



US008730436B2

(12) **United States Patent**
Cho et al.

(10) **Patent No.:** **US 8,730,436 B2**
(45) **Date of Patent:** **May 20, 2014**

(54) **LIQUID CRYSTAL DISPLAY AND METHOD
FOR MANUFACTURING THE SAME**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(75) Inventors: **Jun Beom Cho**, Anseong-si (KR);
Hyeon Jin Seo, Gumi-si (KR); **Jeong**
Hoon Lee, Gumi-si (KR); **Dhang Kwon**,
Daejeon-si (KR); **Hang Sup Cho**,
Gumi-si (KR); **Ho Su Kim**, Gumi-si
(KR)

7,492,435	B2	2/2009	Jeon
7,501,163	B2	3/2009	Kim
7,630,042	B2	12/2009	Yoon
7,701,545	B2	4/2010	Niiya
2003/0128311	A1	7/2003	Tsuda et al.
2004/0125319	A1	7/2004	Lim et al.
2005/0122446	A1	6/2005	Jeon
2007/0002237	A1	1/2007	Yoon
2007/0122566	A1	5/2007	Kim
2007/0146618	A1	6/2007	Hashimoto
2007/0263165	A1	11/2007	Sung et al.
2008/0283175	A1	11/2008	Hagood et al.
2009/0009709	A1	1/2009	Niiya
2009/0103039	A1	4/2009	Satoh
2009/0122241	A1	5/2009	Satoh

(73) Assignee: **LG Display Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 23 days.

(21) Appl. No.: **13/455,816**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Apr. 25, 2012**

JP	07-005473	1/1995
JP	2005-258173	9/2005
JP	2007-094184	4/2007
KR	1020070045880 A	5/2007

(65) **Prior Publication Data**

US 2012/0206686 A1 Aug. 16, 2012

OTHER PUBLICATIONS

Related U.S. Application Data

(62) Division of application No. 12/209,639, filed on Sep.
12, 2008, now Pat. No. 8,184,257.

Office Action issued in corresponding Korean Patent Application No.
10-2007-0100349, mailed Jan. 24, 2013.

Primary Examiner — Kaveh Kianni

(74) *Attorney, Agent, or Firm* — Brinks Gilson & Lione

(30) **Foreign Application Priority Data**

Oct. 5, 2007 (KR) 2007-100349

(57) **ABSTRACT**

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

(52) **U.S. Cl.**
USPC **349/122; 349/155; 349/156**

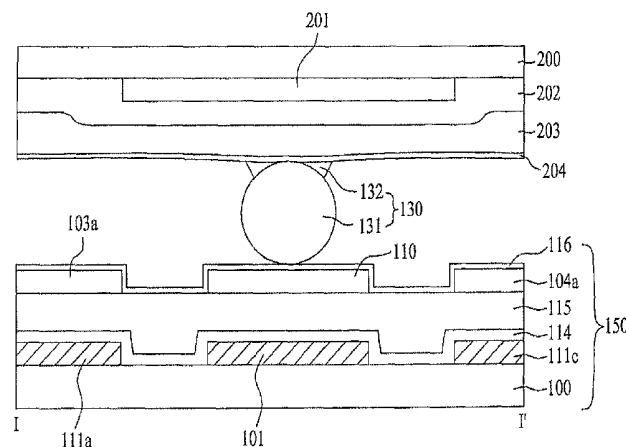
(58) **Field of Classification Search**
CPC G02F 1/1339; G02F 1/1341; G02F
2001/13398; G02F 1/13392; G02F 1/13394;
G02F 1/136209; G02F 1/133512; G02F
2001/136222

USPC 349/155, 156

See application file for complete search history.

Disclosed herein are a liquid crystal display (LCD) device
and a method for manufacturing the same, capable of prevent-
ing problems (i.e., movement of balls, damage to the surfaces
that face spacers upon application of predetermined pressure,
and variation in cell gap) associated with the use of the ball
spacers. The liquid crystal display device includes a first
substrate and a second substrate facing each other, a spacer
formed on the first substrate, wherein the spacer includes a
plurality of balls and a solid to aggregate the balls together
and adhere the balls to the first substrate, a hard coating layer
formed on the second substrate facing the spacer, and a liquid
crystal layer filled between the first substrate and the second
substrate.

