flexible substrate.

The first electrode 20 is disposed on the substrate 10. The first electrode 20 is made of a transparent conductive metal oxide such as ITO or IZO.

The organic thin layer 100 is disposed on the first electrode 20. The organic thin layer 100 includes an emission layer 120, a first buffer layer 110, and a second buffer layer 130. At least one layer of the organic thin layer 100 includes the organic metallic complex compound according to one embodiment of the present invention.

The first and second buffer layers 110 and 130 may include at least one selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL), and an electron injection layer (EIL), and may respectively further include an electron blocking layer or a hole blocking layer to improve light emitting characteristics of the emission layer 120.

The second electrode 30 is disposed on the second buffer layer 130. The second electrode 30 may be formed using lithium (Li), magnesium (Mg), calcium (Ca), aluminum (Al), Al:Li, Ba:Li, or Ca:Li having a small work function.

When the organic photoelectric device 1 is applied with an electric field, the holes and electrons are injected from the first electrode 20 and the second electrode 30, respectively. The injected holes and electrons are recombined on the emission layer of the organic thin layer 100 to provide light emitting excitons. The provided light emitting excitons emit light by transiting to the ground state.

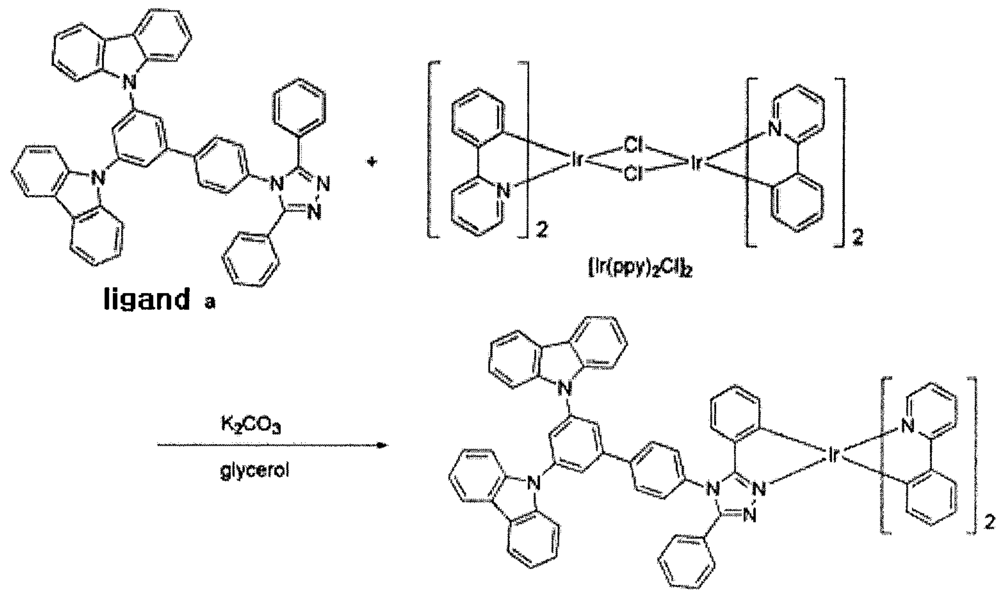
The following examples illustrate the present invention in more detail. However, it is understood that the present invention is not limited by these examples.

(Preparation of Organic Metallic Complex Compound)

(Example 1)

An organic metallic complex compound represented by the following Chemical Formula 14 was prepared based on the following Reaction Scheme 1.

[Reaction Scheme 1]



Chemical Formula 14

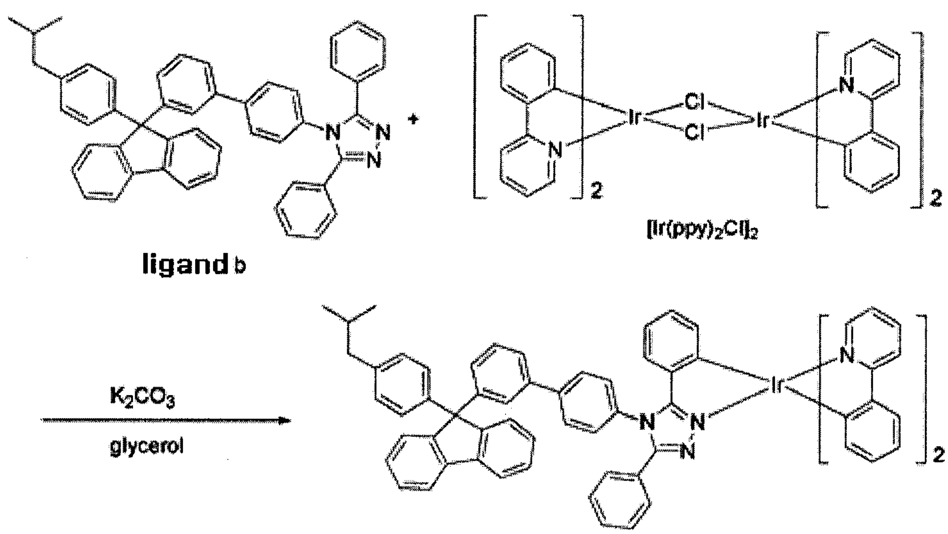
1g (0.9 mmol) of $[Ir(ppy)_2Cl]_2$, 1.64g (2.33 mmol) of a ligand a, and 1.3g of potassium carbonate were dissolved in anhydrous glycerol, and reacted while being heated and agitated in a nitrogen atmosphere at 200°C for 24 hours.

