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(54) **NITROGEN HETEROCYCLE-FUSED BENZENE-BENZIMIDAZOLE ORGANIC COMPOUND, DISPLAY PANEL AND DISPLAY APPARATUS**

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C09K 11/06	(2006.01)

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

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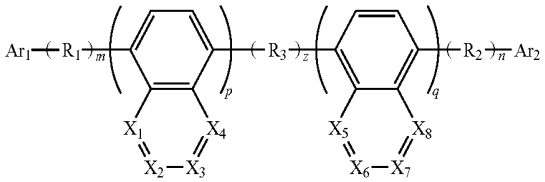
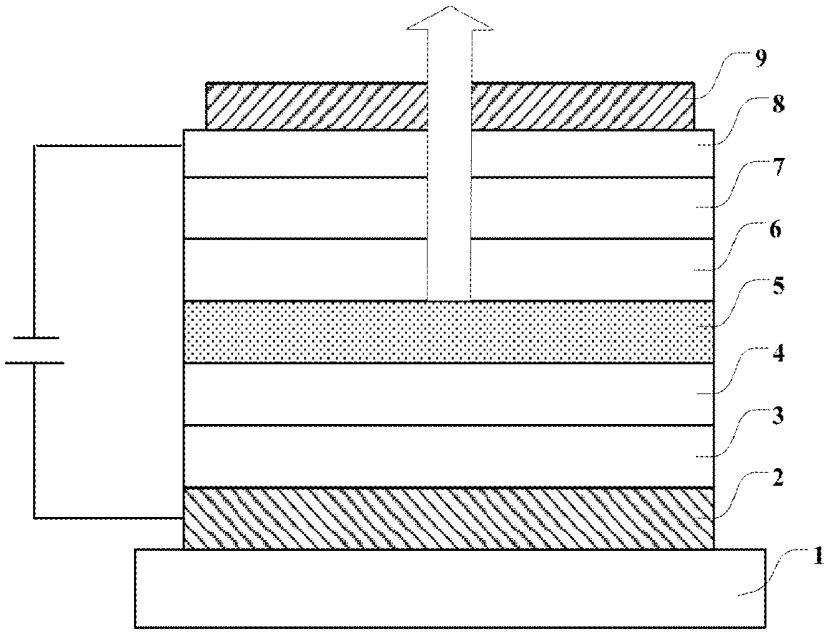
(57) **ABSTRACT**

The present disclosure relates to a field of organic electroluminescent materials, and in particular to a novel nitrogen heterocycle-fused benzene-benzimidazole organic compound, a display panel and a display apparatus. The nitrogen heterocycle-fused benzene-benzimidazole organic compound has a structure represented by the following formula. The compound according to the present disclosure can be applied to a capping layer, a hole transmission layer, an electron transmission layer and a light-emitting layer of an organic light-emitting device, which can improve light extraction efficiency and luminous efficiency of a top-emission type organic photoelectric device (especially most effective for pixels of blue light), and can alleviate the angular dependence of luminescence of OLED device (most effective for pixels of red/green light), while effectively blocking water and oxygen in the external environment, and protecting the OLED display panel from erosion of water and oxygen.





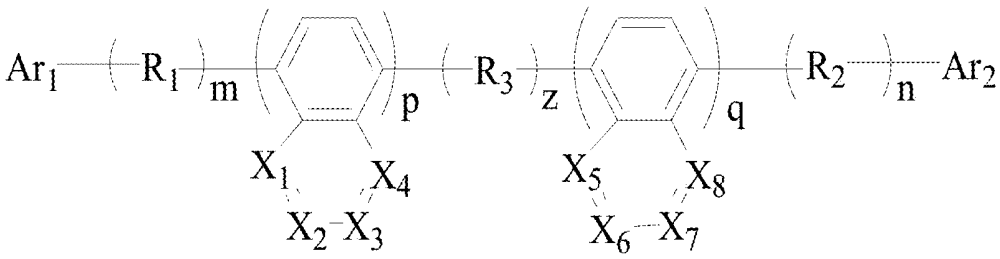


FIG. 1

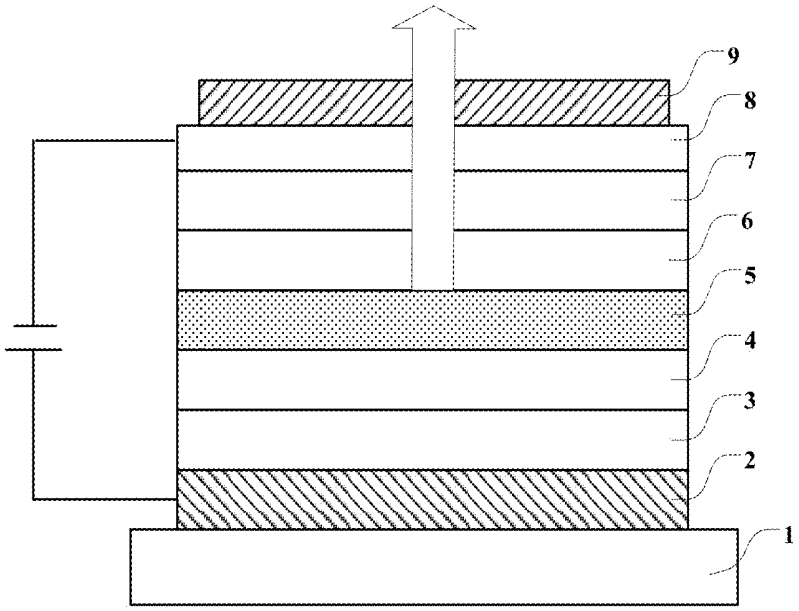
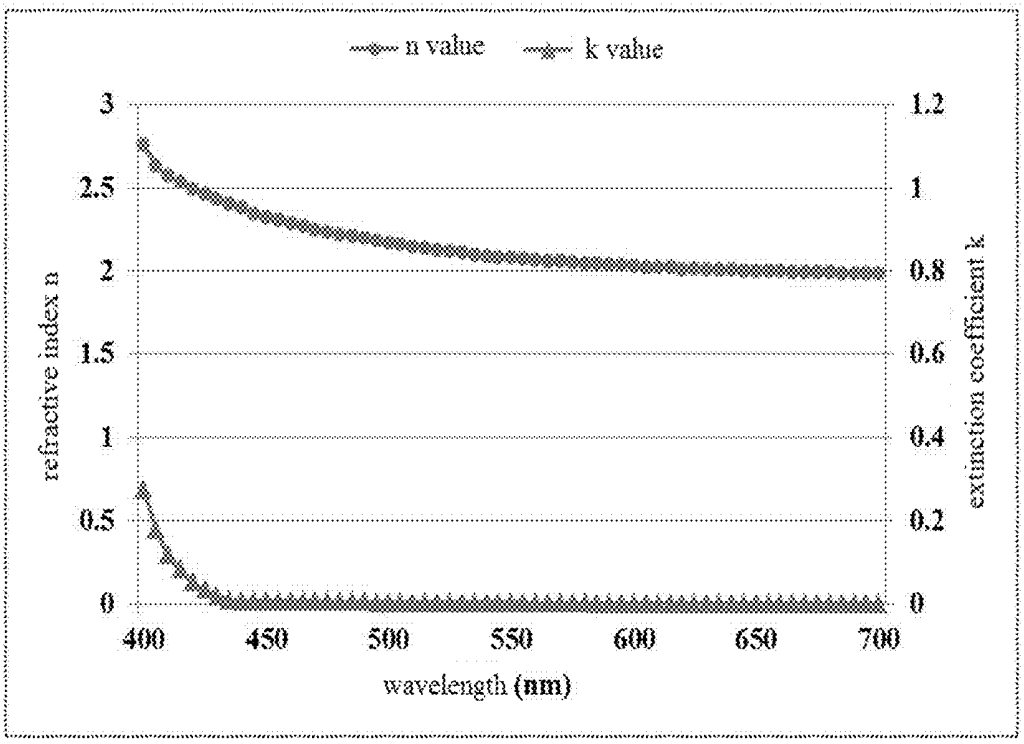


FIG. 2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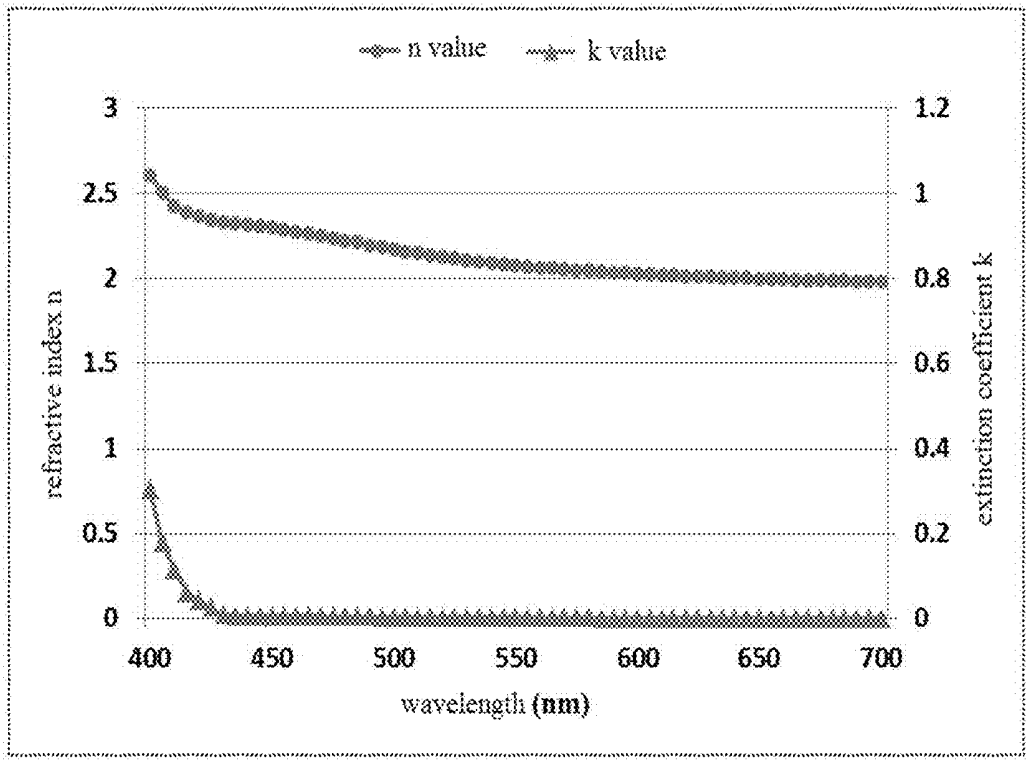
k value
refractive index n
extinction coefficient k
wavelength (nm)
3
2.5
2
1.5
1
0.5
0
1.2
1
0.8
0.6
0.4
0.2
0
400
450
500
550
600
650
700

FIG. 3


n value
k value
refractive index n
extinction coefficient k
wavelength (nm)
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2.5
2
1.5
1
0.5
0
1.2
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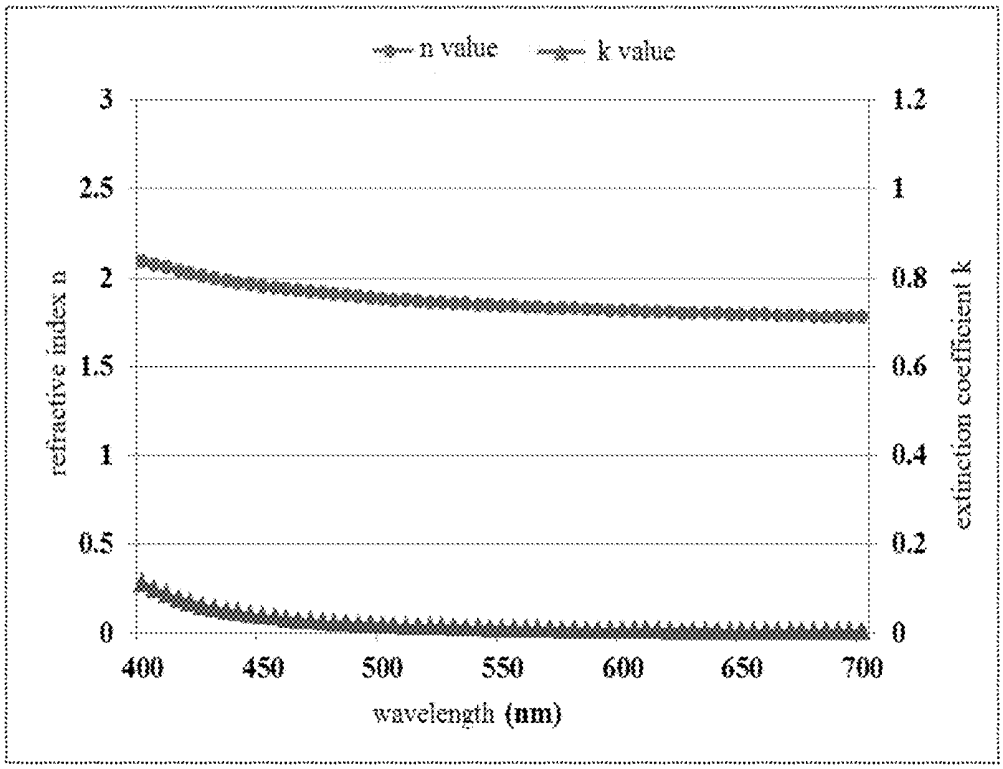
0.8
0.6
0.4
0.2
0
400
450
500
550
600
650
700

FIG. 4


n value
k value
refractive index n
extinction coefficient k
3
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0.5
0
1.2
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0.4
0.2
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400
450
500
550
600
650
700
wavelength (nm)

FIG. 5

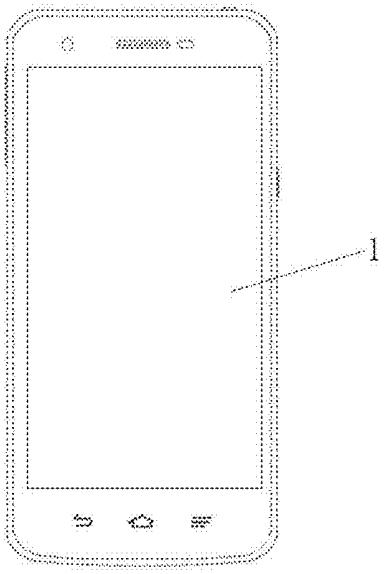

1

FIG. 6

NITROGEN HETEROCYCLE-FUSED BENZENE-BENZIMIDAZOLE ORGANIC COMPOUND, DISPLAY PANEL AND DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure claims priority to Chinese Patent Application No. 201811099985.2, filed on Sep. 20, 2018, the content of which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the field of organic electroluminescent materials, and in particular, to a novel nitrogen heterocycle-fused benzene-benzimidazole organic compound, and a display panel and display apparatus containing the nitrogen heterocycle-fused benzene-benzimidazole organic compound.

