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(54) **ORGANIC LIGHT EMITTING DIODE DISPLAY AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Young-In HWANG**, Yongin-si (KR); **Baek-Woon LEE**, Yongin-si (KR); **Hae-Yeon LEE**, Bucheon-si (KR); **Young-Gu JU**, Daegu-si (KR)

Correspondence Address:
CANTOR COLBURN, LLP
20 Church Street, 22nd Floor
Hartford, CT 06103 (US)

(73) Assignees: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR); **Kyungpook National University Industry-Academic Cooperation Foundation**, Daegu-si (KR)

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(57) **ABSTRACT**

An organic light emitting diode (OLED) display and a method of manufacturing the same are disclosed. The OLED display includes a first pixel, a second pixel, and a third pixel that display different colors. The display includes a first electrode, a second electrode that is opposite to the first electrode, and an emission layer which is disposed between the first electrode and the second electrode. A semi-transparent member is positioned on or under the first electrode and forms a microcavity together with the second electrode. An overcoating film is positioned under the semi-transparent member. At least one of the first pixel, the second pixel, and the third pixel has embossings formed in a surface of the semi-transparent member.

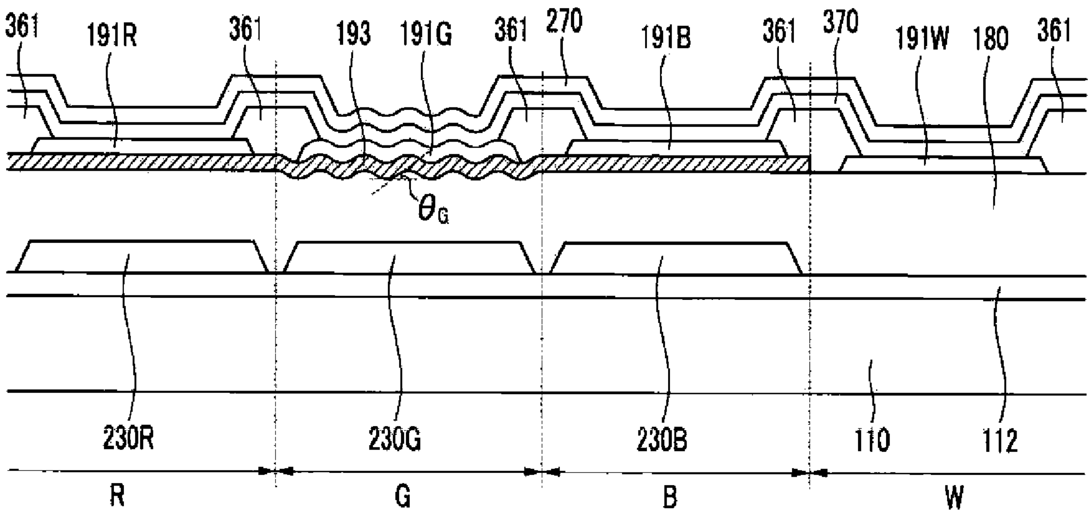


FIG.1

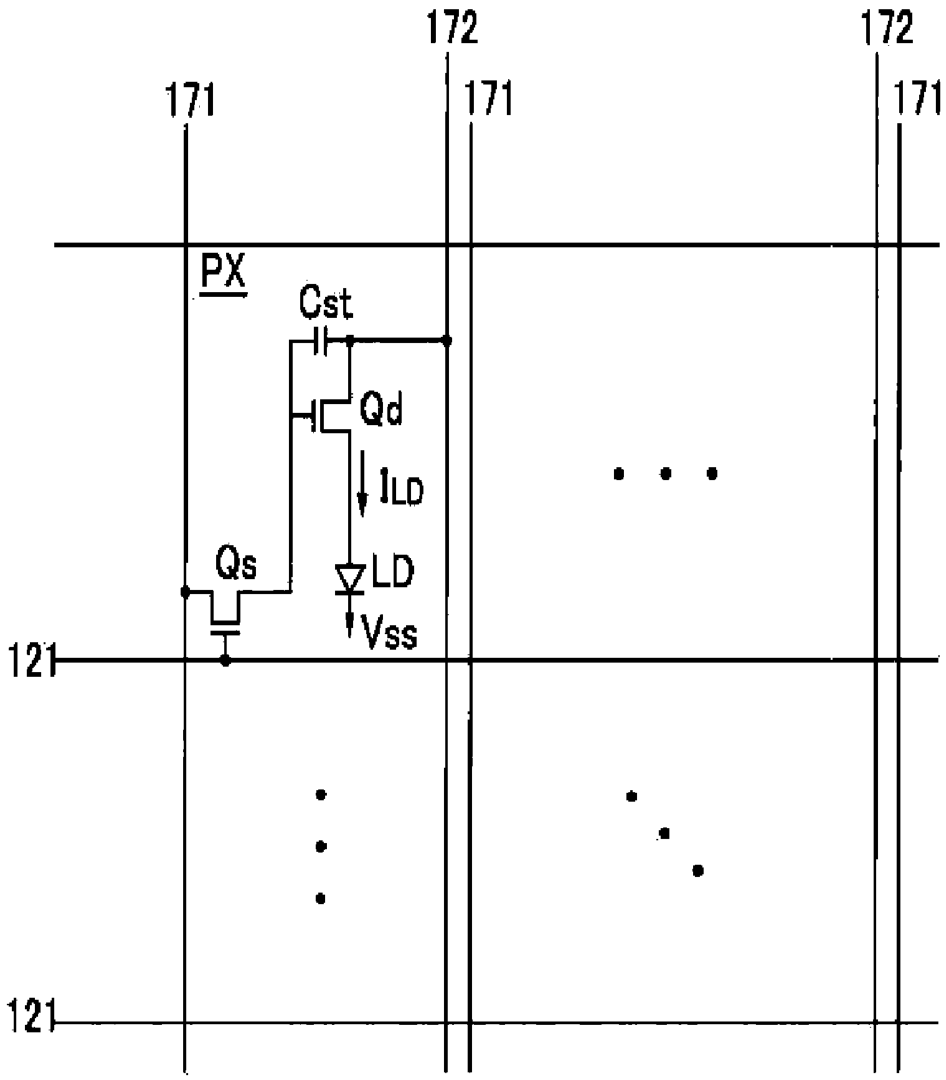


FIG.2

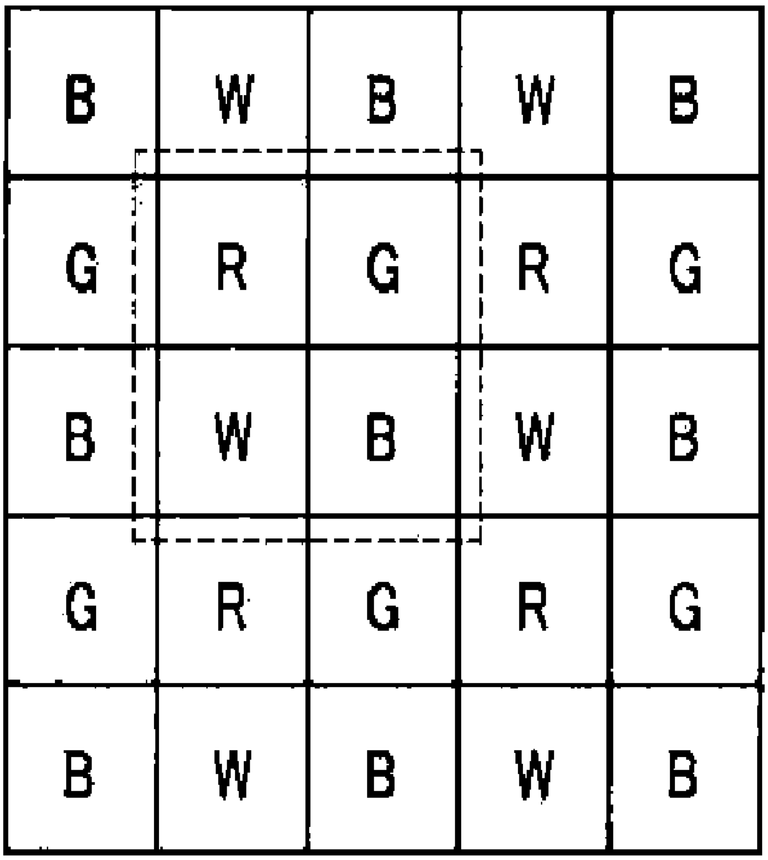
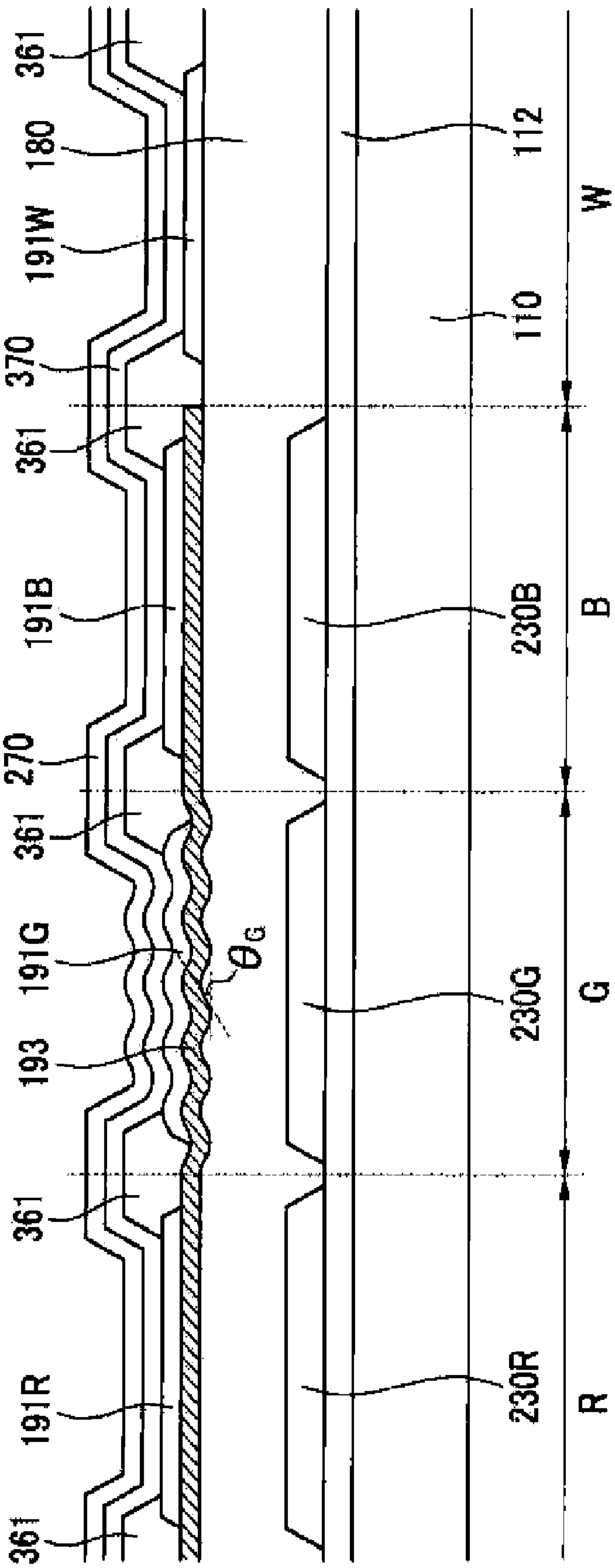


FIG.3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191B
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361
191G
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191R
361
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W
110
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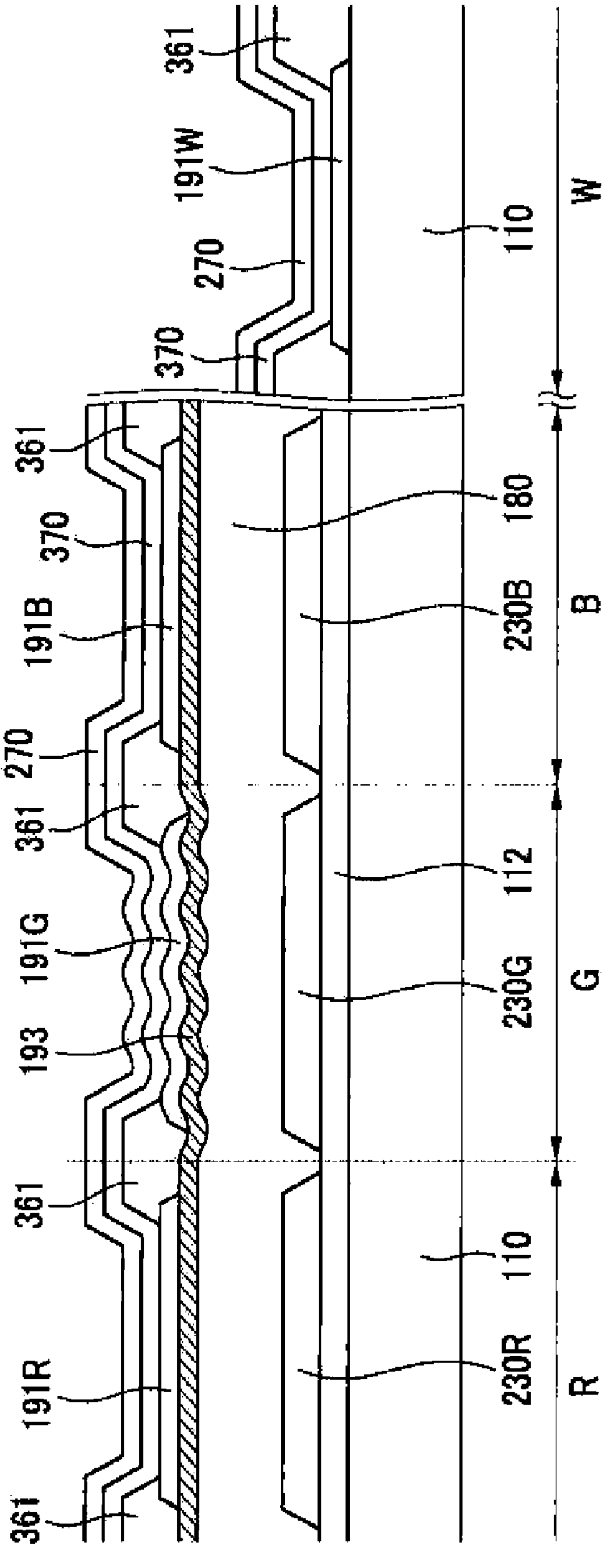
G
230R
R

FIG.4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270
191B
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180
110
R
G
B
W

