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(54) **MANUFACTURE METHOD OF QUANTUM-DOT COLOR FILTER AND LIQUID CRYSTAL DISPLAY DEVICE**

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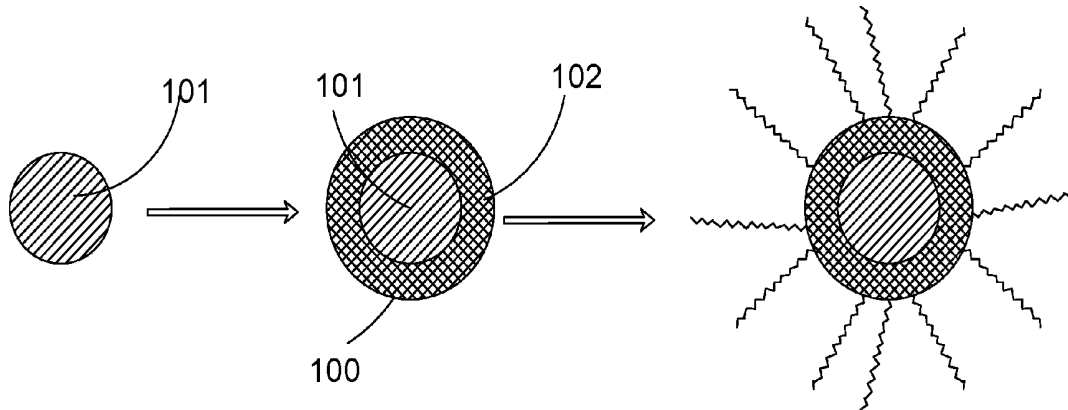
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(57) **ABSTRACT**

A liquid crystal display device includes a liquid crystal panel and a back light module located under the liquid crystal panel. The liquid crystal panel includes a first substrate and a second substrate arranged opposite to each other; a liquid crystal layer arranged between the first substrate and the second substrate; an upper polarizer arranged at one side of the first substrate that is distant from the liquid crystal layer; a lower polarizer arranged at one side of the second substrate that is distant from the liquid crystal layer; and a quantum-dot color filter arranged between the back light module and the lower polarizer. The back light module emit blue light, which excites red and green quantum dots contained in the quantum-dot color filter to emit red light and green light, respectively.



