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(19) **United States**(12) **Patent Application Publication**(10) **Pub. No.: US 2003/0007114 A1****Kim et al.**(43) **Pub. Date:****Jan. 9, 2003**(54) **ARRAY PANEL FOR A TRANSFLECTIVE
LIQUID CRYSTAL DISPLAY DEVICE****Publication Classification**(51) **Int. Cl.⁷** **G02F 1/1335**(52) **U.S. Cl.** **349/113**(76) **Inventors:** **Dong-Guk Kim**, Seoul (KR);
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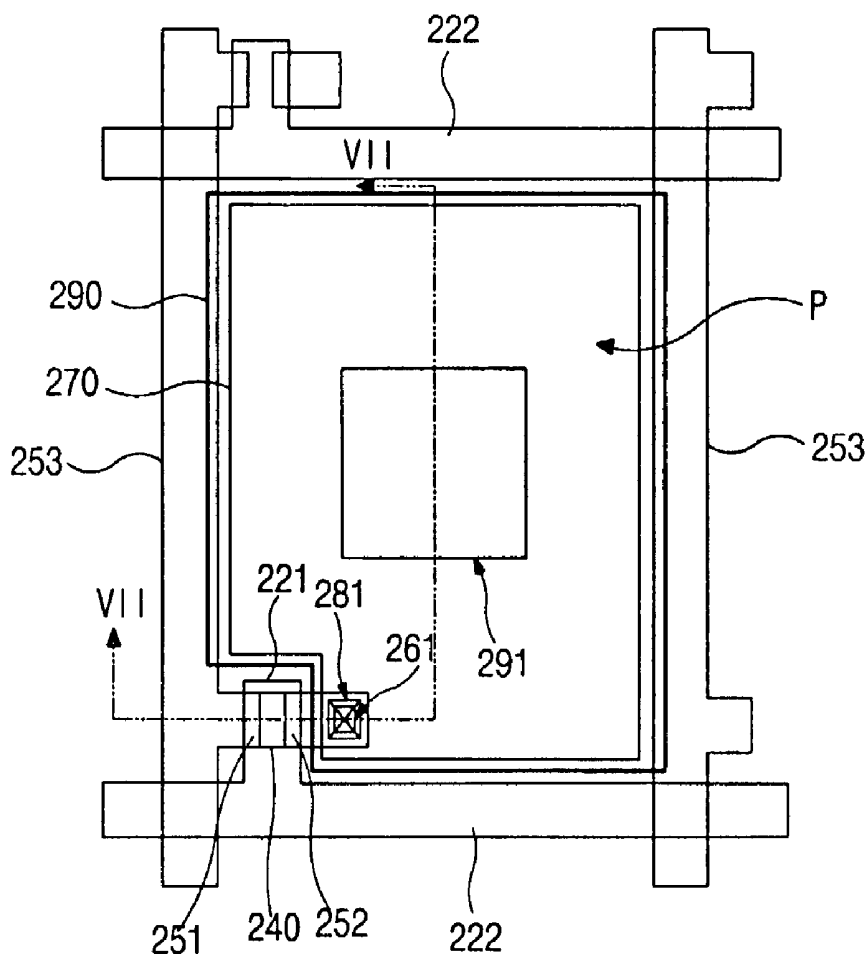
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ABSTRACT

An array panel for a transflective liquid crystal display device includes a substrate; a thin film transistor on the substrate; a first passivation layer covering the thin film transistor and having a first transmissive hole and an inclined portion surrounding the first transmissive hole; a transparent electrode on the first passivation layer, the transparent electrode contacting the thin film transistor; and a reflector over the transparent electrode, the reflector completely covering the inclined portion and having a second transmissive hole corresponding to the first transmissive hole.

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Jul. 4, 2001 (KR) 2001-39638



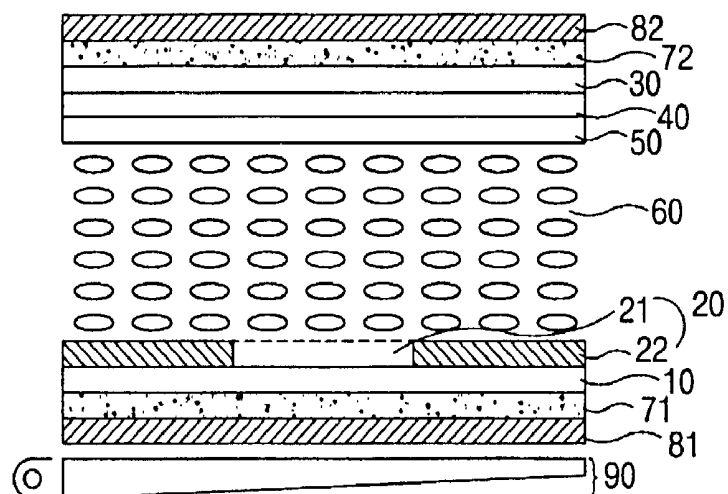


FIG. 1
(PRIOR ART)

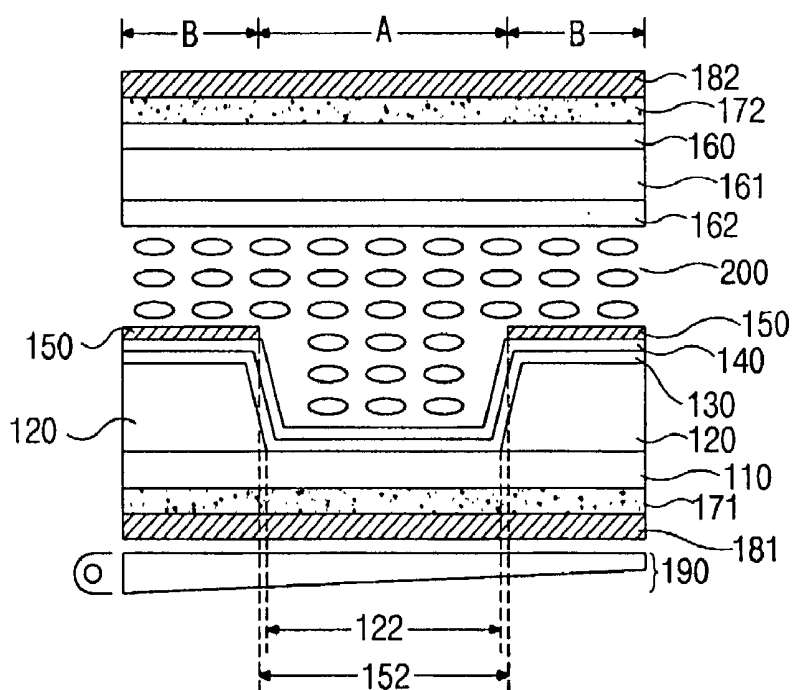


FIG. 2
(PRIOR ART)

