US 20050128390A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2005/0128390 A1

Yang (43) Pub. Date: Jun. 16, 2005

(54) TRANSFLECTIVE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

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

Correspondence Address:
WEI TE CHUNG
FOXCONN INTERNATIONAL, INC.
1650 MEMOREX DRIVE
SANTA CLARA, CA 95050 (US)

(73) Assignee: **INNOLUX DISPLAY CORP.**

(21) Appl. No.: **10/997,704**

(22) Filed: **Nov. 24, 2004**

(30) **Foreign Application Priority Data**

Dec. 12, 2003 (CN) 200310112580.5

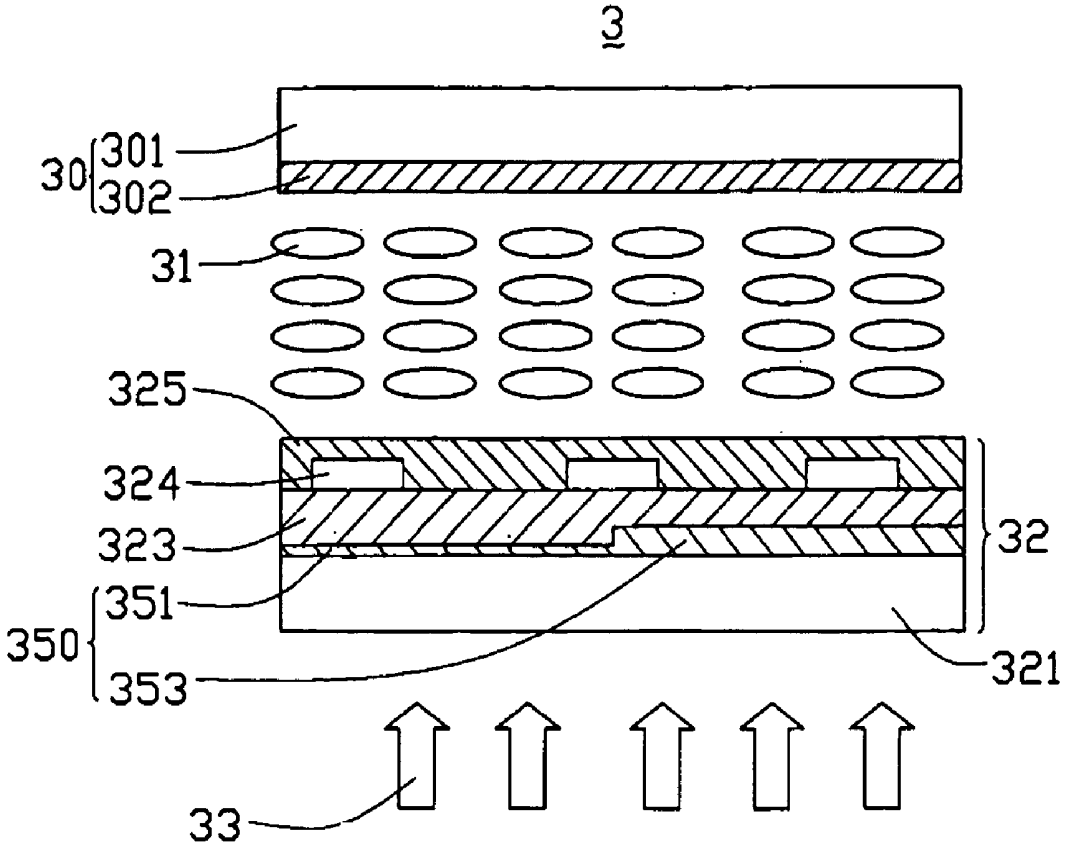
Publication Classification

(51) **Int. Cl.**[7] **G02F 1/1347**; G02F 1/1343

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

(57) **ABSTRACT**

A liquid crystal display (**3**) includes: a first substrate (**30**); a second substrate (**32**); a liquid crystal layer (**31**) interposed between the substrates; and a plurality of pixel regions each defined by respective pixel electrodes (**324**) and a common electrode (**350**), for application of a voltage to the liquid crystal layer and formation of a fringe electric field at each pixel region. Each pixel region includes a transmissive region and a reflective region. The liquid crystal display can effectively use light beams from the outside environment and from a backlight module. Therefore the liquid crystal display can be used not only in bright conditions, but also in dark conditions.



