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(54) **LIQUID CRYSTAL DISPLAY PANEL AND LIQUID CRYSTAL DISPLAY DEVICE CONTAINING THE SAME**

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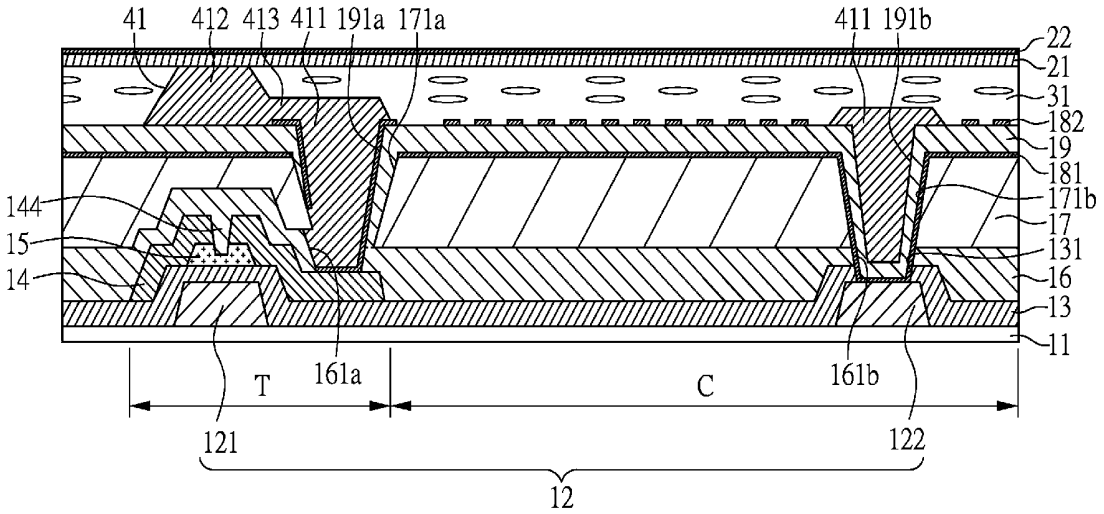
USPC **349/106**

(57) **ABSTRACT**

A liquid crystal display panel is disclosed, which comprises: a first substrate with a metal layer formed thereon; a first passivation layer, formed on the metal layer; a color filter layer with a first opening, disposed on the first passivation layer; a first electrode, formed on the color filter layer; a second passivation layer with a second opening, disposed on the first electrode layer and covering partial sidewall of the first opening, wherein the second opening corresponds to the first opening to expose the metal layer; a second electrode layer disposed on the second passivation layer and electrically connecting to the metal layer; a second substrate opposite to the first substrate; and a light-shielding layer, disposed between the first substrate and the second substrate and comprising a filling part, wherein the filling part is disposed in the second opening and covers the exposed color filter layer.