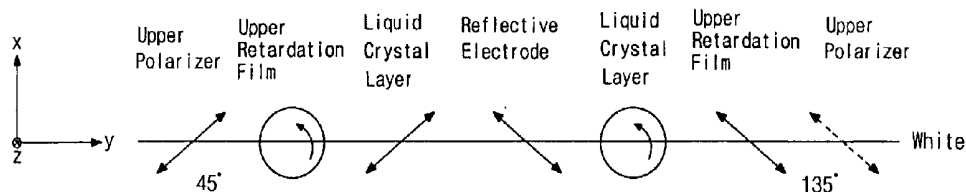


FIG. 3A
(PRIOR ART)

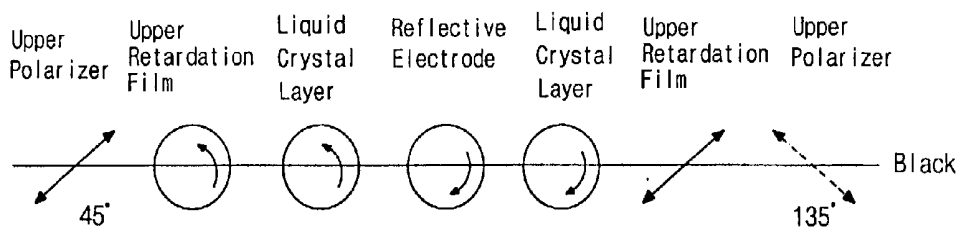


FIG. 3B
(PRIOR ART)

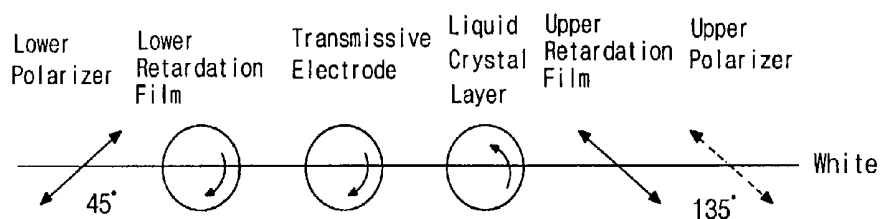


FIG. 4A
(PRIOR ART)

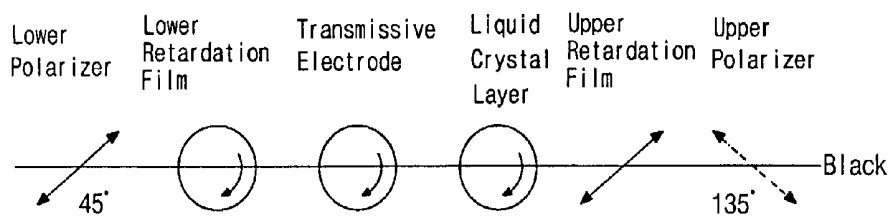


FIG. 4B
(PRIOR ART)

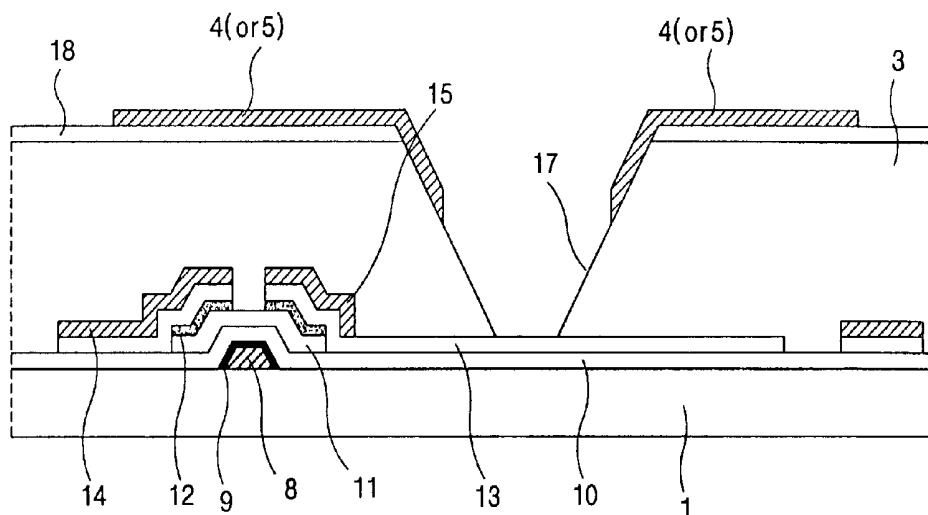


FIG. 5
(PRIOR ART)

