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(54) **Title:** LAMINATE FOR A SENSOR DEVICE, METHOD OF USING THE SAME AND METHOD OF MANUFACTURING THE SAME

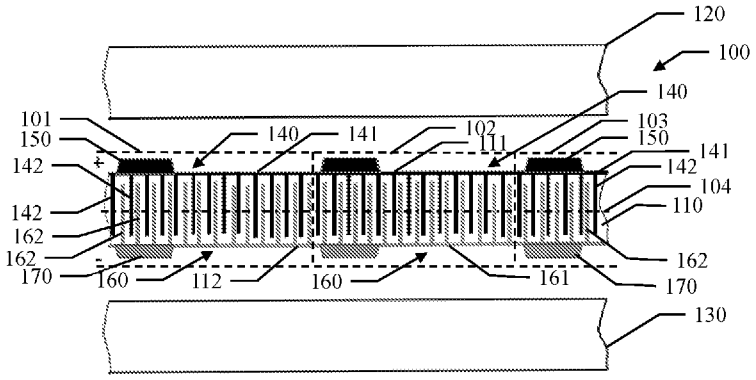

Figure 3

(57) **Abstract:** A laminate for a sensor device comprises: a substrate layer laminated with an encapsulation layer; a plurality of contiguous first conduction portions arranged between the layers; a plurality of first contact portions electrically adjoining respective ones of the first conduction portions and adapted to be associated with the sensor device; a plurality of contiguous second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions; and a plurality of second contact portions electrically adjoining respective ones of the second conduction portions and adapted to be associated with the sensor device.

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LAMINATE FOR A SENSOR DEVICE, METHOD OF USING THE SAME AND METHOD OF MANUFACTURING THE SAME

TECHNICAL FIELD

The present disclosure relates to a laminate, more particularly to a laminate for a sensor device, a method of using a laminate, and a method of manufacturing a laminate.

BACKGROUND

A conventional sensor device typically has a sensing zone with a fixed length which mismatches a required length in practice. Where the length of the sensing zone is greater than a required length, complex modifications may be required to fit the sensing zone, which can be inconvenient and may result in damage. Where the length of the sensing zone is smaller than the required length, multiple such sensing zones may be provided. However, unless a combined length of the multiple sensing zones matches the required length, complex modifications may still be required.

SUMMARY

It is an object of the present disclosure to overcome or ameliorate at least one of the shortcomings associated with a conventional sensor device.

In a first aspect, there is provided a laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of contiguous first conduction portions arranged between the layers;

a plurality of first contact portions electrically adjoining respective ones of the first conduction portions and adapted to be associated with the sensor device;

a plurality of contiguous second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions; and

a plurality of second contact portions electrically adjoining respective ones of the second conduction portions and adapted to be associated with the sensor device.

The laminate can be advantageously cut to size without requiring any complex modification. More particularly, a section with a matching length can be cut from the laminate, provided that the cut section comprises at least one of the first contact portion and at least one of the second contact portion for operative association with sensor electronics.

In a second aspect, there is provided a laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of contiguous conduction portions arranged between the layers; and

a plurality of contact portions electrically adjoining respective ones of the conduction portions and adapted to be associated with the sensor device.

The laminate of the second aspect can be advantageously cut into, for example, any even number of sections, with one section operatively associated with another section in a mirror arrangement for use in the manner of the first aspect.

In a third aspect, there is provided a laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of first conduction portions arranged between the layers;

a plurality of first contact portions electrically adjoining respective ones of the first conduction portions and adapted to be exposed to an external environment;

a plurality of second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions across a same reference line; and

a plurality of second contact portions electrically adjoining respective ones of the second conduction portions and adapted to be exposed to the external environment.

In a fourth aspect, there is provided a tape strip comprising a laminate of any one of the first to third aspects. In a fifth aspect, there is provided a tape roll comprising a laminate of any one of the first to third aspects.

In a sixth aspect, there is provided a method of using a laminate of any one of the first to third aspects, comprising:

applying a segment of the laminate onto a surface; and

slicing the segment into pieces each including at least one of the first contact portions and at least one of the second contact portions.

The method of the sixth aspect is advantageous in that the steps can be performed in any order to provide pieces of required lengths. Such pieces may have identical or different lengths, depending on applications.

