

TITLE OF THE INVENTION
GLASS SUBSTRATE FOR ELECTRONIC DEVICE AND METHOD OF PRODUCING
ELECTRONIC DEVICE

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of producing a glass substrate for use in an exposed part of an electronic
10 device such as a display device, and a method of producing such an electronic device.

2. Description of the Prior Art

In an exposed part of a display device or the like, it
15 is necessary to provide a transparent covering member for preventing breakage and stain. While plastic is the most convenient as the covering member, application of glass which is superior to plastic in visibility, durability, acid resistance, heat resistance and the like is also proposed
20 (Japanese Unexamined Patent Publication No. 2007-241179).

Also for a touch panel in a touch panel-incorporated liquid crystal display, using glass in place of a film material such as PET (polyethylene terephthalate) is advantageous because of less restriction in production process and ability
25 of taking advantage of the aforementioned merits of glass.

However, when glass is used in an exposed part of an electronic device, it is necessary to take the best measures for preventing the touch panel and the cover glass from being broken during production and use of the electronic device. It is also important to take a measure for preventing glare in the glass surface due to reflection.

The present invention was devised in consideration of the above problems, and it is an object of the present invention to provide a glass substrate for electronic device enabling effective utilization of merits of glass by ameliorating brittleness of glass physically without causing increase in production cost, and to provide an electronic device.

SUMMARY OF THE INVENTION

For achieving the above object, in a production method of glass substrate according to claim 1, a plurality of glass substrates for electronic device are produced from one sheet of glass base material, through a resist step (ST2) for providing a resist layer having hydrofluoric acid resistance on a front face side of front and back faces of the glass base material; a partition step (ST3) for partitioning the glass base material into a plurality of use areas by forming a partition line that does not penetrate the glass base material from the front face side of the glass base material by laser light or a cutter blade; and an etching step (ST4) for etching the glass

base material having undergone the partition step to thin the glass base material from a back face side, while deepening the partition line.

In the etching step of the present invention, the etching treatment is preferably executed while the glass base material with the back face side up is held in a horizontal position. In the etching step, it is preferred to spray a chemical polishing liquid on the front and back faces of the glass base material.

In a production method of glass substrate according to claim 2, a plurality of glass substrates for electronic device are produced from one sheet of glass base material, through a resist step (ST11-ST13) for providing a front face resist layer having hydrofluoric acid resistance discretely on a front face side of front and back faces of the glass base material, while providing a back face resist layer having hydrofluoric acid resistance on a back face side of the glass base material in a position corresponding to the front face resist layer; a partition step (ST14) for partitioning the glass base material into a plurality of use areas by forming a partition line that does not penetrate the glass base material by etching the part where no resist layer is provided in the glass base material; and an etching step (ST16) for etching the entire glass base material in the condition that the front face resist layer and the back face resist layer are peeled off, to thin the glass

base material, while deepening the partition line.

In a production method of glass substrate according to claim 3, a plurality of glass substrates for electronic device are produced from one sheet of glass base material, through a resist step (ST21-ST23) for providing a front face resist layer having hydrofluoric acid resistance discretely on a front face side of front and back faces of the glass base material, while providing a back face resist layer having hydrofluoric acid resistance on a back face side of the glass base material in a position corresponding to the front face resist layer; a separation step (ST24) for separating the glass base material into a plurality of use areas of glass substrate by etching the part where no resist layer is provided in the glass base material; and a deformation step (ST25) for deforming a center region of plate thickness in a glass end face into an arc face by further etching the end face of the glass substrate.

A production method of electronic device according to claim 9 includes the step of incorporating the glass substrate into an electronic device as a cover glass contacting a user. Here the expression contacting a user means concept including direct contact and indirect contact, and for both cases, the cover glass allows artificial press.

A production method of electronic device according to claim 10 includes the step of incorporating the glass substrate into an electronic device as a member of user side in a touch

panel of a touch panel-incorporated display device. This member on the user side also allows artificial press.

In any of the above inventions, a plurality of glass substrates are produced from one sheet of glass base material, however, since circumference of the glass substrate will not be cut physically, a crack or the like will not occur, and mechanical strength is greatly improved. In brief, it is often the case that a crack existing in circumference, in particular, becomes a starting point of breakage in glass, however, the glass substrate produced in the present invention lacks a crack in circumference of the glass substrate, so that brittleness of the glass is greatly ameliorated.

