



US007321408B2

(12) **United States Patent**
Yang

(10) **Patent No.:** **US 7,321,408 B2**
(45) **Date of Patent:** **Jan. 22, 2008**

(54) **IN-PLANE FIELD TYPE TRANSFLECTIVE
LIQUID CRYSTAL DISPLAY DEVICE**

(75) Inventor: **Chiu-Lien Yang**, Miao-Li (TW)

(73) Assignee: **Innolux Display Corp.**, Chu-Nan,
Miao-Li County (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 342 days.

(21) Appl. No.: **11/028,031**

(22) Filed: **Dec. 31, 2004**

(65) **Prior Publication Data**

US 2005/0190324 A1 Sep. 1, 2005

(30) **Foreign Application Priority Data**

Feb. 27, 2004 (TW) 93105064 A

(51) **Int. Cl.**

G02F 1/1335 (2006.01)

G02F 1/1343 (2006.01)

(52) **U.S. CL.** **349/114; 349/141**

(58) **Field of Classification Search** **349/114,**
349/141

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,220,444 A 6/1993 Mitsui et al.
5,598,285 A 1/1997 Kondo et al.
5,684,551 A 11/1997 Nakamura et al.

5,691,791 A 11/1997 Nakamura et al.
5,737,046 A 4/1998 Moriwaki et al.
5,847,789 A 12/1998 Nakamura et al.
6,097,458 A 8/2000 Tsuda et al.
6,195,140 B1 2/2001 Kubo et al.
6,215,538 B1 4/2001 Narutaki et al.
6,281,952 B1 8/2001 Okamoto et al.
6,295,109 B1 9/2001 Kubo et al.
6,330,047 B1 12/2001 Kubo et al.
6,341,002 B1 1/2002 Shimizu et al.
6,366,333 B1 4/2002 Yamamoto et al.
6,433,847 B1 8/2002 Minoura
6,452,654 B2 9/2002 Kubo et al.
6,501,521 B2 12/2002 Matsushita et al.
6,650,385 B1* 11/2003 Liu 349/113
6,914,656 B2* 7/2005 Sakamoto et al. 349/141

* cited by examiner

Primary Examiner—David Nelms

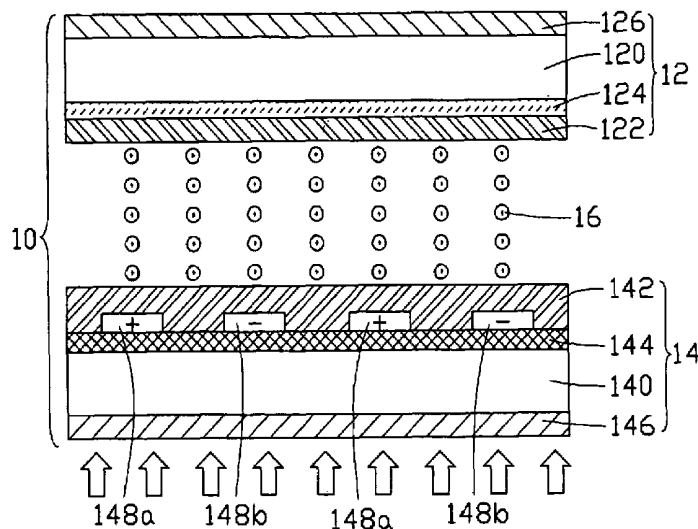
Assistant Examiner—David Y. Chung

(74) *Attorney, Agent, or Firm*—Wei Te Chung

(57) **ABSTRACT**

A liquid crystal display device (10) includes an upper substrate (12), a lower substrate (14) and a liquid crystal layer (16) interposed between the upper substrate and the lower substrate. A plurality of pixel regions, each pixel region comprising a pixel electrode and a common electrode (148a, 148b), for applying a voltage to the liquid crystal layer. Each pixel region includes a reflection region and a transmission region; and all the pixel and common electrodes are positioned at either the upper substrate or the lower substrate. The display working both in reflection mode and transmission mode has a wide view angle.

