US 20100066965A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2010/0066965 A1

(43) Pub. Date: Mar. 18, 2010

Chen et al.

(54) TRANSFLECTIVE LIQUID CRYSTAL DISPLAY PANEL AND LIQUID CRYSTAL DISPLAY DEVICE HAVING THE SAME

(76) Inventors: **Chien-Hong Chen**, Tainan (TW); **Chih-Yung Hsieh**, Tainan (TW); **Ying-Jen Chen**, Tainan (TW)

Correspondence Address:
TROP, PRUNER & HU, P.C.
1616 S. VOSS ROAD, SUITE 750
HOUSTON, TX 77057-2631 (US)

(21) Appl. No.: **12/558,764**

(22) Filed: **Sep. 14, 2009**

(30) **Foreign Application Priority Data**

Sep. 15, 2008 (TW) 97135387

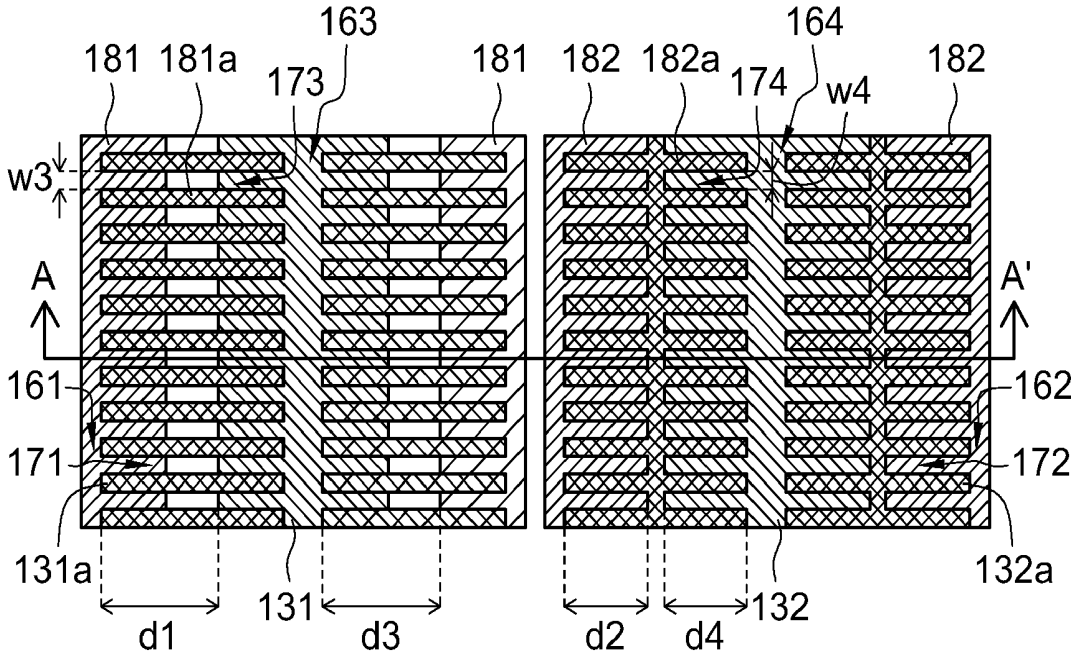
Publication Classification

(51) **Int. Cl.**
G02F 1/1343 (2006.01)

(52) **U.S. Cl.** **349/141**

(57) **ABSTRACT**

A liquid crystal display (LCD) device including a backlight module and an LCD panel is provided. The backlight module is used for providing light penetrating through the LCD panel disposed at one side of the backlight module. The LCD panel includes a substrate, a scan line, a first and a second data line, a first and a second switch element and a first and a second pixel electrode. The scan line and the two data lines, which are perpendicular to the scan line, are disposed on the substrate. The switch elements are respectively disposed at the intersection of the scan line and the first data line and the intersection of the scan line and the second data line. The pixel electrodes are respectively electrically connected to the switch elements. The area of the first pixel electrode is substantially less than that of the second one.



