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

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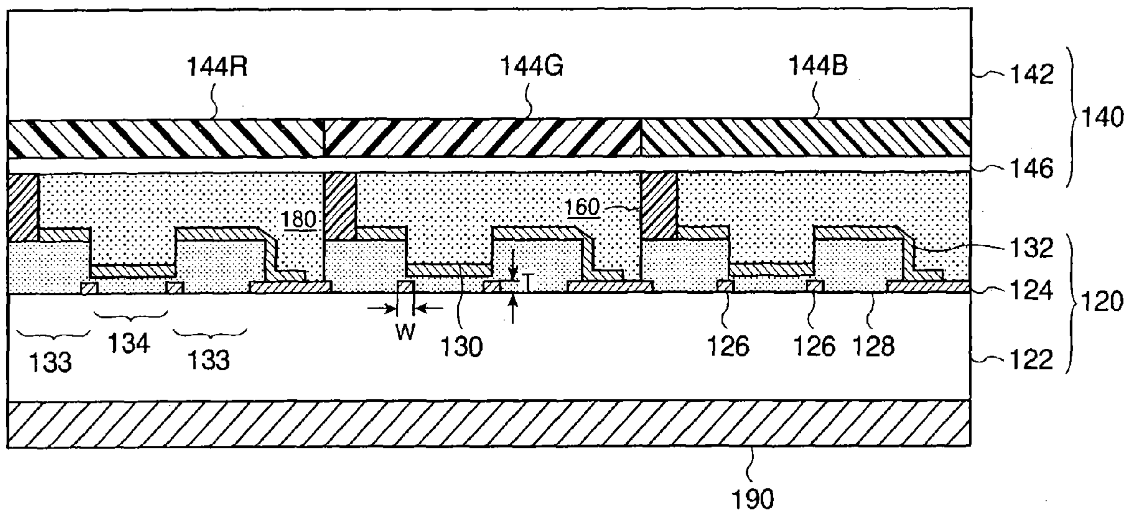
(57) **ABSTRACT**

An LCD device includes a transparent glass plate 122 and thin film transistor electrodes 124 formed on the glass plate 122. A photosensitive insulation film 128 is coated on the glass plate 122 and the thin film transistor electrodes 124. The insulation film 128 includes transparent and reflective regions 134 and 133 which are different in thickness. Light shielding films 126 are positioned underneath boundaries of the transparent and reflective regions 134 and 133. Where an optical exposure stage includes different reflection coefficient portions, the light shielding films 126 prevent light reflected by the exposure stage from reaching the insulation film thereby maintaining the accuracy of its patterning.



