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(54) **ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE**

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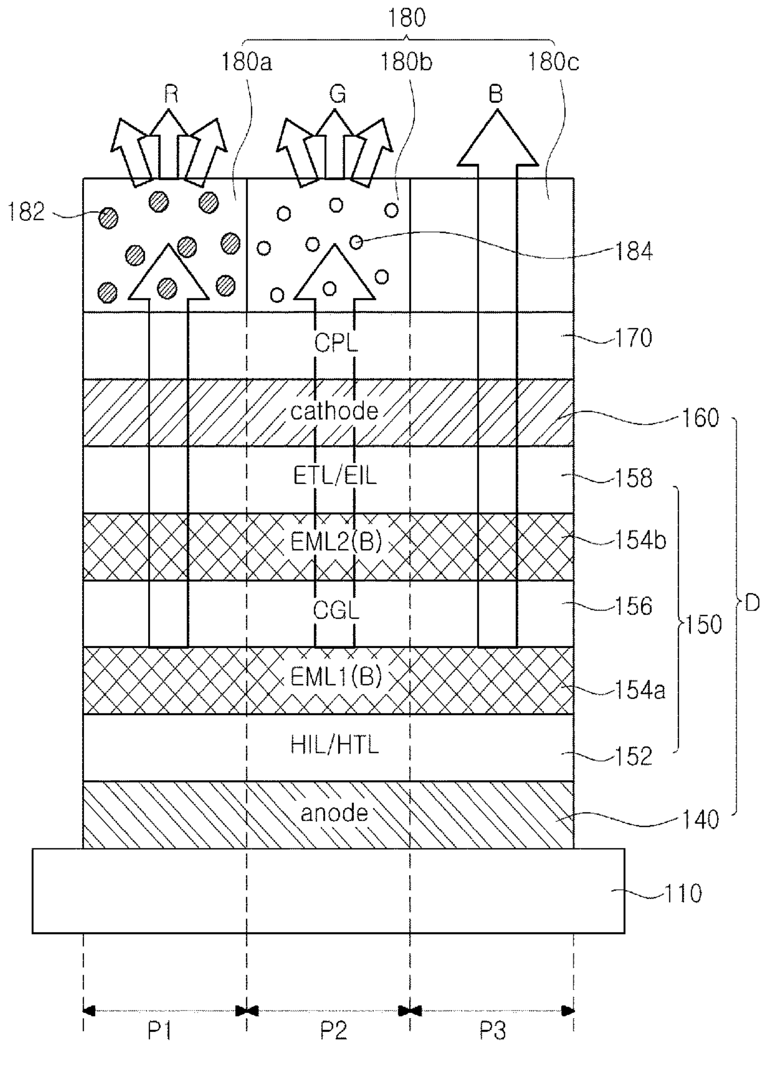
(57) **ABSTRACT**

An organic light emitting diode display device includes a substrate on which first, second and third pixel regions are defined; a first electrode in each of the first, second and third pixel regions on the substrate; a hole auxiliary layer on the first electrode; a first light emitting material layer on the hole auxiliary layer and emitting first light; an electron auxiliary layer on the first light emitting material layer; a second electrode on the electron auxiliary layer; and a color changing layer under the first electrode or on the second electrode, wherein the color changing layer includes first, second and third portions corresponding to the first, second and third pixel regions, respectively, and wherein the first portion absorbs the first light and outputs second light, the second portion absorbs the first light and outputs third light, and the third portion passes the first light as it is.



