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(54) METAL COORDINATION COMPOUND AND ELECTROLUMINESCENCE DEVICE

(76) Inventors: **Takao Takiguchi**, Tokyo (JP); **Akira Tsuboyama**, Kanagawa-ken (JP); **Shinjiro Okada**, Kanagawa-ken (JP); **Jun Kamatani**, Kanagawa-ken (JP); **Seishi Miura**, Kanagawa-ken (JP); **Takashi Moriyama**, Kanagawa-ken (JP); **Satoshi Igawa**, Kanagawa-ken (JP); **Manabu Furugori**, Kanagawa-ken (JP); **Hidemasa Mizutani**, Kabushiki (JP)

Correspondence Address:
FITZPATRICK CELLA HARPER & SCINTO
30 ROCKEFELLER PLAZA
NEW YORK, NY 10112 (US)

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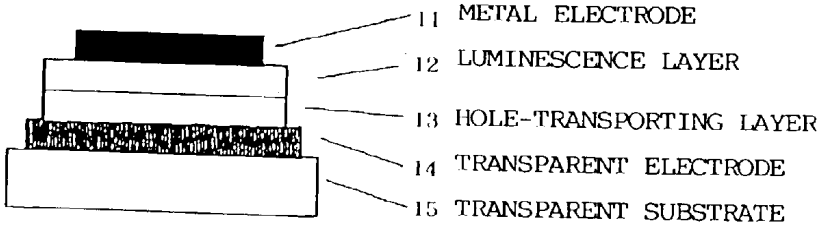
(57) **ABSTRACT**

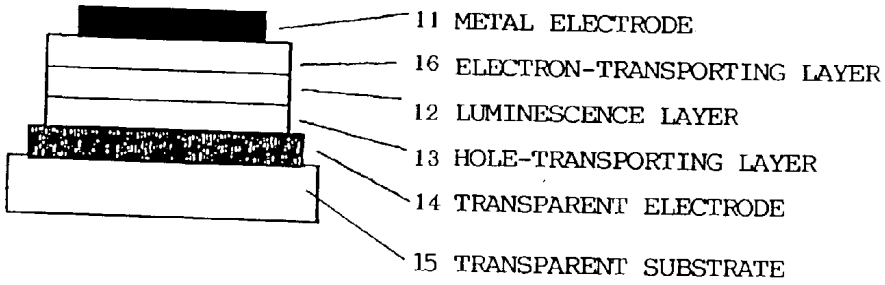
A metal coordination compound having a basic structure represented by formula: $ML_mL'_n$ (1), wherein M is a metal atom of Ir, Pt, Rh or Pd; L and L' are mutually different bidentate ligands; m is 1, 2 or 3; wherein at least one bidentate ligand has a partial structure formed by condensation via an alkylene group having 2-10 carbon atoms, is provided. In an electroluminescence device composed of one or a plurality of organic films disposed between a cathode and an anode, at least one layer is a luminescence layer which is formed by incorporating luminescence molecules constituting the metal coordination compound having a structure of the formula (1) described above as a guest material in a host material thereby to provide an electroluminescence device producing luminescence at high efficiency and stably keeping a high luminance for a long period.

FIG. 1

(a)


11 METAL ELECTRODE
12 LUMINESCENCE LAYER
13 HOLE-TRANSPORTING LAYER
14 TRANSPARENT ELECTRODE
15 TRANSPARENT SUBSTRATE

(b)


11 METAL ELECTRODE
16 ELECTRON-TRANSPORTING LAYER
12 LUMINESCENCE LAYER
13 HOLE-TRANSPORTING LAYER
14 TRANSPARENT ELECTRODE
15 TRANSPARENT SUBSTRATE

(c)

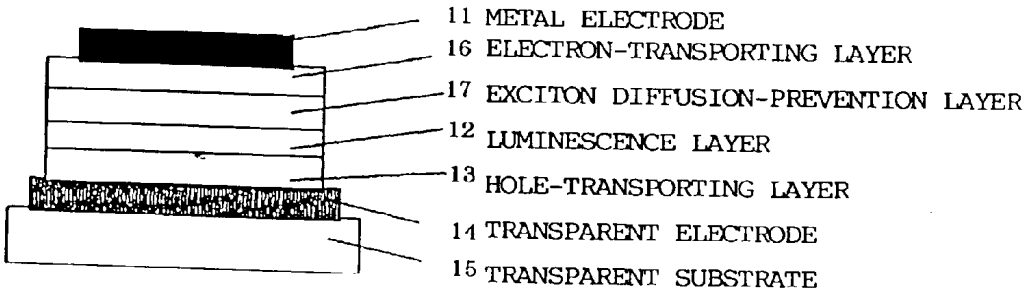

11 METAL ELECTRODE
16 ELECTRON-TRANSPORTING LAYER
17 EXCITON DIFFUSION-PREVENTION LAYER
12 LUMINESCENCE LAYER
13 HOLE-TRANSPORTING LAYER
14 TRANSPARENT ELECTRODE
15 TRANSPARENT SUBSTRATE

FIG. 2

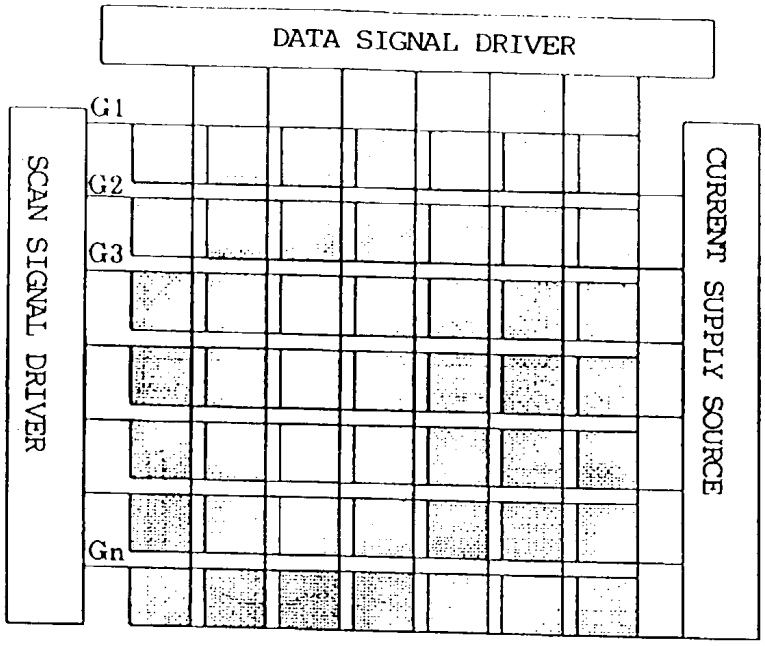
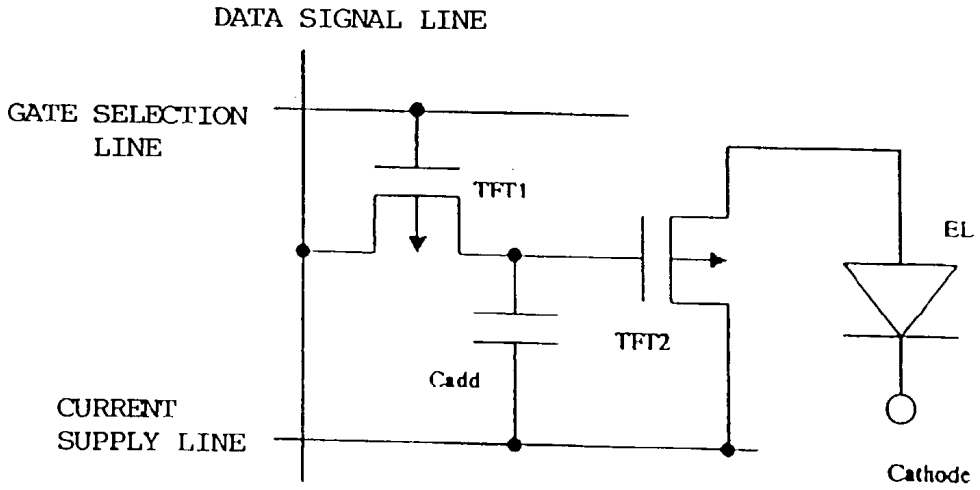

DATA SIGNAL DRIVER
SCAN SIGNAL DRIVER
CURRENT SUPPLY SOURCE
G1
G2
G3
Gn

FIG. 3


DATA SIGNAL LINE
GATE SELECTION LINE
TFT1
TFT2
Cadd
EL
CURRENT SUPPLY LINE
Cathode

METAL COORDINATION COMPOUND AND ELECTROLUMINESCENCE DEVICE

TECHNICAL FIELD

[0001] The present invention relates to an electroluminescence device using an organic compound, more particularly to an organic electroluminescence device (hereinafter, referred to as an "organic EL device") using a metal coordination compound as a luminescent material.

BACKGROUND ART

[0002] An applied study on an organic EL device as a luminescence device of a high-speed responsiveness and a high efficiency has been energetically conducted. Basic structures thereof are shown in FIGS. **1**(*a*) and (*b*) (e.g., Macromol. Symp. 125, 1-48 (1997)).

[0003] As shown in **FIG. 1**, an organic EL device generally has a structure comprising a transparent electrode **14**, a metal electrode **11**, and a plurality of organic film layers therebetween on a transparent substrate **15**.

[0004] In the device of **FIG. 1**(*a*), the organic layers comprise a luminescence layer **12** and a hole-transporting layer **13**. For the transparent electrode **14**, ITO, etc., having a large work function are used, for providing a good hole-injection characteristic from the transparent electrode **14** to the hole-transporting layer **13**. For the metal electrode **11**, a metal, such as aluminum, magnesium or an alloy of these, having a small work function is used for providing a good electron-injection characteristic to the organic layers. These electrodes have a thickness of 50-200 nm.

[0005] For the luminescence layer **12**, aluminum guinolynol complexes (a representative example thereof is Alq3 shown hereinafter), etc., having an electron-transporting characteristic and luminescence characteristic are used. For the hole-transporting layer **13**, biphenyldiamine derivatives (a representative example thereof is α-NPD shown hereinafter), etc., having an electron-donative characteristic are used.

[0006] The above-structured device has a rectifying characteristic, and when an electric field is applied between the metal electrode **11** as a cathode and the transparent electrode **14** as an anode, electrons are injected from the metal electrode **11** into the luminescence layer **12** and holes are injected from the transparent electrode **15**. The injected holes and electrons are recombined within the luminescence layer **12** to form excitons and cause luminescence. At this time, the hole-transporting layer **13** functions as an electron-blocking layer to increase the recombination efficiency at a boundary between the luminescence layer **12** and hole-transporting layer **13**, thereby increasing the luminescence efficiency.

[0007] Further, in the structure of **FIG. 1**(*b*), an electron-transporting layer **16** is disposed between the metal electrode **11** and the luminescence layer **12**. By separating the luminescence and the electron and hole-transportation to provide a more effective carrier blocking structure, efficient luminescence can be performed. For the electron-transporting layer **16**, an electron-transporting material, such as an oxadiazole derivative, can be used.

[0008] Luminescence used heretofore in organic EL devices generally includes two types including fluorescence and phosphorescence. In a fluorescence device, fluorescence at the time of transition of luminescence material molecule from a singlet exciton state to the ground state is produced. On the other hand, in a phosphorescence device, luminescence via a triplet exciton state is utilized.

[0009] In recent years, the phosphorescence device providing a higher luminescence yield than the fluorescence device has been studied.

[0010] Representative published literature may include:

[0011] Article 1: Improved energy transfer in electrophosphorescent device (D. F. O'Brien, et al., Applied Physics Letters, Vol. 74, No. 3, p. 422 (1999)); and

[0012] Article 2: Very high-efficiency green organic light-emitting devices based on electrophosphorescence (M. A. Baldo, et al., Applied Physics Letters, Vol. 75, No. 1, p. 4 (1999)).

[0013] In these articles, a structure including 4 organic layers as shown in **FIG. 1**(*c*) has been principally used, including, from the anode side, a hole-transporting layer **13**, a luminescence layer **12**, an exciton diffusion-prevention layer **17** and an electron-transporting layer **16**. Materials used therein include carrier-transporting materials and phosphorescent materials. Abbreviations of the respective materials are as follows.