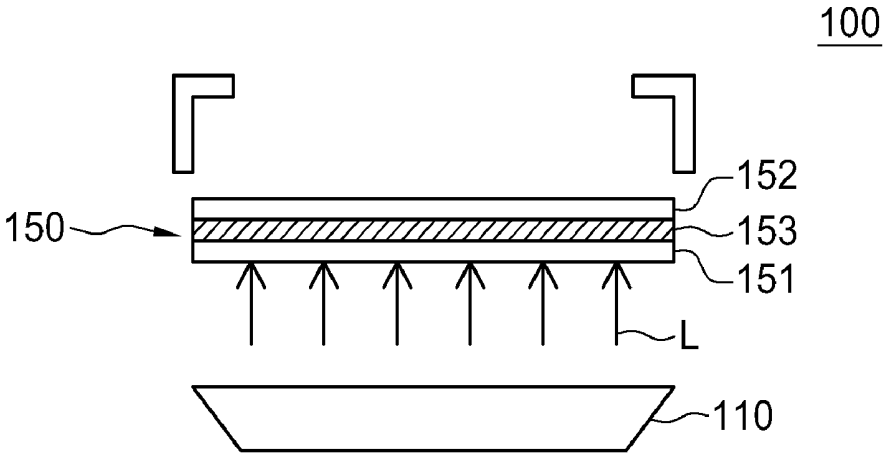

100
152
150
153
151
L
110

FIG. 1

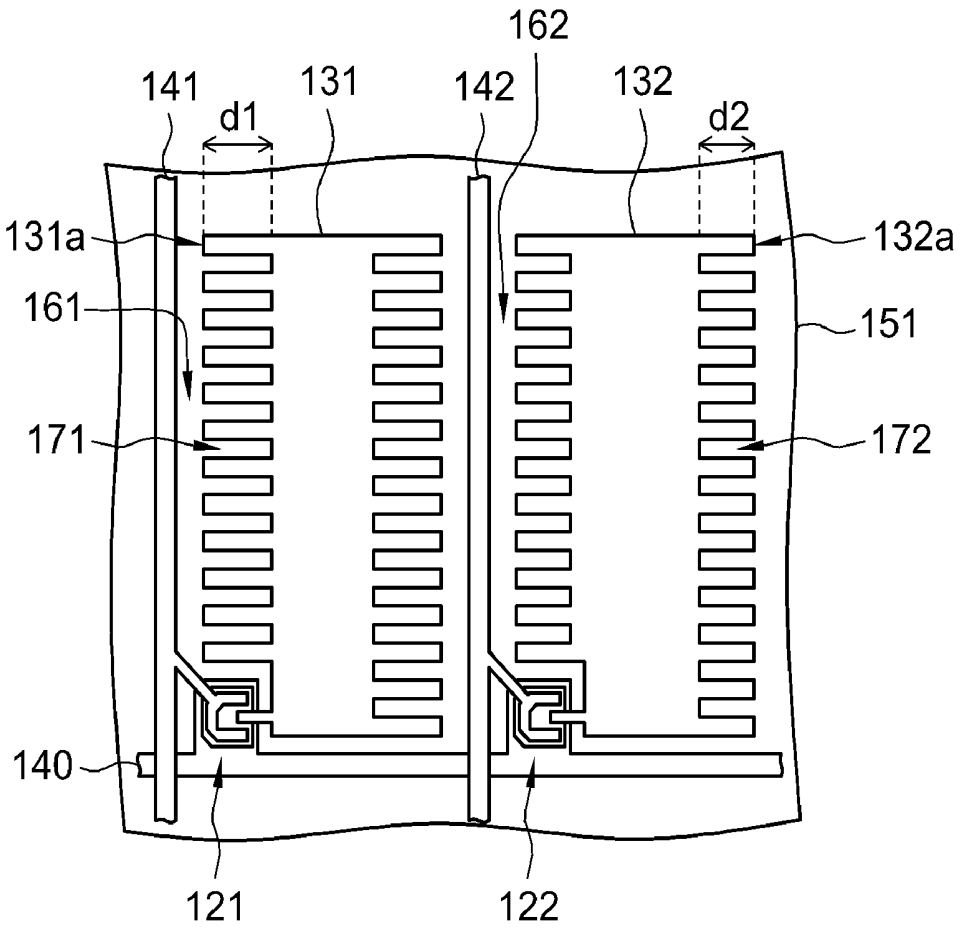

162
141
d1
131
142
132
d2
131a
132a
161
151
171
172
140
121
122

FIG. 2

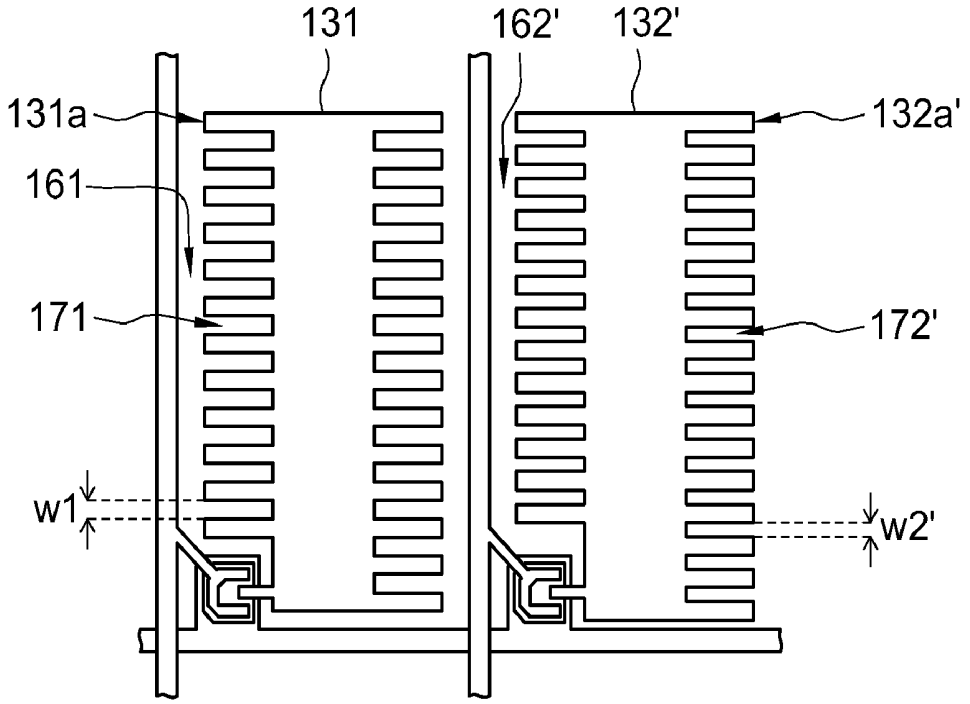

131
162'
132'
131a
132a'
161
171
172'
w1
w2'