FIG.5

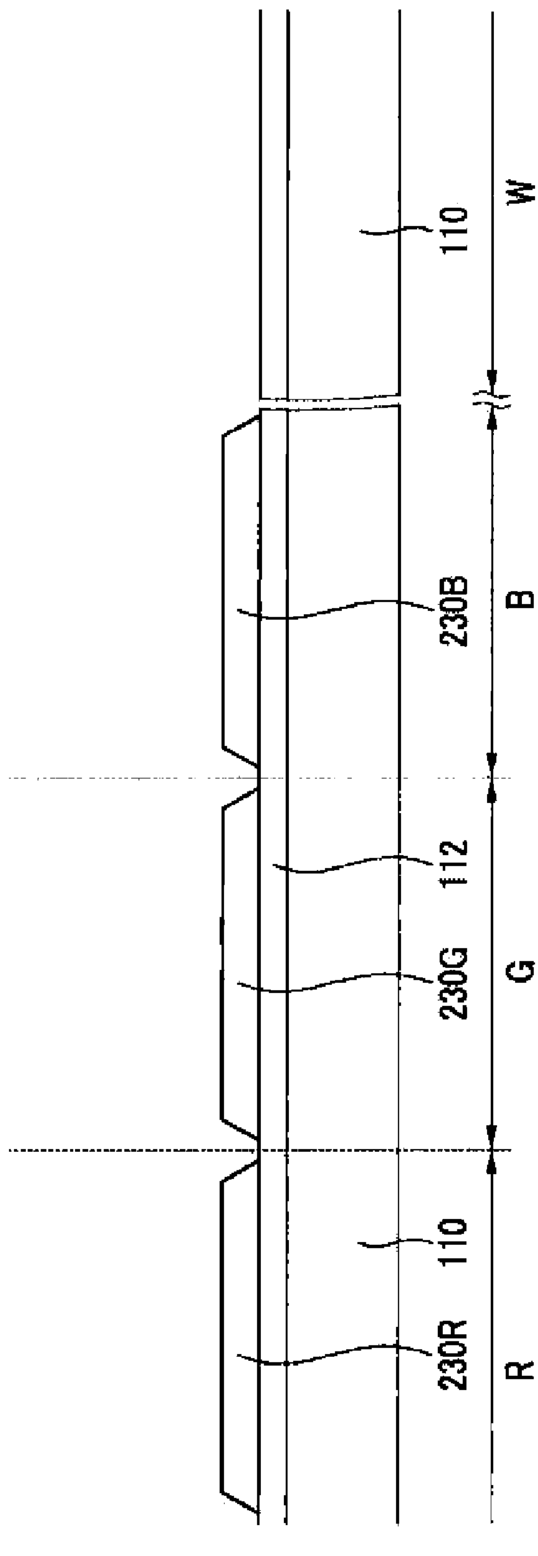


FIG.6

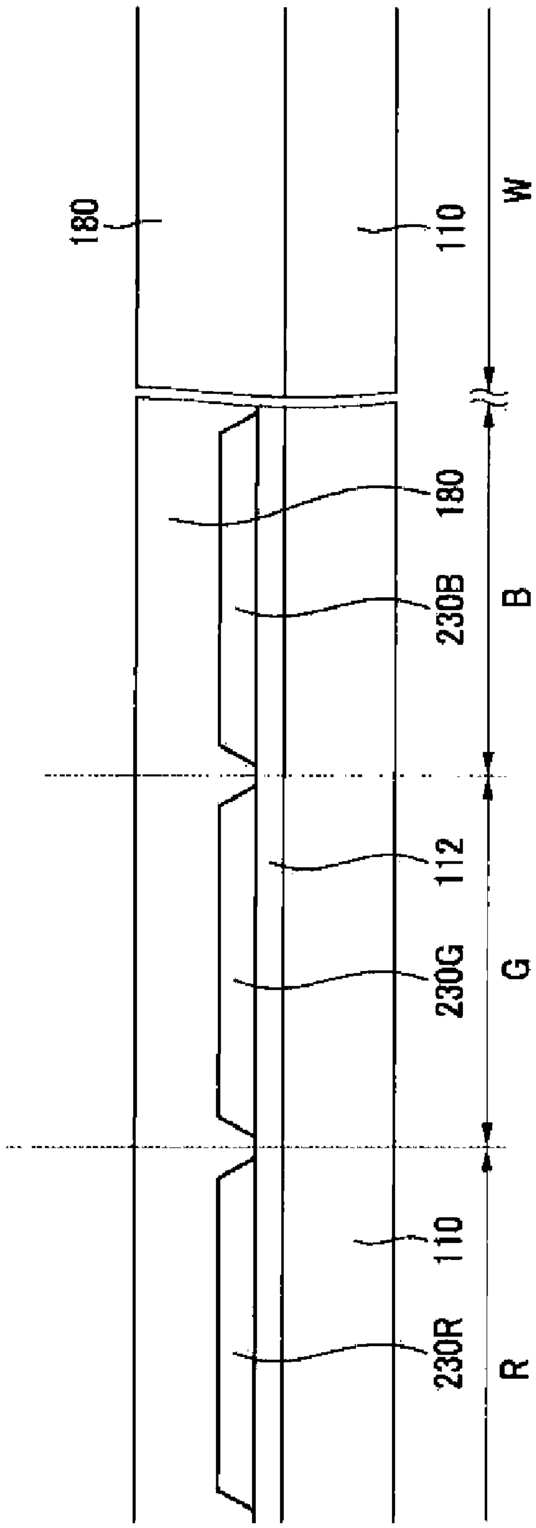


FIG.7

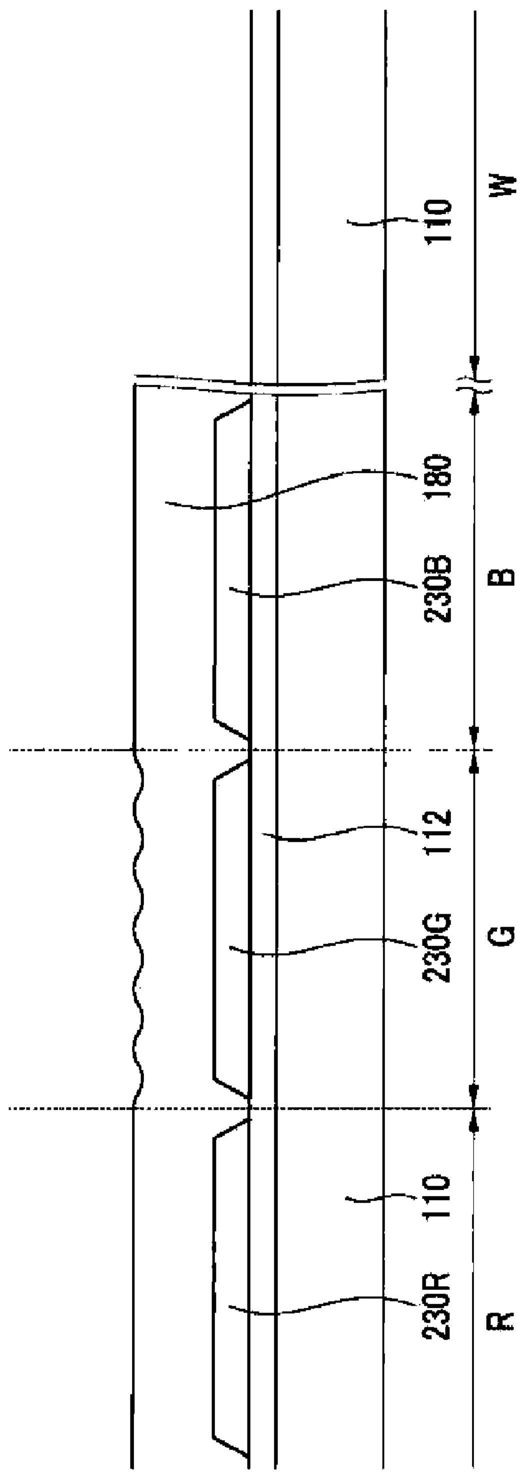


FIG.8

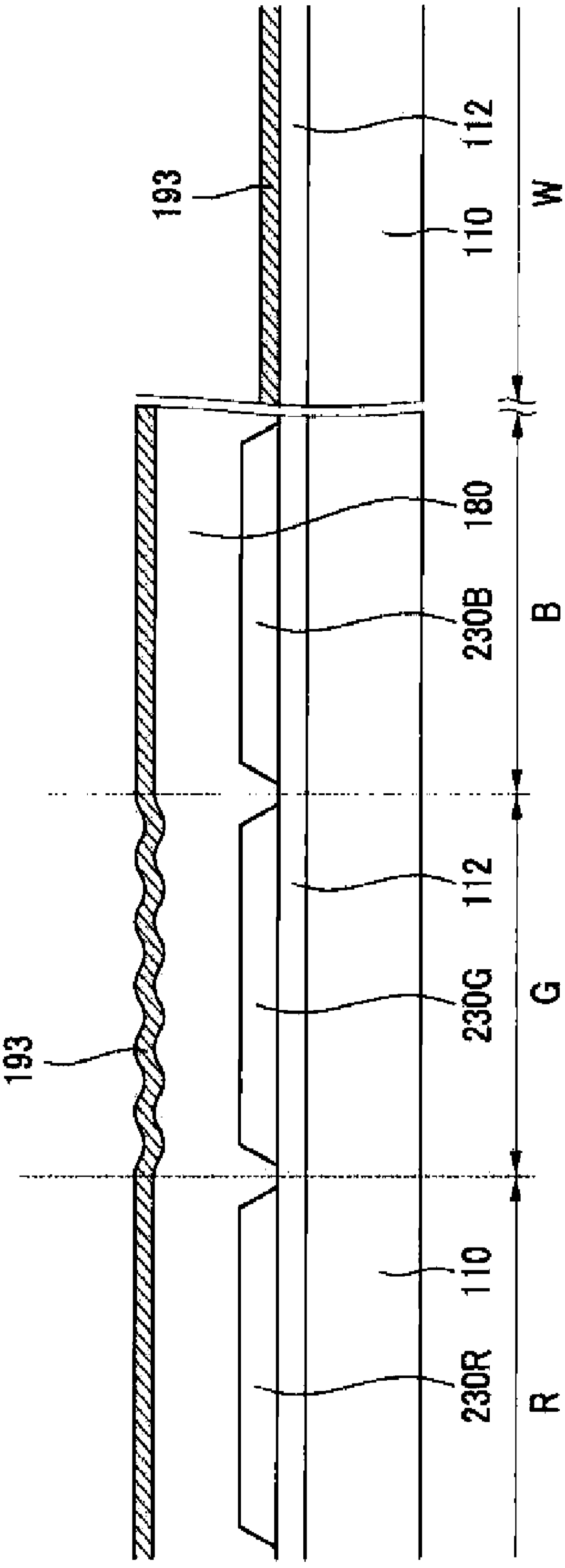


FIG.9

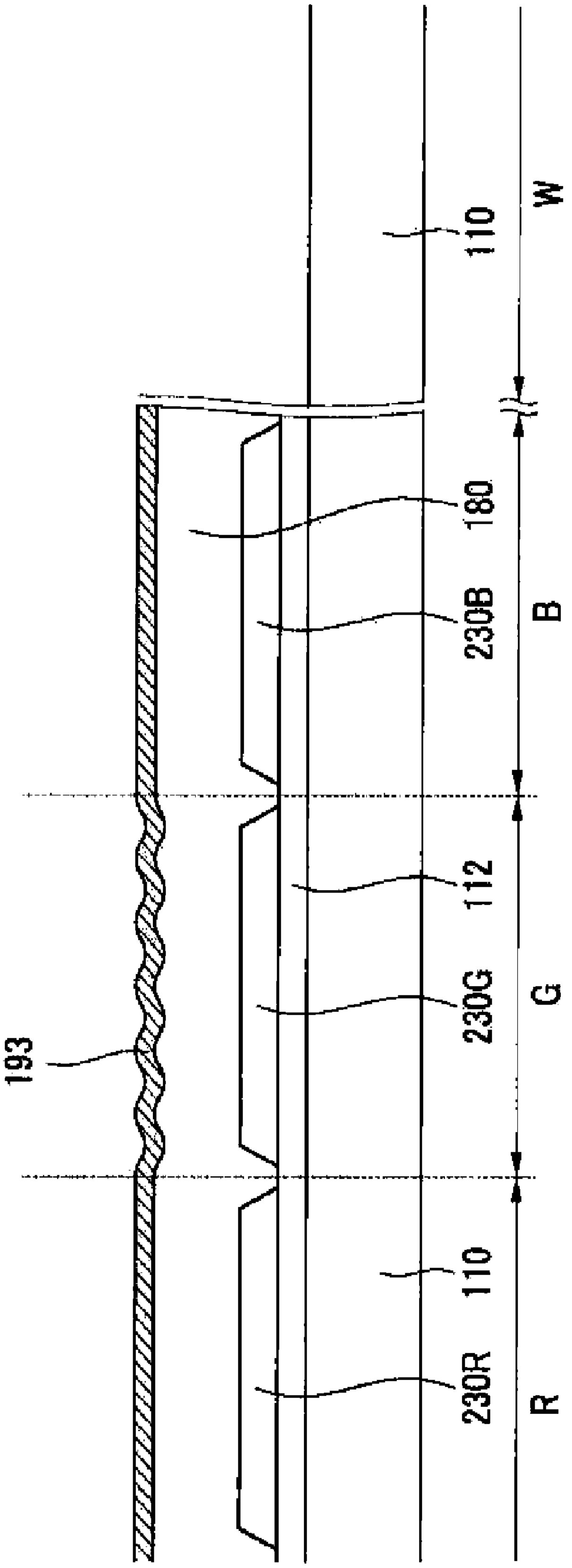


FIG.10

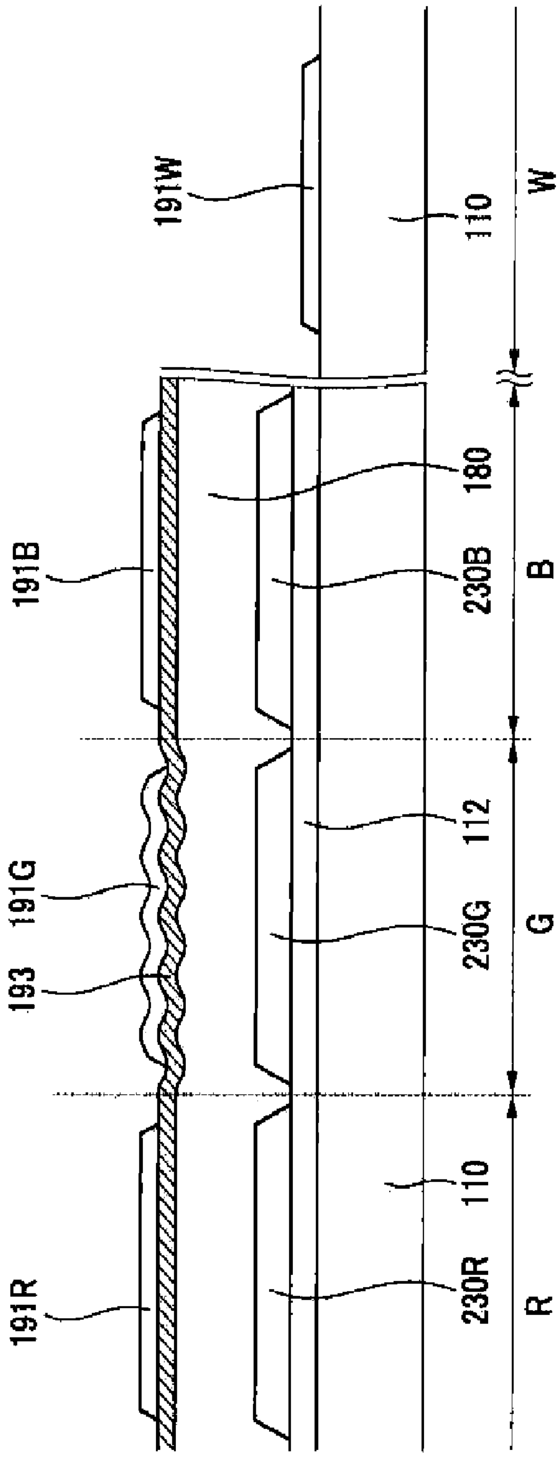
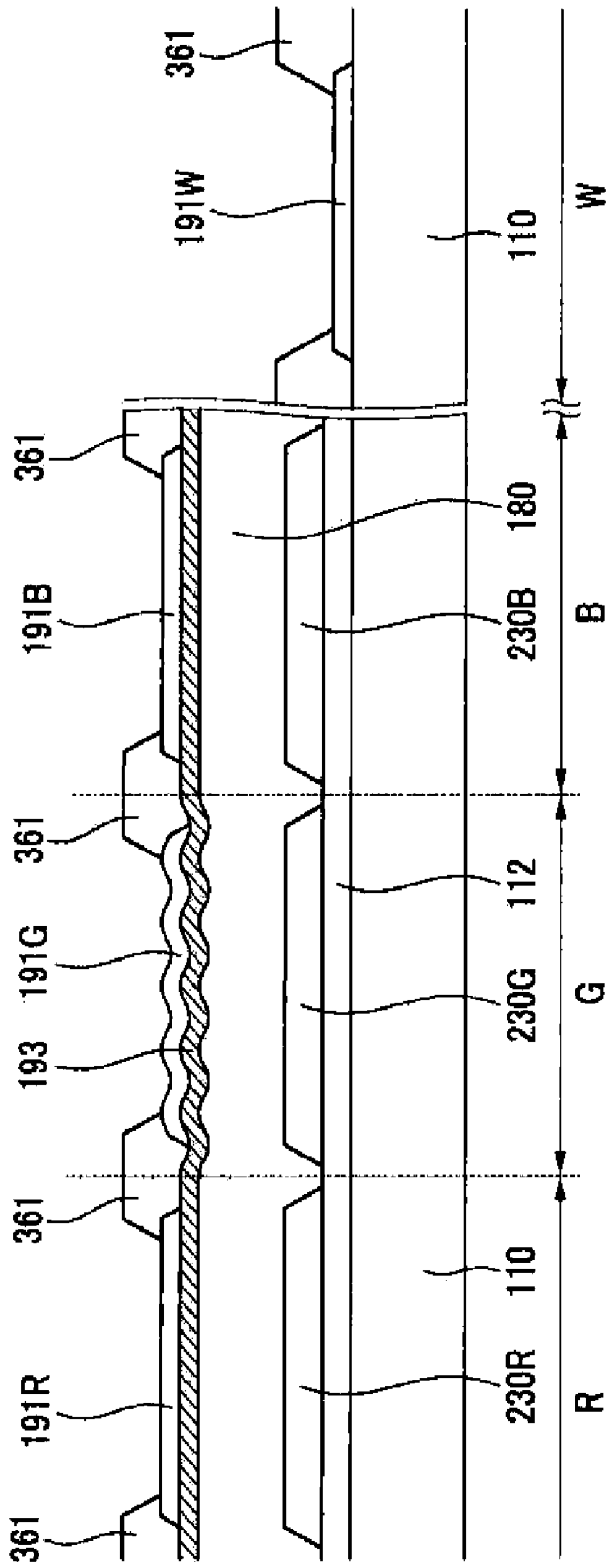


FIG.11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W
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191G
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G
193
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110
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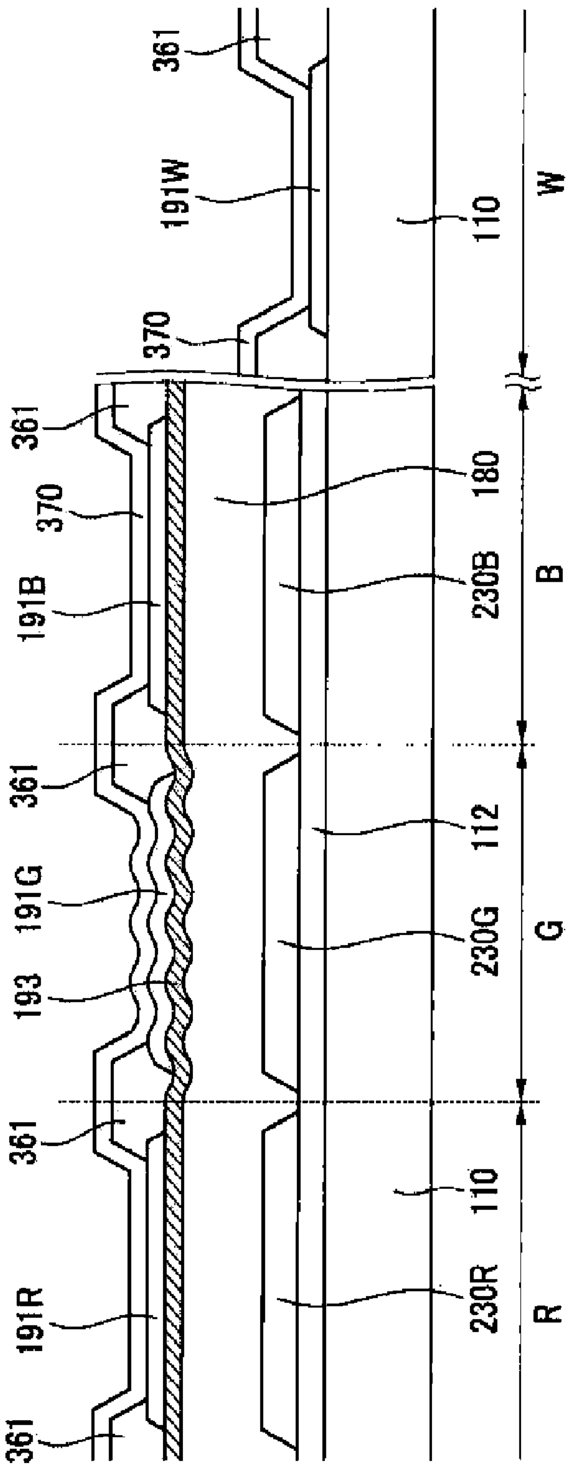
230R
R
361

FIG.12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W
370
361
370
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191B
