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(54) **IMIDAZOLE DERIVATIVE, MATERIAL AND ORGANIC LIGHT-EMITTING DEVICE COMPRISING THE SAME**

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(52) **U.S. Cl.**

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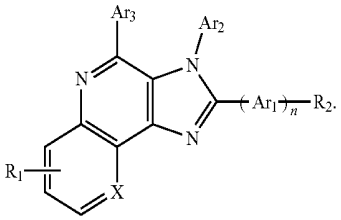
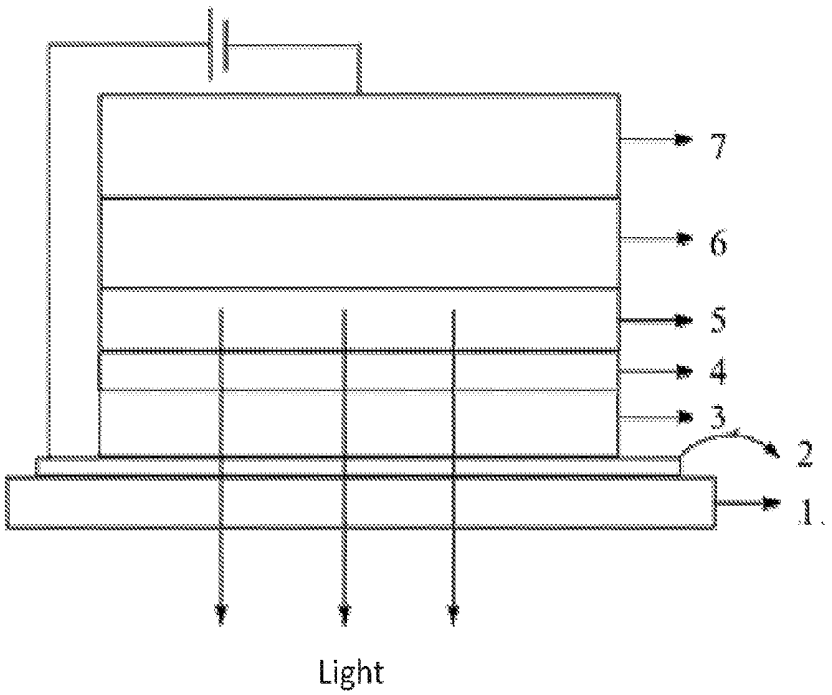
(57) **ABSTRACT**

There is provided an imidazole derivative, wherein the structural formula of the imidazole derivative is as represented by formula



There is further provided a material containing the imidazole derivative and an organic light-emitting device containing the imidazole derivative. The imidazole derivative has an excellent carrier transport capacity, and the organic light-emitting device produced by using the material has obviously reduced starting voltage and improved luminous efficiency and luminance; and due to the features such as relatively good film-forming performance and simple material synthesis and purification methods which are applicable to mass production, the imidazole derivative is an ideal option for an electron transport material of organic light-emitting devices.



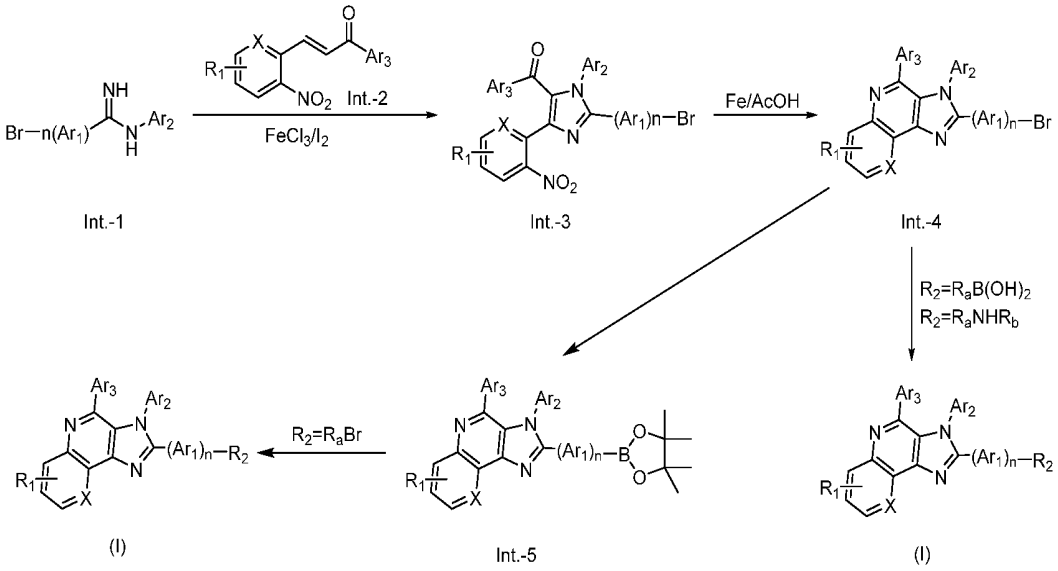

Int.-1
Int.-2
FeCl3/I2
Int.-3
Fe/AcOH
Int.-4
R2=RaB(OH)2
R2=RaNHRb
R2=RaBr
(I)
Int.-5
(I)

FIG.1

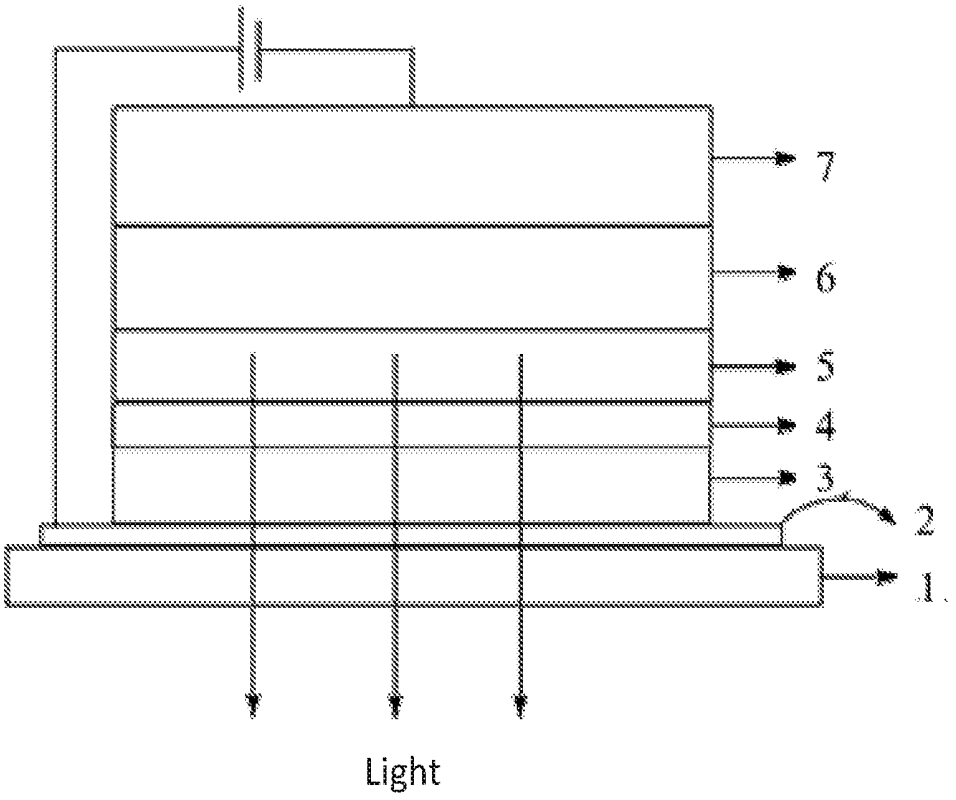

7
6
5
4
3
2
1
Light

FIG. 2

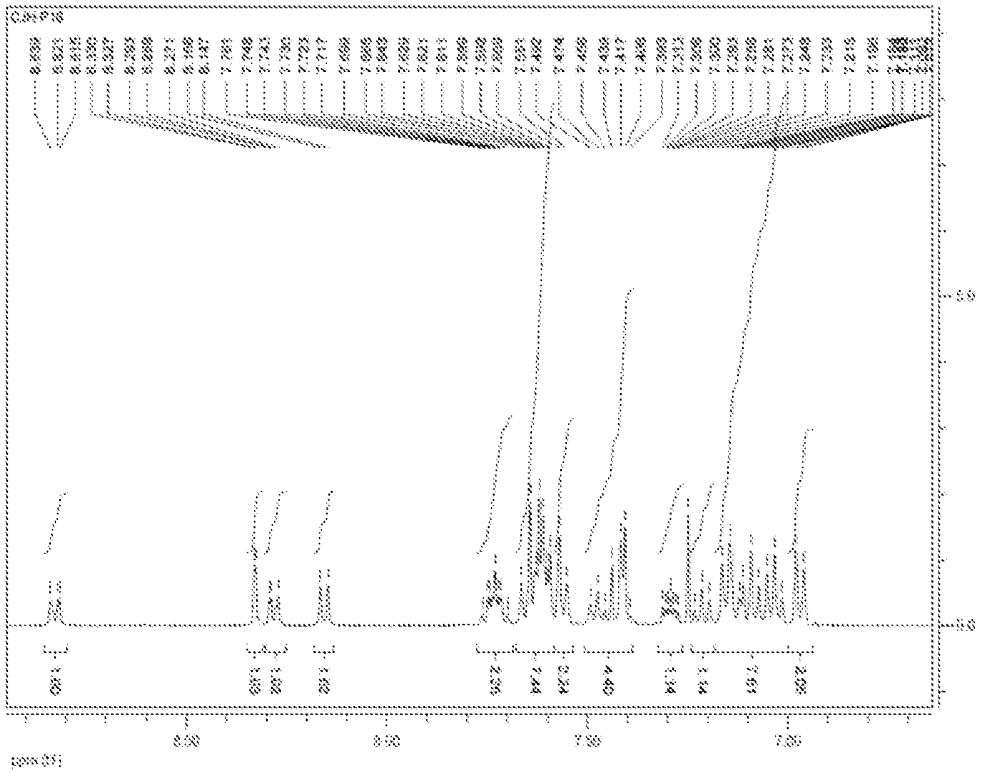


FIG.3

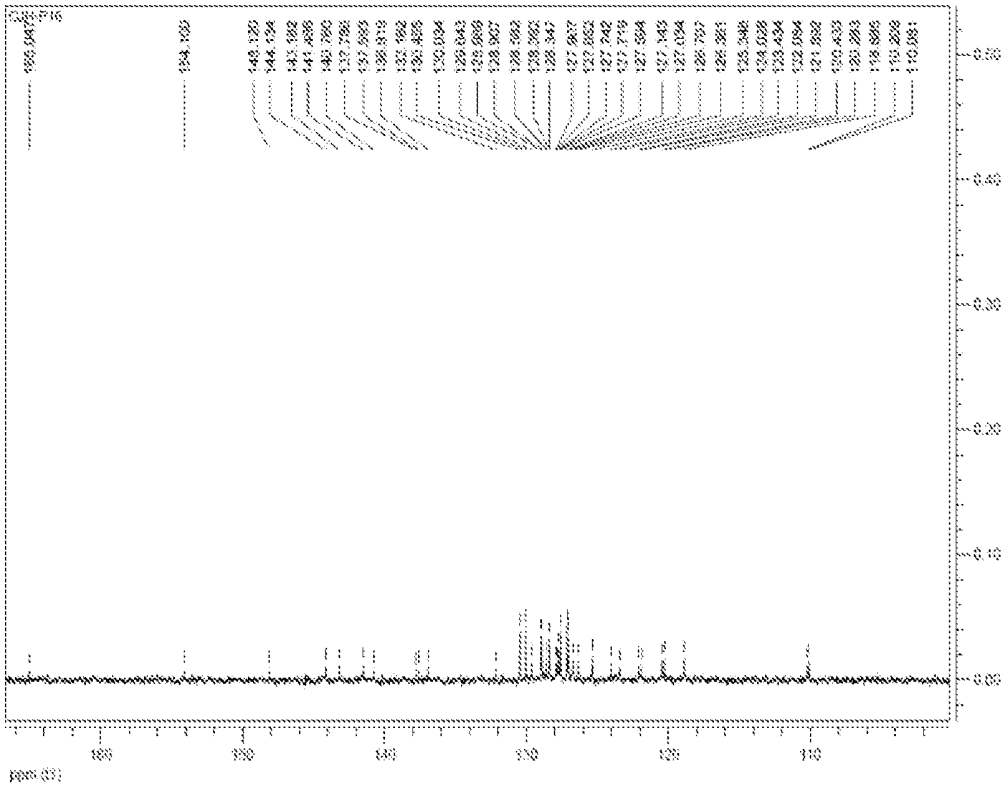


FIG.4

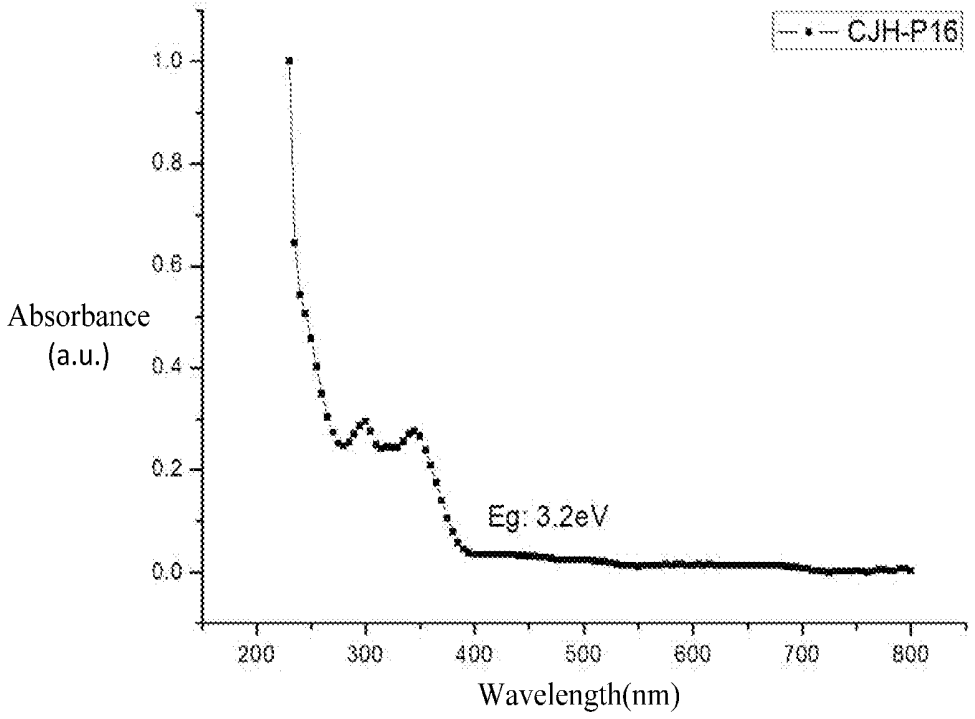

CJH-P16
Absorbance
(a.u.)
1.0
0.8
0.6
0.4
0.2
0.0
Eg: 3.2eV
200
300
400
500
600
700
800
Wavelength(nm)

FIG.5

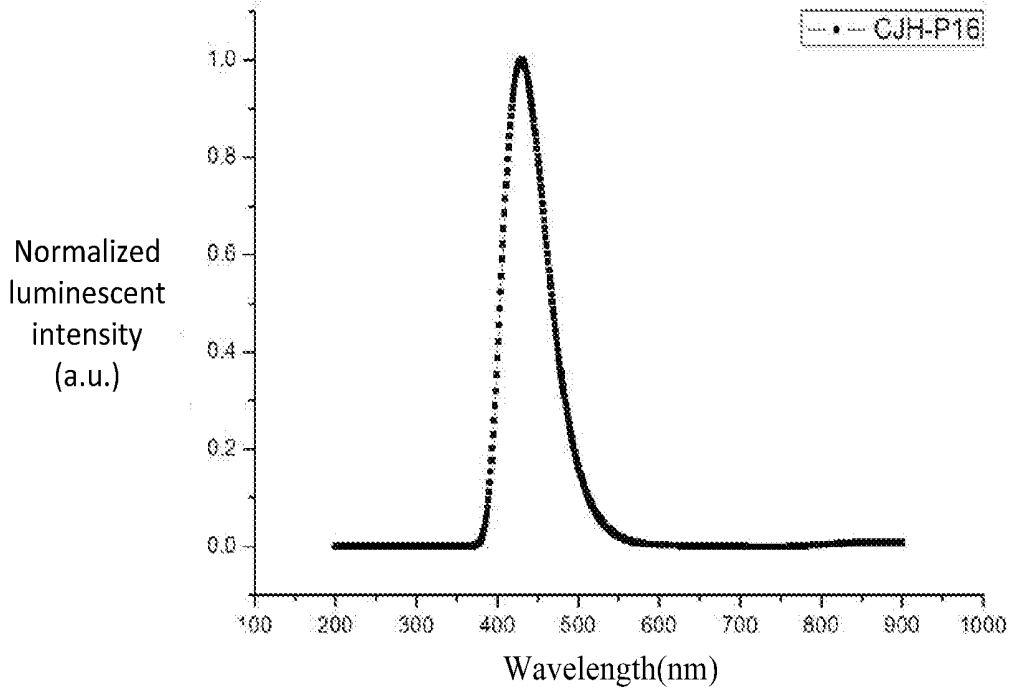

CJH-P16
Normalized
luminescent
intensity
(a.u.)
1.0
0.8
0.6
0.4
0.2
0.0
100
200
300
400
500
600
700
800
900
1000
Wavelength(nm)

FIG.6

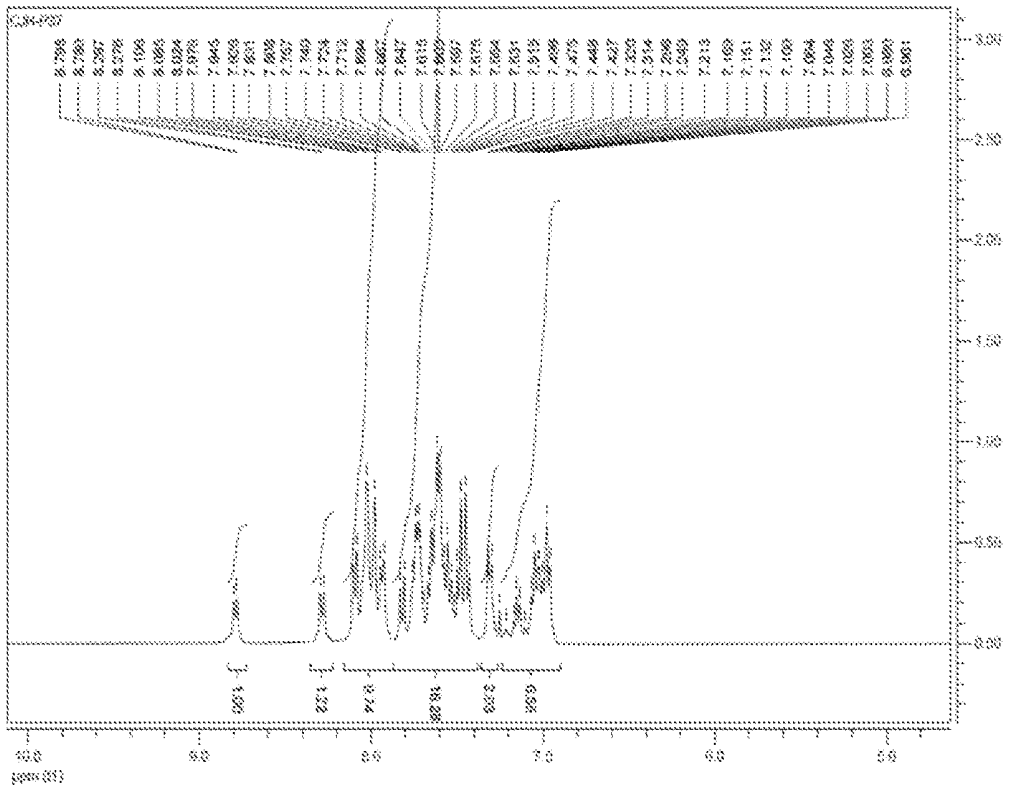


FIG.7

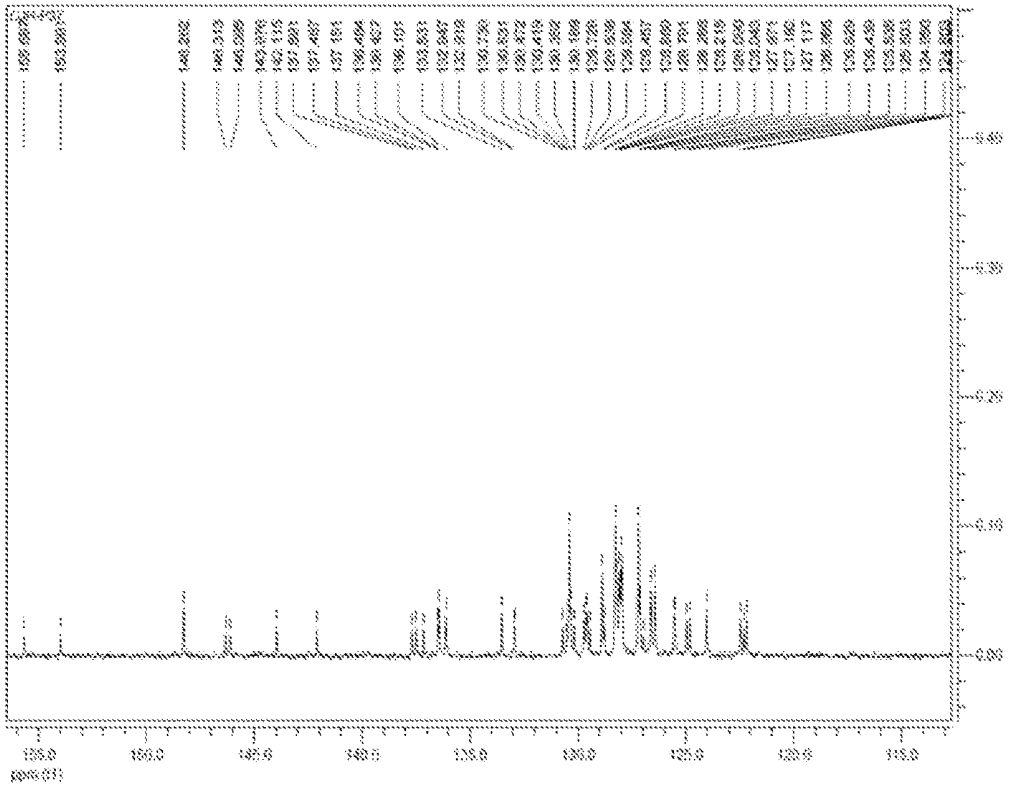


FIG.8

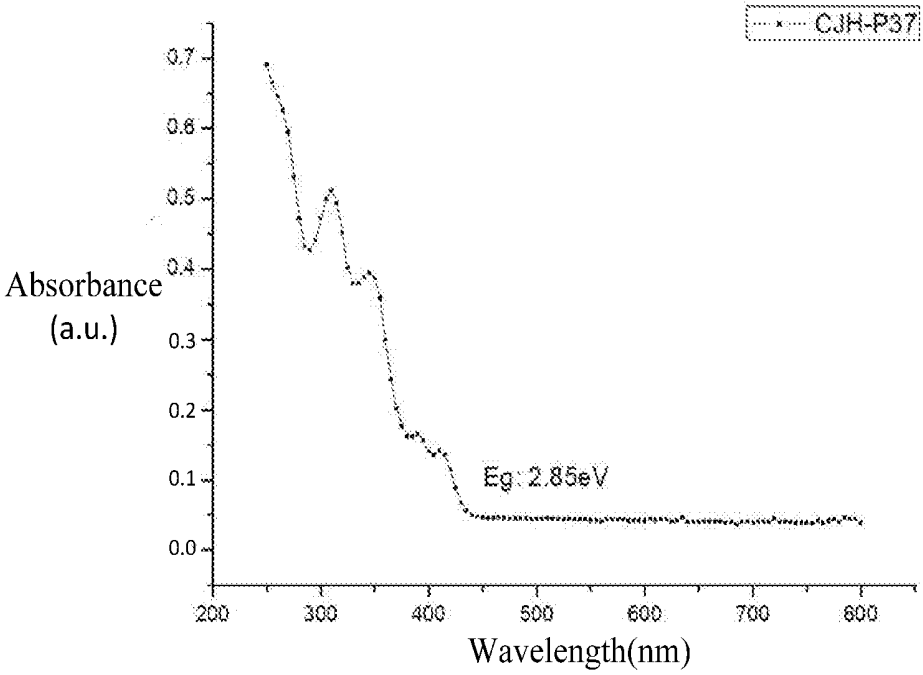

CJH-P37
Absorbance
(a.u.)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Eg: 2.85eV
200
300
400
500
600
700
800
Wavelength(nm)

FIG.9

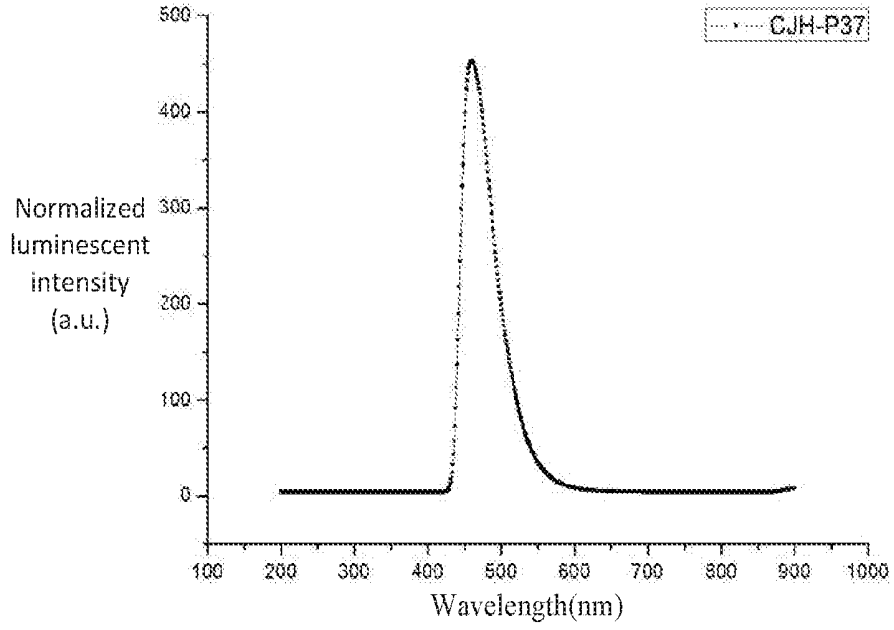

CJH-P37
Normalized
luminescent
intensity
(a.u.)
500
400
300
200
100
0
100
200
300
400
500
600
700
800
900
1000
Wavelength(nm)

FIG.10

IMIDAZOLE DERIVATIVE, MATERIAL AND ORGANIC LIGHT-EMITTING DEVICE COMPRISING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to the technical field of organic light-emitting materials, and in particular to an imidazole derivative, a material and organic light-emitting device comprising the same.

BACKGROUND ART

[0002] Related research on organic light-emitting device (PLED for short) has been carried out as early as 1963, when Pope et al. first discovered the electroluminescence of the organic compound of single crystal anthracene. In 1987, the US Kodak Company produced an amorphous film device by means of evaporation of small organic molecules, reducing the driving voltage to below 20V. Due to the features such as ultra-thinness, full curing, self-luminescence, high luminance, a wide visual angle, a fast response speed, a low driving voltage, low power consumption, bright in colour, high contrast, a simple production process, a good temperature property, and flexible display, such the device can be widely used in flat panel displays and area light sources, and thus has been widely researched, developed and used.

[0003] After more than 20 years of development, organic EL materials have completely implement red, blue, and green light emission, and the application field has been expanded from the field of small molecules to the field such as macromolecules and metal complexes. In recent years, the organic electroluminescence display technology has been matured, and some products have entered the market. However, in industrialization, there are still many urgent problems to be solved, in particular for various organic materials used to produce the devices, there are still many problems which yet have not been solved, such as the carrier injection and transport properties, the material electroluminescence property, the service life, the color purity, and matching between various materials and between various materials and various electrodes. In particular, the light-emitting devices cannot satisfy the practical requirements in terms of the luminous efficiency and service life, which greatly limits the development of the OLED technology. The metal complex phosphorescent material that implements triplet state light emission has high luminous efficiency, and green and red light-emitting materials thereof can satisfy the requirements for use; however, due to the special electronic structural feature of the metal complex, the blue light-emitting material thereof cannot satisfy the requirements for use.

[0004] After more than 20 years of development, organic EL materials have completely implement red, blue, and green light emission, and the application field has been expanded from the field of small molecules to the field such as macromolecules and metal complexes. In recent years, the organic electroluminescence display technology has been matured, and some products have entered the market. However, in industrialization, there are still many urgent problems to be solved, in particular for various organic materials used to produce the devices, there are still many problems which yet have not been solved, such as the carrier injection and transport properties, the material electroluminescence property, the service life, the color purity, and matching between various materials and between various electrodes.

[0005] Therefore, there is a need to provide an imidazole derivative that can improve the electron mobility, reduce the driving voltage, and improve the luminance and efficiency of the device, so as to solve at least one of the above problems.

SUMMARY OF THE INVENTION

[0006] An objective of the present invention is to provide an imidazole derivative.

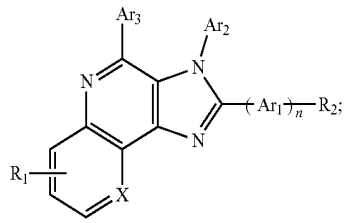
[0007] Another objective of the present invention is to provide a material containing the imidazole derivative.

[0008] A third objective of the present invention is to provide an organic light-emitting device.

[0009] In order to achieve the above objectives, the present invention employs the following technical solutions;

[0010] An imidazole derivative has a structural formula as represented by formula I:

I



[0011] wherein R_1 and R_2 respectively and independently represent hydrogen, deuterium, a C_1-C_8 linear or branched alkyl group, a C_1-C_8 linear or branched alkoxy group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryl vinyl group, a substituted or unsubstituted C_6-C_{60} fused-ring aryl group, a substituted or unsubstituted C_6-C_{60} arylamine group, a substituted or unsubstituted C_6-C_{60} nitrogen atom-containing fused-ring acyl group, a substituted or unsubstituted C_6-C_{60} sulfur or oxygen atom-containing fused-ring aryl group, a substituted or unsubstituted C_6-C_{60} phosphorus, silicon, or boron atom-containing fused-ring aryl group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

[0012] Ar_1, Ar_2, and Ar_3 respectively and independently represent a substituted or unsubstituted phenyl group, a substituted or unsubstituted naphthyl group, a substituted or unsubstituted fluorenyl group, a substituted or unsubstituted spirofluorenyl group, a substituted or unsubstituted anthryl group, a substituted or unsubstituted pyridyl group, a substituted or unsubstituted pyrimidyl group, a substituted or unsubstituted quinolyl group and/or a substituted or unsubstituted carbazolyl group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

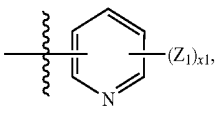
[0013] n represents an integer of 1-5; and

[0014] x represents a carbon atom or a nitrogen atom.

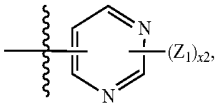
[0015] Preferably, the cyclic structure of the substituted or unsubstituted C_2-C_{60} heterocyclic aryl group contains at least one of N, O, and S atoms.

[0016] Preferably, in the R_1, R_2, Ar_1, Ar_2, and Ar_3 groups, the C_2-C_{60} heterocyclic aryl groups are respectively and independently selected from one or a plurality of the following structures of formulas II-1 to II-15:

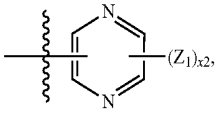
II-1



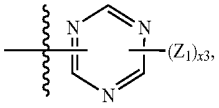
II-2



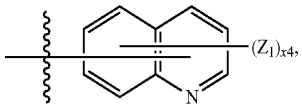
II-3



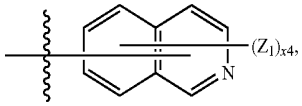
II-4



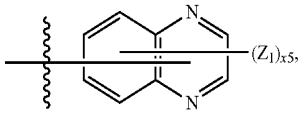
II-5



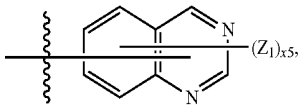
II-6



II-7



II-8



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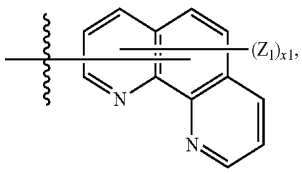
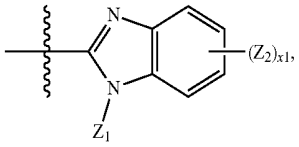
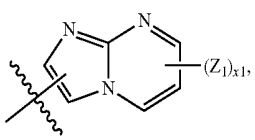


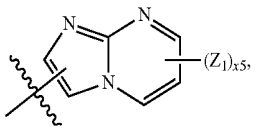
II-10



II-11



II-12



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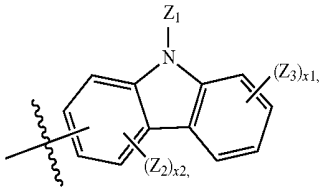
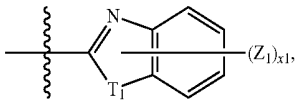
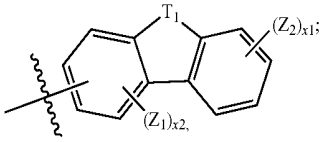
II-13



II-14



II-15



[0017] wherein Z_1, Z_2, and Z_3 respectively and independently represent hydrogen, deuterium, a halogen atom, a hydroxyl group, a nitrile group, a nitro group, an amino group, an amidine group, a hydrazine group, a hydrazone group, a carboxyl group or a carboxylate thereof, a sulfonic group or a sulfonate thereof, a phosphate group or a phosphate thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{60} cycloalkane group, a C_3-C_{60} cycloolefin group, a C_6-C_{60} aryl group, a C_6-C_{60} aryl group containing at least one of —F, —CN, or a C_1-C_{10} alkyl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} aryl thioether group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

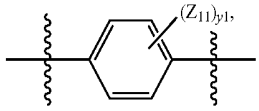
[0018] x1 represents an integer of 1-4; x2 represents an integer of 1-3; x3 represents an integer of 1 or 2; x4 represents an integer of 1-6; x5 represents an integer of 1-5:

[0019] T_1 represents an oxygen atom or a sulfur atom; and

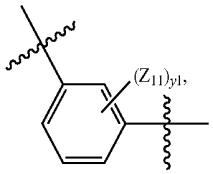
[0020] ∿∿∿ represents a bond between a substituent and a main structure.

[0021] Preferably, Ar_1 contains but is not limited to the following structures of III-1 to III-16:

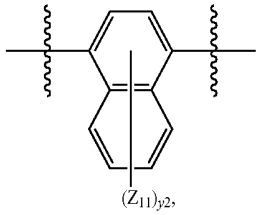
III-1



III-2



III-3



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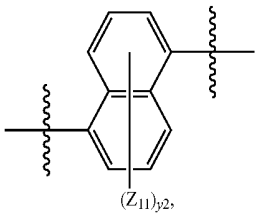
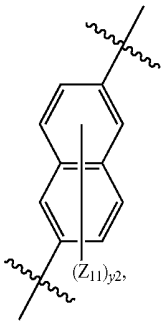
III-4



III-5



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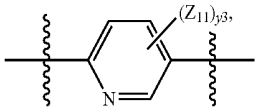
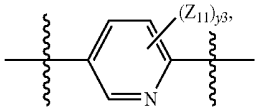
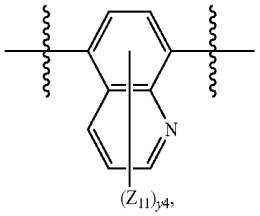


III-7



III-8



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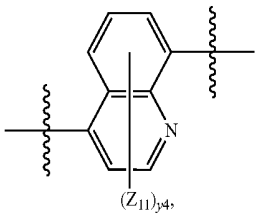
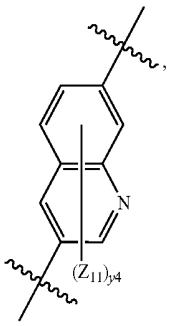


III-11



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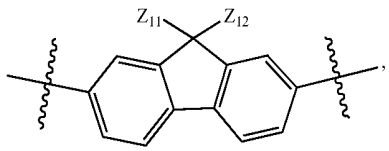
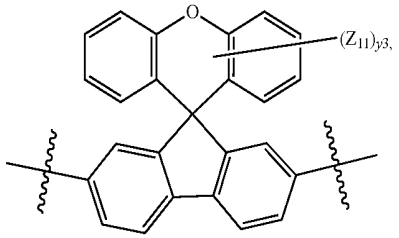
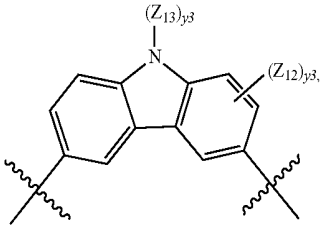
III-12



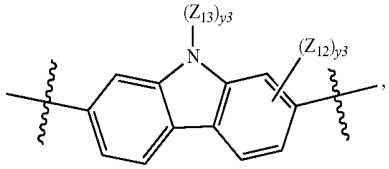
III-13



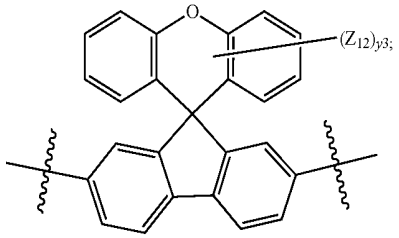
III-14



III-15



III-16



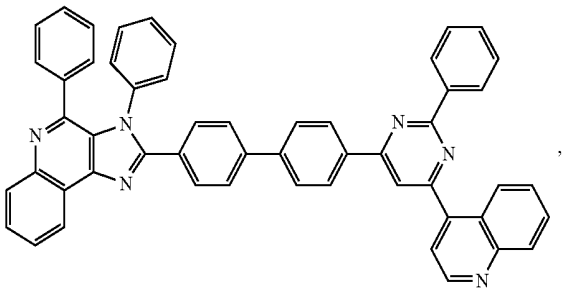
[0022] wherein Z_{11} and Z_{12} respectively and independently represent hydrogen, deuterium, a halogen atom, a hydroxyl group, a nitrile group, a nitro group, an amino group, an amidine group, a hydrazine group, a hydrazone group, a carboxyl group or a carboxylate thereof, a sulfonic group or a sulfonate thereof, a phosphate group or a phosphate thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{60} cycloalkane group, a C_3-C_{60} cycloolefin group, a C_6-C_{60} aryl group, a C_6-C_{60} aryl group containing at least one of —F, —CN, or a C_1-C_{10} alkyl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} aryl thioether group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

[0023] Z_{13} represents a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} aryl thioether group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group; and

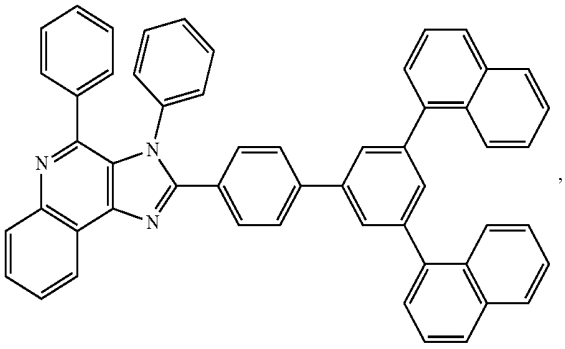
[0024] y1 represents an integer of 1-4; y2 represents an integer of 1-6; y3 represents an integer of 1-3; and y4 represents an integer of 1-5.

