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(54) **LIQUID CRYSTAL DISPLAY DEVICE**

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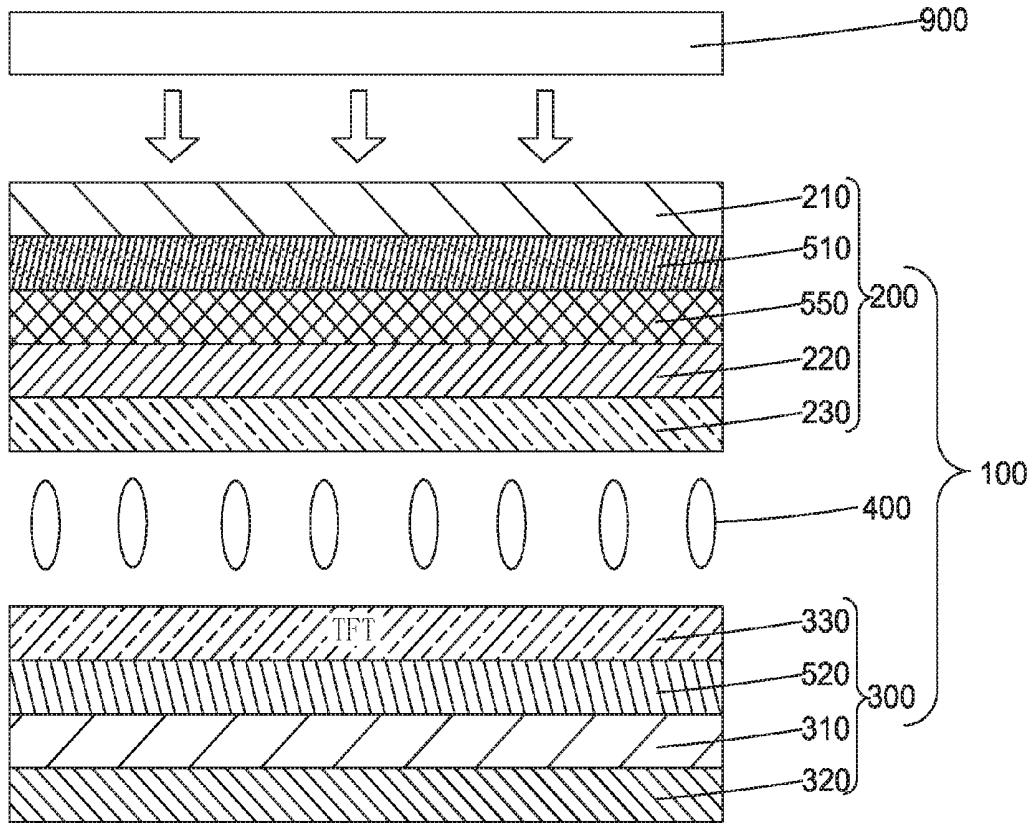
(57) **ABSTRACT**

The present invention provides a liquid crystal display device, which includes a liquid crystal panel including a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other, wherein the first substrate and the second substrate respectively include one of a quantum dot color filter plate and an optic film layer. The present invention is structured to have the quantum dot color filter plate and the optic film layer respectively arranged on different substrates so that even the refractive index of the optic film layer is relatively large, internal total reflection at an interface between the quantum dot color filter plate and the optic film layer and emission angles of light beams being not convergent toward a normal line due to the refractive index may not happen so as to effectively eliminate interference caused by the refractive index of the optic film layer and improve the displaying performance of the liquid crystal display device.