19 Claims, 9 Drawing Sheets



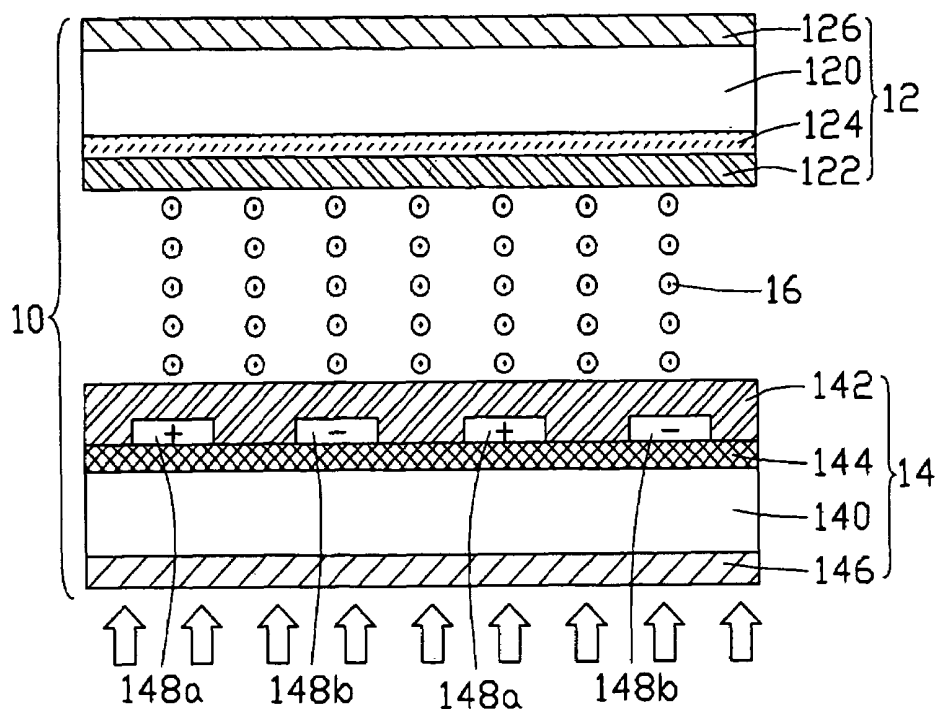


FIG. 1A

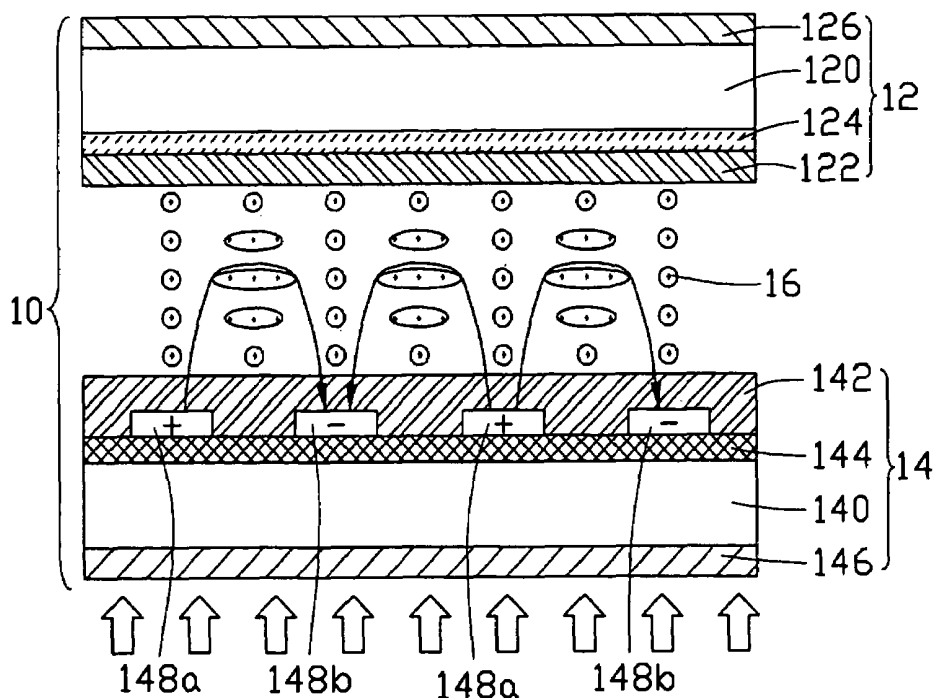


FIG. 1B

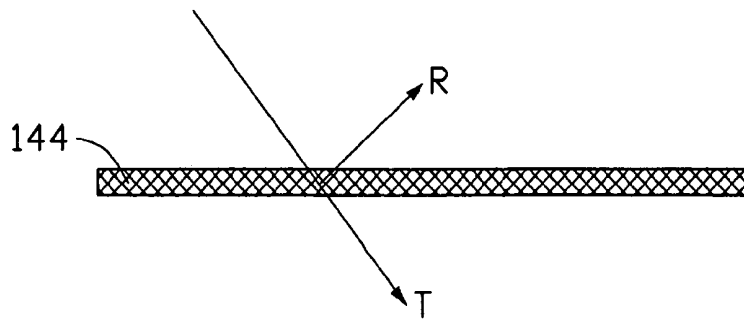


FIG. 1C

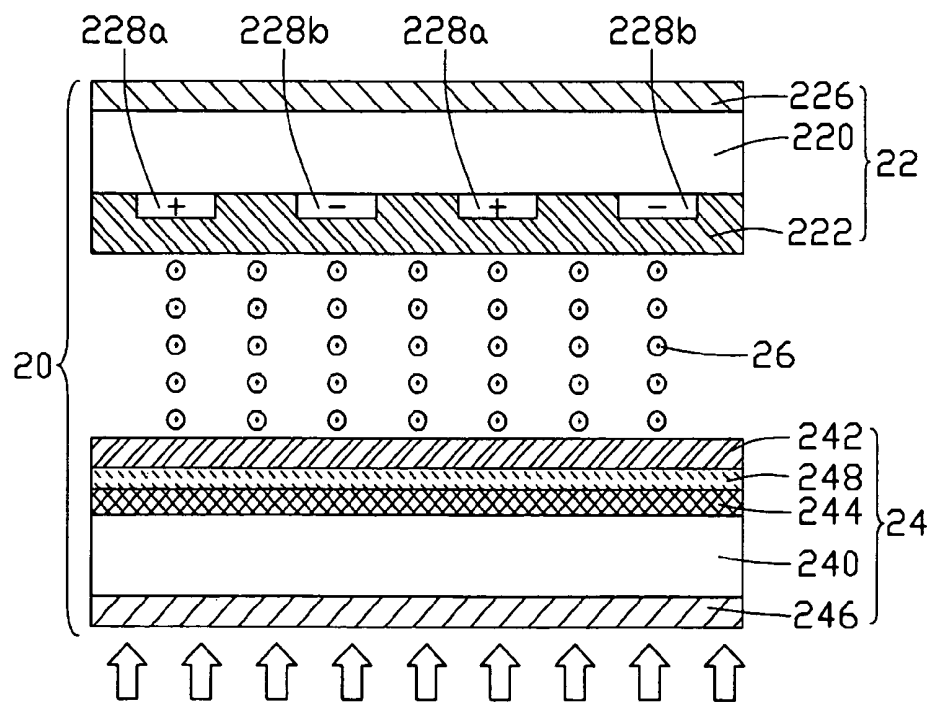


FIG. 2A

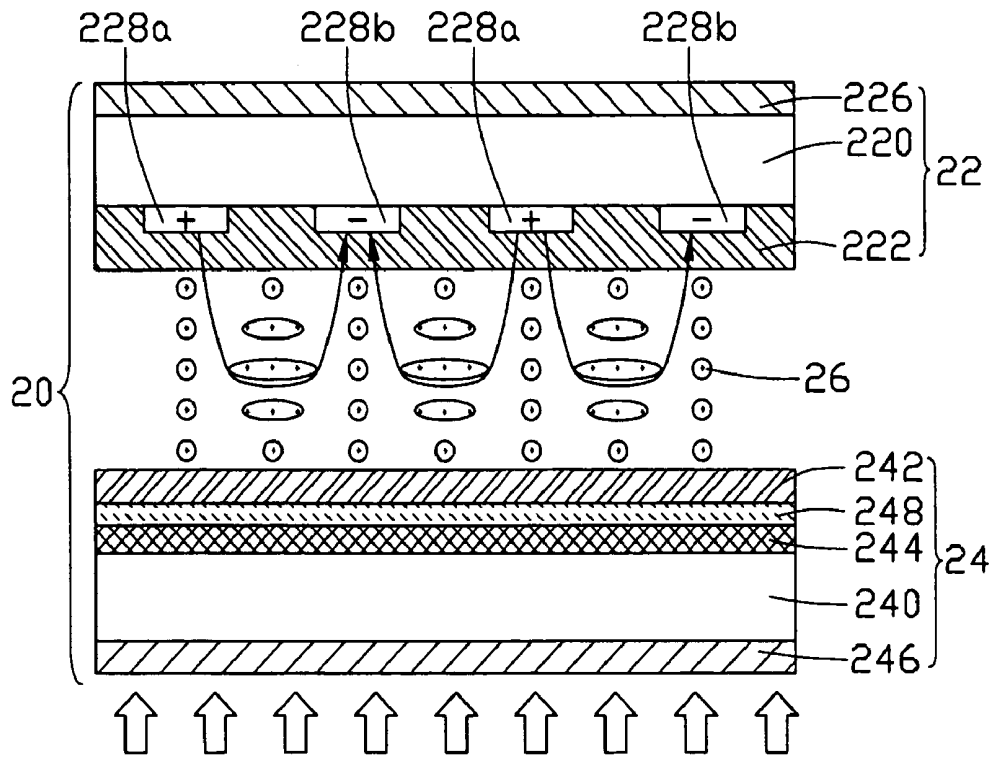


FIG. 2B

