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(54) **LIQUID CRYSTAL DISPLAY PANEL**

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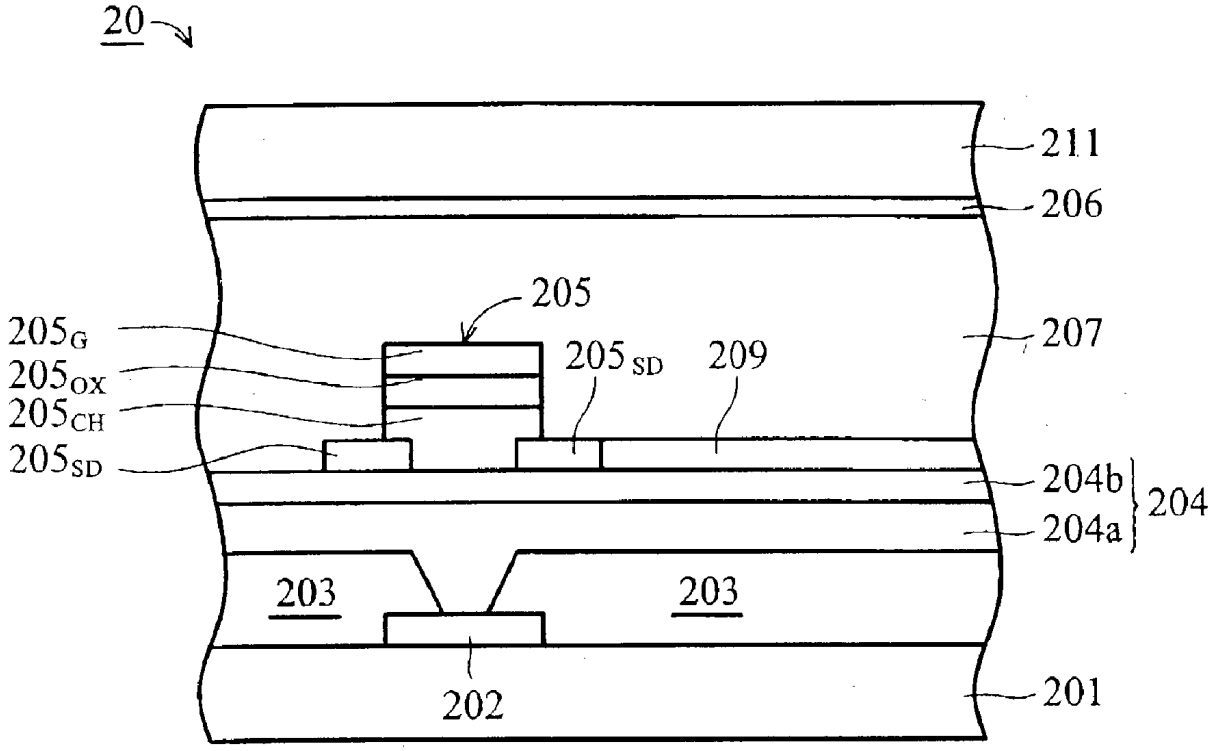
(57) **ABSTRACT**

A LCD panel. The LCD panel includes first and second substrates, a black matrix, a color filter, a composite layer, a plurality of pixel elements, a transparent conductive layer, and a liquid crystal layer. The substrates are opposed to each other. The black matrix is disposed on the first substrate, and the color filter is disposed on the first substrate and at least a portion of the black matrix. The composite layer is disposed on the color filter and the black matrix. The pixel elements corresponding to the color filter are disposed on the composite layer and arranged as array. The transparent conductive layer is disposed on the second substrate. The liquid crystal layer formed between the first and second substrates.