[0014] Alq3: aluminum quinolinol complex

[0015] α-NPD: N4,N4'-di-naphthalene-1-yl-N4,N4'-diphenyl-biphenyl-4,4'-diamine

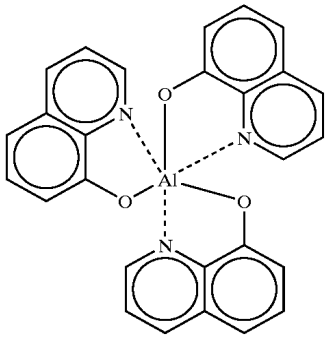
[0016] CBP: 4,4'-N,N'-dicarbazole-biphenyl

[0017] BCP: 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline

[0018] PtOEP: platinum-octaethylporphyrin complex

[0019] $Ir(ppy)_3$: iridium-phenylpyrimidine complex

AIq3



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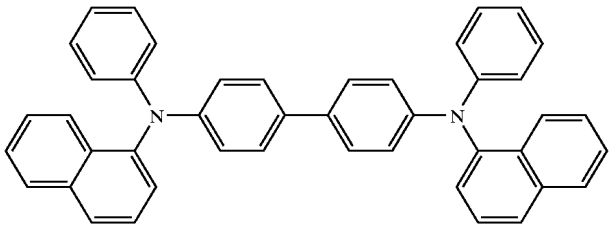
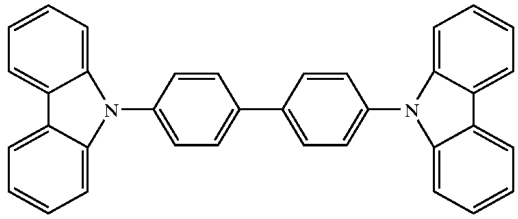
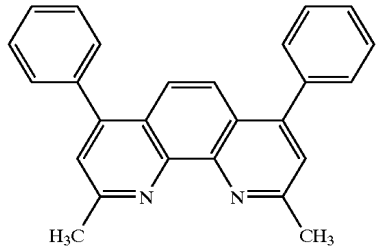
α-NPD



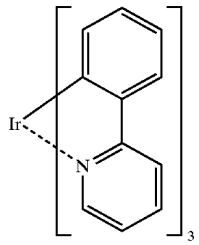
CBP



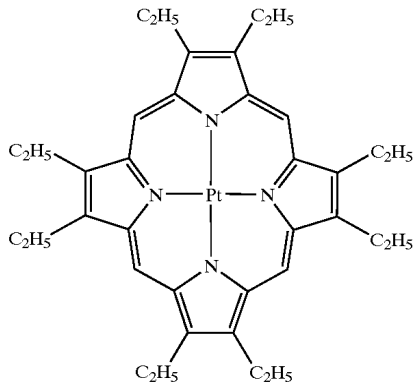
BCP



Ir(ppy)3



PtOEP



[0020] However, the organic EL device utilizing phosphorescence described above is accompanied with a problem regarding a deterioration in luminescence particularly in an energization state. The reason of the deterioration has not been clarified, but is conceived as follows. Generally, a life of the triplet excitons is longer by three or more digits than the life of a singlet exciton, so that excited molecules are held in a high-energy state for a longer period. As a result, it may be considered that reaction with surrounding materials such as polymer formation among the excitons, a change in minute molecular structure and a change in structure of the surrounding material are caused.

[0021] Anyway, the phosphorescence device is expected to have a high luminescence efficiency but on the other hand, the device is problematic in terms of deterioration in energized state. As a result, the luminescent material used in the phosphorescence device is desired to be a compound providing a high-efficiency luminescence and a high stability.

DISCLOSURE OF INVENTION

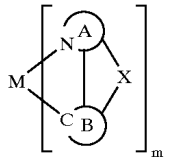
[0022] Accordingly, an object of the present invention is to provide a luminescence device allowing high-efficiency luminescence, retaining a high luminance or brightness for a long period and exhibiting a stability. The present invention provides a particular metal coordination compound as a novel luminescent material therefor.

[0023] A metal coordination compound according to the present invention is represented by the following formula (1):

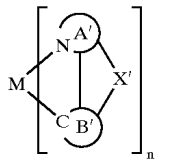
$$ML_mL'_n \quad (1),$$

[0024] wherein M is a metal atom of Ir, Pt, Rh or Pd; L and L' are mutually different bidentate ligands; m is 1, 2 or 3; n is 0, 1 or 2 with the proviso that m+n is 2 or 3; a partial structure ML_m is represented by formula (2) shown below and a partial structure ML'_n is represented by formula (3), (4) or (5) shown below:

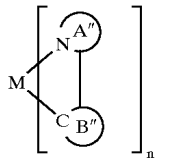
(2)



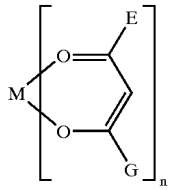
(3)



(4)



(5)



[0025] wherein N and C are nitrogen and carbon atoms, respectively; A, A' and A" are respectively a cyclic group

capable of having a substituent and connected to the metal atom M via the nitrogen atom; B, B' and B" are respectively a cyclic group capable of having a substituent and connected to the metal atom M via the carbon atom;

[0026] {wherein the substituent denotes a halogen atom, a cyano group, a nitro group, a trialkylsilyl group (of which the alkyl groups are independently a linear or branched alkyl group having 1 to 8 carbon atoms), a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom), or an aromatic cyclic group capable of having a substituent (of which the substituent denotes a halogen atom, a cyano group, a nitro group, a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom)};

[0027] A and B, A' and B', and A" and B" are respectively bonded to each other via a covalent bond; and

[0028] A and B, and A' and B' are bonded to each other via X and X', respectively, in which X and X' are respectively a linear or branched alkylene group having 2-10 carbon atoms (of which the alkylene group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkylene group can include a hydrogen atom that can be replaced with a fluorine atom); and

[0029] E and G are independently a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom), or an aromatic cyclic group capable of having a substituent (of which the substituent denotes a halogen atom, a cyano group, a nitro group, a trialkylsilyl group (of which the alkyl groups are independently a linear or branched alkyl group having 1 to 8 carbon atoms), or a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom)).

[0030] In the metal coordination compound according to the present invention; n in the formula (1) may preferably be 0, the partial structure ML'_n in the formula (1) may preferably be represented by the formula (3), the partial structure ML'_n in the formula (1) may preferably be represented by the formula (4), and the partial structure ML'_n in the formula (1) may preferably be represented by the formula (5).

[0031] Further, X in the formula (1) may preferably be a linear or branched alkylene group having 2-6 carbon atoms (of which the alkylene group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkylene group can include a hydrogen atom that can be replaced with a fluorine atom).

[0032] Further, M in the formula (1) may preferably be Ir.

[0033] Further, the present invention provides an electroluminescence device, wherein a layer comprising the above-mentioned metal coordination compound is sandwiched between opposing two electrodes between which a voltage is applied thereby to provide luminescence.

[0034] Particularly, an electroluminescence device causing phosphorescence by application of an electric field is preferred.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] **FIG. 1** illustrates embodiments of the luminescence device according to the present invention, wherein (a) is a device structure comprising 2 organic layers, (b) is a device structure comprising 3 organic layers, and (c) is a device structure comprising 4 organic layers.

[0036] **FIG. 2** schematically illustrates an example of a panel structure including an organic EL device and drive means.

[0037] **FIG. 3** illustrates an example of pixel circuit using TFTs (thin film transistors).

BEST MODE FOR PRACTICING THE INVENTION

[0038] Needless to say, in the case of constituting a luminescence layer with a carrier-transporting host material and a luminescent guest, the luminescent material per se requires a high quantum yield but it is important to efficiently effect energy transfer between host materials or between host and guest materials, in order to enhance a luminescence efficiency of an organic EL device. Further, the reason of a deterioration in luminescence by current application (energization) has not been clarified as yet but may be considered to be associated with at least an environmental change of the luminescent material due to the luminescence material by itself or its surrounding materials.

[0039] The present inventors have conducted various studies and have found the above-mentioned metal coordination compound of the formula (1) and also that an organic EL device using the luminescent material allows high-efficiency luminescence, keeps a high luminance (brightness) for a long period, and causes less deterioration under current application.

[0040] In the metal coordination compound represented by the above-mentioned formula (1), n may preferably be 0 or 1, more preferably 0. Further, the partial structure ML'n may preferably be represented by the above-mentioned formula (3). Further, in the formula (1) described above, X may preferably be a linear or branched alkylene group having 2-6 carbon atoms (of which the alkylene group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—,

—CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkylene group can include a hydrogen atom that can be replaced with a fluorine atom). Further, M in the formula may preferably be Ir or Rh, more preferably Ir.

[0041] The metal coordination compound used in the present invention emits phosphorescence, and its lowest excited state is believed to be an MLCT* (metal-to-ligand charge transfer) excited state or π-π* excited state in a triplet state. Phosphorescence is caused at the time of transition from such a state to the ground state.

[0042] By utilizing phosphorescence by photo-excitation, it is possible to determine a phosphorescence yield and a life of phosphorescence.

[0043] <Measuring Methods of Physical Properties>

[0044] Hereinbelow, measuring methods of physical properties in the present invention will be described.

[0045] (1) Discrimination Method between Phosphorescence and Fluorescence

[0046] Discrimination of phosphorescence was effected whether a sample compound caused oxygen deactivation or not. The compound is dissolved in chloroform and divided into a solution aerated with oxygen and a solution aerated with nitrogen, followed by irradiation with light to compare their photoluminescence. As a result, luminescence resulting from the compound is little observed with respect to the oxygen-aerated solution, whereas photoluminescence can be confirmed with respect to the nitrogen-aerated solution, thus discriminating these luminescence. Hereinafter, with respect to all the compounds according to the present invention, photoluminescence is confirmed by this method unless otherwise noted specifically.

[0047] (2) A phosphorescence yield used in the present invention may be determined according to the following formula:

$$\Phi(\text{sample})/\Phi(st)=[Sem(\text{sample})/Iabs(\text{sample})]/[Sem(st)/Iabs(st)],$$

[0048] wherein Iabs(st) denotes an absorption coefficient at an excitation wavelength of the standard sample; Sem(st), a luminescence spectral areal intensity when excited at the same wavelength: Iabs(sample), an absorption coefficient at an excitation wavelength of an objective compound; and Sem(sample), a luminescence spectral areal intensity when excited at the same wavelength.

[0049] Phosphorescence quantum yield values described herein are relative quantum yield with respect to a quantum yield Φ=1 of $Ir(ppy)_3$ as a standard sample.

[0050] (3) Method of Measurement of Phosphorescence Life

[0051] A compound is dissolved in chloroform and spin-coated onto a quartz substrate in a thickness of ca. 0.1 μm and used as a sample for measurement. This sample is exposed to pulsative nitrogen laser light at an excitation wavelength of 337 nm at room temperature by using a luminescence life meter (made by Hamamatsu Photonics K.K.). After completion of the excitation pulses, the decay time of luminescence intensity is measured.

[0052] When an initial luminescence intensity is denoted by I_0, a luminescence intensity after t(sec) is defined according to the following formula with reference to a luminescence life τ(sec):

$$I=I_0 \cdot exp(-t/\tau).$$

[0053] A phosphorescence yield of the metal coordination compound of the present invention is a high value of 0.11-0.8, and a phosphorescence life is a short one of 1-40 μsec.

[0054] If the phosphorescence life is long, the number of molecules in a triplet excited state waiting for the luminescence when used in an organic EL device is increased, thus leading to a problem of a lowering in luminescence efficiency particularly at a high current density. Accordingly, in order to enhance the luminescence efficiency, it is effective to shorten the above-mentioned phosphorescence life. The metal coordination compound of the present invention is a suitable luminescence material for an organic EL device because of a high phosphorescence yield and a short phosphorescence life.

[0055] Further, because rotational vibration in a dihedral angle direction between the cyclic groups A and B within a molecule is suppressed by the alkylene group represented by X in the formula (2) characterizing the present invention (and further that between the cyclic groups A' and B' in a molecule is suppressed by the alkylene group shown by X' in the case where the partial structure ML'n is represented by the formula (3)), it may be considered that the metal coordination compound of the present invention is decreased in intermolecular energy deactivation pass to accomplish a high efficiency luminescence.

[0056] Further, by appropriately selecting the length of the above-mentioned alkylene groups, it becomes possible to change dihedral angles between the cyclic groups A and B and between the cyclic groups A and B and between the cyclic groups A' and B' within molecule to allow control of emission wavelength, particularly shift to shorter wavelength.

[0057] Also from the above-described viewpoint, the metal coordination compound of the present invention is suitable as a luminescent material for the organic EL device.

[0058] Further, as shown in Examples described hereinafter, it has been clarified that the metal coordination compound of the present invention exhibited an excellent performance for stability in a current conduction durability test. By a state change in intermolecular interaction due to introduction of the above-mentioned alkylene group(s) as a characteristic feature of the present invention, it is possible to control intermolecular interaction with a host material etc., thus suppressing formation of excited association product causing thermal deactivation. As a result, it may be considered that the device characteristic is improved.

[0059] <Synthesis of Iridium Coordination Compound>

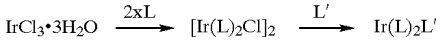
[0060] Synthesis schemes of the metal coordination compound represented by the above-mentioned formula (1) used in the present invention will be shown by taking an iridium coordination compound as an example.

[0061] Synthesis of iridium coordination compound

$$Ir(CH_3COCHCOCH_3)_3 \xrightarrow{3xL} Ir(L)_3$$

or

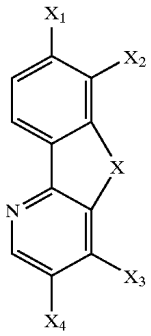
-continued



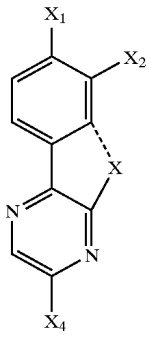
[0062] Hereinbelow, specific structural formulas of the metal coordination compound used in the present invention are shown in Tables 1-1 to 1-14, which are however only representative examples and the present invention is not restricted to these examples.

[0063] L_1-L_{11}' used in Tables 1-1 to 1-14 have structures shown below.