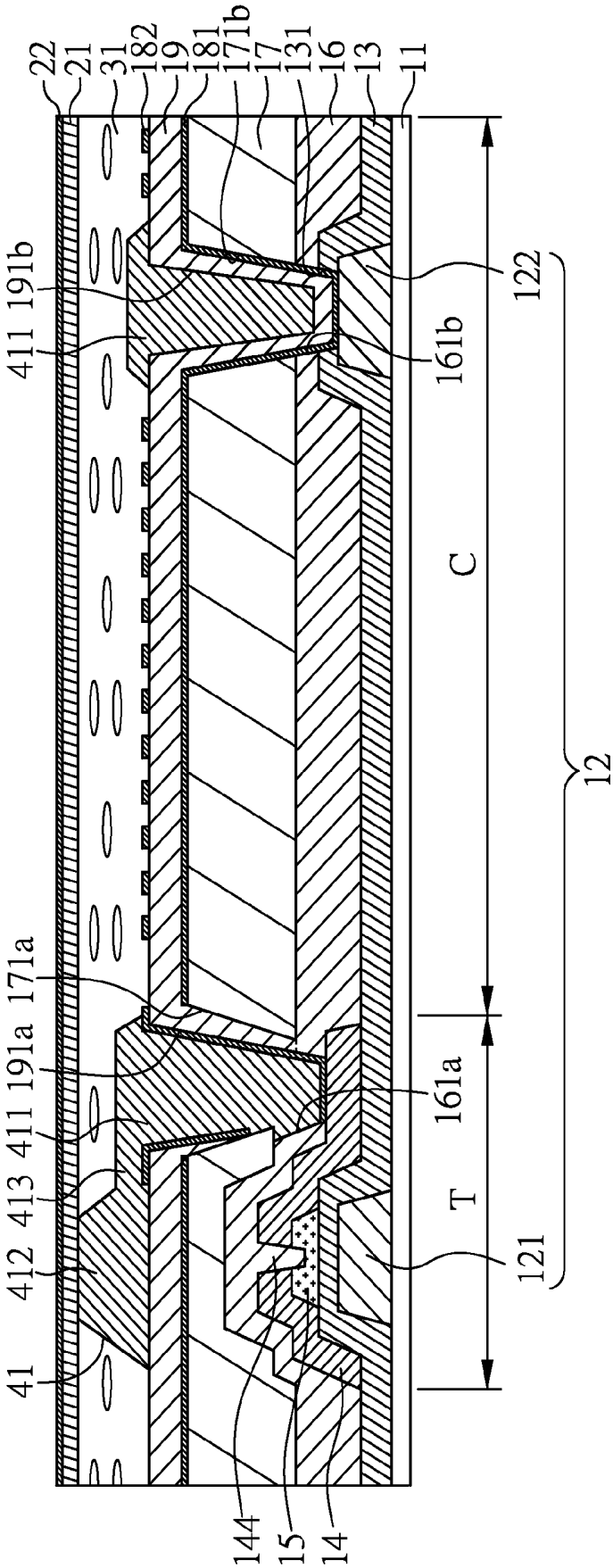

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FIG. 1

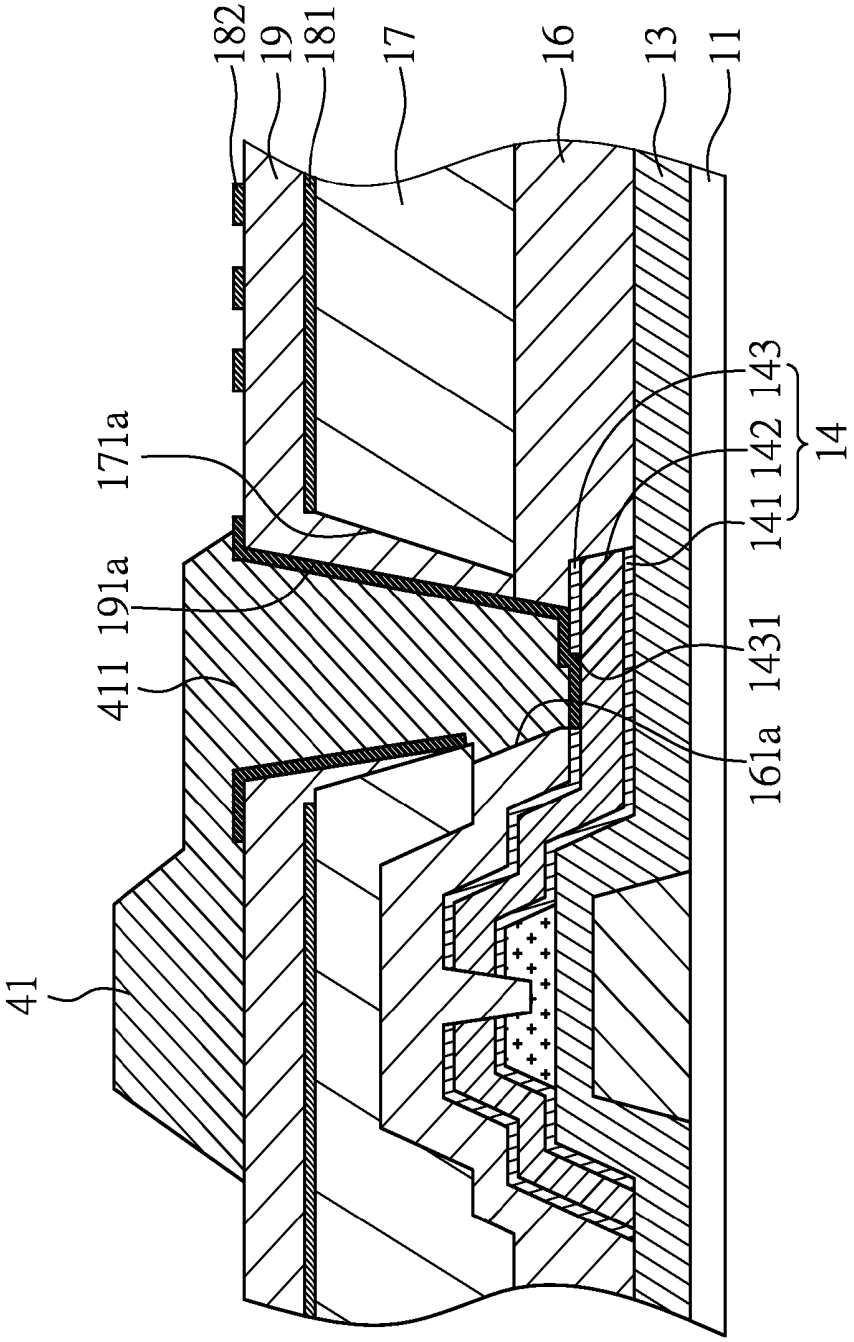

FIG. 2

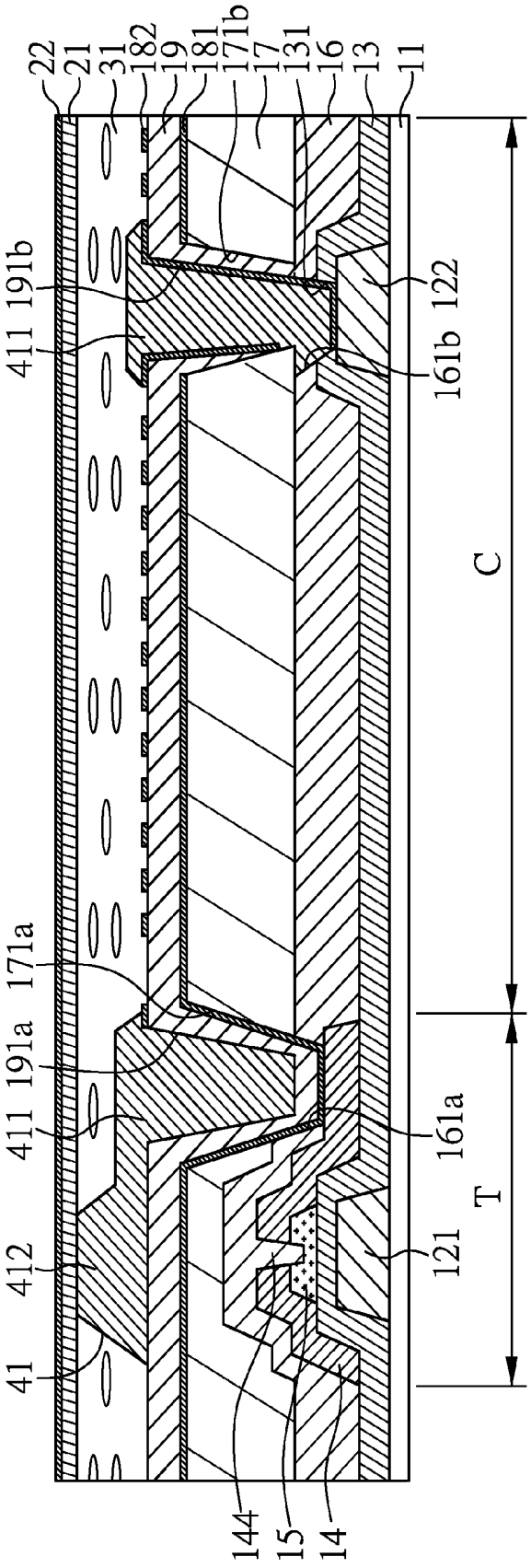
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FIG. 3

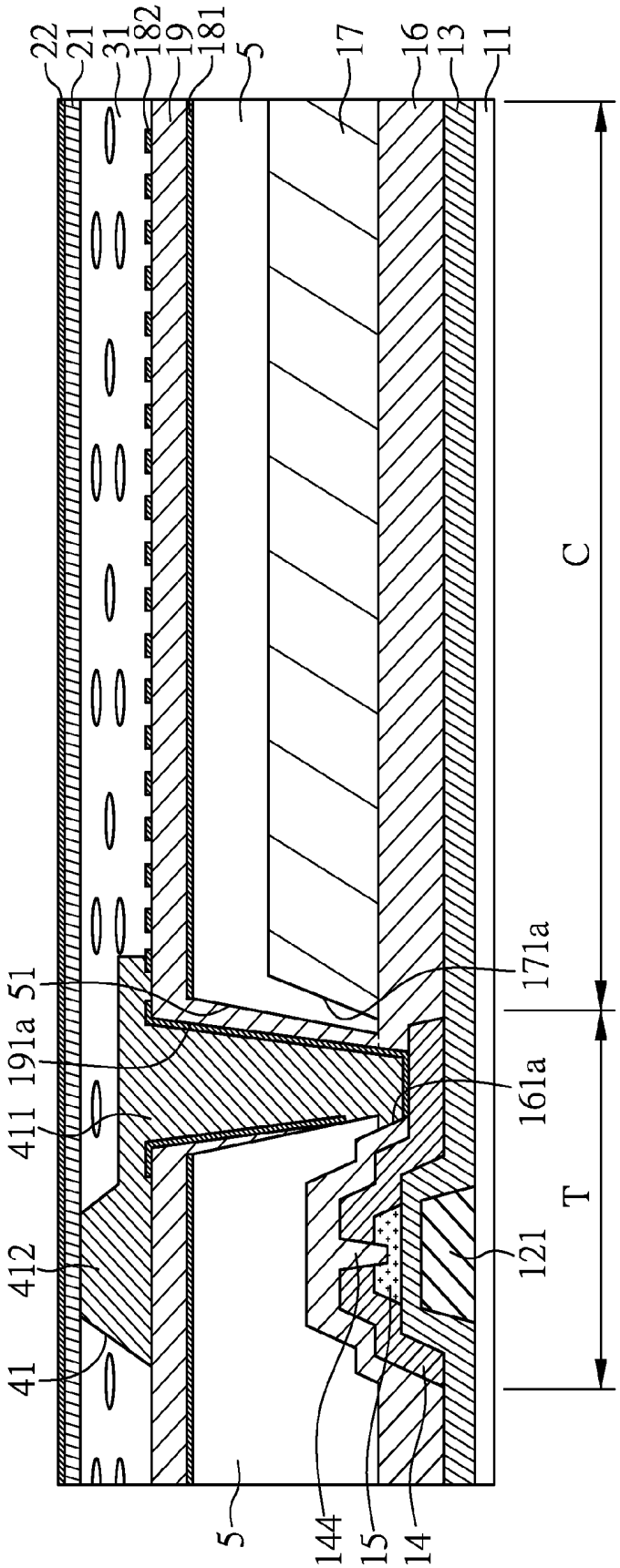
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FIG. 4

