US 20180097184A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0097184 A1**

LEE et al. (43) **Pub. Date: Apr. 5, 2018**

(54) **ORGANIC COMPOUND, AND ORGANIC LIGHT EMITTING DIODE AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME**

(71) Applicant: **LG DISPLAY CO., LTD.**, Seoul (KR)

(72) Inventors: **Seung-Jae LEE**, PAJU-SI (KR); **Jong-Kwan BIN**, PAJU-SI (KR); **Bo-Min SEO**, PAJU-SI (KR); **Hye-Ock CHOI**, HWASEONG-SI (KR)

(73) Assignee: **LG DISPLAY CO., LTD.**, SEOUL (KR)

(21) Appl. No.: **15/718,980**

(22) Filed: **Sep. 28, 2017**

(30) **Foreign Application Priority Data**

Sep. 30, 2016 (KR) 10-2016-0126656

Publication Classification

(51) **Int. Cl.**

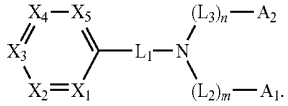
H01L 51/00	(2006.01)
H01L 27/32	(2006.01)
C07D 401/12	(2006.01)
C07D 409/12	(2006.01)
C07D 405/12	(2006.01)
C07D 213/38	(2006.01)
C07D 239/26	(2006.01)
C07D 251/24	(2006.01)

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

CPC ***H01L 51/0061*** (2013.01); ***H01L 27/3244*** (2013.01); ***C07D 401/12*** (2013.01); ***C07D 409/12*** (2013.01); *H01L 51/5088* (2013.01); ***C07D 213/38*** (2013.01); ***H01L 51/006*** (2013.01); ***C07D 239/26*** (2013.01); ***C07D 251/24*** (2013.01); ***C07D 405/12*** (2013.01)

(57) **ABSTRACT**

The present invention provides an organic compound for an organic light emitting diode. The organic compound is represented by:



The organic compound is capable of reducing a driving voltage of an organic light emitting diode by an excellent charge transporting property. The present invention also provides an organic light emitting diode and an organic light emitting display device including the organic compound.

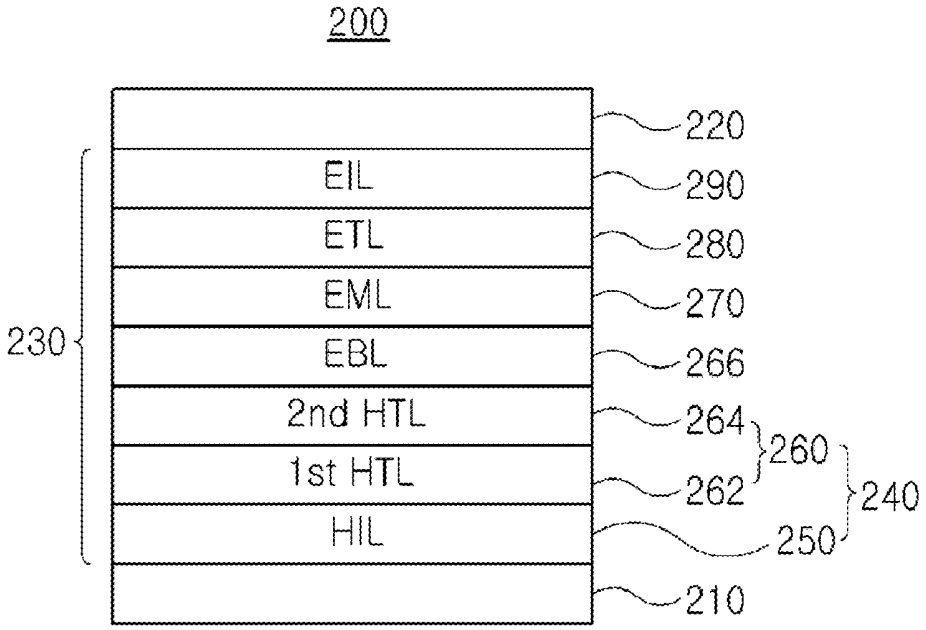


FIG. 1

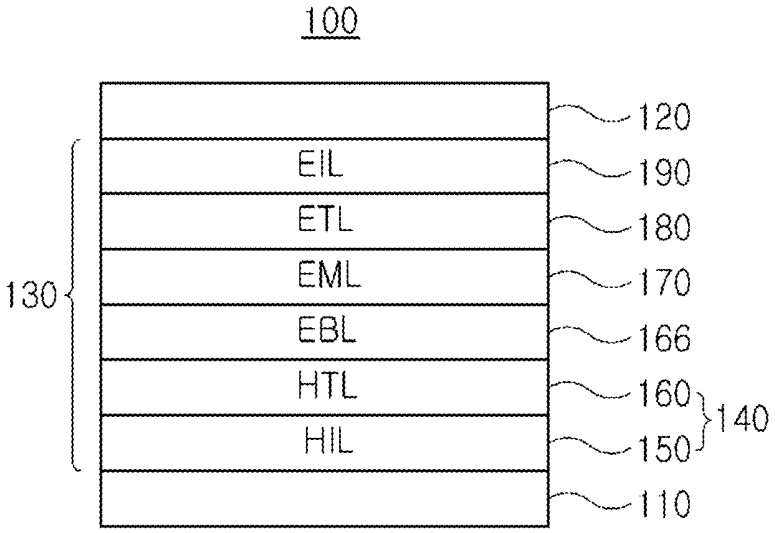

100
120
EIL
190
ETL
180
EML
170
EBL
166
HTL
160
HIL
150
140
130
110

FIG. 2

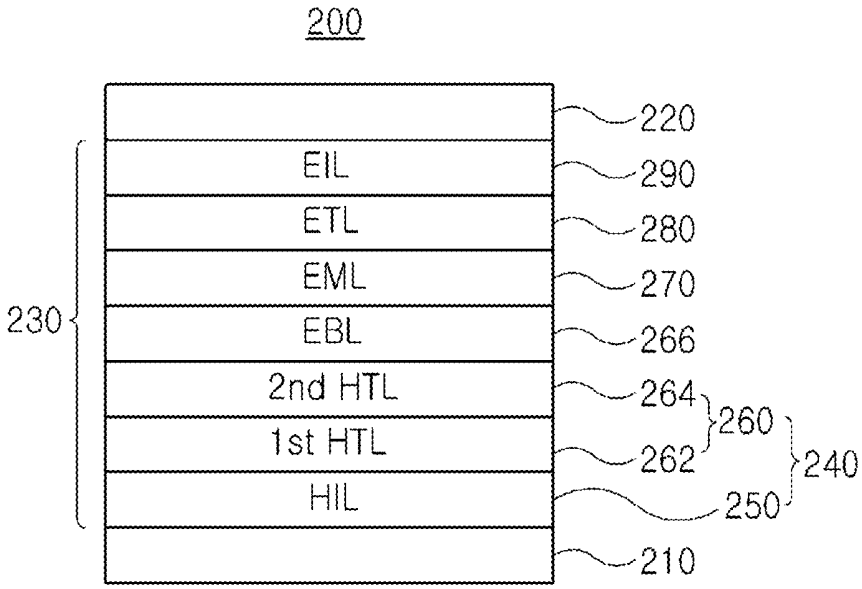

200
220
EIL
290
ETL
280
EML
270
EBL
266
2nd HTL
264
1st HTL
262
260
HIL
250
240
230
210

FIG. 3

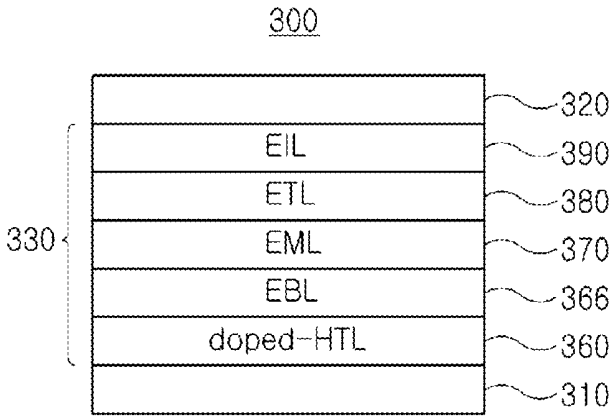

300
320
EIL
390
ETL
380
330
EML
370
EBL
366
doped-HTL
360
310

FIG. 4

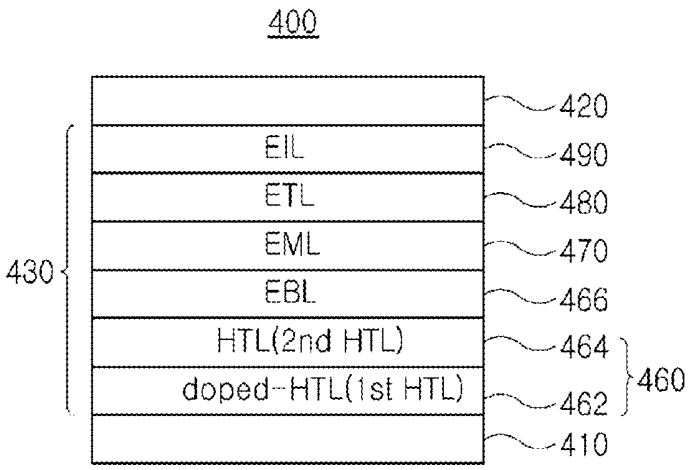

400
420
EIL
490
ETL
480
430
EML
470
EBL
466
HTL(2nd HTL)
464
460
doped-HTL(1st HTL)
462
410

FIG. 5

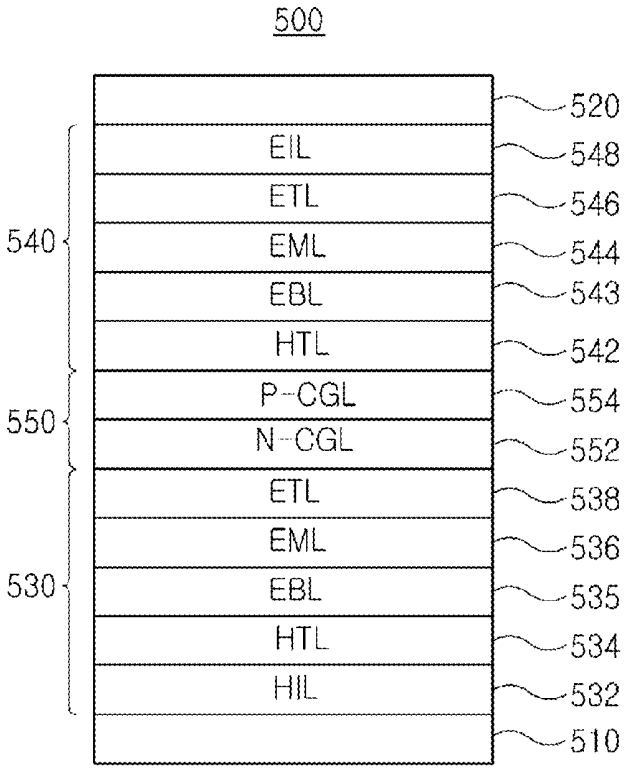

500
520
EIL
548
ETL
546
EML
544
EBL
543
HTL
542
P-CGL
554
N-CGL
552
ETL
538
EML
536
EBL
535
HTL
534
HIL
532
510
540
550
530

FIG. 6

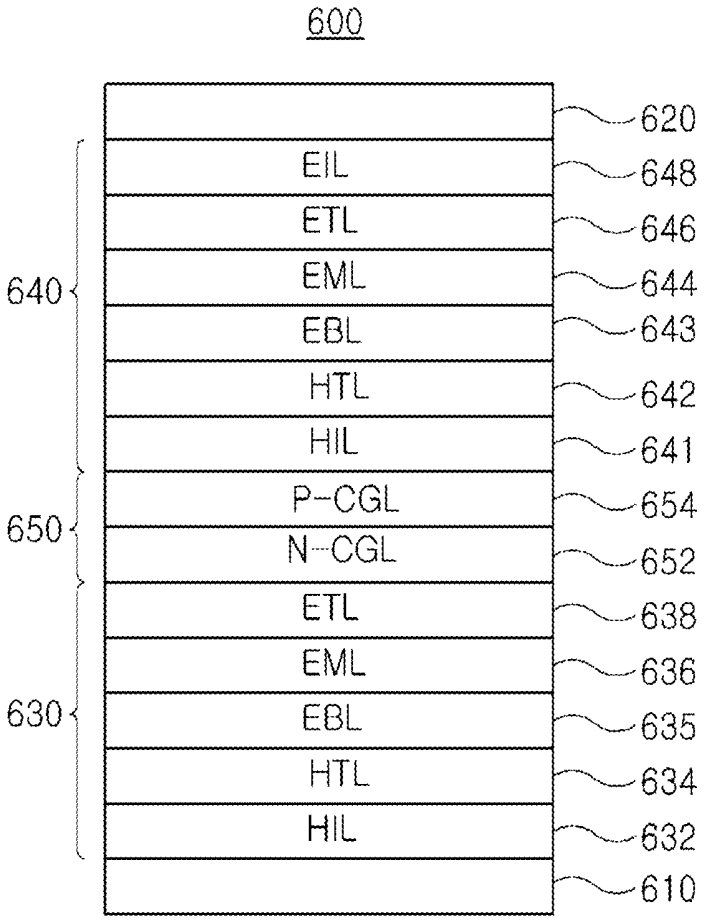

600
620
EIL
648
ETL
646
EML
644
EBL
643
HTL
642
HIL
641
P-CGL
654
N-CGL
652
ETL
638
EML
636
EBL
635
HTL
634
HIL
632
610
640
650
630

FIG. 7

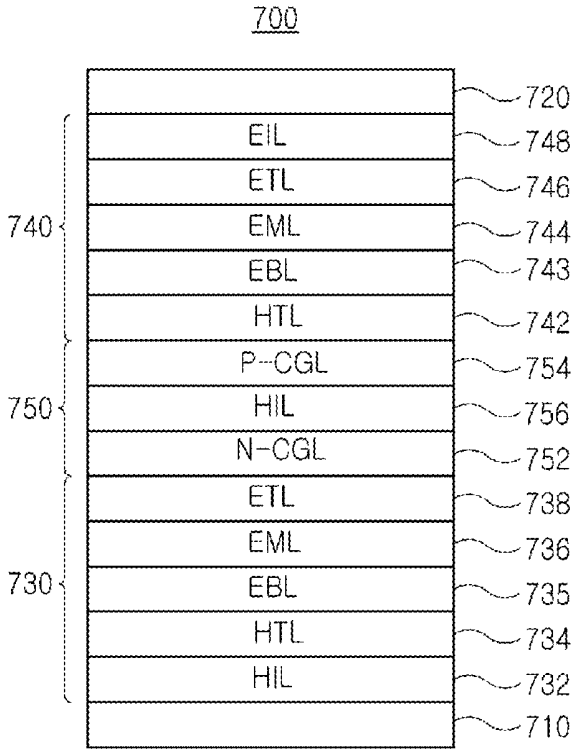

700
720
EIL
748
ETL
746
740
EML
744
EBL
743
HTL
742
P-CGL
754
750
HIL
756
N-CGL
752
ETL
738
EML
736
730
EBL
735
HTL
734
HIL
732
710

FIG. 8

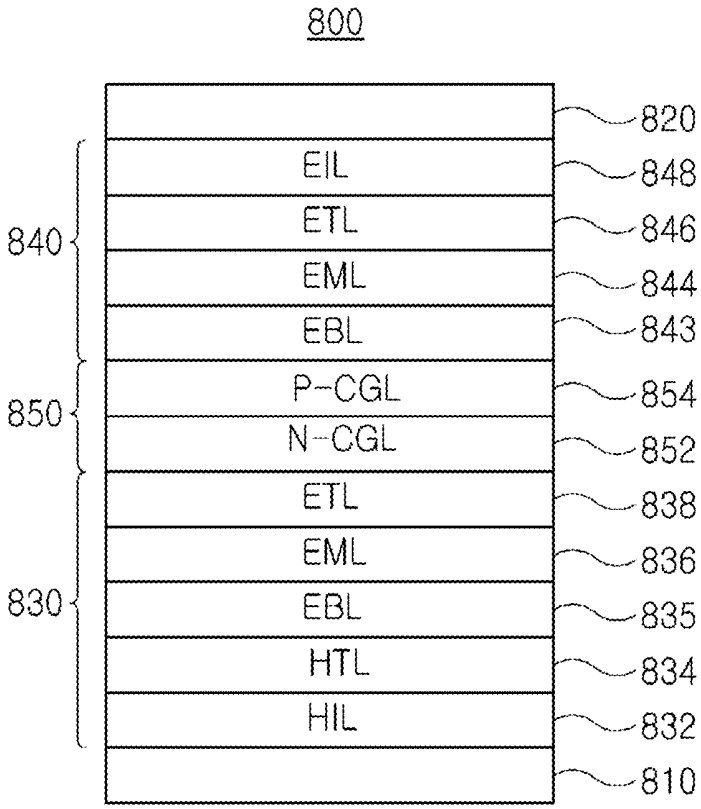

800
820
EIL
848
ETL
846
840
EML
844
EBL
843
P-CGL
854
850
N-CGL
852
ETL
838
EML
836
830
EBL
835
HTL
834
HIL
832
810

FIG. 9

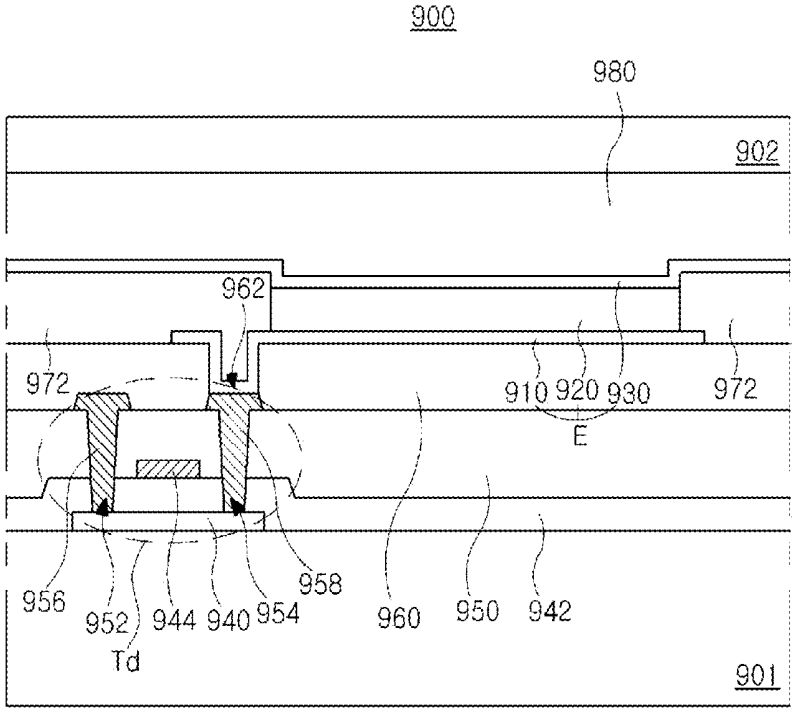

900
980
902
962
972
910
920
930
E
972
956
952
Td
944
940
954
958
960
950
942
901

FIG. 10A

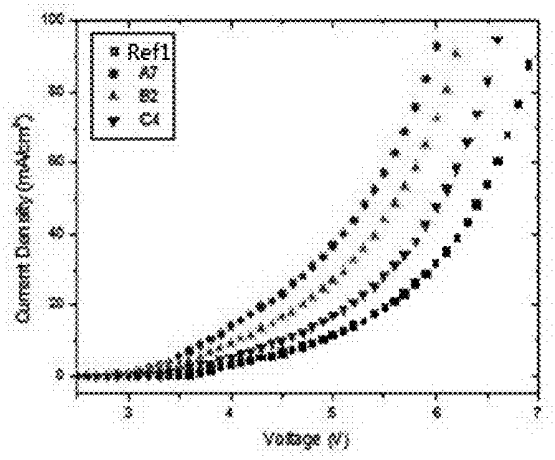

Ref1
A7
B2
C1
Current Density (mA/cm²)
Voltage (V)

