US 20060279688A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0279688 A1**

Wu et al. (43) **Pub. Date: Dec. 14, 2006**

(54) **LIQUID CRYSTAL PANEL AND FABRICATION METHOD THEREOF**

(75) Inventors: **Pin-Chun Wu**, Gueishan Township (TW); **Zsan-Zsan Cheng**, Gueishan Township (TW); **Chih-Chieh Chang**, Gueishan Township (TW); **Lin-Huei Wang**, Gueishan Township (TW)

Correspondence Address:
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948 (US)

(73) Assignee: **Quanta Display Inc.**

(21) Appl. No.: **11/392,975**

(22) Filed: **Mar. 28, 2006**

(30) **Foreign Application Priority Data**

Jun. 10, 2005 (TW)..... 94119251

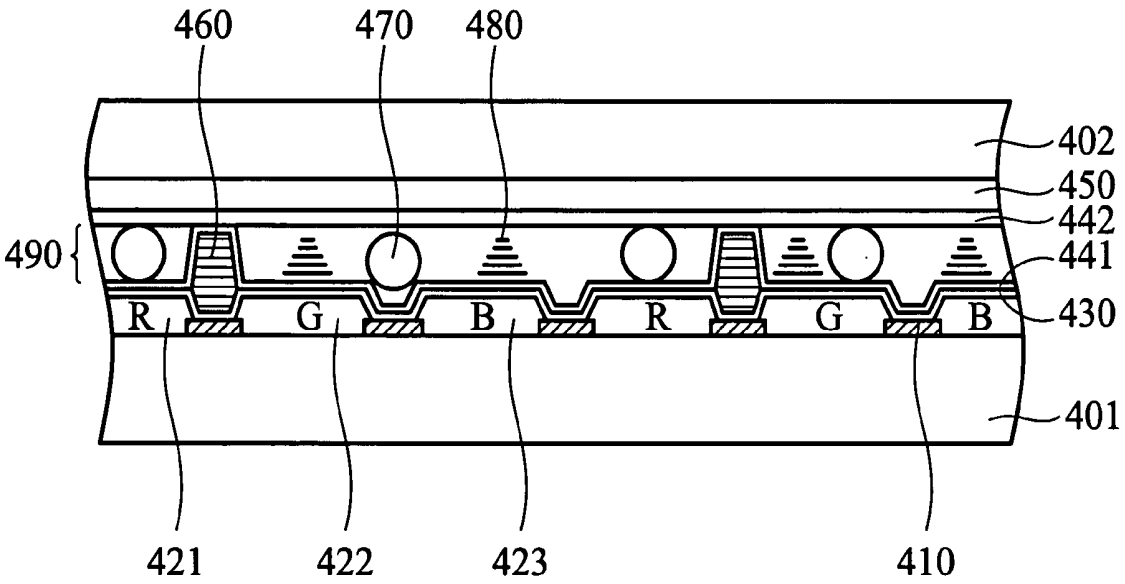
Publication Classification

(51) **Int. Cl.**
G02F 1/1339 (2006.01)

(52) **U.S. Cl.** **349/155**

(57) **ABSTRACT**

A liquid crystal panel and method for fabricating the same are provided. A plurality of photo spacers and ball spacers are disposed between a color filter substrate and an array substrate. The device for simultaneously applying photo spacers and ball spacers exhibits the ability to eliminate force impact and overcome problems such as touch mura and sound mura.



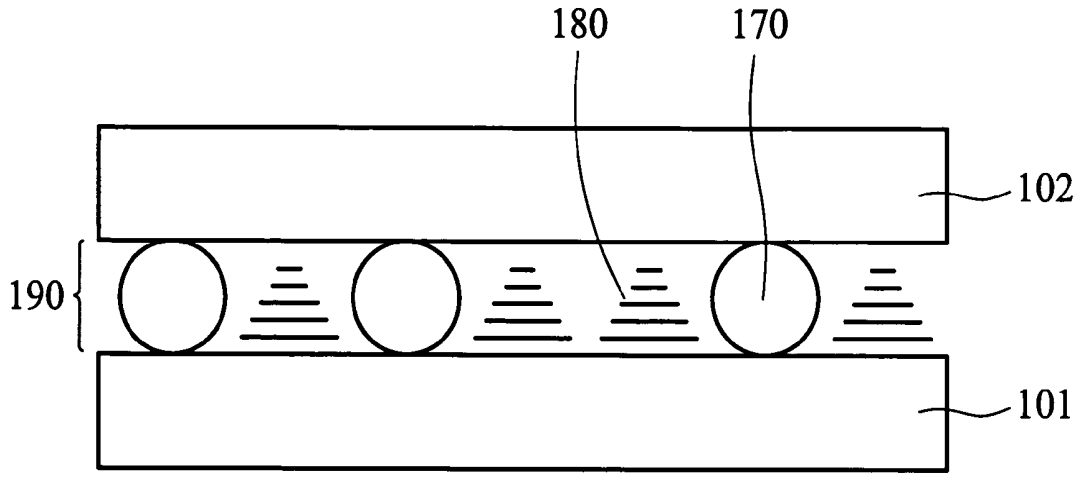


FIG. 1 (RELATED ART)