[0025] Preferably, the structural formula of the compound having a structural formula I is specifically represented by any one of but is not limited to the following formulas CJH-P01 to CJH-P100:

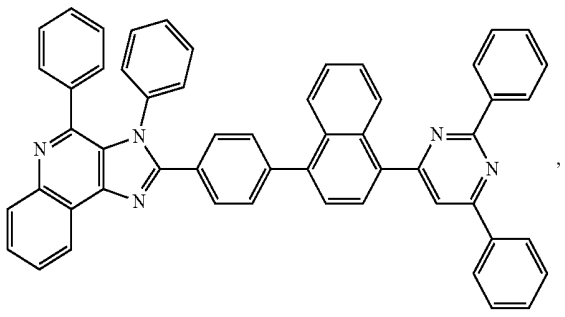
CJH-P01



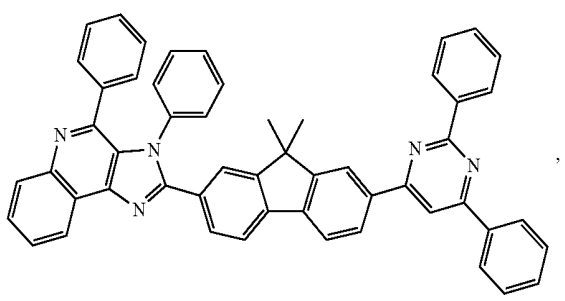
CJH-P02



CJH-P03



CJH-P04



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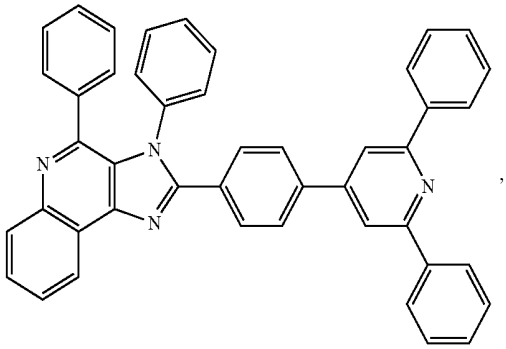
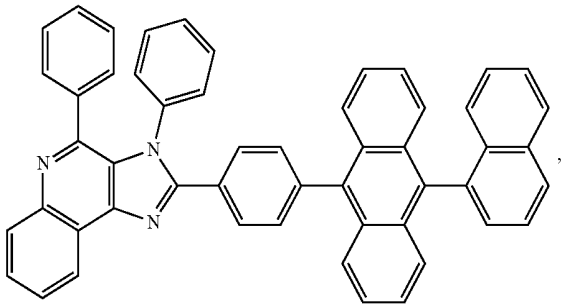
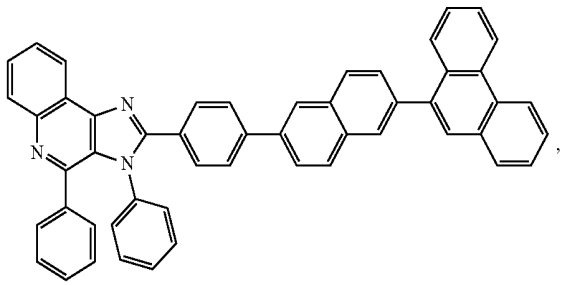
CJH-P05



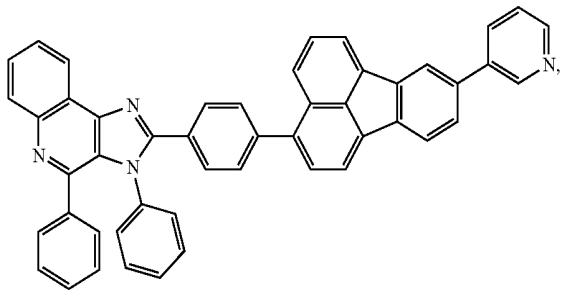
CJH-P06



CJH-P07



CJH-P08



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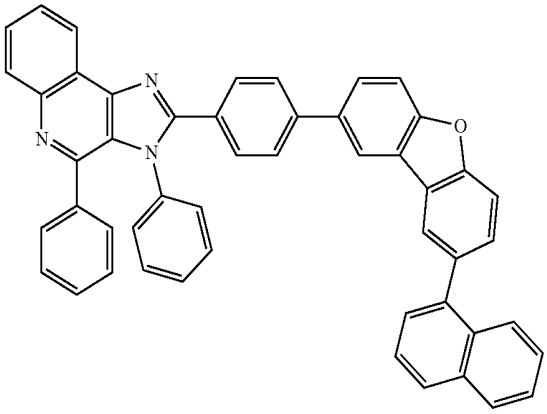
CJH-P09



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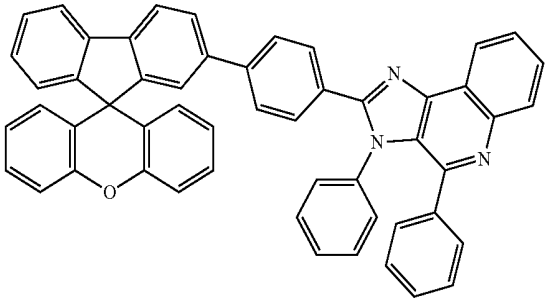
CJH-P10



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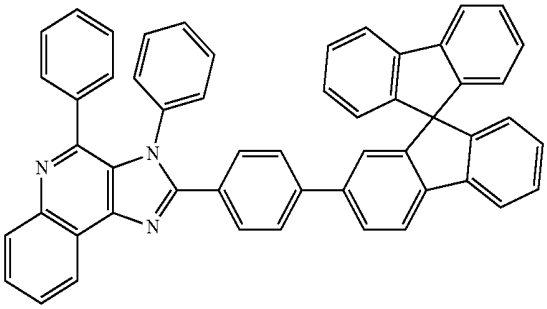
CJH-P11



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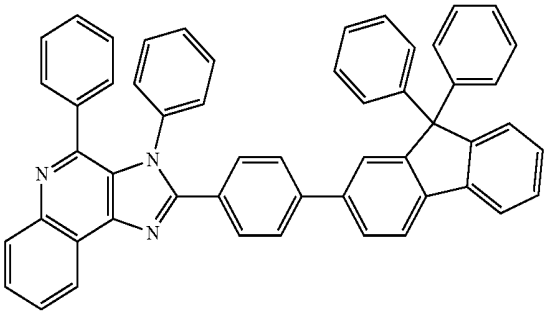
CJH-P12



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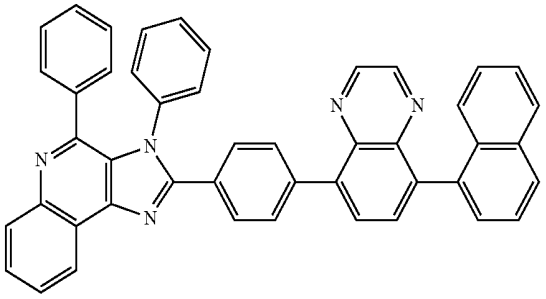
CJH-P13



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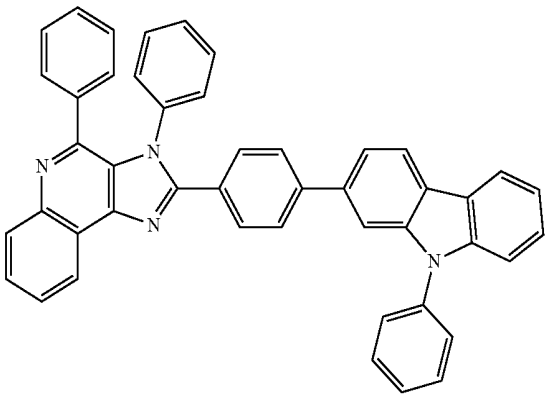
CJH-P14



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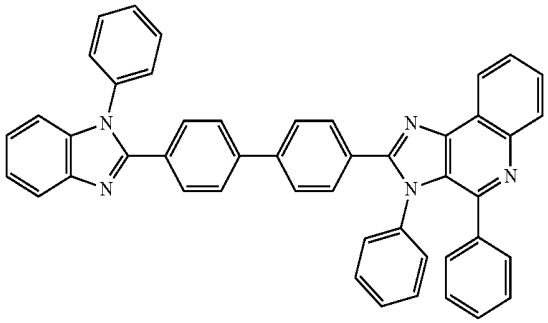
CJH-P15



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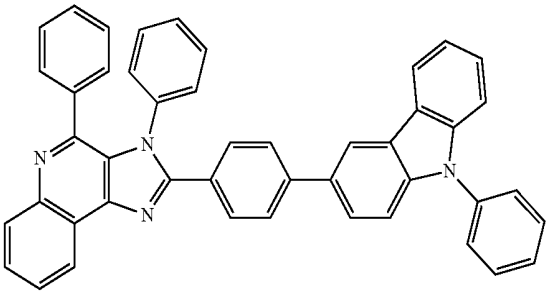
CJH-P16



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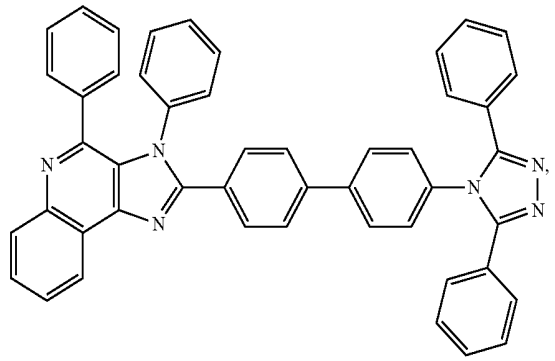
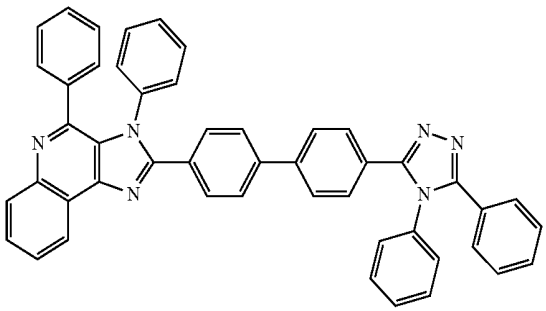
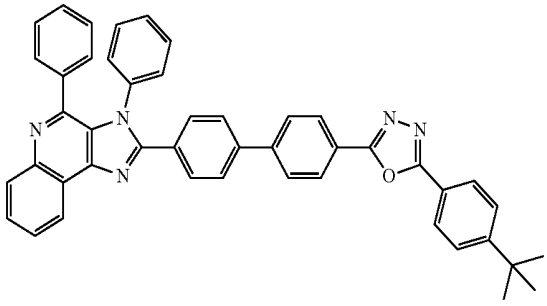
CJH-P17



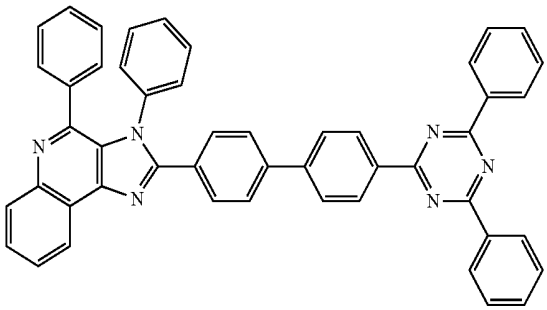
CJH-P18



CJH-P19



CJH-P20



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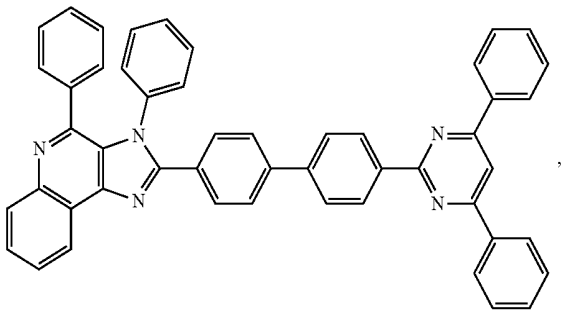
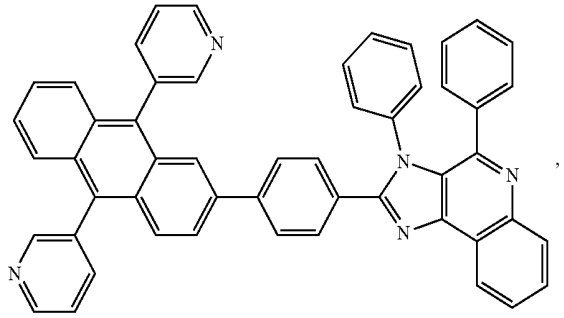
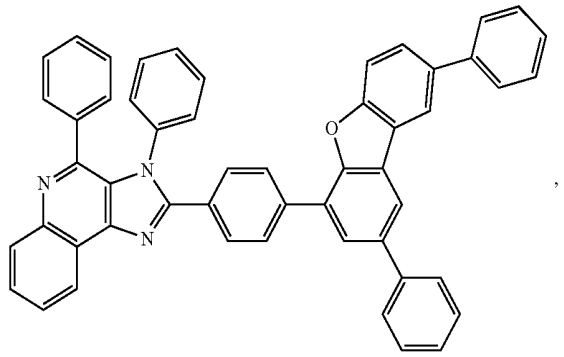
CJH-P21



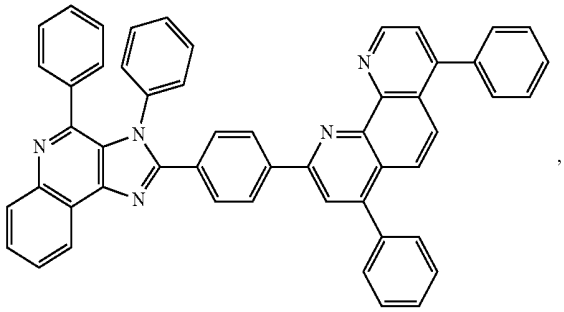
CJH-P22



CJH-P23



CJH-P24



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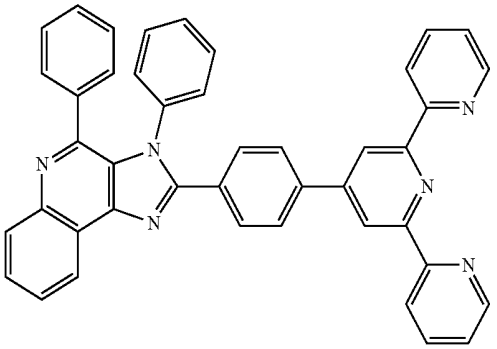
CJH-P25



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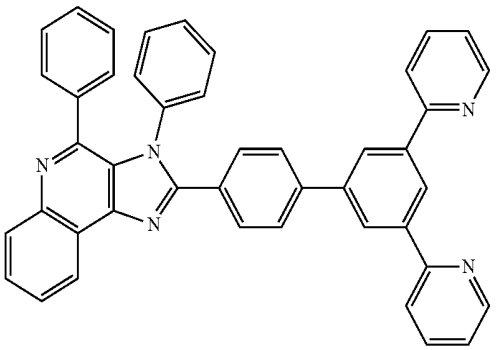
CJH-P26



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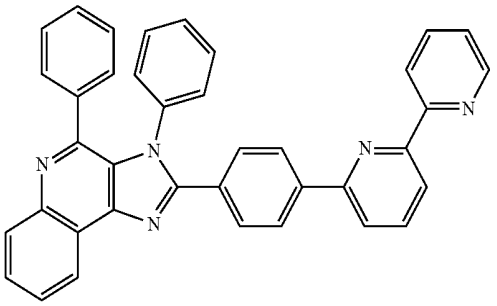
CJH-P27



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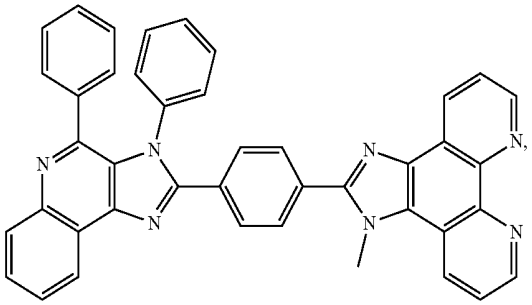
CJH-P28



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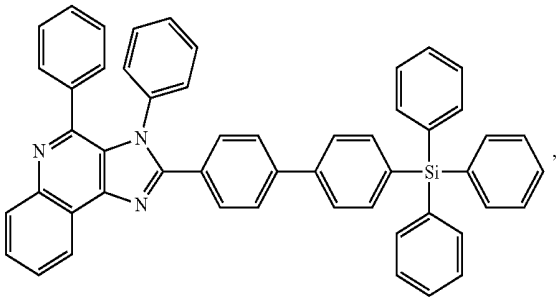
CJH-P29



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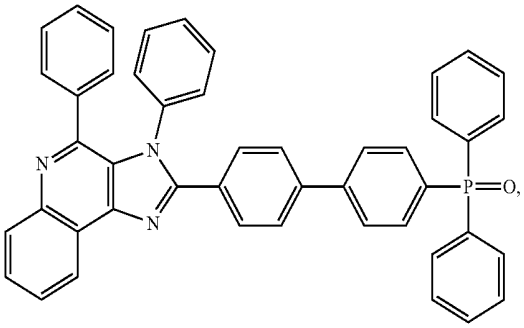
CJH-P30



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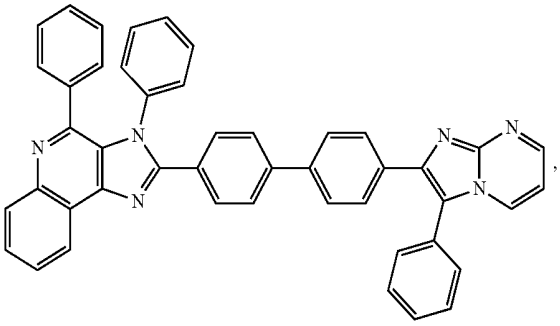
CJH-P31



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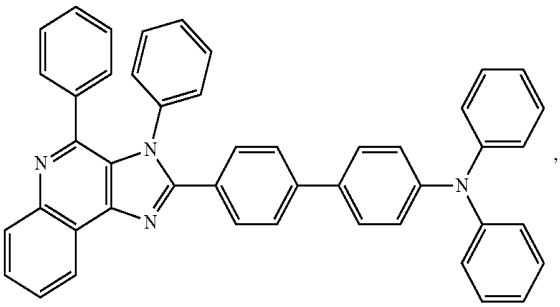
CJH-P32



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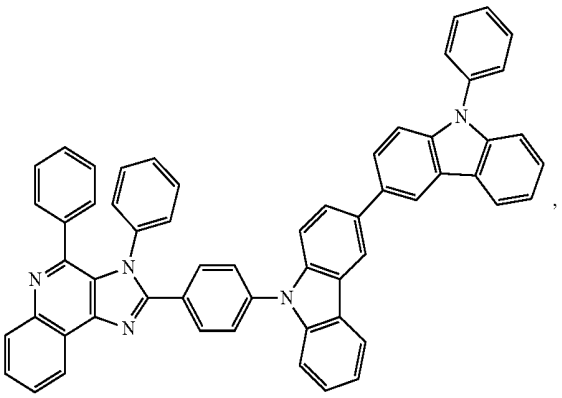
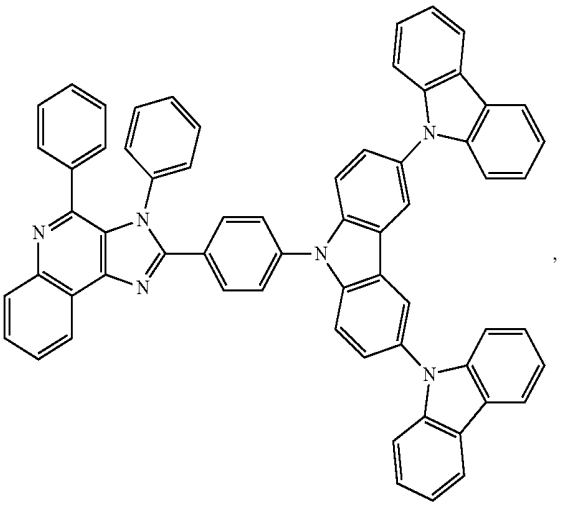
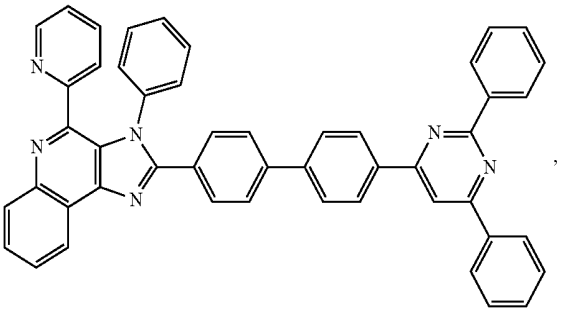
CJH-P33



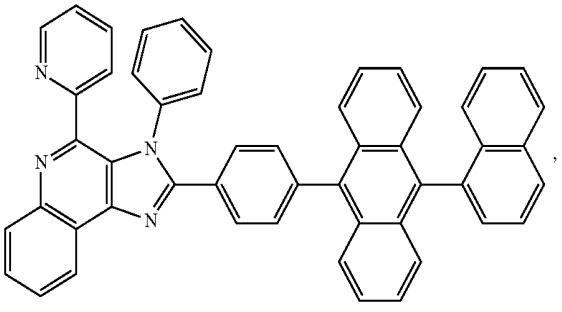
CJH-P34



CJH-P35



CJH-P36



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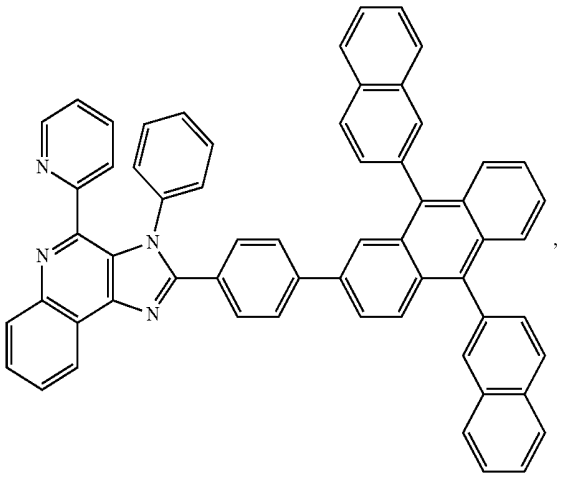
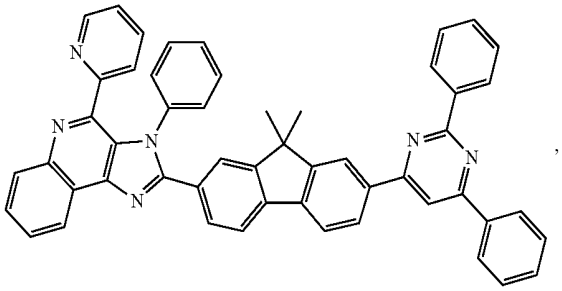
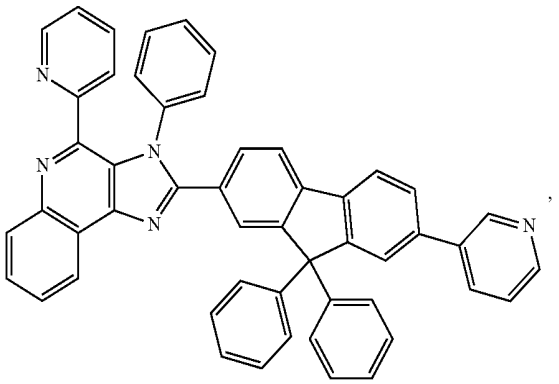
CJH-P37



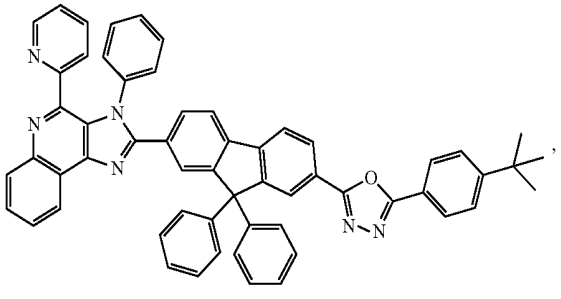
CJH-P38



CJH-P39



CJH-P40



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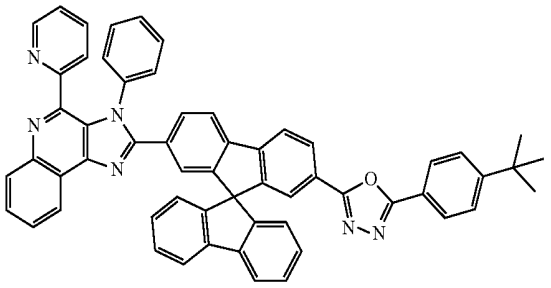
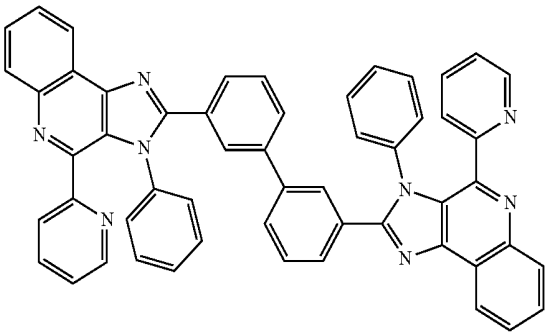
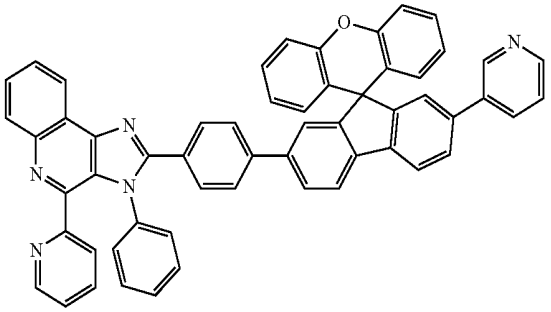
CJH-P41



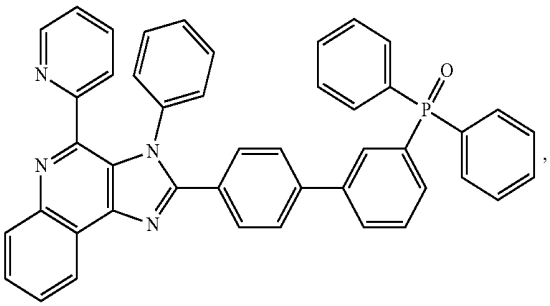
CJH-P42



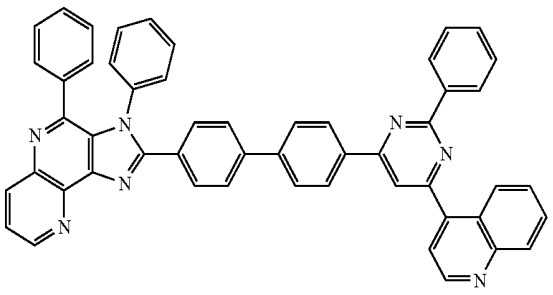
CJH-P43



CJH-P44



CJH-P45



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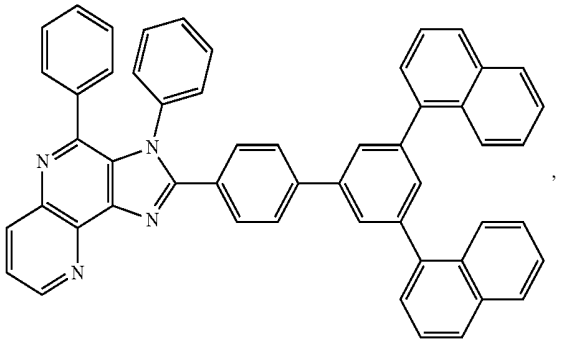
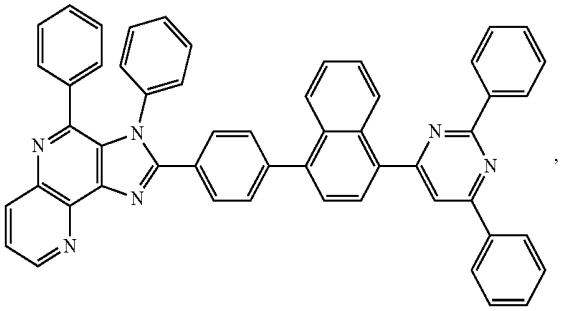
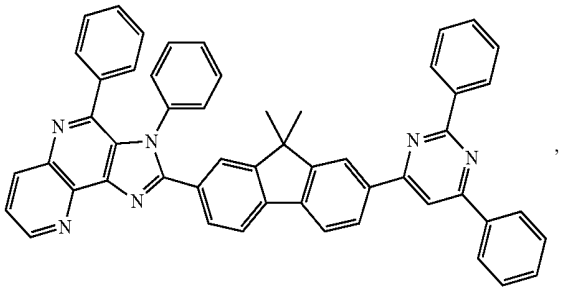
CJH-P46



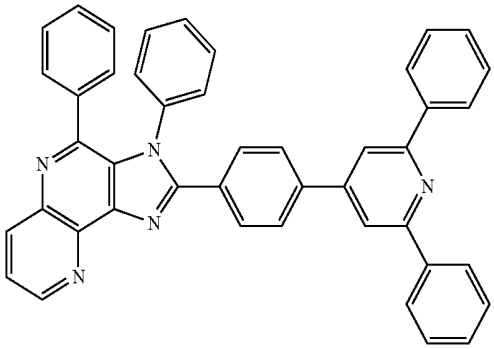
CJH-P47



CJH-P48



CJH-P49



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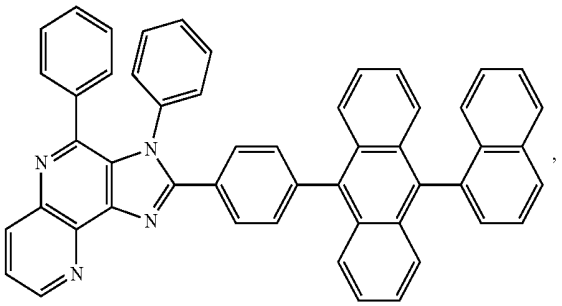
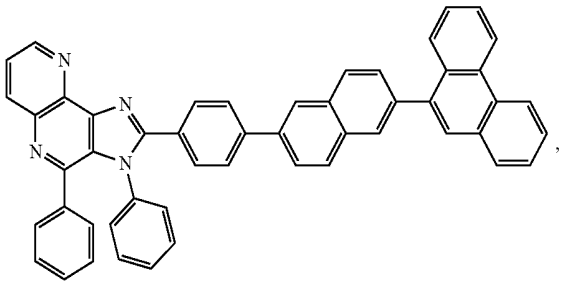
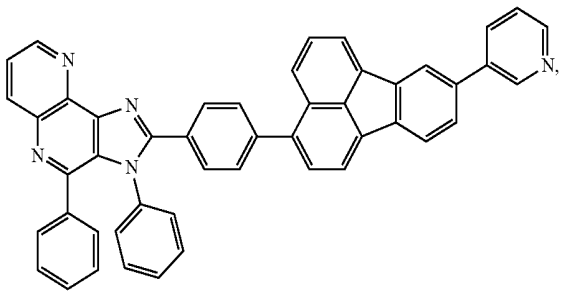
CJH-P50



CJH-P51



CJH-P52



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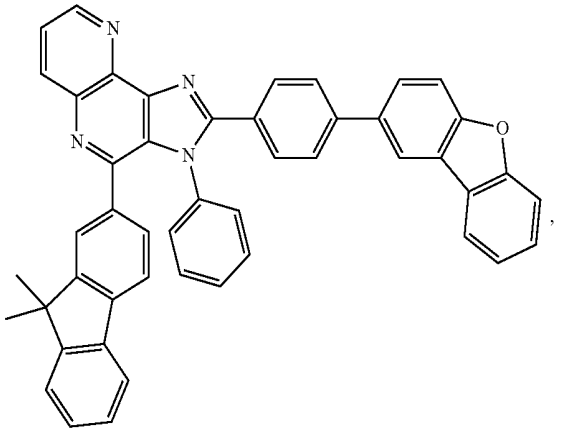

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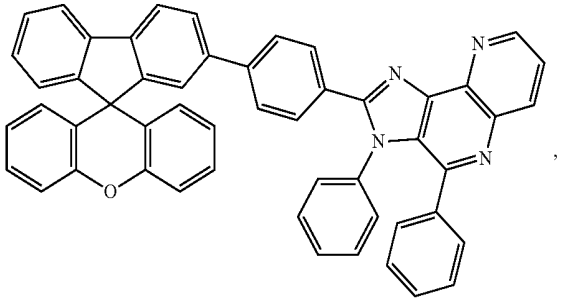

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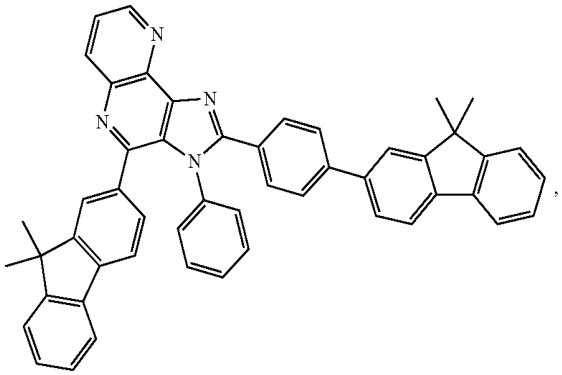

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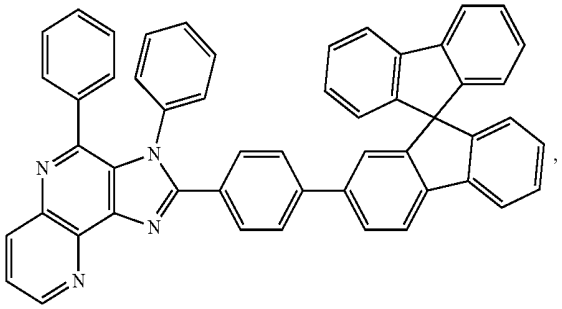

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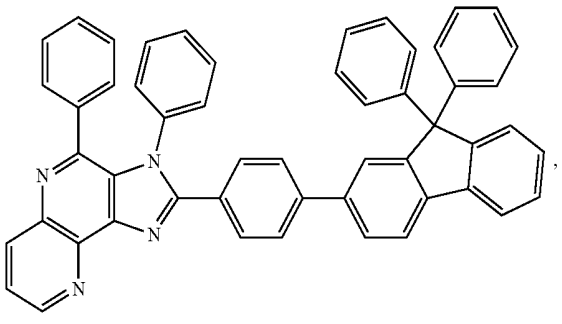

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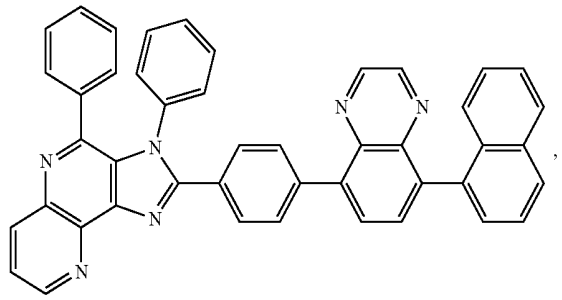

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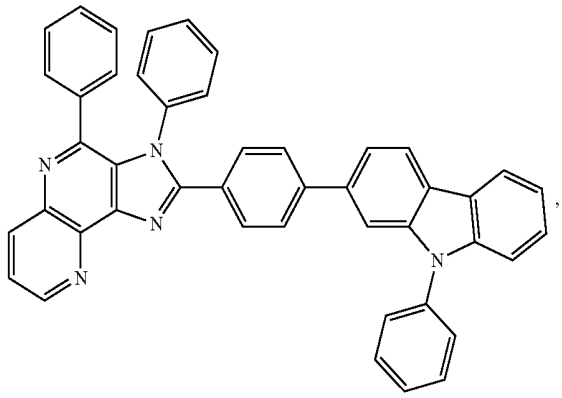

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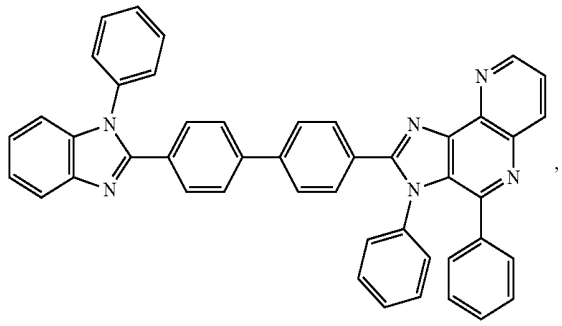

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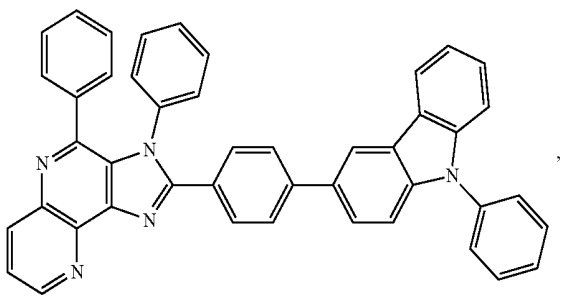

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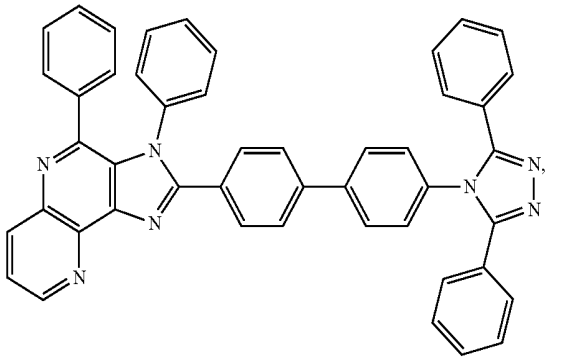
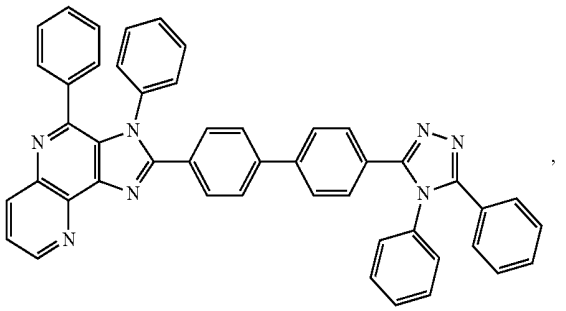


CJH-P63



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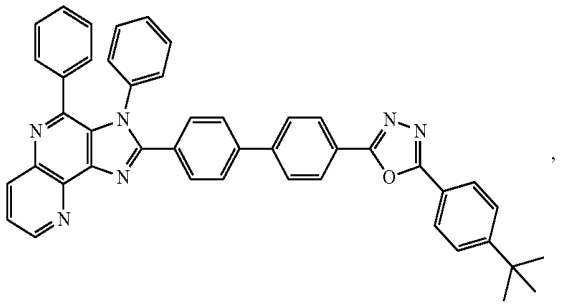
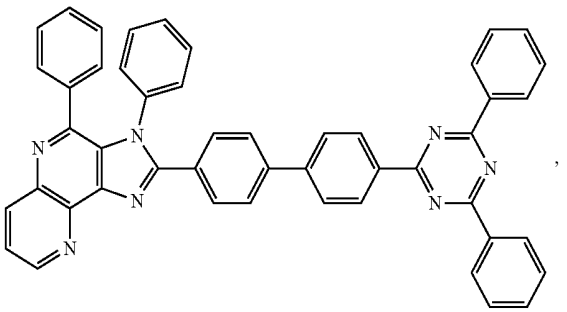


CJH-P65



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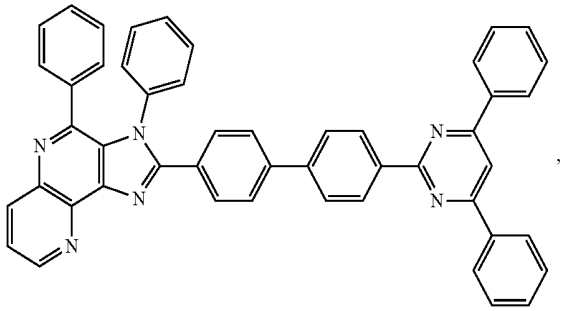
CJH-P66