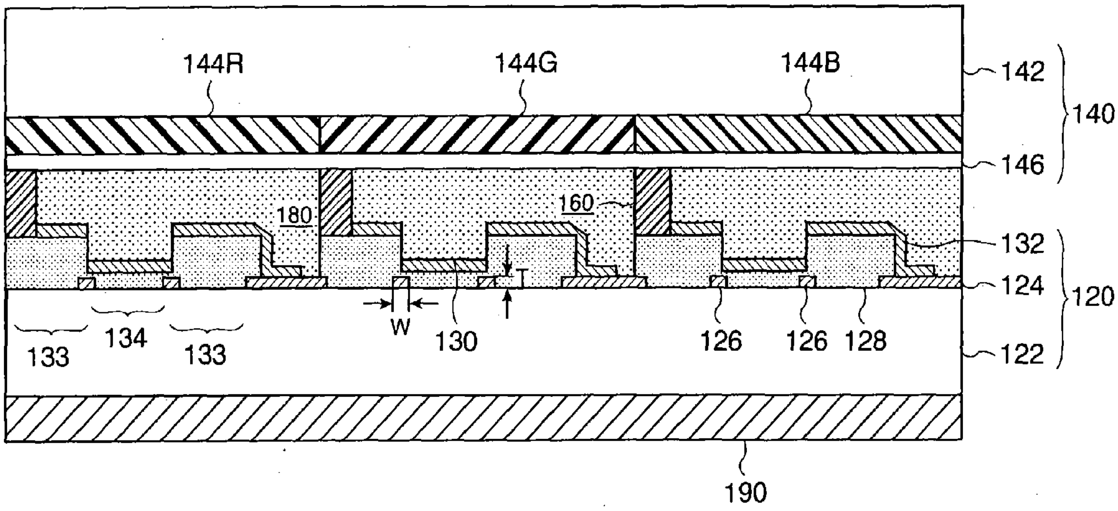

144R
144G
144B
142
140
146
180
160
132
124
120
133
134
133
W
130
T
126
126
128
122
190

FIG. 1

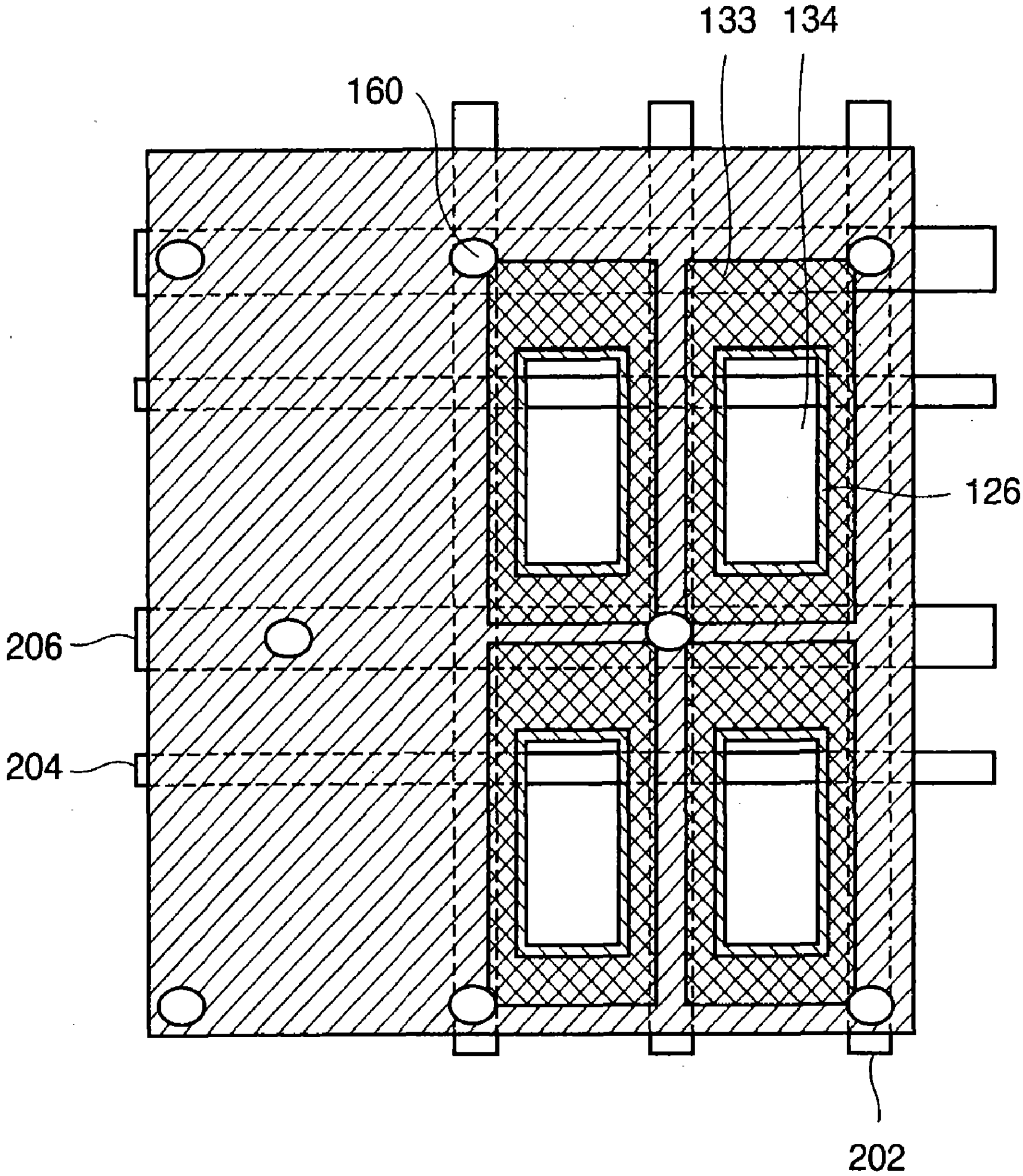


FIG. 2

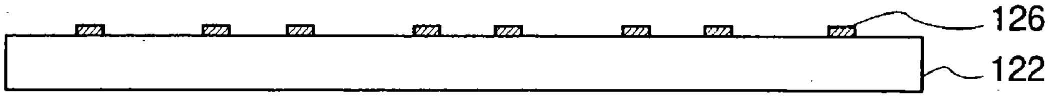


FIG. 3A

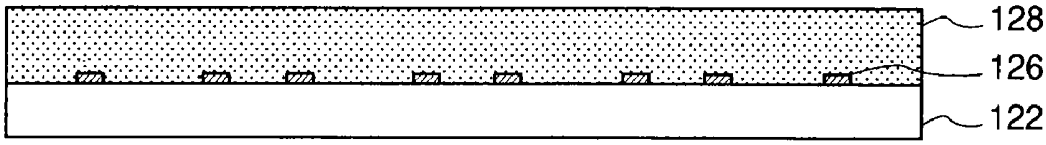


FIG. 3B

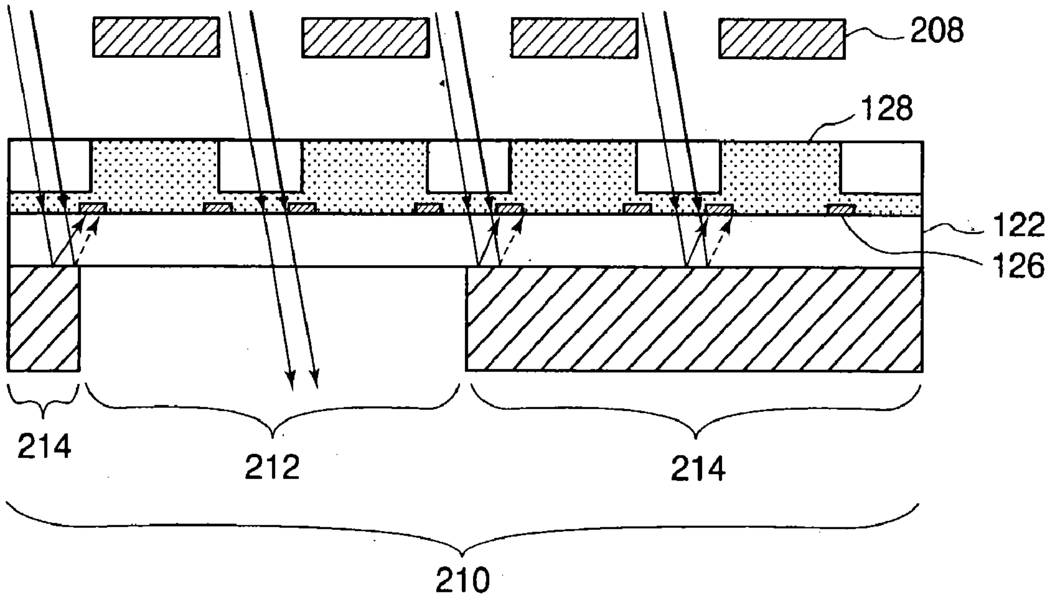


