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(54) **TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATION METHOD THEREOF**

(75) Inventors: **Kyeong Jin Kim**, Gyeonggi-do (KR); **Mi Kyoung Jang**, Busan-si (KR)

Correspondence Address:
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747 (US)

(73) Assignee: **LG. PHILIPS LCD CO., LTD.**

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(57) **ABSTRACT**

A transflective LCD includes an upper substrate having a common electrode formed therein; a lower substrate spaced apart by a predetermined interval from the upper substrate and facing the upper substrate, the lower substrate having a pixel region including a switching region, a reflection part, and a transmission part, and including a delta film, a thin film transistor layer, a color filter layer and a reflector formed therein; a liquid crystal layer interposed between the upper substrate and the lower substrate; and a backlight assembly disposed below the lower substrate, for supplying light toward the lower substrate.

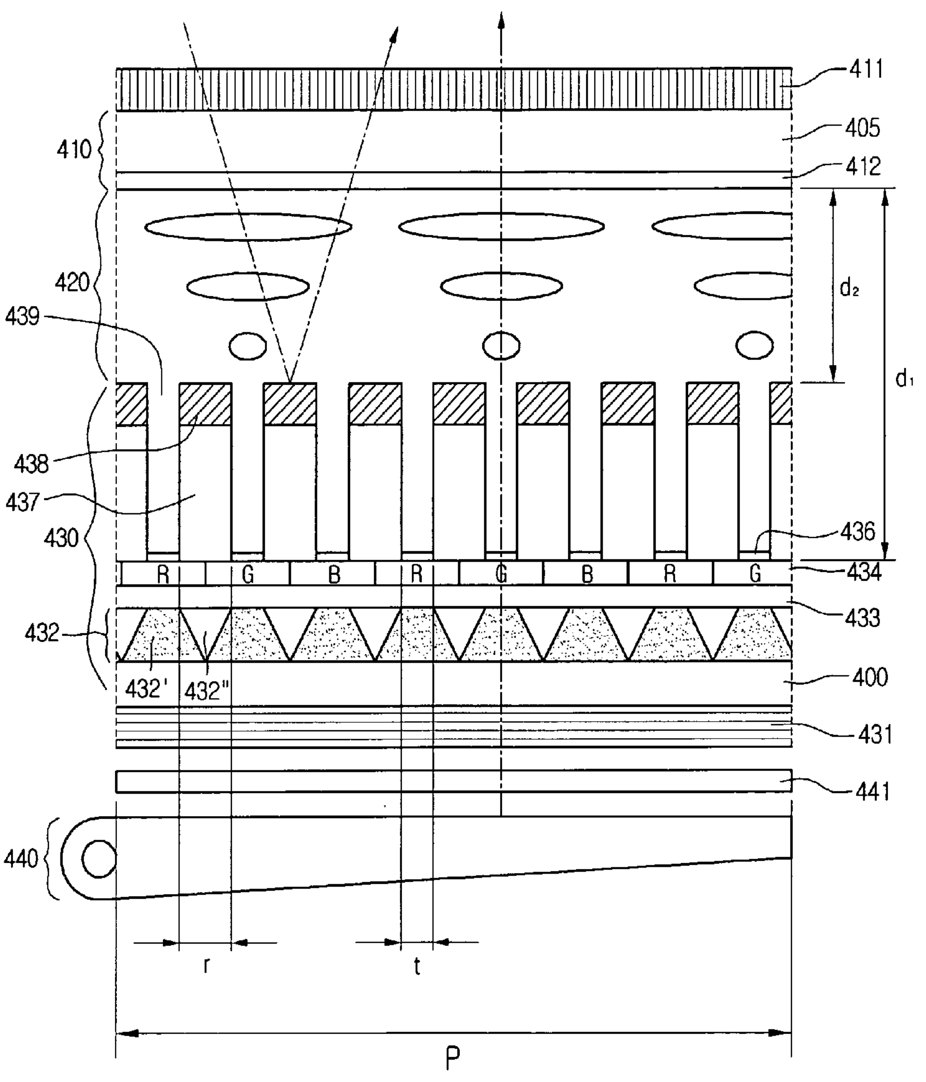

Fig.1
Related Art

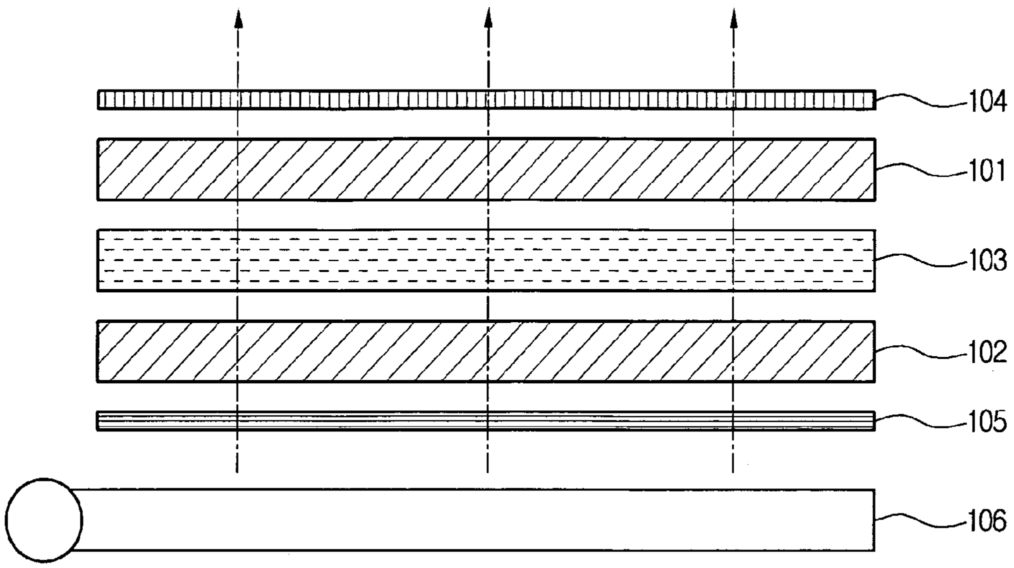

Fig.2
Related Art

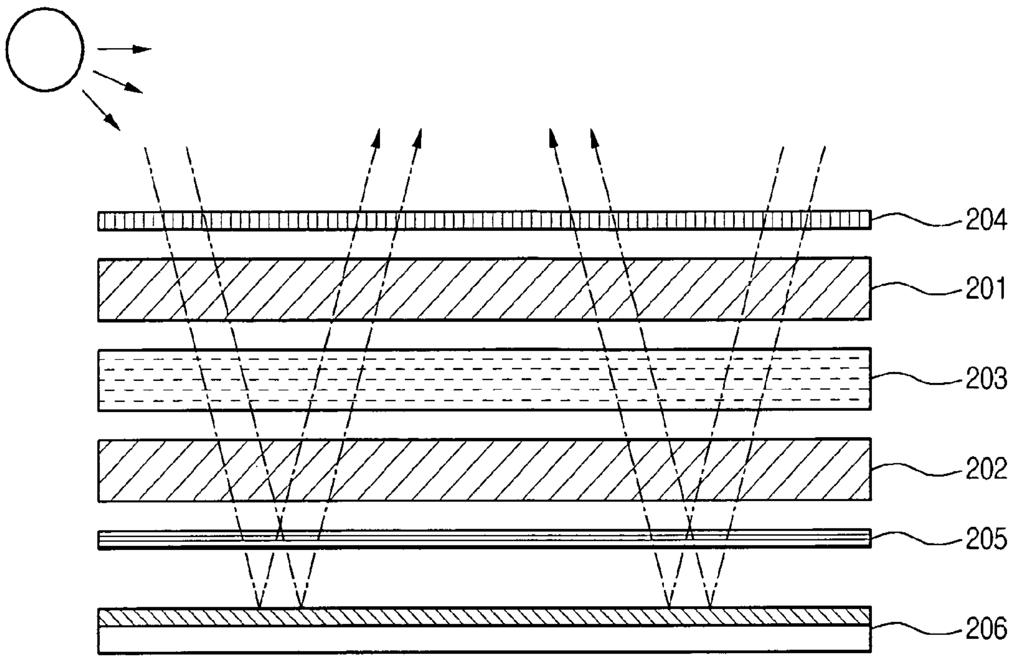

Fig.3
Related Art

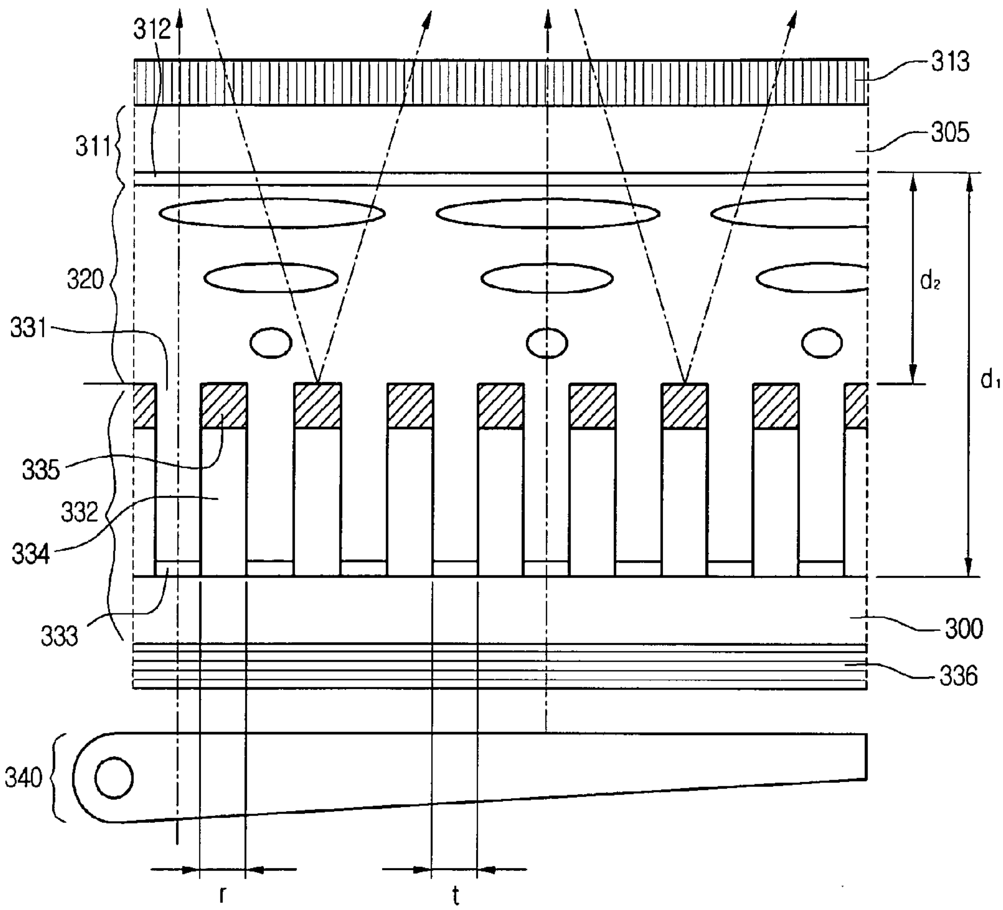

Fig.4

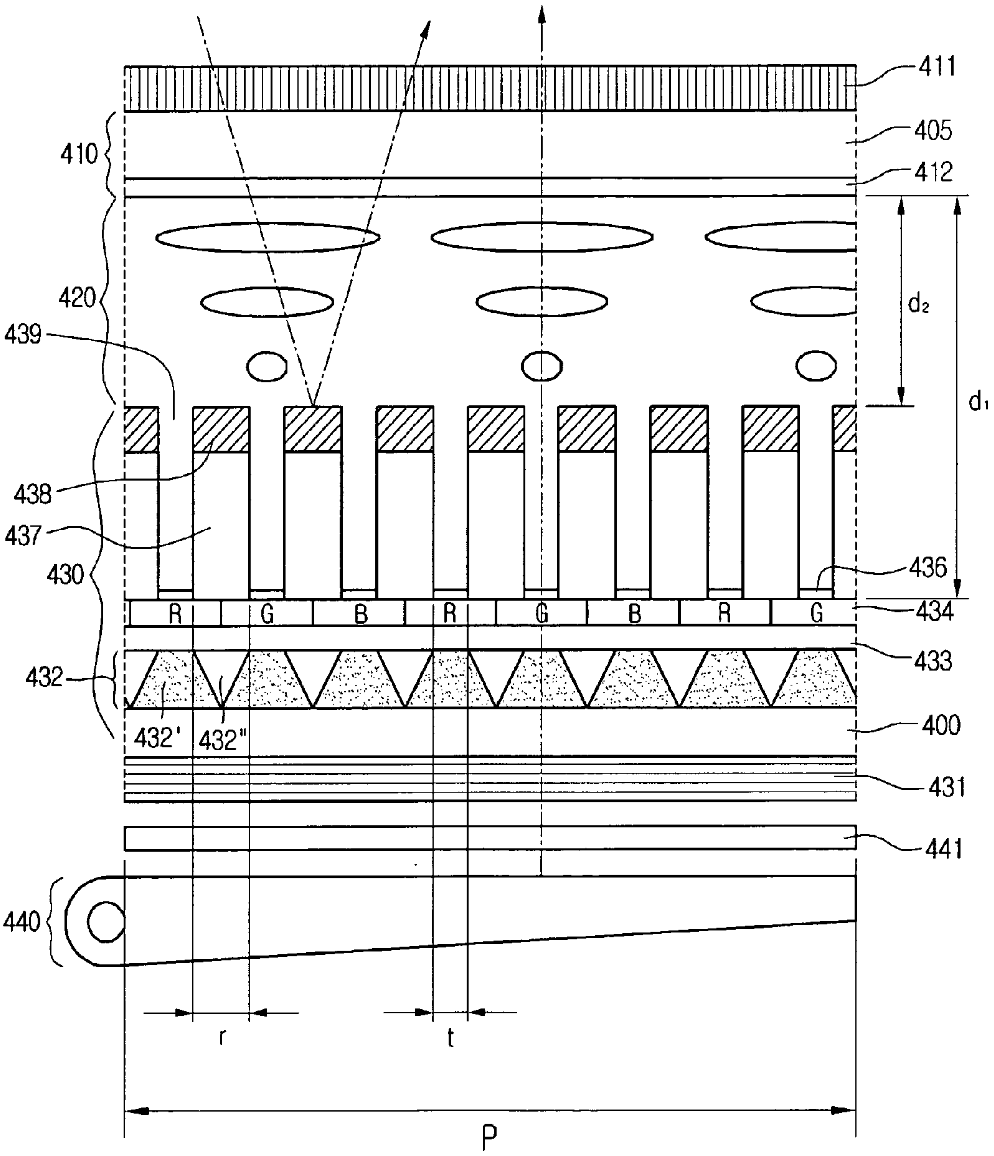
411
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Fig.5A

