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(54) DISPLAY DEVICE

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(57) **ABSTRACT**

A display device includes a display panel. A light control film is disposed above the display panel. The light control film includes a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction. A base film layer is disposed on the light control layer. A polarizing film is disposed above the light control film. The polarizing film includes a phase retardation layer, a first protective layer, a polarizing layer, and a second protective layer.

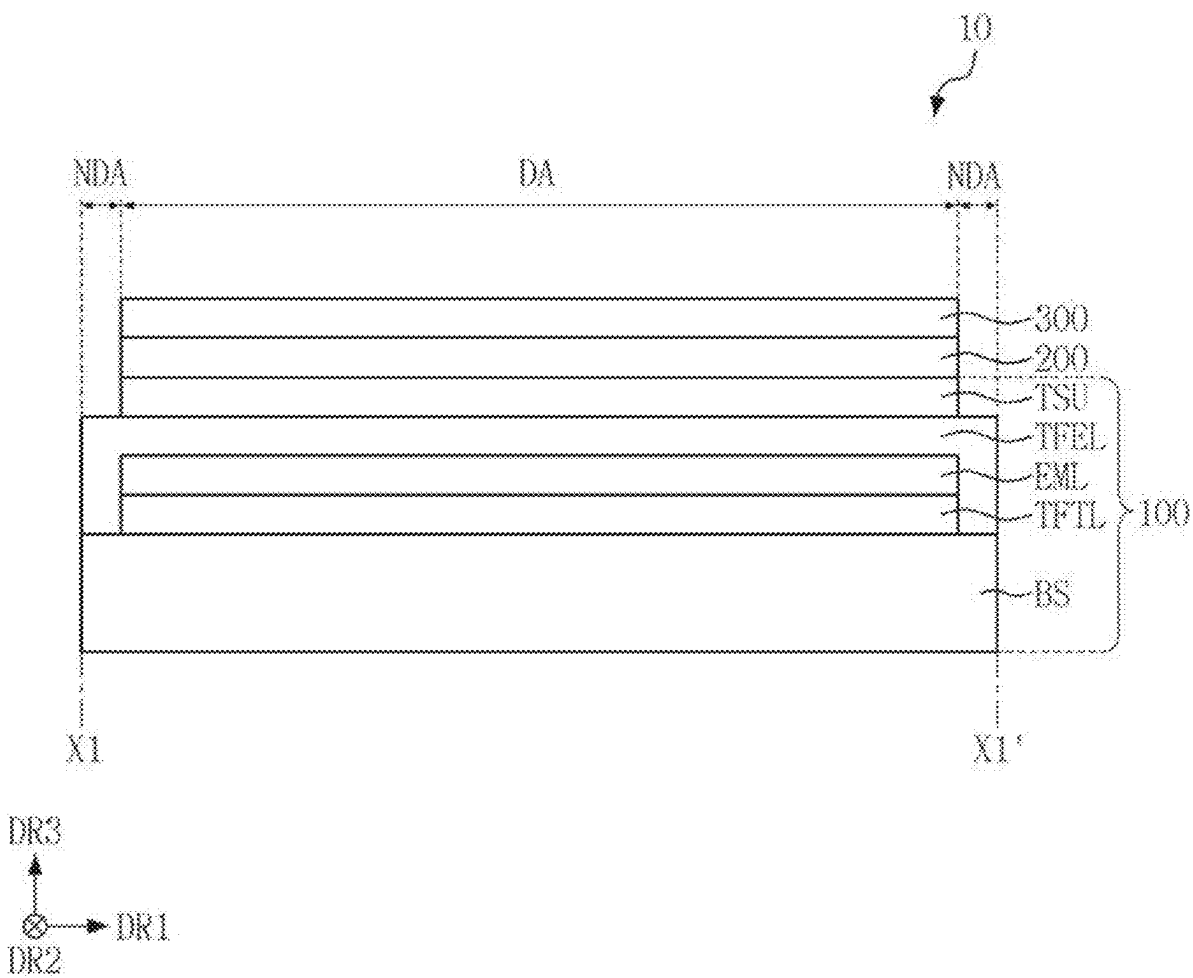


FIG. 1

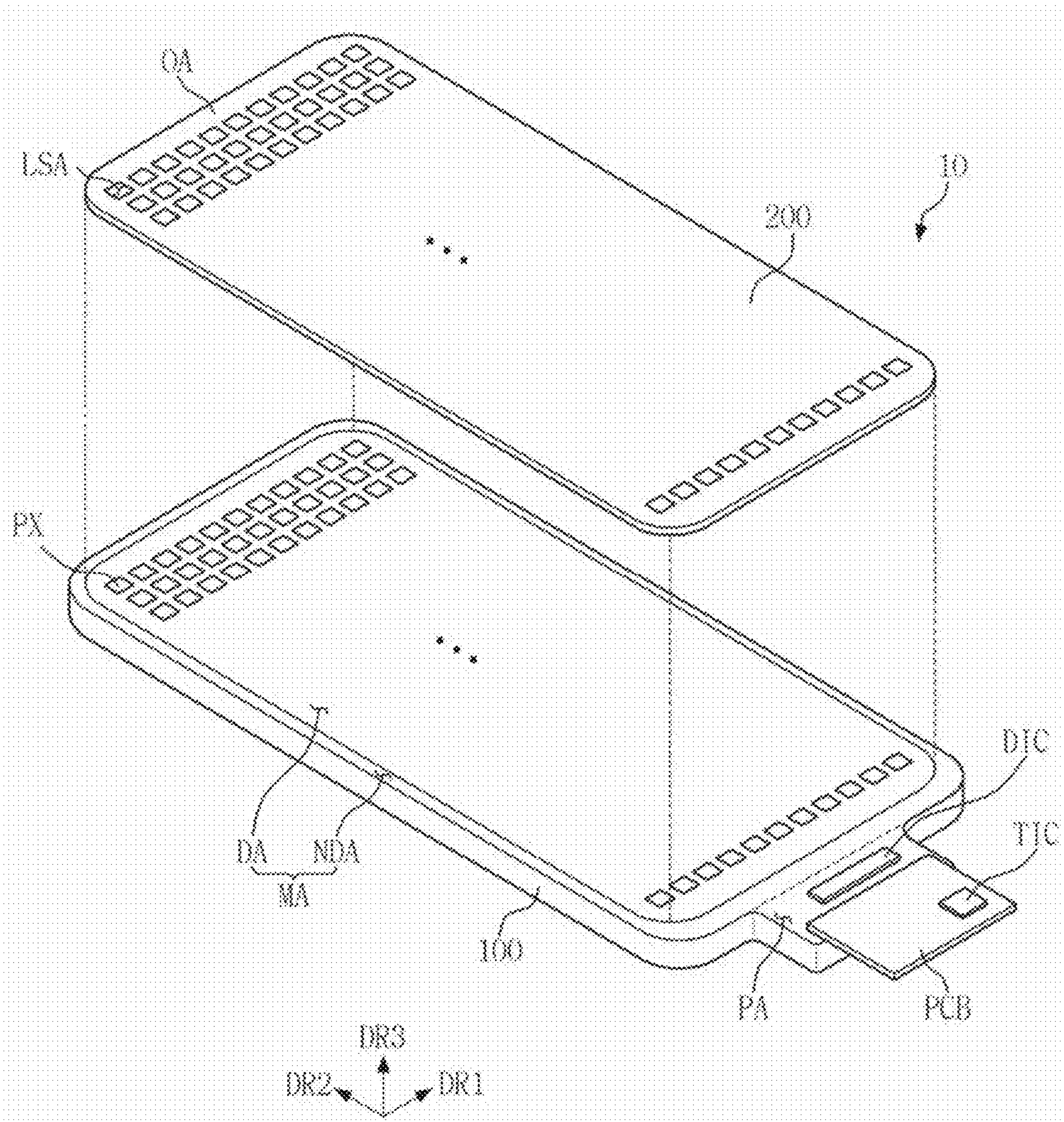


FIG. 2

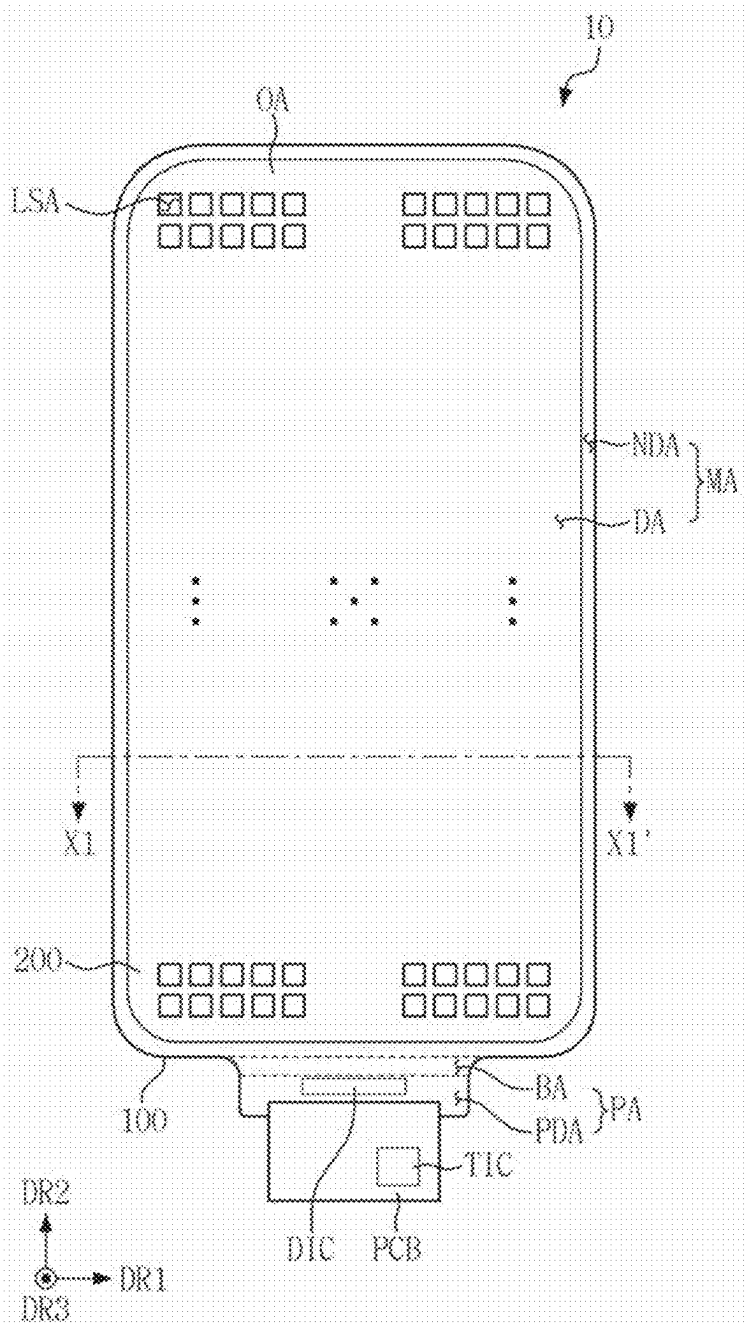


FIG. 3

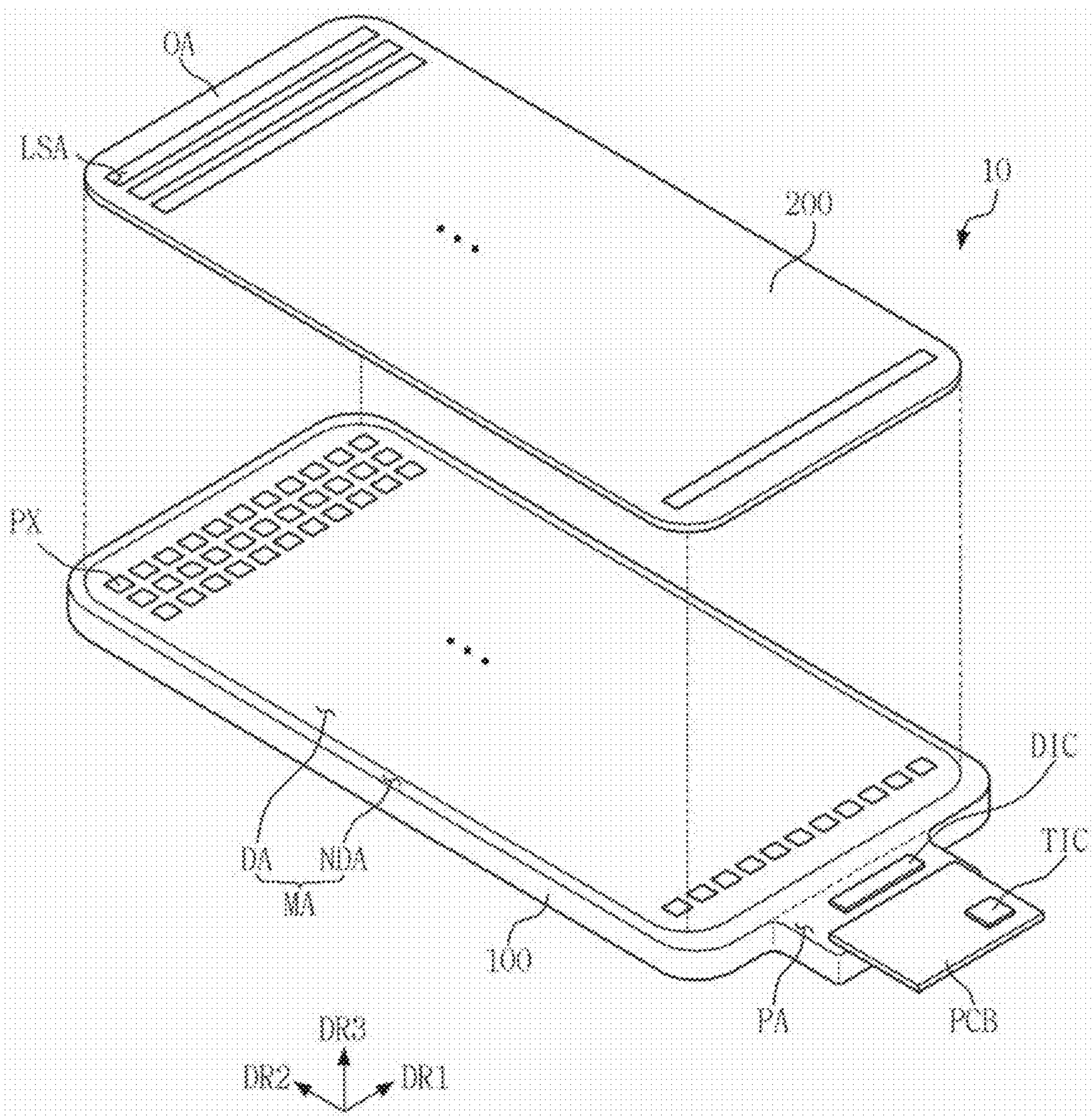


FIG. 4

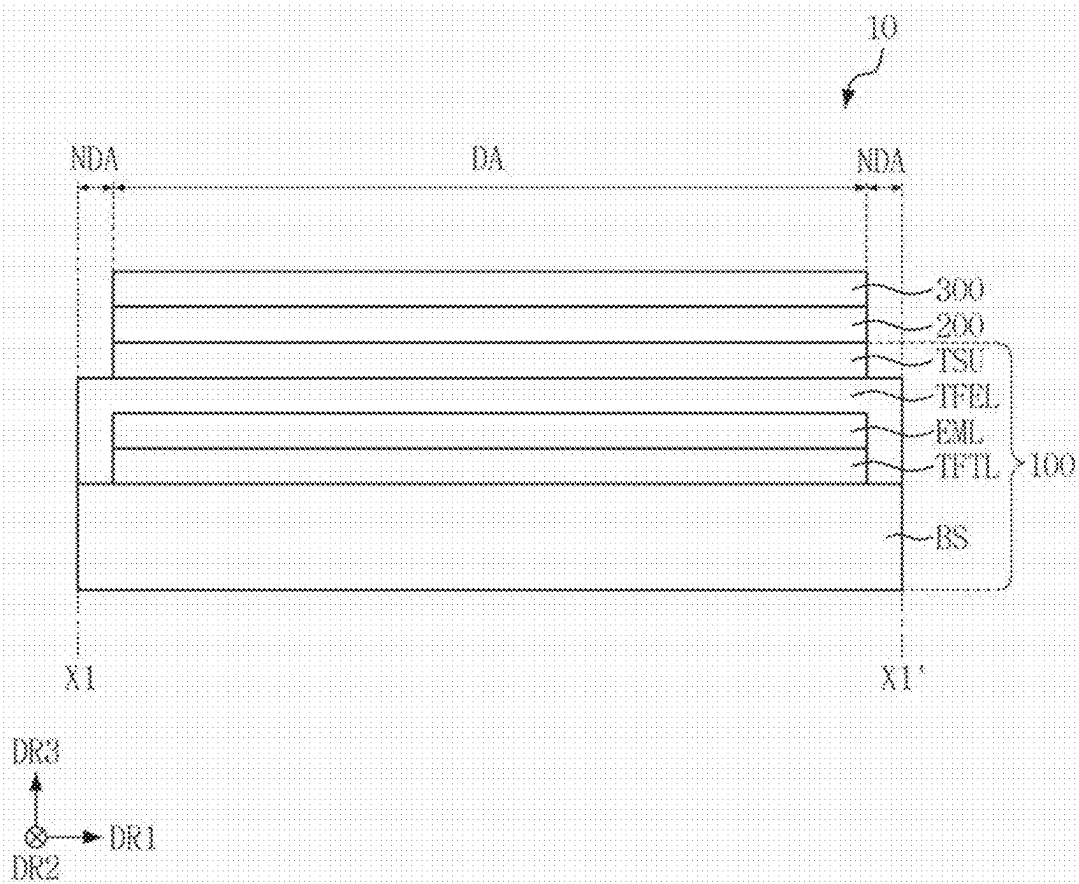


FIG. 5A

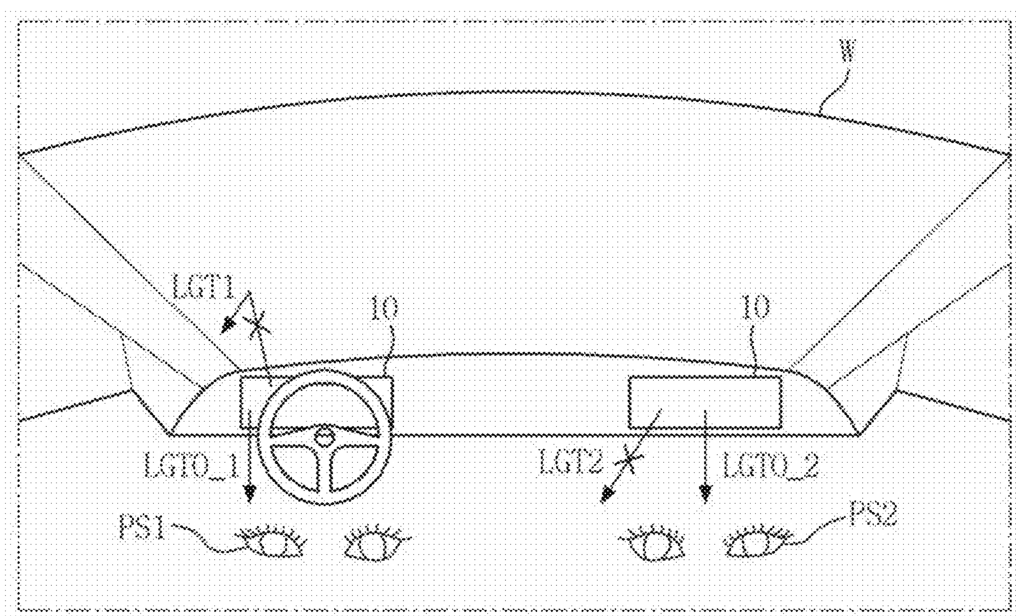


FIG. 5B

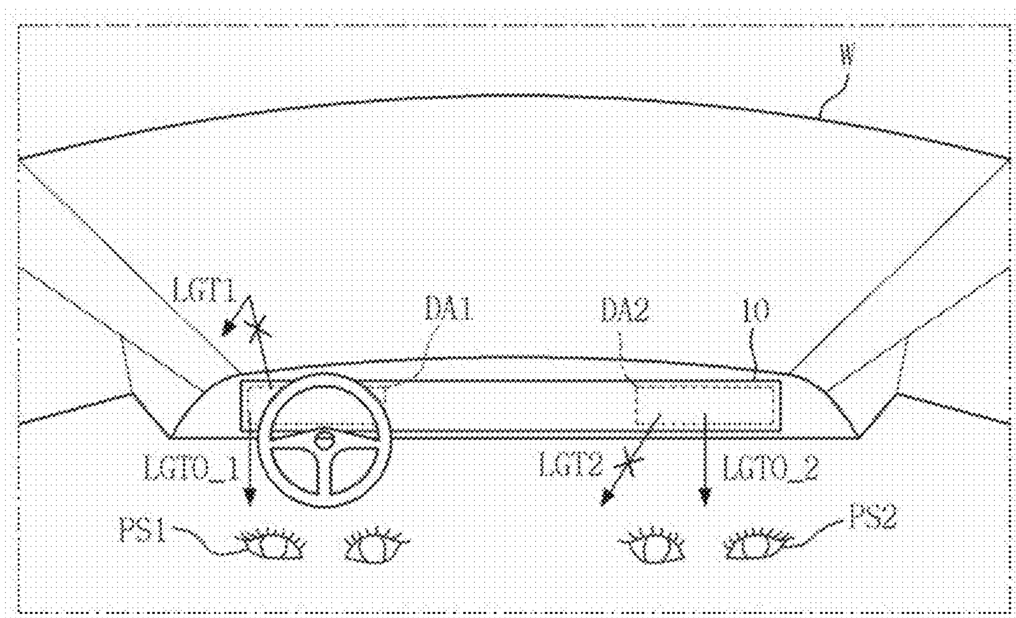


FIG. 6

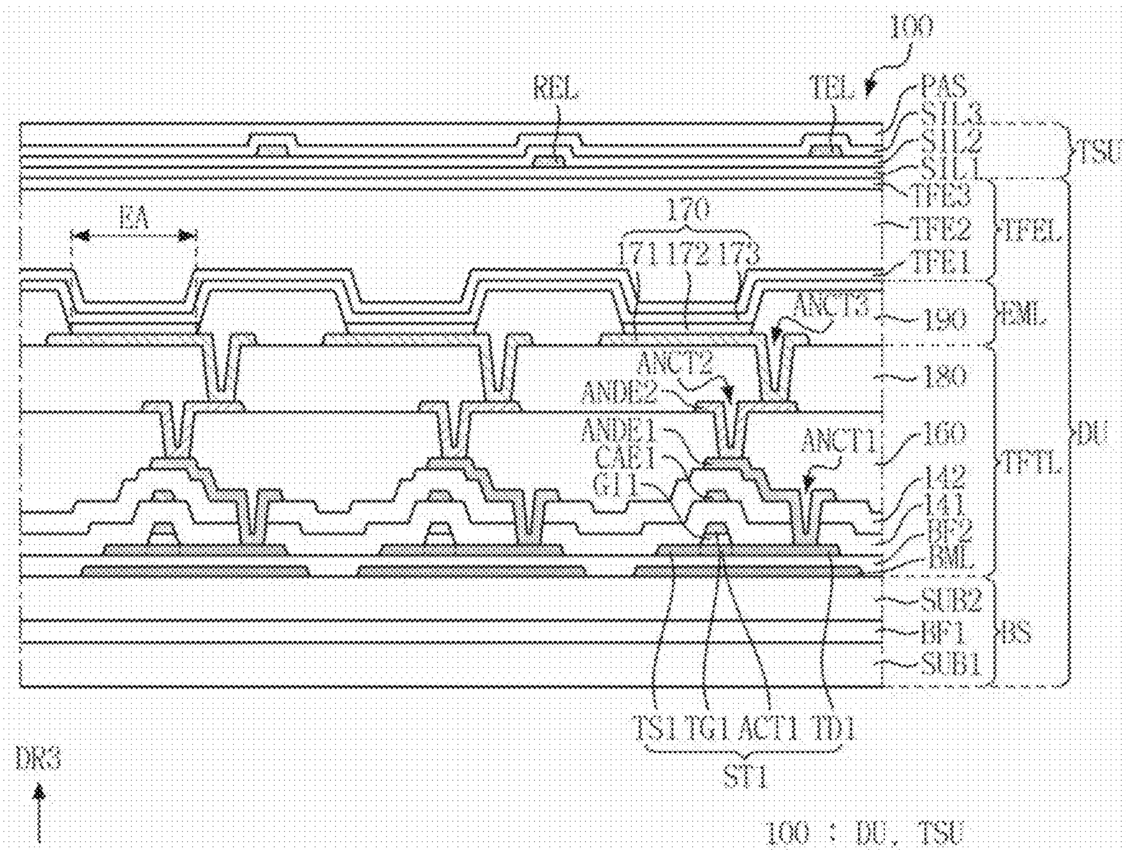

100
REL
TEL
PAS
SIL3
SIL2
SIL1
TSU
TFE3
TFE2
TFE1
TFEL
EA
170
171 172 173
ANCT3
190
EML
180
ANCT2
ANDE2
ANDE1
CAE1
GI1
ANCT1
160
TFTL
DU
142
141
BF2
BML
SUB2
BF1
BS
SUB1
TS1 TG1 ACT1 TD1
ST1
DR3
100 : DU, TSU