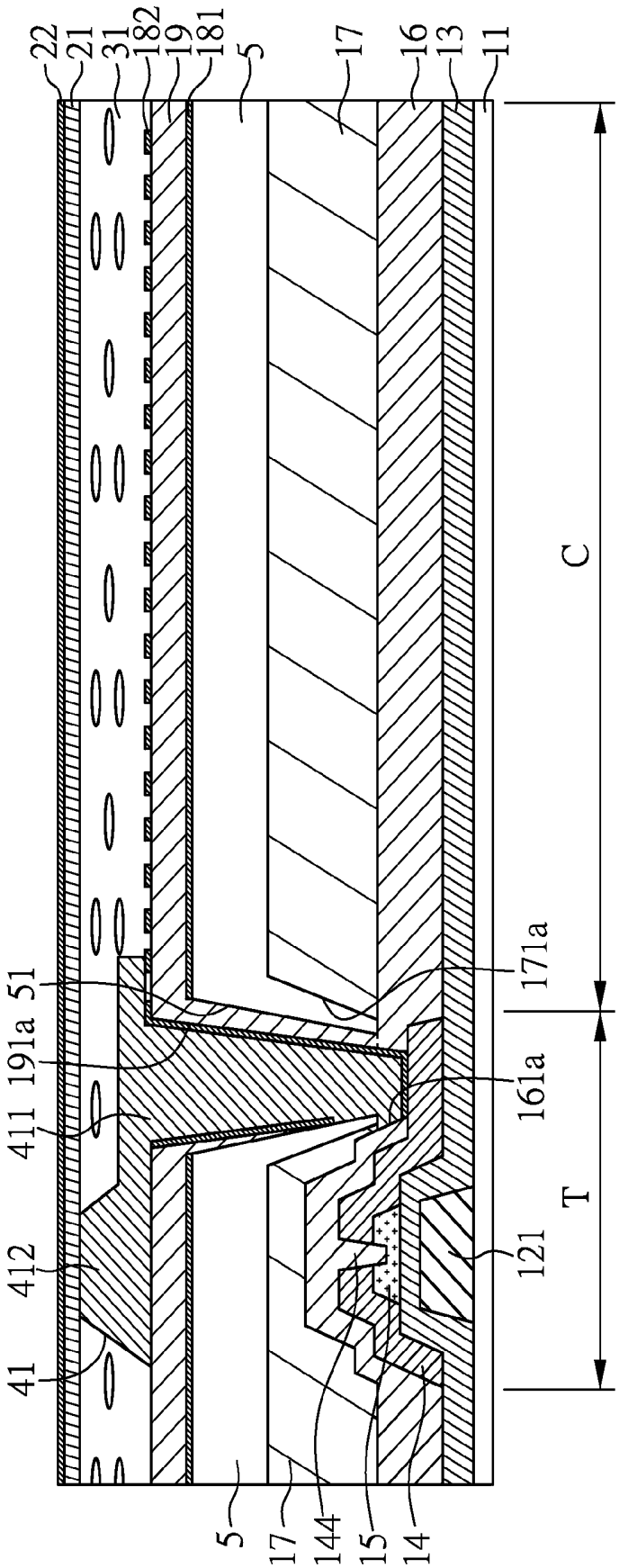
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FIG. 5