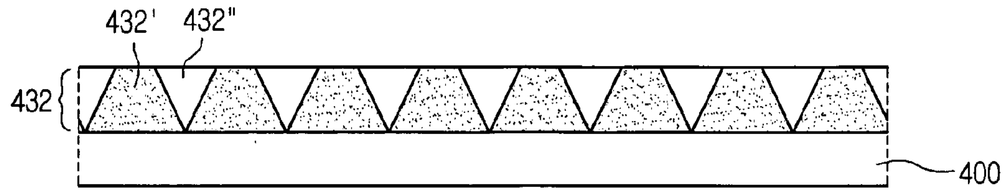

Fig.5B

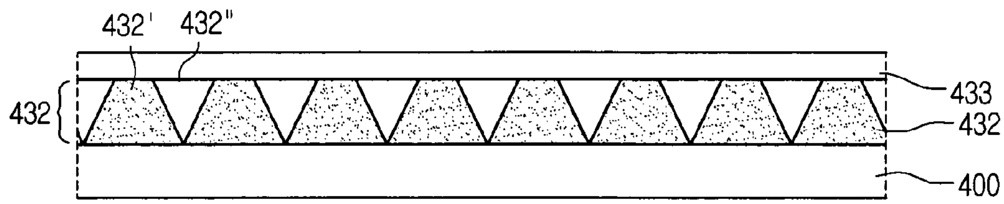

Fig.5C

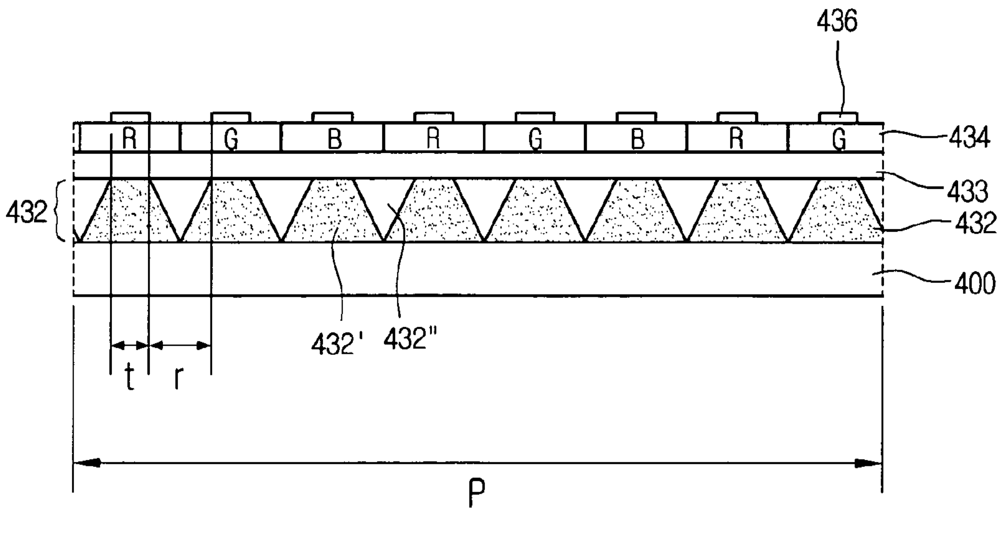

Fig.5D

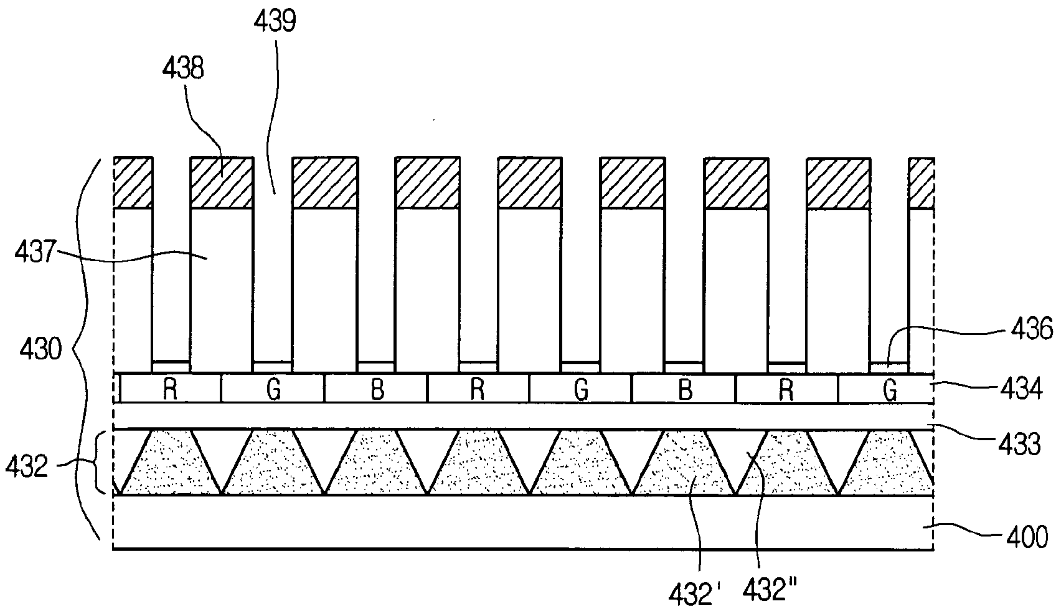

Fig.6(a)

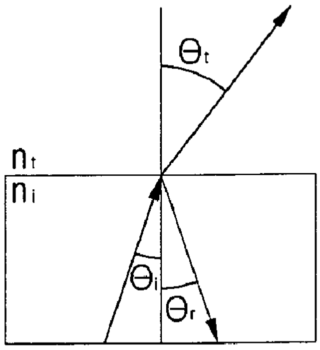

Fig.6(b)

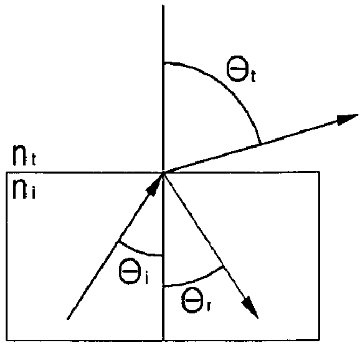

Fig.6(c)

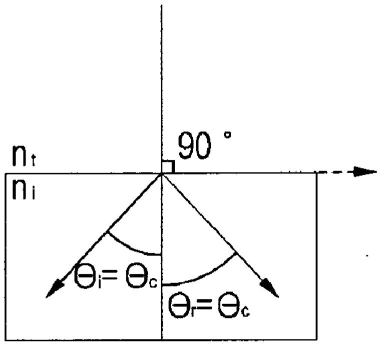

Fig.6(d)

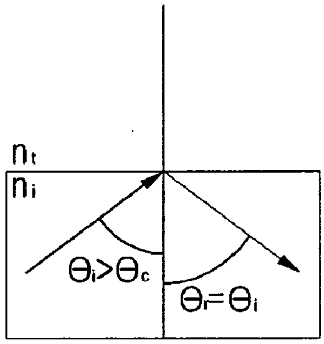

Fig.7

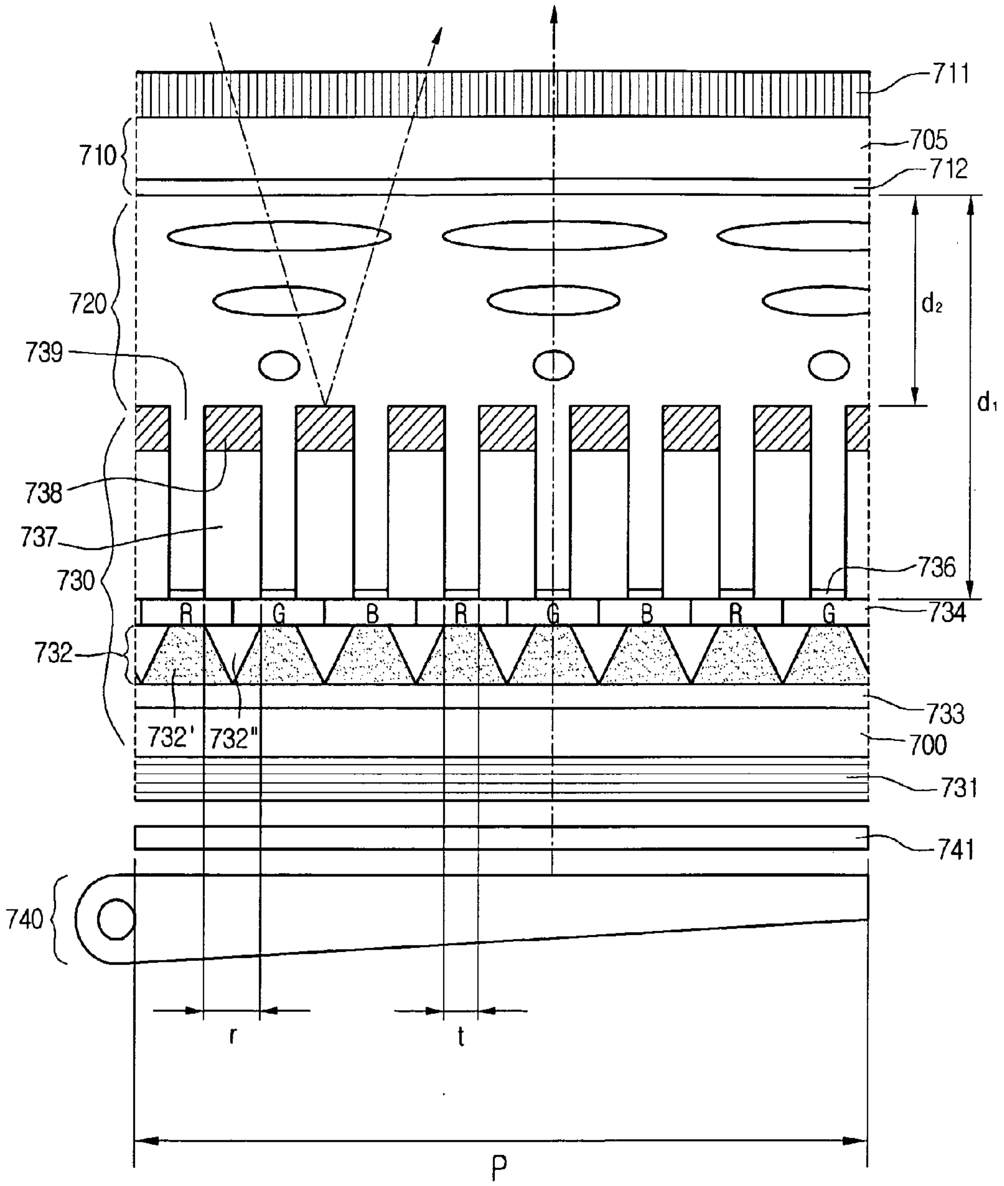
711
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Fig.8A

