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(54) ORGANIC ELECTROLUMINESCENCE DEVICE HAVING RGB PIXEL AREAS

(57) An organic electroluminescence device having RGB pixel areas, wherein optical compensation layers (10, 11) are respectively arranged between the red light emitting layer (4) and the first organic functional layer (12) as well as between the green light emitting layer (5) and the first organic functional layer (12), the optical compensation layers (10, 11) are made of a first hole transport material and a second hole transport material, the first hole transport material has a triplet-state energy level ≥ 2.48eV and a HOMO energy level ≤ -5.5eV, the second hole transport material has a HOMO energy level > -5.5eV, and the difference between the HOMO energy level of the first hole transport material and the HOMO energy level of the second hole transport material is ≤ 0.2eV. Its preparation process is simple, and it can significantly reduce power consumption of the light-emitting device so as to increase light-emitting efficiency.

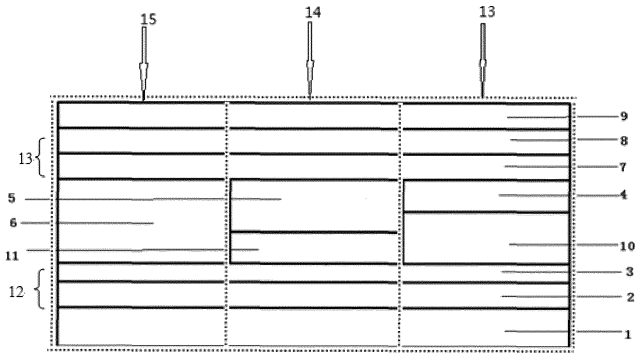

FIG. 3

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Description

Technical Field

[0001] The present invention pertains to the technical field of organic electroluminescence devices, and in particular relates to an organic electroluminescence device having optical compensation layers.

Background

[0002] The light-emitting layer of an organic electroluminescence device OLED is mainly made of fluorescent material, or phosphorescent material, or mixed fluorescent and phosphorescent material. The LED display unit consists of three kinds of red, green, blue pixels, and when a top-emitting OLED device structure is used, because the three kinds of pixels have different light-emitting wavelengths, the thicknesses of the light-emitting layers would have certain differences. Usually, an optical compensation layer is utilized to modify the thickness of a light-emitting layer, the thickness of the optical compensation layer can be over 100nm, so the optical compensation layer needs to have very good electrical charge transfer rate, in order to ensure that the device has the characteristics of low voltage and high efficiency.

[0003] The material used to make the existing optical compensation layer has a high triplet-state energy level, but often has low charge transfer rate and thus cannot be made to be thick enough, therefore, as an optical compensation layer, it has a high drive voltage. In another aspect, material with a high charge transfer rate often has a low triplet-state energy level, which adversely affects the efficiency of green-light devices. Currently, the optical compensation layer is arranged between HIL and HTL, and is made of material with a high hole transfer rate (1.5-2 times of the transfer rate of NPB), although such arrangement alleviates the thickness increase of the organic layer to a certain extent and does not adversely affect the drive voltage of the organic light-emitting device, it does not take the special electric characteristic requirements of different light-emitting material into consideration, and cannot effectively increase the efficiency of the organic light-emitting device and reduce the power consumption of the display device.

[0004] The patent literature CN201210395191.7 of Samsung discloses an electroluminescence device, as shown in FIG. 1, it sequentially comprises a substrate 110, a first electrode 120, a hole injection layer 130, a hole transport layer 140, a buffer layer 150, a light-emitting layer 160, an electron transport layer 170, an electron injection layer 180 and a second electrode 190. The hole transport layer 140 consists of sequentially deposited layers of a first charge generation layer 141, a first mixed layer 142, a second charge generation layer 143 and a second mixed layer 144. The first charge generation layer 141 can be made of a mixture that contains a first compound and a second compound and is doped with a first charge generation material; the first mixed layer 142 can be made of a mixture that contains the first compound and the second compound; the second charge generation layer 143 can be made of a mixture that contains a third compound and a fourth compound and is doped with a second charge generation material; the second mixed layer 144 can be made of a mixture that contains the third compound and the fourth compound, in this aspect, the third compound and the fourth compound has a weigh ratio of 6:4 to 8:2. In this patent, the charge generation layer cannot provide an effective function for blocking excitons, so the buffer layer is required.

[0005] The patent literature CN200510077967.0 discloses an electroluminescence device, as shown in FIG. 2, a second hole transport layer 18-2 is arranged upon a first hole transport layer 18-1 in a green-light pixel area 200; the second hole transport layer 18-2 and a third hole transport layer 18-3 are arranged upon the first hole transport layer 18-1 in a red-light pixel area 300. The first hole transport layer 18-1, the second hole transport layer 18-2 and the third hole transport layer 18-3 can be made of different materials, but these hole transport layers are made of the same material. Although this patent discloses utilization of hole transport layers with a mixed structure to increase light-emitting efficiency and such arrangement alleviates the thickness of the light-emitting layer to a certain extent, the HTL material suitable to make the green-light optical compensation layer is still required to have a high triplet-state energy level T1 with its HOMO energy level $\leq$ -5.5eV, and this kind of material often has a low charge transfer rate and thus cannot be made to be thick enough, therefore, this device has a high drive voltage.

Summary of the Invention

[0006] Accordingly, one objective of the present invention is to solve the technical problem that the red-light and green-light optical compensation layers in prior art are made of materials with a low charge transfer rate or a poor exciton blocking effect, by providing an organic electroluminescence device that has an optical compensation layer made of two hole transport materials with different energy gaps, which can significantly reduce power consumption of the light-emitting device, so as to increase light-emitting efficiency.

[0007] The present invention also provides a preparation method of the above-mentioned organic electroluminescence device.

[0008] In order to solve the above-mentioned technical problem, the present invention adopts the following technical

scheme:

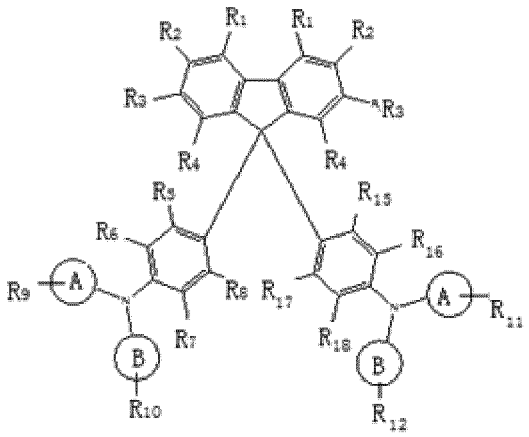
An organic electroluminescence device having RGB pixel areas comprises a substrate, with a first electrode layer, a plurality of organic layers and a second electrode layer formed in sequence on the substrate, wherein, the organic layers include a first organic functional layer, a light emitting layer and a second organic functional layer arranged upon the first electrode layer, the light emitting layer comprises a red light emitting layer, a green light emitting layer and a blue light emitting layer, wherein, optical compensation layers are respectively arranged between the red light emitting layer and the first organic functional layer as well as between the green light emitting layer and the first organic functional layer, the optical compensation layers are made of a first hole transport material and a second hole transport material, the first hole transport material has a triplet-state energy level ≥ 2.48eV and a HOMO energy level ≤ -5.5eV, the second hole transport material has a HOMO energy level > -5.5eV, and the difference between the HOMO energy level of the first hole transport material and the HOMO energy level of the second hole transport material is ≤ 0.2eV.

[0009] The optical compensation layers include a red light optical compensation layer arranged between the red light emitting layer and the first organic functional layer, and a green light optical compensation layer arranged between the green light emitting layer and the first organic functional layer.

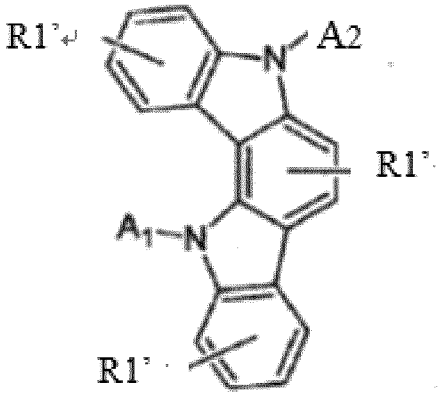
[0010] The first hole transport material and second hole transport material contained in the red light optical compensation layer has a mass ratio of 1:99 to 99:1.

[0011] The first hole transport material and second hole transport material contained in the green light optical compensation layer has a mass ratio of 5:95 to 50:50, preferably 10:90 to 30:70.

[0012] The first hole transport material has a structure defined by the following structural formula (1) or structural formula (2):



structural formula (1)

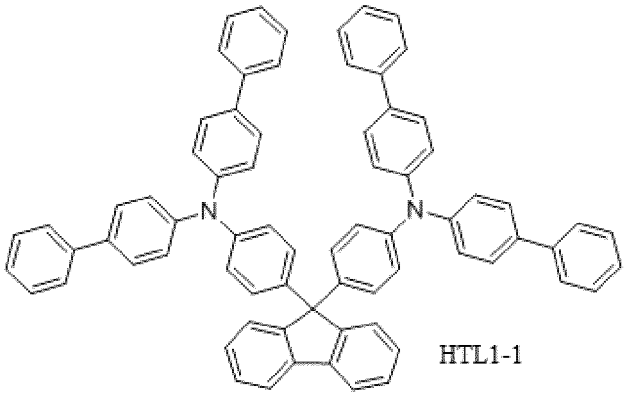


structural formula (2)

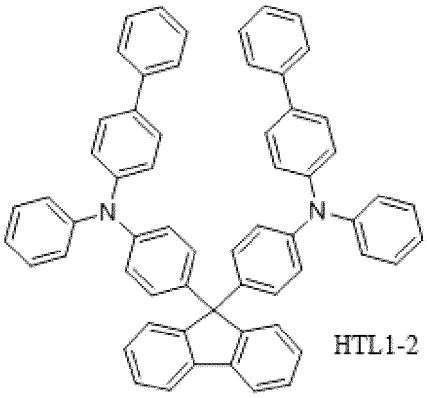
in the structural formula (1), the groups A and B are individually selected from phenyl group, naphthyl group or phenyl-

amino group;
the groups of R_1, R_2, R_3, R_4, R5, R_6, R_7, R_8, R_{15}, R_{16}, R_{17} and R_{18} are identical or different, and are individually selected from hydrogen element, halogen element, CN, NO_2, amino group, C_6-C_{30} fused cyclic aryl group, C_6-C_{30} fused heterocyclic aryl group, C_6-C_{20} alkyl group or C_6-C_{30} alcohol group;
the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group;
in the structural formula (2), the groups of A1 and A2 are individually selected from C_6-C_{30} aryl group or C_6-C_{30} heterocyclic aryl group, the group R1' is selected from hydrogen, alkyl group, alkoxyl group or basic group;
and the structural formula (2) also meets the following condition: at least one of the groups of A1 and A2 has a condensed ring structure.

