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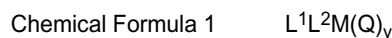
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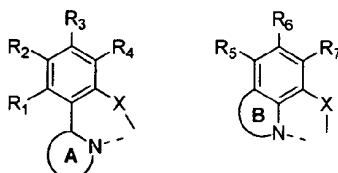
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(54) **Electroluminescent device using electroluminescent compounds**

(57) The present invention relates to an electroluminescent device. More specifically, the electroluminescent device according to the present invention is comprised of a first electrode; a second electrode; and at least one organic layer (s) interposed between the first electrode and the second electrode; and the organic layer comprises one or more organic electroluminescent compound(s) represented by Chemical Formula (1) as host material:



wherein, the ligands,  $\text{L}^1$  and  $\text{L}^2$  are independently selected from the following structures:



wherein, M represents a divalent or trivalent metal;

y is 0 when M is a divalent metal, while y is 1 when M is a trivalent metal;

Q represents (C6-C60)aryloxy or tri(C6-C60)arylsilyl, and the aryloxy or triarylsilyl of Q may be further substituted by (C1-C60)alkyl or (C6-C60)aryl.

The electroluminescent devices according to the invention exhibit excellent color purity and luminous efficiency.

## Description

## FIELD OF THE INVENTION

5 [0001] The present invention relates to an electroluminescent device comprising electroluminescent compounds.

## BACKGROUND OF THE INVENTION

10 [0002] Among display devices, electroluminescence devices (EL devices) are self-luminescent display devices showing the advantage of wide angle of view, excellent contrast and rapid response rate, as compared to LCD's.

[0003] EL devices are classified into inorganic EL devices and organic EL devices depending on the material for forming the emitting layer and the luminescent mechanism. Among them, organic EL devices are highly advantageous in view of luminous efficiency, color purity and operation voltage, so that full-color displays may be easily realized.

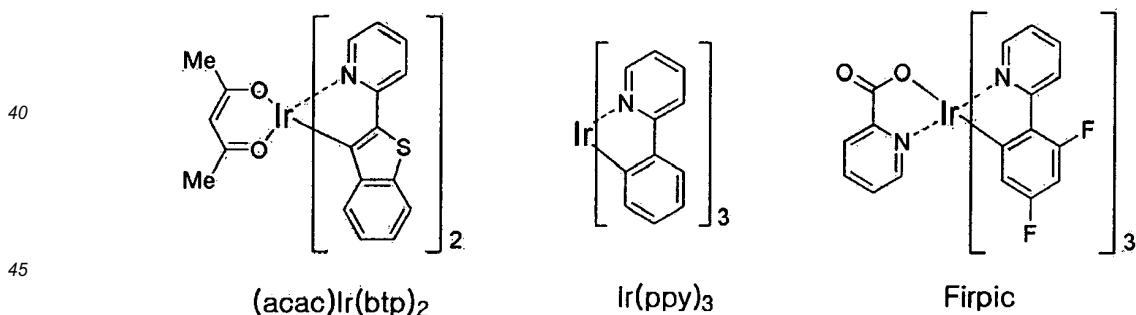
15 [0004] In the meanwhile, Eastman Kodak developed in 1987 an organic EL device which employs a low molecular weight aromatic diamine as a material for forming an EL layer, and an aluminum complex, for the first time [Appl. Phys. Lett. 51, 913, 1987].

[0005] EL materials can be functionally classified into host materials and dopant materials. It is generally known that a device structure having the most excellent EL properties can be fabricated with an EL layer prepared by doping a dopant on a host. Recently, development of organic EL devices with high efficiency and long life comes to the fore as an urgent subject, and particularly urgent is development of a material with far better EL properties as compared to conventional EL materials as considering EL properties required for a medium to large size OLED panel. The desired properties for the host material (serving as a solid state solvent and an energy conveyer) are high purity and appropriate molecular weight to enable vapor-deposition in vacuo. In addition, glass transition temperature and thermal decomposition temperature should be high to ensure thermal stability. Further, the host material should have high electrochemical stability for providing long life. It is to be easy to form an amorphous thin film, with high adhesiveness to other adjacent materials but without interlayer migration.

20 [0006] The most important factor to determine luminous efficiency in an OLED (organic light-emitting diode) is the type of electroluminescent material. Though fluorescent materials has been widely used as an electroluminescent material up to the present, development of phosphorescent materials is one of the best methods to improve the luminous efficiency theoretically up to four(4) times, in view of electroluminescent mechanism.

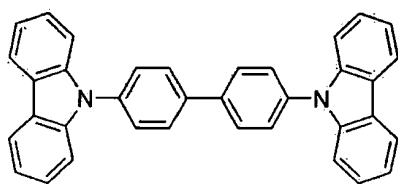
30 [0007] Up to now, iridium (III) complexes are widely known as phosphorescent material, including (acac)Ir(btp)<sub>2</sub>, Ir(ppy)<sub>3</sub> and Firpic, as the red, green and blue one, respectively. In particular, a lot of phosphorescent materials have been recently investigated in Korea, Japan, Europe and America, and developments of further improved phosphorescent materials are expected.

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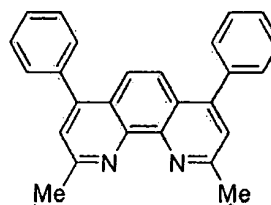


50 [0008] As a host material for phosphorescent light emitting material, 4,4'-N,N'-dicarbazole-biphenyl (CBP) has been most widely known up to the present, and OLED's having high efficiency to which a hole blocking layer (such as BCP and BAQ) has been applied have been developed. East-North Pioneer (Japan) or the like reported OLED's of high performances which were developed by using bis(2-methyl-8-quinolino)(p-phenylphenolato) aluminum (III) (BAQ) and derivatives thereof as the host of phosphorescent material.

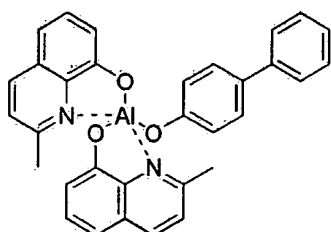
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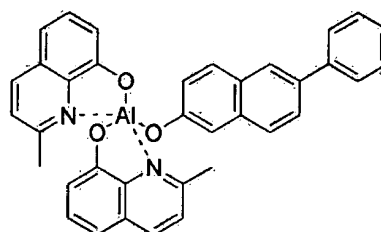
CBP



BCP



BAiq



BAiq 유도체

[0009] Though the materials in prior art are advantageous in view of light emitting property, they have low glass transition temperature and very poor thermal stability, so that the materials tend to be changed during the process of high temperature vapor-deposition in vacuo. In an organic electroluminescent device, it is defined that power efficiency =  $(\pi / \text{voltage}) \times \text{current efficiency}$ . Thus, the power efficiency is inversely proportional to the voltage, and the power efficiency should be higher in order to obtain lower power consumption of an OLED. In practice, an OLED employing phosphorescent electroluminescent (EL) material shows significantly higher current efficiency (cd/A) than an OLED employing fluorescent EL material. However, in case that a conventional material such as BAiq and CBP as host material of the phosphorescent material is employed, no significant advantage can be obtained in terms of power efficiency (lm/w) because of higher operating voltage as compared to an OLED employing a fluorescent material.

[0010] In general, an organic electroluminescent device is basically established as a laminate form consisting of anode/organic EL layer/cathode, being properly equipped with a hole injection transport layer and an electron injection layer; for example, currently known are the structures of anode/hole injection layer/hole transport layer/organic EL layer/cathode; anode/hole injection layer/hole transport layer/organic EL layer/electron injection layer/cathode; and anode/hole injection layer/hole transport layer/organic EL layer/electron transport layer/electron injection layer/cathode, or the like.

[0011] Various organic compounds may be used in the electron injection layer or the electron transport layer of these laminate-type devices. These compounds include a light-metal complexes represented by tris(8-quinolinolate)aluminum ( $\text{Alq}_3$ ), oxadiazole, triazole, benzimidazole, benzoxazole, benzothiazole, or the like, but they are not fully satisfactory in view of EL luminance, durability, or the like. Among them,  $\text{Alq}_3$  is reported as the most preferable compound having excellent stability and high electron affinity. When it is employed in a blue electroluminescent device, however, color purity is deteriorated by luminescence due to exciton diffusion.

[0012] As described above, recent progresses for commercialization of electroluminescent devices have been prominent, which are characterized by obtaining EL devices of slim-type having high luminance with low applied voltage, variety of EL wavelength and rapid response, and low power consumption is essential for devices of high efficiency and long life.

#### SUMMARY OF THE INVENTION

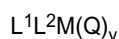
[0013] Thus, the object of the invention is to provide electroluminescent devices comprised of a first electrode; a second electrode; and at least one organic layer(s) interposed between the first electrode and the second electrode; wherein the organic layer comprises divalent or trivalent metal complex as host material, with various electroluminescent dopants.

[0014] Another object of the invention is to provide electroluminescent devices exhibiting excellent luminous efficiency, high color purity, low operation voltage and good operation life.

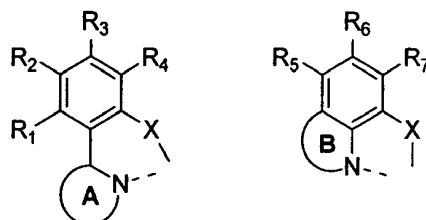
[0015] Specifically, the electroluminescent device according to the present invention is comprised of a first electrode; a second electrode; and at least one organic layer(s) interposed between the first electrode and the second electrode; and the organic layer comprises one or more organic electroluminescent compound(s) represented by Chemical Formula

(1) as host material:

Chemical Formula 1



wherein, the ligands,  $L^1$  and  $L^2$  are independently selected from the following structures:



wherein, M represents a divalent or trivalent metal;

y is 0 when M is a divalent metal, while y is 1 when M is a trivalent metal;

Q represents (C6-C60)aryloxy or tri(C6-C60)arylsilyl, and the aryloxy or triarylsilyl of Q may be further substituted by (C1-C60)alkyl or (C6-C60)aryl;

X represents O, S or Se;

ring A and ring B independently represent a 5- or 6-membered heteroaromatic ring, or a 5- or 6-membered heteroaromatic ring with a (C6-C60)aromatic ring fused; ring A may form a chemical bond with  $R_1$  to form a fused ring, and ring A or ring B may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, (C1-C60)alkyl substituted by halogen, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino;

$R_1$  through  $R_7$  independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, (C6-C60)aryl, (C4-C60)heteroaryl, di(C1-C30)alkylamino and di(C6-C30)arylamino; or each of them may be linked to an adjacent substituent via alkylene or alkenylene to form a fused ring; and

the aryl or heteroaryl to be substituted on ring A or ring B, or the aryl, heteroaryl of  $R_1$  through  $R_7$ , or the fused ring formed by linkage to an adjacent substituent via alkylene or alkenylene may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60) cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a cross-sectional view of an OLED.

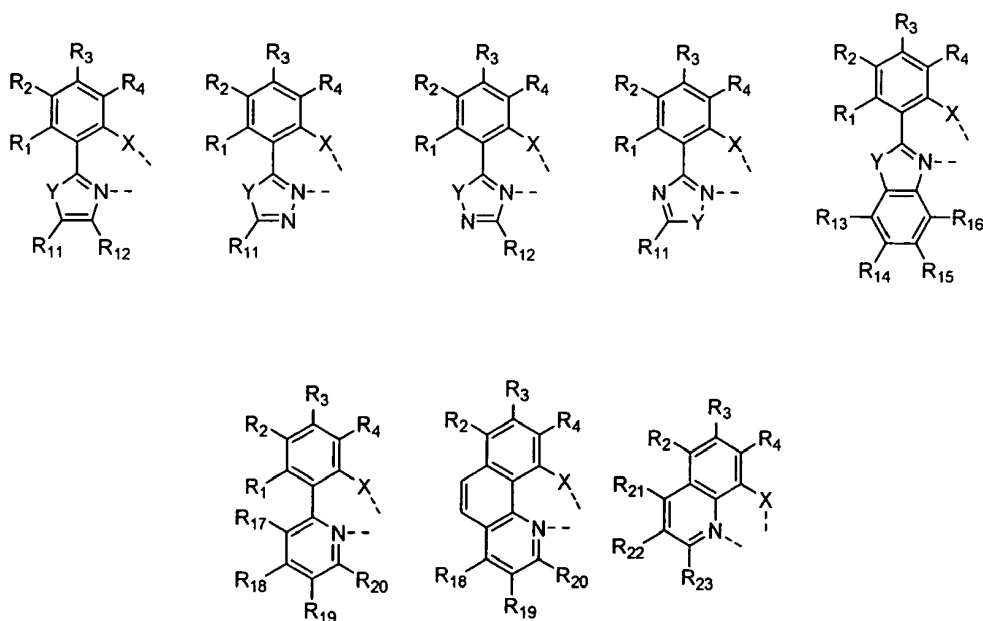
#### DETAILED DESCRIPTION OF THE INVENTION

[0017] Referring now to the Drawings, Fig. 1 illustrates a cross-sectional view of an OLED comprising a Glass 1, Transparent electrode 2, Hole injection layer 3, Hole transport layer 4, Electroluminescent layer 5, Electron transport layer 6, Electron injection layer 7 and an Al cathode 8.

[0018] The term 'alkyl' or 'alkoxy' described herein include both linear and branched alkyl or alkoxy groups.

[0019] The term 'heteroaromatic ring' described herein means a 5- or 6-membered aromatic group containing one or more heteroatom(s) selected from N, O and S, and include, for example, pyrrole, pyrazole, oxazole, isoxazole, thiazole, isothiazole, imidazole, oxadiazole, thiadiazole, pyridine, pyrazine, pyrimidine and pyridazine. Specific examples of 5- or 6-membered heteroaromatic rings fused with a (C6-C30)aromatic ring include indazole, benzoxazole, benzothiazole, benzimidazole, phthalazine, quinoxaline, quinazoline, cinnoline, carbazole, phenanthridine, acridine, quinoline and isoquinoline. Ring A is preferably selected from oxazole, thiazole, imidazole, oxadiazole, thiadiazole, benzoxazole, benzothiazole, benzimidazole, pyridine and quinoline.

[0020] Ligand  $L_1$  and  $L_2$  are independently selected from the following structures:



wherein, X, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are defined as in Chemical Formula (1);

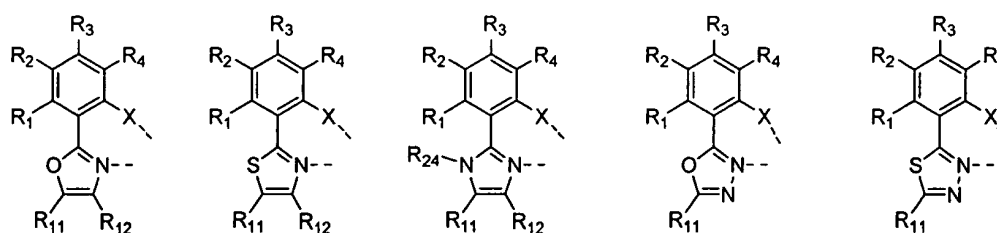
Y represents O, S or NR<sub>24</sub>;

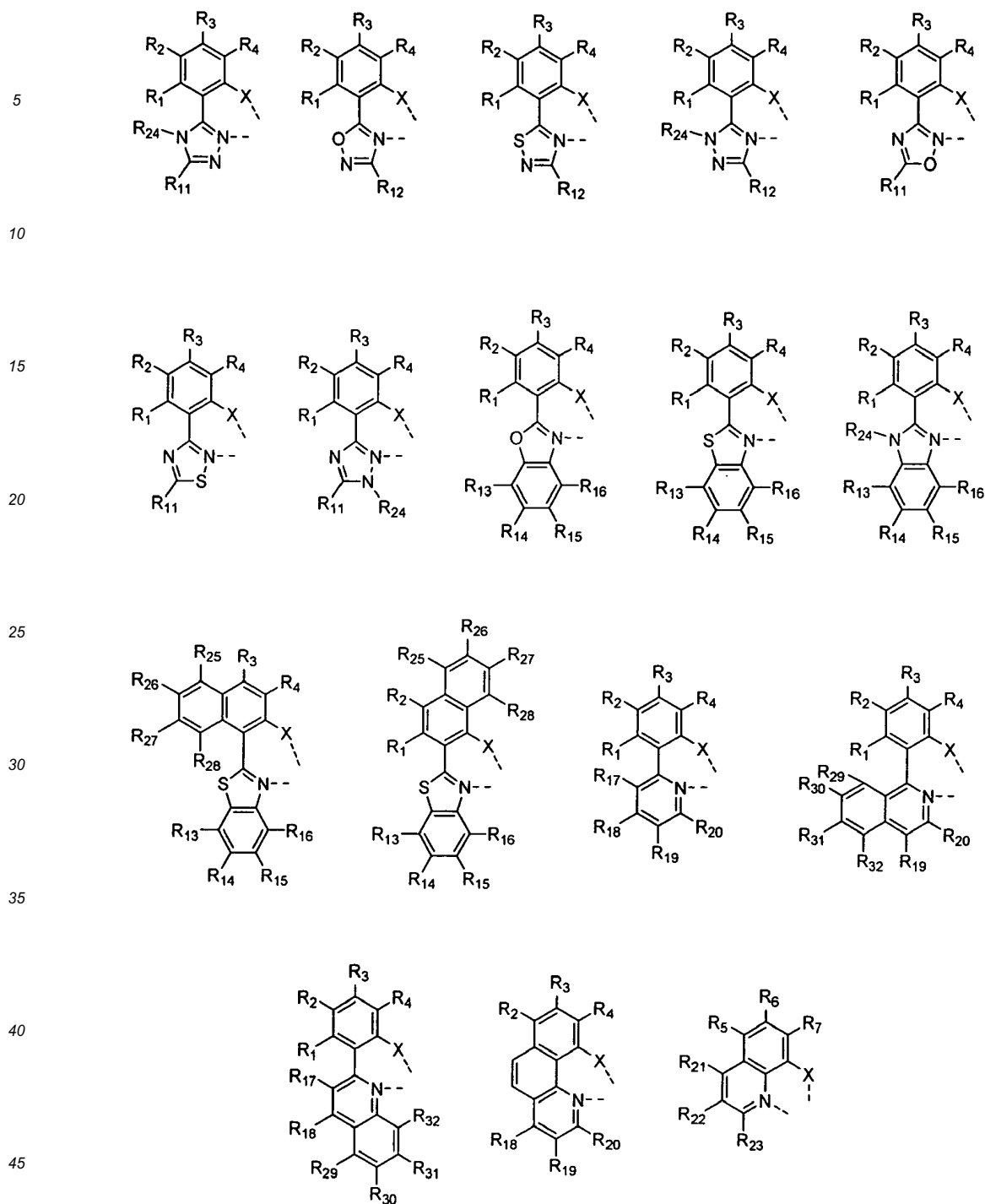
R<sub>11</sub> through R<sub>23</sub> independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylamino; or each of R<sub>13</sub> through R<sub>16</sub> and R<sub>17</sub> through R<sub>20</sub> may be linked to an adjacent substituent via alkylene or alkenylene to form a fused ring; and the fused ring may be substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino;

R<sub>24</sub> represents (C1-C60)alkyl or (C6-C60)aryl; and

the aryl or heteroaryl of R<sub>11</sub> through R<sub>24</sub> may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino.

[0021] Ligands, L<sup>1</sup> and L<sup>2</sup> may be independently selected from the following structures:





wherein, X is defined as in Chemical Formula (1);

R<sub>1</sub> through R<sub>7</sub> independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent (s), tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, (C6-C60)aryl, (C4-C60)heteroaryl, di(C1-C30)alkylamino or di(C6-C30)arylamino;

R<sub>11</sub> through R<sub>23</sub> independently represents hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent (s), (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylamino;

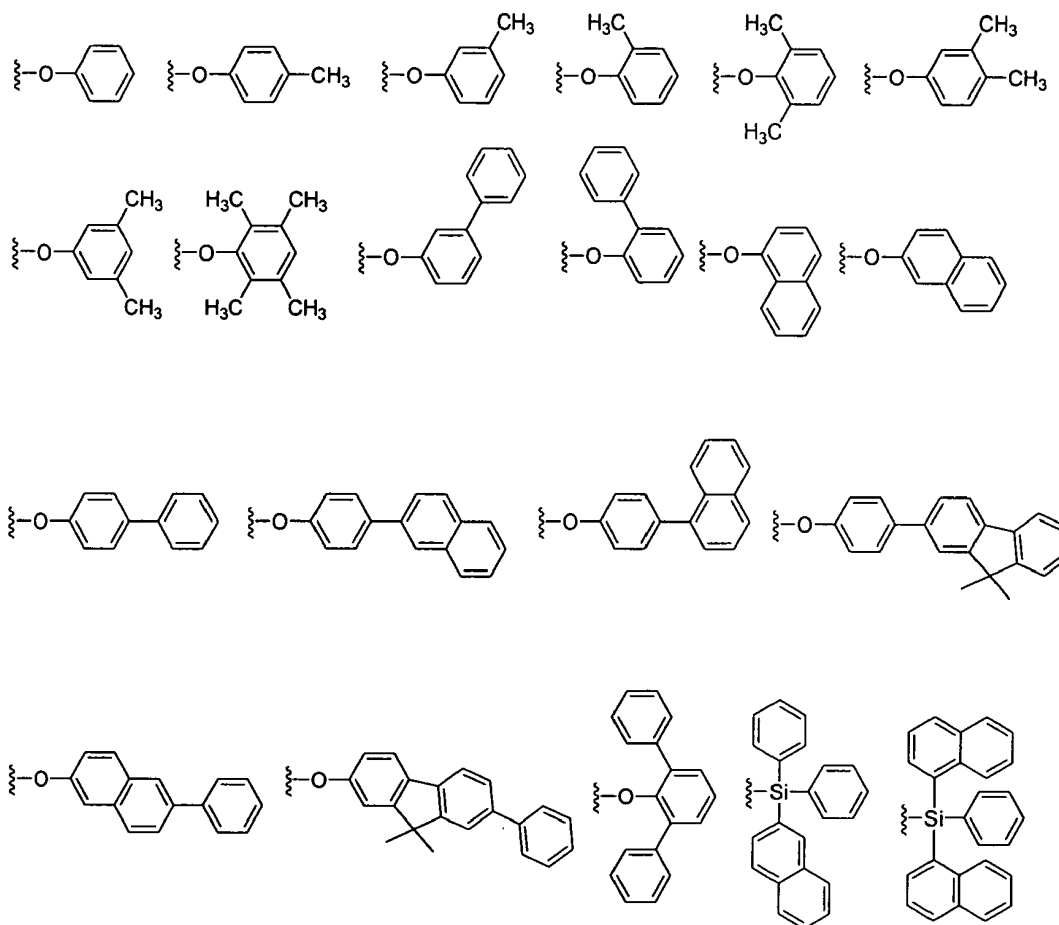
R<sub>24</sub> represents (C1-C60)alkyl, (C6-C60)aryl or (C4-C60)heteroaryl;

R<sub>25</sub> through R<sub>32</sub> independently represent hydrogen, (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen

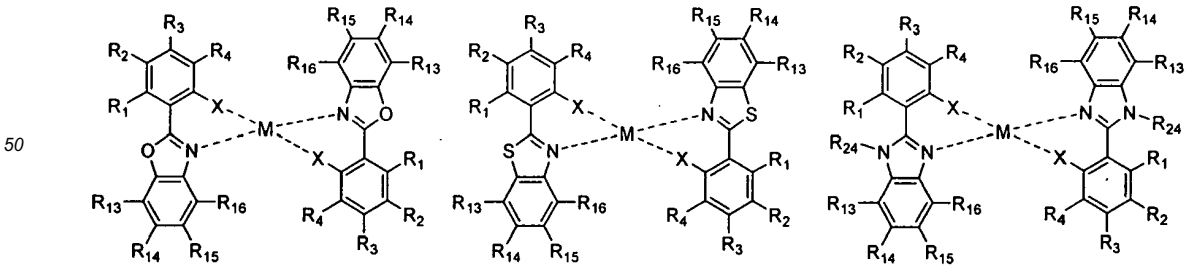
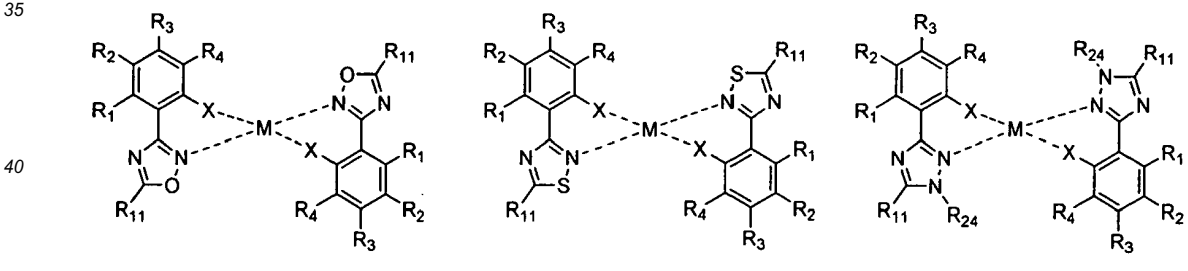
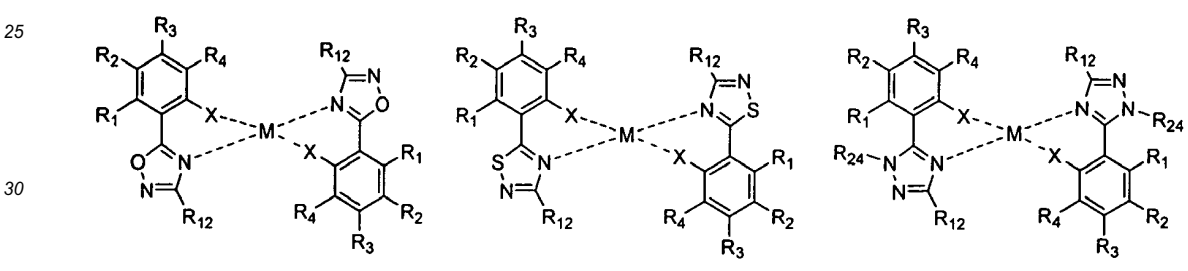
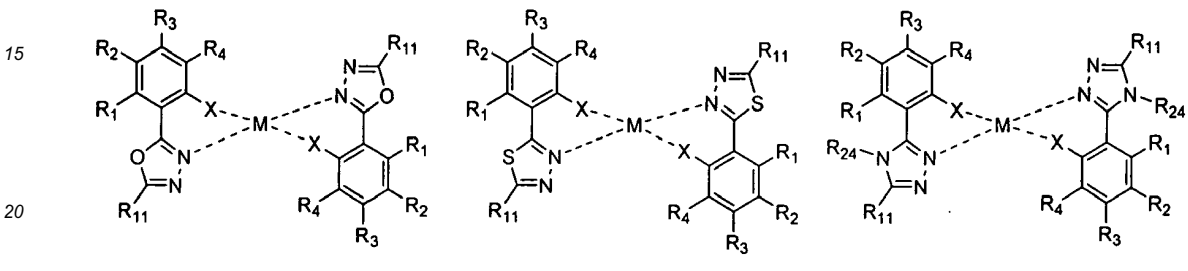
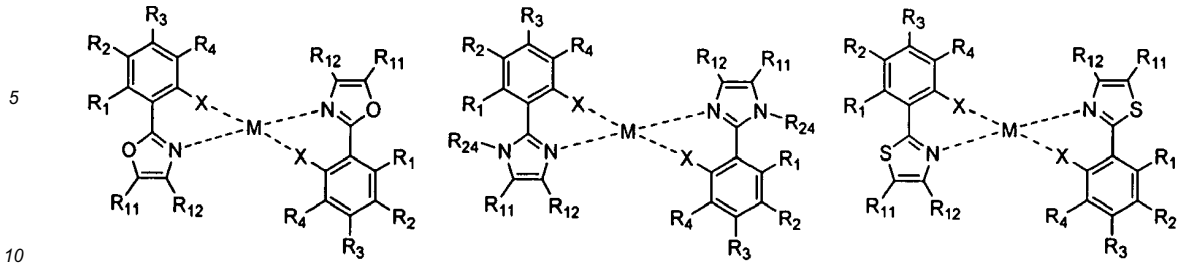
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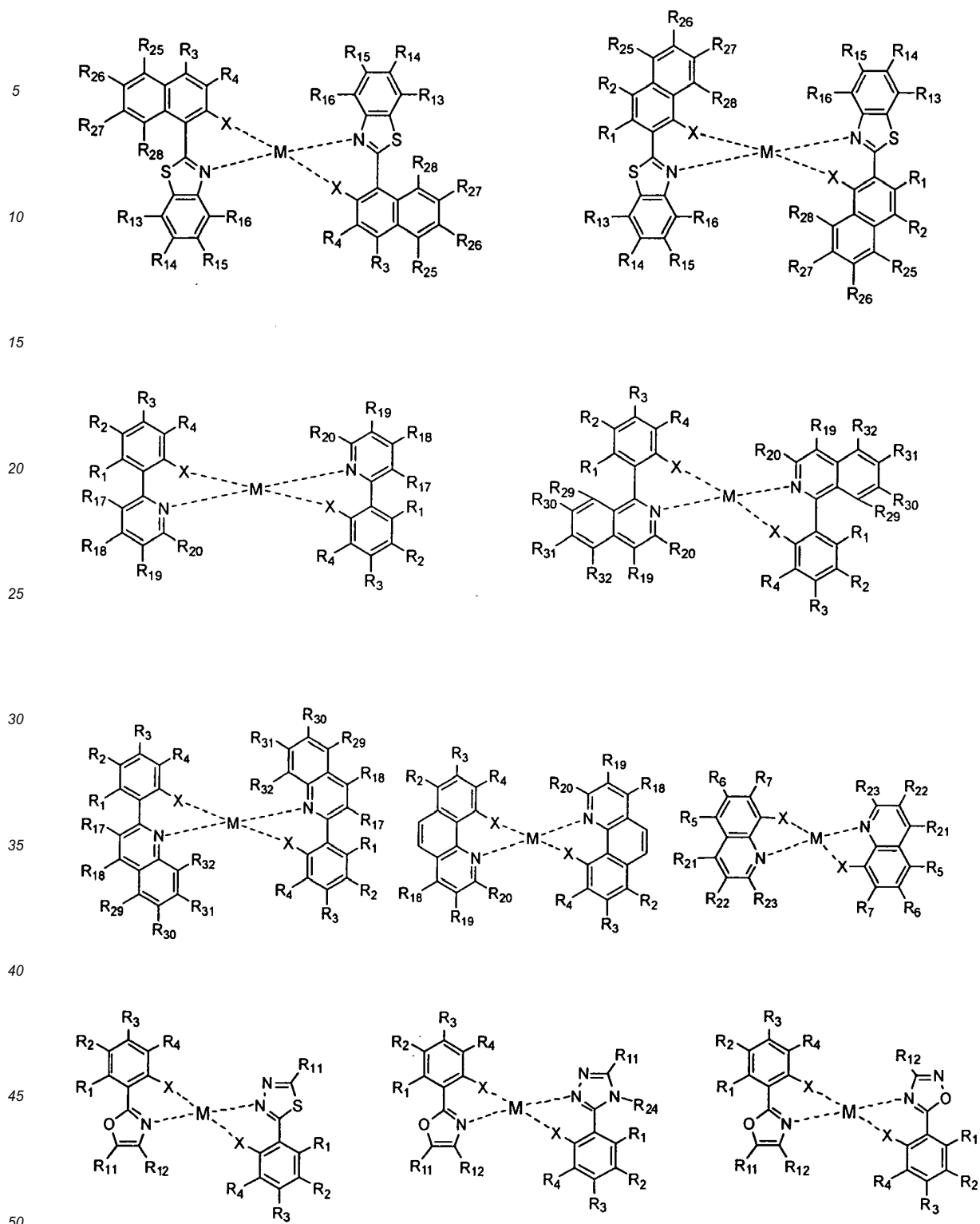
substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylamino; the aryl or heteroaryl of R<sub>1</sub> through R<sub>7</sub>, R<sub>11</sub> through R<sub>23</sub>, R<sub>24</sub> and R<sub>25</sub> through R<sub>32</sub> may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino; and the alkyl may be linear or branched.

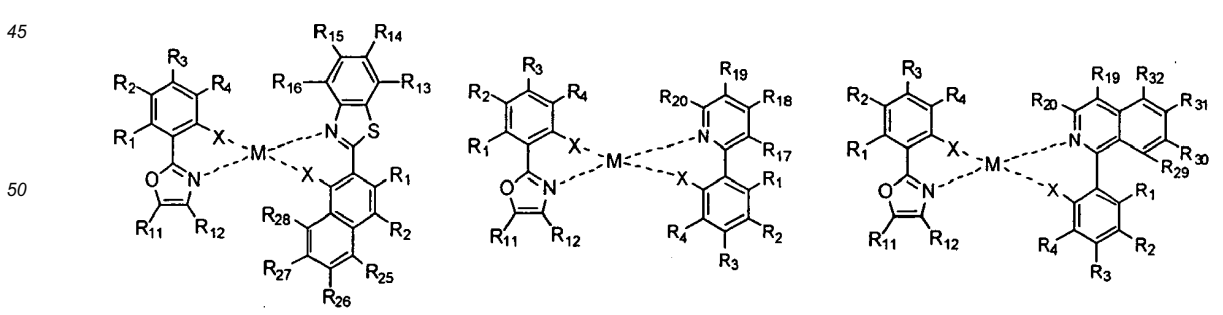
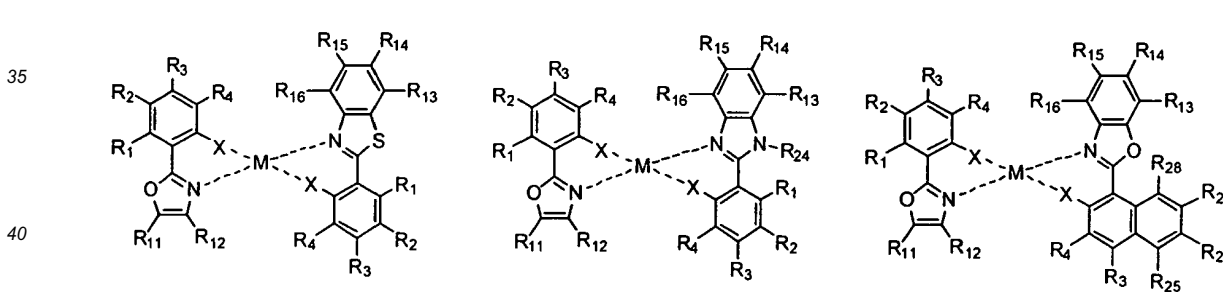
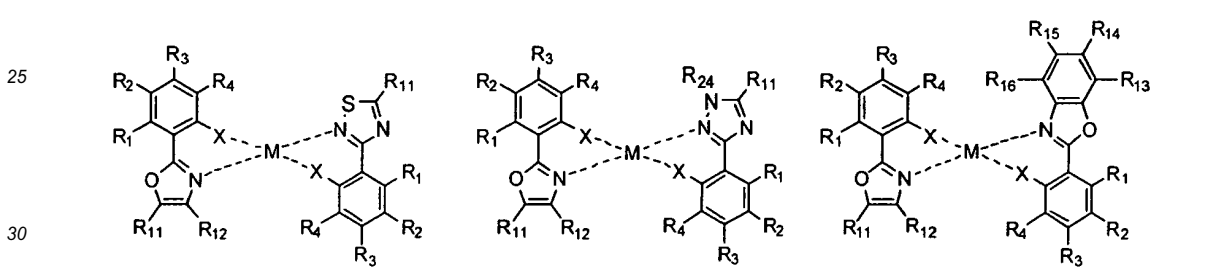
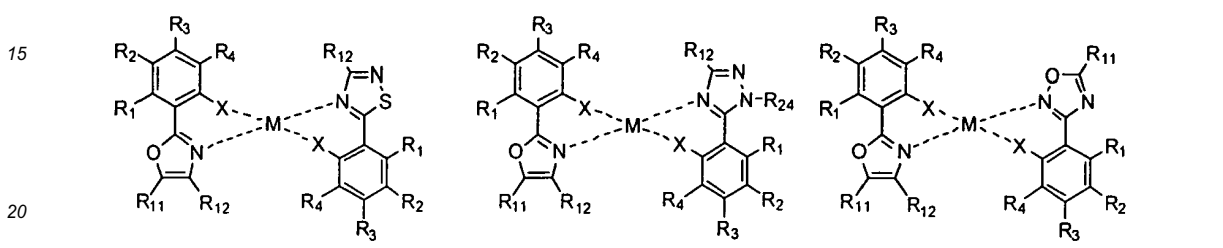
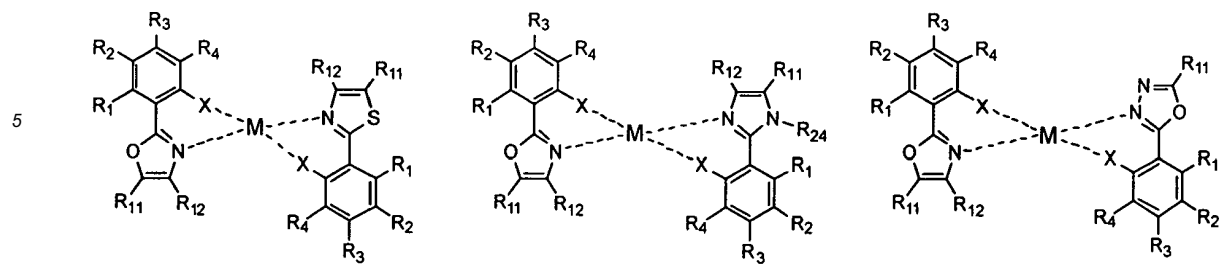
[0022] In Chemical Formula (1), M represents a bivalent metal selected from a group consisting of Be, Zn, Mg, Cu and Ni, or a trivalent metal selected from a group consisting of Al, Ga, In and B; and Q is selected from the following structures:



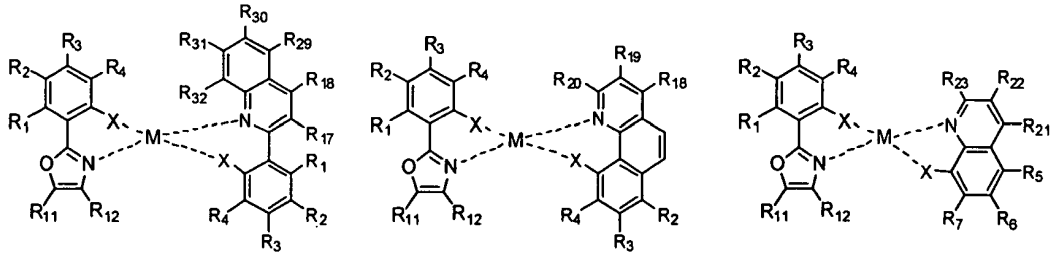
[0023] When M is a bivalent metal, the compounds represented by Chemical Formula (1) can be specifically exemplified by the following compounds, but are not restricted thereto:





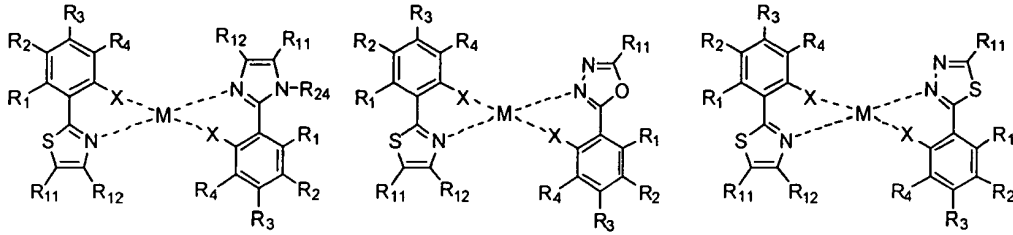


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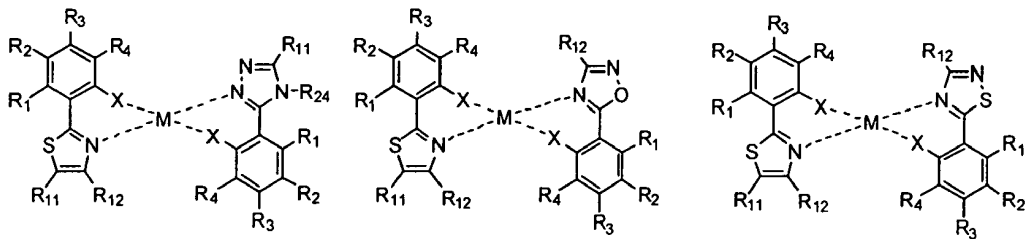
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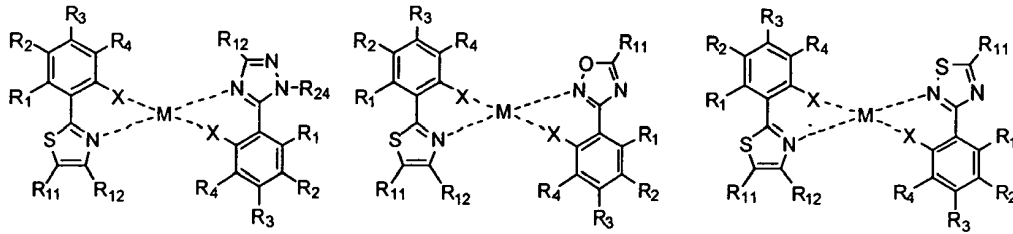
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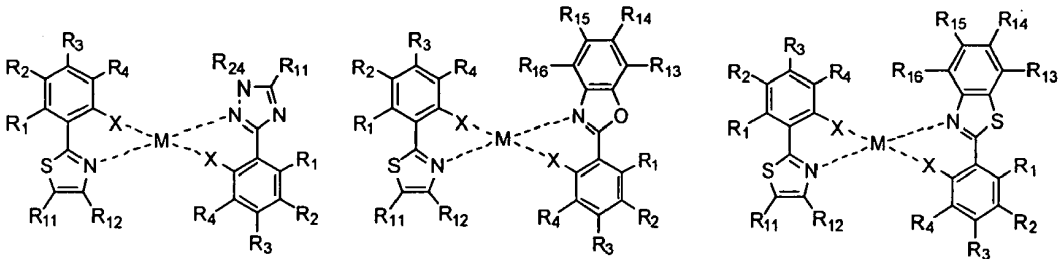
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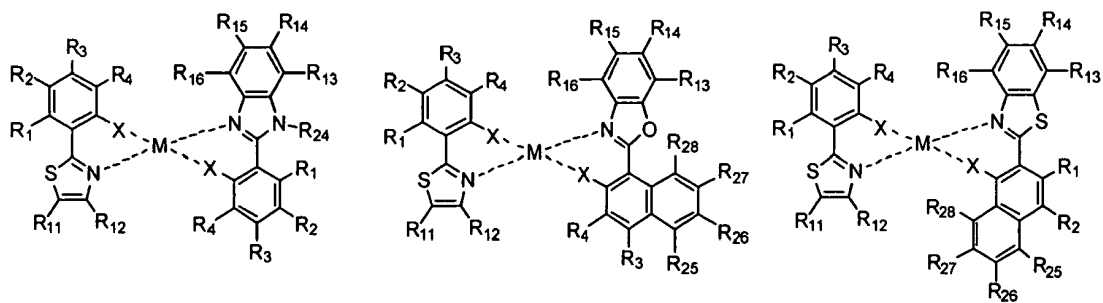
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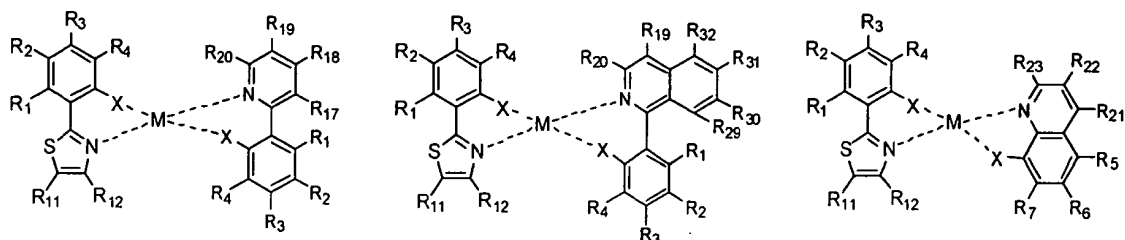
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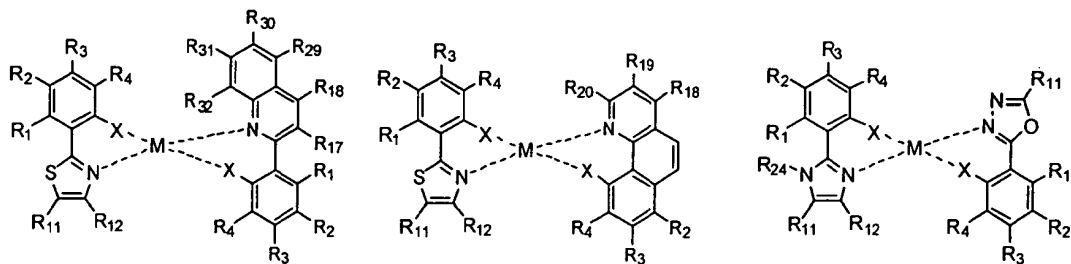
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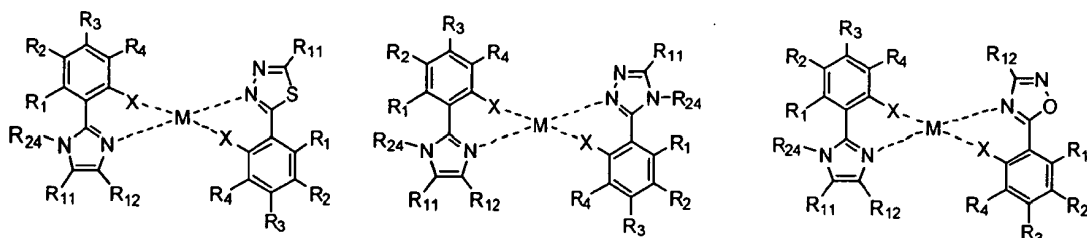
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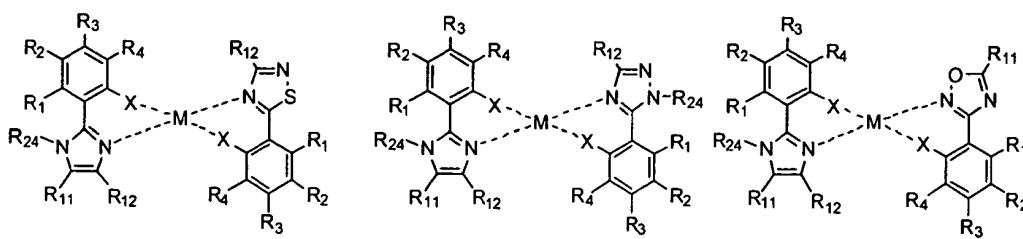
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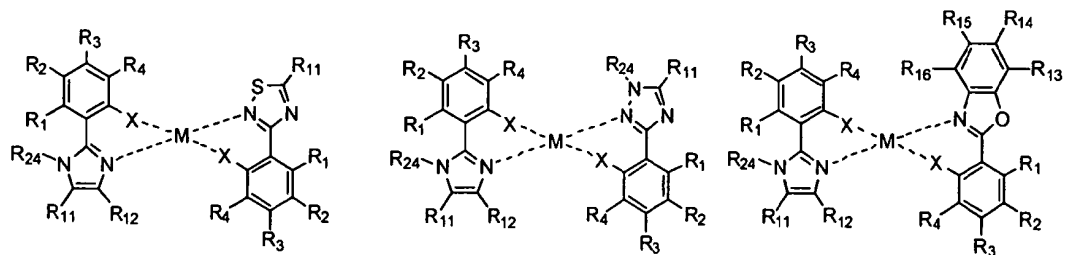
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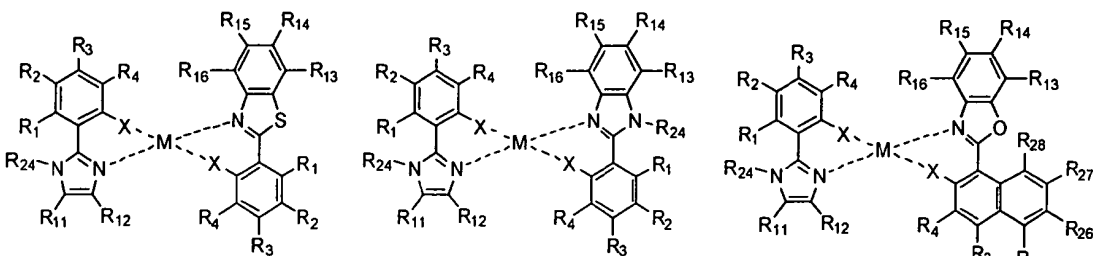
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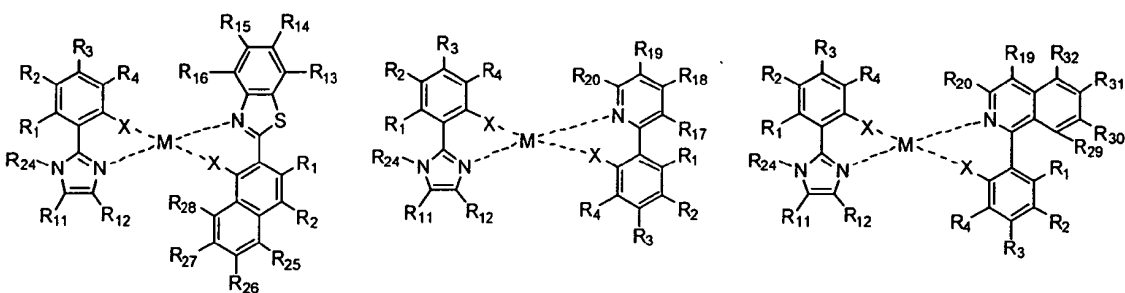
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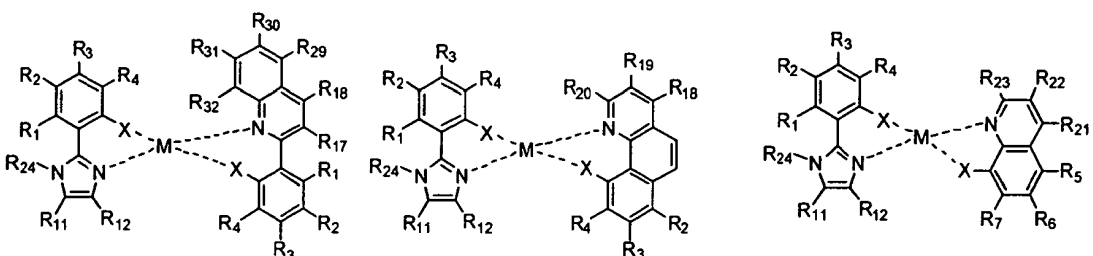
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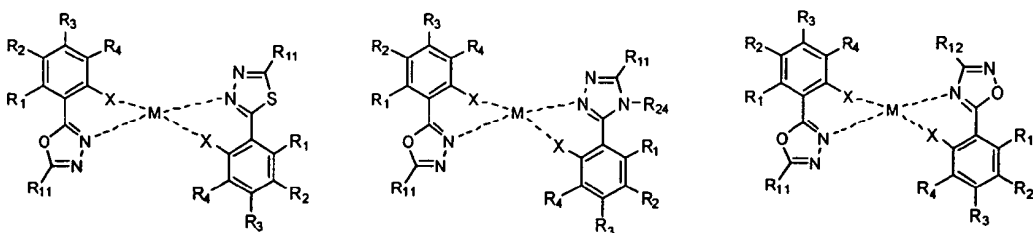
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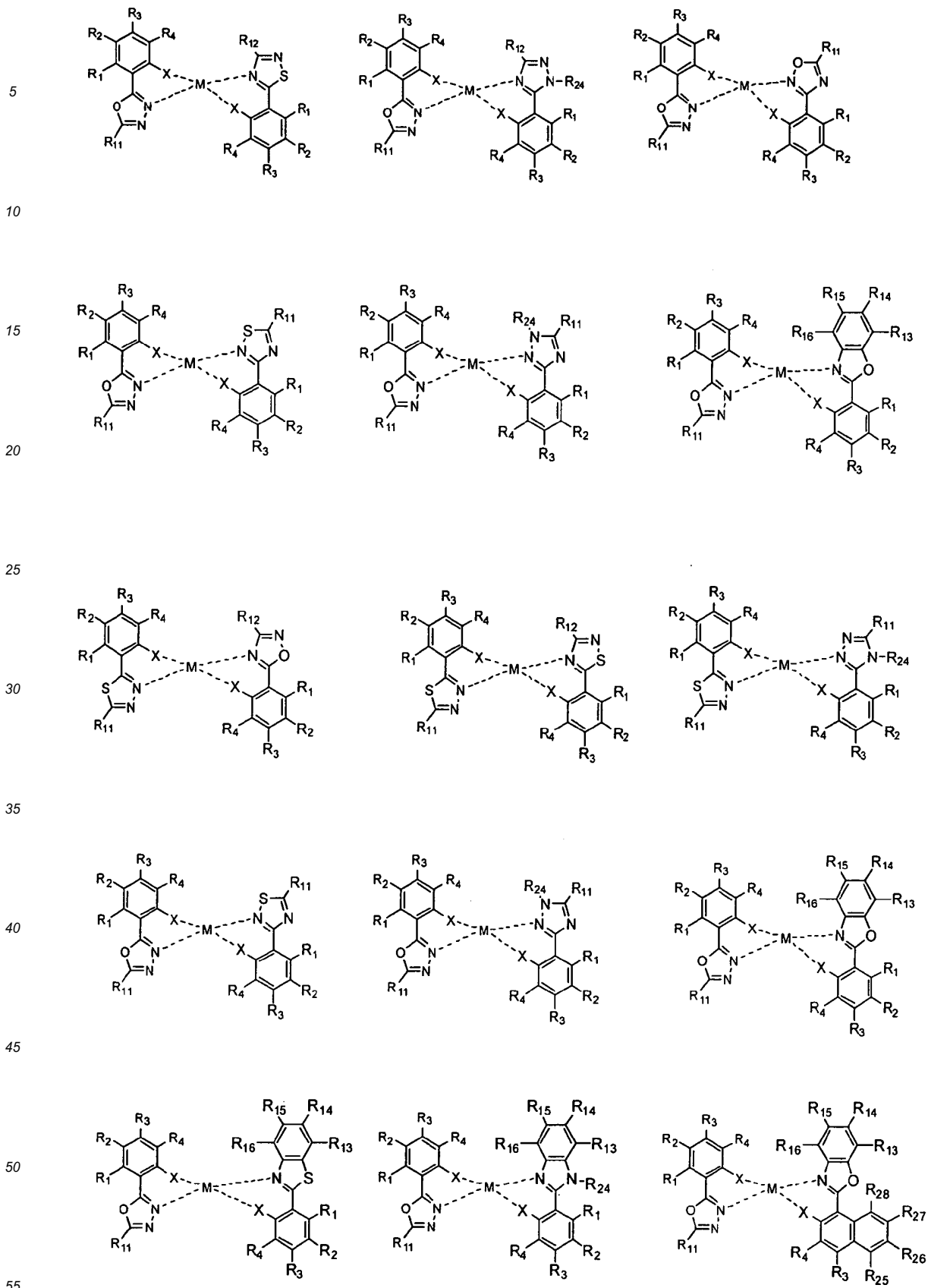


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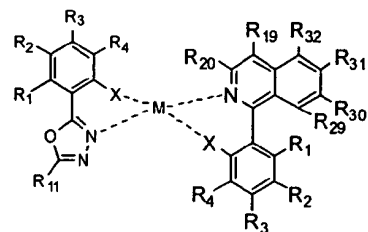
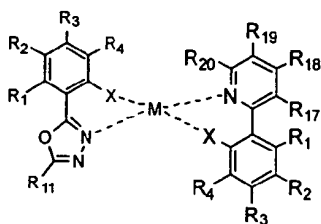
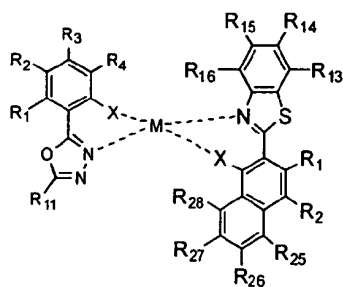
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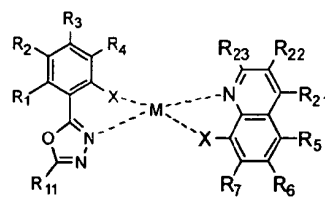
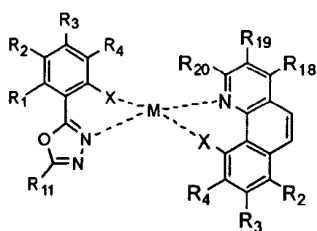
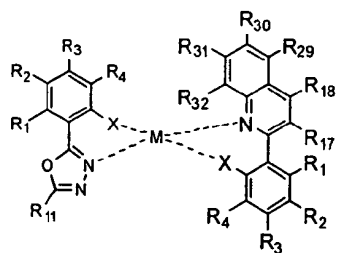
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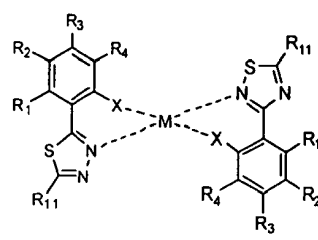
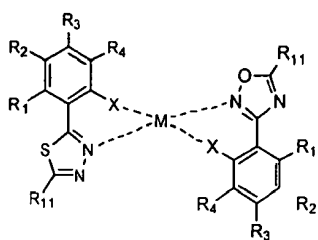
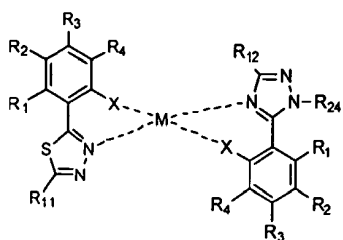


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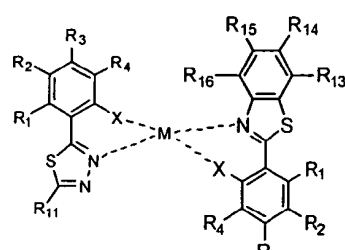
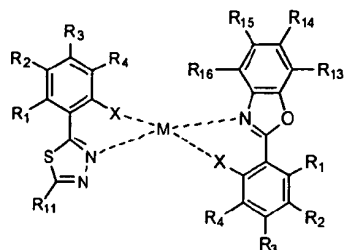
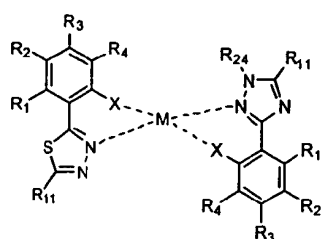
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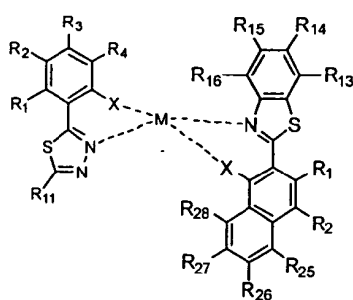
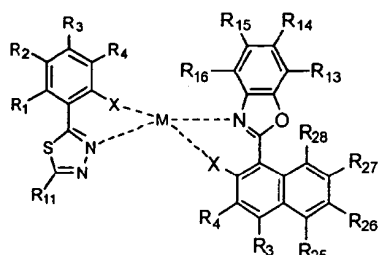
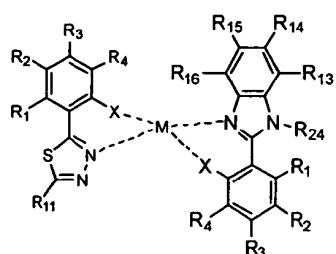
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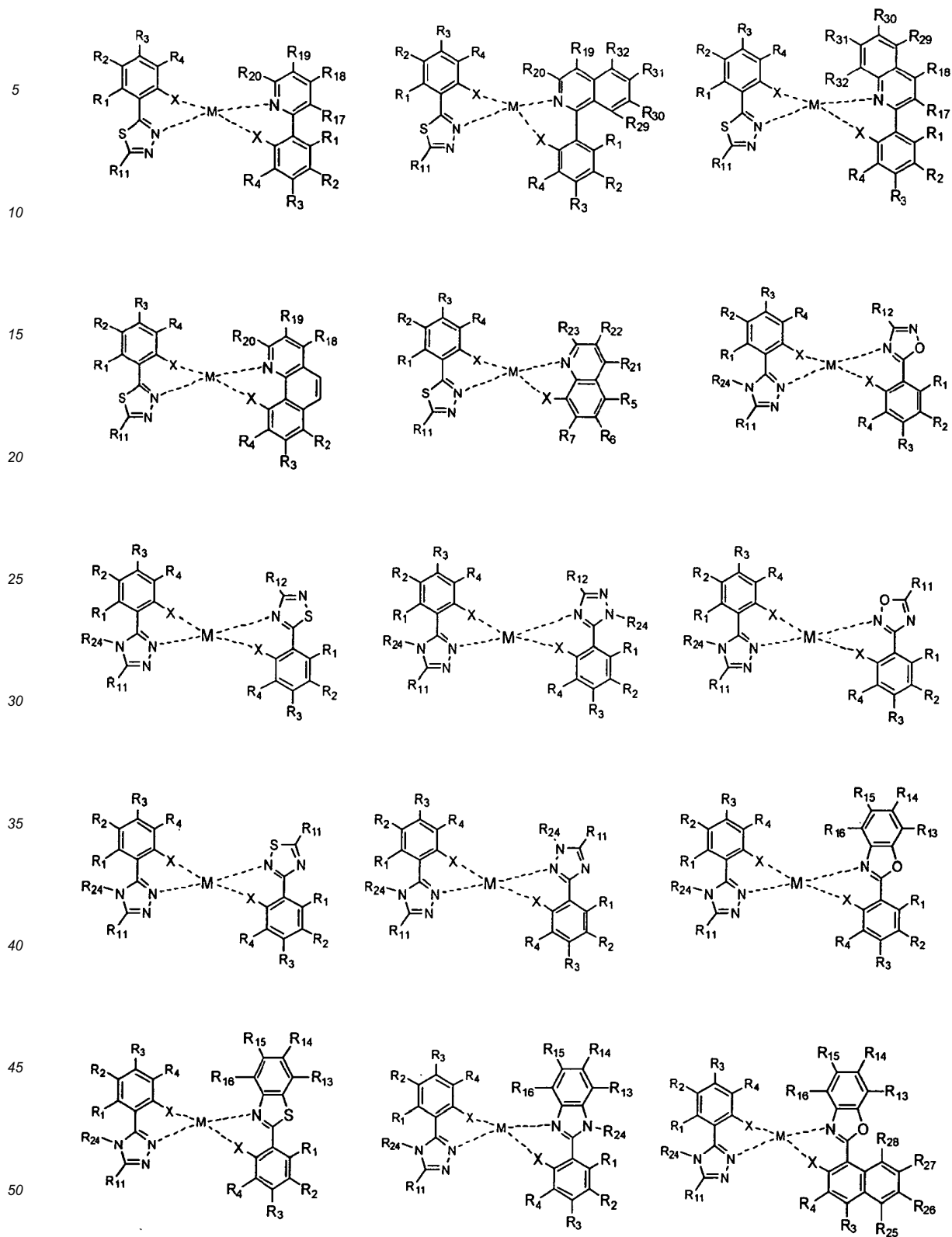
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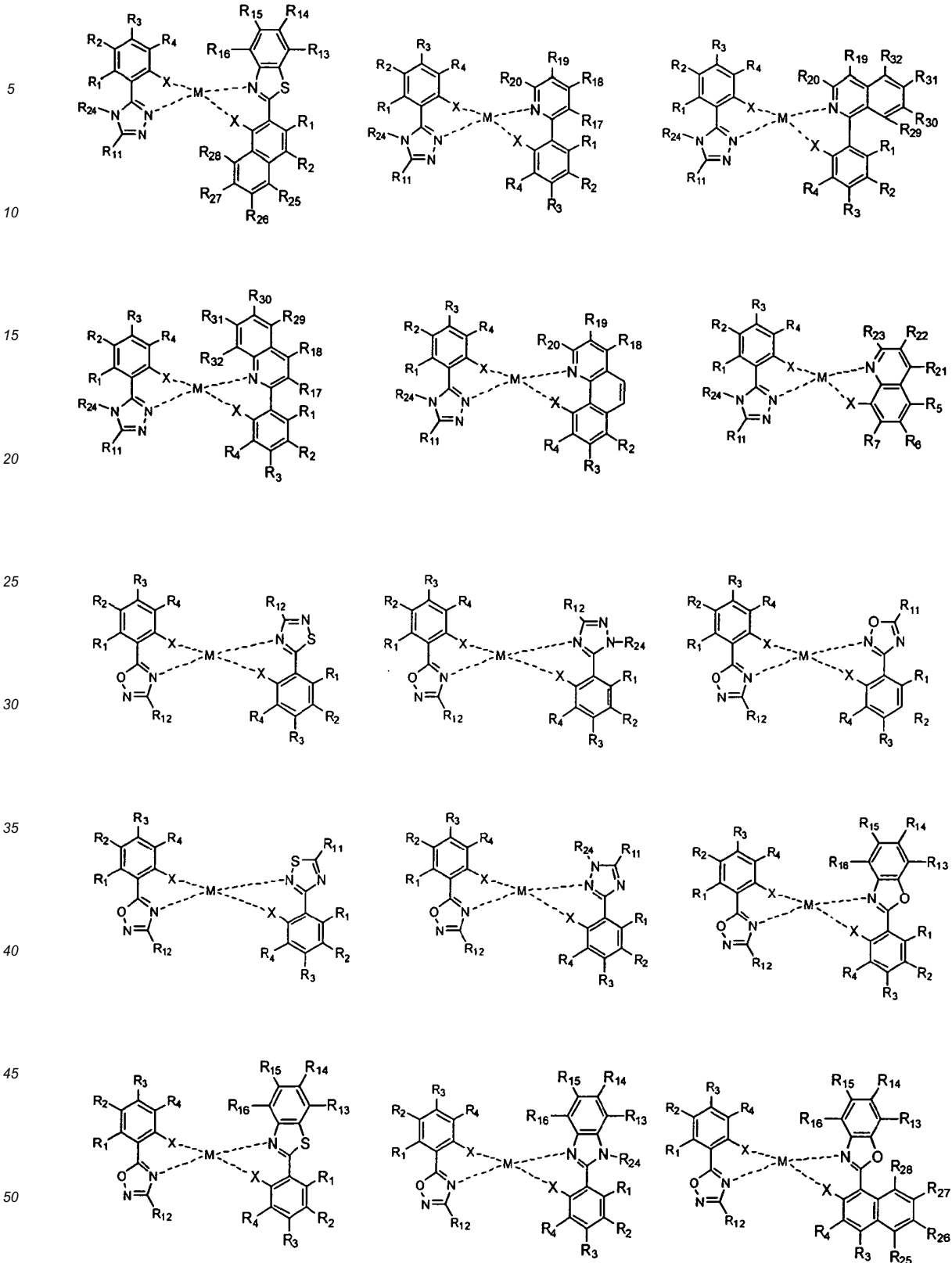


