US 20060092347A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2006/0092347 A1

Kim et al. (43) Pub. Date: May 4, 2006

(54) LIQUID CRYSTAL DISPLAY DEVICE HAVING HIGH BRIGHTNESS

(75) Inventors: **Sung-Ki Kim**, Seoul (KR); **Yong-Jin Cho**, Seoul (KR); **Hae-Yeol Kim**, Gyeonggi-Do (KR)

Correspondence Address:
MCKENNA LONG & ALDRIDGE LLP
1900 K STREET, NW
WASHINGTON, DC 20006 (US)

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

(21) Appl. No.: **11/148,566**

(22) Filed: **Jun. 9, 2005**

(30) **Foreign Application Priority Data**

Sep. 22, 2004 (KR) 10-2004-076083

Publication Classification

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

(52) **U.S. Cl.** **349/62**

(57) **ABSTRACT**

A liquid crystal display device includes: a liquid crystal panel; a backlight assembly for irradiating light onto the liquid crystal panel; and a reflection layer between the liquid crystal panel and the backlight assembly for increasing an amount of light incident onto the liquid crystal panel.

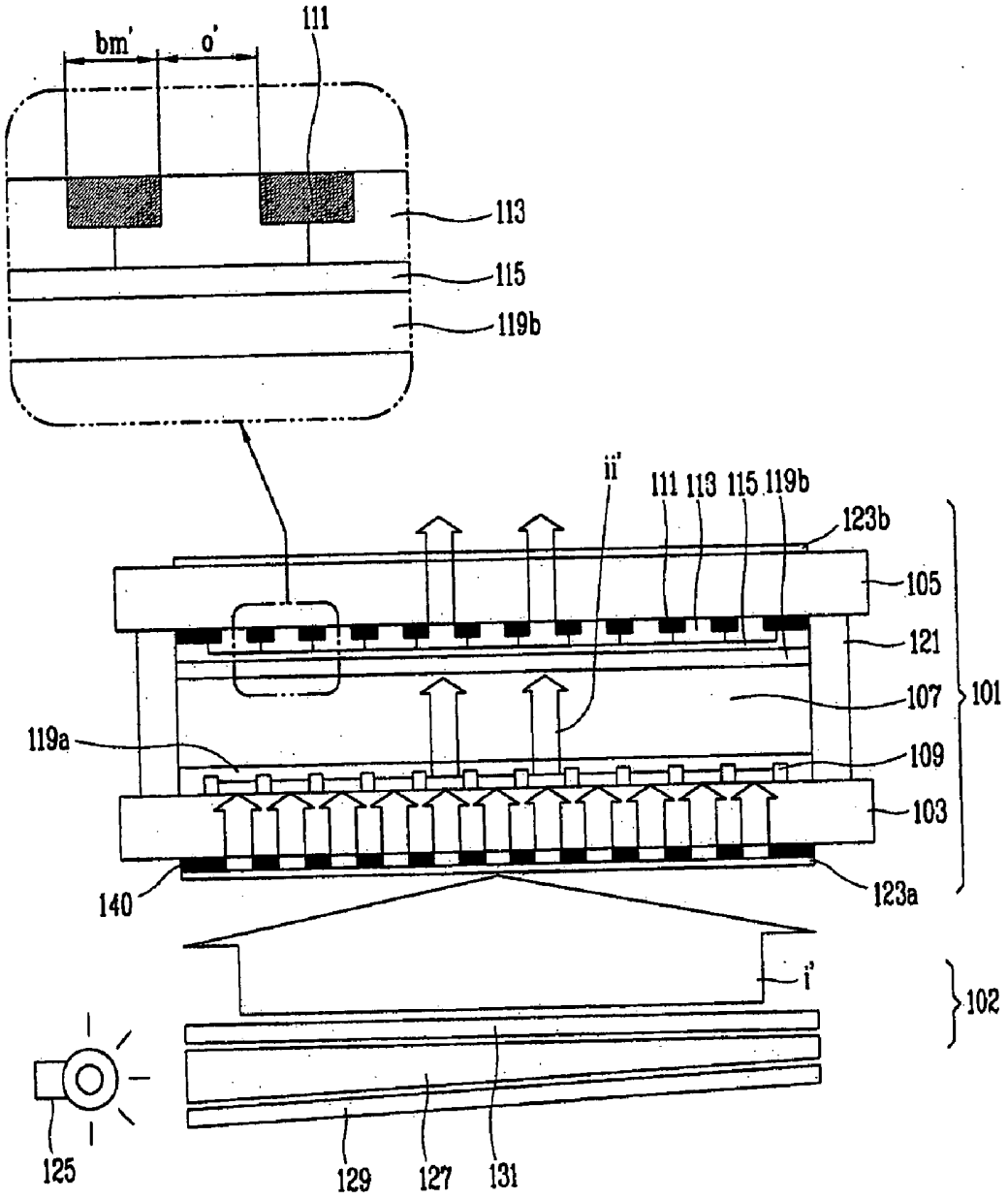


FIG. 1
RELATED ART

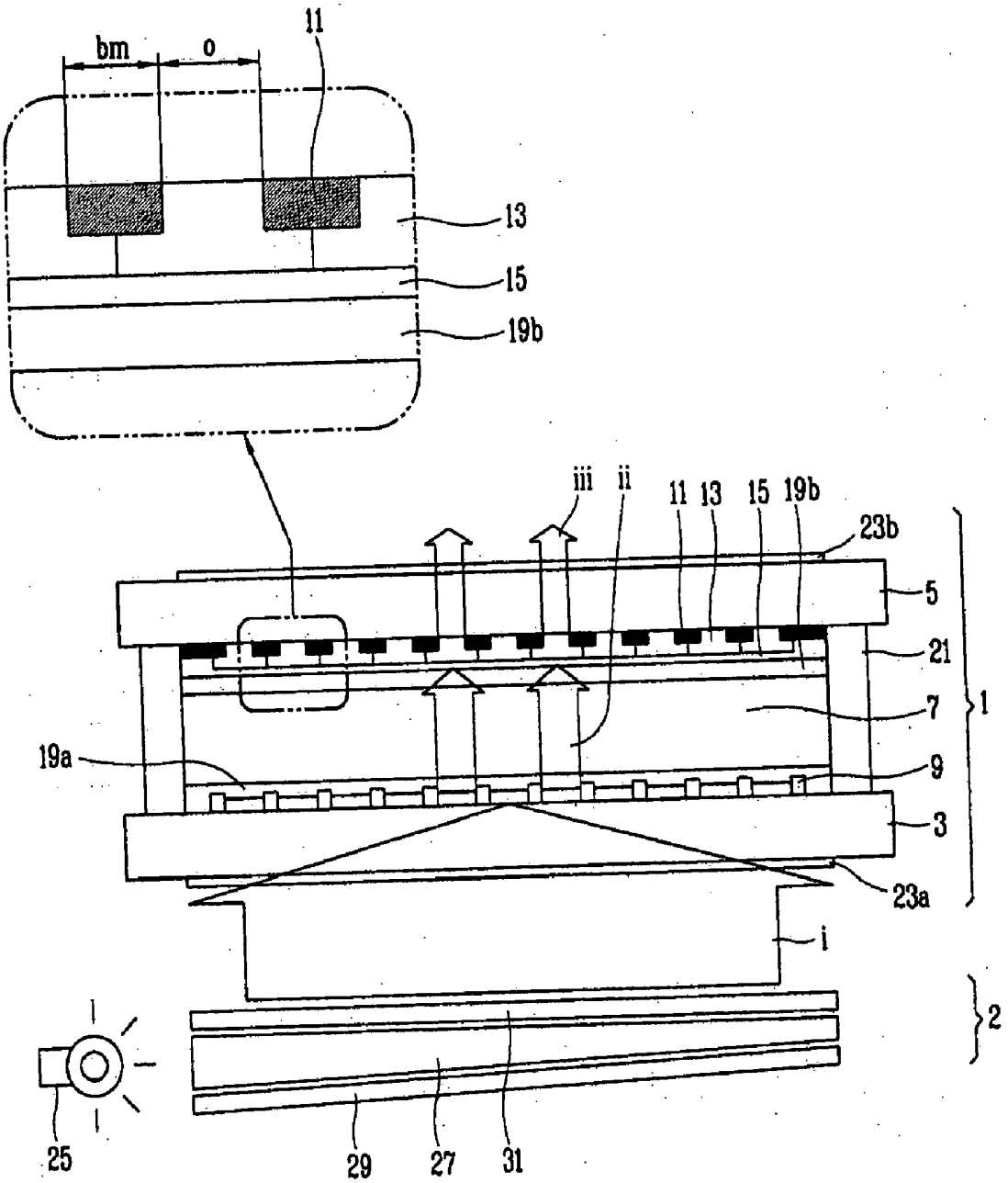


FIG. 2

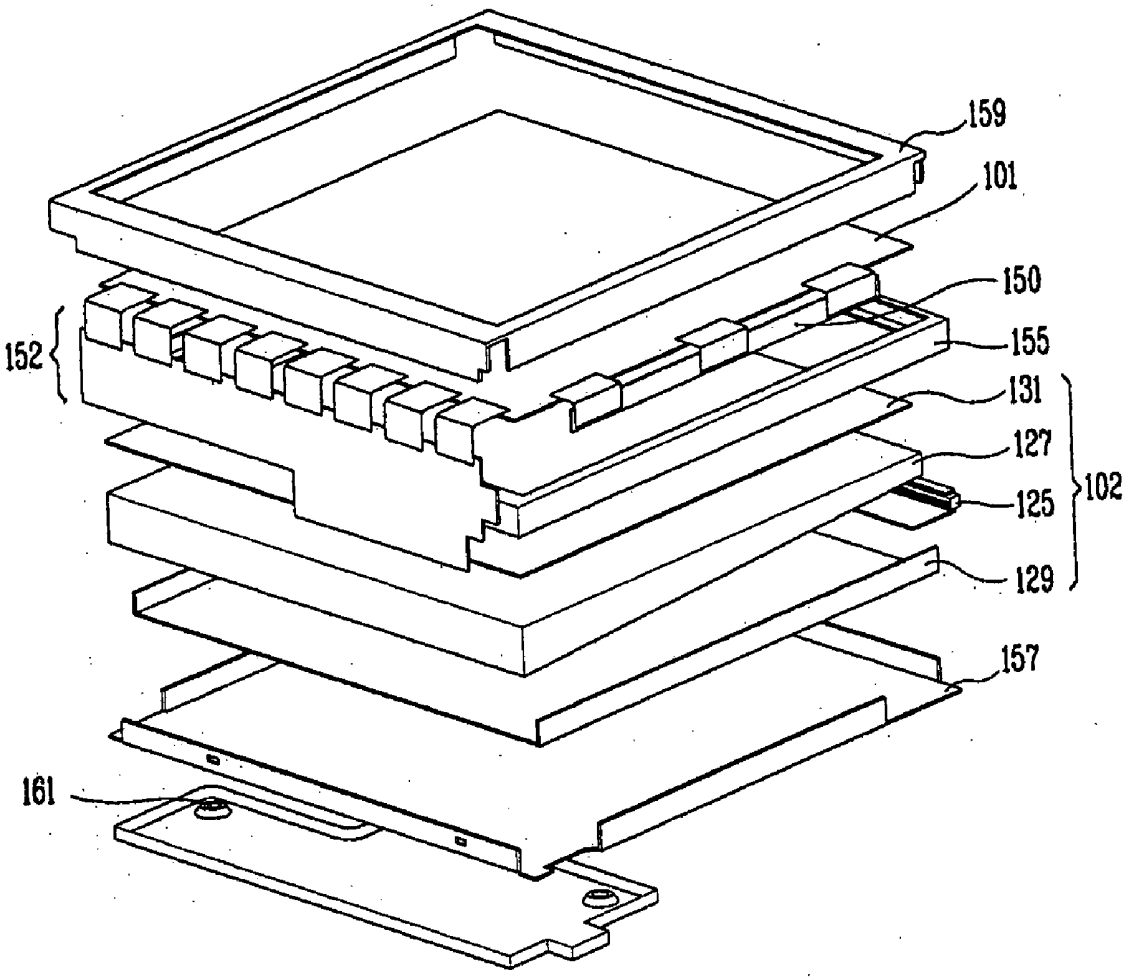
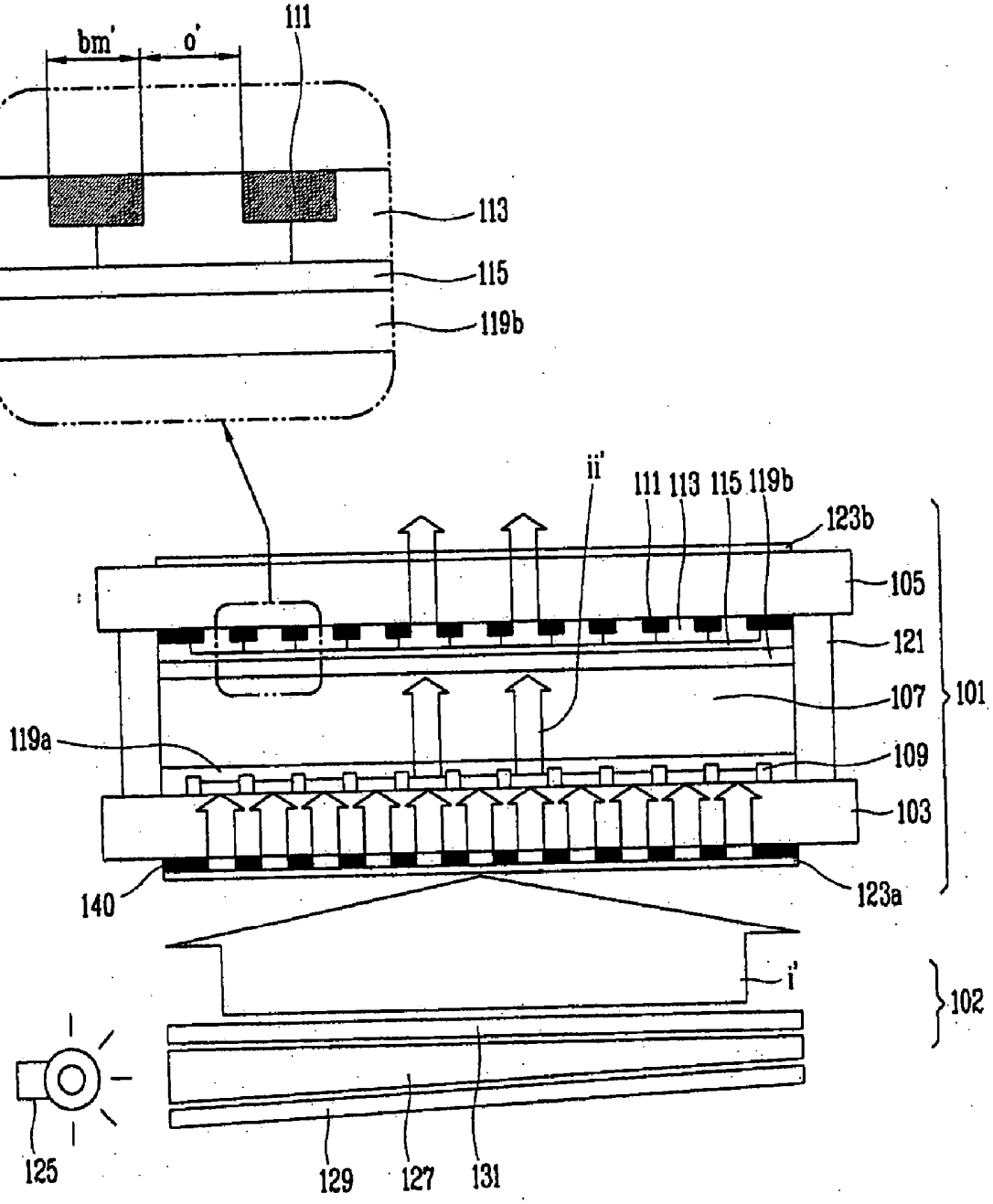