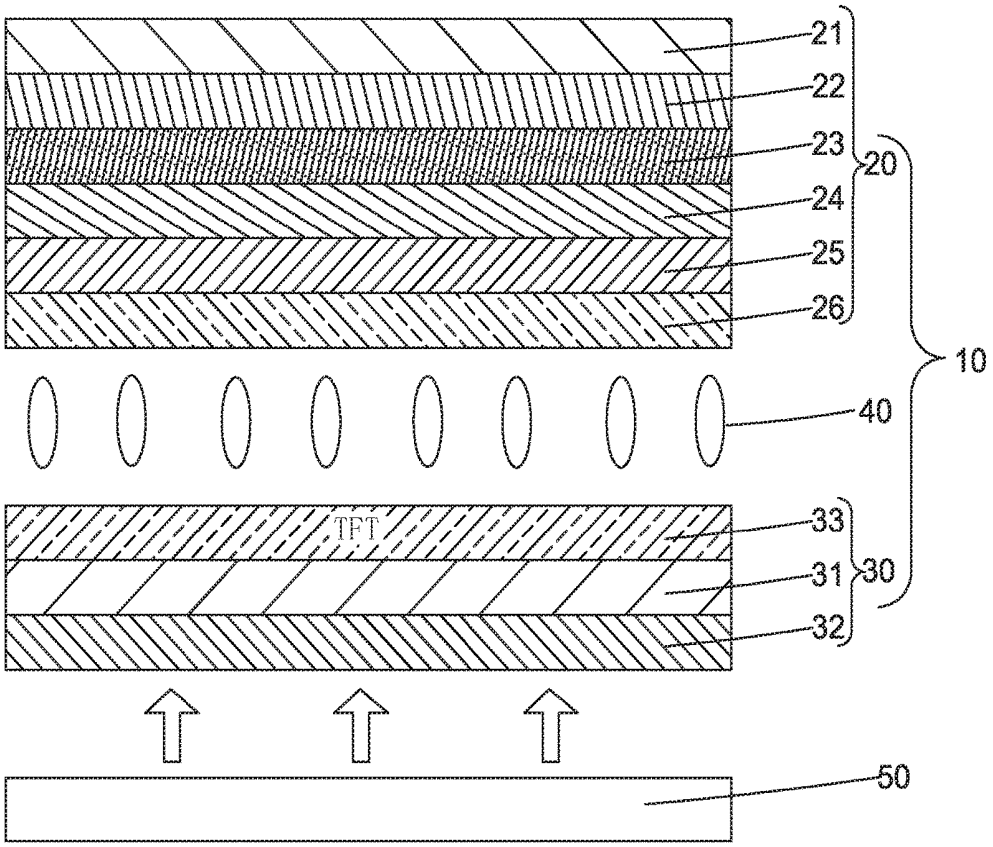
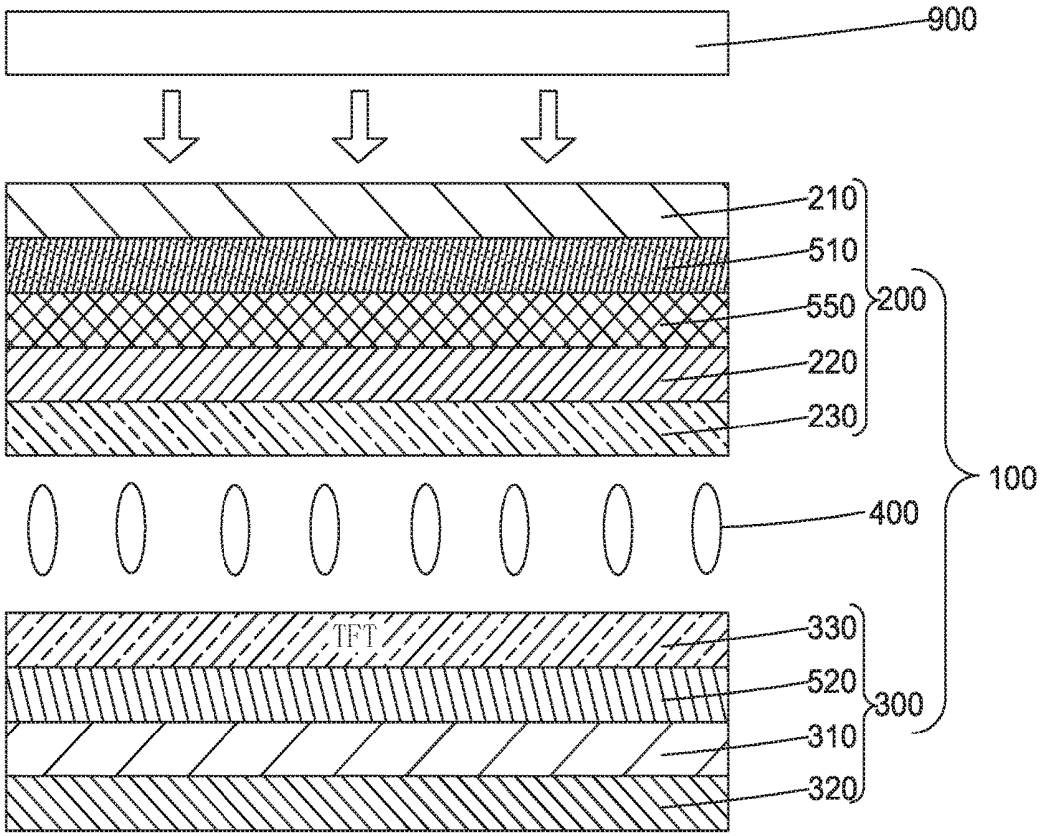


Fig. 1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230
200
100
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TFT
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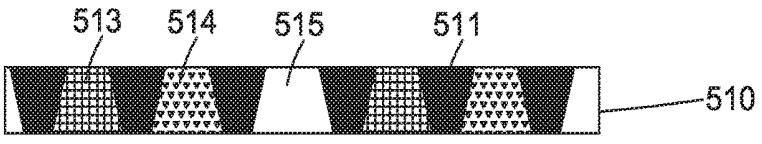
310
320
300

Fig. 2


513
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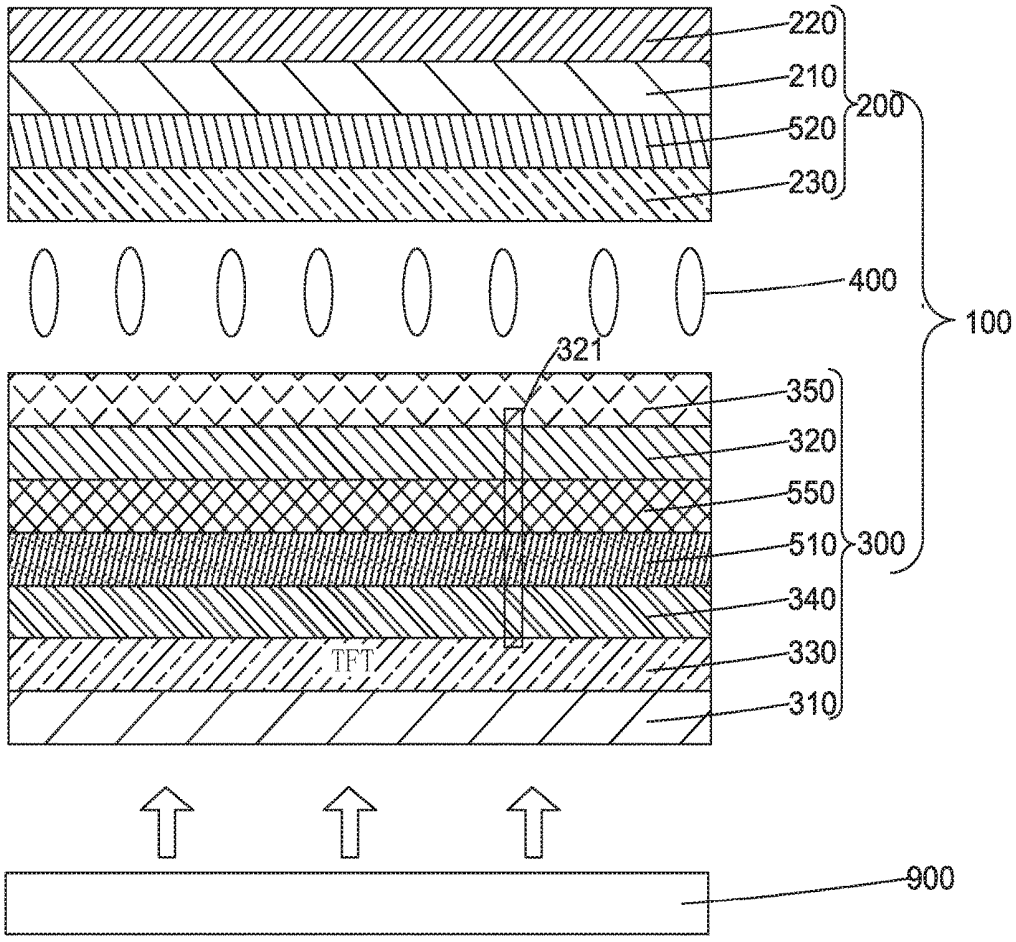
515
511
510

