US007667797B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 7,667,797 B2**
(45) **Date of Patent: Feb. 23, 2010**

(54) **LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 490 days.

(21) Appl. No.: **11/643,499**

(22) Filed: **Dec. 20, 2006**

(65) **Prior Publication Data**

US 2007/0153175 A1 Jul. 5, 2007

(30) **Foreign Application Priority Data**

Dec. 30, 2005 (KR) 10-2005-0135941

(51) **Int. Cl.**
G02F 1/1335 (2006.01)

(52) **U.S. Cl.** **349/106**; 349/114

(58) **Field of Classification Search** 349/104, 349/106–109, 113–115
See application file for complete search history.

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(57) **ABSTRACT**

A liquid crystal display device includes an array substrate having reflective and transmissive regions in a pixel region, wherein the array substrate includes a reflective electrode corresponding to the reflective region and a pixel electrode on a first substrate. A color filter substrate defines the reflective region and the transmissive region in the pixel region. The color filter substrate includes a color filter with first and second portions that correspond to the respective transmissive and reflective regions on a second substrate. The thickness of the second portion is less than a thickness of the first portion. The combined thickness of the scatter and the thickness of the second portion is greater than the thickness of the first portion; and a liquid crystal layer between the array and color filter substrates.

21 Claims, 7 Drawing Sheets

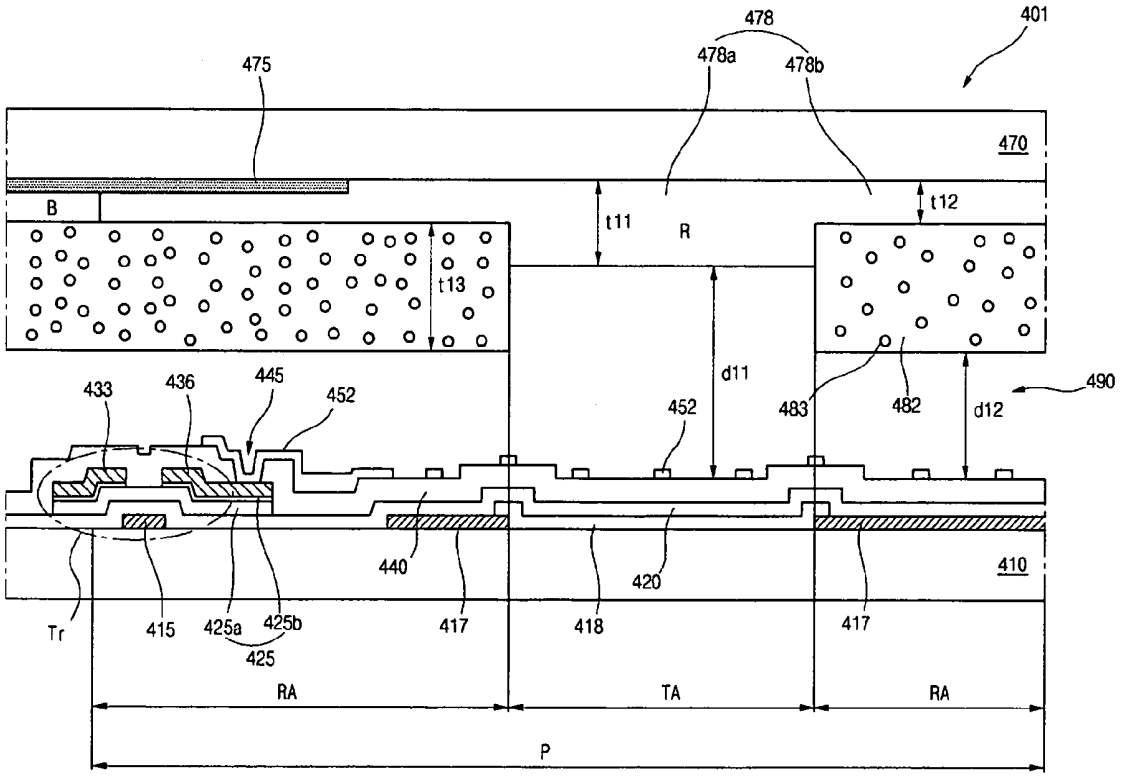


FIG. 1
RELATED ART

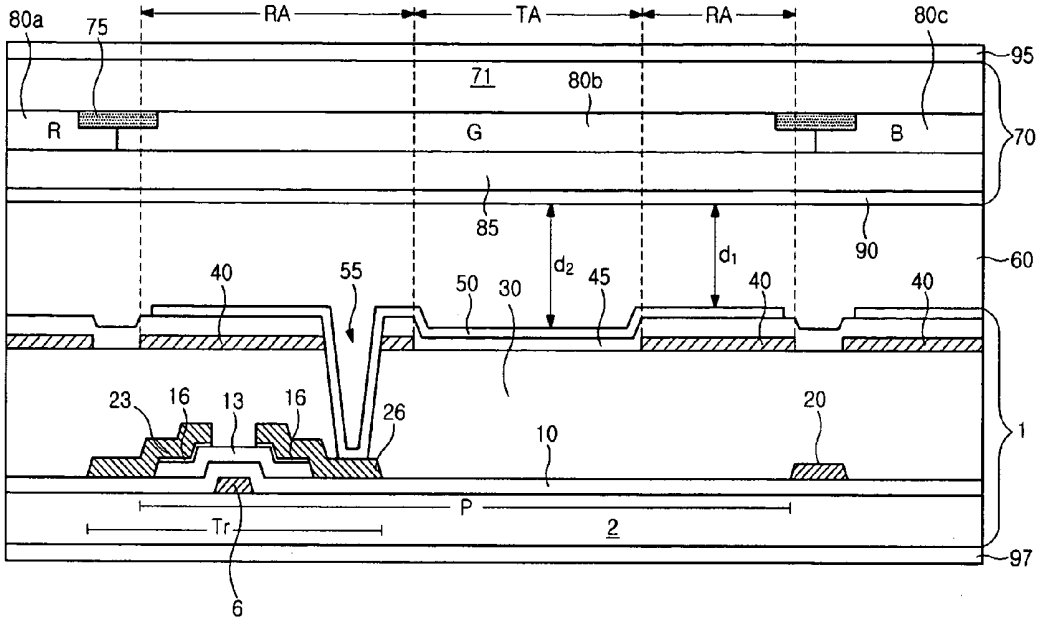


FIG. 2
RELATED ART

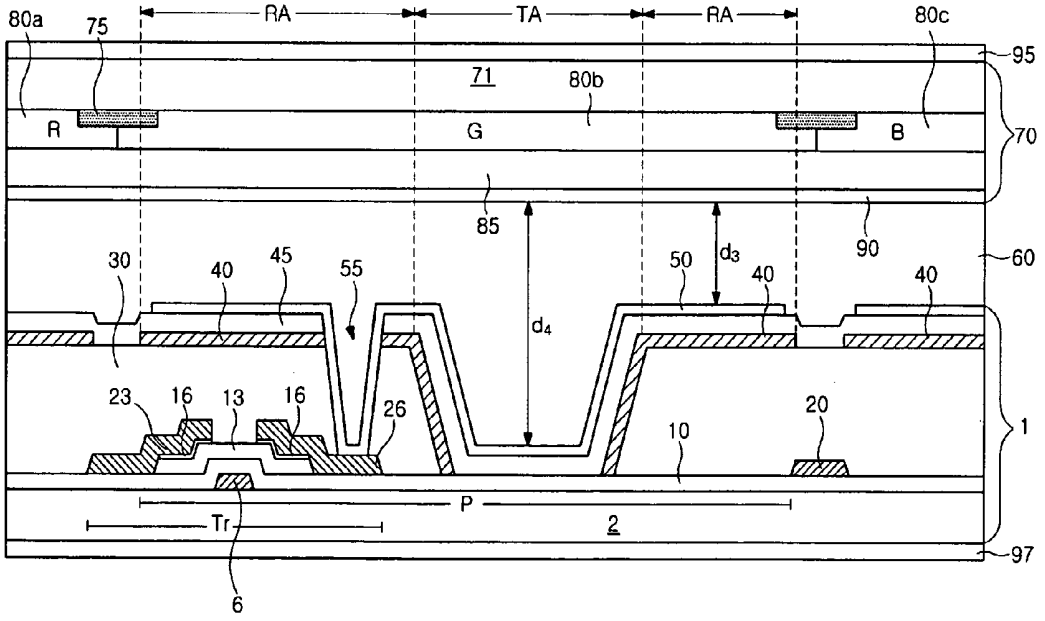


FIG. 3
RELATED ART

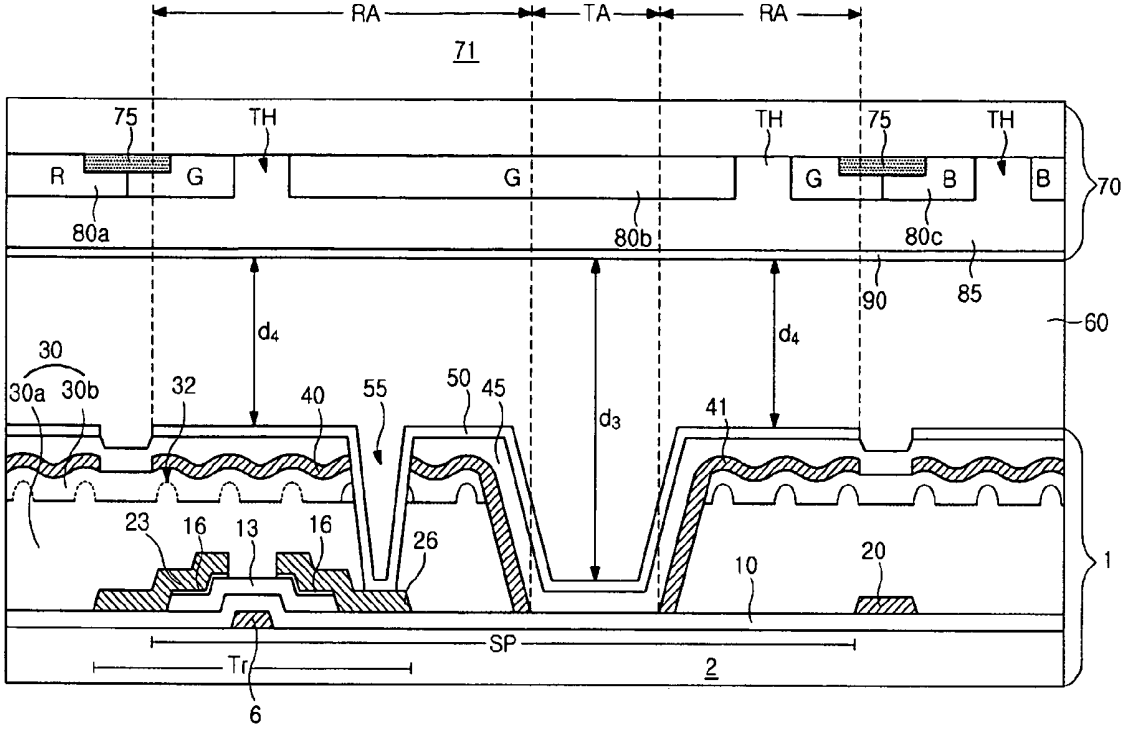


FIG. 4

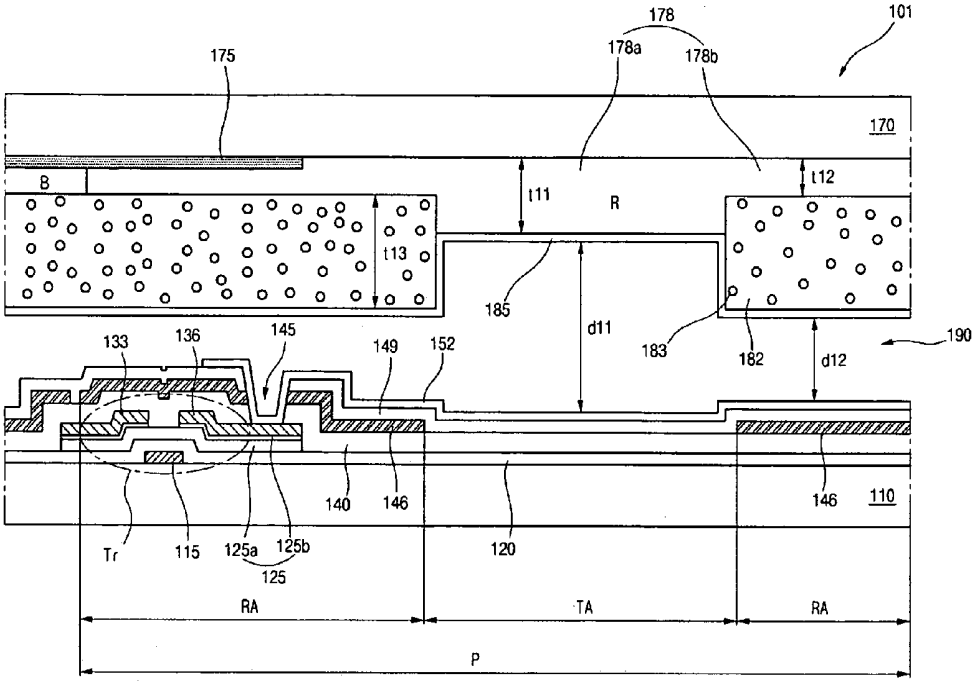

178
101
175
178a
178b
170
B
t11
R
t12
t13
185
d11
183
182
d12
190
133
136
145
149
152
140
146
146
110
Tr
115
125a
125b
125
120
RA
TA
RA
P