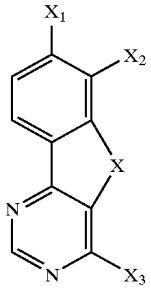
L_1



L_2



L_3



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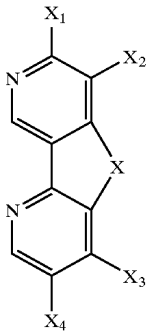
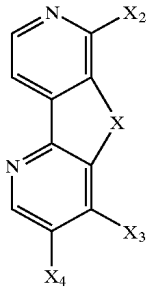
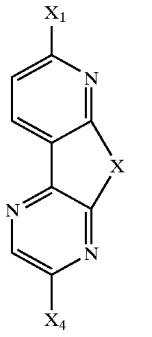
L_4



L_5



L_6



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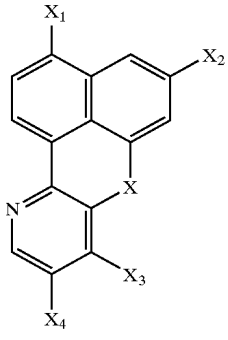

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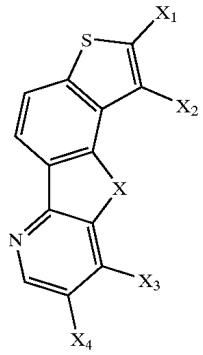
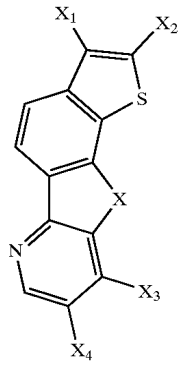
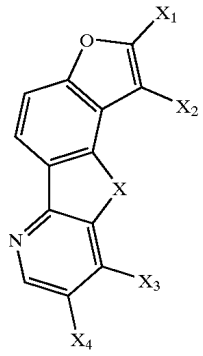


L_9



L_{10}



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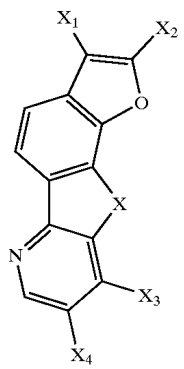

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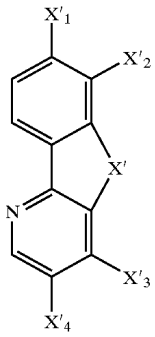
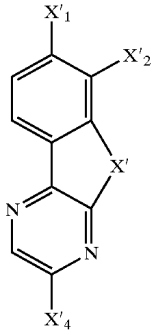


L_2'



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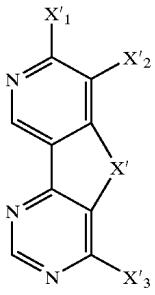

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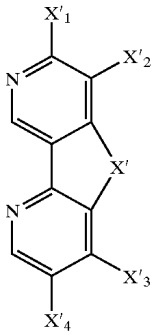

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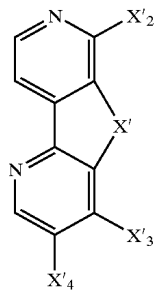
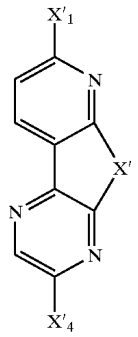
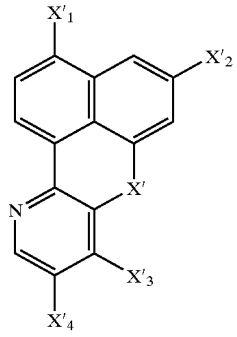
L_5'



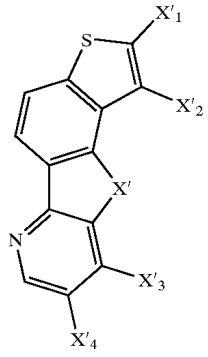
L_6'



L_7'



L_8'



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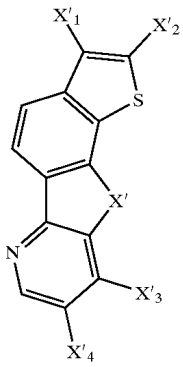
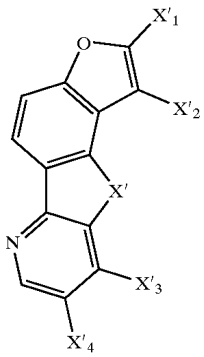
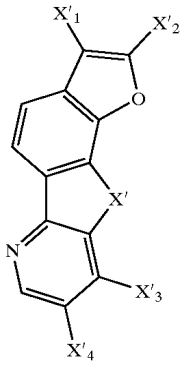
L_9'



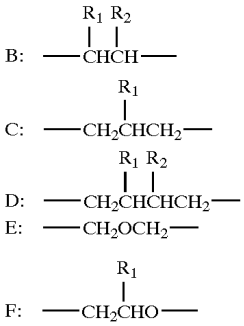
L_{10}'



L_{11}'



[0064] B-M' used for X and X' in Tables 1-1 to 1-14 have structures shown below.



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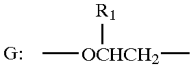
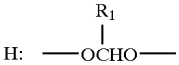
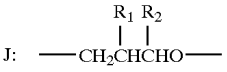
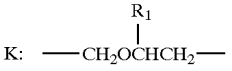
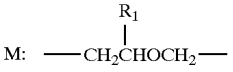
G: 

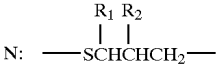
H: 

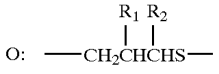
I: 

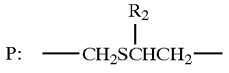
J: 

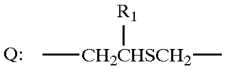
K: 

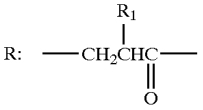
M: 

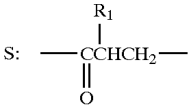
N: 

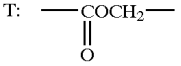
O: 

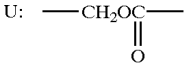
P: 

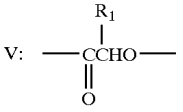
Q: 

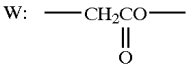
R: 

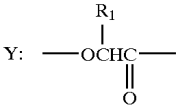
S: 

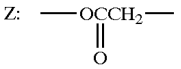
T: 

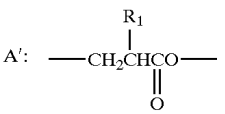
U: 

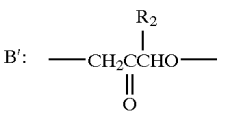
V: 

W: 

Y: 

Z: 

A′: 

B′: 

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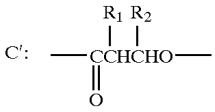
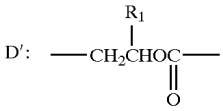
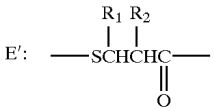
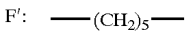
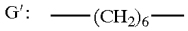
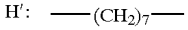
C′: 

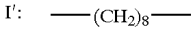
D′: 

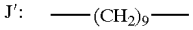
E′: 

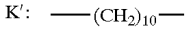
F′: 

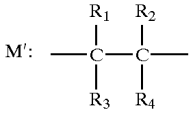
G′: 

H′: 

I′: 

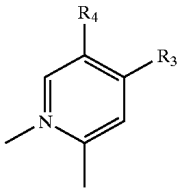
J′: 

K′: 

M′: 

[**0065**] Pi-Qn2 used for A" and B" in Tables 1-10 and 1-11 have structures shown below.

Pi:



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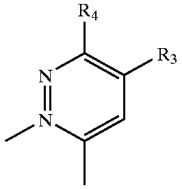
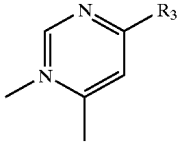
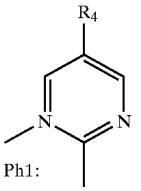


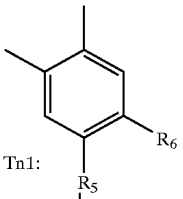
Py1:



Py2: -continued



Ph1:



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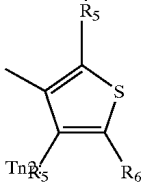
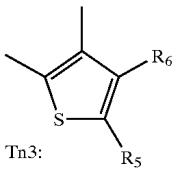
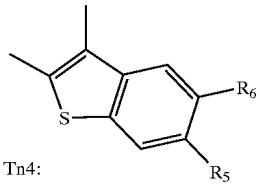


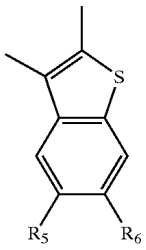
Tn2:



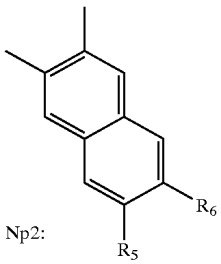
Tn3:



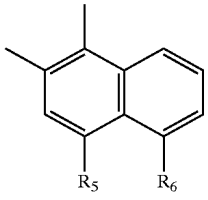
Tn4:



Np1:



Np2:



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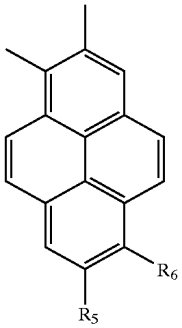
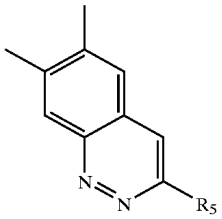
Pe1:



Cn1:



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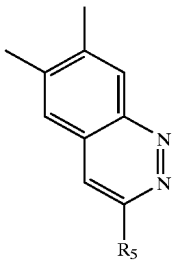

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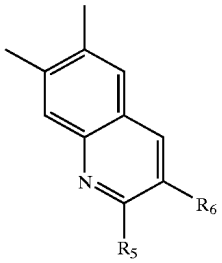

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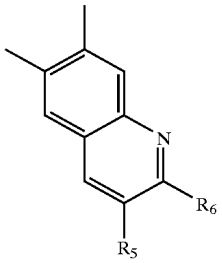


[0066] Further, L and L', aromatic groups present as substituents for the cyclic structures A" and B", and Ph2 to Ph3 used for E and G in Tables 1-1 to 1-14 have structures shown below.

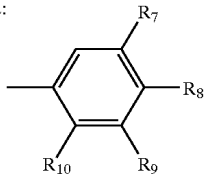
TABLE 1 1

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
1	Ir	3	0	L1	B	H	H	H	H	H	H	—	—	—	—
2	Ir	3	0	L1	B	H	H	F	H	H	H	—	—		
3	Ir	3	0	L1	B	H	H	H	F	H	H				
4	Ir	3	0	L1	B	H	H	F	F	H	H				
5	Ir	3	0	L1	B	H	H	CF3	H	H	H	—	—	—	—
6	Ir	3	0	L1	B	H	H	H	CF3	H	H	—	—	—	—
7	Ir	3	0	L1	B	H	H	F	CF3	H	H				
8	Ir	3	0	L1	B	H	H	CF3	F	H	H	—	—		
9	Ir	3	0	L1	B	H	H	CI	CF3	H	H	—	—	—	
10	Ir	3	0	L1	B	H	H	CH3	H	H	H	—	—	—	
11	Ir	3	0	L1	B	H	H	H	CH3	H	H	—	—	—	
12	Ir	3	0	L1	B	H	H	OCH3	H	H	H	—	—	—	
13	Ir	3	0	L1	B	H	H	H	OCH3	H	H	—	—	—	
14	Ir	3	0	L1	B	H	H	OCF3	H	H	H	—	—	—	
15	Ir	3	0	L1	B	H	H	H	OcF3	H	H	—	—	—	—
16	Ir	3	0	L1	B	H	H	CI	H	H	H	—	—	—	
17	Ir	3	0	L1	B	H	H	H	CI	H	H	—	—	—	
18	Ir	3	0	L1	B	H	H	Br	H	H	H				
19	Ir	3	0	L1	B	H	H	H	Br	H	H	—	—	—	
20	Ir	3	0	L1	B	H	H	H	OC4H9	H	H	—	—	—	
21	Ir	3	0	L1	B	H	H	OC4H9	H	H	H	—	—	—	
22	Ir	3	0	L1	B	H	H	H	OCH(CH3)2	H	H	—	—	—	—
23	Ir	3	0	L1	B	H	H	Br	H	H	H	—			
24	Ir	3	0	L1	B	H	H	H	H	CI	H				
25	Ir	3	0	L1	B	H	H	H	H	H	CI	—	—	—	—
26	Ir	3	0	L1	B	H	H	H	H	CF3	H	—	—		
27	Ir	3	0	L1	B	H	H	H	H	H	CF3				
28	Ir	3	0	L1	B	H	H	Ph3	H	H	H	—	—		
29	Ir	3	0	L1	B	H	H	Ph3	H	H	CF3				
30	Ir	3	0	L1	B	H	H	Ph2	H	H	H	H	F	H	H
31	Ir	3	0	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
32	Ir	3	0	L1	B	H	H	Tn5	H	H	H	H	H	—	—
33	Ir	3	0	L1	B	H	H	Np3	H	H	H	H	H	—	
34	Ir	3	0	L1	B	H	H	H	Tn5	H	H	H	H	—	—
35	Ir	3	0	L1	B	H	H	Tn7	H	H	H	H	H	—	—
36	Ir	3	0	L1	B	H	H	Pe2	H	H	H	H	—	—	—
37	Ir	3	0	L1	B	H	H	Tn8	H	H	H	H	H	—	
38	Ir	3	0	L1	B	H	H	Np4	H	H	H	H	—		
39	Ir	3	0	L1	B	H	H	Tn6	H	H	H	H	H	—	—
40	Ir	3	0	L1	B	CH3	H	H	H	H	H	—	—	—	—
41	Ir	3	0	L1	B	CH3	H	F	H	H	H	—	—	—	
42	Ir	3	0	L1	B	CH3	H	CF3	H	H	H	—	—	—	—
43	Ir	3	0	L1	B	CH3	H	H	CF3	H	H	—			
44	Ir	3	0	L1	B	CH3	H	F	CF3	H	H	—	—		
45	Ir	3	0	L1	B	H	CH3	CF3	F	H	H	—	—		
46	Ir	3	0	L1	B	H	CH3	CI	CF3	H	H	—	—		
47	Ir	3	0	L1	B	H	CH3	OC4H9	H	H	H	—	—	—	—
48	Ir	3	0	L1	B	H	CH3	H	OCH(CH3)2	H	H	—	—	—	
49	Ir	3	0	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H

