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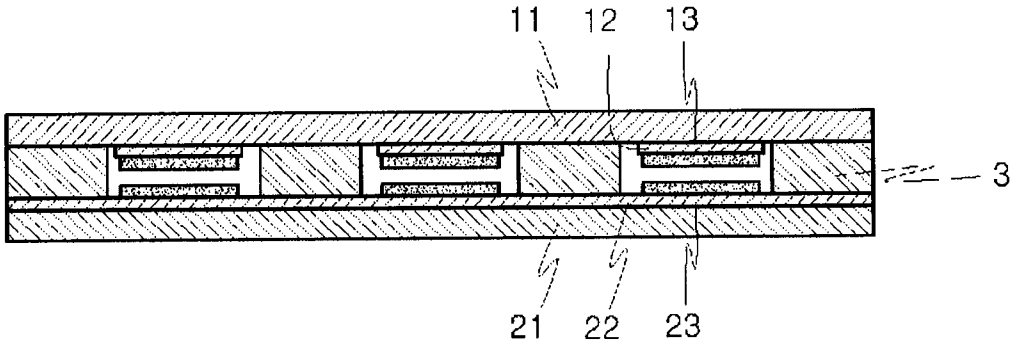
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[Continued on next page]

(54) Title: HIGH-TEMPERATURE TACTILE SENSOR AND METHOD OF MANUFACTURING THE SAME

FIG.1



(57) Abstract: A tactile sensor having a resistance pattern having abrasion resistance and excellent stability even at a high temperature and a method of manufacturing the same are disclosed. The high-temperature tactile sensor includes an upper plate which is configured by forming an electrode pattern made of a conductive material on one surface of an upper film and forming a resistance pattern on a surface of the electrode pattern, and a lower plate which is configured by forming an electrode pattern made of a conductive material on one surface of a lower film and forming a resistance pattern on a surface of the electrode pattern, wherein the resistance patterns are arranged to face each other and spacers are installed between the resistance patterns to stack the upper and lower plates, and wherein the resistance patterns are formed by mixing carbon nanotubes (CNTs) with polyimide.

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HIGH-TEMPERATURE TACTILE SENSOR AND METHOD OF MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a tactile sensor and a method of manufacturing the same, and more particularly to a tactile sensor having a resistance pattern having abrasion resistance and excellent stability even at a high temperature and a method of manufacturing the same.

Description of the Related Art

Recently, a tactile function for obtaining information regarding circumferential environment through touch, for example, a contact force, vibration, surface roughness, heat conductivity versus temperature change and the like has been used for advanced information collection. A biomimetic tactile sensor capable of replacing tactile sensation can be used for microsurgery of blood vessels, various medical diagnoses such as a cancer diagnosis and treatment. Further, the biomimetic tactile sensor can be applied to tactile display technology which will be important for virtual environment technology in the future.

The tactile sensor has been widely used in an industrial

robot, a mouse, a touch pad and the like.

In the tactile sensor, electrode patterns are formed on two films and resistance patterns are formed on the electrode patterns. The tactile sensor detects whether there is a contact or not from a contact resistance between the two resistance patterns. The resistance patterns forming the tactile sensor are formed of a composite material in which carbon black, ink, polydimethylsiloxane (PDMS) and polyurethane are mixed at a specified ratio.

Since the resistance patterns have low abrasion resistance and impact resistance, the resistance patterns may be damaged in the operation to cause a malfunction. Further, there is a problem that it is difficult to adhere the resistance patterns to a film made of polyimide.

Further, there is a problem that the resistance patterns cannot be used at a high temperature equal to or larger than 200 ℃.

SUMMARY OF THE INVENTION

Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a high-temperature tactile sensor having a resistance pattern capable of being operated even at a high temperature and a method of manufacturing the same.

Further, it is another object of the present invention to provide a high-temperature tactile sensor having a resistance pattern with high abrasion resistance and impact resistance and a method of manufacturing the same.

