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(54) Title: STRETCHABLE ELECTRONIC COMPONENT CARRIER

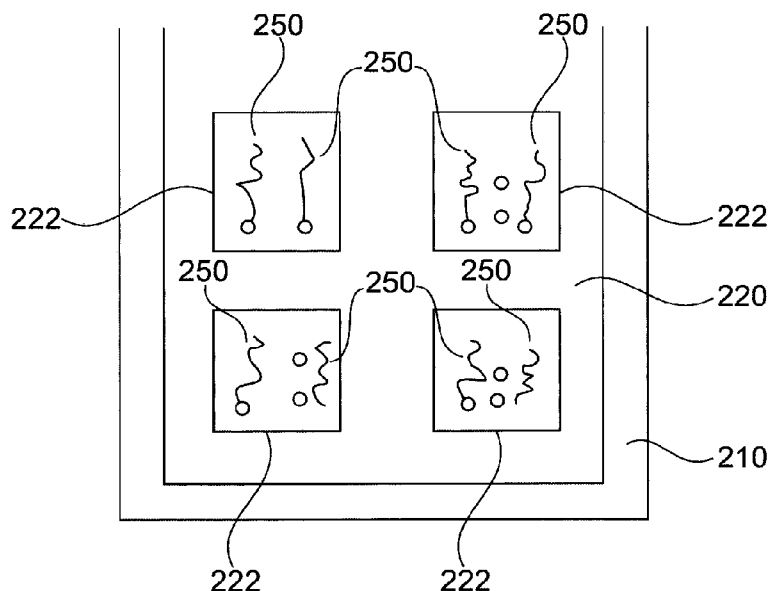


Fig. 2H

(57) Abstract: A method of manufacturing a stretchable electronic component carrier, the method comprising: a) providing a sheet of conductive foil material, b) providing a rigid support structure on a first part of a surface of the sheet of conductive foil material, c) providing a stretchable support structure on a second part of the surface of the sheet of conductive foil material, d) curing the first and second support structure to fasten them to the sheet of conductive foil material, and e) processing the sheet of conductive foil material to form a stretchable conductive layer structure.

Stretchable electronic component carrier

The invention relates to stretchable electronic component carriers, in particular to a method of manufacturing a stretchable electronic component carrier, such as a stretchable printed circuit board, and a stretchable electronic component carrier manufactured by such method.

Various electronic applications require (or would benefit) from a stretchable component carrier, such as a stretchable printed circuit board (PCB). This is particularly the case for so-called wearable or conformal electronics, which, depending on the specific application, may need a bendable (2D) or truly stretchable (3D) PCB. Examples of wearable electronic applications include e.g. wrist watches, activity bands and other devices that are carried on, in or close to the body. These may include well-known PCB technologies, such as e.g. rigid-flex and flex PCBs which are capable of providing 2D bending. However, these technologies are usually not sufficient for truly conformal electronic devices, e.g. medical sensor devices that should be capable of being attached to the curvy surface of a human or animal body while causing as little discomfort as possible to the wearer. Instead, such devices require a PCB that is not only bendable (2D flexibility) but stretchable to provide 3D flexibility.

In order to provide the desired 3D flexibility a number of technical difficulties have to be overcome as both the substrate carrier (the dielectric material) and the conductive structure (e.g. copper traces) formed thereon must exhibit properties which support the needed function.

The breaking strain of the commonly employed conductive material copper (Cu) is ~4%. Thus, an exemplary 10mm long straight Cu track can be stretched only by 400µm before it breaks and will accordingly not be able to meet the requirements of conformal or stretchable electronics. Excessive work, theoretically and experimental, have been performed on the stretchability of conducting traces. It was found that when forming the conducting traces not straight, as it is common in normal PCB routing, but in a serpentine structure, extreme high elongation of even Cu tracks can be achieved and thereby fulfilling the conformal requirements (Y. Zhang et al ,

Soft Matter, 2013, 9, 8062, Y.Su et al., Journal of the Mechanics and Physics of Solids 60 (2012) 487-508, good references can also be found at John Roger' s group, University of Illinois <http://rogers.matse.illinois.edu/>). In other words the stretchability is achieved via a change of the geometry. This is also
5 discussed in the published UK patent application GB 2489508 A.

With regard to the dielectric substrate, a variety of intrinsically stretchable materials are known, e.g. silicone, epoxy resins, thermoplastic elastomers etc. In addition to such intrinsically stretchable materials, material classes with a tuned modulus have been developed (Nat. Mat. 6, 76, 2007,
10 Nat. Com. 3, 1267 (2012)). Here, the module is locally tuned by introducing fibres/particles which lead to a locally different module. This tuning is especially advantageous when something stiff, e.g. a conducting track or a chip component, has to be attached on top or in the substrate. This approach reduces the stress gradient in the interface between stretchable and stiff
15 material.

When forming a conformal PCB it is necessary to combine both conductor and dielectric materials to form a fully functional board. Two known main approaches are sputtering of the conducting material directly onto a stretchable substrate (structuring of the conducting traces either happen
20 already during the sputtering process using a mask or during a subsequent etch process) or by using a copper clad polyimide laminate, structuring the copper via e.g. a photo process into serpentine tracks and then cutting out the polyimide with the tracks in a serpentine manner. Often it can be seen that the later one is encapsulated into silicone.

