US009966536B2

(12) United States Patent
Itoi

(10) Patent No.: US 9,966,536 B2
(45) Date of Patent: May 8, 2018

(54) **ORGANIC ELECTROLUMINESCENCE DEVICE**

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**, Yongin, Gyeonggi-Do (KR)

(72) Inventor: **Hiroaki Itoi**, Yokohama (JP)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin, Gyeonggi-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 285 days.

(21) Appl. No.: **14/701,307**

(22) Filed: **Apr. 30, 2015**

(65) **Prior Publication Data**

US 2016/0079542 A1 Mar. 17, 2016

(30) **Foreign Application Priority Data**

Sep. 9, 2014 (JP) 2014-183625
Sep. 9, 2014 (JP) 2014-183626

(51) **Int. Cl.**
H01L 51/50 (2006.01)
H01L 51/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 51/0061*** (2013.01); ***H01L 51/006*** (2013.01); *H01L 51/0058* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01L 51/0061; H01L 51/506; H01L 51/5064
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0289008 A1* 11/2010 Jang H01L 51/5052 257/40
2011/0156016 A1* 6/2011 Kawamura C07C 211/54 257/40

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2004-339066 A 12/2001
JP 2002241352 A * 8/2002

(Continued)

OTHER PUBLICATIONS

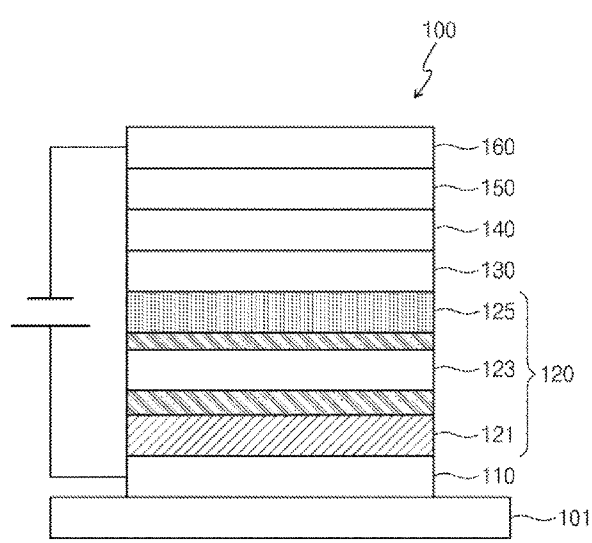
Machine Translation of JP 2002241352 A (Year: 2017).*

Primary Examiner — Michael M Dollinger
(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

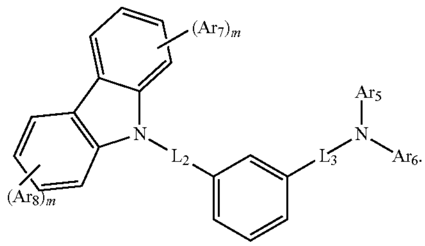
(57) **ABSTRACT**

An organic electroluminescent (EL) device including an anode; an emission layer for obtaining luminescence via a singlet excited state; and a laminated structure between the anode and the emission layer, the laminated structure including at least three layers having different components, wherein the laminated structure includes a first layer including a hole transport compound, the hole transport compound being obtained by doping an electron accepting compound having a lowest unoccupied molecular orbital (LUMO) level of about −9.0 eV to about −4.0 eV; and a second layer between the first layer and the emission layer, the second layer being closer to the emission layer than the first layer and including a compound represented by the following Formula 1:

(Continued)



[Formula 1]



11 Claims, 1 Drawing Sheet

(52) **U.S. Cl.**
CPC *H01L 51/0067* (2013.01); *H01L 51/0072* (2013.01); *H01L 51/0073* (2013.01); *H01L 51/0074* (2013.01); *H01L 51/0081* (2013.01); *H01L 51/5004* (2013.01); *H01L 51/506* (2013.01); *H01L 51/5012* (2013.01); *H01L 51/5056* (2013.01); *H01L 51/5064* (2013.01); *H01L 2251/308* (2013.01); *H01L 2251/552* (2013.01)

(58) **Field of Classification Search**
USPC 428/690
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0215308	A1*	9/2011	Im	H01L 51/006 257/40
2012/0326137	A1*	12/2012	Song	H01L 51/5064 257/40
2013/0049579	A1	2/2013	Kaiser et al.	
2014/0001444	A1*	1/2014	Kim	H01L 51/5064 257/40

FOREIGN PATENT DOCUMENTS

JP	4770033	B2	7/2011
JP	2011-187959	A	9/2011
JP	2013-522864	A	6/2013
KR	10-2013-0007159	A	1/2013
WO	WO-2007/105906	A1	9/2007
WO	WO-2008/145239	A2	12/2008

* cited by examiner

FIG. 1

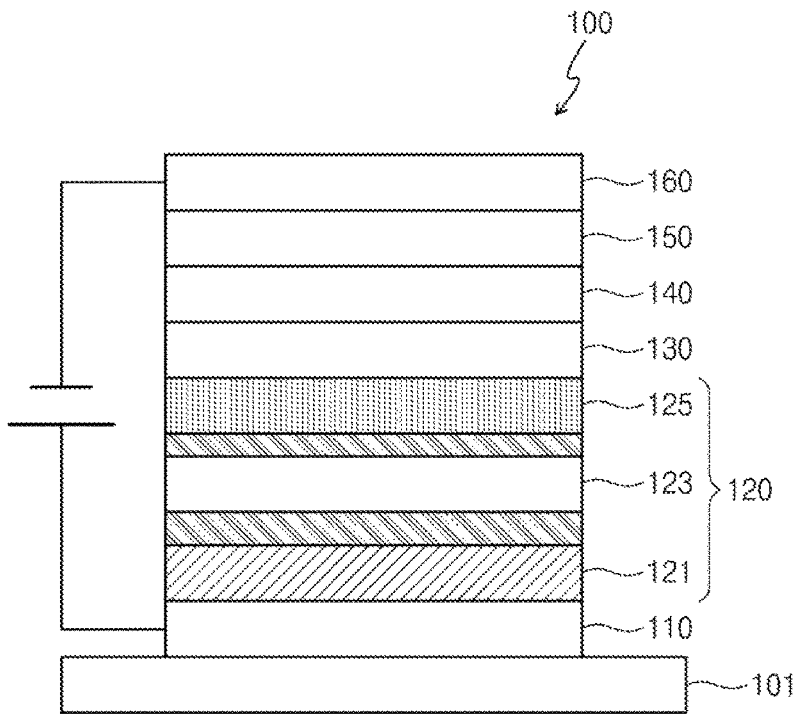
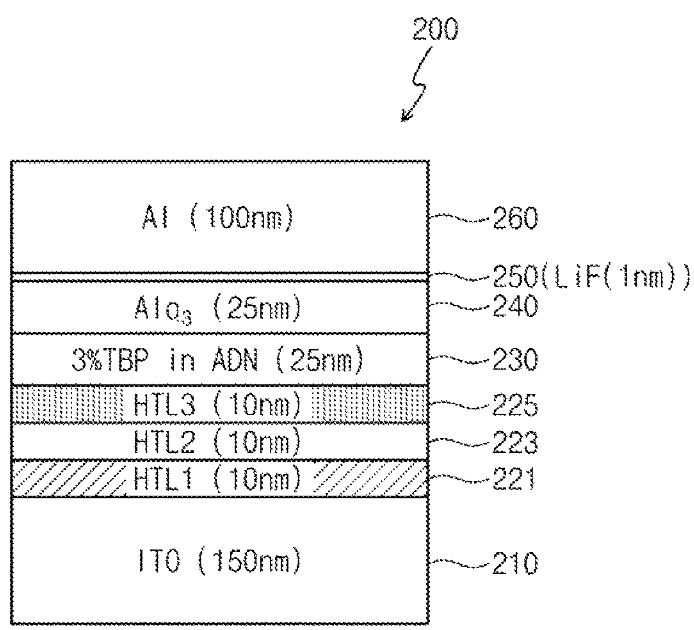

100
160
150
140
130
125
123
120
121
110
101

FIG. 2


200
Al (100nm)
260
250(LiF(1nm))
AlQ3 (25nm)
240
3%TBP in ADN (25nm)
230
HTL3 (10nm)
225
HTL2 (10nm)
223
HTL1 (10nm)
221
ITO (150nm)
210

ORGANIC ELECTROLUMINESCENCE DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

Japanese Patent Application No. 2014-183625, filed on Sep. 9, 2014, and Japanese Patent Application No. 2014-183626 filed on Sep. 9, 2014 in the Japanese Patent Office, and entitled: "Organic Electroluminescent Device," are incorporated by reference herein in their entirety.

BACKGROUND

1. Field

Embodiments relate to an organic electroluminescent device.

2. Description of the Related Art

Recently, an organic electroluminescent display (organic EL display) is being actively developed as an image display apparatus. The organic EL display is, unlike a liquid crystal display or the like, a self-emitting type display which embodies display through light emission of a luminescent material including an organic compound of the light emitting layer by recombining holes and electrons injected from an anode and a cathode in an emission layer.

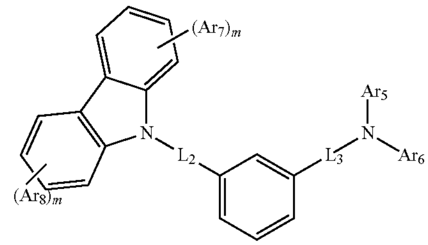
An example of an organic electroluminescent device (organic EL device) may include an anode, a hole transport layer disposed on the anode, an emission layer disposed on the hole transport layer, an electron transport layer disposed on the emission layer and a cathode disposed on the electron transport layer. Holes may be injected from the anode, and the injected holes are injected into the emission layer through the hole transport layer. Meanwhile, electrons are injected from the cathode, and the injected electrons are injected into the emission layer through the electron transport layer. The holes and the electrons injected into the emission layer are recombined, and excitons are generated in the emission layer. The organic EL device emits light by using light generated by the radiation deactivation of the excitons. The organic EL device is not limited to the aforementioned constitution, but many modifications thereof are possible.

SUMMARY

Embodiments are directed to an organic electroluminescent device.

Embodiments provide organic EL devices including a laminated structure of at least three layers having different components between an anode and an emission layer for obtaining luminescence mainly via a singlet excited state. The laminated structure includes a first layer including a hole transport compound obtained by doping an electron accepting compound having a lowest unoccupied molecular orbital (LUMO) level of about −9.0 eV to about −4.0 eV; and a second layer disposed between the first layer and the emission layer. The second layer is closer to the emission layer than the first layer and includes a compound represented by the following Formula 1.

[Formula 1]

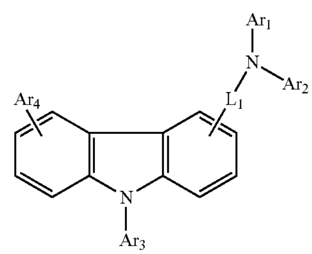


In Formula 1, Ar_5 to Ar_8 are a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring or a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, m is an integer from 0 to 4, and L_2 and L_3 are a single bond, a substituted or unsubstituted arylene group having 6 to 18 carbon atoms for forming a ring or a substituted or unsubstituted heteroarylene group having 5 to 15 carbon atoms for forming a ring.

The organic EL device according to an embodiment may help improve hole injection properties from an anode, passivate hole transport laminated structure from electrons not consumed in an emission layer, prevent diffusion of energy of an excited state generated in the emission layer into the hole transport laminated structure and control the charge balance of a whole device, thereby realizing the improvement of emission efficiency and long life.

In some embodiments, a third layer including a compound represented by the following Formula 2 may be included between the anode and the second layer.

[Formula 2]



In Formula 2, Ar_1, Ar_2 and Ar_3 are a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring or a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, Ar_4 is a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, and L_1 is a single bond, a substituted or unsubstituted arylene group having 6 to 18 carbon atoms for forming a ring or a substituted or unsubstituted heteroarylene group having 5 to 15 carbon atoms for forming a ring.

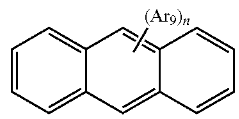
The organic EL device according to an embodiment includes a compound having a carbazolyl group in a hole transport laminated structure, and hole transport properties and current flow durability may be improved, emission efficiency may be improved, and long life may be realized.

In other embodiments, the first layer may include a compound represented by the above Formula 2.

The organic EL device according to an embodiment includes a compound having a carbazolyl group in a hole transport laminated structure, and hole transport properties and current flow durability may be improved, emission efficiency may be improved, and long life may be realized.

In still other embodiments, the emission layer may include a compound represented by the following Formula 3.

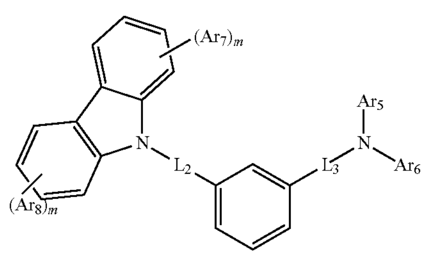
[Formula 3]



In Formula 3, each Ar_9 is independently a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 carbon atoms for forming a ring, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted arylthio group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group or a hydroxyl group, and n is an integer from 1 to 10.

In other embodiments, organic EL devices include a laminated structure of at least three layers having different components between an anode and an emission layer for obtaining luminescence mainly via a singlet excited state. The laminated structure includes a first layer formed by using an electron accepting compound having a LUMO level of about −9.0 eV to about −4.0 eV as a main component, and a second layer disposed between the first layer and the emission layer. The second layer is closer to the emission layer than the first layer and includes a compound represented by the following Formula 1.

[Formula 1]

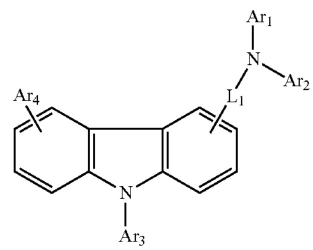


In Formula 1, Ar_5 to Ar_8 are a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring or a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, m is an integer from 0 to 4, and L_2 and L_3 are a single bond, a substituted or unsubstituted arylene group having 6 to 18 carbon atoms for forming a ring or a substituted or unsubstituted heteroarylene group having 5 to 15 carbon atoms for forming a ring.

The organic EL device according to an embodiment may improve hole injection properties from an anode, passivate hole transport laminated structure from electrons not consumed in an emission layer, prevent diffusion of energy of an excited state generated in the emission layer into the hole transport laminated structure and control the charge balance of a whole device, thereby realizing the improvement of emission efficiency and long life.

In some embodiments, a third layer including a compound represented by the following Formula 2 may be included between the first layer and the second layer.

[Formula 2]

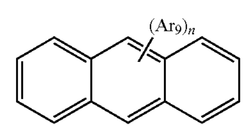


In Formula 2, Ar_1, Ar_2 and Ar_3 are a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring or a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, Ar_4 is a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, and L_1 is a single bond, a substituted or unsubstituted arylene group having 6 to 18 carbon atoms for forming a ring or a substituted or unsubstituted heteroarylene group having 5 to 15 carbon atoms for forming a ring.

The organic EL device according to an embodiment includes a compound having a carbazolyl group in a hole transport laminated structure, and hole transport properties and current flow durability may be improved, emission efficiency may be improved, and long life may be realized.

In other embodiments, the emission layer may include a compound represented by the following Formula 3.

[Formula 3]



In Formula 3, each Ar_9 is independently a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 carbon atoms for forming a ring, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted arylthio group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group having 5 to 50 carbon atoms for forming a ring, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group or a hydroxyl group, and n is an integer from 1 to 10.

The organic EL device according to an embodiment may realize the improvement of emission life and long life.

According to the present disclosure, an organic EL device having high efficiency and long life may be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will be apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. **1** illustrates a schematic diagram of an organic EL device according to an embodiment; and

FIG. **2** illustrates a schematic diagram of an organic EL device according to an embodiment.

DETAILED DESCRIPTION

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

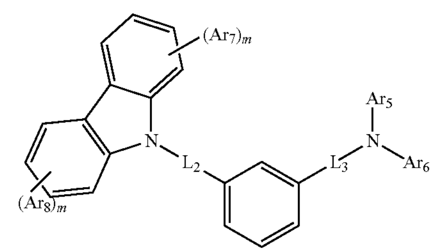
In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

Hole injection properties from an anode may be improved by disposing a layer formed by using an electron accepting compound adjacent to the anode. According to an embodiment, a laminated layer having hole transport properties between an emission layer and an anode may be regarded as a structure, and a hole transport layer doped with an electron accepting material may be laminated adjacent to, e.g., directly adjacent to, the anode in the laminated structure and an intermediate layer including an amine derivative having a carbazolyl derivative may be laminated adjacent to, e.g., directly adjacent to, the emission layer.

The organic EL device according to an embodiment will be explained. FIG. **1** illustrates a schematic diagram of an organic EL device **100** according to an embodiment. The organic EL device **100** may include, e.g., an anode **110** on a substrate **101**, an emission layer **130**, an electron transport layer **140**, an electron injection layer **150** and a cathode **160**. Between the anode **110** and the emission layer **130**, a hole transport band **120** may be disposed. The hole transport band **120** may be a band for disposing or including a hole transport layer or a hole injection layer.

According to an embodiment, to realize an organic EL device having improved emission efficiency and long life, a laminated structure of at least three layers having different components may be provided in the hole transport band **120** between the anode **110** and the emission layer **130**. The laminated structure may include at least a first layer **121** and a second layer **125**. At least one layer (e.g., the first layer **121**) disposed adjacent to the anode **110** may include a hole transport compound obtained by doping an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV. At least one layer (e.g., the second layer **125**) disposed between the first layer **121** and the emission layer **130** and closer to the emission layer **130** may include a compound represented by the following Formula 1.

[Formula 1]



In Formula 1, Ar_5 to Ar_8 may each independently be or include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, each m may independently be an integer of 0 to 4, and L_2 and L_3 may each independently be or may include, e.g., a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms. In an implementation, adjacent ones of Ar_5 to Ar_8 may form a ring. For example, adjacent ones of Ar_5 and Ar_6 may be combined to form a ring. In an implementation, adjacent Ar_7s and/or adjacent Ar_8s may be combined to form a ring.

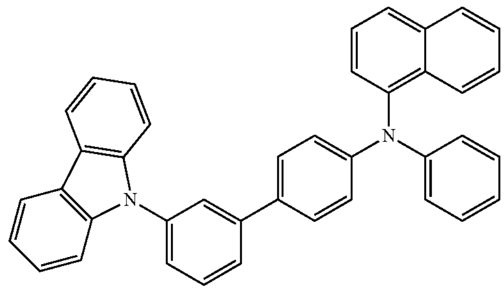
In an implementation, Ar_5 to Ar_8 may each independently include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acetonaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a pyranyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

In an implementation, L_2 and L_3, may each independently include, other than a single bond, e.g., a phenylene group, a biphenylylene group, a terphenylylene group, a naphthalene group, an anthrylene group, a phenanthrylene group, a fluorirane group, an indanediyl group, a pyrenediyl group, an acenaphthenediyl group, a fluoranthenediyl group, a triphenylenediyl group, a pyridinediyl group, a pyranediyl group, a quinolinediyl group, an isoquinolinediyl group, a benzofuranediyl group, a benzothiophenediyl group, an indolediyl group, a carbazolediyl group, a benzoxazolediyl group, a benzothiazolediyl group, a quinoxalinediyl group, a benzoimidazolediyl group, a dibenzofuranediyl group, or the like. In an implementation, the phenylene group, the terphenylene group, the fluorenediyl group, the carbazolediyl group, the dibenzofuranediyl group, or the like may be used.

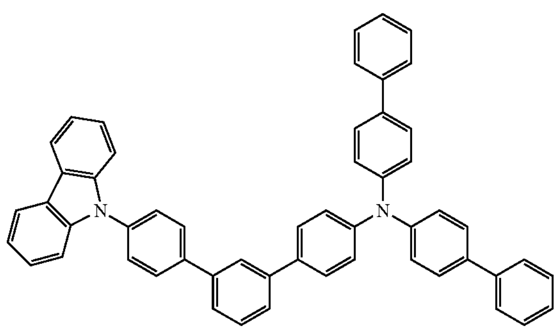
In an implementation, the compound represented by Formula 1 may include, e.g., one of the following Compounds 1 to 22.