In accordance with an aspect of the present invention, there is provided a high-temperature tactile sensor comprising: an upper plate which is configured by forming an electrode pattern made of a conductive material on one surface of an upper film and forming a resistance pattern on a surface of the electrode pattern; and a lower plate which is configured by forming an electrode pattern made of a conductive material on one surface of a lower film and forming a resistance pattern on a surface of the electrode pattern, wherein the resistance patterns are arranged to face each other and spacers are installed between the resistance patterns to stack the upper plate and the lower plate, and wherein the resistance patterns are formed by mixing carbon nanotubes (CNTs) with a liquid polymer having excellent heat resistance and abrasion resistance.

In accordance with another aspect of the present invention, there is provided a method of manufacturing a tactile sensor comprising: an upper plate manufacturing process (P11) in which an electrode pattern and a resistance pattern are sequentially formed on one surface of an upper film; a lower plate manufacturing process (P12) in which an electrode

pattern and a resistance pattern are sequentially formed on one surface of a lower film; and a stacking process (P2) in which the upper and lower plates are stacked such that the resistance patterns face each other, and wherein in the upper plate manufacturing process and the lower plate manufacturing process, the resistance patterns are formed by screen printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates a cross-sectional view of a high-temperature tactile sensor according to the present invention;

FIGS. 2 to 6 illustrate cross-sectional views showing a process of manufacturing the high-temperature tactile sensor according to the present invention; wherein FIGS. 2 and 3 illustrate cross-sectional views showing a process of manufacturing an upper plate, FIGS. 4 and 5 illustrate cross-sectional views showing a process of manufacturing a lower plate, and FIG. 6 illustrates a cross-sectional view showing a process of stacking the upper plate and the lower plate; and

FIG. 7 illustrates a diagram for explaining a process of manufacturing the high-temperature tactile sensor according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a high-temperature tactile sensor and a manufacturing process thereof according to the present invention will be described in detail with reference to the accompanying drawings.

FIG. 1 illustrates a cross-sectional view of a high-temperature tactile sensor according to the present invention.

FIGS. 2 to 6 illustrate cross-sectional views showing a process of manufacturing the high-temperature tactile sensor according to the present invention. FIGS. 2 and 3 illustrate cross-sectional views showing a process of manufacturing an upper plate. FIGS. 4 and 5 illustrate cross-sectional views showing a process of manufacturing a lower plate. FIG. 6 illustrates a cross-sectional view showing a process of stacking the upper plate and the lower plate.

First, the high-temperature tactile sensor according to the present invention is explained.

The high-temperature tactile sensor according to the present invention is characterized by that resistance patterns are formed of carbon nanotubes.

The tactile sensor according to the present invention includes an upper plate 1 which is configured by forming an electrode pattern 12 made of a conductive material on one surface of an upper film 11 and forming a resistance pattern 13 on the surface of the electrode pattern 12, and a lower plate 2 which is configured by forming an electrode pattern 22 made of a conductive material on one surface of a lower film 21 and forming a resistance pattern 23 on the surface of the electrode pattern 22. The tactile sensor is configured by arranging the resistance patterns 13 and 23 to face each other and installing spacers 3 between the resistance patterns 13 and 23. The resistance patterns 13 and 23 are configured by mixing carbon nanotubes (CNTs) with polyimide.

A polymer film (a polyimide film, a polyester film or the like) is used as the upper and lower films 11 and 21 for manufacturing the tactile sensor. Particularly, it is preferable to use a polyimide film having excellent heat resistance and abrasion resistance as a substrate.

The electrode patterns 12 and 22 are formed by depositing one selected from a group consisting of titanium, nickel, gold and copper using an E-beam or sputtering device. Further, the electrode patterns are formed by plating for convenience of the process. The upper and lower films 11 and 21 and the electrode patterns 12 and 22 are manufactured by a FPCB process to simplify the manufacturing process and reduce the manufacturing

cost.