4 Claims, 7 Drawing Sheets



RELATED ART

FIG. 1

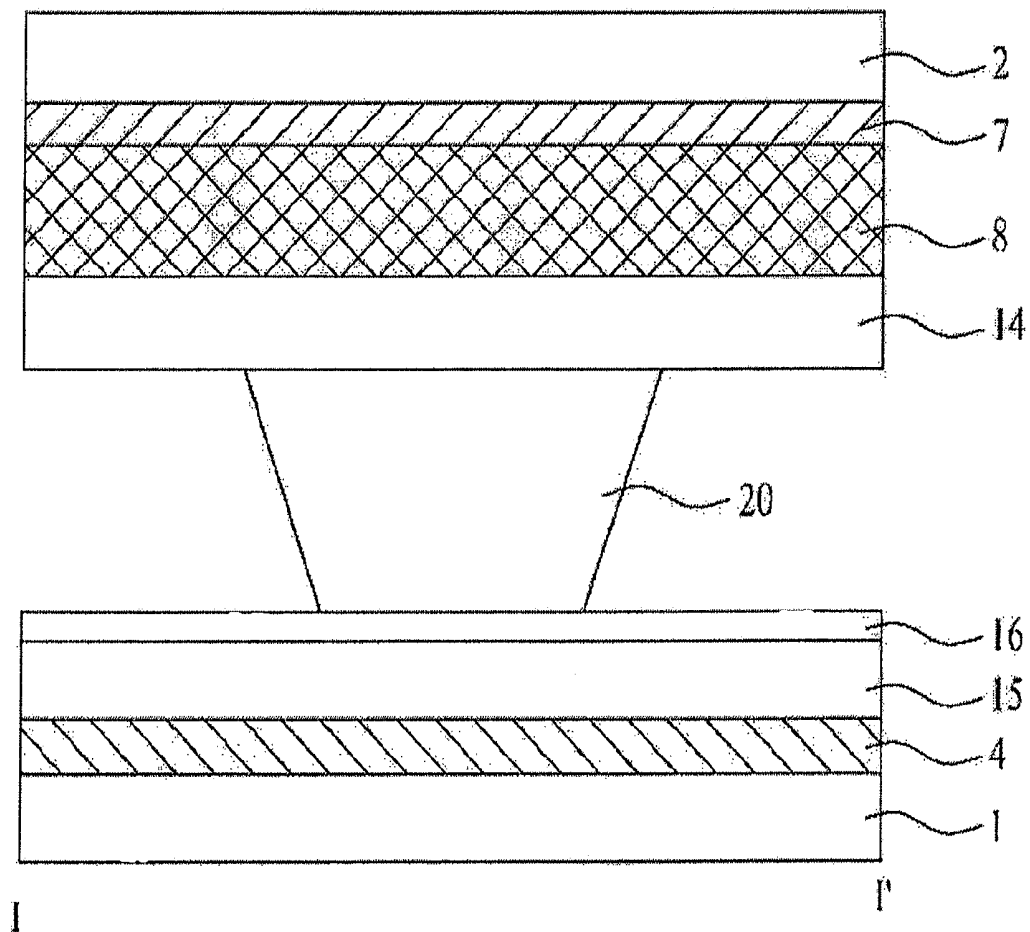


FIG. 2

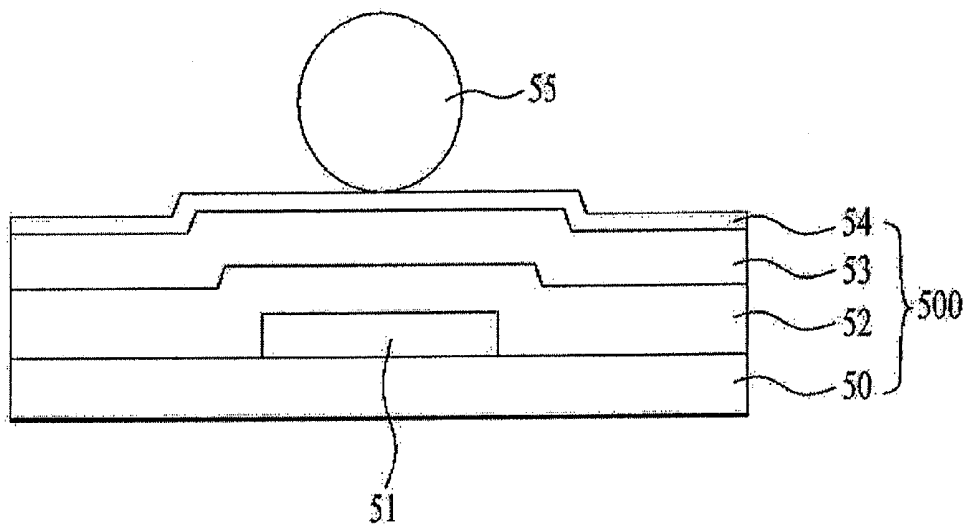


FIG. 3

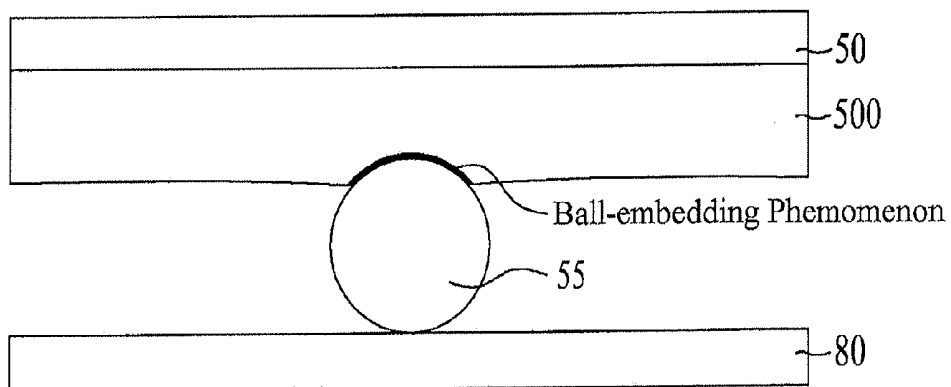


FIG. 4