-continued

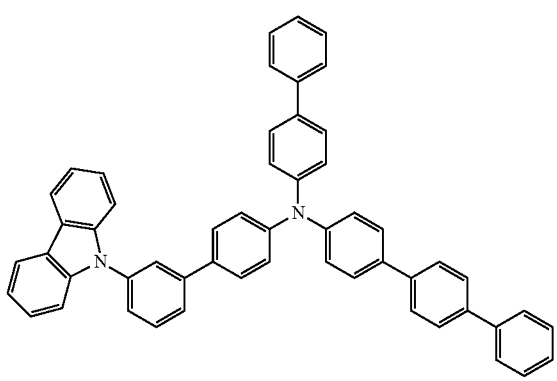
1



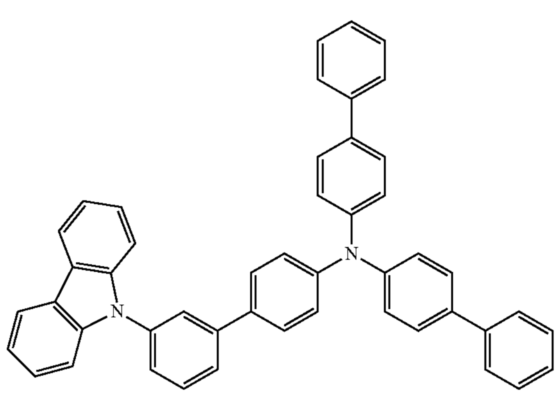
2



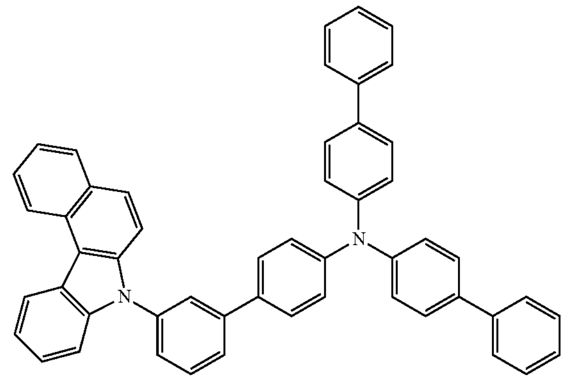
3



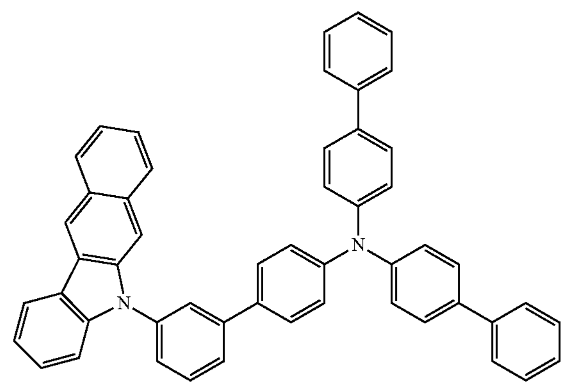
4



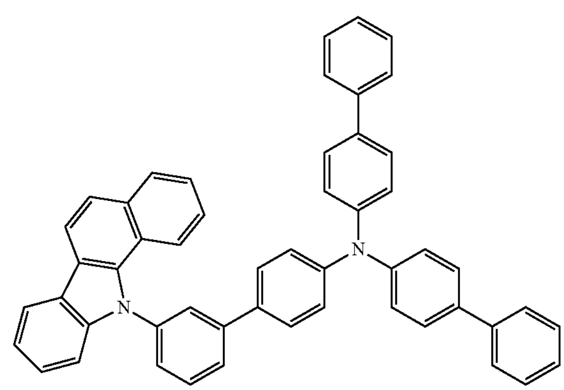
5



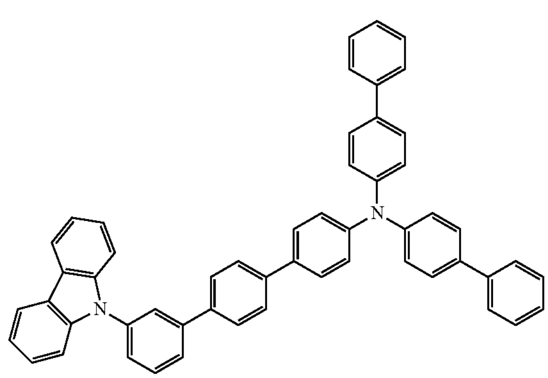
6



7

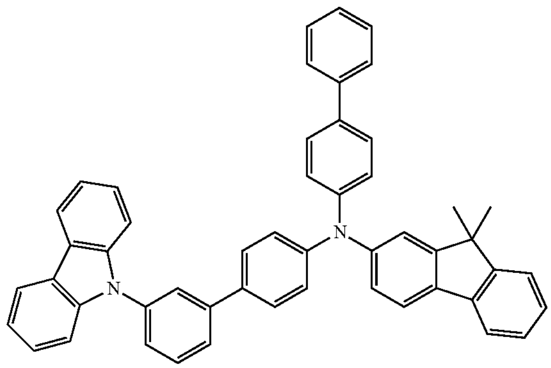


8

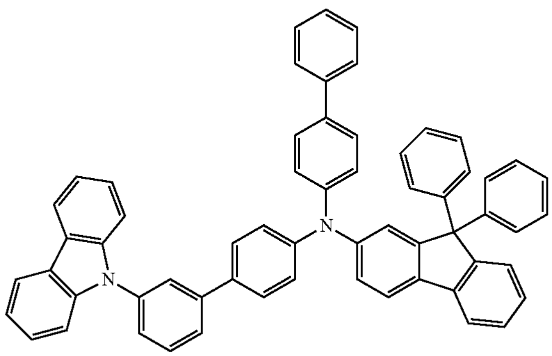


-continued

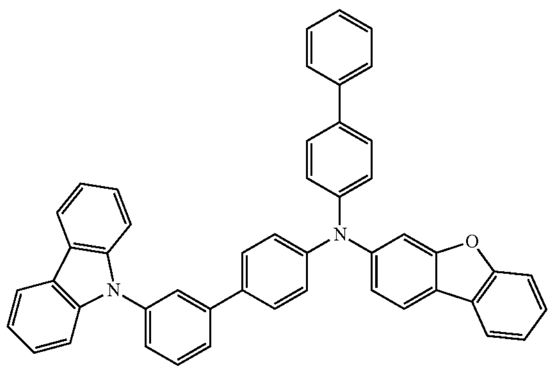
9



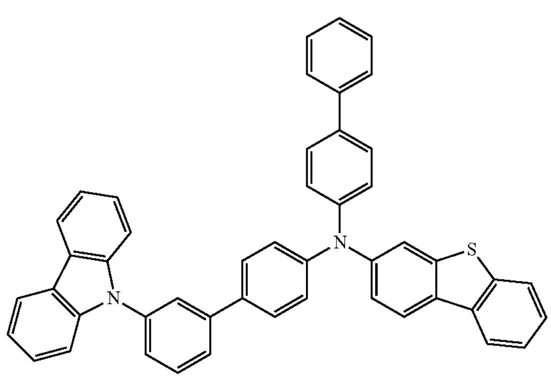
10



11

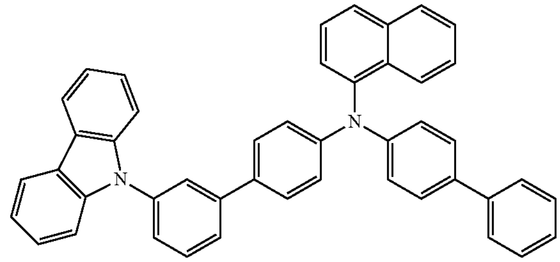


12

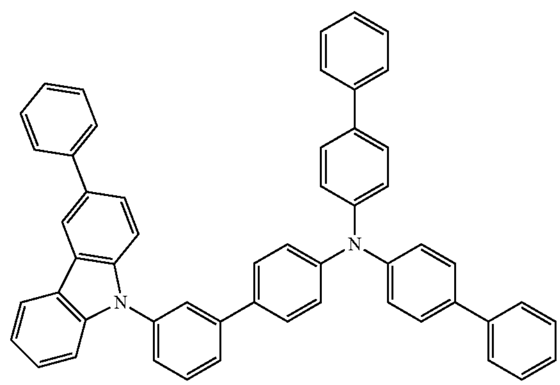


-continued

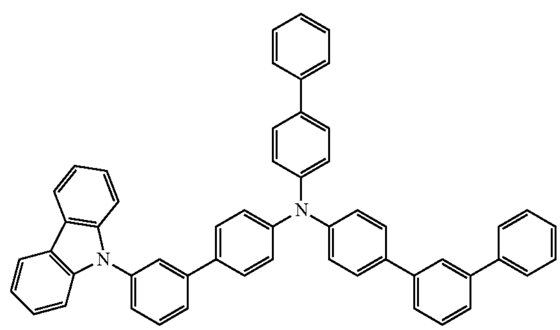
13



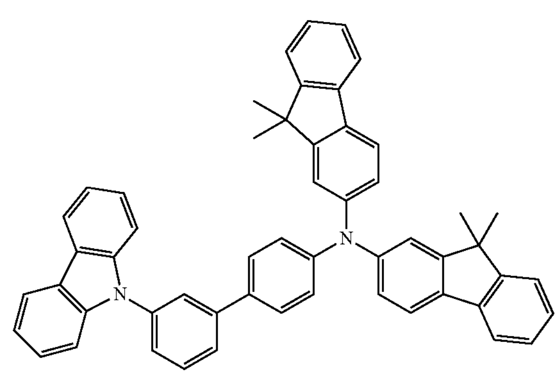
14



15

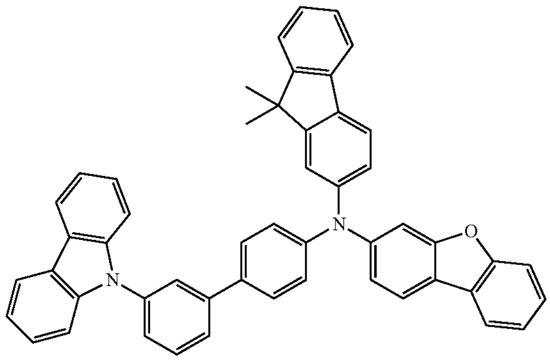


16

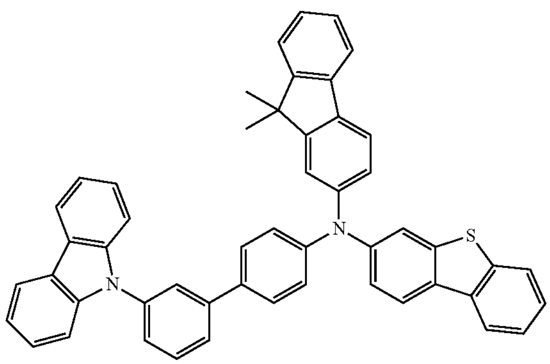


-continued

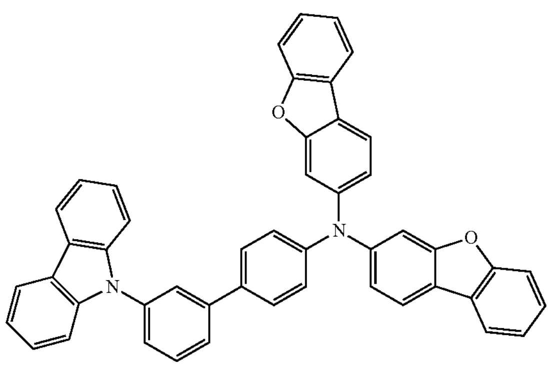
17



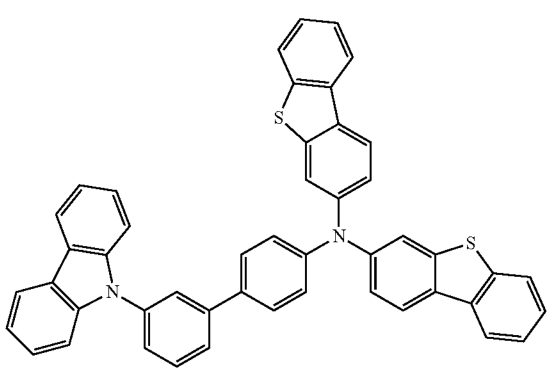
18



19

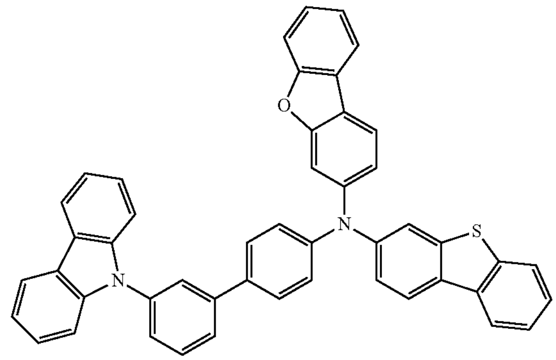


20

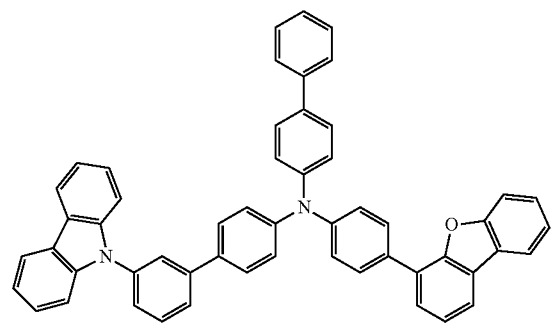


-continued

21

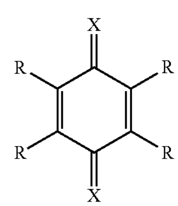


22

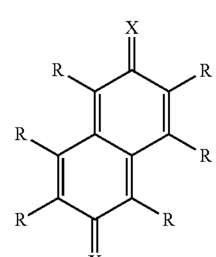


At least one layer (e.g., the first layer **121**) disposed adjacent to, e.g., directly adjacent to, the anode **110** of the laminated structure may include a hole transport compound doped with an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV. The electron accepting compound doped in the first layer **121** may include, e.g., a compound represented by one of the following Formulae ac1 to ac14. In an implementation, a doping amount of the electron accepting compound may be, e.g., about 0.1 wt % to about 50 wt %, with respect to a total weight of all materials constituting the first layer **121**. In an implementation, the doping amount may be, e.g., about 0.5 wt % to about 5 wt %.

ac1

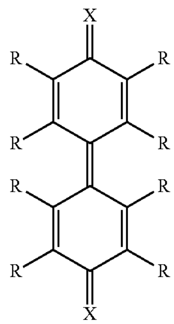


ac2

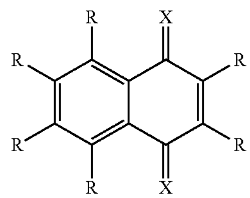


-continued

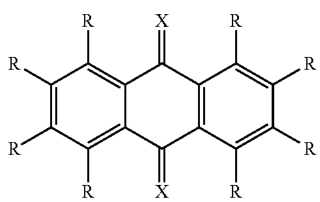
ac3



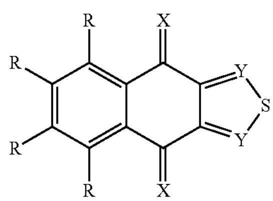
ac4



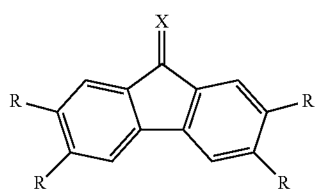
ac5



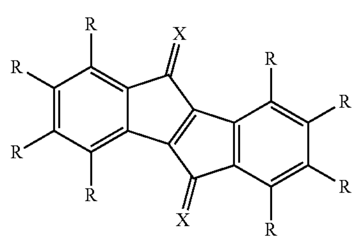
ac6



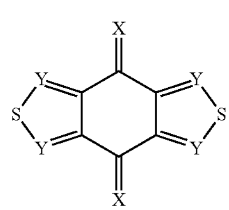
ac7



ac8

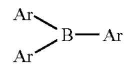


ac9

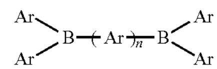


-continued

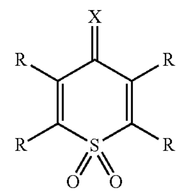
ac10



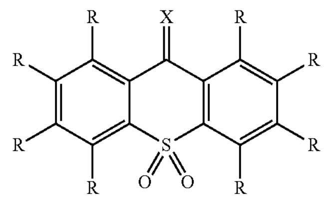
ac11



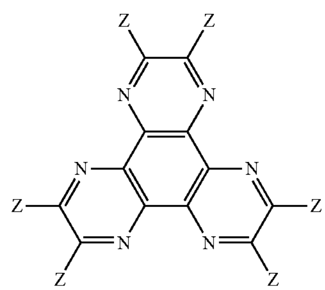
ac12



ac13



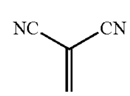
ac14



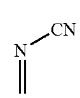
In Formulae ac1 to ac14, each R may independently be or include, e.g., a hydrogen atom, a deuterium atom, a halogen atom, a fluoroalkyl group having 1 to 10 carbon atoms, a cyano group, an alkoxy group having 1 to 10 carbon atoms, an alkyl group having 1 to 10 carbon atoms, or a substituted or unsubstituted aryl group having 6 to 30 ring carbon atoms. In an implementation, all Rs may not be the hydrogen atom, the deuterium atom, and/or the fluorine atom in the same molecule. Each Ar may independently be or include, e.g., a substituted or unsubstituted electron withdrawing aryl group having 6 to 30 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 3 to 30 ring carbon atoms. Y may be, e.g., a methine group (—CH═) or a nitrogen atom (—N═). Z may be, e.g., pseudohalogen or sulfur (S). X may be, e.g., a group represented by one of the following Formulae X1 to X7.

x1

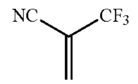
x2



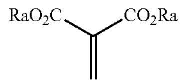
x3



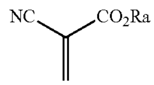
-continued



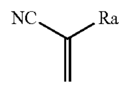
x4



x5



x6



x7

In Formulae X1 to X7, each Ra may independently be or include, e.g., a hydrogen atom, a deuterium atom, a halogen atom, a fluoroalkyl group having 1 to 10 carbon atoms, a cyano group, an alkoxy group having 1 to 10 carbon atoms, an alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted aryl group having 6 to 30 ring carbon atoms, or a substituted or unsubstituted heteroaryl group having 3 to 30 ring carbon atoms.

Examples of the substituted or unsubstituted aryl group having 6 to 30 ring carbon atoms or the substituted or unsubstituted heteroaryl group having 3 to 30 ring carbon atoms, represented by R, Ar, and Ra, may include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, a m-terphenyl-4-yl group, a m -terphenyl-3-yl group, a m-terphenyl-2-yl group, an o-tolyl group, a m-tolyl group, a p -tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenylyl group, a 4"-t-butyl-p-terphenyl-4-yl group, a fluoranthenyl group, a fluorenyl group, a 1-pyrrolyl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 1-indolyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoindolyl group, a 2-isoindolyl group, a 3-isoindolyl group, a 4-isoindolyl group, a 5-isoindolyl group, a 6-isoindolyl group, a 7-isoindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, a 8-isoquinolyl group, a 2-quinoxalinyl group, a 5-quinoxalinyl group, a 6-quinoxalinyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 9-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, a 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 10-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 10-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrole-3-yl group, a 2-methylpyrrole-4-yl group, a 2-methylpyrrole-5-yl group, a 3-methylpyrrole-1-yl group, a 3-methylpyrrole-2-yl group, a 3-methylpyrrole-4-yl group, a 3-methylpyrrole-5-yl group, a 2-t-butylpyrrole-4-yl group, a 3-(2-phenylpropyl)pyrrole-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, a 4-t-butyl-3-indolyl group, and the like.

Examples of the fluoroalkyl group having 1 to 10 carbon atoms, represented by R and Ra, may include a perfluoroalkyl group such as a trifluoromethyl group, a pentafluoroethyl group, a heptafluoropropyl group, a heptadecafluorooctane group, and the like. or a monofluoromethyl group, a difluoromethyl group, a trifluoroethyl group, a tetrafluoropropyl group, an octafluoropentyl group, and the like.

Examples of the alkyl group having 1 to 10 carbon atoms, represented by R and Ra, may include a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, a s-butyl group, an isobutyl group, a t-butyl group, a n-pentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-

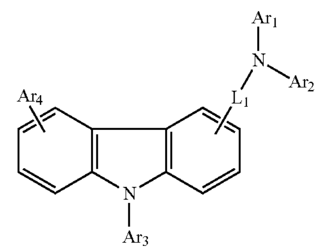
dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, a 1,2,3-trinitropropyl group, a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, a 4-methylcyclohexyl group, a 1-adamantyl group, a 2-adamantyl group, a 1-norbomyl group, a 2-norbornyl group, and the like.

The alkoxy group having 1 to 10 carbon atoms, represented by R and Ra, is a group represented by —OY, and examples of Y may include a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, a s-butyl group, an isobutyl group, a t-butyl group, a n-pentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, a 1,2,3-trinitropropyl group, and the like.

A halogen atom represented by R and Ra may be fluorine, chlorine, bromine, or iodine.

In an implementation, the hole transport compound included in the first layer **121** may include a suitable hole transport compound. For example, compounds having a carbazolyl group may be used. In an implementation, the hole transport compound having the carbazolyl group may be, e.g., an amine-containing compound represented by the following Formula 2.

[Formula 2]



In Formula 2, Ar_1, Ar_2, and Ar_3 may each independently be or include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, Ar_4 may be or may include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, and L_1 may be or may include, e.g., a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms.

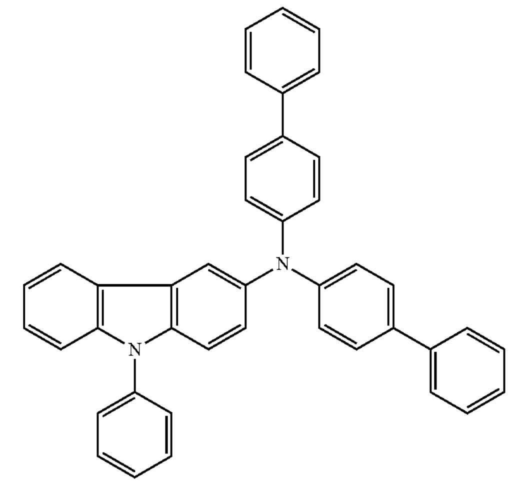
In an implementation, Ar_1 to Ar_3 may each independently include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acenaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a pyranyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

In an implementation, Ar_4 may include, e.g., the aryl group and the heteroaryl group that are the same as the groups described as examples of Ar_1 to Ar_3, and the alkyl group may be a methyl group or an ethyl group.

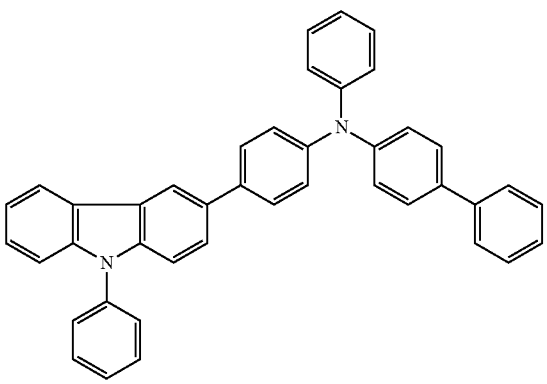
In an implementation, L_1 may include, other than a single bond, e.g., a phenylene group, a biphenylylene group, a terphenylylene group, a naphthalene group, an anthrylene group, a phenanthrylene group, a fluorirane group, an indanediyl group, a pyrenediyl group, an acenaphthenediyl group, a fluoranthenediyl group, a triphenylenediyl group, a pyridinediyl group, a pyranediyl group, a quinolinediyl group, an isoquinolinediyl group, a benzofuranediyl group, a benzothiophenediyl group, an indolediyl group, a carbazolediyl group, a benzoxazolediyl group, a benzothiazolediyl group, a quinoxalyldiyl group, a benzoimidazolediyl group, a dibenzofuranediyl group, or the like. In an implementation, the phenylene group, the terphenylene group, the fluorenediyl group, the carbazolediyl group, the dibenzofuranediyl group, or the like may be used.

The compound represented by Formula 2 may include, e.g., one of the following Compounds 23 to 38.

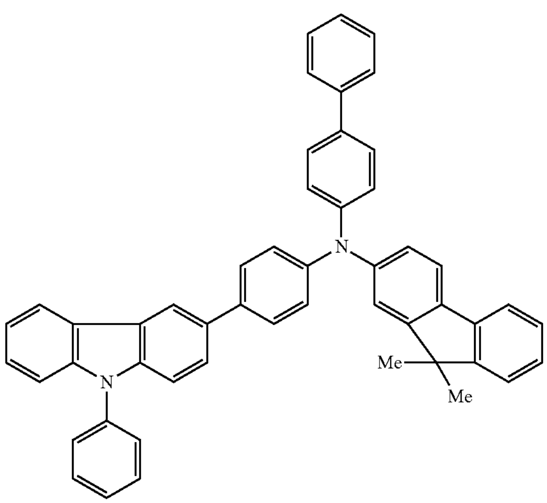
23



24

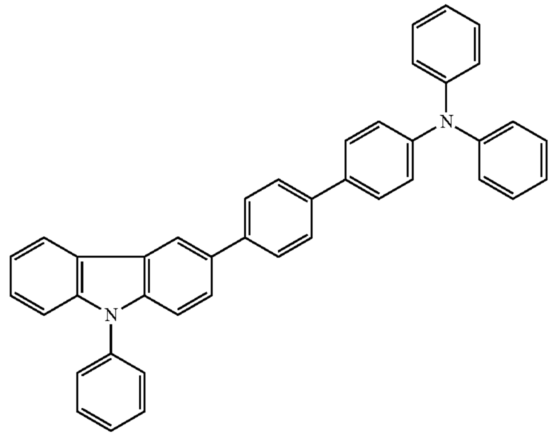


25

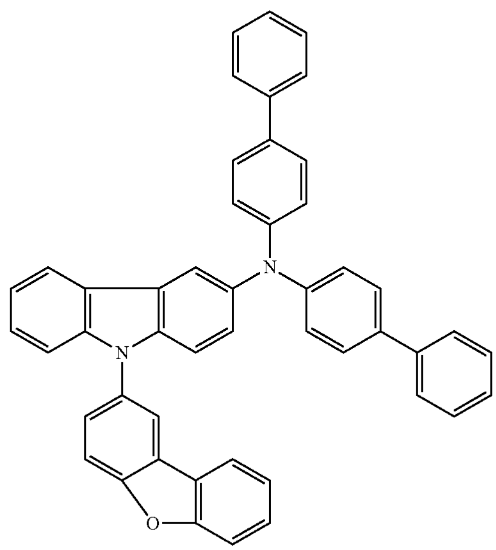


-continued

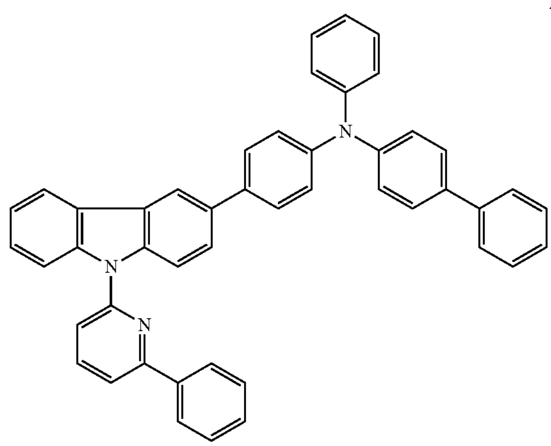
26



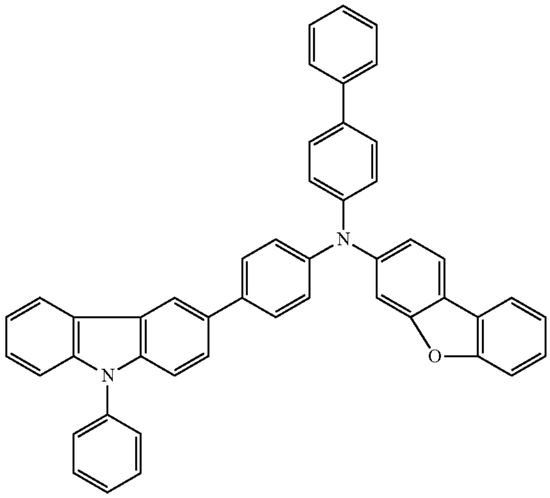
27



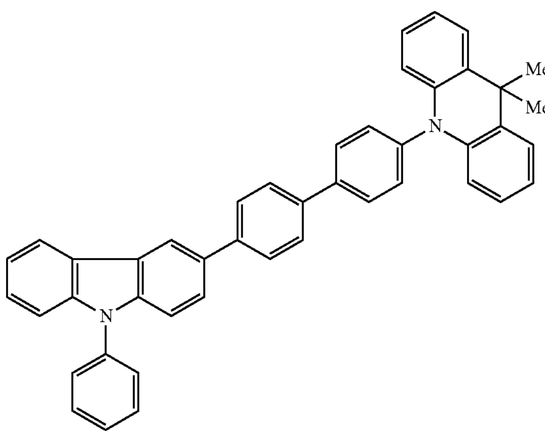
28



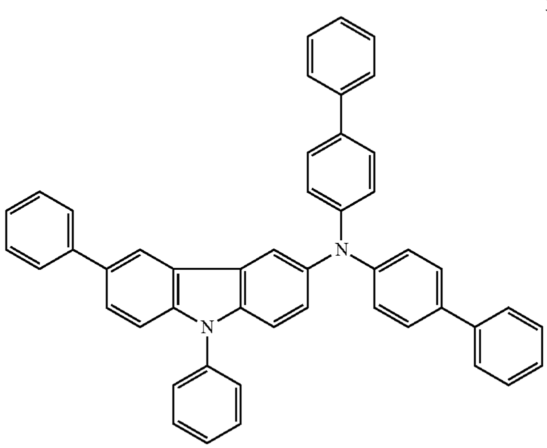
29



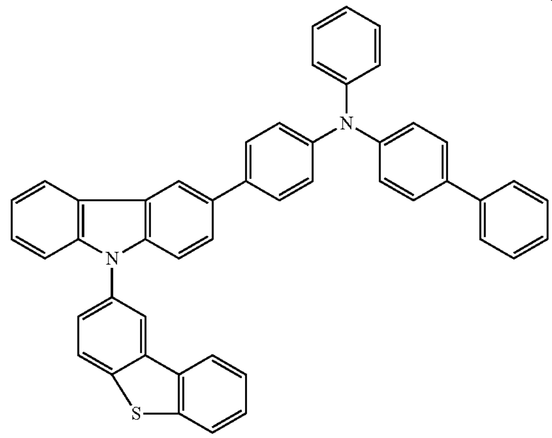
30



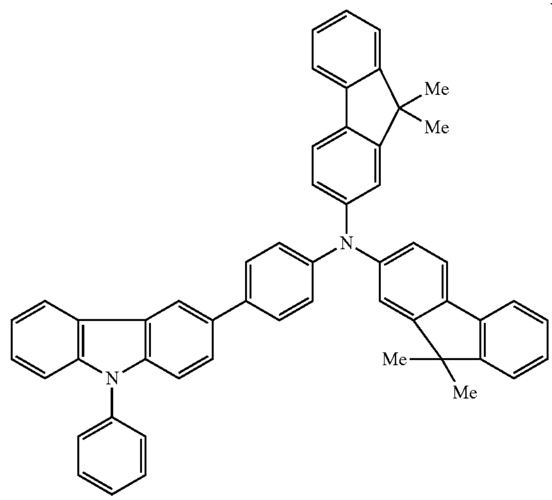
31



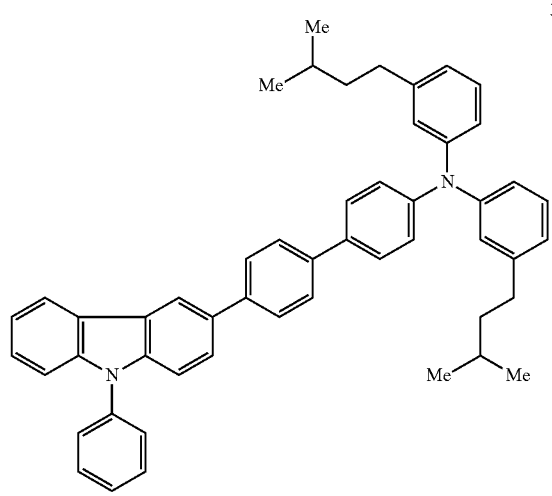
32



33

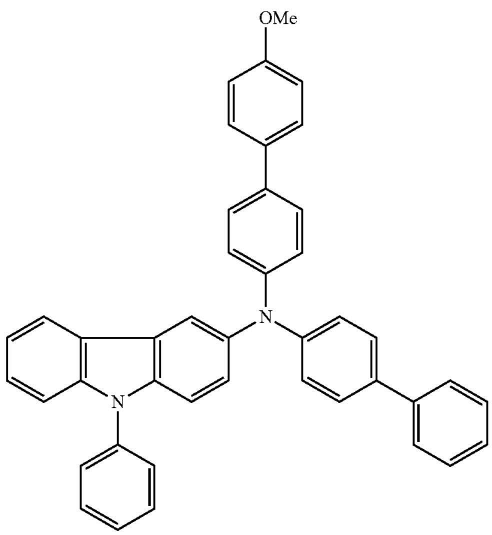


34

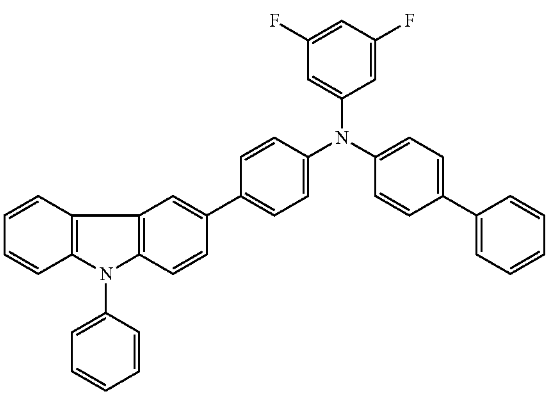


-continued

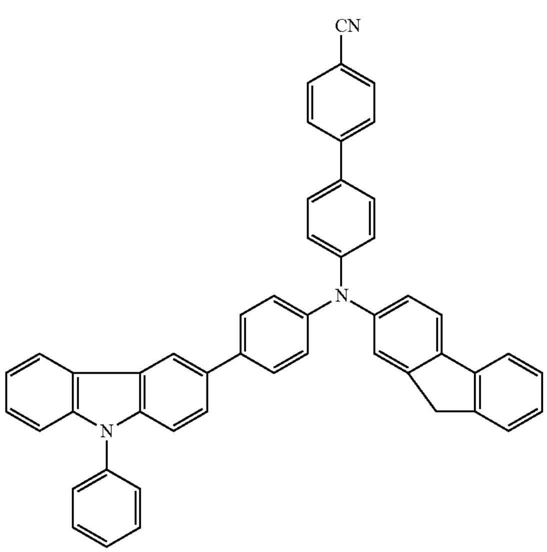
35



36

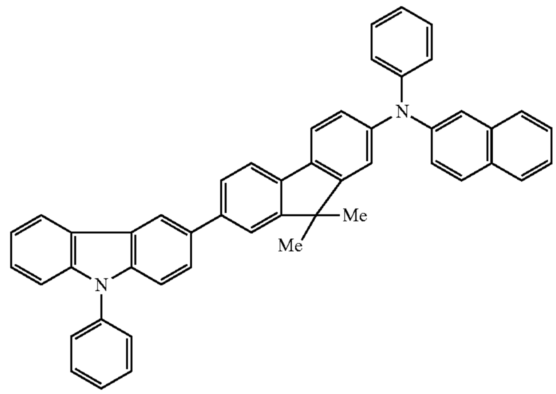


37



-continued

38



In an implementation, in the hole transport band **120** of the organic EL device **100**, the laminated structure of at least three layers may be provided with at least one layer (e.g., a third layer **123**) including a compound represented by the above Formula 2 between the anode **110** and the second layer **125**. In the laminated structure, the position of the third layer **123** is not specifically limited, and the third layer may be disposed between the first layer **121** and the second layer **125**. The compound represented by Formula 2 and included in the third layer **123** may include one of the above-described Compounds 23 to 38, which are explained as the compounds having a carbazolyl group included in the first layer **121**.