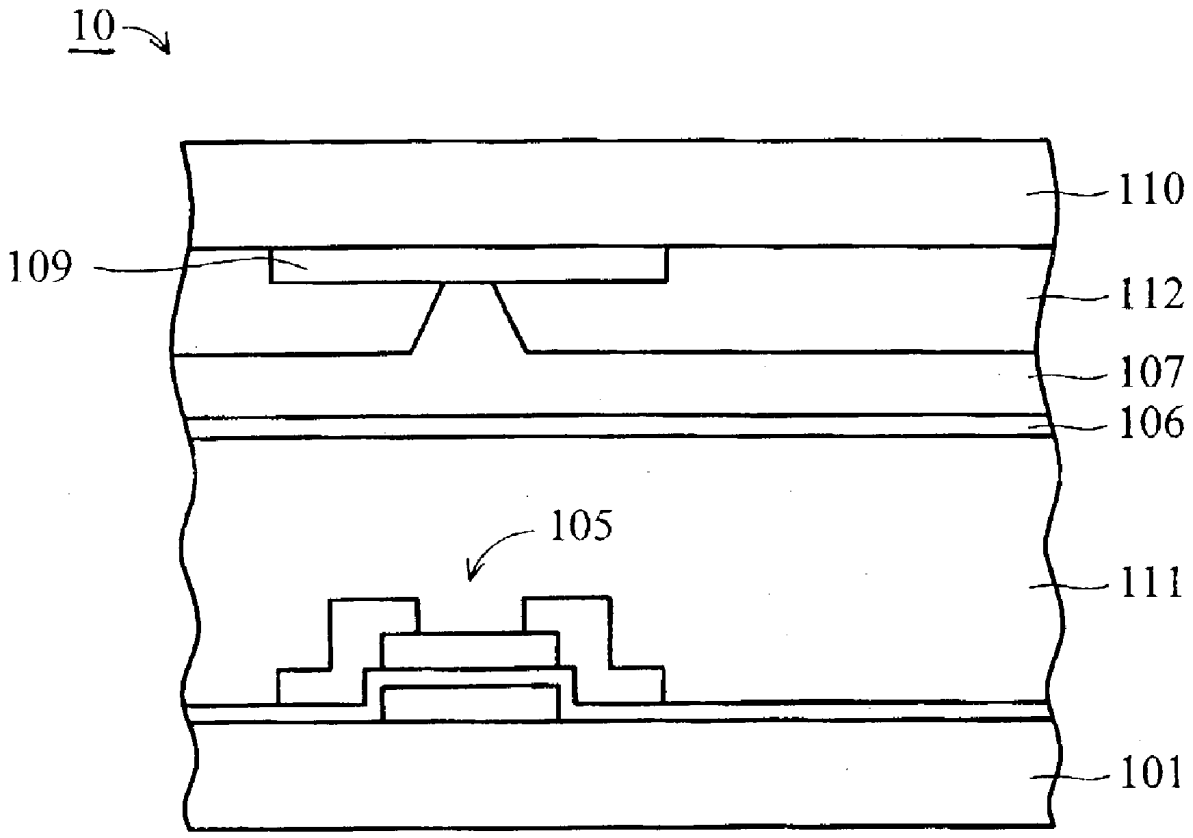


FIG. 1 (PRIOR ART)