25 The published German patent application DE 10 2006 055 576 A1 describes a method of manufacturing a stretchable circuit carrier by applying a stretchable material to an electrically conductive foil to form a substrate layer, whereupon the foil is structured in such a way that it forms a conductive structure including at least one stretchable conductive trace. However, due to
30 the stretchability of the substrate, this structuring is difficult to perform, especially with standard equipment for handling a circuit carrier during the structuring process(es).

Although as described above, various techniques exist for providing electronic component carriers that are suitable for conformal electronics, these

all suffer from various drawbacks, the main one being complicated and consequently expensive manufacture that calls for special equipment and tools as compared to production of standard circuit boards.

5 It is an object of the invention to provide stretchable electronic component carriers for conformal electronic devices in a simple and cost-efficient way.

 In order to achieve the object defined above, a method of manufacturing a stretchable electronic component carrier and a stretchable electronic
10 component carrier according to the independent claims are provided.

 According to an exemplary embodiment of the invention, a method of manufacturing a stretchable electronic component carrier is provided. The method comprises providing a sheet of conductive foil material (conductive sheet), providing a rigid support structure on a first part of a surface of the
15 sheet of conductive foil material, providing a stretchable support structure on a second part of the surface of the sheet of conductive foil material, curing the first and second support structure to fasten them to the sheet of conductive foil material and thereby form the stretchable electronic component carrier, and processing the sheet of conductive foil material to form a stretchable
20 conductive layer structure.

 According to another exemplary embodiment of the invention, a stretchable electronic component carrier is provided which is manufactured by the above-mentioned method.

 In the context of the present application, the term "stretchable" may
25 particularly denote a material which is capable of being stretched in all three dimensions in the sense that application of a certain amount of force in a given direction will cause the dimension of the material to change in that direction.

 In the context of the present application, the term "rigid" may in particular denote a material which is not stretchable (or only stretchable to a
30 very limited degree).

 In the context of the present application, the term "sheet" may in particular denote a substantially flat piece of material extending mainly in two dimensions, e.g. with a rectangular, triangular, square, circular, elliptical, trapezoidal or similar perimeter.

In the context of the present application, the term "foil material" may in particular denote a substantially flat or planar material.

In the context of the present application, the term "electronic component carrier" may particularly denote any support structure which is
5 capable of accommodating one or more electronic components thereon and/or therein (e.g. embedded therein, such that the electronic component carrier forms an embedded component package (ECP)) for providing both mechanical support and electrical connectivity.

In the context of the present application, the term "layer structure" may
10 particularly denote a continuous layer, a patterned layer or a plurality of non-consecutive islands within a common plane.

According to an exemplary embodiment of the invention, by providing a rigid support structure on a first part of the conductive sheet surface and a stretchable support structure on a second (e.g. the remaining) part of the
15 conductive sheet surface, such that the rigid and stretchable support structures form a combined support structure, the cured structure will, due to the rigidity provided by the rigid support structure, be easy to handle during the subsequent processing to form a stretchable conductive layer structure. In particular, this handling can be made without the need for special tools other
20 than those used in production of regular (i.e. non-stretchable) electronic component carriers. The resulting electronic component carrier will nevertheless, in particular when the first part of the conductive sheet surface is smaller than the second part, exhibit a high degree of stretchability due to the stretchable support structure. Thus, a simple and efficient method of
25 manufacturing a stretchable electronic component carrier is provided, and the resulting stretchable electronic component carrier fulfills the requirements of modern wearable and conformal electronic devices.

In the following, further exemplary embodiments of the method and the
30 electronic component carrier will be explained.

In an embodiment, the rigid support structure forms a frame structure, and the stretchable support structure is arranged within the frame structure.

In the context of the present application, the term "frame structure" may in particular denote a structure that is suitable for partially or completely

surrounding another structure in the sense that the frame structure is an at least substantially closed structure that leaves room for another structure, such as the stretchable support structure.

By providing the rigid support structure as a frame structure, the resulting structure exhibits rigidity at well-defined part thereof. Furthermore, the frame structure facilitates the step of providing the stretchable support structure as the frame structure may make it easier to control where to arrange the stretchable support structure (i.e. within the frame) and where not.

10 In an embodiment, the frame structure comprises a plurality of sub frames.

In this embodiment, the frame structure may e.g. be formed as an array of sub-frames, i.e. a main or outer frame comprising a mesh-like structure forming the walls of the sub-frames. The array may comprise any number of rows N and any number of columns M, thereby forming an NxM array, such as 15 an 1x2, 1x3, 1x4, 2x1, 2x2, 2x3, 2x4, 3x1, 3x2, 3x3, 3x4, 4x1, 4x2, 4x3, 4x4 array etc.

In this embodiment, the rigid support structure is distributed as a mesh-like structure over the surface of the conductive sheet and thereby provides 20 rigidity across the surface, which further facilitates handling of the cured structure during the processing.

In an embodiment, the rigid support structure comprises an embedded electronic component. In other words, the rigid support structure may at least partially form an embedded component package (ECP).