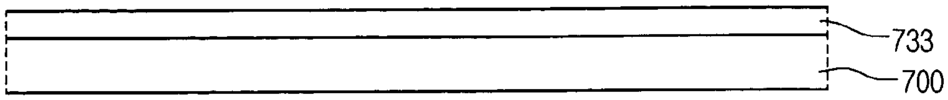


Fig.8B

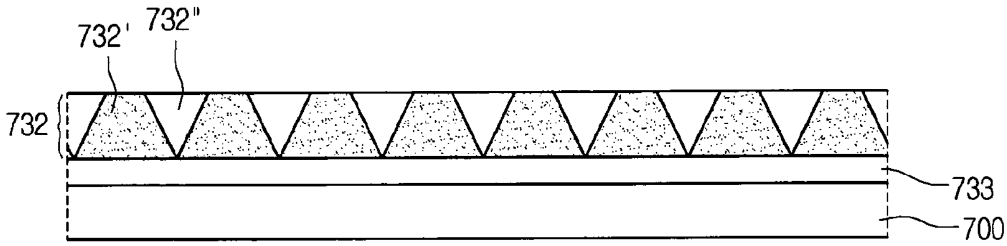


Fig.8C

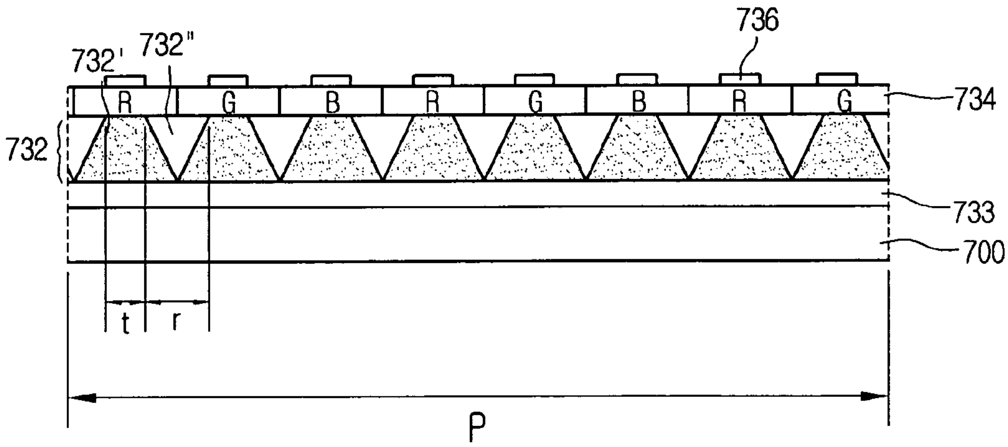


Fig.8D

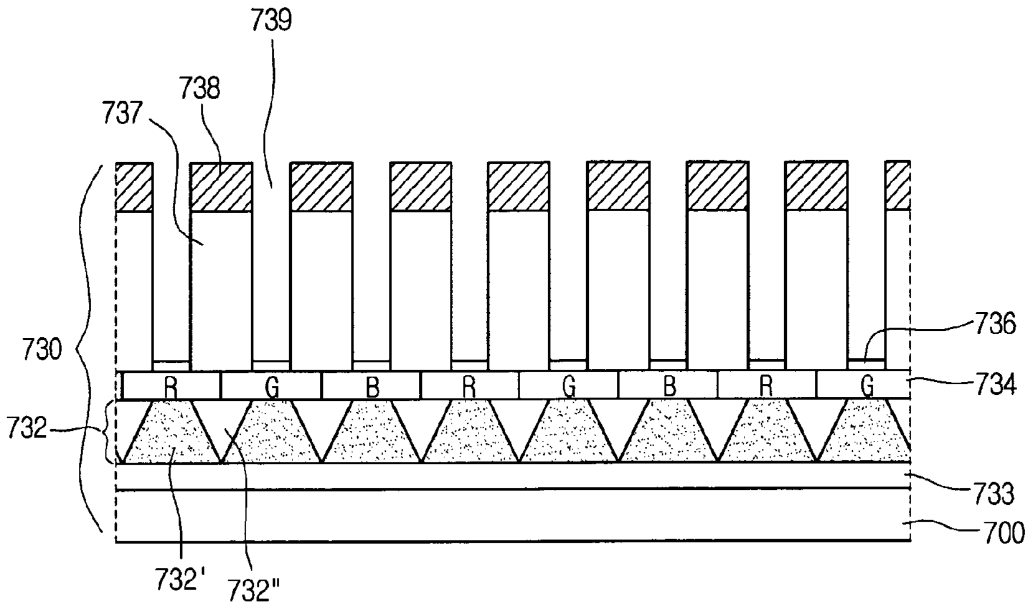
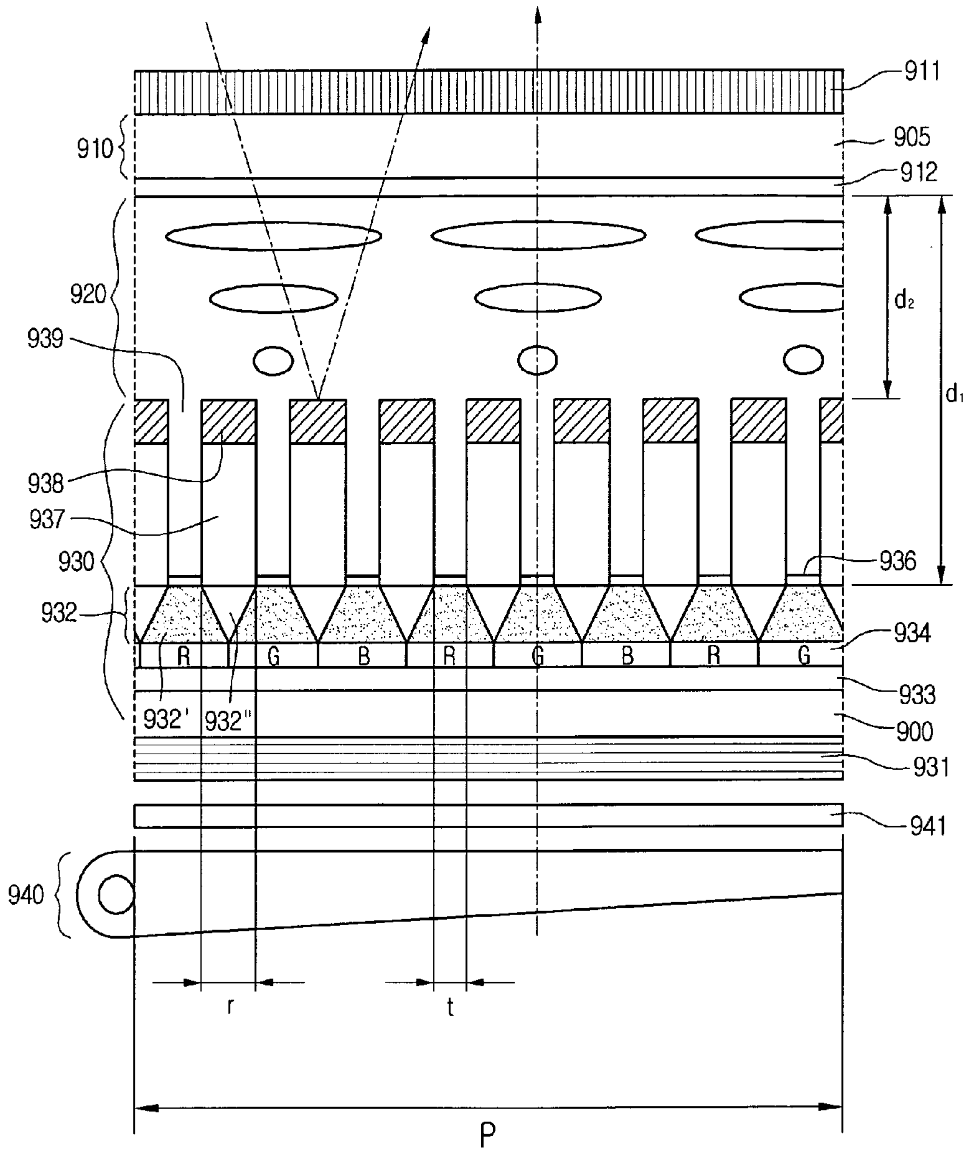


Fig.9



911
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Fig.10A

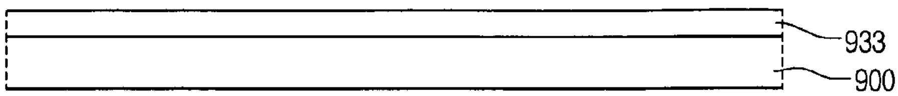


Fig.10B

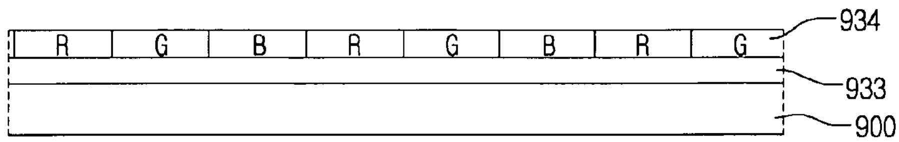


Fig.10C

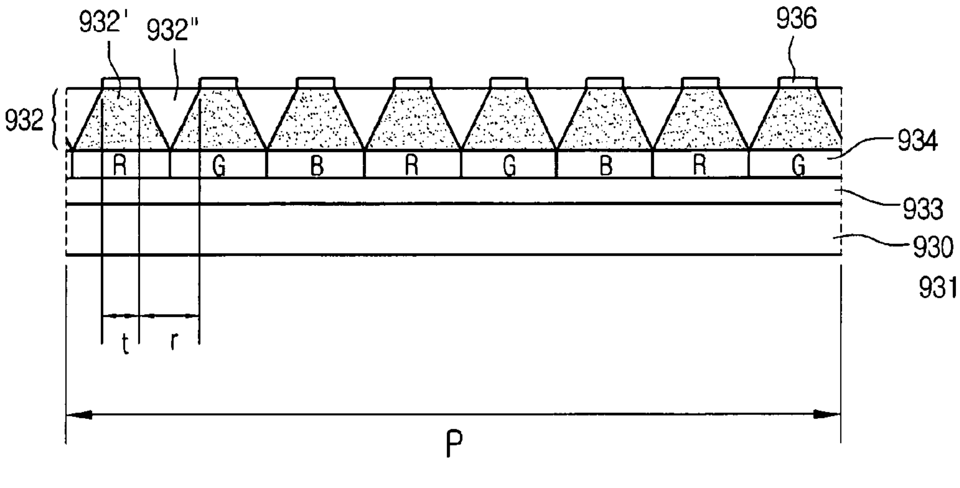
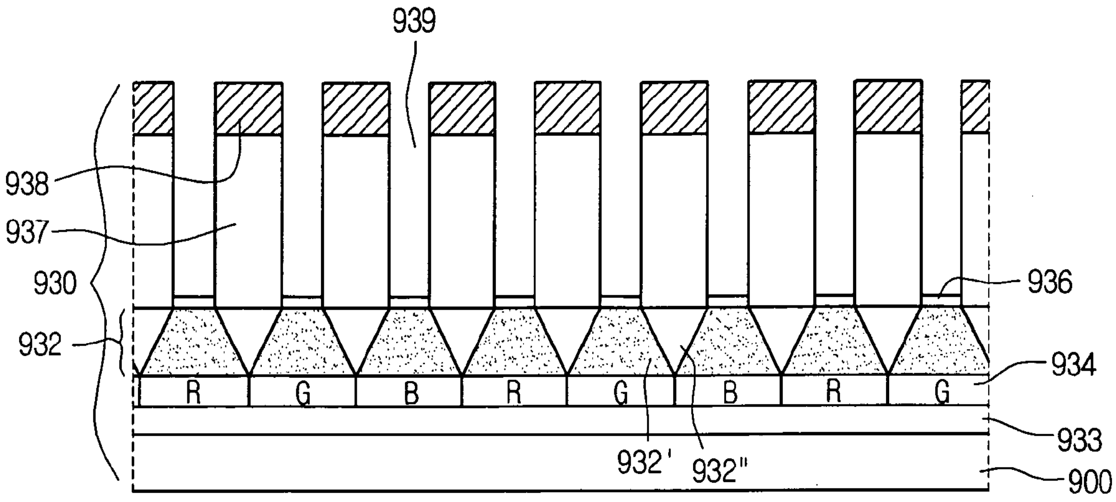


