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(54) **CURVED LIQUID CRYSTAL DISPLAY PANEL AND CURVED LIQUID CRYSTAL DISPLAY APPARATUS**

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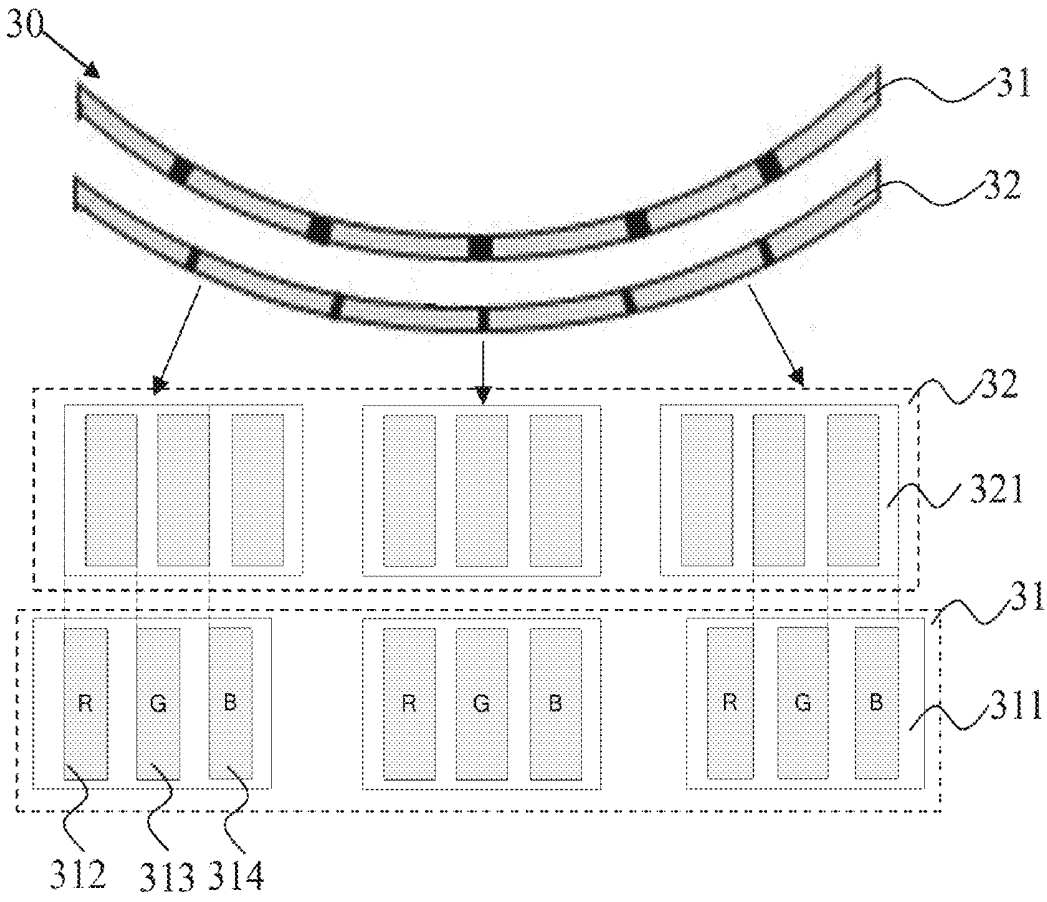
(57) **ABSTRACT**

A curved LCD panel is provided. The curved LCD panel comprises a curved color filter substrate and a cured array substrate. A plurality of regions are formed along a longitudinal direction of the color filter substrate. In each of the regions of the color filter substrate, according to a greatest shifted distance between the color filter and the array substrate, a width of the black matrix within the region is predetermined. The black matrix can have different widths in the different regions to prevent the color shifting phenomenon.