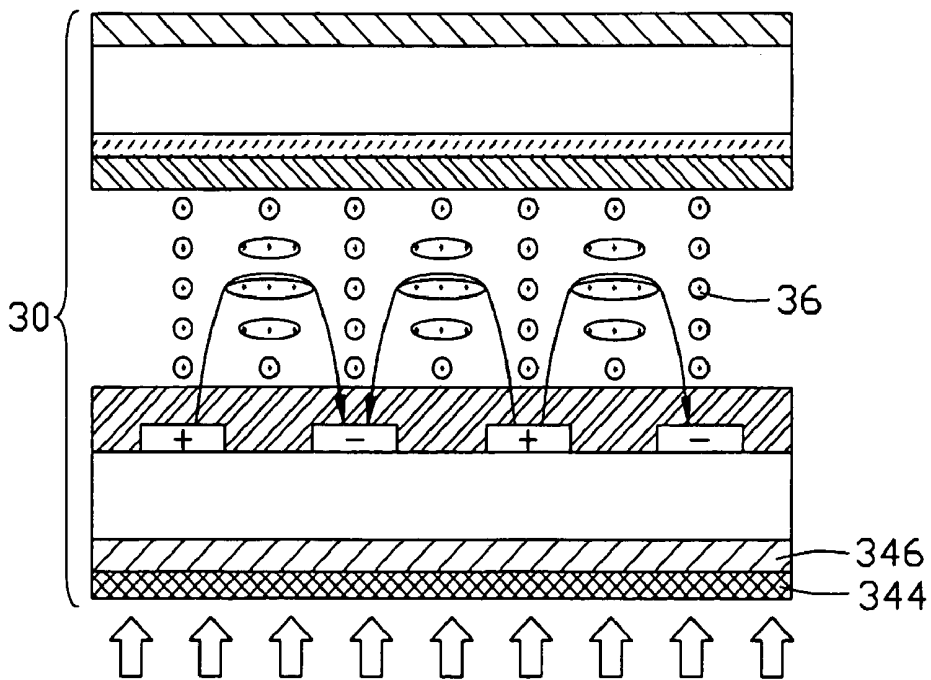


FIG. 3

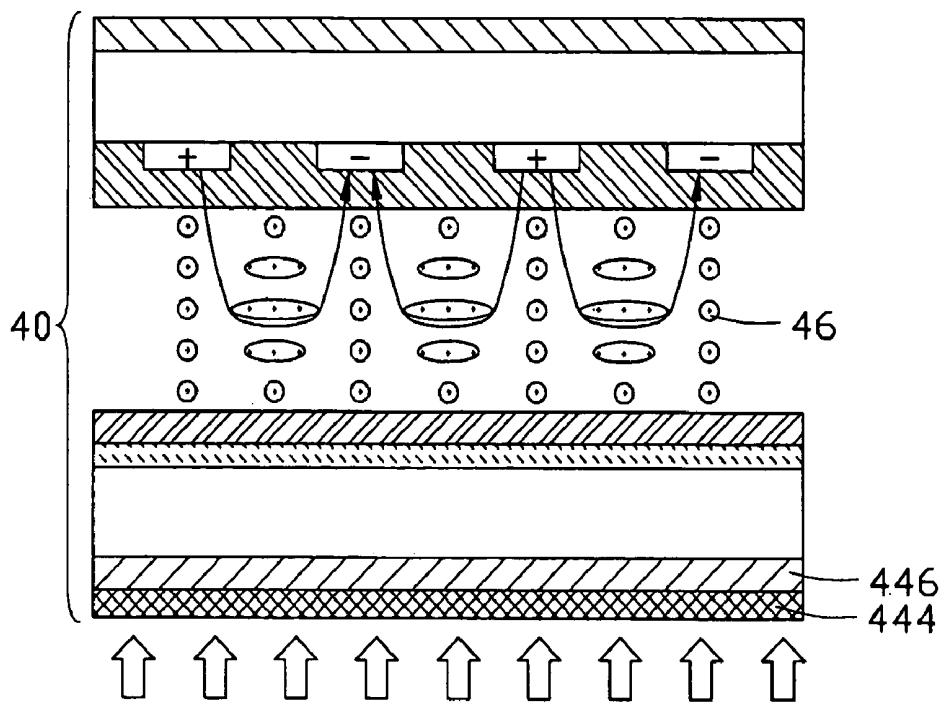


FIG. 4

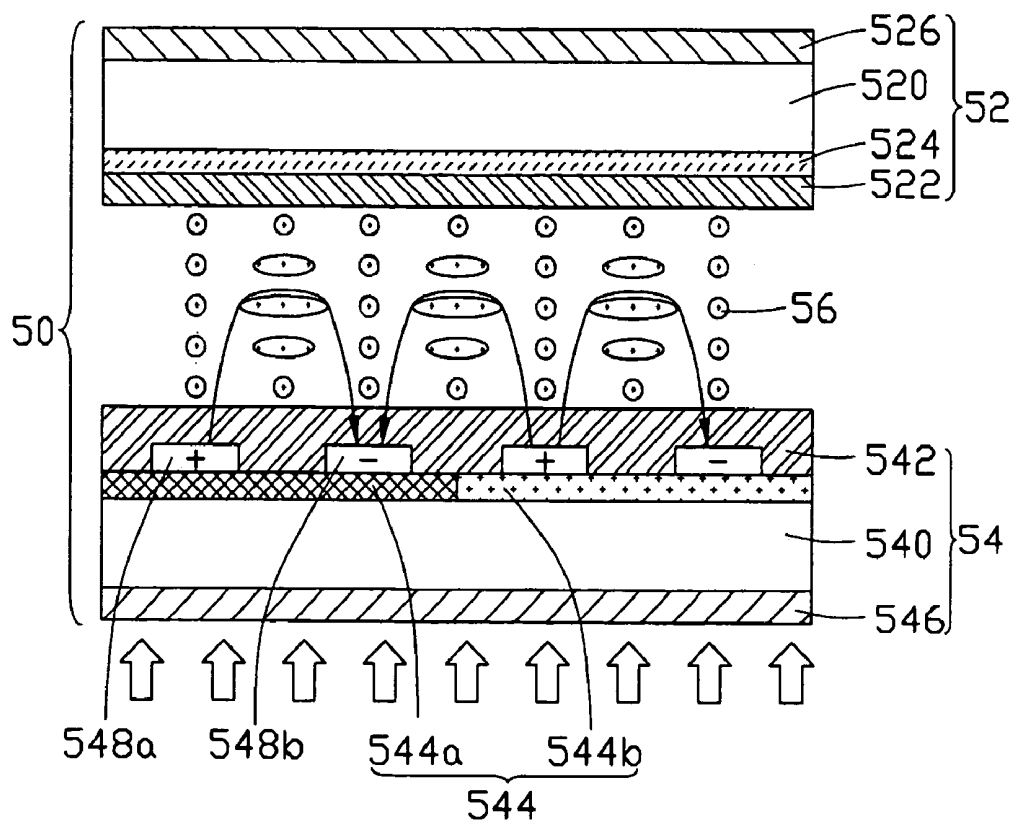


FIG. 5A

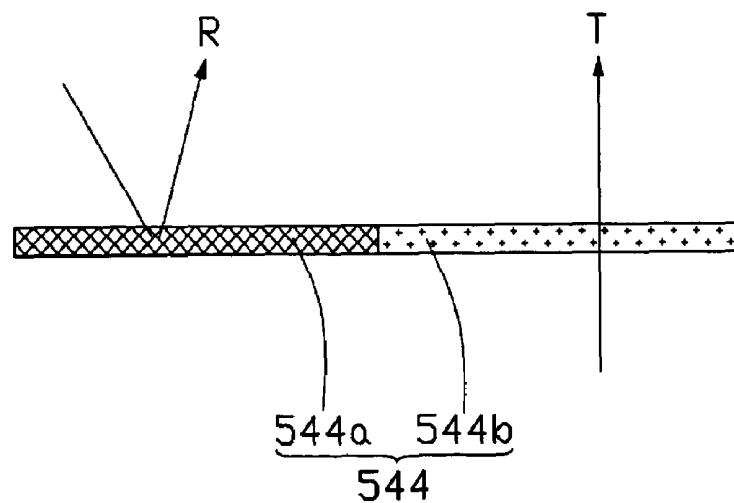


FIG. 5B

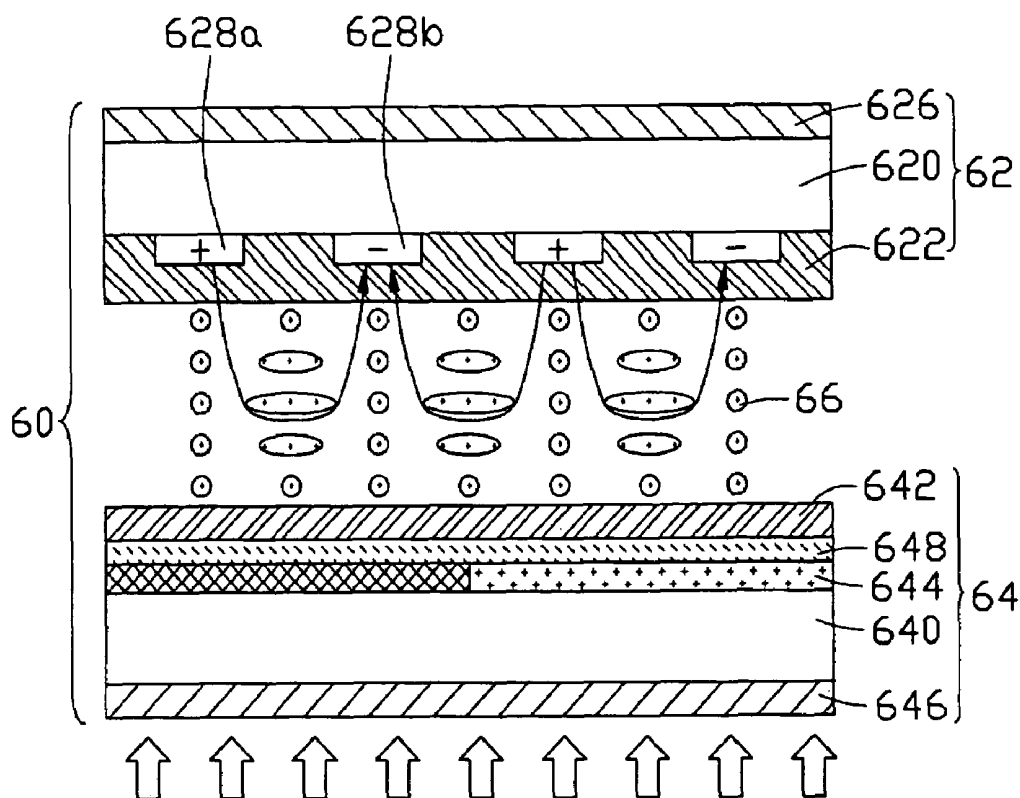


FIG. 6

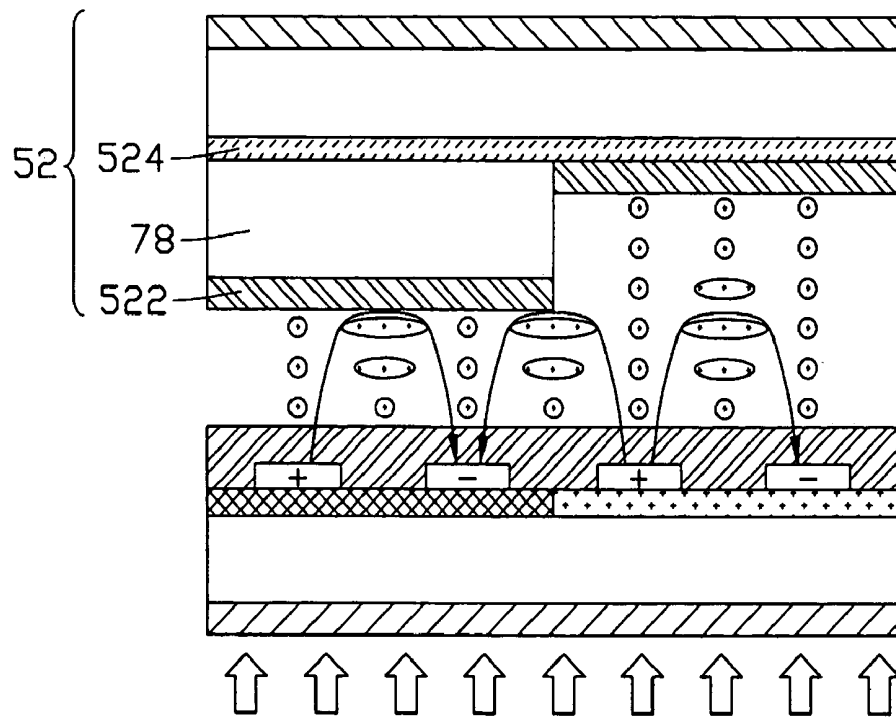


FIG. 7

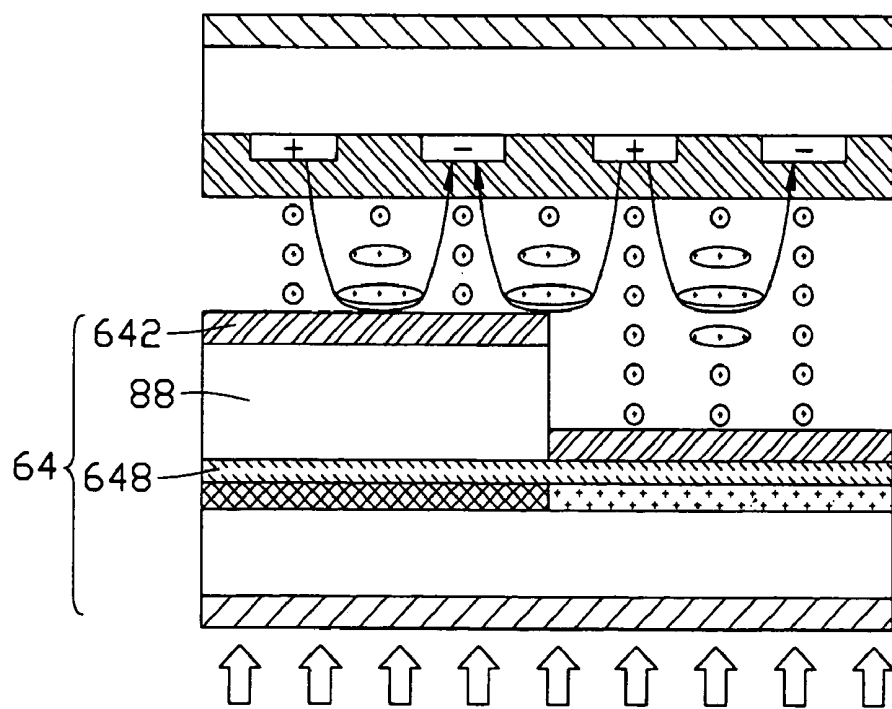