Fig.10D



TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATION METHOD THEREOF

[0001] This application claims the priority benefit of Patent Application No. 10-2003-0100693 filed on Dec. 30, 2003 in Republic of Korea, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a transflective liquid crystal display device and fabrication method thereof, and more particularly, to a transflective liquid crystal display device having a COT structure in which a delta film functioning as light induction material is formed on a lower substrate, and to a fabrication method thereof.

[0004] 2. Description of the Related Art

[0005] Generally, a liquid crystal display device (LCD) is a flat display having advantages such as lightweight, slim profile, and low power consumption, and is widely used for portable computers such as notebook computers, office automation machines, audio/video apparatuses and the like.

[0006] The LCD controls an electric field applied to a liquid crystal material having dielectric anisotropy to transmit or shield light, thereby displaying an image. Unlike electro-luminescence (EL), cathode ray tube (CRT), light emitting diode (LED) and the like, the LCD does not generate light by itself, but uses ambient light or a backlight assembly for generating light.

[0007] Generally, the LCDs can be classified into two different categories: transmission type and reflection type depending on the usage method of light.

[0008] The transmission type LCD includes an LCD panel and a backlight, where the LCD panel has two glass substrates, and a liquid crystal layer interposed therebetween.

[0009] **FIG. 1** is a cross-sectional view schematically showing a structure of the transmission type LCD according to the related art.

[0010] Referring to **FIG. 1**, the transmission type LCD includes: a lower substrate **102**; an upper substrate **101** which faces the lower substrate **102**; a liquid crystal layer **103** including liquid crystal molecules interposed between the upper and the lower substrates **101** and **102**; a first polarizing plate **105** disposed on an outer surface of the lower substrate **102**; a second polarizing plate **104** disposed on an outer surface of the upper substrate **101**; and a backlight assembly **106** generating light to supply light.

[0011] The lower substrate **102** includes a base substrate, a plurality of gate lines and data lines arranged in a matrix configuration on the base substrate, and a plurality of thin film transistors (TFTs) disposed on the base substrate at intersection points between the plurality of gate lines and data lines and functioning as switching elements. The upper substrate **101** includes a base substrate, and a black matrix (BM) layer, a color filter layer, and a common electrode on an inner surface of the base substrate.

[0012] The first polarizing plate **105** and the second polarizing plate **104** are respectively attached on the lower substrate **102** and the upper substrate **101** such that an optical transmission axis of the first polarizing plate **105** is at a right angle to that of the second polarizing plate **104**.

[0013] The arrangement of the first and second polarizing plates **105** and **104** is employed to transmit or shield light provided from the backlight assembly **106**.

[0014] However, in the transmission type LCD of the related art, it is difficult to realize slimness and lightweight of the LCD due to a large volume and a heavy weight of the backlight assembly **106**. Also, there is a problem that a power consumption of the backlight assembly **106** is excessively increased.

[0015] Therefore, researches for a reflection type LCD using ambient light instead of the backlight assembly **106**, are actively performed. Due to its low power consumption capability, such a reflection type LCD is widely used as a portable display device such as an electronic organizer and a PDA (Personal Digital Assistant).

[0016] **FIG. 2** is a cross-sectional view schematically showing a structure of the reflection type LCD according to the related art.

[0017] Referring to **FIG. 2**, the reflection type LCD includes: a lower substrate **202**; an upper substrate **201** which faces the lower substrate **202**; a liquid crystal layer **203** including liquid crystal molecules interposed between the upper and the lower substrates **201** and **202**; a first polarizing plate **205** disposed on an outer surface of the lower substrate **202**; a second polarizing plate **204** disposed on an outer surface of the upper substrate **201**; and a reflector **206** arranged outside the first polarizing plate **205**.

[0018] The lower substrate **202** includes a lower base substrate, a plurality of gate lines and data lines arranged in a matrix configuration on the lower base substrate, and a plurality of thin film transistors (TFTs) disposed on the lower base substrate at intersection points between the plurality of gate lines and data lines and functioning as switching elements. The upper substrate **201** includes an upper base substrate, and a black matrix (BM) layer, a color filter layer, and a common electrode on an inner surface of the upper base substrate.

[0019] In the reflection type LCD, an electric field applied to the liquid crystal molecules having dielectric anisotropy is controlled to transmit or block ambient light reflected by the reflector **206**, thereby displaying an image.

[0020] However, in the related art reflection type LCD, when ambient light does not have a sufficient intensity (for example, the surrounding is dim), brightness level of a displayed image is lowered and the displayed information is not readable, which is problematic.

[0021] **FIG. 3** is a cross-sectional view schematically showing a construction of a transflective LCD according to the related art.

[0022] Referring to **FIG. 3**, the transflective LCD includes: an upper substrate **311** having an upper common electrode **312** and a color filter layer formed on a first base substrate **305**; a lower substrate **332**, i.e., array substrate, facing the upper substrate **311** and spaced apart by a predetermined interval from the upper substrate **311**; a liquid crystal layer **320** interposed between the upper substrate **311** and the lower substrate **332**; and a backlight assembly **340** disposed below the lower substrate **332**, for providing light toward the lower substrate **332**.

[**0023**] On outer surfaces of the upper substrate **311** and the lower substrate **332**, i.e., on an upper surface of the upper substrate **311** and on a lower surface of the lower substrate **332**, upper and lower polarizing plates **313** and **336** for converting natural light into linearly polarized light by transmitting only the light parallel to their optical transmission axes are disposed.

[**0024**] The optical transmission axis of the upper polarizing plate **313** is at a right angle to that of the lower polarizing plate **336**.

[**0025**] On the base substrate **305**, the color filter layer (not shown) transmitting only the light having a specific wavelength, and the upper common electrode **312** that is one of two electrodes for forming an electric field are formed.

[**0026**] On a second base **300** of the lower substrate **332**, at least one lower pixel electrode **333** that is the other electrode for forming the electric field, a passivation layer **334** having a transmission hole **331** exposing a portion of the pixel electrode, and a reflector **335** are sequentially formed.

[**0027**] Also, TFTs, gate lines and data lines are formed on the base substrate **300** so as to apply a predetermined voltage to the corresponding pixel electrode **333**.

[**0028**] At this time, a region corresponding to the reflector **335** is a reflection part 'r' and a region corresponding to the portion of the pixel electrode, exposed by the transmission hole **331**, is a transmission part 't'. Also, 'd,' is a cell gap for the transmission mode and 'd_2' is a cell gap for the reflection mode.

[**0029**] In the above reflection type LCD, a phase difference δ of the liquid crystal layer **320** is obtained by the following formula:

$$\delta = \Delta n \cdot d$$

[**0030**] where δ: phase difference of liquid crystal, Δn: refractive index of liquid crystal, d: cell gap.

[**0031**] Thus, the phase difference is controllable by the refractive index of the liquid crystal and cell gap. To reduce a difference in optical efficiency between the reflection mode by the reflection part 'r' and the transmission mode by the transmission part 't', it is required to realize a similar phase difference between the two modes.

[**0032**] In the transmission mode, light passes through the LCD panel once, but in the reflection mode, light passes through the LCD panel twice. Accordingly, a real effective cell gap in the reflection mode is two times greater than that in the transmission mode, so that the reflection mode has a phase difference two times greater than that of the transmission mode. To compensate for such a difference, the reflection mode and the transmission mode have different cell gaps d_1 and d_2 in the structure.

[**0033**] In the related art transflective LCD, one pixel is divided into the reflection part and the transmission part. At this point, if an area ratio of the reflection part and the transmission part becomes different in one pixel, there is a problem in that optical efficiencies in the reflection mode and the transmission mode become different even if the cell gaps of the liquid crystal layer between the two modes are made different to compensate for the phase difference between the two modes.