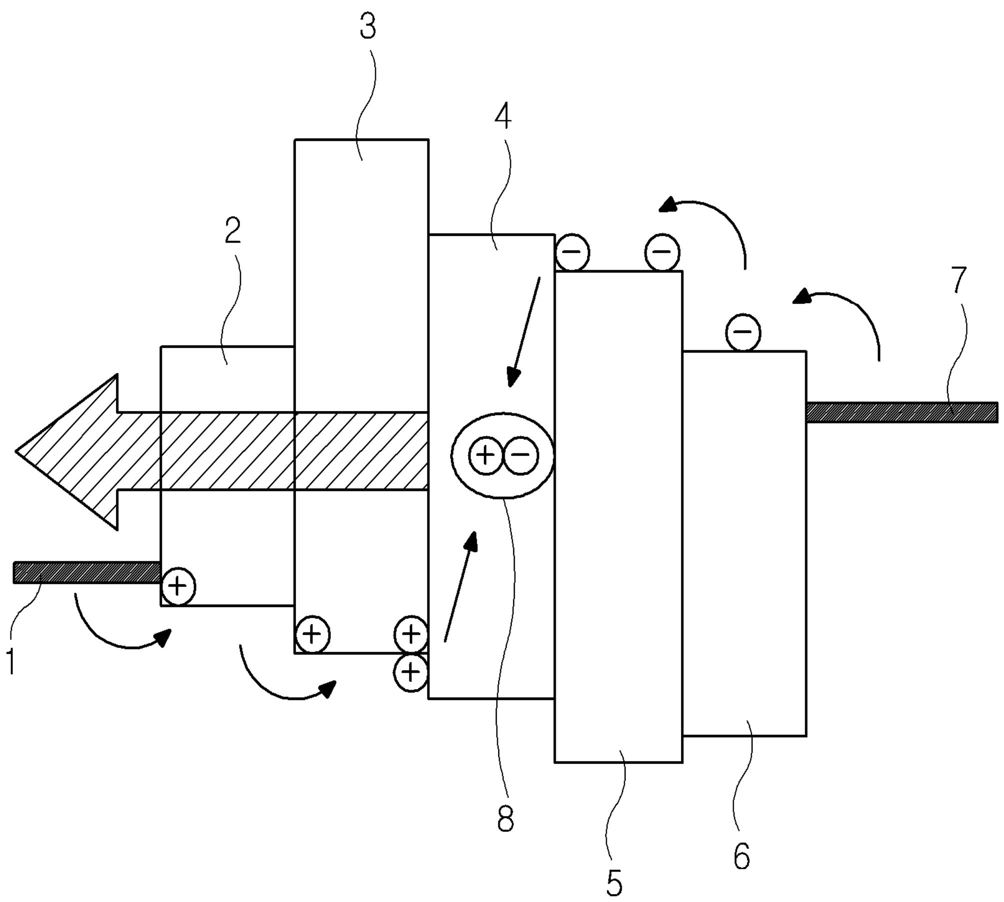


FIG. 1

Related Art

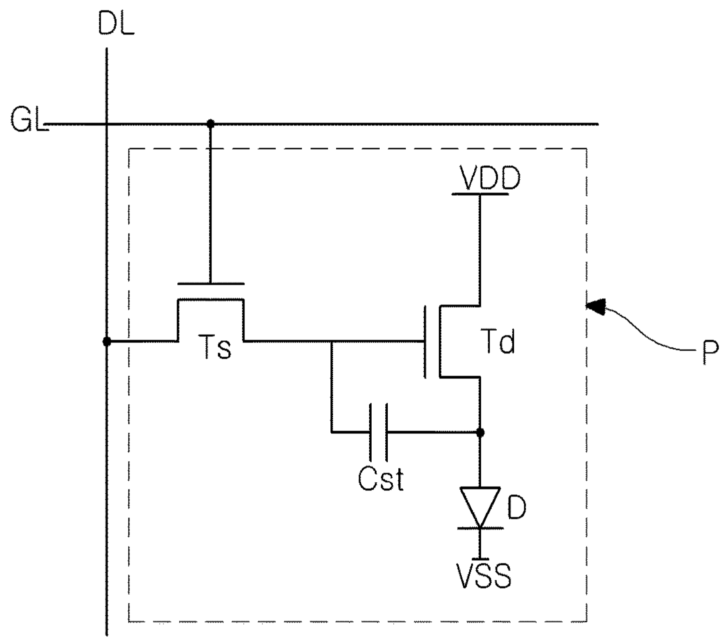

DL
GL
VDD
Ts
Td
P
Cst
D
VSS

FIG. 2

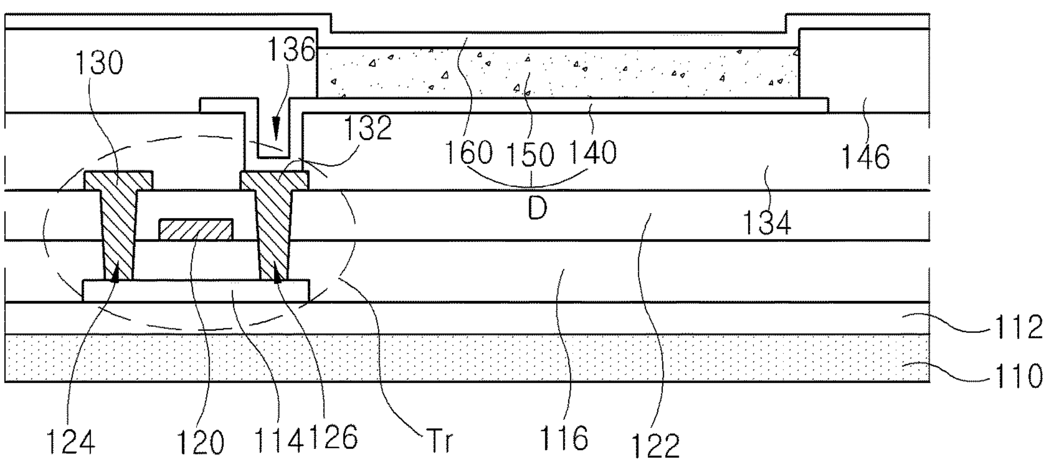

130
136
132
160 150 140
D
146
134
112
110
124
120
114
126
Tr
116
122

FIG. 3

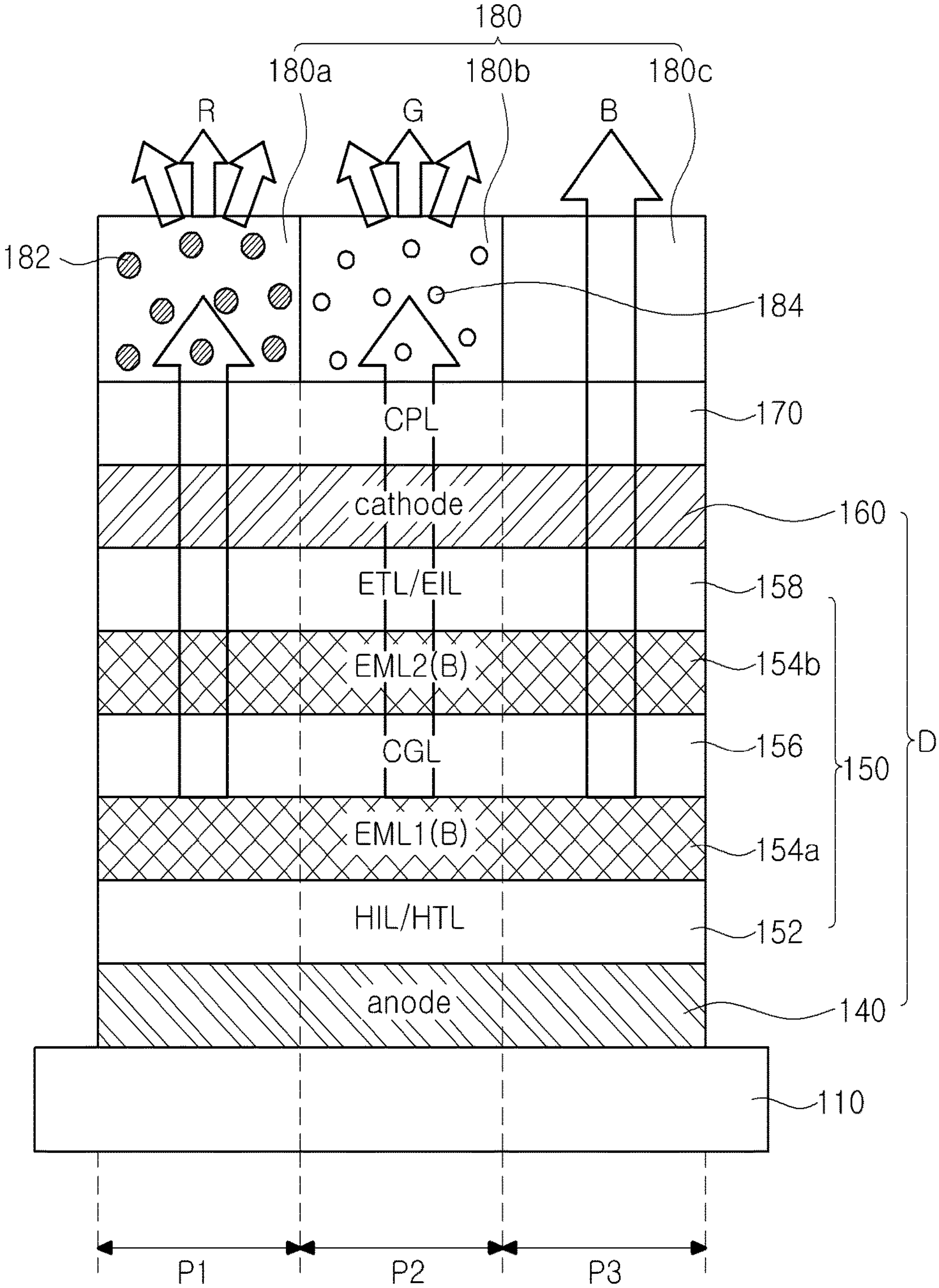

180
180a
180b
180c
R
G
B
182
184
CPL
170
cathode
160
ETL/EIL
158
EML2(B)
154b
CGL
156
150
D
EML1(B)
154a
HIL/HTL
152
anode
140
110
P1
P2
P3

FIG. 4

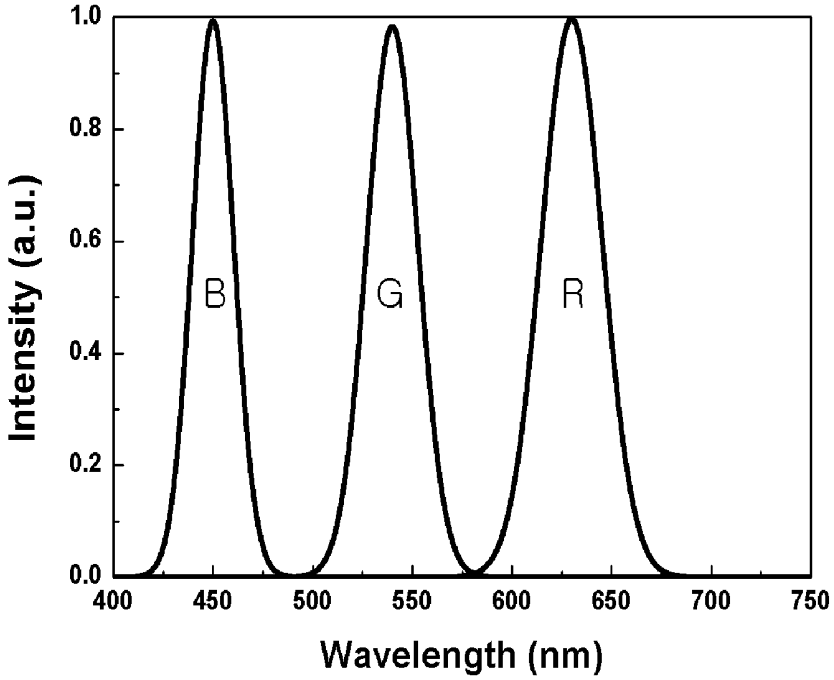

1.0
0.8
0.6
0.4
0.2
0.0
Intensity (a.u.)
B
G
R
400
450
500
550
600
650
700
750
Wavelength (nm)

FIG. 5

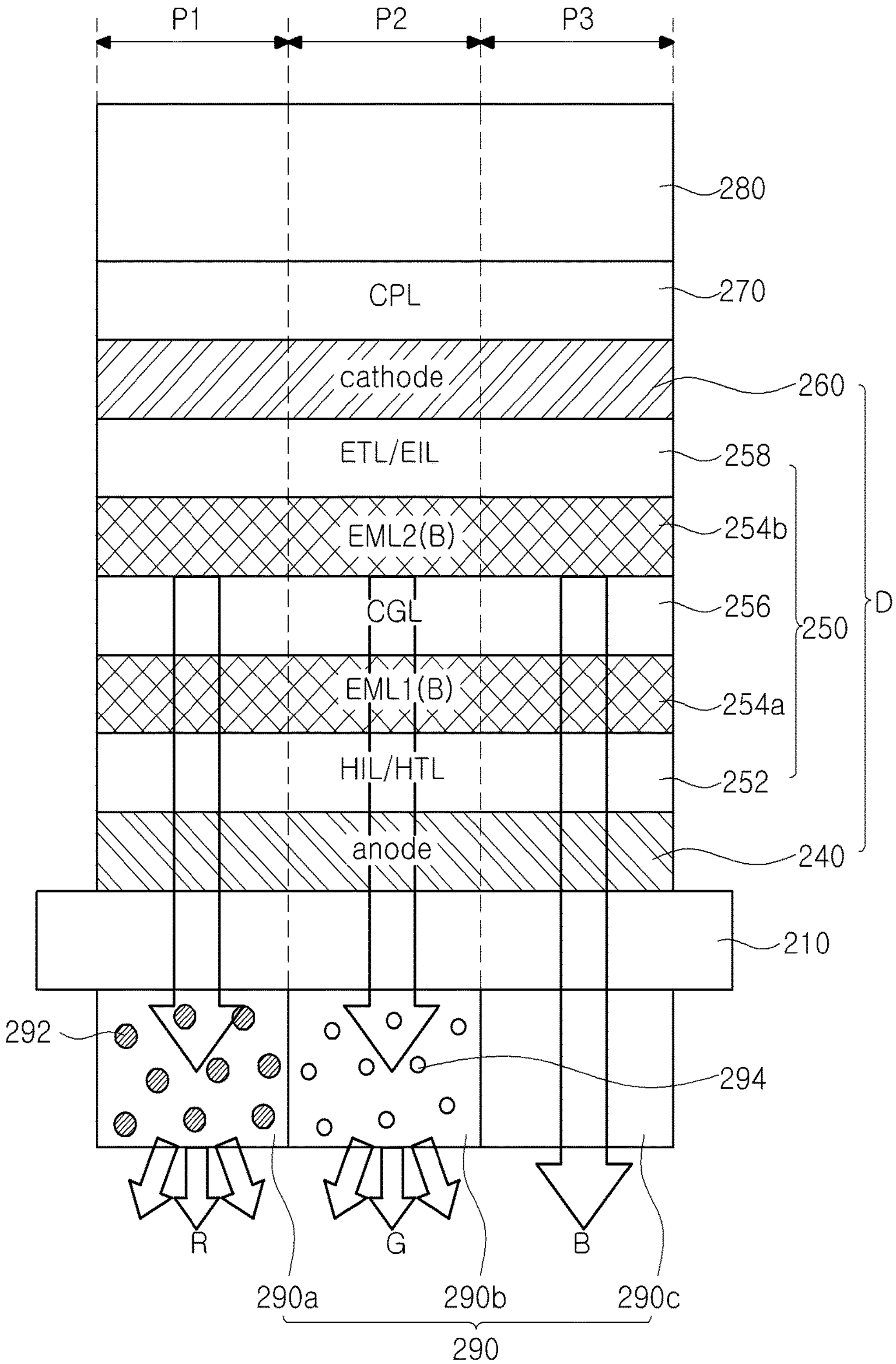

P1
P2
P3
280
CPL
270
cathode
260
ETL/EIL
258
EML2(B)
254b
CGL
256
250
D
EML1(B)
254a
HIL/HTL
252
anode
240
210
292
294
R
G
B
290a
290b
290c
290

FIG. 6

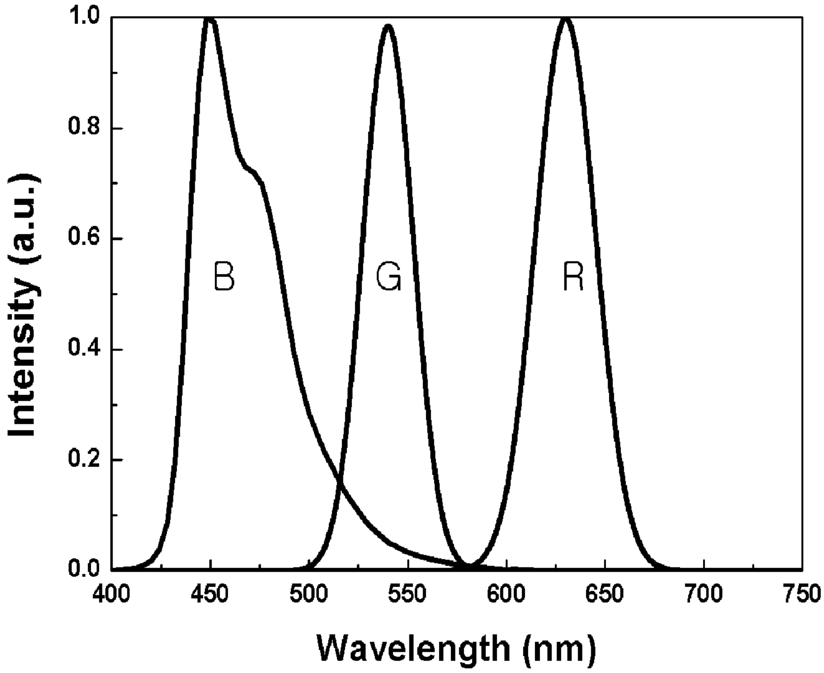

1.0
0.8
0.6
0.4
0.2
0.0
Intensity (a.u.)
B
G
R
400
450
500
550
600
650
700
750
Wavelength (nm)