In the invention according to claim 1 or claim 2, since an etching step is provided to thin a back face of the glass base material, or a front face and a back face of the glass base material, a crack will not remain not only in circumference of the glass substrate but also at least in the back face. Since artificial external pressure is applied on a front face side of the glass substrate having an antireflection coating, when a crack remains on the back face side, glass may break from that point. However, there remains no crack on the back face of the glass substrate of the present invention, so that physical strength of the glass substrate can be improved. Therefore, excellent strength is realized even when it is used as a cover glass of a display device, for example. The glass substrate

of the present invention can be effectively used also as an alternative of a film material used as a touch panel.

In the present invention, since an etching step is provided, even if acute angle arises in a circumferential part during a partition step, the angle is smoothened roundly in the etching step. Therefore, even if something comes into contact with the glass circumference during the subsequent production step, the probability of occurrence of a new crack is greatly reduced.

10 In the present invention, while the partition line is not necessarily made penetrate in the etching step, mechanical strength of the glass substrate can be improved maximally by making the partition line penetrate. On the other hand, when an embodiment that the etching step ends before the partition
15 line penetrates is employed, a peel-off treatment for removing a resist layer is facilitated and secured. That is, although the glass base material has a partition line, the production efficiency will not be deteriorated because the peel-off treatment can be executed as a unit as a whole. On the other
20 hand, when the coating layer is removed after separation into individual glass substrates, an operation of aligning the individual glass substrates is required.

In the case of an invention according to claim 1 wherein a resist layer is provided only on a front face of the glass
25 base material, it is preferred to form a resist layer by exposing

a dry film resist layer pasted on the glass base material to light. On the other hand, in the case of the invention according to claim 2 or claim 3 wherein a resist layer is provided on a front face and a back face of the glass base material, the glass
5 base material may be masked by dipping the glass base material in a masking agent without limited to the aforementioned method.

The antireflection coating extinguishes reflection waves by phase difference between reflection light on the front face of thin film and reflection light on the back face of the thin
10 film, and preferably includes a SiO_2 layer, a TiO_2 layer, a SiO_2 layer, a TiO_2 layer, and a SiO_2 layer laminated in this order on the glass front face by sputtering. Indium tin oxide ITO layer may be provided in place of titanium oxide TiO_2 layer, and a four-layer structure made up of a SiO_2 layer, a TiO_2 layer,
15 a SiO_2 layer, and a TiO_2 layer may be employed in place of the five-layer structure.

Preferably, the glass base material should be alkaline glass. Since alkaline glass is inexpensive, it is efficient, for example, as a cover glass of an electronic device, and exerts
20 more excellent transmissivity than an acryl board and the like. It is also superior to an acryl board and the like in durability including acid resistance and heat resistance as well as in visibility.

According to the present invention as described above,
25 it is possible to produce a glass substrate in which brittleness

of glass is ameliorated, and to realize an electronic device effectively utilizing merits of glass.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a flow chart illustrating a first production method of a glass substrate;

 Fig. 2 is a flow chart illustrating a second production method of a glass substrate;

 Fig. 3 is a plan view illustrating a structure of a photo
10 mask;

 Fig. 4 is a plan view showing a glass substrate provided with a resist layer;

 Fig. 5 is a flow chart illustrating a third production method of a glass substrate; and

15 Fig. 6 is a plan view showing a glass substrate provided with a resist layer.

DETAILED DESCRIPTION OF THE INVENTION

 In the following, the present invention will be described
20 in detail by way of embodiments.

<First Embodiment>

 Fig. 1 is a flow chart illustrating a production method of a glass substrate according to a first embodiment. Here, a glass substrate produced through steps ST1 to ST6 is used,
25 for example, as a cover glass of a liquid crystal display of

a mobile phone. The glass substrate may also be used as a glass substrate on the user side forming a touch panel-incorporated liquid crystal display. In a touch panel-incorporated liquid crystal display, since one of two glass substrates also serves
5 as a glass substrate of touch panel, a glass substrate produced in the process of Fig. 1 is used as the glass substrate on the user side facing the glass substrate constituting the liquid crystal display.