FIG. 3

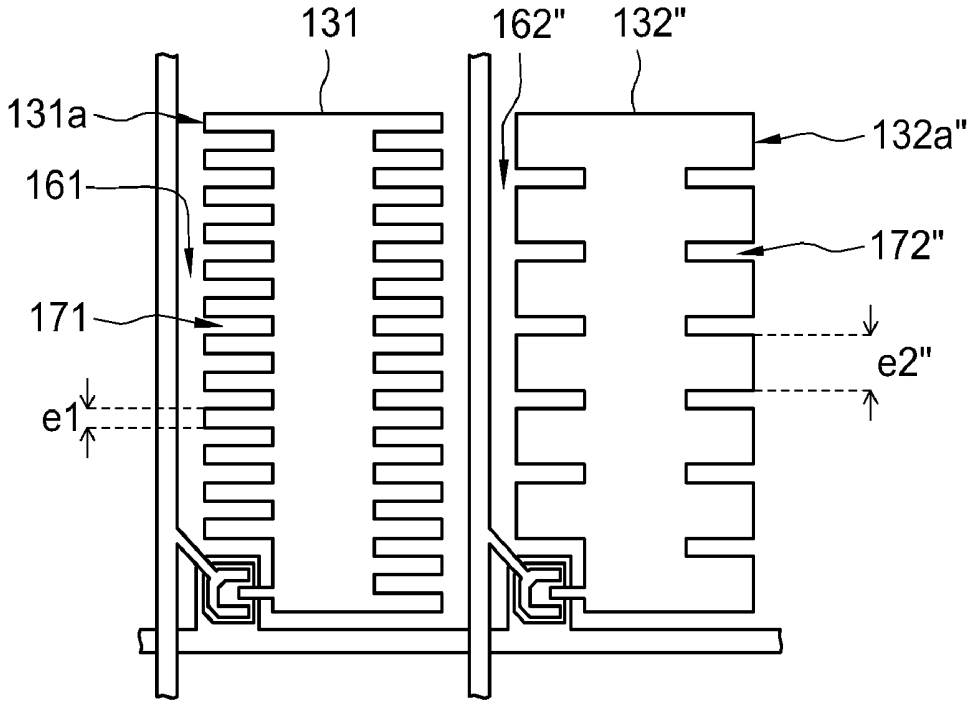

131
162"
132"
131a
132a"
161
172"
171
e2"
e1

FIG. 4

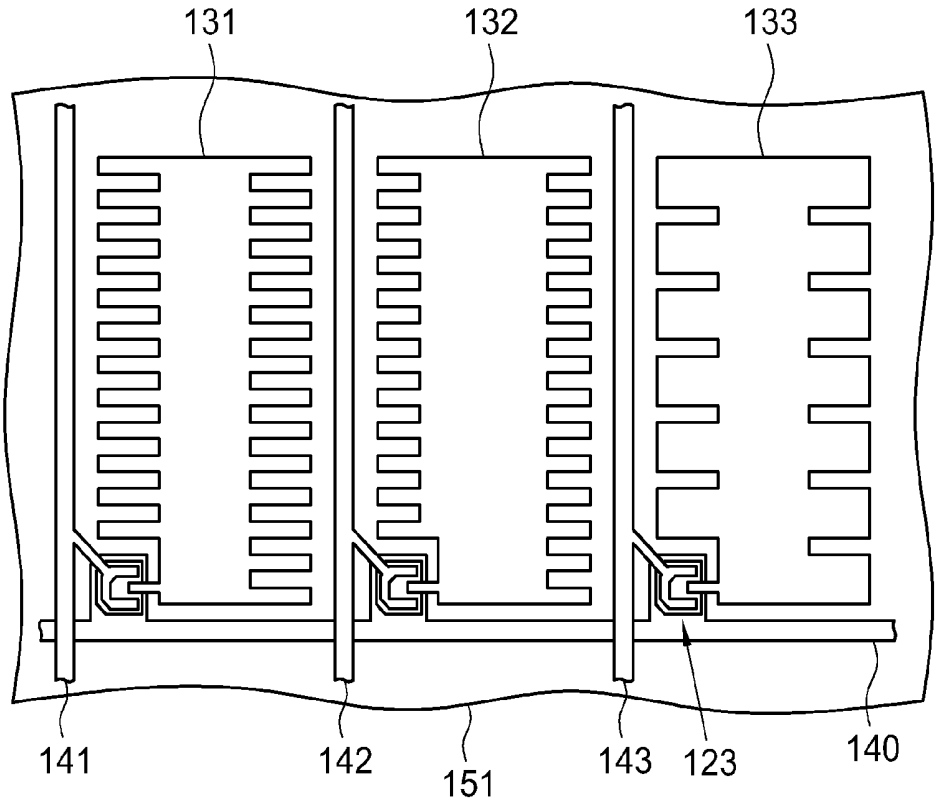

131
132
133
141
142
151
143
123
140

FIG. 5

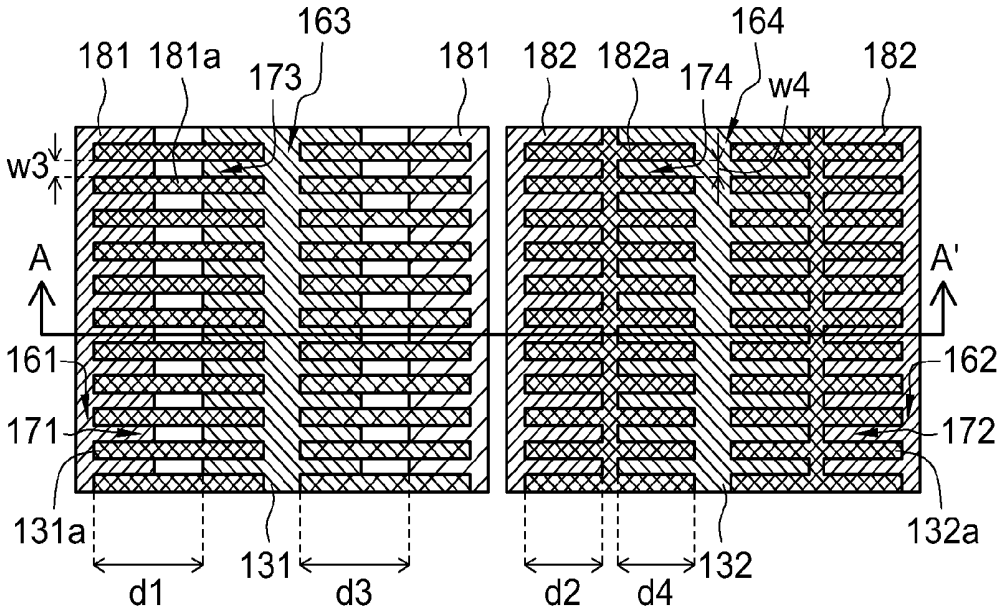

163
164
181
181a
173
181
182
182a
174
w4
182
w3
A
A'
161
162
171
172
131a
131
132
132a
d1
d3
d2
d4

FIG. 6

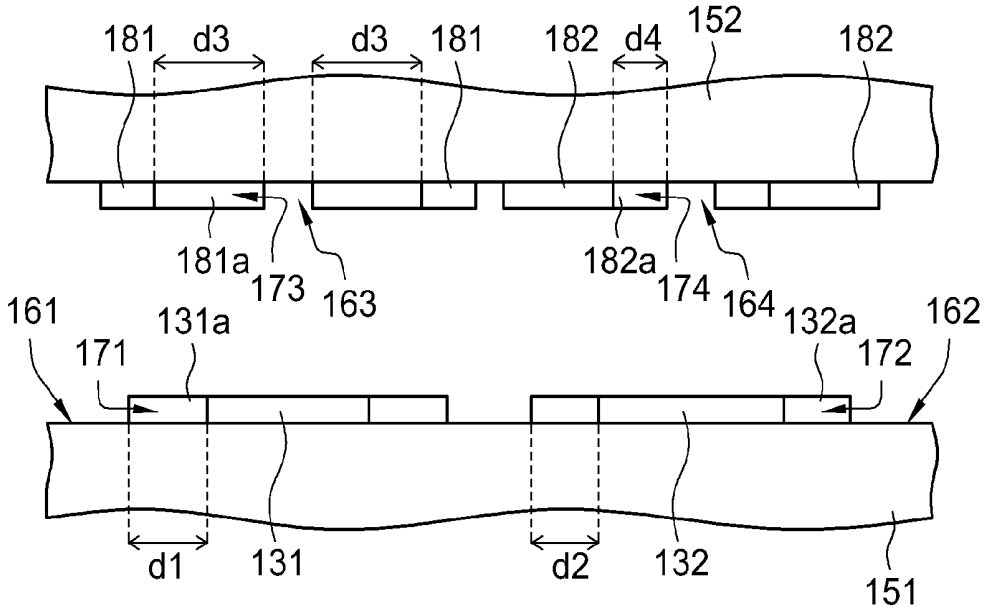

181
d3
d3
181
182
d4
152
182
181a
173
163
182a
174
164
161
131a
132a
162
171
172
d1
131
d2
132
151

FIG. 7

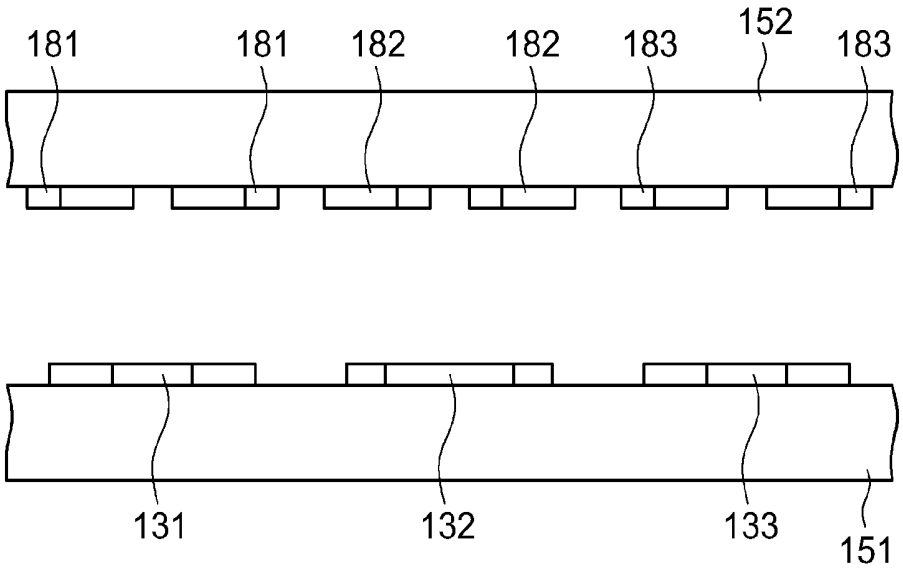

181
181
182
182
183
152
183
131
132
133
151

FIG. 8

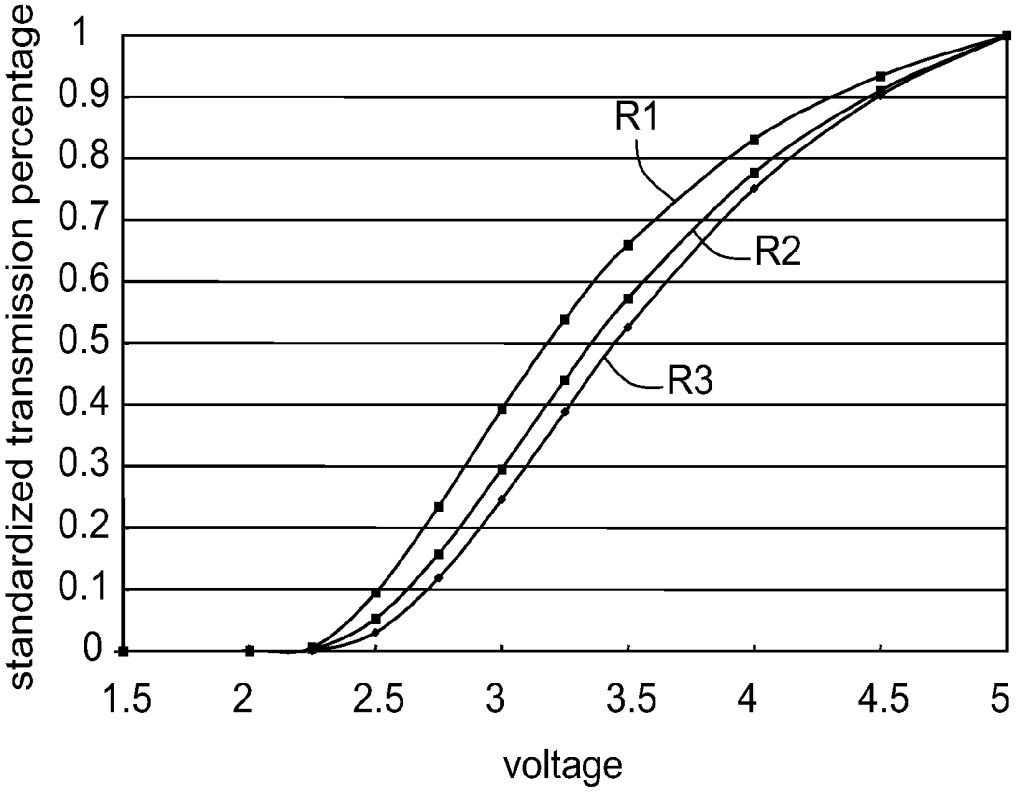

standardized transmission percentage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
R1
R2
R3
1.5
2
2.5
3
3.5
4
4.5
5
voltage