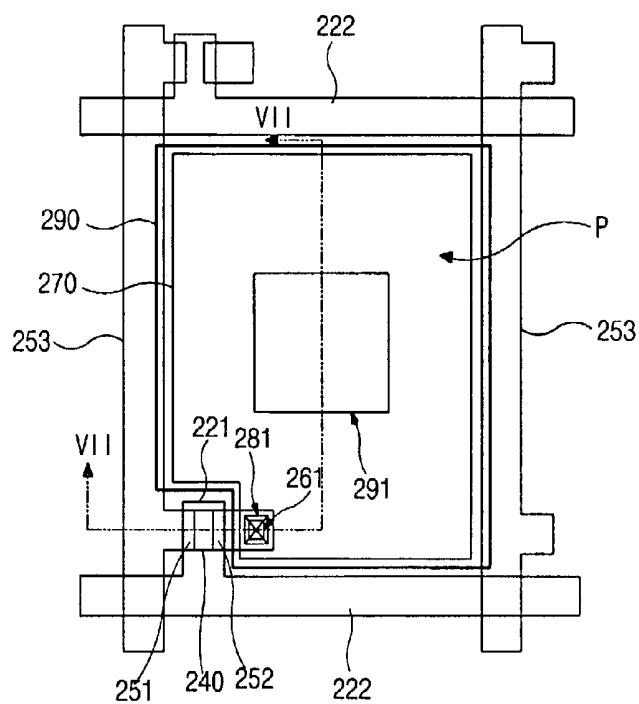


FIG. 6

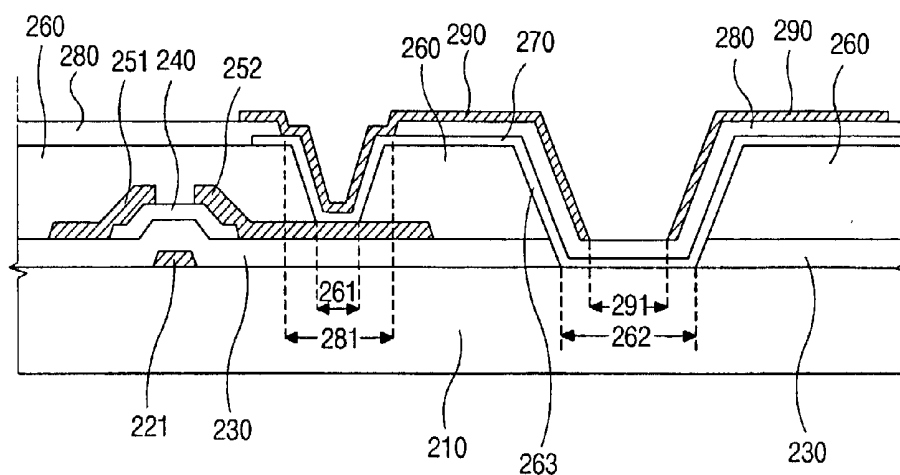


FIG. 7

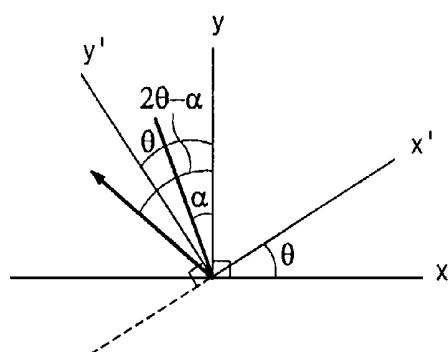


FIG. 8

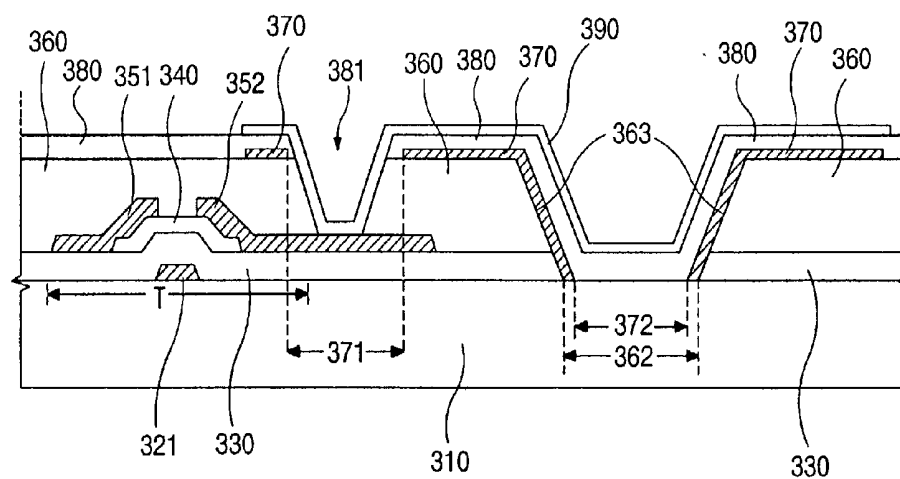


FIG. 9

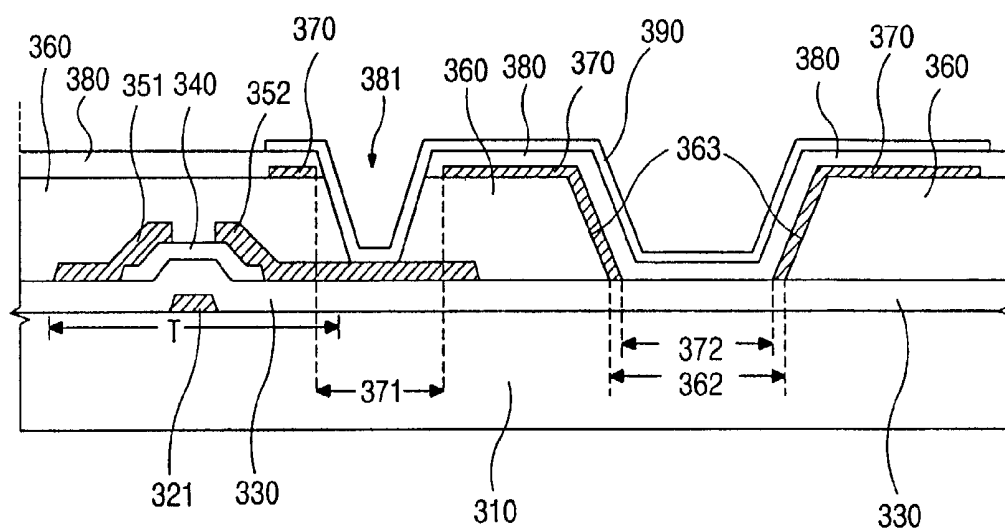


FIG. 10

ARRAY PANEL FOR A TRANSLFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

[0001] This application claims the benefit of Korean Patent Application No. 2001-39638, filed on Jul. 4, 2001 in Korea, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display (LCD) device and more particularly, to an array panel for a transreflective liquid crystal display device.

[0004] 2. Discussion of the Related Art

[0005] In general, the LCD device includes two substrates, which are spaced apart and facing each other, and a liquid crystal layer interposed between the two substrates. Each of the substrates includes an electrode and the electrodes of each substrate are facing each other, also. Voltage is applied to each electrode and an electric field is induced between the electrodes. An alignment of the liquid crystal molecule is changed by the intensity of the electric field, and the LCD device displays a picture by transmissivity of the light varying according to the arrangement of the liquid crystal molecules.

[0006] Because the liquid crystal display device is not luminescent, it needs an additional light source in order to display images, and the liquid crystal display device is categorized into a transmissive type and a reflective type depending on the kind of light source.

[0007] In the transmissive type, a back light behind a liquid crystal panel is used as a light source. Light incident from the back light penetrates the liquid crystal panel, and the amount of the transmitted light is controlled according to the alignment of the liquid crystal molecules. Here, the substrates must be transparent and the electrode of each substrate must also be formed of transparent conductive material. As the transmissive liquid crystal display device uses the back light as a light source, it can display a bright image in dark surroundings. By the way, because an amount of the transmitted light is very small for the light incident from the back light, the brightness of the back light should be increased in order to increase the brightness of the LCD device. Consequently, the transmissive liquid crystal display device has high power consumption due to the back light.

[0008] On the other hand, in the reflective type LCD device, sunlight or artificial light is used as a light source of the LCD device. The light incident from the outside is reflected at a reflective plate of the LCD device according to the arrangement of the liquid crystal molecules. Since there is no back light, the reflective type LCD device has much lower power consumption than the transmissive type LCD device. However, the reflective type LCD device cannot be used in dark places because it depends on an external light source.

[0009] Therefore, a transreflective LCD device, which can be used both in a transmissive mode and in a reflective mode, has been recently proposed. A conventional transreflective LCD device will be described hereinafter more in detail.

