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(54) **ORGANIC LIGHT EMITTING DISPLAY DEVICE, METHOD OF FABRICATING THE SAME, AND COLOR FILTER PLATE**

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G02B 5/22	(2006.01)
G02B 5/20	(2006.01)
H01L 51/52	(2006.01)

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

CPC ***H01L 27/322*** (2013.01); ***G02B 5/201*** (2013.01); ***G02B 5/223*** (2013.01); ***H01L 27/3244*** (2013.01); *H01L 51/5284* (2013.01); *H01L 2251/5338* (2013.01)

(58) **Field of Classification Search**

CPC ... H01L 27/322; H01L 51/5284; H01L 51/56; H01L 27/3244; H01L 2227/323; G02B 5/223; G02B 5/201

See application file for complete search history.

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(57) **ABSTRACT**

A color filter plate for a display device according to an embodiment includes a substrate including a first pixel region; a first color filter pattern over the substrate and transmitting light having a first wavelength range; and a first dye layer corresponding to the first color filter pattern and over the substrate, the first dye layer including first and second dyes, wherein the first dye absorbs light having a second wavelength range other than the first wavelength range, and the second dye absorbs light having a third wavelength range other than the first wavelength range and the second wavelength range.

20 Claims, 7 Drawing Sheets

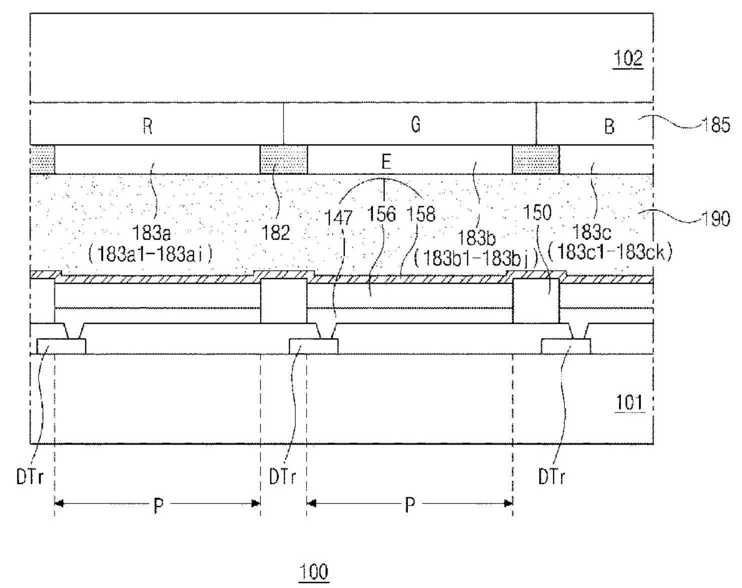

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FIG. 1
