

9901567-9

30-3-99

IPQS

1

TITLE OF THE INVENTION

Image Display Apparatus ✓

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image display apparatus (so-called plasma address display apparatus) for displaying an image by using plasma to drive an electro-optical material layer.

Description of the Prior Art

A conventional method for increasing resolution and contrast of a liquid crystal display is, for example, a so-called active matrix address method which drives an active element such as a transistor provided for each display pixel.

However, this method requires providing a number of semiconductor elements such as thin-film transistors. This results in difficulty to obtain a high yield when a large-area display is desired. This also increases the production cost.

In order to solve this problem, there has been suggested a method of using a discharge plasma instead of a semiconductor element such as a MOS transistor and a thin-film transistor as the active element.

The image display apparatus using discharge plasma for driving liquid crystal, which will be referred as a plasma address display apparatus) includes a liquid crystal

layer made from an electro-optical material and a plasma cell for plasma discharge which are provided adjacent to each other via a thin glass plate.

In this plasma address display apparatus, a plasma cell is divided by partitions into a line-shaped plasma cells, which are successively switched from one to another for performing plasma discharge. This switching is synchronized with a signal voltage application to a transparent electrode provided to oppose to the plasma cells via the liquid crystal layer, thus driving the liquid crystal layer.

In this plasma address display apparatus, handling of the thin glass plate is highly complicated. The thin glass plate is easily broken during a handling and a heating process, which significantly lowers the yield.

Moreover, the plasma address display apparatus also has a problem that an ultraviolet ray caused by plasma light emission deteriorates the liquid crystal material.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an image display apparatus enabling to easily handle the thin glass plate and easily assemble the apparatus, which in turn enables to obtain a high production yield.

Another object of the present invention is to provide an image display apparatus in which the liquid crystal layer is not affected by the ultraviolet ray caused by plasma light emission.

The image display apparatus according to the present invention includes: a

plasma cell having a plurality of discharge electrodes arranged at a predetermined interval and parallel to one another on one main surface of a first substrate; a dielectric thin plate arranged at a predetermined distance from the first substrate; and a seal portion for sealing the space between the first substrate and the dielectric thin plate; an electro-optical material layer; and a second substrate having on its opposing surface electrodes formed to extend approximately in the direction vertical to the discharge electrodes, the second substrate being placed via the electro-optical material layer over the dielectric thin plate, wherein the dielectric thin plate is a layered body having at least a thin glass plate and a high-molecule polymer film which are bonded to each other.

In the image display apparatus, the layered body further includes an ultraviolet-ray shading film.

The dielectric thin plate is a layered body including a thin glass plate and a high-molecule polymer film bonded to each other instead of a single thin glass plate. This enables to mitigate the stress and increase the shock resistance, which makes its handling easier.

Moreover, the ultraviolet-ray shading film provided in the layered body enables to cut off the ultraviolet ray generated in the plasma cell, thus suppressing the affect to the liquid crystal material constituting the liquid crystal layer.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

Fig. 1 is a perspective view of a configuration example of a plasma address display apparatus according to the present invention.

Fig. 2 is a schematic cross sectional view of a configuration example of the plasma address display apparatus according to the present invention.

Fig. 3 is a cross sectional view of an essential portion of a dielectric thin plate.

Fig. 4 schematically shows arrangement of data electrodes, discharge electrodes, and discharge channels.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Description will now be directed to an embodiment of the present invention with reference to the attached drawings.

As shown in Fig. 1 and Fig. 2, the plasma address display apparatus according to the present invention has a so-called flat panel structure in which an electro-optical display cell 1, a plasma cell 2, and a dielectric thin plate 3 provided therebetween are layered.

The dielectric thin plate 3 functions as a capacitor and should be as thin as possible for assuring electrical connection between the electro-optical display cell 1 and the plasma cell 2 and suppressing two-dimensional spread of electric charge. More specifically, the dielectric thin plate 3 should be as thin as, for example, 100 micrometers or below, and preferably, 50 micrometers.