FIG. 9A

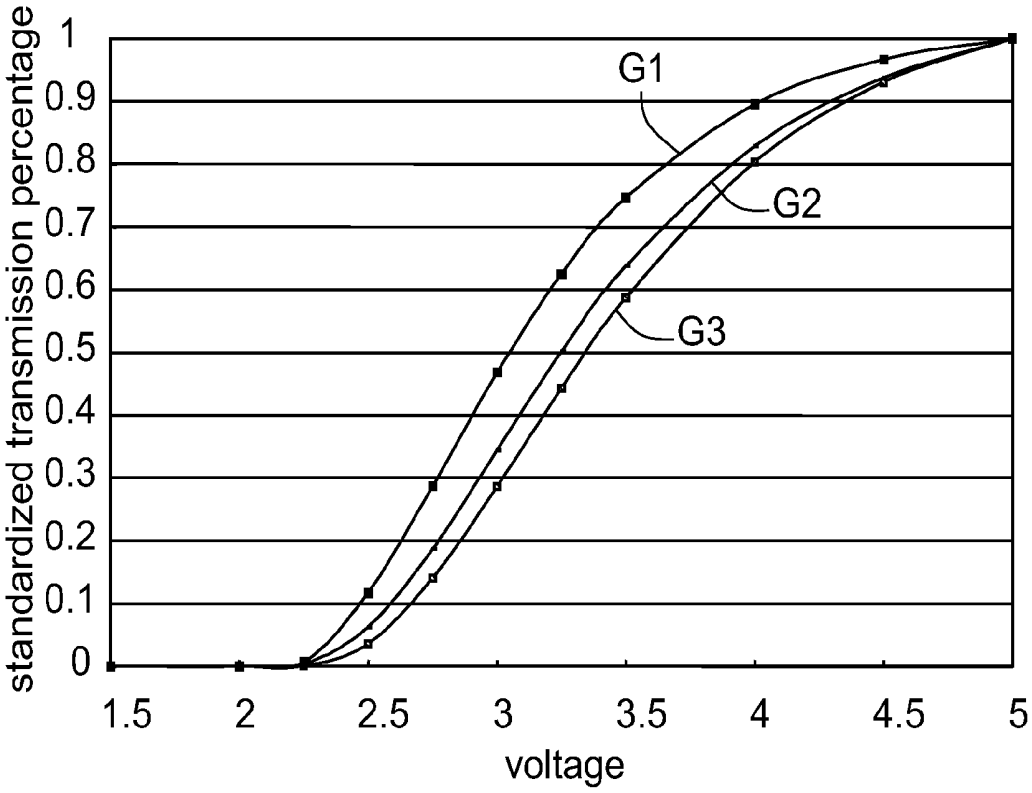

standardized transmission percentage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
G1
G2
G3
1.5
2
2.5
3
3.5
4
4.5
5
voltage

FIG. 9B

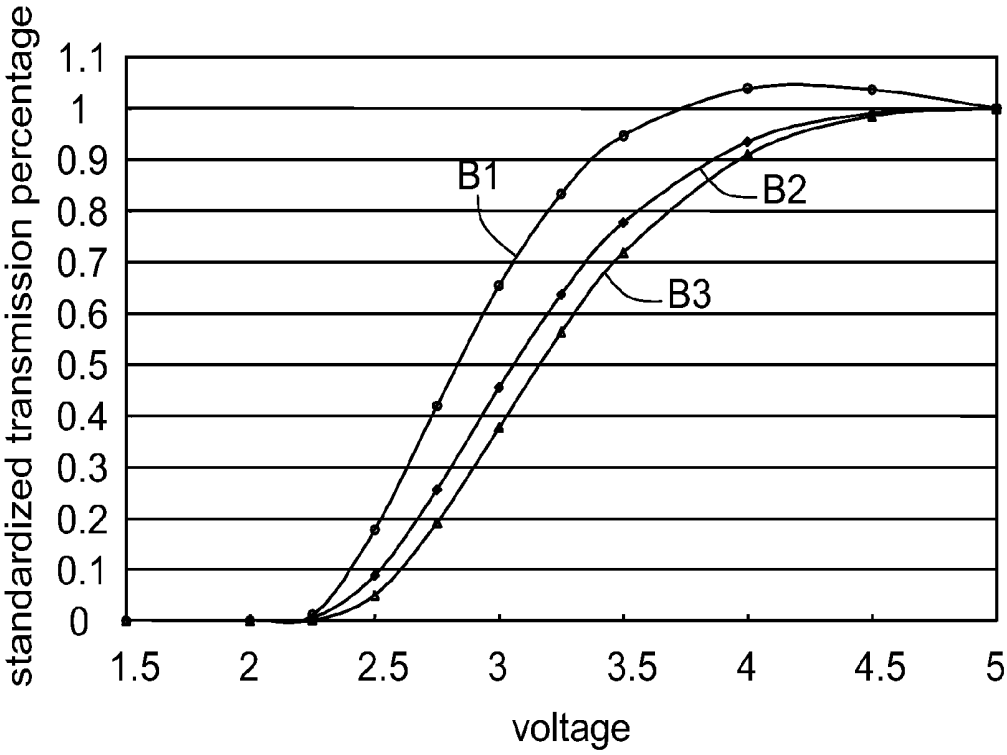

standardized transmission percentage
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.5
2
2.5
3
3.5
4
4.5
5
voltage
B1
B2
B3

FIG. 9C

TRANSFLECTIVE LIQUID CRYSTAL DISPLAY PANEL AND LIQUID CRYSTAL DISPLAY DEVICE HAVING THE SAME

[0001] This application claims the benefit of Taiwan application Serial No. 97135387, filed Sep. 15, 2008, the subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates in general to a liquid crystal display panel and a liquid crystal display device using the same, and more particularly to a multi-domain liquid crystal display panel and a liquid crystal display device using the same.

[0004] 2. Description of the Related Art

[0005] Consumer electronic products have been more and more popular in the recent years. All kinds of electronic products, such as mobile phones, laptop computers and liquid crystal display (LCD) televisions, have already become a vital part of people's daily lives, especially thin-type LCD devices. LCD devices have become the most popular type of displays and televisions because of their low power consumption and compact size and gradually replace the conventional cathode ray tube (CRT) displays. As the market demand for LCD devices has increased greatly, consumers demand the LCD devices with better features, such as large viewing angle, high contrast ratio and accurate color temperature.

[0006] When an image is viewed along the normal direction of the display panel of the conventional vertical alignment LCD device, the gamma values of red, green and blue gamma curves decrease in the following order: red>green>blue. As a result, at different gray levels, a color temperature shift phenomenon will occurs at a chromaticity point of the white light generated by color mixing. For example, the color temperature of white light at gray level **128** is higher than that of white light at gray level **255**. Therefore, the accuracy of color display of the LCD device is affected seriously.

