

TITLE OF THE INVENTION

Glass Substrate for Flat Panel Display, and Process for Producing the Same

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process for producing a glass substrate for a flat panel display, the glass substrate having a surface patterned in a predetermined form by wet etching.

2. Description of the Prior Art

Flat panel displays (FPD) include flat display devices such as plasma displays (PDP), liquid crystal displays (LCD), field emission displays (FED) and electroluminescence displays (ELD). In these flat display devices, a thin glass substrate is used in their front and/or in their back.

With respect to substrates for FPDs, there are common technical challenges, i.e., reduction in weight and reduction in thickness, regardless of the kinds of FPDs. Moreover, there are different technical challenges depending on the kinds of FPDs. Therefore, patterning is applied for glass substrates depending on the kinds of the FPDs for which the glass substrates are used. In this specification, the term "patterning" generally means to process at least a part of the surface of a glass substrate into a predetermined form by etching. It specifically means, for

example, to reduce the thickness of a glass substrate by etching the entire surface of the glass substrate, to etch at least a part of the surface of a glass substrate after application of masking, and to form steps on a glass substrate by controlling the amount of etching depending on positions in the glass substrate.

For example, partitions are required to be formed in a glass substrate for FPD. Known methods for forming partitions into a stripe form or into a matrix form include a screen printing method comprising screen printing a dielectric paste repeatedly which will form partitions, followed by burning, and a sandblast method comprising applying a dielectric paste, drying it and then removing an unnecessary portion by sandblast.

In addition, with respect to glass substrates for LCD and those for FED, reduction in thickness of glass substrates is required. Currently mainstream methods for reduction in thickness of glass substrates include a wet etching method comprising chemically polishing glass substrates using an etchant, a mechanical polishing method comprising physically polishing a glass substrate by rubbing a pad thereon using abrasive grains, and a chemical mechanical polishing (CMP) method which is a combination of the above two methods.

Since glass substrates for ELD are used as back caps, impressed glass substrates are required. Patterning techniques known today include a blast method in which patterning is effected by sandblasting portions which will be

thinned, a press forming method in which patterning is effected by pressing a mold against a glass substrate heated to a high temperature, and a mechanical polishing method in which a glass substrate is polished by rubbing a pad thereon using abrasive grains.

As described above, when patterning glass substrates for FPD, methods using mechanical polishing have conventionally been employed. However, such methods have the following problems.

A first problem with mechanical polishing is that there are physical limitations to fine patterning, so that it is difficult to polish glass substrates in the order of micrometer. Even patterning in the order of millimeter results in glass substrates of unsatisfactory surface conditions. The mechanical polishing is therefore unsuitable for glass substrates for displays.

On the other hand, the sandblast method has a problem of producing large amounts of abrasive grains and ground glass dust, resulting in accumulation of such waste on the surface of a glass substrate. In addition, similar to the mechanical polishing, the sandblast method results in unsatisfactory surface conditions, and the method is therefore unsuitable for glass substrates for displays.

Furthermore, the press forming method has a problem of high production cost because a mold is pressed against a glass substrate while making the glass substrate into a high

temperature condition until it is softened. In addition, this method has another problem of high production cost of the mold used in the method.

In view of the above circumstances, it is considered that for the purpose of patterning on the surface of a glass substrate by etching, the chemical polishing method using wet etching is advantageous rather than the methods of mechanically polishing.

However, since conventional chemical polishing methods use hydrofluoric acid, which is a strong acid, for etchants, there are problems of erosion of a masking layer or peeling of a masking layer from a glass substrate during etching. No suitable methods for forming masks have been established yet.

The present invention was made in view of the above problems. A main object of the present invention is to provide a process for producing a glass substrate for FPD, the glass substrate being patterned with high accuracy by forming on the surface of the glass substrate a cover layer of high chemical resistance and high adhesiveness prior to wet etching, and to provide a glass substrate for FPD.