In the following, description will be given with
10 reference to Fig. 1. In the present embodiment, alkaline glass GL having an area of about 400×500 mm, thinned to 1 mm or less (preferably about 0.7 mm) is used. First, on either side (for example, front face side) of front and back faces of a glass base material GL, an antireflection coating is formed (ST1).
15 Concretely, on the glass base material GL, a silicon dioxide SiO_2 layer and a titanium oxide TiO_2 layer are laminated repeatedly plural times by sputtering.

It is preferable, but not limited, to form five films of SiO_2 (Fa1 layer), TiO_2 (Fb1 layer), SiO_2 (Fa2 layer), TiO_2 (Fb2
20 layer), and SiO_2 (Fa3 layer) in this order, as shown in Fig. 1(a). And in this case, the Fa1 layer is formed into a film thickness of about 100-700 angstroms, the Fb1 layer is formed into a film thickness of about 100-300 angstroms, the Fa2 layer is formed into a film thickness of about 100-500 angstroms, the
25 Fb2 layer is formed into a film thickness of about 500-1500

angstroms, and the Fa3 layer is formed into a film thickness of about 100-1000 angstroms.

Subsequently, dry film resist is pasted on a front face of the glass base material GL so as to cover the antireflection coating, which is then irradiated with UV to form a resist layer RS having hydrofluoric acid resistance (ST2). Fig. 1(a) shows relation of lamination among the glass base material GL, the antireflection coating and the resist layer RS.

Then, laser light is emitted on top face of resist layer RS, to modify the glass base material GL along a partition line (ST3). Since a partition line by laser light is formed to have such a depth that does not penetrate the glass base material, integrity of the glass base material is kept even after the treatment in step ST3. Usually, glass base material GL is partitioned into rectangles of about 40 mm x 70 mm by this partition line, however, it may certainly be partitioned into any other shape including an approximate circular shape.

In place of laser light irradiation, a scribe machine may be used, and in that case, a partition line which is a notch GV is formed by a cutter blade (ST3'). Fig. 1(b) shows a glass base material formed with the partition line GV, and also in this case, since the partition line GV does not penetrate the glass base material GL, integrity of the glass base material GL is maintained.

Next the glass base material GL having undergone the

treatment of step ST3 or step ST3' is etched with a chemical polishing liquid containing hydrofluoric acid (ST4). The chemical polishing liquid preferably contains 1-10% by weight of hydrofluoric acid and 20-50% by weight of sulfuric acid.

5 Concentration of hydrofluoric acid is preferably 1-5% by weight, and more preferably 1-3% by weight. Also concentration of sulfuric acid in this polishing liquid is preferably 30-45% by weight, and more preferably 35-42% by weight.

By this etching treatment, the part not covered with the resist layer RS in the glass base material GL is etched, so that

10 the partition line GV is deepened, and the glass base material GL is thinned from back face side. As a result, even if a crack occurs during formation of the partition line GV or during subsequent transportation, the crack can be extinguished.

15 An etching amount is appropriately selected, and when plate thickness of the glass base material GL is about 0.7 mm, the glass base material GL is thinned to about 0.6-0.5 mm by the treatment of step ST4, resulting that the partition line will actually penetrate the glass base material GL. The glass

20 base material thinned to such an extent can be freely bent to an angle of 90° or less, however, in this embodiment, since the partition line GV is surface-smoothed while the glass base material GL is thinned, there is no crack in an end face of the glass substrate cut out from the glass base material GL, and

25 excellent cracking strength is exerted.

By the way, in the treatment of step ST4, it is preferred to spray the chemical polishing liquid in a shower form both on the front face and the back face of the glass base material GL that is held in a horizontal position with the back face side of the glass base material GL not covered with the resist layer RS up. Glass base material GL is accommodated, for example, in a special storage case, and by forming the bottom face of the storage case into a mesh, it is possible to directly apply the chemical polishing liquid to the partition line GV. Further, since the partition line GV opens downward, a reaction product by the etching treatment will not remain and adhere in the partition line GV.