As described above, the resistance patterns 13 and 23 are mixtures of a liquid polymer having excellent heat resistance and abrasion resistance and carbon nanotubes, which are formed by mixing carbon nanotubes with a liquid polymer. Although a mixing ratio of carbon nanotubes may be adjusted according a desired surface resistance, a mixed amount of carbon nanotubes is 0.5 weight % to 8 weight % with respect to the total mixture with regard to the characteristics of the tactile sensor. A polyimide-based material having excellent heat resistance and abrasion resistance is used as a liquid polymer.

If the amount of carbon nanotubes is excessively large, the resistance patterns will fail to serve as a resistor due to increased conductivity. If the amount of carbon nanotubes is excessively small, the resistance patterns will serve as an insulator and fail to serve as a resistor.

The resistance patterns 13 and 23 are formed by a screen printing method.

That is, the resistance patterns 13 and 23 are formed by printing liquid polyimide mixed with carbon nanotubes only on a pattern formation portion.

Further, the upper and lower plates 1 and 2 with the resistance patterns 13 and 23 formed thereon may be cured at a temperature of 200 ℃ to 400 ℃ to improve strength and abrasion resistance of the resistance patterns.

In the tactile sensor having the above configuration, the upper and lower films 11 and 21 are manufactured to have a thickness of 10 ㎛ to 150 ㎛.

A method of manufacturing the tactile sensor having the above configuration according to the present invention is explained below.

In an upper plate manufacturing process P11, the electrode pattern and the resistance pattern are sequentially formed on one surface of the upper film. In a lower plate manufacturing process P12, the electrode pattern and the resistance pattern are sequentially formed on one surface of the lower film. In a stacking process P2, the upper and lower plates are arranged such that the resistance patterns face each other, and the spacers are installed between the resistance patterns. In the upper plate manufacturing process and the lower plate manufacturing process, the resistance patterns are formed by screen printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder.

In the method of manufacturing the tactile sensor formed through the above processes, the process of manufacturing the upper and lower plates is described below.

First, the upper plate manufacturing process includes a step of coating the electrode pattern 12 made of a conductive material on one surface of the upper film 11 made of a polymer film, and a step of forming the resistance pattern 13 by screen

printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder on the surface of the formed electrode pattern 12.

In such a process, the electrode patterns 12 and 22 are formed using an E-beam deposition method, a sputtering method or a plating method. The carbon nanotubes forming the resistance patterns 13 and 23 occupy 0.5 weight % to 8 weight % with respect to the total weight of the mixture of polyimide and carbon nanotubes.

Further, the resistance patterns 13 and 23 are formed by a screen printing method. Further, a curing process is performed at a temperature of 200 ℃ to 450 ℃ on the upper and lower plates manufactured in the upper and lower plate manufacturing processes.

The curing process is performed to harden the resistance patterns 13 and 23 so that they have higher strength. As the resistance patterns are hardened through the curing process, abrasion resistance and impact resistance are further improved.

The lower plate manufacturing process is performed in the similar way as the above-described upper plate manufacturing process.

However, if it is necessary to install the spacers 3, a process of installing the spacers 3 may be selectively performed.

That is, the spacers 3 may be further installed in a

space between the resistance patterns such that the resistance patterns 13 and 23 are not in contact with each other. In a method of bonding the upper and lower plates 1 and 2 using the spacers, the upper and lower plates 1 and 2 are bonded to each other using a thermal adhesive double-sided tape or a thermal adhesive tape for film adhesion.

According to the present invention, it is possible to provide a high-temperature tactile sensor having a resistance pattern with high abrasion resistance and impact resistance by forming the resistance pattern using carbon nanotubes having excellent abrasion resistance and impact resistance.

Further, according to the present invention, the resistance pattern is formed by screen printing carbon nanotubes mixed with a liquid polymer and then cured. Accordingly, it is possible to use the tactile sensor even at a high temperature.

Although the preferred embodiment of the present invention has 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.