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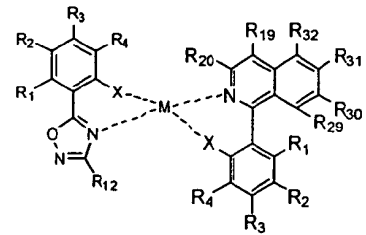
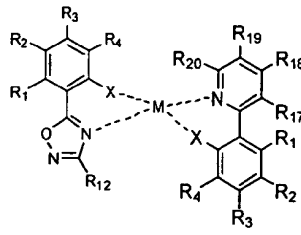
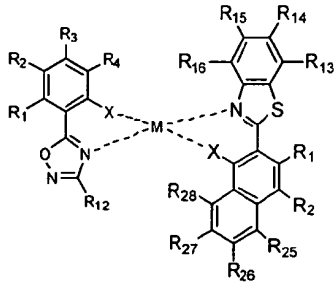
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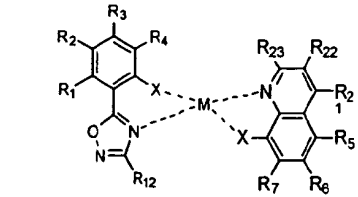
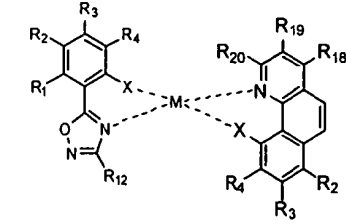
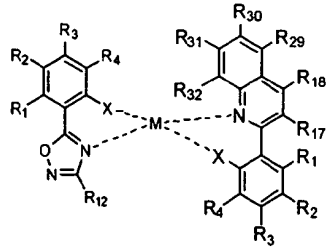




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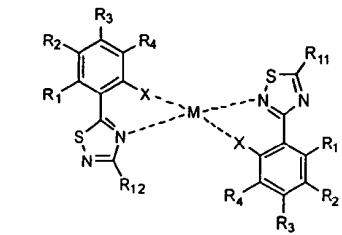
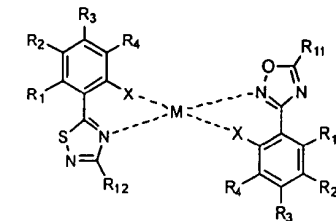
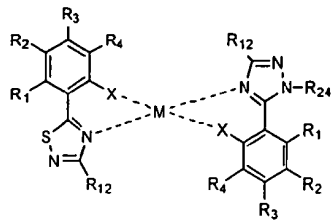


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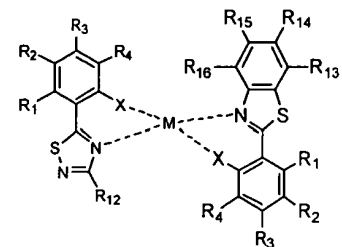
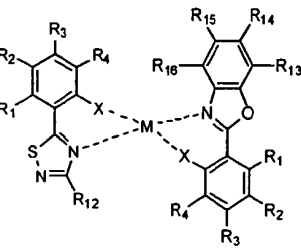
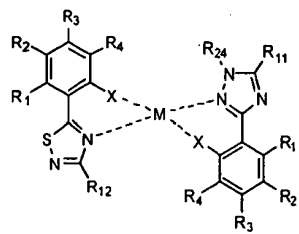
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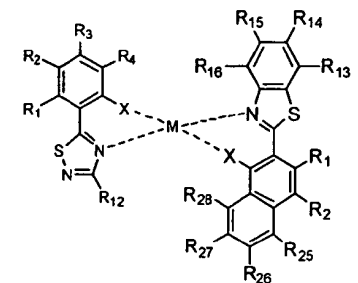
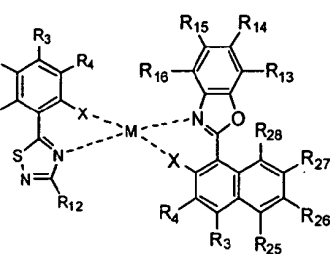
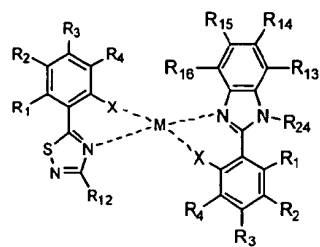
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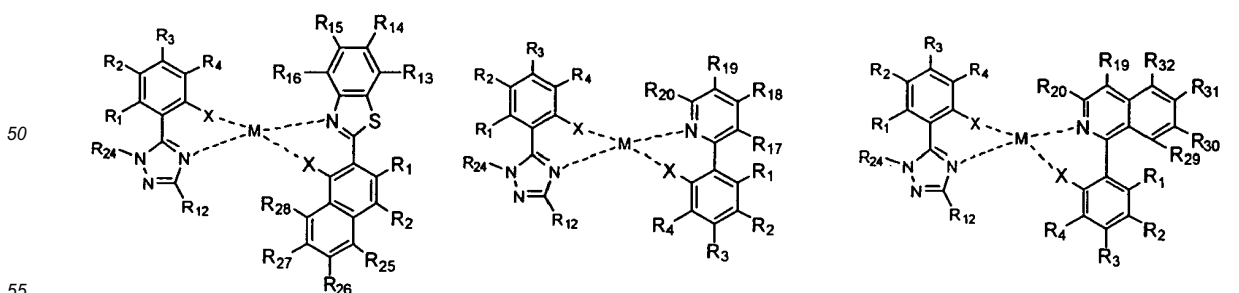
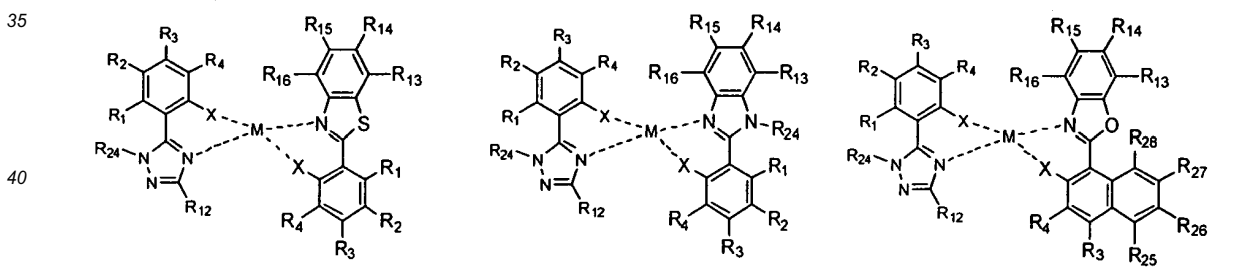
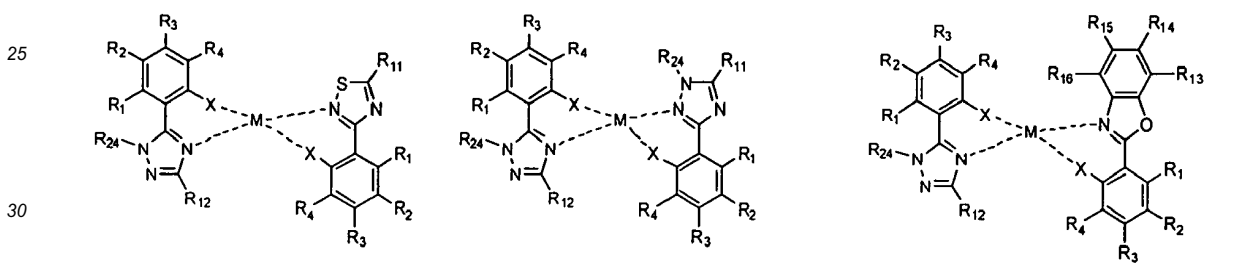
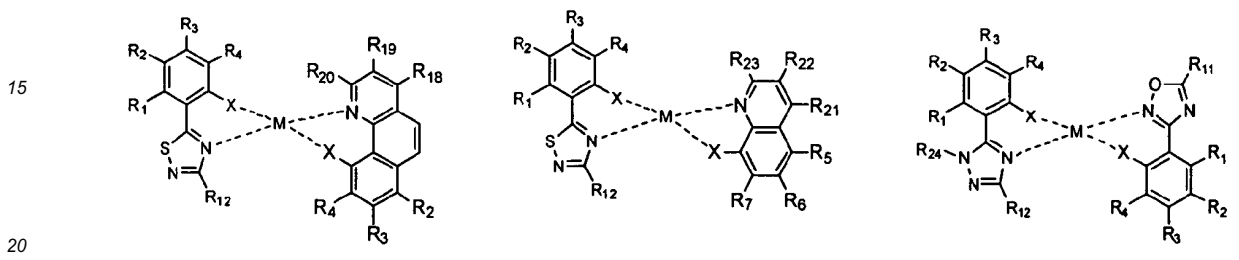
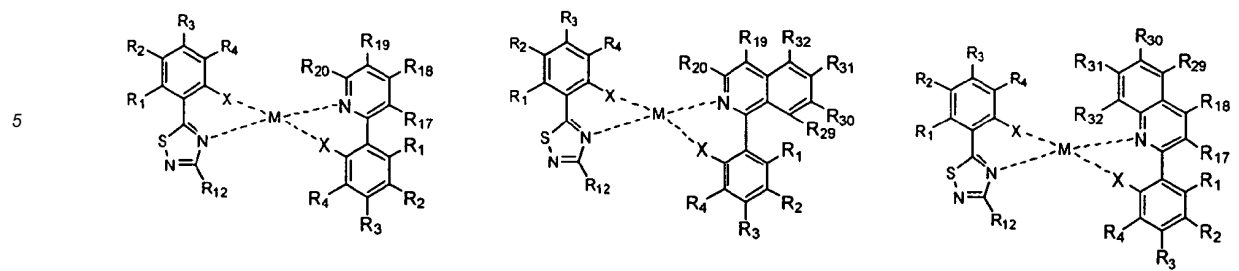
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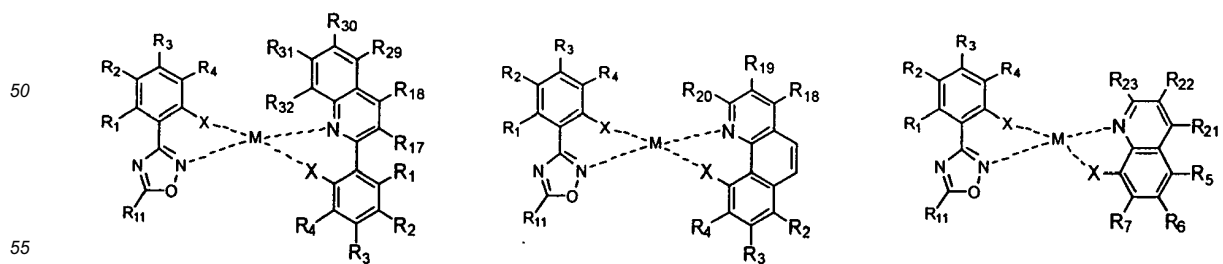
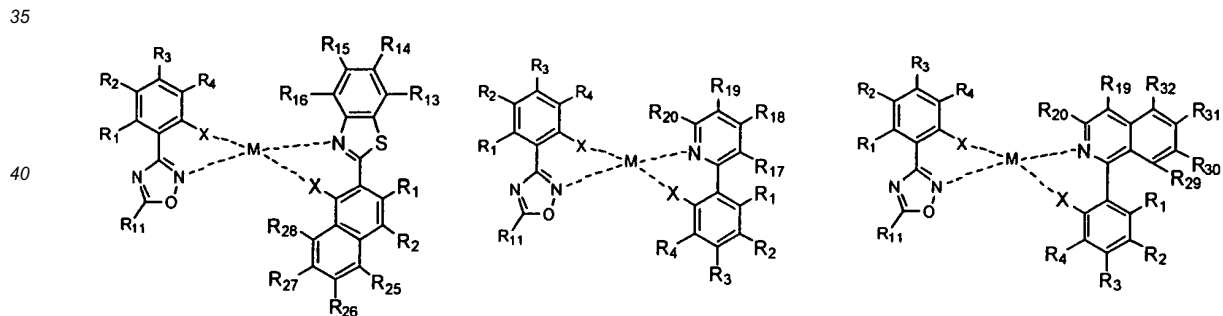
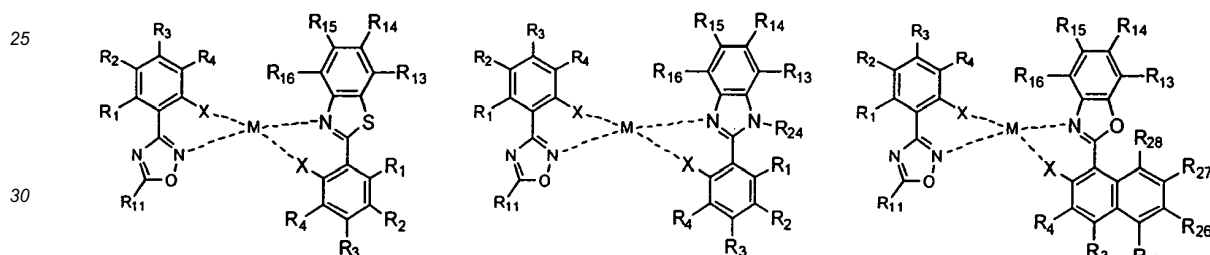
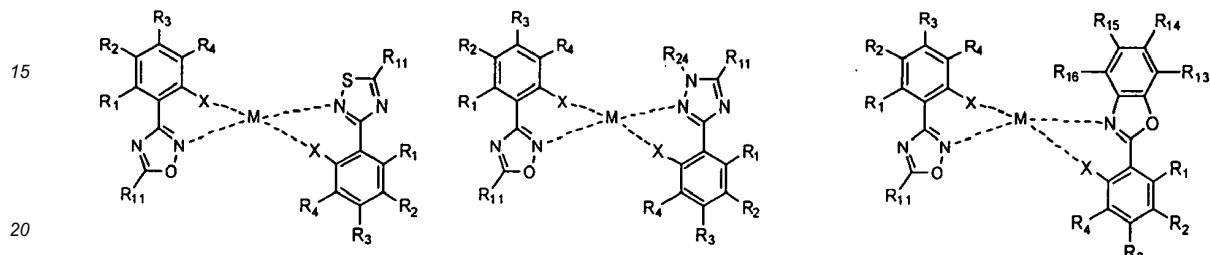
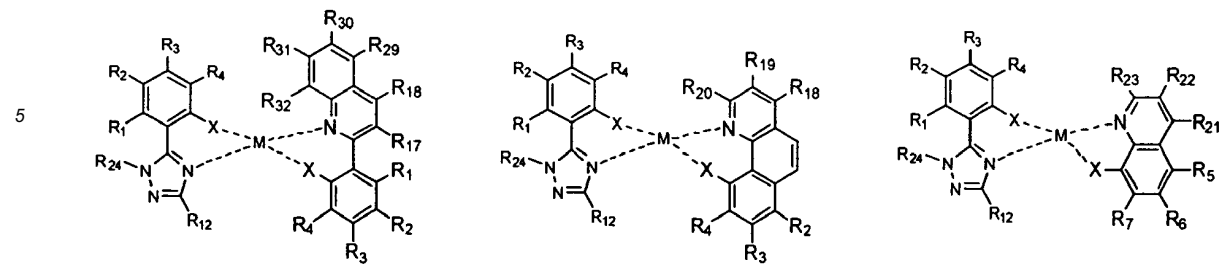


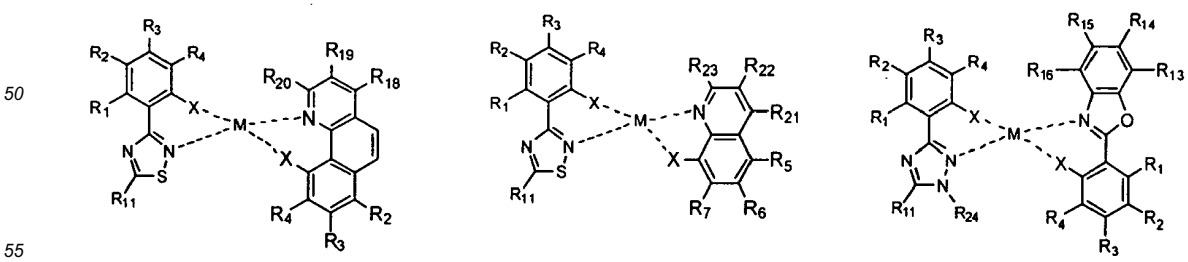
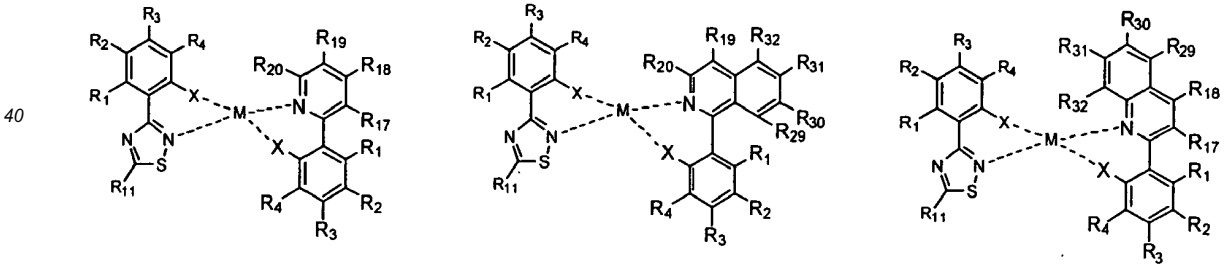
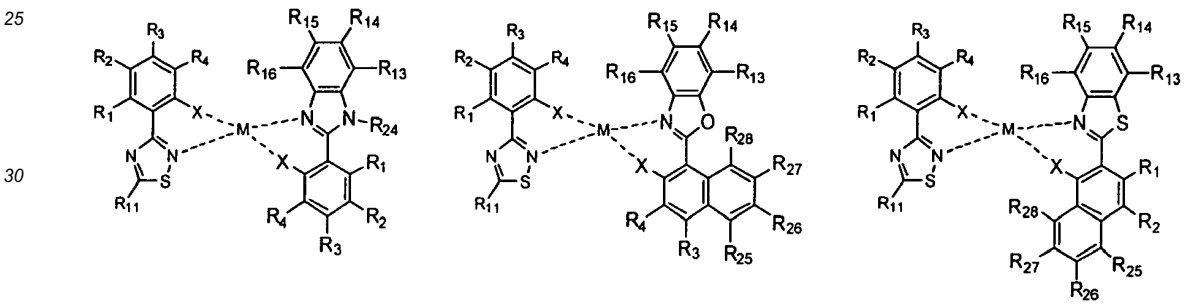
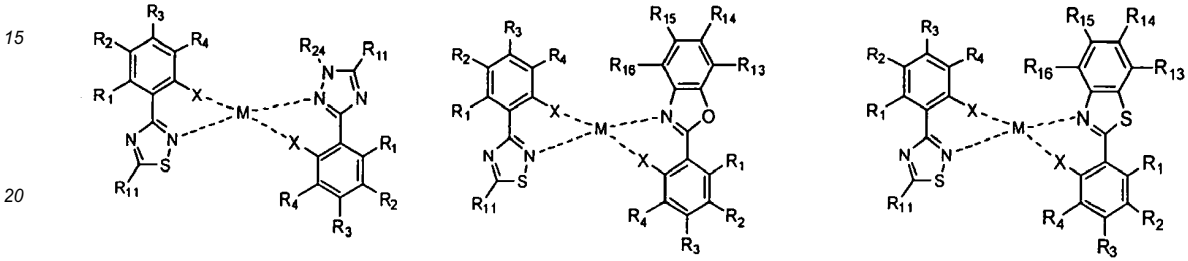
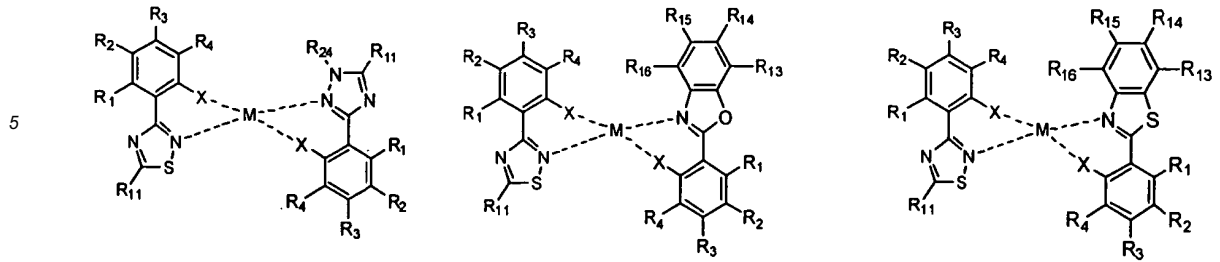
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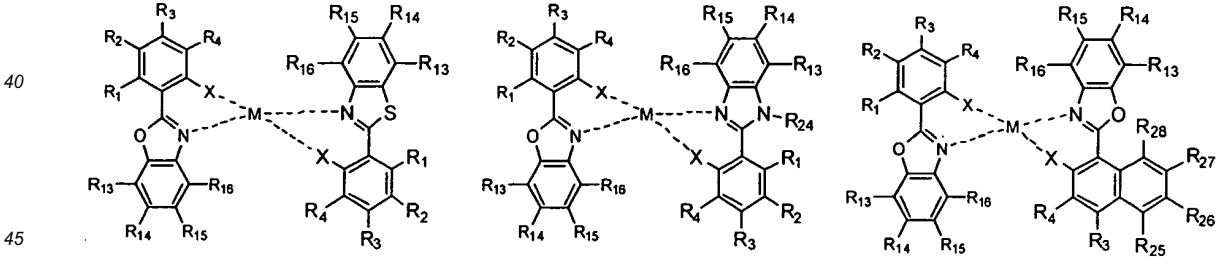
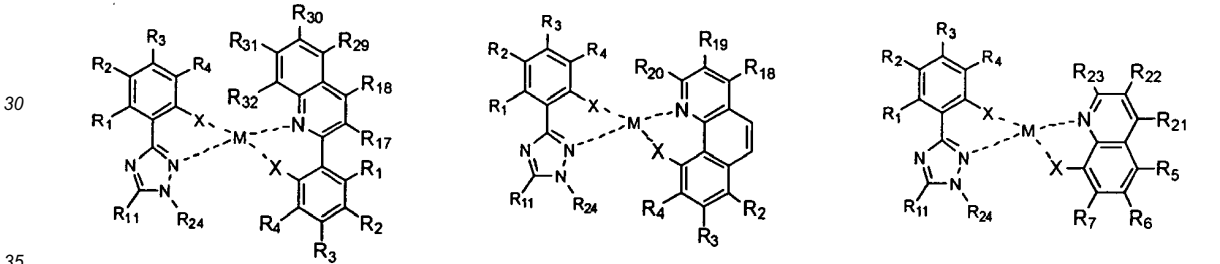
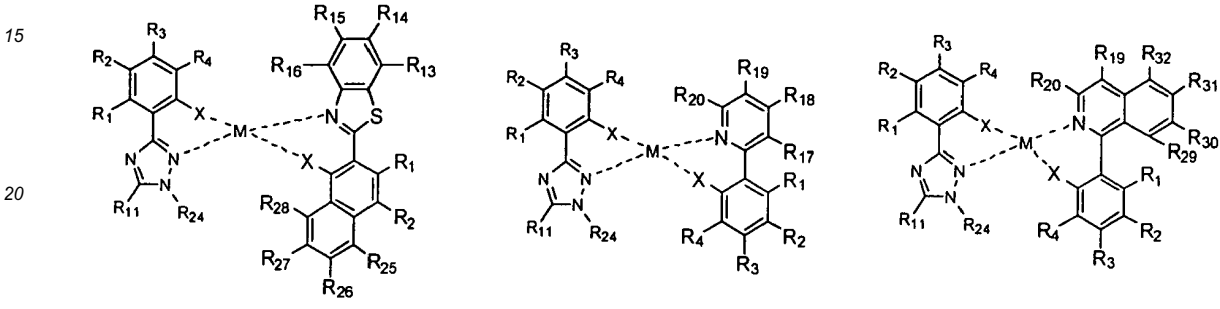
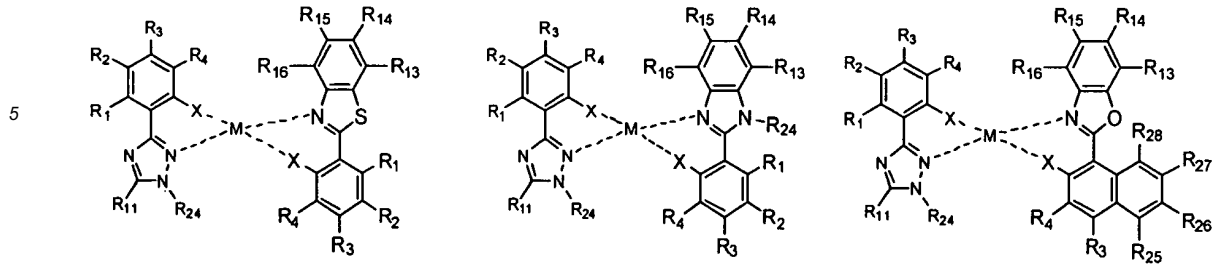
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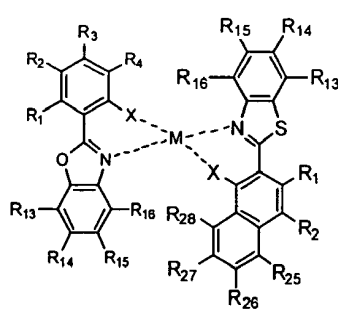




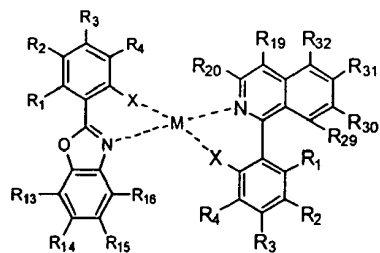
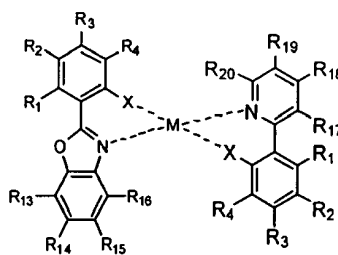




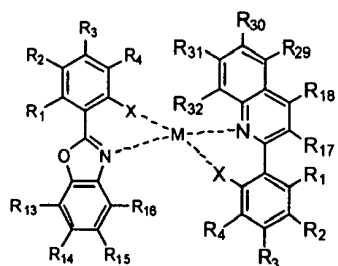
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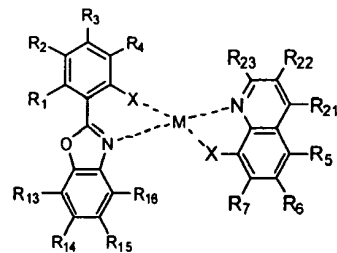
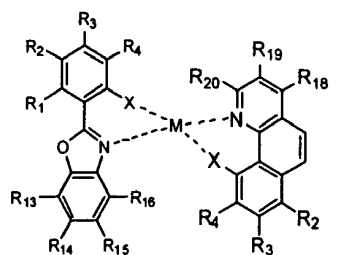
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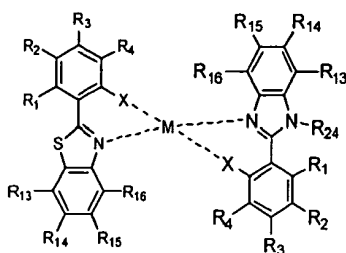
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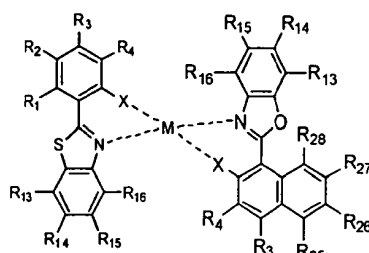
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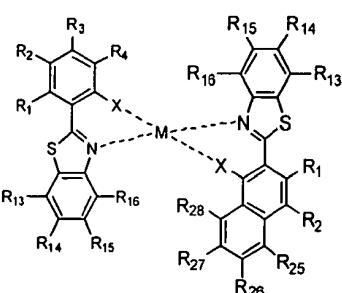
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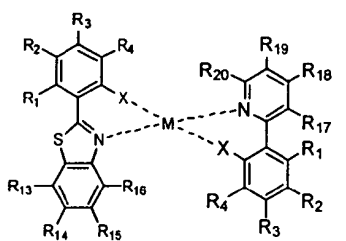
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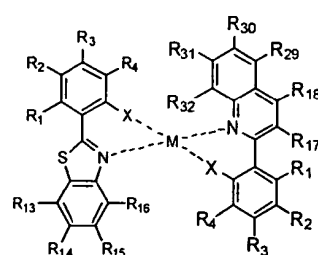
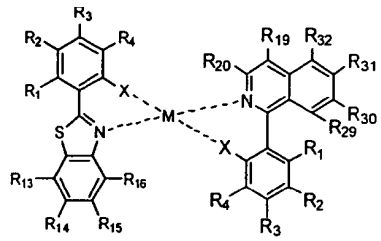
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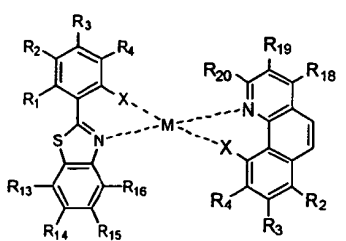
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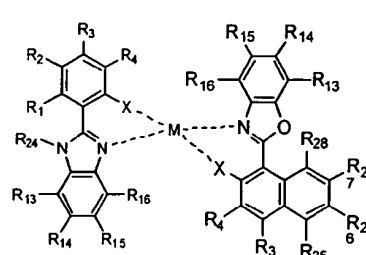
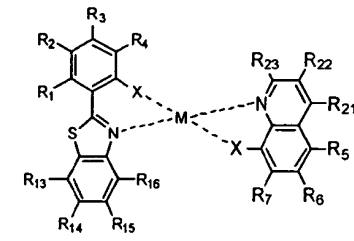
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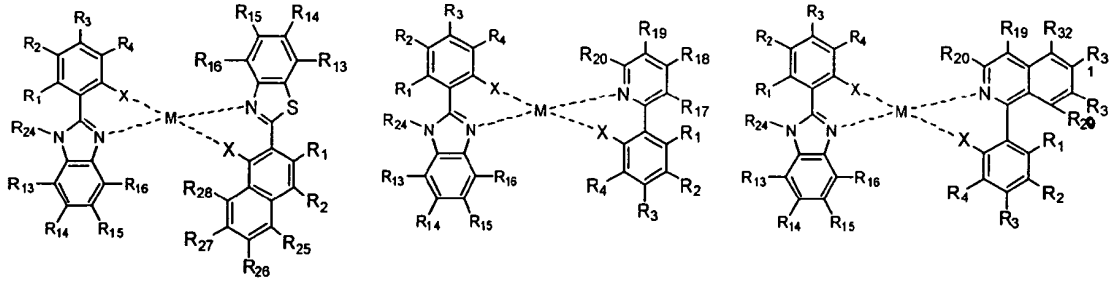
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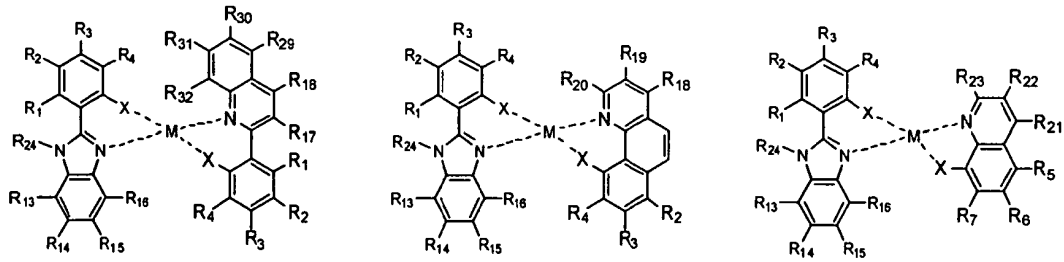


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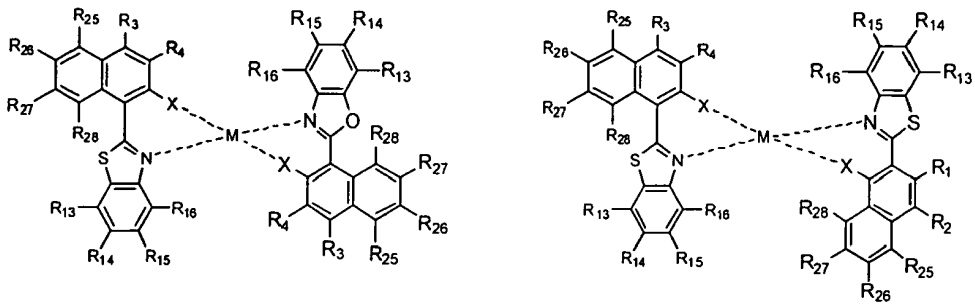
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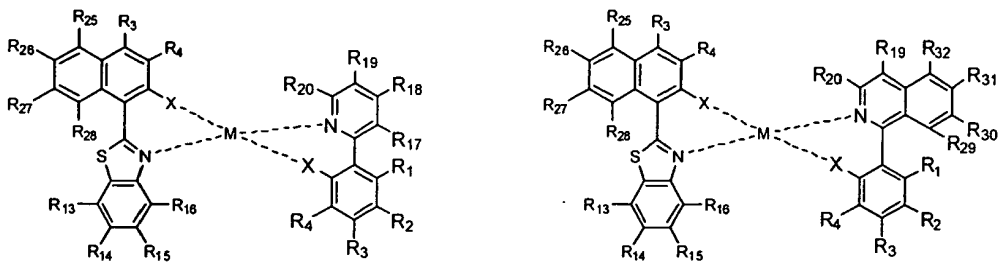
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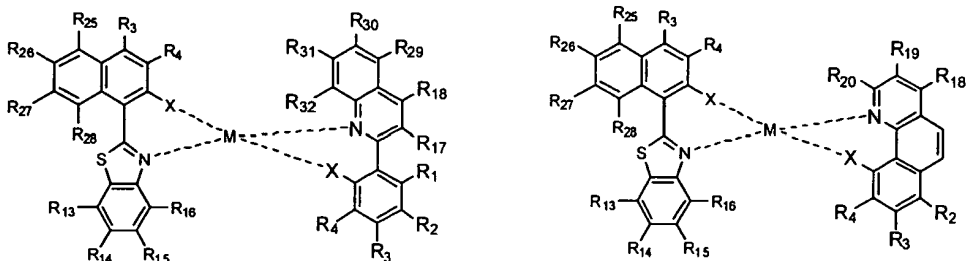
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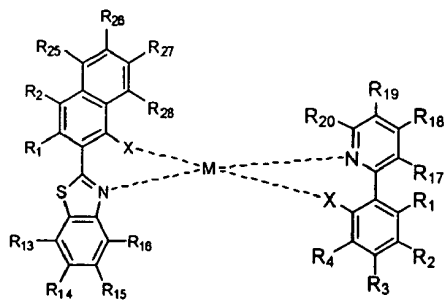
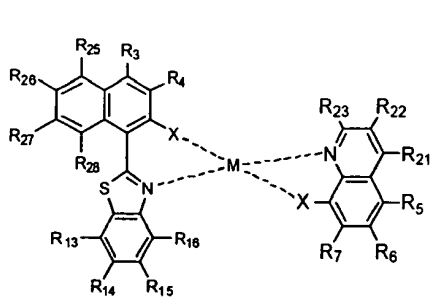
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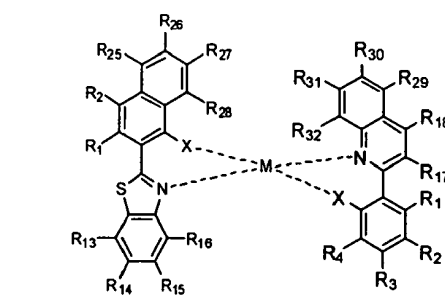
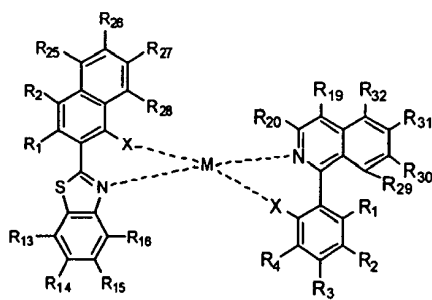
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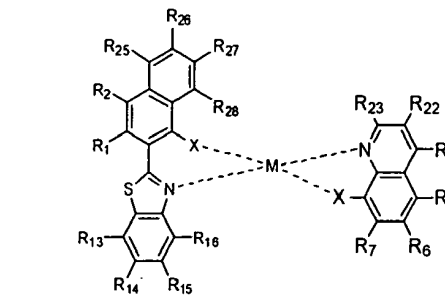
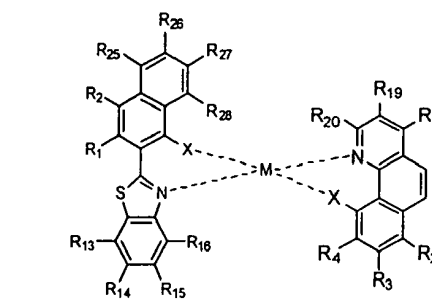
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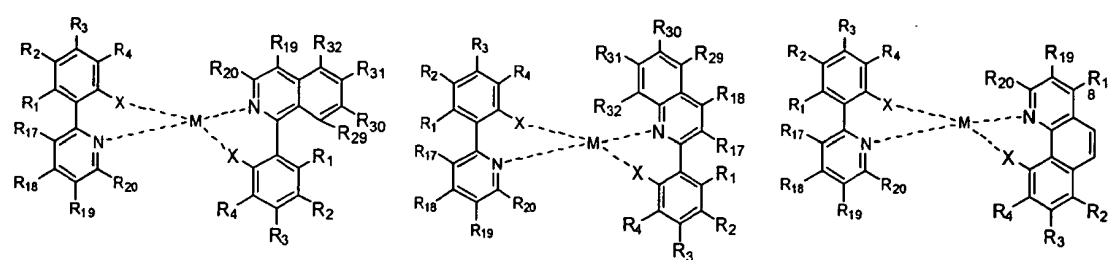
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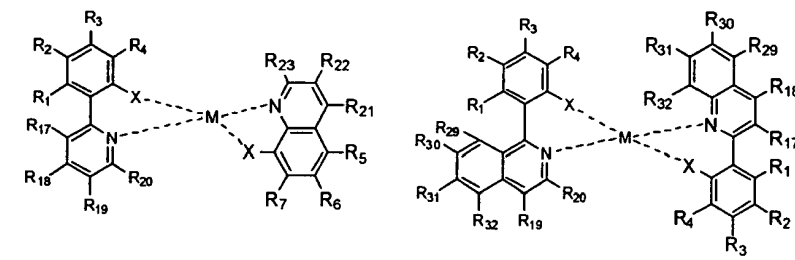
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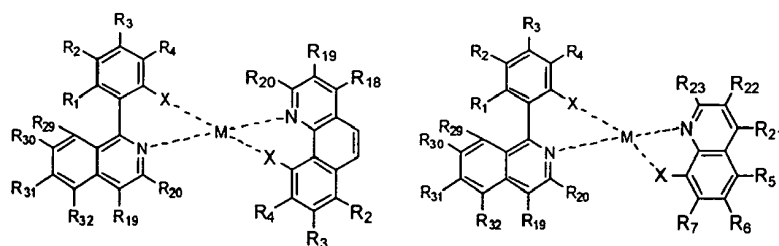
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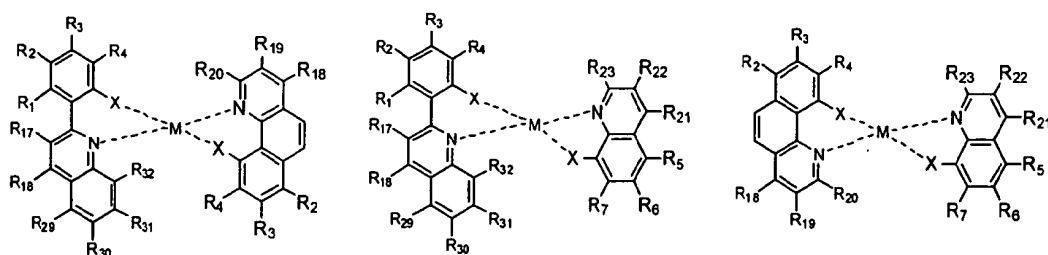
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wherein, X represents O, S or Se; M represents Be, Zn, Mg, Cu or Ni;

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R<sub>1</sub> through R<sub>7</sub> independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, dimethylamino, diethylamino or diphenylamino;

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R<sub>11</sub> through R<sub>23</sub> independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, dimethylamino, diethylamino or diphenylamino;

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R<sub>24</sub> represents methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, phenyl, biphenyl, naphthyl, anthryl or fluorenyl;

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R<sub>25</sub> through R<sub>32</sub> independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, cyano, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, methoxy, ethoxy, butoxy, hexyloxy, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, dimethylamino, diethylamino or diphenylamino; and

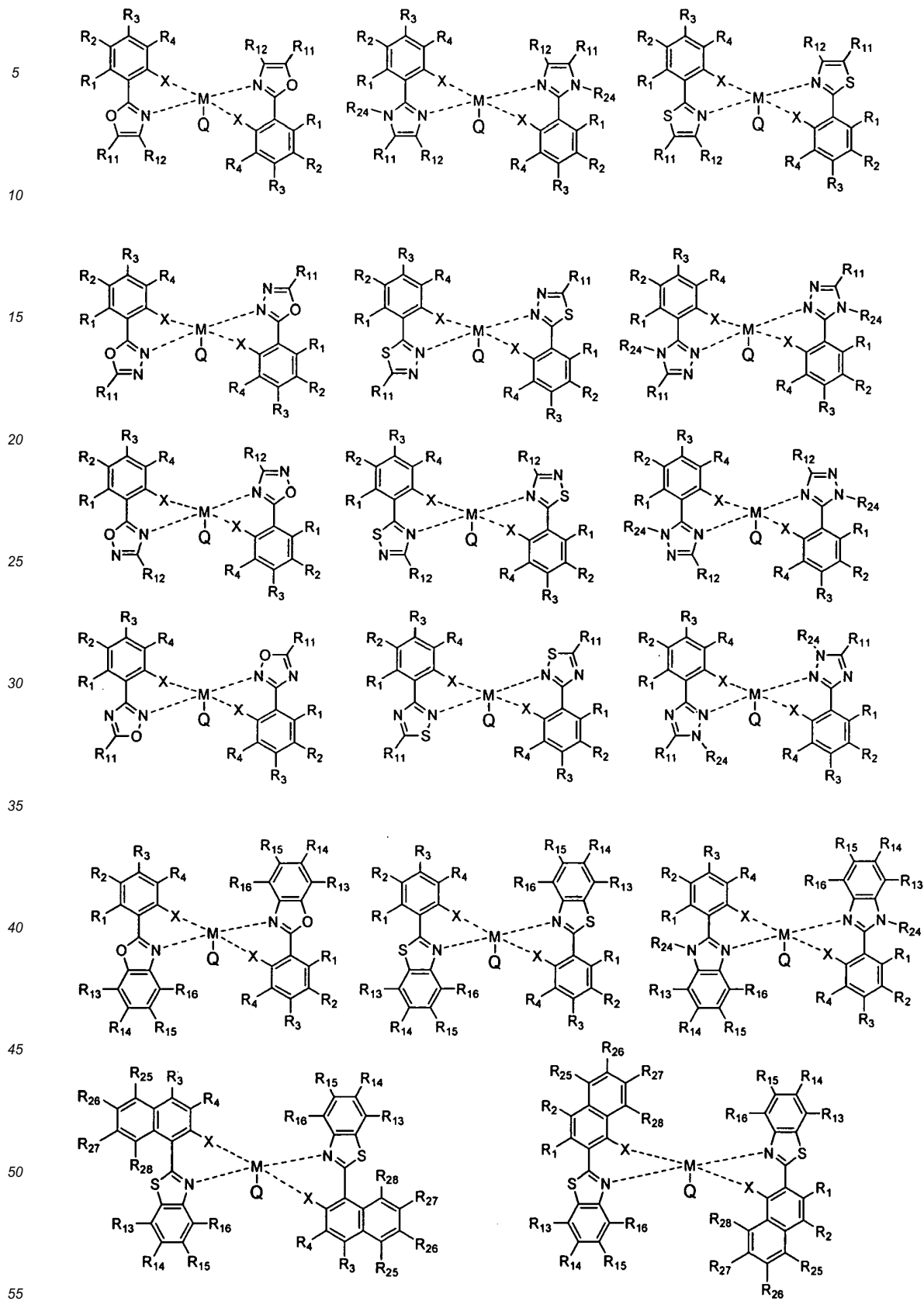
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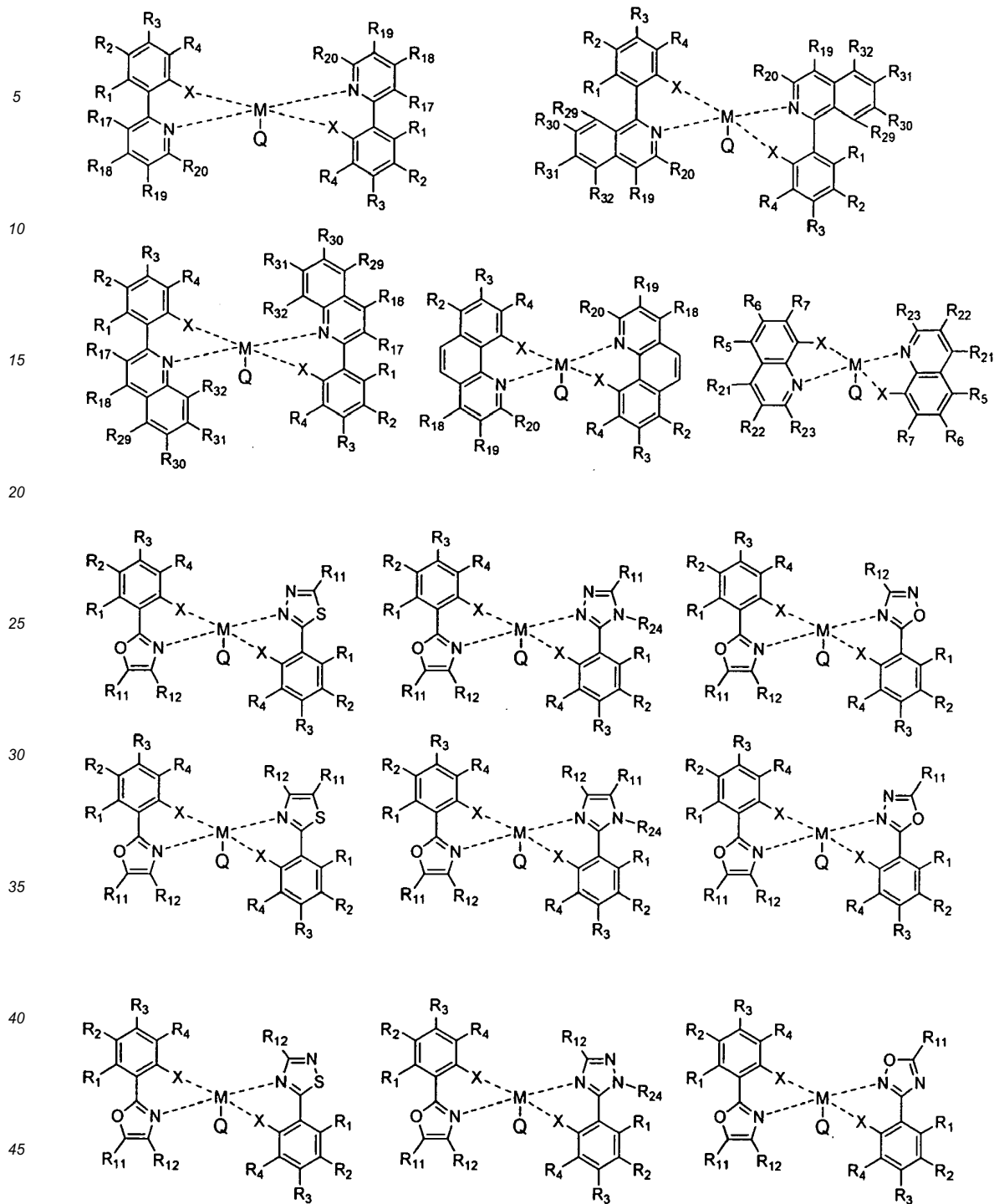
the phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl or benzoxazolyl of R<sub>1</sub> through R<sub>7</sub>, R<sub>11</sub> through R<sub>23</sub>, R<sub>24</sub> and R<sub>25</sub> through R<sub>32</sub> may be further substituted by one or more substituent(s) selected from methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, cyano, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, methoxy, ethoxy, butoxy, hexyloxy, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, dimethylamino, diethylamino and diphenylamino.

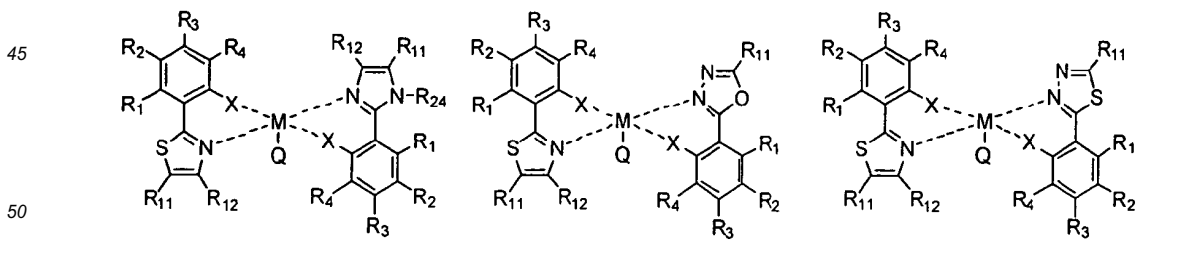
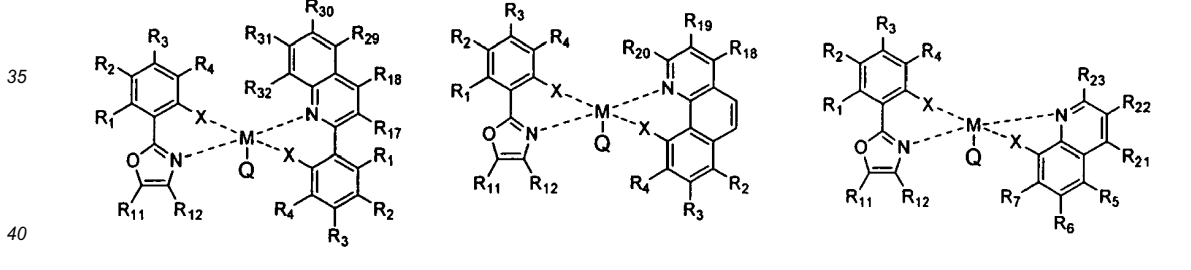
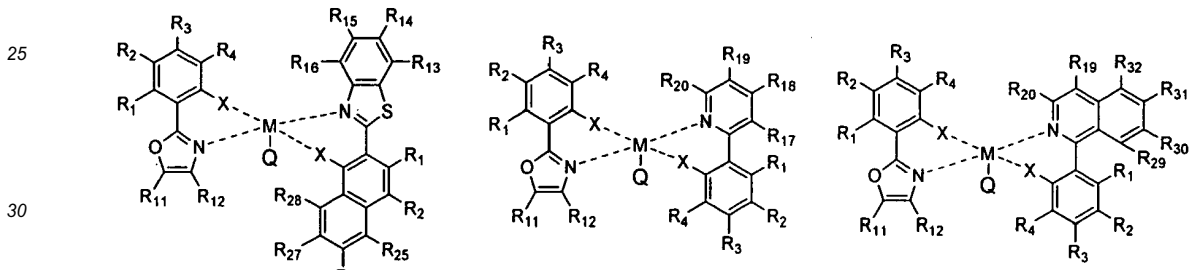
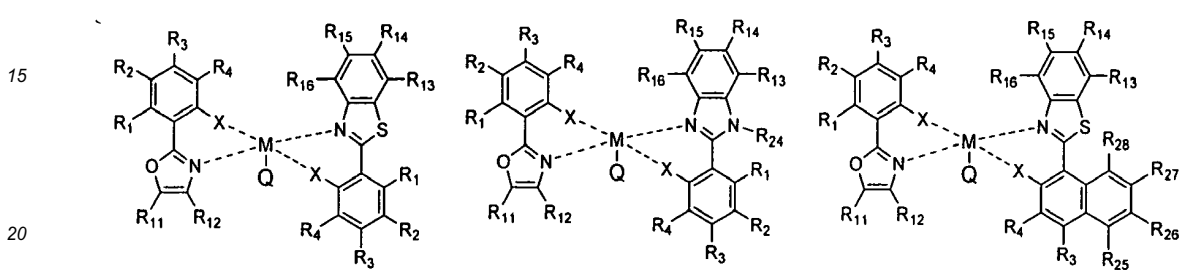
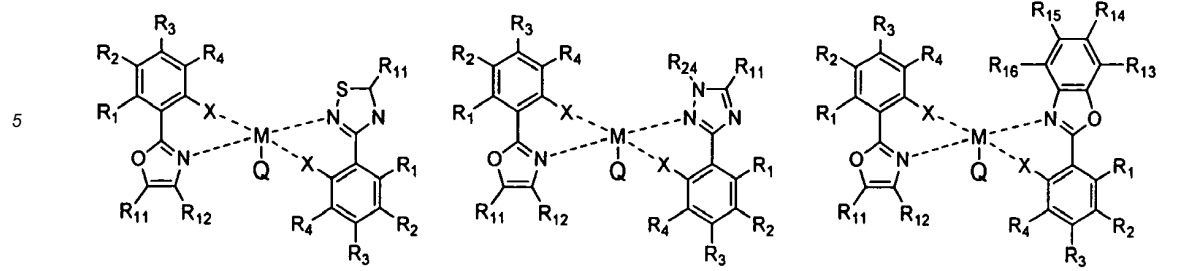
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[0024] When M is a trivalent metal, the compounds represented by Chemical Formula (1) according to the present invention can be specifically exemplified by the following compounds, but they are not restricted thereto:

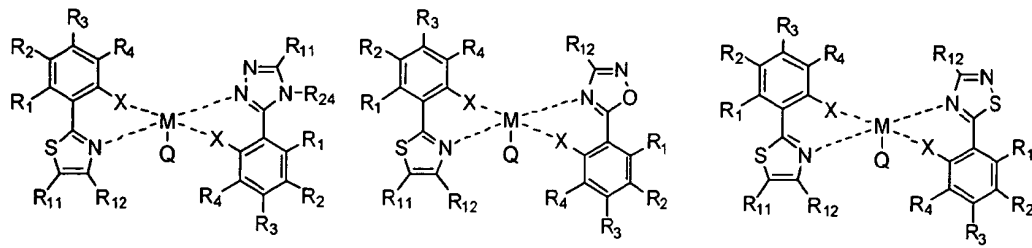






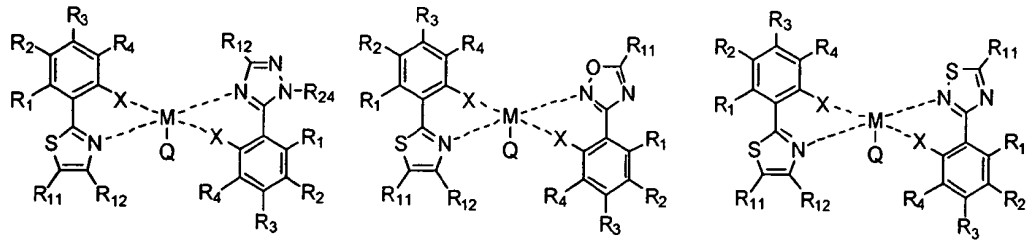
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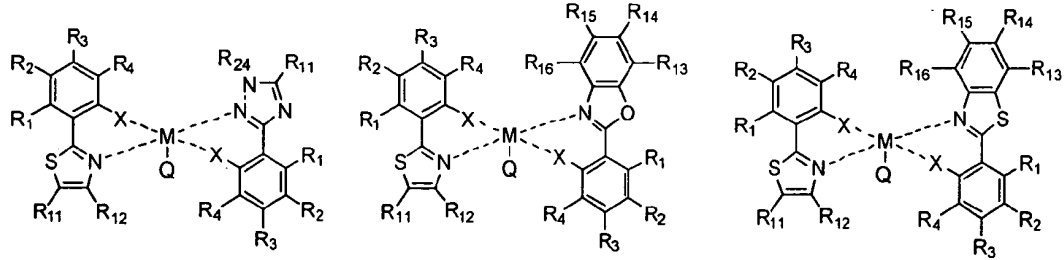
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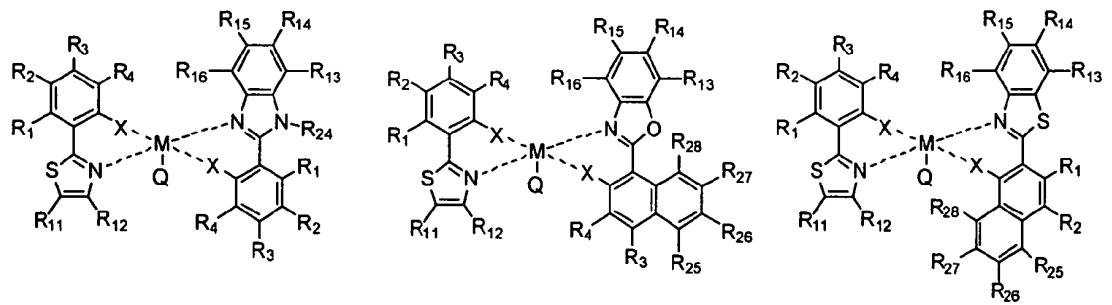
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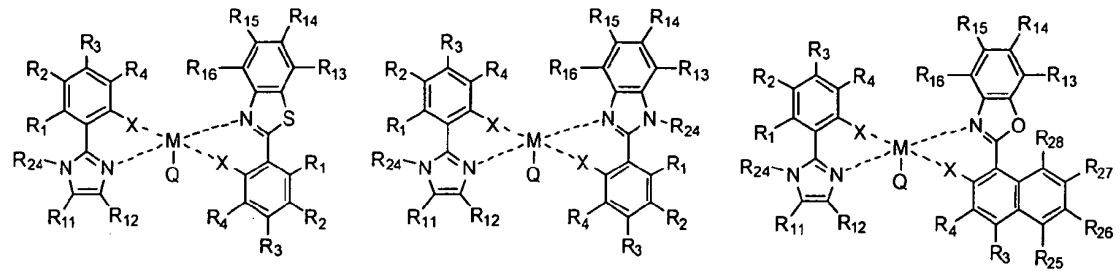
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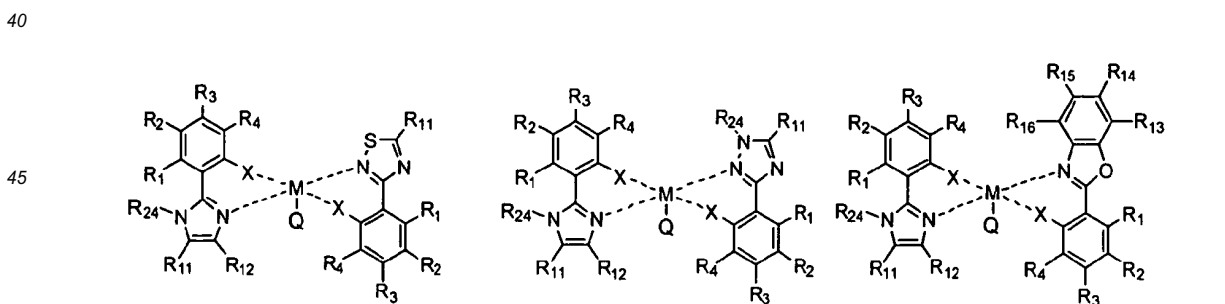
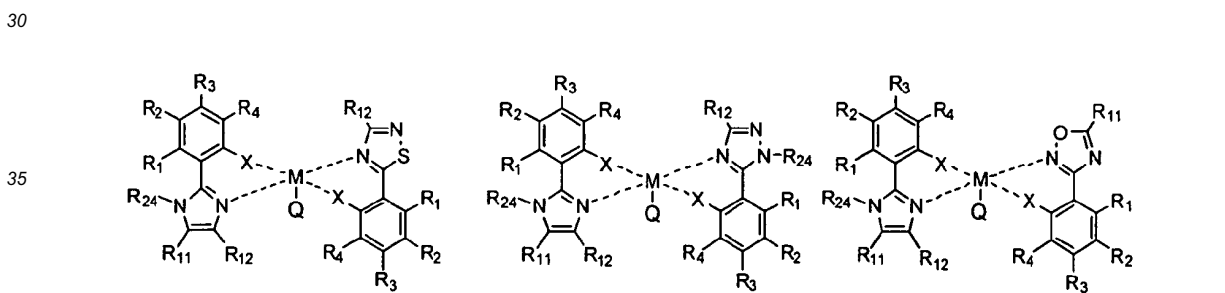
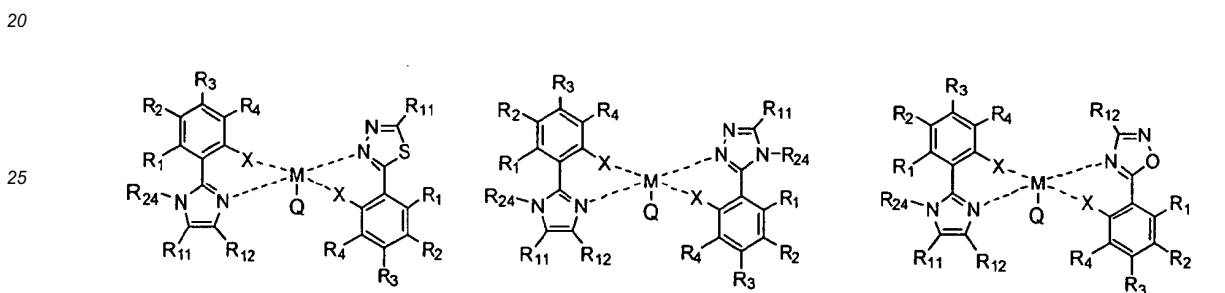
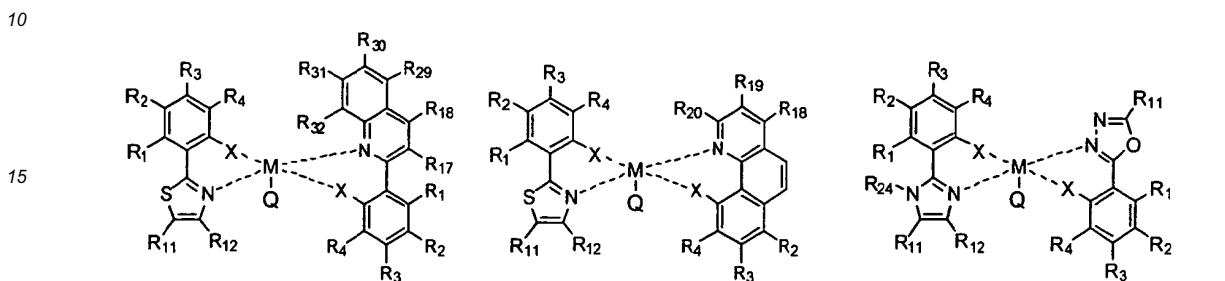
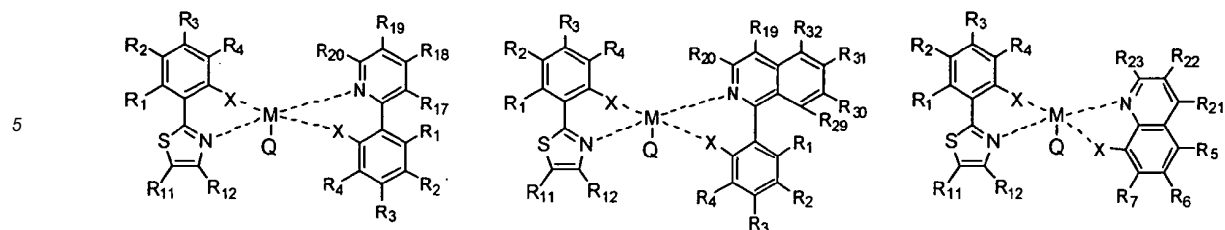
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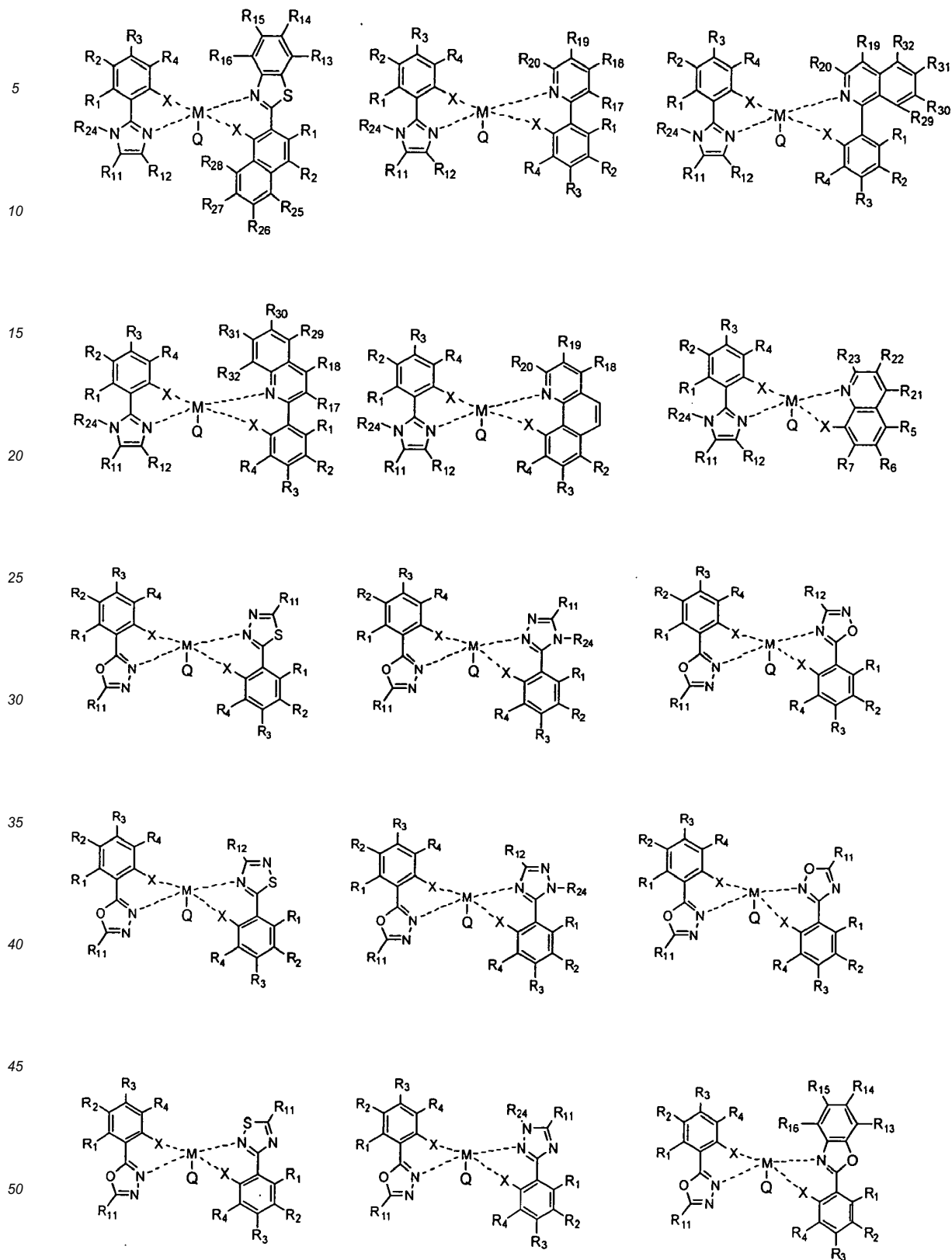
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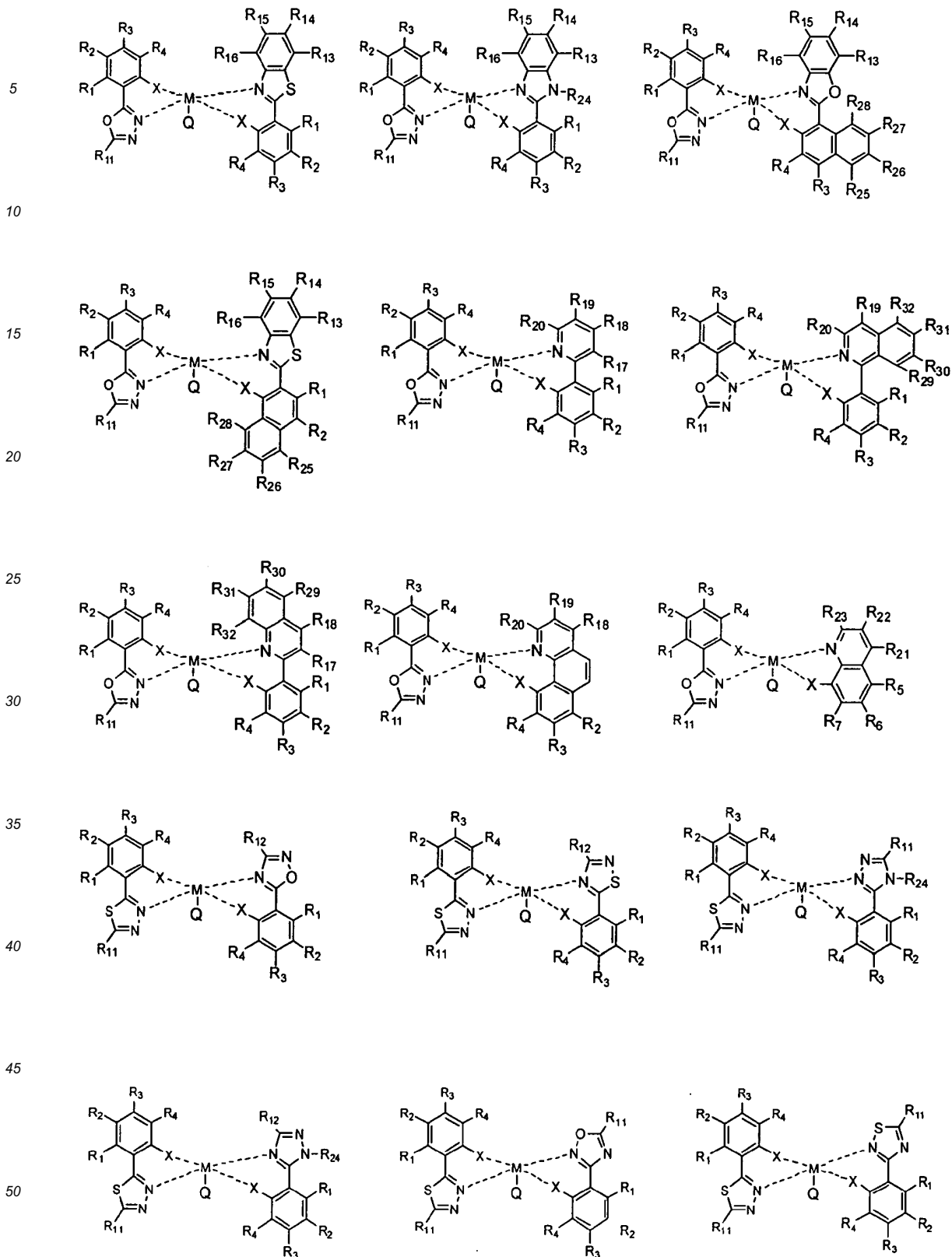
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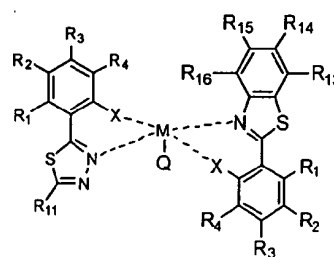
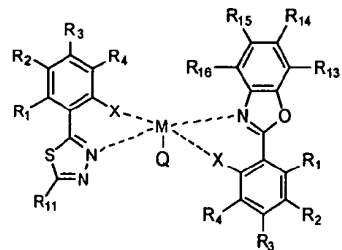
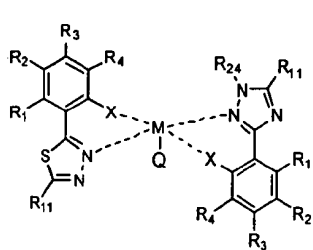
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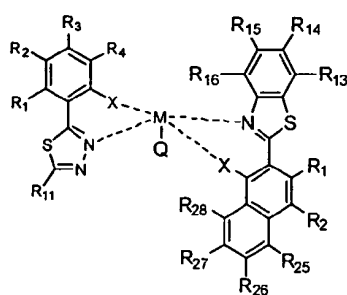
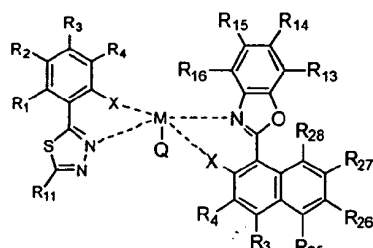
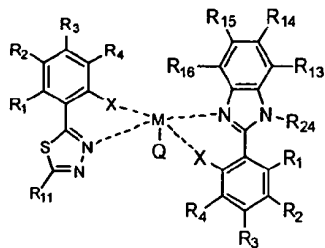




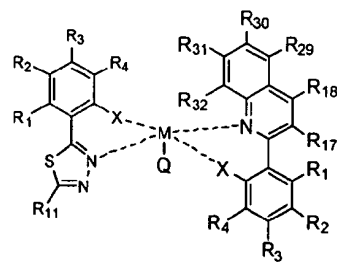
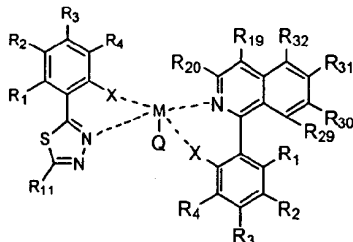
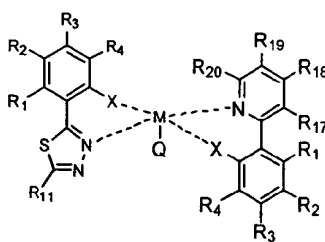
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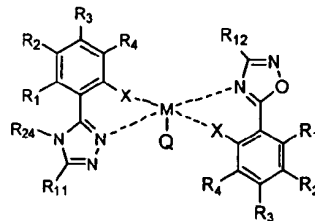
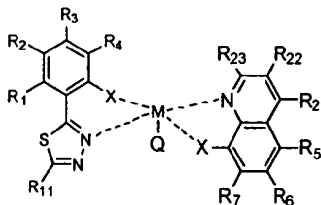
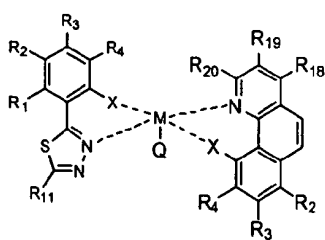


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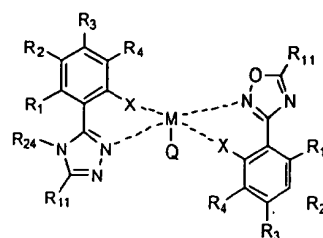
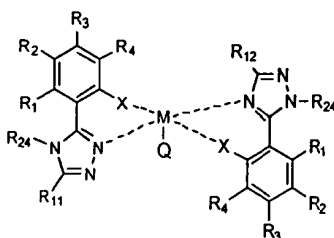
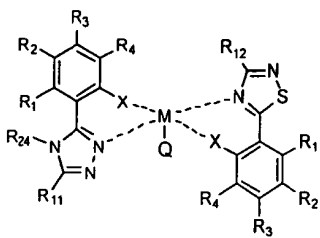
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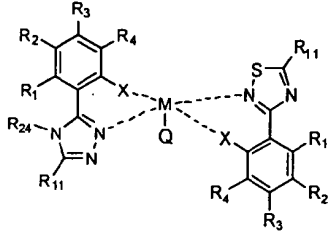
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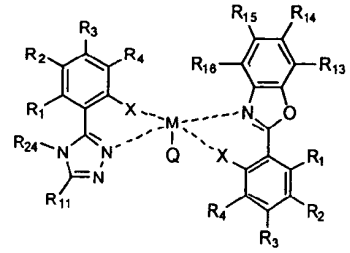
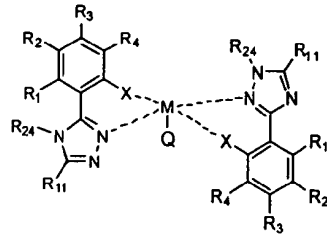
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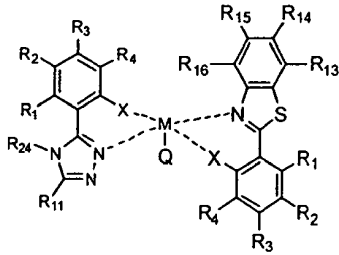
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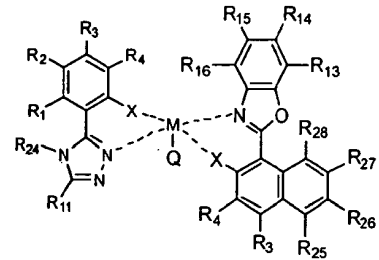
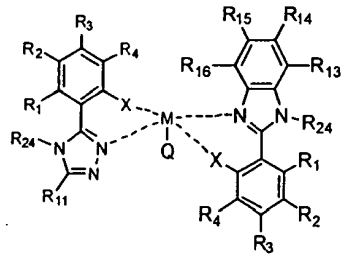
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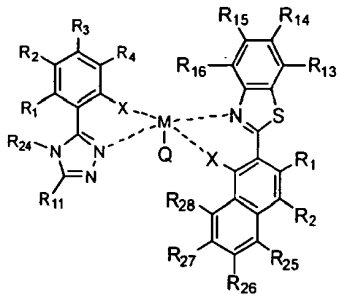
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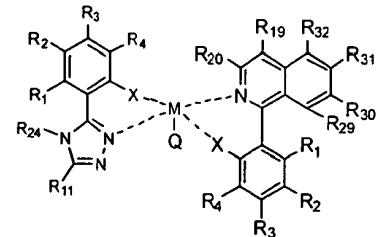
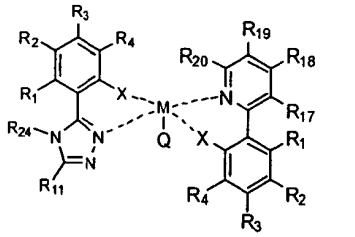
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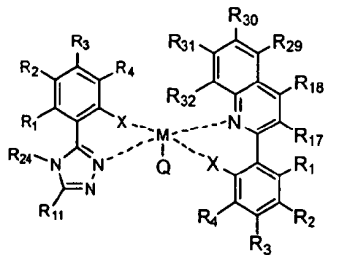
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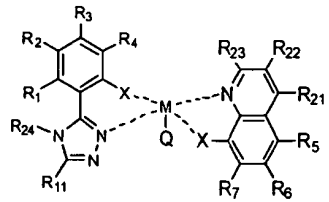
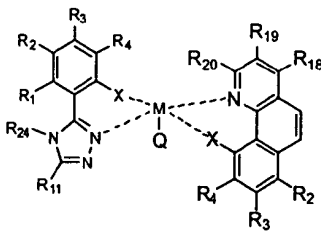
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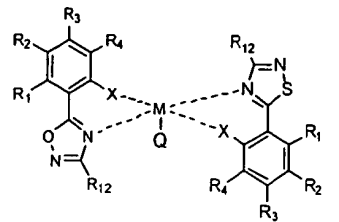
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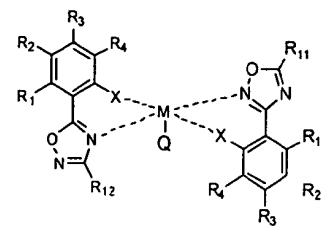
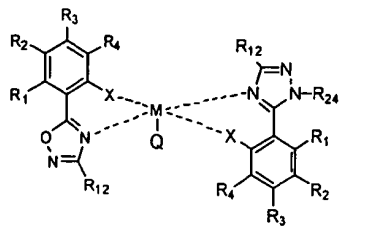
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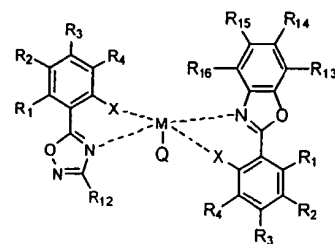
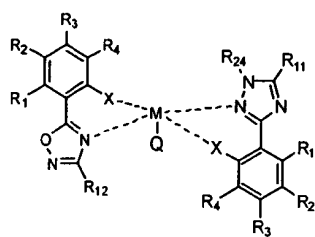
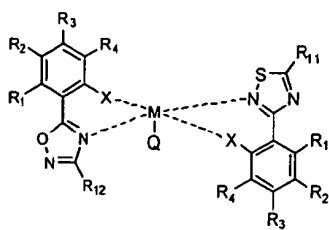


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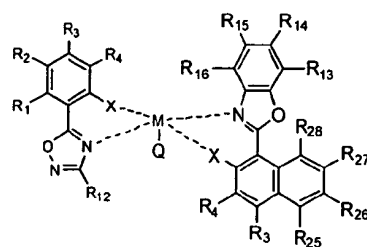
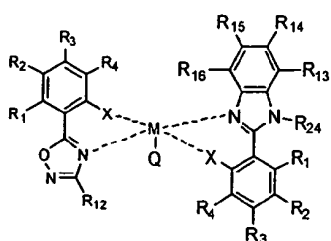
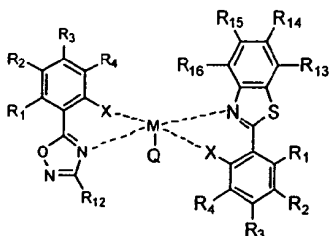


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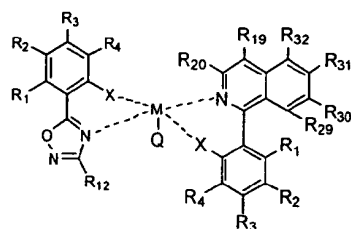
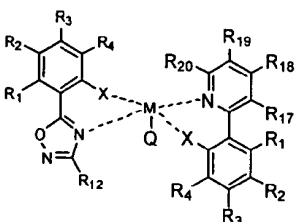
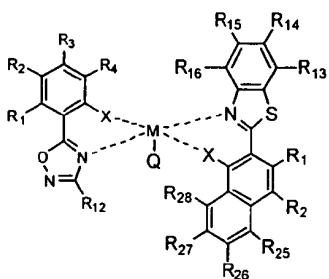
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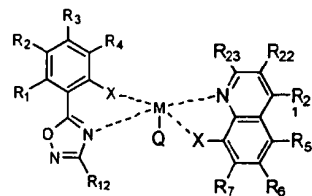
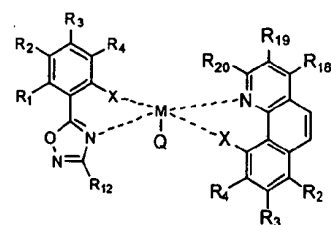
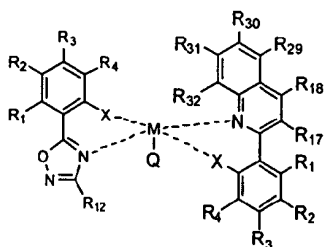
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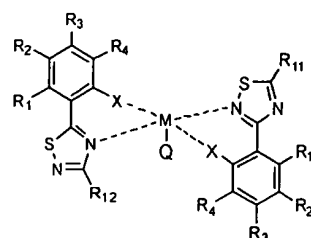
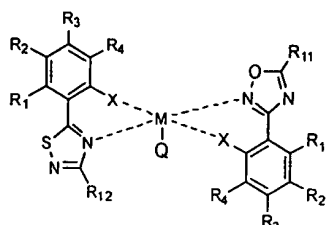
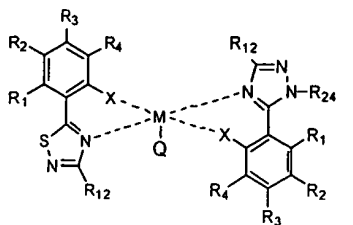


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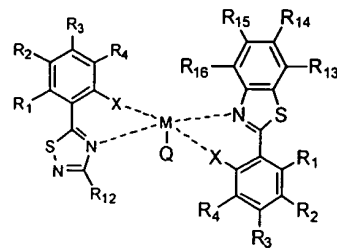
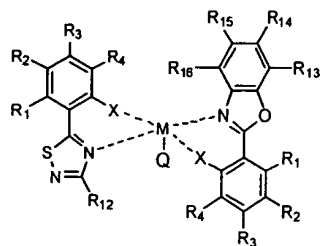
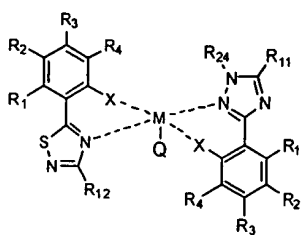
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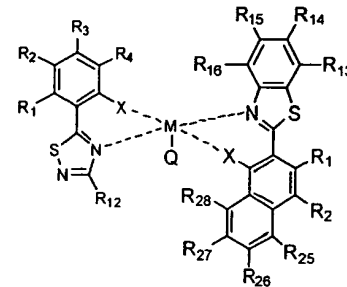
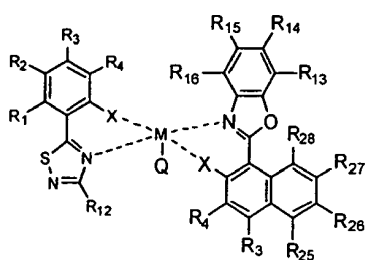
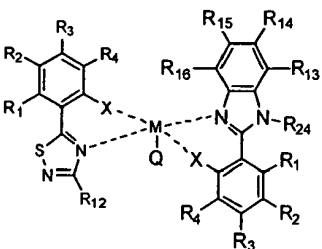
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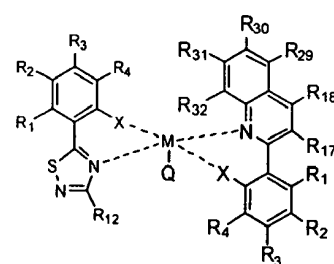
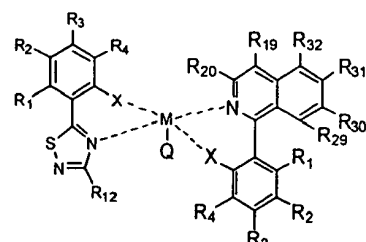
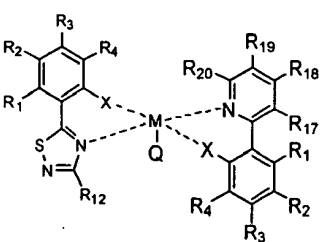


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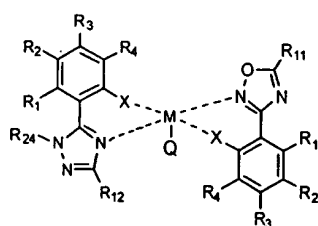
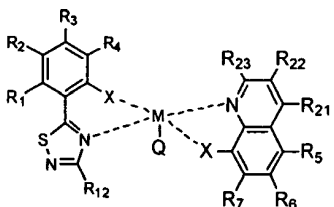
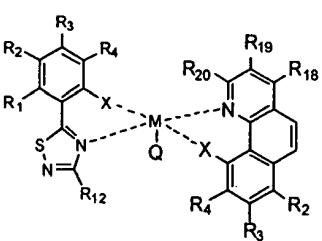
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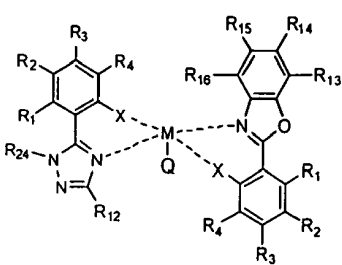
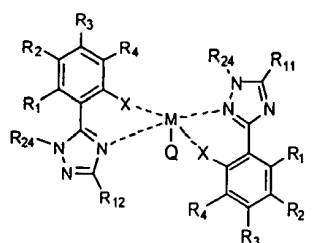
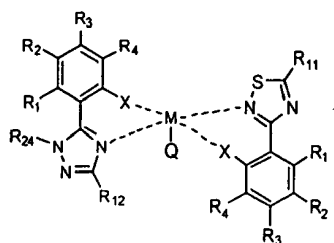
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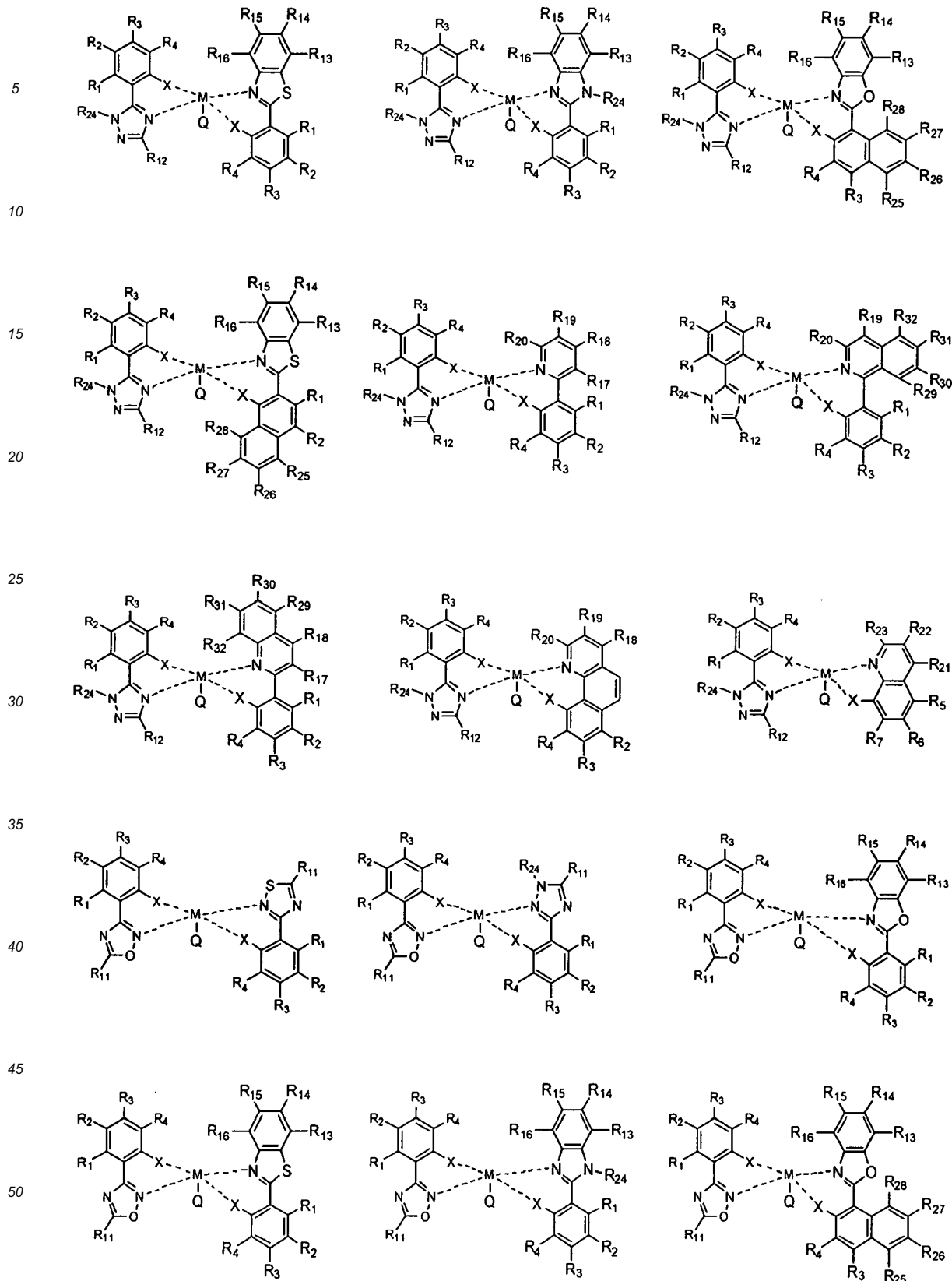
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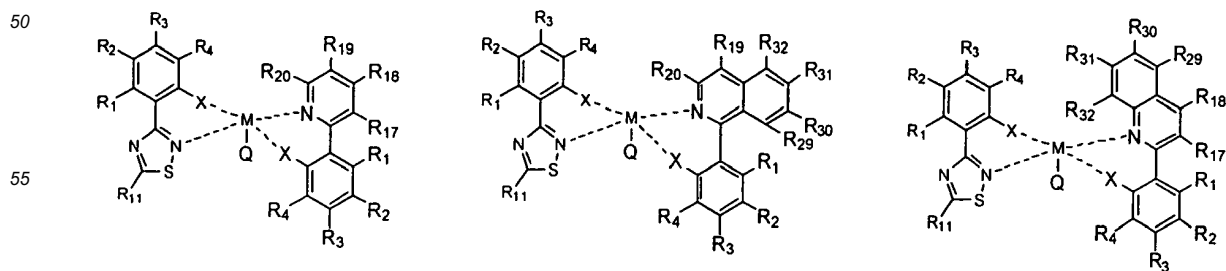
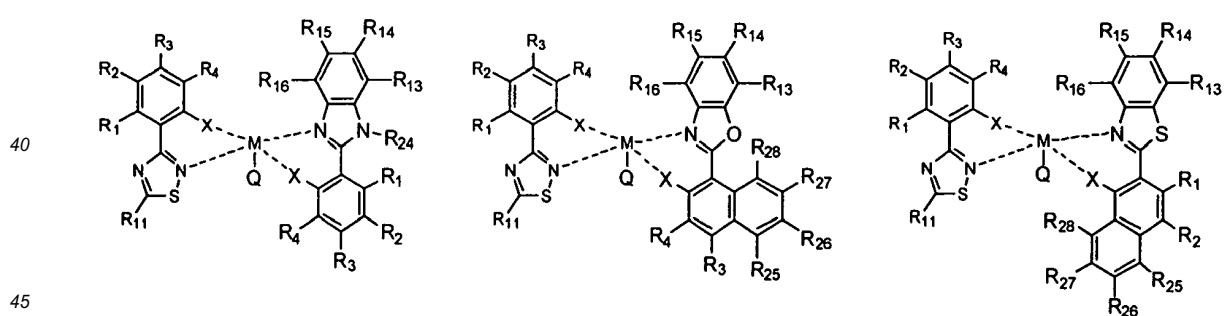
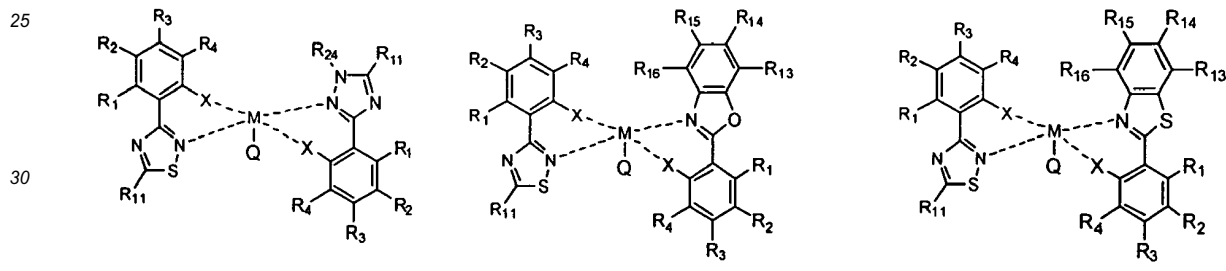
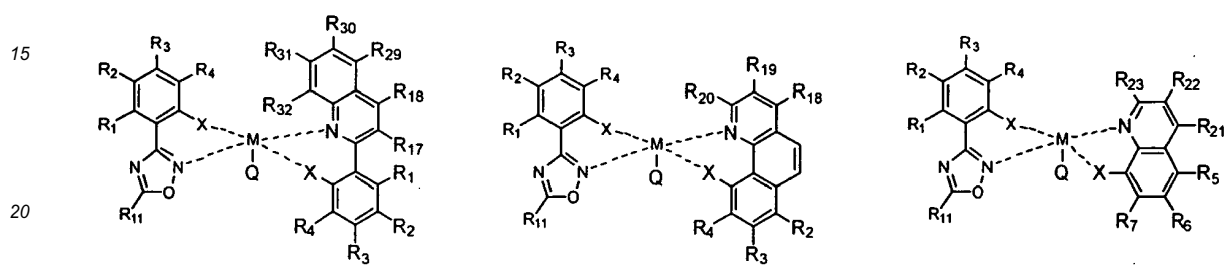
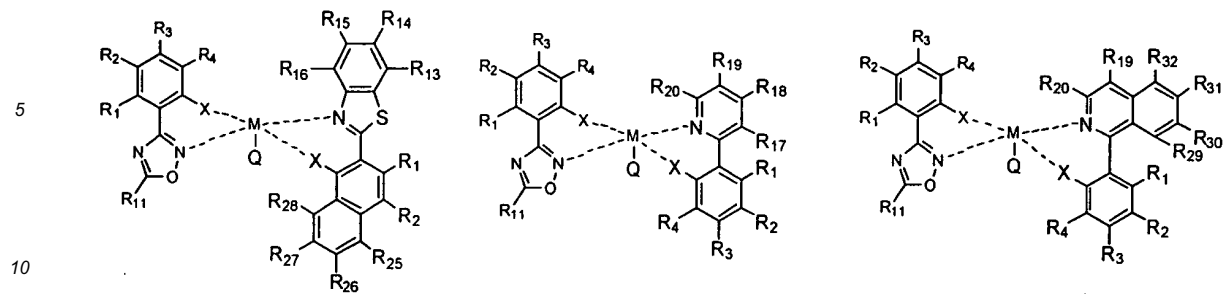


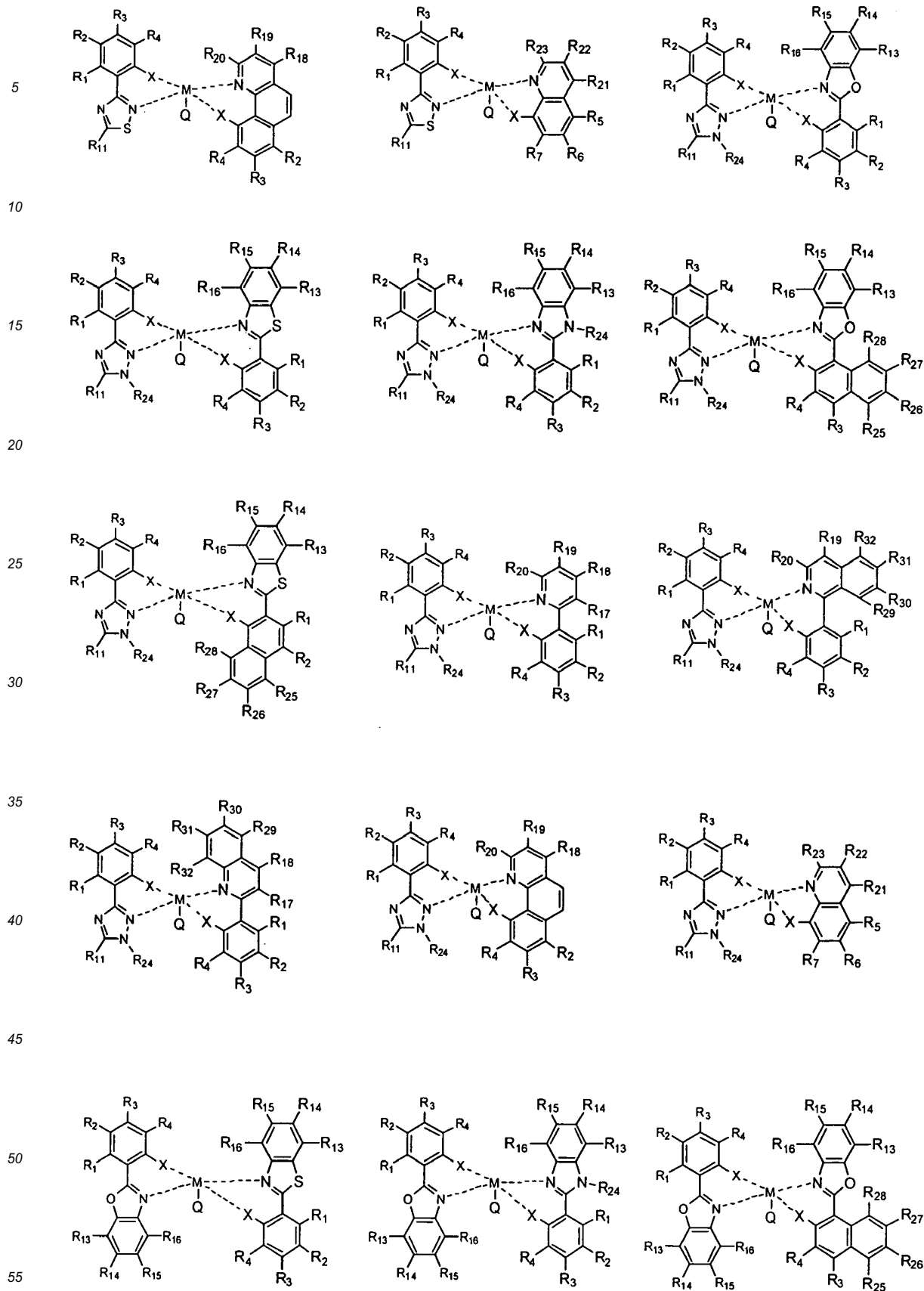
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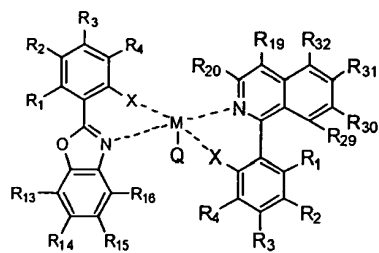
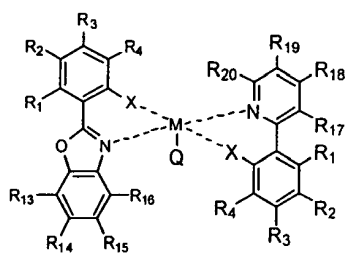
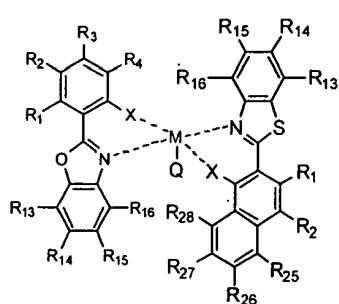
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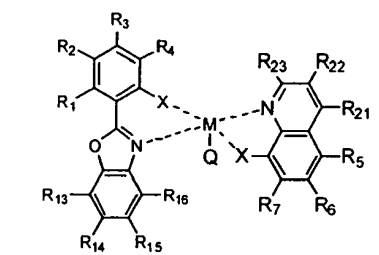
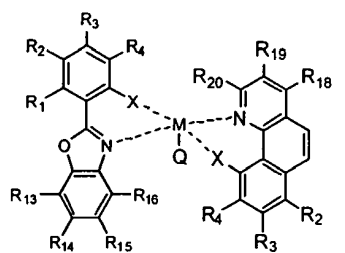
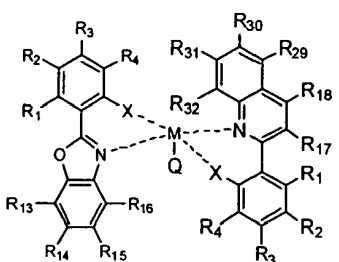


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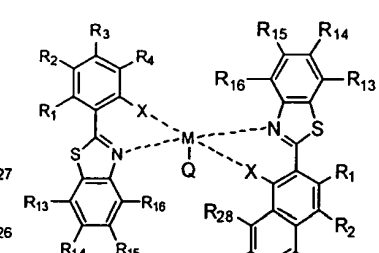
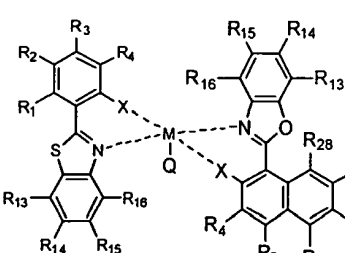
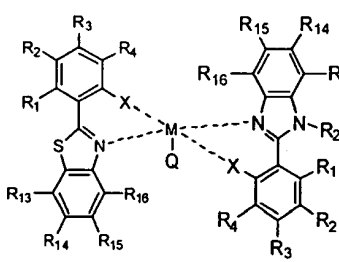
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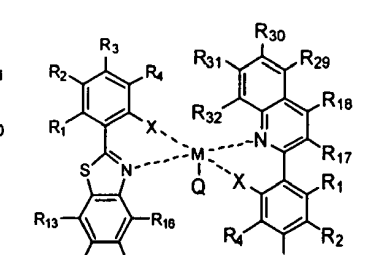
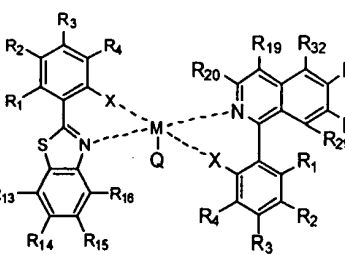
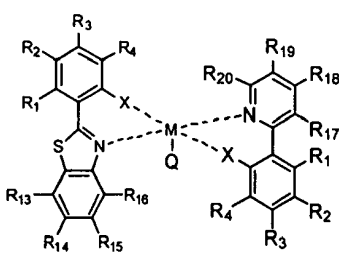
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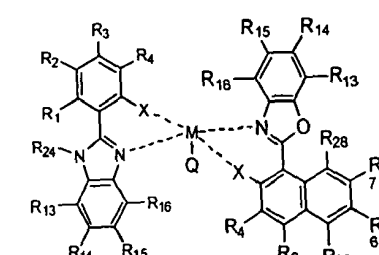
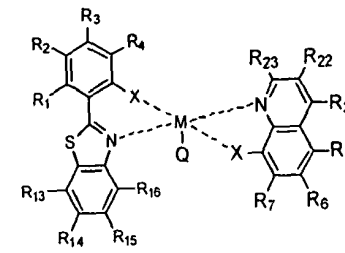
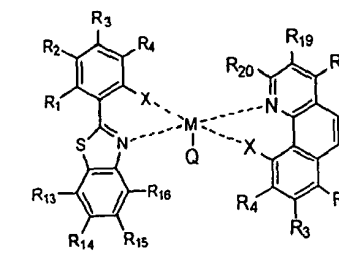
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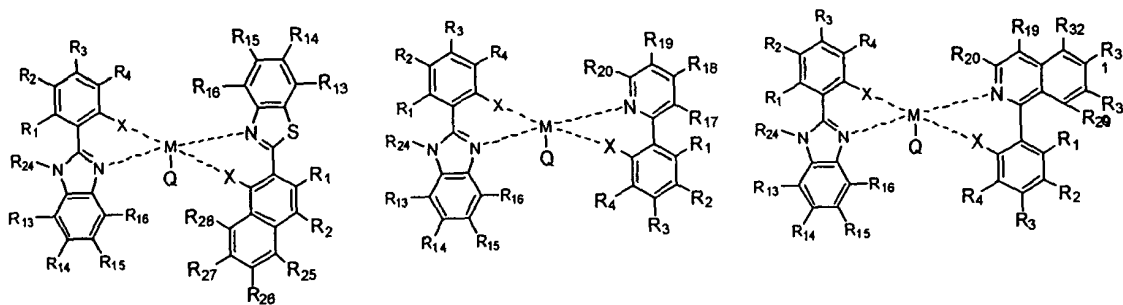
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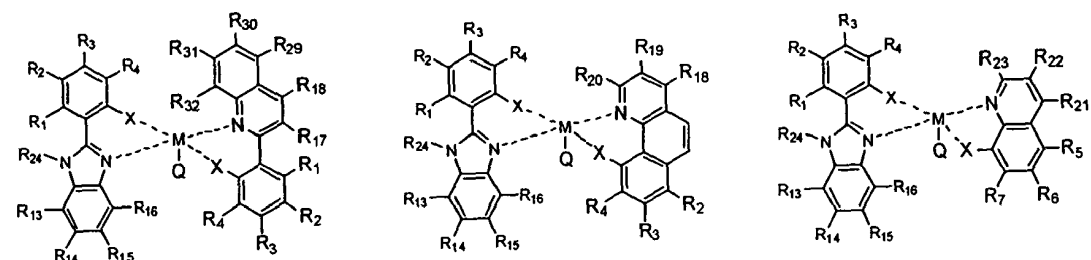
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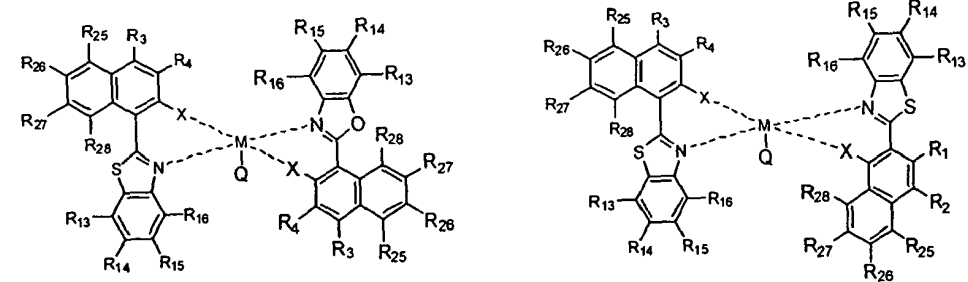
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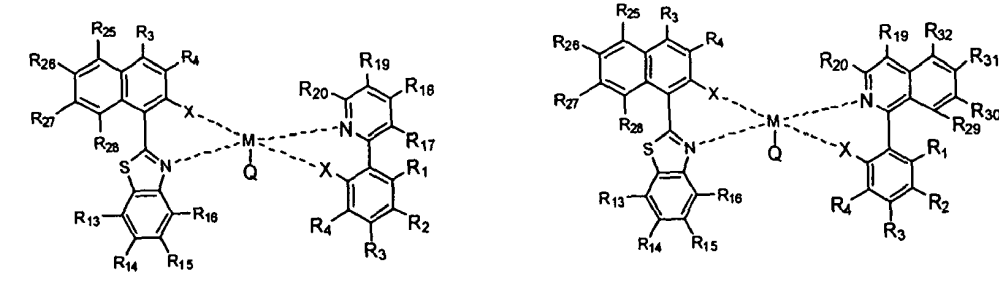
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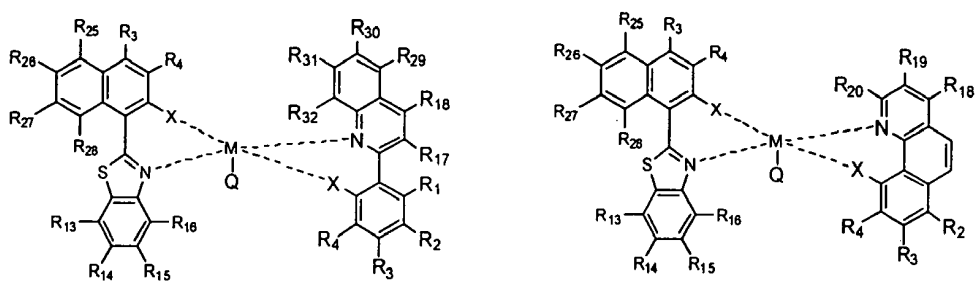
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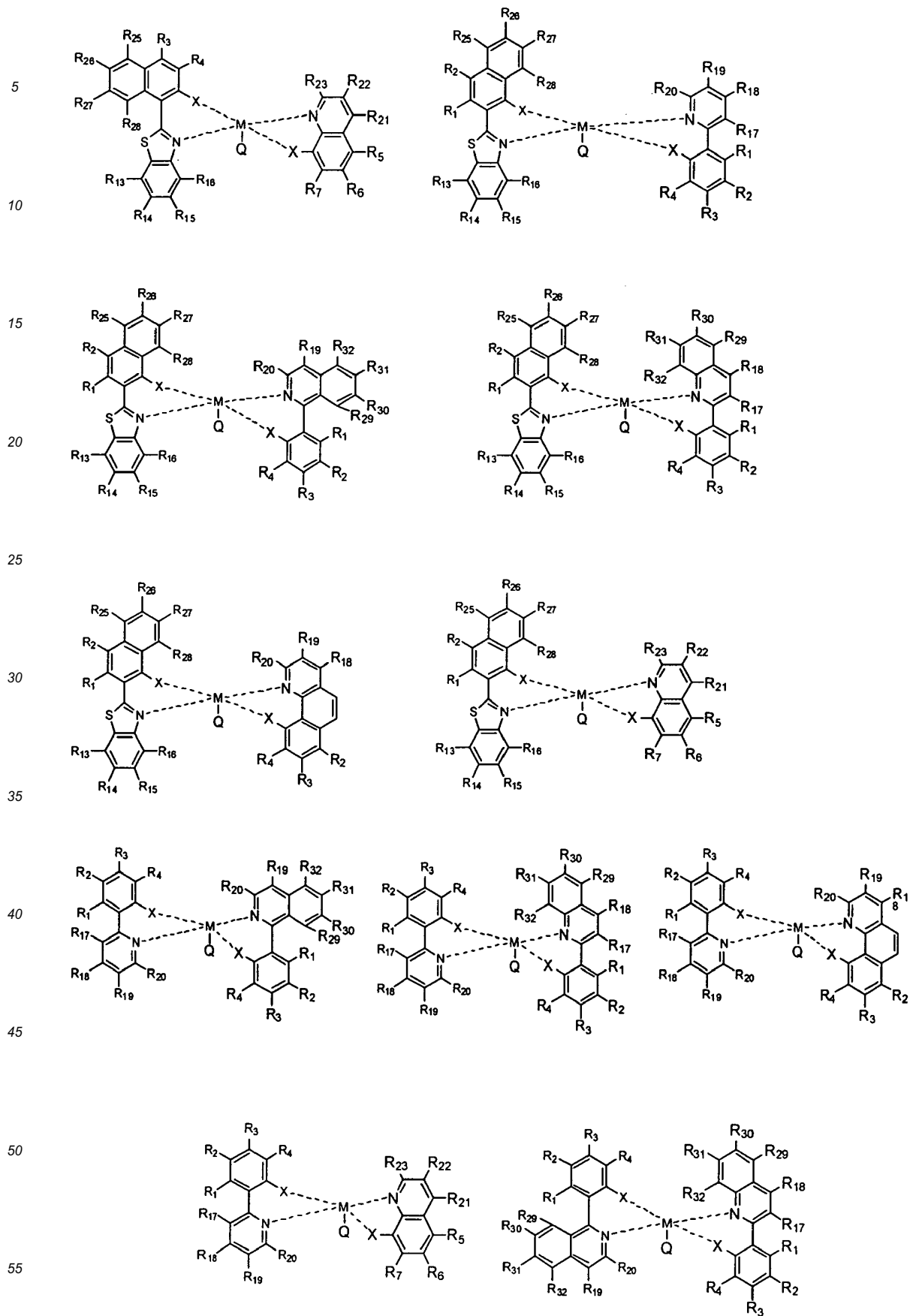
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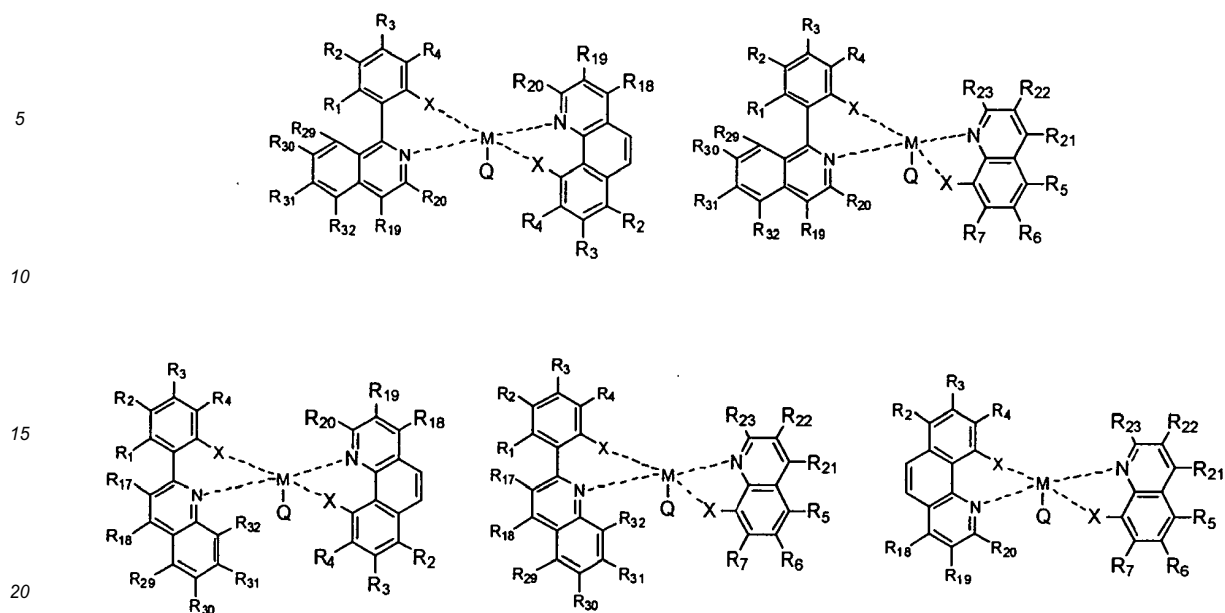
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wherein, X represents O, S or Se; M represents Al, Ga, In or B; Q represents (C6-C60)aryloxy or tri(C6-C60)arylsilyl, and the aryloxy and triarylsilyl of Q may be further substituted by (C1-C60)alkyl or (C6-C60)aryl;

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$R_1$  through  $R_7$  independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, dimethylamino, diethylamino or diphenylamino;

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$R_{11}$  through  $R_{23}$  independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, dimethylamino, diethylamino or diphenylamino;

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$R_{24}$  represents methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, phenyl, biphenyl, naphthyl, anthryl or fluorenyl;

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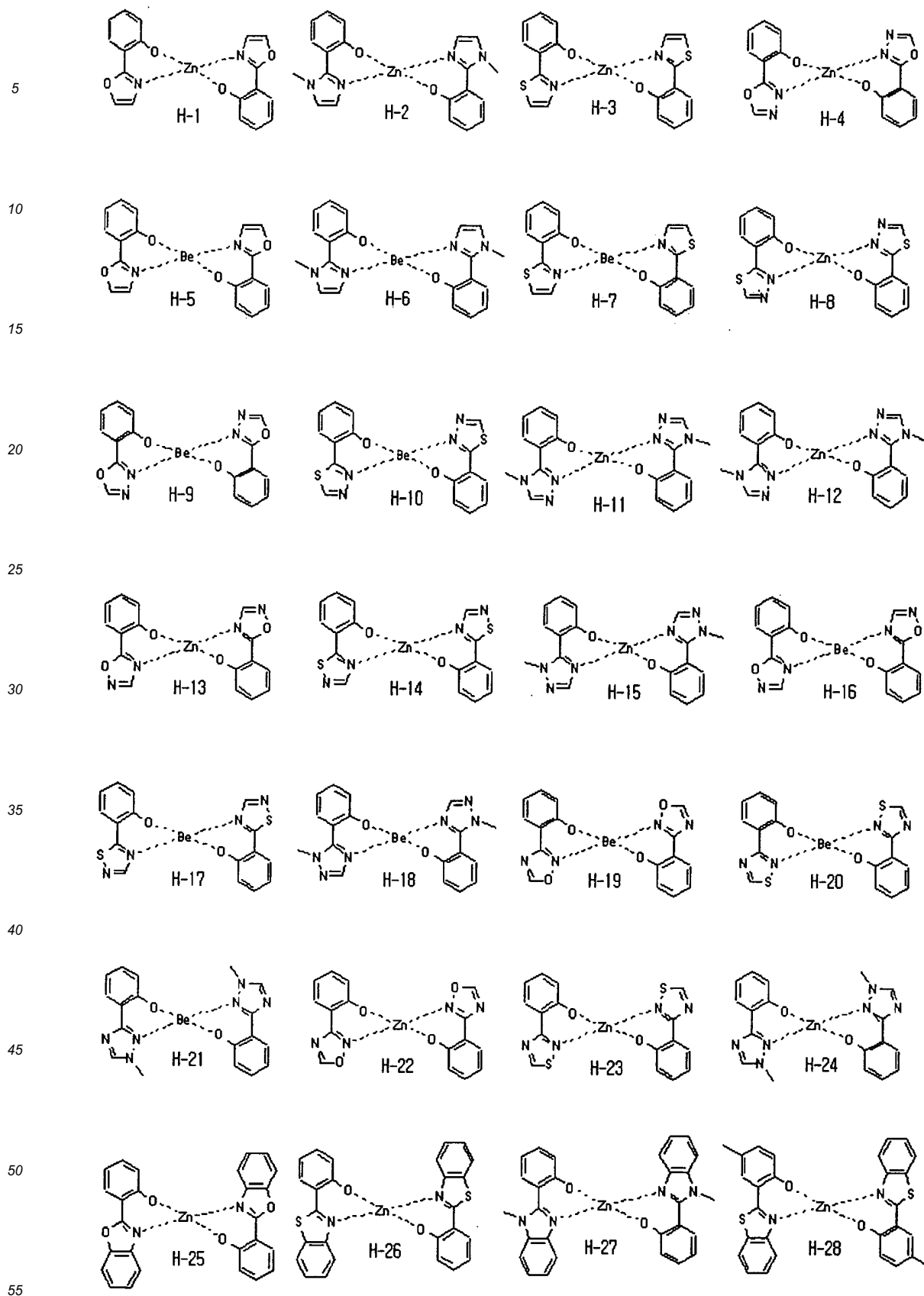
$R_{25}$  through  $R_{32}$  independently represent hydrogen, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, cyano, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, methoxy, ethoxy, butoxy, hexyloxy, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, dimethylamino, diethylamino or diphenylamino; and