In a seventh aspect, there is provided a process of manufacturing a laminate, comprising:

forming, on a substrate layer, a plurality of first conduction portions;

forming, on the substrate layer, a plurality of second conduction portions interdigitating respectively with the first conduction portions;

forming, on the substrate layer, a plurality of first contact portions electrically and respectively adjoining the first conduction portions;

forming, on the substrate layer, a plurality of second contact portions electrically and respectively adjoining the second conduction portions; and

encapsulating the conduction portions with an encapsulation layer to form the laminate, with the contact portions exposed from the encapsulation layer.

In another aspect, there is provided a laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of contiguous first conduction portions arranged between the layers;

a plurality of first contact portions electrically coupled to respective ones of the first conduction portions and adapted to be associated with the sensor device;

a plurality of contiguous second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions; and

a plurality of second contact portions electrically coupled respective ones of the second conduction portions and adapted to be associated with the sensor device.

In yet another aspect, there is provided a laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of coupled first conduction portions arranged between the layers;

a plurality of first contact portions electrically coupled to respective ones of the first conduction portions and adapted to be associated with the sensor device;

a plurality of coupled second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions; and

a plurality of second contact portions electrically coupled to respective ones of the second conduction portions and adapted to be associated with the sensor device.

BRIEF DESCRIPTION OF THE DRAWINGS

Example embodiments of the present disclosure are described in more detail hereinafter with reference to the drawings.

Figure 1 shows a top partial view of a laminate for a sensor device, according to one example embodiment of the present disclosure.

Figure 2 shows a side partial view of the laminate of Figure 1.

Figure 3 shows a top partial exploded view of the laminate of Figure 1.

Figure 4 shows a side partial exploded view of the laminate of Figure 1.

Figure 5 shows a process of laminating or joining the layers of the laminate of Figure 1, according to one example embodiment of the present disclosure.

Figure 6 shows an exploded isometric view of the laminate of Figure 1, with arrows indicating a lamination or joining direction.

DESCRIPTION

Figures 1 and 2 respectively show top and side partial views of a laminate 100 for a sensor device according to one example embodiment. Figures 3 and 4 respectively show top and side partial exploded views of the laminate 100. The laminate 100 of this example takes the exemplary form of a cuttable tape, with Figures 1 to 4 partially showing the cuttable tape in an unrolled state. The laminate 100 has a thickness of about 2 millimetres. In other embodiments, the thickness can range up to 14 millimetres, for example. The laminate 100 may be regarded as a sensing laminate for providing a sensing zone.

The laminate 100 of this example includes a substrate layer 110 encapsulated with first and second encapsulation layers 120, 130, a plurality of contiguous first conduction portions 140, a plurality of first contact portions 150, a plurality of contiguous second conduction portions 160, and a plurality second contact portions 170.

In this example, the encapsulation layers 120, 130 sandwich the substrate layer 110 therebetween. The encapsulation layers 120, 130 are made of a dielectric material and each have a thickness of about 1 millimetre in this example. The encapsulation layers 120, 130 may have the same or different thicknesses (e.g., ranging from 1 millimetre to 5 millimetre, for example) in other embodiments. More specifically, the dielectric material is made of compliant silicone filled with a carbon compound. That is, the dielectric material of this embodiment is a carbon-filled silicone (i.e., silicone containing carbon particulates). The dielectric material may, in other embodiments, be made of another polymer such as a flexible acrylic or polyurethane (e.g., non-carbon filled) with desirable dielectric properties that result in pressure dependent permittivity. It should be noted that the dielectric material may, in other embodiments, have dielectric properties that result in a permittivity characteristic dependent on other types of presence indication. The dielectric material may also, in other embodiments, be made of other elastomers such as a flexible polyurethane or flexible acrylic will fillers (e.g. carbon fillers) that impart pressure sensitive diffusivity.

The first conduction portions 140 are arranged between the substrate layer 110 and the first encapsulation layer 120, more particularly laminated (or sandwiched) between the substrate layer 110 and the first encapsulation layer 120. Each one of the first conduction portions 140 is contiguous with a neighbouring one of the first conduction portions 140. In particular, each of the first conduction portions 140 includes an elongated base section 141 disposed at and

extending along a first lateral edge 111 of the substrate layer 110, and a plurality of elongated finger sections 142 extending perpendicularly from the base section 141 towards a second lateral edge 112 of the substrate layer 110 opposite to the first lateral edge 111. The finger sections 142 are in electrical contact with the base section 141. The base section 141 of each one of the first conduction portions 140 electrically contacts the base section 141 of a neighbouring one of the first conduction portions 140.