BACKGROUND

[0003] Organic light-emitting diode (OLED) has made great progress after several decades of development. Although an internal quantum efficiency of the OLED is already close to 100%, an external quantum efficiency of the OLED is only about 20%. Most of light are confined inside the light-emitting device due to factors such as surface plasma loss and waveguide effect, resulting in a large energy loss.

[0004] In a top-emission type device, an organic capping layer (CPL) is usually deposited on a translucent metal electrode Al to adjust an optical interference distance, suppress external light reflection, and suppress extinction caused by movement of surface plasmas, thereby enhancing extraction efficiency of the light, and improving luminous efficiency.

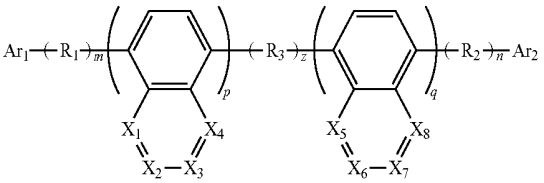
[0005] The existing CPL materials mostly use aromatic amine derivatives, phosphoxy derivatives and quinolinone derivatives, etc., which have both hole transmission function and electron transmission function and then the light extraction efficiency is improved to some extent. However, the refractive index of the existing CPL materials is generally no greater than 1.9, which does not meet the requirements of high refractive index; an amine derivative of specific structures having high refractive index and materials conforming to specific parameters can improve the light extraction efficiency, but cannot simultaneously solve the problem of luminous efficiency, especially for blue light-emitting elements. In order to increase the density of molecules and achieve high thermal stability, molecular structures of the existing materials are designed too big and loose, and molecules cannot be closely packed, resulting too many molecular gel holes during evaporation and poor coverage tightness.

SUMMARY

[0006] The present disclosure provides a series of novel nitrogen heterocycle-fused benzene-benzimidazole organic compounds in which a nitrogen heterocycle-fused benzene-benzimidazole structure is used as a central skeleton.

[0007] In one embodiment, the present disclosure provides a nitrogen heterocycle-fused benzene-benzimidazole organic compound, having a chemical structure represented by chemical formula I:

chemical formula I

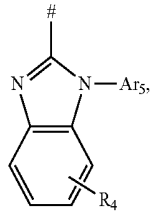


[0008] each of X_1-X_8 independently represents a nitrogen atom or a carbon atom, and at least one of X_1-X_4 is a nitrogen atom, and at least one of X_5-X_8 is a nitrogen atom; m, n, p, q, and z each independently represent a number of 0, 1, or 2, and p+q≥1;

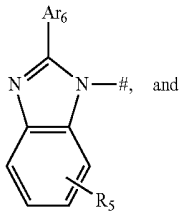
[0009] R_1, R_2, and R_3 each independently represent a single bond, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, or substituted or unsubstituted C6-C40 heteroaryl;

[0010] Ar_1 and Ar_2 each independently represent one of the following structures shown by chemical formula II, chemical formula III, and chemical formula IV:

chemical formula II

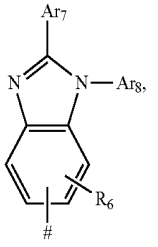


chemical formula III



and

chemical formula IV



[0011] # represents a bonding position in the chemical formula I;

[0012] Ar_5, Ar_6 and Ar_7 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted

silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl; and

[0013] R_4, R_5, and R_6 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl.

[0014] In another embodiment, the present disclosure provides a display panel including an organic light-emitting device, and the organic light-emitting device comprises an anode, a cathode arranged opposite to the anode, a capping layer located at a side of the cathode facing away from the anode, and an organic layer located between the anode and the cathode, and the organic layer comprises a hole transmission layer, an electron transmission layer, and a light-emitting layer, at least one of the capping layer, the hole transmission layer, the electron transmission layer, and the light-emitting layer is made of the nitrogen heterocycle-fused benzene-benzimidazole organic compound as described above.

[0015] In still another embodiment, the present disclosure provides a display apparatus including the above display panel.

BRIEF DESCRIPTION OF DRAWINGS

[0016] Embodiments of the present disclosure or in the related art, and the accompanying drawings used in the embodiments or in the related art are briefly described below. The drawings described below are merely a part of embodiments of the present disclosure.

[0017] FIG. **1** is a chemical formula of a nitrogen heterocycle-fused benzene-benzimidazole organic compound according to an embodiment of the present disclosure.

[0018] FIG. **2** is a structural schematic diagram showing an organic light-emitting device according to an embodiment of the present disclosure.

[0019] FIG. **3** is a graph showing refractive index and extinction coefficient of a compound CP4 according to an embodiment of the present disclosure.

[0020] FIG. **4** is a graph showing refractive index and extinction coefficient of a compound CP11 according to an embodiment of the present disclosure.

[0021] FIG. **5** is a graph showing refractive index and extinction coefficient of comparative example Com-1 (CBP) in a comparative example.

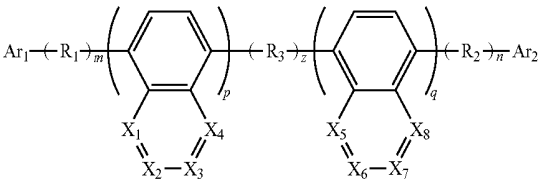
[0022] FIG. **6** is a schematic diagram showing a display apparatus according to an embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0023] The present disclosure is further described by the following embodiments and comparative examples, which are merely intended to illustrate but not to limit the present disclosure.

[0024] In one embodiment, the present disclosure provides a nitrogen heterocycle-fused benzene-benzimidazole organic compound, having a chemical structure represented by chemical formula I:

chemical formula I

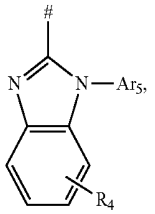


[0025] each of X_1-X_8 independently represents a nitrogen atom or a carbon atom, and at least one of X_1-X_4 is a nitrogen atom, and at least one of X_5-X_8 is a nitrogen atom; m, n, p, q, and z each independently represent a number of 0, 1, or 2, and $p+q \geq 1$;

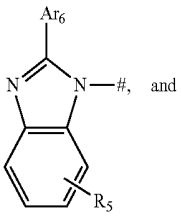
[0026] R_1, R_2, and R_3 each independently represent a single bond, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, or substituted or unsubstituted C6-C40 heteroaryl;

[0027] Ar_1 and Ar_2 each independently represent one of the following structures shown by chemical formula II, chemical formula III, and chemical formula IV:

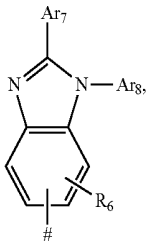
chemical formula II



chemical formula III



chemical formula IV



[0028] # represents a bonding position in the chemical formula I;

[0029] Ar_5, Ar_6 and Ar_7 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl; and

[0030] R_4, R_5, and R_6 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, or substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl.

[0031] The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure adopts an aromatic fused ring structure having a large density, so that molecular packing is better, and polarizability of fragments is larger under a reasonable design. For visible light having a wavelength between 400 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure can provide a good refractive index ($n \geq 2.0$). For visible light having a wavelength between 430 nm and 700 nm, the extinction coefficient k of the nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure is less than or equal to 0. For visible light having a wavelength between 400 nm and 700 nm, transmittance of the nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure is greater than 65%. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure has a high glass transition temperature and good molecular thermal stability, i.e., no thermal decomposition occurs when evaporation is performed.

[0032] When the nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure is applied to an organic electroluminescent device, the light extraction efficiency and luminous efficiency of the top-emission type organic photoelectric device can be improved, especially most effective for improving luminous efficiency of blue pixels, and the angular dependence of light emission of the OLED device light can be alleviated, especially most effective for the red/green light pixel. Meanwhile, water and oxygen in the external environment can be effectively blocked, and the OLED display panel can be protected from erosion of water and oxygen.

[0033] According to an embodiment of the present disclosure, in the chemical formula I, m=n=0, p>0, q>0, and z>0.

[0034] According to an embodiment of the present disclosure, in the chemical formula I, q=z=0.

[0035] According to an embodiment of the present disclosure, in the chemical formula I, m>0, and n=0; or, n>0, and m=0.

[0036] According to an embodiment of the present disclosure, in the chemical formula I, p>0, q>0, and m=n=z=0.

[0037] According to an embodiment of the present disclosure, in the chemical formula I, p>0, and m=n=q=z=0.

[0038] According to an embodiment of the present disclosure, in the chemical formula I, m=n.

[0039] According to an embodiment of the present disclosure, in the chemical formula I, p>0, q>0, X_1 and X_8 represent a same atom, X_2 and X_7 represent a same atom, X_3 and X_6 represent a same atom, and X_4 and X_5 represent a same atom.

[0040] According to an embodiment of the present disclosure, in the chemical formula I, R_1 and R_2 represent a same substituent.

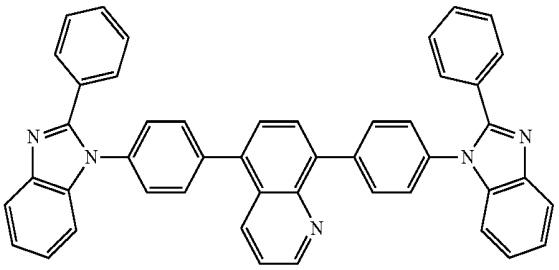
[0041] According to an embodiment of the present disclosure, in the chemical formula I, Ar_1 and Ar_2 represent a same substituent.

[0042] According to an embodiment of the present disclosure, in the chemical formula I, only one of X_1-X_4 represent a nitrogen atom, and/or only one of X_5-X_8 represent a nitrogen atom.

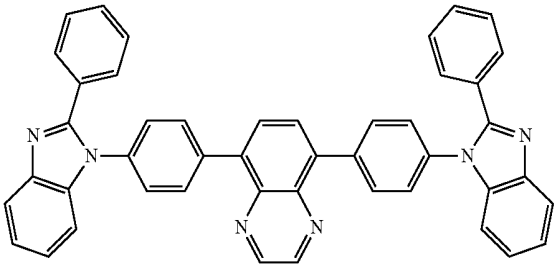
[0043] According to an embodiment of the present disclosure, in the chemical formula I, at least two of X_1-X_4 represent a nitrogen atom, and/or, at least two of X_5-X_8 represent a nitrogen atom.