[0010] FIG. 1 is a cross-sectional view of a conventional transreflective LCD device. In FIG. 1, the conventional trans-

reflective LCD device has a lower substrate **10** and an upper substrate **30**, and the substrates **10** and **30** are spaced apart from and facing each other.

[0011] A pixel electrode **20** is formed on the inner surface of the lower substrate **10** and connected to the thin film transistor (not shown) formed on the inner surface of the lower substrate **10**. The pixel electrode **20** includes a transmissive electrode **21** and a reflective electrode **22**. The reflective electrode **22** has a hole in which the transmissive electrode **21** is located. The transmissive electrode **21** is formed of a transparent conductive material such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), which has high transmittance. The reflective electrode **22** is formed of an opaque conductive material such as aluminum (Al), which has high reflectance and low resistivity.

[0012] Next, a color filter **40**, which corresponds to the pixel electrode **20**, is formed on the inner surface of the upper substrate **30** and a common electrode **50** is formed on the color filter **40**. The common electrode **50** is also made of the transparent conductive material.

[0013] A liquid crystal layer **60** is disposed between the lower and upper substrates **10** and **30**, and molecules of the liquid crystal layer **60** are arranged horizontally with respect to the substrates **10** and **30**.

[0014] On the outer surfaces of the substrates **10** and **30**, a first retardation film **71** and a second retardation film **72** are arranged, respectively. The first and second retardation films **71** and **72** change the polarized state of light. In case of the first and second retardation films **71** and **72** having a phase difference of $\lambda/4$ ($\lambda=550$ nm), an incident circular polarized light changes into linear polarized light, and an incident linear polarized light changes into circular polarized light.

[0015] A first polarizer **81** and a second polarizer **82** are arranged on the outer surface of the first and second retardation films **71** and **72**. The second polarizer **82** is an analyzer, and the transmission axis of the second polarizer **82** has an angle of 90 degrees with the transmission axis of the first polarizer **81**.

[0016] Next, a back light **90** is located under the outside of the first polarizer **81**. The back light **90** is used as a light source of a transmissive mode of the transreflective LCD device.

[0017] This transreflective LCD device is a normally white mode and in such case, white light is emitted when voltage is not applied. By the way, the transreflective LCD device is planned on the basis of the reflective mode. Accordingly, transmittance of the transmissive mode becomes only 50% of the transmittance of the reflective mode when the voltage is not applied, and thus gray light is emitted in the transmissive mode.

[0018] FIG. 2 illustrates the transreflective LCD device to solve the above problem. In FIG. 2, the transreflective LCD device is divided into a transmissive region "A" and a reflective region "B".

[0019] The transreflective LCD device has a lower substrate **110** and an upper substrate **160** facing apart from each other. A first passivation layer **120** is formed on the inner surface of the lower substrate **110**, and the first passivation layer **120** has a first transmissive hole **122** in the transmissive region "A". A transmissive electrode **130** of a transparent conduc-

tive material is formed on the first passivation layer 120. Next, a second passivation layer 140 is formed on the transmissive electrode 130, and a reflective electrode 150 is formed on the second passivation layer 140. The reflective electrode 150 has a second transmissive hole 152 exposing the transmissive electrode 130 on the first transmissive hole 122. On the other hand, a thin film transistor (not shown) is formed on the inner surface of the lower substrate 110, and the thin film transistor is connected electrically to not only the transmissive electrode 130 but also the reflective electrode 150.

[0020] A color filter 161 is formed on the inner surface of the upper substrate 160 and a common electrode 162 is formed on the color filter 161.

[0021] Next, retardation films 171 and 172 are arranged on the outer surface of the lower and upper substrates 110 and 160, respectively. Polarizers 181 and 182 are arranged on the outer surface of the respective retardation film 171 and 172. A back light 190 is located under the lower polarizer 181.

[0022] A liquid crystal layer 200 is disposed between the reflective electrode 150 and the common electrode 162. The liquid crystal molecules of the liquid crystal layer 200 are arranged horizontally with respect to the substrates 110 and 160. The liquid crystal layer 200 has a positive permittivity anisotropy value, so the liquid crystal molecules are arranged parallel to a direction of the electric field induced between the reflective electrode 150 and the common electrode 162 when voltage is applied to the electrodes 130, 150 and 162.

[0023] A phase difference of the liquid crystal layer depends on the refractive index anisotropy value (A_n) and the thickness (d) of the liquid crystal layer. Therefore, the phase difference of the liquid crystal layer can be controlled by changing the thickness of the liquid crystal layer.

[0024] Accordingly, as shown in FIG. 2, the first passivation layer 120 has a first transmissive hole 122 so that the brightness in the transmissive mode and the reflective mode may be made uniform. At this time, it is desirable that the liquid crystal layer 200 in the transmissive region "A" has twice thickness of the liquid crystal layer 200 in the reflective region "B".

[0025] The polarized situations of the transfective LCD device of FIG. 2 are illustrated in FIGS. 3A and 3B and in FIGS. 4A and 4B.

[0026] FIGS. 3A and 3B shows the polarized states before and after applying voltage in the reflective mode, respectively. Here, the polarized situations are represented according to a progressing direction of the light. Meanwhile, y-axis is a direction parallel to the substrates 110 and 160 of FIG. 2 and z-axis is a direction perpendicular to the substrates 110 and 160. And x-axis is defined in a direction perpendicular to both the y-axis and the z-axis. Therefore, the transmission axis of the upper polarizer 182 has an angle of 135 degrees to the x-axis and the transmission axis of the lower polarizer 181 has an angle of 45 degrees to the x-axis as watched from the bottom of the liquid crystal panel. In the meantime, the transmission axis of the upper polarizer 182 has an angle of 45 degrees to the x-axis as watched from the top of the liquid crystal panel.

[0027] At this time, the liquid crystal layer 200 disposed in the reflective region "B" of FIG. 2 has a phase difference of $\lambda/4$ and is right-circularly polarized before applying voltage.

[0028] The optical axis of the lower retardation film 171 of FIG. 2 is parallel to the y-axis and the lower retardation film 171 is right-handed. Therefore, an incident light of 45 degrees is right-circularly polarized and an incident light to be right-circularly polarized is linearly polarized at an angle of 135 degrees. An incident light of 135 degrees is left-circularly polarized and an incident light to be left-circularly polarized is linearly polarized at an angle of 45 degrees.

[0029] On the other hand, the optical axis of the upper retardation film 172 of FIG. 2 is parallel to the x-axis and the upper retardation film 172 is left-handed. And thus an incident light of 45 degrees to the x-axis is left-circularly polarized and an incident light to be left-circularly polarized is linearly polarized at an angle of 135 degrees. Next, an incident light of 135 degrees to the x-axis is right-circularly polarized and an incident light to be right-circularly polarized is linearly polarized at an angle of 45 degrees.