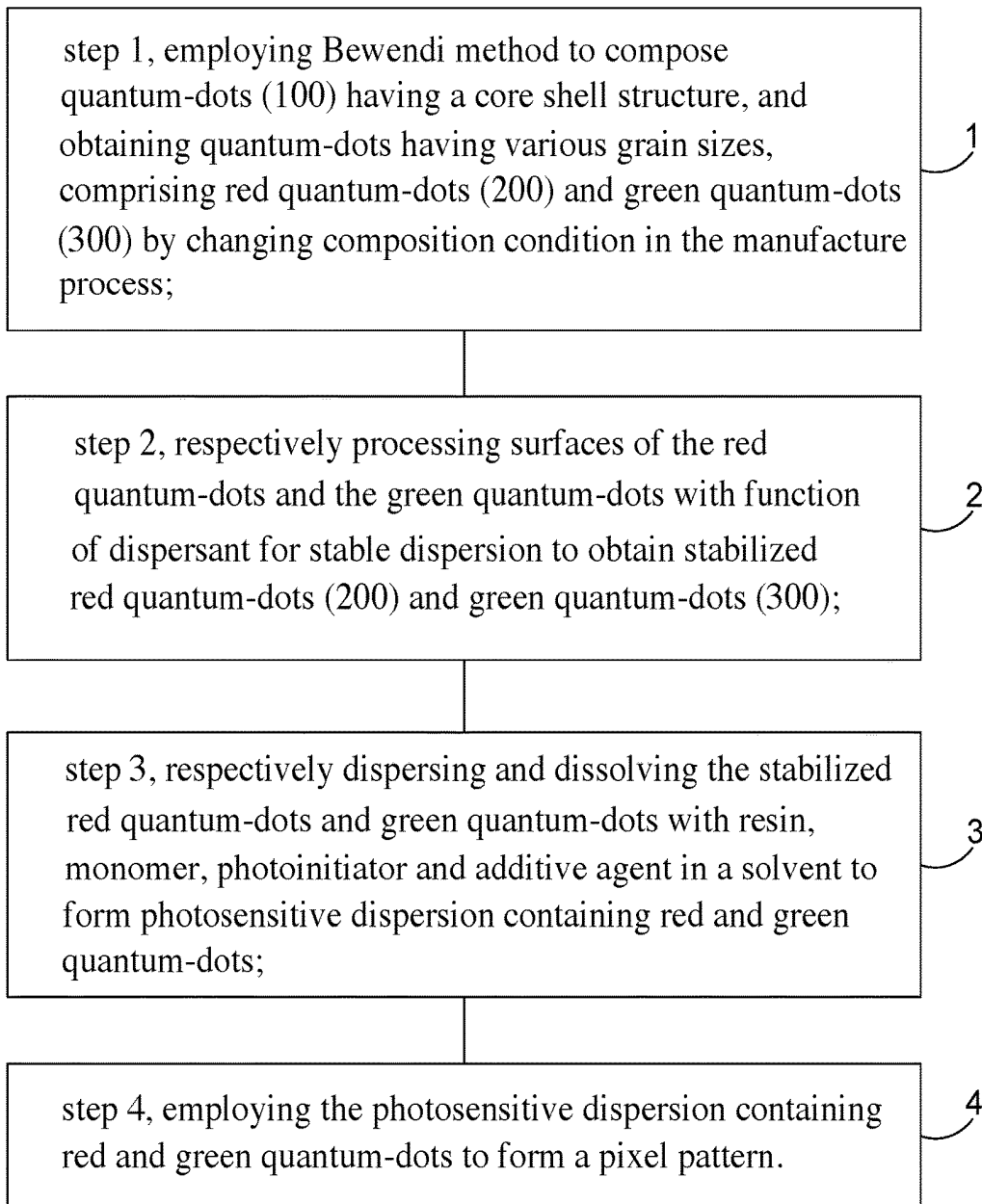


Fig. 1

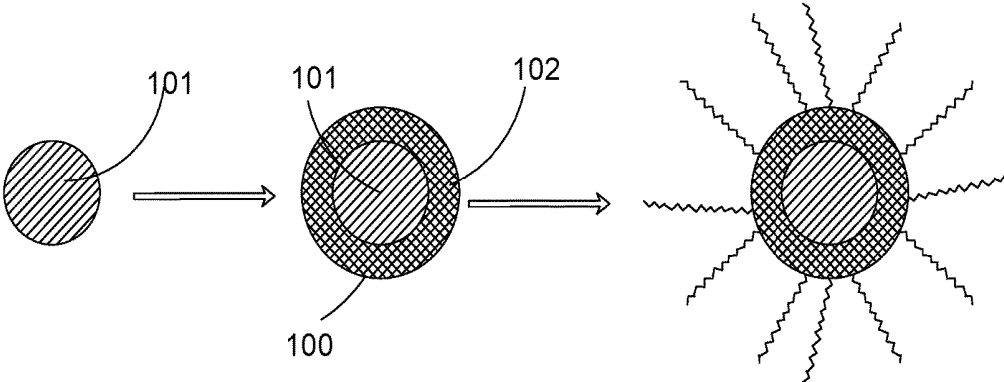


Fig. 2

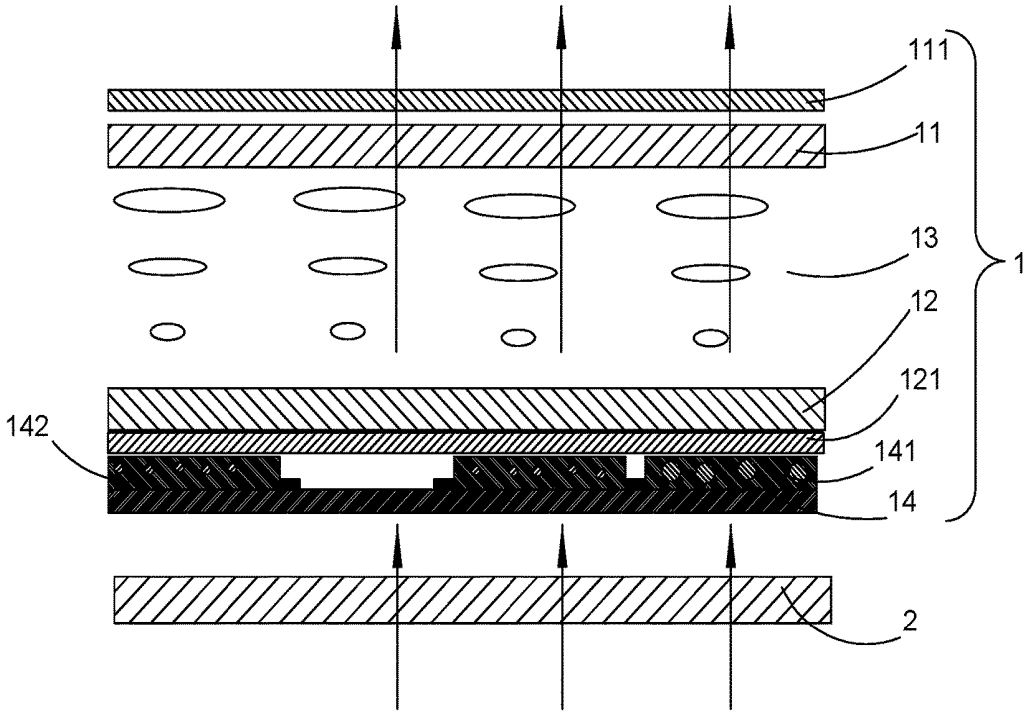


Fig. 3

## MANUFACTURE METHOD OF QUANTUM-DOT COLOR FILTER AND LIQUID CRYSTAL DISPLAY DEVICE

### CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** This is a divisional application of co-pending patent application Ser. No. 14/423,125, filed on Feb. 21, 2015, which is a national stage of PCT application number PCT/CN2015/072465, filed on Feb. 8, 2015, claiming foreign priority of Chinese patent application number 201410812020.9, filed on Dec. 23, 2014.

### FIELD OF THE INVENTION

**[0002]** The present invention relates to a display technology field, and more particularly to a manufacture method of a quantum-dot color filter and a liquid crystal display device.

### BACKGROUND OF THE INVENTION

**[0003]** The color of the present LCD (Liquid Crystal Display) relies on the CF (color filter) to realize. The CF layer is formed by color light block materials with a series of photolithography processes. The common CF light block material is formed by dissolving and dispersing resin (polymer), monomer, photoinitiator and pigment in the solvent.

**[0004]** The pigment is the substance that makes the CF to realize colors. When the light emitted by the back light module passes through the RGB CF layer, only the light corresponding to the R, G, B wave bands can pass through, and the light of other wave bands is absorbed by the pigment. Therefore, the light generates RGB colors after passing through the CF layer. The present common RGB pigments are R254, R177, G58 and B166. On one hand, the transmission peaks of these organic pigments are wider and the color densities are restricted, which makes the liquid crystal display hard to realize border color gamut; on the other hand, most of the light passing through the CF layer is absorbed (the loss rate is about 66%), and only small proportional light can pass through. Therefore, the light efficiency is extremely low (generally the entire light efficiency is lower than 5%). The QDs (Quantum-Dots) are some extremely small semiconductor nano crystals, which comprise zincum, cadmium, selenium and sulphur atoms. The grain diameters of the crystals are less than 10 nm. Different from the pigment, the quantum-dots emit light as being excited by electricity or light. The wavelength of the emitting light is extremely narrow and the color is pure. The color of the emitting light is decided by the composition material, the diameter and the shape of the quantum-dots. The size is smaller, the light will be more like blue, and the size is larger, the light will be more like red. With the precise control, the colorful R, G, B light can be emitted. Therefore, the brightness of the display screen and the vividness of the images can be tremendously promoted and save energy if the quantum-dots are applied in the color block material.