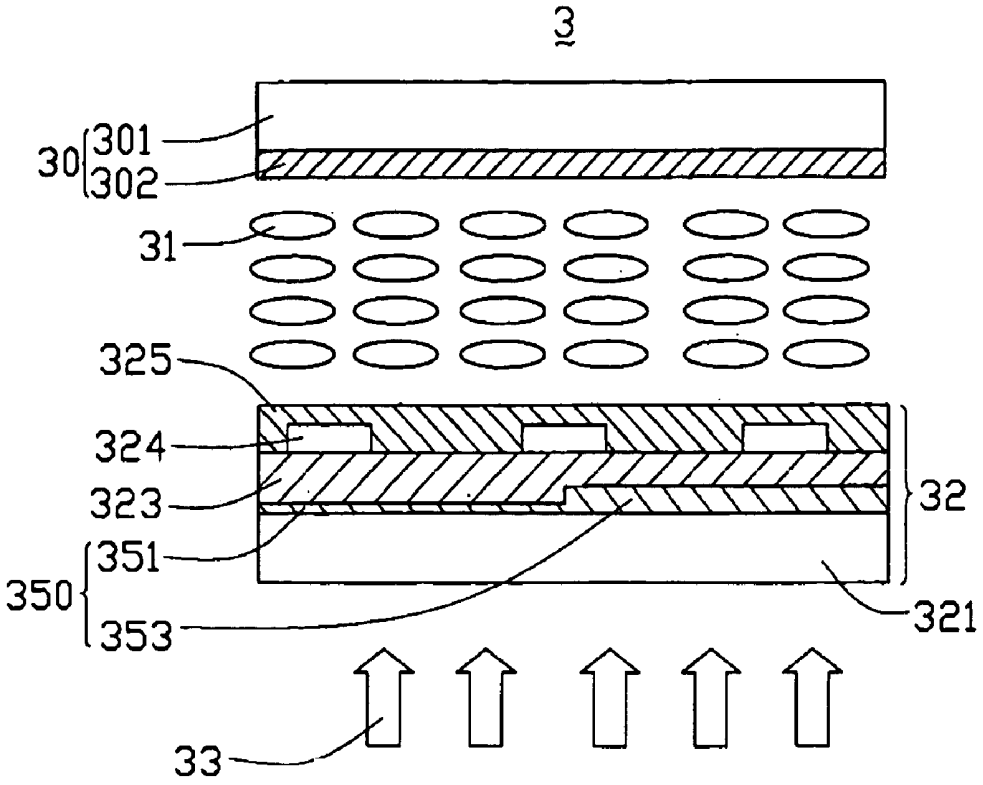


FIG. 1

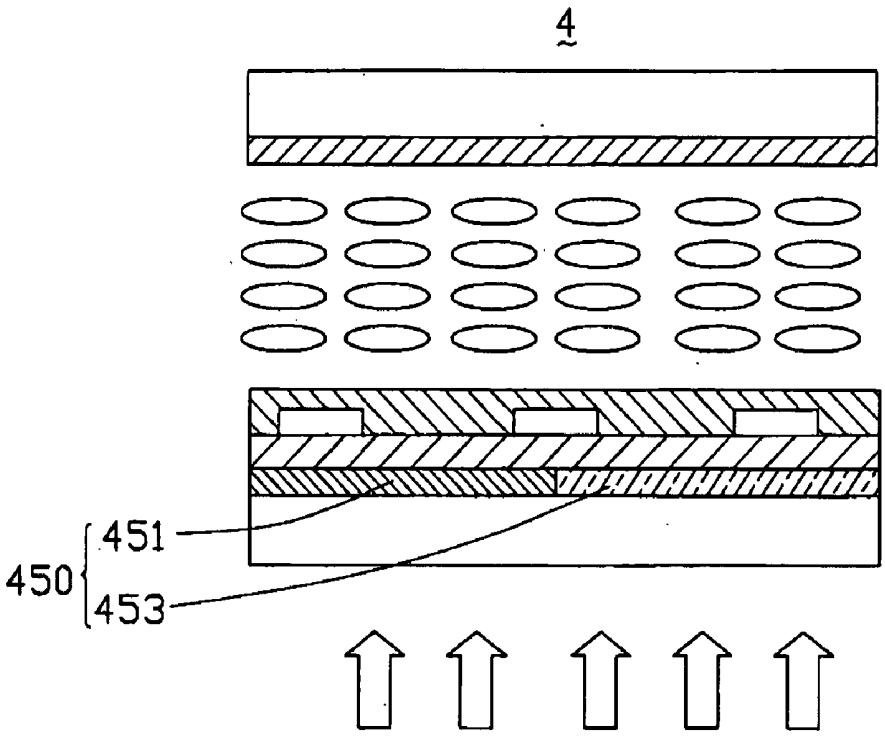


FIG. 2

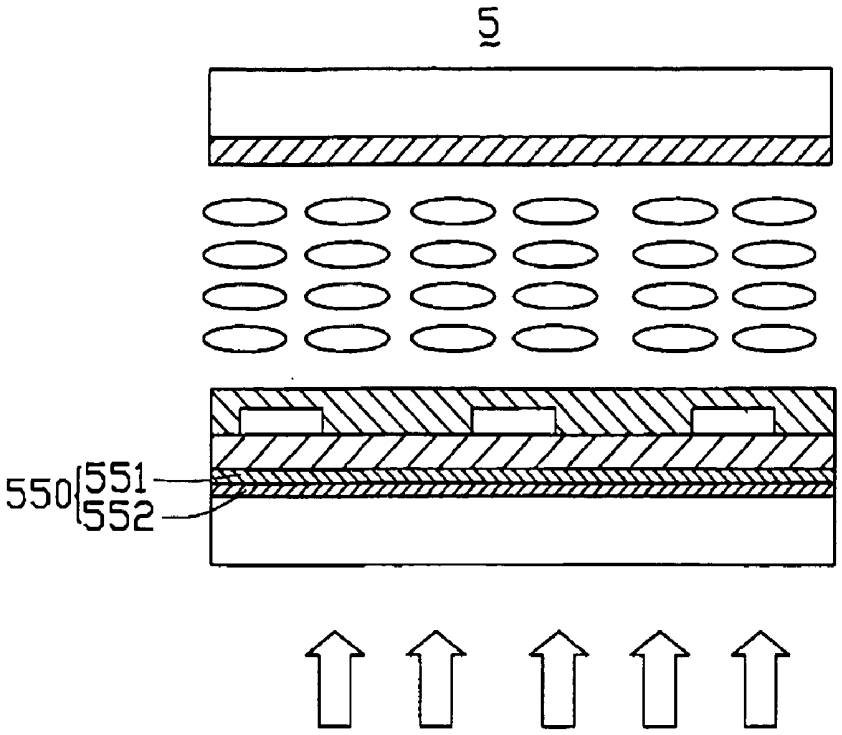


FIG. 3

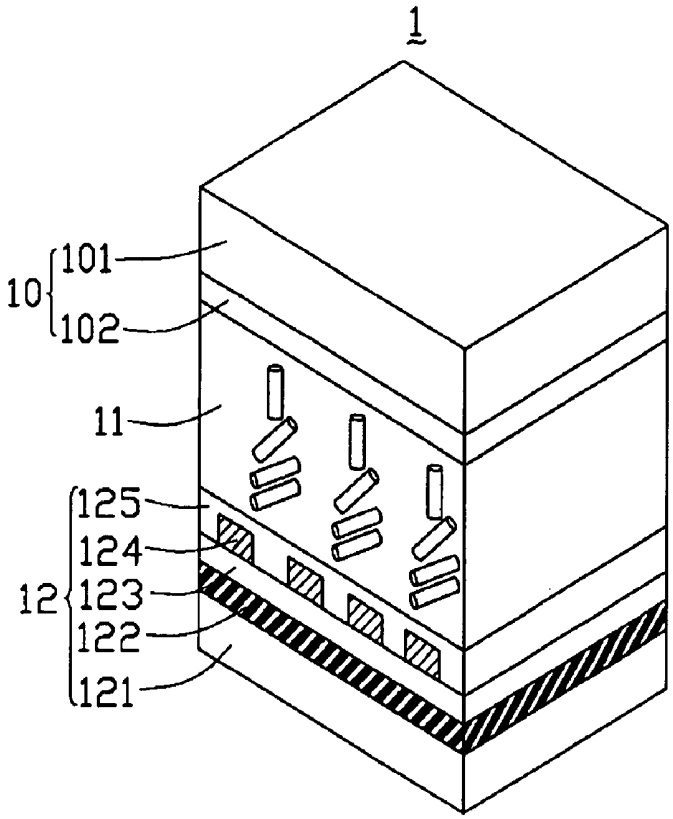


FIG. 4
(PRIOR ART)

TRANSFLECTIVE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to liquid crystal displays, and especially to a transflective fringe field switching liquid crystal display (FFS LCD).