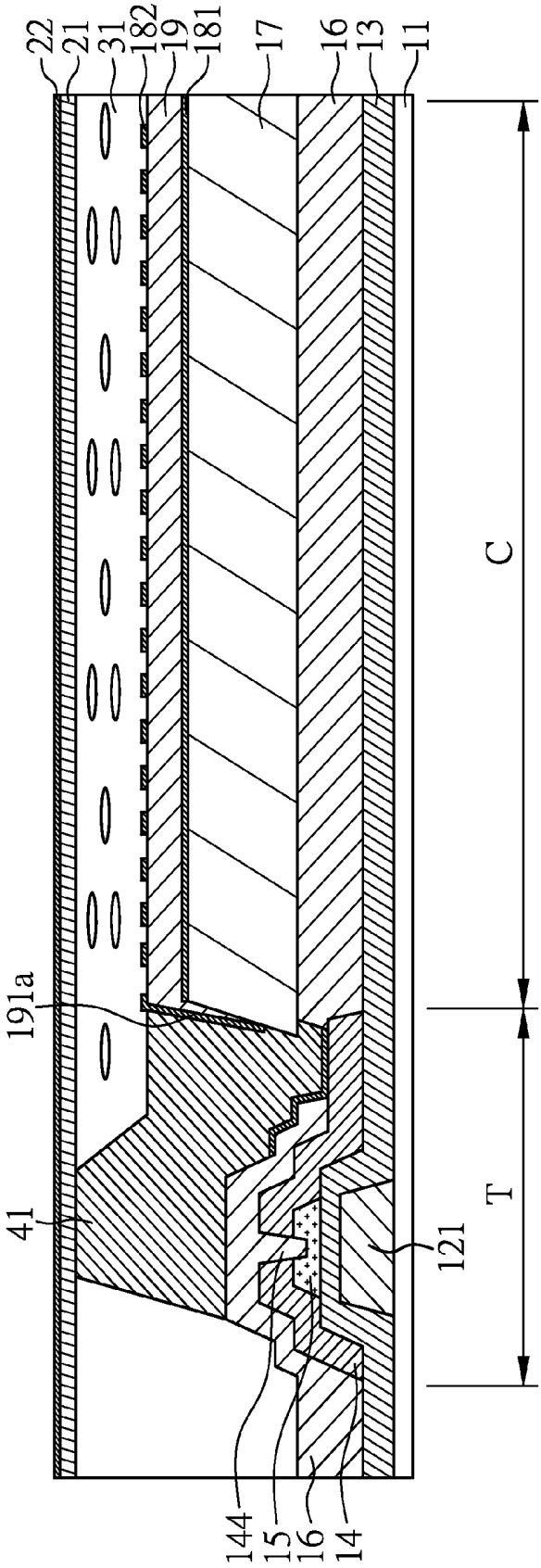

FIG. 6

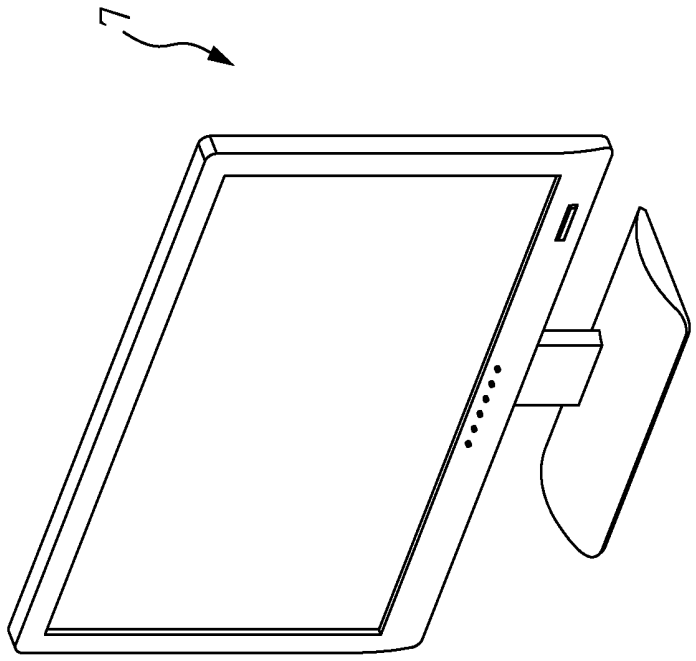

FIG. 7

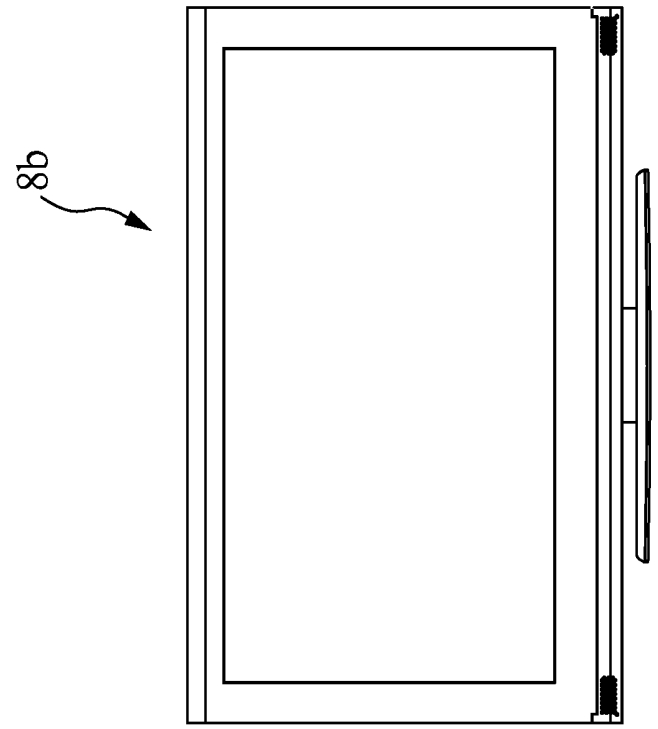

FIG. 9

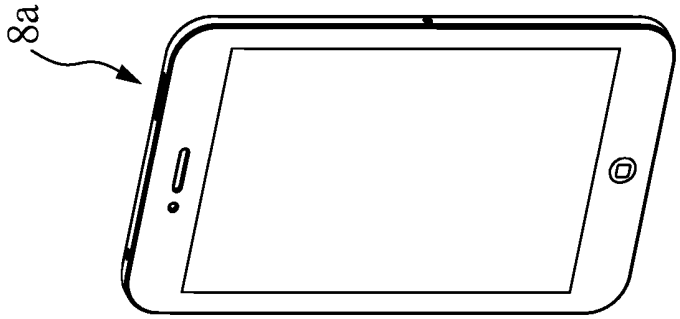

FIG. 8

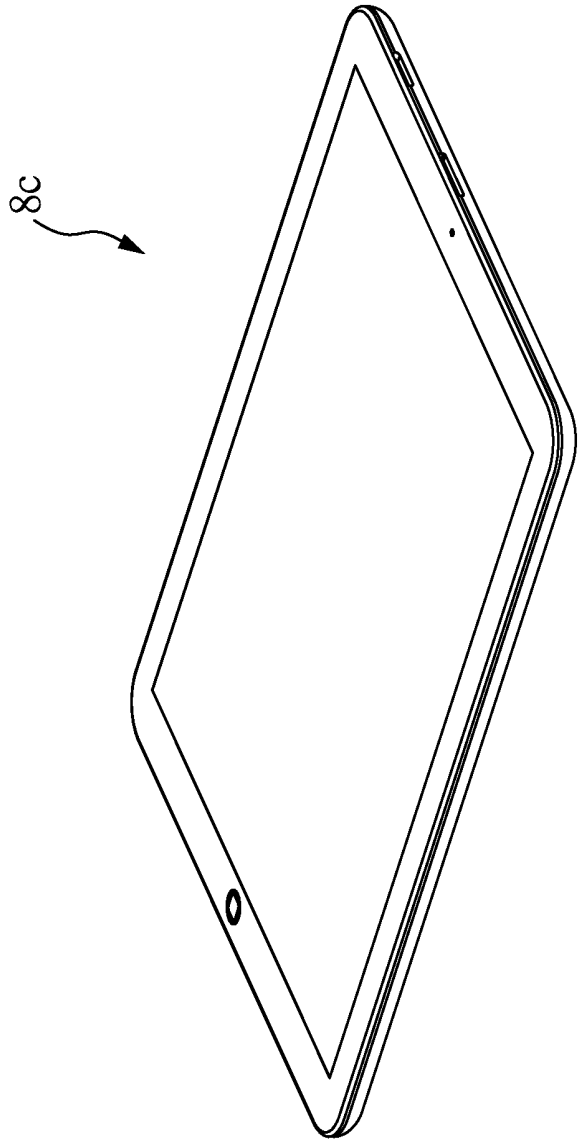

FIG. 10

LIQUID CRYSTAL DISPLAY PANEL AND LIQUID CRYSTAL DISPLAY DEVICE CONTAINING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefits of the Taiwan Patent Application Serial Number 102108040, filed on Mar. 7, 2013, the subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display panel and a liquid crystal display device containing the same and, more particularly, to a liquid crystal display panel with high aperture ratio and a liquid crystal display device containing the same.

[0004] 2. Description of Related Art

[0005] In recent years, liquid crystal display (LCD) devices are developed toward having small volume, thin thickness and light weight as the display techniques progresses. The LCD can be applied to various fields. For example, the daily used devices such as cell phones, notebooks, video cameras, cameras, music players, navigation devices, and televisions. The LCD device mainly comprises a LCD panel and a backlight module.

[0006] However, the conventional LCD panel is mainly formed by assembling the bottom substrate with TFTs (TFT side) and the upper substrate with the color filter (CF side), wherein both the bottom substrate and the upper substrate are patterned. A broader light-shielding layer such as black matrix has to be used to prevent the light leakage caused by the assembly shift. The broader light-shielding layer may reduce the aperture ratio, which leads to the light transmission rate reduced.

[0007] Therefore, it is desirable to provide a LCD panel which can solve the aforementioned problem of the assembly shift and have improved aperture ratio, in order to be applied to small and medium display devices.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide a liquid crystal display (LCD) panel and a liquid crystal display device containing the same, which has improved aperture ratios and can be applied to small and medium display devices.

[0009] To achieve the object, the liquid crystal display panel of the present invention comprises: a first substrate with a metal layer formed thereon; a first passivation layer disposed on the metal layer; a color filter layer disposed on the first passivation layer and having a first opening; a first electrode layer disposed on the color filter layer; a second passivation layer disposed on the first electrode layer and covering partial sidewall of the first opening of the color filter layer, wherein the second passivation layer has a second opening corresponding to the first opening to expose the metal layer; a second electrode layer disposed on the second passivation layer, covering a sidewall of the second opening of the second passivation layer, and electrically connecting to the metal layer; a second substrate opposite to the first substrate; and a light-shielding layer comprising a filling part and a supporting part, and disposed between the first substrate and the second substrate, wherein the filling part is disposed in the second opening of the second passivation layer and covers the color filter layer exposed from the second passivation layer and the second electrode, and the supporting part is disposed between the second substrate and the first or second passivation layer to form a space therebetween for disposing liquid crystals therein.

[0010] Furthermore, the present invention also provides a liquid crystal display (LCD) device comprising the aforementioned LCD panels. The LCD device of the present invention may further comprise: a backlight module disposed under the LCD panel (i.e. a side of the first substrate); and a driving unit. The backlight module and the driving unit can be any backlight module and driving unit generally used in the art, so the description thereto is omitted herein.

[0011] Other objects, advantages, and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a cross-sectional view of an LCD panel according to Embodiment 1 of the present invention;

[0013] FIG. **2** is a cross-sectional view of an LCD panel according to Embodiment 1 of the present invention;

[0014] FIG. **3** is a cross-sectional view of an LCD panel according to Embodiment 2 of the present invention;

[0015] FIG. **4** is a cross-sectional view of an LCD panel according to Embodiment 3 of the present invention;

[0016] FIG. **5** is a cross-sectional view of an LCD panel according to Embodiment 4 of the present invention;

[0017] FIG. **6** is a cross-sectional view of an LCD panel according to Embodiment 5 of the present invention;

[0018] FIG. **7** is a perspective view of an LCD device according to Embodiment 6 of the present invention;

[0019] FIG. **8** is a perspective view of a cell phone according to the present invention;

[0020] FIG. **9** is a perspective view of a TV according to the present invention; and

[0021] FIG. **10** is a perspective view of a tablet PC according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] The present invention has been described in an illustrative manner, and it is to be understood that the terminology used is intended to be in the nature of description rather than of limitation. Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, it is to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