FIG. 7A

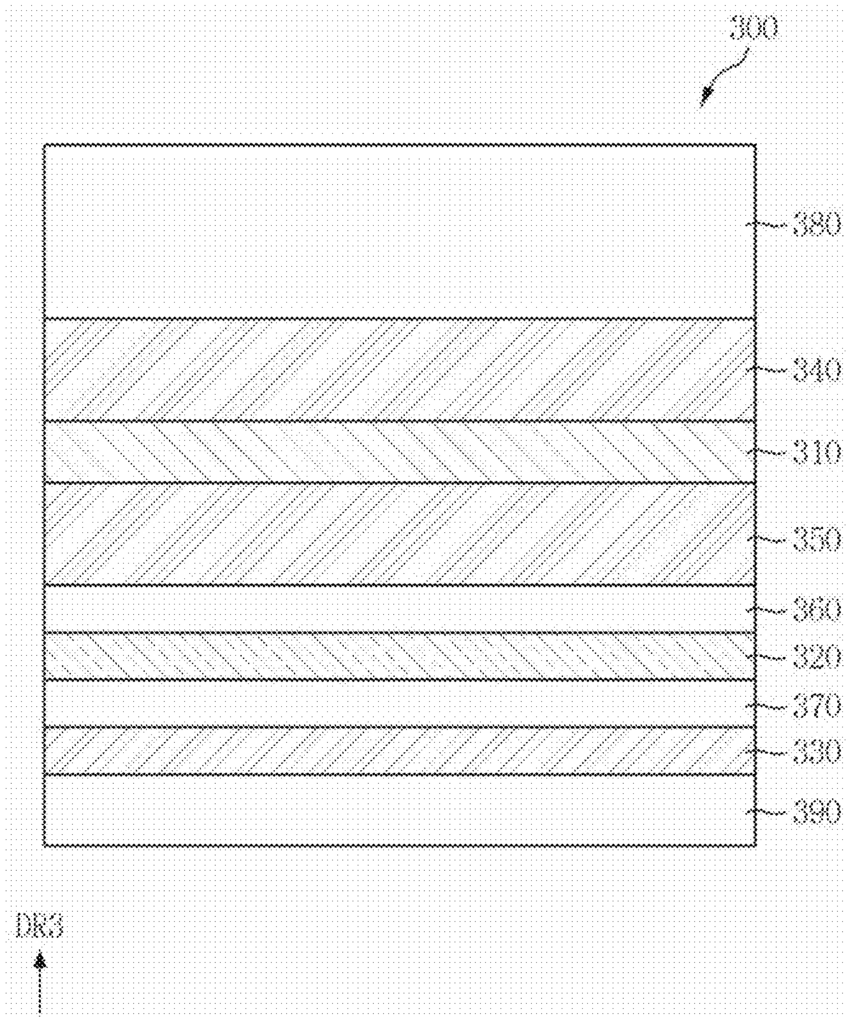


FIG. 7B

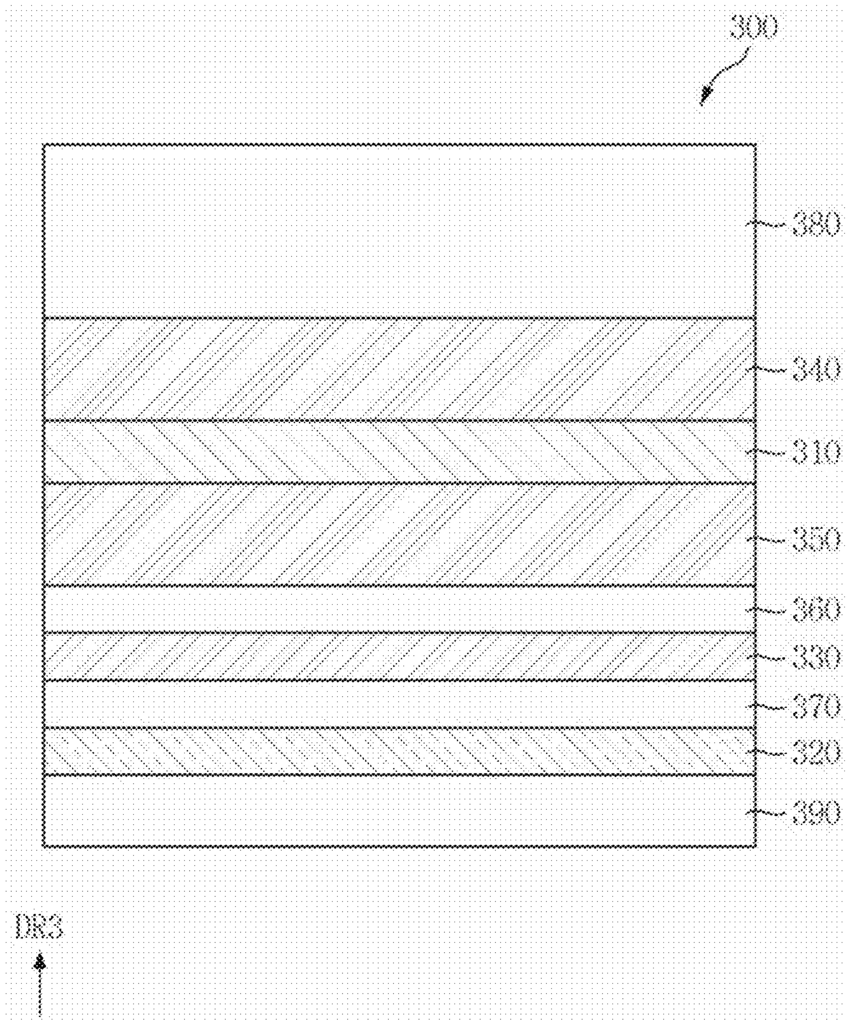


FIG. 8

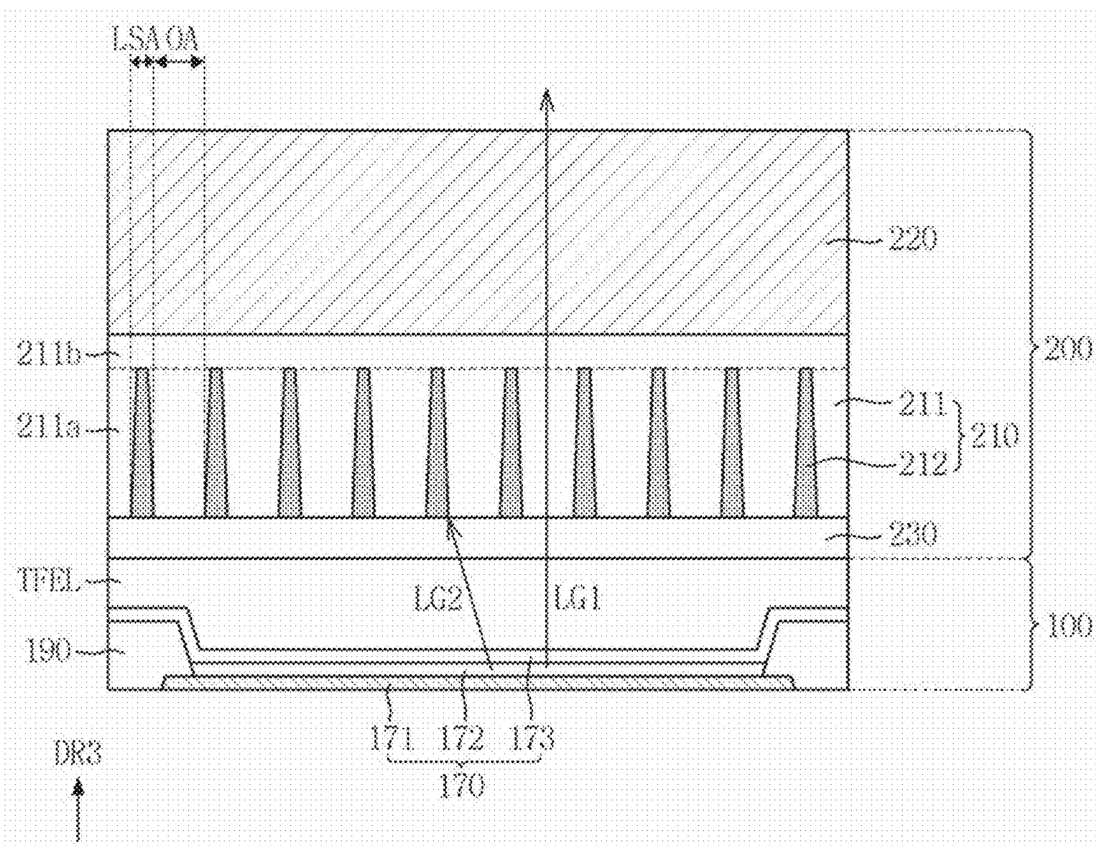

LSA
OA
220
211b
200
211a
211
210
212
230
TFEL
LG2
LG1
100
190
171
172
173
170
DR3

FIG. 9

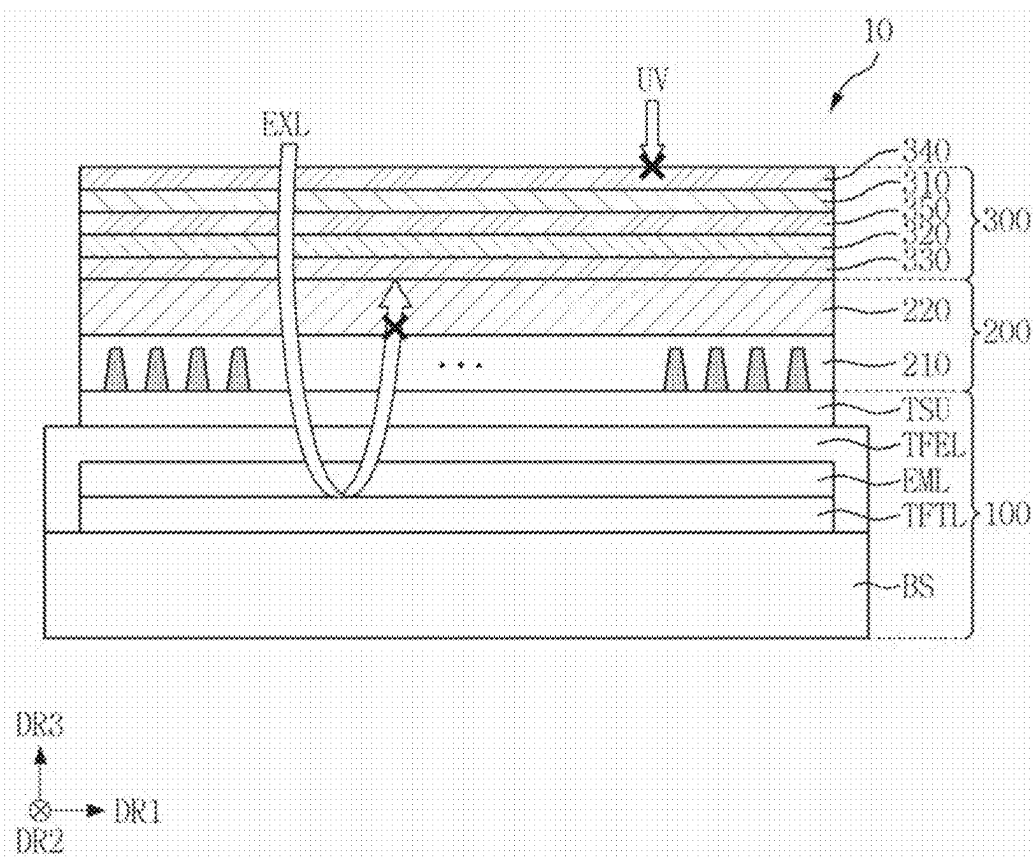

10
UV
EXL
340
310
350
320
330
300
220
200
210
TSU
TFEL
EML
TFTL
100
BS
DR3
DR1
DR2

FIG. 10

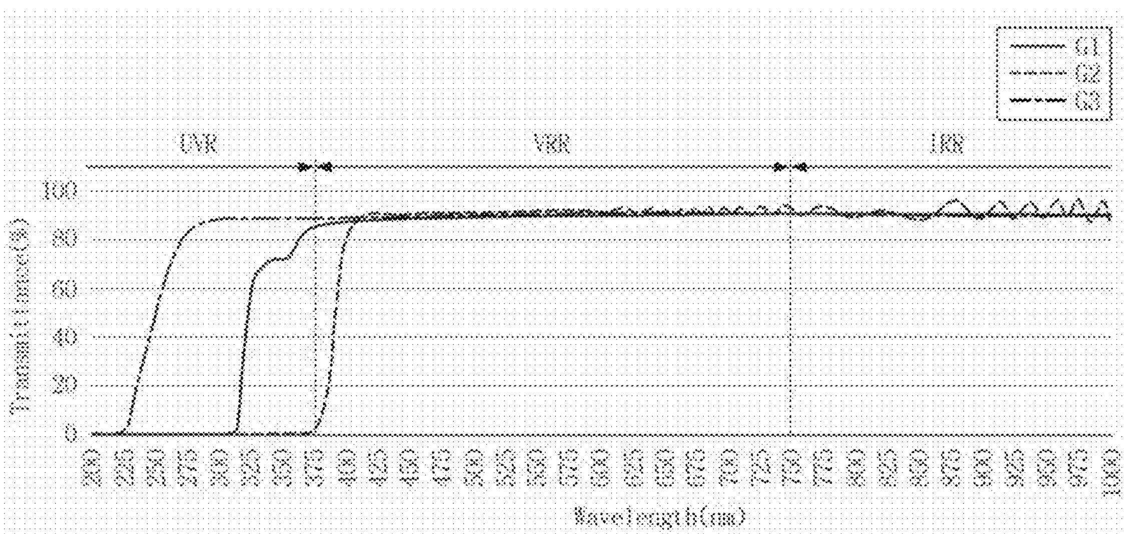

G1
G2
G3
UVR
VRR
IRR
100
80
60
40
20
0
Transmittance(%)
200
225
250
275
300
325
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700
725
750
775
800
825
850
875
900
925
950
975
1000
Wavelength(nm)

FIG. 11A

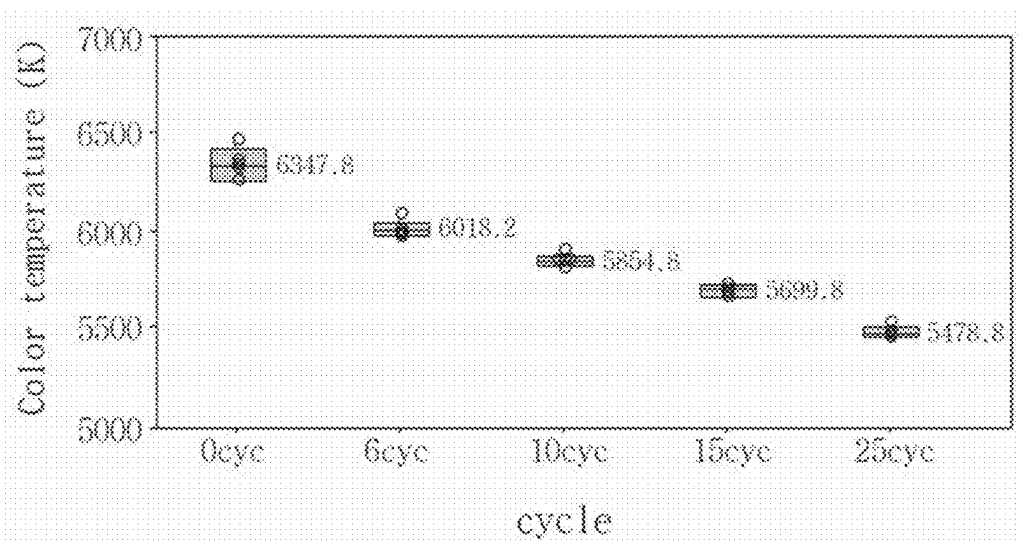

7000
6500
6000
5500
5000
Color temperature (K)
6347.8
6018.2
5854.8
5699.8
5478.8
0cyc
6cyc
10cyc
15cyc
25cyc
cycle

FIG. 11B