**[0005]** The present quantum-dot color filters are all located inside the cell. The principles of generating colors by the quantum-dots and the commonly used pigment in the color filter are different. The quantum-dots are excited by light and the energy band structure of the quantum-dot changes to emit light having a specific wavelength. The back light of the liquid crystal display generates a linearly polarized light of specific direction after passing through the

polarizer. The polarization state of the polarized light of specific direction will be changed (the directions of depolarization and polarization are changed) after the linearly polarized light excites the quantum-dots. Therefore, the light path and the brightness become uncontrollable.

### SUMMARY OF THE INVENTION

**[0006]** An objective of the present invention is to provide a manufacture method of a quantum-dot color filter, and the process of the manufacture method is simple and easy to realize.

**[0007]** Another objective of the present invention is to provide a liquid crystal display device, which the quantum-dot color filter is located outside the upper, lower polarizers to prevent that the light efficiency descends due to the change to the polarization state made by the quantum-dots. Accordingly, the liquid crystal display device possesses border color gamut and higher brightness, and saves energy.

**[0008]** For realizing the aforesaid objectives, the present invention provides a manufacture method of a quantum-dot color filter, comprising steps of:

**[0009]** Step 1, employing Bewendi method to compose quantum-dots having a core shell structure, and obtaining quantum-dots having various grain sizes, comprising red quantum-dots and green quantum-dots by changing composition condition in the manufacture process, and the grain sizes of the red quantum-dots are 5-7 nm, the grain sizes of the green quantum-dots are 3-5 nm;

**[0010]** Step 2, respectively processing surfaces of the red quantum-dots and the green quantum-dots with function of dispersant for stable dispersion to obtain stabilized red quantum-dots and green quantum-dots;

**[0011]** Step 3, respectively dispersing and dissolving the stabilized red quantum-dots and green quantum-dots with resin, monomer, photoinitiator and additive agent in a solvent to form photosensitive dispersion containing red and green quantum-dots;

**[0012]** Step 4, employing the photosensitive dispersion containing red and green quantum-dots to form a pixel pattern.

**[0013]** In Step 1, a range of grain sizes of the quantum-dots is 3-8 nm, the grain sizes of the red quantum-dots are 5-7 nm, and the grain sizes of the green quantum-dots are 3-5 nm.

**[0014]** The manufacture process of quantum-dots in Step 1 comprises:

**[0015]** Step 11, manufacturing CdS cores of the quantum-dots;

**[0016]** Step 12, manufacturing ZnS shells covering the exterior of the CdS cores.

**[0017]** In Step 3 and the total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing red quantum-dots, a content of the stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %;

**[0018]** the total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing green quantum-dots, a content of the stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the

photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %.

**[0019]** The dispersant in Step 2 is a micromolecular coupling agent or an amphiphilic macromolecular coupling agent.

**[0020]** In Step 3, the resin is polyacrylate polymer, and the monomer is polyhydroxy acrylics monomer, and the solvent is solvent of one or more kinds of propylene glycol monomethyl ether propionates; the photoinitiator is acetophenone group, biimidazole, benzoin group or benzophenone; the additive agent is at least one of leveling agent, defoamer and heat stabilizer.

**[0021]** The pixel pattern is formed in Step 4 by spray coating or patterning.

**[0022]** The present invention further provides a liquid crystal display device, comprising a liquid crystal panel and a back light module located under the liquid crystal panel, and the liquid crystal panel comprises a first substrate and a second substrate, which are oppositely located, a liquid crystal layer located between the first substrate and the second substrate, an upper polarizer, located at one side of the first substrate away from the liquid crystal layer, a lower polarizer, located at one side of the second substrate away from the liquid crystal layer and a quantum-dot color filter located between the back light module and the lower polarizer.