The first contact portions 150 electrically adjoin respective ones of the first conduction portions 140 and are adapted to be associated with the sensor device. Figure 1 shows one of the first contact portions 150 being associated with a first electrode 910 of the sensor device. Specifically, each one of the first contact portions 150 is exposed from the encapsulation layers 120, 130, and is in electrical contact with the base section 141 of the respective first conduction portion 140. In this example, the first contact portions 150 are arranged equidistantly along the first lateral edge 111. That is, each one of the first contact portions 150 is positioned at an equal distance from a neighbouring one of the first contact portions 150.

The second conduction portions 160 are arranged between the substrate layer 110 and the second encapsulation layer 120, more particularly laminated (or sandwiched) between the substrate layer 110 and the second encapsulation layer 120. Each one of the second conduction portions 160 is contiguous with a neighbouring one of the second conduction portions 160. In particular, each of the second conduction portions 160 includes an elongated base section 161 disposed at and extending along the second lateral edge 112 of the substrate layer 110, and a plurality of elongated finger sections 162 extending perpendicularly from the base section 161 towards the first lateral edge 111 of the substrate layer 110. The finger sections 162 are in electrical contact with the base section 161. The base section 161 of each one of the second conduction portions 160 electrically contacts the base section 161 of a neighbouring one of the second conduction portions 160.

The second contact portions 170 electrically adjoin respective ones of the second conduction portions 160 and are adapted to be associated with the sensor device. Figure 1 shows one of the second contact portions 170 being associated with a second electrode 920 of the sensor device. Specifically, each one of the second contact portions 170 is exposed from the encapsulation layers 120, 130, and is in electrical contact with the base section 161 of the respective second conduction portion 160. In this example, the second contact portions 170 are arranged equidistantly along the second lateral edge 112. That is, each one of the second contact portions 170 is positioned at an equal distance from a neighbouring one of the second contact portions 170.

In this example, the first conduction portions 140 and the second conduction portions 160 are substantially formed (e.g., printed) onto the substrate layer 110 using a conductive ink. The second conduction portions 160 interdigitate with respective ones of the first conduction portions 140. Specifically, the finger sections 142 of each first conduction portion 140 interdigitate with the finger sections 162 of the corresponding second conduction portion 160. In this configuration, each neighbouring pair of the finger sections 142, 162 cooperate to function as a capacitor, with a respective fringe-field extending into an environment of the neighbouring pair, and with a capacitance thus sensitive to a pressure induced change in the permittivity of the encapsulation layers 120, 130. That is, with the encapsulation layers 120, 130 forming partially or wholly the environment of each neighbouring pair and with the permittivity of the encapsulation layers 120, 130 being dependent on a spatial relation of the carbon particles distributed therein, a pressure-induced deformation of the encapsulation layers 120, 130 causes a corresponding change in the spatial relation of the carbon particles, which in turn results in a corresponding change in the permittivity of the encapsulation layers 120, 130. Such a fringe-field is guided through the encapsulation layer 120, 130 by the carbon particulates therein. Through changing relevant configurations (e.g., dimensions and spacing) of the neighbouring pair, the respective fringe-field can be configured accordingly. The carbon particles can also be configured in terms of, for example, density and distribution according to needs. PCT Application No. PCT/IB2023/055843 provides example configurations.

In use, when an external pressure is applied to the encapsulation layers 120, 130, a resulting change in capacitance is sensed by the associated sensor device. . That is, the associated sensor device receives from the laminate 100 a signal that enable the determination of the capacitance of the layers 120, 130 and changes to that capacitance. These changes can then be related to changes to, or the imposition, of an external pressure on the layers. In one example arrangement, the sensor device comprises a printed circuit board (PCB) on which electronics and a battery of the sensor device are provided. Moreover, the electrodes 910, 920 via which the sensor device is operatively associated with the laminate 100 are respective alligator clip electrodes. A processor of the sensor device may be configured to: a) calculated a capacitance value based on an impedance measurement obtained via the associated laminate 100 through the electrodes 910, 920, b) display on an associated display device the calculated capacitance value, and c) trigger an alarm if the calculated capacitance value exceeds a threshold. In another arrangement, at step b), the processor may instead be configured to indicate a calibrated force in Newtons based on the calculated capacitance value.

The sensor device in electrical communication with the laminate 100 via the electrodes 910, 920 may include any suitable electronics, such as those for wireless communication in accordance with the IEEE 802.15 (Bluetooth) and IEEE 802.11 (WiFi) standards. Other such electronics may, for example, include those for telemetry, pressure sensing, presence sensing, force sensing and proximity sensing suitable for home security robotics and healthcare applications. The electronics may also include those for signal conditioning.