FIG. 10B

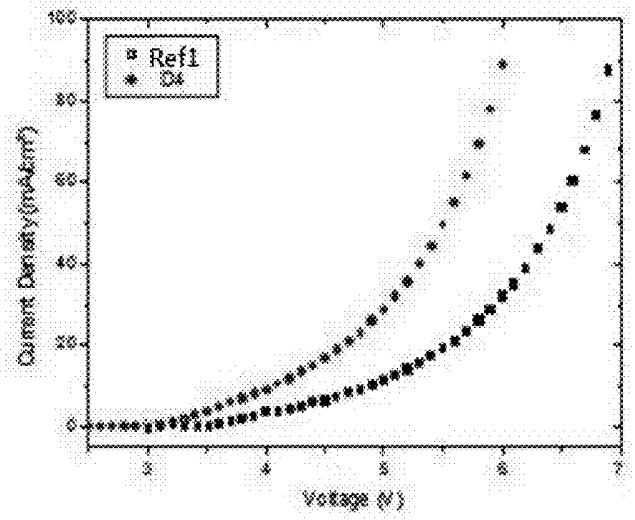


FIG. 10C

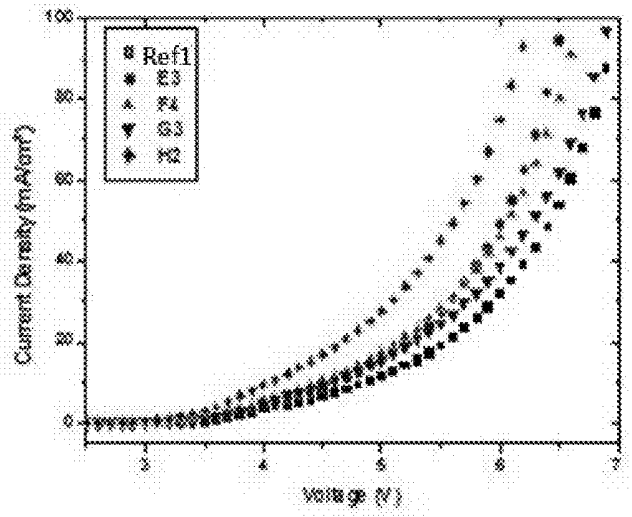


FIG. 11A

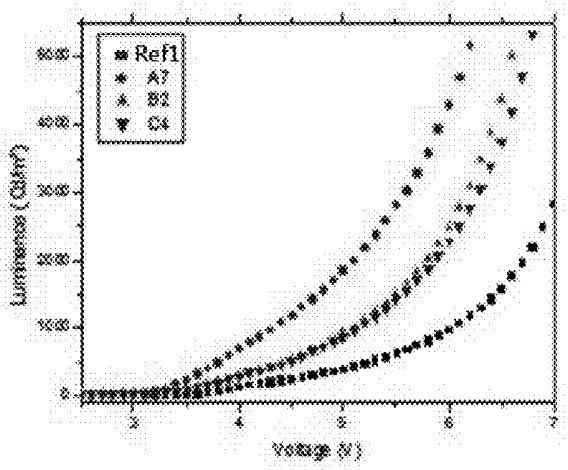


FIG. 11B

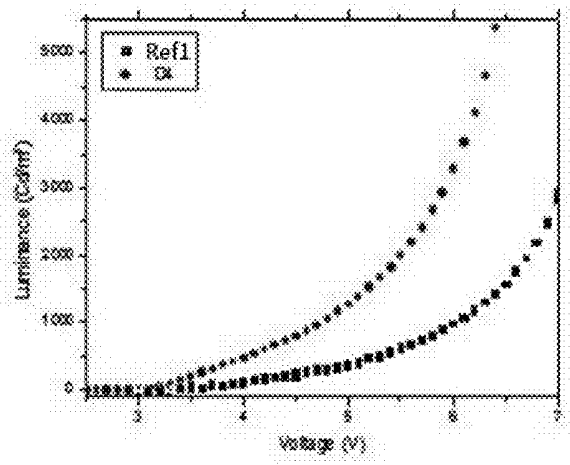


FIG. 11C

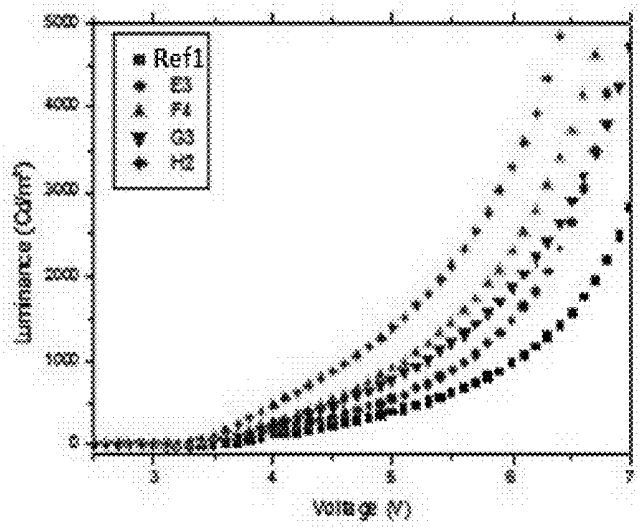


FIG. 12A

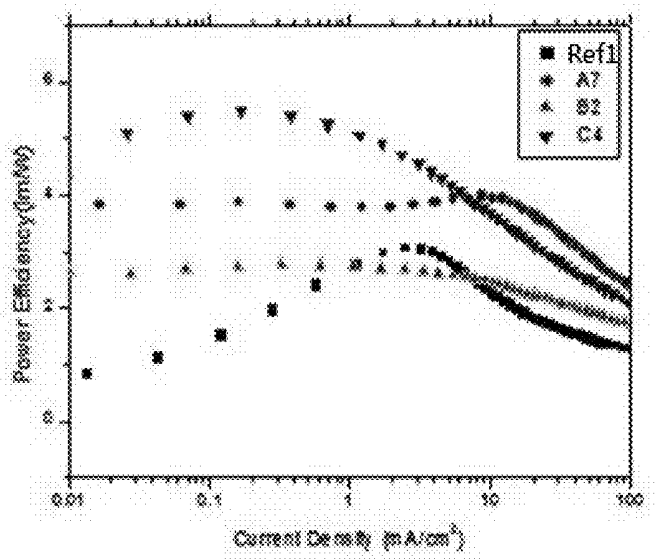


FIG. 12B

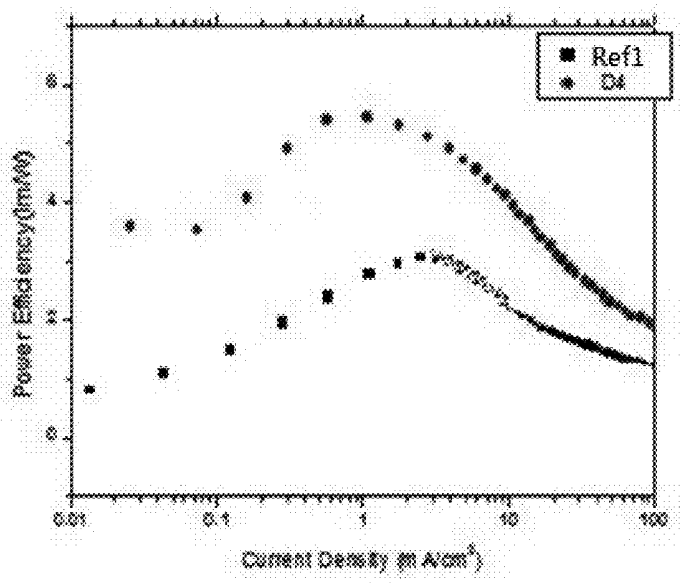


FIG. 12C

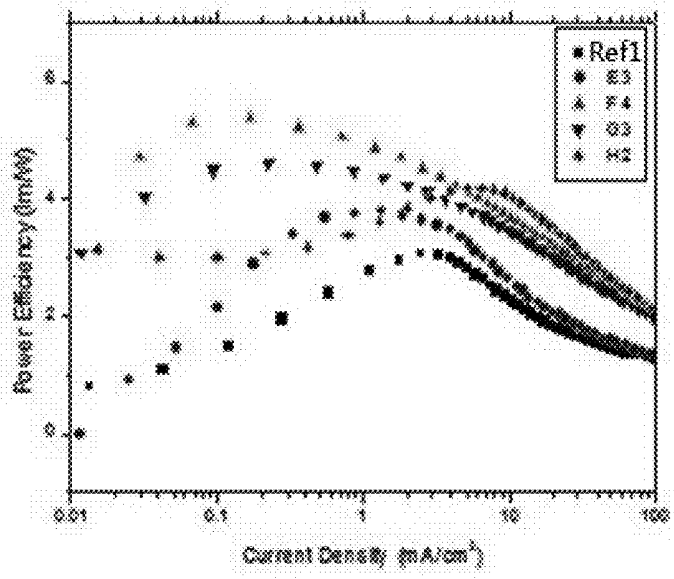


FIG. 13A

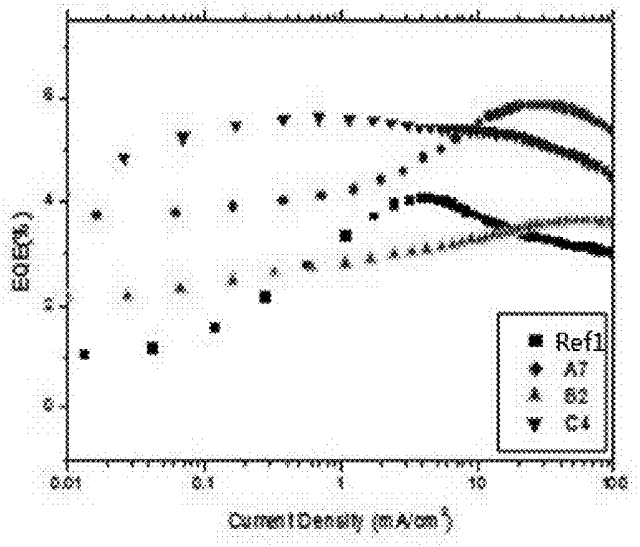


FIG. 13B

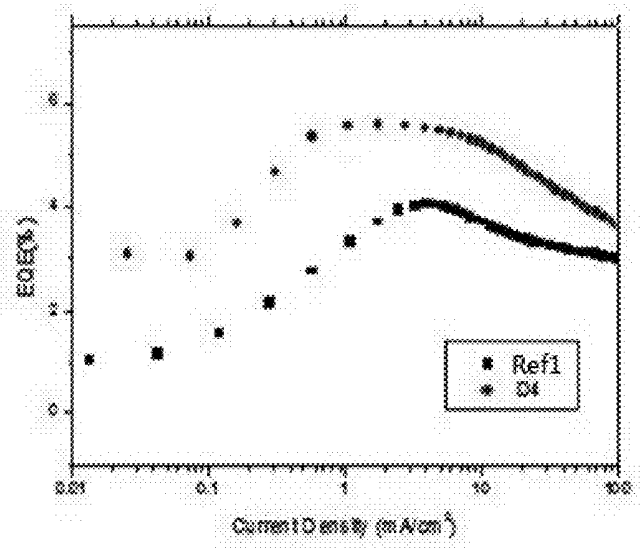


FIG. 13C

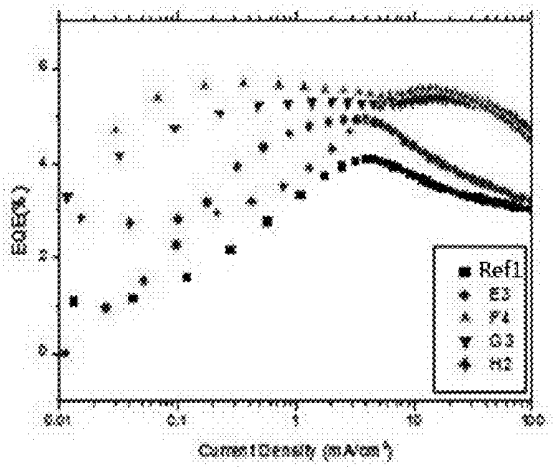


FIG. 14A

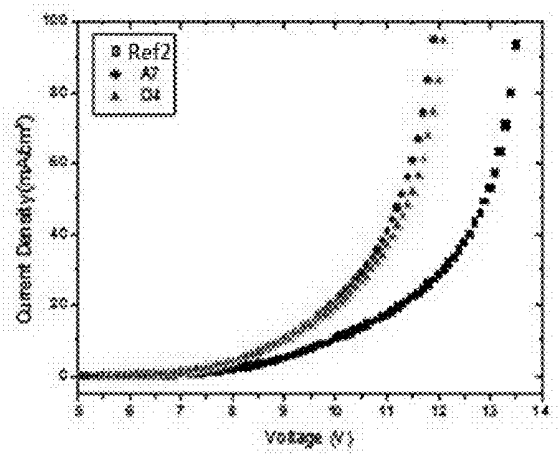


FIG. 14B

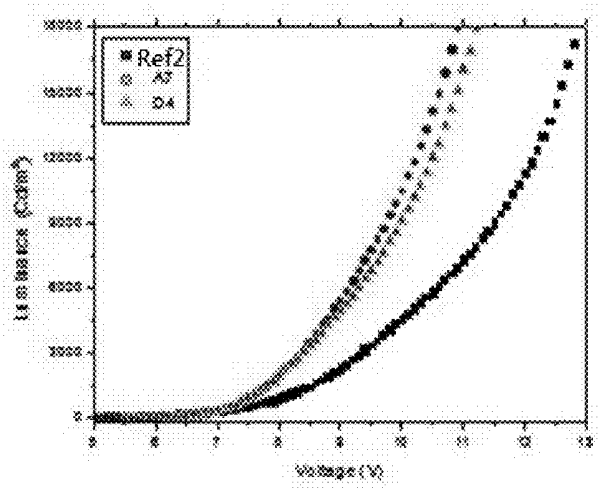


FIG. 14C

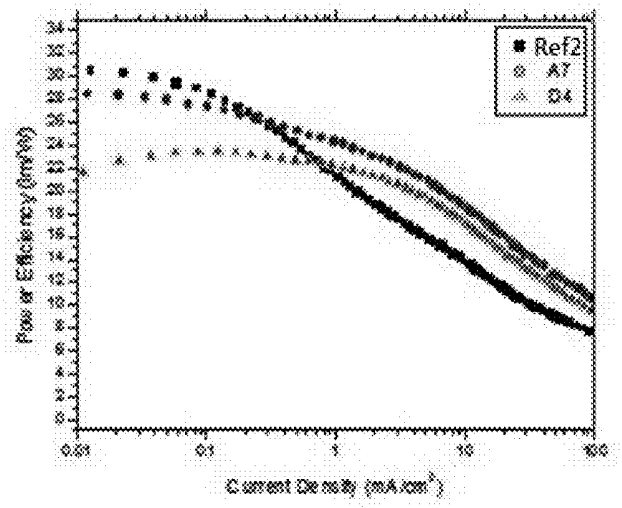


FIG. 14D

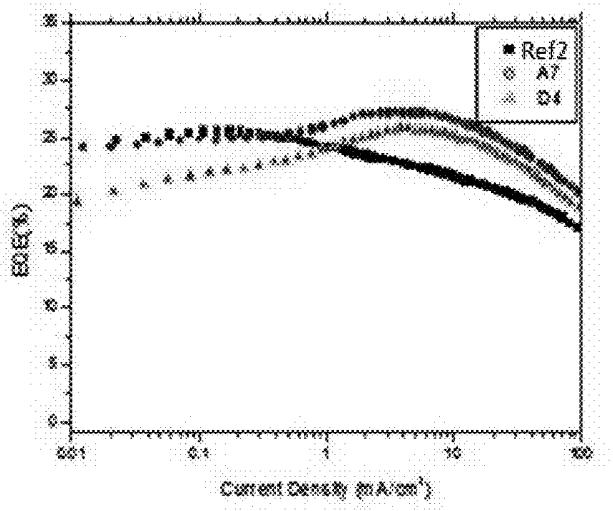


FIG. 15A

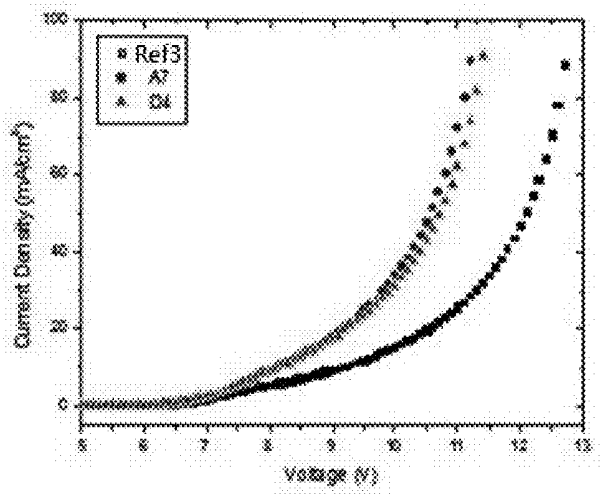


FIG. 15B

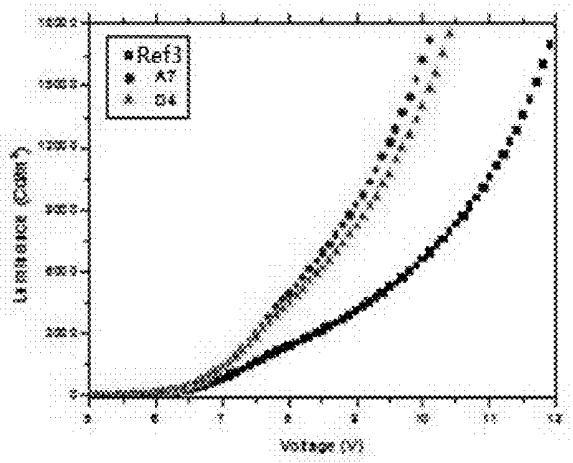


FIG. 15C

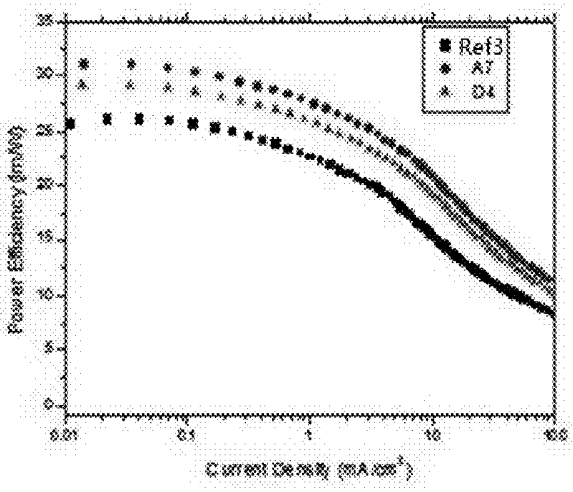
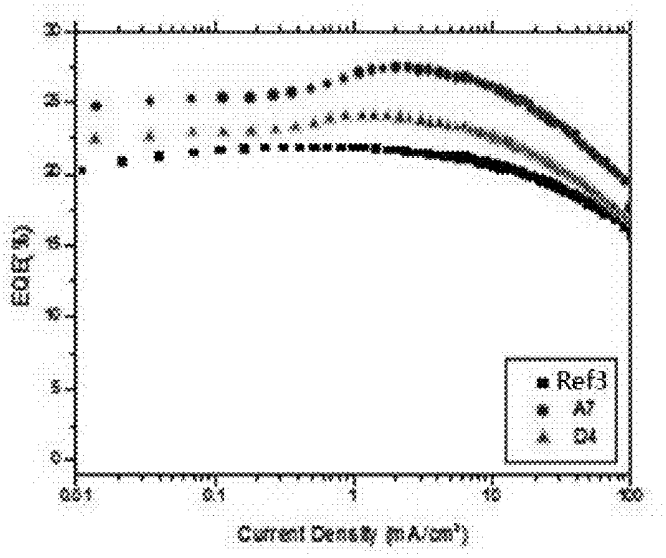


FIG. 15D



ORGANIC COMPOUND, AND ORGANIC LIGHT EMITTING DIODE AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority benefit of Korean Patent Application No. 10-2016-0126656 filed in the Republic of Korea on Sep. 30, 2016, which is hereby incorporated by reference into the present application.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to an organic compound. More particularly, the present invention relates to an organic compound capable of reducing a driving voltage of an organic light emitting diode by an excellent charge transporting property, and the organic light emitting diode and the organic light emitting display device including the organic compound.

Discussion of the Related Art

[0003] As recent requirements of a flat panel display device having a small occupied area have increased, an organic light emitting display (OLED) device including an organic light emitting diode have been developed. The OLED device may be referred to as an organic electroluminescent device (OELD).

[0004] The organic light emitting diode emits light by injecting electrons from a cathode as an electron injection electrode and holes from an anode as a hole injection electrode into an emitting material layer (EML), combining the electrons with the holes, generating an exciton, and transforming the exciton from an excited state to a ground state. A flexible substrate, for example, a plastic substrate, can be used as a base substrate where elements are formed. The OLED device can be operated at a voltage (e.g., 10V or below) lower than a voltage required to operate other display devices. Moreover, the OLED device has an excellent color purity.

[0005] An organic emitting layer of the OLED device may have a single-layered structure of an emitting material layer (EML). Alternatively, to improve an emitting efficiency, the organic emitting layer may have a multi-layered structure. For example, the organic emitting layer may include a hole injection layer (HIL), a hole transporting layer (HTL), the EML, an electron transporting layer (ETL) and an electron injection layer (EIL).

[0006] To further improve the property or characteristic of the organic light emitting diode, a white emitting diode including at least two stacks is introduced. It may be referred to as a tandem structure organic light emitting diode. The tandem structure organic light emitting diode includes a charge generation layer (CGL) between adjacent stacks.

[0007] The organic materials used for the organic light emitting diode may be classified into an emitting material and a charge transporting material. In addition, the charge transporting material may be classified into a hole injection material, a hole transporting material, an electron transporting material and an electron injection material. Since high driving voltage and high current density in the organic light emitting diode may provide strong stress on the organic materials, there are bad effect on the stability and the lifetime.

[0008] The research for increasing the efficiency of the organic light emitting diode and reducing the power consumption of the organic light emitting diode by controlling an energy level of the charge transporting layer and/or the charge injection layer has been carried out. For example, Korean Patent Publication No. 2015-0026463 discloses the lifetime of the organic light emitting diode may be improved by using a charge transporting material having a vinyl end-group to decrease thermal degradation and prevent a pixel contraction.

[0009] However, a charge transporting material being capable of improving the current density, the lifetime and the emitting efficiency and decreasing the driving voltage and the stress to the organic light emitting diode is still required.

SUMMARY OF THE INVENTION

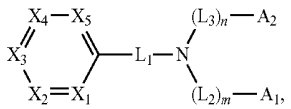
[0010] Accordingly, an embodiment of the present invention is directed to an organic compound, an organic light emitting diode and an organic light emitting display (OLED) device including the same that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0011] An object of the present invention is to provide an organic compound having an excellent hole transporting property and a charge generation property.

[0012] Another object of the present invention is to provide an organic light emitting diode and an OLED device having advantages in the driving voltage and the lifetime.

[0013] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0014] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, an organic compound is represented by following Formula:



each of X_1 to X_5 is independently CR or N, and at least one of X_1 to X_5 is N, wherein R is selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkylhalide group, halogen, substituted or non-substituted C_1 to C_{20} alkyl group, substituted or non-substituted C_1 to C_{20} alkoxy group, substituted or non-substituted C_5 to C_{30} aryl group, substituted or non-substituted C_5 to C_{30} heteroaryl group, substituted or non-substituted C_6 to C_{30} arylalkyl group, substituted or non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted or non-substituted C_6 to C_{30} aryloxyl group, substituted or non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted or non-substituted C_1 to C_{20} alkylamine group, substituted or non-substituted C_5 to C_{30}

arylamine group, substituted or non-substituted C_5 to C_{30} hetero-arylamine group, substituted or non-substituted C_1 to C_{30} alkylsilyl group, substituted or non-substituted C_5 to C_{30} arylsilyl group and substituted or non-substituted C_5 to C_{30} hetero-arylsilyl group, wherein each of A_1 and A_2 is independently selected from the group consisting of substituted or non-substituted C_1 to C_{20} alkyl group, substituted or non-substituted C_1 to C_{20} alkoxy group, substituted or non-substituted C_5 to C_{30} aryl group, substituted or non-substituted C_5 to C_{30} heteroaryl group, substituted or non-substituted C_6 to C_{30} arylalkyl group, substituted or non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted or non-substituted C_6 to C_{30} aryloxyl group, substituted or non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted or non-substituted C_1 to C_{20} alkylamine group, substituted or non-substituted C_5 to C_{30} arylamine group and substituted or non-substituted C_5 to C_{30} hetero-arylamine group, and wherein each of L_1 to L_3 is independently selected from the group of consisting substituted or non-substituted C_5 to C_{30} arylene group, substituted or non-substituted C_5 to C_{30} heteroarylene group, substituted or non-substituted C_6 to C_{30} arylalkylene group, substituted or non-substituted C_6 to C_{30} hetero-arylalkylene group, substituted or non-substituted C_6 to C_{30} aryloxylene group and substituted or non-substituted C_6 to C_{30} hetero-aryloxylene group, and each of "m" and "n" is 0 or 1.

[0015] In another aspect, an organic light emitting diode comprises a first electrode; a second electrode facing the first electrode; and an emitting part between the first and second electrodes and including an emitting material layer and an organic layer, wherein the organic layer includes the above organic compound.

[0016] In another aspect, an organic light emitting diode comprises first and second electrodes facing each other; a first emitting part between the first and second electrodes and including a first emitting material layer; a second emitting part between the first emitting part and the second electrode and including a second emitting material layer; and a P-type charge generation layer between the first and second emitting parts, wherein the P-type charge generation layer includes the above organic compound.

[0017] In another aspect, an organic light emitting diode comprises first and second electrodes facing each other; a first emitting part between the first and second electrodes and including a first emitting material layer; a second emitting part between the first emitting part and the second electrode and including a second emitting material layer; and a charge generation layer between the first and second emitting parts, wherein the second emitting part further includes an electron blocking layer between the charge generation layer and the second emitting part and includes the above organic compound.

[0018] In another aspect, an organic light emitting display device comprises a substrate; the above organic light emitting diode: and a thin film transistor between the substrate and the organic light emitting diode and connected to the organic light emitting diode.

[0019] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0021] FIG. **1** is a schematic cross-sectional view of an organic light emitting diode according to a first embodiment of the present invention.

[0022] FIG. **2** is a schematic cross-sectional view of an organic light emitting diode according to a second embodiment of the present invention.

[0023] FIG. **3** is a schematic cross-sectional view of an organic light emitting diode according to a third embodiment of the present invention.

[0024] FIG. **4** is a schematic cross-sectional view of an organic light emitting diode according to a fourth embodiment of the present invention.

[0025] FIG. **5** is a schematic cross-sectional view of an organic light emitting diode according to a fifth embodiment of the present invention.

[0026] FIG. **6** is a schematic cross-sectional view of an organic light emitting diode according to a sixth embodiment of the present invention.

[0027] FIG. **7** is a schematic cross-sectional view of an organic light emitting diode according to a seventh embodiment of the present invention.

[0028] FIG. **8** is a schematic cross-sectional view of an organic light emitting diode according to an eighth embodiment of the present invention.

[0029] FIG. **9** is a schematic cross-sectional view of an OLED device according to an embodiment of the present invention.

[0030] FIG. **10**A, FIG. **10**B and FIG. **10**C are graphs showing the current density of the organic light emitting diode including an organic compound in an exciton blocking layer.

[0031] FIG. **11**A, FIG. **11**B and FIG. **11**C are graphs showing the luminance of the organic light emitting diode including an organic compound in an exciton blocking layer.

[0032] FIG. **12**A, FIG. **12**B and FIG. **12**C are graphs showing the power efficiency (or emitting efficiency) of the organic light emitting diode including an organic compound in an exciton blocking layer.

[0033] FIG. **13**A, FIG. **13**B and FIG. **13**C are graphs showing the external quantum efficiency (EQE) of the organic light emitting diode including an organic compound in an exciton blocking layer.

[0034] FIG. **14**A, FIG. **14**B, FIG. **14**C and FIG. **14**D are graphs showing emitting properties of a tandem structure organic light emitting diode including an organic compound in an upper exciton blocking layer.

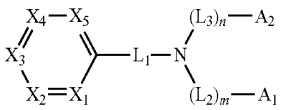
[0035] FIG. **15**A, FIG. **15**B, FIG. **15**C and FIG. **15**D are graphs showing emitting properties of a tandem structure organic light emitting diode including an organic compound in a charge generation layer and a hole transporting layer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] Reference will now be made in detail to the preferred embodiments, examples of which are illustrated in the accompanying drawings.

[0037] In an embodiment of the present invention, an organic compound includes an arylamine moiety and a hetero-aromatic moiety connected (or linked) to a nitrogen atom of the arylamine moiety. The organic compound is represented in Formula 1.

[Formula 1]



[0038] In Formula 1, each of X_1 to X_5 is independently CR or N, and at least one of X_1 to X_5 is N. R is selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkyl-halide group, halogen, substituted or non-substituted C_1 to C_{20} alkyl group, substituted or non-substituted C_1 to C_{20} alkoxy group, substituted or non-substituted C_5 to C_{30} aryl group, substituted or non-substituted C_5 to C_{30} heteroaryl group, substituted or non-substituted C_6 to C_{30} arylalkyl group, substituted or non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted or non-substituted C_6 to C_{30} aryloxyl group, substituted or non-substituted C_6 to C_{30} heteroaryloxyl group, substituted or non-substituted C_1 to C_{20} alkylamine group, substituted or non-substituted C_5 to C_{30} arylamine group, substituted or non-substituted C_5 to C_{30} hetero-arylamine group, substituted or non-substituted C_1 to C_{30} alkylsilyl group, substituted or non-substituted C_5 to C_{30} arylsilyl group and substituted or non-substituted C_5 to C_{30}hetero-arylsilyl group.

[0039] Each of A_1 and A_2 is independently selected from the group consisting of substituted or non-substituted C_1 to C_{20} alkyl group, substituted or non-substituted C_1 to C_{20} alkoxy group, substituted or non-substituted C_5 to C_{30}aryl group, substituted or non-substituted C_5 to C_{30} heteroaryl group, substituted or non-substituted C_6 to C_{30}arylalkyl group, substituted or non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted or non-substituted C_5 to C_{30} aryloxyl group, substituted or non-substituted C_5 to C_{30} heteroaryloxyl group, substituted or non-substituted C_1 to C_{20} alkylamine group, substituted or non-substituted C_5 to C_{30} arylamine group and substituted or non-substituted C_5 to C_{30} hetero-arylamine group.

[0040] Each of L_1 to L_3 is independently selected from the group consisting of substituted or non-substituted C_5 to C_{30} arylene group, substituted or non-substituted C_5 to C_{30} heteroarylene group, substituted or non-substituted C_6 to C_{30} arylalkylene group, substituted or non-substituted C_6 to C_{30} hetero-arylalkylene group, substituted or non-substituted C_6 to C_{30} aryloxylene group and substituted or non-substituted C_6 to C_{30} hetero-aryloxylene group, and each of "m" and "n" is 0 (zero) or 1.

[0041] In the term of "substituted", the substituent may include halogen-substituted or non-substituted alkyl group, halogen-substituted or non-substituted alkoxy group, halogen, cyano group, carboxyl group, carbonyl group, amino group, alkylamino group, nitro group, hydroxyl group, sulfonate group, alkyl silyl group, alkoxy silyl group, cycloakyl silyl group, aryl silyl group, substituted or non-substituted aryl group or heteroaryl group, but it is not limited thereto.

[0042] The term of "hetero", which is used in heteroaryl, heteroarylene, and so on, means that at least one carbon atom in the aromatic ring or alicyclic ring is substituted by a heteroatom being selected from the group consisting of nitrogen atom (N), oxygen atom (O) and sulfur atom (S).

[0043] When each of A_1 and A_2 is an aromatic ring and some of X_1 to X_5 is CR, each of the fused ring of A_1 and A_2 and R may independently be fused or non-fused homo-aromatic ring, such as phenyl, biphenyl, terphenyl, tetraphenyl, naphtyl, anthracenyl, indenyl, phenalenyl, phenanthrenyl, azulenyl, pyrenyl, fluorenyl, tetracenyl, indacenyl or spiro-fluorenyl, or fused or non-fused hetero-aromatic ring, such as pyrrolyl, pyridyl (or pyridinyl), pyrimidyl (pyrimidinyl), pyrazinyl, pyridazinyl, triazinyl, tetrazinyl, imidazolyl, pyrazolyl, indolyl, carbazolyl, benzocarbazolyl, dibenzocarbazolyl, indolocarbazolyl, indenocarbazolyl, quinolinyl, iso-quinolinyl, phthalazinyl, quinoxalinyl, cinnolinyl, quinazolinyl, benzoquinolinyl, benzo iso-quinolinyl, benzoquinazolinyl, benzoquinoxalinyl, acrydinyl, phenanthrolinyl, furanyl, pyranyl, oxazinyl, oxazolyl, oxadiazolyl, triazolyl, dioxynyl, benzofuranyl, dibenzofuranyl, thiopyranyl, thiazinyl, thiophenyl or N-substituted spiro-fluorenyl.

[0044] For example, each of A_1 and A_2 may be selected from the group consisting of phenyl, biphenyl, terphenyl, where each benzene ring is connected in a meta-position or a para-position, fluorenyl, benzothiophenyl, dibenzothiophenyl, benzofuranyl, dibenzofuranyl, pyrrolyl, pyridinyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazinyl, tetrazinyl, imidazolyl, pyrazolyl, indolyl, carbazolyl, benzocarbazolyl, dibenzocarbazolyl, indolocarbazolyl, indenocarbazolyl, quinolinyl, iso-quinolinyl, phthalazinyl, quinoxalinyl, cinnolinyl, quinazolinyl, benzoquinolinyl, benzo iso-quinolinyl, benzoquinazolinyl and benzoquinoxalinyl.

[0045] Each of L_1 to L_3 may be an aromatic linker. For example, each of L_1 to L_3 may be selected from the group consisting of phenylene, biphenylene, terphenylene, tetraphenylene, indenylene, naphthylene, azulenylene, indacenylene, acenaphthenylene, fluorenylene, spiro-fluorenylene, phenalenylene, phenanthrenylene, anthracenylene, fluoranthrenylene, triphenylenylene, pyrenylene, chrysenylene, naphthacenylene, picenylene, perylenylene, pentaphenylene, hexacenylene, pyrrolylene, imidazolylene, pyrazolylene, pyridinylene, pyrazinylene, pyrimidinylene, pyridazinylene, isoindolylene, indolylene, indazolylene, purinylene, quinolinylene, isoquinolinylene, benzoquinolinylene, phthalazinylene, naphthyridinylene, quinoxalinylene, quinazolinylene, benzo-isoquinolinylene, benzoquinazolinylene, benzoquinoxalinylene, cinnolinylene, phenanthridinylene, acridinylene, phenanthrolinylene, phenazinylene, benzoxazolylene, benzimidazolylene, furanylene, benzofuranylene, thiophenylene, benzothiophenylene, thiazolylene, isothiazolylene, benzothiazolylene, isoxazolylene, oxazolylene, triazolylene, tetrazolylene, oxadiazolylene, triazinylene, dibenzofuranylene, dibenzothiophenylene, carbazolylene, benzocarbazolylene, dibenzocarbazolylene, indolocarbazolylene, indenocarbazolylene, imidazopyrimidinylene and imidazopyridinylene.

[0046] When the number of rings of L_1 and L_2 is increased, the conjugation length of the organic compound is increased such that the energy band gap of the organic compound is decreased. Accordingly, the number of rings of L_1 and L_2 may be 1 or 2, and beneficially 1. To improve the electron injection/transporting property of the organic compound, L_1 and L_2 may be 5-numbered atom ring to 7-numbered atom ring, and beneficially 6-numbered atom ring. In

this instance, each of L_1 and L_2 may be phenylene, pyrrolylene, imidazolylene, pyrazolylene, pyrazinylene, pyrimidinylene, pyridazinylene, furanylene or thiophenylene, but it is not limited thereto.

[0047] The organic compound in Formula 1 has excellent properties, including the hole transporting property, the emitting efficiency and the color purity. When the organic compound is included in the organic layer of an organic light emitting diode, the hole transporting efficiency in the organic light emitting diode is improved such that there is an advantage in the driving voltage. In addition, since the balance of the hole and the electron in the organic light emitting diode is improved, the emitting efficiency is increased.

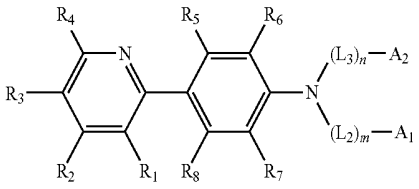
[0048] In an embodiment of the present invention, the organic compound includes an arylamine moiety and a hetero-aromatic moiety directly or indirectly connected to a nitrogen atom of the arylamine moiety. The organic compound may be used for the hole auxiliary layer and/or an electron blocking layer. Due to the organic compound, the hole is efficiently injected and/or transported, and the electron migration to the anode is blocked.

[0049] In addition, when the organic compound, which has excellent hole transporting property, is used for the charge generation layer with a dopant having the deep lowest unoccupied molecular orbital (LUMO), the electron is migrated toward the anode and the hole migrated toward the cathode. Namely, the charge generation property is provided by the organic compound.

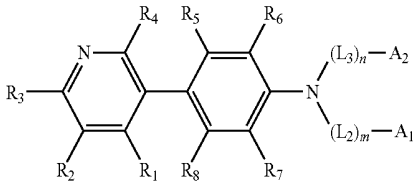
[0050] Namely, the organic compound singly or in combination with the dopant is used for an organic layer, e.g., a hole auxiliary layer such as a hole transporting layer or a hole injection layer, an electron blocking layer and a p-type charge transporting layer.

[0051] The organic compound, which includes an arylamine moiety and a pyridine moiety connected to a nitrogen atom of the arylamine moiety via a phenelene linker, may be represented in one of Formulas 2a to 2c.

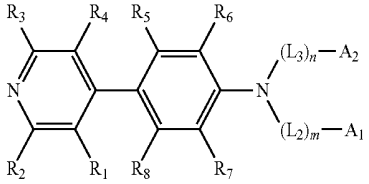
[Formula 2a]



[Formula 2b]



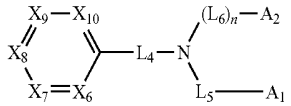
[Formula 2c]



[0052] In Formulas 2a to 2c, each of R_1 to R_8 may be independently selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkylhalide group, halogen, substituted or non-substituted C_1 to C_{20} alkyl group, substituted or non-substituted C_1 to C_{20} alkoxy group, substituted or non-substituted C_5 to C_{30} aryl group, substituted or non-substituted C_5 to C_{30} heteroaryl group, substituted or non-substituted C_6 to C_{30} arylalkyl group, substituted or non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted or non-substituted C_6 to C_{30} aryloxyl group, substituted or non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted or non-substituted C_1 to C_{20} alkylamine group, substituted or non-substituted C_5 to C_{30} arylamine group, substituted or non-substituted C_5 to C_{30} hetero-arylamine group, substituted or non-substituted C_1 to C_{30} alkylsilyl group, substituted or non-substituted C_5 to C_{30} arylsilyl group and substituted or non-substituted C_5 to C_{30} hetero-arylsilyl group. A_1, A_2, L_2, L_3, m and n are same as defined in Formula 1.

[0053] On the other hand, the organic compound, which includes an arylamine moiety and a hetero-aromatic moiety connected to a nitrogen atom of the arylamine moiety via a phenelene linker, may be represented in one of Formula 3.

[Formula 3]

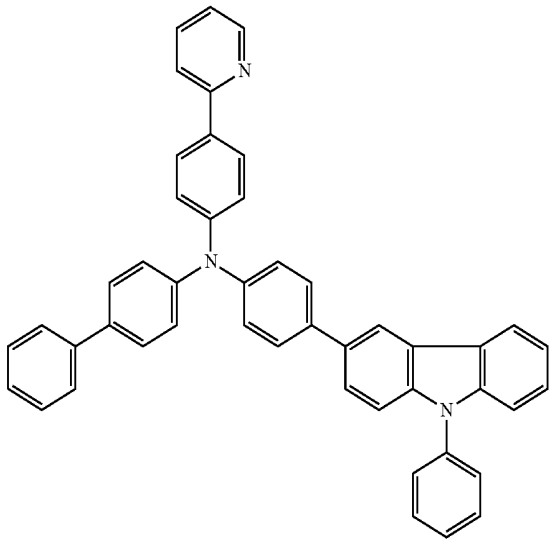


[0054] In Formula 3, one of X_6 to X_{10} is N, and the rest of X_6 to X_{10} is CR. R, A_1, A_2, n are same as defined in Formula 1. Each of L_4 to L_6 is substituted or non-substituted phenylene.

[0055] The organic compound of the present invention may be one of the materials in Formula 4.