FIG. 7

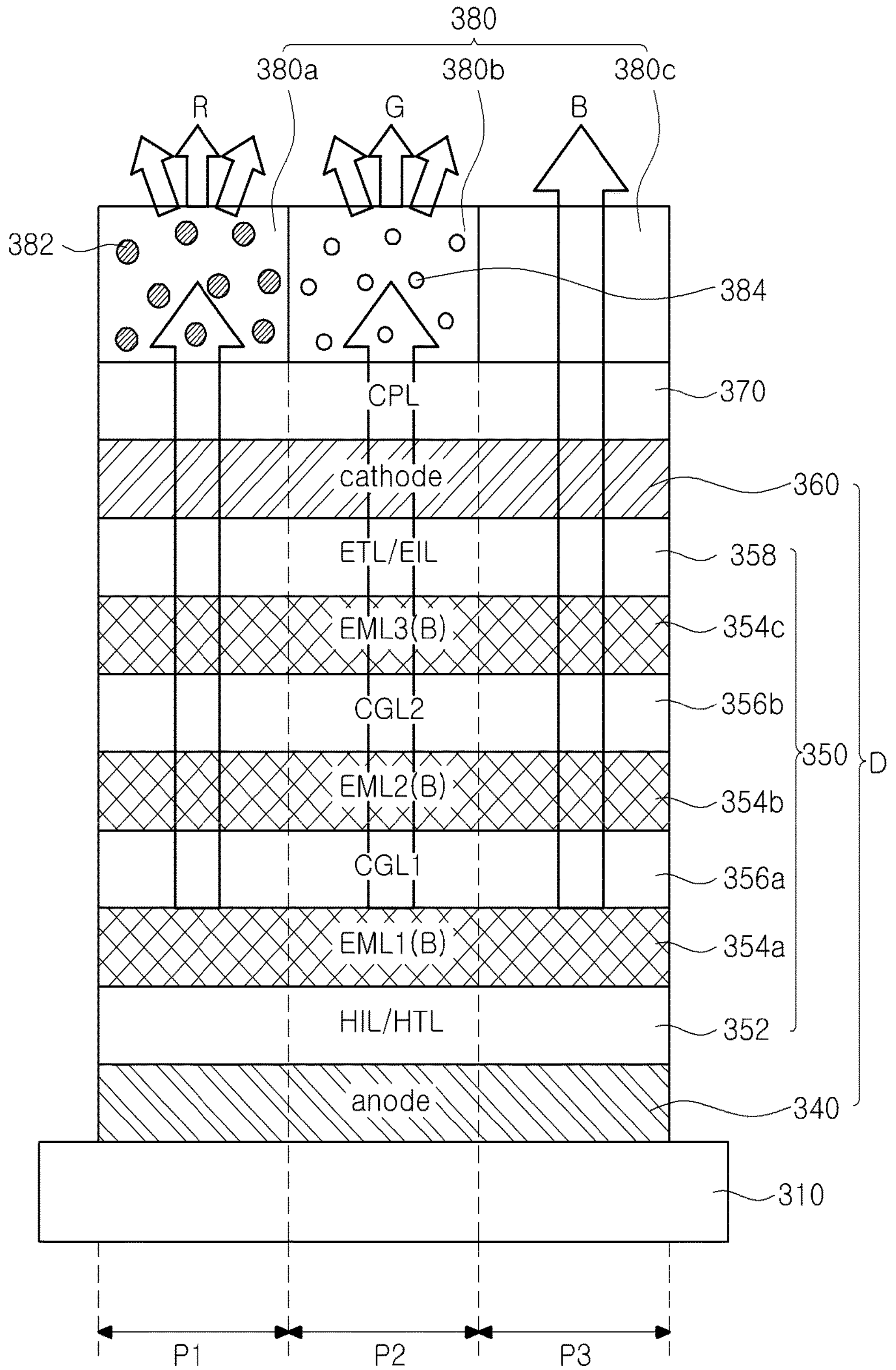

380
380a
380b
380c
R
G
B
382
384
CPL
370
cathode
360
ETL/EIL
358
EML3(B)
354c
CGL2
356b
350
D
EML2(B)
354b
CGL1
356a
EML1(B)
354a
HIL/HTL
352
anode
340
310
P1
P2
P3

FIG. 8

ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority from and the benefit under 35 U.S.C § 119(a) of Korean Patent Application No. 10-2016-0181465 filed on Dec. 28, 2016, which is hereby incorporated by reference in its entirety into the present application.

BACKGROUND OF THE INVENTION

Field of the Disclosure

[0002] The present disclosure relates to an organic light emitting diode display device, and more particularly, to an organic light emitting diode display device capable of improving light efficiency and color gamut.

Discussion of the Related Art

[0003] Recently, flat panel displays have been widely developed and applied to various fields because of their thin profile, light weight, and low power consumption.

[0004] Among the flat panel displays, organic light emitting diode (OLED) display devices, which may be referred to as organic electroluminescent display devices, emit light due to the radiative recombination of an exciton after forming the exciton from an electron and a hole by injecting charges into a light emitting layer between a cathode for injecting electrons and an anode for injecting holes.

[0005] The organic light emitting diode display devices generally include a flexible substrate such as plastic. Since they are self-luminous, the organic light emitting diode display devices have excellent contrast ratios. Further, the organic light emitting diode display devices have a response time of several micro seconds, and thus there are advantages in displaying moving images by such devices. Furthermore, the organic light emitting diode display devices have wide viewing angles and are stable under low temperatures. Since the organic light emitting diode display devices are driven by a low voltage of direct current (DC) 5V to 15V, it is easy to design and manufacture driving circuits. Moreover, the manufacturing processes of the organic light emitting diode display device are simple since only deposition and encapsulation steps are required.

[0006] FIG. **1** is a view of illustrating a band diagram of a related art organic light emitting diode display device.

[0007] In FIG. **1**, the organic light emitting diode display device includes an anode **1**, a cathode **7** and a light emitting material layer **4** between the anode **1** and the cathode **7**. A hole transporting layer (HTL) **3** is disposed between the anode **1** and the light emitting material layer **4** for injecting holes into the light emitting material layer **4**, and an electron transporting layer (ETL) **5** is disposed between the cathode **7** and the light emitting material layer **4** for injecting electrodes into the light emitting material layer **4**. At this time, to further efficiently inject the holes and the electrons, a hole injecting layer (HIL) **2** may be disposed between the anode **1** and the hole transporting layer **3**, and an electron injecting layer (EIL) **6** may be disposed between the cathode **7** and the electron transporting layer **5**.

[0008] In the organic light emitting diode display device having the above-mentioned structure, a hole (+) injected into the light emitting material layer **4** through the hole injecting layer **2** and the hole transporting layer **3** from the anode **1** is combined with an electron (−) injected into the light emitting material layer **4** through the electron injecting layer **6** and the electron transporting layer **5** from the cathode **7**, whereby an exciton **8** is generated and light is emitted from the exciton **8**. Here, the light has a color corresponding to a band gap of the light emitting material layer **4**.

[0009] The organic light emitting diode display devices can be classified into a bottom emission type, a top emission type and a both side emission type according to an output direction of light emitted from the light emitting material layer **4**. The light emitted from the light emitting material layer **4** can be outputted to the outside through the anode **1** in the bottom emission type, can be outputted to the outside through the cathode **7** in the top emission type, and can be outputted to the outside through both the anode **1** and the cathode **7**.

[0010] In the organic light emitting diode display device, one pixel includes red, green and blue sub pixels, and the red, green and blue sub pixels include the light emitting material layers **4** emitting red, green and blue light, respectively. The light emitted from the sub pixels is mixed to thereby display an image.

[0011] However, the related art organic light emitting diode display device has a problem that color gamut is low due to low color purity. At this time, to increase the color purity, a microcavity effect can be applied, and viewing angle becomes narrow.

[0012] In addition, the light emitting material layers **4** emitting red, green and blue light are formed of different materials and have different properties. Accordingly, the related art organic light emitting diode display device also has a problem that the red, green and blue sub pixels have different luminous efficiencies and different lifetimes.

SUMMARY OF THE INVENTION

[0013] Accordingly, the present disclosure is directed to an organic light emitting diode display device that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0014] An object of the present disclosure is to provide an organic light emitting diode display device having wide color gamut.

[0015] Another object of the present disclosure is to provide an organic light emitting diode display device including sub pixels, which have uniform luminous efficiencies and lifetimes.

[0016] Additional features and advantages of the present disclosure will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the present disclosure. The objectives and other advantages of the present disclosure will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0017] To achieve these and other advantages and in accordance with the purpose of the present disclosure, as embodied and broadly described herein, there is provided an organic light emitting diode display device that includes a substrate on which first, second and third pixel regions are defined; a first electrode in each of the first, second and third pixel regions on the substrate; a hole auxiliary layer on the first electrode; a first light emitting material layer on the hole auxiliary layer and emitting first light; an electron auxiliary layer on the first light emitting material layer; a second electrode on the electron auxiliary layer; and a color changing layer under the first electrode or on the second electrode, wherein the color changing layer includes first, second and third portions corresponding to the first, second and third pixel regions, respectively, and wherein the first portion absorbs the first light and outputs second light, the second portion absorbs the first light and outputs third light, and the third portion passes the first light as it is.

[0018] It is to be understood that both the foregoing general description and the following detailed description are by example and explanatory and are intended to provide further explanation of the present disclosure as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The accompanying drawings, which are included to provide a further understanding of the present disclosure and which are incorporated in and constitute a part of this specification, illustrate embodiments of the present disclosure and together with the description serve to explain the principles of the present disclosure. In the drawings:

[0020] FIG. **1** is a view of illustrating a band diagram of a related art organic light emitting diode display device.

[0021] FIG. **2** is a circuit diagram of one pixel region of an organic light emitting diode display device according to an embodiment of the present disclosure.

[0022] FIG. **3** is a cross-sectional view of an organic light emitting diode display device according to the embodiment of the present disclosure.

[0023] FIG. **4** is a schematic cross-sectional view of an organic light emitting diode display device according to a first embodiment of the present disclosure.

[0024] FIG. **5** is a view showing the spectrum of light emitted from the organic light emitting diode display device according to the first embodiment of the present disclosure.

[0025] FIG. **6** is a schematic cross-sectional view of an organic light emitting diode display device according to a second embodiment of the present disclosure.

[0026] FIG. **7** is a view showing the spectrum of light emitted from the organic light emitting diode display device according to the second embodiment of the present disclosure.

[0027] FIG. **8** is a schematic cross-sectional view of an organic light emitting diode display device according to a third embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0028] Reference will now be made in detail to embodiments of the disclosure, examples of which are illustrated in the accompanying drawings.

[0029] FIG. **2** is a circuit diagram of one pixel region of an organic light emitting diode display device according to an embodiment of the present disclosure. All the components of the organic light emitting diode display device according to all embodiments of the present disclosure are operatively coupled and configured.

[0030] In FIG. **2**, the organic light emitting diode display device according to the embodiment of the present disclosure includes a gate line GL, a data line DL, a switching thin film transistor Ts, a driving thin film transistor Td, a storage capacitor Cst and a light emitting diode D. The gate line GL and the data line DL cross each other to define a pixel region P. The switching thin film transistor Ts, the driving thin film transistor Td, the storage capacitor Cst and the light emitting diode D are formed in the pixel region P. The organic light emitting diode display device has a plurality of such pixel regions Ps.

[0031] More particularly, a gate electrode of the switching thin film transistor Ts is connected to the gate line GL and a source electrode of the switching thin film transistor Ts is connected to the data line DL. A gate electrode of the driving thin film transistor Td is connected to a drain electrode of the switching thin film transistor Ts, and a source electrode of the driving thin film transistor Td is connected to a high voltage supply VDD. An anode of the light emitting diode D is connected to a drain electrode of the driving thin film transistor Td, and a cathode of the light emitting diode D is connected to a low voltage supply VSS. The storage capacitor Cst is connected to the gate electrode and the drain electrode of the driving thin film transistor Td.