FIG. 3


bm'
o'
111
113
115
119b
ii'
111 113 115 119b
123b
105
121
107
101
119a
109
103
140
123a
i'
102
125
129
127
131

LIQUID CRYSTAL DISPLAY DEVICE HAVING HIGH BRIGHTNESS

[0001] The present invention claims the benefit of Korean Patent Application No. 2004-0076083 filed in Korea on Sep. 22, 2004, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display device, and particularly, to a liquid crystal display device having high brightness.

[0004] 2. Description of the Related Art

[0005] Recently, as more and more portable electronic instruments, such as mobile phones, PDAs, notebook computers, and the like are being developed, lighter and more compact flat panel display devices capable of being used in these instruments have been required. As the demand for these flat panel display devices increases, more research as in LCD (Liquid Crystal Display), PDP (Plasma Display Panel), FED (Field Emission Display), VFD (Vacuum Fluorescent Display) and the like are actively being carried out. Considering such aspects as mass production capability, display driving ease, and high image quality, the LCD device is the display device among the flat panel display devices that is currently receiving the most attention.

[0006] In general, the LCD device is designed to display desired images by individually providing a data signal according to image information to pixels arranged in matrix. The data signals adjusts the light transmissivity of the pixels. **FIG. 1** shows a cross-sectional view of a related art LCD device. As shown in **FIG. 1**, the LCD device includes a liquid crystal panel **1** having pixels arranged in matrix and a backlight assembly **2** for irradiating light onto the liquid crystal panel **1**.

[0007] The liquid crystal panel **1** includes a TFT (Thin Film Transistor) array substrate **3** and a color filter substrate **5**, which face each other and are attached to each other with a cell gap between them. A liquid crystal layer **7** fills the cell gap between the TFT array substrate **3** and the color filter substrate **5**.

[0008] Although not shown in **FIG. 1**, a plurality of pixels are defined by gate lines and data lines on the TFT array substrate **3**. A driving device, such as a thin film transistor **9**, is formed in each pixel. A black matrix **11** is formed on the color filter substrate **3** to prevent light leakage in the regions where the gate lines, the data lines and the thin film transistor **9** are located. A color filter layer **13** having red, green, and blue filters for producing the full color spectrum is formed in the black matrix **11** of the color filter substrate.

[0009] The TFT array substrate **3** and the color filter substrate **5** respectively have a pixel electrode and a common electrode. Alignment layers **19***a* and **19***b* for aligning liquid crystal molecules are coated on the TFT array substrate **3** and the color filter substrate **5**, respectively. The TFT array substrate **3** and the color filter substrate **5** are attached to each other by a sealing material **21**. Lower and upper polarizers **23***a* and **23***b* for polarizing light coming out of the backlight assembly are formed on upper and rear surfaces of the liquid crystal panel **1**, respectively.