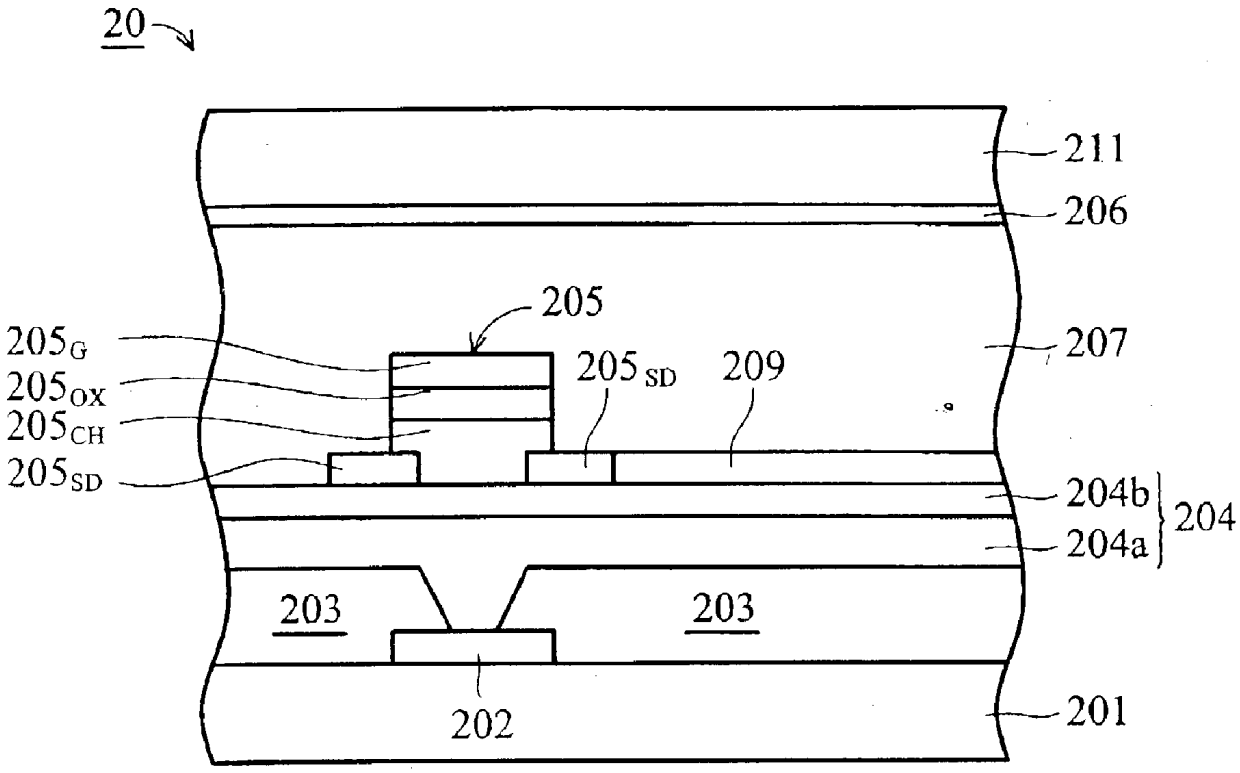

20
211
206
205
205_G
205_{OX}
205_{CH}
205_{SD}
205_{SD}
209
207
204b
204a
204
203
203
202
201

FIG. 2

LIQUID CRYSTAL DISPLAY PANEL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates in general to a liquid crystal display (LCD) panel. In particular, the present invention relates to thin film transistors (TFTs), color filters, black matrixes disposed on the same substrate of the LCD panel.

[0003] 2. Description of the Related Art

[0004] LCDs have the advantages of low power consumption, thin profiles, light weight and low driving-voltage. LCDs have been put to practical use with personal computers, navigation systems, hand held gaming devices, projectors, view finders and portable electronics (watches, electronic calculators and televisions).

[0005] In a conventional thin film transistor liquid crystal display (TFT-LCD) panel, the backlight module results in high power consumption. Varied TFT structures and manufacturing approaches such as increasing the backlight power or increasing the transparency of the LCD have been disclosed, to reduce power consumption.

[0006] **FIG. 1** is a cross sectional diagram showing a conventional LCD panel structure. The conventional LCD panel **10** includes: two glass substrates (bottom substrate **101** and top substrate **110**), a black matrix **109**, a color filter **112**, a passivation layer **107**, a transparent conductive layer **106** such as indium tin oxide (ITO), a plurality of TFTs (herein, only one TFT is shown) **105**, and a liquid crystal layer **111**. The glass substrates **101** and **110** are oppositely disposed each other. The black matrix **109** is disposed on the top substrate **110**, and the color filter **112** is disposed on the top substrate **110** and the black matrix **109**. The passivation layer **107** and the transparent conductive layer **106** are sequentially disposed on the color filter **112**. TFTs **105** are disposed and arranged on the bottom substrate **101** to create TFT array. The liquid crystal layer **111** in which liquid crystal has been filled is formed between bottom substrate **101** and top substrate **110**.

[0007] In **FIG. 1**, the TFT **105** used for LCD panel **10** is directly formed on the bottom substrate **101** near the backlight module (not shown), and the color filter **112** is formed on the top substrate **110**. Since TFT array is directly formed on the bottom substrate **101** near the backlight module, the transparency of the LCD panel **10** is decreased. This results in poor picture quality.

[0008] In addition, each TFT **105** in the TFT array has a bottom gate structure (as shown in **FIG. 1**), and fabrication of the conventional LCD panel **10** requires at least five patterning masks. This results in higher manufacturing cost. Furthermore, it is difficult to achieve mass production.

[0009] Therefore, increasing the picture quality and simplifying the TFT process steps is a very important issue for the LCD industry.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide a LCD panel manufactured by a simplified TFT process to increase the throughput and reduce the manufacturing cost. Moreover, it is an object of the present invention to provide a LCD panel with increased transparency, thereby improving the picture quality.

[0011] According to an aspect of the invention, there is provided a LCD panel including: first and second substrates, which oppose each other; a black matrix disposed on the first substrate; a color filter disposed on the first substrate and at least a portion of the black matrix; a composite layer disposed on the color filter and the black matrix; a plurality of pixel elements corresponding to the color filter arranged as array on the composite layer; a transparent conductive layer disposed on the second substrate; and a liquid crystal layer formed between the first and second substrates.

[0012] Each of the pixel elements is composed of at least one thin film transistor and one pixel electrode. Moreover, in the present invention, the thin film transistor has a top-gate structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings, given by way of illustration only and thus not intended to be limitative of the present invention.

