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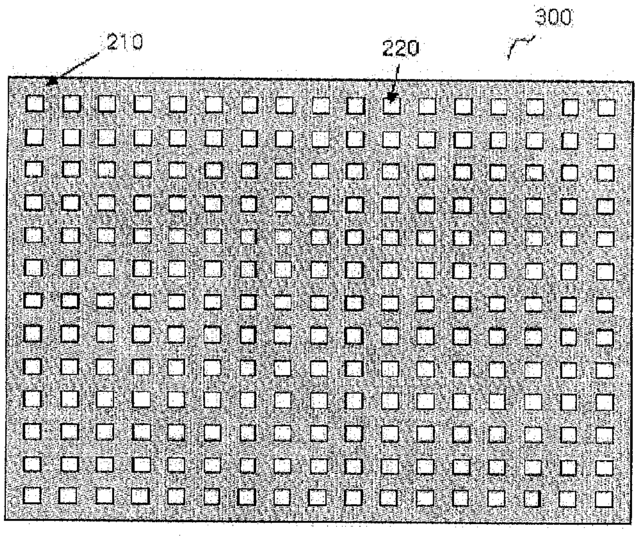
(54) **Title:** CONDUCTIVE PANEL STRUCTURE AND MANUFACTURING METHOD THEREOF



(57) **Abstract:** Disclosed is a method of changing the sheet resistance of a conductive substrate used in a touch panel to increase durability of the substrate used and change the resistance of the substrate at a predetermined portion so as to improve the properties of the substrate. According to this invention, the method of changing the sheet resistance of the conductive substrate includes forming an etch mask having a triangular, rectangular, pentagonal, hexagonal, circular or specific linear shape on a substrate having a conductive thin-film layer, and then physically or chemically etching the substrate in the predetermined shape to increase the sheet resistance thereof. The method of this invention includes changing the resistance of a substrate through control of the aperture rate of the conductive thin-film layer of the substrate by uniformly etching the entire substrate or selectively etching a predetermined portion of the substrate to thus increase the aperture rate of the predetermined portion.

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【DESCRIPTION】

【Invention Title】

CONDUCTIVE PANEL STRUCTURE WHICH RESISTANCE IS CONTROLLED BY PATTERNING, AND MANUFACTURING METHOD THEREOF

【Technical Field】

The present invention relates to a method of controlling the sheet resistance of a substrate having a conductive thin-film layer, usable in a touch panel, and a substrate manufactured thereby. More particularly, the present invention relates to a novel transparent conductive substrate structure, in which the sheet resistance of a conductive thin-film layer formed on a substrate for reducing power consumption of an electronic display device is controlled by patterning the thin-film layer, having a sufficient thickness, such that desired sheet resistance can be realized without the need for precise control of the thickness of the thin-film layer, thus maintaining mechanical durability and reliability of the thin-film layer and reducing the manufacturing cost, and also in which the shape, size or density of the pattern are designed to vary depending on the position of the substrate, thus improving electrical properties, such as electric field distribution, and to a method of manufacturing the same.

【Background Art】

After a transparent electroconductive film was first reported as a result of the oxidation of a deposited cadmium (Cd) metal film using a glow discharge device in 1907, transparent conducting oxide (TCO) has been applied in various fields to date. Thorough research and development into materials of TCO thin-film layers and commercialization thereof began in the 1960s. In this regard, a TCO thin-film layer formed of SnO_2 has been developed using a pyrolysis spray process or a sputtering process, and has been applied to building windows or photovoltaic cells so as to reduce energy consumption.

Further, a TCO thin-film layer having high-quality of Sn-doped In_2O_3 (ITO), deposited using a sol-gel process, an evaporation process or a sputtering process, has its main application range in flat panel displays and touch panel devices, including liquid crystal displays or plasma display panels, and is therefore regarded as presently widely useful TCOs.

Moreover, research into ternary or quaternary oxides containing two or three or more multi-cations selected from among Cd^{2+}, In^{3+}, Ga^{3+}, and Sn^{4+}, in addition to binary oxide materials, has been actively conducted these days. Simultaneously, research into transparent conductive films having a multilayered structure of TCO/metal layer/TCO, capable of exhibiting excellent transmittance and electroconductivity while reducing the use of ITO, has also been conducted.

Particularly, in the case of a resistive touch panel, a glass substrate coated with a transparent conductive film used therefor is typically formed of ITO glass (glass entirely coated with ITO thin-film layer) having transmittance of 90% or more (93% or more requires the use of specific glass having high transmittance) and sheet resistance of about 400~500 Ω/□. In the ITO glass satisfying such requirements, the applied ITO thin-film layer has a thickness of about 13~20 nm.

As such, when the ITO thin-film layer is formed to the small thickness noted above, an impurity, such as a Na ion (included in soda-lime glass mainly used as the glass substrate), diffusing into the ITO after passing through a barrier layer (positioned between the glass substrate and the ITO thin-film layer) during a heat treatment process, may greatly affect the conductivity of ITO.

Further, if the thin-film layer is too thin, the properties of the ITO thin-film layer may easily change due to the invasion of moisture, oxygen or nitrogen in the air, resulting in very low environmental resistance, such as easily changeable sheet resistance.