In general, the dielectric thin plate 3 is made from glass. However, the glass

plate is difficult to handle. Moreover, if the glass plate is broken by mistake, the glass pieces are scattered, causing a troublesome work for putting things in order.

To cope with this, the present embodiment employs as the dielectric thin plate 3 a layered body (backed glass) which is a thin glass plate backed with a high-molecule polymer film.

For example, if a high-molecule polymer film is formed on a part of or over the entire surface of the thin glass plate, it is possible to mitigate the stress, increasing the strength against a shock without changing the thickness. This significantly simplify the handling of the dielectric thin plate 3.

A high-molecule polymer film may be formed, for example, from a thermoplastic resin. If a heat resistance and a chemicals resistance are considered, it is preferable to employ a polyimide high-molecule material.

It should be noted that by adding a small amount of an oxide of Sr, Ba, or the like, it is possible to improve the dielectric constant and increase the voltage applied to the liquid crystal layer (electro-optical display cell 1), which also serves for power saving.

The aforementioned layered body may have any layered structure of the thin glass and the high-molecule film. For example, it is possible to set any value for the number of the thin glass plate layers and the number of the high-molecule polymer film layers. As the simplest and the most effective structure, the high-molecule polymer film may be sandwiched between two thin glass plate.

In this case the thin glass plate is the member which is in direct contact with the electro-optical cell 1 and the plasma cell 2. This enables to obtain a plasma address display apparatus having a high reliability. Moreover, the entire thickness may easily be set to 100 micrometers or below by etching.

The layered body may be prepared by using thermal fusion or using an adhesive for bonding.

Furthermore, by providing a ultraviolet-ray shading film in the layered body, it is possible to effectively shade the ultraviolet ray generated by the plasma cell 2. This enables to significantly reduce the ultraviolet ray reaching the electro-optical cell 1.

The ultraviolet-ray shading film may be formed from a material absorbing ultraviolet ray. It is possible to use an ordinary ultraviolet ray shading film. It is also possible to use a material such as SiO_2 and TiO_2 for constituting the ultraviolet ray shading film by using a film having a high refractive index in combination with a film having a low refractive index.

This ultraviolet ray shading film may be made from any number of layers which can be provided inside or outside of the layered body.

Fig. 3 is a cross sectional view of a configuration example of the dielectric thin plate 3 as the aforementioned layered body. This dielectric thin plate 3 includes at its center an ultraviolet-ray shading film 31 which is covered from its both sides high-molecule polymer films 32 and then sandwiched by thin glass plates 33. This structure enables to mitigate the stress and increase the shock resistance as well as cut

off the ultraviolet ray.

On the other hand, the electro-optical display cell 1 is formed by junction with a glass substrate (upper substrate) arranged via a spacer 6 over the dielectric thin plate 3.

The space between the dielectric thin plate 3 and the upper substrate 4 is filled with a liquid crystal material as the electro-optical material constituting the liquid crystal layer 7. It should be noted that the electro-optical material may also be other than the liquid crystal material.

Here, the distance between the upper substrate 4 and the dielectric thin plate 3 is maintained to be 4 to 10 micrometers, for example, uniformly over the entire display surface.

Moreover, the upper substrate 4 has an opposing surface toward the dielectric thin plate 3, on which opposing surface a plurality of data electrodes 5 extending in the row direction are arranged at a predetermined interval in the column direction.

On the other hand, the plasma cell 2 is constituted by the dielectric thin plate 3 and a glass substrate (lower substrate) 8 arranged below the dielectric thin plate 3.

The lower substrate 8 has an opposing surface toward the dielectric thin plate 3, on which opposing surface a plurality of anode electrodes 9A and cathode electrodes 9K extending in the column direction, i.e., orthogonally intersecting the data electrodes 5 are alternately arranged parallel to one another at a predetermined interval, thus constituting a discharge electrode group.