The first and second conduction portions 140, 160 are shown in Figure 2 to interdigitate across a dash-dotted reference line 104. Further, the first conduction portions 140 and the second conduction portions 160 are arranged on a same plane, more particularly on a surface plane of the substrate layer 110.

In this example, the contact portions 150, 170 exposed from the encapsulation layers 120, 130 are exposed to an external environment (e.g., air). In other embodiments, the contact portions 150, 170 exposed from the encapsulation layers 120, 130 may be covered by, for example, respective peelable films. The contact portions 150, 170 can be discretely or integrally provided along a length of the laminate 100 at the respective conduction portions 140, 160. Moreover, the contact portions 150, 170 of this embodiment are arranged on respective ones of laterally protruding portions of the substrate layer 110. That is, the substrate layer 110 has a plurality of first protruding portions spacedly arranged along the substrate layer 110 and laterally protruding from the first lateral side 111, and a plurality of second protruding portions spacedly arranged along the substrate layer 110 and laterally protruding from the second lateral side 112. The first contact portions 150 are arranged respectively on the first protruding portions. The second contact portions 170 are arranged respectively on the second protruding portions.

As shown by the dashed lines in Figure 3, the laminate 100 with such a configuration can be understood to include a plurality of sensing elements 101–103 each having a respective one of the first contact portions 150 and a respective one of the second contact portions 170. In this particular example, the first contact portions 150 are arranged symmetrically with respect to the second contact portions 170 about the dash-dotted reference line 104. In some examples, the first contact portions 150 may be arranged asymmetrically with respect to the second contact portion 170 along the reference line 104.

Shown in Figure 5 is a schematic diagram of a manufacture process 800 of laminating or joining the layers 110–130 to form the laminate 100 (i.e., a process 800 of manufacturing the laminate 100), according to one example. In step 810, the conduction portions 140, 160 are printed onto the substrate layer 110, and the contact portions 150, 170 are printed respectively onto the

laterally protruding portions of the substrate layer 110. The conduction portions 140, 160 may be printed concurrently or otherwise with respect to the contact portions 150, 170. In step 820, the layers 110–130 are laminated and formed into the laminate 100 in the shape of a tape roll (or a tape strip), with the contact portions 150, 170 exposed and extending laterally away from the encapsulation layers 120,130. Figure 6 shows an exploded isometric view of the laminate 100, with arrows indicating a lamination direction.

The manufacture process may be otherwise understood to involve the following steps performed by a manufacturer in any suitable order. In a first step, a manufacturer forms, on the substrate layer 110, the first conduction portions 140. In a second step, the manufacturer forms, on the substrate layer 110, the second conduction portions 160 interdigitating respectively with the first conduction portions 140. In a third step, the manufacturer forms, on the substrate layer 110, the first contact portions 150 electrically and respectively adjoining the first conduction portions 140. In a fourth step, the manufacturer forms, on the substrate layer110, the second contact portions 170 electrically and respectively adjoining the second conduction portions 160. In a fifth step, the manufacturer encapsulates the conduction portions 140, 160 with the encapsulation layers 120, 130 to form the laminate 100, with the contact portions 150, 170 exposed from the encapsulation layers 120, 130. Some of these steps may be performed concurrently. The order of these steps may be changed. Depending on design, the encapsulation with the second encapsulation layer 130 may be omitted from the fifth step such that the conduction portions 140, 160 are encapsulated only by the first encapsulation layer 120. Depending on design, the encapsulation with the second encapsulation layer 130 may be performed separately with respect to that with the first encapsulation layer 120.

The laminate 100 of Figure 1 may be deployed in a number of ways. In one example, a user cuts and applies a piece (e.g., a segment) of the laminate 100 onto a target surface. Next, the user slices the applied piece into smaller pieces each including at least one of the sensing elements 101–103. In another example, the user cuts the laminate 100 into the smaller pieces, and applies the smaller pieces onto the target surface. In either example, the user further removes any protection films from the contact portions 150, 170, either before or after any one of the described user steps. Moreover, provided that the dielectric material of the encapsulation layers 120, 130 has a sufficient inherent adhesiveness, the user may adhere the cut pieces onto the target surface without the use of any additional adhesives. In other words, the user may adhere the cut pieces onto the target surfaces using a dielectric adhesive inherently provided by the dielectric material. In embodiments where the laminate 100 adopts the form of an uncut strip, the laminate 100 may be sliced after being adhered to a target surface. This provides convenience

particularly where, for example, trimming or cutting is preferred only after adherence of the strip to the target surface.

