US 20140036179A1

(19) **United States**

(12) **Patent Application Publication**

HUANG et al.

(10) **Pub. No.: US 2014/0036179 A1**

(43) **Pub. Date: Feb. 6, 2014**

(54) **LIQUID CRYSTAL DISPLAY PANEL AND DISPLAY DEVICE**

(71) Applicants: **CHENGDU BOE OPTOELECTRONICS TECHNOLOGY CO., LTD**, Chengdu (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Li HUANG**, Beijing (CN); **Seungyik PARK**, Beijing (CN); **Lyulyun HWANG**, Beijing (CN)

(73) Assignees: **CHENGDU BOE OPTOELECTRONICS TECHNOLOGY CO., LTD.**, Chengdu (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(21) Appl. No.: **13/957,775**

(22) Filed: **Aug. 2, 2013**

(30) **Foreign Application Priority Data**

Aug. 3, 2012 (CN) 201210276295.6

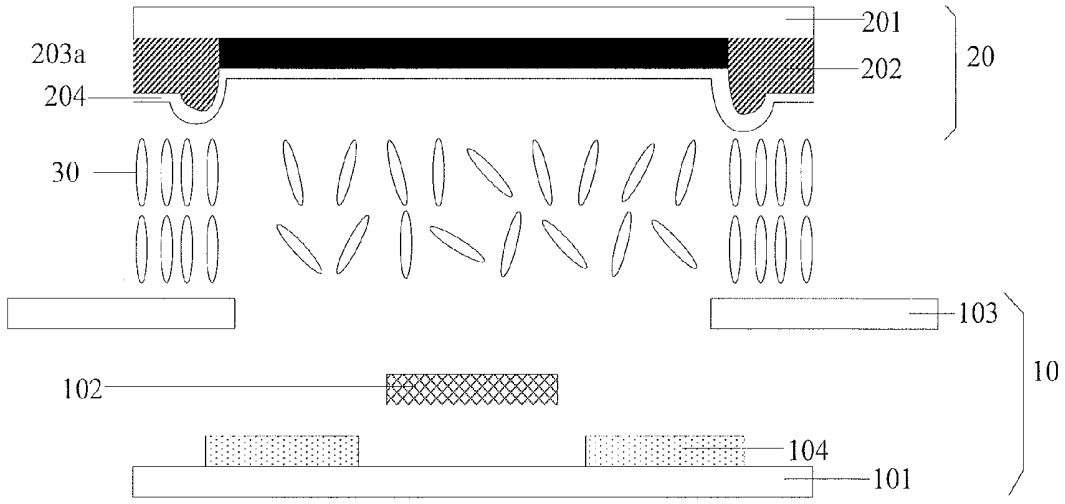
Publication Classification

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

(52) **U.S. Cl.**
CPC *G02F 1/133512* (2013.01)
USPC **349/33**

(57) **ABSTRACT**

Embodiments of the invention provide a LCD panel and a display device, the LCD panel comprises an array substrate and a color filter substrate, the array substrate comprises a first transparent substrate, a data line and a pixel electrode disposed on an inner side of the first transparent substrate, the color filter substrate comprises a second transparent substrate, a color resin, a first black matrix and a common electrode overlaying the color resin and the first black matrix, wherein the first black matrix comprising a flat bottom layer and a protrusion formed on the flat bottom layer, the protrusion has slant surfaces near a boundary between the non-pixel region and the pixel region of the second transparent substrate.