Furthermore, if the thin-film layer is thin, the deviation of the sheet resistance is increased even by a small thickness deviation, electrical properties are sensitively changed according to the variation in thickness ratio of the substrate to the thin-film layer of the substrate or in uniformity with the thin-film layer on the same substrate, undesirably decreasing the reproducibility of products. Therefore, although the process of applying ITO on a substrate should be more precisely controlled, it is much more difficult to conduct than the process of making the ITO thin-film layer sufficiently thick to a predetermined thickness or more.

Under the influence of such a difficult process and film management, ITO glass actually having a thick film, leading to transmittance of about 89% or more and sheet resistance of about 200 Ω/□, is supplied at much lower prices than ITO glass having transmittance of about 90% or more and sheet resistance of about 400~500 Ω/□.

Despite such price difference, film management, and difficult process control, in the case where a resistive touch screen has a thick ITO film, the sheet resistance thereof is decreased, and thus the terminal resistance of the touch screen is reduced. Hence, since current is increased with respect to generally used standard voltage (i.e., 5 V), power consumption is increased, resulting in difficulty in the application of such a touch screen to mobile products. Further, the thick ITO film undesirably slightly decreases the transmittance. Accordingly, ITO glass of the thick thin-film layer having low sheet resistance of about 200 Ω/□ is difficult to use in practice.

Moreover, since ITO glass of the thinner thin-film layer having at least 600 Ω/□ has the problems of environmental resistance and reliability of the film, it is difficult to apply to products in practice.

【Disclosure】

【Technical Problem】

Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and an object of the present invention is to provide a novel transparent conductive substrate structure and a method of manufacturing the same, in which the sheet resistance of a conductive thin-film layer formed on a transparent conductive substrate is controlled by patterning the thin-film layer, having a sufficient thickness, such that desired sheet resistance can be obtained without the need to precisely control the thickness of the thin-film layer, thus maintaining the mechanical durability and reliability of the thin-film layer and reducing the manufacturing cost.

Another object of the present invention is to provide a novel transparent conductive substrate structure and a method of manufacturing the same, in which the shape, size or density of a pattern are designed to vary depending on the position of a substrate, thus improving electrical properties, such as electric field distribution.

The intention of the present invention is to manufacture products using an inexpensive and highly reliable substrate through a technique of uniformly etching a substrate including a conductive thin-film layer having low resistance formed thereon in a circular, triangular, rectangular, pentagonal or hexagonal shape without breaking continuity of the conductive thin-film layer to design such a shape so as to remarkably increase the sheet resistance of the conductive thin-film layer.

【Technical Solution】

In order to accomplish the above objects, the present invention provides a conductive substrate structure, comprising a conductive thin-film layer formed on a light transmissive substrate to a predetermined thickness and having predetermined resistivity; and a plurality of electrode patterns for applying predetermined current via the thin-film layer through electrical connection of the thin-film layer to an external control circuit, in which the thin-film layer has a pattern formed through a predetermined patterning process so as to obtain sheet resistance causing current flowing between the plurality of electrode patterns to be equal to or lower than a predetermined value determined by a predetermined critical value of required power, and so as to easily control electric field distribution formed through the electrode pattern.

In addition, the present invention provides a method of manufacturing a conductive substrate structure for use in a touch screen device, comprising preparing a substrate having a conductive thin-film layer formed thereon; and patterning the conductive thin-film layer of the substrate using a predetermined patterning process to change sheet resistance of the conductive thin-film layer of the substrate to a desired value.

【Advantageous Effects】

According to the present invention, the conductive transparent substrate structure of the present invention can be imparted with a thicker thin-film layer through a process of etching the conductive thin-film layer in a predetermined shape to increase the sheet resistance thereof, thus improving poor environmental resistance and reliability of a conventional substrate structure having a thin thin-film layer. Further, even though the thickness of the thin-film layer is not precisely controlled, desired sheet resistance can be realized, leading to maintenance of mechanical durability and reliability and decreased manufacturing cost.

In addition, the shape, size or density of the pattern is designed to vary depending on the position of the substrate, therefore improving electrical properties including electric field distribution.

【Description of Drawings】

FIG. 1 is a view showing a shadow mask used in physical etching for the formation of a substrate having remarkably increased sheet resistance, according to the present invention;

FIG. 2 is a view showing a printing mask used in chemical etching for the formation of a substrate having remarkably increased sheet resistance, according to the present invention;

FIG. 3 is a view showing a substrate obtained by uniformly etching ITO on a conventional ITO transparent conductive film substrate in a rectangular shape, according to a first embodiment of the present invention;

FIG. 4 is a view showing a substrate obtained by uniformly etching ITO on a conventional ITO transparent conductive film substrate in a linear shape, according to a second embodiment of the present invention;

FIG. 5 is a view schematically showing the ITO substrate of FIG. 4, on which one substrate electrode of a four-wire touch screen is formed;

FIG. 6 is a view showing a substrate obtained by uniformly etching ITO on a conventional ITO transparent conductive film substrate only at a margin portion thereof in a rectangular shape, according to a third embodiment of the present invention;

FIG. 7 is a view showing a substrate obtained by uniformly etching ITO on a conventional ITO transparent conductive film substrate in a rectangular shape such that the margin portion and the central portion of the substrate have ITO aperture rates different from each other, according to a fourth embodiment of the present invention;

FIG. 8 is a view showing a substrate obtained by etching ITO on a conventional ITO transparent conductive film substrate in different shapes such that the margin portion and the central portion of the substrate have ITO aperture rates different from each other, according to a fifth embodiment of the present invention;

FIG. 9 is a view showing the structure and operation of a general capacitive touch panel; and

FIG. 10 is a view schematically showing the process of forming a group of five-wire electrodes (or capacitive electrodes) on the ITO substrate of FIG. 6.