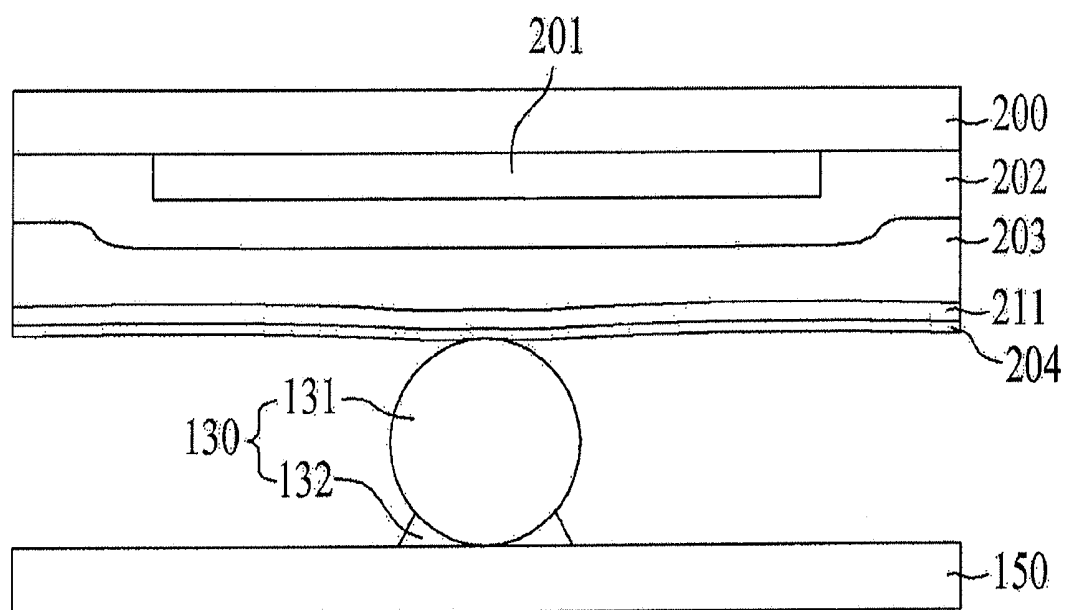


FIG. 5

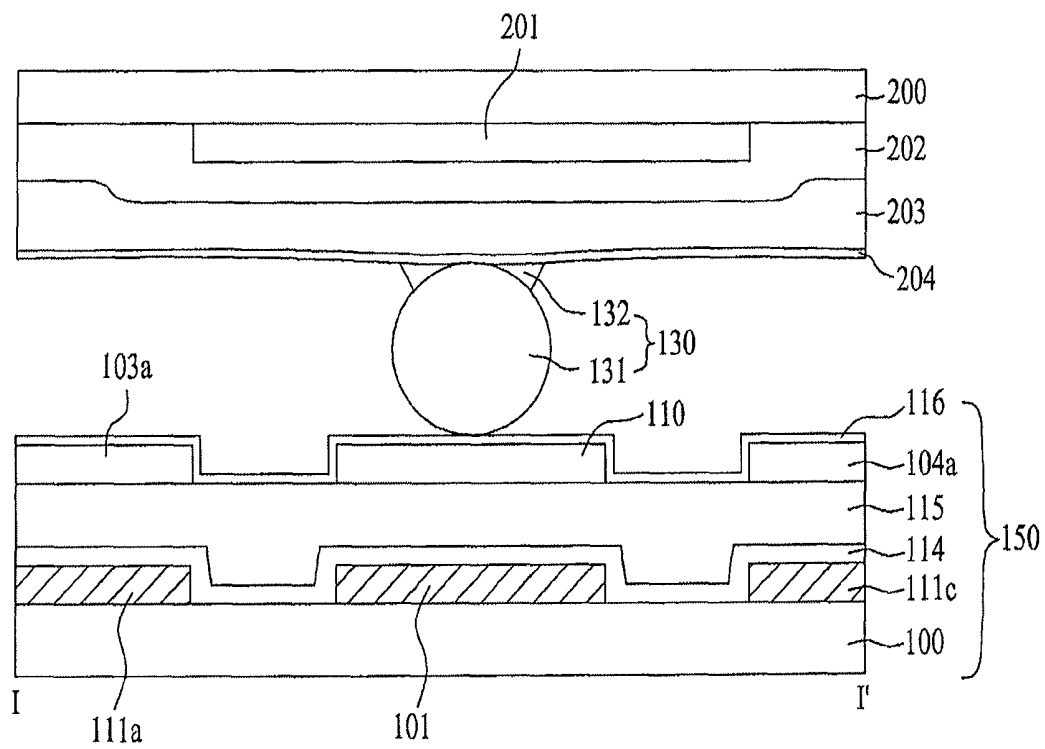


FIG. 6

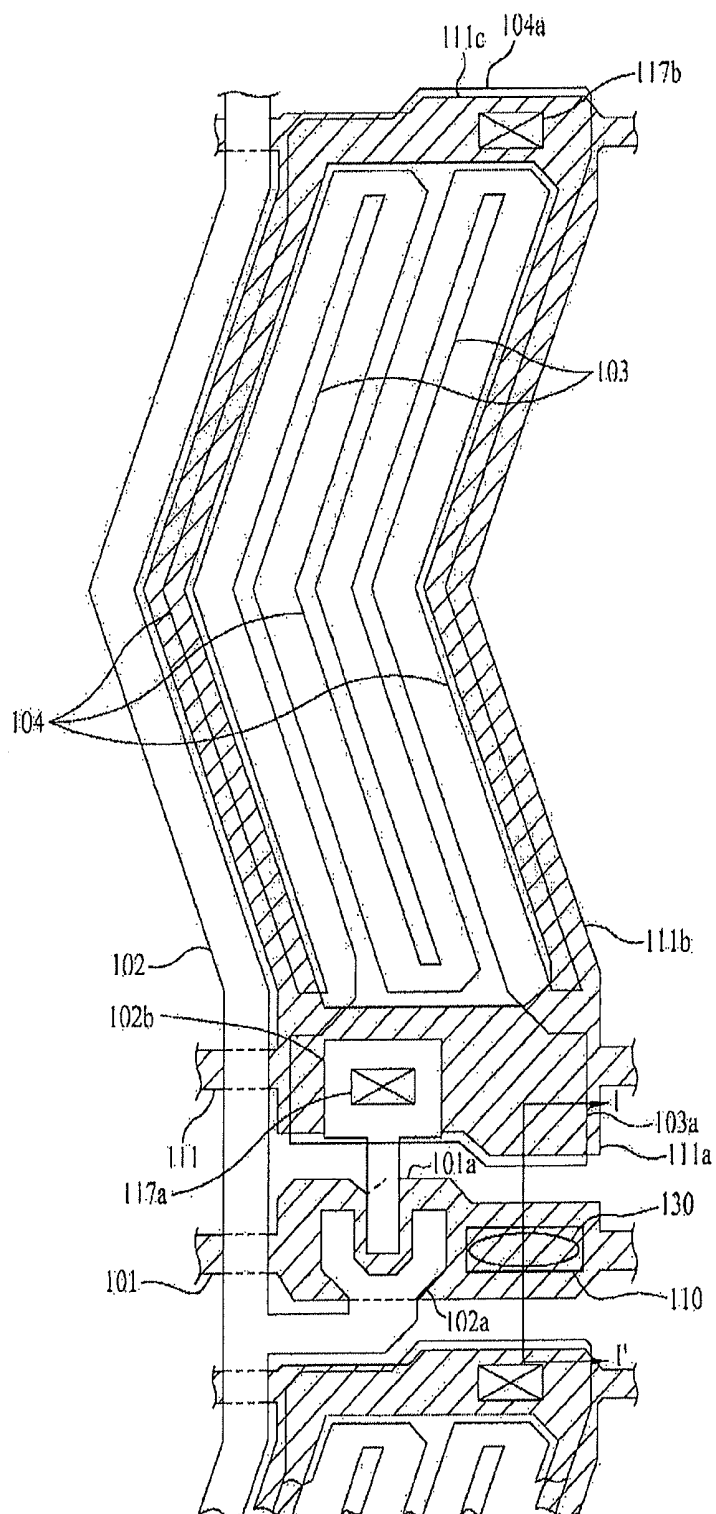


FIG. 7

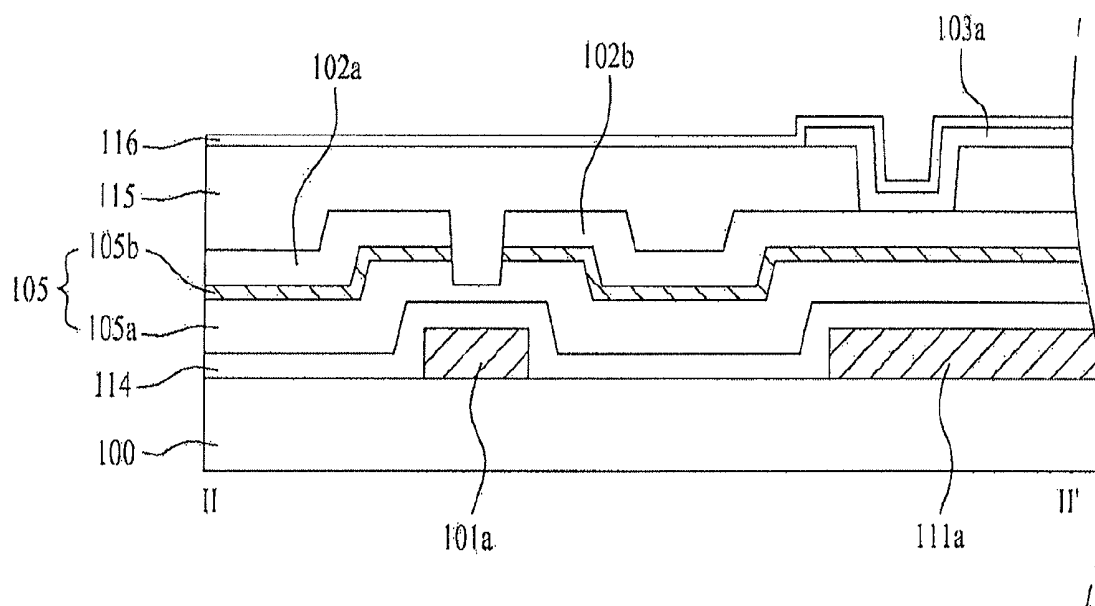
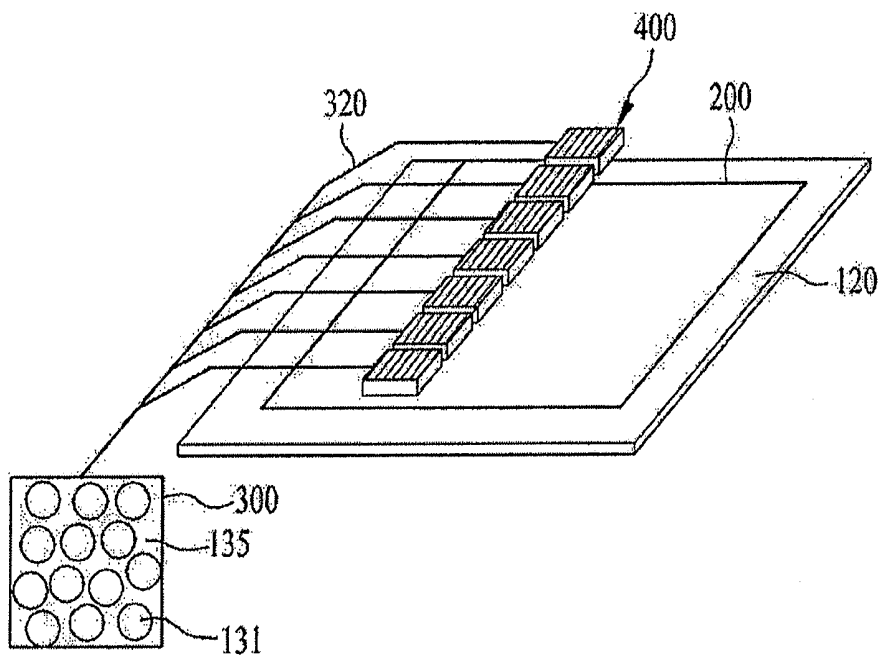


