

TITLE OF THE INVENTION

CARD HAVING AN IMAGE DISPLAYING FUNCTION

BACKGROUND OF THE INVENTION

5

1. Field of the Invention

The present invention relates to an IC card having an image displaying function, and more particularly to an IC card in which a displaying
10 element having an excellent strength, such as a liquid crystal cell or an organic EL, is used.

2. Description of the Prior Art

An IC card not only has a larger memory capacity
15 as compared with a magnetic card or the like but also has an advantage of having an operation processing function. However, with a conventional IC card, one cannot confirm the contents stored in the memory by eye inspection, so that this point is a great problem.
20 Therefore, development of an IC card having an image displaying function is in progress (See Japanese Patent Application Laid-Open (JP-A) No. 2003-270657).

In this invention, in consideration of bending deformation of the card, a liquid crystal cell using a
25 plastic substrate instead of a glass substrate is

proposed.

However, the plastic is inferior to glass in terms of chemical resistance and heat resistance, and in particular is outstandingly inferior to glass in terms of heat resistance, thereby raising a problem in that the plastic is thermally deformed during the production steps, so that one cannot arrange interconnect terminals and the like in a fine manner. Particularly, with a liquid crystal cell that is mounted on an IC card, the interconnect patterns and the internal elements must be reduced in scale to the limit, so that one cannot realize a liquid crystal cell having a commercial power as long as a plastic substrate is used.

Thus, completion of a glass substrate that realizes a display element such as a liquid crystal cell or an organic EL being strong against bending deformation while making most of the advantage of the glass is earnestly demanded. Specifically, a glass substrate of a display element is strongly desired that is not easily broken even if the liquid crystal screen is pressed with a finger or even if the IC card is bent.

The present invention has been made in view of the above problems, and an object thereof is to

provide an IC card having a display element mounted thereon that is hardly broken by a pressing force or a bending deformation.

5 SUMMARY OF THE INVENTION

In order to solve the aforementioned problems, the first aspect of the present invention is a card having an image displaying function and including a central controlling unit that collectively controls
10 all of the operations including a data transmitting and receiving process to and from an external apparatus; a displaying element that displays necessary information on the basis of an instruction from the central controlling unit; and a power supply
15 unit that supplies electric power to each unit of the card, wherein the displaying element is completed in such a manner that a bonded glass plate obtained by bonding a first glass plate exposed to a user and a second glass plate not exposed to the user to include
20 a plurality of displaying element regions therein is reduced in thickness to have a combined thickness of 0.60 mm or below by a mechanical or chemical process, followed by separation.

Here, the mechanical or chemical process
25 includes all of a chemical process alone, a physical

process alone, and a combined process of having a chemical process and a physical process. The chemical process specifically is a thinning process using an etchant containing hydrofluoric acid. In the present invention, the thickness of the glass plate as a whole is reduced to 0.6 mm or below, preferably 0.4 mm or below, by the chemical or mechanical process. Here, the image displaying function includes not only a function of displaying photographs and pictures but also a function of displaying characters and numerals, as described in the Examples.

In the present invention, both the first glass plate and the second glass plate are reduced in thickness by the mechanical or chemical process, whereby the cracks forming a base point of breakage can be eliminated during the step of etching the glass, so that a display element of a liquid crystal cell, an organic EL, or the like can be realized that is hardly broken by the external pressure.

Here, the displaying element preferably has a peripheral fringe end surface that is etched within a range that does not exceed 60 μm after the bonded glass plate is reduced in thickness and separated into individual elements. In this case also, since the peripheral fringe end surface that is mostly likely to

generate cracks can be smoothened by etching, the strength can be further increased. Here, researches made by the present inventors have confirmed that the strength does not change even if it is etched beyond
5 60 μm .