Related Art

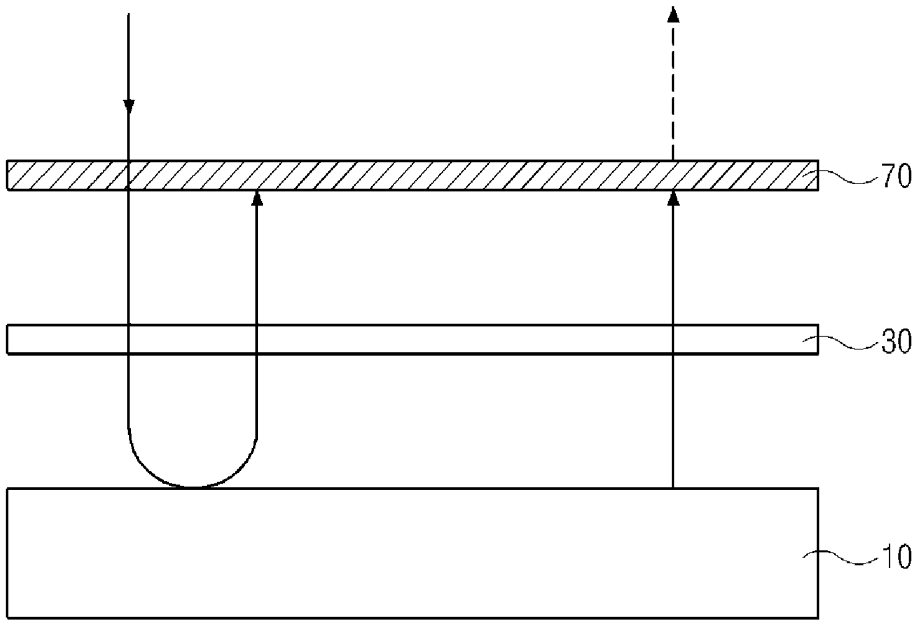


FIG. 2

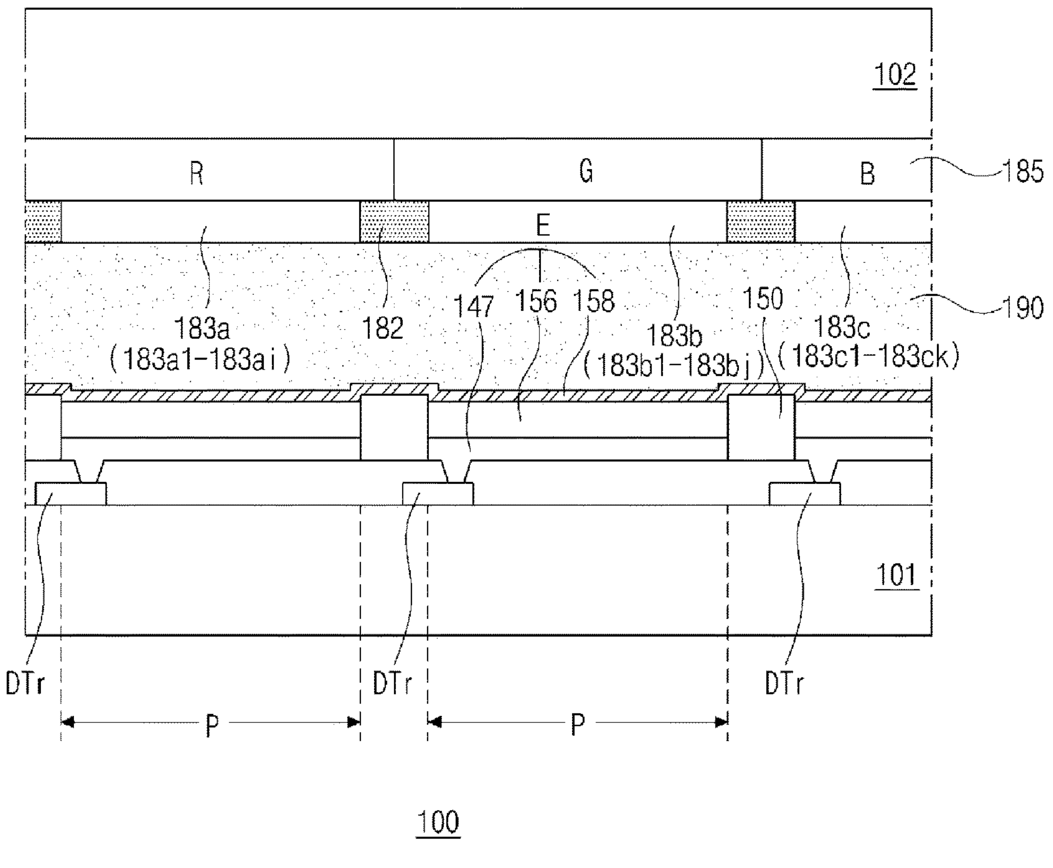

102
R
G
B
185
E
183a
(183a1-183ai)
182
147
156
158
183b
(183b1-183bj)
150
183c
(183c1-183ck)
190
101
DTr
DTr
DTr
P
P
100

FIG. 3A

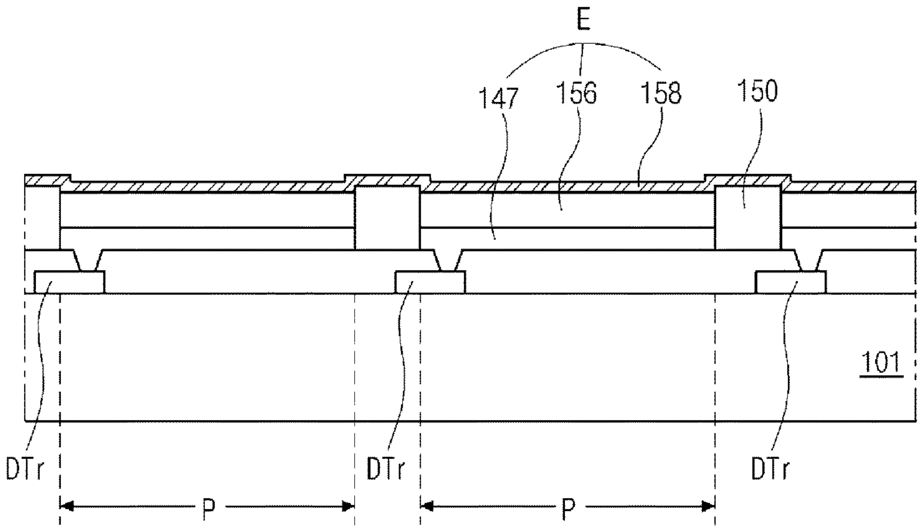


FIG. 3B

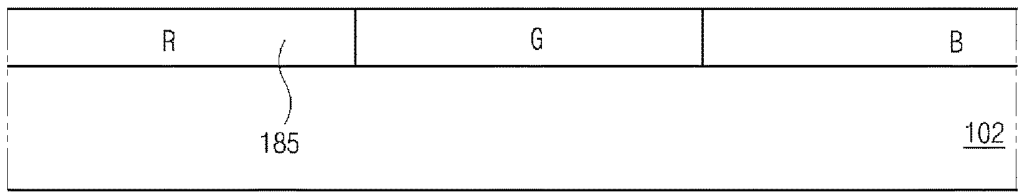


FIG. 3C

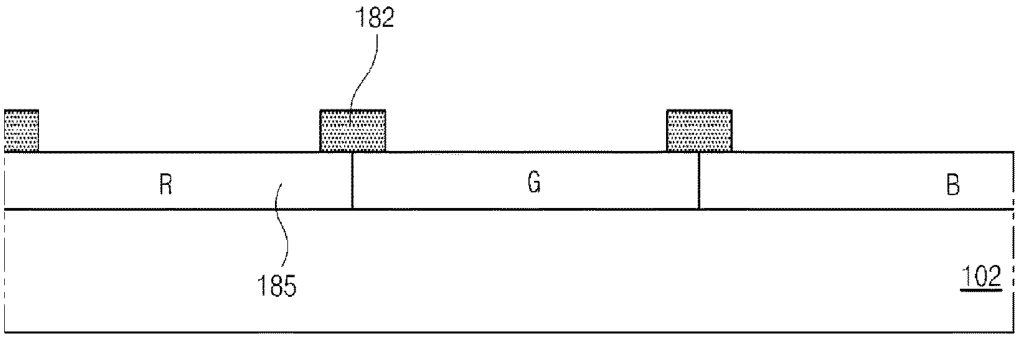


FIG. 3D

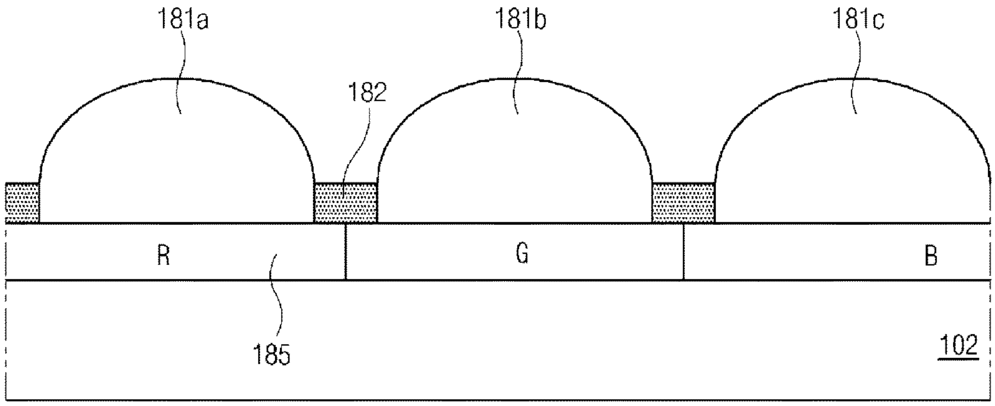


FIG. 3E

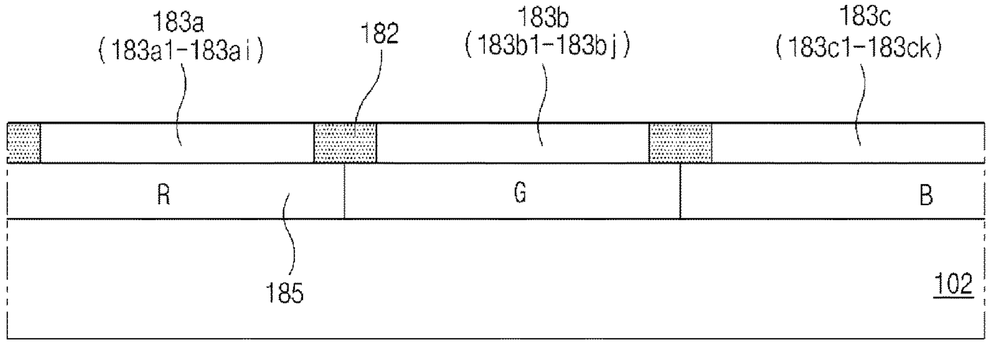

183a
(183a1-183ai)
182
183b
(183b1-183bj)
183c
(183c1-183ck)
R
G
B
185
102

FIG. 3F

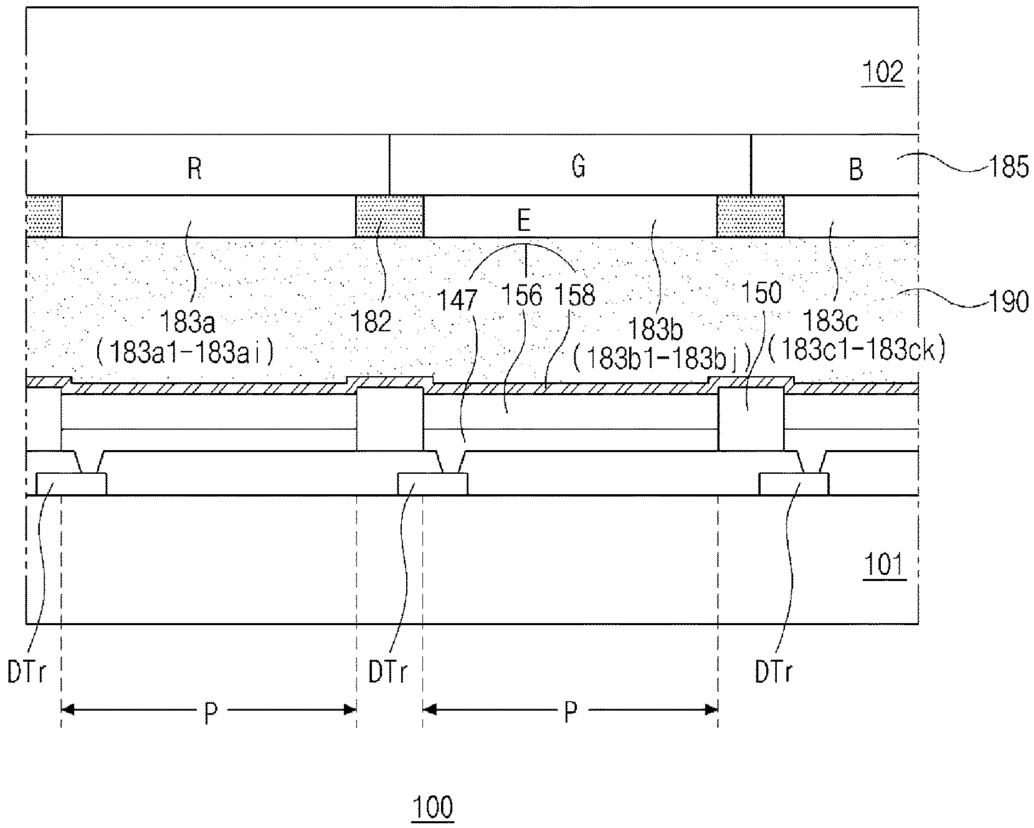
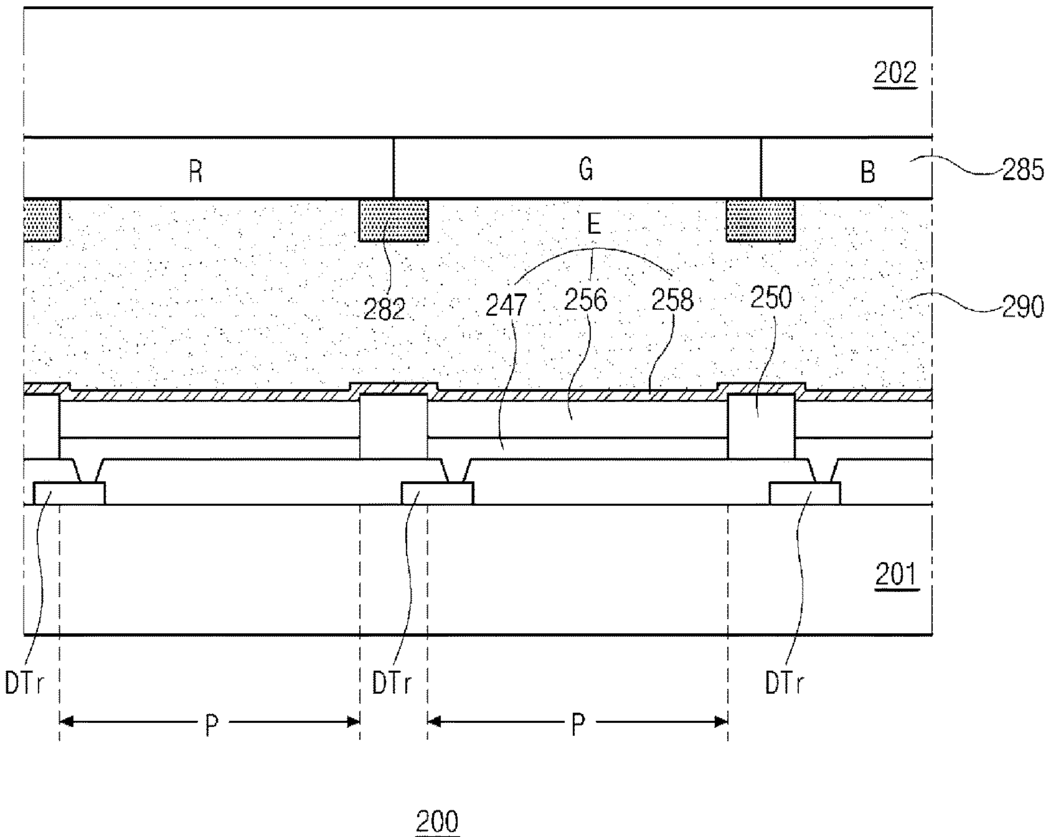

102
R
G
B
185
E
183a
(183a1-183ai)
182
147
156
158
183b
(183b1-183bj)
150
183c
(183c1-183ck)
190
101
DTr
DTr
DTr
P
P
100

FIG. 4



ORGANIC LIGHT EMITTING DISPLAY DEVICE, METHOD OF FABRICATING THE SAME, AND COLOR FILTER PLATE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Korean Patent Application No. 10-2015-0122627, filed in Republic of Korea on Aug. 31, 2015, which is hereby incorporated by reference.

BACKGROUND

1. Field of the Invention

Embodiments of the invention relate to a color filter plate and an organic light emitting display (OLED) device, and more particularly, to a color filter plate and an OLED device being capable of preventing a visibility degradation by an ambient light and improving transmissivity and a method of fabricating the OLED device.

2. Discussion of the Related Art

Recently, flat panel display devices, such as a plasma display panel (PDP), a liquid crystal display (LCD) device, and an OLED device, are widely researched and used.

Among these flat panel display devices, since the OLED device as a self-emission type display device does not implement a backlight unit, the OLED device may have advantages of light weight and thin profile.

In addition, the OLED device has excellent characteristics of a viewing angle, a contrast ratio, power consumption, a response time, production costs, production yield, and so on.

An organic emitting diode of the OLED device may include first and second electrodes and an organic emitting layer, which includes a hole transporting layer (HTL), an electron transporting layer (ETL) and an emitting material layer (EML) therebetween, between the first and second electrodes.

In addition, to improve an emitting efficiency, the organic emitting layer may further include a hole injection layer (HIL) between the first electrode and the HTL and an electron injection layer (EIL) between the second electrode and the ETL.

When voltages are applied to the first and second electrodes, the holes from the first electrode and the electrons from the second electrodes are combined in the EML such that excitons are generated. The excitons are transited from an exciting state to a ground state such that the light is emitted from the organic emitting layer.

FIG. **1** is a schematic view illustrating a related art OLED device.