Embodiment 1

[0023] As shown in FIG. **1**, the LCD panel of the present embodiment comprises: a first substrate **11** with a patterned second metal layer **14** formed thereon, wherein the second metal layer **14** is used as a source electrode and, a drain electrode; a first passivation layer **16** disposed on the second metal layer **14**, wherein the first passivation layer **16** has a first opening **161***a* to expose partial second metal layer **14** using as a connecting ring; a color filter layer **17** disposed on the first passivation layer **16** and having a first opening **171***a* corre-

sponding to the first opening **161***a* of the first passivation layer **16**; a patterned first electrode layer **181** disposed on the color filter layer **17**, wherein the patterned first electrode layer **181** is disconnected with the second metal layer **14**; a second passivation layer **19** disposed on the first electrode layer **181** and covering partial sidewall of the first opening **171***a* of the color filter layer **17**, wherein the second passivation layer **19** has a first opening **191***a* corresponding to the first opening **161***a* of the first passivation layer **16** and the first opening **171***a* of the color filter layer **17** to expose parts of the second metal layer **14**; a patterned second electrode layer **182** disposed on the second passivation layer **19**, covering a sidewall of the first opening **191***a* of the second passivation layer **19** and parts of the sidewall of the first opening **161***a* of the first passivation layer **16**, and electrically connecting to the second metal layer **14**, wherein the second electrode layer **182** is electrically separated from the first electrode layer **181**; a second substrate **21** opposite to the first substrate **11**; and a light-shielding layer **41** comprising a filling part **411** and a supporting part **412**, and disposed between the first substrate **11** and the second substrate **21**, wherein the filling part **411** is disposed in the first opening **191***a* of the second passivation layer **19**, and an area of the filling part **411** is larger than that of the first opening **191***a* of the second passivation layer **19** to cover the first opening **191***a* of the second passivation layer **19** and the exposed layers such as the exposed parts of the color filter layer **17**, the first passivation layer **16** or the second electrode layer **182**. In other words, the filling part **411** can fill the first opening **161***a* of the first passivation layer **16**, the first opening **171***a* of the color filter layer **17** and the first opening **191***a* of the second passivation layer **19**. In addition, the supporting part **412** is disposed between the second passivation layer **19** and the second substrate **21** to form a predetermined space **31** therebetween for disposing liquid crystals therein, and a height of the predetermined space **31** is a cell gap. A connecting part **413** can be selectively disposed between the filling part **411** and the supporting part **412** and cover electrode traces.

[0024] Hereinafter, a detail structure of the LCD panel of the present embodiment is described. As shown in FIG. **1**, the LCD panel of the present embodiment further comprises an active element region T, which comprises: a gate electrode **121** formed by a patterned first metal layer **12**, an insulating layer **1.3** (i.e. gate insulating layer), a patterned semiconductor layer **15**, and a source and drain electrode layer formed by a patterned second metal layer **14**, wherein the first metal layer **12** is disposed on the first substrate **11**, the insulating layer **13** is disposed on the first substrate **11** and covers the gate electrode **121** of the first metal layer **12**, the semiconductor layer **15** is disposed on the insulating layer **13**, and a second metal layer **14** is disposed on the semiconductor layer **1.5**. Herein, a gap is formed between the source electrode and the drain electrode of the second metal layer **14** to define a channel region **144**. To this step, a main structure of a thin film transistor (TFT) is obtained. Herein, each layer in the active element region T can be formed by any conventional process for TFT, so the description thereof is omitted herein.

[0025] In addition, as shown in FIG. **1**, the first metal layer **12** further comprise a connecting electrode **122** in a display region C, and the connecting electrode **122** provides a common voltage signal to the first electrode layer **181**. Furthermore, the insulating layer **13** also covers the connecting electrode **122** when the insulating layer **13** in active element region T is formed.

[0026] In the present embodiment, the first substrate **11** is used as a bottom substrate, which can be a glass substrate, a plastic substrate, a silicon substrate, a ceramic substrate, or any conventional bottom substrate generally used in the art. In addition, materials of the first metal layer **12** and the second metal layer **14** can respectively be any conductive material generally used in the art, such as metals, alloys, metal oxides, metal oxynitrides, or other common electrode material used in the art. Preferably, the materials of the first metal layer **12** and the second metal layer **14** are respectively metals. In particular, the second metal layer **14** can have a three-layered structure comprising a MoN layer **141**, an Al layer **142**, and a MoN layer **143**, as shown in FIG. **2**. However, in other embodiments of the present invention, the first metal layer **12** and the second metal layer **14** may be respectively formed by a single metal material such as Cu. Furthermore, a material for the insulating layer **13** can be any gate insulating material generally used in the art, such as SiNx or SiOx.

[0027] After the TFT in the active element region T is formed, a surface of the second metal layer **14** is covered with a first passivation layer **16**, as shown in FIG. **1**. Herein, the first passivation layer **16** also covers the insulating layer **13** both in the display region C and on the connecting electrode **122**. After the conventional patterning process used in the art, a first opening **161***a* and a second opening **161***b* of the first passivation layer **16** are formed, and an insulator opening **131** is formed in the insulating layer **13**. The first opening **161***a* of the first passivation layer **16** is located in the active element region T and corresponds to the source and drain electrode of the second metal layer **14**. The second opening **161***b* of the first passivation layer **16** and the insulator opening **131** is located in the display region C and corresponds to the connecting electrode **122**. Preferably, the bottom area (diameter) of the second opening **161***b* of the first passivation layer **16** is equal to or larger than the top area (diameter) of the insulator opening **131**, and the axes of the insulator opening **131** and the second opening **161***b* of the first passivation layer **16** substantially overlap with each other. Herein, the insulator opening **131** and the second opening **161***b* of the first passivation layer **16** can be formed simultaneously.

[0028] After the first passivation layer **16** and the openings are formed, a color filter layer **17** is formed on the first passivation layer **16**. Similarly, after the conventional patterning process used in the art, a first opening **171***a* and a second opening **171***b* of the color filter layer **17** are formed. The first opening **171***a* of the color filter layer **17** corresponds to the first opening **161***a* of the first passivation layer **16** to expose the corresponding source and drain electrode of the second metal layer **14**. The second opening **171***b* of the color filter layer **17** corresponds to the second opening **161***b* of the first passivation layer **16** and the insulator opening **131** of the insulating layer **13** to expose the corresponding connecting electrode **122**. Herein, the second opening **171***b* of the color filter layer **17** can be formed together with the insulator opening **131** and the second opening **161***b* of the first passivation layer **16**, or the second opening **171***b* and the insulator opening **131** as well as the second opening **161***b* are formed in different etching steps. Preferably, the bottom area (diameter) of the first opening **171***a* of the color filter layer **17** is equal to or larger than the top area (diameter) of the first opening **161***a* of the first passivation layer **16**; the bottom area (diameter) of the second opening **171***b* of the color filter layer **17** is equal to or larger than the top area (diameter) of the second opening **161***b* of the first passivation layer **16**; and the axes of the

second opening **171***b* of the color filter layer **17**, the insulator opening **131** and the second opening **161***b* of the first passivation layer **16** substantially overlap with each other. Herein, the process for patterning the color filter layer **17** can be any patterning process generally used in the art to form a color filter layer **17** comprising red pixels, green pixels and blue pixels. However, in other embodiments, colors of pixels of the color filter layer **17** are not limited thereto.

[0029] Then, a patterned first electrode layer **181** is formed on the color filter layer **17**. The first electrode layer **181** in the display region C further extends to the second opening **171***b* of the color filter layer **17**, the second opening **161***b* of the first passivation layer **16** and the insulator opening **131** to electrically connect with the connecting electrode **122**.

[0030] A second passivation layer **19** is formed to cover surfaces of the first electrode layer **181** and the color filter layer **17**. Then, the second passivation layer **19** is etched by a conventional process such as a photolithography process to form a first opening **191***a* of the second passivation layer **19** in the active element region T. The first opening **191***a* of the second passivation layer **19** corresponds to the first opening **161***a* of the first passivation layer **16** and the first opening **171***a* of the color filter layer **17** to expose the source and drain electrode of the second metal layer **14**. It should be noted that the axis of the first opening **191***a* of the second passivation layer **19** is not aligned with the first opening **171***a* of the color filter layer **17**, in order to reduce the aperture area and ensure the continuity of the etched inclined plane which is related to the accuracy of electrode connection. As shown in FIG. **1**, the axis of the first opening **191***a* of the second passivation layer **19** slightly left-shifts from the first opening **171***a* of the color filter layer **17**, so there is no undercut found in the right inclined plane of the opening region. Therefore, the upper electrode (i.e. second electrode layer **182**) can successfully connect with the bottom electrode (i.e. the second metal layer **14**). On the other hand, in the left inclined plane of the opening region, an undercut that the left side of the first opening **161***a* of the first passivation layer **16** exceeds that of the first opening **171***a* of the color filter layer **17** is formed due to the difference of the etching rates between the color filter layer **17** and the passivation layer (i.e. the first passivation layer **16** and the second passivation layer **19**). Especially, when the passivation layer is etched, the etching rate of the color filter layer **17** is slower than that of the passivation layer. In this case, the color filter layer **17** unprotected with the second passivation layer **19** is exposed. Preferably, the bottom area (diameter) of the first opening **191***a* of the second passivation layer **19** is equal to or smaller than the top area (diameter) of the first opening **171***a* of the color filter layer **17**.

