



**“Process for fabricating neural interfaces based on a combination of molding and screen printing”**

FIELD OF THE INVENTION

5           The present invention concerns the field of implantable neural interface devices and, in particular, it refers to a new process for fabricating polymeric neural interfaces based on a combination of molding and screen printing, and to the interfaces thus obtained. The invention simplifies the process for fabricating the above-mentioned devices, both from an operational point of view and from a cost reduction perspective.

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STATE OF THE ART

          Neural interfaces are biomedical devices that allow bidirectional communication with the nervous system (central and peripheral). By using neural interfaces in the form of implantable electrodes on peripheral nerves, it is possible to obtain information about  
15   the neural activity of the implanted nerve, and thus monitor and diagnose various diseases, or transmit current to modulate or stimulate the aforesaid activity and regulate the physiological functions associated with the nerve itself, treating the aforesaid diseases.

          The implantable electrodes specifically referred to in the present application  
20   generally comprise layers of insulating material that encapsulate conductive traces, and are in particular and preferably electrodes of the cuff type.

          The fabrication methods typically employed for the realization of this kind of interfaces include photolithography and 3D printing. Both of these approaches present criticalities. Photolithography is a fabricating technique that exploits a jig to transfer a  
25   desired geometry onto a layer of photoresist, i.e. a light-sensitive material that acts as a sacrificial layer of the device to be obtained [1]. The realization of a neural interface by photolithography comprises successive fabricating steps including spin coating, metal deposition, and etching. By using these techniques it is possible to obtain devices

with a high spatial resolution ( $\mu\text{m}/\text{nm}$ ) with different geometries, as demonstrated by numerous devices made in the field of neural interfaces [2], [3]. However, the realization of neural interfaces by photolithography techniques presents numerous problems that restrict the use thereof to a broader market in the clinical field. In this regard, the current  
5 technologies for the realization of the neural electrodes are extremely expensive, require sophisticated equipment and large spaces, as well as they require very time-consuming realization processes, as they are complex and elaborate, which limit their fabrication. This, in fact, can only happen after having set up extremely expensive facilities and recruited highly specialized personnel.

10 Moreover, the main limitation lies in the scarce selection of materials for fabricating the interfaces, limited to resins and noble metals whose chemical-physical characteristics are very far from those of the nerve tissue, creating long-term biocompatibility problems following their implantation. A recent alternative is represented by 3D printing, which includes a family of methods based on so-called  
15 additive manufacturing, such as inkjet printing, electrodynamic printing, aerosol jet printing, or customised systems [4]–[7]. Thanks to 3D printing, it is possible to create highly customisable neural interfaces, which can reproduce more complex anatomical characteristics, using organic and polymeric materials. It is a simpler process to implement than photolithography, and cheaper. However, when making polymeric  
20 devices it is difficult to achieve high resolutions, due to the inherent limitations of the extrusion printing process.

Processes that make use of molding techniques, and in particular extrusion printing, for the realization of fully polymeric neural interfaces are also for example mentioned in patent publication WO2024009237.

25 Patent publication US2022071537 describes a Fabrication process for multi-channel neural electrodes that makes use (also) of a micro-forming technology. However, the conductive material and the cover layer of the electrode are deposited by a lithographic step. This method also presents criticalities related to the need to use

complex machinery and experienced operators for realization, as well as limits to the possibilities of customising the electrode geometry.

The adoption of casting/similar-screen-printing and the abandonment of molding techniques for the production of soft and fully polymeric neural devices allows  
5 an improvement in the resolutions of the insulating layers, simultaneously and considerably reducing the costs associated with the purchase and maintenance of the printing platforms. Other processes substantially affected by similar limitations and criticalities are described in documents WO2017218413 and EP2245454.

In this context, it is therefore desirable to resort to new realization methods that  
10 enrich the production options, particularly from the point of view of simplicity and economy, but also from that of the resolution of the layers and the customisation of the geometries.