【Mode for Invention】

Hereinafter, a detailed description will be given of the preferred embodiments of the present invention with reference to the appended drawings.

FIGS. 1 and 2 show a shadow mask and a printing mask used in physical etching and chemical etching, respectively, for the formation of a conductive transparent substrate structure, according to the present invention.

According to the preferred embodiment of the present invention, an etching process, among processes used for the formation of a substrate having remarkably increased sheet resistance, may include various physical or chemical processes. In regard to the physical etching process, as shown in FIG. 1, a substrate including a conductive thin-film layer having low resistance formed thereon, that is, a conventional ITO transparent conductive film substrate 100 is etched through a shadow mask having an etch-masking region 10 and etching regions 20 using physical sputtering (plasma ion beam/neutral beam sputtering), so that the portions of the substrate corresponding to the etching regions 20 are etched. Thereby, as shown in FIG. 3, the substrate having remarkably increased sheet resistance may result. In the chemical etching process, as shown in FIG. 2, a printing process is conducted on a substrate 200, including a conductive thin-film layer having low resistance formed thereon, through a printing mask having a etch-masking region 100, through which an etch-masking paste is printed on the substrate, and etching regions 120. Consequently, the etch-masking paste is printed on the substrate in the shape of FIG. 1. Thereafter, sintering and drying processes are performed, and then an etching process using an ITO etchant is performed, thus obtaining the substrate having remarkably increased sheet resistance, as shown in FIG. 3.

The conductive thin-film layer used in the present invention includes, for example, a conventional ITO thin-film layer, but is not limited thereto. Alternatively, useful are transparent conductive films formed of IZO, AZO, FTO or ATO, or semi-transparent conductive films, including multilayered structures or monolayered half mirrors, usable in specific touch screens.

According to the etching process, as shown in FIG. 3, a substrate including a conductive thin-film layer having low resistance formed thereon, for example, an ITO substrate 210 such as glass or PC PET, is uniformly etched in the rectangular shape so as not to break continuity of the conductive thin-film layer, thus forming etched glass surfaces 220, leading to a substrate 300 in which the sheet resistance of the conductive thin-film layer is increased. As such, the opening ratio (the ratio of the area of the substrate to the area of the conductive thin-film layer to be etched, that is, the area of the conductive thin-film layer to be etched/the area of the substrate) varies depending on the desired sheet resistance. Presently, taking into account the fact that the glass specification for a general four-wire resistive touch screen is 500 Ω/□ ± 20% (in the case of a high specification, ± 10% is required, but the cases of ± 10% and ± 20% are not actually used due to reliability problems), in the embodiment of FIG. 3, a minimum feature size, which constitutes the pattern defined by portions where the conductive thin-film layer is etched in the range of the aperture rate of about 0.1~0.9 to realize about 400~500 Ω/□ corresponding to desired sheet resistance, is determined to be 0.1~ones of mm. However, in consideration of the increase in sheet resistance in response to the high aperture rate, as long as the conductive thin-film layer has remarkably increased sheet resistance through the uniform etching of the conductive thin-film layer without breaking continuity thereof, the present invention is not limited to the rectangular shape shown in FIG. 3, but a circular, triangular, pentagonal or hexagonal shape may be applied.

In the case of the four-wire resistive touch screen, since an upper substrate and a lower substrate are responsible for the x axis and the y axis, respectively, as shown in FIG. 4, usable is a substrate 400 having glass surfaces 320 formed by etching an ITO substrate 310 such as glass or PC PET in a linear shape.

FIG. 5 schematically shows the electrode of the substrate responsible for the y axis of the four-wire resistive touch screen using the substrate having increased sheet resistance through uniform etching of ITO in the linear shape according to the embodiment of FIG. 4. Portions 420 where ITO is uniformly etched in the linear shape are connected to an FPC terminal 450, whereby the ITO etched portions 420 may act as equipotential electrodes 440.

In the wire electrode of the five-wire resistive touch screen or capacitive touch screen, as the conductivity ratio of the wire electrode and the ITO thin-film layer of the substrate is increased, the electric field distribution is easy to linearly design, and thus, the wires may be easily designed in practice. Preferably, a substrate having locally different sheet resistances may be used. In the present invention, in the case where voltage is applied to four corners of ITO glass having sheet resistance of 500 Ω/□, it is possible to use the principle in which the voltage applied to the corners of the glass is uniformly distributed into the glass using a group of metal wire patterns so as to make the electric field distribution in the substrate uniformly linear. In such a case, when the conductivity of the used wire is higher than that of ITO, the equipotential surface may be easily formed on the ITO substrate into the linear shape corresponding to a desired design form. In addition, as the difference between conductivities of the wire electrode and the ITO substrate is increased, the number of wire electrode layers (in FIG. 10, the number of wire layers is 4) may be decreased. Alternatively, in the case where the number of wire layers is the same, wire design for linearity may be easily realized. In brief, according to the present invention, the shape suitable for selectively increasing the aperture rate at the desired portion of the substrate is designed, thus making the design of a substrate having locally different aperture rates possible.

