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(54) Title: **NARROW BORDER TOUCH SENSORS**

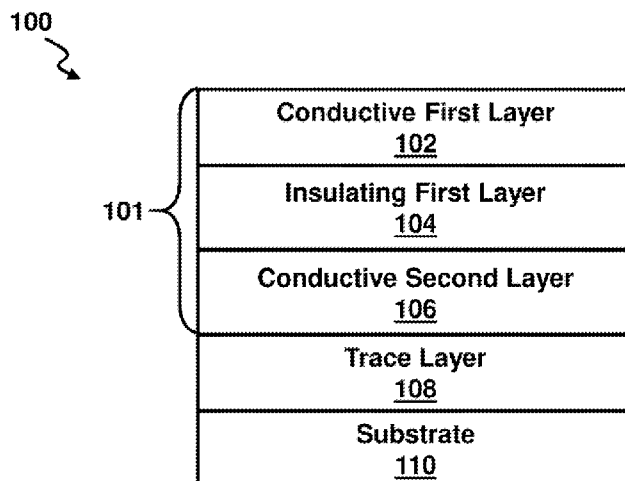


FIG. 1A

(57) Abstract: An example device including a touch sensor is described. The touch sensor may include an insulating layer, a conductive first layer, and a conductive second layer separated from the conductive first layer by the insulating layer. The device may further include a conductive trace layer, and a substrate positioned to hold the conductive trace layer, wherein the conductive trace layer is insulated from the conductive first layer.



NARROW BORDER TOUCH SENSORS

BACKGROUND

[0001] Touch sensors may be used as an input interface to an electronic device. For example, touch sensors may be used in touchscreen phones, tablets, and notebooks. Replacing physical input buttons with touchscreens provides high flexibility. Also, touchscreen electronic devices may allow for a wider range of graphical interactions between a user and an application. Larger surfaces for the touchscreen of the device may allow for easier interaction of the user with the application.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1A is a schematic diagram illustrating layers of a touch sensor, according to an example;

[0003] FIG. 1B is a schematic diagram illustrating layers of a first touchscreen, according to an example;

[0004] FIG. 1C is a schematic diagram illustrating layers of a second touchscreen, according to an example;

[0005] FIG. 1D is a schematic diagram illustrating layers of a third touchscreen, according to an example;

[0006] FIG. 2A is a schematic diagram illustrating a first conductive layer of a touch sensor, according to an example;

[0007] FIG. 2B is a schematic diagram illustrating a second conductive layer of a touch sensor, according to an example;

[0008] FIG. 2C is a schematic diagram illustrating a third conductive layer of a touch sensor, according to an example;

[0009] FIG. 3 is a schematic diagram illustrating electrical connections in a first touchscreen, according to an example;

[0010] FIG. 4 is a schematic diagram illustrating electrical connections in a second touchscreen, according to an example; and

[0011] FIG. 5 is a flowchart illustrating a method for manufacturing a touchscreen, according to an example.

DETAILED DESCRIPTION

[0012] The examples described herein provide new configurations for a touch sensor that eliminates line tracing on the left and right side of a touch screen for a device such as a smartphone, tablet computer, or convertible touch screen device. A multi-layer stack is provided that includes a non-conductive substrate layer within the stack to help electrically isolate the other adjacent metal layers from one another and from the trace lines. By configuring the stack in this manner, line tracing on the left and right side of the touch screen is eliminated.

[0013] FIG. 1A is a schematic diagram illustrating a device 100 comprising a touch sensor 101, according to an example. The touch sensor 101 comprises an insulating first layer 104, a conductive first layer 102, and a conductive second layer 106 separated from the conductive first layer by the insulating layer 104. The device 100 further comprises a conductive trace layer 108, and a substrate 110 positioned to hold the conductive trace layer, wherein the conductive trace layer 108 is insulated from the conductive first layer 102.

[0014] In an example, the conductive first layer 102 may be a conductive signal receiver layer of the touch sensor 101, and the conductive second layer 106 may be a conductive signal transmitter layer of the touch

sensor 101. The conductive second layer 106; e.g., the conductive signal transmitter layer, of the touch sensor 101 may be configured to generate an electric signal. The conductive first layer 102; e.g., the conductive signal receiver layer of the touch sensor 101 may be configured to detect the electrical signal generated by the conductive signal transmitter layer through a capacitance interaction between the conductive second layer 106; e.g., the conductive signal transmitter layer, and the conductive first layer 102; e.g., the conductive signal receiver layer. When a part of the human body, such as fingertips, come in proximity to the touch sensor 101, the capacitance between the conductive signal transmitter layer and the conductive signal receiver layer is changed, due to the presence of the dielectric materials in human body which impact the capacitance. This change in capacitance impacts the electric signal detected by the conductive signal receiver layer, which consequently indicate that the touch sensor 101 is touched by the human body, such as a fingertip.