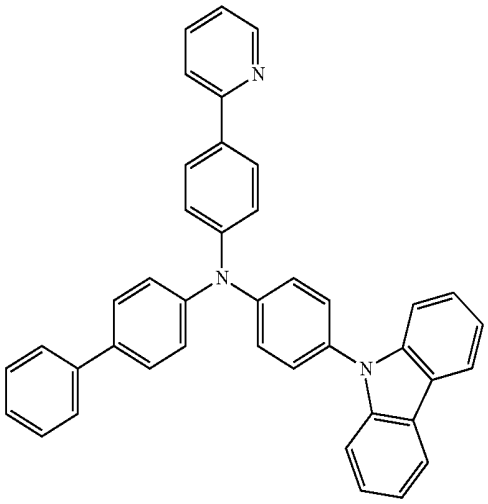
[Formula 4]

H-01

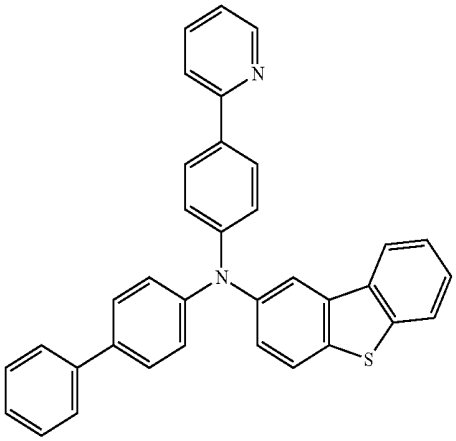


-continued

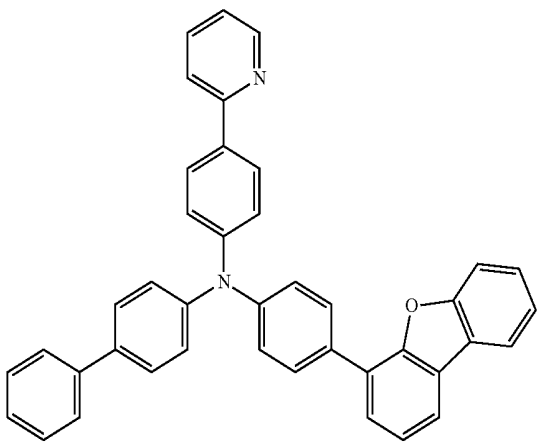
H-02



H-03

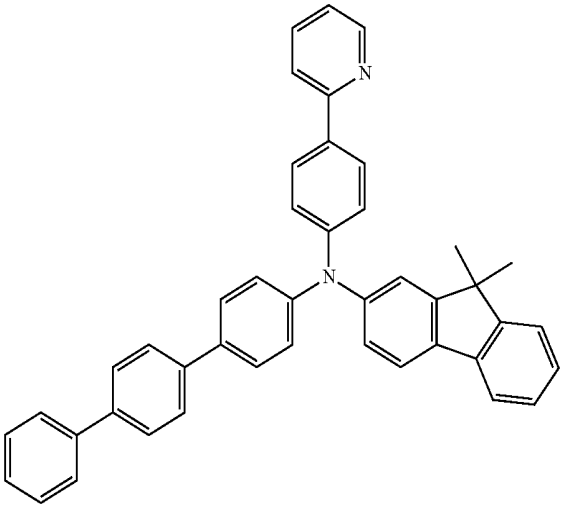


H-04

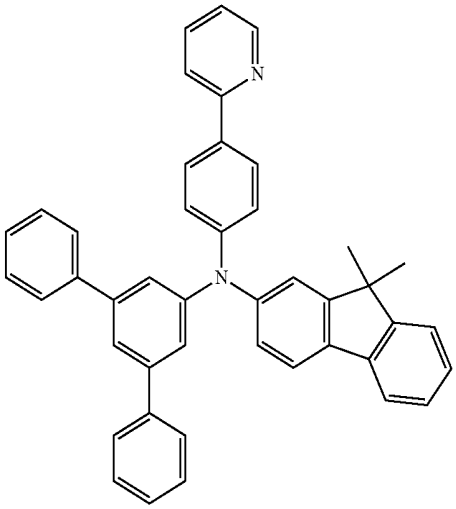


-continued

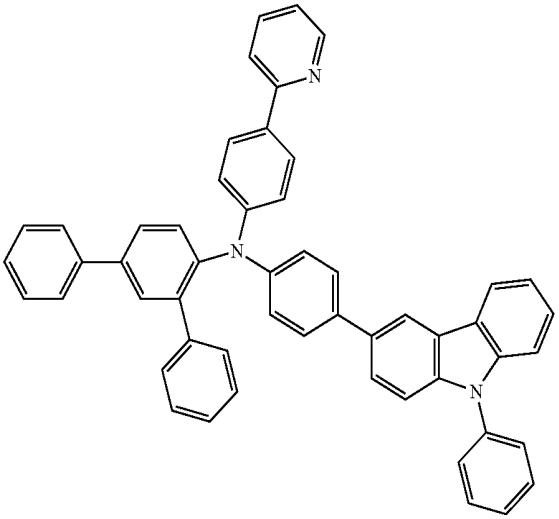
H-05



H-06

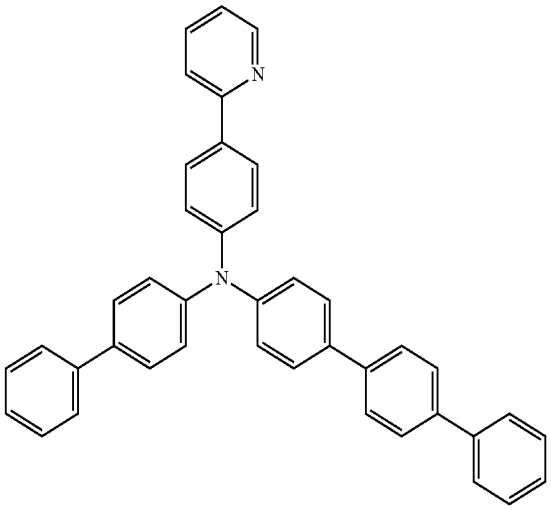


H-07

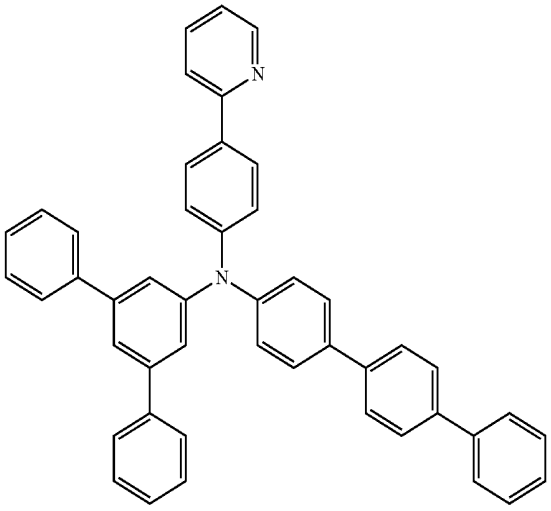


-continued

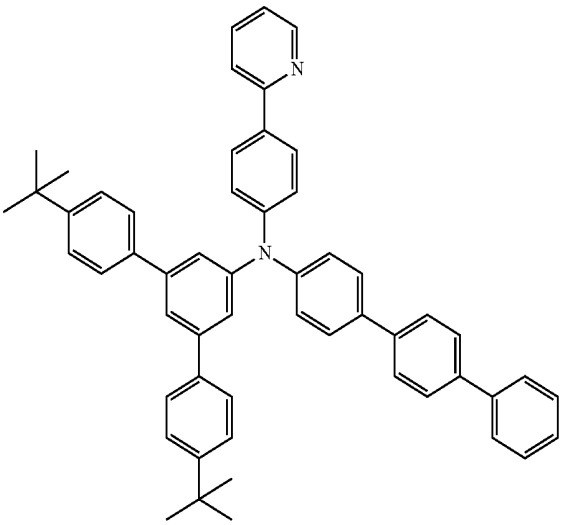
H-08



H-09

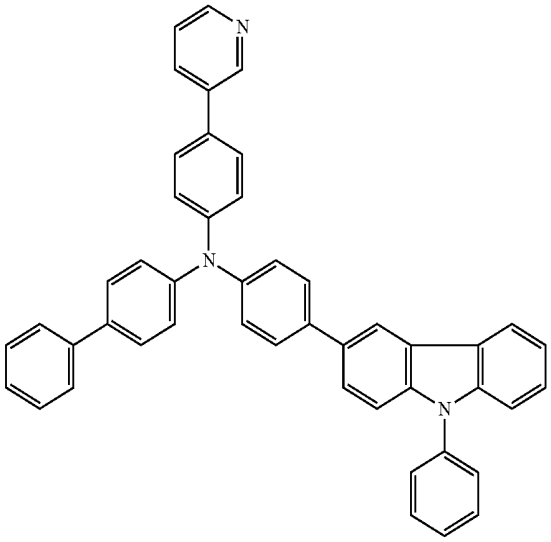


H-10

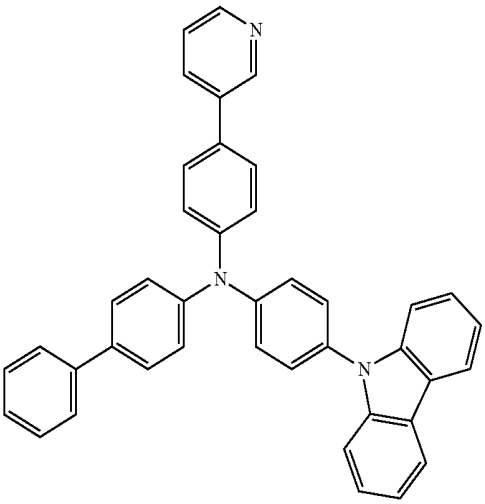


-continued

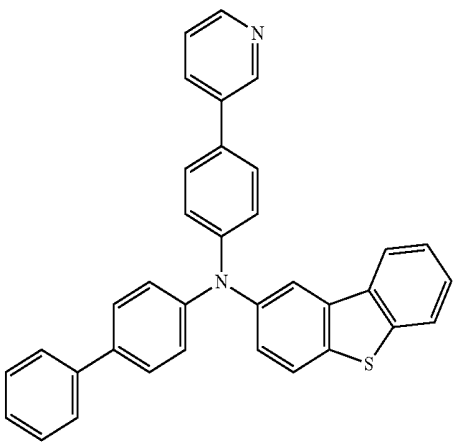
H-11



H-12

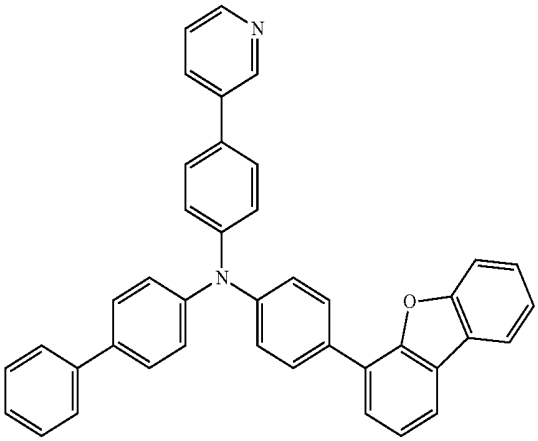


H-13

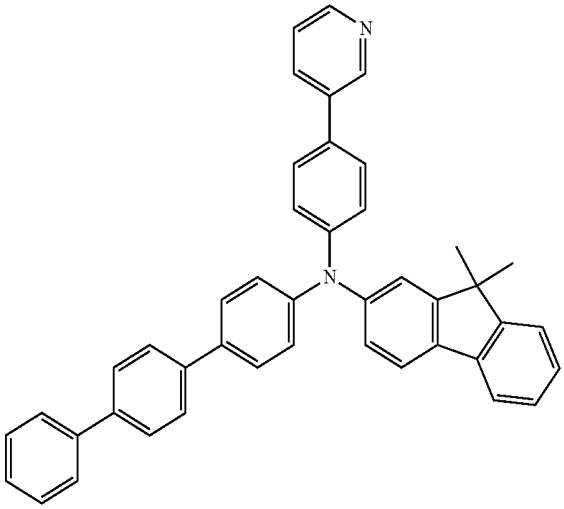


-continued

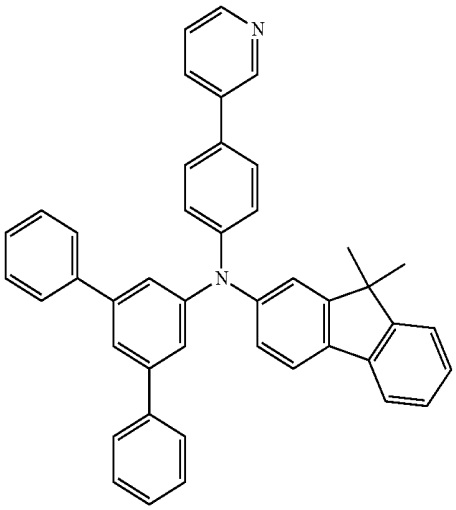
H-14



H-15

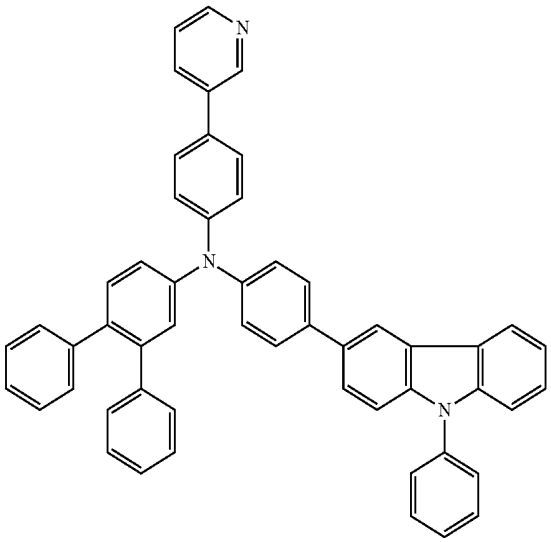


H-16

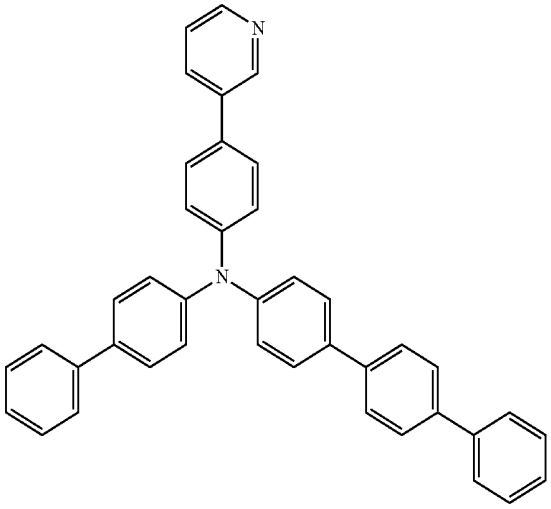


-continued

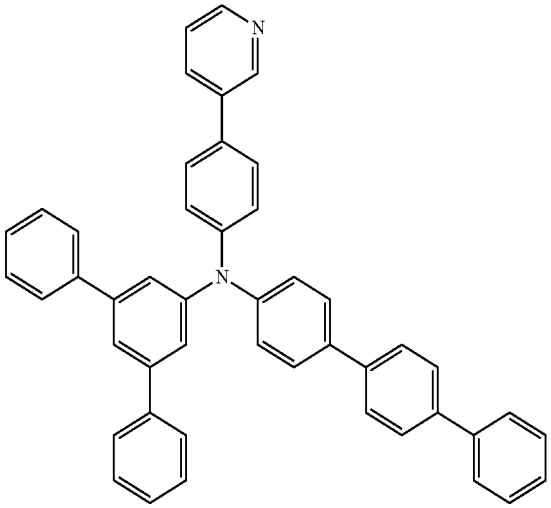
H-17



H-18

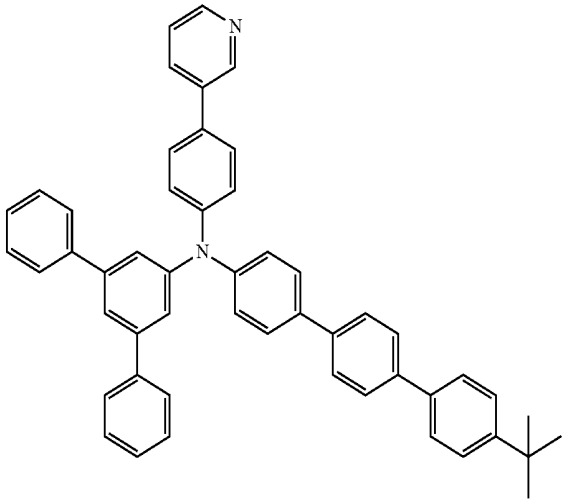


H-19

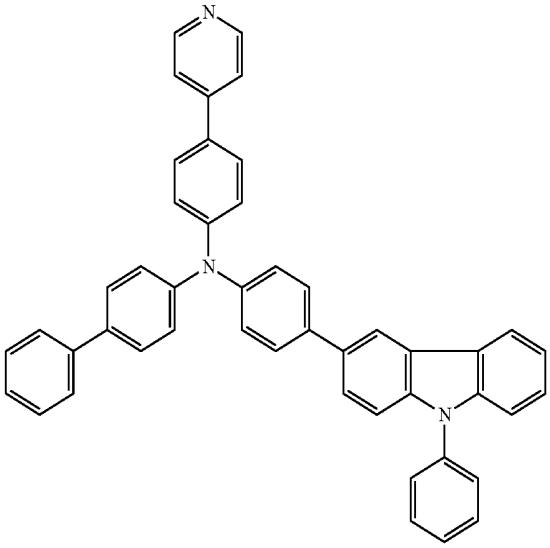


-continued

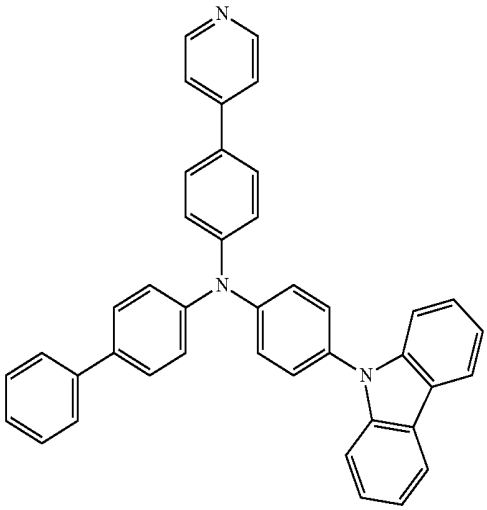
H-20



H-21

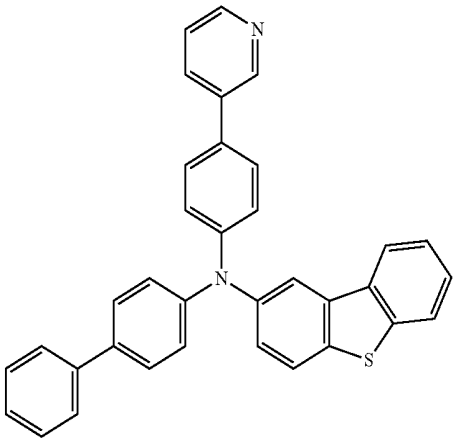


H-22

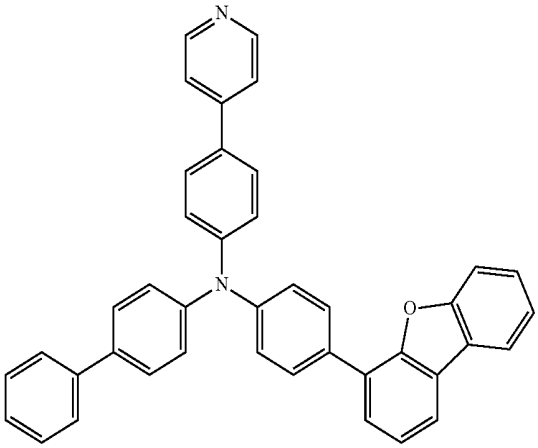


-continued

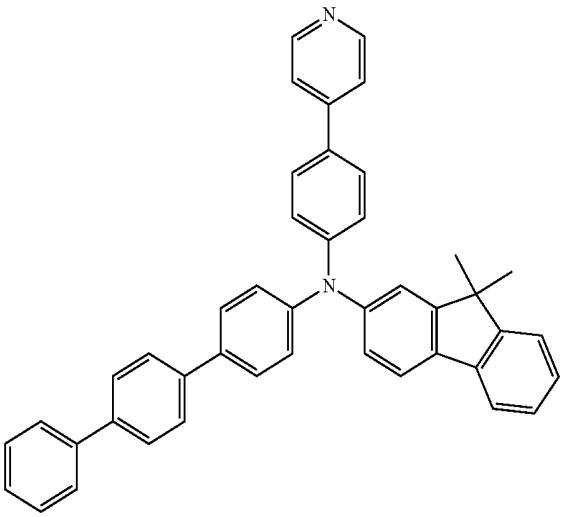
H-23



H-24

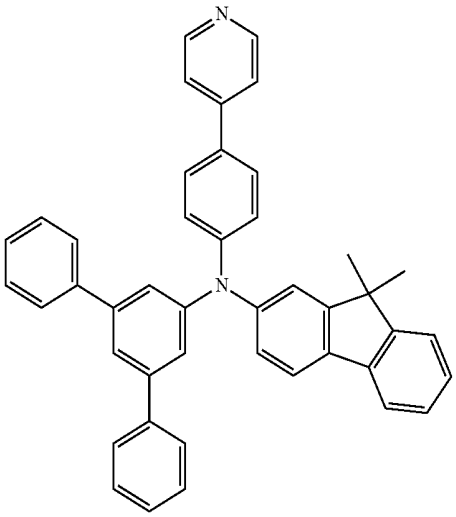


H-25

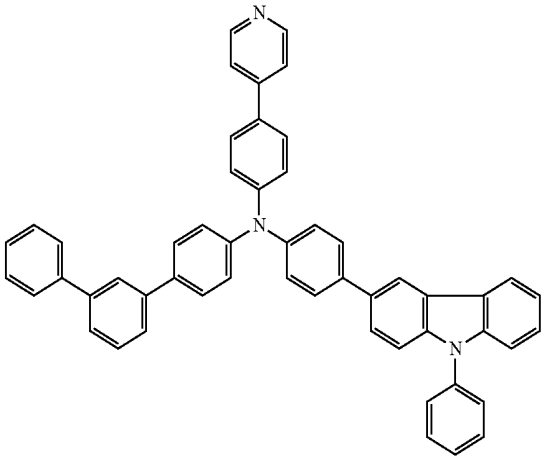


-continued

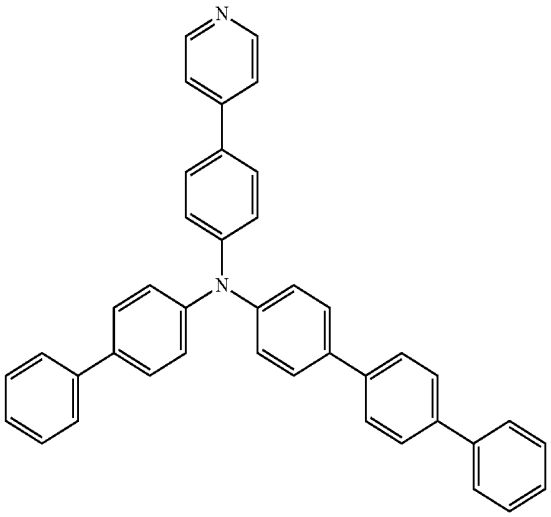
H-26



H-27

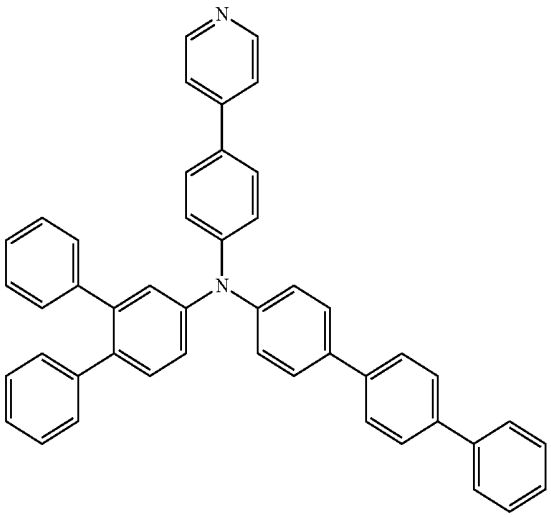


H-28

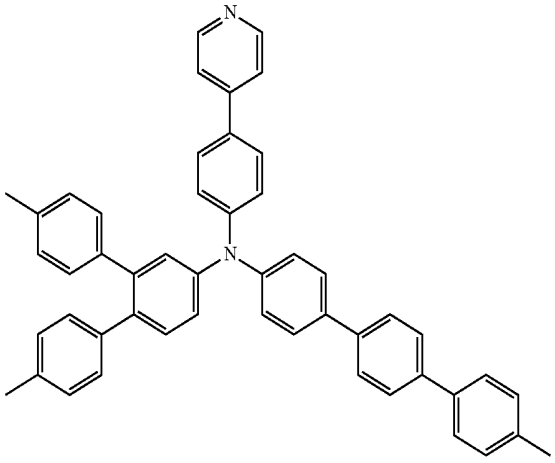


-continued

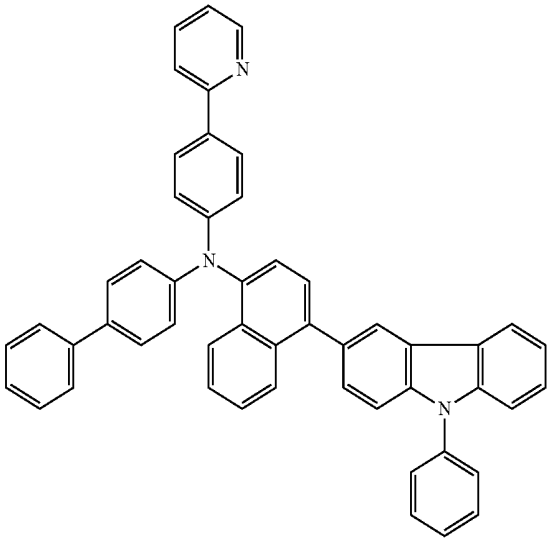
H-29



H-30

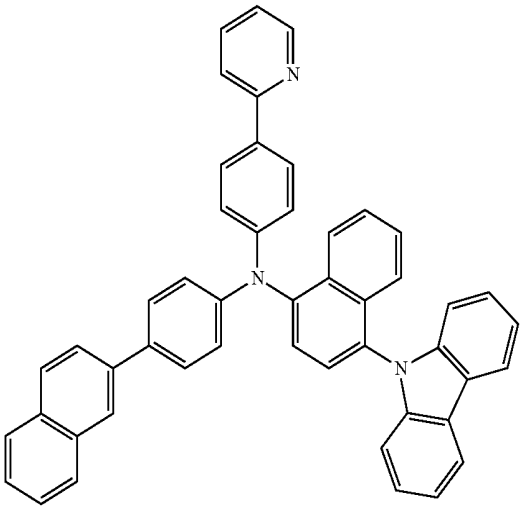


H-31

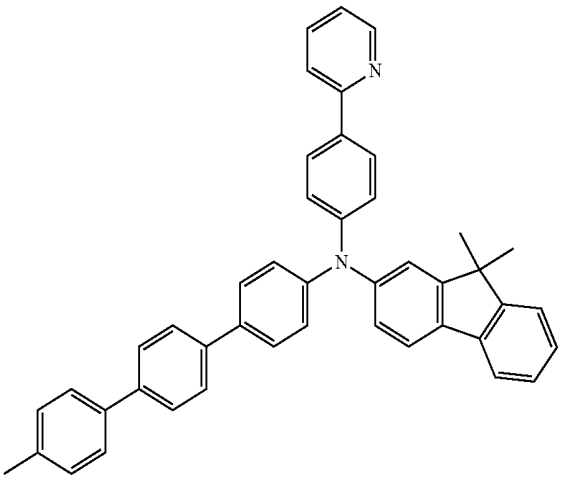


-continued

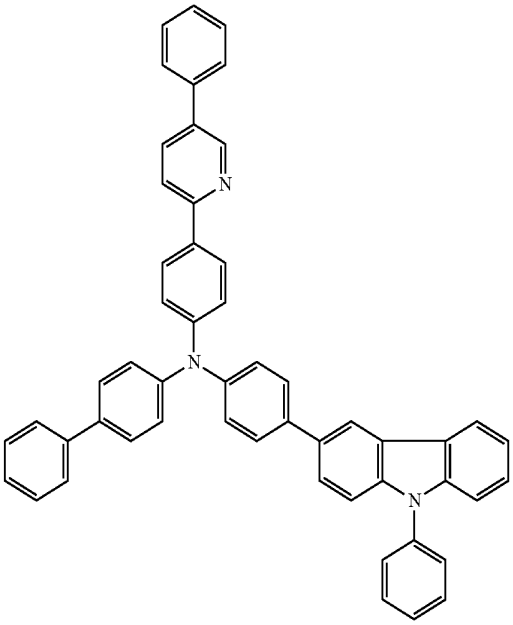
H-32



H-33

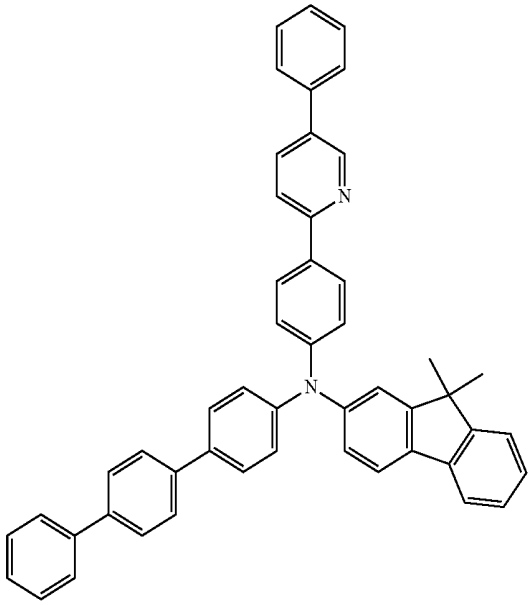


H-34

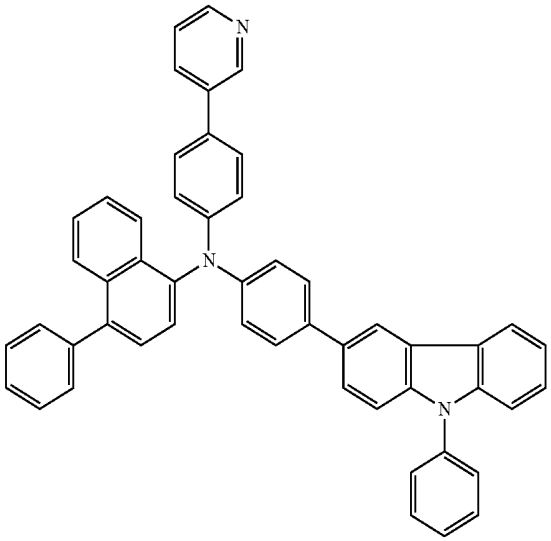


-continued

H-35

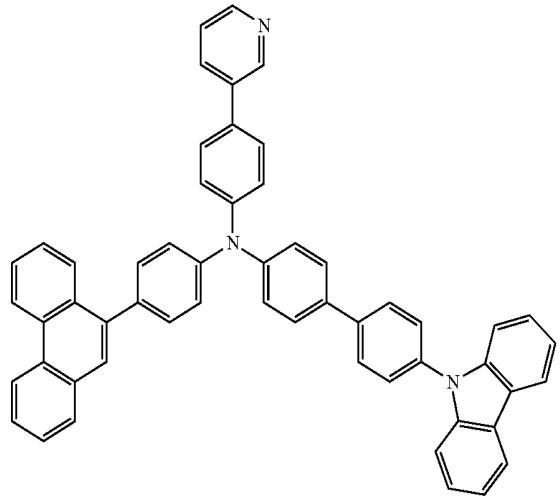


H-36

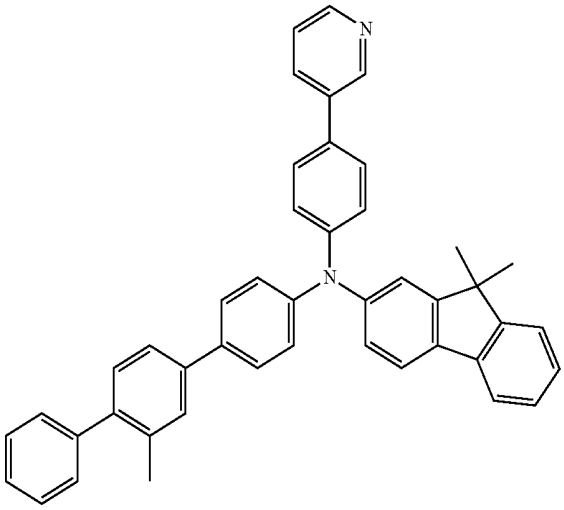


-continued

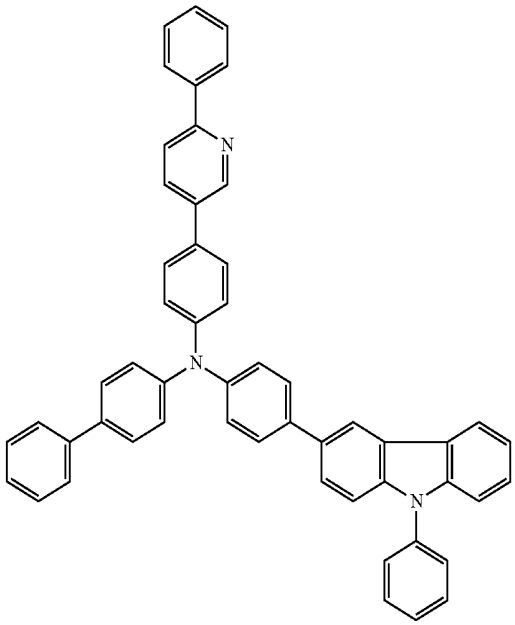
H-37



H-38

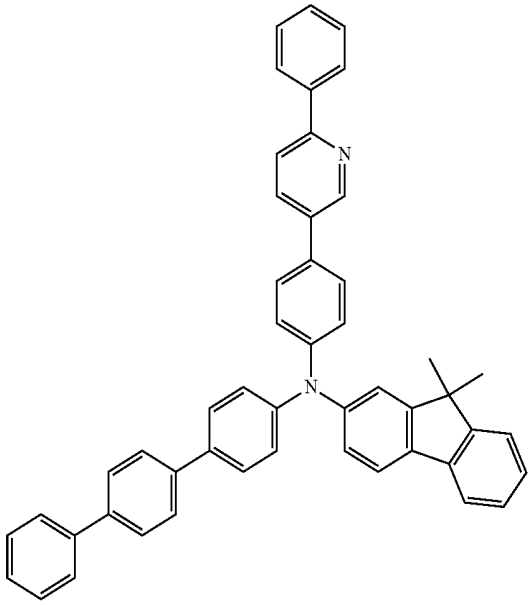


H-39

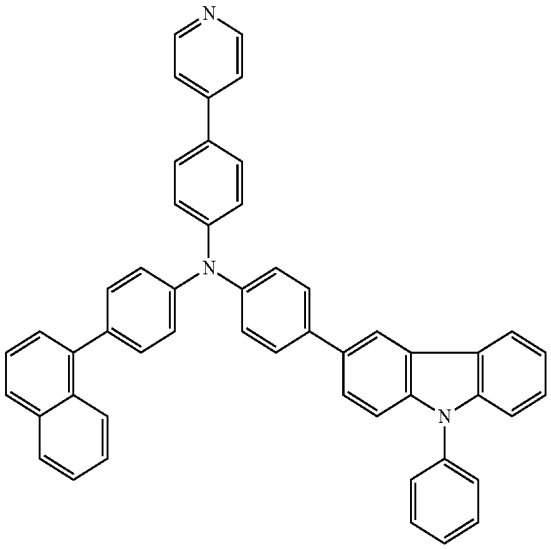


-continued

H-40

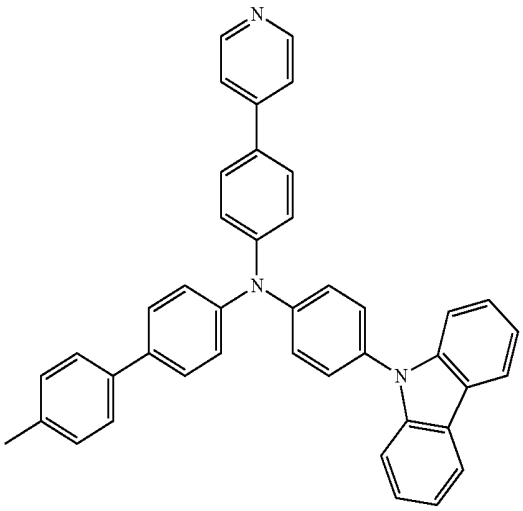


H-41

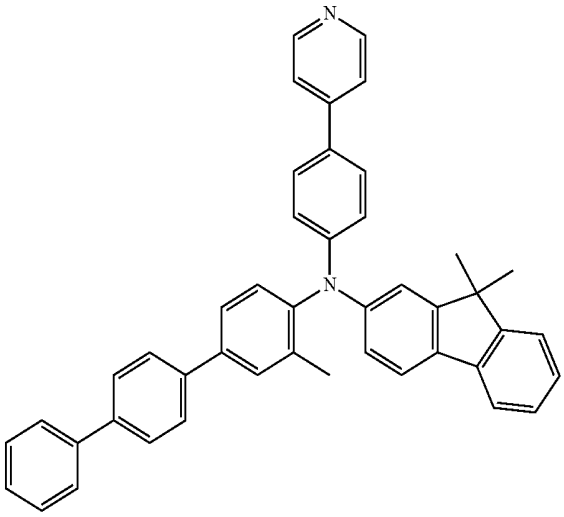


-continued

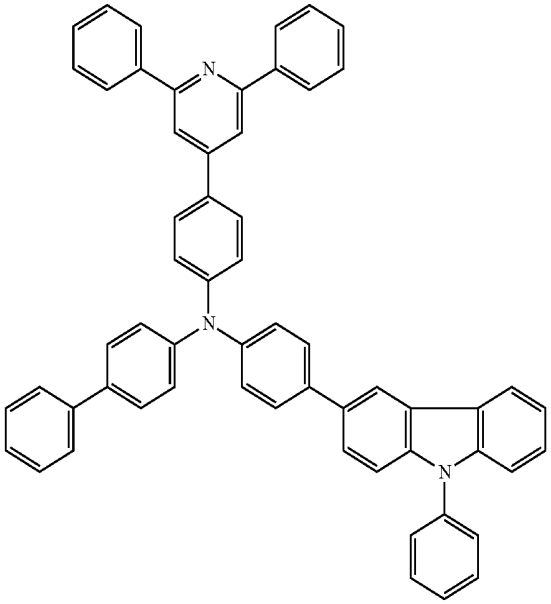
H-42



H-43

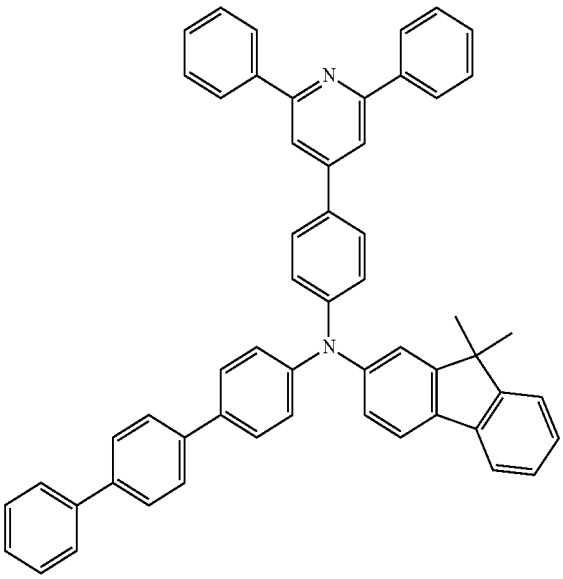


H-44

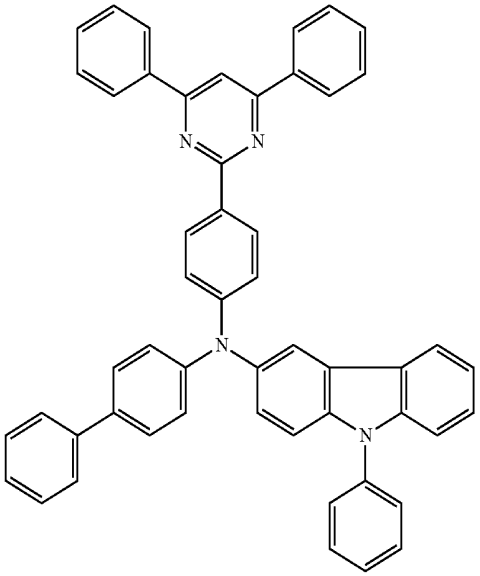


-continued

H-45

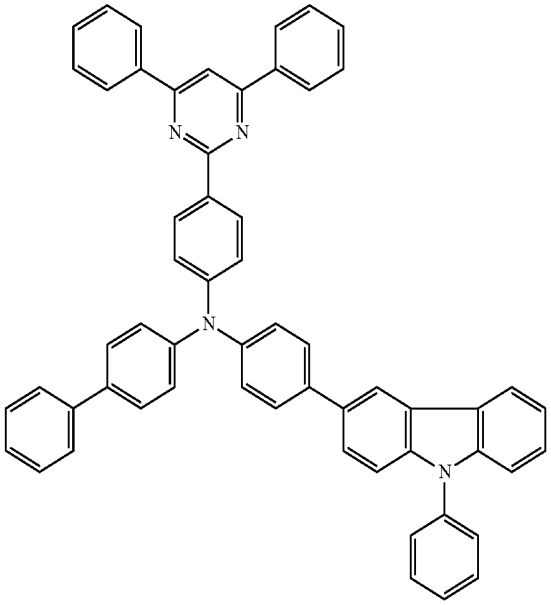


H-46

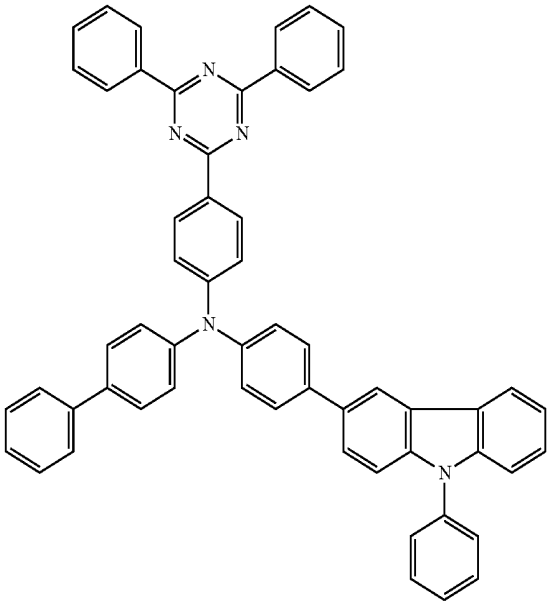


-continued

H-47

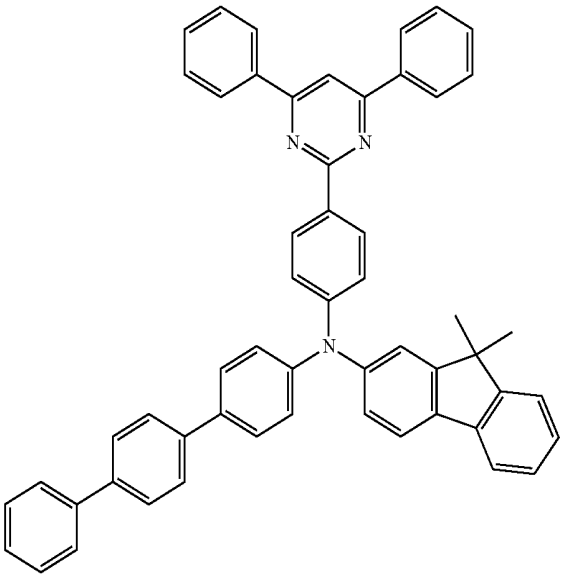


H-48

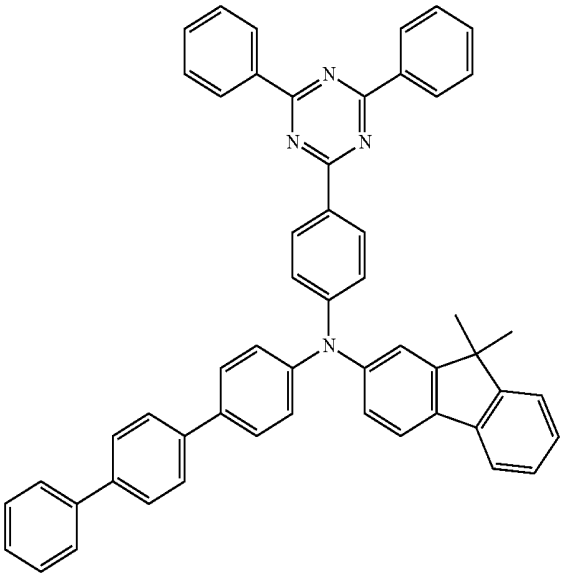


-continued

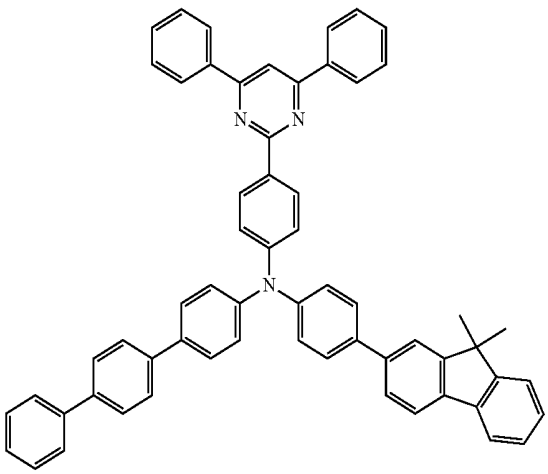
H-49



H-50

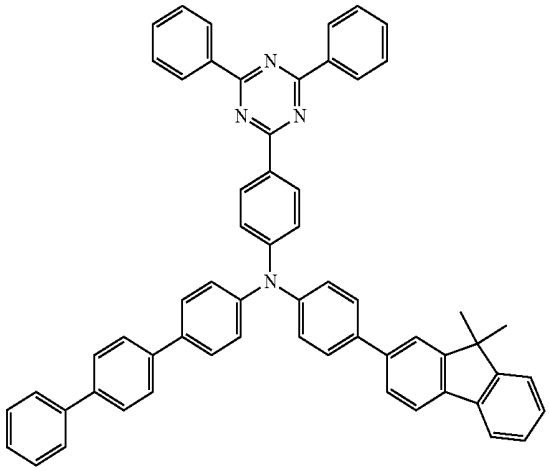


H-51



-continued

H-52



[0056] Since the organic compound of the present invention has an excellent hole transporting property, when the organic compound is included in the organic layer of an organic light emitting diode, the hole transporting efficiency in the organic light emitting diode is improved such that there is an advantage in the driving voltage. In addition, since the balance of the hole and the electron in the organic light emitting diode is improved, the emitting efficiency is increased. Moreover, since the stress on the organic materials by high driving voltage is decreased, the life time and the emitting efficiency are improved.

[0057] The organic compound singly or in combination with the dopant is used for an organic layer, e.g., a hole auxiliary layer such as a hole transporting layer or a hole injection layer, an electron blocking layer and a p-type charge transporting layer.

[0058] FIG. **1** is a schematic cross-sectional view of an organic light emitting diode according to a first embodiment of the present invention.

[0059] As shown in FIG. **1**, the organic light emitting diode **100** includes a first electrode **110**, a second electrode **120**, an emitting part **130** between the first and second electrodes **110** and **120**. The emitting part **130** includes a hole auxiliary layer **140**, which may include a hole injection layer (HIL) **150** and a hole transporting layer (HTL) **160**, an emitting material layer (EML) **170**, an electron transporting layer (ETL) 180 and an electron injection layer (EIL) **190** sequentially stacked on the first electrode **110**. The organic light emitting diode **100** may further include an electron blocking layer (EBL) **166** between the hole auxiliary layer **140** and the EML **170**. The EBL **166** may be omitted.

[0060] The first electrode **110** as an anode includes a high work function conductive material, e.g., indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

[0061] The second electrode **120** as a cathode includes a low work function conductive material, e.g., aluminum (Al), magnesium (Mg), calcium (Ca), silver (Ag) or their alloy.

[0062] The EML **170** may include a host and a dopant.

[0063] For example, the EML **170** in a blue pixel may include an anthracene derivative compound, a pyrene derivative compound and a perylene derivative compound as the host and the dopant doped to the host.

[0064] For example, a fluorescent host material, such as 4,4'-bis(2,2'-diphenylyinyl)-1,1'-biphenyl (DPVBi), 9,10-di-(2-naphtyl)anthracene (AND), tetra-t-butylperylene (TBADN), 2-tert-butyl-9,10-di(2-naphthyl)anthracene, 2-methyl-9, 10-di(2-naphtyl)anthracene (MADN), or 2,2', 2"-(1,3,5-benzinetriyl)-tris(1-phenyl-1-H-benzimidazole (TBPi), may be used. A fluorescent dopant material, such as 4,4'-bis(9-ethyl-3-carbazovinylene)-1,1'-biphenyl (BCz-VBi) or diphenyl-[4-(2-[1,1;4,1]terphenyl-4-yl-vinyl)-phenyl]-amine (BD-1) may be used.

[0065] The EML **170** in a green pixel may include a carbazole derivative compound as a phosphorescent host and a metal complex, e.g., dp2Ir(acac) or op2Ir(acac), as a phosphorescent dopant. The EML **170** in a red pixel may include a carbazole derivative compound as a phosphorescent host and a metal complex, e.g., Btp2Ir(acac), as a phosphorescent dopant. The dopant may have a weight % of about 1 to 30 with respect to the host.

[0066] The ETL **180** is positioned between the EML **170** and the second electrode **120**, and the EIL **190** is positioned between the ETL **180** and the second electrode **120**. The ETL **180** may be formed of a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole, benzimidazole or triazine. For example, the ETL **180** may be formed of an electron transporting material selected from the group consisting of tris-(8-hydroxyquinoline aluminum (Alq3), 2-biphenyl-4-yl-5-(4-t-butylphenyl)-1,3,4-oxadiazole (PBD), spiro-PBD, Liq, 2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazol, 3-(biphenyl-4-yl)-5-(4-tertbutylphenyl)-4-phenyl-4H-1,2,4-triazole (TAZ), 4,7-diphenyl-1,10-phenanthroline (Bphen), tris(phenylquinoxaline (TPQ) and 1,3,5-tris(N-phenylbenzimiazole-2-yl)benzene (TPBI), but it is not limited thereto.

[0067] Alternatively, the ETL **180** may include the above electron transporting material and a metal, e.g., alkali metal or alkali earth metal, as a dopant. In this instance, the dopant may have a weight % of about 1 to 20 with respect to the electron transporting material, but it is not limited thereto. For example, the dopant may be one of Li, Na, K, Cs, Mg, Sr, Ba and Ra, but it is not limited thereto. The ETL **180** may have a single-layered structure or a multi-layered structure.

[0068] The EIL **190** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate, but it is not limited thereto.

[0069] The hole auxiliary layer **140** and the EBL **166** are positioned between the first electrode **110** and the EML **170**. The hole auxiliary layer **140** may include the HIL **150** between the first electrode **110** and the EML **170** and the HTL **160** between the HIL **150** and the EML **170**.

[0070] The interface property between the first electrode **110** of an inorganic material and the HTL **160** of an organic material is improved by the HIL **150**. For example, the HIL **150** may be formed of a hole injection material such as 4,4',4"-tris(3-methylphenylphenylamino)triphenylamine (MTDATA), copper phthalocyanine (CuPc), Tris(4-carbazoyl-9-yl-phenyl)amine (TCTA), N,N'-diphenyl-N,N'-bis(1-naphthyl)-1,1'-biphenyl-4,4 "-diamine (NPB or NPD), 1,4,5,8,9,11-hexaazatriphenylenehexacarbonitrile (HATCN), 1,3,5-tris[4-(diphenylamino)phenyl]benzene (TDAPB), poly(3,4-ethylenedioxythiphene)polystyrene sulfonate (PEDOT/PSS), 2,3,5, 6-tetrafluoro-7,7, 8, 8-tetracyanoquinodi-

methane (F4TCNQ) or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine.

[0071] Alternatively, the organic compound of the present invention may be doped into the hole injection material to form the HIL **150**. In this instance, the organic compound of the present invention may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0072] The HIL **150** may have a double-layered structure. In this instance, a lower layer (first HIL) of the HIL **150**, which is closer to the first electrode **110** than the an upper layer (second HIL) of the HIL **150**, may include the hole injection material without the organic compound of the present invention, and the upper layer of the HIL **150**, which is positioned between the lower layer and the HTL **160**, may include the hole injection material with the organic compound of the present invention.

[0073] The HTL **160** is positioned between the HIL **150** and the EML **170** to be adjacent to the EML **170**. The HTL **160** may include only the organic compound of the present invention or may include the organic compound and a hole transporting dopant. For example, the hole transporting dopant may be one of N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine (TPD), NPD and 4,4'-bis(N-carbazolyl)-1,1'-biphenyl (CBP). The hole transporting dopant may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0074] When the hole is migrated toward the second electrode **120** or the electron is migrated toward the first electrode **110** beyond the EML **170**, the lifetime and the emitting efficiency of the organic light emitting diode may be decreased. To prevent this problem, the organic light emitting diode in an embodiment of the present invention may include an exciton blocking layer at an upper side or a lower side of the EML **170**.

[0075] For example, the EBL **166** is formed between the hole auxiliary layer **140** and the EML **170** to block the migration of the electron. The EBL **166** may include the organic compound in an embodiment of the present invention.

[0076] Although not shown, a hole blocking layer may be formed between the EML **170** and the ETL **180** to block the migration of the hole. For example, the hole blocking layer may include a material of the ETL **180**, such as a derivative of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole, benzimidazole or triazine. The hole blocking layer may include a material having a relatively low highest occupied molecular orbital (HOMO), such as 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP) or bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum (III) (BAlq).

[0077] The organic light emitting diode **100** according to the first embodiment of the present invention includes the first electrode **110** and the second electrode **120**, the emitting part **130** including the EML **170**, the hole auxiliary layer **140**, optionally the EBL **166**, and at least one of the hole auxiliary layer **140** and the EBL **166** includes the organic compound of the present invention.

[0078] Since the organic compound of the present invention has an excellent hole transporting property, the organic compound singly or in combination with a dopant is used for the hole auxiliary layer **140** and/or the EBL **166** such that the driving voltage and the power consumption of the organic light emitting diode **100** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **100** is improved.

[0079] FIG. **2** is a schematic cross-sectional view of an organic light emitting diode according to a second embodiment of the present invention.

[0080] As shown in FIG. **2**, the organic light emitting diode **200** includes a first electrode **210**, a second electrode **220**, an emitting part **230** between the first electrode **210** and the second electrode **220**. The emitting part **230** includes a hole auxiliary layer **240**, an EBL **266**, an EML **270**, an ETL **280** and an EIL **290**. The hole auxiliary layer **240** and the EBL **266** are positioned between the first electrode **210** and the EML **270**, and the ETL **280** and the EIL **290** are positioned between the EML **270** and the second electrode **220**. The hole auxiliary layer **240** includes an HIL **250** and an HTL **260** including a first HTL **262** and a second HTL **264**.

[0081] As mentioned above, the first electrode **210** as an anode includes a high work function conductive material, and the second electrode **220** as a cathode includes a low work function conductive material. The EML **270** may include a host and a dopant. The ETL **280** may include a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole, benzimidazole or triazine. The ETL **280** may further include alkali metal or alkali earth metal as a dopant. The EIL **290** between the ETL **280** and the second electrode **220** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate.

[0082] The interface property between the first electrode **210** of an inorganic material and the HTL **260** of an organic material is improved by the HIL **250**. For example, the HIL **250** may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, the organic compound of the present invention may be doped into the hole injection material to form the HIL **250**. In addition, the HIL **250** may include a lower layer (first HIL) of the HIL **250**, which may include the hole injection material without the organic compound of the present invention, and the upper layer of the HIL **250**, which may include the hole injection material with the organic compound of the present invention.

[0083] The HTL **260** includes the first HTL **262**, which is closer to the HIL **250** than the second HTL **264**, and the second HTL **262**, which is closer to the EML **270** than the first HTL **262**.

[0084] For example, the first HTL **262** may include the organic compound of the present invention and a hole transporting dopant, e.g., TPD, NPD or CBP. The hole transporting dopant may have a weight % of about 0.1 to 50, but it is not limited thereto. The second HTL **264** may include the organic compound of the present invention without the hole transporting dopant.

[0085] Alternatively, the first HTL **262** may include the organic compound of the present invention without the hole transporting dopant, and the second HTL **264** may include the organic compound of the present invention and the hole transporting dopant.

[0086] The EBL **266** is formed between the hole auxiliary layer **240** and the EML **270** to block the migration of the

electron. The EBL **266** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the EML **270** and the ETL **280** to block the migration of the hole.

[0087] In the organic light emitting diode **200**, the HTL **260** has a double-layered structure. One of the HTL **260** only includes the organic compound of the present invention (i.e., without the hole transporting dopant), and the other one of the HTL **260** includes the organic compound of the present invention with the hole transporting dopant.