[0030] In FIG. 3A, as voltage is not applied to the transfective LCD device, a light is linearly polarized at an angle of 45 degrees to the x-axis through the upper polarizer 182 of FIG. 2, and the linearly polarized light is left-circularly polarized through the upper retardation film 172. Next, the left-circularly polarized light goes through the liquid crystal layer 200 disposed in the reflective region "B" to be linearly polarized at an angle of 45 degrees from the left-circularly polarization. This linearly polarized light is reflected at the reflective electrode 150 of FIG. 2, and so the progressing direction of the light changes. Accordingly, the reflective light has a polarizing angle of 135 degrees to the x-axis. Next, the linearly polarized light at an angle of 135 degrees is left-circularly polarized through the liquid crystal layer 200 disposed in the reflective region "B". The left-circularly polarized light is linearly polarized at an angle of 135 degrees again through the upper retardation film 172. As the linearly polarized light has a polarizing direction to coincide with the transmission axis of the upper polarizer 182, the linearly polarized light is all transmitted. Therefore, the displayed picture becomes white.

[0031] Next, in FIG. 3B, when voltage is applied to the transfective LCD device, a light is linearly polarized at an angle of 45 degrees to the x-axis through the upper polarizer 182 of FIG. 2, and the linearly polarized light is left-circularly polarized through the upper retardation film 172. The left-circularly polarized light goes through the liquid crystal layer 200 disposed in the reflective region "B" without change of the polarized state. Next, the left-circularly polarized light is reflected at the reflective electrode 150 of FIG. 2, and so the left-circularly polarized light is right-circularly polarized. The right-circularly polarized light does not change through the liquid crystal layer 200 disposed in the reflective region "B". Next, the right-circularly polarized light is linearly polarized at an angle of 45 degrees through the upper retardation film 172, and the linearly polarized light has a direction perpendicular to the transmission axis of the upper polarizer 182. Accordingly, the linearly polarized light is not transmitted, and thus the displayed picture becomes black.

[0032] FIGS. 4A and 4B shows the polarized states before and after applying voltage in the transmissive mode,

respectively. At this time, the liquid crystal layer **200** disposed in the transmissive region "A" of **FIG. 2** has a phase difference of $\lambda/2$ before applying voltage.

[0033] In **FIG. 4A**, as voltage is not applied to the transmissive LCD device, light incident from the back light **190** to the lower polarizer **181** of **FIG. 2** is linearly polarized at an angle of 45 degrees to the x-axis through the lower polarizer **181**, and the linearly polarized light is right-circularly polarized through the lower retardation film **171**. Next, the right-circularly polarized light goes through the transmissive electrode **130** and the right-circularly polarized light is left-circularly polarized through the liquid crystal layer **200** disposed in the transmissive region "A". The left-circularly polarized light is linearly polarized at an angle of 135 degrees through the upper retardation film **172**. As the linearly polarized light has a polarizing direction to coincide with the transmission axis of the upper polarizer **182**, the linearly polarized light is all transmitted. Therefore, the displayed picture becomes white.

[0034] On the other hand, in **FIG. 4B**, when voltage is applied to the transmissive LCD device, light from the back light **190** is linearly polarized at an angle of 45 degrees to the x-axis through the lower polarizer **181** of **FIG. 2**, and the linearly polarized light is right-circularly polarized through the lower retardation film **171**. The right-circularly polarized light goes through the transmissive electrode and the liquid crystal layer **200** disposed in the transmissive region "A" without change of the polarized state. Next, the right-circularly polarized light is linearly polarized at an angle of 45 degrees through the upper retardation film **172**, and the linearly polarized light has a direction to be perpendicular to the transmission axis of the upper polarizer **182**. Accordingly, the linearly polarized light is not transmitted, and thus the displayed picture becomes black.

[0035] As stated above, different thickness between the transmissive region and the reflective region makes the displayed picture uniform and substantially dark in the black mode. Therefore, the contrast ratio of the transmissive LCD device is increased and the quality of picture improves.

[0036] By the way, in the case of forming the transmissive hole **122** of **FIG. 2**, an inclined portion is formed between the transmissive region "A" and the reflective region "B", and the thickness of the liquid crystal layer **200** disposed in the inclined portion changes continuously. Accordingly, when the voltage is applied to the transmissive LCD device, a fringe field is produced in the inclined portion and a distortion occurs. Also, the phase difference of the liquid crystal layer varies in the region, and thus light leakage occurs.

[0037] The structure of the array panel for the transmissive LCD device to prevent the leakage light like this is suggested in the Japanese publication No. 2000-275660. **FIG. 5** is the representative drawing of 2000-275660.

[0038] As shown in **FIG. 5**, a thin film transistor, which includes a double-layered gate electrode **8** and **9**, an active layer **11**, ohmic contact layers **12**, a source electrode **14** and a drain electrode **15**, is formed on a substrate **1**. A transparent electrode **13**, which connects to the thin film transistor, is formed on the substrate **1**. An interlayer **3** of a photosensitive resin is formed on the thin film transistor and the transparent electrode **13**. The interlayer **13** has a transmissive hole

exposing a part of the transparent electrode **13** and inclined portion **17**. The inclined portion **17** is a border area between a transmissive region and a reflective region. A reflector **4** or **5** is formed on the interlayer **3**, and the reflector **4** or **5** covers a part of the inclined portion **17**. A concave-convex section **18** is formed between the interlayer **3** and the reflector **4** or **5** in order to increase reflection. In the array panel of 2000-275660, the effective area of the transmissive mode and the reflective mode has to be equal in order to get a stable picture. Here, the inclined portion **17** does not belong to the transmissive mode or the reflective mode. Therefore, the inclined portion is neither the transmissive region nor the reflective region. If one end of the reflector **4** or **5** is located on the inclined portion **17**, the effective area of the transmissive region and the reflective region is not influenced even though there are a bit errors.

[0039] However, as stated above, the leakage light occurs in the inclined area **17**. If the reflector **4** or **5** is formed covering all the inclined portion **17** in order to prevent the light leakage, the reflector **4** or **5** contacts the transparent electrode **13**, and thus galvanic corrosion happens between the transparent electrode **13** and the reflector **4** or **5**. Accordingly, the reflector **4** or **5** should not contact the transparent electrode **13** and must cover only a part of the inclined portion **17**.

SUMMARY OF THE INVENTION

[0040] Accordingly, the present invention is directed to an array panel for a transmissive liquid crystal display device that substantially obviates one or more of problems due to limitations and disadvantages of the related art.