[0015] FIG. 1B, with reference to FIG. 1A, is a schematic diagram illustrating a device 115 according to an example. The device 115 may comprise the conductive first layer 102 and the conductive second layer 106 formed on the top and bottom of the insulating first layer 104, respectively. The device 115 may comprise the trace layer 108 formed on the substrate 110.

In an example, the trace layer 108 may be connected to the conductive second layer 106 via a first optically clear adhesive (OCA) layer 116. The first OCA layer 106 may be set to mechanically couple the trace layer 108 with the conductive second layer 106. The device 115 may further comprise a second OCA layer 117 set to mechanically couple a cover glass 118 to the conductive first layer 102 of the device 100.

[0016] FIG. 1C, with reference to FIGS. 1A through 1B, is a schematic diagram illustrating a device 120 according to an example. The device 120 may comprise a conductive third layer 122 formed in direct contact with the glass layer 118. The conductive third layer 122 may be a conductive signal transmitter and receiver layer. The conductive third layer 122 may be connected to the trace layer 108 via a third OCA layer 123. The trace layer 108 may be formed on the substrate 110.

[0017] FIG. 1D, with reference to FIGS. 1A through 1C, is a schematic diagram illustrating a device 130 according to an example. The device 130 may comprise a touch sensitive device 132. The touch sensitive device 132 may comprise an insulating second layer 134, a conductive fourth layer 136 positioned above and contacting the insulating second layer 134. The touch sensitive device 132 may further comprise an insulating fourth layer 138 positioned below the insulating second layer 134 and a conductive sixth layer 140 positioned above and contacting the insulating fourth layer 138. The device 130 may further comprise an insulating third layer 142 positioned below the insulating second layer 134. A conductive fifth layer 144 may also be positioned below and contacting the insulating third layer 142 in the device 130.

[0018] A fourth OCA layer 148 may be positioned above the conductive fourth layer 136. The device 130 may comprise a fifth OCA layer 146 positioned between and mechanically coupling the insulating second and third layers 134 and 142. The device 130 may comprise the glass layer 118 positioned above the fourth OCA layer 148, wherein the fourth OCA layer 148 is set to mechanically couple the glass layer 118 to the conductive fourth layer 136. The device 130 may comprise a sixth OCA layer 152 positioned above the conductive sixth layer 140 and set to mechanically couple the conductive sixth layer 140 to the conductive fifth layer 144.

[0019] In an example, the conductive fourth layer 136 may be a conductive signal receiver layer, and the conductive fifth layer 144 may be a conductive signal transmitter layer. In another example, the conductive fourth layer 136 may be a conductive signal transmitter layer, and the conductive fifth layer 144 may be a conductive signal receiver layer. In an example, the device 130 may be a touchscreen.

[0020] In an example, any of the conductive first layer 102, conductive second layer 106, conductive third layer 122, conductive fourth layer 136, conductive fifth layer 144, conductive sixth layer 140, and trace layer 108 may comprise indium tin oxide (ITO). In an example, any of the insulating first layer 104, insulating second layer 106, insulating second layer 134, insulating third layer 142, insulating fourth layer 138, and substrate 110 may comprise a

thermoplastic material such as polyethylene terephthalate (PET); e.g., Mylar[®] polyester film. In an example, any of the first OCA layer 106, the second OCA layer 117, the third OCA layer 123, the fourth OCA layer 148, the fifth OCA layer 146, and the sixth OCA layer 152 may comprise silicone.

[0021] In an example, any of the insulating first layer 104, insulating second layer 106, insulating second layer 134, insulating third layer 142, insulating fourth layer 138 may have a thickness from approximately 20 μ m to approximately 150 μ m. In an example, the substrate 110 may have a thickness from approximately 20 μ m to approximately 100 μ m. In an example, any of the first OCA layer 106, the second OCA layer 117, the third OCA layer 123, the fourth OCA layer 148, the fifth OCA layer 146, and the sixth OCA layer 152 may have a thickness from approximately 20 μ m to approximately 100 μ m. In an example, any of the conductive first layer 102, conductive second layer 106, conductive third layer 122, conductive fourth layer 136, conductive fifth layer 144, conductive sixth layer 140, and trace layer 108 may have a thickness less than approximately 1 μ m.