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191G
193
230G
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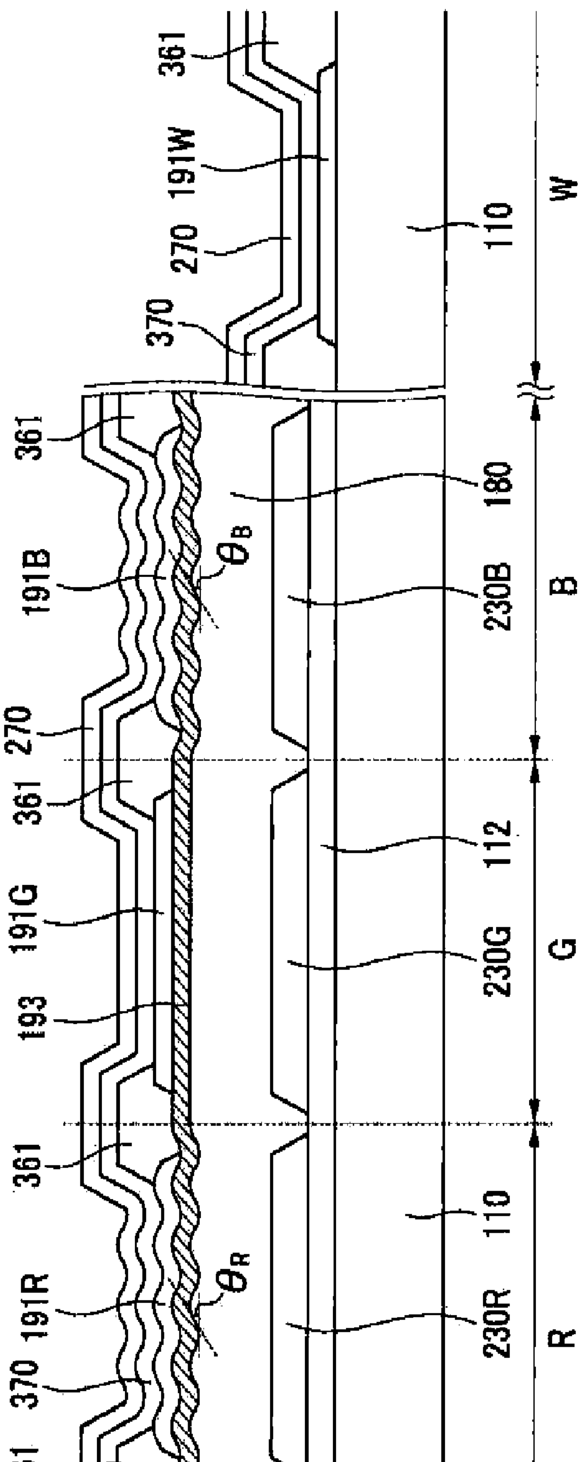
230R
R
361

FIG.13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θ_B
230B
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361
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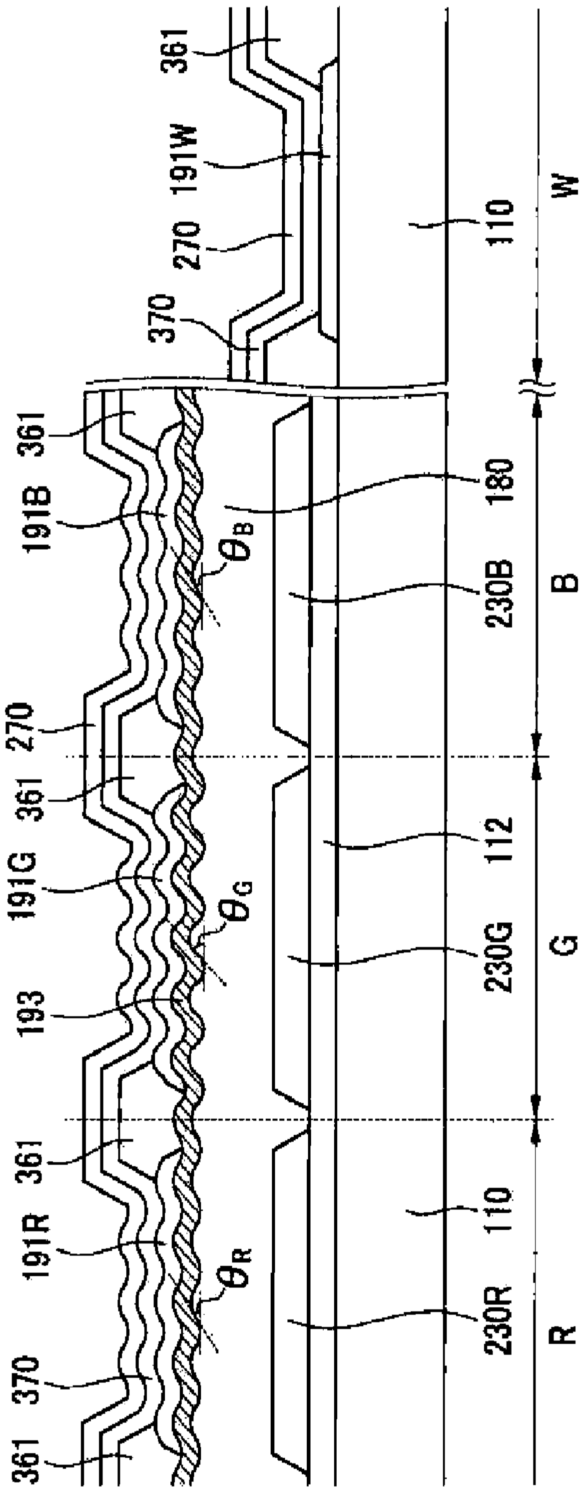
191G
230G
G
193
361
110
191R
θ_R
230R
R
370
361

FIG.14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191R
θR
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191G
θG
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270
191B
θB
361
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180
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R
G
B
W