[0044] According to an embodiment of the present disclosure, the nitrogen heterocycle-fused benzene-benzimidazole organic compound is one of the following compounds:

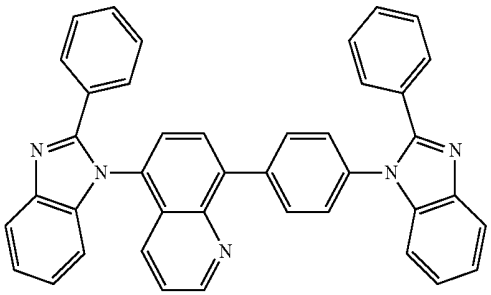
CP1



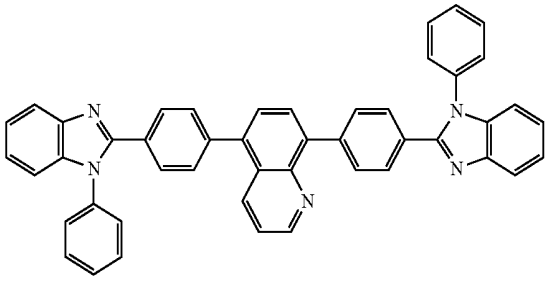
CP2



CP3



CP4



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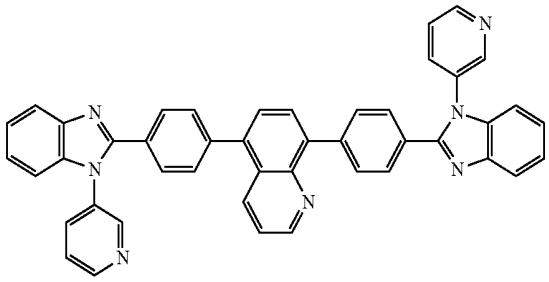
CP5



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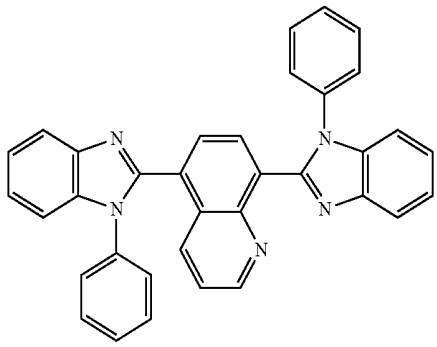
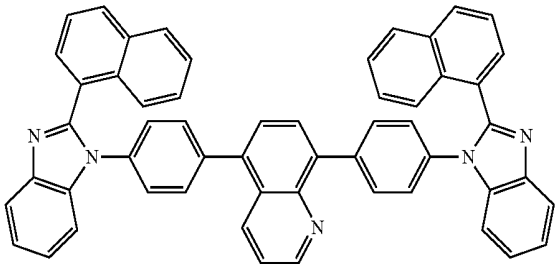
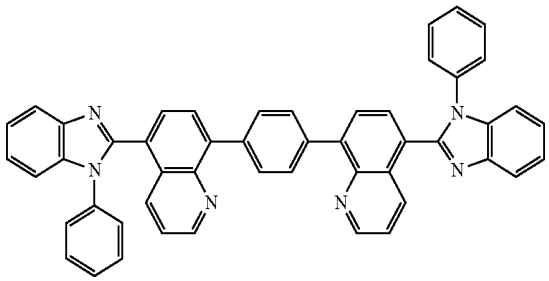


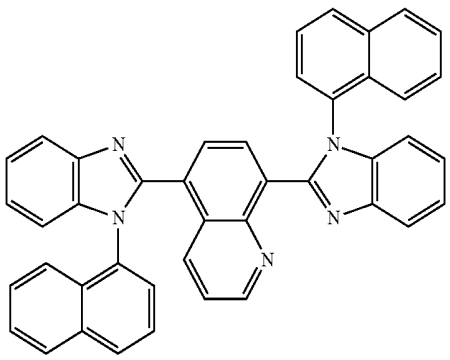
CP7



CP8



CP9



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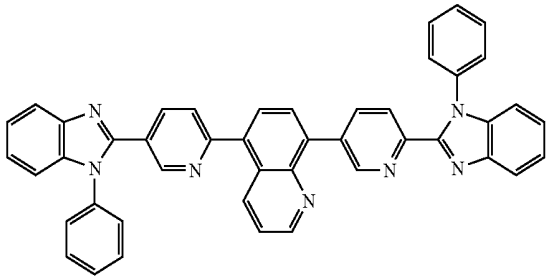
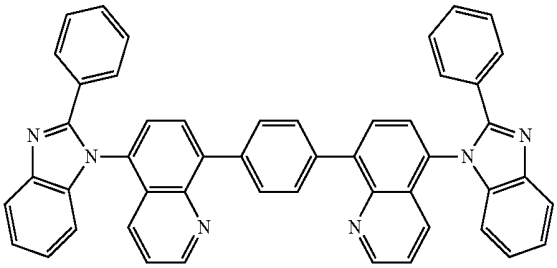
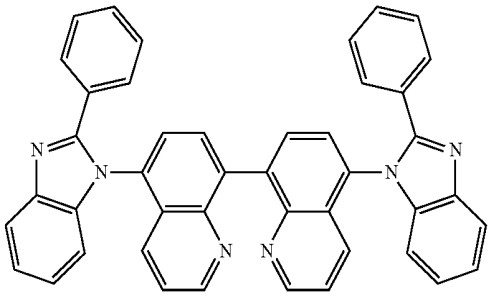
CP10



CP11



CP12



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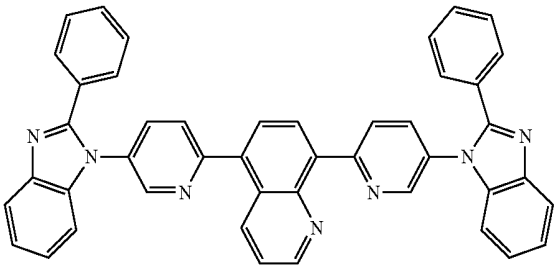
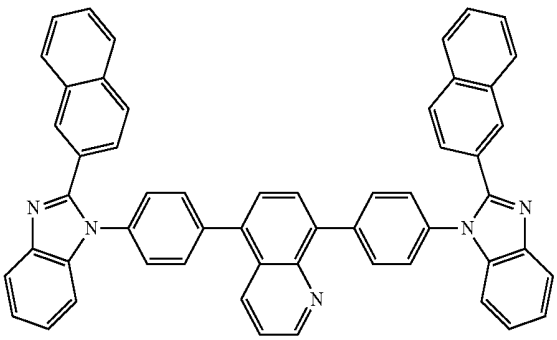


CP14



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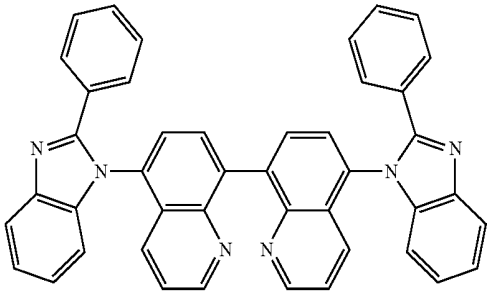
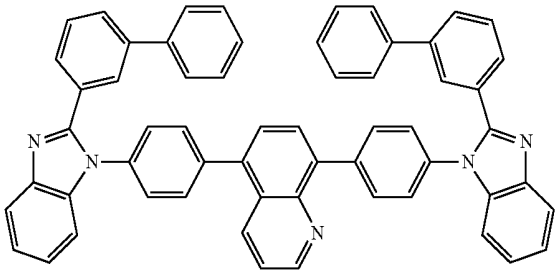
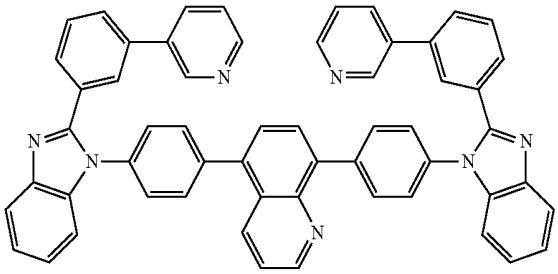
CP15



CP16



CP17



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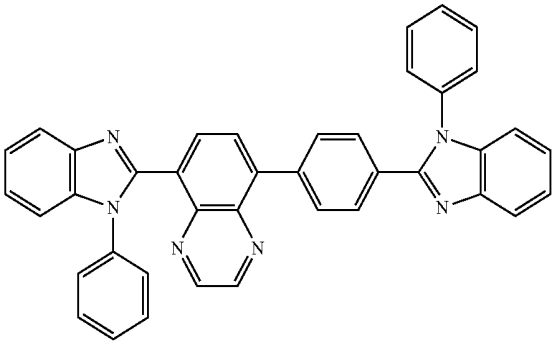

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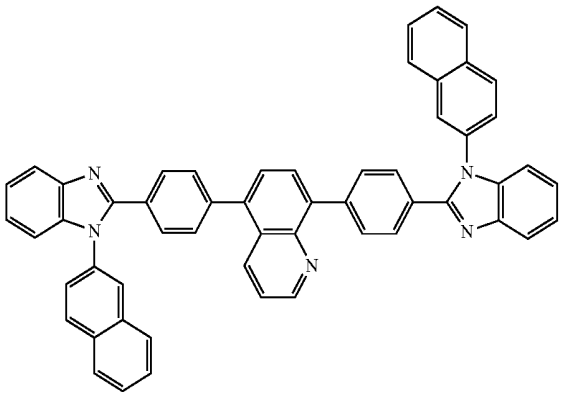

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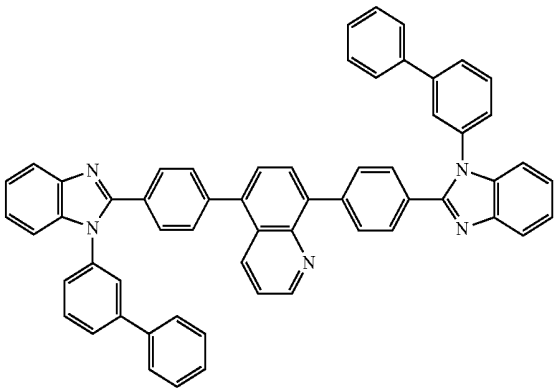

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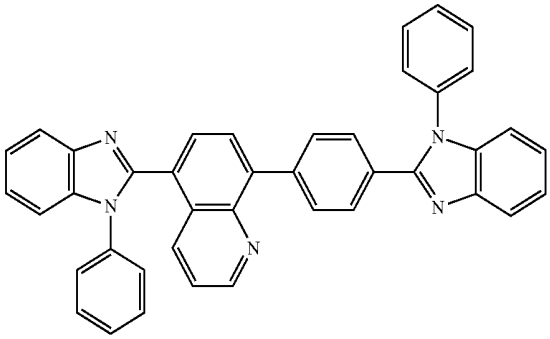

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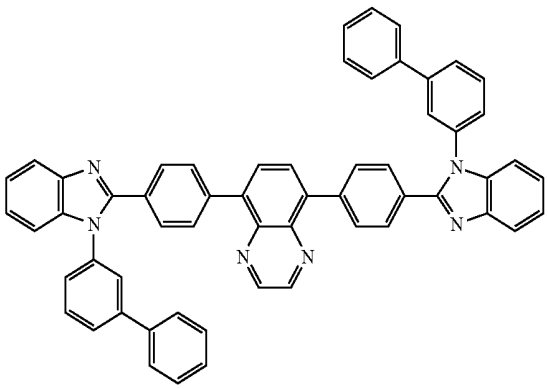

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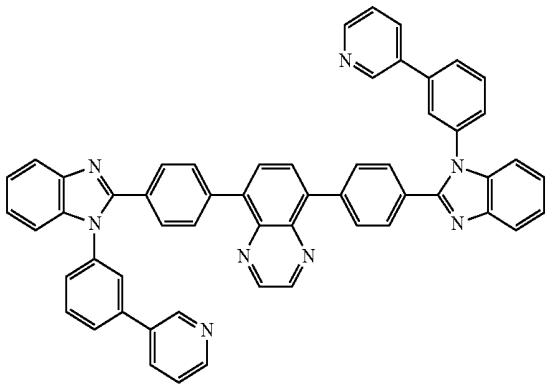

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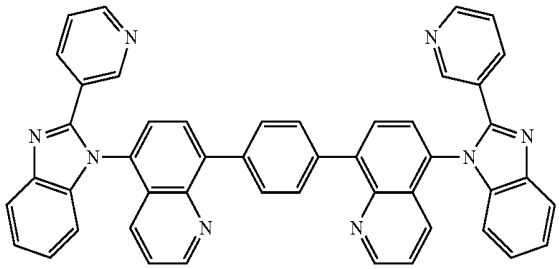

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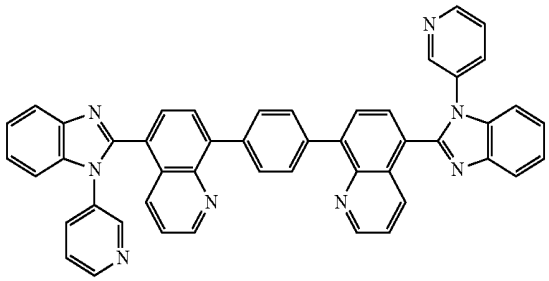

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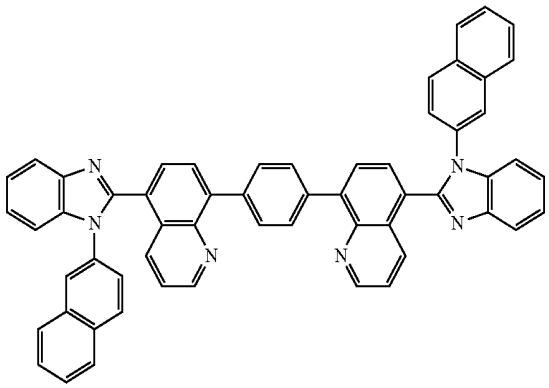

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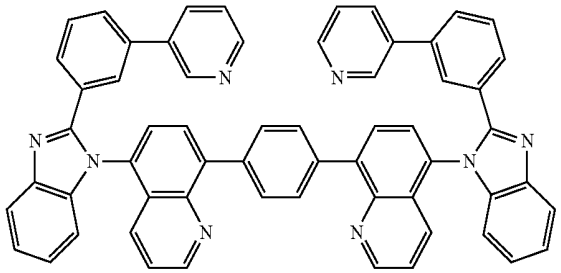