Further, with the above configuration, since glass base material GL is kept in a horizontal position, the glass substrate separated from the glass base material GL will not dissociate discretely even when the partition line GV is deepened. On the other hand, when the glass base material is dipped in a chemical polishing bath, the glass base material will be urged by the chemical polishing liquid and easily crack along the partition line, and the glass substrate will dissociate discretely.

Once the etching treatment of step ST4 ends as described above, the resist layer RS is peeled off to complete a cover glass for a display device (ST5).

<Second Embodiment>

Fig. 2 is a flow chart illustrating a production method of a glass substrate according to a second embodiment. This glass substrate is also used as cover glass of a display device. The glass substrate may also be used as a glass substrate on the user side forming a touch panel-incorporated liquid crystal display.

Also in this embodiment, first an antireflection coating is formed on either face of the glass base material GL (ST10). Structure of the antireflection coating is as same as that of the first embodiment, and five layers of SiO_2 (Fa1 layer), TiO_2 (Fb1 layer), SiO_2 (Fa2 layer), TiO_2 (Fb2 layer), and SiO_2 (Fa3 layer) are formed in this order, as shown in Fig. 2(a).

Next, a photosensitive film material Fi is pasted on a front face and a back face of the glass base material GL (ST11). The photosensitive film material Fi used in the embodiment is formed of a laminate of a translucent base film 1, a photosensitive layer 2, and a release film 3, as shown in Fig. 2(b). And after peeling off the release film 3 from the photosensitive film material Fi, the photosensitive film material Fi is pasted on the front face and the back face of the glass base material GL by a rotor.

Then the entire glass base material GL is covered with a photo mask 4 for partitioning of the glass base material GL into a plurality of use areas of about 40 mm x 70 mm. Fig. 3 is a plan view illustrating the photo mask 4, and an unexposed

part 4A (light blocking part) having a line width of about 1 mm to 5 mm is provided in a rectangular ring like form in a circumferential part of a use area 4B as a glass substrate. Fig. 2(c) is a cross section view showing the condition that the photo mask 4 is placed. An unexposed part 4A of the photo mask 4 specifies a polishing line (partition line GV) in the etching treatment.

Subsequently, UV radiation is effected from above the photo mask 4 to make an exposed part 2B of the photosensitive layer 2 light cure (ST12). And the glass base material GL in this condition is developed with an alkaline solution, to remove an unexposed part 2A of the photosensitive layer 2 (ST13). Through the treatments as described above, the front face and the back face of the glass base material GL are covered with the resist layer 2B having hydrofluoric acid resistance except for the unexposed part 2A. Fig. 4 is a plan view showing this condition, and depicts the resist layer 2B that will not be etched and the partition line GV that will be etched.

Next, the glass base material GL covered with the resist layer 2B is dipped in a chemical polishing bath, and etched (primary etching) with a chemical polishing liquid (ST14). The chemical polishing liquid preferably contains 1-10% by weight of hydrofluoric acid and 20-50% by weight of sulfuric acid. Concentration of hydrofluoric acid is preferably 1-5% by weight, and more preferably 1-3% by weight. Concentration of sulfuric

acid in this polishing liquid is preferably 30-45% by weight and more preferably 35-42% by weight.

In the etching step of step ST14, it is preferred that the glass base material GL is positioned upright, and micro
5 bubbles are allowed to continuously rise along the front face and the back face of the glass base material GL. With such a configuration, it is possible to prevent an eluted glass component (reaction product) from adhering again to the partition line GV where the resist layer 2B is absent. In this
10 embodiment, since the partition line GV is as thin as about 1-5 mm, partial variation in polishing rate may occur unless re-adhesion of the reaction product is prevented, and the etching depth of the partition line GV cannot be equalized.

In this manner, the partition line GV is deepened, and
15 the primary etching treatment of step ST14 is ended in the timing that plate thickness of the glass base material GL in that part reaches about 100-300 μm . Fig. 2(e) depicts the glass base material GL at the end of the primary etching, and shows that an edge angle ED is formed in an upper end of the partition line
20 GV. This edge angle tends to be closer to 90 degrees as the polishing rate increases.

Then the glass base material GL is dipped into a peel-off bath, to remove the resist layer 2B (ST15). Subsequently, the glass base material GL is placed in an appropriate storage unit,
25 and a chemical polishing liquid is sprayed in a shower form on

the front face and the back face, to execute a finish etching treatment (ST16). While the glass base material GL is placed in a horizontal position in the storage unit, the front face and the back face of the glass base material may be inversed
5 in an appropriate timing.