Fig. 3


220
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200
520
230
400
100
321
350
320
550
510
300
340
TFT
330
310
900

Fig. 4

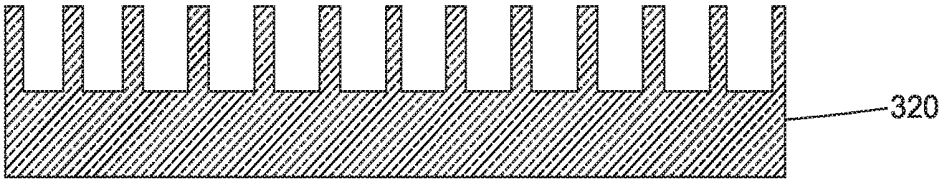


Fig. 5

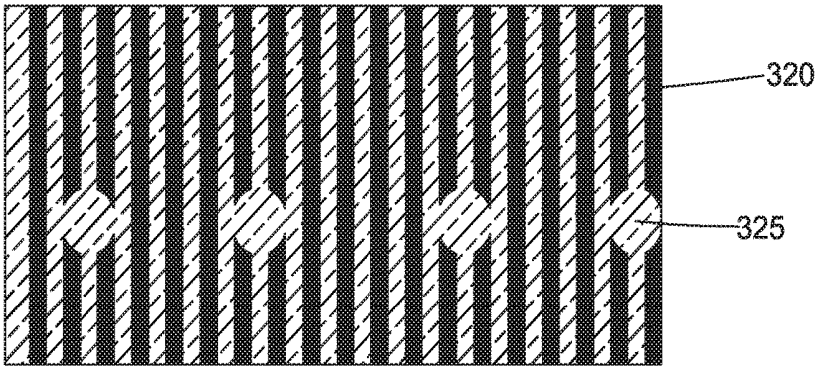
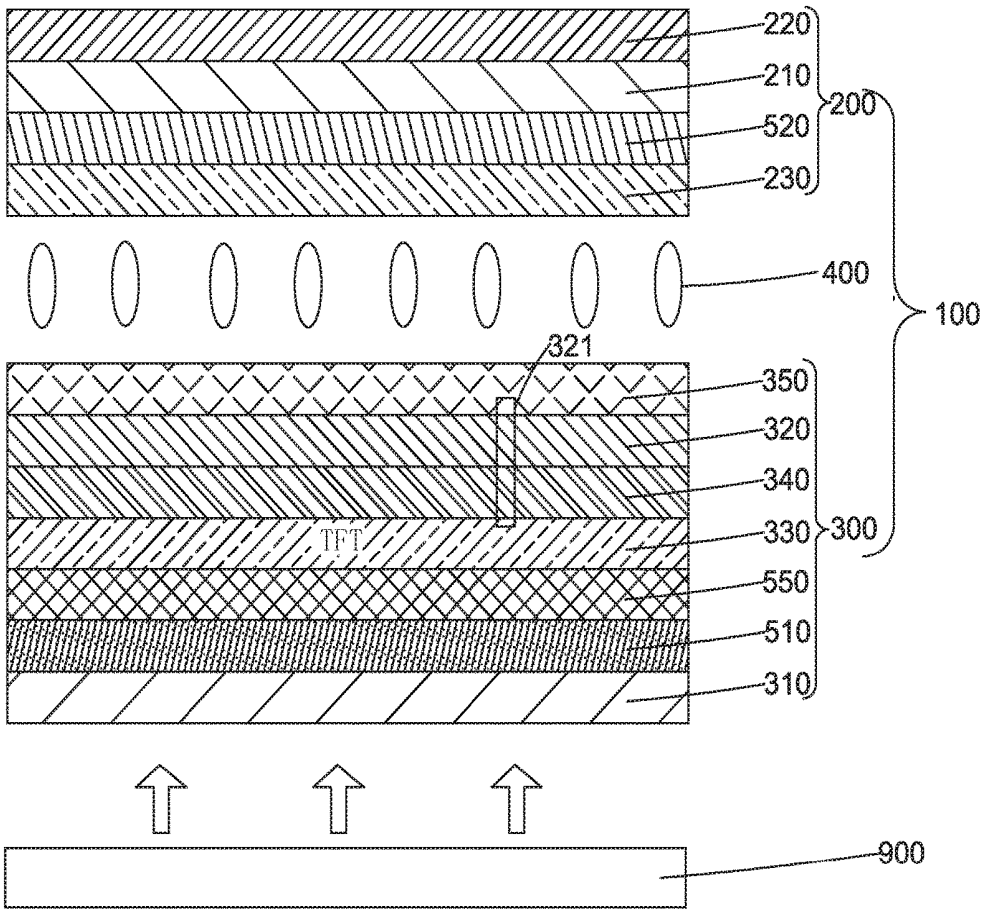