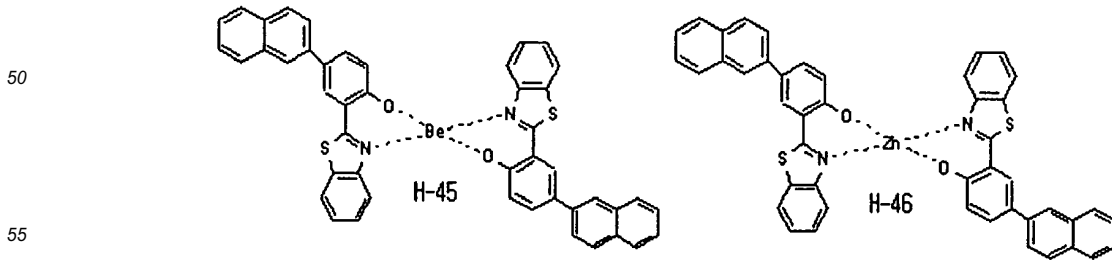
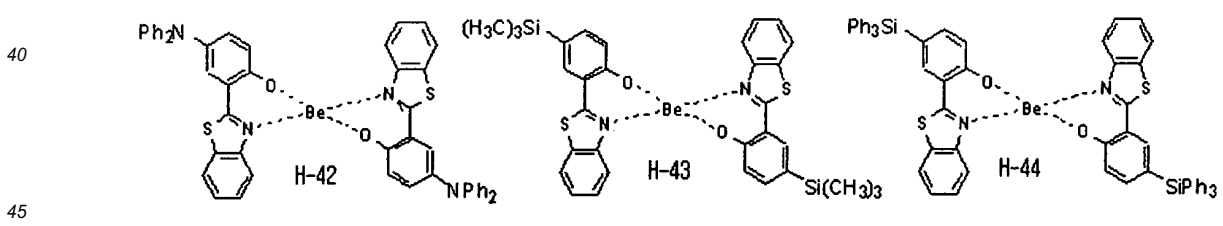
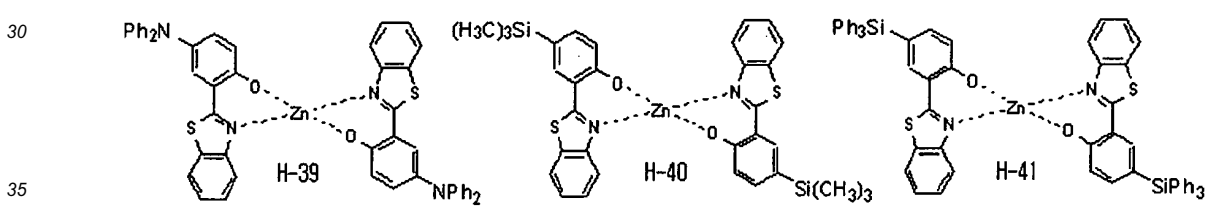
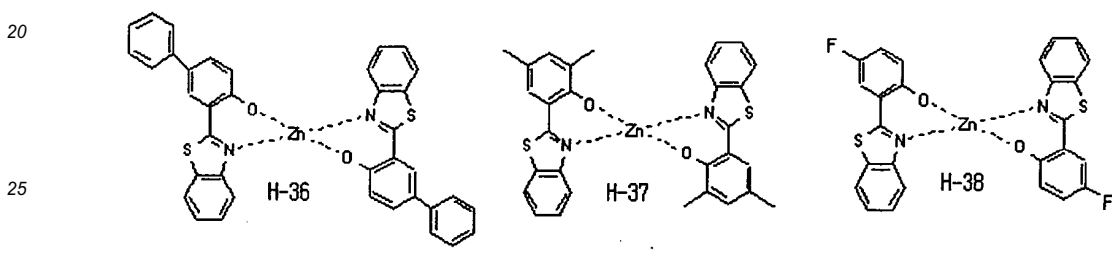
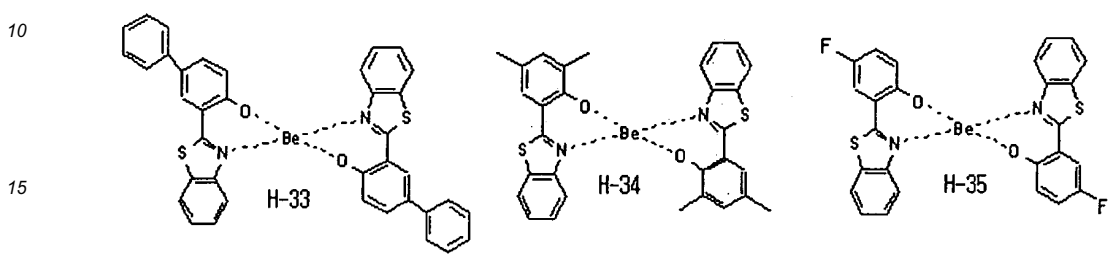
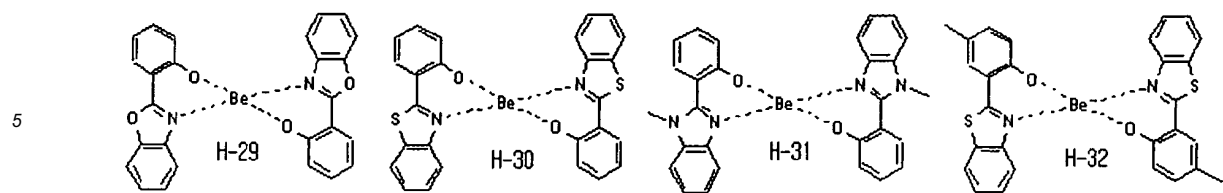
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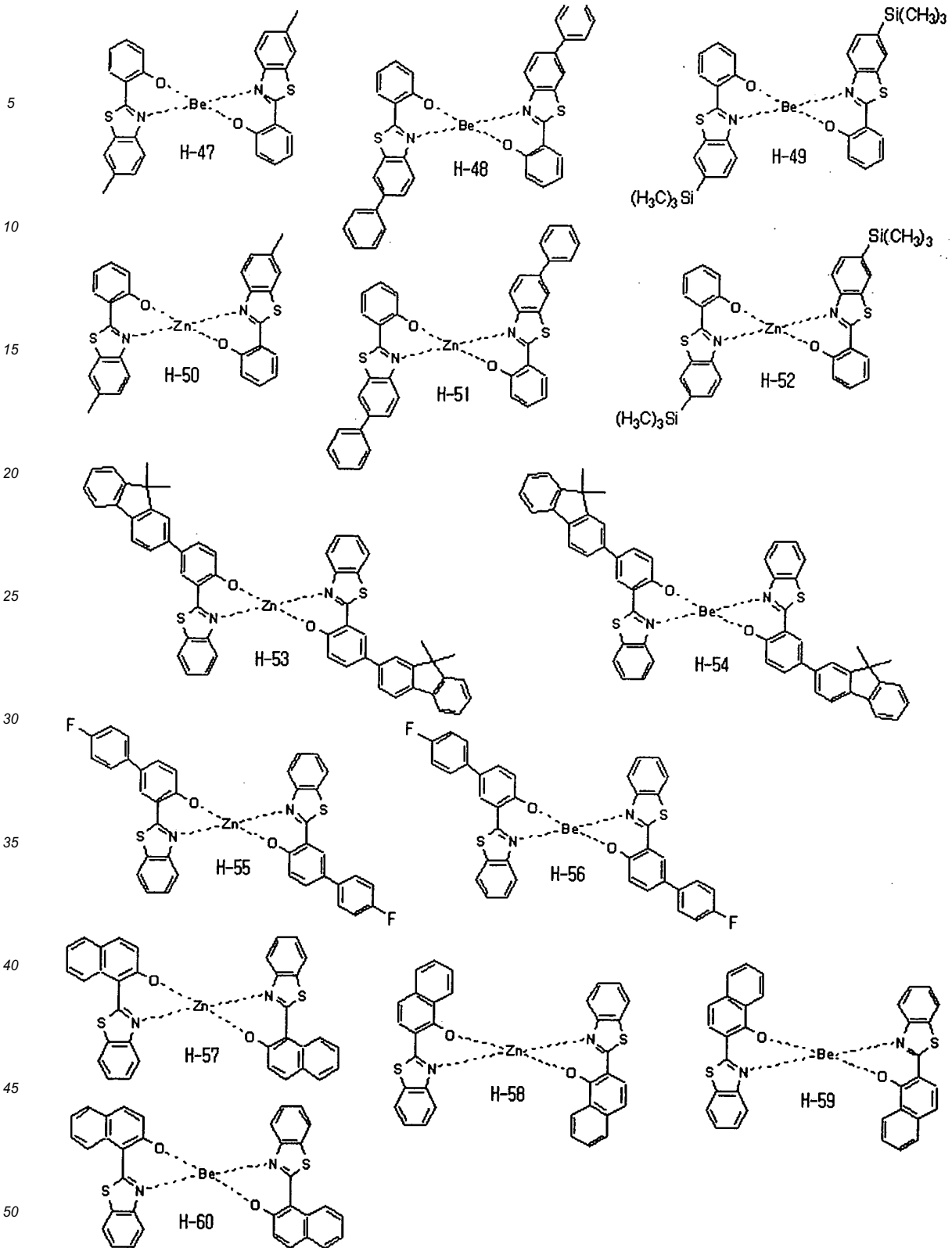
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the phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl or benzoxazolyl of  $R_1$  through  $R_7$ ,  $R_{11}$  through  $R_{23}$ ,  $R_{24}$  and  $R_{25}$  through  $R_{32}$  may be further substituted by one or more substituent(s) selected from methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-pentyl, i-pentyl, n-hexyl, n-heptyl, n-octyl, 2-ethylhexyl, n-nonyl, decyl, dodecyl, hexadecyl, fluoro, chloro, cyano, trifluoromethyl, perfluoroethyl, trifluoroethyl, perfluoropropyl, perfluorobutyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, methoxy, ethoxy, butoxy, hexyloxy, phenyl, biphenyl, naphthyl, anthryl, fluorenyl, pyridyl, quinolyl, furanyl, thiophenyl, thiazolyl, imidazolyl, oxazolyl, benzofuranyl, benzothiazolyl, benzimidazolyl, benzoxazolyl, trimethylsilyl, triethylsilyl, tripropylsilyl, tri(t-butyl)silyl, t-butyl dimethylsilyl, dimethylphenylsilyl, triphenylsilyl, dimethylamino, diethylamino and diphenylamino.

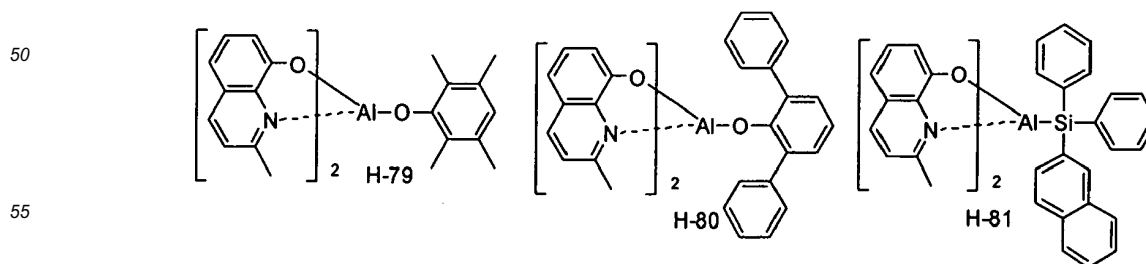
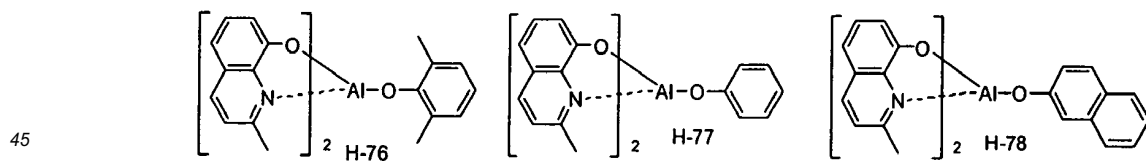
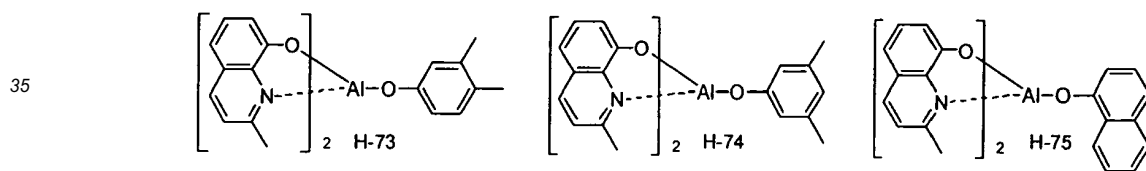
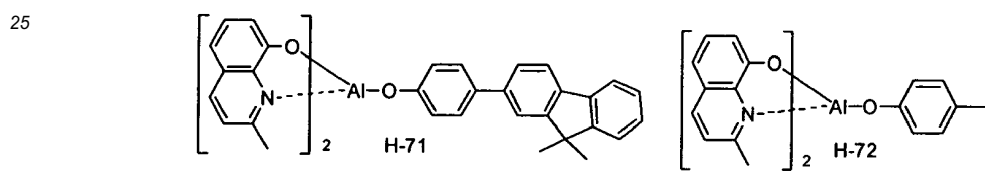
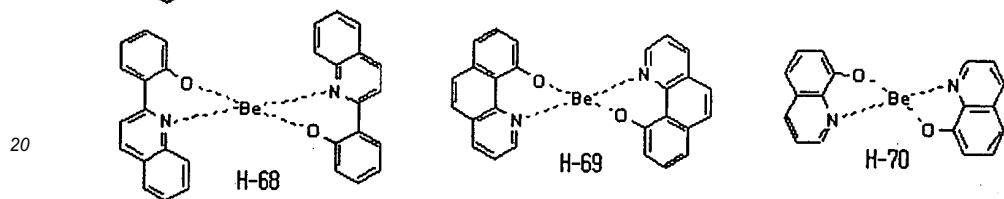
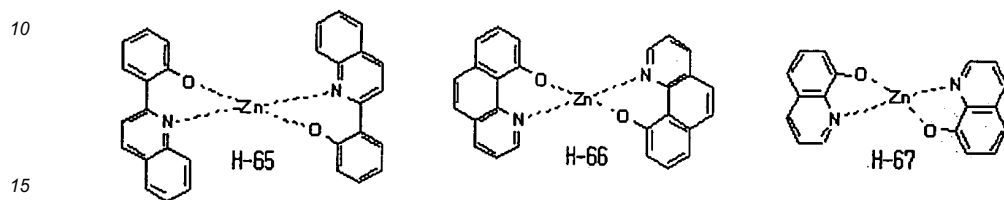
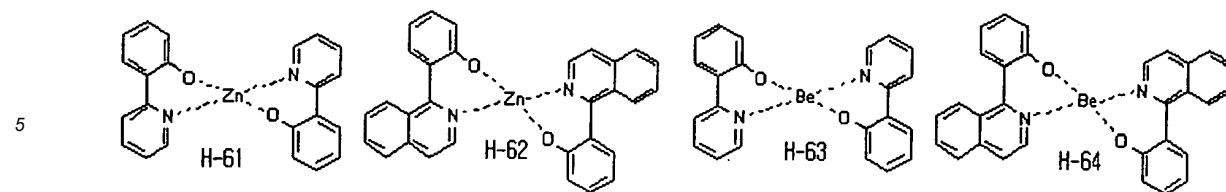
[0025] The compound represented by Chemical Formula (1) according to the present invention is preferably selected from the following compounds, but they are not restricted thereto:



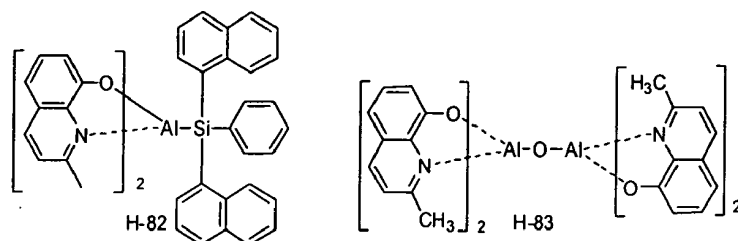




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[0026] The electroluminescent device according to the present invention is **characterized in that** the organic layer comprises an electroluminescent layer, which comprises one or more electroluminescent compound(s) represented by Chemical Formula (1) as electroluminescent host, and one or more electroluminescent dopant(s) in an amount from 1 to 20% by weight. The electroluminescent dopant applied to the electroluminescent device according to the invention is not particularly restricted, but may be exemplified by the compounds represented by Chemical Formula (2):

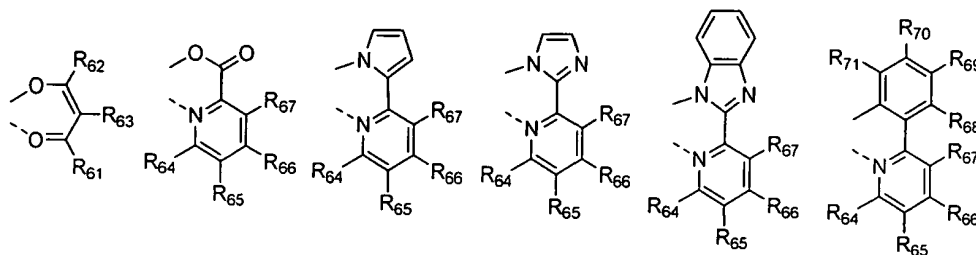
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Chemical Formula 2

 $M^1L^3L^4L^5$ 

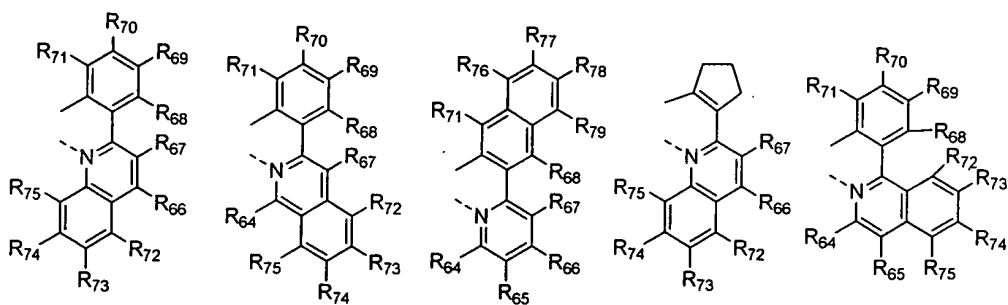
20 wherein,  $M^1$  is selected from a group consisting of Group 7, 8, 9, 10, 11, 13, 14, 15 and 16 in the Periodic Table, and ligands  $L^3$ ,  $L^4$  and  $L^5$  are independently selected from the following structures:

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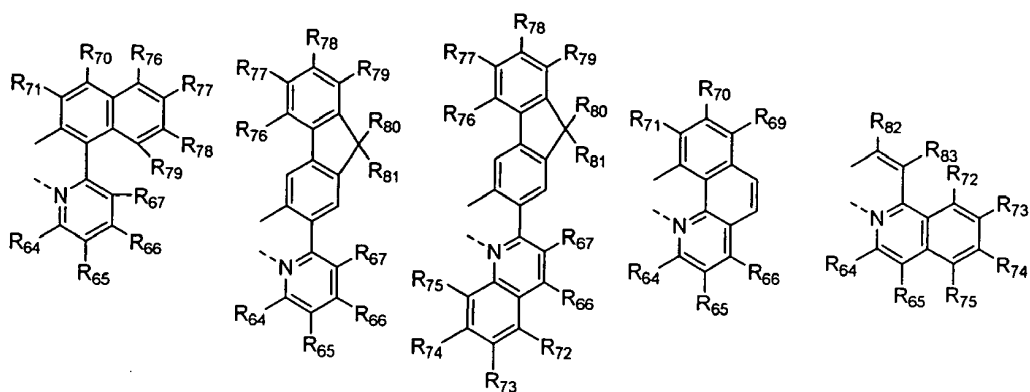
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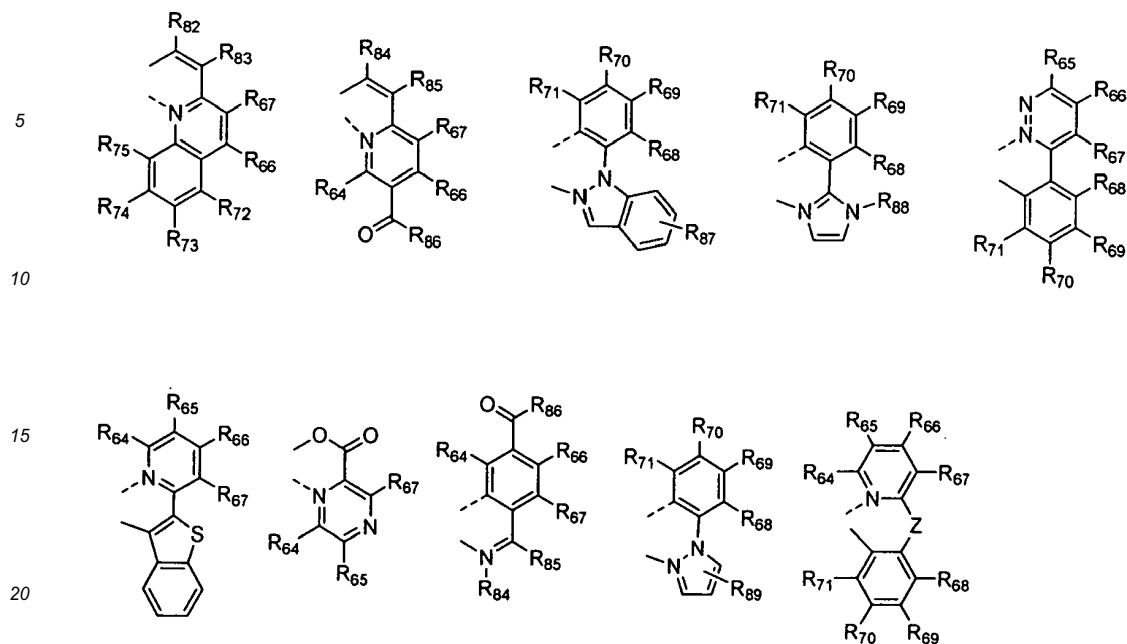
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25 wherein, R<sub>61</sub> through R<sub>63</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), (C6-C60)aryl with or without (C1-C60)alkyl substituent(s), or halogen;

30 R<sub>64</sub> through R<sub>79</sub> independently represent hydrogen, (C1-C60)alkyl, (C1-C30)alkoxy, (C3-C60)cycloalkyl, (C2-C30)alkenyl, (C6-C60)aryl, mono or di(C1-C30)alkylamino, mono or di(C6-C30)arylamino, SF<sub>5</sub>, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, cyano or halogen; or each of R<sub>70</sub> through R<sub>76</sub> may be linked to an adjacent substituent via (C2-C12)alkylene or (C2-C12)alkenylene to form a fused ring or a multi-fused ring; and the alkyl, cycloalkyl, alkenyl or aryl of R<sub>64</sub> through R<sub>79</sub>, or the fused ring or multi-fused ring formed from R<sub>70</sub> and R<sub>76</sub> by linkage via alkylene or alkenylene may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, (C6-C60)aryl and halogen;

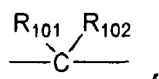
35 R<sub>80</sub> through R<sub>83</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), or (C6-C60)aryl with or without (C1-C60)alkyl substituent(s);

40 R<sub>84</sub> and R<sub>85</sub> independently represents hydrogen, linear or branched (C1-C60)alkyl, (C6-C60)aryl or halogen, or R<sub>84</sub> and R<sub>85</sub> may be linked via (C3-C12)alkylene or (C3-C12)alkenylene with or without a fused ring to form an alicyclic ring or a monocyclic or polycyclic aromatic ring; and the alkyl, aryl or the alicyclic ring or the monocyclic or polycyclic aromatic ring formed therefrom by linkage via (C3-C12)alkylene or (C3-C12)alkenylene may be further substituted by one or more substituent(s) selected from linear or branched (C1-C60)alkyl with or without halogen substituent(s), (C1-C30)alkoxy, halogen, tri(C1-C30)alkylsilyl, tri(C6-C30)arylsilyl and (C6-C60)aryl;

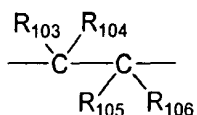
R<sub>86</sub> represents (C1-C60)alkyl, (C6-C60)aryl, (C5-C60)heteroaryl or halogen;

45 R<sub>87</sub> through R<sub>89</sub> independently represent hydrogen, (C1-C60)alkyl, (C6-C60)aryl or halogen, and the alkyl or aryl of R<sub>86</sub> through R<sub>89</sub> may be further substituted by halogen or (C1-C60)alkyl; and Z represents

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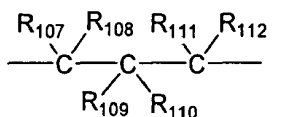


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or



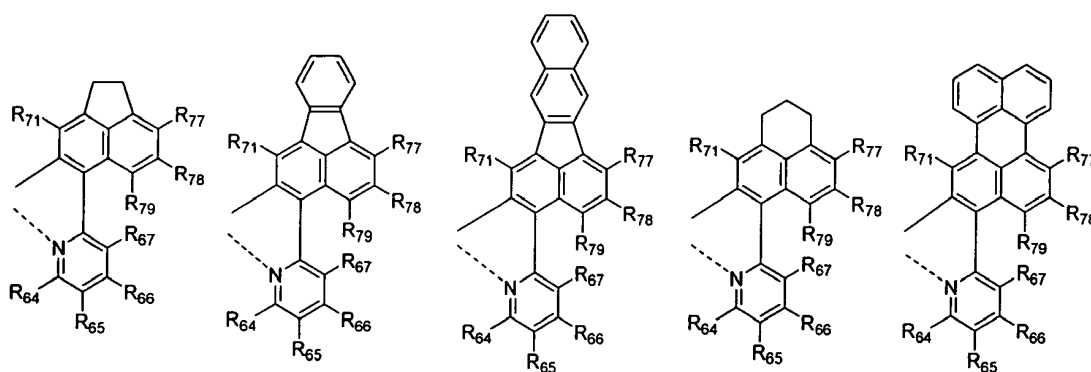
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wherein  $R_{101}$  through  $R_{112}$  independently represent hydrogen, (C1-C60) alkyl with or without halogen substituent (s), (C1-C30) alkoxy, halogen, (C6-C60) aryl, cyano or (C5-C60) cycloalkyl, or each of  $R_{101}$  through  $R_{112}$  may be linked to an adjacent substituent via alkylene or alkenylene to form a (C5-C7) spiro ring or a (C5-C9) fused ring, or they may be linked to  $R_{67}$  or  $R_{68}$  via alkylene or alkenylene to form a (C5-C7) fused ring.

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**[0027]** In Chemical Formula (2),  $M^1$  may be selected from Ir, Pt, Pd, Rh, Re, Os, Tl, Pb, Bi, In, Sn, Sb, Te, Au and Ag, and the ligands,  $L^3$ ,  $L^4$  and  $L^5$  of the compound of Chemical Formula (2) may be independently selected from the following structures, but they are not restricted thereto.

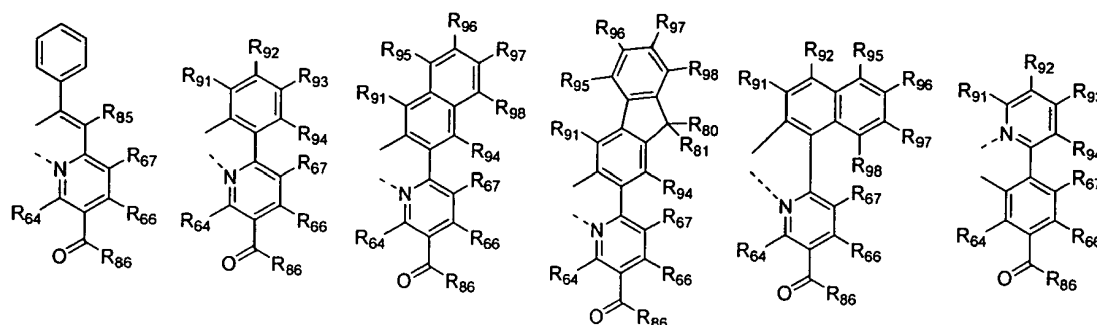
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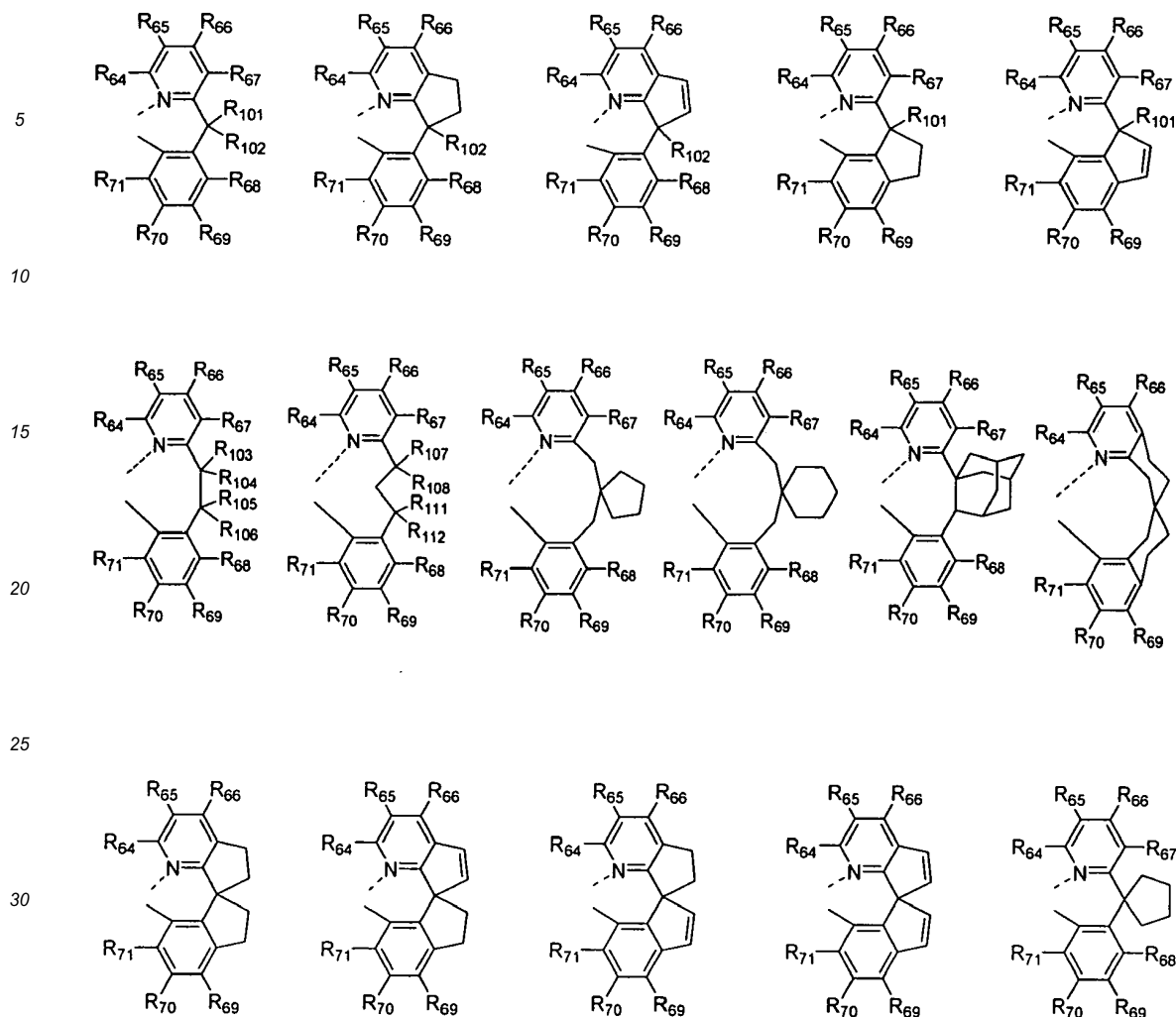
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wherein, R<sub>64</sub> through R<sub>79</sub> independently represent hydrogen, (C1-C60)alkyl, (C1-C30)alkoxy, (C3-C60)cycloalkyl, (C2-C30)alkenyl, (C6-C60)aryl, mono or di(C1-C30)alkylamino, mono or di(C6-C30)arylamino, SF<sub>5</sub>, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, cyano or halogen;

the alkyl, cycloalkyl, alkenyl or aryl of R<sub>64</sub> through R<sub>79</sub> may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, (C6-C60)aryl and halogen;

R<sub>80</sub> and R<sub>81</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), or (C6-C60)aryl with or without (C1-C60)alkyl substituent(s);

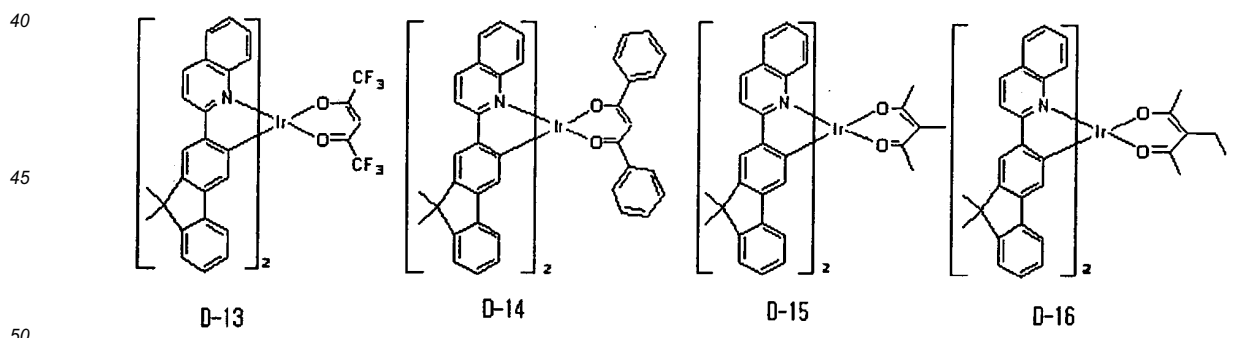
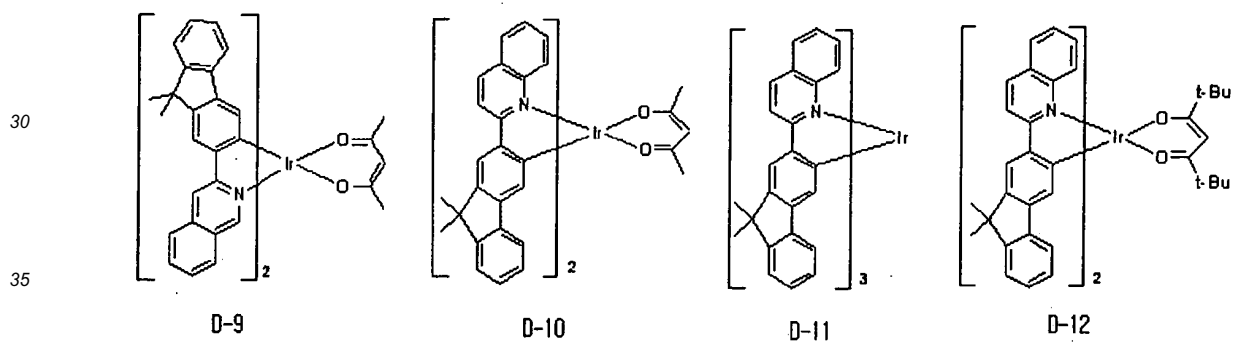
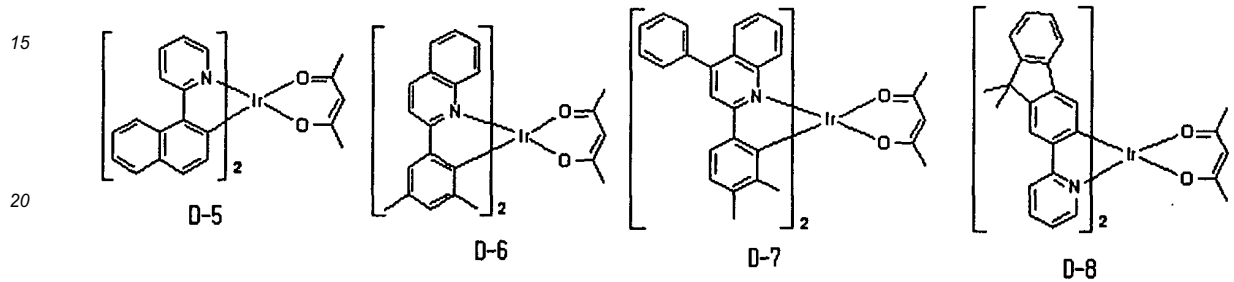
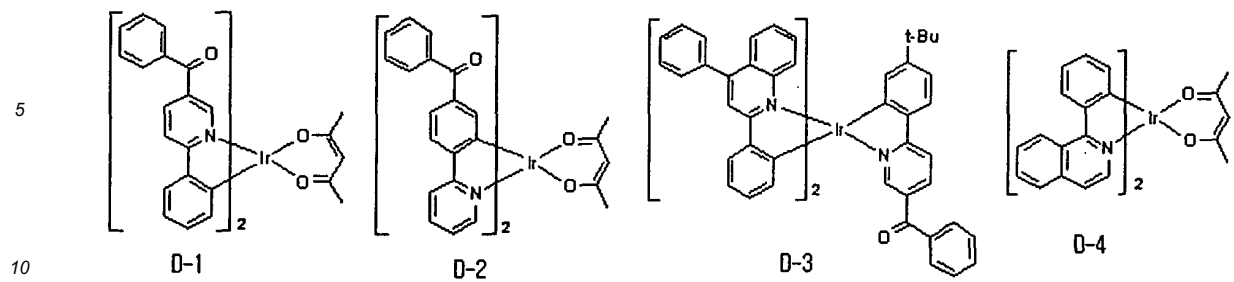
R<sub>85</sub> independently represents hydrogen, linear or branched (C1-C60)alkyl, (C6-C60)aryl or halogen; and the alkyl or aryl of R<sub>85</sub> may be further substituted by one or more substituent(s) selected from linear or branched (C1-C60)alkyl with or without halogen substituent(s), (C1-C30)alkoxy, halogen, tri(C1-C30)alkylsilyl, tri(C6-C30)arylsilyl and (C6-C60)aryl;

R<sub>86</sub> represents (C1-C60)alkyl, (C6-C60)aryl or halogen; and the alkyl or aryl of R<sub>86</sub> may be further substituted by halogen or (C1-C60)alkyl;

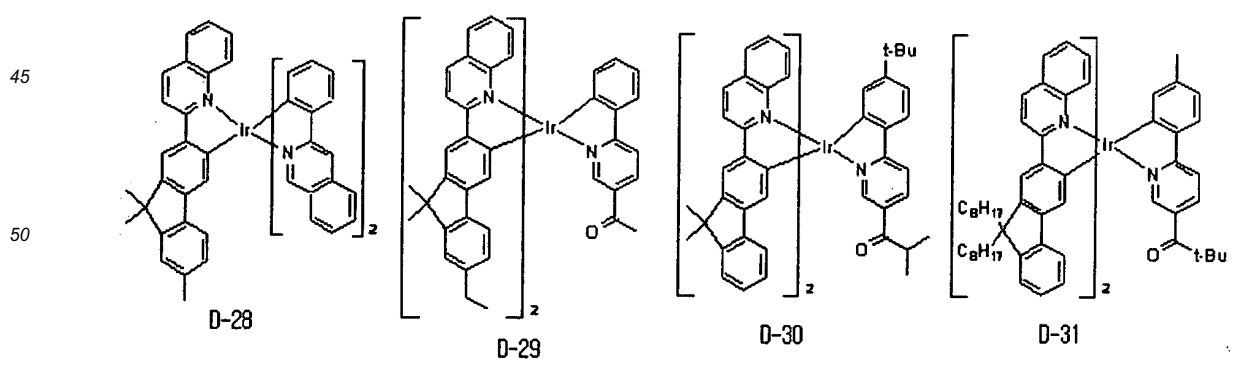
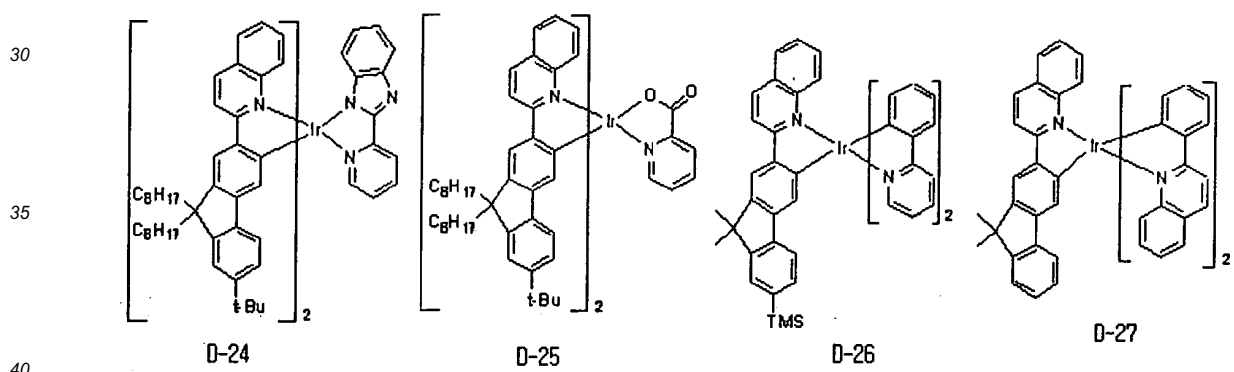
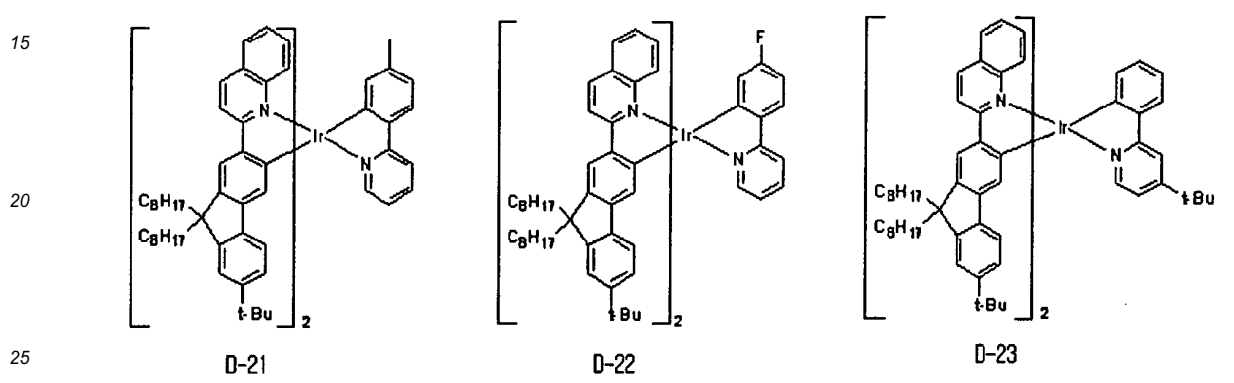
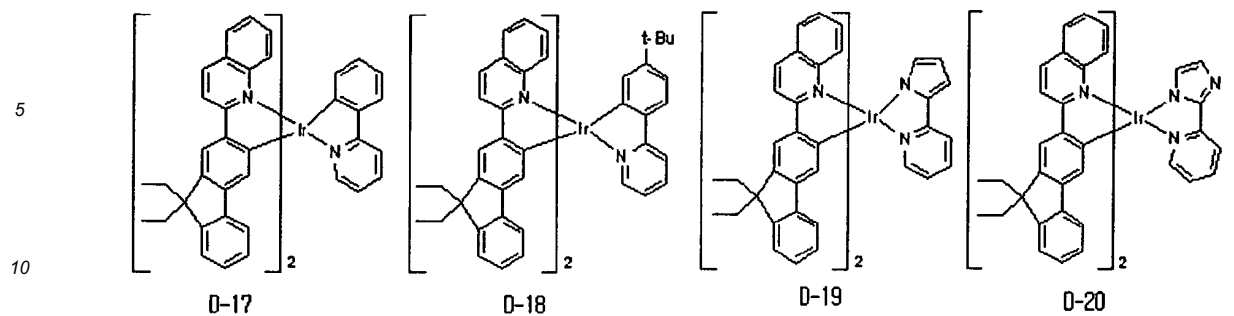
R<sub>91</sub> through R<sub>98</sub> independently represent hydrogen, linear or branched (C1-C60)alkyl with or without halogen substituent(s), (C1-C30)alkoxy, halogen, tri(C1-C30)alkylsilyl, tri(C6-C30)arylsilyl or (C6-C60)aryl; and

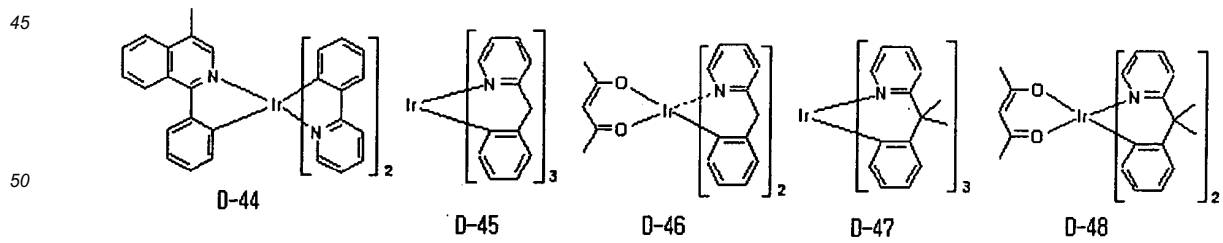
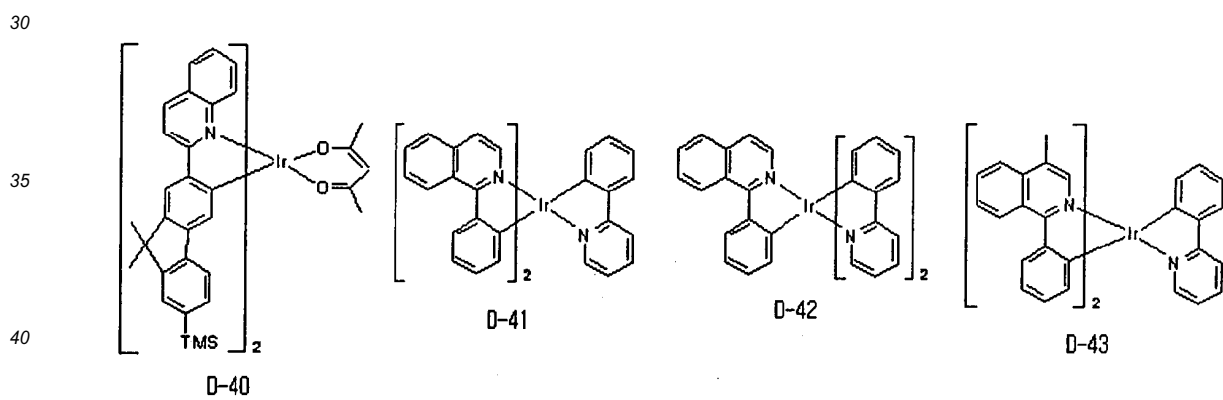
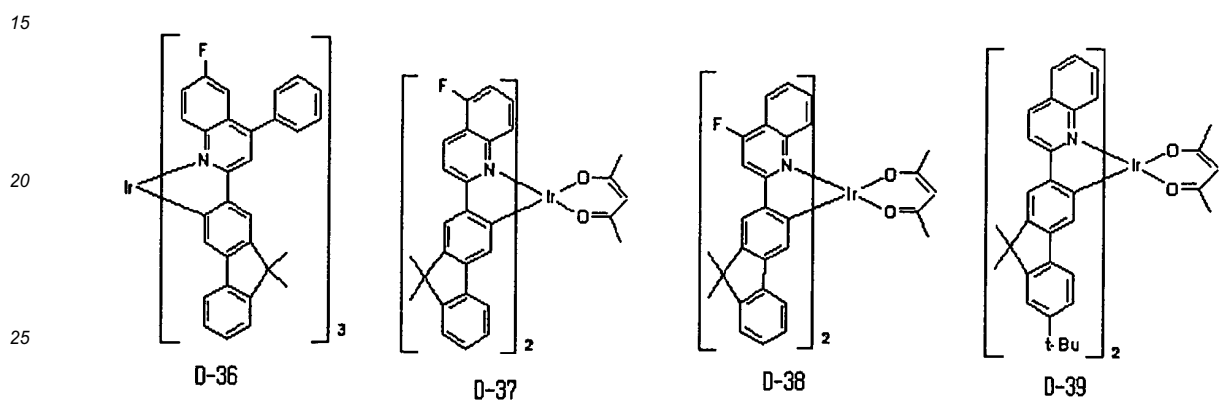
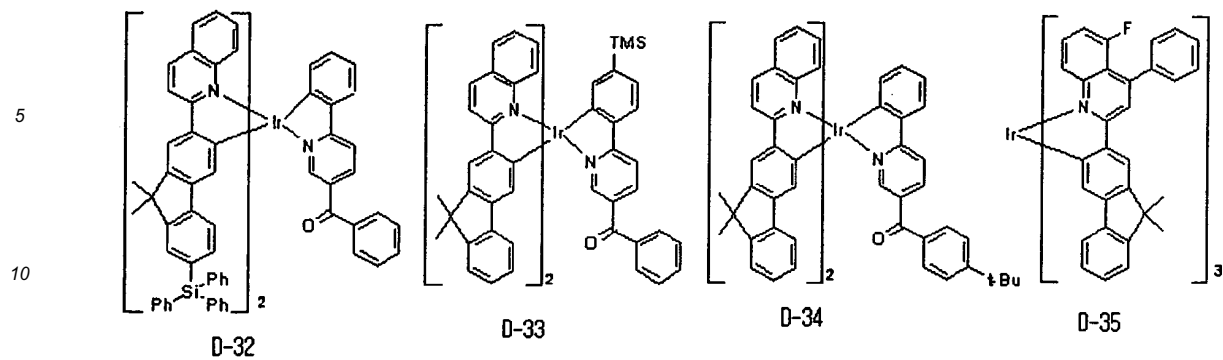
R<sub>101</sub> through R<sub>108</sub>, R<sub>111</sub> and R<sub>112</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), (C1-C30)alkoxy, halogen, (C6-C60)aryl, cyano or (C5-C60)cycloalkyl.

**[0028]** The dopant compounds represented by Chemical Formula (2) may be exemplified by the compounds represented by one of the following structural formulas, but they are not restricted thereto.

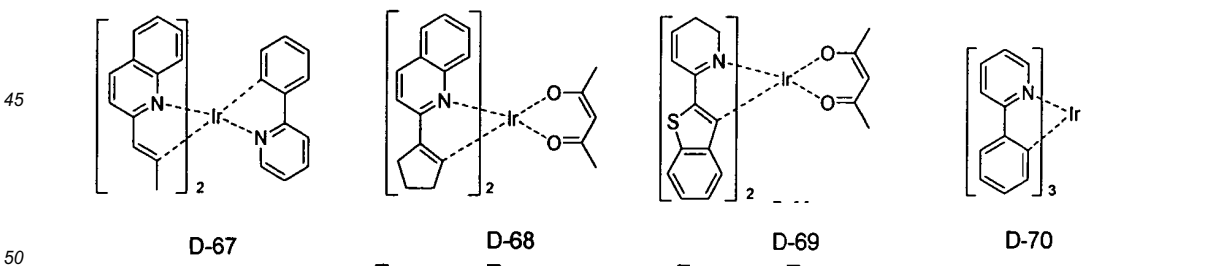
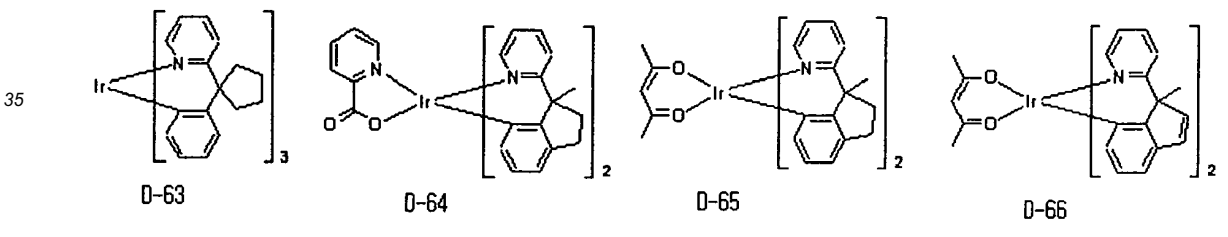
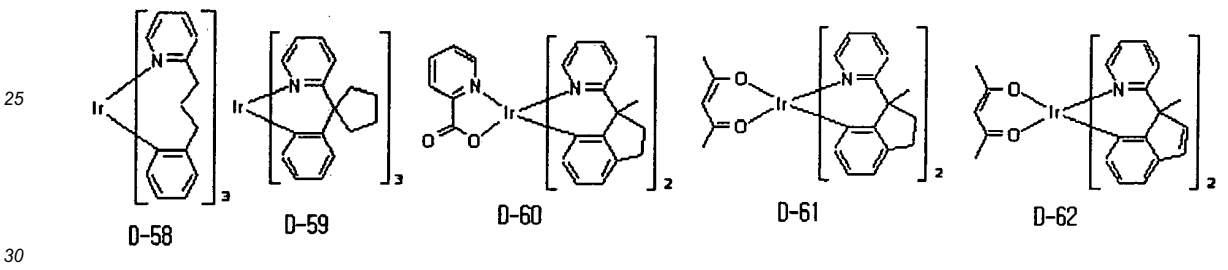
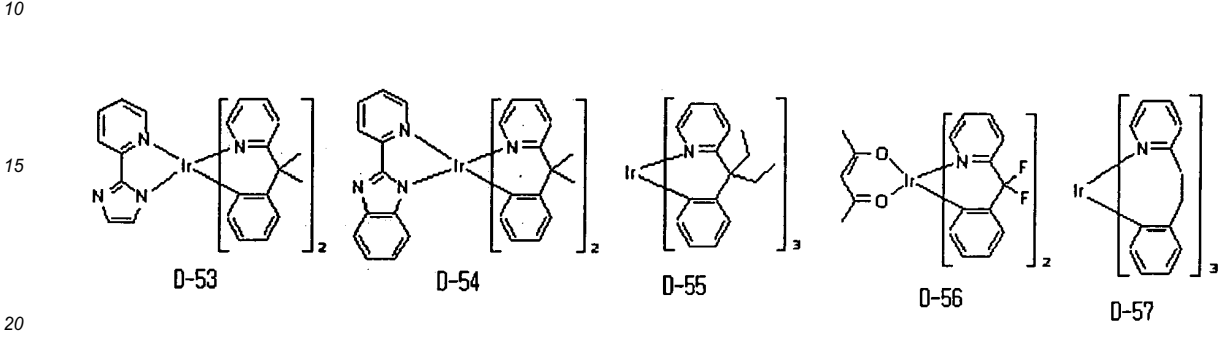
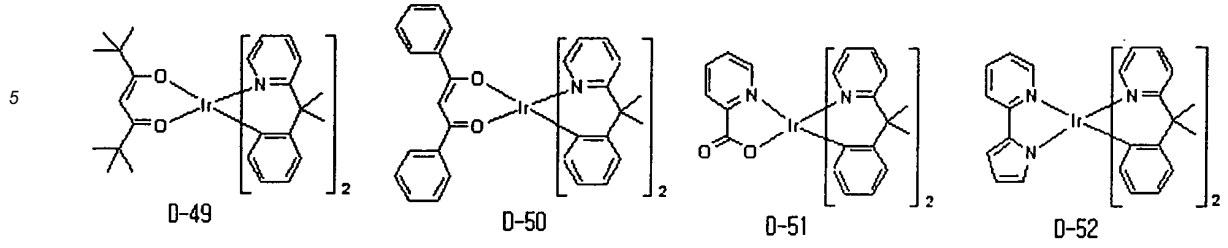


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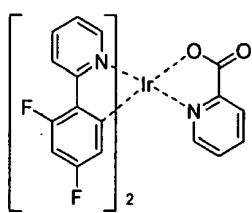




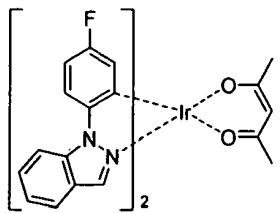
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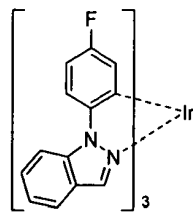
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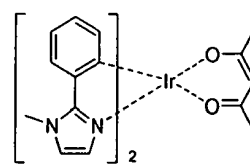
D-71



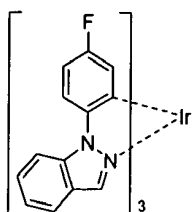
D-72



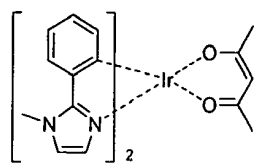
D-73



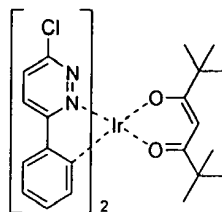
D-74



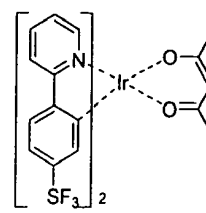
D-75



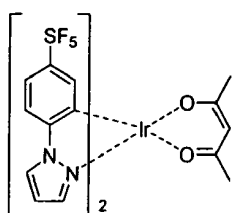
D-76



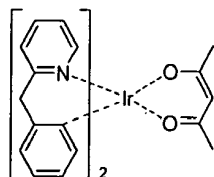
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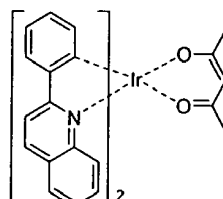
D-78



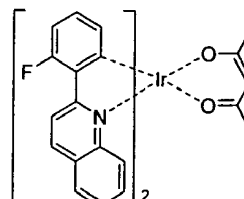
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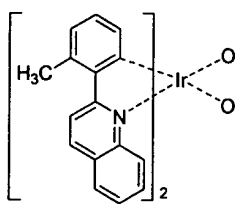
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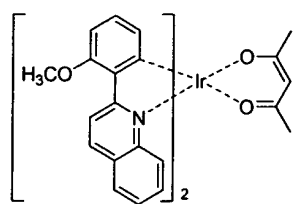
D-81



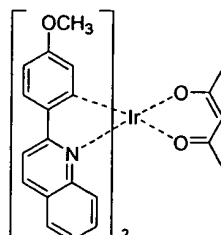
D-82



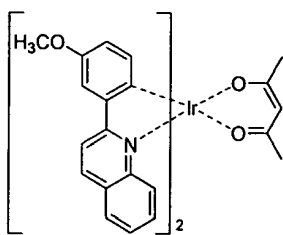
D-83



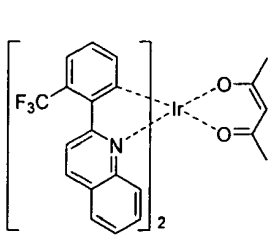
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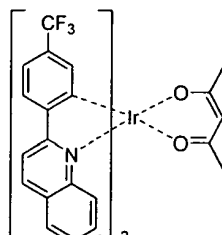
D-85



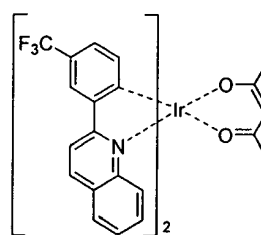
D-86



D-87

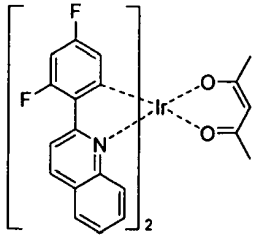


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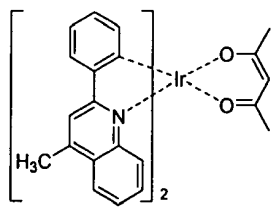


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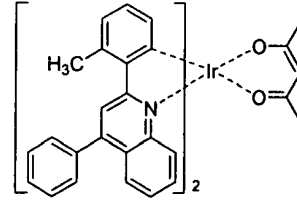
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D-90



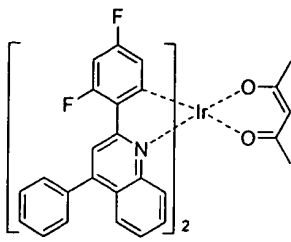
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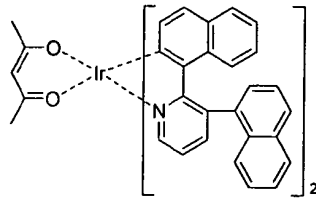
D-92

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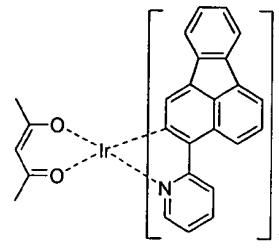
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D-93



D-94

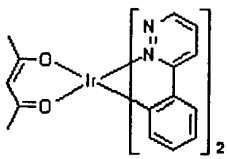


D-95

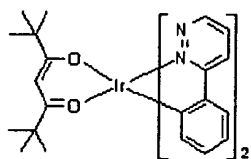
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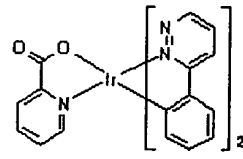
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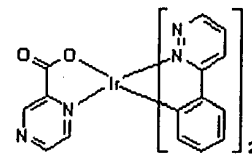
D-96



D-97



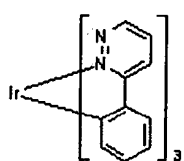
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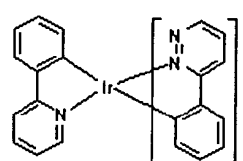
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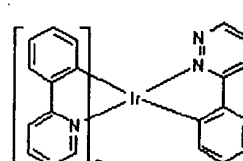
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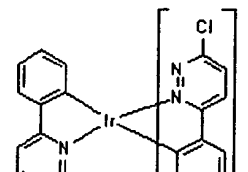
D-100



D-101



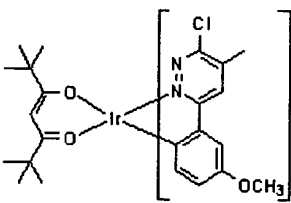
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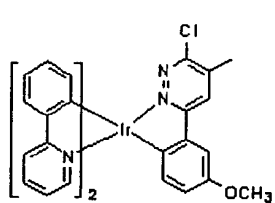
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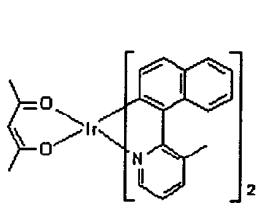
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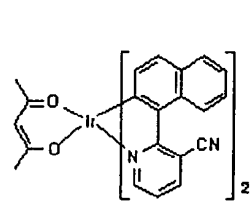
D-104



D-105

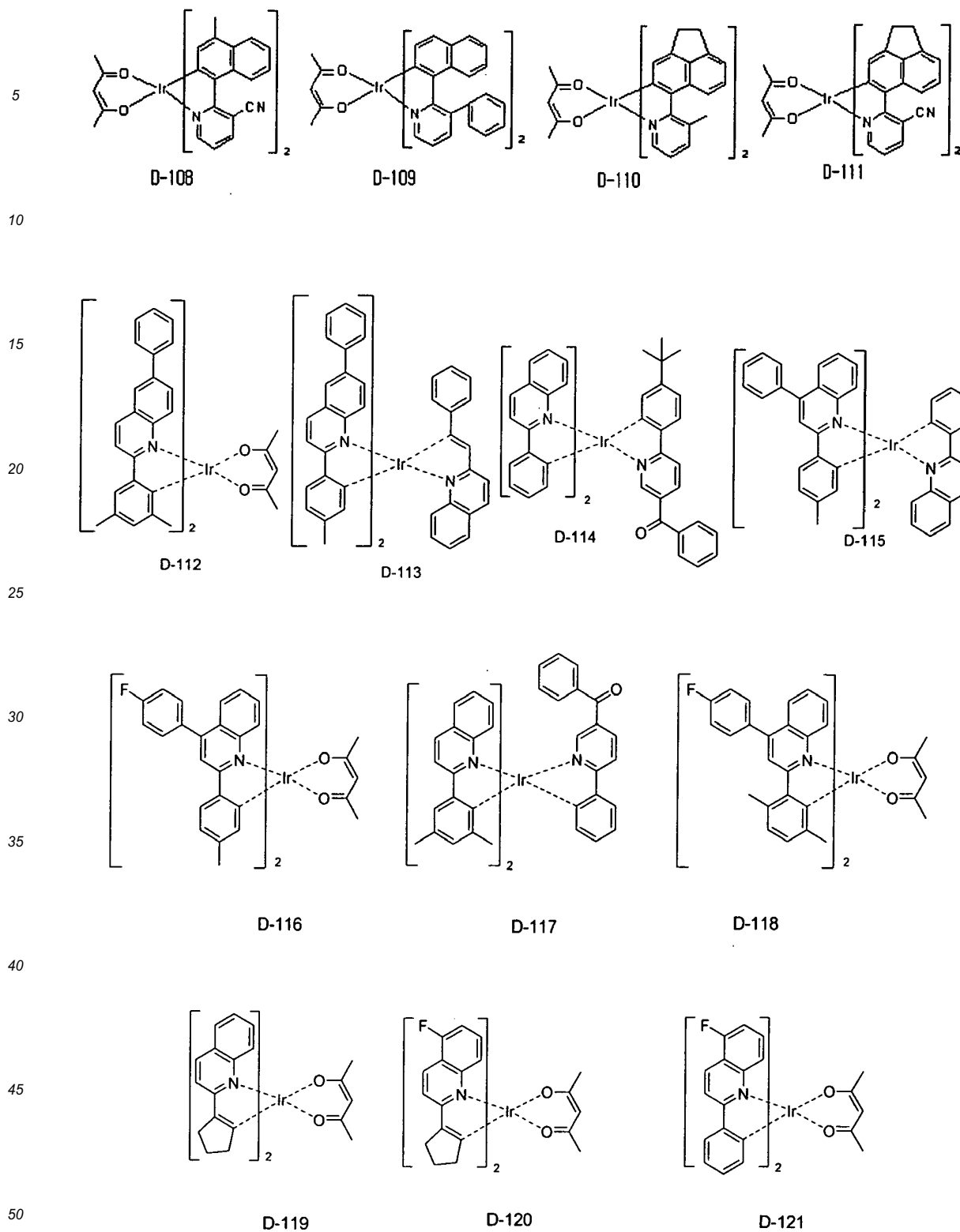


D-106



D-107

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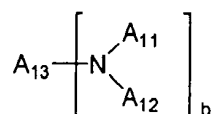


[0029] The organic electroluminescent device according to the invention may further comprise one or more compound (s) selected from arylamine compounds and styrylamine compounds, as well as the organic electroluminescent compound represented by Chemical Formula (1). Examples of arylamine or styrylamine compounds include the compounds represented by Chemical Formula (3), but they are not restricted thereto:

55

## Chemical Formula 3

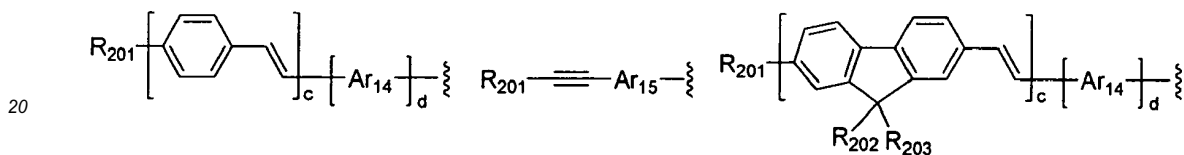
5



10 wherein,  $Ar_{11}$  and  $Ar_{12}$  independently represent (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, (C6-C60)arylamino, (C1-C60)alkylamino, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, or (C3-C60)cycloalkyl, or  $Ar_{11}$  and  $Ar_{12}$  may be linked via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

15 when b is 1,  $Ar_{13}$  represents (C6-C60)aryl, (C4-C60)heteroaryl, or a substituent represented by one of the following structural formulas:

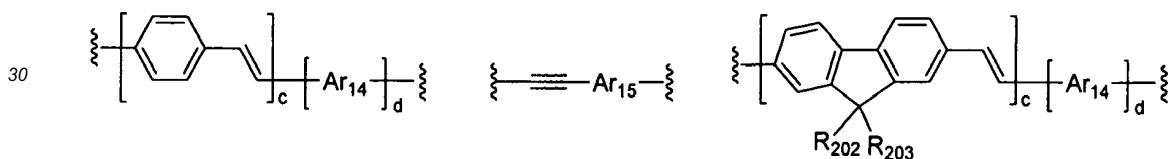
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25 when b is 2,  $Ar_{13}$  represents (C6-C60)arylene, (C4-C60)heteroarylene, or a substituent represented by one of the following structural formulas:

25



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35 wherein  $Ar_{14}$  and  $Ar_{15}$  independently represent (C6-C60)arylene or (C4-C60)heteroarylene;

35

$R_{201}$  through  $R_{203}$  independently represent hydrogen, deuterium, (C1-C60)alkyl or (C6-C60)aryl;

c is an integer from 1 to 4, d is an integer of 0 or 1; and

40

the alkyl, aryl, heteroaryl, arylamino, alkylamino, cycloalkyl or heterocycloalkyl of  $Ar_{11}$  and  $Ar_{12}$ , or the aryl, heteroaryl, arylene or heteroarylene of  $Ar_{13}$ , or the arylene or heteroarylene of  $Ar_{14}$  and  $Ar_{15}$ , or the alkyl or aryl of  $R_{201}$  through  $R_{203}$  may be further substituted by one or more substituent(s) selected from a group consisting of deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C6-C60)aryloxy, (C1-C60)alkyloxy, (C6-C60)arylthio, (C1-C60)alkylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro and hydroxyl.