[0032] The organic light emitting diode display device is driven to display an image. For example, when the switching thin film transistor Ts is turned on by a gate signal applied through the gate line GL, a data signal from the data line DL is applied to the gate electrode of the driving thin film transistor Td and an electrode of the storage capacitor Cst through the switching thin film transistor Ts. When the driving thin film transistor Td is turned on by the data signal, an electric current flowing through the light emitting diode D is controlled, thereby displaying an image. The light emitting diode D emits light due to the current supplied through the driving thin film transistor Td from the high voltage supply VDD.

[0033] Namely, the amount of the current flowing through the light emitting diode D is proportional to the magnitude of the data signal, and the intensity of light emitted by the light emitting diode D is proportional to the amount of the current flowing through the light emitting diode D. Thus, the pixel regions P show different gray levels depending on the magnitude of the data signal, and as a result, the organic light emitting diode display device displays an image.

[0034] In addition, the storage capacitor Cst maintains charges corresponding to the data signal for a frame when the switching thin film transistor Ts is turned off. Accordingly, even if the switching thin film transistor Ts is turned off, the storage capacitor Cst allows the amount of the current flowing through the light emitting diode D to be constant and the gray level shown by the light emitting diode D to be maintained until a next frame.

[0035] Meanwhile, in each of the pixel regions Ps, one or more transistors and/or capacitors may be added in addition to the switching thin film transistor Ts, the driving thin film transistor Td and the storage capacitor Cst.

[0036] FIG. **3** is a cross-sectional view of an organic light emitting diode display device according to the embodiment of the present disclosure and shows one pixel region. However, the organic light emitting diode display device of FIG. **3** obviously includes a plurality of such pixel regions.

[0037] As shown in FIG. **3**, the organic light emitting diode device according to the embodiment of the present disclosure can include a substrate **110**, a thin film transistor Tr disposed on the substrate **110**, and a light emitting diode D disposed on the substrate **110** and connected to the thin film transistor Tr. An encapsulation layer can be disposed on the light emitting diode D.

[0038] The substrate **110** can be a glass substrate or a flexible substrate formed of a polymer such as polyimide.

[0039] A buffer layer **112** can be formed on the substrate **110**, and the thin film transistor Tr can be formed on the buffer layer **112**. The buffer layer **112** can be formed of an inorganic insulating material such as silicon oxide (SiO_2) and silicon nitride (SiNx). The buffer layer **112** can be omitted.

[0040] A semiconductor layer **114** is formed on the buffer layer **112**. The semiconductor layer **114** can be formed of an oxide semiconductor material or polycrystalline silicon. When the semiconductor layer **114** is formed of the oxide semiconductor material, a light-blocking pattern can be formed under the semiconductor layer **114**. The light-blocking pattern blocks light from being incident on the semiconductor layer **114** to prevent the semiconductor layer **114** from being degraded by the light. Alternatively, the semiconductor layer **114** can be formed of polycrystalline silicon, and in this instance, impurities can be doped in both ends of the semiconductor layer **114**.

[0041] A gate insulating layer **116** of an insulating material is formed on the semiconductor layer **114**. The gate insulating layer **116** can be formed of an inorganic insulating material such as silicon oxide (SiO_2) and silicon nitride (SiNx).

[0042] A gate electrode **120** of a conductive material such as metal can be formed on the gate insulating layer **116** to correspond to a central portion of the semiconductor layer **114**.

[0043] In FIG. **3**, the gate insulating layer **116** is formed over substantially all of the substrate **110**. Alternatively, the gate insulating layer **116** can be patterned to have the same shape as the gate electrode **120**.

[0044] An interlayer insulating layer **122** of an insulating material is formed on the gate electrode **120**. The interlayer insulating layer **122** can be formed over substantially all of the substrate **110**. The interlayer insulating layer **122** can be formed of an inorganic insulating material such as silicon oxide (SiO_2) and silicon nitride (SiNx) or an organic insulating material such as benzocyclobutene and photo acryl.

[0045] The interlayer insulating layer **122** includes first and second contact holes **124** and **126** exposing top surfaces of both sides of the semiconductor layer **114**. The first and second contact holes **124** and **126** are spaced apart from the gate electrode **120**. The gate electrode **120** can be disposed between the first and second contact holes **124** and **126**.

[0046] The first and second contact holes **124** and **126** are also formed in the gate insulating layer **116**. Alternatively, when the gate insulating layer **116** is patterned to have the same shape as the gate electrode **120**, the first and second contact holes **124** and **126** are formed only in the interlayer insulating layer **122**.

[0047] A source electrode **130** and a drain electrode **132** of a conductive material such as metal are formed on the interlayer insulating layer **122**.

[0048] The source and drain electrodes **130** and **132** are spaced apart from each other with respect to the gate electrode **120**. The source and drain electrodes **130** and **132** contact both sides of the semiconductor layer **114** through the first and second contact holes **124** and **126**, respectively.

[0049] In the organic light emitting diode display device, a thin film transistor Tr includes the semiconductor layer **114**, the gate electrode **120**, the source electrode **130** and the drain electrode **132**. The thin film transistor Tr functions as a driving element and corresponds to the driving thin film transistor Td of FIG. **2**.

[0050] The thin film transistor Tr can have a coplanar structure where the gate electrode **120** and the source and drain electrodes **130** and **132** are disposed at one side of the semiconductor layer **114**, over the semiconductor layer **114**.

[0051] Alternatively, the thin film transistor Tr can have an inverted staggered structure where the gate electrode is disposed under the semiconductor layer and the source and drain electrodes are disposed over the semiconductor layer. In this instance, the semiconductor layer can be formed of amorphous silicon.

[0052] A gate line and a data line cross each other to define a pixel region, and a switching element is connected to the gate line and the data line. The switching element is also connected to the thin film transistor Tr of the driving element. The switching element can have the same structure as the thin film transistor Tr.

[0053] In addition, a power line can be further formed in parallel to and apart from the gate line or the data line, and a storage capacitor can be further formed to constantly maintain a voltage at the gate electrode of the thin film transistor Tr during one frame.

[0054] A passivation layer **134** is formed on the source and drain electrodes **130** and **132**. The passivation layer **134** can be formed over substantially all of the substrate **110**. The passivation layer **134** covers the thin film transistor Tr and has a drain contact hole **136** exposing the drain electrode **132**. The passivation layer **134** can be formed of an inorganic insulating material such as silicon oxide (SiO_2) and silicon nitride (SiNx) or an organic insulating material such as benzocyclobutene and photo acryl. The passivation layer **134** can have a flat top surface.

[0055] In FIG. **3**, although the drain contact hole **136** is formed directly over the second contact hole **126**, the drain contact hole **136** can be spaced apart from the second contact hole **126**.

[0056] A first electrode **140** is formed on the passivation layer **134** and is connected to the drain electrode **132** of the thin film transistor Tr through the drain contact hole **136**. The first electrode **140** is separately disposed in each pixel region. The first electrode **140** can be an anode and can be formed of a conductive material having a relatively high work function. For example, the first electrode **140** can be formed of a transparent conductive material such as indium tin oxide (ITO) and indium zinc oxide (IZO).

[0057] A bank layer **146** is formed on the first electrode **140** and the passivation layer **134**. The bank layer **146** covers edges of the first electrode **140**. The bank layer **146** exposes a central portion of the first electrode **140** corresponding to the pixel region.

[0058] A light emitting layer **150** is formed on the first electrode **140** exposed by the bank layer **146**. A structure of the light emitting layer **150** will be described in detail later.

[0059] A second electrode **160** is formed over the substrate **110** on which the light emitting layer **150** is formed. The second electrode **160** can be formed over substantially all of a display area. The second electrode **160** can be formed of a conductive material having relatively low work function and can serve as a cathode. For example, the second electrode **160** can be formed of aluminum (Al), magnesium (Mg), silver (Ag) or their alloy, but is not limited to this.

[0060] The first electrode **140**, the light emitting layer **150** and the second electrode **160** constitute a light emitting diode D.

[0061] The organic light emitting diode display device can be a bottom emission type where light emitted from the light emitting layer **150** is outputted to the outside through the first electrode **140**.

[0062] Alternatively, the organic light emitting diode display device according to the present disclosure can be a top emission type where light emitted from the light emitting layer **150** is outputted to the outside through the second electrode **160**. In this case, the first electrode **140** can further include a reflection electrode or reflection layer under the first electrode **140**. For example, the reflection electrode or reflection layer can be formed of aluminum-palladium-copper (APC) alloy. At this time, the second electrode **160** can have a relatively thin thickness such that light is transmitted therethrough.

First Embodiment

[0063] FIG. **4** is a schematic cross-sectional view of an organic light emitting diode display device according to a first embodiment of the present disclosure and shows a pixel. However, the organic light emitting diode display device of FIG. **4** obviously includes a plurality of pixels or pixel regions.

[0064] In FIG. **4**, first, second and third pixel regions P**1**, P**2** and P**3** are defined on a substrate **110**. A light emitting diode D is disposed in each pixel region P**1**, P**2** and P**3**. The first, second and third pixel regions P**1**, P**2** and P**3** correspond to red, green and blue sub pixels, respectively.

[0065] The light emitting diode D includes a first electrode **140**, a light emitting layer **150** and a second electrode **160**. The light emitting layer **150** includes a hole auxiliary layer **152**, a first light emitting material layer **154***a*, a charge generation layer **156**, a second light emitting material layer **154***b*, and an electron auxiliary layer **158**.

[0066] More particularly, the first electrode **140** is formed in each of the first, second and third pixel regions P**1**, P**2** and P**3** as an anode. In the figure, although the first electrodes **140** in the first, second and third pixel regions P**1**, P**2** and P**3** are connected to each other, the first electrodes **140** in the first, second and third pixel regions P**1**, P**2** and P**3** are separated from each other.

[0067] The first electrode **140** can be formed of a transparent conductive material such as indium tin oxide (ITO) and indium zinc oxide (IZO). In addition, a reflection electrode or a reflection layer can be further formed under the first electrode **140**. For example, the reflection electrode or the reflection layer can be formed of aluminum-palladium-copper (APC) alloy.

[0068] Meanwhile, the first electrode **140** can include a reflection electrode, and in this case, the first electrode **140** can have a triple-layered structure of ITO/APC/ITO.

[0069] The hole auxiliary layer **152** is formed on the first electrode **140** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The hole auxiliary layer **152** can include at least one of a hole injecting layer (HIL) and a hole transporting layer (HTL). Here, the hole auxiliary layers **152** in the first, second and third pixel regions P**1**, P**2** and P**3** are formed of the same material, have the same structure and have the same thickness.

[0070] The hole auxiliary layer **152** in one pixel region P**1**, P**2** and P**3** can be connected to another hole auxiliary layer **152** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the hole auxiliary layer **152** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0071] The hole auxiliary layer **152** can be formed through a vacuum evaporation process. Alternatively, the hole auxiliary layer **152** can be formed through a soluble process.

[0072] The first light emitting material layer **154***a* is formed on the hole auxiliary layer **152** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The first light emitting material layer **154***a* includes a blue light emitting material emitting blue light.