Consequently, it is easy to design a wire electrode for a five-wire resistive touch screen or a capacitive touch screen.

Specifically, as shown in FIG. 6, shown is a designed substrate 600 on which glass surfaces 520 uniformly etched in a rectangular shape are formed only at the margin portion of an ITO transparent conductive film substrate 510. In addition, as shown in FIG. 7, there is a designed substrate 700 on which glass surfaces 620 uniformly etched in a rectangular shape are formed at the margin portion and central portion of an ITO transparent conductive film substrate 610 to have different densities so as to make the ITO aperture rates of such portions different.

In addition, as shown in FIG. 8, there is a designed substrate 800 on which glass surfaces 720 etched in different shapes, that is, circular and rectangular shapes, are formed at the margin portion and central portion, respectively, of an ITO transparent conductive film substrate 710 to make the ITO aperture rates of such portions different. In this way, the magnitude of the sheet resistance may selectively vary depending on the position of the substrate.

In FIG. 9, the structure and operation of a general capacitive touch screen are shown. As shown in the drawing, the capacitive touch screen is a device for transferring predetermined signal voltage generated from a signal voltage generator 301 to a touch panel 1 through a detecting circuit 201, and detecting current signals flowing through a plurality of electrodes 60, 62, 64, 66 disposed on the substrate 120 when bringing a user 80, having predetermined impedance, into contact with a predetermined position P(x, y) so as to enable the calculation of the horizontal position signal x and the vertical position signal y on the panel 1 from the respective current signals.

On the substrate 120, a plurality of electrode patterns 10, 20, 30, 40, 50 is formed so as to accurately detect respective current components 71, 72, 73, 74. Such electrode patterns function to control the electric field distribution on the panel in order to prevent the loss of current and in order to accurately induce the current into electrodes UL, UR, DL, DR at four corners of the substrate.

As such, the design of the electrode pattern is simplified as the difference between sheet resistances of the ITO film on the substrate and the conductor, functioning as the electrode material, is increased. Further, since the electric field distribution on the ITO film is mainly determined by the electrode pattern, the electric field distribution may be more effectively controlled using the electrode pattern, thus realizing good panel properties.

In order to obtain the above-mentioned properties, FIG. 10 illustrates the electrodes formed on a substrate 900 designed according to the embodiment of FIG. 6, in which glass surfaces uniformly etched in the rectangular shape are formed on an ITO glass substrate 810 at the margin portion thereof, where a group of five-wire or capacitive electrodes 850 is formed, so as to form a group of wire patterns 820 having sheet resistance increased only at the margin portion of the substrate.

Although the preferred embodiments of the present invention, in regard to the conductive transparent substrate structure, the touch panel using the same, and the manufacturing method thereof, have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

【Industrial Applicability】

As described hereinbefore, the conductive transparent substrate structure of the present invention is imparted with a thicker thin-film layer using a process of etching the conductive thin-film layer in a predetermined shape to increase the sheet resistance thereof, thus improving poor environmental resistance and reliability of a conventional substrate structure having a thin thin-film layer. In addition, desired sheet resistance can be obtained even though the thickness of the thin-film layer is not precisely controlled, and therefore it is possible to maintain mechanical durability and reliability and decrease the manufacturing cost. Further, the shape, size or density of the pattern may be differently designed depending on the position of the panel, thus improving the electrical properties, such as linearity of electric field distribution.

【CLAIMS】

【Claim 1】

A conductive substrate structure, comprising:

a conductive thin-film layer formed on a light transmissive substrate to a predetermined thickness and having predetermined resistivity; and

a plurality of electrode patterns for applying predetermined current via the thin-film layer through electrical connection of the thin-film layer to an external control circuit,

in which the thin-film layer has a pattern formed through a predetermined patterning process so as to obtain sheet resistance causing current flowing between the plurality of electrode patterns to be equal to or lower than a predetermined value determined by a predetermined critical value of required power, and so as to easily control electric field distribution formed through the electrode pattern.

【Claim 2】

The structure according to claim 1, wherein the thin-film layer has a pattern defined by portions where the thin-film layer is removed, in which the portions determine an aperture rate on the substrate and have a minimum feature size ranging from 1 mm to 10 mm, and

the pattern continues along a path of current between the plurality of electrodes on the substrate.

【Claim 3】

The structure according to claim 1, wherein the conductive thin-film layer is a monolayered or multilayered conductive film.

【Claim 4】

The structure according to claim 1, wherein the conductive thin-film layer is a semi-transparent conductive film.

【Claim 5】

The structure according to claim 1, wherein the conductive thin-film layer has a pattern having different aperture rates in some regions of the substrate to make electrical properties of the substrate locally different.

【Claim 6】

A touch screen device, formed using the conductive substrate structure of any one of claims 1 to 4.

【Claim 7】

The device according to claim 6, which is a four-wire resistive touch screen formed using the conductive substrate structure.

【Claim 8】

The device according to claim 6, which is a five-wire touch screen or capacitive touch screen formed using the conductive substrate structure.