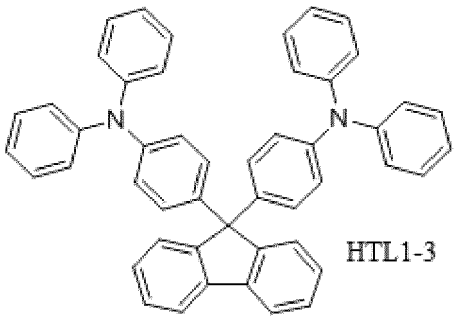
[0013] The first hole transport material has a structure selected from the following structural formulas (HTL1-1) to (HTL21-10):



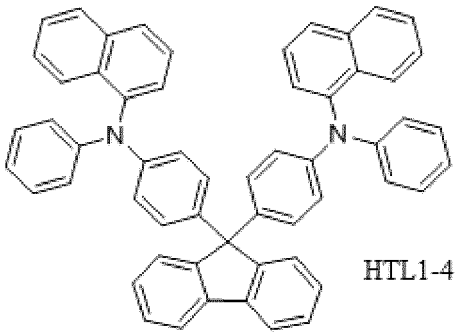
HTL1-1



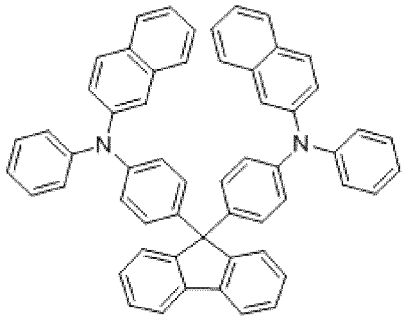
HTL1-2



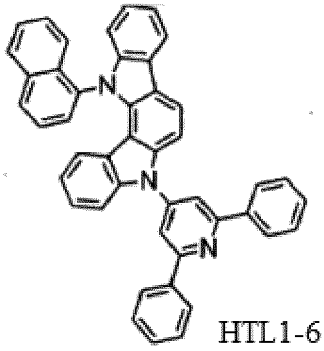
HTL1-3



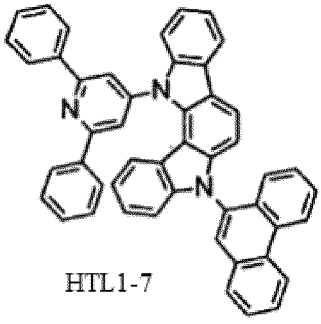
HTL1-4



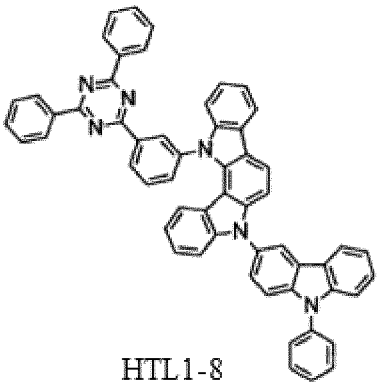
HTL1-5



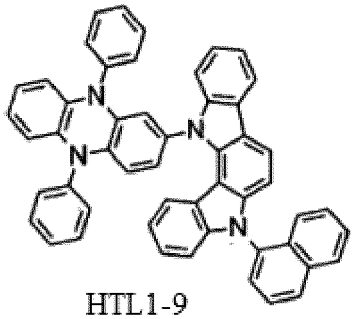
HTL1-6



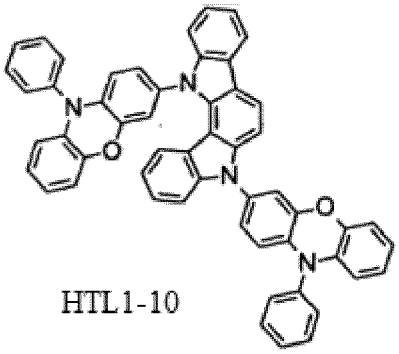
HTL1-7



HTL1-8

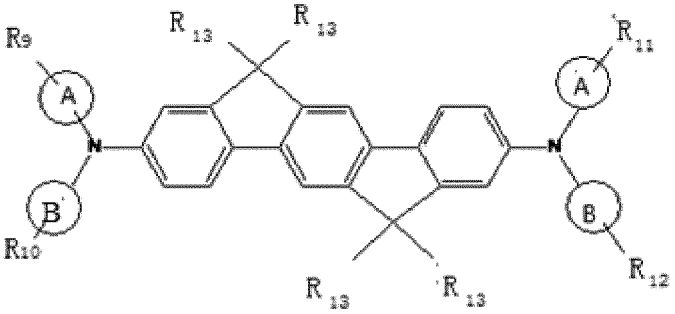


HTL1-9

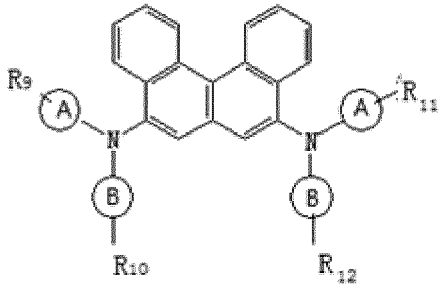


HTL1-10

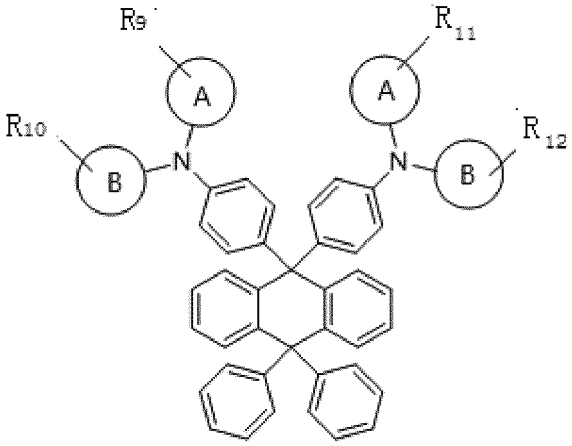
[0014] The second hole transport material has an indenofluorene structure defined by the following structural formula (3), structural formula (4), structural formula (5) or structural formula (6):



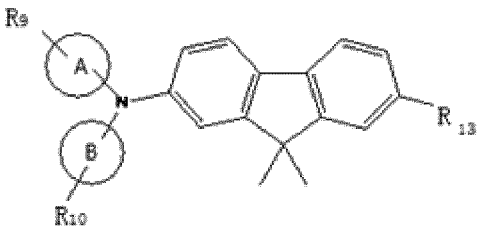
structural formula (3)



structural formula (4)



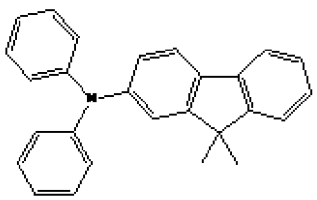
structural formula (5)



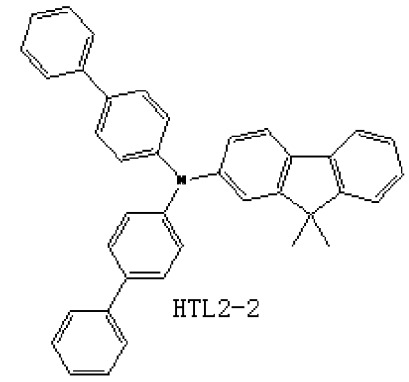
structural formula (6)

wherein, the groups of A and B are individually selected from phenyl group, naphthyl group or phenyl-amino group; the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group; the group of R_{13} is selected from C_1-C_6 alkyl group or hydroxyl group, preferably, the group R_{13} is methyl group, ethyl group, propyl group, isopropyl group, butyl group, isobutyl group, n-amyl group or n-hexyl group.

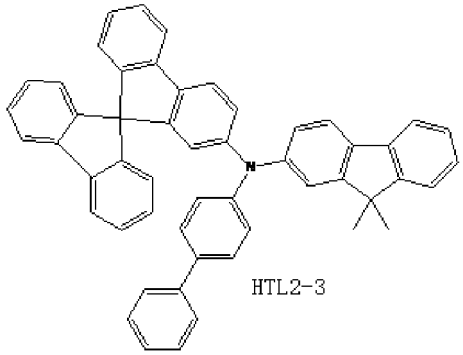
[0015] The second hole transport material has a structure selected from the following structural formulas (HTL2-1) to (HTL2-18):