After the reaction, the reactant was poured into distilled water and solids were filtered off. Then, the organic metallic complex compound represented by Chemical Formula 14 was obtained by dissolving the filtered solids in chloroform and performing silica gel column chromatography.

(Example 2)

An organic metallic complex compound represented by the following Chemical Formula 15 was prepared based on the following Reaction Scheme 2.

[Reaction Scheme 2]



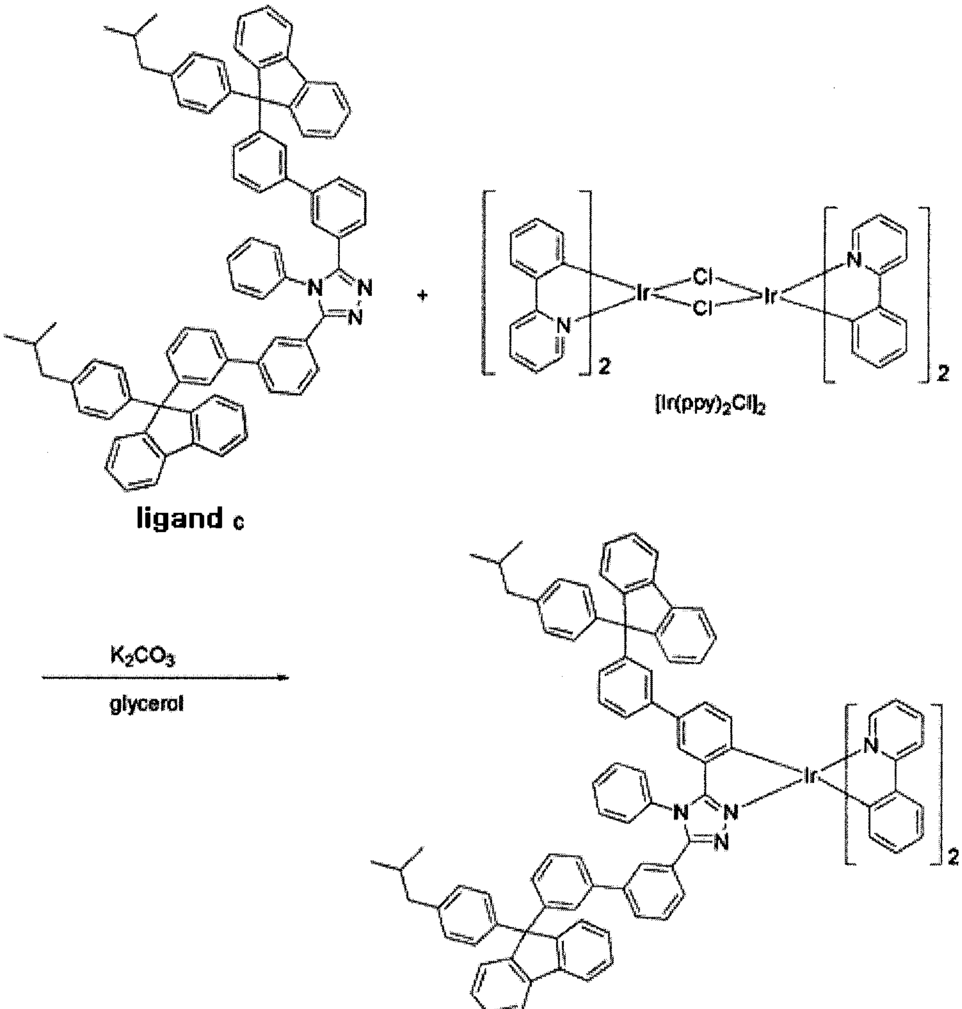
chemical Formula 15

The organic metallic complex compound represented by Chemical Formula 15 was prepared according to the same method as Example 1, except that a ligand b was used.

(Example 3)

An organic metallic complex compound represented by the following Chemical Formula 16 was prepared based on the following Reaction Scheme 3.

[Reaction Scheme 3]



chmeical formula 16

The organic metallic complex compound represented by Chemical Formula 16 was prepared according to the same method as Example 1, except that a ligand c was used.