FIG. 8

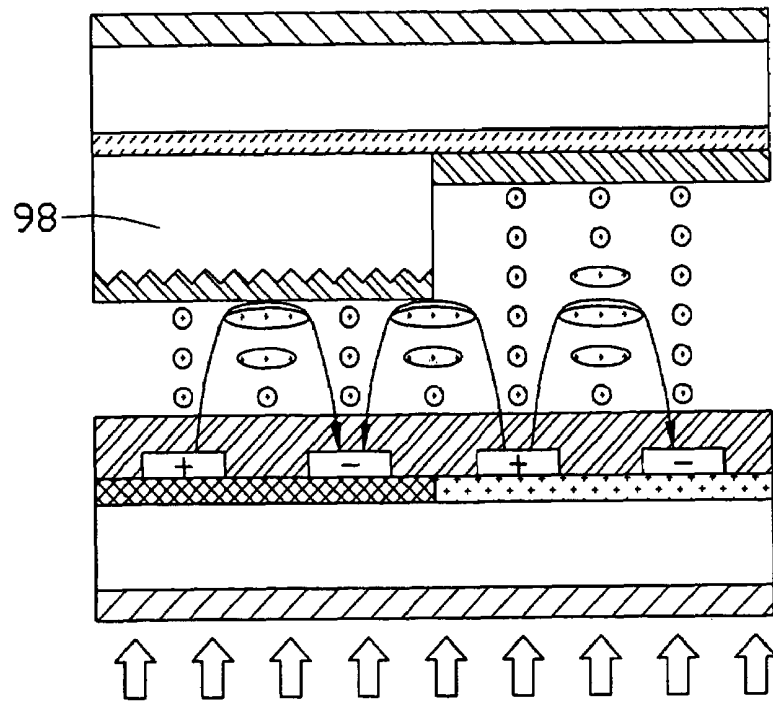


FIG. 9

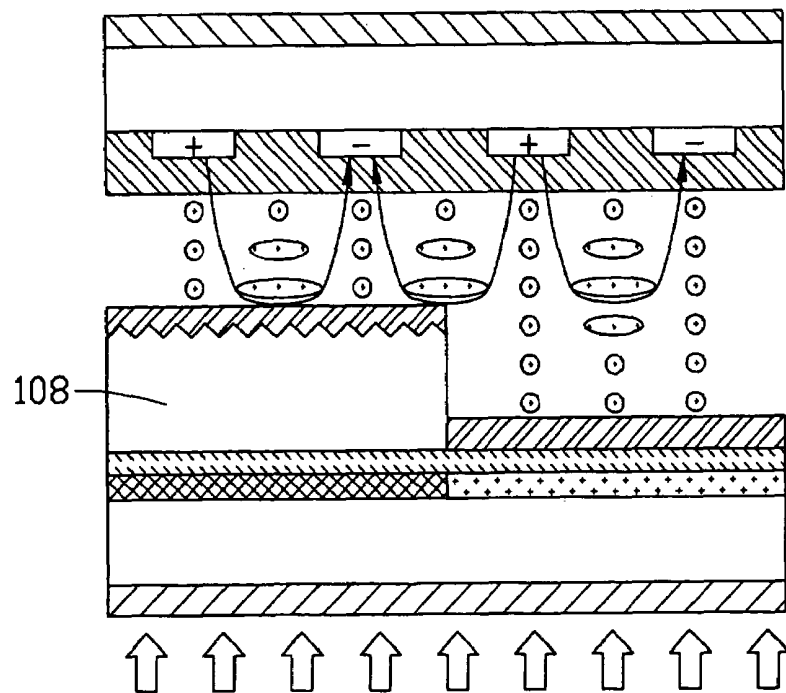


FIG. 10

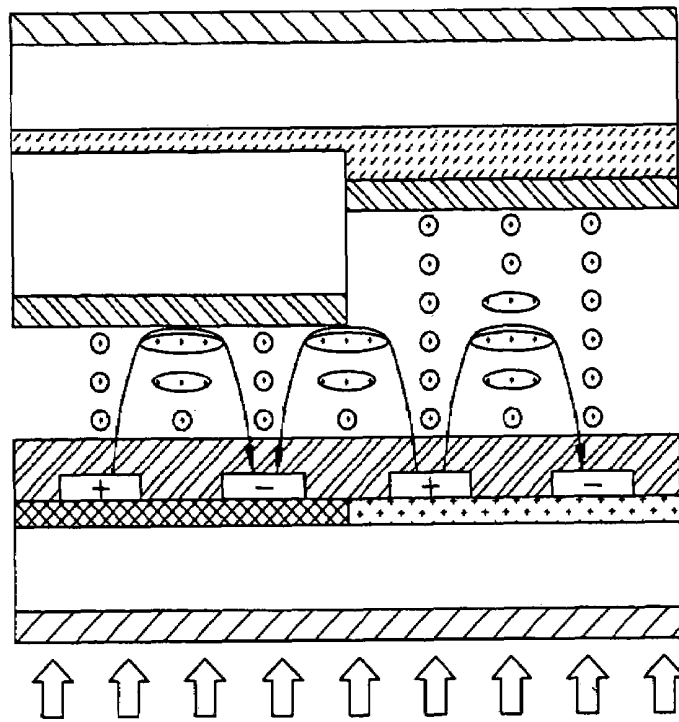


FIG. 11

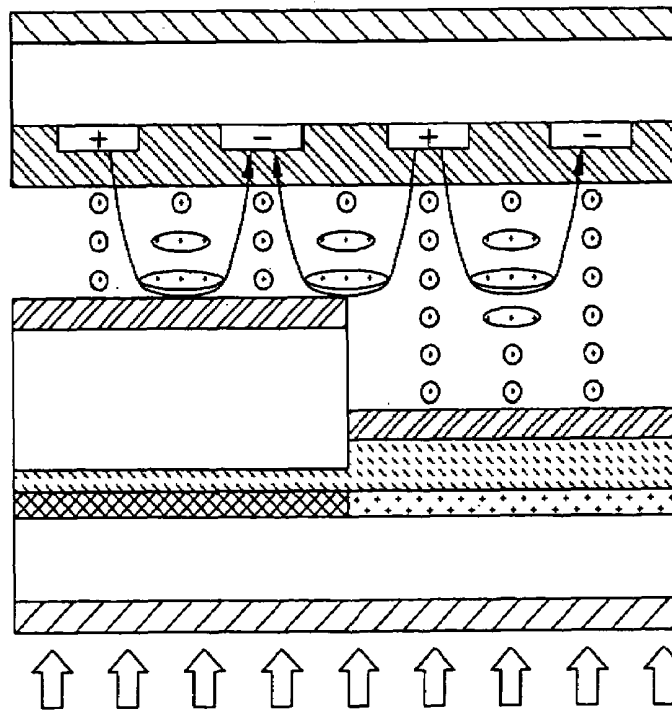


FIG. 12

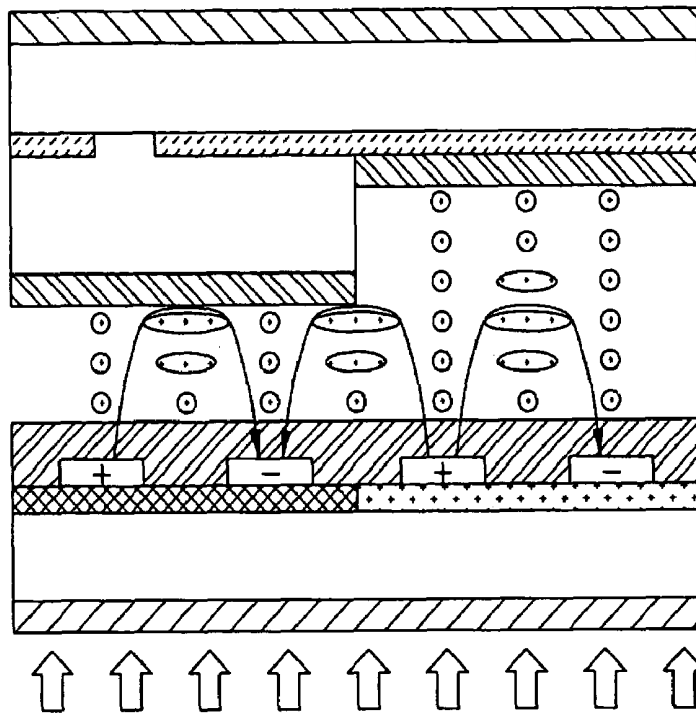


FIG. 13

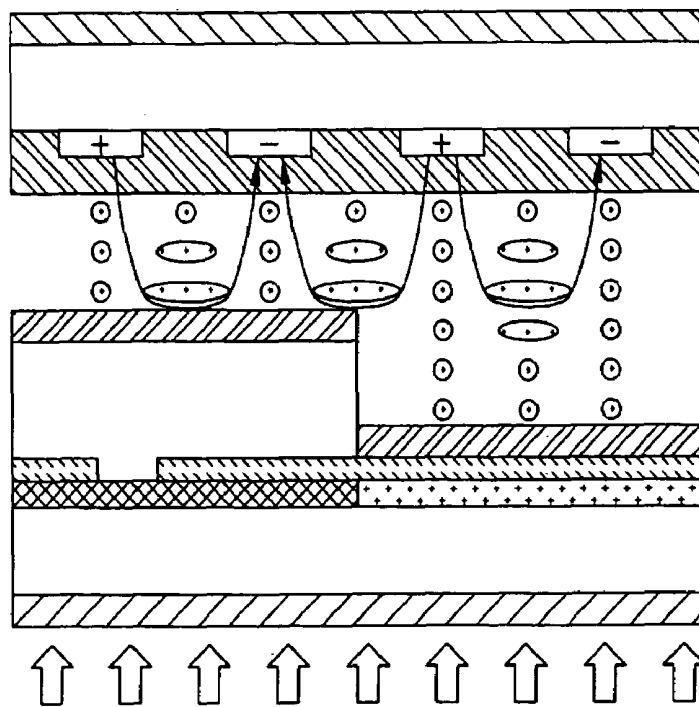


FIG. 14

IN-PLANE FIELD TYPE TRANSLLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

CROSS REFERENCE TO RELATED APPLICATION

This application is related to a co-pending application entitled "transflective mode liquid crystal display," and assigned to the same assignee as this application.