FIG. 8



LIQUID CRYSTAL DISPLAY AND METHOD FOR MANUFACTURING THE SAME

The present patent document is a divisional of U.S. patent application Ser. No. 12/209,639, filed Sep. 12, 2008, now U.S. Pat. No. 8,184,257 which claims priority to Korean Patent Application No. P2007-100349 filed in Korea on Oct. 5, 2007, which are hereby incorporated by reference.

BACKGROUND

1. Field of the Invention

The present invention relates to a liquid crystal display (LCD) device. More particularly, the present invention relates to a liquid crystal display (LCD) device and a method for manufacturing the same, capable of preventing problems (i.e., movement of balls, damage to the surfaces that face spacers upon application of predetermined pressure, and variation in cell gap) associated with the use of the ball spacers.

2. Discussion of the Related Art

With the progress of an information-dependent society, the demand for various display devices has increased. To meet such a demand, efforts have recently been made to research flat panel display devices such as liquid crystal displays (LCDs), plasma display panels (PDPs), electro-luminescent displays (ELDs) and vacuum fluorescent displays (VFDs). Some types of such flat panel displays are being practically applied to various appliances for display purposes.

Of these, LCDs are currently most widely used as substitutes for cathode ray tubes (CRTs) in association with mobile image display devices because LCDs have the advantages of superior picture quality, lightness, slimness, and low power consumption. Various applications of LCDs are being developed in association with not only mobile image display devices such as monitors of notebook computers, but also monitors of TVs to receive and display broadcast signals, and monitors of laptop computers.

Successful application of such LCDs to diverse image display devices depends on whether or not the LCDs can realize desired high picture quality including high resolution, high brightness, large display area, and the like, while maintaining desired characteristics of lightness, slimness and low power consumption.

Hereinafter, a conventional LCD device will be described with reference to the annexed drawings.

FIG. 1 is a sectional view illustrating a conventional LCD device.

The conventional LCD device comprises a first substrate 1 and a second substrate 2 that face each other, a liquid crystal layer (not shown) filled between the first substrate 1 and the second substrate 2 and a column spacer 20 to maintain the thickness of the liquid crystal layer.

The column spacer 20 is arranged in a region provided above a gate line 4. That is, the gate line 4 is arranged on the first substrate 1, a gate insulating film 15 is arranged over the entire surface of the first substrate 1 including the gate line 4, and a passivation film 16 is arranged on the gate insulating film 15.

A black matrix layer 7 is formed on the second substrate 2 to shield non-pixel regions (i.e., portions where gate and data lines, and thin film transistors are formed) other than pixel regions. In addition, a color filter layer, comprising R, G and B color filters arranged at respective pixel regions, is formed on the second substrate 2 including the black matrix layer 7. A common electrode 14 is formed over the entire surface of the second substrate 2 including the color filter layer 8.

The column spacer 20 is formed on the common electrode 14 in a region corresponding to the gate line 4. Accordingly, the first and second substrates 1 and 2 are joined together such that the column spacer 20 is arranged above the gate line 4.

The column spacer 20 is formed in an array process performed on the first substrate 1 or the second substrate 2. The column spacer 20 is fixedly formed in the form of a column with a certain height on the predetermined substrate.

The column spacer 20 is fixed in a specific position. Accordingly, it is advantageous that the column spacer 20 does not move and thus has no negative effect on the flow of liquid crystals, when the liquid crystals are dropped for the formation of the liquid crystal layer. However, the column spacer has a large area in contact with the corresponding substrate, thus disadvantageously causing display defects, e.g., touch defects.

BRIEF SUMMARY

A liquid crystal display device comprises: a first substrate and a second substrate facing each other; a spacer formed on the first substrate, wherein the spacer comprises a plurality of balls and a solid to aggregate the balls together and adhere the balls to the first substrate; a hard coating layer formed on the second substrate facing the spacer; and a liquid crystal layer filled between the first substrate and the second substrate.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. 1 is a sectional view illustrating a conventional liquid crystal display device;

FIG. 2 is a sectional view illustrating a liquid crystal display device comprising a ball spacer;

FIG. 3 is a sectional view illustrating a phenomenon in which a ball spacer is embedded in the substrate surface facing the spacer, when the ball spacer is used;

FIG. 4 is a sectional view illustrating a liquid crystal display device according to a first embodiment of the present invention;

FIG. 5 is a sectional view illustrating a liquid crystal display device according to a second embodiment of the present invention;

FIG. 6 is a plan view illustrating a liquid crystal display device according to an embodiment of the present invention;

FIG. 7 is a sectional view illustrating the structure of the liquid crystal display device, taken along the line II-II' of FIG. 6; and

FIG. 8 is a schematic view illustrating an inkjet system for the formation of the spacer.

DETAILED DESCRIPTION OF THE DRAWINGS AND THE PRESENTLY PREFERRED EMBODIMENTS

Hereinafter, an LCD device and a method for manufacturing the same according to the present invention will be described with reference to the annexed drawings.

3

FIG. 2 is a sectional view illustrating a liquid crystal display device comprising a ball spacer.

As shown in FIG. 2, in the liquid crystal display device using the ball spacer, a ball spacer **55** is arranged on the outermost surface of a color filter array **500** which comprises a black matrix layer **51**, a color filter layer **52**, an overcoat layer **53** and an alignment film **54** arranged on a second substrate **50** in this order.