25 In an embodiment, the step of providing the rigid support structure comprises providing a sheet of prepreg material (i.e. a polymer material with glass fiber reinforcement, fully or not fully cured), forming at least one cut-out portion in the sheet of prepreg material, and arranging the sheet of prepreg material on the sheet of conductive foil material.

30 In this embodiment, the at least one cut-portion in the prepreg sheet defines the second part of the surface of the conductive sheet where the stretchable support structure is to be formed once the prepreg sheet has been arranged on the sheet of conductive material.

In this way, the rigid support structure may be provided in a simple manner without the need for special tools besides those that are available in setups for manufacturing regular electronic component carriers.

In an embodiment, the method further comprises providing a protective
5 film on at least one side of the sheet of prepreg material prior to forming the at least one cut-out portion therein, and removing the protective film prior to the curing.

The protective film serves to protect the prepreg material during the subsequent arrangement of the stretchable support structure, in particular to
10 prevent any undesirable reaction between the two materials. The protective film is especially important in the case where the prepreg with protective film acts as a stencil to provide the stretchable material via a stencil / screen print step.

In an embodiment, the step of providing the stretchable support structure comprises arranging a stretchable dielectric material on the sheet of
15 conductive foil material such that the stretchable dielectric material covers the second part of the surface.

In sum, the first and second parts of the surface of the conductive sheet may correspond to the total surface of the conductive sheet.

20 In an embodiment, the stretchable dielectric material is selected from the group consisting of silicone and stretchable polymers, all elastomeric polymers such as silicone, natural and synthetic rubber or derivate thereof (e.g. polyurethane rubbers), thermoplastic elastomers, e.g. thermoplastic polyurethane, generally low/no and high cross linked polymers, generally
25 materials which show a low Young modulus and a high elastic deformation capability. Exemplary materials include TPE-O or TPO, TPE-V or TPV, TPE-U or TPU, TPE-E or TPC, TPE-S or TPS, and TPE-A or TPA.

In an embodiment, the stretchable dielectric material is a paste material. In this case, the stretchable dielectric material may easily be applied to
30 parts of the surface not containing the rigid support structure.

In an embodiment, the stretchable dielectric material is arranged in a process selected from the group consisting of stencil printing, screen printing, inkjet, spray coating, flexograph, slot die coating, curtain coating, dispensing, e-spray, and other coating techniques.

As known in the art, each of these processes has advantages and disadvantages. Particularly preferable is the process of stencil printing where the rigid support structure acts as the stencil and where the dielectric material is a silicone paste or another paste-like system with adequate viscosity for being
5 applied.

In an embodiment, the method further comprises removing at least a part of the rigid support structure after the step of processing the sheet of conductive foil material.

By removing at least a part of the rigid support structure, both the total
10 and local rigidity of the electronic component carrier can be selectively reduced and the stretchability correspondingly increased. This may be useful in cases where a very high stretchability is needed or where some regions having rigidity may cause a problem during use.

In an embodiment, the at least part of the rigid support structure is re-
15 moved in a cutting process.

Cutting tools are widely used in manufacturing of regular electronic component carriers, such that this additional step will not add significantly to the complexity or cost of the manufacturing process.

Preferably, the cutting is done at the end of the process chain.

20 In an embodiment, the method further comprises providing a further sheet of conductive foil material on the side of the rigid support structure and the stretchable support structure that faces away from the sheet of conductive foil material prior to the curing.

In other words, this embodiment provides a double-sided electronic
25 component carrier with conductive sheets on both sides.

In an embodiment, the method further comprises processing the further sheet of conductive foil material to form a further stretchable conductive layer structure.

Thus, in this embodiment stretchable conductive structures are formed
30 on both sides of the electronic component carrier, which may provide further flexibility with regard to particular arrangements of electronic components and the need to meet certain design requirements imposed on the conductive layer structure by particular applications.

In this embodiment through connections between the first and second conductive foil can be realized via laser/mechanical drilling and subsequent galvanic metallization of the holes in rigid as well as stretchable parts of the component carrier.

- 5 In an embodiment, the conductive foil material comprises a metal or a metal alloy.

These materials provide good electric conductivity and are easy to process using known techniques, such as application of photo resist material, etching baths etc. Preferably, materials like gold or organic surface protection
10 (OSP) may be applied to the end surfaces.

In an embodiment, the conductive material comprises a material selected from the group consisting of copper, iron, gold, nickel, and magnesium.

- The aspects defined above and further aspects of the invention are apparent from the examples of embodiment to be described hereinafter and are
15 explained with reference to these examples of embodiment.

Figure 1 shows a flowchart corresponding to a method of manufacturing a stretchable electronic component carrier in accordance with an exemplary embodiment of the invention.

- 20 Figures 2A to 2H show a series of cross-sectional views of a stretchable electronic component carrier during manufacture in accordance with a method according to an exemplary embodiment of the invention.

- The illustrations in the drawings are schematic. In different drawings,
25 similar or identical elements are provided with the same reference signs.

- Figure 1 shows a flowchart 100 corresponding to a method of manufacturing a stretchable electronic component carrier in accordance with an exemplary embodiment of the invention. The illustrated method 100 comprises steps 102, 104, 106, 108, and 110. These and further steps will
30 now be described with reference also to the corresponding illustrations in Figures 2A-2H.