FIG. 5

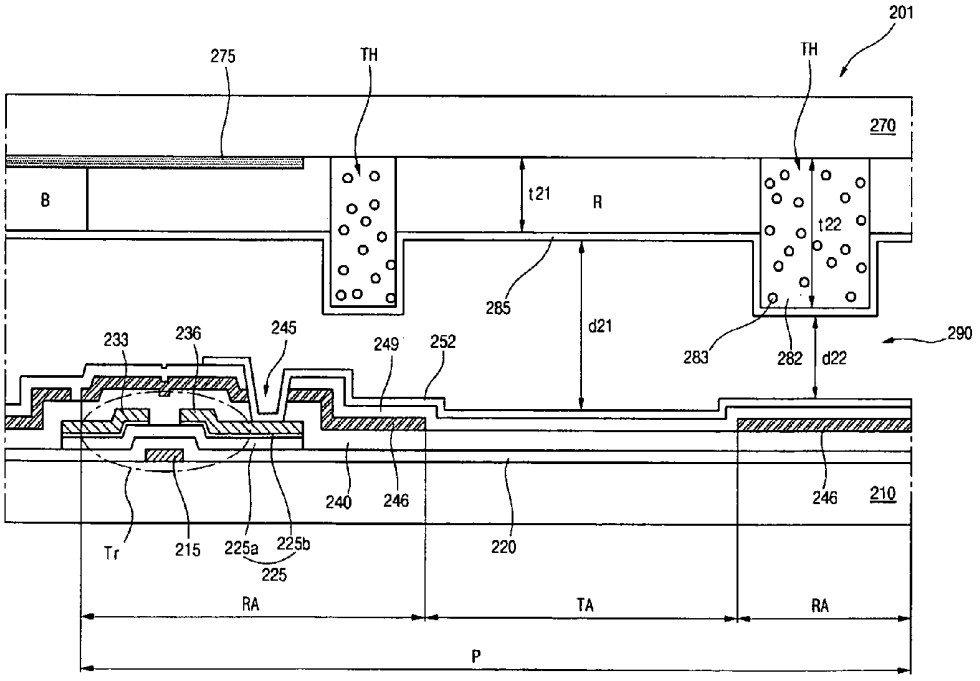

201
275
TH
TH
270
B
t21
R
t22
285
d21
283
282
d22
290
233
236
245
249
252
240
246
246
210
Tr
215
225a
225b
225
220
RA
TA
RA
P

FIG. 6

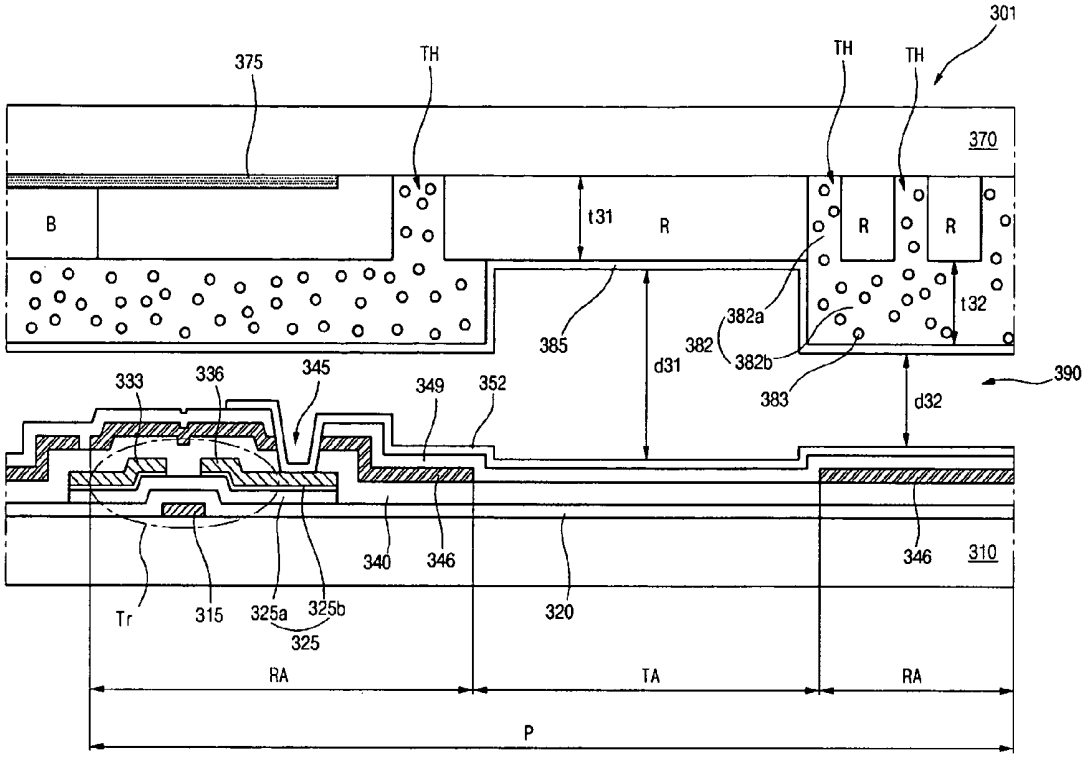

301
375
TH
TH
TH
370
B
t31
R
R
R
t32
385
382a
382
382b
383
d31
d32
390
333
336
345
349
352
340
346
346
310
Tr
315
325a
325b
325
320
RA
TA
RA
P

FIG. 7

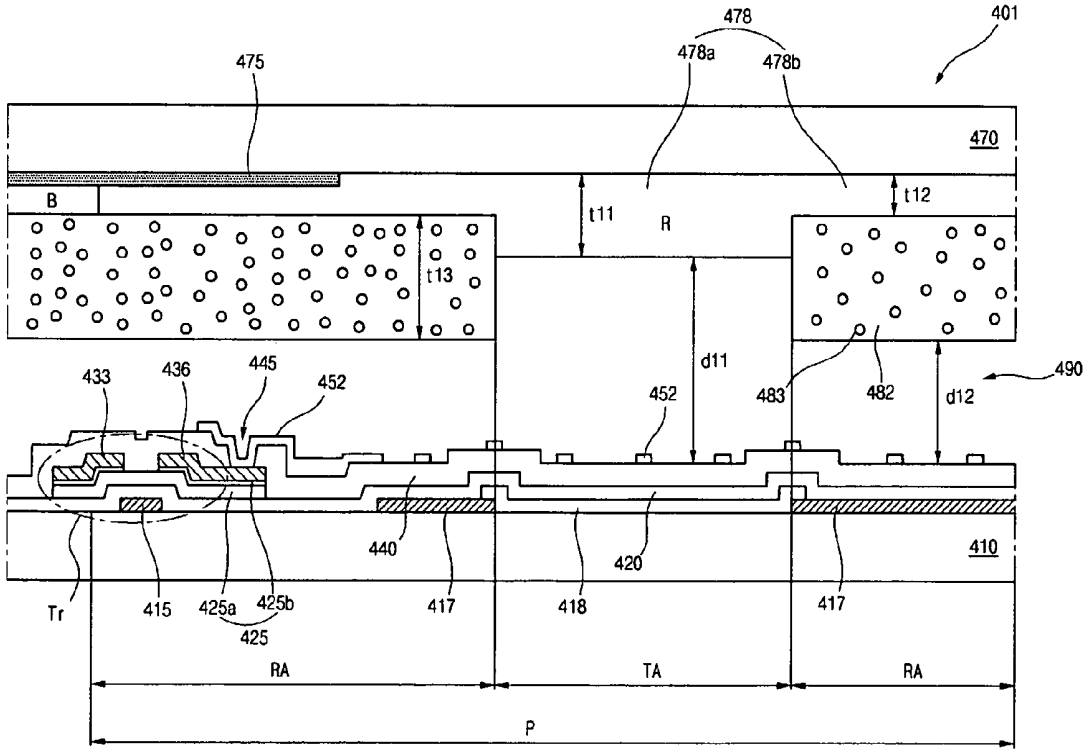

401
478
478a
478b
475
470
B
t11
R
t12
t13
d11
d12
490
433
436
445
452
452
483
482
440
420
410
Tr
415
425a
425b
425
417
418
417
RA
TA
RA
P