[0073] The first light emitting material layer **154***a* in one pixel region P**1**, P**2** and P**3** can be connected to another first light emitting material layer **154***a* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the first light emitting material layer **154***a* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0074] The first light emitting material layer **154***a* can be formed through a vacuum evaporation process. At this time, the first light emitting material layer **154***a* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0075] Alternatively, the first light emitting material layer **154***a* can be formed through a soluble process. At this time, the first light emitting material layer **154***a* can include poly(N-vinylcarbazole), polyphenylphenyl dendron, or conjugated triphenylene polymers as a dopant, but is not limited to this.

[0076] The charge generation layer (CGL) **156** is formed on the first light emitting material layer **154***a* in each of the first, second and third pixel regions P**1**, P**2** and P**3**.

[0077] The charge generation layer **156** generates and provides electrons and holes. The charge generation layer **156** can have a PN junction structure in which an N-type charge generation layer and a p-type charge generation layer are bonded. At this time, the N-type charge generation layer is disposed over the first light emitting material layer **154***a* and the P-type charge generation layer.

[0078] Meanwhile, a metal layer can be further formed between the N-type charge generation layer and the P-type charge generation layer. Preferably, the metal layer has a thickness of 4 nm or less. For example, the metal layer can be formed of aluminum (Al) or silver (Ag), but is not limited to this.

[0079] The charge generation layer **156** can be formed through a vacuum evaporation process. At this time, the N-type charge generation layer can have a single layer structure of an electron transporting material doped with an electron injecting material or a double layer structure in which an electron injecting material and an electron transporting material are sequentially stacked, but is not limited to this. The P-type charge generation layer can have a single layer structure of a hole transporting material doped with a hole injecting material or a double layer structure in which a hole transporting material and a hole injecting material are sequentially stacked, but is not limited to this. For example, LiF, CsCO3, NaF, Ca, Ba, Na, Li, LiQ and the like can be used as the electron injecting material, and BPhen, TPBi, B3PyPB, BCP and the like can be used as the electron transporting material, but are not limited to this. In addition, TAPC, TCTA, NPB, NPD and the like can be used as the hole transporting material, and MoO3, WO3, V2O5, ReO3, HATCN, F4TCNQ and the like can be used as the hole injecting material, but are not limited to this.

[0080] Alternatively, the charge generation layer **156** can be formed through a soluble process. At this time, PEDOT:PSS, PMA/TFB, WO3/PEDOT:PSS and the like can be used as the charge generation layer **156**.

[0081] The second light emitting material layer **154***b* is formed on the charge generation layer **156** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The second light emitting material layer **154***b* is formed of a blue light emitting material emitting blue light.

[0082] The second light emitting material layer **154***b* in one pixel region P**1**, P**2** and P**3** can be connected to another second light emitting material layer **154***b* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the second light emitting material layer **154***b* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0083] The second light emitting material layer **154***b* can be formed through a vacuum evaporation process. At this time, the second light emitting material layer **154***b* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0084] A thickness of the second light emitting material layer **154***b* is equal to or smaller than a thickness of the first light emitting material layer **154***a*. For example, the thickness of the first light emitting material layer **154***a* can be 20 nm to 60 nm, and the thickness of the second light emitting material layer **154***b* can be 20 nm to 30 nm, but is not limited to this.

[0085] In the meantime, a buffer layer can be further formed between the first light emitting material layer **154***a* and the charge generation layer **156** or between the charge generation layer **156** and the second light emitting material layer **154***b*. The buffer layer is formed through a vacuum evaporation process and increases the mobility of charges at an interface between a layer formed through a soluble process and a layer through a vacuum evaporation process.

[0086] Accordingly, when the first light emitting material layer **154***a* is formed through the soluble process and the charge generation layer **156** is formed through the vacuum evaporation process, the buffer layer is disposed between the first light emitting material layer **154***a* and the charge generation layer **156**.

[0087] Alternatively, when the first light emitting material layer **154***a* and the charge generation layer **156** are formed through the soluble process, the buffer layer is disposed between the charge generation layer **156** and the second light emitting material layer **154***b*, which is formed through the vacuum evaporation process.

[0088] The buffer layer can be formed of a bipolar compound, and the bipolar compound can be a monomolecular material having both electron properties and hole properties. More specifically, the bipolar compound is a material in which an electron-affinity core and a hole-affinity core are synthesized as a compound. For example, the bipolar compound can include an arylamine group and one of a heteroaryl group, a silicon group having an aromatic substituent and a sulfonyl group in a molecule, but is not limited to this.

[0089] The buffer layer has a relatively thin thickness of 1 nm to 5 nm, and beneficially, 1 nm to 3 nm.

[0090] In addition, an electron transporting layer can be further formed between the first light emitting material layer **154***a* and the charge generation layer **156**, and a hole transporting layer can be further formed between the charge generation layer **156** and the second light emitting material layer **154***b*.

[0091] At this time, the electron transporting layer and the charge generation layer **156** can be formed through a vacuum evaporation process, and the buffer layer can be formed between the first light emitting material layer **154***a* formed through the soluble process and the electron transporting layer.

[0092] The charge generation layer **156** and the second light emitting material layer **154***b* can be omitted.

[0093] The electron auxiliary layer **158** is formed on the second light emitting material layer **154***b* in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The electron auxiliary layer **158** can include at least one of an electron transporting layer and an electron auxiliary layer.

[0094] The electron auxiliary layer **158** in one pixel region P**1**, P**2** and P**3** can be connected to another electron auxiliary layer **158** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the electron auxiliary layer **158** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0095] The electron auxiliary layer **158** can be formed through a vacuum evaporation process.

[0096] The second electrode **160** is formed on the electron auxiliary layer **158** in each of the first, second and third pixel regions P**1**, P**2** and P**3** as a cathode. The second electrode **160** in one pixel region P**1**, P**2** and P**3** can be connected to another second electrode **160** in a next pixel region P**1**, P**2** and P**3** to form one body. The second electrode **160** can be formed over substantially all of the substrate **110**.

[0097] The second electrode **160** can be formed of a conductive material having relatively low work function. For example, the second electrode **160** can be formed of aluminum (Al), magnesium (Mg), silver (Ag) or their alloy, but is not limited to this.

[0098] Here, light emitted from the first and second light emitting material layers **154***a* and **154***b* is outputted to the outside through the second electrode **160**. The second electrode **160** can have a relatively thin thickness such that the light emitted from the first and second light emitting material layers **154***a* and **154***b* passes therethrough.

[0099] As mentioned above, the first electrode **140**, the light emitting layer **150** and the second electrode **160** constitute the light emitting diode D.

[0100] Meanwhile, a capping layer **170** is formed on the second electrode **160**. The capping layer **170** can be formed over substantially all of the substrate **110** like the second electrode **160**. The capping layer **170** can be formed of an organic material having a relatively high refractive index. At this time, the wavelength of light moving along the capping layer **170** is amplified by surface plasma resonance, and thus the intensity of the peak is increased, thereby improving the light efficiency in the top emission type organic light emitting diode display device.

[0101] The capping layer **170** can be omitted.

[0102] Next, an encapsulation layer **180** is formed on the capping layer **170**. The encapsulation layer **180** protects the light emitting diode D by blocking moisture or oxygen from the outside. The encapsulation layer **180** can be formed of a polymer functioning as an absorber or a buffer.

[0103] Here, a single layer including an inorganic layer or multiple layers including inorganic and organic layers can be further formed between the capping layer **170** and the encapsulation layer **180**.

[0104] In the meantime, the encapsulation layer **180** functions as a color changing layer. More specifically, the encapsulation layer **180** includes first, second and third portions **180***a*, **180***b* and **180***c* corresponding to the first, second and third pixel regions P**1**, P**2** and P**3**, respectively. The first portion **180***a* includes a first color changing material **182**, the second portion **180***b* includes a second color changing material **184**, and the third portion **180***c* does not include any color changing material.

[0105] The first color changing material **182** in the first portion **180***a* absorbs blue light and emits red light, and the second color changing material **184** in the second portion **180***b* absorbs blue light and emits green light.

[0106] The first and second color changing materials **182** and **184** can be quantum dots. At this time, the first and second color changing materials **182** and **184** can have different sizes.

[0107] Each quantum dot includes a core, and it is beneficial that a size of the core is 2 nm to 10 nm. The quantum dot can include only the core. Alternatively, the quantum dot can include a core and a shell or a core and first and second shells, but is not limited to this.

[0108] The quantum dot can be formed of PbS, PbSe, CdSe, CdS, InAs, or InP, but is not limited to this.

[0109] For example, the encapsulation layer **180** of the present disclosure can be formed by printing an adhesive polymer including the color changing materials **182** and **184** in a liquid phase or laminating a film including the color changing materials **182** and **184**.

[0110] In the organic light emitting diode display device according to the first embodiment of the present disclosure, blue light emitted from the first and second light emitting material layers **154***a* and **154***b* is outputted to the outside through the second electrode **160**. That is, the organic light emitting diode display device according to the first embodiment of the present disclosure is a top emission type.

[0111] At this time, while passing through the encapsulation layer **180**, the blue light emitted from the first and second light emitting material layers **154***a* and **154***b* is changed into red light R to be outputted in the first pixel region P**1**, is changed into green light G to be outputted in the second pixel region P**2**, and is outputted without a change in the third pixel region P**3**.

[0112] More particularly, in the first pixel region P**1**, the first color changing material **182** in the first portion **180***a* of the encapsulation layer **180** absorbs the blue light emitted from the first and second light emitting material layers **154***a* and **154***b* and emits the red light R. In the second pixel region P**2**, the second color changing material **184** in the second portion **180***b* of the encapsulation layer **180** absorbs the blue light emitted from the first and second light emitting material layers **154***a* and **154***b* and emits the green light G. On the other hand, in the third pixel region P**3**, since the third portion **180***c* of the encapsulation layer **180** does not include any color changing material, the blue light emitted from the first and second light emitting material layers **154***a* and **154***b* passes through the third portion **180***c* as it is.

[0113] Meanwhile, the microcavity effect can be applied to the organic light emitting diode display device according to the first embodiment of the present disclosure in order to increase the color purity. At this time, the first light emitting material layer **154***a* can be formed in a position satisfying the first order cavity condition, and the second light emitting material layer **154***b* can be formed in a position satisfying the second order cavity condition. Alternatively, the first light emitting material layer **154***a* can be formed in a position satisfying the second order cavity condition, and the second light emitting material layer **154***b* can be formed in a position satisfying the third order cavity condition.

[0114] The spectrum of red, green and blue light R, G and B emitted from the organic light emitting diode display device according to the first embodiment of the present disclosure is as shown in FIG. **5**. FIG. **5** is a view showing the spectrum of light emitted from the organic light emitting diode display device according to the first embodiment of the present disclosure.

[0115] As described above, in the organic light emitting diode display device according to the first embodiment of the present disclosure, the red, green and blue light R, G and B is outputted by using the color changing materials **182** and **184** such as the quantum dot. Thus, the color purity can be increased, and the light efficiency can be improved. At this time, the color purity can be further increased by applying the microcavity effect.

[0116] The color changing materials **182** and **184** scatter light such that light is emitted in a direction other than the front direction, and thus the viewing angle can be improved.

[0117] In addition, since the light emitting material layers **154***a* and **154***b* emitting single color light, i.e., blue light are used for the first, second and third pixel regions P**1**, P**2** and P**3**, the luminous efficiencies and lifetimes can be uniform in the first, second and third pixel regions P**1**, P**2** and P**3**.