WHAT IS CLAIMED IS:

1. A high-temperature tactile sensor comprising:

an upper plate which is configured by forming an electrode pattern made of a conductive material on one surface of an upper film and forming a resistance pattern on a surface of the electrode pattern; and

a lower plate which is configured by forming an electrode pattern made of a conductive material on one surface of a lower film and forming a resistance pattern on a surface of the electrode pattern,

wherein the resistance patterns are arranged to face each other and spacers are installed between the resistance patterns to stack the upper plate and the lower plate, and

wherein the resistance patterns are formed by mixing carbon nanotubes (CNTs) with a liquid polymer having excellent heat resistance and abrasion resistance.

2. The high-temperature tactile sensor according to claim 1, wherein the carbon nanotubes forming the resistance patterns occupy 0.5 weight % to 8 weight % with respect to a total weight of a mixture of polyimide or high-temperature silicon and carbon nanotubes.

3. The high-temperature tactile sensor according to claim

1 or 2, wherein the resistance patterns are screen printed.

4. The high-temperature tactile sensor according to claim 1 or 2, wherein a polyimide film having excellent abrasion resistance and heat resistance is used as the upper and lower films.

5. A method of manufacturing a tactile sensor comprising:

an upper plate manufacturing process (P11) in which an electrode pattern and a resistance pattern are sequentially formed on one surface of an upper film;

a lower plate manufacturing process (P12) in which an electrode pattern and a resistance pattern are sequentially formed on one surface of a lower film; and

a stacking process (P2) in which the upper and lower plates are stacked such that the resistance patterns face each other, and

wherein in the upper plate manufacturing process and the lower plate manufacturing process, the resistance patterns are formed by screen printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder.

6. The method according to claim 5, wherein spacers are disposed between the upper plate and the lower plate.

7. The method according to claim 5 or 6, wherein the upper plate manufacturing process includes:

coating the electrode pattern made of a conductive material on one surface of the upper film made of a polymer film; and

forming the resistance pattern by screen printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder on a surface of the formed electrode pattern, and

wherein the lower plate manufacturing process includes:

coating the electrode pattern made of a conductive material on one surface of the lower film made of a polymer film; and

forming the resistance pattern by screen printing a liquid in which liquid polyimide is mixed with carbon nanotube (CNT) powder on a surface of the formed electrode pattern.

8. The method according to claim 7, wherein the upper and lower films have a thickness of 10 ㎛ to 150 ㎛.

9. The method according to claim 8, wherein the electrode patterns are formed using an E-beam deposition method, a sputtering method or a plating method.

10. The method according to claim 9, wherein the carbon nanotubes forming the resistance patterns occupy 0.5 weight %

to 8 weight % with respect to a total weight of a mixture of polyimide and carbon nanotubes.

11. The method according to claim 10, wherein the resistance patterns are formed by a screen printing method.

12. The method according to claim 11, wherein a curing process is further performed at a temperature of 200 ℃ to 450 ℃ on the upper and lower plates manufactured in the upper and lower plate manufacturing processes.