Also, the fourth aspect of the present invention is a card having an image displaying function, including a central controlling unit that collectively controls all of the operations including a data
10 transmitting and receiving process to and from an external apparatus; a displaying element that displays necessary information on the basis of an instruction from the central controlling unit; and a power supply unit that supplies electric power to each unit of the
15 card, wherein the displaying element has a combined thickness of 0.60 mm or below in which a second glass plate exposed to a user and a first glass plate not exposed to the user are bonded, a peripheral fringe of the second glass plate has a side surface that is
20 physically cut and separated, and a peripheral fringe of the first glass plate has a physically cut-out line formed therein that is smoothened by an etching process. In this invention also, the combined thickness of the glass plate is preferably 0.4 mm or
25 below.

In the present invention, since the peripheral fringe of the first glass plate is smoothened by an etching process, the cracks forming a base point of breakage are absent in the peripheral fringe of the first glass plate. For this reason, even if a bending force is applied in a direction from the second glass plate exposed to the user, the first glass plate that largely receives a tension is hardly broken.

Also, the fifth aspect of the present invention is a card having an image displaying function and including a central controlling unit that collectively controls all of the operations including a data transmitting and receiving process to and from an external apparatus; a displaying element that displays necessary information on the basis of an instruction from the central controlling unit; and a power supply unit that supplies electric power to each unit of the card, wherein the displaying element has a combined thickness of 0.60 mm or below in which a second glass plate exposed to a user and a first glass plate not exposed to the user are bonded, and peripheral fringes of the second glass plate and the first glass plate have a physically cut-out line formed therein that is smoothened by an etching process. The combined thickness of the glass plate is preferably 0.4 mm or

below.

In the present invention, since the peripheral fringes of the first glass plate and the second glass plate are smoothened by an etching process, the cracks forming a base point of breakage are absent in the peripheral fringe of each glass plate. For this reason, even if a bending force is applied in any direction, the glass plate is hardly broken.

The liquid crystal cell according to each aspect of the present invention preferably has a four-point bending strength of 120 MPa or above, more preferably 140 MPa or above, by a testing method according to JIS R 1601 (the bending strength testing method of fine ceramics). Here, assuming that the bonded glass plate having a thickness of t is a single member, the bending strength σ is calculated from $\sigma = 3P(L - l)/(2Wt^2)$. In the above formula, P , L , l , W , and t represent the maximum load, the interfulcrum distance, the interfulcrum distance (on the load side), the width of the test piece, and the thickness of the test piece, respectively.

Here, in the case of the fourth aspect of the present invention, the measurement is made by applying a stress in a direction from the second glass plate exposed to the user to the first glass plate not

exposed to the user. On the other hand, with the display element according to the third to fifth aspects of the present invention, the above-mentioned strength can be realized even if measurement is made
5 in any direction.

Also, in any aspect of the present invention, it is preferable that the first glass plate and the second glass plate each have a plate thickness of 0.10 mm or below and have a four-point bending strength of
10 4000 MPa or above by a testing method according to JIS R 1601. In this test, since the first glass plate and the second glass plate are separated, and individual glass plates are subjected to the measurement, each glass plate can be freely warped, so that a large
15 four-point bending strength is realized.

The displaying element having the above-described characteristics, with regard to the bonded glass plate in which the first glass plate and the second glass plate enclose a plurality of displaying
20 element regions, is preferably produced by executing, in this order, a first step of forming a first scribe line on a surface of the first glass plate; a second step of bringing an etchant into contact with the first scribe line; a third step of forming a second
25 scribe line, which corresponds to the first scribe

line, on a surface of the second glass plate of the bonded glass plate having passed through the second step, and a fourth step of applying a stress to the bonded glass plate in a direction from the second
5 glass plate exposed to the user to the first glass plate not exposed to the user, so as to cut and separate the bonded glass plate along the scribe line.