Once the cut piece is applied onto the target surface, the associated sensor device is operable to detect an object in the corresponding environment through the fringe-fields provided by the finger sections 142, 162 in the manner described heretofore.

In one example of home security application, multiple cut segments of the laminate 100 are positioned under a carpet and configured to detect the presence of a person standing or walking on the carpet, with each segment being provided with a respective electrode pair. That is, where multiple sensing elements 101–103 exist in a cut segment, an electrode pair connected electrically to any one of the sensing elements 101–103 of the cut segment is in electrical communication therethrough with the other sensing elements 101–103 of the same cut segment. Moreover, the electronic device can be further calibrated to distinguish between a human and an animal (e.g., a cat). In particular, with the human standing on the carpet, the electronic device can be operated to learn a detection pattern through, for example, signal conditioning and telemetry. Once the pattern is learned, the electronic device can be configured to be triggered only by detections of matching patterns. Once triggered, the electronic device can communicate accordingly with an associated computing device, for example.

In summary, the laminate is advantageous in a number of ways. The laminate, in the form of either a roll or a strip, can be cut into multiple pieces (or segments), each including at least one sensing element, according to user needs. Moreover, where a cut piece includes multiple sensing elements, only one of the sensing elements needs to be associated with an electrode pair. Additionally, through configuring the finger sections, the detection fringe-fields can be configured accordingly for different applications and for different needs. Furthermore, through the use of a dielectric material with a sufficient adhesiveness, the laminate or the cut piece can be adhered to a target surface without the use of any other adhesive. Lastly, the laminate 100 can be formed easily using known roll forming techniques by simply having the conduction portions printed onto the substrate layer prior to lamination.

In addition to those described hereinabove, some alternative configurations are also described hereinafter. Where references are made to any reference numerals in the description of such alternative configurations, such references are intended solely to facilitate understanding. Any specific embodiments depicted in the figures in which the reference numerals appear are not to be construed as being limited by the alternative configurations where the specific embodiments would otherwise be rendered unclear.

In some embodiments, the laminate 100 may, instead of being a tape roll, take the form of a tape strip including at least one sensing element.

In some embodiments, at least one of the sensing elements may include any number of the first contact portions and any number of the second contact portions, with the first contact portions being optionally equal in number to the second contact portions. Further, any number of the sensing elements may be cut or trimmed into a single piece.

In some embodiments, the substrate layer 110 may be made of paper and may have the conduction portions 140, 160 printed thereon. The contact portions 150, 170 may also be printed thereon in a similar manner. In the preferred embodiment the conduction portions 140, 160 may be formed from or using a conductive ink.

In some embodiments, the first conduction portions 140 may be arranged on a first plane and the second conduction portions 160 may be arranged on a second plane different from the first plane. For example, the first and second planes may be respective ones of opposite surface planes of the substrate layer 110.

In some embodiments, the laminate 100 may comprise or be formed with lines of weakness to facilitate breaking of the laminate 100 into pieces or segments, with such lines of weakness preferably extending transversely from the first lateral edge 111 to the second lateral edge 112. This may be useful where the use of a cutting tool (e.g., a knife) is undesirable.

In some embodiments, at least one of the first and second contact portions 150, 170 may be covered with a peelable film, whether partially or fully.

In some embodiments, the first contact portions 150 may be staggered with respect to the second contact portions 170 along the substrate layer 110.

In some embodiments, the finger sections 142 of the first conduction portion 140 may have different lengths. Those 162 of the second conduction portion 160 may also have different lengths. In some embodiments, the finger sections 142 may have a first length, and the finger sections 162 may have a second length different from the first length. The finger sections 142, 162 may have any configuration provided that each neighbouring pair of the finger sections 142, 162 cooperate to provide a respective fringe-field.

In some embodiments, the first contact portions 150 may be arranged non-equidistantly. The second contact portions 170 may also be arranged non-equidistantly. This may be useful where segments with different numbers of sensing elements are needed.

In some embodiments, the first conduction portions 240 may be spaced apart from one another such that the first conduction portions 240 are non-contiguous. Similarly, the second conduction portions 260 may optionally be spaced apart from one another such that the second conduction portions 260 are non-contiguous.