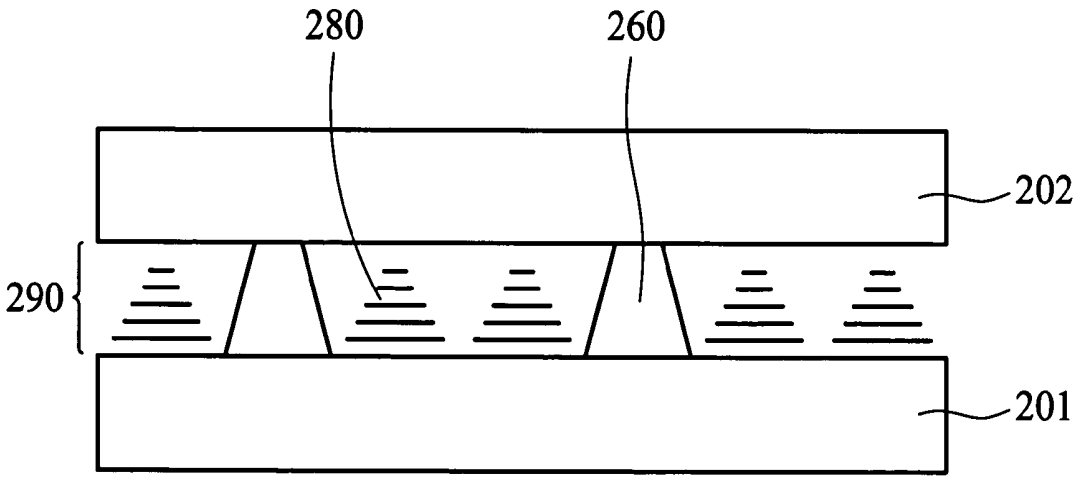


FIG. 2 (RELATED ART)

