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(54) TOUCH SCREEN PANEL

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(57) **ABSTRACT**

A touch screen panel includes a plurality of first connection patterns formed on a substrate; an insulation layer having a plurality of contact holes that exposes portions of the plurality of first connection patterns; and a plurality of first electrodes and a plurality of second electrodes formed on the insulating layer, wherein at least one of the plurality of first connection patterns connects at least one adjacent pair of the plurality of first electrodes through at least two of the plurality of contact holes that expose respective portions of the at least one of the plurality of first connection patterns, and at least one hollow is formed by portions of the at least one adjacent pair of the plurality of first electrodes being formed in the at least two of the plurality of contact holes.

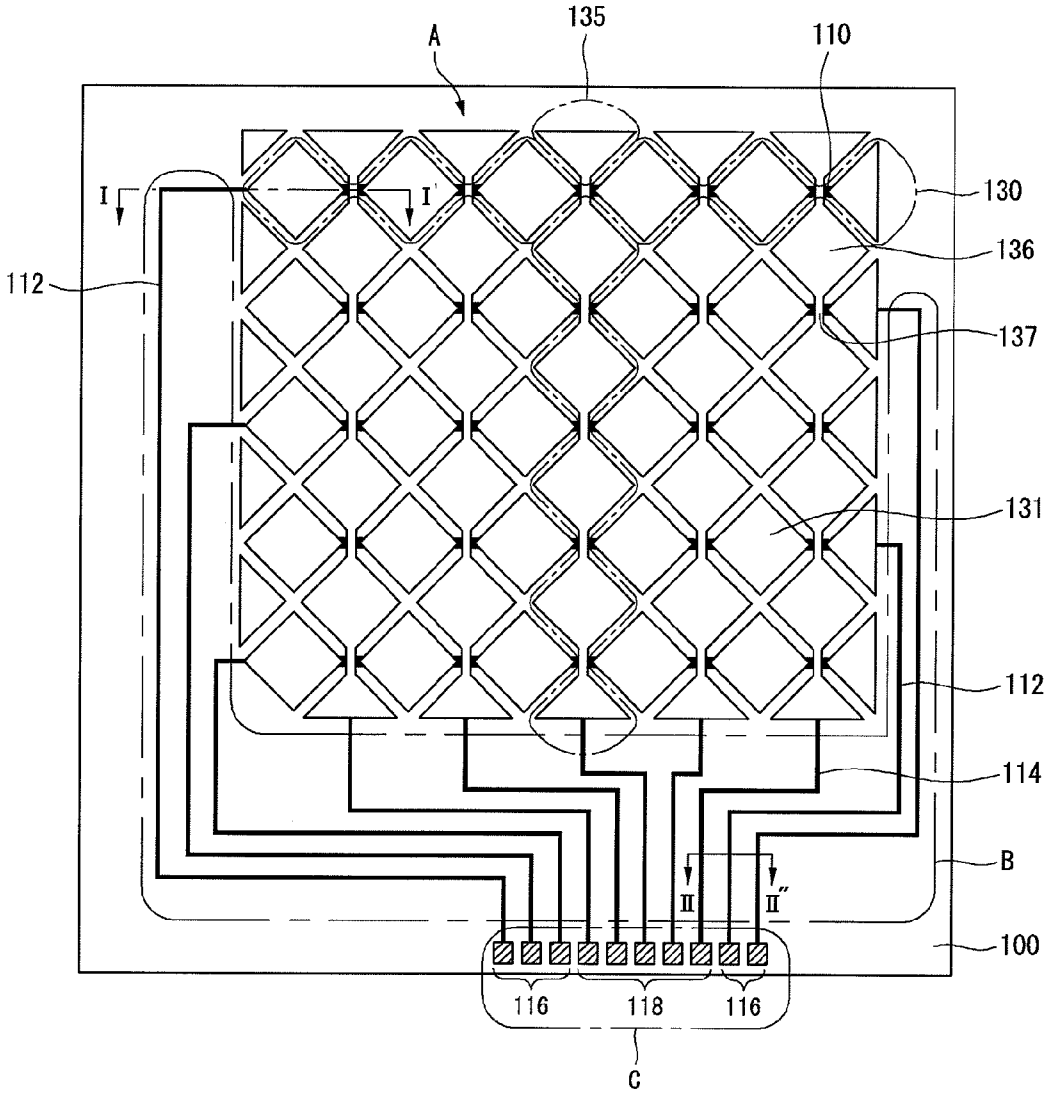


FIG. 1

RELATED ART

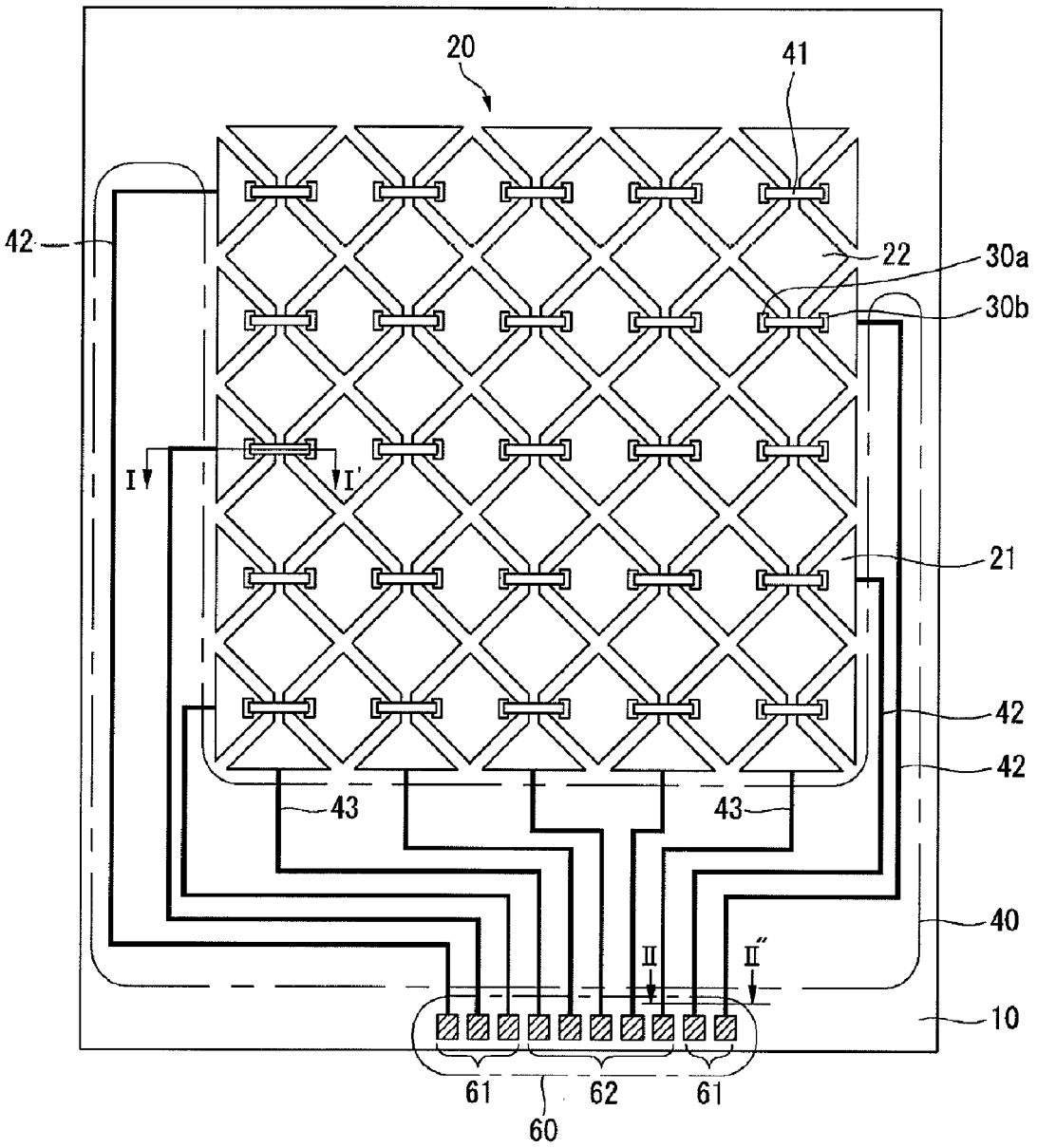


FIG. 2

RELATED ART

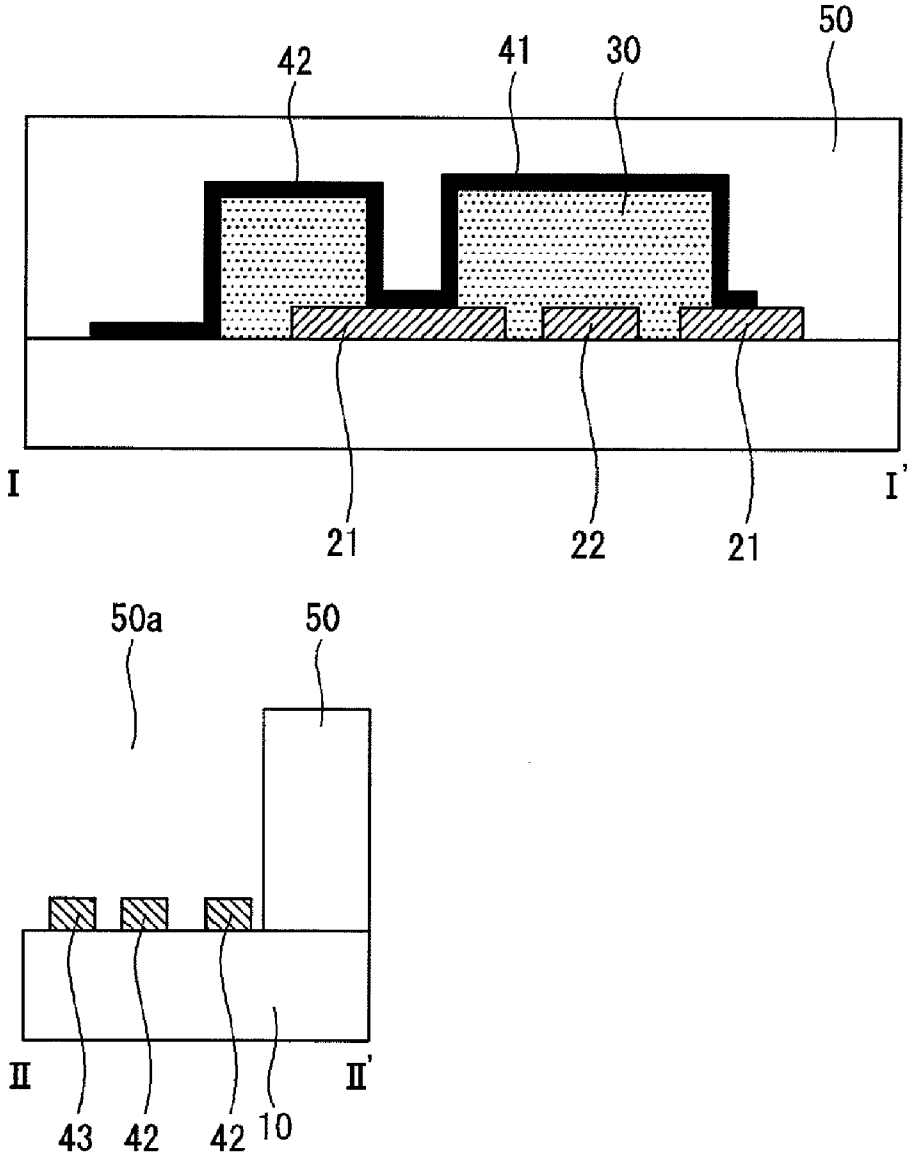


FIG. 3A

RELATED ART

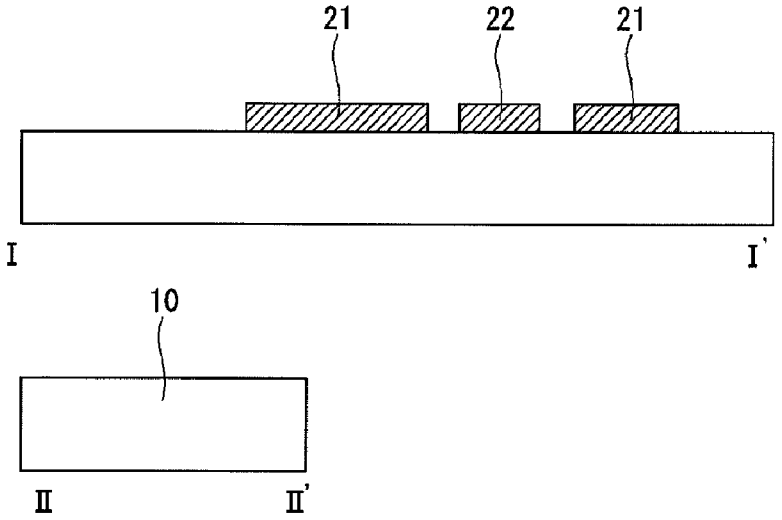


FIG. 3B

RELATED ART

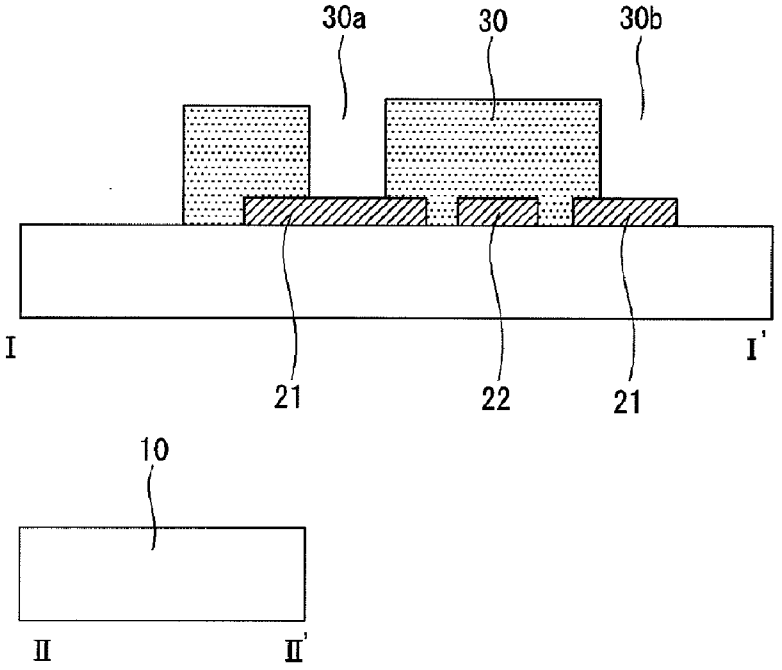


FIG. 3C

RELATED ART

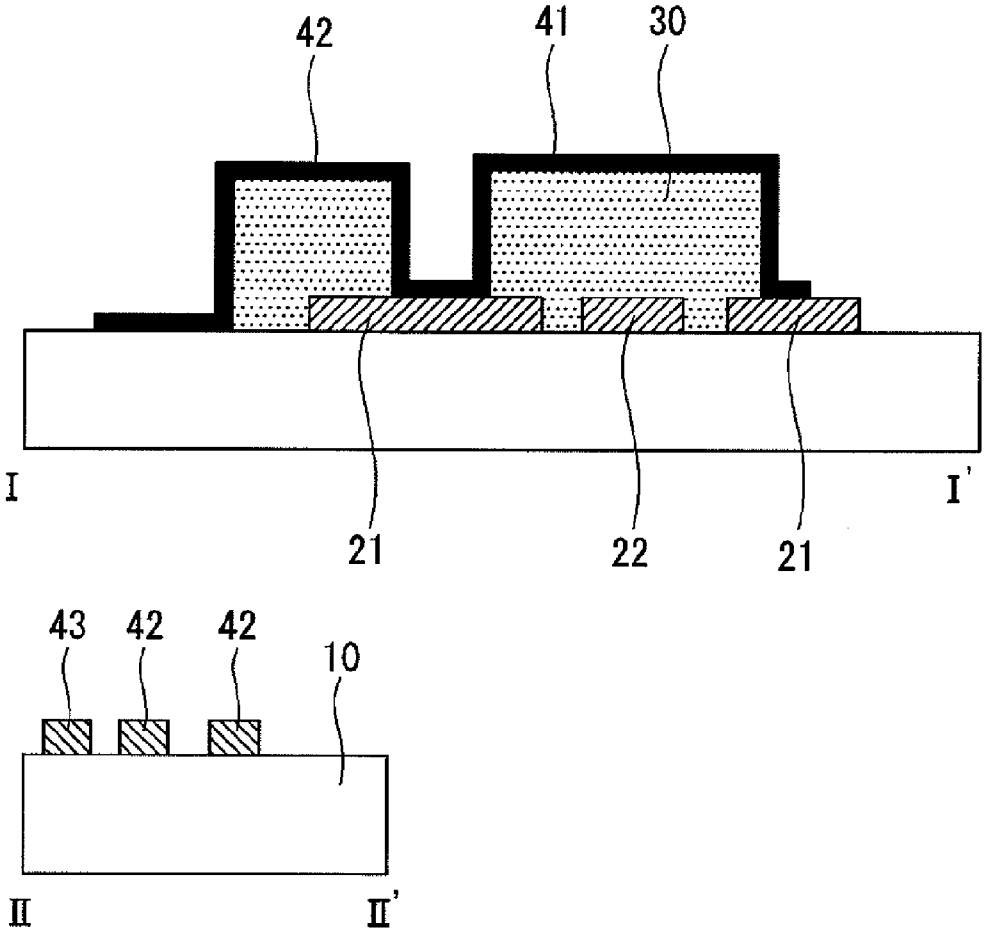
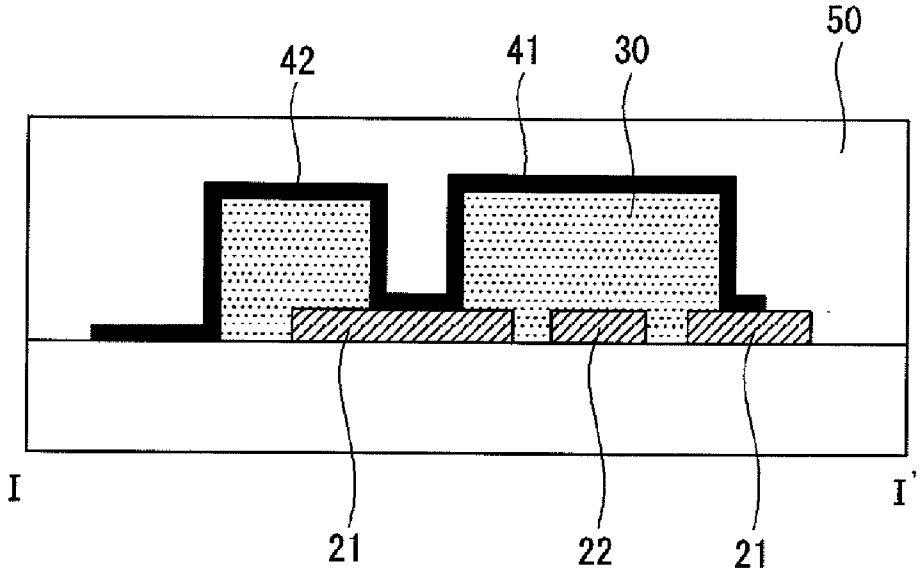


FIG. 3D

RELATED ART



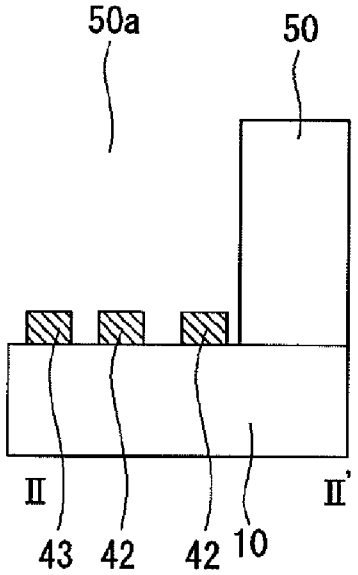


FIG. 4

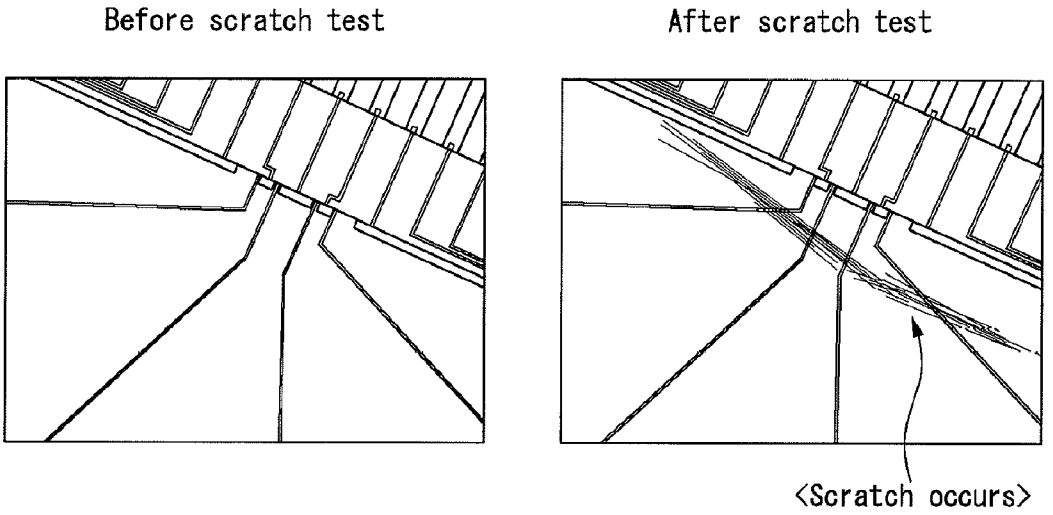


FIG. 5

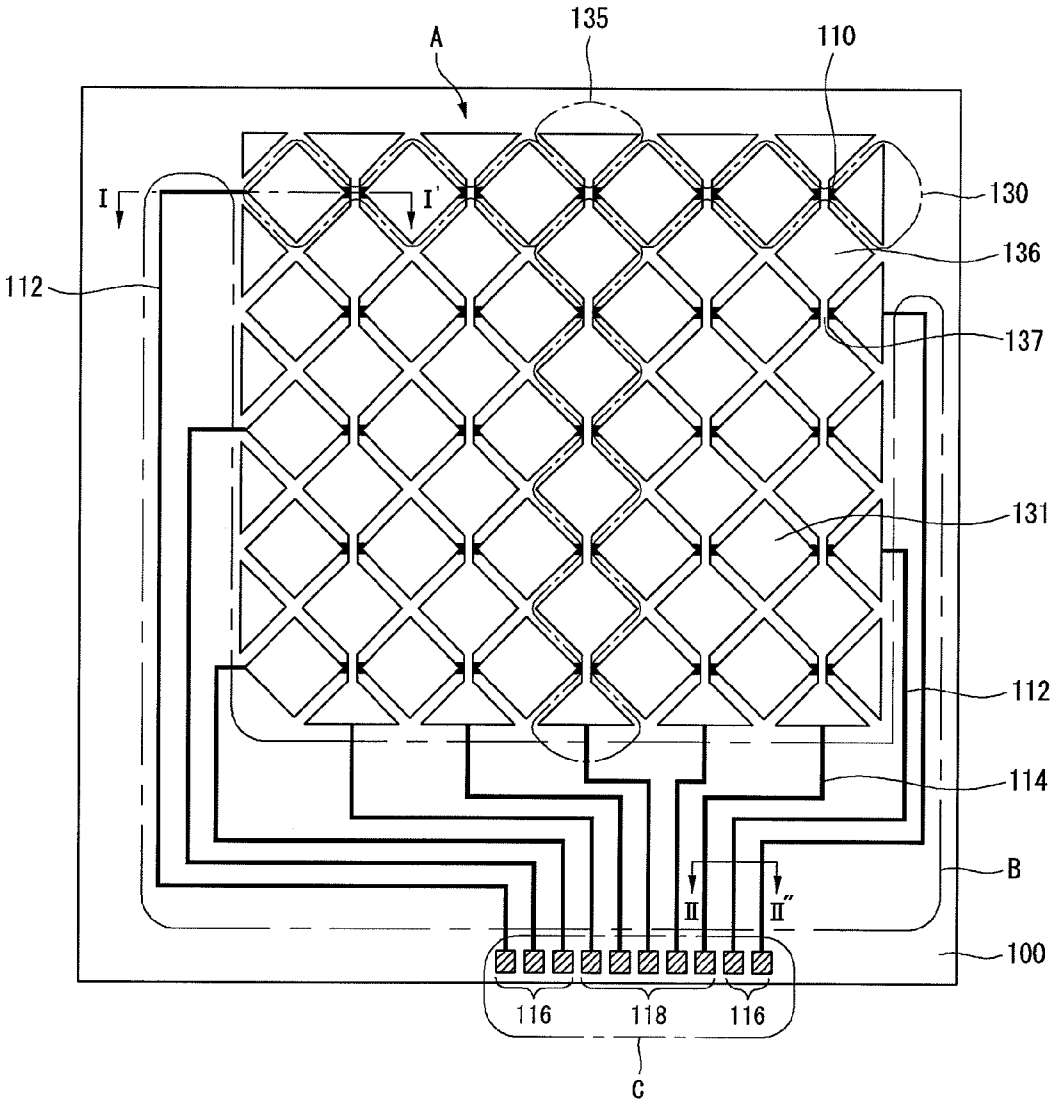


FIG. 6

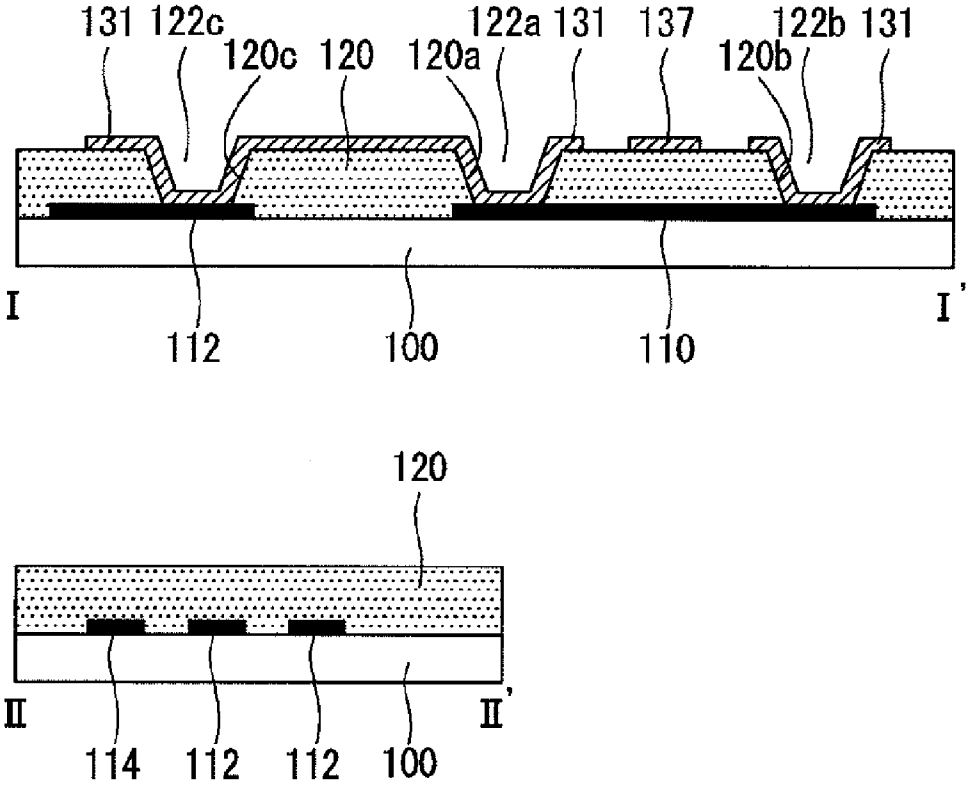

131
122c
120c
120
120a
122a
131
137
120b
122b
131
I
I'
112
100
110
120
II
II'
114
112
112
100