As shown in Figure 1, the method 100 begins at step 102 by providing a sheet of conductive foil material, such as the rectangular sheet of copper foil 210 shown in Figure 2A. The sheet 210 may be pre-manufactured, cut off

from a roll of foil or stamped out of a larger sheet. Although the illustrated sheet 210 is made of copper, other materials, such as iron, gold, nickel, magnesium and similar conductive materials may be used. The sheet 210 has a thickness in the range of 2 μ m to 100 μ m, in particular 2 μ m to 35 μ m, more particularly 2 μ m to 18 μ m.

The method 100 continues at step 104 by providing a rigid support structure on a first part of a surface of the sheet of conductive foil material 210. Figure 2B shows a prepreg sheet 220 comprising four rectangular cut-out portions 222 forming corresponding sub frames. It is noted that the cut-out portions may also have other shapes, such as triangular, square, polygonal, circular or elliptical. The prepreg sheet 220 may have a protective cover film applied to at least one of its surfaces. Such protective film material is also cut through when forming the sub frames 222, such that these remain open. As shown in Figure 2C, the prepreg sheet 220 is arranged on the copper sheet 210 such that the latter is covered by the prepreg material except for the areas corresponding to the sub frames 222. In Figure 2C, also the aforementioned protective film or coating 224 can be seen. The prepreg sheet 222 with protective film 224 is fastened, e.g. tacked to the copper sheet 210, such that the layered structure with cut-out portions 222 as shown in cross-section in Figure 2D is obtained. In other words, the prepreg sheet 220 covers a first part of the surface of the copper sheet 210, while the remainder of the sheet surface (as a second part of the surface) is not covered by any material and thus exposed through the sub frames 222.

The method 100 continues at step 106 by providing a stretchable support structure on a second part of the surface of the sheet 210 of conductive foil material. More specifically, as shown in Figure 2E, a stretchable material 230 in paste form, e.g. silicone paste, is stencil printed into the sub frames 222 by means of a squeegee 240 which is drawn across the upper surface of the structure (e.g. from the upper part in the drawing towards the lower part in the drawing). As a result, the surface parts of the copper sheet 210 that were exposed through the cut-out portions 222 in the prepreg sheet 220 get covered with silicone paste. During application of the silicone paste, the protective film 224 assures that silicone paste is not mixed into the prepreg material 220. Once the sub frames 222 have been filled with silicone paste,

the protective film 224 is removed as shown in Figure 2F. This Figure also shows portions of silicone paste 232 within the sub frames 220. In an embodiment, a second copper sheet 212 may then, as shown in Figure 2G be put on top of the structure such that a double sided electronic component carrier, such as a PCB having conductive traces on both sides, can be produced, if desired. For single sided component carriers, this last step is simply omitted. It is noted that in an additional process step, which is standard in PCB manufacturing, holes (laser/mechanical drill) and subsequently, in a galvanic step, through connections between top and bottom conductive foils can be made (in both materials).

The method 100 continues at step 108 by curing the first and second support structures 220, 232 to fasten them to the sheet of conductive foil material 210. This curing process may be performed in a variety of well-known ways, e.g. by application of heat and/or pressure.

The method 100 continues at step 110 by processing the sheet of conductive foil material (i.e. the surface of sheet 210 facing away from the cured prepreg material and silicone paste 232) to form a stretchable conductive layer structure consisting of stretchable conductive traces 250 as shown in Figure 2H. The stretchable conductive traces 250 preferably are formed in a generally known way, e.g by application of photo resist, followed by development and etching, and have a meander-like or similar known geometry that improves stretchability of the traces 250. The process of forming the conductive traces 250 as well as further cutting and drilling operations for providing holes and other structural changes in the PCB may be performed by use of the same processing, handling and tools as used in production of regular (i.e. rigid and flex) printed circuit boards. This is due to the rigidity provided by the rigid material 220. In the absence of this material, the structure would be very difficult to handle (due to the high flexibility and stretchability of the silicone alone) during these final production steps. As shown schematically in Figure 2H, the conductive traces 250 are formed in the areas 222 of the component carrier that contain the stretchable support structure 232. If desirable, regular (non-stretchable) conductive traces or terminal surfaces (not shown) may be formed in rigid portions of the board, thereby forming a rigid stretch PCB. Depending on the specific application, it may be desirable to reduce or remove

the rigidity of the board. This may be done as part of the final processing step by cutting away the corresponding material.

Summarizing, the present invention provides a simple and cost effective method of manufacturing a stretchable electronic component structure, such
5 as a printed circuit board for conformal electronic applications, such as electronic devices that are to be worn directly at the human or animal body. The resulting stretchable electronic component carrier is of the highest quality and can be designed in a wide variety of ways to meet the demands of a wide variety of applications. In particular, the method may be carried out without
10 the need for special tools or processes in comparison to those already available for manufacturing regular printed circuit boards.

It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined.

15 It should also be noted that reference signs in the claims shall not be construed as limiting the scope of the claims.