[0031] In another process, the step for forming the first opening **161***a* of the first passivation layer **16** is omitted. In this process, only the second opening **161***b* of the first passivation layer **16** is firstly formed, and then the first opening **161***a* of the first passivation layer **16** is formed at the same time when the second passivation layer **19** is etched to form the first opening **191***a* thereof. In other word, the first opening **191***a* of the second passivation layer **19** corresponds to the first opening **171***a* of the color filter layer **17** in off-axis, and the first passivation layer **16** and the second passivation layer **19** are etched at the same time to expose the second metal layer **14**. In this process, the undercut which causes the color filter layer **17** unprotected with the second passivation layer **19** is also observed.

[0032] In the present embodiment, the materials of the first passivation layer **16**, the second passivation layer **19** and the insulating layer **13** can be any passivation layer material used in the art such as SiNx or SiOx, which can be formed in a single layer or multiple layers, and the materials of the first passivation layer **16**, the second passivation layer **19** and the insulating layer **13** can be identical to or different from each other. In the present embodiment, SiNx is used to form the first passivation layer **16**, the second passivation layer **19** and the insulating layer **13**. However, in other embodiments, the materials thereof can be materials other than SiNx.

[0033] Then, as shown in FIG. **1**, a second electrode layer **182** is formed in the active element region T and the display region C. In the active element region T, the second electrode layer **182** extends from an upper surface of the second passivation layer **19** to the first opening **191***a* of thereof to electrically connect to the second metal layer **14**. When the second metal layer **14** is a three-layered electrode layer, comprising a MoN layer **141**, an Al layer **142**, and a MoN layer **143**, in advance of forming the second electrode layer **182**, an opening **1431** is formed in the MoN layer **143** to expose the Al layer **142** during the etching process for forming the first opening **161***a* of the first passivation layer **16** or the first opening **191***a* of the second passivation layer **19**, and then the sequential formed second electrode layer **182** is electrically connected to the Al layer **142** to obtain a better electrical connection between the second electrode layer **182** and the second metal layer **14**, as shown in FIG. **2**.

[0034] As shown in FIG. **1**, the second electrode layer **182** electrically connects to the second metal layer **14**, so it is used as a pixel electrode layer. The first electrode layer **181** is used as a common electrode layer. The voltage applied between the second electrode layer **182** and the first electrode layer **181** can form a fringe field to introduce the orientation of liquid crystals in the predetermined space **31** to show a grayscale image. Herein, the common electrode layer (i.e. the first electrode layer **181**) can be a planer electrode layer or a finger-shaped electrode layer generally used in the art, and the pixel electrode layer (i.e. the second electrode layer **182**) can be a finger-shaped electrode layer, an L-shaped electrode layer, an intersecting striped electrode layer or a saw-shaped electrode layer generally used in the art. However, the present invention is not particularly limited thereto. In addition, the materials for forming the first electrode layer **181** and the second electrode layer **182** can be any transparent conductive material generally used in the art, such as a transparent electrode material using metal oxides (such as ITO and IZO).

[0035] Then, a light-shielding layer **41** is formed, which comprises: a filling part **411** and a supporting part **412**. The filling part **411** can be disposed in the first opening **191***a* of the second passivation layer **19** in the active element region T and the second opening **171***b* of the color filter layer **17** in the display region C. Especially, in the active element region T, the image sticking problem, that materials or contaminants of the color filter layer **17** without protecting by the second passivation layer **19** or the second electrode layer **182** may gradually permeate into the liquid crystal layer to pollute the liquid crystals, can be solved by disposing the filling part **411** into the first opening **191***a* of the second passivation layer **19**. In addition, the reduced contrast causing by the reflective light from the second metal layer **14** or the first metal layer **12** can also be improved. Preferably, the bottom area of the filling part **411** in the active element region T is larger than the top area of the first opening **191***a* of the second passivation

layer **19**, and the filling part **411** completely covers all the exposed layers below the top of the first opening **191***a* of the second passivation layer **19**, and especially the route that the exposed color filter layer **17** permeating into the liquid crystal layer to prevent the liquid crystals being polluted. Preferably, the bottom area of the filling part **411** in the display region C is larger than the bottom area of the connecting electrode **122** to cover the same. In the present embodiment, the filling part **411** is also disposed in the openings in the display region C. However, the filling part **411** may be not disposed in the openings in the display region C in other embodiments.

[0036] In addition, the supporting part **412** of the light-shielding layer **41** is disposed between the second passivation layer **19** (more specifically, the second electrode layer **182**) and the second substrate **21** to form a predetermined space **31** therebetween with a cell gap, wherein liquid crystals are disposed in this predetermined space **31**. Herein, the supporting part **412** can further be used as the conventional black matrix. Hence, the supporting part **412** has to correspond to the active element region T, especially the semiconductor layer **15** in the active element region T, in order to prevent photo leakage current which may influence the character of TFT.

[0037] Furthermore, in the present embodiment, the material of the light-shielding layer **41** can be any material that can absorb backlight and does not cause liquid crystals being polluted. For example, black resins such as black polystyrene (Black PS) resin or polymers as well as monomers with carbon additives can be used herein. However, the present invention is not particularly limited thereto. In addition, the light-shielding layer **41** can be formed by a two photo mask process or a halftone mask process. When the two photo mask process is used to form the light-shielding layer **41**, the first photo mask is used to form the filling part **411** thereof, and the second photo mask is used to form the supporting part **412** thereof. When the halftone mask process is used to form the light-shielding layer **41**, the filling part **411** and the supporting part **412** thereof can be formed simultaneously. In addition, a connecting part **413** can be selectively disposed between the filling part **411** and the supporting part **412** for connecting, light-shielding or leveling.

[0038] In the present embodiment, a second substrate **21** is disposed opposite to the first substrate **11**, and the material thereof can be any upper substrate material generally used in the art. For example, the second substrate **21** can be a transparent substrate such as a glass substrate, a quartz substrate and a plastic substrate. In addition, a side of the second substrate **21** can further be disposed with a shield electrode **22**, which can shield static electricity to prevent short circuits in liquid crystals or electrode layers. The material thereof can be the same material as those used in the first electrode layer **181** and the second electrode **182**.

Embodiment 2

[0039] As shown in FIG. **3**, the LCD panel of the present embodiment comprises: a first substrate **11** with a connecting electrode **122** formed thereon; an insulating layer **13** disposed on the connecting electrode **122** and having an insulator opening **131**; a first passivation layer **16** disposed on the insulating layer **13** and covering the connecting electrode **122**, wherein the first passivation layer **16** has a second opening **161***b* corresponding to the insulator opening **131**; a color filter layer **17** disposed on the first passivation layer **16** and having a second opening **171***b* corresponding to the second opening **161***b* of the first passivation layer **16** and the insulator opening **131**; a first electrode layer **181** disposed on the color filter layer **17**; a second passivation layer **19** disposed on the first electrode layer **181** and covering partial sidewall of the second opening **171***b* of the color filter layer **17**, wherein the second passivation layer **19** has a second opening **191***b* corresponding to the second opening **171***b* of the color filter layer **17**, the second opening **161***b* of the first passivation layer **16** and the insulator opening **131** to expose the connecting electrode **122**; a second electrode layer **182** disposed on the second passivation layer **19**, covering a sidewall of the second opening **191***b* of the second passivation layer **19** and electrically connecting to the connecting electrode **122**, wherein the second electrode layer **182** electrically separates from the first electrode layer **181**; a second substrate **21** opposite to the first substrate **11**; and a light-shielding layer **41** comprising a filling part **411** and a supporting part **412**, and disposed between the first substrate **11** and the second substrate **21**, wherein the filling part **411** is disposed in second opening **191***b* of the second passivation layer **19** and covers the exposed part of the color filter layer **17**, and the supporting part **412** is disposed between the second passivation layer **19** and the second substrate **21** to form a predetermined space **31** therebetween for disposing liquid crystals therein.