TABLE 1 1-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
50	Ir	3	0	L1	B	H	CH3	Np3	H	H	H	H	H	—	—

Ph2:



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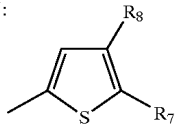
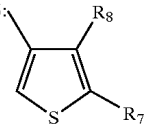
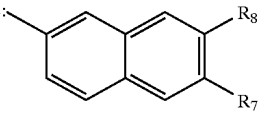


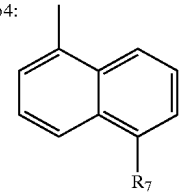
Tn6:



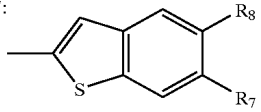
Npe:



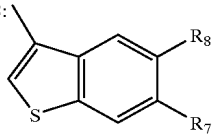
Np4:



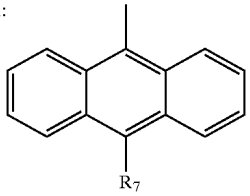
Tn7:



Tn8:



An:



Pe2:

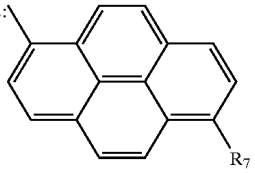
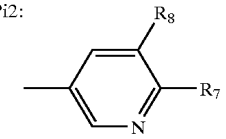
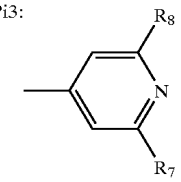
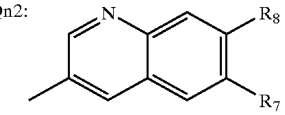
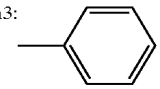


TABLE 1 1-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
Pi2: 															
Pi3: 															
Qn2: 															
Ph3: 															

[0067]

TABLE 1-2

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
51	Ir	3	0	L1	B	H	CH3	Tn6	H	H	H	H	H	—	—
52	Ir	3	0	L1	B	CH3	CH3	H	H	H	H	—	—	—	—
53	Ir	3	0	L1	C	H	—	H	H	H	H	—	—	—	—
54	Ir	3	0	L1	C	H	—	F	H	H	H	—	—	—	—
55	Ir	3	0	L1	C	H	—	H	F	H	H	—	—	—	—
56	Ir	3	0	L1	C	H	—	F	F	H	H	—	—	—	—
57	Ir	3	0	L1	C	H	—	CF3	H	H	H	—	—	—	—
58	Ir	3	0	L1	C	H	—	H	CF3	H	H	—	—	—	—
59	Ir	3	0	L1	C	H	—	F	CF3	H	H	—	—	—	—
60	Ir	3	0	L1	C	H	—	CF3	F	H	H	—	—	—	—
61	Ir	3	0	L1	C	H	—	Cl	CF3	H	H	—	—	—	—
62	Ir	3	0	L1	C	H	—	CH3	H	H	H	—	—	—	—
63	Ir	3	0	L1	C	H	—	H	CH3	H	H	—	—	—	—
64	Ir	3	0	L1	C	H	—	OCH3	H	H	H	—	—	—	—
65	Ir	3	0	L1	C	H	—	H	OCH3	H	H	—	—	—	—
66	Ir	3	0	L1	C	H	—	OCF3	H	H	H	—	—	—	—
67	Ir	3	0	L1	C	H	—	H	OCF3	H	H	—	—	—	—
68	Ir	3	0	L1	C	H	—	Cl	H	H	H	—	—	—	—
69	Ir	3	0	L1	C	H	—	H	Cl	H	H	—	—	—	—
70	Ir	3	0	L1	C	H	—	Br	H	H	H	—	—	—	—
71	Ir	3	0	L1	C	H	—	H	Br	H	H	—	—	—	—
72	Ir	3	0	L1	C	H	—	H	OC4H9	H	H	—	—	—	—
73	Ir	3	0	L1	C	H	—	OC4H9	H	H	H	—	—	—	—
74	Ir	3	0	L1	C	H	—	H	OCH(CH3)2	H	H	—	—	—	—
75	Ir	3	0	L1	C	H	—	Br	H	H	H	—	—	—	—
76	Ir	3	0	L1	C	H	—	H	H	Cl	H	—	—	—	—
77	Ir	3	0	L1	C	H	—	H	H	H	Cl	—	—	—	—
78	Ir	3	0	L1	C	H	—	H	H	CF3	H	—	—	—	—
79	Ir	3	0	L1	C	H	—	H	H	H	CF3	—	—	—	—
80	Ir	3	0	L1	C	H	—	Ph3	H	H	H	—	—	—	—
81	Ir	3	0	L1	C	H	—	Ph3	H	H	CF3	—	—	—	—
82	Ir	3	0	L1	C	H	—	Ph2	H	H	H	H	F	H	H
83	Ir	3	0	L1	C	H	—	Ph2	H	H	H	H	H	CF3	H
84	Ir	3	0	L1	C	H	—	Tn5	H	H	H	H	H	—	—
85	Ir	3	0	L1	C	H	—	Np3	H	H	H	H	H	—	—
86	Ir	3	0	L1	C	H	—	H	Tn5	H	H	H	H	—	—
87	Ir	3	0	L1	C	H	—	Tn7	H	H	H	H	H	—	—

TABLE 1-2-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
88	Ir	3	0	L1	C	H	—	Pe2	H	H	H	H	—	—	—
89	Ir	3	0	L1	C	H	—	Tn8	H	H	H	H	H	—	—
90	Ir	3	0	L1	C	H	—	Np4	H	H	H	H	—	—	—
91	Ir	3	0	L1	C	H	—	Tn6	H	H	H	H	H	—	—
92	Ir	3	0	L1	C	CH3	—	H	H	H	H	—	—	—	—
93	Ir	3	0	L1	C	CH3	—	F	H	H	H	—	—	—	—
94	Ir	3	0	L1	C	CH3	—	CF3	H	H	H	—	—	—	—
95	Ir	3	0	L1	C	CH3	—	H	CF3	H	H	—	—	—	—
96	Ir	3	0	L1	C	CH3	—	F	CF3	H	H	—	—	—	—
97	Ir	3	0	L1	C	CH3	—	CF3	F	H	H	—	—	—	—
98	Ir	3	0	L1	C	CH3	—	Cl	CF3	H	H	—	—	—	—
99	Ir	3	0	L1	C	CH3	—	OC4H9	H	H	H	—	—	—	—
100	Ir	3	0	L1	C	CH3	—	H	OCH(CH3)2	H	H	—	—	—	—

[0068]

TABLE 1-3

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
101	Rh	3	0	L1	B	H	H	H	H	H	H	—	—	—	—
102	Rh	3	0	L1	B	H	H	F	H	H	H	—	—	—	—
103	Rh	3	0	L1	B	H	H	H	F	H	H	—	—	—	—
104	Rh	3	0	L1	B	H	H	F	F	H	H	—	—	—	—
105	Rh	3	0	L1	B	H	H	CF3	H	H	H	—	—	—	—
106	Rh	3	0	L1	B	H	H	H	CF3	H	H	—	—	—	—
107	Rh	3	0	L1	B	H	H	F	CF3	H	H	—	—	—	—
108	Rh	3	0	L1	B	H	H	CF3	F	H	H	—	—	—	—
109	Rh	3	0	L1	B	H	H	Cl	CF3	H	H	—	—	—	—
110	Rh	3	0	L1	B	H	H	CH3	H	H	H	—	—	—	—
111	Rh	3	0	L1	B	H	H	H	CH3	H	H	—	—	—	—
112	Rh	3	0	L1	B	H	H	OCH3	H	H	H	—	—	—	—
113	Rh	3	0	L1	B	H	H	H	OCH3	H	H	—	—	—	—
114	Rh	3	0	L1	B	H	H	OCF3	H	H	H	—	—	—	—
115	Rh	3	0	L1	B	H	H	H	OCF3	H	H	—	—	—	—
116	Rh	3	0	L1	B	H	H	Cl	H	H	H	—	—	—	—
117	Rh	3	0	L1	B	H	H	H	Cl	H	H	—	—	—	—
118	Rh	3	0	L1	B	H	H	Br	H	H	H	—	—	—	—
119	Rh	3	0	L1	B	H	H	H	Br	H	H	—	—	—	—
120	Rh	3	0	L1	B	H	H	H	OC4H9	H	H	—	—	—	—
121	Rh	3	0	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
122	Rh	3	0	L1	B	H	H	H	OCH(CH3)2	H	H	—	—	—	—
123	Rh	3	0	L1	B	H	H	Br	H	H	H	—	—	—	—
124	Rh	3	0	L1	B	H	H	H	H	Cl	H	—	—	—	—
125	Rh	3	0	L1	B	H	H	H	H	H	Cl	—	—	—	—
126	Pt	2	0	L1	B	H	H	H	H	CF3	H	—	—	—	—
127	Pt	2	0	L1	B	H	H	H	H	H	CF3	—	—	—	—
128	Pt	2	0	L1	B	H	H	Ph3	H	H	H	—	—	—	—
129	Pt	2	0	L1	B	H	H	Ph3	H	H	CF3	—	—	—	—
130	Pt	2	0	L1	B	H	H	Ph2	H	H	H	H	F	H	H
131	Pt	2	0	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
132	Pt	2	0	L1	B	H	H	Tn5	H	H	H	H	H	—	—
133	Pt	2	0	L1	B	H	H	Np3	H	H	H	H	H	—	—
134	Pt	2	0	L1	B	H	H	H	Tn5	H	H	H	H	—	—
135	Pt	2	0	L1	B	H	H	Tn7	H	H	H	H	H	—	—
136	Pt	2	0	L1	B	CH3	H	F	H	H	H	—	—	—	—
137	Pt	2	0	L1	B	CH3	H	CF3	H	H	H	—	—	—	—
138	Pt	2	0	L1	B	CH3	H	H	CF3	H	H	—	—	—	—
139	Pt	2	0	L1	B	CH3	H	F	CF3	H	H	—	—	—	—
140	Pt	2	0	L1	B	CH3	H	H	H	H	H	—	—	—	—
141	Pd	2	0	L1	B	CH3	H	F	H	H	H	—	—	—	—
142	Pd	2	0	L1	B	CH3	H	CF3	H	H	H	—	—	—	—
143	Pd	2	0	L1	B	CH3	H	H	CF3	H	H	—	—	—	—
144	Pd	2	0	L1	B	CH3	H	F	CF3	H	H	—	—	—	—
145	Pd	2	0	L1	B	H	CH3	CF3	F	H	H	—	—	—	—
146	Pd	2	0	L1	B	H	CH3	Cl	CF3	H	H	—	—	—	—
147	Pd	2	0	L1	B	H	CH3	OC4H9	H	H	H	—	—	—	—
148	Pd	2	0	L1	B	H	CH3	H	OCH(CH3)2	H	H	—	—	—	—

TABLE 1-3-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
149	Pd	2	0	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
150	Pd	2	0	L1	B	H	CH3	Np3	H	H	H	H	H	—	—

[0069]

TABLE 1-4

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
151	Ir	3	0	L1	D	H	H	H	H	H	H	—	—	—	—
152	Ir	3	0	L1	D	H	H	F	H	H	H	—	—	—	—
153	Ir	3	0	L1	D	H	H	H	F	H	H	—	—	—	—
154	Ir	3	0	L1	D	H	H	F	F	H	H	—	—	—	—
155	Ir	3	0	L1	D	H	H	CF3	H	H	H	—	—	—	—
156	Ir	3	0	L1	D	H	H	H	CF3	H	H	—	—	—	—
157	Ir	3	0	L1	D	H	H	F	CF3	H	H	—	—	—	—
158	Ir	3	0	L1	D	H	H	CF3	F	H	H	—	—	—	—
159	Ir	3	0	L1	D	H	H	Cl	CF3	H	H	—	—	—	—
160	Ir	3	0	L1	D	H	H	CH3	H	H	H	—	—	—	—
161	Ir	3	0	L1	D	H	H	H	CH3	H	H	—	—	—	—
162	Ir	3	0	L1	D	CH3	H	OCH3	H	H	H	—	—	—	—
163	Ir	3	0	L1	D	H	CH3	H	OCH3	H	H	—	—	—	—
164	Ir	3	0	L1	D	CH3	CH3	OCF3	H	H	H	—	—	—	—
165	Ir	3	0	L1	D	H	H	H	OCF3	H	H	—	—	—	—
166	Ir	3	0	L1	E	—	—	H	H	H	H	—	—	—	—
167	Ir	3	0	L1	E	—	—	H	Cl	H	H	—	—	—	—
168	Ir	3	0	L1	E	—	—	Br	H	H	H	—	—	—	—
169	Ir	3	0	L1	E	—	—	H	Br	H	H	—	—	—	—
170	Ir	3	0	L1	E	—	—	H	OC4H9	H	H	—	—	—	—
171	Ir	3	0	L1	F	H	—	H	H	H	H	—	—	—	—
172	Ir	3	0	L1	F	H	—	H	OCH(CH3)2	H	H	—	—	—	—
173	Ir	3	0	L1	F	H	—	Br	H	H	H	—	—	—	—
174	Ir	3	0	L1	F	H	—	H	H	Cl	H	—	—	—	—
175	Ir	3	0	L1	F	C2H5	—	H	H	H	Cl	—	—	—	—
176	Ir	3	0	L1	G	H	—	H	H	CF3	H	—	—	—	—
177	Ir	3	0	L1	G	H	—	H	H	H	H	—	—	—	—
178	Ir	3	0	L1	G	H	—	Ph3	H	H	H	—	—	—	—
179	Ir	3	0	L1	G	H	—	Ph3	H	H	CF3	—	—	—	—
180	Ir	3	0	L1	G	H	—	H	H	H	H	—	—	—	—
181	Ir	3	0	L1	H	H	—	Ph2	H	H	H	H	H	CF3	H
182	Ir	3	0	L1	H	H	—	Tn5	H	H	H	H	H	—	—
183	Ir	3	0	L1	H	H	—	Np3	H	H	H	H	H	—	—
184	Ir	3	0	L1	H	CH3	—	H	Tn5	H	H	H	H	—	—
185	Ir	3	0	L1	H	H	—	Tn7	H	H	H	H	H	—	—
186	Ir	3	0	L1	I	H	H	H	H	H	H	—	—	—	—
187	Ir	3	0	L1	I	H	H	Tn8	H	H	H	H	H	—	—
188	Ir	3	0	L1	I	H	H	Np4	H	H	H	H	—	—	—
189	Ir	3	0	L1	I	H	H	Tn6	H	H	H	H	H	—	—
190	Ir	3	0	L1	I	CH3	H	H	H	H	H	—	—	—	—
191	Ir	3	0	L1	J	H	H	F	H	H	H	—	—	—	—
192	Ir	3	0	L1	J	H	H	CF3	H	H	H	—	—	—	—
193	Ir	3	0	L1	J	H	H	H	CF3	H	H	—	—	—	—
194	Ir	3	0	L1	J	CH3	H	F	CF3	H	H	—	—	—	—
195	Ir	3	0	L1	J	H	CH3	CF3	F	H	H	—	—	—	—
196	Ir	3	0	L1	K	—	H	Cl	CF3	H	H	—	—	—	—
197	Ir	3	0	L1	K	—	H	OC4H9	H	H	H	—	—	—	—
198	Ir	3	0	L1	K	—	H	H	OCH(CH3)2	H	H	—	—	—	—
199	Ir	3	0	L1	K	—	H	Ph2	H	H	H	H	F	H	H
200	Ir	3	0	L1	K	—	CH3	Np3	H	H	H	H	H	—	—