FIG.15

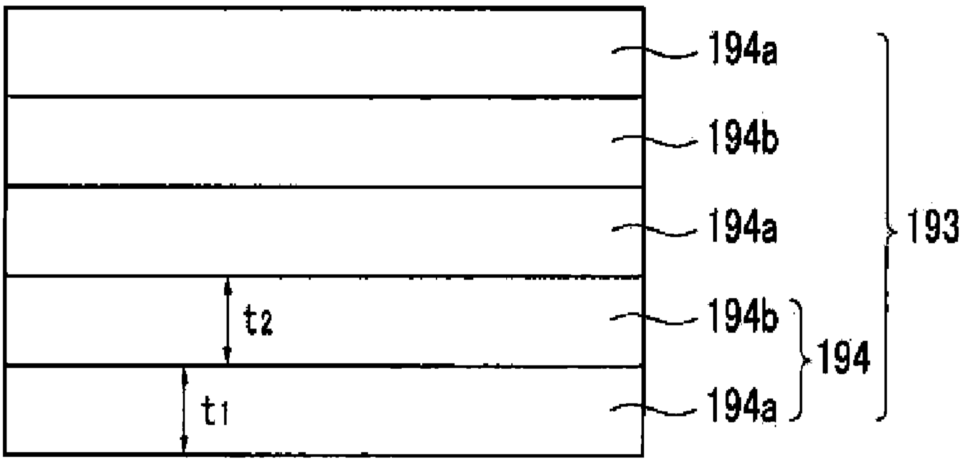


FIG.16

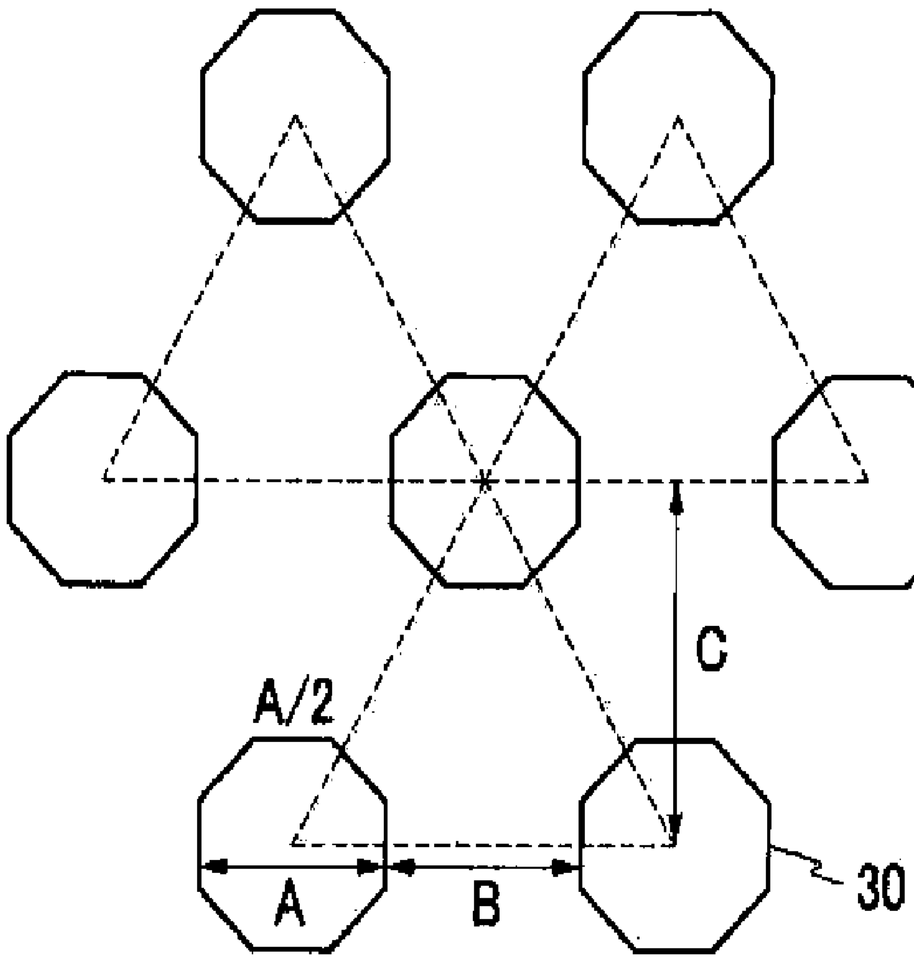


FIG.17

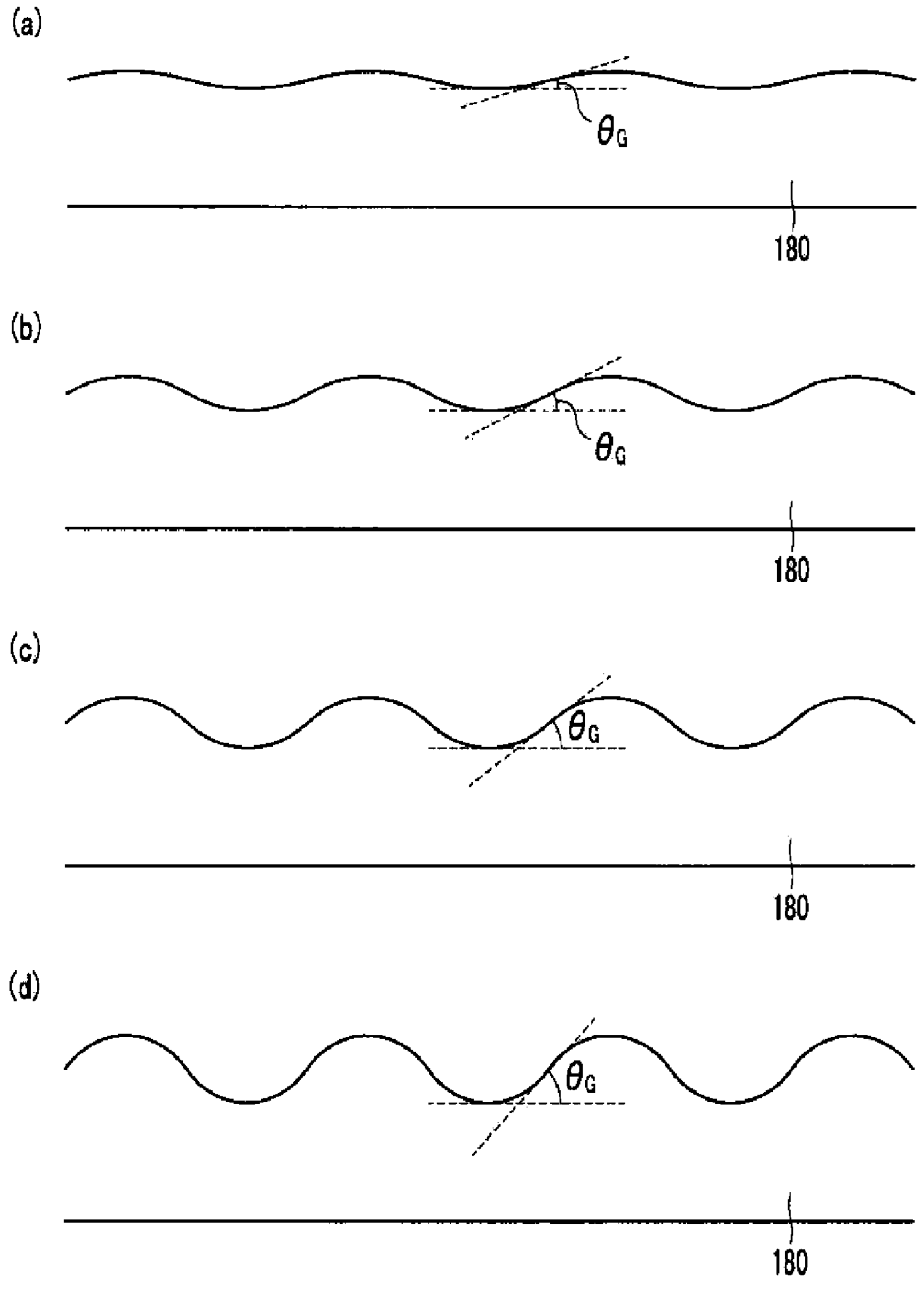


FIG.18

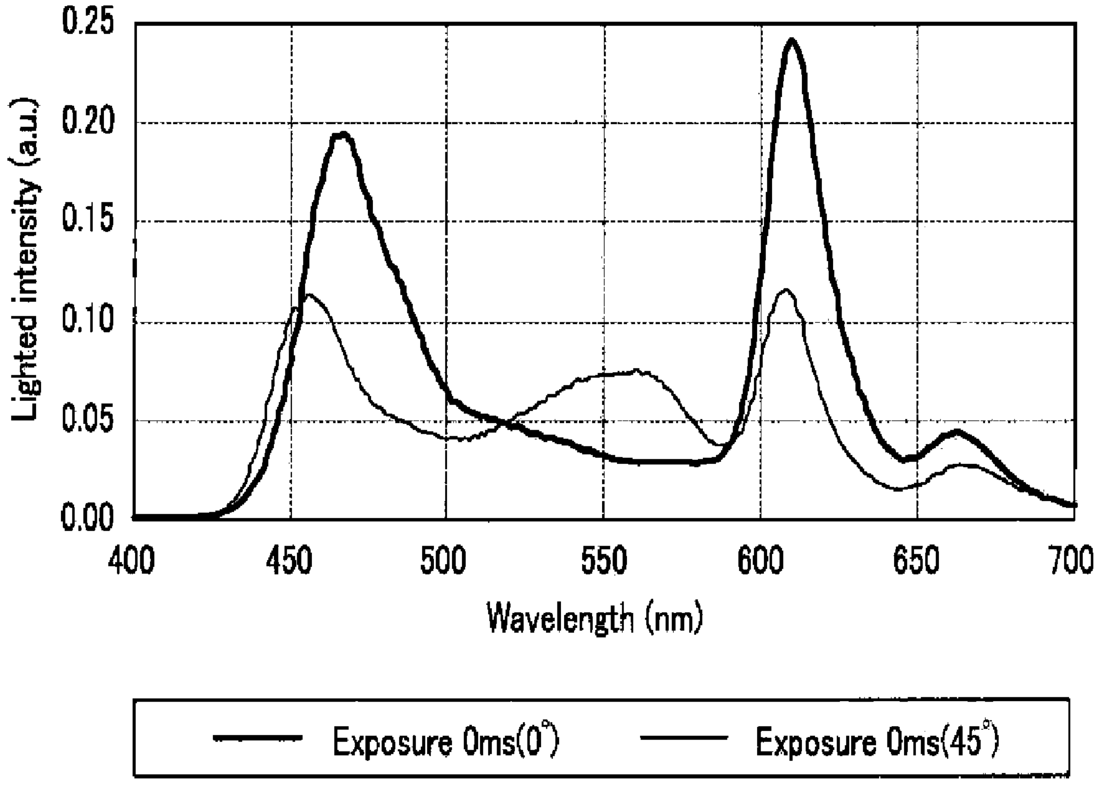
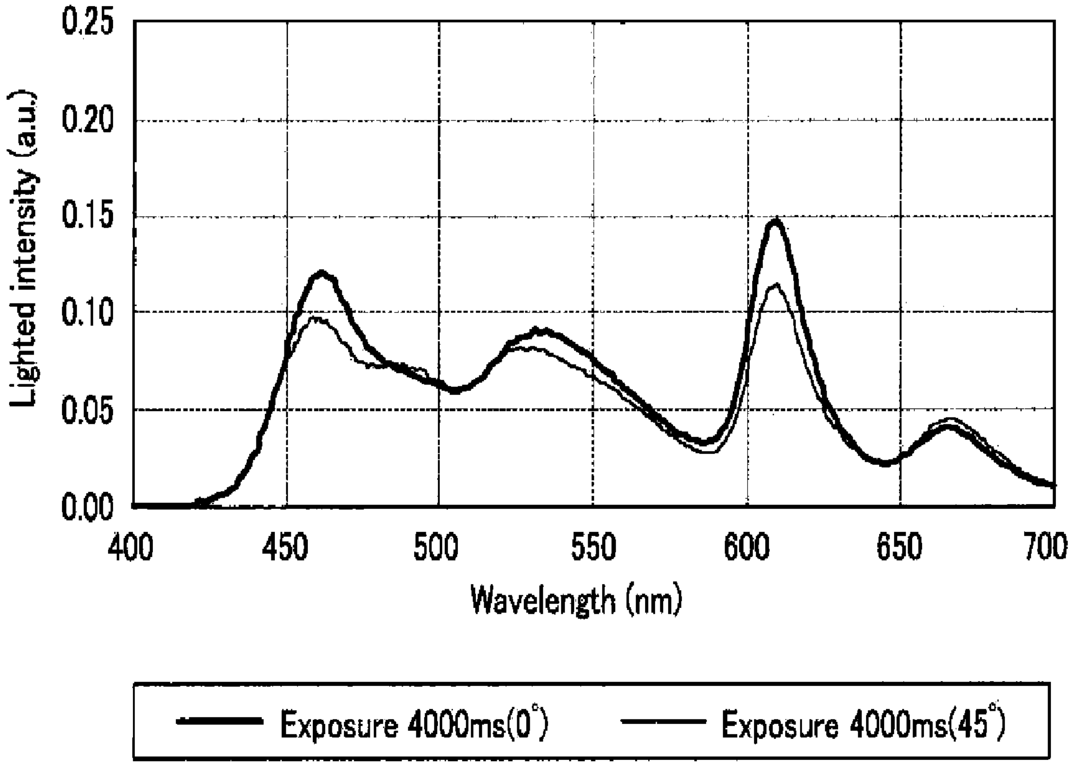

0.25
0.20
0.15
0.10
0.05
0.00
Lighted intensity (a.u.)
400
450
500
550
600
650
700
Wavelength (nm)
Exposure 0ms(0°)
Exposure 0ms(45°)

FIG.19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0.20
0.15
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0.05
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Lighted intensity (a.u.)
400
450
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550
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700
Wavelength (nm)
Exposure 4000ms(0°)
Exposure 4000ms(45°)

FIG.20

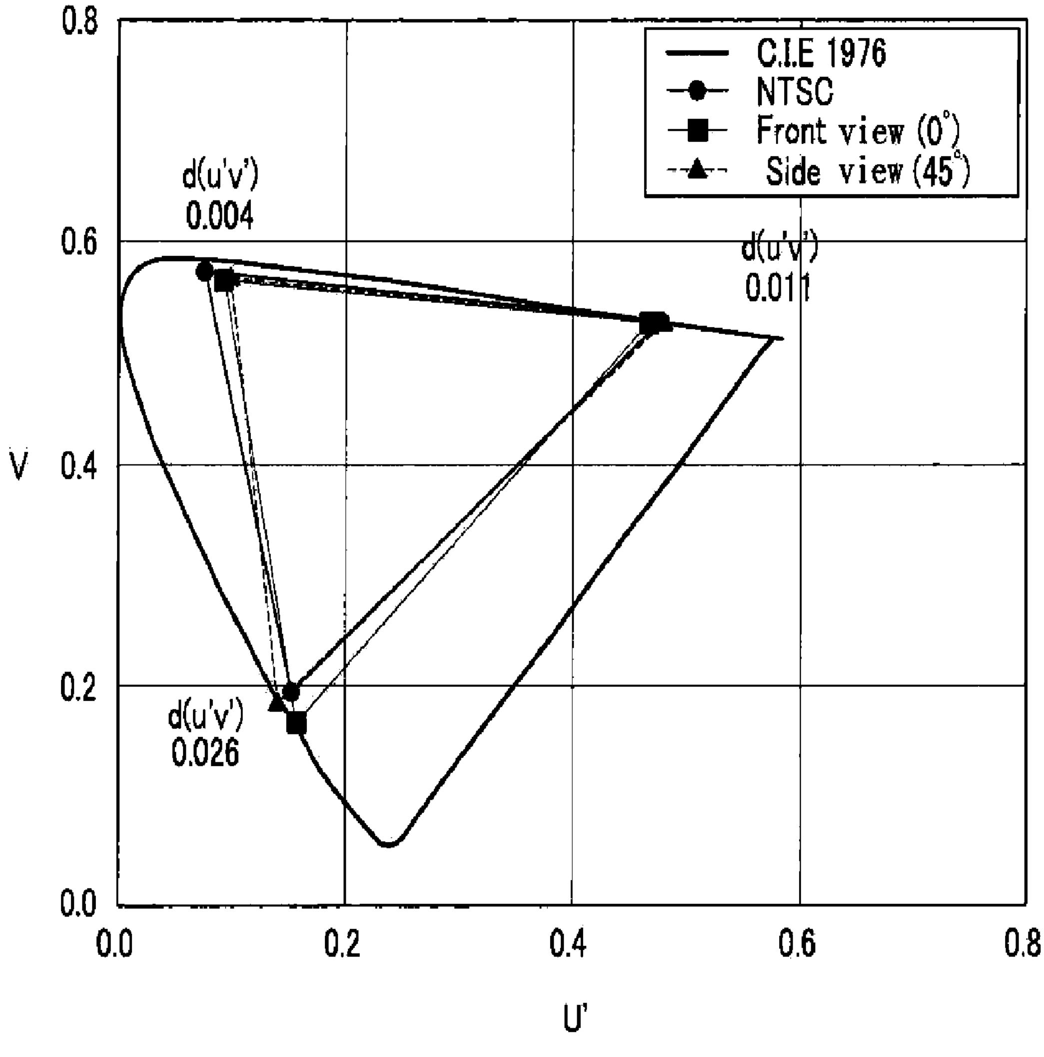

0.8
0.6
0.4
0.2
0.0
V
0.0
0.2
0.4
0.6
0.8
U'
C.I.E 1976
NTSC
Front view (0°)
Side view (45°)
d(u'v')
0.004
d(u'v')
0.011
d(u'v')
0.026