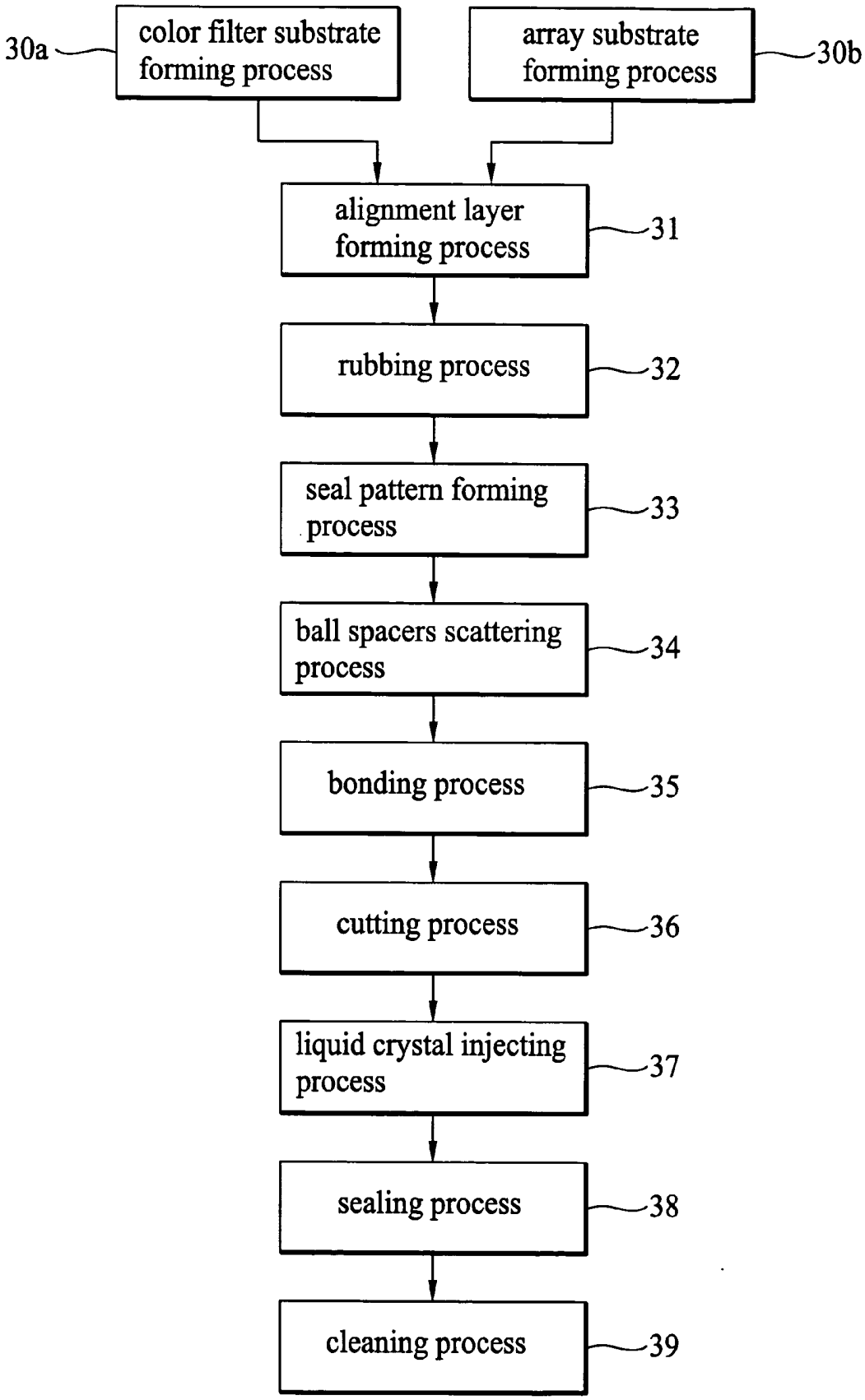


FIG. 3 (RELATED ART)