Recently, methods in which the ball spacer **55** is dotted through an ink-jetting technique in a desired position have been suggested. In accordance with these methods, after the ball spacer **55** is formed in the desired position, it often moves from the initial position due to external force applied during the formation process or an impact applied in use. Accordingly, efforts have been made to fix the ball spacer **55** in the desired portion.

FIG. 3 is a sectional view illustrating a phenomenon in which, when a ball spacer is used, the ball spacer is embedded in the substrate surface that faces the spacer.

As shown in FIG. 3, in a case where the ball spacer **55** is formed on the second substrate **80** which faces the first substrate **50** provided with the color filter array **500**, when the ball spacer **55** is fixed on the second substrate **80**, a phenomenon, so-called "ball-embedding defect", in which the ball spacer **55** is lodged in the upper surface of the color filter array **500** which faces the ball spacer **55**, because it is harder than the color filter array **500**, occurs inside the first substrate **50** and the second substrate **80**, upon application of predetermined pressure to join the first substrate **50** to the second substrate **80**.

In this case, a decrease in cell gap comparable to the thickness, at which the ball spacer **55** is embedded, occurs. As a result, the ball spacer **55** exhibits optical effects different from the panel having a normal cell gap due to a decreased liquid crystal amount. Accordingly, the panel where the ball-embedding defects occur may be considered defective. In addition, when the ball spacer **55** is embedded in the color filter array **500** that faces the ball spacer **55**, an area in which the ball spacer **55** comes in contact with the color filter array **500** is greatly increased, and the ball spacer **55** cannot exhibit superior contact area decrease effects, as compared to conventional column spacers. Upon touch operation, in which the first substrate or the second substrate **80** is pushed in one direction, the frictional force is increased and the risk of touch defects is thus increased. As a consequence, the liquid crystal margin (defined as the range of a liquid crystal dropping amount at which gravity and touch defects do not occur) of the ball spacer **55** is lower than that of a structure free from ball-embedding defects.

An example where the ball spacer **55** is formed on the second substrate **80** is illustrated in FIG. 3. If necessary, the ball spacer **55** may be formed on the first substrate **50** provided with the color filter array **500**, and thus come in contact with a thin film transistor array arranged on the first substrate **50**. In this case, the outermost film of the thin film transistor array may include an organic or inorganic insulating film, like a passivation film. The ball-embedding phenomenon shown in FIG. 3 may occur in the organic or inorganic insulating film that comes in contact with the ball spacer. As a result, the afore-mentioned problems may occur.

Accordingly, a liquid crystal display device and a method for manufacturing the same capable of solving the ball-embedding problem, based on structural approaches, will be illustrated in detail with reference to the annexed drawings.

FIG. 4 is a sectional view illustrating a liquid crystal display device according to a first embodiment of the present invention.

4

As shown in FIG. 4, the liquid crystal display device according to the first embodiment of the present invention comprises: a thin film transistor array substrate **150**, and a second substrate **200** comprising a color filter array that face each other; a liquid crystal layer (not shown) filled between the thin film transistor array substrate **150** and the color filter array; a plurality of balls **131** arranged on the thin film transistor array substrate **150**; and a solid **132** to adhere the balls **131** to the thin film transistor array substrate **150**.

The color filter array comprises a black matrix layer **201** formed in a non-pixel region on the second substrate **200**; a color filter layer **202** formed on the second substrate **200** including the black matrix layer **201**; an overcoat layer **203** formed over the entire surface of the second substrate **200** including the black matrix layer **201** and the color filter layer **202**; and a hard coating layer **211** formed over the overcoat layer **203**.

The color filter layer **202** and the overcoat layer **203** may be selectively omitted. The spacer **130** is arranged in a portion provided within the width of the black matrix layer **201** on the thin film transistor array substrate **150**. That is, the spacer **130** is formed in the non-pixel region and fixed by means of a solid **132** for the purpose of preventing movement.

A second alignment film **204** to define initial alignment of liquid crystals is further formed on the hard coating layer **211**, and a first alignment film (not shown) is further formed on the thin film transistor array substrate **150**. The formation of the first and second alignment films is optional.

The hard coating layer **211** formed over the entire surface of the second substrate **200** has hardness equivalent or comparable to that of the ball **131**. In the process of joining the thin film transistor substrate **150** to the second substrate **200** comprising the color filter array, when the spacer **130** comprising the ball **131** and the solid **132** faces the second alignment film **204** arranged on the hard coating layer **211**, the hard coating layer **211** can prevent the ball **131** from being embedded in the second alignment film **204** as its hardness is comparable to that of the ball **131**. That is, the ball-embedding phenomenon can be prevented.

Although not shown, the thin film transistor array substrate **150** comprises: a plurality of gate lines and a plurality of data lines that intersect each other to define pixel regions; a plurality of thin film transistors formed at respective intersections between the gate lines and the data lines; pixel electrodes and common electrodes alternately formed in the pixel regions; a gate insulating film formed between the gate line layer and the data line layer; and a passivation film formed between the data line and the pixel electrode (See FIG. 6). In this case, the liquid crystal is driven based on an in-plane electric field (horizontal field) applied between the pixel electrode and the common electrode. The thin film transistor is electrically connected to the pixel electrode.

If needed, the pixel electrode alone may be formed without the common electrode in the pixel region. In this case, a vertical electric field may be applied between the pixel electrode and the common electrode by forming the common electrode over the second substrate **200**. In a case where the common electrode is made of a transparent electrode material such as indium tin oxide (ITO) or indium zinc oxide (IZO), the common electrode may be used as an alternative to the hard coating layer **211**.

In addition, the thin film transistor array substrate **150** comprises the first substrate and the thin film transistor arranged thereon. In addition to the afore-mentioned configuration, the thin film transistor array may be modified into a variety of forms.

Meanwhile, the spacer **130** is formed in accordance with an ink-jetting method which is performed by jetting a spacer-forming material contained in an ink-jet head (not shown) in predetermined portions. The spacer-forming material comprises about 2 to about 20% by weight of a liquid thermosetting binder (in an uncured state of the solid **132**), the solid **132** (in a cured final state of the liquid thermosetting binder) and the balls **131**. In this regard, the balls **131** are not stacked in the form of a laminate, instead being spread over the color filter substrate **210** in the form of a monolayer. As shown in FIG. 4, the spacer **130** is composed of a single ball **131**. Alternatively, the spacer **130** may be composed of a plurality of balls **131** arranged in a longitudinal direction. If necessary, as shown in the drawings, the balls **131** may be arranged in both horizontal and vertical directions in the one plane.

In the process of ink-jetting, the spacer-forming material comprising the balls for forming the spacer **130** is jetted in the corresponding region and then cured at about 80 to about 300° C. As a result, the thermosetting binder is cured and then solidified in the form of aggregates including the plurality of balls, while the solvent is volatilized.