(Preparation of Organic Photoelectric Device)

A first electrode was formed of ITO in a size of 20mm x 20mm x 0.7mm on a glass substrate of 15Ω/cm^2 and 1200Å, which was produced by the Corning Company.

The substrate with the first electrode formed therein went through ultrasonic rinsing in isopropyl alcohol and deionized water for 5 minutes, respectively, and then went through UV ozone cleaning for 30 minutes.

The upper part of the first electrode was spin-coated with poly(ethylenedioxy)thiophene (PEDOT). An emission layer was formed on top of the PEDOT.

As for a host material for the emission layer, a 1:1 mixture of polyvinylcarbazole (PVK) and 4,4'-N,N'-dicarbazolebiphenyl (CBP) was used. The organic metallic complex compounds prepared according to Examples 1 to 3 were used in a content of 7% as dopants. The emission layer was spin-coated to a thickness of 500Å.

A hole blocking layer was formed to a thickness of 50Å on the emission layer through vacuum-deposition of bis(2-methyl-8-quinolinolate)-4-(phenylphenolate)aluminum (BAlq). Subsequently, an electron transport layer (ETL) was formed at a thickness of 200Å on the hole blocking film through vacuum-deposition of tris(8-hydroxy-quinolate)aluminum (Alq_3).

An organic photoelectric device was fabricated by sequentially vacuum-depositing LiF on an electron transport layer (ETL) to a thickness of 10Å to form an electron injection layer (EIL), and vacuum-depositing Al as a second electrode.

(Measurement of Organic Photoelectric Device Performance)

To determine the characteristics of the organic photoelectric device fabricated above, initial driving voltage (which is also referred to as "turn-on voltage"), maximum luminance (cd/m^2), driving voltage (V) at a luminance of

1000cd/m^2, current efficiency (cd/A), and electric power efficiency (lm/W) were measured. The results are shown in the following Table 1.

Also, photoluminescence (PL) intensities of the organic metallic complex compounds prepared according to Examples 1 to 3 were measured, and the measurement results are shown in the following Table 1.

[Table 1]

Compound	PL intensity (nm)	Initial driving voltage (V)	Luminance at 1000cd/m^2				Maximum luminance (cd/m^2)
			Driving voltage (V)	Current efficiency (cd/V)	Electric power efficiency (lm/W)	Color coordinates (x, y)	
Example 1	505	4.2	8.4	25.94	9.7	0.30, 0.60	10,690
Example 2	510	4.4	8.8	18.75	6.7	0.29, 0.59	11,810
Example 3	510	4.6	10.2	6.94	2.14	0.29, 0.57	10,500

Referring to Table 1, although the organic photoelectric device was fabricated not through vacuum deposition but through spin-coating, which is a wet process, the organic metallic complex compound used in the organic thin layer showed high efficiency of about 26cd/A in case of Example 1, and all had maximum luminance of over 10,000cd/m^2.

Also, the driving voltage ranged from 4.2 V to 4.6 V, and the driving voltage at 1000cd/m^2 ranged from 8.4 V to 10.2 V.

The organic metallic complex compound according to an embodiment of the present invention shows an excellent solubility characteristic in an organic solvent, such as toluene, chloroform, or chlorobenzene, due to decreased Van der Waals force among molecules, which is different from $Ir(ppy)_3$ or $Ir(mppy)_3$ that are known to be effective among green phosphorescent light emitting organic metallic complex compounds. This proves that the use of the organic metallic complex compound makes it possible to easily fabricate an organic photoelectric device even through a wet process.

When a bulky substituent is introduced into the organic metallic complex compound of the present invention, the organic metallic complex compound can improve solubility since molecules therein become apart from one another, and crystallinity decreases. The organic metallic complex compound suppresses intermolecular interaction and thus improves luminous efficiency and electrical characteristics.

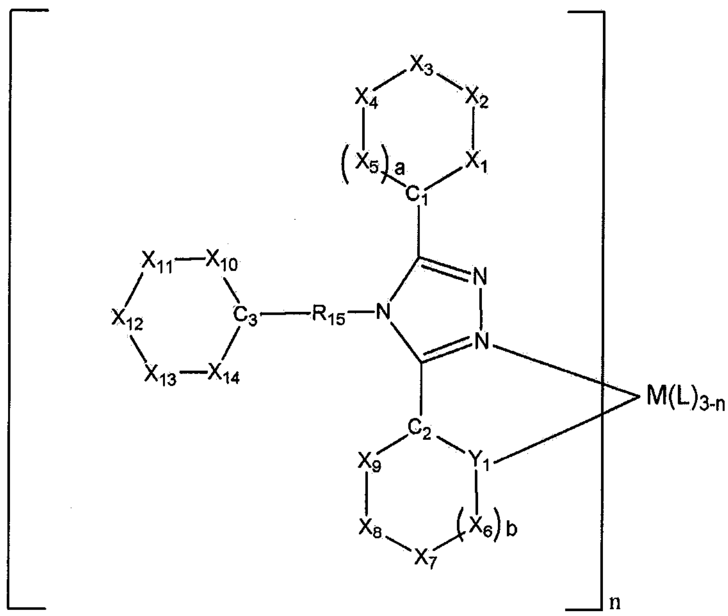
Therefore the organic metallic complex compound according to one embodiment of the present invention may be usefully applied to a phosphorescent light emitting material of an organic photoelectric device.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. An organic metallic complex compound for an organic photoelectric device represented by the following Chemical Formula 1:

[Chemical Formula 1]



wherein, in the above Chemical Formula 1,

n is an integer ranging from 1 to 3,

a and b are independently integers of 0 or 1,

the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aliphatic cyclic compound, a hetero aliphatic cyclic compound, an aromatic cyclic compound, and a hetero aromatic cyclic compound,

M is a metal to form an octahedral complex, L is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom, or a monovalent anionic didentate ligand of a monovalent anion bound to M through a coordinate covalent bond with two heteroatoms,

C_1 to C_3 are $-C(R_{17})_h-$, where h is an integer of 0 or 1,

Y_1 is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom,

X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, where i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2,

R_1 to R_5 and R_{17} are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_1 to R_5 are present as independent substituents, or are fused together to form a cycle bound to the X_1 to X_{14},

at least one of R_1 to R_5 is selected from the group consisting of a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, and a substituted or unsubstituted biarylphenyl,

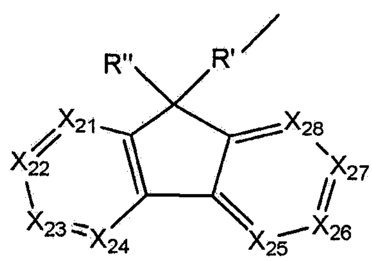
R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

R_{15} is selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene,

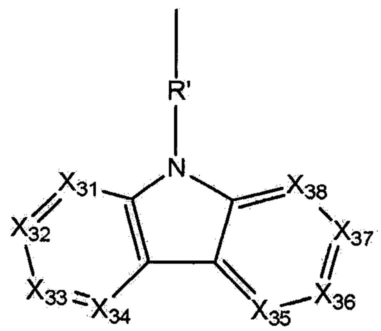
wherein the term "substituted" refers to one substituted with at least a substituent selected from the group consisting of a halogen, a cyano, a hydroxy, an amino, a substituted or unsubstituted C6 to C30 aryl, and a substituted or unsubstituted C2 to C30 heteroaryl instead of hydrogen.

2. The organic metallic complex compound of claim 1, wherein the R_1 to R_5 are independently selected from the group consisting of substituents represented by the following Chemical Formulae 2 to 6:

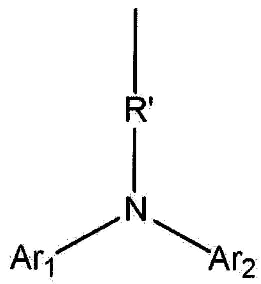
[Chemical Formula 2]



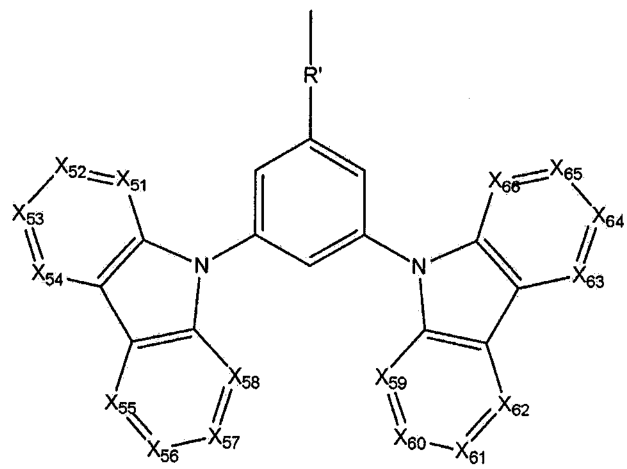
[Chemical Formula 3]



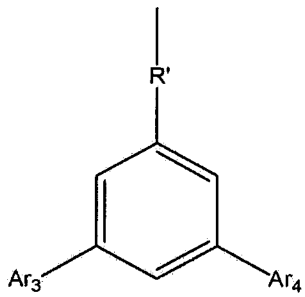
[Chemical Formula 4]



[Chemical Formula 5]



[Chemical Formula 6]



wherein, in the above Chemical Formulae 2 to 6,

X_{21} to X_{28}, X_{31} to X_{38}, and X_{51} to X_{66} are independently selected from the group consisting of CR_{18} and N,

R_{18} and R'' are independently selected from the group consisting of hydrogen, a halogen, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$, $C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