[0088] The organic light emitting diode **200** according to the second embodiment of the present invention includes the first electrode **210** and the second electrode **220**, the emitting part **230** including the EML **270**, the hole auxiliary layer **240**, optionally the EBL **266**, and at least one of the hole auxiliary layer **240** and the EBL **266** includes the organic compound of the present invention. In addition, the HTL **260** includes a first layer only including the organic compound of the present invention and a second layer including the organic compound of the present invention with the hole transporting dopant.

[0089] Since the organic compound of the present invention has an excellent hole transporting property, the organic compound singly or in combination with a dopant is used for the hole auxiliary layer **240** and/or the EBL **266** such that the driving voltage and the power consumption of the organic light emitting diode **200** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **200** is improved.

[0090] FIG. **3** is a schematic cross-sectional view of an organic light emitting diode according to a third embodiment of the present invention.

[0091] As shown in FIG. **3**, the organic light emitting diode **300** includes a first electrode **310**, a second electrode **320**, an emitting part **330** between the first electrode **310** and the second electrode **320**. The emitting part **330** includes a doped-HTL **360**, an EBL **366**, an EML **370**, an ETL **380** and an EIL **390**. The doped-HTL **360** and the EBL **366** are positioned between the first electrode **310** and the EML **370**, and the ETL **380** and the EIL **390** are positioned between the EML **370** and the second electrode **320**.

[0092] As mentioned above, the first electrode **310** as an anode includes a high work function conductive material, and the second electrode **320** as a cathode includes a low work function conductive material. The EML **370** may include a host and a dopant. The ETL **380** may include a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole, benzimidazole or triazine. The ETL **380** may further include alkali metal or alkali earth metal as a dopant. The EIL **390** between the ETL **380** and the second electrode **320** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate.

[0093] The doped-HTL **360** between the first electrode **310** and the EML **370** includes the organic compound of the present invention and a hole injection dopant such as MTDATA, CuPc, TCTA, NPB(NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. The hole injection dopant may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0094] The EBL **366** is formed between the doped-HTL **360** and the EML **370** to block the migration of the electron. The EBL **366** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the EML **370** and the ETL **380** to block the migration of the hole.

[0095] In the organic light emitting diode **300**, the doped-HTL **360** is formed by doping the hole injection dopant (hole injection material) into the organic compound of the present invention and contacts the first electrode **310** and the EBL **366** (or the EML **370** without the EBL **366**).

[0096] The organic light emitting diode **300** according to the third embodiment of the present invention includes the first and second electrode **310** and **320** and the emitting part **330** including the EML **370**, the doped-HTL **360**, optionally the EBL **366**, and at least one of the doped-HTL **360** and the EBL **366** includes the organic compound of the present invention.

[0097] Since the organic compound of the present invention has an excellent hole transporting property, the doped-HTL **360** has functions of the HIL as well as the HTL. Accordingly, even though the HTL **360** without the HIL is positioned between first electrode **310** and the EML **370**, there are sufficient hole injection and transporting properties.

[0098] The organic compound singly or in combination with a dopant is used for the doped-HTL **360** and/or the EBL **366** such that the driving voltage and the power consumption of the organic light emitting diode **300** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **300** is improved.

[0099] FIG. **4** is a schematic cross-sectional view of an organic light emitting diode according to a fourth embodiment of the present invention.

[0100] As shown in FIG. **4**, the organic light emitting diode **400** includes a first electrode **410**, a second electrode **420**, an emitting part **430** between the first and second electrodes **410** and **420**. The emitting part **430** includes an HTL **460**, an EBL **466**, an EML **470**, an ETL **480** and an EIL **490**. The HTL **460** and the EBL **466** are positioned between the first electrode **410** and the EML **470**, and the ETL **480** and the EIL **490** are positioned between the EML **470** and the second electrode **420**. The HTL **460** includes a first HTL **462** as a doped-HTL and a second HTL **464**.

[0101] As mentioned above, the first electrode **410** as an anode includes a high work function conductive material, and the second electrode **420** as a cathode includes a low work function conductive material. The EML **470** may include a host and a dopant. The ETL **480** may include a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole, benzimidazole or triazine. The ETL **480** may further include alkali metal or alkali earth metal as a dopant. The EIL **490** between the ETL **480** and the second electrode **420** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate.

[0102] The HTL **460** includes the first HTL **462** and the second HTL **464** sequentially stacked on the first electrode **420**. Namely, the first HTL **462** is positioned between the first electrode **420** and the second HTL **464**.

[0103] The first HTL **462** includes the organic compound of the present invention and a hole injection dopant such as MTDATA, CuPc, TCTA, NPB(NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-

amine. The hole injection dopant may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0104] The second HTL **464**, which is positioned between the first HTL **462** and the EML **470**, includes only the organic compound of the present invention or includes the organic compound of the present invention and a hole transporting dopant, e.g., TPD, NPD or CBP. The hole transporting dopant may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0105] Namely, in comparison to the organic light emitting diode according to the third embodiment (FIG. **3**), the organic light emitting diode according to the fourth embodiment includes the second HTL **464**, which includes the organic compound of the present invention with or without the hole transporting dopant, as well as the first HTL **462** as the doped-HTL.

[0106] The EBL **466** is formed between the HTL **460** and the EML **470** to block the migration of the electron. The EBL **466** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the EML **470** and the ETL **480** to block the migration of the hole.

[0107] The organic light emitting diode **400** according to the fourth embodiment of the present invention includes the first **410** and the second electrode **420** and the emitting part **430** including the EML **470**, the HTL **460**, optionally the EBL **466**, and at least one of the HTL **460** and the EBL **466** includes the organic compound of the present invention. In addition, the HTL **460** includes the first HTL **462** including the organic compound of the present invention with the hole injection dopant and the second HTL **464** including the organic compound of the present invention with or without the hole transporting dopant.

[0108] Since the organic compound of the present invention has an excellent hole transporting property, the first HTL **462**, where the hole injection dopant is doped, has functions of the HIL as well as the HTL. In addition, since the second HTL, which includes the organic compound of the present invention with or without the hole transporting dopant, is further formed between the first HTL **462** and the EML **470**, the hole is further efficiently provided into the EML **470**.

[0109] The organic compound singly or in combination with a dopant is used for the HTL **460** and/or the EBL **466** such that the driving voltage and the power consumption of the organic light emitting diode **400** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **400** is improved.

[0110] FIG. **5** is a schematic cross-sectional view of an organic light emitting diode according to a fifth embodiment of the present invention.

[0111] As shown in FIG. **5**, the organic light emitting diode **500** includes a first electrode **510**, a second electrode **520**, a first emitting part **430** (a lower emitting part) between the first and second electrode **510** and **520**, a second emitting part **540** (an upper emitting part) between the first emitting part **530** and the second electrode **520** and a charge generation layer (CGL) **550** between the first and second emitting parts **530** and **540**.

[0112] As mentioned above, the first electrode **510** as an anode includes a high work function conductive material, and the second electrode **520** as a cathode includes a low work function conductive material.

[0113] The first emitting part **530** may include an HIL **532**, a first HTL (a lower HTL) **534**, a first EML (a lower EML) **536** and a first ETL (a lower ETL) **538**, optionally a first EBL (a lower EBL) **535** between the first HTL **534** and the first EML **536**.

[0114] The HIL **532** is positioned between the first electrode **510** and the first EML **536** and may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, the HIL **532** may further include the organic compound of the present invention doped into the hole injection material by a doping ratio of about 0.1 to 50 weight %. Alternatively, the HIL **532** may include a lower layer, which may include the hole injection material without the organic compound of the present invention, and the upper layer, which may include the hole injection material with the organic compound of the present invention.

[0115] The first HTL **534** is positioned between the HIL **532** and the first EML **536**, and the first EML **536** is positioned between the first HTL **534** and the first ETL **538**. The first ETL **538** is positioned between the first EML **536** and the CGL **550**. The first EBL **535** is formed between the first HTL **534** and the first EML **536** to block the migration of the electron. The first EBL **535** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the first EML **536** and the first ETL **538** to block the migration of the hole.

[0116] The second emitting part **540** includes a second HTL (an upper HTL) **542**, a second EML (an upper EML) **544**, a second ETL (an upper ETL) **546** and an EIL **548**, and optionally a second EBL (an upper EBL) **543** between the second HTL **542** and the second EML **544**.

[0117] The second EML **544** is positioned between the second HTL **542** and the second electrode **520**, and the second ETL **546** is positioned between the second EML **544** and the second electrode **520**. In addition, the EIL **548** is positioned between the second ETL **546** and the second electrode **520**.

[0118] Each of the first EML **536** and the second EML **544** may include a host and a dopant. The first EML **536** and the second EML **544** emit the light having different colors. For example, the first EML **536** may emit the blue light, and the second EML **544** may emit the green light, the yellow-green light or the orange light, each of which has a longer wavelength than the blue light. In second EML **544** emitting the yellow-green light, CBP as a host and Ir(2-phq)3 as a dopant may be used.

[0119] Each of the first HTL **534** and the second HTL **542** may include a hole transporting material, such as TPD, NPD and CBP, or include the organic compound of the present invention. Alternatively, each of the first HTL **534** and the second HTL **542** may include the organic compound of the present invention with the above hole transporting material as a hole transporting dopant. The first HTL **534** and the second HTL **542** may be formed of the same material or different materials.

[0120] Each of the first ETL **538** and the second ETL **546** may include an electron transporting material such as a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole or benzimidazole (e.g., 2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole). The EIL **548** may include an alkali

halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate. The first ETL ETL **538** and the second ETL **546** may be formed of the same material or different materials.

[0121] The CGL **550** is positioned between the first emitting part **530** and the second emitting part **540** and includes an N type CGL (N-CGL) **552** adjacent to the first emitting part **530** and a P type CGL (P-CGL) **554** adjacent to the second emitting part **540**. The electron is provided into the first emitting part **530** by the N-CGL **552**, and the hole is provided into the second emitting part **540** by the P-CGL **554**.

[0122] The N-CGL **552** may be an organic layer doped by alkali metal, e.g., Li, Na, or K, or alkali earth metal, e.g., Mg, Ca, Sr, Ba or Ra. For example, the host organic material for the N-CGL **552** may be 4,7-diphenyl-1,10-phenanthroline (Bphen) or MTDATA. The alkali metal or alkali earth metal may be doped by a weight % of about 0.1 to 30.

[0123] The P-CGL **554** includes the organic compound of the present invention. In addition, the P-CGL **554** may further include a hole injection material, e.g., MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine, as a dopant. In this instance, the hole injection material may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0124] The second EBL **543** is formed between the second HTL **542** and the second EML **544** to block the migration of the electron. The second EBL **543** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the second EML **544** and the second ETL **546** to block the migration of the hole.

[0125] As mentioned above, the organic compound of the present invention has excellent hole transporting property. Accordingly, in the tandem structure organic light emitting diode **500** emitting the white light, the organic compound singly or in combination with the dopant is used for at least one of the second HTL **542**, the P-CGL **554** and the second EBL **543** such that the driving voltage and the power consumption of the organic light emitting diode **500** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **500** is improved.

[0126] FIG. **6** is a schematic cross-sectional view of an organic light emitting diode according to a sixth embodiment of the present invention.

[0127] As shown in FIG. **6**, the organic light emitting diode **600** includes a first electrode **610**, a second electrode **620**, a first emitting part **630** (a lower emitting part) between the first and second electrode **610** and **620**, a second emitting part **640** (an upper emitting part) between the first emitting part **630** and the second electrode **620** and a CGL **650** between the first and second emitting parts **630** and **640**.

[0128] As mentioned above, the first electrode **610** as an anode includes a high work function conductive material, and the second electrode **620** as a cathode includes a low work function conductive material.

[0129] The first emitting part **630** may include a first HIL (a lower HIL) **632**, a first HTL (a lower HTL) **634**, a first EML (a lower EML) **636** and a first ETL (a lower ETL) **638**, and optionally a first EBL (a lower EBL) **635** between the first HTL **634** and the first EML **636**.