SUMMARY OF THE INVENTION

[**0034**] Accordingly, the present invention is directed to a transflective LCD and fabrication method thereof that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[**0035**] An object of the present invention is to provide a transflective LCD having a COT structure in which a delta film is formed on a lower substrate to guide a light generated from a light source in the transmission mode, thereby enhancing light transmittance.

[**0036**] In one aspect, the present invention provides a transflective LCD and fabrication method thereof in which although one pixel region is divided into a reflection part and a transmission part at a different area ratio, optical efficiency in the transmission mode is enhanced by a delta film, thereby reducing a difference in the optical efficiency between the reflection mode and the transmission mode.

[**0037**] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[**0038**] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a transflective LCD including: an upper substrate having a common electrode formed on a first base substrate; a lower substrate spaced apart by a predetermined interval from the upper substrate and facing the upper substrate, the lower substrate having a pixel region including a switching region, a reflection part, and a transmission part, and including a delta film, a thin film transistor layer, a color filter layer and a reflector formed on a second base substrate; a liquid crystal layer interposed between the upper substrate and the lower substrate; and a backlight assembly disposed below the lower substrate, for supplying light toward the lower substrate.

[**0039**] According to another aspect of the present invention, there is provided a method of fabricating a transflective LCD, the method including: forming a delta film on a substrate by depositing a first material having a first refractive index on the substrate and patterning the first material to form a first pattern and forming a second material having a second refractive index between the first patterns; defining a pixel region including a switching region, a reflection part and a transmission part, and forming a thin film transistor on the switching region; sequentially forming a color filter layer and a pixel electrode on a thin film transistor layer having the thin film transistor; and sequentially depositing a passivation layer and a reflector on the defined pixel region to form a reflection part and exposing a predetermined portion to form a transmission part.

[**0040**] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0042] **FIG. 1** is a cross-sectional view schematically showing a structure of a transmission type LCD of the related art;

[0043] **FIG. 2** is a cross-sectional view schematically showing a structure of a reflection type LCD of the related art;

[0044] **FIG. 3** is a cross-sectional view schematically showing a structure of a transflective LCD of the related art;

[0045] **FIG. 4** is a cross-sectional view schematically showing a structure of a transflective LCD according to a first embodiment of the present invention;

[0046] **FIGS. 5A through 5D** are sectional views illustrating a method of fabricating a transflective LCD according to the first embodiment of the present invention;

[0047] FIGS. **6**(*a*) through **6**(*d*) are schematic views illustrating total internal reflection paths in a delta film according to the present invention;

[0048] **FIG. 7** is a cross-sectional view schematically showing a structure of a transflective LCD according to a second embodiment of the present invention;

[0049] **FIGS. 8A through 8D** are sectional views illustrating a method of fabricating a transflective LCD according to the second embodiment of the present invention;

[0050] **FIG. 9** is a cross-sectional view schematically showing a structure of a transflective LCD according to a third embodiment of the present invention; and

[0051] **FIGS. 10A through 10D** are sectional views illustrating a method of fabricating a transflective LCD according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0052] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0053] **FIG. 4** is a cross-sectional view schematically showing a structure of a transflective LCD according to a first embodiment of the present invention.

[0054] Referring to **FIG. 4**, the transflective LCD includes: an upper substrate **410** having a common electrode **412** formed on an inner surface of a first base substrate **405**; a lower substrate **430** spaced apart by a predetermined interval from the upper substrate **410** and facing the upper substrate **410**, the lower substrate **430** having a pixel region 'P' defined to include at least one switching region, at least one reflection part 'r', and at least one transmission part 't', and including a delta film **432**, a thin film transistor layer **433**, a color filter layer **434** and a reflector **438** sequentially formed on a second base substrate **400**; a liquid crystal layer **420** provided between the upper substrate **410** and the lower substrate **430**; and a backlight assembly **440** disposed below the lower substrate **430**, for providing light. The delta film is also referred to herein as a transflective pattern layer since its pattern corresponds to the transmission parts 't' the reflection parts 'r'.

[0055] On an upper surface of the upper substrate **410** and on a lower surface of the lower substrate **430**, upper and lower polarizing plates **411** and **431** for converting natural light into linearly polarized light by transmitting only the light parallel to their optical transmission axes are further disposed as part of the transflective LCD. The optical transmission axis of the upper polarizing plate **411** is at a right angle to that of the lower polarizing plate **431**.

[0056] The transflective LCD further includes a collimating film **441** disposed between the lower polarizing plate **431** and the backlight assembly **440**. The collimating film **441** changes an incident angle of the light emitted from the backlight assembly **440** such that a parallel light is incident on the lower substrate **430**.

[0057] The common electrode **412** formed on the inner surface of the first base substrate **405** is one of two electrodes for forming an electric field applied to the liquid crystal layer **420**, and is formed of a transparent conductive material.

[0058] Also, the delta film **432** formed on the second base substrate **400** functions to enhance efficiency of light passing through the transmission parts 't' defined in the pixel region P. The delta film **432** is shaped in an isosceles trapezoid pattern composed of a plurality of isosceles trapezoids connected to each other. In each trapezoid, the top part is shorter than the bottom part. The isosceles trapezoid pattern corresponds to the transmission parts 't' and the reflective parts 'r' of the pixel region 'P' as shown.

[0059] The delta film **432** is formed of an light induction medium **432**' having a first refractive index and the isosceles trapezoid pattern, and of a material **432**" having a second refractive index and formed between the isosceles trapezoids of the medium **432**'.

[0060] At this time, the light induction medium **432**' having the first refractive index is formed of a material having a refractive index greater than the material **432**" having the second refractive index. That is, the first refractive index is greater than the second refractive index.

[0061] The thin film transistor layer **433** formed on the delta film **432** has a plurality of thin film transistors each including a gate electrode, a source electrode and a drain electrode. The thin film transistor layer **433** further includes an active layer and an ohmic contact layer. On the gate electrodes, a gate insulating layer is formed.

[0062] A black matrix layer (not shown), a color filter layer **434** including sequentially repeated red (R), green (G) and blue (B) color filters, and a pixel electrode **436** which is the other electrode of the two electrodes for forming an electric field applied to the liquid crystal layer, are formed on the thin film transistor layer **433**. Multiple pixel electrodes **436** generally exist in the pixel region P.

[0063] At this point, each pixel electrode **436** is electrically connected with the corresponding drain electrode provided in the thin film transistor layer **433**. Each pixel electrode **436** is connected with the corresponding drain electrode through a contact hole formed in an insulating layer covering the drain electrode.

[0064] Also, on the pixel electrodes **436**, a passivation layer **437** and a reflector **438** are sequentially formed and patterned to define transmission holes **439** partially exposing the pixel electrodes **436**.

[0065] At this time, a region corresponding to each projecting part of the reflector **438** is referred to as a reflection part 'r' and a region corresponding to each pixel electrode exposed by the transmission hole **439** is referred to as a transmission part 't'.

[0066] The liquid crystal layer **420** is interposed between the pixel electrodes **436** and the common electrode **412**. When a voltage is applied to the pixel electrode(s) **436** and the common electrode **412**, the liquid crystal molecules of the liquid crystal layer **420** are aligned by an electric field generated between the pixel electrode(s) **436** and the common electrode **412**.

[0067] Upper and lower alignment films are respectively formed on the pixel electrodes **436** and between the common electrode **412** to determine an initial arrangement of the liquid crystal molecules.

[0068] In the meanwhile, to reduce a difference between the traveling distances of the light for the reflection part 'r' and the transmission part 't', a cell gap di of the transmission part 't' is designed to be two times greater than a cell gap d_2 of the reflection part 'r'.

[0069] Specifically, a phase difference δ of the liquid crystal layer **420** is expressed by the following formula:

$$\delta=\Delta n \cdot d$$

[0070] where δ: phase difference of liquid crystal, Δn: refractive index of liquid crystal, d: cell gap.

[0071] To reduce a difference in optical efficiency between the reflection mode using light reflection and the transmission mode using light transmission, it is required to make the cell gap of the transmission part greater than the cell gap of the reflection part such that the phase difference of the liquid crystal layer is kept at a constant value. All the components of the LCD of **FIG. 4** (and FIGS. **7** to **9**) are operatively disposed.

[0072] In the meanwhile, like the general transmission type LCD, the transflective LCD is fabricated by a method including the steps of forming a lower array substrate having thin film transistors and pixel electrodes, forming an upper color filter substrate having a color filter layer and a common electrode, and forming an LC cell including arrangement of the two substrates, injection of a liquid crystal material, sealing, and attachment of polarizing plates.

[0073] **FIGS. 5A through 5D** are sectional views illustrating a method of fabricating a transflective LCD according to the first embodiment of the present invention. This method can be used to fabricate the LCD of **FIG. 4**.

[0074] Referring to **FIG. 5A**, a predetermined pattern is formed with a first material **432'** having a first refractive index on a substrate **400**, and then a second material **432"** having a second refractive index is deposited between the spaces within the predetermined pattern, thereby forming the delta film **432**.

[0075] In detail, the first material **432'** is deposited on the substrate **400** and is then patterned using an etching process, thereby forming the pattern of isosceles trapezoids connected to each other. At this time, each isosceles trapezoid in the pattern has a long bottom side and a short top side.