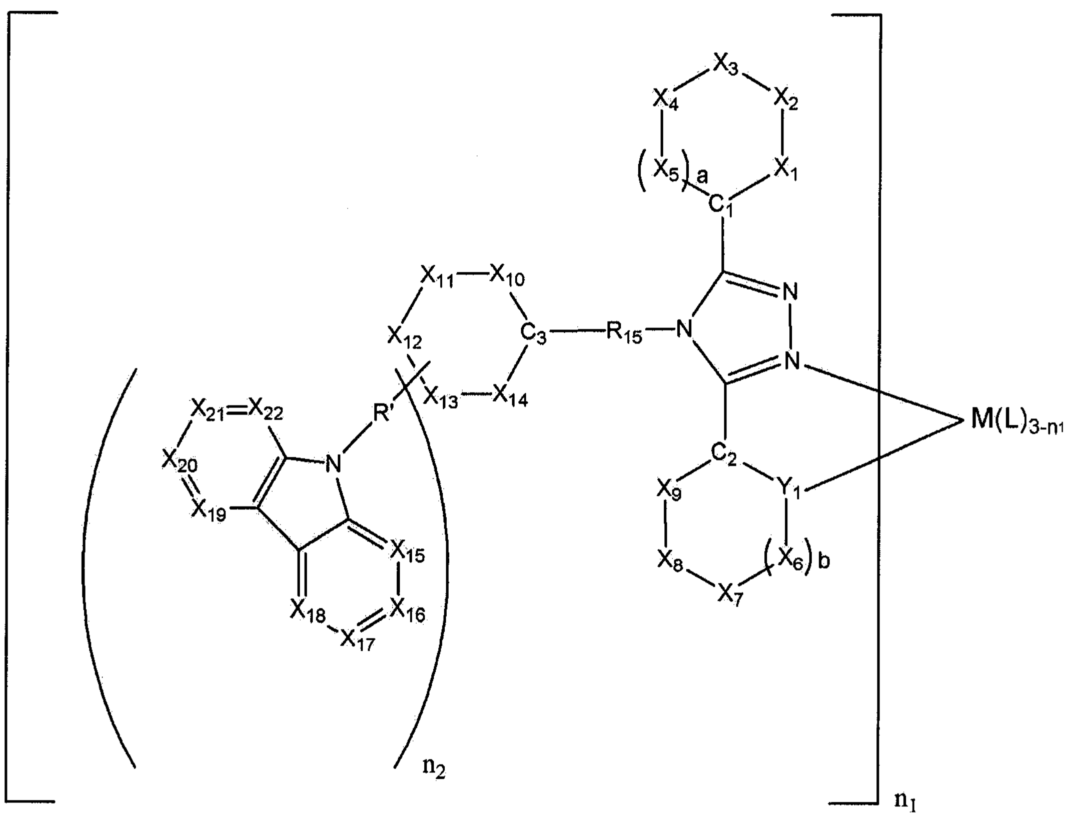
R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl,

R' is selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene, and

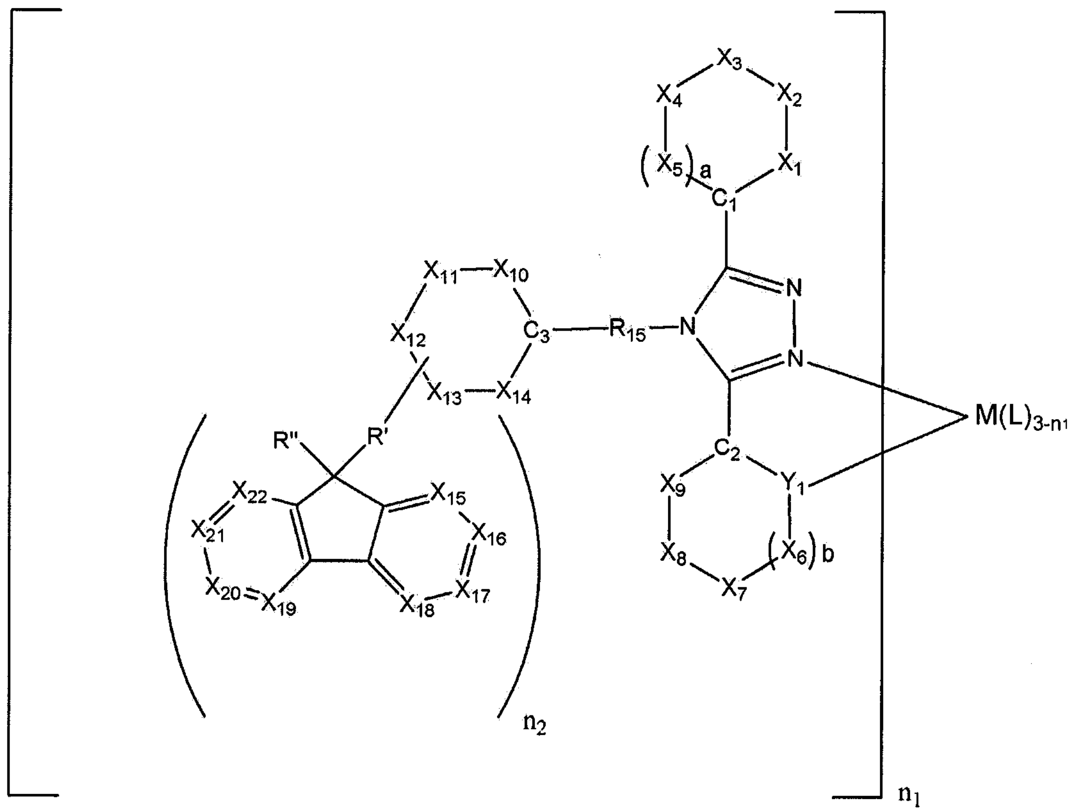
Ar_1 to Ar_4 are selected from the group consisting of a substituted or unsubstituted C6 to C30 aryl and a substituted or unsubstituted C2 to C30 heteroaryl, wherein the term "substituted" refers to one substituted with at least a substituent selected from the group consisting of a halogen, a cyano, a hydroxy, an amino, a substituted or unsubstituted C6 to C30 aryl, and a substituted or unsubstituted C2 to C30 heteroaryl instead of hydrogen.