FIG. 3C

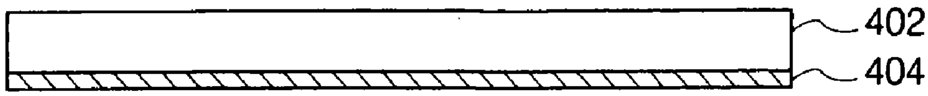


FIG. 4A

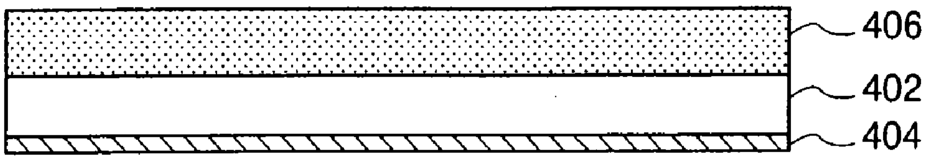


FIG. 4B

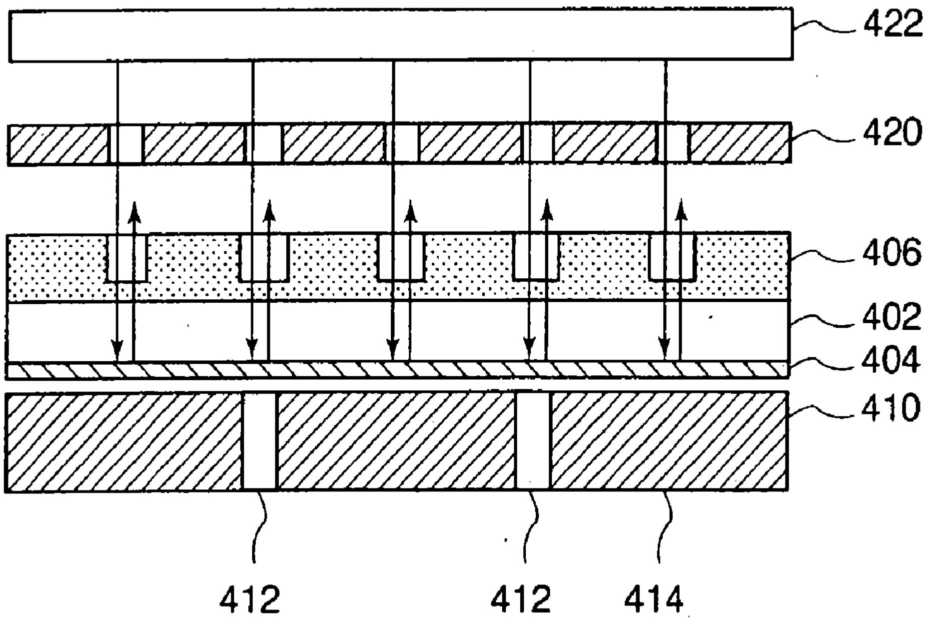


FIG. 4C

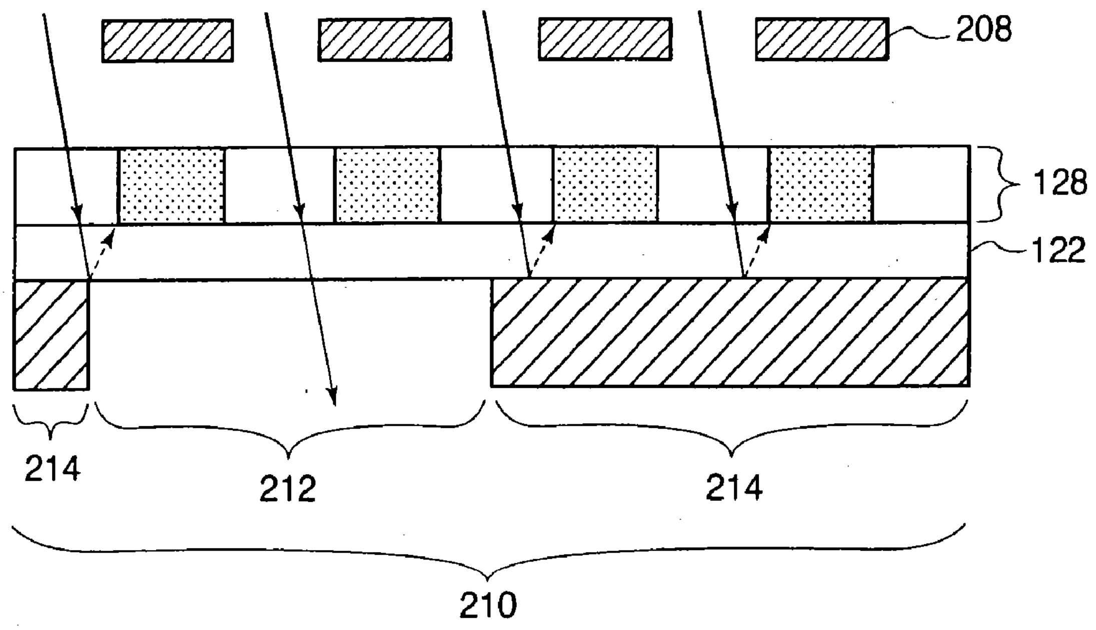


FIG. 5 PRIOR ART

LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

FIELD OF THE INVENTION

[0001] This invention generally relates to a liquid crystal display device and a method of manufacturing the same and, more particularly, to a liquid crystal display device requiring highly accurate dimensions of a photomask pattern designed for the exposure of photoresist and a method of manufacturing such liquid crystal display device.