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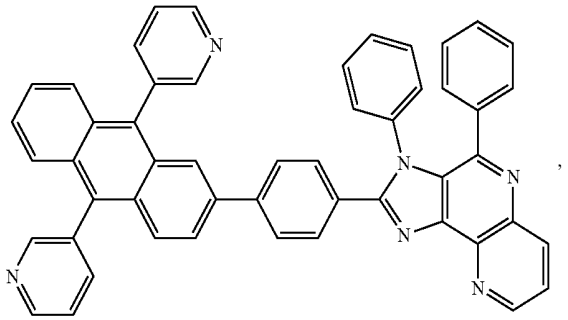
CJH-P67



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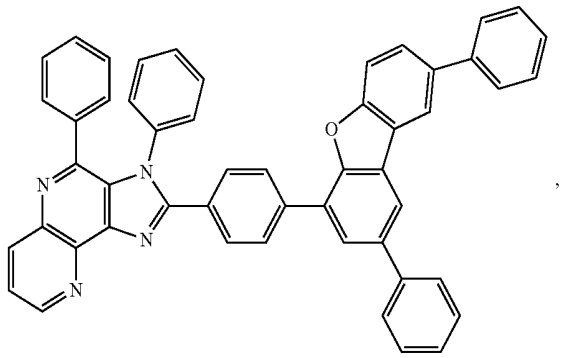
CJH-P68



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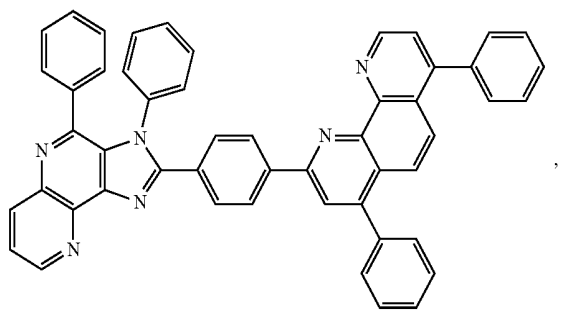

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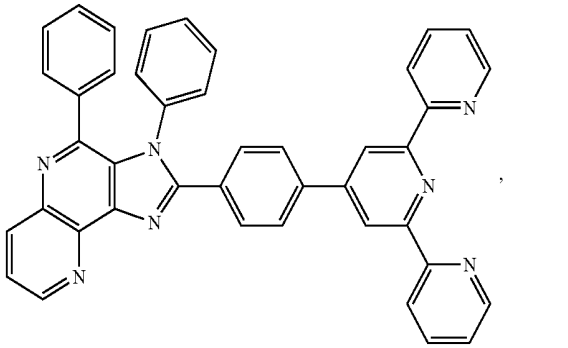
CJH-P70



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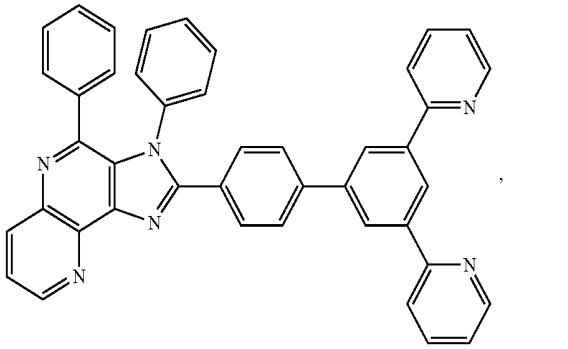
CJH-P71



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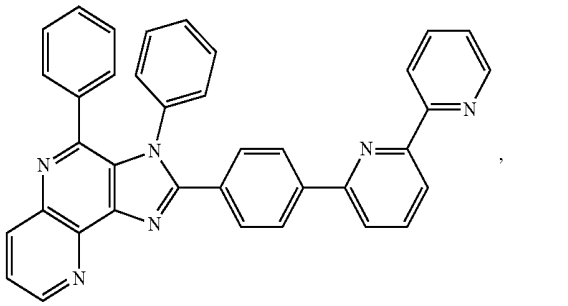
CJH-P72



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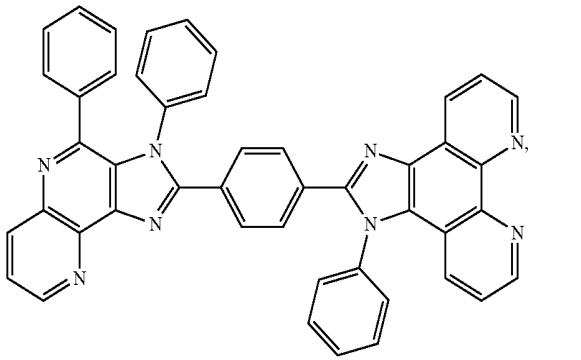
CJH-P73



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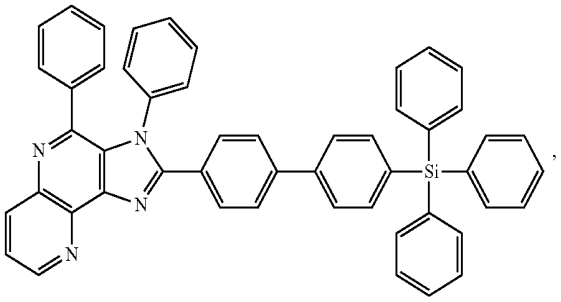
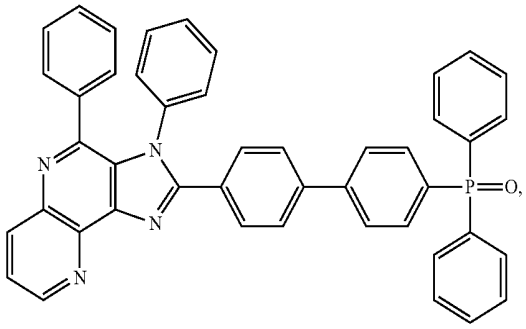
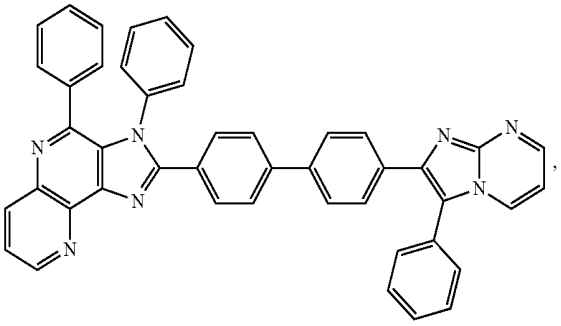
CJH-P74



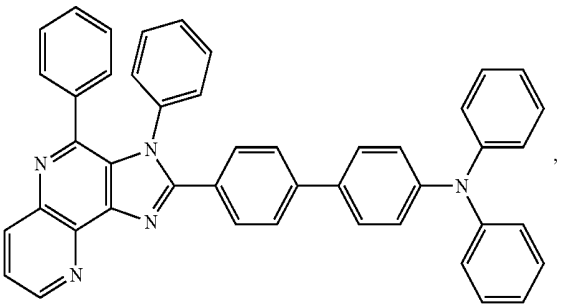
CJH-P75



CJH-P76



CJH-P77



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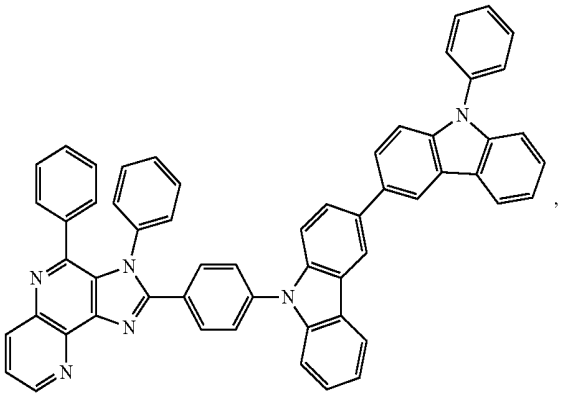
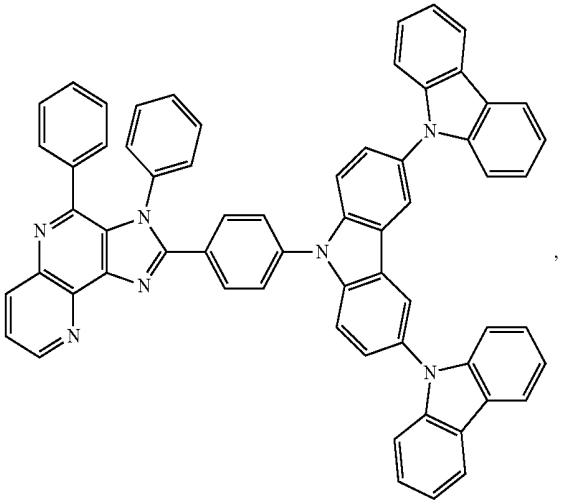
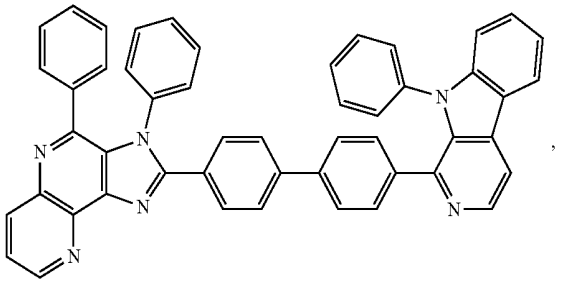
CJH-P78



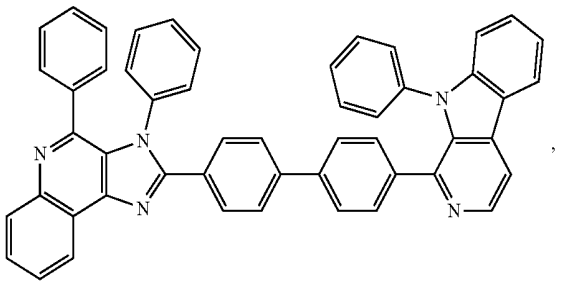
CJH-P79



CJH-P80



CJH-P81



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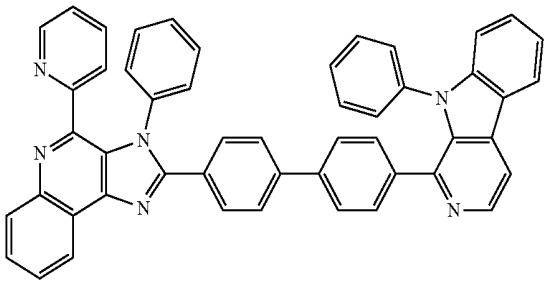
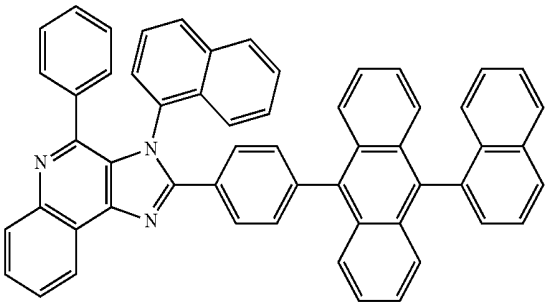
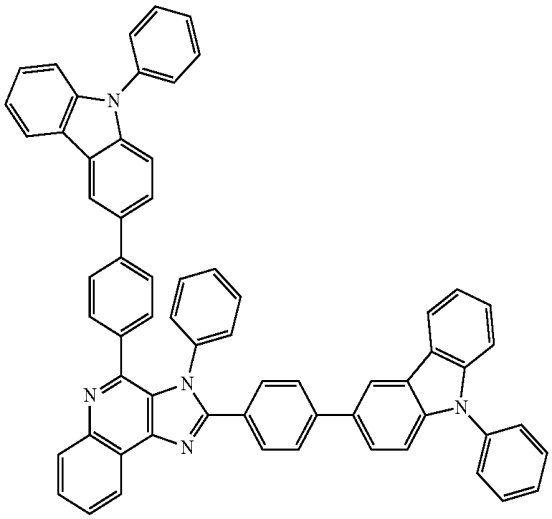
CJH-P82



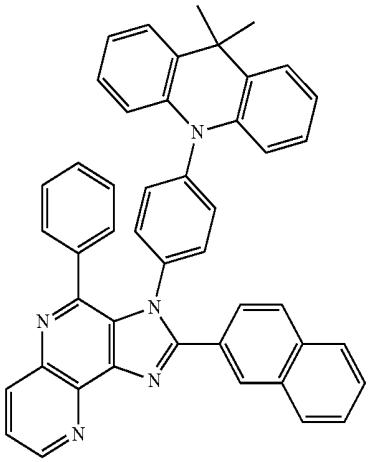
CJH-P83



CJH-P84



CJH-P85



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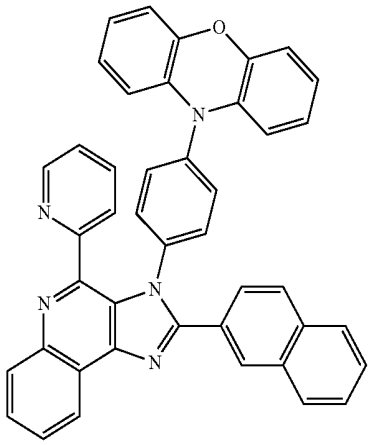
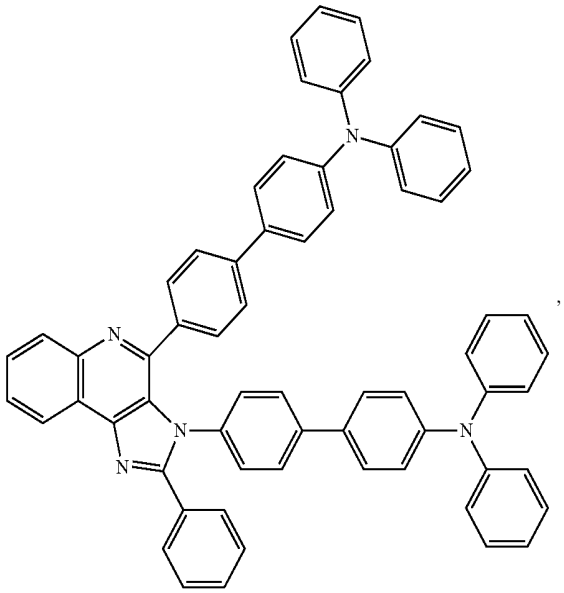
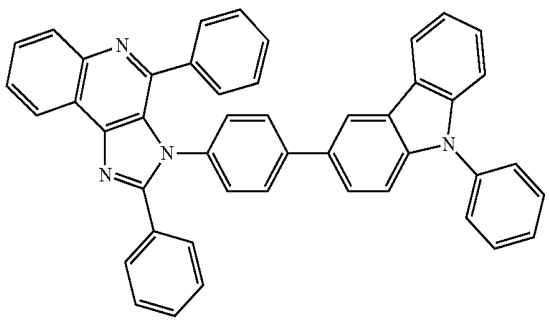
CJH-P86



CJH-P87



CJH-P88



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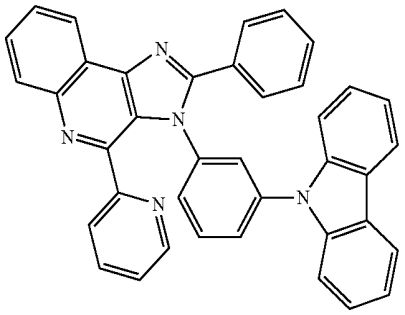
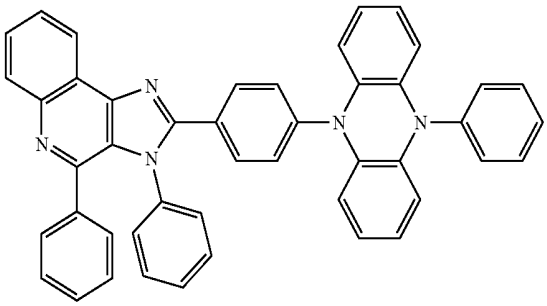
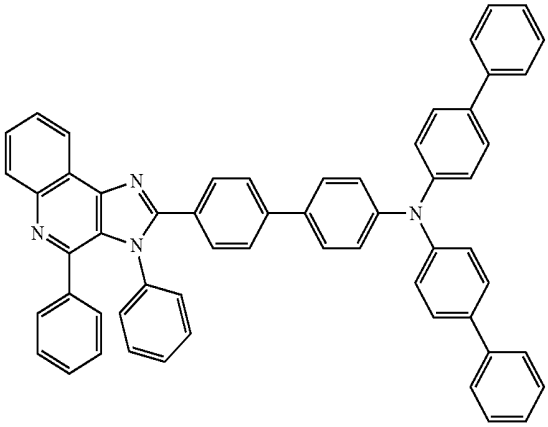
CJH-P89



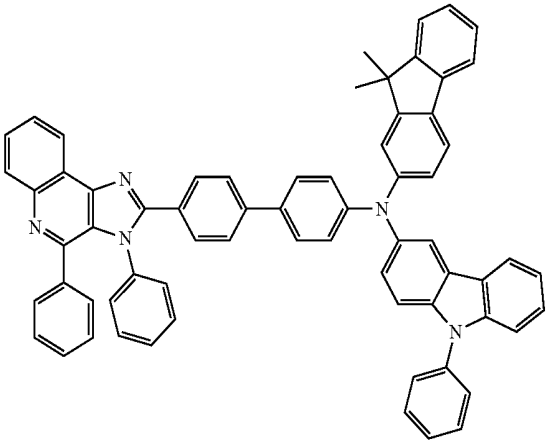
CJH-P90



CJH-P91



CJH-P92



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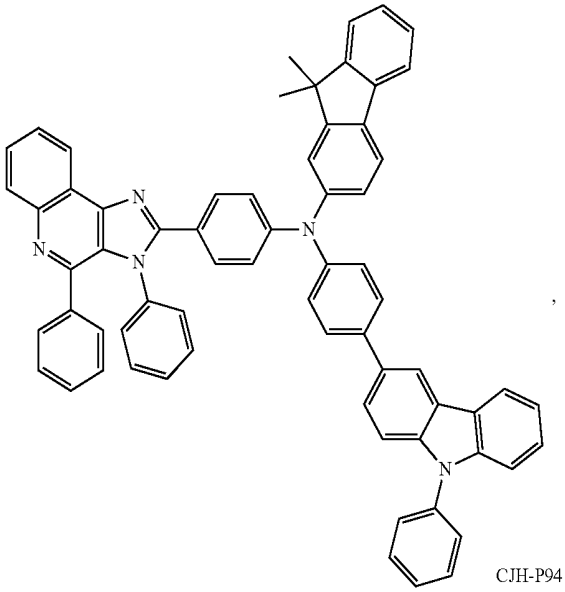
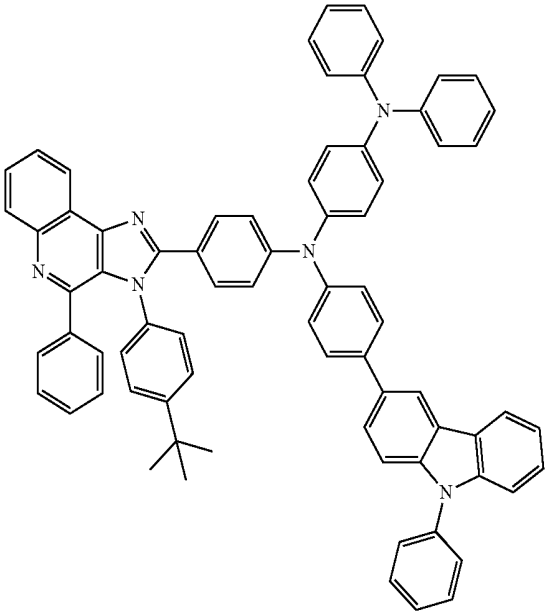
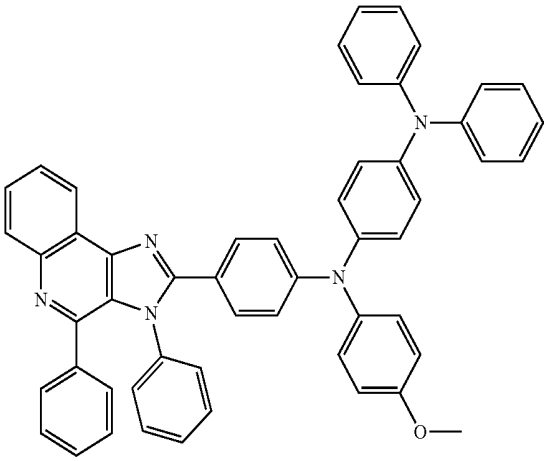
CJH-P93



CJH-P94



CJH-P95



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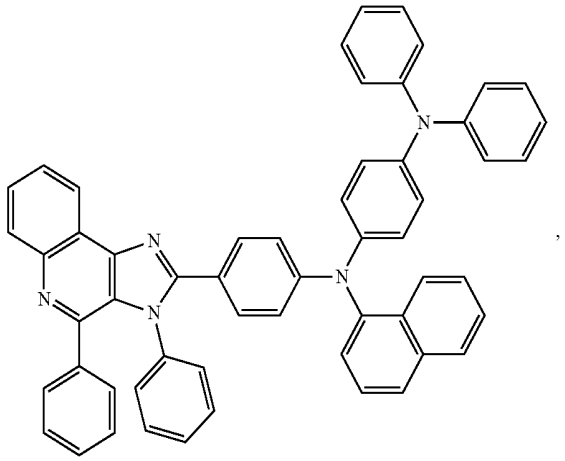
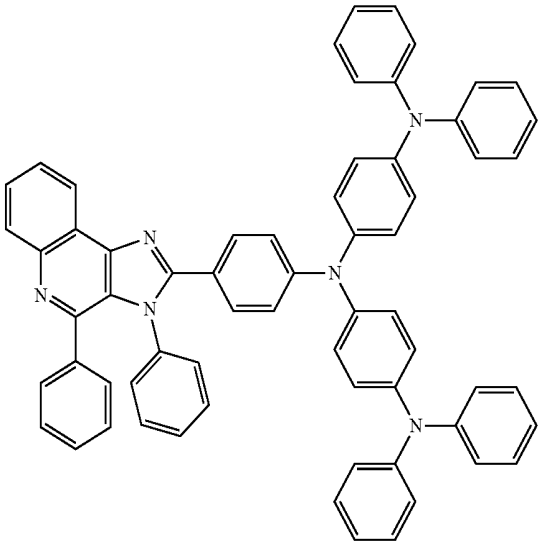
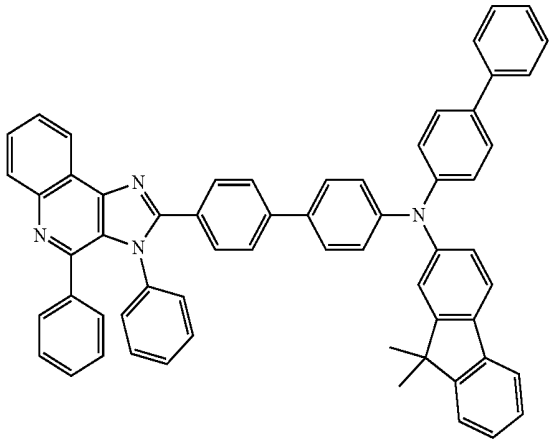
CJH-P96



CJH-P97



CJH-P98



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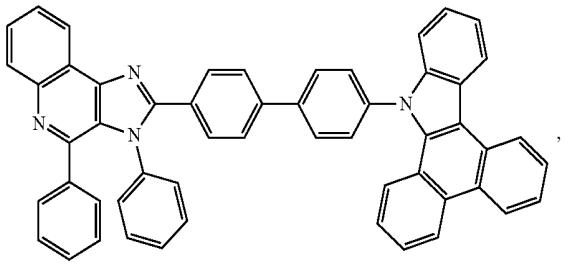
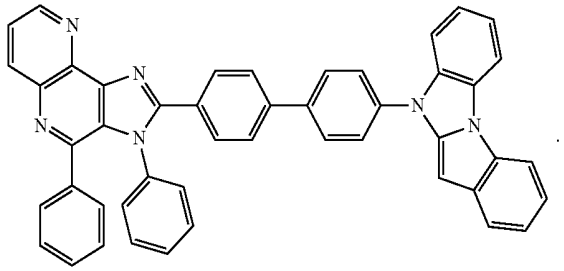
CJH-P99



CJH-P100



[0026] In order to achieve the above second objective, the present invention further provides a material, wherein a raw material of the material contains one or a plurality of the above imidazole derivatives.

[0027] Preferably, the material is an organic light-emitting material. The material containing the compound of the present invention has the capability of carrier transport.

[0028] In order to achieve the above third objective, the present invention further provides an organic light-emitting device, wherein the material of the organic light-emitting device contains one or a plurality of the above imidazole derivatives. The organic light-emitting device of the present invention can be either a top-emitting device or a bottom-emitting device. The structure and preparation method of the organic light-emitting device are not limited in the present invention. The organic light-emitting device produced by using the compound of the present invention has a reduced starting voltage and improved luminous efficiency and luminance.

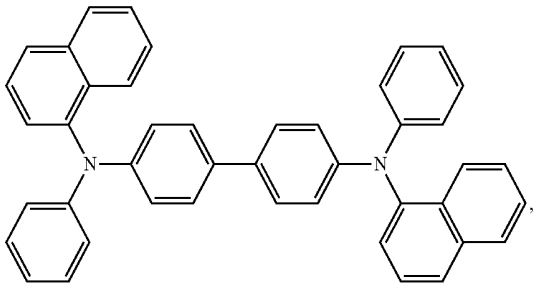
[0029] Preferably, the organic light-emitting device comprises a substrate, an anode layer disposed on the substrate, a hole transport layer disposed on the anode layer, an organic light-emitting layer disposed on the hole transport layer, an electron transport layer disposed on the organic light-emitting layer, and a cathode layer disposed on the electron transport layer.

[0030] Preferably, the material of at least one of the hole transport layer, the organic light-emitting layer, and the electron transport layer in the organic light-emitting device contains one or a plurality of the above imidazole derivatives.

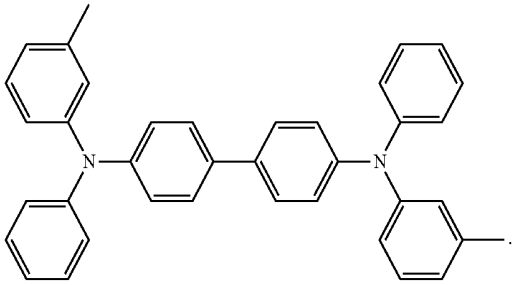
[0031] Preferably, the material of the substrate is glass or a flexible substrate.

[0032] Preferably, the material of the anode layer is an inorganic material or organic conductive polymer, wherein the inorganic material is indium tin oxide, zinc oxide, tin zinc oxide, gold, silver, or copper; and the organic conductive polymer is selected from at least one of polythiophene, sodium polyvinyl benzene sulfonate, and polyaniline.

[0033] Preferably, the material of the hole transport layer further comprises but is not limited to one or a plurality of the following compounds:

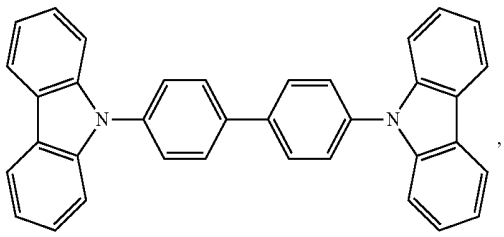


NPB

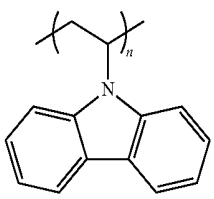


TPD

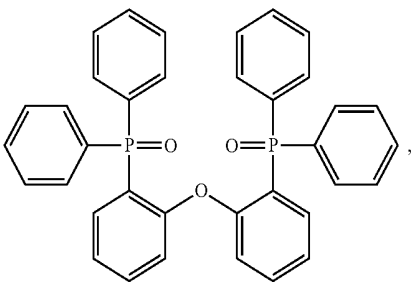
[0034] Preferably, the material of the organic light-emitting layer further comprises but is not limited to one or a plurality of the following compounds:



CBP



PVK



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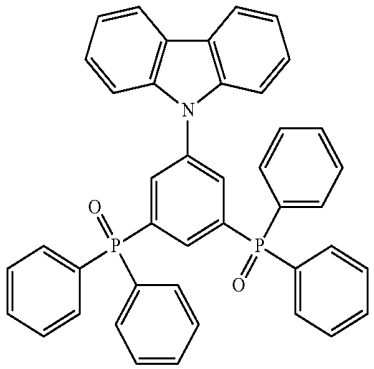
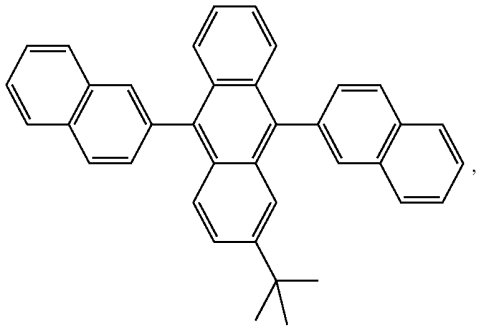
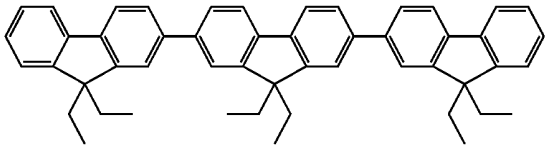
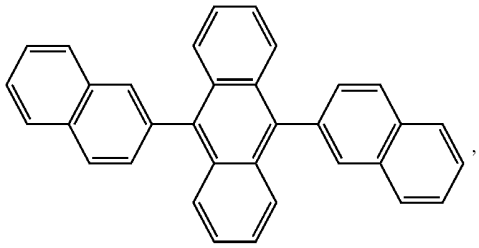






E3



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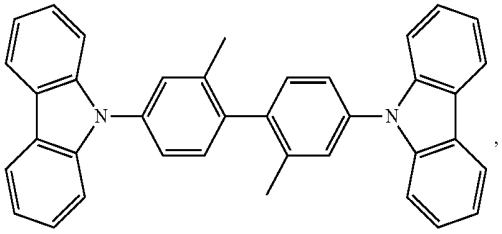
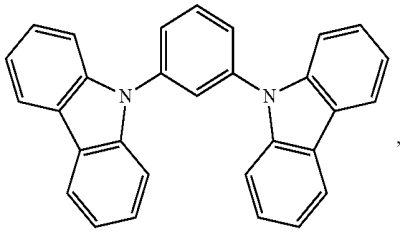


dmCBP



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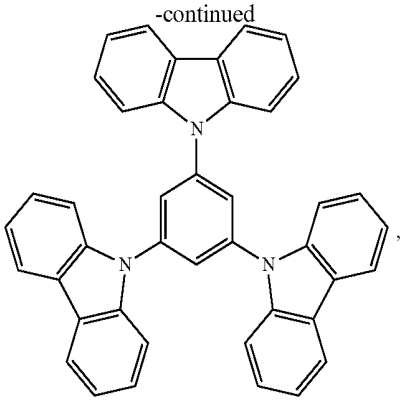
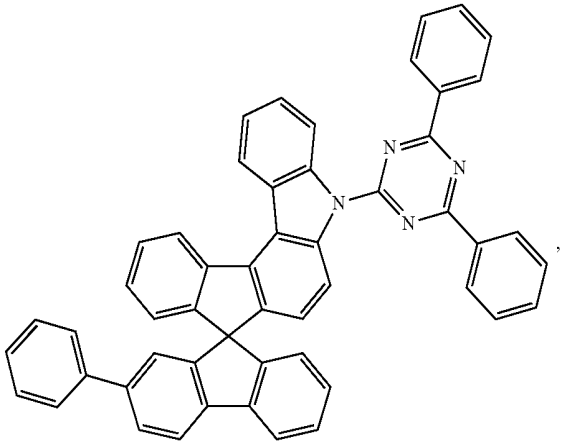
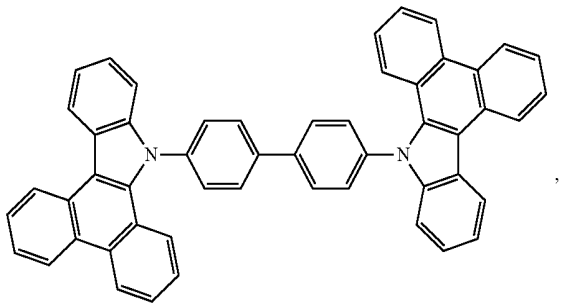


TCzP



Slic-H117



BCPB

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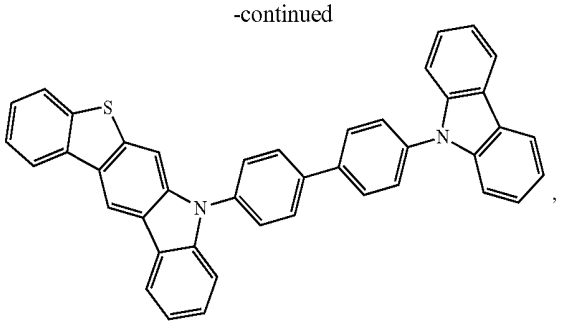
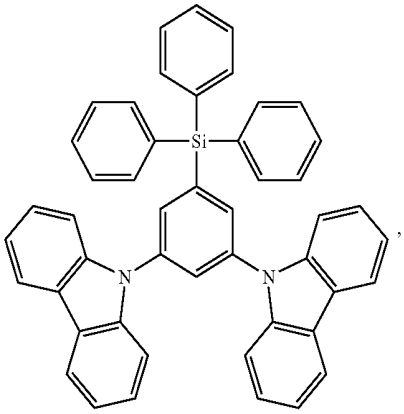
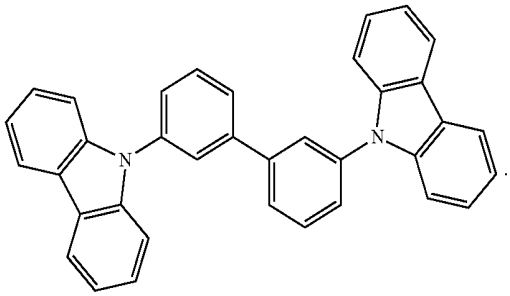


Slic-H065



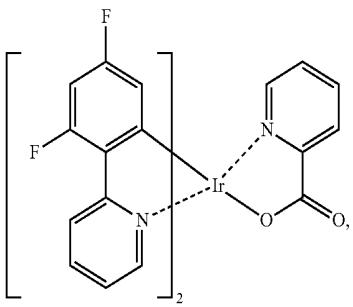
SimCP

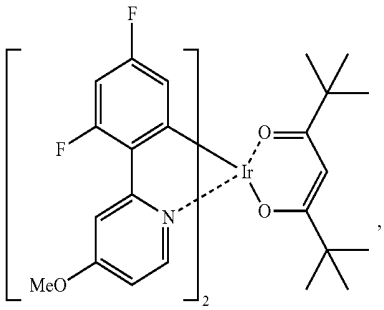


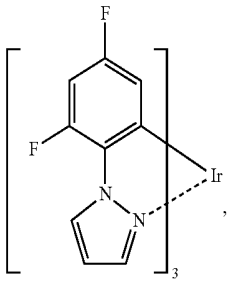
mCBP

[0035] Preferably, the material of the organic light-emitting layer further comprises doping materials, wherein the doping materials comprise red, green, and blue doping materials.