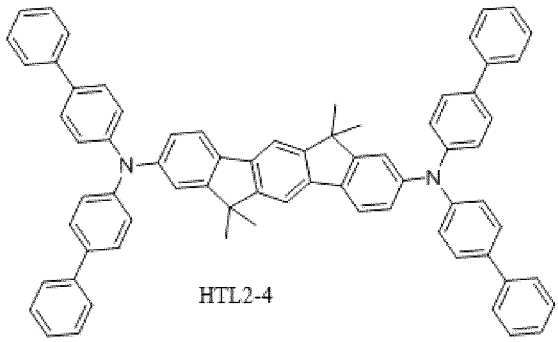
HTL2-1



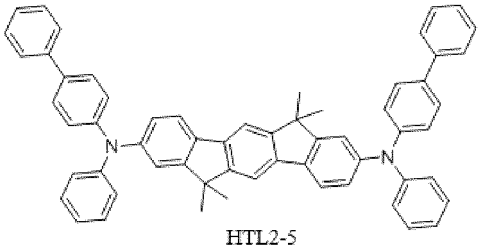
HTL2-2



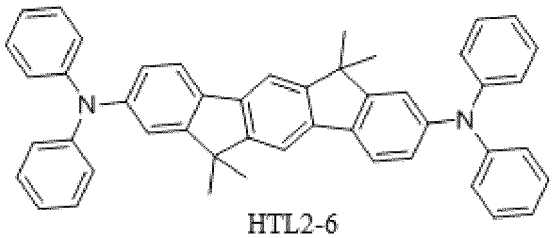
HTL2-3



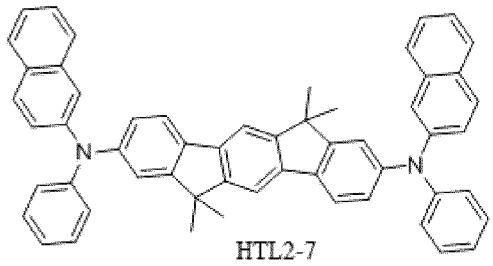
HTL2-4



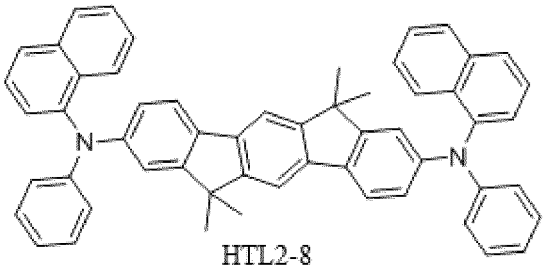
HTL2-5



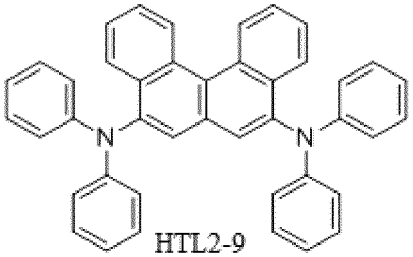
HTL2-6



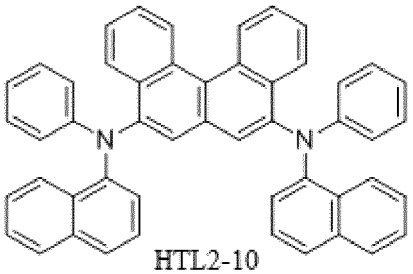
HTL2-7



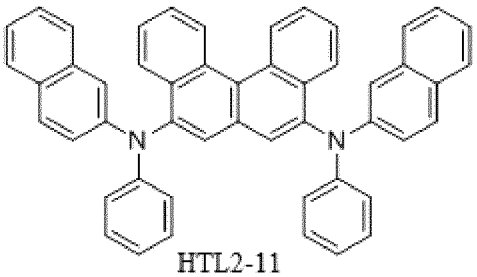
HTL2-8



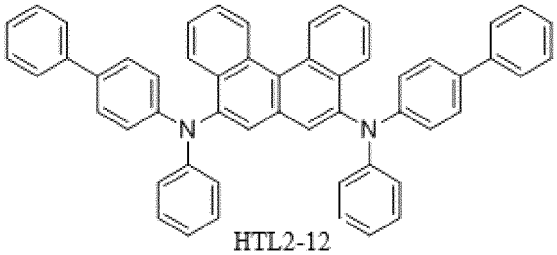
HTL2-9



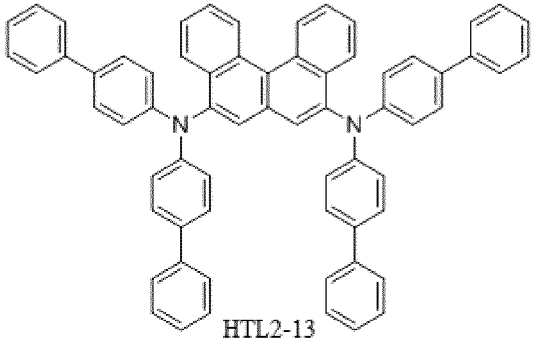
HTL2-10



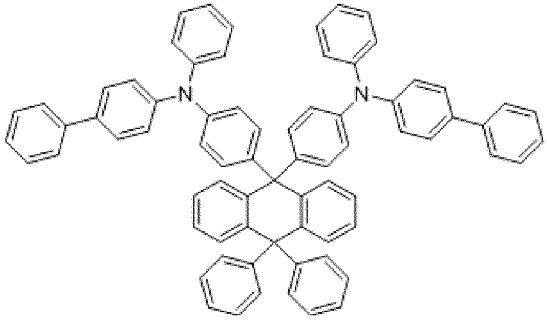
HTL2-11



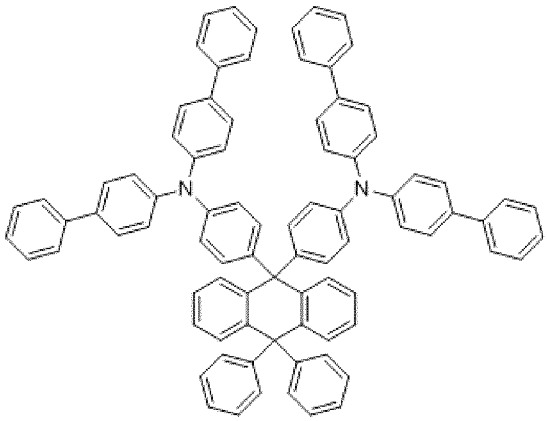
HTL2-12



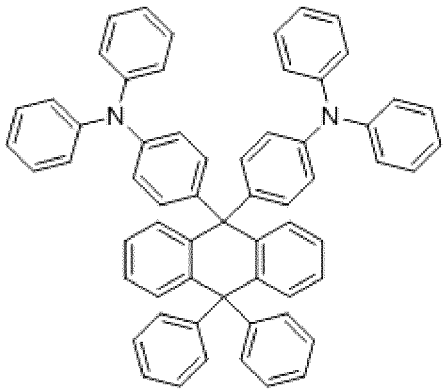
HTL2-13



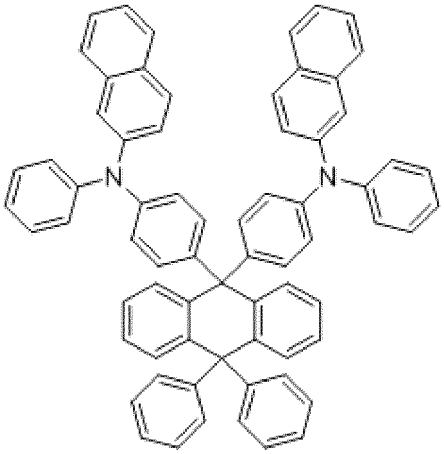
HTL2-14



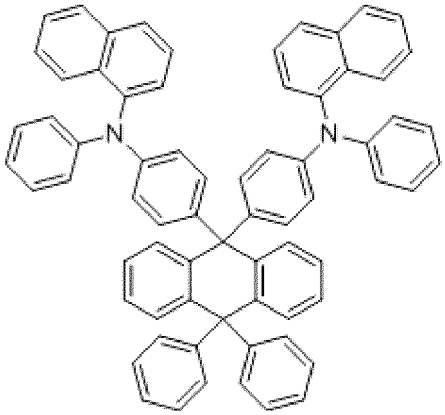
HTL2-15



HTL2-16



HTL2-17



HTL2-18

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[0016] As compared to prior art, the above-mentioned technical scheme of the present invention has the following advantages:

In the organic electroluminescence display device of the present invention, optical compensation layers are arranged between the light-emitting layer and the hole transport layer, and in the evaporation coating process of the optical compensation layers with such structure, the red-light optical compensation layer and the red light emitting layer can be prepared by using the same group of mask, the green-light optical compensation layer and the green light emitting layer can be prepared by using the same group of mask, which can avoid repeated aligning operations of the masks and thus increase the process precision to a certain extent. This is because every aligning operation of

the masks always has certain error, therefore, with less times of aligning operations, the error is less and the overall yield is higher.

[0017] Furthermore, the inventors of the present invention carry out creative research and daringly utilize a combination of a material having a high triplet-state energy level and a material having a high charge transfer rate to make the optical compensation layer of the present invention, and set the HOMO energy level difference between the two materials to be $\leq$ 0.2eV, so that the optical compensation layer can be made to have different thicknesses according to requirements, and neither the light-emitting efficiency nor the drive voltage of the device is adversely affected. If the HOMO energy level difference between the two materials is too large, the first hole transport material cannot have an effect of blocking the green-light excitons.

Brief Description of the Drawings

[0018] In order to make the content of the present invention more easy to be understood clearly, hereinafter, detailed description of the present invention is further provided according to specific embodiments of the present invention with reference to the appended drawings, wherein,

FIG. 1 is a structural schematic diagram of a light-emitting device in prior art;
FIG. 2 is a structural schematic diagram of another light-emitting device in prior art;
FIG. 3 is a structural schematic diagram of a light-emitting device of the present invention.

[0019] Wherein, 1-first electrode layer, 2-hole injection layer, 3-hole transport layer, 4-red light emitting layer, 5-green light emitting layer, 6-blue light emitting layer, 7-electron transport layer, 8-second electrode layer, 9-optical coupling layer, 10-red light optical compensation layer, 11-green light optical compensation layer, 12-first organic functional layer, 13-second organic functional layer.

Detailed Description of Embodiments

[0020] In order to make the objective, technical scheme and advantages of the present invention more clear, hereinafter, detailed description of implementation ways of the present invention is given below, with reference to the appended drawings.

[0021] The present invention may be implemented in many different ways, and should not be interpreted to be limited to the embodiments described herein. On the contrary, by providing these embodiments, the present disclosure is made complete and thorough, and the inventive concept of the present invention is sufficiently conveyed to those skilled in the art, wherein the present invention is defined by the claims. In the appended drawings, for the sake of clarity, dimensions and relative sizes of layers and areas might be exaggerated. It should be understood that, when one element such as a layer, an area or a substrate plate is described as "formed on" or "configured on" another element, this one element may be configured directly upon that another element, or there may exist intermediate element(s). On the contrary, when one element is described as "directly formed upon" or "directly configured upon" another element, there exist no intermediate element.

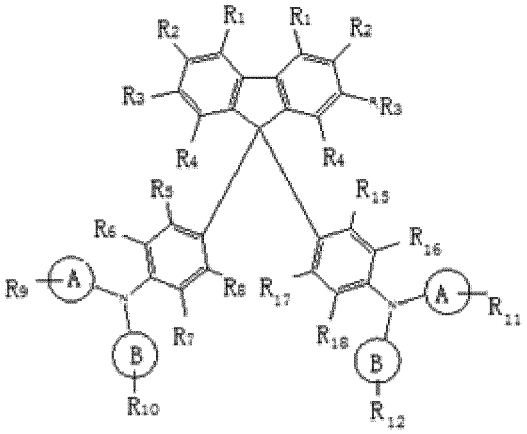
[0022] As shown in FIG. 3, it is a structural schematic diagram of an organic electroluminescence device having RGB pixel areas in accordance with the present invention.

[0023] This organic electroluminescence device having RGB pixel areas comprises a substrate (not shown in the drawing), with a first electrode layer 1 (anode layer), a plurality of organic layers, a second electrode layer 8 (cathode layer) and an optical coupling layer 9 formed in sequence on the substrate, wherein, the organic layers include a first organic functional layer 12, a light emitting layer and a second organic functional layer 13 arranged upon the first electrode layer 1, the light emitting layer comprises a red light emitting layer 4 with a thickness of H_R, a green light emitting layer 5 with a thickness of H_G and a blue light emitting layer 6 with a thickness of H_B, where $H_B > H_G > H_R$, and optical compensation layers are respectively arranged between the red light emitting layer 4 and the first organic functional layer 12 as well as between the green light emitting layer 5 and the first organic functional layer 12, the optical compensation layers are made of a first hole transport material and a second hole transport material, the first hole transport material has a triplet-state energy level $\geq$ 2.48eV and a HOMO energy level $\leq$ -5.5eV, the second hole transport material has a HOMO energy level > -5.5eV, and the difference between the HOMO energy level of the first hole transport material and the HOMO energy level of the second hole transport material is $\leq$ 0.2eV

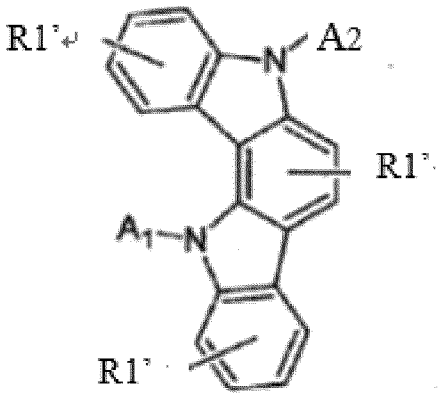
[0024] The optical compensation layers include a red light optical compensation layer 10 arranged between the red light emitting layer 4 and the first organic functional layer 12, and a green light optical compensation layer 11 arranged between the green light emitting layer 5 and the first organic functional layer 12. The first hole transport material and second hole transport material contained in the red light optical compensation layer 10 has a mass ratio of 1:99 to 99:1,

preferably 10:90 to 30:70. The first hole transport material and second hole transport material contained in the green light optical compensation layer 11 has a mass ratio of 5:95 to 50:50, preferably 10:90 to 30:70.

[0025] The first hole transport material has a structure defined by the following structural formula (1) or structural formula (2):



structural formula (1)



structural formula (2)

in the structural formula (1), the groups A and B are individually selected from phenyl group, naphthyl group or phenylamino group;

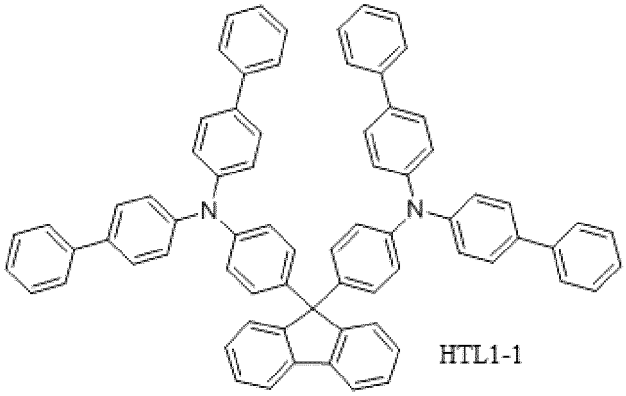
the groups of R_1, R_2, R_3, R_4, R5, R_6, R_7, R_8, R_{15}, R_{16}, R_{17} and R_{18} are identical or different, and are individually selected from hydrogen element, halogen element, CN, NO_2, amino group, C_6-C_{30} fused cyclic aryl group, C_6-C_{30} fused heterocyclic aryl group, C_6-C_{20} alkyl group or C_6-C_{30} alcohol group;

the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group;

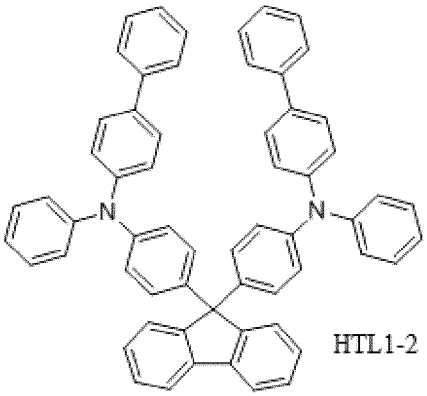
in the structural formula (2), the groups of A1 and A2 are individually selected from C_6-C_{30} aryl group or C_6-C_{30} heterocyclic aryl group, the group R1' is selected from hydrogen, alkyl group, alkoxyl group or basic group;

and the structural formula (2) also meets the following condition: at least one of the groups of A1 and A2 has a condensed ring structure.