[0118] Moreover, since the light emitting material layers **154***a* and **154***b* are formed as a stack structure, the driving voltage can be reduced, and the luminous efficiency and the lifetime can be improved.

Second Embodiment

[0119] FIG. **6** is a schematic cross-sectional view of an organic light emitting diode display device according to a second embodiment of the present disclosure and shows a pixel. However, the organic light emitting diode display device of FIG. **6** obviously includes a plurality of pixels or pixel regions.

[0120] In FIG. **6**, first, second and third pixel regions P**1**, P**2** and P**3** are defined on a substrate **210**. A light emitting diode D is disposed in each pixel region P**1**, P**2** and P**3**. The first, second and third pixel regions P**1**, P**2** and P**3** correspond to red, green and blue sub pixels, respectively.

[0121] The light emitting diode D includes a first electrode **240**, a light emitting layer **250** and a second electrode **260**. The light emitting layer **250** includes a hole auxiliary layer **252**, a first light emitting material layer **254***a*, a charge generation layer **256**, a second light emitting material layer **254***b*, and an electron auxiliary layer **258**.

[0122] More particularly, the first electrode **240** is formed in each of the first, second and third pixel regions P**1**, P**2** and P**3** as an anode. In the figure, although the first electrodes **240** in the first, second and third pixel regions P**1**, P**2** and P**3** are connected to each other, the first electrodes **240** in the first, second and third pixel regions P**1**, P**2** and P**3** are separated from each other.

[0123] The first electrode **240** can be formed of a transparent conductive material such as indium tin oxide (ITO) and indium zinc oxide (IZO).

[0124] The hole auxiliary layer **252** is formed on the first electrode **240** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The hole auxiliary layer **252** can include at least one of a hole injecting layer (HIL) and a hole transporting layer (HTL). Here, the hole auxiliary layers **252** in the first, second and third pixel regions P**1**, P**2** and P**3** are formed of the same material, have the same structure and have the same thickness.

[0125] The hole auxiliary layer **252** in one pixel region P**1**, P**2** and P**3** can be connected to another hole auxiliary layer **252** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the hole auxiliary layer **252** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0126] The hole auxiliary layer **252** can be formed through a vacuum evaporation process. Alternatively, the hole auxiliary layer **252** can be formed through a soluble process.

[0127] The first light emitting material layer **254***a* is formed on the hole auxiliary layer **252** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The first light emitting material layer **254***a* includes a blue light emitting material emitting blue light.

[0128] The first light emitting material layer **254***a* in one pixel region P**1**, P**2** and P**3** can be connected to another first light emitting material layer **254***a* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the first light emitting material layer **254***a* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0129] The first light emitting material layer **254***a* can be formed through a vacuum evaporation process. At this time, the first light emitting material layer **254***a* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0130] Alternatively, the first light emitting material layer **254***a* can be formed through a soluble process. At this time, the first light emitting material layer **254***a* can include poly(N-vinylcarbazole), polyphenylphenyl dendron, or conjugated triphenylene polymers as a dopant, but is not limited to this.

[0131] The charge generation layer (CGL) **256** is formed on the first light emitting material layer **254***a* in each of the first, second and third pixel regions P**1**, P**2** and P**3**.

[0132] The charge generation layer **256** generates and provides electrons and holes. The charge generation layer **256** can have a PN junction structure in which an N-type charge generation layer and a p-type charge generation layer are bonded. At this time, the N-type charge generation layer is disposed over the first light emitting material layer **254***a* and the P-type charge generation layer.

[0133] Meanwhile, a metal layer can be further formed between the N-type charge generation layer and the P-type charge generation layer. Preferably, the metal layer has a thickness of 4 nm or less. For example, the metal layer can be formed of aluminum (Al) or silver (Ag), but is not limited to this.

[0134] The charge generation layer **256** can be formed through a vacuum evaporation process. At this time, the N-type charge generation layer can have a single layer structure of an electron transporting material doped with an electron injecting material or a double layer structure in which an electron injecting material and an electron transporting material are sequentially stacked, but is not limited to this. The P-type charge generation layer can have a single layer structure of a hole transporting material doped with a hole injecting material or a double layer structure in which a hole transporting material and a hole injecting material are sequentially stacked, but is not limited to this. For example, LiF, CsCO3, NaF, Ca, Ba, Na, Li, LiQ and the like can be used as the electron injecting material, and BPhen, TPBi, B3PyPB, BCP and the like can be used as the electron transporting material, but are not limited to this. In addition, TAPC, TCTA, NPB, NPD and the like can be used as the hole transporting material, and MoO3, WO3, V2O5, ReO3, HATCN, F4TCNQ and the like can be used as the hole injecting material, but are not limited to this.

[0135] Alternatively, the charge generation layer **256** can be formed through a soluble process. At this time, PEDOT:PSS, PMA/TFB, WO3/PEDOT:PSS and the like can be used as the charge generation layer **256**.

[0136] The second light emitting material layer **254***b* is formed on the charge generation layer **256** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The second light emitting material layer **254***b* is formed of a blue light emitting material emitting blue light.

[0137] The second light emitting material layer **254***b* in one pixel region P**1**, P**2** and P**3** can be connected to another second light emitting material layer **254***b* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the second light emitting material layer **254***b* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0138] The second light emitting material layer **254***b* can be formed through a vacuum evaporation process. At this time, the second light emitting material layer **254***b* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0139] A thickness of the second light emitting material layer **254***b* is equal to or smaller than a thickness of the first light emitting material layer **254***a*. For example, the thickness of the first light emitting material layer **254***a* can be 20 nm to 60 nm, and the thickness of the second light emitting material layer **254***b* can be 20 nm to 30 nm, but is not limited to this.

[0140] In the meantime, a buffer layer can be further formed between the first light emitting material layer **254***a* and the charge generation layer **256** or between the charge generation layer **256** and the second light emitting material layer **254***b*. The buffer layer is formed through a vacuum evaporation process and increases the mobility of charges at an interface between a layer formed through a soluble process and a layer through a vacuum evaporation process.

[0141] Accordingly, when the first light emitting material layer **254***a* is formed through the soluble process and the charge generation layer **256** is formed through the vacuum evaporation process, the buffer layer is disposed between the first light emitting material layer **254***a* and the charge generation layer **256**.

[0142] Alternatively, when the first light emitting material layer **254***a* and the charge generation layer **256** are formed through the soluble process, the buffer layer is disposed between the charge generation layer **256** and the second light emitting material layer **254***b*, which is formed through the vacuum evaporation process.

[0143] The buffer layer can be formed of a bipolar compound, and the bipolar compound can be a monomolecular material having both electron properties and hole properties. More specifically, the bipolar compound is a material in which an electron-affinity core and a hole-affinity core are synthesized as a compound. For example, the bipolar compound can include an arylamine group and one of a heteroaryl group, a silicon group having an aromatic substituent and a sulfonyl group in a molecule, but is not limited to this.

[0144] The buffer layer has a relatively thin thickness of 1 nm to 5 nm, and beneficially, 1 nm to 3 nm.

[0145] In addition, an electron transporting layer can be further formed between the first light emitting material layer **254***a* and the charge generation layer **256**, and a hole transporting layer can be further formed between the charge generation layer **256** and the second light emitting material layer **254***b*.

[0146] At this time, the electron transporting layer and the charge generation layer **256** can be formed through a vacuum evaporation process, and the buffer layer can be formed between the first light emitting material layer **254***a* formed through the soluble process and the electron transporting layer.

[0147] The charge generation layer **256** and the second light emitting material layer **254***b* can be omitted.

[0148] The electron auxiliary layer **258** is formed on the second light emitting material layer **254***b* in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The electron auxiliary layer **258** can include at least one of an electron transporting layer and an electron auxiliary layer.

[0149] The electron auxiliary layer **258** in one pixel region P**1**, P**2** and P**3** can be connected to another electron auxiliary layer **258** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the electron auxiliary layer **258** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0150] The electron auxiliary layer **258** can be formed through a vacuum evaporation process.

[0151] The second electrode **260** is formed on the electron auxiliary layer **258** in each of the first, second and third pixel regions P**1**, P**2** and P**3** as a cathode. The second electrode **260** in one pixel region P**1**, P**2** and P**3** can be connected to another second electrode **260** in a next pixel region P**1**, P**2** and P**3** to form one body. The second electrode **260** can be formed over substantially all of the substrate **110**.

[0152] The second electrode **260** can be formed of a conductive material having relatively low work function. For example, the second electrode **260** can be formed of aluminum (Al), magnesium (Mg), silver (Ag) or their alloy, but is not limited to this.

[0153] As mentioned above, the first electrode **240**, the light emitting layer **250** and the second electrode **260** constitute the light emitting diode D.

[0154] Meanwhile, a capping layer **270** is formed on the second electrode **260**. The capping layer **270** can be formed over substantially all of the substrate **210** like the second electrode **260**.

[0155] The capping layer **270** can be omitted.

[0156] Next, an encapsulation layer **280** is formed on the capping layer **270**. The encapsulation layer **280** protects the light emitting diode D by blocking moisture or oxygen from the outside. The encapsulation layer **280** can be formed of a polymer functioning as an absorber or a buffer.

[0157] Here, a single layer including an inorganic layer or multiple layers including inorganic and organic layers can be further formed between the capping layer **270** and the encapsulation layer **280**.

[0158] In the meantime, a color changing layer **290** is formed under the substrate **210**. The color changing layer **290** includes first, second and third portions **290***a*, **290***b* and **290***c* corresponding to the first, second and third pixel regions P**1**, P**2** and P**3**, respectively. The first portion **290***a* includes a first color changing material **292**, the second portion **290***b* includes a second color changing material **294**, and the third portion **290***c* does not include any color changing material.

[0159] The first color changing material **292** in the first portion **290***a* absorbs blue light and emits red light, and the second color changing material **294** in the second portion **290***b* absorbs blue light and emits green light.

[0160] The first and second color changing materials **292** and **294** can be quantum dots. At this time, the first and second color changing materials **292** and **294** can have different sizes.

[0161] Each quantum dot includes a core, and it is beneficial that a size of the core is 2 nm to 10 nm. The quantum dot can include only the core. Alternatively, the quantum dot can include a core and a shell or a core and first and second shells, but is not limited to this.

[0162] The quantum dot can be formed of PbS, PbSe, CdSe, CdS, InAs, or InP, but is not limited to this.

[0163] For example, the encapsulation layer **290** of the present disclosure can be formed by printing an adhesive polymer including the color changing materials **292** and **294** in a liquid phase or laminating a film including the color changing materials **292** and **294**.

[0164] Meanwhile, the color changing layer **290** can be disposed between the substrate **210** and the first electrode **240**.

[0165] In the organic light emitting diode display device according to the second embodiment of the present disclosure, blue light emitted from the first and second light emitting material layers **254***a* and **254***b* is outputted to the outside through the first electrode **240**. That is, the organic light emitting diode display device according to the second embodiment of the present disclosure is a bottom emission type.

[0166] At this time, while passing through the color changing layer **290**, the blue light emitted from the first and second light emitting material layers **254***a* and **254***b* is changed into red light R to be outputted in the first pixel region P**1**, is changed into green light G to be outputted in the second pixel region P**2**, and is outputted without a change in the third pixel region P**3**.