[0007] One existing industrial solution is to use red, green and blue gray-levels to represent the white gray-level to be displayed. However, when different colors at different gray-levels are displayed, a lot of memory space is needed to respectively buffer the data of red, green and blue colors, which relatively increases the manufacturing cost of the LCD device.

SUMMARY OF THE INVENTION

[0008] The invention is directed to a liquid crystal display (LCD) panel and a LCD device using the same. The areas of the pixel electrodes corresponding to different data lines are different. Accordingly, the gamma curves corresponding to different pixel electrodes compensate each other, for lowering the color temperature shift phenomenon of the image at different gray levels. Therefore, the display quality is improved.

[0009] According to the present invention, a LCD panel is provided. The LCD panel includes a substrate, a scan line, a first data line, a second data line, a first switch element, a first pixel electrode, a second switch element and a second pixel electrode. The scan line, the first data line and the second data line are disposed on the substrate. The first data line and the second data line are perpendicular to the scan line. The first switch element is disposed at the intersection of the scan line and the first data line. The second switch element is disposed at the intersection of the scan line and the second data line. The first pixel electrode is electrically connected to the first switch element. The second pixel electrode is electrically connected to the second switch element. The area of the first pixel electrode is less than that of the second pixel electrode.

[0010] According to the present invention, a LCD device is provided. The LCD device includes a backlight module and a LCD panel. The backlight module is used for providing light penetrating through the LCD panel. The LCD panel is disposed at one side of the backlight module and includes a substrate, a scan line, a first data line, a second data line, a first switch element, a first pixel electrode, a second switch element and a second pixel electrode. The scan line, the first data line and the second data line are disposed on the substrate. The first data line and the second data line are perpendicular to the scan line. The first switch element is disposed at the intersection of the scan line and the first data line. The second switch element is disposed at the intersection of the scan line and the second data line. The first pixel electrode is electrically connected to the first switch element. The second pixel electrode is electrically connected to the second switch element. The area of the first pixel electrode is less than that of the second pixel electrode.

[0011] According to the present invention, a LCD panel is provided. The LCD panel includes a first substrate, a scan line, a first data line, a second data line, a first switch element, a first pixel electrode, a second switch element, a second pixel electrode, a second substrate, a first common electrode and a second common electrode. The scan line, the first data line and the second data line are disposed on the first substrate. The first data line and the second data line are perpendicular to the scan line. The first switch element is disposed at the intersection of the scan line and the first data line. The second switch element is disposed at the intersection of the scan line and the second data line. The first pixel electrode is disposed on the first substrate and electrically connected to the first switch element. The second pixel electrode is disposed on the first substrate and electrically connected to the second switch element. The second substrate is disposed opposite to the first substrate. The first common electrode is disposed on the second substrate. At least part of the first common electrode overlaps the first pixel electrode. The second common electrode is disposed on the second substrate. At least part of the second common electrode overlaps the second pixel electrode. The overlapping area of the first pixel electrode and the first common electrode is less than that of the overlapping area of the second pixel electrode and the second common electrode.

[0012] According to the present invention, a LCD device is provided. The LCD device includes a backlight module and a LCD panel. The backlight module is used for providing light penetrating through the LCD panel. The LCD panel is disposed at one side of the backlight module. The LCD panel includes a first substrate, a scan line, a first data line, a second data line, a first switch element, a first pixel electrode, a second switch element, a second pixel electrode, a second substrate, a first common electrode and a second common electrode. The scan line, the first data line and the second data line are disposed on the first substrate. The first data line and the second data line are perpendicular to the scan line. The first switch element is disposed at the intersection of the scan line and the first data line. The second switch element is

disposed at the intersection of the scan line and the second data line. The first pixel electrode is disposed on the first substrate and electrically connected to the first switch element. The second pixel electrode is disposed on the first substrate and electrically connected to the second switch element. The second substrate is disposed opposite to the first substrate. The first common electrode is disposed on the second substrate. At least part of the first common electrode overlaps the first pixel electrode. The second common electrode is disposed on the second substrate. At least part of the second common electrode overlaps the second pixel electrode. The overlapping area of the first pixel electrode and the first common electrode is less than that of the overlapping area of the second pixel electrode and the second common electrode.

[0013] The invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** illustrates a liquid crystal display device according to a preferred embodiment of the present invention;

[0015] FIG. **2** illustrates a first substrate of the LCD device in FIG. **1**;

[0016] FIG. **3** illustrates the design that a first fine slit and a second fine slit have different widths;

[0017] FIG. **4** illustrates the design that a first protruding edge and a second protruding edge have different widths;

[0018] FIG. **5** illustrates the LCD panel including a first pixel electrode, a second pixel electrode and a third pixel electrode;

[0019] FIG. **6** illustrates the first pixel electrode, the second pixel electrode, a first common electrode and a second common electrode of the LCD panel;

[0020] FIG. **7** shows a cross-sectional view along the line A-A' in FIG. **6**;

[0021] FIG. **8** shows a cross-sectional view of the LCD panel with a third common electrode; and

[0022] FIGS. **9**A~**9**C respectively show the V-T curve diagrams of different regions when the first pixel electrode and the first common electrode display color.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The liquid crystal display (LCD) device according to a preferred embodiment of the present invention includes at least a backlight module and a LCD panel. The areas of the pixel electrodes of different color pixels in the LCD panel are different. As a result, the gamma curves of the color pixels compensate each other, so the displayed image has substantially the same color temperature at different gray levels. The display quality of the product is therefore improved. Some embodiments according to the present invention are provided as examples in the following paragraphs, but the present invention is not limited thereto. Furthermore, unnecessary components are not shown in the drawings of the embodiment for clarity.

[0024] Please refer to FIG. **1** and FIG. **2** at the same time. FIG. **1** illustrates a LCD device according to a preferred embodiment of the present invention. FIG. **2** illustrates a first substrate of the LCD device in FIG. **1**. The LCD device **100** includes a backlight module **110** and a LCD panel **150**. The backlight module **110** is used for providing light L penetrating through the LCD panel **150**. The LCD panel **150** disposed at one side of the LCD module **110** includes the first substrate **151**, a scan line **140**, a first data line **141**, a second data line **142**, a first switch element **121**, a first pixel electrode **131**, a second switch element **122** and a second pixel electrode **132**. The scan line **140**, the first data line **141** and the second data line **142** are disposed on the first substrate **151**. The first data line **141** and the second data line **142** are respectively perpendicular to the scan line **140**. The first switch element **121** is disposed near the intersection of the scan line **140** and the first data line **141**. The second switch element **122** is disposed near the intersection of the scan line **140** and the second data line **142**. The first pixel electrode **131** is electrically connected to the first switch element **121**, and the second pixel electrode **132** is electrically connected to the second switch element **122**. The area of the first pixel electrode **131** is less than that of the second pixel electrode **132**.

[0025] For example, the first pixel electrode **131** of the present embodiment is used for displaying blue, and the LCD panel **150** is a multi-domain vertical alignment (MVA) LCD panel. Because the area of the first pixel electrode **131** is less than that of the second pixel electrode **132**, the gamma curve of the pixel corresponding to the first pixel electrode **131** is located below the gamma curve of the pixel corresponding to the second pixel electrode **132**. As a result, the gamma curves corresponding the first pixel electrode **131** and the second pixel electrode **132** compensate each other, so that the LCD panel **150** has the same color temperature at different white gray-levels. The display quality is therefore improved. The following describes the details.