BACKGROUND OF THE INVENTION

[0002] A half transparent or hybrid type liquid crystal display (LCD) device includes a thin film transistor (TFT) array substrate, which is, in turn, provided with reflective and transparent display portions. The reflective display portion is generally made of thin film transistors formed on the TFT array substrate, an insulation film covering the thin film transistors and reflective electrodes formed on the insulation film. The transparent display portion is, on the other hand, made of the insulation film and transparent electrodes. The insulation film of the reflective display portion is different in thickness from that of the transparent display portion to increase the reflectivity and transmittance of the reflective and transparent display portions, respectively. In addition, when the TFT array substrate is put together with a counter substrate, the cell gaps defined in the reflective and transparent display portions are configured to be optimal, respectively. In order to adjust such thickness difference between the reflective and transparent display portions, a photoresist is coated on both the reflective and transparent display portions of the TFT array substrate, the transparent display portion is subjected to an optical exposure treatment, and both reflective and transparent display portions are developed and post-baked.

[0003] Since a photoresist with high transmittance is, however, used for the insulation film, it is subjected to reflecting light from an exposure stage during the exposure treatment.

[0004] As shown in **FIG. 5**, an optical exposure stage **210** is provided with recesses **212**, which are used to set a TFT array substrate on the exposure stage **210** or to detach it from the stage **210**, and plates **214**. Although the recesses **212** do not reflect incident light, the plates **214** reflect it as shown by dotted lines and arrows. Thus, portions of an insulation film **128** corresponding to the recesses **212** receive incident light passing through a photomask **208**. The other portions of the insulation film **128** corresponding to the plates **214**, however, receive not only incident light passing through the photomask **208** but also reflecting light from the plates **214**. Since pattern dimensions depend on receiving quantity of light, patterns of the portions positioned above the recesses **212** are small in width but those of the portions positioned above the plates **214** are wide in width though not shown in different widths in **FIG. 5**. Such pattern different widths between them cause visibly uneven brightness of images displayed by an LCD device.

SUMMARY OF THE INVENTION

[0005] It is, accordingly, an object of the present invention to provide an LCD device without such visibly uneven brightness.

[0006] It is another object of the present invention to provide an LCD device with improvement of such visibly uneven brightness caused by pattern width difference resulting from receiving quantity of light reflecting from an optical exposure stage.

[0007] According to one aspect of the present invention, an LCD device comprises a substrate, thin film transistors formed on the substrate, an insulation film defining first and second regions to cover the thin film transistors, the first and second regions of the insulation film being different in thickness from each other, and light shielding films provided at portions underneath boundaries of the first and second regions.

[0008] The LCD device further comprises transparent electrode film formed on the first region, and reflective electrode film formed on the second region.

[0009] The LCD device is characterized in that the light shielding film is made of the same material as the thin film transistors.

[0010] According to another aspect of the present invention, a method of manufacturing an LCD device comprises the steps of forming a light shielding film with first and second regions on a substrate, forming a photosensitive insulation film on the light shielding film, and exposing the insulation film to position the light shielding film at boundaries of the first and second regions by using a photomask.

[0011] The method of manufacturing a liquid crystal display device is characterized in that the step of forming the light shielding film further forms thin film transistors by using the same material as the light shielding film.

[0012] According to a unique aspect of the present invention, a method of manufacturing a liquid crystal display device comprises the steps of forming any one of reflective, light shielding or diffusing films on a back surface of a substrate, forming a photosensitive insulation film on a front surface of the substrate, and exposing the insulation film by using a photomask.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed descriptions when considered in connection with the accompanying drawings, wherein:

[0014] **FIG. 1** shows a schematically sectional view of an LCD device in accordance with a first embodiment of the present invention;

[0015] **FIG. 2** is a partial schematic view of a layout of the LCD device shown in **FIG. 1**;

[0016] **FIGS. 3A** to 3C are sectional views of components to explain production steps of the LCD device in accordance with the first embodiment of the present invention;

[0017] **FIGS. 4A** to 4C are sectional views of components to explain production steps of the LCD device in accordance with a second embodiment of the present invention; and

[0018] **FIG. 5** is a schematically sectional view to explain a prior art production step of an LCD device.