3. The organic metallic complex compound of claim 1, wherein the organic metallic complex compound represented by the above Chemical Formula 1 is selected from the group consisting of the following Chemical Formulae 7 to 9:

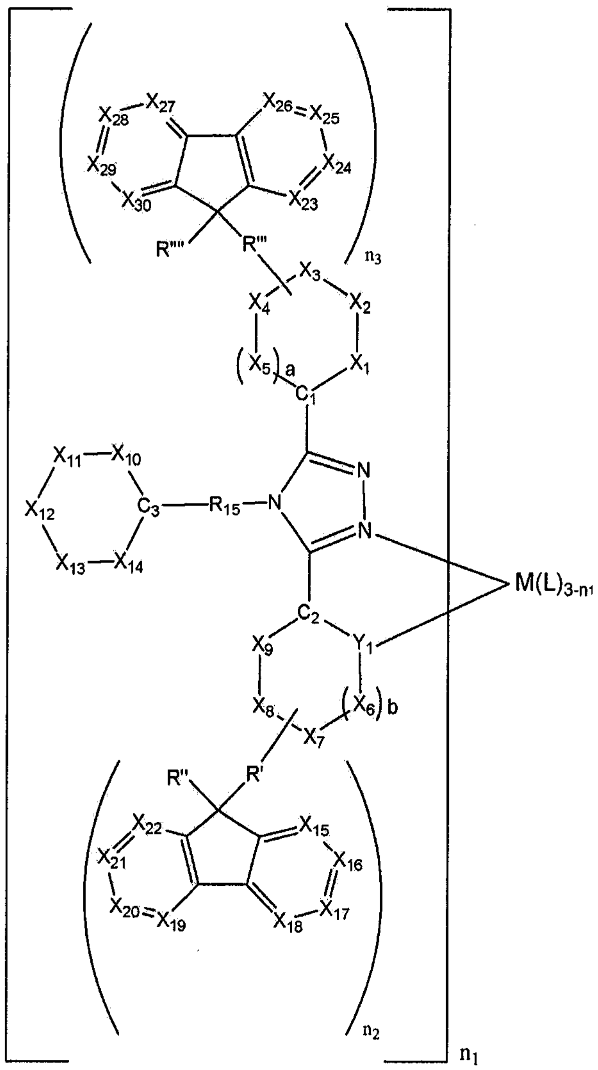
[Chemical Formula 7]



[Chemical Formula 8]



[Chemical Formula 9]



wherein, in the above Chemical Formulae 7 to 9,

n_1 is an integer ranging from 1 to 3, n_2 and n_3 are independently integers ranging from 1 to 5,

a and b are independently integers of 0 or 1,

the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aliphatic cyclic compound, a hetero aliphatic cyclic compound, an aromatic cyclic compound, and a hetero aromatic cyclic compound,

M is a metal to form an octahedral complex,

L is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom, or a monovalent anionic didentate ligand of a monovalent anion bound to M through a coordinate covalent bond with two heteroatoms,

C_1 to C_3 are $-C(R_{17})_h-$, where h is an integer of 0 or 1,

Y_1 is a monovalent anionic didentate ligand bound to M through a coordinate covalent bond with an sp^2 carbon and a heteroatom,

X_1 to X_{14} are independently $C(R_1)_i(R_2)_j$, $N(R_3)_k$, $Si(R_4)_o(R_5)_p$, O, or S, where i, j, k, o, and p are independently integers of 0 or 1, and i+j and o+p are independently integers of 1 or 2,

X_{15} to X_{30} are independently selected from the group consisting of CR_{18} and N,