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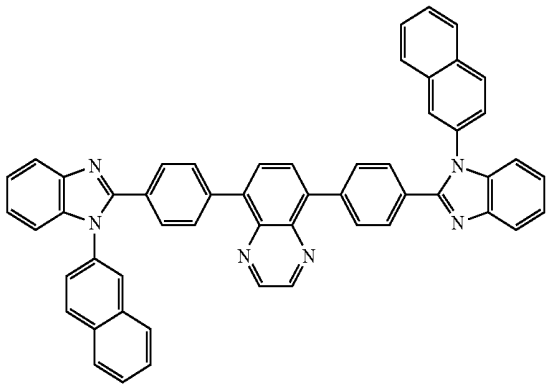

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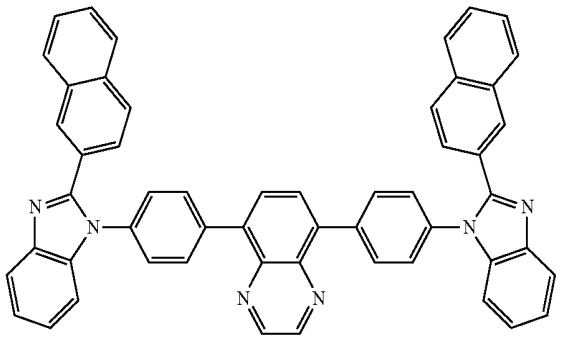

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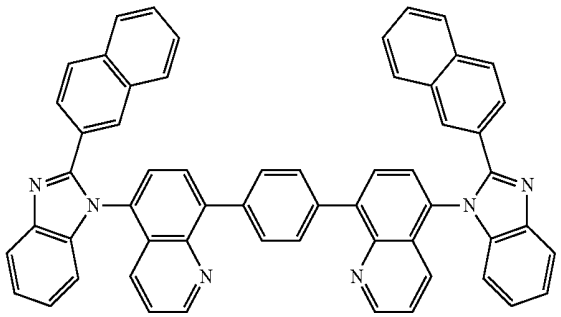

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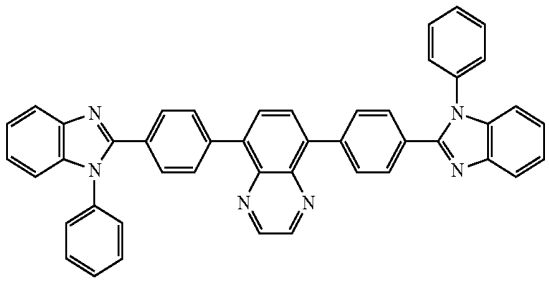

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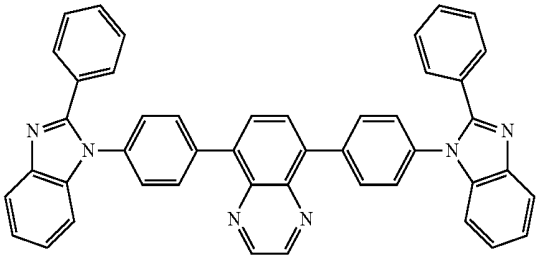

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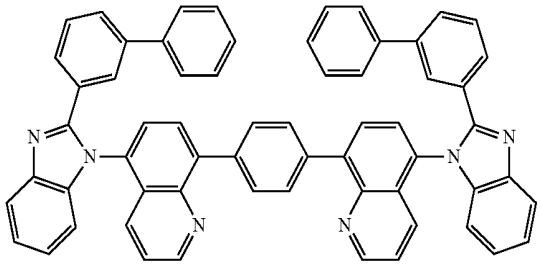


[0045] According to an embodiment of the present disclosure, for visible light having a wavelength between 400 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has a refractive index n greater than or equal to 2.0.

[0046] According to an embodiment of the present disclosure, for visible light having a wavelength between 430 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has an extinction coefficient k less than or equal to 0.0.

[0047] According to an embodiment of the present disclosure, for visible light having a wavelength between 400 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has a transmittance greater than 65%.

[0048] The novel compounds with the above design can be applied to the capping layer CPL of an organic layer, and can serve as a host material, a doping material, or a material for an electron transmission layer or a hole transmission layer.

[0049] In another embodiment, the present disclosure provides an organic light-emitting display panel including an organic light-emitting device. The organic light-emitting device includes an anode, a cathode arranged opposite to the anode, a capping layer located at a side of the cathode facing away from the anode, an organic layer located between the anode and the cathode. The organic layer includes a hole transmission layer, an electron transmission layer, and a light-emitting layer. At least one of the capping layer, the hole transmission layer, the electron transmission layer, and the light-emitting layer is made of the nitrogen heterocycle-fused benzene-benzimidazole organic compound as described above.

[0050] In the organic light-emitting device provided by the present disclosure, the anode can be made of a metal selected from a group consisting of copper, gold, silver, iron, chromium, nickel, manganese, palladium, platinum, etc., and alloys thereof. The anode can also be made of metal oxide, such as indium oxide, zinc oxide, indium tin oxide (ITO), indium zinc oxide (IZO), and the like. The anode can also be made of a conductive polymer, such as polyaniline, polypyrrole, poly(3-methylthiophene) and the like. In addition to the anode material mentioned above, the anode can also be made of any suitable material or material combination including the suitable anode materials known in the related art, as long as the material is conducive to injecting holes.

[0051] In the organic light-emitting device provided by the present disclosure, the cathode can be made of metal, such as aluminum, magnesium, silver, indium, tin, titanium, etc., or alloys thereof. The cathode can also be made of multiple-layer metal material, such as LiF/Al, LiO_2/Al, BaF_2/Al, and the like. In addition to the cathode materials listed above, the cathode can also be made of any suitable material or material combination including the suitable cathode material known in the related art, as long as the material is conducive to injecting electrons.

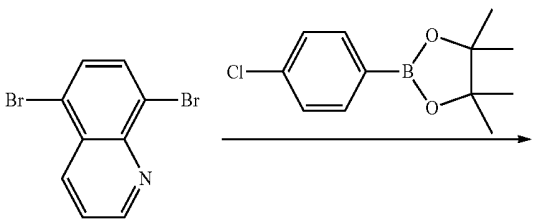
[0052] According to embodiments of the present disclosure, the organic light-emitting device was manufactured by forming an anode on a transparent or opaque smooth substrate, forming an organic thin layer on the anode, and then forming a cathode on the organic thin layer. The organic thin layer can be formed by a known film-forming method such as vapor deposition, sputtering, spin coating, dipping, ion plating, and the like. Finally, an organic optical covering layer, i.e., a capping layer (CPL) was prepared on the cathode. The material of the CPL is the nitrogen heterocycle-fused benzene-benzimidazole organic compound described in the present disclosure. The CPL can be prepared by a vapor evaporation method or a solution method. The solution method includes an ink-jet printing method, spin coating, blade coating, screen printing, roll-to-roll printing, and the like.

[0053] The novel compounds with the above design can be applied to the capping layer CPL of the organic layer, and can also serve as a host material, a doping material, or a material for an electron transmission layer or a hole transmission layer.

[0054] Synthesis of intermediates M1-M7 is described below.

[0055] Synthesis of Intermediate M1

[0056] When one of X_1 and X_2 is a nitrogen atom, a synthetic route is as follows:



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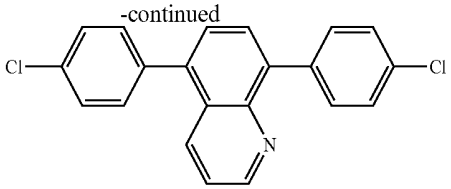


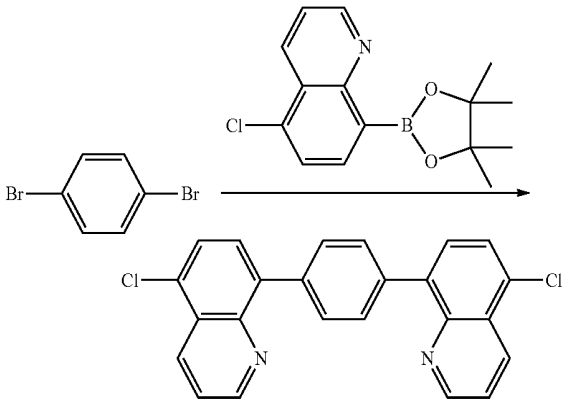
Intermediate M1

[0057] In nitrogen atmosphere, raw materials of 5,8-dibromoquinoline (0.012 mol), 1-chloro-4-phenylborate (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added into 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added dropwise, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Intermediate M1.

[0058] Elemental analysis results of the Intermediate M1 (Molecular Formula $C_{21}H_{13}Cl_2N$): theoretical value: C, 72.01; H, 3.74; Cl, 20.24; N, 4.40; test value: C, 72.03; H, 3.75; Cl, 20.24; N, 3.97. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 349.04, and test value: 349.25.

[0059] Synthesis of Intermediate M5

[0060] When one of X_1 and X_2 is a nitrogen atom, a synthetic route is as follows:



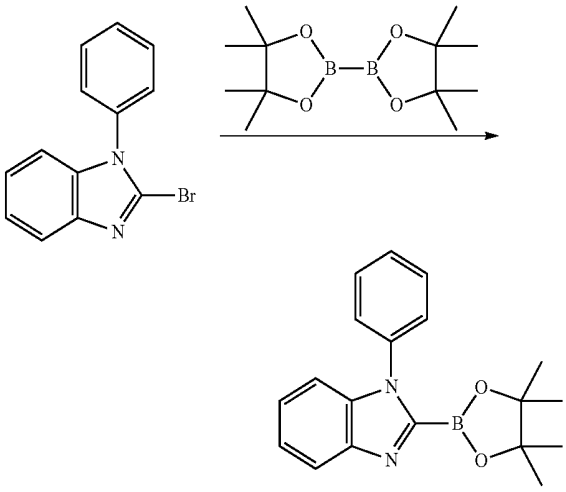
Intermediate M5

[0061] In nitrogen atmosphere, raw materials of 1,4-dibromobenzene (0.012 mol), 5-chloro-8-quinoline borate (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added into 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Intermediate M5.

[0062] Elemental analysis results of the Intermediate M5 (Molecular Formula $C_{24}H_{13}Cl_2N_2$): theoretical value: C, 71.83; H, 3.52; Cl, 17.67; N, 6.98; test value: C, 71.86; H, 3.53; Cl, 17.65; N, 6.96. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 400.05, and test value: 400.24.

[0063] Synthesis of Intermediate M7

[0064] When the Ar group is a phenyl group, a synthetic route is as follows:



Intermediate M7

[0065] In nitrogen atmosphere, raw materials of 2-bromo-1-phenylbenzimidazole (0.012 mol), bis(pinacolato)diboron (0.012 mol) and palladium acetate (0.0003 mol) were sequentially added into 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Intermediate M7.

[0066] Elemental analysis results of the Intermediate M7 (Molecular Formula $C_{19}H_{21}BN_2O_2$): theoretical value: C, 71.27; H, 6.61; B, 3.38; N, 8.75; O, 9.99; test value: C, 71.28; H, 6.63; B, 3.38; N, 8.74; O, 9.97. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 320.17, and test value: 320.46.

[0067] Similarly, Intermediates M2, M3, M4, and M6 can be prepared. Structures of the Intermediates M1-M7 are shown in Table 1. In the following Intermediates, X_1 and X_2 are a C atom or a nitrogen atom, and at least one of X_1 and X_2 is a nitrogen atom; the Ar groups each are independently

selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl, which are consistent with the first aspect described above corresponding to the embodiments of the present disclosure.