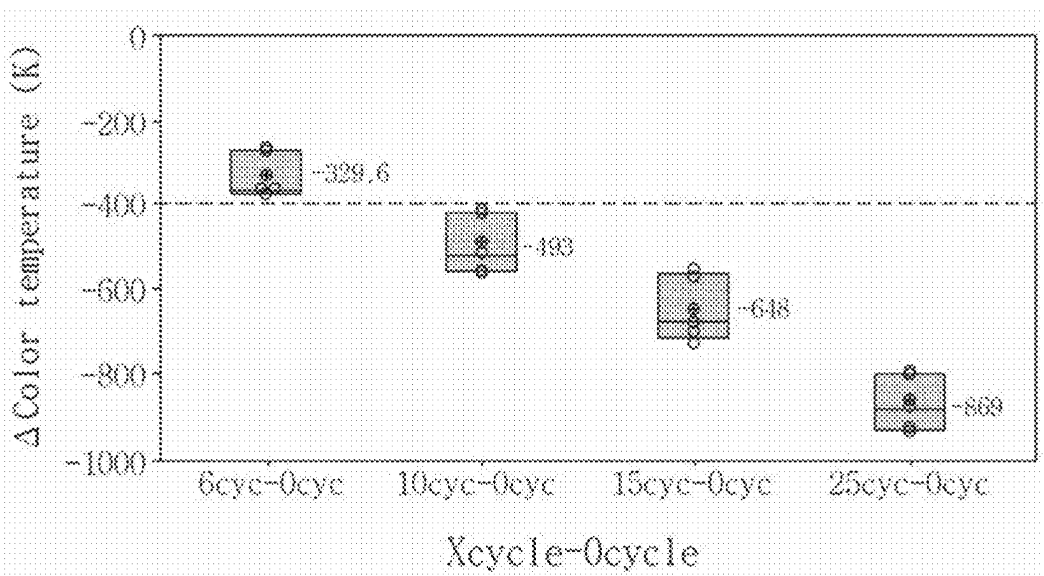

0
-200
-400
-600
-800
-1000
ΔColor temperature (K)
-329.6
-493
-648
-869
6cyc-0cyc
10cyc-0cyc
15cyc-0cyc
25cyc-0cyc
Xcycle-0cycle

FIG. 11C

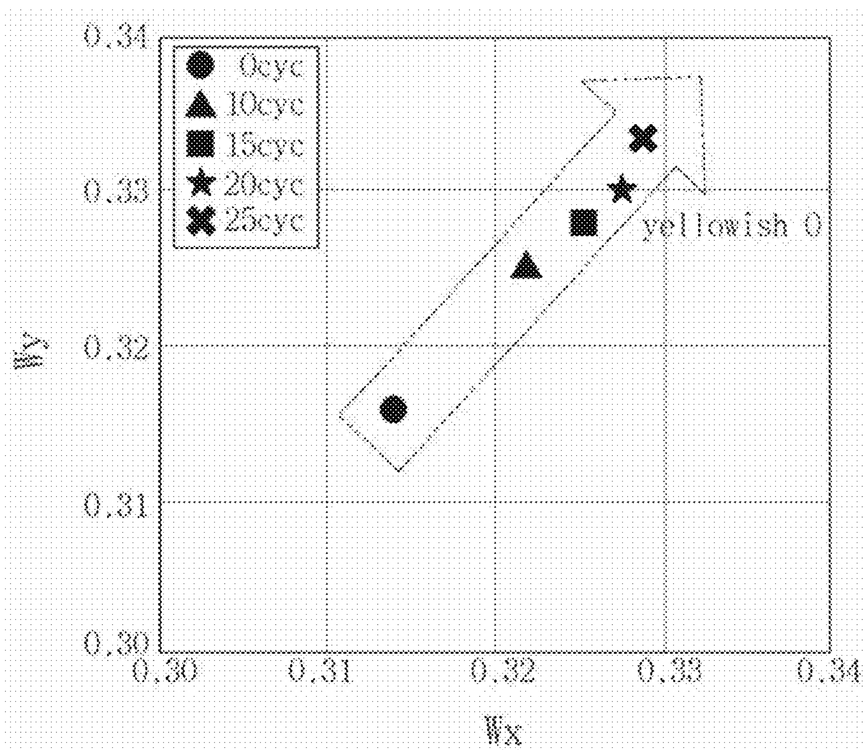

0cyc
10cyc
15cyc
20cyc
25cyc
yellowish 0
0.34
0.33
0.32
0.31
0.30
0.30
0.31
0.32
0.33
0.34
Wy
Wx

FIG. 12A

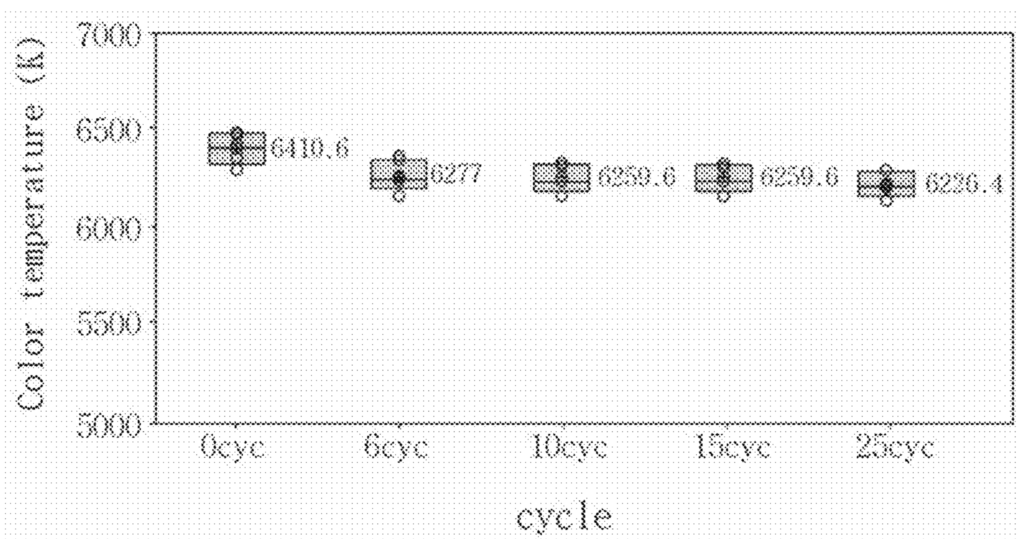

Color temperature (K)
7000
6500
6000
5500
5000
6410.6
6277
6259.6
6259.6
6226.4
0cyc
6cyc
10cyc
15cyc
25cyc
cycle

FIG. 12B

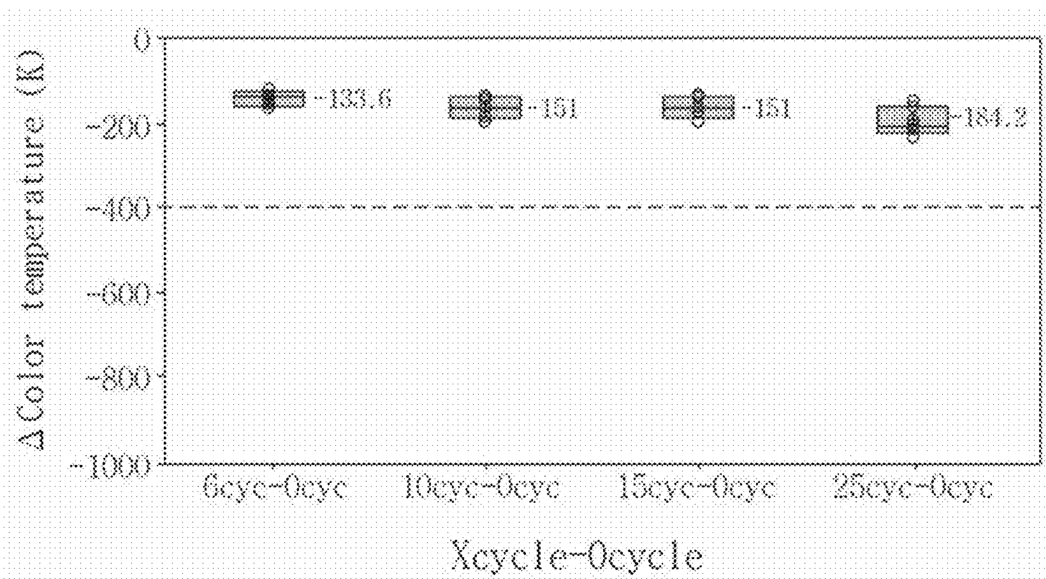

0
-200
-400
-600
-800
-1000
ΔColor temperature (K)
-133.6
-151
-151
-184.2
6cyc-0cyc
10cyc-0cyc
15cyc-0cyc
25cyc-0cyc
Xcycle-0cycle

FIG. 12C

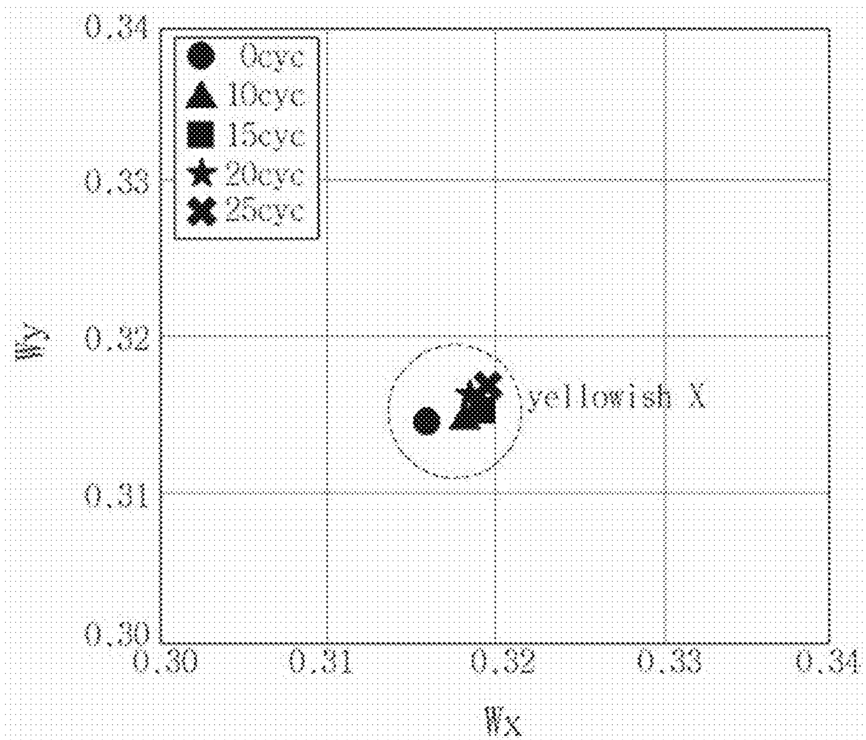

0.34
0.33
0.32
0.31
0.30
Wy
0cyc
10cyc
15cyc
20cyc
25cyc
yellowish X
0.30
0.31
0.32
0.33
0.34
Wx