[0040] Hereinafter, a detail structure of the LCD panel of the present embodiment is described. As shown in FIG. **3**, the LCD panel of the present embodiment further comprises an active element region T, which comprises: a gate electrode **121**, an insulating layer **13**, a semiconductor layer **15** and a second metal layer **14**, wherein the gate electrode **121** is disposed on the first substrate **11**, the insulating layer **13** is disposed on the first substrate **11** and covers the gate electrode **121**, the semiconductor layer **15** is disposed on the insulating layer **13**, and the second metal layer **14** as a source electrode and a drain electrode is disposed on two corresponding sides of the semiconductor layer **15**. Herein, a gap is formed between the source electrode and the drain electrode of the second metal layer **14** to define a channel region **144**. Herein, each layer in the active element region T can be formed by any conventional process for TFT, so the description thereof is omitted herein.

[0041] In addition, as shown in FIG. **3**, the gate electrode **121** in the active element region T and the connecting electrode **122** in the display region C can be formed with the same process. Furthermore, the insulating layer **13** covers the gate electrode **121** and the connecting electrode **122** when that is formed in the active element region T.

[0042] After the TFI in the active element region T is formed, a surface of the second metal layer **14** is covered with a first passivation layer **16**. Herein, the first passivation layer **16** also covers the insulating layer **13** both in the display region C and on the connecting electrode **122**. After the conventional patterning process used in the art, an insulator opening **131** is formed in the insulating layer **13** and a second opening **161***b* of the first passivation layer **16** is formed in the display region C to expose the connecting electrode **122**. The insulator opening **131** and the second opening **161***b* of the first passivation layer **16** can be formed simultaneously, and the bottom area of the second opening **161***b* of the first passivation layer **16** is larger or equal to the top area of the insulator layer **13**. In other embodiment, the insulator opening **131** and the second opening **161***b* of the first passivation layer **16** can be formed in different steps, wherein the insulator layer **13** is firstly patterned to form the insulator opening **131**, and then

the second opening **161***b* of the first passivation layer **16** corresponding to the insulator opening **131** is formed. The axes of the insulator opening **131** and the second opening **161***b* of the first passivation layer **16** substantially overlap with each other. After the patterning process, a first opening **161***a* of the first passivation layer **16** is also formed to expose the second metal layer **14** for the source and drain electrode.

[0043] After the openings of the first passivation layer **16** formed, a patterned color filter layer **17** is formed on the first passivation layer **16**. A first opening **171***a* of the color filter layer **17** corresponds to the second metal layer **14**; and a second opening **171***b* thereof corresponds to the connecting electrode **122**. Especially, the second opening **171***b* thereof corresponds to the second opening **161***b* of the first passivation layer **16** and the insulator opening **131** of the insulating layer **13** to expose the corresponding connecting electrode **122**. Herein, the second opening **171***b* of the color filter layer **17** can be formed together with the insulator opening **131** and the second opening **161***b* of the first passivation layer **16**, or the second opening **171***b* and the insulator opening **131** as well as the second opening **161***b* are formed in different etching steps. Preferably, the bottom area (diameter) of the second opening **171***b* of the color filter layer **17** is equal to or larger than the top area (diameter) of the second opening **161***b* of the first passivation layer **16**. Then, a patterned first electrode layer **181** is formed on the color filter layer **17**. The first electrode layer **181** in the active element region T extends to the first opening **171***a* of the color filter layer **17** and the first opening **161***a* of the first passivation layer **16** to electrically connect with the second metal layer **14**.

[0044] A second passivation layer **19** is formed to cover surfaces of the first electrode layer **181** and the color filter layer **17**. Then, the second passivation layer **19** is etched by a conventional process such as a photolithography process to form a second opening **191***b* of the second passivation layer **19** in the display region C to expose the connecting electrode **122**. It should be noted that the axis of the second opening $\mathbf{191}_b$ of the second passivation layer **19** is not aligned with that of the second opening **171***b* of the color filter layer **17**, in order to reduce the aperture area. In other word, the axis of the second opening **171***b* of the color filter layer **17** is not aligned with those of the second opening **161***b* of the first passivation layer **16**, the insulator opening **131** and the second opening **191***b* of the second passivation layer **19**. In addition, the second opening **161***b* of the first passivation layer **16**, the insulator opening **131** and the second opening **191***b* of the second passivation layer **19** can be formed with identical etching process, and the axes thereof are aligned with each other. In this case, the sequential formed second electrode layer can laterally electrically connect to the connecting electrode **122**. In the display region C, an undercut is observed in the second opening **161***b* of the first passivation layer **16** and the insulator opening **131** (the left side of the second opening **161***b* in FIG. **2**) due to the difference of the etching rates between the color filter layer **17** and the passivation layer **19**. In this case, parts of the color filter layer **17** unprotected with the second passivation layer **19** is exposed.

[0045] Then, as shown in FIG. **3**, a second electrode layer **182** is formed. In the display region C, the second electrode layer **182** extends from an upper surface of the second passivation layer **19** to the second opening **191***b* of the second passivation layer **19** to electrically connect to the connecting electrode **122**.

[0046] In the present embodiment, the second electrode layer **182** electrically connects to the connecting electrode **122**, so it is used as a common electrode layer. The first electrode layer **181** is used as a pixel electrode layer. Herein, the common electrode layer (i.e. the second electrode layer **182**) can be any patterned electrode layer generally used in the art, and the pixel electrode layer (i.e. the first electrode layer **181**) can be a planer electrode layer (unpatterned electrode layer) generally used in the art. However, the present invention is not particularly limited thereto.

[0047] Then, a light-shielding layer **41** is formed, which comprises: a filling part **411** and a supporting part **412**. The filling part **411** can be disposed in the active element region T and the second opening **191***b* of the second passivation layer **19** in the display region C. Especially, in the display region C, the image sticking problem, that materials or contaminants of the color filter layer **17** without protecting by the second passivation layer **19** may gradually permeate into the liquid crystal layer to pollute the liquid crystals, can be solved by disposing the filling part **411** into the second opening **191***b* of the second passivation layer **19** to cover the exposed color filter layer **17**. Both the problems of the light reflectance causing by the metal layer in the active element region T and the photo leakage current in the channel region **144** of the semiconductor layer **15** can also be solved. In the present embodiment, the filling part **411** also disposed in the openings in the active element region T. However, in other embodiments, the first opening **191***a* in the active element region T does not have to be filled with the filling part **411**.

[0048] In addition, the supporting part **412** of the light-shielding layer **41** is disposed between the second passivation layer **19** (more specifically, the second electrode layer **182**) and the second substrate **21** to form a predetermined space **31** therebetween with a cell gap, wherein liquid crystals are disposed in this predetermined space **31**. Furthermore, the supporting part **412** can also functions as the conventional black matrix. Hence, the supporting part **412** has to correspond to the active element region T, especially the semiconductor layer **15** in the active element region T.

[0049] The materials and the processes for each elements and layers of the LCD panel of the present embodiment are the same as those illustrated in Embodiment 1, and therefore the descriptions thereto are omitted herein.

Embodiment 3

[0050] As shown in FIG. **4**, the LCD panel of the present embodiment is similar to that of Embodiment 1, except the following differences. The LCD panel of the present embodiment further comprises a patterned planer layer **5**. In the visible region C, the planer layer **5** is disposed between the color filter layer **17** and the first electrode layer **181**. In addition, the color filter layer **17** is not disposed on the first passivation layer **16**, and the planer layer **5** is directly disposed on the first passivation layer **16** in the active element region T. Herein, materials for the planer layer **5** can be any material generally used in the art, such as PEN, PMMA, PI, Al_2O_3, oxides (for example, SiOx) or nitrides (for example, SiNx).

Embodiment 4

[0051] As shown in FIG. **5**, the LCD panel of the present embodiment is similar to that of Embodiment 1, except the following differences. The LCD panel of the present embodi-

ment further comprises a patterned planer layer **5** disposed between the color filter layer **17** and the first electrode layer **181** both in the visible region C and the active element region T. Herein, the material of the planer layer **5** is identical to that used in Embodiment 3, and therefore the descriptions thereto are omitted herein.