R_1 to R_5, R_{17}, R_{18}, R'', and R'''' are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, N R_{162}, P R_{162}, P OR_{162}, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, Si R_{163}, Si $CH_{32}R_{16}$, Si $(Ph)_2R_{16}$, B R_{162}, B OR_{162}, C $(O)R_{16}$, $C(O)OR_{16}$, C(O)N R_{162}, CN, NO_2, SO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_1 to R_5 are present as independent substituents, or are fused together to form a cycle bound to the X_1 to X_{14},

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

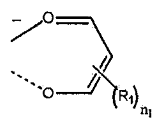
R_{15}, R', and R''' are independently selected from the group consisting of a single bond, a substituted or unsubstituted C6 to C30 arylene, a substituted or unsubstituted C2 to C30 heteroarylene, and a substituted or unsubstituted C1 to C20 alkylene,

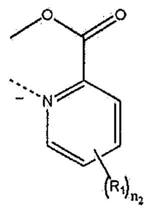
wherein the term “substituted” refers to one substituted with at least a substituent selected from the group consisting of a halogen, a cyano, a hydroxy, an amino, a substituted or unsubstituted C6 to C30 aryl, and a substituted or unsubstituted C2 to C30 heteroaryl instead of hydrogen.

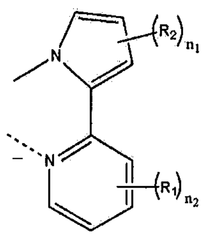
4. The organic metallic complex compound of claim 1, wherein the cyclic compound group including C_1 and X_1 to X_5, the cyclic compound group including C_2, Y_1, and X_6 to X_9, and the cyclic compound group including C_3 and X_{10} to X_{14} are independently selected from the group consisting of an aromatic cyclic compound and a hetero aromatic cyclic compound.

5. The organic metallic complex compound of claim 1, wherein the L is selected from the group consisting of ligands represented by the following Chemical Formulae 10 to 16:

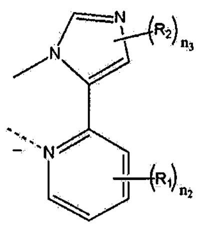
[Chemical Formula 10] [Chemical Formula 11] [Chemical Formula 12]

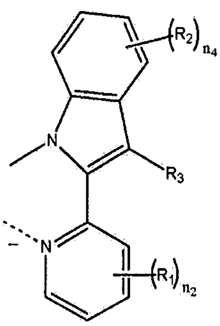


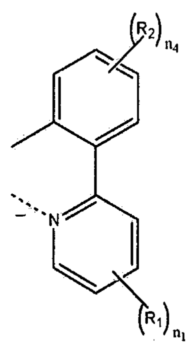




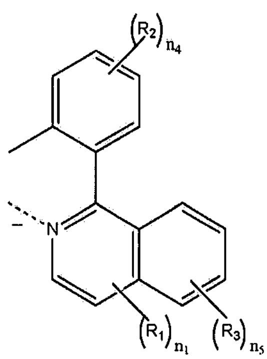
[Chemical Formula 13] [Chemical Formula 14] [Chemical Formula 15]







[Chemical Formula 16]



wherein, in the above Chemical Formulae 10 to 16,

R_1 to R_3 are independently selected from the group consisting of hydrogen, a halogen, a substituted or unsubstituted fluorene, a substituted or unsubstituted carbazole, a substituted or unsubstituted arylamine, a substituted or unsubstituted biarylphenyl, R_{16}, OR_{16}, $N(R_{16})_2$, $P(R_{16})_2$, $P(OR_{16})_2$, POR_{16}, PO_2R_{16}, PO_3R_{16}, SR_{16}, $Si(R_{16})_3$, $Si(CH_3)_2R_{16}$, $Si(Ph)_2R_{16}$, $B(R_{16})_2$, $B(OR_{16})_2$,

$C(O)R_{16}$, $C(O)OR_{16}$, $C(O)N(R_{16})_2$, CN, NO_2, SOR_{16}, SO_2R_{16}, and SO_3R_{16},

R_{16} is selected from the group consisting of a substituted or unsubstituted C1 to C30 alkyl, a substituted or unsubstituted C2 to C30 alkenyl, a substituted or unsubstituted C2 to C30 alkynyl, a substituted or unsubstituted C1 to C30 heteroalkyl, a substituted or unsubstituted C3 to C40 aryl, and a substituted or unsubstituted C3 to C40 heteroaryl, and

n_1 is an integer ranging from 1 to 3, n_2, n_4, and n_5 are integers ranging from 1 to 4, and n_3 is an integer of 1 or 2,

wherein the term “substituted” refers to one substituted with at least a substituent selected from the group consisting of a halogen, a cyano, a hydroxy, an amino, a substituted or unsubstituted C6 to C30 aryl, and a substituted or unsubstituted C2 to C30 heteroaryl instead of hydrogen.