In some embodiments, the first contact portions 150 may differ from the second contact portions 170 in any one of number, position, and shape. Depending on applications, the laminate 100 may be cut into a plurality of pieces, with each piece including any number of such sensing elements. Moreover, in some embodiments, each sensing element may include any number of the first contact portions in electrical communication with one another, and any number of the second contact portions in electrical communication with one another.

In some embodiments, the laminate 100 may include the first conduction portions 140 and the first contact portions 150 while excluding the second conduction portions 160 and the second contact portions 170. A segment cut from the laminate 100 may be positioned with respect to another segment cut from the laminate 100 to form a configuration similar to that of Figure 1.

In some embodiments, instead of electrically adjoining the respective conduction portions 140, 160, the contact portions 150, 170 may instead be spaced from and operatively coupled to the respective conduction portions 140, 160.

In some embodiments, each neighbouring pair of the first conduction portions 140 may be electrically coupled to each other. Each neighbouring pair of the second conduction portions 160 may be electrically coupled to each other.

In some embodiments, the second conduction portions 160 may not interdigitate with the respective first conduction portions 140 across a same reference line. Depending on design, one of the second conduction portions 160 may interdigitate with the corresponding first conduction portion 140 across a first reference line, and another one of the second conduction portions 160 may interdigitate with the corresponding first conduction portion 140 across a second reference line different from the first reference line.

In some embodiments, unlike the embodiment of Figure 1, the second conduction portions 160 may be arranged instead between the substrate layer 110 and the second encapsulation layer 130, such that the first conduction portions 140 are arranged on one plane while the second conduction portions 160 are arranged on another plane.

CLAIMS

1. A laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of contiguous first conduction portions arranged between the layers;

a plurality of first contact portions electrically adjoining respective ones of the first conduction portions and adapted to be associated with the sensor device;

a plurality of contiguous second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions; and

a plurality of second contact portions electrically adjoining respective ones of the second conduction portions and adapted to be associated with the sensor device.

2. The laminate of claim 1, wherein each one of the first conduction portions is contiguous with a neighbouring one of the first conduction portions, and each one of the second conduction portions is contiguous with a neighbouring one of the second conduction portions.

3. The laminate of claim 1 or 2, wherein the second conduction portions interdigitate with the respective ones of the first conduction portions across a same reference line.

4. The laminate of any one of the preceding claims, wherein the first conduction portions and the second conduction portions are arranged on a same plane.

5. The laminate of any one of the preceding claims, wherein at least one of the contact portions is exposed to an external environment.

6. The laminate of any one of the preceding claims, wherein at least one of the contact portions is covered with a peelable film.

7. The laminate of any one of the preceding claims, wherein the first contact portions are arranged symmetrically with respect to the second contact portions.

8. The laminate of any one of the preceding claims, wherein the first contact portions are arranged equidistantly.

9. The laminate of any one of the preceding claims, wherein the substrate layer is made of one of paper and silicone, and the conduction portions are formed from a conductive ink.

10. The laminate of any one of the preceding claims, wherein the encapsulation layer is made of a dielectric material.

11. The laminate of claim 10, wherein the dielectric material is compliant and includes a carbon compound.

12. The laminate of any one of the preceding claims, wherein the encapsulation has a thickness of about 1 millimetre.

13. The laminate of any one of the preceding claims, adapted to be cut into a plurality of sensing elements each having a respective one of the first contact portions and a respective one of the second contact portions.

14. The laminate of any one of the preceding claims, further comprising a plurality of lines of weakness.

15. The laminate of any one of the preceding claims, further comprising another encapsulation layer, the substrate layer being laminated between the encapsulation layers.

16. A laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of first conduction portions arranged between the layers;

a plurality of first contact portions electrically adjoining respective ones of the first conduction portions and adapted to be exposed to an external environment;

a plurality of second conduction portions arranged between the layers and interdigitating with respective ones of the first conduction portions across a same reference line; and

a plurality of second contact portions electrically adjoining respective ones of the second conduction portions and adapted to be exposed to the external environment.

17. A laminate for a sensor device comprising:

a substrate layer laminated with an encapsulation layer;

a plurality of contiguous conduction portions arranged between the layers; and

a plurality of contact portions electrically adjoining respective ones of the conduction portions and adapted to be associated with the sensor device.