[0026] The structure of the LCD panel **150** is illustrated further. As shown in FIG. **2**, the first pixel electrode **131** has at least a first main slit **161**, and the second pixel electrode **132** has at least a second main slit **162**. The first pixel electrode **131** has several first fine slits **171** and several first protruding edges **131***a* which are corresponding to the edge of the first main slit **161**. The second pixel electrode **132** has several second fine slits **172** and several second protruding edges **132***a* which are corresponding to the edge of the second main slit **162**. Many different designs can be applied to the present embodiment for making the area of the first pixel electrode **131** less than the area of the second pixel electrode **132**. For example, the lengths of the first fine slits **171** can be substantially greater than that of the second fine slits **172**, so that the area of the first pixel electrode **131** is less than the area of the second pixel electrode **132**. As shown in FIG. **2**, the lengths d**1** of the first fine slits **171** are substantially greater than the lengths d**2** of the second fine slits **172**. On the whole, the area of the first pixel electrode **131** is less than the area of the second pixel electrode **132**. Relatively speaking, the area of the first main slit **161** and the first fine slits **171** on the first substrate **151** is larger than the area of the second main slit **162** and the second fine slits **172** on the first substrate **151**.

[0027] Moreover, the first fine slits **171** and the second fine slits **172** of the LCD panel **150** of the present embodiment can have different widths. Please refer to FIG. **3**, which illustrates the design that the first fine slits **171** and the second fine slits **172** have different widths. The widths w**1** of the first fine slits **171** of the first pixel electrode **131** is substantially greater than the widths w**2'** of the second fine slits **172'** of the second pixel electrode **132'**. Therefore, the area of the first pixel electrode **131** is less than the area of the second pixel electrode **132'**.

[0028] Furthermore, the widths of the first protruding edges **131***a* can be different from that of the second protruding

edges **132***a* to make the area of the first pixel electrode **131** less than the area of the second pixel electrode **132**. Please refer to FIG. **4**, which illustrates the design that the first protruding edges and the second protruding edges have different widths. The widths e**1** of the first protruding edges **131***a* are substantially less than the widths e**2**" of the second protruding edges **132***a*". On the whole, the area of the first pixel electrode **131** is less than the area of the second pixel electrode **132**".

[0029] When in practical use, the LCD panel **150** of the present embodiment can apply different designs at the same time, such as the design that the lengths d**1** of the first fine slits **171** are less than the lengths d**2** of the second fine slits **172**, the design that the widths w**1** of the first fine slits **171** are greater than the widths w**2**' of the second fine slits **172**, the design that the widths e**1** of the first protruding edges **131***a* are less than the widths e**2**" of the second protruding edges **132***a* and other designs as well. As a result, the area of the first pixel electrode **131** is less than that of the second pixel electrode **132**. Other designs including changing the size of the protruding edges, the main slit and the fine slits to make the area of the first pixel electrode **131** less than the area of the second pixel electrode **132** are encompassed by the present invention.

[0030] On the other hand, the LCD panel **150** of the present embodiment can further include a third data line, a third switch element and a third pixel electrode. Please refer to FIG. **5**, which illustrates the LCD panel including the first pixel electrode, the second pixel electrode and the third pixel electrode. The third data line **143** is disposed on the first substrate **151** and perpendicular to the scan line **140**. The third switch element **123** is disposed near the intersection of the scan line **140** and the third data line **143**. The third pixel electrode **133** is electrically connected to the third switch element **123**. The area of the first pixel electrode **131** is less than the area of the third pixel electrode **133**. The area of the second pixel electrode **132** and the area of the third pixel electrode **133** can be the same or different according to the demand. In other words, the area of the first pixel electrode **131**, the area of the second pixel electrode **132** and the area of the third pixel electrode **133** can be substantially all different. Furthermore, the above designs of changing the lengths or widths of the protruding parts, the main slit and the fine slits can be applied to the pixel electrodes **131**, **132** and **133** for making the area of the first pixel electrodes **131** less than the area of the second pixel electrode **132** and the area of the third pixel electrode **133**.

[0031] When in practical use, the LCD panel **150** of the LCD device **100** of the present embodiment can further include a second substrate **152** (shown in FIG. **1**), a first common electrode **181** (shown in FIG. **6**) and a second common electrode **182** (shown in FIG. **6**). Please refer to FIG. **6** and FIG. **7** at the same time. FIG. **6** illustrates the first pixel electrode, the second pixel electrode, the first common electrode and the second common electrode according to the preferred embodiment of the present invention. FIG. **7** shows a cross-sectional view along the line A-A' in FIG. **6**. The second substrate **152** is disposed opposite to the first substrate **151**. The first common electrode **181** is disposed on the second substrate **152**. At least part of the first common electrode **181** overlaps the first pixel electrode **131**. The second common electrode **182** is disposed on the second substrate **152**. At least part of the second common electrode **182** overlaps the second pixel electrode **132**. The overlapping area of the first pixel electrode **131** and the first common electrode **181** is less than the overlapping area of the second pixel electrode **132** and the second common electrode **182**. Moreover, a color filter can further be disposed on the second substrate **152**.

[0032] Speaking more specifically, the first common electrode **181** and the second common electrode **182** respectively have at least a third main slit **163** and at least a fourth main slit **164**. The first common electrode **181** has several third fine slits **173** and several third protruding edges **181***a* which are corresponding to the edge of the third main slit **163**. The second common electrode **182** has several fourth fine slits **174** and several fourth protruding edges **182***a* which are corresponding to the edge of the fourth main slit **164**. The lengths of the first fine slits **171** or the third fine slits **173** are greater than the lengths of the second fine slits **172** or the fourth fine slits **174**. In the practical designs shown in FIG. **6** and FIG. **7**, the lengths d**1** of the first fine slits **171** are greater than the lengths d**2** of the second fine slits **172**, and the lengths d**3** of the third fine slits **173** are greater than the lengths d**4** of the fourth fine slits **174**. More specifically speaking, the lengths d**1** of the first fine slits **171** are for example substantially equal to the lengths d**3** of the third fine slits **173**. The lengths d**2** of the second fine slits **172** are for example substantially equal to the lengths d**4** of the fourth fine slits **174**. Besides, at least part of the first fine slits **171** overlaps the third fine slits **173**, and the second fine slits **172** do not overlap the fourth fine slits **174**. However, the present invention does not limit the design of the lengths d**1**, d**2**, d**3** and d**4** of the first, second, third and fourth fine slits **171**, **172**, **173** and **174**. As long as the overlapping area of the first pixel electrode **131** and the first common electrode **181** is less than that of the second pixel electrode **132** and the second common electrode **182**, the present invention encompasses such modification.

[0033] Also, the LCD panel **150** of the present embodiment can apply the design that the widths of the first fine slits **171**, the second fine slits **172**, the third fine slits **173** and the fourth fine slits **174** are all different. For example, the widths w**1** of the first fine slits **171** are greater than the widths w**2**' of the second fine slits **172** (as shown in FIG. **3**), and the widths w**3** of the third fine slits **173** are larger than the widths w**4** of the fourth fine slits **174**. Other designs of changing the widths of the fine slits to make the overlapping area of the first pixel electrode **131** and the first common electrode **181** less than that of the second pixel electrode **132** and the second common electrode **182** are encompassed by the present invention.

[0034] In another embodiment, the widths of the first protruding edges **131***a*, the second protruding edges **132***a*, the third protruding edges **181***a* and the fourth protruding edges **182***a* can be different. For example, the widths of the third protruding edges **181***a* are less than the widths of the fourth protruding edges **182***a*. Other designs of changing the widths of the protruding edges to make the overlapping area of the first pixel electrode **131** and the first common electrode **181** less than that of the second pixel electrode **132** and the second common electrode **182** are encompassed by the present invention.

[0035] When in practical use, the LCD panel **150** of the present embodiment can apply the designs of rearranging the lengths of the slits, the widths of the slits, the widths of the protruding parts or other modifications to make the overlapping area of the first pixel electrode **131** and the first common electrode **181** less than that of the second pixel electrode **132** and the second common electrode **182**. Other designs of changing the size of the protruding edges, the main slits and the fine slits to make the overlapping area of the first pixel

electrode **131** and the first common electrode **181** less than that of the second pixel electrode **132** and the second common electrode **182** are encompassed by the present invention.