[0022] FIGS. 2A through 2C, with reference to FIGS. 1A through 1D, illustrate conductive layers according to various examples. FIG. 2A is a schematic diagram illustrating a plurality of conductive first lines 202 in a first direction 201. In an example, any of the conductive first layer 102, conductive third layer 122, and conductive fourth layer 136 may comprise the plurality of conductive first lines 202 in the first direction 201. FIG. 2B is a schematic diagram illustrating a plurality of conductive second lines 204 in a second direction 203 different from the first direction 201. In an example, any of the conductive second layer 106, conductive third layer 122, and conductive fifth layer 144 may comprise the plurality of conductive second lines 204 in the second direction 203. FIG. 2C is a schematic diagram illustrating a plurality of conductive trace lines 206 in the first direction 201. In an example, any of the trace layer 108 and the conductive sixth layer 140 may comprise the plurality of conductive trace lines 206 in the first direction 201. In an example, the first direction 201 is approximately perpendicular to the second direction 203.

[0023] FIG. 3, with reference to FIGS. 1A through 2C, is a schematic diagram illustrating electrical connections between the conductive trace lines 206 and the plurality of conductive second lines 204. Each conductive trace line of the plurality of conductive trace lines 206 may be electronically coupled to a corresponding second line of the plurality of conductive second lines 204. For example, a trace line 306 may be electronically coupled to a corresponding second line 304 by an electronic connector 308. In an example, the electronic connector 308 may comprise a conductive adhesive such as Anisotropic Conductive Film (ACF).

[0024] FIG. 4, with reference to FIGS. 1A through 3, is a schematic diagram illustrating a touch screen 400, according to an example. The touch screen 400 may comprise a first longitudinal dimension 402 oriented in the first direction 201, and a second longitudinal dimension 404 oriented in the second direction 203.

[0025] The touch screen 400 may include a first plurality of bonding pads 406 positioned along a first edge 408 of the touch screen in the second longitudinal dimension 404. The first edge 408 is positioned at the top edge of the touch screen 400. Each trace line in the plurality of conductive trace lines 206 may be electronically coupled to a corresponding first bonding pad of the first plurality of bonding pads 406. For example, the trace line 306 may be electronically coupled to a first bonding pad 410.

[0026] The touch screen 400 may include a second plurality of bonding pads 412 positioned along a second edge 414 of the touch screen 400 in the second longitudinal dimension 404. The second edge 414 is positioned at the bottom edge of the touch screen 400. The first edge 408 and second edge 414 are on opposed ends of the touch screen 400; e.g., on the top and bottom end, respectively. Each first line in the plurality of conductive first lines 202 may be electronically coupled to a second bonding pad of the second plurality of bonding pads 412. For example, the first line 416 may be electronically coupled to a second bonding pad 418. Arranging the trace lines as illustrated in FIG. 4, prevents the need for routing the trace lines on the

lateral left and right sides of the touch screen 400. This allows for manufacturing borderless touchscreen, or touchscreens with narrow borders.

[0027] FIG. 5, with reference to FIGS. 1A through 4, is a flowchart illustrating a method 500 for manufacturing any of the devices 115, 120, and 130, according to an example. In block 501, the method 500 creates the cover glass layer 118. In block 502, the method 500 creates the signal transmitter and receiver layers. The signal transmitter and receiver layers may be any of the conductive first layer 102, conductive second layer 106, conductive third layer 122, conductive fourth layer 136, and conductive fifth layer 144. For manufacturing any of the devices 100, 115, and 130, the signal transmitter and receiver layer may be created on the corresponding first layer 104, insulating second layer 134, and insulating third layer 142. In an example, the signal transmitter and receiver layer may be created by depositing using chemical vapor deposition, CVD. For manufacturing the device 120, the method 500 creates the signal transmitter and receiver directly on the glass layer 118, for example by using CVD.

[0028] In block 503, the method 500 creates the trace routing film for borderless design. The trace routing film may be any of the trace layer 108 and the conductive sixth layer 140. In an example, the trace layer 108 may be deposited on the substrate 110 and the conductive sixth layer 140 on the insulating fourth layer 138 using CVD. In block 504, the method 500 prepares any of the OCA layers 106, 117, 123, 148, 146. In block 505, the method 500 finishes the sensor level lamination bonding process, by bonding the conductive second layer 106 to the trace layer 108 using the first OCA layer 106, bonding the conductive third layer 122 to the trace layer 108 using the third OCA layer 123, bonding the insulating second layer 134 to the insulating third layer 142 using the fifth OCA layer 146, and bonding the conductive fifth layer 144 to the conductive sixth layer 140 using the sixth OCA layer 152. In block 506, the method 500 finishes the glass layer lamination bonding process by bonding the glass layer 118 to the conductive first layer 102 using the second OCA layer 117, and the glass layer 118 to the conductive fourth layer 136 using the fourth OCA layer 148.