[0010] The LCD device is a light receiving display device having the characteristic of displaying images by adjusting light transmission through the device without emitting light by itself. Thus, a separate unit for irradiating light onto the liquid crystal panel **1**, namely, a backlight assembly **2** is provided at the rear surface of the liquid crystal panel **1**. A light source **25** of the backlight assembly **2** is installed at a side surface of a light-guiding plate **27**, a reflection sheet **29** is positioned at the rear surface of the light-guiding plate **27**, and an optical sheet **31** is laminated on the light-guiding plate **27**. Therefore, light irradiated from the light source **25** is condensed by the light-guiding plate **27** and passes through the optical sheets **31**, including a diffusion sheet and a prism sheet. Thereafter, the light is irradiated onto the region of the liquid crystal panel **1** of the LCD device as indicated with arrow i in **FIG. 1**. As a result, characters or images can be displayed using the light passing through the liquid crystal panel **1**.

[0011] In the color filter type LCD device according to the related art, most light i irradiated from the backlight assembly **2** is substantially absorbed or blocked. However, some light iii passes through the lower TFT array substrate **3**, elements of the upper color filter substrate **5** and the liquid crystal layer **7**, sequentially, as a part of the display. Only as much as about 3% to 5% of the initially irradiated light is displayed. Thus, the light efficiency is very low.

SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention is directed to a liquid crystal display device having high brightness that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0013] An object of the present invention is to provide a liquid crystal display device having high brightness.

[0014] An object of the present invention is to provide a liquid crystal display device that minimizes light loss.

[0015] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0016] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a liquid crystal display device includes: a liquid crystal panel; a backlight assembly for irradiating light onto the liquid crystal panel; and a reflection layer between the liquid crystal panel and the backlight assembly for increasing an amount of light incident onto the liquid crystal panel.

[0017] In another aspect, a method of manufacturing a liquid crystal display device includes: forming a liquid crystal panel; forming a backlight assembly for irradiating light onto the liquid crystal panel; and forming a reflection layer between the liquid crystal panel and the backlight assembly for increasing an amount of light incident onto the liquid crystal panel.

[0018] In another aspect, a liquid crystal display device includes: a liquid crystal panel includes a black matrix

positioned along gate lines and data lines on a first side of a thin film transistor array substrate for preventing light leakage; a backlight assembly for irradiating light onto the liquid crystal panel; and a reflection layer between the liquid crystal panel having a same pattern as the black matrix.

[0019] 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

[0020] 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.

[0021] **FIG. 1** shows a cross-sectional view of a related art LCD device.

[0022] **FIG. 2** shows a liquid crystal display device according to an exemplary embodiment of the present invention.

[0023] **FIG. 3** is a cross-sectional view of the liquid crystal display device according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Hereinafter, a liquid crystal display device according to an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0025] In general, light efficiency in the related art liquid crystal display device, as shown in **FIG. 1**, is lower than about 5%. One of the main factors that lowers the light efficiency is the shielding action of a black matrix on the color filter substrate. The black matrix **11** is a light blocking region for absorbing light irradiating through the gate line, data line and the TFT **9** regions on the TFT array substrate **3** to prevent light leakage from these regions. As shown in **FIG. 1**, the black matrix **11** blocks and absorbs light in a significant area within the liquid crystal panel **1**, and thus degrades the brightness level of the liquid crystal display device.

[0026] The black matrix **11** forms the light blocking region bm to prevent light from being passed through a predetermined region within the liquid crystal panel **1**, and, as the arrows ii and iii indicate in **FIG. 1**, blocks part of the light ii from going on after passing through a liquid crystal layer **7**. As a result, the black matrix **11** decreases the amount of light ii transmitted through the color filter substrate and thus lowers the brightness of the liquid crystal display device. However, the light blocking region bm formed by the black matrix, as aforementioned, prevents light leakage from the regions of the gate lines, the data lines, and the TFT, which are parts of the liquid crystal display device that can not be removed.

[0027] In an exemplary embodiments of the present invention, the brightness of the liquid crystal display device is improved by increasing the amount of light, which is irradiated from the backlight, through the liquid crystal panel. The brightness of the liquid crystal display device can be improved without increasing light output from the backlight assembly. More particularly, a reflection layer having the same pattern as the black matrix pattern of the liquid crystal display device is formed at the rear surface of the TFT array substrate, so as to reflect light, which is irradiated onto the light blocking region, back into the back light assembly for subsequent reflection into the light transmission region of the liquid crystal panel. As a result, the loss of light, which is caused by the absorbing action of the black matrix, is minimized. Accordingly, a condensation rate of light incident onto the light transmission region of the liquid crystal panel, namely, intensity of the light is increased. In other words, the light ongoing toward the black matrix on the second substrate is reflected by the reflection layer according to exemplary embodiments of the present invention, and thus returns the reflected light to the inside of the light-guiding plate and is then reflected again on a reflection plate at the lower surface of the light-guiding plate, and then condensed into the light transmission region of the liquid crystal panel along with other light from the backlight assembly.