**[0023]** The back light module is a blue-fluorescence light source, and a red quantum-dot pixel pattern and a green quantum-dot pixel pattern are formed at one side of the quantum-dot color filter close to the lower polarizer.

**[0024]** The present invention further provides a manufacture method of a quantum-dot color filter, comprising steps of:

**[0025]** Step 1, employing Bewendi method to compose quantum-dots having a core shell structure, and obtaining quantum-dots having various grain sizes, comprising red quantum-dots and green quantum-dots by changing composition condition in the manufacture process;

**[0026]** Step 2, respectively processing surfaces of the red quantum-dots and the green quantum-dots with function of dispersant for stable dispersion to obtain stabilized red quantum-dots and green quantum-dots;

**[0027]** Step 3, respectively dispersing and dissolving the stabilized red quantum-dots and green quantum-dots with resin, monomer, photoinitiator and additive agent in a solvent to form photosensitive dispersion containing red and green quantum-dots;

**[0028]** Step 4, employing the photosensitive dispersion containing red and green quantum-dots to form a pixel pattern;

**[0029]** wherein in Step 1, a range of grain sizes of the quantum-dots is 3-8 nm, the grain sizes of the red quantum-dots are 5-7 nm, the grain sizes of the green quantum-dots are 3-5 nm;

**[0030]** wherein the manufacture process of quantum-dots in Step 1 comprises:

**[0031]** Step 11, manufacturing CdS cores of the quantum-dots;

**[0032]** Step 12, manufacturing ZnS shells covering the exterior of the CdS cores;

**[0033]** wherein in Step 3 and the total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing red quantum-dots, a content of the

stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %;

**[0034]** the total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing green quantum-dots, a content of the stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %.

**[0035]** The benefits of the present invention are that the manufacture method of the quantum-dot color filter provided by the present invention is simple and easy to realize. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process. The liquid crystal display device of the present invention utilizes the back light module generating blue-fluorescence as the light source. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process, and the quantum-dot color filter is located outside the polarizer to prevent that the light efficiency descends due to the change to the polarization state made by the quantum-dots. Accordingly, the liquid crystal display device possesses border color gamut and higher brightness, and saves energy.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0036]** The technical solution and the beneficial effects of the present invention are best understood from the following detailed description with reference to the accompanying figures and embodiments.

**[0037]** In drawings,

**[0038]** FIG. 1 is a flowchart of a manufacture method of a quantum-dot color filter according to the present invention;

**[0039]** FIG. 2 is a diagram showing Steps 1 and 2 of the manufacture method of the quantum-dot color filter according to the present invention; and

**[0040]** FIG. 3 is a structural diagram of a liquid crystal display device according to the present invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0041]** For better explaining the technical solution and the effect of the present invention, the present invention will be further described in detail with the accompanying drawings and the specific embodiments.

**[0042]** Please refer to FIG. 1. The present invention provides manufacture method of a quantum-dot color filter, comprising:

**[0043]** Step 1, employing Bewendi method to compose quantum-dots **100** having a core shell structure, and obtaining quantum-dots having various grain sizes, comprising red quantum-dots **200** and green quantum-dots **300** by changing composition condition in the manufacture process.

**[0044]** Specifically, please refer to FIG. 2, the manufacture process of quantum-dots **100** in Step 1 comprises:

**[0045]** Step 11, manufacturing CdS cores **101** of the quantum-dots **100**.

**[0046]** Step 12, manufacturing ZnS shells **102** covering the exterior of the CdS cores **101**.

[0047] The grain sizes of the CdS cores **101** are 2-5 nm, and a range of grain sizes of the quantum-dots **100** is 3-8 nm; the grain sizes of the red quantum-dots **200** are 5-7 nm, the grain sizes of the green quantum-dots **300** are 3-5 nm.