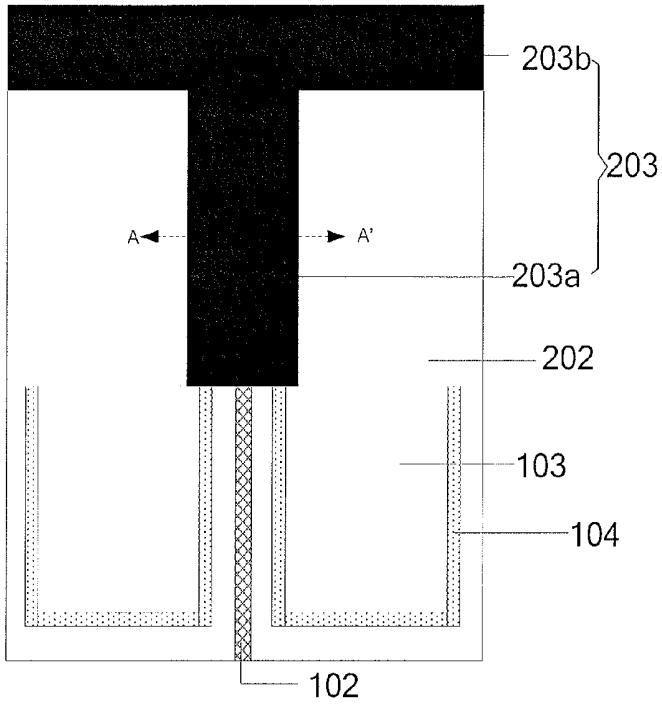

203b
203
A
A'
203a
202
103
104
102

Fig.1

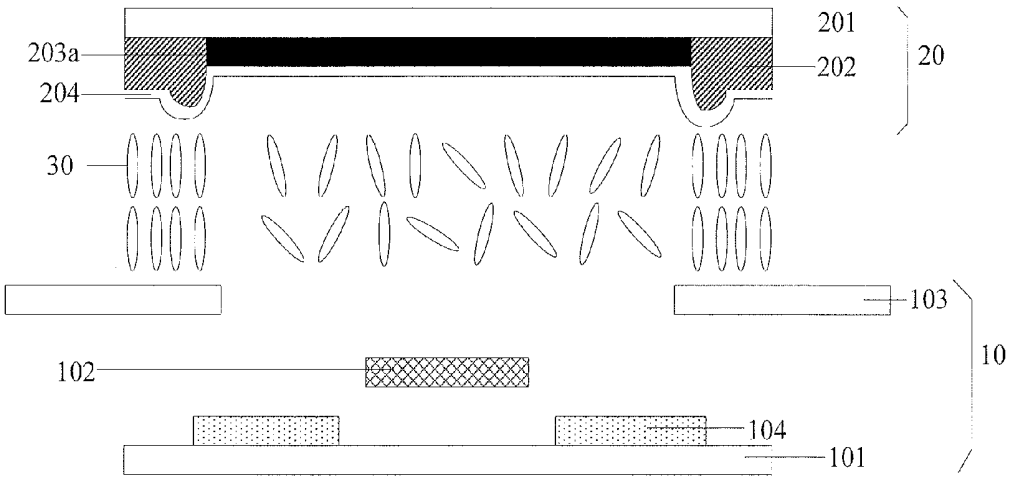

201
20
203a
202
204
30
103
10
102
104
101

Fig.2

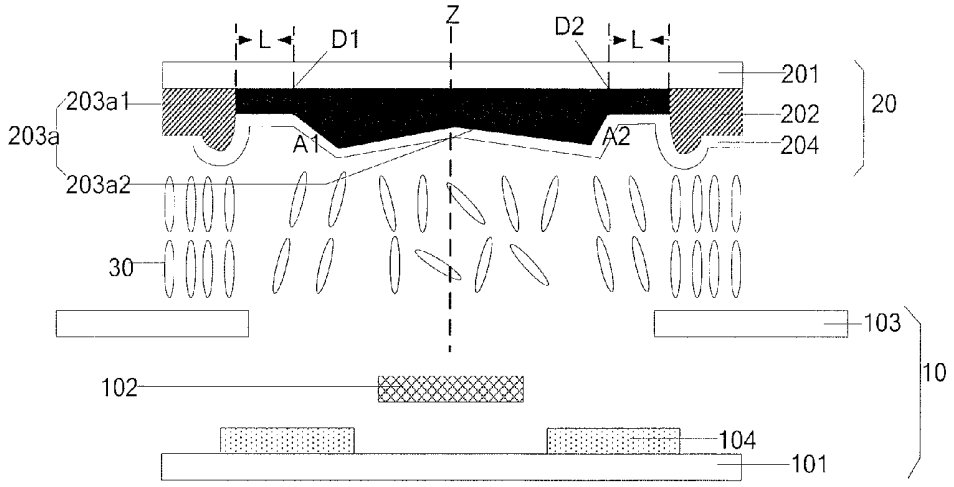

Z
L
D1
D2
L
201
203a1
202
20
203a
A1
A2
204
203a2
30
103
10
102
104
101

Fig.3

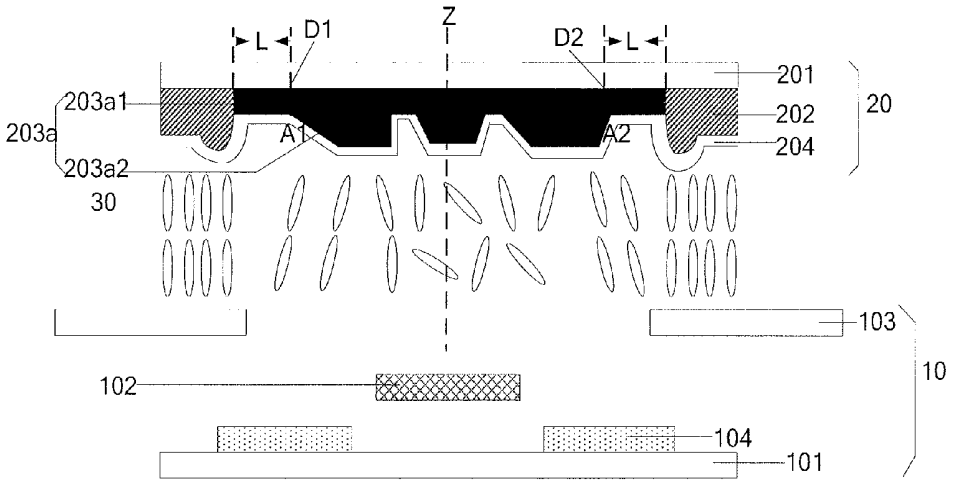

Z
L
D1
D2
L
201
203a1
202
20
203a
A1
A2
204
203a2
30
103
10
102
104
101

Fig.4

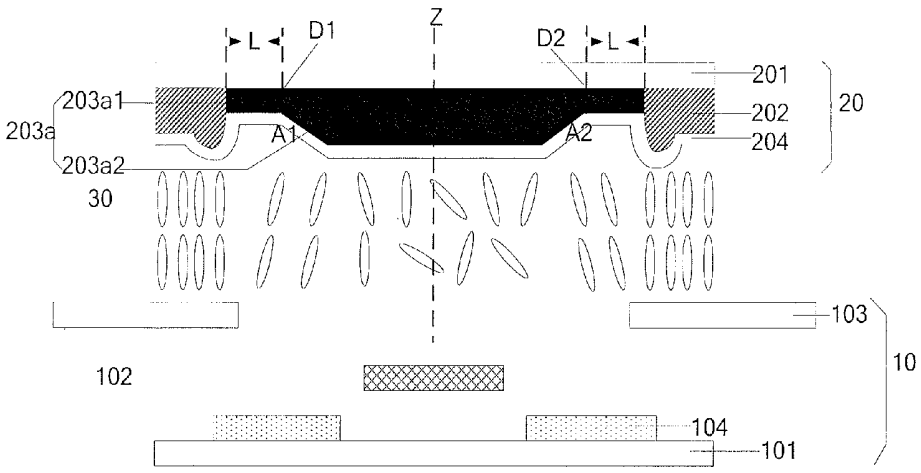

Z
L
D1
D2
L
201
203a1
202
20
203a
A1
A2
204
203a2
30
103
10
102
104
101

Fig.5

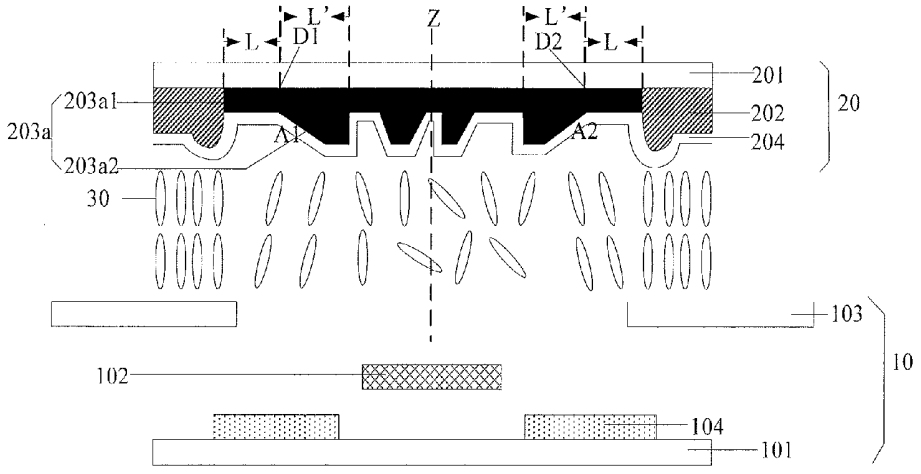

L'
Z
L'
L
D1
D2
L
201
203a1
202
20
203a
A1
A2
204
203a2
30
103
10
102
104
101

Fig.6

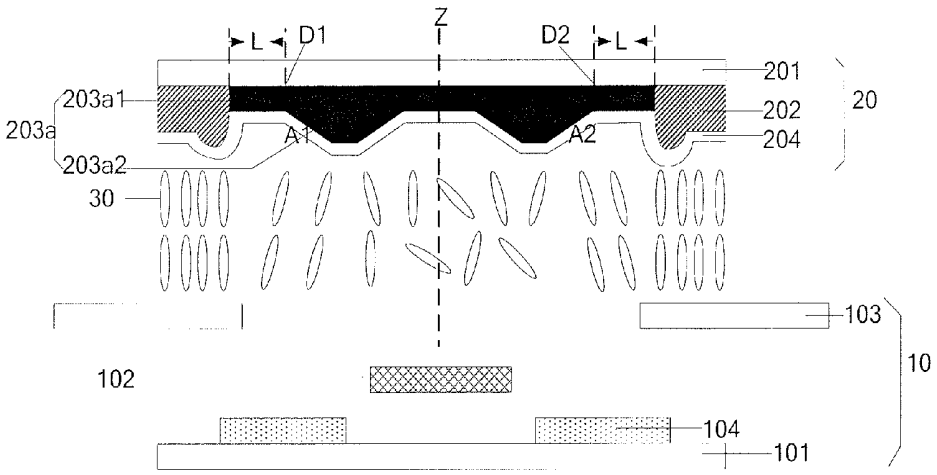

Z
L
D1
D2
L
201
203a1
202
20
203a
A1
A2
204
203a2
30
103
10
102
104
101

Fig.7

LIQUID CRYSTAL DISPLAY PANEL AND DISPLAY DEVICE

[0001] Embodiments of the invention relate to the technical field of liquid crystal displays (LCDs), more particularly, to a LCD panel and a display device.

BACKGROUND

[0002] A Thin Film Transistor Liquid Crystal Display (TFT-LCD) comprises an array substrate, a color filter substrate and a liquid crystal layer disposed between the array substrate and the color filter substrate. In the color filter substrate, pixel regions comprising color resins of three colors of red, green and blue and non-pixel regions comprising black matrices formed at gaps between the color resins of the three colors of red, green and blue are formed on the color filter substrate, and common electrodes are formed on the black matrices (non-pixel regions) and the color resins (pixel regions).