FIG. 8A

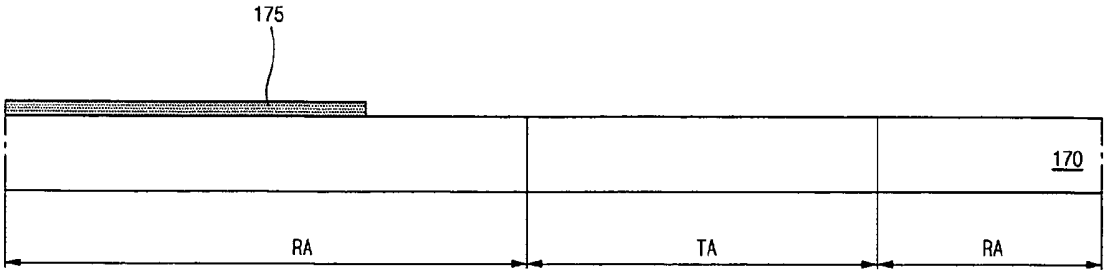

175
170
RA
TA
RA

FIG. 8B

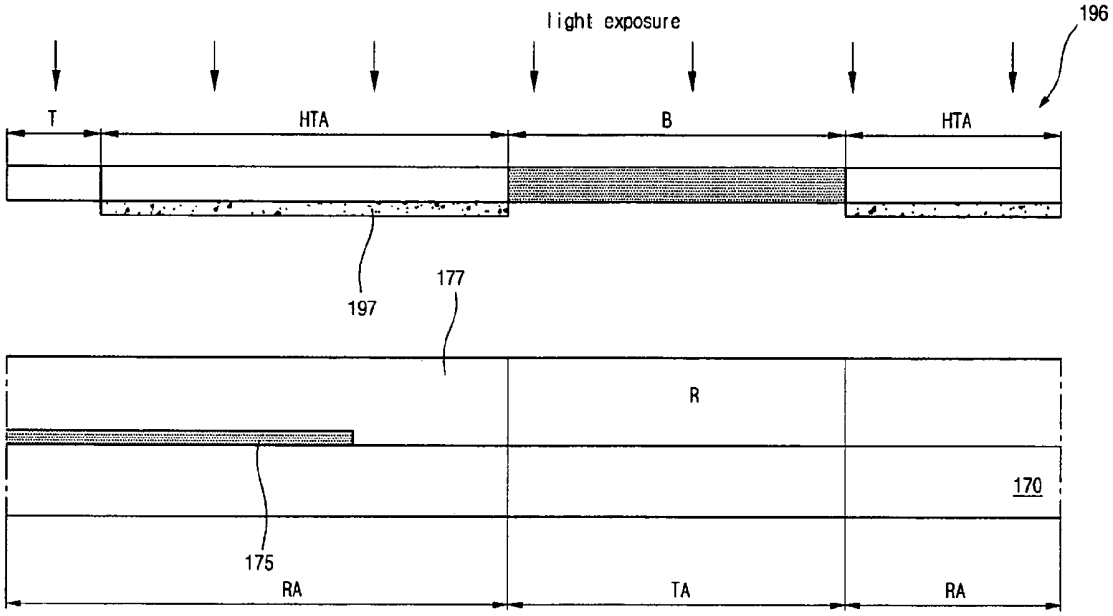

light exposure
196
T
HTA
B
HTA
197
177
R
170
175
RA
TA
RA

FIG. 8C

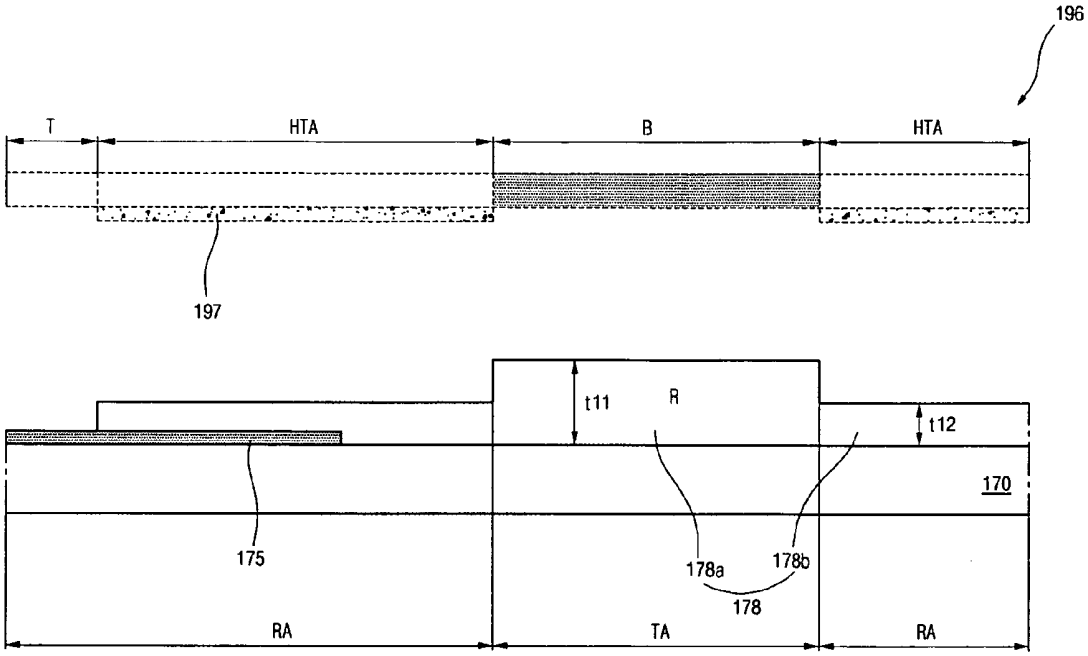

196
T
HTA
B
HTA
197
t11
R
t12
170
175
178a
178b
178
RA
TA
RA

FIG. 8D

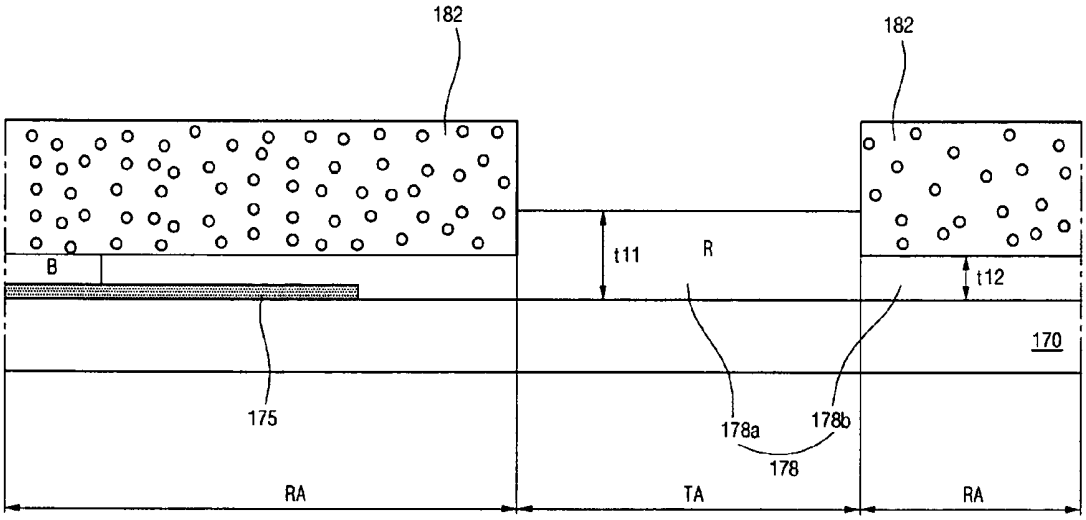
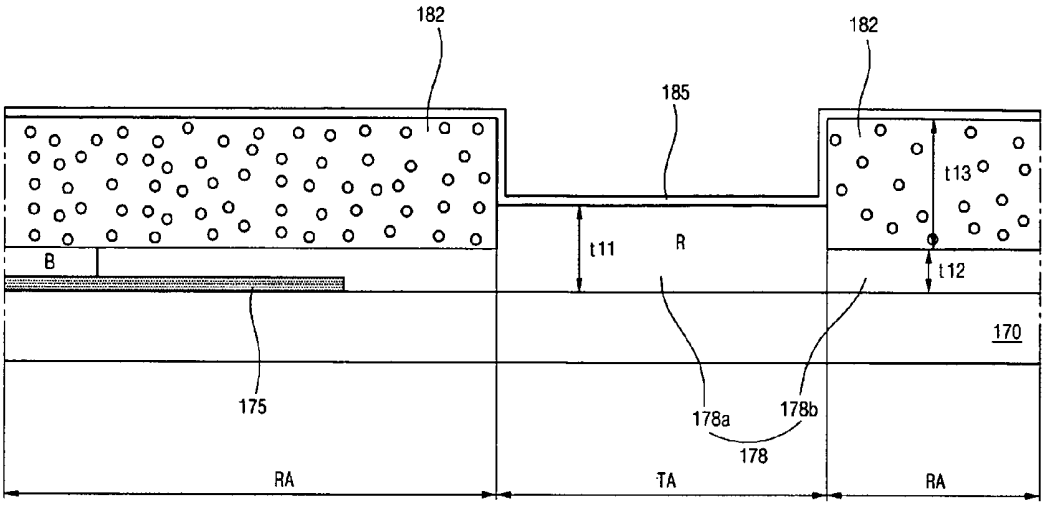

182
182
B
t11
R
t12
170
175
178a
178b
178
RA
TA
RA

FIG. 8E



LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME

This application claims the benefit of Korean Patent Application No. 2005-0135941, filed on Dec. 30, 2005, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

1. Technical Field

The present invention relates to a liquid crystal display device, and more particularly, relates to a liquid crystal display device and a method of fabricating the same.

2. Discussion of the Related Art

Many types of flat panel displays have been developed to serve as substitutes for cathode-ray tubes (CRTs), such as liquid crystal display (LCD) devices, plasma display panels (PDPs), field emission displays, and electro-luminescence displays (ELDs). LCD devices have many advantages over CRTs, including higher resolution, thinner profile, more compact size, and lower power usage during operation.

LCD devices generally include two substrates that are spaced apart and face each other and a liquid crystal layer interposed between the two substrates. The two substrates also include electrodes that face each other such that a voltage applied between the electrodes induces an electric field across the liquid crystal layer. Alignment of the liquid crystal molecules in the liquid crystal layer changes in relation to the intensity of the induced electric field which alters the light transmissivity of the LCD device. Thus, the LCD device displays images by varying the intensity of the induced electric field within respective pixel regions that are provided with the LCD device.

LCD devices may be categorized into transmissive type, reflective type, and transflective type. Transmissive type LCDs require a backlight and consumes a relatively large amount of power during operation. Reflective type LCDs are operated with the aid of external light, and the brightness of the display is proportional to the amount of external light available. Transflective type LCDs are selectively operated in either transmissive or reflective modes. Transflective type LCD devices improve upon the disadvantages of the transmissive type and reflective type LCD devices.

Referring to FIG. **1**, in an array substrate **1**, a gate electrode **6**, and a gate line (not shown) are formed on a first substrate **2**. A gate insulating layer **10** is formed on the gate electrode **6**. A semiconductor layer that is formed from an active layer **13** and an ohmic contact layer **16** is provided on the gate insulating layer **10** over the gate electrode **6**. Source and drain electrodes **23**, **26** are formed on the ohmic contact layer **16**. Each of the gate electrode **6**, the semiconductor layer, and the source and drain electrodes **23**, **26** combine to form a thin film transistor Tr. A data line **20** is provided on the gate insulating layer **10**. The data line **20** crosses the gate line to define a pixel region P. A first passivation layer **30** is formed on the data line **20** and the source and drain electrodes **23**, **26**. A reflective electrode **40** is formed on the first passivation layer **30** in a reflective region RA. A second passivation layer **45** is formed on the reflective electrode **40**. A pixel electrode **50** is formed on the second passivation layer **45** in the pixel region P. The pixel electrode **50** contacts the drain electrode **26** through a drain contact hole **55**.