[0041] An advantage of the present invention is to provide an array panel for a transmissive liquid crystal display device in which a leakage light does not happen and has an increased contrast ratio.

[0042] Another advantage of the present invention is to provide an array panel for a transmissive liquid crystal display device which has no afterimage.

[0043] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. These and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0044] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, an array panel for a transmissive liquid crystal display device includes a substrate; a thin film transistor on the substrate; a first passivation layer covering the thin film transistor and having a first transmissive hole and an inclined portion surrounding the first transmissive hole; a transparent electrode on the first passivation layer, the transparent electrode contacting the thin film transistor; and a reflector over the transparent electrode, the reflector completely covering the inclined portion and having a second transmissive hole corresponding to the first transmissive hole. Here, the inclined portion slopes with an angle with respect to the substrate, and thereby light reflected at the reflector corresponding to the inclined portion substantially goes out of sight. The angle is

within a range of about 20 to 110 degrees. And the angle is within a range of about 42 to 70 degrees, and thereby the light entirely goes out of sight. The first passivation layer includes one of a benzocyclobutene (BCB) and a photosensitive acrylic resin. The array panel further includes a second passivation layer disposed between the transparent electrode and the reflector, and the second passivation layer includes silicon nitride. The reflector is connected to the transparent electrode. The array panel further includes a gate line and a data line crossing each other and being electrically connected to the thin film transistor.

[0045] In another aspect, an array panel for a transmissive liquid crystal display device includes a substrate; a thin film transistor on the substrate; a first passivation layer covering the thin film transistor, the first passivation layer having a first transmissive hole and an inclined portion surrounding the first transmissive hole; a reflector on the first passivation layer, the reflector completely covering the inclined portion and having a second transmissive hole corresponding to the first transmissive hole; and a transparent electrode over the reflector, the transparent electrode contacting the thin film transistor. The inclined portion slopes with an angle with respect to the substrate, and thereby a light reflected at the reflector corresponding to the inclined portion substantially going out of sight. The angle is within a range of about 20 to 110 degrees. And the angle is within a range of about 42 to 70 degrees, and thereby the light entirely going out of sight. The first passivation layer includes one of a benzocyclobutene (BCB) and a photosensitive acrylic resin. The array panel further includes a second passivation layer disposed between the transparent electrode and the reflector, and the second passivation layer includes silicon nitride. And the array panel further includes a gate line and a data line crossing each other and being electrically connected to the thin film transistor.

[0046] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0048] In the drawings:

[0049] FIG. 1 is a cross-sectional view of a conventional transmissive liquid crystal display device;

[0050] FIG. 2 is a cross-sectional view of another transmissive liquid crystal display device;

[0051] FIGS. 3A and 3B are drawings showing polarized situations before and after applying voltage in the reflective mode of FIG. 2;

[0052] FIGS. 4A and 4B are drawings of showing polarized situations before and after applying voltage in the transmissive mode of FIG. 2;

[0053] FIG. 5 is a drawing of a conventional transmissive LCD according to Japanese published application no. 2000-275660;

[0054] FIG. 6 is a plan view of showing an array panel according to a first embodiment of the present invention;

[0055] FIG. 7 is a cross-sectional view corresponding to the line VII-VII of FIG. 6;

[0056] FIG. 8 is a drawing of calculating an inclined angle in the array panel of the present invention; and

[0057] FIG. 9 is a cross-sectional view of the array panel according to a second embodiment of the present invention.

[0058] FIG. 10 is a cross-sectional view of the array panel according to a third embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0059] Reference will now be made in detail to the illustrated embodiment of the present invention, which is illustrated in the accompanying drawings.

[0060] FIG. 6 is a plan view of an array panel for a transmissive liquid crystal display device according to a first embodiment of the present invention, and FIG. 7 is a cross-sectional view corresponding to the line VII-VII of FIG. 6.

[0061] In FIG. 6 and FIG. 7, a gate electrode 221 is formed on a substrate 210, and the gate electrode 221 is connected to a gate line 222 extending horizontally in the context of the figures. The substrate 210 is made of an insulating material such as glass, and the gate electrode 221 and the gate line 222 are formed of a conducting material such as a metal. A gate insulator 230 covers the gate electrode 221 and the gate line 222. The gate insulator 230 can be made of silicon nitride or silicon oxide. Next, an active layer 240 is formed on the gate insulator 230, and the active layer 240 is made of amorphous silicon. A source electrode 251 and a drain electrode 252 are formed on the active layer 240. The source electrode 251 is connected to a data line 253, which extends vertically in the context of the figure and crosses the gate line 222 to define a pixel region "P". Though not shown in the figures, ohmic contact layers are formed between the active layer 240 and the source and drain electrodes 251 and 252 to lower contact resistance between the active layer 240 and the two electrodes 251 and 252.

[0062] A first passivation layer 260 covers the source electrode 251, the drain electrode 252 and the data line 253. The first passivation layer 260 has a first contact hole 261, a first transmissive hole 262 and an inclined portion 263. The first contact hole 261 exposes a part of the drain electrode 252, and the first transmissive hole 262 exposes a part of the substrate 210 through the gate insulator 230. The first transmissive hole 262 can be formed in only the first passivation layer 260. The first passivation layer 260 is made of a benzocyclobutene (BCB) or a photosensitive acrylic resin. Next, a transparent electrode 270 is formed on the first passivation layer 260. The transparent electrode 270 is located in the pixel region "P" and is connected to the drain electrode 252 through the first contact hole 261. The transparent electrode 270 is made of a transparent conducting material such as an indium-tin-oxide (ITO).

[0063] A second passivation layer 280 is formed on the transparent electrode 270. The second passivation layer 280 has a second contact hole 281, which exposes a part of the

transparent electrode **270**. The second passivation layer **280** is made of a silicon nitride. A reflector **290** is formed on the second passivation layer **280**. The reflector **290** is made of a metal, which reflects light well like aluminum (Al), and is connected to the transparent electrode **270** through the second contact hole **281**. Then the reflector **290** acts as a reflective electrode. The reflector **290** has a second transmissive hole **291**, which exposes the transparent electrode **270** placed in the first transmissive hole **262**. At this time, the reflector **290** entirely covers the inclined portion **263**.

[0064] If the reflector **290** contacts the transparent electrode **270** of ITO and is patterned by a wet etching method, galvanic erosion can occur at the contact area of the reflector **290** and the transparent electrode **270**. Therefore, the second passivation layer **280** makes the contact area small, which prevents or limits the galvanic erosion. The second passivation layer **280** can be omitted if the reflector **290** is formed by a dry etching method.

[0065] Like this, the reflector covers the inclined portion located between the transmissive region and the reflective region in order to intercept the leakage light. At this time, the inclined portion should have a fixed angle.