Implementation of the invention is not limited to the preferred embodiments shown in the figures and described above. Instead, a multiplicity of variants is possible which use the solutions shown and the principle according
20 to the invention even in the case of fundamentally different embodiments.

C l a i m s

1. A method of manufacturing a stretchable electronic component carrier,
the method comprising:
providing a sheet of conductive foil material,
5 providing a rigid support structure on a first part of a surface of the
sheet of conductive foil material,
providing a stretchable support structure on a second part of the sur-
face of the sheet of conductive foil material,
curing the first and second support structure to fasten them to the
10 sheet of conductive foil material, and
processing the sheet of conductive foil material to form a stretchable
conductive layer structure.
2. The method according to the preceding claim, wherein the rigid support
15 structure forms a frame structure, and wherein the stretchable support
structure is arranged within the frame structure.
3. The method according to the preceding claim, wherein the frame
structure comprises a plurality of sub frames.
20
4. The method according to any of the preceding claims, wherein the rigid
support structure comprises an embedded electronic component.
5. The method according to any of the preceding claims, wherein the step
25 of providing the rigid support structure comprises
providing a sheet of prepreg material,
forming at least one cut-out portion in the sheet of prepreg material,
and
arranging the sheet of prepreg material on the sheet of conductive foil
30 material.

6. The method according to the preceding claim, further comprising providing a protective film on at least one side of the sheet of prepreg material prior to forming the at least one cut-out portion therein, and removing the protective film prior to the curing.

5

7. The method according to any of the preceding claims, wherein the step of providing the stretchable support structure comprises arranging a stretchable dielectric material on the sheet of conductive foil material such that the stretchable dielectric material covers the second part of the surface.

10

8. The method according to the preceding claim, wherein the stretchable dielectric material is selected from the group consisting of silicone and stretchable polymers.

15 9. The method according to claim 7 or 8 claim, wherein the stretchable dielectric material is a paste material.

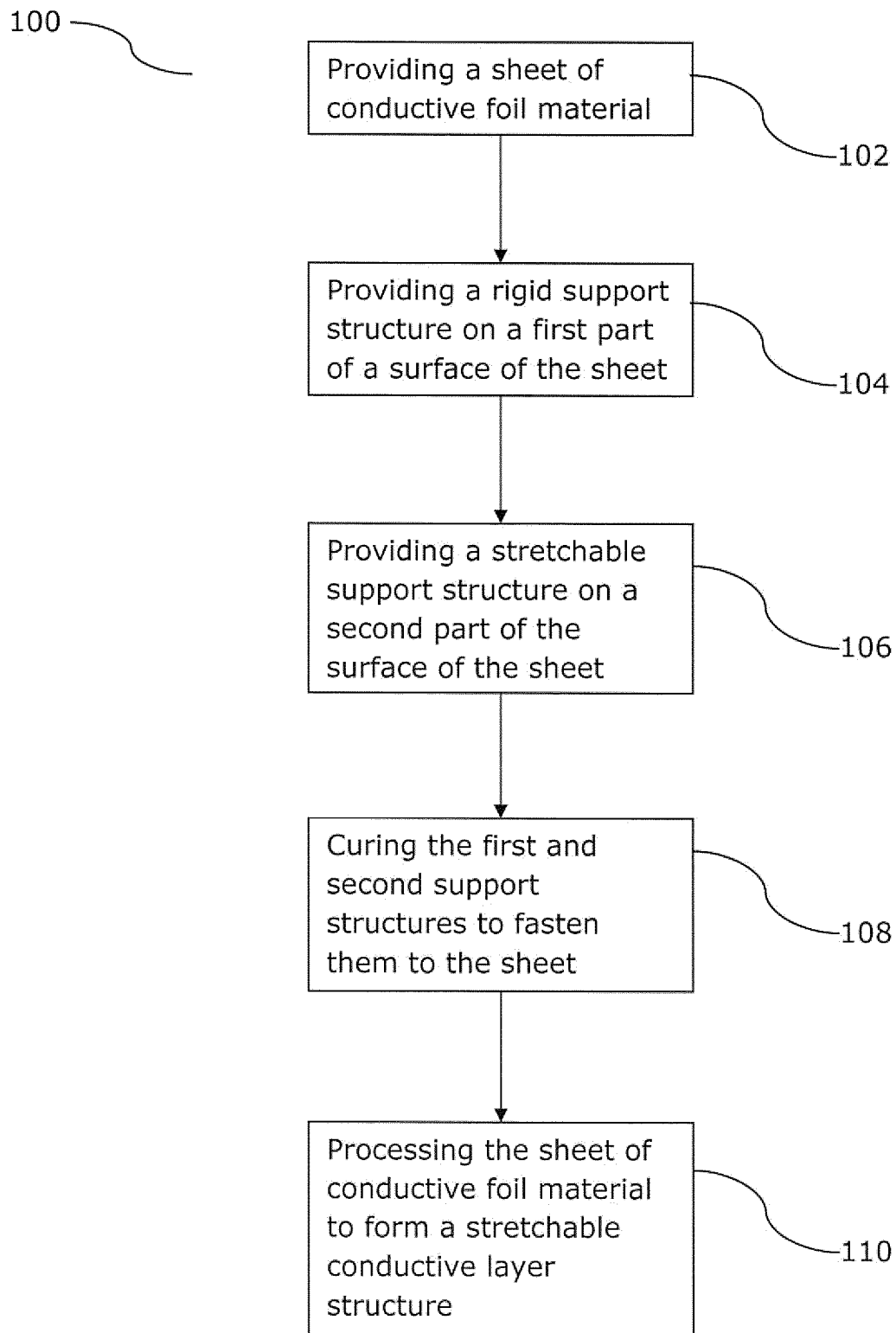
10. The method according to any claims 7 to 9, wherein the stretchable dielectric material is arranged in a process selected from the group consisting of stencil printing, screen printing, inkjet, spray coating, flexograph, slot die coating, curtain coating, dispensing, and e-spray.