SUMMARY OF THE INVENTION

In order to attain the above object, the present invention provides a process for producing a glass substrate for FPD, the glass substrate having a surface patterned in a predetermined

form, the process comprising the steps of: forming a cover layer on a part of the surface of a glass substrate; etching the surface of the glass substrate except the part having the cover layer formed thereon by a treatment using an etchant containing hydrofluoric acid; and removing the cover layer.

A first preferable example of the cover layer includes one formed by film transfer using a resin selected from epoxy resin, polyvinyl acetal resin, polyester resin and fluororesin as a raw material of a cover material.

A second preferable example of the cover layer includes one formed by coating a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or by coating a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent.

A third preferable example of the cover layer includes one formed by screen printing using a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or screen printing using a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent.

Since each of the above three types of cover layers has a high chemical resistance and a high adhesiveness to glass substrates, only the surface of a glass substrate except a part on which a cover layer is formed is etched even when being treated

with an etchant containing hydrofluoric acid. Accordingly, glass substrates for FPD can be produced, the glass substrates being patterned with high accuracy.

The present invention can achieve a reduction of running cost since a glass substrate is directly patterned using an etchant. In addition, since a pattern is formed through an etching treatment to a glass substrate, it is possible to selectively etch portions which are subjected to the treatment. Moreover, in the present invention, a cover layer does not peel from a glass substrate and it is possible to selectively etch the glass substrate to a depth of about 1 μm or more since an acid resistant cover material is adhered firmly to the glass substrate.

In the present invention, it is preferable for the etchant to contain at least one inorganic acid selected from hydrochloric acid, sulfuric acid and phosphoric acid in addition to hydrofluoric acid from the viewpoint of controlling the etching rate. In the present invention, from the viewpoint of preventing reaction products such as silicofluoride compounds caused by etching from attaching to a glass substrate, it is preferable that the etchant contain at least one surfactant selected from carboxylic acid based surfactants, phenol based surfactants, amide based surfactants, fatty acid ester based surfactants, phosphoric acid ester based surfactants, sulfuric acid ester based surfactants, sulfonic acid ester based surfactants, amine based surfactants, ether based surfactants

and macromolecular alcohols in addition to hydrofluoric acid.

As described above, according to the process for producing a glass substrate for FPD of the present invention, an acid-resistant cover layer is adhered firmly to a glass substrate. Therefore, the cover layer does not peel from the substrate during an etching process and a part of the glass substrate can be patterned selectively.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1(a) to 1(f) are schematic views that illustrate a step of patterning a glass substrate for ELD.

Fig. 2 is a schematic view that illustrates an example of an etching pattern of a glass substrate for LCD or ELD.

Fig. 3 is a schematic view that illustrates an example of an etching pattern of a glass substrate for PDP.

Fig. 4 is a schematic view that illustrates an example of an etching pattern of a glass substrate for ELD.

Fig. 5 is a schematic view that illustrates an example of an etching pattern of a laminated glass substrate.

DETAILED DESCRIPTION OF THE INVENTION

A glass substrate for FPD manufactured according to the present invention results from the essential steps: a step of forming a cover layer on a part of the surface of a glass substrate (a covering step); a step of etching the surface of the

glass substrate except the part having the cover layer formed thereon by a treatment using an etchant containing hydrofluoric acid (an etching step); and removing the cover layer (a removal step). In the following, the present invention will be described step by step.

(Covering Step)

The glass substrate for use in this step has no particular limitations as long as it is a known glass substrate which is usually employed in PDP, LCD, FED and ELD. However, in general, soda-lime glass and non-alkali glass are preferably used.

The size and thickness of the glass substrate are appropriately adopted depending on the display device into which it is to be installed and are not particularly limited.

As the cover layer to be formed in a part of the surface of the glass substrate, preferably used is one which has a chemical resistance such that the cover layer is not eroded with an etchant containing hydrofluoric acid during the etching step described later and which has an adhesiveness such that the cover layer does not peel from the glass substrate. In the present invention, the above cover layer is formed by using a specific resin as a raw material of a cover material and using a specific technique.