[0130] The first HIL **632** is positioned between the first electrode **610** and the first EML **636**, and the first HTL **634** is positioned between the first HIL **632** and the first EML **636**. The first EML **636** is positioned between the first HTL **634** and the first ETL **638**, and the first ETL **638** is positioned between the first EML **636** and the CGL **650**. The first EBL **635** is formed between the first HTL **634** and the first EML **636** to block the migration of the electron. The first EBL **635** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the first EML **636** and the first ETL **638** to block the migration of the hole.

[0131] The second emitting part **640** includes a second HIL (an upper HIL) **641**, a second HTL (an upper HTL) **642**, a second EML (an upper EML) **644**, a second ETL (an upper ETL) **646** and an EIL **648**, and optionally a second EBL (an upper EBL) **643** between the second HTL **642** and the second EML **644**.

[0132] The second HIL **641** is positioned between the CGL **650** and the second HTL **642**, and the second HTL **642** is positioned between the second HIL **641** and the second electrode **620**. The second EML **644** is positioned between the second HTL **642** and the second electrode **620**, and the second ETL **646** is positioned between the second EML **644** and the second electrode **620**. In addition, the EIL **648** is positioned between the second ETL **646** and the second electrode **620**.

[0133] Each of the first EML **636** and the second EML **644** may include a host and a dopant. The first EML **636** and the second EML **644** emit the light having different colors. For example, the first EML **636** may emit the blue light, and the second EML **644** may emit the green light, the yellow-green light or the orange light, each of which has a longer wavelength than the blue light.

[0134] Each of the first HIL **632** and the second HIL **641** may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB(NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, each of the first HIL **632** and the second HIL **641** may further include the organic compound of the present invention doped into the hole injection material by a doping ratio of about 0.1 to 50 weight %. The first HIL **632** and the second HIL **641** may be formed of the same material or different materials.

[0135] Each of the first HTL **634** and the second HTL **642** may include a hole transporting material, such as TPD, NPD and CBP, or include the organic compound of the present invention. Alternatively, each of the first HTL **634** and the second HTL **642** may include the organic compound of the present invention with the above hole transporting material as a hole transporting dopant. The first HTL **634** and the second HTL **642** may be formed of the same material or different materials.

[0136] Each of the first ETL **638** and the second ETL **646** may include an electron transporting material such as a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole or benzimidazole (e.g., 2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole). The EIL **648** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq),

lithium benzoate or sodium stearate. The first ETL **638** and the second ETL **646** may be formed of the same material or different materials.

[0137] The CGL **650** is positioned between the first emitting part **630** and the second emitting part **640** and includes an N-CGL **652** adjacent to the first emitting part **630** and a P-CGL **654** adjacent to the second emitting part **640**. The electron is provided into the first emitting part **630** by the N-CGL **652**, and the hole is provided into the second emitting part **640** by the P-CGL **654**.

[0138] The N-CGL **652** may be an organic layer doped by alkali metal, e.g., Li, Na, or K, or alkali earth metal, e.g., Mg, Ca, Sr, Ba or Ra. For example, the host organic material for the N-CGL **652** may be 4,7-diphenyl-1,10-phenanthroline (Bphen) or MTDATA. The alkali metal or alkali earth metal may be doped by a weight % of about 0.1 to 30.

[0139] The P-CGL **654** includes the organic compound of the present invention. In addition, the P-CGL **654** may further include a hole injection material, e.g., MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine, as a dopant. In this instance, the hole injection material may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0140] The second EBL **643** is formed between the second HTL **642** and the second EML **644** to block the migration of the electron. The second EBL **643** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the second EML **644** and the second ETL **646** to block the migration of the hole.

[0141] As mentioned above, the organic compound of the present invention has excellent hole transporting property. Accordingly, in the tandem structure organic light emitting diode **600** emitting the white light, the organic compound singly or in combination with the dopant is used for at least one of the second HIL **641**, the second HTL **642**, the P-CGL **654** and the second EBL **643** such that the driving voltage and the power consumption of the organic light emitting diode **600** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **600** is improved.

[0142] FIG. **7** is a schematic cross-sectional view of an organic light emitting diode according to a seventh embodiment of the present invention.

[0143] As shown in FIG. **7**, the organic light emitting diode **700** includes a first electrode **710**, a second electrode **720**, a first emitting part **730** (a lower emitting part) between the first and second electrode **710** and **720**, a second emitting part **740** (an upper emitting part) between the first emitting part **730** and the second electrode **720** and a CGL **750** between the first and second emitting parts **730** and **740**.

[0144] As mentioned above, the first electrode **710** as an anode includes a high work function conductive material, and the second electrode **720** as a cathode includes a low work function conductive material.

[0145] The first emitting part **730** may include a first HIL (a lower HIL) **732**, a first HTL (a lower HTL) **734**, a first EML (a lower EML) **736** and a first ETL (a lower ETL) **738**, and optionally a first EBL (a lower EBL) **735** between the first HTL **734** and the first EML **736**.

[0146] The first HIL **732** is positioned between the first electrode **710** and the first EML **736**, and the first HTL **734** is positioned between the first HIL **732** and the first EML **736**. The first EML **736** is positioned between the first HTL **734** and the first ETL **738**, and the first ETL **738** is positioned between the first EML **736** and the CGL **750**.

[0147] The first EBL **735** is formed between the first HTL **734** and the first EML **736** to block the migration of the electron. The first EBL **735** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the first EML **736** and the first ETL **738** to block the migration of the hole.

[0148] The second emitting part **740** includes a second HTL (an upper HTL) **742**, a second EML (an upper EML) **744**, a second ETL (an upper ETL) **746** and an EIL **748**, and optionally a second EBL (an upper EBL) **743** between the second HTL **742** and the second EML **744**.

[0149] The second HTL **742** is positioned between the CGL **750** and the second electrode **720**, and the second EML **744** is positioned between the second HTL **742** and the second electrode **720**. The second ETL **746** is positioned between the second EML **744** and the second electrode **720**, and the EIL **748** is positioned between the second ETL **746** and the second electrode **720**.

[0150] Each of the first EML **736** and the second EML **744** may include a host and a dopant. The first EML **736** and the second EML **744** emit the light having different colors. For example, the first EML **736** may emit the blue light, and the second EML **744** may emit the green light, the yellow-green light or the orange light, each of which has a longer wavelength than the blue light.

[0151] The first HIL **732** may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB(NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, the first HIL **732** may further include the organic compound of the present invention doped into the hole injection material by a doping ratio of about 0.1 to 50 weight %.

[0152] Each of the first HTL **734** and the second HTL **742** may include a hole transporting material, such as TPD, NPD and CBP, or include the organic compound of the present invention. Alternatively, each of the first and second HTLs **734** and **742** may include the organic compound of the present invention with the above hole transporting material as a hole transporting dopant. The first HTL **734** and the second HTL **742** may be formed of the same material or different materials.

[0153] Each of the first ETL **738** and the second ETL **746** may include an electron transporting material such as a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole or benzimidazole (e.g., 2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole). The EIL **748** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate. The first and second ETLs **738** and **746** may be formed of the same material or different materials.

[0154] The CGL **750** is positioned between the first emitting part **730** and the second emitting part **740** and includes an N-CGL **752** adjacent to the first emitting part **730**, a P-CGL **754** adjacent to the second emitting part **740** and a second HIL (intermediate charge generation layer) **756** between the N-CGL **752** and the P-CGL **754**. The electron

is provided into the first emitting part **730** by the N-CGL **752**, and the hole is provided into the second emitting part **740** by the P-CGL **754**.

[0155] The N-CGL **752** may be an organic layer doped by alkali metal, e.g., Li, Na, or K, or alkali earth metal, e.g., Mg, Ca, Sr, Ba or Ra. For example, the host organic material for the N-CGL **752** may be 4,7-diphenyl-1,10-phenanthroline (Bphen) or MTDATA. The alkali metal or alkali earth metal may be doped by a weight % of about 0.1 to 30.

[0156] The P-CGL **754** includes the organic compound of the present invention. In addition, the P-CGL **754** may further include a hole injection material, e.g., MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine, as a dopant. In this instance, the hole injection material may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0157] The second HIL **756** may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, the second HIL **756** may further include the organic compound of the present invention doped into the hole injection material by a doping ratio of about 0.1 to 50 weight %. The first HIL **732** and the second HIL **756** may be formed of the same material or different materials.

[0158] The second EBL **743** is formed between the second HTL **742** and the second EML **744** to block the migration of the electron. The second EBL **743** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the second EML **744** and the second ETL **746** to block the migration of the hole.

[0159] As mentioned above, the organic compound of the present invention has excellent hole transporting property. Accordingly, in the tandem structure organic light emitting diode **700** emitting the white light, the organic compound singly or in combination with the dopant is used for at least one of the second HTL **742**, the P-CGL **754**, the second HIL **756** and the second EBL **743** such that the driving voltage and the power consumption of the organic light emitting diode **700** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **700** is improved.

[0160] FIG. **8** is a schematic cross-sectional view of an organic light emitting diode according to an eighth embodiment of the present invention.

[0161] As shown in FIG. **8**, the organic light emitting diode **800** includes a first electrode **810**, a second electrode **820**, a first emitting part **830** (a lower emitting part) between the first electrode **810** and the second electrode **820**, a second emitting part **840** (an upper emitting part) between the first emitting part **830** and the second electrode **820** and a CGL **850** between the first emitting part **830** and the second emitting part **840**.

[0162] As mentioned above, the first electrode **810** as an anode includes a high work function conductive material, and the second electrode **820** as a cathode includes a low work function conductive material.

[0163] The first emitting part **830** may include an HIL **832**, an HTL **834**, a first EML (a lower EML) **836** and a first ETL (a lower ETL) **838**, and optionally a first EBL (a lower EBL) **835** between the HTL **834** and the first EML **836**.

[0164] The HIL **832** is positioned between the first electrode **810** and the first EML **836**, and the HTL **834** is positioned between the HIL **832** and the first EML **836**. The first EML **836** is positioned between the HTL **834** and the first ETL **838**, and the first ETL **838** is positioned between the first EML **836** and the CGL **850**.

[0165] The first EBL **835** is formed between the HTL **834** and the first EML **836** to block the migration of the electron. The first EBL **835** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the first EML **836** and the first ETL **838** to block the migration of the hole.

[0166] The second emitting part **840** includes a second EML (an upper EML) **844**, a second ETL (an upper ETL) **846** and an EIL **848**, and optionally a second EBL (an upper EBL) **843** between the CGL **850** and the second EML **844**.

[0167] The second EML **844** is positioned between the CGL **850** and the second electrode **820**. The second ETL **846** is positioned between the second EML **844** and the second electrode **820**, and the EIL **848** is positioned between the second ETL **846** and the second electrode **820**.

[0168] Each of the first EML **836** and the second EML **844** may include a host and a dopant. The first EML **836** and the second EML **844** emit the light having different colors. For example, the first EML **836** may emit the blue light, and the second EML **844** may emit the green light, the yellow-green light or the orange light, each of which has a longer wavelength than the blue light.

[0169] The HIL **832** may be formed of a hole injection material such as MTDATA, CuPc, TCTA, NPB(NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine. Alternatively, the HIL **832** may further include the organic compound of the present invention doped into the hole injection material by a doping ratio of about 0.1 to 50 weight %.

[0170] The HTL **834** may include a hole transporting material, such as TPD, NPD and CBP, or include the organic compound of the present invention. Alternatively, the HTL **834** may include the organic compound of the present invention with the above hole transporting material as a hole transporting dopant.

[0171] Each of the first ETL **838** and the second ETL **846** may include an electron transporting material such as a derivative compound of oxadiazole, triazole, phenanthroline, benzoxazole, benzothiazole or benzimidazole (e.g., 2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole). The EIL **848** may include an alkali halide compound, e.g., LiF, CsF, NaF or BaF2, or an organo-metallic compound, e.g., lithium quinolate (Liq), lithium benzoate or sodium stearate. The first ETL **838** and the second ETL **846** may be formed of the same material or different materials.

[0172] The CGL **850** is positioned between the first emitting part **830** and the second emitting part **840** and includes an N-CGL **852** adjacent to the first emitting part **830**, a P-CGL **854** adjacent to the second emitting part **840** and a second HIL **856** between the N-CGL **852** and the P-CGL **854**. The electron is provided into the first emitting part **830** by the N-CGL **852**, and the hole is provided into the second emitting part **840** by the P-CGL **854**.

[0173] The N-CGL **852** may be an organic layer doped by alkali metal, e.g., Li, Na, or K, or alkali earth metal, e.g., Mg, Ca, Sr, Ba or Ra. For example, the host organic material for

the N-CGL **852** may be 4,7-diphenyl-1,10-phenanthroline (Bphen) or MTDATA. The alkali metal or alkali earth metal may be doped by a weight % of about 0.1 to 30.

[0174] The P-CGL **854** includes the organic compound of the present invention. In addition, the P-CGL **854** may further include a hole injection material, e.g., MTDATA, CuPc, TCTA, NPB (NPD), HATCN, TDAPB, PEDOT/PSS, F4TCNQ or N-(biphenyl-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluoren-2-amine, as a dopant. In this instance, the hole injection material may have a weight % of about 0.1 to 50, but it is not limited thereto.

[0175] The second EBL **843** is formed between the CGL **850** and the second EML **844** to block the migration of the electron. The second EBL **843** may contact a surface of the CGL **850** and a surface of the second EML **844**. The second EBL **843** may include the organic compound of the present invention. Although not shown, a hole blocking layer may be formed between the second EML **844** and the second ETL **846** to block the migration of the hole.

[0176] As mentioned above, the organic compound of the present invention has excellent hole transporting property. Accordingly, in the tandem structure organic light emitting diode **800** emitting the white light, the organic compound singly or in combination with the dopant is used for at least one of the P-CGL **854** and the second EBL **843** such that the driving voltage and the power consumption of the organic light emitting diode **800** is reduced and the lifetime and the emitting efficiency of the organic light emitting diode **800** is improved.

[0177] In the organic light emitting diodes in FIGS. **5** to **8**, at least one of the HIL, the HTL, the EBL and the P-CGL includes the organic compound of the present invention with or without a dopant. In addition, the organic light emitting diodes may further include additional emitting part and additional CGL between adjacent emitting parts.

[0178] FIG. **9** is a schematic cross-sectional view of an OLED device according to the present invention.

[0179] As shown in FIG. **9**, the OLED device **900** includes a driving thin film transistor (TFT) Td, a planarization layer **960** covering the driving TFT Td, an organic light emitting diode E on the planarization layer **960** and connected to the driving TFT Td.

[0180] The driving TFT Td includes a semiconductor layer **940**, a gate electrode **944**, a source electrode **956** and a drain electrode **958**. The driving TFT Td in FIG. **9** has a coplanar structure.

[0181] A first substrate **901** and a second substrate **902** facing the first substrate **901** are attached to form a display panel. Each of the first substrate **901** and the second substrate **902** may be a glass substrate, a thin flexible substrate or a polymer plastic substrate. The first substrate **901**, on which the driving TFT Td and the organic light emitting diode E are formed, may be referred to as an array substrate. The organic light emitting diode E is encapsuled by the second substrate **902** which may be referred to as an encapsulation substrate. For example, the first substrate **901** and the second substrate **902** may be attached to each other by an adhesive layer **980**.

[0182] The semiconductor layer **940** is formed on the first substrate **901**. The semiconductor layer **940** may be formed of an oxide semiconductor material. When the semiconductor layer **940** includes the oxide semiconductor material, a light-shielding pattern (not shown) may be formed under the semiconductor layer **940**. The light to the semiconductor layer **940** is shielded or blocked by the light-shielding pattern such that thermal degradation of the semiconductor layer **940** can be prevented. On the other hand, when the semiconductor layer **940** includes polycrystalline silicon, impurities may be doped into both sides of the semiconductor layer **940**.

[0183] A gate insulating layer **942** is formed on the semiconductor layer **940** and over an entire surface of the first substrate **901**. The gate insulating layer **942** may be formed of an inorganic insulating material such as silicon oxide or silicon nitride.

[0184] The gate electrode **944**, which is formed of a conductive material, e.g., metal, is formed on the gate insulating layer **942** to correspond to a center of the semiconductor layer **940**. In addition, a gate line (not shown) and a first capacitor electrode (not shown) may be formed on the gate insulating layer **942**. The gate line may extends along a first direction, and the first capacitor electrode may be connected to the gate electrode **944**. The gate insulating layer **942** in FIG. **9** covers an entire surface of the first substrate **901**. Alternatively, the gate insulating layer **942** may be patterned to have the same shape as the gate electrode **944**.

[0185] An interlayer insulating layer **950**, which is formed of an insulating material, is formed on an entire surface of the first substrate **901** including the gate electrode **944**. The interlayer insulating layer **950** may be formed of an inorganic insulating material, e.g., silicon oxide or silicon nitride, or an organic insulating material, e.g., benzocyclobutene or photo-acryl.

[0186] The interlayer insulating layer **950** includes first and second semiconductor contact holes **952** and **954** exposing both sides of the semiconductor layer **940**. The first and second semiconductor contact holes **952** and **954** are positioned at both sides of the gate electrode **944** to be spaced apart from the gate electrode **944**. In FIG. **9**, the first semiconductor contact hole **952** and the second semiconductor **954** are formed through the gate insulating layer **942** as well as the interlayer insulating layer **950**. Alternatively, when the gate insulating layer **942** has the same shape as the gate electrode **944**, the first semiconductor contact hole **952** and the second semiconductor contact hole **954** may be formed in the interlayer insulating layer **950** except the gate insulating layer **942**.

[0187] The source electrode **956** and the drain electrode **958**, which are formed of a conductive material, e.g., metal, are formed on the interlayer insulating layer **950**. In addition, a data line (not shown) extending along a second direction, a power line (not shown) and a second capacitor electrode (not shown) may be formed on the interlayer insulating layer **950**. The data line crosses the gate line to define a pixel region, and the power line is spaced apart from and parallel to the data line. The second capacitor electrode is connected to the drain electrode **958** and overlaps the first capacitor electrode to form a storage capacitor with the interlayer insulating layer **950**.

[0188] The source electrode **956** and the drain electrode **958** are spaced apart from each other with respect to the gate electrode **944** and respectively contact both sides of the semiconductor layer **940** through the first and second semiconductor contact holes **952** and **954**.

[0189] In the driving TFT Td, the gate electrode **944**, the source electrode **956** and the drain electrode **958** are posi-

tioned over the semiconductor layer **940**. Namely, the driving TFT Td has a coplanar structure.

[0190] Alternatively, in the driving TFT Td, the gate electrode may be positioned under the semiconductor layer, and the source and drain electrodes may be positioned over the semiconductor layer such that the driving TFT Td may have an inverted staggered structure. In this instance, the semiconductor layer may include amorphous silicon.

[0191] A switching TFT (not shown) is formed on the first substrate **901**. The switching TFT may have substantially the same structure as the driving TFT Td. The gate electrode **944** is connected to a drain electrode of the switching TFT, and the source electrode **956** is connected to the power line. A gate electrode and a source electrode of the switching TFT are connected to the gate line and the data line, respectively.

[0192] A planarization layer **960**, which provides a flat top surface and includes a drain contact hole **962** exposing the drain electrode **958** of the driving TFT Td, is formed to cover the driving TFT Td. The drain contact hole **962** may be spaced apart from the second semiconductor contact hole **954** in a plane.

[0193] The organic light emitting diode E is disposed on the planarization layer **960** and includes a first electrode **910**, an organic emitting layer **920** and a second electrode **930**. The first electrode **910** is connected to the drain electrode **958** of the driving TFT Td, and the organic emitting layer **920** and the second electrode **930** are sequentially stacked on the first electrode **910**. A bank **972** as a pixel definition layer is formed to cover an edge of the first electrode **910**.

[0194] As mentioned above, the first electrode **910** as an anode includes a high work function conductive material, and the second electrode **930** as a cathode includes a low work function conductive material.

[0195] The second substrate **902** is attached to the first substrate **901** using the adhesive layer **980**. Although not shown, a barrier layer for preventing the moisture and/or oxygen penetration into the organic light emitting diode E may be formed between the second substrate **902** and the organic light emitting diode E to cover the organic light emitting diode E.

[0196] As explained through FIGS. **1** to **8**, the organic emitting layer **920** may include an HIL, an HTL, an EBL and a CGL with an EML, and at least of the HIL, the HTL, the EBL and the CGL includes the organic compound of the present invention. When the organic light emitting diode E has the tandem structure as those in FIGS. **5** to **8** as a white OLED, a color filter (not shown) may be formed under or over the organic light emitting diode E to provide a full-color image.

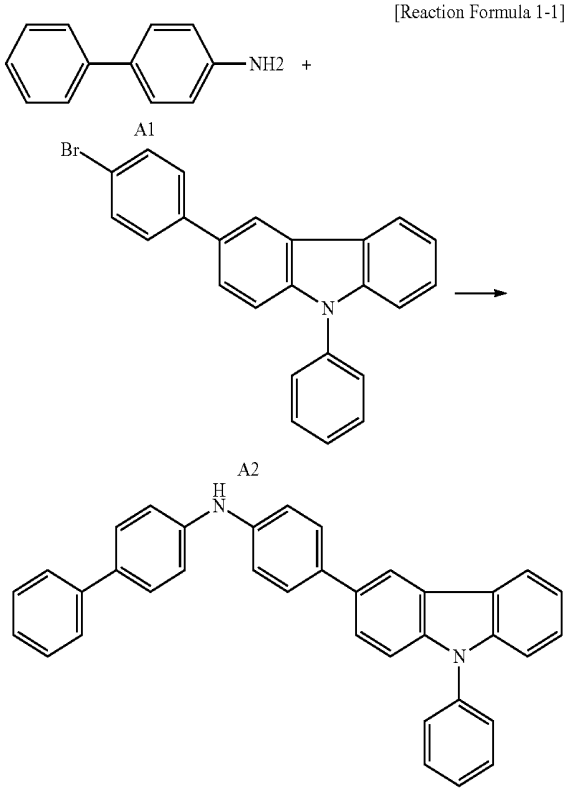
[0197] As mentioned above, the organic compound of the present invention has excellent hole transporting property. Accordingly, the organic compound of the present invention is used for the hole auxiliary layer (e.g., the HIL and/or the HTL) and the EBL. In this instance, the hole injection material or the hole transporting material may be doped into the organic compound such that the hole transporting property is further improved. In addition, in the tandem structure organic light emitting diode emitting the white light, the organic compound singly or in combination with the dopant is used for the P-CGL to provide the charge into adjacent emitting part. As a result, the driving voltage and the power consumption of the organic light emitting diode is reduced and the lifetime and the emitting efficiency of the organic light emitting diode is improved.

Synthesis

[0198] 1. Synthesis of the Compound A7

[0199] (1) the Compound A3

[Reaction Formula 1-1]

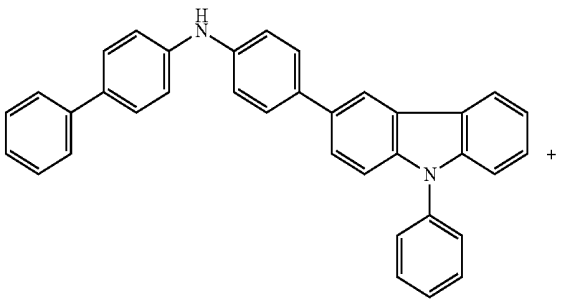


A3

[0200] In the 250 mL rounded-bottom flask, the compound A1 (3.00 g, 17.73 mmol), the compound A2 (7.77 g, 19.50 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.24 g, 0.27 mmol), (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene(BINAP) (0.33 g, 0.53 mmol) and sodium tert-butoxide (2.39 g, 24.82 mmol) were dissolved in toluene (120 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound A3 was obtained. (6.05 g, 12.43 mmol)

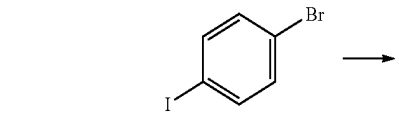
[0201] (2) the Compound A5

[Reaction Formula 1-2]

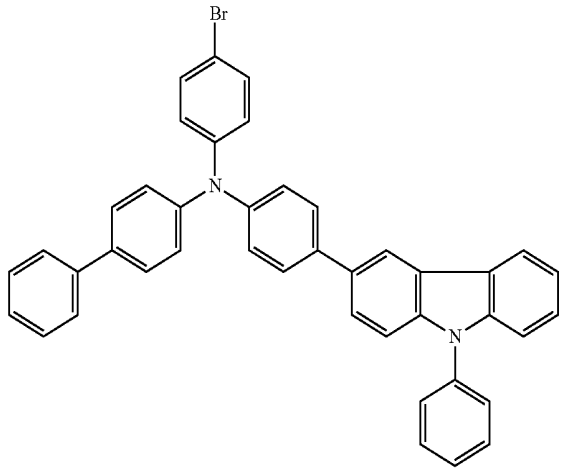


A3

-continued

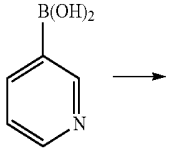


A4

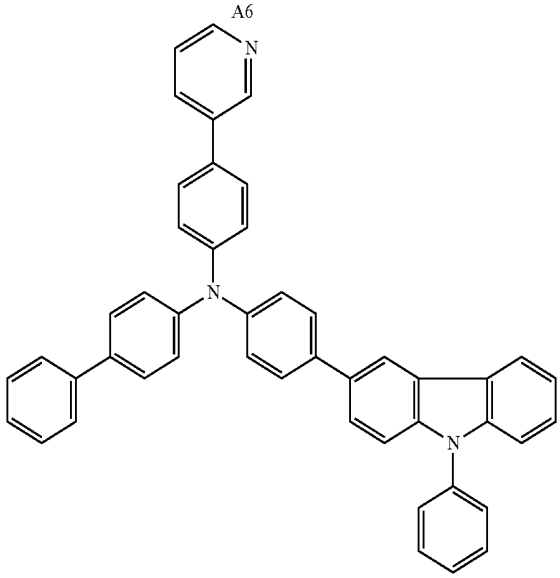


A5

-continued



A6



A7

[0202] In the 250 mL rounded-bottom flask, the compound A3 (6.05 g, 12.43 mmol), the compound A4 (5.28 g, 18.65 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethylxanthene (0.07 g, 0.12 mmol), palladium(II) acetate (0.03 g, 0.12 mmol) and sodium tert-butoxide(1.80 g, 18.77 mmol) were dissolved in toluene (120 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound A5 was obtained. (7.21 g, 11.24 mmol)

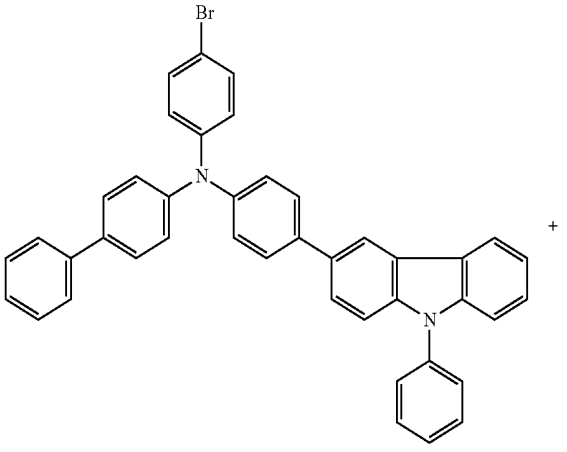
[0203] (3) the Compound A7

[0204] In the 100 mL rounded-bottom flask, the compound A5 (2.00 g, 3.12 mmol), the compound A6 (0.42 g, 3.43 mmol), tetrakis(triphenylphosphine)palladium(0) (0.18 g, 0.16 mmol) and potassium carbonate (2.76 g, 20.00 mmol) were put into a mixture of toluene (40 mL), ethanol (20 mL) and water (10 mL) and stirred under the temperature of 100° C. for 24 hrs. After the completion of the reaction, the mixture was extracted and condensed using water and ethyl acetate. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound A7 was obtained. (1.36 g, 2.13 mmol)

[0205] 1HNMR (500 MHz, CD2Cl2) 8.86 (s, 1H), 8.53~8.299 (m, 3H), 8.19 (d, 1H), 7.70~7.29 (m, 28H)

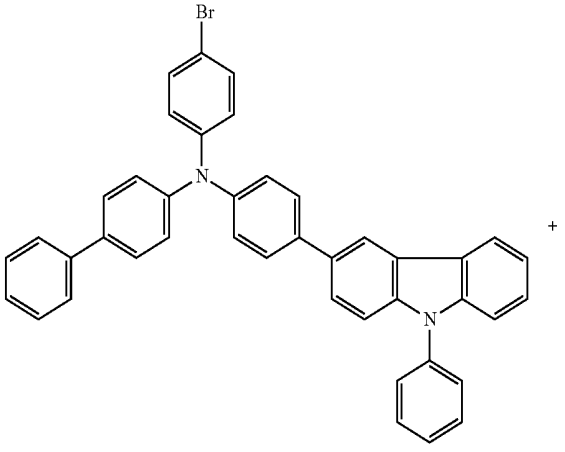
[0206] 2. Synthesis of the Compound B2

[Reaction Formula 1-3]



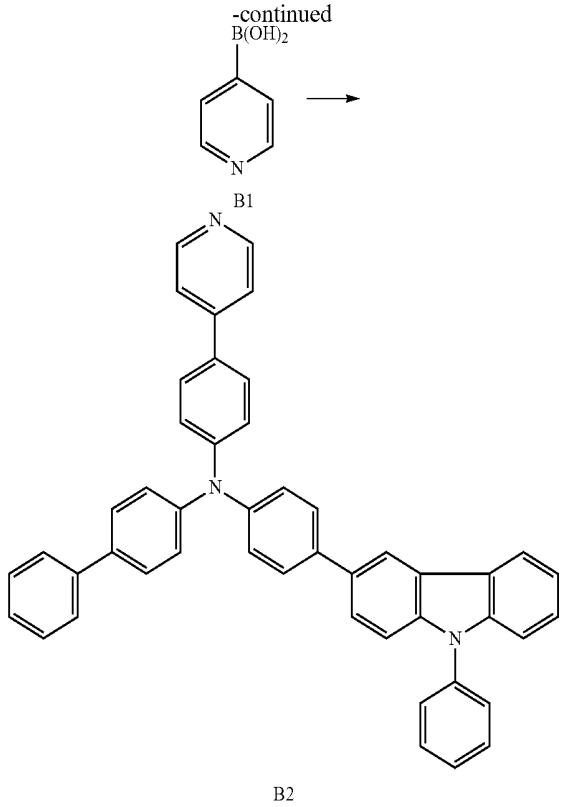
A5

[Reaction Formula 2]



A5

-continued



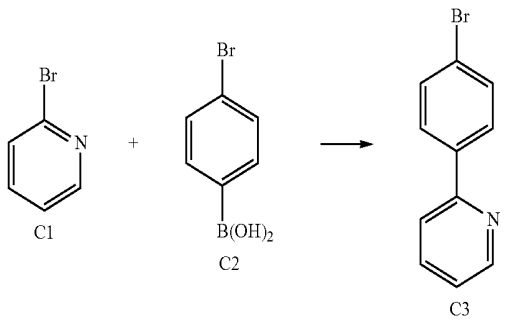
[0207] In the 100 mL rounded-bottom flask, the compound A5 (2.00 g, 3.12 mmol), the compound B1 (0.42 g, 3.43 mmol), tetrakis(triphenylphosphine)palladium(0) (0.18 g, 0.16 mmol) and potassium carbonate (2.76 g, 20.00 mmol) were put into a mixture of toluene (40 mL), ethanol (20 mL) and water (10 mL) and stirred under the temperature of 100° C. for 24 hrs. After the completion of the reaction, the mixture was extracted and condensed using water and ethyl acetate. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound B2 was obtained. (1.28 g, 2.00 mmol)

[0208] 1HNMR (500 MHz, CD2Cl2) 8.58 (d, 2H), 8.37 (s, 1H), 8.19 (d, 1H), 7.70~7.29 (m, 29H)