[0003] FIGS. **1** and **2** show a LCD panel fabricated by cell-assembling the color filter substrate and the array substrate. In the LCD panel, the array substrate comprises: a first transparent substrate **101**, a light-shielding strip **104**, a data line **102**, a gate line (not shown in the figure) and a pixel electrode **103** formed on the first transparent substrate **101**; the color filter substrate comprises: a second transparent substrate **201**, a color resin **202**, a black matrix **203** disposed at gaps between color resins and a common electrode **204** overlaying the color resin and the black matrix. Moreover, the liquid crystal layer comprising liquid crystal molecules **30** is disposed between the color filter substrate and the array substrate.

[0004] With reference to FIG. **2**, in the non-pixel region of the LCD panel, there is a complicated electric field consisted of electric fields generated between the common electrode **204** on the color filter substrate and the edge of the pixel electrode **103** on the array substrate, between the common electrode **204** on the color filter substrate and the data line **102** on the array substrate, between the edge of the pixel electrode **103** on the array substrate and the data line **102** on the array substrate, between the common electrode **204** on the color filter substrate and the light-shielding strip **104** on the color filter substrate, which makes the orientation of the liquid crystal molecules **30** in the non-pixel region abnormal. Due to the presence of the black matrix **203**, the black matrix can block the transmittance of the light even if the liquid crystal molecules **30** are of abnormal orientations. However, when the color filter substrate and the array substrate are misaligned, the abnormally-oriented