1. Field of the Invention

The present invention relates to a liquid crystal display. More particularly, the present invention relates to an in-plane field type liquid crystal display device having a transmission display region and a reflection display region in each pixel.

2. Description of the Prior Art

Due to the features of being thin and consuming little power, liquid crystal display devices have been used in a broad range of fields. Applications include office automation (OA) apparatuses such as word processors and personal computers, portable information apparatuses such as portable electronic schedulers, videocassette recorders (VCRs) provided with information panels, and mobile phones provided with liquid crystal monitors.

Unlike with a cathode ray tube (CRT) display or an electroluminescence (EL) display, the liquid crystal display screen of a liquid crystal display device does not emit light itself. Instead, in a conventional transmission type liquid crystal display device, an illuminator called a backlight is provided at a rear or one side of the liquid crystal display device. The amount of light received from the backlight which passes through the liquid crystal panel is controlled by the liquid crystal panel, in order to obtain images for display.

In the transmission type liquid crystal display device, the backlight consumes 50% or more of the total power consumed by the liquid crystal display device. That is, the backlight is a major contributor to power consumption.

In order to overcome the above problem, a reflection type liquid crystal display device has been developed for portable information apparatuses which are often used outdoors or in places where artificial ambient light is available. The reflection type liquid crystal display device is provided with a reflector formed on one of a pair of substrates, instead of having a backlight. Ambient light is reflected from a surface of the reflector to illuminate the display screen.

The reflection type liquid crystal display device using the reflection of ambient light is disadvantageous, insofar as the visibility of the display screen is extremely low when the surrounding environment is dark. Conversely, the transmission type liquid crystal display device is disadvantageous when the surrounding environment is bright. That is, the color reproduction is low and the display screen is not sufficiently clear because the display brightness is only slightly less than the brightness of the ambient light. In order to improve the display quality in a bright surrounding environment, the intensity of the light from the backlight needs to be increased. This increases the power consumption of the backlight and reduces the efficiency of the liquid crystal display device. Moreover, when the liquid crystal display device needs to be viewed at a position exposed to direct sunlight or direct artificial light, the display quality is generally lower. For example, when a display screen fixed in a car or a display screen of a personal computer receives direct sunlight or artificial light, surrounding images are

reflected from the display screen, making it difficult to observe the images of the display screen itself.

In order to overcome the above problems, an apparatus which realizes both a transmission mode display and a reflection mode display in a single liquid crystal display device has been developed. The apparatus is called as a transflective liquid crystal display, and has been disclosed in literature such as Japanese Laid-Open Publication No. 7-333598. The transflective liquid crystal display device uses a semi-transmissive reflection film which partly transmits light and partly reflects light. Typically, the transflective liquid crystal display includes an upper substrate, a lower substrate, a liquid crystal layer interposed between the substrates, and the semi-transmissive reflection film. A common electrode is positioned on the upper substrate, and a plurality of pixel electrodes are positioned on the lower substrate. However, the transflective liquid crystal display still has an inherent drawback that cannot be eliminated; namely, a very narrow viewing angle. By adding one or more compensation films on the transflective liquid crystal display, this problem can be ameliorated to some extent. However, the extra components increase costs proportionately.

It is desired to provide an in-plane field type transflective liquid crystal display which overcomes the above-described deficiencies.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a liquid crystal display device which has a wide view angle and which can work in both a reflection mode and a transmission mode.

Another object of the present invention is to provide a liquid crystal display device providing a bright, clear display under any ambient light conditions.

To achieve the above objects, a liquid crystal display device in accordance with the present invention comprises an upper substrate, a lower substrate and a liquid crystal layer interposed between the upper substrate and the lower substrate. A plurality of pixel regions, each pixel region comprising a pixel electrode and a common electrode, for applying a voltage to the liquid crystal layer. Each pixel region includes a reflection region and a transmission region; and all the pixel and common electrodes are positioned at either the upper substrate or the lower substrate.

In certain embodiments, the liquid crystal layer has different thicknesses in the reflection region and the transmission region of each pixel region. In further embodiments, the liquid crystal display device includes a color filter layer with different thicknesses in the reflection region and the transmission region of each pixel region. Alternatively, a part of the color filter layer in the reflection region of each pixel region has no color dye therein.

Other objects, advantages and novel features of the present invention will be apparent from the following detailed description of exemplary embodiments thereof with reference to the attached drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a schematic, cross-sectional view of one pixel region of an in-plane field type transflective liquid crystal display device ("the LCD") according to a first exemplary embodiment of the present invention, showing the LCD with no voltage applied, and backlight entering the LCD;

3

FIG. 1B is similar to FIG. 1A, but showing the LCD with a voltage applied and resulting electric fields;

FIG. 1C is an enlarged view of a dielectric translector of the LCD of FIGS. 1A and 1B, showing essential optical paths thereof;

FIG. 2A is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a second exemplary embodiment of the present invention, showing the LCD with no voltage applied, and backlight entering the LCD;

FIG. 2B is similar to FIG. 2A, but showing the LCD with a voltage applied and resulting electric fields;

FIG. 3 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a third exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 4 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a fourth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 5A is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a fifth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 5B is an enlarged view of a dielectric translector of the LCD of FIG. 5A, showing essential optical paths thereof;

FIG. 6 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a sixth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 7 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a seventh exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 8 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to an eighth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 9 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a ninth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 10 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a tenth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 11 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to an eleventh exem-

4

plary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 12 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a twelfth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD;

FIG. 13 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a thirteenth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD; and

FIG. 14 is a schematic, cross-sectional view of one pixel region of an in-plane field type transfective liquid crystal display device ("the LCD") according to a fourteenth exemplary embodiment of the present invention, showing the LCD with a voltage applied and resulting electric fields, and backlight entering the LCD.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Referring to FIGS. 1A and 1B, a liquid crystal display device 10 of Example 1 according to the present invention includes an upper substrate 12, a lower substrate 14, and a liquid crystal layer 16 interposed between the upper substrate 12 and the lower substrate 14. The upper substrate 12 comprises a color filter layer 124 and an upper polarizer 126 positioned respectively on opposite bottom and top surfaces of an upper glass plate 120. An upper alignment layer 122 is positioned on a bottom surface of the color filter layer 124 adjacent to the liquid crystal layer 16. The lower substrate 14 comprises a dielectric translector 144 and a lower polarizer 146 positioned respectively on opposite top and bottom surfaces of a lower glass plate 140. A pair of electrodes is defined herein as a pixel electrode 148a and a common electrode 148b. A plurality of pairs of electrodes are positioned on the dielectric translector 144 near the liquid crystal layer 16. A lower alignment layer 142 is positioned on the dielectric translector 144 adjacent to the liquid crystal layer 16, the lower alignment layer 142 covering the pixel electrodes 148a and common electrodes 148b.

The dielectric translector 144 is a multi-layer stacked arrangement of dielectric materials. That is, each stack comprises a number of thin film dielectric layers. Referring to FIG. 11C, an optical reflectivity R and a transmissibility T of the dielectric translector 144 can be controlled by configuring the thicknesses, the number and/or the refractive indexes of the layers thereof accordingly. That is, the duly configured dielectric translector 144 can transmit backlight and can reflect ambient light. Thus the liquid crystal display device 10 provides a transfective display that works in both a transmission mode and a reflection mode. Further, because the dielectric translector 144 does not conduct electricity, using the dielectric translector 144 does not influence the distribution of electric fields in the liquid crystal layer 16.

In operation, when no voltage is applied between the pixel and common electrodes 148a and 148b, long axes of liquid crystal molecules in the liquid crystal layer 16 maintain a predetermined angle relative to the upper alignment layer 122 and the lower alignment layer 142, and the liquid crystal molecules are stationed parallel to the upper and lower substrates 12 and 14.