Referring to FIG. **1**, the OLED device **10** includes the second electrode (not shown) as a cathode. To facilitate the electron injection and increase the emitting efficiency, the second electrode may be formed of a metallic material, e.g., magnesium, magnesium-silver alloy, aluminum, lithium-aluminum alloy and calcium. However, the second electrode of the above metallic material has a high light reflectance. As a result, the ambient light is reflected by the second electrode such that the visibility of the OLED device **10** is degraded. Namely, the ambient contrast ratio of the OLED device **10** is decreased.

To prevent the above problem, a circular polarization plate, which includes a linear polarization plate **70** and a ¼ retardation plate **30**, is disposed on or over the second electrode.

However, when the circular polarization plate is used, the light from the organic emitting layer of the OLED device **10** (i.e., the internal light) is absorbed by the circular polarization plate such the OLED device **10** may have that the transmissivity below about 43%. Namely, the transmissivity of the OLED device **10** is remarkably decreased. To compensate the decreased transmissivity, the power consumption of the OLED device **10** should be increased.

On the other hand, since the circular polarization plate is susceptible to damage from moisture, a tri-acetyl-cellulose (TAC) film is attached to lower and upper sides of the circular polarization plate to protect the circular polarization plate from the moisture.

However, since the TAC film has a hard (i.e., solid or stiff) property, the circular polarization plate including the TAC films is difficult to use for a flexible OLED device.

SUMMARY

Accordingly, the present invention is directed to a flexible OLED device, a method of fabricating the same, and a color filter plate that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

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

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, a color filter plate includes a substrate including a first pixel region; a first color filter pattern over the substrate and transmitting light having a first wavelength range; and a first dye layer corresponding to the first color filter pattern and over the substrate, the first dye layer including first and second dyes, wherein the first dye absorbs light having a second wavelength range other than the first wavelength range, and the second dye absorbs light having a third wavelength range other than the first wavelength range and the second wavelength range.

In another aspect, a display panel includes first and second substrates facing each other and including a first pixel region; a thin-film transistor between the first substrate and the second substrate; a first color filter pattern over the second substrate and transmitting light having a first wavelength range; and a first dye layer corresponding to the first color filter pattern and over the second substrate, the first dye layer including first and second dyes, wherein the first dye absorbs light having a second wavelength range other than the first wavelength range, and the second dye absorbs light having a third wavelength range other than the first wavelength range and the second wavelength range.

In another aspect, an organic light emitting display (OLED) device includes first and second substrates facing each other and including a first pixel region; an organic emitting diode between the first and second substrates and in the first pixel region; and an adhesive layer between the second substrate and the organic emitting diode and including first to third dyes, wherein the first dye absorbs light having a wavelength range below 450 nm, and the second dye absorbs light having a wavelength range of 550 to 650 nm, and wherein the third dye absorbs light having a wavelength range above 720 nm.

In another aspect, a method of fabricating an organic light emitting display (OLED) device includes forming an organic emitting diode on a first substrate including red, green and blue pixel regions; forming red, green and blue color filter pattern on a second substrate, the red, green and blue color filter patterns respectively corresponding to the red, green and blue pixel regions; forming first to third dye layers respectively on the red, green and blue color filter patterns; and attaching the first and second substrates, wherein the first dye layer includes first and second dyes, and the second dye layer includes the first dye and a third dye, wherein the third dye layer includes the second and third dyes, and the first to third dyes respectively absorbs light having first to third wavelength ranges, respectively, and wherein the second wavelength range is larger than the first wavelength range and smaller than the third wavelength range.

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 invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **1** is a schematic view illustrating a related art OLED device.

FIG. **2** is a schematic cross-sectional view of an OLED device according to a first embodiment of the present invention.

FIGS. **3**A through **3**F are schematic cross-sectional views illustrating a fabricating process of an OLED device according to the first embodiment of the present invention.

FIG. **4** is a schematic cross-sectional view of an OLED device according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings.

FIG. **2** is a schematic cross-sectional view of an OLED device according to the first embodiment of the present invention. All the components of the OLED device according to all embodiments of the present invention are operatively coupled and configured.

As shown in FIG. **2**, the OLED device **100** includes a first substrate **101** including pixel regions P, a second substrate **102** facing the first substrate **101**, an organic emitting diode E, first to third dye layer **183***a*, **183***b* and **183***c* and a color filter layer **185** including red, green and blue color filter patterns R, G and B. Each of the first, second and third dye layers **183***a*, **183***b* and **183***c* includes more than one dye to absorb light having a different wavelength range. Each dye layer is labelled **183***a* (**183***a***1**-**183***ai*), **183***b* (**183***b***1**-**183***bj*) and **183***c* (**183***c***1**-**183***ck*), as illustrated in FIGS. **2**, **3**E and **3**F to indicate that each of the dye layers **183***a*, **183***b* and **183***c* includes more than one dye, where i, j and k each represents a natural number higher than one. The pixel regions P includes red, green and blue pixel regions P, and the red, green and blue color filter patterns R, G and B respectively corresponds to the red, green and blue pixel regions P.

Each of the first and second substrates **101** and **102** may have a flexible property. For example, each of the first and second substrates **101** and **102** may include a flexible glass or a flexible plastic.

A driving thin film transistor (TFT) DTr is formed on or over the substrate **101** in each pixel region P, and a bank **150** is formed over the first substrate **101** at a boundary of the pixel regions P.

The organic emitting diode E is disposed between the first and second substrates **101** and **102** and is electrically connected to the driving TFT DTr. The organic emitting diode E includes first and second electrodes **147** and **158** and an organic emitting layer **156** between the first and second electrodes **147** and **158**. The first electrode **147** is electrically connected to an electrode of the driving TFT DTr and has an island shape in each pixel region P to be separated in adjacent pixel regions P. The organic emitting layer **156** in the pixel regions P is formed of the same material. For example, the white light may be emitted from the organic emitting layer **156** in all of the pixel regions P. The second electrode **158** covers an entire of a display area of the OLED device **100**.

The first electrode **147** may include a relatively high work function material to serve as an anode, and the second electrode **158** may include a relatively low work function material to serve as a cathode. For example, the first electrode **147** may include a transparent conductive material, e.g., indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), and the second electrode **158** may include a metallic material, e.g., magnesium, magnesium-silver alloy, aluminum, lithium-aluminum alloy or calcium.

The color filter layer **185** is formed on or over the second substrate **102**, and a black matrix **182**, which has a lattice shape and corresponds to a boundary of the pixel regions P, is formed on the color filter layer **185**. Namely, the black matrix **182** may overlap the bank **150**.

The color filter layer **185** may provide a flat top surface, and the black matrix **182** is formed to expose a portion of the color filter layer **185** in the pixel region P. Namely, the black matrix **182** is positioned at a boundary of the adjacent color filter patterns R, G and B. The black matrix **182** has an opening in correspondence to the pixel region P such that the color filter layer **185** and the black matrix **182** provide an uneven top surface.

In addition, the first to third dye layers **183***a*, **183***b*, **183***c* are formed on the color filter layer **185** and correspond to the pixel regions P. The first to third dye layers **183***a* to **183***c* correspond to the red, green and blue color filter patterns R, G and B, respectively. In other words, the first to third dye layers **183***a*, **183***b*, **183***c* fill the openings of the black matrix **182** such that the first to third dye layers **183***a*, **183***b*, **183***c* and the black matrix **182** may provide a flat top surface.