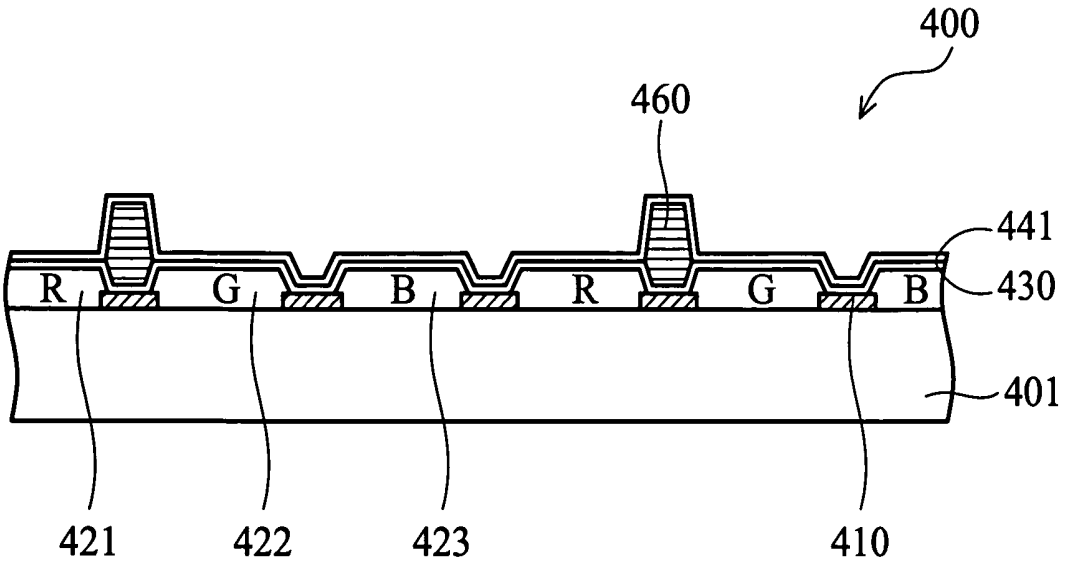


FIG. 4a

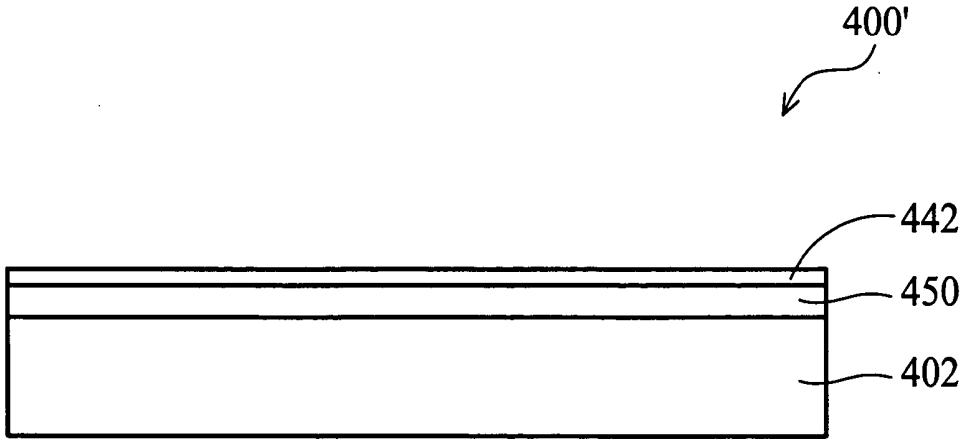


FIG. 4b

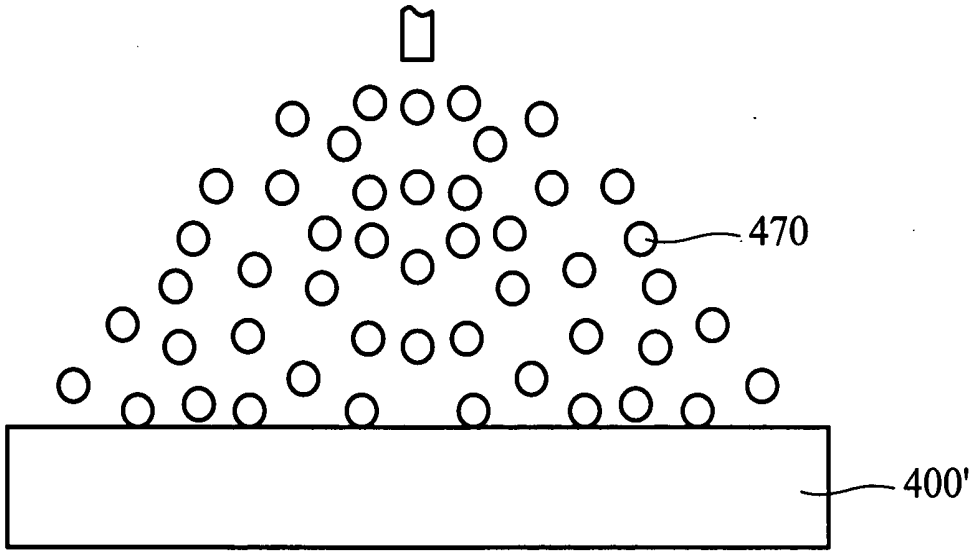


FIG. 4c

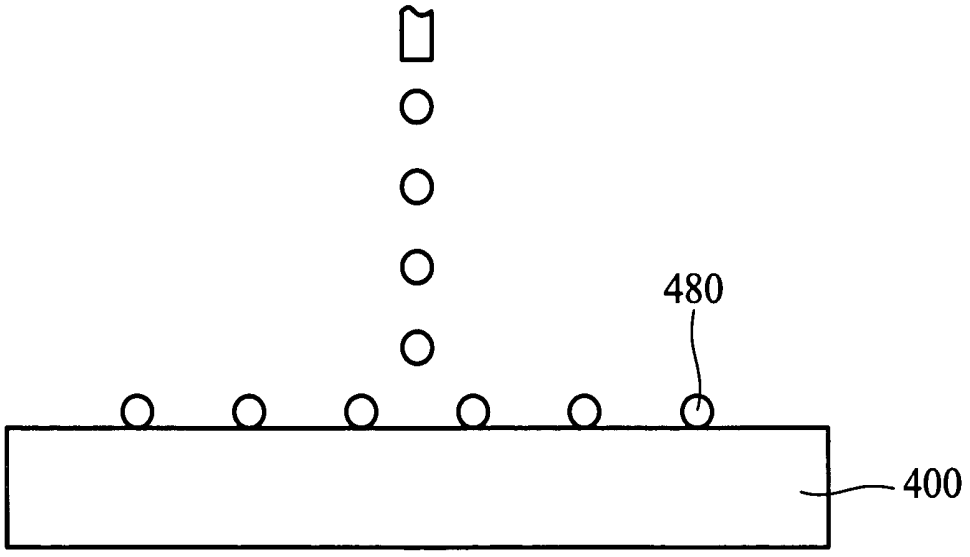


FIG. 4d

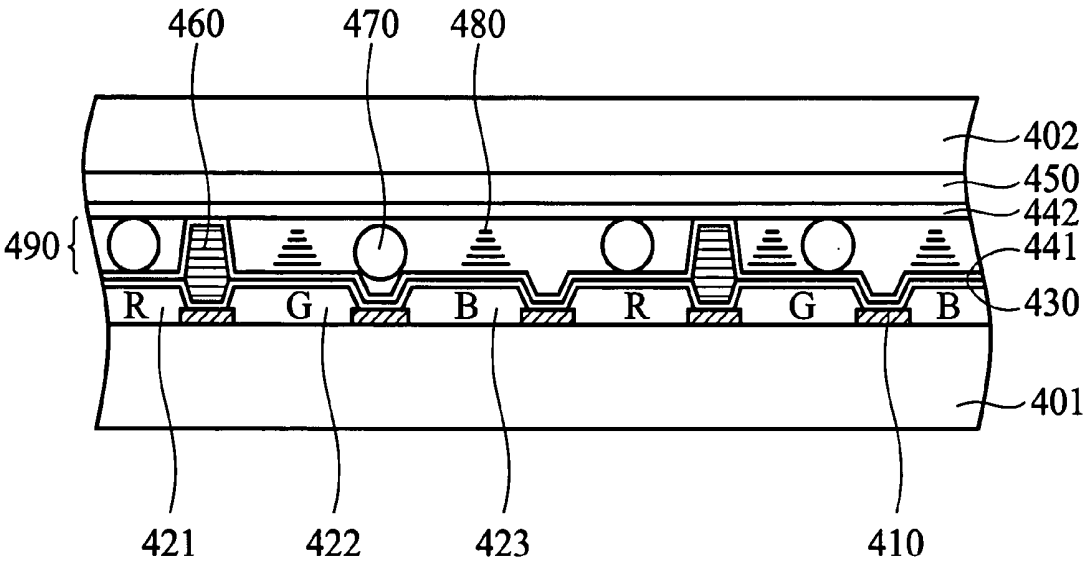


FIG. 4e

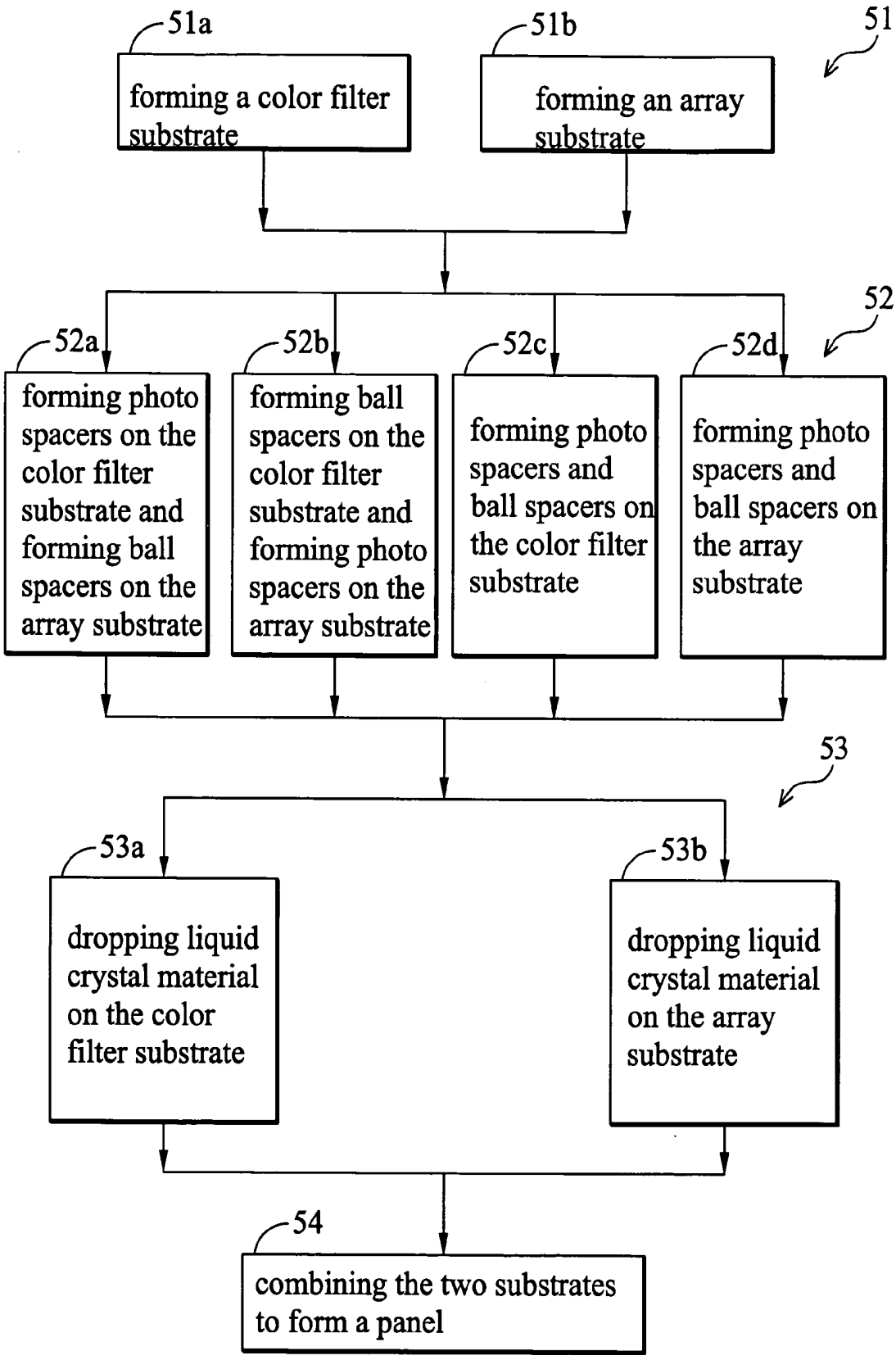

51a
forming a color filter substrate
51b
forming an array substrate
51
52a
forming photo spacers on the color filter substrate and forming ball spacers on the array substrate
52b
forming ball spacers on the color filter substrate and forming photo spacers on the array substrate
52c
forming photo spacers and ball spacers on the color filter substrate
52d
forming photo spacers and ball spacers on the array substrate
52
53
53a
dropping liquid crystal material on the color filter substrate
53b
dropping liquid crystal material on the array substrate
54
combining the two substrates to form a panel

FIG. 5

LIQUID CRYSTAL PANEL AND FABRICATION METHOD THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the invention

[0002] The invention relates to a liquid crystal panel and fabrication method thereof, and more particularly, to a liquid crystal panel having improved optical properties.

[0003] 2. Background

[0004] In the current display technology, liquid crystal panel having the advantages of small size, low weight, low electricity consumption, full-color display, and potentially taking the place of conventional cathode ray tube (CRT).

[0005] Generally speaking, liquid crystal panel fabrication utilizes ball spacers or photo spacers.

[0006] **FIG. 1** shows a conventional liquid crystal panel using ball spacers. The panel comprises color filter substrate **101** and array substrate **102**, with ball spacers **170** disposed therebetween, and liquid crystal material **180** filled therebetween to adjust the amount of light by rotation of liquid crystal when applying an electric field.