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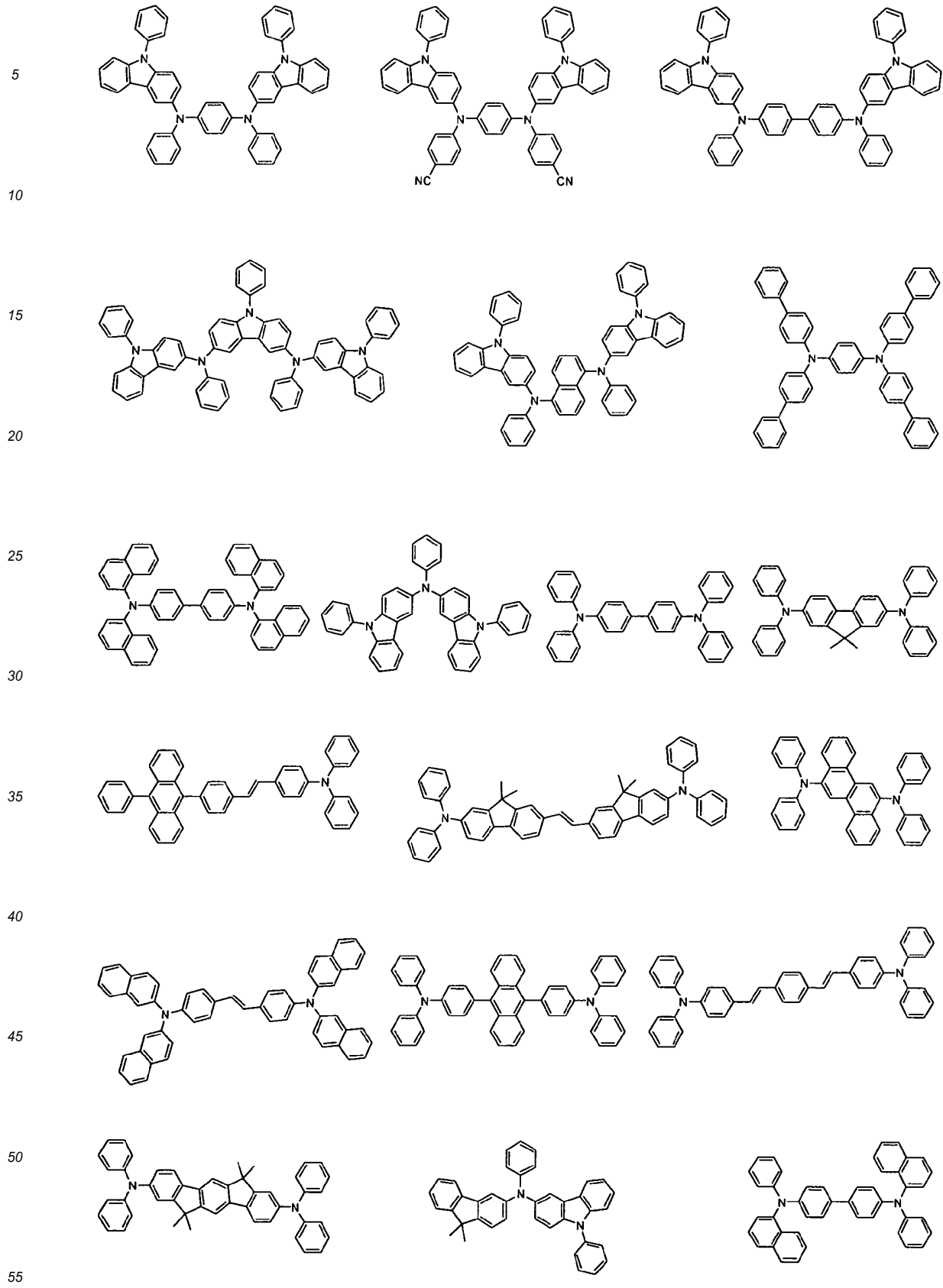
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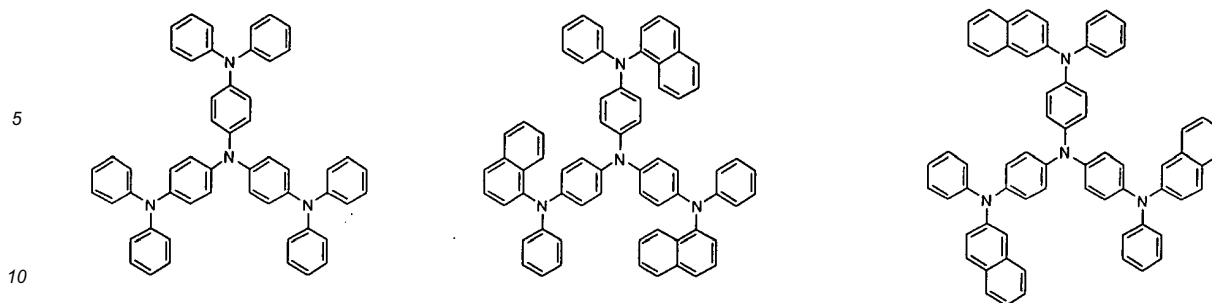
[0030] The arylamine compounds and styrylarylamino compounds may be more specifically exemplified by the following compounds, but are not restricted thereto.

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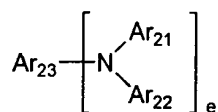


[0031] In an organic electroluminescent device according to the present invention, the organic layer may further comprise one or more metal(s) selected from a group consisting of organic metals of Group 1, Group 2, 4<sup>th</sup> period and 5<sup>th</sup> period transition metals, lanthanide metals and d-transition elements, as well as the organic electroluminescent compound represented by Chemical Formula (1). The organic layer may comprise an electroluminescent layer and a charge generating layer at the same time.

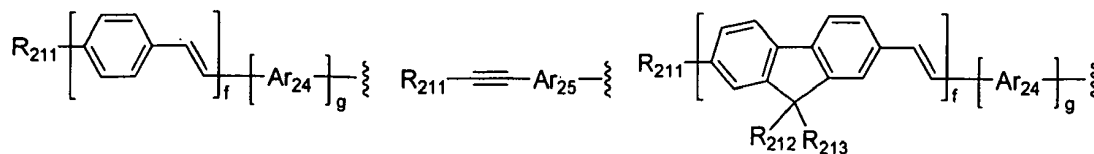
[0032] The present invention can realize an electroluminescent device having a pixel structure of independent light-emitting mode, which comprises an organic electroluminescent device containing the compound of Chemical Formula (1) as a sub-pixel, and one or more sub-pixel(s) comprising one or more metal compounds selected from a group consisting of Ir, Pt, Pd, Rh, Re, Os, Tl, Pb, Bi, In, Sn, Sb, Te, Au and Ag, patterned in parallel at the same time.

[0033] Further, an organic display can be formed, which also comprises one or more compound(s) selected from compounds having electroluminescent peak of wavelength of not more than 560 nm, as well as the organic electroluminescent compound described above, in the organic layer. The compounds having electroluminescent peak of wavelength of not more than 560 nm may be exemplified by the compounds represented by one of Chemical Formulas (4) to (9), but they are not restricted thereto.

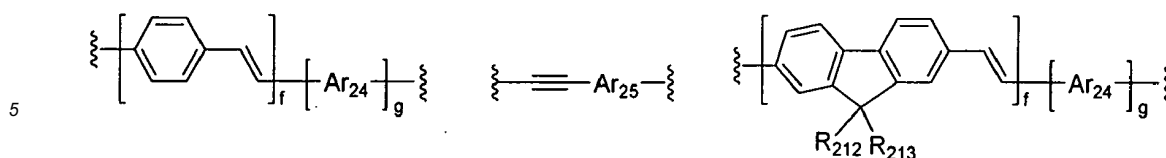
#### Chemical Formula 4



[0034] In Chemical Formula (4), Ar<sub>21</sub> and Ar<sub>22</sub> independently represent (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, (C6-C60)arylamino, (C1-C60)alkylamino, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom (s) selected from N, O and S, or (C3-C60)cycloalkyl, or Ar<sub>21</sub> and Ar<sub>22</sub> may be linked via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring; when e is 1, Ar<sub>23</sub> represents (C6-C60)aryl, (C4-C60)heteroaryl, or a substituent represented by one of the following structural formulas:



when e is 2, Ar<sub>23</sub> represents (C6-C60)arylene, (C4-C60)heteroarylene, or a substituent represented by one of the following structural formulas:



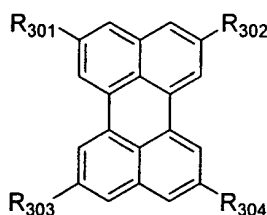
10 wherein  $Ar_{24}$  and  $Ar_{25}$  independently represent (C6-C60)arylene or (C4-C60)heteroarylene;

15  $R_{211}$  through  $R_{213}$  independently represent hydrogen, deuterium, (C1-C60)alkyl or (C6-C60)aryl;

$f$  is an integer from 1 to 4,  $g$  is an integer of 0 or 1; and

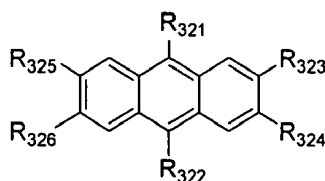
20 the alkyl, aryl, heteroaryl, arylamino, alkylamino, cycloalkyl or heterocycloalkyl of  $Ar_{21}$  and  $Ar_{22}$ , or the aryl, heteroaryl, arylene or heteroarylene of  $Ar_{23}$ , or the arylene or heteroarylene of  $Ar_{24}$  and  $Ar_{25}$ , or the alkyl or aryl of  $R_{211}$  through  $R_{213}$  may be further substituted by one or more substituent(s) selected from a group consisting of deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxy, (C6-C60)alkoxy, (C1-C60)alkylthio, (C1-C60)alkoxy, (C1-C60)alkylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro and hydroxyl.

### Chemical Formula 5

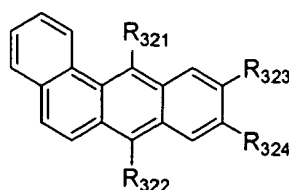


35 **[0035]** In Chemical Formula (5),  $R_{301}$  through  $R_{304}$  independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, (C1-C60)alkoxy, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, carboxyl, nitro or hydroxyl, or each of  $R_{301}$  through  $R_{304}$  may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring; the alkyl, alkenyl, alkynyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, arylsilyl, alkylsilyl, alkylamino or arylamino of  $R_{301}$  through  $R_{304}$ , or the alicyclic ring, or the monocyclic or polycyclic aromatic ring formed therefrom by linkage to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring may be further substituted by one or more substituent(s) selected from deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C4-C60)heteroaryl, a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, (C1-C60)alkoxy, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, carboxyl, nitro and hydroxyl.

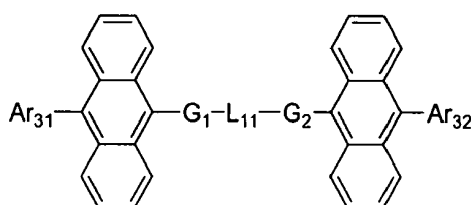
### Chemical Formula 6



Chemical Formula 7



Chemical Formula 8

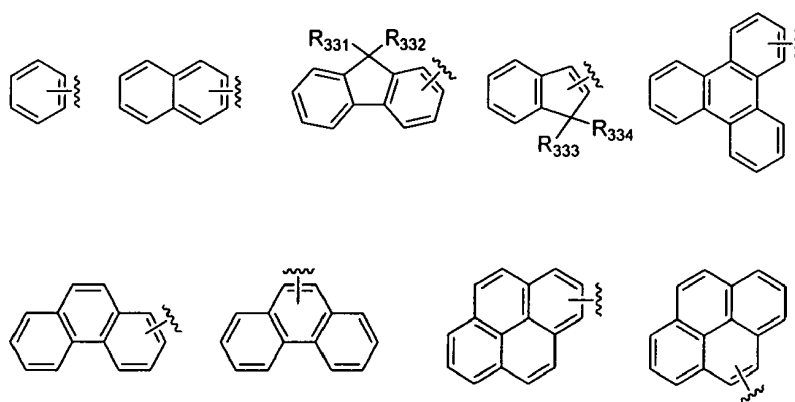


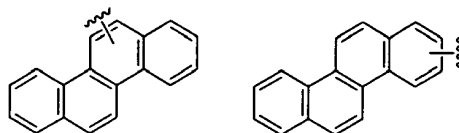
**[0036]** In Chemical Formulas (6) to (8),  $R_{321}$  and  $R_{322}$  independently represent (C6-C60)aryl, (C4-C60)heteroaryl or a 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, or (C3-C60) cycloalkyl, and the aryl or heteroaryl of  $R_{321}$  and  $R_{322}$  may be further substituted by one or more substituent(s) selected from a group consisting of deuterium, (C1-C60)alkyl, halo(C1-C60)alkyl, (C1-C60)alkoxy, (C3-C60)cycloalkyl, (C6-C60) aryl, (C4-C60)heteroaryl, halogen, cyano, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl and tri(C6-C60)arylsilyl;

$R_{323}$  through  $R_{326}$  independently represent hydrogen, deuterium, (C1-C60)alkyl, (C1-C60)alkoxy, halogen, (C4-C60)heteroaryl, (C5-C60)cycloalkyl or (C6-C60)aryl, and the heteroaryl, cycloalkyl or aryl of  $R_{323}$  through  $R_{326}$  may be further substituted by one or more substituent(s) selected from a group consisting of deuterium, (C1-C60)alkyl with or without halogen substituent(s), (C1-C60)alkoxy, (C3-C60)cycloalkyl, halogen, cyano, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl and tri(C6-C60)arylsilyl;

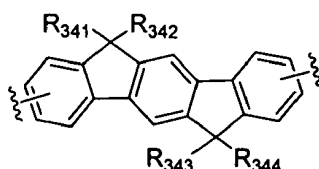
$G_1$  and  $G_2$  independently represent a chemical bond or (C6-C60)arylene with or without one or more substituent (s) selected from (C1-C60)alkyl, (C1-C60)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl and halogen;

$Ar_{31}$  and  $Ar_{32}$  represent (C4-C60)heteroaryl or an aryl selected from the following structures:



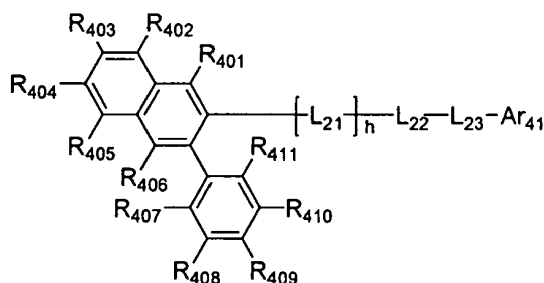


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 10 the aryl or heteroaryl of Ar<sub>31</sub> and Ar<sub>32</sub> may be substituted by one or more substituent(s) selected from deuterium, (C1-C60)alkyl, (C1-C60)alkoxy, (C6-C60)aryl and (C4-C60)heteroaryl;  
 L<sub>11</sub> represents (C6-C60)arylene, (C4-C60)heteroarylene or a compound represented by the following structure:



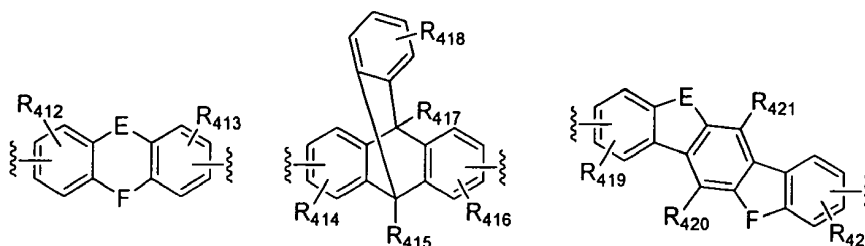
15  
 20 the arylene or heteroarylene of L<sub>11</sub> may be substituted by one or more substituent(s) selected from deuterium, (C1-C60)alkyl, (C1-C60)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl and halogen;  
 R<sub>331</sub> through R<sub>334</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl or (C6-C60)aryl, or each of them may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;  
 25 R<sub>341</sub> through R<sub>344</sub> independently represent hydrogen, deuterium, (C1-C60)alkyl, (C1-C60)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl or halogen, or each of them may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring.

## Chemical Formula 9



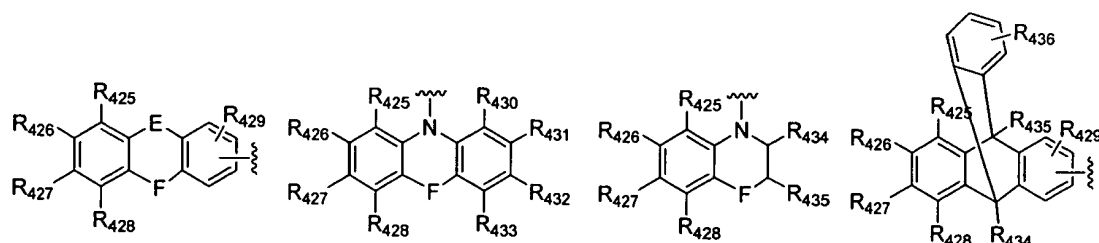
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 35  
 40 [0037] In Chemical Formula 9,

45 L<sub>21</sub> represents (C6-C60)arylene, (C3-C60)heteroarylene containing one or more heteroatom(s) selected from N, O and S, or a divalent group selected from the following structures:



L<sub>22</sub> and L<sub>23</sub> independently represent a chemical bond, (C1-C60)alkyleneoxy, (C1-C60)alkylenethio, (C6-C60)aryleneoxy, (C6-C60)arylenethio, (C6-C60)arylene, or (C3-C60)heteroarylene containing one or more heteroatom(s) selected from N, O and S;

Ar<sub>41</sub> represents NR<sub>423</sub>R<sub>424</sub>, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, adamantyl, (C7-C60)bicycloalkyl, or a substituent selected from the following structures:



wherein, R<sub>401</sub> through R<sub>411</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro or hydroxyl, or each of R<sub>401</sub> through R<sub>411</sub> may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

R<sub>412</sub> through R<sub>422</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro or hydroxyl, or each of R<sub>412</sub> through R<sub>422</sub> may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

R<sub>423</sub> and R<sub>424</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro or hydroxyl, or R<sub>423</sub> and R<sub>424</sub> may be linked via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

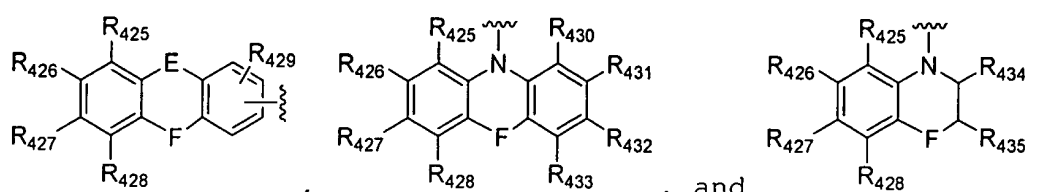
R<sub>425</sub> through R<sub>436</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro or hydroxyl, or each of R<sub>425</sub> through R<sub>436</sub> may be linked to an adjacent substituent via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

E and F independently represent a chemical bond, -(CR<sub>437</sub>R<sub>438</sub>)<sub>n</sub>-, -N(R<sub>439</sub>)-, -S-, -O-, -Si(R<sub>440</sub>)(R<sub>441</sub>)-, -P(R<sub>442</sub>)-, -C(=O)-, -B(R<sub>443</sub>)-, -In(R<sub>444</sub>)-, -Se-, -Ge(R<sub>445</sub>)(R<sub>446</sub>)-, -Sn(R<sub>447</sub>)(R<sub>448</sub>)-, -Ga(R<sub>449</sub>)- or -(R<sub>450</sub>)C=C(R<sub>451</sub>)-;

R<sub>437</sub> through R<sub>451</sub> independently represent hydrogen, deuterium, halogen, (C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri

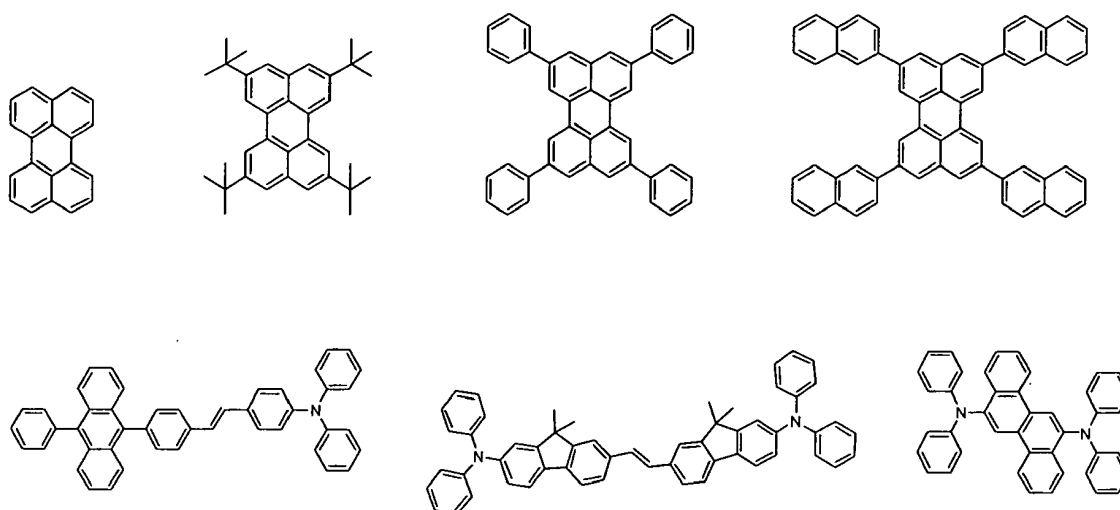
(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro or hydroxyl, or R<sub>437</sub> and R<sub>438</sub>, R<sub>440</sub> and R<sub>441</sub>, R<sub>445</sub> and R<sub>446</sub>, R<sub>447</sub> and R<sub>448</sub>, and R<sub>450</sub> and R<sub>451</sub> may be linked via (C3-C60)alkylene or (C3-C60)alkenylene with or without a fused ring to form an alicyclic ring, or a monocyclic or polycyclic aromatic ring;

the arylene or heteroarylene of L<sub>21</sub> through L<sub>23</sub>, the aryl or heteroaryl of Ar<sub>41</sub>, or the alkyl, aryl, heteroaryl, heterocycloalkyl, cycloalkyl, trialkylsilyl, dialkylarylsilyl, triarylsilyl, alkenyl, alkynyl, alkylamino or arylamino of R<sub>401</sub> through R<sub>411</sub>, R<sub>412</sub> through R<sub>422</sub>, R<sub>423</sub>, R<sub>424</sub>, R<sub>425</sub> through R<sub>436</sub>, and R<sub>437</sub> through R<sub>451</sub> may be further substituted independently by one or more substituent(s) selected from deuterium, halogen, (C1-C60)alkyl, halo(C1-C60)alkyl, (C6-C60)aryl, (C3-C60)heteroaryl containing one or more heteroatom(s) selected from N, O and S with or without (C6-C60)aryl substituent, morpholino, thiomorpholino, 5- or 6-membered heterocycloalkyl containing one or more heteroatom(s) selected from N, O and S, (C3-C60)cycloalkyl, tri(C1-C60)alkylsilyl, di(C1-C60)alkyl(C6-C60)arylsilyl, tri(C6-C60)arylsilyl, adamantyl, (C7-C60)bicycloalkyl, (C2-C60)alkenyl, (C2-C60)alkynyl, cyano, (C1-C60)alkylamino, (C6-C60)arylamino, (C6-C60)ar(C1-C60)alkyl, (C1-C60)alkyloxy, (C1-C60)alkylthio, (C6-C60)aryloxy, (C6-C60)arylthio, (C1-C60)alkoxycarbonyl, (C1-C60)alkylcarbonyl, (C6-C60)arylcarbonyl, carboxyl, nitro, hydroxyl,

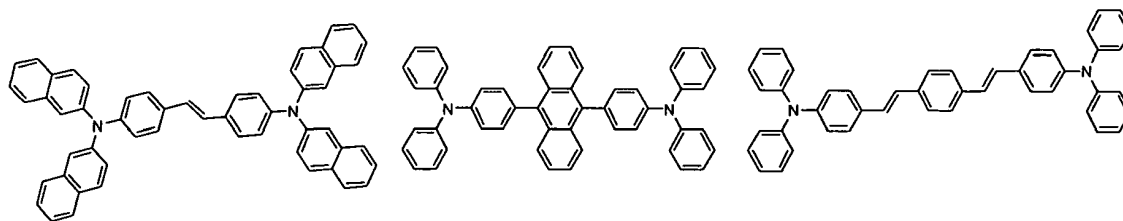


h is an integer from 1 to 4; and  
i is an integer from 1 to 4.

**[0038]** The compounds having the electroluminescent peak of the wavelength of not more than 560 nm can be exemplified by the following compounds, but they are not restricted thereto.

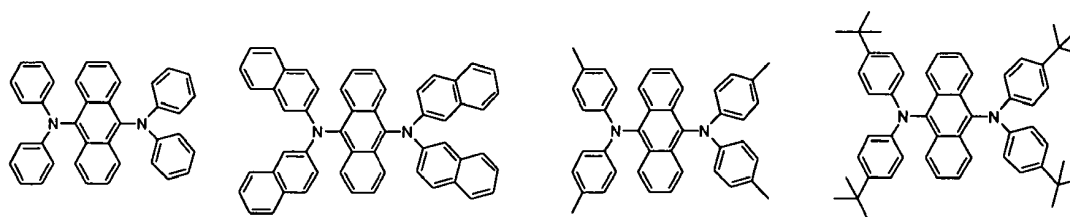


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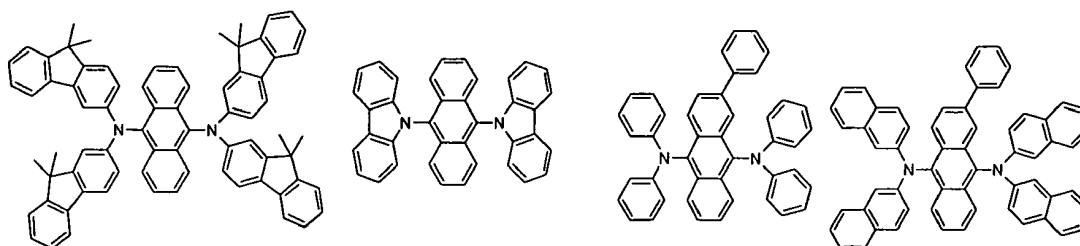
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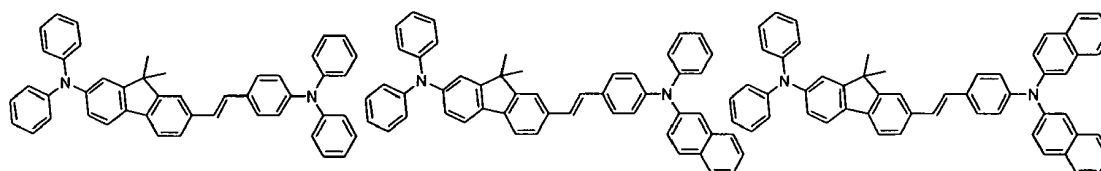
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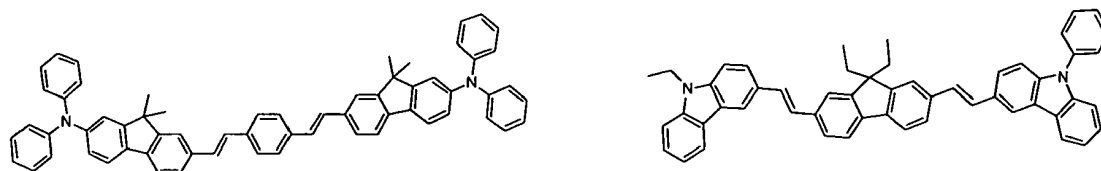
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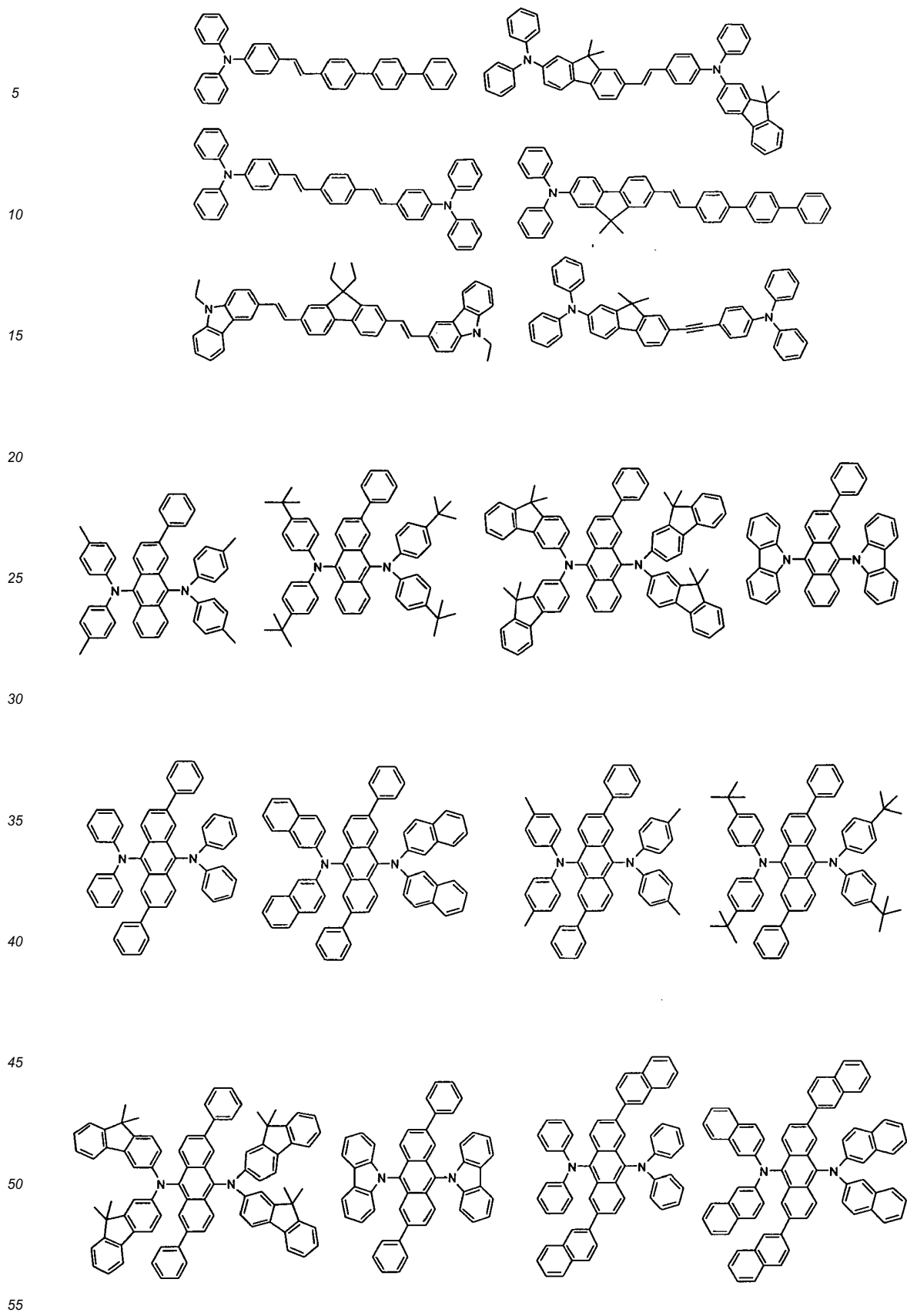
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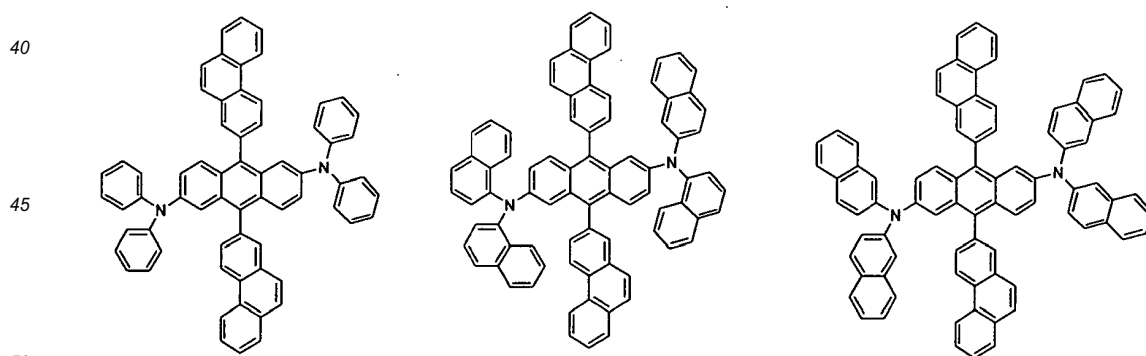
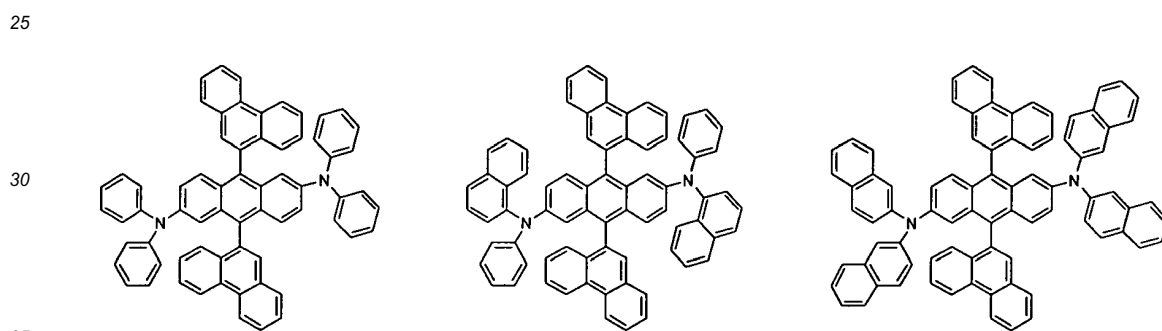
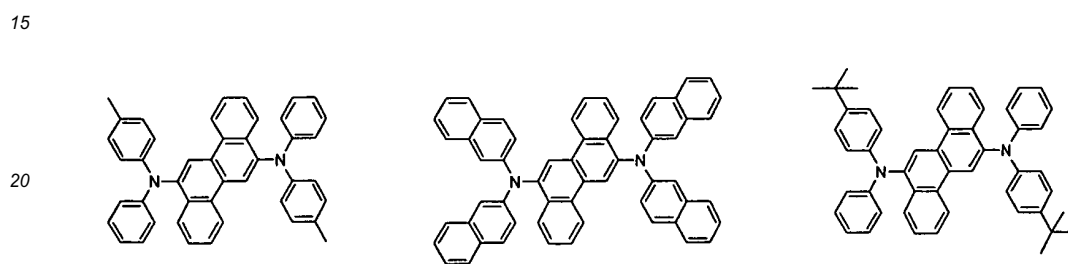
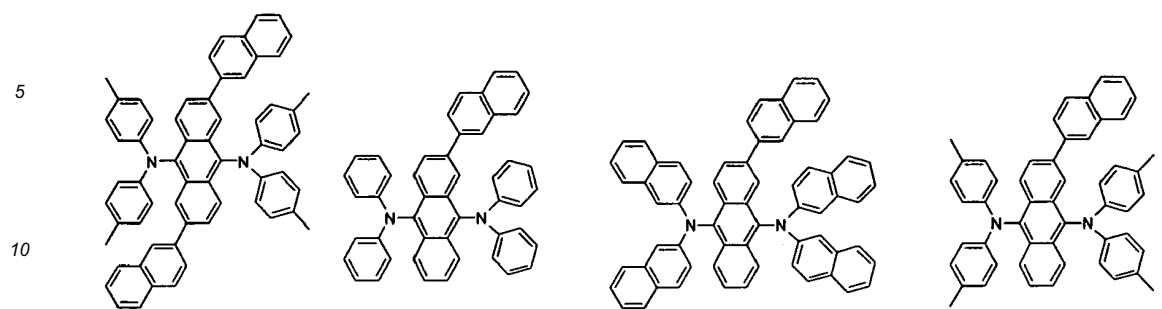
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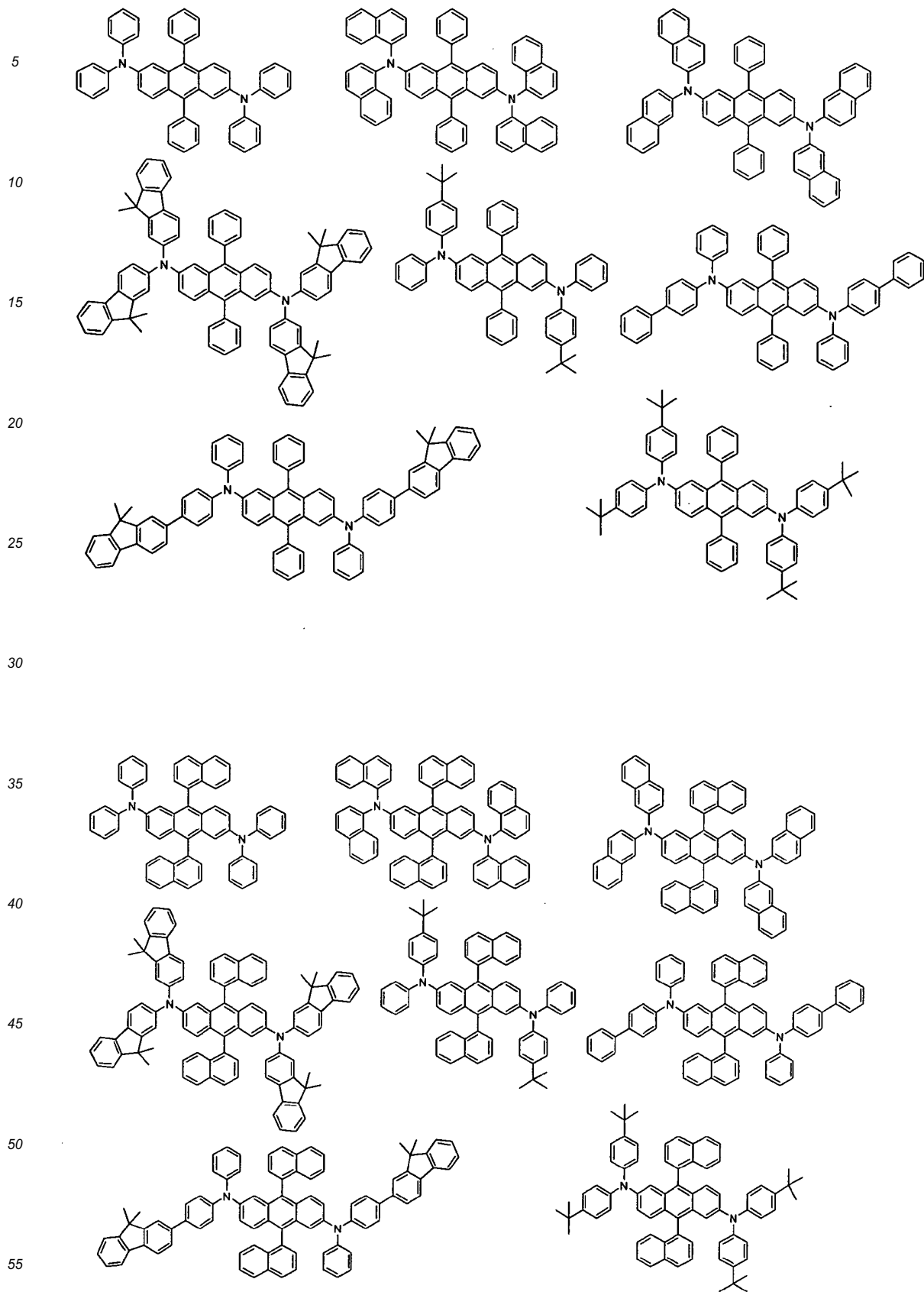
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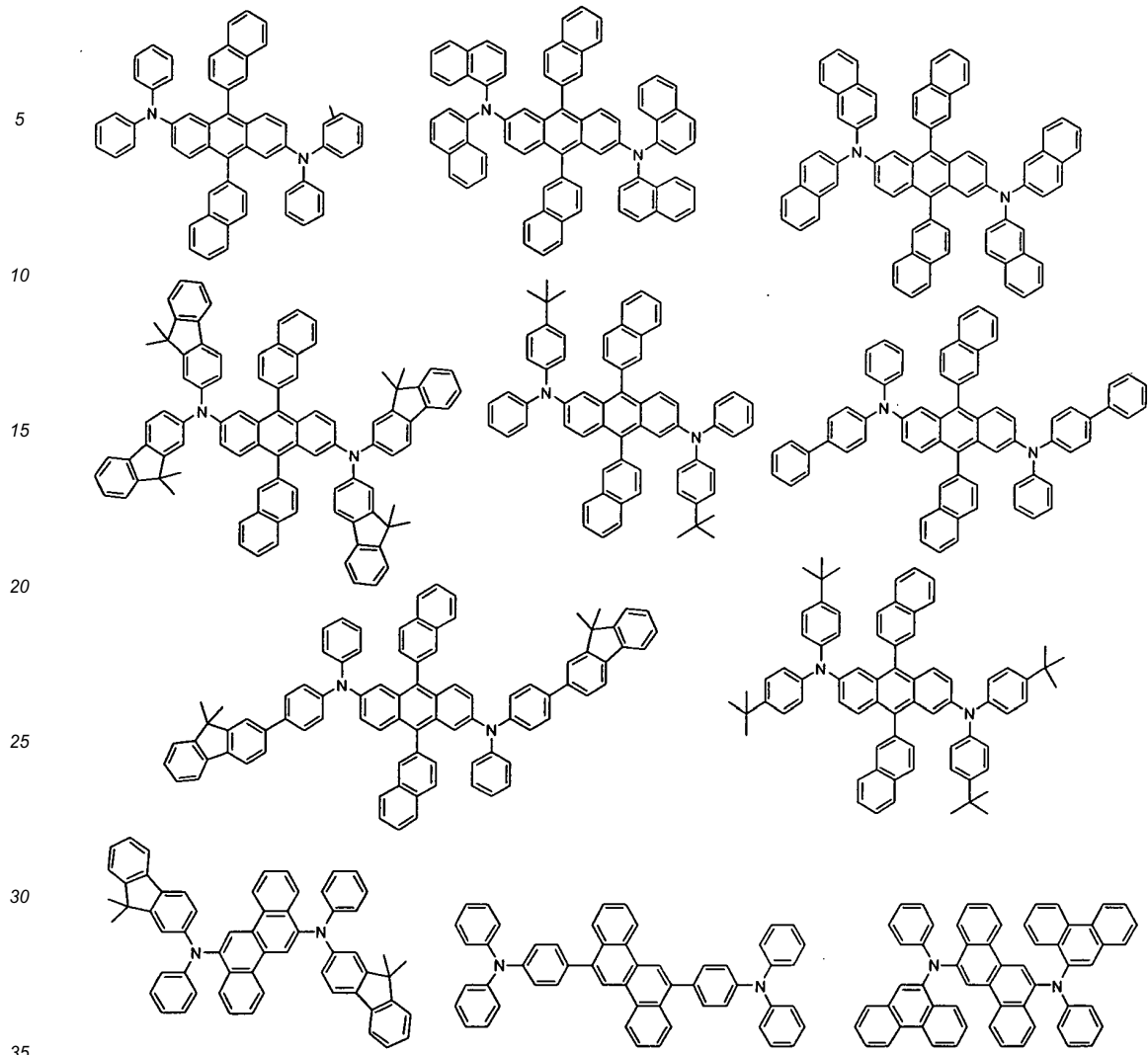
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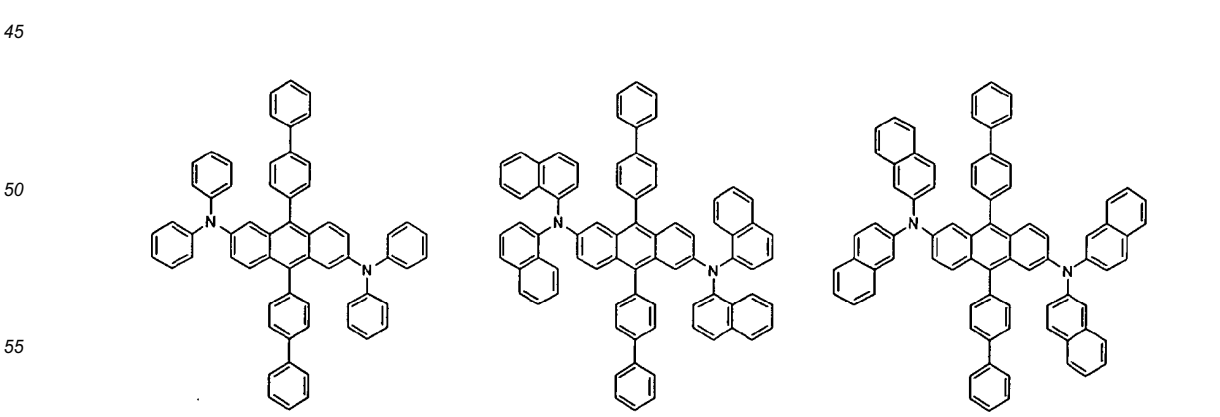
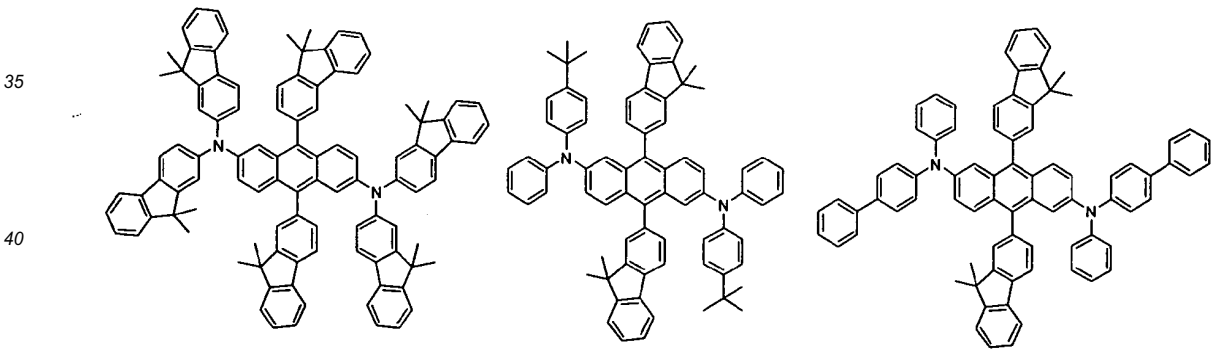
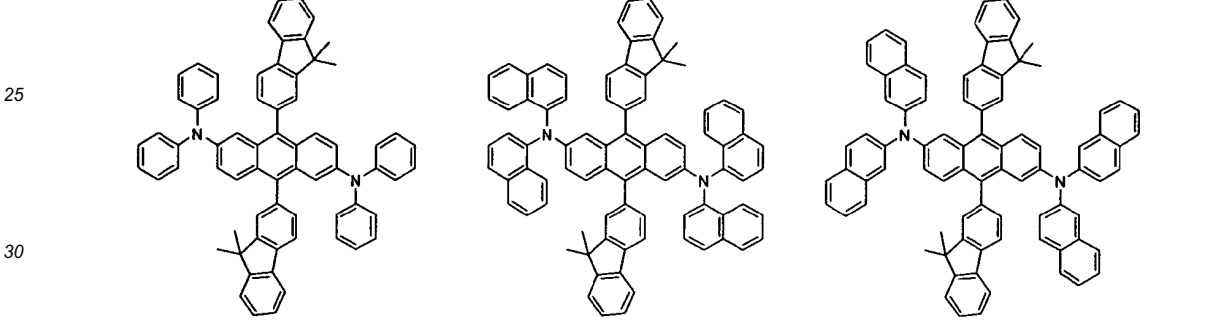
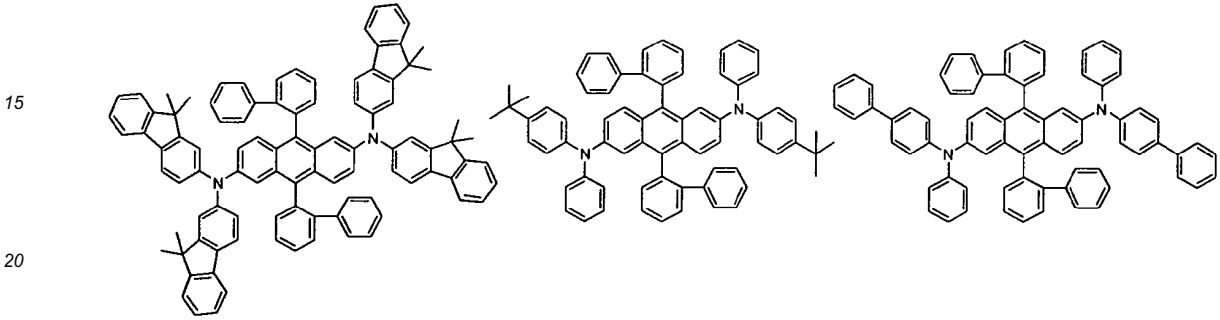
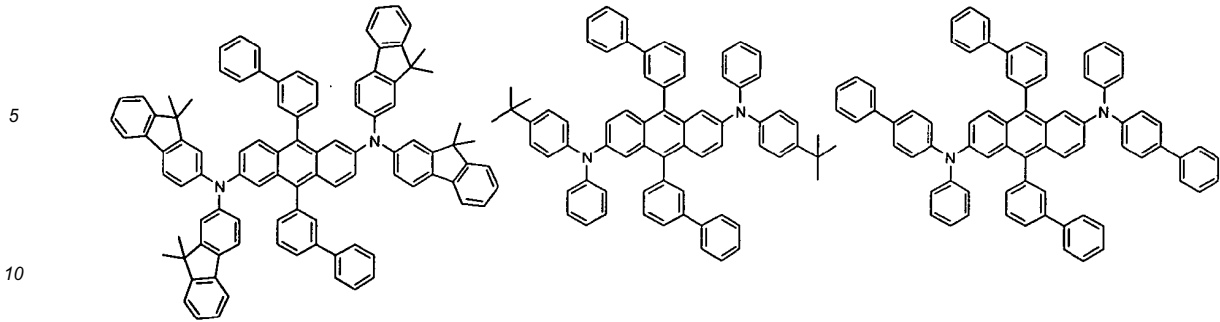




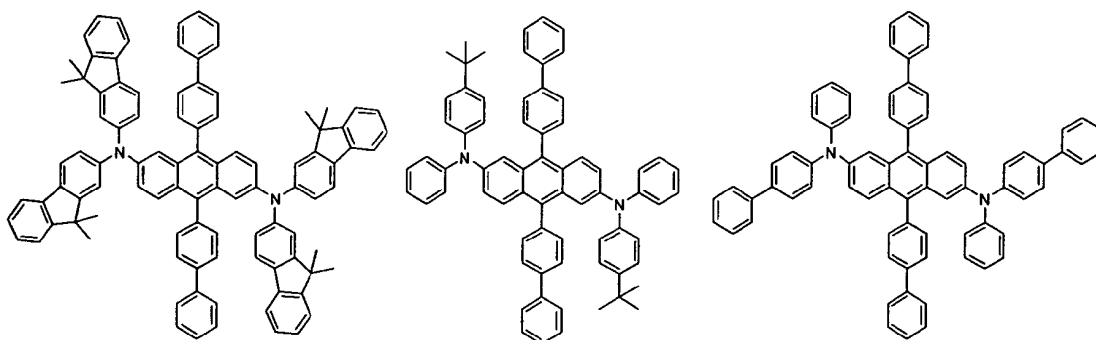
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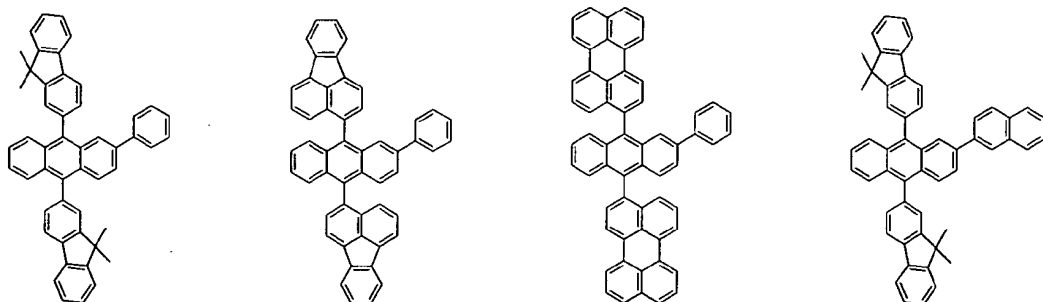