In this case, by performing liquid phase etching on the outer surfaces of the first glass plate and the
10 second glass plate, it is easy to restrain the arithmetic mean roughness (R_a) of the surface of the glass plate to be $0.005\text{ }\mu\text{m}$ or below and to restrain the maximum surface roughness (R_{max}) to be $0.06\text{ }\mu\text{m}$ or below. Here, the glass plate may be aluminosilicate
15 glass or borosilicate glass, and also includes aluminoborosilicate glass. As long as the glass plate has this composition, it may be any of alkali glass, low-alkali glass, and non-alkali glass.

Preferably, the displaying element is produced
20 further through a fifth step of bringing an etchant into contact only with the peripheral fringes of the first glass plate and the second glass plate after the fourth step. In this case, even if cracks are present in the peripheral fringe side surface of the glass
25 plate, these cracks disappear, thereby increasing the

strength of the bonded glass plate. Here, the amount of etching is suitably 10 μm to 60 μm . Even if the etching is carried out to 60 μm or above, the strength is not increased.

5 With the invention constructed as described above, a displaying element that adopts a glass substrate having a flexibility and being strong against the bending deformation can be realized, thereby realizing a card in which the breakage is
10 restrained even if a bending stress is applied.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an external view of an IC card according to the first Example;

15 Fig. 2 is an internal construction view of the IC card of Fig. 1;

Fig. 3 is an external view of an IC card according to the second Example;

20 Fig. 4 is an internal construction view of the IC card of Fig. 3;

Fig. 5 is an internal construction view of the IC card of the third Example;

Fig. 6 is a step view showing a part of the steps for producing a liquid crystal cell;

25 Fig. 7 is a model view describing the steps for

producing a liquid crystal cell; and

Fig. 8 is a model view describing the structure of bonded glass plates.

5 DETAILED DESCRIPTION OF THE INVENTION

Hereafter, the present invention will be described in further detail on the basis of the Examples. Fig. 1 is an external view of an IC card according to the first Example. Here, a contact-type
10 IC card that is utilized as a credit card is exemplified.

As shown in Fig. 1, the IC card CR of this Example is constructed in such a manner that an IC module MO is disposed in the upper left part of the
15 card, and a liquid crystal cell LCD is disposed on the right side of the card. Since this IC card CR is of contact-type, a connection terminal unit TM is formed on the upper surface of the IC module MO. Here, the reason why the liquid crystal cell LCD is disposed at
20 a position other than the central position is that, even if a force in the bending direction is applied at both ends of the IC card CR, the effect thereof may not be extended to the liquid crystal cell LCD.

Fig. 2 is a block diagram showing an internal
25 construction of the IC card CR. The IC card CR is

constructed to include a connection terminal unit TM
that is brought into contact with a connection
terminal of a card reader writer RW at the time of use,
a capacitor unit PW that supplies a direct current
5 voltage supplied from the card reader writer RW to
each unit and stores the electric power thereof, an IC
module MO including a CPU and a memory, a liquid
crystal driving unit CT that is controlled by the IC
module MO to execute a picture-drawing operation, and
10 a liquid crystal cell LCD that displays the contents
of a non-volatile memory (ROM: Read Only Memory) of
the IC module MO. For the capacitor unit PW, an
electric double-layer capacitor being excellent in the
electric capacitance per unit volume is used among the
15 capacitors being excellent in the charging
characteristics in a short period of time.

The IC card CR having the above-described
construction is mounted onto a card reader writer RW
that is disposed in a shop or the like at the time of
20 card payment. Then, through the connection terminal
unit TM, a direct current power supply voltage is
supplied from the card reader writer RW to the IC card
CR. Next, the face of the card owner is displayed on
the liquid crystal cell LCR on the basis of the data
25 stored in the non-volatile memory. For this reason,

the shop side that wishes to receive the amount to be paid with the IC card can identify the person with certainty.

Also, in parallel with this displaying operation,
5 the card reader writer RW reads the data of the memory (EEPROM: Electronically Erasable and Programmable Read Only Memory) of the IC module MO out through the connection terminal unit TM. Then, the remaining amount after receipt of the charge is written from the
10 card reader writer RW into the memory (EEPROM) of the IC module MO. Then, the liquid crystal cell LCD displays the remaining amount together with the charge for use of this time.