In the organic EL device **100**, in the laminated structure of at least three layers having different components disposed in the hole transport band **120**, at least one of the first layer **121** (including the hole transport compound doped with an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV) may be disposed adjacent to, e.g., directly adjacent to the anode **110**, and at least one of the second layer **125** (including the compound represented by Formula 1) may be disposed adjacent to, e.g., directly adjacent to, the emission layer **130**. The organic EL device **100** according to an embodiment may include an amine-containing compound (having a carbazolyl group) in the hole transport second layer **125** disposed adjacent to the emission layer **130** in the laminated structure, and the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**. In addition, the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented, and the whole charge balance of the organic EL device **100** may be controlled.

In the organic EL device **100**, the first layer **121** (including the electron accepting compound) may be disposed toward the anode **100**, e.g., adjacent to or directly adjacent to, the anode **110**. By disposing the layer including the electron accepting compound adjacent to the anode **110**, hole injection properties from the anode may be improved. In addition, by including the hole transport compound (having the carbazolyl group and represented by Formula 2) in the first layer **121**, charge transport properties and current flow durability may be improved.

In the organic EL device **100**, the third layer **123** (including the compound having the carbazolyl group and represented by Formula 2) may be disposed closer to the emission layer **130** than the first layer **121**, e.g., the third layer **123** may be between the emission layer **130** and the first layer

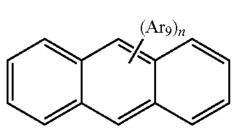
121. By including the compound having the carbazolyl group in the hole transport laminated structure, charge transport properties and current flow durability may be improved. In addition, by including the compound represented by Formula 2 in the third layer **123**, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented. In addition, the amine derivative having the carbazolyl group and represented by Formula 2 may help restrain the diffusion of the electron accepting compound into the emission layer **130**.

In addition, by disposing the second layer **125** (including the compound represented by Formula 1) adjacent to the emission layer **130**, the diffusion of the electron accepting compound included in the first layer **121** into the emission layer **130** may be restrained, the hole transport first layer **121** and second layer **123** may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport first layer **121** and third layer **123** may be prevented. In addition, by including the amine derivative having the carbazolyl group and represented by Formula 1 in the second layer **125**, the hole transport properties and the current flow durability of the laminated structure may be improved.

In addition, in the laminated structure disposed in the hole transport band **120** between the anode **110** and the emission layer **130** in the organic EL device **100**, the compound having the carbazolyl group may be included in at least three layers. By including the compound having the carbazolyl group in the hole transport laminated structure, charge transport properties and current flow durability may be improved. In addition, in the laminated structure disposed in the hole transport band **120** between the anode **110** and the emission layer **130** in the organic EL device **100**, a compound represented by Formula 1 or Formula 2 may be included in at least three layers. Thus, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented.

In the organic EL device **100**, light emission mainly via a singlet excited state may be obtained in the emission layer **130**. As the material of the emission layer **130**, suitable luminescent materials may be used, e.g., a fluoranthene derivative, a pyrene derivative, an arylacetylene derivative, a fluorene derivative, a perylene derivative, a chrysene derivative, or the like. In an implementation, the pyrene derivative, the perylene derivative, and/or the anthracene derivative may be used. For example, an anthracene derivative or anthracene-containing compound represented by the following Formula 3 may be used as the material of the emission layer **130**.

[Formula 3]

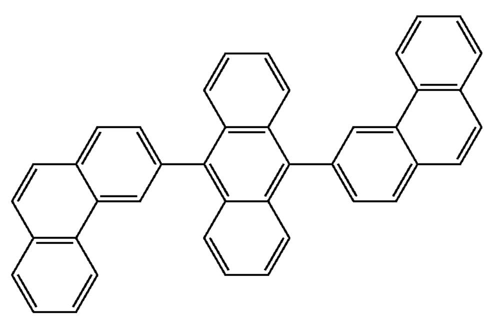


In Formula 3, each Ar_9 may independently be or include, e.g., a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 ring carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 ring carbon atoms, a substituted or unsubstituted arylthio group having 6 to 50 ring carbon atoms, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group or a hydroxyl group, and n may be an integer of 1 to 10.

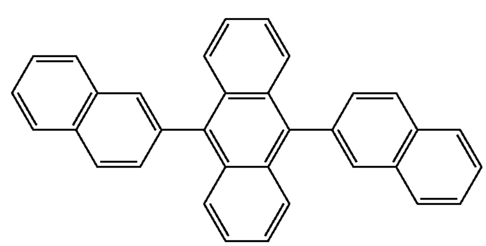
In an implementation, Ar_9 may include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a phenylnaphthyl group, a naphthylphenyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acetonaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a furanyl group, a pyranyl group, a thienyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a pyrazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

In an implementation, the compound represented by Formula 3 may be, e.g., one of the following Compounds a-1 to a-12.

a-1

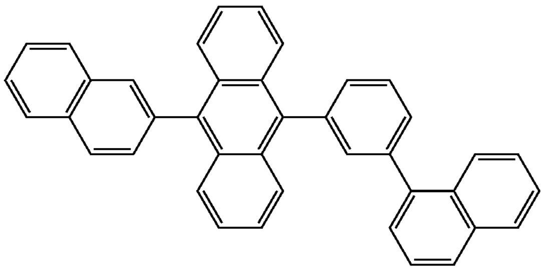


a-2

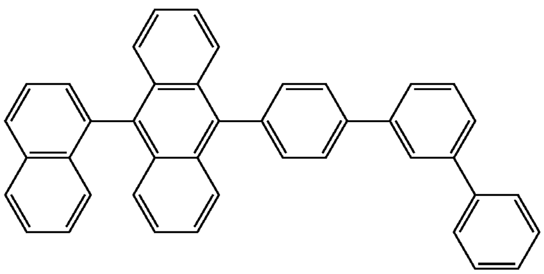


-continued

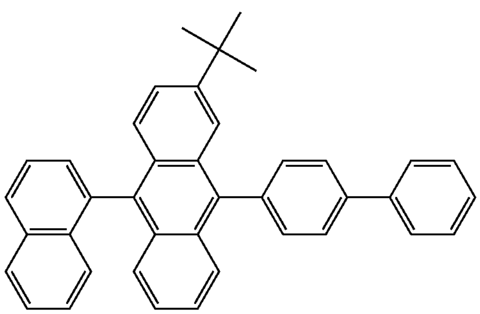
a-3



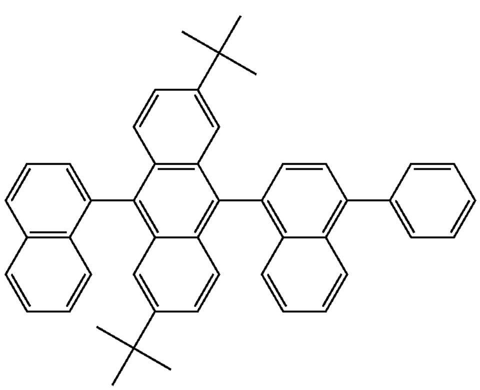
a-4



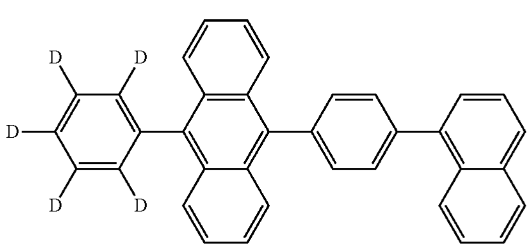
a-5



a-6

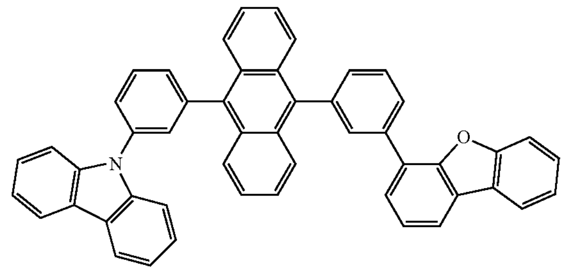


a-7

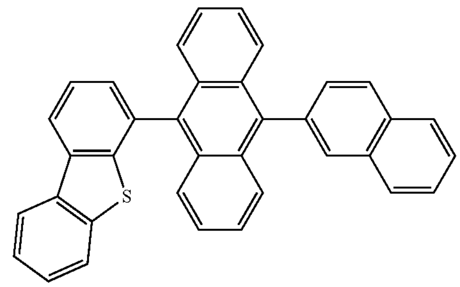


-continued

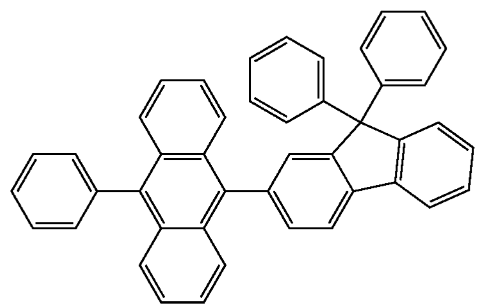
a-8



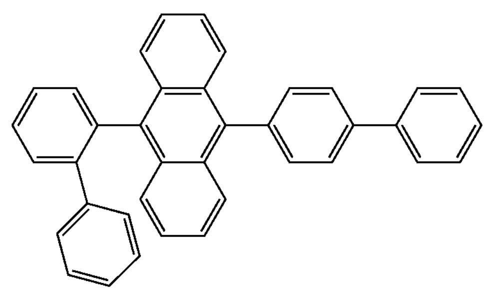
a-9



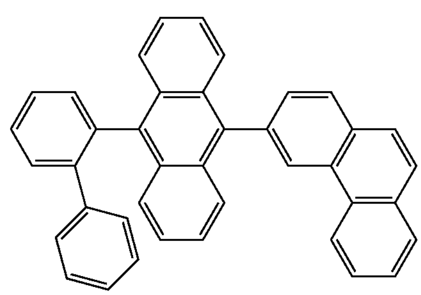
a-10



a-11



a-12



As described above, the organic EL device **100** according to an embodiment may improve hole injection properties from the anode **110** by disposing at least one layer of the first layer **121** including the hole transport compound doped with the electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV. The above-described effects may be remarkable when combined with the emission layer **130** including the compound represented by Formula 3, and the driving at a low voltage of the organic EL device **100** may be realized.

The organic EL device according to an embodiment will be explained in more detail referring to the organic EL device **100** shown in FIG. **1**. In the organic EL device **100** according to an embodiment, the substrate **101** may be, e.g., a transparent glass substrate, a semiconductor substrate formed using silicon, etc., or a flexible substrate of a resin, etc. The anode **110** may be disposed on the substrate **101**, and may be formed using indium tin oxide (ITO), indium zinc oxide (IZO), etc.

As described above, the hole transport band **120** may be disposed between the anode **110** and the emission layer **130**. In an embodiment, a hole injection layer may be formed as the first layer **121** on the anode **110** by, e.g., doping the electron accepting compound into the hole transport compound. As the hole transport compound, the compound represented by Formula 2 may be used.

The hole transport layer may be formed as the third layer **123** using a material including the hole transport material represented by Formula 2 and may be closer to the emission layer **130** than the hole injection layer **121**. In addition, the hole transport layer **123** may be laminated in plural, and in this case, the hole transport layer disposed adjacent to the hole injection layer **121** may include the electron accepting compound.

An intermediate layer may be formed as the second layer **125** using a material including the hole transport material represented by Formula 1 and may be closer to the emission layer **130** than the hole transport layer **123**. In an implementation, the intermediate layer **125** may be formed adjacent to, e.g., directly adjacent to, the emission layer **130**. Thus, the diffusion of the electron accepting compound included in the hole injection layer **121** and/or the hole transport layer **123** into the emission layer **130** may be restrained, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented. Accordingly, the emission efficiency and the life of the organic EL device may be improved.

The emission layer **130** may be formed adjacent to the intermediate layer **125**. As the host material of the emission layer **130**, e.g., an anthracene-containing compound represented by Formula 3 may be used. In addition, the emission layer **130** may include a suitable p-type dopant, e.g., 2,5,8,11-tetra-t-butylperylene (TBP).

On the emission layer **130**, an electron transport layer **140** may be formed using, e.g., a material including tris(8-hydroxyquinolinato)aluminum (Alq3). On the electron transport layer **140**, the electron injection layer **150** may be formed using a material including, e.g., lithium fluoride, lithium 8-quinolinato, etc. In addition, on the electron injection layer **150**, the cathode **160** may be formed using a metal such as Al, Ag, etc. or a transparent material such as ITO, IZO, etc. Each of the above-described layers may be formed by selecting an appropriate layer forming method according to a material, such as a vacuum deposition method, a sputtering method, various coating methods, etc.

In the organic EL device according to an embodiment, the material for an organic EL device may be applied in an organic EL display of an active-matrix type using a TFT.

In addition, in the organic EL device **100** according to an embodiment, through the combination of the above-described layer structure and the materials, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented, and the whole charge balance of the organic EL device **100** may be controlled. In addition, by disposing the intermediate layer **125** toward the emission layer **130**, the diffusion of the electron accepting compound into the emission layer **130** may be restrained, and the emission efficiency and the life of the organic EL device may be improved.

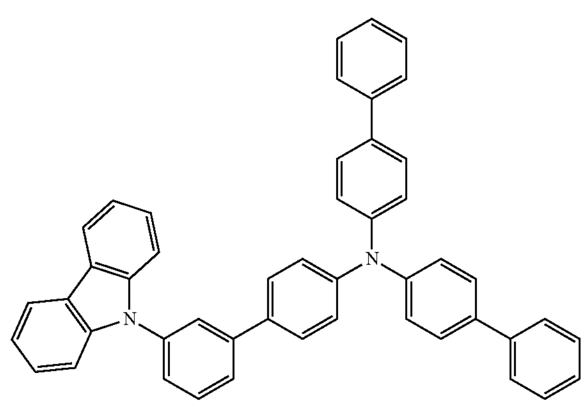
The following Examples and Comparative Examples are provided in order to highlight characteristics of one or more embodiments, but it will be understood that the Examples and Comparative Examples are not to be construed as limiting the scope of the embodiments, nor are the Comparative Examples to be construed as being outside the scope of the embodiments. Further, it will be understood that the embodiments are not limited to the particular details described in the Examples and Comparative Examples.

EXAMPLES

Preparation Method

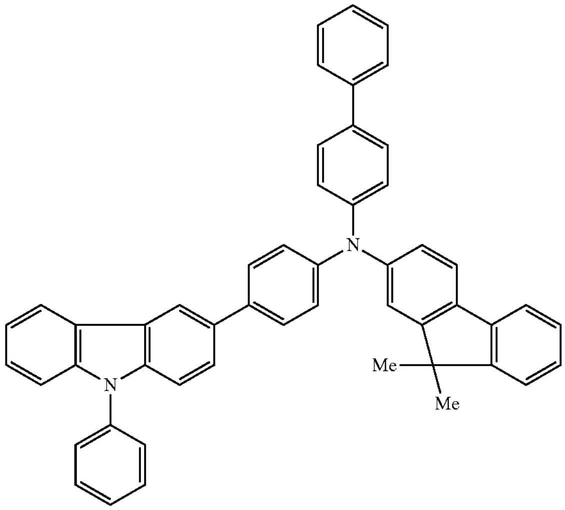
An organic EL device was manufactured using the above-described materials. FIG. **2** illustrates a schematic diagram of an organic EL device **200** according to an embodiment. In the Examples, an anode **110** was formed using ITO to have a layer thickness of about 150 nm. A layer HTL**1** was formed (as a hole injection layer **221**) by using Compound 25 (as a compound represented by Formula 2) or Compound 41 (described below), forming a layer having a thickness of about 10 nm, and doping Compound 39 (a compound represented by Formula ac14, as the electron accepting compound) in an amount of about 3 wt % with respect to a total weight of the materials constituting the layer HTL**1**. Another layer HTL**2** was formed (as a hole transport layer **223**) by using Compound 25 or Compound 42 (described below) to have a layer thickness of about 10 nm. In addition, another layer HTL**3** was formed (as an intermediate layer **225**) by using Compound 4 (as a compound represented by Formula 2) to have a layer thickness of about 10 nm.

4

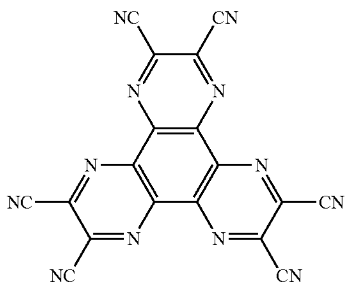


-continued

25



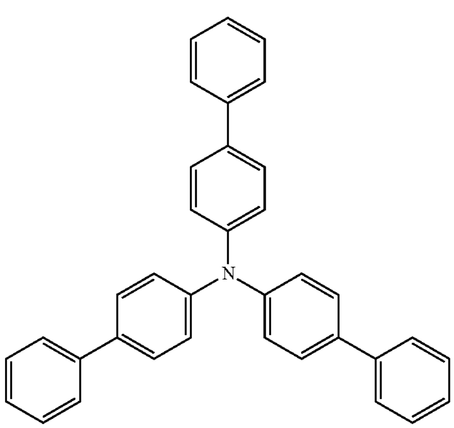
39



Then, an emission layer **130** was formed using a host material including 9,10-di(2-naphthyl)anthracene (ADN) (as a compound represented by Formula 3) doped with about 3% of TBP to have a layer thickness of about 25 nm. An electron transport layer **140** was formed using Alq3 to have a layer thickness of about 25 nm, an electron injection layer **150** was formed using LiF to have a layer thickness of about 1 nm, and a cathode **116** was formed using Al to have a layer thickness of about 100 nm.

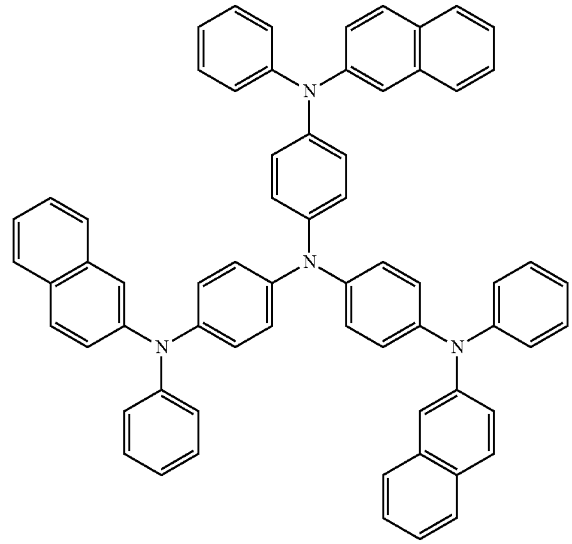
In addition, organic EL devices were manufactured using the following Compounds 40 to 43, as opposed to the above-described compounds in HTL**1** to HTL**3**, as Comparative Examples.

40

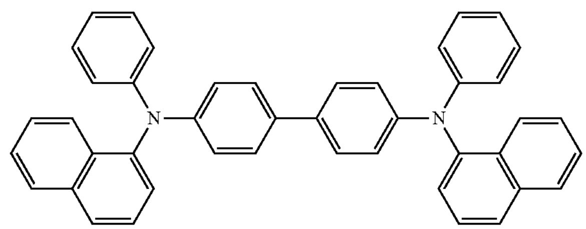


-continued

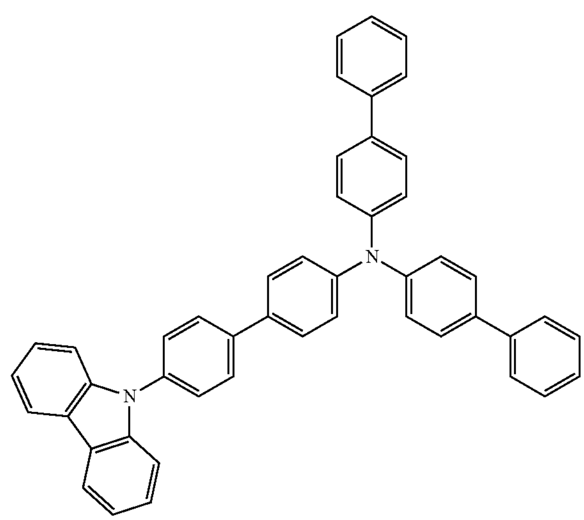
41



42



43



In Examples 1-1 to 1-3 and Comparative Examples 1-1 to 1-4, combinations of the compounds used in the HTL**1** to HTL**3** of the organic EL devices thus manufactured are summarized in the following Table 1.

TABLE 1

	HTL1	HTL2	HTL3
Example 1-1	Compounds 25 + 39	Compound 25	Compound 4
Example 1-2	Compounds 41 + 39	Compound 25	Compound 4
Example 1-3	Compounds 25 + 39	Compound 42	Compound 4

TABLE 1-continued

	HTL1	HTL2	HTL3
Comparative Example 1-1	Compounds 25 + 39	Compound 4	Compound 25
Comparative Example 1-2	Compounds 25	Compound 25	Compound 4
Comparative Example 1-3	Compound 25 + 39	Compounds 25	Compound 40
Comparative Example 1-4	Compounds 25 + 39	Compound 25	Compound 43

With respect to the organic EL devices manufactured in the Examples and the Comparative Examples, voltage, power efficiency, and current efficiency were evaluated. In addition, current density was about 10 mA/cm^2. Evaluation results are illustrated in the following Table 2.

TABLE 2

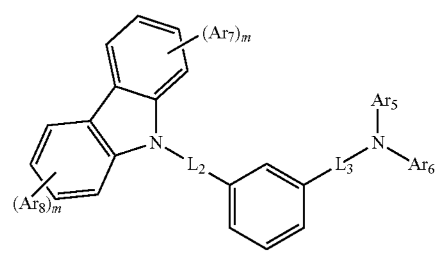
	Voltage (V)	Emission efficiency (cd/A)	Half life (h)
Example 1-1	6.3	7.7	3,700
Example 1-2	6.4	7.5	3,300
Example 1-3	6.3	7.4	2,800
Comparative Example 1-1	6.4	7.3	2,200
Comparative Example 1-2	7.5	6.3	2,000
Comparative Example 1-3	6.4	7.3	2,300
Comparative Example 1-4	6.6	7.3	2,600

As may be seen in Table 2, the driving voltage was lowered and the half life was improved for the organic EL device of Example 1-1, when compared to that of Comparative Example 1-2, in which the electron accepting compound, Compound 39, was not doped in HTL**1**. In addition, emission efficiency and half life of the device was improved in Example 1-2, in which the electron accepting compound was doped in a non-carbazole-based hole transport material, Compound 41. In addition, the emission efficiency and the life of the device was improved in Example 1-3, in which the non-carbazole-based hole transport compound, Compound 42, was used in the hole transport layer HTL**2**. When comparing Example 1-1 with Comparative Example 1-1, in which the compound included in the hole transport layers of HTL**2** and HTL**3** were reversed, a slight decrease in driving voltage and an increase of the emission efficiency and the half-life were observed. In addition, when comparing Examples 1-1 and 1-3 with Comparative Examples 1-3 and 1-4, which included a non-carbazole hole transport material in HTL**3** or a carbazole hole transport material having a different structure, respectively, the same or slightly decreased driving voltage and an improvement in the emission efficiency and the life were observed.

As described above, in the laminated structure of at least three layers having different components in a hole transport band in an organic EL device, an organic EL device having high efficiency and long life may be provided by including at least one layer that includes the hole transport compound doped with the electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV adjacent to the anode and including at least one layer having a compound represented by Formula 1 closer to the emission layer than the layer that includes the hole transport compound doped with the electron accepting compound.

Hereinafter, an organic EL device according to another embodiment will be explained. Referring to FIGS. **1** and **2**, according to an embodiment, to realize an organic EL device having improved emission efficiency and long life, a laminated structure of at least three layers having different components may be provided in the hole transport band **120** between the anode **110** and the emission layer **130**. The laminated structure may include at least a first layer **121** and a second layer **125**. At least one layer (e.g., the first layer **121**) adjacent to the anode **110** of the laminated structure may include an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component. Here, "including the electron accepting compound as a main component" means that including the electron accepting compound in an amount of greater than or equal to about 50 wt % with respect to a total weight of all materials constituting the first layer **121**. At least one layer (e.g., the second layer **125**) between the first layer **121** and the emission layer **130** and adjacent to the emission layer **130** may include a compound represented by the following Formula 1.

[Formula 1]



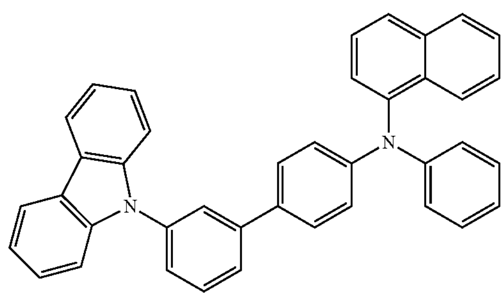
In Formula 1, Ar_5 to Ar_8 may each independently be or may include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, each m may independently be an integer of 0 to 4, and L_2 and L_3 may each independently be or may include, e.g., a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms. In an implementation, adjacent one of Ar_5 to Ar_8 may form a ring. For example, adjacent Ar_5 and Ar_6 may be combined to form a ring. In an implementation, adjacent Ar_7s and/or adjacent Ar_8s may be combined to form a ring.

In an implementation, Ar_5 to Ar_8 may each independently include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acetonaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a pyranyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

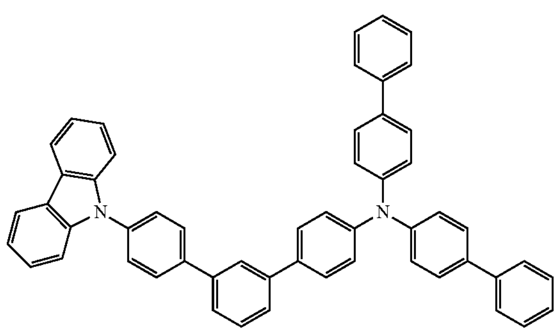
In an implementation, L_2 and L_3 may each independently include, e.g., other than a single bond, a phenylene group, a biphenylene group, a terphenylylene group, a naphthylene group, an anthrylene group, a phenanthrylene group, a fluorirane group, an indanediyl group, a pyrenediyl group, an acenaphthenediyl group, a fluoranthenediyl group, a triphenylenediyl group, a pyridinediyl group, a pyranediyl group, a quinolinediyl group, an isoquinolinediyl group, a benzofuranediyl group, a benzothiophenediyl group, an indolediyl group, a carbazolediyl group, a benzoxazolediyl group, a benzothiazolediyl group, a quinoxalinediyl group, a benzoimidazolediyl group, a dibenzofuranediyl group, or the like. In an implementation, the phenylene group, the terphenylene group, the fluorenediyl group, the carbazolediyl group, the dibenzofuranediyl group, or the like may be used.

Examples of the compound represented by Formula 1 may include one of the following Compounds 1 to 22.