Fig. 6


220
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510
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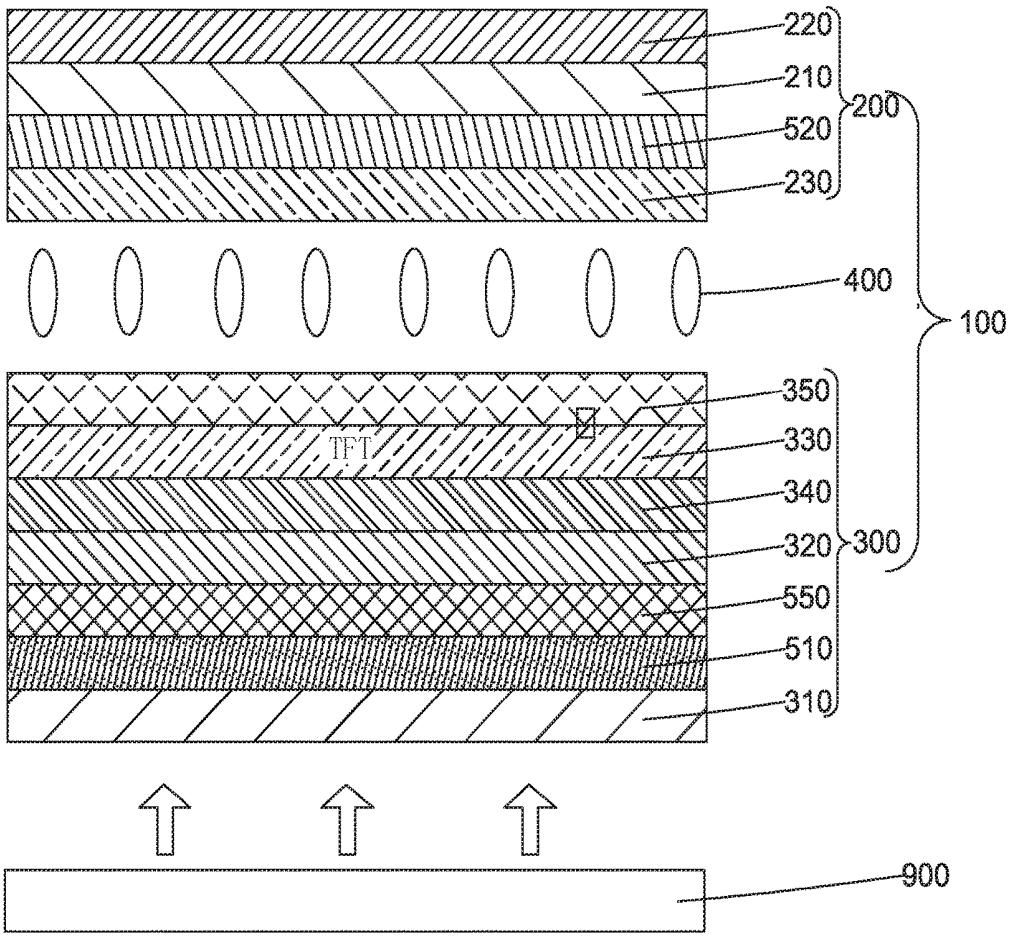
900

Fig. 7


220
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350
TFT
330
340
320
300
550
510
310
900

Fig. 8

LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to the field of display technology, and more particular to a liquid crystal display device.

2. The Related Arts

[0002] The development of science and technology and the progress of human society make people increasingly rely on exchange and transmission of information. As a major carrier, as well as a physical basis, for exchange and transmission of information, a display device is now a hot spot and highland that scientists who devote themselves to study and research in the field of photoelectronics must capture.

[0003] Quantum dots (QDs) are generally extremely tiny organic nanometer crystals that are not visually observable and are mostly nanometer materials having a three-dimensional configuration made of elements of II-VI groups or III-V groups. Due to the quantum confinement effect, transportation of electrons and holes in the interior is constrained and a continuous energy band is converted into a discrete energy level structure. Once receiving excitation of external energy, such as light or electricity, the quantum dots give off a color light and the color of the light is determined by the constituent materials, size and shape of the quantum dots. Different sizes of quantum dots provide different extents of quantum confinement for electrons and holes so that the discrete energy level structures are different. Generally, the smaller the particles are, the longer the wavelength that will be absorbed would be; and the larger the particles are, the shorter the wavelength that will be absorbed would be. Regular quantum dots absorb blue light that has a relatively short wavelength and will be excited to give off color light of a longer wavelength. Such a characteristic allows the quantum dots to change the color of light emitting from a light source.

[0004] An advantage of quantum dots is that through adjustment of the size of the quantum dots, it is possible to realize emissive wavelength covering both infrared band and entire visible light band, and the band of the emissive light band can be made narrow and shows high degree of color saturation. The quantum dots have a high quantum dot conversion efficiency and the material shows stable property; the manufacturing method is simple, allowing for preparation from solutions and ensuring rich resources.

[0005] Heretofore, a liquid crystal display (LCD) provides colors by means of a color filter (CF) layer. A conventional color filter layer is formed by subjecting color resist materials to a series of photolithographic operations. The color resist materials are made by dissolving and distributing a polymer, a monomer, a photo initiator, and a pigment in a solvent. Recently, manufacturers, such as Samsung Electronics Co., Ltd., proposed an idea of using a quantum dot color filter (QDCF) made of quantum dot materials to replace the conventional color filter plate.

[0006] Making a QDCF with QD nanometer materials requires solvents and ligands used in combination and certain progress has been made in this field. For example, some patent documents have been available concerning fabrication of color filter plates with quantum dots. However, the quantum dot color filter plates proposed in these patent documents are arranged inside liquid crystal cells. Since the principles based on which colors are generated are different between the quantum dots and the commonly used pigments of the color filter plates, where light emission of the quantum dots is achieved through excitation by light to cause a change of the energy band structure of the quantum dot so as to emit a specific wavelength of light, if the common way that a polarizer (POL) is attached to an outside surface of a glass backing a liquid crystal display is still adopted, then backlight that passes through a lower polarizer generates linear polarization light polarized at a specific direction and when the linear polarization light is applied to excite quantum dots, the polarized light in the specific direction would change the polarization condition thereof (such as de-polarization or variation of polarization direction). This results in uncontrollability concerning light path and brightness.

[0007] To prevent the above problems, a polarizer structure must be added between the QDCF and a liquid crystal layer. As shown in FIG. **1**, which is a schematic view illustrating a structure of a conventional liquid crystal display device, the liquid crystal display device comprises a liquid crystal panel **10** and a backlight module **50** arranged under the liquid crystal panel **10**. The liquid crystal panel **10** comprises a first substrate **20** and a second structure **30** that are respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer **40** arranged between the first substrate **20** and the second substrate **30**. The first substrate **20** comprises a first backing plate **21** and an optic film layer **22**, a quantum dot color filter layer **23**, a planarization layer **24**, an upper polarizer **25**, and an electrode layer **26** that are arranged, in sequence, on a side of the first backing plate **21** that is adjacent to the liquid crystal layer **40**; and the second substrate **30** comprises a second backing plate **31**, a thin-film transistor (TFT) layer **32** arranged on a side of the second backing plate **31** that is adjacent to the liquid crystal layer **40**, and a lower polarizer **33** arranged on a side of the second backing plate **31** that is distant from the liquid crystal layer **40**, wherein due to high sensitivity of the QD materials to moisture and oxygen, the planarization layer **24** is provided between the upper polarizer **25** and the quantum dot color filter layer **23** for planarization of the quantum dot color filter layer **23** and protection of the quantum dot color filter layer **23**. Further, the operation mechanism of the quantum dot color filter layer **23** is photoluminescence, where the conversion achievable by such excitation does not provide an efficiency of 100% and thus, additional filtration must be taken for light transmitting through the quantum dot color filter layer **23** in order to remove an extra portion of the backlighting given off from a top surface of the quantum dot color filter layer **23**. This is the function that the optic film layer **22** is provided for.