[0167] More particularly, in the first pixel region P**1**, the first color changing material **292** in the first portion **290***a* of the color changing layer **290** absorbs the blue light emitted from the first and second light emitting material layers **254***a* and **254***b* and emits the red light R. In the second pixel region P**2**, the second color changing material **294** in the second portion **290***b* of the color changing layer **290** absorbs the blue light emitted from the first and second light emitting material layers **254***a* and **254***b* and emits the green light G. On the other hand, in the third pixel region P**3**, since the third portion **290***c* of the color changing layer **290** does not include any color changing material, the blue light emitted from the first and second light emitting material layers **254***a* and **254***b* passes through the third portion **290***c* as it is.

[0168] The spectrum of red, green and blue light R, G and B emitted from the organic light emitting diode display device according to the first embodiment of the present disclosure is as shown in FIG. **7**. FIG. **7** is a view showing the spectrum of light emitted from the organic light emitting diode display device according to the second embodiment of the present disclosure.

[0169] As described above, in the organic light emitting diode display device according to the second embodiment of the present disclosure, the red, green and blue light R, G and B is outputted by using the color changing materials **292** and **294** such as the quantum dot. Thus, the color purity can be increased, and the light efficiency can be improved. At this time, the color purity can be further increased by applying the microcavity effect.

[0170] The color changing materials **292** and **294** scatter light such that light is emitted in a direction other than the front direction, and thus the viewing angle can be improved.

[0171] In addition, since the light emitting material layers **254***a* and **254***b* emitting single color light, i.e., blue light are used for the first, second and third pixel regions P**1**, P**2** and P**3**, the luminous efficiencies and lifetimes can be uniform in the first, second and third pixel regions P**1**, P**2** and P**3**.

[0172] Moreover, since the light emitting material layers **254***a* and **254***b* are formed as a stack structure, the driving voltage can be reduced, and the luminous efficiency and the lifetime can be improved.

Third Embodiment

[0173] FIG. **8** is a schematic cross-sectional view of an organic light emitting diode display device according to a third embodiment of the present disclosure and shows a pixel. However, the organic light emitting diode display device of FIG. **8** obviously includes a plurality of pixels or pixel regions.

[0174] In FIG. **8**, first, second and third pixel regions P**1**, P**2** and P**3** are defined on a substrate **310**. A light emitting diode D is disposed in each pixel region P**1**, P**2** and P**3**. The first, second and third pixel regions P**1**, P**2** and P**3** correspond to red, green and blue sub pixels, respectively.

[0175] The light emitting diode D includes a first electrode **340**, a light emitting layer **350** and a second electrode **360**. The light emitting layer **350** includes a hole auxiliary layer **352**, a first light emitting material layer **354***a*, a first charge generation layer **356***a*, a second light emitting material layer **354***b*, a second charge generation layer **356***b*, a third light emitting material layer **354***c*, and an electron auxiliary layer **358**.

[0176] More particularly, the first electrode **340** is formed in each of the first, second and third pixel regions P**1**, P**2** and P**3** as an anode. In the figure, although the first electrodes **340** in the first, second and third pixel regions P**1**, P**2** and P**3** are connected to each other, the first electrodes **340** in the first, second and third pixel regions P**1**, P**2** and P**3** are separated from each other.

[0177] The first electrode **340** can be formed of a transparent conductive material such as indium tin oxide (ITO) and indium zinc oxide (IZO). In addition, a reflection electrode or a reflection layer can be further formed under the first electrode **140**. For example, the reflection electrode or the reflection layer can be formed of aluminum-palladium-copper (APC) alloy.

[0178] Meanwhile, the first electrode **340** can include a reflection electrode, and in this case, the first electrode **140** can have a triple-layered structure of ITO/APC/ITO.

[0179] The hole auxiliary layer **352** is formed on the first electrode **340** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The hole auxiliary layer **352** can include at least one of a hole injecting layer (HIL) and a hole transporting layer (HTL). Here, the hole auxiliary layers **352** in the first, second and third pixel regions P**1**, P**2** and P**3** are formed of the same material, have the same structure and have the same thickness.

[0180] The hole auxiliary layer **352** in one pixel region P**1**, P**2** and P**3** can be connected to another hole auxiliary layer **352** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the hole auxiliary layer **352** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0181] The hole auxiliary layer **352** can be formed through a vacuum evaporation process. Alternatively, the hole auxiliary layer **352** can be formed through a soluble process.

[0182] The first light emitting material layer **354***a* is formed on the hole auxiliary layer **352** in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The first light emitting material layer **354***a* includes a blue light emitting material emitting blue light.

[0183] The first light emitting material layer **354***a* in one pixel region P**1**, P**2** and P**3** can be connected to another first light emitting material layer **354***a* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the first light emitting material layer **354***a* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0184] The first light emitting material layer **354***a* can be formed through a vacuum evaporation process. At this time, the first light emitting material layer **354***a* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0185] Alternatively, the first light emitting material layer **354***a* can be formed through a soluble process. At this time, the first light emitting material layer **354***a* can include poly(N-vinylcarbazole), polyphenylphenyl dendron, or conjugated triphenylene polymers as a dopant, but is not limited to this.

[0186] The first charge generation layer (CGL1) **356***a* is formed on the first light emitting material layer **354***a* in each of the first, second and third pixel regions P**1**, P**2** and P**3**.

[0187] The first charge generation layer **356***a* generates and provides electrons and holes. The first charge generation layer **356***a* can have a PN junction structure in which an N-type charge generation layer and a p-type charge generation layer are bonded. At this time, the N-type charge generation layer of the first charge generation layer **356***a* is disposed over the first light emitting material layer **354***a* and the P-type charge generation layer.

[0188] Meanwhile, a metal layer can be further formed between the N-type charge generation layer and the P-type charge generation layer of the first charge generation layer **356***a*. Preferably, the metal layer of the first charge generation layer **356***a* has a thickness of 4 nm or less. For example, the metal layer can be formed of aluminum (Al) or silver (Ag), but is not limited to this.

[0189] The first charge generation layer **356***a* can be formed through a vacuum evaporation process. At this time, the N-type charge generation layer of the first charge generation layer **356***a* can have a single layer structure of an electron transporting material doped with an electron injecting material or a double layer structure in which an electron injecting material and an electron transporting material are sequentially stacked, but is not limited to this. The P-type charge generation layer of the first charge generation layer **356***a* can have a single layer structure of a hole transporting material doped with a hole injecting material or a double layer structure in which a hole transporting material and a hole injecting material are sequentially stacked, but is not limited to this. For example, LiF, CsCO3, NaF, Ca, Ba, Na, Li, LiQ and the like can be used as the electron injecting material, and BPhen, TPBi, B3PyPB, BCP and the like can be used as the electron transporting material, but are not limited to this. In addition, TAPC, TCTA, NPB, NPD and the like can be used as the hole transporting material, and MoO3, WO3, V2O5, ReO3, HATCN, F4TCNQ and the like can be used as the hole injecting material, but are not limited to this.

[0190] Alternatively, the first charge generation layer **356***a* can be formed through a soluble process. At this time, PEDOT:PSS, PMA/TFB, WO3/PEDOT:PSS and the like can be used as the first charge generation layer **356***a*.

[0191] The second light emitting material layer **354***b* is formed on the first charge generation layer **356***a* in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The second light emitting material layer **354***b* is formed of a blue light emitting material emitting blue light.

[0192] The second light emitting material layer **354***b* in one pixel region P**1**, P**2** and P**3** can be connected to another second light emitting material layer **354***b* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the second light emitting material layer **354***b* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0193] The second light emitting material layer **354***b* can be formed through a vacuum evaporation process. At this time, the second light emitting material layer **354***b* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0194] A thickness of the second light emitting material layer **354***b* is equal to or smaller than a thickness of the first light emitting material layer **354***a*. For example, the thickness of the first light emitting material layer **354***a* can be 20 nm to 60 nm, and the thickness of the second light emitting material layer **354***b* can be 20 nm to 30 nm, but is not limited to this.

[0195] In the meantime, a buffer layer can be further formed between the first light emitting material layer **354***a* and the first charge generation layer **356***a* or between the first charge generation layer **356***a* and the second light emitting material layer **354***b*. The buffer layer is formed through a vacuum evaporation process and increases the mobility of charges at an interface between a layer formed through a soluble process and a layer through a vacuum evaporation process.

[0196] Accordingly, when the first light emitting material layer **354***a* is formed through the soluble process and the first charge generation layer **356***a* is formed through the vacuum evaporation process, the buffer layer is disposed between the first light emitting material layer **154***a* and the first charge generation layer **356***a*.

[0197] Alternatively, when the first light emitting material layer **354***a* and the first charge generation layer **356***a* are formed through the soluble process, the buffer layer is disposed between the first charge generation layer **356***a* and the second light emitting material layer **354***b*, which is formed through the vacuum evaporation process.

[0198] The buffer layer can be formed of a bipolar compound, and the bipolar compound can be a monomolecular material having both electron properties and hole properties. More specifically, the bipolar compound is a material in which an electron-affinity core and a hole-affinity core are synthesized as a compound. For example, the bipolar compound can include an arylamine group and one of a heteroaryl group, a silicon group having an aromatic substituent and a sulfonyl group in a molecule, but is not limited to this.

[0199] The buffer layer has a relatively thin thickness of 1 nm to 5 nm, and beneficially, 1 nm to 3 nm.

[0200] In addition, an electron transporting layer can be further formed between the first light emitting material layer **354***a* and the first charge generation layer **356***a*, and a hole transporting layer can be further formed between the first charge generation layer **356***a* and the second light emitting material layer **354***b*.

[0201] At this time, the electron transporting layer and the first charge generation layer **356***a* can be formed through a vacuum evaporation process, and the buffer layer can be formed between the first light emitting material layer **354***a* formed through the soluble process and the electron transporting layer.

[0202] The second charge generation layer (CGL2) **356***b* is formed on the second light emitting material layer **354***b* in each of the first, second and third pixel regions P**1**, P**2** and P**3**.

[0203] The second charge generation layer **356***b* generates and provides electrons and holes. The second charge generation layer **356***b* can have a PN junction structure in which an N-type charge generation layer and a p-type charge generation layer are bonded. At this time, the N-type charge generation layer of the second charge generation layer **356***b* is disposed over the second light emitting material layer **354***b* and the P-type charge generation layer.

[0204] Meanwhile, a metal layer can be further formed between the N-type charge generation layer and the P-type charge generation layer of the second charge generation layer **356***b*. Preferably, the metal layer of the second charge generation layer **356***b* has a thickness of 4 nm or less. For example, the metal layer can be formed of aluminum (Al) or silver (Ag), but is not limited to this.

[0205] The second charge generation layer **356***b* can be formed through a vacuum evaporation process. At this time, the N-type charge generation layer of the second charge generation layer **356***b* can have a single layer structure of an electron transporting material doped with an electron injecting material or a double layer structure in which an electron injecting material and an electron transporting material are sequentially stacked, but is not limited to this. The P-type charge generation layer of the second charge generation layer **356***b* can have a single layer structure of a hole transporting material doped with a hole injecting material or a double layer structure in which a hole transporting material and a hole injecting material are sequentially stacked, but is not limited to this. For example, LiF, CsCO3, NaF, Ca, Ba, Na, Li, LiQ and the like can be used as the electron injecting material, and BPhen, TPBi, B3PyPB, BCP and the like can be used as the electron transporting material, but are not limited to this. In addition, TAPC, TCTA, NPB, NPD and the like can be used as the hole transporting material, and

MoO3, WO3, V2O5, ReO3, HATCN, F4TCNQ and the like can be used as the hole injecting material, but are not limited to this.