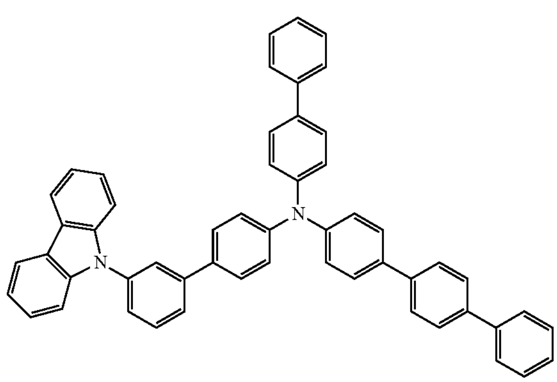
1



2

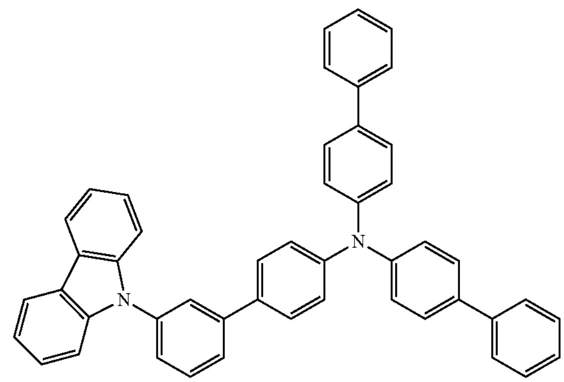


3

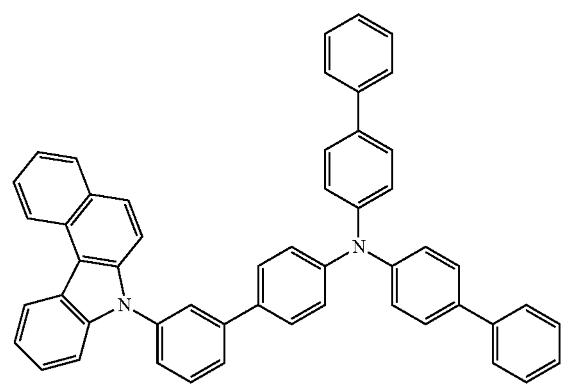


-continued

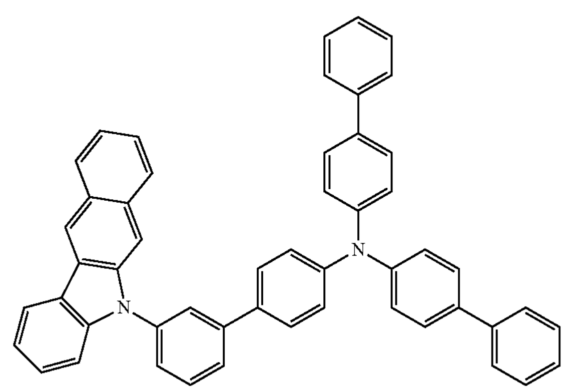
4



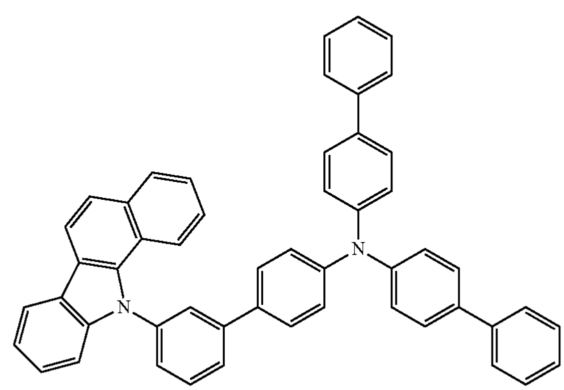
5



6

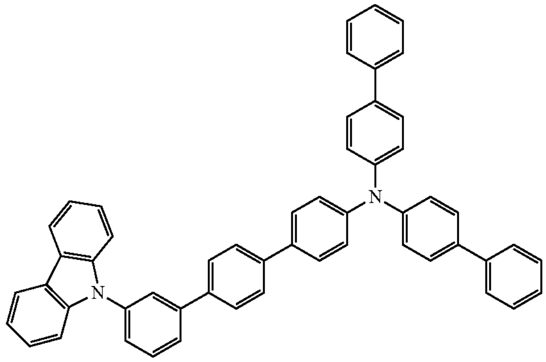


7

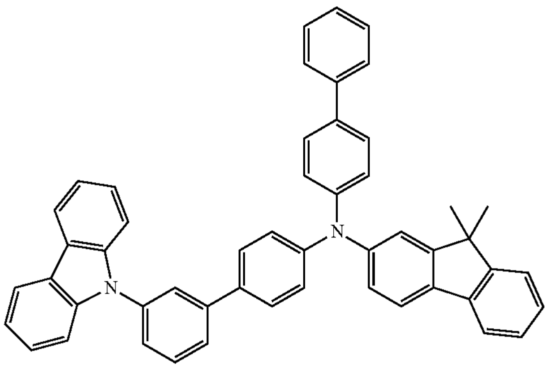


-continued

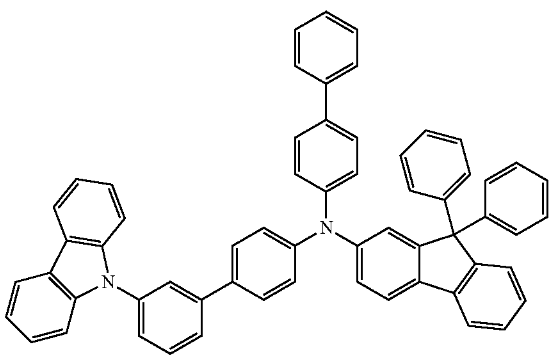
8



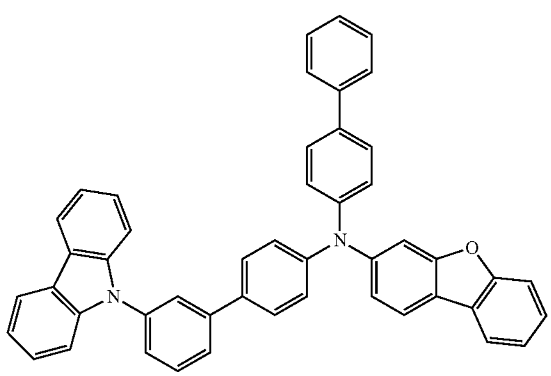
9



10

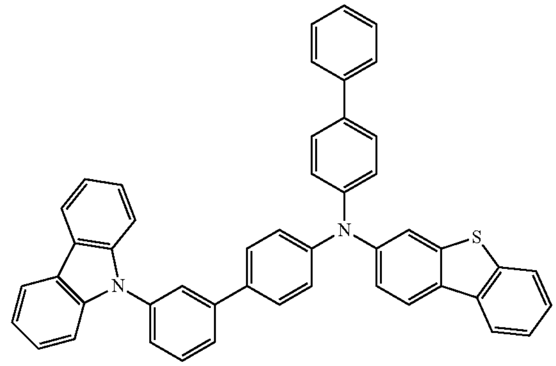


11

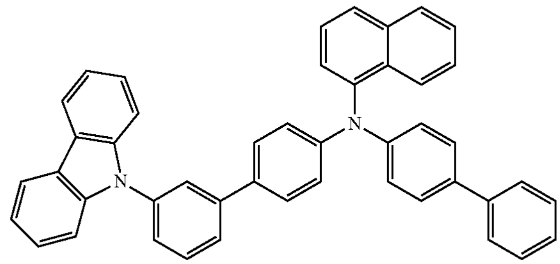


-continued

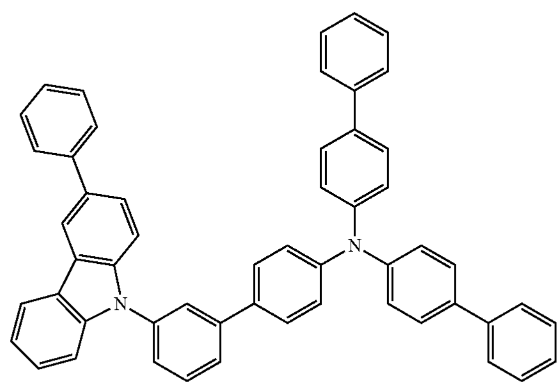
12



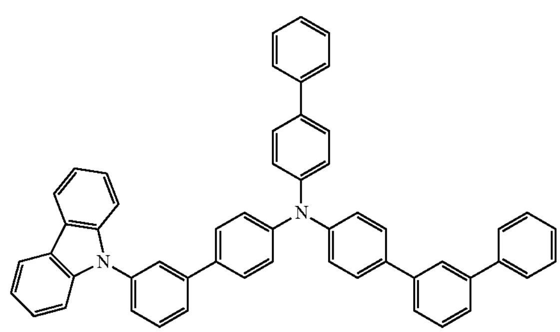
13



14

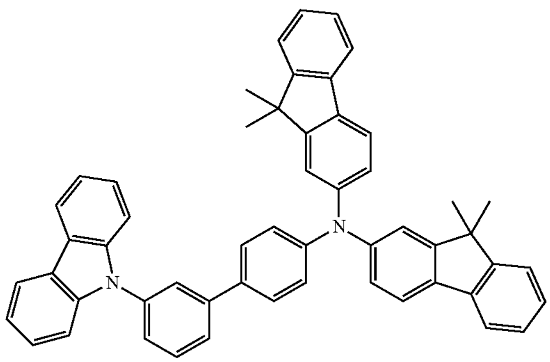


15

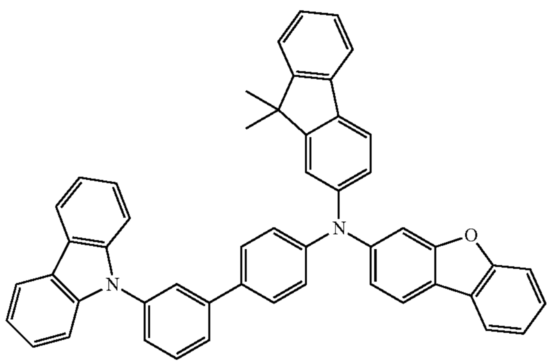


-continued

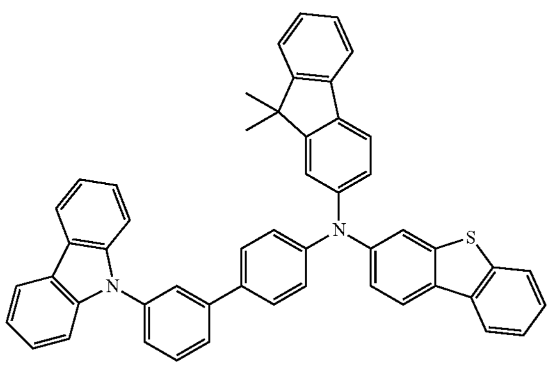
16



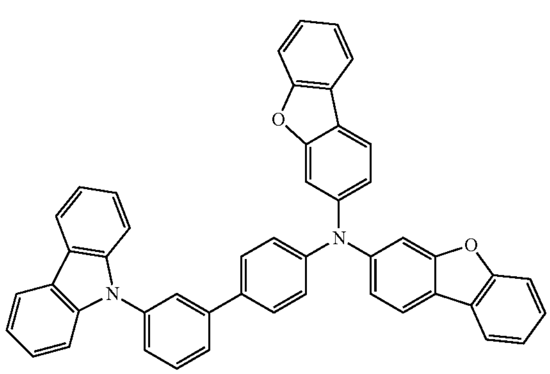
17



18

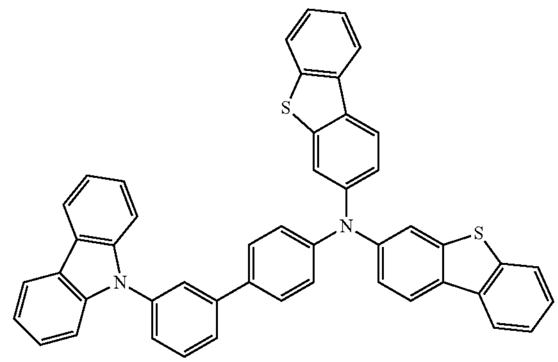


19

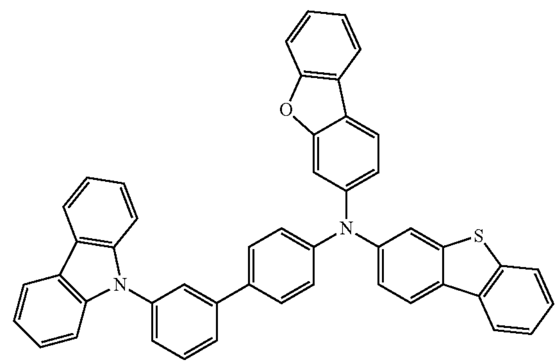


-continued

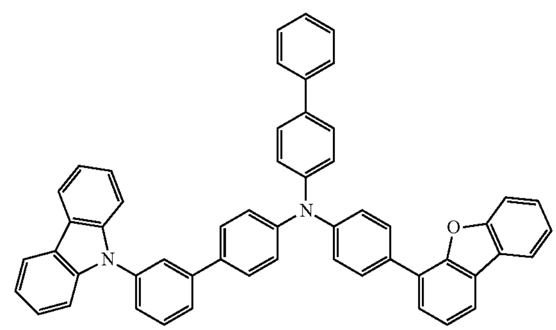
20



21

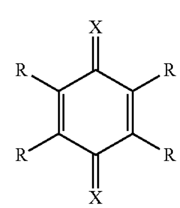


22



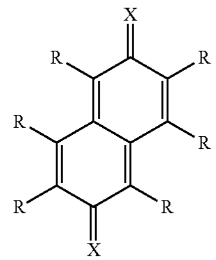
At least one layer (e.g., the first layer **121**) adjacent to the anode **110** of the laminated structure may include an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component. The amount of the electron accepting compound in the first layer **121** may be greater than or equal to about 50 wt %, with respect to a total weight of all materials constituting the first layer **121**. In an implementation, the electron accepting compound may be, e.g., represented by one of the following Formulae ac1 to ac14.

ac1

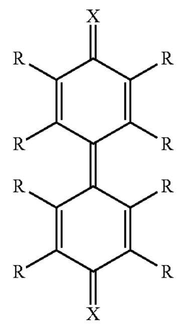


-continued

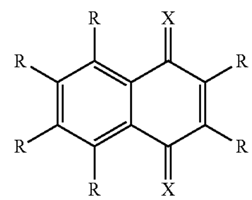
ac2



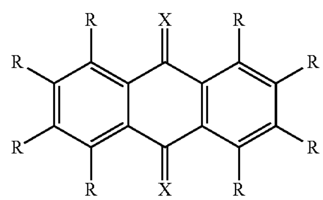
ac3



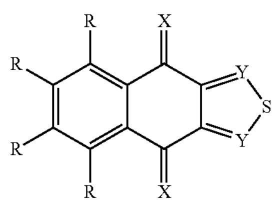
ac4



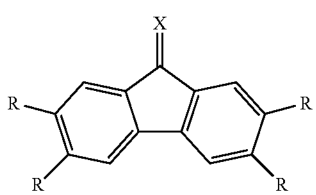
ac5



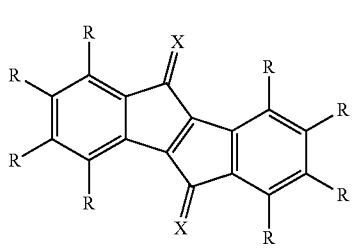
ac6



ac7

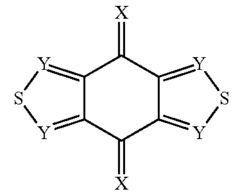


ac8

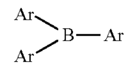


-continued

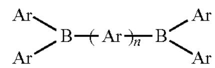
ac9



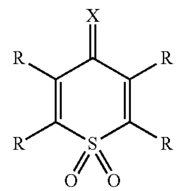
ac10



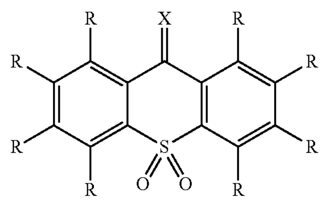
ac11



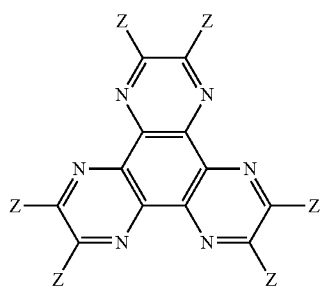
ac12



ac13



ac14

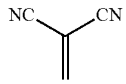


In Formulae ac1 to ac14, each R may independently be, e.g., a hydrogen atom, a deuterium atom, a halogen atom, a fluoroalkyl group having 1 to 10 carbon atoms, a cyano group, an alkoxy group having 1 to 10 carbon atoms, an alkyl group having 1 to 10 carbon atoms, or an aryl group having 6 to 30 ring carbon atoms. In an implementation, Rs may not all be hydrogen atoms, deuterium atoms, and/or the fluorine atoms in the same molecule. Each Ar may independently be or include, e.g., a substituted or unsubstituted electron withdrawing aryl group having 6 to 30 carbon atoms or a substituted or unsubstituted heteroaryl group having 3 to 30 carbon atoms. Each Y may independently be, e.g., a methine group (—CH═) or a nitrogen atom (—N═). Z may be, e.g., pseudohalogen or sulfur (S). Each X may independently be a group represented by one of the following Formulae x1 to x7.

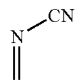
x1

-continued

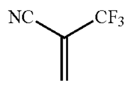
x2



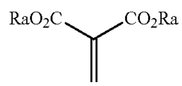
x3



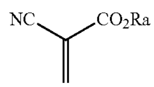
x4



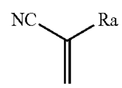
x5



x6



x7



In Formulae x1 to x7, Ra may be or may include, e.g., a hydrogen atom, a deuterium atom, a halogen atom, a fluoroalkyl group having 1 to 10 carbon atoms, a cyano group, an alkoxy group having 1 to 10 carbon atoms, an alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted aryl group having 6 to 30 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 3 to 30 ring carbon atoms.

Examples of the substituted or unsubstituted aryl group having 6 to 30 ring carbon atoms or the substituted or unsubstituted heteroaryl group having 3 to 30 ring carbon atoms, represented by R, Ar, and/or Ra, may include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, a m-terphenyl-4-yl group, a m-terphenyl-3-yl group, a m-terphenyl-2-yl group, an o-tolyl group, a m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenylyl group, a 4"-t-butyl-p-terphenyl-4-yl group, a fluoranthenyl group, a fluorenyl group, a 1-pyrrolyl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 1-indolyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoindolyl group, a 2-isoindolyl group, a 3-isoindolyl group, a 4-isoindolyl group, a 5-isoindolyl group, a 6-isoindolyl group, a 7-isoindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, a 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, a 8-isoquinolyl group, a 2-quinoxalinyl group, a 5-quinoxalinyl group, a 6-quinoxalinyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 9-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, a 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 10-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 10-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrole-1-yl group, a 2-methylpyrrole-3-yl group, a 2-methylpyrrole-4-yl group, a 2-methylpyrrole-5-yl group, a 3-methylpyrrole-1-yl group, a 3-methylpyrrole-2-yl group, a 3-methylpyrrole-4-yl group, a 3-methylpyrrole-5-yl group, a 2-t-butylpyrrole-4-yl group, a 3-(2-phenylpropyl)pyrrole-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, a 4-t-butyl-3-indolyl group, or the like.

Examples of the substituted or unsubstituted fluoroalkyl group having 1 to 10 carbon atoms, represented by R and Ra, may include a perfluoroalkyl group such as a trifluoromethyl group, a pentafluoroethyl group, a heptafluoropropyl group, a heptadecafluorooctane group, etc. or a monofluoromethyl group, a difluoromethyl group, a trifluoroethyl group, a tetrafluoropropyl group, an octafluoropentyl group, or the like.

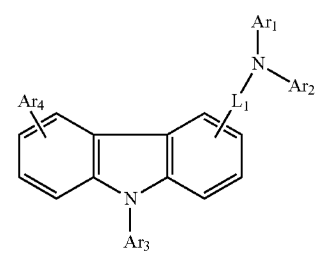
Examples of the alkyl group having 1 to 10 carbon atoms, represented by R and Ra, may include a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, a s-butyl group, an isobutyl group, a t-butyl group, a n-pentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, a 1,2,3-trinitropropyl group, a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, a 4-methylcyclohexyl group, a 1-adamantyl group, a 2-adamantyl group, a 1-norbornyl group, a 2-norbornyl group, or the like.

The alkoxy group having 1 to 10 carbon atoms, represented by R and Ra, is a group represented by —OY, and examples of Y may include a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, a s-butyl group, an isobutyl group, a t-butyl group, a n-pentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, a 1,2,3-trinitropropyl group, or the like.

A halogen atom represented by R and Ra may be fluorine, chlorine, bromine, and iodine.

In an implementation, in the hole transport band **120** of the organic electroluminescent device **100**, the laminated structure of at least three layers may include at least one layer (e.g., the third layer **123**) including a compound represented by the following Formula 2, between the first layer **121** and the second layer **125**.

[Formula 2]



In Formula 2, Ar_1, Ar_2, and Ar_3 may each independently be or may include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms. Ar_4 may be or may include, e.g., a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms. L_1 may be or may include, e.g., a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms, or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms.

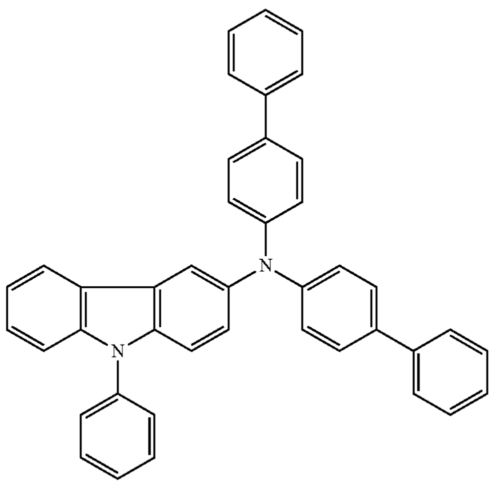
In an implementation, Ar_1 to Ar_3 may each independently include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acetonaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a pyranyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

In an implementation, in Ar_4, the aryl group and the heteroaryl group may be the same as the groups described as examples of Ar_1 to Ar_3, and the alkyl group may be a methyl group or an ethyl group.

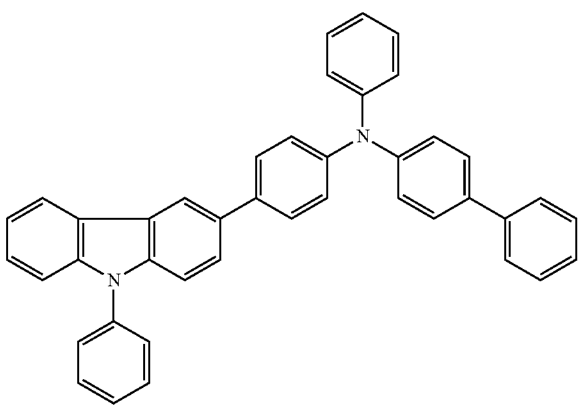
In an implementation, L_1 may include, e.g., other than a single bond, a phenylene group, a biphenylene group, a terphenylene group, a naphthalene group, an anthrylene group, a phenanthrylene group, a fluorirane group, an indanediyl group, a pyrenediyl group, an acenaphthenediyl group, a fluoranthenediyl group, a triphenylenediyl group, a pyridinediyl group, a pyranediyl group, a quinolilnediyl group, an isoquinolinediyl group, a benzofuranediyl group, a benzothiophenediyl group, an indolediyl group, a carbazolediyl group, a benzoxazolediyl group, a benzothiazolediyl group, a quinoxalinediyl group, a benzoimidazolediyl group, a dibenzofuranediyl group, or the like. In an implementation, the phenylene group, the terphenylene group, the fluorenediyl group, the carbazolediyl group, the dibenzofuranediyl group, or the like may be used.

Examples of the compound represented by Formula 2 may include one of the following Compounds 23 to 38.