[0008] However, for the structure of the liquid crystal display device shown in FIG. **1**, when the optic film layer **22** has a large refractive index, total internal reflection may occur at an interface between the quantum dot color filter layer **23** and the optic film layer **22**, or the refractive index may make emission angles of light beams projected outward not converge toward a normal line, making it adverse for the displaying performance of the display device.

[0009] In view of the above problems, it is desired to provide a novel structure for liquid crystal display devices.

SUMMARY OF THE INVENTION

[0010] An objective of the present invention is to provide a liquid crystal display device, in which a quantum dot color filter plate and an optic film layer are provided on separate substrates to effectively eliminate interference caused by the refractive index of the optic film layer and improve the displaying performance of the liquid crystal display device.

[0011] To achieve the above objective, the present invention provides a liquid crystal display device, which comprises a liquid crystal panel and a backlight module;

[0012] wherein the liquid crystal panel comprises a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer arranged between the first substrate and the second substrate, wherein the second substrate comprises an array substrate, which comprises a thin-film transistor (TFT) layer;

[0013] the first substrate and the second substrate respectively comprise one of the quantum dot color filter plate and the optic film layer, wherein the optic film layer provides a function of wave filtration; and

[0014] the backlight module is arranged on an upper or lower side of the liquid crystal panel and the quantum dot color filter plate is located between the backlight module and the optic film layer, wherein the optic film layer functions to remove an extra amount of backlighting emitting from the backlight module after transmission through the quantum dot color filter plate.

[0015] The first substrate further comprises a first backing plate and an upper polarization layer; and

[0016] the second substrate further comprises a second backing plate and a lower polarization layer.

[0017] The first substrate comprises the quantum dot color filter plate and the second substrate comprises the optic film layer;

[0018] the backlight module is arranged on the upper side of the liquid crystal panel;

[0019] the first substrate further comprises an encapsulation layer and a function layer; and

[0020] in the first substrate, the quantum dot color filter plate, the encapsulation layer, the upper polarization layer, and the function layer are arranged, in sequence from the upper side to the lower side, on a side of the first backing plate that is adjacent to the liquid crystal layer.

[0021] The first substrate comprises the optic film layer and the second substrate comprises the quantum dot color filter plate;

[0022] the backlight module is arranged on the lower side of the liquid crystal panel; and

[0023] the second substrate further comprises an encapsulation layer, a planarization layer, and a pixel electrode layer.

[0024] In the second substrate, the TFT layer, the planarization layer, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on side of the second backing plate that is adjacent to the liquid crystal layer.

[0025] In the second substrate, the quantum dot color filter plate, the encapsulation layer, the TFT layer, the planarization layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

[0026] In the second substrate, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, the planarization layer, the TFT layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

[0027] The lower polarization layer comprises a metal nanometer wire-grid polarization plate;

[0028] the second substrate comprises a via formed therein and extending through the lower polarization layer to allow the pixel electrode layer to electrically connect, through the via, to the TFT layer; and

[0029] the lower polarization layer is formed through nanoimprint lithography by means of a nanoimprint template, wherein a process conducted to form the via in the lower polarization layer is that in applying the nanoimprint lithography to form the lower polarization layer, a via pattern is formed in the lower polarization layer and then, an etching operation that is conducted subsequently removes metal from the via pattern so as to form the via in the lower polarization layer.

[0030] The quantum dot color filter plate comprises a pixel separation layer and a red pixel unit, a green pixel unit, and a blue pixel unit that are separated from each other by the pixel separation layer; and

[0031] the backlight module comprises a blue fluorescent light source and the red pixel unit and the green pixel unit are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation, and the blue pixel unit is formed of a material comprising a transparent organic material.

[0032] The optic film layer is formed through a patterning operation and is provided for removing blue fluorescent light that emits from the backlight module and is not converted after transmission through the red pixel unit and the green pixel unit.

[0033] The present invention also provides a liquid crystal display device, which comprises a liquid crystal panel and a backlight module;

[0034] wherein the liquid crystal panel comprises a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer arranged between the first substrate and the second substrate, wherein the second substrate comprises an array substrate, which comprises a thin-film transistor (TFT) layer;

[0035] the first substrate and the second substrate respectively comprise one of the quantum dot color filter plate and the optic film layer, wherein the optic film layer provides a function of wave filtration; and

[0036] the backlight module is arranged on an upper or lower side of the liquid crystal panel and the quantum dot color filter plate is located between the backlight module and the optic film layer, wherein the optic film layer functions to remove an extra amount of backlighting emitting from the backlight module after transmission through the quantum dot color filter plate;

[0037] wherein the first substrate further comprises a first backing plate and an upper polarization layer; and

[0038] the second substrate further comprises a second backing plate and a lower polarization layer; and

[0039] wherein the quantum dot color filter plate comprises a pixel separation layer and a red pixel unit, a green pixel unit, and a blue pixel unit that are separated from each other by the pixel separation layer; and

[0040] the backlight module comprises a blue fluorescent light source and the red pixel unit and the green pixel unit are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation, and the blue pixel unit is formed of a material comprising a transparent organic material.

[0041] The efficacy of the present invention is that the present invention provides a liquid crystal display device, which comprises a liquid crystal panel comprising a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other, wherein the first substrate and the second substrate respectively comprise one of a quantum dot color filter plate and an optic film layer. The present invention is structured to have the quantum dot color filter plate and the optic film layer respectively arranged on different substrates so that even the refractive index of the optic film layer is relatively large, internal total reflection at an interface between the quantum dot color filter plate and the optic film layer and emission angles of light beams being not convergent toward a normal line due to the refractive index may not happen so as to effectively eliminate interference caused by the refractive index of the optic film layer and improve the displaying performance of the liquid crystal display device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] The technical solution, as well as other beneficial advantages, of the present invention will become apparent from the following detailed description of embodiments of the present invention, with reference to the attached drawings.