[0036] Preferably, the blue doping material comprises but is not limited to one or a plurality of the following compounds:







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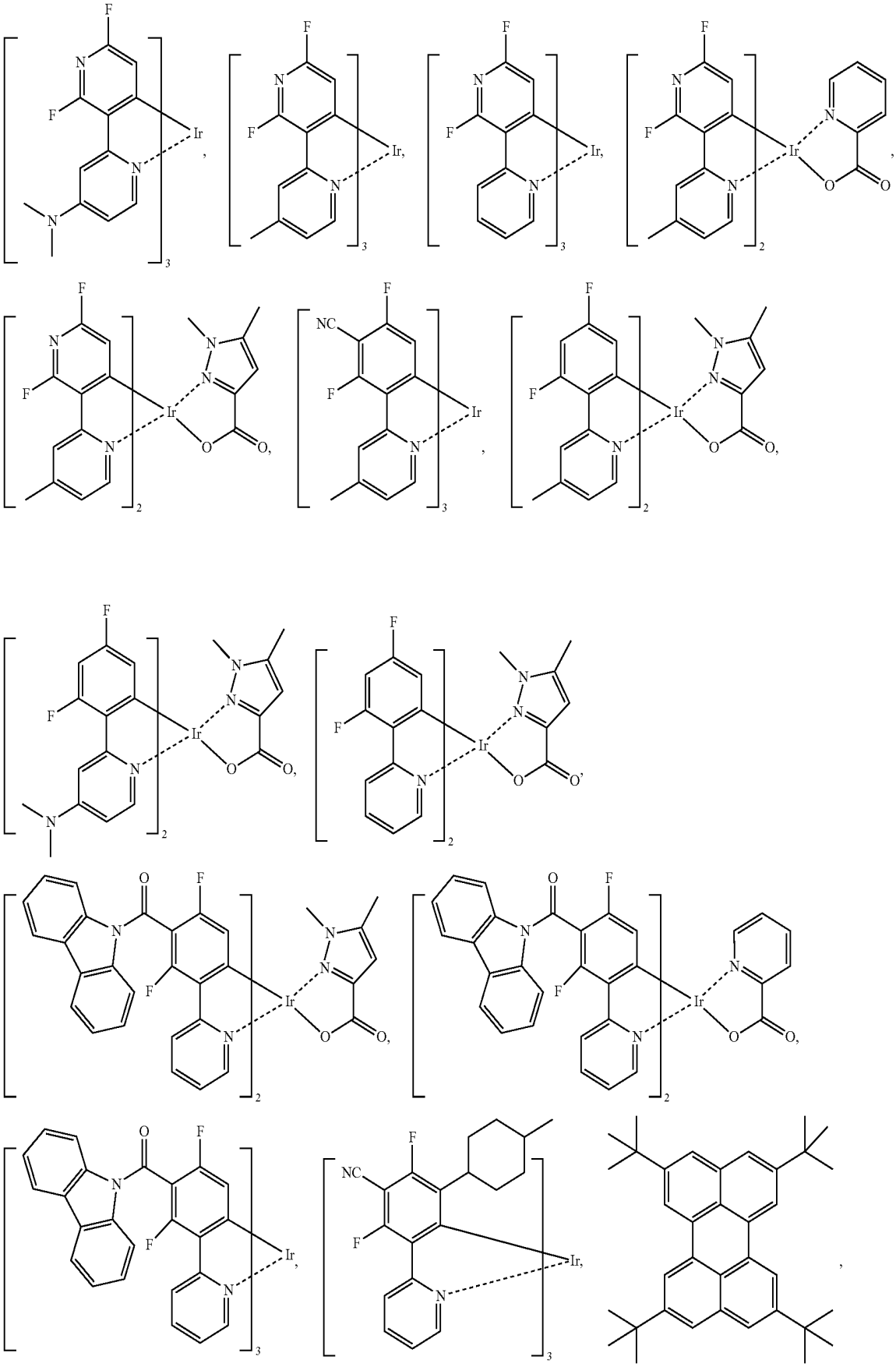

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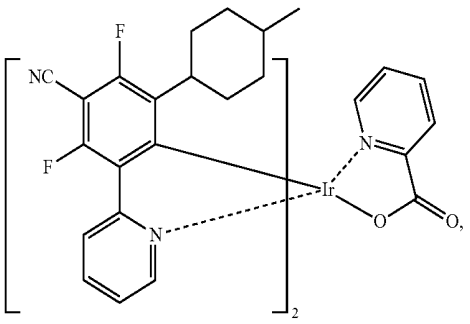

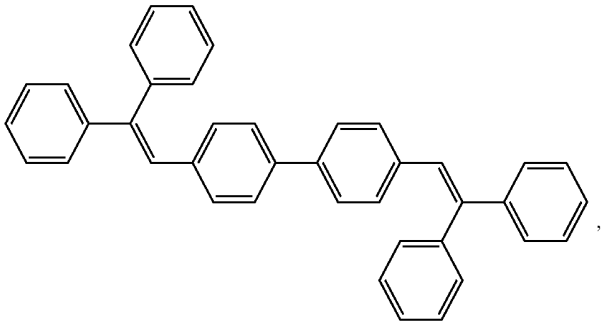

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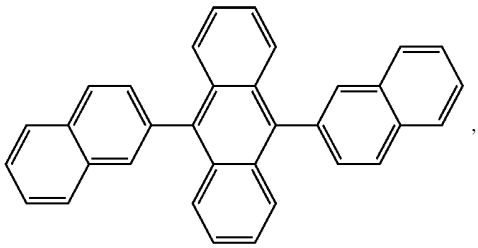

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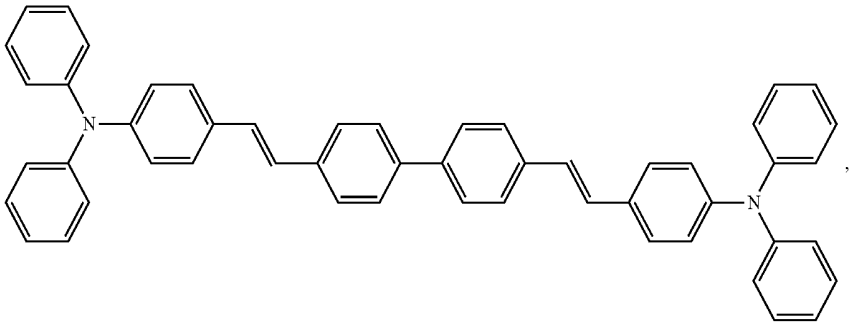

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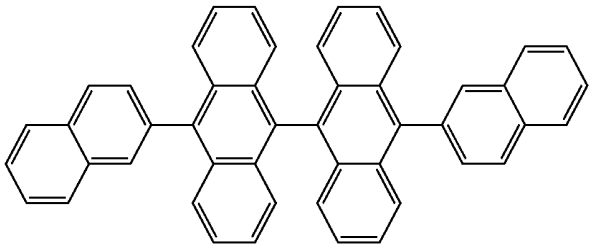

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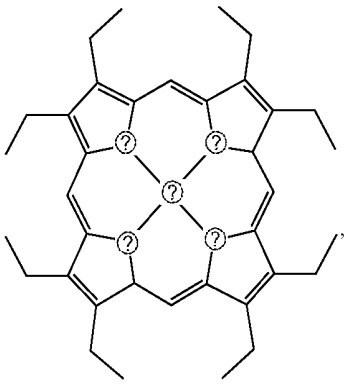
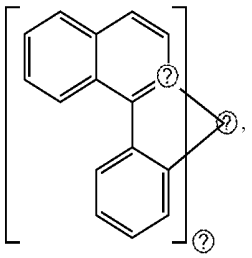
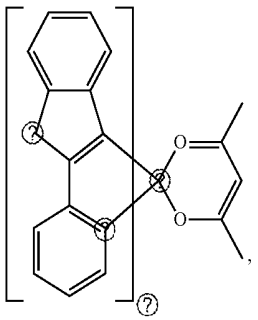
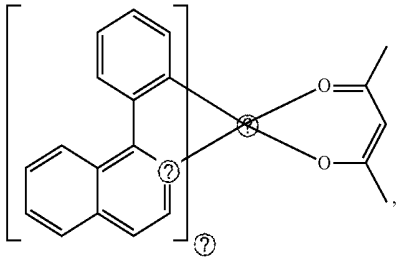
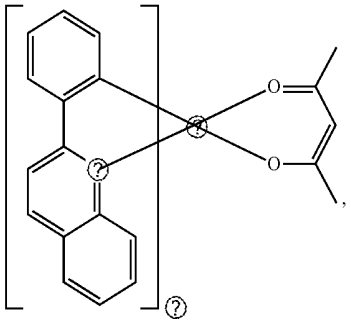
[0037] Preferably, the red doping material comprises but is not limited to one or a plurality of the following compounds:











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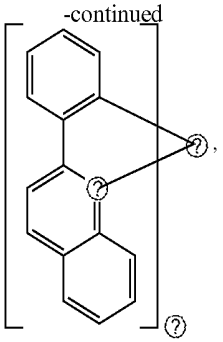

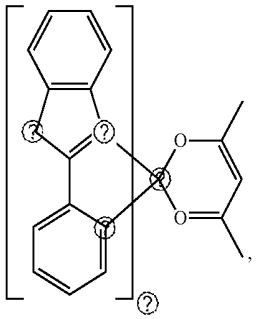

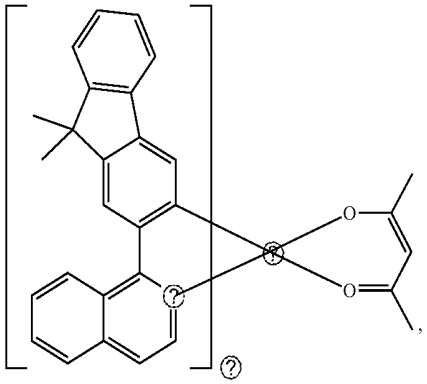

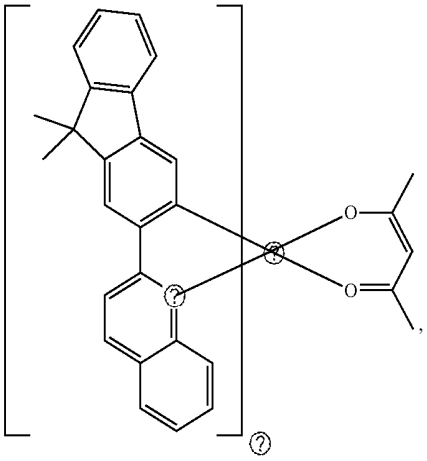

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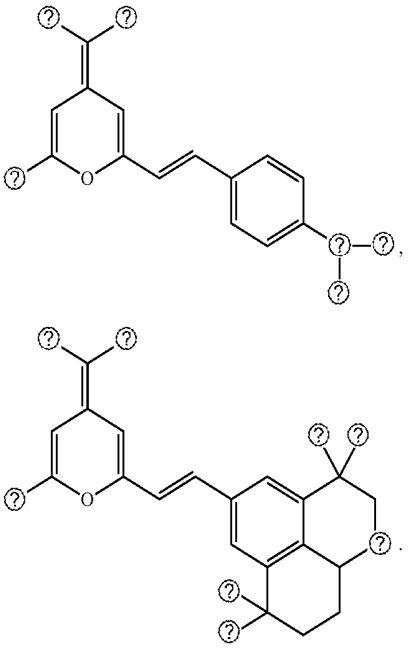

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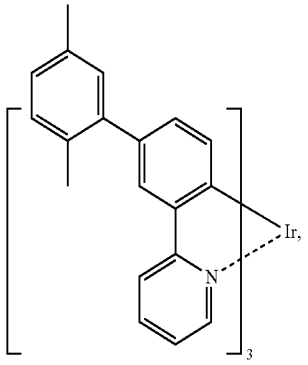
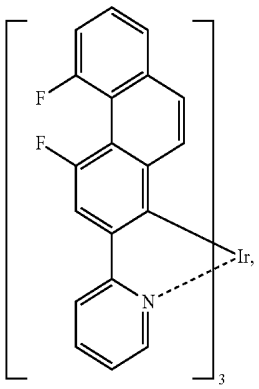
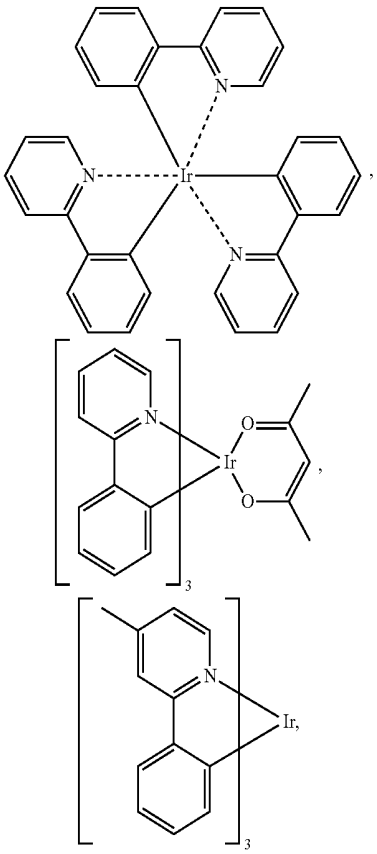
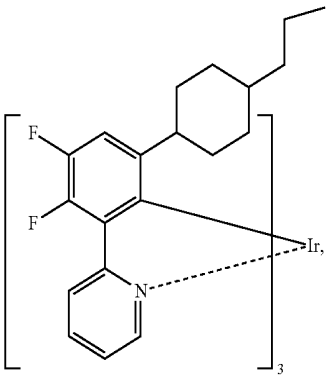
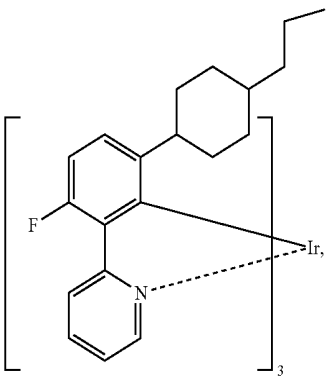




[0038] Preferably, the green doping material comprises but is not limited to one or a plurality of the following compounds:







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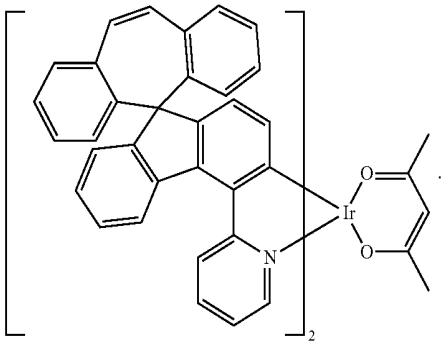
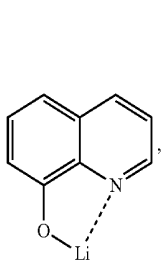
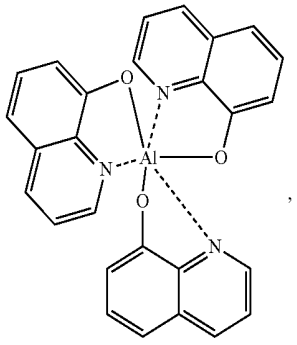


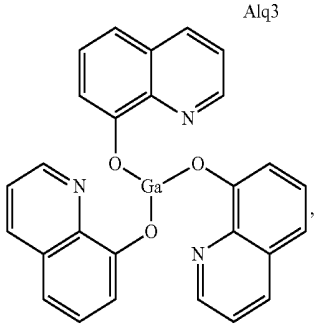
[0039] Preferably, the material of the electron transport layer further comprises but is not limited to one or a plurality of the following compounds:



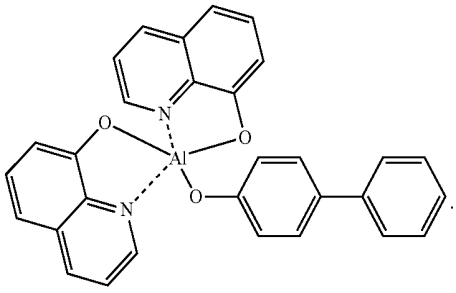
LiQ



Alq3



Gaq3

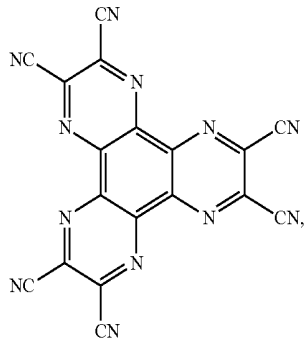


BAlq

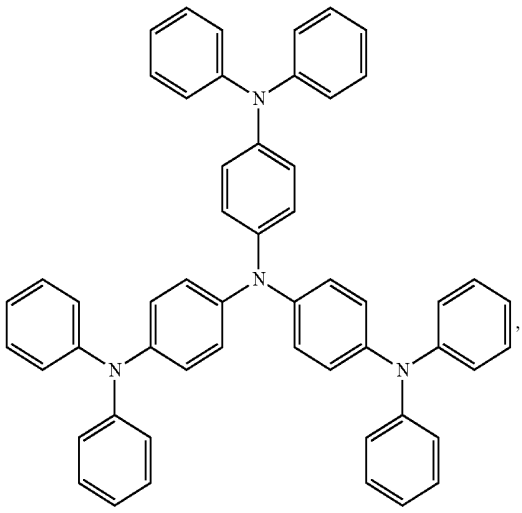
[0040] Preferably, the material of the cathode layer is selected from any one of or an alloy formed by any two of or a fluoride of the following elements: lithium, magnesium, silver, calcium, strontium, aluminum, indium, copper, gold, and silver.

[0041] Preferably, a hole injection layer is further disposed between the anode layer and the hole transport layer in the organic light-emitting device.

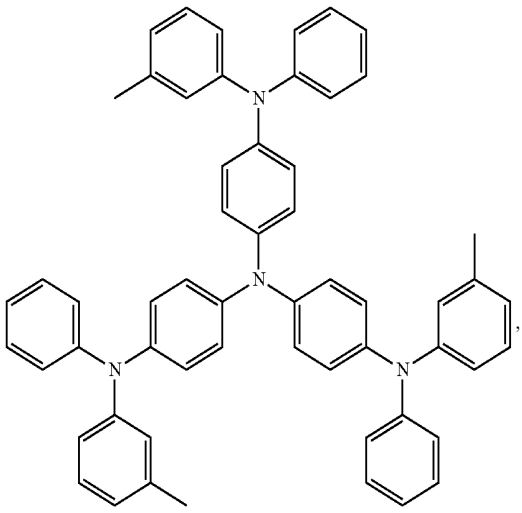
[0042] Preferably, the material of the hole injection layer comprises but is not limited to one or a plurality of the following compounds:



HATCN



TDATA



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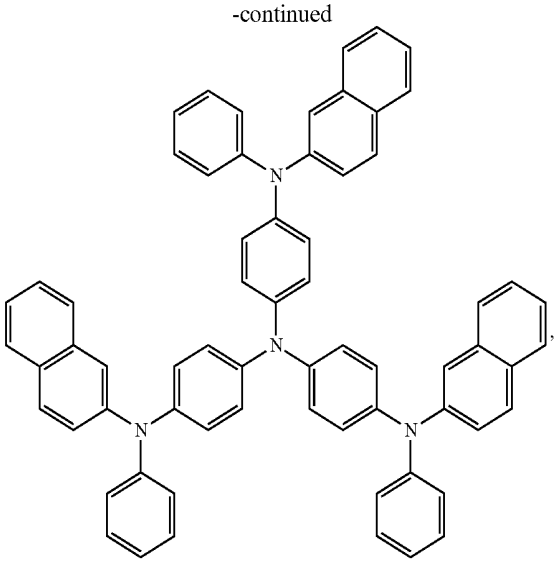


2-TNATA

[0043] Preferably, the thickness of the hole injection layer is 30-50 nm, preferably 40 nm.

[0044] Preferably, the thickness of the hole transport layer is 5-15 nm, preferably 10 nm.

[0045] Preferably, the thickness of the organic light-emitting layer is 10-100 nm, preferably 40 nm.

[0046] Preferably, the thickness of the electron transport layer is 10-30 nm, preferably 50 nm.

[0047] Preferably, the thickness of the cathode layer is 90-110 nm, preferably 100 nm.

[0048] The present invention further provides use of an indenoimidazole compound, comprising use in preparation of an organic light-emitting material and use in production of an organic light-emitting device.

[0049] In addition, unless otherwise specified, raw materials used in the present invention all can be obtained through commercial purchase. Any range described in the present invention comprises the end values and any value between the end values, and any sub-range formed by the end values or any values between the end values.

[0050] The present invention has the following beneficial effects:

[0051] The imidazole derivative represented by formula I and provided by the present invention has the capability of carrier transport, and the organic light-emitting device produced by using the material of the present invention has a reduced starting voltage and improved luminous efficiency and luminance. Due to the features such as relatively good film-forming performance and simple material synthesis and purification methods which are applicable to mass production, the series of imidazole derivatives are ideal options for an electron transport material of organic light-emitting devices. The use of the imidazole derivative as a light-emitting material, a host material in a light-emitting layer, a hole transport material, an electron transport material, or a hole block material also falls within the protection scope.

DESCRIPTION OF THE DRAWINGS

[0052] The specific implementations of the present invention are further described in detail below with reference to the drawings.

[0053] FIG. **1** illustrates a flow chart of a method for preparing a compound of formula I in the present invention;

[0054] FIG. **2** illustrates a schematic structural diagram of an OLED device in Example 6 of the present invention, with a substrate **1**, an anode layer **2**, a hole injection layer **3**, a hole transport layer **4**, an organic light-emitting layer **5**, an electron transport layer **6**, and a cathode layer **7**;

[0055] FIG. **3** illustrates a ^{1}H-NMR spectrum of the compound of formula CJH-P16 in Example 1 of the present invention;

[0056] FIG. **4** illustrates a ^{13}C-NMR spectrum of the compound of formula CJH-P16 in Example 1 of the present invention:

[0057] FIG. **5** illustrates a visible-ultraviolet absorption spectrum of the compound of formula CJH-P16 in Example 1 of the present invention;

[0058] FIG. **6** illustrates a fluorescent spectrum of the compound of formula CJH-P16 in Example 1 of the present invention:

[0059] FIG. **7** illustrates a ^{1}H-NMR spectrum of the compound of formula CJH-P37 in Example 2 of the present invention;

[0060] FIG. **8** illustrates a ^{13}C-NMR spectrum of the compound of formula CJH-P37 in Example 2 of the present invention:

[0061] FIG. **9** illustrates a visible-ultraviolet absorption spectrum of the compound of formula CJH-P37 in Example 2 of the present invention;

[0062] FIG. **10** illustrates a fluorescent spectrum of the compound of formula CJH-P37 in Example 2 of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0063] In order to more clearly describe the present invention, the present invention is further described below with reference to the preferred Examples and drawings. Similar components in the drawings are represented by the same reference number. A person skilled in the art should understand that the following specific description content is for description instead of for limitation, and the protection scope of the present invention shall not be limited thereto.

[0064] In the description of the present invention, unless otherwise stated, the "plurality" means two or more; the directions or positional relationships indicated by the terms "upper", "lower", et al. are based on the positions or positional relationships shown in the drawings, which are merely intended for convenience of describing the present invention and simplifying the description, but do not indicate or imply that the devices or elements referred to necessarily have a specific direction or constructed and operated in a specific direction, thus shall not be understood as a limitation to the present invention.

[0065] In the present invention, unless otherwise specified, the preparation methods are conventional methods. The used raw materials can be obtained from public commercial channels unless otherwise specified, and the percentages are mass percentages unless otherwise specified.

[0066] Test instruments and methods for performance tests of OLED materials and devices in the following examples are as follows:

[0067] Conditions for a performance test of an OLED device:

[0068] luminance and the chromaticity coordinates: tested by using a spectrum scanner PhotoResearch PR-71;

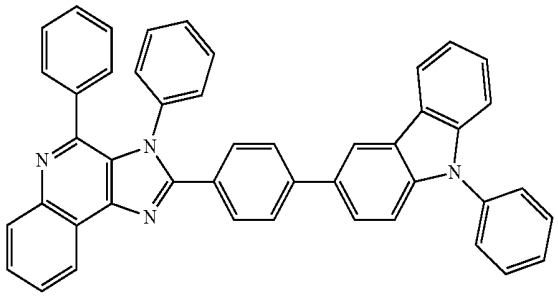
[0069] current density and turn-on voltage: tested by using a digital source meter Keithley 2420; and

[0070] power efficiency: tested by using NEWPORT 1931-C.

Example 1

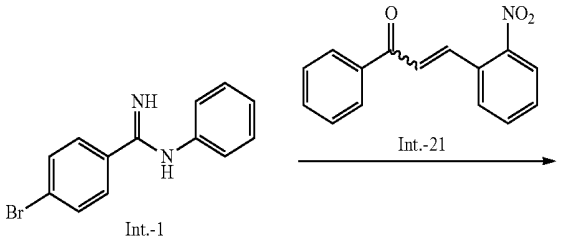
[0071] The structural formula of the compound CJH-P16 is as follows:

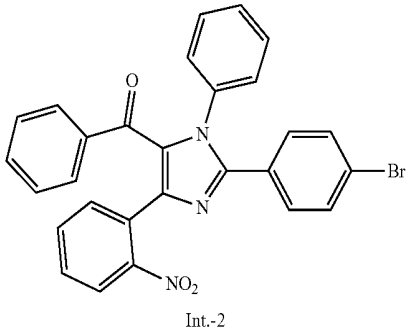
CJH-P16



[0072] A preparation route thereof is as follows:

[0073] Step 1: Preparation of an Intermediate Int.-2

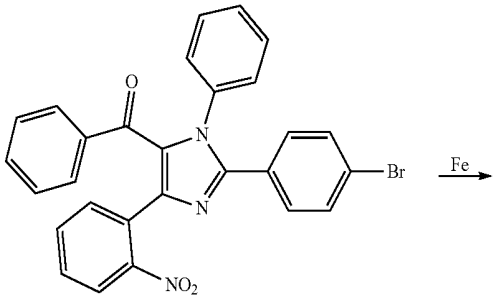




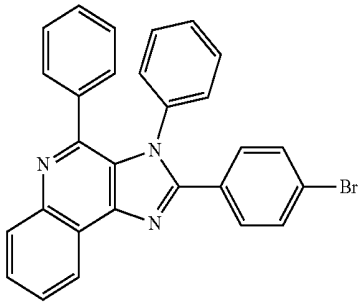
Int.-2

[0074] 1.2 g of iodine and 80 ml of dichlorobenzene are added to 15 g (54.5 mmol) of 4-bromo-N-phenylbentamidine Int.-1, 14 g (54.5 mmol) of Int.-21, and 1.5 g of anhydrous ferric chloride, oxygen is introduced, heating is performed to 110° C., stirring is performed for a reaction for 8 hours, then a mixture is cooled to room temperature and filtered, a filter cake is washed with petroleum ether, and recrystallization is performed by means of ethanol, so as to obtain 21.7 g of Int.-2 in yellow solid, with a yield of 76%.

[0075] Step 2: Preparation of an Intermediate Int.-3



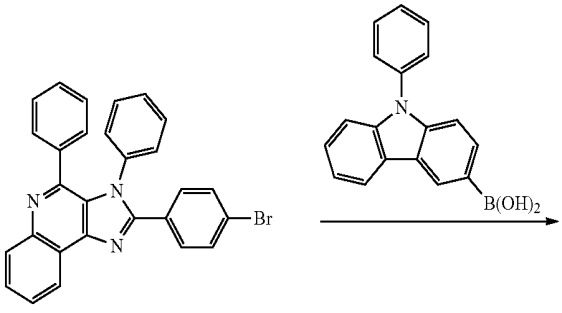
Int.-2



Int.-3

[0076] 20 g (38.1 mmol) of the intermediate Int.-2 is dispersed in 150 ml of glacial acetic acid and heated to 100° C. under the protection of nitrogen, 10.6 g (0.19 mol) of iron powder is added in batches during stirring for a reaction for 1 hour, heating is performed for a reflux reaction for 10 hours, then a mixture is cooled to room temperature and filtered, a filtrate is decompression-concentrated to dryness, and separation and purification are performed by means of a silica gel column, so as to obtain 15.2 g of Int.-3 in yellow solid, with a yield of 84%.

[0077] Step 3: Preparation of the Compound CJH-P16



Int.-3

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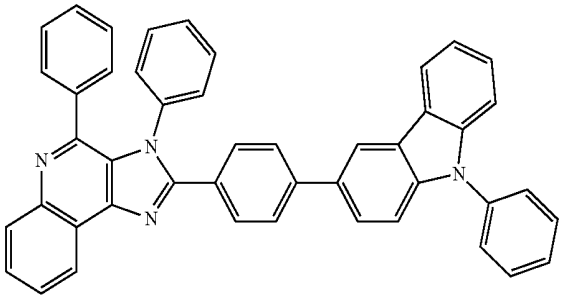


CJH-P16

[0078] 40 mL of toluene, 10 mL of ethanol, and 5 mL of water are added to 5 g (10.5 mmol) of the intermediate Int.-3, 3.6 g (12.6 mmol) of 9-phenyl-9H-carbazole-3-boronic acid, 4.5 g (42 mmol) of sodium carbonate, and 5 mg of a $Pd(PPh_3)_4$ catalyst, heating is performed for refluxing, stirring is performed for a reaction for 12 hours, then a mixture is cooled to room temperature, extraction is performed by means of ethyl acetate, an organic phase is dried and filtered, a filtrate is decompression-concentrated to dryness, and separation and purification are performed by means of a silica gel column, hot refluxing is performed by means of ethanol, and filtering is performed while the heat remains, so as to obtain 5.9 g of CJH-P16 in yellow solid, with a yield of 88%. With HRMS $C_{46}H_{30}N$, a standard molecular weight 638.247, and a test result 639.2562, for nuclear magnetic ^{1}HNMR and ^{13}CNMR, reference is made to FIGS. **3** and **4**, and for a visible-ultraviolet absorption spectrum and a fluorescent spectrum, reference is made to FIGS. **5** and **6**.

[0079] The following compounds are prepared with reference to the synthetic method of Example 1, that is, the method steps are the same as those in Example 1, except that a different compound is used to replace the 9-phenyl-9H-carbazole-3-boronic acid in step 3 of Example 1 according to actual needs so as to obtain a different desired product, and the mass amount of the compound is changed according to the molar amount. The results are shown in Table 1:

TABLE 1

Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
1	CJH-P01	755.2932	7.6×10^{-5}
2	CJH-P02	727.2915	4.8×10^{-5}
3	CJH-P03	754.2979	5.5×10^{-5}
4	CJH-P04	744.3131	5.9×10^{-5}
5	CJH-P05	627.2553	5.3×10^{-5}
6	CJH-P06	700.2765	4.4×10^{-5}
7	CJH-P07	700.2762	5.2×10^{-5}
8	CJH-P08	675.2557	5.7×10^{-5}
9	CJH-P09	690.2554	7.8×10^{-5}
10	CJH-P10	728.2716	4.7×10^{-5}
11	CJH-P11	712.2761	4.4×10^{-5}
12	CJH-P12	714.2918	5.5×10^{-5}
13	CJH-P13	652.2508	6.4×10^{-5}
14	CJH-P14	639.2553	3.4×10^{-5}
15	CJH-P15	666.2664	6.2×10^{-5}
16	CJH-P16	639.2562	3.7×10^{-5}
17	CJH-P17	693.2778	5.8×10^{-5}

TABLE 1-continued

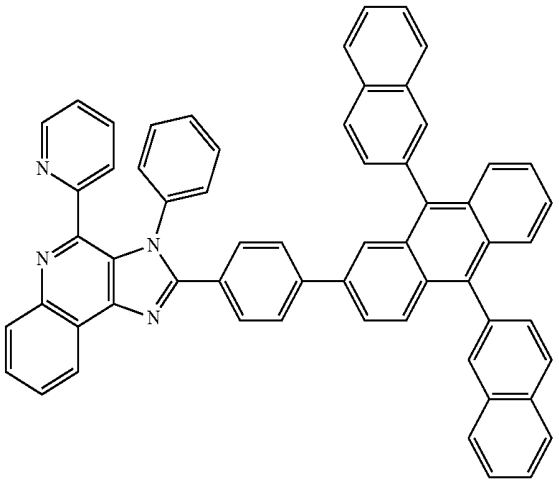
Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
18	CJH-P18	693.2776	7.4×10^{-5}
19	CJH-P19	674.2928	5.5×10^{-5}
20	CJH-P20	705.2775	8.4×10^{-5}
21	CJH-P21	704.2822	5.8×10^{-5}
22	CJH-P22	728.2821	7.3×10^{-5}
23	CJH-P23	716.2710	3.5×10^{-5}
24	CJH-P24	728.2824	6.7×10^{-5}
25	CJH-P25	629.2463	5.5×10^{-5}
26	CJH-P26	628.2512	8.6×10^{-5}
27	CJH-P27	552.2203	7.2×10^{-5}
28	CJH-P28	630.2415	6.9×10^{-5}
29	CJH-P29	732.2847	5.2×10^{-5}
30	CJH-P30	674.2378	5.8×10^{-5}
31	CJH-P31	667.2624	6.8×10^{-5}
32	CJH-P32	641.2719	5.5×10^{-5}
33	CJH-P81	716.2825	7.1×10^{-5}
34	CJH-P83	748.2765	6.3×10^{-5}
35	CJH-P84	880.3453	4.0×10^{-5}
36	CJH-P88	639.2556	4.5×10^{-5}
37	CJH-P99	739.2874	4.1×10^{-5}

Example 2

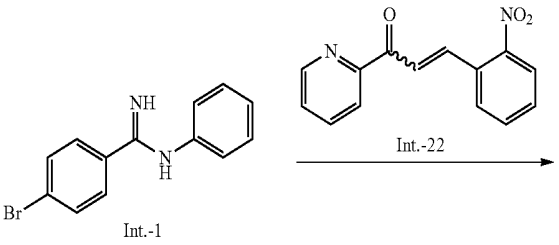
[0080] The structural formula of the compound CJH-P37 is as follows:

CJH-P37



[0081] A preparation route thereof is as follows:

[0082] Step 1: Preparation of an Intermediate Int.-4



Int.-1

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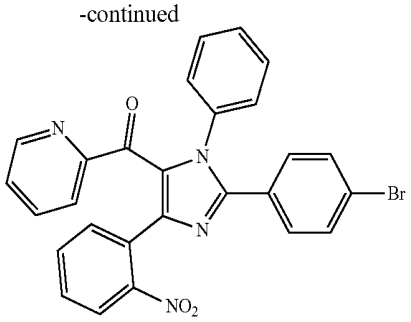
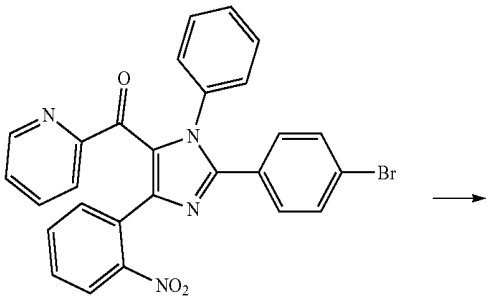


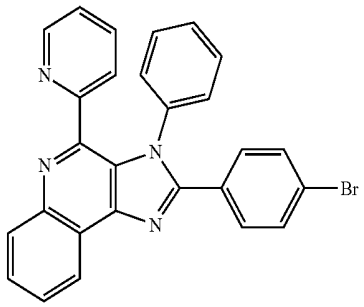
Int.-4

[0083] For a synthetic operation, reference is made to step 1 of Example 1, wherein Int.-21 in step 1 of Example 1 is replaced with Int.-22 (3-(2-nitrophenyl)-1-(2-pyridyl)propyl-2-en-1-one), so as to obtain the intermediate Int.-4 in yellow solid, with a yield of 88%.

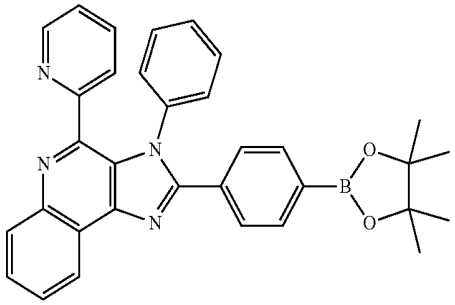
[0084] Step 2: Preparation of an Intermediate Int.-5



Int.-4



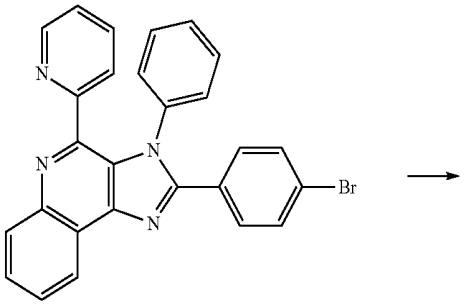
Int.-5



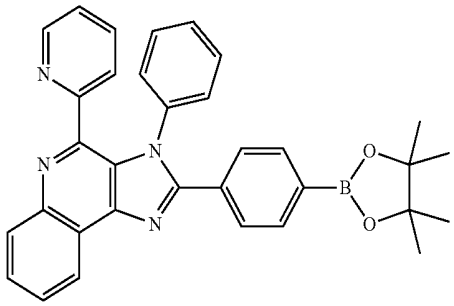
Int.-6

[0085] For a synthetic operation, reference is made to step 2 of Example 1, wherein the intermediate Int.-2 in step 2 of Example 1 is replaced with the intermediate Int.-4, so as to obtain the intermediate Int.-5 in white solid, with a yield of 90%.

[0086] Step 3: Preparation of an Intermediate Int.-6



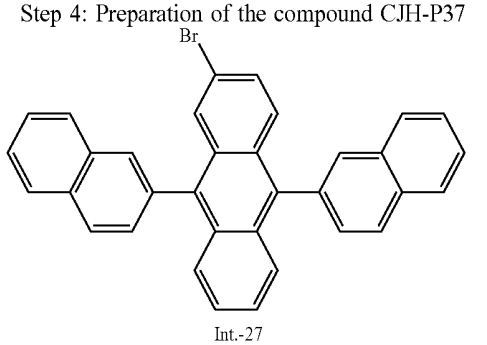
Int.-5



Int.-6

[0087] 10 g (20.9 mmol) of the intermediate Int.-5, 6.4 g (25 mmol) of bis(pinacolate)diboron, and 3.0 g (31.4 mmol) of potassium acetate are mixed, then 54 mg of a $PdCl_2$(dppf) CH_2Cl_2 catalyst and 80 mL of N,N-dimethylformamide are added, heating is performed under the protection of nitrogen to 90° C., stirring is performed for a reaction for 12 hours, then a mixture is cooled to room temperature, poured into ice water, and filtered, a filter cake is washed with water, and separation and purification are performed by means of a silica gel column, so as obtain 10 g of Int.-6 in white solid, with a yield of 92%.

[0088] Step 4: Preparation of the compound CJH-P37



Int.-27

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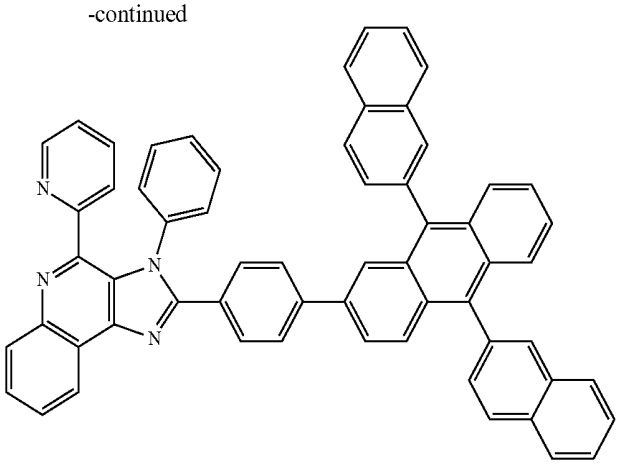


CJH-P37

[0089] 40 mL of toluene, 10 mL of ethanol, and 5 mL of water are added to 5 g (9.5 mmol) of the intermediate Int.-6, 4.4 g (8.6 mmol) of Int.-27, 3.7 g (34.9 mmol) of sodium carbonate, and 5 mg of a $Pd(PPh_3)_4$ catalyst, heating is performed for refluxing, stirring is performed for a reaction for 12 hours, then a mixture is cooled to room temperature, extraction is performed by means of ethyl acetate, an organic phase is dried and filtered, a filtrate is decompression-concentrated to dryness, separation and purification are performed by means of a silica gel column, heating is performed to boiling by means of ethanol, and then filtering is performed while the heat remains, so as to obtain 4.9 g of CJH-P37 in yellow solid, with a yield of 68.5%. With HRMS $C_{61}H_{38}N_4$, a standard molecular weight 826.3096, and a test result 827.3182, for nuclear magnetic ^{1}HNMR and ^{13}CNMR, reference is made to FIGS. **7** and **8**, and for a visible-ultraviolet absorption spectrum and a fluorescent spectrum, reference is made to FIGS. **9** and **10**.

[0090] The following compounds are prepared with reference to the synthetic method of Example 2, that is, the method steps are the same as those in Example 2, except that a different compound is used to replace the Int.-27 in step 4 of Example 2 according to actual needs so as to obtain a different desired product, and the mass amount of the compound is changed according to the molar amount. The results are shown in Table 2:

TABLE 2

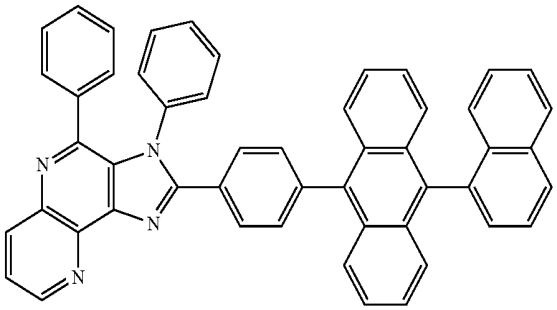
Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
38	CJH-P35	705.2776	8.6×10^{-5}
39	CJH-P36	701.2715	7.6×10^{-5}
40	CJH-P37	827.3182	5.3×10^{-5}
41	CJH-P38	745.3092	6.4×10^{-5}
42	CJH-P39	716.2822	8.3×10^{-5}
43	CJH-P40	839.3502	4.4×10^{-4}
44	CJH-P41	837.3356	4.7×10^{-4}
45	CJH-P42	795.2994	5.8×10^{-5}
46	CJH-P43	806.2935	9.6×10^{-5}
47	CJH-P44	675.2323	6.8×10^{-5}
48	CJH-P82	717.2773	8.4×10^{-5}

Example 3

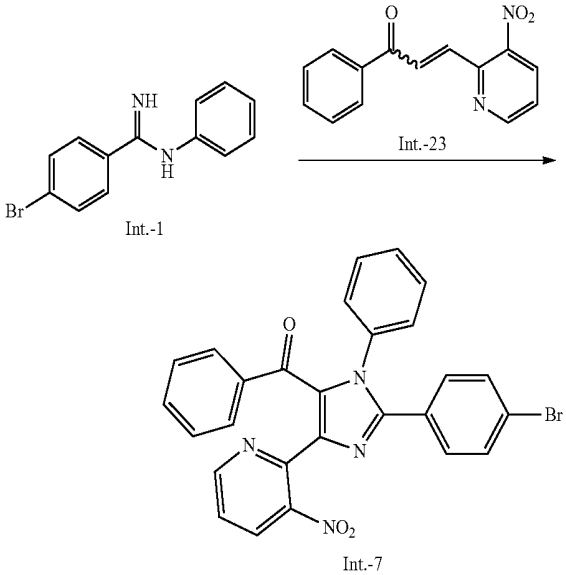
[0091] The structural formula of the compound CJH-P50 is as follows:

CJH-P50



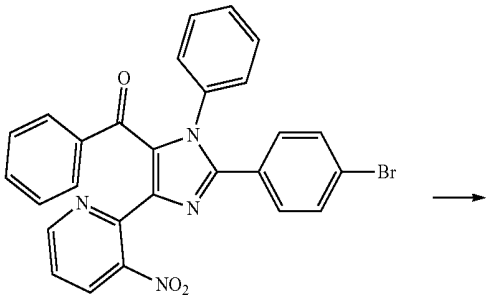
[0092] A preparation route thereof is as follows:

[0093] Step 1: Preparation of an Intermediate Int.-7

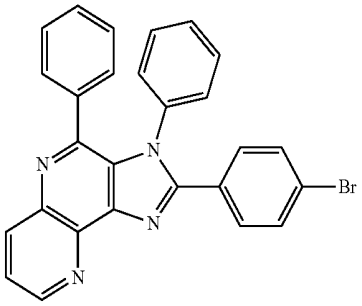


[0094] For a synthetic operation, reference is made to step 1 of Example 1, wherein Int.-21 in step 1 of Example 1 is replaced with an intermediate Int.-23, so as to obtain the intermediate Int.-7 in yellow solid, with a yield of 56%.