Then, even after the IC card CR is taken out
15 from the card reader writer RW, the displaying operation of the liquid crystal cell LCD is maintained by the direct current voltage stored in the capacitor unit PW, so that the card owner can confirm the remaining amount as well as the charge for use of this
20 time.

As shown above, the IC card CR according to the first Example has been described; however, the present invention is not limited to the construction shown in Figs. 1 and 2. Figs. 3 and 4 are an external view and
25 an internal construction view showing an IC card

according to the second Example which is an IC card of non-contact type that does not require a connection terminal unit TM. This IC card CR is constructed in such a manner that an operation unit WH is disposed in the lower left part of the card, and an antenna AN is incorporated in the upper part of the card. Also, as shown in Fig. 4, by disposing a solar cell PW in the card, the displaying function is enabled even in a state of being separated from the card reader writer RW.

Here, the transmission and receipt of data between the card reader writer RW and the IC module MO is executed via the antenna AN and the modulating and demodulating unit TR. Namely, the payment of the transaction charge is executed through a wireless line, and the amount after payment is written into the memory (EEPROM) of the IC module MO. Also, the amount after the payment is displayed on the liquid crystal cell LCD.

The operation unit WH is an input device which is also referred to as a scroll wheel and which is constructed in such a manner that numerous touch sensors are arranged in an annular shape. Then, by pressing any of the upper, lower, left, and right ones of the touch sensors arranged on a circumference or by

sliding on the circumference in a clockwise direction
or in the anticlockwise direction with a finger, an
instruction of the user can be transmitted. For this
reason, the card owner can confirm the remaining
5 amount and the history of use of the IC card after the
power supply is turned on by a suitable manual
operation. Also, even if identification of the person
is requested prior to the payment of the charge, the
photograph of the person can be displayed and shown to
10 the shop side.

Here, as still another Example, an IC card CR
that does not have a battery mounted thereon can be
made. Fig. 5 shows an IC card of the third Example,
which eliminates the need for incorporation of the
15 battery by realizing a power feeding operation through
a wireless line. Namely, by bringing the IC card CR
closer to the card reader writer RW, this IC card CR
is electromagnetically coupled with the card reader
writer RW. A high-frequency electromagnetic wave
20 transmitted from the card reader writer RW to the
antenna unit passes through a resonance circuit and is
converted into a direct current voltage in the
rectifying unit PW1. Then, this direct current
voltage is stored into the capacitor unit PW2. The
25 stored direct current voltage is used as a power

supply voltage of each unit. Here, the power feeding operation from the card reader writer RW to the IC card CR is continued to be executed also during the following data transmitting and receiving process.

5 For this reason, the IC module MO having received the power feeding operation can transmit necessary information to the card reader writer RW through the antenna unit AN. On the other hand, the card reader writer RW returns the information after
10 the payment to the IC module MO after the payment of the charge is carried out. Therefore, with this third Example as well, the remaining amount after the payment is written into the memory (EEPROM) of the IC module MO and is also displayed on the liquid crystal
15 cell LCD.

 In the meantime, all of the above-described Examples are greatly characterized in that a liquid crystal cell is mounted on an IC card CR. However, the IC card is typically housed in a rear pocket of
20 the trouser after being stored into a wallet or the like. For this reason, there is a high possibility that a pressing force may be applied on the surface of the IC card, or the IC card may receive a force in the bending direction.

25 Thus, a liquid crystal cell that is not easily

broken even with such an external force is produced by the following procedure. Fig. 6A is a production step flow diagram until a bonded glass plate 1 made of a first glass plate G1 and a second glass plate G2 and having a plurality of liquid crystal cell regions is cut and separated. Here, a bonded glass plate constructed with a second glass plate G2 exposed to a user and a first glass plate G1 not exposed to the user is thinned to the targeted plate thickness value T, and a cut-out groove having a suitable depth is formed. The targeted plate thickness value T is suitably set within a range of 0.1 to 0.60 mm in accordance with the kind of the IC card.