[0070]

TABLE 1-5

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
201	Ir	3	0	L1	M	H	—	H	H	H	H	—	—	—	—
202	Ir	3	0	L1	M	H	—	F	H	H	H	—	—	—	—

TABLE 1-5-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
203	Ir	3	0	L1	M	H	—	H	F	H	H	—	—	—	—
204	Ir	3	0	L1	N	H	H	H	H	H	H	—	—	—	—
205	Ir	3	0	L1	N	H	H	CF3	H	H	H	—	—	—	—
206	Ir	3	0	L1	N	CH3	H	H	CF3	H	H	—	—	—	—
207	Ir	3	0	L1	O	H	H	F	CF3	H	H	—	—	—	—
208	Ir	3	0	L1	O	H	H	CF3	F	H	H	—	—	—	—
209	Ir	3	0	L1	O	H	H	Cl	CF3	H	H	—	—	—	—
210	Ir	3	0	L1	P	—	H	H	H	H	H	—	—	—	—
211	Ir	3	0	L1	P	—	H	H	CH3	H	H	—	—	—	—
212	Ir	3	0	L1	P	—	H	OCH3	H	H	H	—	—	—	—
213	Ir	3	0	L1	Q	H	—	H	H	H	H	—	—	—	—
214	Ir	3	0	L1	Q	H	—	OCF3	H	H	H	—	—	—	—
215	Ir	3	0	L1	Q	H	—	H	OCF3	H	H	—	—	—	—
216	Ir	3	0	L1	R	H	—	H	H	H	H	—	—	—	—
217	Ir	3	0	L1	R	H	—	H	Cl	H	H	—	—	—	—
218	Ir	3	0	L1	R	H	—	H	H	H	H	—	—	—	—
219	Ir	3	0	L1	S	H	—	H	Br	H	H	—	—	—	—
220	Ir	3	0	L1	S	H	—	H	OC4H9	H	H	—	—	—	—
221	Ir	3	0	L1	S	H	—	OC4H9	H	H	H	—	—	—	—
222	Ir	3	0	L1	T	—	—	H	H	H	H	—	—	—	—
223	Ir	3	0	L1	T	—	—	Br	H	H	H	—	—	—	—
224	Ir	3	0	L1	T	—	—	H	H	H	H	—	—	—	—
225	Ir	3	0	L1	U	—	—	H	H	H	Cl	—	—	—	—
226	Ir	3	0	L1	U	—	—	H	H	CF3	H	—	—	—	—
227	Ir	3	0	L1	U	—	—	H	H	H	CF3	—	—	—	—
228	Ir	3	0	L1	V	H	—	H	H	H	H	—	—	—	—
229	Ir	3	0	L1	V	H	—	Ph3	H	H	H	—	—	—	—
230	Ir	3	0	L1	V	H	—	Ph2	H	H	H	H	F	H	H
231	Ir	3	0	L1	W	—	—	H	H	H	H	—	—	—	—
232	Ir	3	0	L1	W	—	—	Tn5	H	H	H	H	H	—	—
233	Ir	3	0	L1	W	—	—	Np3	H	H	H	H	H	—	—
234	Ir	3	0	L1	Y	H	—	H	H	H	H	—	—	—	—
235	Ir	3	0	L1	Y	H	—	Tn7	H	H	H	H	H	—	—
236	Ir	3	0	L1	Y	H	—	Pe2	H	H	H	H	—	—	—
237	Ir	3	0	L1	Z	—	—	H	H	H	H	—	—	—	—
238	Ir	3	0	L1	Z	—	—	Np4	H	H	H	H	—	—	—
239	Ir	3	0	L1	Z	—	—	Tn6	H	H	H	H	H	—	—
240	Ir	3	0	L1	A'	H	—	H	H	H	H	—	—	—	—
241	Ir	3	0	L1	A'	H	—	F	H	H	H	—	—	—	—
242	Ir	3	0	L1	A'	CH3	—	CF3	H	H	H	—	—	—	—
243	Ir	3	0	L1	B'	—	H	H	H	H	H	—	—	—	—
244	Ir	3	0	L1	B'	—	H	F	CF3	H	H	—	—	—	—
245	Ir	3	0	L1	B'	—	CH3	CF3	F	H	H	—	—	—	—
246	Ir	3	0	L1	C'	H	H	Cl	CF3	H	H	—	—	—	—
247	Ir	3	0	L1	C'	H	H	OC4H9	H	H	H	—	—	—	—
248	Ir	3	0	L1	C'	H	CH3	H	H	H	H	—	—	—	—
249	Ir	3	0	L1	D'	H	—	Ph2	H	H	H	H	F	H	H
250	Ir	3	0	L1	D'	CH3	—	Np3	H	H	H	H	H	—	—

[0071]

TABLE 1-6

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
251	Ir	3	0	L1	D'	H	H	H	H	H	H	—	—	—	—
252	Ir	3	0	L1	E'	H	H	H	H	H	H	—	—	—	—
253	Ir	3	0	L1	E'	H	H	H	F	H	H	—	—	—	—
254	Ir	3	0	L1	E'	H	CH3	F	F	H	H	—	—	—	—
255	Ir	3	0	L1	F'	—	—	CF3	H	H	H	—	—	—	—
256	Ir	3	0	L1	F'	—	—	H	H	H	H	—	—	—	—
257	Ir	3	0	L1	F'	—	—	F	CF3	H	H	—	—	—	—
258	Ir	3	0	L1	F'	—	—	CF3	F	H	H	—	—	—	—
259	Ir	3	0	L1	F'	—	—	Cl	CF3	H	H	—	—	—	—
260	Ir	3	0	L1	G'	—	—	H	H	H	H	—	—	—	—
261	Ir	3	0	L1	G'	—	—	H	CH3	H	H	—	—	—	—
262	Ir	3	0	L1	G'	—	—	OCH3	H	H	H	—	—	—	—
263	Ir	3	0	L1	G'	—	—	H	OCH3	H	H	—	—	—	—
264	Ir	3	0	L1	G'	—	—	OCF3	H	H	H	—	—	—	—
265	Ir	3	0	L1	G'	—	—	H	OCF3	H	H	—	—	—	—

TABLE 1-6-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
266	Ir	3	0	L1	H'	—	—	H	H	H	H	—	—	—	—
267	Ir	3	0	L1	H'	—	—	H	Cl	H	H	—	—	—	—
268	Ir	3	0	L1	H'	—	—	Br	H	H	H	—	—	—	—
269	Ir	3	0	L1	H'	—	—	H	Br	H	H	—	—	—	—
270	Ir	3	0	L1	H'	—	—	H	OC4H9	H	H	—	—	—	—
271	Ir	3	0	L1	I'	—	—	H	H	H	H	—	—	—	—
272	Ir	3	0	L1	I'	—	—	H	OCH(CH3)2	H	H	—	—	—	—
273	Ir	3	0	L1	I'	—	—	Br	H	H	H	—	—	—	—
274	Ir	3	0	L1	I'	—	—	H	H	Cl	H	—	—	—	—
275	Ir	3	0	L1	I'	—	—	H	H	H	Cl	—	—	—	—
276	Ir	3	0	L1	J'	—	—	H	H	H	H	—	—	—	—
277	Ir	3	0	L1	J'	—	—	H	H	H	CF3	—	—	—	—
278	Ir	3	0	L1	J'	—	—	Ph3	H	H	H	—	—	—	—
279	Ir	3	0	L1	J'	—	—	Ph3	H	H	CF3	—	—	—	—
280	Ir	3	0	L1	J'	—	—	Ph2	H	H	H	H	F	H	H
281	Ir	3	0	L1	K'	—	—	Ph2	H	H	H	H	H	CF3	H
282	Ir	3	0	L1	K'	—	—	H	H	H	H	—	—	—	—
283	Ir	3	0	L1	K'	—	—	Np3	H	H	H	H	H	—	—
284	Ir	3	0	L1	K'	—	—	H	Tn5	H	H	H	H	—	—
285	Ir	3	0	L1	K'	—	—	Tn7	H	H	H	H	H	—	—
286	Rh	3	0	L1	C	H	—	Pe2	H	H	H	H	—	—	—
287	Rh	3	0	L1	C	H	—	Tn8	H	H	H	H	H	—	—
288	Rh	3	0	L1	C	H	—	Np4	H	H	H	H	—	—	—
289	Rh	3	0	L1	I	H	H	Tn6	H	H	H	H	H	—	—
290	Rh	3	0	L1	D'	CH3	—	H	H	H	H	—	—	—	—
291	Rh	3	0	L1	F'	—	—	F	H	H	H	—	—	—	—
292	Pt	2	0	L1	C	H	—	CF3	H	H	H	—	—	—	—
293	Pt	2	0	L1	O	H	H	H	CF3	H	H	—	—	—	—
294	Pt	2	0	L1	Z	—	—	F	CF3	H	H	—	—	—	—
295	Pt	2	0	L1	D'	H	—	CF3	F	H	H	—	—	—	—
296	Pt	2	0	L1	F'	—	—	Cl	CF3	H	H	—	—	—	—
297	Pt	2	0	L1	H'	—	—	OC4H9	H	H	H	—	—	—	—
298	Pd	2	0	L1	I'	—	—	H	OCH(CH3)2	H	H	—	—	—	—
299	Pd	2	0	L1	G	H	—	Ph2	H	H	H	H	F	H	H
300	Pd	2	0	L1	C	H	—	Np3	H	H	H	H	H	—	—

[0072]

TABLE 1-7

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
301	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	H	H	H	—	—	—	—
302	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	F	H	H	—	—	—	—
303	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	F	H	H	—	—	—	—
304	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	CF3	H	H	H	—	—	—	—
305	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	CF3	H	H	—	—	—	—
306	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	CF3	H	H	—	—	—	—
307	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	Cl	CF3	H	H	—	—	—	—
308	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	CH3	H	H	H	—	—	—	—
309	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	OCF3	H	H	H	—	—	—	—
310	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	OC4H9	H	H	—	—	—	—
311	Ir	2	1	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
				L1'	B	H	H	H	OCH(CH3)2	H	H	—	—	—	—
312	Ir	2	1	L1	B	H	H	Br	H	H	H	—	—	—	—
				L1'	B	H	H	H	H	Cl	H	—	—	—	—
313	Ir	2	1	L1	B	H	H	H	H	H	Cl	—	—	—	—
				L1'	B	H	H	H	H	CF3	H	—	—	—	—