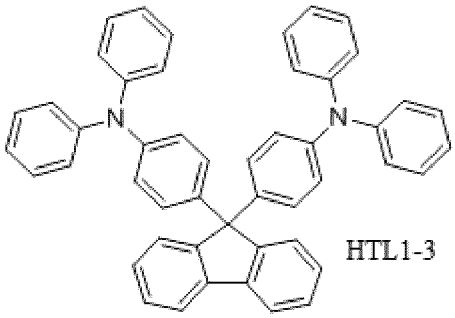
[0026] The first hole transport material has a structure selected from the following structural formulas (HTL21-1) to (HTL21-10):



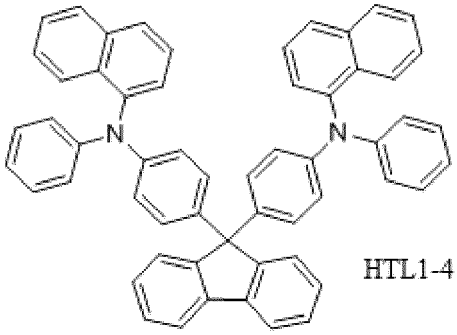
HTL1-1



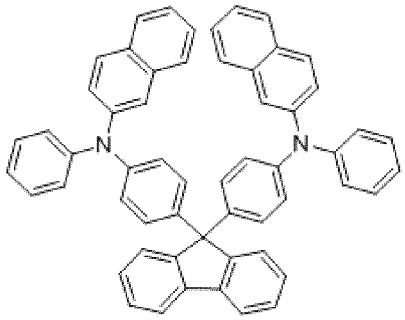
HTL1-2



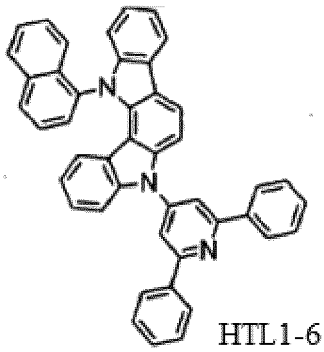
HTL1-3



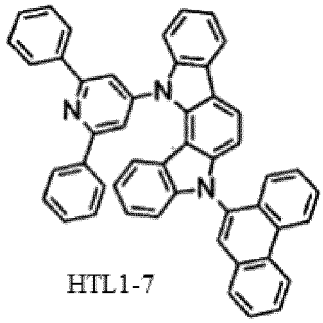
HTL1-4



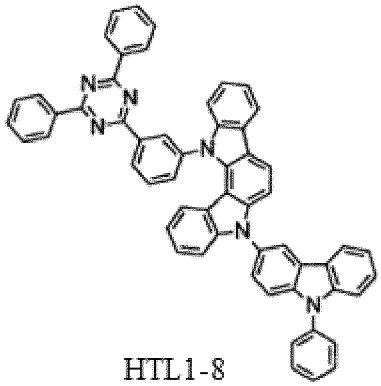
HTL1-5



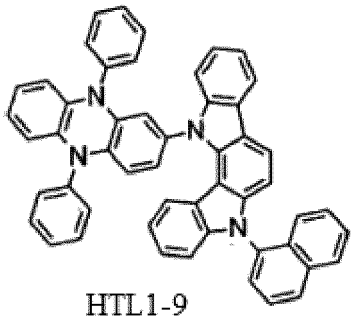
HTL1-6



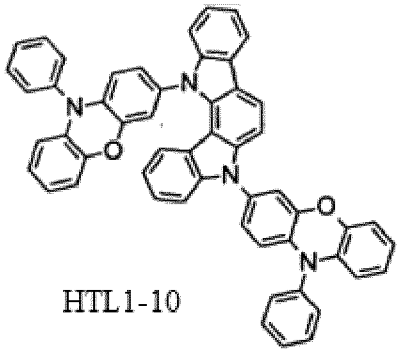
HTL1-7



HTL1-8

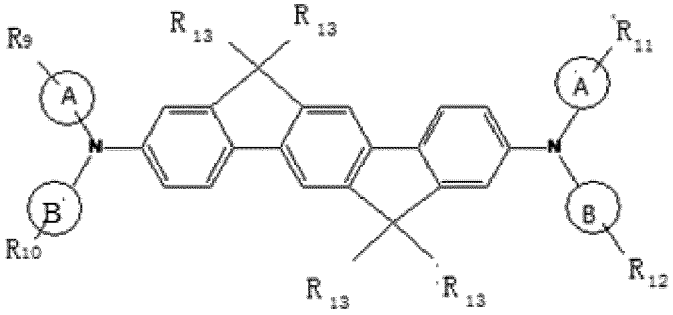


HTL1-9

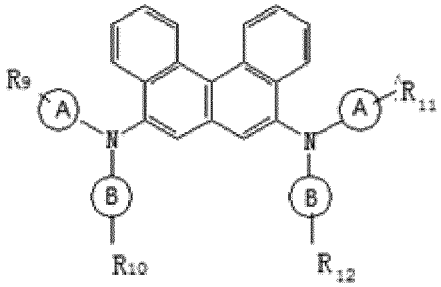


HTL1-10

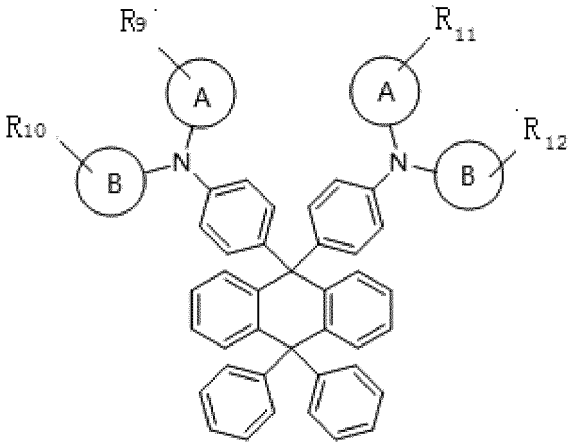
[0027] The second hole transport material has an indenofluorene structure defined by the following structural formula (3), structural formula (4), structural formula (5) or structural formula (6):



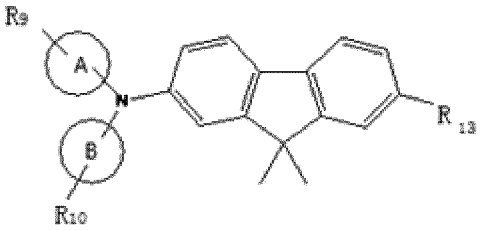
structural formula (3)



structural formula (4)



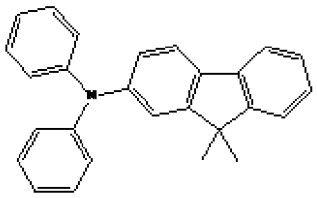
structural formula (5)



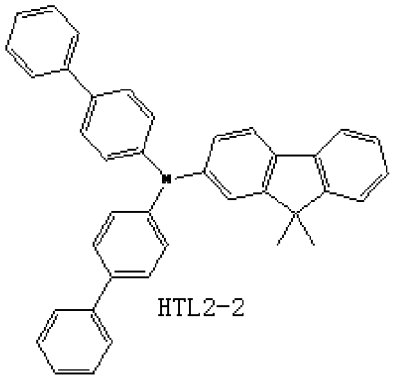
structural formula (6)

wherein, the groups of A and B are individually selected from phenyl group, naphthyl group or phenyl-amino group; the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group; the group of R_{13} is selected from C_1-C_6 alkyl group or hydroxyl group, preferably, the group R_{13} is methyl group, ethyl group, propyl group, isopropyl group, butyl group, isobutyl group, n-amyl group or n-hexyl group.

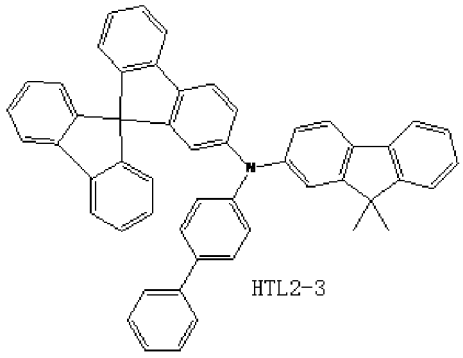
[0028] The second hole transport material has a structure selected from the following structural formulas (HTL2-1) to (HTL2-18):