[0007] **FIG. 2** shows another conventional liquid crystal panel using photo spacers. The panel comprises color filter substrate **201** and array substrate **202**, with photo spacers **260** disposed therebetween, and liquid crystal material **180** filled therebetween.

[0008] **FIG. 3** is a flowchart of a conventional vacuum injection process injecting liquid crystal material into a panel through an opening in a seal pattern, applying a pressure difference between the interior and exterior of the panel and capillarity.

[0009] As shown in **FIG. 3**, the fabrication process comprises forming a color filter substrate and an array substrate in step **30***a* and **30***b* respectively, forming an alignment layer on the two substrates respectively in step **31**, rubbing the alignment layer to freely align subsequently-formed liquid crystal molecules of a liquid crystal material in step **32**, forming a seal pattern with an opening in step **33**, scattering ball spacers on the array substrate to maintain a uniform cell gap between the two substrates in step **34**, bonding the two substrates in step **35**, cutting the bonded large substrates into a plurality of small panels in step **36**, injecting a liquid crystal material into each panel by vacuum injection method in step **37**, sealing the opening of the panels in step **38**, and cleaning the panels in step **39**.

[0010] US Patent no. 20040125319 A1 discloses a liquid crystal device fabricated by conventional vacuum injection, which eliminates gravity mura.

[0011] Only a single type of spacers is normally used to maintain uniform cell gap. However, with increased panel size, possible touch mura or sound mura results if only one type of spacers is used.

[0012] Moreover, it is difficult to use vacuum injection in panel fabrications, especially in larger panel fabrications. It can take up to 5 days to inject a liquid crystal material into the cell gap of a 30-inch panel by vacuum injection, and utility rate(60% or less) of liquid crystal material is also low. There is therefore a need in panel fabrication to address the short injection time requirement and overcome problems such as touch mura and sound mura.

SUMMARY

[0013] In an embodiment, a liquid crystal panel is provided, comprising a first substrate and a second substrate opposite to the first substrate. A gate line and data line are formed on the first substrate, a switch is formed at an intersection of the gate line and the data line, a color filter is formed on the second substrate, a plurality of ball spacers and photo spacers are disposed between the first substrate and the second substrate, and a liquid crystal material is interposed between the first substrate and the second substrate.

[0014] A method for fabricating a liquid crystal panel is also provided. A first substrate is provided. A second substrate is provided. A plurality of photo spacers is formed on the first substrate. A plurality of ball spacers is formed on the second substrate. A liquid crystal material is dropped on the first substrate or the second substrate, and the two substrates are then combined.

[0015] In another method for fabricating a liquid crystal panel, a first substrate is provided. A second substrate is provided. A plurality of photo spacers and ball spacers is formed on the first substrate. A liquid crystal material is dropped on the first substrate or the second substrate, and the two substrates are then combined.

DESCRIPTION OF THE DRAWINGS

[0016] The invention can be more fully understood by reading the subsequent detailed description in conjunction with the examples and references made to the accompanying drawings, wherein:

[0017] **FIG. 1** shows a conventional liquid crystal panel using only ball spacers.

[0018] **FIG. 2** shows a conventional liquid crystal panel using only photo spacers.

[0019] **FIG. 3** is a flowchart of a conventional process using vacuum injection.

[0020] **FIGS. 4***a*, **4***b*, and **4***e* illustrate a portion of the liquid crystal panel according to an embodiment of the invention.

[0021] **FIG. 4***c* illustrates a process for scattering ball spacers.

[0022] **FIG. 4***d* illustrates One Drop Fill (ODF) process.

[0023] **FIG. 5** is a flowchart of fabrication of the liquid crystal panel according the invention.

DETAILED DESCRIPTION

[0024] **FIG. 4***a* is a color filter substrate **400** having a first substrate **401**, which is substantially transparent, preferably of glass, quartz or plastic. The first substrate **401** comprises black matrices **410**, color filters **421** (R for red), **422** (G for green), **423** (B for blue), a transparent conductive layer **430**, and a first alignment layer **441**. The black matrices **410** can be of chromium (Cr), resin or other opaque material. The three colors of R, G, B can be formed on the first substrate **401** to form the color filters **421**, **422**, and **423** by well-

known methods such as dyeing, pigment dispersion, printing, or electro-deposition. The transparent conductive layer **430** can be of one or more metal oxide layers, such as indium tin oxide (ITO) layer. The first alignment layer **441** can be of polymer, such as polyimide (PI) to form a thin layer at a thickness between about 500 to 1000 Å by well-known methods such as gravure. Uniform photo spacers **460** are formed on black matrices **410** at a predetermined distance to support the first substrate **401** and the second substrate **402** to maintain a uniform cell gap **490** (as shown in **FIG. 4***e*). In an embodiment, the photo spacers **460** are disposed apart from each other by one pixel intervals in data line and gate line directions. The photo spacers **460** can be formed by photolithography or etching. The photo spacers **460** exhibit the ability to eliminate force impact by absorbing force from pressure or vibration. Photo spacers **460** can be, but are not limited to, disposed on the color filter substrate **400**, while photo spacers **460** can also be disposed on the array substrate **400'** (as shown in **FIG. 4***b*). The cross-section of photo spacers **460** can be any shape, such as a quadrilateral, hexagon, octagon, polygon, circle, or any other shape. The photo spacer **460** can be a cube, cylinder, sphere, quadrilateral column, hexagonal column, octagonal column, or any other polygonal column.