[0003] 2. Description of the Prior Art

[0004] Recently, liquid crystal displays have become widely used in computer and communication products such as notebooks, cell phones and personal digital assistants. This is largely due to the thinness, lightness, and low power consumption of liquid crystal displays. Usually a liquid crystal display needs a planar light source, such as a backlight module, to display images. The backlight module is the main power consuming component of the liquid crystal display. In order to reduce power consumption, reflective type liquid crystal displays have been developed. A reflective liquid crystal display uses natural light beams to provide a planar light source. However, conventional reflective liquid crystal displays have some limitations; for example, a long response time and a narrow view angle.

[0005] To resolve the above-mentioned problems, a reflective fringe field switching liquid crystal display (FFS LCD) is described in U.S. Pat. No. 6,583,842 issued on Jun. 24, 2003. As represented in **FIG. 4**, the FFS LCD **1** includes a first substrate **10**, a second substrate **12**, and a liquid crystal layer **11** interposed between the substrates **10**, **12**.

[0006] The first substrate **10** comprises a first glass sheet **101** and a first alignment film **102**. The first alignment film **102** is adhered on one surface (not labeled) of the first glass sheet **101**, the surface facing the liquid crystal layer **11**.

[0007] The second substrate **12** comprises a second glass sheet **121**, a common electrode **122**, an insulating layer **123**, a plurality of pixel electrodes **124**, and a second alignment film **125**. The second glass sheet **121**, the common electrode **122**, and the insulating layer **123** are stacked from bottom to top in the order. The pixel electrodes **124** are formed on the insulating layer **123**, and are spaced apart from and parallel to each other. The common electrode **122** is uniformly formed on the second glass sheet **121**, and is made of a high reflectivity metal such as aluminum. Therefore, the common electrode **122** functions as both an electrically conductive electrode and a reflector.

[0008] The reflective FFS LCD **1** can efficiently use natural light beams, due to the reflection of the common electrode **122**. Thus power consumption is reduced. Also, the common electrode **122** and the pixel electrodes **124** are both formed on the second substrate **12**, which provides a dense fringe electric field parallel to the second substrate **12**. The fringe electric field yields a fast response time and a wide view angle.

[0009] However, when the ambient environment is dark, the reflection of ambient light by the common electrode **122** is limited. The visibility of the reflective FFS LCD display **1** is poor. Conversely, a transmission type liquid crystal display is disadvantageous when the ambient environment is bright.

[0010] An improved liquid crystal display which overcomes the above-mentioned problems and shortcomings is desired.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide a liquid crystal display which can be used not only in a bright environment but also in a dark environment, and which has a wide viewing angle.

[0012] To achieve the above object, a liquid crystal display of the present invention comprises: a first substrate; a second substrate; a liquid crystal layer between the first substrate and the second substrate; and a plurality of pixel regions each defined by respective pixel electrodes and a common electrode, for application of a voltage to the liquid crystal layer and formation of a fringe electric field at each pixel region. Each pixel region includes a transmissive region and a reflective region. The liquid crystal display can effectively use light beams from the outside environment and from a backlight module. Therefore the liquid crystal display can be used not only in bright conditions, but also in dark conditions.

[0013] Other objects, advantages and novel features of the present invention will be apparent from the following detailed description of preferred embodiments thereof with reference to the attached drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a schematic, cross-sectional view of one sub-pixel area of a transflective FFS LCD according to a first embodiment of the present invention;

[0015] **FIG. 2** is a schematic, cross-sectional view of one sub-pixel area of a transflective FFS LCD according to a second embodiment of the present invention;

[0016] **FIG. 3** is a schematic, cross-sectional view of one sub-pixel area of a transflective FFS LCD according to a third embodiment of the present invention; and

[0017] **FIG. 4** is a schematic, isometric view of one sub-pixel area of a conventional FFS LCD.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0018] **FIG. 1** is a view of one sub-pixel area of a transflective FFS LCD **3** according to the first embodiment of the present invention. The transflective FFS LCD **3** includes a first substrate **30**, a second substrate **32**, a liquid crystal layer **31**, and a backlight module (not shown). The liquid crystal layer **31** is interposed between the first substrate **30** and the second substrate **32**, and the backlight module is located below the second substrate **32**.