The color filter layer **185** is positioned between the organic emitting diode E and the second substrate **102**, and the first to third dye layers **183***a* to **183***c* are positioned between the organic emitting diode E and the color filter layer **185**.

The first dye layer **183***a* includes a first dye absorbing the light of a first wavelength range and a second dye absorbing the light of a second wavelength range. The second dye layer **183***b* includes the first dye and a third dye absorbing the light of a third wavelength range. The third dye layer **183***c* includes the second and third dyes.

The center wavelength of the second wavelength range is larger than that of the first wavelength range and smaller than that of the third wavelength range. For example, the first wavelength range corresponds to a blue wavelength range and may be about 450 to 490 nm. The second wavelength range corresponds to a green wavelength range and may be about 490 to 550 nm. The third wavelength range corresponds to a red wavelength range and may be about 650 to 720 nm.

In addition, each of the first to third dye layers **183***a* to **183***c* may further include at least one of a fourth dye absorbing a fourth wavelength range whose center wavelength is smaller than that of the first wavelength range, a fifth dye absorbing a fifth wavelength range whose center wavelength is larger than that of the third wavelength range, and a sixth dye absorbing a sixth wavelength range whose center wavelength is between that of the second and that of the third wavelength ranges. For example, each of the first to third dye layers **183***a* to **183***c* may further include all of the fourth to sixth dyes.

For example, the first dye may include at least one being selected from the group consisting of acridine orange, acridine yellow, proflavin (acridine-based compounds), auramine O (arylmethine-based compound), coumarin 6, coumarin 343 (coumarin-based compounds), 4-(dicyanomethylene)-2-methyl-6-(p-dimethylaminostyryl)-4H-pyran (DCM) and 4-Dimethylamino-4'-nitrostilbene (merocyanine-based compounds). The first dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the first dye layer **183***a*.

The second dye may include at least one being selected from the group consisting of auramine O, crystal viole (arylmethine-based compounds), N,N'-Difluoroboryl-1,9-dimethyl-5-[(4-(2-trimethylsilylethynyl), N,N'-Difluoroboryl-1,9-dimethyl-5-phenydipyrrin (dipyrrin-based compounds), eosin Y, fluorescein, sulforhodamine 101, rhodamine 123, rhodamine 6G, rhodamine B, rose bengal (xanthene-based compounds cryptocyanine, thiacarbocyanine (C3), indodicarbocyanine (C5) and indotricarbocyanine (C7) (cyanine-based compounds). The second dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the second dye layer **183***b*.

The fourth dye may include at least one being selected from the group consisting of 4',6-diamidino-2-phenylindole (DAPI), dimethylsulfoxide, dansyl glycine, dioxane, lucifer yellow CH, hoechst 33258, DMF and piroxicam (miscellaneous-based compounds). The fourth dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the fourth dye.

The fifth dye may include at least one being selected from the group consisting of nile blue, oxazine 1 and NIR (oxazine-based compounds). The fifth dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the fifth dye.

The first substrate **101** including the second electrode **158** and the second substrate **102** including the first to third dye layers **183***a* to **183***c* are attached to each other using an adhesive layer **190**. Namely, the adhesive layer **190** is disposed between the second electrode **158** and the first to third dye layers **183***a* to **183***c*. The adhesive layer **190** has a transparent property and an adhesive property.

The ambient (i.e., external) light absorption and the internal light transmittance in the OLED device **100** according to the first embodiment of the present invention are explained with reference to FIG. **2**.

In a red pixel region, the first dye layer **183***a* includes the first, second and fourth to sixth dyes. In a green pixel region, the second dye layer **183***b* includes the first and third to sixth dyes. In a blue pixel region, the third dye layer **183***c* includes the second to sixth dyes.

The external light passes through the red, green and blue color filter patterns R, G and B and the first to third dye layers **183***a* to **183***c*, respectively.

In the red pixel region, the external light passes through the red color filter pattern R and the first dye layer **183***a* such that the light having a wavelength range substantially below 650 nm and above 720 nm is absorbed and the light having the wavelength range about 650 to 720 nm is transmitted through the red color filter pattern R and the first dye layer **183***a*. Then, the light is reflected by the second electrode **158** of the organic emitting diode E toward the first dye layer **183***a*. As a result, non-absorbed light having the wavelength range substantially below 650 nm and above 720 nm is absorbed again by the first dye layer **183***a* and the red color filter pattern R.

In the green pixel region, the external light passes through the green color filter pattern G and the second dye layer **183***b* such that the light having a wavelength range substantially below 490 nm and above 550 nm is absorbed and the light having the wavelength range about 490 to 550 nm is transmitted through the green color filter pattern G and the second dye layer **183***b*. Then, the light is reflected by the second electrode **158** of the organic emitting diode E toward the second dye layer **183***b*. As a result, non-absorbed light having the wavelength range substantially below 490 nm and above 550 nm is absorbed again by the second dye layer **183***b* and the green color filter pattern G.

In the blue pixel region, the external light passes through the blue color filter pattern B and the third dye layer **183***c* such that the light having a wavelength range substantially below 450 nm and above 490 nm is absorbed and the light having the wavelength range about 450 to 490 nm is transmitted through the blue color filter pattern B and the third dye layer **183***c*. Then, the light is reflected by the second electrode **158** of the organic emitting diode E toward the third dye layer **183***c*. As a result, non-absorbed light having the wavelength range substantially below 450 nm and above 490 nm is absorbed again by the third dye layer **183***c* and the blue color filter pattern B.

In this instance, the absorption wavelength ranges of the first to third dye layers **183***a* to **183***c* may be greater than those of the red, green and blue color filter patterns R, G and B, respectively. As a result, by disposing the first to third dye layers **183***a* to **183***c* under the first to third color filter patterns R, G and B, the reflectance of the external light is efficiently blocked such that the visibility of the OLED device **100** is improved.

In the present invention, the black matrix **182** is disposed between the color filter layer **185** and the organic emitting diode E and positioned at a boundary of adjacent color filter patterns R, G and B of the color filter layer **185**. As a result, a portion of the red color filter pattern R, a portion of the green color filter pattern G and a portion of the blue color filter pattern B are disposed between the black matrix **182** and the second substrate **102**. The external light is partially absorbed by the color filter patterns R, G and B and is reflected by the black matrix **182**. The reflected external light is absorbed again by the color filter patterns R, G and B. On the other hand, if the black matrix **182** is directly formed on the second substrate **102**, i.e., between the second substrate **102** and the color filter layer **185**, the external light is directly reflected by the black matrix **182**. Accordingly, in the OLED device **100**, the external light reflection is decreased.

Although the dye layers **183***a* to **183***c* are between the second substrate **102** and the organic emitting diode E in the above embodiment and in FIG. **2**, the second substrate **102** is between the dye layers **183***a* to **183***c* and the organic emitting diode E in another embodiment. In one embodiment, the color filter patterns R, G, and B are all above the second substrate **102**, and the dye layers **183***a* to **183***c* are all above and corresponding to the color filter pattern R, G, and B, respectively. In another embodiment, the color filter patterns R, G, and B are all between the second substrate **102** and the organic emitting diode E, and the dye layers **183***a* to **183***c* are all above the second substrate **102** and corresponding to the color filter pattern R, G, and B, respectively.