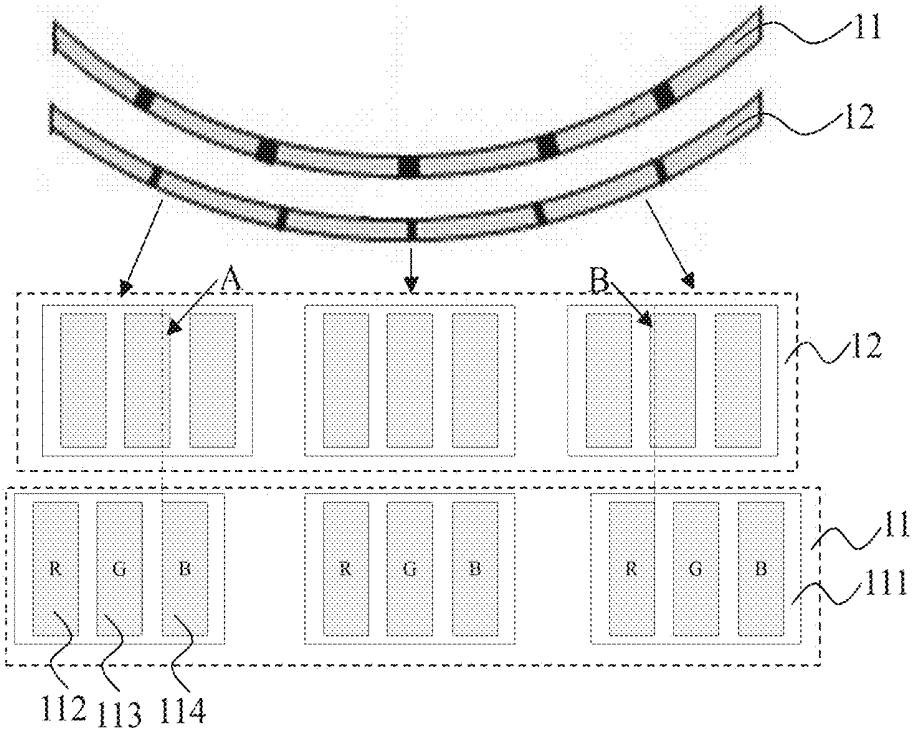


Fig.1

PRIOR ART

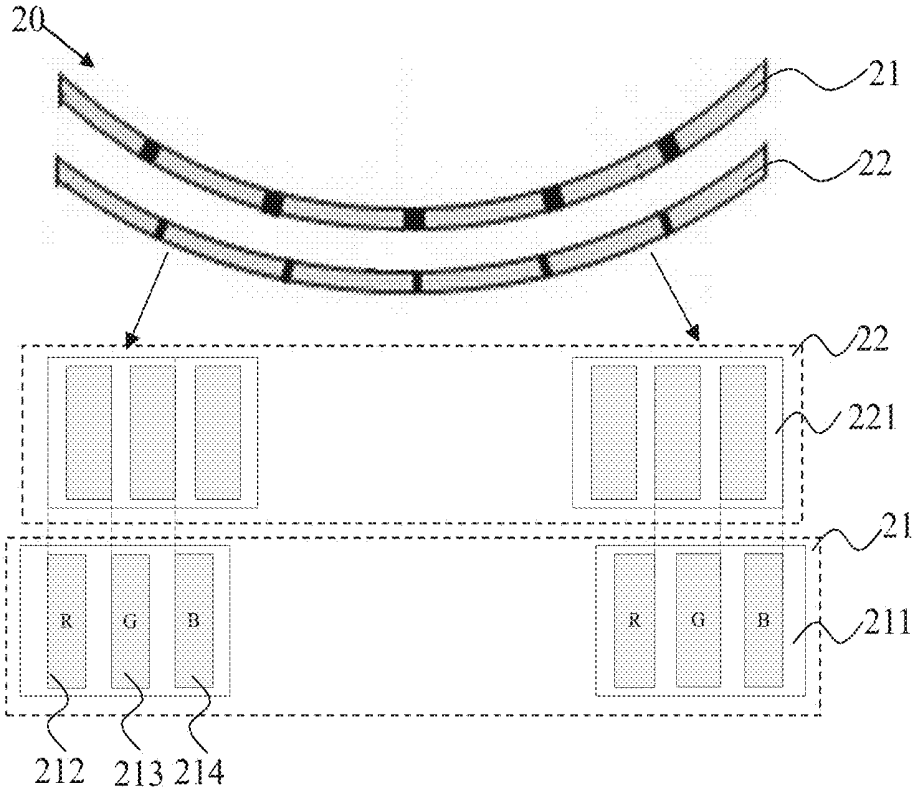


Fig.2

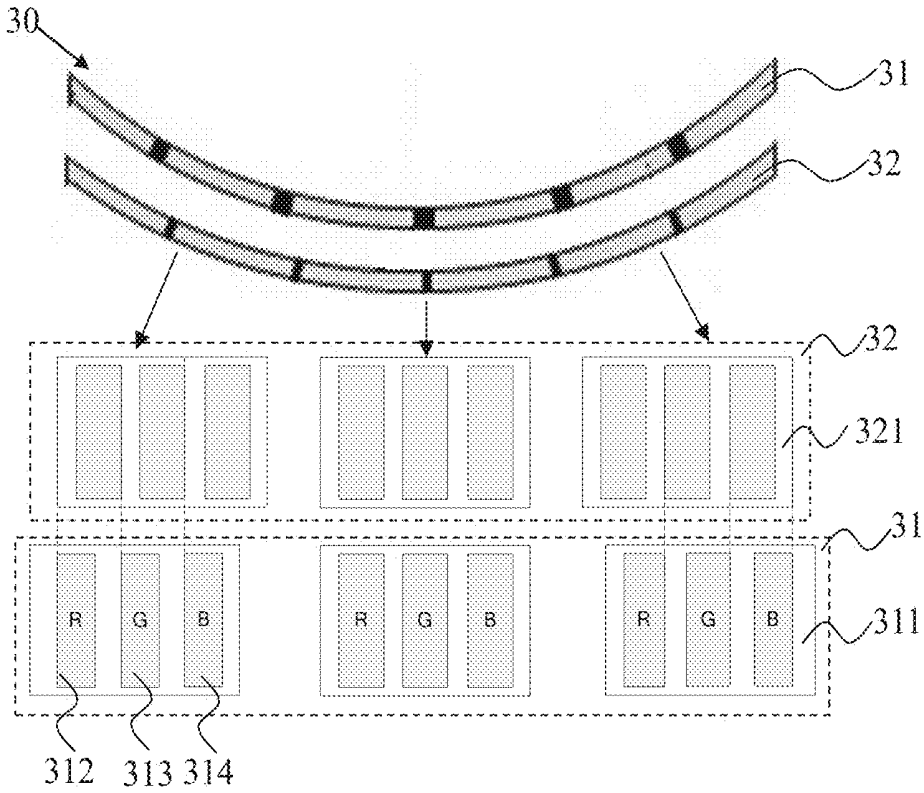


Fig.3

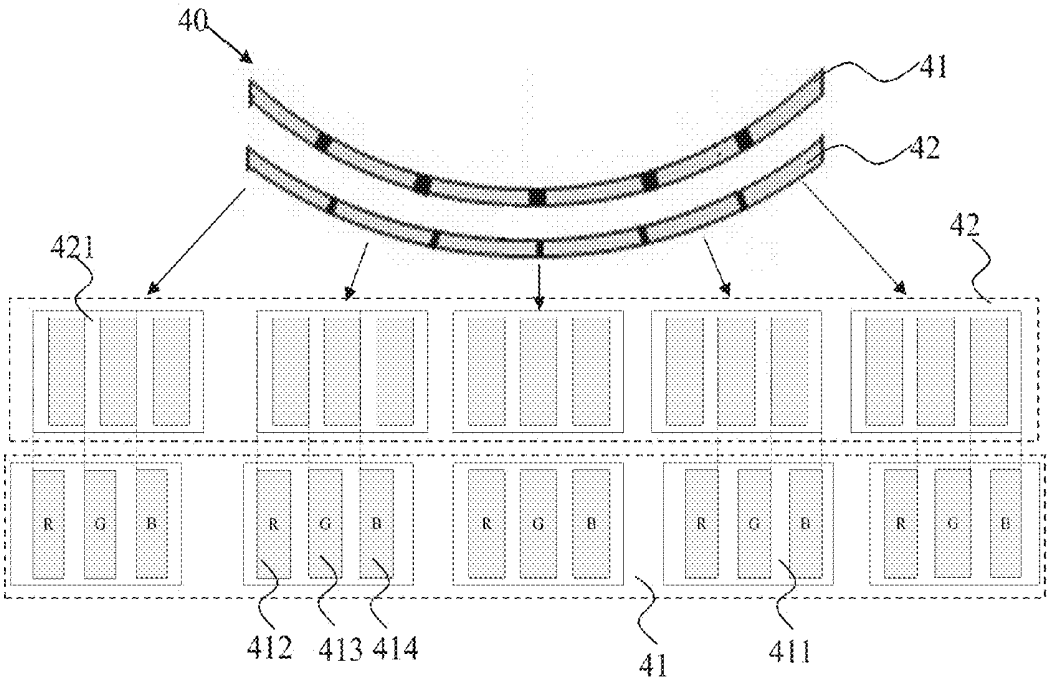


Fig.4

CURVED LIQUID CRYSTAL DISPLAY PANEL AND CURVED LIQUID CRYSTAL DISPLAY APPARATUS

FIELD OF THE INVENTION

[0001] The present invention relates to a technical field of displays, and more particularly to a curved liquid crystal display (LCD) panel and a curved LCD apparatus.

BACKGROUND OF THE INVENTION

[0002] A curved LCD is an LCD with a cured structure, comprising a cured color filter substrate **11** and a cured array substrate **12**. The color filter substrate **11** can comprise a black matrix **111**, red filters **112**, green filters **113**, and blue filters **114**. Refer to FIG. **1**, which is a schematic diagram and a partially structural view showing a conventional curved LCD are illustrated.

[0003] The black matrix **111** on the color filter substrate **11** is configured to prevent colored lights from being mixed and leaked. In general, the conventional LCD is first made as a flat panel, and the flat panel is curved by a curving process. In the curving process, the color filter substrate and the array substrate may be shifted a distance with respect to each other. Referring to FIG. **1**, a left side of the color filter substrate is shifted leftward a distance with respect to the array substrate, and a right side of the color filter substrate is shifted rightward a distance with respect to the array substrate.