[0019] The first substrate **30** comprises a first glass sheet **301**, and a first alignment film **302** covering the first glass sheet **301** and facing the liquid crystal layer **31**. The second substrate **32** comprises a second glass sheet **321**, a common electrode **350**, an insulating layer **323**, a plurality of pixel electrodes **324**, and a second alignment film **325**. The second glass sheet **321**, the common electrode **350**, the insulating layer **323**, and the pixel electrodes **324** are stacked from bottom to top in the order. A plurality of pixel regions is defined by the pixel electrodes **324** and the common elec-

trode **350**. Each of the pixel regions includes a transmissive region T and a reflective region R. Light reflected in the reflective region R and light transmitted through the transmissive region T is utilized in displaying an image.

[**0020**] The pixel electrodes **324** are transparent strip electrodes, and are spaced apart from and parallel to each other. The common electrode **350** has a transmissive area **351** according to the corresponding transmissive region T, and a reflective area **353** according to the corresponding reflective region R. The common electrode **350** is made of an aluminum film, and a transmission ratio of the aluminum film depends on a thickness thereof. When the thickness is equal to 100 nanometers, the transmission ratio is 1%. If the thickness is decreased, the transmission ratio increases proportionately, and vice versa. Therefore, the thickness of the reflective area **353** is defined as being more than 100 nanometers, and the thickness of the transmissive area **351** is defined as being less than 100 nanometers. Accordingly, the reflective area **353** can reflect natural light beams from the outside environment, and light beams **33** from the backlight module can pass through the transmissive area **351**. In other words, the transflective FFS LCD **3** can be used in a dark environment and also in a bright environment.

[**0021**] The transmissive area **351** of the aluminum film has a higher impedance than the reflective area **353**, because the thickness of the transmissive area **351** is less than that of the reflective area **353**. In order to decrease the impedance of the transmissive area **351**, an indium tin oxide (ITO) film (not shown) is attached to one surface thereof.

[**0022**] **FIG. 2** is a view of one sub-pixel area of a transflective FFS LCD **4** according to the second embodiment of the present invention. Unlike the transflective FFS LCD **3**, the transflective FFS LCD **4** has a common electrode **450**, and the common electrode **450** includes a reflective area **453** and a transmissive area **451**. The reflective area **453** is made of a metal film; for example, an aluminum film. A thickness of the aluminum film is more than 100 nanometers. The transmissive area **451** is made of an indium tin oxide (ITO) film or an indium zinc oxide (IZO) film. Both the indium tin oxide film and the indium zinc oxide film are transparent.

[**0023**] **FIG. 3** is a view of one sub-pixel area of a transflective FFS LCD **5** according to the third embodiment of the present invention. A common electrode **550** includes a transparent conductive film **552**, and a transflective film **551** covering the transparent conductive film **552**. The transflective film **551** has a multi-layer construction, and commonly comprises seven to nine layers. In particular, the transflective film **551** comprises a plurality of layers of different transparent materials stacked one on the other in alternate fashion. The layers are typically indium tin oxide (ITO) films and indium zinc oxide (IZO) films. The refractive ratio and thickness of each of the layers can be configured according to need, and the number of layers can also be configured according to need. In this way, the transflective film **551** having a desired transmission ratio and a desired reflective ratio can be obtained.

[**0024**] The transflective FFS LCDs **3**, **4**, **5** can effectively use light beams from the outside environment and from respective backlight modules. Therefore the transflective FFS LCDs **3**, **4**, **5** can be used not only in bright conditions, but also in dark conditions. In addition, in a further embodiment, the common electrode and the pixel electrodes can be used to form a transflective element. That is, the common electrode is a transparent film, and the pixel electrodes are reflective elements. In particular, the common electrode can be an indium tin oxide film or an indium zinc oxide film. The pixel electrodes can be made of a metal, such as aluminum.

[**0025**] While the present invention has been described with reference to particular embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. Therefore, various modifications of the described embodiments can be made by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims.