TABLE 1-7-continued

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
314	Ir	2	1	L1	B	H	H	H	H	H	CF3	—	—	—	—
				L1'	B	H	H	Ph3	H	H	H	—	—	—	—
315	Ir	2	1	L1	B	H	H	Ph3	H	H	CF3	—	—	—	—
				L1'	B	H	H	Ph2	H	H	H	H	F	H	H
316	Ir	2	1	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
				L1'	B	H	H	Tn5	H	H	H	H	H	—	—
317	Ir	2	1	L1	B	H	H	Np3	H	H	H	H	H	—	—
				L1'	B	H	H	H	Tn5	H	H	H	H	—	—
318	Ir	2	1	L1	B	H	H	Tn7	H	H	H	H	H	—	—
				L1'	B	H	H	Pe2	H	H	H	H	—	—	—
319	Ir	2	1	L1	B	H	H	Tn8	H	H	H	H	H	—	—
				L1'	B	H	H	Np4	H	H	H	H	—	—	—
320	Ir	2	1	L1	B	H	H	Tn6	H	H	H	H	H	—	—
				L1'	B	CH3	H	H	H	H	H	—	—	—	—
321	Ir	2	1	L1	B	CH3	H	F	H	H	H	—	—	—	—
				L1'	B	CH3	H	CF3	H	H	H	—	—	—	—
322	Ir	2	1	L1	B	CH3	H	H	CF3	H	H	—	—	—	—
				L1'	B	CH3	H	F	CF3	H	H	—	—	—	—
323	Ir	2	1	L1	B	H	CH3	CF3	F	H	H	—	—	—	—
				L1'	B	H	CH3	Cl	CF3	H	H	—	—	—	—
324	Ir	2	1	L1	B	H	CH3	OC4H9	H	H	H	—	—	—	—
				L1'	B	H	CH3	H	OCH(CH3)2	H	H	—	—	—	—
325	Ir	2	1	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
				L1'	B	H	CH3	Np3	H	H	H	H	H	—	—

[0073]

TABLE 1-8

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
326	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	H	H	H	H	—	—	—	—
327	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	F	H	H	H	—	—	—	—
328	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	F	F	H	H	—	—	—	—
329	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	F	CF3	H	H	—	—	—	—
330	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	Cl	CF3	H	H	—	—	—	—
331	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	D	CH3	H	OCH3	H	H	H	—	—	—	—
332	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	E	—	—	H	OC4H9	H	H	—	—	—	—
333	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	F	C2H5	—	H	H	H	Cl	—	—	—	—
334	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	G	H	—	Ph3	H	H	CF3	—	—	—	—
335	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	H	H	—	Ph2	H	H	H	H	H	CF3	H
336	Ir	2	1	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
				L1'	I	H	H	H	H	H	H	—	—	—	—
337	Ir	2	1	L1	B	H	H	Br	H	H	H	—	—	—	—
				L1'	J	H	H	CF3	H	H	H	—	—	—	—
338	Ir	2	1	L1	B	H	H	H	H	H	Cl	—	—	—	—
				L1'	K	—	CH3	Np3	H	H	H	H	H	—	—
339	Ir	2	1	L1	B	H	H	H	H	H	CF3	—	—	—	—
				L1'	M	H	—	H	F	H	H	—	—	—	—
340	Ir	2	1	L1	B	H	H	Ph3	H	H	CF3	—	—	—	—
				L1'	N	CH3	H	H	CF3	H	H	—	—	—	—
341	Ir	2	1	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
				L1'	O	H	H	Cl	CF3	H	H	—	—	—	—
342	Ir	2	1	L1	B	H	H	Np3	H	H	H	H	H	—	—
				L1'	P	—	H	OCH3	H	H	H	—	—	—	—
343	Ir	2	1	L1	B	H	H	Tn7	H	H	H	H	H	—	—
				L1'	Q	H	—	H	H	H	H	—	—	—	—
344	Ir	2	1	L1	B	H	H	Tn8	H	H	H	H	H	—	—
				L1'	R	H	—	H	Cl	H	H	—	—	—	—

TABLE 1-8-continued

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
345	Ir	2	1	L1	B	H	H	Tn6	H	H	H	H	H	—	—
				L1'	S	H	—	H	OC4H9	H	H	—	—	—	—
346	Ir	2	1	L1	B	CH3	H	F	H	H	H	—	—	—	—
				L1'	V	H	—	Ph2	H	H	H	H	F	H	H
347	Ir	2	1	L1	B	CH3	H	H	CF3	H	H	—	—	—	—
				L1'	Y	H	—	Pe2	H	H	H	H	—	—	—
348	Ir	2	1	L1	B	H	CH3	CF3	F	H	H	—	—	—	—
				L1'	A'	CH3	—	CF3	H	H	H	—	—	—	—
349	Ir	2	1	L1	B	H	CH3	OC4H9	H	H	H	—	—	—	—
				L1'	C'	H	H	Cl	CF3	H	H	—	—	—	—
350	Ir	2	1	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
				L1'	D'	CH3	—	Np3	H	H	H	H	H	—	—

[0074]

TABLE 1-9

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
351	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	H	H	H	—	—	—	—
352	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	F	H	H	—	—	—	—
353	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	F	H	H	—	—	—	—
354	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	CF3	H	H	H	—	—	—	—
355	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	CF3	H	H	—	—	—	—
356	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	F	CF3	H	H	—	—	—	—
357	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	Cl	CF3	H	H	—	—	—	—
358	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	CH3	H	H	H	—	—	—	—
359	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	OCF3	H	H	H	—	—	—	—
360	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	B	H	H	H	OC4H9	H	H	—	—	—	—
361	Pt	1	1	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
				L1'	B	H	H	H	OCH(CH3)2	H	H	—	—	—	—
362	Pt	1	1	L1	B	H	H	Br	H	H	H	—	—	—	—
				L1'	B	H	H	H	H	Cl	H	—	—	—	—
363	Pt	1	1	L1	B	H	H	H	H	H	Cl	—	—	—	—
				L1'	B	H	H	H	H	CF3	H	—	—	—	—
364	Pt	1	1	L1	B	H	H	H	H	H	CF3	—	—	—	—
				L1'	B	H	H	Ph3	H	H	H	—	—	—	—
365	Pt	1	1	L1	B	H	H	Ph3	H	H	CF3	—	—	—	—
				L1'	B	H	H	Ph2	H	H	H	H	F	H	H
366	Pd	1	1	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
				L1'	B	H	H	Tn5	H	H	H	H	H	—	—
367	Pd	1	1	L1	B	H	H	Np3	H	H	H	H	H	—	—
				L1'	B	H	H	H	Tn5	H	H	H	H	—	—
368	Pd	1	1	L1	B	H	H	Tn7	H	H	H	H	H	—	—
				L1'	B	H	H	Pe2	H	H	H	H	—	—	—
369	Pd	1	1	L1	B	H	H	Tn8	H	H	H	H	H	—	—
				L1'	B	H	H	Np4	H	H	H	H	—	—	—
370	Pd	1	1	L1	B	H	H	Tn6	H	H	H	H	H	—	—
				L1'	B	CH3	H	H	H	H	H	—	—	—	—
371	Rh	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				L1'	C	H	—	Cl	CF3	H	H	—	—	—	—
372	Rh	2	1	L1	B	H	H	Ph3	H	H	CF3	—	—	—	—
				L1'	N	CH3	H	H	CF3	H	H	—	—	—	—
373	Pt	1	1	L1	B	H	H	Tn6	H	H	H	H	H	—	—
				L1'	S	H	—	H	OC4H9	H	H	—	—	—	—

TABLE 1-9-continued

No	M	m	n	L L'	X X'	R1 R1	R2 R2	X1 X1'	X2 X2'	X3 X3'	X4 X4'	R7 R7	R8 R8	R9 R9	R10 R10
374	Pt	1	1	L1	B	H	CH3	OC4H9	H	H	H	—	—	—	—
				L1'	C'	H	H	Cl	CF3	H	H	—	—	—	—
375	Pd	1	1	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
				L1'	D'	CH3	—	Np3	H	H	H	H	H	—	—

[0075]

TABLE 1-10

				L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9 A"	R10
												R7	R8	R9 B"	R10
No	M	m	n	L'		A"	B"	R3	R4	R5	R6	R7	R8	R9	R10
376	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
377	Ir	2	1	L1	B	H	H	F	CF3	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
378	Ir	2	1	L1	B	H	H	Cl	CF3	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
379	Ir	2	1	L1	B	H	H	H	OCF3	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
380	Ir	2	1	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
381	Ir	2	1	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
				—		Ph1	Pi	Ph2	H	H	H	H	F	H	H
												—	—	—	—
382	Ir	2	1	L1	B	H	H	Tn7	H	H	H	H	H	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
383	Ir	2	1	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
				—		Tn2	Pi	H	CH3	H	H	—	—	—	—
												—	—	—	—
384	Ir	2	1	L1	B	H	CH3	Np3	H	H	H	H	H	—	—
				—		Tn3	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
385	Ir	2	1	L1	C	H	—	H	H	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
386	Ir	2	1	L1	D	H	H	CF3	H	H	H	—	—	—	—
				—		Np2	Pi	H	H	H	CF3	—	—	—	—
												—	—	—	—
387	Ir	2	1	L1	E	—	—	H	Cl	H	H	—	—	—	—
				—		Pe1	Py1	H	—	H	H	—	—	—	—
												—	—	—	—
388	Ir	2	1	L1	F	H	—	H	OCH(CH3)2	H	H	—	—	—	—
				—		Tn1	Pr	H	H	Ph3	H	—	—	—	—
												—	—	—	—

[0076]

TABLE 1-11

				L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
												A"			
												R7	R8	R9	R10
												B"			
No	M	m	n	L'		A"	B"	R3	R4	R5	R6	R7	R8	R9	R10
389	Ir	2	1	L1	H	H	—	Ph2	H	H	H	H	H	CF3	H
				—		Ph1	Pi	H	H	H	Tn5	—	—	—	—
												H	H	—	—
390	Ir	2	1	L1	H	CH3	—	H	Tn5	H	H	H	H	—	—
				—		Ph1	Pi	H	H	H	Tn8	—	—	—	—
												H	H	—	—
391	Rh	2	1	L1	I	H	H	Tn8	H	H	H	H	H	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
392	Rh	2	1	L1	P	—	H	OCH3	H	H	H	—	—	—	—
				—		Ph1	Pi	H	Ph2	H	H	F	F	F	F
												—	—	—	—
393	Rh	2	1	L1	V	H	—	Ph2	H	H	H	H	F	H	H
				—		Tn2	Py2	—	H	H	H	—	—	—	—
												—	—	—	—
394	Rh	2	1	L1	D'	H	—	Ph2	H	H	H	H	F	H	H
				—		Tn3	Pi	Np3	H	CF3	H	H	H	—	—
												—	—	—	—
395	Pt	1	1	L1	F'	—	—	F	CF3	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
396	Pt	1	1	L1	J'	—	—	Ph3	H	H	CF3	—	—	—	—
				—		Tn1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
397	Pt	1	1	L1	C	H	—	Pe2	H	H	H	H	—	—	—
				—		Np2	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
398	Pd	1	1	L1	B	H	H	H	H	H	H	—	—	—	—
				—		Ph1	Pi	H	H	H	H	—	—	—	—
												—	—	—	—
399	Pd	1	1	L1	B	H	H	H	OCH(CH3)2	H	H	—	—	—	—
				—		Tn3	Pi	Ph2	H	H	CH3	H	C3F7	H	H
												—	—	—	—
400	Pd	1	1	L1	C	H	—	H	H	H	H	—	—	—	—
				—		Np1	PR	H	H	An	H	—	—	—	—
												H	—	—	—

[0077]

TABLE 1-12

				L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
												E			
												R7	R8	R9	R10
												G			
No	M	m	n	G								R7	R8	R9	R10
401	Ir	2	1	L1	B	H	H	H	H	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
402	Ir	2	1	L1	B	H	H	F	CF3	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
403	Ir	2	1	L1	B	H	H	Cl	CF3	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
404	Ir	2	1	L1	B	H	H	H	OCF3	H	H	—	—	—	—
				CF3								—	—	—	—
				CF3								—	—	—	—

TABLE 1-12-continued

				L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
													E		
				E								R7	R8	R9	R10
													G		
No	M	m	n	G								R7	R8	R9	R10
405	Ir	2	1	L1	B	H	H	OC4H9	H	H	H	—	—	—	—
				CF3								—	—	—	—
				CF3								—	—	—	—
406	Ir	2	1	L1	B	H	H	Ph2	H	H	H	H	H	CF3	H
				Ph3								—	—	—	—
				Ph3								—	—	—	—
407	Ir	2	1	L1	B	H	H	Tn7	H	H	H	H	H	—	—
				Ph2								H	C3H7	H	H
				Ph2								H	C3H7	H	H
408	Ir	2	1	L1	B	H	CH3	Ph2	H	H	H	H	F	H	H
				Tn5								H	H	—	—
				Tn5								H	H	—	—
409	Ir	2	1	L1	B	H	CH3	Np3	H	H	H	H	H	—	—
				CH3								—	—	—	—
				Ph3								—	—	—	—
410	Ir	2	1	L1	C	H	—	H	H	H	H	—	—	—	—
				Tn6								H	H	—	—
				Tn6								H	H	—	—
411	Ir	2	1	L1	D	H	H	CF3	H	H	H	—	—	—	—
				Np3								CH3O	H	—	—
				Np3								CH3O	H	—	—
412	Ir	2	1	L1	E	—	—	H	Cl	H	H	—	—	—	—
				Np4								F	—	—	—
				Np4								F	—	—	—
413	Ir	2	1	L1	F	H	—	H	OCH(CH3)2	H	H	—	—	—	—
				Tn7								CH3	H	—	—
				Tn7								CH3	H	—	—

[0078]

TABLE 1-13

				L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
														E	
				E								R7	R8	R9	R10
														G	
No	M	m	n	G								R7	R8	R9	R10
414	Ir	2	1	L1	H	H	—	Ph2	H	H	H	H	H	CF3	H
				Tn8								H	H	—	—
				Tn8								H	H	—	—
415	Ir	2	1	L1	H	CH3	—	H	Tn5	H	H	H	H	—	—
				Pe2								H	—	—	—
				Pe2								H	—	—	—
416	Rh	2	1	L1	I	H	H	Tn8	H	H	H	H	H	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
417	Rh	2	1	L1	P	—	H	OCH3	H	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
418	Rh	2	1	L1	V	H	—	Ph2	H	H	H	H	F	H	H
				CH3								—	—	—	—
				CH3								—	—	—	—
419	Rh	2	1	L1	D'	H	—	Ph2	H	H	H	H	F	H	H
				Ph3								—	—	—	—
				Ph3								—	—	—	—
420	Pt	1	1	L1	F'	—	—	F	CF3	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
421	Pt	1	1	L1	J'	—	—	Ph3	H	H	CF3	—	—	—	—
				CF3								—	—	—	—
				CF3								—	—	—	—