[0076] Here, the etching process can be performed using various methods. For example, in a photolithography process, a photoresist film is first coated to form a photoresist layer. Next, an exposure mask is aligned over the photoresist layer, and the exposure processing is performed to expose a specific portion (E) of the photoresist layer to light. Thereafter, the exposed photoresist is developed, and then the etching process of the patterned portions is performed depending on whether the photoresist material is a positive type or a negative type. Thereafter, the remaining photoresist layer is removed, so that the material **432'** having the first refractive index is made in the pattern of the isosceles trapezoids. Next, the material **432"** having the second refractive index is deposited on the substrate **400** having the first material **432'** patterned in the isosceles trapezoids. At this time, the material **432'** having the first refractive index is a light induction medium, and is formed of a material having a refractive index greater than the material **432"** having the second refractive index such that a total internal reflection is allowed.

[0077] FIGS. **6**(*a*)-**6**(*d*) are views illustrating a path of the total internal reflection in the delta film according to the present invention.

[0078] As shown in FIGS. **6**(*a*)-**6**(*d*), a condition of $n_i>n_t$ should be satisfied for the total internal reflection. At this time, n_i is a refractive index of the first material **432'**, and n_t is a refractive index of the second material **432"**.

[0079] Also, when the condition of $\theta_r>\theta c=\text{arcsine}(n_t/n_i)$ is satisfied, light travels while performing the total internal reflection without refraction. Herein, θ_r is a reflection angle, θ_c is a critical angle, θ_i is an incident angle for the first material **432'**; and θ_t is a refraction angle for the second material **432"**. FIGS. **6**(*a*)-**6**(*d*) show that the total internal reflection is achieved in **FIG. 6**(*c*).

[0080] Returning to **FIG. 5B**, once the delta film **432** is formed, a pixel region 'P' including switching region(s), reflection part(s) 'r' and transmission part(s) 't' are defined on the delta film **432**. The switching regions are formed in the thin film transistor layer **433**.

[0081] In more detail, as a switching region, a gate line, a gate electrode, a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, a data line, and a passivation film are formed on the substrate having the delta film **432**, thereby forming a thin film transistor (TFT). The LCD has the data and gate lines in a matrix configuration such that the thin film transistor is formed at each intersection of the corresponding gate line and the corresponding data line to form the thin film transistor layer **433** having the TFTs.

[0082] Next, as shown in **FIG. 5C**, a black matrix layer (not shown), a color filter layer **434** including red (R), green

(G) and blue (B) color filters sequentially repeated, pixel electrodes **436** (the other of the two electrodes for forming an electric field applied to the liquid crystal) are sequentially formed on the thin film transistor layer **433**.

[**0083**] Here, as known, each pixel electrode **436** is electrically connected with the drain electrode of the corresponding TFT provided in the thin film transistor layer **433**. At this time, the drain electrode is connected to the pixel electrode **436** by exposing the drain electrode through a corresponding contact hole.

[**0084**] After that, as shown in **FIG. 5D**, a passivation layer **437** and a reflector **438** are sequentially deposited in the pixel region (P) on the resultant structure of the substrate and then patterned to form the reflector **438** used in the reflection mode. The reflector **438** (and the passivation layer **437**) as patterned correspond to the reflection parts ‘r’. The reflector **438** as patterned exposes the pixel electrodes **436** via transmission holes **439**. The light from the backlight assembly **440** is transmitted through the pixel electrodes **436** and the transmission holes **439** in the transmission mode. This completes the formation of the lower substrate **430** of the transflective LCD according to the first embodiment of the present invention. The fabrication of the upper substrate **410** and the LC layer **420** and other known layers are performed using existing techniques.

[**0085**] Thus, the delta film **432** satisfying the above condition is primarily formed on the substrate **400** of the transflective LCD having the COT structure to guide light generated from the backlight assembly in the transmission mode, thereby improving the light transmittance significantly.

[**0086**] **FIG. 7** is a cross-sectional view schematically showing a structure of a transflective LCD according to a second embodiment of the present invention.

[**0087**] The transflective LCD of the second embodiment provides a thin film transistor layer **733** formed directly on a second base substrate **700** in a lower substrate **730**.

[**0088**] Referring to **FIG. 7**, the transflective LCD includes: an upper substrate **710** having a common electrode **712** formed on an inner surface of a first base substrate **705**; a lower substrate **730** spaced apart by a predetermined interval from the upper substrate **710** and facing the upper substrate **710**, the lower substrate **730** having a pixel region ‘P’ defined to include switching regions, reflection parts ‘r’, and transmission parts ‘t’, and including the thin film transistor layer **733**, a delta film **732**, and a color filter layer **734** sequentially formed on the second base substrate **700**; a liquid crystal layer **720** filled between the upper substrate **710** and the lower substrate **730**; and a backlight assembly **740** disposed below the lower substrate **730**, for providing light.

[**0089**] As in the first embodiment, a collimating film **741** is further disposed between a lower polarizing plate **731** and the backlight assembly **740**. The collimating film **741** changes an incident angle of the light emitted from the backlight assembly **740** such that a parallel light is incident on the lower substrate **730**.

[**0090**] The LCD of **FIG. 7** further includes the polarizing plates **731** and **711**, pixel electrodes **736**, a passivation layer **737**, and a reflector **738** exposing the pixel electrodes **736** through transmission holes **739**.

[**0091**] The second embodiment is identical to the first embodiment, except that the TFT layer **733** is disposed between the delta film **732** and the base substrate **700**, instead of being between the delta film and the color filter layer. As such, a further detailed description of the same elements of the second embodiment will be omitted, except for as provided below.

[**0092**] Particularly, in the second embodiment, the delta film **732** is formed over the second base substrate **700** after the thin film transistor layer **733** is first formed on the base substrate **700**. The delta film **732** has a pattern of isosceles trapezoids connected to each other. The isosceles trapezoid pattern corresponds to the transmission parts ‘t’ of the pixel region P. The delta film **732** is composed of a light induction medium **732'** having a first refractive index, and a material **732"** having a second refractive index and formed between the isosceles trapezoids of the medium **732'** pattern. At this time, the light induction medium **732'** having the first refractive index is formed of a material having a refractive index greater than the material **732"** having the second refractive index.

[**0093**] **FIGS. 8A through 8D** are sectional views illustrating a method of fabricating a transflective LCD according to the second embodiment of the present invention. This method can be used to fabricate the LCD of **FIG. 7**.

[**0094**] The description of the second embodiment will be brief because it can be understood with reference to the first embodiment of **FIGS. 5A through 5D**.

[**0095**] Referring to **FIG. 8A**, a thin film transistor layer **733** defining a pixel region including switching regions, reflection parts ‘r’ and transmission parts ‘t’ is formed on a base substrate **700**.

[**0096**] Next, referring to **FIG. 8B**, a first material **732'** having a first refractive index is deposited and patterned on the thin film transistor layer **733** to form a predetermined pattern, and then a second material **732"** having a second refractive index is deposited between the predetermined patterns, thereby forming a delta film **732**.

[**0097**] Next, referring to **FIG. 8C**, a color filter layer **734** and pixel electrodes **736** are sequentially formed on the delta film **732**.

[**0098**] In more detail, a black matrix layer (not shown), a color filter layer **734** including red (R), green (G) and blue (B) color filters sequentially repeated, the pixel electrodes **736** are formed on the substrate including the delta film **732**.

[**0099**] Next, referring to **FIG. 8D**, a passivation layer **737** and a reflector **738** are sequentially deposited in the defined pixel region P, and patterned to correspond to the reflective parts ‘r’ and transmission parts ‘t’ having transmission holes **739**.

[**0100**] Thus, the delta film **732** satisfying the above condition is formed in the lower substrate **730** of the transflective LCD to guide light generated from the backlight assembly in the transmission mode, thereby improving the light transmittance significantly.

[**0101**] **FIG. 9** is a cross-sectional view schematically showing a structure of a transflective LCD according to a third embodiment of the present invention. The third embodiment is identical to the second embodiment, except that a color filter layer **934** is disposed between a delta film **932** and a TFT layer **933**. As a result, the description thereof will be brief.

[**0102**] Referring to **FIG. 9**, the transflective LCD includes: an upper substrate **910** having a common electrode **912** formed on an inner surface of a first base substrate **905**; a lower substrate **930** spaced apart by a predetermined interval from the upper substrate **910** and facing the upper substrate **910**, the lower substrate **930** having a pixel region P defined to include switching regions, reflection parts 'r', and transmission parts 't', and including the thin film transistor layer **933**, the color filter layer **934**, and the delta film **932** sequentially formed on a second base substrate **900**; a liquid crystal layer **920** filled between the upper substrate **910** and the lower substrate **930**; and a backlight assembly **940** disposed below the lower substrate **930**, for providing light.

[**0103**] A collimating film **941** is further disposed between a lower polarizing plate **931** and the backlight assembly **940**. The collimating film **941** changes an incident angle of the light emitted from the backlight assembly **940** such that a parallel light is incident on the lower substrate **930**.