[0095] Step 2: Preparation of an Intermediate Int.-8



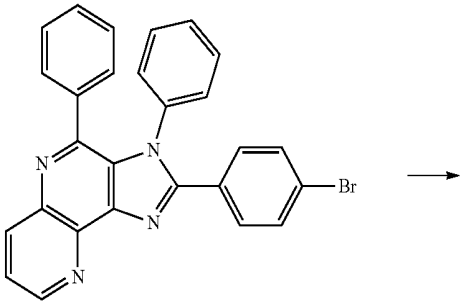
Int.-7



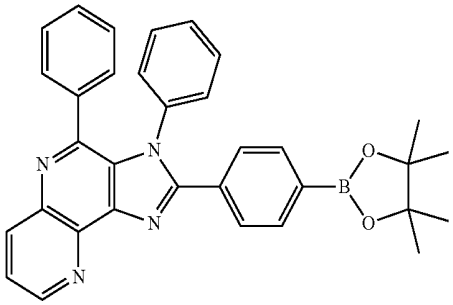
Int.-8

[0096] For a synthetic operation, reference is made to step 2 of Example 1, wherein the Int.-2 in step 2 of Example 1 is replaced with the Int.-7, so as to obtain the intermediate Int.-8 in yellow solid, with a yield of 87%.

[0097] Step 3: Preparation of an Intermediate Int.-9



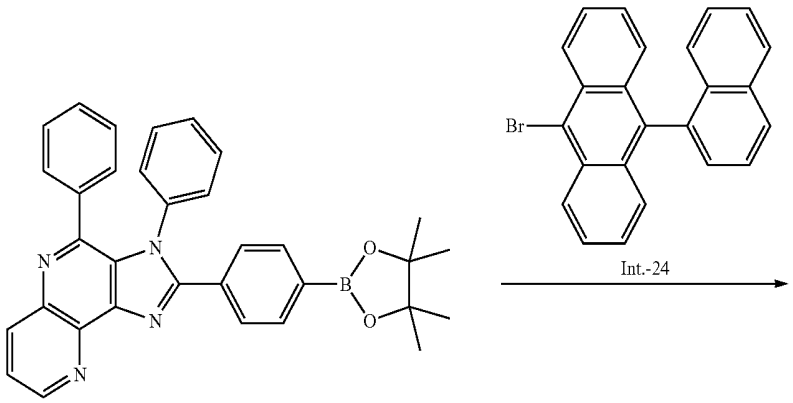
Int.-8



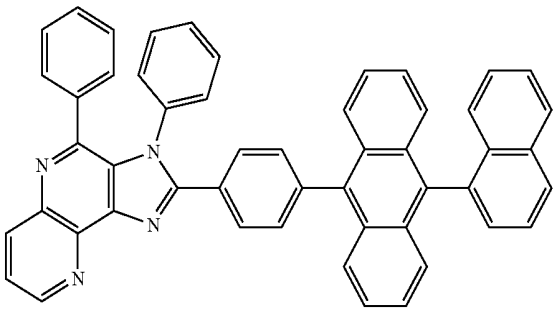
Int.-9

[0098] For a synthetic operation, reference is made to step 3 of Example 2, wherein the Int.-5 in step 3 of Example 2 is replaced with the Int.-8, so as to obtain the intermediate Int.-9 in yellow solid, with a yield of 92%.

[0099] Step 4: Preparation of the Compound CJH-P50



Int.-9



CJH-P50

[0100] 40 mL of toluene, 10 mL of ethanol, and 5 mL of water are added to 5 g (9.5 mmol) of the intermediate Int.-9, 3.3 g (8.6 mmol) of Int.-24, 3.7 g (34.9 mmol) of sodium carbonate, and 5 mg of a $Pd(PPh_3)_4$ catalyst, heating is performed for refluxing, stirring is performed for a reaction for 12 hours, then a mixture is cooled to room temperature, extraction is performed by means of ethyl acetate, an organic phase is dried and filtered, a filtrate is decompression-concentrated to dryness, separation and purification are performed by means of a silica gel column, heating is performed to boiling by means of ethyl acetate, and then filtering is performed while the heat remains, so as to obtain 4.0 g of CJH-P50 in white solid, with a yield of 66%. The HRMS is $C_{51}H_{32}N_4$, a standard molecular weight is 700.2627, a test result is 701.2714, ^{1}HNMR (δ, CDCl3) is as follows: 8.89-8.86 (1H, m); 8.32-8.30 (1H, m); 8.06-7.99 (2H, m); 7.80-7.65 (8H, m); 7.55-7.41 (7H, m); 8.35-7.29 (2H, m); 7.26-7.13 (6H, m); and 7.10-7.02 (5H, m). The carrier mobility is 5.8×10^{-4} cm^2/VS.

[0101] The following compounds are prepared with reference to the synthetic method of Example 3, that is, the method steps are the same as those in Example 3, except that a different compound is used to replace the Int.-24 in step 4 of Example 3 according to actual needs so as to obtain a different desired product, and the mass amount of the compound is changed according to the molar amount. The results are shown in Table 3:

TABLE 3

Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
49	CJH-P45	756.2887	8.8×10^{-5}
50	CJH-P46	727.2874	6.4×10^{-5}
51	CJH-P47	755.2936	7.4×10^{-5}
52	CJH-P48	745.3088	6.6×10^{-5}
53	CJH-P49	628.2512	6.7×10^{-5}
54	CJH-P50	701.2714	5.8×10^{-4}
55	CJH-P51	701.2716	6.4×10^{-5}
56	CJH-P52	676.2515	6.2×10^{-5}
57	CJH-P53	681.2662	6.0×10^{-5}
58	CJH-P54	729.2664	7.2×10^{-5}
59	CJH-P55	707.3186	5.6×10^{-5}
60	CJH-P56	713.2714	6.7×10^{-5}
61	CJH-P57	715.2875	6.9×10^{-5}
62	CJH-P58	653.2466	4.2×10^{-5}

TABLE 3-continued

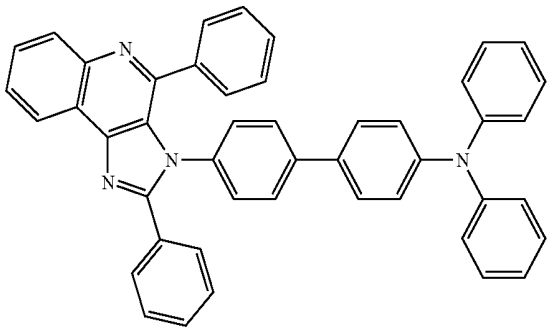
Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
63	CJH-P59	640.2512	5.8×10^{-5}
64	CJH-P60	667.2621	4.2×10^{-4}
65	CJH-P61	640.2513	5.5×10^{-5}
66	CJH-P62	694.2724	8.6×10^{-5}
67	CJH-P63	694.2726	5.2×10^{-4}
68	CJH-P64	675.2885	3.7×10^{-4}
69	CJH-P65	706.2724	7.5×10^{-5}
70	CJH-P66	705.2774	4.4×10^{-4}
71	CJH-P67	729.2776	8.2×10^{-5}
70	CJH-P68	717.2665	7.1×10^{-5}
73	CJH-P69	729.2774	6.3×10^{-4}
74	CJH-P70	630.2414	3.0×10^{-4}
75	CJH-P71	629.2462	8.4×10^{-5}
76	CJH-P72	553.2153	7.6×10^{-5}
77	CJH-P73	693.2525	7.2×10^{-5}
78	CJH-P74	733.2794	8.0×10^{-5}
79	CJH-P75	675.2322	8.8×10^{-5}
80	CJH-P76	668.2572	5.2×10^{-4}
81	CJH-P77	642.2665	6.6×10^{-5}
82	CJH-P80	717.2772	6.2×10^{-4}
83	CJH-P100	679.2618	8.6×10^{-5}

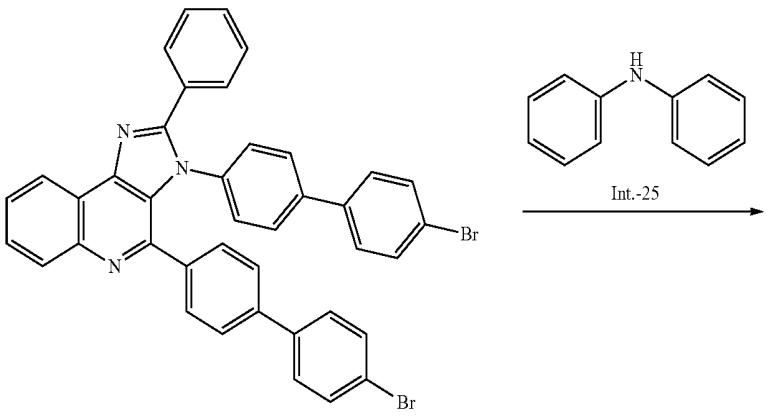
Example 4

[0102] The structural formula of the compound CJH-P87 is as follows:

CJH-P87



[0103] A preparation route thereof is as follows:



Int.-10

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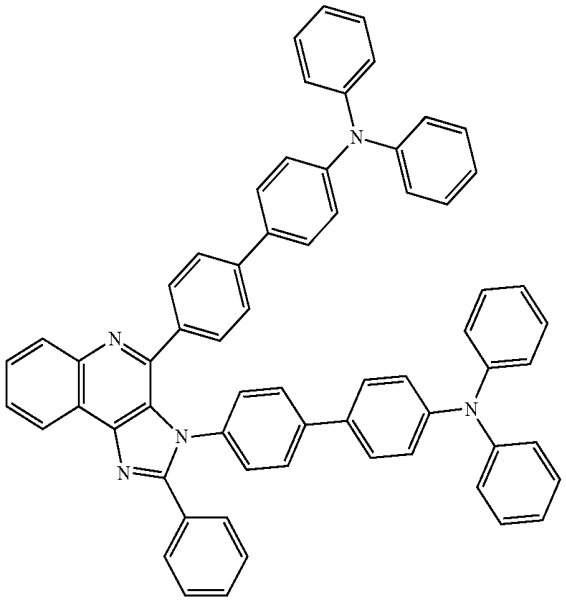


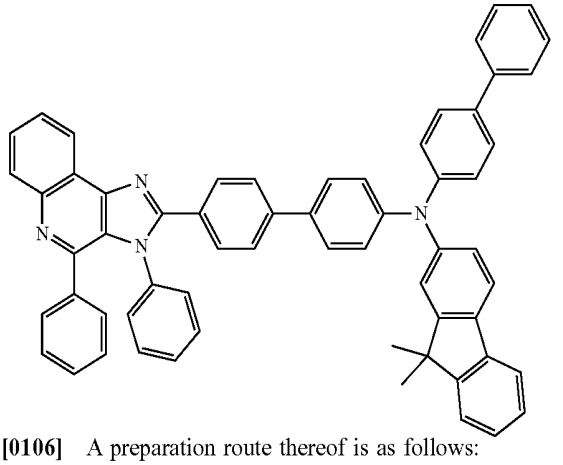
CJH-P87

[0104] 5 g (7.0 mmol) of an intermediate Int.-10, 2.6 g (15.5 mmol) of diphenylamine, and 2.0 g (21.2 mmol) of sodium tert-butoxide are mixed, then 73 mg (0.08 mmol) of a Pd2 (dba)3 catalyst and 80 mL of toluene are added, 0.2 mL of a 10% tri-tert-butyl phosphorus toluene solution is added under the protection of nitrogen, heating is performed to 90° C., stirring is performed for a reaction for 16 hours, then a mixture is cooled to room temperature, 80 mL of water is added to separate an organic phase, an aqueous phase is extracted by means of ethyl acetate, the organic phase is dried by means of anhydrous sodium sulfate and filtered, a filtrate is decompression-concentrated to dryness, and separation and purification are performed by means of a silica gel column, so as to obtain 4.7 g of white solid, with a yield of 76%. The HRMS is $C_{64}H_{45}N_5$, a standard molecular weight is 883.3675, a test result is 884.3762, ^{1}HNMR (δ, CDCl3) is as follows: 8.81-8.79 (1H, m); 8.30-8.28 (1H, d); 7.76-7.69 (2H, m); 7.60-7.59 (2H, d); 7.37-7.12 (22H, m); and 7.08-6.93 (17H, m). The carrier mobility is 6.4×10^{-5} cm^2VS.

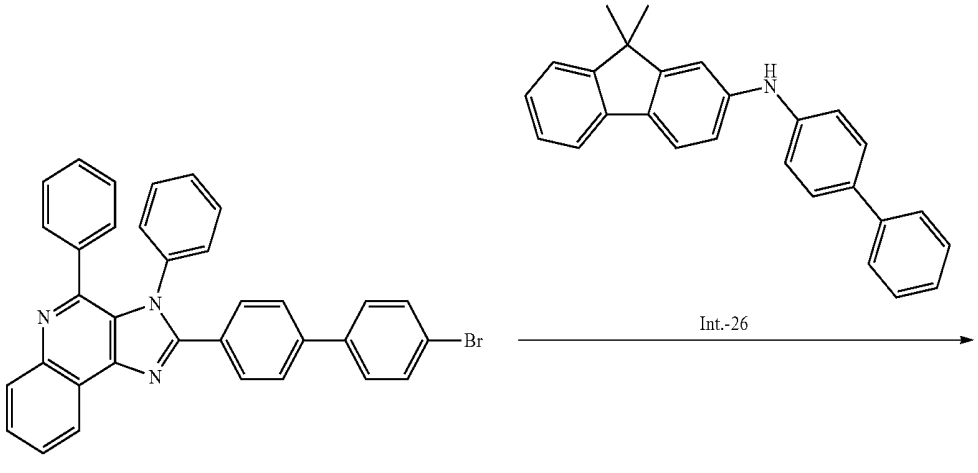
Example 5

[0105] The structural formula of the compound CJH-P98 is as follows:

CJH-P98



[0106] A preparation route thereof is as follows:



Int.-11

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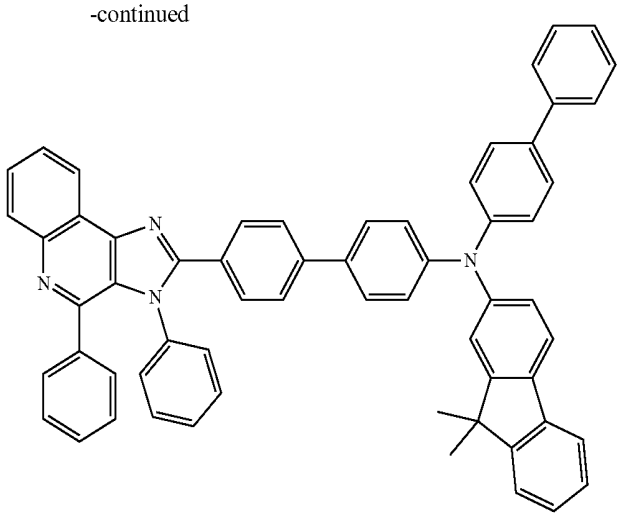


CJH-P98

[0107] 5 g (9.0 mmol) of an intermediate Int.-11, 3.0 g (8.5 mmol) of an intermediate Int.-26, and 1.2 g (12.75 mmol) of sodium tert-butoxide are mixed, then 73 mg (0.08 mmol) of a Pd2 (dba)3 catalyst and 80 mL of toluene are added, 0.2 mL of a 10% tri-tert-butyl phosphorus toluene solution is added under the protection of nitrogen, heating is performed to 90° C., stirring is performed for a reaction for 16 hours, then a mixture is cooled to room temperature, 80 mL of water is added for filtering, a filter cake is washed with water and ethanol, and separation and purification are performed by means of a silica gel column, so as to obtain 4.5 g of white solid, with a yield of 64%. The HRMS is $C_{61}H_{44}N_4$, a standard molecular weight is 832.3566, a test result is 833.3653, ^{1}HNMR (δ, CDCl3) is as follows: 8.33-8.29 (1H, m); 7.76-7.71 (2H, m); 7.49-7.44 (2H, m); 7.31-7.16 (27H, m); 7.12-7.01 (5H, m); 6.99-6.96 (1H, d); and 1.41 (6H, s). The carrier mobility is 5.8×10^{-5} cm^2/VS.

[0108] The following compounds are prepared with reference to the synthetic method of Example 5, that is, the method steps are the same as those in Example 5, except that a different compound is used to replace the Int.-26 in Example 5 according to actual needs so as to obtain a different desired product, and the mass amount of the compound is changed according to the molar amount. The results are shown in Table 4:

Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
84	CJH-P33	804.3135	4.7×10^{-5}
85	CJH-P34	893.3402	5.0×10^{-5}
86	CJH-P78	805.3092	4.5×10^{-5}
87	CJH-P79	894.3354	6.0×10^{-5}
88	CJH-P85	656.2822	5.2×10^{-5}
89	CJH-P86	630.2304	5.5×10^{-5}
90	CJH-P87	884.3762	6.4×10^{-5}
91	CJH-P89	564.2192	5.9×10^{-5}
92	CJH-P90	654.2664	7.7×10^{-5}
93	CJH-P91	793.3342	5.6×10^{-5}
94	CJH-P92	922.3922	4.2×10^{-5}
95	CJH-P93	922.3920	3.8×10^{-5}

-continued

Mass spectrum test results and carrier mobility of different compounds

Serial number	Compound No.	Mass spectrum test result	Carrier mobility (cm^2/VS)
96	CJH-P94	1029.4653	8.5×10^{-5}
97	CJH-P95	762.3242	7.7×10^{-5}
98	CJH-P96	782.3294	7.5×10^{-5}
99	CJH-P97	899.3874	5.5×10^{-4}
100	CJH-P98	833.3653	5.8×10^{-5}

Example 6

[0109] An organic light-emitting device, which is a bottom-emitting device, has a structure as shown in FIG. **2** and comprises a substrate **1**, an anode layer **2** disposed on the substrate **1**, a hole injection layer **3** disposed on the anode layer **2**, a hole transport layer **4** disposed on the hole injection layer **3**, an organic light-emitting layer **5** disposed on the hole transport layer **4**, an electron transport layer **6** disposed on the organic light-emitting layer **5**, and a cathode layer **7** disposed on the electron transport layer **6**, wherein the preparation thereof comprises the following steps:

[0110] 1) the glass substrate coated with an ITO conductive layer is sonicated in a cleaning agent for 30 minutes, washed in deionized water, sonicated in an acetone/ethanol mixed solvent for 30 minutes, baked in a clean environment to complete dryness, and irradiated with an ultraviolet cleaning machine for 10 minutes, and the surface thereof is bombarded with a low energy cation beam:

[0111] 2) the treated ITO glass substrate is placed in a vacuum chamber, which is vacuumized to 1×10-5-9× 10-3 Pa, and a compound 2-TNATA is evaporated on a film of the anode layer to form a hole injection layer, wherein an evaporation rate is 0.1 nm/s, and the thickness of an evaporation film is 40 nm;

[0112] 3) NPB is evaporated on the hole injection layer to form a hole transport layer, wherein an evaporation rate is 0.1 nm/s, and the thickness of an evaporation film is 10 nm:

[0113] 4) ADN is evaporated on the hole transport layer as a host material and DPVBi as a doping material, with the mass ratio of AND to DPVBi being 98:2, so as to form an organic light-emitting layer of the device, wherein an evaporation rate is 0.1 nm/s, and the film thickness of the organic light-emitting layer obtained by means of the evaporation is 40 nm:

[0114] 5) the compound (of formula I) of the present invention is evaporated on the organic light-emitting layer as a host material and LiQ as a doping material, with the mass ratio of the compound (of formula I) to LiQ being 90:10, so as to form an electron transfer layer, wherein an evaporation rate is 0.1 nm/s, and the thickness of an evaporation film is 50 nm;

[0115] 6) a magnesium/silver alloy is sequentially evaporated on the electron transfer layer to form a cathode layer of the device, wherein an evaporation rate of the magnesium/silver alloy is 2.0-3.0 nm/s, the thickness of an evaporation film is 100 nm, and the mass ratio of magnesium to silver is 1:9, so as to obtain the OLED device provided by the present invention.

[0116] An OLED-1 provided by the present invention is obtained through the same steps as described above, wherein CJH-P19 is selected as the compound (of formula I) in step 5).

[0117] An OLED-2 provided by the present invention is obtained through the same steps as described above, wherein CJH-P36 is selected as the compound (of formula I) in step 5).

[0118] An OLED-3 provided by the present invention is obtained through the same steps as described above, wherein CJH-P37 is selected as the compound (of formula I) in step 5).

[0119] An OLED-4 provided by the present invention is obtained through the same steps as described above, wherein CJH-P50 is selected as the compound (of formula I) in step 5).

[0120] An OLED-5 provided by the present invention is obtained through the same steps as described above, wherein CJH-P63 is selected as the compound (of formula I) in step 5).

[0121] A comparative OLED-6 is obtained through the same steps as described above, wherein the compound (of formula I) in step 5) is replaced with Alq3. The performance test results of the obtained devices OLED-1 to OLED-6 are shown in Table 5.

TABLE 5

Performance test results of OLED-1 to OLED-6

Device No.	Material	Turn-on Voltage (V)	Current density (mA/cm^2)	Luminance (Cd/m^2)	Current efficiency (Cd/A)	Emission color	Half life (hour)
OLED-1	CJH-P19	4.6	50	3018	6.03	Blue	455
OLED-2	CJH-P36	4.2	50	3092	6.18	Blue	483
OLED-3	CJH-P37	4.8	50	3037	6.07	Blue	474
OLED-4	CJH-P50	4.3	50	3478	6.94	Blue	486

TABLE 5-continued

Performance test results of OLED-1 to OLED-6

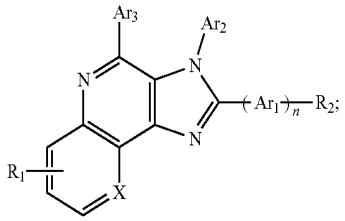
Device No.	Material	Turn-on Voltage (V)	Current density (mA/cm^2)	Luminance (Cd/m^2)	Current efficiency (Cd/A)	Emission color	Half life (hour)
OLED-5	CJH-P63	4.2	50	3332	6.65	Blue	505
OLED-6	Alq3	7.8	50	1564	3.12	Blue	114

[0122] It can be known from the above that the device produced by using the organic material of the present invention has a low turn-on voltage, and in the case of the same current density, the luminance and efficiency are significantly higher than the case where Alq3 is used to form an electron transport layer, and the half-life of the device is much longer.

[0123] Apparently, the above-described examples of the present invention are merely illustrations for clear description of the present invention instead of limitation to the implementation manners of the present invention, a person skilled in the art can further make other variations or modifications of different forms on the basis of the above description, all of the implementation manners cannot be listed herein, and any obvious variations or modifications derived from the technical solutions of the present invention still fall within the protection scope of the present invention.

1. An imidazole derivative, wherein the structural formula of the imidazole derivative is as represented by formula I:

I



wherein R_1 and R_2 respectively and independently represent hydrogen, deuterium, a C_1-C_8 linear or branched alkyl group, a C_1-C_8 linear or branched alkoxy group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryl vinyl group, a substituted or unsubstituted C_6-C_{60} fused-ring aryl group, a substituted or unsubstituted C_6-C_{60} arylamine group, a substituted or unsubstituted C_6-C_{60} nitrogen atom-containing fused-ring aryl group, a substituted or unsubstituted C_6-C_{60} sulfur or oxygen atom-containing fused-ring aryl group, a substituted or unsubstituted C_6-C_{60} phosphorus, silicon, or boron atom-containing fused-ring aryl group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

Ar_1, Ar_2, and Ar_3 respectively and independently represent a substituted or unsubstituted phenyl group, a substituted or unsubstituted naphthyl group, a substituted or unsubstituted fluorenyl group, a substituted or unsubstituted spirofluorenyl group, a substituted or unsubstituted anthryl group, a substituted or unsubstituted pyridyl group, a substituted or unsubstituted pyrimidyl group, a substituted or unsubstituted quinolyl

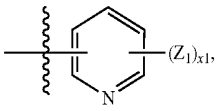
group, a substituted or unsubstituted carbazolyl group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

n represents an integer of 1-5; and

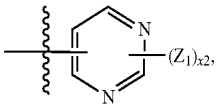
x represents a carbon atom or a nitrogen atom.

2. The imidazole derivative according to claim **1**, wherein in the R_1, R_2, Ar_1, Ar_2, and Ar_3 groups, the C_2-C_{60} heterocyclic aryl groups are respectively and independently selected from one or a plurality of the following structures of formulas II-1 to II-15:

II-1



II-2



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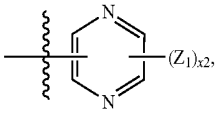
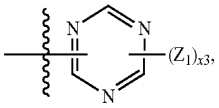
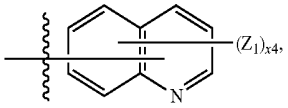


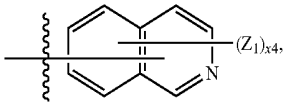
II-4



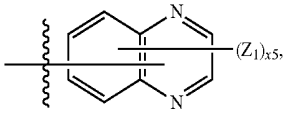
II-5



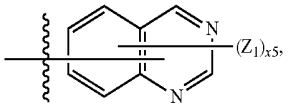
II-6



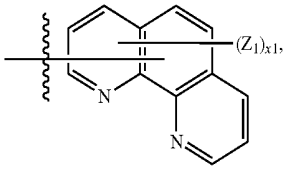
II-7



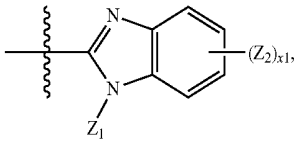
II-8



II-9



II-10



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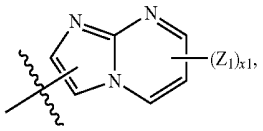
II-11



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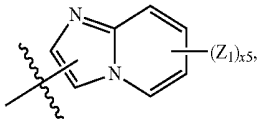

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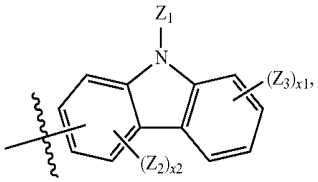
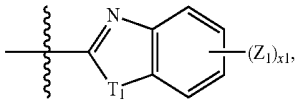
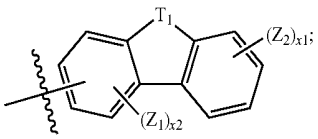


II-14



II-15



wherein Z_1, Z_2, and Z_3 respectively and independently represent hydrogen, deuterium, a halogen atom, a hydroxyl group, a nitrile group, a nitro group, an amino group, an amidine group, a hydrazine group, a hydrazone group, a carboxyl group or a carboxylate thereof, a sulfonic group or a sulfonate thereof, a phosphate group or a phosphate thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{60} cycloalkane group, a C_3-C_{60} cycloolefin group, a C_6-C_{60} aryl group, a C_6-C_{60} aryl group containing at least one of —F, —CN, or a C_1-C_{10} alkyl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} aryl thioether group, or a substituted or unsubstituted C_2-C_{60} heterocyclic aryl group;

x1 represents an integer of 1-4; x2 represents an integer of 1-3; x3 represents an integer of 1 or 2; x4 represents an integer of 1-6; x5 represents an integer of 1-5;

T_1 represents an oxygen atom or a sulfur atom; and

 represents a bond between a substituent and a main structure.

3. The imidazole derivative according to claim **1**, wherein the structural formula of the compound having a structural formula I is specifically represented by the following formulas CJH-P01 to CJH-P100:

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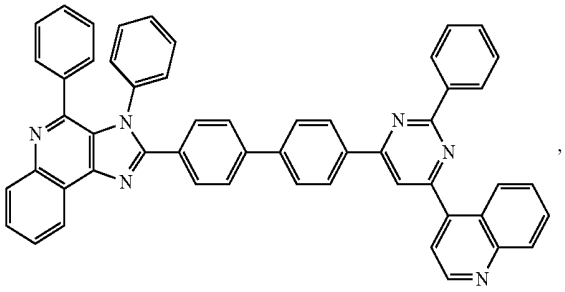
CJH-P01



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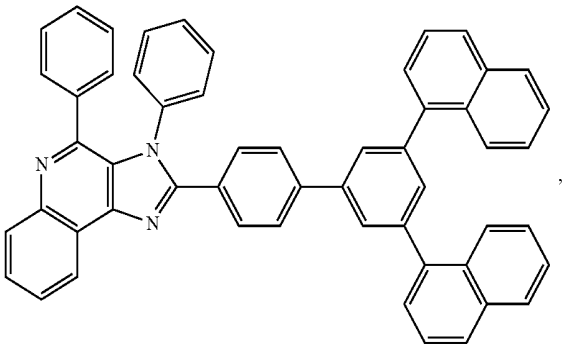
CJH-P02



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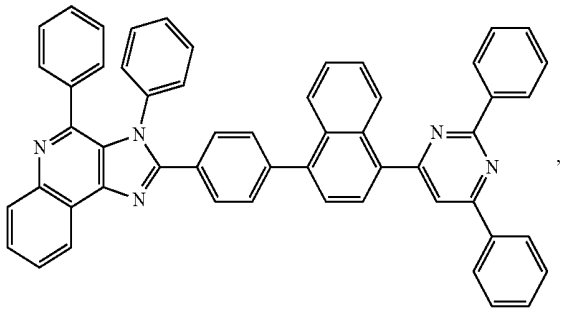
CJH-P03



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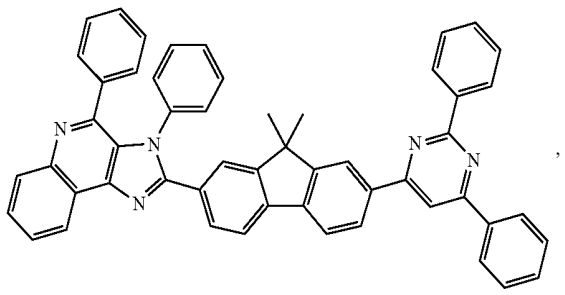
CJH-P04



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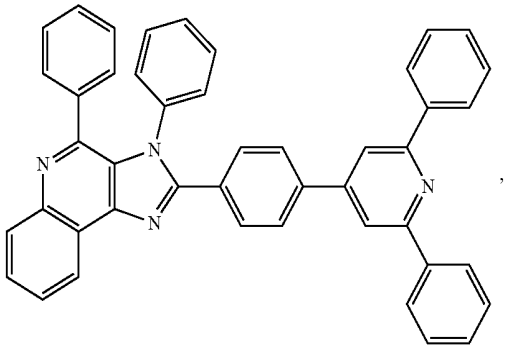
CJH-P05



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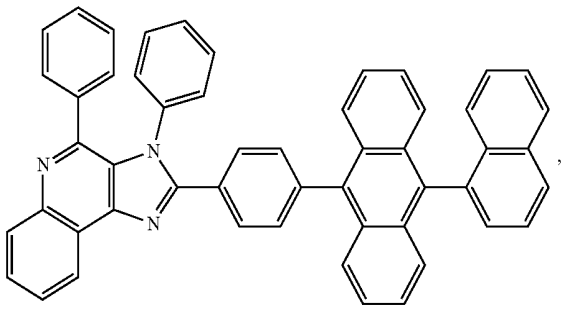
CJH-P06



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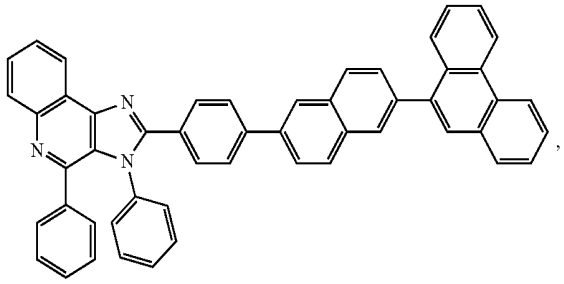
CJH-P07



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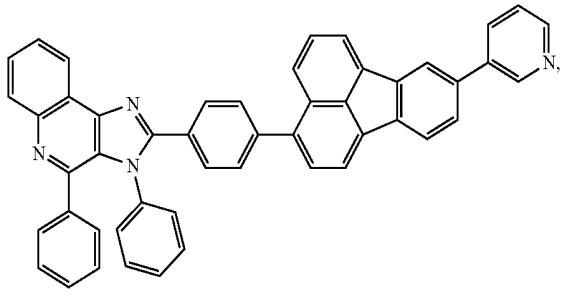
CJH-P08



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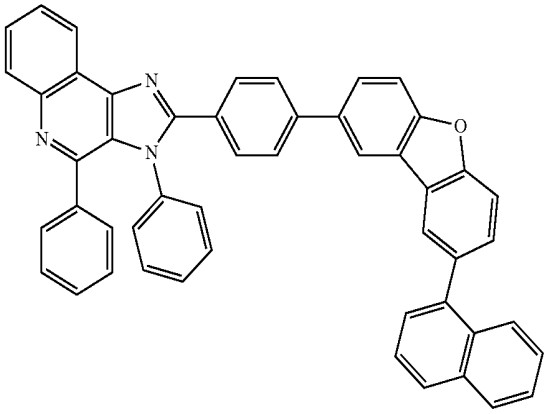
CJH-P09



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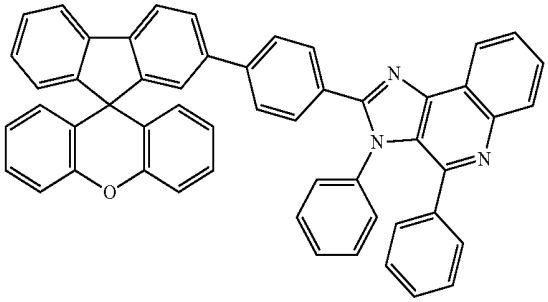
CJH-P10



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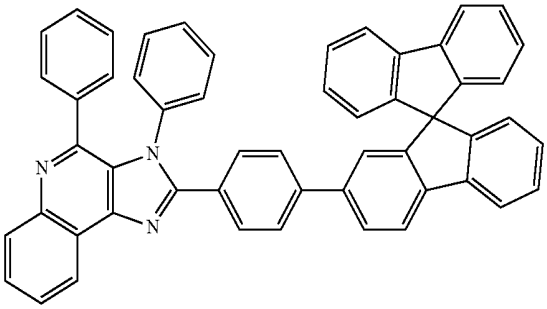
CJH-P11



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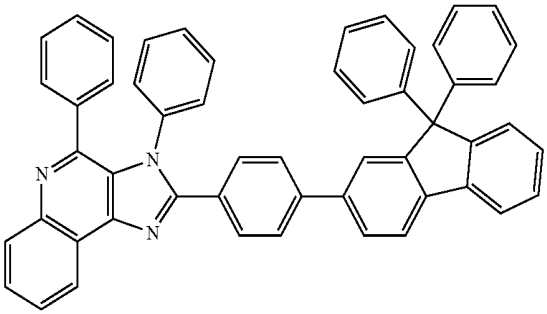

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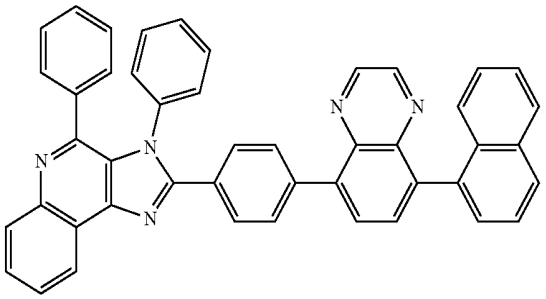

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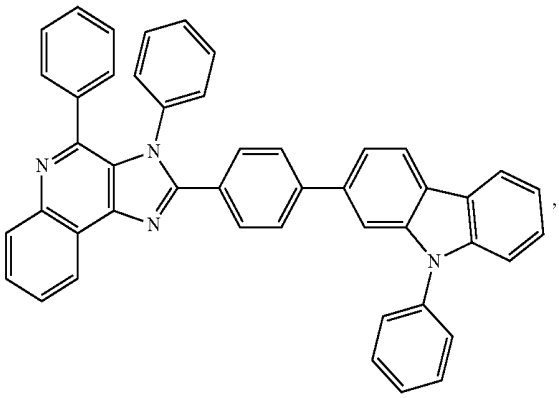
CJH-P14



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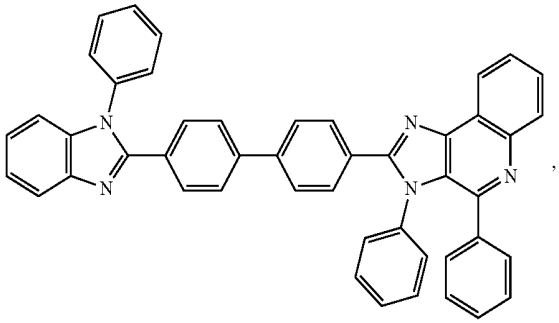

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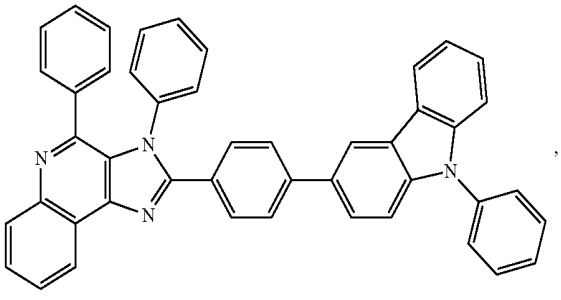
CJH-P16



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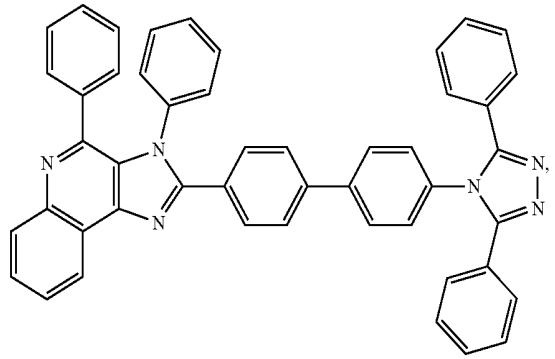

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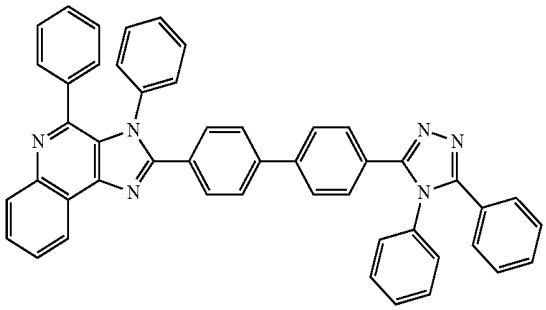

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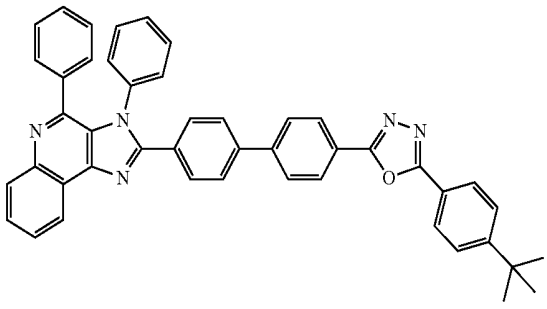

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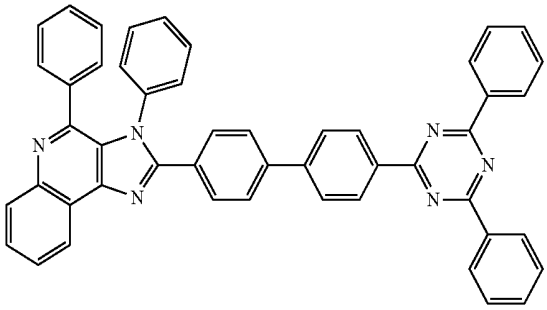

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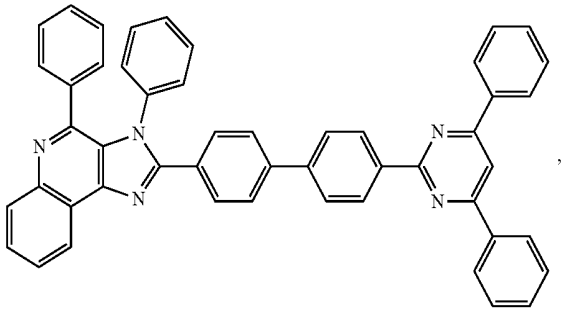