[**0025**] **FIG. 4b** shows an array substrate **400'** having a transparent second substrate **402**, preferably of glass, quartz or plastic, with a circuit layer **450** and a second alignment layer **442** formed thereon. Although it is not shown in **FIG. 4***b*, the circuit layer **450** comprises gate lines, date lines, switches, a passivation layer and a transparent conductive layer. The second alignment layer **442** can be of the same material as the first alignment layer **441**.

[**0026**] **FIG. 4***c* shows a scattering of uniform ball spacers **470** on array substrate **400'** to support the first substrate **401** and the second substrate **402** to maintain a uniform cell gap **490** (as shown in **FIG. 4***e*) by well-known methods such as dry spray or wet spray. The distribution density of ball spacers **470** is at least 160 per cm^2, preferably 160 to 300/cm^2 or 160 to 250/cm^2, more preferably 160 to 200/cm^2. Ball spacers **470** can be, but are not limited to, disposed on the array substrate **400'**, while ball spacers **470** can also be disposed on the color filter substrate **400**. The cross-section of ball spacers **470** can be any shape, such as a quadrilateral, hexagon, octagon, polygon, circle, or any other shape. The ball spacer **470** can be a cube, cylinder, sphere, quadrilateral column, hexagonal column, octagonal column, or any other polygonal column. The ball spacers **470** can be resin, silica, glass fiber, or photosensitive materials. Ball spacers **470** eliminate force impact by absorbing force from pressure or vibration. For example, the pressures can be 2 kgf of pressure by hand-touch or by a roller for testing a panel, and the vibrations can be produced by high-frequency vibration comprising sound vibration from an amplifier near a panel.

[**0027**] **FIG. 4***d* shows a One Drop Fill (ODF) process, comprising dropping a liquid crystal material **480** on the color filter substrate **400**, and then combining with array substrate **400'** by sealant material pre-coated on the color filter substrate **400** or the array substrate **400'** to form a panel. After the combination, liquid crystal material **480** is filled in the space between the two substrates, as shown in **FIG. 4***e*. Liquid crystal material **480** can be, but is not limited to, dropped on the color filter substrate **400**, while liquid crystal material **480** can also be dropped on the array substrate **400'**.

[**0028**] **FIG. 4***e* shows a liquid crystal panel according to an embodiment of the present invention. The panel comprises a transparent-first substrate **401** and a second substrate **402** opposite the substrate **401**. A circuit layer **450**, comprising gate lines, date lines, switches, a passivation layer and a transparent conductive layer, is formed on the second substrate **402**. Color filters **421**, **422**, and **423** are formed on the first substrate **401**. Ball spacers **470** are formed between the first substrate **401** and the second substrate **402**. The cross-section of ball spacers **470** can be any shape, such as a quadrilateral, hexagon, octagon, polygon, circle, or any other shape. The ball spacer **470** can be a cube, cylinder, sphere, quadrilateral column, hexagonal column, octagonal column, or any other polygonal column. The distribution density of ball spacers **470** is at least 160 per cm^2, preferably 160 to 300/cm^2 or 160 to 250/cm^2, more preferably 160 to 200/cm^2. Ball spacers **470** eliminate force impact by absorbing force from pressure or vibration. For example, the pressures can be 2 kgf of pressure by hand-touch or by a roller for testing a panel, and the vibrations can be produced by high-frequency vibration comprising sound vibration from an amplifier near a panel. The cross-section of photo spacers **460** can be any shape, such as a quadrilateral, hexagon, octagon, polygon, circle, or any other shape. The photo spacer **460** can be a cube, cylinder, sphere, quadrilateral column, hexagonal column, octagonal column, or any other polygonal column. Photo spacers **460** can also eliminate force impact as described. Liquid crystal material **480** is filled between the two substrates.

[**0029**] **FIG. 5** is a flowchart of fabrication of a liquid crystal panel according to the invention. In **FIG. 5**, the fabrication method comprises forming the two substrates in step **51**, forming the two spacers in step **52**, forming liquid crystal material in step **53**, and combining the two substrates in step **54**. The fabrication method comprises forming a color filter substrate in step **51***a* and forming an array substrate in step **51***b* respectively, then forming photo spacers on the color filter substrate and forming ball spacers on the array substrate in step **52***a*, forming ball spacers on the color filter substrate and forming photo spacers on the array substrate in step **52***b*, forming photo spacers and ball spacers on the color filter substrate in step **52***c*, or forming photo spacers and ball spacers on the array substrate in step **52***d*, and dropping liquid crystal material on the color filter substrate in step **53***a* or dropping liquid crystal material on the array substrate in step **53***b*, and combining the two substrates to form a panel in step **54**.