The solid is an uncured form of the liquid thermosetting binder. For example, the solid includes at least one selected from acrylic-based, urethane-based and epoxy-based organic compounds, or a silicone-based compound. Specific examples of acrylic compounds include ethyl methacrylate, N-butyl methacrylate, isobutyl methacrylate, dicyclopentan-yl methacrylate, benzyl methacrylate, glycidyl methacrylate, 2-hydroxyethyl methacrylate, methacrylic acid isobornyl methacrylate and styrene polymers, and combinations thereof.

The solvent is selected from those that have a boiling point of about 60 to about 300° C. For example, glycol ether may be used as the solvent. Examples of useful glycol ethers include propylene glycol methyl ether (PGME), dipropylene glycol methyl ether (DGME), tripropylene glycol methyl ether (TGME), propylene glycol methyl ether acetate (PGMEA), dipropylene glycol methyl ether acetate (DGMEA), propylene glycol n-propyl ether (PGPE), dipropylene glycol n-propyl ether (DGPE), propylene glycol n-butyl ether (PGBE), dipropylene glycol n-butyl ether (DGBE), tripropylene glycol n-butyl ether (TGBE), propylene glycol phenyl ether (PGPE), propylene glycol diacetate (PGD), dipropylene glycol dimethyl ether (DGDE), diethylene glycol ethyl ether (DGEE), diethylene glycol methyl ether (DGME), diethylene glycol n-butyl ether (DGBE), diethylene glycol hexyl ether (DGHE), diethylene glycol n-butyl ether acetate (DGBEA), ethylene glycol propyl ether (EGPE), ethylene glycol n-butyl ether (EGBE), ethylene glycol hexyl ether (EGHE), ethylene glycol n-butyl ether acetate (EGBEA), triethylene glycol methyl ether (TGME), triethylene glycol ethyl ether (TGEE), triethylene glycol n-butyl ether (TGBE), ethylene glycol phenyl ether (EGPE) and ethylene glycol n-butyl ether mixtures (EGBEM).

Preferably, the solvent has a surface tension of 20 to 80 dynes/cm, a viscosity of 1 to 30 cP and a density of 0.8 to 1.2 g/cc at ambient temperature. Based on these properties, the solvent is volatilized and removed during curing at about 80 to about 300° C.

In addition, the balls **131** are made of an organic compound e.g. divinylbenzene. The balls **131** can be distinguished from other ingredients, in that the balls are present in the form of a white powder, while the solid and the solvent are in a liquid state. If necessary, the balls **131** may be subjected to surface-treatment prior to being mixed into the spacer-forming material so that they can be distinguished from other liquid components.

The process for forming the spacer **130** will be illustrated below. The spacer-forming material comprising a plurality of balls and a mixed liquid material consisting of a liquid thermosetting binder and a solvent is ink-jetted and then heated. In the process of heating, the solvent is volatilized, and the liquid thermosetting binder is cured such that the balls are aggregated together and fixed on the first substrate, to form a solid. As a consequence, the spacer **130** is obtained.

In this case, the hard coating layer **211**, which is formed on the second substrate **200** that faces the spacer **130**, may be selectively formed only in a region where the spacer **130** is formed. As shown in the drawing, it is more preferable that the hard coating layer **211** be formed over the entire surface of the spacer **130** to reduce the number of masks to be used.

In addition, as illustrated above, by forming the hard coating layer **211** that has the same hardness as or a similar hardness to the ball **131**, it is possible to prevent touch defects caused by the ball-embedding phenomenon. As a result, the liquid crystal margin can be increased from a level less than about 0.8% shown in FIG. 3 up to about 5.5%.

Hereinafter, a liquid crystal display device according to a second embodiment of the present invention will be illustrated with reference to the annexed drawings.

FIG. 5 is a sectional view illustrating a liquid crystal display device according to the second embodiment of the present invention.

As shown in FIG. 5, the liquid crystal display device according to the second embodiment of the present invention comprises: a thin film transistor substrate **150** and a second substrate **200** comprising a color filter array that face each other; a liquid crystal layer (not shown) filled between the thin film transistor array substrate **150** and the color filter array; a ball **131** arranged on the color filter array; and a solid **132** to adhere the ball **131** to the color filter array.

The liquid crystal display device of the second embodiment is different from that of the first embodiment in that the spacer **130** comprising the ball **131** is formed on the second substrate **200**. When the spacer **130** is formed on the second substrate **200**, a hard coating pattern **110** is formed in a portion corresponding to the spacer **130** on the thin film transistor array substrate **150** that faces the spacer **130**. That is, unlike the hard coating layer formed over the entire surface of the second substrate in the first embodiment, the hard coating pattern **110** is at the same level as a second storage electrode **103a** or a common electrode connection pattern **104a** made of a transparent electrode material adjacent thereto. That is, the hard coating pattern **110** is formed at the same level as the transparent electrode (e.g., pixel electrode) adjacent thereto to reduce the number of masks used for forming the same. In addition, the hard coating pattern **110** must be arranged as the uppermost layer of the thin film transistor array substrate **150** that directly comes in contact with the spacer **130** in order to minimize damage to the surface that faces the spacer **130**.

The hard coating pattern **110** is arranged on the gate line **101** and has a length (in a longitudinal direction of the gate line **101**) of about 60 to about 120 μm and a width of about 10 to about 30 μm . If needed, the second storage electrode **103a** or the third common connection electrode **104a** may be formed such that it overlaps the gate line **101**. In these cases, the hard coating pattern **110** is formed such that it is spaced apart from the second storage electrode **103a** and the third common connection electrode **104a**.

The color filter array comprises a black matrix layer **201** formed in a non-pixel region on the second substrate **200**; a color filter layer **202** formed on the second substrate **200** including the black matrix layer **201**; and an overcoat layer

203 formed over the entire surface of the second substrate **200** including the black matrix layer **201** and the color filter layer **202**.

A second alignment film **204** to define initial alignment of liquid crystals may be further formed on the overcoat layer **203**, and a first alignment film **116** may be further formed over the entire surface of the top including the uppermost layer (the pixel electrode and the hard coating pattern **110**) of the thin film transistor array substrate **150**. The first and second alignment films **116** and **204** are optional. The first and second alignment films **116** and **204** have thicknesses smaller than the thicknesses (i.e., about 1,000 Å) of the pixel electrode and the hard coating pattern **110**, thus being hardly affected by variations in thickness. Furthermore, the first and second alignment films **116** and **204** are completely baked prior to joining of both substrates, thus minimizing deformation caused by applied pressure. Accordingly, the surface variation of the first alignment film **116** that directly comes in contact with the spacer **130** is considered to be only slight and negligible.

The formation of the spacer **130** is performed in accordance with the ink-jetting method illustrated in the first embodiment, and constituent components of the spacer **130** are the same as in the first embodiment. Accordingly, a detailed explanation thereof is omitted.

Hereinafter, the structure provided on the first substrate will be described in detail with reference to the annexed drawings. The configuration of the first substrate is applicable to the first and second embodiments.

FIG. 6 is a plan view illustrating a liquid crystal display device of the present invention. FIG. 7 is a sectional view taken along the line II-II' of FIG. 6.