[0004] The greater a curvature of the cured structure is, the larger the shifted distance between the color filter substrate and the array substrate is, resulting in a color shifting phenomenon. Both the green filters **113** and the blue filters **114** of the color filter substrate **11** may be covered by the green pixels of the array substrate **12**. Therefore, when a green image is displayed by a left side of the LCD panel, a blue region (the region A in FIG. **1**) may occur at a right side of the green image. In addition, both the green filters **113** and the red filters **112** of the color filter substrate **11** may be covered by the green pixels of the array substrate **12**. Therefore, when the green image is displayed by a right side of the LCD panel, a red region (the region B in FIG. **1**) may occur at a left side of the green image. Accordingly, a display quality of the curved LCD is greatly degraded.

[0005] As a result, it is necessary to provide a curved LCD panel and a curved LCD apparatus to solve the problems existing in the conventional technologies, as described above.

SUMMARY OF THE INVENTION

[0006] The present invention provides a curved LCD panel and a curved LCD apparatus, wherein the black matrix can have different widths in the different regions to prevent the color shifting phenomenon. In the conventional curved LCD panel and apparatus, the color shifting phenomenon results from a shifted distance between the color filter substrate and the array substrate, thereby deteriorating a display quality of the LCD.

[0007] A primary object of the present invention is to provide a curved LCD panel comprising: a curved color filter substrate comprising a black matrix and color filters; and a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively; wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in one of the regions positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region. In one of the regions positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region. The regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

[0008] In the curved LCD panel of the present invention, a width of black matrix in the left region and far away from the middle region is larger than a width of black matrix in the left region and close to the middle region.

[0009] In the curved LCD panel of the present invention, a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

[0010] In the curved LCD panel of the present invention, the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

[0011] Another object of the present invention is to provide a curved LCD panel comprising: a curved color filter substrate comprising a black matrix and color filters; and a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively; wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in each of the regions of the color filter substrate, according to a greatest shifted distance between the color filter and the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region.

[0012] In the curved LCD panel of the present invention, one of the regions is positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, the width of the black matrix within the region is predetermined.

[0013] In the curved LCD panel of the present invention, one of the regions is positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined.

[0014] In the curved LCD panel of the present invention, the regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

[0015] In the curved LCD panel of the present invention, a width of black matrix in the left region and far away from the

middle region is larger than a width of black matrix in the left region and close to the middle region.

[0016] In the curved LCD panel of the present invention, a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

[0017] In the curved LCD panel of the present invention, the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

[0018] Still another object of the present invention is to provide a curved LCD apparatus comprising a backlight module and a curved LCD panel. The backlight module comprises: at least one light source emitting light rays; and a light guide plate transmitting the light rays. The curved LCD panel receives the light rays transmitted from the light guide plate and comprises: a curved color filter substrate comprising a black matrix and color filters; and a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively; wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in each of the regions of the color filter substrate, according to a greatest shifted distance between the color filter and the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region.

[0019] In the curved LCD apparatus of the present invention, one of the regions is positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, the width of the black matrix within the region is predetermined.

[0020] In the curved LCD apparatus of the present invention, one of the regions is positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined.

[0021] In the curved LCD apparatus of the present invention, the regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

[0022] In the curved LCD apparatus of the present invention, a width of black matrix in the left region and far away from the middle region is larger than a width of black matrix in the left region and close to the middle region.

[0023] In the curved LCD apparatus of the present invention, a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

[0024] In the curved LCD apparatus of the present invention, the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

[0025] In the curved LCD apparatus of the present invention, according to the widths of the black matrix in the regions, a brightness in regions of the light guide plate is adjusted.

[0026] In the conventional curved LCD panel and apparatus, the color shifting phenomenon results from a shifted distance between the color filter substrate and the array substrate, thereby deteriorating a display quality of the LCD. In comparison to the prior art, the black matrix in the curved LCD panel and the curved LCD apparatus of the present invention can have different widths in the different regions to prevent the color shifting phenomenon.

[0027] The structure and the technical means adopted by the present invention to achieve the above-mentioned and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

[0028] FIG. **1** illustrates a schematic diagram and a partially structural view showing a conventional curved LCD;

[0029] FIG. **2** illustrates a schematic diagram and a partially structural view showing a curved LCD according to a first embodiment of the present invention;

[0030] FIG. **3** illustrates a schematic diagram and a partially structural view showing a curved LCD according to a second embodiment of the present invention; and

[0031] FIG. **4** illustrates a schematic diagram and a partially structural view showing a curved LCD according to a third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] The following embodiments are referring to the accompanying drawings for exemplifying specific implementable embodiments of the present invention. Furthermore, directional terms described by the present invention, such as upper, lower, front, back, left, right, inner, outer, side, etc., are only directions by referring to the accompanying drawings, and thus the used directional terms are used to describe and understand the present invention, but the present invention is not limited thereto.