[0029] The present disclosure has been shown and described with reference to the foregoing exemplary implementations. Although specific examples have been illustrated and described herein it is manifestly intended that the scope of the claimed subject matter be limited only by the following claims and equivalents thereof. It is to be understood, however, that other forms, details, and examples may be made without departing from the spirit and scope of the disclosure that is defined in the following claims.

CLAIMS

1. A device comprising:
 - a touch sensor comprising:
 - an insulating layer;
 - a conductive first layer; and
 - a conductive second layer separated from the conductive first layer by the insulating layer;
 - a conductive trace layer; and
 - a substrate positioned to hold the conductive trace layer, wherein the conductive trace layer is insulated from the conductive first layer.
2. The device of claim 1, wherein the conductive first layer comprises a plurality of conductive first lines in a first direction, the conductive second layer comprises a plurality of conductive second lines in a second direction different from the first direction, and the conductive trace layer comprises a plurality of conductive trace lines in the first direction.
3. The device of claim 2, wherein the first direction is approximately perpendicular to the second direction.
4. The device of claim 2, wherein each conductive trace line of the plurality of conductive trace lines is electronically coupled to a corresponding second line of the plurality of conductive second lines.
5. The device of claim 4, comprising a touch screen comprising:
 - the touch sensor;
 - a first longitudinal dimension oriented in the first direction;
 - a second longitudinal dimension oriented in the second direction;
 - a first plurality of bonding pads along a first edge of the touch screen in the second longitudinal dimension, wherein each trace line in the plurality of conductive trace lines is electronically coupled to a corresponding first bonding

pad of the first plurality of bonding pads; and

a second plurality of bonding pads along a second edge of the touch screen in the second longitudinal dimension, wherein each first line in the plurality of conductive first lines is electronically coupled to a second bonding pad of the second plurality of bonding pads.

6. The device of claim 1, wherein the insulating layer comprises a top insulating layer and a bottom insulating layer, wherein the conductive first layer is deposited over the top insulating layer, and the conductive second layer is deposited over the bottom insulating layer.

7. The device of claim 6, wherein the conductive first layer, the conductive second layer, and the conductive trace layer comprise Indium tin oxide, and wherein the top insulating layer and the bottom insulating layer comprise a thermoplastic material.

8. A touch screen comprising:
a touch sensitive device comprising:
an insulating first layer;
a conductive first layer positioned above and contacting the insulating first layer;
an insulating second layer positioned below the insulating first layer; and
a conductive second layer positioned above and contacting the insulating second layer;
an insulating third layer positioned between the insulating first and second layers;
a conductive third layer positioned below and contacting the insulating third layer;
a first optical adhesive layer positioned between and mechanically coupling the insulating first and third layers;
a second optical adhesive layer positioned above the conductive first

layer; and

a glass layer positioned above the second optical adhesive layer, wherein the second optical adhesive layer is set to mechanically couple the glass layer to the conductive first layer.

9. The touch screen of claim 8, wherein the insulating and conductive first, second and third layers comprise a first longitudinal dimension oriented in a first direction, and a second longitudinal dimension oriented in the second direction, wherein the conductive first layer comprises a plurality of conductive first lines arranged in the second direction, the conductive second layer comprises a plurality of conductive second lines in the first direction, and the conductive third layer comprises a plurality of conductive third lines in the second direction, and wherein the plurality of conductive second lines comprise a same number of conductive lines as the plurality of conductive third lines.

10. The touch screen of claim 9, comprising:

a plurality of first bonding pads positioned in proximity to a first edge in the first longitudinal dimension of the insulating first layer and arranged in the first direction; and

a plurality of second bonding pads positioned in proximity to a second edge in the first longitudinal dimension of the insulating first layer and arranged in the first direction,

wherein each of the plurality of the conductive second lines is electronically coupled to a corresponding third line of the plurality of the conductive third lines, and

wherein each of the plurality of conductive third lines is electronically coupled to a corresponding first bonding pad of the first plurality of bonding pads, and each of the first plurality of conductive first lines is electronically coupled to a corresponding second bonding pad of the second plurality of bonding pads.

11. The touch screen of claim 10, wherein the first and the second

directions are approximately perpendicular to each other, and wherein the conductive first layer, the conductive second layer, and the conductive third layer comprise Indium tin oxide, and wherein the insulating first layer, the insulating second layer, and the insulating third layer comprise a thermoplastic material.

12. A touch sensing device comprising:
a touch sensor comprising:
an insulating first layer;
a conductive first layer located above and connected to the insulating first layer; and
a conductive second layer located below and connected to the insulating first layer;
an insulating second layer located below the insulating first layer;
a conductive third layer located above and connected to the insulating second layer;
an optical adhesive layer located above the conductive first layer; and
a glass layer located above the optical adhesive layer, wherein the optical adhesive layer is set to mechanically couple the glass layer to the conductive first layer.