A plurality of gate lines **101** and a plurality of data lines **102** are arranged on the first substrate **100**, such that the gate lines **101** and the data lines **102** intersect each other, to define pixel regions. In addition, common lines **111** are arranged on the first substrate **100** such that the common lines extend in parallel to the gate lines **101**.

In addition, thin film transistors are located at respective intersections of the data lines **101** and the gate lines **102**. Each thin film transistor includes: a gate electrode **101a** protruding from the associated gate line **101**; a gate insulating film **114** formed over the entire surface of the first substrate **100** including the gate electrodes **101a**, the gate lines **101** and the common lines **101**; a "U"-shaped source electrode **102a** and a drain electrode **102b** arranged at both sides of the gate electrode **101a** such that the drain electrode **102b** is partially located in the "U"-shaped source electrode **102a**; and semiconductor layers **105** (**105a**, **105b**) arranged in regions including portions under the source electrode **102a** and the drain electrode **102b**, and channel portions between the source electrode **102a** and the drain electrode **102b**. The semiconductor layers **105** include an amorphous silicon layer **105a** and an impurity semiconductor layer (n+ layer) **105b** arranged thereon. The impurity semiconductor layer **105b** is formed by removing the channel region present between the source electrode **102a** and the drain electrode **102b**. The shape of the source electrode **102a** is not limited to the "U"-shape and may be "-"- or "L"-shaped.

The data line **102** has a central bent portion at each sub-pixel such that the data line **102** forms a zigzag line. The common line **111** is integrally formed with a storage electrode **111a** at each pixel and the storage electrode **111a** is connected to a common electrode connection electrode **111b** which lies adjacent to both sides of the data line **102** and protrudes in parallel to the data line **102**. As mentioned above, the data line **102** crosses the gate line **101** and has a bent portion at each

pixel. Exemplary embodiments of the present invention are not limited thereto and the data line may perpendicularly cross the gate line, or may be tilted at a predetermined angle with respect to the gate line. In the illustrated drawings, the reason for imparting the bent portion to the data line **102** at each pixel is that the common electrode **104** and the pixel electrode **103** extend in parallel to the data line, and a vertically symmetrical electric field is thus generated, on the basis of the bent portion, which allows for orientation of liquid crystals in different directions and thus leads to an improvement in viewing angle.

The common electrode **104** and the pixel electrode **103** are made of transparent electrodes at the same level in pixel regions and have alternately arranged portions. The common electrode **104** is partially overlapped with the common electrode connection electrode **111b** arranged therebeneath. A second common electrode connection electrode **111c** which extends in parallel to the gate line **101** has, as an electrical contact, a second contact portion **117b** which passes through the passivation film **115** and the gate insulating film **114** interposed between the common electrode **104** and the second common electrode connection electrode **111c**.

In addition, the pixel electrode **103** is branched from the second storage electrode **103a** overlapping the first storage electrode **111a**, and has, as an electrical contact, a first contact portion **117a** which passes through the passivation film **115** interposed between the pixel electrode **103** and the drain electrode **102b**.

Hereinafter, a method for manufacturing the structure of the first substrate **100** including the thin film transistors, the common electrodes and the pixel electrodes will be illustrated in detail.

A metal such as Mo, Al or Cr is deposited on a first substrate **100** and is then patterned through photolithographic processes to simultaneously form a plurality of gate lines **101**, gate electrodes **101a**, common lines **111** extending parallel to the gate lines **101**, first storage electrodes **111a** integrally formed with the common lines **111**, and first common electrodes **111b** and second common electrodes **111c** branched from the first storage electrodes **111a** and protruded in pixel regions. At this time, the gate electrodes **101a** are formed in predetermined positions provided by pixel regions such that they are protruded from the gate lines **201**, and the first storage electrodes **111a**, the first common connection electrodes **111b** and the second common connection electrodes **111c** are formed in the boundaries between adjacent pixel regions.

Then, an inorganic insulating material is deposited over the first substrate **100** provided with the gate lines **101**, the common lines **111**, the gate electrodes **101a**, the first storage electrodes **111a**, and the first and second common connection electrodes **111b** and **111c**, to form a gate insulating film **114**.

Subsequently, an amorphous silicon layer **105a** and an impurity semiconductor layer **105b** are sequentially deposited on the gate insulating film **114**.

A metal such as Mo, Al or Cr is deposited on the resulting structure and a photosensitive film is applied thereto. For example, the photosensitive film may be a negative photosensitive film.

The portions where the data lines, source electrodes and drain electrodes are formed define a light-transmission part, the channel portions of the semiconductor layers define a light-semi-transmission part, and the remaining portions defined a light-shielding part. In this regard, masks (not shown) defined as the light-shielding part are positioned on the photosensitive film.

Subsequently, the photosensitive film is exposed to light and is then developed through the masks, to form a first

photosensitive film pattern such that the portions provided by the light-transmission part remain un-etched, the portions provided by the light-semi-transmission part are partially removed, and the portions provided by the light-shielding part are completely removed. The metal material is patterned using the first photosensitive film pattern (not shown) in accordance with photolithographic processes. The first photosensitive film pattern includes a first pattern which has a bent portion in each pixel region, while crossing the gate line **101**, and a second pattern (corresponding to the light-transmission part where the source and drain electrodes are formed, including the light-semi-transmission part of the masks) which is connected to the first pattern at the intersection of the gate line **101** and extends toward the pixel region. After the patterning of the metal using the first photosensitive film pattern, data lines **102** which cross the gate lines **101** and have a bent portion at respective pixel regions are formed, and dummy patterns (not shown) connected to the data lines **102** are formed in portions corresponding to the second pattern.

Subsequently, the impurity semiconductor layer **105b** and the amorphous silicon layer **105a** are primarily selectively removed using the data lines **102** and the dummy patterns as masks.

Subsequently, with respect to the first photosensitive film pattern (not shown), the first photosensitive film pattern is subjected to ashing such that the photosensitive film provided by the light-semi-transmission part of the mask which has a relatively smaller thickness is removed, to form a second photosensitive film pattern (not shown).

Subsequently, the portions, where the metal material (located in the same layer as the data line **102**) of the dummy pattern and the impurity semiconductor layer **105b** are exposed, are selectively removed using the second photosensitive film pattern as a mask, to form source electrodes **102a** and drain electrodes **102b** and to pattern the impurity semiconductor layer **105b** arranged thereunder. In this process, the impurity semiconductor layer **105b** interposed between the source electrode **102a** and the drain electrode **102b** is removed. The removed region is defined as a channel portion. The source electrode **102a** is formed in the "U" shape that protrudes from the data line **102** toward the pixel region. The drain electrode **102b** is spaced apart from the source electrode **102a** by a predetermined distance and is partially embedded in the "U" form of the source electrode **102a**.

Subsequently, a passivation film **115** is deposited over the gate insulating film **114** provided with the data lines **102**, the source electrodes **102a** and the drain electrodes **102b**. At this time, the passivation film **115** is generally made of an inorganic material e.g., SiN_x . In order to increase an aperture ratio of liquid crystal cells, low dielectric organic materials such as benzocyclobutene (BCB), spin on glass (SOG) and acryl may be used.