25 11. The method according to any of the preceding claims, further comprising removing at least a part of the rigid support structure after the step of processing the sheet of conductive foil material.

12. The method according to the preceding claim, wherein the at least part of the rigid support structure is removed in a cutting process.

30 13. The method according to any of the preceding claims, further comprising providing a further sheet of conductive foil material on the side of the rigid support structure and the stretchable support structure that faces away from the sheet of conductive foil material prior to the curing.

14. The method according to the preceding claim, further comprising processing the further sheet of conductive foil material to form a further stretchable conductive layer structure.
- 5 15. The method according to any of the preceding claims, wherein the conductive foil material comprises a metal or a metal alloy.
16. The method according to the preceding claim, wherein the conductive material comprises a material selected from the group consisting of copper,
10 iron, gold, nickel, and magnesium.
17. A stretchable electronic component carrier manufactured by a method according to any of the preceding claims.

1/5**Fig. 1**

2/5

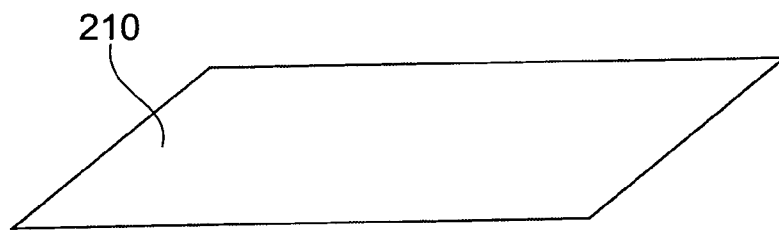


Fig. 2A

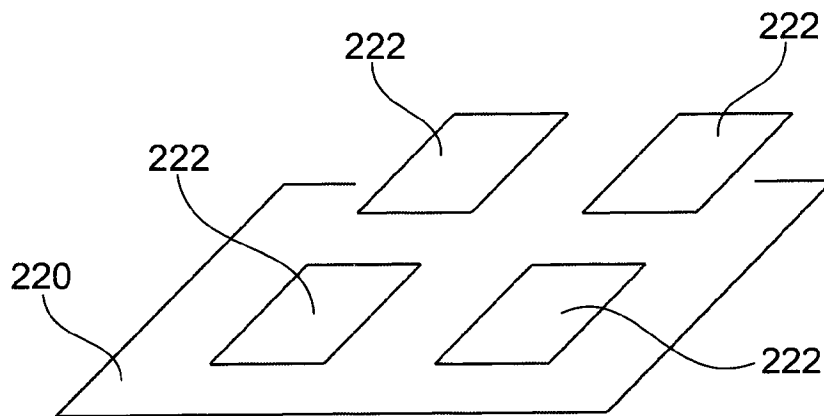


Fig. 2B

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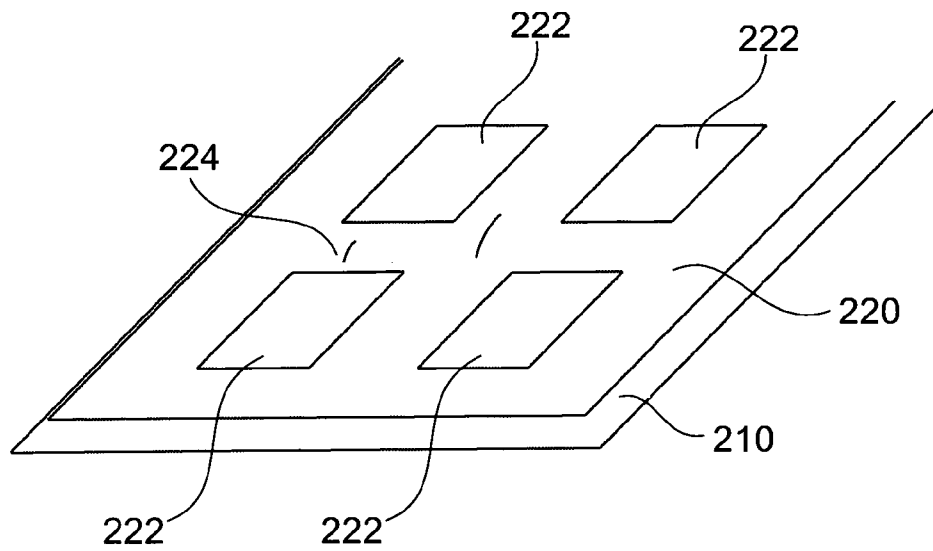