TABLE 1-13-continued

No	M	m	n	L	X	R1	R2	X1	X2	X3	X4	R7	R8	R9	R10
														E	
				E								R7	R8	R9	R10
														G	
				G								R7	R8	R9	R10
422	Pt	1	1	L1	C	H	—	Pe2	H	H	H	H	—	—	—
				Pi2								H	H	—	—
				Pi2								H	H	—	—
423	Pd	1	1	L1	B	H	H	H	H	H	H	—	—	—	—
				CH3								—	—	—	—
				CH3								—	—	—	—
424	Pd	1	1	L1	B	H	H	H	OCH9CH3)2	H	H	—	—	—	—
				CF3								—	—	—	—
				CF3								—	—	—	—
425	Pd	1	1	L1	C	H	—	H	H	H	H	—	—	—	—
				Qn2								H	H	—	—
				Qn2								H	H	—	—

[0079]

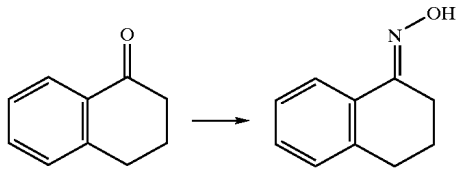
TABLE 1-14

No	M	m	n	L	X	R1	R2	R3	R4	X1	X2	X3	X4
426	Ir	3	0	L2	B	H	H	—	—	H	H	—	H
427	1r	3	0	L3	B	H	H	—	—	F	H	H	—
428	Ir	3	0	L4	B	H	H	—	—	H	F	H	H
429	Ir	3	0	L5	B	H	H	—	—	—	F	H	H
430	Ir	3	0	L6	B	H	H	—	—	CF3	—	—	H
431	Ir	3	0	L7	B	H	H	—	—	H	H	H	H
432	Ir	3	0	L8	B	H	H	—	—	F	CF3	H	H
433	Ir	3	0	L9	B	H	H	—	—	H	H	CF3	F
434	Ir	3	0	L10	B	H	H	—	—	H	H	H	H
435	Ir	3	0	L11	B	H	H	—	—	H	H	H	H
436	Ir	3	0	L2'	B	H	H	—	—	H	CH3	—	H
437	Ir	3	0	L3'	B	H	H	—	—	OCH3	H	H	—
438	Ir	3	0	L4'	B	H	H	—	—	H	H	H	H
439	Ir	3	0	L5'	B	H	H	—	—	—	H	H	H
440	Ir	3	0	L6'	B	H	H	—	—	H	—	—	H
441	Ir	3	0	L7'	B	H	H	—	—	H	H	H	H
442	Ir	3	0	L8'	B	H	H	—	—	H	H	H	H
443	Ir	3	0	L9'	B	H	H	—	—	H	H	H	H
444	Ir	3	0	L10'	B	H	H	—	—	H	H	H	H
445	Ir	3	0	L11'	B	H	H	—	—	H	H	H	H
446	Ir	3	0	L1	M'	CH3	CH3	CH3	CH3	H	H	H	H
447	Ir	3	0	L1	M'	C2H5	C2H5	C2H5	C2H5	H	H	H	H
448	Ir	3	0	L1	M'	CH3	CH3	CH3	CH3	F	H	H	H
449	Ir	3	0	L1	M'	CH3	CH3	CH3	CH3	H	F	H	H
450	Ir	3	0	L1	M'	CH3	CH3	CH3	CH3	F	CH3	H	H

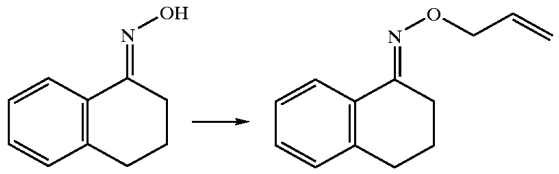
[0080] Hereinbelow, the present invention will be described specifically based on Examples.

EXAMPLE 1>

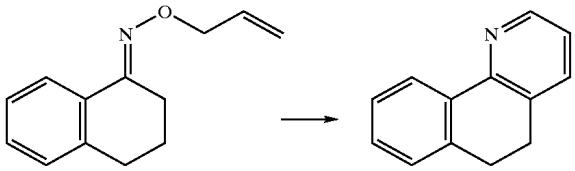
[0081] (Synthesis of Example Compound No. 1)



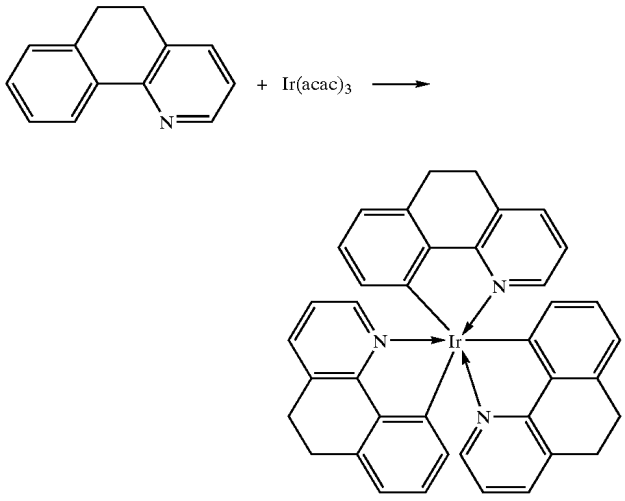
[0082] In a 2 L (liter)-three-necked flask, 69.0 g (472 mM) of α-tetralone, 50.0 g (720 mM) of hydroxylamine hydrochloride, 500 ml of ethanol and 360 ml of 2N-sodium hydroxide aqueous solution were placed and stirred for 1 hour at room temperature. The solvent was removed under reduced pressure to provide a dry solid (residue). To the residue, 500 ml of water was added and extracted three times with 150 ml of ethyl acetate. The organic layer was dried with anhydrous magnesium sulfate, followed by removal of the solvent under reduced pressure to obtain 74 g (Yield: 97.2%) of a pale yellow crystal of α-tetralone=oxime.



[0083] In a 1 L-three-necked flask, 80 ml of tetrahydrofuran and 23.8 g (595 M) of 60%-oily sodium hydride were placed and stirred for 5 minutes at room temperature, followed by addition thereof dropwise to solution of 74.0 g (459 mM) of α-tetralone=oxime in 500 ml of anhydrous DMF (dimethylformamide) in 15 minutes. Thereafter, the system was stirred for 1 hour at room temperature, followed by addition of 113.5 g (939 mM) of allyl bromide and further stirring for 12 hours at room temperature. After the reaction, the reaction product was subjected to removal of the solvent under reduced pressure to obtain a residue. To the residue, 500 ml of water was added and extracted three times with 200 ml of ethyl acetate. The organic layer was dried with anhydrous magnesium sulfate and subjected to removal of the solvent under reduced pressure to obtain a brown liquid. The liquid was subjected to distilling-off of the solvent under reduced pressure to obtain 79.5 g (Yield: 86.0%) of α-tetralone=oxime=O-allyl=ether having a boiling agent of 75-80° C. (6.7 Pa).



[0084] In a 1L-autoclave, 58.0 g (288 mM) of α-tetralone=oxime=O-allyl=ether was placed and aerated with oxygen gas, followed by hermetic sealing with a cap and vigorous stirring for 5 days at 190° C. The reaction mixture was cooled to room temperature to provide a high-viscous brown liquid, which was dissolved in chloroform and extracted three times with 300 ml of 5%-hydrochloric acid. The aqueous layer was alkalified with 48%-sodium hydroxide and extracted three times with 350 ml of chloroform. The organic layer was dried with anhydrous magnesium sulfate and concentrated under reduced pressure, followed by purification by silica gel column chromatography using chloroform as an eluent and purification by silica gel column chromatography using a mixture solvent of hexane/ethyl acetate=5/1 as an eluent to obtain 7.7 g of a pale brown liquid. The liquid was purified by using a Kugelrohr distillation apparatus (ball-tube oven) to obtain 6.6 g (Yield: 12.6%) of colorless benzo[h]-5,6-dihydroquinoline.



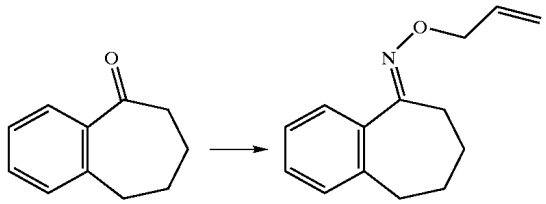
[0085] In a 100 ml-four-necked flask, 50 ml of glycerol was placed and heated for 2 hours at 130-140° C. under stirring and bubbling with nitrogen. The glycerol was cooled to 100° C. by standing, and 0.91 g (5.02 mM) of benzo[h]-5,6-dihydroquinoline and 0.50 g (1.02 mM) of iridium (III) acetylacetonate were added thereto, followed by stirring for 5 hours at 190-215° C. under heating and nitrogen stream. The reaction product was cooled to room temperature and poured into 300 ml of 1N-hydrochloric acid to obtain a precipitate, which was recovered by filtration and washed with water, followed by dissolution in acetone to remove an insoluble matter by filtration. The acetone was removed

under reduced pressure to obtain a residue, which was purified by silica gel column chromatography using chloroform as an eluent to obtain 0.11 g (Yield: 14.7%) of yellow powder of iridium (III) tris{benzo[h]-5,6-dihydroquinoline}.

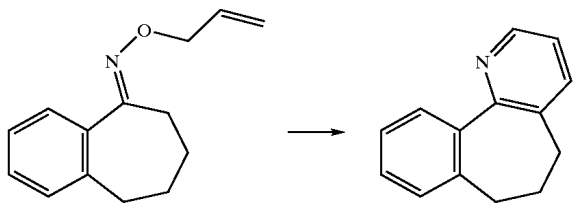
[0086] This compound exhibited a PL (photoluminescence) spectrum having λmax (maximum emission wavelength) of 511 nm and a quantum yield of 0.51 in a solution state. For comparison, when a solution of $Ir(ppy)_3$ as the above-mentioned conventional luminescent material which was not crosslinked with an alkylene group, different from the metal coordination compound of the present invention, was subjected to measurement of PL spectrum in a similar manner, λmax (maximum emission wavelength) was 510 nm and a quantum yield was 0.40. Further, an organic EL device prepared in Example 3 described hereinafter caused luminescence at a high luminance under application of an electric field. Further, EL spectrum thereof had a λmax (maximum emission wavelength) of 510 nm.

EXAMPLE 2>

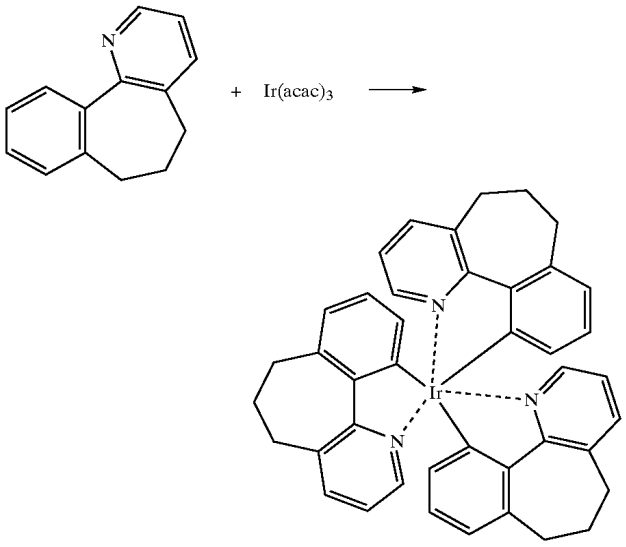
[0087] (Synthesis of Ex. Comp. No. 53)



[0088] In a 3 L (liter)-three-necked flask, 166.0 g (1036 mM) of 1-benzosuberone, 125.0 g (1141 mM) of O-allylhydroxylamine hydrochloride, 93.5 g (1140 mM) of sodium acetate, 158.0 g (1143 mM) of potassium carbonate and 1500 ml of ethanol were placed and stirred for 1.5 hours at 80° C. under heating. The reaction product was cooled to room temperature and subjected to removal of the solvent under reduced pressure to obtain a residue. To the residue, 1500 ml of water was added and extracted three times with 500 ml of ethyl acetate. The organic layer was dried with anhydrous magnesium sulfate and subjected to removal of the solvent under reduced pressure to obtain a pale brown liquid. The liquid was subjected to distilling-off of the solvent under reduced pressure to obtain 221.8 g (Yield: 99.0%) of 1-benzosuberone=oxime=O-allyl=ether having a boiling agent of 75-83° C. (4.0 Pa).



[0089] In a 5L-autoclave, 222.0 g (1022 mM) of 1-benzosuberone=oxime=O-allyl=ether was placed and aerated with oxygen gas, followed by hermetic sealing with a cap and vigorous stirring for 3 days at 190° C. The reaction mixture was cooled to room temperature to provide a high-viscous brown liquid, which was dissolved in 2 liters of chloroform and extracted three times with 500 ml of 5%-hydrochloric acid. The aqueous layer was alkalified with 48%-sodium hydroxide and extracted three times with 500 ml of chloroform. The organic layer was dried with anhydrous magnesium sulfate and subjected to removal of the solvent under reduced pressure, followed by purification by silica gel column chromatography using a mixture solvent of hexane/ethyl acetate=5/1 as an eluent to obtain 19 g of a pale brown liquid. The liquid was purified by using a Kugelrohr distillation apparatus (ball-tube oven) to obtain 13.5 g (Yield: 6.8%) of pale green 3,2'-trimethylene-2-phenyl-pyridine.