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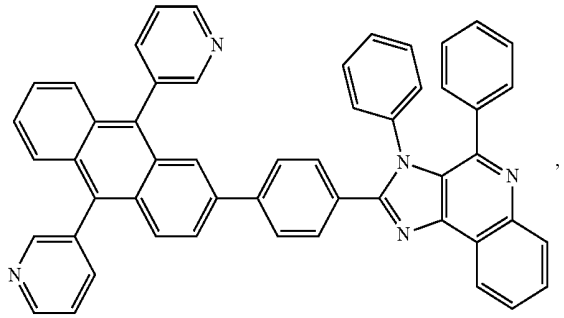
CJH-P22



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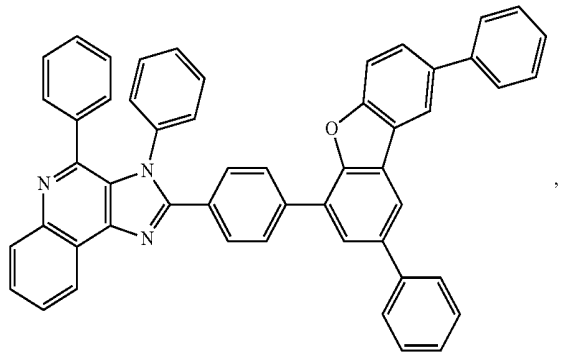

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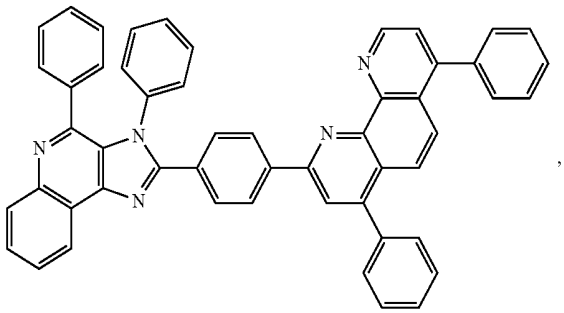

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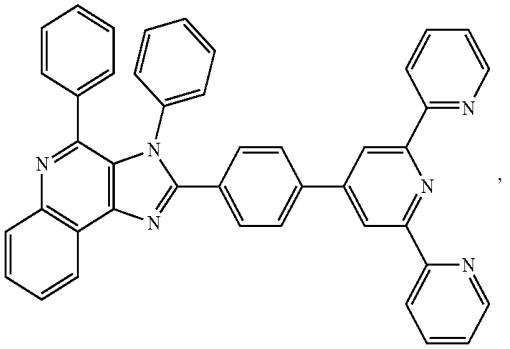

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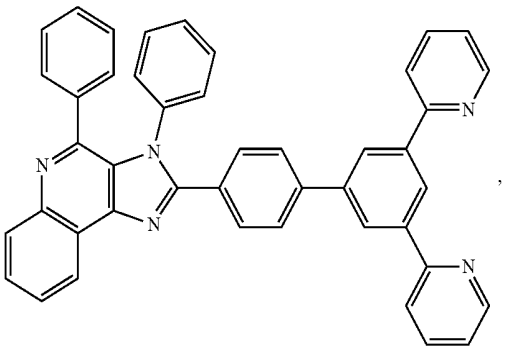

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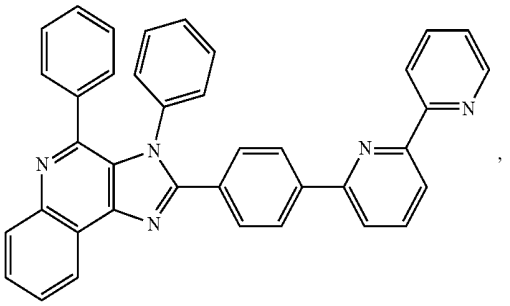

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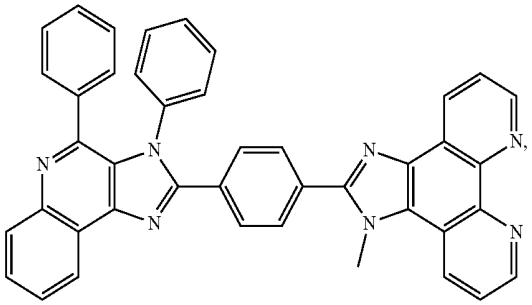

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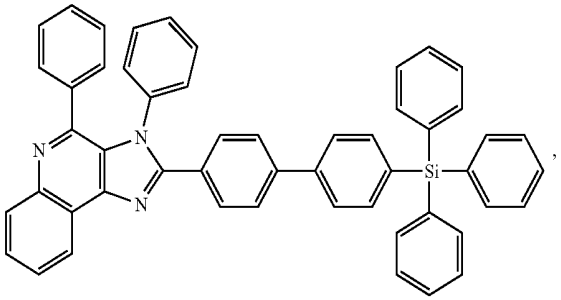
CJH-P29



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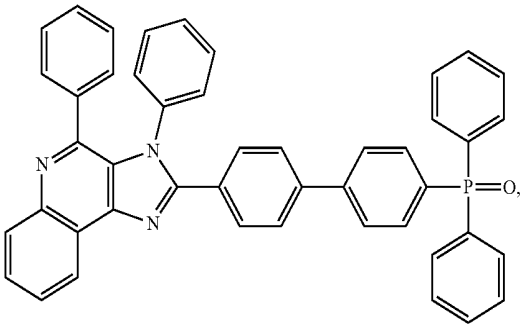
CJH-P30



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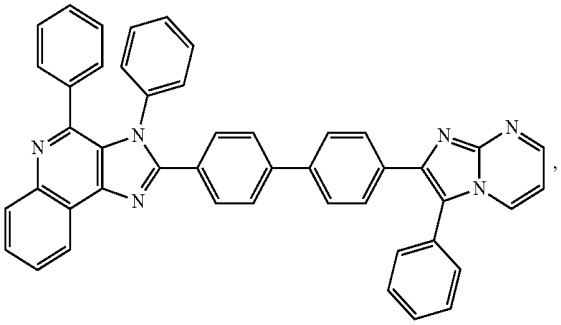

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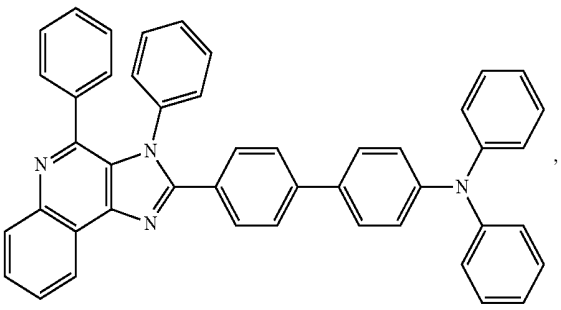

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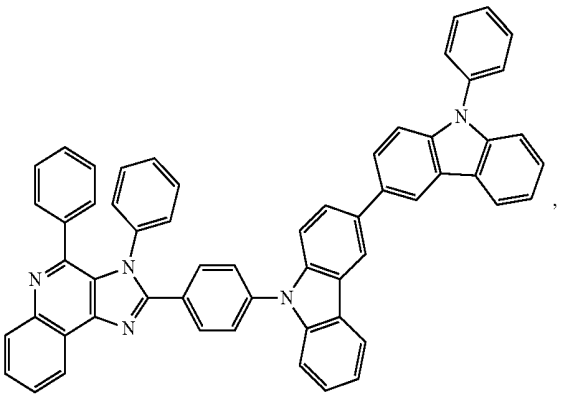

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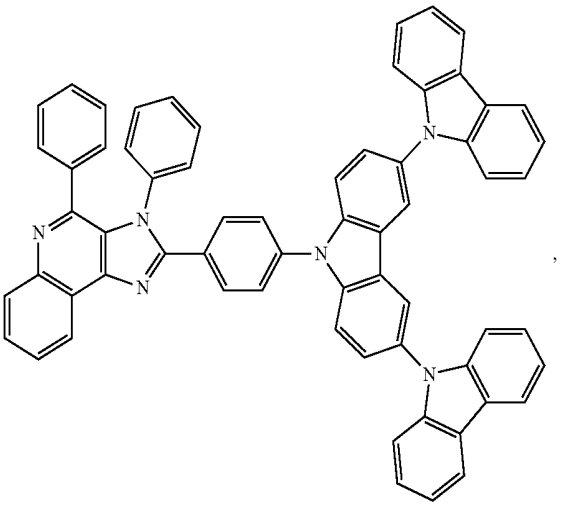

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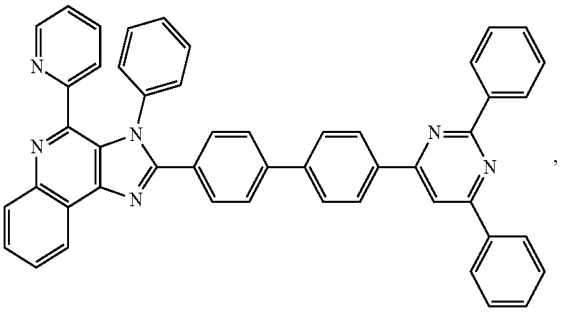

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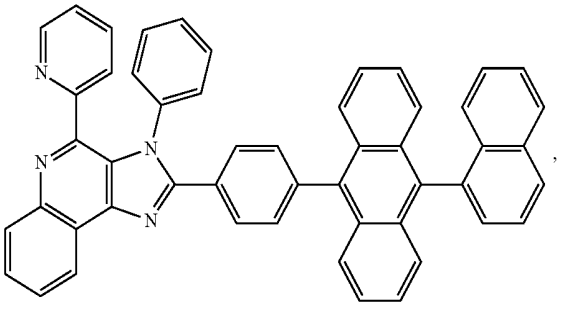

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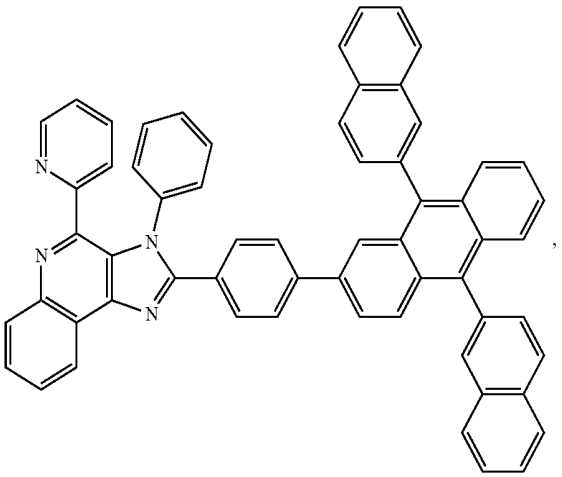
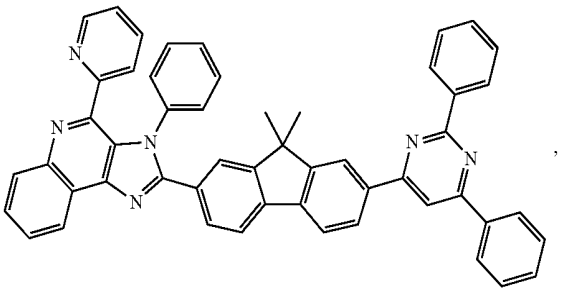


CJH-P38



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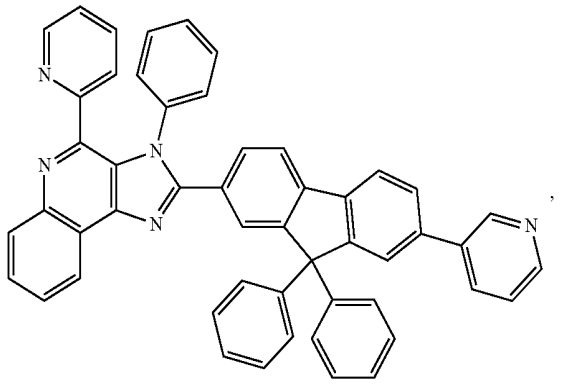
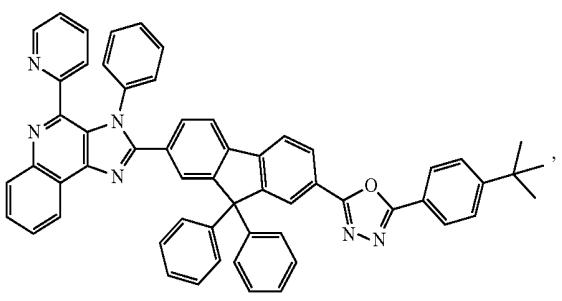


CJH-P40



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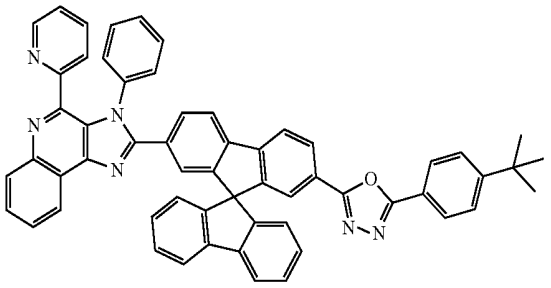
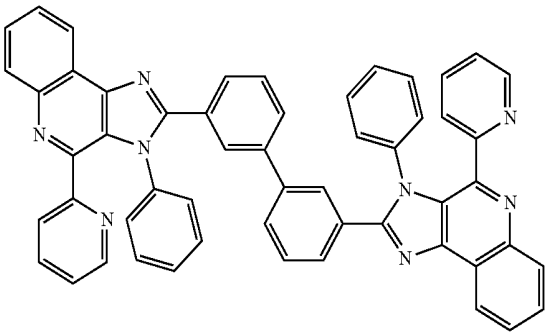
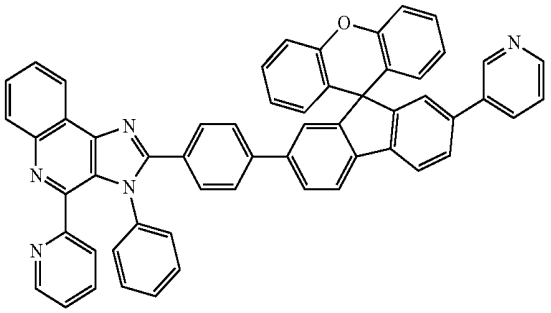
CJH-P41



CJH-P42



CJH-P43



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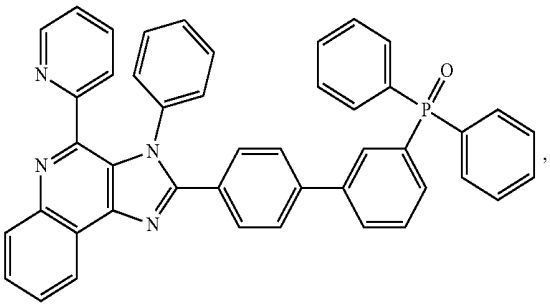
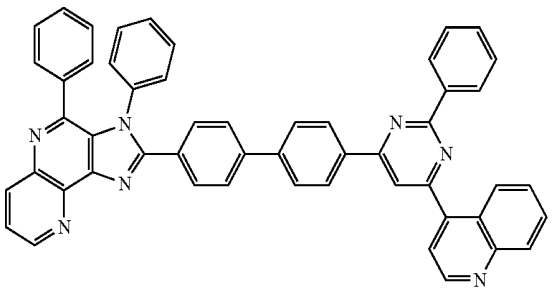


CJH-P45



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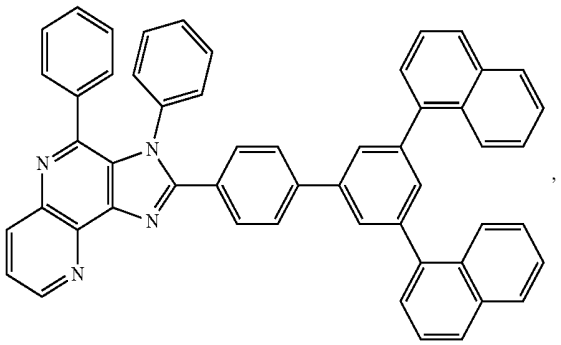
CJH-P46



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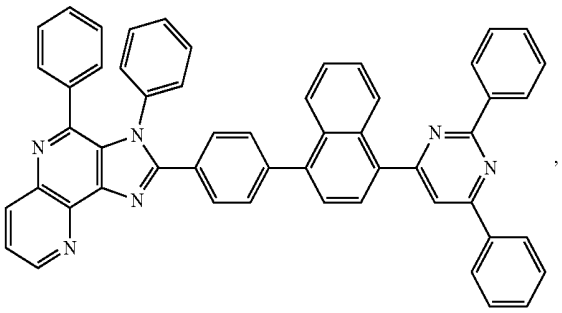

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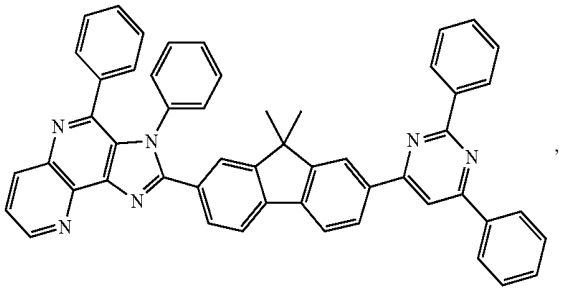

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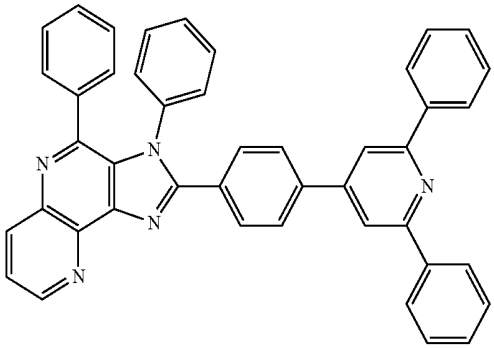

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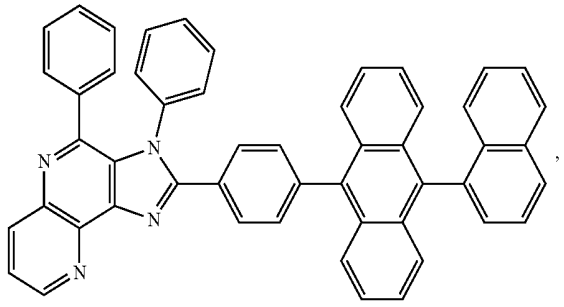

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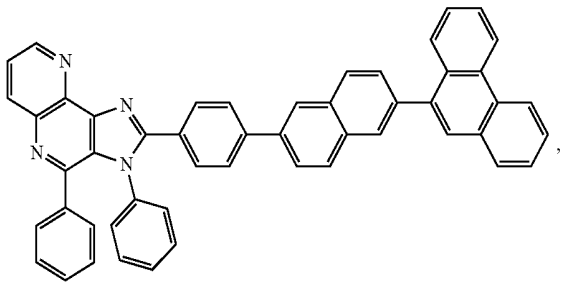

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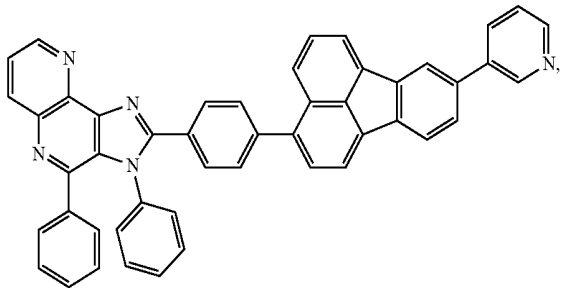

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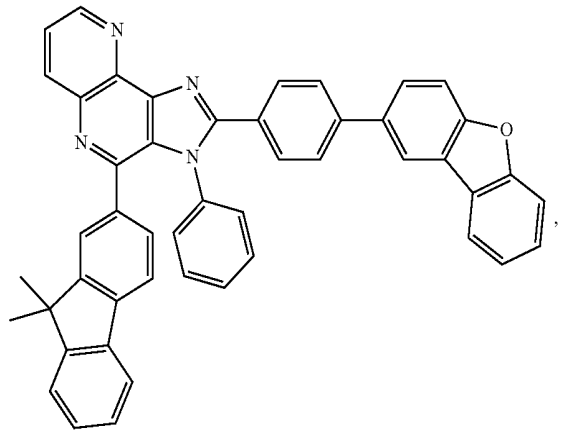

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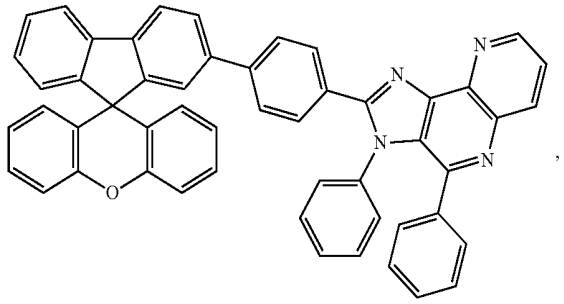

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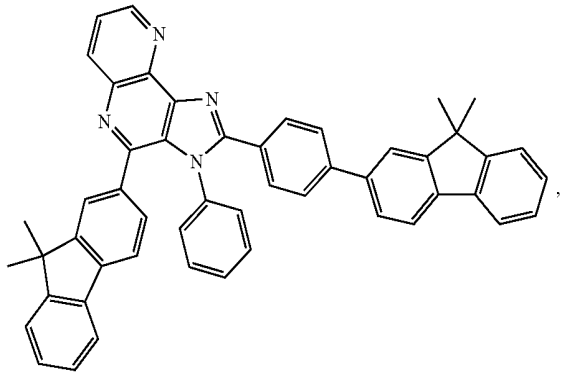

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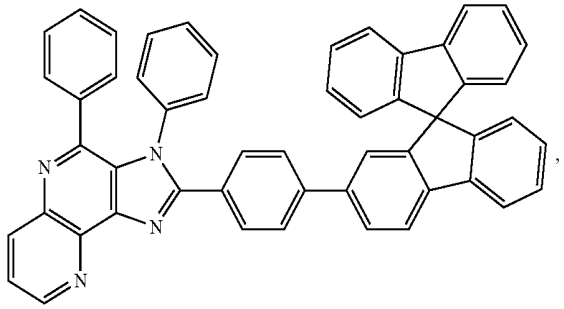

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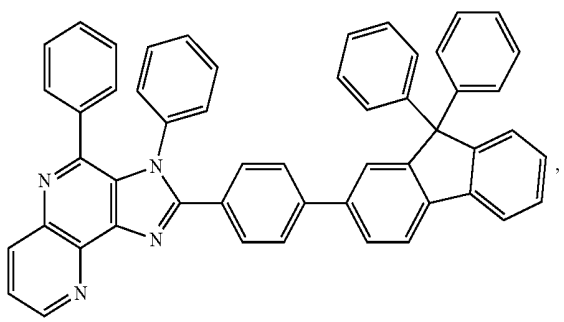

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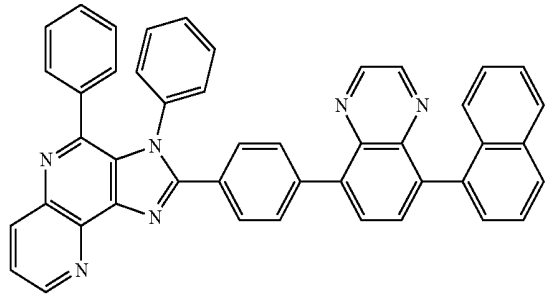

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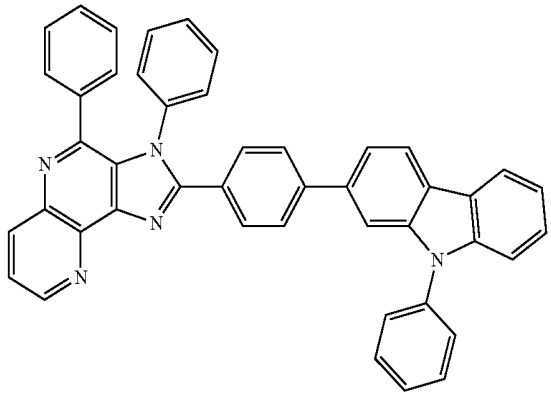

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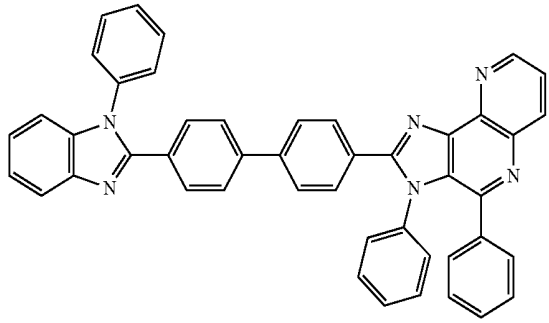

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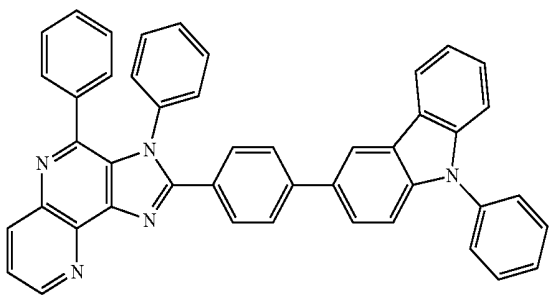

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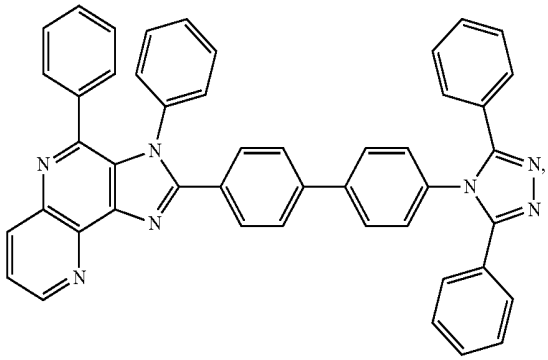

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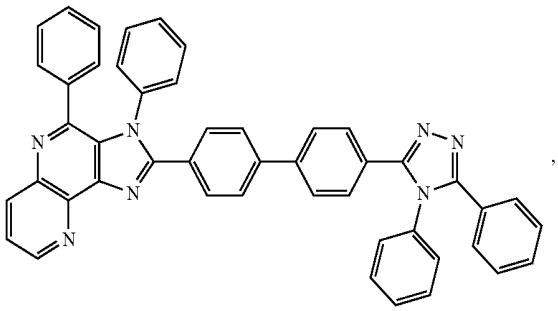

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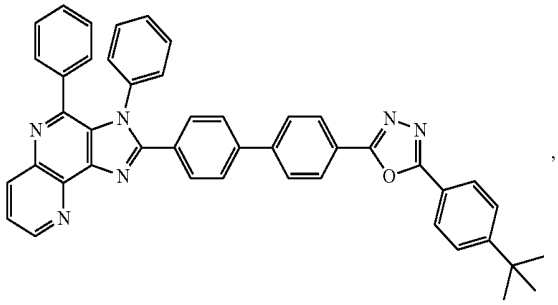

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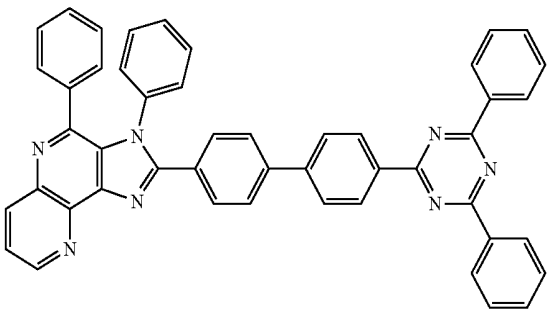

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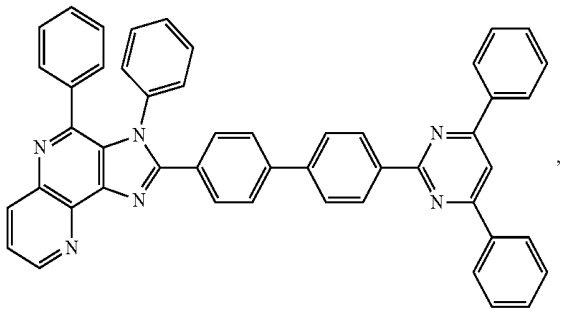

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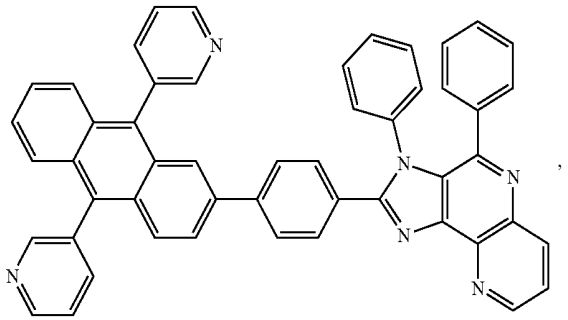

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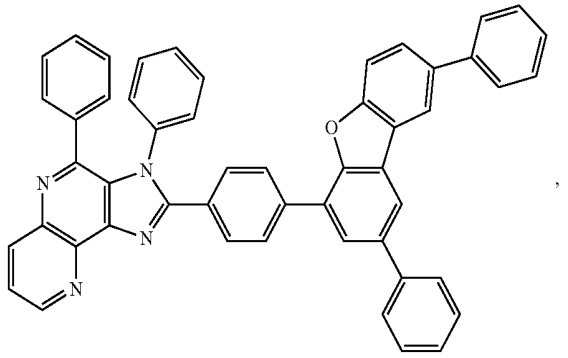
CJH-P68



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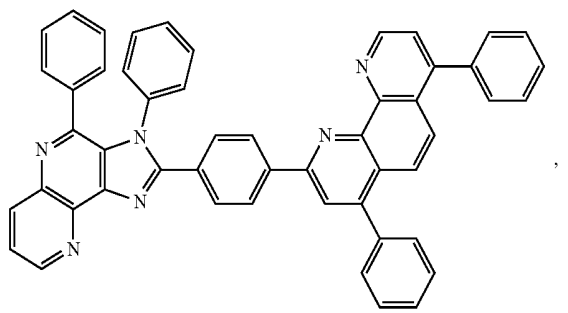
CJH-P69



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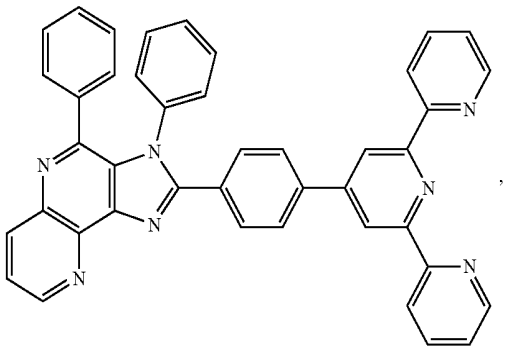
CJH-P70



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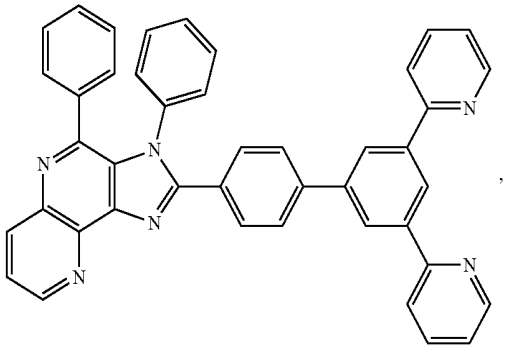

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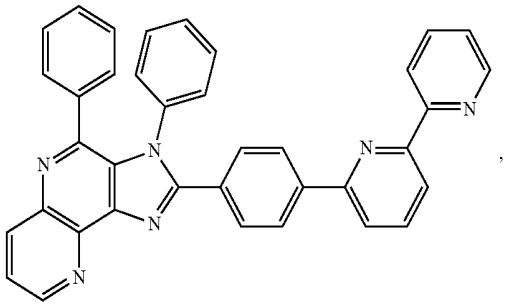

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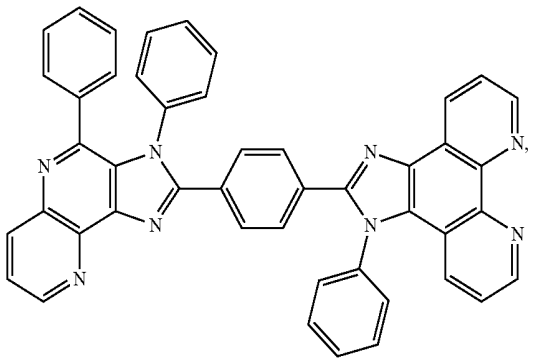

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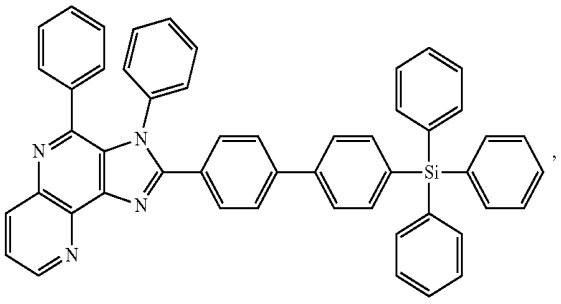

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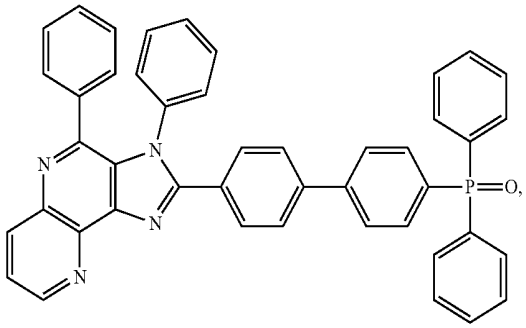

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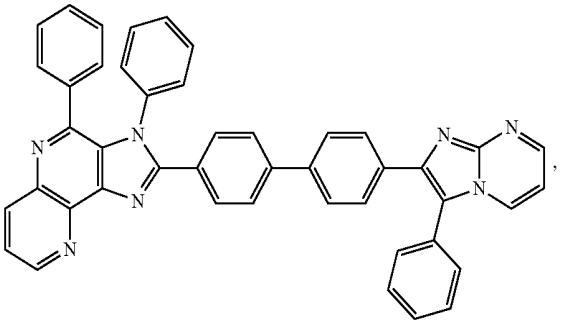

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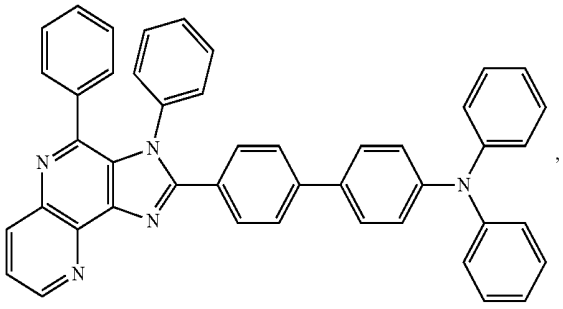

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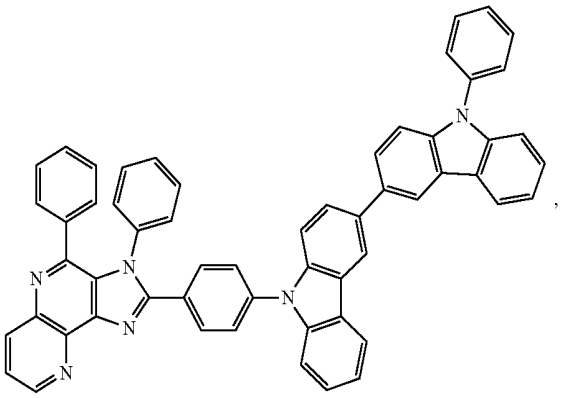

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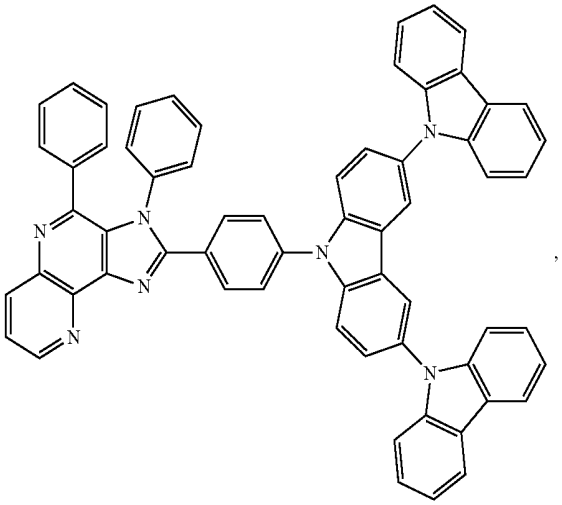
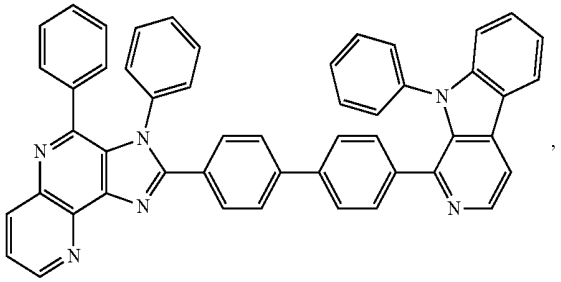


CJH-P80



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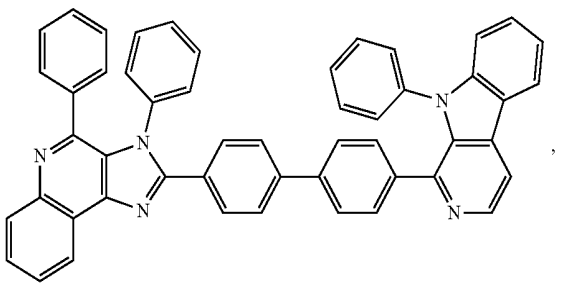

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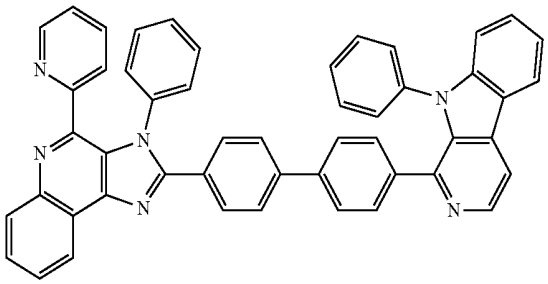
CJH-P82



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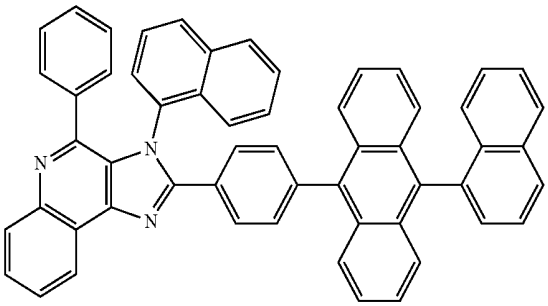

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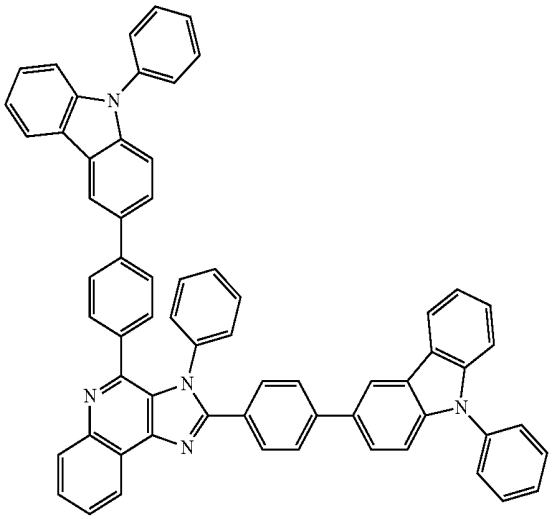

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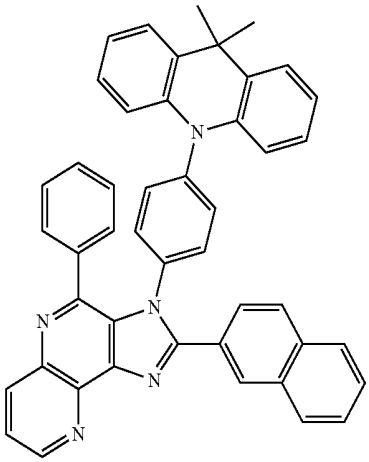