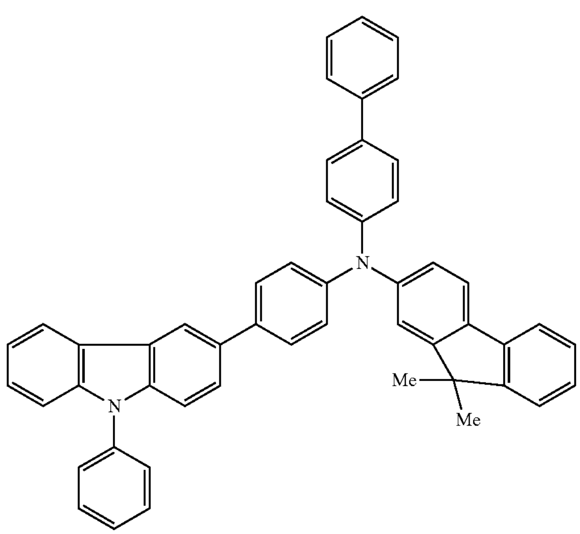
23



24

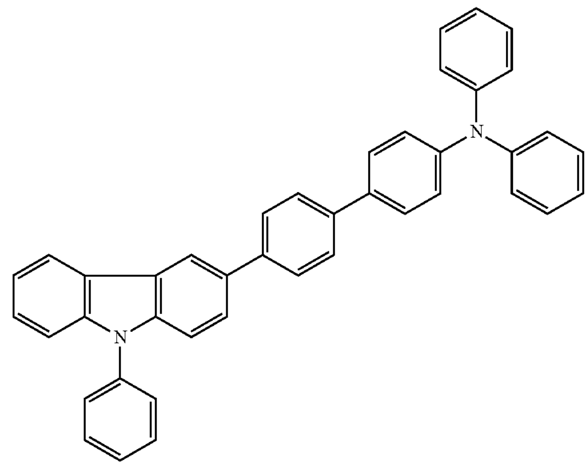


25

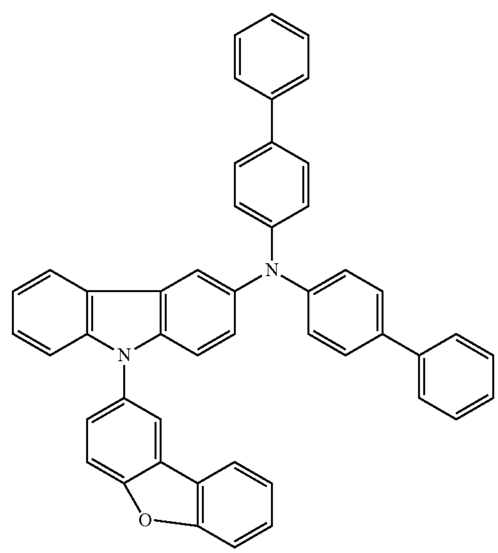


-continued

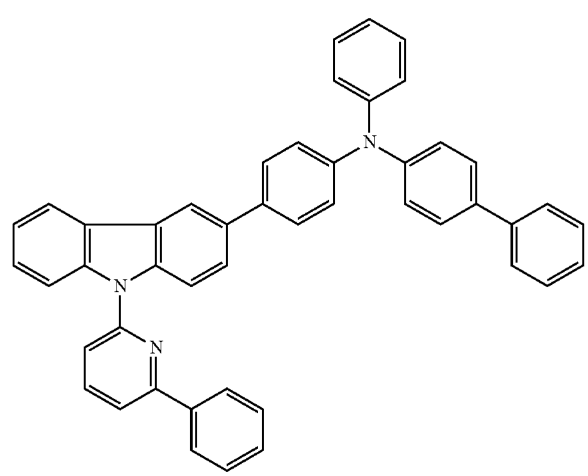
26



27

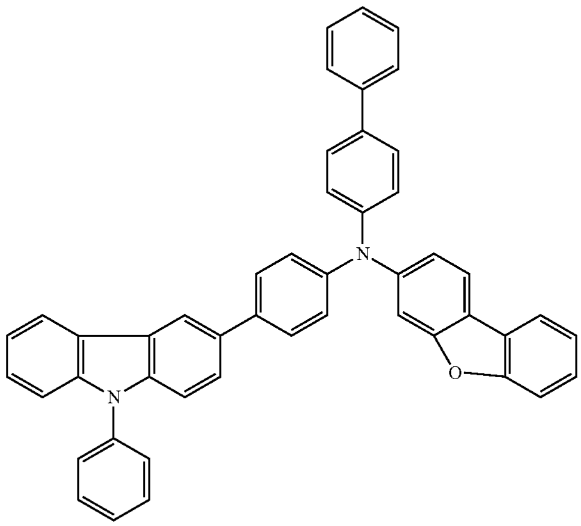


28

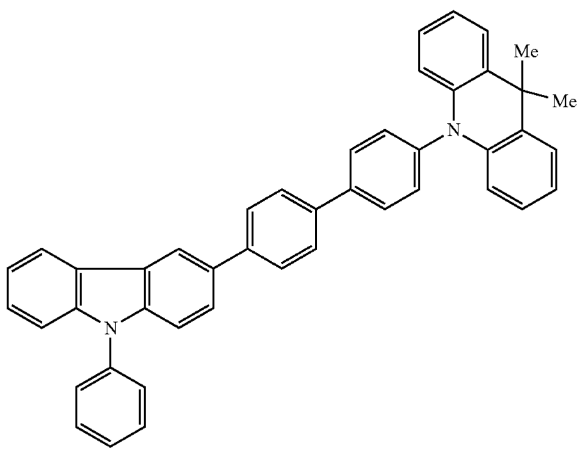


-continued

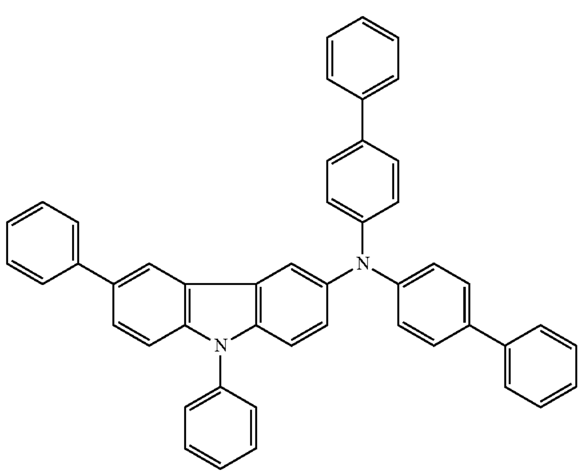
29



30

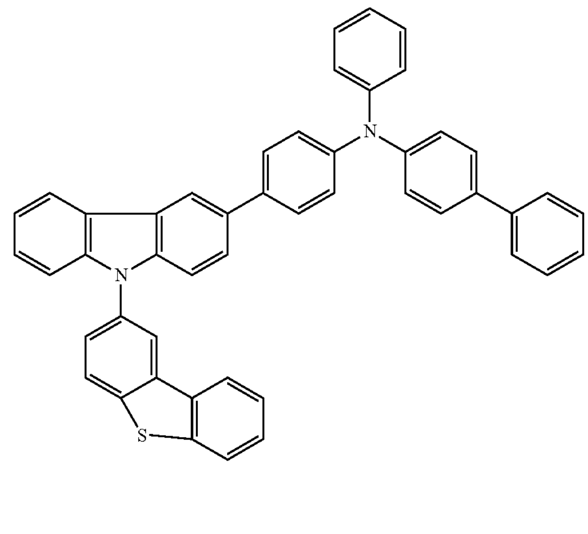


31

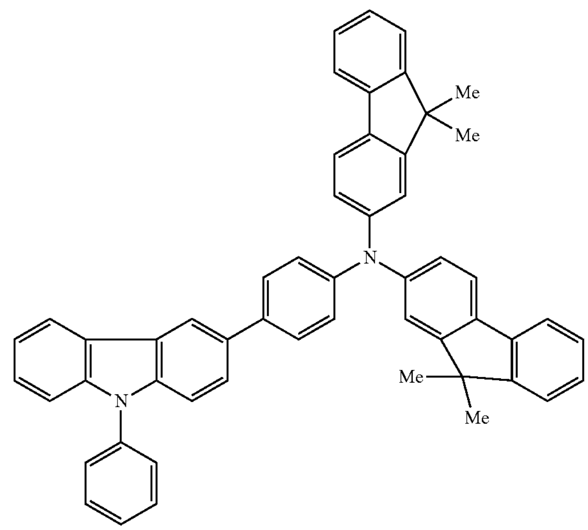


-continued

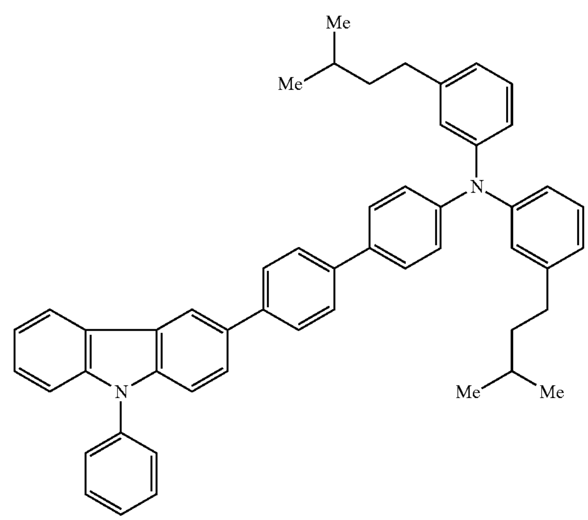
32



33

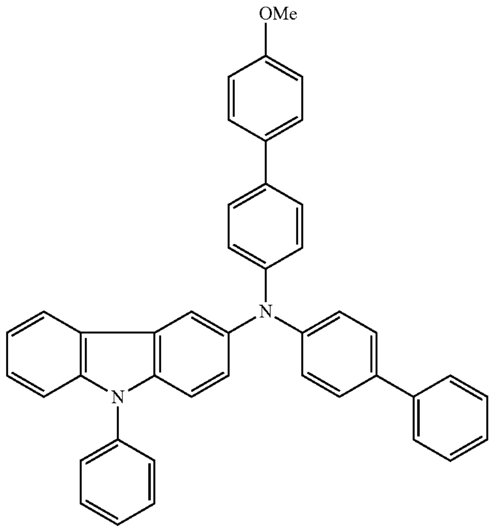


34

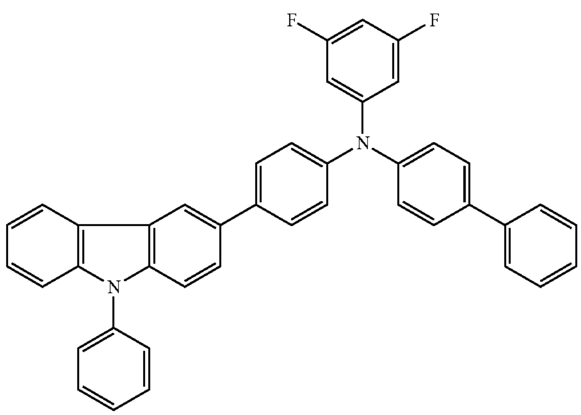


-continued

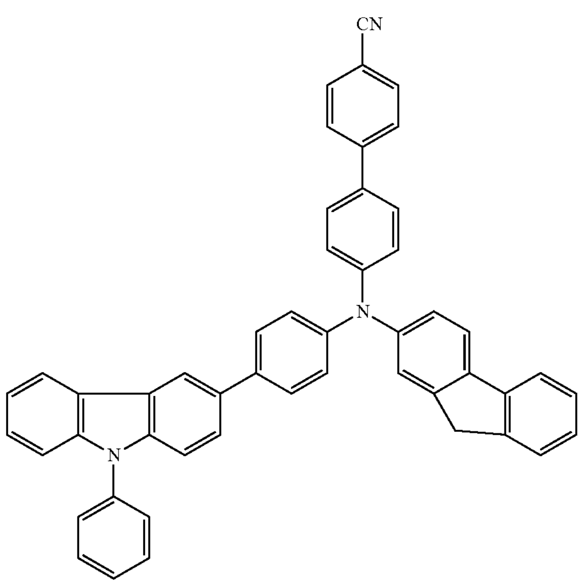
35



36

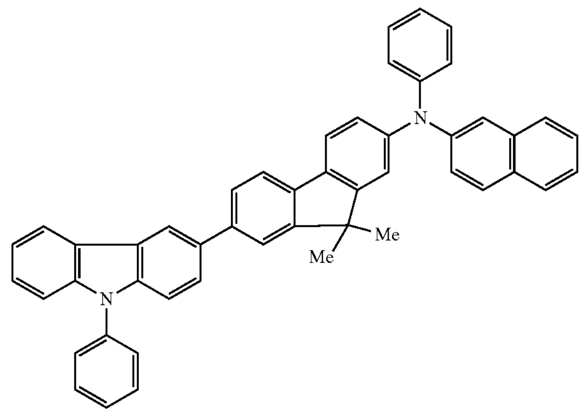


37



-continued

38



In the laminated structure of at least three layers having different components in the hole transport band **120** in the organic EL device **100**, at least one layer (e.g., the first layer **121**) formed by using the electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component may be adjacent to the anode **110**, and at least one layer (e.g., the second layer **125**) including the compound represented by Formula 1 may be adjacent to the emission layer **130**. For example, the first layer **121** may be between the anode **110** and the second layer **125**. For example, the second layer **125** may be between the first layer **121** and the emission layer **130**.

By forming the first layer **121** using the electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component, hole injection properties from the anode **110** may be improved. Thus, in an embodiment, the first layer **121** including the electron accepting compound may be disposed toward or adjacent to the anode **110**, and hole injection properties from the anode **110** of the organic EL device **100** may be markedly improved.

The organic EL device **100** according to an embodiment may include an amine derivative or amine-containing compound having a carbazolyl group, e.g., a compound represented by Formula 1, in the hole transport second layer **125** adjacent to the emission layer **130**. The hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**. In addition, the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented, and a whole charge balance of the organic EL device **100** may be controlled.

In the organic EL device **100**, the third layer **123** including the compound having the carbazolyl group, e.g., represented by Formula 2, may be disposed closer to the emission layer **130** than the first layer **121**. By including the compound having the carbazolyl group in the hole transport laminated structure, charge transport properties and current flow durability may be improved. In an implementation, by including the compound represented by Formula 2 in the third layer **123**, the hole transport laminated structure may be passivated from electrons that are not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented. In addition, the amine derivative having the carbazolyl group and represented by

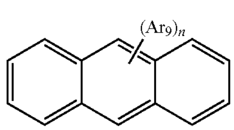
Formula 2 may help restrain diffusion of the electron accepting compound into the emission layer **130**.

In addition, by disposing the second layer **125** (including the compound represented by Formula 1) adjacent to the emission layer **130**, diffusion of the electron accepting compound included in the first layer **121** into the emission layer **130** may be restrained or prevented, the hole transport first layer **121** and second layer **123** may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport first layer **121** and third layer **123** may be prevented. In addition, by including the amine derivative having the carbazolyl group represented by Formula 1 in the second layer **125**, the hole transport properties and the current flow durability of the laminated structure may be improved.

In an implementation, in a layer constituting the laminated structure of the hole transport band **120** between the anode **110** and the emission layer **130** in the organic EL device **100**, the compound having the carbazolyl group may be included. By including the compound having the carbazolyl group in the layer constituting the laminated structure of the hole transport band **120**, charge transport properties and current flow durability may be improved. In an implementation, in the layer constituting the laminated structure of the hole transport band **120** between the anode **110** and the emission layer **130** in the organic EL device **100**, the compound represented by Formula 1 or 2 may be included. Thus, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130** and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented.

In the organic EL device **100**, light emission, mainly via a singlet excited state, may be obtained in the emission layer **130**. As the material of the emission layer **130**, suitable luminescent materials may be used, e.g., a fluoranthene derivative, a pyrene derivative, an arylacetylene derivative, a fluorene derivative, a perylene derivative, a chrysene derivative, or the like. In an implementation, the pyrene derivative, the perylene derivative, and/or the anthracene derivative may be used. For example, an anthracene derivative or anthracene-containing compound represented by the following Formula 3 may be used as the material of the emission layer **130**.

[Formula 3]

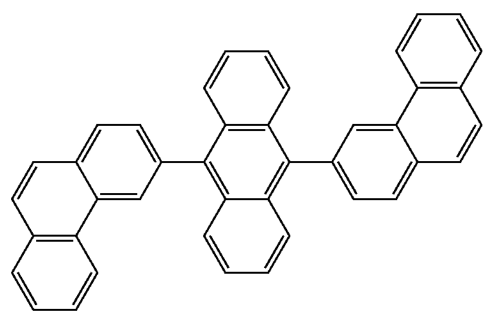


In Formula 3, each Ar_9 may independently be or include, e.g., a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 ring carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 ring carbon atoms, a substituted or unsubstituted arylthio group having 6 to 50 ring carbon atoms, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group or a hydroxyl group, and n may be an integer of 1 to 10.

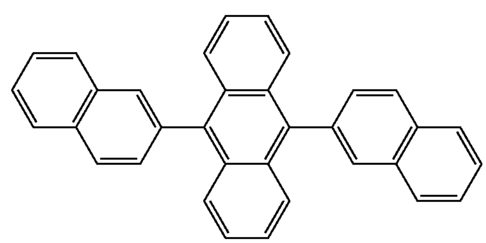
In an implementation, Ar_9 in the above Formula 3 may include, e.g., a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a phenylnaphthyl group, a naphthylphenyl group, an anthryl group, a phenanthryl group, a fluorenyl group, an indenyl group, a pyrenyl group, an acetonaphthenyl group, a fluoranthenyl group, a triphenylenyl group, a pyridyl group, a furanyl group, a pyranyl group, a thienyl group, a quinolyl group, an isoquinolyl group, a benzofuranyl group, a benzothienyl group, an indolyl group, a carbazolyl group, a benzoxazolyl group, a benzothiazolyl group, a quinoxalyl group, a benzoxazolyl group, a pyrazolyl group, a dibenzofuranyl group, or a dibenzothienyl group. In an implementation, the phenyl group, the biphenyl group, the terphenyl group, the fluorenyl group, the carbazolyl group, the dibenzofuranyl group, or the like may be used.

In an implementation, the compound represented by Formula 3 may be, e.g., one of the following Compounds a-1 to a-12.

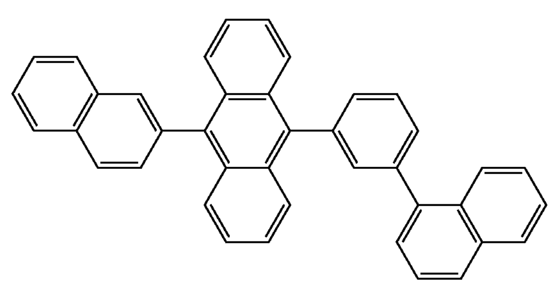
a-1



a-2

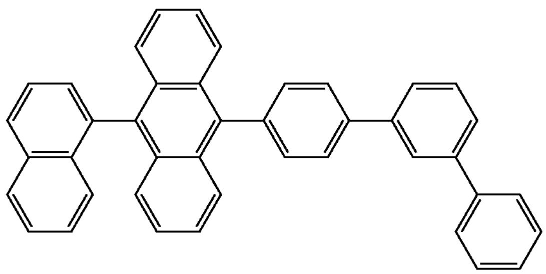


a-3

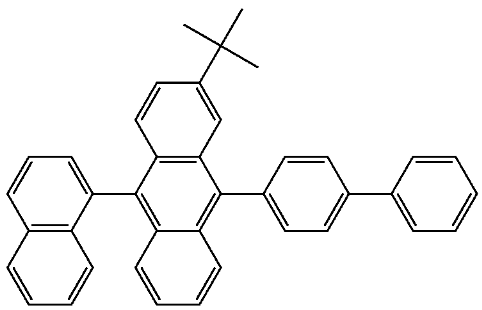


-continued

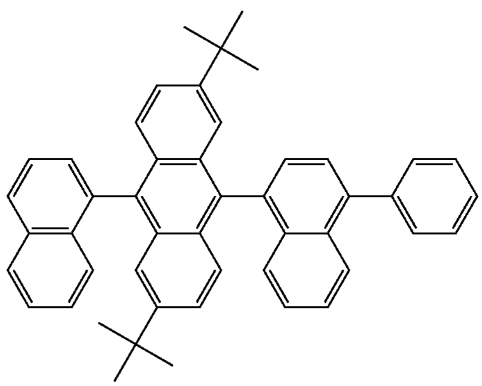
a-4



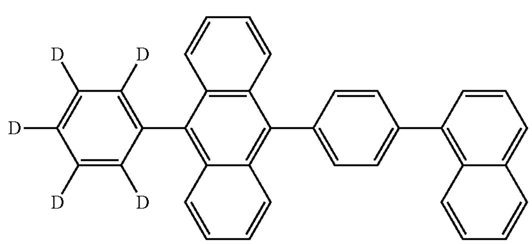
a-5



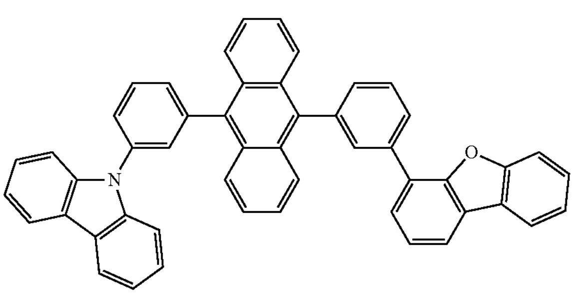
a-6



a-7

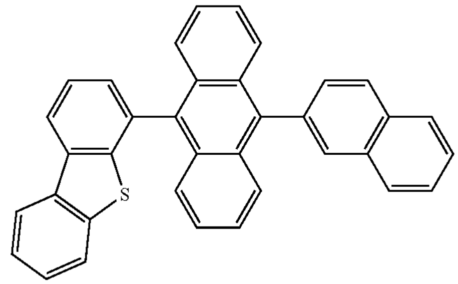


a-8

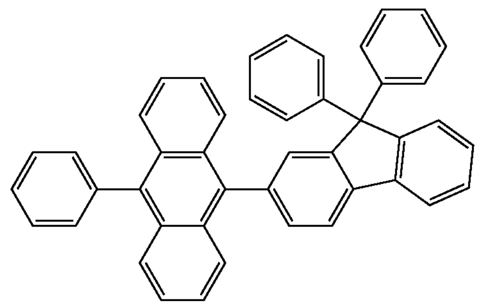


-continued

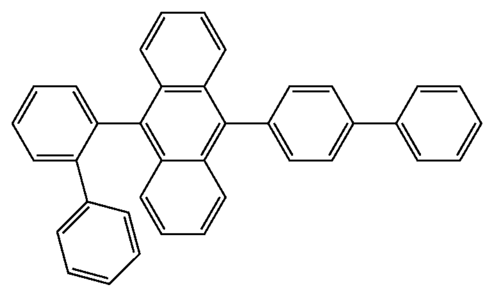
a-9



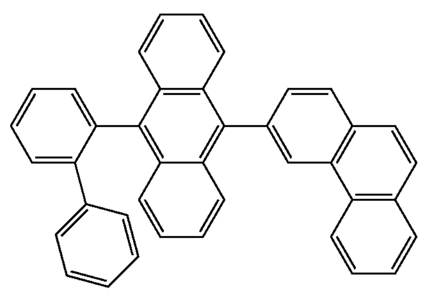
a-10



a-11



a-12



As described above, the organic EL device **100** according to an embodiment may help improve hole injection properties from the anode **110** by forming the first layer **121** using or including the electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component. However, the above-described effects are remarkable when combined with the emission layer **130** including the compound represented by Formula 3, and the driving at a low voltage of the organic EL device **100** may be realized.

The organic EL device according to an embodiment will be explained in more detail referring to the organic EL device **100** shown in FIG. **1**. In the organic EL device **100** according to an embodiment, the substrate **101** may be, e.g., a transparent glass substrate, a semiconductor substrate formed using silicon, or the like, or a flexible substrate of a resin, etc. The anode **110** may be disposed on the substrate **101** and may be formed using, e.g., ITO, IZO, or the like.

As described above, the hole transport band **120** may be disposed between the anode **110** and the emission layer **130**. In an implementation, a hole injection layer may be formed as the first layer **121** (by using the electron accepting compound as a main component) on the anode **110**.

The hole transport layer may be formed as the third layer **123** (using a material including the hole transport material represented by Formula 2) closer to the emission layer **130** than the hole injection layer **121**, e.g., between the emission layer **130** and the hole injection layer **121**. In an implementation, the hole transport layer **123** may be laminated in plural, and in this case, the hole transport layer disposed adjacent to the hole injection layer **121** may include the electron accepting compound.

An intermediate layer may be formed as the second layer **125** (using a material including the hole transport material represented by Formula 1) closer to the emission layer **130** than the hole transport layer **123**, e.g., between the emission layer **130** and the hole transport layer **123**. The intermediate layer **125** may be formed adjacent to, e.g., directly adjacent to or directly contacting, the emission layer **130**. Thus, the diffusion of the electron accepting compound included in the hole injection layer **121** and/or the hole transport layer **123** into the emission layer **130** may be restrained or prevented, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, and the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented. Accordingly, the emission efficiency and the life of the organic EL device may be improved.

The emission layer **130** may be formed adjacent to, e.g., directly adjacent to, the intermediate layer **125**. As the host material of the emission layer **130**, e.g., an anthracene-containing compound represented by Formula 3 may be used. In an implementation, the emission layer **130** may include a suitable p-type dopant such as TBP.

On the emission layer **130**, an electron transport layer **140** may be formed using, e.g., a material including Alq3. On the electron transport layer **140**, the electron injection layer **150** may be formed using a material including lithium fluoride, lithium 8-quinolinato, etc. In addition, on the electron injection layer **150**, the cathode **160** may be formed using a metal such as Al, Ag, etc. or a transparent material such as ITO, IZO, etc. Each of the above-described layers may be formed by selecting an appropriate layer forming method according to a material, such as a vacuum deposition method, a sputtering method, various coating methods, etc.

In the organic EL device according to an embodiment, the material for an organic EL device may be applied in an organic EL display of an active-matrix type using a TFT.

In addition, in the organic EL device **100** according to an embodiment, through the combination of the layer structure and the materials, the hole transport laminated structure may be passivated from electrons not consumed in the emission layer **130**, the diffusion of energy of an excited state generated in the emission layer **130** into the hole transport laminated structure may be prevented, and the whole charge balance of the organic EL device **100** may be controlled. In addition, by disposing the intermediate layer **125** toward or directly adjacent to the emission layer **130**, the diffusion of the electron accepting compound into the emission layer **130** may be restrained, and the emission efficiency and the life of the organic EL device may be improved.

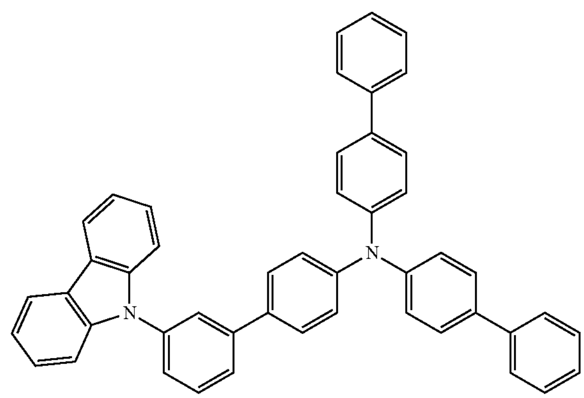
Example 2

Preparation Method

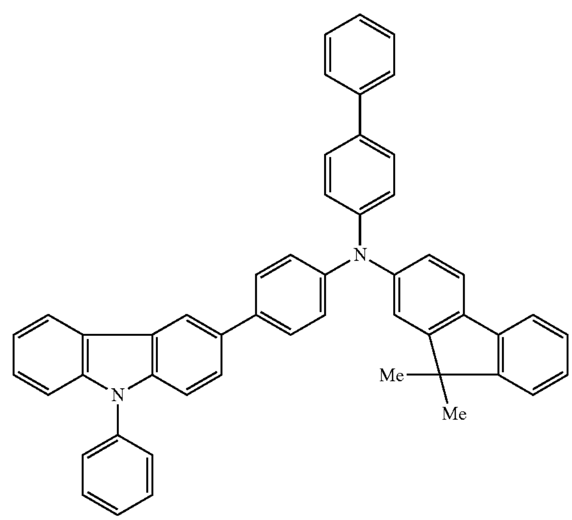
An organic EL device was manufactured using the above-described materials.

FIG. **2** illustrates a schematic diagram of an organic EL device **200** according to an embodiment. In this embodiment, an anode **110** was formed using ITO to have a layer thickness of about 150 nm. A layer HTL**1** as a hole injection layer **221** having a layer thickness of about 10 nm was formed using Compound 39 as the electron accepting compound. HTL**2** was formed as a hole transport layer **223** using Compound 25 (represented by Formula 2) or Compound 41 (described below) to have a layer thickness of about 10 nm. In addition, HTL**3** was formed as an intermediate layer **225** using Compound 4 (as a compound represented by Formula 1) to have a layer thickness of about 10 nm.

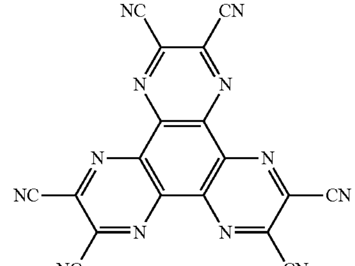
4



25



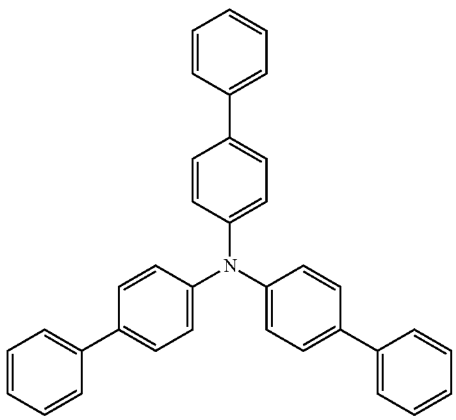
39



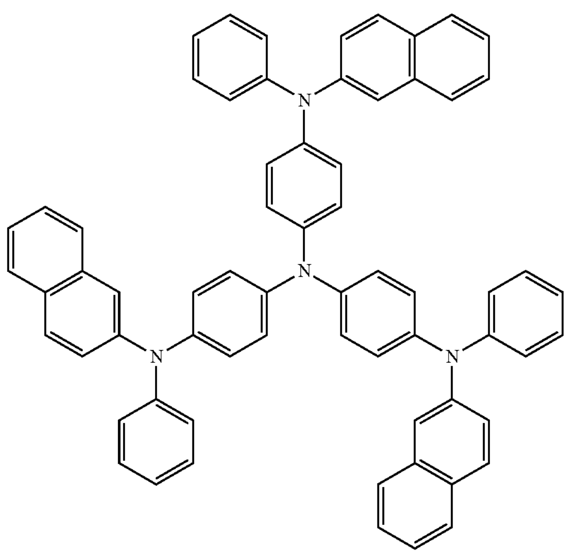
Then, an emission layer **130** was formed using a host material including ADN (as the compound represented by Formula 3), doped with about 3% of TBP to have a layer thickness of about 25 nm. An electron transporting layer **140** was formed using Alq3 to have a layer thickness of about 25 nm, an electron injection layer **150** was formed using LiF to have a layer thickness of about 1 nm, and a cathode **116** was formed using Al to have a layer thickness of about 100 nm.

In addition, organic EL devices were manufactured using the following Compounds 40 to 43, as opposed to the above-described compounds in HTL**1** to HTL**3**, as Comparative Examples.