DETAILED EXPLANATION OF THE PREFERRED EMBODIMENTS

[0019] Embodiments of the present invention will be explained below with reference to the attached drawings. It should be noted that the present invention is not limited to the embodiments but covers their equivalents. Throughout the attached drawings, similar or same reference numerals show similar, equivalent or same components. The drawings, however, are shown schematically for the purpose of explanation **80** that their components are not necessarily the same in shape or dimension as actual ones. In other words, concrete shapes or dimensions of the components should be considered as described in these specifications, not. in view of the ones shown in the drawings. Further, some components shown in the drawings may be different in dimension or ratio from each other.

FIRST EMBODIMENT

[0020] **FIG. 1** shows a schematically sectional view of an LCD device in accordance with a first embodiment of the present invention. As shown in **FIG. 1**, the LCD device includes a thin film transistor (TFT) array substrate **120** and a color filter substrate **140**. The TFT array and color filter substrates **120** and **140** are provided opposite to each other, define a predetermined cell gap supported by spacers **160**, and are put together by a sealing material around their peripheral portions. A liquid crystal material injected into the cell gap becomes a liquid crystal layer **180**.

[0021] The TFT array substrate **120** includes a transparent glass plate **122**, and TFT electrodes **124** and light shielding films **126** formed on the glass plate **122**. The TFT electrodes **124** and light shielding films **126** are covered with an insulation film **128**. Further, the insulation film **128** is coated with transparent electrodes **130** made of an indium-tin-oxide (ITO) film and reflective electrodes **132** made of a metal film. In order to widen a viewing field for reflecting light, the reflective electrodes **132** are provided with uneven portions. An alignment film (not shown) is coated on the transparent and reflective electrodes **130** and **132**.

[0022] The light shielding films **126** to be explained later in detail with reference to **FIG. 2** are made of such materials that substantially prevent light, which passes through regions of the transparent electrode and reflects from an optical exposure stage to be set forth later with reference to **FIG. 3**C, from arriving at regions of the reflective electrodes **132**. They are preferably of the same materials as those of the TFT electrodes **124** such as molybdenum because the light shielding films **126** are formed in the same process as the TFT electrodes **124**.

[0023] The light shielding films **126** are disposed at the locations underneath the boundary regions between transparent and reflection regions **134** and **133**. The thickness and width of the light shielding films **126** are configured to substantially prevent light, which passes through regions of the transparent electrodes and reflects from the exposure stage, from arriving at regions of the reflective electrodes **132**. In other words, the thickness and width of the light shielding films **126** are determined in accordance with a material and light beam radiating conditions, such as light wavelength, frequency, and radiating angle and duration. For example, where such a material and radiating energy are molybdenum and 300 mJ/cm^2, respectively, the light shielding films **126** are 0.3 μm to 10 μm in thickness and preferably about 6 μm in width.

[0024] **FIG. 2** shows a partial schematic view of a layout of the LCD device shown in **FIG. 1**. As shown in **FIG. 2**, signal lines **202** cross over scanning lines **204** to form a matrix. The transparent and reflective regions **134** and **133** are provided in each element (pixel) of the matrix. Auxiliary capacitor lines **206** are disposed in parallel with the scanning lines **204**. As described above, the light shielding films **126** are provided at the locations underneath the boundary regions between the transparent and reflection regions **134** and **133**. Thus, the light shielding films **126** are shown in locations between the transparent and reflective regions **134** and **133** in **FIG. 2**. In short, the light shielding films **126** are provided to surround the transparent regions **134**.

[0025] On the other hand, as shown in **FIG. 1**, the color filter substrate **140** includes color photoresist films **144**R (red), **144**G (green) and **144**B (blue) formed on a transparent glass plate **142**. A transparent electrode **146** and is coated with an alignment film (not shown).

[0026] Further, there are two different length optical paths by way of the liquid crystal layer **180** through which light passes in response to transparent and reflective display modes of the LCD device shown in **FIG. 1**, respectively. Namely, when the LCD device carries out the transparent display mode, light from a rear light source **190** passes through the liquid crystal layer **180** once. However, when it carries out the reflective display mode, incident light from color photoresist film **144** passes through the liquid crystal layer **180** and light reflecting from the reflective electrode **132** passes through the liquid crystal layer **180** again. Where the height of the reflective electrode **132** is the same as that of the transparent electrode **130**, the optical length of the reflecting light is much longer than that of the light passing through. Thus, in order to obtain optimal optical characteristics in both transparent and reflective display modes, the cell gaps between the transparent electrode **130** and the electrode **146** and that between the reflective electrode **132** and the electrode **146** are necessarily designed to be optimum. The former is bigger than the latter as shown in **FIG. 1** to adjust the optical lengths to be optimum. For that purpose, optical exposure is carried out only for the regions in the substrate on which the transparent electrodes are formed and, then, the substrate is subjected to development and post baking processes.