[0014] **FIG. 1** is a cross-sectional diagram showing a conventional LCD panel structure.

[0015] **FIG. 2** is a cross-sectional diagram showing a LCD panel structure according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] **FIG. 1** is a cross-sectional schematic diagram of the LCD panel structure according to the present invention. In the embodiment of the invention, the LCD panel **20** structure includes the follow elements.

[0017] First, a first substrate **201** and a second substrate **211** are oppositely disposed each other. In the invention, the first substrate **201** serves as a bottom substrate (the substrate close to the backlight module), and the second substrate **211** serves as a top substrate. The first and second substrates **201** and **211** are transparent substrate such as glass substrate, quartz substrate or the like. In the embodiment, the glass substrates are used for the first and second substrates **201** and **211**.

[0018] Next, a black matrix **202** is disposed on the first substrate **201**. Functions of the black matrix **202** are described as follow:

[0019] (1) Masking the light, which influences the picture quality, to enhance the contrast of the LCD panel;

[0020] (2) Surrounding each pixel element in LCD panel to prevent color mixing between red (R), green (G), and blue (B) colors; and

[0021] (3) Masking the amorphous silicon film (α-Si film) in the TFT to prevent irradiation by stray light.

[0022] The materials used for the black matrix **202** can be chromium (Cr), molybdenum (Mo), aluminum (Al), tung-

sten (W), tantalum (Ta), titanium (Ti) or the like. In the embodiment, chromium metal is used for black matrix **202**.

[**0023**] Next, a color fitter **203** is disposed on the first substrate **201** and at least a portion of the black matrix **202**. The color filter **203** is composed of three types of color coatings (R, G, and B) according to the specific arrangment, and corresponds to the pixel electrode in the LCD panel **20**.

[**0024**] Next, a composite layer **204** is disposed on the color filter **203** and the black matrix **202**. In the embodiment, the composite layer **204** includes a planarizing layer **204***a* and an optionally passivation layer **204***b*. The planarizing layer **204***a* is used for eliminating the rough surface due to the color filter **203** and the black matrix **202**, and the passivation layer **204***b* is used for protecting each device structure disposed on the bottom substrate **201** from damage in subsequent process. The planarizing layer **204***a* can be a transparent insulator such as resin or polymer. The passivation layer **204***b* can be silicon nitride or silicon oxynitride.

[**0025**] Next, pixel elements corresponding to the color filter **203** are disposed on the composite layer **204** and arranged as an array. Each of the pixel elements is composed of one TFT **205** and one pixel electrode **209**. All the TFTs **205** (herein, only one TFT is shown to simplify the diagram) create the TFT array (not shown). Moreover, in the embodiment, each TFT **205** has a top-gate structure. The TFT **205** includes source and drain regions $\mathbf{205}_{SD}$, a channel layer $\mathbf{205}_{CH}$, and a gate structure (gate $\mathbf{205}_{G}$ and gate insulating layer $\mathbf{205}_{OX}$) . The source and drain regions $\mathbf{205}_{SD}$ are disposed on the comoosite layer **204** separated by an interval, and one of them is connected to the pixel electrode **209**. The channel layer $\mathbf{205}_{CH}$ such as an amorphous silicon layer is disposed on the composite layer **204** between the source and drain regions $\mathbf{205}_{SD}$, and electrically connected to the source and drain regions $\mathbf{205}_{SD}$, respectively. The gate $\mathbf{205}_{C}$ and gate insulating layer $\mathbf{205}_{OX}$ are disposed on the channel layer $\mathbf{205}_{CH}$. In addition, the TFT **205** may have a bottom-gate structure as known in the prior art.

[**0026**] Next, a transparent conductive layer **206** is disposed on the second substrate **211**. In the embodiment, the transparent conductive layer **206** is ITO.

[**0027**] Finally, a liquid crystal layer **207** in which liquid crystal has been filled is formed between the top substrate **211** and the bottom substrate **201**.

[**0028**] According to the LCD panel **20** of the invention, the TFT **205** having a top-gate structure can be defined by lithography using two to four patterning masks only. Therefore, the throughput can be increased, and the manufacturing cost can be reduced. Moreover, since the black matrix **202** used for masking the TFT **205** to prevent irradiation by stray light and the TFT **205** are formed on the same substrate **201**, the distance between them can be closed to reduce the area of the black matrix **202**. Accordingly, the effective display area for LCD panel **20** can be increased.

[**0029**] Also, since no black matrix or color filter is disposed on the top substrate **201**, the transparence for the LCD panel **20** can be increased without raising the power.