[0066] FIG. 8 is a drawing of calculating an inclined angle of the inclined portion in the array panel of the present invention.

[0067] As illustrated in FIG. 8, x-axis is defined in a direction parallel to the substrate **210** of FIG. 7 and y-axis is defined in a direction perpendicular to the x-axis. And also x'-axis is defined in a direction parallel to the incline plane of the inclined portion and y'-axis is defined in a direction perpendicular to the x'-axis. The x'-axis and the y'-axis have an angle of " θ " to the x-axis and the y-axis, respectively.

[0068] After light in the air passes through the upper substrate of the transfective LCD device, it is refracted at the liquid crystal layer and goes to the incline plane of the inclined portion. When the light incident upon the incline plane has an angle of " α " with respect to the y-axis, the incident light must be reflected toward the region between the y'-axis and the x-axis for the reflected light to go out of sight. Thus, the leakage light can be blocked. At this time, the reflected light makes an angle of " $2\theta - \alpha$ " with the y-axis, and the " $2\theta - \alpha$ " should be larger than the " α ". Therefore, the " θ " is bigger than the " α ".

[0069] Light incident from the outside to the transfective LCD device has an incidence angle of 0 to 90 degrees with respect to the longitudinal axis of the substrate. Here, the incident light having an incidence angle near 0 degree is emitted with an angle similar to the incidence angle. Accordingly, the incidence angle of the incident light is considered within a range of about 20 to 90 degrees.

[0070] If the refractive index of the air is " n_1 ", the average refractive index of the liquid crystal layer is " n_2 " and the incidence angle of the incident light is " θ_1 ", the transmission angle " θ_2 " of the transmitted light is calculated with the Snell's law ($n_1 \cdot \sin(\theta_1) = n_2 \cdot \sin(\theta_2)$). Here, the transmission angle " θ_2 " is the same as the angle " α ". When the " n_1 " is 1, the " n_2 " is 1.5 and the incidence angle " θ_1 " is within a range of about 20 to 90 degrees, the transmission angle " θ_2 " becomes about 13 to 42 degrees. Therefore, the " α " is within a range of about 20 to 90 degrees.

[0071] When a 12.1 inch panel, which is widely used for a notebook PC, is looked at from 30 centimeters away, the picture of the panel is seen without lowering of the contrast ratio at the maximum 30 degrees with respect to the longitudinal axis of the substrate. As the incidence angle " θ_1 " of the incident light is about 30 degrees, the transmission angle " θ_2 " of the transmitted light, i.e. the angle " α ", becomes about 20 degrees. It is possible that the incline plane is formed by an inclination angle of about 110 degrees and the inclination angle " θ " should be bigger than the angle " α ", and thus the inclination angle " θ " of the incline plane may be about 20 to 110 degrees.

[0072] On the other hand, as stated above, the maximum value of the " α " is 42 degrees. Accordingly, if the angle " α " is bigger than 42 degrees, the reflected light to all the incident light is made to go out of sight. Consequently, the inclination angle " θ " should desirably be within an angle of about 42 to 70 degrees.

[0073] The inclination angle " θ " can be controlled according to the process condition of forming the first passivation layer **260** of FIG. 7. For example, in case of forming the first passivation layer of the BCB, which is patterned in a dry etching method using an etching gas, the inclination angle " θ " is controlled by changing the dry etching condition. Generally, the gas for etching the BCB includes sulfur hexafluoride (SF_6) or oxygen (O_2). At this time, if the composition rate of the O_2 in the etching gas is large, the etched BCB has a small inclination angle, and if the composition rate of the O_2 in the etching gas is small, the etched BCB has a large inclination angle. This is the reason a photoresist layer, which is used in etch of the BCB, is removed quickly in proportion to a quantity of O_2 . Besides, the gradient of the etched BCB is gentle if the pressure of the etching gas is low, and the gradient of the etched BCB is steep if the pressure of the etching gas is high.

[0074] Meanwhile, if a photosensitive resin such as acrylic resin is used as the first passivation layer, the physical properties of the photosensitive resin can be changed or the light intensity of exposing the border region can be controlled to change the inclination angle. Here, quick change in the exposing light intensity results in a gentle incline plane, and slow change in the exposing light intensity results in a steep incline plane.

[0075] In the present invention, if the inclination angle of the inclined portion is over 20 degrees, and then the leakage light can be intercepted. Therefore, the contrast ratio of the transfective LCD device increases.

[0076] In the first embodiment of the present invention, the reflector is formed over the transparent electrode, but the reflector can be formed under the transparent electrode. This second embodiment of the present invention is described in the following.

[0077] FIG. 9 is a cross-sectional view of the array panel according to the second embodiment of the present invention. A plan view of the second embodiment is similar to FIG. 6.

[0078] In FIG. 9, a thin film transistor "T" is formed on a substrate **310** and the thin film transistor "T" includes a gate electrode **321**, a source electrode **351** and a drain electrode **352**. The gate electrode **321** is formed on the substrate **310** and a gate insulator **330** covers the gate

electrode **321**. And an active layer **340** as a channel of the thin film transistor "T" is formed on the gate insulator **330**. Next, the source electrode **351** and the drain electrode **352** are formed on the active layer **340**. Though not shown in the figures, ohmic contact layers are formed between the active layer **340** and the source and drain electrodes **351** and **352**.

[0079] A first passivation layer **360** covers the source electrode **351** and the drain electrode **352**. The first passivation layer **360** has a first transmissive hole **362** and an inclined portion **363**. The first transmissive hole **362** exposes a part of the substrate **310** through the gate insulator **330**. The first passivation layer **360** is made of a benzocyclobutene (BCB) or a photosensitive acrylic resin. Here, an inclination angle of the inclined portion **363** is over 20 degrees, and it is desirable that the inclination angle of the inclined portion **363** is within a range of about 42 to 70 degrees.

[0080] Next, a reflector **370** is formed on the first passivation layer **360**. The reflector **370** has an open portion **371** over the drain electrode **352** and a second transmissive hole **372** corresponding to the first transmissive hole **362**. The reflector **370** is made of a metal, which reflects light well like aluminum (Al). At this time, the reflector **370** entirely covers the inclined portion **363**.

[0081] A second passivation layer **380** is formed on the reflector **370** and covers the reflector **370**. The second passivation layer **380** has a contact hole **381**, which exposes a part of the drain electrode **352**, through the first passivation layer **360** through the open portion **371**. The second passivation layer **380** is made of a silicon nitride. The second passivation layer **380** over the transmissive holes **362** and **372** can be etched.