When a voltage is applied (in the driven state), an electric field (not labeled) is generated between the pixel and common electrodes **148a**, **148b**. Because the pixel electrodes **148a** and the common electrodes **148b** are on the same layer, the electric field is substantially parallel to the upper and lower substrates **12**, **14**. The substantially parallel electric field drives the liquid crystal molecules of the liquid crystal layer **16** to rotate so they have a new orientation that is still parallel to the upper and lower substrates **12** and **14**. The change in orientation results in a change in light transmission, and the displayed image has the important advantage of a wide viewing angle.

Referring to FIGS. **2A** and **2B**, a liquid crystal display device **20** of Example 2 according to the present invention includes an upper substrate **22**, a lower substrate **24**, and a liquid crystal layer **26** interposed between the upper substrate **22** and the lower substrate **24**. The upper substrate **22** comprises an upper alignment layer **222** and an upper polarizer **226** positioned respectively on opposite bottom and top surfaces of an upper glass plate **220**. A pair of electrodes is defined herein as a pixel electrode **228a** and a common electrode **228b**. A plurality of pairs of electrodes are positioned on a bottom surface of the upper glass plate **220**, the pairs of electrodes being covered by the upper alignment layer **222**. The lower substrate **24** comprises a dielectric translector **244** and a lower polarizer **246** positioned respectively on opposite top and bottom surfaces of a lower glass plate **240**. A color filter layer **248** and a lower alignment layer **242** are stacked in that order from bottom to top on a top surface of the dielectric translector **244**, with the lower alignment layer **242** being adjacent to the liquid crystal layer **26**. The dielectric translector **244** has substantially the same structure as that of the dielectric translector **144** of Example 1.

Referring to FIG. **3**, a liquid crystal display device **30** of Example 3 according to the present invention is structured similar to the liquid crystal display device **10** of Example 1. The difference is that a dielectric translector **344** of Example 3 is positioned far away from a liquid crystal layer **36**, on a bottom surface of a lower polarizer **346**.

Referring to FIG. **4**, a liquid crystal display device **40** of Example 4 according to the present invention is structured similar to the liquid crystal display device **20** of Example 2. The difference is that a dielectric translector **444** of Example 4 is positioned far away from a liquid crystal layer **46**, on a bottom surface of a lower polarizer **446**.

Referring to FIG. **5A**, a liquid crystal display device **50** of Example 5 according to the present invention includes an upper substrate **52**, a lower substrate **54**, and a liquid crystal layer **56** interposed between the upper substrate **52** and the lower substrate **54**. The upper substrate **52** comprises a color filter layer **524** and an upper polarizer **526** positioned respectively on opposite bottom and top surfaces of an upper glass plate **520**. An upper alignment layer **522** is positioned on a bottom surface of the color filter layer **524**, adjacent to the liquid crystal layer **56**. The lower substrate **54** comprises a dielectric translector **544** and a lower polarizer **546** positioned respectively on opposite top and bottom surfaces of a lower glass plate **540**. A pair of electrodes is defined herein as a pixel electrode **548a** and a common electrode **548b**. A plurality of pairs of electrodes are positioned on the dielectric translector **544** adjacent to the liquid crystal layer **56**. A lower alignment layer **542** is positioned on the dielectric translector **544**, adjacent to the liquid crystal layer **56**. The lower alignment layer **542** covers the pixel electrodes **548a** and common electrodes **548b**.

Referring also to FIG. **5B**, the dielectric translector **544** includes a plurality of reflective areas **544a** and a plurality of transmission areas **544b** arranged alternately in a regular, repeating array. The reflective areas **544a** and transmission areas **544b** can comprise multi-layer stacks of dielectric materials, with each stack comprising a number of thin film dielectric layers. The reflection and transmission of the dielectric translector **544** can be controlled by adjusting the number of layers, the refractive indexes of the layers and/or the thicknesses of the layers in the stacks. Alternatively, the reflective areas **544a** can be made of a highly reflective material such as aluminum, and the transmission areas **544b** can be made of a translucent material or a material having one or more holes therein. A single reflective area **544a** and an adjacent single transmission area **544b** cooperatively define a single pixel region or part of a single pixel region. In the illustrated embodiment, for simplicity, it is assumed that a single reflective area **544a** and an adjacent single transmission area **544b** cooperatively define a single pixel region. Each pixel region thus comprises a transmission region and a reflection region. Accordingly, a plurality of pixel regions are defined by respective pairs of reflective areas **544a** and the transmission areas **544b**. In manufacturing, a ratio of areas of the reflective area **544a** and the transmission area **544b** is configured so that the dielectric translector **544** can transmit backlight and can reflect ambient light. Thus the liquid crystal display device **10** of Example 5 provides a transmissive display that works in both a transmission mode and a reflection mode. Further, because the dielectric translector **544** does not conduct electricity, using the dielectric translector **544** does not influence the distribution of electric fields in the liquid crystal layer **56**.

In operation, when no voltage is applied between the pixel and common electrodes **548a** and **548b**, long axes of liquid crystal molecules in the liquid crystal layer **56** maintain a predetermined angle relative to the upper alignment layer **522** and the lower alignment layer **542**, and the liquid crystal molecules are stationed parallel to the upper and lower substrates **52** and **54**.

When a voltage is applied (in the driven state), an electric field (not labeled) is generated between the pixel and common electrodes **548a**, **548b**. Because the pixel electrodes **548a** and the common electrodes **548b** are on the same layer, the electric field is substantially parallel to the upper and lower substrates **52**, **54**. The substantially parallel electric field drives liquid crystal molecules of the liquid crystal layer **56** to rotate so they have a new orientation that is still parallel to the upper and lower substrates **52** and **54**. The change in orientation results in a change in light transmission, and the displayed image has the important advantage of a wide viewing angle.

Referring to FIG. **6**, a liquid crystal display device **60** of Example 6 according to the present invention includes an upper substrate **62**, a lower substrate **64**, and a liquid crystal layer **66** interposed between the upper substrate **62** and the lower substrate **64**. The upper substrate **62** comprises an upper alignment layer **622** and an upper polarizer **626** positioned respectively on opposite bottom and top surfaces of an upper glass plate **620**. A pair of electrodes is defined herein as a pixel electrode **628a** and a common electrode **628b**. A plurality of pairs of electrodes are positioned on a bottom surface of the upper glass substrate **620**, with the upper alignment layer **622** covering the pairs of electrodes. The lower substrate **64** comprises a dielectric translector **644** and a lower polarizer **646** positioned respectively on opposite top and bottom surfaces of a lower glass plate **640**.

A color filter layer **648** and a lower alignment layer **642** are stacked in that order from bottom to top on a top surface of the dielectric translector **644**, with the lower alignment layer **642** being adjacent to the liquid crystal layer **66**. The dielectric translector **644** has substantially the same structure as that of the dielectric translector **544** of Example 5.

In Examples 5 and 6, in each pixel region, a length of an optical path of light in the reflective area is substantially twice that in the transmission area. This can result in poor chromatic qualities, poor brightness, low contrast ratio, etc. in the displayed image. For balanced optical paths of light in the transmission region and the reflection region and a resultant improved displayed image, in Examples 7 through 14, a thickness of the liquid crystal layer dt in each transmission region is structured to be twice a thickness of the liquid crystal layer dr in each reflection region. That is, the liquid crystal layer is structured so that $dt=2dr$. With such structuring, the lengths of optical paths of light beams contributing to the displayed image (i.e., reflected light beams in the reflection region, and transmitted light beams in the transmission region) are substantially equal to each other. Although $dt=2dr$ is preferable, dt and dr may be appropriately varied according to particular display characteristics, as long as $dt>dr$. Typically, dt is about 4 to 6 millimeters, and dr is about 2 to 3 millimeters. Accordingly, a kind of transmissive spacer having a thickness of about 2 to 3 millimeters is provided in each pixel region at either the upper substrate or the lower substrate.

Referring to FIG. 7, in Example 7, a passivation layer **78** is added to the upper substrate **52** of the liquid crystal display device of Example 5. The passivation layer **78** is located between the color filter layer **524** and the upper alignment layer **522**, in the reflection region. Referring to FIG. 8, in Example 8, a passivation layer **88** is added to the lower substrate **64** of the liquid crystal display device of Example 6. The passivation layer **88** is located between the color filter layer **648** and the lower alignment layer **642**, in the reflection region.