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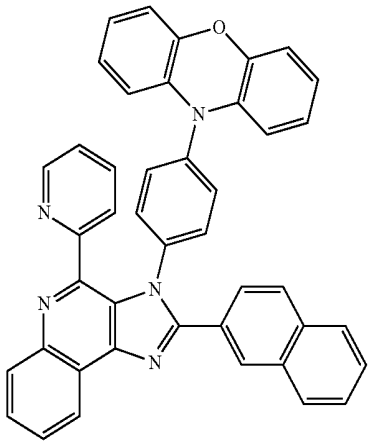
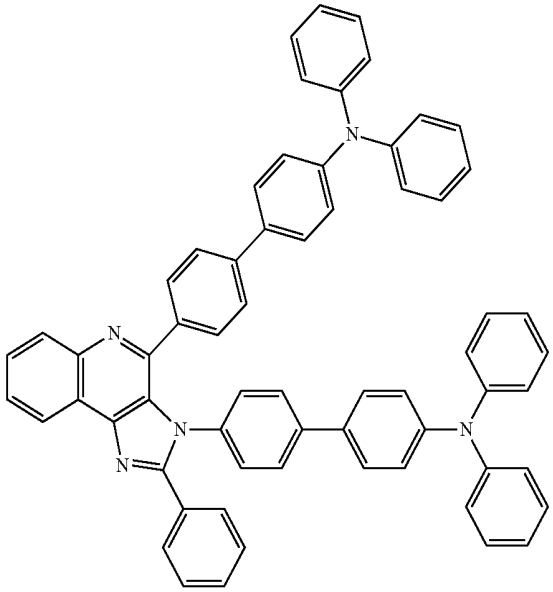
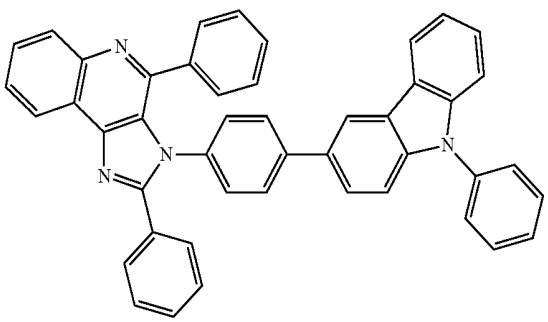
CJH-P86



CJH-P87



CJH-P88



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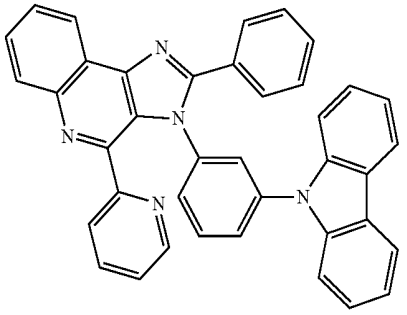
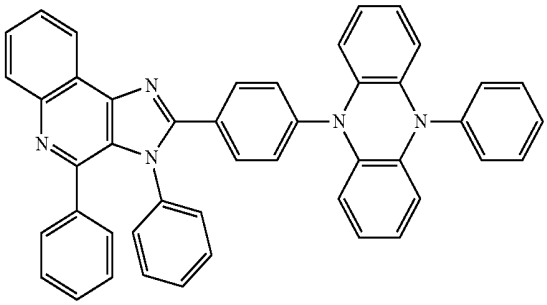
CJH-P89



CJH-P90



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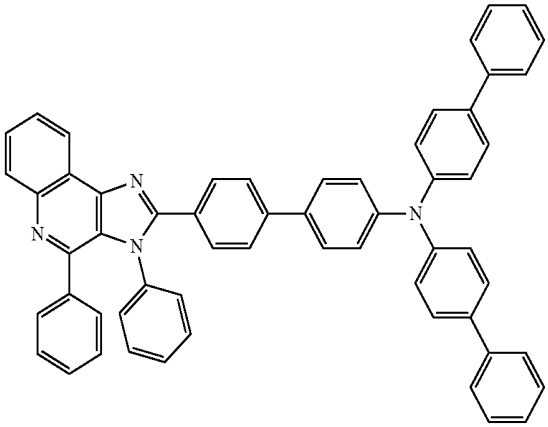

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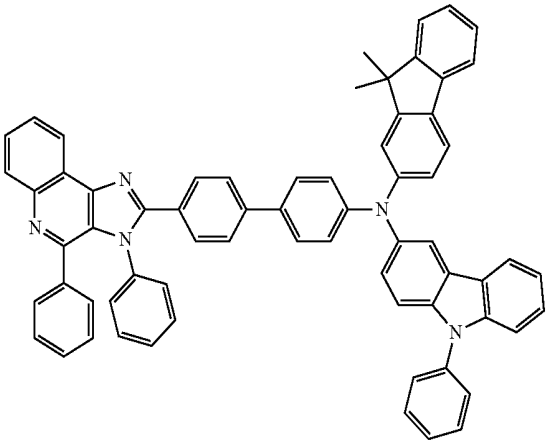

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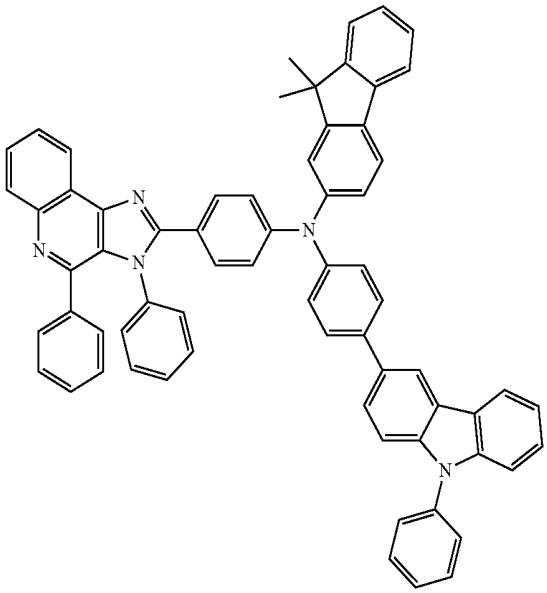
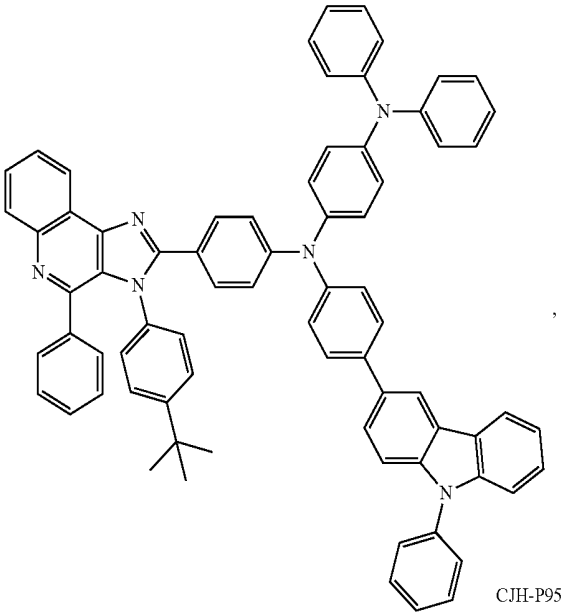
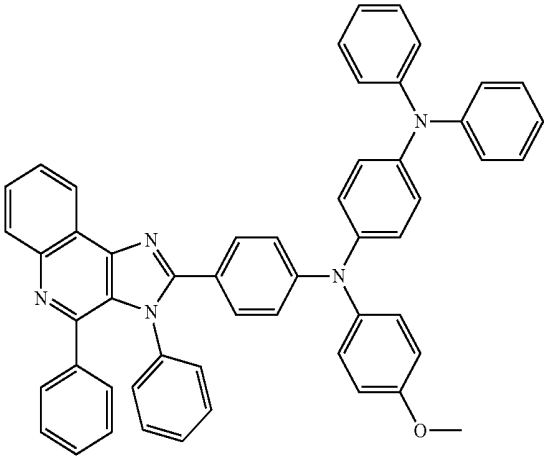
CJH-P93



CJH-P94



CJH-P95



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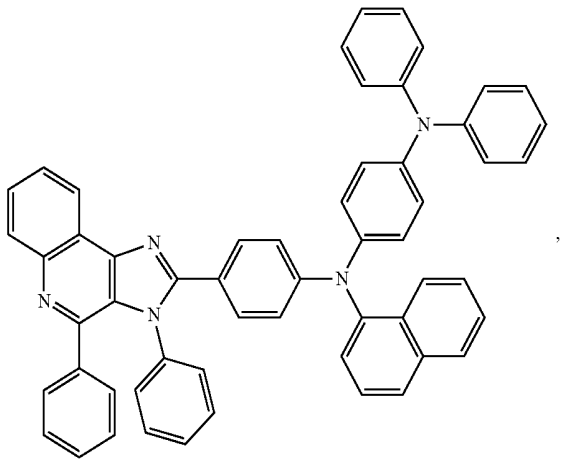
CJH-P96



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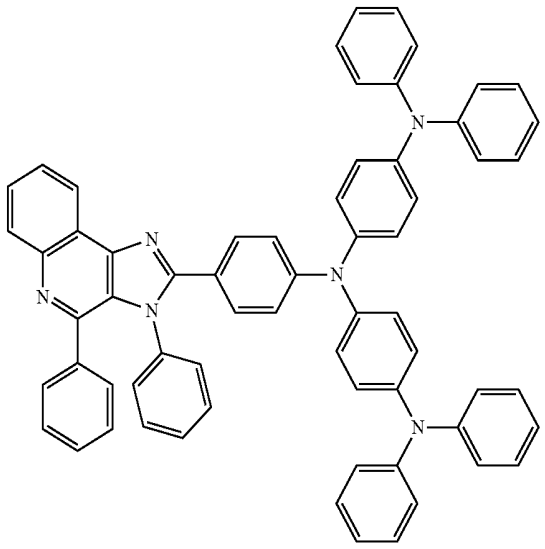
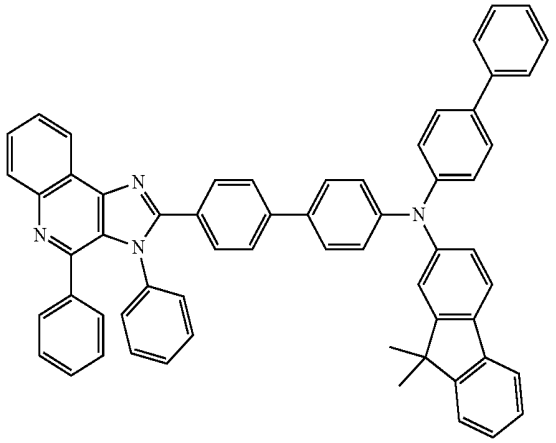


CJH-P98



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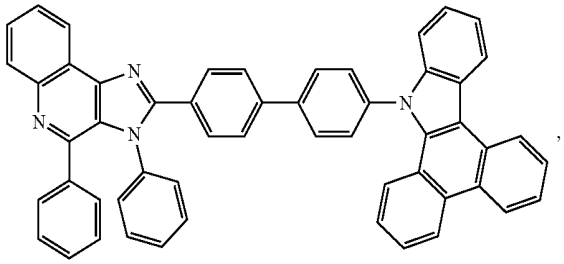
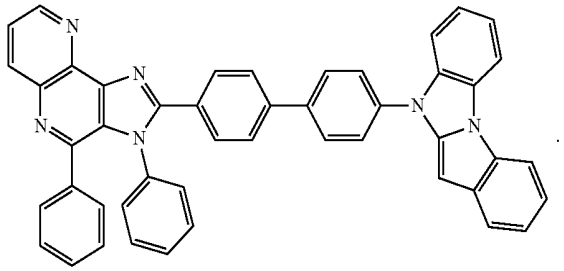
CJH-P99



CJH-P100



4. A material, wherein a raw material of the material contains one or a plurality of the imidazole derivatives according to claim **1**.

5. The material according to claim **4**, wherein the material is an organic light-emitting material.

6. An organic light-emitting device, wherein the material of the organic light-emitting device contains one or a plurality of the imidazole derivatives according to claim **1**.

7. The organic light-emitting device according to claim **6**, wherein the material of at least one of a hole transport layer, an organic light-emitting layer, and an electron transport layer in the organic light-emitting device contains one or a plurality of the imidazole derivatives.

8. The organic light-emitting device according to claim **7**, wherein, preferably, the thickness of the hole injection layer is 30-50 nm, preferably 40 nm; the thickness of the hole transport layer is 5-15 nm, preferably 10 nm; the thickness of the organic light-emitting layer is 10-100 nm, preferably 40 nm; the thickness of the electron transport layer is 10-30 nm, preferably 50 nm; and the thickness of the cathode layer is 90-110 nm, preferably 100 nm.

9. Use of the imidazole derivative according to claim **1** in preparation of an organic light-emitting material.

10. Use of the imidazole derivative according to claim **1** in preparation of an organic light-emitting device.

11. The imidazole derivative according to claim **2**, wherein the structural formula of the compound having a structural formula I is specifically represented by the following formulas CJH-P01 to CJH-P100:

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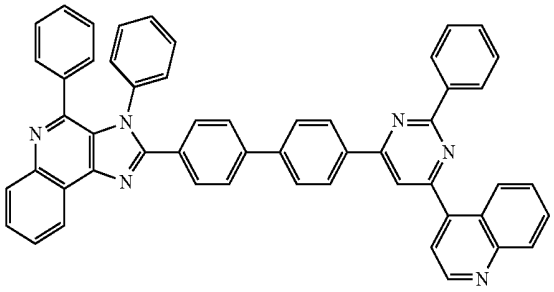
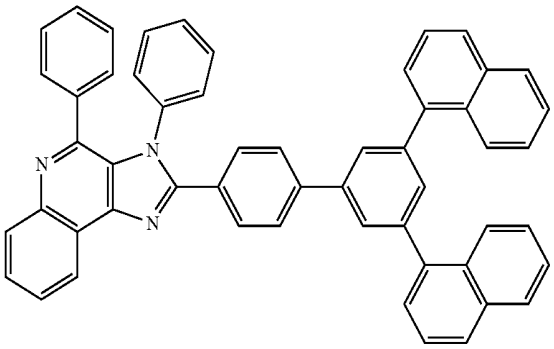
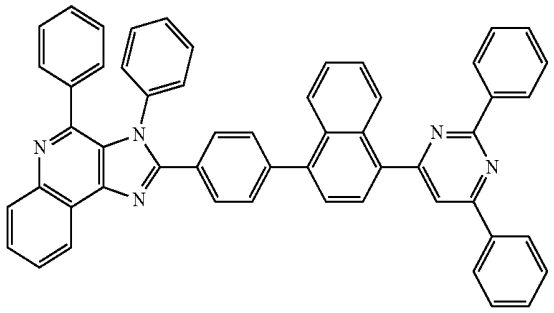
CJH-P01



CJH-P02



CJH-P03



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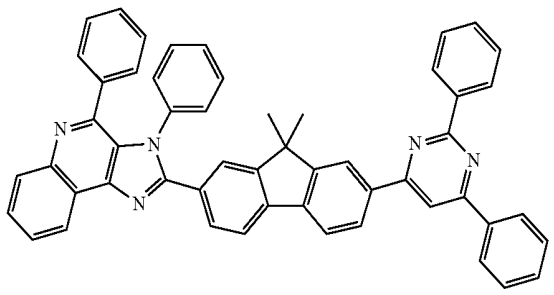

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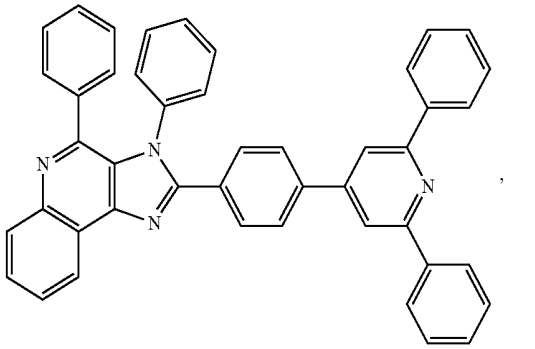

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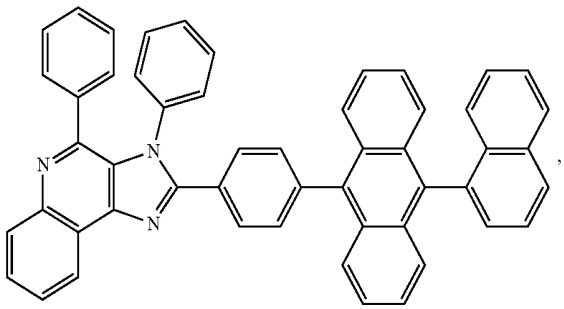

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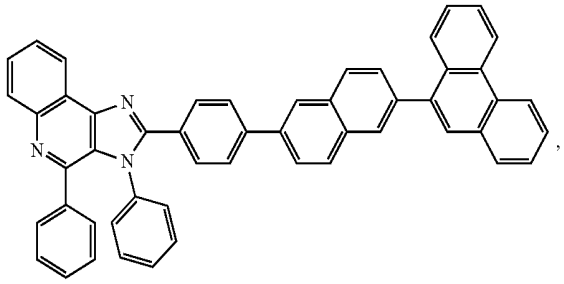

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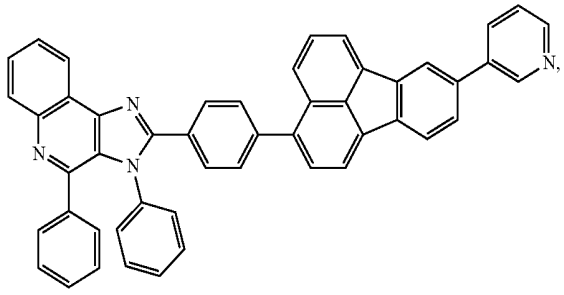

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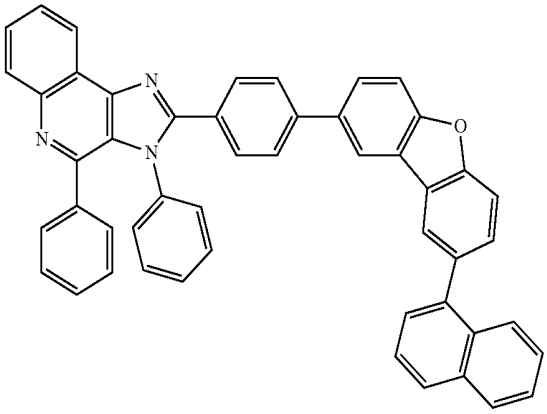

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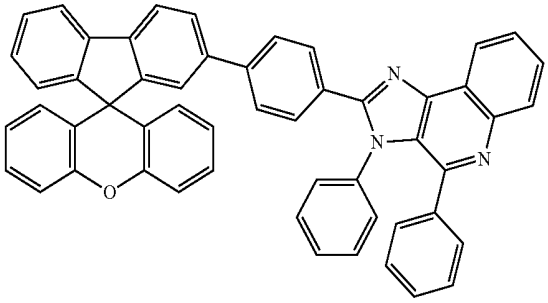
CJH-P10



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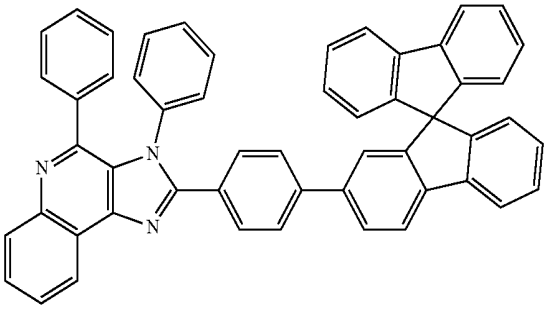
CJH-P11



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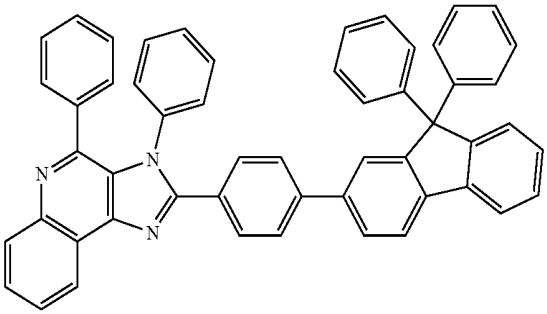

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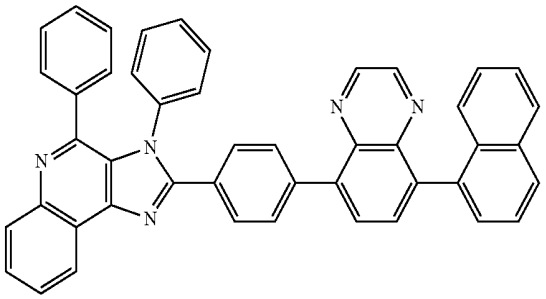
CJH-P13



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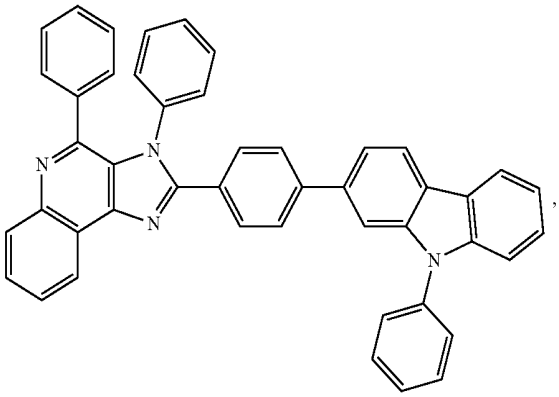

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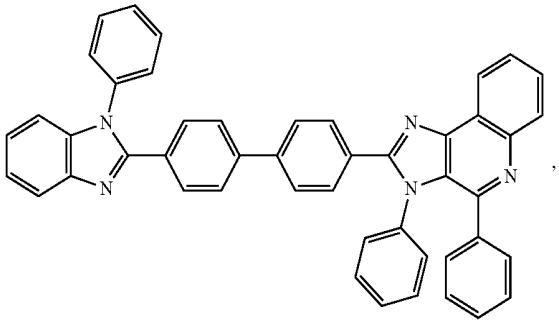

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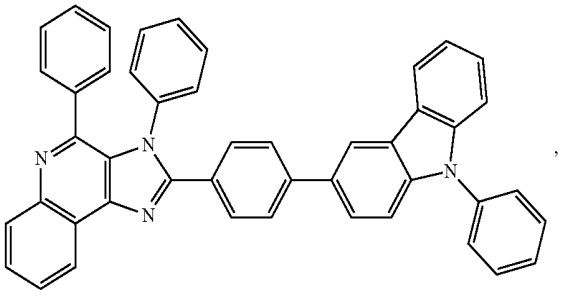

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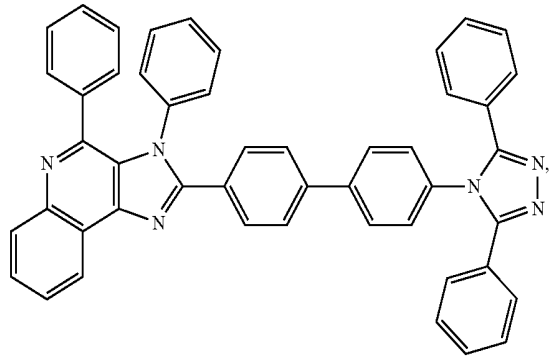
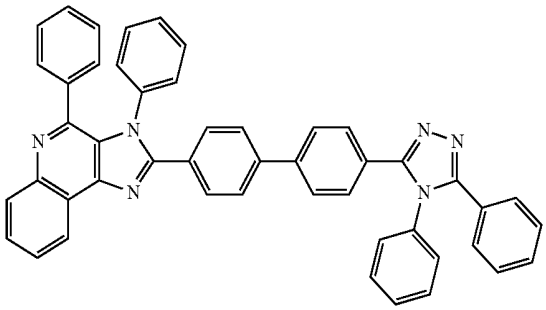


CJH-P18



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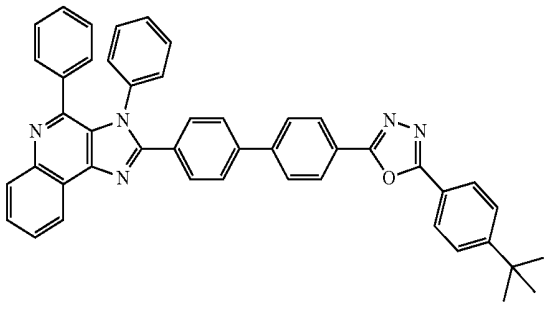

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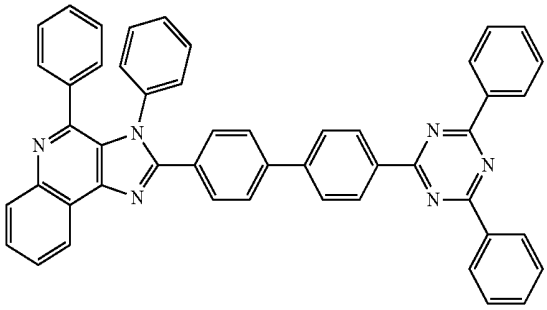
CJH-P20



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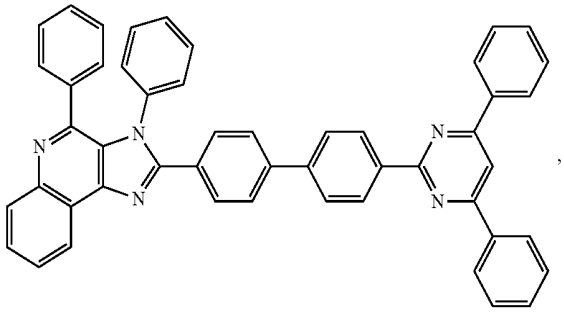

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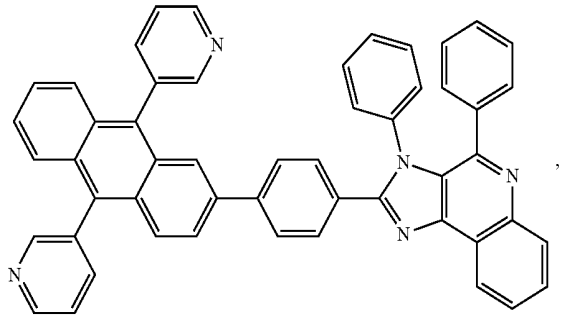

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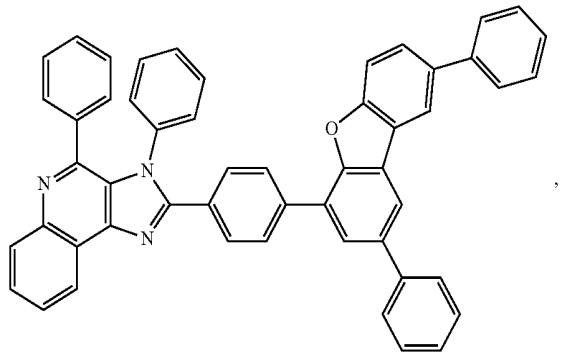
CJH-P23



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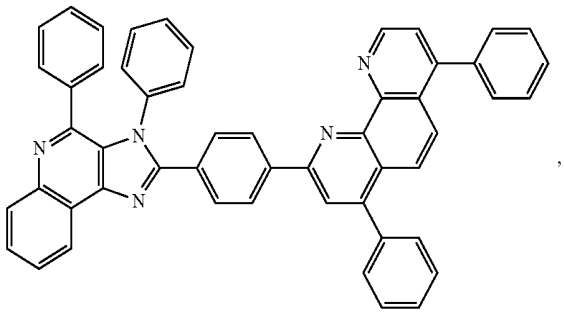
CJH-P24



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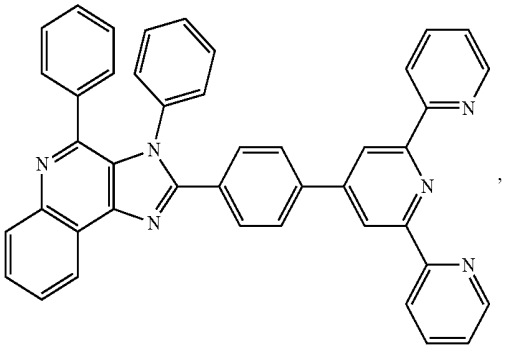

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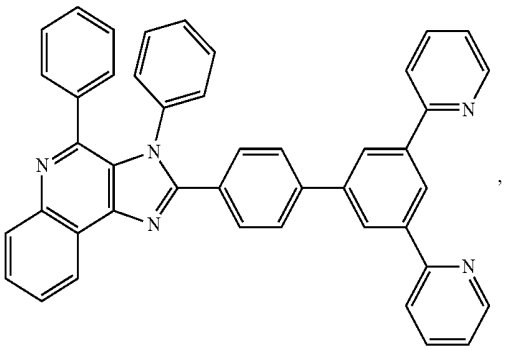

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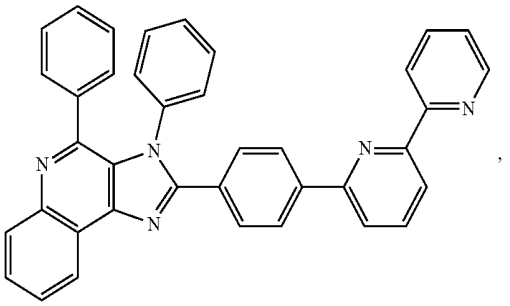

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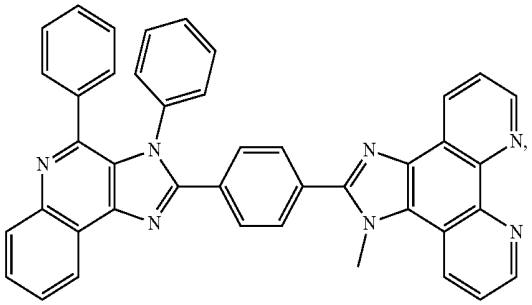

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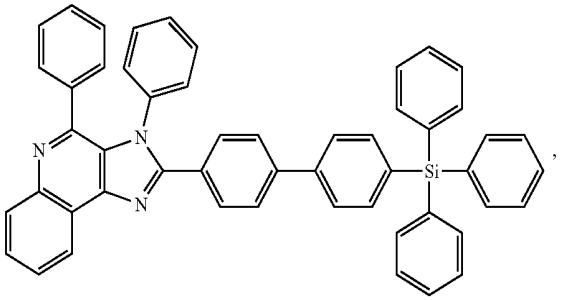

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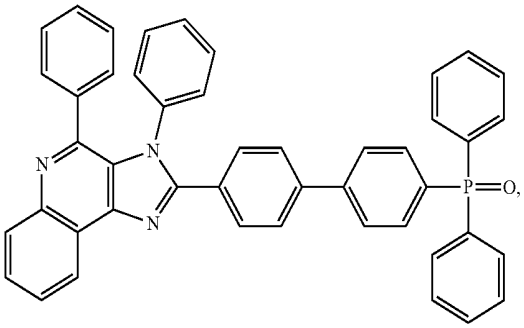
CJH-P30



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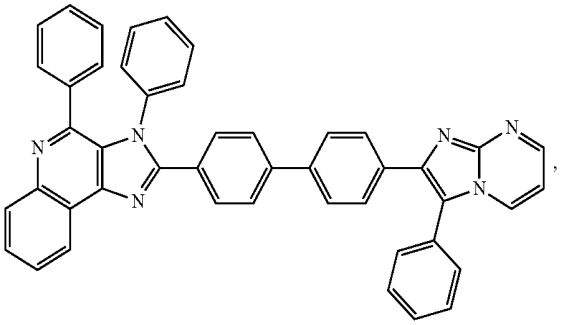

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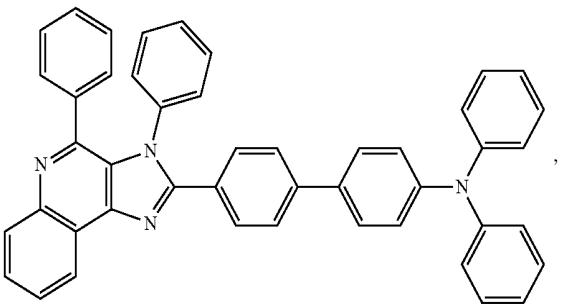

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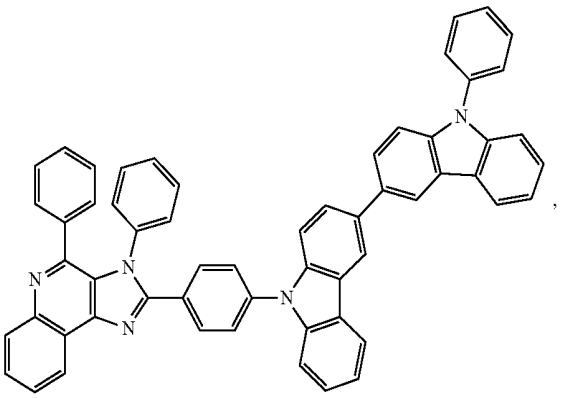

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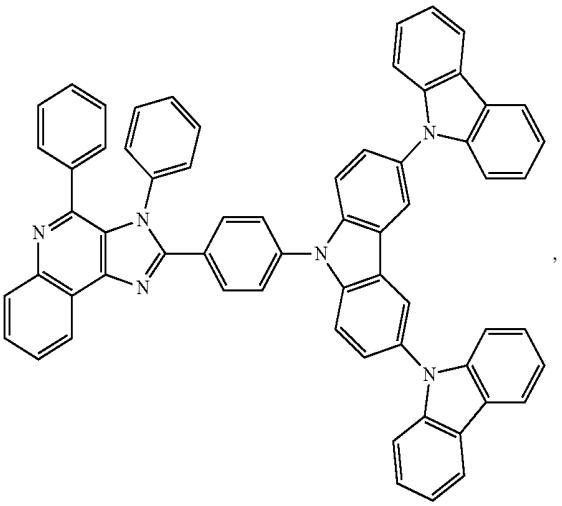

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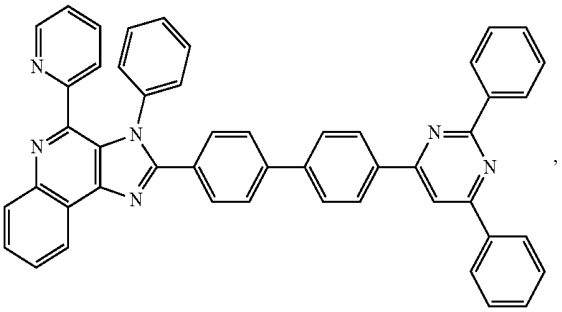

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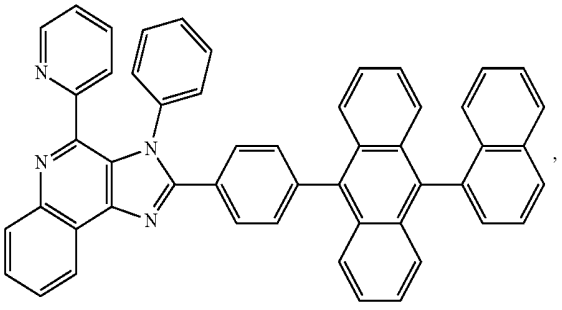

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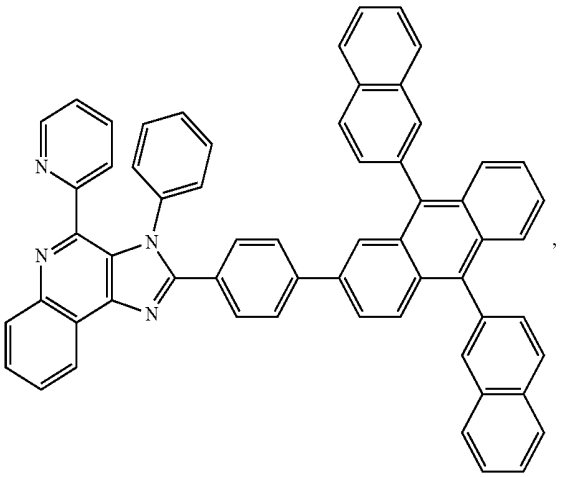

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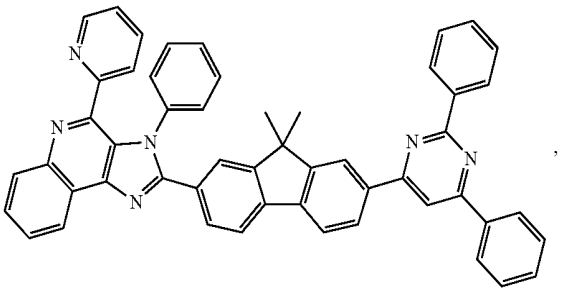

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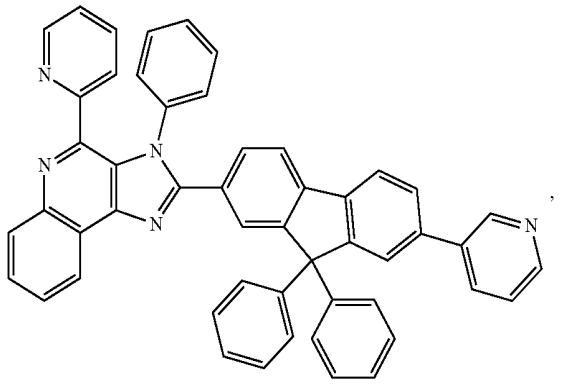
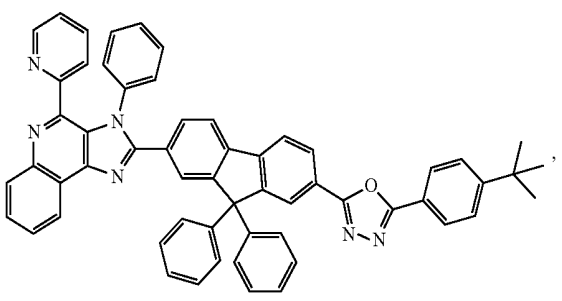


CJH-P40



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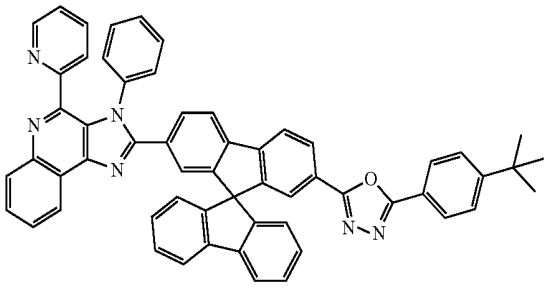
CJH-P41



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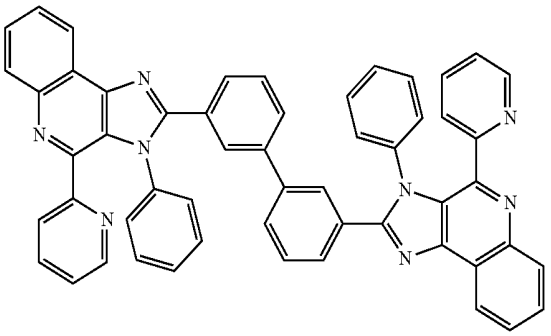

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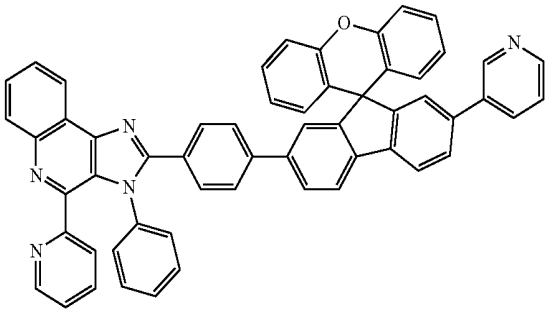