[0033] In drawings, elements with a similar structure have the same reference number.

[0034] Referring to FIG. **2**, a schematic diagram and a partially structural view showing a curved LCD according to a first embodiment of the present invention are illustrated therein. The curved LCD panel **20** of the present embodiment comprises a cured color filter substrate **21** and a cured array substrate **22**.

[0035] As shown in FIG. **2**, the color filter substrate **21** comprises a black matrix **211** and color filters, and the color filters comprise red filters **212**, green filters **213**, and blue filters **214**. The array substrate **22** is opposite the color filter substrate **21** and comprises pixel electrodes **221**, data lines (not shown), and scan lines (not shown). The pixel electrodes **221** of the array substrate **22** correspond to the color filters of the color filter substrate **21**, respectively. The light rays from the pixel electrodes and passing through the color filter substrate **21** can be red, green, or blue.

[0036] As shown in FIG. **2**, the cured color filter substrate **21** is opposite the cured array substrate **22**, and the color filters of the color filter substrate **21** and the pixel electrodes **221** of the array substrate **22** may be shifted a distance with respect to each other. At a left side of the curved LCD panel **20**, the color filters of the color filter substrate **21** are shifted leftward a distance with respect to the corresponding pixel electrodes **221**. At a right side of the curved LCD panel **20**, the color

filters of the color filter substrate **21** are shifted rightward a distance with respect to the corresponding pixel electrodes **221**.

[0037] To prevent the color shifting phenomenon, in the color filter substrate **21** of the curved LCD panel **20** of the present embodiment, two regions are formed along a longitudinal direction of the color filter substrate **21**, and the two regions are positioned symmetrically with respect to the central axis of the color filter substrate **21**. At the leftmost side or the rightmost side of the color filter substrate **21**, a shifted distance between the color filter substrate **21** and the corresponding pixel electrode **221** is greatest. In one of the regions positioned at the left side of the color filter substrate **21**, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode **221** of the array substrate **22**, i.e. according to the greatest shifted distance, a width of the black matrix **211** within the region (the left region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the left region) of the curved LCD panel **20**. In one of the regions positioned at the right side of the color filter substrate **21**, according to a shifted distance between a rightmost color filter of the color filter substrate **21** and a rightmost pixel electrode **221** of the array substrate **22**, i.e. according to the greatest shifted distance, a width of the black matrix **211** within the region (the right region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the right region) of the curved LCD panel **20**.

[0038] In the curved LCD panel **20** of the present embodiment, the black matrix **211** can have different widths in the left region and the right region, so as to prevent that the light rays from one of the pixel electrodes **221** are emitted to an adjacent color filter (the wrong color filter), but not the corresponding color filter, i.e. preventing the color shifting phenomenon. Moreover, the color filter substrate **21** and the array substrate **22** are disposed symmetrically, and the widths of the black matrix **211** in the left region and the right region of the color filter substrate **21** are determined symmetrically. That is, the black matrix **211** in the left region and the right region may have different widths, but can have the same area, so as to form the same brightness at the left side and the right side of the curved LCD panel **20**, thereby preventing a brightness difference in the curved LCD panel **20**.

[0039] In the curved LCD panel of the present embodiment, the black matrix can have different widths in the different regions for preventing the color shifting phenomenon.

[0040] Referring to FIG. **3**, a schematic diagram and a partially structural view showing a curved LCD according to a second embodiment of the present invention are illustrated. The curved LCD panel **30** of the present embodiment comprises a cured color filter substrate **31** and a cured array substrate **32**.

[0041] As shown in FIG. **3**, the color filter substrate **31** comprises a black matrix **311** and color filters, and the color filters comprise red filters **312**, green filters **313**, and blue filters **314**. The array substrate **32** is opposite the color filter substrate **31** and comprises pixel electrodes **321**, data lines (not shown), and scan lines (not shown). The pixel electrodes **321** of the array substrate **32** correspond to the color filters of the color filter substrate **31**, respectively. The light rays from the pixel electrodes and passing through the color filter substrate **31** can be red, green, or blue.

[0042] As shown in FIG. **3**, the cured color filter substrate **31** is opposite the cured array substrate **32**, and the color filters of the color filter substrate **31** and the pixel electrodes **321** of the array substrate **32** may be shifted a distance with respect to each other. At a left side of the curved LCD panel **30**, the color filters of the color filter substrate **31** are leftward shifted a distance with respect to the corresponding pixel electrodes **321**. At a right side of the curved LCD panel **30**, the color filters of the color filter substrate **31** are rightward shifted a distance with respect to the corresponding pixel electrodes **321**.