As a first example, it is preferable to form a cover layer by film transfer using a resin selected from epoxy resin,

polyvinyl acetal resin, polyester resin and fluororesin as the raw material of a cover material.

As a second example, it is preferable to form a cover layer by coating a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or by coating a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent. In this case, an organic solvent such as toluene, hexane and ethyl acetate is preferably used as the solvent.

As a third example, it is preferable to form a cover layer by screen printing using a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or by screen printing using a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent. In this case, an organic solvent such as toluene, hexane and ethyl acetate is preferably used as the solvent.

In the present invention, when forming a cover layer on a part of the surface of a glass substrate using the above specific raw materials of a cover material, it is possible to appropriately form the pattern of the cover layer according to a specific technique of forming the cover layer such as film transfer, coating and screen printing.

For example, when using film transfer or coating as a

technique of forming a cover layer, it is preferable to form the cover layer on a part of the surface of a glass substrate by forming the coat layer on the entire surface of the glass substrate and, then, cutting and removing the cover layer corresponding to a portion which requires to be etched. On the other hand, when using screen printing as a technique of forming a cover layer, it is preferable to form the cover layer on a part of the surface of a glass substrate by applying a raw material of a cover material to a part of the surface of a glass substrate through a screen corresponding to a pattern.

It is noted that in the present invention a cover layer may be formed either on one side of a glass substrate or on both sides thereof. In the case where the cover layer is formed only on one side of a glass substrate, when a thin glass substrate is not demanded, it can be produced by conducting etching, which is described later, with a cover layer disposed on the entire surface of the other side of the glass substrate through application of a raw material of a cover material thereto. In the case where the coat layer is formed only on one side of a glass substrate, when a thin glass substrate is demanded, it can be produced by conducting etching without applying nothing to the other side of the glass substrate.

(Etching Step)

The etchant used in the present invention contains hydrofluoric acid as an essential etching component. The

etchant is used preferably at a concentration of hydrofluoric acid within the range from 1 to 45% by weight, more preferably from 1 to 10% by weight, and still more preferably from 2 to 5% by weight. In particular, when patterning as in the present invention, a hydrofluoric acid concentration exceeding 45% by weight will result in a too high etching rate, which will cause an adverse effect of affecting the smoothness of an etched glass portion. On the other hand, a hydrofluoric acid concentration of lower than 1% by weight will result in a too low etching rate, which will require a too much time for etching.

In the present invention, from the viewpoint of controlling the etching rate, preferably used is an etchant containing at least one inorganic acid selected from hydrochloric acid, sulfuric acid, nitric acid and phosphoric acid in addition to hydrofluoric acid.

In the present invention, from the viewpoint of preventing reaction products such as silicofluoride compounds caused by etching from attaching to a glass substrate, preferably used is an etchant containing at least one surfactant selected from carboxylic acid based surfactants, phenol based surfactants, amide based surfactants, fatty acid ester based surfactants, phosphoric acid ester based surfactants, sulfuric acid ester based surfactants, sulfonic acid ester based surfactants, amine based surfactants, ether based surfactants and macromolecular alcohols in addition to hydrofluoric acid. In other words, when

conducting etching by use of such an etchant, it is possible to prevent etched portions from causing undulation or pits.

In this step, it is preferable to etch the front surface and/or the back surface of a glass substrate into a depth of 1 μm or more, preferably 100 to 700 μm by immersing the glass substrate in the etchant or applying the etchant to the glass substrate.

When immersing a glass substrate in an etchant, it is preferable to conduct etching by causing a predetermined size of processing vessel to contain the etchant and making the etchant flow. In this case, the etching capacity can be enhanced by use of a processing vessel which can accommodate several tens of glass substrates therein. Attachment of a thermoregulation device to the processing vessel is convenient for condition management in the etching step because it becomes possible to achieve a constant etching. The reaction temperature in this step is not limited particularly, but it usually is preferable to conduct etching within or around the temperature range from 20 to 50°C by appropriately designing the composition of the etchant.