In a color filter substrate **70**, a black matrix **75** is formed on a second substrate **71**. Red (R), green (G) and blue (B) color filters **80***a*, **80***b*, and **80***c* are formed in the corresponding pixel regions P. An overcoat layer **85** is formed on the color filters **80***a*, **80***b* and **80***c*. A common electrode **90** is formed on the overcoat layer **85**.

A liquid crystal layer **60** is provided between the array substrate **1** and the color filter substrate **70**. When voltages are applied to both the pixel and common electrodes **50**, **90**, an electric field is induced within the liquid layer **60**, and the liquid crystal molecules therein are reoriented in proportion to the electric field. Although not shown in the drawings, an alignment layer is formed on each of the transparent and common electrodes **50**, **90**. Additionally, first and second retardation films **97**, **95** may be formed on outer surfaces of the first and second substrates **2** and **71**.

As best shown in FIG. **1**, a cell gap d_1 (i.e. the thickness of the liquid crystal layer **60**) of the reflective region RA is substantially the same as a cell gap d_2 of the transmissive region TA. In a reflective mode, an external light passes through the liquid crystal layer **60**, then reflects on the reflective electrode **40**, and then passes through the liquid crystal layer **60** again. Light in the reflective mode substantially travels as far through liquid crystal layer **60** as in the transmissive mode. Accordingly, there is a phase difference of light between the reflective and the transmissive modes.

To minimize or eliminate the phase difference, the transflective type LCD device of FIG. **2** provided. In the transflective type LCD device, a cell gap d_4 (i.e. the thickness of the liquid crystal layer **60**) within the transmissive region TA is substantially twice the cell gap d_3 within the reflective region RA. Accordingly, the phase difference of FIG. **1** is substantially prevented because light travels through the same thickness of liquid crystal in both modes.

However, the transflective type LCD devices of FIGS. **1** and **2** have some problems. Light in the reflective mode passes through the color filter twice, and light in the transmissive mode passes through the color filter only once. Accordingly, color property differences between the reflective mode and the transmissive mode may occur. Also, the brightness in the reflective mode may be less than in the transmissive mode. Further, the reflectivity is reduced because the reflective electrode is flat.

Referring to FIG. **3**, a through hole TH is formed in the color filters **80***a*, **80***b* and **80***c* in the reflective region RA. Light passing through the through hole TH in the reflective mode has substantially the same properties as light passing through the device in the transmissive mode, and brightness in the reflective mode is increased. Further, a first passivation layer **30** formed from two sub layers **30***a*, **30***b* has an uneven surface, which provides the reflective electrode **40** with a similar uneven surface. The uneven surface of the reflective electrode **40** increases the overall reflectivity. However, at least two mask processes are required to form the uneven surface. The additional mast process increase the fabrication time and product cost of an LCD device. Also, the processes of forming the uneven surface, makes it difficult to form a dual cell gap structure within the LDC panel.