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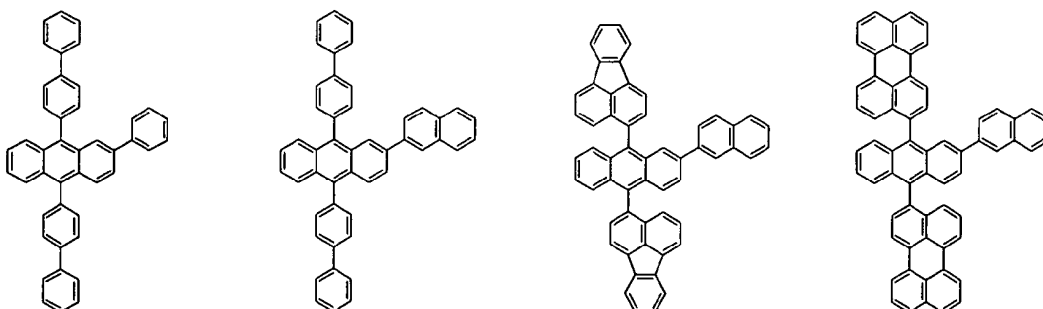
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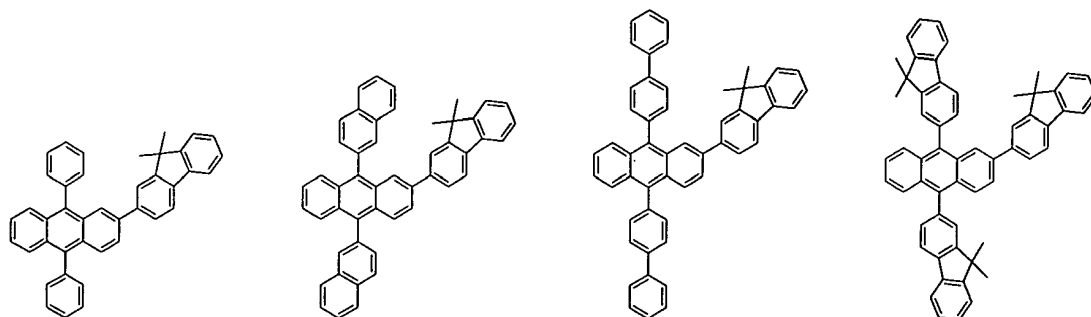
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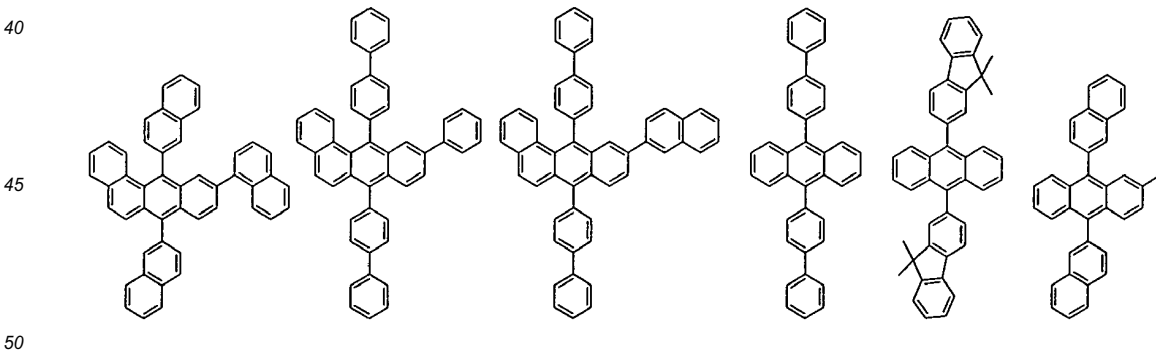
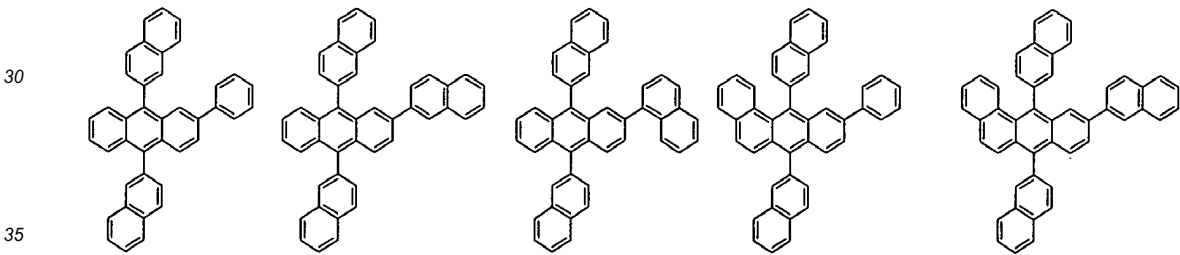
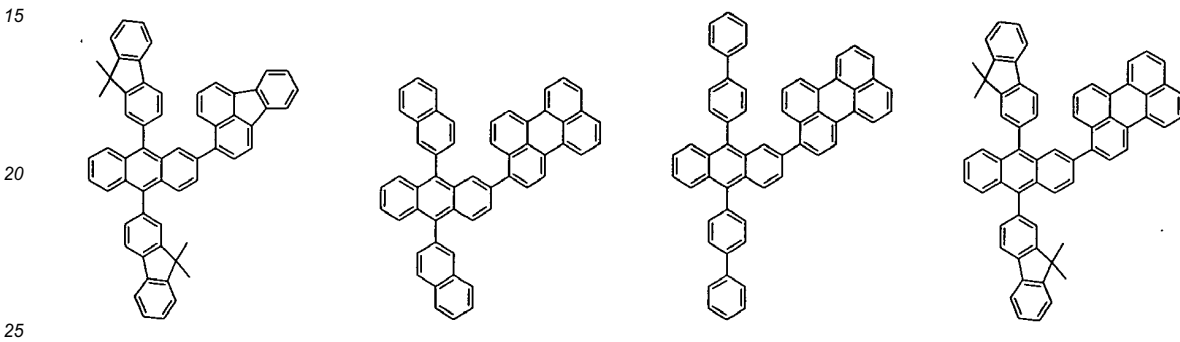
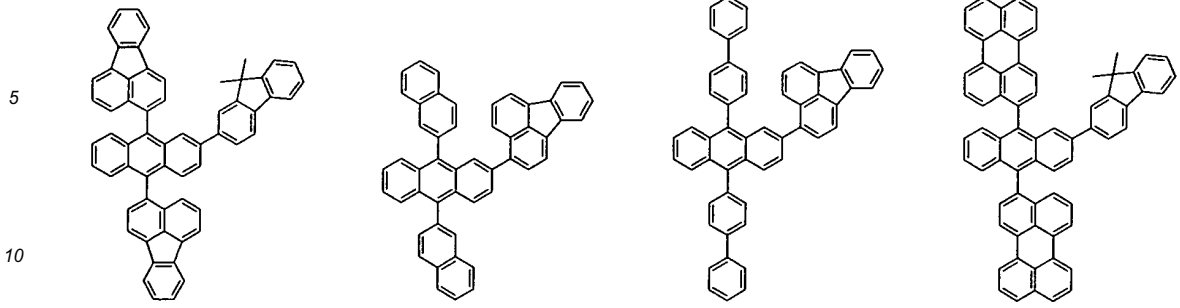


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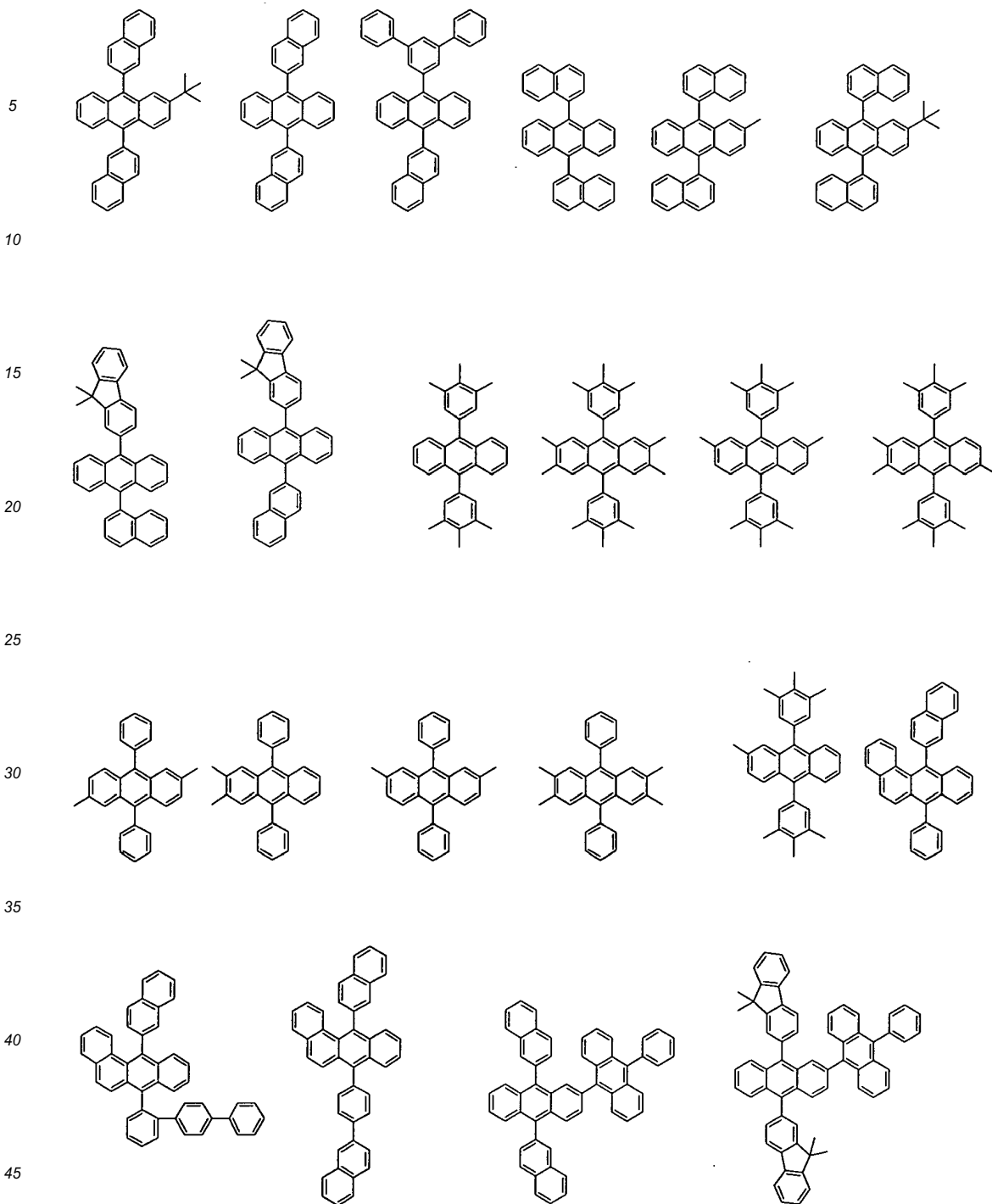
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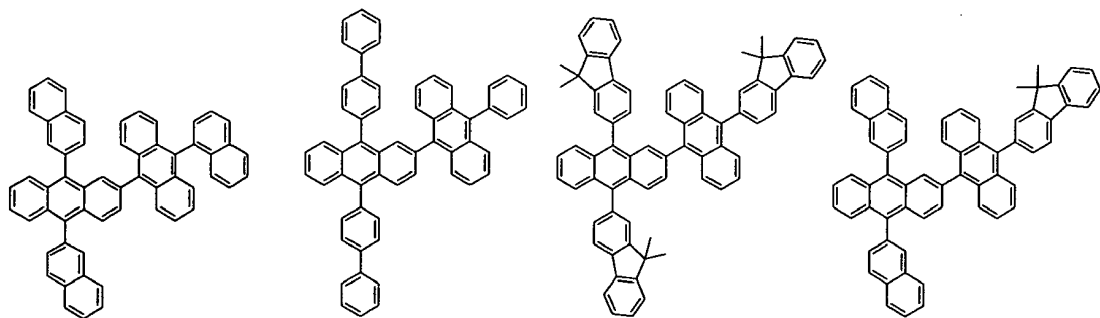
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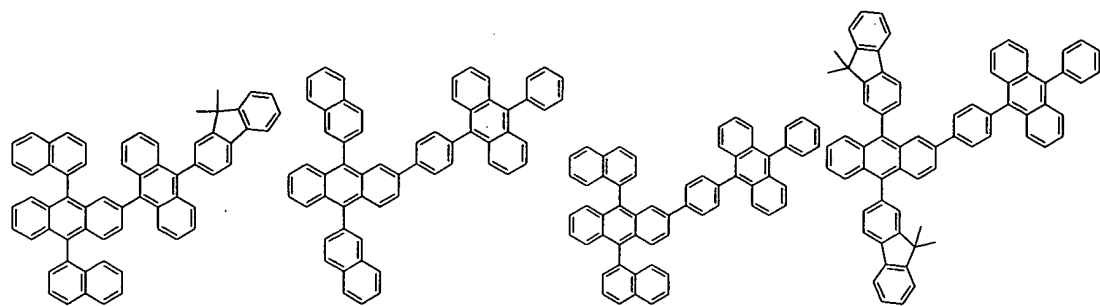


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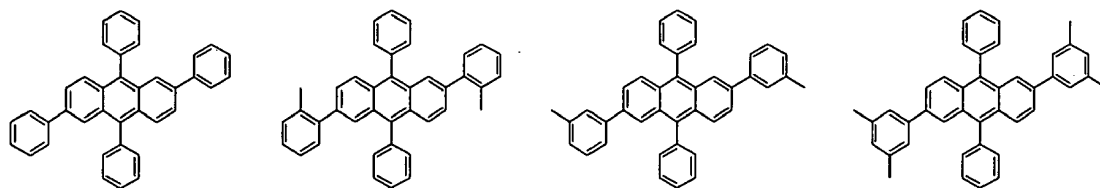
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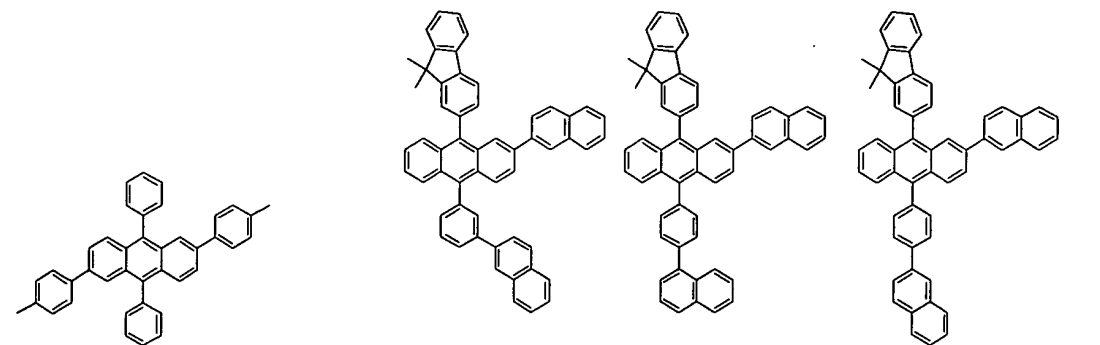
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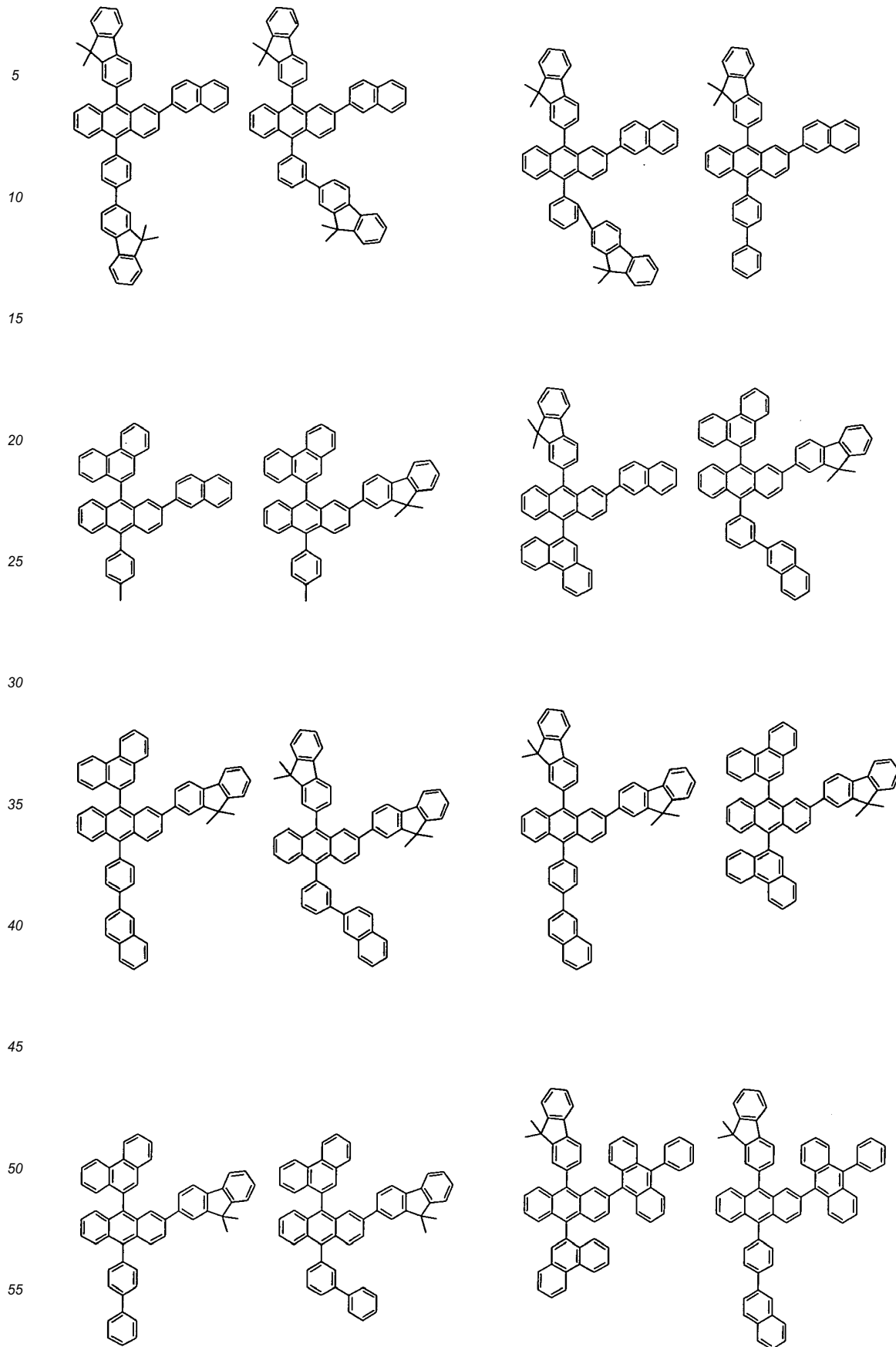


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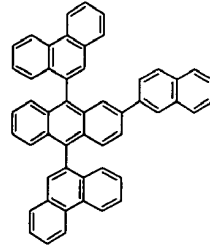
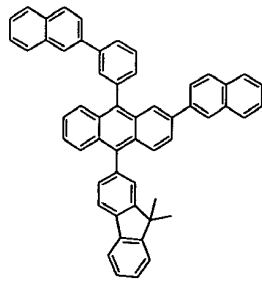
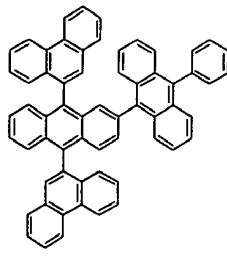
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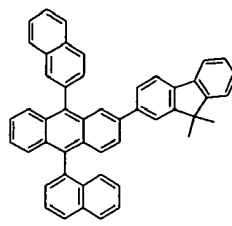
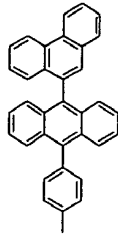
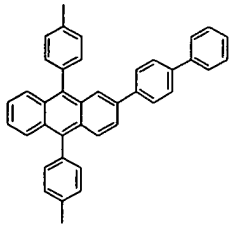


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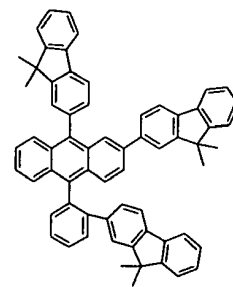
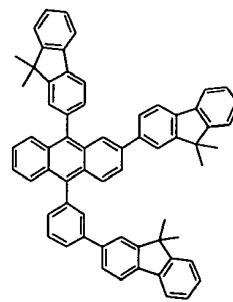
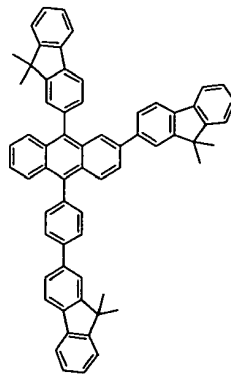
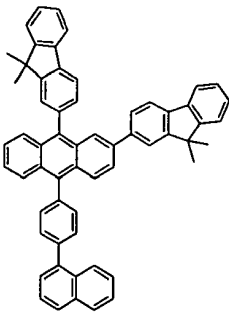
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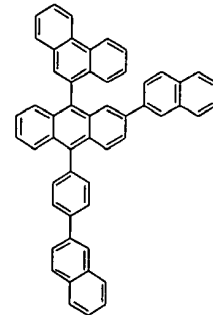
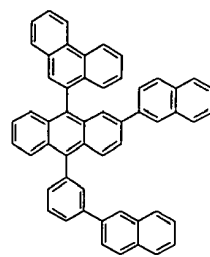
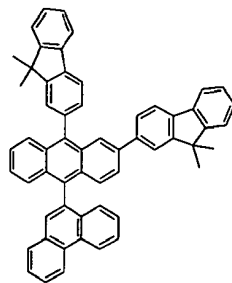
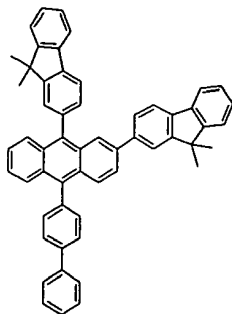


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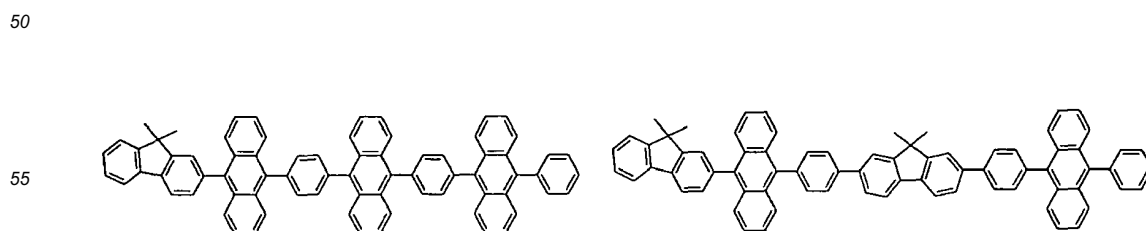
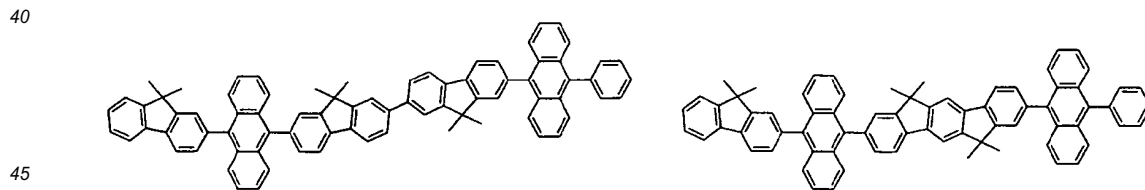
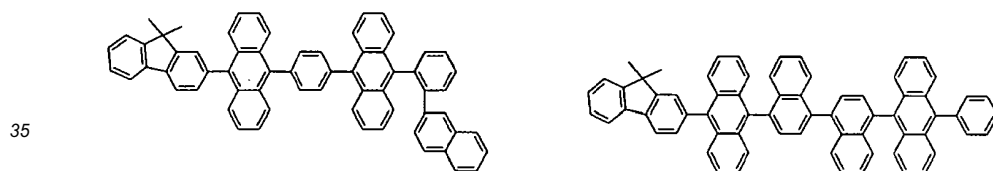
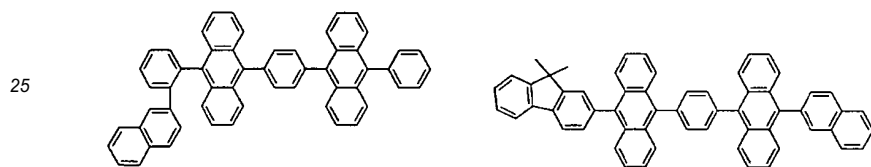
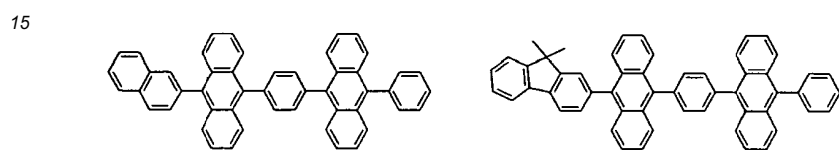
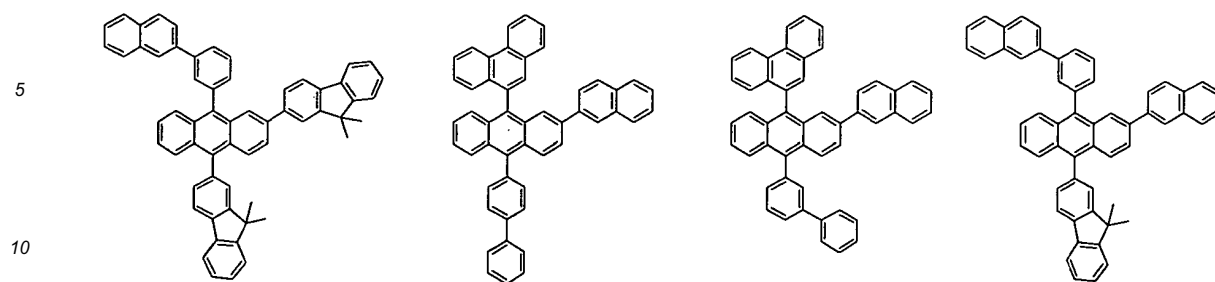
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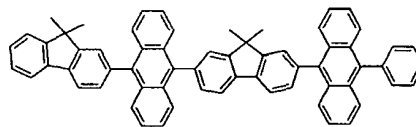
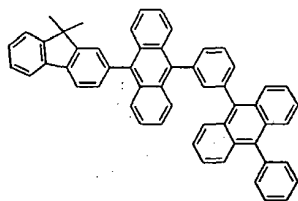


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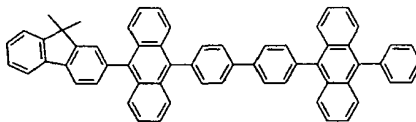
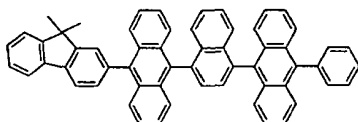
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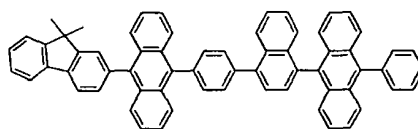
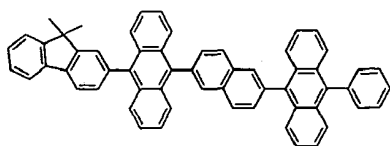


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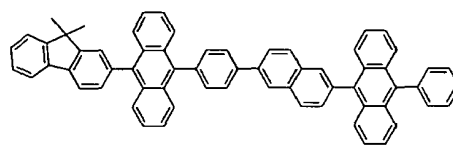
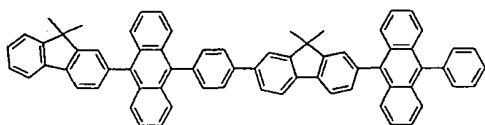
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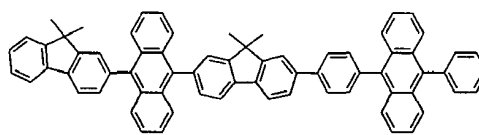
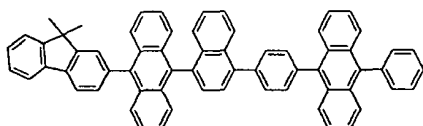


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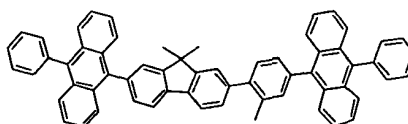
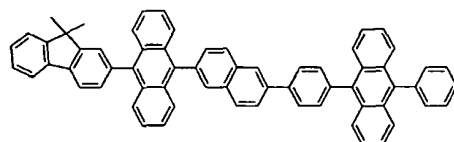


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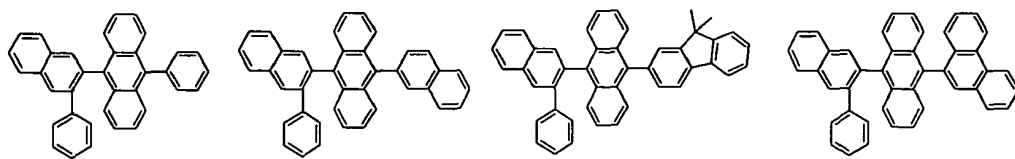
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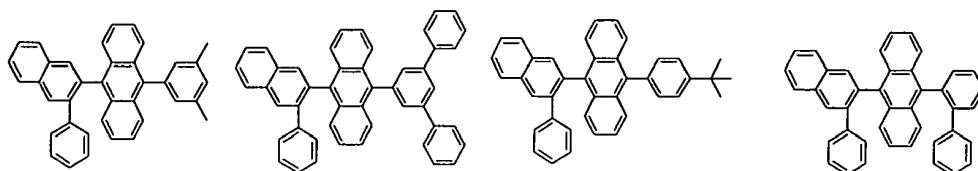
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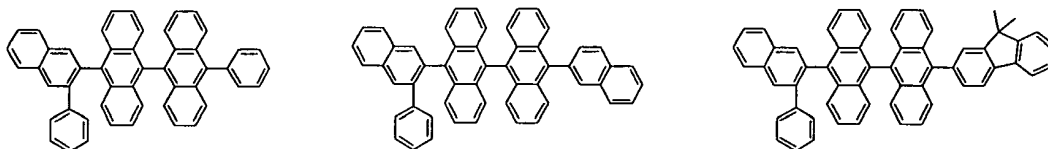
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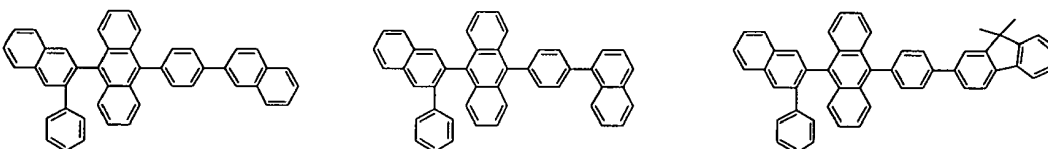
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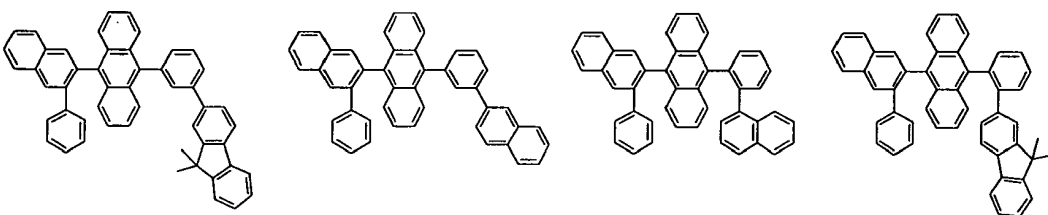
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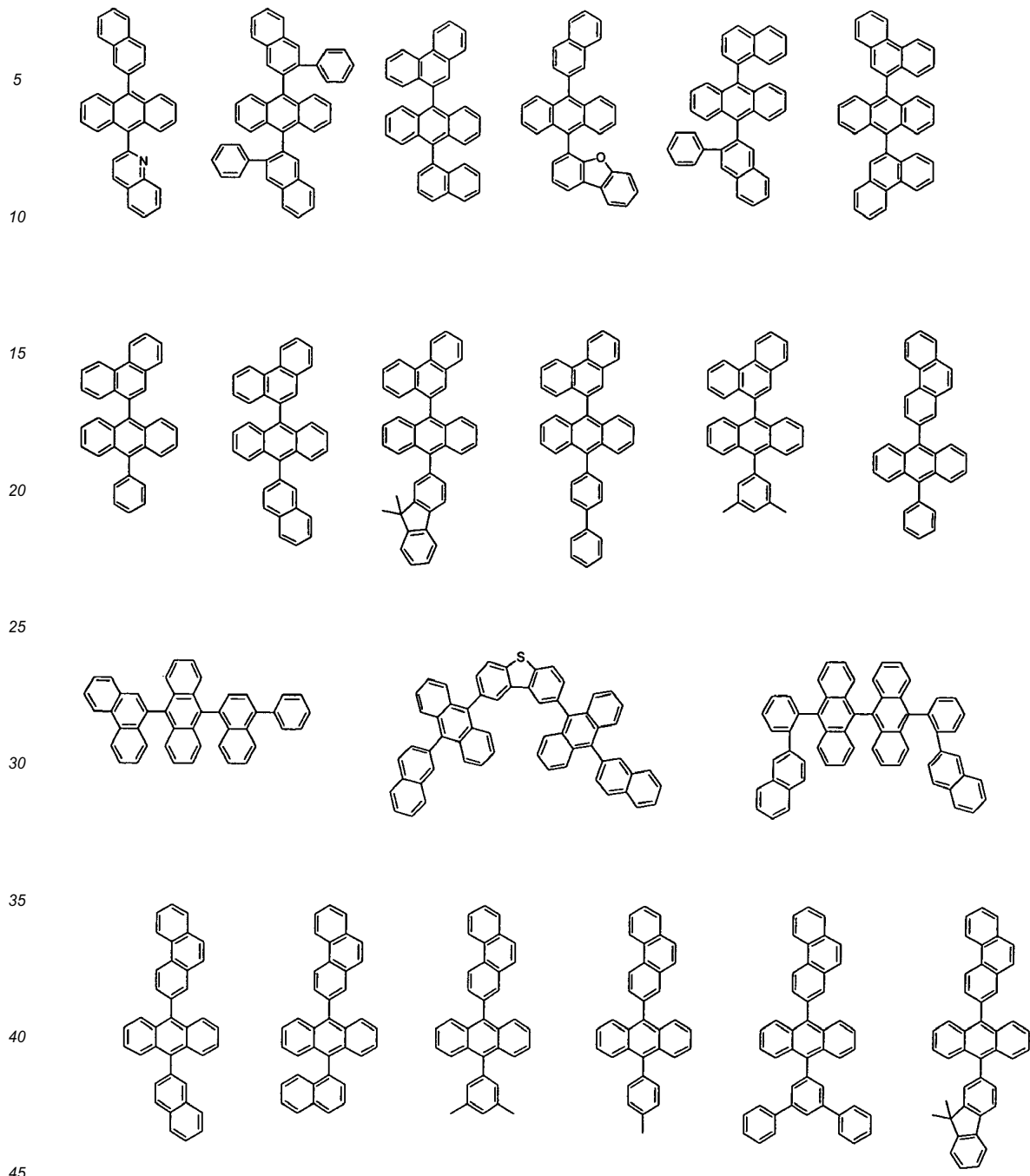
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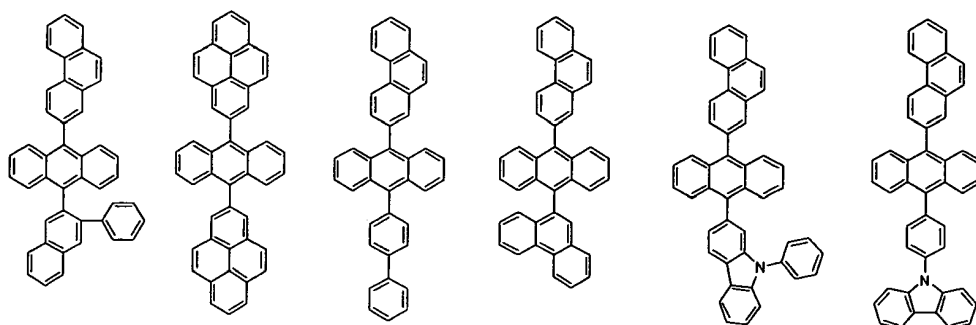


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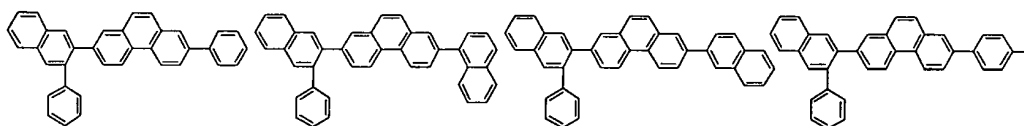


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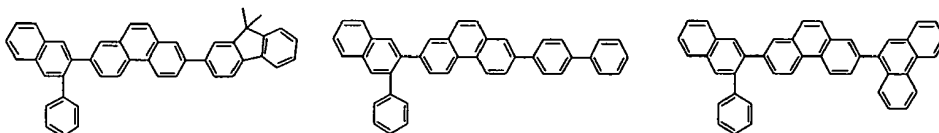
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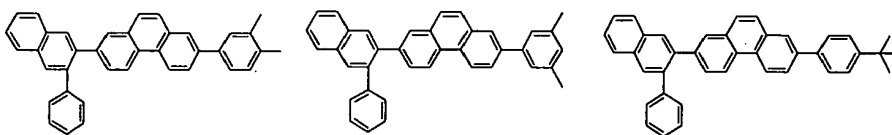


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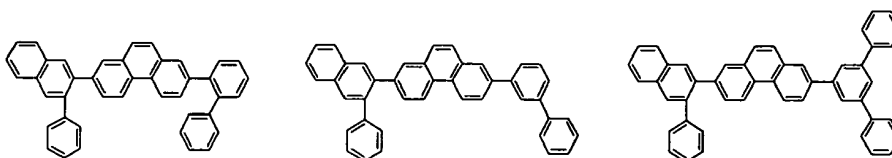


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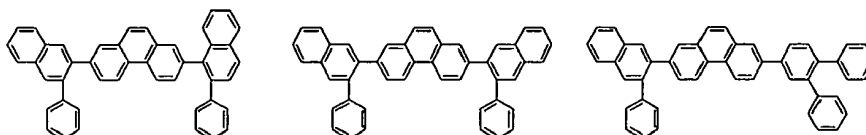
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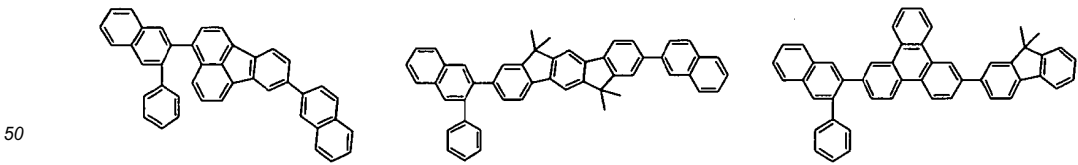
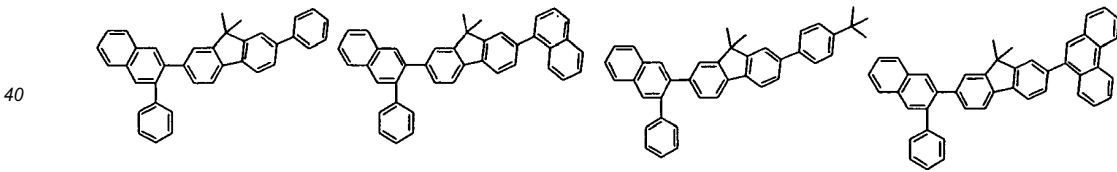
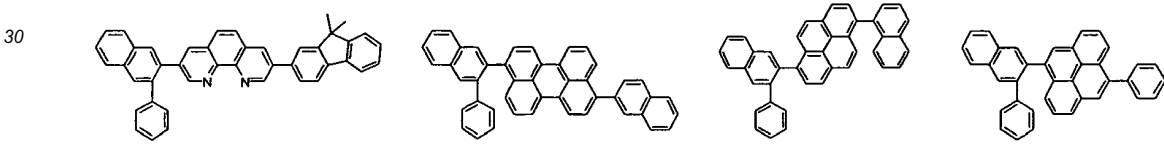
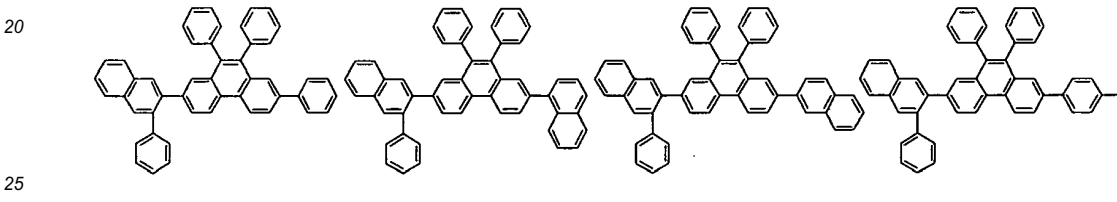
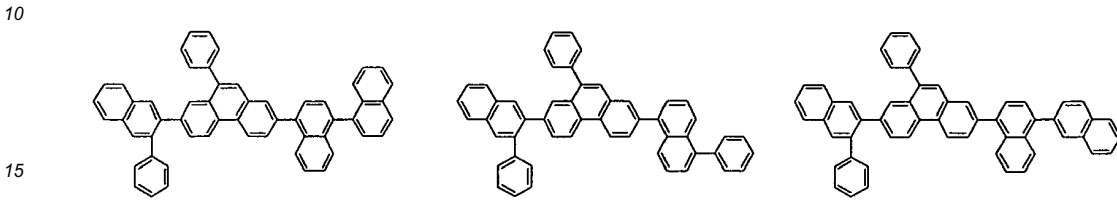
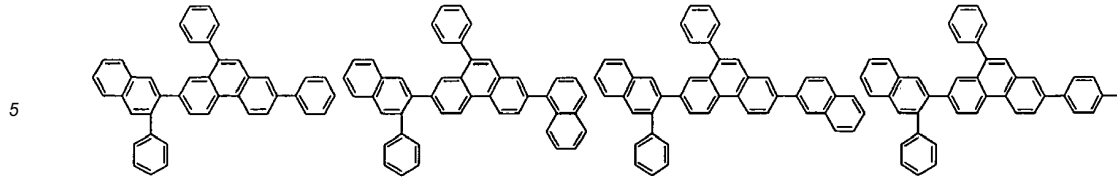


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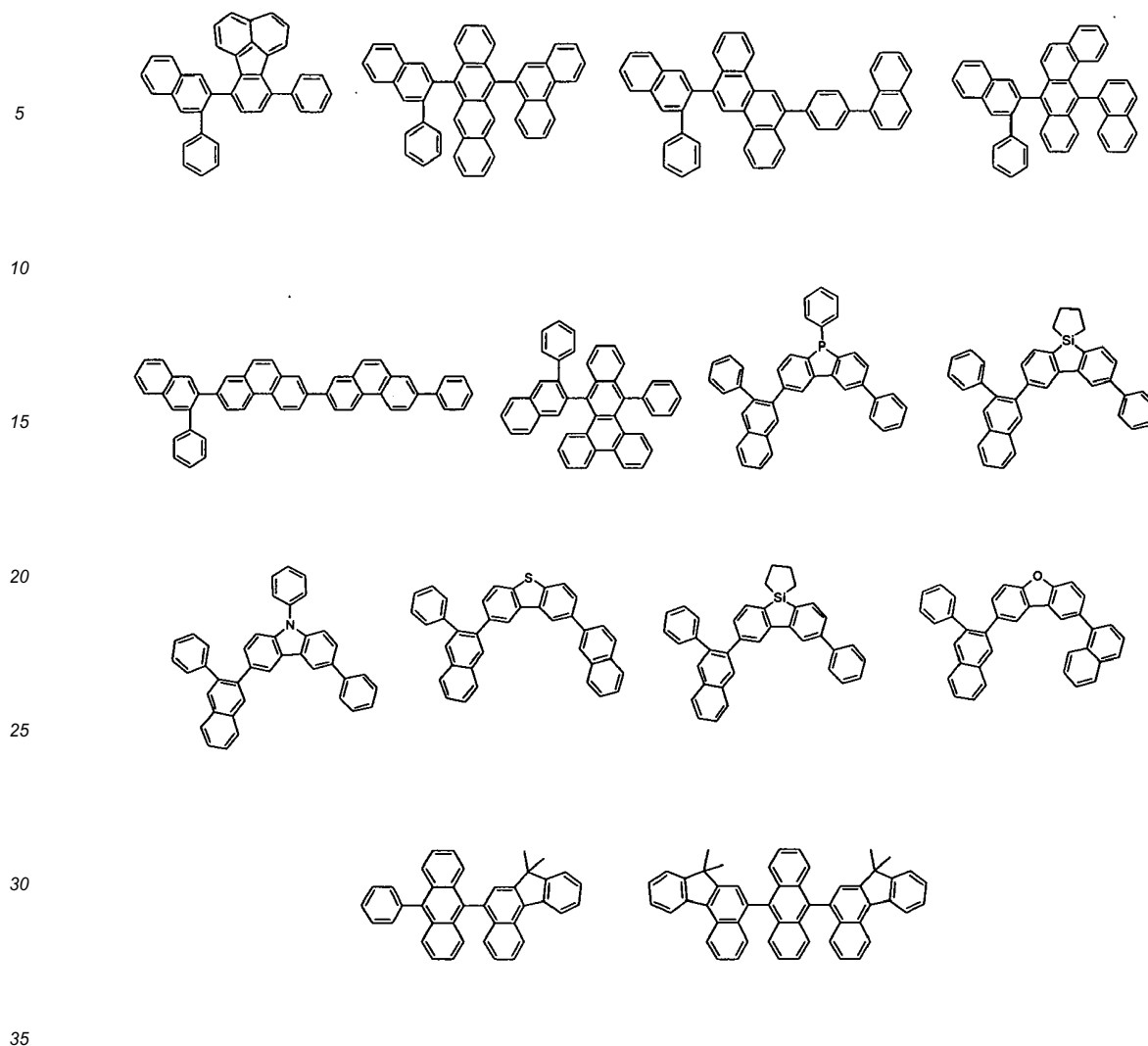
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[0039] In an organic electroluminescent device according to the present invention, it is preferable to displace one or more layer(s) (here-in-below, referred to as the "surface layer") selected from chalcogenide layers, metal halide layers and metal oxide layers, on the inner surface of at least one side of the pair of electrodes. Specifically, it is preferable to arrange a chalcogenide layer of silicon and aluminum metal (including oxides) on the anode surface of the EL medium layer, and a metal halide layer or a metal oxide layer on the cathode surface of the EL medium layer. As the result, stability in operation can be obtained.

[0040] Examples of chalcogenides preferably include  $\text{SiO}_x$  ( $1 \leq x \leq 2$ ),  $\text{AlO}_x$  ( $1 \leq x \leq 1.5$ ),  $\text{SiON}$ ,  $\text{SiAlON}$ , or the like. Examples of metal halides preferably include  $\text{LiF}$ ,  $\text{MgF}_2$ ,  $\text{CaF}_2$ , fluorides of rare earth metals or the like. Examples of metal oxides preferably include  $\text{Cs}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{MgO}$ ,  $\text{SrO}$ ,  $\text{BaO}$ ,  $\text{CaO}$ , or the like.

[0041] In an organic electroluminescent device according to the present invention, it is also preferable to arrange, on at least one surface of the pair of electrodes thus manufactured, a mixed region of electron transport compound and a reductive dopant, or a mixed region of a hole transport compound with an oxidative dopant. Accordingly, the electron transport compound is reduced to an anion, so that injection and transportation of electrons from the mixed region to an EL medium are facilitated. In addition, since the hole transport compound is oxidized to form a cation, injection and transportation of holes from the mixed region to an EL medium are facilitated. Preferable oxidative dopants include various Lewis acids and acceptor compounds. Preferable reductive dopants include alkali metals, alkali metal compounds, alkaline earth metals, rare-earth metals, and mixtures thereof.

[0042] The electroluminescent devices according to the invention exhibit excellent luminous efficiency, good color purity, and very good operation life with lowered operation voltage.

Best Mode

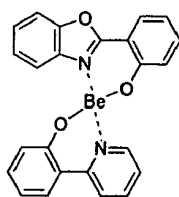
[0043] The present invention is further described by referring to Preparation Examples and Examples in order to illustrate luminescent properties of the novel electroluminescent devices according to the present invention, but those examples are provided for better understanding of the present invention only but are not intended to limit the scope of the invention by any means.

Preparation Example

[0044] Preparation Examples 1 to 18 are described in Korean Patent Registration No. 0684109.

[Preparation Example 1] Preparation of Compound (1)

[0045]



Compound 1

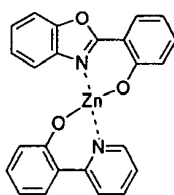
[0046] In methanol (50 mL), dissolved was 2-pyridin-2-yl-phenol (1.0 g, 5.84 mmol), and aqueous 1 M sodium hydroxide solution (10 mL) was added thereto. To the mixture, a solution of beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol) dissolved in aqueous methanol (methanol 7 mL : water 3 mL) was added, and the resultant mixture was stirred at ambient temperature for 2 hours. Thereafter, 2-hydroxy-phenyl benzoxazole (1.54 g, 7.30 mmol) dissolved in methanol (50 mL) was slowly added thereto. The reaction mixture was stirred at ambient temperature for additional 2 hours, and warmed to 50°C. After stirring 10 hours, the precipitate produced was filtered, washed with water (50 mL) and acetone (50 mL), and dried to obtain the title compound, Compound (1) (0.80 g, 2.04 mmol, yield: 34%).

MS/FAB: 391 (found), 391.43 (calculated)

EA: C 73.55%, H 4.59%, N 7.05%, O 12.41%

[Preparation Example 2] Preparation of Compound (2)

[0047]



Compound 2

[0048] In methanol (50 mL), dissolved was 2-pyridin-2-yl-phenol (1.0 g, 5.84 mmol), and aqueous 1 M sodium hydroxide solution (10 mL) was added thereto. To the mixture, a solution of zinc acetate (0.95 g, 5.18 mmol) dissolved in methanol (10 mL) was added dropwise, and the resultant mixture was stirred at ambient temperature for 2 hours. Thereafter, 2-hydroxy-phenyl benzoxazole (1.50 g, 7.10 mmol) dissolved in methanol (50 mL) was slowly added thereto. The reaction mixture was further stirred at ambient temperature for 10 hours. The precipitate produced then was filtered, washed with water (50 mL) and acetone (50 mL), and dried to obtain the title compound, Compound (2) (0.72 g, 1.61 mmol, yield: 27%).

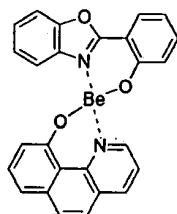
MS/FAB: 447 (found), 447.79 (calculated)

EA: C 64.22%, H 4.01%, N 6.05%, O 10.95%

[Preparation Example 3] Preparation of Compound (3)

[0049]

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Compound 3

15 **[0050]** By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 10-hydroxybenzo[h]quinoline (1.48 g, 7.58 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (3) (0.35 g, 0.84 mmol, yield 14%).

MS/FAB: 415 (found), 415.46 (calculated)

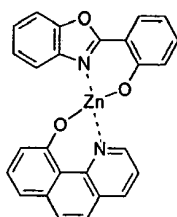
EA: C 75.02%, H 4.27%, N 6.64%, O 11.65%

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[Preparation Example 4] Preparation of Compound (4)

[0051]

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Compound 4

35 **[0052]** By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 10-hydroxybenzo[h]quinoline (1.48 g, 7.58 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (104) (0.52 g, 1.10 mmol, yield 19%).

MS/FAB: 471 (found), 471.81 (calculated)

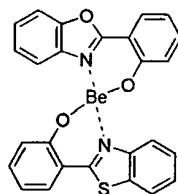
EA: C 66.08%, H 3.79%, N 5.84%, O 10.30%

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[Preparation Example 5] Preparation of Compound (5)

[0053]

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Compound 5

55 **[0054]** By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 2-hydroxy-phenyl benzothiazole (1.72 g, 7.57 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (5) (0.96 g, 2.15 mmol, yield 37%).

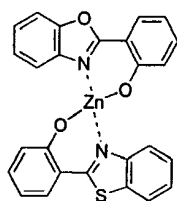
MS/FAB: 447 (found), 447.52 (calculated)

EA: C 69.68%, H 4.01%, N 6.16%, O 10.85%, S 7.05%

[Preparation Example 6] Preparation of Compound (6)

[0055]

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Compound 6

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15 [0056] By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 2-hydroxy-phenyl benzothiazole (1.72 g, 7.57 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (6) (1.36 g, 2.70 mmol, yield 46%).

MS/FAB: 503 (found), 503.88 (calculated)

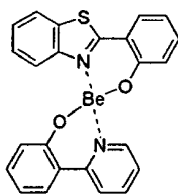
EA: C 61.88%, H 3.54%, N 5.46%, O 9.73%, S 6.26%

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[Preparation Example 7] Preparation of Compound (7)

[0057]

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Compound 7

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35 [0058] By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 2-pyridin-2-yl-phenol (1.30 g, 7.59 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (107) (0.59 g, 1.45 mmol, yield 25%).

MS/FAB: 407 (found), 407.50 (calculated)

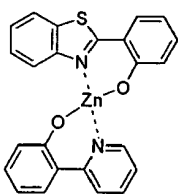
EA: C 70.64%, H 4.35%, N 6.76%, O 7.96%, S 7.75%

40

[Preparation Example 8] Preparation of Compound (8)

[0059]

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Compound 8

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55 [0060] By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 2-pyridin-2-yl-phenol (1.30 g, 7.59 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (8) (0.83 g, 1.79 mmol, yield 31%).

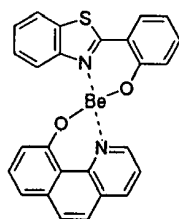
MS/FAB: 463 (found), 463.86 (calculated)

EA: C 62.04%, H 3.82%, N 5.98%, O 7.02%, S 6.83%

[Preparation Example 9] Preparation of Compound (9)

[0061]

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Compound 9

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15 **[0062]** By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 2-hydroxybenzo[h]quinoline (1.48 g, 7.58 mmol) instead of 2-hydroxy-phenyl benzoxazole, and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (9) (0.98 g, 2.27 mmol, yield 39%).

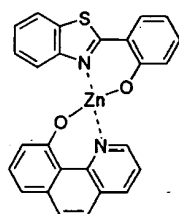
MS/FAB: 431 (found), 431.52 (calculated)

20 EA: C 72.22%, H 4.10%, N 6.40%, O 7.62%, S 7.33%

[Preparation Example 10] Preparation of Compound (10)

[0063]

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Compound 10

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**[0064]** By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 10-hydroxybenzo[h]quinoline (1.48 g, 7.58 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 4 was repeated to obtain the title compound, Compound (10) (1.22 g, 2.50 mmol, yield 43%).

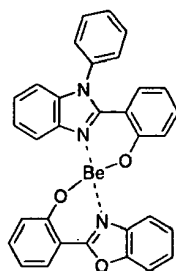
MS/FAB: 487 (found), 487.88 (calculated)

40 EA: C 63.93%, H 3.65%, N 5.64%, O 6.70%, S 6.44%

[Preparation Example 11] Preparation of Compound (11)

[0065]

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Compound 11

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**[0066]** By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (2.17

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g, 7.58 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (11) (0.56 g, 1.11 mmol, yield 19%).

MS/FAB: 506 (found), 506.57 (calculated)

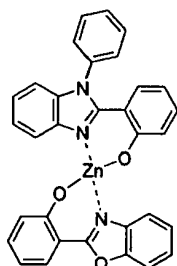
EA: C 75.67%, H 4.50%, N 8.20%, O 9.68%

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[Preparation Example 12] Preparation of Compound (12)

[0067]

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Compound 12

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[0068] By using 2-hydroxy-phenyl benzoxazole (1.23 g, 5.82 mmol), 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (2.17 g, 7.58 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (12) (0.72 g, 1.28 mmol, yield 22%).

25 MS/FAB: 562 (found), 562.93 (calculated)

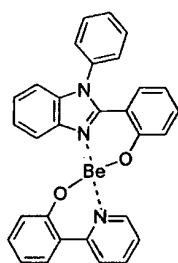
EA: C 68.16%, H 4.05%, N 7.36%, O 8.68%

25

[Preparation Example 13] Preparation of Compound (13)

[0069]

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Compound 13

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[0070] By using 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (1.67 g, 5.83 mmol), 2-pyridin-2-ylphenol (1.30 g, 7.59 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (13) (0.84 g, 1.80 mmol, yield 31%).

45 MS/FAB: 466 (found), 466.55 (calculated)

EA: C 77.08%, H 4.87%, N 8.90%, O 6.98%

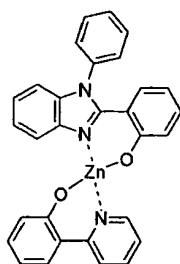
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[Preparation Example 14] Preparation of Compound (14)

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[0071]

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Compound 14

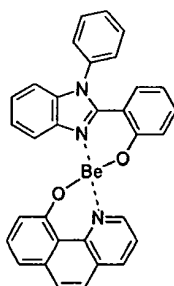
**[0072]** By using 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (1.67 g, 5.83 mmol), 2-pyridin-2-yl-phenol (1.30 g, 7.59 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (14) (0.88 g, 1.68 mmol, yield 29%).

MS/FAB: 522 (found), 522.91 (calculated)

EA: C 68.81%, H 4.33%, N 7.92%, O 6.32%

[Preparation Example 15] Preparation of Compound (15)

**[0073]**



Compound 15

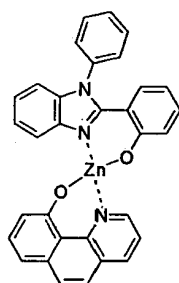
**[0074]** By using 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (1.67 g, 5.83 mmol), 10-hydroxybenzo[h]quinoline (1.50 g, 7.68 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (15) (0.53 g, yield 9%).

MS/FAB: 490 (found), 490.57 (calculated)

EA: C 78.20%, H 4.68%, N 8.42%, O 6.70%

[Preparation Example 16] Preparation of Compound (16)

**[0075]**



Compound 16

**[0076]** By using 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (1.67 g, 5.83 mmol), 10-hydroxybenzo[h]quinoline (1.50 g, 7.68 mmol) and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (16) (0.42 g, 0.77 mmol, yield 13%).

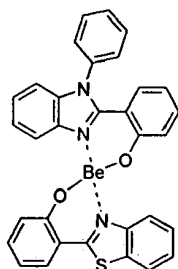
MS/FAB: 546 (found), 546.93 (calculated)  
 EA: C 70.13%, H 4.16%, N 7.58%, O 5.98%

[Preparation Example 17] Preparation of Compound (17)

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[0077]

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Compound 17

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[0078] By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (2.17 g, 7.58 mmol) and beryllium sulfate tetrahydrate (1.05 g, 5.93 mmol), the same procedure as described in Preparation Example 1 was repeated to obtain the title compound, Compound (17) (0.64 g, 1.22 mmol, yield 21%).

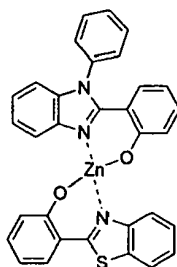
MS/FAB: 522 (found), 522.64 (calculated)

25 EA: C 73.42%, H 4.34%, N 7.97%, O 6.25%, S 6.04%

[Preparation Example 18] Preparation of Compound (18)

[0079]

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Compound 18

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[0080] By using 2-hydroxy-phenyl benzothiazole (1.32 g, 5.80 mmol), 2-(1-phenyl-1H-benzimidazol-2-yl)-phenol (2.17 g, 7.58 mmol), and zinc acetate (0.95 g, 5.18 mmol), the same procedure as described in Preparation Example 2 was repeated to obtain the title compound, Compound (18) (0.94 g, 1.62 mmol, yield 28%).

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MS/FAB: 578 (found), 578.99 (calculated)

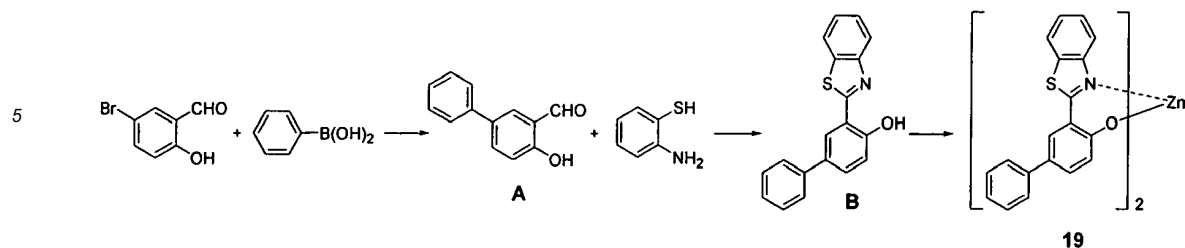
EA: C 66.22%, H 3.94%, N 7.16%, O 5.70%, S 5.49%

[Preparation Example 19] Preparation of Compound (19)

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[0081]

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#### Preparation of Compound A

15 [0082] In dimethylethylene glycol (200 mL) and ethanol (100 mL), dissolved were 5-bromo-2-hydroxybenzaldehyde (20.0 g, 99.5 mmol), phenylboronic acid (13.4 g, 109.5 mmol) and tetrakis palladium (0) triphenylphosphine ( $\text{Pd}(\text{PPh}_3)_4$ ) (5.8 g, 5.0 mmol). Aqueous 2M potassium carbonate solution (132 mL) was added thereto, and the resultant mixture was stirred under reflux at  $90^\circ\text{C}$  for 4 hours. When the reaction was completed, water (100 mL) was added to the reaction mixture to quench the reaction. The mixture was then extracted with ethyl acetate (200 mL), and the extract was dried under reduced pressure. Purification via silica gel column chromatography (n-hexane:MC = 1:5) gave Compound (A) (12.0 g, 61.0 mmol).

#### Preparation of Compound (B)

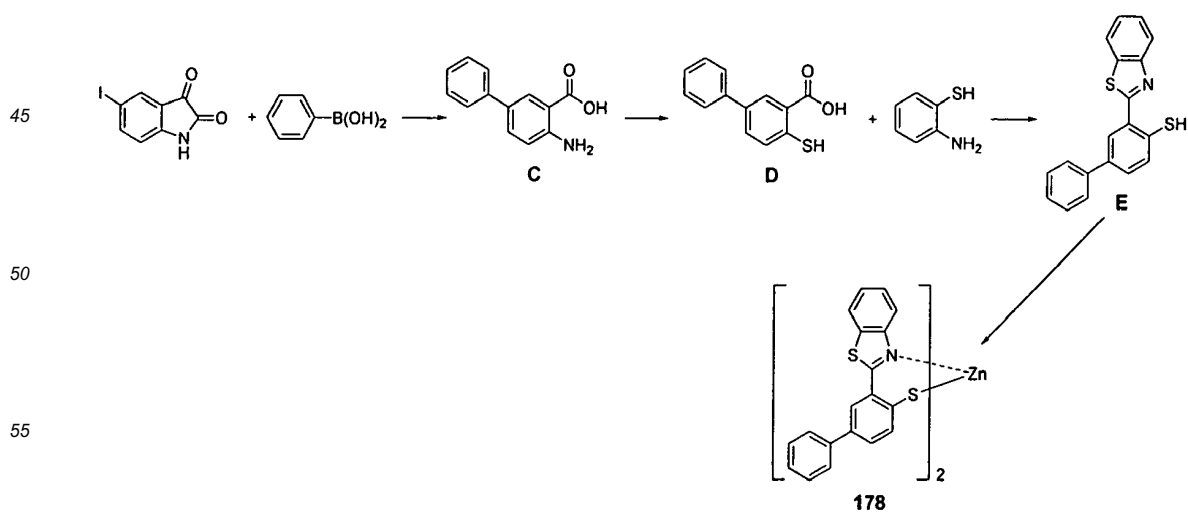
25 [0083] In 1,4-dioxane (12 mL), dissolved were 2-aminobenzenethiol (3.8 g, 30.2 mmol) and Compound (A) (5.0 g, 25.2 mmol), and the mixture was stirred at  $100^\circ\text{C}$  under pressure for 12 hours. When the reaction was completed, the reaction mixture was cooled to room temperature, and extracted with dichloromethane (100 mL) and water (100 mL). The extract was then dried under reduced pressure and the residue was purified via silica gel column chromatography (n-hexane:MC = 3:1) to obtain Compound (B) (4.5 g, 4.8 mmol).

#### Preparation of Compound (19)

30 [0084] Compound (B) (4.5 g, 14.8 mmol) and sodium hydroxide (0.6 g, 14.8 mmol) were dissolved in ethanol (100 mL). After stirring the solution for 30 minutes, slowly added was  $\text{Zn}(\text{CH}_3\text{COO})_2 \cdot 2\text{H}_2\text{O}$  (1.8 g, 8.2 mmol), and the resultant mixture was stirred at room temperature for 12 hours. When the reaction was completed, the reaction mixture was washed sequentially with water (200 mL), ethanol (200 mL) and hexane (200 mL), and dried under reduced pressure to obtain the title compound (19) (4.5 g, 6.7 mmol, 45%).

[Preparation Example 20] Preparation of Compound (178)

#### [0085]



Preparation of Compound (C)

[0086] In dimethylene glycol (600 mL), dissolved was 5-iodoindoline-2,3-dione (10.0 g, 36.6 mmol) and phenylboronic acid (5.4 g, 43.9 mmol). To the solution, added were tetrakis palladium (0) triphenylphosphine ( $\text{Pd}(\text{PPh}_3)_4$ ) (2.1 g, 1.8 mmol) and aqueous 2M sodium hydrocarbonate solution (120 mL). The mixture was stirred under reflux for 12 hours, and the solvent was removed when the reaction was completed. Aqueous 5% sodium hydroxide solution (120 mL) was added to the residue, and the resultant mixture was stirred at room temperature. The aqueous solution was extracted with dichloromethane, and the aqueous layer was collected. After adding aqueous 30% hydrogen peroxide (120 mL), the temperature was raised to 50°C, and stirring was conducted for 30 minutes. After cooling to room temperature, slowly added was aqueous 1N hydrochloric acid to the aqueous solution to adjust the pH 4. The solid produced then was filtered under reduced pressure and dried to obtain Compound (C) (5.5 g, 26.0 mmol).