FIG. 13A

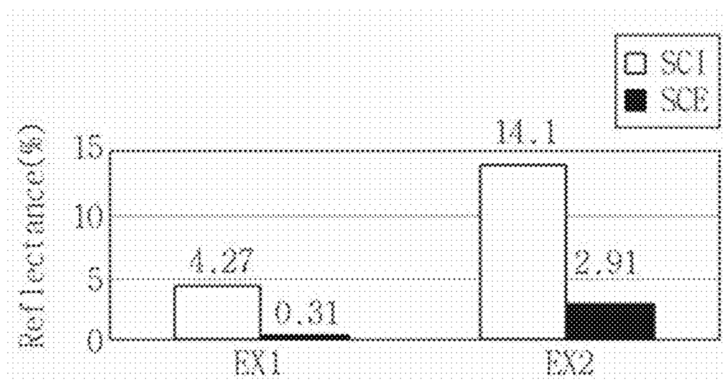


FIG. 13B

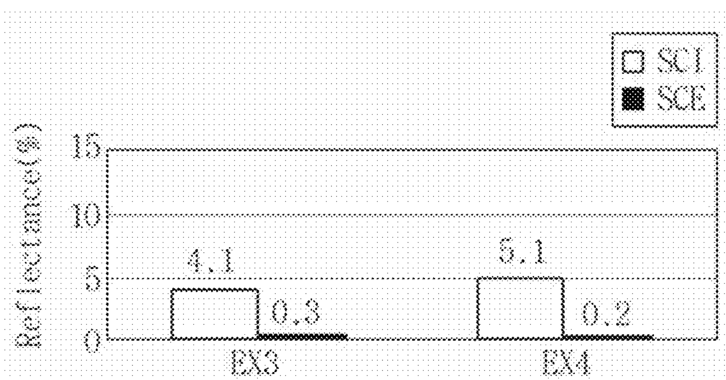
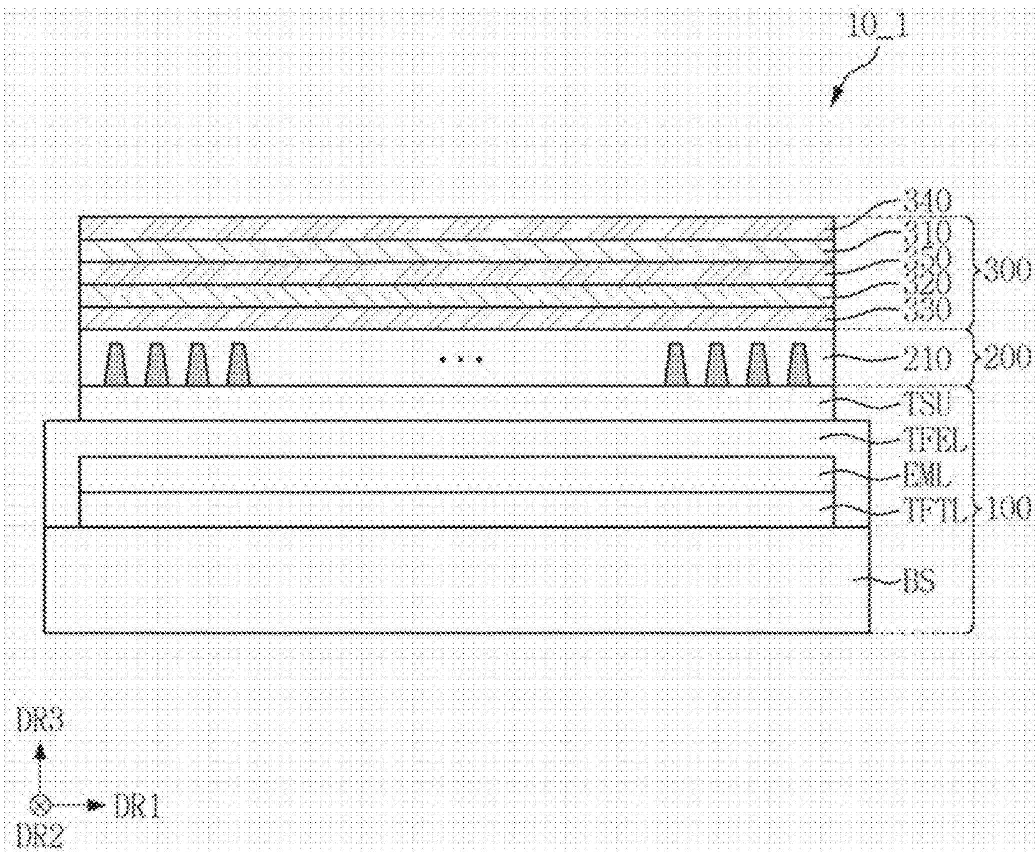


FIG. 14


10_1
340
310
350
320
330
300
210
200
TSU
TFEL
EML
TFTL
100
BS
DR3
DR1
DR2

DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. § 119 to Korean Patent Application No. 10-2024-0021710, filed on Feb. 15, 2024 in the Korean Intellectual Property Office, the disclosure of which is incorporated by reference in its entirety herein.

1. TECHNICAL FIELD

[0002] The present disclosure relates to a display device.

2. DISCUSSION OF RELATED ART

[0003] The demand for display devices for displaying an image which are provided in various forms has increased along with the development of the information society. The display device may be a flat panel display, such as a liquid crystal display, a field emission display, or a light emitting display panel. The light emitting display device may include an organic light emitting diode display device including an organic light emitting diode element as a light emitting element or a light emitting diode display device including an inorganic light emitting diode element such as a light emitting diode (LED) as a light emitting element.

[0004] When the display device is applied to a vehicle display device, an image displayed on the vehicle display device disposed in front of a driver or passenger is reflected on a windshield at night and may interfere with the driver's driving. Therefore, it is necessary to control a viewing angle of the image displayed on the vehicle display device. In addition, for purpose of protecting privacy, it is necessary to control the viewing angle of the images displayed on the vehicle display device to prevent the images disposed in front of the driver from being provided to passengers and to prevent images displayed in front of passengers from being provided to the driver.

SUMMARY

[0005] Aspects of embodiments of the present disclosure provide a display device capable of controlling a viewing angle.

[0006] Aspects of embodiments of the present disclosure also provide a display device capable of minimizing yellowing.

[0007] Aspects of embodiments of the present disclosure also provide a display device capable of minimizing external light reflection.

[0008] However, aspects of embodiments of the present disclosure are not restricted to those set forth herein. The above and other aspects of embodiments of the present disclosure will become more apparent to one of ordinary skill in the art to which the present disclosure pertains by referencing the detailed description of the present disclosure given below.

[0009] According to an embodiment of the present disclosure, a display device includes a display panel. A light control film is disposed above the display panel. The light control film includes a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction. A base film layer is disposed on the light control layer. A polarizing film is disposed above the light control film. The polarizing film includes a phase retardation layer, a first protective layer, a polarizing layer, and a second protective layer.

[0010] In an embodiment, the light control film is disposed directly between the display panel and the polarizing film.

[0011] In an embodiment, at least one of the first protective layer and the second protective layer is disposed on an opposite side of the display panel with respect to the light control film.

[0012] In an embodiment, an ultraviolet transmittance of the base film layer is greater than an ultraviolet transmittance of the first protective layer and the second protective layer.

[0013] In an embodiment, the first protective layer and the second protective layer include an ultraviolet absorber.

[0014] In an embodiment, a birefringence of the light control film is less than or equal to about 0.03.

[0015] In an embodiment, an SCI reflectance of the display device is less than or equal to about 5.5%.

[0016] In an embodiment, the base film layer includes tri-acetyl cellulous (TAC).

[0017] In an embodiment, the first protective layer and the second protective layer include tri-acetyl cellulous (TAC).

[0018] According to an embodiment of the present disclosure, a display device includes a display panel. A light control film is disposed above the display panel. The light control film includes a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction. A base film layer is disposed on the light control layer. A polarizing film is disposed above the light control film. The polarizing film includes a phase adjustment layer and a polarization protective layer disposed on the phase adjustment layer.

[0019] In an embodiment, the light control film is disposed directly between the display panel and the polarizing film.

[0020] In an embodiment, the polarization protective layer is disposed on an opposite side of the display panel with respect to the light control film.

[0021] In an embodiment, an ultraviolet transmittance of the base film layer is greater than an ultraviolet transmittance of the polarization protective layer.

[0022] In an embodiment, the polarization protective layer includes an ultraviolet absorber.

[0023] In an embodiment, a birefringence of the light control film is less than or equal to about 0.03.

[0024] In an embodiment, an SCI reflectance of the display device is less than or equal to about 5.5%.

[0025] In an embodiment, the base film layer includes tri-acetyl cellulous (TAC).

[0026] In an embodiment, the polarization protective layer includes tri-acetyl cellulous (TAC).

[0027] According to an embodiment of the present disclosure, a display device includes a display panel. A light control film is disposed above the display panel. The light control film includes a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction. A polarizing film is disposed above the light control film. The polarizing film includes a phase retardation layer, a first protective layer, a polarizing layer, and a second protective layer. The light control layer is in direct contact with the polarizing film. A birefringence of the light control film is less than or equal to about 0.03.

[0028] In an embodiment, an SCI reflectance of the display device is less than or equal to about 5.5%.

[0029] In the display device according to an embodiment of the present disclosure, the viewing angle may be controlled.

[0030] In the display device according to an embodiment of the present disclosure, the yellowing may be minimized.

[0031] In the display device according to an embodiment of the present disclosure, the external light reflection may be minimized.

[0032] However, the effects of embodiments of the present disclosure are not restricted to the one set forth herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The above and other aspects and features of the present disclosure will become more apparent by describing in detail non-limiting embodiments thereof with reference to the attached drawings, in which:

[0034] FIG. **1** is an exploded perspective view illustrating a display device according to an embodiment of the present disclosure;

[0035] FIG. **2** is a plan view illustrating a display device according to an embodiment of the present disclosure;

[0036] FIG. **3** is an exploded perspective view illustrating a display device according to an embodiment of the present disclosure;

[0037] FIG. **4** is a schematic cross-sectional view of the display device taken along line X**1**-X**1'** of FIG. **2** according to an embodiment of the present disclosure;

[0038] FIG. **5**A is a schematic view of the display device applied to a vehicle according to an embodiment of the present disclosure;

[0039] FIG. **5**B is a schematic view of the display device applied to a vehicle according to an embodiment of the present disclosure;

[0040] FIG. **6** is a cross-sectional view illustrating an example of a display panel according to an embodiment of the present disclosure;

[0041] FIG. **7**A is a cross-sectional view illustrating a polarizing film according to an embodiment of the present disclosure;

[0042] FIG. **7**B is a cross-sectional view illustrating a polarizing film according to an embodiment of the present disclosure;

[0043] FIG. **8** is a cross-sectional view illustrating a light control film according to an embodiment of the present disclosure;

[0044] FIG. **9** is a cross-sectional view illustrating a display device according to an embodiment of the present disclosure;

[0045] FIG. **10** is a graph illustrating light transmittance for each wavelength of a base film layer of a light control film according to a first comparative example, a protective layer of a polarizing film according to an embodiment of the present disclosure, and a base film layer of a light control film according to an embodiment of the present disclosure;

[0046] FIGS. **11**A to **11**C are graphs illustrating solar test results of a display device according to a second comparative example;

[0047] FIGS. **12**A to **12**C are graphs illustrating solar test results of a display device according to embodiments of the present disclosure;

[0048] FIGS. **13**A and **13**B are graphs illustrating external light reflectance of a display device according to third to fifth comparative examples and an embodiment of the present disclosure; and

[0049] FIG. **14** is a cross-sectional view illustrating a display device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0050] The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which non-limiting embodiments of the present disclosure are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the described embodiments set forth herein.

[0051] It will also be understood that when a layer is referred to as being "on" another layer or substrate, it can be directly on the other layer or substrate, or intervening layers may also be present. When a layer is referred to as being "directly on" another layer or substrate, no intervening layers may be present. The same reference numbers indicate the same components throughout the specification.

[0052] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

[0053] FIG. **1** is an exploded perspective view illustrating a display device according to an embodiment. FIG. **2** is a plan view illustrating a display device according to an embodiment. FIG. **3** is an exploded perspective view illustrating a display device according to an embodiment.

[0054] Referring to FIGS. **1** to **3**, a display device **10** is a device that displays at least one moving image and or a still image, and may be used as a display screen of each of various products such as vehicles, televisions, laptop computers, monitors, billboards, and Internet of Things (IoT) as well as portable electronic devices such as mobile phones, smartphones, tablet personal computers (PCs), smartwatches, watch phones, mobile communication terminals, electronic organizers, electronic books, portable multimedia players (PMPs), navigation devices, and ultra mobile PCs (UMPCs).

[0055] In some embodiments in which the display device **10** is used as a display screen for a vehicle, the display device **10** may be a vehicle display. The vehicle display may provide users with various service information such as convenience functions, media information, etc., as well as information about vehicle operation information and status information. In an embodiment in which the display device **10** includes an input device such as a touch panel, the user may manipulate various functions such as a driving mode of the vehicle and convenience functions through the display device **10**.

[0056] In an embodiment, the display device **10** may be any one of an organic light emitting display device, a liquid crystal display device, a plasma display device, a field emission display device, an electrophoretic display device, an electrowetting display device, a quantum dot light emitting display device, and a micro LED display device. Hereinafter, it is mainly described that the display device **10** is the organic light emitting display device. However, embodiments of the present disclosure are not necessarily limited thereto.

[0057] The display device **10** according to an embodiment may include a display panel **100**, a light control film **200**, a display driving circuit DIC, a circuit board PCB, and a touch driving circuit TIC.

[0058] The display panel **100** may include a plurality of pixels PX arranged in a first direction DR**1** and a second direction DR**2**. In an embodiment, each of the pixels PX may have a planar shape such as a rectangle, a square, or a rhombus. For example, as illustrated in the drawing, each of the pixels PX may have a planar shape such as a square. However, embodiments of the present disclosure are not necessarily limited thereto and each of the pixels PX may have various shapes such as a polygon, a circle, and an ellipse in plan view.

[0059] In the illustrated drawings, the first direction DR**1** and the second direction DR**2** are each horizontal directions and intersect each other. For example, the first direction DR**1** and the second direction DR**2** may be orthogonal to each other. In addition, a third direction DR**3** may be a vertical direction intersecting the first direction DR**1** and the second direction DR**2**, for example, orthogonal to the first direction DR**1** and the second direction DR**2**. However, embodiments of the present disclosure are not necessarily limited thereto and the first to third directions DR**1** to DR**3** may cross each other at various different angles. In the present specification, a direction indicated by the first to third directions DR**1**, DR**2**, and DR**3** in the drawing may be referred to as one side, and an opposite direction may be referred to as the other side, and unless otherwise specified, may include both sides.

[0060] In an embodiment, the display panel **100** may include a main area MA and a protruding area PA protruding from one side of the main area MA, such as a lower side in the second direction DR**2**).

[0061] In an embodiment, the main area MA may be formed in a rectangular shape in a plan view having relatively short sides in the first direction DR**1** and relatively long sides in the second direction DR**2** intersecting the first direction DR**1**. A corner where the relatively short side in the first direction DR**1** and the relatively long side in the second direction DR**2** meet may be rounded to have a predetermined curvature or may be formed at a right angle. However, the planar shape of the display device **10** is not necessarily limited to a quadrangular shape, and may be formed in other polygonal, circular, or oval shapes. In an embodiment, the main area MA may be formed to be flat. However, embodiments of the present disclosure are not necessarily limited thereto, and the main area MA may include curved portions formed at left and right ends in some embodiments. In this embodiment, the curved portion may have a constant curvature or a changing curvature.

[0062] The main area MA may include a display area DA in which pixels are formed to display an image, and a non-display area NDA which is a peripheral area of the display area DA and may not include pixels.

[0063] In addition to pixels, scan lines, data lines, and power lines connected to the pixels may be disposed in the display area DA. In an embodiment in which the main area MA includes the curved portion, the display area DA may be disposed on the curved portion. In this embodiment, the image of the display panel **100** may be viewed even on the curved portion.

[0064] The non-display area NDA may be defined as an area from the outside of the display area DA to an edge of the display panel **100** (e.g., in a plan view). In an embodiment, a scan driver for applying scan signals to the scan lines and link lines connecting the data lines and the display driving circuit DIC may be disposed in the non-display area NDA.

[0065] The protruding area PA may protrude from one side of the main area MA. For example, the protruding area PA may protrude from a lower side of the main area MA (e.g., in the second direction DR**2**) as illustrated in FIG. **2**. In an embodiment, a length of the protruding area PA in the first direction DR**1** may be less than a length of the main area MA in the first direction DR**1**.

[0066] In an embodiment, the protruding area PA may include a bending area BA and a pad area PDA. In this embodiment, the pad area PDA may be disposed on one side of the bending area BA (e.g., in the second direction DR**2**), and the main area MA may be disposed on the other side of the bending area BA (e.g., in the second direction DR**2**). For example, the pad area PDA may be disposed on a lower side of the bending area BA (e.g., in the second direction DR**2**), and the main area MA may be disposed on an upper side of the bending area BA (e.g., in the second direction DR**2**).