[**0030**] The device for simultaneously applying photo spacers and ball spacers exhibits the ability to eliminate force impact and overcome problems such as touch mura and sound mura. The term "touch mura" means a non-uniform display problem caused by direct touch such as hand-touch; the term "sound mura" means a non-uniform display problem caused by high-frequency vibration such as sound vibration from amplifier near a panel.

[**0031**] Sound mura appears in conventional panels using only photo spacers or ball spacers, upon on application of sound vibrations to the panel. However, when rolling the inventive panel 3-times at 2 kgf of pressure from panel left

to right, no touch mura is observed. When further vibrating the panel at high-frequency such as 80, 160, and 320 MHz, no sound mura is observed. The cell gap of the inventive panel is about 4.5 um, photo spacers are about 18 um*18 um*4.7 um, distribution of photo spacers is 1 spacer/pixel, diameter of ball spacers is about 4.6 to 4.8 um, and ball spacers is about 160 to 200/cm^2.

[0032] While the invention has been described by way of example and in terms of preferred embodiment, it is to be understood that the invention is not limited thereto. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation to encompass all such modifications and similar arrangements.

What is claimed is:

1. A liquid crystal panel, comprising:

a first substrate;

a second substrate opposite to the first substrate;

a gate line and a data line disposed on the first substrate;

a switch disposed at an intersection of the gate line and the data line;

a color filter disposed on the second substrate;

a plurality of ball spacers disposed between the first substrate and the second substrate;

a plurality of photo spacers disposed between the first substrate and the second substrate; and

a liquid crystal material interposed between the first substrate and the second substrate.

2. The liquid crystal panel of claim 1, wherein the ball spacers are distributed at least 160 per cm^2.

3. The liquid crystal panel of claim 1, wherein the ball spacers are distributed about 160 to 300 per cm^2.

4. The liquid crystal panel of claim 1, wherein the ball spacers and the photo spacers absorb force resulting from pressure or vibration.

5. The liquid crystal panel of claim 4, wherein the pressure comprises a direct hand-touch.

6. The liquid crystal panel of claim 4, wherein the vibration comprises a high-frequency sound vibration resulting from an amplifier near the liquid crystal panel.

7. The liquid crystal panel of claim 1, wherein the cross section of the ball spacers is polygon or circle.

8. The liquid crystal panel of claim 1, wherein the cross section of the photo spacers is polygon or circle.

9. A method for fabricating a liquid crystal panel comprising:

providing a first substrate;

providing a second substrate;

forming a plurality of photo spacers on the first substrate;

forming a plurality of ball spacers on the second substrate;

dropping a liquid crystal material on the first substrate or the second substrate; and

combining the first substrate with the second substrate.

10. The method of claim 9, wherein the ball spacers are distributed at least 160 per cm^2.

11. The method of claim 9, wherein the ball spacers are distributed about 160 to 300 per cm^2.

12. The method of claim 9, wherein the ball spacers and the photo spacers absorb force resulting from pressure or vibration.

13. The method of claim 12, wherein the pressure comprises a direct hand-touch.

14. The method of claim 12, wherein the vibration comprises a high-frequency sound vibration resulting near the liquid crystal panel.

15. A method for fabricating a liquid crystal panel comprising:

providing a first substrate;

providing a second substrate;

forming a plurality of photo spacers and ball spacers on the first substrate;

dropping a liquid crystal material on the first substrate or the second substrate, and

combining the first substrate with the second substrate.

16. The method of claim 15, wherein the ball spacers are distributed at least 160 per cm^2.

17. The method of claim 15, wherein the ball spacers are distributed about 160 to 300 per cm^2.

18. The method of claim 15, wherein the ball spacers and the photo spacers absorb force resulting from pressure or vibration.

19. The method of claim 18, wherein the pressure comprises a direct hand-touch.

20. The method of claim 18, wherein the vibration comprises a high-frequency sound vibration resulting near the liquid crystal panel.

* * * * *

专利名称(译)	液晶面板及其制造方法		
公开(公告)号	US20060279688A1	公开(公告)日	2006-12-14
申请号	US11/392975	申请日	2006-03-28
[标]申请(专利权)人(译)	广辉电子股份有限公司		
申请(专利权)人(译)	广辉INC.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	WU PIN CHUN CHENG ZSAN ZSAN CHANG CHIH CHIEH WANG LIN HUEI		
发明人	WU, PIN-CHUN CHENG, ZSAN-ZSAN CHANG, CHIH-CHIEH WANG, LIN-HUEI		
IPC分类号	G02F1/1339		
CPC分类号	G02F1/13394 G02F1/13392		
优先权	094119251 2005-06-10 TW		
其他公开文献	US7633593		
外部链接	Espacenet USPTO		

摘要(译)

提供一种液晶面板及其制造方法。多个光间隔物和球间隔物设置在滤色器基板和阵列基板之间。用于同时施加光间隔物和球间隔物的装置具有消除力冲击并克服诸如触摸mura和声音mura之类的问题的能力。