This step may also be carried out in such a manner that the etchant is discharged from the processing vessel continuously while the reaction products caused by the etching are filtered off through a filter or the like and the filtered etchant is introduced to the processing vessel again. By using

an etchant while circulating it in such a manner, it is possible to supply an etchant which always is fresh and has a uniform composition. Therefore, a highly accurate etching treatment can be conducted with stability even when the etching treatment is conducted continuously.

In this step, a device which continuously generates bubbles of nitrogen gas or the like from the lower part of the processing vessel can also be used. Use of such a device can stabilize etching conditions because bubbles remove reaction products formed on the surface of a glass substrate during the etching. In order to enhance the effect of removing reaction products by bubbles, it is preferable to hold a glass substrate vertically or obliquely depending on the viscosity of the etchant or the etching conditions. In particular, preferred is an obliquity from 5 degrees to 45 degrees from the vertical.

(Removal Step)

In the removal step, after the end of the etching step, a glass substrate is washed by an appropriate method and the cover layer formed on the surface of the glass substrate is peeled off by an appropriate method.

Next, the present invention will be described based on drawings showing the embodiments thereof. Figs. 1(a) to 1(f) illustrate a process for producing a glass substrate for ELD according to the present invention, which schematically show a basic process of patterning. The following is a description of a

method for forming a pattern.

A cover layer 2 is formed on the surface of a glass substrate 1 which will be subjected to pattern formation (Figs. 1(a) and 1(b)). The raw material of a cover material to be applied to the glass substrate 1 is not limited particularly as long as it is of excellent acid resistance. Polystyrene based resin, polyester based resin, polyamide based resin and polyethylene based resin are preferably used. The glass substrate is also not limited particularly. In general, soda-lime glass and non-alkali glass are preferably used.

Subsequently, the cover layer is cut along the outline of a pattern by cutting or punching. Thus, a necessary portion in the surface of the glass substrate 1 is made uncovered (Figs. 1(c) and 1(d)). In Fig. 1(c), the edged tool 3 for cutting is pressed to the substrate 1 perpendicularly. After that, a specific portion of the cover layer 2 is removed (Fig. 1(d)). The removed portion corresponds to the substrate portion to be deleted by patterning.

When the treatment shown above is finished, the glass substrate 1 is coated with an etchant or is immersed in the etchant to form thereon a pattern of a shape to be required (Fig. 1(e)). In Fig 1(e), arrows 4 show patterned direction. When the glass substrate 1 is immersed in the etchant, the etching amount is controlled at a level as deep as several micrometers by rendering the etchant composition and the temperature distribution uniform. In addition, reaction products are

prevented from attaching the glass substrate again.

Finally, the glass substrate 1 is washed and the cover layer 2 is peeled off by an appropriate method (Fig. 1(f)). Although in the example shown in Figs. 1(a) to 1(f) the etching treatment is applied on only one side of the glass substrate 1, both sides of the glass substrate may be etched. In this case, reduction in thickness is achieved through the etching treatment with respect to uncovered portions of the surfaces. When only one side is subjected to the etching treatment, a raw material of a cover material may be applied to the entire rear surface of the glass substrate 1.

It is preferable to hold the glass substrate vertically or obliquely depending on the viscosity of the etchant or the etching conditions. In use of the bubble generator which will be described in examples given below, to incline a glass substrate results in an effect of removing reaction products attached to the surface of a glass substrate by bubbles. The angle of the inclination is preferably from 5 degrees to 45 degrees from the vertical.

Fig. 2 illustrates an example of patterning of a body portion of a substrate used for LCD and ELD. Fig 2(a) is a plain view, and Fig 2(b) is a view taken along the line A-A of Fig. 2(a). Fig. 3 illustrates a glass substrate used for PDP, which is patterned in a matrix form.