TABLE 1

Structures of Intermediates M1-M7

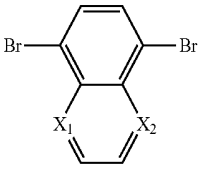
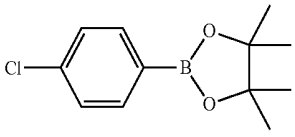
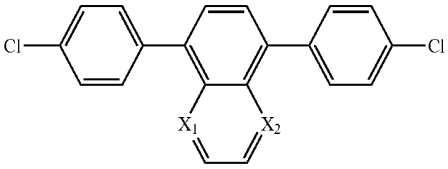
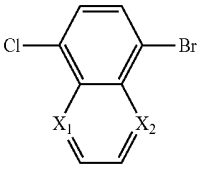
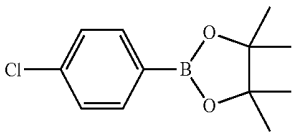
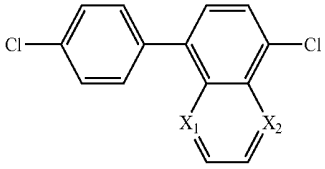
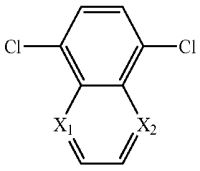
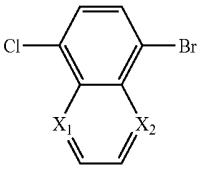
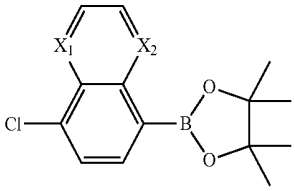
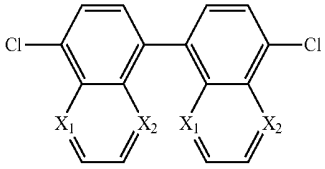
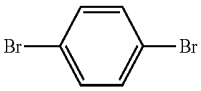
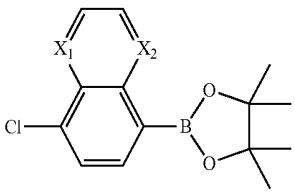
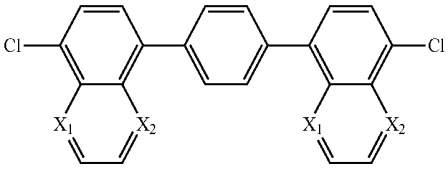
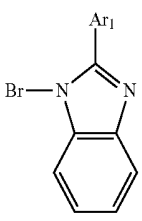
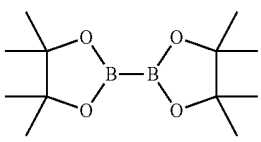
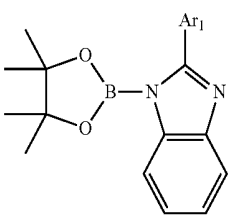
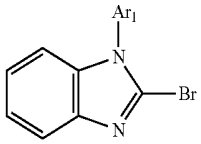
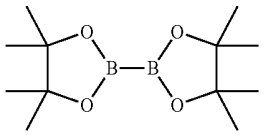
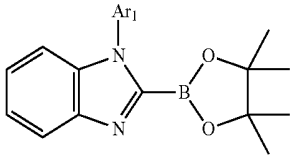
raw material 1	raw material 2	Intermediates
		
		
NG	NG	 Intermediate M3
		 Intermediate M4
		 Intermediate M5
		 Intermediate M6

TABLE 1-continued

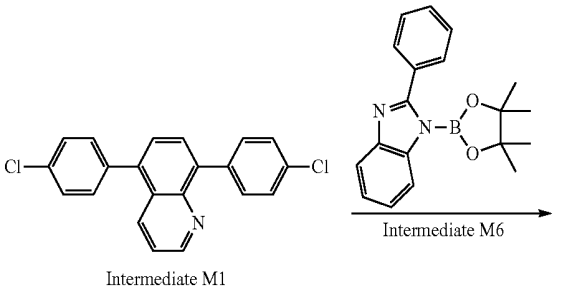
Structures of Intermediates M1-M7

raw material 1	raw material 2	Intermediates
		
		Intermediate M7

[0068] A further embodiment of the present disclosure provides methods for preparing several exemplary nitrogen heterocycle-fused benzene-benzimidazole organic compounds, which are described in exemplary Examples 1-6 below.

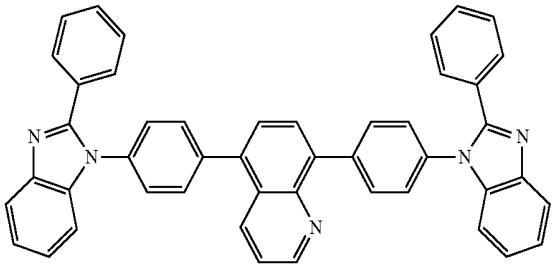
EXAMPLE 1

[0069] A synthetic route of Compound CP1 is as follows:



Intermediate M1

Intermediate M6



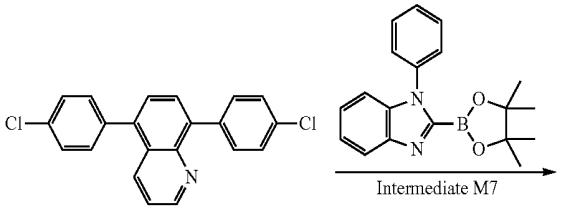
Compound CP1

[0070] In nitrogen atmosphere, raw materials of the Intermediate M1 (0.012 mol), the Intermediate M6 (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added into 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP1.

[0071] Elemental analysis results of the Compound CP1 (Molecular Formula $C_{47}H_{31}N_5$): theoretical value: C, 84.79; H, 4.69; N, 10.52; test value: C, 84.81; H, 4.70; N, 10.49. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 665.26, and test value: 665.50.

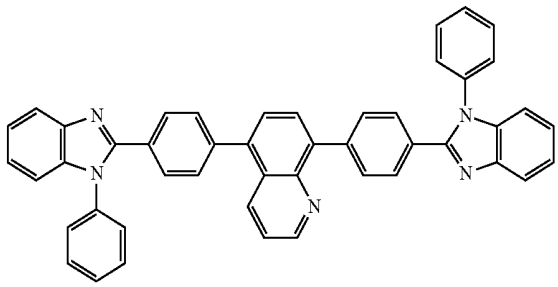
EXAMPLE 2

[0072] A synthetic route of Compound CP4 is as follows:



Intermediate M1

Intermediate M7



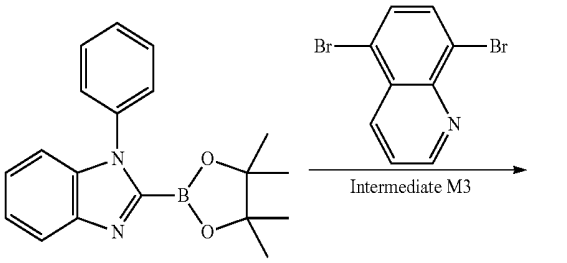
Compound CP4

[0073] In nitrogen atmosphere, raw materials of the Intermediate M1 (0.012 mol), the Intermediate M7 (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added into 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP4.

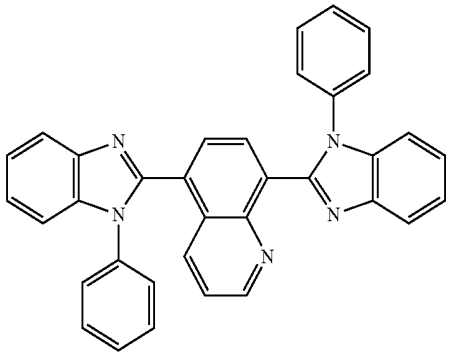
[0074] Elemental analysis results of the Compound CP4 (Molecular Formula $C_{47}H_{31}N_5$): theoretical value: C, 84.79; H, 4.69; N, 10.52; test value: C, 84.80; H, 4.71; N, 10.49. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 665.26, and test value: 665.30.

EXAMPLE 3

[0075] A synthetic route of Compound CP6 is as follows:



Intermediate M1



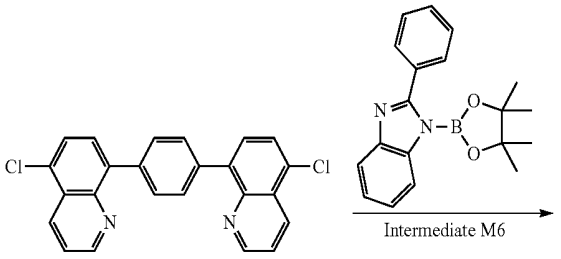
Compound CP4

[0076] In nitrogen atmosphere, raw materials of the Intermediate M7 (0.025 mol), the Intermediate M3 (0.012 mol) and palladium acetate (0.0003 mol) were sequentially added to 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP6.

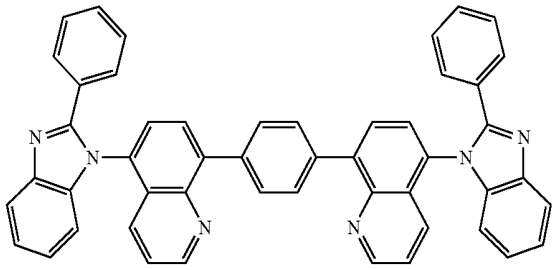
[0077] Elemental analysis results of the Compound CP6 (Molecular Formula $C_{35}H_{23}N_5$): theoretical value: C 81.85; H, 4.51; N, 13.64; test value: C, 81.83; H, 4.49; N, 13.68. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 513.20, and test value: 513.32.

EXAMPLE 4

[0078] A synthetic route of Compound CP11 is as follows:



Intermediate M5



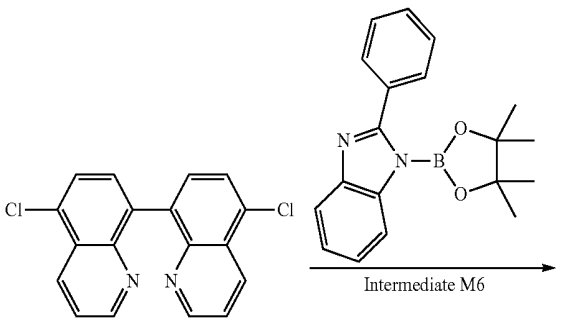
Compound CP11

[0079] In nitrogen atmosphere, raw materials of the Intermediate M5 (0.012 mol), the Intermediate M6 (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added to 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP11.

[0080] Elemental analysis results of the Compound CP11 ($C_{50}H_{32}N_6$): theoretical value: C, 83.78; H, 4.50; N, 11.72; test value: C, 83.76; H, 4.49; N, 11.75. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 716.27, and test value: 716.56.

EXAMPLE 5

[0081] A synthetic route of Compound CP12 is as follows:



Intermediate M4

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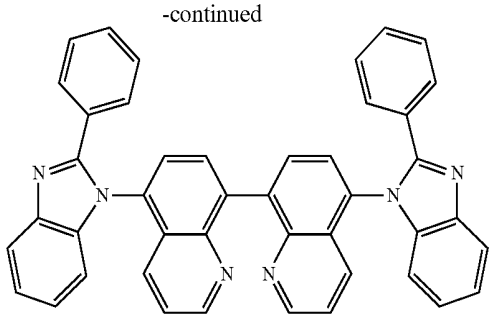


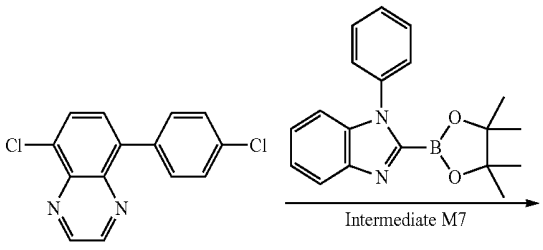
Compound CP12

[0082] In nitrogen atmosphere, raw materials of the Intermediate M4 (0.012 mol), the Intermediate M6 (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added to 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP12.

[0083] Elemental analysis results of the Compound CP12 ($C_{44}H_{28}N_6$): theoretical value: C, 82.48; H, 4.40; N, 13.12; test value: C, 82.50; H, 4.42; N, 13.08. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 640.24, and test value: 640.48.

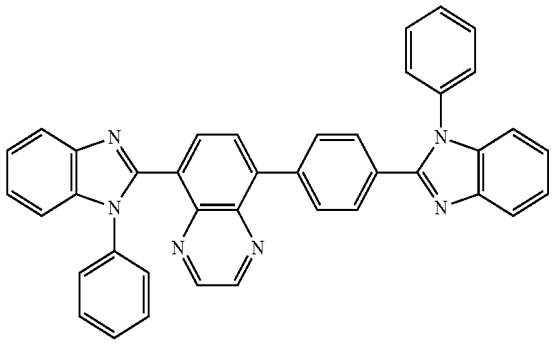
EXAMPLE 6

[0084] A synthetic route of Compound CP18 is as follows:



Intermediate M7

Intermediate M2



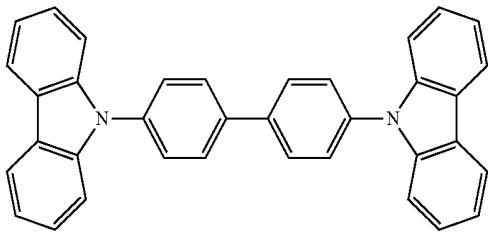
Compound CP18

[0085] In nitrogen atmosphere, raw materials of the Intermediate M2 (0.012 mol), the Intermediate M7 (0.025 mol) and palladium acetate (0.0003 mol) were sequentially added to 150 mL DMF in a 250 mL three-necked flask, mixed and stirred. After a solution of K_3PO_4 (0.045 mol) in water was added, the mixture was refluxed for 10 hours at a temperature of 130° C., and then naturally cooled to room temperature. After completion of the reaction, 100 mL deionized water was added, and then a few droplets of 2M HCl were added, and then the mixture was extracted with dichloromethane, and an organic phase was collected and dried by anhydrous Na_2SO_4. The dried solution was filtered, and the solvent was removed using a rotary evaporator to obtain a crude product. The obtained crude product was purified through silica gel column chromatography to obtain the Compound CP18.

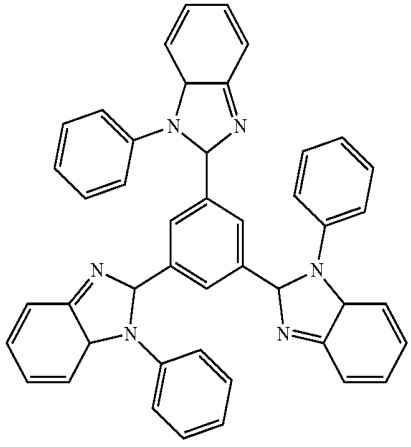
[0086] Elemental analysis results of the Compound CP18 ($C_{40}H_{26}N_6$): theoretical value: C, 81.34; H, 4.44; N, 14.23; test value: C, 81.34; H, 4.42; N, 14.25. The ESI-MS (m/z) (M+) was obtained by liquid chromatography-mass spectrometry: theoretical value: 590.22, and test value: 590.46.