FIG.21

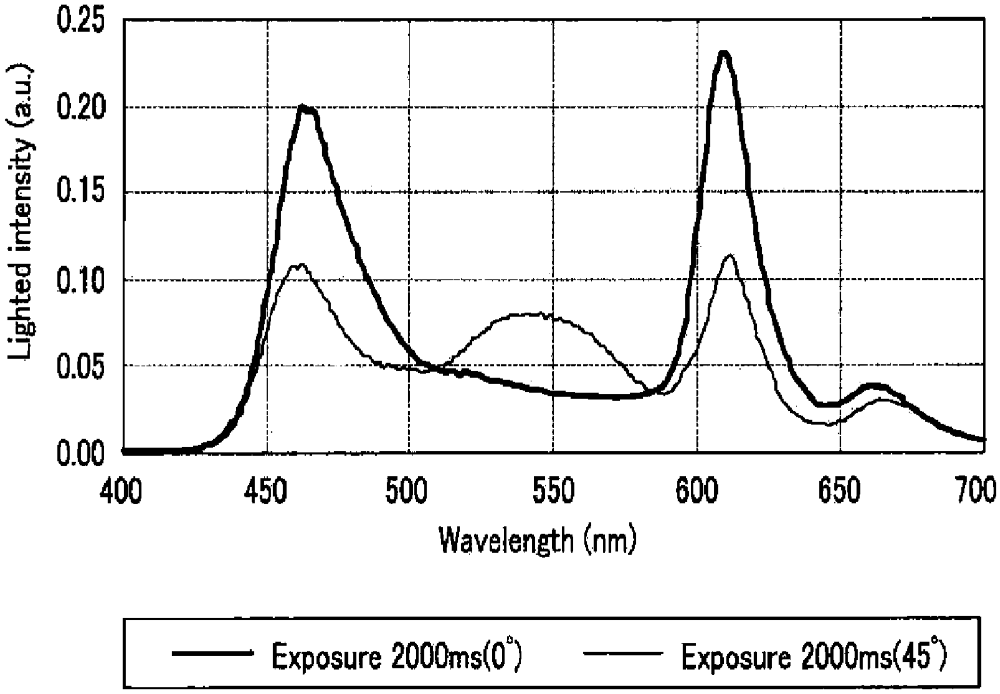

0.25
0.20
0.15
0.10
0.05
0.00
Lighted intensity (a.u.)
400
450
500
550
600
650
700
Wavelength (nm)
Exposure 2000ms(0°)
Exposure 2000ms(45°)

FIG.22

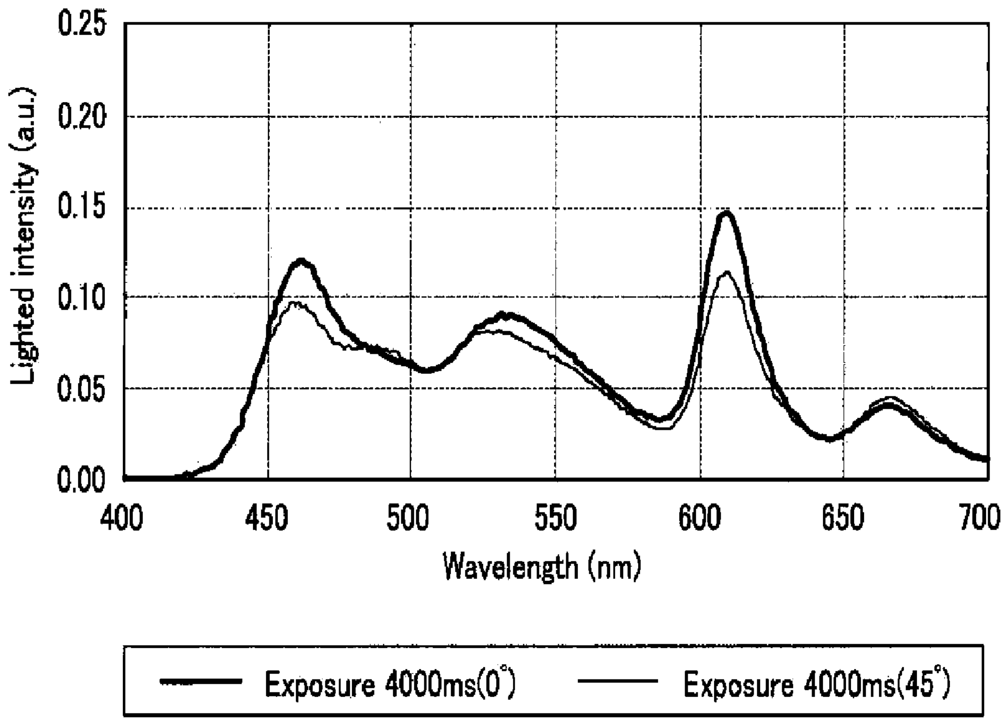

0.25
0.20
0.15
0.10
0.05
0.00
Lighted intensity (a.u.)
400
450
500
550
600
650
700
Wavelength (nm)
Exposure 4000ms(0°)
Exposure 4000ms(45°)

FIG.23

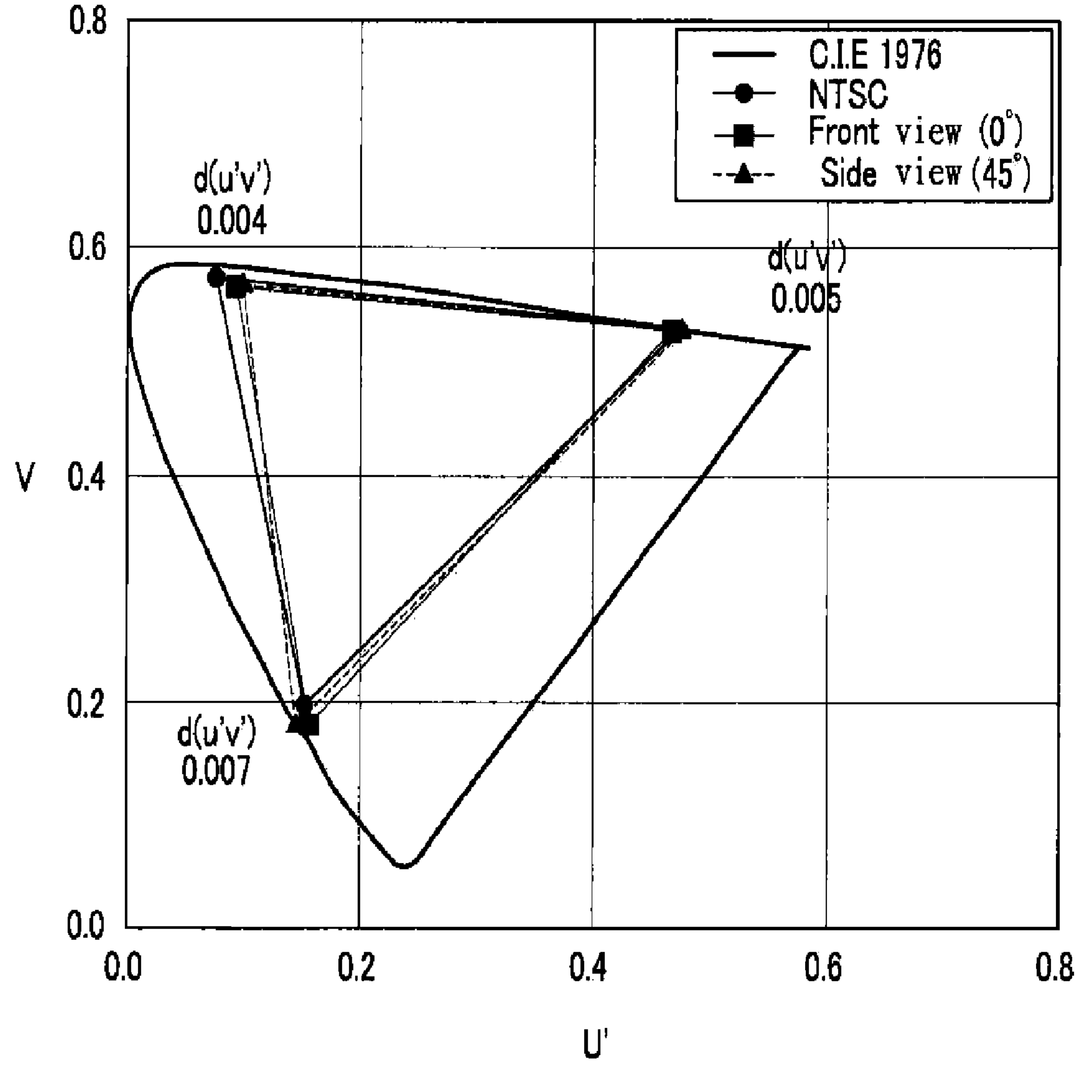

0.8
0.6
V 0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
U'
C.I.E 1976
NTSC
Front view (0°)
Side view (45°)
d(u'v')
0.004
d(u'v')
0.005
d(u'v')
0.007

FIG.24A

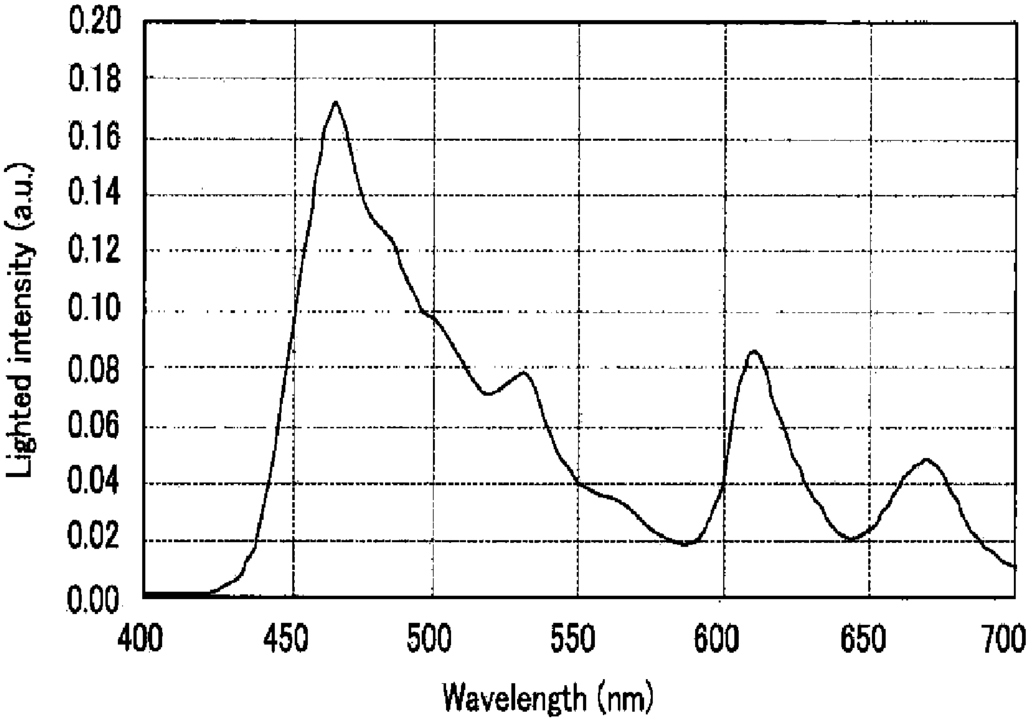
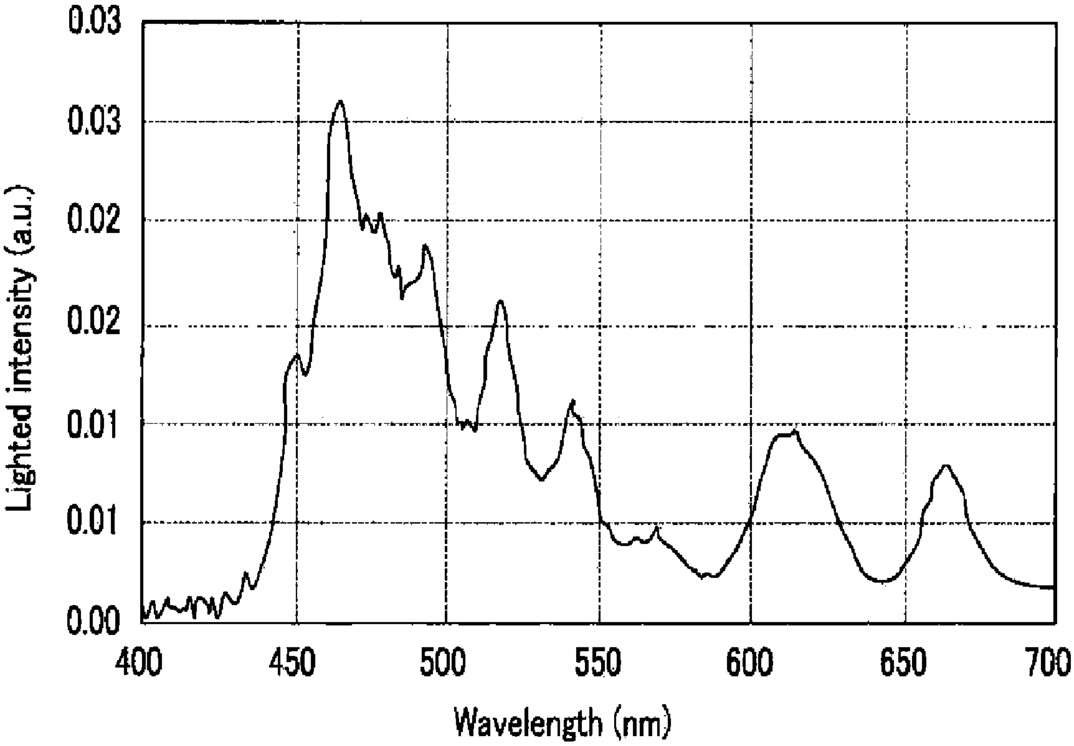

0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Lighted intensity (a.u.)
400
450
500
550
600
650
700
Wavelength (nm)

FIG.24B


0.03
0.03
0.02
0.02
0.01
0.01
0.00
Lighted intensity (a.u.)
400
450
500
550
600
650
700
Wavelength (nm)

ORGANIC LIGHT EMITTING DIODE DISPLAY AND METHOD OF MANUFACTURING THE SAME

[0001] This application claims priority to Korean Patent Application No. 10-2008-0014544 filed on Feb. 18, 2008, and all the benefits accruing therefrom under 35 U.S.C. §119, the contents of which in its entirety are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an organic light emitting diode display and a method of manufacturing the same.

[0004] 2. Description of the Related Art

[0005] Currently, a decrease in weight and thickness of monitors, televisions, etc., is requested, and according to such a request, cathode ray tubes ("CRTs") are being replaced with liquid crystal displays ("LCDs").

[0006] However, since the LCD is a light-receiving type device, it requires a separate light source such as backlight, and the LCD has a limitation in response speed and viewing angle.

[0007] As a display device which can overcome the limitation, an organic light emitting diode display ("OLED" display) has been in the spotlight.

[0008] The OLED display includes two electrodes and an emission layer which is sandwiched therebetween, and it forms excitons by combining electrons which are injected from one electrode and holes which are injected from another electrode in the emission layer and emits light as excitons release energy.

[0009] Because the OLED display is a self-light emitting type, the OLED display does not require a separate light source, whereby it is advantageous in power consumption and has an excellent response speed, viewing angle, and contrast ratio.

[0010] The OLED display includes a plurality of pixels such as a red pixel, a blue pixel, and a green pixel, and expresses full colors by combining the pixels.