Fig. 4 illustrates a glass substrate used for ELD, which is

patterned in a step form in a body portion of it. Fig 4(a) is a plain view, and Fig 4(b) is a view taken along the line B-B of Fig. 4(a). Fig. 5 illustrates an example of applying patterning to a laminate of glass substrates. In Fig 5, non-patterned substrate 5a and patterned substrate 5b form a lamination. Fig 5(a) is a plain view, and Fig 5(b) is a view taken along the line C-C of Fig. 5(a). Although the forms described above are illustrated here as glass substrates for FPD, various pattern forms such as a circular patterning and a polygonal patterning are also available. The size of the patterning can be controlled even at a level of several tens of micrometers.

The present invention will be described in detail with reference to examples. The invention, however, is not limited at all by these examples.

(Glass Substrate)

A non-alkali glass substrate (10 cm × 10 cm, 1.1 mm in thickness) was used as a glass substrate.

(Etchant)

An etchant containing 3% of hydrofluoric acid and 5% of sulfuric acid as etching components was prepared using water as a solvent.

(Covering)

The entire of both sides of the glass substrate was covered using a polystyrene based resin as a raw material of a cover

material.

(Patterning of Cover Layer)

The cover material in the portion where etching was to be applied was cut and removed.

(Processing Vessel)

A processing vessel was constituted of a holding section where a glass substrate is held at a constant angle, a bubble discharge section where bubbles are formed from a lower portion of the holding section through introduction of gas, and a circulation section where an etchant is circulated. In addition, experiments were carried out while the processing vessel was heated to 40°C.

(Results)

It was confirmed that a glass substrate itself was etched in a depth of 300 μm through an operation for 90 minutes under the above conditions. The portions not to be etched were covered with the cover layer. When the cover material was removed finally, the thickness of the etched portion was measured randomly at 20 points. The maximum variation in the thickness was 5 μm .

What is claimed is:

1. A process for producing a glass substrate for a flat panel display, the glass substrate having a surface patterned in a predetermined form, the process comprising the steps of: forming a cover layer on a part of the surface of a glass substrate; etching the surface of the glass substrate except the part having the cover layer formed thereon by a treatment using an etchant containing hydrofluoric acid; and removing the cover layer, wherein

the cover layer is formed by film transfer using a resin selected from epoxy resin, polyvinyl acetal resin, polyester resin and fluororesin as a raw material of a cover material.

2. A process for producing a glass substrate for a flat panel display, the glass substrate having a surface patterned in a predetermined form, the process comprising the steps of: forming a cover layer on a part of the surface of a glass substrate; etching the surface of the glass substrate except the part having the cover layer formed thereon by a treatment using an etchant containing hydrofluoric acid; and removing the cover layer, wherein

the cover layer is formed by coating a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or by coating a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent.

3. A process for producing a glass substrate for a flat panel display, the glass substrate having a surface patterned in a predetermined form, the process comprising the steps of: forming a cover layer on a part of the surface of a glass substrate; etching the surface of the glass substrate except the part having the cover layer formed thereon by a treatment using an etchant containing hydrofluoric acid; and removing the cover layer, wherein

the cover layer is formed by screen printing using a resin as it is which is selected from polystyrene based resin, polyamide based resin, polyester based resin and polyethylene based resin or by screen printing using a solution as a raw material of a cover material, the solution being obtained by dissolving the resin in a solvent.

4. The process for producing a glass substrate for a flat panel display according to any of claims 1 to 3, wherein the etchant contains at least one inorganic acid selected from hydrochloric acid, sulfuric acid, nitric acid and phosphoric acid in addition to hydrofluoric acid.

5. The process for producing a glass substrate for a flat panel display according to any of claims 1 to 4, wherein the etchant contains at least one surfactant selected from carboxylic acid based surfactants, phenol based surfactants, amide based surfactants, fatty acid ester based surfactants, phosphoric acid ester based surfactants, sulfuric acid ester based surfactants,

sulfonic acid ester based surfactants, amine based surfactants, ether based surfactants and macromolecular alcohols in addition to hydrofluoric acid.

6. A glass substrate for a flat panel display, the glass substrate being produced by the process according to any of claims 1 to 5.