[0036] The LCD panel **150** of the LCD device **100** of the present embodiment can include the third data line **143**, the third switch element **124** and the third pixel electrode **133**, as shown in FIG. **5**. More specifically speaking, the LCD panel **150** can further include the third common electrode **183**. Please refer to FIG. **8**, which shows a cross-sectional view of the LCD panel with the third common electrode. The third common electrode **183** is disposed on the second substrate **152** and corresponding to the third pixel electrode **133**. At least part of the third common electrode **183** overlaps the third pixel electrode **133**. The lengths and widths of the main slits, the fine slits and the protruding edges can be different from the above-described arrangement for making the overlapping area of the first pixel electrode **131** and the first common electrode **181** less than that of the third pixel electrode **133** and the third common electrode **183**. Furthermore, the overlapping area of the second pixel electrode **132** and the second common electrode **182** can be the same as or different from that of the third pixel electrode **133** and the third common electrode **183**. In other words, the overlapping area of the first pixel electrode **131** and the first common electrode **181**, the overlapping area of the second pixel electrode **132** and the second common electrode **182** and the overlapping area of the third pixel electrode **133** and the third common electrode **183** can be substantially all different. When in practical use, the first pixel electrode **131** and the first common electrode **181** are in the first color pixel. The second pixel electrode **132** and the second common electrode **182** are in the second color pixel. The third pixel electrode **133** and the third common electrode **183** are in the third color pixel.

[0037] The LCD panel **150** can be classified into three different regions according to the existence of the common electrodes and the pixel electrodes. The first region is the region in which the electrodes are formed on both the first substrate **151** and the second substrate **152**. The second region is the region in which the electrodes are formed on one of the first substrate **151** and the second substrate **152**, and the fine slits are formed on the other substrate. The third region is the region in which the fine slits are formed on both the first substrate **151** and the second substrate **152**. The first pixel electrode **131** and the first common electrode **181** in FIG. **6** are used as an example to perform simulation as follows. Please refer to FIGS. **9**A-**9**C, which respectively show the V-T curve diagrams of different regions when the first pixel electrode and the first common electrode display color. When the first pixel electrode **131** and the first common electrode **181** are used for displaying red, as shown in FIG. **9**A, the slope of the V-T curve R**1** of the first region is substantially greater than that of the V-T curve R**2** of the second region. Also, the slope of the V-T curve R**2** of the second region is substantially greater than that of the V-T curve R**3** of the third region. Furthermore, when the first pixel electrode **131** and the first common electrode **181** are used for displaying green, as shown in FIG. **9**B, the slope of the V-T curve G**1** of the first region is substantially greater than that of the V-T curve G**2** of the second region. Also, the slope of the V-T curve G**2** of the second region is substantially greater than that of the V-T curve G**3** of the third region. Moreover, when the first pixel electrode **131** and the first common electrode **181** are used for displaying blue, as shown in FIG. **9**C, the slope of the V-T curve B**1** of the first region is substantially greater than that of the V-T curve B**2** of the second region. Also, the slope of the V-T curve B**2** of the second region is substantially greater than that of the V-T curve B**3** of the third region.

[0038] From the above simulation results, it can be known that when the area of the first main slit **161** and the third main slit **163** of the first pixel electrode **131** and the first common electrode **181** increases, the slope of the V-T curve decreases. In other words, the gamma curve substantially lowers the location in the gamma curve diagram. In the present embodiment, the overlapping area of the first pixel electrode **131** and the first common electrode **181** is less than that of the second pixel electrode **132** and the second common electrode **182**. Also, the overlapping area of the first pixel electrode **131** and the first common electrode **181** is less than that of the third pixel electrode **133** and the third common electrode **183**. Therefore, the first color pixel corresponding to the first pixel electrode **131** and the first common electrode **181** has the slit area with the greatest percentage. The first pixel electrode **131** of the present embodiment is used for displaying blue as an example. Compared to the conventional color pixels having the slits with the same area, the V-T curve of the blue color of the LCD device **100** of the present embodiment has less slope and is at a lower location in the gamma curve diagram. Accordingly, the red light and green light at the same gray level with higher transmission compensate the blue light at the same gray level with less transmission, so that the white light has the same color temperature at different gray levels. Therefore, the color temperature remains the same at all gray levels.

[0039] On the other hand, the first switch element **121** and the second switch element **122** of the present embodiment are thin film transistors (TFT). The LCD panel **150** further includes the first storage capacitor (Cst) and the second storage capacitor. The first storage capacitor is electrically connected to the first pixel electrode **131**. The second storage capacitor is electrically connected to the second pixel electrode **132**. Generally speaking, when an image is displayed, the pixel voltage generates a feedthrough voltage after the scan line is off. As a result, the liquid crystal **153** (shown in FIG. **1**) between the substrates **151** and **152** senses the decreasing of the voltage. The amount that the voltage is decreased is related to the liquid crystal capacitor (Clc), the storage capacitor and the gate-drain capacitor (Cgd) and can be shown as

$$\Delta V = \frac{Cgd}{Cst + Clc + Cgd}(Vgh - Vgl).$$

Vgh is the voltage when the gate is on. Vgl is the voltage when the gate is off. The area ratio of the first color pixel used for displaying blue in the present embodiment is greater than that of the red and green color pixel. As a result, the liquid crystal capacitor of the first color pixel is less than the liquid crystal capacitors of the red and green color pixels. Moreover, according to the following relation:

$$\Delta V = \frac{Cgd}{Cst + Clc + Cgd}(Vgh - Vgl) = \frac{1}{[(Cst + Clc)/Cgd] + 1}(Vgh - Vgl),$$

the storage capacitor and the gate-drain capacitor of each color pixel need to apply different designs to maintain the

feedthrough voltage to be the same in the first color pixel, the second color pixel and the third color pixel. Following describes two different conditions.

[0040] First, when the ratio of the storage capacitor to the liquid crystal capacitor of each color pixel is constant, the liquid crystal capacitor and the first storage capacitor of the first color pixel (displaying blue) are less than those of other color pixels (displaying red and green). Therefore, the sum of the storage capacitor and liquid crystal capacitor of the first color pixel is less than that of red and green color pixels. Also, the gate-drain capacitor of the first color pixel has to be less than that of the second and third color pixels, for maintaining a constant feedthrough voltage. In other words, the gate-drain capacitor of the first TFT in the first color pixel is less than that of the second TFT.

[0041] Second, when the ratio of the storage capacitor to the liquid crystal capacitor of each color pixel is not constant, the conditions for three different color pixels to have the same feedthrough voltage is to maintain the same value of (Cst+Clc)/Cgd. The liquid crystal capacitor of the first color pixel (displaying blue) is less than that of the red and green color pixel. Therefore, the storage capacitor and the gate-drain capacitor can be adjusted respectively to maintain the same (Cst+Clc)/Cgd in each color pixel, completely according to the demand.

[0042] On the whole, when the ratio of the storage capacitor to the liquid crystal capacitor is constant, the gate-drain capacitor of the blue color pixel has to be the least one in order to maintain the same feedthrough voltage. When the ratio of the storage capacitor to the liquid crystal capacitor is not constant, the storage capacitor and the gate-drain capacitor of each color pixel can be adjusted according to the demand.

[0043] In the LCD panel and the LCD device using the same according to the preferred embodiment of the present invention, the areas of the electrodes in different color pixels are different, and the ratios of the slits in different color pixels are different. As a result, the gamma curves of different color pixels compensate each other, so that the displayed image substantially has the same color temperature at different white gray-levels. Therefore, the color temperature remains the same at all white gray-levels, and the display quality of the product is improved. Furthermore, the color temperature shift phenomenon is reduced through the layout of the electrodes. The requirement of the memory capacity for changing the gray levels of different colors is lowered, which reduces the manufacturing cost.