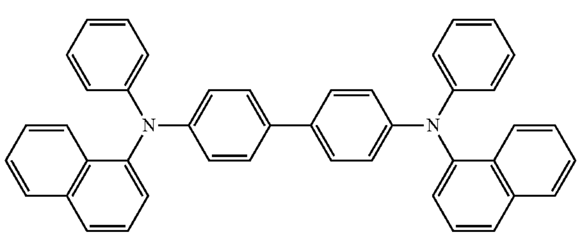
40



41

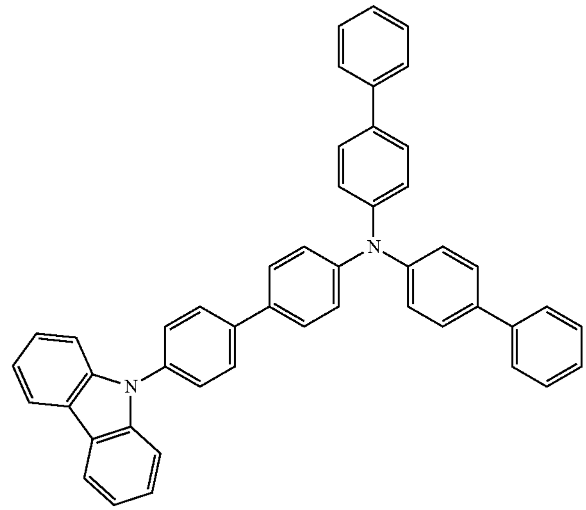


42



-continued

43



The combinations of the compounds used in the HTL**1** to HTL**3** of the organic EL devices according to the Examples and Comparative Examples are summarized in the following Table 3.

TABLE 3

	HTL1	HTL2	HTL3
Example 2-1	Compounds 39	Compound 25	Compound 4
Example 2-2	Compounds 39	Compound 41	Compound 4
Comparative Example 2-1	Compounds 39	Compound 4	Compound 25
Comparative Example 2-2	Compounds 25	Compound 25	Compound 4
Comparative Example 2-3	Compound 39	Compounds 25	Compound 40
Comparative Example 2-4	Compounds 39	Compound 25	Compound 42

With respect to the organic EL devices manufactured in the Examples and Comparative Examples, voltage, power efficiency, and current efficiency were evaluated. In addition, current density was about 10 mA/cm^2. Evaluation results are illustrated in the following Table 4.

TABLE 4

	Voltage (V)	Emission efficiency (cd/A)	Half life (h)
Example 1-1	6.5	7.7	3,500
Example 1-2	6.6	7.5	2,900
Comparative Example 1-1	6.8	6.5	2,100
Comparative Example 1-2	7.5	6.3	2,000
Comparative Example 1-3	6.5	7.3	2,400
Comparative Example 1-4	6.7	7.4	2,500

As may be seen in Table 4, an improvement of the emission efficiency and the device life were observed for Example 2-1, when compared to a case in which HTL**2** and HTL**3** were reversed (Comparative Example 2-1) and to a case in which a layer including the electron accepting compound was not used in HTL**1** to HTL**3** (Comparative

Example 2-2). In addition, the improving effects of the emission efficiency and the device life were observed in a case using the non-carbazole-based hole transport material, Compound 41, in the hole transport layer HTL**2** (Example 2-2). In addition, when comparing Example 2-1 with a case using the non-carbazole-based hole transport material, Compound 40, in HTL**3** (Comparative Example 2-3) or a case using a carbazole-based hole transport material, Compound 42, having a different structure from the compound having the carbazolyl group and represented by Formula 1, in HTL**3**, the effects of improving the emission efficiency and the device life were observed.

From the above explanation, in the laminated structure of at least three layers having different components disposed in the hole transport band in the organic EL device according to an embodiment, high efficiency and long life may be provided by disposing at least one layer formed by using an electron accepting compound having a LUMO level from about −9.0 eV to about −4.0 eV as a main component adjacent to the anode, e.g., directly adjacent to the anode, and by disposing at least one layer including a compound represented by Formula 1 closer to an emission layer than the layer including the electron accepting compound as a main component.

By way of summation and review, for the application of an organic EL device in a display apparatus, the organic EL device may have high efficiency and long life. For example, in a blue emission region and a green emission region, the emission efficiency and the life of the organic EL device may not be sufficient. To realize the high efficiency of the organic EL device, a band between an anode and an emission layer, and the normalization and the stabilization with the emission layer may be considered. The disposition of a layer formed using an electron accepting material (hereinafter, will be referred to as an acceptor layer) to assist hole transportation may be considered.

As a hole transport material used in a hole transport layer, various compounds such as an anthracene-containing compound or an aromatic amine compound, etc. may be considered. However, an organic EL device using an amine compound including a carbazole part in a hole transport layer or an emission layer may be considered. In addition, an organic EL device including an electron accepting dopant having the lowest unoccupied molecular orbital (LUMO) level from about −9.0 eV to about −4.0 eV in at least one layer of organic material layers disposed between an emission layer and an anode may be considered.

In addition, an organic EL device manufactured by laminating a hole transport layer formed by using an amine-containing compound having a carbazole moiety and a fluorene moiety and being adjacent to an emission layer and having a hole injection layer having a three-layered structure between an anode and the hole transport layer may be considered. The hole injection layer may include from the anode, (1) a layer including a diamine derivative in which each carbazole moiety is combined with two nitrogen atoms, respectively, (2) a layer including a diamine derivative in which each carbazole moiety is combined with two nitrogen atoms, respectively, and an amine derivative in which a carbazole moiety and a fluorine moiety are combined with a nitrogen atom, and (3) a layer including HAT. In addition, an organic EL device having a repeating structure of (1) a layer including an amine derivative having a carbazole moiety and a fluorene moiety, (2) a layer including an amine derivative having a HAT doped carbazole moiety and a fluorene moiety, and (3) a layer including an amine derivative having a carbazole moiety and a fluorene moiety, between an anode and an emission layer, wherein the layer including the amine derivative having the carbazole moiety and the fluorene moiety is adjacent to the emission layer, may be considered.

A material for forming a specific layer of an organic EL device may be considered in view of the configuration of device.

The embodiments may provide an organic electroluminescent device having high efficiency and long life.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

What is claimed is:

1. An organic electroluminescent (EL) device, comprising:

an anode;

an emission layer for obtaining luminescence via a singlet excited state; and

a laminated structure between the anode and the emission layer, the laminated structure including at least three layers having different components,

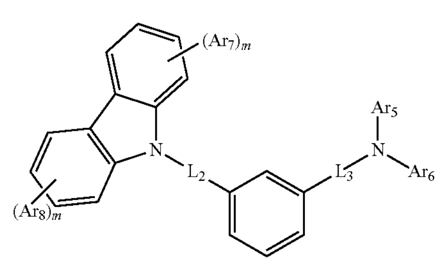
wherein the laminated structure includes:

a first layer including a hole transport compound, the hole transport compound being doped with an electron accepting compound that has a lowest unoccupied molecular orbital (LUMO) level of about −9.0 eV to about −4.0 eV;

a second layer between the first layer and the emission layer, the second layer being closer to the emission layer than the first layer and including a compound represented by the following Formula 1,

a third layer between the first layer and the second layer, the third layer includes a compound represented by the following Formula 2:

[Formula 1]



wherein, in Formula 1,

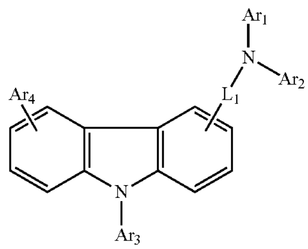
Ar_5 to Ar_8 are each independently a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms,

adjacent Ar_7s can be combined to form a ring, and adjacent Ar_8s can be combined to form a ring,

each m is independently an integer of 0 to 4, and

L_2 and L_3 are each independently a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms, or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms,

[Formula 2]



wherein, in Formula 2,

Ar_1, Ar_2, and Ar_3 are each independently a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms,

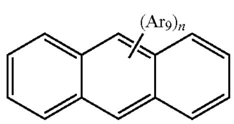
Ar_4 is a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, and

L_1 is a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms, or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms.

2. The organic EL device as claimed in claim **1**, wherein the first layer includes a compound represented by Formula 2.

3. The organic EL device as claimed in claim **1**, wherein the emission layer includes an anthracene-containing compound represented by the following Formula 3:

[Formula 3]



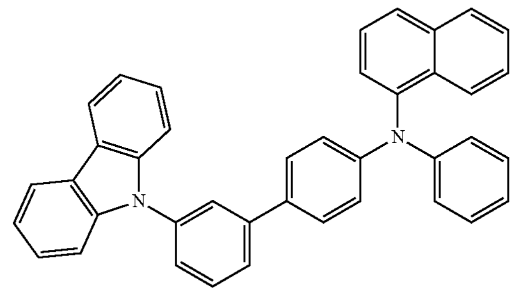
wherein, in Formula 3,

each Ar_9 is independently a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 ring carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 ring carbon atoms, a substituted or unsubstituted arylthio group having 6 to 50 ring carbon atoms, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group, or a hydroxyl group, and

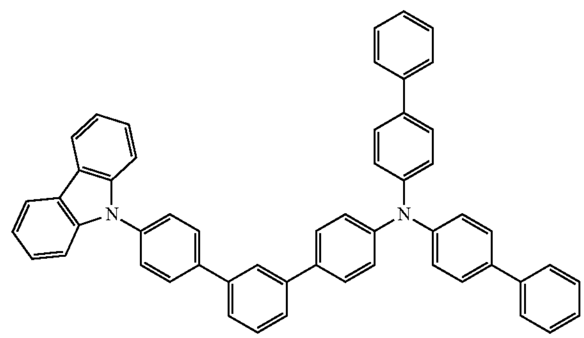
n is an integer of 1 to 10.

4. The organic EL device as claimed in claim **3**, wherein the second layer includes one of the following Compounds 1 to 22:

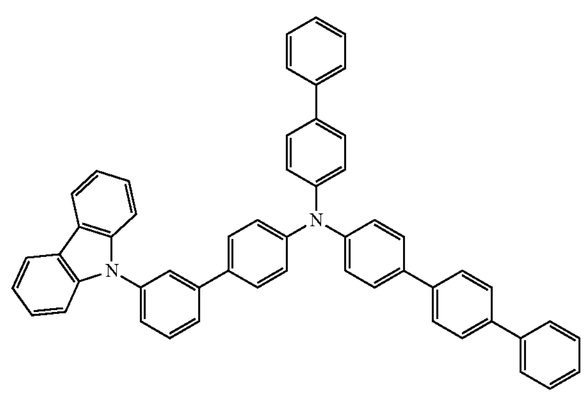
1



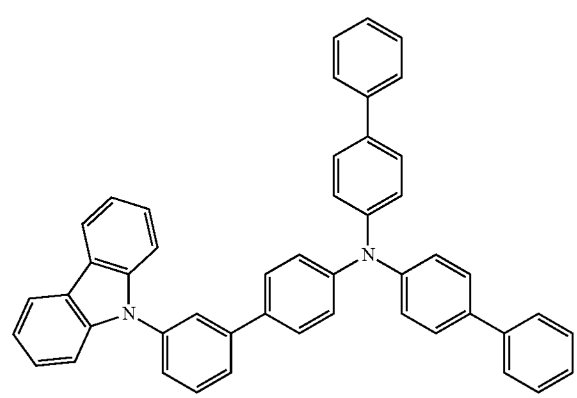
2



3

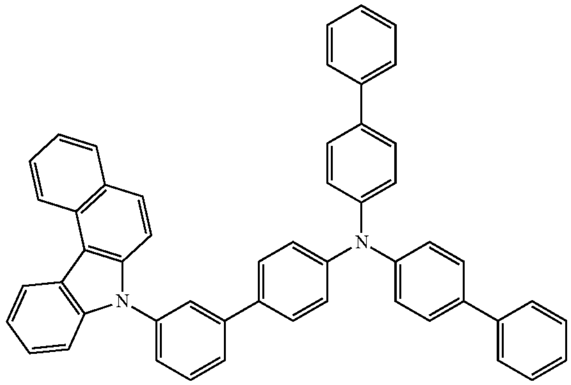


4

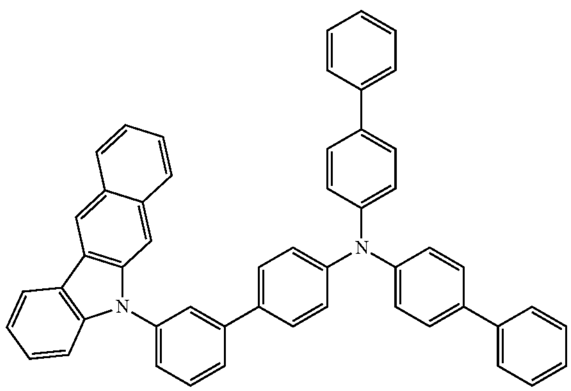


-continued

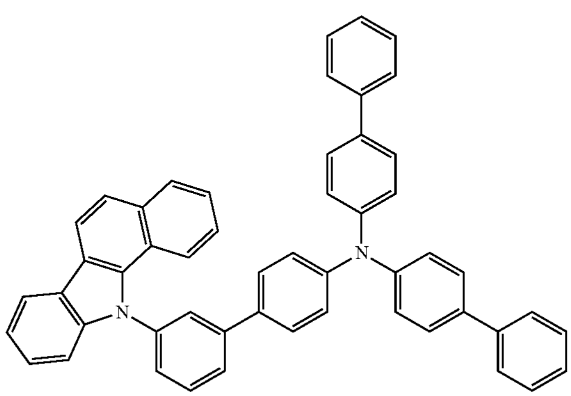
5



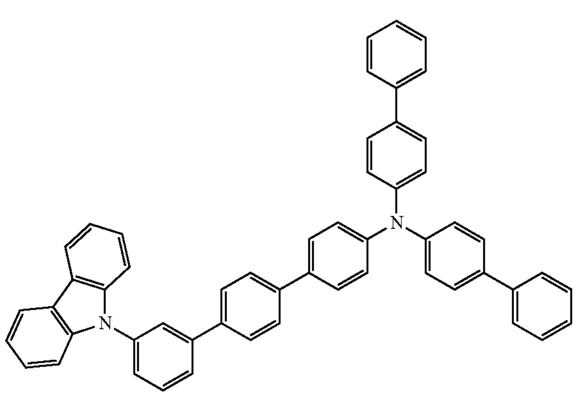
6



7

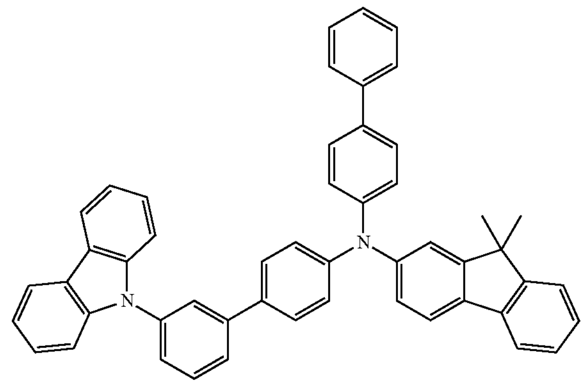


8

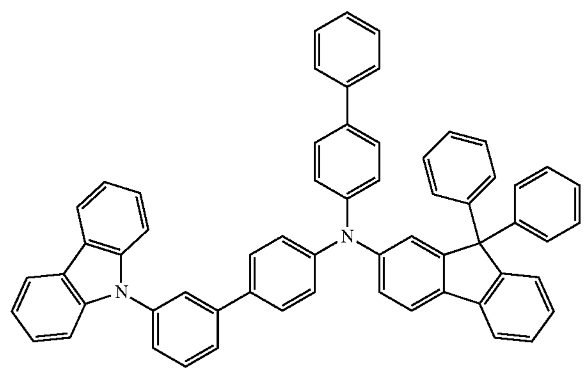


-continued

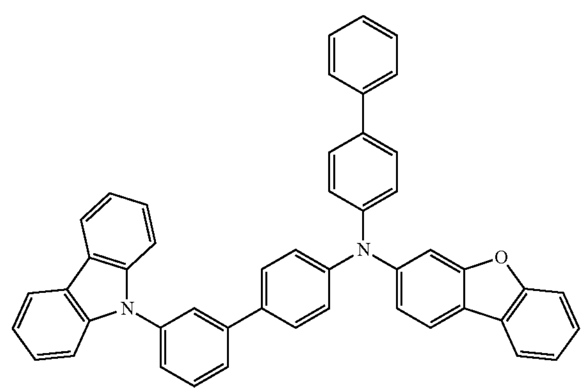
9



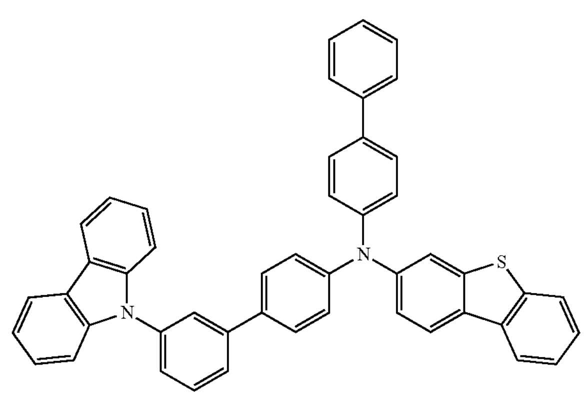
10



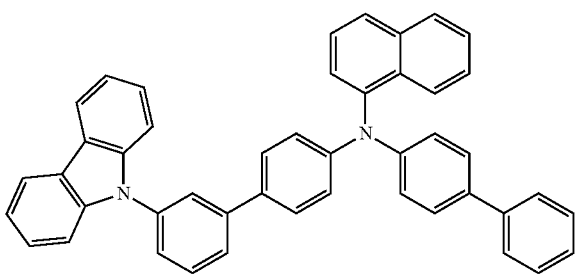
11



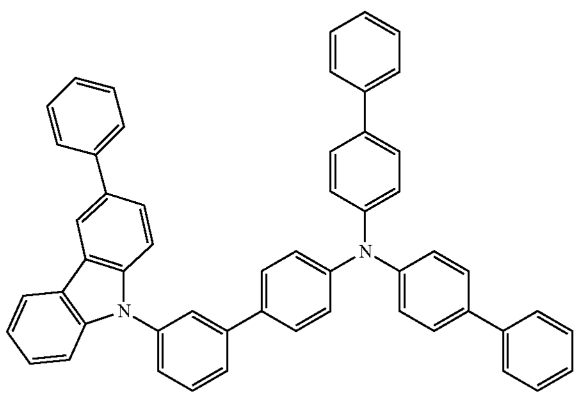
12



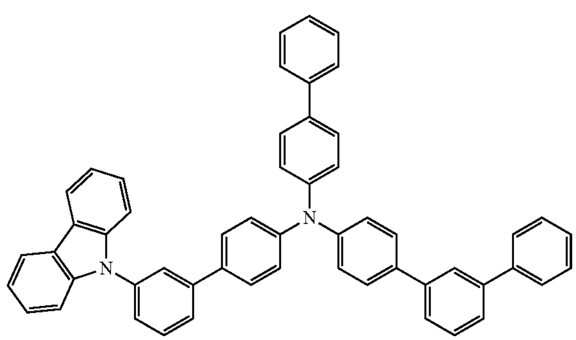
13



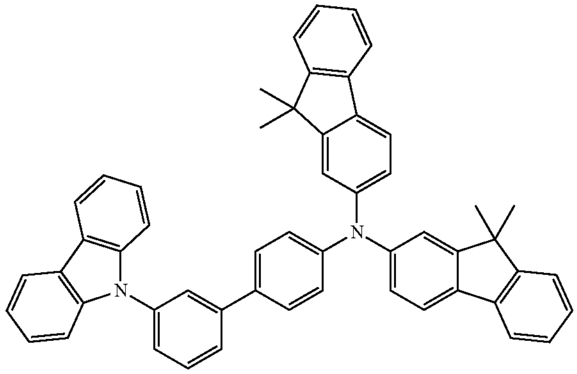
14



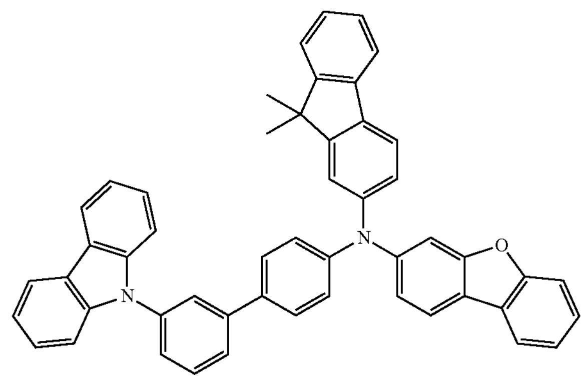
15



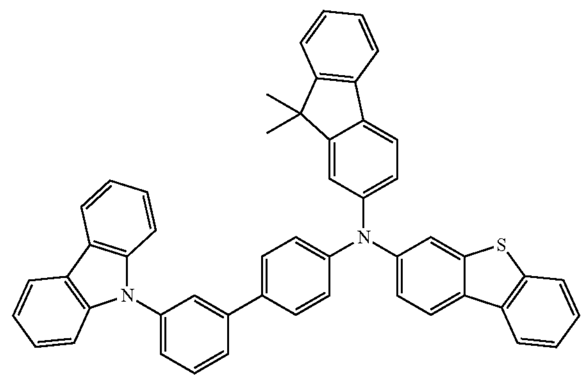
16



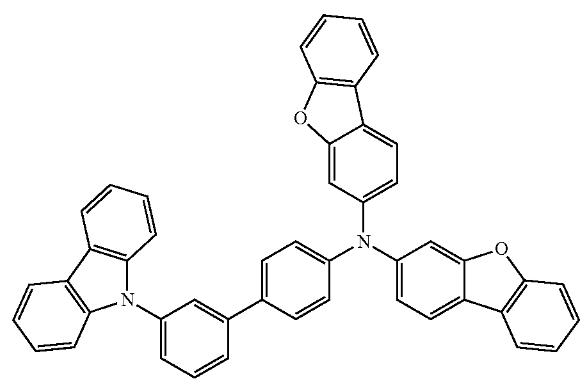
17



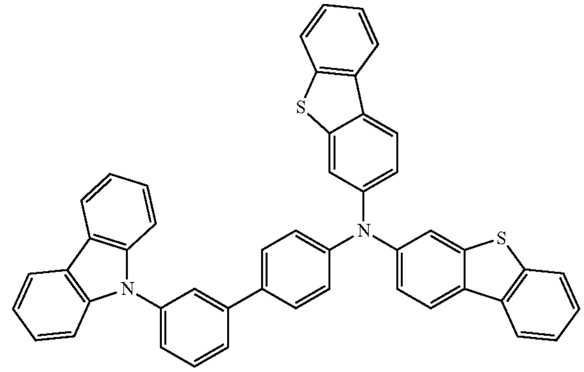
18



19

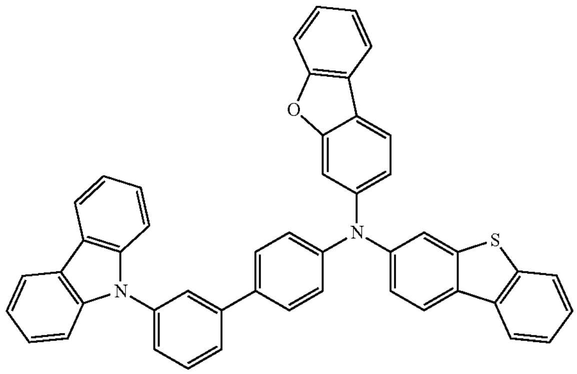


20

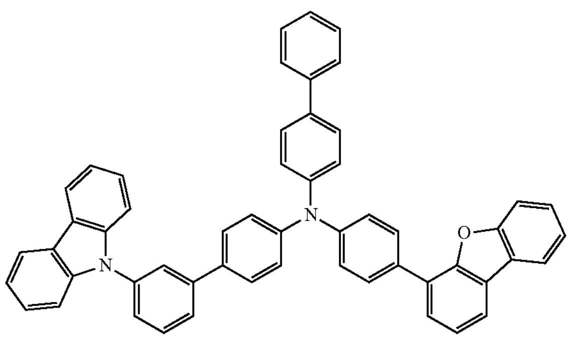


-continued

21

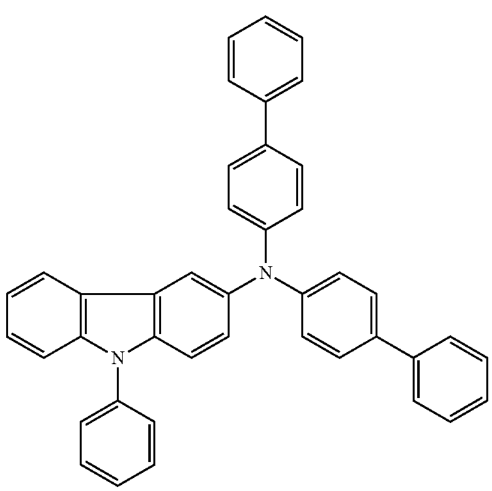


22



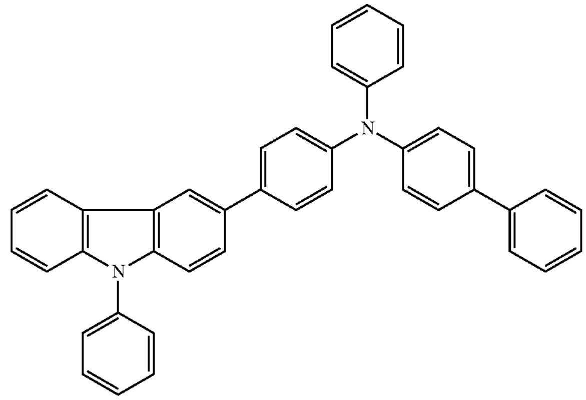
5. The organic EL device as claimed in claim 1, wherein the third layer includes one of the following Compounds 23 to 38:

23

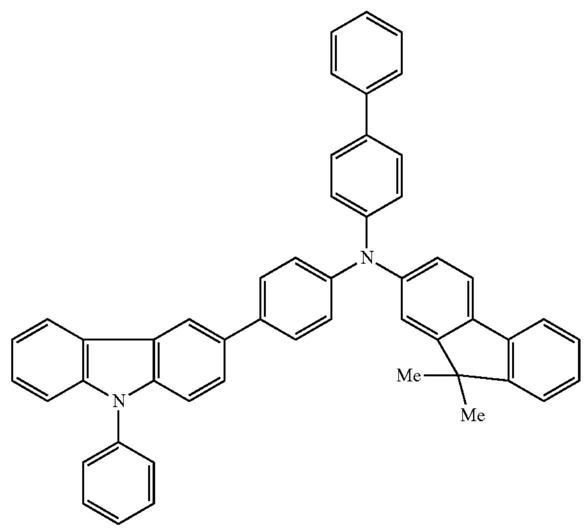


-continued

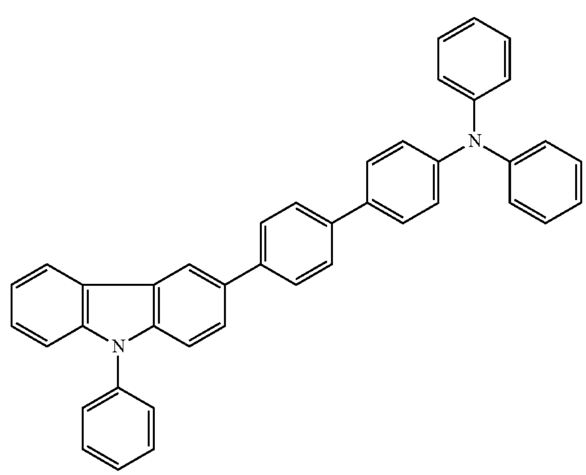
24



25

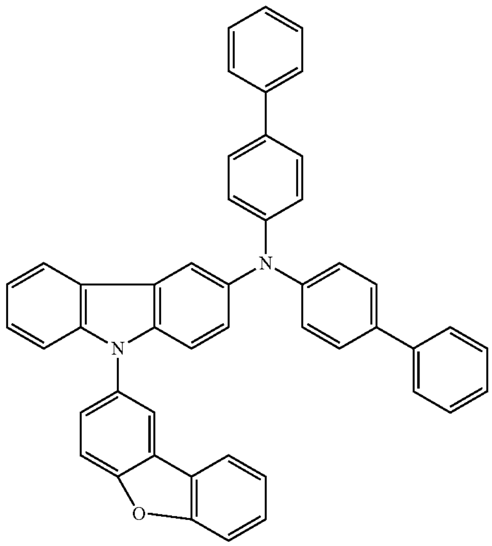


26

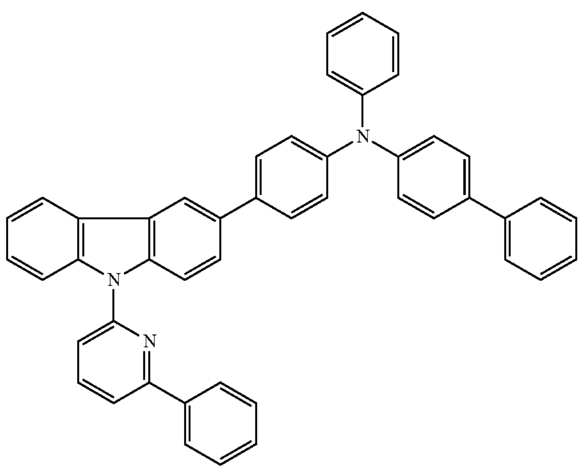


-continued

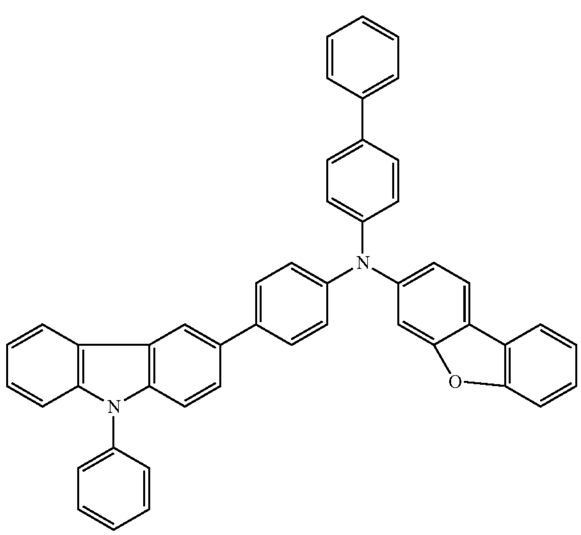
27



28

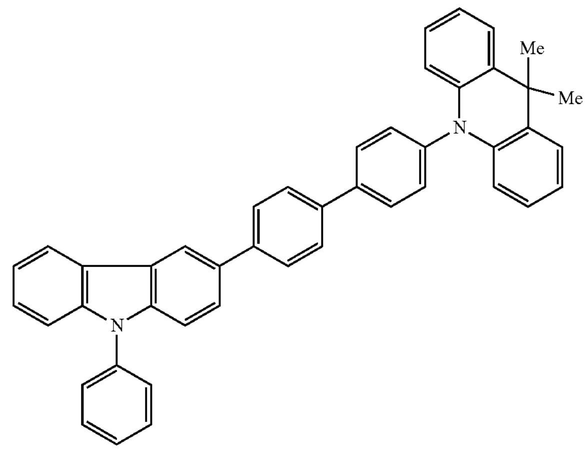


29

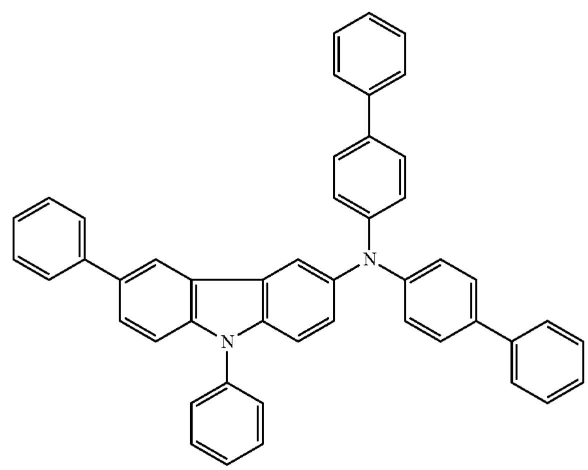


-continued

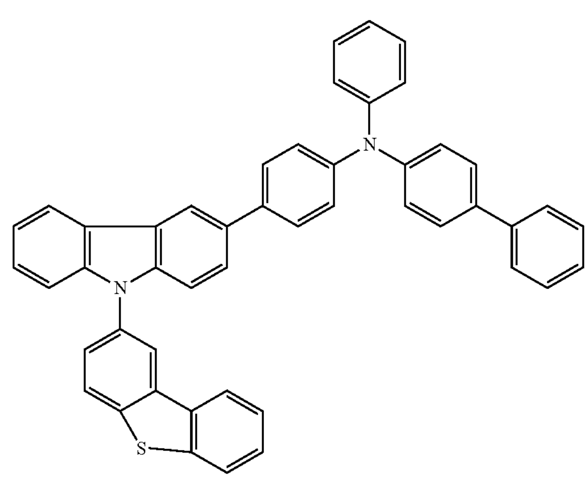
30



31

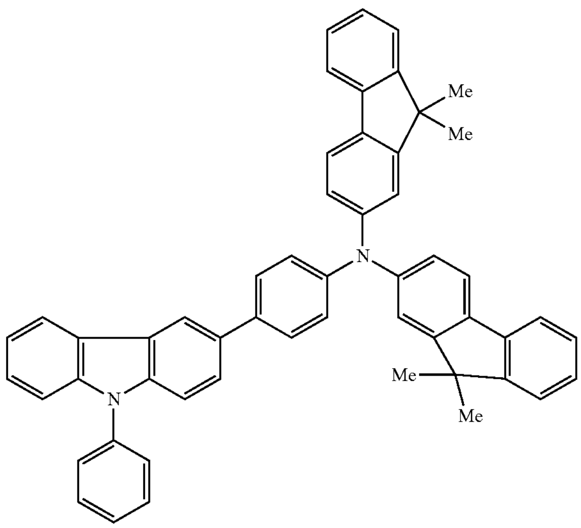


32

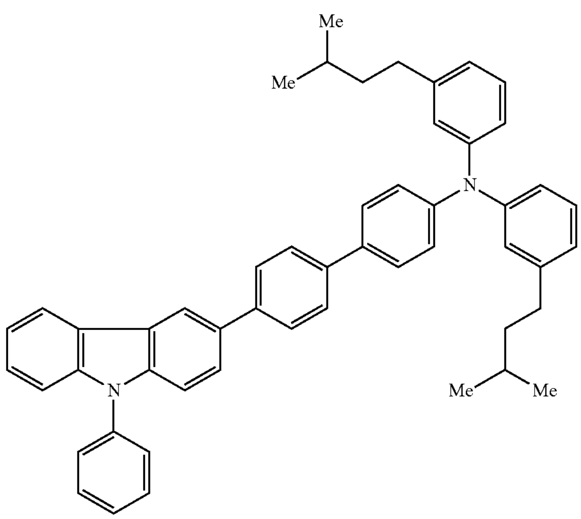


-continued

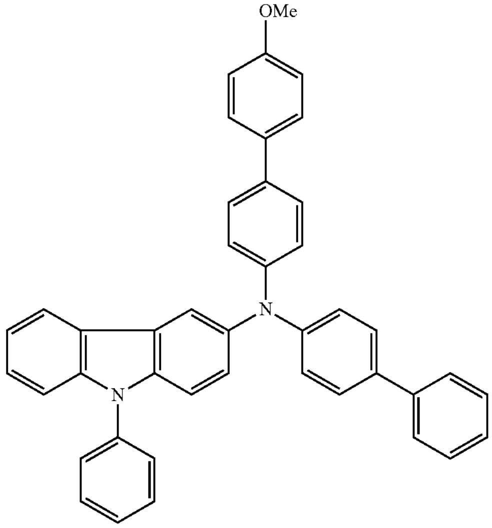
33



34

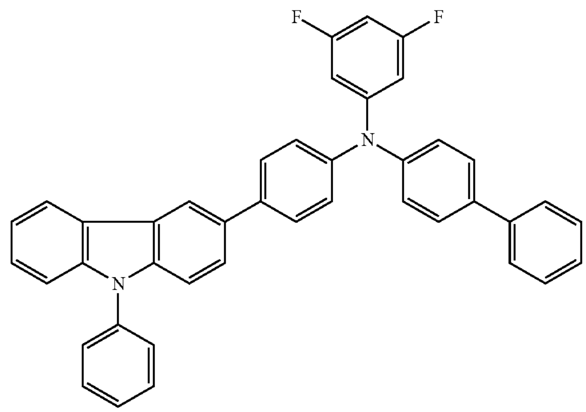


35

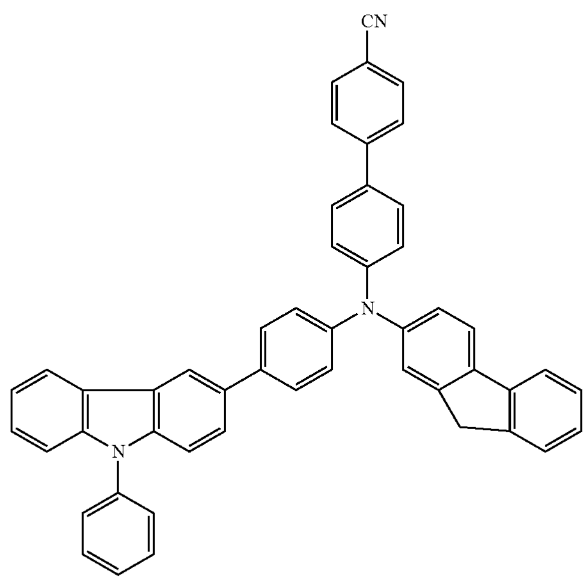


-continued

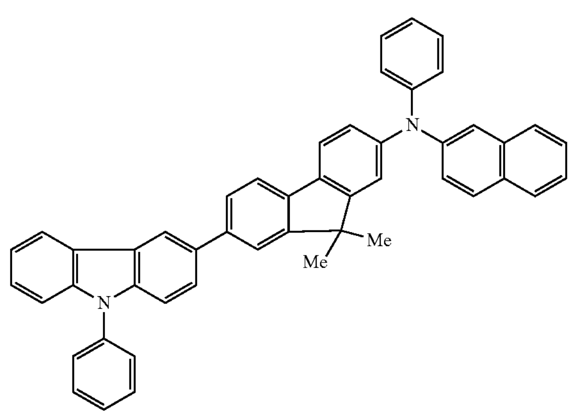
36



37



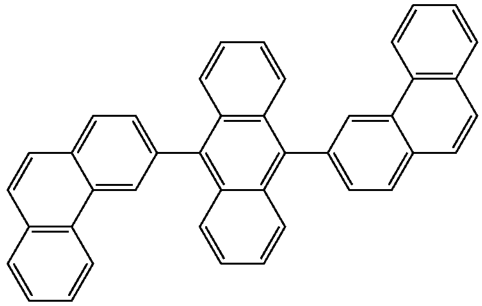
38



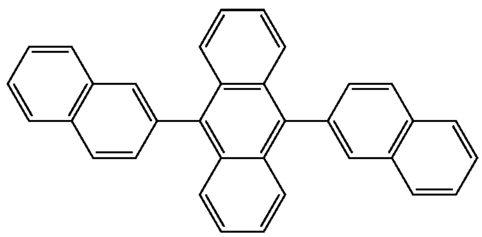
6. The organic EL device as claimed in claim **3**, wherein the anthracene-containing compound includes one of the following Compounds a-1 to a-12:

-continued

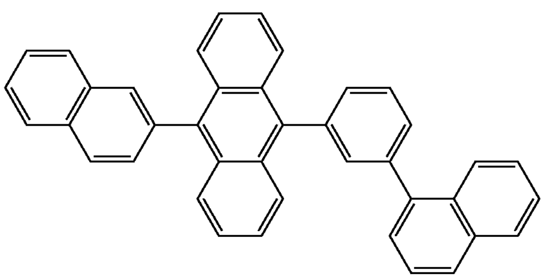
a-1



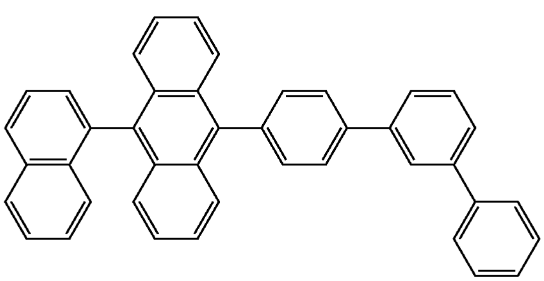
a-2



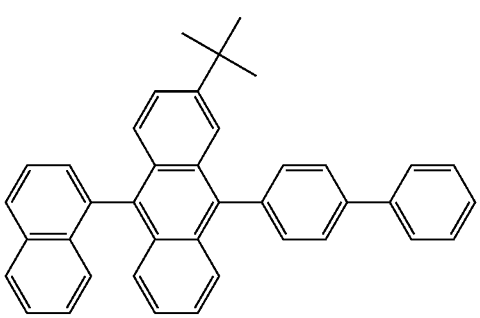
a-3



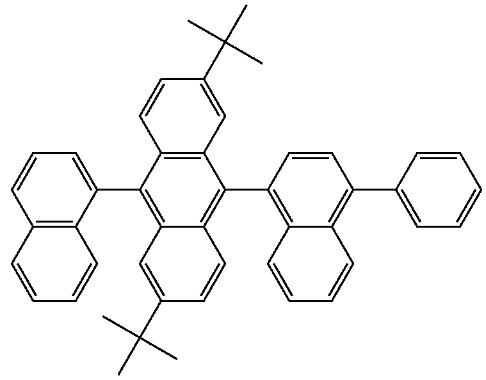
a-4



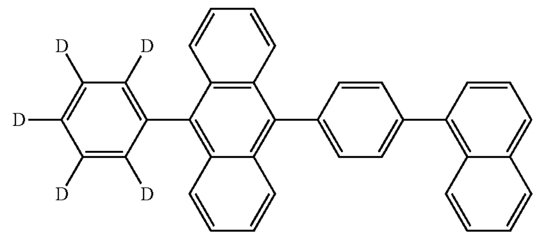
a-5



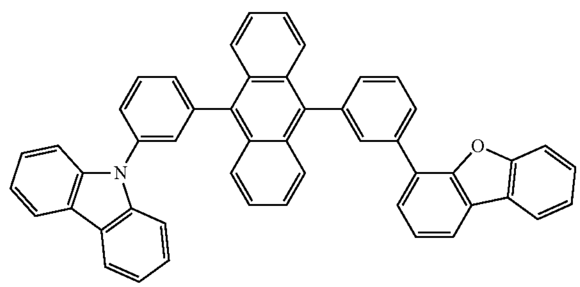
a-6



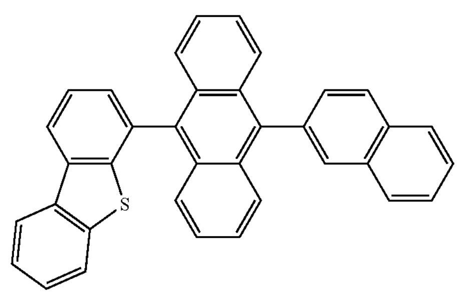
a-7



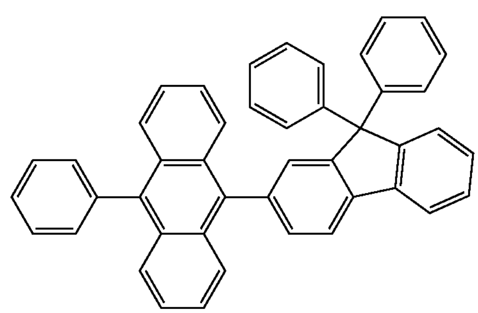
a-8



a-9

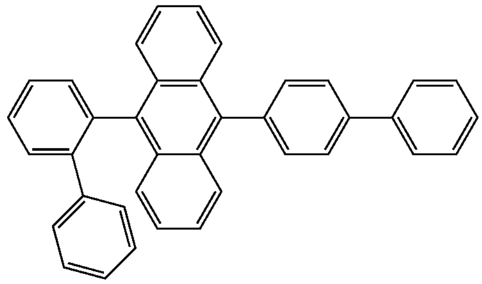


a-10

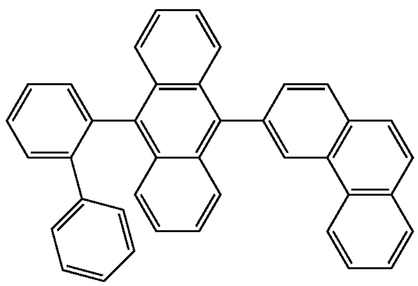


-continued

a-11



a-12



7. An organic electroluminescent (EL) device, comprising:

an anode;

an emission layer for obtaining luminescence via a singlet excited state; and

a laminated structure between the anode and the emission layer, the laminated structure including at least three layers having different components,

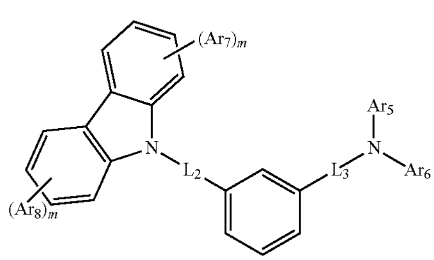
wherein the laminated structure includes:

a first layer including an electron accepting compound having a lowest unoccupied molecular orbital (LUMO) level of about −9.0 eV to about −4.0 eV as a main component;

a second layer between the first layer and the emission layer, the second layer being adjacent to the emission layer and including a compound represented by the following Formula 1, and

a third layer between the first layer and the second layer, the third layer includes a compound represented by the following Formula 2:

[Formula 1]



wherein, in Formula 1,

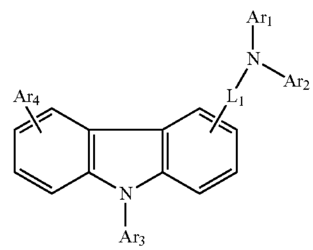
Ar_5 to Ar_8 are each independently a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms,

adjacent Ar_7s can be combined to form a ring, and adjacent Ar_8s can be combined to form a ring,

each m is independently an integer of 0 to 4, and

L_2 and L_3 are each independently a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms, or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms,

[Formula 2]



wherein, in Formula 2,

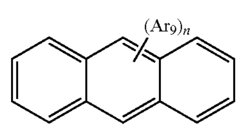
Ar_1, Ar_2, and Ar_3 are each independently a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms or a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms,

Ar_4 is a substituted or unsubstitute aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50 ring carbon atoms, or a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, and

L_1 is a single bond, a substituted or unsubstituted arylene group having 6 to 18 ring carbon atoms, or a substituted or unsubstituted heteroarylene group having 5 to 15 ring carbon atoms.

8. The organic EL device as claimed in claim 7, wherein the emission layer includes an anthracene-containing compound represented by the following Formula 3:

[Formula 3]



wherein, in Formula 3,

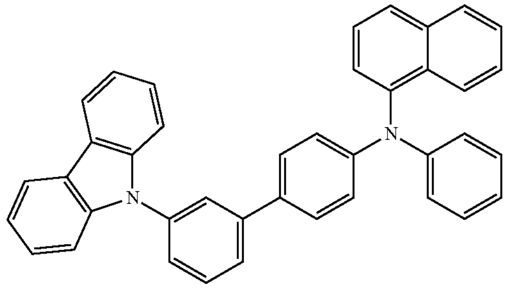
each Ar_9 is independently a hydrogen atom, a deuterium atom, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 ring carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 50 ring carbon atoms, a substituted or unsubstituted arylthio group having 6 to 50 ring carbon atoms, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, a substituted or unsubstituted aryl group having 6 to 50 ring carbon atoms, a substituted or unsubstituted heteroaryl group having 5 to 50ring carbon atoms, a substituted or unsubstituted silyl group, a carboxyl group, a halogen atom, a cyano group, a nitro group, or a hydroxyl group, and

n is an integer of 1 to 10.

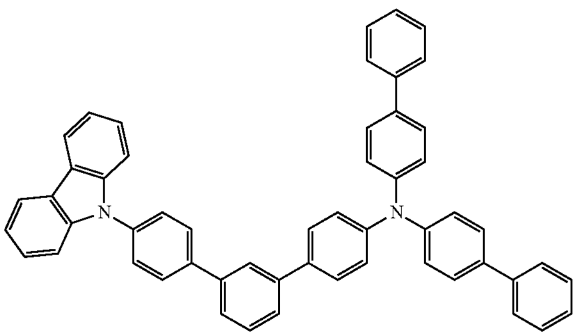
9. The organic EL device as claimed in claim 7, wherein the second layer includes one of the following Compounds 1 to 22:

-continued

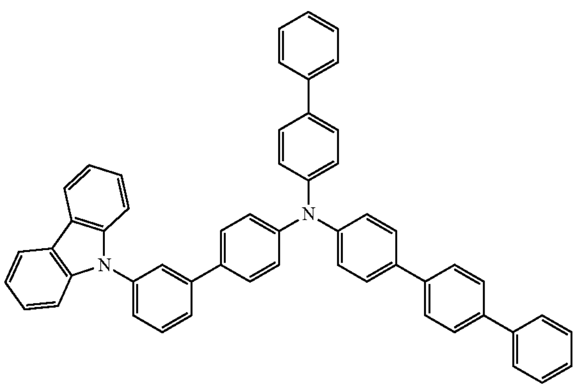
1



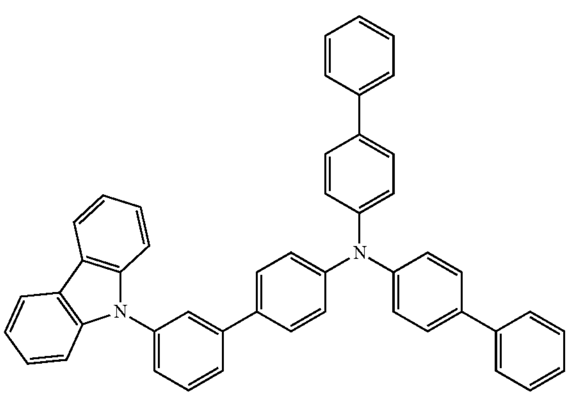
2



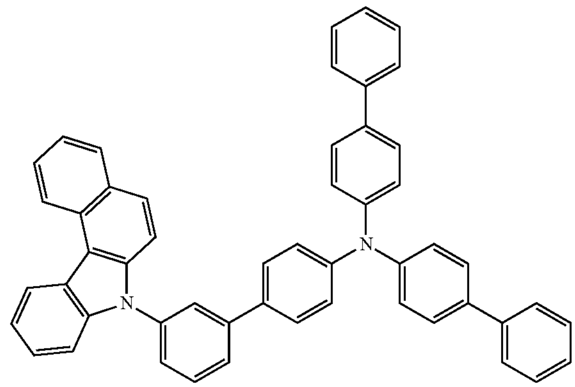
3



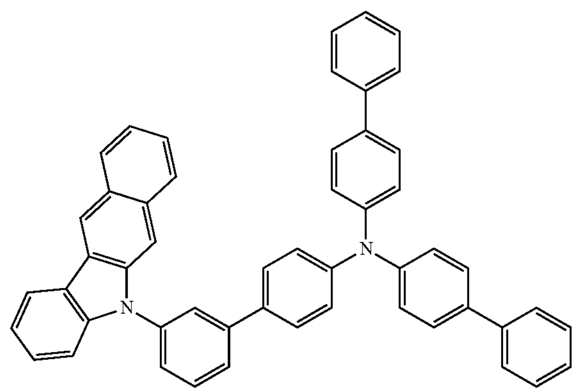
4



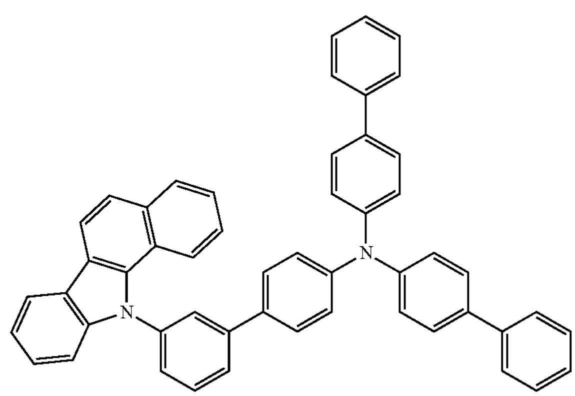
5



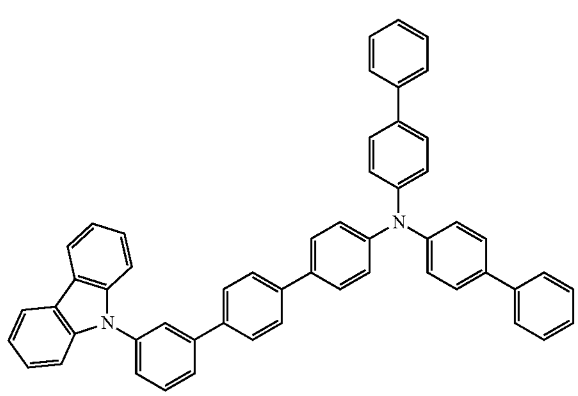
6



7

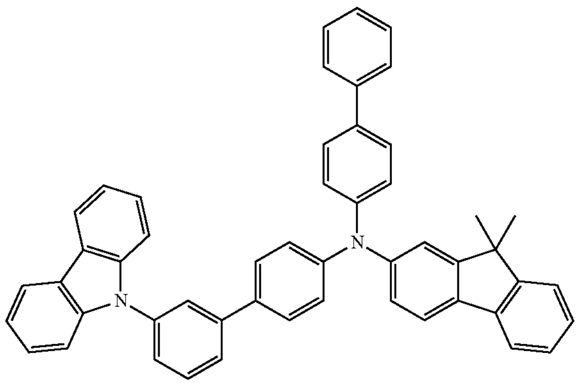


8

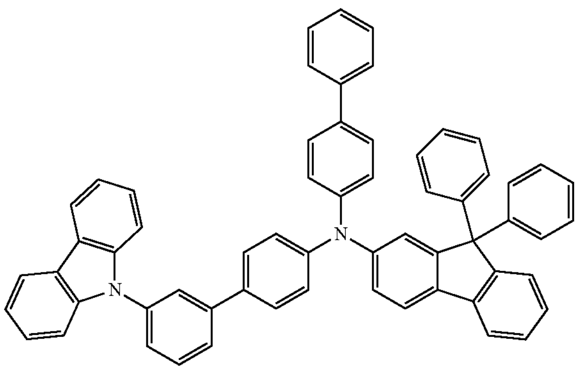


-continued

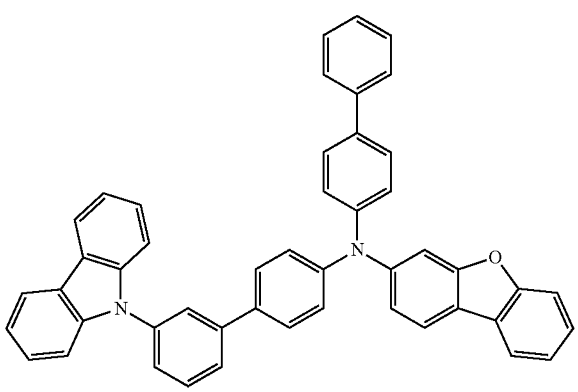
9



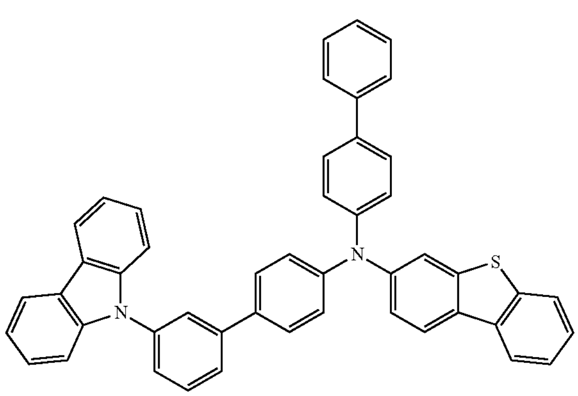
10



11

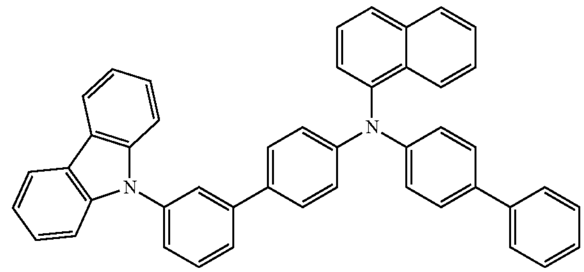


12

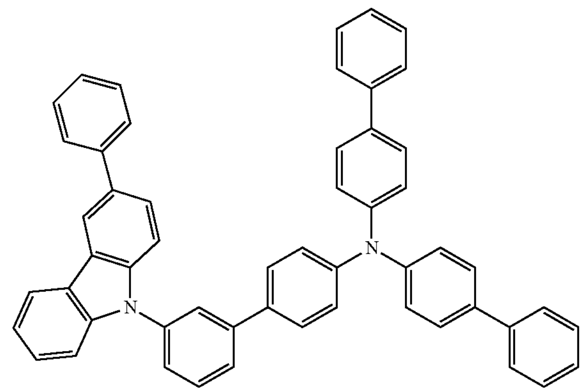


-continued

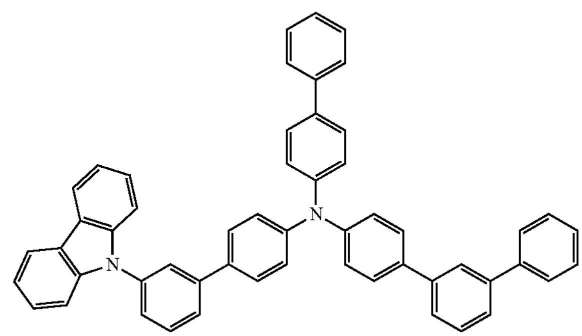
13



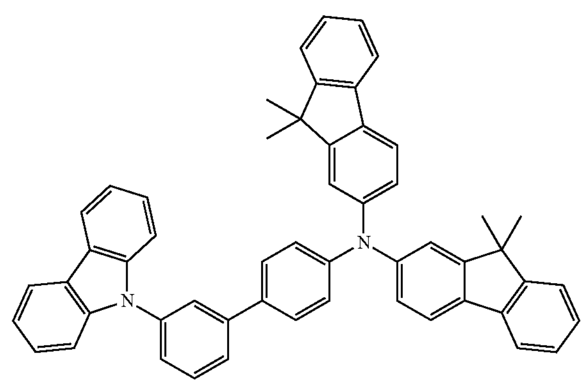
14



15

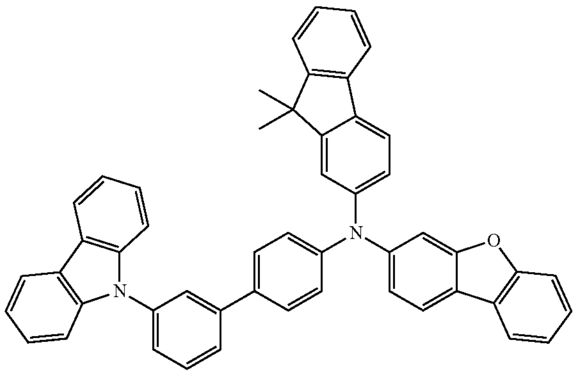


16

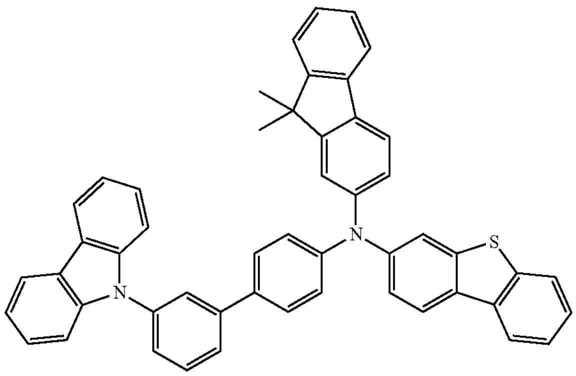


-continued

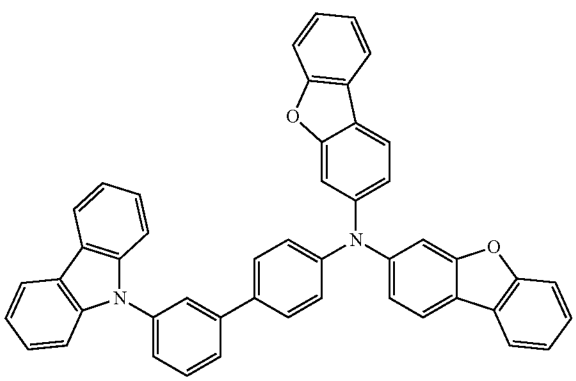
17



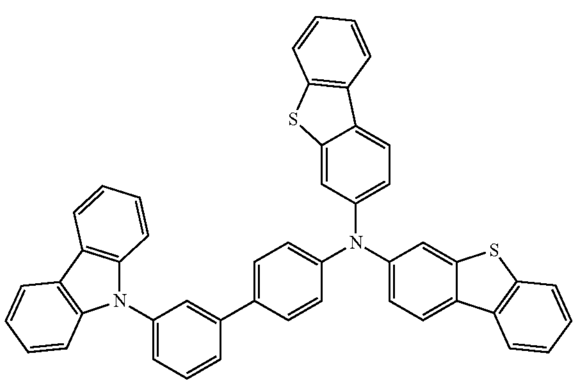
18



19

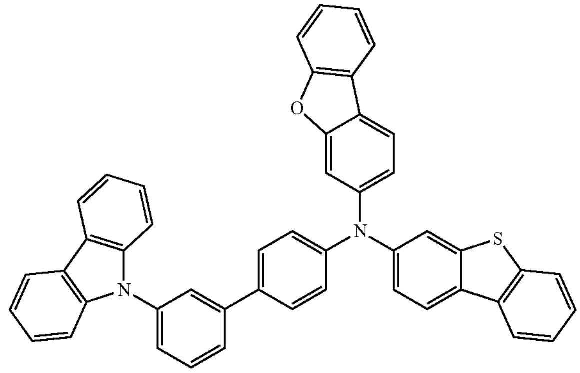


20

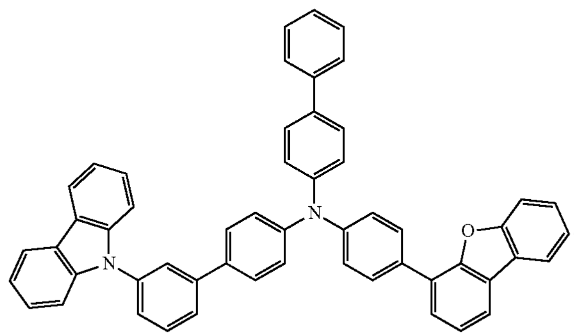


-continued

21

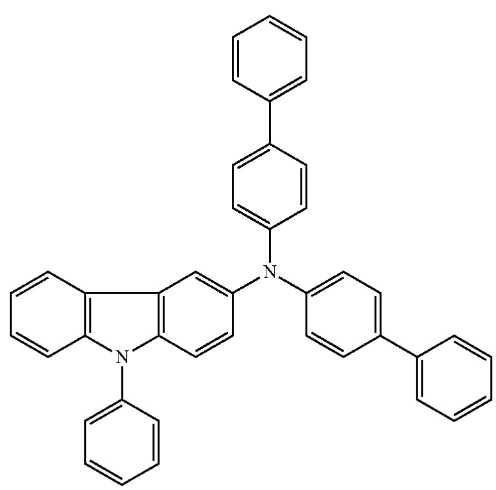


22

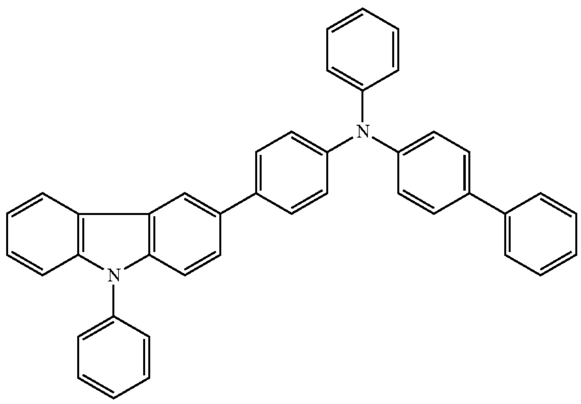


10. The organic EL device as claimed in claim **9**, wherein the third layer includes one of the following Compounds 23 to 38:

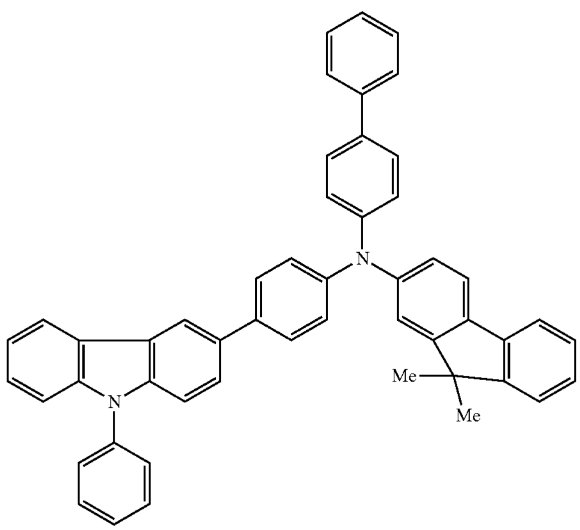
23



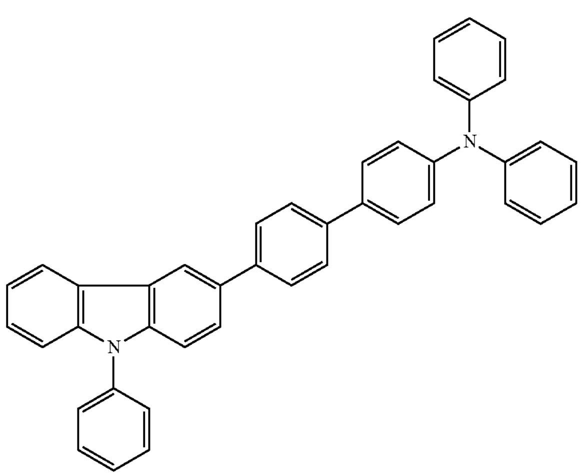
24



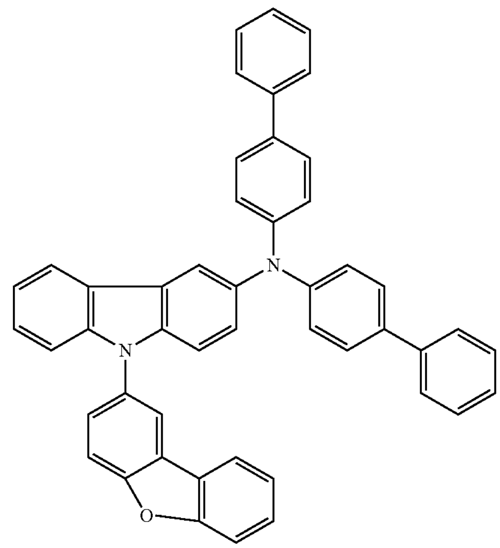
25



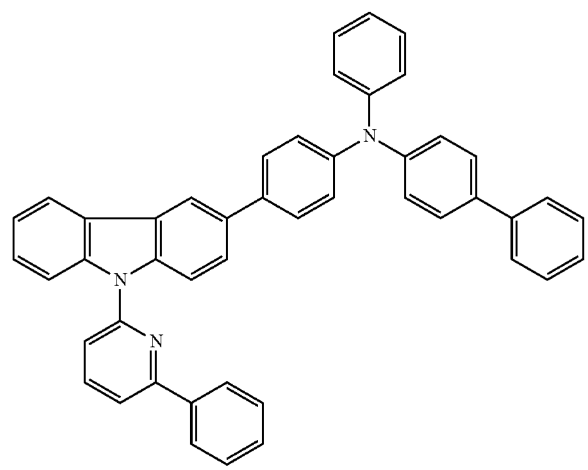
26



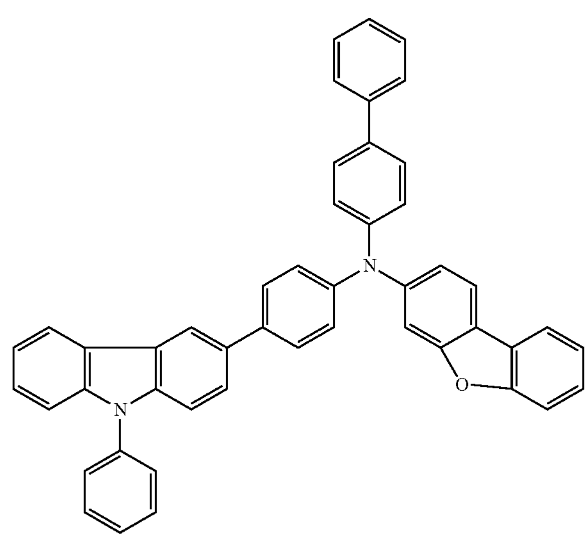
27



28

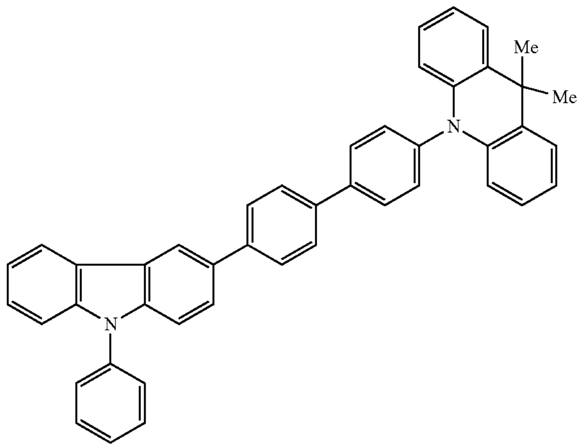


29

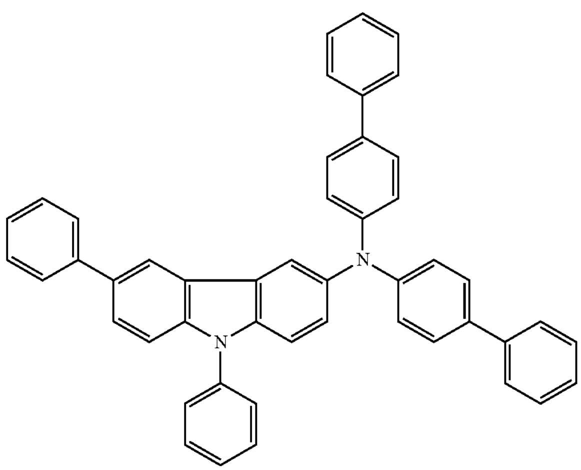


-continued

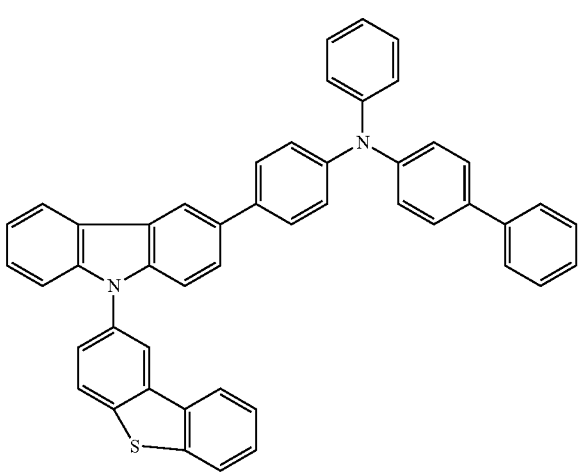
30



31

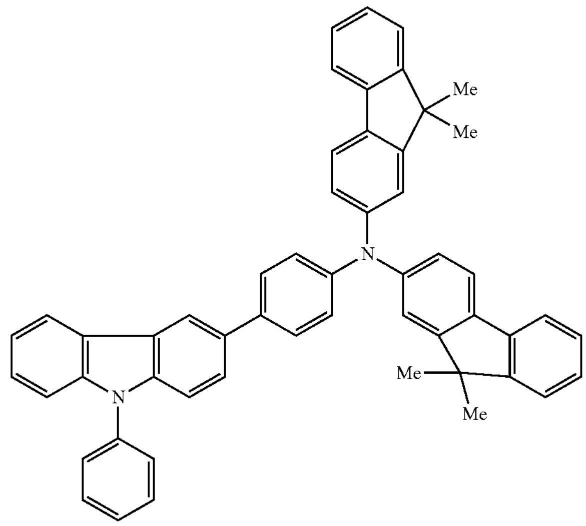


32

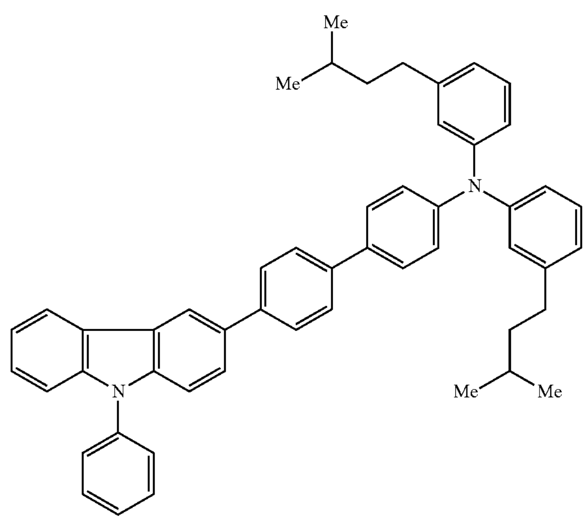


-continued

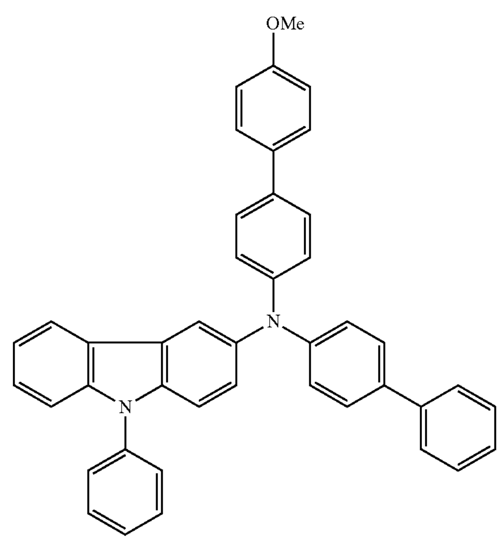
33



34

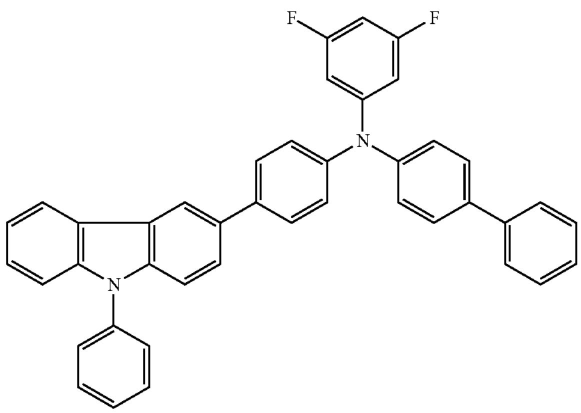


35

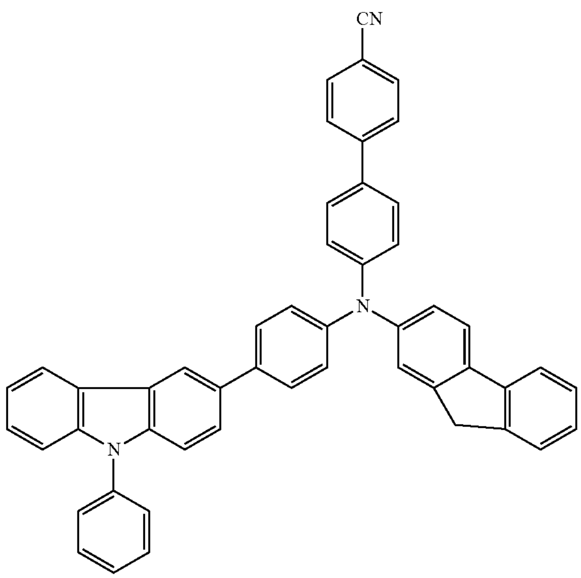


-continued

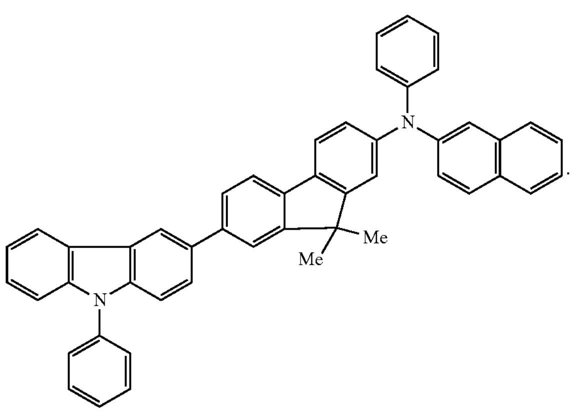
36



37

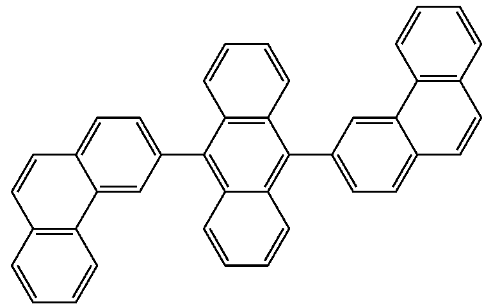


38

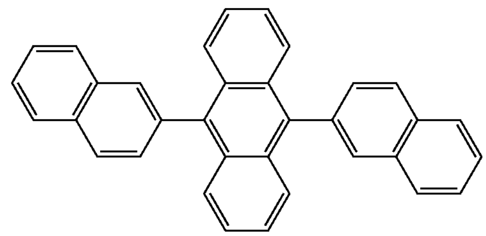


11. The organic EL device as claimed in claim **8**, wherein the anthracene-containing compound includes one of the following Compounds a-1 to a-12:

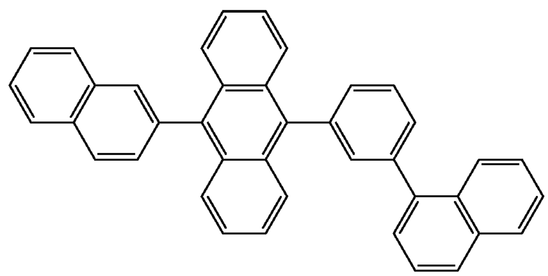
a-1



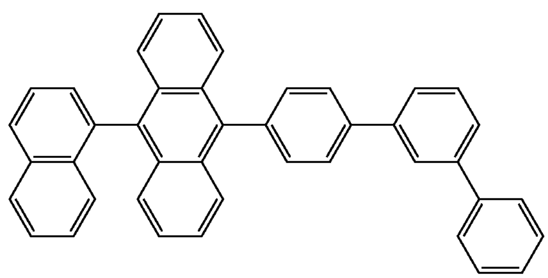
a-2



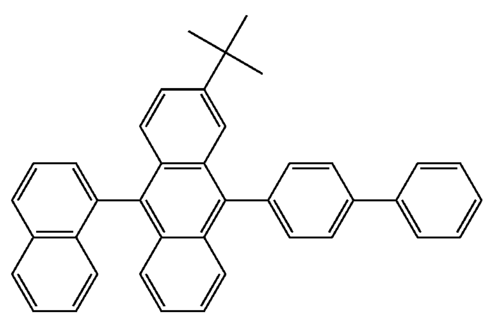
a-3



a-4

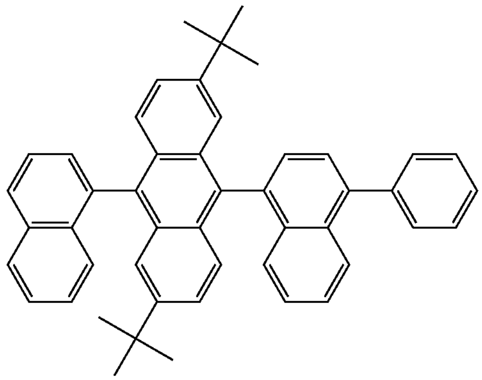


a-5

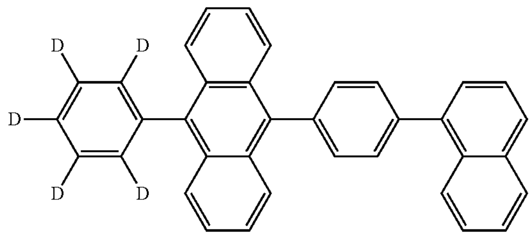


-continued

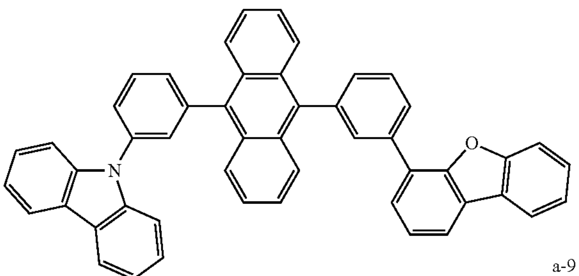
a-6



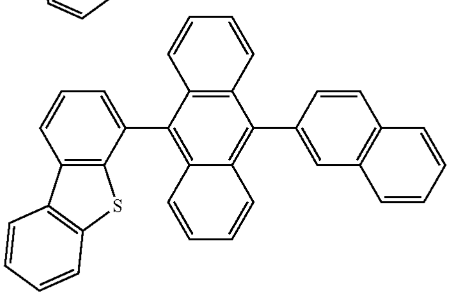
a-7



a-8

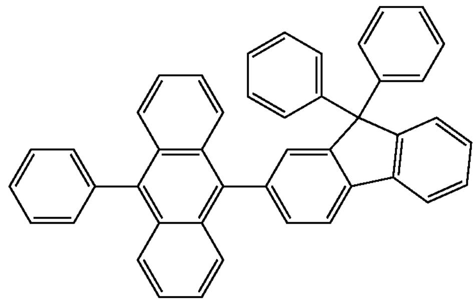


a-9

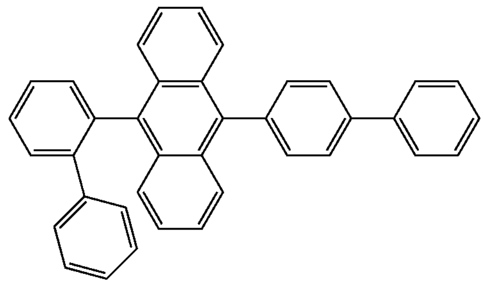


-continued

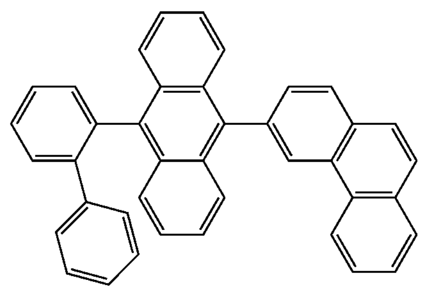
a-10



a-11



a-12



.

* * * * *