liquid crystal molecules **30** in the non-pixel region cause different light transmittance, as a result, the first black matrix **203***a* parallel to the data line **102** can not block the light from the abnormally-oriented liquid crystal molecules in the non-pixel region, which may lead to pixel light leakage and reduce the picture quality of the display device.

SUMMARY

[0005] Embodiments of the invention provide a LCD panel and a display device which may solve the light leakage issue caused by the misalignment between the color filter substrate and the array substrate and improve the picture quality.

[0006] To meet the above objectives, embodiments of the invention employ the following technical solutions:

[0007] On one hand, the invention provides a LCD display comprising:

[0008] an array substrate which comprises: a first transparent substrate, a data line and a pixel electrode disposed on an inner side of the first transparent substrate;

[0009] a color filter substrate which comprises: a second transparent substrate comprising a pixel region and a non-pixel region, a color resin disposed in the pixel region, a first black matrix disposed in the non-pixel region and above the data line; and a common electrode overlaying the color resin and the first black matrix;

[0010] wherein the first black matrix comprises: a flat bottom layer and a protrusion formed on the flat bottom layer, the protrusion has slant surfaces near a boundary between the non-pixel region and the pixel region, such that an electric field for rotating liquid crystal molecules at edges of the first black matrix is generated between the common electrode overlaying the slant surfaces and the pixel electrode.