Moreover, each pair of the anode electrode 9A and the cathode electrode 9K is isolated by a partition wall 10 having a predetermined width and extending along the electrodes. Each of the partition walls 10 has an apex in abutment with the lower surface of the dielectric thin plate 3, thus maintaining an almost constant distance between the lower substrate 8 and the dielectric thin plate 3.

Furthermore, the dielectric thin plate 3 has its edge portion in hermetical junction with the lower substrate 8 by a frit seal 11 made from a glass having a low melting point. Thus, the plasma cell 2 is constituted as an airtight space. This airtight space is filled with, for example, He, Ne, Ar gas, or mixture thereof, which can be ionized.

In the aforementioned plasma address display apparatus, in the space between the lower substrate 8 and the dielectric thin plate 3, there are formed a plurality of discharge channels 12 isolated from one another by the partition wall 10 and arranged in parallel to one another in the row direction. The discharge channels 12 orthogonally intersect the data electrodes 5.

Accordingly, the data electrodes 5 are driven on the column basis, whereas the discharge channels 12 are driven on the row basis. As shown in Fig. 4, intersection points of the data electrodes 5 and the discharge channels 12 correspond to pixels 13.

In the plasma display apparatus having the aforementioned configuration, when a drive voltage is applied between the anode electrode 9A and the cathode electrode 9K corresponding to a predetermined discharge channel 12, the gas contained in the

discharge channel 12 is ionized, causing plasma discharge so as to maintain the anode potential.

If a data voltage is applied in this state, the data voltage is written into the liquid crystal layer corresponding to a plurality of pixels 13 arranged in the column direction corresponding to the discharge channel 12 which has caused the plasma discharge.

When the plasma discharge terminates, the discharge channel 12 is at a floating potential, and the data voltage written into the liquid crystal layer 7 corresponding to the pixels 13 is maintained until the next write period (for example, until the next one field or frame). In this case, the discharge channel 12 functions as a sampling switch and the liquid crystal layer 7 corresponding to the pixels 13 function as a sampling capacitor.

The data voltage written into the liquid crystal layer 7 causes the liquid crystal to operate to display an image on pixel basis. Accordingly, by successively scanning the discharge channels 12 causing plasma discharge in synchronization with application of a data voltage to the data electrodes 5, it is possible to drive the liquid crystal layer 7 in the same way as in the active matrix addressing method, thus enabling to display a two-dimensional image.

While a specific embodiment of the present invention has been described, the present invention is not to be limited to this embodiment but can be modified in various ways.

As is clear from the aforementioned, the present invention enables to easily

handle the thin glass plate and easily assemble the image display apparatus (plasma address display apparatus), thus increasing the production yield.

Moreover, when the dielectric thin plate is a layered body of a thin glass plate and a high-molecule polymer film, it is possible scattering of glass pieces even if the dielectric thin plate is broken.

Furthermore, by providing an ultraviolet-ray shading film in the dielectric thin plate, it is possible to suppress the affect from the ultraviolet ray caused by plasma light emission.



WHAT IS CLAIMED IS

1. An image display apparatus comprising:

a plasma cell including a plurality of discharge electrodes arranged at a predetermined interval and parallel to one another on one main surface of a first substrate; a dielectric thin plate arranged at a predetermined distance from said first substrate; and a seal portion for sealing the space between said first substrate and said dielectric thin plate;

an electro-optical material layer; and

a second substrate having on its opposing surface electrodes formed to extend approximately in the direction vertical to said discharge electrodes, the second substrate being placed via said electro-optical material layer over said dielectric thin plate,

wherein said dielectric thin plate is a layered body having at least a thin glass plate and a high-molecule polymer film which are bonded to each other.

2. An image display apparatus as claimed in Claim 1 wherein said layered body further includes an ultraviolet-ray shading film.

3. An image display apparatus as claimed in Claim 1 wherein said dielectric thin plate has a thickness equal to or below 100 micrometers.