[0067] In an embodiment, the display panel **100** may be flexibly formed to be curved, bent, folded, or rolled. Therefore, the display panel **100** may be bent in a thickness direction, such as in a third direction DR**3**, in the bending area BA. In this embodiment, before the display panel **100** is bent, one surface of the pad area PDA of the display panel **100** faces upward, but after the display panel **100** is bent, one surface of the pad area PDA of the display panel **100** faces downward. As a result, since the pad area PDA is disposed on a lower side of the main area MA, the pad area PDA may overlap the main area MA (e.g., in the third direction DR**3**).

[0068] Pads electrically connected to the display driving circuit DIC and the circuit board PCB may be disposed in the pad area PDA of the display panel **100**.

[0069] The display driving circuit DIC outputs signals and voltages for driving the display panel **100**. For example, the display driving circuit DIC may supply data voltages to the data lines. In addition, the display driving circuit DIC may supply power voltage to the power line and scan control signals to a scan driver. In an embodiment, the display driving circuit DIC may be formed as an integrated circuit (IC) and be attached onto the display panel **100** in the pad area PDA using a chip on glass (COG) method, a chip on plastic (COP) method, or an ultrasonic bonding method. However, embodiments of the present disclosure are not necessarily limited thereto. For example, in an embodiment the display driving circuit DIC may be mounted on the circuit board PCB.

[0070] The pads may include display pads electrically connected to the display driving circuit DIC and touch pads electrically connected to the touch lines.

[0071] In an embodiment, the circuit board PCB may be attached onto the pads using an anisotropic conductive film. Accordingly, lead lines of the circuit board PCB may be electrically connected to the pads. In an embodiment, the display circuit board PCB may be a flexible film such as a flexible printed circuit board, a printed circuit board, or a chip on film.

[0072] The touch driving circuit TIC may be connected to touch electrodes of a touch sensor layer TSU (see FIG. **4**) of the display panel **100**. The touch driving circuit TIC applies driving signals to the touch electrodes of the touch sensor layer TSU (see FIG. **4**) and measures capacitance values of the touch electrodes. In an embodiment, the driving signal may be a signal having a plurality of driving pulses. The touch driving circuit TIC may not only determine whether a touch is input but also calculate touch coordinates where a touch is input, based on the capacitance values.

[0073] The touch driving circuit TIC may be disposed on the circuit board PCB. For example, in an embodiment the touch driving circuit TIC may be formed as an integrated circuit and be disposed directly on the circuit board PCB. However, embodiments of the present disclosure are not necessarily limited thereto.

[0074] The light control film **200** may be disposed on the main area MA of the display panel **100**. In some embodiments, the light control film **200** may be manufactured separately from the display panel **100** and attached onto the display panel **100**. In an embodiment, the light control film **200** may include an adhesive layer to which a release film is attached before being attached to the display panel **100**. When the light control film **200** is attached onto the display panel **100**, the release film may then be removed, and the display panel **100** and the light control film **200** may be bonded to each other through the adhesive layer.

[0075] The light control film **200** may be disposed on the display area DA of the main area MA. The light control film **200** may control a viewing angle of light emitted from the display panel **100**.

[0076] However, embodiments of the present disclosure are not necessarily limited thereto, and a size of the light control film **200** in a plan view may be greater than a size of the display area DA. In this embodiment, the light control film **200** may overlap (e.g., in the third direction DR**3**) both the display area DA and the non-display area NDA.

[0077] The light control film **200** may include a transmissive area OA and a non-transmissive area LSA.

[0078] As illustrated in FIG. **1**, the transmissive area OA may surround the non-transmissive areas LSA (e.g., in the first and/or second directions DR**1**, DR**2**). However, embodiments of the present disclosure are not necessarily limited thereto, and the non-transmissive area LSA may also surround the transmissive areas OA (e.g., in the first and/or second directions DR**1**, DR**2**) in some embodiments. In an embodiment, the transmissive areas OA and the non-transmissive areas LSA may be alternately disposed in the first direction DR**1** or alternately disposed in the second direction DR**2**.

[0079] Hereinafter, for convenience of explanation, an embodiment in which the transmissive area OA surrounds the non-transmissive areas LSA will be described as an example.

[0080] The transmissive area OA may be an area in which a light blocking pattern **212** (see FIG. **8**) is not disposed. As illustrated in FIG. **1**, the transmissive area OA may surround the non-transmissive areas LSA in a plan view.

[0081] In an embodiment, the transmissive area OA may have a quadrangular shape in plan view as illustrated in FIGS. **1** and **2**. However embodiments of the present disclosure are not necessarily limited thereto. In some embodiments, the transmissive area OA may have a circular, oval, or polygonal shape in a plan view. In some embodiments, the shape of the transmissive area OA may substantially correspond to the shape of the display panel **100**.

[0082] The non-transmissive areas LSA may be remaining areas of the light control film **200** excluding the transmissive area OA. The non-transmissive areas LSA may be areas in which the light blocking pattern **212** (see FIG. **8**) is disposed.

[0083] As illustrated in FIG. **1**, the non-transmissive areas LSA may be arranged in the first direction DR**1** and the second direction DR**2**. In an embodiment, as illustrated in FIG. **3**, the non-transmissive areas LSA may extend longitudinally in the first direction DR**1** and be arranged in the second direction DR**2**. In an embodiment, the non-transmissive areas LSA may extend longitudinally in the second direction DR**2** and be arranged in the first direction DR**1**.

[0084] As illustrated in FIG. **1**, when the non-transmissive areas LSA are disposed along the first direction DR**1** and the second direction DR**2**, the viewing angle may be controlled in both the first direction DR**1** and the second direction DR**2**. As illustrated in FIG. **3**, when the non-transmissive areas LSA are disposed along the first direction DRI or the second direction DR**2**, the viewing angle may be controlled in the first direction DR**1** or the second direction DR**2**. For example, the arrangement and shape of the transmissive areas OA may be variously modified depending on the required control direction of the viewing angle.

[0085] FIG. **4** is a schematic cross-sectional view of the display device taken along line **X1**-**X1'** of FIG. **2**.

[0086] Referring to FIG. **4**, in an embodiment the display device **10** may include a display panel **100**, a light control film **200**, and a polarizing film **300**.

[0087] In an embodiment, the display panel **100** may include a base member BS, a thin film transistor layer TFTL, a light emitting element layer EML, a thin film encapsulation layer TFEL, and a touch sensor layer TSU.

[0088] The base member BS may include a substrate. The substrate may be made of an insulating material such as glass, quartz, or a polymer resin. In an embodiment, the polymer material may include polyethersulphone (PES), polyacrylate (PA), polyarylate (PAR), polyetherimide (PEI), polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyphenylene sulfide (PPS), polyallylate, polyimide (PI), polycarbonate (PC), cellulose triacetate (CAT), cellulose acetate propionate (CAP), or a combination thereof. However, embodiments of the present disclosure are not necessarily limited thereto. Alternatively, the substrate may also include a metal material.

[0089] The substrate may be a rigid substrate or may be a flexible substrate that may be bent, folded, and rolled. In an embodiment in which the substrate is the flexible substrate, the substrate may be formed of polyimide PI. However, embodiments of the present disclosure are not necessarily limited thereto.

[0090] The thin film transistor layer TFTL may be disposed on the base member BS (e.g., disposed directly thereon in the third direction DR**3**). In the thin film transistor layer TFTL, scan lines, data lines, power lines, scan control lines, and routing lines connecting the pads and the data lines as well as thin film transistors of each of the pixels may be formed. In an embodiment, each of the thin film transistors may include a gate electrode, a semiconductor layer, a source electrode, and a drain electrode.

[0091] In an embodiment, the thin film transistor layer TFTL may be disposed in the display area DA and the non-display area NDA. For example, the thin film transistors of each of the pixels, the scan lines, the data lines, and the power lines of the thin film transistor layer TFTL may be disposed in the display area DA. The scan control lines and link lines of the thin film transistor layer TFTL may be disposed in the non-display area NDA.

[0092] The light emitting element layer EML may be disposed on the thin film transistor layer TFTL (e.g., disposed directly thereon in the third direction DR**3**)). The light emitting element layer EML may include pixels including a first electrode, a light emitting layer, and a second electrode, and a pixel defining film defining the pixels. In an embodiment, the light emitting layer may be an organic light emitting layer including an organic material. In this embodiment, the light emitting layer may include a hole transporting layer, an organic light emitting layer, and an electron transporting layer. When a predetermined voltage is applied to the first electrode and a cathode voltage is applied to the second electrode through the thin film transistor of the thin film transistor layer TFTL, holes and electrons move to the organic light emitting layer through the hole transporting layer and the electron transporting layer, respectively, and are bonded to each other in the organic light emitting layer to emit light. The pixels of the light emitting element layer EML may be disposed in the display area DA.

[0093] The thin film encapsulation layer TFEL may be disposed on the light emitting element layer EML (e.g., disposed directly thereon in the third direction DR**3**). The thin film encapsulation layer TFEL may serve to prevent oxygen or moisture from permeating into the light emitting element layer EML. For example, in an embodiment the thin film encapsulation layer TFEL may include at least one inorganic film. In some embodiments, the inorganic film may be a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, or an aluminum oxide layer. However, embodiments of the present disclosure are not necessarily limited thereto. In addition, the thin film encapsulation layer TFEL may serve to protect the light emitting element layer EML from foreign substances such as dust. For example, in an embodiment the thin film encapsulation layer TFEL may include at least one organic film. In some embodiments, the organic film may be made of an acrylic resin, an epoxy resin, a phenolic resin, a polyamide resin, or a polyimide resin. However, embodiments of the present disclosure are not necessarily limited thereto.

[0094] The thin film encapsulation layer TFEL may be disposed in both the display area DA and the non-display area NDA. For example, in an embodiment the thin film encapsulation layer TFEL may be disposed to cover the light emitting element layer EML of the display area DA and the non-display area NDA, and cover the thin film transistor layer TFTL of the non-display area NDA.

[0095] The touch sensor layer TSU may be disposed on the thin film encapsulation layer TFEL (e.g., disposed directly thereon in the third direction DR**3**). In an embodiment in which the touch sensor layer TSU is directly disposed on the thin film encapsulation layer TFEL, the thickness of the display device **10** may be reduced as compared to an embodiment in which a separate touch panel including the touch sensor layer TSU is attached onto the thin film encapsulation layer TFEL.

[0096] The touch sensor layer TSU may include touch electrodes for sensing a user's touch in a capacitance method, and touch lines connecting the pads and the touch electrodes. For example, in an embodiment the touch sensor layer TSU may sense a user's touch in a self-capacitance method or a mutual capacitance method.

[0097] The touch electrodes of the touch sensor layer TSU may be disposed in a touch sensor area overlapping the display area DA. The touch lines of the touch sensor layer TSU may be disposed in a touch peripheral area overlapping the non-display area NDA.

[0098] The light control film **200** may be disposed on the display panel **100** (e.g., disposed directly thereon in the third direction DR**3**). In an embodiment, the light control film **200** may be manufactured separately from the display panel **100** and attached onto the display panel **100**. The light control film **200** may include an adhesive layer to which a release film is attached before being attached to the display panel **100**. When the light control film **200** is attached onto the display panel **100**, the release film may be removed, and the display panel **100** and the light control film **200** may be bonded to each other through the adhesive layer.

[0099] In an embodiment, the light control film **200** may be disposed to overlap the display area DA. The light control film **200** may serve to absorb or block light that travels beyond a certain angle with respect to the third direction DR**3** among the light emitted from the light emitting element layer EML. For example, the light control film **200** may control the viewing angle by limiting the range of angles that the light travels.

[0100] The polarizing film **300** may be disposed on the light control film **200** (e.g., disposed directly thereon in the third direction DR**3**). The polarizing film **300** may reduce external light reflection. In an embodiment, the polarizing film **300** may include a phase adjusting layer such as a polarizing layer **310** (see FIG. **7**A) and a phase retardation layer **320** (see FIG. **7**A), and may reduce external light reflection by adjusting a phase of external light incident on the polarizing film **300**.

[0101] In an embodiment, the display device **10** may further include a cover window. The cover window may be additionally disposed on the polarizing film **300**. In this embodiment, the polarizing film **300** and the cover window may be attached by a transparent adhesive member such as a pressure sensitive adhesive film (PSA) or an optically clear adhesive film (OCA).

[0102] FIG. **5**A is a schematic view when the display device is applied to a vehicle according to an embodiment of the present disclosure.

[0103] FIG. **5**B is a schematic view when the display device is applied to a vehicle according to an embodiment of the present disclosure.

[0104] Referring to FIGS. **5**A and **5**B, the display device **10** according to an embodiment may be, for example, a display device applied to a vehicle. The vehicle may include a body forming an exterior of the vehicle and an interior space defined by the body. The body may include a windshield W that protects a driver PS**1** and a passenger PS**2** from the outside and provides visibility to the driver PS**1**. As illustrated in the drawing, the display device **10** may be provided in the interior space.

[0105] In some embodiments, the display device **10** may be disposed on a dashboard provided in the interior space. As an example, in an embodiment the display device **10** may be disposed on a dashboard in front of a driver's seat to provide speed information, etc. to the driver PS**1**, may be disposed on a dashboard in front of a passenger seat to provide entertainment information, etc. to the passenger PS**2**, and/or may be disposed in the center of the dashboard to provide map information, etc. FIG. **5**A illustrates that the display device **10** is disposed on the dashboard in front of the driver's seat and in front of the passenger seat, respectively.

[0106] As another example, as illustrated in FIG. **5**B, the display device **10** may extend from the dashboard positioned in front of the driver's seat to the dashboard positioned in front of the passenger seat. For example, the display device **10** may be an integrated display connected from the dashboard positioned in front of the driver's seat to the dashboard positioned in front of the passenger seat. In this embodiment, the display device **10** may include a first display area DA**1** positioned in front of the driver's seat and a second display area DA**2** positioned in front of the passenger seat. In an embodiment, the display device **10** may further include a third display area between the first display area DA**1** and the second display area DA**2**.

[0107] Hereinafter, for convenience of explanation, the embodiment of FIG. **5**A will be described as an example. However, embodiments of the present disclosure are not necessarily limited to the embodiment of FIG. **5**A, and in the integrated display as in the embodiment of FIG. **5**B, the first display area DA**1** and the second display area DA**2** correspond to the display device **10** in front of the driver's seat and the display device **10** in front of the passenger seat, respectively, of FIG. **5**A, and the same technical idea may be applied thereto.

[0108] The driver PS**1** may recognize (e.g., visually recognize) a display screen of the display device **10** through light LGT**0_1** emitted from the display device **10** towards the driver PS**1**. However, some light LGT**1** among the light emitted from the display device **10** in front of the driver's seat may be reflected on the surrounding windshield W and provided to the driver PS**1**. In this case, the image displayed on the windshield W may interfere with the driving of the driver PS**1**. However, in the display device **10** according to an embodiment of the present disclosure, it is possible to prevent in advance a portion of light LGT**1** of the light emitted from the display device **10** in front of the driver's seat from being reflected on the surrounding windshield W and provided to the driver PS**1** by adjusting a viewing angle, especially a vertical viewing angle, with respect to a front direction (e.g., the direction facing the driver PS**1**) of the light emitted from the display device **10**.

[0109] In an embodiment, the passenger PS**2** may recognize (e.g., visually recognize) a display screen of the display device **10** through light LGT**0_2** emitted from the display device **10** in front of the passenger seat towards the passenger PS**2**. However, some light LGT**2** of the light emitted from the display device **10** in front of the passenger seat may be provided toward the driver PS**1** which may distract the driver PS**1** from safely operating the vehicle. However, in the display device **10** according to an embodiment of the present disclosure, it is possible to prevent a portion of the light LGT**2** of the light emitted from the display device **10** in front of the passenger seat from being provided to the driver by adjusting the viewing angle, especially the left and right viewing angles, with respect to the front direction (e.g., the direction facing the passenger PS**2**) of the light emitted from the display device **10**.

[0110] It is illustrated in the drawing that the display device **10** in front of the driver's seat adjusts the vertical viewing angle, and the display device **10** in front of the passenger seat adjusts the left and right viewing angle. However, embodiments of the present disclosure are not necessarily limited thereto. As an example, the display device **10** in front of the driver's seat may also adjust the right and left viewing angle, and the display device **10** in front of the passenger seat may also adjust the vertical viewing angle. As another example, the display device **10** in front of the driver's seat and the display device **10** in front of the passenger seat may also adjust both the vertical viewing angle and the left and right viewing angle, respectively.

[0111] The viewing angle may be adjusted by the light control film **200**. The viewing angle may be limited to a predetermined angle range by the light control film **200**. As an example, in an embodiment, when an imaginary line facing the driver PS**1** or passenger PS**2** in the front direction and extending in a direction perpendicular to the display surface of the display device **10** is taken as a normal line, the viewing angle may be an angle within about 35° from the normal line. In some embodiments, the angle within about 35° from the normal line may be defined as an effective viewing angle. However, embodiments of the present disclosure are not necessarily limited thereto.

[0112] FIG. **6** is a cross-sectional view illustrating an example of a display panel according to an embodiment.

[0113] Referring to FIG. **6**, the display panel **100** may include a display layer DU and a touch sensor layer TSU. In an embodiment, the display layer DU may include a base member BS, a thin film transistor layer TFTL, a light emitting element layer EML, and a thin film encapsulation layer TFEL (e.g., consecutively arranged in the third direction DR**3**).

[0114] In an embodiment, the base member BS may include a first substrate SUB**1**, a first buffer film BF**1** disposed on the first substrate SUB**1** (e.g., disposed directly thereon in the third direction DR**3**), and a second substrate SUB**2** disposed on the first buffer film BF**1** (e.g., disposed directly thereon in the third direction DR**3**).