As mentioned above, in the OLED device **100**, the external light except the light having the wavelength range about 650 to 720 nm (e.g., red light wavelength range) is absorbed by the red color filter pattern R and the first dye layer **183***a*, and the external light except the light having the wavelength range about 490 to 550 nm (e.g., green light wavelength range) is absorbed by the green color filter pattern G and the second dye layer **183***b*. In addition, the external light except the light having the wavelength range about 450 to 490 nm (e.g., blue light wavelength range) is absorbed by the blue color filter pattern B and the third dye layer **183***c*. As a result, the visibility degradation of the OLED device **100** by the external (i.e., ambient) light is prevented.

On the other hand, the internal light, which is emitted from the organic emitting diode E, passes through the first to third dye layers **183***a* to **183***c* and the red, green and blue color filter patterns R, G and B, respectively.

In the red pixel region, the internal light passes through the first dye layer **183***a* and the red color filter pattern R such that the light having a wavelength range substantially below 650 nm and above 720 nm is absorbed and the light having the wavelength range about 650 to 720 nm is transmitted through the first dye layer **183***a* and the red color filter pattern R.

In the green pixel region, the internal light passes through the second dye layer **183***b* and the green color filter pattern G such that the light having a wavelength range substantially below 490 nm and above 550 nm is absorbed and the light having the wavelength range about 490 to 550 nm is transmitted through the second dye layer **183***b* and the green color filter pattern G.

In the blue pixel region, the internal light passes through the third dye layer **183***c* and the blue color filter pattern B such that the light having a wavelength range substantially below 450 nm and above 490 nm is absorbed and the light having the wavelength range about 450 nm to 490 nm is transmitted through the third dye layer **183***c* and the blue color filter pattern B.

In this instance, the center wavelengths of the transmittance wavelength ranges of the first to third dye layers **183***a* to **183***c* may be smaller than those of the red, green and blue color filter patterns R, G and B, respectively. As a result, by disposing the first to third dye layers **183***a* to **183***c* under the first to third color filter patterns R, G and B, the color purity of the OLED device **100** is improved.

As mentioned above, in the OLED device **100**, the light having the wavelength range about 650 to 720 nm (e.g., red light wavelength range) of the total light from the organic emitting diode E passes through the first dye layer **183***a* and the red color filter pattern R, and the light having the wavelength range about 490 to 550 nm (e.g., green light wavelength range) is passes through the second dye layer **183***b* and the green color filter pattern G. In addition, the light having the wavelength range about 450 to 490 nm (e.g., blue light wavelength range) is passes through the third dye layer **183***c* and the blue color filter pattern B. As a result, the color purity of the OLED device **100** is improved.

In addition, in the OLED device **100** of the present invention, since the visibility degradation by the external light is prevented without the circular polarization plate (of FIG. **1**), the transmissivity of the internal light in the OLED device **100** is improved. Moreover, since the OLED device **100** does not require the circular polarization plate having the hard property, a flexible OLED device can be provided.

FIGS. **3**A through **3**F are schematic cross-sectional views illustrating a fabricating process of an OLED device according to the first embodiment of the present invention.

The fabricating process of the OLED device may include a step of forming an organic emitting diode on a first substrate in each pixel region, a step of forming a color filter layer on a second substrate, a step of forming first to third dye layers on the color filter layer and a step of attaching the first and second substrates.

In this instance, the first dye layer **183***a* includes the first and second dyes respectively absorbing the first and second wavelength ranges, and the second dye layer **183***b* include the first and third dyes respectively absorbing the first and third wavelength ranges. In addition, the third dye layer **183***c* includes the second and third dyes respectively absorbing the second and third wavelength ranges. Each of the first to third dye layers **183***a* to **183***c* may further include the fourth to sixth dyes.

As shown in FIG. **3**A, the driving TFT DTr is formed on the first substrate **101** in each pixel region P, and the organic emitting diode E is formed over the driving TFT DTr. The organic emitting diode E include the first and second electrodes **147** and **158** and the organic emitting layer **156** therebetween, and the first electrode **147** is electrically connected to the driving TFT DTr. In addition, the bank **150** is formed at a boundary of the pixel region P to define the pixel region P. The bank **150** may cover edges of the first electrode **147**.

In this instance, the first electrode **147** may include a transparent conductive material, e.g., indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), and the second electrode **158** may include a metallic material, e.g., magnesium, magnesium-silver alloy, aluminum, lithium-aluminum alloy or calcium.

Next, as shown in FIG. **3**B, the color filter layer **185** including the red, green and blue color filter patterns R, G and B is formed on the second substrate **102**. The second substrate **102** may have a flexible property. For example, the second substrate **102** may include a flexible glass or a flexible plastic.

Next, as shown in FIG. **3**C, the black matrix **182** corresponding to the boundary of the pixel region P is formed on the color filter layer **185**.

Next, as shown in FIG. **3**D, a first dye solution **181***a* including the first and second dyes is dropped on the red color filter pattern R in the red pixel region, a second dye solution **181***b* including the first and third dyes is dropped on the green color filter pattern G in the green pixel region, and a third dye solution **181***c* including the second and third dyes is dropped on the blue color filter pattern B in the blue pixel region. The first to third dye solutions **181***a* to **181***c* may be formed by a solution process, for example, a screen printing process, an inkjet printing process and a nozzle printing process.

As mentioned above, the first dye absorbs the light of a first wavelength range, i.e., 450 to 490 nm, the second dye absorbs the light of a second wavelength range, i.e., 490 to 550 nm, and the third dye absorbs the light of a third wavelength range, i.e., 650 to 720 nm.

In addition, each of the first to third dye solutions **181***a* to **181***c* may further include at least one of the fourth to sixth dyes. The fourth dye absorbs the light of a fourth wavelength range whose center wavelength is smaller than that the first wavelength range, a fifth dye absorbs the light of a fifth wavelength range being larger than the third wavelength range, and a sixth dye absorbs the light of a sixth wavelength range between the second and third wavelength ranges.

Next, as shown in FIG. **3**E, the first to third dye solutions **181***a* to **181***c* (of FIG. **3**D) are dried to form the first to third dye layers **183***a* to **183***c* respectively on the red, green and blue color filter patterns R, G and B. Since the overflow of the first to third dye solutions **181***a* to **181***c* are blocked by the black matrix **182**, the first to third dye solutions **181***a* to **181***c* can be dried by a single drying process. To sufficiently block the overflow of the first to third dye solutions **181***a* to **181***c* into adjacent pixel regions P, the black matrix **181** may have a hydrophobic property.

The color filter layer **185** includes pigments, while the first to third dye layers **183***a* to **183***c* include dyes. The pigment has a heat resistance property (i.e., high thermal stability), while the dye is damaged by a high temperature process (i.e., low thermal stability). Namely, if the first to third dye layers **183***a* to **183***c* are formed directly on the second substrate **102**, the first to third dye layers **183***a* to **183***c* are damaged by the step of forming the black matrix **182** (i.e., a high temperature process). Accordingly, it is desired that the first to third dye layers **183***a* to **183***c* are formed before forming the color filter layer **185**. In other words, the color filter layer **185** is positioned between the second substrate **102** and each of the first to third dye layers **183***a* to **183***c*.