Preparation of Compound (D)

[0087] Compound (C) (7.1 g, 33.3 mmol) was dissolved in water (18 mL) and concentrated hydrochloric acid (7 mL), and the solution was stirred at room temperature. After 10 minutes, the temperature was lowered to 0°C, and sodium nitrate ( $\text{NaNO}_3$ ) (2.3 g, 33.3 mmol) dissolved in water (10 mL) was slowly added thereto. Then, the resultant mixture was stirred while maintaining the temperature at 0°C. In a separate reaction vessel, sodium sulfide nonahydrate ( $\text{Na}_2\text{S}\cdot 9\text{H}_2\text{O}$ ) (9.6 g, 39.9 mmol) and sulfur (1.3 g, 39.9 mmol) were dissolved in water (10 mL), and aqueous 10M sodium hydroxide (4 mL) was added thereto. This mixture was added to the reaction mixture at 0°C, and the resultant mixture was warmed to room temperature and stirred until the gas was not generated any more. When the reaction was completed, concentrated hydrochloric acid was added until the solid occurred, and the mixture was filtered under reduced pressure. The solid obtained was added to aqueous sodium hydrocarbonate ( $\text{NaHCO}_3$ ) solution (85 mL), and the mixture was stirred under reflux for 20 minutes and cooled to room temperature. After removing insoluble solid (impurities), concentrated hydrochloric acid was added to the aqueous solution to form solid again. The solid obtained by filtration under reduced pressure was added to ethanol (30 mL), and the mixture was stirred under reflux for 20 minutes. The insoluble solid (impurities) was removed, and the filtrate was concentrated. Zinc (2.2 g, 33.3 mmol) and glacial acetic acid (30 mL) was added thereto, and the resultant mixture was stirred under reflux for 48 hours. When the reaction was completed, the reaction mixture was cooled to room temperature, and the solid collected was added to aqueous 5M sodium hydroxide solution (63 mL), and the mixture was stirred under reflux for 30 minutes. After removing insoluble solid (impurities), concentrated hydrochloric acid was added in small portions to acidify the aqueous solution. The solid produced then was collected, and added to ethanol (20 mL). After stirring under reflux for 30 minutes, insoluble solid (impurities) was removed and the filtrate was concentrated to obtain Compound (D) (1.8 g, 7.6 mmol).

Preparation of Compound (E)

[0088] Compound (D) (5.0 g, 21.7 mmol), 2-aminobenzenethiol (2.1 mL, 19.5 mmol) and polyphosphoric acid (20 g) were stirred in a reaction vessel under reflux at 140°C for 24 hours. When the reaction was completed, the reaction mixture was cooled to room temperature, and aqueous saturated sodium hydroxide solution was slowly added to adjust the pH neutral. The solid produced then was filtered under reduced pressure to obtain the solid product. Washing with ethanol and drying the solid gave Compound (E) (5.4 g, 17.1 mmol).

Preparation of Compound (178)

[0089] Compound (E) (5.0 g, 15.6 mmol) and sodium hydroxide (0.6 g, 15.6 mmol) were dissolved in ethanol (100 mL), and the solution was stirred for 30 minutes. After slowly adding  $\text{Zn}(\text{CH}_3\text{COO})_2\cdot 2\text{H}_2\text{O}$  (1.9 g, 8.7 mmol) thereto, the resultant mixture was stirred at room temperature for 12 hours. Thereafter, the mixture was sequentially washed with water (200 mL), ethanol (200 mL) and hexane (200 mL), and dried under reduced pressure to obtain the title compound, Compound (178) (7.1 g, 10.1 mmol, 65%).

[0090] According to the same procedure as Preparation Examples 19 and 20, Compounds 19 through 336 listed in Table 1 were prepared, of which the  $^1\text{H}$  NMR and MS/FAB data are listed in Table 2. The compounds listed in Table 1 are those containing divalent metal M.

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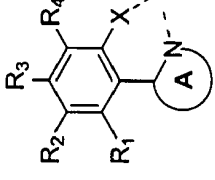




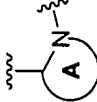
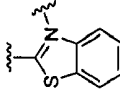
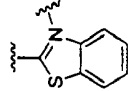
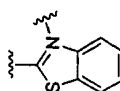
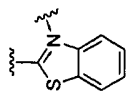
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Table 1

L <sup>1</sup> L <sup>2</sup> M		M				
		X	Zn	Zn	Zn	Zn
 $I_1^1 = I_1^2 =$						
	R <sub>4</sub>	H	H	H		
	R <sub>3</sub>	H	H		H	
	R <sub>2</sub>		H	H	H	
	R <sub>1</sub>	H		H	H	
	Comp. No.	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	
						

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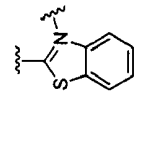
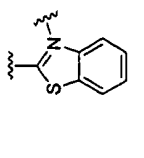
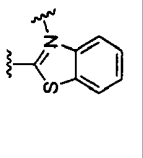
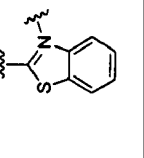
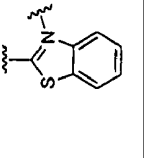
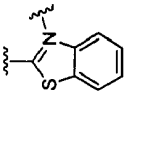
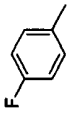
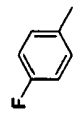
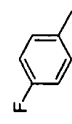
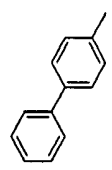
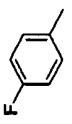
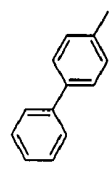
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>	H		H	H	H	H
R <sub>2</sub>		H	H	H		H
R <sub>1</sub>	H	H	H		H	
Comp. No.	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
R <sub>4</sub>	H		H	H	H	H
R <sub>3</sub>		H		H		H
R <sub>2</sub>	H	H	H		H	H
R <sub>1</sub>	H	H	H	H	H	
Comp. No.	<b>29</b>	<b>30</b>	<b>31</b>	<b>32</b>	<b>33</b>	<b>34</b>

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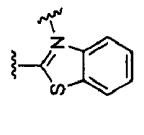
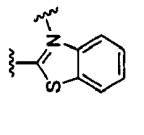
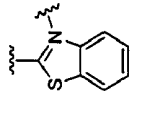
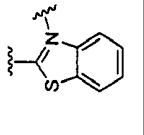
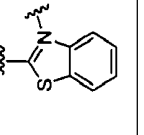
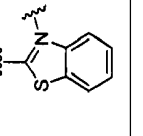
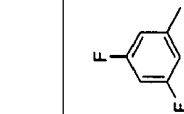
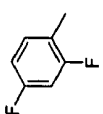
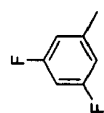
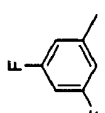
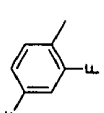
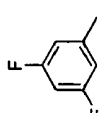
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H		H	H	
R <sub>3</sub>		H	H	H	H	H
R <sub>2</sub>	H		H	H		H
R <sub>1</sub>	H	H	H		H	H
Comp. No.	<b>35</b>	<b>36</b>	<b>37</b>	<b>38</b>	<b>39</b>	<b>40</b>

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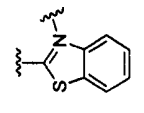
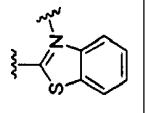
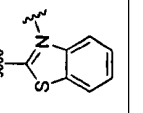
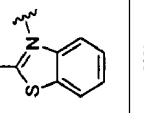
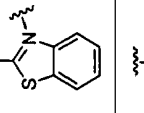
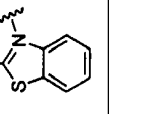

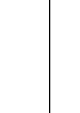
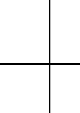
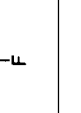


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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>		H	H	H	H	
R <sub>2</sub>	H	H	H		H	H
R <sub>1</sub>	H			H	H	H
Comp. No.	<b>41</b>	<b>42</b>	<b>43</b>	<b>44</b>	<b>45</b>	<b>46</b>

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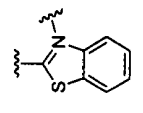
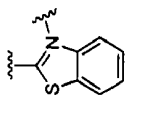
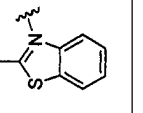
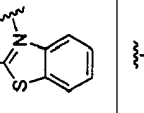
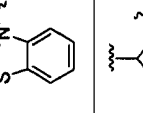
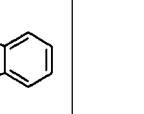


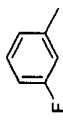

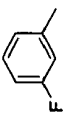

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H		H	H
R <sub>3</sub>	H	H		H	H	
R <sub>2</sub>	H		H	H		H
R <sub>1</sub>		H	H	H	H	H
Comp. No.	<b>47</b>	<b>48</b>	<b>49</b>	<b>50</b>	<b>51</b>	<b>52</b>

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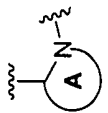
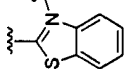
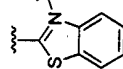
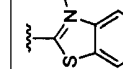
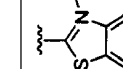
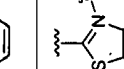
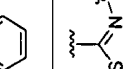
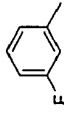



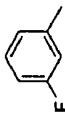

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>		H	H	H	H	
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H	H		H	H	H
R <sub>1</sub>	H		H	H		H
Comp. No.	<b>53</b>	<b>54</b>	<b>55</b>	<b>56</b>	<b>57</b>	<b>58</b>

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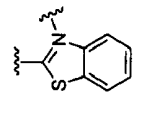
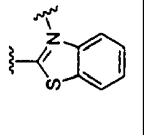
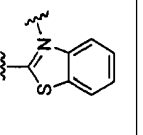
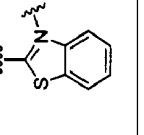
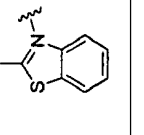
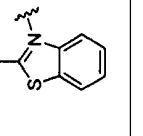
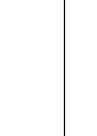
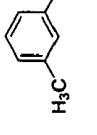
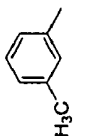
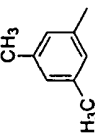
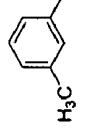
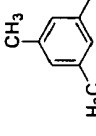
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>	H		H	H	H	H
R <sub>2</sub>		H	H	H	H	
R <sub>1</sub>	H	H	H			H
Comp. No.	<b>59</b>	<b>60</b>	<b>61</b>	<b>62</b>	<b>63</b>	<b>64</b>

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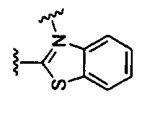
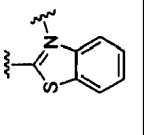
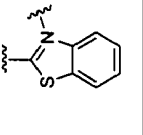
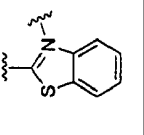
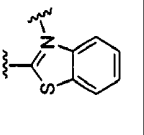
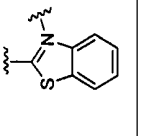
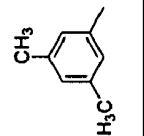
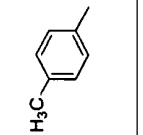
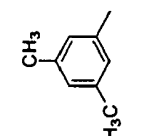
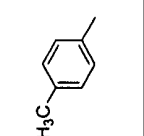
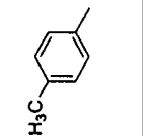
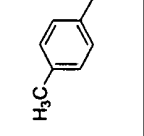
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	H	
R <sub>3</sub>		H	H		H	H
R <sub>2</sub>	H	H		H	H	H
R <sub>1</sub>	H	H	H	H		H
Comp. No.	<b>65</b>	<b>66</b>	<b>67</b>	<b>68</b>	<b>69</b>	<b>70</b>

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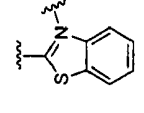
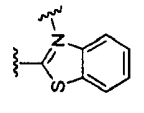
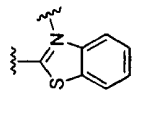
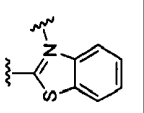
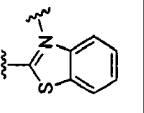
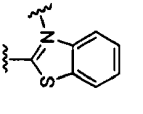
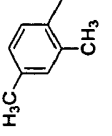
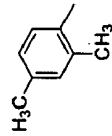
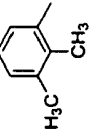
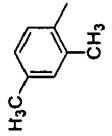
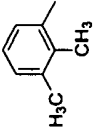
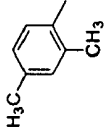
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H		H	H
R <sub>3</sub>		H	H	H	H	
R <sub>2</sub>	H		H	H		H
R <sub>1</sub>	H	H		H	H	H
Comp. No.	71	72	73	74	75	76

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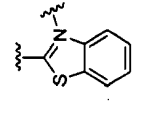
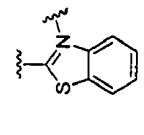
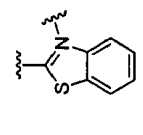
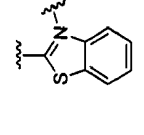
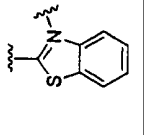
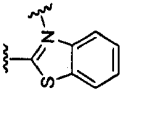
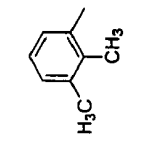
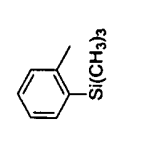
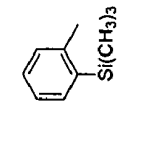
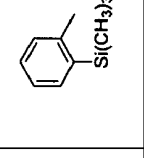
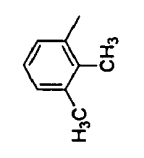
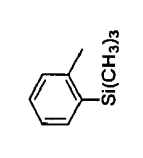
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	H	
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H	H	H	H		H
R <sub>1</sub>		H		H	H	H
Comp. No.	<b>77</b>	<b>78</b>	<b>79</b>	<b>80</b>	<b>81</b>	<b>82</b>

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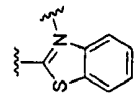
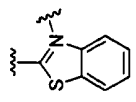
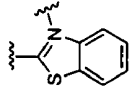
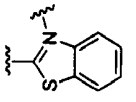
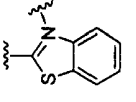
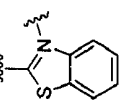
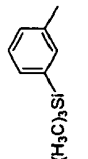
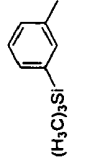
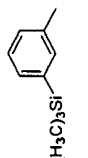
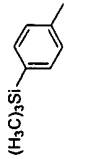
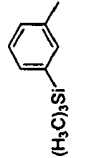
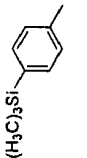
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>	H		H	H	H	H
R <sub>2</sub>		H	H	H		H
R <sub>1</sub>	H	H	H		H	
Comp. No.	<b>83</b>	<b>84</b>	<b>85</b>	<b>86</b>	<b>87</b>	<b>88</b>

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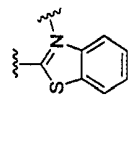
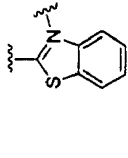
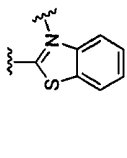
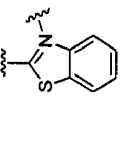
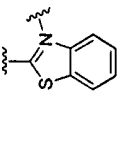
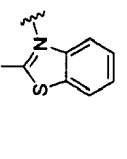


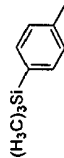



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(continued)

	Zn	Zn	OZn	OZn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H		H
R <sub>3</sub>		H		H	H	H
R <sub>2</sub>	H	H	H		H	H
R <sub>1</sub>	H	H	H	H	H	
Comp. No.	<b>89</b>	<b>90</b>	<b>91</b>	<b>92</b>	<b>93</b>	<b>94</b>

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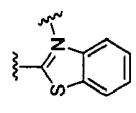
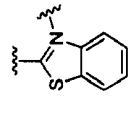
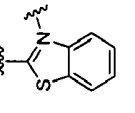
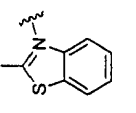
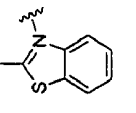
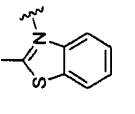
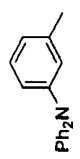
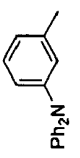
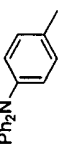
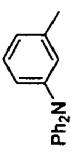
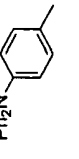
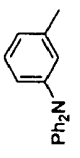
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	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H		H	H
R <sub>3</sub>	H	H		H		H
R <sub>2</sub>	H		H	H	H	
R <sub>1</sub>		H	H	H	H	H
Comp. No.	<b>95</b>	<b>96</b>	<b>97</b>	<b>98</b>	<b>99</b>	<b>100</b>

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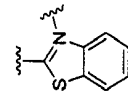
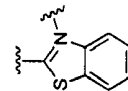
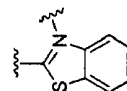
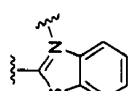
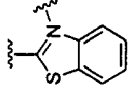
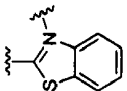
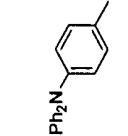
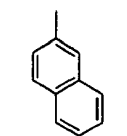
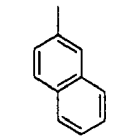
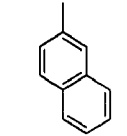
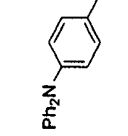
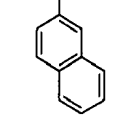
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>		H	H	H	H	
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H	H		H	H	H
R <sub>1</sub>	H		H	H		H
Comp. No.	<b>101</b>	<b>102</b>	<b>103</b>	<b>104</b>	<b>105</b>	<b>106</b>

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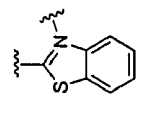
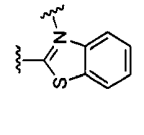
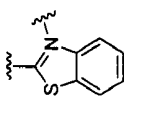
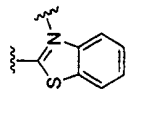
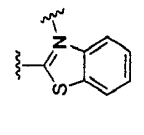
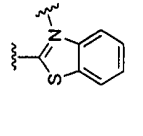
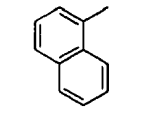
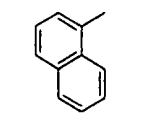
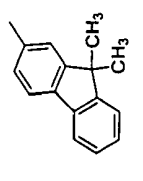
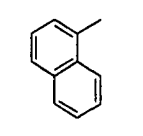
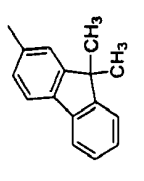
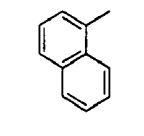
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	H	H
R <sub>3</sub>		H	H	H	H	
R <sub>2</sub>	H	H		H		H
R <sub>1</sub>	H	H	H		H	H
Comp. No.	<b>107</b>	<b>108</b>	<b>109</b>	<b>110</b>	<b>111</b>	<b>112</b>

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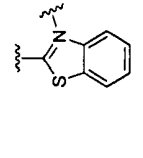
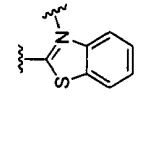
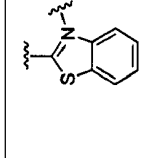
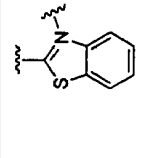
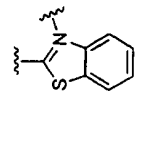
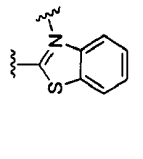
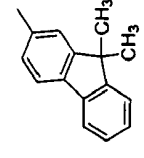
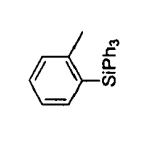
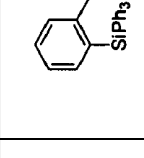
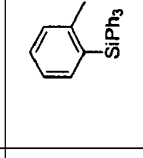
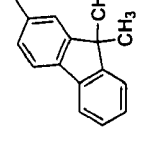
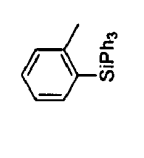
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	H	
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H	H		H	H	H
R <sub>1</sub>		H	H	H		H
Comp. No.	<b>113</b>	<b>114</b>	<b>115</b>	<b>116</b>	<b>117</b>	<b>118</b>

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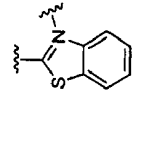
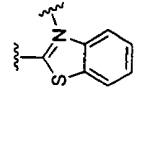
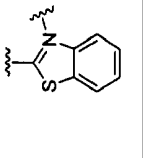
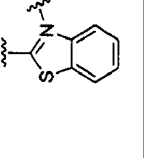
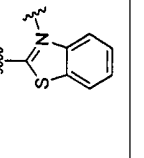
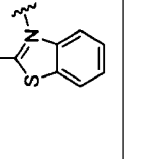
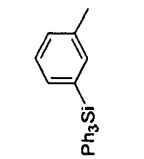
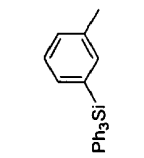
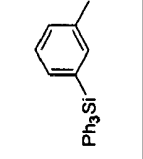
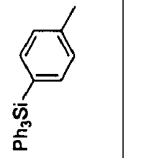
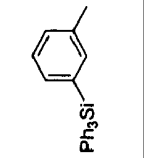
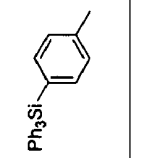
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	H	H
R <sub>3</sub>		H	H	H	H	H
R <sub>2</sub>	H	H		H	H	
R <sub>1</sub>	H	H	H			H
Comp. No.	<b>119</b>	<b>120</b>	<b>121</b>	<b>122</b>	<b>123</b>	<b>124</b>

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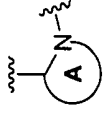
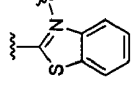
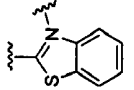
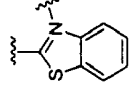
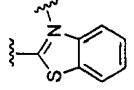
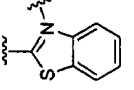
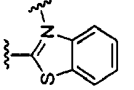
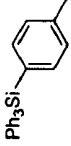
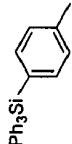
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H		H	H	-CH <sub>3</sub>	H
R <sub>3</sub>		H	-CH <sub>3</sub>	H	H	H
R <sub>2</sub>	H	H	H	-CH <sub>3</sub>	H	H
R <sub>1</sub>	H	H	H	H	H	-CH <sub>3</sub>
Comp. No.	<b>125</b>	<b>126</b>	<b>127</b>	<b>128</b>	<b>129</b>	<b>130</b>

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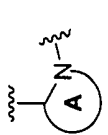
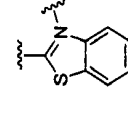
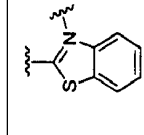
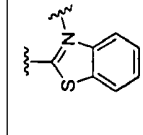
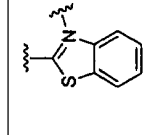
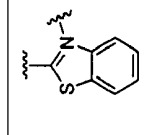
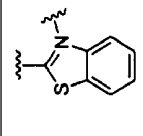
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	-CH <sub>3</sub>	H	H	-CH <sub>3</sub>	H	-CH <sub>3</sub>
R <sub>3</sub>	H	-CH <sub>3</sub>	-CH <sub>3</sub>	-CH <sub>3</sub>	H	H
R <sub>2</sub>	-CH <sub>3</sub>	H	-CH <sub>3</sub>	H	-CH <sub>3</sub>	H
R <sub>1</sub>	H	-CH <sub>3</sub>	H	H	-CH <sub>3</sub>	-CH <sub>3</sub>
Comp. No.	<b>131</b>	<b>132</b>	<b>133</b>	<b>134</b>	<b>135</b>	<b>136</b>

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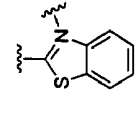
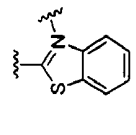
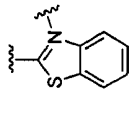
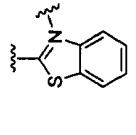
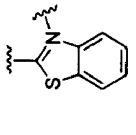
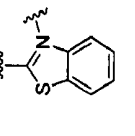
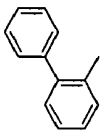
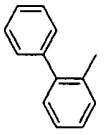
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H
R <sub>3</sub>	H	H	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H	
R <sub>2</sub>	H	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H	H	H
R <sub>1</sub>	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H	H		H
Comp. No.	<b>137</b>	<b>138</b>	<b>139</b>	<b>140</b>	<b>141</b>	<b>142</b>

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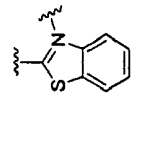
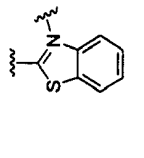
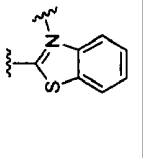
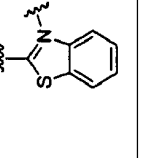
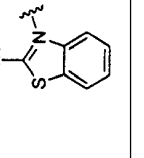
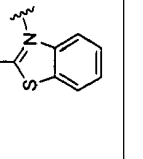
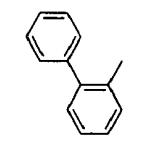
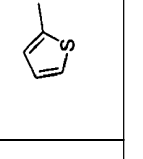
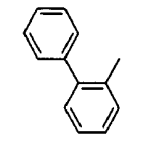
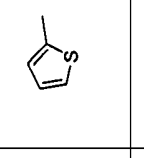
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>		H	-CH <sub>3</sub>	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H
R <sub>3</sub>	H	H	H	H	H	
R <sub>2</sub>	H		-C(CH <sub>3</sub> ) <sub>3</sub>	-CH <sub>3</sub>		H
R <sub>1</sub>	H	H	H	H	H	H
Comp. No.	<b>143</b>	<b>144</b>	<b>145</b>	<b>146</b>	<b>147</b>	<b>148</b>

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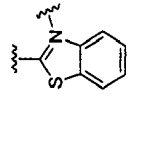
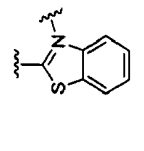
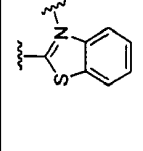
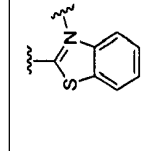
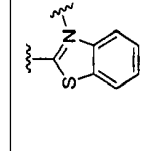
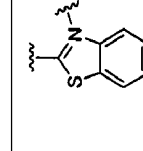


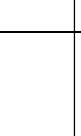

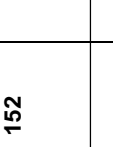
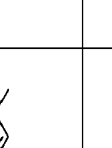
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	Zn	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	-CH <sub>3</sub>		H	H
R <sub>3</sub>	H		H	H	H	H
R <sub>2</sub>		H		-CH <sub>3</sub>	H	
R <sub>1</sub>	H	H	H	H		H
Comp. No.	<b>149</b>	<b>150</b>	<b>151</b>	<b>152</b>	<b>153</b>	<b>154</b>

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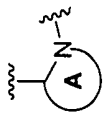
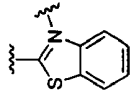
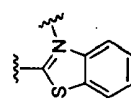
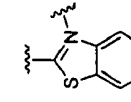
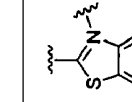
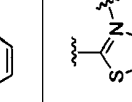
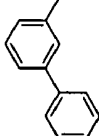
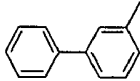
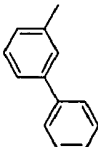
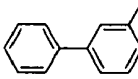
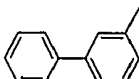
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(continued)

	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	O
					
R <sub>4</sub>	H		H	H	
R <sub>3</sub>		H		H	H
R <sub>2</sub>	H	H	H		H
R <sub>1</sub>	H	H	H	H	H
Comp. No.	<b>155</b>	<b>156</b>	<b>157</b>	<b>158</b>	<b>159</b>

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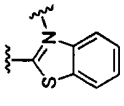
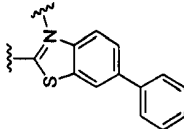
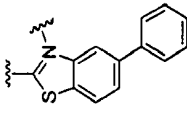
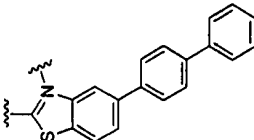
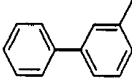
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(continued)

	Zn	Zn	Zn	Zn
X	O	O	O	O
				
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>		H	H	H
Comp. No.	<b>160</b>	<b>161</b>	<b>162</b>	<b>163</b>

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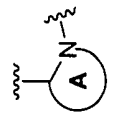
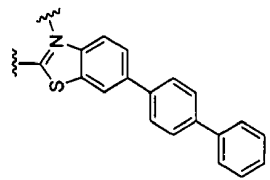
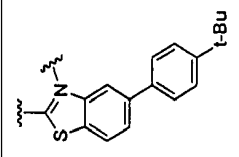
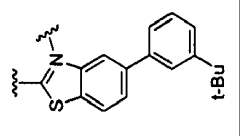
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(continued)

	Zn	Zn	Zn
X	O	O	O
			
R <sub>4</sub>	H	H	H
R <sub>3</sub>	H	H	H
R <sub>2</sub>	H	H	H
R <sub>1</sub>	H	H	H
Comp. No.	<b>164</b>	<b>165</b>	<b>166</b>

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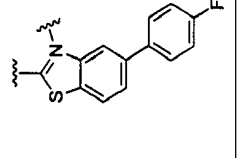
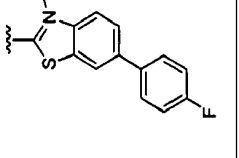
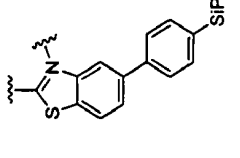
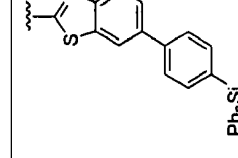
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(continued)

	Zn	Zn	Zn	Zn
X	O	O	O	O
				
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
Comp. No.	<b>167</b>	<b>168</b>	<b>169</b>	<b>170</b>

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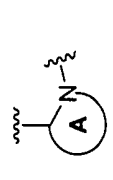
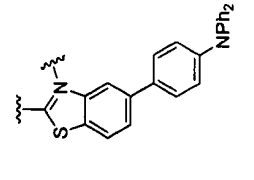
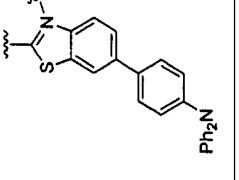
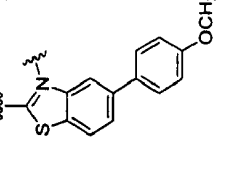
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(continued)

	Zn	Zn	Zn
X	O	O	O
			
R <sub>4</sub>	H	H	H
R <sub>3</sub>	H	H	H
R <sub>2</sub>	H	H	H
R <sub>1</sub>	H	H	H
Comp. No.	<b>171</b>	<b>172</b>	<b>173</b>

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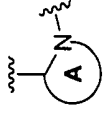
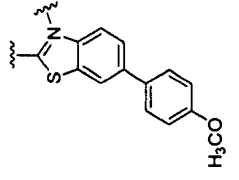
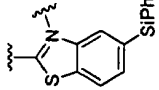
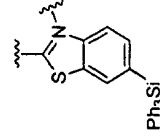
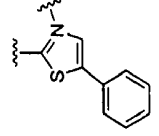
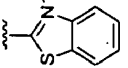

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(continued)

	Zn	Zn	Zn	Zn	Zn
X	O	O	O	O	S
					
R <sub>4</sub>	H	H	H	H	H
R <sub>3</sub>	H	H	H	H	H
R <sub>2</sub>	H	H	H	H	
R <sub>1</sub>	H	H	H	H	H
Comp. No.	<b>174</b>	<b>175</b>	<b>176</b>	<b>177</b>	<b>178</b>

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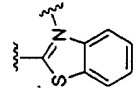
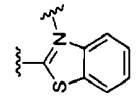
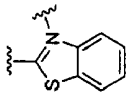
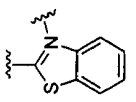
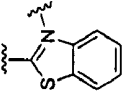
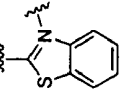

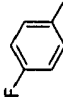

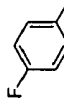
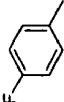

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H	H	
R <sub>3</sub>	H		H	H		H
R <sub>2</sub>	H	H	H		H	H
R <sub>1</sub>		H	H	H	H	H
Comp. No.	<b>179</b>	<b>180</b>	<b>181</b>	<b>182</b>	<b>183</b>	<b>184</b>

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>	H	H	H		H	
R <sub>2</sub>	H		H	H	H	H
R <sub>1</sub>		H		H	H	H
Comp. No.	<b>185</b>	<b>186</b>	<b>187</b>	<b>188</b>	<b>189</b>	<b>190</b>

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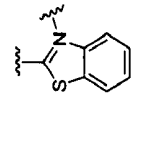
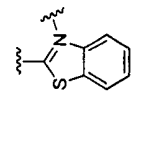
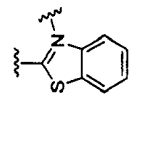
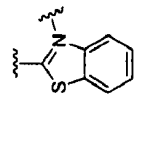
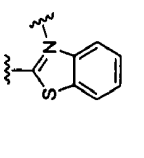
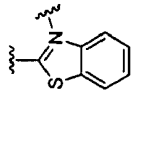
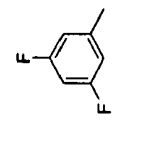
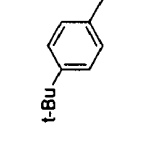
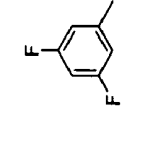
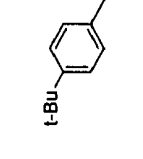
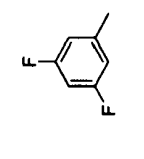
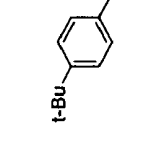
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H	H	H	H	
R <sub>3</sub>	H		H		H	H
R <sub>2</sub>		H	H	H		H
R <sub>1</sub>	H	H		H	H	H
Comp. No.	<b>191</b>	<b>192</b>	<b>193</b>	<b>194</b>	<b>195</b>	<b>196</b>

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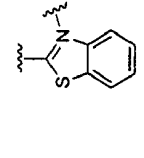
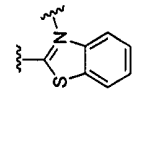
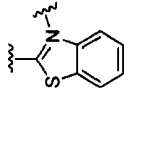
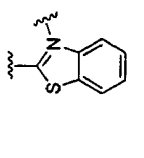
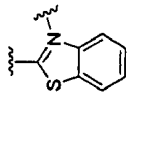
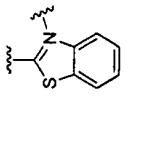
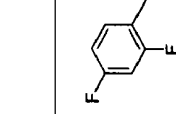
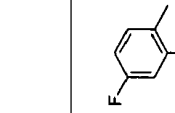
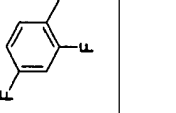
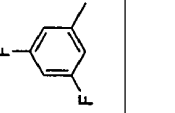
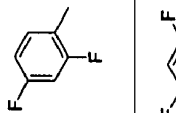
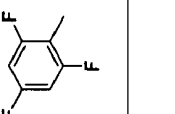
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H		H	H	H	H
R <sub>1</sub>		H	H	H		
Comp. No.	<b>197</b>	<b>198</b>	<b>199</b>	<b>200</b>	<b>201</b>	<b>202</b>

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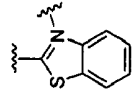
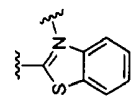
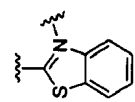
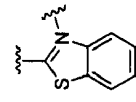
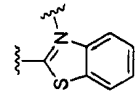
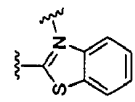
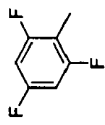
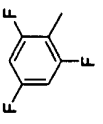

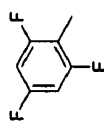
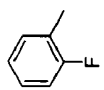

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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H		H	H	H	H
R <sub>3</sub>	H	H		H	H	
R <sub>2</sub>		H	H	H		H
R <sub>1</sub>	H	H	H		H	H
Comp. No.	<b>203</b>	<b>204</b>	<b>205</b>	<b>206</b>	<b>207</b>	<b>208</b>

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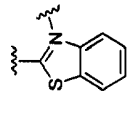
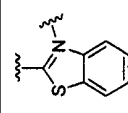
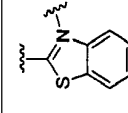
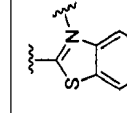
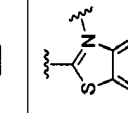
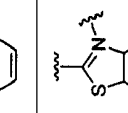
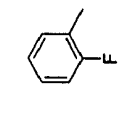
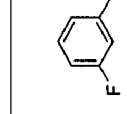
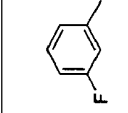
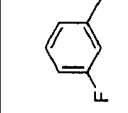
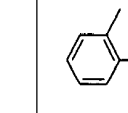
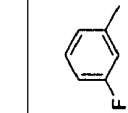
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>		H	H		H	H
R <sub>3</sub>	H	H		H	H	H
R <sub>2</sub>	H		H	H	H	
R <sub>1</sub>	H	H	H	H		H
Comp. No.	<b>209</b>	<b>210</b>	<b>211</b>	<b>212</b>	<b>213</b>	<b>214</b>

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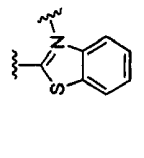
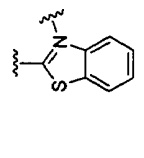
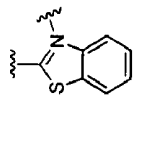
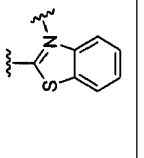
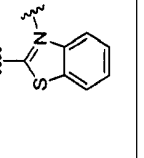
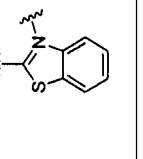
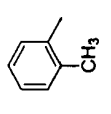
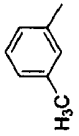
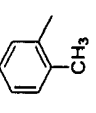
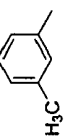
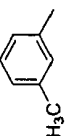
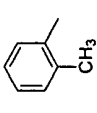
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H	H	
R <sub>3</sub>		H	H	H		H
R <sub>2</sub>	H	H	H		H	H
R <sub>1</sub>	H		H	H	H	H
Comp. No.	<b>215</b>	<b>216</b>	<b>217</b>	<b>218</b>	<b>219</b>	<b>220</b>

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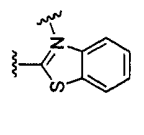
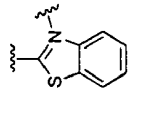
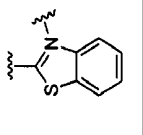
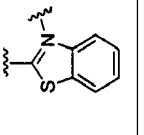
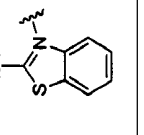
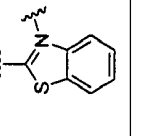
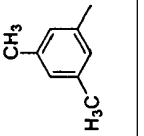
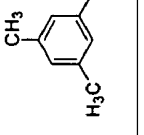
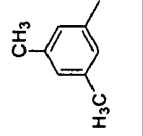
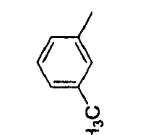
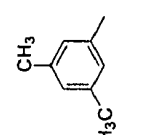
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>	H	H	H		H	H
R <sub>2</sub>	H	H		H	H	
R <sub>1</sub>			H	H	H	H
Comp. No.	<b>221</b>	<b>222</b>	<b>223</b>	<b>224</b>	<b>225</b>	<b>226</b>

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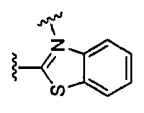
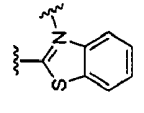
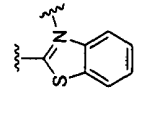
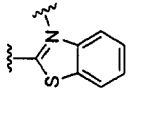
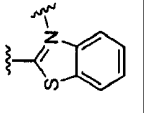
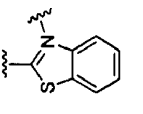
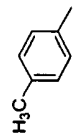
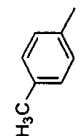
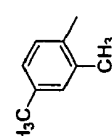
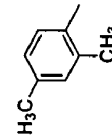
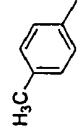
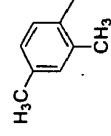
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>		H	H		H	H
R <sub>2</sub>	H	H	H	H		H
R <sub>1</sub>	H		H	H	H	
Comp. No.	<b>227</b>	<b>228</b>	<b>229</b>	<b>230</b>	<b>231</b>	<b>232</b>

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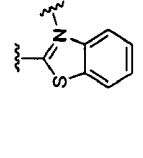
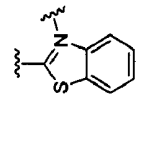
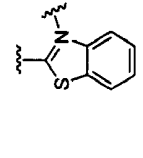
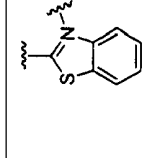
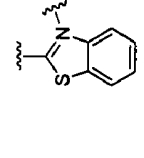
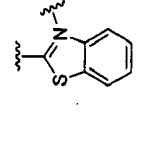
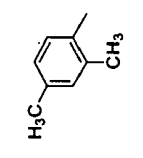
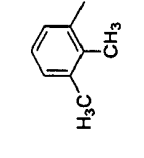
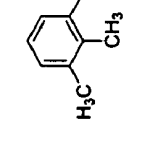
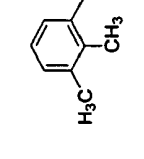
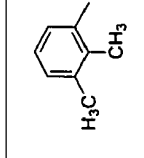
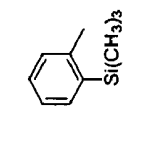
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>		H	H	H		H
R <sub>3</sub>	H	H		H	H	H
R <sub>2</sub>	H		H	H	H	H
R <sub>1</sub>	H	H	H		H	
Comp. No.	<b>233</b>	<b>234</b>	<b>235</b>	<b>236</b>	<b>237</b>	<b>238</b>

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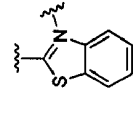
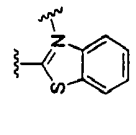
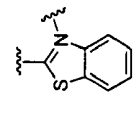
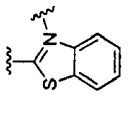
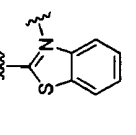
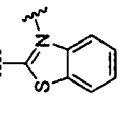
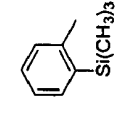
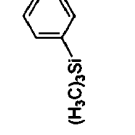
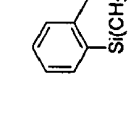
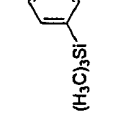
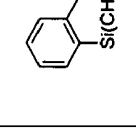
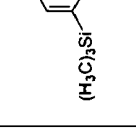
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H	H	
R <sub>3</sub>		H	H	H		H
R <sub>2</sub>	H		H		H	H
R <sub>1</sub>	H	H	H	H	H	H
Comp. No.	<b>239</b>	<b>240</b>	<b>241</b>	<b>242</b>	<b>243</b>	<b>244</b>

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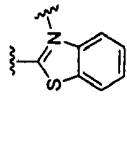
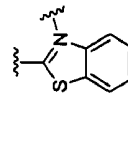
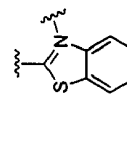
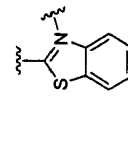
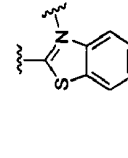
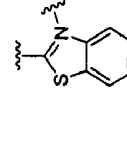
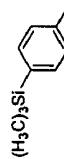
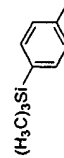

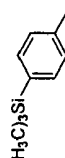
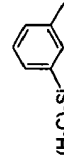
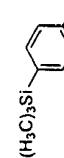
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>	H	H	H		H	
R <sub>2</sub>	H		H	H	H	H
R <sub>1</sub>		H		H	H	H
Comp. No.	<b>245</b>	<b>246</b>	<b>247</b>	<b>248</b>	<b>249</b>	<b>250</b>

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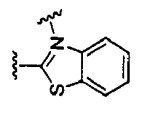
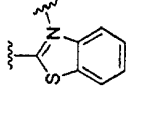
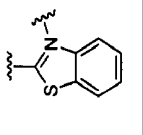
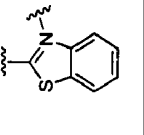
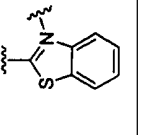
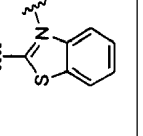

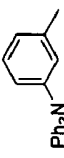

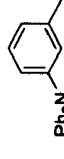

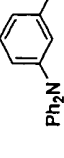
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H		H	H	H	H
R <sub>3</sub>	H	H	H	H	H	
R <sub>2</sub>		H	H	H		H
R <sub>1</sub>	H	H			H	H
Comp. No.	<b>251</b>	<b>252</b>	<b>253</b>	<b>254</b>	<b>255</b>	<b>256</b>

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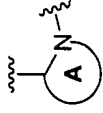
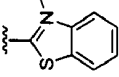
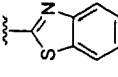
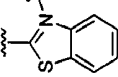
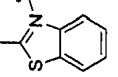
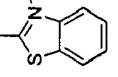
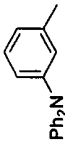
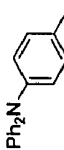
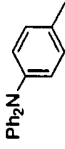
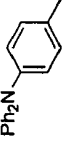
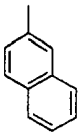
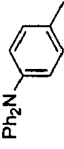
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>		H	H		H	H
R <sub>3</sub>	H		H	H	H	H
R <sub>2</sub>	H	H		H	H	
R <sub>1</sub>	H	H	H	H		H
Comp. No.	257	258	259	260	261	262

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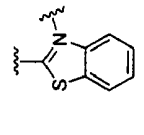
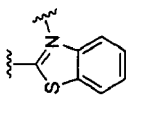
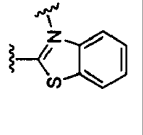
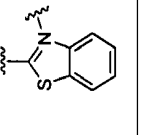
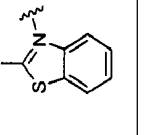
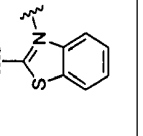
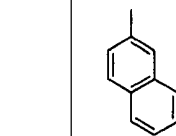
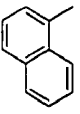
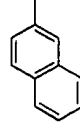
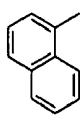
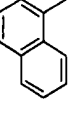
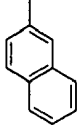
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H		H
R <sub>3</sub>		H	H		H	H
R <sub>2</sub>	H	H	H	H	H	
R <sub>1</sub>	H		H	H	H	H
Comp. No.	<b>263</b>	<b>264</b>	<b>265</b>	<b>266</b>	<b>267</b>	<b>268</b>

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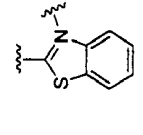
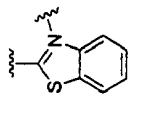
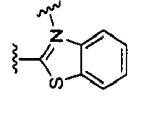
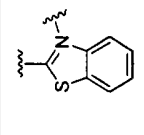
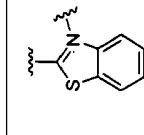
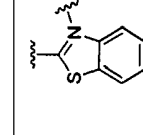
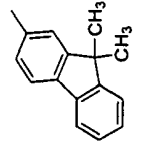
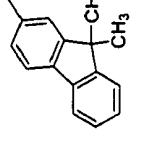
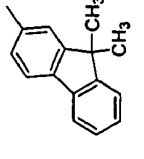
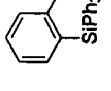
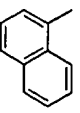
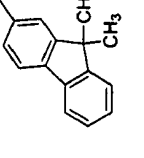
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>	H	H		H	H	H
R <sub>2</sub>	H		H	H	H	
R <sub>1</sub>		H	H		H	H
Comp. No.	<b>269</b>	<b>270</b>	<b>271</b>	<b>272</b>	<b>273</b>	<b>274</b>

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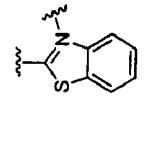
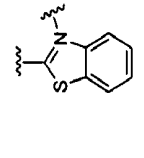
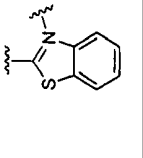
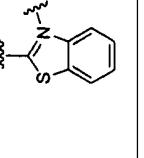
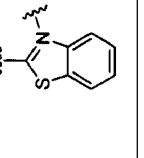
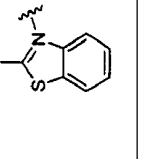
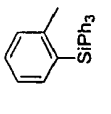
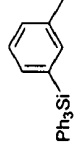
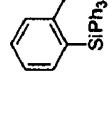
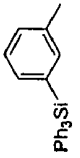
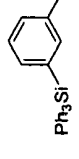
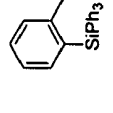
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H		H		H
R <sub>3</sub>		H	H		H	H
R <sub>2</sub>	H	H	H	H	H	
R <sub>1</sub>	H		H	H	H	H
Comp. No.	<b>275</b>	<b>276</b>	<b>277</b>	<b>278</b>	<b>279</b>	<b>280</b>

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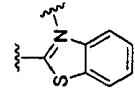
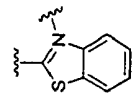
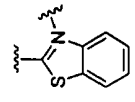
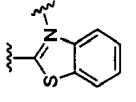
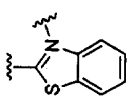
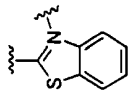
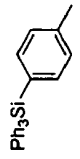
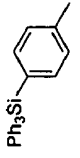
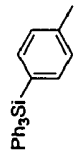
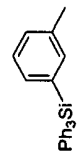
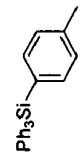
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	H	H	H		H
R <sub>3</sub>	H	H	H		H	-CH <sub>3</sub>
R <sub>2</sub>	H	H		H	H	H
R <sub>1</sub>			H	H	H	H
Comp. No.	<b>281</b>	<b>282</b>	<b>283</b>	<b>284</b>	<b>285</b>	<b>286</b>

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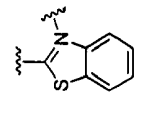
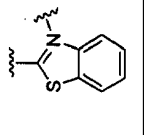
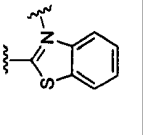
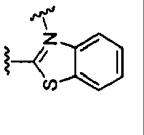
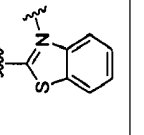
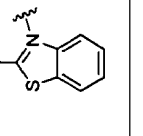
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	H	-CH <sub>3</sub>	H	-CH <sub>3</sub>	H	H
R <sub>3</sub>	H	H	H	H	-CH <sub>3</sub>	-CH <sub>3</sub>
R <sub>2</sub>	-CH <sub>3</sub>	H	H	-CH <sub>3</sub>	H	-CH <sub>3</sub>
R <sub>1</sub>	H	H	-CH <sub>3</sub>	H	-CH <sub>3</sub>	H
Comp. No.	<b>287</b>	<b>288</b>	<b>289</b>	<b>290</b>	<b>291</b>	<b>292</b>

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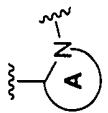
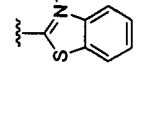
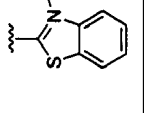
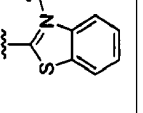
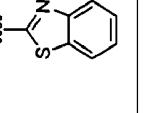
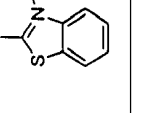
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(continued)

Comp. No.	<b>293</b>	<b>294</b>	<b>295</b>	<b>296</b>	<b>297</b>	<b>298</b>
R <sub>1</sub>	H	-CH <sub>3</sub>	-CH <sub>3</sub>	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H
R <sub>2</sub>	H	-CH <sub>3</sub>	H	H	-C(CH <sub>3</sub> ) <sub>3</sub>	H
R <sub>3</sub>	-CH <sub>3</sub>	H	H	H	H	-C(CH <sub>3</sub> ) <sub>3</sub>
R <sub>4</sub>	-CH <sub>3</sub>	H	-CH <sub>3</sub>	H	H	H
X	S	S	S	S	S	S
						
Zn	Zn	Zn	Zn	Zn	Zn	Zn

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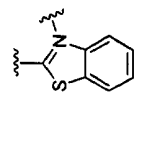
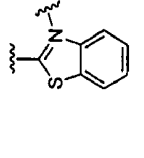
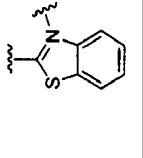
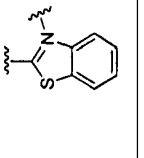
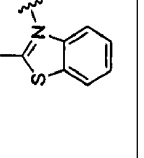
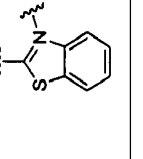
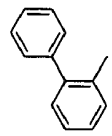
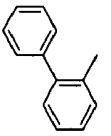
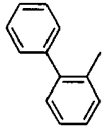
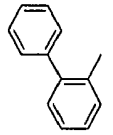
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H		H	-CH <sub>3</sub>
R <sub>3</sub>	H	H		H	H	H
R <sub>2</sub>	H	H	H	H		-C(CH <sub>3</sub> ) <sub>3</sub>
R <sub>1</sub>	H		H	H	H	H
Comp. No.	<b>299</b>	<b>300</b>	<b>301</b>	<b>302</b>	<b>303</b>	<b>304</b>

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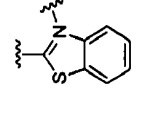
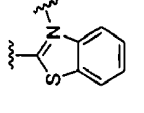
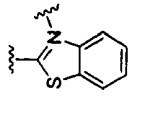
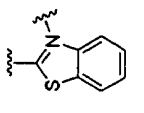
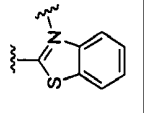
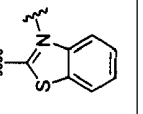





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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>	-C(CH <sub>3</sub> ) <sub>3</sub>	H	H	H	H	-CH <sub>3</sub>
R <sub>3</sub>	H	H		H		H
R <sub>2</sub>	-CH <sub>3</sub>		H		H	
R <sub>1</sub>	H	H	H	H	H	H
Comp. No.	<b>305</b>	<b>306</b>	<b>307</b>	<b>308</b>	<b>309</b>	<b>310</b>

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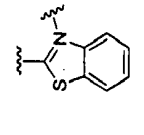
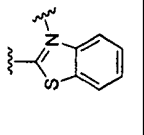
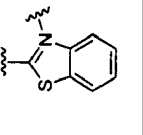
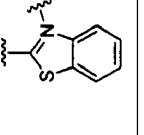
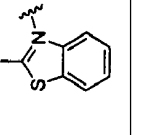
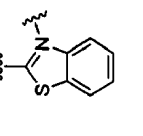
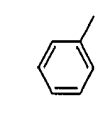
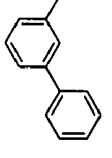
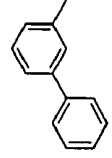
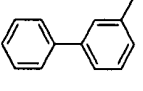
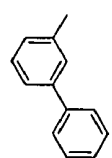
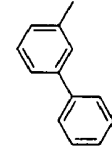
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(continued)

	Zn	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S	S
						
R <sub>4</sub>		H	H	H		H
R <sub>3</sub>	H	H	H		H	
R <sub>2</sub>	-CH <sub>3</sub>	H		H	H	H
R <sub>1</sub>	H		H	H	H	H
Comp. No.	<b>311</b>	<b>312</b>	<b>313</b>	<b>314</b>	<b>315</b>	<b>316</b>

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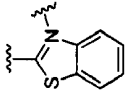
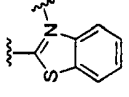
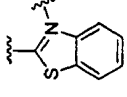
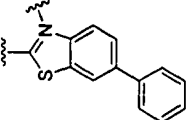
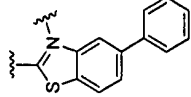
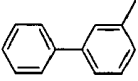
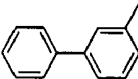
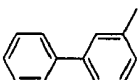
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	Zn	Zn	Zn	Zn	Zn
X	S	S	S	S	S
					
R <sub>4</sub>	H		H	H	H
R <sub>3</sub>	H	H	H	H	H
R <sub>2</sub>		H	H	H	H
R <sub>1</sub>	H	H		H	H
Comp. No.	<b>317</b>	<b>318</b>	<b>319</b>	<b>320</b>	<b>321</b>

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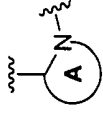
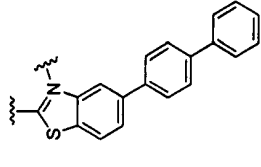
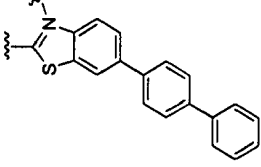
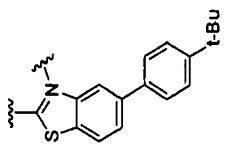
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(continued)

	Zn	Zn	Zn
X	S	S	S
			
R <sub>4</sub>	H	H	H
R <sub>3</sub>	H	H	H
R <sub>2</sub>	H	H	H
R <sub>1</sub>	H	H	H
Comp. No.	<b>322</b>	<b>323</b>	<b>324</b>

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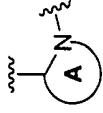
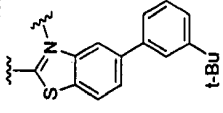
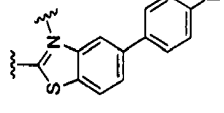
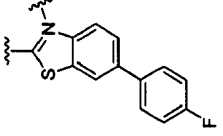
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	Zn	Zn	Zn
X	S	S	S
			
R <sub>4</sub>	H	H	H
R <sub>3</sub>	H	H	H
R <sub>2</sub>	H	H	H
R <sub>1</sub>	H	H	H
Comp. No.	<b>325</b>	<b>326</b>	<b>327</b>

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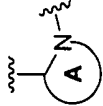
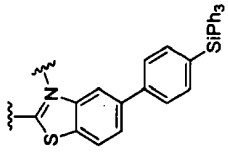
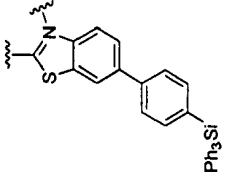
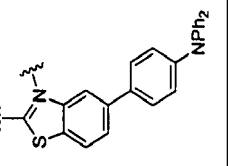
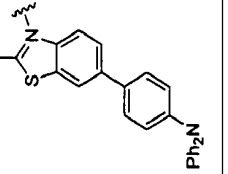
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(continued)

	Zn	Zn	Zn	Zn
X	S	S	S	S
				
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
Comp. No.	<b>328</b>	<b>329</b>	<b>330</b>	<b>331</b>

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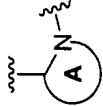
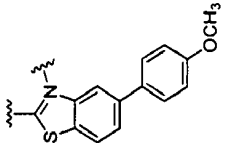
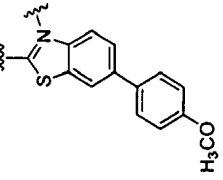
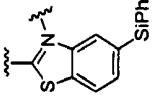
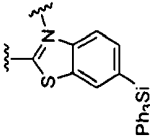
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	Zn	Zn	Zn	Zn
X	S	S	S	S
				
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
Comp. No.	<b>332</b>	<b>333</b>	<b>334</b>	<b>335</b>

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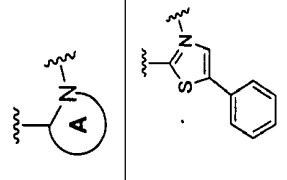
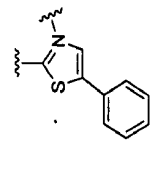
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(continued)

	Zn
X	S
	
R <sub>4</sub>	H
R <sub>3</sub>	H
R <sub>2</sub>	H
R <sub>1</sub>	H
Comp. No.	<b>336</b>

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Table 2

Comp. No.	<sup>1</sup> H NMR(CDCI <sub>3</sub> , 200 MHz)	MS/FAB	
		found	calculated
5 <b>19</b>	δ = 6.85(d, 2H), 7.22-7.32(m, 8H), 7.48-7.55(m, 10H), 8.12-8.23(dd, 4H)	668.1	670.1
<b>21</b>	δ = 6.85(m, 2H), 7.27-7.38(m, 8H), 7.54-7.67(m, 14H), 8.13-8.25(m, 4H)	668.1	670.1
10 <b>23</b>	δ = 6.85(m, 2H), 7.27-7.32(m, 8H), 7.48-7.55(m, 18H), 8.12-8.23(m, 4H)	704.0	706.1
<b>25</b>	δ = 7.03-7.10(m, 8H), 7.37(m, 2H), 7.46-7.55(m, 8H), 8.12-8.25(m, 4H)	704.0	706.1
<b>27</b>	δ = 6.85(m, 2H), 7.27-7.32(m, 8H), 7.48-7.55(m, 18H), 8.12-8.23(m, 4H)	820.1	822.3
15 <b>29</b>	δ = 7.05(m, 2H), 7.10(m, 2H), 7.22(m, 2H), 7.32-7.37(m, 6H), 7.46-7.56(m, 16H), 8.12(d, 2H), 8.23(d, 2H)	820.1	822.3
<b>32</b>	δ = 1.34(s, 18H), 6.85(m, 2H), 7.27(m, 2H), 7.35-7.40(m, 8H), 7.53-7.56(m, 6H), 8.12-8.23(dd, 4H)	780.2	782.3
20 <b>33</b>	δ = 1.34(s, 18H), 7.01-7.10(m, 4H), 7.35-7.40(m, 10H), 7.55(m, 4H), 8.14-8.25(m, 4H)	780.2	782.3
<b>36</b>	δ = 6.64(m, 2H), 6.85(m, 2H), 6.96(m, 4H), 7.27(m, 2H), 7.53-7.55(m, 6H), 8.24-8.25(m, 4H)	740.0	742.1
25 <b>39</b>	δ = 6.74-6.85(m, 6H), 7.27(m, 2H), 7.44(m, 2H), 7.53-7.55(m, 6H), 8.12-8.23(m, 4H)	740.0	742.1
<b>44</b>	δ = 6.51(m, 4H), 6.85(m, 2H), 7.27(m, 2H), 7.52-7.54(m, 6H), 8.12(m, 2H), 8.24(m, 2H)	776.0	778.1
30 <b>99</b>	δ = 6.46-6.52(m, 12H), 6.62(m, 4H), 7.01(m, 12H), 7.23(m, 4H), 7.37(m, 2H), 7.55(m, 4H), 8.12(m, 2H), 8.23(m, 2H)	1002.2	1004.5
<b>100</b>	δ = 6.46-6.52(m, 12H), 6.62(m, 4H), 6.85(m, 2H), 7.01(m, 8H), 7.23-7.27(m, 6H), 7.53-7.55(m, 6H), 8.23-8.25(m, 4H)	1002.2	1004.5
35 <b>103</b>	δ = 6.85(m, 2H), 7.27-7.32(m, 6H), 7.52-7.56(m, 8H), 7.67-7.73(m, 6H), 7.89(m, 2H), 8.12-8.23(m, 4H)	768.1	770.2
<b>109</b>	δ = 6.85(m, 2H), 7.27-7.38(m, 8H), 7.54-7.67(m, 14H), 8.13-8.25(m, 4H)	768.1	770.2
40 <b>111</b>	δ = 1.67(s, 12H), 7.27-7.28(m, 4H), 7.38(m, 2H), 7.55-7.60(m, 10H), 7.77(m, 2H), 7.84-7.90(m, 4H), 8.13-8.25(m, 4H)	900.2	902.4
<b>124</b>	δ = 6.85(m, 2H), 7.27(m, 2H), 7.36(m, 18H), 7.53-7.60(m, 26H), 8.15-8.25(m, 4H)	1184.2	1186.9
45 <b>125</b>	δ = 7.01(s, 2H), 7.10(m, 2H), 7.36-7.37(m, 20H), 7.54-7.60(m, 24H), 8.12(d, 2H), 8.24(d, 2H)	1184.2	1186.9
<b>161</b>	δ = 6.79-6.88(m, 4H), 7.05(m, 2H), 7.22-7.32(m, 8H), 7.48(m, 4H), 7.77(m, 2H), 8.29-8.34(m, 4H)	668.1	670.1
<b>162</b>	δ = 6.79-6.88(m, 4H), 7.05(m, 2H), 7.22-7.32(m, 8H), 7.48(m, 4H), 7.77(m, 2H), 8.18(m, 2H), 8.45(m, 2H)	668.1	670.1
50 <b>163</b>	δ = 7.79(m, 2H), 6.88(m, 2H), 7.05(m, 2H), 7.31-7.32(m, 8H), 7.48-7.54(m, 12H), 7.77(m, 2H), 8.18(m, 2H), 8.43(m, 2H)	820.1	822.3
<b>164</b>	δ = 6.78-6.80(m, 4H), 7.04(m, 2H), 7.22(m, 2H), 7.31-7.32(m, 6H), 7.48-7.54(m, 12H), 7.77(m, 2H), 8.30-8.33(m, 4H)	820.1	822.3
55 <b>165</b>	δ = 1.36(s, 18H), 6.78-6.89(m, 4H), 7.05(m, 2H), 7.31-7.40(m, 10H), 7.78(m, 2H), 8.20(m, 2H), 8.50(m, 2H)	780.2	782.3
<b>166</b>	δ = 1.34(s, 18H), 6.70(m, 2H), 6.88(m, 2H), 7.07(m, 2H), 7.31-7.40(m, 10H), 7.77(m, 2H), 8.28-8.32(m, 4H)	780.2	782.3

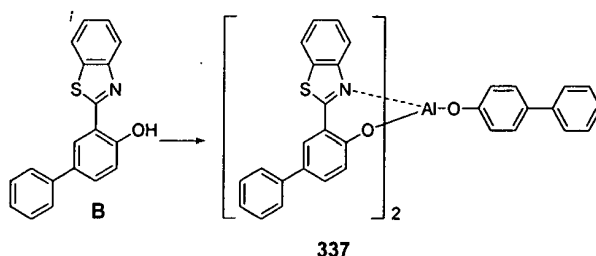
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Comp. No.	<sup>1</sup> H NMR(CDCl <sub>3</sub> , 200 MHz)	MS/FAB	
		found	calculated
167	δ = 6.80-6.90(m, 4H), 7.03-7.05(m, 6H), 7.31(m, 2H), 7.46(m, 4H), 7.77(m, 2H), 8.18(m, 2H), 8.45(m, 2H)	704.0	706.1
168	δ = 6.80-6.90(m, 4H), 7.03-7.08(m, 6H), 7.31(m, 2H), 7.46(m, 4H), 7.77(m, 2H), 8.29-8.34(m, 4H)	704.0	706.1
169	δ = 6.79(m, 2H), 6.88(m, 2H), 7.05(m, 2H), 7.31-7.36(m, 20H), 7.54-7.60(m, 20H), 7.77(m, 2H), 8.18(m, 2H), 8.46(m, 2H)	1184.2	1186.9
170	δ = 6.79(m, 2H), 6.88(m, 2H), 7.05(m, 2H), 7.31-7.36(m, 20H), 7.54-7.60(m, 20H), 7.77(m, 2H), 8.30-8.34(m, 4H)	1184.2	1186.9
171	δ = 6.46-6.52(m, 12H), 6.62(m, 4H), 6.79(m, 2H), 6.88(m, 2H), 7.01-7.05(m, 10H), 7.23-7.31(m, 6H), 7.77(m, 2H), 8.18(m, 2H), 8.46(m, 2H)	1002.2	1004.5
172	δ = 6.46-6.52(m, 12H), 6.62(m, 4H), 6.79-6.88(m, 4H), 7.01-7.05(m, 10H), 7.23(m, 4H), 7.31(m, 2H), 7.77(m, 2H), 8.30-8.34(m, 4H)	1002.2	1004.5
178	δ = 8.23 (d, 2H), 8.13(d, 2H), 7.55-7.20(m, 20H)	700.1	700.0
191	δ = 1.34(s, 18H), 7.28-7.30(m, 4H), 7.35-7.40(m, 4H), 7.54(m, 6H), 8.12(m, 2H), 8.23(m, 2H)	814.1	812.1
194	δ = 6.64(m, 2H), 6.96(m, 4H), 7.32-7.38(m, 4H), 7.55(m, 4H), 8.12(m, 2H), 8.23(m, 2H)	773.9	771.9
223	δ = 2.35(s, 12H), 6.82(d, 2H), 7.09(s, 4H), 7.28-7.30(m, 4H), 7.55(m, 6H), 8.15-8.24(m, 4H)	758.0	756.1
259	δ = 6.46-6.52(m, 12H), 6.62(m, 4H), 7.02(m, 8H), 7.24-7.30(m, 8H), 7.56(m, 6H), 8.13(t, 2H), 8.23(t, 2H)	1035.1	1034.2
283	δ = 7.30-7.36(m, 22H), 7.54-7.60(m, 26H), 8.12(m, 2H), 8.24(m, 2H)	1219.2	1216.3
287	δ = 2.34(s, 6H), 6.86(m, 2H), 7.12(d, 4H), 7.57(m, 4H), 8.13-8.25(m, 4H)	577.9	575.9
291	δ = 2.36(s, 12H), 6.70(s, 2H), 6.85(s, 2H), 7.55(m, 4H), 8.14-8.25(m, 4H)	606.0	604.5
311	δ = 2.36(s, 6H), 7.08(s, 4H), 7.22(m, 2H), 7.32(m, 4H), 7.48(m, 8H), 8.20(m, 4H)	730.0	728.4
320	δ = 7.06-7.10(m, 4H), 7.24-7.32(m, 10H), 7.48(m, 4H), 7.77(m, 2H), 8.29-8.34(m, 4H)	702.1	700.1
336	δ = 7.06-7.12(m, 4H), 7.22-7.34(m, 10H), 7.48(m, 4H), 8.00(s, 2H)	601.9	599.9

[Preparation Example 3] Preparation of Compound (337)

[0091]



[0092] Compound (B) (4.5 g, 14.8 mmol) and aluminum isopropoxide (3.0 g, 14.8 mmol) were dissolved in chloroform (50. mL)/isopropyl alcohol (150 mL), and the solution was stirred at 60°C for 3 hours. When the solution became clear,

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4-phenylphenol (3.0 g, 17.8 mmol) was added thereto, and the resultant mixture was stirred under reflux at 80°C for 3 hours. Then, Compound (B) (4.5 g, 14.8 mmol) was added thereto, and the mixture was stirred under reflux for 12 hours. When the reaction was completed, the reaction mixture was cooled to room temperature, and the solid produced was obtained by filtration under reduced pressure. The solid was then sequentially washed with isopropyl alcohol (500 mL),  
5 methanol (300 mL) and ethyl ether (250 mL), to obtain the title compound (337) (3.8 g, 7.6 mmol, 51%).