[0043] To prevent the color shifting phenomenon, in the color filter substrate **31** of the curved LCD panel **30** of the present embodiment, three regions are formed along a longitudinal direction of the color filter substrate **31**, and the three regions comprise a left region, a middle region, and a right region. The left region and the right region are positioned symmetrically at the left side and the right side of the middle region, respectively. At the leftmost side or the rightmost side of the color filter substrate **31**, a shifted distance between the color filter and the corresponding pixel electrode **321** is greatest. In one of the regions positioned at the left side of the color filter substrate **31**, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode **321** of the array substrate **32**, i.e. according to the greatest shifted distance, a width of the black matrix **311** within the region (the left region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the left region) of the curved LCD panel **30**. In one of the regions positioned at the right side of the color filter substrate **31**, according to a shifted distance between a rightmost color filter of the color filter substrate **31** and a rightmost pixel electrode **321** of the array substrate **32**, i.e. according to the greatest shifted distance, a width of the black matrix **311** within the region (the right region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the right region) of the curved LCD panel **30**.

[0044] In the middle region of the color filter substrate **31**, a shifted distance between the color filter and the corresponding pixel electrode **321** is smallest, and the color shifting phenomenon will not occur in the middle region of the curved LCD panel **30**. Therefore, the widths of the black matrix **311** within the middle region are not required to be adjusted according to the shifted distance between the color filter and the corresponding pixel electrode **321**.

[0045] Therefore, in the color filter substrate **31** of the curved LCD panel **30** of the present embodiment, a width of black matrix **311** in the left region is larger than a width of black matrix **311** in the middle region, and similarly, a width of black matrix **311** in the right region is also larger than a width of black matrix **311** in the middle region.

[0046] In the curved LCD panel **30** of the present embodiment, the black matrix **311** can have different widths in the left region and the right region, so as to prevent that the light rays from one of the pixel electrodes **321** are emitted to an adjacent color filter (the wrong color filter), but not the corresponding color filter, i.e. preventing the color shifting phenomenon. Moreover, the width of black matrix **311** in the middle region is smaller, and thus an aperture ratio of the curved LCD panel **30** can be promoted for improving a display efficiency of the curved LCD panel **30**.

[0047] Compared with the first embodiment, in the curved LCD panel of the present embodiment, the width of black matrix in the middle region can be smaller for improving the display efficiency and the aperture ratio of the curved LCD panel.

[0048] Referring to FIG. **4**, a schematic diagram and a partially structural view showing a curved LCD according to a second embodiment of the present invention are illustrated. The curved LCD panel **40** of the present embodiment comprises a cured color filter substrate **41** and a cured array substrate **42**.

[0049] As shown in FIG. **4**, the color filter substrate **41** comprises a black matrix **411** and color filters, and the color filters comprise red filters **412**, green filters **413**, and blue filters **414**. The array substrate **42** is opposite the color filter substrate **41** and comprises pixel electrodes **421**, data lines (not shown), and scan lines (not shown). The pixel electrodes **421** of the array substrate **42** correspond to the color filters of the color filter substrate **41**, respectively. The light rays from the pixel electrodes and passing through the color filter substrate **41** can be red, green, or blue.

[0050] As shown in FIG. **4**, the cured color filter substrate **41** is opposite the cured array substrate **42**, and the color filters of the color filter substrate **41** and the pixel electrodes **421** of the array substrate **42** may be shifted a distance with respect to each other. At a left side of the curved LCD panel **40**, the color filters of the color filter substrate **41** are leftward shifted a distance with respect to the corresponding pixel electrodes **421**. At a right side of the curved LCD panel **40**, the color filters of the color filter substrate **41** are rightward shifted a distance with respect to the corresponding pixel electrodes **421**.

[0051] To prevent the color shifting phenomenon, in the color filter substrate **41** of the curved LCD panel **40** of the present embodiment, five regions are formed along a longitudinal direction of the color filter substrate **41**, and the five regions comprise two left regions, a middle region, and two right regions. The two left regions and the two right regions are positioned symmetrically at the left side and the right side of the middle region. At the leftmost side or the rightmost side of the color filter substrate **41**, a shifted distance between the color filter and the corresponding pixel electrode **421** is greatest. In one of the regions positioned at the left side of the color filter substrate **41**, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode **421** of the array substrate **42**, i.e. according to the greatest shifted distance, a width of the black matrix **411** within the region (the left region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the left region) of the curved LCD panel **40**. In one of the regions positioned at the right side of the color filter substrate **41**, according to a shifted distance between a rightmost color filter of the color filter substrate **41** and a rightmost pixel electrode **421** of the array substrate **42**, i.e. according to the greatest shifted distance, a width of the black matrix **411** within the region (the right region) is predetermined to prevent the color shifting phenomenon from occurring in the region (the right region) of the curved LCD panel **40**.