[0043] In the drawings:

[0044] FIG. **1** is a schematic view showing a structure of a conventional liquid crystal display device;

[0045] FIG. **2** is a schematic view showing a structure of a first embodiment of a liquid crystal display device according to the present invention;

[0046] FIG. **3** is a schematic view showing a structure of a quantum dot color filter plate included in the liquid crystal display device according to the present invention;

[0047] FIG. **4** is a schematic view showing a structure of a second embodiment of the liquid crystal display device according to the present invention;

[0048] FIG. **5** is a cross-sectional view showing a lower polarization layer of the second embodiment of the liquid crystal display device according to the present invention;

[0049] FIG. **6** is a schematic, top plan view illustrating formation of vias in the lower polarization layer of the second embodiment of the liquid crystal display device according to the present invention;

[0050] FIG. **7** is a schematic view showing a structure of a third embodiment of the liquid crystal display device according to the present invention; and

[0051] FIG. **8** is a schematic view showing a structure of a fourth embodiment of the liquid crystal display device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0052] To further expound the technical solution adopted in the present invention and the advantages thereof, a detailed description will be given with reference to the preferred embodiments of the present invention and the drawings thereof.

[0053] The present invention provides a liquid crystal display device, in which a quantum dot color filter plate **510** and an optic film layer **520** are arranged on different substates in order to effectively elminates interference caused by the refrative index of the optic film layer **520** and improve displaying performance of the liquid crystal display device. Specifically, reference being had to FIG. **2**, which is a schematic view showing a structure of a first embodiment of a liquid crystal display device according to the present invention, in the instant embodiment, the liquid crystal display device comprises a liquid crystal panel **100** and a backlight module **900**.

[0054] The liquid crystal panel **100** comprises a first substrate **200** and a second substrate **300** respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer **400** arranged between the first substrate **200** and the second substrate **300**, wherein the second substrate **300** is an array substrate, which comprises a thin-film transistor (TFT) layer **330** thereon.

[0055] The first substrate **200** and the second substrate **300** respectively comprise one of the quantum dot color filter plate **510** and the optic film layer **520** arranged thereon, wherein the optic film layer **520** provides a function of wave filtration.

[0056] The backlight module **900** is arranged on an upper or lower side of the liquid crystal panel **100** and the quantum dot color filter plate **510** is located between the backlight module **900** and the optic film layer **520**. The optic film layer **520** functions to remove an extra amount of backlighting emitting from the backlight module **900** after transmission through the quantum dot color filter plate **510**.

[0057] Specifically, the first substrate **200** further comprises a first backing plate **210** and an upper polarization layer **220**; and the second substrate **300** further comprises a second backing plate **310** and a lower polarization layer **320**.

[0058] Specifically, in the instant embodiment, the first substrate **200** comprises the quantum dot color filter plate **510** and the second substrate **300** comprises the optic film layer **520**; and the backlight module **900** is arranged on the upper side of the liquid crystal panel **100**.

[0059] Specifically, the first substrate **200** further comprises an encapsulation layer **550** for planarization of the quantum dot color filter plate **510** and encapsulation and thus protection of the quantum dot color filter plate **510** and a function layer **230** for electrode and/or alignment; and in the first substrate **200**, the quantum dot color filter plate **510**, the encapsulation layer **550**, the upper polarization layer **220**, and the function layer **230** are arranged, in sequence from the upper side to the lower side, on a side of the first backing plate **210** that is adjacent to the liquid crystal layer **400**.

[0060] Specifically, as shown in FIG. **3**, the quantum dot color filter plate **510** comprises a pixel separation layer **511** and a red pixel unit **513**, a green pixel unit **514**, and a blue pixel unit **515** that are separated from each other by the pixel separation layer **511**.

[0061] Specifically, the backlight module **900** comprises a blue fluorescent light source. The red pixel unit **513** and the green pixel unit **514** are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation. Since blue light carries higher energy, which may excite a red quantum dot (that is a quantum dot that emits red light) and a green quantum dot (that is a quantum dot that emits green light) to respectively generate red light and green light, the backlight module **900** that generates blue fluorescent light may serve as a backlighting source such that blue light is supplied by the backlight module **900** itself, and thus, a blue pixel unit **515** may be formed by filling a transparent organic material.

[0062] Specifically, the optic film layer **520** is formed through a patterning operation and is provided for removing the blue fluorescent light that emits from the backlight module **900** but has not yet been converted after transmission through the red pixel unit **513** and the green pixel unit **514**.

[0063] Referring to FIG. **4**, which is a schematic view showing a structure of a second embodiment of the liquid crystal display device according to the present invention, in the instant embodiment, the liquid crystal display device comprises a liquid crystal panel **100** and a backlight module **900**.

[0064] The liquid crystal panel **100** comprises a first substrate **200** and a second substrate **300** respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer **400** arranged between the first substrate **200** and the second substrate **300**, wherein the second substrate **300** is an array substrate, which comprises a thin-film transistor (TFT) layer **330** thereon.

[0065] In the instant embodiment, the first substrate **200** comprises an optic film layer **520** and the second substrate **300** comprises a quantum dot color filter plate **510**, wherein the optic film layer **520** provides a function of wave filtration.

[0066] The backlight module **900** is arranged on the lower side of the liquid crystal panel **100** and the optic film layer **520** is located between the backlight module **900** and the quantum dot color filter plate **510** and functions to remove an extra amount of backlighting emitting from the backlight module **900** after transmission through the quantum dot color filter plate **510**.

[0067] Specifically, the first substrate **200** further comprises a first backing plate **210** and an upper polarization layer **220**; and the second substrate **300** further comprises a second backing plate **310**, a lower polarization layer **320**, an encapsulation layer **550**, a planarization layer **340**, and a pixel electrode layer **350**.