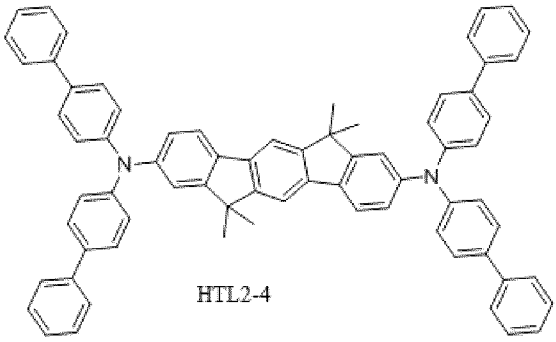
HTL2-1



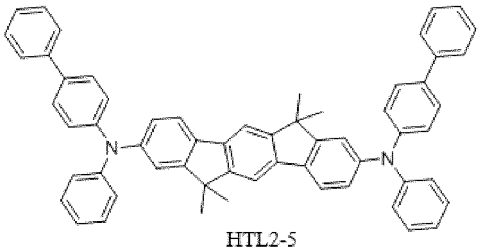
HTL2-2



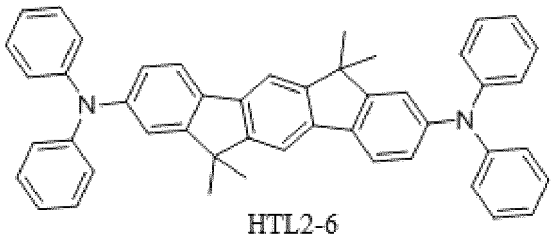
HTL2-3



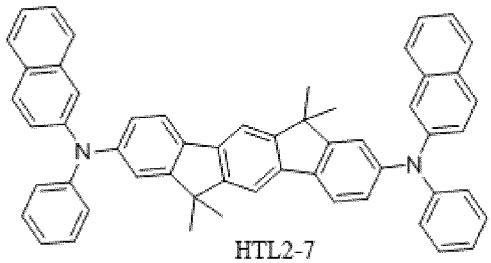
HTL2-4



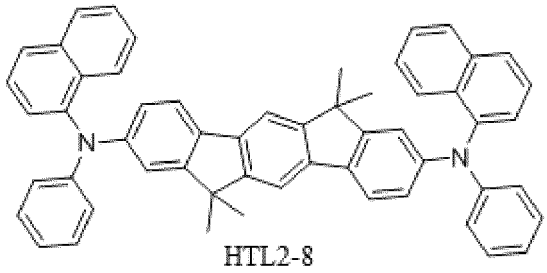
HTL2-5



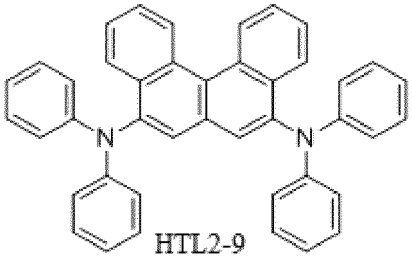
HTL2-6



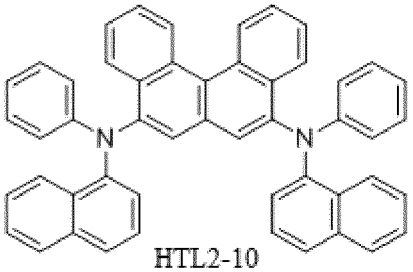
HTL2-7



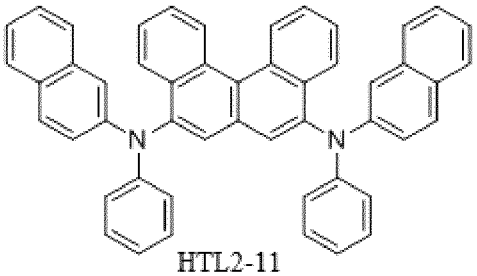
HTL2-8



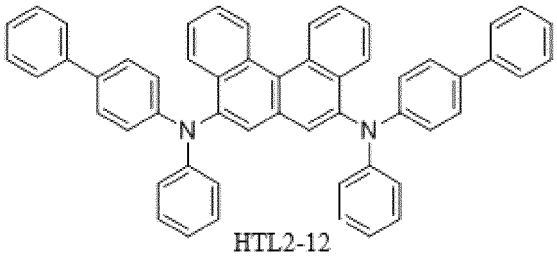
HTL2-9



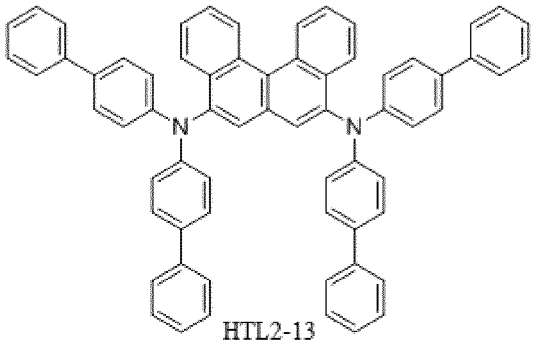
HTL2-10



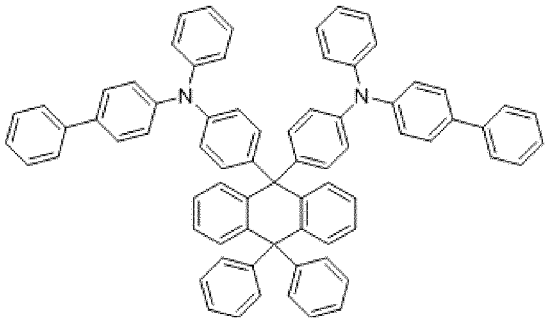
HTL2-11



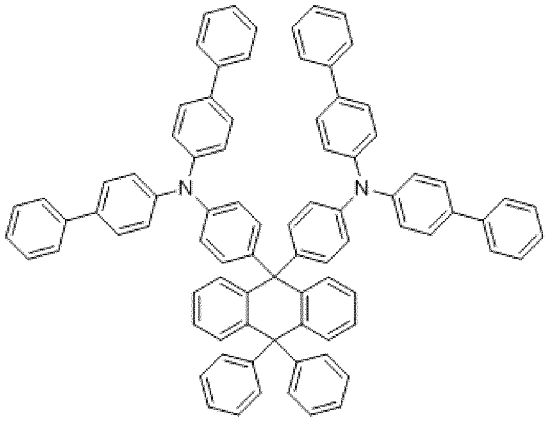
HTL2-12



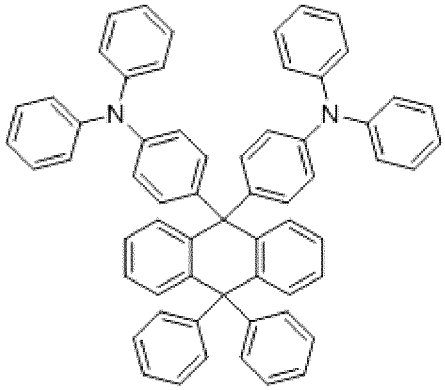
HTL2-13



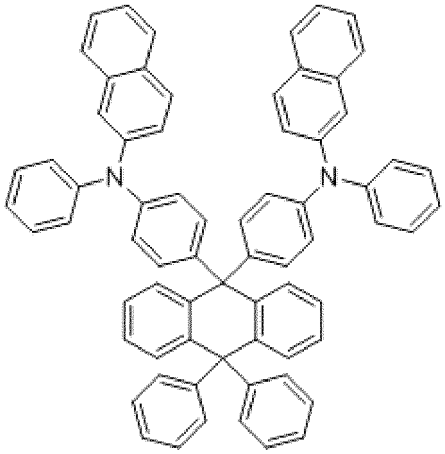
HTL2-14



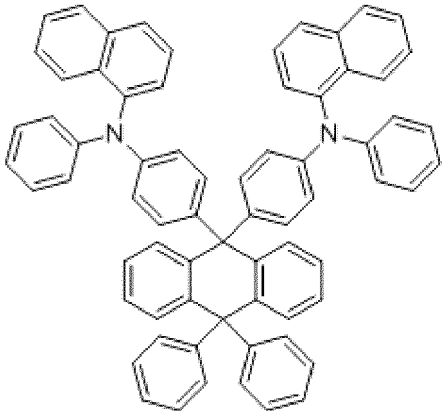
HTL2-15



HTL2-16



HTL2-17



HTL2-18

[0029] The substrate is selected from a glass substrate or a flexible substrate.

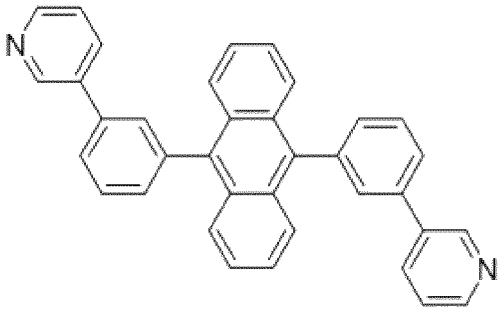
[0030] The first electrode layer 1 (anode layer) can adopt an inorganic material or an organic conducting polymer. The inorganic material is usually a metal oxide, such as indium tin oxide, zinc oxide, indium zinc oxide, or a metal with high work function, such as gold, copper, silver, preferably, it is indium tin oxide (ITO). The organic conducting polymer is preferably selected from Polythiophene / Polyethylene based sodium benzene sulfonate (hereinafter abbreviated as PEDOT:PSS) and Polyaniline (hereinafter abbreviated as PANI).

[0031] The second electrode layer 8 (cathode layer) usually adopts metal, metal compound or alloy with low work function, such as lithium, magnesium, calcium, strontium, aluminum, indium. In the present invention, the electron transport layer 7 is preferably doped with an active metal such as Li, K, Cs which is preferably prepared by evaporation coating of an alkali metal compound.

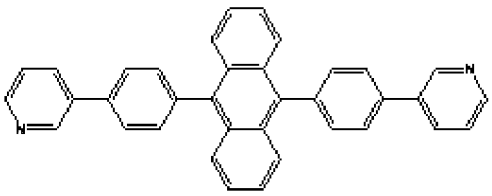
[0032] The hole injection layer 2 (HIL) has a matrix material that is preferably HAT, 4,4-(N-3-methyl-phenyl-N-phenyl-amino)-triphenylamine (m-MTDATA), 4,4TDAT, or tri-(N-2-naphthyl-N-phenyl-amino)-triphenylamine (2-TNATA).

[0033] The hole transport layer 3 (HTL) has a matrix material that may adopt a low molecular material of the arylamine type or the branched polymer species, preferably N,N-di-(1-naphthyl)-N.N-diphenyl-1,1'-biphenyl-4,4'-diamine (NPB).

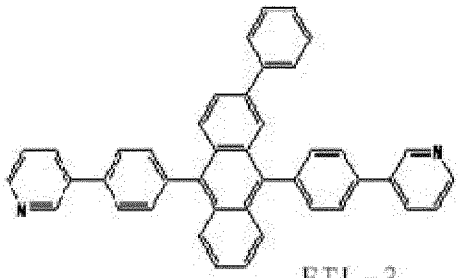
[0034] The electron transport layer 7 has a material selected from Alq_3, Bphen, BAlq or selected from the following materials:



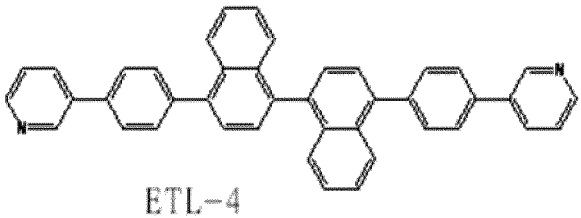
ETL-1



ETL-2

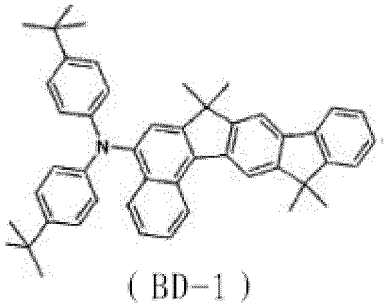


ETL-3

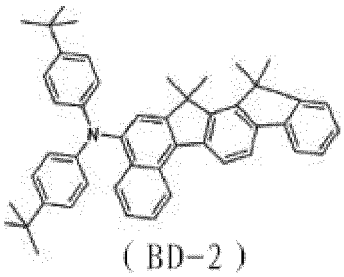


ETL-4

[0035] The blue light emitting layer 6 usually adopts a host material selected from ADN and its derivatives, together with a dye having a molecular structure selected from the following formula (BD-1) or formula (BD-2):



(BD-1)

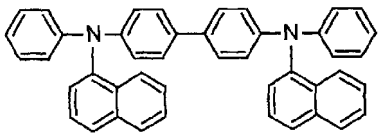
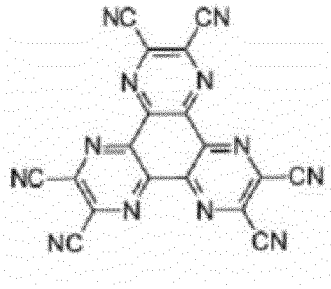
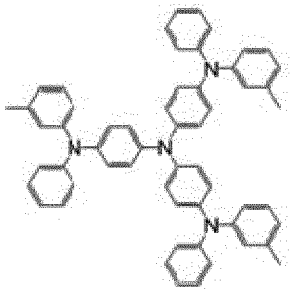
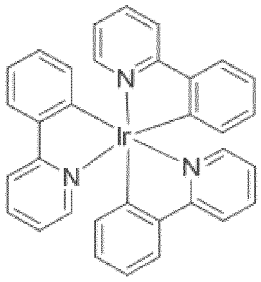


(BD-2)

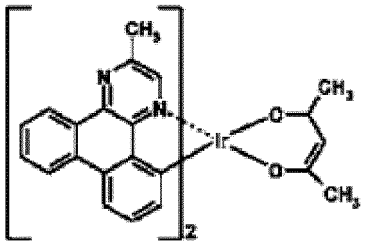
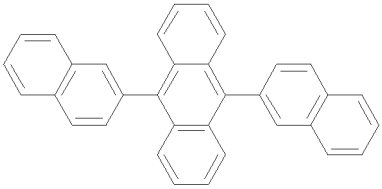
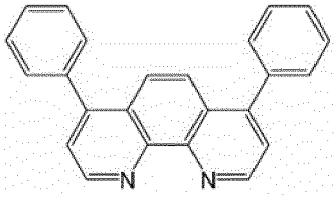
[0036] The red light emitting layer 4 usually adopts the following material: $Ir(piq)_3$, $Ir(piq)_2(acac)$, $Btp_2Ir(acac)$, $Ir(MDQ)_2(acac)$, $Ir(DBQ)_2(acac)$, $Ir(fbi)_2(acac)$, $Ir(2\text{-}phq)_3$, $Ir(2\text{-}phq)_2(acac)$, $Ir(bt)_2(acac)$, PtOEP, etc.

[0037] The green light emitting layer 5 usually adopts the following material: $Ir(ppy)_3$, $Ir(ppy)_2(acac)$, etc.

[0038] The structural formulas of the main chemical substances in the present invention are explained as follows:

Abbreviation	Structural Formula
NPB	
HAT	
MTDATA	
$Ir(ppy)_3$	

(continued)

Abbreviation	Structural Formula
$Ir(MDQ)_2(acac)$	
ADN	
BPhen	

[0039] Some embodiments are given below, for specifically explaining the technical scheme of the present invention with reference to the appended drawings. It should be noted that, the following embodiments are only intended to help understanding the present invention, not to limit the present invention.

[0040] The organic electroluminescence device of Embodiments 1-14 has the following structures, and the differences thereof are different materials used by the red light optical compensation layer 10 and the green light optical compensation layer 11.

[0041] Blue light emitting area 15 (within the leftmost dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(100nm)/NPB(20nm)/ADN(30nm):BD-1/ETL-1(35nm)/Mg:Ag (20nm)/MTDATA(50nm)

[0042] Green light emitting area 14 (within the middle dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(100nm)/NPB(20nm)/HTL1:HTL2(60nm)/CBP(30nm):Ir(ppy)3/ ETL-1 (35nm)/Mg:Ag(20nm)/MTDATA(50nm)

[0043] Red light emitting area 13 (within the rightmost dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(100nm)/NPB(20nm)/HTL1:HTL2(110nm)/CBP(30nm): Ir(mdq)2(acac)/ETL-1(35nm)/Mg:Ag(20nm)/MTDA-TA(50nm)

Embodiment 1

[0044] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-1, and the second hole transport material HTL2 has a structure as shown by formula HTL2-1; In the red light optical compensation layer 10, the first hole transport material HTL21-1 and second hole transport material HTL2-1 have a mass ratio of 50:50;
In the green light optical compensation layer 11, the first hole transport material HTL21-1 and second hole transport material HTL2-1 have a mass ratio of 50:50.

Embodiment 2

[0045] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-2, and the second hole transport material HTL2 has a structure as shown by formula HTL2-2; In the red light optical compensation layer 10, the first hole transport material HTL1-2 and second hole transport material HTL2-2 have a mass ratio of 1:99;
In the green light optical compensation layer 11, the first hole transport material HTL1-2 and second hole transport material HTL2-2 have a mass ratio of 50:50.

Embodiment 3

[0046] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-3, and the second hole transport material HTL2 has a structure as shown by formula HTL2-3; In the red light optical compensation layer 10, the first hole transport material HTL1-3 and second hole transport material HTL2-3 have a mass ratio of 99:1; In the green light optical compensation layer 11, the first hole transport material HTL2-3 and second hole transport material HTL2-3 have a mass ratio of 95:5.

Embodiment 4

[0047] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-4, and the second hole transport material HTL2 has a structure as shown by formula HTL2-18; In the red light optical compensation layer 10, the first hole transport material HTL1-4 and second hole transport material HTL2-18 have a mass ratio of 90:10; In the green light optical compensation layer 11, the first hole transport material HTL1-4 and second hole transport material HTL2-18 have a mass ratio of 5:95.

Embodiment 5

[0048] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-5, and the second hole transport material HTL2 has a structure as shown by formula HTL2-16; In the red light optical compensation layer 10, the first hole transport material HTL1-5 and second hole transport material HTL2-16 have a mass ratio of 70:30; In the green light optical compensation layer 11, the first hole transport material HTL1-5 and second hole transport material HTL2-16 have a mass ratio of 15:85.