FIG. 7A

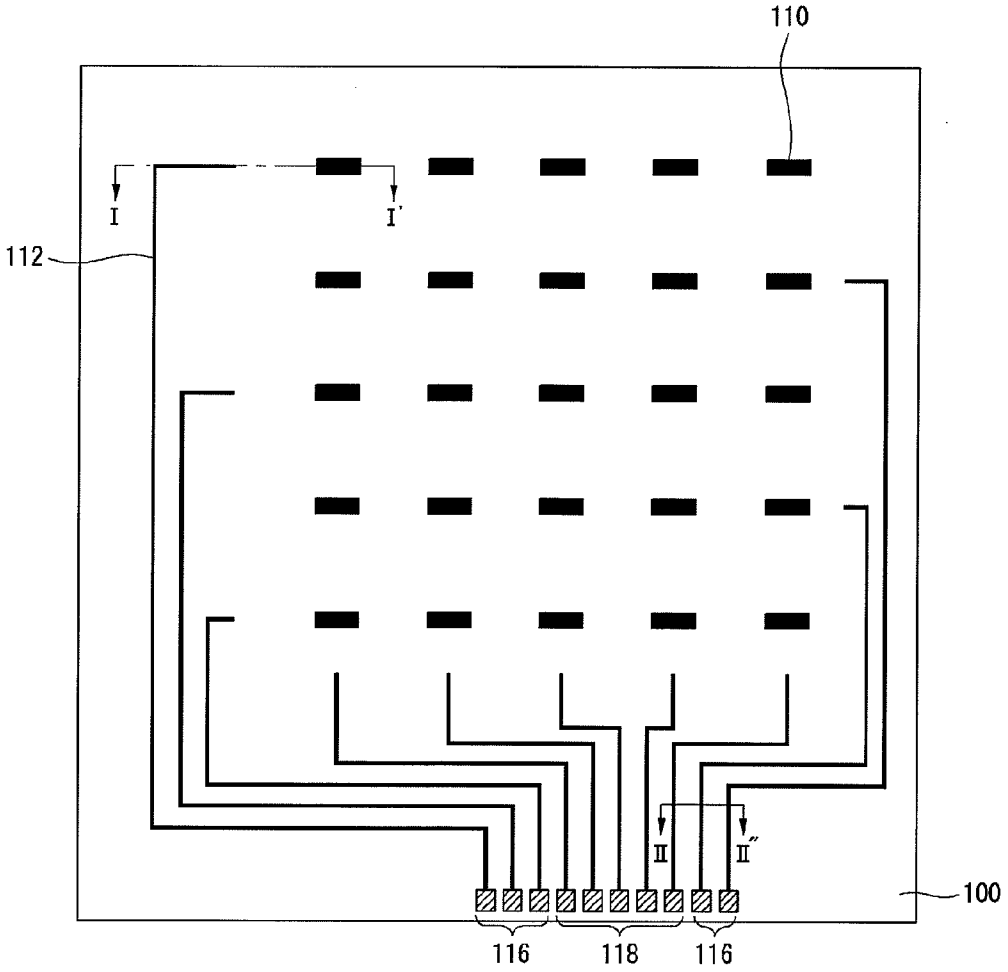


FIG. 7B

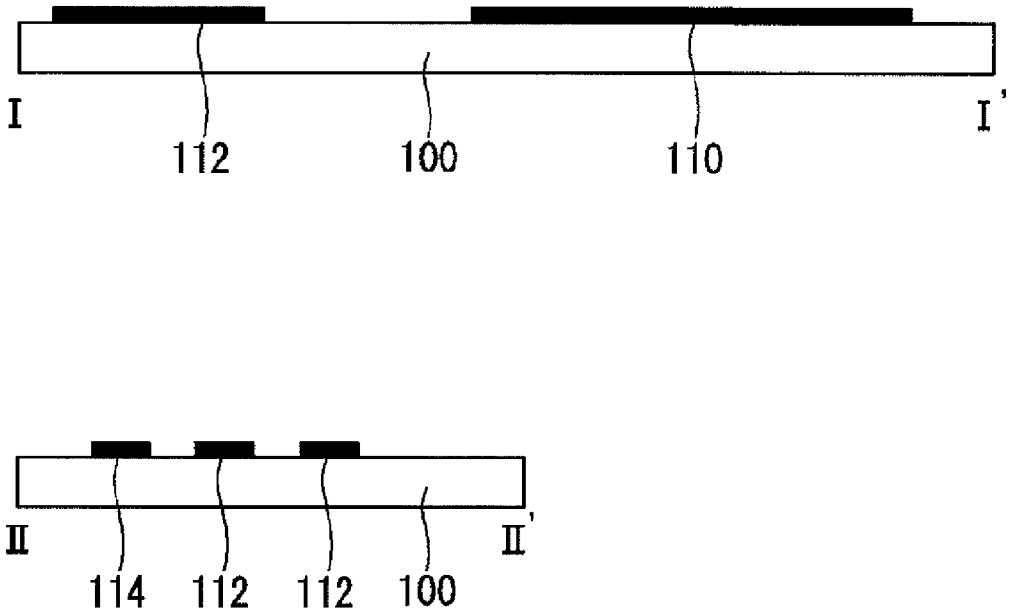


FIG. 8A

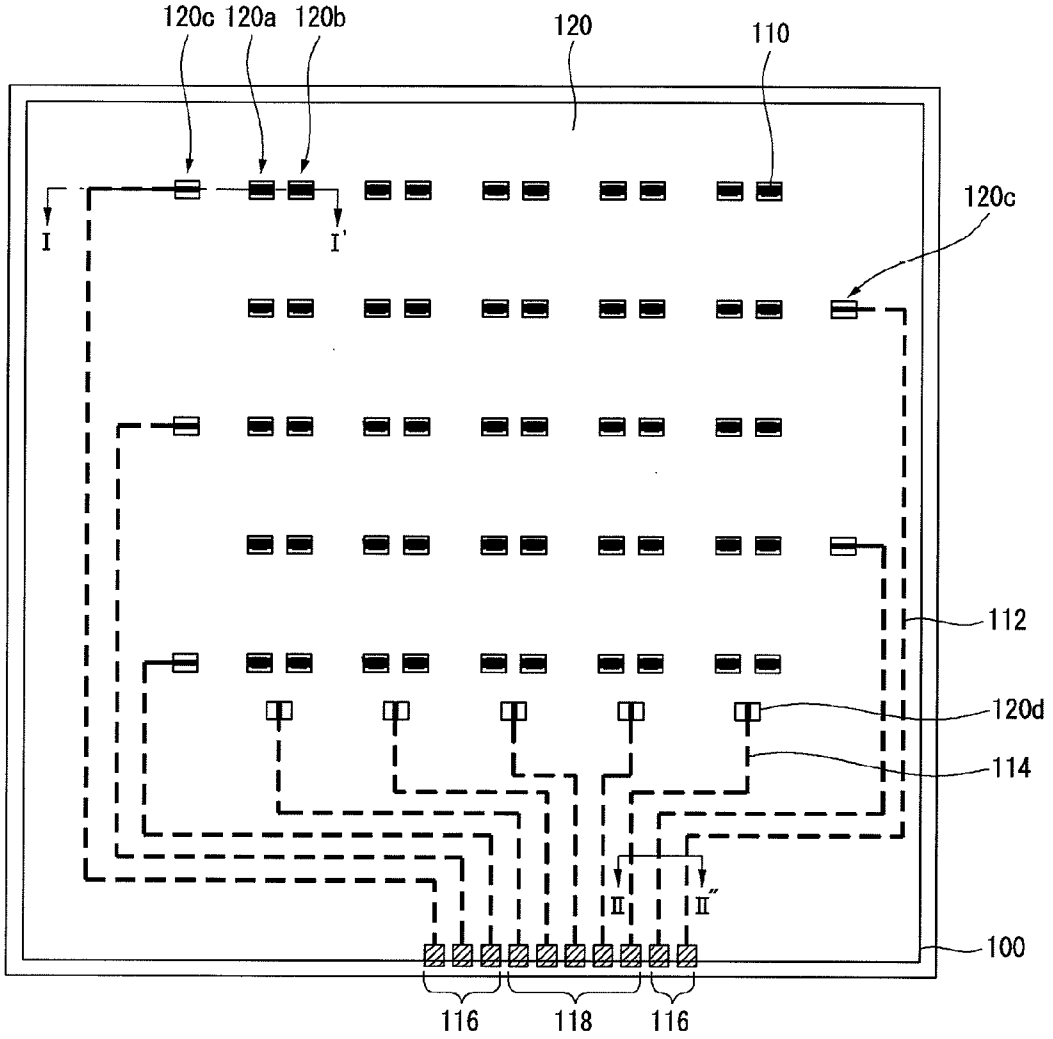

120c
120a
120b
120
110
I
I'
120c
112
120d
114
II
II''
100
116
118
116

FIG. 8B

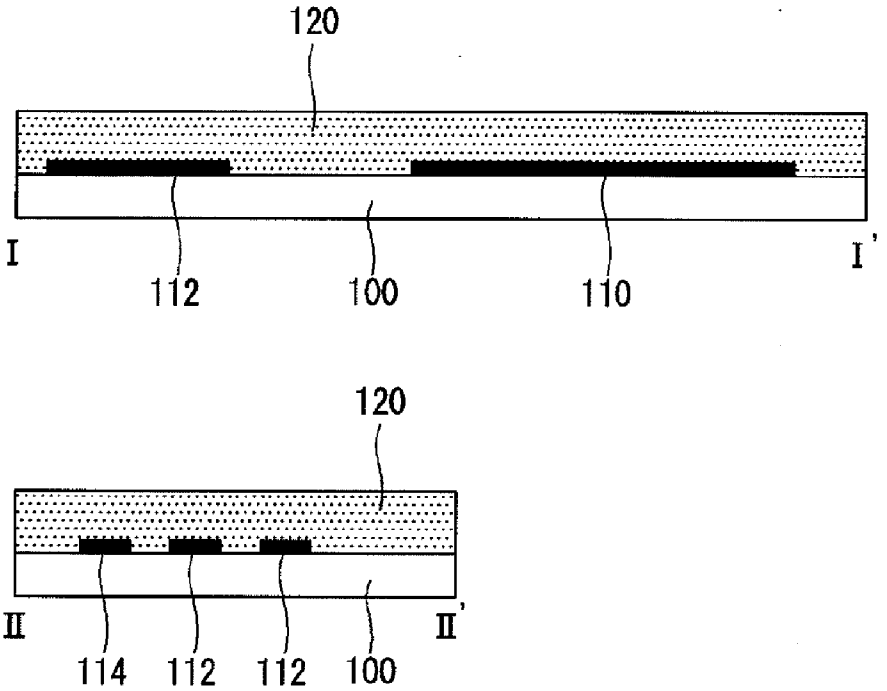


FIG. 8C

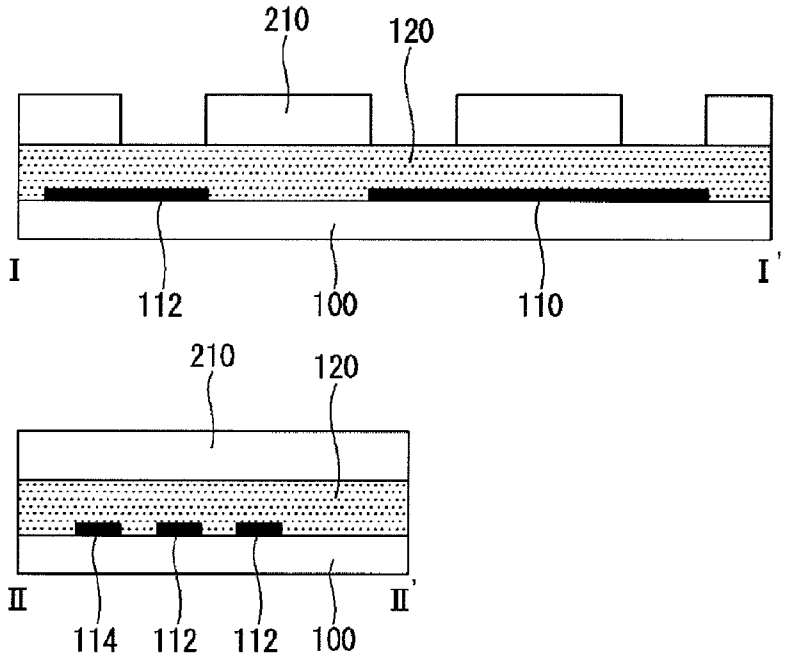

210
120
I
I'
112
100
110
210
120
II
II'
114
112
112
100

FIG. 8D

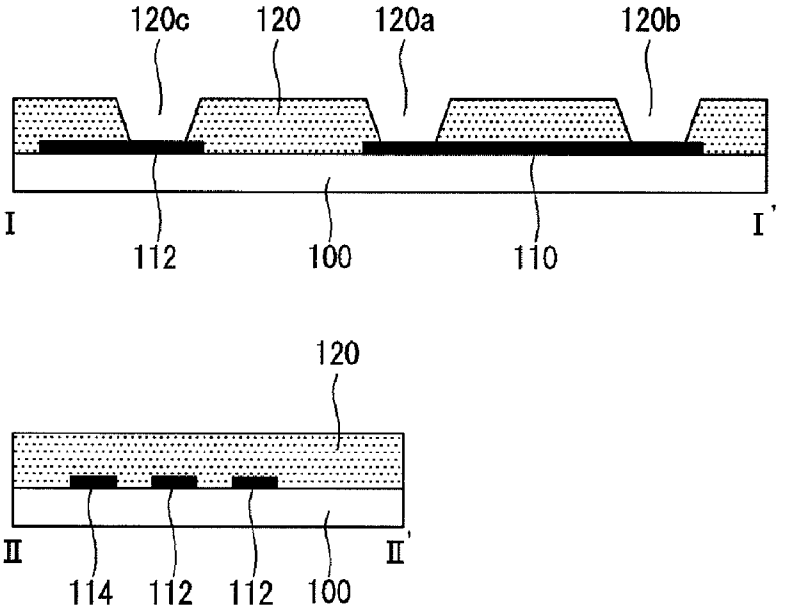

120c
120
120a
120b
I
I'
112
100
110
120
II
II'
114
112
112
100

FIG. 9A

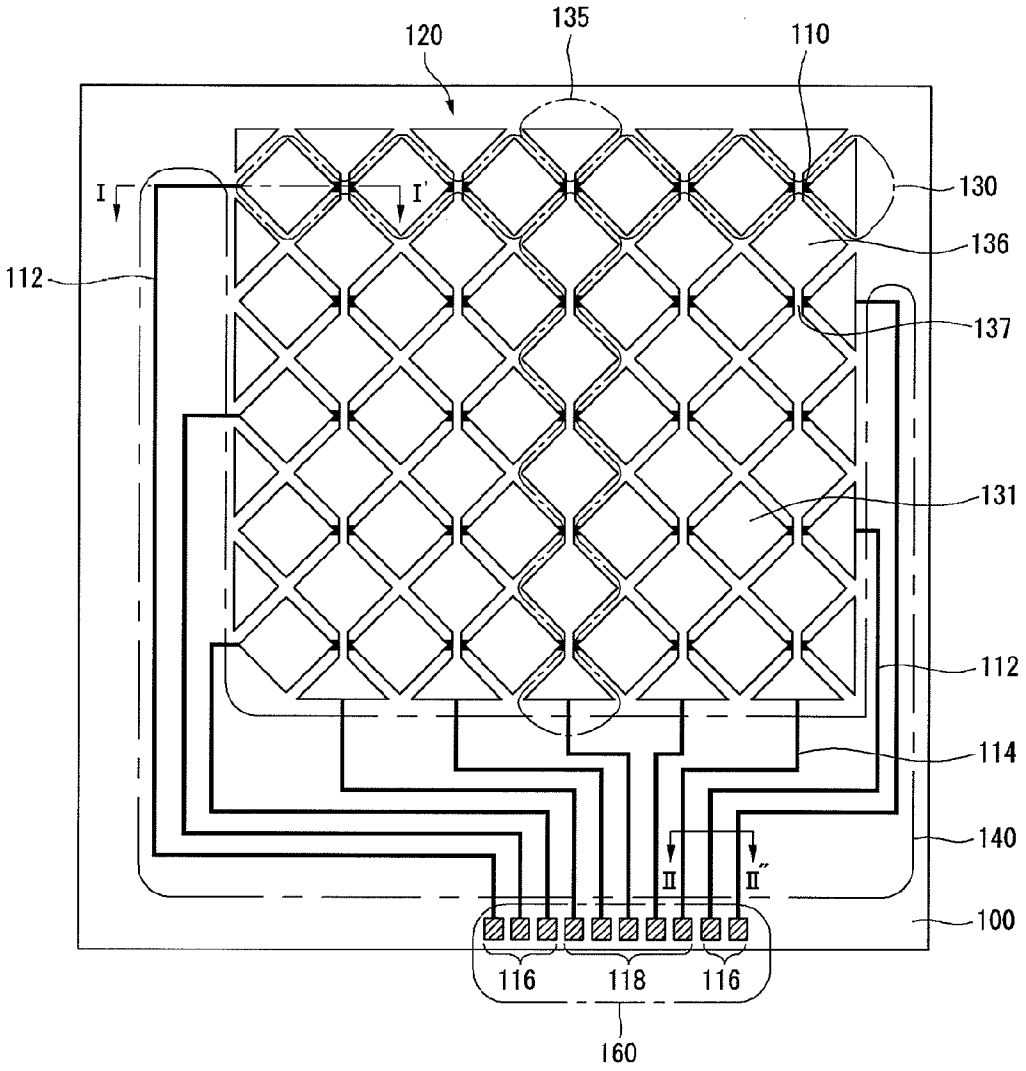

120
135
110
130
136
137
131
112
114
140
100
I
I'
II
II'
116
118
116
160

FIG. 9B

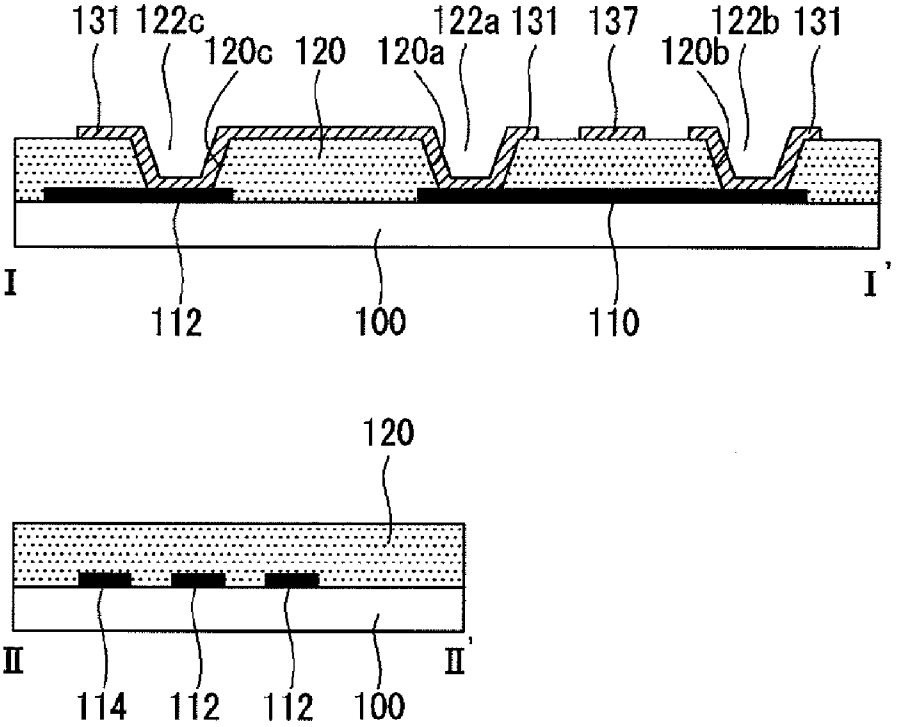