[0027] A method of manufacturing the LCD device of the first embodiment will be explained with reference to **FIGS. 3A, 3B** and 3C. The method of manufacturing the LCD device is primarily characterized in that the light shielding films **126** are formed on the glass plate **122** as shown in **FIG.** 3A, the photosensitive insulation film **128** is further coated on the. light shielding films **126** and the glass plate **122** as shown in **FIG.** 3B and optical energy radiation is carried out only for the transparent regions of the insulation films **128** by using the photomask **208** as shown in **FIG. 3C**.

[0028] As shown in **FIG. 3**C, the radiating light passes through the recess **212** of an optical exposure stage **210** and travels to the other side of the exposure stage **210**. The reflecting light from the plates **214**, on the other hand, travels in the glass plate **122** again but does not reach the insulation film **128** because the light shielding films **126** stop it. Thus, the portions of the insulation film **128** positioned above both the recess **212** and the plates **214** receive substantially the same quantity of light.

[**0029**] A comparison test has been made for each of the following LCD devices: (1) the first embodiment LCD device provided with patterns of the thick and thin portions of the insulation film underneath the transparent and reflective electrodes **130** and **132**, respectively, and with the light shielding films **126** formed around the transparent regions **134**, and (2) a prior art LCD device provided with patterns of the thick and thin portions of the insulation films underneath the transparent and reflective electrodes, respectively, but with no light shielding films. As a result, 70% uneven display has been visibly recognized for the prior art LCD device but no uneven display has been visibly recognized for the first embodiment LCD device.

[**0030**] Since, as described above with respect to the first embodiment, the receiving quantity of light is substantially equal for both portions of the insulation film **128** positioned above the recesses **212** and the plates **214**, neither the patterns positioned above the recesses **212** become narrow in width nor those above the plates **214** become wide in width. Its structure does not bring about an uneven display For the sake of simplicity, the TFT electrodes **124** are omitted from the drawings of **FIGS. 3A** to **3**C. In order to reduce manufacturing steps, time and costs, it is preferable to form the TFT electrodes **124** at the same time, and by using the same material, as the light shielding films **126**.

SECOND EMBODIMENT

[**0031**] The LCD device according the first embodiment of the present invention prevents an uneven display due to different reflection coefficients at the exposure stage **210** with the light shielding films **126** provided at predetermined locations between the glass plate **122** and the insulation film **128**. An LCD device in accordance with a second embodiment of the present invention is, however, provided with a reflective film coated on the back surface of its TFT array substrate to avoid such an uneven display.

[**0032**] The second embodiment LCD device will be explained below with reference to **FIGS. 4A** to 4C. A method of manufacturing the second embodiment LCD device is characterized in that a reflective film **404** is formed on a glass plate **402** as shown in **FIG. 4A, a** photosensitive insulation film **406** is formed on the glass plate as shown in **FIG.** 4B, and energy radiation is selectively carried out for transparent regions of the insulation film **406** by using a photomask **420** as shown in **FIG. 4C**.

[**0033**] Now, the second embodiment LCD device will be explained below in detail. A 400 mm×500 mm glass plate **402** is prepared and a reflective chromium film **404** is uniformly formed on its back surface (**FIG. 4A**). The film forming and patterning steps similar to those in an ordinary process to form thin film transistors are repeated to form thin film transistors, electrodes, wirings and pixel electrodes (but such thin film transistors, electrodes, wirings and pixel electrodes are not shown in **FIGS. 4A, 4B** or 4C).