Subsequently, a portion of the passivation film **115** arranged on the drain electrode **102b** is selectively etched to form a first contact portion **117a**, and the passivation film **115** and the gate insulating film **114** provided in predetermined portions on the second common connection electrode **111c** are selectively removed to form a second contact portion **117b**.

Subsequently, a transparent electrode is deposited over the passivation film **115** including the first and second contact portions **117a** and **117b** and is then selectively removed, to form a plurality of common electrodes **104** which are partially overlapped with the common electrode connection electrodes **111b** at respective pixels and spaced apart from one another, third common connection electrodes **104a** overlapping the second common connection electrodes **111c** and

connecting the common electrodes **104** in pixel regions of the common electrodes **104**, and a plurality of pixel electrodes **103** alternating with the common electrodes **104**.

Subsequently, a first alignment film **116** is formed over the entire surface of the passivation film **115** including the pixel electrode **103** and the common electrodes **104**.

FIG. 8 is a schematic view illustrating an inkjet system used to form the spacers according to the present invention.

First, when a gas, e.g., nitrogen is injected into a supply tank **300** filled with a spacer-forming material wherein balls **131** are mixed with a liquid material **135** consisting of a liquid thermosetting binder and a solvent, the supply tank **300** undergoes an increase in internal pressure, which causes the spacer-forming material present in the supply tank **300** to be supplied through a pipe **320** into a plurality of inkjet heads **400**.

The spacer-forming material supplied into the inkjet head **400** is sprayed through a nozzle (not shown) present inside the inkjet head **400** and is discharged in the predetermined portions of the second alignment film **204** (not shown in FIG. 10) arranged over the black matrix layer **201** (not shown in FIG. 10) on the second substrate **200**. In this discharge process, since the spacer-forming material has slight spreadability and is oblate, it is cured through a heating process to form a spacer **130**.

The pipe **320** is connected with a supply pipe (not shown) in the inkjet head **400**. Thus, the spacer-forming material supplied via the pipe **320** flows through the supply pipe in the head **400**. At this time, when a voltage applier **480** applies a voltage to a piezoelectric device (not shown), the piezoelectric device causes mechanical deformation, thus contracting the passage of the supply pipe and allowing the spacer-forming material to be discharged through the opposite nozzle (not shown).

At this time, at least one of the head **400** and a substrate stage **210** may be moved in a predetermined direction. Accordingly, when a large area of the second substrate **200** is provided, the second substrate **200** is divided into portions and ink-jet processes through the heads **400** provided in the ink-jet system are carried out in respective portions.

An example where the liquid crystal display device according to the present invention employs an in-plane switching (IPS) mode was illustrated with reference to the drawings. In the cases where the afore-mentioned spacer is applied to TN-mode liquid crystal display devices in which pixel electrodes are formed at respective pixels and common electrodes are further formed on the second substrate, it is possible to obtain the same effects as in the example.

The liquid crystal display device and the method for manufacturing the same have the following advantages.

First, since the spacers are made of balls with a small area in contact with the substrate that faces the spacers and a solid to adhere the balls to the substrate, they can reduce the frictional force due to the small area in contact with the substrate surface and allow two substrates, which are shifted upon touch operation, to rapidly return to their original states, thus preventing touch defects.

Second, the spacers are formed using a material comprising a solid to adhere the balls to the substrate surface where the spacers are to be formed, thus being not movable in the space between the two substrates, instead being fixed in the initial position, thereby preventing light leakage caused by movement of the balls.

Third, a hard coating layer or a hard coating pattern formed on the substrate surface that faces ball spacers functions to prevent problems (i.e., damage to the substrate surface that faces the spacers, and the ball spacer-embedding phenom-

11

enon) associated with the use of the ball spacers that are harder than organic or inorganic insulating films.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

The invention claimed is:

1. A liquid crystal display device comprising:

a first substrate and a second substrate facing each other;

a gate line and a data line disposed on the first substrate such that the gate line and the data line intersect each other to define a pixel region;

a thin film transistor disposed at an intersection between the gate line and the data line;

a black matrix layer disposed on the second substrate in a portions corresponding to the gate line and the data line; a color filter layer disposed on the second substrate including the black matrix layer;

a spacer formed in a predetermined portion provided within a width of the black matrix layer, wherein the spacer comprises a plurality of balls, and a solid to aggregate the balls together and adhere the balls to the first substrate;

12

a hard coating layer disposed on the second substrate facing the spacer, wherein the hard coating layer has substantially hardness equivalent to that of the balls; and

a liquid crystal layer filled between the first substrate and the second substrate.

2. The liquid crystal display device according to claim 1, further comprising:

an overcoat layer disposed on the color filter layer,

wherein the hard coating layer is disposed on the overcoat layer.

3. The liquid crystal display device according to claim 1, wherein the solid includes at least one material selected from the group consisting of acrylic-based, urethane-based and epoxy-based organic compounds, and silicone compounds.

4. The liquid crystal display device according to claim 1, wherein the spacer is formed by heating a spacer-forming material, comprising a liquid material consisting of about 2 to about 20 wt % of a liquid thermosetting binder in an uncured state of the solid and a solvent, and about 0.1 to about 3.0 wt % of the balls, with respect to the total weight of the liquid material, to volatilize the solvent and cure the liquid thermosetting binder.

* * * * *

专利名称(译)	液晶显示器及其制造方法		
公开(公告)号	US8730436	公开(公告)日	2014-05-20
申请号	US13/455816	申请日	2012-04-25
[标]申请(专利权)人(译)	CHO JUN BEOM SEO金铉 李桢勋 KWON DHANG CHO HANG SUP 金浩SU		
申请(专利权)人(译)	CHO JUN BEOM SEO金铉 李桢勋 KWON DHANG CHO HANG SUP 金浩SU		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	CHO JUN BEOM SEO HYEON JIN LEE JEONG HOON KWON DHANG CHO HANG SUP KIM HO SU		
发明人	CHO, JUN BEOM SEO, HYEON JIN LEE, JEONG HOON KWON, DHANG CHO, HANG SUP KIM, HO SU		
IPC分类号	G02F1/1343		
CPC分类号	G02F2201/50 G02F1/133512 G02F1/13392 G02F1/134363 G02F2202/28		
优先权	1020070100349 2007-10-05 KR		
其他公开文献	US20120206686A1		
外部链接	Espacenet USPTO		

摘要(译)

本发明公开了一种液晶显示 (LCD) 装置及其制造方法，能够防止相关的问题 (即球的移动，在施加预定压力时面对间隔物的表面的损坏，以及单元间隙的变化)。使用球垫片。液晶显示装置包括彼此面对的第一基板和第二基板，在第一基板上形成的间隔物，其中间隔物包括多个球和固体以将球聚集在一起并将球粘附到第一基板上，形成在面对间隔物的第二基板上的硬涂层，以及填充在第一基板和第二基板之间的液晶层。