131
122c
120c
120
120a
122a
131
137
120b
122b
131
I
I'
112
100
110
120
II
II'
114
112
112
100

FIG. 10

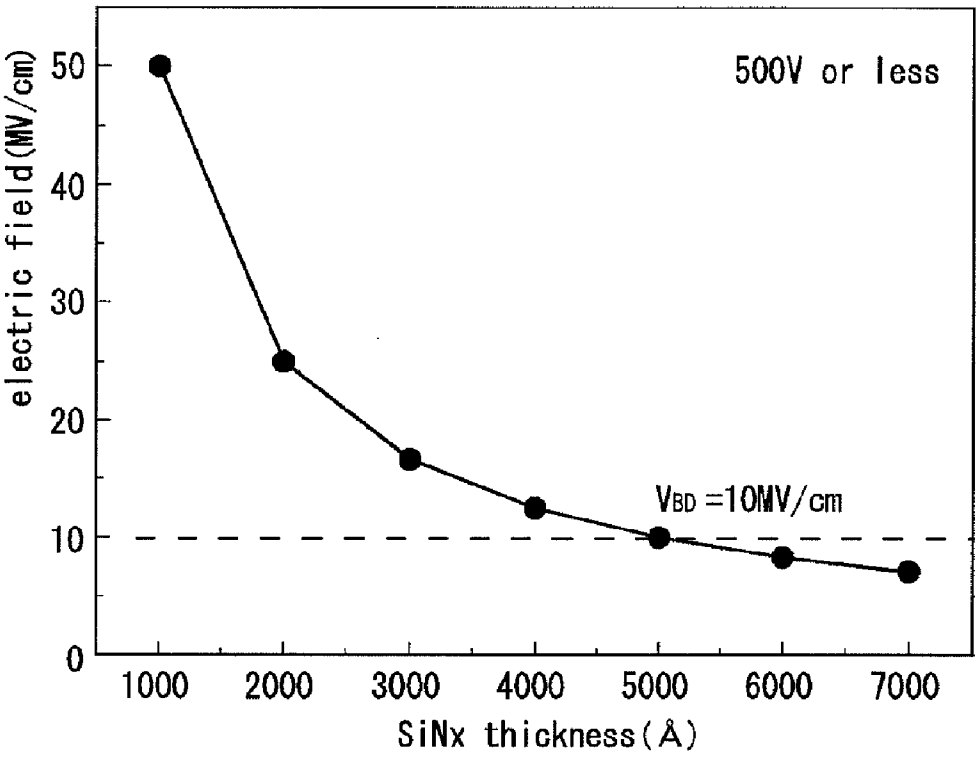

500V or less
VBD =10MV/cm
electric field(MV/cm)
0
10
20
30
40
50
1000
2000
3000
4000
5000
6000
7000
SiNx thickness(Å)

FIG. 11

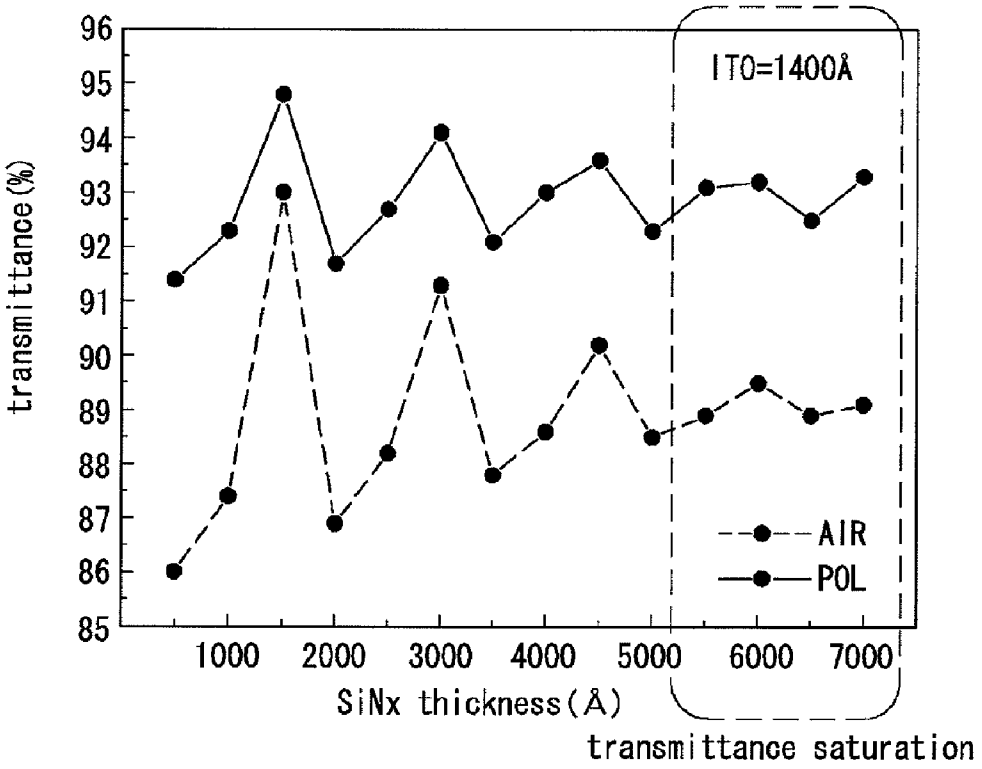

96
95
94
93
92
91
90
89
88
87
86
85
transmittance(%)
ITO=1400Å
AIR
POL
1000
2000
3000
4000
5000
6000
7000
SiNx thickness(Å)
transmittance saturation

FIG. 12

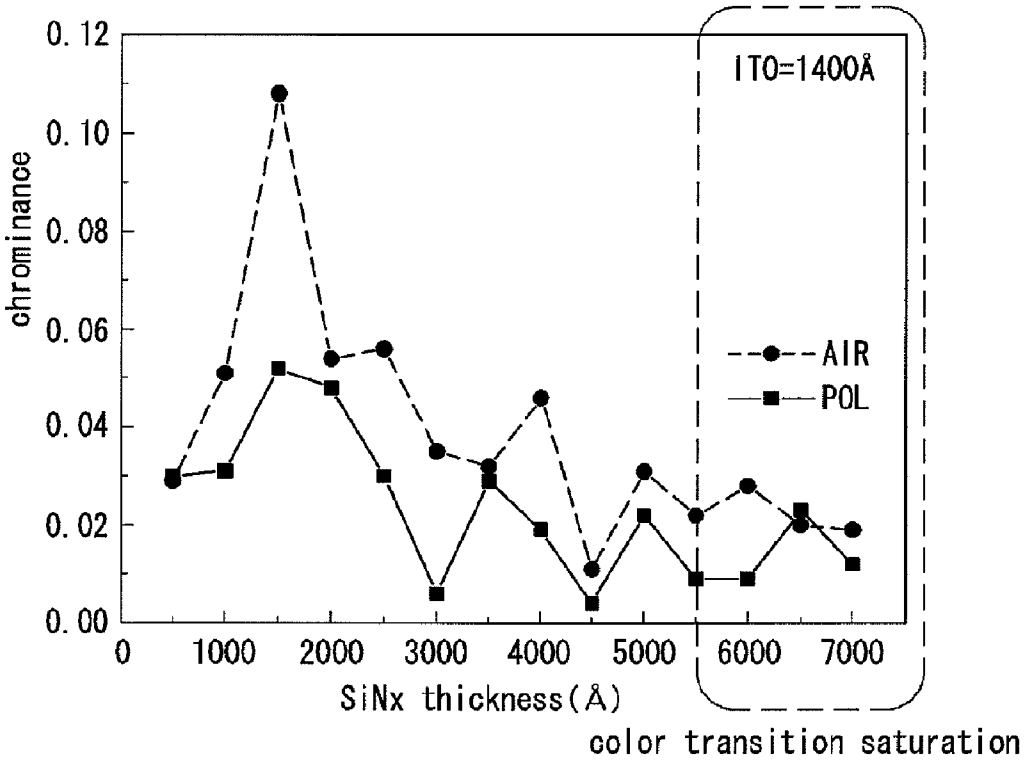

0.12
0.10
0.08
0.06
0.04
0.02
0.00
chrominance
0
1000
2000
3000
4000
5000
6000
7000
SiNx thickness(Å)
ITO=1400Å
AIR
POL
color transition saturation