6. The organic metallic complex compound of claim 1, wherein M is selected from the group consisting of a Group 8 element and a Group 10 element of the periodic table.

7. The organic metallic complex compound of claim 1, wherein M is selected from the group consisting of Ir, Pt, Rh, and Pd.

8. The organic metallic complex compound of claim 1, wherein M is Ir.

9. An organic photoelectric device comprising

an organic layer between a pair of electrodes,

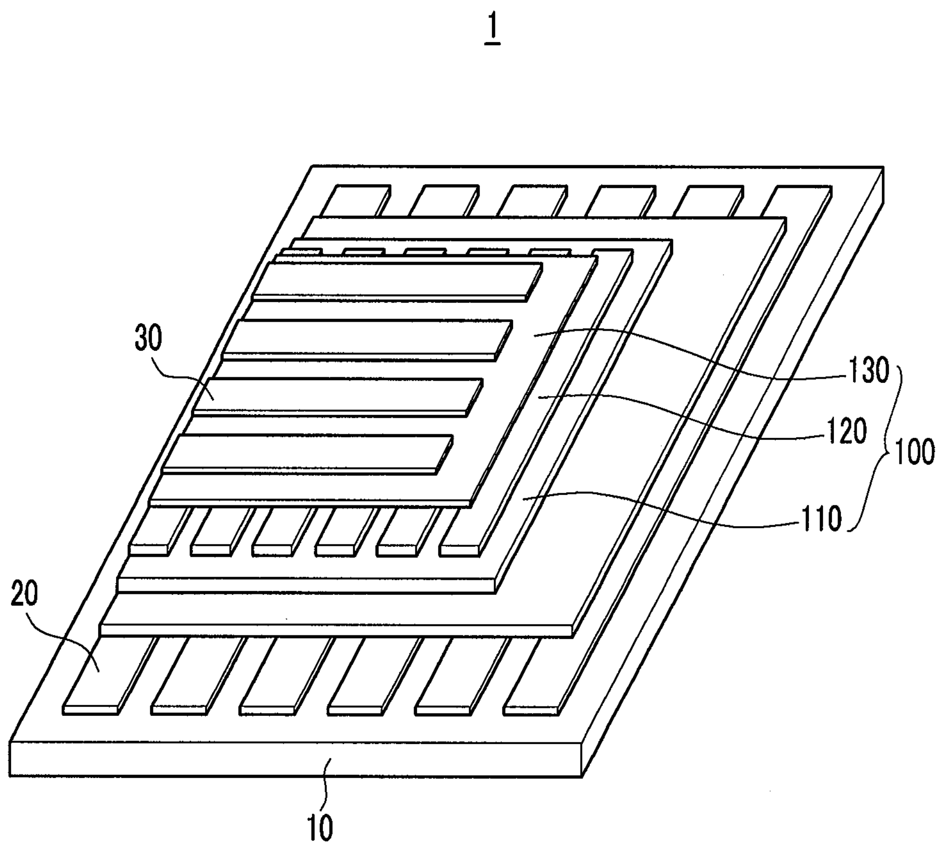
wherein the organic layer includes the organic metallic complex compound according to one of claims 1 to 8.

10. The organic photoelectric device of claim 9, wherein the organic thin layer is an emission layer.

11. The organic photoelectric device of claim 9, wherein the organic thin layer further comprises a layer selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), a hole blocking layer, and a combination thereof.

12. The organic photoelectric device of claim 9, wherein the organic thin layer further comprises a layer selected from the group consisting of an electron injection layer (EIL), an electron transport layer (ETL), an electron blocking layer, and a combination thereof.

FIG. 1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/007010

A. CLASSIFICATION OF SUBJECT MATTER

C07D 249/06(2006.01)i, C07D 209/82(2006.01)i, C07D 403/14(2006.01)i, C07D 403/08(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC : H01L

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

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

eKOMPASS(KIPO internal)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2004-220931 A (MITSUBISHI CHEMICALS CORP) 05.08.2004. see claims 1-8	1,2,4-12 3
Y	WO 03/007394 A2 (consiglio Nazionale delle Ricerche) 23.01.2003. see claim 13-16	1-12
Y	JP 2002-352957 A (HONDA MOTOR CO LTD) 06.12.2002. see claims 3-5 and descrption	1-12

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 AUGUST 2009 (10.08.2009)	**11 AUGUST 2009 (11.08.2009)**

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Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

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Authorized officer

Na, Young Min

Telephone No. 82-42-481-8394

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/007010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2004-220931 A	05.08.2004	AU 2003-242111 A1 AU 2003-242111 A1 JP 2008-208843 A WO 2003-104621 A1	09.06.2003 22.12.2003 11.09.2008 18.12.2003
WO 03/007394 A2	23.01.2003.	none	
JP 2002-352957 A	06.12.2002.	none	