[0011] However, the OLED display has different light-emitting efficiency according to light emitting materials. That is, among a red color, a green color, and a blue color, a material having low light-emitting efficiency cannot express a color of a desired color coordinate. Even when emitting light of a white color by combining a red color, a green color, and a blue color, desired white color light cannot be emitted due to the color having low light-emitting efficiency. Therefore, because a range of a color which can express is limited, color reproducibility is deteriorated.

[0012] Light which is emitted from an emission layer is discharged to the outside through a substrate and a plurality of thin films such as an electrode and an insulating layer. Due to an interface between the substrate and the thin films or total reflection in a substrate surface, the light which is discharged to the outside is only about 20% of light which is emitted from the emission layer. Accordingly, light-emitting efficiency is deteriorated, leading to a decrease in the luminance.

[0013] In the OLED display, due to a limitation in the light emitting material and light-emitting efficiency, color reproducibility and luminance may be deteriorated.

[0014] As a solution to this, a microcavity has been proposed.

[0015] As light is repeatedly reflected from a reflective layer and a semi-transparent layer which are apart from each other by a predetermined gap (hereinafter referred to as an "optical path length"), a strong interference effect is generated between the light. The microcavity effect may be described by a principle in which light of a specific wavelength is amplified and light of other wavelengths is attenuated.

[0016] Accordingly, in the front view, luminance is improved and color reproducibility also increases.

[0017] However, in order to express a full color while using the microcavity, a red pixel, a green pixel, and a blue pixel should have an optical path length corresponding to a wavelength of each pixel. In order to form a microcavity having a different optical path length in each pixel, a process for adjusting an optical path length should be performed for each pixel and thus the number of process steps increases.

[0018] Further, because luminance and color reproducibility are set based on the front view, a color shift may be generated in the microcavity according to a viewing angle.

BRIEF SUMMARY OF THE INVENTION

[0019] The present invention has been made in an effort to provide an organic light emitting diode display and a method of manufacturing the same having advantages of simplifying a process which is required for forming a microcavity, and increasing luminance and color reproducibility in the front view and the side view.

[0020] According to an exemplary embodiment of the invention, the invention provides an organic light emitting diode (OLED) display device comprising a plurality of pixels. The display device comprises: a first electrode; a second electrode which is opposite to the first electrode; an emission layer which is disposed between the first electrode and the second electrode; a semi-transparent member is positioned on or under the first electrode and forms a microcavity together with the second electrode; and an overcoating film that is positioned under the semi-transparent member, wherein at least one of the pixels includes embossings formed in a surface of the overcoating film, the embossings forming a flexural surface having a tilt angle.

[0021] According to an exemplary embodiment, the pixel includes a green pixel, a blue pixel and a red pixel.

[0022] According to an exemplary embodiment, the embossings are formed in the green pixel.

[0023] According to an exemplary embodiment, the embossings are formed in the red pixel and the blue pixel.

[0024] According to an exemplary embodiment, the embossings are formed in the green pixel, the red pixel and the blue pixel, and the tilt angle of the embossings formed in the green pixel is different from that of that embossings formed in the red pixel and the blue pixel.

[0025] According to an exemplary embodiment, the tilt angle of the embossings formed in the green pixel is greater than that of the embossings formed in the red pixel and the blue pixel.

[0026] According to an exemplary embodiment, the embossings formed in the red pixel and in the blue pixel have substantially identical tilt angles.

[0027] According to an exemplary embodiment, the emission layer includes a plurality of sub-emission layers which emit light of different wavelengths and emits white light by combining the light of the different wavelengths.

[0028] According to an exemplary embodiment, the OLED display device further comprises a color filter that is formed in the pixel.

[0029] According to an exemplary embodiment, the semi-transparent member comprises N number of layers including a first layer and a second layer are alternately stacked, the first and second layers having different refractive indexes.

[0030] According to an exemplary embodiment, the semi-transparent member has a substantially uniform thickness in each of the plurality of pixels, and the thicknesses of the first layer and the second layer in N−1 number of layers are $\lambda/4n_1$ and $\lambda/4n_2$, respectively (n_1 is a refractive index of the first layer, n_2 is a refractive index of the second layer, and λ is a wavelength of a green region).

[0031] According to an exemplary embodiment, the first layer comprises silicon oxide (SiO_2), and the second layer comprises silicon nitride (SiN_x).

[0032] According to an exemplary embodiment, the semi-transparent member has a substantially uniform thickness, and when a gap between the second electrode and the semi-transparent member is an optical path length (L), the optical path length is the smallest value among values satisfying both $L=m_1\lambda_1/2$ and $L=m_2\lambda_2/2$ (λ_1 is a wavelength of a red region, λ_2 is a wavelength of a blue region, and m_1 and m_2 are natural numbers).

[0033] According to an exemplary embodiment, the pixel further includes a white pixel, wherein the overcoating film is not formed in the white pixel.

[0034] According to an exemplary embodiment of the invention, the invention provides a method of manufacturing an OLED display device having a plurality of pixels. The method includes forming a plurality of thin film transistors on a substrate, forming an overcoating film on the substrate and the thin film transistor, forming embossings in a surface of the overcoating film, the embossings having a tilt angle; forming a semi-transparent member on the overcoating film; forming a first electrode on the semi-transparent member, forming an emission layer on the first electrode, and forming a second electrode on the emission layer.

[0035] According to an exemplary embodiment, the forming of embossings in a surface of the overcoating film includes disposing a mask having an opening on the overcoating film and exposing, and performing heat treatment of the exposed overcoating film.

[0036] According to an exemplary embodiment, the pixel includes a green pixel, a red pixel and a blue pixel.

[0037] According to an exemplary embodiment, the embossings are formed in the green pixel.

[0038] According to an exemplary embodiment, the embossings are formed in the red pixel and the blue pixel.

[0039] According to an exemplary embodiment, the embossings are formed in the green pixel, the red pixel, and the blue pixel, and the tilt angle of embossings formed in the green pixel is different from that of the embossings formed in the red pixel and the blue pixel.

[0040] According to an exemplary embodiment, the tilt angle is adjusted by varying an exposure amount.

[0041] According to an exemplary embodiment, the tilt angle is adjusted by varying the size of openings of the mask.

[0042] According to an exemplary embodiment, the forming of embossings in a surface of the overcoating film includes forming a contact hole which exposes a part of the thin film transistor in the overcoating film.

[0043] According to an exemplary embodiment, the pixel further includes a white pixel, and wherein the forming of embossings in a surface of the overcoating film comprises removing the overcoating film which is formed in the white pixel.

[0044] According to an exemplary embodiment of the invention, the invention provides a light emitting display device having a plurality of pixels. The display device includes a first electrode, a second electrode which is opposite to the first electrode; an emission layer which is disposed between the first electrode and the second electrode, a semi-transparent layer which forms a microcavity with the second electrode, wherein the semi-transparent layer includes a flexural surface, the flexural surface being inclined with respect to the plane of the semi-transparent layer.

[0045] According to an exemplary embodiment, the pixel includes a green pixel, a blue pixel and a red pixel, and the flexural surface is formed in the green pixel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] The above and/or other aspects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

[0047] FIG. **1** is an equivalent circuit diagram of an exemplary embodiment of an OLED display according to the present invention;

[0048] FIG. **2** is a top plan view illustrating a disposition of a plurality of pixels in an exemplary embodiment of an OLED display according to the present invention;

[0049] FIG. **3** is a cross-sectional view of an exemplary embodiment of an OLED display according to the present invention;

[0050] FIG. **4** is a cross-sectional view illustrating an exemplary embodiment of an OLED display according to the present invention;

[0051] FIGS. **5** to **12** are cross-sectional views sequentially illustrating an exemplary embodiment of a method of manufacturing the OLED display of FIG. **4** according to of the present invention;

[0052] FIG. **13** is a cross-sectional view illustrating an exemplary embodiment of an OLED display according to the present invention;

[0053] FIG. **14** is a cross-sectional view illustrating an exemplary embodiment of an OLED display according to the present invention;

[0054] FIG. **15** is a schematic diagram illustrating an exemplary embodiment of a semi-transparent member according to the present invention;

[0055] FIG. **16** is a schematic diagram illustrating a plurality of microholes which are formed in a semi-transparent unit of a mask;

[0056] FIG. **17** is a diagram illustrating the change of a tilt angle of embossings according to an exposure amount;

[0057] FIG. **18** is a graph illustrating a light emitting spectrum in a front view and a side view of a red pixel R and a blue pixel B in an exemplary embodiment of an OLED display according to the present invention;

[0058] FIG. **19** is a graph illustrating a light emitting spectrum in a front view and a side view of a green pixel G in an exemplary embodiment of an OLED display according to the present invention;

[0059] FIG. **20** is a graph illustrating color reproducibility of an exemplary embodiment of an OLED display according to the present invention;

[0060] FIG. **21** is a graph illustrating a light emitting spectrum in a front view and a side view of a red pixel R and a blue pixel B in an exemplary embodiment of an OLED display according to the present invention;

[0061] FIG. **22** is a graph illustrating a light emitting spectrum in a front view and a side view of a green pixel G in an exemplary embodiment of an OLED display according to the present invention;

[0062] FIG. **23** is a graph illustrating color reproducibility of an exemplary embodiment of an OLED display according to the present invention;

[0063] FIG. **24**A is a graph illustrating a spectrum of light passing through a white pixel W when an overcoating film and a lower insulating layer are formed in the white pixel W according to an exemplary embodiment of the present invention; and

[0064] FIG. **24**B is a graph illustrating a spectrum of light passing through a white pixel W when an overcoating film and a lower insulating layer are not formed in the white pixel W according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0065] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout.

[0066] It will be understood that when an element is referred to as being "on" another element, it can be directly on the other element or intervening elements may be present therebetween. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0067] It will be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0068] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

[0069] Furthermore, relative terms, such as "lower" or "bottom" and "upper" or "top," may be used herein to describe one element's relationship to another element as illustrated in the Figures. It will be understood that relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. For example, if the device in one of the figures is turned over, elements described as being on the "lower" side of other elements would then be oriented on "upper" sides of the other elements. The exemplary term "lower", can therefore, encompasses both an orientation of "lower" and "upper," depending on the particular orientation of the figure. Similarly, if the device in one of the figures is turned over, elements described as "below" or "beneath" other elements would then be oriented "above" the other elements. The exemplary terms "below" or "beneath" can, therefore, encompass both an orientation of above and below.

[0070] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0071] Exemplary embodiments of the present invention are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments of the present invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the present invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present invention.

[0072] Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

[0073] An OLED display according to an exemplary embodiment of the present invention is now described in detail with reference to FIG. **1**.

[0074] FIG. **1** is an equivalent circuit diagram of an exemplary embodiment of an OLED display according to the present invention.

[0075] Referring to FIG. **1**, the OLED display according to an exemplary embodiment of the present invention includes a plurality of signal lines **121**, **171**, and **172** and a plurality of pixels PX connected thereto which are arranged in a matrix form.

[0076] The signal lines include a plurality of gate lines **121** which transmits gate signals (or scanning signals), a plurality of data lines **171** which transmits data signals, and a plurality of driving voltage lines **172** which transmits driving voltages. The gate lines **121** extend in a row direction and are substantially parallel to each other, and the data lines **171** and the driving voltage lines **172** extend in a column direction and are substantially parallel to each other.

[0077] Each pixel PX includes a switching thin film transistor Qs, a driving thin film transistor Qd, a storage capacitor Cst, and an organic light emitting diode ("OLED") LD.

[0078] Each switching thin film transistor Qs includes a control terminal, an input terminal, and an output terminal. The control terminal is connected to a gate line **121**, the input terminal thereof is connected to a data line **171**, and the output terminal is connected to a driving thin film transistor Qd via the storage capacitor Cst. A data signal is applied to the data line **171**. The switching thin film transistor Qs transmits the data signal to the driving thin film transistor Qd in response to a scanning signal which is applied to the gate line **121**.

[0079] The driving thin film transistor Qd includes a control terminal, an input terminal, and an output terminal. The control terminal is connected to the switching thin film transistor Qs, the input terminal is connected to the driving voltage line **172**, and the output terminal is connected to the OLED LD. The driving thin film transistor Qd flows an output current I_{LD}, whose magnitude changes according to a voltage between the control terminal and the output terminal.

[0080] The capacitor Cst is connected between the control terminal and the input terminal of the driving thin film transistor Qd. The capacitor Cst charges a data signal which is applied to the control terminal of the driving thin film transistor Qd and sustains the charge even after the switching thin film transistor Qs is turned off.

[0081] The OLED LD includes an anode connected to the output terminal of the driving thin film transistor Qd and a cathode connected to a common voltage Vss. The OLED LD emits light with different intensity according to an output current I_{LD} of the driving thin film transistor Qd, thereby displaying an image.

[0082] The switching thin film transistor Qs and the driving thin film transistor Qd are n-channel field effect transistors ("FETs"). However, at least one of the switching thin film transistor Qs and the driving thin film transistor Qd may be a p-channel FET. Further, a connection relationship of the thin film transistors Qs and Qd, the capacitor Cst, and the OLED LD can be changed.

[0083] The OLED display shown in FIG. **1** is further described with reference to FIG. **2**.

[0084] FIG. **2** is a top plan view illustrating a plurality of pixels in an exemplary embodiment of an OLED display according to the present invention.

[0085] Referring to FIG. **2**, the OLED display includes a red pixel R which displays a red color, a green pixel G which displays a green color, a blue pixel B which displays a blue color, and a white pixel W which does not display a color. The above pixels are arranged in such a manner that neighboring red, green, blue and white pixels constitute a group and the group is repeated along a row and/or a column. However, the pixel arrangement can be varied depending on applications.

[0086] The OLED display of FIG. **2** is further described in detail with reference to FIG. **3**.

[0087] FIG. **3** is a cross-sectional view illustrating a structure of an exemplary embodiment of an OLED display according to the present invention.

[0088] A plurality of thin film transistor arrays (not shown) is arranged on an insulating substrate **110**. The thin film transistor array includes a switching thin film transistor (not shown) and a driving thin film transistor (not shown) which are disposed in each pixel. The switching thin film transistor and the driving thin film transistor are electrically connected to each other.

[0089] A lower insulating layer **112** is formed on the thin film transistor array and the substrate **110**. A plurality of contact holes (not shown) which expose a part of the switching thin film transistor and the driving thin film transistor are formed in the lower insulating layer **112**.

[0090] A red filter **230**R, a green filter **230**G, and a blue filter **230**B are formed on the lower insulating layer **112** so as to correspond to the red pixel R, the green pixel G, and the blue pixel B, respectively. No color filter is formed in the white pixel, but a transparent filter (not shown) can be formed in the white pixel W. The color filters **230**R, **230**G, and **230**B can be disposed in the form of a color filter on array (COA).

[0091] An overcoating film **180** is formed on the color filters **230**R, **230**G, and **230**B and the lower insulating layer **112**. A plurality of contact holes (not shown) are formed in the overcoating film **180**.

[0092] The overcoating film **180** may be made of a photosensitive organic material such as an acryl-based compound. The overcoating film **180** provides a smooth surface while embedding the color filters **230**R, **230**G, and **230**B.

[0093] Embossings are formed in the surface of the overcoating film **180** corresponding to the green pixel G, to thereby provide a plurality of flexures. The embossings can prevent a color shift according to a viewing angle by scattering light while changing a microcavity condition in the green pixel G. Details thereon are further described hereinafter.