[0011] On the other hand, the invention provides a display device comprising the above LCD panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to clearly illustrate the technical solution of the embodiments of the invention, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the invention and thus are not imitative of the invention.

[0013] FIG. **1** schematically illustrates a top view of a display panel after cell-assembling an array substrate and a color filter substrate, in which the lower part of the figure illustrates a cut-away configuration;

[0014] FIG. **2** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate;

[0015] FIG. **3** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate provided by a first embodiment of the invention;

[0016] FIG. **4** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate provided by a second embodiment of the invention;

[0017] FIG. **5** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate provided by a third embodiment of the invention;

[0018] FIG. **6** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate provided by a fourth embodiment of the invention; and

[0019] FIG. **7** schematically illustrate a cross section of a display panel after cell-assembling an array substrate and a color filter substrate provided by a fifth embodiment of the invention.

DESCRIPTION OF THE REFERENCE NUMERALS

[0020] **10**: array substrate; **20**: color filter substrate; **30**: liquid crystal molecules, **101**: first transparent substrate; **102**: data line; **103**: pixel electrode; **104**: light-shielding strip; **201**:

second transparent substrate; **202**: color resin; **203**: black matrix; **203***a:* first black matrix; **203***a***1**: flat bottom layer; **203***a:* protrusion; **203***b:* second black matrix; **204**: common electrode.

DETAILED DESCRIPTION

[0021] In order to make objects, technical details and advantages of the embodiments of the invention clear, the technical solutions of the embodiment will be described in a clearly and fully understandable way accompanying the drawings related to the embodiments of the invention. It is obvious that the described embodiments are merely a part but not all of the embodiments of the invention. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the invention.

[0022] All the drawings of the invention are schematic views of the display and are used for the purpose of clearly describing the structures related to the inventive features; other structures irrelevant to the invention are not or only partially illustrated in the drawings.

Embodiment 1

[0023] An embodiment of the invention provides a liquid crystal display panel shown in FIG. **3** (which is a cross section taken along the line A-A' in a way similar to FIG. **2**), which comprises: an array substrate **10** and a color filter substrate **20**.

[0024] The array substrate **10** comprises: a first transparent substrate **101**; a data line **102** and a gate line (not shown in the figure) disposed on an inner side of the first transparent substrate **101**. It may further comprises a pixel electrode **103** disposed on the inner side of the first transparent substrate **101**. Moreover, it may further comprises a light-shielding strip **104** disposed on the inner side of the first transparent substrate **101**. It is noted that the drawings only illustrate spatial relationships between the afore-described patterns disposed on the first transparent substrate **101** to show that the patterns are made of different film layers and no electrical connection exists between the different patterns, while patterns or film layers irrelevant to the invention are not shown in the drawings.

[0025] The color filter substrate **20** comprises: a second transparent substrate **201** comprising a pixel region and a non-pixel region; a color resin **202** disposed in the pixel region; and a first black matrix **203***a* disposed in the non-pixel region and above the data line **102**. The color filter substrate **20** may further comprises a second black matrix **203***b* (not shown in FIG. **3**) parallel to the gate line and a common electrode **204** overlaying the color resin **202** as well as the first and second black matrices **203***a* and **203***b*.

[0026] The first black matrix **203***a* comprises: a flat bottom layer **203***a***1** and a protrusion **203***a***2** formed on the flat bottom layer, wherein the protrusion **203***a***2** has slant surfaces A1, A2 near the boundary between the non-pixel region and the pixel region (i.e., the boundary between the first black matrix **203***a* and the color resin **202**).

[0027] As an example, the intersection positions where the slant surfaces A1, A2 of the protrusion **203***a***2** near the boundary between the first black matrix **203***a* and the color resin **202** are conjoined with the flat bottom layer **203***a***1** are defined as first positions D1, D2, respectively. By this means, the slant surface A1, A2 incline from the first positions D1, D2, towards a perpendicular bisection plane Z of the first black matrix **203***a,* wherein the perpendicular bisection plane Z extends along the direction of the data line **102**.