[0115] In an embodiment, the first substrate SUB**1** and the second substrate SUB**2** may be made of an insulating material such as glass, quartz, or polymer resin. Examples of the polymer material may include polyethersulphone (PES), polyacrylate (PA), polyarylate (PAR), polyetherimide (PEI), polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyphenylene sulfide (PPS), polyallylate, polyimide (PI), polycarbonate (PC), cellulose triacetate (CAT), cellulose acetate propionate (CAP), or a combination thereof. However, embodiments of the present disclosure are not necessarily limited thereto. Alternatively, the substrate may also include a metal material.

[0116] The first substrate SUB**1** and the second substrate SUB**2** may be rigid substrates or flexible substrates that may be bent, folded, and rolled. In an embodiment in which the substrate is the flexible substrate, the substrate may be formed of polyimide PI. However, embodiments of the present disclosure are not necessarily limited thereto.

[0117] The first buffer film BF**1** is a film for protecting a first thin film transistor ST**1** and a light emitting layer **172** from moisture permeating through the first and second substrates SUB**1** and SUB**2**, which are vulnerable to moisture permeation. In an embodiment, the first buffer film BF**1** may be formed of a plurality of inorganic films alternately stacked (e.g., in the third direction DR**3**). For example, in an embodiment the first buffer film BF**1** may be formed of a multi-film in which one or more inorganic films of a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, and an aluminum oxide layer are alternately stacked (e.g., in the third direction DR**3**).

[0118] In an embodiment, the thin film transistor layer TFTL may include a lower metal layer BML, a second buffer film BF**2**, a first thin film transistor ST**1**, a first gate insulating film GI**1**, a first interlayer insulating film **141**, a first capacitor electrode CAE**1**, a second interlayer insulating film **142**, a first anode connection electrode ANDE**1**, a first organic film **160**, a second anode connection electrode ANDE**2**, and a second organic film **180**.

[0119] The lower metal layer BML may be disposed on the second substrate SUB**2** (e.g., disposed directly thereon in the third direction DR**3**). The lower metal layer BML may be disposed to overlap a first active layer ACT**1** of the first thin film transistor ST**1** in the third direction DR**3** to prevent leakage current from occurring when light is incident on the first active layer ACT**1** of the first thin film transistor ST**1**. In an embodiment, the lower metal layer BML may be formed as a single layer or multiple layers made of any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd), and copper (Cu), or an alloy thereof. However, embodiments of the present disclosure are not necessarily limited thereto. For example, the lower metal layer BML may be omitted in some embodiments.

[0120] The second buffer film BF**2** may be disposed on the lower metal layer BML (e.g., disposed directly thereon). The second buffer film BF**2** is a film for protecting the first thin film transistor ST**1** and the light emitting layer **172** from moisture permeating through the first and second substrates SUB**1** and SUB**2**, which are vulnerable to moisture permeation. The second buffer film BF**2** may be formed of a plurality of inorganic films alternately stacked. For example, in an embodiment the second buffer film BF**2** may be formed as a multi-film in which one or more inorganic films of a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, and an aluminum oxide layer are alternately stacked. However, embodiments of the present disclosure are not necessarily limited thereto.

[0121] The first active layer ACT**1** of the first thin film transistor ST**1** may be disposed on the second buffer film BF**2** (e.g., disposed directly thereon in the third direction DR**3**). In an embodiment, the first active layer ACT**1** of the first thin film transistor ST**1** includes polycrystalline silicon, single crystal silicon, low-temperature polycrystalline silicon, amorphous silicon, or an oxide semiconductor. The first active layer ACT**1** of the first thin film transistor ST**1** exposed and not covered by the first gate insulating film GI**1** may be doped with impurities or ions to have conductivity. Therefore, a first source electrode TS**1** and a first drain electrode TD**1** of the first active layer ACT**1** of the first thin film transistor ST**1** may be formed.

[0122] The first gate insulating film GI**1** may be disposed on the first active layer ACT**1** of the first thin film transistor ST**1** (e.g., disposed directly thereon in the third direction DR**3**). It is illustrated in FIG. **6** that the first gate insulating film GI**1** is disposed between a first gate electrode TG**1** and the first active layer ACT**1** of the first thin film transistor ST**1** (e.g., in the third direction DR**3**). However, embodiments of the present disclosure are not necessarily limited thereto. For example, in an embodiment the first gate insulating film GI**1** may also be disposed between the first interlayer insulating film **141** and the first active layer ACT**1** and between the first interlayer insulating film **141** and the second buffer film BF**2**. In an embodiment, the first gate insulating film GI**1** may be formed as an inorganic film, for example, a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, or an aluminum oxide layer.

[0123] The first gate electrode TG**1** of the first thin film transistor ST**1** may be disposed on the first gate insulating film GI**1** (e.g., disposed directly thereon in the third direction DR**3**). The first gate electrode TG**1** of the first thin film transistor ST**1** may overlap the first active layer ACT**1** in the third direction DR**3**. In an embodiment, the first gate electrode TG**1** of the first thin film transistor ST**1** may be formed as a single layer or a multi-layer made of any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd), and copper (Cu), or an alloy thereof. However, embodiments of the present disclosure are not necessarily limited thereto.

[0124] The first interlayer insulating film **141** may be disposed on the first gate electrode TG**1** of the first thin film transistor ST**1** (e.g., disposed directly thereon). In an embodiment, the first interlayer insulating film **141** may be formed of an inorganic film, for example, a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, or an aluminum oxide layer. The first interlayer insulating film **141** may include a plurality of inorganic films.

[0125] The first capacitor electrode CAE**1** may be disposed on the first interlayer insulating film **141** (e.g., disposed directly thereon in the third direction DR**3**). The first capacitor electrode CAE**1** may overlap the first gate electrode TG**1** of the first thin film transistor ST**1** in the third direction DR**3**. Since the first interlayer insulating film **141** has a predetermined dielectric constant, a capacitor may be formed by the first capacitor electrode CAE**1**, the first gate electrode TG**1**, and the first interlayer insulating film **141** disposed between the first capacitor electrode CAE**1** and the first gate electrode TG**1**. In an embodiment, the first capacitor electrode CAE**1** may be formed of a single layer or a multi-layer made of any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd), and copper (Cu), or an alloy thereof. However, embodiments of the present disclosure are not necessarily limited thereto.

[0126] The second interlayer insulating film **142** may be disposed on the first capacitor electrode CAE**1** (e.g., disposed directly thereon). In an embodiment, the second interlayer insulating film **142** may be formed of an inorganic film, for example, a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, or an aluminum oxide layer. The second interlayer insulating film **142** may include a plurality of inorganic films.

[0127] The first anode connection electrode ANDE**1** may be disposed on the second interlayer insulating film **142** (e.g., disposed directly thereon in the third direction DR**3**). In an embodiment, the first anode connection electrode ANDE**1** may be connected to (e.g., directly connected thereto) the first drain electrode TD**1** of the first thin film transistor ST**1** through a first anode contact hole ANCT**1** penetrating through the first interlayer insulating film **141** and the second interlayer insulating film **142** to expose the first drain electrode TD**1** of the first thin film transistor ST**1**. In an embodiment, the first anode connection electrode ANDE**1** may be formed of a single layer or a multi-layer made of any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd), and copper (Cu), or an alloy thereof.

[0128] The first organic film **160** for planarization may be disposed on the first pixel connection electrode ANDE**1** (e.g., disposed directly thereon). In an embodiment, the first organic film **160** may be formed of an organic film made of an acryl resin, an epoxy resin, a phenolic resin, a polyamide resin, a polyimide resin, or the like.

[0129] The second anode connection electrode ANDE2 may be disposed on the first organic film **160** (e.g., disposed directly thereon in the third direction DR3). In an embodiment, the second anode connection electrode ANDE2 may be connected to (e.g., directly connected thereto) the first anode connection electrode ANDE1 through a second anode contact hole ANCT2 penetrating through the first organic film **160** to expose the first anode connection electrode ANDE1. In an embodiment, the second anode connection electrode ANDE2 may be formed as a single layer or a multi-layer made of any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd), and copper (Cu), or an alloy thereof.

[0130] The second organic film **180** may be disposed on the second anode connection electrode ANDE2 (e.g., disposed directly thereon). In an embodiment, the second organic film **180** may be formed as an organic film made of an acryl resin, an epoxy resin, a phenolic resin, a polyamide resin, a polyimide resin, or the like.

[0131] It is illustrated in FIG. **6** that the first thin film transistor ST1 is formed in a top gate type in which the first gate electrode TG1 is positioned above the first active layer ACT1. However, embodiments of the present disclosure are not necessarily limited thereto. For example, in an embodiment the first thin film transistor ST1 may be formed in a bottom gate type in which the first gate electrode TG1 is positioned below the first active layer ACT1 or a double gate type in which the first gate electrode TG1 is positioned both above and below the first active layer ACT1.

[0132] The light emitting element layer EML may be disposed on the second organic film **180** (e.g., disposed directly thereon in the third direction DR3). The light emitting element layer EML may include light emitting elements **170** and a bank **190**. In an embodiment, each of the light emitting elements **170** may include a first light emitting electrode **171**, a light emitting layer **172**, and a second light emitting electrode **173**.

[0133] The first light emitting electrode **171** may be formed on the second organic film **180** (e.g., disposed directly thereon in the third direction DR3). In an embodiment, the first light emitting electrode **171** may be connected to the second anode connection electrode ANDE2 through a third anode contact hole ANCT3 penetrating through the second organic film **180** to expose the second anode connection electrode ANDE2.

[0134] In an embodiment, the first light emitting electrode **171** may be formed on the second organic film **180** (e.g., disposed directly thereon in the third direction DR3). In an embodiment, the first light emitting electrode **171** may be connected to the second anode connection electrode ANDE2 through a third anode contact hole ANCT3 penetrating through the second organic film **180** to expose the second anode connection electrode ANDE2.

[0135] In an embodiment including a top emission structure in which light is emitted toward the second light emitting electrode **173** based on the light emitting layer **172**, the first light emitting electrode **171** may be formed of a metal material having high reflectance, such as a stacked structure (Ti/Al/Ti) of aluminum and titanium, a stacked structure (ITO/Al/ITO) of aluminum and indium tin oxide (ITO), an APC alloy, and a stacked structure (ITO/APC/ITO) of an APC alloy and ITO. The APC alloy is an alloy of silver (Ag), palladium (Pd), and copper (Cu).

[0136] The bank **190** may be formed to partition the first light emitting electrode **171** on the second organic film **180** to define a light emitting area EA. The bank **190** may include an opening that exposes at least a portion of an upper surface of the first light emitting electrode **171**. For example, in an embodiment the bank **190** may expose a central portion of the first light emitting electrode **171** and the bank **190** may be formed to cover an edge of the first light emitting electrode **171**. In an embodiment, the bank **190** may be formed of an organic film such as an acrylic resin, an epoxy resin, a phenolic resin, a polyamide resin, or a polyimide resin.

[0137] The light emitting area EA refers to an area in which the first light emitting electrode **171**, the light emitting layer **172**, and the second light emitting electrode **173** are sequentially stacked and holes from the first light emitting electrode **171** and electrons from the second light emitting electrode **173** are bonded to each other in the light emitting layer **172** to emit light. The light emitting area EA may be defined by, and may correspond with, the opening of the bank **190**.

[0138] The light emitting layer **172** is formed on the first light emitting electrode **171** and the bank **190**. In an embodiment, the light emitting layer **172** may be disposed within the opening of the bank **190**. However, embodiments of the present disclosure are not necessarily limited thereto. The light emitting layer **172** may include an organic material to emit light of a predetermined color. For example, in an embodiment the light emitting layer **172** may include a hole transporting layer, an organic material layer, and an electron transporting layer.

[0139] The second light emitting electrode **173** may be disposed on the light emitting layer **172** (e.g., in the third direction DR3). The second light emitting electrode **173** may be formed to cover the light emitting layer **172**. In an embodiment, the second light emitting electrode **173** may be a common layer commonly formed in all the light emitting areas EA. In an embodiment, a capping layer may be formed on the second light emitting electrode **173**.

[0140] In an embodiment having the top emission structure, the second light emitting electrode **173** may be formed of transparent conductive oxide (TCO) such as indium tin oxide (ITO) or indium zinc oxide (IZO) capable of transmitting light, or a semi-transmissive conductive material such as magnesium (Mg), silver (Ag), or an alloy of magnesium (Mg) and silver (Ag). When the second light emitting electrode **173** is formed of the semi-transmissive conductive material, light emission efficiency may be increased by a micro cavity.

[0141] The thin film encapsulation layer TFEL may be disposed on the second light emitting electrode **173** (e.g., disposed directly thereon in the third direction DR3). In an embodiment, the thin film encapsulation layer TFEL may include at least one inorganic film to prevent oxygen or moisture from permeating into the light emitting element layer. In addition, the thin film encapsulation layer TFEL may include at least one organic film to protect the light emitting element layer from foreign substances such as dust. For example, in an embodiment the thin film encapsulation layer TFEL may include a first encapsulation film TFE1, a second encapsulation film TFE2, and a third encapsulation film TFE3 (e.g., consecutively stacked in the third direction DR3).

[0142] The first encapsulation film TFE1 (e.g., a first inorganic encapsulation film) may be disposed on the second light emitting electrode 173 (e.g., disposed directly thereon in the third direction DR3). The first encapsulation film TFE1 may be an inorganic film of a single layer or a multi-layer. In an embodiment, the first encapsulation film TFE1 may be formed of a single film or a multi-film in which one or more inorganic films of a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, and an aluminum oxide layer are alternately stacked (e.g., in the third direction DR3).

[0143] The second encapsulation film TFE2 (e.g., a first organic encapsulation film) may be disposed on the first encapsulation film TFE1 (e.g., disposed directly thereon in the third direction DR3). The second encapsulation film TFE2 may be an organic film of a single layer or a multi-layer. In an embodiment, the second encapsulation film TFE2 may include a polymer-based material. Examples of the polymer-based material may include polyethylene terephthalate, polyethylene naphthalate, polycarbonate, polyimide, polyethylene sulfonate, polyoxymethylene, polyarylate, hexamethyldisiloxane, acrylic resin (e.g., polymethyl methacrylate, polyacrylic acid, etc.), or any combination thereof.

[0144] The third encapsulation film TFE3 (e.g., a second inorganic encapsulation film) may be disposed on the second encapsulation film TFE2 (e.g., disposed directly thereon in the third direction DR3). The third encapsulation film TFE3 may be an inorganic film of a single layer or a multi-layer. In an embodiment, the third encapsulation film TFE3 may include the same material as the first encapsulation film TFE1. For example, the third encapsulation film TFE3 may be formed of a single film or a multi-film in which one or more inorganic films of a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, and an aluminum oxide layer are alternately stacked (e.g., in the third direction DR3).

[0145] The touch sensor layer TSU may be disposed on the thin film encapsulation layer TFEL (e.g., disposed directly thereon in the third direction DR3). The touch sensor layer TSU may include a plurality of touch electrodes for sensing a user's touch in a capacitance method, and touch lines connecting the plurality of touch electrodes and the touch driver. For example, the touch sensor layer TSU may sense the user's touch in a mutual capacitance method or a self-capacitance method.

[0146] In an embodiment, the touch sensor layer TSU may be disposed on a separate substrate disposed on the display layer DU. In this embodiment, the substrate supporting the touch sensor layer TSU may be an encapsulation member that encapsulates the display layer DU.

[0147] The plurality of touch electrodes of the touch sensor layer TSU may be disposed in a touch sensor area overlapping the display area. The touch lines of the touch sensor layer TSU may be disposed in a touch peripheral area overlapping the non-display area.

[0148] In an embodiment, the touch sensor layer TSU may include a first touch insulating film SIL1, a first touch electrode REL, a second touch insulating film SIL2, a second touch electrode TEL, and a third touch insulating film SIL3.

[0149] The first touch insulating film SIL1 may be disposed on the thin film encapsulation layer TFEL (e.g., disposed directly thereon in the third direction DR3). The first touch insulating film SIL1 may have insulation and optical functions. The first touch insulating film SIL1 may include at least one inorganic film. For example, in an embodiment the first touch insulating film SIL1 may be an inorganic film including at least one of a silicon nitride layer, a silicon oxynitride layer, a silicon oxide layer, a titanium oxide layer, and an aluminum oxide layer. However, embodiments of the present disclosure are not necessarily limited thereto. For example, in some embodiments the first touch insulating film SIL1 may be omitted.

[0150] The first touch electrode REL may be disposed on the first touch insulating film SIL1 (e.g., disposed directly thereon in the third direction DR3). The first touch electrode REL may not overlap the light emitting element 170 (e.g., in the third direction DR3). In an embodiment, the first touch electrode REL may be formed as a single layer made of molybdenum (Mo), titanium (Ti), copper (Cu), aluminum (Al), or indium tin oxide (ITO), or be formed as a stacked structure (Ti/Al/Ti) of aluminum and titanium, a stacked structure (ITO/AI/ITO) of aluminum and ITO, an APC alloy, and a stacked structure (ITO/APC/ITO) of an APC alloy and ITO.

[0151] The second touch insulating film SIL2 may cover the first touch electrode REL and the first touch insulating film SIL1. The second touch insulating film SIL2 may have insulation and optical functions. For example, in an embodiment the second touch insulating film SIL2 may be made of the materials illustrated in the first touch insulating film SIL1.