SUMMARY

A first representative embodiment of a liquid crystal display device includes an array substrate formed with reflective and transmissive regions in a pixel region, wherein the array substrate includes a reflective electrode corresponding to the reflective region and a pixel electrode on a first substrate. A color filter substrate with the reflective region and the transmissive region is provided in the pixel region that includes a color filter with first and second portions that correspond to the transmissive and reflective regions on a second substrate,

respectively. The thickness of the second portion is less than a thickness of the first portion. A scatter layer is provided on the second portion. The combined thickness of the scatter layer and of the second portion is greater than the thickness of the first portion. A liquid crystal layer is provided between the array and color filter substrates.

Another representative embodiment of a liquid crystal display device includes an array substrate with reflective and transmissive regions formed in a pixel region. The array substrate includes a reflective electrode corresponding to the reflective region and a pixel electrode formed on a first substrate and a color filter substrate with the reflective and transmissive regions formed in the pixel region. The color filter substrate includes a color filter with a through hole in the reflective region on a second substrate and a scatter layer that includes a first portion filling the through hole. The thickness of the first portion is greater than the color filter. A liquid crystal layer is provided between the array and color filter substrates.

Another representative embodiment provides a method of fabricating a liquid crystal display device. The method includes the steps of fabricating an array substrate with reflective and transmissive regions in a pixel region and fabricating the array substrate to include a reflective electrode corresponding to the reflective region and a pixel electrode on a first substrate. A color filter substrate is provided with the reflective and transmissive regions in the pixel region. The method of forming the color filter includes the steps of forming the color filter substrate with first and second portions that correspond to the transmissive and reflective regions on a second substrate, respectively and interposing a liquid crystal layer between the array and color filter substrates, and forming a scatter layer on the second portion. The thickness of the second portion is less than a thickness of the first portion and the combined thickness of the scatter portion and the second portion is greater than the thickness of the first portion.

Another representative embodiment is a method of fabricating a liquid crystal display device that includes the steps of fabricating an array substrate having reflective and transmissive regions in a pixel region, including the steps of forming a reflective electrode corresponding to the reflective region and a pixel electrode on a first substrate and fabricating a color filter substrate having the reflective region and the transmissive region in the pixel region. The step of fabricating the color filter substrate includes the steps of forming a color filter with a through hole in the reflective region on a second substrate and forming a scatter layer with a first portion filling the through hole interposing a liquid crystal layer between the array and color filter substrates. The thickness of the first portion is greater than a thickness of the color filter.

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

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.

In the drawings:

FIGS. **1** to **3** are cross-sectional views illustrating examples of transflective type LCD devices according to the related art.

FIG. **4** is a cross-sectional view illustrating a transflective type LCD device according to a first exemplary embodiment.

FIG. **5** is a cross-sectional view illustrating a transflective type LCD device according to a second exemplary embodiment.

FIG. **6** is a cross-sectional view illustrating a transflective type LCD device according to a third exemplary embodiment.

FIG. **7** is a cross-sectional view illustrating a transflective type LCD device according to a fourth exemplary embodiment.

FIGS. **8**A to **8**E are cross-sectional views illustrating a method of fabricating the color filter substrate according to the embodiment of FIG. **4**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

Referring to FIG. **4**, a transflective type LCD device **101** is provided that includes an array substrate, a color filter substrate and a liquid crystal layer **190** provided therebetween. In the array substrate, a gate electrode **115** and a gate line (not shown) are formed on a first substrate **110**. A gate insulating layer **120** is formed on the first substrate **110** having the gate electrode **115**. A semiconductor layer **125** is formed on the gate insulating layer **120** over the gate electrode **115**. The semiconductor layer **125** includes an active layer **125***a* formed from intrinsic amorphous silicon and an ohmic contact layer **125***b* formed from impurity-doped amorphous silicon. Source and drain electrodes **133**, **136** are formed on the ohmic contact layer **125***b*. A data line (not shown) is formed on the gate insulating layer **120**, which is made of the same material as the source and drain electrodes **133**, **136**. The data line crosses the gate line to define a pixel region P. The gate electrode **115**, the semiconductor layer **125** and the source and drain electrodes **133**, **136** form a thin film transistor Tr.

A first passivation layer **140** is formed on the first substrate **110** having the source and drain electrodes **133**, **136**. The first passivation layer **140** may be formed from an organic insulating material such as benzocyclobutene (BCB) and acrylic resin. A top surface of the first passivation layer **140** is normally substantially flat. A reflective electrode **146** is formed on the first passivation layer **140** in a reflective region RA. The reflective electrode **146** has a transmissive hole corresponding to a transmissive region TA. A top surface of the reflective electrode **146** is substantially flat. The reflective electrode **146** be formed from a highly reflective material such as aluminum (Al). A second passivation layer **149** is formed on the first substrate **110** having the reflective electrode **146**.

A drain contact hole **145** is formed through the first passivation layer **140**, the reflective electrode **146**, and the second passivation layer **149** to expose the drain electrode **136**. A pixel electrode **152** is formed on the second passivation layer **140** in the pixel region P and contacts the drain electrode **136** through the drain contact hole **145**. The pixel electrode **152** may also contact the reflective electrode **146** through the drain contact hole **145**. The pixel electrode **152** may be formed from a transparent conductive material such as indium-tin-oxide (ITO), indium-zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO). A height of the array substrate within the reflective region RA is substantially the same as a height of the array substrate within the transmissive region TA. A black matrix **175** is formed on a second substrate **170** in the color filter substrate. The black matrix **175** may correspond to the thin film transistor T, and the gate and data lines.

A color filter **178** is formed in the corresponding pixel region P. The color filter **178** includes red (R), green (G) and

blue (B) color filters. The color filter **178** has a first portion **178***a* that corresponds to the transmissive region TA and a second portion **178***b* that corresponds to the reflective region RA. The thickness t**11** of the first portion **178***a* is greater than the thickness t**12** of the second portion **178***b*. For example, the thickness t**11** of the first portion **178***a* is substantially twice the thickness t**12** of the second portion **178***b*. While light in a reflective mode passes through the color filter **178** twice, and light in a transmissive mode passes through the color filter **178** once, because the first portion **178***a* has twice the thickness of the second portion **178***b*, the color in the reflective mode can be substantially the same as that in the transmissive mode.

A scatter layer **182** is provided on the second portion **178***b* that may be formed from a transparent organic insulating material such as a photoresist and a photo acrylic. The scatter layer **182** includes a plurality of beads **183** that scatters light. The beads **183** may be arranged within the scatter layer **182** so that the beads **183** can function as an uneven pattern as shown in FIG. **3**. The thickness t**13** of the scatter layer **182** is such that a cell gap d**11** (i.e. the thickness of the liquid crystal layer **190**) of the transmissive region TA is substantially twice a cell gap d**12** of the reflective region RA. In some embodiments, the thickness t**13** of the scatter layer **182** may be one and half times greater the thickness t**11** of the first portion **178***a*. A common electrode **185** is formed on the second substrate **170** from a transparent conductive material such as indium-tin-oxide (ITO), indium-zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO).