[0028] Construction of a liquid crystal display device will now be described in accordance with an exemplary embodiment of the present invention. **FIG. 2** shows a liquid crystal display device according to an exemplary embodiment of the present invention. The liquid crystal display shown in **FIG. 2** has a liquid crystal panel **101** with pixels arranged in matrix. A backlight assembly **102** is arranged at the rear surface of the liquid crystal panel **101**.

[0029] A gate driving unit **150** and a data driving unit **152** are connected to the top surface of the liquid crystal panel **101**. The gate driving unit **150** and the data driving unit **152** are coupled to the liquid crystal panel **101** to respectively provide a scan signal and image information to gate lines and data lines formed on the TFT array substrate of the liquid crystal panel **101**. Accordingly, the pixels of the liquid crystal panel **101** can be driven.

[0030] The liquid crystal panel **101** includes a TFT array substrate and a color filter substrate facing and being attached to each other with a uniform cell gap between them. A liquid crystal layer is in the cell gap between the TFT array substrate and the color filter substrate. Although not shown in **FIG. 2**, the liquid crystal panel **101** is formed by adhering the TFT array substrate and the color filter substrate together. A pixel electrode and a common electrode are respectively formed on the TFT array substrate and the color filter substrate to apply an electric field across the liquid crystal layer. When a voltage of a data signal is applied across the pixel electrode and the common electrode, the liquid crystal in the liquid crystal layer is aligned according to the electric field between the common electrode and the pixel electrode. As a result, characters or images can be displayed by adjusting the amount of light transmitted by a pixel based upon the voltage of the data signal. In addition, in order to control the voltage of the data signal applied to the pixel electrode by a pixel, a switching device, such as a TFT or the like, is individually provided for each pixel on the TFT array substrate.

[0031] The backlight assembly **102** includes a light-guiding plate **127** positioned at the rear surface of the liquid crystal panel **101**, a lighting light source **125** positioned at a side surface of the light-guiding plate **127** having a wedge shape, for example, and a reflection plate **129** positioned at the rear surface of the light-guiding plate **127**. An optical sheet **131** is arranged between the liquid crystal panel **101** and the light-guiding plate **127**. Light generated from the backlight assembly **102** is incident onto a side surface of the light-guiding plate **127** formed of a transparent material, and thereafter is guided by the light-guiding plate **127** inclined by a certain angle. Light reflected by the reflection plate **129** positioned at the rear surface of the light-guiding plate **127** is guided toward an upper surface by the light-guiding plate **127** to be incident onto the liquid crystal panel **101**.

[0032] A diffusion sheet and a prism sheet can be used as the optical sheet **131** positioned between the liquid crystal panel **101** and the light-guiding plate **127**. A protection sheet can additionally be positioned between the TFT array substrate **103** and the backlight assembly **102**. However, the backlight assembly according to an exemplary embodiment of the present invention is not limited to an edge-type backlight assembly. The backlight assembly according to other exemplary embodiments of the present invention can be a direct-type backlight assembly in which a plurality of light sources are arranged at a rear surface of the liquid crystal panel so as to directly transmit light onto the front surface of the liquid crystal panel.

[0033] On the other hand, the liquid crystal panel **101** and the backlight assembly **102** are wrapped with a guide panel **155**, and side surfaces of the wrapped crystal panel **101** and the backlight assembly **102** are supported by a lower cover **157**. Moreover, edges of the upper surface of the liquid crystal panel **101** are compressed by a top case **159**. The top case **159** is coupled to the guide panel **155**. The guide panel **155** is coupled to the lower cover **157** and the lower cover **157** is wrapped with a cover shield **161**.

[0034] **FIG. 3** is a cross-sectional view of the liquid crystal display device according to an exemplary embodiment of the present invention. As shown in **FIG. 3**, the liquid crystal panel **101** includes a TFT array substrate **103** and a color filter substrate **105** facing each other and attached to each other with a uniform cell gap between them. A liquid crystal layer **107** fills the uniform cell gap between the TFT array substrate **103** and the color filter substrate **105**.