[0028] That is to say, the two outmost slant surfaces A1, A2 of the protrusion **203***a***2** incline towards the perpendicular bisection plane Z from the first positions D1, D2 respectively, thereby ensuring the common electrode **204** overlaying the first black matrix is also inclined on the two outmost slant surfaces A1, A2.

[0029] The misalignment between the color filter substrate **20** and the array substrate **10** normally causes a mismatch in the vertical direction; therefore in the embodiment of the invention, the first black matrix **203***a* is fabricated as the protrusion **203***a***2** comprising two slant surfaces A1, A2. A distance between the two slant surfaces A1, A2 and the pixel electrode **103** is relatively small, a strong electric field may be generated between the common electrode **204** overlaying the two slant surfaces A1, A2 and the pixel electrode **103** (that is, a strong electric field is generated at the boundary between the non-pixel region and the pixel region). Similar to the vertical electric field in the pixel region, the strong electric field may cause the liquid crystal molecules at the edges of the black matrix in the non-pixel region to be in the same orientation as the liquid crystal molecules in the pixel region, and suppress the effect of other miscellaneous weak electric fields on the liquid crystal molecules, thereby regulating the light passing the liquid crystal molecules at the edges of the black matrix in the non-pixel region, so as to decrease or avoid pixel light leakage.

[0030] In the above embodiment, the array substrate **10**, the color resin **202** of the color filter substrate **20**, and the second black matrix **203***b* parallel to the gate line may employ conventional structures and materials in the field, which will not be elaborated here. Furthermore, the perpendicular bisection plane Z of the first black matrix **203***a* extending along the direction of the data line **102** is indicated as a broken line in FIGS. **3** to **7**. Moreover, since the boundary between the first black matrix **203***a* and the color resin **202** refers to two boundaries, the first positions in all the embodiments of the invention refer to the afore-described first positions D1, D2.

[0031] The protrusion **203***a***2** of the first black matrix **203***a* as provided by the embodiment of the invention may be a protrusion of any shape (such as a triangle or a trapezoidal) that comprises the two slant surfaces A1, A2 at the first positions D1, D2, as long as the electric field between the common electrode **204** overlaying the two slant surfaces A1, A2 of the protrusion **203***a***2** and the pixel electrode **103** can make the liquid crystal molecules at the edges of the first black matrix **203***a* in the non-pixel region to be of a similar orientation as the liquid crystal molecules in the pixel region.

[0032] In all embodiments of the invention, the slant surfaces at the first positions refer to the two slant surfaces A1, A2 at the first positions D1, D2 near the boundary between the first black matrix **203***a* and the color resin **202**, that is, the slant surface A1 at the first position D1 and the slant surface A2 at the first position D2. Moreover, the two slant surfaces A1, A2 may have the same or different inclination angles. For example, the example shown in FIGS. **3** and **4** has two slant surfaces having different inclination angles.

[0033] In all the embodiments of the invention, the inclination angle of the slant surfaces A1, A2 are not limited, as long as the electric field between the common electrode **204** overlaying the two slant surfaces A1, A2 of the protrusion **203***a***2** and the pixel electrode **103** can make the liquid crystal mol-

ecules at the edges of the first black matrix **203***a* in the non-pixel region to be of a similar orientation as the liquid crystal molecules in the pixel region.

[0034] As an example, distance L between the first position D1, D2 and the boundary between the first black matrix **203***a* and the color resin **202** may be 0.9 μm~1.1 μm. For example, the distances L between the first positions D1, D2 and the boundary between the first black matrix **203***a* and the color resin **202** are the same and may be any value between 0.9 μm~1.1 μm. Preferably, the distance L is 1 μm.

[0035] As an example, the height of the slant surfaces A1, A2 along the direction vertical to the flat bottom layer **203***a***1** of the first black matrix **203***a*, that is, the distance from the apex of the slant surfaces A1, A2 to the flat bottom layer **203***a***1**, may be 0.9 μm~1.1 μm. For example, the height of the slant surface A1 along the direction vertical to the flat bottom layer **203***a***1** of the first black matrix **203***a* is h1, the height of the slant surface A2 along the direction vertical to the flat bottom layer **203***a***1** of the first black matrix **203***a* is h2, both h1 and h2 may have a value between 0.9 μ~1.1 μm but different from each other. In this case, the height of the protrusion **203***a***2** can not exceed the maximum height of h1 and h2. Preferably, h1=h1=1 μm.

[0036] In the embodiment of the invention, the contact surface of the protrusion **203***a***2** and the common electrode **204**, which locates between the slant surfaces A1, A2, may be slant or flat, as long as the process requirements can be met. For example, in FIG. **3** the contact surface is a slant surface, while in FIG. **5** it is a flat surface.