Next, as shown in FIG. **3**F, the first and second substrates **101** and **102** are attached to each other using the adhesive layer **190** such that the first to third dye layers **183***a* to **183***c* face the second electrode **158**.

In FIGS. **3**A to **3**F, the steps of forming the color filter layer **185**, the black matrix **182** and the first to third dye layers **183***a* to **183***c* are performed after the step of forming the driving TFT DTr, the bank **150** and the organic emitting diode E. However, there is no limitation in the order of these steps.

FIG. **4** is a schematic cross-sectional view of an OLED device according to the second embodiment of the present invention.

As shown in FIG. **4**, the OLED device **200** includes a first substrate **201** including pixel regions P, a second substrate **202** facing the first substrate **201**, an organic emitting diode E, a color filter layer **285** including red, green and blue color filter patterns R, G and B and an adhesive layer **290** including first to third dyes. The pixel regions P includes red, green and blue pixel regions P, and the red, green and blue color filter patterns R, G and B respectively corresponds to the red, green and blue pixel regions P.

Each of the first and second substrates **201** and **202** may have a flexible property. For example, each of the first and second substrates **201** and **202** may include a flexible glass or a flexible plastic.

A driving thin film transistor (TFT) DTr is formed on or over the substrate **201** in each pixel region P, and a bank **250** is formed over the first substrate **201** at a boundary of the pixel regions P.

The organic emitting diode E is disposed between the first and second substrates **201** and **202** and is electrically connected to the driving TFT DTr. The organic emitting diode E includes first and second electrodes **247** and **258** and an organic emitting layer **256** between the first and second electrodes **247** and **258**. The first electrode **247** is electrically connected to an electrode of the driving TFT DTr and has an island shape in each pixel region P to be separated in adjacent pixel regions P. The organic emitting layer **256** in the pixel regions P is formed of the same material. For example, the white light may be emitted from the organic emitting layer **256** in all of the pixel regions P. The second electrode **258** covers an entire of a display area of the OLED device **200**.

The first electrode **247** may include a relatively high work function material to serve as an anode, and the second electrode **258** may include a relatively low work function material to serve as a cathode. For example, the first electrode **247** may include a transparent conductive material, e.g., indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), and the second electrode **258** may include a metallic material, e.g., magnesium, magnesium-silver alloy, aluminum, lithium-aluminum alloy or calcium.

The color filter layer **285** is formed on or over the second substrate **202**, and a black matrix **282**, which has a lattice shape and corresponds to a boundary of the pixel regions P, is formed on the color filter layer **285**. Namely, the black matrix **282** may overlap the bank **250**. The black matrix **282** may be omitted.

The adhesive layer **290** including first to third dyes is disposed between the color filter layer **185** and the second electrode **258**. The first and second substrates **201** and **202** are attached to each other by the adhesive layer **290** to provide the OLED device **200**.

The first dye absorbs the light having a first wavelength range below about 450 nm, the second dye absorbs the light having a second wavelength range of about 550 to 650 nm, and the third dye absorbs the light having a third wavelength range above about 720 nm.

For example, the first dye may include at least one being selected from the group consisting of 4',6-diamidino-2-phenylindole (DAPI), dimethylsulfoxide, dansyl glycine, dioxane, lucifer yellow CH, hoechst 33258, DMF and piroxicam (miscellaneous-based compounds). The first dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the first dye.

The second dye may include at least one being selected from the group consisting of cryptocyanine, thiacarbocyanine (C3), indodicarbocyanine (C5) and indotricarbocyanine (C7) (cyanine-based compounds). The second dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the second dye.

The third dye may include at least one being selected from the group consisting of nile blue, oxazine 1 and NIR (oxazine-based compounds). The third dye may be a mixture of at least two of the above compounds to adjust the absorption wavelength range of the third dye.

Since the first to third dyes are included into the adhesive layer **290**, one side of the adhesive layer **290** contacts the color filter layer **285**.

The ambient (i.e., external) light absorption and the internal light transmittance in the OLED device **200** according to the first embodiment of the present invention are explained.

The external light passes through the red, green and blue color filter patterns R, G and B and the adhesive layer **290**, respectively.

The external light passes through the red, green and blue color filter patterns R, G and B and the adhesive layer **290** such that the light having a wavelength range below 450 nm, between 550 nm and 650 nm and above 720 nm is absorbed and the light having the wavelength range between 450 nm and 550 nm and between 650 nm and 720 nm is transmitted through the red, green and blue color filter patterns R, G and B and the adhesive layer **290**. Then, the light is reflected by the second electrode **258** of the organic emitting diode E toward the adhesive layer **290**. As a result, non-absorbed light having the wavelength range below 450 nm, between 550 nm and 650 nm and above 720 nm is absorbed again by the adhesive layer **290** and the red, green and blue color filter patterns R, G and B.

In this instance, the absorption wavelength ranges of the adhesive layer **290** may be greater than those of the color filter layer **285** including the red, green and blue color filter patterns R, G and B, respectively. As a result, by disposing the adhesive layer **290** under the first to third color filter layer **285**, the reflectance of the external light is efficiently blocked such that the visibility of the OLED device **200** is improved.

In the present invention, the black matrix **282** is disposed between the color filter layer **285** and the organic emitting diode E and positioned at a boundary of adjacent color filter patterns R, G and B of the color filter layer **285**. As a result, a portion of the red color filter pattern R, a portion of the green color filter pattern G and a portion of the blue color filter pattern B are disposed between the black matrix **282** and the second substrate **202**. The external light is partially absorbed by the color filter patterns R, G and B and is reflected by the black matrix **282**. The reflected external light is absorbed again by the color filter patterns R, G and B. Accordingly, in the OLED device **200**, the external light reflection is decreased.

As mentioned above, in the OLED device **200**, the external light except the light having the wavelength range of 450 to 490 nm (e.g., blue light wavelength range), 490 to 550 nm (e.g., green light wavelength range) and 650 to 720 nm (e.g., red light wavelength range) is absorbed by the color filter layer **285** and the adhesive layer **290**. As a result, the visibility degradation of the OLED device **200** by the external (i.e., ambient) light is prevented.

On the other hand, the internal light, which is emitted from the organic emitting diode E, passes through the adhesive layer **290** and the red, green and blue color filter patterns R, G and B, respectively.

The internal light passes through the adhesive layer **290** and the red, green and blue color filter patterns R, G and B such that the light having a wavelength range below 450 nm, between 550 nm and 650 nm and above 720 nm is absorbed and the light having the wavelength range of 450 to 550 nm and 650 to 720 nm is transmitted through the adhesive layer **290** and the color filter layer **285**.

In this instance, the transmittance wavelength ranges of the adhesive layer **290** may be smaller than those of the color filter layer **285**, respectively. As a result, by disposing the adhesive layer **290** under the color filter layer **285**, the color purity of the OLED device **200** is improved.