[0035] The TFT array substrate **103** has a plurality of pixels defined by gate lines and data lines. A driving device such as a TFT **109** is formed in each pixel. The color filter substrate **105** includes a black matrix **111** for forming a light blocking region bm' to prevent light leakage from regions of the gate lines, the data lines and the TFT **109**. A color filter layer **113** is disposed in the black matrix **111** for displaying colors. Further, the TFT array substrate **103** and the color filter substrate **105** respectively have a pixel electrode and a common electrode **115**. In the alternative, the liquid crystal panel can be an IPS (In-Plain Switching) mode liquid crystal display device having both the pixel electrode and the common electrode **115** formed on the TFT array substrate **103**. Alignment layers **119***a* and **119***b* are coated on the TFT array substrate **103** and the color filter substrate **105** for aligning liquid crystal molecules of the liquid crystal layer **107**.

[0036] The black matrix **111** is formed at the region on the color filter substrate **105** that corresponds to the region of the gate lines, the data lines and the TFT. The light blocking region bm' is thus defined within the liquid crystal panel. The black matrix **111** may be formed of a metal material, such as chrome (Cr) or chrome oxide (CrOx). However, when the IPS mode liquid crystal display device having both the common electrode and the pixel electrode on the TFT array substrate is adopted, those metal materials of the black matrix may have influence on a transverse electric field. Thus, a resin layer made of a black resin can be used instead of the metal materials.

[0037] The TFT array substrate **103** and the color filter substrate **105** are attached by a sealing material **121**. Lower and upper polarizers **123***a* and **123***b* for polarizing light coming from the backlight assembly **102** are formed at upper and lower portions of the liquid crystal panel **101**. Furthermore, the backlight assembly for irradiating light i' onto the liquid crystal panel **101** is positioned at the lower portion of the lower polarizer **123***a*. Here, the light irradiated from a lighting light source **125** of the backlight assembly **102** is condensed by a light-guiding plate **127**. After the condensed light passes through an optical sheet **131** of a diffusion sheet and a prism sheet, the light is incident onto the region of the liquid crystal panel **101** of the liquid crystal display device as indicated with an arrow i' in the drawing.

[0038] A reflection layer **140**, which has the same pattern as the black matrix **111** pattern formed on the color filter substrate **103**, is positioned between the liquid crystal panel **101** and the lower polarizer **123***b*. The reflection layer **140** allows the light i' emitted from the backlight assembly **102** to be condensed onto a light transmission region o' of the liquid crystal panel **101**. The reflection layer **140**, as an opaque metal layer formed of molybderum (Mo), aluminum (Al), aluminum-neodymium (Al—Nd), cuprum (Cu), chrome (Cr), titanium (Ti) or alloys thereof, is made of a metal material capable of maximizing a reflection rate of light. Otherwise, the reflection layer **140** may be formed of any material which can maximize the reflection rate.

[0039] The reflection layer **140** is patterned in the same pattern as the light blocking region bm' formed by the black matrix **111**, and hence reflects light irradiated toward the black matrix **111** among light emitted from the backlight assembly **102** back into the backlight assembly **102** so as to add more light into the outgoing path. As a result, the amount of light irradiated toward the light transmission region o' can be increased.

[0040] The reflection layer can be formed on the lower surface of the TFT array substrate **103** by a photo-etching process. In the alternative, the reflection layer can be formed separately from the liquid crystal panel **101** as a separate substrate and be positioned between the liquid crystal panel **101** and the backlight assembly **102**.

[0041] The light going toward the black matrix **111** of the second substrate is reflected by the reflection layer **140** formed at the rear surface of the TFT array substrate so as to return into the light-guiding plate **127** of the backlight assembly **102**. The light returned into the light-guiding plate **127** is reflected by the reflection plate **129** positioned at the lower portion of the light-guiding plate **127** to be supplied into the light transmission region o' of the liquid crystal panel **101**. As a result, as shown in **FIG. 3**, the light outgoing

toward the reflection layer **140** among the light i' emitted from the backlight assembly **102** is blocked by the reflection layer **140** and returns to the backlight assembly **102**, so that the amount of light i' outgoing to the light transmission region o' is increased. Accordingly, light efficiency of the liquid crystal display device can be improved and high brightness can be realized.

[**0042**] As aforementioned, in the present invention, by forming the reflection layer at the rear surface of the TFT array substrate, light blocked by the black matrix returns into the light-guiding plate and the returned light is condensed into the light transmission region of the liquid crystal panel so as to be able to provide a liquid crystal display device with improved brightness. The present invention is not limited on the embodiment of this specification. The present invention can be applied to various types of liquid crystal display devices. For instance, the liquid crystal display device according to the present invention can be used in a direct-type backlight assembly as well as an edge-type backlight assembly. The liquid crystal panel can also be used in a TN mode liquid crystal panel, an IPS mode liquid crystal panel or a VA (Vertical alignment) liquid crystal panel. In addition, a shielding type black matrix of the liquid crystal display device may be formed on the TFT array substrate rather than on the color filter substrate. When the color filter substrate is attached to the TFT array substrate in this case, the extra width of the black matrix provided to accommodate mis-alignments between the two substrate can be narrowed so as to reduce an area of the light blocking region of the liquid crystal panel.