【Claim 9】

A method of manufacturing a conductive substrate structure for use in a touch screen device, comprising:

preparing a substrate having a conductive thin-film layer formed thereon; and

patterning the conductive thin-film layer of the substrate using a predetermined patterning process to change sheet resistance of the conductive thin-film layer of the substrate to a desired value.

【Claim 10】

The method according to claim 9, wherein the patterning further comprises forming a mask of a pattern defined by portions where the thin-film layer is removed, in which the portions determine an aperture rate on the substrate and have a minimum feature size ranging from 1 mm to 10 mm.

【Claim 11】

The method according to claim 9, wherein the patterning is conducted by making an aperture rate locally different so as to control the sheet resistance of the substrate locally differently.

Fig. 1

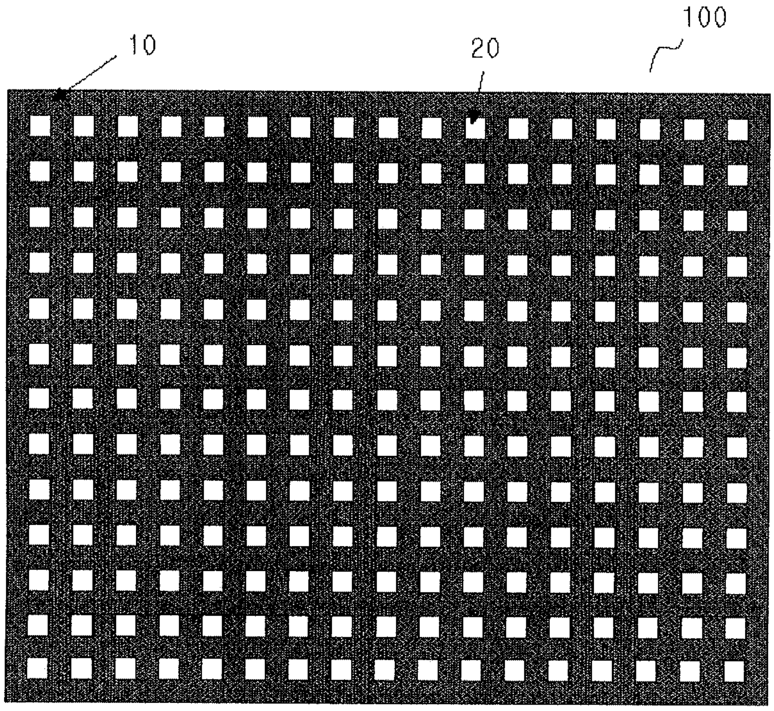

Fig. 2

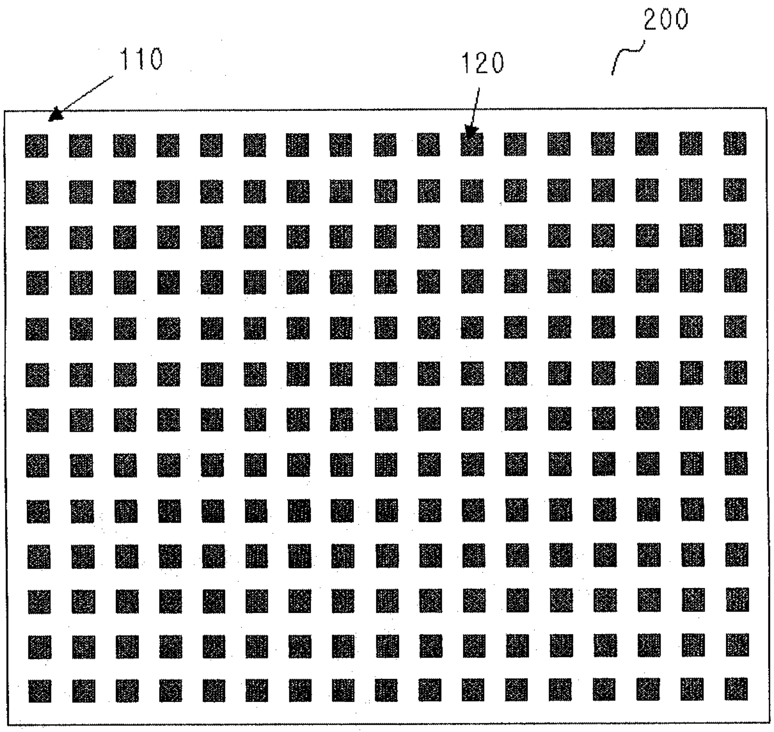

Fig. 3

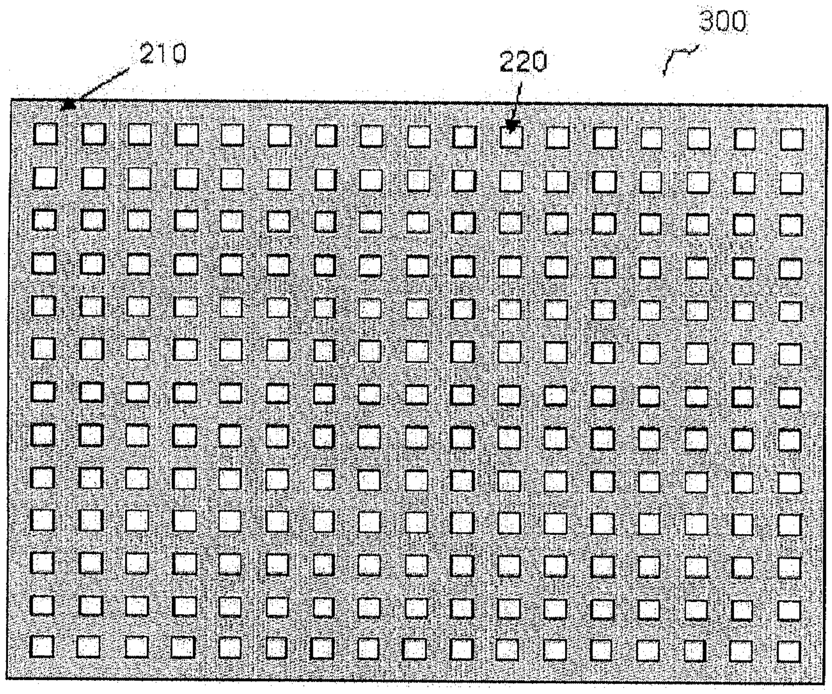

Fig. 4

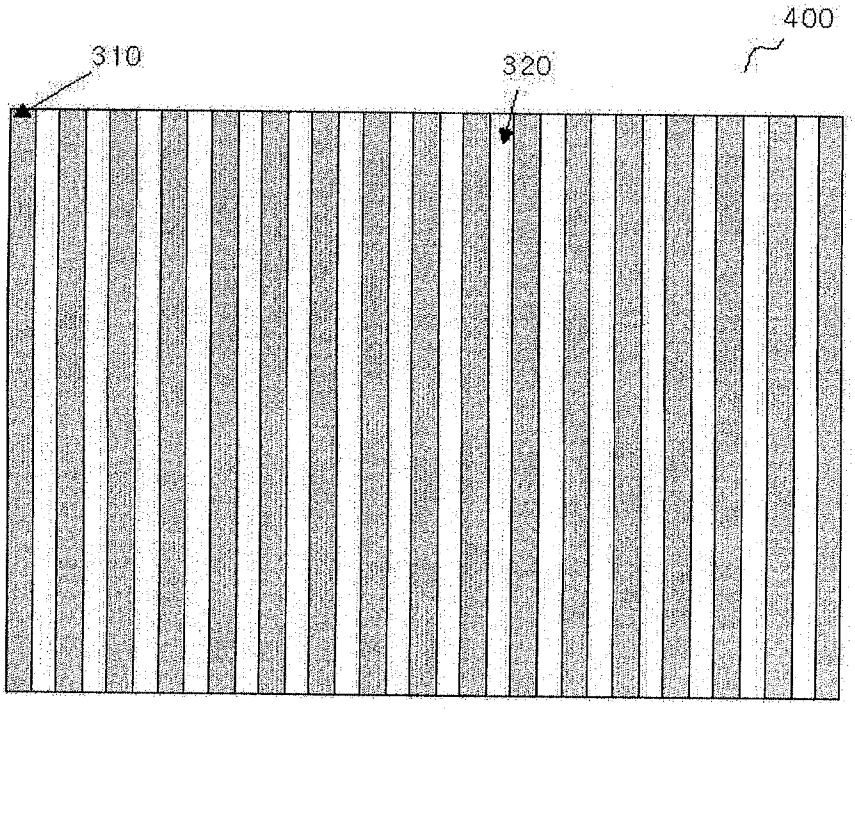

Fig. 5

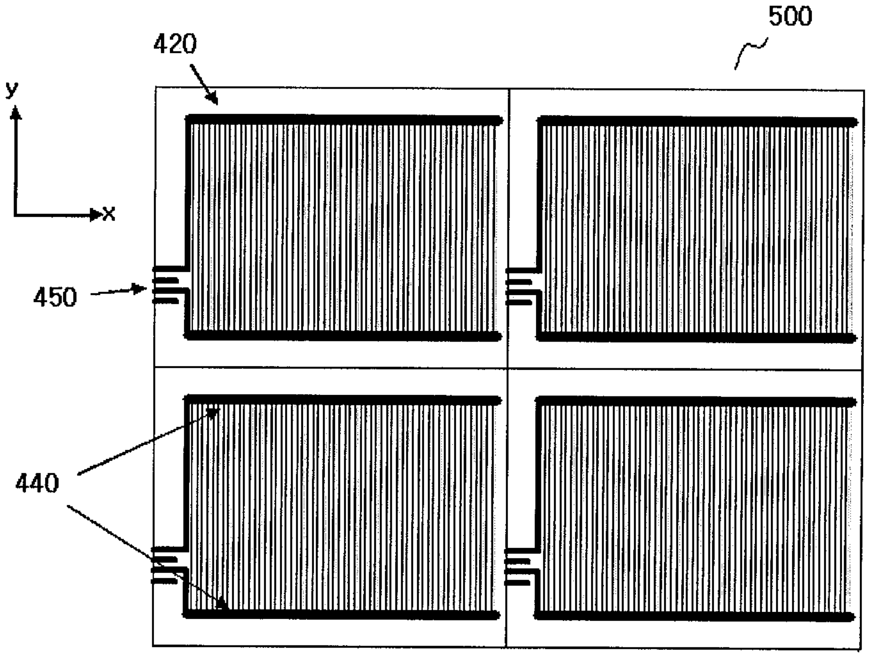

Fig. 6

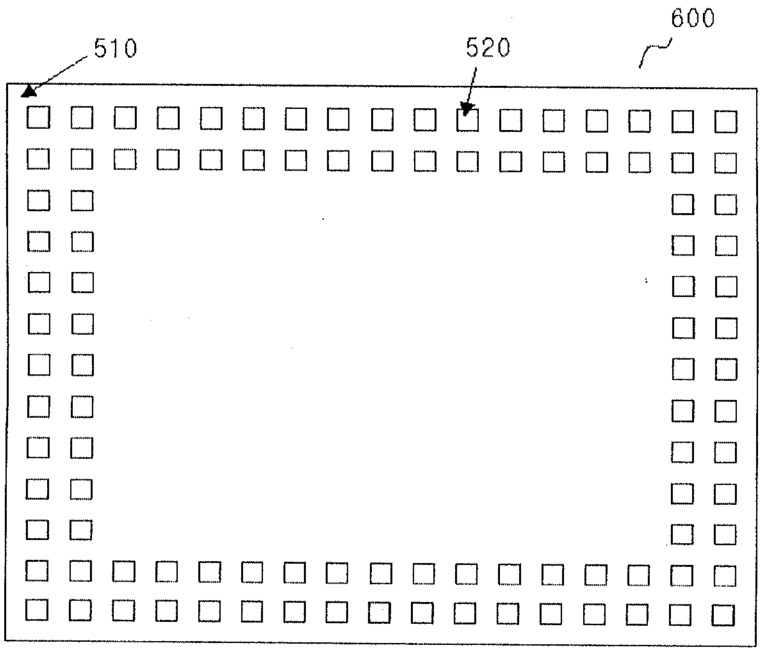

Fig. 7

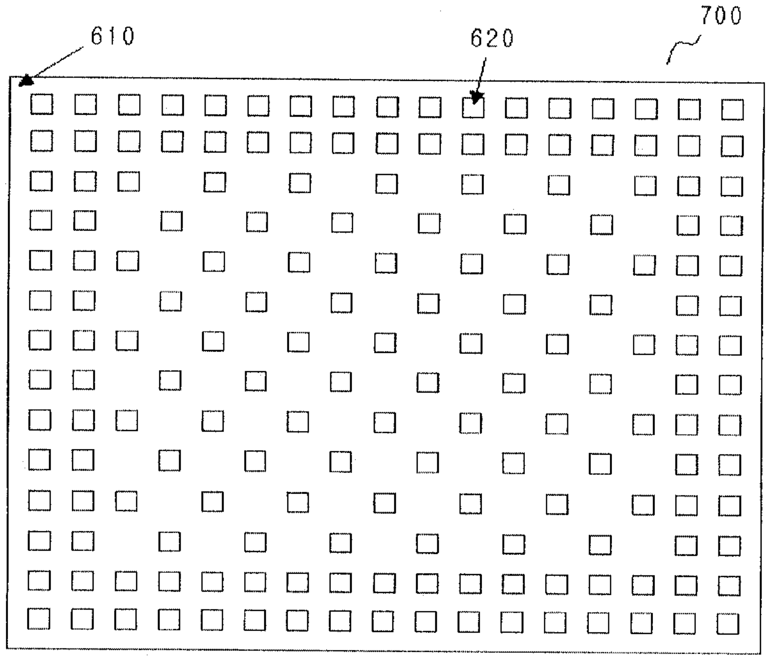

Fig. 8

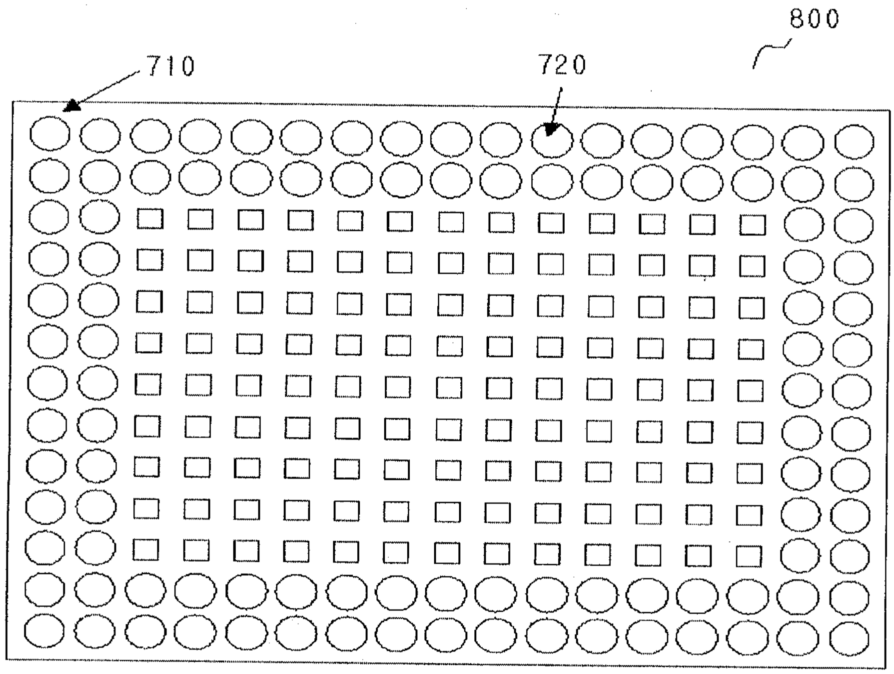