Embodiment 2

[0037] With reference to FIG. **4**, the embodiment differs from the LCD panel of embodiment 1 in that the protrusion of the first black matrix **203***a* of this embodiment comprises three trapezoidal sub-protrusions, and the sizes of the three sub-protrusions are different from each other.

Embodiment 3

[0038] With reference to FIG. **5**, the embodiment differs from the LCD panel of embodiment 1 in that the protrusion **203***a***2** of this embodiment comprises one trapezoidal sub-protrusion. Preferably, the trapezoidal sub-protrusion is symmetrical about the perpendicular bisection plane Z of the first black matrix **203***a* extending along the direction of data line. That is to say, the slant surfaces A1, A2 are symmetrical about the perpendicular bisection plane Z. Moreover, the bottom surface of the flat bottom layer **203***a***1** is also symmetrical about the perpendicular bisection plane Z. Meanwhile, the contact surface of the trapezoidal sub-protrusion and the common electrode **204**, which locates between the slant surfaces A1 and A2, is a flat plane and parallel to the flat bottom layer **203***a***1**. The contact portion, where the contact surface locates, is also symmetrical about the perpendicular bisection plane Z of the first black matrix **203***a* extending along the direction of the data line **102**.

Embodiment 4

[0039] With reference to FIG. **6**, the embodiment differs from the LCD panel of embodiment 1 in that the protrusion **203***a***2** of the embodiment comprises at least two trapezoidal sub-protrusions (such as four). Preferably, two of the four trapezoidal sub-protrusions that are closer to the boundary between the first black matrix **203***a* and the color resin **202** are symmetrical about the perpendicular bisection plane Z of the first black matrix **203***a* extending along the direction of the data line **102**.

[0040] The two trapezoidal sub-protrusions that are closer to the boundary between the first black matrix **203***a* and the color resin **202** are the two trapezoidal sub-protrusions respectively comprising the two slant surfaces A1, A2 at the first positions D1, D2, and the two slant surfaces A1, A2 are the slant surfaces of the protrusion **203***a***2** that are closest to the boundary between the first black matrix **203***a* and the color resin **202**.

[0041] As an example, a width L' of the contact region where the trapezoidal sub-protrusions that are closer to the boundary between the first black matrix **203***a* and the color resin **202** contacts with the flat bottom layer is preferably 0.9 μm~1.1 μm (the width used herein refers to a width of the contact region in the gate line-parallel direction of the array substrate **10**), such that an electric field similar to those in the pixel region is effectively formed in the region near the slant surfaces to avoid light leakage.

Embodiment 5

[0042] With reference to FIG. **7**, the embodiment differs from the LCD panel of embodiment 1 in that the protrusion **203***a***2** of the embodiment comprises two trapezoidal sub-protrusions. In this case, the two trapezoidal sub-protrusions respectively comprise the two slant surfaces A1, A2 at the first positions D1, D2, and the two slant surfaces A1, A2 are the slant surfaces of the protrusion **203***a***2** that are closest to the boundary between the first black matrix **203***a* and the color resin **202**. Meanwhile, the two trapezoidal sub-protrusions are symmetrical about the perpendicular bisection plane Z of the first black matrix **203***a* extending along the direction of the data line.

[0043] Preferably, as illustrated in FIG. **7**, the two trapezoidal sub-protrusions respectively comprising the slant surfaces A1, A2 are both isosceles trapezoidal sub-protrusions.

Embodiment 6

[0044] This embodiment provides a display device comprising any of the afore-mentioned LCD panel.

[0045] As an example, the above display device may further comprise a backlight source disposed at an outside of the array substrate of the display panel.

[0046] The display device may be a LCD monitor, a LCD TV, a digital photoframe, a mobile phone, a tablet PC and any product or part having a display function.

[0047] In the LCD panel and the display device provided by the above embodiments, when the color filter substrate and the array substrate are misaligned, a strong electric field is generated between the common electrode overlaying the two slant surfaces of the first black matrix of the color filter substrate and the array substrate. The strong electric field is similar to the vertical electric field in the pixel region, and may cause the liquid crystal molecules at the edges of the black matrix in the non-pixel region to be in the same orientation as the liquid crystal molecules in the pixel region, such that light passing through the liquid crystal molecules at the edge of first black matrix in the non-pixel region is regulated, so as to overcome the light leakage issue caused by the misalignment between the color filter substrate and the array substrate, and improve the picture quality. Meanwhile, the amount of material of the black matrix is reduced.