FIG. 13

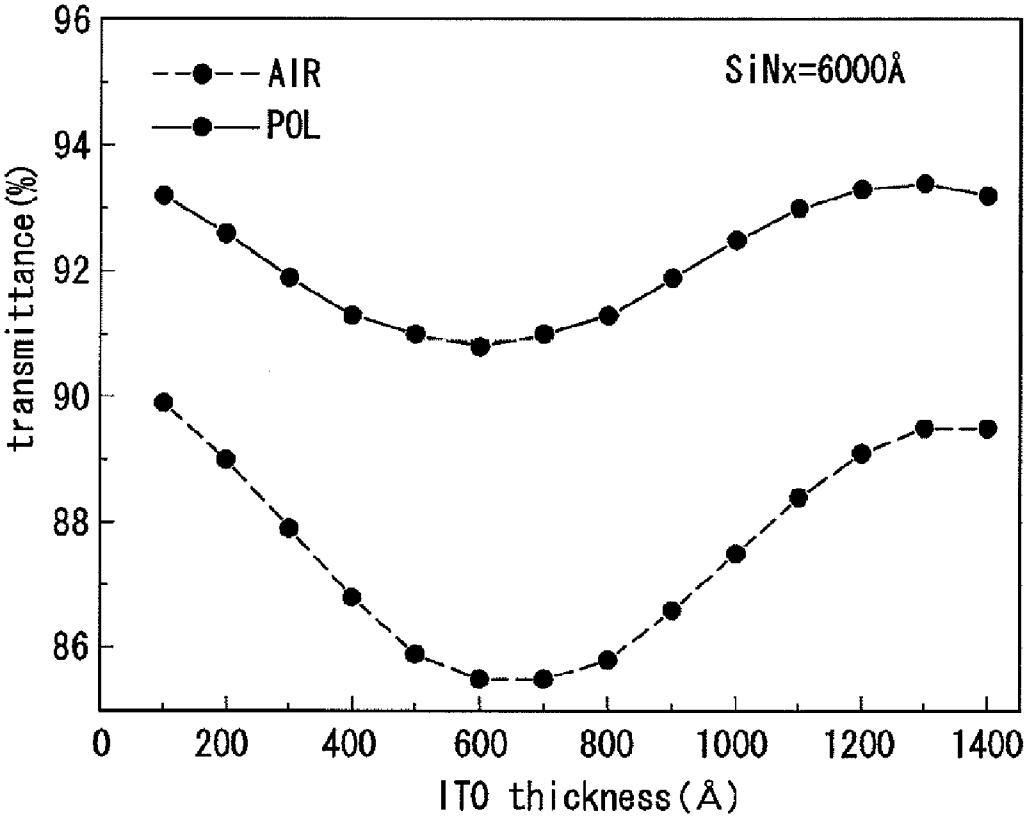

96
94
92
90
88
86
transmittance(%)
AIR
POL
SiNx=6000Å
0
200
400
600
800
1000
1200
1400
ITO thickness(Å)

FIG. 14

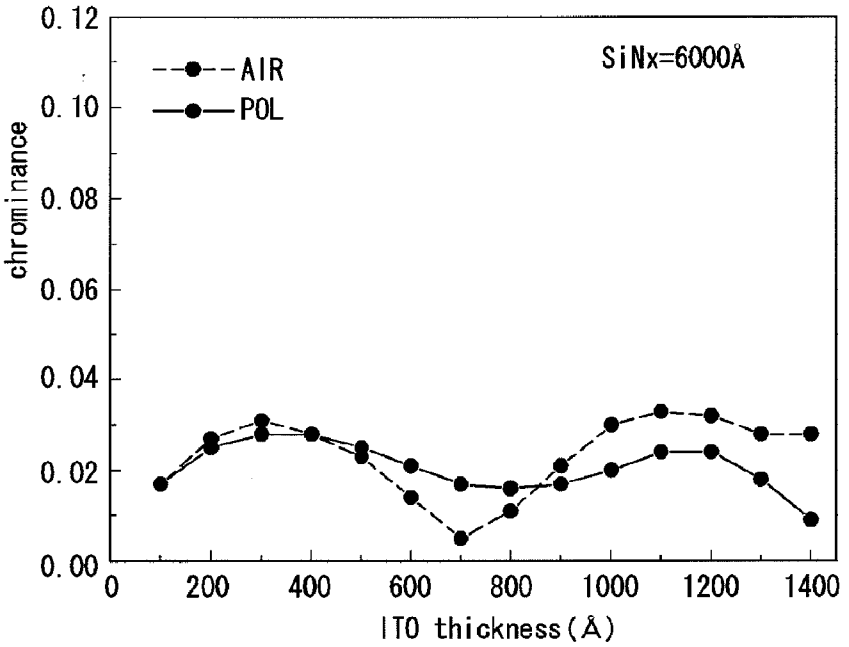

0.12
0.10
0.08
0.06
0.04
0.02
0.00
chrominance
AIR
POL
SiNx=6000Å
0
200
400
600
800
1000
1200
1400
ITO thickness(Å)

FIG. 15

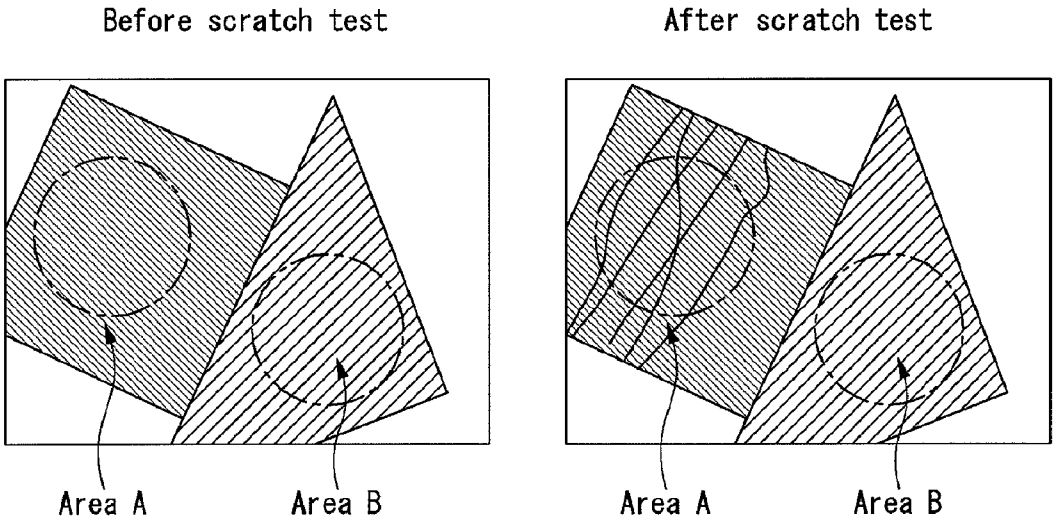
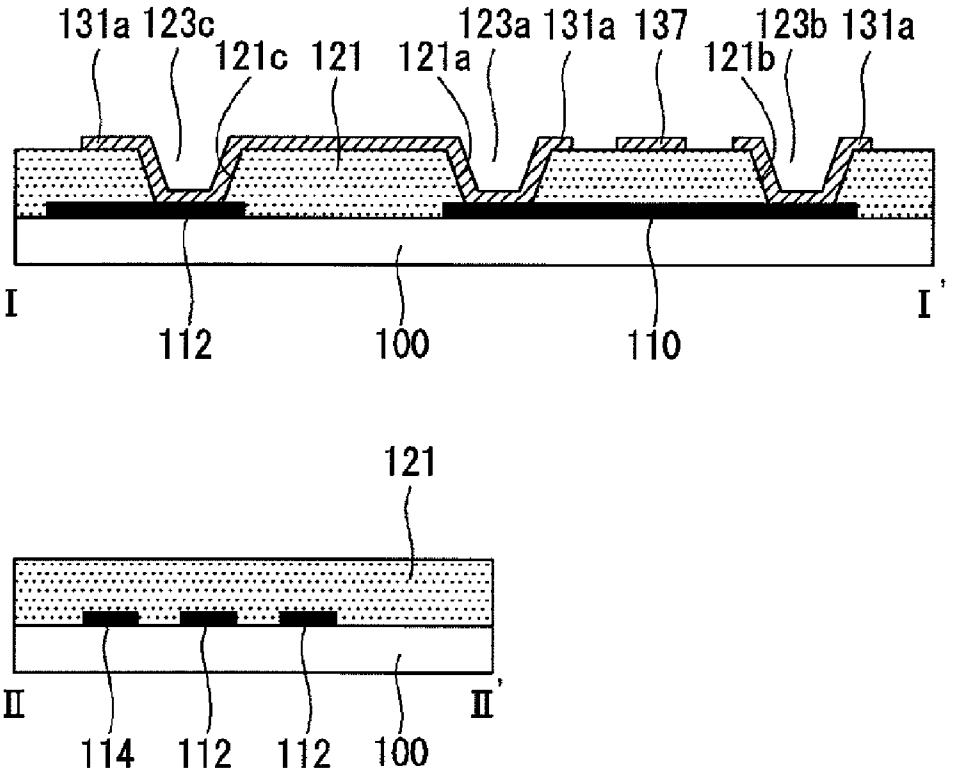

Before scratch test
After scratch test
Area A
Area B
Area A
Area B

FIG. 16


131a
123c
121c
121
121a
123a
131a
137
121b
123b
131a
I
I'
112
100
110
121
II
II'
114
112
112
100

TOUCH SCREEN PANEL

[0001] This application claims the priority and the benefit of Korea Patent Application No. 10-2010-012617 filed on Feb. 11, 2010, the entire content of which is incorporated herein by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] Embodiments of this invention relate to a capacitive type touch screen panel.

[0004] 2. Discussion of the Related Art

[0005] Along with the development of the electronics industry, display devices, such as a liquid crystal display, an electroluminescent display, and a plasma display panel having a quick response speed, low power consumption, and an excellent color reproduction rate, have been in the spotlight. The display device is used for various electronic products such as a television, a monitor for a computer, a notebook computer, a mobile phone, a display unit of a refrigerator, a personal digital assistant, and an automated teller machine. In general, the display device interfaces with various input devices such as a keyboard, a mouse, and a digitizer. However, when a separate input device such as a keyboard, a mouse a digitizer is used, a user is required to know how to use the separate input device, and as the separate input device occupies space, the display device that is separate from the various input devices is inconvenient in view of customer satisfaction. Therefore, need for a convenient and simple input device that can reduce erroneous operation has gradually increased. According to such request a touch screen panel in which a user can input information by directly contacting with a screen by a finger or a pen is suggested.

[0006] Because the touch screen panel has a simple configuration while occurring little or no erroneous operations, can perform an input action without a separate input device, and has convenience in which the user can quickly and easily manipulate through contents displayed on a screen, the touch screen panel is applied to various display devices.

[0007] Touch screen panels are classified into a resistive type, a capacitive type, an electromagnetic type and so on according to a detection method of a touched portion. The resistive type touch screen panel determines a touched position by a voltage gradient according to resistance in a state that a DC voltage is applied to metal electrodes formed on an upper plate or a lower plate. The capacitive type touch screen panel senses a touched position according to a difference in capacitance created in an upper or lower plate when the user physically contacts with a conductive film formed on the upper or lower plate. The electromagnetic type touch screen panel detects a touched portion by reading an LC value induced as an electromagnetic pen touches a conductive film.

[0008] Hereinafter, a conventional capacitive type touch screen panel will be described with reference to FIGS. **1** and **2**. FIG. **1** is a top plan view illustrating a conventional capacitive type touch screen panel, and FIG. **2** is a cross-sectional view illustrating the touch screen panel taken along line I-I' and line II-II' of FIG. **1**.

[0009] Referring to FIGS. **1** and **2**, the conventional capacitive type touch screen panel includes an electrode forming part **20**, a routing wire forming part **40**, a pad part **60**, and a protective layer **50**.

[0010] The electrode forming part **20** is formed on a substrate **10** and includes a plurality of first electrodes **21** arranged in parallel in a first direction (for example, an X-axis direction) and a plurality of second electrodes **22** arranged to intersect in a direction (for example, an Y-axis direction) perpendicular to the first electrodes **21**. The first electrodes **21** and the second electrodes **22** intersect each other, but sustain an electrical insulation state by an insulation film **30**. Further, neighboring first electrodes **21** arranged in the first direction are connected to each other by a bridge **41**. That is, the bridge **41** connects the neighboring first electrodes **21** to each other through contact holes **30***a* and **30***b* formed in the insulation film **30** covering the first and second electrodes **21** and **22**.

[0011] The routing wire forming part **40** is formed on the substrate **10** at positions outside the electrode forming part **20** and includes a plurality of first routing wires **42** connected to the plurality of first electrodes **21**, respectively, and a plurality of second routing wires **43** connected to the plurality of second electrodes **22**, respectively.