18. A tape strip comprising the laminate of any one of the preceding claims.

19. A tape roll comprising the laminate of any one of the preceding claims.

20. A sensor device comprising the laminate of any one of claims 1 to 17 and electronics associated with the laminate.

21. A method of using the laminate of any one of claims 1 to 17, comprising:

applying a segment of the laminate onto a surface; and

slicing the segment into pieces each including at least one of the first contact portions and at least one of the second contact portions.

22. The method of claim 21, wherein applying the segment includes adhering the segment onto the surface using a dielectric adhesive provided by the encapsulation layer.

23. A process of manufacturing a laminate, comprising:

forming, on a substrate layer, a plurality of first conduction portions;

forming, on the substrate layer, a plurality of second conduction portions interdigitating respectively with the first conduction portions;

forming, on the substrate layer, a plurality of first contact portions electrically and respectively adjoining the first conduction portions;

forming, on the substrate layer, a plurality of second contact portions electrically and respectively adjoining the second conduction portions; and

encapsulating the conduction portions with an encapsulation layer to form the laminate, with the contact portions exposed from the encapsulation layer.

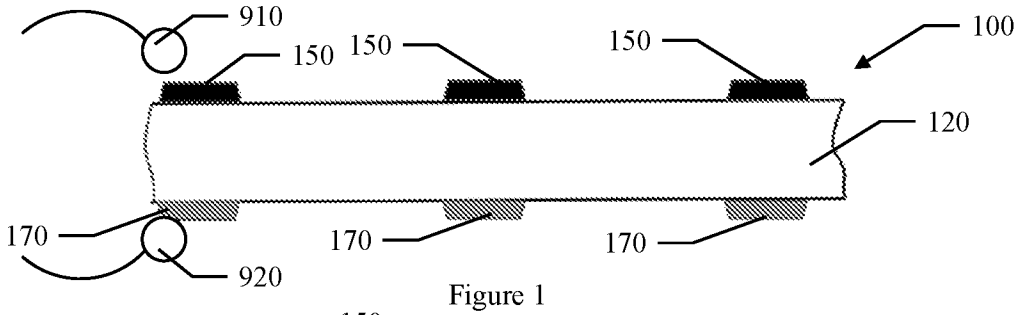

Figure 1

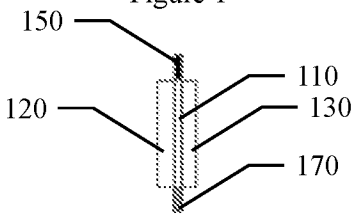