[**0043**] 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:

a liquid crystal panel;

a backlight assembly for irradiating light onto the liquid crystal panel; and

a reflection layer between the liquid crystal panel and the backlight assembly for increasing an amount of light incident onto the liquid crystal panel.

2. The device of claim 1, wherein the liquid crystal panel includes:

a color filter substrate and a thin film transistor array substrate facing each other;

an electrode on at least one of the two substrates for generating an electric field;

a plurality of gate lines and data lines crossing each other on a first side of the thin film transistor array substrate defining pixel region;

a thin film transistor formed at each crossing between the gate lines and the data lines;

a color filter layer formed on the color filter substrate;

a liquid crystal layer formed between the color filter substrate and the thin film transistor array substrate; and

a black matrix along the plurality of gate lines and data lines for preventing light leakage.

3. The device of claim 2, wherein the black matrix is formed on the color filter substrate.

4. The device of claim 2, wherein the black matrix is formed on the thin film transistor array substrate.

5. The device of claim 2, wherein the liquid crystal panel is one of a twisted nematic mode liquid crystal panel, an in-plain switching mode liquid crystal panel, and a vertical alignment liquid crystal panel.

6. The device of claim 2, wherein the reflection layer reflects light, which is irradiated from the backlight assembly toward the black matrix to the backlight assembly and changes the light outgoing path so as to increase a condensation rate of light irradiated toward the light transmission region of the liquid crystal panel.

7. The device of claim 2, wherein the reflection layer has a same pattern as the black matrix.

8. The device of claim 2, wherein the reflection layer is on a second side of the thin film transistor array substrate opposite to a first side of the liquid crystal panel.

9. The device of claim 2, wherein the reflection layer is separate from the liquid crystal panel and positioned between the liquid crystal panel and the backlight assembly.

10. The device of claim 2, wherein the reflection layer is formed of one of molybderum (Mo), aluminum (Al), aluminum-neodymium (Al—Nd), cuprum (Cu), chrome (Cr), titanium (Ti) and alloys thereof.

11. The device of claim 1, wherein the backlight assembly is one of an edge-type backlight assembly and a direct-type backlight assembly.

12. The device of claim 1, further comprising an upper polarizer and a lower polarizer arranged at first and second sides of the liquid crystal panel, respectively, for polarizing light.

13. A method of manufacturing a liquid crystal display device comprising:

forming a liquid crystal panel;

forming a backlight assembly for irradiating light onto the liquid crystal panel; and

forming a reflection layer between the liquid crystal panel and the backlight assembly for increasing an amount of light incident onto the liquid crystal panel.

14. The method of claim 13, wherein the reflection layer is formed on a second side of the thin film transistor array substrate opposite to the first side of the liquid crystal panel by a photo-etching process.

15. The method of claim 13, wherein the reflection layer is formed separately from the liquid crystal panel and installed between the liquid crystal panel and the backlight assembly.

16. A liquid crystal display device comprising:

a liquid crystal panel including a black matrix positioned along gate lines and data lines on a first side of a thin film transistor array substrate for preventing light leakage;

a backlight assembly for irradiating light onto the liquid crystal panel; and

a reflection layer between the liquid crystal panel having a same pattern as the black matrix.

17. The device of claim 16, wherein the reflection layer is on a second side of the thin film transistor array substrate opposite to the first side of the liquid crystal panel.

18. The device of claim 16, wherein the reflection layer is separate from the liquid crystal panel and positioned between the liquid crystal panel and the backlight assembly.

19. The device of claim 16, wherein the backlight assembly is one of an edge-type backlight assembly and a direct-type backlight assembly.

20. The device of claim 16, further comprising an upper polarizer and a lower polarizer arranged at first and second sides of the liquid crystal panel, respectively, for polarizing light.

* * * * *

专利名称(译)	具有高亮度的液晶显示装置		
公开(公告)号	US20060092347A1	公开(公告)日	2006-05-04
申请号	US11/148566	申请日	2005-06-09
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG.PHILIPS LCD CO.LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	KIM SUNG KI CHO YONG JIN KIM HAE YEOL		
发明人	KIM, SUNG-KI CHO, YONG-JIN KIM, HAE-YEOL		
IPC分类号	G02F1/1335		
CPC分类号	G02F1/133512 G02F1/133615		
优先权	1020040076083 2004-09-22 KR		
其他公开文献	US8085367		
外部链接	Espacenet USPTO		

摘要(译)

一种液晶显示装置，包括：液晶面板;背光组件，用于将光照射到液晶面板上;以及液晶面板和背光组件之间的反射层，用于增加入射到液晶面板上的光量。