[0012] The pad part **60** includes a plurality of first pads connected to the plurality of first electrodes **21** through the plurality of first routing wires **42**, respectively, and a plurality of second pads **62** connected to the plurality of second electrodes **22** through the plurality of second routing wires **43**, respectively.

[0013] The protective layer **50** covers the electrode forming part **20** and the routing wire forming part **40** and prevents the first and second electrodes **21** and **22** and the first and second routing wires **42** and **43** from being exposed to the outside.

[0014] Hereinafter, a method of manufacturing a conventional capacitive type touch screen panel will be described with reference to FIGS. **3**A to **3**D.

[0015] Referring to FIG. **3**A, a first conductive layer for forming first and second electrodes is deposited on the substrate **10** including an electrode forming part **20**, a routing wire forming part **40**, and the pad part **60** through a deposition process such as a sputtering method. As the first conductive layer, an indium tin oxide (ITO) layer is generally used. After a photoresist is coated on the substrate **10** in which the first conductive layer is formed, a first photoresist pattern for exposing the first conductive layer is formed in the electrode forming part **20** by performing a photolithography process using a first mask. After removing the first conductive layer exposed by the first photoresist pattern through wet etching, a plurality of first electrodes **21** and a plurality of second electrodes **22** intersecting the first electrodes **21** are formed on the substrate **10** by ashing the remaining first photoresist pattern.

[0016] Referring to FIG. **3**B, after the first insulation film **30** is formed on the substrate **10** in which the plurality of first and second electrodes **21** and **22** are formed, the first insulation film **30** of the pad part **60** and the routing wire forming part **40** is removed and first and second contact holes **30***a* and **30***b* penetrating the first insulation film **30** of the electrode **20** are formed with a photolithography process and an etching process using a second mask. The first and second contact holes **30***a* and **30***b* expose a portion of the neighboring first electrodes **21**. The first insulation film **30** includes silicon nitride, silicon oxide, or organic resin.

[0017] Referring to FIG. **3**C, a second conductive layer is formed on an entire surface of the substrate **10** in which the first and second contact holes **30***a* and **30***b* are formed through a deposition process such as a sputtering method. The second conductive layer includes aluminum (Al) or molybdenum (Mo). After coating a photoresist on the substrate in which the

second conductive layer is formed, first and second routing wires **42** and **43** are formed in a routing wire forming portion on the substrate **10** and a connection electrode **41** is formed on the first insulation film **30** of the electrode forming part **20** by performing a photolithography process and an etching process using a third mask. The connection electrode **41** connects the neighboring first electrodes **21** to each other through the first and second contact holes **30***a* and **30***b* formed in the first insulation film **30**.

[0018] Referring to FIG. **3**D, after a second insulation film **50** as a protective film is formed on an entire surface of the substrate **10** in which the connection electrode **41** and the first and second routing wires **42** and **43** are formed, a through hole **50***a* for penetrating the second insulation film **50** is formed to expose the first and second routing wires **42** and **43** of the pad **60** with a photolithography process and an etching process using a fourth mask.

[0019] However, the conventional capacitive type touch screen panel is manufactured with **4** mask processes, as described above, and each mask process accompanies a photolithography process requiring a series of continuous processes such as photoresist (PR), coating, alignment, exposure, development, and cleaning and thus it is necessary to reduce a number of a mask process. Further, because the first insulation film of an intersecting portion of the first electrode and the second electrode has a wide area and uses silicon nitride, silicon oxide, and organic resin, there is a problem that the first insulation film is viewed or apparent from the outside due to a color difference between the first insulation film and a periphery thereof. Further, the second insulation film formed as a protective film at the top of the touch screen panel is made of the same material as that of the first insulation film, and adhesive strength is weakened by gas used when depositing the first and second insulation films and thus surface hardness is weakened. Therefore, after a touch screen panel is manufactured, when a next process of forming a display device is performed, an additional problem of a scratch occurs. FIG. **4** is a drawing illustrating states before and after performing a scratch test of the touch screen panel manufactured in the related art, wherein the left picture illustrates a state before a scratch test and the right picture illustrates a state after a scratch test.

SUMMARY OF THE INVENTION

[0020] An object of this invention is to provide a touch screen panel that can improve productivity by reducing a process tact time through reducing mask process number of a capacitive type touch screen panel.

[0021] Another object of this invention is to provide a touch screen panel that can solve a visibility problem occurring due to a color difference between a first insulation layer for covering a first electrode and a second electrode used as a touch electrode and having a wide area and a periphery thereof and that can improve a transmittance and a color transition characteristic.

[0022] Another object of this invention is to provide a touch screen panel that can solve a problem of a scratch occurring due to low surface hardness of a second insulation layer formed as a protective layer at the top of the touch screen panel.

[0023] Additional features and advantages of this invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of this invention. The objectives and other advantages of this invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0024] To achieve these and other advantages and in accordance with the purpose of this invention, as embodied and broadly described, a touch screen panel includes a substrate; an electrode forming part comprising a plurality of first electrode serials and a plurality of second electrode serials formed on the substrate, the plurality of first electrode serials being arranged in parallel in a first direction, and the plurality of second electrode serials being arranged to intersect the first electrode serials; a routing wire forming part formed on the substrate at positions outside the electrode forming part and comprising a plurality of first routing wires connected to the plurality of first electrode serials, respectively, and a plurality of second routing wires connected to the plurality of second electrode serials, respectively; a plurality of first connection patterns formed on the same layer with the pluralities of first and second routing wires; and an insulation layer formed between the pluralities of first and second electrode serials and the substrate, and having a plurality of contact holes to expose portions of the plurality of first connection patterns, wherein each of the plurality of first electrode serials comprises a plurality of first electrode patterns and each of the plurality of second electrode serials comprises a plurality of second electrode patterns, and the plurality of first electrode patterns is formed as separated plurality of patterns, and the separated plurality of patterns are connected to each other through the plurality of contact holes and by the plurality of first connection patterns.

[0025] Another embodiment of the invention includes a method of manufacturing a touch screen panel, the method including a first process of forming a plurality of first connection patterns, a plurality of first routing wires, and a plurality of second routing wires simultaneously on a substrate; a second process of forming an insulation layer on an entire surface of the substrate and a plurality of contact holes in the insulating layer for exposing portions of at least one of the plurality of first connection patterns; and a third process of forming a plurality of first electrode serials and a plurality of second electrode serials on the insulation layer in which the plurality of contact holes are formed, the plurality of first electrode serials being arranged in parallel in a first direction, and the plurality of second electrode serials being arranged in parallel in a second direction intersecting the first direction.

[0026] Another embodiment of the invention includes a touch screen panel including a substrate; a plurality of first connection patterns formed on the substrate; an insulation layer formed on the substrate to cover the plurality of first connection patterns, and having a plurality of contact holes that exposes portions of the plurality of first connection patterns; and a plurality of first electrodes and a plurality of second electrodes formed on the insulating layer, the plurality of first electrodes being arranged in parallel in a first direction, and the plurality of second electrodes being arranged in a second direction that intersects the first direction, wherein at least one of the plurality of first connection patterns connects at least one adjacent pair of the plurality of first electrodes through at least two of the plurality of contact holes that expose respective portions of the at least one of the plurality of first connection patterns, and at least one hollow is formed

by portions of the at least one adjacent pair of the plurality of first electrodes being formed in the at least two of the plurality of contact holes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate implementations of the invention and together with the description serve to explain the principles of the invention. In the drawings:

[0028] FIG. **1** is a top plan view illustrating a related art capacitive type touch screen panel;

[0029] FIG. **2** is a cross-sectional view illustrating the touch screen panel taken along line I-I' and line II-II' of FIG. **1**;

[0030] FIGS. **3**A to **3**D are cross-sectional views illustrating a process of manufacturing the touch screen panel shown in FIG. **1**;

[0031] FIG. **4** is a drawing illustrating states before and after performing a scratch test of a related art touch screen panel;

[0032] FIG. **5** is a top plan view illustrating a touch screen panel according to an embodiment of this invention;

[0033] FIG. **6** is a cross-sectional view illustrating the touch screen panel taken along line I-I' and line II-II' of FIG. **5**;

[0034] FIGS. **7**A to **7**B are a top plan view and a cross-sectional view illustrating a first mask process of a process of manufacturing the touch screen panel shown in FIG. **5**;

[0035] FIGS. **8**A to **8**D are a top plan view and cross-sectional views illustrating a second mask process of a process of manufacturing the touch screen panel shown in FIG. **5**;

[0036] FIGS. **9**A to **9**B are a top plan view and a cross-sectional view illustrating a third mask process of a process of manufacturing the touch screen panel shown in FIG. **5**;

[0037] FIG. **10** is a graph illustrating an electric field value of a breakdown point in which an insulation layer is destroyed or damaged according to a thickness of silicon nitride used as an insulation layer when a thickness of ITO used as first and second electrode patterns is 1,400 Å;

[0038] FIG. **11** is a graph illustrating a transmittance of a touch screen panel according to a thickness of silicon nitride used as an insulation layer when a thickness of ITO using as first and second electrode patterns is 1,400 Å;

[0039] FIG. **12** is a graph illustrating a color transition characteristic of a touch screen panel according to a thickness of silicon nitride used as an insulation layer when that a thickness of ITO used as first and second electrode patterns is 1,400 Å;

[0040] FIG. **13** is a graph illustrating a characteristic of a transmittance according to a thickness of ITO used as first and second electrode patterns when a thickness of silicon nitride formed as an insulation layer is 6,000 Å;

[0041] FIG. **14** is a graph illustrating a color transition characteristic according to a thickness of ITO used as first and second electrode patterns when a thickness of silicon nitride formed as an insulation layer is 6,000 Å;

[0042] FIG. **15** is a drawing illustrating a result before and after performing a scratch test of an area A in which the top of a touch screen panel is an insulation layer and an area B in which the top of a touch screen panel is ITO; and

[0043] FIG. **16** is a cross-sectional view illustrating a touch screen panel according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0044] Hereinafter, example embodiments of this invention will be described in detail with reference to FIGS. **5** to **16**. Like reference numerals designate like elements throughout the specification.

[0045] An array substrate for a liquid crystal display according to an example embodiment of this invention will be described with reference to FIGS. **5** and **6**. FIG. **5** is a top plan view illustrating a touch screen panel according to an example embodiment of this invention, and FIG. **6** is a cross-sectional view illustrating the touch screen panel taken along line I-I' and line II-II' of FIG. **5**.

[0046] Referring to FIGS. **5** and **6**, a capacitive type touch screen panel according to an example embodiment of this invention includes an electrode forming part A, a routing wire forming part B, and a pad part C.

[0047] The electrode forming part A includes a plurality of first electrode serials **130** optionally arranged in parallel in a first direction (for example, an X-axis direction) and a plurality of second electrode serial **135** optionally arranged in a second direction (for example, an Y-axis direction) to intersect the first electrode serials **130**. Each of the first electrode serials **130** includes first electrode patterns **131** having a triangle, a quadrangle, a diamond shape, a polygon, and so on, and first connection patterns **110** for connecting neighboring first electrode patterns **131**. Each of the second electrode serials **135** includes second electrode patterns **136** having a triangle, a quadrangle, a diamond shape, a polygon, and so on, similar to the first electrode patterns **131** and second connection patterns **137** for connecting neighboring second electrode patterns **136**.

[0048] In an example embodiment of this invention, the first connection patterns **110** are formed separately from the first electrode patterns **131**, and the second connection patterns **137** are integrally formed with the second electrode patterns **136**. Alternatively, the first connection patterns **110** may be integrally formed with the first electrode patterns **131**, and the second connection patterns **137** may be formed separately from the second electrode patterns **136**.

[0049] The routing wire forming part B is formed on the substrate **100** at positions outside the electrode forming part A, and includes a plurality of first routing wires **112** connected to the plurality of first electrode serials **130**, respectively and a plurality of second routing wires **114** connected to the plurality of second electrode serials **135**, respectively.

[0050] The pad part C includes a plurality of first pads **116** connected to the plurality of first electrode serials **130** through the plurality of first routing wires **112**, respectively, and a plurality of second pads **118** connected to the plurality of second electrode serials **135** through the plurality of second routing wires **114**, respectively.

[0051] In the example embodiment of this invention, the first connection patterns **110**, and the first and second routing wires **112** and **114** are formed on a substrate **100** through a same process and are made of a same material. In other embodiments, the first connection patterns **110**, and the first and second routing wires **112** and **114** are formed of different materials. The first connection patterns **110** and the first and second routing wires **112** and **114** include one of Al, AlNd,

Mo, MoTi, Cu, and Cr. Because these materials have a low resistivity, it is possible to lower contact resistance between the first and second electrode patterns **131** and **136** and the first connection pattern **110** or routing wires **112** and **114**. Because ITO has high resistivity and should have a thick thickness, it is difficult to use ITO as a routing wire, and thus ITO is not used in the embodiment. However, the ITO may be used if desired.

[0052] Further, it is preferable, though not necessary, that the first connection patterns **110** connecting the neighboring first electrode patterns are formed to have a thickness of about 2,000 Å to about 3,000 Å and a width of about 3 μm to about 10 μm. If a thickness of the first connection patterns **110** is less than 2,000 Å, the resistance of the first connection patterns **110** is high, and if a thickness of the first connection patterns **110** is larger than 3,000 Å, a step difference of a pattern increases. Also, if a width of the first connection patterns **110** is less than 3 μm, the resistance of the first connection patterns **110** is high, and if a width of the first connection patterns **110** is larger than 10 μm, the pattern is visible.

[0053] Further, in the example embodiment, because the first connection patterns **110** and the first and second routing wires **112** and **114** are formed through one same mask process, one mask process can be omitted, compared with the related art that forms a connection pattern for connecting electrode patterns and routing wires in a two mask processes. Accordingly, it is possible to reduce a cost and a tact time (manufacturing time required per product unit for achieving a daily production target amount).