Embodiment 6

[0049] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-6, and the second hole transport material HTL2 has a structure as shown by formula HTL2-15; In the red light optical compensation layer 10, the first hole transport material HTL1-6 and second hole transport material HTL2-15 have a mass ratio of 40:60; In the green light optical compensation layer 11, the first hole transport material HTL1-6 and second hole transport material HTL2-15 have a mass ratio of 40:60.

Embodiment 7

[0050] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-7, and the second hole transport material HTL2 has a structure as shown by formula HTL2-14; In the red light optical compensation layer 10, the first hole transport material HTL1-7 and second hole transport material HTL2-14 have a mass ratio of 50:50; In the green light optical compensation layer 11, the first hole transport material HTL1-7 and second hole transport material HTL2-14 have a mass ratio of 30:70.

Embodiment 8

[0051] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-8, and the second hole transport material HTL2 has a structure as shown by formula HTL2-13; In the red light optical compensation layer 10, the first hole transport material HTL1-8 and second hole transport material HTL2-13 have a mass ratio of 35:65; In the green light optical compensation layer 11, the first hole transport material HTL1-8 and second hole transport material HTL2-13 have a mass ratio of 25:75.

Embodiment 9

[0052] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-9, and the second hole transport material HTL2 has a structure as shown by formula HTL2-12; In the red light optical compensation layer 10, the first hole transport material HTL1-9 and second hole transport material HTL2-12 have a mass ratio of 90:10; In the green light optical compensation layer 11, the first hole transport material HTL1-9 and second hole transport material HTL2-12 have a mass ratio of 45:55.

Embodiment 10

[0053] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-10, and the second hole transport material HTL2 has a structure as shown by formula HTL2-11 or HTL2-6;
In the red light optical compensation layer 10, the first hole transport material HTL1-10 and second hole transport material HTL2-11 have a mass ratio of 45:55;
In the green light optical compensation layer 11, the first hole transport material HTL1-10 and second hole transport material HTL2-6 have a mass ratio of 10:90.

Embodiment 11

[0054] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-1, and the second hole transport material HTL2 has a structure as shown by formula HTL2-10; In the red light optical compensation layer 10, the first hole transport material HTL21-1 and second hole transport material HTL2-10 have a mass ratio of 95:5;
In the green light optical compensation layer 11, the first hole transport material HTL21-1 and second hole transport material HTL2-10 have a mass ratio of 5:95.

Embodiment 12

[0055] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-3, and the second hole transport material HTL2 has a structure as shown by formula HTL2-9 or HTL2-17;
In the red light optical compensation layer 10, the first hole transport material HTL1-3 and second hole transport material HTL2-17 have a mass ratio of 55:45;
In the green light optical compensation layer 11, the first hole transport material HTL1-3 and second hole transport material HTL2-9 have a mass ratio of 20:80.

Embodiment 13

[0056] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-5, and the second hole transport material HTL2 has a structure as shown by formula HTL2-8 or HTL2-4;
In the red light optical compensation layer 10, the first hole transport material HTL1-5 and second hole transport material HTL2-8 have a mass ratio of 55:45;
In the green light optical compensation layer 11, the first hole transport material HTL1-5 and second hole transport material HTL2-4 have a mass ratio of 20:80.

Embodiment 14

[0057] Wherein, the first hole transport material HTL1 has a structure as shown by formula HTL1-8, and the second hole transport material HTL2 has a structure as shown by formula HTL2-5 or HTL2-7;
In the red light optical compensation layer 10, the first hole transport material HTL1-8 and second hole transport material HTL2-7 have a mass ratio of 30:70;
In the green light optical compensation layer 11, the first hole transport material HTL1-8 and second hole transport material HTL2-5 have a mass ratio of 40:60.

Comparison Example

[0058] Blue light emitting area 15 (within the leftmost dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(100nm)/NPB(20nm)/ADN(30nm):BD-1/ETL-1(35nm)/Mg:Ag (20nm)/MTDATA(50nm)
[0059] Green light emitting area 14 (within the middle dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(160nm)/NPB(20nm)/CBP(30nm):Ir$(ppy)_3$/ETL-1(35nm)/ Mg:Ag(20nm)/MTDATA(50nm)
[0060] Red light emitting area 13 (within the rightmost dotted line block in FIG. 3): ITO/HAT(10nm)/MTDA-TA(210nm)/NPB(20nm)/CBP(30nm):Ir$(mdq)_2$(acac)/ETL-1(35nm)/ Mg:Ag(20nm)/MTDATA(50nm)
[0061] The test results of the devices are listed below:

	Blue light efficiency (cd/A)	Green light efficiency (cd/A)	Red light efficiency (cd/A)
Embodiment 1	4.3	70.2	29.3

(continued)

	Blue light efficiency (cd/A)	Green light efficiency (cd/A)	Red light efficiency (cd/A)
Embodiment 2	4.3	66.3	29.8
Embodiment 3	4.3	69.5	32.1
Embodiment 4	4.3	72.5	30.6
Embodiment 5	4.3	72.1	28.4
Embodiment 6	4.3	67.0	34.2
Embodiment 7	4.3	69.4	30.3
Embodiment 8	4.3	75.1	36.7
Embodiment 9	4.3	65.2	33.1
Embodiment 10	4.3	64.2	27.0
Embodiment 11	4.3	69.0	28.9
Embodiment 12	4.3	65.9	27.0
Embodiment 13	4.3	71.5	33.5
Embodiment 14	4.3	72.2	30.4
Comparison Example	4.3	63.3	26.9

[0062] As indicated by the test results, because the optical compensation layers is made of a combination of a hole transport material having a high energy level and a material having a high charge transfer rate, the light emitting efficiencies of the red light emitting layer and the green light emitting layer are significantly increased.

[0063] Apparently, the aforementioned embodiments are merely examples illustrated for clearly describing the present invention, rather than limiting the implementation ways thereof. For those skilled in the art, various changes and modifications in other different forms can be made on the basis of the aforementioned description. It is unnecessary and impossible to exhaustively list all the implementation ways herein. However, any obvious changes or modifications derived from the aforementioned description are intended to be embraced within the protection scope of the present invention.

Claims

1. An organic electroluminescence device having RGB pixel areas, comprising a substrate, with a first electrode layer (1), a plurality of organic layers and a second electrode layer (8) formed in sequence on the substrate, wherein, the organic layers include a first organic functional layer (12), a light emitting layer and a second organic functional layer (13) arranged upon the first electrode layer (1), the light emitting layer comprises a red light emitting layer (4), a green light emitting layer (5) and a blue light emitting layer (6),
characterized in that,
optical compensation layers are respectively arranged between the red light emitting layer (4) and the first organic functional layer (12) as well as between the green light emitting layer (5) and the first organic functional layer (12), the optical compensation layers are made of a first hole transport material and a second hole transport material, the first hole transport material has a triplet-state energy level $\geq$ 2.48eV and a HOMO energy level $\leq$ -5.5eV, the second hole transport material has a HOMO energy level > -5.5eV, and the difference between the HOMO energy level of the first hole transport material and the HOMO energy level of the second hole transport material is $\leq$ 0.2eV.

2. The organic electroluminescence device having RGB pixel areas of Claim 1, **characterized in that**, the optical compensation layers include a red light optical compensation layer (10) arranged between the red light emitting layer (4) and the first organic functional layer (12), and a green light optical compensation layer (11) arranged between the green light emitting layer (5) and the first organic functional layer (12).

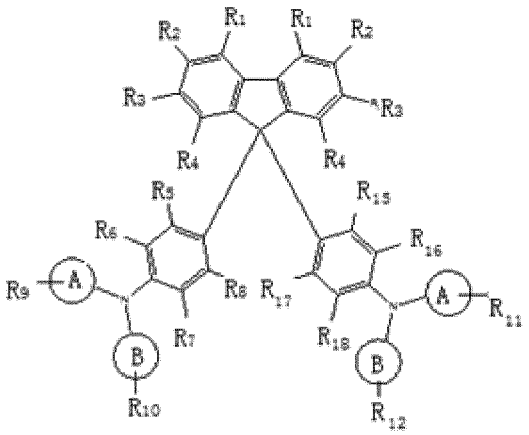
3. The organic electroluminescence device having RGB pixel areas of Claim 2, **characterized in that**, the first hole transport material and second hole transport material contained in the red light optical compensation layer (10) has

a mass ratio of 1:99 to 99:1.

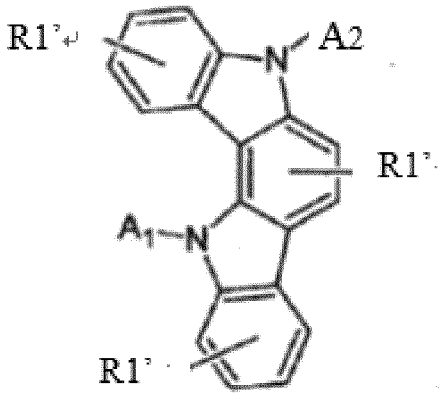
4. The organic electroluminescence device having RGB pixel areas of Claim 2, **characterized in that**, the first hole transport material and second hole transport material contained in the green light optical compensation layer (11) has a mass ratio of 5:95 to 50:50.

5. The organic electroluminescence device having RGB pixel areas of Claim 4, **characterized in that**, the first hole transport material and second hole transport material contained in the green light optical compensation layer (11) has a mass ratio of 10:90 to 30:70.

6. The organic electroluminescence device having RGB pixel areas of any one of Claims 1-5, **characterized in that**, the first hole transport material has a structure defined by the following structural formula (1) or structural formula (2):



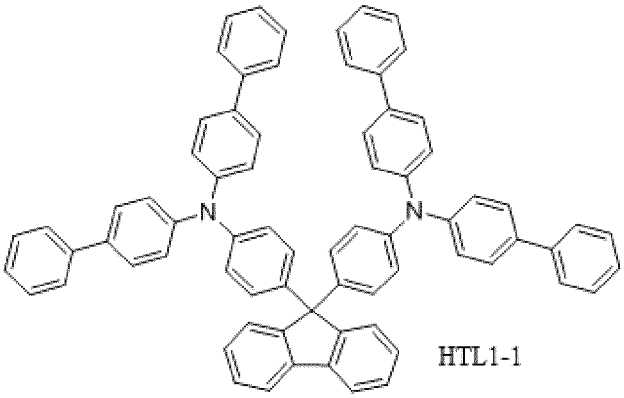
structural formula (1)



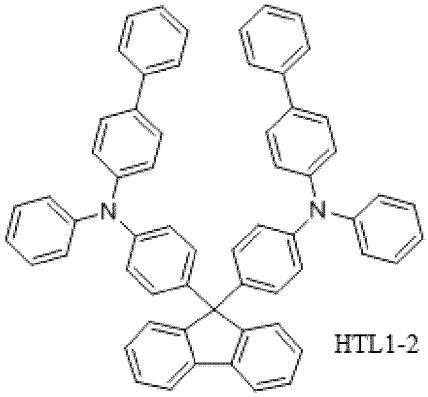
structural formula (2)

in the structural formula (1), the groups A and B are individually selected from phenyl group, naphthyl group or phenyl-amino group;
the groups of R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_{15}, R_{16}, R_{17} and R_{18} are identical or different, and are individually selected from hydrogen element, halogen element, CN, NO_2, amino group, C_6-C_{30} fused cyclic aryl group, C_6-C_{30} fused heterocyclic aryl group, C_6-C_{20} alkyl group or C_6-C_{30} alcohol group;
the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group;
in the structural formula (2), the groups of A1 and A2 are individually selected from C_6-C_{30} aryl group or C_6-C_{30} heterocyclic aryl group, the group R1' is selected from hydrogen, alkyl group, alkoxyl group or basic group;
and the structural formula (2) also meets the following condition: at least one of the groups of A 1 and A2 has a condensed ring structure.