13. The device of claim 12, wherein the insulating first and second layer, and the conductive first, second and third layers comprise a first longitudinal dimension oriented in a first direction, and a second longitudinal dimension oriented in the second direction, wherein the conductive first layer comprises a plurality of conductive first lines arranged in the second direction, the conductive second layer comprises a plurality of conductive second lines in the first direction, and the conductive third layer comprises a plurality of conductive third lines in the second direction, and wherein the plurality of conductive second lines comprise a same number of conductive lines as the plurality of conductive third lines.

14. The device of claim 13, comprising:

a plurality of first bonding pads located in proximity of a first edge in the first longitudinal dimension of the insulating first layer and arranged in the first direction; and

a plurality of second bonding pads located in proximity of a second edge in the first longitudinal dimension of the insulating first layer and arranged in the first direction,

wherein each of the plurality of conductive second lines is electronically coupled to a corresponding third line of the plurality of conductive third lines, and

wherein each of the plurality of conductive third lines is electronically coupled to a corresponding first bonding pad of the first plurality of bonding pads, and each of the plurality of conductive first lines is electronically coupled to a corresponding second bonding pad of the second plurality of bonding pads.

15. The device of claim 14, wherein the first and the second directions are approximately perpendicular to each other, and wherein the conductive first layer, the conductive second layer, and the conductive third layer comprise Indium tin oxide, and wherein the insulating first layer and the insulating second layer comprise a thermoplastic material.

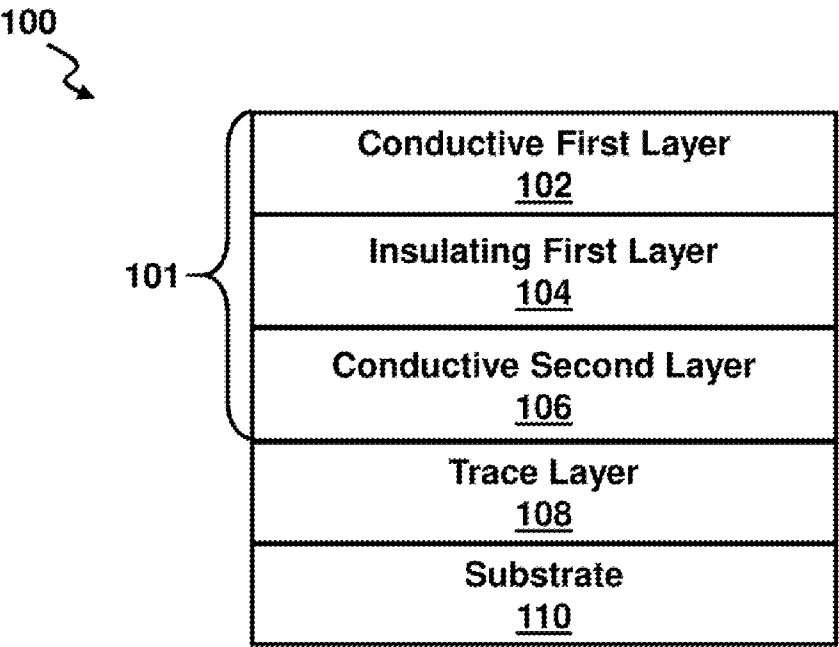


FIG. 1A

115 

Glass Layer <u>118</u>
Second OCA Layer <u>117</u>
Conductive First Layer <u>102</u>
Insulating First Layer <u>104</u>
Conductive Second Layer <u>106</u>
First OCA Layer <u>106</u>
Trace Layer <u>108</u>
Substrate <u>110</u>