[0054] In the example embodiment of this invention, an insulation layer **120** is formed on the substrate **100** in which the first connection patterns **110** and the first and second routing wires **112** and **114** are formed, and in the insulation layer **120**, first and second contact holes **120***a* and **120***b* for exposing portions of each of the first connection patterns **110**, a third contact hole **120***c* for exposing one portion of the first routing wires **112** and a fourth contact hole **120***d* (see FIG. **8**A) for exposing one portion of the second routing wires **114** are formed. The insulation layer **120** includes silicon nitride (SiNx). If a thickness of the insulation layer **120** is less than 5,000 Å, the insulation layer **120** may be destroyed or damaged by a voltage applied to the first electrode serial **130** and the second electrode serial **135**. Therefore, in order to prevent or reduce a phenomenon in which a failure occurs due to destruction or damage of the insulation layer **120** while using the touch screen panel, it is preferable, though not required, to form the insulation layer so that a thickness of the insulation layer is about 5,000 Å or more.

[0055] Further, if a thickness of the insulation layer **120** is about 6,000 Å, a saturation state in which a transmittance no longer increases is observed and a color transition phenomenon becomes a minimum. That is, in view of a transmittance and chromaticity expression, when a thickness of the insulation layer **120** is 6,000 Å or more, a transmittance becomes a maximum and a color transition phenomenon becomes a minimum and thus it is most preferable that the insulation layer **120** has a thickness of 6,000 Å or more. However, if a thickness of the insulation layer **120** exceeds 7,000 Å, it is difficult to form a contact hole and much more process time is required due to a characteristic of a silicon nitride layer used as a material of the insulation layer **120**. Accordingly, it is not preferable, though not required, that a thickness of the insulation layer **120** exceeds 7,000 Å. Therefore, when considering stability of the insulation layer **120**, a good light transmittance, and chromaticity expression ability together, it is preferable, though not required, to form a thickness of the insulation layer **120** in a range of 5,000 Å to 7,000 Å.

[0056] Further, a plurality of first electrode serials **130** and a plurality of second electrode serials **135** are formed on the insulation layer **120** in which the first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* (see FIG. **8**A) are formed. Each of the plurality of first electrode serials **130** includes a plurality of first electrode patterns **131** and is optionally arranged in a first direction (for example, an x-axis direction). Each of the plurality of second electrode serials **135** includes a plurality of second electrode patterns **136** and is optionally arranged in a second direction (for example, a y-axis direction) intersecting the first direction. Because the first electrode patterns **131** forming the first electrode serial **130** are separated from each other, the first electrode patterns **131** are connected to the portions of the first connection pattern **110** exposed through the first and second contact holes **120***a* and **120***b* formed in the insulation layer **120**, and the first electrode patterns **131** positioned at the outermost side are connected to the first routing wires **112** exposed through the third contact hole **120***c*.

[0057] As shown in FIG. **6**, portions of the plurality of first electrode patterns **131** are formed in the contact holes **120***a*, **120***b* and **120***c* so that the portions of the plurality of first electrode patterns **131** are partially filled in the contact holes **120***a*, **120***b* and **120***c*. For example, portions of the plurality of first electrode patterns **131** are formed on side walls of the contact holes **120***a*, **120***b* and **120***c*, and on exposed portions of the first connection patterns **110** and the first routing wires **112**. Accordingly, hollows or cavities **122***a*, **122***b*, and **122***c* are respectively formed by the portions of the plurality of first electrode patterns **131** being partially filled in the contact holes **120***a*, **120***b* and **120***c*.

[0058] The second electrode patterns **136** forming the second electrode serial **135** are integrally formed with the second connection patterns **137** and are connected to the second routing wires **114** exposed through the fourth contact hole **120***d* (see FIG. **8**A).

[0059] The first and second electrode patterns **131** and **136** and the second connection patterns **137** are made of the same material through the same process. The first and second electrode patterns **131** and **136** and the second connection patterns **137** are made of a transparent metal material such as ITO or IZO. In the example embodiment, because the first and second electrode serials **130** and **135** and the second connection patterns **137** using ITO are formed in a top layer of the touch screen panel and ITO has very high hardness, a scratch does not occur in a subsequent process of forming a display device on the other surface of the substrate **100** of the touch screen panel, and thus a touch screen panel of a good quality is obtained.

[0060] Hereinafter, a method of manufacturing a capacitive type touch screen panel according to the example embodiment of this invention will be described with reference to FIGS. **7**A to **9**B.

[0061] FIGS. **7**A to **7**B are a top plan view and a cross-sectional view illustrating a first mask process in the method of manufacturing the capacitive type touch screen panel according to the example embodiment of this invention.

[0062] Referring to FIGS. **5**, **7**A, and **7**B, a first conductive pattern group including first connection patterns **110**, first routing wires **112**, and second routing wires **114** is formed on

the substrate **100** including an electrode forming part A, the routing wire forming part B, and the pad part C using the first mask process.

[0063] In more detail, a first conductive layer is deposited on the substrate **100** through a deposition process such as a sputtering method. As the first conductive layer is patterned with a photolithography process and an etching process using a first mask, the first conductive pattern group including the first connection patterns **110**, the first routing wires **112**, and the second routing wires **114** is formed. Here, as a material forming the first conductive pattern group, Al, AlNd, Mo, MoTi, Cu, Cr, ITO and so on are used. The first connection pattern **110** formed in the electrode forming area A (see FIG. **5**) is formed to have a thickness of about 2,000 Å to about 3,000 Å and a width of about 3 μm to about 10 μm.

[0064] In another embodiment, the first conductive pattern group including the first connection patterns **110**, the first routing wires **112**, and the second routing wires **114** may be formed by being printed on the substrate **100**. Subsequent drying and/or heating process may be performed. In such a case, the photolithography process and the etching process using the first mask may be skipped. In other embodiments, other pattern forming processes may be used.

[0065] FIGS. **8**A to **8**D are a top plan view and cross-sectional views illustrating a second mask process in a method of manufacturing a capacitive type touch screen panel according to the example embodiment of this invention. The first and second routing wires **112** and **114** indicated by dotted lines in FIG. **8**A because they are covered by the insulation layer **120**, and the first and second routing wires **112** and **114** are portions that are not displayed in a top plan view, however for a better understanding, in this invention, the first and second routing wires **112** and **114** are indicated by dotted lines.

[0066] Referring to FIGS. **8**A and **8**B, the insulation layer **120** is formed through a deposition method such as sputtering on an entire surface of the substrate **100** in which the first conductive pattern group including the first connection patterns **110**, the first routing wires **112**, and the second routing wires **114** is formed. As a material of the insulation layer **120**, an inorganic insulation material such as silicon nitride (SiNx) is used. A thickness of the insulation layer **120** is preferably set to a range of about 5,000 Å to about 10,000 Å, more preferably, though not required, to a range of about 5,000 Å to about 7,000 Å.

[0067] After the insulation layer **120** is formed, as shown in FIG. **8**C, a photoresist pattern **210** is formed on a portion in which the insulation layer **120** should exist by a photolithography process using a second mask. First to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* (see FIG. **8**A) penetrating the insulation layer **120** are formed with a dry etching process using the photoresist pattern **210**. Next, when the photoresist pattern **210** is removed, as shown in FIG. **8**D, first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* for exposing the first conductive patterns **110**, **112**, and **114** are formed. Here, the first contact hole **120***a* exposes a portion of the first connection pattern **110**, the second contact hole **120***b* exposes another portion of the first connection pattern **110**, the third contact hole **120***c* exposes a portion of the first routing wire **112**, and the fourth contact hole **120***d* (see FIG. **8**A) exposes a portion of the second routing wire **114**.

[0068] FIGS. **9**A to **9**B are a top plan view and a cross-sectional view illustrating a third mask process in the method of manufacturing the capacitive type touch screen panel according to the example embodiment of this invention. FIG. **9**A is a top plan view illustrating the third mask process in the method of manufacturing the capacitive type touch screen panel according to the example embodiment of this invention, and for a better understanding, in FIG. **9**A, the insulation layer **120** formed between the first conductive pattern group and the second conductive pattern group is not depicted.

[0069] Referring to FIGS. **9**A and **9**B, the second conductive pattern groups including a plurality of first electrode serials **130** and a plurality of second electrode serials **135** formed on the insulation layer **120** in which the first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* (see FIG. **8**A) are formed using the third mask process. The plurality of first electrode serials **130** are optionally arranged in parallel in a first direction (for example, an x-direction). And the plurality of second electrode serials **135** are optionally arranged in parallel in a second direction (for example, a y-direction) intersecting the first direction.

[0070] In more detail, the second conductive layer is deposited through a deposition process such as sputtering on an entire surface of the insulation layer **120** in which the first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* (see FIG. **8**A) are formed. Thereafter, the second conductive layer is patterned with a photolithography process and an etching process using a third mask to form the second conductive pattern group including a plurality of first electrode serials **130** arranged parallel in the first direction (for example, an x-direction) and a plurality of second electrode serials **135** arranged parallel in the second direction (for example, an y-direction) intersecting the first direction. Here, each of the first electrode serials **130** includes the plurality of first electrode patterns **131**, and each of the second electrode serials **135** includes the plurality of second electrode patterns **136** and the second connection patterns **137** for connecting neighboring second electrode patterns **136**. As a material of the second conductive layer, ITO is used, and if a thickness thereof is about 1,200 Å to about 1,600 Å, a maximum transmittance can be obtained.

[0071] Also, as shown in FIG. **9**B, portions of the plurality of first electrode patterns **131** are deposited in the contact holes **120***a*, **120***b* and **120***c* so that the portions of the plurality of first electrode patterns **131** are partially filled in the contact holes **120***a*, **120***b* and **120***c*. For example, portions of the plurality of first electrode patterns **131** are deposited on side walls of the contact holes **120***a*, **120***b* and **120***c*, and on exposed portions of the first connection patterns **110** and the first routing wires **112**. Accordingly, hollows or cavities **122***a*, **122***b*, and **122***c* are respectively formed by the portions of the plurality of first electrode patterns **131** being partially filled in the contact holes **120***a*, **120***b* and **120***c*.

[0072] In embodiments of the invention, a cross section that is perpendicular to an axial direction of at least one of the first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* may be any shape. A rectangular shape is shown in FIG. **8**A, but embodiments of the invention includes having circular, oval, polygonal, or irregular shapes. Additionally, at least one of the hollows or cavities **122***a*, **122***b*, and **122***c* may be formed to extend in an axial direction of at least one of the first to fourth contact holes **120***a*, **120***b*, **120***c*, and **120***d* (see FIG. **8**A). Additionally, a depth of at least one of the hollows or cavities **122***a*, **122***b*, and **122***c* may be about 2,000 Å to about 9,000 Å in the axial direction depending on a thickness of the insulation layer **120** and at thickness of the pluralities of first and second electrode patterns.

[0073] Here, each of the first and second electrode patterns **131** and **136** is formed in a triangle, a quadrangle, a diamond, a polygon shape and so on, but a shape of the first and second electrode patterns **131** and **136** is not limited thereto and may include other random shapes. Further, in the example embodiment of this invention, the first electrode patterns **131** formed on the insulation layer **120** are separated, and the second electrode patterns **136** are integrally formed with the second connection pattern **137**, but the first electrode patterns **131** may be integrally formed with a connection pattern on the insulation layer **120**, and the second electrode patterns **136** may be separated. In this later instance, the second electrode patterns **136** are electrically connected by another connection pattern formed between the insulation layer **120** and the substrate **100**.

[0074] Next, a pad part C including a plurality of first pads **116** and a plurality of second pads **118** is formed. The plurality of first pads **116** are connected to the plurality of first electrode serials **130** through the plurality of first routing wires **112**, respectively, and the plurality of second pads **118** are connected to the plurality of second electrode serials **135** through the plurality of second routing wires **114**, respectively.

[0075] According to the example embodiment of this invention, because the first connection patterns **110** and the first and second routing wires **112** and **114** are formed through the same process, at least one mask process may be omitted. Therefore, a cost can be reduced and a tact time can be reduced according to reduction of the number of masks.

[0076] Further, in the example embodiment, because silicon nitride (SiNx) is used as the insulation layer **120**, a visibility problem occurring due to a color difference between the insulation layer **120** and a periphery can be solved or reduced. Because a thickness of the insulation layer **120** is set to a range of 5,000 Å to 7,000 Å, a transmittance becomes a maximum and a color transition phenomenon becomes a minimum and thus a destruction or damage phenomenon of the insulation layer **120** can be suppressed. Therefore, stability of the touch screen panel can be remarkably improved.

[0077] FIGS. **10** to **12** are simulation graphs illustrating a breakdown voltage, a transmittance, and a color transition characteristic according to a thickness of silicon nitride in the touch screen panel formed by using ITO as the first and second electrode patterns **131** and **136** and using silicon nitride as the insulation layer **120**.

[0078] FIG. **10** is a graph illustrating an electric field value of a breakdown point in which an insulation layer is destroyed or damaged according to a thickness of silicon nitride used as an insulation layer when a thickness of ITO used as first and second electrode patterns is about 1,400 Å. In FIG. **10**, a horizontal axis represents a thickness (Å) of silicon nitride and a vertical axis represents intensity (MV/cm) of an electric field. As shown in FIG. **10**, it is very important to appropriately adjust a thickness of silicon nitride because silicon nitride is destroyed or damaged when an electric field of 10 megavolt/cm or more is applied. In a condition in which a voltage (this value is a reliability condition of a touch screen panel manufacturer) of 500 volts or less is applied between the first and second electrode patterns **131** and **136** of the touch screen panel, when a thickness of silicon nitride is about 5,000 Å or less, insulation of silicon nitride was destroyed or damaged. Therefore, silicon nitride as the insulation layer **120** should be formed in a thickness of 5,000 Å or more.