[0094] Referring to FIG. **3**, the embossings provide a plurality of flexural surfaces on the surface of the overcoating film. The flexural surfaces are inclined by a tilt angle θ_G with respect to the plane of the overcoating film **180**.

[0095] A semi-transparent member **193** is formed on the overcoating film **180**. Because the semi-transparent member **193** is formed along the surface flexure of the overcoating film **180**, the semi-transparent member **193** of the green pixel G has a surface having flexures. The semi-transparent member **193** is formed in the red pixel R, the blue pixel B, and the green pixel G, but not in the white pixel W.

[0096] The semi-transparent member **193** transmits a part of light and reflects a part of light. The semi-transparent can employ distributed Bragg reflection ("DBR") for adjusting reflexibility of a specific wavelength. The DBR may be made of a plurality of layers with different refractive indexes which are alternately stacked. However, the semi-transparent member **193** is not limited thereto, and may be formed of an opaque thin metallic layer such as silver (Ag) or aluminum (Al). The semitransparent member using the DBR is further described hereinafter.

[0097] A plurality of pixel electrodes **191**R, **191**G, **191**B, and **191**W are formed on the semi-transparent member **193**. The pixel electrode **191**G of the green pixel G has a surface having flexures along embossings which are formed in the surface of the overcoating film **180**.

[0098] The pixel electrodes **191**R, **191**G, **191**B, and **191**W are respectively connected to driving thin film transistors through contact holes (not shown) which are formed in the overcoating film **180** and the lower insulating layer **112**. The pixel electrodes **191**R, **191**G, **191**B, and **191**W may be made of a transparent conductor such as indium tin oxide (ITO) or indium zinc oxide (IZO).

[0099] An insulating layer **361** is formed on each of the pixel electrodes **191**R, **191**G, **191**B, and **191**W. The insulating layer **361** is formed in such a way to expose the pixel electrodes **191**R, **191**G, **191**B, and **191**W to contact edges of the pixel electrodes **191**R, **191**G, **191**B, and **191**W and includes a plurality of openings.

[0100] An organic emission layer **370** is formed on the insulating layer **361** and the pixel electrodes **191**R, **191**G, **191**B, and **191**W.

[0101] An auxiliary layer (not shown) for improving light emitting efficiency of the organic emission layer **370** may be further included at a lower part and/or an upper part of the organic emission layer **370**. The auxiliary layer may include more than one which is selected from an electron transport layer, a hole transport layer, an electron injection layer, and a hole injection layer.

[0102] According to an exemplary embodiment, the organic emission layer **370** may be formed of a plurality of sub-emission layers (not shown) by sequentially stacking materials which intrinsically emit light of a red color, a green color, a blue color, etc., and emits white light by combining the colors. In this case, the sub-emission layers can be formed horizontally as well as vertically, and the organic emission layer is not limited to a combination of a red color, a green color, and a blue color, but can be formed of, for example, a combination of various other colors so long as it can emit white light.

[0103] The organic emission layer **370** which is positioned at the green pixel G has a surface having flexures along the embossings which are formed in the surface of the overcoating film **180**.

[0104] A common electrode **270** is formed on the organic emission layer **370**. The common electrode **270** may be made of a metal having high reflexibility. The common electrode **270** is formed on the entire surface of the organic emission layer **370** and constitutes a pair of electrodes together with the pixel electrodes **191**R, **191**G, **191**B, and **191**W to flow a current to the organic emission layer **370**. The common electrode **270** which is positioned at the green pixel G has a surface having flexures along the embossings which are formed in a surface of the overcoating film **180**.

[0105] The pixel electrodes **191**R, **191**G, **191**B, and **191**W, the organic emission layer **370**, and the common electrode **270** constitute an OLED LD. The pixel electrodes **191**R, **191**G, **191**B, and **191**W serve as anodes and the common electrode **270** serves as a cathode, or vice versa.

[0106] The common electrode **270** generates a microcavity effect together with the semi-transparent member **193**. The microcavity effect operates to amplify light of a specific wavelength by constructive interference as light is repeatedly reflected from a reflective layer and a semi-transparent layer which are spaced apart from each other by an optical path length. The common electrode **270** functions as a reflective layer and the semi-transparent member **193** functions as a semi-transparent layer.

[0107] The common electrode **270** greatly reforms light emitting characteristics of light which is emitted from the organic emission layer **370**. Light around a wavelength corresponding to a resonance wavelength of a microcavity among the reformed light is reinforced through the semi-transparent member **193** and light of other wavelengths is suppressed. In this case, reinforcement and suppression of light of a specific wavelength can be determined according to the optical path length. The optical path length can be adjusted by changing the thickness of the semi-transparent member **193**.

[0108] As described above, the semi-transparent member **193** may employ a DBR layer, and includes a plurality of layers which are made of inorganic materials having different refractive indexes which are alternately stacked. In a case where the semi-transparent member **193** is made of a plurality of layers made of inorganic materials, the semi-transparent member **193** can reduce loss of light when light transmits or is reflected, compared with a case where the semi-transparent member **193** is made of a metal such as Ag or Al.

[0109] The semi-transparent member **193** using the DBR is further described with reference to FIG. **15**.

[0110] FIG. **15** is a schematic diagram illustrating a semi-transparent member according to an exemplary embodiment of the present invention.

[0111] Referring to FIG. **15**, the semi-transparent member **193** has a structure in which an inorganic layer **194** including a first layer **194***a* and a second layer **194***b* are multiply stacked, i.e., the first layer **194***a* and the second layer **194***b* are alternately and repeatedly stacked. The first layer **194***a* and the second layer **194***b* may be made of inorganic materials having different refractive indexes, for example the first layer **194***a* may be made of silicon oxide (SiO_2) having a refractive index of about 1.4 and the second layer **194***b* may be made of silicon nitride (SiN_x) having a refractive index of about 1.6.

[0112] When it is assumed that an N number of first layers **194***a* and second layers **194***b* are stacked in total, the N−1 number of layers excepting one layer can have a fixed thickness at a specific wavelength regardless of a red pixel, a green pixel, and a blue pixel. For example, the N−1 number of layers can be fixed to a λ/4 thickness at a wavelength of a green region, and the thickness of the first and second layers can be determined as follows:

$$\text{thickness } t_1 \text{ of first layer} = \lambda/4n_1 \tag{1}$$

$$\text{thickness } t_2 \text{ of second layer} = \lambda/4n_2 \tag{2}$$

[0113] where n_1 is a refractive index of silicon oxide, n_2 is a refractive index of silicon nitride, and λ is a wavelength of a green region.

[0114] When a wavelength of a green region is about 530 nm, thicknesses t_1 and t_2 of the first layer **194***a* and the second layer **194***b* may be approximately 945 nm and about 830 nm, respectively.

[0115] In order to obtain a microcavity effect in each of the red pixel R, the green pixel G, and the blue pixel B, the optical path length is adjusted in each pixel. The optical path length can be adjusted by changing the thickness of the remaining layer excepting the N−1 number of layers among the N number of layers.

[0116] The thickness of the remaining layer can be formed such that the optical path length satisfies a constructive interference condition in both the red pixel R and the blue pixel B. Thus, the manufacturing process can be simplified.

[0117] An optical path length L which satisfies the constructive interference condition in both the red pixel R and the blue pixel B is represented by Equation (3):

$$L \approx m\,\lambda_1/2 \approx (m+1)\lambda_2/2 \tag{3}$$

[0118] where m is a natural number, λ_1 is a wavelength of a red region, and λ_2 is a wavelength of a blue region. In an exemplary embodiment of the present invention, the optical path length can be determined to the smallest value among values satisfying the constructive interference condition, and for example m≈2.

[0119] The optical path length which satisfies the constructive interference condition in both the red pixel R and the blue pixel B is set, and then the optical path length of the green pixel G is adjusted by the embossings which are formed in the surface of the overcoating film **180** of the green pixel G.

[0120] Because the embossings are formed in a surface of the overcoating film **180** of the green pixel G, the semi-transparent member **193**, the pixel electrode **191**G, the organic emission layer **370** and the common electrode **270** which are stacked in the green pixel G also have flexures. Therefore, light which is emitted from the organic emission layer **370** is discharged to the outside after sequentially passing through the pixel electrode **191**G, the overcoating film **180**, the green filter **230**G, and the substrate **110**. The discharged light forms a predetermined angle θ_G from light which is vertically emitted to the substrate **110**. Due to the tilt angle θ_G of the embossings, the path difference of light in the green wavelength region is changed.

[0121] The path difference in the green wavelength region is represented by Equations (4) and (5):

$$\text{path difference}=2nd' \cos\theta_G \quad (4)$$

$$\text{path difference}=\lambda/2 \quad (5)$$

[0122] where n is a refractive index of an organic emission layer, d'' is an actual optical path length, θ_G is a tilt angle of embossings, and λ is a green wavelength region.

[0123] When rearranging Equations (4) and (5), a wavelength which is amplified by constructive interference in a green wavelength region is represented by Equation (6).

$$\lambda=4nd' \cos\theta_G \quad (6)$$

[0124] However, in consideration of a tilt angle θ_G by embossings, an actual optical path length d' is represented by Equation (7) using a normal length d between the common electrode **270** and the semi-transparent member **193**.

$$d'=d \cos\theta_G \quad (7)$$

[0125] When rearranging Equations (6) and (7), Equations (6) and (7) are represented by Equation (8).

$$\lambda=4nd \cos^2\theta_G \quad (8)$$

[0126] Referring to Equation (8), it can be seen that a wavelength of light which is amplified by constructive interference is varied with the tilt angle θ_G of the embossings, i.e., proportional to the square of the cosine of the tilt angle θ_G.

[0127] Therefore, in the green pixel G, a microcavity condition can be set by adjusting the tilt angle of the embossings in a green wavelength region.

[0128] In an exemplary embodiment, the embossings can be formed in the green, red and blue pixel regions with different tilt angles. For example, the embossings can be formed in such a way that the tilt angle of the embossings formed in the green pixel is greater than that of the embossings formed in the red pixel and the blue pixel. Details thereon are further described hereinafter.

[0129] When exposing the overcoating film **180**, the tilt angle θ_G can be adjusted by varying an exposure amount. When the exposure amount is large, because an exposure depth increases in a surface of the overcoating film **180**, the tilt angle θ_G increases, and when the exposure amount is less, because the exposure depth decreases, the tilt angle θ_G decreases.

[0130] As another method, the tilt angle θ_G may be adjusted by varying an opening size of a exposure mask used when exposing the overcoating film **180**.

[0131] The color shift may be described by a phenomenon in which a color looks different as a peak wavelength of a light emitting spectrum which is seen from the side view moves toward a short wavelength or a long wavelength, compared with a peak wavelength of a light emitting spectrum which is seen from the front view. The color shift is very large in light of a green wavelength region in the white light which is emitted from the organic emission layer **370**. Because light of a red wavelength region in the white light which is emitted from the organic emission layer **370** is not significantly changed by a peak wavelength of a light emitting spectrum according to the change of a microcavity condition, the color shift is not very high. In light of a blue wavelength region, because the phenomenon in which the spectrum moves to a short wavelength according to a viewing angle is limited due to a cut-off phenomenon occurring at a region of about 450 nm or less, the color shift is also not very significant.

[0132] Therefore, in the present exemplary embodiment, after a microcavity condition simultaneously satisfying a constructive interference condition is set in the red pixel R and the blue pixel B, a microcavity condition in the green pixel G can be set by adjusting a tilt angle of embossings in the green pixel G, thereby mitigating the color shift.

[0133] This is described with reference to FIGS. **18** and **19**.

[0134] FIG. **18** is a graph illustrating a light emitting spectrum in a front view and a side view of a red pixel R and a blue pixel B in an OLED display according to an exemplary embodiment of the present invention. FIG. **19** is a graph illustrating a light emitting spectrum in a front view and a side view of a green pixel G in an OLED display according to an exemplary embodiment of the present invention.

[0135] Referring to FIG. **18**, it can be seen that, with respect to light of a red region (about 610 nm) and light of a blue region (about 460 nm), a difference between peak wavelengths in the front view (thick line) and the side view (thin line) is not significant even if embossings are not formed in such pixel regions. Referring to FIG. **19**, it can also be seen that a difference between peak wavelengths in the front view (thick line) and the side view (thin line) is not significant with respect to light of a green region (about 530 nm), due to the embossings formed in the green pixel G.

[0136] This is because when light which is emitted from the organic emission layer **370** is repeatedly reflected between the semi-transparent member **193** and the common electrode **270**, the light is reflected in several directions by embossings and is seen with the same condition regardless of a specific direction due to scattering of the light which is reflected in several directions. Accordingly, because light of the same wavelength region is emitted regardless of a viewing angle, a color shift according to a viewing angle can be prevented.

[0137] FIG. **20** is a graph illustrating color reproducibility of an OLED display according to an exemplary embodiment of the present invention, using a C.I.E 1976 chromacity diagram.

[0138] Referring to FIG. **20**, when a semi-transparent member and embossings in the green pixel G are employed, color reproducibility is about 97% of NTSC in case of the front view and about 99% of NTSC in case of the side view. It can be seen from this result that the change in the color reproducibility between the front view and the side view is remarkably reduced when using a semi-transparent member, as compared with a conventional case where the color reproducibility between the front view and side views is changed by about 30-40%.

[0139] Further, the color shift d(u'v') in a red region, a green region, and a blue region can be represented by a numerical value. In FIG. **20**, numerical values of the color shift d(u'v') in the red region, the green region, and the blue region are about 0.011, 0.004 and 0.026 respectively. It can be seen from this result that the color shift is remarkably reduced when using a semi-transparent member and embossings in the green pixel G, as compared with a conventional case where the color shift is about 0.07 to 0.09.

[0140] Another exemplary embodiment of the present invention is described with reference to FIG. **4**.

[0141] Referring to FIG. **4** is a cross-sectional view illustrating an OLED display according to another exemplary embodiment of the present invention.

[0142] In the OLED display of this exemplary embodiment, structures of the red pixel R, the green pixel G, and the blue pixel B are the same as in the previous embodiment, but the structure of the white pixel W is different.

[0143] In the present exemplary embodiment, in the white pixel W, the overcoating film **180** and the lower insulating layer **112** are not formed. As can be seen in the above-described exemplary embodiment, the white pixel W is irrelevant to a microcavity effect, unlike the red pixel R, the blue pixel B, and the green pixel G. Therefore, because the white pixel W does not include the semi-transparent member **193** and the color filter, the overcoating film **180** and the lower insulating layer **112** may also be omitted.

[0144] By removing the overcoating film **180** and the lower insulating layer **112**, because light which is emitted from an organic emission layer **370** is discharged to the outside after passing through the pixel electrode **191**W and the substrate **110**. Thus, light deformation due to a refractive index of each thin film when passing through a plurality of other thin films can be prevented so that intrinsic white light can be emitted. Further, by reducing an amount of light which is absorbed by each thin film among light which is emitted from the organic emission layer, light emitting efficiency can also be improved. Also, damage to the overcoating film **180** due to gases being generated when etching the semi-transparent member **193** can be mitigated.

[0145] This exemplary embodiment is further described with reference to FIGS. **24**A and **24**B.