[**0104**] The LCD of the third embodiment further includes the polarizing plates **911** and **931**, pixel electrodes **936**, a passivation layer **937**, a reflector **938** exposing the pixel electrodes **936** via transmission holes **939**. The delta film **932** has a light induction material **932'** having a first refractive index and a pattern, and a material **932"** having a second refractive index and formed between isosceles trapezoids of the medium **932"**. The first refractive index is greater than the second refractive index.

[**0105**] **FIGS. 10A through 10D** are sectional views illustrating a method of fabricating a transflective LCD according to the third embodiment of the present invention. This method can be used to fabricate the LCD of **FIG. 9**.

[**0106**] A detailed description of the third embodiment will be brief because it can be understood with reference to the first/second embodiment of **FIGS. 5A-5D** and **8A-8D**.

[**0107**] First, referring to **FIG. 10A**, a pixel region P including switching regions, reflection parts 'r' and transmission parts 't' is defined and then a thin film transistor layer **933** is formed on a second base substrate **900**.

[**0108**] Next, referring to **FIG. 10B**, a color filter layer **934** is formed on the thin film transistor layer **933**.

[**0109**] Next, referring to **FIG. 10C**, a first material **932'** having a first refractive index is deposited on the color filter layer **934** and patterned to form a predetermined pattern, and then a second material **932"** having a second refractive index is deposited between the predetermined patterns of the first material **932'**, thereby forming a delta film **932**.

[**0110**] Next, pixel electrodes **936** are formed on the delta film **932**. Each pixel electrode **936** is electrically connected with the drain electrode of the corresponding thin film transistor formed in the thin film transistor layer **933** through a contact hole.

[**0111**] Next, referring to **FIG. 10D**, a passivation layer **937** and a reflector **938** are sequentially deposited in the defined pixel region P, and patterned to correspond to the reflective parts 'r' and transmission parts 't' with transmission holes **939**.

[**0112**] Although the isosceles trapezoid pattern has been discussed for the delta film, the invention covers other patterns/shapes for the delta film. Any pattern of which a top side length corresponding to a width of a light-emission part is shorter than a bottom side length corresponding to a width of a light-incident part may be used.

[**0113**] As described above, in the transflective LCD of the present invention, a delta film of a light induction medium is formed inside the transflective LCD having a COT structure to guide a light generated from the backlight assembly in the transmission mode, thereby enhancing the light transmittance significantly.

[**0114**] Also, although one pixel region is divided into the reflection part(s) and the transmission part(s) at a different area ratio, the delta film enhances optical efficiency in the transmission mode, thereby reducing a difference in the optical efficiency between the reflection mode and the transmission mode.

[**0115**] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A transflective LCD comprising:

an upper substrate having a common electrode;

a lower substrate spaced apart by a predetermined interval from the upper substrate and facing the upper substrate, the lower substrate including a pixel region having a switching region, a reflection part, and a transmission part, and further including a delta film, a thin film transistor layer, a color filter layer and a reflector;

a liquid crystal layer interposed between the upper substrate and the lower substrate; and

a backlight assembly disposed below the lower substrate, for supplying light toward the lower substrate.

2. The transflective LCD according to claim 1, wherein the delta film, the thin film transistor layer, the color filter layer and the reflector are sequentially formed on a base substrate.

3. The transflective LCD according to claim 1, wherein the thin film transistor layer, the delta film, and the color filter layer are sequentially formed on a base substrate.

4. The transflective LCD according to claim 1, wherein the thin film transistor layer, the color filter layer, and the delta film are sequentially formed on a base substrate.

5. The transflective LCD according to claim 1, wherein the delta film has a pattern of which a top side length corresponding to a width of a light-emission part is shorter than a bottom side length corresponding to a width of a light-incident part.

6. The transflective LCD according to claim 1, wherein the delta film has a pattern formed corresponding to the transmission part of the pixel region.

7. The transflective LCD according to claim 6, wherein the delta film is composed of a light induction medium having a first refractive index, and a material having a second refractive index.

8. The transflective LCD according to claim 7, wherein the first refractive index is greater than the second refractive index.

9. The transflective LCD according to claim 1, wherein the thin film transistor layer has thin film transistors coupled to gate lines and data lines.

10. The transflective LCD according to claim 1, wherein the reflector has a pattern corresponding to the reflection part of the defined pixel region.

11. The transflective LCD according to claim 1, further comprising:

an upper polarizing plate disposed on an outer surface of the upper substrate;

a lower polarizing plate disposed on an outer surface of the lower substrate; and

a collimating film disposed between the lower polarizing plate and the backlight assembly.

12. A method of fabricating a transflective LCD, the method comprising:

forming a delta film on a substrate by depositing a first material having a first refractive index on the substrate and patterning the first material to form a first pattern and by forming a second material having a second refractive index on the first pattern;

defining a pixel region including a switching region, a reflection part and a transmission part, and forming a thin film transistor in the switching region;

sequentially forming a color filter layer and a pixel electrode on a thin film transistor layer having the thin film transistor; and

forming a reflector in the defined pixel region to correspond to the reflection part and to expose the pixel electrode corresponding to the transmission part.

13. The method according to claim 12, further comprising:

preparing a substrate having a common electrode at a position facing the substrate having the delta film, the thin film transistor layer, the color filter layer and the reflector; and

filling a liquid crystal layer between the facing substrates.

14. The method according to claim 12, wherein the delta film comprises a first medium having a first refractive index and a second medium having a second refractive index, and the first medium having the first refractive index is formed of a light induction medium having a refractive index greater than the second refractive index.

15. A method of fabricating a transflective LCD, the method comprising:

defining a pixel region including a switching region, a reflection part and a transmission part on a substrate, and forming a thin film transistor in the switching region;

forming a delta film on the substrate by depositing a first material having a first refractive index on the substrate and patterning the first material to form a first pattern and by forming a second material having a second refractive index on the first pattern;

sequentially forming a color filter layer and a pixel electrode on the delta film; and

forming a reflector in the defined pixel region to correspond to the reflection part and to expose the pixel electrode corresponding to the transmission part.

16. The method according to claim 15, further comprising:

preparing a substrate having a common electrode at a position facing the substrate having the delta film, the thin film transistor layer, the color filter layer and the reflector; and

filling a liquid crystal layer between the facing substrates.

17. The method according to claim 15, wherein the first refractive index is greater than the second refractive index.

18. A method of fabricating a transflective LCD, the method comprising:

defining a pixel region including a switching region, a reflection part and a transmission part on a substrate, and forming a thin film transistor in the switching region;

sequentially forming a color filter layer and a pixel electrode on a thin film transistor layer having the thin film transistor;

forming a delta film on the substrate by depositing a first material having a first refractive index on the substrate and patterning the first material to form a first pattern and by forming a second material having a second refractive index on the first pattern; and

forming a reflector in the defined pixel region to correspond to the reflection part and to expose the pixel electrode corresponding to the transmission part.

19. The method according to claim 18, further comprising:

preparing a substrate having a common electrode at a position facing the substrate having the delta film, the thin film transistor layer, the color filter layer and the reflector; and

filling a liquid crystal layer between the facing substrates.

20. The method according to claim 18, wherein the first refractive index is greater than the second refractive index.

21. A method of fabricating a structure of a display device, the method comprising:

forming a transflective pattern layer, a thin film transistor (TFT) layer, and a color filter layer on a base substrate in a predetermined order,

wherein the transflective pattern layer includes first parts associated with a transmission made of the display device and second parts associated with a reflection mode of the display device.

22. The method according to claim 21, wherein the first pars have a refractive index greater than a refractive index of the second parts.

23. The method according to claim 22, wherein the first parts have a pattern of trapezoids.

24. The method according to claim 21, wherein the predetermined order is the transflective pattern layer, the TFT layer and then the color filter layer.

25. The method according to claim 21, wherein the predetermined order is the TFT layer, the transflective pattern layer and then the color filter layer.

26. The method according to claim 21, wherein the predetermined order is the TFT layer, the color filter layer and then the transflective pattern layer.

27. A structure of a display device, comprising:

a transflective pattern layer, a thin film transistor (TFT) layer, and a color filter layer on a base substrate and arranged in a predetermined order,

wherein the transflective pattern layer includes first parts associated with a transmission made of the display device and second parts associated with a reflection mode of the display device.

28. The structure according to claim 27, wherein the first parts have a refractive index greater than a refractive index of the second parts.

29. The structure according to claim 28, wherein the first parts have a pattern of trapezoids.

30. The structure according to claim 27, wherein the predetermined order is the transflective pattern layer, the TFT layer and then the color filter layer.

31. The structure according to claim 27, wherein the predetermined order is the TFT layer, the transflective pattern layer and then the color filter layer.

32. The structure according to claim 27, wherein the predetermined order is the TFT layer, the color filter layer and then the transflective pattern layer.

* * * * *

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当前申请(专利权)人(译)	LG DISPLAY CO.，LTD.		
[标]发明人	KIM KYEONG JIN JANG MI KYOUNG		
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摘要(译)

透射反射型LCD包括上基板，上基板中形成有公共电极;下基板与上基板隔开预定间隔并面向上基板，下基板具有包括开关区域，反射部分和透射部分的像素区域，并且包括δ膜，薄膜晶体管层，滤色器层和形成在其中的反射器;液晶层夹在上基板和下基板之间;背光组件设置在下基板下方，用于向下基板提供光。