[0152] The second touch electrode TEL may be disposed on the second touch insulating film SIL2 (e.g., disposed directly thereon in the third direction DR3). The second touch electrode TEL may not overlap the light emitting element 170 (e.g., in the third direction DR3). In an embodiment, the second touch electrode TEL may be formed as a single layer made of molybdenum (Mo), titanium (Ti), copper (Cu), aluminum (Al), or indium tin oxide (ITO), or be formed as a stacked structure (Ti/Al/Ti) of aluminum and titanium, a stacked structure (ITO/Al/ITO) of aluminum and ITO, an APC alloy, and a stacked structure (ITO/APC/ITO) of an APC alloy and ITO.

[0153] The third touch insulating film SIL3 may cover the second touch electrode TEL and the second touch insulating film SIL2. The third touch insulating film SIL3 may have insulation and optical functions. In an embodiment, the third touch insulating film SIL3 may be made of the materials illustrated in the second touch insulating film SIL2.

[0154] In some embodiments, the first touch insulating film SIL1, the second touch insulating film SIL2, and the third touch insulating film SIL3 may be organic films. For example, in an embodiment the first touch insulating film SIL1, the second touch insulating film SIL2, and the third touch insulating film SIL3 may be organic films made of an acryl resin, an epoxy resin, a phenolic resin, a polyamide resin, a polyimide resin, or the like.

[0155] The touch sensor layer TSU may further include a planarization film PAS for planarization. The planarization film PAS may be disposed on the third touch insulating film SIL3 (e.g., disposed directly thereon in the third direction DR3). In an embodiment, the planarization film PAS may be formed of an organic film made of an acrylic resin, an epoxy resin, a phenolic resin, a polyamide resin, a polyimide resin, or the like.

[0156] FIG. **7**A is a cross-sectional view illustrating a polarizing film according to an embodiment. FIG. **7**B is a cross-sectional view illustrating a polarizing film according to an embodiment.

[0157] Referring to FIGS. **7**A and **7**B, a polarizing film **300** according to an embodiment may include a polarizing layer **310**, a phase retardation layer **320**, a phase compensation layer **330**, a first protective layer **340**, and a second protective layer **350**.

[0158] The polarizing layer **310** may polarize light incident on the polarizing layer **310** into light in the same direction as a polarization axis. In an embodiment, the polarizing layer **310** may be composed of a polyvinyl alcohol (PVA) film containing a polarizer and/or a dichroic dye. In an embodiment, the dichroic dye may be an iodine molecule or/and a dye molecule.

[0159] In an embodiment, the polarizing layer **310** may be formed by stretching a polyvinyl alcohol film in one direction and immersing a polyvinyl alcohol film in a solution of iodine or/and dichroic dye. In this embodiment, the iodine molecules or/and the dichroic dye molecules may be arranged side by side in the stretching direction. Since the iodine molecules and the dye molecules exhibit dichroism, the iodine molecules and the dye molecules may absorb light vibrating in the stretching direction and transmit light vibrating in a direction perpendicular to the stretching direction.

[0160] The phase retardation layer **320** may be disposed below the polarizing layer **310** (e.g., in a direction opposite to the third direction DR**3**). The phase retardation layer **320** may serve to retard a phase of polarized light passing through the polarizing layer **310**. Light passing through the phase retardation layer **320** may be circularly or elliptically polarized. Accordingly, external light reflectance may be reduced. The phase retardation layer **320** may be disposed farther from the light source than the polarizing layer **310**. For example, when external light is incident from the top of the polarizing layer **310**, the phase retardation layer **320** may be disposed below the polarizing layer **310** (e.g., in a direction opposite to the third direction DR**3**).

[0161] In an embodiment, the phase retardation layer **320** may be a positive A plate. However, embodiments of the present disclosure are not necessarily limited thereto and the phase retardation layer **320** may be one of a negative A plate, a positive C plate, or a negative C plate in some embodiments. The phase retardation layer **320** may be a quarter wave plate (QWP). In an embodiment, the phase retardation layer **320** may include at least one of polycarbonate (PC), tri-acetyl cellulous (TAC), and cyclo olefin polymer.

[0162] The phase compensation layer **330** may be disposed below the phase retardation layer **320** (e.g., in a direction opposite to the third direction DR**3**). In an embodiment, the phase compensation layer **330** may be a positive C plate. However, embodiments of the present disclosure are not necessarily limited thereto and the phase compensation layer **330** may be one of a positive A plate, a negative A plate, or a negative C plate in some embodiments. In an embodiment, the phase compensation layer **330** may include at least one of polycarbonate (PC), tri-acetyl cellulous (TAC), and cyclo olefin polymer. However, embodiments of the present disclosure are not necessarily limited thereto and in some embodiments, the phase compensation layer **330** may be omitted.

[0163] The first protective layer **340** and the second protective layer **350** may be disposed on (e.g., disposed directly thereon) upper and lower surfaces of the polarizing layer **310**. The first protective layer **340** and the second protective layer **350** may serve to support the polarizing layer **310** and supplement a mechanical strength of the polarizing layer **310**. In an embodiment, the first protective layer **340** and the second protective layer **350** may include tri-acetyl cellulous (TAC), cyclo olefin polymer, polymethyl methacrylate (PMMA), and polyethylene terephthalate (PET), etc.

[0164] A first adhesive layer **360** may be disposed between the second protective layer **350** and the phase retardation layer **320** (e.g., in the third direction DR**3**). The first adhesive layer **360** may serve to attach the phase retardation layer **320** to a lower portion of the second protective layer **350**. In an embodiment, the first adhesive layer **360** may be a pressure sensitive adhesive (PSA). For example, the first adhesive layer **360** may be an acrylic pressure sensitive adhesive.

[0165] A second adhesive layer **370** may be disposed between the phase retardation layer **320** and the phase compensation layer **330** (e.g., in the third direction DR**3**). The second adhesive layer **370** may serve to attach the phase compensation layer **330** to a lower portion of the phase retardation layer **320**. In an embodiment, the second adhesive layer **370** may be a pressure sensitive adhesive (PSA). For example, the second adhesive layer **370** may be an acrylic pressure sensitive adhesive. In some embodiments, when the phase compensation layer **330** is omitted, the second adhesive layer **370** may also be omitted.

[0166] In some embodiments, as illustrated in FIG. **7**A, the phase retardation layer **320** may be disposed on the phase compensation layer **330** (e.g., in the third direction DR**3**), and the polarizing layer **310** may be disposed on the phase retardation layer **320** (e.g., in the third direction DR**3**). However, as described above, the second adhesive layer **370** may be disposed between the phase compensation layer **330** and the phase retardation layer **320** (e.g., in the third direction DR**3**), and the first adhesive layer **360** and the second protective layer **350** may be disposed between the phase retardation layer **320** and the polarizing layer **310** (e.g., in the third direction DR**3**).

[0167] In an embodiment, as illustrated in FIG. **7**B, the phase compensation layer **330** may be disposed on the phase retardation layer **320** (e.g., in the third direction DR**3**), and the polarizing layer **310** may be disposed on the phase compensation layer **330** (e.g., in the third direction DR**3**). In this embodiment, the second adhesive layer **370** may be provided between the phase retardation layer **320** and the phase compensation layer **330** (e.g., in the third direction DR**3**), and the first adhesive layer **360** and the second protective layer **350** may be provided between the phase compensation layer **330** and the polarizing layer **310** (e.g., in the third direction DR**3**).

[0168] A third adhesive layer **380** may be disposed on the first protective layer **340** (e.g., disposed directly thereon in the third direction DR**3**). The third adhesive layer **380** may serve to attach the polarizing film **300** and the cover window described above in FIG. **4**. In an embodiment, the third adhesive layer **380** may include a photocurable resin, for example, a UV-curable resin. The third adhesive layer **380** may include an acrylic resin, such as an acrylic ester-based material.

[0169] A fourth adhesive layer **390** may be disposed below the phase retardation layer **320** (e.g., directly below in a direction opposite to the third direction DR**3**). The fourth adhesive layer **390** may serve to attach the polarizing film **300** and the light control film **200** (see FIG. **4**) described above in FIG. **4**. In an embodiment, the fourth adhesive layer **390** may be a pressure sensitive adhesive (PSA). For example, the fourth adhesive layer **390** may be an acrylic pressure sensitive adhesive.

[0170] In some embodiments, the polarizing film **300** may include a phase adjustment layer and a polarization protective layer. The polarization protective layer may be disposed on the phase adjustment layer. For example, the display device **10** may be stacked (e.g., in the third direction DR**3**) in the following order: the display panel **100** (see FIG. **4**), the light control film **200** (see FIG. **4**), the phase adjustment layer, and the polarization protective layer.

[0171] In an embodiment, the phase adjustment layer may include at least one of the polarizing layer **310**, the phase retardation layer **320**, and the phase compensation layer **330**. As an example, the phase adjustment layer may include only the polarizing layer **310**, and as another example, the phase adjustment layer may include only the polarizing layer **310** and the phase retardation layer **320**. However, embodiments of the present disclosure are not necessarily limited to the above-described examples.

[0172] In an embodiment, the polarization protective layer may include at least one of the first protective layer **340** and the second protective layer **350**. For example, the polarization protective layer may include only the first protective layer **340** on the polarizing layer **310**. However, embodiments of the present disclosure are not necessarily limited thereto.

[0173] FIG. **8** is a cross-sectional view illustrating a light control film according to an embodiment.

[0174] Referring to FIG. **8**, the light control film **200** may be disposed on the display panel **100**. In an embodiment, the light control film **200** may include a light control layer **210**, a base film layer **220**, and a fifth adhesive layer **230**.

[0175] The light control layer **210** may control a viewing angle of light emitted from the light emitting layer **172**. For example, when first light LG**1** emitted from the light emitting layer **172** travels at an angle that is less than or equal to a predetermined angle with respect to the third direction DR**3**, the first light LG**1** may be emitted to the outside (e.g., the external environment) through a light transmission pattern **211**. However, when second light LG**2** emitted from the light emitting layer **172** travels at an angle that is greater than or equal to a predetermined angle with respect to the third direction DR**3**, the second light LG**2** may be absorbed or blocked by the light blocking film LS and not emitted to the outside (e.g., the external environment).

[0176] The light control layer **210** may include a light transmission pattern **211** and a light blocking pattern **212**.

[0177] The light transmission pattern **211** may be disposed on the base film layer **220**. The light transmission pattern **211** may be disposed below the base film layer **220** (e.g., in the direction opposite to the third direction DR3). In an embodiment, the light transmission pattern **211** may be disposed across the transmissive area OA and the non-transmissive area LSA. The light transmission pattern **211** may transmit the light emitted from the light emitting layer **172**.

[0178] The light transmission pattern **211** may include a transparent organic material. For example, in an embodiment the light transmission pattern **211** may include an organic film made of an acryl resin, an epoxy resin, a phenolic resin, a polyamide resin, a polyimide resin, or the like. In an embodiment, the light transmission pattern **211** may include silicon oxynitride or silicon oxide.

[0179] In some embodiments, the light transmission pattern **211** may include a first portion **211*a*** that overlaps the light blocking pattern **212** in a horizontal direction perpendicular to the third direction DR**3**, and a second portion **211*b*** disposed on the first portion **211*a*** (e.g., disposed directly thereon in the third direction DR**3**). The first portion **211*a*** may be disposed in the transmissive area OA. The first portion **211*a*** may be disposed alternately with the light blocking pattern **212** in the horizontal direction perpendicular to the third direction DR**3**. The second portion **211*b*** may be disposed across the transmissive area OA and the non-transmissive area LSA. The second portion **211*b*** may overlap the first portion **211*a*** and the light blocking pattern **212** in the third direction DR**3**. The light transmission pattern **211** may include a groove disposed in the non-transmissive area LSA.

[0180] However, embodiments of the present disclosure are not necessarily limited thereto. For example, in an embodiment the second portion **211*b*** may be omitted. In this embodiment, the light blocking pattern **212** may be disposed directly on the base film layer **220** (e.g., in a direction opposite to the third direction DR3).

[0181] In an embodiment, the light blocking pattern **212** may be disposed alternately with the first portion **211*a*** of the light transmission pattern **211** (e.g., in the horizontal direction perpendicular to the third direction DR**3**). The light blocking pattern **212** may be disposed on the second portion **211*b*** of the light transmission pattern **211** (e.g., directly thereon in a direction opposite to the third direction DR**3**). The light blocking pattern **212** may be disposed below the second portion **211*b*** of the light transmission pattern **211**. The light blocking pattern **212** may be disposed within the groove of the light transmission pattern **211**. The light blocking pattern **212** may absorb or block the light emitted from the light emitting layer **172**.

[0182] The light blocking pattern **212** may include a light blocking organic material. For example, in an embodiment the light blocking pattern **212** may include an organic material including an organic black pigment such as carbon black, as a photosensitive resin capable of absorbing or blocking light.

[0183] In some embodiments, the light blocking pattern **212** may have a shape having a width (e.g., length in the horizontal direction perpendicular to the third direction DR3) that becomes narrower from the bottom to the top. For example, the light blocking pattern **212** may have a shape having a width that becomes narrower in the third direction DR**3**. For example, the width of the light blocking pattern **212** may become narrower as it approaches the base film layer **220**. However, embodiments of the present disclosure are not necessarily limited thereto. For example, in an embodiment the width of the light blocking pattern **212** may be constant along the third direction DR**3**.

[0184] The base film layer **220** may support the light control layer **210**. For example, the base film layer **220** may provide a space in which the light control layer **210** may be formed when manufacturing the light control film **200**.

[0185] In some embodiments, the base film layer **220** may include at least one of polyethylene terephthalate (PET), polycarbonate (PC), and tri-acetyl cellulous (TAC).

[0186] The light control film **200** may be manufactured by forming the light control layer **210** on the base film layer **220**

(e.g., in the third direction DR3). For example, in an embodiment the light transmission pattern **211** may be formed by applying a light transmitting material layer containing transparent liquid resin on the base film layer **220**, forming a groove using a roller or jig, and then curing the light transmitting material layer while maintaining a shape of the groove. The light blocking pattern **212** may be formed by applying a light blocking material layer containing black pigment and liquid resin to the groove and then curing the light blocking material layer. In some embodiments, the curing of the light transmitting material layer and the light blocking material layer may be ultraviolet curing.

[0187] The fifth adhesive layer **230** may be disposed on the light control layer **210** (e.g., disposed directly thereon in the direction opposite to the third direction DR3). The fifth adhesive layer **230** may be disposed below the light control layer **210**. The fifth adhesive layer **230** may serve to attach the light control film **200** and the display panel **100** to each other. In an embodiment, the fifth adhesive layer **230** may be a pressure sensitive adhesive (PSA). For example, the fifth adhesive layer **230** may be an acrylic pressure sensitive adhesive.

[0188] FIG. **9** is a cross-sectional view illustrating a display device according to an embodiment. FIG. **10** is a graph illustrating light transmittance for each wavelength of a base film layer of a light control film according to a first comparative example, a protective layer of a polarizing film according to an embodiment of the present disclosure, and a base film layer of a light control film according to an embodiment of the present disclosure. In FIG. **9**, the first to fifth adhesive layers **360**, **370**, **380**, **390**, and **230** are omitted.

[0189] Referring to FIGS. **9** and **10**, the light control film **200** may be disposed on the display panel **100** (e.g., disposed directly thereon in the third direction DR3). The polarizing film **300** may be disposed on the light control film **200** (e.g., disposed directly thereon in the third direction DR3). The light control film **200** may be disposed between the display panel **100** and the polarizing film **300** (e.g., in the third direction DR3). The display device **10** may be stacked (e.g., in the third direction DR3) in the following order: the display panel **100**, the light control film **200**, and the polarizing film **300**.

[0190] Ultraviolet (UV) transmittance of the first protective layer **340** and the second

[0191] protective layer **350** of the polarizing film **300** may be lower than ultraviolet (UV) transmittance of the base film layer **220** of the light control film **200**. For example, the first protective layer **340** and the second protective layer **350** of the polarizing film **300** may block most of the emitted ultraviolet (UV).

[0192] For example, in an embodiment the average ultraviolet (UV) transmittance of the first protective layer **340** and the second protective layer **350** of the polarizing film **300** may be less than or equal to about 5%. In the present specification, ultraviolet (UV) may refer to light with a wavelength less than or equal to about 375 nm. For example, as illustrated in FIG. **10**, ultraviolet (UV) may be light included in an ultraviolet range (UVR) with a wavelength less than or equal to about 375 nm, visible light may be light included in a visible light region (VRR) with a wavelength in a range of about 375 nm to about 750 nm, and infrared may be light included in an infrared region (IRR) with a wavelength greater than about 750 nm. The average ultraviolet (UV) transmittance may refer to average transmittance for ultraviolet in the range less than or equal to about 375 nm.

[0193] A first graph G1 illustrated in FIG. **10** is a graph illustrating light transmittance of the base film layer **220** of the light control film **200** according to a first comparative example, a second graph G2 is a graph illustrating light transmittance of the first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment of the present disclosure, and a third graph G3 is a graph illustrating light transmittance of the base film layer **220** of the light control film **200** according to an embodiment of the present disclosure. The base film layer **220** of the light control film **200** according to the first comparative

[0194] example may include polyethylene terephthalate (PET). The first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment of the present disclosure may include tri-acetyl cellulous (TAC), and the base film layer **220** of the light control film **200** according to an embodiment of the present disclosure may include tri-acetyl cellulous (TAC).