[**0034**] A photosensitive organic insulation film **406** is then coated on the glass plate **402** on which the thin film transistors, etc. are formed (**FIG. 4B**). The glass plate **402** provided with the reflective and insulation films **404** and **406** on its dual surfaces, respectively, is loaded on an optical exposure stage **410**. The exposure stage **410** is provided with recesses **412** used to set the glass plate **402** on the exposure stage **410** or to detach it from the stage **410**. Light from a light source **422** is radiated only through transparent portions with the photomask **420**. The radiated light does not pass through the reflective film **404** but reflects from it. Such reflecting light passes through the glass plate **402** and the insulation film **406** again and returns to the photomask **420**. The quantity of the light passing through, and returning to, the insulation film **406** is substantially the same whether the transparent regions are positioned above the recesses or not. Dimensions or shapes of the uneven portions of the insulation film **406** formed after the exposure and development treatments are substantially the same whether the transparent regions are positioned above the recesses or not. Thus, an uneven display is not visually recognized on the LCD device.

[**0035**] Instead of coating the reflective film **404** on the back of the glass plate **402**, a light shielding or diffusion film can be alternatively attached to it to obtain substantially the same effect as in the first embodiment. A light shielding film **404** prevents the light from reaching the exposure stage **410**, i.e., the light reflecting from the exposure stage **410** does not return to the insulation film **406** whether the transparent regions are positioned above the recesses or not. Also, the diffusion film diffuses the light traveling to the exposure stage **410**. As a result, in either case, the light transmitted from the exposure stage **410** to the insulation film **406** remains substantially the same in quantity whether the transparent regions are positioned above the recesses or not.

[**0036**] After uneven (concave and convex) portions are made on the insulation film **406**, reflective and transparent electrodes are formed on the concave and convex portions to define reflective and transparent regions, respectively. It is desirable to use ITO and molybdenum or aluminum films for the transparent and reflective electrodes, respectively. Further, it is also desirable to form much smaller convex and concave portions on the surface of the convex portions so that they diffuse the incident light to widen a viewing angle in the reflective display mode.

[**0037**] With the structure described above, the total receiving quantity of light at the portions positioned above the recesses **412** of the exposure stage **410** is substantially the same as that at the portions positioned above absence of the recesses **412** of the exposure stage **410**. Thus, pattern sizes formed on the insulation film **406** are not different whether such pattern is positioned above the recesses **412** of the exposure stage **410** or not. An uneven display has not been visually recognized in the second embodiment LCD device, either.

[**0038**] According to the present invention, the receiving quantity of light by a photosensitive resin film from an optical exposure stage is nil or uniform even though an exposure stage includes surface portions with uneven reflection coefficients and an LCD device has uniform brightness or displays.

1. A liquid crystal display device comprising:

a substrate;

thin film transistors formed on said substrate;

an insulation film defining first and second regions to cover said thin film transistors,

said first and second regions of said insulation film being different in thickness from each other; and

a light shielding film provided at portions underneath boundaries of said first and second regions.

2. The liquid crystal display device according to claim 1, further comprising:

transparent electrode film formed on said first region; and

reflective electrode film formed on said second region.

3. The liquid crystal display device according to claim 1 or **2**, wherein said light shielding film is made of the same material as said thin film transistors.

4. A method of manufacturing a liquid crystal display device comprising the steps of:

forming a light shielding film with first and second regions on a substrate;

forming a photosensitive insulation film on said light shielding film; and

exposing said photosensitive insulation film to position said light shielding film at boundaries of said first and second regions by using a photomask.

5. The method of manufacturing a liquid crystal display device according to claim 4, wherein said step of forming said light shielding film further forms thin film transistors by using the same material as said light shielding film.

6. A method of manufacturing a liquid crystal display device comprising the steps of:

forming any one of reflective, light shielding or diffusing films on a back surface of a substrate;

forming a photosensitive insulation film on a front surface of said substrate; and

exposing said insulation film by using a photomask.

* * * * *

专利名称(译)	液晶显示装置及其制造方法		
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[标]申请(专利权)人(译)	株式会社东芝		
申请(专利权)人(译)	株式会社东芝		
当前申请(专利权)人(译)	日本展示CENTRAL INC.		
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优先权	2002219888 2002-07-29 JP		
其他公开文献	US6933995		
外部链接	Espacenet USPTO		

摘要(译)

LCD装置包括透明玻璃板122和形成在玻璃板122上的薄膜晶体管电极124.光敏绝缘膜128涂覆在玻璃板122和薄膜晶体管电极124上。绝缘膜128包括透明和反射的区域134和133的厚度不同。遮光膜126位于透明和反射区域134和133的边界下方。当光学曝光台包括不同的反射系数部分时，遮光膜126防止曝光台反射的光到达绝缘膜，从而保持精度。它的图案。