Anyway, by executing such an etching treatment, the partition line GV is further deepened, and also the front and back faces of glass are etched. As a result, even when a relatively acute edge angle ED arises in the partition line GV
10 during the primary etching (ST14), the edge angle ED will be smooth-faced. Further, since the glass front face and back face are etched, even if fine cracks remain on the glass front and back faces, these can be extinguished.

And the finish etching treatment is ended when the upper
15 and lower two partition lines GV penetrate. As described above, in the present embodiment, since the finish etching (ST16) is executed after the primary etching for forming the partition line GV (ST14), a separation treatment and a face-smoothing treatment of glass substrate are executed by the finish etching,
20 so that a firm glass substrate can be produced.

Further, since the glass substrate is eventually thinned to about 0.5 mm or less, flexibility comparable to that of plastic can be exerted. Therefore, for example, in a production process of a display device, merits of glass including acid
25 resistance and heat resistance are effectively exerted.

Further, as a cover glass, excellent visibility and durability are exerted.

When an additional etching treatment (ST25) similar to that of the third embodiment is provided following the finish etching (ST16), it is possible to deform an end face of the glass substrate (within the range of $-\alpha t$ to $+\alpha t$ from center O of plate thickness) into an arc face, and to further increase the glass strength (see Fig. 5(b)).

Radius of curvature R of the arc face should be preferably 0.4t or higher, and more preferably 0.5t or higher for all ($\alpha = 0.5$) or most ($0.5 > \alpha \geq 0.35$) of the glass end face having a plate thickness t. Other content of the additional etching is as same as that of the secondary etching of the third embodiment (ST25), and the range to be deformed into arc face ($-\alpha t$ to $+\alpha t$) and an evaluation method of radius of curvature R are also as same as that in a third embodiment.

While embodiments are described in detail above, the specific description will not particularly limit the present invention. In particular, not limited to the production method of the embodiment using a photosensitive film for masking treatment, it is also preferred to form a coating layer by dipping the glass base material GL into a liquid bath retaining a masking material in the case of the second embodiment, for example. With such a configuration, the coating layer can be provided also in the circumference of the glass base material.

<Third Embodiment>

While the etching treatment is executed after peeling off the resist layer 2B in the second embodiment (ST15, ST16), the etching treatment may be conducted while the resist layer 2B remains. However, in this case, since glass base material GL is not thinned, it is preferred to thin it in advance to an appropriate plate thickness (preferably, about 0.4-0.6 mm or less) by an etching treatment.

Fig. 5 is a flow chart and a schematic view for illustrating the third embodiment. A glass substrate produced in the third embodiment is used, for example, as a cover glass of a liquid crystal display of a mobile phone. Also, the glass substrate may be used as a glass substrate on the user side constituting a touch panel-incorporated liquid crystal display.

In the third embodiment, in place of pasting a photosensitive film material, a photosensitive film is provided by a dipping method (ST21). In the dipping method, a glass base material GL in a vertical position is dipped in a bath containing a coating liquid (photosensitive agent), and the glass base material GL is drawn up at a rate corresponding to viscosity of the coating liquid, to form a photosensitive film having a predetermined film thickness. Prior to the treatment of step ST21, the glass base material GL may or may not be provided with

an antireflection coating.

Next, the glass base material GL is covered with a photo mask 4 so as to partition the entire glass base material GL into a plurality of use areas, and UV radiation is effected from above the photo mask 4 to make an exposed part 2B of the photosensitive layer 2 light cure (ST22). Then the glass base material GL in this condition is developed with an alkaline solution, to remove an unexposed part 2A of the photosensitive layer 2. (ST23).

Through these treatments, the front face and the back face of glass base material GL is covered with a resist layer 2B having hydrofluoric acid resistance. Fig. 6 shows the resist layer 2B that will not be etched, and a partition line GV and an open window HO that will be etched. As depicted, the partition line GV is formed through length and breadth to achieve partition into use areas as glass substrates. The open window HO is formed into an oval shape inside a use area as a glass substrate. The open window HO turns into a through-hole by a primary etching treatment of step ST24.