[0209] 3. Synthesis of the Compound C4

[0210] (1) The Compound C3

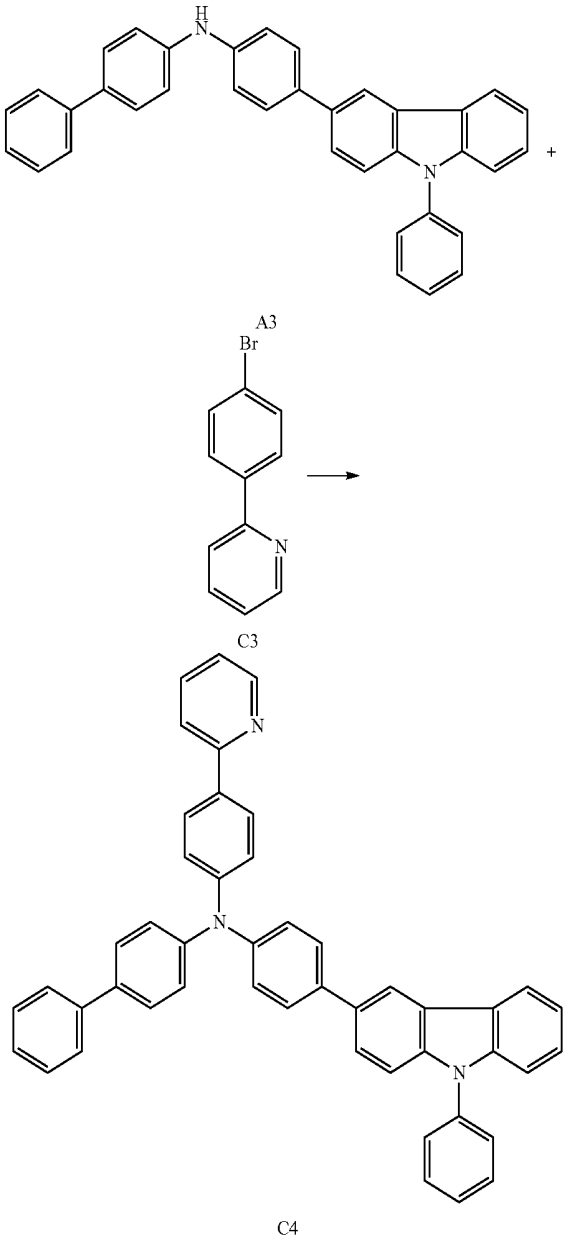
[Reaction Formula 3-1]



[0211] In the 250 mL rounded-bottom flask, the compound C1 (5.00 g, 31.65 mmol), the compound C2 (6.99 g, 34.81 mmol), tetrakis(triphenylphosphine)palladium(0) (1.83 g, 1.58 mmol) and potassium carbonate (8.29 g, 60.00 mmol) were put into a mixture of toluene (120 mL), ethanol (60 mL) and water (30 mL) and stirred under the temperature of 100° C. for 24 hrs. After the completion of the reaction, the mixture was extracted and condensed using water and ethyl acetate. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound C3 was obtained. (5.92 g, 25.29mmol)

[0212] (2) The Compound C4

[Reaction Formula 3-2]



[0213] In the 100 mL rounded-bottom flask, the compound A3(2.00 g, 4.11 mmol), the compound C3 (1.06 g, 4.52 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.06 g, 0.06 mmol), tri-tert-butylphosphine (0.02 g, 0.12 mmol) and sodium tert-butoxide (0.55 g, 5.75 mmol) were dissolved in toluene (40 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and

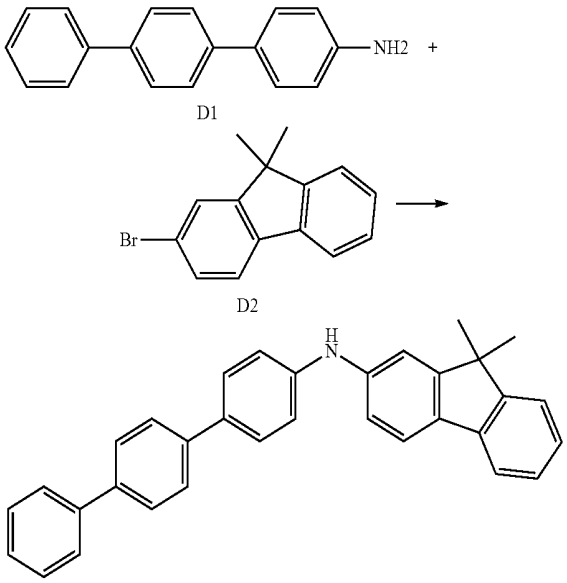
condensed using dichloromethane and water. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound C4 was obtained. (1.40 g, 2.18 mmol)

[0214] 1HNMR (500 MHz, CD2Cl2) 8.63 (d, 1H), 8.37 (s, 1H), 8.19 (d, 1H), 7.97 (d, 2H), 7.73~7.23 (m, 28H)

[0215] 4. Synthesis of the Compound D4

[0216] (1) The Compound D3

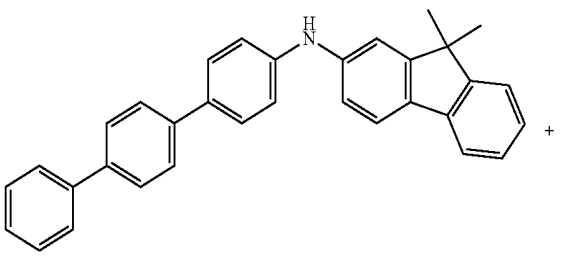
[Reaction Formula 4-1]



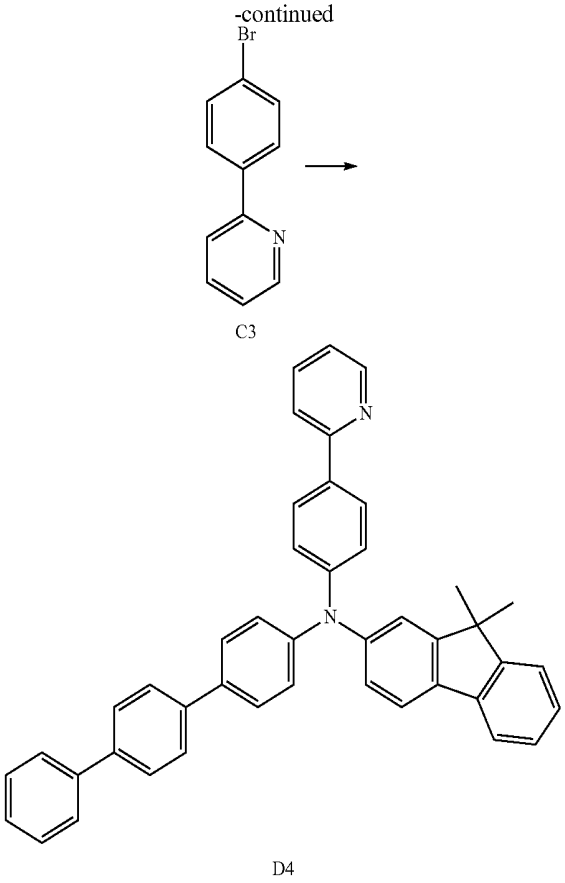
[0217] In the 250 mL rounded-bottom flask, the compound D1(3.00 g, 12.23 mmol), the compound D2 (3.22 g, 11.80 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.17 g, 0.18 mmol), (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene(BINAP) (0.23 g, 0.37 mmol) and sodium tert-butoxide(1.65 g, 17.12 mmol) were dissolved in toluene (120 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound D3 was obtained. (3.80 g, 8.68 mmol)

[0218] (2) The Compound D4

[Reaction Formula 4-2]



-continued



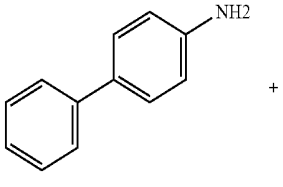
[0219] In the 100 mL rounded-bottom flask, the compound D3(1.50 g, 3.43 mmol), the compound C3 (0.88 g, 3.77 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.05 g, 0.05 mmol), tri-tert-butylphosphine (0.02 g, 0.10 mmol) and sodium tert-butoxide(0.46 g, 4.80 mmol) were dissolved in toluene (50 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and condensed using dichloromethane and water. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound D4 was obtained. (1.15 g, 1.95mmol)

[0220] 1HNMR (500 MHz, CD2Cl2) 8.62 (d, 1H), 7.95 (d, 2H), 7.73~7.58 (m, 12H), 7.46~7.11 (m, 13H), 1.42 (s, 6H)

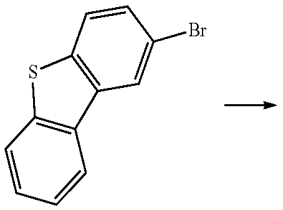
[0221] 5. Synthesis of the Compound E3

[0222] (1) The Compound E2

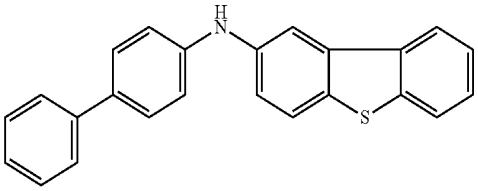
[Reaction Formula 5-1]



-continued



E1

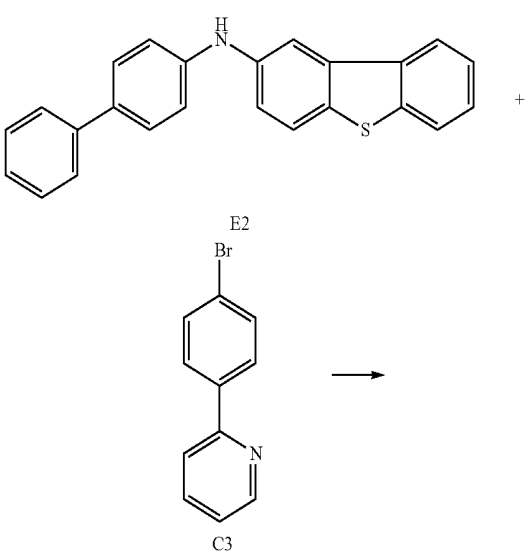


E2

[0223] In the 250 mL rounded-bottom flask, the compound A1(2.00 g, 11.82 mmol), the compound E1 (3.42 g, 13.00 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.16 g, 0.18 mmol), (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene(BINAP) (0.22 g, 0.35 mmol) and sodium tert-butoxide(1.59 g, 16.55 mmol) were dissolved in toluene (110 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound E2 was obtained. (3.05 g, 8.68 mmol)

[0224] (2) The Compound E3

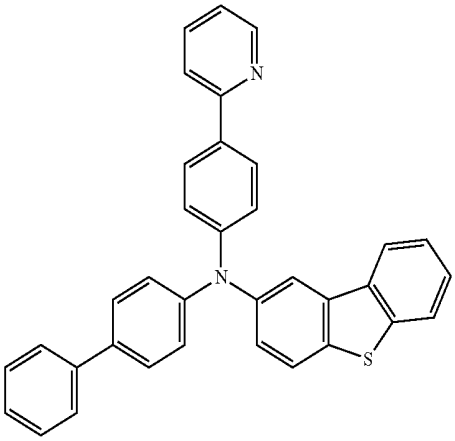
[Reaction Formula 5-2]



E2

C3

-continued



E3

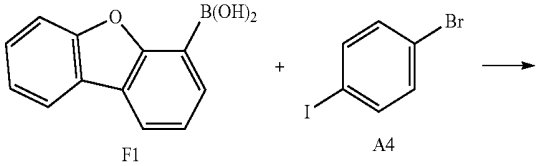
[0225] In the 100 mL rounded-bottom flask, the compound E3(1.50 g, 4.27 mmol), the compound C3 (1.10 g, 4.69 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.06 g, 0.06 mmol), tri-tert-butylphosphine (0.03 g, 0.13 mmol) and sodium tert-butoxide(0.57 g, 5.98 mmol) were dissolved in toluene (50 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and condensed using dichloromethane and water. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound E3 was obtained. (1.21 g, 2.40 mmol)

[0226] 1HNMR (500 MHz, CD2Cl2) 8.62 (d, 1H), 8.01~7.94 (m, 4H), 7.85~7.73 (m, 4H), 7.60~7.20 (m, 15H)

[0227] 6. Synthesis of the Compound F4

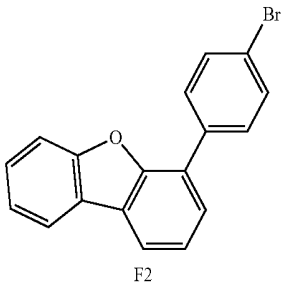
[0228] (1) The Compound F2

[Reaction Formula 6-1]



F1

A4



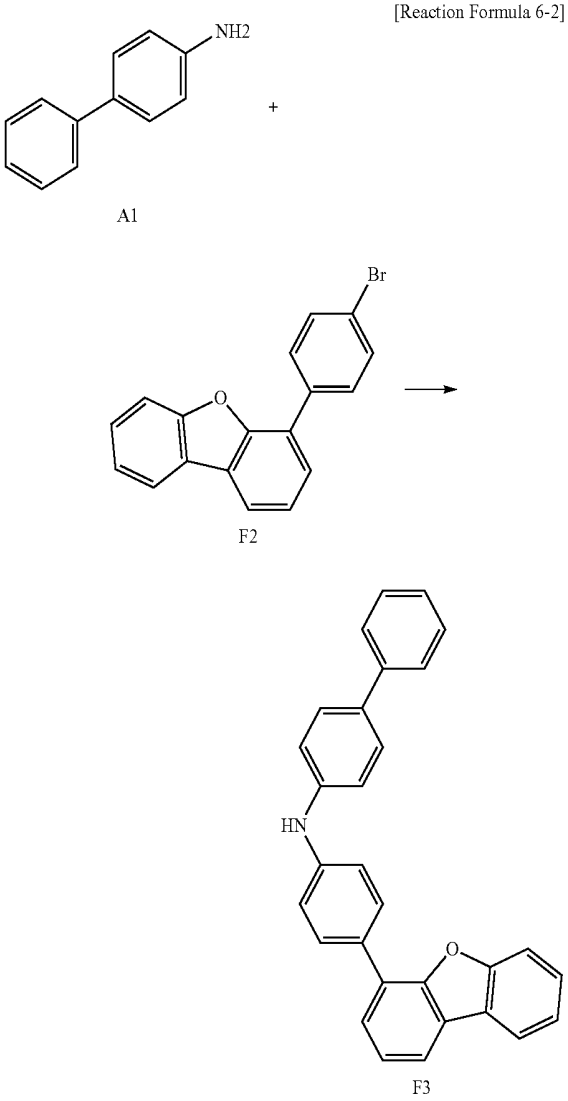
F2

[0229] In the 250 mL rounded-bottom flask, the compound F 1 (3.00 g, 14.15 mmol), the compound A4 (4.00 g, 14.15 mmol), tetrakis(triphenylphosphine)palladium(0) (0.82 g, 0.71 mmol) and potassium carbonate (4.84 g, 35.00 mmol) were put into a mixture of toluene (70 mL), ethanol (35 mL) and water (17.5 mL) and stirred under the temperature of 100° C. for 24 hrs. After the completion of the reaction, the

mixture was extracted and condensed using water and dichloromethane. The mixture was separated by a column using dichloromethane and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound F2 was obtained. (5.92 g, 25.29 mmol)

[0230] (2) The Compound F3

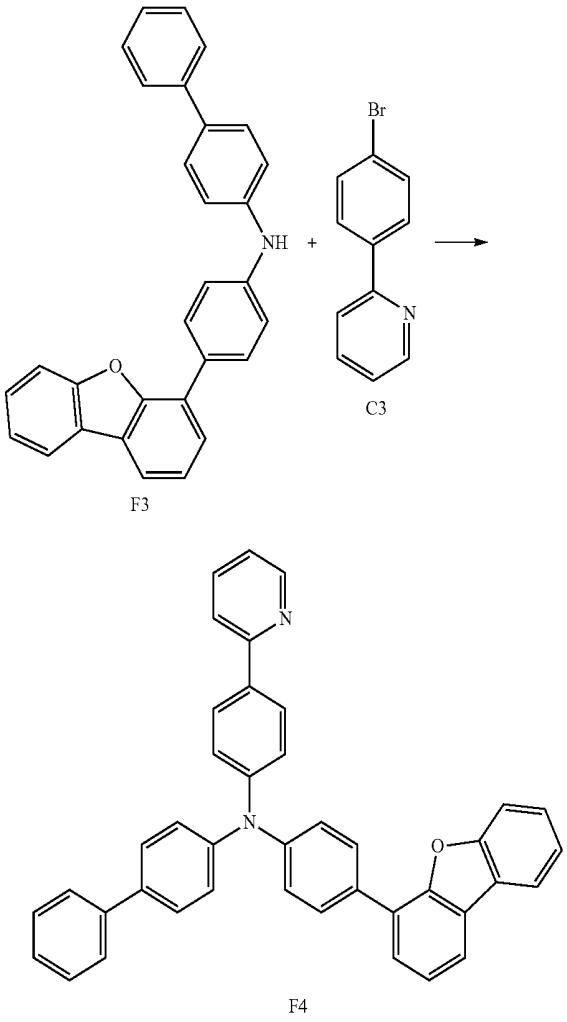
[Reaction Formula 6-2]



[0231] In the 250 mL rounded-bottom flask, the compound A1 (1.80 g, 10.64 mmol), the compound F2 (3.78 g, 11.70 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.15 g, 0.16 mmol), (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene(BINAP) (0.20 g, 0.32 mmol) and sodium tert-butoxide(1.43 g, 14.89 mmol) were dissolved in toluene (100 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound F3 was obtained. (3.05 g, 7.41 mmol)

[0232] (3) The Compound F4

[Reaction Formula 6-3]



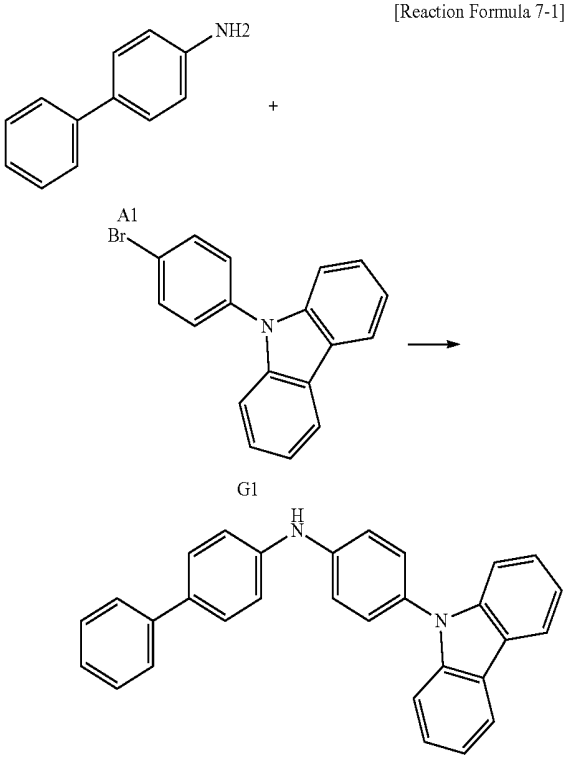
[0233] In the 100 mL rounded-bottom flask, the compound F3(1.50 g, 3.65 mmol), the compound C3(0.94 g, 4.01 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.05 g, 0.05 mmol), tri-tert-butylphosphine (0.02 g, 0.11 mmol) and sodium tert-butoxide(0.49 g, 5.10 mmol) were dissolved into toluene (100 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and condensed using dichloromethane and water. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound F4 was obtained. (1.32 g, 2.34 mmol)

[0234] 1HNMR (500 MHz, CD2Cl2) 8.64 (d, 1H), 8.01~7.88 (m, 6H), 7.75 (m, 2H), 7.63~7.57 (m, 6H), 7.49~7.21 (m, 13H)

[0235] 7. Synthesis of the Compound G3

[0236] (1) The Compound G2

[Reaction Formula 7-1]

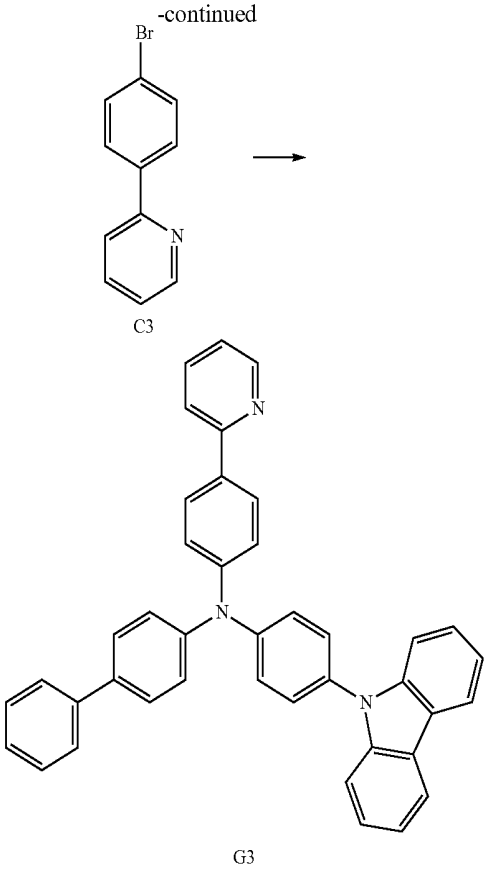


G2

[0237] In the 500 mL rounded-bottom flask, the compound A1(5.00 g, 29.55 mmol), the compound G1 (10.47 g, 32.50 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.41 g, 0.44 mmol), (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene(BINAP) (0.55 g, 0.89 mmol) and sodium tert-butoxide(3.98 g, 41.37 mmol) were dissolved in toluene (250 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound G2 was obtained. (7.53 g, 18.34 mmol)

[0238] (2) The Compound G3

-continued



G3

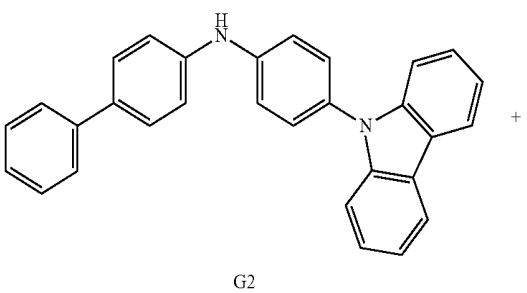
[0239] In the 100 mL rounded-bottom flask, the compound G2(1.50 g, 3.65 mmol), the compound C3 (0.94 g, 4.02 mmol), tris(dibenzylideneacetone) dipalladium(0) (0.05 g, 0.05 mmol), tri-tert-butylphosphine (0.02 g, 0.11 mmol) and sodium tert-butoxide(0.49 g, 5.12 mmol) were dissolved into toluene (40 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and condensed using dichloromethane and water. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound G3 was obtained. (0.98 g, 1.74 mmol)

[0240] 1HNMR (500 MHz, CD2Cl2) 8.65 (d, 1H), 8.14 (d, 2H), 8.0 (d, 2H), 7.77~7.76 (m, 2H), 7.62~7.58 (m, 4H), 7.49~7.33 (m, 18H)

[0241] 8. Synthesis of the Compound H2

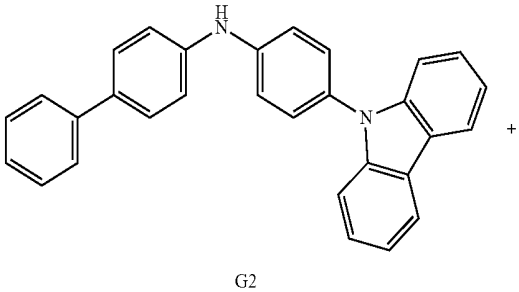
[0242] (1) The Compound H1

[Reaction Formula 7-2]



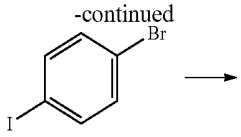
G2

[Reaction Formula 8-1]

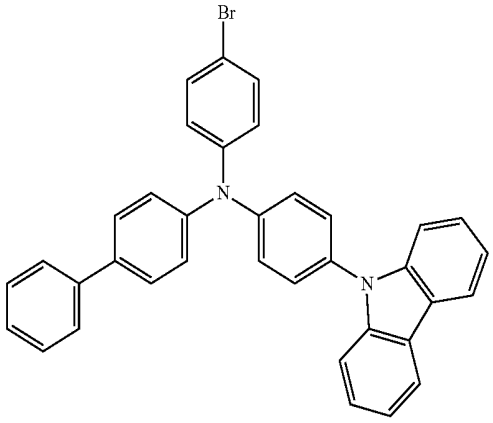


G2

-continued



A4

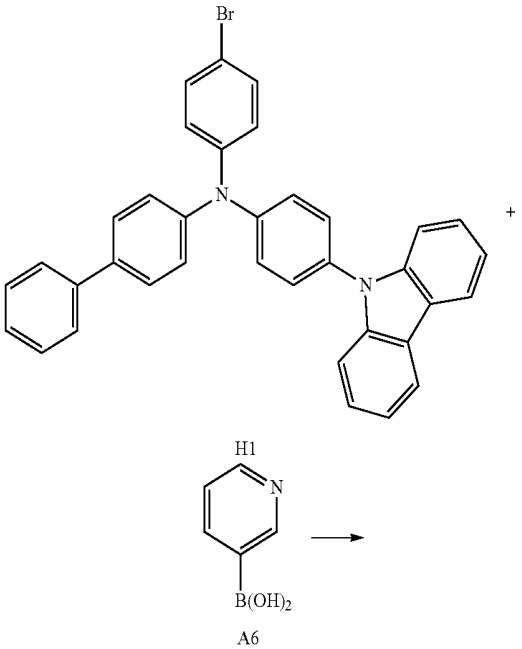


H1

[0243] In the 250 mL rounded-bottom flask, the compound G2(2.00 g, 4.87 mmol), the compound A4 (2.07 g, 7.31 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethylxanthene (0.03 g, 0.05 mmol), palladium(II) acetate (0.01 g, 0.05 mmol) and sodium tert-butoxide(0.71 g, 7.36 mmol) were dissolved in toluene (50 mL) and stirred in the bath of the temperature of 100° C. for 24 hrs. After the completion of the reaction, toluene was removed, and the resultant was extracted and distilled under the reduced pressure using dichloromethane and water. After the silica gel column, the solvent was distilled under the reduced pressure such that the compound H1 was obtained. (2.24 g, 3.96 mmol)

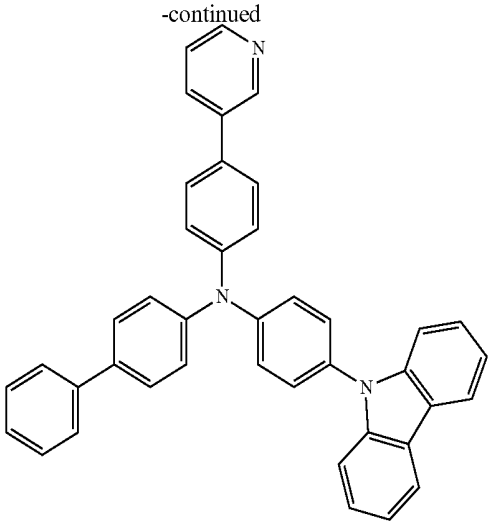
[0244] (2) The Compound H2

[Reaction Formula 8-2]



A6

-continued



H2

[0245] In the 100 mL rounded-bottom flask, the compound H1 (2.00 g, 3.54 mmol), the compound A6 (0.48 g, 3.89 mmol), tetrakis(triphenylphosphine)palladium(0) (0.20 g, 0.18 mmol) and potassium carbonate (2.76 g, 20.00 mmol) were dissolved into a mixture of toluene (40 mL), ethanol (20 mL) and water (10 mL) and stirred under the temperature of 100° C. for 24 hrs. After the completion of the reaction, the resultant was extracted and condensed using water and ethyl acetate. The mixture was separated by a column using ethyl acetate and n-hexane and precipitated using dichloromethane and petroleum ether. The precipitate was filtered such that the compound H2 was obtained. (1.54 g, 2.41 mmol)

[0246] 1HNMR (500 MHz, CD2Cl2) 8.65 (d, 1H), 8.14 (d, 2H), 8.03 (d, 2H), 7.77~7.76 (m, 2H), 7.62~7.58 (m, 4H), 7.49~7.33 (m, 18H)

[0247] Organic Light Emitting Diode

1. EXAMPLE 1 (EX1)

[0248] An ITO layer is patterned to form the anode (3 mm*3 mm), and the anode is washed. The anode is loaded in a vacuum chamber having a base pressure of 1*10−6, and layers are sequentially deposited as below.

[0249] (1) HIL: (HAT-CN, 50 Å),

[0250] (2) HTL: (α-NPB, 1000 Å),

[0251] (3) EBL: (compound A7, 150 Å),

[0252] (4) blue EML: (host (MADN) doped by dopant (BD-1, 4 wt %), 250 Å),

[0253] (5) first ETL: (2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole, 100~300 Å),

[0254] (6) second ETL (Bphen doped by Li (2 wt %), 100 Å),

[0255] (7) EIL (LiF, 5~10 Å) and

[0256] (8) cathode (A1, 800~1000 Å).

[0257] The deposited structure is loaded in the drying box and encapsuled by an UV-cured expoxy and a getter. The organic light emitting diode has an emitting area of 9 mm2.

2. EXAMPLE 2 (EX2)

[0258] Instead of the compound A7, the compound B2 is used.

3. EXAMPLE 3 (EX3)

[0259] Instead of the compound A7, the compound C4 is used.

4. EXAMPLE 4 (EX4)

[0260] Instead of the compound A7, the compound D4 is used.

5. EXAMPLE 5 (EX5)

[0261] Instead of the compound A7, the compound E3 is used.

6. EXAMPLE 6 (EX6)

[0262] Instead of the compound A7, the compound F4 is used.

7. EXAMPLE 7 (EX7)

[0263] Instead of the compound A7, the compound G3 is used.

8. EXAMPLE 8 (EX8)

[0264] Instead of the compound A7, the compound H2 is used.

9. COMPARATIVE EXAMPLE 1 (REF1)

[0265] Instead of the compound A7, the compound TCTA is used.

[0266] The EL property of the organic light emitting diode in "Example 1" to "Example 8" and "Comparative Example 1" is measured using the current supply "KEITHLEY" and the photometer "PR 650" under the room temperature. The driving voltage, the luminance, the power efficiency, the external quantum efficiency (EQE) and the color coordinate index of the organic light emitting diodes of are measured and listed in Table 1. The current density, the luminance, the power efficiency and the EQE are shown in FIGS. **10**A to **13**C.

TABLE 1

		V	Cd/A	lm/W	EQE (%)	CIE_x	CIE_y
Ex1	A7	3.78	4.88	4.05	5.64	0.142	0.112
Ex2	B2	4.07	3.18	2.46	3.32	0.142	0.115
Ex3	C4	4.50	5.20	3.63	5.34	0.140	0.117
Ex4	D4	4.03	5.29	4.12	5.40	0.140	0.119
Ex5	E3	4.22	4.28	3.18	4.87	0.141	0.104
Ex6	F4	4.54	5.23	3.62	5.45	0.140	0.115
Ex7	G3	4.55	4.92	3.40	5.30	0.140	0.110
Ex8	H2	4.04	5.27	4.10	5.62	0.141	0.112
Ref1	TCTA	4.90	3.28	2.10	3.43	0.145	0.115

[0267] As shown in Table 1 and FIGS. **10**A to **13**C, in comparison to "Comparative Example 1", the driving voltage of the organic light emitting diode of the present invention (Ex 1 to Ex 8) is reduced (about 23%), the power efficiency of the organic light emitting diode of the present invention (Ex 1 to Ex 8) is improved (about 96%). In addition, the EQE of the organic light emitting diode of the present invention (Ex 1 to Ex 8) is improved (about 94%).

[0268] Namely, by using the organic compound of the present invention in the EBL, there are advantages in the driving voltage, the luminance, the power efficiency and/or the EQE.

[0269] Tandem Structure Organic Light Emitting Diode

1. EXAMPLE 9 (EX9)

[0270] An ITO layer is patterned to form the anode (3 mm*3 mm), and the anode is washed. The anode is loaded in a vacuum chamber having a base pressure of 1*10−6, and layers are sequentially deposited as below.

[0271] (1) HIL: (HAT-CN, 50 Å),

[0272] (2) first HTL: (α-NPB, 1000 Å),

[0273] (3) first EBL: (TCTA, 150 Å),

[0274] (4) first EML (blue): (host (MADN) doped by dopant (BD-1, 4 wt %), 250 Å),

[0275] (5) first ETL: (2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole, 100~300 Å),

[0276] (6) N-CGL: (Bphene doped by Li (2 wt %), 100 Å),

[0277] (7) P-CGL: (HAT-CN, 100 Å),

[0278] (8) second HTL: (α-NPB, 100 Å),

[0279] (9) second EBL: (compound A7, 100 Å),

[0280] (10) second EML (YG): (CBP doped by $Ir(2\text{-phq})_3$, 300 Å),

[0281] (11) second ETL: (2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole, 350~400 Å),

[0282] (12) EIL (LiF, 5~10 Å) and

[0283] (13) cathode (A1, 800~1000 Å).

[0284] The deposited structure is loaded in the drying box and encapsuled by an UV-cured expoxy and a getter. The organic light emitting diode has an emitting area of 9 mm2.

2. EXAMPLE 10 (EX10)

[0285] Instead of the compound A7, the compound D4 is used.

3. COMPARATIVE EXAMPLE 2 (REF2)

[0286] Instead of the compound A7, the compound TCTA is used.