[0052] In the middle region of the color filter substrate **41**, a shifted distance between the color filter and the corresponding pixel electrode **421** is smallest, and the color shifting phenomenon will not occur in the middle region of the curved LCD panel **40**. Therefore, the widths of the black matrix **411** within the middle region are not required to be adjusted according to the shifted distance between the color filter and the corresponding pixel electrode **421**.

[0053] Therefore, in the color filter substrate **41** of the curved LCD panel **40** of the present embodiment, a width of black matrix **411** in the left region is larger than a width of black matrix **411** in the middle region, and similarly, a width of black matrix **411** in the right region is also larger than a width of black matrix **411** in the middle region.

[0054] A width of black matrix **411** in the left region and far away from the middle region is larger than a width of black matrix **411** in the left region and close to the middle region. That is, in the two left regions, a width of black matrix **411** far away from the middle region is larger than a width of black matrix **411** close to the middle region.

[0055] A width of black matrix **411** in the right region and far away from the middle region is larger than a width of black matrix **411** in the right region and close to the middle region. That is, in the two right regions, a width of black matrix **411** far away from the middle region is larger than a width of black matrix **411** close to the middle region.

[0056] In the curved LCD panel **40** of the present embodiment, the black matrix **411** can have different widths in the left regions and the right regions, so as to prevent that the light rays from one of the pixel electrodes **421** are emitted to an adjacent color filter (the wrong color filter), but not the corresponding color filter, i.e. preventing the color shifting phenomenon. Moreover, the width of black matrix **411** close to the middle region is smaller, and thus an aperture ratio of the curved LCD panel **40** can be promoted for improving a display efficiency of the curved LCD panel **40**.

[0057] Compared with the second embodiment, in the curved LCD panel of the present embodiment, the plurality of the left regions and the right regions are formed improving the display efficiency and the aperture ratio of the curved LCD panel.

[0058] The present invention further provides a curved LCD apparatus. The curved LCD apparatus comprises a backlight module and the curved LCD panel. The backlight module may comprise at least one light source and a light guide plate, and the light source emits light rays, and the light guide plate transmits the light rays to the curved LCD panel. The curved LCD panel of the present embodiment comprises a cured color filter substrate and a cured array substrate.

[0059] The color filter substrate comprises a black matrix and color filters, and the color filters can comprise red filters, green filters, and blue filters. The array substrate is opposite the color filter substrate and comprises pixel electrodes, data lines, and scan lines. The pixel electrodes of the array substrate correspond to the color filters of the color filter substrate, respectively. The light rays from the pixel electrodes and passing through the color filter substrate can be red, green, or blue.

[0060] The cured color filter substrate is opposite the cured array substrate, and the color filters of the color filter substrate and the pixel electrodes of the array substrate may be shifted a distance with respect to each other. At a left side of the curved LCD panel, the color filters of the color filter substrate are leftward shifted a distance with respect to the corresponding pixel electrodes. At a right side of the curved LCD panel, the color filters of the color filter substrate are rightward shifted a distance with respect to the corresponding pixel electrodes.

[0061] To prevent the color shifting phenomenon, in the color filter substrate of the curved LCD panel of the present embodiment, a plurality of regions are formed along a longitudinal direction of the color filter substrate. In each region, according to the greatest shifted distance between the color filter substrate and the array substrate, a width of the black matrix within the corresponding region is predetermined to

prevent the color shifting phenomenon from occurring in this region of the curved LCD panel.

[0062] Since the black matrix can have different widths in the different regions, the brightness in the different regions may be different. In the curved LCD panel of the present embodiment, according to the different widths of the black matrix in the different regions, the backlight module can adjust the brightness in different regions of the light guide plate for achieving a consistent brightness to display images.

[0063] In the curved LCD panel and the curved LCD apparatus of the present invention, the black matrix can have different widths in the different regions to prevent the color shifting phenomenon. In the conventional curved LCD panel and apparatus, the color shifting phenomenon results from a shifted distance between the color filter substrate and the array substrate, thereby deteriorating a display quality of the LCD.

[0064] The present invention has been described above with a preferred embodiment thereof, and it is understood that many changes and modifications to the described embodiment can be carried out without departing from the scope and the spirit of the invention that is intended to be limited only by the appended claims.