Next, glass base material GL covered with the resist layer 2B is dipped in a chemical polishing bath, to effect primary etching with a chemical polishing liquid (ST24). This primary etching is effected until the glass base material GL is penetrated by etching the partition line GV and the open window HO in the direction of plate thickness of the glass base material GL. Therefore, at the end of the primary etching, the glass

base material GL is separated into a plurality of glass substrates 5 ... 5 by the partition line GV.

The primary etching (ST24) is executed for each glass base material GL while the inner area (25 sections in the example of Fig. 6) of the partition line GV is held. Preferably it is executed in such a manner that one glass base material GL is stored in one storage case, and a plurality of storage cases are dipped into a chemical polishing bath.

Polishing rate of the glass base material GL is preferably 5 $\mu\text{m}/\text{min}$ or less, and more preferably about 3 $\mu\text{m}/\text{min}$. This is because if the polishing rate is too high, a glass component (reaction product) eluted from the glass base material will adhere again to the etched partition line GV to deteriorate the flatness of the glass end face. Composition of the chemical polishing liquid is as same as that of the foregoing embodiments.

In either case, the glass base material GL is separated into a plurality of glass substrates 5 ... 5 at the end of the first etching. End face of each glass substrate 5 is slightly sharp and forms an acute angle, as shown in Fig. 5(b). Accordingly, a protruding portion PK can become an origin of cracking during use of the glass substrate 5.

In the third embodiment, as the primary etching ends, the plural storage cases holding the glass substrates 5 ... 5 are transferred to another chemical polishing bath, and end face

of each glass substrate 5 is further etched (ST25). Polishing rate of the secondary etching is preferably $4\text{ }\mu\text{m/min}$ or higher, and more preferably about $5\text{ }\mu\text{m/min}$.

As a result of such secondary etching, the partition line
5 GV and the open window HO are further etched and the protruding portion PK formed in end face of the glass substrate is deformed into an arc having radius of curvature R.

Fig. 5(c) shows an end face of the glass substrate 5 at the end of the secondary etching in an ideal manner. The
10 deformation of glass end face into an arc results from progression of etching in the horizontal direction in the drawing due to peeling of a terminal end part TE of the resist layer 2B from the glass GL. In other words, in the third embodiment, the resist layer 2B having adhesiveness of such a
15 degree that the terminal end part TE is peeled off to a certain extent by the etching liquid is formed.

However, in an actual production, the entire end face of the glass substrate 5 need not necessarily be deformed into a perfect arc face, and it suffices that the acute angular portion
20 of the protruding portion PF is deformed into an arc. That is, in the secondary etching (ST25), it suffices that the range of $-\alpha t$ to $+\alpha t$ from the center of plate thickness 0 of the glass substrate 5 having plate thickness t is deformed into an arc face having radius of curvature R (see Fig. 5(d)). Here, 0.35
25 $\leq \alpha \leq 0.5$ is satisfied, and all ($\alpha = 0.5$) or most ($0.5 > \alpha \geq$

0.35) of the end face of the glass substrate 5 becomes an arc face having radius of curvature R by the secondary etching (ST25).

The arc face having radius of curvature R has actually
5 a slightly wavy concavo-convex shape when an actual glass end face is observed under a microscope. When all or most of the actual glass end face falls within the range of $0.98R$ - $1.02R$, radius of curvature of the glass end face is evaluated as R in the present specification. In Fig. 5(e), an arc face having
10 radius of curvature R is represented by a solid line, and an arc face having radius of curvature $R_+ = 1.02R$ and an arc face having radius of curvature $R_- = 0.98R$ are represented by broken lines. Therefore, when all or most of the actual glass end face is positioned within the region represented by the broken lines
15 in Fig. 5(e), radius of curvature of the glass end face is evaluated as R .

By the way, polishing time is set so that radius of curvature R at the end of the secondary etching is preferably $0.4t$ or higher ($R \geq 0.4t$), and more preferably $0.5t$ or higher
20 ($R \geq 0.5t$) for all or most of the end face of glass having plate thickness t . Considering the production efficiency, it is preferred to set the polishing time so that radius of curvature R satisfies $0.4t \leq R \leq 0.6t$.