FIG.1

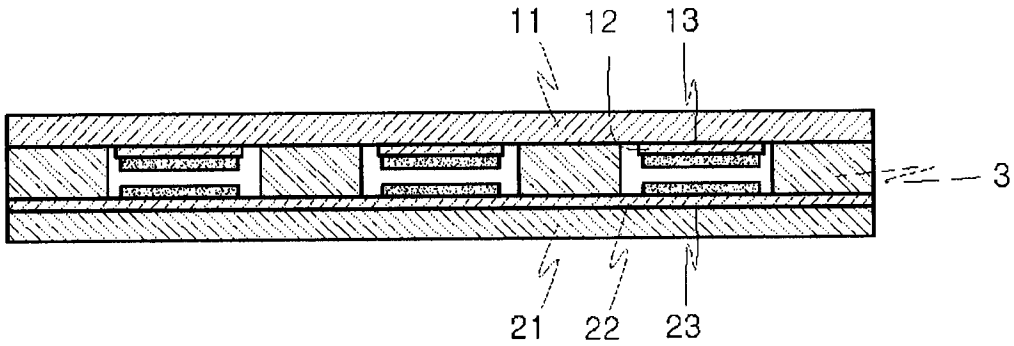


FIG.2

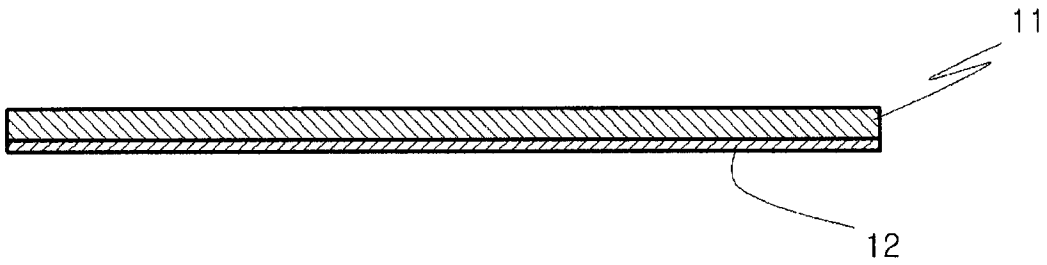


FIG.3

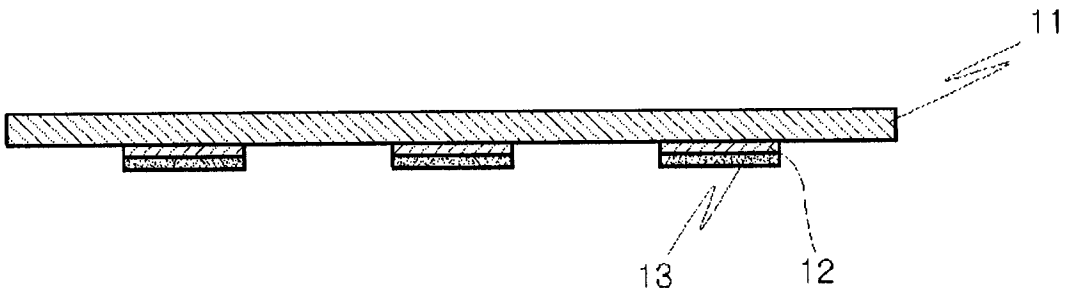


FIG.4