[0287] The EL property of the organic light emitting diode in "Example 9", "Example 10" and "Comparative Example 2" is measured using the current supply "KEITHLEY" and the photometer "PR 650" under the room temperature. The driving voltage, the luminance, the power efficiency, the external quantum efficiency (EQE) and the color coordinate index of the organic light emitting diodes of are measured and listed in Table 2. The current density, the luminance, the power efficiency and the EQE are shown in FIGS. **14**A to **14**D.

TABLE 2

		V	Cd/A	lm/W	EQE (%)	CIE_x	CIE_y
Ex9	A7	9.07	52.67	18.24	26.09	0.316	0.335
Ex10	D4	9.09	48.99	16.93	24.78	0.312	0.327
Ref2	TCTA	9.87	43.38	13.80	21.11	0.341	0.342

[0288] As shown in Table 2 and FIGS. **14**A to **14**D, in comparison to "Comparative Example 2", the driving voltage of the organic light emitting diode of the present invention (Ex 9 and Ex 10) is reduced (about 8%), the power

efficiency of the organic light emitting diode of the present invention (Ex 9 and Ex 10) is improved (about 32%). In addition, the EQE of the organic light emitting diode of the present invention (Ex 9 and Ex 10) is improved (about 24%).

[0289] Namely, by using the organic compound of the present invention in the second EBL, there are advantages in the driving voltage, the luminance, the power efficiency and/or the EQE.

4. EXAMPLE 11 (EX11)

[0290] An ITO layer is patterned to form the anode (3 mm*3 mm), and the anode is washed. The anode is loaded in a vacuum chamber having a base pressure of 1*10−6, and layers are sequentially deposited as below.

[0291] (1) HIL : (HAT-CN, 50 Å),

[0292] (2) first HTL: (α-NPB, 1000 Å),

[0293] (3) first EBL: (TCTA, 150 Å),

[0294] (4) first EML (blue): (host (MADN) doped by dopant (BD-1, 4 wt %), 250 Å),

[0295] (5) first ETL: (2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole, 100~300 Å),

[0296] (6) N-CGL: (Bphene doped by Li (2 wt %), 100 Å),

[0297] (7) P-CGL: (the compound A7 doped by F4TCNQ (10 wt %), 100 Å),

[0298] (8) second HTL: (the compound A7, 100 Å),

[0299] (9) second EML (YG): (CBP doped by $Ir(2\text{-phq})_3$, 300 Å),

[0300] (10) second ETL: (2-[4-(9,10-Di-2-naphthalenyl-2-anthracenyl)phenyl]-1-phenyl-1H-benzimidazole, 350~400 Å),

[0301] (11) EIL (LiF, 5~10 Å) and

[0302] (12) cathode (A1, 800Å1000 Å).

[0303] The deposited structure is loaded in the drying box and encapsuled by an UV-cured expoxy and a getter. The organic light emitting diode has an emitting area of 9 mm2.

5. EXAMPLE 12 (EX12)

[0304] Instead of the compound A7 in the P-CGL and the second HTL, the compound D4 is used.

6. COMPARATIVE EXAMPLE 3 (REF3)

[0305] Instead of the compound A7 in the P-CGL and the second HTL, the compound α-NPB is used.

[0306] The EL property of the organic light emitting diode in "Example 11", "Example 12" and "Comparative Example 3" is measured using the current supply "KEITHLEY" and the photometer "PR 650" under the room temperature. The driving voltage, the luminance, the power efficiency, the external quantum efficiency (EQE) and the color coordinate index of the organic light emitting diodes of are measured and listed in Table 3. The current density, the luminance, the power efficiency and the EQE are shown in FIGS. **15**A to **15**D.

TABLE 3

		V	Cd/A	lm/W	EQE (%)	CIE_x	CIE_y
Ex11	A7	8.14	53.19	20.54	25.58	0.318	0.333
Ex12	D4	8.18	49.44	18.99	22.38	0.343	0.364
Ref3	α-NPB	9.25	44.8	15.20	20.82	0.351	0.362

[0307] As shown in Table 3 and FIGS. **15**A to **15**D, in comparison to "Comparative Example 3", the driving voltage of the organic light emitting diode of the present invention (Ex 11 and Ex 12) is reduced (about 12%), the power efficiency of the organic light emitting diode of the present invention (Ex 11 and Ex 12) is improved (about 35%). In addition, the EQE of the organic light emitting diode of the present invention (Ex 11 and Ex 12) is improved (about 23%).

[0308] Namely, by using the organic compound of the present invention in the P-CGL and the second HTL, there are advantages in the driving voltage, the luminance, the power efficiency and/or the EQE.

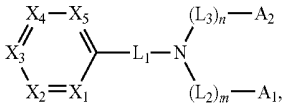
[0309] As shown in "Example 1" to "Example 12" and "Comparative Example 1" to "Comparative Example 3", the organic light emitting diode including the organic compound of the present invention in at least one of the HTL and the EBL in the single stack structure and in at least one of HTL, the EML and the P-CGL in the tandem structure has advantages in the driving voltage, the power consumption, the power efficiency and the EQE and provide the full color image. In addition, the lifetime of the organic light emitting diode is also improved.

[0310] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic compound, represented by following Formula 1:

[Formula 1]



wherein each of X_1 to X_5 is independently CR or N, and at least one of X_1 to X_5 is N,

wherein R is at least one selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkylhalide group, halogen, substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group, non-substituted C_5 to C_{30} hetero-arylamine group, substituted C_1 to C_{30} alkylsilyl group,

non-substituted C_1 to C_{30} alkylsilyl group, substituted C_5 to C_{30} arylsilyl group, non-substituted C_5 to C_{30} arylsilyl group, substituted C_5 to C_{30} hetero-arylsilyl group and non-substituted C_5 to C_{30} hetero-arylsilyl group,

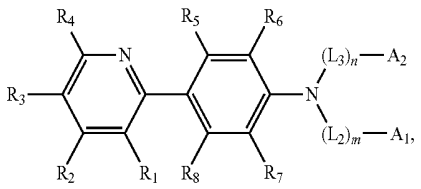
wherein each of A_1 and A_2 is at least one independently selected from the group consisting of substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group and non-substituted C_5 to C_{30} hetero-arylamine group, and

wherein each of L_1 to L_3 is at least one independently selected from the group of consisting substituted C_5 to C_{30} arylene group, non-substituted C_5 to C_{30} arylene group, substituted C_5 to C_{30} heteroarylene group, non-substituted C_5 to C_{30} heteroarylene group, substituted C_6 to C_{30} arylalkylene group, non-substituted C_6 to C_{30} arylalkylene group, substituted C_6 to C_{30} hetero-arylalkylene group, non-substituted C_6 to C_{30} hetero-arylalkylene group, substituted C_6 to C_{30} aryloxylene group, non-substituted C_6 to C_{30} aryloxylene group, substituted C_6 to C_{30} hetero-aryloxylene group and non-substituted C_6 to C_{30} hetero-aryloxylene group, and

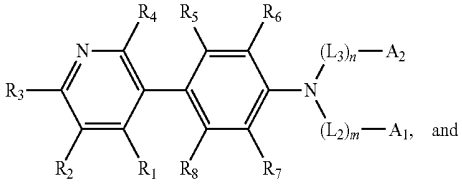
wherein each of "m" and "n" is 0 or 1.

2. The organic compound according to claim **1**, wherein the Formula 1 is represented by one of following Formulas 2a to 2c:

[Formula 2a]



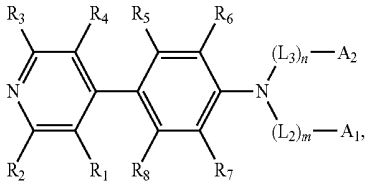
[Formula 2b]



and

-continued

[Formula 2c]



wherein each of R_1 to R_8 is at least one independently selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkylhalide group, halogen, substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group, non-substituted C_5 to C_{30} hetero-arylamine group, substituted C_1 to C_{30} alkylsilyl group, non-substituted C_1 to C_{30} alkylsilyl group, substituted C_5 to C_{30} arylsilyl group, non-substituted C_5 to C_{30} arylsilyl group, substituted C_5 to C_{30} hetero-arylsilyl group and non-substituted C_5 to C_{30} hetero-arylsilyl group, and

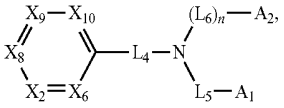
wherein each of A_1 and A_2 is at least one independently selected from the group consisting of substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group and non-substituted C_5 to C_{30} hetero-arylamine group, and

wherein each of L_2 and L_3 is at least one independently selected from the group of consisting substituted C_5 to C_{30} arylene group, non-substituted C_5 to C_{30} arylene group, substituted C_5 to C_{30} heteroarylene group, non-substituted C_5 to C_{30} heteroarylene group, substituted C_6 to C_{30} arylalkylene group, non-substituted C_6 to C_{30} arylalkylene group, substituted C_6 to C_{30} hetero-arylalkylene group, non-substituted C_6 to C_{30} hetero-arylalkylene group, substituted C_6 to C_{30} aryloxylene

group, non-substituted C_6 to C_{30} aryloxylene group, substituted C_6 to C_{30} hetero-aryloxylene group and non-substituted C_6 to C_{30} hetero-aryloxylene group, and wherein each of "m" and "n" is 0 or 1.

3. The organic compound according to claim **1**, wherein the Formula 1 is represented by Formula 3:

[Formula 3]



wherein one of X_6 to X_{10} is N, and the remaining of X_6 to X_{10} is CR,

wherein each of L_4 to L_6 is substituted phenylene or non-substituted phenylene,

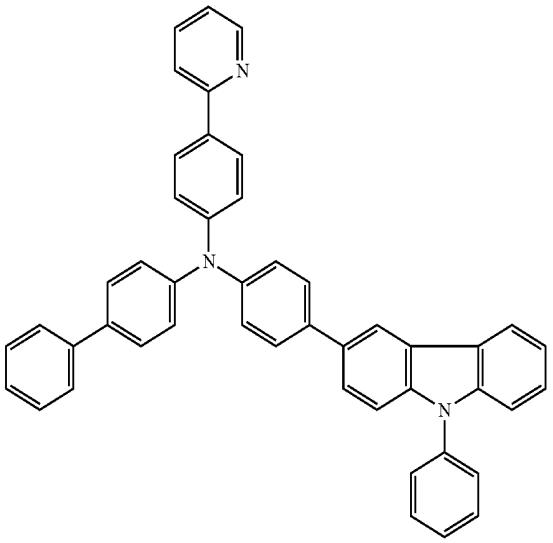
wherein R is at least one selected from the group consisting of hydrogen, deuterium, tritium, hydroxyl group, cyano group, nitro group, C_1 to C_{20} alkylhalide group, halogen, substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group, non-substituted C_5 to C_{30} hetero-arylamine group, substituted C_1 to C_{30} alkylsilyl group, non-substituted C_1 to C_{30} alkylsilyl group, substituted C_5 to C_{30} arylsilyl group, non-substituted C_5 to C_{30} arylsilyl group, substituted C_5 to C_{30} hetero-arylsilyl group and non-substituted C_5 to C_{30} hetero-arylsilyl group,

wherein each of A_1 and A_2 is at least one independently selected from the group consisting of substituted C_1 to C_{20} alkyl group, non-substituted C_1 to C_{20} alkyl group, substituted C_1 to C_{20} alkoxy group, non-substituted C_1 to C_{20} alkoxy group, substituted C_5 to C_{30} aryl group, non-substituted C_5 to C_{30} aryl group, substituted C_5 to C_{30} heteroaryl group, non-substituted C_5 to C_{30} heteroaryl group, substituted C_6 to C_{30} arylalkyl group, non-substituted C_6 to C_{30} arylalkyl group, substituted C_6 to C_{30} hetero-arylalkyl group, non-substituted C_6 to C_{30} hetero-arylalkyl group, substituted C_6 to C_{30} aryloxyl group, non-substituted C_6 to C_{30} aryloxyl group, substituted C_6 to C_{30} hetero-aryloxyl group, non-substituted C_6 to C_{30} hetero-aryloxyl group, substituted C_1 to C_{20} alkylamine group, non-substituted C_1 to C_{20} alkylamine group, substituted C_5 to C_{30} arylamine group, non-substituted C_5 to C_{30} arylamine group, substituted C_5 to C_{30} hetero-arylamine group and non-substituted C_5 to C_{30} hetero-arylamine group, and

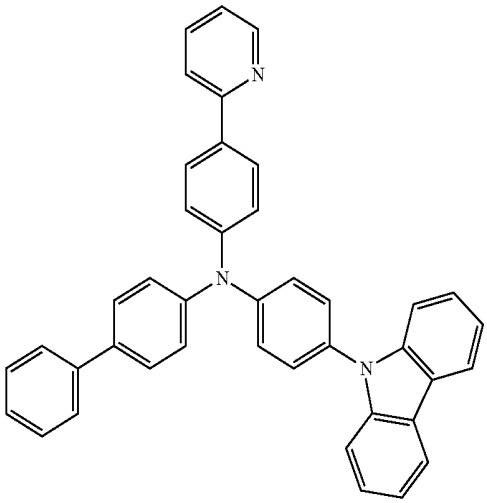
wherein "n" is 0 or 1.