As the secondary etching as described above ends, the
25 storage case storing the glass substrate 5 is dipped into a

peel-off tank and the resist layer 2B is removed to complete the glass substrate 5 (ST26). Prior to the secondary etching treatment, the resist layer 2B may be removed, and in this case, the glass end face may be deformed into an arc face while the
5 glass substrate is thinned.

As described above, also by the third embodiment, it is possible to produce a glass substrate overcoming the brittleness of glass, and merits of glass including acid resistance and heat resistance can be effectively exerted.

What is claimed is :

1. A method of producing a glass substrate for producing a plurality of glass substrates for electronic device from one sheet of glass base material, comprising:

a resist step (ST2) for providing a resist layer having hydrofluoric acid resistance on only a front face side of front and back faces of the glass base material;

a partition step (ST3) for partitioning the glass base material into a plurality of use areas by forming a partition line that does not penetrate the glass material from the front face side of the glass base material by laser light or a cutter blade; and

an etching step (ST4) for etching both front and back faces of the glass base material having undergone the partition step to thin the glass base material from a back face side, while deepening the partition line from a front face side in such a manner that the partition line penetrate the glass base material to partition the glass base material.

2. A method of producing a glass substrate for producing a plurality of glass substrates for electronic device from one sheet of glass base material comprising:

A resist step (ST11-ST13) for providing a front face resist layer having hydrofluoric acid resistance discretely on a front face of front and back faces of the glass base material, while providing a back face resist layer having hydrofluoric acid resistance on a back face side of the glass

base material in a position corresponding to the front face resist layer;

a partition step (ST14) for partitioning the glass base material into a plurality of use areas by forming a partition line that does not penetrate the glass base material by etching the part where no resist layer is provided in the glass base material;

a peeling-off step (ST15) for dipping the glass base material into peel-off bath and removing the resist layer thereon; and

an etching step (ST16) for etching the entire glass base material in the condition that the front face resist layer and the back face resist layer are peeled off, to thin the glass base material, while deepening the partition line in such a manner that the partition line penetrate the glass base material to partition the glass base material (ST16).

3. A method of producing a glass substrate for producing a plurality of glass substrates for electronic device from one sheet of glass base material comprising:

a thinning step for thinning the glass base material in advance to 0.4-0.6 mm or less in thickness;

a resist step (ST21-23) for providing a front face resist layer having hydrofluoric acid resistance discretely on a front face side of front and back faces of the glass base material, while providing a back face resist layer having hydrofluoric acid resistance on a back face side of the glass base material in a position corresponding to the front face resist layer;

a separation step (ST24) for separating the glass base material into a plurality of use areas of glass substrate by etching on the part on the

front and back faces of the glass base material where no resist layer is provided in the glass

base material; and

a deformation step (ST25) for deforming a center region of plate thickness in a glass end face into an arc face by further etching the end face of glass substrate.

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4. The production method according to any one of claims 1 to 3, comprising a film formation step for forming an antireflection coating on the entire front face side of the glass base material prior to the resist step.

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5. The production method according to claim 2 or 3, wherein a completed glass substrate has a center region of plate thickness of glass end face deformed into an arc face, and radius of curvature R of the arc face satisfies $0.4t \leq R \leq 0.6t$ with respect to plate thickness t of the glass substrate.

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6. The production method according to claim 5, wherein the arc face is formed in a range of $-\alpha t$ to $+\alpha t$ ($0.35 \leq \alpha \leq 0.5$) based on center of plate thickness O of the glass substrate having plate thickness t .

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7. The production method according to claim 4, wherein as the antireflection coating, a SiO_2 layer, a TiO_2 layer, a SiO_2 layer, a TiO_2 layer, and a SiO_2 layer are laminated in this order on a glass front face by sputtering.

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8. The production method according to any one of claims 1 to 7, wherein the glass base material is alkaline glass.

5 9. A method of producing an electronic device comprising the step of incorporating the glass substrate produced by the production method of any one of claims 1 to 8, into an electronic device as a cover glass that will be in contact with a user.

10 10. A method of producing an electronic device comprising the step of incorporating the glass substrate produced by the production method of any one of claims 1 to 8, into an electronic device as a member of user side in a touch panel of a touch panel-incorporated display device.