Fig. 2C

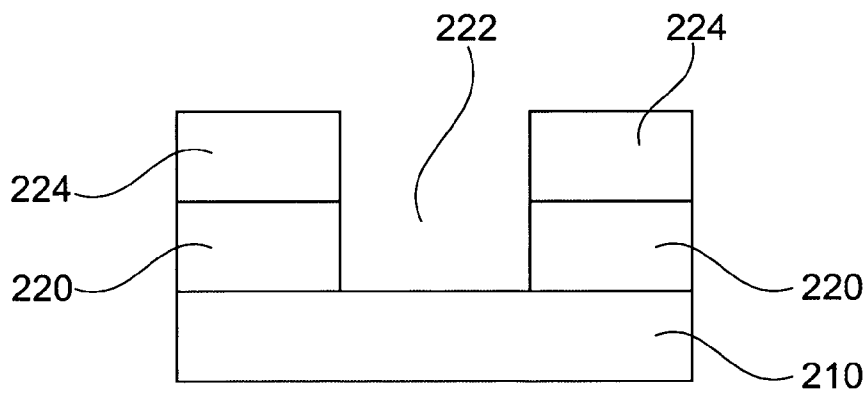


Fig. 2D

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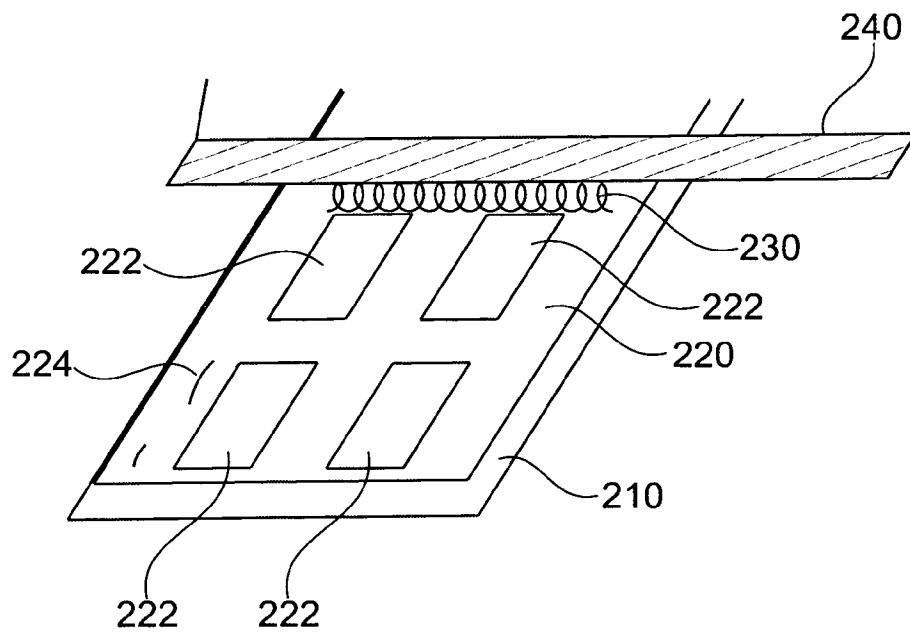