Figure 2

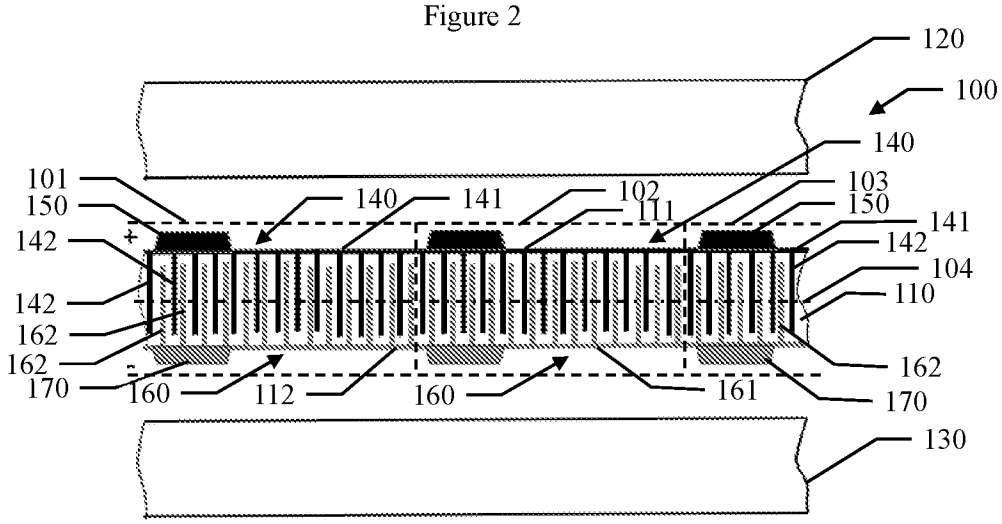

Figure 3

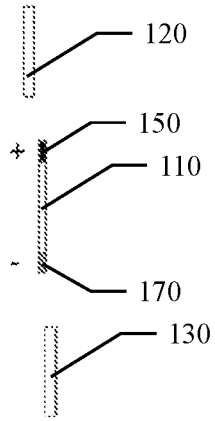

Figure 4

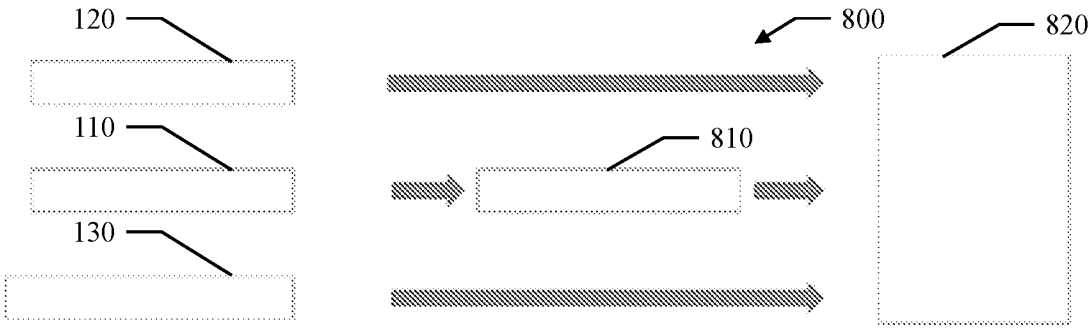

Figure 5

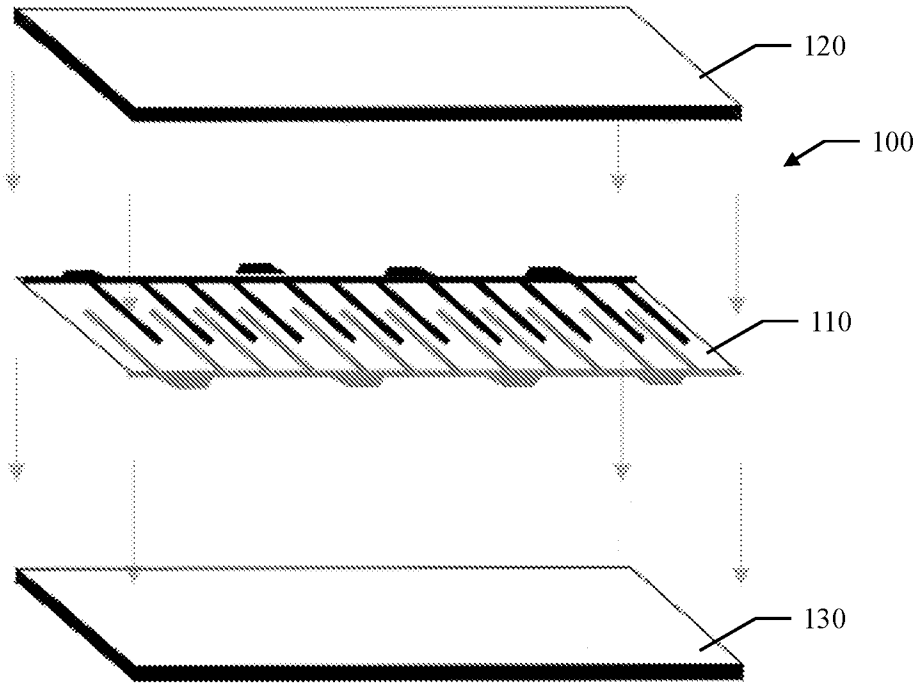

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2024/055468

A. CLASSIFICATION OF SUBJECT MATTER

G01L 1/14(2006.01)i; **H01G 4/018**(2006.01)i; **H01G 5/013**(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)

G01L 1/14(2006.01); G01L 5/00(2006.01); G01N 17/04(2006.01); G01N 27/00(2006.01); G01N 27/04(2006.01); G01N 27/12(2006.01); G01N 27/22(2006.01); G06T 1/00(2006.01)

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
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: laminate, layer, conduct, contact, expose, environment, film, dielectric material

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018-0100825 A1 (STMICROELECTRONICS S.R.L.) 12 April 2018 (2018-04-12) paragraphs [0005]-[0009], [0033]-[0037], [0041]-[0043], [0046] and figures 1-2	1-12,15-17,20,23
Y		13-14,18-19,21-22
Y	US 6103033 A (SAY et al.) 15 August 2000 (2000-08-15) column 32, lines 14-27 and figures 15A-16	13-14,18-19,21-22
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A	JP 2019-200142 A (MAZDA MOTOR CORP.) 21 November 2019 (2019-11-21) claims 1-2 and figure 1	1-23

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 September 2024	**13 September 2024**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2024/055468

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