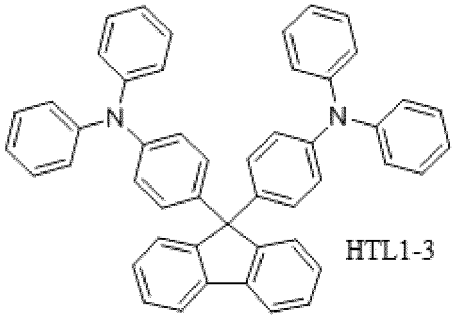
7. The organic electroluminescence device having RGB pixel areas of Claim 6, **characterized in that**, the first hole transport material has a structure selected from the following structural formulas (HTL1-1) to (HTL1-10) :



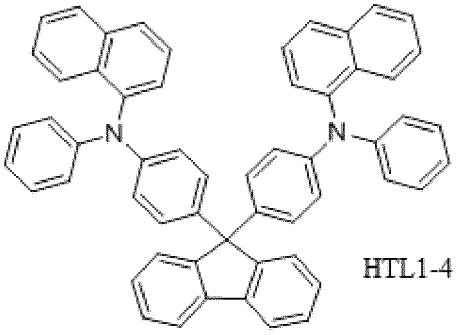
HTL1-1



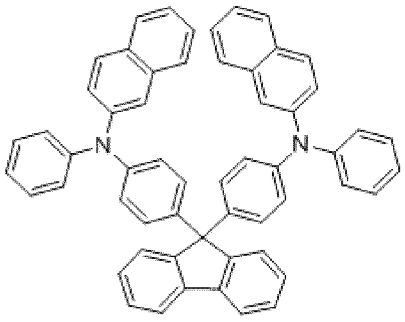
HTL1-2



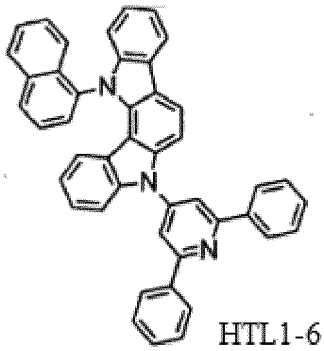
HTL1-3



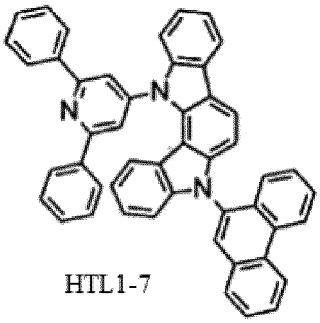
HTL1-4



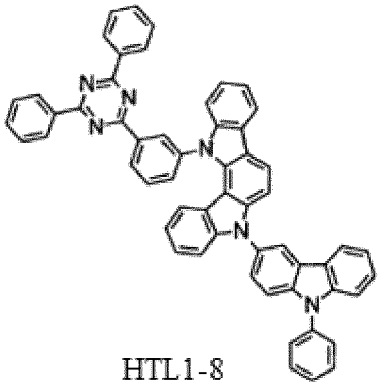
HTL1-5



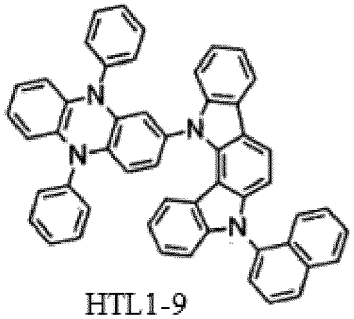
HTL1-6



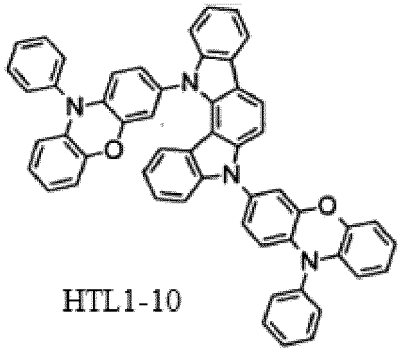
HTL1-7



HTL1-8

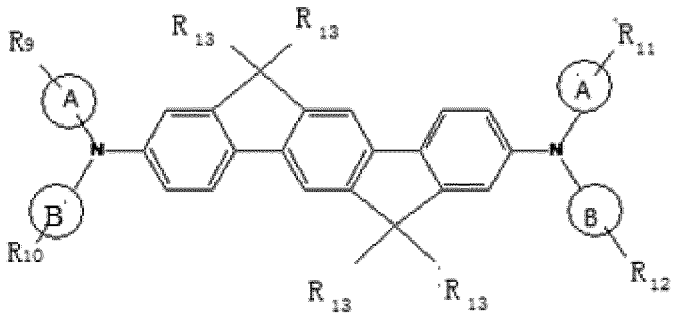


HTL1-9

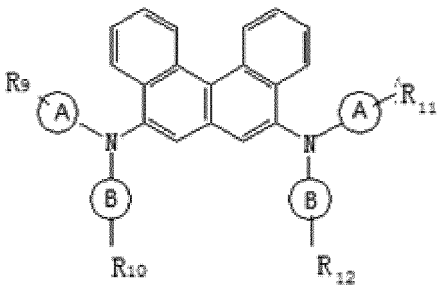


HTL1-10

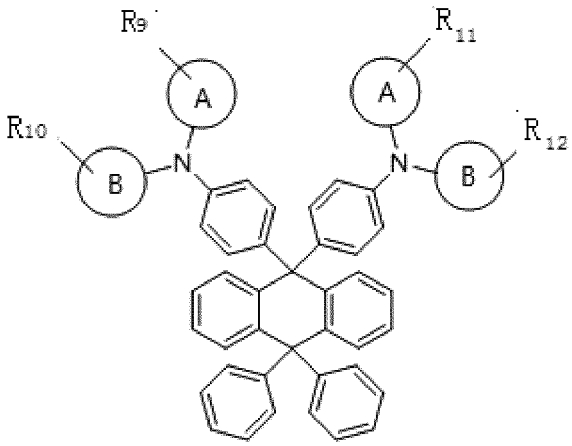
8. The organic electroluminescence device having RGB pixel areas of any one of Claims 1-5, **characterized in that**, the second hole transport material has an indenofluorene structure defined by the following structural formula (3), structural formula (4), structural formula (5) or structural formula (6):



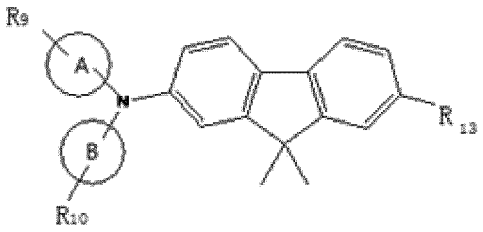
structural formula (3)



structural formula (4)



structural formula (5)

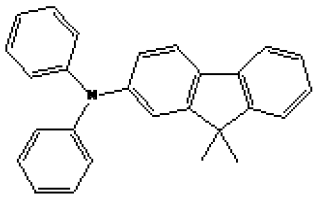


structural formula (6)

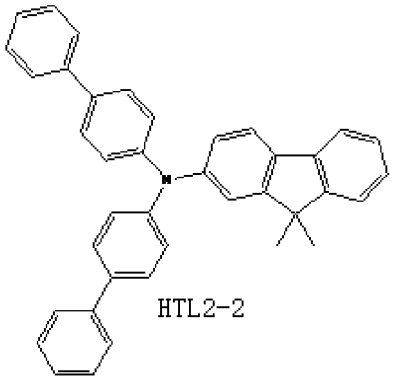
wherein, the groups of A and B are individually selected from phenyl group, naphthyl group or phenyl-amino group; the groups of R_9, R_{10}, R_{11} and R_{12} are identical or different, and are individually selected from C_6-C_{30} aryl group; the group of R_{13} is selected from C_1-C_6 alkyl group or hydroxyl group.

9. The organic electroluminescence device having RGB pixel areas of Claim 8, **characterized in that**, the group R_{13} is methyl group, ethyl group, propyl group, isopropyl group, butyl group, isobutyl group, n-amyl group or n-hexyl group.

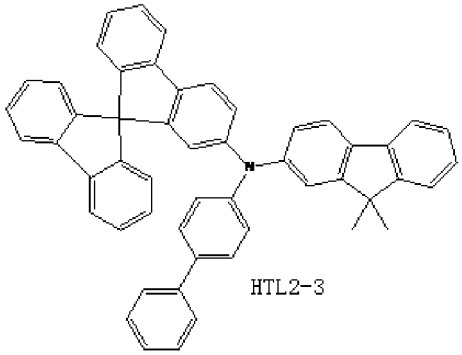
10. The organic electroluminescence device having RGB pixel areas of Claim 8, **characterized in that**, the second hole transport material has a structure selected from the following structural formulas (HTL2-1) to (HTL2-18):



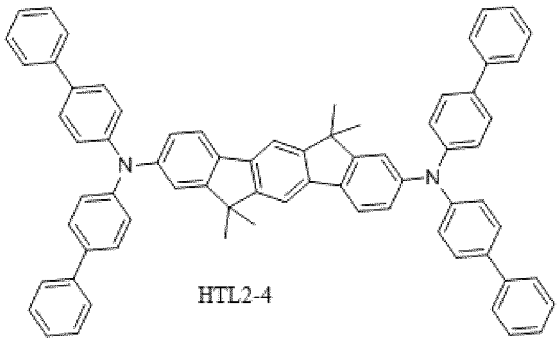
HTL2-1



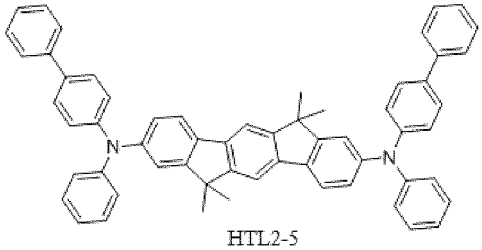
HTL2-2



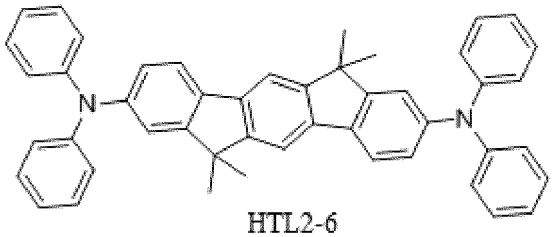
HTL2-3



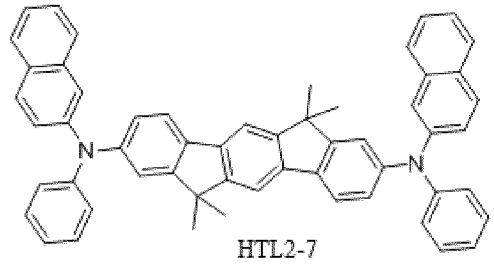
HTL2-4



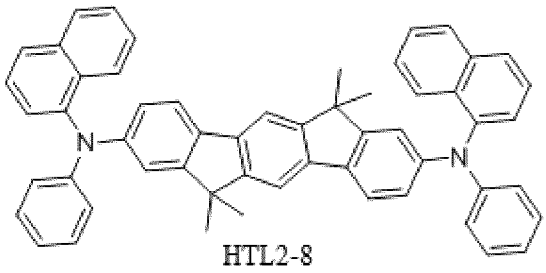
HTL2-5



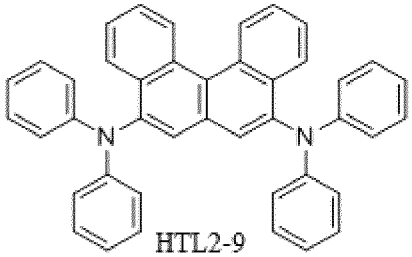
HTL2-6



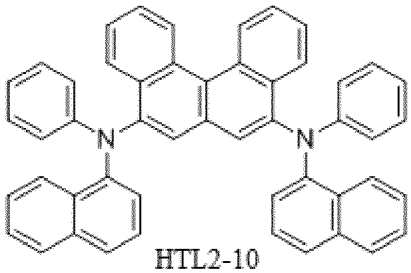
HTL2-7



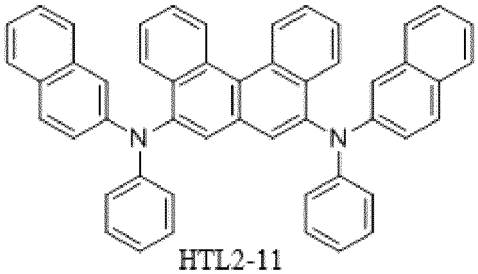
HTL2-8



HTL2-9



HTL2-10



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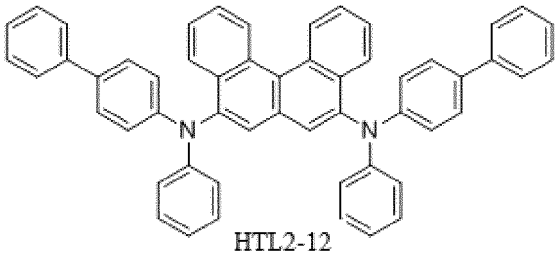