[0044] While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A liquid crystal display (LCD) panel, comprising:
- a substrate;
- a scan line, disposed on the substrate;
- a first data line and a second data line, disposed on the substrate and perpendicular to the scan line;
- a first switch element, disposed at the intersection of the scan line and the first data line;
- a first pixel electrode, electrically connected to the first switch element;
- a second switch element, disposed at the intersection of the scan line and the second data line; and
- a second pixel electrode, electrically connected to the second switch element;
- wherein the area of the first pixel electrode is less than that of the second pixel electrode.

2. The LCD panel according to claim **1**, wherein the first pixel electrode is used for displaying blue.

3. The LCD panel according to claim **1**, wherein the first pixel electrode and the second pixel electrode respectively comprise at least a first main slit and at least a second main slit, the first pixel electrode has a plurality of first fine slits which are corresponding to the edge of the first main slit, and the second pixel electrode has a plurality of second fine slits which are corresponding to the edge of the second main slit.

4. The LCD panel according to claim **3**, wherein the lengths of the first fine slits are substantially greater than that of the second fine slits.

5. The LCD panel according to claim **3**, wherein the widths of the first fine slits are substantially greater than that of the second fine slits.

6. The LCD panel according to claim **3**, wherein the first pixel electrode has a plurality of first protruding edges which are corresponding to the edge of the first main slit, the first protruding edges and the first fine slits are staggered, the second pixel electrode has a plurality of second protruding edges which are corresponding to the edge of the second main slit, the second protruding edges and the second fine slits are staggered, and the widths of the first protruding edges are less than that of the second protruding edges.

7. The LCD panel according to claim **1** further comprising:
- a first storage capacitor, electrically connected to the first pixel electrode; and
- a second storage capacitor, electrically connected to the second pixel electrode;
- wherein the first storage capacitor is less than the second storage capacitor.

8. The LCD panel according to claim **7**, wherein the first switch element and the second switch element are a first thin film transistor (TFT) and a second TFT, and a gate-drain capacitor of the first TFT is less than that of the second TFT.

9. The LCD panel according to claim **1** further comprising:
- a third data line, disposed on the substrate and perpendicular to the scan line;
- a third switch element, disposed at the intersection of the scan line and the third data line; and
- a third pixel electrode, electrically connected to the third switch element;
- wherein the area of the first pixel electrode is less than that of the third pixel electrode.

10. The LCD panel according to claim **9**, wherein the area of the first pixel electrode, the area of the second pixel electrode and the area of the third pixel electrode are substantially all different.

11. A liquid crystal display (LCD) panel, comprising:
- a first substrate;
- a scan line, disposed on the first substrate;
- a first data line and a second data line, disposed on the first substrate and perpendicular to the scan line;
- a first switch element, disposed at the intersection of the scan line and the first data line;
- a first pixel electrode, disposed on the first substrate and electrically connected to the first switch element;

a second switch element, disposed at the intersection of the scan line and the second data line;

a second pixel electrode, disposed on the first substrate and electrically connected to the second switch element;

a second substrate, disposed opposite to the first substrate;

a first common electrode, disposed on the second substrate, at least part of the first common electrode overlapping the first pixel electrode; and

a second common electrode, disposed on the second substrate, at least part of the second common electrode overlapping the second pixel electrode;

wherein the overlapping area of the first pixel electrode and the first common electrode is less than that of the second pixel electrode and the second common electrode.

12. The LCD panel according to claim **11**, wherein the first pixel electrode and the second pixel electrode respectively comprise at least a first main slit and at least a second main slit, the first common electrode and the second common electrode respectively comprise at least a third main slit and at least a fourth main slit, the first pixel electrode has a plurality of first fine slits which are corresponding to the edge of the first main slit, the second pixel electrode has a plurality of second fine slits which are corresponding to the edge of the second main slit, the first common electrode has a plurality of third fine slits which are corresponding to the edge of the third main slit, and the second common electrode has a plurality of fourth fine slits which are corresponding to the edge of the fourth main slit.

13. The LCD panel according to claim **12**, wherein the lengths of the first fine slits or the third fine slits are greater than that of the second fine slits or the fourth fine slits.

14. The LCD panel according to claim **12**, wherein at least some of the first fine slits overlap the third fine slits, and the second fine slits do not overlap the fourth fine slits.

15. The LCD panel according to claim **12**, wherein the widths of the first fine slits are greater than that of the second fine slits, and the widths of the third fine slits are greater than that of the fourth fine slits.

16. The LCD panel according to claim **12**, wherein the first pixel electrode has a plurality of first protruding edges which are corresponding to the edge of the first main slit, the first protruding edges and the first fine slits are staggered, the second pixel electrode has a plurality of second protruding edges which are corresponding to the edge of the second main slit, the second protruding edges and the second fine slits are staggered, the first common electrode has a plurality of third protruding edges which are corresponding to the edge of the third main slit, the third protruding edges and the third fine slits are staggered, the second common electrode has a plurality of fourth protruding edges which are corresponding to the edge of the fourth main slit, the fourth protruding edges and the fourth fine slits are staggered.

17. The LCD panel according to claim **16**, wherein the widths of the first fine slits are greater than that of the second fine slits, and the widths of the first protruding edges are less than that of the second protruding edges.

18. The LCD panel according to claim **16**, wherein the widths of the third fine slits are greater than that of the fourth fine slits, and the widths of the third protruding edges are less than that of the fourth protruding edges.

19. The LCD panel according to claim **11** further comprising:

a third data line, disposed on the first substrate and perpendicular to the scan line;

a third switch element, disposed at the intersection of the scan line and the third data line;

a third pixel electrode, disposed on the first substrate and electrically connected to the third switch element; and

a third common electrode, disposed on the second substrate, at least part of the third common electrode overlapping the third pixel electrode;

wherein the overlapping area of the first pixel electrode and the first common electrode is less than that of the third pixel electrode and the third common electrode.

20. The LCD panel according to claim **19**, wherein the overlapping area of the first pixel electrode and the first common electrode, the overlapping area of the second pixel electrode and the second common electrode and the overlapping area of the third pixel electrode and the third common electrode are substantially all different.

* * * * *

专利名称(译)	透反液晶显示面板和具有该透反液晶显示面板的液晶显示装置		
公开(公告)号	US20100066965A1	公开(公告)日	2010-03-18
申请号	US12/558764	申请日	2009-09-14
[标]申请(专利权)人(译)	陈建HONG HSIEH CHIH YUNG 陈颖JEN		
申请(专利权)人(译)	陈建HONG HSIEH CHIH-YUNG 陈应JEN		
当前申请(专利权)人(译)	陈建HONG HSIEH CHIH-YUNG 陈应JEN		
[标]发明人	CHEN CHIEN HONG HSIEH CHIH YUNG CHEN YING JEN		
发明人	CHEN, CHIEN-HONG HSIEH, CHIH-YUNG CHEN, YING-JEN		
IPC分类号	G02F1/1343		
CPC分类号	G02F1/133514 G02F2001/134345 G02F1/134309		
优先权	097135387 2008-09-15 TW		
其他公开文献	US8310629		
外部链接	Espacenet USPTO		

摘要(译)

提供一种包括背光模块和LCD面板的液晶显示（LCD）装置。背光模块用于提供穿透设置在背光模块一侧的LCD面板的光线。 LCD面板包括基板，扫描线，第一和第二数据线，第一和第二开关元件以及第一和第二像素电极。扫描线和垂直于扫描线的两条数据线设置在基板上。开关元件分别设置在扫描线和第一数据线以及扫描线和第二数据线的交叉点处。像素电极分别电连接到开关元件。第一像素电极的面积基本上小于第二像素电极的面积。