[0068] Specifically, in the second substrate **300**, the TFT layer **330**, the planarization layer **340**, the quantum dot color filter plate **510**, the encapsulation layer **550**, the lower polarization layer **320**, and the pixel electrode layer **350** are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate **310** that is adjacent to the liquid crystal layer **400**.

[0069] Specifically, as shown in FIG. **5**, the lower polarization layer **320** comprises a metal nanometer wire-grid polarization plate.

[0070] Specifically, the second substrate **300** comprises a via **321** extending through the lower polarization layer **320**. Further, in the instant embodiment, the via **321** necessarily extends through the planarization layer **340**, the quantum dot color filter plate **510**, the encapsulation layer **550**, and the lower polarization layer **320** that are located between the pixel electrode layer **350** and the TFT layer **330** in order to allow the pixel electrode layer **350** to electrically connect to the TFT layer **330** through the via **321**.

[0071] Specifically, the lower polarization layer **320** is formed through nanoimprint lithography by means of a nanoimprint template and, thus, as shown in FIG. **6**, a process for forming the via **321** in the lower polarization layer **320** is that in applying nanoimprint lithography to form the lower polarization layer **320**, a via pattern **325** is formed in the lower polarization layer **320** and then, an etching operation that is conducted subsequently removes metal from the via pattern **325** so as to form the via **321** in the lower polarization layer **320**.

[0072] Specifically, the quantum dot color filter plate **510** comprises a pixel separation layer **511** and a red pixel unit **513**, a green pixel unit **514**, and a blue pixel unit **515** that are separated from each other by the pixel separation layer **511**; and the backlight module **900** comprises a blue fluorescent light source, and the red pixel unit **513** and the green pixel unit **514** are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation, and the blue pixel unit **515** comprises a transparent organic material.

[0073] Specifically, the optic film layer **520** is formed through a patterning operation and is provided for removing the blue fluorescent light that emits from the backlight module **900** but has not yet been converted after transmission through the red pixel unit **513** and the green pixel unit **514**.

[0074] Referring to FIG. **7**, which is a schematic view showing a structure of a thrid embodiment of the liquid crystal display device according to the present invention, compared to the second embodiment described above, the instant embodiment is structured such that in the second substrate **300**, the quantum dot color filter plate **510**, the encapsulation layer **550**, the TFT layer **330**, the planarization layer **340**, the lower polarization layer **320**, and the pixel electrode layer **350** are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate **310** that is adjacent to the liquid crystal layer **400**, such that the via **321** that provides electrical connection between the pixel electrode layer **350** and the TFT layer **330** only needs to extend through the planarization layer **340** and the lower polarization layer **320** that are located between the pixel electrode layer **350** and the TFT layer **330**. The remaining features are similar to those of the second embodiment described above and repeated description will be omitted herein.

[0075] Referring to FIG. **8**, which is a schematic view showing a structure of a fourth embodiment of the liquid crystal display device according to the present invention, compared to the second embodiment described above, the instant embodiment is structured such that in the second substrate **300**, the quantum dot color filter plate **510**, the encapsulation layer **550**, the lower polarization layer **320**, the planarization layer **340**, the TFT layer **330**, and the pixel electrode layer **350** are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate **310** that is adjacent to the liquid crystal layer **400**. As a result, there is no need to form a via **321** in the lower polarization layer **320** and the pixel electrode layer **350** and

the TFT layer **330** are directly set in electrical connection with each other. The remaining features are similar to those of the second embodiment described above and repeated description will be omitted herein.

[0076] In summary, the present invention provides a liquid crystal display device, which comprises a liquid crystal panel comprising a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other, wherein the first substrate and the second substrate respectively comprise one of a quantum dot color filter plate and an optic film layer. The present invention is structured to have the quantum dot color filter plate and the optic film layer respectively arranged on different substrates so that even the refractive index of the optic film layer is relatively large, internal total reflection at an interface between the quantum dot color filter plate and the optic film layer and emission angles of light beams being not convergent toward a normal line due to the refractive index may not happen so as to effectively eliminate interference caused by the refractive index of the optic film layer and improve the displaying performance of the liquid crystal display device.

[0077] Based on the description given above, those having ordinary skills in the art may easily contemplate various changes and modifications of he technical solution and the technical ideas of the present invention. All these changes and modifications are considered belonging to the protection scope of the present invention as defined in the appended claims.

What is claimed is:

1. A liquid crystal display device, comprising a liquid crystal panel and a backlight module;

wherein the liquid crystal panel comprises a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer arranged between the first substrate and the second substrate, wherein the second substrate comprises an array substrate, which comprises a thin-film transistor (TFT) layer;

the first substrate and the second substrate respectively comprise one of the quantum dot color filter plate and the optic film layer, wherein the optic film layer provides a function of wave filtration; and

the backlight module is arranged on an upper or lower side of the liquid crystal panel and the quantum dot color filter plate is located between the backlight module and the optic film layer, wherein the optic film layer functions to remove an extra amount of backlighting emitting from the backlight module after transmission through the quantum dot color filter plate.

2. The liquid crystal display device as claimed in claim **1**, wherein the first substrate further comprises a first backing plate and an upper polarization layer; and

the second substrate further comprises a second backing plate and a lower polarization layer.

3. The liquid crystal display device as claimed in claim **2**, wherein the first substrate comprises the quantum dot color filter plate and the second substrate comprises the optic film layer;

the backlight module is arranged on the upper side of the liquid crystal panel;

the first substrate further comprises an encapsulation layer and a function layer; and

in the first substrate, the quantum dot color filter plate, the encapsulation layer, the upper polarization layer, and the function layer are arranged, in sequence from the upper side to the lower side, on a side of the first backing plate that is adjacent to the liquid crystal layer.

4. The liquid crystal display device as claimed in claim **2**, wherein the first substrate comprises the optic film layer and the second substrate comprises the quantum dot color filter plate;

the backlight module is arranged on the lower side of the liquid crystal panel; and

the second substrate further comprises an encapsulation layer, a planarization layer, and a pixel electrode layer.

5. The liquid crystal display device as claimed in claim **4**, wherein in the second substrate, the TFT layer, the planarization layer, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on side of the second backing plate that is adjacent to the liquid crystal layer.