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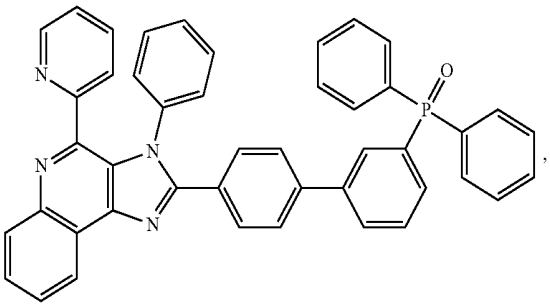
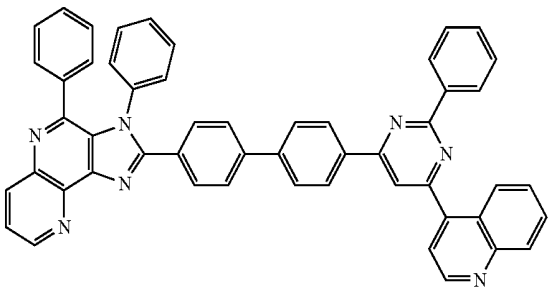


CJH-P45



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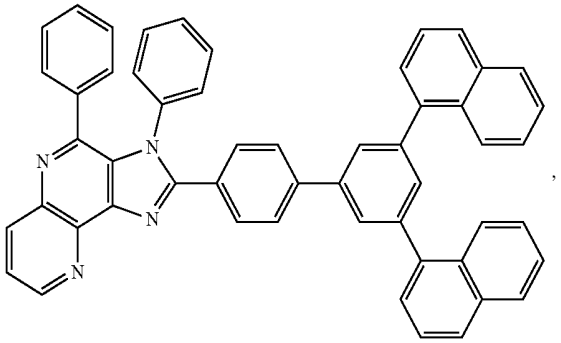
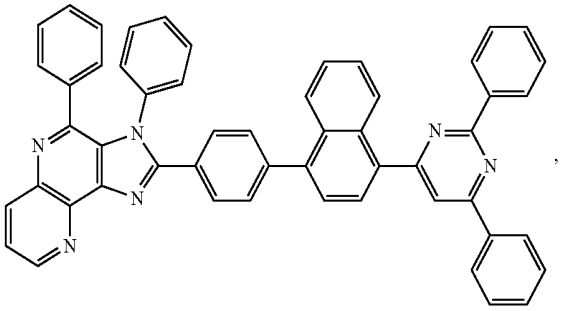
CJH-P46



CJH-P47



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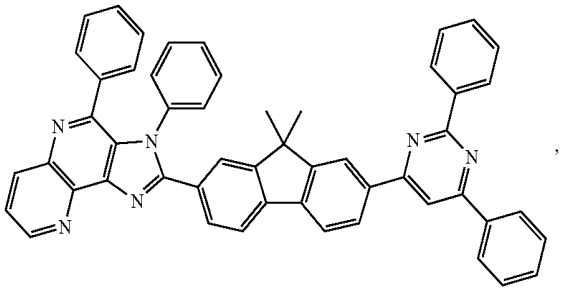

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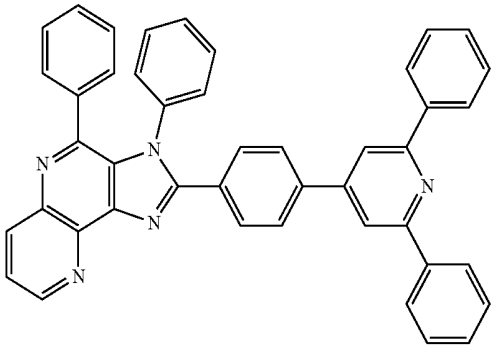

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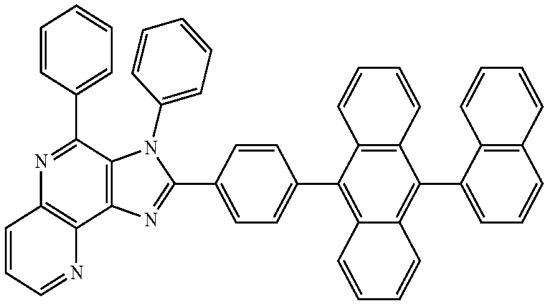
CJH-P50



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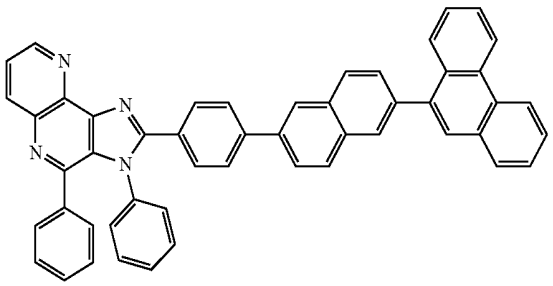
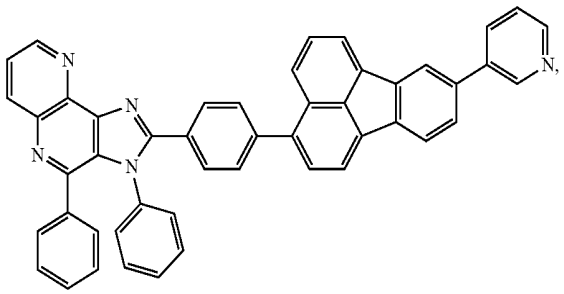


CJH-P52



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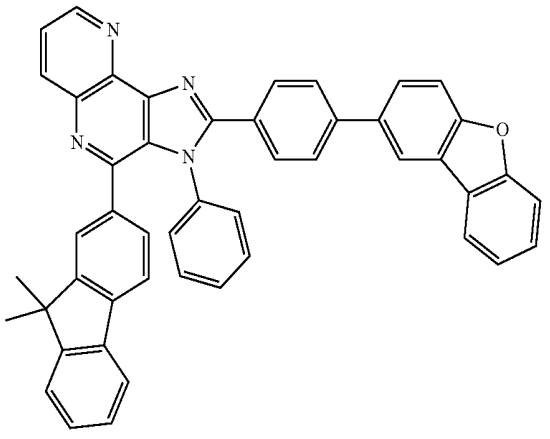

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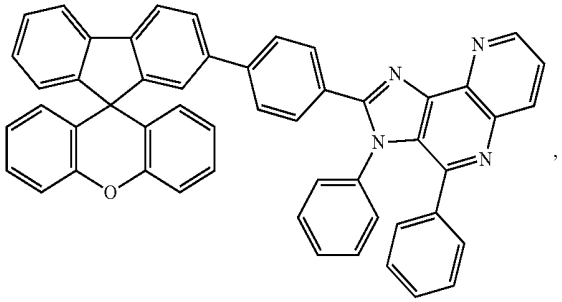
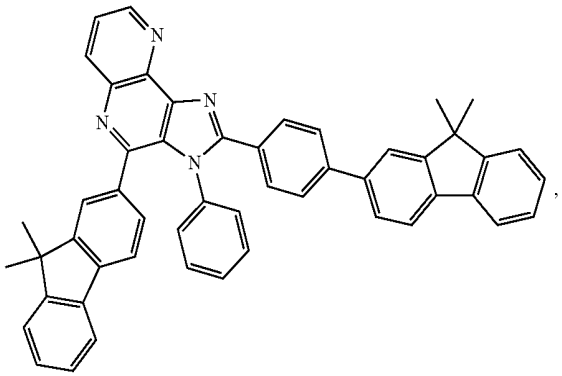
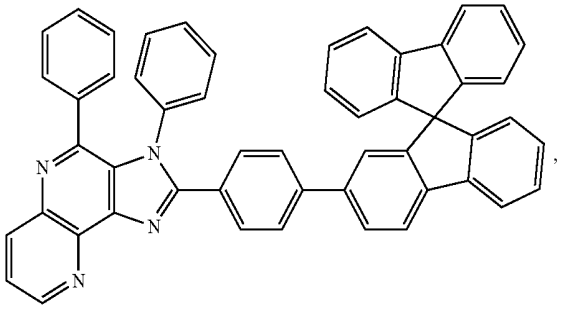
CJH-P54



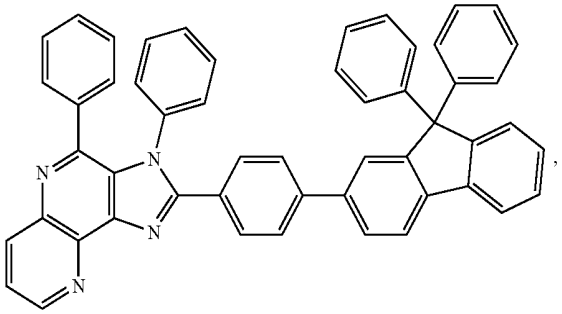
CJH-P55



CJH-P56



CJH-P57



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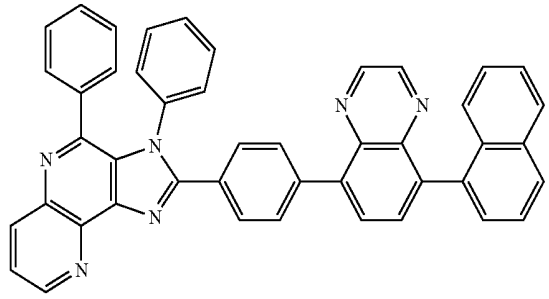
CJH-P58



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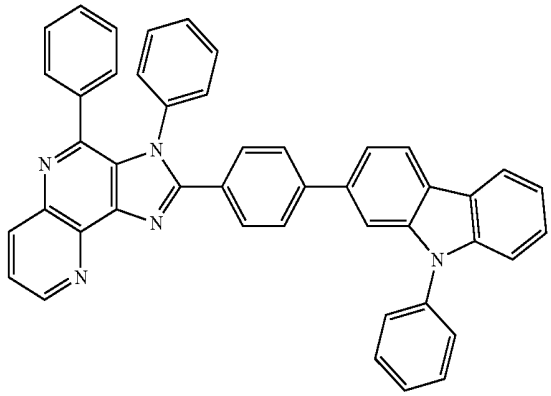

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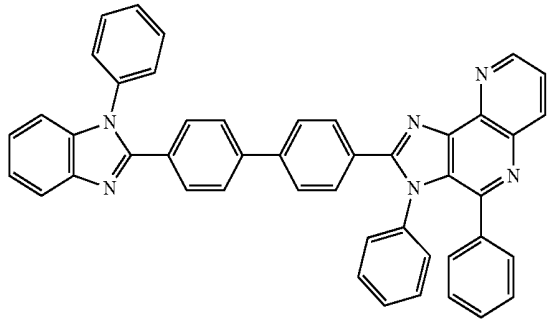

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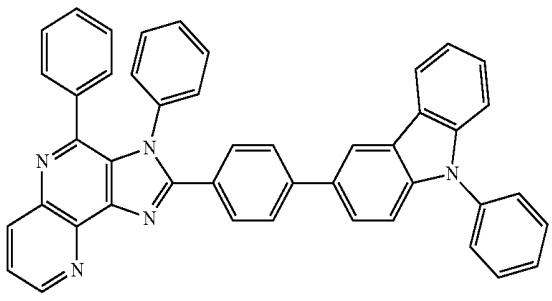

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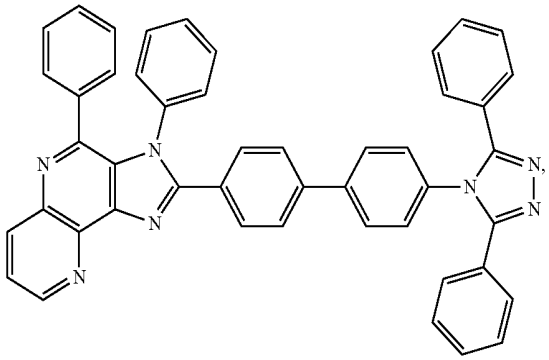
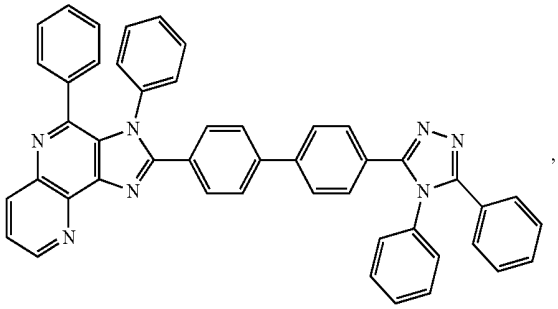


CJH-P63



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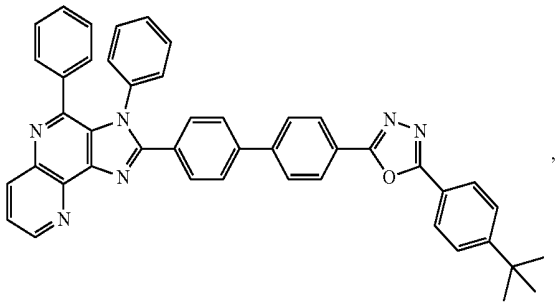

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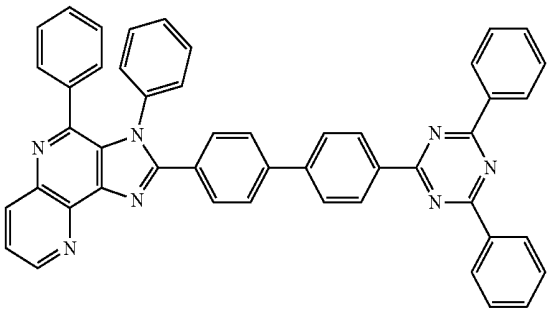

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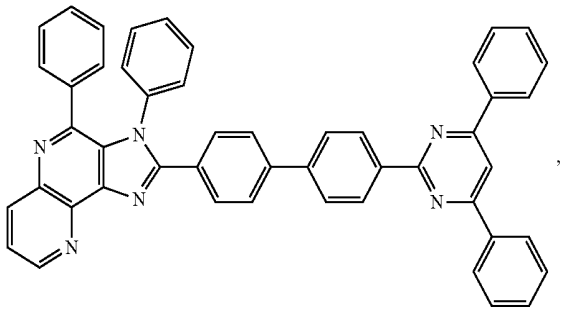
CJH-P66



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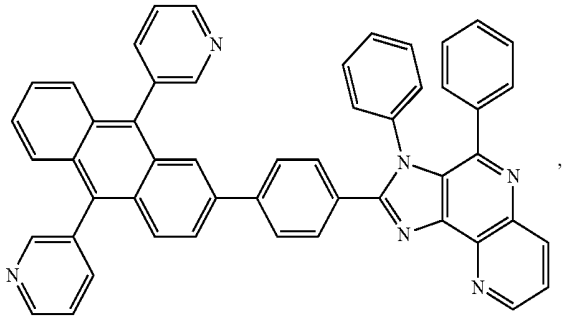
CJH-P67



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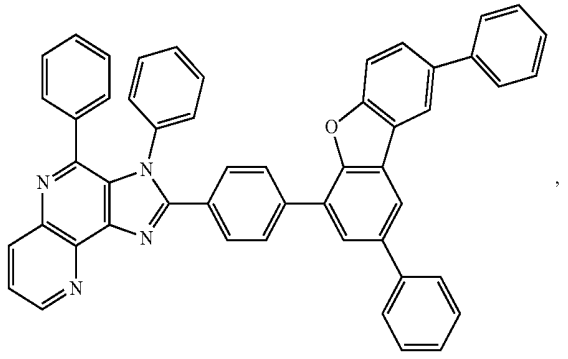

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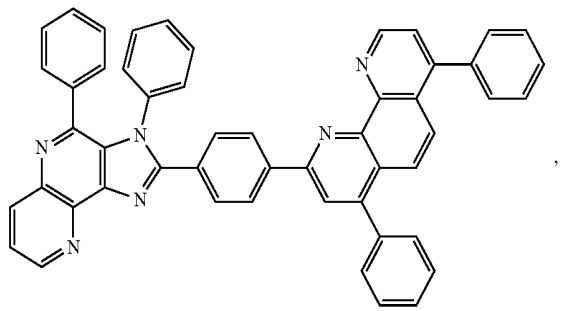

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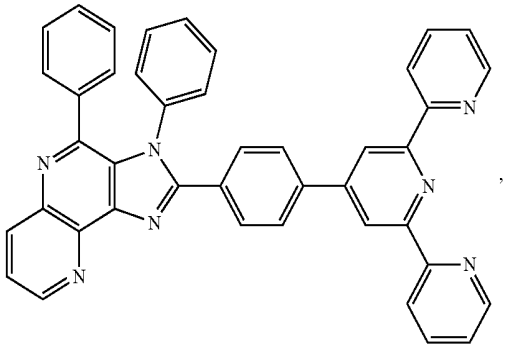

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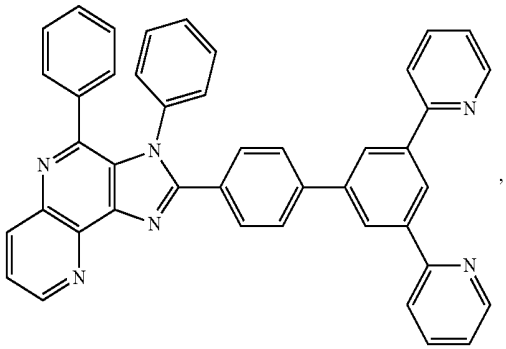

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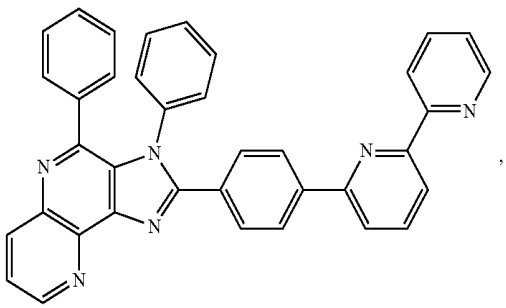

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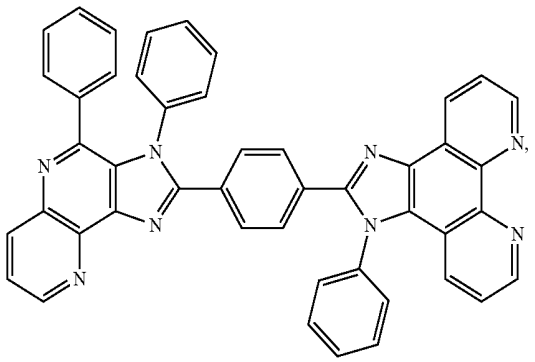

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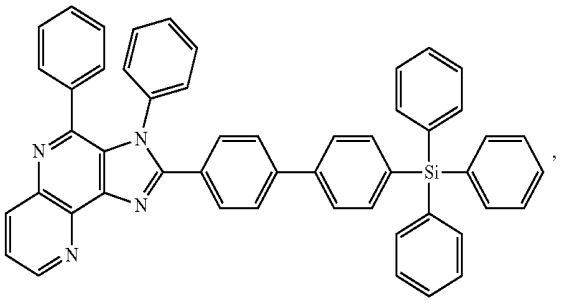

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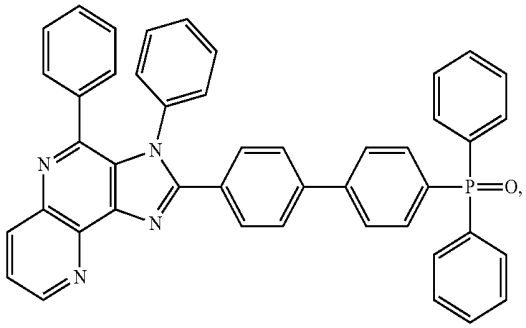

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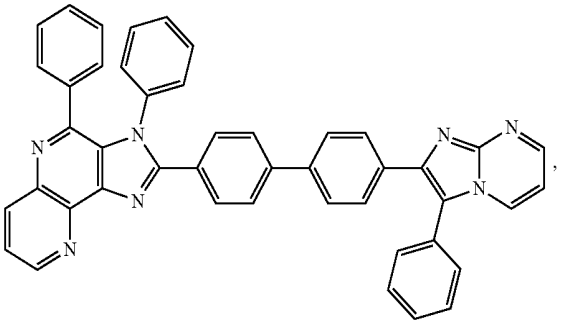

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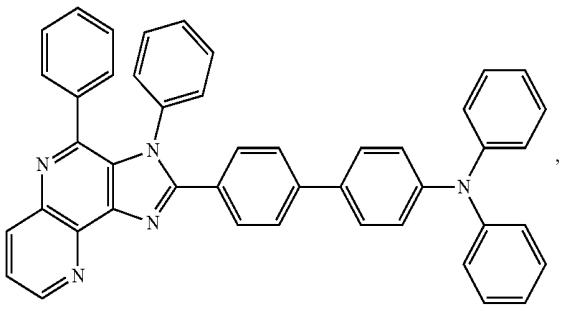

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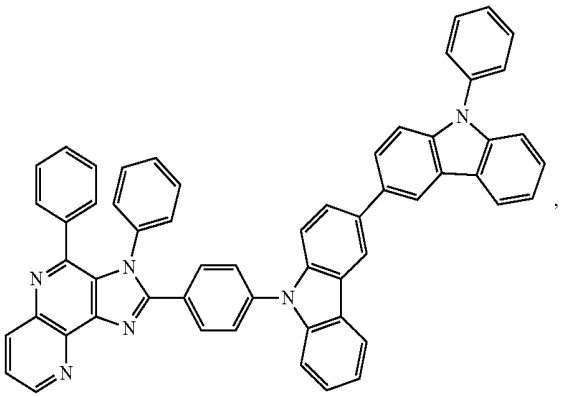

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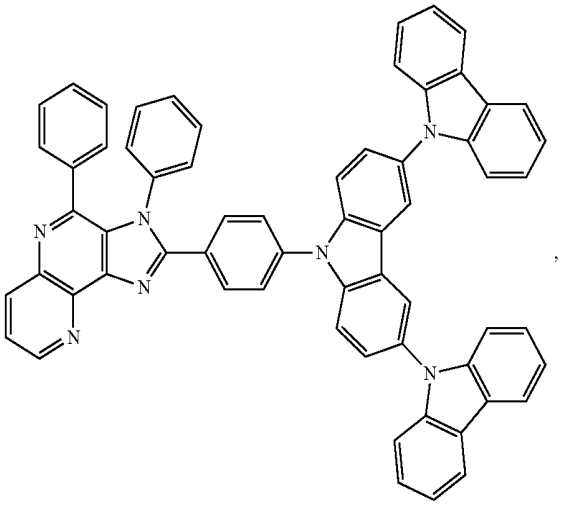
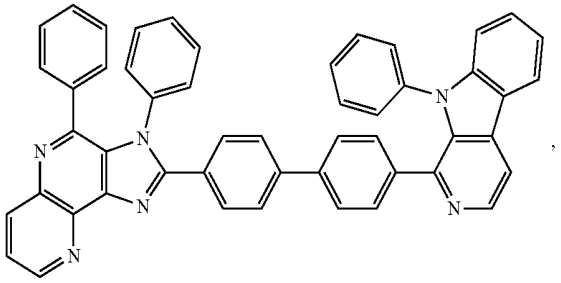


CJH-P80



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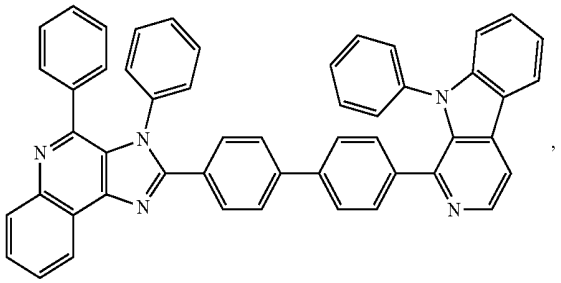

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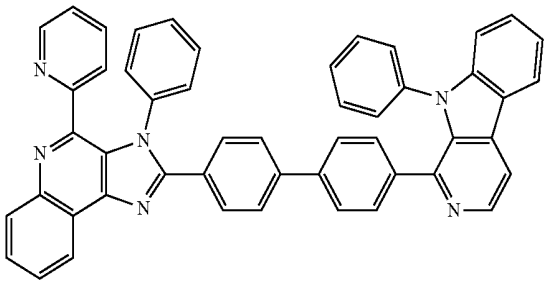

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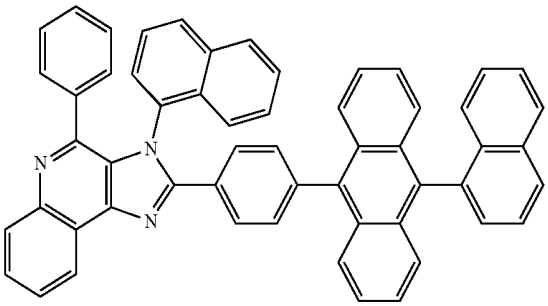

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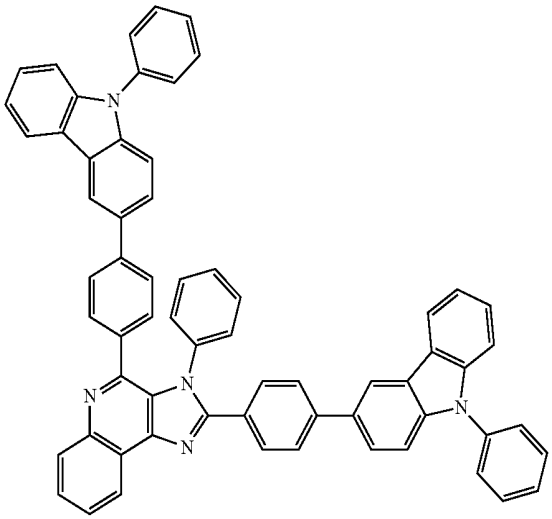

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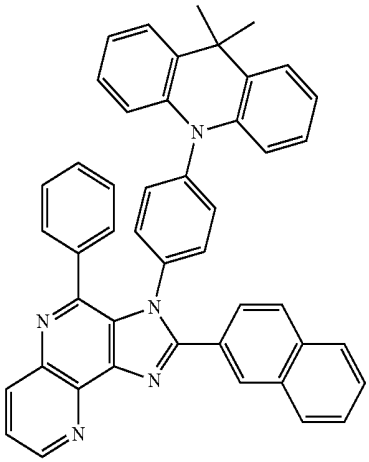

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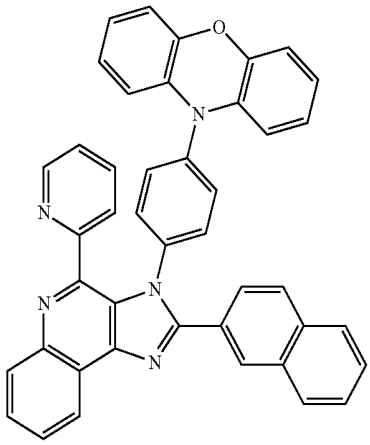

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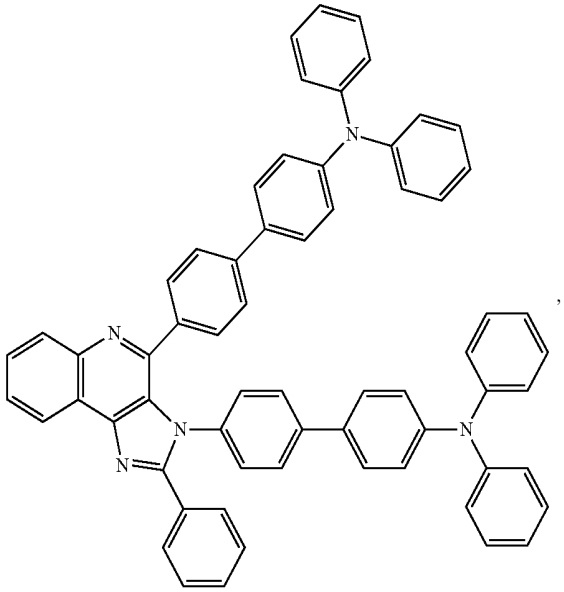

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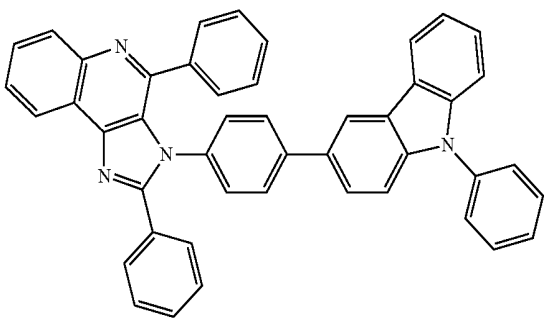

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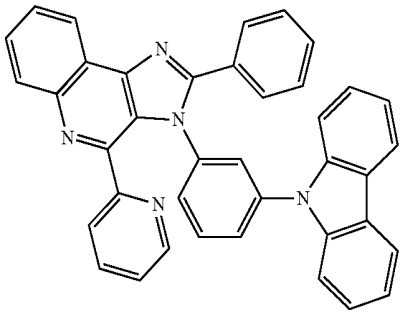

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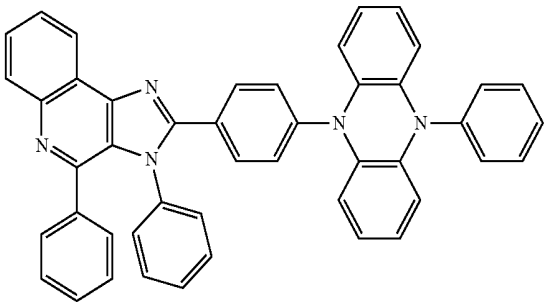

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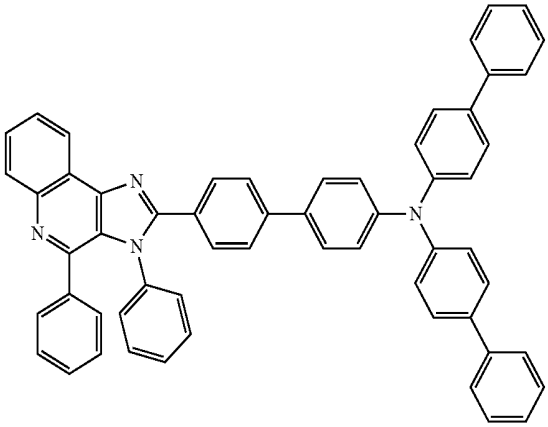

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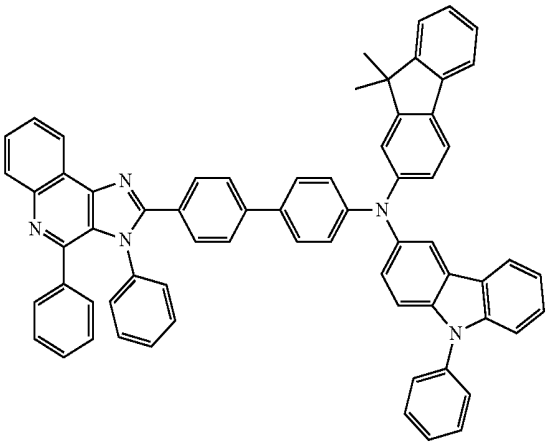

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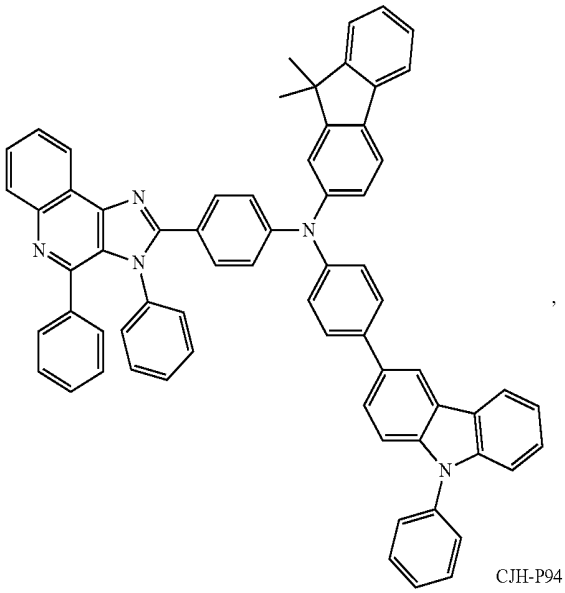

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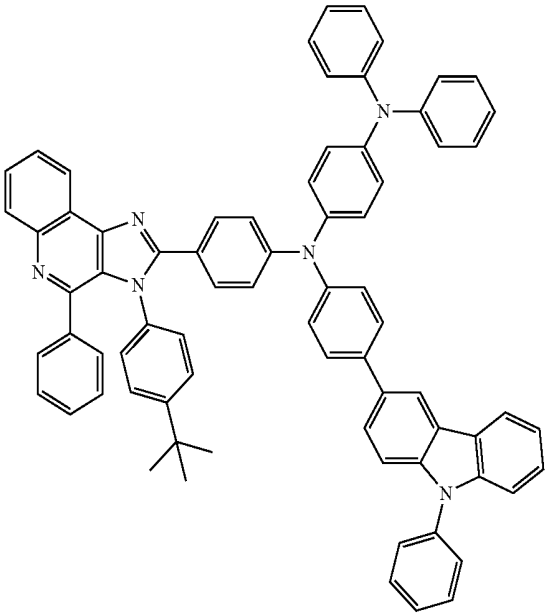

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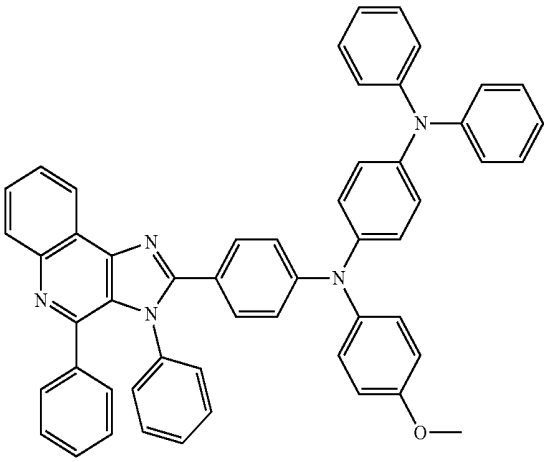

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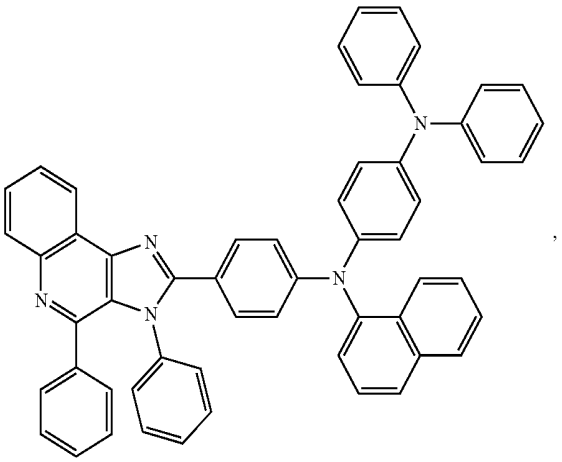

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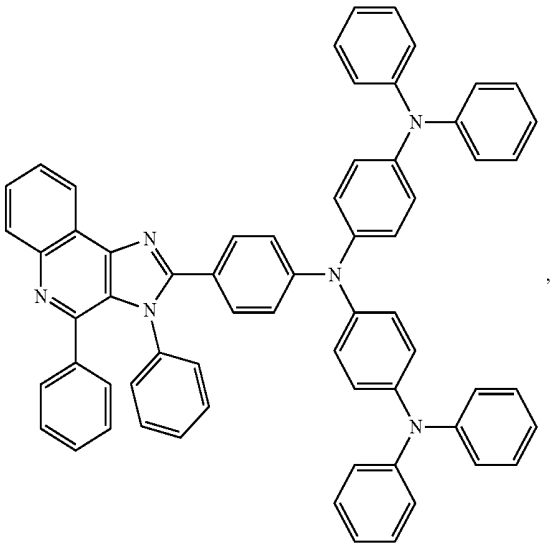

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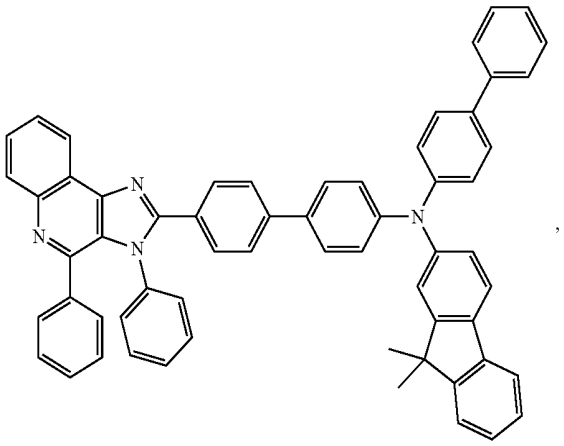

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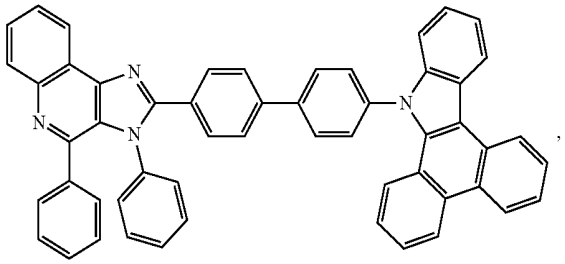

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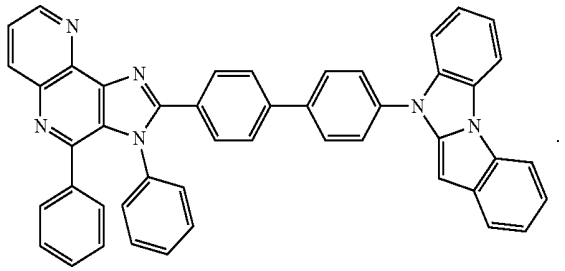

12. A material, wherein a raw material of the material contains one or a plurality of the imidazole derivatives according to claim **2**.

13. A material, wherein a raw material of the material contains one or a plurality of the imidazole derivatives according to claim **3**.

14. An organic light-emitting device, wherein the material of the organic light-emitting device contains one or a plurality of the imidazole derivatives according to claim **2**.

15. An organic light-emitting device, wherein the material of the organic light-emitting device contains one or a plurality of the imidazole derivatives according to claim **3**.

16. Use of the imidazole derivative according to claim **2** in preparation of an organic light-emitting material.

17. Use of the imidazole derivative according to claim **3** in preparation of an organic light-emitting material.

18. Use of the imidazole derivative according to claim **2** in preparation of an organic light-emitting device.

19. Use of the imidazole derivative according to claim **3** in preparation of an organic light-emitting device.

* * * * *

专利名称(译)	咪唑衍生物，材料和包括该咪唑衍生物的有机发光装置		
公开(公告)号	US20200144516A1	公开(公告)日	2020-05-07
申请号	US16/631006	申请日	2018-08-29
申请(专利权)人(译)	SHIJIAZHUANG CHENGZHI YONGHUA DISPLAY MATERIAL CO., LTD.		
当前申请(专利权)人(译)	SHIJIAZHUANG CHENGZHI YONGHUA DISPLAY MATERIAL CO., LTD.		
[标]发明人	CAO JIANHUA DONG LIANG WANG SHIBO HUA RUIMAO		
发明人	CAO, JIANHUA DONG, LIANG WANG, SHIBO ZHANG, JIANCHUAN SUI, YAN HUA, RUIMAO		
IPC分类号	H01L51/00 C07D471/04 C09K11/06 C07D471/14		
CPC分类号	H01L51/0072 H01L51/5072 H01L51/006 H01L2251/558 C07D471/14 H01L51/0061 C09K2211/1018 C07D471/04 C09K11/06 C07D519/00 C07F7/10 C07F9/6561 H01L51/0052 H01L51/0058 H01L51/0059 H01L51/0067		
优先权	201710851696.2 2017-09-20 CN		
外部链接	Espacenet USPTO		

摘要(译)

本发明提供了一种咪唑衍生物，其中咪唑衍生物的结构式为 还提供了一种包含咪唑衍生物的材料和一种包含咪唑衍生物的有机发光装置。 咪唑衍生物具有优良的载流子传输能力，使用该材料生产的有机发光器件具有明显降低的起始电压，并提高了发光效率和亮度。 并且由于咪唑衍生物具有相对较好的成膜性能，简单的材料合成和纯化方法等可大量生产的特点，是有机发光器件电子传输材料的理想选择。