[0048] Specifically, the blue light has higher energy which can excite the red quantum-dots (quantum-dots emitting red light) and the green quantum-dots (quantum-dots emitting green light) to respectively generate red, green light. Therefore, the back light module generating blue-fluorescence can be used as the light source. The blue light is provided by the back light module. Accordingly, the quantum-dot color filter can manufacture only the red quantum-dot pixel pattern and the green quantum-dot pixel pattern. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process.

[0049] Step 2, respectively processing surfaces of the red quantum-dots and the green quantum-dots with function of dispersant for stable dispersion to obtain stabilized red quantum-dots **200** and green quantum-dots **300**.

[0050] The dispersant in Step 2 is a micromolecular coupling agent or an amphiphilic macromolecular coupling agent.

[0051] Step 3, respectively dispersing and dissolving the stabilized red quantum-dots and green quantum-dots with resin, monomer, photoinitiator and additive agent in a solvent to form photosensitive dispersion containing red and green quantum-dots.

[0052] Specifically, the photoinitiator is acetophenone group, biimidazole, benzoin (styrax) group or benzophenone;

[0053] the acetophenone group is  $\alpha$ ,  $\alpha$ -diethoxyacetophenone, 2-hydroxy-2-methylpropiophenone (HMPP) or 2-methyl-2-morpholino-1-(4-methyl-phenylthio) propane-1-ketone, etc;

[0054] the benzoin (styrax) group is benzyl, 2-phenylacetophenone alcohol or benzoin ether, etc.

[0055] The additive agent is at least one of leveling agent, defoamer and heat stabilizer.

[0056] The total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing red quantum-dots, a content of the stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %.

[0057] The total weight of the photosensitive dispersion is as the base in the photosensitive dispersion containing green quantum-dots, a content of the stabilized red quantum-dots is 5-20 wt %, and a content of the resin is 2-15 wt %, and a content of the monomer is 3-10 wt %, and a content of the photoinitiator is 0.1-0.6 wt %, and a content of the additive agent is 0.1-2 wt %, and a content of the solvent is 70-90 wt %.

[0058] In Step 3, the resin is polyacrylate polymer, and the monomer is polyhydroxy acrylics monomer, and the solvent is solvent of one or more kinds of propylene glycol monomethyl ether propionates.

[0059] Step 4, employing the photosensitive dispersion containing red and green quantum-dots to form a pixel pattern.

[0060] The pixel pattern is formed in Step 4 by spray coating or patterning. Specifically, the patterning can comprise processes of coating, exposure, development, et cetera.

[0061] Please refer to FIG. 3. The present invention further provides a liquid crystal display device, comprising a liquid crystal panel **1** and a back light module **2** located under the liquid crystal panel **1**, and the liquid crystal panel comprises a first substrate **11** and a second substrate **12**, which are oppositely located, a liquid crystal layer **13** located between the first substrate **11** and the second substrate **12**, an upper polarizer **111**, located at one side of the first substrate **11** away from the liquid crystal layer **13**, a lower polarizer **121**, located at one side of the second substrate **12** away from the liquid crystal layer **13** and a quantum-dot color filter **14** located between the back light module **2** and the lower polarizer **121**.

[0062] Because the light emitted by the quantum-dots possesses properties of narrow wavelength (small half peak), bright color (high color density), the color filter containing quantum-dots can make the liquid crystal display device have border color gamut. Meanwhile, because the light efficiency of the quantum-dots is high (the light efficiency of the quantum-dots can reach up over 88%), the brightness of the liquid crystal display device can be better and save energy. Moreover, in the structure, the quantum-dot color filter is designed outside the upper, lower polarizer to prevent that the light efficiency descends due to the change to the polarization state made by the quantum-dots. In the preferred embodiment, the quantum-dot color filter is located between the back light module and the lower polarizer.