This production method is carried out by successively passing through an etching step (ST1) in which the bonded glass plate is chemically polished immediately near to the targeted plate thickness value; a first scribe step (ST2) in which a first scribe line which is a cut-out line is formed on a surface of the first glass plate G1 not exposed to the user; an additional etching step (ST3) in which an etchant is brought into contact with the first scribe line; a second scribe step (ST4) in which a predetermined second scribe line is formed on a surface of the second glass plate G2; a cutting and

separating step (ST5) in which the bonded glass plate is cut and separated by applying a stress to the scribe lines that are formed on the surfaces of the first glass plate and the second glass plate; and a
5 finishing etching step (ST6).

Fig. 8 is a view representing a bonded glass plate 1 serving as a target of cutting and separating, where Fig. 8A is a plan view, and Fig. 8B is a schematic cross-sectional view of Fig. 8A along the A-
10 A line. This bonded glass plate 1 is obtained by bonding a second glass plate G2 which will be exposed to the user to become an image displaying surface of the liquid crystal panel and a first glass plate G1 which will be a back surface plate of the image
15 displaying surface.

A thin film transistor and a transparent electrode are formed on the surface of the first glass plate G1 that is opposing against the second glass plate G2, and further an orientation film is laminated
20 (not illustrated). On the other hand, a color filter is formed to be sectioned into black matrices on a surface of the second glass plate G2 serving as the image displaying surface that is opposing against the first glass plate G1, and an overcoat, a transparent
25 electrode, and an orientation film are successively

laminated (not illustrated). The bonding of these glass plates G1 and G2 is carried out with a not-illustrated spacer, a sectioning resin 3, and an outer circumferential resin 7 interposed between the two glass plates G1 and G2. Here, a polarization plate is bonded on an outer surface of the bonded glass plate 1 after the finishing etching step (ST6).

A liquid crystal enclosing region 2 is present to intervene between the glass plates G1 and G2. This liquid crystal enclosing region 2 is sectioned by disposing a sectioning resin 3 at the time of bonding the glass plates G1 and G2. Here, an outer circumferential resin 7 is disposed between the glass plates G1 and G2 to surround all the liquid crystal enclosing regions 2, whereby a sealed space that obstructs the penetration of the etchant is formed.

Next, with reference to Fig. 7, the production method of the Example will be described. Fig. 7A, Fig. 7B, Fig. 7C, Fig. 7D, and Fig. 7E show the first scribe step (ST2), the additional etching step (ST3), the second scribe step (ST4), the cutting and separating step (ST5), and the finishing etching step (ST6), respectively.

Prior to the first scribe step (ST2), an etching step (ST1) is provided. The bonded glass plate 1 is

etched immediately near to the targeted value T to have a plate thickness of $T + \delta$. Here, the remaining etching value δ is 200 μm or below, preferably 20 to 120 μm , more preferably 20 to 80 μm for the bonded
5 glass plate 1 as a whole. Therefore, the remaining etching value in terms of each glass plate G1 and G2 is 100 μm or below, preferably 10 to 60 μm , more preferably 10 to 40 μm , disregarding the gap between the glass plates G1 and G2.

10 Thereafter, in the first scribe step (ST2), as shown in Fig. 7A, a scribe line 5a having a depth of about 10 to 15% of the plate thickness thereof is formed on the surface of the first glass plate G1. The scribe line 5a is formed by the circumferential
15 surface of a disk-shaped wheel cutter 4 made of diamond or a superhard alloy and having a sharp-edged circumferential surface. The scribe line 5a is for dividing each liquid crystal enclosing region 2, and is formed between adjacent liquid crystal enclosing
20 regions 2. This scribe line (cut-out line) 5a grows to become a cut-out groove by an etching process, and will be a cutting line of the glass plate G1 in the cutting and separating step (ST5).