[0206] The third light emitting material layer **354***c* is formed on the second charge generation layer **356***b* in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The third light emitting material layer **354***c* is formed of a blue light emitting material emitting blue light.

[0207] The third light emitting material layer **354***c* in one pixel region P**1**, P**2** and P**3** can be connected to another third light emitting material layer **354***c* in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the third light emitting material layer **354***c* can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0208] The third light emitting material layer **354***c* can be formed through a vacuum evaporation process. At this time, the third light emitting material layer **354***c* can include an anthracene derivative, a benzofluorene derivative, or an iridium (Ir) derivative as a dopant, but is not limited to this. Here, Firpic can be used as the Ir derivative.

[0209] A thickness of the third light emitting material layer **354***c* is equal to or smaller than the thickness of the second light emitting material layer **354***b*. For example, the thickness of the third light emitting material layer **354***c* can be 20 nm to 30 nm, but is not limited to this.

[0210] The electron auxiliary layer **358** is formed on the third light emitting material layer **354***c* in each of the first, second and third pixel regions P**1**, P**2** and P**3**. The electron auxiliary layer **358** can include at least one of an electron transporting layer and an electron auxiliary layer.

[0211] The electron auxiliary layer **358** in one pixel region P**1**, P**2** and P**3** can be connected to another electron auxiliary layer **358** in a next pixel region P**1**, P**2** and P**3** to form one body. Alternatively, the electron auxiliary layer **358** can be separated by the first, second and third pixel regions P**1**, P**2** and P**3**.

[0212] The electron auxiliary layer **358** can be formed through a vacuum evaporation process.

[0213] The second electrode **360** is formed on the electron auxiliary layer **358** in each of the first, second and third pixel regions P**1**, P**2** and P**3** as a cathode. The second electrode **360** in one pixel region P**1**, P**2** and P**3** can be connected to another second electrode **360** in a next pixel region P**1**, P**2** and P**3** to form one body. The second electrode **360** can be formed over substantially all of the substrate **310**.

[0214] The second electrode **360** can be formed of a conductive material having relatively low work function. For example, the second electrode **360** can be formed of aluminum (Al), magnesium (Mg), silver (Ag) or their alloy, but is not limited to this.

[0215] Here, light emitted from the first, second and third light emitting material layers **354***a*, **354***b* and **354***c* is outputted to the outside through the second electrode **360**. The second electrode **360** can have a relatively thin thickness such that the light emitted from the first, second and third light emitting material layers **354***a*, **354***b* and **354***c* passes therethrough.

[0216] As mentioned above, the first electrode **340**, the light emitting layer **350** and the second electrode **360** constitute the light emitting diode D.

[0217] Meanwhile, a capping layer **370** is formed on the second electrode **360**. The capping layer **370** can be formed over substantially all of the substrate **310** like the second electrode **360**. The capping layer **370** can be formed of an organic material having a relatively high refractive index. At this time, the wavelength of light moving along the capping layer **370** is amplified by surface plasma resonance, and thus the intensity of the peak is increased, thereby improving the light efficiency in the top emission type organic light emitting diode display device.

[0218] The capping layer **370** can be omitted.

[0219] Next, an encapsulation layer **380** is formed on the capping layer **370**. The encapsulation layer **380** protects the light emitting diode D by blocking moisture or oxygen from the outside. The encapsulation layer **380** can be formed of a polymer functioning as an absorber or a buffer.

[0220] Here, a single layer including an inorganic layer or multiple layers including inorganic and organic layers can be further formed between the capping layer **370** and the encapsulation layer **380**.

[0221] In the meantime, the encapsulation layer **380** includes first, second and third portions **380***a*, **380***b* and **380***c* corresponding to the first, second and third pixel regions P**1**, P**2** and P**3**, respectively. The first portion **380***a* includes a first color changing material **382**, the second portion **380***b* includes a second color changing material **384**, and the third portion **380***c* does not include any color changing material.

[0222] The first color changing material **382** in the first portion **380***a* absorbs blue light and emits red light, and the second color changing material **384** in the second portion **380***b* absorbs blue light and emits green light.

[0223] The first and second color changing materials **382** and **384** can be quantum dots. At this time, the first and second color changing materials **382** and **384** can have different sizes.

[0224] Each quantum dot includes a core, and it is beneficial that a size of the core is 2 nm to 10 nm. The quantum dot can include only the core. Alternatively, the quantum dot can include a core and a shell or a core and first and second shells, but is not limited to this.

[0225] The quantum dot can be formed of PbS, PbSe, CdSe, CdS, InAs, or InP, but is not limited to this.

[0226] For example, the encapsulation layer **380** of the present disclosure can be formed by printing an adhesive polymer including the color changing materials **382** and **384** in a liquid phase or laminating a film including the color changing materials **382** and **384**.

[0227] In the organic light emitting diode display device according to the third embodiment of the present disclosure, blue light emitted from the first, second and third light emitting material layers **354***a*, **354***b* and **354***c* is outputted to the outside through the second electrode **360**. That is, the organic light emitting diode display device according to the second embodiment of the present disclosure is a top emission type.

[0228] At this time, while passing through the encapsulation layer **380**, the blue light emitted from the first, second and third light emitting material layers **354***a*, **354***b* and **354***c* is changed into red light R to be outputted in the first pixel region P**1**, is changed into green light G to be outputted in the second pixel region P**2**, and is outputted without a change in the third pixel region P**3**.

[0229] More particularly, in the first pixel region P**1**, the first color changing material **382** in the first portion **380***a* of the encapsulation layer **380** absorbs the blue light emitted from the first, second and third light emitting material layers **354***a*, **354***b* and **354***c* and emits the red light R. In the second pixel region P**2**, the second color changing material **384** in the second portion **380**b of the encapsulation layer **380** absorbs the blue light emitted from the first, second and third light emitting material layers **354**a, **354**b and **354**c and emits the green light G. On the other hand, in the third pixel region P**3**, since the third portion **380**c of the encapsulation layer **380** does not include any color changing material, the blue light emitted from the first, second and third light emitting material layers **354**a, **354**b and **354**c passes through the third portion **380**c as it is.

[0230] Meanwhile, the microcavity effect can be applied to the organic light emitting diode display device according to the third embodiment of the present disclosure in order to increase the color purity. At this time, the first light emitting material layer **354**a can be formed in a position satisfying the first order cavity condition, the second light emitting material layer **354**b can be formed in a position satisfying the second order cavity condition, and the third light emitting material layer **354**c can be formed in a position satisfying the third order cavity condition.

[0231] As described above, in the organic light emitting diode display device according to the third embodiment of the present disclosure, the red, green and blue light R, G and B is outputted by using the color changing materials **382** and **384** such as the quantum dot. Thus, the color purity can be increased, and the light efficiency can be improved. At this time, the color purity can be further increased by applying the microcavity effect.

[0232] The color changing materials **382** and **384** scatter light such that light is emitted in a direction other than the front direction, and thus the viewing angle can be improved.

[0233] In addition, since the first, second and third light emitting material layers **354**a, **354**b and **354**c emitting single color light, i.e., blue light are used for the first, second and third pixel regions P**1**, P**2** and P**3**, the luminous efficiencies and lifetimes can be uniform in the first, second and third pixel regions P**1**, P**2** and P**3**.

[0234] Moreover, since the light emitting material layers **354**a, **354**b and **354**c are formed as a stack structure of three layers, the driving voltage can be further reduced, and the luminous efficiency and the lifetime can be further improved as compared with the first embodiment.

[0235] Although the top emission type is described in the third embodiment of the present disclosure, the third embodiment of the present disclosure can be applied to the bottom emission type.

[0236] It will be apparent to those skilled in the art that various modifications and variations can be made in a display device of the present disclosure without departing from the sprit or scope of the embodiments. Thus, it is intended that the present disclosure covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic light emitting diode display device, comprising:

a substrate on which first, second and third pixel regions are defined;

a first electrode in each of the first, second and third pixel regions on the substrate;

a hole auxiliary layer on the first electrode;

a first light emitting material layer on the hole auxiliary layer and emitting first light;

an electron auxiliary layer on the first light emitting material layer;

a second electrode on the electron auxiliary layer; and

a color changing layer under the first electrode or on the second electrode,

wherein the color changing layer includes first, second and third portions corresponding to the first, second and third pixel regions, respectively, and

wherein the first portion absorbs the first light and outputs second light, the second portion absorbs the first light and outputs third light, and the third portion passes the first light as is.

2. The organic light emitting diode display device of claim **1**, wherein the first portion includes a first color changing material, the second portion includes a second color changing material, and the first and second color changing materials are quantum dots.

3. The organic light emitting diode display device of claim **1**, further comprising:

a first charge generation layer and a second light emitting material layer between the first light emitting material layer and the electron auxiliary layer,

wherein the second light emitting material layer emits light having a same wavelength as the first light.

4. The organic light emitting diode display device of claim **3**, wherein a thickness of the second light emitting material layer is equal to or smaller than a thickness of the first light emitting material layer.

5. The organic light emitting diode display device of claim **4**, further comprising:

a second charge generation layer and a third light emitting material layer between the second light emitting material layer and the electron auxiliary layer,

wherein the third light emitting material layer emits light having a same wavelength as the first light.

6. The organic light emitting diode display device of claim **5**, wherein a thickness of the third light emitting material layer is equal to or smaller than the thickness of the second light emitting material layer.

7. The organic light emitting diode display device of claim **3**, further comprising:

a buffer layer between the first light emitting material layer and the first charge generation layer or between the first charge generation layer and the second light emitting material layer,

wherein the buffer layer is formed of a bipolar compound.

8. The organic light emitting diode display device of claim **1**, wherein the color changing layer is disposed on the second electrode, and is an encapsulation layer blocking moisture or oxygen from outside.

9. The organic light emitting diode display device of claim **1**, wherein the color changing layer is disposed under the first electrode, and

wherein the substrate is disposed between the color changing layer and the first electrode or the color changing layer is disposed between the substrate and the first electrode.

10. The organic light emitting diode display device of claim **1**, wherein the first light is blue light, the second light is red light, and the third light is green light.

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当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	YOUN JUN HO BAEK HEUME IL		
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摘要(译)

有机发光二极管显示装置包括：基板，在基板上限定第一，第二和第三像素区域;基板上的第一，第二和第三像素区域中的每一个中的第一电极;在第一电极上的孔辅助层;在所述空穴辅助层上并且发射第一光的第一发光材料层;在第一发光材料层上的电子辅助层;电子辅助层上的第二电极;以及在所述第一电极或所述第二电极下面的变色层，其中所述变色层包括分别对应于所述第一，第二和第三像素区域的第一部分，第二部分和第三部分，并且其中所述第一部分吸收所述第一光并且输出第二光，第二部分吸收第一光并输出第三光，并且第三部分照原样通过第一光。