Fig. 9

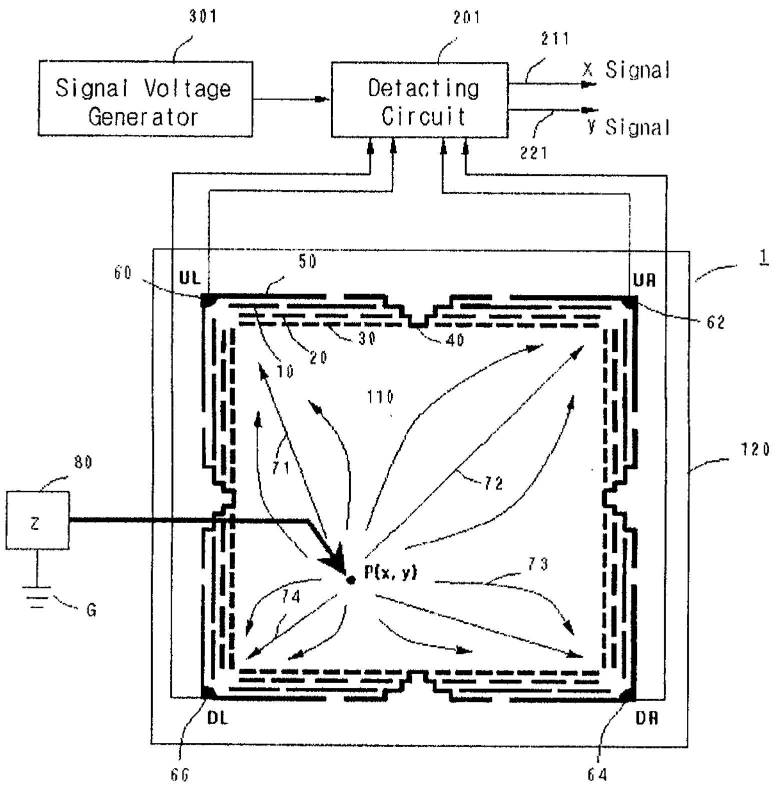
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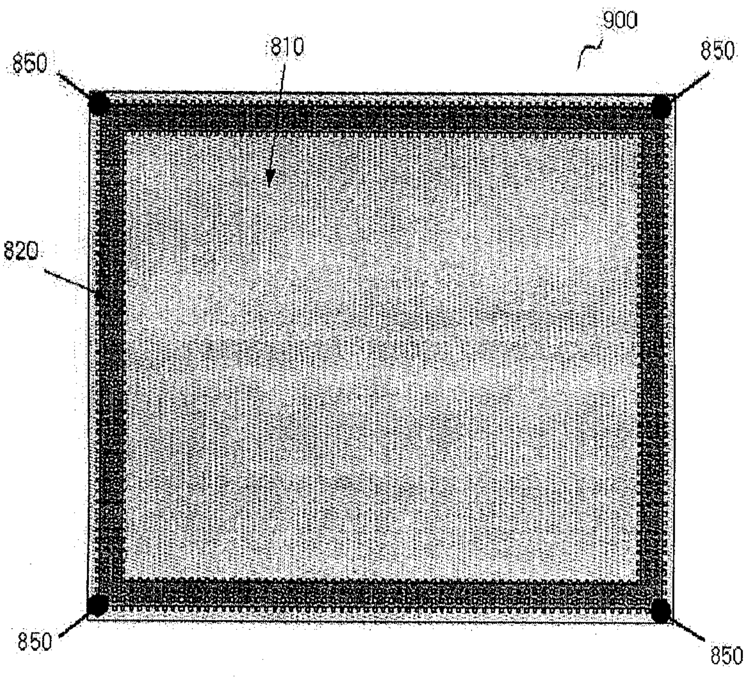
Fig. 10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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/002499

A. CLASSIFICATION OF SUBJECT MATTER

G02F 1/1333(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 G02F, G02B, G06F, G06K, G09G, H01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and applications for inventions since 1975
Korean Utility models and applictions for Utility models since 1975
Japanese Utility models and application for Utility models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) "touch", "ITO", "patterning"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X Y A	US 2004-0095336 A1 HEE JUNG HONG et al.) 20 May 2004 See figures 3, 4, 6, 7.	1, 3, 4, 6, 7-10 2 5, 11
A	US 2004-0188150 A1 (JAMES T.RICAHRD et al.) 30 September 2004 See figures 1C, 3.	1-11
A	US 2005-0040928 A1 (KAO WAN LEE et al.) 24 Feburary 2005 See figure 5.	1-11
A	US 2002-0135569 A1 (CHI-RUEY CHEN) 26 September 2002 See figures 3-5.	1-11
A	JP 10-096846 A (JIOMATETSUKU CO., LTD.) 14 April 1998 See figure 1.	1-11

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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