6. The liquid crystal display device as claimed in claim **4**, wherein in the second substrate, the quantum dot color filter plate, the encapsulation layer, the TFT layer, the planarization layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

7. The liquid crystal display device as claimed in claim **4**, wherein in the second substrate, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, the planarization layer, the TFT layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

8. The liquid crystal display device as claimed in claim **5**, wherein the lower polarization layer comprises a metal nanometer wire-grid polarization plate;

the second substrate comprises a via formed therein and extending through the lower polarization layer to allow the pixel electrode layer to electrically connect, through the via, to the TFT layer; and

the lower polarization layer is formed through nanoimprint lithography by means of a nanoimprint template, wherein a process conducted to form the via in the lower polarization layer is that in applying the nanoimprint lithography to form the lower polarization layer, a via pattern is formed in the lower polarization layer and then, an etching operation that is conducted subsequently removes metal from the via pattern so as to form the via in the lower polarization layer.

9. The liquid crystal display device as claimed in claim **1**, wherein the quantum dot color filter plate comprises a pixel separation layer and a red pixel unit, a green pixel unit, and a blue pixel unit that are separated from each other by the pixel separation layer; and

the backlight module comprises a blue fluorescent light source and the red pixel unit and the green pixel unit are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation, and the blue pixel unit is formed of a material comprising a transparent organic material.

10. The liquid crystal display device as claimed in claim **9**, wherein the optic film layer is formed through a patterning operation and is provided for removing blue fluorescent light

that emits from the backlight module and is not converted after transmission through the red pixel unit and the green pixel unit.

11. A liquid crystal display device, comprising a liquid crystal panel and a backlight module;

wherein the liquid crystal panel comprises a first substrate and a second substrate respectively arranged at upper and lower sides and opposite to each other and a liquid crystal layer arranged between the first substrate and the second substrate, wherein the second substrate comprises an array substrate, which comprises a thin-film transistor (TFT) layer;

the first substrate and the second substrate respectively comprise one of the quantum dot color filter plate and the optic film layer, wherein the optic film layer provides a function of wave filtration; and

the backlight module is arranged on an upper or lower side of the liquid crystal panel and the quantum dot color filter plate is located between the backlight module and the optic film layer, wherein the optic film layer functions to remove an extra amount of backlighting emitting from the backlight module after transmission through the quantum dot color filter plate;

wherein the first substrate further comprises a first backing plate and an upper polarization layer; and

the second substrate further comprises a second backing plate and a lower polarization layer; and

wherein the quantum dot color filter plate comprises a pixel separation layer and a red pixel unit, a green pixel unit, and a blue pixel unit that are separated from each other by the pixel separation layer; and

the backlight module comprises a blue fluorescent light source and the red pixel unit and the green pixel unit are respectively formed of a red quantum dot ink material and green quantum dot ink material each applied through an inkjet printing operation, and the blue pixel unit is formed of a material comprising a transparent organic material.

12. The liquid crystal display device as claimed in claim **11**, wherein the first substrate comprises the quantum dot color filter plate and the second substrate comprises the optic film layer;

the backlight module is arranged on the upper side of the liquid crystal panel;

the first substrate further comprises an encapsulation layer and a function layer; and

in the first substrate, the quantum dot color filter plate, the encapsulation layer, the upper polarization layer, and the function layer are arranged, in sequence from the upper side to the lower side, on a side of the first backing plate that is adjacent to the liquid crystal layer.

13. The liquid crystal display device as claimed in claim **11**, wherein the first substrate comprises the optic film layer and the second substrate comprises the quantum dot color filter plate;

the backlight module is arranged on the lower side of the liquid crystal panel; and

the second substrate further comprises an encapsulation layer, a planarization layer, and a pixel electrode layer.

14. The liquid crystal display device as claimed in claim **13**, wherein in the second substrate, the TFT layer, the planarization layer, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on side of the second backing plate that is adjacent to the liquid crystal layer.

15. The liquid crystal display device as claimed in claim **13**, wherein in the second substrate, the quantum dot color filter plate, the encapsulation layer, the TFT layer, the planarization layer, the lower polarization layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

16. The liquid crystal display device as claimed in claim **13**, wherein in the second substrate, the quantum dot color filter plate, the encapsulation layer, the lower polarization layer, the planarization layer, the TFT layer, and the pixel electrode layer are arranged, in sequence from the lower side to the upper side, on a side of the second backing plate that is adjacent to the liquid crystal layer.

17. The liquid crystal display device as claimed in claim **15**, wherein the lower polarization layer comprises a metal nanometer wire-grid polarization plate;

the second substrate comprises a via formed therein and extending through the lower polarization layer to allow the pixel electrode layer to electrically connect, through the via, to the TFT layer; and

the lower polarization layer is formed through nanoimprint lithography by means of a nanoimprint template, wherein a process conducted to form the via in the lower polarization layer is that in applying the nanoimprint lithography to form the lower polarization layer, a via pattern is formed in the lower polarization layer and then, an etching operation that is conducted subsequently removes metal from the via pattern so as to form the via in the lower polarization layer.

18. The liquid crystal display device as claimed in claim **11**, wherein the optic film layer is formed through a patterning operation and is provided for removing blue fluorescent light that emits from the backlight module and is not converted after transmission through the red pixel unit and the green pixel unit.

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专利名称(译)	液晶显示装置		
公开(公告)号	US20180284531A1	公开(公告)日	2018-10-04
申请号	US15/539697	申请日	2017-04-19
[标]申请(专利权)人(译)	深圳市华星光电技术有限公司		
申请(专利权)人(译)	深圳市中国星光电科技有限公司.		
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摘要(译)

本发明提供一种液晶显示装置，其包括液晶面板，所述液晶面板包括分别设置在上侧和下侧并且彼此相对的第一基板和第二基板，其中所述第一基板和所述第二基板分别包括以下之一：量子点彩色滤光片和光学薄膜层。本发明的结构是将量子点彩色滤光片和光学膜层分别设置在不同的基板上，使得光学膜层的折射率相对较大，量子点彩色滤光片之间界面处的内部全反射由于折射率，光束和光学薄膜层以及光束不会向法线收敛的发射角可能不会发生，从而有效地消除了由光学薄膜层的折射率引起的干扰，并改善了光学薄膜层的显示性能。液晶显示装置。