[0087] Test results of the thermal properties and refractive indexes of the nitrogen heterocycle-fused benzene-benzimidazole organic compounds according to the present disclosure are listed in Table 2. In Table 2, the structural formulas of the compounds CBP, TPBI, and Alq3 used in Comparative Example Com-1, Comparative Example Com-2, and Comparative Example Com-3, respectively, are as follows:

CBP



TPBI



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Alq3

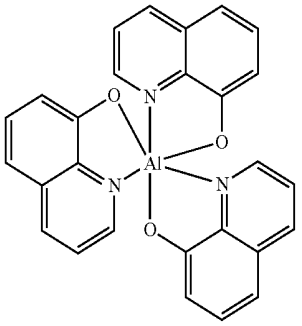


TABLE 2

test results of thermal performance and refractive index

		refractive index		
compound	Tg (° C.)	n@450	n@530	n@620
CP1	153	2.20	2.05	1.98
CP4	160	2.35	2.14	2.05
CP6	154	2.26	2.11	2.04
CP11	157	2.30	2.09	2.01
CP12	158	2.41	2.20	2.12
CP15	156	2.34	2.13	2.06
CP18	158	2.29	2.12	2.04
CP23	153	2.26	2.11	2.04
CP24	161	2.36	2.16	2.07
CP27	158	2.34	2.15	2.08
CP30	162	2.45	2.23	2.09
CP32	155	2.39	2.18	2.07
CBP	108	1.87	1.81	1.78
A1q3	149	1.78	1.75	1.73
TPBI	121	1.80	1.76	1.73

* Taking n@450 as an example, n@450 means the refractive index of the nitrogen heterocycle-fused benzene-benzimidazole compound according to the present disclosure at a wavelength of 450 nm.

[0088] As can be seen from Table 2 above, the nitrogen heterocycle-fused benzene-benzimidazole organic compounds provided by the present disclosure have a higher glass transition temperature Tg. For light having wavelengths of 450 nm, 530 nm, and 620 nm, all of the nitrogen heterocycle-fused benzene-benzimidazole organic compounds of the present disclosure have a refractive index greater than 2.0.

[0089] As shown in FIGS. **3-5**, FIG. **3** is a graph showing refractive index and extinction coefficient of CP4; FIG. **4** is a graph showing refractive index and extinction coefficient of CP11; FIG. **5** is a graph showing refractive index and extinction coefficient of Com-1 (CBP). As can be seen from FIG. **3-5**, for light having a wavelength in the range of 400 nm to 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compounds provided by the present disclosure have a refractive index greater than or equal to 2.0. However, for light having a wavelength in the range of 430 nm to 700 nm, the refractive index of the Comparative Example Com-1 is less than 2.0. Moreover, the value of the extinction coefficient k of the nitrogen heterocycle-fused benzene-benzimidazole organic compound designed in the present disclosure is almost 0 for light having a wavelength greater than 450 nm of the blue light wavelength, which will not affect luminescence of the material of the light-emitting layer in the region of blue light.

[0090] Organic Light-Emitting Device

[0091] FIG. **2** is a structural schematic diagram showing an organic light-emitting device according to an embodiment of the present disclosure. As shown in FIG. **2**, the organic light-emitting device provided by the present disclosure includes: a substrate **1**, an ITO anode **2**, a first hole transmission layer **3**, a second hole transmission layer **4**, a light-emitting layer **5**, a first electron transmission layer **6**, a second electron transmission layer **7**, a cathode **8** (magnesium silver electrode, mass ratio 9:1 of magnesium to silver) and a capping layer CPL**9**. The ITO anode **2** has a thickness of 15 nm. The first hole transmission layer **3** has a thickness of 10 nm. The second hole transmission layer **4** has a thickness of 110 nm. The light-emitting layer **5** has a thickness of 30 nm. The first electron transmission layer **6** has a thickness of 30 nm. The second electron transmission layer **7** has a thickness of 5 nm. The magnesium silver electrode **8** has a thickness of 15 nm. The capping layer CPL**9** has a thickness of 100 nm.

[0092] The steps for preparing the organic light-emitting device according to the present disclosure are as follows.

[0093] 1) A glass substrate **1** was cut into a size of 50 mm×50 mm×0.7 mm, subjected to ultrasonic treatment respectively in isopropyl alcohol and in deionized water for 30 minutes, and then exposed to ozone for about 10 minutes for cleaning. The obtained glass substrate with an ITO anode **2** is mounted on a vacuum deposition apparatus.

[0094] 2) On the ITO anode **2**, the material HAT-CN was evaporated by vacuum evaporation to a thickness of 10 nm and used as the first hole transmission layer **3**.

[0095] 3) The material TAPC was evaporated by vacuum evaporation on the first hole transmission layer **3** to a thickness of 110 nm and used as the second hole transmission layer **4**.

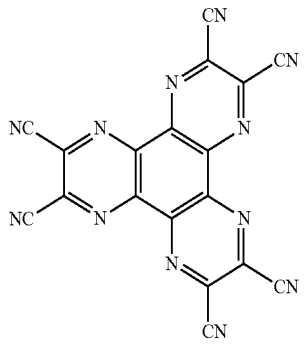
[0096] 4) The light-emitting layer **5** was co-deposited on the second hole transmission layer **4** in which CBP is used as a host material. Ir(ppy)3 is used as a doping material, a mass ratio of Ir(ppy)3 to CBP is 1:9. The light-emitting layer **5** has a thickness of 30 nm.

[0097] 5) The material TPBI was evaporated by vacuum evaporation on the light-emitting layer **5** to a thickness of 30 nm and used as the first electron transmission layer **6**.

[0098] 6) The material Alq3 was evaporated by vacuum evaporation on the first electron transmission layer **6** to a thickness of 5 nm and used as the second electron transmission layer **7**.

[0099] 7) Magnesium silver electrode was formed by vacuum evaporation on the second electron transmission layer **7** to a thickness of 15 nm and used as the cathode **8**, in which the mass ratio of Mg to Ag is 9:1.

[0100] 8) The compound CP1 according to the present disclosure was evaporated by vacuum evaporation on the cathode 8 to a thickness of 100 nm and used as a capping layer CPL.



HAT-CN

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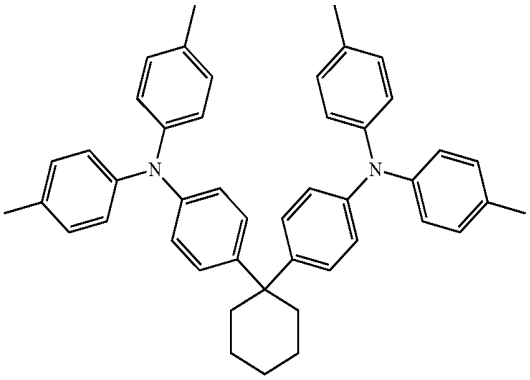
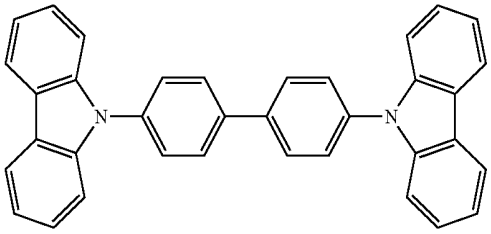
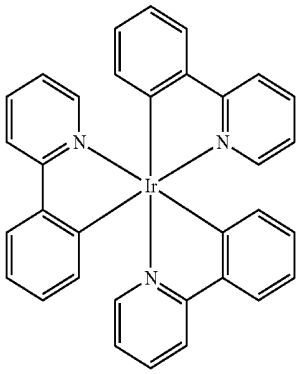


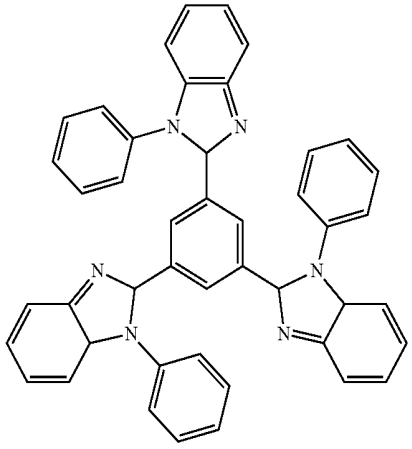
TAPC



CBP



$Ir(ppy)_3$



TPBI

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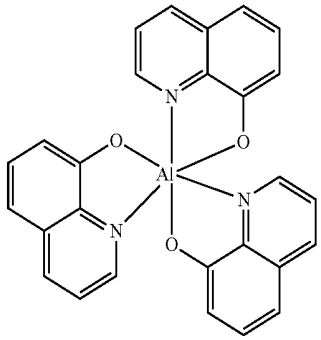


Alq_3

[0101] The preparation methods of the device examples 2-12 and the device comparative example 1 were the same except that the compounds used in the vacuum evaporation at step 7) are different. The compounds used in the step 7) of the device examples 2-12 and the device comparative example 1 are CP4, CP6, CP11, CP12, CP15, CP18, CP23, CP24, CP27, CP30, CP32, and CBP, respectively. All of the devices prepared above differ only in the material selection of the CPL layer, and the materials of other layers, for example, the light-emitting layer and the auxiliary layers, are the same.

TABLE 3

test results of luminescence performance of the devices

	@10 mA/cm^2			service life
No.	drive voltage(V)	current efficiency (cd/A)	brightness (cd/m^2)	(based on comparative example 1)
device example 1	4.3	36.5	3651.4	1.9
device example 2	4.5	35.4	3539.6	1.8
device example 3	4.4	36.1	3609.5	2.2
device example 4	4.2	35.8	3581.7	2.1
device example 5	4.3	36.2	3621.8	1.7
device example 6	4.4	35.4	3542.1	1.6
device example 7	4.5	35.7	3570.4	2.0
device example 8	4.3	36.3	3631.2	2.1
device example 9	4.4	36.6	3659.4	1.9
device example 10	4.3	36.2	3620.9	2.1
device example 11	4.4	35.8	3581.8	1.9
device example 12	4.3	36.7	3669.8	1.8
device comparative example 1	5.0	26.9	2691.7	1

[0102] As can be seen from the above Table 3, the optical devices using the nitrogen heterocycle-fused benzene-benzimidazole organic compound according to the present disclosure have a lower driving voltage, higher current efficiency, higher brightness, and longer service life compared with the device comparative example 1.

[0103] Another embodiment of the present disclosure provides a display panel including the organic light-emitting device as described above.

[0104] Yet another embodiment of the present disclosure provides a display apparatus including the display panel as described above.

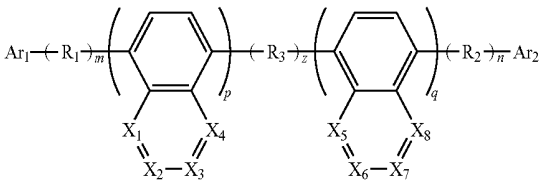
[0105] In the present disclosure, the organic light-emitting device may be an OLED, which can be used in an organic light-emitting display apparatus. The organic light-emitting

display apparatus may be a mobile phone display screen, a computer display screen, a liquid crystal television display screen, a smart watch display screen, or a smart car display panel, VR or AR helmet display screen, and display screens of various smart devices, etc. FIG. **6** is a schematic diagram showing a display apparatus according to an embodiment of the present disclosure, in which the reference number **1** is a mobile phone display screen.

What is claimed is:

1. A nitrogen heterocycle-fused benzene-benzimidazole organic compound, having a chemical structure represented by chemical formula I:

chemical formula I

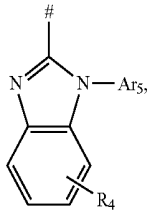


wherein each of X_1-X_8 independently represents a nitrogen atom or a carbon atom, and at least one of X_1-X_4 is a nitrogen atom, and at least one of X_5-X_8 is a nitrogen atom; m, n, p, q, and z each independently represent a number of 0, 1, or 2, and p+q≥1;

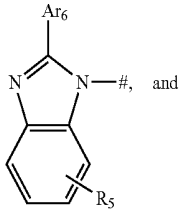
R_1, R_2, and R_3 each independently represent a single bond, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, or substituted or unsubstituted C6-C40 heteroaryl;

Ar_1 and Ar_2 each independently represent one of the following structures shown by chemical formula II, chemical formula III, and chemical formula IV:

chemical formula II



chemical formula III



and

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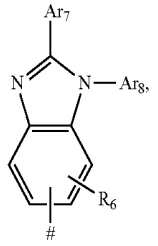
chemical formula IV



wherein # represents a bonding position in the chemical formula I;

Ar_5, Ar_6 and Ar_7 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl; and

R_4, R_5, and R_6 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl.

2. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, m=n=0, p>0, q>0, and z>0.

3. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, q=z=0.

4. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, m>0, and n=0; or, n>0, and m=0.

5. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, p>0, q>0, and m=n=z=0.

6. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, p>0, and m=n=q=z=0.

7. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, m=n.

8. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, p>0, q>0, and

X_1 and X_8 represent a same atom, X_2 and X_7 represent a same atom, X_3 and X_6 represent a same atom, and X_4 and X_5 represent a same atom.

9. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, R_1 and R_2 represent a same substituent.

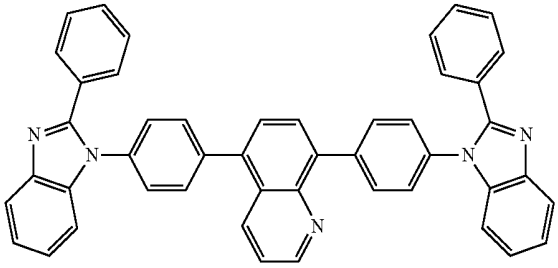
10. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, Ar_1 and Ar_2 represent a same substituent.

11. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, only one of X_1-X_4 represents a nitrogen atom, and/or only one of X_5-X_8 represents a nitrogen atom.

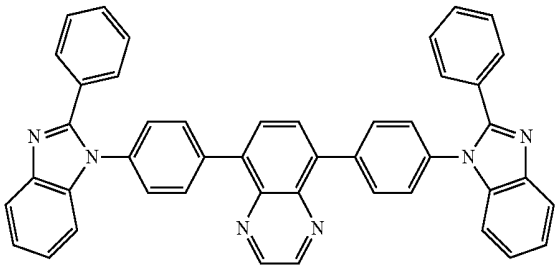
12. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein in the chemical formula I, at least two of X_1-X_4 represent a nitrogen atom, and/or, at least two of X_5-X_8 represent a nitrogen atom.

13. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein the nitrogen heterocycle-fused benzene-benzimidazole organic compound is one of the following compounds:

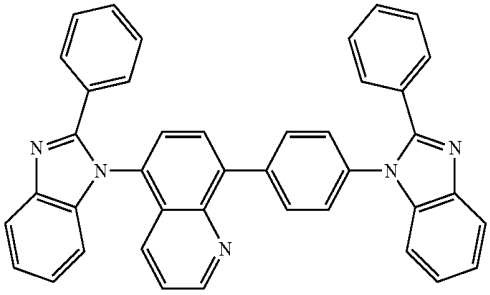
CP1



CP2



CP3



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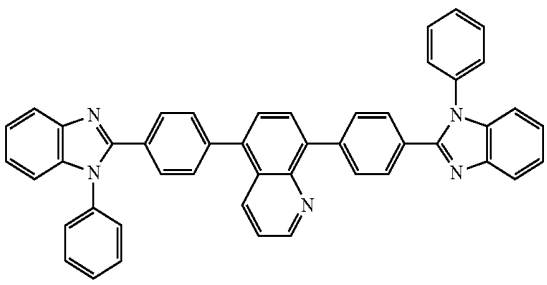

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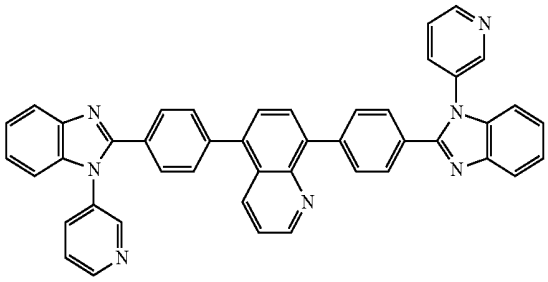

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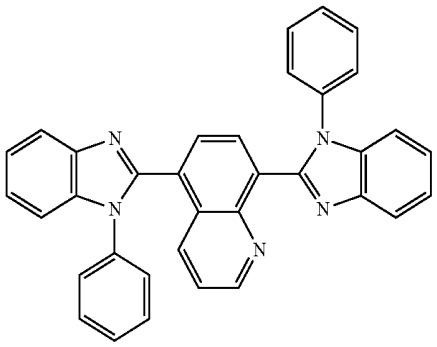

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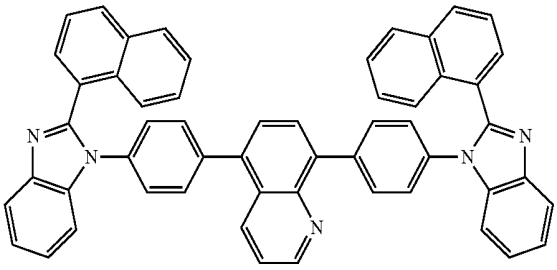

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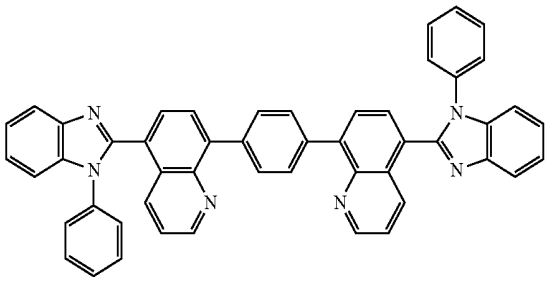

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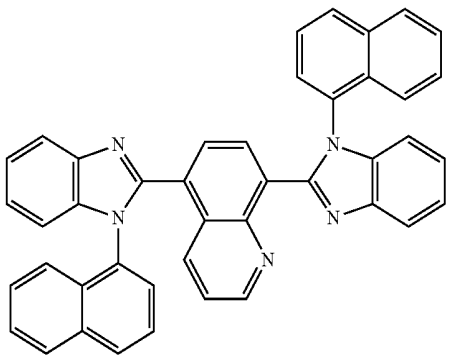

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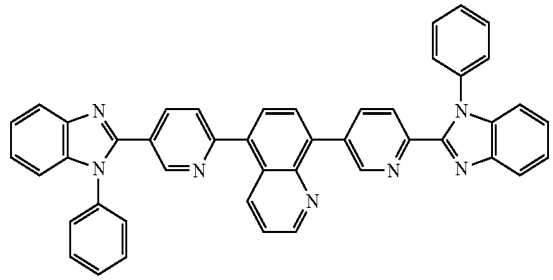

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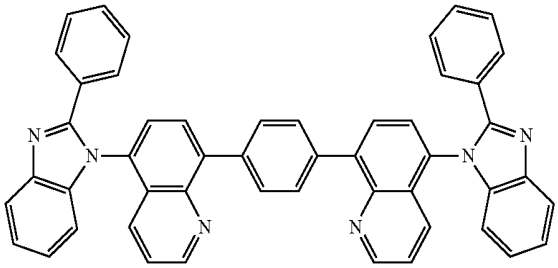

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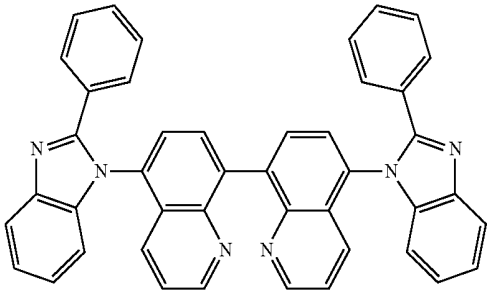

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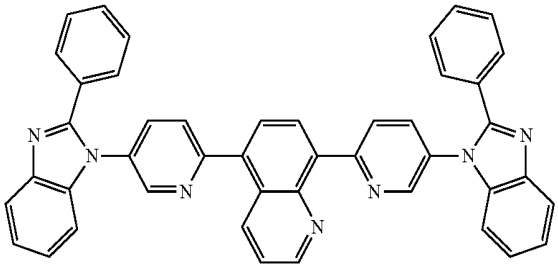

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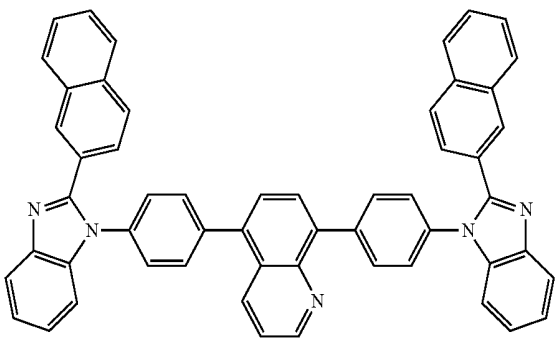

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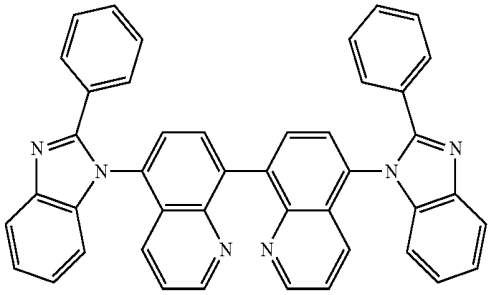

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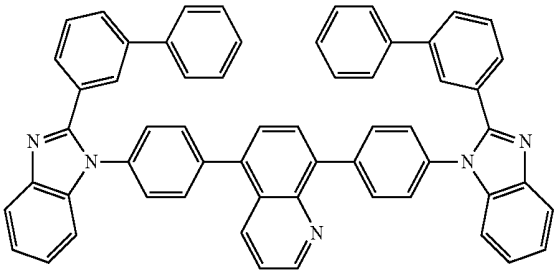

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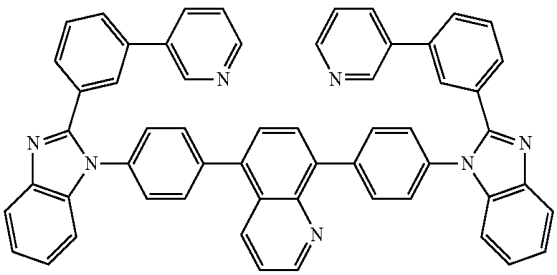

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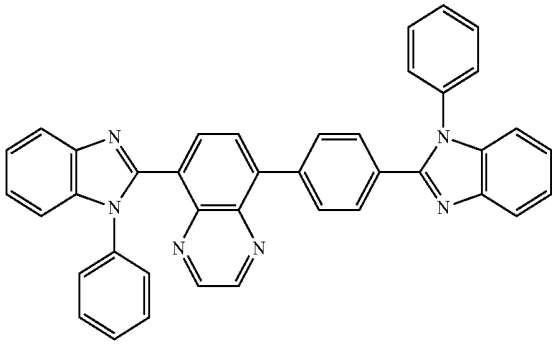

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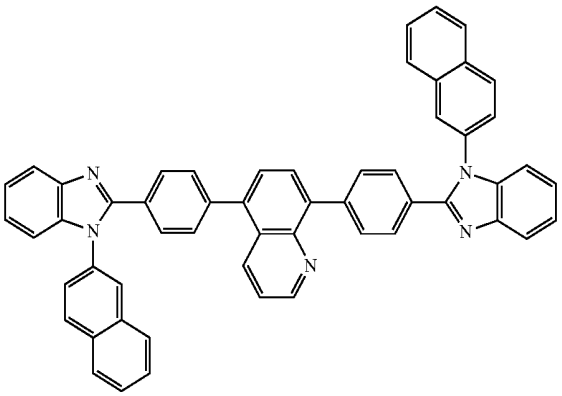

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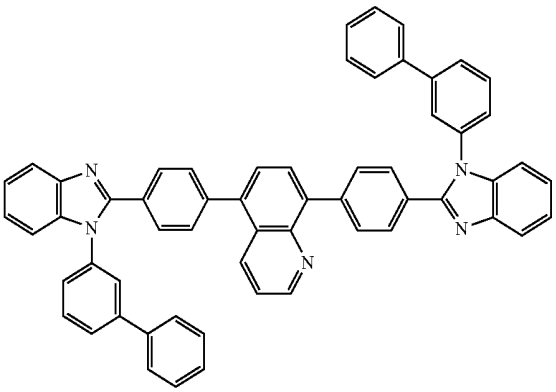

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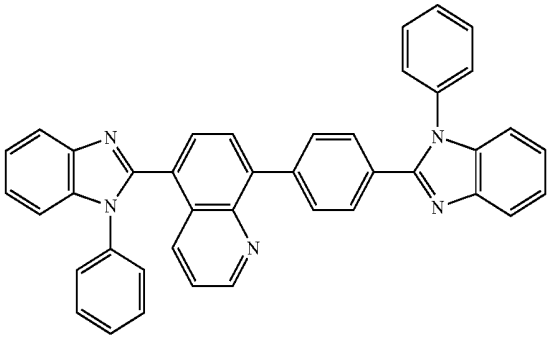

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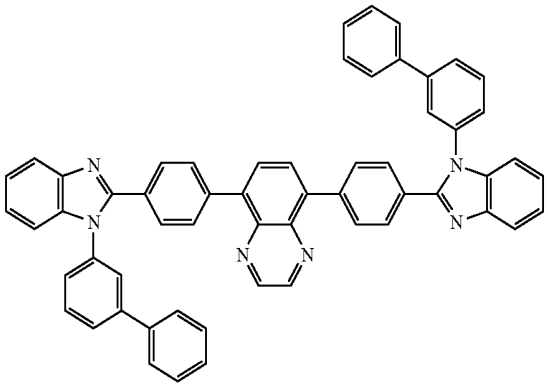