Embodiment 5

[0052] As shown in FIG. **6**, the LCD panel of the present embodiment is similar to that of Embodiment 1, except the following differences. There are no color filter layer **17** and the second electrode layer **182** formed in the active element region T, and the light-shielding layer **41** directly covers the exposed color filter layer **17**, parts of the first electrode layer **181** and the channel region **144** of the semiconductor layer **15**. Herein, the material of the light-shielding layer **41** is identical to that used in Embodiment 1, and therefore the descriptions thereto are omitted herein.

[0053] FIG. **6** is a cross-sectional view of the LCD panel of the present embodiment according to a single cross-hatching line, which is used to show the undercut observed in the color filter layer **17** and the first passivation layer **16**. However, when the LCD panel of the present embodiment is presented according to another cross-hatching line, the second electrode layer **182** extends from an upper surface of the second passivation layer **19** to the first opening **191***a* of the second passivation layer **19** to electrically connect to the second metal layer **14** (not shown in the figure).

Embodiment 6

[0054] FIG. **7** is a perspective view of the LCD device of the present embodiment, which comprises: any one of the LCD panels described in Embodiments 1-5; and other elements for forming the LCD device such as external containers, driving elements, and backlight modules.

[0055] In addition, the LCD panels described in Embodiments 1-5 can also be applied to electronic devices other than the LCD device, for example, a cell phone **8***a* shown in FIG. **8**, a TV **8***b* shown in FIG. **9**, and a tablet PC **8***c* shown in FIG. **10**.

[0056] Although the present invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A liquid crystal display panel, comprising:

a first substrate with a metal layer formed thereon;

a first passivation layer disposed on the metal layer;

a color filter layer disposed on the first passivation layer and having a first opening;

a first electrode layer disposed on the color filter layer;

a second passivation layer disposed on the first electrode layer and covering partial sidewall of the first opening of the color filter layer, wherein the second passivation layer has a second opening corresponding to the first opening to expose the metal layer;

a second electrode layer disposed on the second passivation layer, covering a sidewall of the second opening, and electrically connecting to the metal layer;

a second substrate opposite to the first substrate; and

a light-shielding layer comprising a filling part and a supporting part, and disposed between the first substrate and the second substrate,

wherein the filling part is disposed in the second opening and covers the color filter layer exposed from the second passivation layer and the second electrode, and the supporting part is disposed between the second substrate and the first passivation layer or the second passivation layer to form a space therebetween for disposing liquid crystal therein.

2. The liquid crystal display panel as claimed in claim **1**, further comprising an active element region, which comprises: a gate electrode layer, an insulating layer, a semiconductor layer, and a source and drain electrode layer formed by the metal layer, wherein the gate electrode is disposed on the first substrate, the insulating layer is disposed on the first substrate and covering the gate electrode layer, the semiconductor layer is disposed on the insulating layer, and a source electrode and a drain electrode of the source and drain electrode layer are respectively disposed at two corresponding sides of the semiconductor layer.

3. The liquid crystal display panel as claimed in claim **2**, wherein the supporting part of the light-shielding layer corresponds to the semiconductor layer.

4. The liquid crystal display panel as claimed in claim **2**, wherein the first electrode layer is a common electrode layer, and the second electrode layer is a pixel electrode layer.

5. The liquid crystal display panel as claimed in claim **1**, further comprising an insulating layer, wherein the insulating layer is disposed on the first substrate and covers the metal layer, the metal layer is a connecting electrode layer, the insulating layer has a third opening to expose the connecting electrode layer, and the second electrode layer is used as a common electrode layer.

6. The liquid crystal display panel as claimed in claim **5**, further comprising an active element region, which comprises: a gate electrode layer, a semiconductor layer, and a source and drain electrode layer, wherein the gate electrode is disposed on the first substrate, the insulating layer covers the gate electrode layer, the semiconductor layer is disposed on the insulating layer, and the source and drain electrode layer is disposed on the semiconductor layer.

7. The liquid crystal display panel as claimed in claim **6**, wherein the first electrode layer is a pixel electrode layer and electrically connects to the source and the drain electrode layer.

8. The liquid crystal display panel as claimed in claim **6**, wherein the supporting part of the light-shielding layer corresponds to the semiconductor layer.

9. The liquid crystal display panel as claimed in claim **1**, wherein a material of the light-shielding layer is a black resin.

10. The liquid crystal display panel as claimed in claim **1**, further comprising: a planer layer disposed between the color filter layer and the first electrode.

11. The liquid crystal display panel as claimed in claim **2**, wherein the color filter layer is not disposed in the active element region.

12. A liquid crystal display device, comprising:

a driving unit;

a backlight unit; and

a liquid crystal display panel, comprising:

a first substrate with a metal layer formed thereon;

a first passivation layer disposed on the metal layer;

a color filter layer disposed on the first passivation layer and having a first opening;

a first electrode layer disposed on the color filter layer;

a second passivation layer disposed on the first electrode layer and covering partial sidewall of the first opening, wherein the second passivation layer has a second opening corresponding to the first opening to expose the metal layer;

a second electrode layer disposed on the second passivation layer, covering a sidewall of the second opening of the second passivation layer, and electrically connecting to the metal layer;

a second substrate opposite to the first substrate; and

a light-shielding layer comprising a filling part and a supporting part, and disposed between the first substrate and the second substrate, wherein the filling part is disposed in the second opening and covers the color filter layer exposed from the second passivation layer and the second electrode, and the supporting part is disposed between the second substrate and the first passivation layer or the second passivation layer to form a space therebetween for disposing liquid crystal therein.

13. The liquid crystal display device as claimed in claim **12**, further comprising an active element region, which comprises: a gate electrode layer, an insulating layer, a semiconductor layer, and a source and drain electrode layer formed by the metal layer, wherein the gate electrode is disposed on the first substrate, the insulating layer is disposed on the first substrate and covering the gate electrode layer, the semiconductor layer is disposed on the insulating layer, and the source and drain electrode layer is disposed on the semiconductor layer.

14. The liquid crystal display device as claimed in claim **13**, wherein the supporting part of the light-shielding layer corresponds to the semiconductor layer.

15. The liquid crystal display device as claimed in claim **12**, further comprising an insulating layer, wherein the insulating layer is disposed on the first substrate and covers the metal layer, the metal layer is a connecting electrode layer, the insulating layer has a third opening to expose the connecting electrode layer, and the second electrode layer is used as a common electrode layer.

16. The liquid crystal display device as claimed in claim **15**, further comprising an active element region, which comprises: a gate electrode layer, a semiconductor layer, and a source and drain electrode layer, wherein the gate electrode is disposed on the first substrate, the insulating layer covers the gate electrode layer, the semiconductor layer is disposed on the insulating layer, and the source and drain electrode layer is disposed on the semiconductor layer.

17. The liquid crystal display device as claimed in claim **16**, wherein the supporting part of the light-shielding layer corresponds to the semiconductor layer.

18. The liquid crystal display device as claimed in claim **12**, further comprising: a planer layer disposed between the color filter layer and the first electrode.

* * * * *

专利名称(译)	液晶显示面板和包含该液晶显示面板的液晶显示装置		
公开(公告)号	US20140253850A1	公开(公告)日	2014-09-11
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[标]申请(专利权)人(译)	群创光电股份有限公司		
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摘要(译)

本发明公开了一种液晶显示面板，包括：第一基板，其上形成有金属层;形成在金属层上的第一钝化层;具有第一开口的滤色器层，设置在第一钝化层上;形成在滤色器层上的第一电极;第二钝化层，具有第二开口，设置在第一电极层上并覆盖第一开口的部分侧壁，其中第二开口对应于第一开口以暴露金属层;第二电极层，设置在第二钝化层上并电连接到金属层;与第一基板相对的第二基板;遮光层，设置在第一基板和第二基板之间，并包括填充部分，其中填充部分设置在第二开口中并覆盖暴露的滤色器层。