As mentioned above, in the OLED device **200**, the light having the wavelength range of 650 to 720 nm (e.g., red light wavelength range) of the total light from the organic emitting diode E passes through the adhesive layer **290** and the red color filter pattern R, and the light having the wavelength range of 490 to 550 nm (e.g., green light wavelength range) is passes through the adhesive layer **290** and the green color filter pattern G. In addition, the light having the wavelength range of 450 to 490 nm (e.g., blue light wavelength range) is passes through the adhesive layer **290** and the blue color filter pattern B. As a result, the color purity of the OLED device **200** is improved.

In addition, in the OLED device **200** of the present invention, since the visibility degradation by the external light is prevented without the circular polarization plate (of FIG. **1**), the transmissivity of the internal light in the OLED device **200** is improved. Moreover, since the OLED device **200** does not require the circular polarization plate having the hard property, a flexible OLED device can be provided. Further, though the color filter plate including the second substrate **102**, the black matrix **182**, the dye layers **183***a* to **183***c*, and the color filter layer **185** is used in the OLED device **200**, the color filter plate may be used in other type of display device such as a LCD display device to provide similar effect and benefit.

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

What is claimed is:

1. A color filter plate for a display device, the color filter plate comprising:

a substrate including a first pixel region;

a first color filter pattern over the substrate and transmitting light having a first wavelength range; and

a first dye layer corresponding to the first color filter pattern and over the substrate, the first dye layer including first and second dyes,

wherein the first dye absorbs light having a second wavelength range other than the first wavelength range, and the second dye absorbs light having a third wavelength range other than the first wavelength range and the second wavelength range.

2. The color filter plate according to claim **1**, wherein the substrate further includes a second pixel region and a third pixel region, and the color filter plate further comprises:

a second color filter pattern over the substrate and transmitting light having the third wavelength range;

a second dye layer corresponding to the second color filter pattern and over the substrate, the second dye layer including the first dye and a third dye;

a third color filter pattern over the substrate and transmitting light having the second wavelength range; and

a third dye layer corresponding to the third color filter pattern and over the substrate, the third dye layer including the second and third dyes,

wherein the third dye absorbs light having the first wavelength range.

3. The color filter plate according to claim **1**, further comprising:

a black matrix at a boundary of the first color filter pattern, wherein a portion of the first color filter pattern is positioned between the black matrix and the substrate.

4. The color filter plate according to claim **1**, wherein the first wavelength range is 450 to 490 nm, and the second wavelength range is 490 to 550 nm, and

wherein the third wavelength range is 650 to 720 nm.

5. The color filter plate according to claim **1**, wherein each of the first to third dye layers further includes fourth, fifth and sixth dyes,

wherein the fourth dye absorbs light having a wavelength range being smaller than the first wavelength range, and the fifth dye absorbs light having a wavelength range being greater than the third wavelength range, and

wherein the sixth dye absorbs light having a wavelength range between the second and third wavelength range.

6. The color filter plate according to claim **2**, further comprising:

a black matrix at a boundary between the first color filter pattern and the second color filter pattern,

wherein a portion of each of the first color filter pattern and the second color filter pattern is positioned between the black matrix and the substrate.

7. The color filter plate according to claim **2**, wherein the first, second and third dye layers are disposed under the first, second and third color filter patterns.

8. The color filter plate according to claim **6**, wherein the first to third dye layers and the black matrix provide a flat top surface.

9. The color filter plate according to claim **3**, wherein the black matrix has a hydrophobic property.

10. A display panel, comprising:

first and second substrates facing each other and including a first pixel region;

a thin-film transistor between the first substrate and the second substrate;

a first color filter pattern over the second substrate and transmitting light having a first wavelength range; and

a first dye layer corresponding to the first color filter pattern and over the second substrate, the first dye layer including first and second dyes,

wherein the first dye absorbs light having a second wavelength range other than the first wavelength range, and the second dye absorbs light having a third wavelength range other than the first wavelength range and the second wavelength range.

11. The display panel according to claim **10**, comprising:

an organic emitting diode between the first substrate and the second substrate.

12. An organic light emitting display device, comprising:

first and second substrates facing each other and including a first pixel region;

an organic emitting diode between the first and second substrates and in the first pixel region; and

an adhesive layer between the second substrate and the organic emitting diode and including first, second and third dyes,

wherein the first dye absorbs light having a wavelength range below 450 nm, and the second dye absorbs light having a wavelength range of 550 to 650 nm, and

wherein the third dye absorbs light having a wavelength range above 720 nm.

13. The organic light emitting display device according to claim **12**, further comprising a color filter layer between the second substrate and the first substrate,

wherein the color filter layer includes a first color filter pattern, a second color filter pattern, and a third color filter pattern.

14. The organic light emitting display device according to claim **13**, wherein the color filter layer is between the second substrate and the adhesive layer.

15. The organic light emitting display device according to claim **13**, wherein the adhesive layer contacts the color filter layer.

16. The organic light emitting display device according to claim **13**, further comprising:

a black matrix at a boundary of the first, second, and third color filter patterns,

wherein a portion of the first color filter pattern, a portion of the second color filter pattern and a portion of the third color filter pattern are positioned between the black matrix and the second substrate.

17. A method of fabricating an organic light emitting display device, comprising:

forming an organic emitting diode on a first substrate including red, green and blue pixel regions;

forming red, green and blue color filter pattern on a second substrate to form a color filter layer, the red, green and blue color filter patterns respectively corresponding to the red, green and blue pixel regions;

forming first, second and third dye layers respectively on the red, green and blue color filter patterns; and

attaching the first and second substrates,

wherein the first dye layer includes first and second dyes, and the second dye layer includes the first dye and a third dye,

wherein the third dye layer includes the second and third dyes, and the first to third dyes respectively absorbs light having first to third wavelength ranges, respectively, and

wherein the second wavelength range is larger than the first wavelength range and smaller than the third wavelength range.

18. The method according to claim **17**, further comprising:

forming a black matrix on the color filter layer at a boundary of the red, green and blue pixel regions before the step of forming the first to third dye layers.

19. The method according to claim **18**, wherein the step of forming the first to third dye layers is performed by a solution process, and the black matrix has a hydrophobic property.

20. The method according to claim **18**, wherein the step of forming the first to third dye layers includes:

dropping a first dye solution on the red color filter pattern;

dropping a second dye solution on the green color filter pattern;

dropping a third dye solution on the blue color filter pattern; and

drying the first to third dye solution by a single drying process to form the first to third dye layers.

* * * * *

专利名称(译)	有机发光显示装置，其制造方法以及滤色板		
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[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO.，LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO.，LTD.		
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发明人	PAEK, SEUNG-HAN BAE, HYO-DAE OH, YOUNG-MU LEE, JEONG-WON SONG, HEON-IL YEO, JONG-HOON		
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摘要(译)

根据实施例的用于显示装置的滤色板包括：基板，包括第一像素区域;在基板上方的第一滤色器图案并透射具有第一波长范围的光;第一染料层对应于第一滤色器图案并位于基板上，第一染料层包括第一和第二染料，其中第一染料吸收具有第一波长范围以外的第二波长范围的光，第二染料吸收具有除第一波长范围和第二波长范围之外的第三波长范围的光。