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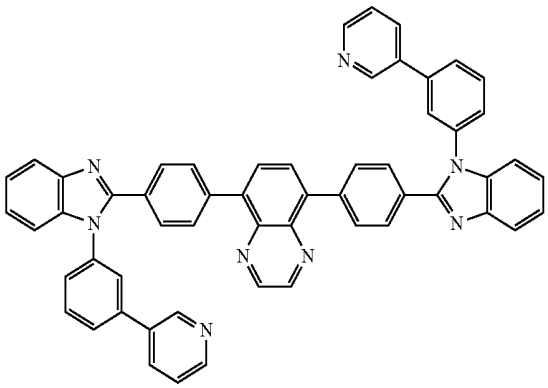

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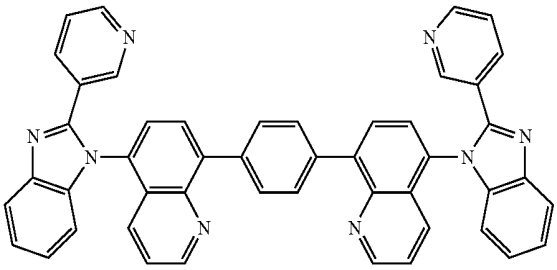

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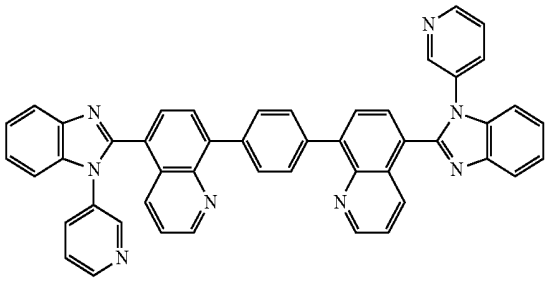

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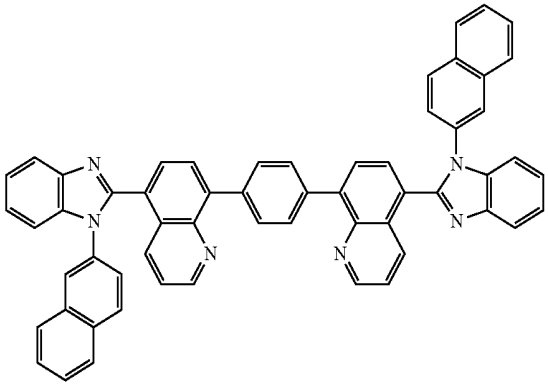

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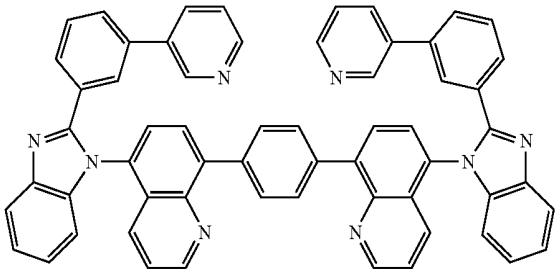

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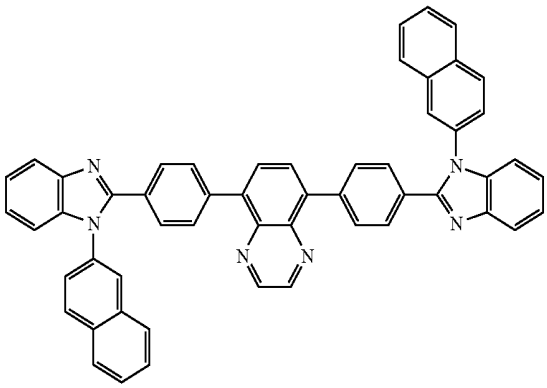

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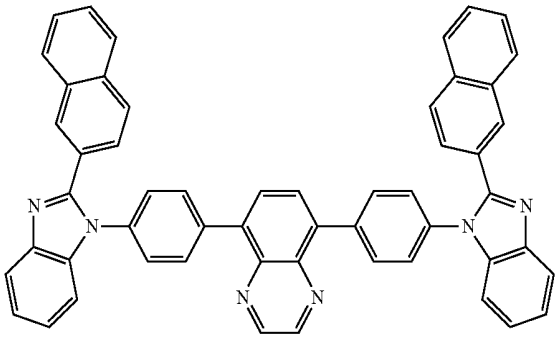

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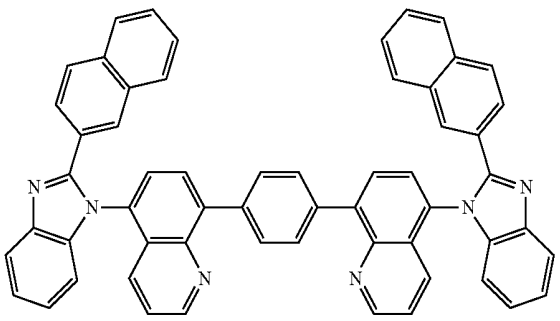

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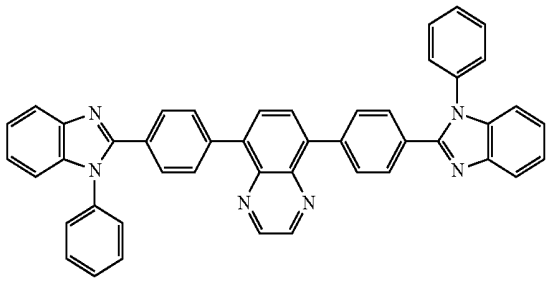

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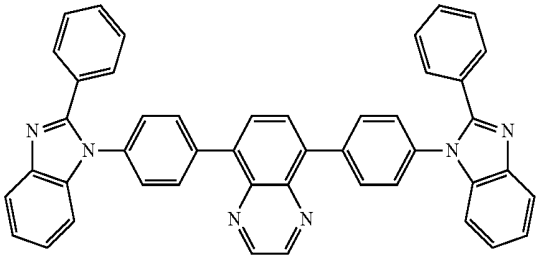

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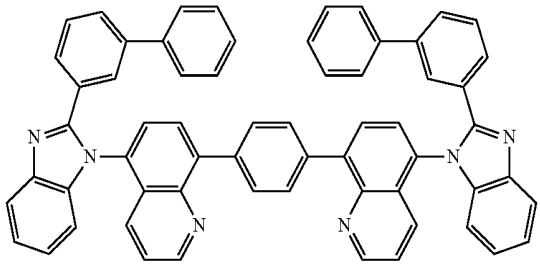


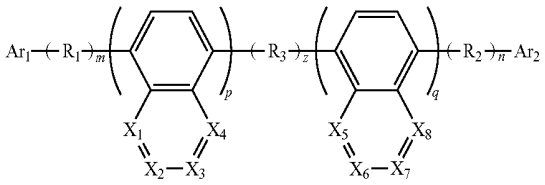
14. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein, for visible light having a wavelength between 400 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has a refractive index n greater than or equal to 2.0.

15. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein, for visible light having a wavelength between 430 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has an extinction coefficient k less than or equal to 0.0.

16. The nitrogen heterocycle-fused benzene-benzimidazole organic compound according to claim **1**, wherein, for visible light having a wavelength between 400 nm and 700 nm, the nitrogen heterocycle-fused benzene-benzimidazole organic compound has a transmittance greater than 65%.

17. A display panel, comprising an organic light-emitting device, wherein the organic light-emitting device comprises an anode, a cathode arranged opposite to the anode, a capping layer located at a side of the cathode facing away from the anode, and an organic layer located between the anode and the cathode, wherein the organic layer comprises a hole transmission layer, an electron transmission layer, and a light-emitting layer, at least one of the capping layer, the hole transmission layer, the electron transmission layer, and the light-emitting layer is made of a nitrogen heterocycle-fused benzene-benzimidazole organic compound, having a chemical structure represented by chemical formula I:

chemical formula I

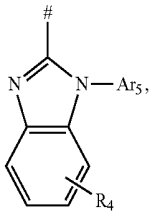


wherein each of X_1-X_8 independently represents a nitrogen atom or a carbon atom, and at least one of X_1-X_4 is a nitrogen atom, and at least one of X_5-X_8 is a nitrogen atom; m, n, p, q, and z each independently represent a number of 0, 1, or 2, and p+q≥1;

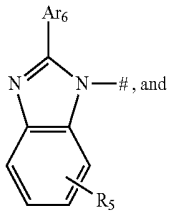
R_1, R_2, and R_3 each independently represent a single bond, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, or substituted or unsubstituted C6-C40 heteroaryl;

Ar_1 and Ar_2 each independently represent one of the following structures shown by chemical formula II, chemical formula III, and chemical formula IV:

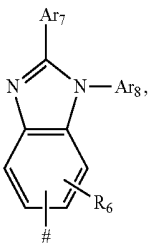
chemical formula II



chemical formula III



chemical formula IV



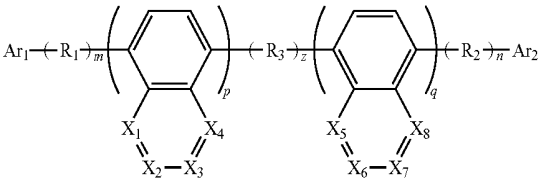
wherein # represents a bonding position in the chemical formula I;

Ar_5, Ar_6 and Ar_7 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl; and

R_4, R_5, and R_6 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl.

18. A display apparatus comprising a display panel, wherein the display panel comprises an organic light-emitting device, wherein the organic light-emitting device comprises an anode, a cathode arranged opposite to the anode, a capping layer located at a side of the cathode facing away from the anode, and an organic layer located between the anode and the cathode, wherein the organic layer comprises a hole transmission layer, an electron transmission layer, and a light-emitting layer, at least one of the capping layer, the hole transmission layer, the electron transmission layer, and the light-emitting layer is made of a nitrogen heterocycle-fused benzene-benzimidazole organic compound, having a chemical structure represented by chemical formula I:

chemical formula I

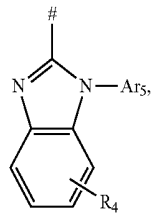


wherein each of X_1-X_8 independently represents a nitrogen atom or a carbon atom, and at least one of X_1-X_4 is a nitrogen atom, and at least one of X_5-X_8 is a nitrogen atom; m, n, p, q, and z each independently represent a number of 0, 1, or 2, and p+q≥1;

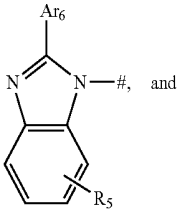
R_1, R_2, and R_3 each independently represent a single bond, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, or substituted or unsubstituted C6-C40 heteroaryl;

Ar_1 and Ar_2 each independently represent one of the following structures shown by chemical formula II, chemical formula III, and chemical formula IV:

chemical formula II



chemical formula III



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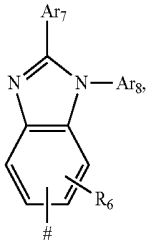
chemical formula IV



wherein # represents a bonding position in the chemical formula I;

Ar_5, Ar_6 and Ar_7 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl; and

R_4, R_5, and R_6 each are independently selected from a group consisting of hydrogen atom, substituted or unsubstituted C1-C30 alkyl, substituted or unsubstituted silicylene, substituted or unsubstituted C1-C30 alkoxy, substituted or unsubstituted C6-C40 aryl, substituted or unsubstituted C10-C40 fused aryl, and substituted or unsubstituted C6-C40 heteroaryl.

* * * * *

专利名称(译)	氮杂环稠合苯 - 苯并咪唑有机化合物，显示板和显示装置		
公开(公告)号	US20190173021A1	公开(公告)日	2019-06-06
申请号	US16/266066	申请日	2019-02-03
[标]申请(专利权)人(译)	武汉天马微电子有限公司		
申请(专利权)人(译)	武汉天马微电子有限公司.		
当前申请(专利权)人(译)	武汉天马微电子有限公司.		
[标]发明人	ZHANG LEI GAO WEI ZHU QING NIU JINGHUA LIU YING AN PING		
发明人	ZHANG, LEI GAO, WEI ZHU, QING NIU, JINGHUA LIU, YING AN, PING		
IPC分类号	H01L51/00 C07D401/14 C07D403/14 C09K11/06		
CPC分类号	H01L51/0072 C07D401/14 C07D403/14 C09K11/06 C09K2211/1018 H01L51/5012 H01L51/5056 H01L51/5088 H01L51/5072 H01L51/5092		
优先权	201811099985.2 2018-09-20 CN		
外部链接	Espacenet USPTO		

摘要(译)

本发明涉及有机电致发光材料领域，具体涉及一种新型氮杂环稠合苯 - 苯并咪唑有机化合物，显示面板和显示装置。氮杂环稠合的苯 - 苯并咪唑有机化合物具有由下式表示的结构。根据本发明的化合物可以应用于有机发光器件的覆盖层，空穴传输层，电子传输层和发光层，其可以提高顶部的光提取效率和发光效率。 - 发射型有机光电器件（尤其对蓝光像素最有效），可以减轻OLED器件发光的角度依赖性（对红/绿光像素最有效），同时有效阻挡外部环境中的水和氧气，保护OLED显示面板免受水和氧气的侵蚀。