 In the additional etching step (ST3) shown in
25 Fig. 7B, after an etchant is brought into contact with

the outer surface of the bonded glass plate 1, washing
with water that removes the etchant from the surface
of the bonded glass plate 1 is carried out. The
contact of the etchant is carried out by etching the
5 surfaces of the glass plates G1 and G2 containing the
scribe line 5a. The etching in the present step is
carried out by immersing the bonded glass plate 1 into
the etchant. The etchant is not specifically limited
as long as it is a glass-dissolving liquid; however,
10 an aqueous solution containing hydrogen fluoride at a
concentration of 55% or below is used.

In this additional etching step, the two glass
plates G1 and G2 are etched to become thin plates by
the amount of the remaining etching value δ (namely,
15 the additional etching amount). For this reason, by
this additional etching, the cracks on the surface of
the glass plate G1 that have been generated at the
time of forming the scribe line 5a are removed with
certainty. However, since the etching amount is
20 limited, the cut-out groove that has grown from the
scribe line 5a is not completely smoothened.

In the second scribe step (ST4) subsequent to
the additional etching step (ST3), as shown in Fig. 7C,
a second scribe line 5b that will be the cutting line
25 of the glass plate G2 in the cutting and separating

step (ST5) is formed on the surface of the second glass plate G2. This second scribe line 5b is formed at a position corresponding to the first scribe line 5a, and is formed between adjacent display regions 2
5 by the wheel cutter 4.

In this manner, by this cutting and separating method, the scribe line 5b is formed on the second glass plate G2 for the first time in the second scribe step (ST4). Namely, the scribe line 5b that will be a
10 starting point of the glass breakage is not formed on the second glass plate G2 until this stage. Therefore, in the etching step (ST3) until the second scribe step (ST4) and in the step of transporting the bonded glass plate 1, the second glass plate G2 functions as a
15 mechanical reinforcing plate of the first glass plate G1.

In the cutting and separating step (ST5), as shown in Fig. 7D, the bonded glass plate 1 is cut and separated by using the scribe lines 5a and 5b as
20 cutting lines. In the present step, a stress is applied to the scribe lines 5a and 5b by a load, and the bonded glass plate 1 is cut and separated along the scribe lines 5a and 5b by this stress. Since the scribe line 5a has grown to become a cut-out groove
25 from which the cracks have been removed by the etching

process, the cut surface of the glass plate G1 after the cutting and separating process is smoother than the cut surface of the glass plate G2.

The load for cutting and separating is applied
5 in a direction from the second glass plate G2 having the second scribe line 5b disposed thereon to the first glass plate G1. Here, in accordance with the needs, a load may be applied thereafter in a direction from the first glass plate G1 to the second glass
10 plate G2. In any case, the bonded glass plate 1 is separated along the scribe lines 5a and 5b.

The bonded glass plate 1 that has been cut through the above-described steps is used as a liquid crystal cell. Breakage of this liquid crystal cell is
15 restrained with certainty even if the liquid crystal cell receives a load from outside, because the cut surface of the first glass plate G1 is a flat and smooth surface. Therefore, a polarization film may be bonded onto the liquid crystal cell at this stage;
20 however, in order to enhance the strength further, it is lastly subjected to the finishing etching step (ST7).

In the finishing etching step (ST7), as shown in Fig. 7E, the front and rear surfaces of the first
25 glass plate G1 and the second glass plate G2 excluding

the peripheral fringe side surfaces are covered with a masking member MS having a hydrofluoric acid resistance. This masking process may be carried out by screen printing or by bonding a sheet-shaped masking member MS. Also, the peripheral fringe between the first glass plate G1 and the second glass plate G2 is sealed with a sealing member SE having a hydrofluoric acid resistance. Here, the masking process may be executed prior to the cutting and separating process (ST5). In this case, the masking process is carried out so as not to cover the scribe lines 5a and 5b.