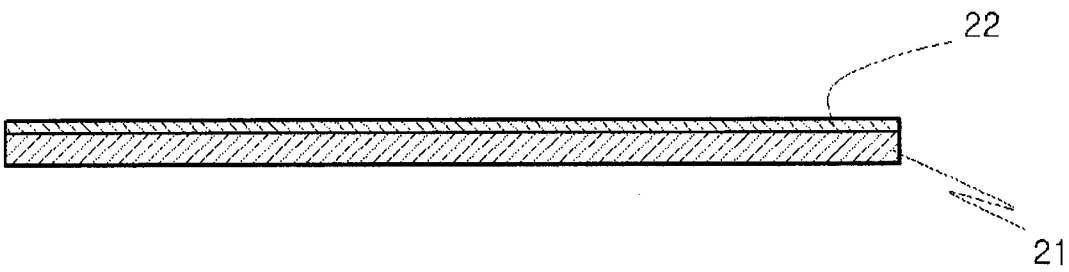


FIG.5

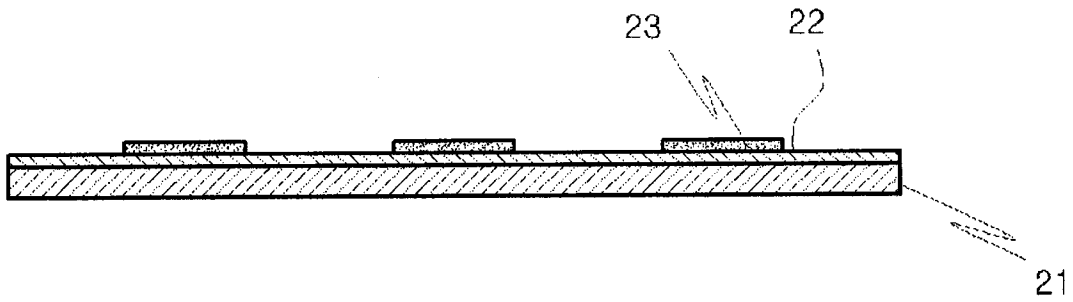


FIG.6

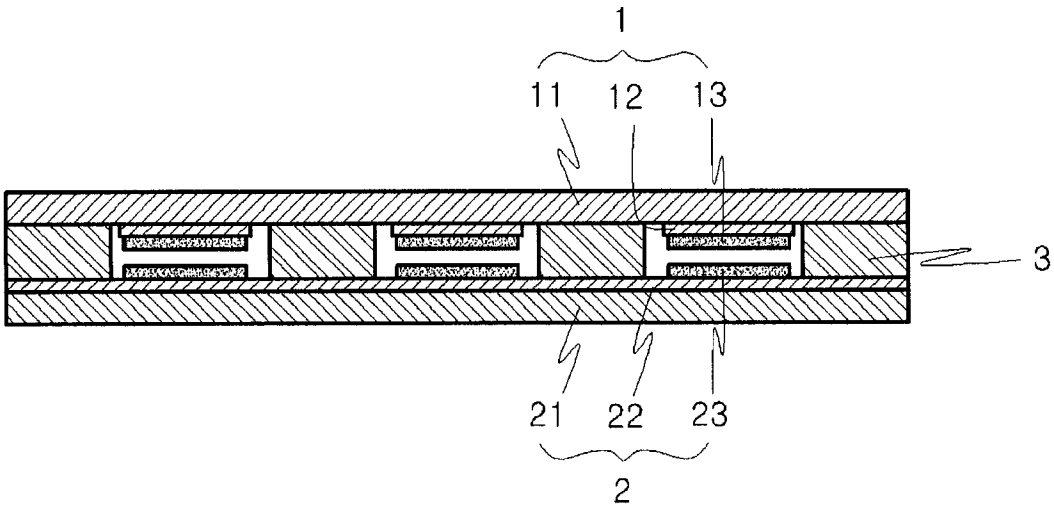
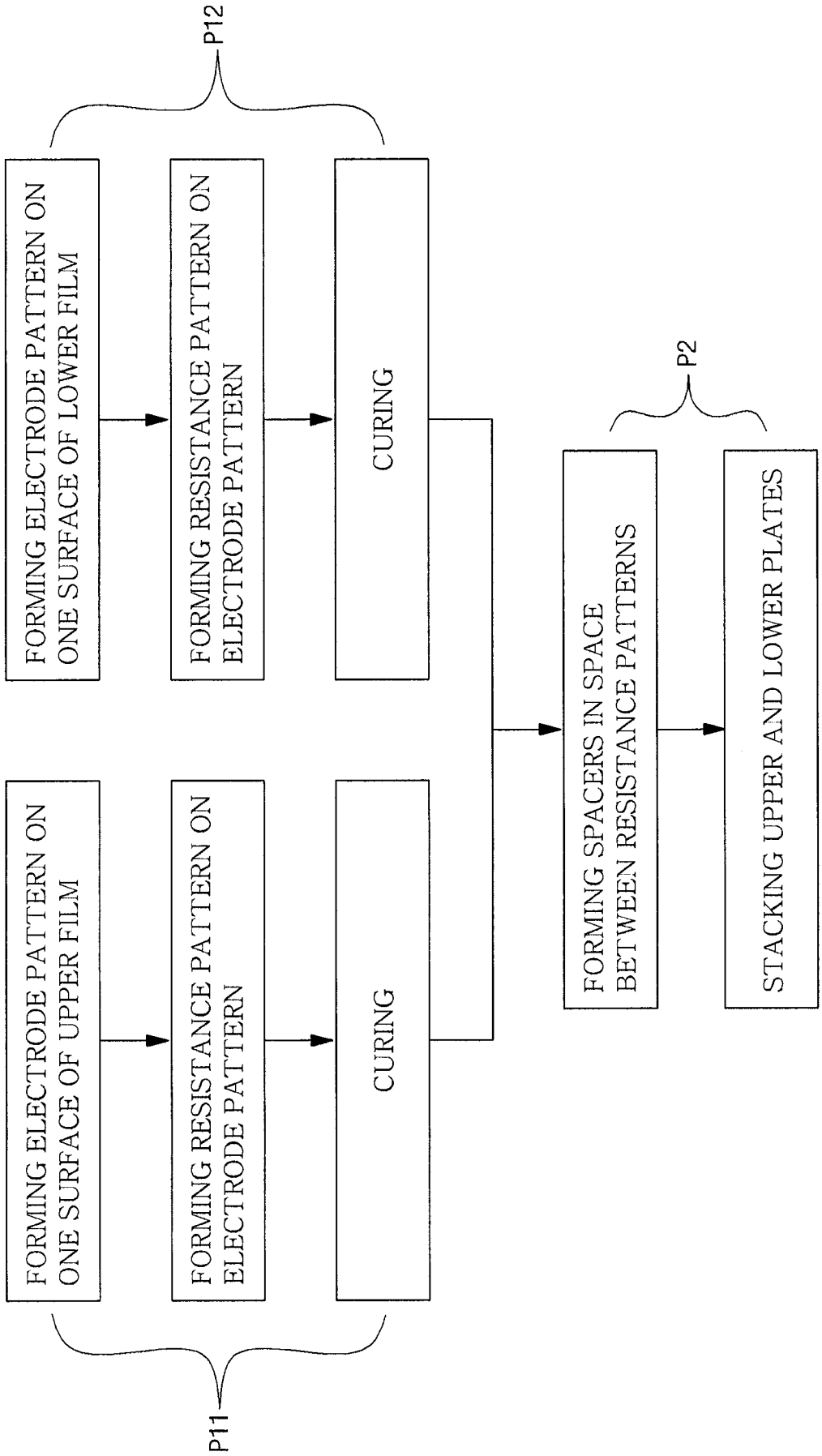