**[0093]** According to the same procedure as Preparation Example 21, Compounds 337 through 426 listed in Table 3 were prepared, of which the <sup>1</sup>H NMR and MS/FAB data are listed in Table 4. The compounds listed in Table 3 are those containing trivalent metal M.

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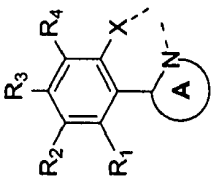














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Table 3

L <sup>1</sup> L <sup>2</sup> M(Q) <sub>y</sub>		M	Q	y	
 $L^1 = L^2 =$	No.				
	337	H		1	
	338		H		1
	339	H			1
	340	H	H		1
	R <sub>1</sub>	H			
	R <sub>2</sub>		H		
	R <sub>3</sub>	H	H		
	R <sub>4</sub>	H	H		
X	O	O	O	O	
					

(continued)

5		1	1	1	1	1	1	1
10								
15		Al	Al	Al	Al	Al	Al	Al
20	X	O	O	O	O	O	O	O
25								
30	R <sub>4</sub>	H	H		H	H	H	H
35	R <sub>3</sub>	H		H	H	H	H	
40	R <sub>2</sub>		H	H	H		H	H
45	R <sub>1</sub>	H	H	H		H		H
50	No.	341	342	343	344	345	346	347
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	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>		H	H	H	H	H	H
R <sub>3</sub>	H		H		H	H	
R <sub>2</sub>	H	H		H	H		H
R <sub>1</sub>	H	H	H	H		H	H
No.	348	349	350	351	352	353	354

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(continued)

	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>	H		H	H		H	H
R <sub>3</sub>	H	H	H		H	H	H
R <sub>2</sub>	H	H		H	H	H	H
R <sub>1</sub>		H	H	H	H		
No.	355	356	357	358	359	360	361

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(continued)

	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>	H	H		H	H	H	
R <sub>3</sub>	H		H	H		H	H
R <sub>2</sub>		H	H		H	H	H
R <sub>1</sub>	H	H	H	H	H		H
No.	<b>362</b>	<b>363</b>	<b>364</b>	<b>365</b>	<b>366</b>	<b>367</b>	<b>368</b>

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	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>	H	H	H		H	H	H
R <sub>3</sub>		H	H	H	H		H
R <sub>2</sub>	H		H	H		H	H
R <sub>1</sub>	H	H		H	H	H	
No.	<b>369</b>	<b>370</b>	<b>371</b>	<b>372</b>	<b>373</b>	<b>374</b>	<b>375</b>

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(continued)

	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>		H	H	H		H	
R <sub>3</sub>	H	H		H	H		H
R <sub>2</sub>	H		H	H	H	H	H
R <sub>1</sub>	H	H	H		H	H	H
No.	<b>376</b>	<b>377</b>	<b>378</b>	<b>379</b>	<b>380</b>	<b>381</b>	<b>382</b>

(continued)

5		1	1	1	1	1	1	1
10								
15		Al	Al	Al	Al	Al	Al	Al
20	X	O	O	O	O	O	O	O
25								
30	R <sub>4</sub>	H	H	H	H	H		H
35	R <sub>3</sub>	H	H	H	H		H	
40	R <sub>2</sub>		H	H		H	H	H
45	R <sub>1</sub>	H			H	H	H	H
50	No.	<b>383</b>	<b>384</b>	<b>385</b>	<b>386</b>	<b>387</b>	<b>388</b>	<b>389</b>
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	1	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O	O
R <sub>4</sub>	H		H	H	H	H	
R <sub>3</sub>	H	H	H		H		H
R <sub>2</sub>		H	H	H		H	H
R <sub>1</sub>	H	H			H	H	H
No.	<b>390</b>	<b>391</b>	<b>392</b>	<b>393</b>	<b>394</b>	<b>395</b>	<b>396</b>

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	1	1	1	1	1	1
	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O
R <sub>4</sub>	H	H		H	H	H
R <sub>3</sub>		H	H	H	H	H
R <sub>2</sub>	H		H	H	H	H
R <sub>1</sub>	H	H	H		H	H
No.	<b>397</b>	<b>398</b>	<b>399</b>	<b>400</b>	<b>401</b>	<b>402</b>

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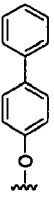
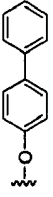
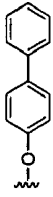
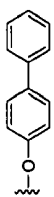
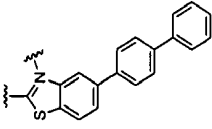
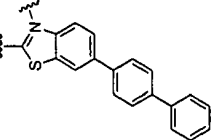
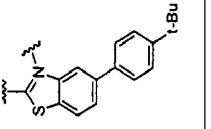
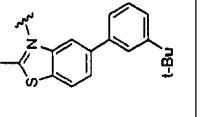
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	1	1	1	1
				
	Al	Al	Al	Al
X	O	O	O	O
				
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R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
No.	<b>403</b>	<b>404</b>	<b>405</b>	<b>406</b>

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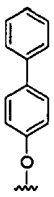

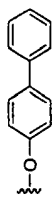
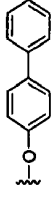
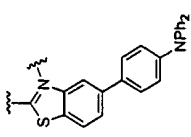
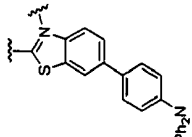
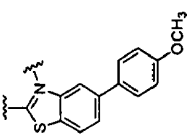
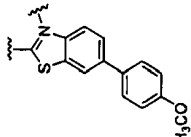
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	1	1	1	1
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X	O	O	O	O
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
No.	<b>407</b>	<b>408</b>	<b>409</b>	<b>410</b>

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	1	1	1	1
				
	Al	Al	Al	Al
X	O	O	O	O
				
R <sub>4</sub>	H	H	H	H
R <sub>3</sub>	H	H	H	H
R <sub>2</sub>	H	H	H	H
R <sub>1</sub>	H	H	H	H
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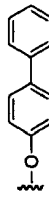
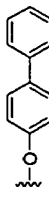
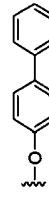
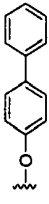
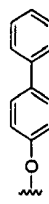
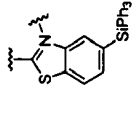
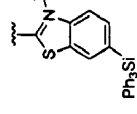
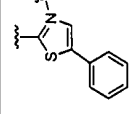
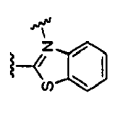
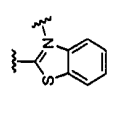
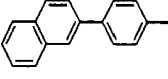
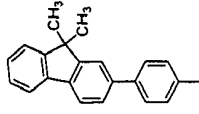
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	1	1	1	1	1
					
	Al	Al	Al	Al	Al
X	O	O	O	O	O
					
R <sub>4</sub>	H	H	H	H	H
R <sub>3</sub>	H	H	H	H	H
R <sub>2</sub>	H	H	H		
R <sub>1</sub>	H	H	H	H	H
No.	<b>415</b>	<b>416</b>	<b>417</b>	<b>418</b>	<b>419</b>

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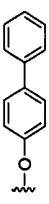
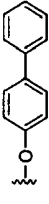
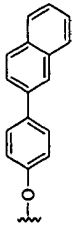
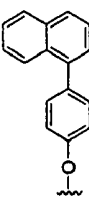
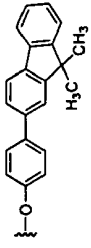
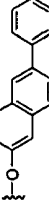
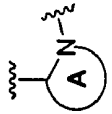
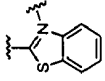
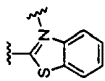
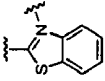
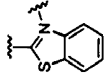
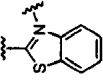
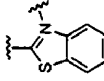
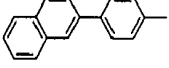
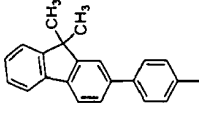




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(continued)

	1	1	1	1	1	1
						
	Al	Al	Al	Al	Al	Al
X	O	O	O	O	O	O
						
R <sub>4</sub>	H	H	H	H	H	H
R <sub>3</sub>			H	H	H	H
R <sub>2</sub>	H	H				
R <sub>1</sub>	H	H	H	H	H	H
No.	<b>420</b>	<b>421</b>	<b>422</b>	<b>423</b>	<b>424</b>	<b>425</b>

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(continued)

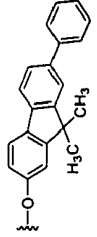
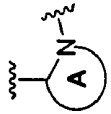
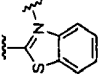

	1
	
	Al
X	O
	
R <sub>4</sub>	H
R <sub>3</sub>	H
R <sub>2</sub>	
R <sub>1</sub>	H
No.	<b>426</b>

Table 4

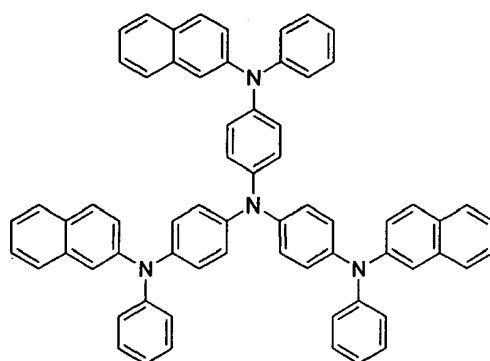
Comp. No.	<sup>1</sup> H NMR(CDCI <sub>3</sub> , 200 MHz)	MS/FAB	
		found	calculated
337	δ =6.79-6.85(m, 4H), 7.27-7.32(m, 18H), 7.48-7.56(m, 12H), 8.12-8.25(m, 4H)	801.2	800.2
340	δ =6.79-6.85(m, 4H), 7.03(m, 4H), 7.22-7.32(m, 7H), 7.46-7.56(m, 12H), 8.14-8.25(m, 4H)	837.2	836.2
350	δ =1.37(s, 18H), 6.79-6.90(m, 4H), 7.22-7.40(m, 15H), 7.48-7.55(m, 8H), 8.14-8.25(m, 4H)	913.3	912.3
359	δ =2.37(s, 6H), 6.79(d, 2H), 6.94-7.02(m, 4H), 7.20-7.32(m, 15H), 7.48-7.55(m, 6H), 8.15-8.23(m, 4H)	829.2	828.2
362	δ =2.38(s, 12H), 6.79-6.84(m, 6H), 7.09(s, 4H), 7.19-7.34(m, 7H), 7.48-7.54(m, 8H), 8.13-8.26(m, 4H)	857.2	856.2
365	δ =2.24(s, 6H), 6.85(m, 4H), 7.12(m, 4H), 7.28-7.32(m, 11H), 7.49-7.55(m, 8H), 8.21(m, 4H)	829.2	828.2
398	δ =6.46-6.52(m, 12H), 6.62(m, 4H), 6.80(m, 4H), 7.01(m, 8H), 7.20-7.33(m, 11H), 7.50-7.54(m, 8H), 8.10-8.20(m, 4H)	1135.3	1134.3
401	δ =6.79(m, 4H), 6.88(m, 2H), 7.05(m, 2H), 7.20-7.35(m, 13H), 7.48(m, 6H), 7.77(m, 2H), 8.29-8.34(m, 4H)	800.9	800.1
416	δ =6.79(m, 4H), 6.88(m, 2H), 7.05(m, 2H), 7.22(m, 1H), 7.31-7.36(m, 11H), 7.48-7.54(m, 14H), 7.83(m, 2H), 8.33(dd, 2H), 8.46(m, 2H)	1165.5	1164.2
417	δ =6.79(m, 4H), 6.88(m, 2H), 7.05(m, 2H), 7.22-7.32(m, 13H), 7.48(m, 6H), 8.01(s, 2H)	700.8	700.1
422	δ =6.79-6.85(m, 4H), 7.21-7.33(m, 12H), 7.50-7.55(m, 11H), 7.67-7.73(m, 3H), 7.89(s, 1H), 8.12-8.23(m, 4H)	851.1	850.1
423	δ =6.79-7.85(m, 4H), 7.25-7.38(m, 13H), 7.49-7.67(m, 14H), 8.13-8.21(m, 4H)	851.1	850.1
424	δ =1.67(s, 6H), 6.79-6.85(m, 4H), 7.22-7.38(m, 12H), 7.49-7.56(m, 12H), 7.77(d, 1H), 7.84-7.90(m, 2H), 8.12(m, 2H), 8.23(m, 2H)	917.0	916.2
425	δ =6.85(m, 2H), 6.97-6.98(m, 2H), 7.23-7.32(m, 11H), 7.48-7.62(m, 15H), 7.85(d, 1H), 8.13-8.25(m, 4H)	850.9	850.1
426	δ =1.68(s, 6H), 6.85(t, 3H), 7.02(d, 1H), 7.22-7.32(m, 11H), 7.48-7.67(m, 14H), 7.77(d, 1H), 7.90(d, 1H), 8.13-8.26(m, 4H)	917.0	916.2

[Example 1] Manufacture of an OLED

**[0094]** An OLED device was manufactured by using the red phosphorescent compounds according to the invention.

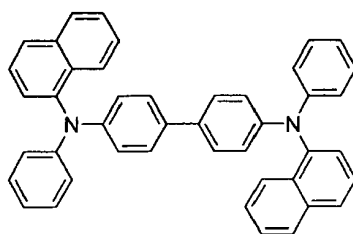
**[0095]** First, a transparent electrode ITO thin film (15 Ω/□) (2) prepared from glass for OLED (produced by Samsung Corning) (1) was subjected to ultrasonic washing with trichloroethylene, acetone, ethanol and distilled water, sequentially, and stored in isopropanol before use.

**[0096]** Then, an ITO substrate was equipped in a substrate folder of a vacuum vapor-deposit device, and 4,4',4"-tris (N,N-(2-naphthyl)-phenylamino)triphenylamine (2-TNATA) was placed in a cell of the vacuum vapor-deposit device, which was then ventilated up to 10<sup>-6</sup> torr of vacuum in the chamber. Electric current was applied to the cell to evaporate 2-TNATA, thereby providing vapor-deposit of a hole injection layer (3) having 60 nm of thickness on the ITO substrate.



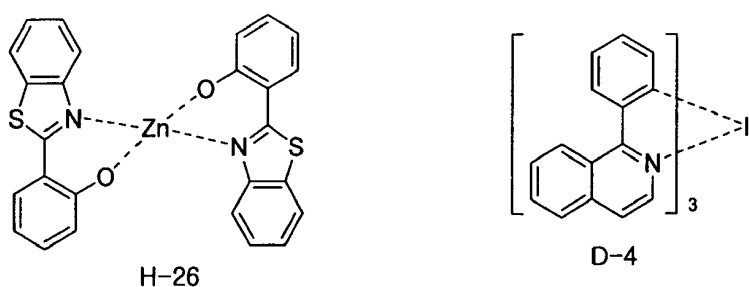
2-TNATA

[0097] Then, to another cell of the vacuum vapor-deposit device, charged was N,N'-bis( $\alpha$ -naphthyl)-N,N'-diphenyl-4,4'-diamine (NPB), and electric current was applied to the cell to evaporate NPB, thereby providing vapor-deposit of a hole transport layer (4) of 20 nm of thickness on the hole injection layer.



NPB

[0098] To another cell of said vacuum vapor-deposit device, charged was an electroluminescent host material according to the present invention (H-26), and a red phosphorescent compound according to the present invention (Compound D-4) was charged to still another cell. The two materials were evaporated at different rates to carry out doping, thereby vapor-depositing an electroluminescent layer (5) having 30 nm of thickness on the hole transport layer. Preferable doping concentration is from 4 to 10% by weight on the basis of the host.

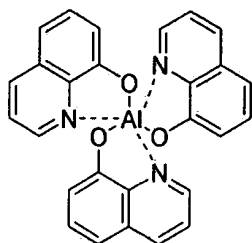


H-26

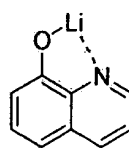
D-4

[0099] Then, tris(8-hydroxyquinoline)aluminum (III) (Alq) was vapor-deposited as an electron transport layer (6) with a thickness of 20 nm, and lithium quinolate (Liq) was vapor-deposited as an electron injection layer (7) with a thickness of 1 to 2 nm. Thereafter, an Al cathode (8) was vapor-deposited with a thickness of 150 nm by using another vacuum vapor-deposit device to manufacture an OLED.

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Alq



Liq

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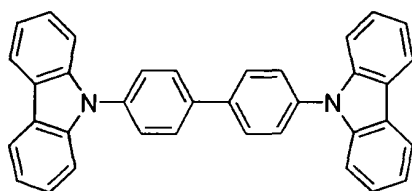
[Comparative Example 1] Manufacture of an OLED by using conventional phosphorescent host

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[0100] After forming a hole injection layer and hole transport layer according to the same procedure described in Example 1, an electroluminescent layer was vapor-deposited as follows.

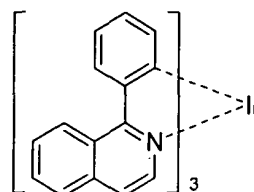
[0101] To another cell of said vacuum vapor-deposit device, charged was 4,4'-N,N'-dicarbazole-biphenyl (CBP) as an electroluminescent host material, and a red phosphorescent compound according to the present invention (Compound D-4) was charged to still another cell. The two materials were evaporated at different rates to carry out doping, thereby vapor-depositing an electroluminescent layer (5) having 30 nm of thickness on the hole transport layer. Preferable doping concentration is from 4 to 10% by weight on the basis of CBP.

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CBP

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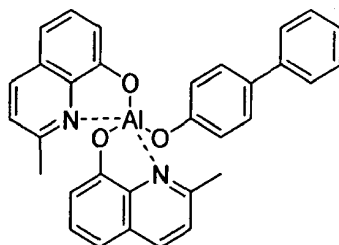


D-4

[0102] Then, bis(2-methyl-8-quinolinato)(p-phenylphenolato)aluminum (III) (BAIq) was vapor-deposited as a hole blocking layer on the electroluminescent layer, according to the same procedure for NPB, and tris(8-hydroxyquinoline) aluminum (III) (Alq) was then vapor-deposited as an electron transport layer (6) with a thickness of 20 nm. Thereafter, lithium quinolate (Liq) was vapor-deposited as an electron injection layer (7) with a thickness of 1 to 2 nm, and an Al cathode (8) was vapor-deposited thereon with a thickness of 150 nm by using another vacuum vapor-deposit device to manufacture an OLED.

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BAIq

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[Experimental Example 1] Determination of properties of OLED's manufactured

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[0103] In order to examine the performance of OLED's, luminous efficiencies of an OLED's of Example 1 comprising the electroluminescent compound according to the invention, and an OLED prepared from Comparative Example 1

comprising a conventional electroluminescent compound were measured at 10 mA/cm<sup>2</sup>, and the results are shown in Table 5.

Table 5

Material	Host	Hole blocking layer	EL color	Operation voltage	Max. luminous efficiency (cd/A)
D-4	H-26	-	Red	7.5	7.8
D-6	H-25	-	Red	7.3	12.6
D-10	H-28	-	Red	7.5	8.4
D-112	H-30	-	Red	7.3	9.0
D-113	H-36	-	Red	7.1	11.4
D-114	H-57	-	Red	7.2	7.2
D-115	H-58	-	Red	7.0	11.6
D-116	H-59	-	Red	7.1	10.5
D-117	H-78	-	Red	7.4	13.6
D-118	Comp.19	-	Red	7.1	11.1
D-119	Comp.128	-	Red	7.4	12.3
D-120	Comp.133	-	Red	7.3	11.3
D-121	Comp.286	-	Red	7.1	11.7
Comp.(D-4)	CBP	BAIq	Red	8.3	6.5

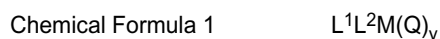
**[0104]** By using the host and dopant according to the present invention, red phosphorescent EL devices having high efficiency of maximum 12.6 cd/A could be manufactured. When the host according to the present invention is used without using a hole blocking layer, the OLED manufactured shows comparable or superior efficiency to the device manufactured by using conventional phosphorescent EL host, CBP.

**[0105]** The device according to the invention can noticeably lower the power consumption of the OLED, with lowering the operation voltage by 0.9~1.7 V.

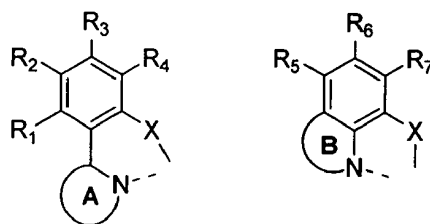
**[0106]** If the invention is applied to mass production of OLED's, the time for mass production can be also shortened to give great benefit on the commercialization.

## Claims

1. An electroluminescent device comprised of a first electrode; a second electrode; and at least one organic layer(s) interposed between the first electrode and the second electrode; wherein the organic layer comprises one or more host compound(s) represented by Chemical Formula (1):



wherein, the ligands, L<sup>1</sup> and L<sup>2</sup> are independently selected from the following structures:



wherein, M represents a divalent or trivalent metal;

y is 0 when M is a divalent metal, while y is 1 when M is a trivalent metal;

Q represents (C6-C60)aryloxy or tri(C6-C60)arylsilyl, and the aryloxy or triarylsilyl of Q may be further substituted by (C1-C60)alkyl or (C6-C60)aryl;

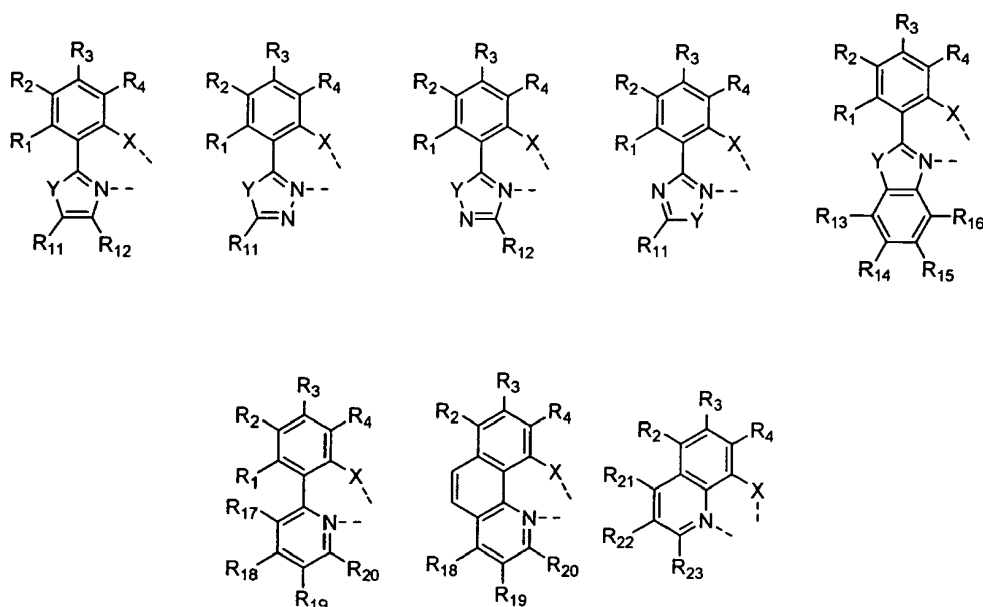
X represents O, S or Se;

ring A and ring B independently represent a 5- or 6-membered heteroaromatic ring, or a 5- or 6-membered heteroaromatic ring with a (C6-C60)aromatic ring fused; ring A may form a chemical bond with R<sub>1</sub> to form a fused ring, and ring A or ring B may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, (C1-C60)alkyl substituted by halogen, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino;

R<sub>1</sub> through R<sub>7</sub> independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, (C6-C60)aryl, (C4-C60)heteroaryl, di(C1-C30)alkylamino and di(C6-C30)arylamino; or each of them may be linked to an adjacent substituent via alkylene or alkenylene to form a fused ring; and

the aryl or heteroaryl to be substituted on ring A or ring B, or the aryl, heteroaryl of R<sub>1</sub> through R<sub>7</sub>, or the fused ring formed by linkage to an adjacent substituent via alkylene or alkenylene may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino.

2. The electroluminescent device according to claim 1, wherein the ligands L<sup>1</sup> and L<sup>2</sup> are independently selected from the following structures:



wherein, X, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are defined as in claim 1;

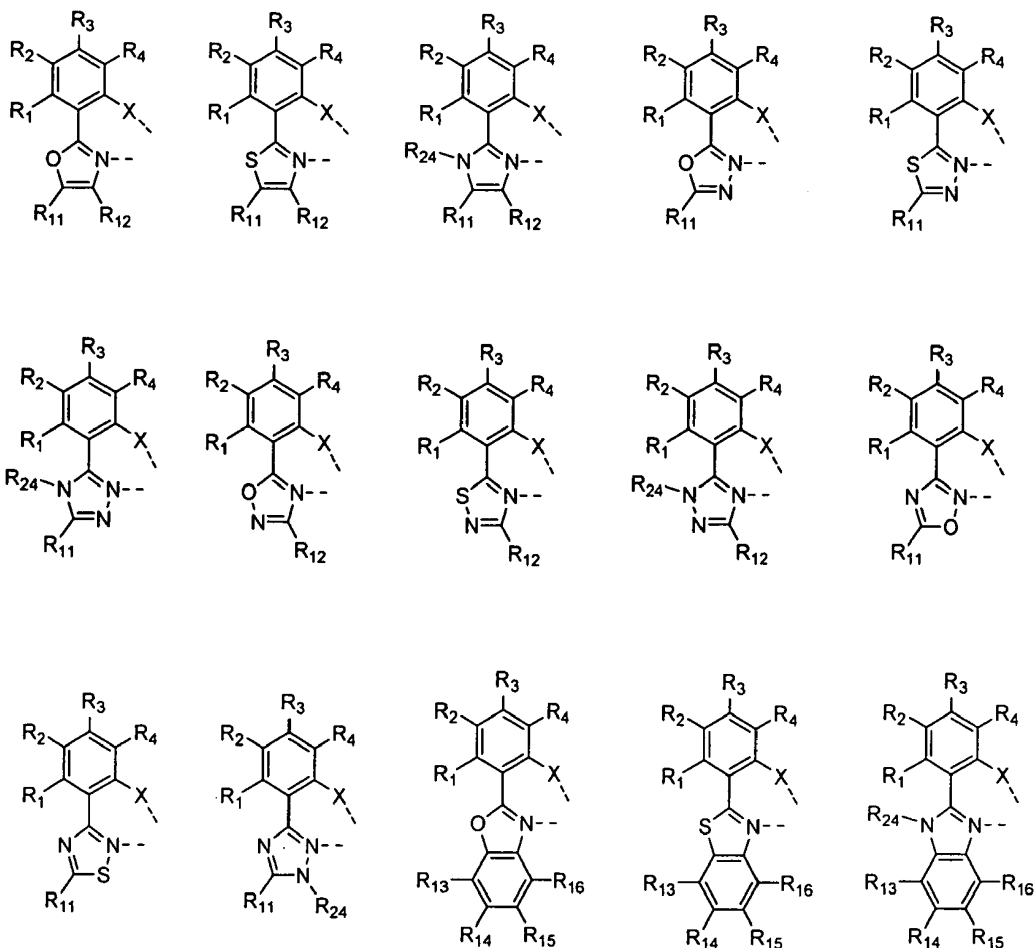
Y represents O, S or NR<sub>24</sub>;

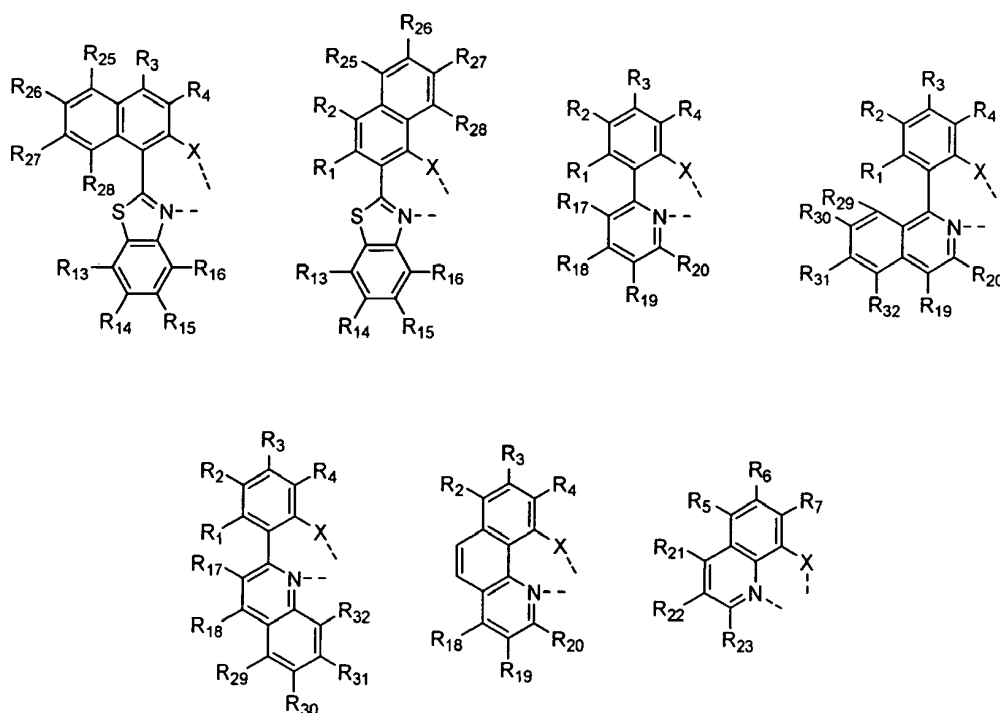
R<sub>11</sub> through R<sub>23</sub> independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylamino; or each of R<sub>13</sub> through R<sub>16</sub> and R<sub>17</sub> through R<sub>20</sub> may be linked to an adjacent substituent via alkylene or alkenylene to form a fused ring; and the fused ring may be substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino;

R<sub>24</sub> represents (C1-C60)alkyl or (C6-C60)aryl; and

the aryl or heteroaryl of R<sub>11</sub> through R<sub>24</sub> may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylamino.

3. The electroluminescent device according to claim 2, wherein the ligands, L<sup>1</sup> and L<sup>2</sup> are independently selected from the following structures:





wherein, X is defined as in claim 1;

$R_1$  through  $R_7$  independently represent hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, (C6-C60)aryl, (C4-C60)heteroaryl, di(C1-C30)alkylamino or di(C6-C30)arylmino;

$R_{11}$  through  $R_{23}$  independently represents hydrogen, (C1-C60)alkyl, halogen, (C1-C60)alkyl with halogen substituent(s), (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylmino;

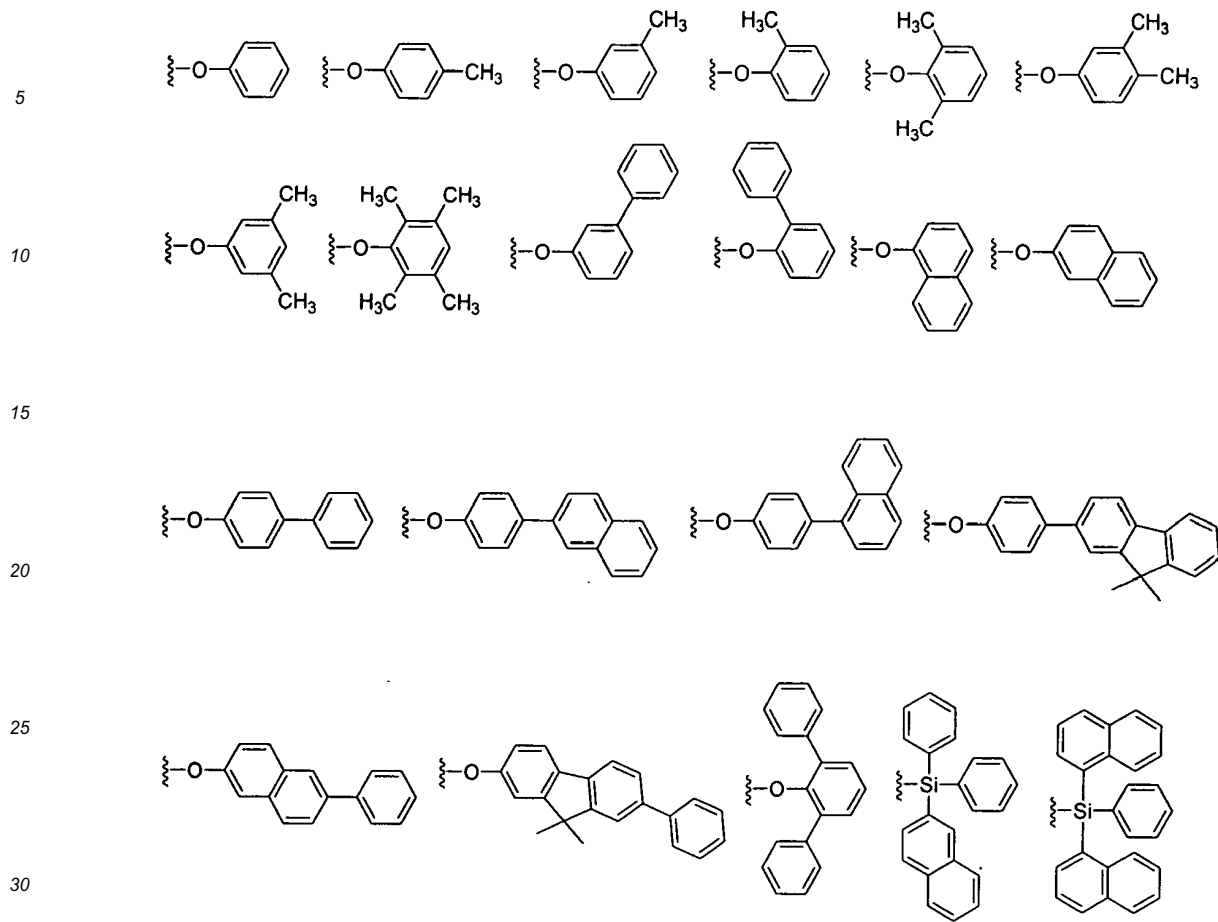
$R_{24}$  represents (C1-C60)alkyl, (C6-C60)aryl or (C4-C60)heteroaryl;

$R_{25}$  through  $R_{32}$  independently represent hydrogen, (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino or di(C6-C30)arylmino;

the aryl or heteroaryl of  $R_1$  through  $R_7$ ,  $R_{11}$  through  $R_{23}$ ,  $R_{24}$  and  $R_{25}$  through  $R_{32}$  may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, halogen, cyano, (C1-C60)alkyl with halogen substituent(s), (C3-C60)cycloalkyl, (C1-C30)alkoxy, (C6-C60)aryl, (C4-C60)heteroaryl, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, di(C1-C30)alkylamino and di(C6-C30)arylmino.

4. The electroluminescent device according to claim 1, wherein M is a bivalent metal selected from Be, Zn, Mg, Cu and Ni, or a trivalent metal selected from Al, Ga, In and B.

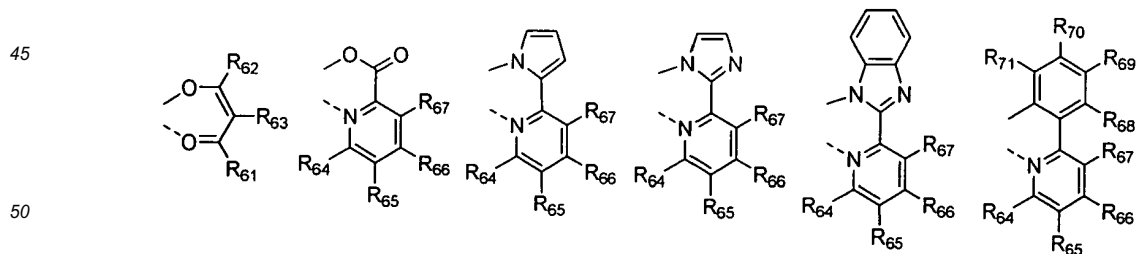
5. The electroluminescent device according to claim 1, wherein Q is selected from the following structures:

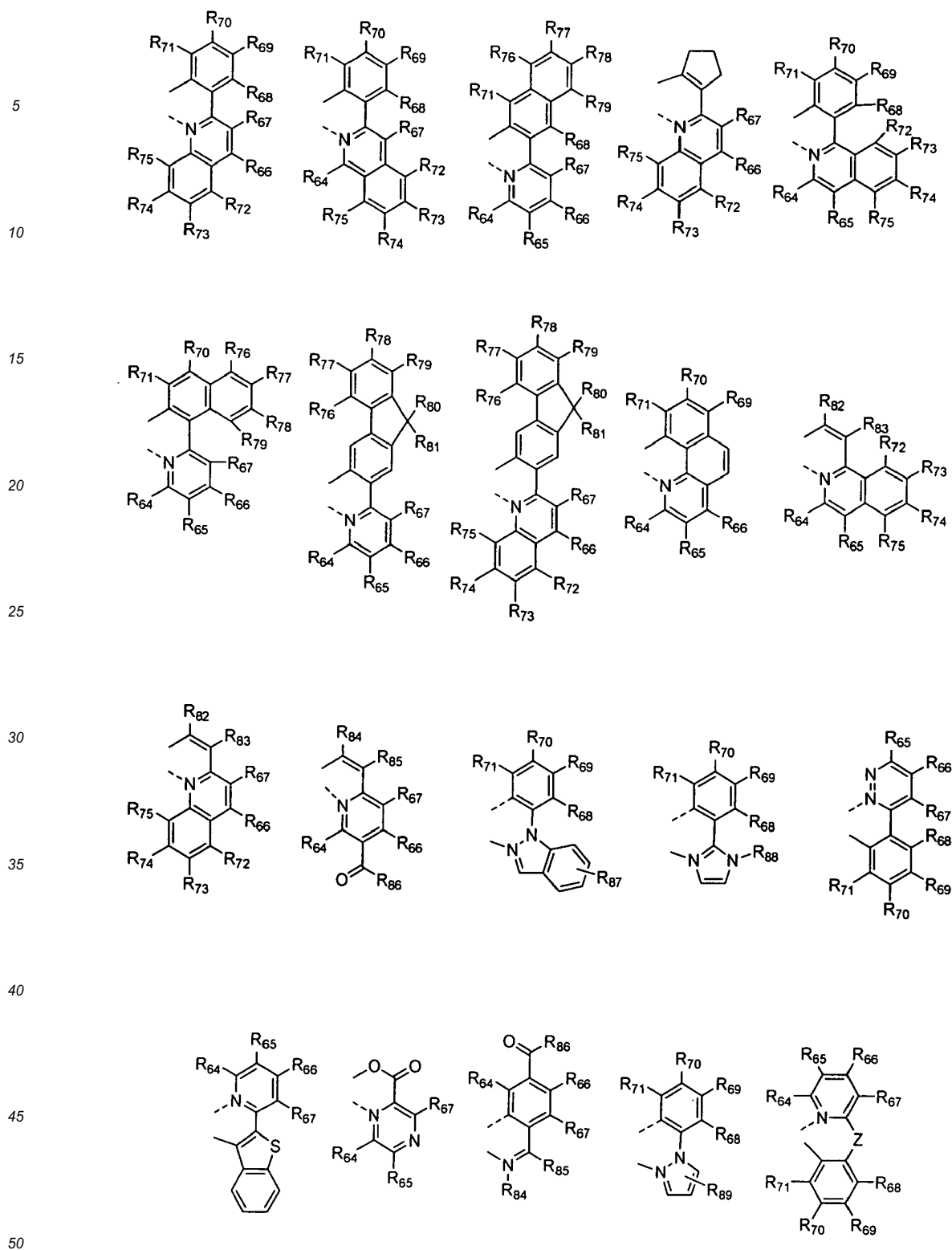


- 35 6. The electroluminescent device according to claim 1, wherein the organic layer comprises an electroluminescent region, which comprises one or more host compound(s) represented by Chemical Formula (1) in claim 1, and one or more electroluminescent dopant(s) represented by Chemical Formula (2):



40 wherein,  $M^1$  is selected from a group consisting of Group 7, 8, 9, 10, 11, 13, 14, 15 and 16 in the Periodic Table, and ligands  $L^3$ ,  $L^4$  and  $L^5$  are independently selected from the following structures:





wherein, R<sub>61</sub> through R<sub>63</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), (C6-C60)aryl with or without (C1-C60)alkyl substituent(s), or halogen;

55 R<sub>64</sub> through R<sub>79</sub> independently represent hydrogen, (C1-C60)alkyl, (C1-C30)alkoxy, (C3-C60)cycloalkyl, (C2-C30)alkenyl, (C6-C60)aryl, mono or di(C1-C30)alkylamino, mono or di(C6-C30)arylamino, SF<sub>5</sub>, tri(C1-C30)alkylsilyl, di(C1-C30)alkyl(C6-C30)arylsilyl, tri(C6-C30)arylsilyl, cyano or halogen; or each of R<sub>70</sub> through R<sub>76</sub> may be linked to an adjacent substituent via (C2-C12)alkylene or (C2-C12)alkenylene to form a fused ring or

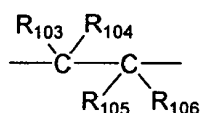
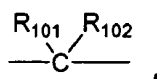
a multi-fused ring; and the alkyl, cycloalkyl, alkenyl or aryl of R<sub>64</sub> through R<sub>79</sub>, or the fused ring or multi-fused ring formed from R<sub>70</sub> and R<sub>76</sub> by linkage via alkylene or alkenylene may be further substituted by one or more substituent(s) selected from (C1-C60)alkyl, (C6-C60)aryl and halogen;

R<sub>80</sub> through R<sub>83</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent(s), or (C6-C60)aryl with or without (C1-C60)alkyl substituent(s);

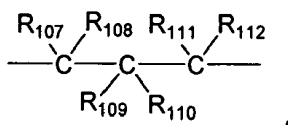
R<sub>84</sub> and R<sub>85</sub> independently represents hydrogen, linear or branched (C1-C60)alkyl, (C6-C60)aryl or halogen, or R<sub>84</sub> and R<sub>85</sub> may be linked via (C3-C12)alkylene or (C3-C12)alkenylene with or without a fused ring to form an alicyclic ring or a monocyclic or polycyclic aromatic ring; and the alkyl, aryl or the alicyclic ring or the monocyclic or polycyclic aromatic ring formed therefrom by linkage via (C3-C12)alkylene or (C3-C12)alkenylene may be further substituted by one or more substituent(s) selected from linear or branched (C1-C60)alkyl with or without halogen substituent(s), (C1-C30)alkoxy, halogen, tri(C1-C30)alkylsilyl, tri(C6-C30)arylsilyl and (C6-C60)aryl; R<sub>86</sub> represents (C1-C60)alkyl, (C6-C60)aryl, (C5-C60)heteroaryl or halogen;

R<sub>87</sub> through R<sub>89</sub> independently represent hydrogen, (C1-C60)alkyl, (C6-C60)aryl or halogen, and the alkyl or aryl of R<sub>86</sub> through R<sub>89</sub> may be further substituted by halogen or (C1-C60)alkyl; and

Z represents



or

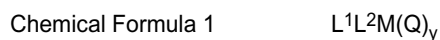


wherein R<sub>101</sub> through R<sub>112</sub> independently represent hydrogen, (C1-C60)alkyl with or without halogen substituent (s), (C1-C30)alkoxy, halogen, (C6-C60)aryl, cyano or (C5-C60) cycloalkyl, or each of R<sub>101</sub> through R<sub>112</sub> may be linked to an adjacent substituent via alkylene or alkenylene to form a (C5-C7) spiro ring or a (C5-C9) fused ring, or they may be linked to R<sub>67</sub> or R<sub>68</sub> via alkylene or alkenylene to form a (C5-C7) fused ring.

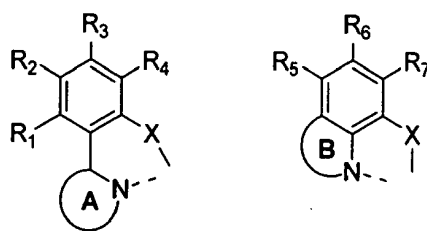
7. The electroluminescent device according to claim 6, wherein the organic layer comprises one or more compound (s) selected from a group consisting of arylamine compounds and styrylarylamine compounds.
8. The electroluminescent device according to claim 6, wherein the organic layer comprises one or more metal(s) selected from a group consisting of organic metals of Group 1, Group 2, 4<sup>th</sup> period and 5<sup>th</sup> period transition metals, lanthanide metals and d-transition elements.
9. The electroluminescent device according to claim 6, which is an organic display which further comprises a compound having the electroluminescent peak with wavelength of not more than 560 nm, in the organic layer.
10. The electroluminescent device according to claim 6, wherein the organic layer comprises an electroluminescent layer and a charge generating layer.
11. The electroluminescent device according to claim 6, wherein a mixed region of reductive dopant and organic sub-

stance, or a mixed region of oxidative dopant and organic substance is placed on the inner surface of one or both electrode(s) among the pair of electrodes.

12. The electroluminescent device according to claim 6, wherein the doping concentration of the electroluminescent dopant to the host in said electroluminescent region is from 1 to 20% by weight.
13. An organic solar cell which comprises an organic electroluminescent compound represented by Chemical Formula (1):



wherein, the ligands, L<sup>1</sup> and L<sup>2</sup> are independently selected from the following structures:



wherein, M represents a divalent or trivalent metal;

y is 0 when M is a divalent metal, while y is 1 when M is a trivalent metal;

Q represents (C<sub>6</sub>-C<sub>60</sub>)aryloxy or tri(C<sub>6</sub>-C<sub>60</sub>)arylsilyl, and the aryloxy or triarylsilyl of Q may be further substituted by (C<sub>1</sub>-C<sub>60</sub>)alkyl or (C<sub>6</sub>-C<sub>60</sub>)aryl;

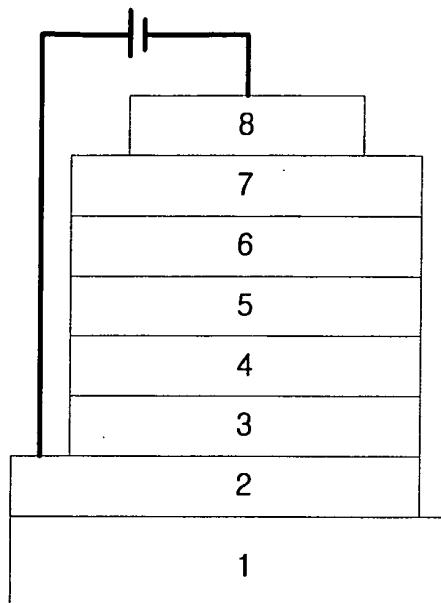
X represents O, S or Se;

ring A and ring B independently represent a 5- or 6-membered heteroaromatic ring, or a 5- or 6-membered heteroaromatic ring with a (C<sub>6</sub>-C<sub>60</sub>)aromatic ring fused; ring A may form a chemical bond with R<sub>1</sub> to form a fused ring, and ring A or ring B may be further substituted by one or more substituent(s) selected from (C<sub>1</sub>-C<sub>60</sub>)alkyl, halogen, (C<sub>1</sub>-C<sub>60</sub>)alkyl substituted by halogen, (C<sub>6</sub>-C<sub>60</sub>)aryl, (C<sub>4</sub>-C<sub>60</sub>)heteroaryl, tri(C<sub>1</sub>-C<sub>30</sub>)alkylsilyl, di(C<sub>1</sub>-C<sub>30</sub>)alkyl(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, tri(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, di(C<sub>1</sub>-C<sub>30</sub>)alkylamino and di(C<sub>6</sub>-C<sub>30</sub>)arylamino;

R<sub>1</sub> through R<sub>7</sub> independently represent hydrogen, (C<sub>1</sub>-C<sub>60</sub>)alkyl, halogen, (C<sub>1</sub>-C<sub>60</sub>)alkyl with halogen substituent(s), tri(C<sub>1</sub>-C<sub>30</sub>)alkylsilyl, di(C<sub>1</sub>-C<sub>30</sub>)alkyl(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, tri(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, (C<sub>6</sub>-C<sub>60</sub>)aryl, (C<sub>4</sub>-C<sub>60</sub>)heteroaryl, di(C<sub>1</sub>-C<sub>30</sub>)alkylamino and di(C<sub>6</sub>-C<sub>30</sub>)arylamino; or each of them may be linked to an adjacent substituent via alkylene or alkenylene to form a fused ring; and

the aryl or heteroaryl to be substituted on ring A or ring B, or the aryl, heteroaryl of R<sub>1</sub> through R<sub>7</sub>, or the fused ring formed by linkage to an adjacent substituent via alkylene or alkenylene may be further substituted by one or more substituent(s) selected from (C<sub>1</sub>-C<sub>60</sub>)alkyl, halogen, cyano, (C<sub>1</sub>-C<sub>60</sub>)alkyl with halogen substituent(s), (C<sub>3</sub>-C<sub>60</sub>)cycloalkyl, (C<sub>1</sub>-C<sub>30</sub>)alkoxy, (C<sub>6</sub>-C<sub>60</sub>)aryl, (C<sub>4</sub>-C<sub>60</sub>)heteroaryl, tri(C<sub>1</sub>-C<sub>30</sub>)alkylsilyl, di(C<sub>1</sub>-C<sub>30</sub>)alkyl(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, tri(C<sub>6</sub>-C<sub>30</sub>)arylsilyl, di(C<sub>1</sub>-C<sub>30</sub>)alkylamino and di(C<sub>6</sub>-C<sub>30</sub>)arylamino.

Fig. 1





**PARTIAL EUROPEAN SEARCH REPORT**

Application Number

which under Rule 63 of the European Patent Convention EP 08 25 4193 shall be considered, for the purposes of subsequent proceedings, as the European search report

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2004/124769 A1 (ISE TOSHIHIRO [JP] ET AL) 1 July 2004 (2004-07-01) * paragraphs [0006], [0096] * compounds 20,23,25,26,28,30,31,33,36,37,39,41,42,43, 45,47,49,50,56,57,60,61,65,66,67,77-79,81, 82,86-88,106,108, 116-118 * claims 1,9,13 *	1-12	INV. C09K11/06 C07F3/06 C07F5/06 H05B33/20 H01L51/00 C07F3/00
X	WO 2004/055130 A (FUJI PHOTO FILM CO LTD [JP]; ISE TOSHIHIRO [JP]; IGARASHI TATSUYA [JP]) 1 July 2004 (2004-07-01) * page 2 - page 5 * * page 7 * * page 8, paragraph 2 - page 9 * * page 11 * compounds 31-36, 39, 41, 44, 46, 47, 49, 51, 52, 54, 56-60, H-4 (page 53), * claim 1 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			C07F H01L H05B C09K
<b>INCOMPLETE SEARCH</b>			
<p>The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims.</p> <p>Claims searched completely :</p> <p>Claims searched incompletely :</p> <p>Claims not searched :</p> <p>Reason for the limitation of the search: see sheet C</p>			
Place of search		Date of completion of the search	Examiner
The Hague		17 June 2009	Ziegler, Jan
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

4  
EPO FORM 1503 03/02 (P04E07)



PARTIAL EUROPEAN SEARCH REPORT

Application Number  
EP 08 25 4193

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (IPC)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	EP 1 394 235 A (FUJI PHOTO FILM CO LTD [JP]) 3 March 2004 (2004-03-03) * paragraphs [0008], [0092] * compounds E-32, E-37, E-38, E-62, E-63, E-64, E-78, E-84, E-86, E-87, E-89, E-90, E-93, E-101, E-102, * claims 1,4,8 *	1-12	
E	EP 2 034 001 A (GRACEL DISPLAY INC [KR]) 11 March 2009 (2009-03-11) * claims 1,20 * -----	13	
			TECHNICAL FIELDS SEARCHED (IPC)

**INCOMPLETE SEARCH  
SHEET C**Application Number  
EP 08 25 4193

Claim(s) searched incompletely:  
1-13

Reason for the limitation of the search:

The present claim 1 relates to an extremely large number of possible compounds. Support within the meaning of Article 84 EPC and disclosure within the meaning of Article 83 EPC is to be found, however, for only a very small proportion of the products claimed (see page 58-62: divalent metals = Zn, Be; trivalent metal = Al; X = O, S for M = Zn and X = O for M = Al). In the present case, the claim 1 so lacks support, and the application so lacks disclosure. Non-compliance with the substantive provisions is such that a meaningful search of the whole claimed subject-matter of the claim could not be carried out (Rule 63 EPC and Guidelines B-VIII, 3). The extent of the search was consequently limited.

The search of claim 1 was restricted to those claimed compounds which appear to be supported and to a generalisation of their structural formulae (In L1 and L2 the metal M = Be, Zn, Mg, Cu, Ni, Al, Ga, In and B. X, R1-R6, A, B, Q, y are as disclosed in claim 1).

The reasoning of claim 1 applies mutatis mutandis for claim 13.



Application Number

EP 08 25 4193

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing claims for which payment was due.

- Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):
- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:
- The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION  
SHEET B**

Application Number  
EP 08 25 4193

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12

host material and OLED comprising the same  
---

2. claim: 13

solar cell comprising a host material  
---

ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 08 25 4193

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-06-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004124769 A1	01-07-2004	NONE	
WO 2004055130 A	01-07-2004	AU 2003294176 A1 EP 1572831 A1 KR 20050084398 A TW 239786 B US 2006052607 A1	09-07-2004 14-09-2005 26-08-2005 11-09-2005 09-03-2006
EP 1394235 A	03-03-2004	WO 02079343 A1 TW 546988 B US 2004072017 A1	10-10-2002 11-08-2003 15-04-2004
EP 2034001 A	11-03-2009	JP 2009102307 A KR 100850886 B1 US 2009078317 A1	14-05-2009 07-08-2008 26-03-2009

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- KR 0684109 [0044]

**Non-patent literature cited in the description**

- *Appl. Phys. Lett.*, 1987, vol. 51, 913 [0004]

专利名称(译)	使用电致发光化合物的电致发光器件		
公开(公告)号	<a href="#">EP2080795A1</a>	公开(公告)日	2009-07-22
申请号	EP2008254193	申请日	2008-12-31
申请(专利权)人(译)	GRACEL显示增量.		
当前申请(专利权)人(译)	GRACEL显示增量.		
[标]发明人	KIM HYUN EUM SUNG JIN CHO YOUNG JUN KWON HYUCK JOO KIM BONG OK KIM SUNG MIN YOON SEUNG SOO		
发明人	KIM, HYUN EUM, SUNG JIN CHO, YOUNG JUN KWON, HYUCK JOO KIM, BONG OK KIM, SUNG MIN YOON, SEUNG SOO		
IPC分类号	C09K11/06 C07F3/06 C07F5/06 H05B33/20 H01L51/00 C07F3/00		
CPC分类号	H01L51/0084 C09K11/06 C09K2211/1003 C09K2211/1007 C09K2211/1011 C09K2211/1029 C09K2211/1033 C09K2211/1044 C09K2211/1048 C09K2211/1051 C09K2211/1059 C09K2211/186 C09K2211/188 H01L51/0077 H01L51/0085 H01L51/5016 H05B33/14 Y02E10/549		
优先权	1020070141997 2007-12-31 KR		
外部链接	<a href="#">Espacenet</a>		

摘要(译)

电致发光器件本发明涉及电致发光器件。更具体地，根据本发明的电致发光器件包括第一电极；第二个电极；在第一电极和第二电极之间插入至少一个有机层；有机层包含一种或多种由化学式(1)表示的有机电致发光化合物作为主体材料：化学式1 L1L2M(Q)y其中，配体，L1和L2独立地选自以下结构：其中，M代表二价或三价金属；当M是二价金属时，y是0，而当M是三价金属时，y是1；Q表示(C6-C60)芳氧基或三(C6-C60)芳基甲硅烷基，Q的芳氧基或三芳基甲硅烷基可进一步被(C1-C60)烷基或(C6-C60)芳基取代。根据本发明的电致发光器件表现出优异的色纯度和发光效率。