In any case, after the cutting and separating step, the side surfaces on the peripheral fringes of the first glass plate G1 and the second glass plate G2 are brought into contact with an etchant so as to etch only the peripheral fringe side surfaces (ST6). Here, it is effective to immerse the bonded glass plate 1 into an etchant tank. It is sufficient that the amount of etching is 60 μm or below. Even if the etching is carried out to exceed that amount, the strength is not increased further.

When the above-described etching processes are over, the flow proceeds to the work of bonding a polarization film after the masking member is peeled

off.

In the meantime, a four-point bending test by the testing method according to JIS R 1601 was carried out on the liquid crystal cell having passed through the finishing etching step. It has been confirmed that the four-point bending strength σ calculated by the following formula is 140 MPa or above. The four-point bending strength $\sigma = 3P(L - l)/(2Wt^2)$.

Here, P, L, l, W, and t represent the maximum load, the interfulcrum distance, the interfulcrum distance (the load side), the width of the test piece, and the thickness of the test piece, respectively.

In the above formula, when the plate thickness of the liquid crystal cell was 0.6 mm, the four-point bending strength of a plurality of samples having passed through the same steps was 138 to 264 MPa. Also, when the plate thickness was 0.3 mm, the four-point bending strength was 142 to 304 MPa. This shows that the smaller the plate thickness is, the better the result will be. Here, when the plate thickness is 1.0 mm, the result will be inferior (128 to 239 MPa) to the result in the case where the plate thickness is 0.6 mm.

With respect to a bonded glass plate 1 prior to proceeding to the finishing etching step (ST5), a

similar strength was confirmed when measurement was made by applying a stress in a direction from the second glass plate exposed to the user to the first glass plate not exposed to the user.

5 Also, when measurement was made by separating the first glass plate and the second glass plate constituting the bonded glass substrate into individual glass plates, a four-point bending strength of about 4000 to 7000 MPa was confirmed with respect
10 to the glass plate of 0.1 mm as a result of the four-point bending test by the testing method according to JIS R 1601. Here, the reason why individual glass plates have a larger strength seems to be that a member that obstructs the bending, such as in the
15 bonded glass plate, is absent.

As shown above, according to the above-described Examples, a liquid crystal cell that is hardly broken by a pressing force or bending deformation can be produced. Therefore, even if this is mounted on an IC
20 card, it will be sufficiently practicable. Here, the specific descriptions are not particularly intended to limit the scope of the present invention, so that it goes without saying that various changes of the design can be made. For example, the present invention can
25 be applied to an organic EL using a glass plate

instead of a liquid crystal cell, and an equivalent performance has been confirmed.

Also, in the above-described Examples, a bonded glass plate 1 having scribe lines 5a and 5b disposed thereon was reduced in thickness by an etching process. However, the bonded glass plate 1 may be reduced in thickness without disposing the scribe lines 5a and 5b. In such a case, the bonded glass plate 1 subjected to thinning is physically separated to cut out individual liquid crystal cells. In this case, since the first glass plate G1 and the second glass plate G2 are respectively etched, the cracks on the outer surfaces are removed, thereby improving the bending strength.

In this case, the four-point bending strength σ was such that, in the case where the plate thickness of the liquid crystal cell was 0.6 mm, the four-point bending strength of a plurality of samples having passed the same steps was 97 to 117 MPa. Also, in the case where the plate thickness was 0.3 mm, the four-point bending strength was 75 to 114 MPa. Here, it has been confirmed that, when the plate thickness is 1.0 mm, the result will be inferior (68 to 103 MPa) to the result in the case where the plate thickness is 0.6 mm.

In these Examples, in order to improve the

bending strength further, one may etch only the peripheral fringe end surfaces of the liquid crystal cell to obtain a smooth surface in a manner similar to that of Fig. 7E. In this case also, it is sufficient
5 that the amount of etching is less than 60 μm , so that it has been confirmed that a liquid crystal cell having a peripheral fringe end surface smoothened has an improved four-point bending strength σ of 140 MPa or above.