FIG.7


P12
FORMING ELECTRODE PATTERN ON ONE SURFACE OF LOWER FILM
FORMING RESISTANCE PATTERN ON ELECTRODE PATTERN
CURING
P11
FORMING ELECTRODE PATTERN ON ONE SURFACE OF UPPER FILM
FORMING RESISTANCE PATTERN ON ELECTRODE PATTERN
CURING
P2
FORMING SPACERS IN SPACE BETWEEN RESISTANCE PATTERNS
STACKING UPPER AND LOWER PLATES

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/006845

A. CLASSIFICATION OF SUBJECT MATTER

G01L 1/18(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 G01L 1/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal)

Keywords: "tactile sensor", "polyimide", "carbon nanotube" and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006-267140 A1 (LEE, HYUNG-KEW et al.) 30 November 2006 see abstract; figure 2b	1-12
A	KR 10-2005-0112917 A (KIM, JONG-HO et al.) 01 December 2005 see the whole document	1-12
A	KR 10-2005-0103409 A (PARK, JONG MAN & KIM, DAESIK) 31 October 2005 see abstract; pages 2 and 3	1-12
A	Qian Kaiyou et al, "Simulation and fabrication of carbon nanotubes field emission pressure sensors", Applied Surface Science, 1 August 2005, Vol. 252, Pages 4198-4201 see the whole document	1-12
A	Ma, Huizhong et al, "Electron field emission properties of carbon nanotubes-deposited flexible film", Applied Surface Science, 25 April 2005, Vol. 251, Pages 258-261 see the whole document	1-12

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 AUGUST 2008 (29.08.2008)	**29 AUGUST 2008 (29.08.2008)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006-267140 A1	30.11.2006	None	
KR 10-2005-0112917 A	01.12.2005	JP 2005-338053 A	08.12.2005
		JP 2005-338053 A2	08.12.2005
		US 2005-262676 A1	01.12.2005
		US 2005-262676 AA	01.12.2005
KR 10-2005-0103409 A	31.10.2005	None	