[0146] FIG. **24**A is a graph illustrating a spectrum of light passing through a white pixel W when an overcoating film **180** and a lower insulating layer **112** are formed in the white pixel W according to an exemplary embodiment of the present invention. FIG. **24**B is a graph illustrating a spectrum of light passing through a white pixel W when an overcoating film **180** and a lower insulating layer **112** are not formed in the white pixel W according to an exemplary embodiment of the present invention.

[0147] Referring to FIGS. **24**A and **24**B, when omitting the overcoating film **180** and the lower insulating layer **112** according to the present exemplary embodiment, it can be seen that color purity and color reproducibility on wavelength of visible rays increase, and that transmittance improves in each wavelength region, and thus light emitting efficiency can be improved.

[0148] A method of manufacturing an OLED display according to the present exemplary embodiment is described hereinafter with reference to FIGS. **5** to **12**.

[0149] FIGS. **5** to **12** are cross-sectional views sequentially illustrating a method of manufacturing the OLED display of FIG. **4** according to an exemplary embodiment of the present invention.

[0150] Referring to FIG. **5**, a plurality of switching thin film transistors (not shown) and a plurality of driving thin film transistors (not shown) are formed on the insulating substrate **110**. A conductive layer, an insulating layer, and a semiconductor layer are formed and patterned on the switching thin film transistor and a driving thin film transistor.

[0151] Thereafter, a lower insulating layer **112** is formed on the switching thin film transistor and the driving thin film transistor, and then a plurality of color filters **230**R, **230**G, and **230**B are formed on the lower insulating layer **112**.

[0152] Next, referring to FIG. **6**, an overcoating film **180** is coated on the lower insulating layer **112** and the color filters **230**R, **230**G, and **230**B.

[0153] Referring to FIG. **7**, an exposure mask (not shown) is disposed on the overcoating film **180** and the overcoating film **180** is exposed. Here, the overcoating film **180** of the white pixel W is removed and a plurality of contact holes (not shown) are formed in each pixel, and at the same time, embossings are formed in the surface of the overcoating film **180** of the green pixel G.

[0154] The removing of the overcoating film **180** of the white pixel W, the forming of a plurality of contact holes, and the forming of embossings can be performed simultaneously using the exposure mask having openings which completely transmit light and semi-transparent portions which transmit only a part of light. For example, the exposure mask can have openings corresponding to a size of the white pixel W at positions corresponding to the white pixel W and openings at a position corresponding to a contact hole of each pixel. Further, the exposure mask can be designed to have semi-transparent portions at positions corresponding to green pixels G in which embossings are formed. The semi-transparent part may be formed to have a plurality of slits or microholes.

[0155] Thereafter, exposure is performed by radiating: light such as ultraviolet rays (UV) on the exposure mask. The exposure amount can be determined according to the tilt angle of embossings.

[0156] Thereafter, by removing the exposure mask and performing heat treatment of the overcoating film **180**, embossings of the green pixel G form soft flexures.

[0157] FIG. **16** is a schematic diagram illustrating a plurality of microholes which are formed in a semi-transparent unit of a mask.

[0158] Referring to FIG. **16**, the microholes **30** can have a plurality of polygonal shapes. In this case, the semi-transparent layer can be designed in consideration of a size A of a microhole **30**, an interval B between neighboring microholes **30**, and an interval C from the central part of the microhole **30** to a predetermined position. For example the size A, the interval B, and the interval C may be about 3 μm, 2 μm, and 4.25 μm, respectively. As the size of the microholes **30** increases, an exposure depth of the overcoating film **180** increases and thus a tilt angle θ_G of embossings increases, and as the size of the microholes **30** decreases, an exposure depth of the overcoating film **180** decreases and thus a tilt angle θ_G of embossings decreases.

[0159] As another method, by changing an exposure amount, the tilt angle θ_G of embossings can be adjusted.

[0160] FIG. **17** is a diagram illustrating the change of a tilt angle θ_G of embossings according to an exposure amount.

[0161] FIG. **17**, (*a*), (*b*), (*c*) and (*d*) show tilt angles θ_G of embossings when exposure amounts are about 2000 ms, about 3000 ms, about 4000 ms, and about 5000 ms, respectively. It can be seen that as an exposure amount increases, the tilt angle θ_G of embossings increases.

[0162] Next, referring to FIG. **8**, a semi-transparent member **193** is formed on the overcoating film **180** and the lower insulating layer **112**. The semi-transparent member **193** can be formed in a plurality of layers by alternately and repeatedly stacking silicon oxide and silicon nitride. The semi-transparent member **193** can be formed with a chemical vapor deposition (CVD) method, and in this case, by performing chemical vapor deposition at a relatively low temperature of about 200° C., the overcoating film **180** which is positioned at a lower part thereof can be prevented from being damaged.

[0163] Next, referring to FIG. **9**, the semi-transparent member **193** and the lower insulating layer **112** which are formed in the white pixel W are removed. Further, in this step, a plurality of contact holes (not shown) are formed in each pixel.

[0164] Next, referring to FIG. **10**, by forming a transparent conductive layer on the semi-transparent member **193** and the substrate **110** and performing a photolithography process, pixel electrodes **191**R, **191**G, **191**B, and **191**W are formed in each pixel.

[0165] Next, referring to FIG. **11**, an insulating layer **361** is formed by coating on the pixel electrodes **191**R, **191**G, **191**B, and **191**W and the semi-transparent member **193** and patterning them.

[0166] Thereafter, an emission layer **370**, in which a red emission layer (not shown), a blue emission layer (not shown), and a green emission layer (not shown) are sequentially stacked, is formed on the entire surface of the substrate.

[0167] Thereafter, a common electrode **270** is formed on the emission layer **370**.

[0168] Another exemplary embodiment of the present invention is described with reference to FIG. **13**.

[0169] FIG. **13** is a cross-sectional view illustrating an OLED display according to another exemplary embodiment of the present invention.

[0170] Alternatively, the above-described exemplary embodiment, in an OLED display device according to an exemplary embodiment, embossings are not formed in a surface of the overcoating film **180** in the green pixel G, but embossings are formed in surfaces of the red pixel R and the blue pixel B.

[0171] That is, after setting a microcavity condition which satisfies a constructive interference condition of the green pixel G, an optical path length can be adjusted by forming embossings in the red pixel R and the blue pixel B. In this case, by setting a tilt angle θ_R of embossings in the red pixel R and a tilt angle θ_B of embossings in the blue pixel B to be substantially equal, the processes can be simplified.

[0172] Another exemplary embodiment of the present invention is described with reference to FIG. **14**.

[0173] FIG. **14** is a cross-sectional view illustrating an OLED display according to another exemplary embodiment of the present invention.

[0174] An OLED display device according to the current exemplary embodiment has embossings in all of a red pixel R, a green pixel G, and a blue pixel B. However, by forming a tilt angle θ_G of the green pixel G to be greater than tilt angles (θ_R, θ_B) of the red pixel R and the blue pixel B, a microcavity condition can be optimized.

[0175] As described above, the tilt angle can be adjusted using an exposure amount when exposing the overcoating film **180** or by using an exposure mask having different opening sizes.

[0176] By forming embossings in the red pixel R and the blue pixel B as well as the green pixel G, a color shift which is slightly generated in the red pixel R and the blue pixel B can also be prevented.

[0177] FIG. **21** is a graph illustrating a light emitting spectrum at a front view and a side view of a red pixel R and a blue pixel B in an OLED display according to this exemplary embodiment of the present invention. FIG. **22** is a graph illustrating a light emitting spectrum in a front view and a side view of a green pixel G in an OLED display according to this exemplary embodiment of the present invention.

[0178] Referring to FIG. **21**, when embossings of predetermined tilt angles (θ_R, θ_B) are formed with an exposure amount of about 2000 ms in the red pixel R and the blue pixel B, it can be seen that the change of a peak wavelength of light of a red region (about 610 nm) and light of a blue region (about 460 nm) is further reduced at the front view and the side view, as compared with the case of previous exemplary embodiment. Further, referring to FIG. **22**, it can be seen that the change of a peak wavelength of light of a green region (about 530 nm) is not very large at the front view and the side view, as in the case of previous exemplary embodiment.

[0179] FIG. **23** is a graph illustrating color reproducibility of an OLED display according to another exemplary embodiment of the present invention with a C.I.E 1976 color coordinate.

[0180] Referring to FIG. **23** showing the C.I.E 1976 chromacity diagram, when observing color reproducibility using a semi-transparent member, white light, and a color filter, the color reproducibility is about 98% of the NTSC at the front view and about 96% of the NTSC at the side view. It can be seen from FIG. **23** that the change of color reproducibility between the front view and the side view is remarkably reduced when using a semi-transparent member, as compared with a conventional case where color reproducibility decreases by about 30-40% of NTSC.

[0181] Further, when considering a color shift d(u'v') in a red region, a green region, and a blue region with a numerical value, it can be seen from FIG. **23** that the color shift in the red region, the green region, and the blue region are about 0.005, 0.004, and 0.007, respectively. It can be seen that the color shift can be remarkably reduced when using the semi-transparent member, as compared with a conventional case where a degree of a color shift is about 0.07 to 0.09. Also, the color shift is remarkably reduced in a red region and a blue region, as compared with previous exemplary embodiment.

[0182] While the present invention has been shown and described with reference to some exemplary embodiments thereof, it should be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of present invention as defined by the appending claims.

What is claimed is:

1. An organic light emitting diode (OLED) display device comprising a plurality of pixels, the display device comprising:

a first electrode;

a second electrode which is opposite to the first electrode;

an emission layer which is disposed between the first electrode and the second electrode;

a semi-transparent member which forms a microcavity together with the second electrode; and

an overcoating film that is positioned under the semi-transparent member,

wherein the pixel includes embossings formed in a surface of the semi-transparent member, the embossings forming a flexural surface having a tilt angle.

2. The OLED display device of claim **1**, wherein the pixel includes a green pixel, a blue pixel and a red pixel.

3. The OLED display device of claim **2**, wherein the embossings are formed in the green pixel.

4. The OLED display device of claim **2**, wherein the embossings are formed in the red pixel and the blue pixel.

5. The OLED display device of claim **2**, wherein the embossings are formed in the green pixel, the red pixel and the blue pixel, and the tilt angle of the embossings formed in the green pixel is different from that of that embossings formed in the red pixel and the blue pixel.

6. The OLED display device of claim **5**, wherein the tilt angle of the embossings formed in the green pixel is greater than that of the embossings formed in the red pixel and the blue pixel.

7. The OLED display device of claim **5**, wherein the embossings formed in the red pixel and in the blue pixel have substantially identical tilt angles.

8. The OLED display device of claim **1**, wherein the emission layer includes a plurality of sub-emission layers which emit lights of different wavelengths and emits white light by combining the lights of the different wavelengths.

9. The OLED display device of claim **8**, further comprising a color filter that is formed under the first electrode.

10. The OLED display device of claim **1**, wherein the semi-transparent member comprises N number of layers including a first layer and a second layer alternately stacked, the first and second layers having different refractive indexes.

11. The OLED display device of claim **10**, wherein the semi-transparent member has a substantially uniform thickness in each of the plurality of pixels, and the thicknesses of the first layer and the second layer in N−1 number of layers are $\lambda/4n_1$ and $\lambda/4n_2$, respectively (n_1 is a refractive index of the first layer, n_2 is a refractive index of the second layer, and λ is a wavelength of a green region).

12. The OLED display device of claim **11**, wherein the first layer comprises silicon oxide (SiO_2), and the second layer comprises silicon nitride (SiN_x).

13. The OLED display device of claim **10**, wherein the semi-transparent member has a substantially uniform thickness in each of the plurality of pixels, and

when a gap between the second electrode and the semi-transparent member is an optical path length (L), the optical path length is the smallest value among values satisfying both $L=m_1\lambda_1/2$ and $L=m_2\lambda_2/2$ (λ_1 is a wavelength of a red region, λ_2 is a wavelength of a blue region, and m_1 and m_2 are natural numbers).

14. The OLED display device of claim **2**, wherein the pixel further includes a white pixel,

wherein the overcoating film is not formed in the white pixel.

15. A method of manufacturing an OLED display device comprising a plurality of pixels, the method comprising:

forming a plurality of thin film transistors on a substrate;

forming an overcoating film on the substrate and the thin film transistor;

forming embossings in a surface of the overcoating film, the embossings having a tilt angle;

forming a semi-transparent member on the overcoating film;

forming a first electrode on the semi-transparent member;

forming an emission layer on the first electrode; and

forming a second electrode on the emission layer.

16. The method of claim **15**, wherein the forming of embossings in a surface of the overcoating film comprises:

disposing a mask having an opening on the overcoating film and exposing; and

performing heat treatment of the exposed overcoating film.

17. The method of claim **16**, wherein the pixel includes a green pixel, a red pixel and a blue pixel.

18. The method of claim **17**, wherein the embossings are formed in the green pixel.

19. The method of claim **17**, wherein the embossings are formed in the red pixel and the blue pixel.

20. The method of claim **17**, wherein the embossings are formed in the green pixel, the red pixel, and the blue pixel, and the tilt angle of embossings formed in the green pixel is different from that of the embossings formed in the red pixel and the blue pixel.

21. The method of claim **16**, wherein the tilt angle is adjusted by varying an exposure amount.

22. The method of claim **16**, wherein the tilt angle is adjusted by varying the size of openings of the mask.

23. The method of claim **15**, wherein the forming of embossings in a surface of the overcoating film comprises forming a contact hole which exposes a part of the thin film transistor in the overcoating film.

24. The method of claim **17**, wherein the pixel further comprises a white pixel, and

wherein the forming of embossings in a surface of the overcoating film comprises removing the overcoating film which is formed in the white pixel.

25. A light emitting display device comprising a plurality of pixels, the comprising:

a first electrode;

a second electrode which is opposite to the first electrode;

an emission layer which is disposed between the first electrode and the second electrode; and

a semi-transparent layer which forms a microcavity with the second electrode,

wherein the semi-transparent layer includes a flexural surface, the flexural surface being inclined with respect to the plane of the semi-transparent layer.

26. The display device of claim **25**, wherein the pixel includes a green pixel, a blue pixel and a red pixel.

27. The display device of claim **26**, wherein the flexural surface is formed in the green pixel.

* * * * *

专利名称(译)	有机发光二极管显示器及其制造方法		
公开(公告)号	US20090206733A1	公开(公告)日	2009-08-20
申请号	US12/111639	申请日	2008-04-29
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO. , LTD. 庆北大学产学合作基础		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD. 庆北大学产学合作基础		
[标]发明人	HWANG YOUNG IN LEE BAEK WOON LEE HAE YEON JU YOUNG GU		
发明人	HWANG, YOUNG-IN LEE, BAEK-WOON LEE, HAE-YEON JU, YOUNG-GU		
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摘要(译)

公开了一种有机发光二极管（OLED）显示器及其制造方法。OLED显示器包括显示不同颜色的第一像素，第二像素和第三像素。显示器包括第一电极，与第一电极相对的第二电极，以及设置在第一电极和第二电极之间的发光层。半透明构件位于第一电极上或下方，并与第二电极一起形成微腔。外涂膜位于半透明构件下方。第一像素，第二像素和第三像素中的至少一个具有形成在半透明构件的表面中的压纹。