10 Here, it goes without saying that the present invention can be applied to a commute ticket for a railroad, a driver's license, a basic resident register, and the like in accordance with the usage of the IC card. Also, it can be used as a multiple-
15 function card in accordance with the data storage amount of the memory.

WHAT IS CLAIMED IS:

1. A card having an image displaying function,
comprising:

a central controlling unit that collectively
5 controls all of the operations including a data
transmitting and receiving process to and from an
external apparatus;

a displaying element that displays necessary
information on the basis of an instruction from the
10 central controlling unit; and

a power supply unit that supplies electric power
to each unit of the card,

wherein the displaying element is completed in
such a manner that a bonded glass plate obtained by
15 bonding a first glass plate exposed to a user and a
second glass plate not exposed to the user to include
a plurality of displaying element regions therein is
reduced in thickness to have a combined thickness of
0.60 mm or below by a mechanical or chemical process,
20 followed by separation.

2. The card having an image displaying function
according to claim 1, which is reduced in thickness by
using an etchant containing hydrofluoric acid.

3. The card having an image displaying function
25 according to claim 1 or 2, wherein the displaying

element has a peripheral fringe end surface that is etched within a range that does not exceed 60 μm after the bonded glass plate is reduced in thickness and separated into individual elements.

5 4. A card having an image displaying function, comprising:

 a central controlling unit that collectively controls all of the operations including a data transmitting and receiving process to and from an
10 external apparatus;

 a displaying element that displays necessary information on the basis of an instruction from the central controlling unit; and

 a power supply unit that supplies electric power
15 to each unit of the card, wherein

 the displaying element has a combined thickness of 0.60 mm or below in which a second glass plate exposed to a user and a first glass plate not exposed to the user are bonded,

20 a peripheral fringe of the second glass plate has a side surface that is physically cut and separated, and

 a peripheral fringe of the first glass plate has a physically cut-out line formed therein that is
25 smoothened by an etching process.

5. A card having an image displaying function,
comprising:

a central controlling unit that collectively
controls all of the operations including a data
5 transmitting and receiving process to and from an
external apparatus;

a displaying element that displays necessary
information on the basis of an instruction from the
central controlling unit; and

10 a power supply unit that supplies electric power
to each unit of the card, wherein

the displaying element has a combined thickness
of 0.60 mm or below in which a second glass plate
exposed to a user and a first glass plate not exposed
15 to the user are bonded, and

peripheral fringes of the second glass plate and
the first glass plate have a physically cut-out line
formed therein that is smoothened by an etching
process.

20 6. The card having an image displaying function
according to claim 4 or 5, wherein, with regard to the
bonded glass plate in which the first glass plate and
the second glass plate enclose a plurality of
displaying element regions,

25 the displaying element is produced by executing,

in this order:

a first step of forming a first scribe line on a surface of the first glass plate;

a second step of bringing an etchant into
5 contact with the first scribe line;

a third step of forming a second scribe line, which corresponds to the first scribe line, on a surface of the second glass plate of the bonded glass plate having passed through the second step, and

10 a fourth step of applying a stress to the bonded glass plate in a direction from the second glass plate exposed to the user to the first glass plate not exposed to the user, so as to cut and separate the bonded glass plate along the scribe line.

15 7. The card having an image displaying function according to claim 6, wherein the displaying element is produced further through a fifth step of bringing an etchant into contact only with the peripheral fringes of the first glass plate and the second glass
20 plate after the fourth step.

8. The card having an image displaying function according to claim 4 or 5, wherein the displaying element has a four-point bending strength of 120 MPa or above as measured by applying a stress in a
25 direction from the second glass plate exposed to the

user to the first glass plate not exposed to the user,
by a testing method according to JIS R 1601.

9. The card having an image displaying function
according to claim 4 or 5, wherein the first glass
5 plate and the second glass plate each have a plate
thickness of 0.10 mm or below and have a four-point
bending strength of 4000 MPa or above by a testing
method according to JIS R 1601.