[0063] The back light module **2** is a blue-fluorescence light source, and a red quantum-dot pixel pattern **141** and a green quantum-dot pixel pattern **142** is formed at one side of the quantum-dot color filter **14** close to the lower polarizer **121**. The blue light has higher energy which can excite the red quantum-dots (quantum-dots emitting red light) and the green quantum-dots (quantum-dots emitting green light) to respectively generate red, green light. Therefore, the back light module generating blue-fluorescence can be used as the light source. The blue light is provided by the back light module. Accordingly, the quantum-dot color filter can manufacture only the red quantum-dot pixel pattern and the green quantum-dot pixel pattern. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process.

[0064] In conclusion, the manufacture method of the quantum-dot color filter provided by the present invention is simple and easy to realize. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process. The liquid crystal display device of the present invention utilizes the back light module generating blue-fluorescence as the light source. One blue quantum-dot pixel pattern process can be eliminated in comparison with the present common RGB process, and the quantum-dot color filter is located outside the polarizer to prevent that the light efficiency descends due to the change to the polarization state made by the quantum-dots. Accordingly, the liquid crystal display device possesses border color gamut and higher brightness, and saves energy.

[0065] Above are only specific embodiments of the present invention, the scope of the present invention is not limited to this, and to any persons who are skilled in the art, change or replacement which is easily derived should be covered by the protected scope of the invention. Thus, the protected scope of the invention should go by the subject claims.

What is claimed is:

1. A liquid crystal display device, comprising:
  - a liquid crystal panel; and
  - a back light module located under the liquid crystal panel; wherein the liquid crystal panel comprises:
    - a first substrate and a second substrate arranged opposite to each other;
    - a liquid crystal layer arranged between the first substrate and the second substrate;
    - an upper polarizer arranged at one side of the first substrate that is distant from the liquid crystal layer;
    - a lower polarizer arranged at one side of the second substrate that is distant from the liquid crystal layer; and
    - a quantum-dot color filter arranged between the back light module and the lower polarizer.
2. The liquid crystal display device according to claim 1, wherein the back light module comprises a blue-fluorescence light source and a red quantum-dot pixel pattern and a green quantum-dot pixel pattern are formed at one side of the quantum-dot color filter adjacent to the lower polarizer, wherein the blue-fluorescence light source emits blue light and the red quantum-dot pixel pattern and the green quantum-dot pixel pattern are excited by the blue light to respectively emit red light and green light.
3. The liquid crystal display device according to claim 2, wherein the red quantum-dot pixel pattern comprises red quantum dots having a particle size in the range of 5-7 nm.
4. The liquid crystal display device according to claim 2, wherein the green quantum-dot pixel pattern comprises green quantum dots having a particle size in the range of 3-5 nm.
5. The liquid crystal display device according to claim 2, wherein the red quantum-dot pixel pattern and the green quantum-dot pixel pattern comprise quantum dots each having a CdS core covered by a ZnS shell.
6. The liquid crystal display device according to claim 5, wherein the quantum dots having a particle size in the range of 2-5 nm.
7. The liquid crystal display device according to claim 6, wherein the quantum dots comprise red quantum dots that form the red quantum-dot pixel pattern and have a particle size in the range of 5-7 nm.
8. The liquid crystal display device according to claim 6, wherein the quantum dots comprise green quantum dots that form the green quantum-dot pixel pattern and have a particle size in the range of 3-5 nm.

\* \* \* \* \*

专利名称(译)	量子点彩色滤光片的制造方法和液晶显示装置		
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[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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发明人	LI, JI MA, XIAOLONG LEE, YUNGJUI		
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优先权	14/423125 2015-02-21 US		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

摘要(译)

液晶显示装置包括液晶面板和位于液晶面板下方的背光模块。液晶面板包括彼此相对设置的第一基板和第二基板;液晶层, 设置在第一基板和第二基板之间;上偏振器, 设置在第一基板的远离液晶层的一侧;偏振器, 设置在第二基板的远离液晶层的一侧;以及设置在背光模块和下偏振器之间的量子点滤色器。背光模块发射蓝光, 其激发包含在量子点滤色器中的红色和绿色量子点, 以分别发射红光和绿光。