[**0030**] The foregoing description has been presented for purposes of illustration and description. Obvious modifications or variations are possible in light of the above teaching. The embodiments were chosen and described to provide the best illustration of the principles of this invention and its practical application to thereby enable those skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the present invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

What is claimed is:

1. A liquid crystal display panel, comprising:

first and second substrates which oppose each other;

a black matrix disposed on the first substrate;

a color filter disposed on the first substrate and at least a portion of the black matrix;

a composite layer disposed on the color filter and the black matrix;

a plurality of pixel elements corresponding to the color filter arranged as array on the composite layer;

a transparent conductive layer disposed on the second substrate; and

a liquid crystal layer formed between the first and second substrates.

2. The display panel as claimed in claim 1, wherein each of the pixel elements is composed of at least one thin film transistor and one pixel electrode.

3. The display panel as claimed in claim 2, wherein the thin film transistor comprises:

source and drain regions disposed on the composite layer separated by an interval, and one of them connected to the pixel electrode;

a channel layer disposed on the composite layer between the source and drain regions, and electrically connected to the source and drain regions, respectively; and

a gate insulating layer and a gate structure disposed on the channel layer.

4. The display panel as claimed in claim 2, wherein the black matrix is disposed underlying each the thin film transistor.

5. The display panel as claimed in claim 3, wherein the black matrix is overlapped by the channel layer.

6. The display panel as claimed in claim 1, wherein the composite layer comprises a planarizing layer and an optional passivation layer disposed on the color filter and the black matrix.

7. The display panel as claimed in claim 6, wherein the planarizing layer is an organic transparent insulator, and the passivation layer is an insulating layer.

8. The display panel as claimed in claim 7, wherein the planarizing layer is resin or polymer.

9. The display panel as claimed in claim 7, wherein the passivation layer is silicon nitride or silicon oxynitride.

10. The display panel as claimed in claim 1, wherein the first and second substrates are transparent substrates.

11. The display panel as claimed in claim 1, wherein the transparent conductive layer is indium tin oxide.

12. The display panel as claimed in claim 1, wherein the channel layer is amorphous silicon (α-Si).

13. A liquid crystal display panel, comprising:

first and second substrates which oppose each other;

a black matrix disposed on the first substrate;

a color filter disposed on the first substrate and at least a portion of the black matrix;

a composite layer disposed on the color filter and the black matrix;

a thin film transistor array corresponding to the color filter arranged on the composite layer, each transistor of the thin film transistor array having a top-gate structure;

a transparent conductive layer disposed on the second substrate; and

a liquid crystal layer formed between the first and second substrates.

14. The display panel as claimed in claim 13, wherein the black matrix is disposed underlying each of the thin film transistors.

15. The display panel as claimed in claim 13, wherein the composite layer comprises a planarizing layer and an optional passivation layer disposed on the color filter and the black matrix.

16. The display panel as claimed in claim 15, wherein the planarizing layer is an organic transparent insulator, and the oassivation layer is an insulating layer.

17. The display panel as claimed in claim 16, wherein the planarizing layer is resin or polymer.

18. The display panel as claimed in claim 16, wherein the passivation layer is silicon nitride or silicon oxynitride.

19. The display panel as claimed in claim 13, wherein the first and second substrates are transparent substrates.

20. The display panel as claimed in claim 13, wherein the transparent conductive layer is indium tin oxide.

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专利名称(译)	液晶显示面板		
公开(公告)号	US20030142252A1	公开(公告)日	2003-07-31
申请号	US10/354343	申请日	2003-01-29
[标]申请(专利权)人(译)	友达光电股份有限公司		
申请(专利权)人(译)	友达光电.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	LUO FANG CHEN		
发明人	LUO, FANG CHEN		
IPC分类号	G02F1/1362 G02F1/1333		
CPC分类号	G02F1/1362 G02F2001/136231 G02F2001/136222 G02F1/136209		
优先权	091101452 2002-01-29 TW		
其他公开文献	US6888588		
外部链接	Espacenet USPTO		

摘要(译)

一块LCD面板。 LCD面板包括第一和第二基板，黑矩阵，滤色器，复合层，多个像素元件，透明导电层和液晶层。基板彼此相对。黑矩阵设置在第一基板上，滤色器设置在第一基板和黑矩阵的至少一部分上。复合层设置在滤色器和黑色矩阵上。对应于滤色器的像素元件设置在复合层上并排列成阵列。透明导电层设置在第二基板上。液晶层形成在第一和第二基板之间。