[0079] FIG. **11** is a graph illustrating a transmittance of a touch screen panel according to a thickness of silicon nitride used as the insulation layer **120** when a thickness of ITO using as the first and second electrode patterns **131** and **136** is about 1,400 Å. In FIG. **11**, a horizontal axis represents a thickness (Å) of silicon nitride and a vertical axis represents a transmittance (%), "AIR" represents a transmittance of an instance in which a polarization sheet is not attached to the touch screen panel, and "POL" represents a transmittance of instance in which a polarization sheet is attached to the touch screen panel. As can be seen from FIG. **11**, in a thickness of 5,000 Å or more in which the insulation layer **120** is not destroyed or damaged, a transmittance gradually increases in a thickness of about 5,000 Å, arrives at a peak value in a thickness of about 6,000 Å, falls again to a thickness of about 6,500 Å, and increases again to a thickness of about 7,000 Å. That is, in an insulation layer thickness of 6,000 Å or more, because a transmittance is saturated, even if a thickness deviation occurs, there is no or little change of transmittance. FIG. **11** shows that a single touch screen panel has a transmittance of about 89%, and when a polarization sheet is attached to the touch screen panel, a transmittance of about 93% was obtained.

[0080] FIG. **12** is a graph illustrating a color transition characteristic of the touch screen panel according to a thickness of silicon nitride used as an insulation layer when a thickness of ITO used as first and second electrode patterns is 1,400 Å. In FIG. **12**, a horizontal axis represents a thickness (Å) of silicon nitride and a vertical axis represents a chrominance, "AIR" represents a chrominance of an instance in which a polarization sheet is not attached to the touch screen panel, and "POL" represents a chrominance of an instance in which a polarization sheet is attached to the touch screen panel. As can be seen from FIG. **12**, similarly to an instance of a transmittance, in a thickness of 5,000 Å or more in which the insulation layer **120** is not destroyed or damaged, a color transition characteristic is similar to a transmittance characteristic.

[0081] FIGS. **13** and **14** are simulation graphs of a transmittance characteristic and a color transition characteristic according to a thickness of an ITO layer in the touch screen panel formed by using ITO as the first and second electrode patterns **131** and **136** and using silicon nitride as an insulation layer **120**.

[0082] FIG. **13** is a graph illustrating a characteristic of transmittance according to a thickness of ITO used as the first and second electrode patterns **131** and **136** when a thickness of silicon nitride formed as an insulation layer **120** is 6,000 Å. In FIG. **13**, a horizontal axis represents a thickness (Å) of an ITO layer, a vertical axis represents a transmittance (%), "AIR" represents a transmittance of an instance in which a polarization sheet is not attached to the touch screen panel, and "POL" represents a transmittance of an instance in which a polarization sheet is attached to the touch screen panel. As can be seen from FIG. **13**, a thickness of silicon nitride is fixed to 6,000 Å and a light transmittance according to an ITO thickness has a minimum value in 700 Å and has a maximum value in 1400 Å.

[0083] FIG. **14** is a graph illustrating a color transition characteristic according to a thickness of ITO used as first and second electrode patterns when a thickness of silicon nitride formed as an insulation layer is 6,000 Å. In FIG. **14**, a horizontal axis represents a thickness (Å) of an ITO layer and a vertical axis represents a chrominance, "AIR" represents a

color transition degree of an example in which a polarization sheet is not attached to the touch screen panel, and "POL" represents a color transition degree of an instance in which a polarization sheet is formed in the touch screen panel. As can be seen from FIG. **14**, when a thickness of silicon nitride is fixed to 6,000 Å and a color transition degree according to an ITO thickness is measured, the color transition degree has a minimum value in about 700 Å, and thus an optimum ITO thickness is obtained in about 100 Å or about 1400 Å. However, in a display of a notebook computer size or more, due to a resistance problem, an optimum ITO thickness is obtained in about 1400 Å. In a consideration of a thickness range of silicon nitride used in the example embodiment, when a thickness of ITO is about 1,200 Å to about 1,600 Å, a maximum transmittance is obtained.

[0084] Further, in the example embodiment, because the first and second electrode serials **130** and **135** and the second connection patterns **137** are formed on a top layer of the touch screen panel, a scratch does not occur in a subsequent process.

[0085] FIG. **15** is a drawing illustrating a result before and after performing a scratch test of an area A in which the top of a touch screen panel is an insulation layer and an area B in which the top of a touch screen panel is ITO. In the result after performing a scratch test, a scratch occurs in the area A of the insulation layer, but a scratch does not occur in the area B of ITO.

[0086] Further, as a thickness of the first connection pattern formed between the insulation layer and the substrate to connect the first electrode patterns is formed in about 2,000 Å to about 3,000 Å, good proccessability and an appropriate resistance value can be obtained, and as a width is set to a range of about 3 μm to about 10 μm, a pattern is not visible.

[0087] FIG. **16** is a cross-sectional view illustrating a touch screen panel according to another embodiment of the invention. Similar to the touch screen panel shown in FIG. **6**, the touch screen panel of FIG. **16** includes a substrate **100**, first connection patterns **110** and first routing wires **112** formed on a substrate **100**, an insulation layer **121** formed over the substrate **100**, first and second contact holes **121***a* and **121***b* for exposing portions of the first connection patterns **110** and a third contact hole **121***c* for exposing one portion of the first routing wires **112** and a fourth contact hole (not shown but similar to 120*d* of FIG. **8**A) for exposing one portion of second routing wires **114**. In the embodiment of FIG. **16**, at least one of the first to fourth contact holes are formed in the insulating layer **121** at an angle so that the contact hole narrows in a depth-wise (or axial) direction. In other embodiments, the contact hole may widen in the depth-wise (or axial) direction. The angle between the a side of at least one of the contact holes, and a surface of the substrate **110**, for example, may be acute or obtuse. In an embodiment of the invention, the angle may be between about 30° to about 90°.

[0088] Further, a plurality of first electrode serials **130** and a plurality of second electrode serials **135** are formed on the insulation layer **121** in which the first to fourth contact holes are formed. Each of the plurality of first electrode serials **130** includes a plurality of first electrode patterns **131***a* and is optionally arranged in a first direction (for example, an x-axis direction). Each of the plurality of second electrode serials **135** includes a plurality of second electrode patterns (not shown) and is optionally arranged in a second direction (for example, a y-axis direction) intersecting the first direction. Because the first electrode patterns **131***a* forming the first electrode serial **130** are separated from each other, the first electrode patterns **131***a* are connected to the portions of the first connection pattern **110** exposed through the first and second contact holes **121***a* and **121***b* formed in the insulation layer **121**, and the first electrode patterns **131***a* positioned at the outermost side are connected to the first routing wires **112** exposed through the third contact hole **121***c*.

[0089] As shown in FIG. **16**, portions of the plurality of first electrode patterns **131***a* are formed in the contact holes **121***a*, **121***b* and **121***c* so that the portions of the plurality of first electrode patterns **131** are partially filled in the contact holes **121***a*, **121***b* and **121***c*. For example, portions of the plurality of first electrode patterns **131***a* are formed on side walls of the contact holes **121***a*, **121***b* and **121***c*, and on exposed portions of the first connection patterns **110** and the first routing wires **112**. Accordingly, at least one of hollows or cavities **123***a*, **123***b*, and **123***c* are respectively formed by the portions of the plurality of first electrode patterns **131***a* being partially filled in the contact holes **121***a*, **121***b* and **121***c*. Additionally, a surface of the first electrode patterns **131***a* exposed to the at least one of the hollows or cavities **123***a*, **123***b*, and **123***c*, may have an angle with respect to the substrate **110** that may be acute or obtuse. In an embodiment of the invention, at least one of the angles may be between about 30° to about 90.

[0090] In an embodiment of the invention, the hollows or cavities need not be opened at one end. That is, an opening of at least one of the hollows or cavities may be plugged by a portion of at least one of first electrode patterns.

[0091] The touch screen panels according to the example embodiments of this invention may be applied to display devices such as a liquid crystal display, a field emission display, a plasma display panel, an electroluminescence device, an electrophoresis display and a flexible display. In these cases, the substrates of the touch screen panels may be also used as substrates of the display devices.

[0092] Although example embodiments have been described with reference to a number of illustrative examples, it should be understood that numerous other modifications and changes can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A touch screen panel, comprising:

a substrate;

an electrode forming part comprising a plurality of first electrode serials and a plurality of second electrode serials formed on the substrate, the plurality of first electrode serials being arranged in parallel in a first direction, and the plurality of second electrode serials being arranged to intersect the first electrode serials;

a routing wire forming part formed on the substrate at positions outside the electrode forming part and comprising a plurality of first routing wires connected to the plurality of first electrode serials, respectively, and a plurality of second routing wires connected to the plurality of second electrode serials, respectively;

a plurality of first connection patterns formed on the same layer with the pluralities of first and second routing wires; and

an insulation layer formed between the pluralities of first and second electrode serials and the substrate, and having a plurality of contact holes to expose portions of the plurality of first connection patterns,

wherein each of the plurality of first electrode serials comprises a plurality of first electrode patterns and each of the plurality of second electrode serials comprises a plurality of second electrode patterns, and

the plurality of first electrode patterns is formed as separated plurality of patterns, and the separated plurality of patterns are connected to each other through the plurality of contact holes and by the plurality of first connection patterns.

2. The touch screen panel of claim **1**, wherein the plurality of first connection patterns and the pluralities of first and second routing wires are formed of the same material.

3. The touch screen panel of claim **1**, wherein the plurality of first connection patterns and the pluralities of first and second routing wires are formed of different materials.

4. The touch screen panel of claim **1**, wherein the plurality of first connection patterns and the pluralities of first and second routing wires are formed of one of Al, AlNd, Cu, Ag, Mo, MoTi and Cr.

5. The touch screen panel of claim **1**, wherein at least one of the plurality of first electrode patterns and the plurality of second electrode patterns include shapes of one of a triangle, a quadrangle, a diamond and a polygon.

6. The touch screen panel of claim **1**, wherein the insulation layer includes silicon nitride, and the plurality of first electrode serials and the plurality of second electrode serials include a transparent conductive material.

7. The touch screen panel of claim **1**, wherein the insulation layer has a thickness of about 5000 Å to about 7000 Å.

8. The touch screen panel of claim **1**, wherein the plurality of first connection patterns has a thickness of about 2000 Å to about 3000 Å, and has a width of about 3 μm to about 10 μm.

9. The touch screen panel of claim **1**, wherein the plurality of second electrode patterns is formed as connected plurality of patterns, and the connected plurality of patterns are connected to each other through a plurality of second connection patterns.

10. The touch screen panel of claim **1**, wherein the pluralities of first and second electrode patterns have thicknesses of about 1200 Å to about 1600 Å.

11. The touch screen panel of claim **1**, wherein a hollow is formed by a portion of the plurality of first electrode patterns being partially filled in the plurality of contact holes.

12. A method of manufacturing a touch screen panel, the method comprising:

a first process of forming a plurality of first connection patterns, a plurality of first routing wires, and a plurality of second routing wires simultaneously on a substrate;

a second process of forming an insulation layer on an entire surface of the substrate and a plurality of contact holes in the insulating layer for exposing portions of at least one of the plurality of first connection patterns; and

a third process of forming a plurality of first electrode serials and a plurality of second electrode serials on the insulation layer in which the plurality of contact holes are formed, the plurality of first electrode serials being arranged in parallel in a first direction, and the plurality of second electrode serials being arranged in parallel in a second direction intersecting the first direction.

13. The method of claim **12**, wherein the first process includes depositing a first conductive layer on the substrate by a deposition process and forming the plurality of first connection patterns, the plurality of first routing wires, and the plurality of second routing wires by patterning the first conductive layer with a photolithography process and an etching process using a first mask;

the second process includes forming the insulation layer through a deposition process and forming the plurality of contact holes for exposing the portions of the at least one of the plurality of first connection patterns, a portion of at least one of the plurality of first routing wires, and a portion of at least one of the plurality of second routing wires with a photolithography process and an etching process using a second mask; and

the third process includes depositing a second conductive layer through a deposition process on the insulation layer in which the plurality of contact holes are formed and forming the plurality of first electrode serials and the plurality of second electrode serials by patterning the second conductive layer with a photolithography process and an etching process using a third mask.

14. The method of claim **12**, wherein the plurality of first connection patterns and the pluralities of first and second routing wires are formed of one of Al, AlNd, Cu, Ag, Mo, MoTi and Cr.

15. The method of claim **12**, wherein at least one of the plurality of first electrode patterns and the plurality of second electrode patterns include shapes of one of a triangle, a quadrangle, a diamond and a polygon.

16. The method of claim **12**, wherein the insulation layer includes silicon nitride, and the plurality of first electrode serials and the plurality of second electrode serials include a transparent conductive material.

17. The method of claim **12**, wherein the insulation layer has a thickness of about 5000 Å to about 7000 Å.

18. The method of claim **12**, wherein the plurality of first connection patterns has a thickness of about 2000 Å to about 3000 Å, and has a width of about 3 μm to about 10

19. The method of claim **12**, wherein the pluralities of first and second electrode patterns have thicknesses of about 1200 Å to about 1600 Å.

20. A touch screen panel, comprising:

a substrate;

a plurality of first connection patterns formed on the substrate;

an insulation layer formed on the substrate to cover the plurality of first connection patterns, and having a plurality of contact holes that exposes portions of the plurality of first connection patterns; and

a plurality of first electrodes and a plurality of second electrodes formed on the insulating layer, the plurality of first electrodes being arranged in parallel in a first direction, and the plurality of second electrodes being arranged in a second direction that intersects the first direction,

wherein at least one of the plurality of first connection patterns connects at least one adjacent pair of the plurality of first electrodes through at least two of the plurality of contact holes that expose respective portions of the at least one of the plurality of first connection patterns, and at least one hollow is formed by portions of the at least one adjacent pair of the plurality of first electrodes being formed in the at least two of the plurality of contact holes.

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