[0090] In a 100 ml-four-necked flask, 50 ml of glycerol was placed and heated for 2 hours at 130-140° C. under stirring and bubbling with nitrogen. The glycerol was cooled to 100° C. by standing, and 0.98 g (5.02 mM) of 3,2'-trimethylene-2-phenylpyridine and 0.50 g (1.02 mM) of iridium (III) acetylacetonate were added thereto, followed by stirring for 8 hours at 190-210° C. under heating and nitrogen stream. The reaction product was cooled to room temperature and poured into 300 ml of 1N-hydrochloric acid to obtain a precipitate, which was recovered by filtration and washed with water, followed by dissolution in acetone to remove an insoluble matter by filtration. The acetone was removed under reduced pressure to obtain a residue, which was purified by silica gel column chromatography using chloroform as an eluent to obtain 0.18 g (Yield: 22.7%) of yellow powder of iridium (III) tris{3,2'-trimethylene-2-phenylpyridine}. An organic EL device prepared in Example 6 described hereinafter caused bluish green luminescence under application of an electric field.

EXAMPLES 3-11 AND COMPARATIVE EXAMPLE 1)

[0091] As each device structure, a device having three-layered organic layers shown in **FIG. 1**(*b*) was used.

[0092] On a glass substrate (transparent substrate 15), a 100 nm-thick ITO (transparent electrode **14**) was formed

and then patterned. On the ITO electrode, the following organic layers and electrode layers were successively formed in the following film thicknesses in a vacuum chamber at a vacuum of 10^{-4} Pa by resistance heating vacuum deposition.

[0093] Organic layer **1** (hole-transporting layer **13**) (40 nm): α-NPD

[0094] Organic layer **2** (luminescence layer **12**) (30 nm): CBP/luminescent material (=95/5)

[0095] This layer was formed by co-deposition of CBP as a host material with a metal coordination compound shown in Table 2 appearing hereinafter in a weight proportion of 5 wt. % as a luminescent material.

[0096] Organic layer **3** (electron-transporting layer **16**) (30 nm): Alq3

[0097] Metal electrode **1** (15 nm): AlLi alloy (Li content: 1.8 wt. %)

[0098] Metal electrode **2** (100 nm): Al

[0099] After the electrode materials were formed into films, the electrodes were patterned to have an opposing electrode area of 3 mm^2.

[0100] Each device was supplied with an electric field with the ITO side as the anode and the Al side as the cathode by applying a voltage so that a current value became constant, thus measuring a change in luminance with time. A current amount (density) was set to 70 mA/cm^2 and respective devices showed luminances obtained at an initial stage in a range of 80-250 cd/m^2. Times required for ½ of these luminances, respectively, were evaluated as a luminance half-life (half-time).

[0101] For measurement, in order to remove factors for device deterioration due to oxygen or water, the above measurement was performed in a dry nitrogen flow after taking the device out of the vacuum chamber.

[0102] In Comparative Example 1, $Ir(ppy)_3$ described in the above-mentioned article 2 was used as a conventional luminescent material.

[0103] The results of current-conduction durability test for the devices using the respective compounds are shown in Table 2. The devices (of the present invention) exhibited clearly larger luminance half-life values than the device using the conventional luminescent material, thus resulting in devices with high durability resulting from a stability of a material used in the present invention.

TABLE 2

	Luminescence material No.	Luminance half-life (Hr)
Example 3	(1)	950
Example 4	(7)	850
Example 5	(48)	700
Example 6	(53)	900
Example 7	(102)	600
Example 8	(131)	500
Example 9	(302)	800
Example 10	(376)	750
Example 11	(401)	650
Comparative Example 1	$Ir(ppy)_3$	350

EXAMPLE 12>

[0104] An embodiment of the electroluminescence device of the present invention applied to an active-matrix type color organic EL display using a TFT circuit shown in **FIG. 3** will be described with reference to **FIG. 2**.

[0105] **FIG. 2** schematically illustrates an example of a panel structure provided with an organic EL device and drive means. In this example, the number of pixels was set to 128×128 pixels. Incidentally, one pixel was composed of three color pixels comprising a green pixel, a blue pixel and a red pixel.

[0106] On a glass substrate, a thin film transistor circuit using polysilicon (referred to as a TFT circuit) was formed by a known method.

[0107] In regions corresponding to the respective color pixels, organic layers and a metal electrode layer were formed in the following thicknesses by vacuum deposition with a hand mask, followed by patterning. Organic layer structures corresponding to the respective color pixels are shown below.

[0108] Green pixel=α-NPD (40 nm)/CBP:phosphorescent material (=93:7 by weight) (30 nm)/BCP (20 nm)/Alq (40 nm)

[0109] Blue pixel: α-NPD (50 nm)/BCP (20 nm)/Alq (50 nm)

[0110] Red pixel: α-NPD (40 nm)/CBP:PtOEP (=93:7 by weight) (30 nm)/BCP (20 nm)/Alq (40 nm)

[0111] A luminescence layer for the green pixel was formed by co-deposition of CBP as a host material with a phosphorescent material (Example Compound No. 1) having a weight proportion of 7 wt. %.

[0112] In the panel shown in **FIG. 2, a** scanning signal driver, a data signal driver and a current supply source are disposed and are connected to gate selection lines, data signal lines and current supply lines, respectively. At intersections of the gate selection lines and data signal lines, a pixel circuit (equivalent circuit) shown in **FIG. 3** is disposed, the gate selection lines G1, G2, G3 . . . Gn are sequentially selected by the scanning signal driver and in synchronism therewith, image (picture) signals are applied from the data signal driver.

[0113] Next, a pixel circuit operation is described with reference to the equivalent circuit shown in **FIG. 3**. When a selection signal is applied to a gate selection line, TFT1 is turned on so that a display signal is supplied from a data signal line to a capacitor Cadd, thereby determining the gate potential of TFT2, whereby a current is supplied to an organic luminescence device (abbreviate as EL) disposed at each pixel through a current supply line depending on the gate potential of TFT2. The gate potential of TFT2 is held

at Cadd during one frame period, so that the current continually flows from the current supply line to the EL device during the period. As a result, luminescence can be retained during one frame period.

[0114] As a result, it has been confirmed that it was possible to display a desired image data, thus resulting in stable display with good image quality.

[0115] In this example, as the application to display, the driving scheme using the TFT circuit of an active-matrix scheme was used. However, the switching device used in the present invention need not be particularly restricted, and can also be readily applicable to a single-crystal silicon substrate, an MIM (metal-insulator-metal) device, an a-Si (amorphous silicon)-type TFT circuit, etc.

[0116] [Industrial Applicability]

[0117] As described above, a luminescence device using a metal coordination compound represented by the above-mentioned formula (1) as a luminescent material had a high phosphorescence efficiency and could retain high-luminance luminescence for a long period. Further, the metal coordination compound is an excellent material allowing control of emission wavelength, particularly shift to a shorter wavelength. Further, the luminescence device of the present invention is also excellent as a display device.

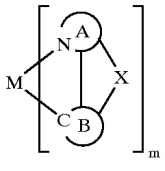
[0118] A high-efficiency luminescence device according to the present invention is applicable to a product requiring energy economization or a high luminance. As applied examples, a display apparatus, an illumination apparatus, a printer light source or a backlight for a liquid crystal display apparatus, etc. are considered. As for a display apparatus, it allows a flat panel display which provides a highly recognizable display at a low energy consumption and is light in weight. As a printer light source, the luminescence device of the present invention can be used instead of a laser light source of a laser beam printer which is currently extensively used. Independently addressable devices are arranged in an array form to effect a desired exposure on a photosensitive drum thereby forming an image. The apparatus volume can be remarkably reduced by using the devices of the present invention.

1. A metal coordination compound represented by the following formula (1):

$$ML_mL'_n \quad (1),$$

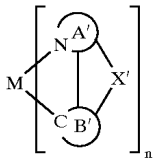
wherein M is a metal atom of Ir, Pt, Rh or Pd; L and L' are mutually different bidentate ligands; m is 1, 2 or 3; n is 0, 1 or 2 with the proviso that m+n is 2 or 3; a partial structure ML_m is represented by formula (2) shown below and a partial structure ML'_n is represented by formula (3), (4) or (5) shown below:

(2)

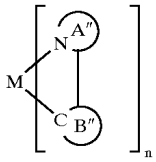


-continued

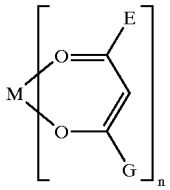
(3)



(4)



(5)



wherein N and C are nitrogen and carbon atoms, respectively; A, A' and A" are respectively a cyclic group capable of having a substituent and connected to the metal atom M via the nitrogen atom; B, B' and B" are respectively a cyclic group capable of having a substituent and connected to the metal atom M via the carbon atom;

(wherein the substituent denotes a halogen atom, a cyano group, a nitro group, a trialkylsilyl group (of which the alkyl groups are independently a linear or branched alkyl group having 1 to 8 carbon atoms), a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom), or an aromatic cyclic group capable of having a substituent (of which the substituent denotes a halogen atom, a cyano group, a nitro group, a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom)};

A and B, A' and B', and A" and B" are respectively bonded to each other via a covalent bond; and

A and B, and A' and B' are bonded to each other via X and X', respectively, in which X and X' are respectively a linear or branched alkylene group having 2-10 carbon atoms (of which the alkylene group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkylene group can include a hydrogen atom that can be replaced with a fluorine atom); and

E and G are independently a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom), or an aromatic cyclic group capable of having a substituent (of which the substituent denotes a halogen atom, a cyano group, a nitro group, a trialkylsilyl group (of which the alkyl groups are independently a linear or branched alkyl group having 1 to 8 carbon atoms), or a linear or branched alkyl group having 1 to 20 carbon atoms (of which the alkyl group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkyl group can include a hydrogen atom that can be replaced with a fluorine atom)}.

2. A metal coordination compound according to claim 1, wherein n in the formula (1) is 0.

3. A metal coordination compound according to claim 1, wherein the partial structure ML'_n in the formula (1) is represented by the formula (3).

4. A metal coordination compound according to claim 1, wherein the partial structure ML'_n in the formula (1) is represented by the formula (4).

5. A metal coordination compound according to claim 1, wherein the partial structure ML'_n in the formula (1) is represented by the formula (5).

6. A metal coordination compound according to claim 1, wherein n in the formula (1) is a linear or branched alkylene group having 2-6 carbon atoms (of which the alkylene group can include one or non-neighboring two or more methylene groups that can be replaced with —O—, —S—, —CO—, —CO—O—, —O—CO—, —CH═CH— or —C≡C— and the alkylene group can include a hydrogen atom that can be replaced with a fluorine atom).

7. A metal coordination compound according to claim 1, wherein M in the formula (1) is Ir.

8. An electroluminescence device, comprising: a substrate, a pair of electrodes disposed on the substrate, and at least one species of a metal coordination compound represented by the formula (1) according to claim 1.

9. An electroluminescence device according to claim 8, wherein phosphorescence is emitted by applying a voltage between the electrodes.

* * * * *

专利名称(译)	金属配位化合物和电致发光器件		
公开(公告)号	US20030235712A1	公开(公告)日	2003-12-25
申请号	US10/181342	申请日	2002-06-17
[标]申请(专利权)人(译)	泷口TAKAO 坪山AKIRA 冈田治郎 镰谷JUN 三浦诚志 MORIYAMA TAKASHI 井川聪 FURUGORI MANABU MIZUTANI秀昌		
申请(专利权)人(译)	泷口TAKAO 坪山AKIRA 冈田治郎 镰谷JUN 三浦诚志 MORIYAMA TAKASHI 井川聪 FURUGORI MANABU MIZUTANI秀昌		
当前申请(专利权)人(译)	佳能株式会社		
[标]发明人	TAKIGUCHI TAKAO TSUBOYAMA AKIRA OKADA SHINJIRO KAMATANI JUN MIURA SEISHI MORIYAMA TAKASHI IGAWA SATOSHI FURUGORI MANABU MIZUTANI HIDEMASA		
发明人	TAKIGUCHI, TAKAO TSUBOYAMA, AKIRA OKADA, SHINJIRO KAMATANI, JUN MIURA, SEISHI MORIYAMA, TAKASHI IGAWA, SATOSHI FURUGORI, MANABU MIZUTANI, HIDEMASA		
IPC分类号	H01L51/50 C07D221/10 C07D221/16 C07F15/00 C09K11/06 G09F9/30 H01L27/32 H01L51/00 H01L51/30 H05B33/14		
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其他公开文献	US6824894
外部链接	Espacenet USPTO

摘要(译)

一种金属配位化合物，具有由下式表示的基本结构：MLmL'n（1），其中M是Ir，Pt，Rh或Pd的金属原子; L和L'是相互不同的二齿配体; m是1,2或3;其中，提供至少一个二齿配体具有通过具有2-10个碳原子的亚烷基缩合形成的部分结构。在由设置在阴极和阳极之间的一个或多个有机膜组成的电致发光器件中，至少一个层是发光层，其通过掺入构成具有式（1）结构的金属配位化合物的发光分子而形成。如上所述，作为主体材料中的客体材料，从而提供一种电效发光器件，其以高效率产生发光并且长时间稳定地保持高亮度。