[0082] Next, a transparent electrode **390** is formed on the second passivation layer **380** and the transparent electrode **390** is connected to the drain electrode **352** through the contact hole **361**. The transparent electrode **370** is made of a transparent conducting material such as an indium-tin-oxide (ITO).

[0083] In the second embodiment of the present invention, the transparent electrode, which is made of the same material as a common electrode of the upper substrate, is formed on the top of the lower substrate, and then an afterimage can be cut off.

[0084] FIG. 10 is a cross-sectional view of the array panel according to a third embodiment of the present invention. A plan view of the third embodiment is similar to FIG. 6. The third embodiment is similar to the second embodiment, except that the first transmissive hole **362** and the second transmissive hole **372** corresponding to the first transmissive hole **362** do not extend through the gate insulation layer **330**.

[0085] In FIG. 10, a thin film transistor "T" is formed on a substrate **310** and the thin film transistor "T" includes a gate electrode **321**, a source electrode **351** and a drain electrode **352**. The gate electrode **321** is formed on the substrate **310** and a gate insulator **330** covers the gate electrode **321**. And an active layer **340** as a channel of the thin film transistor "T" is formed on the gate insulator **330**. Next, the source electrode **351** and the drain electrode **352** are formed on the active layer **340**. Though not shown in the figures, ohmic contact layers are formed between the active layer **340** and the source and drain electrodes **351** and **352**.

[0086] A first passivation layer **360** covers the source electrode **351** and the drain electrode **352**. The first passivation layer **360** has a first transmissive hole **362** and an inclined portion **363**. The first transmissive hole **362** exposes a part of the gate insulator **330**. The first passivation layer **360** is made of a benzocyclobutene (BCB) or a photosensitive acrylic resin. Here, an inclination angle of the inclined portion **363** is over 20 degrees, and it is desirable that the inclination angle of the inclined portion **363** is within a range of about 42 to 70 degrees.

[0087] Next, a reflector **370** is formed on the first passivation layer **360**. The reflector **370** has an open portion **371** over the drain electrode **352** and a second transmissive hole **372** corresponding to the first transmissive hole **362**. Like the first transmissive hole **362**, the second transmissive hole **372** does not extend through the gate insulator **330**. The reflector **370** is made of a metal, which reflects light well like aluminum (Al). At this time, the reflector **370** entirely covers the inclined portion **363**.

[0088] A second passivation layer **380** is formed on the reflector **370** and covers the reflector **370**. The second passivation layer **380** has a contact hole **381**, which exposes a part of the drain electrode **352**, with the first passivation layer **360** through the open portion **371**. The second passivation layer **380** is made of a silicon nitride. The second passivation layer **380** over the transmissive holes **362** and **372** can be etched.

[0089] Next, a transparent electrode **390** is formed on the second passivation layer **380** and the transparent electrode **390** is connected to the drain electrode **352** through the contact hole **361**. The transparent electrode **370** is made of a transparent conducting material such as an indium-tin-oxide (ITO) or Indium Zinc Oxide (IZO).

[0090] In the third embodiment of the present invention, the transparent electrode, which is made of the same material as a common electrode of the upper substrate, is formed on the top of the lower substrate, and then an afterimage can be cut off.

[0091] It will be apparent to those skilled in the art that various modifications and made in the fabrication and application of the present invention without the spirit or scope of the invention. Thus, it is intended that the present the modifications and variations of this invention provided they come within appended claims and their equivalents.

What is claimed is:

1. An array panel for a transfective liquid crystal display device, comprising:

- a substrate;
- a thin film transistor on the substrate;
- a first passivation layer covering the thin film transistor, the first passivation layer having a first transmissive hole and an inclined portion surrounding the first transmissive hole;
- a transparent electrode on the first passivation layer, the transparent electrode contacting the thin film transistor; and

a reflector over the transparent electrode, the reflector completely covering the inclined portion and having a second transmissive hole corresponding to the first transmissive hole.

2. The array panel according to claim 1, wherein the inclined portion slopes with an incline angle with respect to the substrate, such that light reflected at the reflector corresponding to the inclined portion is substantially reflected out of a viewing range.

3. The array panel according to claim 2, wherein the incline angle is within a range of about 20 to 110 degrees.

4. The array panel according to claim 3, wherein the incline angle is within a range of about 42 to 70 degrees.

5. The array panel according to claim 1, wherein the first passivation layer includes one of a benzocyclobutene (BCB) and a photosensitive acrylic resin.

6. The array panel according to claim 1, further comprising a second passivation layer disposed between the transparent electrode and the reflector.

7. The array panel according to claim 6, wherein the second passivation layer is transparent.

8. The array panel according to claim 6, wherein the second passivation layer includes silicon nitride.

9. The array panel according to claim 1, wherein the reflector is connected to the transparent electrode.

10. The array panel according to claim 1, further comprising a gate line and a data line, the gate line and the data line crossing each other and being electrically connected to the thin film transistor.

11. An array panel for a transfective liquid crystal display device, comprising:

a substrate;

a thin film transistor on the substrate;

a first passivation layer covering the thin film transistor, the first passivation layer having a first transmissive hole and an inclined portion surrounding the first transmissive hole;

a reflector on the first passivation layer, the reflector completely covering the inclined portion and having a second transmissive hole corresponding to the first transmissive hole; and

a transparent electrode over the reflector, the transparent electrode contacting the thin film transistor.

12. The array panel according to claim 11, wherein the inclined portion slopes with an incline angle with respect to the substrate, such that light reflected at the reflector corresponding to the inclined portion is substantially reflected out of a viewing range.

13. The array panel according to claim 12, wherein the incline angle is within a range of about 20 to 110 degrees.

14. The array panel according to claim 13, wherein the incline angle is within a range of about 42 to 70 degrees.

15. The array panel according to claim 11, wherein the first passivation layer includes one of a benzocyclobutene (BCB) and a photosensitive acrylic resin.

16. The array panel according to claim 11, further comprising a second passivation layer disposed between the transparent electrode and the reflector.

17. The array panel according to claim 16, wherein the second passivation layer is transparent.

18. The array panel according to claim 16, wherein the second passivation layer includes silicon nitride.

19. The array panel according to claim 11, further comprising a gate line and a data line, the gate line and the data line crossing each other and being electrically connected to the thin film transistor.

20. The array panel according to claim 11, further comprising a gate insulator between the substrate and the first passivation layer.

* * * * *

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摘要(译)

一种用于半透半反液晶显示装置的阵列面板，包括基板；基板上的薄膜晶体管；第一钝化层，覆盖薄膜晶体管并具有第一透射孔和围绕第一透射孔的倾斜部分；第一钝化层上的透明电极，透明电极与薄膜晶体管接触；透明电极上方的反射器，反射器完全覆盖倾斜部分，并具有对应于第一透射孔的第二透射孔。