As described above, the reflective region of the color filter has a smaller thickness than the transmissive region. Accordingly, the transflective type LCD device can have substantially the same color properties (brightness, shade, etc.) in the reflective mode and the transmissive mode. Further, the scatter layer **182** has beads **183** and is formed on the color filter layer in the reflective region to provide the high reflectivity and the dual cell gap structure.

FIG. **5** is a cross-sectional view illustrating a transflective type LCD device according to a second exemplary embodiment of the present invention. The LCD device is similar to that of the first exemplary embodiment except for the color filter and the scatter layer. Accordingly, explanations of parts similar to parts of the first exemplary embodiment are not repeated here for the sake of brevity.

The color filter in a transmissive region TA has approximately the same thickness t**21** as the color filter in a reflective region RA. A through hole TH is formed in the color filter in the reflective region RA, which allows color properties to be substantially the same in the reflective and transmissive modes. A scatter layer **282** fills the through hole TH and is arranged with a thickness t**22** such that the cell gap d**21** (i.e. the thickness of the liquid crystal layer **290**) in the transmissive region TA is substantially twice the cell gap d**22** in the reflective region RA that corresponds to the through hole TH. The thickness t**22** of the scatter layer **282** may be twice the thickness t**21** of the color filter, which accordingly achieves the dual cell gap structure.

FIG. **6** is a cross-sectional view illustrating a transflective type LCD device according to a third exemplary embodiment of the present invention. The LCD device of FIG. **6** is similar to that of the second exemplary embodiment except for the structure of the scatter layer. Accordingly, an explanation of parts similar to parts of the second exemplary embodiment is not repeated here for the sake of brevity.

Similar to the second exemplary embodiment, a color filter in a transmissive region TA substantially has the same thickness t**31** as the color filter in a reflective region RA and a through hole TH is formed in the color filter in the reflective region RA. By forming the through hole TH, the color properties may be substantially the same in the reflective and transmissive modes.

A scatter layer **382** includes first and second portions **382***a* and **382***b*. The first portion **382***a* fills the through hole TH, as is similar to the scatter layer discussed with respect to the second exemplary embodiment. The second portion **382***b* is formed on the color filter in the reflective region RA. The second portion **382***b* has a thickness t**32** and the first portion **382***a* has a thickness (t**31**+t**32**) such that a cell gap d**31** within the transmissive region TA is substantially twice a cell gap d**32** within the reflective region RA. Further, the thickness t**32** of the second portion **382***b* may the same as the thickness t**31** of the color filter, which allows for the dual cell gap structure.

FIG. **7** is a cross-sectional view illustrating a transflective type LCD device according to a fourth exemplary embodiment of the present invention. The LCD device depicted in FIG. **7** is similar to that of the first exemplary embodiment except for the structure of the array substrate and the common electrode. Accordingly, explanations of parts similar to parts of the first exemplary embodiment are not repeated here for the sake of brevity.

The LCD device of the first exemplary embodiment is operated with the electric field that is induced vertically by the pixel electrode of the array substrate and the common electrode of the color filter substrate. The LCD device **401** of the current exemplary embodiment is operated with an in-plane electric field that is induced horizontally by a pixel electrode **452** and reflective and common electrodes **417** and **418** of an array substrate.

Referring to FIG. **7**, in the array substrate, the reflective electrode **417** is formed on a first substrate **410** in a reflective region RA. The reflective electrode **417** may be made of the same material as a gate electrode **415**. A common electrode **418** is formed on the first substrate **410** corresponding to a transmissive hole of the reflective electrode **417**. The common electrode **418** contacts the reflective electrode **417**. The common electrode **418** may be formed from a transparent conductive material such as indium-tin-oxide (ITO), indium-zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO). A gate insulating layer **420** is on the first substrate **410** and has the gate electrode **415**, the reflective electrode **417**, and the common electrode **418**.

A passivation layer **440** is formed on the first substrate **410** having the source and drain electrodes **433**, **436**. The passivation layer **440** has a drain contact hole **445** exposing the drain electrode **436**. A plurality of pixel electrodes **452** are formed on the passivation layer **440** in the pixel region P. The pixel electrodes **452** induce an in-plane electric field with the location of the reflective and common electrodes **417**, **418** below the pixel electrode **452**. The LCD device of the fourth exemplary embodiment is referred to as a FFS (fringe field switching) mode LCD device. Alternately, an IPS (in-plane switching) mode LCD device may be provided. In the IPS mode LCD device, a plurality of pixel electrodes and a plurality of common electrodes are alternately arranged to induce an in-plane electric field.

The structure to induce the in-plane electric field may be substituted in the second and third exemplary embodiments discussed above.

FIGS. **8**A to **8**E are cross-sectional views of a method for fabricating the color filter substrate according to the first exemplary embodiment of the present invention shown in FIG. **4**.

As shown in FIG. **8**A, a black matrix **175** is formed on a substrate **170** with a mask process. The black matrix **175** may be formed from chromium (Cr), chromium oxide (CrOx), or black resin.

As shown in FIG. **8**B, a red (R) resist layer **177** is formed on the substrate **170** having the black matrix **175**. A mask **196** is located over the red (R) resist layer **177**. The mask **196** has a transmitting portion T, a semi-transmitting portion HTA, and a blocking portion B. The transmitting portion T has a relatively high transmittance to allow for transmission of light, the blocking portion B has a relatively low transmittance to block a significant amount of light, and the semi-transmitting portion HTA has a light transmittance between the transmitting portion T and the blocking portion B. The semi-transmitting portion HTA may have a multi-coating layer **197**.

The blocking portion B corresponds to a transmissive region TA and the semi-transmitting portion HTA corresponds to a reflective region RA. The transmitting portion T may be between the blocking portions B and the semi-transmitting portions HTA.

A light exposure is performed for the red (R) resist layer **177**. For example, the red (R) resist layer **177** may be a positive type. When the red (R) resist layer **177** is a negative type, positions of the blocking portion B and the transmitting portion T are altered. After the light exposure, the red (R) resist layer **177** is developed.

Turning now to FIG. **8**C, after exposing and developing the red (R) resist layer **177**, a red (R) color filter **178** is formed in a pixel region P. A first portion **178***a* of the red (R) color filter **178** that corresponds to the transmissive region TA has a thickness t**11** and a second portion **178***b* of the red (R) color filter **178** that corresponds to the reflective region RA has a thickness t**12**. The blue and green color filters may be formed in the same manner as discussed above.

The color filters of the second and third exemplary embodiments may be formed using a mask where the transmitting portions and the blocking portions are alternately arranged in the reflective region RA instead of the semi-transmitting portion HTA of FIG. **8**B. In other words, the transmitting portion corresponds to the through hole (TH of FIGS. **5** and **6**), and the blocking portion is between the transmitting portion in the reflective region RA.

Referring to FIG. **8**D, an organic insulating material having a plurality of beads is deposited on the substrate **170** having the red (R), green, and blue (B) color filters and is patterned with a mask process to form a scatter layer **182** in the reflective region RA. Accordingly, the color filter substrate that corresponds to the reflective region RA is thicker than the color filter substrate that corresponds to the transmissive region TA. The cell gap of the transmissive region is substantially twice a cell gap of the reflective region due to the thickness relationship between the color filter and the scatter layer.

Referring to FIG. **8**E, a common electrode **185** is formed on the substrate **170** having the scatter layer **182**. In the fourth exemplary embodiment, the common electrode is not formed in the color filter substrate, and an over coat layer may be formed on the substrate having the scatter layer.