Fig. 2E

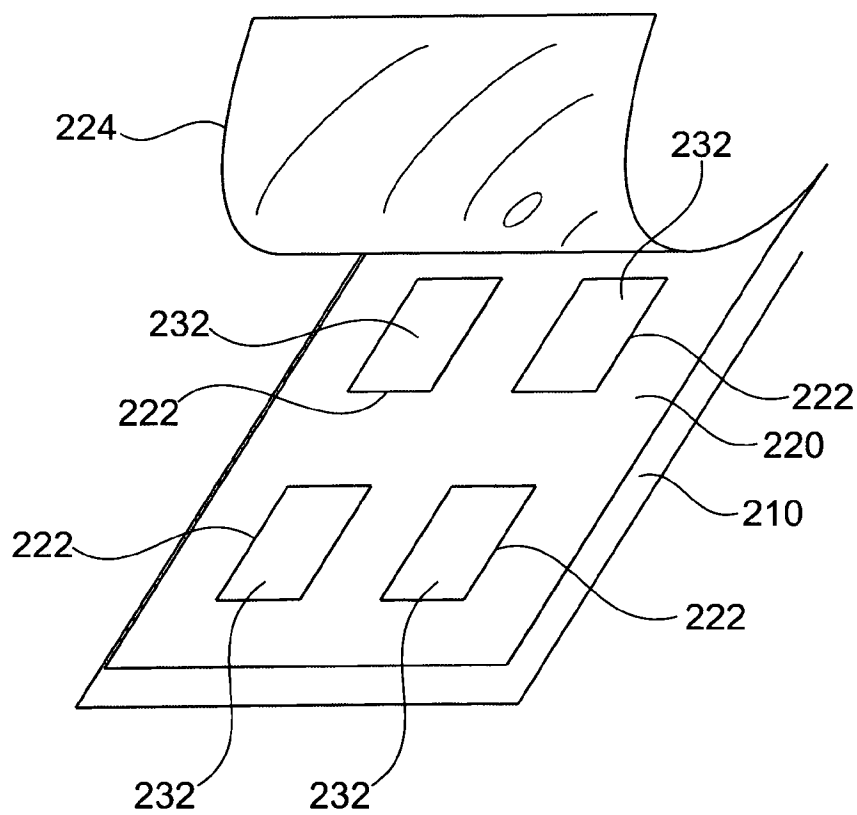


Fig. 2F

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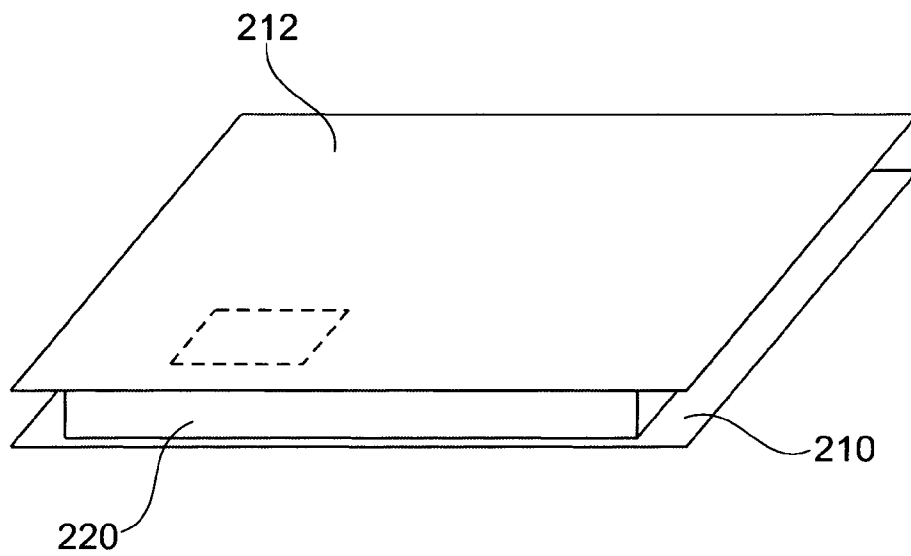


Fig. 2G

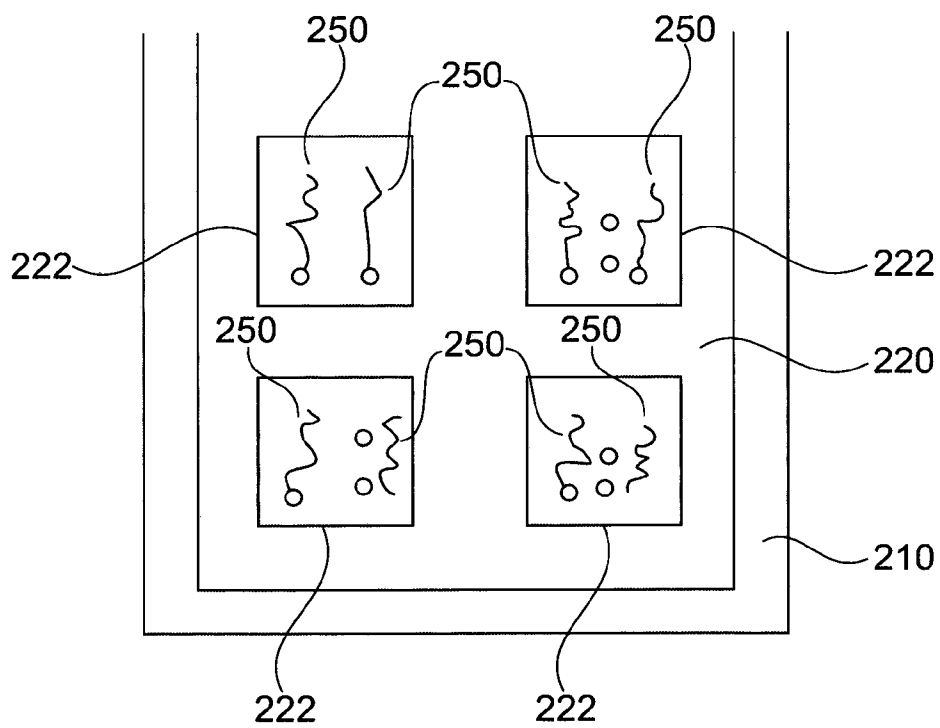


Fig. 2H

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/067875

A. CLASSIFICATION OF SUBJECT MATTER

INV. H05K1/02 H05K3/02 H05K1/03
ADD.

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)
H05K

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)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 255 607 A2 (SCHOELLER & CO ELEKTRONIK [DE]) 10 February 1988 (1988-02-10) the whole document	1-17
A	US 4 687 695 A (HAMBY BILL L [US]) 18 August 1987 (1987-08-18) the whole document	1-17
A	WO 93/11652 A1 (NORTHUMBRIA CIRCUITS LIMITED [GB]) 10 June 1993 (1993-06-10) the whole document	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0255607	A2	10-02-1988	DE 3624719 A1 28-01-1988
			DK 359187 A 23-01-1988
			EP 0255607 A2 10-02-1988
US 4687695	A	18-08-1987	NONE
WO 9311652	A1	10-06-1993	NONE