What I claim is:

1. A transflective fringe field switching liquid crystal display, comprising:

a first substrate;

a second substrate;

a liquid crystal layer between the first substrate and the second substrate; and

a plurality of pixel regions each defined by respective pixel electrodes and a common electrode, for application of a voltage to the liquid crystal layer and formation of a fringe electric field at each pixel region;

wherein each pixel region includes a transmissive region and a reflective region.

2. The transflective fringe field switching liquid crystal display of claim 1, wherein the common electrode is a transflective element which transmits and reflects light beams.

3. The transflective fringe field switching liquid crystal display of claim 2, wherein the common electrode includes a transmissive area and a reflective area.

4. The transflective fringe field switching liquid crystal display of claim 3, wherein the common electrode is made of a metal film.

5. The transflective fringe field switching liquid crystal display of claim 4, wherein the common electrode is made of an aluminum film.

6. The transflective fringe field switching liquid crystal display of claim 4, wherein a thickness of the reflective area is greater than a thickness of the transmissive area.

7. The transflective fringe field switching liquid crystal display of claim 6, wherein the thickness of the reflective area is more than 100 nanometers, and the thickness of the transmissive area is less than 100 nanometers.

8. The transflective fringe field switching liquid crystal display of claim 3, wherein the transmissive area is made of a transparent conductive material, and the reflective area is made of metal.

9. The transflective fringe field switching liquid crystal display of claim 8, wherein the transmissive area is made of an indium zinc oxide film.

10. The transflective fringe field switching liquid crystal display of claim 8, wherein the transmissive area is made of an indium tin oxide film.

11. The transflective fringe field switching liquid crystal display of claim 8, the reflective area is made of an aluminum film, and a thickness of the aluminum film is more than 100 nanometers.

12. The transflective fringe field switching liquid crystal display of claim 2, wherein the common electrode is a transparent conductive film, and the pixel electrodes are reflective elements.

13. The transflective fringe field switching liquid crystal display of claim 12, wherein the common electrode is an indium tin oxide film.

14. The transflective fringe field switching liquid crystal display of claim 12, wherein the common electrode is an indium zinc oxide film.

15. The transflective fringe field switching liquid crystal display of claim 12, wherein the pixel electrodes are made of metal.

16. A transflective fringe field switching liquid crystal display, comprising:

a first substrate;

a second substrate;

a liquid crystal layer between the first substrate and the second substrate; and

a plurality of pixel regions each defined by respective pixel electrodes and a common electrode, for application of a voltage to the liquid crystal layer and formation of a fringe electric field at each pixel region;

wherein the common electrode comprises a transparent conductive film, and a transflective film covering the transparent conductive film.

17. The transflective fringe field switching liquid crystal display of claim 16, wherein the transparent conductive film is an indium tin oxide film.

18. The transflective fringe field switching liquid crystal display of claim 16, wherein the transparent conductive film is an indium zinc oxide film.

19. The transflective fringe field switching liquid crystal display of claim 16, wherein the transflective film comprises a plurality of layers of different transparent conductive material arranged alternately one on the other.

20. A transflective fringe field switching liquid crystal display, comprising:

a first substrate;

a second substrate;

a liquid crystal layer between the first substrate and the second substrate; and

a plurality of pixel regions each defined by respective pixel electrodes and a common electrode, for application of a voltage to the liquid crystal layer and formation of a fringe electric field at each pixel region;

wherein the common electrode comprises a transparent conductive film, and a transflective film at least partially overlapped with the transparent conductive film.

* * * * *

专利名称(译)	透射式边缘场切换液晶显示器		
公开(公告)号	US20050128390A1	公开(公告)日	2005-06-16
申请号	US10/997704	申请日	2004-11-24
[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 G02F1/1347		
CPC分类号	G02F1/134363 G02F1/133555		
优先权	200310112580.5 2003-12-12 CN		
外部链接	Espacenet USPTO		

摘要(译)

液晶显示器（3）包括：第一基板（30）;第二基板（32）;液晶层（31）介于基板之间;多个像素区域，每个像素区域由各个像素电极（324）和公共电极（350）限定，用于向每个像素区域施加电压到液晶层和形成边缘电场。每个像素区域包括透射区域和反射区域。液晶显示器可以有效地使用来自外部环境和背光模块的光束。因此，液晶显示器不仅可以在明亮的条件下使用，而且可以在黑暗条件下使用。