FIG. 1B

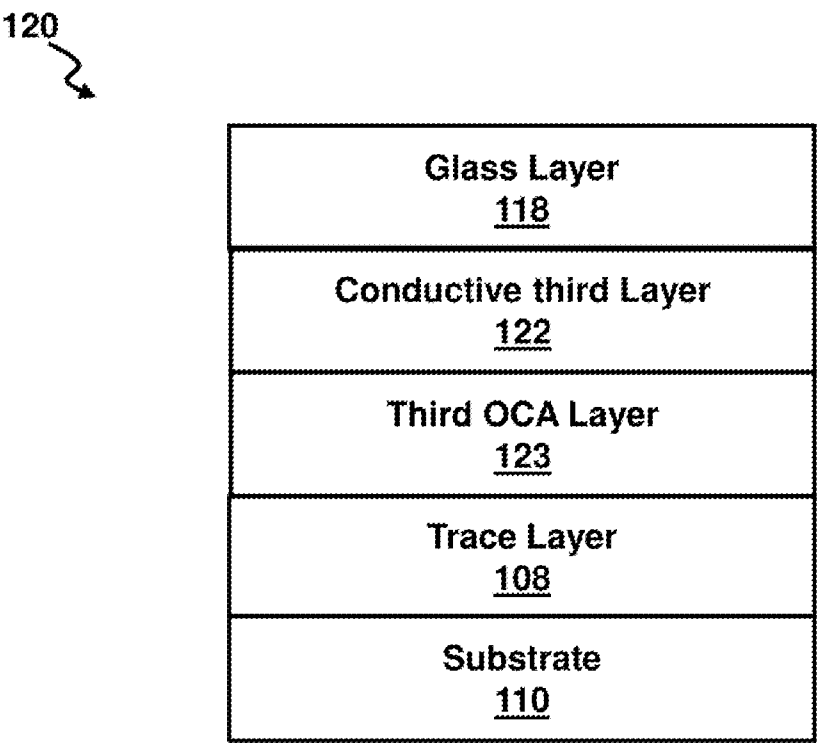


FIG. 1C

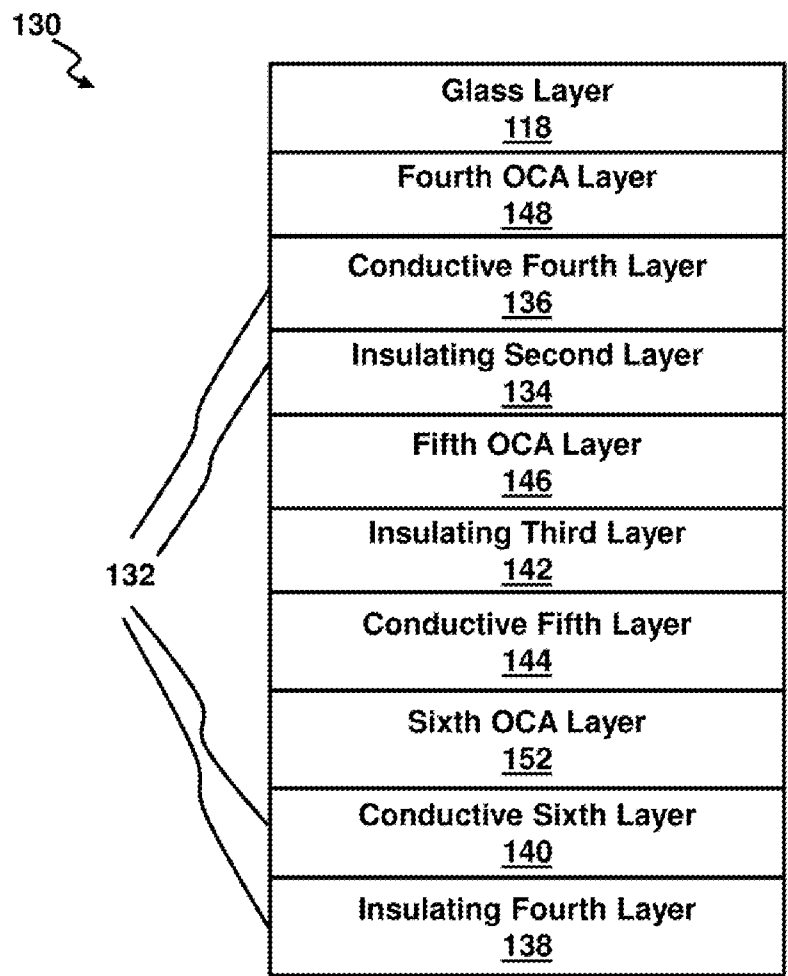


FIG. 1D

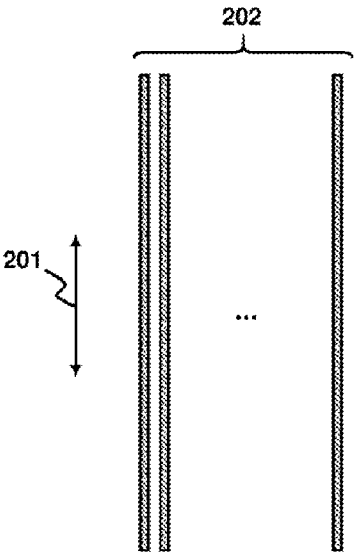


FIG. 2A

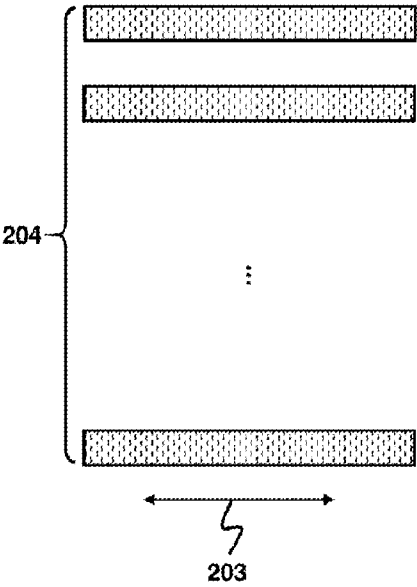


FIG. 2B

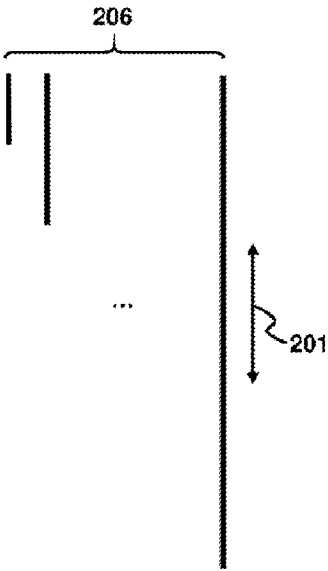


FIG. 2C

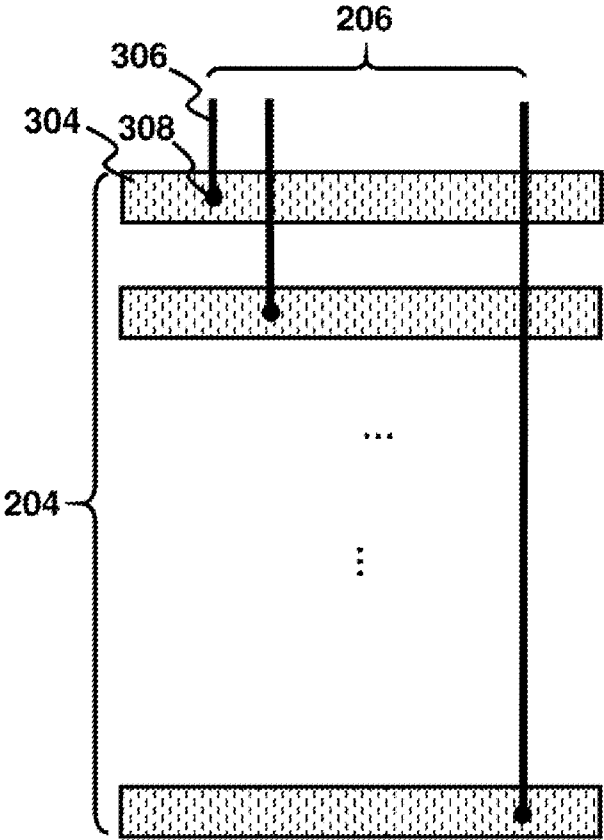


FIG. 3

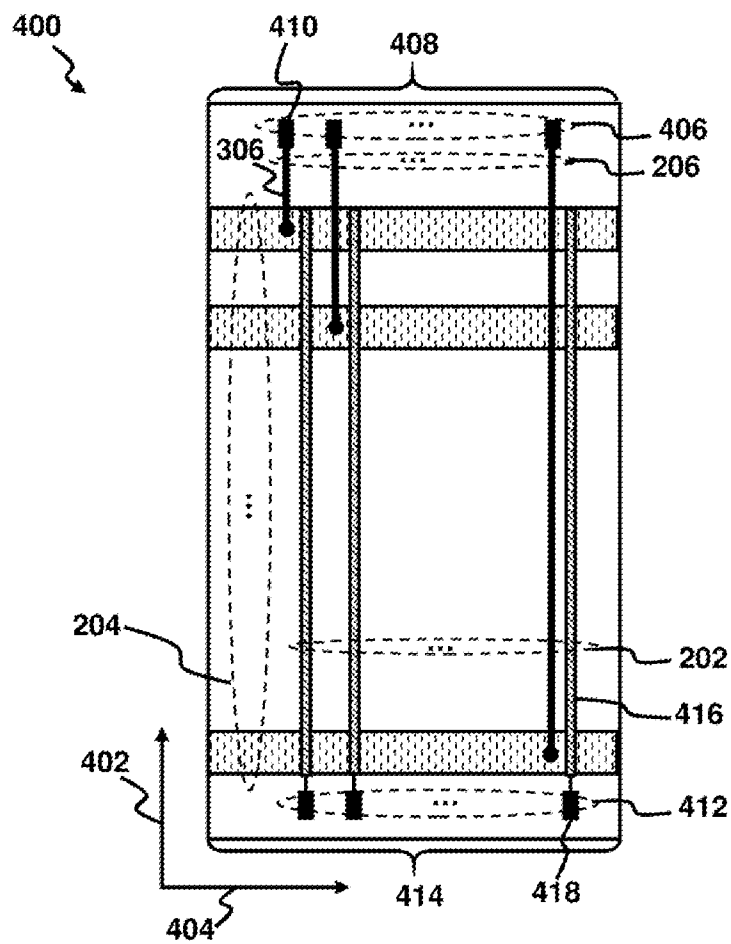


FIG. 4

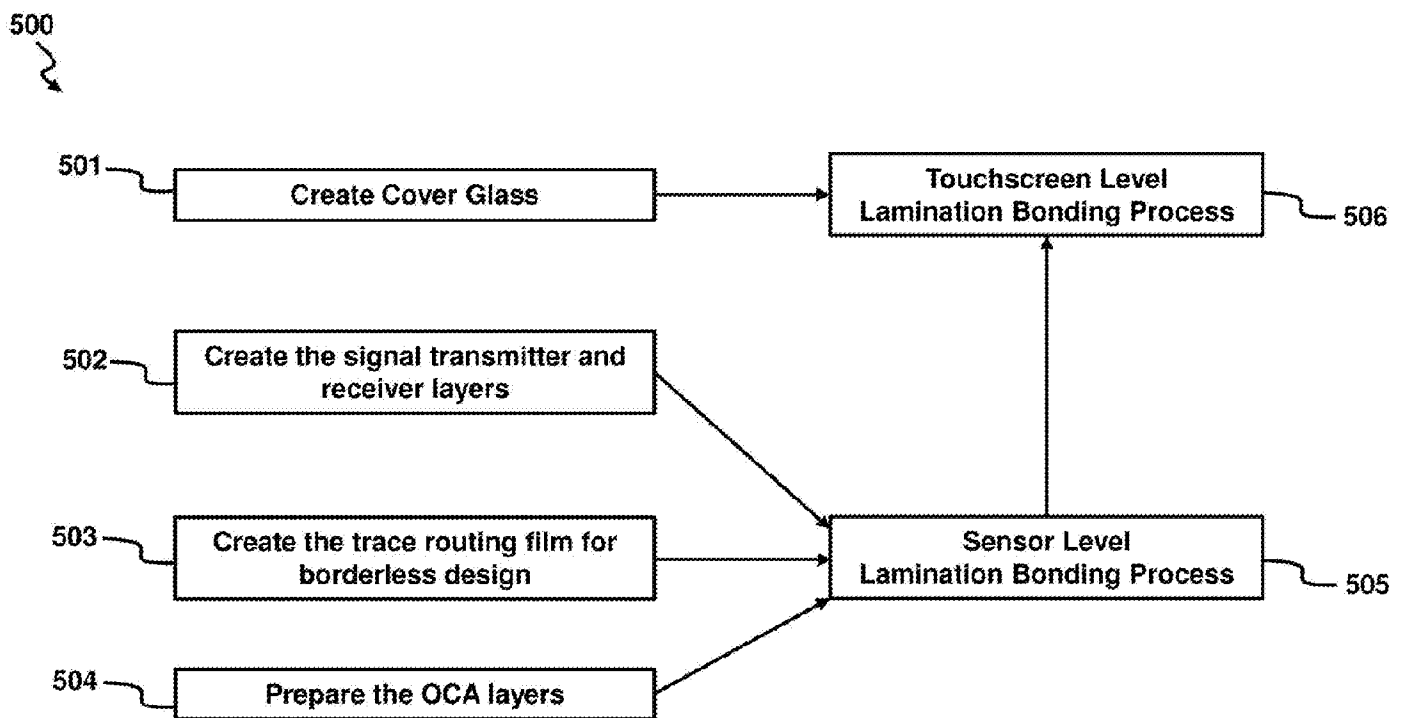


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/092568

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/044(2006.01)i; G06F 3/041(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)

G06F

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

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

CNKI, WPI, CNPAT, EPODOC, IEEE; touch, insulat+, conduct+, trace, pad, direction, substrate, glass, ITO

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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A	US 2015145817 A1 (SYNAPTICS INCORPORATED) 28 May 2015 (2015-05-28) claims 1, 2, figures 3-6	8-11
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A	CN 103778410 A (NANCHANG O-FILM TECH CO., LTD. ET AL.) 07 May 2014 (2014-05-07) the whole document	1-15

☐ 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

08 April 2018

Date of mailing of the international search report

12 April 2018

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2017/092568

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