4. The organic compound according to claim **1**, wherein the organic compound is selected from:

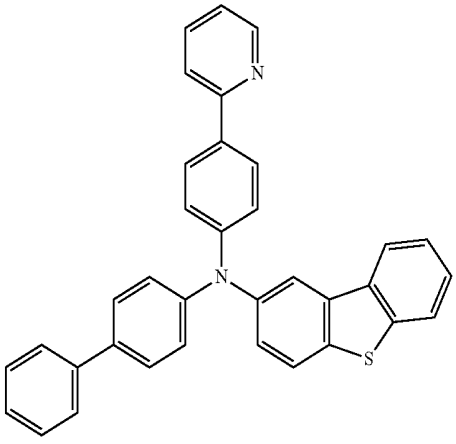
H-01



H-02

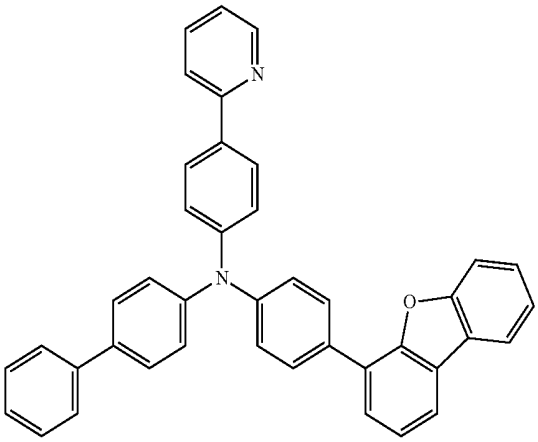


H-03

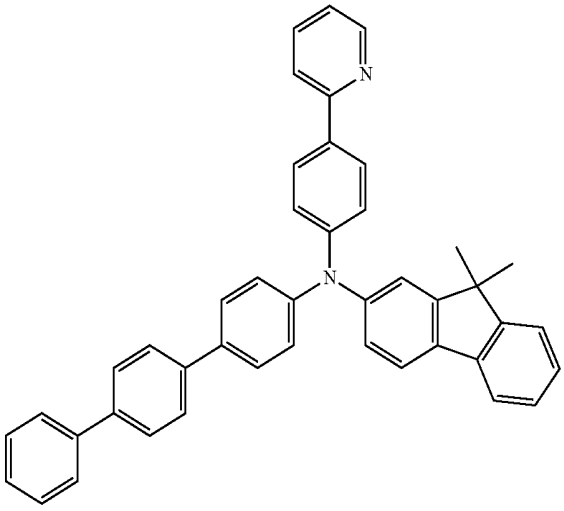


-continued

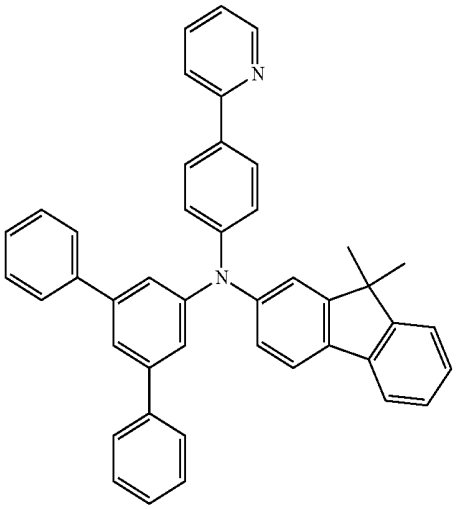
H-04



H-05

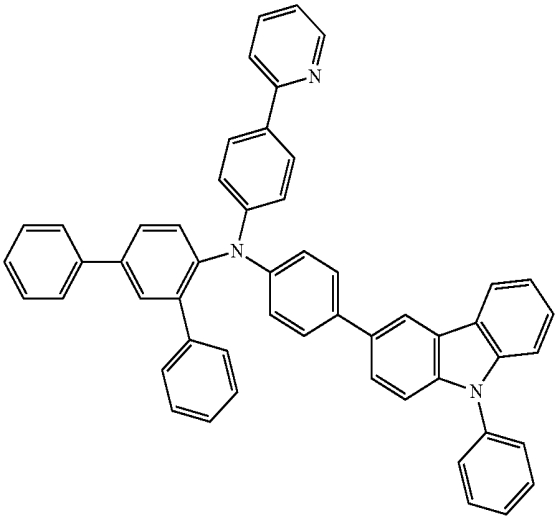


H-06

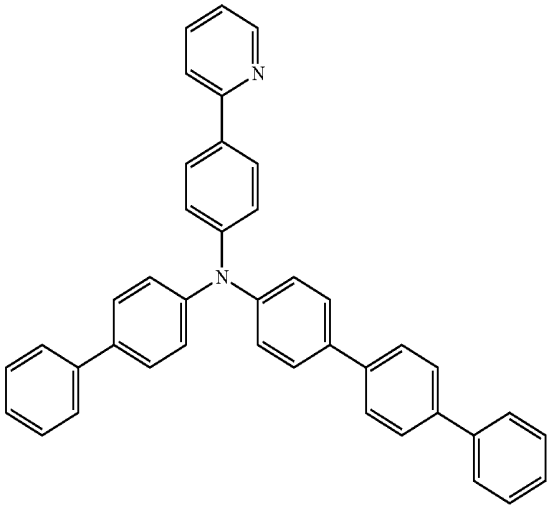


-continued

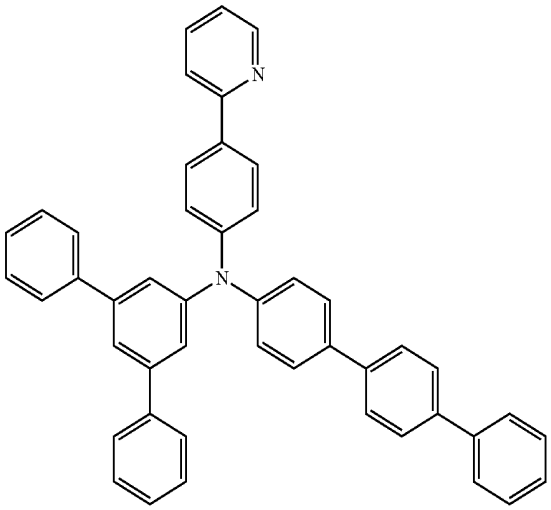
H-07



H-08

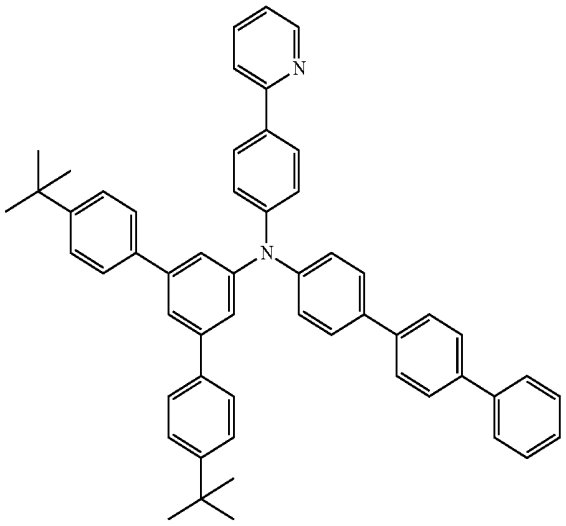


H-09

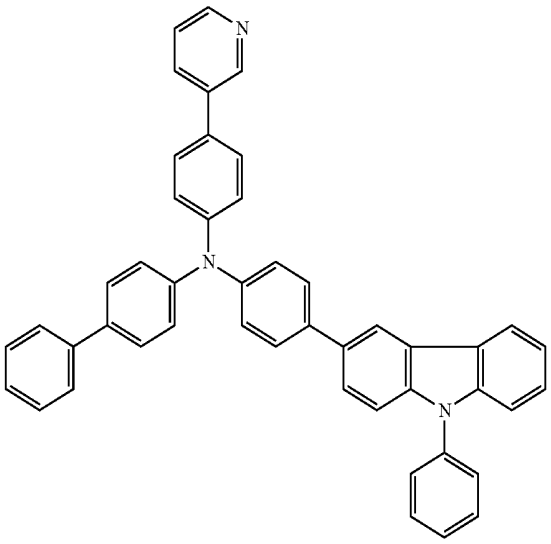


-continued

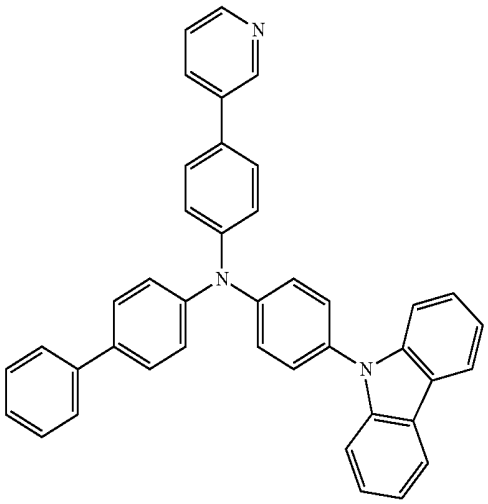
H-10



H-11

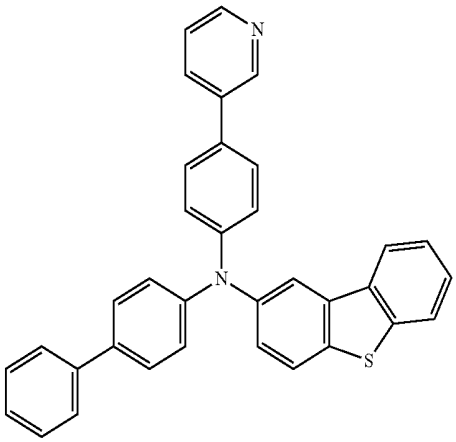


H-12

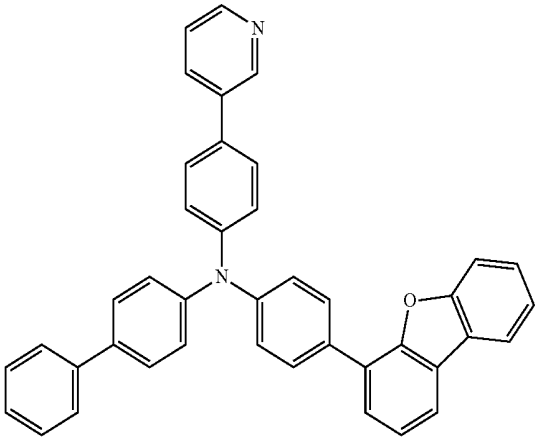


-continued

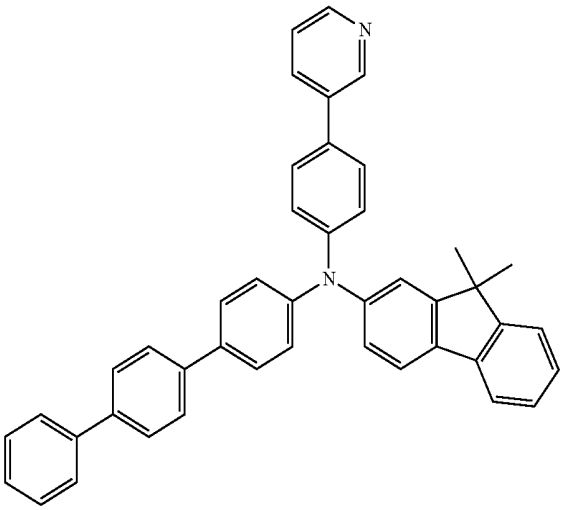
H-13



H-14

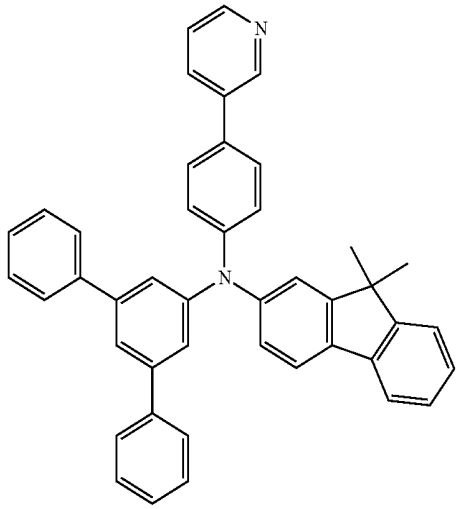


H-15

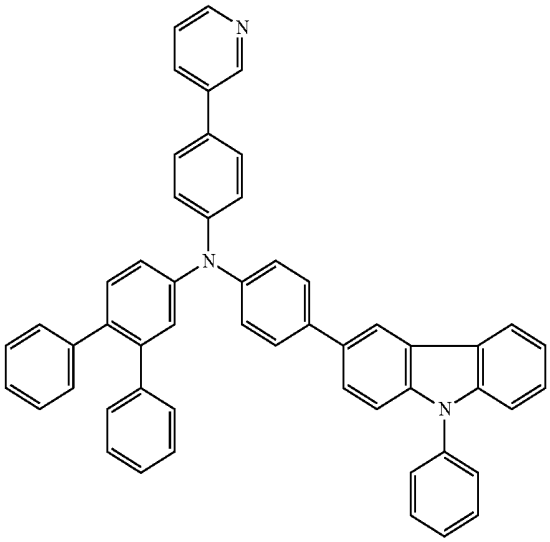


-continued

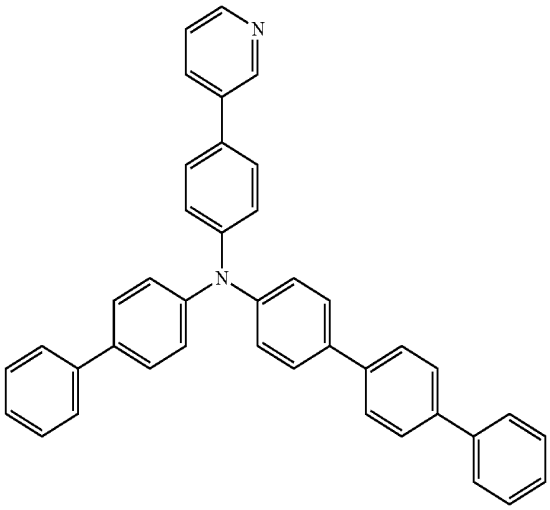
H-16



H-17

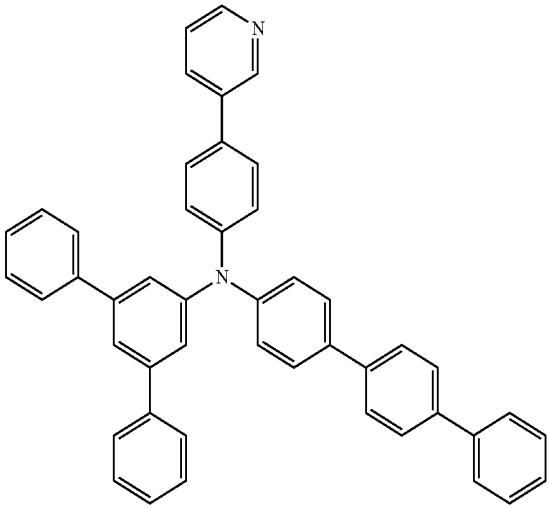


H-18

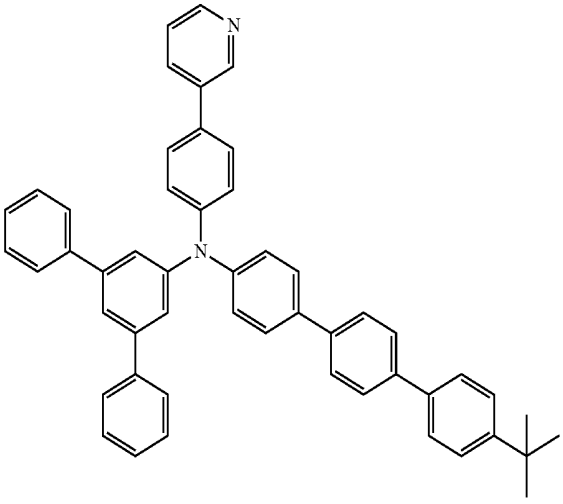


-continued

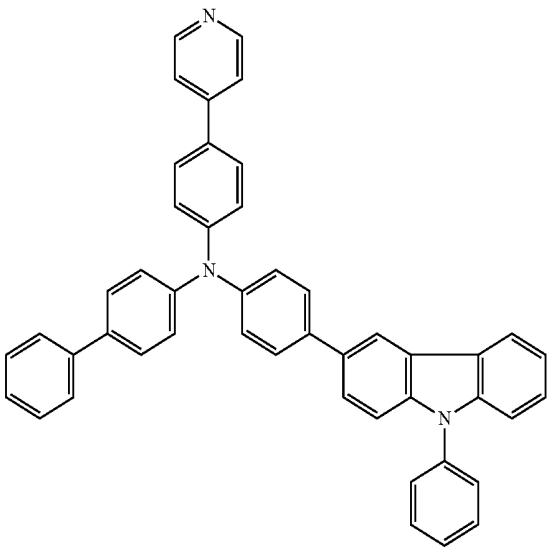
H-19



H-20

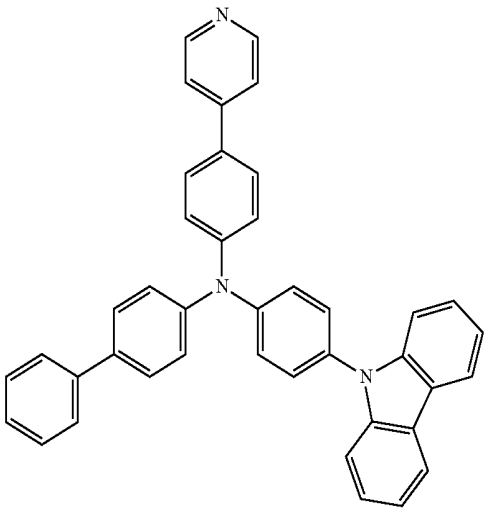


H-21

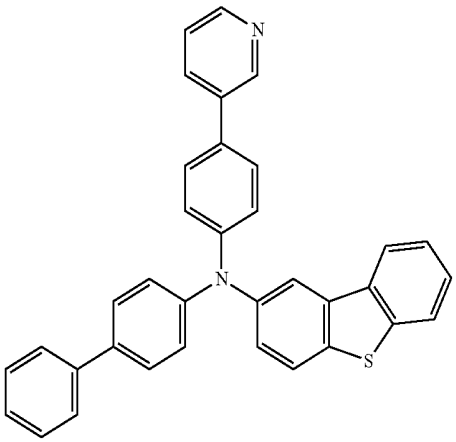


-continued

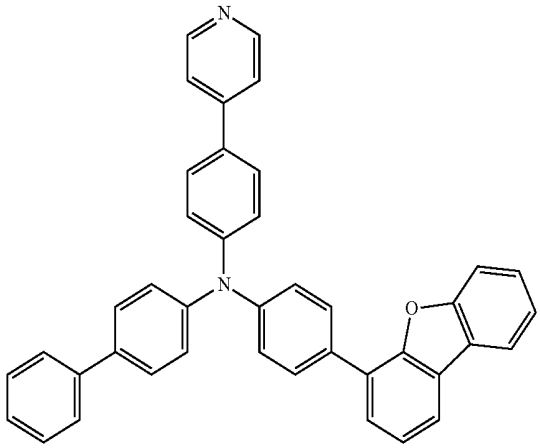
H-22



H-23

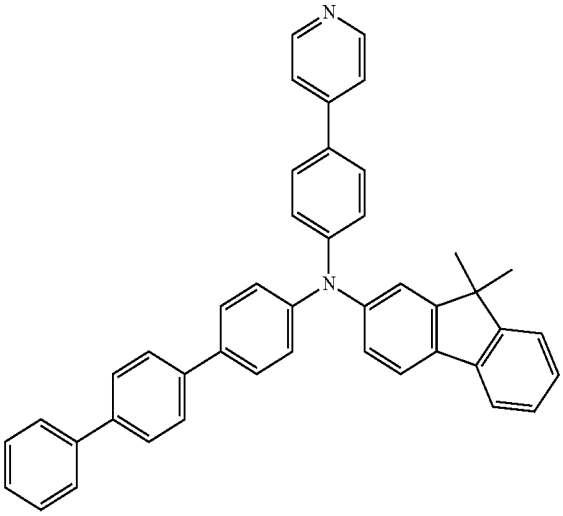


H-24

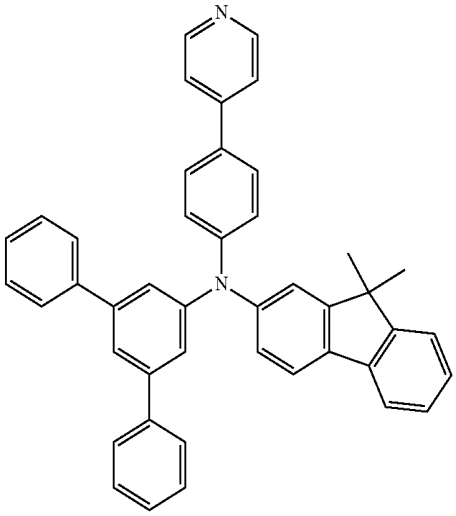


-continued

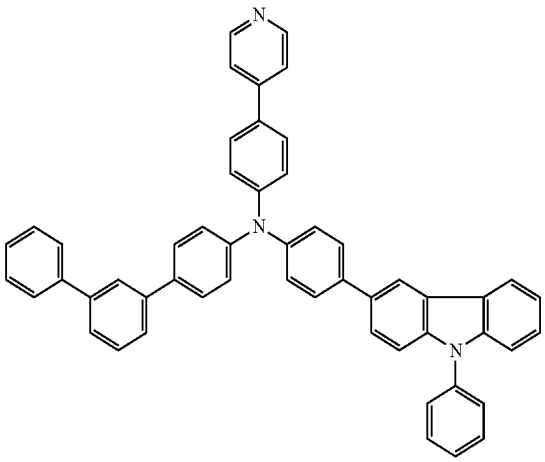
H-25



H-26

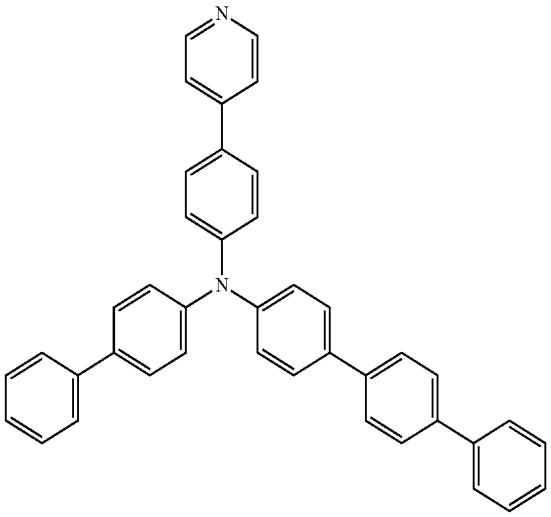


H-27

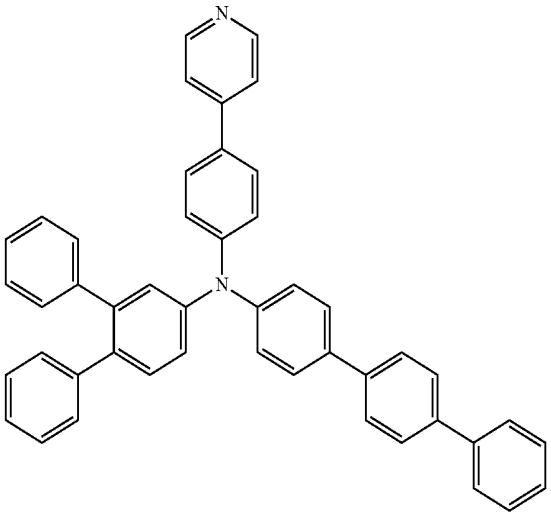


-continued

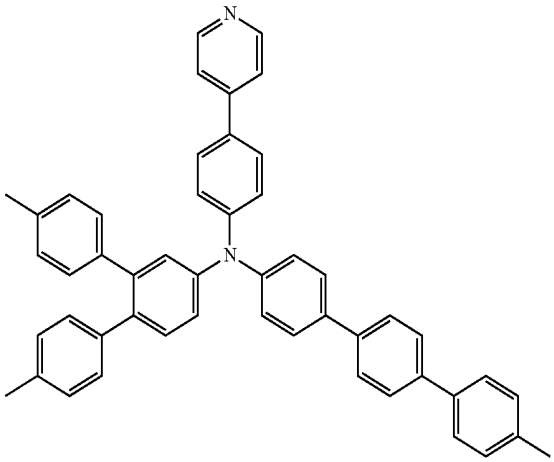
H-28



H-29

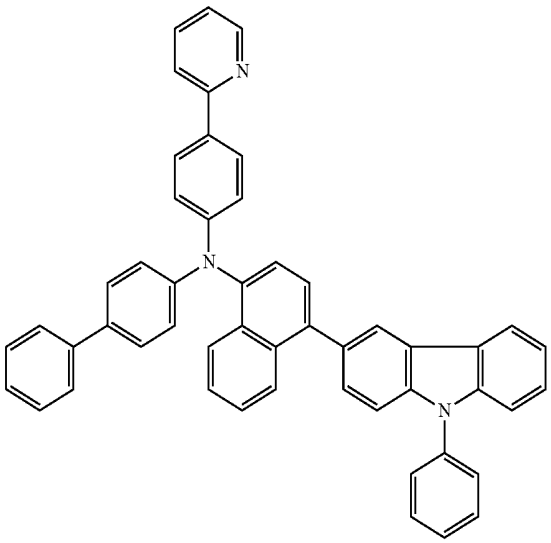


H-30

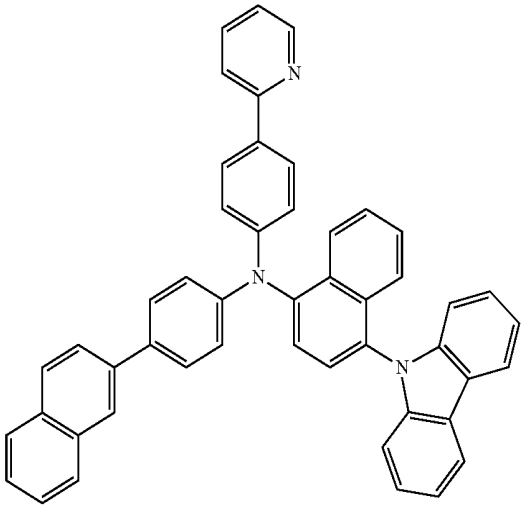


-continued

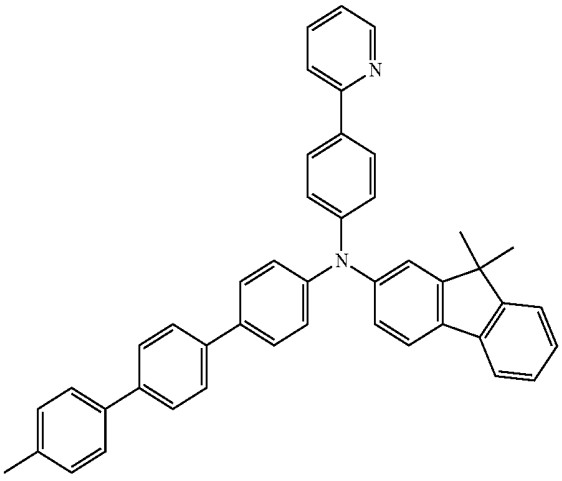
H-31



H-32

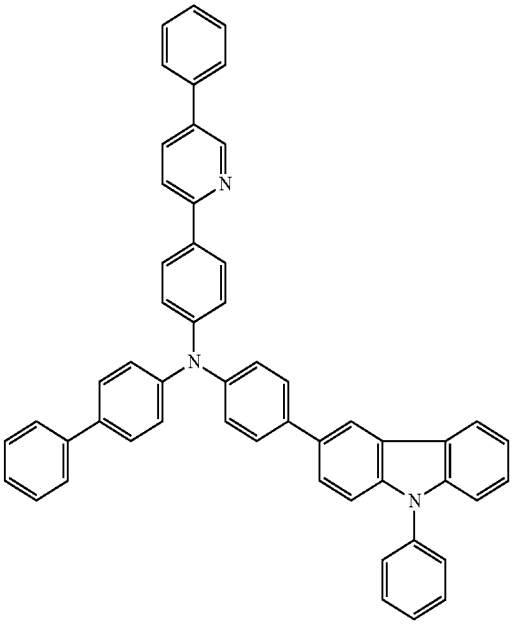


H-33

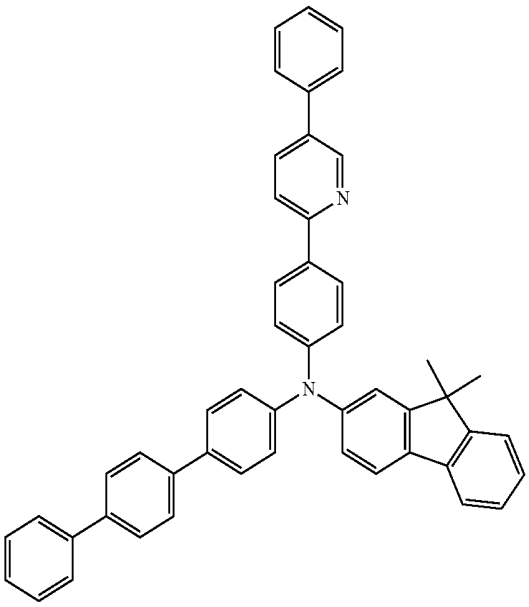


-continued

H-34

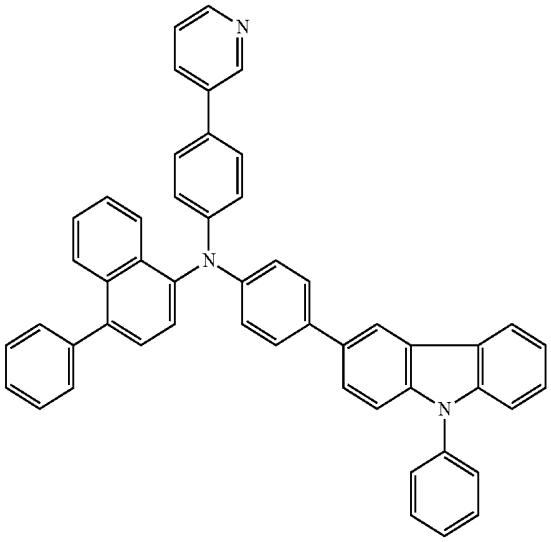


H-35

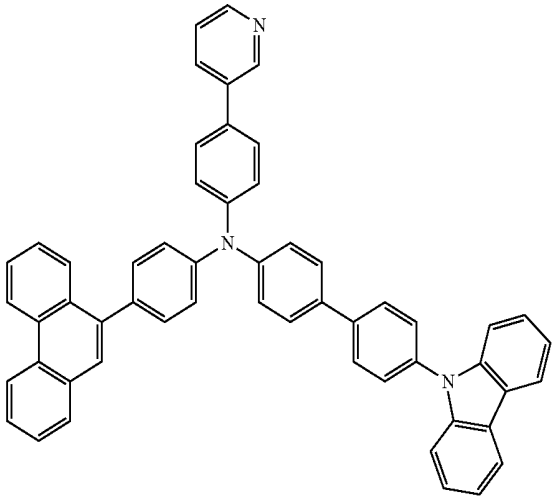


-continued

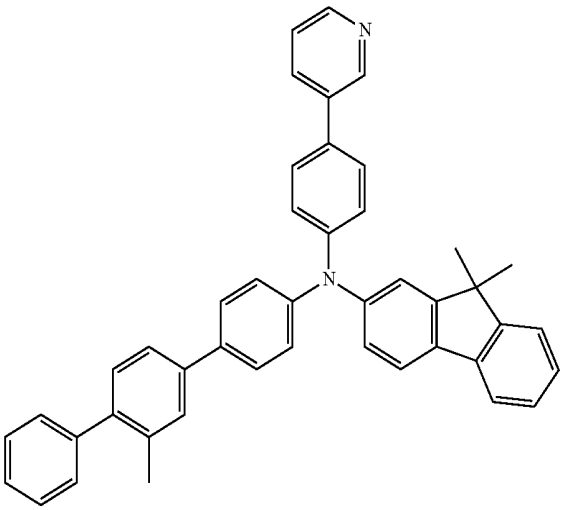
H-36



H-37

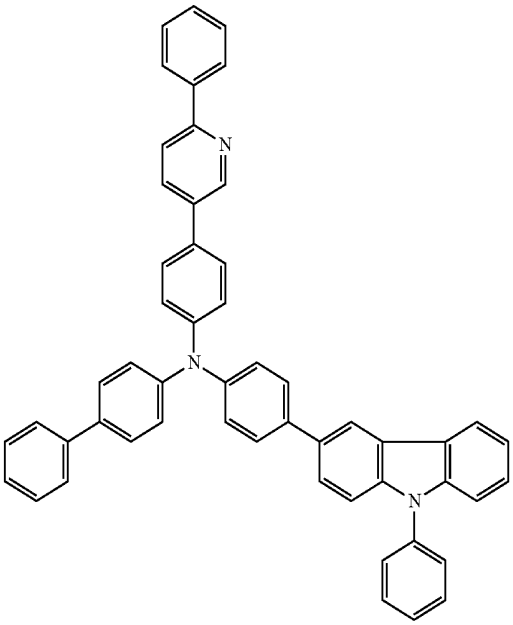


H-38

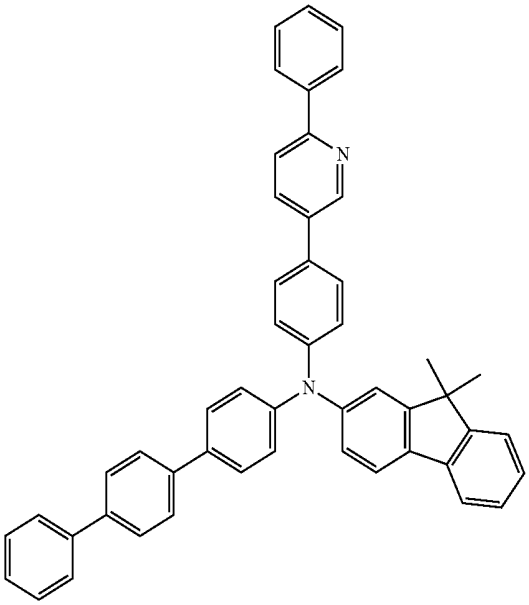


-continued

H-39

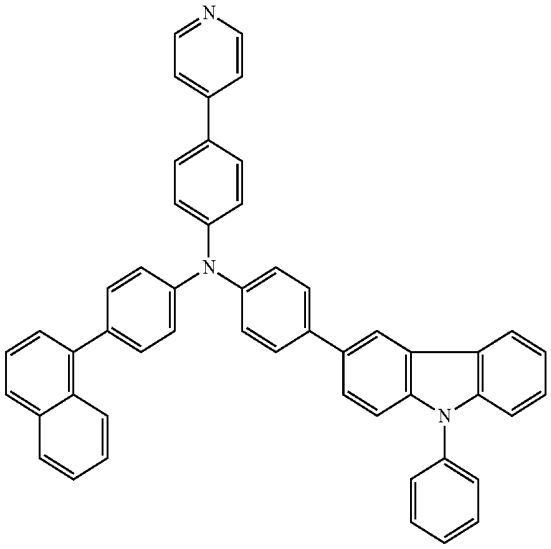


H-40

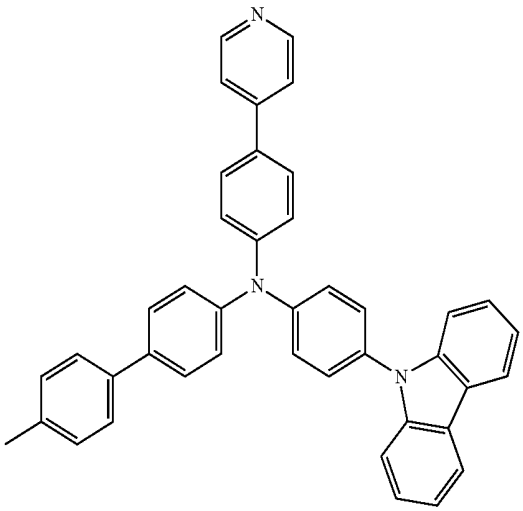


-continued

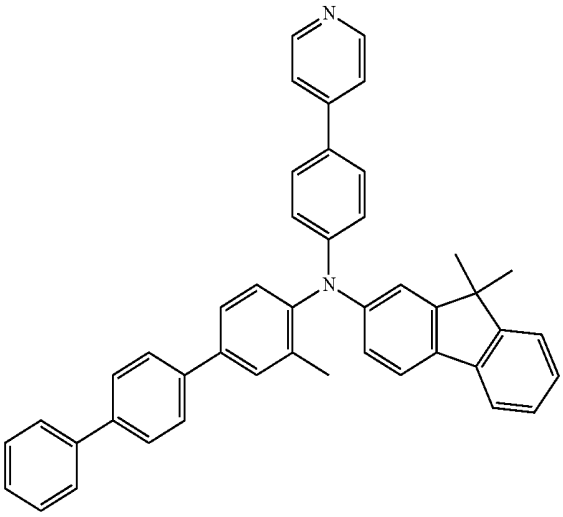
H-41



H-42

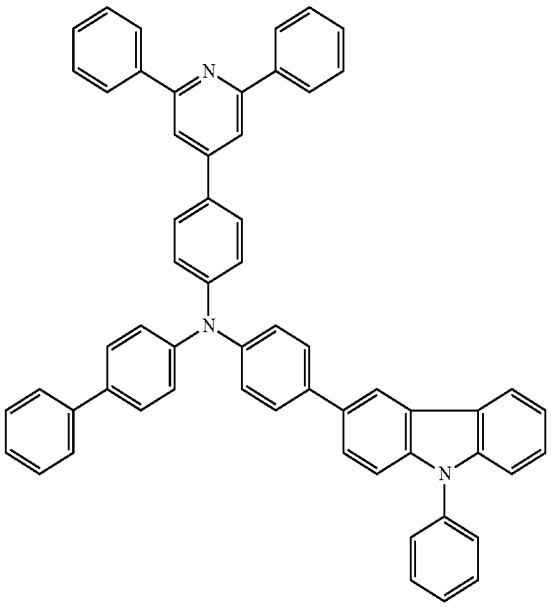


H-43



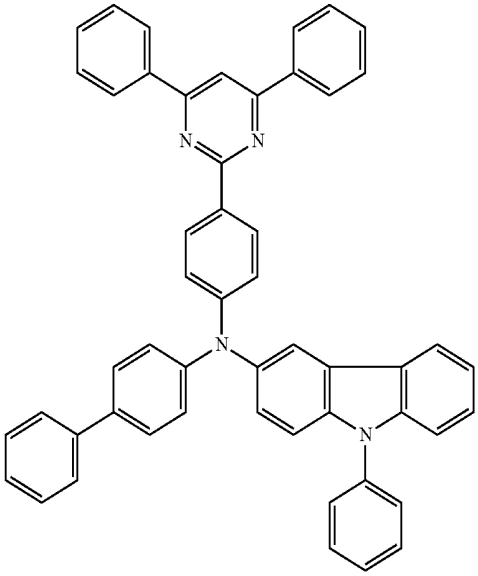
-continued

H-44

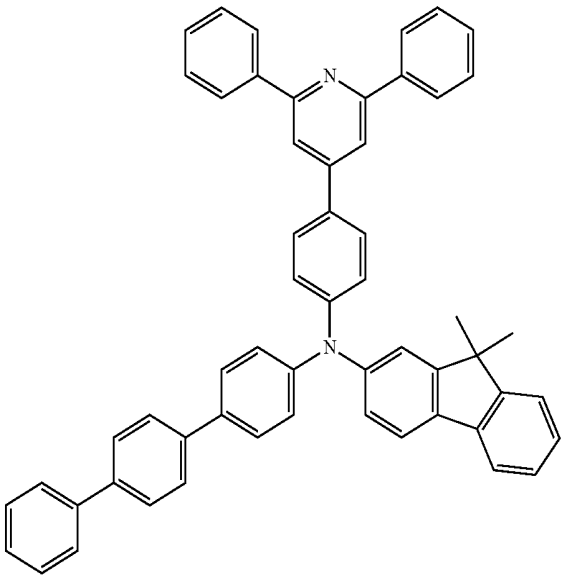


-continued

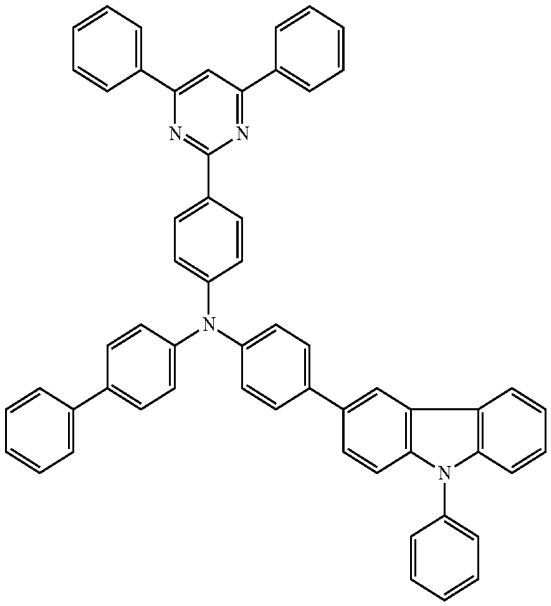
H-46



H-45

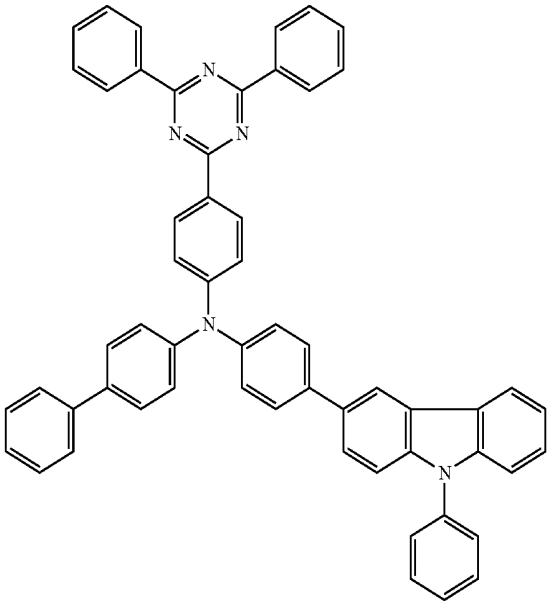


H-47

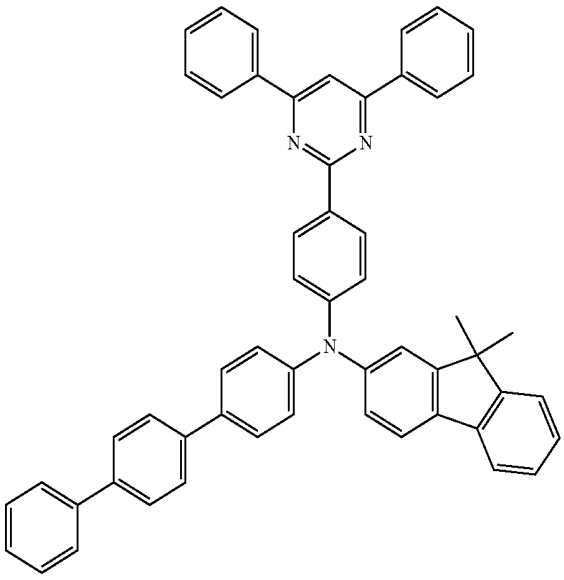


-continued

H-48

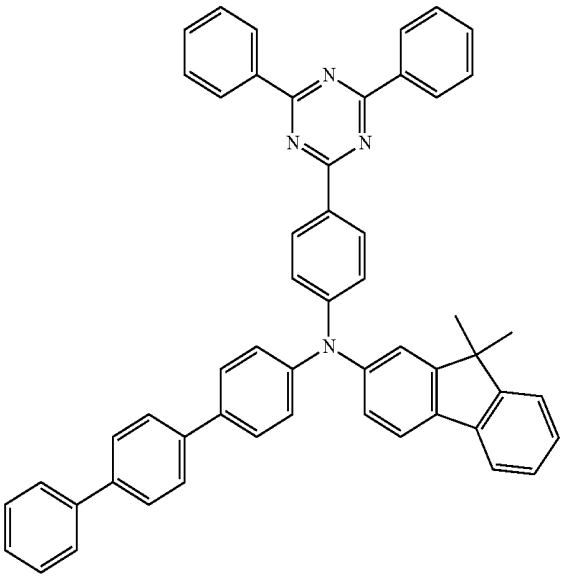


H-49

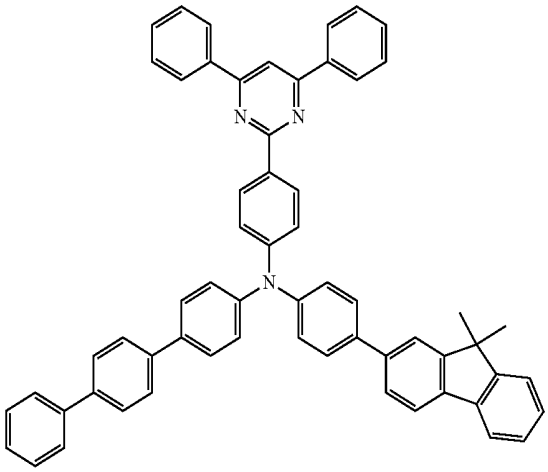


-continued

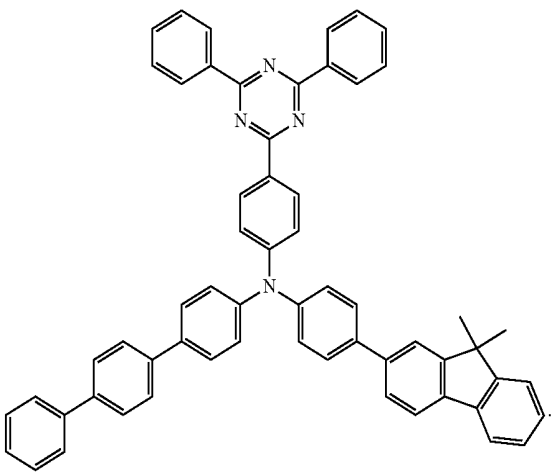
H-50



H-51



H-52



5. An organic light emitting diode, comprising:
a first electrode;
a second electrode facing the first electrode; and
an emitting part between the first electrode and the second electrode and including an emitting material layer and an organic layer, and
wherein the organic layer includes the organic compound of claim 1.

6. The organic light emitting diode according to claim 5, wherein the organic layer is a hole auxiliary layer including a hole injection layer and a hole transporting layer, and
wherein the hole transporting layer includes the organic compound with or without a hole transporting dopant.

7. The organic light emitting diode according to claim 5, wherein the organic layer is a hole auxiliary layer including a hole injection layer and a hole transporting layer, and the hole transporting layer includes a first layer between the hole injection layer and the emitting material layer and a second layer between the first layer and the emitting material layer, and
wherein the first layer includes the organic compound and the second layer includes the organic compound with a hole transporting dopant, or the second layer includes the organic compound and the first layer includes the organic compound with a hole transporting dopant.

8. The organic light emitting diode according to claim 5, wherein the organic layer includes a first hole transporting layer including the organic compound with a hole injection dopant, and the first hole transporting layer contacts the first electrode.

9. The organic light emitting diode according to claim 8, wherein the organic layer further includes a second hole transporting layer between the first hole transporting layer and the emitting material layer and including the organic compound with or without a hole transporting dopant.

10. The organic light emitting diode according to claim 8, wherein the organic layer includes a hole transporting layer and an electron blocking layer between the hole transporting layer and the emitting material layer, and the electron blocking layer includes the organic compound.

11. An organic light emitting display device, comprising:
a substrate;
the organic light emitting diode of claim 5: and
a thin film transistor between the substrate and the organic light emitting diode,
wherein the thin film transistor is connected to the organic light emitting diode.

12. An organic light emitting diode, comprising:
a first electrode and a second electrode facing each other;
a first emitting part between the first electrode and the second electrode and including a first emitting material layer;
a second emitting part between the first emitting part and the second electrode and including a second emitting material layer; and
a P-type charge generation layer between the first emitting part and the second emitting part,
wherein the P-type charge generation layer includes the organic compound of claim 1.

13. The organic light emitting diode according to claim 12, wherein the P-type charge generation layer further includes a hole injection dopant.

14. The organic light emitting diode according to claim 13, wherein the first emitting part includes a hole injection layer and a first hole transporting layer between the first electrode and the first emitting material layer and a first electron transporting layer between the first emitting material layer and the P-type charge generation layer, and
the second emitting part further includes a second hole transporting layer between the P-type charge generation layer and the second electrode, a second electron transporting layer between the second emitting material layer and the second electrode and an electron injection layer between the second electron transporting layer and the second electrode.

15. The organic light emitting diode according to claim 14, wherein the second hole transporting layer includes the organic compound with or without a hole transporting dopant.

16. The organic light emitting diode according to claim 14, further comprising:
an N-type charge generation layer between the P-type charge generation layer and the first electron transporting layer; and
an intermediate charge generation layer between the P-type charge generation layer and the N-type charge generation layer,
wherein the intermediated charge generation layer includes a hole injection material and the organic compound doped to the hole injection material.

17. The organic light emitting diode according to claim 12, wherein the first emitting part includes a hole injection layer and a hole transporting layer between the first electrode and the first emitting material layer and a first electron transporting layer between the first emitting material layer and the P-type charge generation layer, and the second emitting part further includes a second electron transporting layer between the second emitting material layer and the second electrode and an electron injection layer between the second electron transporting layer and the second electrode, and
wherein the P-type charge generation layer further includes a hole injection dopant.

18. An organic light emitting display device, comprising:
a substrate;
the organic light emitting diode of claim 12: and
a thin film transistor between the substrate and the organic light emitting diode,
wherein the thin film transistor is connected to the organic light emitting diode.

19. An organic light emitting diode, comprising:
a first electrode and a second electrode facing each other;
a first emitting part between the first electrode and the second electrode and including a first emitting material layer;
a second emitting part between the first emitting part and the second electrode and including a second emitting material layer; and
a charge generation layer between the first emitting part and the second emitting part,
wherein the second emitting part further includes an electron blocking layer between the charge generation layer and the second emitting part and includes the organic compound of claim 1.

20. An organic light emitting display device, comprising:
a substrate;
the organic light emitting diode of claim **19**; and
a thin film transistor between the substrate and the organic light emitting diode,
wherein the thin film transistor is connected to the organic light emitting diode.

* * * * *

专利名称(译)	有机化合物，有机发光二极管和有机发光显示装置，包括相同的		
公开(公告)号	US20180097184A1	公开(公告)日	2018-04-05
申请号	US15/718980	申请日	2017-09-28
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	LEE SEUNG JAE BIN JONG KWAN SEO BO MIN CHOI HYE OCK		
发明人	LEE, SEUNG-JAE BIN, JONG-KWAN SEO, BO-MIN CHOI, HYE-OCK		
IPC分类号	H01L51/00 H01L27/32 C07D401/12 C07D409/12 C07D405/12 C07D213/38 C07D239/26 C07D251/24		
CPC分类号	H01L51/0061 H01L27/3244 C07D401/12 C07D409/12 C07D405/12 C07D213/38 H01L51/006 C07D239/26 C07D251/24 H01L51/5088 H01L51/5056 H01L51/5096 H01L51/5072 H01L51/5092 H01L51/0067 H01L51/0072 H01L51/0074 H01L51/0073 H01L51/0052 H01L51/0058 C07D403/12 H01L51/50 H01L2251/30 H01L2251/50 H01L51/0059 H01L51/506 H01L51/5064 H01L51/5278		
优先权	1020160126656 2016-09-30 KR		
其他公开文献	US10615347		
外部链接	Espacenet USPTO		

摘要(译)

本发明提供用于有机发光二极管的有机化合物。有机化合物由下式表示： 有机化合物能够通过优异的电荷传输性能降低有机发光二极管的驱动电压。本发明还提供有机发光二极管和包含该有机化合物的有机发光显示装置。