1. A curved LCD panel comprising:
- a curved color filter substrate comprising a black matrix and color filters; and
- a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively;
- wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in one of the regions positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region;
- wherein, in one of the regions positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region;
- wherein the regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

2. The curved LCD panel according to claim **1**, wherein a width of black matrix in the left region and far away from the middle region is larger than a width of black matrix in the left region and close to the middle region.

3. The curved LCD panel according to claim **1**, wherein a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

4. The curved LCD panel according to claim **1**, wherein the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

5. A curved LCD panel comprising:
- a curved color filter substrate comprising a black matrix and color filters; and
- a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively;
- wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in each of the regions of the color filter substrate, according to a greatest shifted distance between the color filter and the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region.

6. The curved LCD panel according to claim **5**, wherein, in one of the regions positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, the width of the black matrix within the region is predetermined.

7. The curved LCD panel according to claim **5**, wherein, in one of the regions positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined.

8. The curved LCD panel according to claim **5**, wherein the regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

9. The curved LCD panel according to claim **8**, wherein a width of black matrix in the left region and far away from the middle region is larger than a width of black matrix in the left region and close to the middle region.

10. The curved LCD panel according to claim **8**, wherein a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

11. The curved LCD panel according to claim **8**, wherein the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

12. A curved LCD apparatus comprising:
- a backlight module comprising:
  - at least one light source emitting light rays;
  - a light guide plate transmitting the light rays; and
- a curved LCD panel receiving the light rays transmitted from the light guide plate and comprising:
  - a curved color filter substrate comprising a black matrix and color filters; and
  - a cured array substrate opposite the color filter substrate and comprising pixel electrodes, data lines, and scan lines wherein the pixel electrodes correspond to the color filters, respectively;
- wherein a plurality of regions are formed along a longitudinal direction of the color filter substrate, and in each of the regions of the color filter substrate, according to a greatest shifted distance between the color filter and the array substrate, a width of the black matrix within the region is predetermined to prevent the color shifting phenomenon from occurring in the region.

13. The curved LCD apparatus according to claim **12**, wherein, in one of the regions positioned at a left side of the color filter substrate, according to a shifted distance between a leftmost color filter of the color filter and a leftmost pixel electrode of the array substrate, the width of the black matrix within the region is predetermined.

14. The curved LCD apparatus according to claim **12**, wherein, in one of the regions positioned at a right side of the color filter substrate, according to a shifted distance between a rightmost color filter of the color filter and a rightmost pixel electrode of the array substrate, a width of the black matrix within the region is predetermined.

15. The curved LCD apparatus according to claim **12**, wherein the regions comprise at least one left region, at least one right region, and a middle region along the longitudinal direction of the color filter substrate, and a width of black matrix in the left region is larger than a width of black matrix in the middle region, and a width of black matrix in the right region is larger than a width of black matrix in the middle region.

16. The curved LCD apparatus according to claim **15**, wherein a width of black matrix in the left region and far away from the middle region is larger than a width of black matrix in the left region and close to the middle region.

17. The curved LCD apparatus according to claim **15**, wherein a width of black matrix in the right region and far away from the middle region is larger than a width of black matrix in the right region and close to the middle region.

18. The curved LCD apparatus according to claim **15**, wherein the at least one left region and the at least one right region are positioned symmetrically at the left side and the right side of the middle region, respectively.

19. The curved LCD apparatus according to claim **12**, wherein according to the widths of the black matrix in the regions, a brightness in regions of the light guide plate is adjusted.

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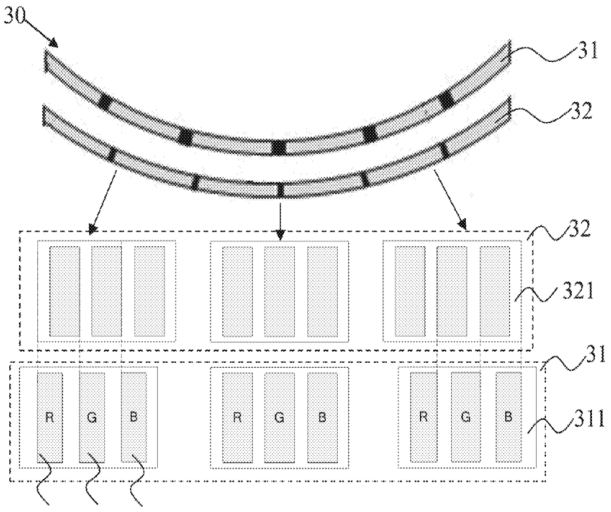
提供弧形LCD面板。弯曲的LCD面板包括弯曲的滤色器基板和固化的阵列基板。沿着滤色器基板的纵向形成多个区域。在滤色器基板的每个区域中，根据滤色器和阵列基板之间的最大移动距离，预定区域内的黑矩阵的宽度。黑矩阵在不同区域可以具有不同的宽度以防止色移现象。