Referring to FIGS. 9 and 10, Examples 9 and 10 respectively shown therein are variations of Examples 7 and 8 respectively. In Examples 9 and 10, surfaces of passivation layers **98** and **108** are made uneven by etching or a like process. Typically, the surfaces define concave and convex shapes. An average thickness of the passivation layers **98** and **108** is dr . The uneven surfaces of the passivation layers **98** and **108** are advantageous over the flat surfaces of the passivation layers **78** and **88** of Examples 7 and 8. This is because the uneven surfaces receive direct and reflected ambient light at various incident angles, and thus diffuse the direct and reflected ambient light. This gives the displayed image of the liquid crystal display device more uniform and higher brightness.

In Examples 5 through 10, in each pixel region, a length of an optical light path in the color filter in the reflection region is twice a length of an optical light path in the color filter in the transmission region. This can result in uneven and poor color purity in the displayed image. For balanced color purity in the transmission region and the reflection region and a resultant improved displayed image, Examples 11 through 14 provide variations of Examples 5 and 6.

Referring to FIGS. 11 and 12, in each of Examples 11 and 12 respectively shown therein, a thickness of the color filter ft in the transmission region is structured to be twice a thickness of the color filter fr in the reflection region. That is, the liquid crystal layer is structured so that $ft=2fr$. With such structuring, the lengths of optical paths of light beams contributing to the displayed image (i.e., reflected colored

light beams in the reflection region, and transmitted colored light beams in the transmission region) are substantially equal to each other. Referring to FIGS. 13 and 14, in each of Examples 13 and 14 respectively shown therein, the color filter in the reflection region is structured to have at least one part with no color dye therein. For example, the reflection region has at least one hole therein. With such structuring, reflected colored light beams in the reflection region and transmitted colored light beams in the transmission region have substantially equal color purity.

All the liquid crystal display devices of Examples 1 through 14 having the above-described structures effectively utilize light. In particular, the light emitted from a backlight and passing through the transmission regions when ambient light is low, and the ambient light reflected at the reflection regions when the ambient light is high. In other words, both the transmission regions and the reflection regions can be utilized to generate a display image. Moreover, each liquid crystal display device provides an even, bright display and a wide viewing angle.

It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set out in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

The invention claimed is:

1. A liquid crystal display device comprising:

an upper substrate;

a lower substrate comprising a dielectric translector;

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

a plurality of pixel regions, each pixel region comprising a pixel electrode and a common electrode, for applying a voltage to the liquid crystal layer;

wherein each pixel region includes a reflection region and a transmission region; and

all the pixel and common electrodes are positioned at the upper substrate.

2. The liquid crystal display device as claimed in claim 1, wherein the dielectric translector, comprises one or more stacks of dielectric materials, each stack comprising a plurality of thin film dielectric layers.

3. The liquid crystal display device as claimed in claim 1, wherein the dielectric translector, the dielectric translector in each pixel region have a reflection area corresponding to the reflection region and a transmission area corresponding to the transmission region.

4. The liquid crystal display device as claimed in claim 3, wherein the upper substrate further comprises passivation layers positioned in the reflection regions between the color filter and the alignment film.

5. The liquid crystal display device as claimed in claim 4, wherein each of the passivation layers has an uneven surface nearest to the liquid crystal layer.

6. The liquid crystal display device as claimed in claim 5, wherein a thickness of the color filter in the reflection region of each pixel region is less than a thickness of the color filter in the transmission region of the pixel region.

7. The liquid crystal display device as claimed in claim 5, wherein a part of the color filter in the reflection region of each pixel region has at least one hole therein.

8. The liquid crystal display device as claimed in claim 3, wherein the reflection area of the dielectric translector is

9

made of one or more highly reflective materials, and the transmission area of the dielectric translector is made of one or more translucent materials or a material having one or more holes therein.

9. The liquid crystal display device as claimed in claim 1, wherein the tower substrate comprises in turn the dielectric translector, a polarizer, a glass plate, and an alignment film.

10. The liquid crystal display device as claimed in claim 1, wherein the upper substrate comprises in turn a polarizer, a glass plate, the common and pixel electrodes, and an alignment film, and the lower substrate comprises in turn a polarizer, a glass plate, the dielectric translector, a color filter, and an alignment film.

11. A liquid crystal display device comprising:

an upper substrate;

a lower substrate comprising a dielectric translector;

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

a plurality of pixel regions, each pixel region comprising a pixel electrode and a common electrode, for applying a voltage to the liquid crystal layer, wherein each pixel region includes a reflection region and a transmission region; and

a color filter positioned at either the upper substrate or the lower substrate, and having different thicknesses in the reflection region and the transmission region of each pixel region;

wherein all the pixel and common electrodes are positioned at the upper substrate.

12. The liquid crystal display device as claimed in claim 11, wherein the dielectric translector, comprises one or more stacks of dielectric materials, each stack comprising a plurality of thin film dielectric layers.

13. The liquid crystal display device as claimed in claim 11, wherein the dielectric translector, the dielectric translector in each pixel region have a reflection area corresponding to the reflection region and a transmission area corresponding to the transmission region.

10

14. The liquid crystal display device as claimed in claim 13, wherein a thickness of the color filter in the transmission region of each pixel region is substantially twice a thickness of the color filter in the reflection region of the pixel region.

15. A liquid crystal display device comprising:

an upper substrate;

a lower substrate comprising a dielectric translector;

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

a plurality of pixel regions, each pixel region comprising a pixel electrode and a common electrode, for applying a voltage to the liquid crystal layer, wherein each pixel region includes a reflection region and a transmission region; and

a color filter positioned at either the upper substrate or the lower substrate, the color filter in each pixel region having a part in the reflection region with no color dye therein;

wherein all the pixel and common electrodes are positioned at the upper substrate.

16. The liquid crystal display device as claimed in claim 15, wherein the dielectric translector, comprises one or more stacks of dielectric materials, each stack comprising a plurality of thin film dielectric layers.

17. The liquid crystal display device as claimed in claim 15, wherein the dielectric translector, the dielectric translector in each pixel region have a reflection area corresponding to the reflection region and a transmission area corresponding to the transmission region.

18. The liquid crystal display device as claimed in claim 15, wherein a thickness of the color filter in the transmission region of each pixel region is substantially twice a thickness of the color filter in the reflection region of the pixel region.

19. The liquid crystal display device as claimed in claim 18, wherein a part of the color filter in the reflection region of each pixel region has at least one hole therein.

* * * * *

专利名称(译)	面内场型半透半反液晶显示装置		
公开(公告)号	US7321408	公开(公告)日	2008-01-22
申请号	US11/028031	申请日	2004-12-31
[标]申请(专利权)人(译)	群创光电股份有限公司		
申请(专利权)人(译)	群创光电股份有限公司.		
当前申请(专利权)人(译)	群创光电		
[标]发明人	YANG CHIU LIEN		
发明人	YANG, CHIU-LIEN		
IPC分类号	G02F1/1335 G02F1/1343		
CPC分类号	G02F1/134363 G02F1/133555		
审查员(译)	内尔姆斯, DAVID		
助理审查员(译)	CHUNG, DAVID Y.		
优先权	093105064 2004-02-27 TW		
其他公开文献	US20050190324A1		
外部链接	Espacenet USPTO		

摘要(译)

液晶显示装置 (10) 包括上基板 (12), 下基板 (14) 和介于上基板和下基板之间的液晶层 (16) 。多个像素区域, 每个像素区域包括像素电极和公共电极 (148a, 148b), 用于向液晶层施加电压。每个像素区域包括反射区域和透射区域;并且所有像素电极和公共电极都位于上基板或下基板上。在反射模式和透射模式下工作的显示器具有宽视角。