[0195] As illustrated in FIG. **10**, the base film layer **220** of the light control film **200** according to the first comparative example including polyethylene terephthalate (PET) and the base film layer **220** of the light control film **200** according to an embodiment including tri-acetyl cellulous may have a transmittance of 80% or more to ultraviolet (UV) with a wavelength of 375 nm. In contrast, the first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment of the present disclosure including tri-acetyl cellulous may have a transmittance of 3% or less to ultraviolet (UV) with a wavelength of 375 nm.

[0196] In some embodiments, the first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment may further include an ultraviolet absorber. In an embodiment, the first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment may perform an ultraviolet (UV) blocking function. Accordingly, the first protective layer **340** and the second protective layer **350** of the polarizing film **300** according to an embodiment may prevent the polarizing layer **310** from being damaged by ultraviolet (UV).

[0197] The display device **10** according to the present embodiment may prevent yellowing of the light control film **200** caused by ultraviolet (UV) by disposing the polarizing film **300** on the light control film **200** (e.g., above the light control film **200** in the third direction DR3).

[0198] For example, the base film layer **220** of the light control film **200** according to an embodiment needs to transmit at least a portion of ultraviolet (UV) to cure the light transmission pattern **211** when manufacturing the light control film **200**. Since a roller or jig through which ultraviolet is difficult to pass through is disposed on a surface where the groove of the light transmission pattern **211** is formed, the base film layer **220** needs to transmit at least a portion of ultraviolet (UV) to cure the light transmission pattern **211**.

[0199] The display device **10** according to an embodiment of the present embodiment may prevent the light control film **200** from yellowing due to ultraviolet (UV) even when exposed to sunlight for a long time, by disposing the polarizing film **300** on the base film layer **220** of the light control film **200** (e.g., in the third direction DR**3**), which may transmit at least a portion of ultraviolet (UV).

[0200] In an embodiment, a birefringence of the light control film **200** may be less than or equal to about 0.03. For example, in an embodiment the birefringence of the light control film **200** may be 0. The birefringence (Δn) may be defined as a difference ($\Delta n = n_e - n_0$) between a refractive index (n_e) in a direction with a different speed depending on a traveling direction and a refractive index (n_0) in a direction with a constant speed regardless of a traveling direction of light. In some embodiments, the light control film **200** may include tri-acetyl cellulous (TAC) having a low birefringence. An SCI reflectance of the display device **10** according to an embodiment may be less than or equal to about 5.5%.

[0201] The display device **10** according to an embodiment may prevent a phase of external light EXL, having a phase that is adjusted to be constant by being incident on the polarizing film **300**, from being distorted again when passing through the light control film **200**, by minimizing the birefringence of the light control film **200** between the polarizing film **300** and the display panel **100**. Accordingly, the external light EXL reflected from the display panel **100** ultimately does not pass through the polarizing film **300**, and an external light EXL reflection of the display device **10** may be reduced.

[0202] FIGS. **11**A to **11**C are graphs illustrating solar test results of a display device according to a second comparative example. FIGS. **12**A to **12**C are graphs illustrating solar test results of a display device according to an embodiment.

[0203] Referring to FIGS. **11**A to **12**C in addition to FIGS. **9** and **10**, the display device **10** according to the second comparative example of FIGS. **11**A to **11**C may be stacked (e.g., in the third direction DR**3**) in the following order: the display panel **100**, the polarizing film **300**, and the light control film **200**. The display device **10** according to an embodiment of FIGS. **12**A to **12**C may be stacked (e.g., in the third direction DR**3**) in the following order: the display panel **100**, the light control film **200**, and the polarizing film **300**.

[0204] FIGS. **11**A and **11**B are graphs measuring a color temperature of the display device **10** after performing a solar test on the display device **10** according to the second comparative example, and FIGS. **12**A and **12**B are graphs measuring a color temperature of the display device **10** after performing a solar test on the display device **10** according to an embodiment. FIG. **11**C is a graph measuring color coordinates of the display device **10** after performing a solar test on the display device **10** according to the second comparative example, and FIG. **12**C is a graph measuring color coordinates of the display device **10** after performing a solar test on the display device **10** according to an embodiment. The color coordinates (Wx, Wy) illustrated in FIGS. **11**C and **12**C represent color coordinates of CIE 1931.

[0205] The solar test performed to derive the results of FIGS. **11**A to **12**C was conducted by irradiating light so that a temperature inside a chamber was 65° C. and a surface temperature of the display device **10** was 85° C. using a solar lamp with an integrated value of power (Watt: W) per unit area (m^2) of 48 W/m^2 in a wavelength range of 300 nm to 400 nm, and an integrated value of power (Watt: W) per unit area (m^2) of 830 W/m^2 in a wavelength range of 280 nm to 3000 nm within the chamber of 25° C. One cycle includes a light irradiation period in which light is irradiated for 8 hours and a rest period in which light is not irradiated for 8 hours. The solar test was conducted under conditions of 65° C. in the chamber and a relative humidity of 30% or less during 0 to 15 cycles, and was conducted under conditions of 65° C. in the chamber and a relative humidity of 50% or more for 16 to 25 cycles.

[0206] As described above with reference to FIGS. **9** and **10**, in an embodiment the ultraviolet (UV) transmittance of the base film layer **220** of the light control film **200** may be greater than the ultraviolet (UV) transmittance of the first protective layer **340** and the second protective layer **350** of the polarizing film **300** so that the light transmission pattern **211** may be sufficiently cured when forming the light control layer **210**. In this case, while the display device **10** according to the second comparative example does not have an upper layer that may block ultraviolet (UV), the display device **10** according to an embodiment of the present disclosure has the polarizing film **300** that blocks ultraviolet (UV). Therefore, the yellowing may be reduced.

[0207] As illustrated in FIGS. **11**A and **11**B, according to the display device **10** according to the second comparative example, in which the display panel **100**, the polarizing film **300**, and the light control film **200** are stacked in that order (e.g., in the third direction DR**3**), as the solar test is conducted from 0 cycle (initial) to 6 cycle, 10 cycle, 15 cycle, and 25 cycle, the color temperature may be significantly reduced.

[0208] For example, according to the display device **10** according to the second comparative example, a color temperature difference between 6 cycle and 0 cycle may be approximately 329.6K, a color temperature difference between 10 cycle and 0 cycle may be approximately 493K, a color temperature difference between 15 cycle and 0 cycle may be approximately 648K, and a color temperature difference between 25 cycle and 0 cycle may be approximately 869K.

[0209] In contrast, as illustrated in FIGS. **12**A and **12**B, according to the display device **10** according to an embodiment, in which the display panel **100**, the light control film **200**, and the polarizing film **300** are stacked in that order (e.g., in the third direction DR**3**), as the solar test is conducted from 0 cycle (initial) to 6 cycle, 10 cycle, 15 cycle, and 25 cycle, the color temperature may be slightly reduced. As an example, in the display device **10** according to an embodiment, a color temperature difference between 25 cycle and 0 cycle in the solar test may be approximately 400K or less, such as approximately 200K or less.

[0210] For example, in the display device **10** according to an embodiment, a color temperature difference between 6 cycle and 0 cycle may be approximately 133.6K, a color temperature difference between 10 cycle and 0 cycle may be approximately 151K, a color temperature difference between 15 cycle and 0 cycle may be approximately 151K, and a color temperature difference between 25 cycle and 0 cycle may be approximately 184.2K.

[0211] In contrast, as illustrated in FIG. **11**C, the display device **10** according to the second comparative example, in which the display panel **100**, the polarizing film **300**, and the light control film **200** are stacked in that order (e.g., in the third direction DR**3**), as the solar test is conducted from 0 cycle (initial) to 6 cycle, 10 cycle, 15 cycle, and 25 cycle, the color coordinates (Wx, Wy) may be significantly increased. For example, the color coordinates (Wx, Wy) may move upward and to the right in a color coordinate system as the cycle of the solar test is conducted.

[0212] In contrast, as illustrated in FIG. **12**C, the display device **10** according to an embodiment, in which the display panel **100**, the light control film **200**, and the polarizing film **300** are stacked in that order (e.g., in the third direction DR**3**), as the solar test is conducted from 0 cycle (initial) to 6 cycle, 10 cycle, 15 cycle, and 25 cycle, the color coordinates (Wx, Wy) may be hardly increased. For example, the color coordinates (Wx, Wy) may hardly move upward and to the right in the color coordinate system as the cycle of the solar test is conducted.

[0213] The yellowing progresses as the color temperature is reduced and the color coordinates are increased. The display device **10** according to an embodiment may minimize the yellowing by disposing the polarizing film **300** on the light control film **200**.

[0214] FIGS. **13**A and **13**B are graphs illustrating external light reflectance of a display device according to third to fifth comparative examples and an embodiment of the present disclosure.

[0215] Referring to FIGS. **13**A and **13**B in addition to FIG. **9**, a first experimental group EX**1** measured a reflectance of the display device **10** according to a third comparative example, a second experimental group EX**2** measured a reflectance of the display device **10** according to a fourth comparative example, a third experimental group EX**3** measured a reflectance of the display device **10** according to a fifth comparative example, and a fourth experimental group EX**4** measured a reflectance of the display device **10** according to an embodiment of the present disclosure.

[0216] The display device **10** according to the third and fifth comparative examples may be stacked (e.g., in the third direction DR**3**) in the following order: the display panel **100**, the polarizing film **300**, and the light control film **200**. The display device **10** according to the fourth comparative example and an embodiment of the present disclosure may be stacked (e.g., in the third direction DR**3**) in the following order: the display panel **100**, the light control film **200**, and the polarizing film **300**.

[0217] In the display device **10** according to the third and fourth comparative examples, the base film layer **220** may include polyethylene terephthalate (PET). In the display device **10** according to the fifth comparative example and an embodiment, the base film layer **220** may include tri-acetyl cellulous (TAC).

[0218] As described above with reference to FIG. **9**, in the display device **10** according to an embodiment, the birefringence of the light control film **200** may be less than or equal to about 0.03. In this embodiment, the light control film **200** may include tri-acetyl cellulous to achieve a low birefringence. The tri-acetyl cellulous may have a lower refractive index than polyethylene terephthalate due to its molecular structure and manufacturing process. An SCI reflectance of the display device **10** according to an embodiment of the present disclosure may be less than or equal to about 5.5%.

[0219] As illustrated in FIGS. **13**A and **13**B, in the first experimental group EX**1** and the third experimental group EX**3**, since the display panel **100**, the polarizing film **300**, and the light control film **200** are stacked in that order (e.g., in the third direction DR**3**), a phase of the external light EXL may not change due to another member while the external light EXL that has passed through the polarizing film **300** is reflected by the display panel **100** and reaches the polarizing film **300** again. Accordingly, external light EXL reflectance may be minimized. For example, in the first experimental group EX**1** and the third experimental group EX**3**, an SCI reflectance may be approximately 5% or less, and an SCE reflectance may be approximately 0.3%.

[0220] A specular component included (SCI) reflectance refers to a total ray reflectance, and a specular component excluded (SCE) reflectance may refer to a diffuse ray reflectance.

[0221] In the second experimental group EX**2** and the fourth experimental group EX**4**, since

[0222] the display panel **100**, the light control film **200**, and the polarizing film **300** are stacked in that order (e.g., in the third direction DR**3**), the phase of external light EXL may be affected by the light control film **200** while the external light EXL that has passed through the polarizing film **300** is reflected by the display panel **100** and reaches the polarizing film **300** again.

[0223] For example, when the birefringence of the light control film **200** is greater than about 0.03, the phase of the external light EXL is shifted by the light control film **200**, so that the external light EXL reflected from the display panel **100** may be emitted to the outside (e.g., the external environment) without being blocked by the polarizing film **300**. In contrast, when the birefringence of the light control film **200** is less than or equal to about 0.03, such as the birefringence is 0, the phase of the external light EXL is not changed by the light control film **200**. Therefore, the external light EXL reflected from the display panel **100** may be blocked by the polarizing film **300**. Accordingly, external light reflection of the display device **10** may be reduced.

[0224] In the second experimental group EX**2**, the base film layer **220** may include polyethylene terephthalate. Due to polyethylene terephthalate having a relatively high birefringence, the second experimental group EX**2** may have a high reflectance of approximately 14.1% in SCI reflectance and approximately 2.91% in SCE reflectance.

[0225] In contrast, in the fourth experimental group EX**4**, the base film layer **220** may include tri-acetyl cellulous. Due to tri-acetyl cellulous having a relatively low birefringence, the fourth experimental group EX**4** may have a low reflectance of approximately 5.1% in SCI reflectance and approximately 0.2% in SCE reflectance.

[0226] The display device **10** according to an embodiment of the present embodiment may minimize the yellowing by including a stacked structure like the second experimental group EX**2** and the fourth experimental group EX**4**, and may reduce the external light reflection by having the base film layer **220** including tri-acetyl cellulous with a low birefringence index like the fourth experimental group EX**4**.

[0227] The display device **10** according to an embodiment of the present disclosure may ensure that the light transmission pattern **211** is cured sufficiently by using the base film layer **220** with a high transmittance to ultraviolet (UV). However, the display device **10** according to an embodiment of the present disclosure may minimize the yellowing of the light control film **200** by disposing the polarizing film **300**, which includes the first protective layer **340** and the second protective layer **350** with a low transmittance to ultraviolet (UV), on the base film layer **220** (e.g., in the third direction DR**3**) with a high transmittance to ultraviolet (UV). In addition, by minimizing the birefringence of the light control film **200** disposed between the polarizing film **300** and the display panel **100**, the external light reflection of the display device **10** may be reduced.

[0228] Hereinafter, the display device according to an embodiment will be described. In the following embodiments, the same components as those of the above-described embodiment will be denoted by the same reference numerals, and an overlapping description thereof may be omitted or simplified and differences will be mainly described.

[0229] FIG. **14** is a cross-sectional view illustrating a display device according to an embodiment of the present disclosure.

[0230] Referring to FIG. **14**, a display device **10_1** according to an embodiment of the present disclosure is different from the display device **10** according to an embodiment described with reference to FIG. **9** and the like in that the display device **10_1** does not include the base film layer **220**.

[0231] For example, in an embodiment the light control film **200** may not include the base film layer **220**. For example, the light control layer **210** of the light control film **200** may be in direct contact with the polarizing film **300** (e.g., in the direction opposite to the third direction DR**3**).

[0232] In the display device **10_1** according to an embodiment of the present disclosure, the birefringence of the light control film **200** may be minimized as the base film layer **220** is removed. Accordingly, external light reflectance may be reduced.

[0233] In concluding the detailed description, those skilled in the art will appreciate that many variations and modifications can be made to the described embodiments without substantially departing from the principles of the present disclosure. Therefore, the described embodiments of the present disclosure are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A display device comprising:
a display panel;
a light control film disposed above the display panel, the light control film including:
a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction, and
a base film layer disposed on the light control layer; and
a polarizing film disposed above the light control film, the polarizing film including a phase retardation layer, a first protective layer, a polarizing layer, and a second protective layer.

2. The display device of claim **1**, wherein the light control film is disposed directly between the display panel and the polarizing film.

3. The display device of claim **1**, wherein the first protective layer and the second protective layer is disposed on a first side of the light control film, and
the display panel is disposed on a second side of the light control film, which the second side is an opposite side of the first side.

4. The display device of claim **1**, wherein an ultraviolet transmittance of the base film layer is greater than an ultraviolet transmittance of the first protective layer and the second protective layer.

5. The display device of claim **4**, wherein the first protective layer and the second protective layer include an ultraviolet absorber.

6. The display device of claim **1**, wherein a birefringence of the light control film is less than or equal to about 0.03.

7. The display device of claim **1**, wherein an SCI reflectance of the display device is less than or equal to about 5.5%.

8. The display device of claim **1**, wherein the base film layer includes tri-acetyl cellulous (TAC).

9. The display device of claim **8**, wherein the first protective layer and the second protective layer include tri-acetyl cellulous (TAC).

10. A display device comprising:
a display panel;
a light control film disposed above the display panel, the light control film including:
a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction, and
a base film layer disposed on the light control layer; and
a polarizing film disposed above the light control film, the polarizing film including a phase adjustment layer and a polarization protective layer disposed on the phase adjustment layer.

11. The display device of claim **10**, wherein the light control film is disposed directly between the display panel and the polarizing film.

12. The display device of claim **10**, wherein the polarization protective layer is disposed on a first side of the light control film, and
the display panel is disposed on a second side of the light control film, which the second side is an opposite side of the first side.

13. The display device of claim **10**, wherein an ultraviolet transmittance of the base film layer is greater than an ultraviolet transmittance of the polarization protective layer.

14. The display device of claim **13**, wherein the polarization protective layer includes an ultraviolet absorber.

15. The display device of claim **10**, wherein a birefringence of the light control film is less than or equal to about 0.03.

16. The display device of claim **10**, wherein an SCI reflectance of the display device is less than or equal to about 5.5%.

17. The display device of claim **10**, wherein the base film layer includes tri-acetyl cellulous (TAC).

18. The display device of claim **17**, wherein the polarization protective layer includes tri-acetyl cellulous (TAC).

19. A display device comprising:
a display panel;
a light control film disposed above the display panel, the light control film including a light control layer including a light transmission pattern and a light blocking pattern disposed alternately with each other in a horizontal direction; and
a polarizing film disposed above the light control film, the polarizing film including a phase retardation layer, a first protective layer, a polarizing layer, and a second protective layer,
wherein the light control layer is in direct contact with the polarizing film, and
a birefringence of the light control film is less than or equal to about 0.03.

20. The display device of claim **19**, wherein an SCI reflectance of the display device is less than or equal to about 5.5%.

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