[0048] What are described above is related to the illustrative embodiments of the disclosure only and not limitative to the scope of the disclosure; the scopes of the disclosure are defined by the accompanying claims.

What is claimed is:

1. A LCD panel comprising:

an array substrate which comprises: a first transparent substrate, a data line and a pixel electrode disposed on an inner side of the first transparent substrate;

a color filter substrate which comprises: a second transparent substrate comprising a pixel region and a non-pixel region, a color resin disposed in the pixel region, a first black matrix disposed in the non-pixel region and above the data line; and a common electrode overlaying the color resin and the first black matrix;

wherein the first black matrix comprises: a flat bottom layer and a protrusion formed on the flat bottom layer, the protrusion has slant surfaces near a boundary between the non-pixel region and the pixel region, such that an electric field for rotating liquid crystal molecules at edges of the first black matrix is generated between the common electrode overlaying the slant surfaces and the pixel electrode.

2. The LCD panel of claim **1**, wherein the boundary between the non-pixel region and the pixel region is a boundary between the first black matrix and the color resin.

3. The LCD panel of claim **2**, wherein the slant surfaces of the protrusions near the boundary between the first black matrix and the color resin are conjoined with the flat bottom layer at first positions, the slant surfaces incline, from the first positions, towards a perpendicular bisection plane of the first black matrix extending along the direction of the data line.

4. The LCD panel of claim **3**, wherein distance between the first position and the boundary between the first black matrix and the color resin is 0.9 μm~1.1 μm.

5. The LCD panel of claim **1**, wherein a height of the slant surface is 0.9 μm~1.1 μm.

6. The LCD panel of claim **1**, wherein the protrusion comprises at least one trapezoidal sub-protrusion.

7. The LCD panel of claim **6**, wherein the protrusion comprises one trapezoidal sub-protrusion and the trapezoidal sub-protrusion is symmetrical about the perpendicular bisection plane of the first black matrix extending along the direction of the data line.

8. The LCD panel of claim **6**, wherein the protrusion comprises four trapezoidal sub-protrusions, and two of the four trapezoidal sub-protrusions that are closer to the boundary between the first black matrix and the color resin are symmetrical about the perpendicular bisection plane of the first black matrix extending along the direction of the data line.

9. The LCD panel of claim **8**, wherein a width of the contact region where the two trapezoidal sub-protrusions that are closer to the boundary between the first black matrix and the color resin contacts with the flat bottom layer is 0.9 μm~1.1 μm.

10. The LCD panel of claim **6**, wherein the protrusion comprises two trapezoidal sub-protrusions and the two trapezoidal sub-protrusions are symmetrical about the perpendicular bisection plane of the first black matrix extending along the direction of the data line.

11. The LCD panel of claim **10**, wherein the trapezoidal sub-protrusions are isosceles trapezoidal sub-protrusions.

12. A display device comprising the LCD panel of claim **1**.

13. The display device of claim **12**, further comprising a backlight source disposed at an outside of the array substrate of the LCD panel.

* * * * *

专利名称(译)	液晶显示面板和显示装置		
公开(公告)号	US20140036179A1	公开(公告)日	2014-02-06
申请号	US13/957775	申请日	2013-08-02
[标]申请(专利权)人(译)	成都京东方光电科技有限公司 京东方科技集团股份有限公司		
申请(专利权)人(译)	成都京东方光电科技有限公司 京东方科技集团股份有限公司.		
当前申请(专利权)人(译)	京东方科技集团股份有限公司. 成都京东方光电科技有限公司.		
[标]发明人	HUANG LI PARK SEUNGYIK HWANG LYULYUN		
发明人	HUANG, LI PARK, SEUNGYIK HWANG, LYULYUN		
IPC分类号	G02F1/1335		
CPC分类号	G02F1/133512 G02F1/133707		
优先权	201210276295.6 2012-08-03 CN		
其他公开文献	US9158148		
外部链接	Espacenet USPTO		

摘要(译)

本发明实施例提供一种液晶显示面板和显示装置，该液晶显示面板包括阵列基板和彩膜基板，该阵列基板包括第一透明基板，数据线和设置在第一透明基板内侧的像素电极透明基板，彩色滤光片基板包括第二透明基板，彩色树脂，第一黑色矩阵和覆盖彩色树脂和第一黑色矩阵的公共电极，其中第一黑色矩阵包括平底层和形成于其上的突起在平坦的底层中，突起在非像素区域和第二透明基板的像素区域之间的边界附近具有倾斜表面。