Through the above processes, the color filter substrate according to the first exemplary embodiment of the present invention is fabricated. The transflective LCD device is fabricated by attaching the color filter substrate and the array substrate and interposing the liquid crystal layer between the two substrates.

As explained in the exemplary embodiments, the reflective region of the color filter has a smaller thickness than the transmissive region of the color filter, or the reflective region of the color filter is provided with a through hole. Accordingly, the transflective type LCD device may have substantially the same color properties in both the reflective and transmissive modes. Further, a scatter layer with beads may be formed in the reflective region. Accordingly, the high reflectivity and the dual cell gap structure can be achieved with a relatively simple processes and at a low cost.

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

What is claimed is:

1. A liquid crystal display device, comprising:

an array substrate comprising reflective and transmissive regions in a pixel region, wherein the array substrate includes a reflective electrode corresponding to the reflective region, and a pixel electrode provided on a first substrate;

a color filter substrate comprising the reflective region and the transmissive region in the pixel region and:

a color filter provided on a second substrate, the color filter comprising first and second portions corresponding to the transmissive and reflective regions, respectively, wherein a thickness of the second portion is less than a thickness of the first portion; and

a scatter layer provided on the second portion, wherein a combined thickness of the scatter layer and the second portion is greater than the thickness of the first portion; and

a liquid crystal layer disposed between the array and color filter substrates.

2. The device according to claim **1**, wherein the thickness of the first and second portions and the scatter layer are such that a cell gap of the liquid crystal layer corresponding to the transmissive region is substantially twice a cell gap of the liquid crystal layer corresponding to the reflective region.

3. The device according to claim **2**, wherein a height of the array substrate corresponding to the transmissive region is substantially the same as a height of the array substrate corresponding to the reflective region.

4. The device according to claim **2**, wherein the thickness of the second portion is substantially half the thickness of the first portion, and the thickness of the scatter layer is substantially one and half the thickness of the first portion.

5. The device according to claim **1**, wherein the scatter layer includes a plurality of beads for scattering light.

6. The device according to claim **1**, wherein the color filter substrate further comprises a common electrode disposed on the scatter layer and the first portion.

7. The device according to claim **1**, wherein the array substrate further comprises a common electrode inducing an in-plane electric field with the pixel electrode.

8. The device according to claim **7**, wherein the common electrode corresponds to a transmissive hole through the reflective electrode corresponding to the transmissive region and is connected to the reflective electrode.

9. The device according to claim **7**, wherein the pixel electrode and the common electrode are alternately arranged.

10. The device according to claim **1**, wherein the pixel electrode corresponds to the pixel region.

11. A method of fabricating a liquid crystal display device, comprising the steps of:

fabricating an array substrate comprising reflective and transmissive regions in a pixel region, and forming a

reflective electrode corresponding to the reflective region and a pixel electrode on a first substrate;

fabricating a color filter substrate having the reflective region and the transmissive region in the pixel region, further comprising the steps of:

forming a color filter on a second substrate comprising first and second portions corresponding to the transmissive and reflective regions, respectively, wherein a thickness of the second portion is less than a thickness of the first portion; and

forming a scatter layer on the second portion, wherein a combined thickness of the scatter layer and the second portion is greater than the thickness of the first portion; and

interposing a liquid crystal layer between the array and color filter substrates.

12. The method according to claim **11**, wherein the step of forming the color filter comprises the steps of:

forming a color resist layer on the second substrate; and

patterning the color resist layer using a mask with a blocking portion corresponding to the transmissive region and a semi-transmitting portion corresponding to the reflective region.

13. The method according to claim **11**, wherein the thickness of the first and second portions and the scatter layer are such that a cell gap of the liquid crystal layer corresponding to the transmissive region is substantially twice a cell gap of the liquid crystal layer corresponding to the reflective region.

14. The method according to claim **13**, wherein a height of the array substrate corresponding to the transmissive region is substantially the same as a height of the array substrate corresponding to the reflective region.

15. The method according to claim **13**, wherein the thickness of the second portion is substantially half the thickness of the first portion, and the thickness of the scatter layer is substantially one and half times greater than the thickness of the first portion.

16. The method according to claim **11**, wherein the scatter layer includes a plurality of beads for scattering light.

17. The method according to claim **11**, wherein the step of fabricating the color filter substrate further comprises the steps of forming a common electrode on the scatter layer and the first portion.

18. The method according to claim **11**, wherein the step of fabricating the array substrate further comprises the step of forming a common electrode inducing an in-plane electric field with the pixel electrode.

19. The method according to claim **18**, wherein the common electrode corresponds to a transmissive hole of the reflective electrode corresponding to the transmissive region and is connected to the reflective electrode.

20. The method according to claim **18**, wherein the pixel electrode and the common electrode are alternately arranged.

21. The method according to claim **11**, wherein the pixel electrode corresponds to the pixel region.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,667,797 B2
APPLICATION NO. : 11/643499
DATED : February 23, 2010
INVENTOR(S) : Chang et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

The first or sole Notice should read --

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 555 days.

Signed and Sealed this

Seventh Day of December, 2010

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office

专利名称(译)	液晶显示装置及其制造方法		
公开(公告)号	US7667797	公开(公告)日	2010-02-23
申请号	US11/643499	申请日	2006-12-20
[标]申请(专利权)人(译)	乐金显示有限公司		
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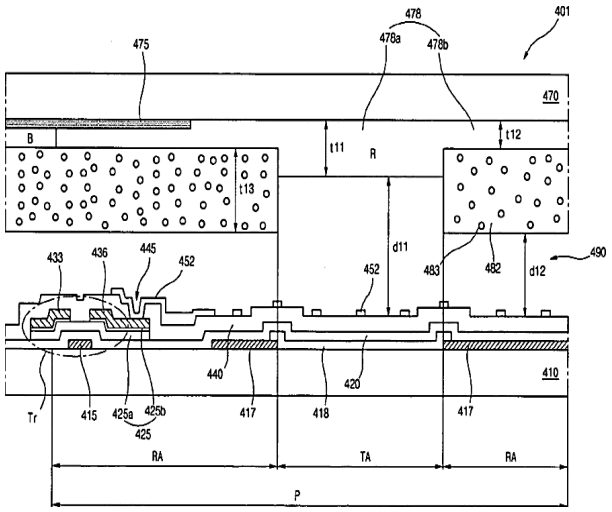
IPC分类号	G02F1/1335		
CPC分类号	G02F1/133504 G02F1/133555 G02F1/133514		
代理机构(译)	BRINKS霍费尔GILSON & LIONE		
优先权	1020050135941 2005-12-30 KR		
其他公开文献	US20070153175A1		
外部链接	Espacenet USPTO		

摘要(译)

一种液晶显示装置，包括阵列基板，所述阵列基板在像素区域中具有反射和透射区域，其中，所述阵列基板包括与所述反射区域对应的反射电极和在第一基板上的像素电极。滤色器基板限定像素区域中的反射区域和透射区域。滤色器基板包括滤色器，该滤色器具有第一和第二部分，第一和第二部分对应于第二基板上的相应透射和反射区域。第二部分的厚度小于第一部分的厚度。散射的组合厚度和第二部分的厚度大于第一部分的厚度;以及阵列和滤色器基板之间的液晶层。