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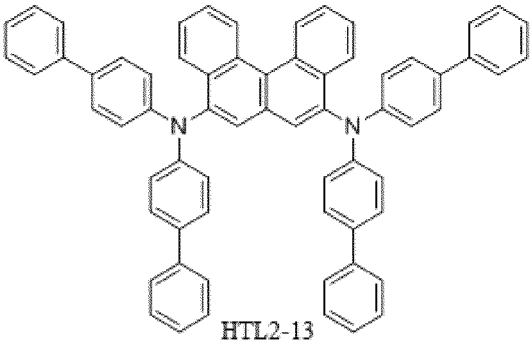
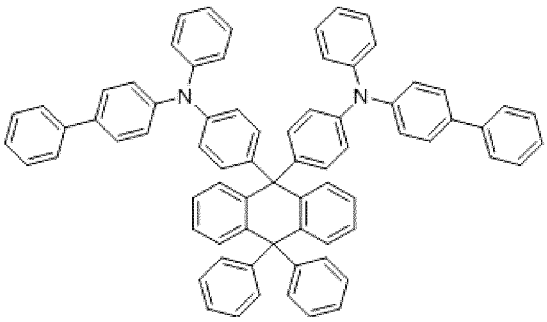


HTL2-13



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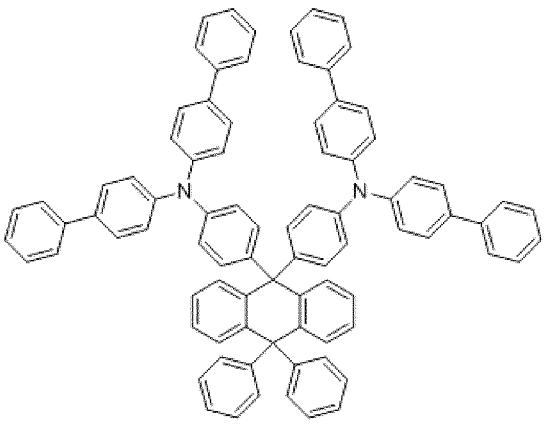
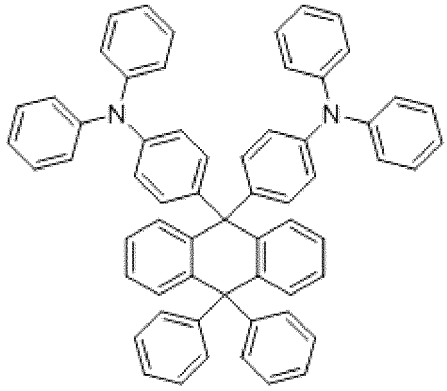
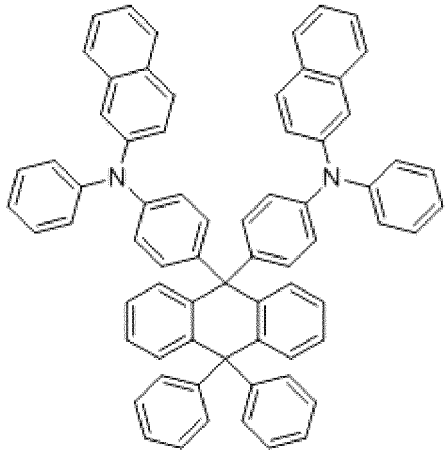


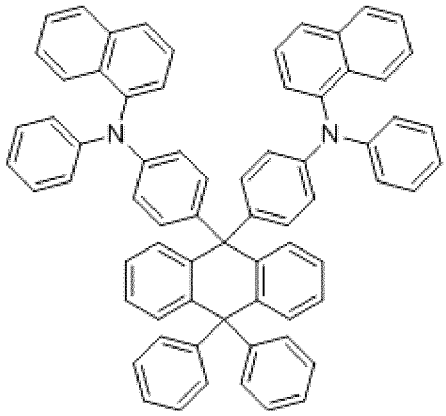
HTL2-15



HTL2-16



HTL2-17



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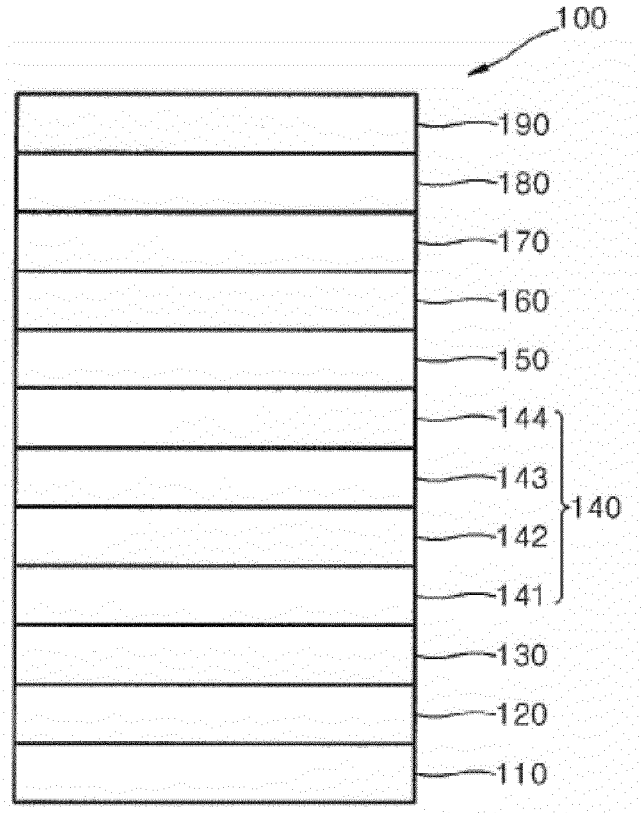
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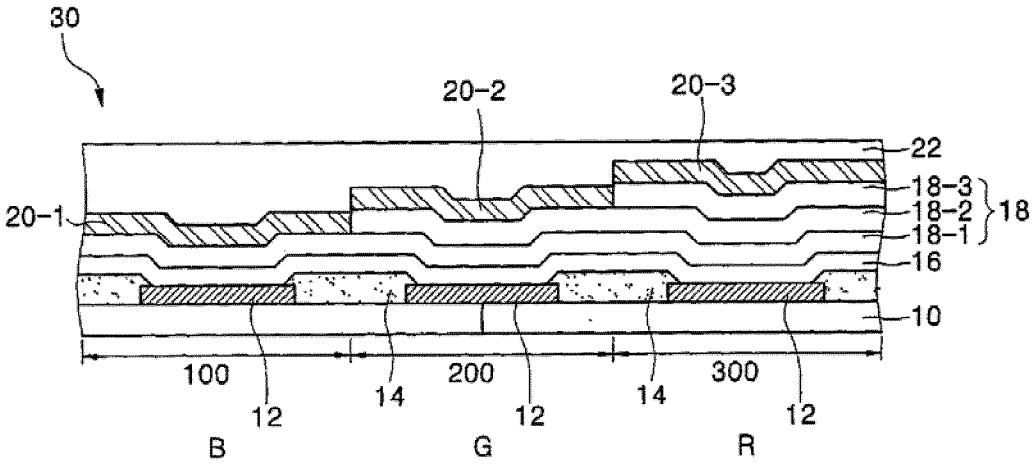
FIG. 1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G
R

FIG. 2

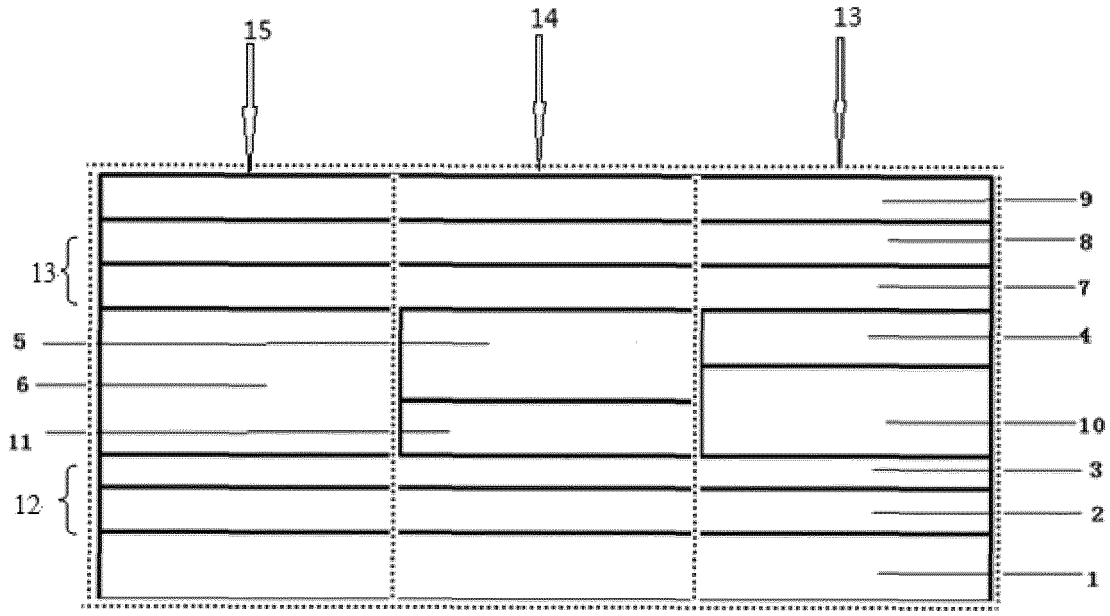

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/099376

A. CLASSIFICATION OF SUBJECT MATTER

H01L 51/54 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L51/

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

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

CPRS, CNTXT, VEN: homo, OLED, RGB, red, green, blue

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104241317 A (SAMSUNG DISPLAY CO., LTD.) 24 December 2014 (24.12.2014) claims 1-6; description, paragraphs [0030]-[0097], and figures 2-4,8	1-10
PX	CN 104538559 A (BEIJING VISIONOX TECHNOLOGY CO., LTD. et al.) 22 April 2015 (22.04.2015) claims 1-10	1-10

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

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2016	06 April 2016

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	ZHAO, Ying Telephone No. (86-10) 62089521

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/099376

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 104241317 A	24 December 2014	KR 20140142977 A	15 December 2014
		US 2014361257 A1	11 December 2014
		TW 201448200 A	16 December 2014
CN 104538559 A	22 April 2015	None	

Form PCT/ISA /210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201210395191 **[0004]**
- CN 200510077967 **[0005]**

专利名称(译)	具有RGB像素区域的有机电致发光器件		
公开(公告)号	EP3242343A4	公开(公告)日	2018-08-15
申请号	EP2015875213	申请日	2015-12-29
[标]申请(专利权)人(译)	北京维信诺科技有限公司 昆山工研院新型平板显示技术中心有限公司 昆山国显光电有限公司		
申请(专利权)人(译)	北京维信诺科技有限公司. 昆山新型平板显示技术中心CO.LTD 昆山GO-维信诺光电科技有限公司.		
当前申请(专利权)人(译)	北京维信诺科技有限公司. 昆山新型平板显示技术中心CO.LTD 昆山GO-维信诺光电科技有限公司.		
[标]发明人	LIU SONG LI WEIWEI HE LIN		
发明人	LIU, SONG LI, WEIWEI HE, LIN		
IPC分类号	H01L51/54		
CPC分类号	H01L51/5262 H01L2251/552 C07D487/04 H01L27/3211 H01L51/0052 H01L51/0054 H01L51/0058 H01L51/0059 H01L51/006 H01L51/0067 H01L51/0071 H01L51/0072 H01L51/5004 H01L51/506 H01L51/5064 H01L51/5265 H01L51/5016 C07C211/54 C07C211/58 C07C211/61 H01L51/0055 H01L51/5008 H01L51/5056		
代理机构(译)	HERRMANN，UWE		
优先权	201410853953.2 2014-12-31 CN		
其他公开文献	EP3242343B1 EP3242343A1		
外部链接	Espacenet		

摘要(译)

一种具有RGB像素区域的有机电致发光器件，其中光学补偿层（10,11）分别设置在红色发光层（4）和第一有机功能层（12）之间以及绿色发光层（5）之间）和第一有机功能层（12），光学补偿层（10,11）由第一空穴传输材料和第二空穴传输材料制成，第一空穴传输材料具有三重态能级‰¥2.48 eV和HOMO能级≈-5.5eV，第二空穴传输材料的HOMO能级> -5.5eV，第一空穴传输材料的HOMO能级与第二个空穴的HOMO能级之差运输材料‰0.2eV。其制备工艺简单，可显着降低发光器件的功耗，从而提高发光效率。