#### SUMMARY OF THE INVENTION

15 The process proposed here, according to the present invention, as a solution to the technical problems listed is based on an unprecedented combination of steps correlatable to molding techniques and of a screen printing step made using a customised silicone jig. All the elements necessary for the realization of the invention can be fabricated by using commercial resin 3D printers, significantly reducing costs. It  
20 is also useful to emphasize that the proposed technique makes it possible to use a wide range of polymeric materials, so as to be able to customise the device based on the anatomical district of interest. The aforesaid polymeric materials can be used both for the realization of the substrate and the conductive tracks of the electrode, thus limiting post-implantation biocompatibility problems, given their chemical-physical  
25 characteristics more similar to those of the tissue of interest. In addition, the proposed process does not require the use of sophisticated machinery, being developed mainly through (manual and/or automated) deposition of polymeric material, significantly facilitating the fabricating process and thus allowing to obtain a neural electrode with

very low technological cost, customisable to the needs of the patient and easy industrial scalability.

The objective achieved by the present invention is, therefore, to provide a process for the realization of an implantable neural electrode that allows to obviate the problems encountered in the prior art, with particular reference to the complexity of existing fabricating processes, the limits of customisation and resolution of the layers that make up the interface. The process according to the invention has more precisely the characteristics set forth in the appended claim 1. Preferred characteristics of the present invention are the subject-matter of the dependent claims.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

The characteristics and advantages of the process for fabricating polymeric neural interfaces based on a combination of molding and screen printing, and the interfaces thus obtained according to the present invention will result more clearly from the following description of an embodiment thereof, provided by way of non-limiting example, with reference to the accompanying drawings, in which:

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- Figure 1 shows a summary diagram of the steps of the fabricating process object of the invention.
- Figure 2 concerns a prototype of an electrode obtained with the fabrication method object of the invention; in particular, views a1) and a2) are views from above and from below of a cuff electrode with the connections to the external PCB being present, view b) is an enlargement on the nerve closure area, seen from above, and view c) is an enlargement of the closure area, seen in section, the diameter being sized on the vagus nerve of pigs.
- Figure 3 represents an optical microscope analysis of an electrode obtained with the method according to the invention; in particular, views a1) and a2) offer an overview of the electrode in a flat configuration, views b1) -b4) an

ordering of respective active sites, view c) offers a three-dimensional reconstruction of the active site of b4), with width and height measurements reported.

- 5           ▪ Figure 4 concerns representations of two examples of molds usable in the method according to the invention; in particular, image a) refers to a bi-layer mold, and image b) to a tri-layer mold, being highlighted in grey with the same plane shades at the same height, the darker shades corresponding to higher planes.
- 10          ▪ Figure 5 is a diagram referring to the cyclic voltammetry (CV) of an active site of the prototype of cuff electrode made with the method according to the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

15           This will be followed by a description of different embodiments and variations of the invention and its parts, based on different aspects of it that can be used separately or in combination.

20           The fabrication method according to the invention provides as said an economical and easy to implement solution for the realization of neural interfaces, and in particular cuff electrodes consisting for example of two layers of insulating material that encapsulate conductive traces (i.e. made of conductive polymer), exposed at the level of the so-called "active sites", i.e. holes obtained in the insulating layer for contact with the biological tissue.

25           With particular reference to figure 1 and figure 4, according to one aspect of the invention, two molds typically obtained by 3D printing are used, a first mold 1 to support deposition of the insulating material and a second mold 2 for the production of a

perforated stencil 3 that serves as a stencil or jig for the deposition of a pattern of conductive polymer.

While the second mold 2 can be considered of canonical configuration, with an upper cavity 2a that is the negative of the stencil 3 to be made and therefore has reliefs 2b that draw the conductive pattern to be obtained, the first mold, shown in more detail in figure 4, in two different variants thereof 1, 11, the first for the realization of a two-layer interface, the second for the realization of a three-layer interface, has a more particular geometry characterized by a cavity 1a, 11a for the realization of a first electrically insulating polymeric layer intended for contact with the nerve, provided with first reliefs 1b, 11b to obtain exposure holes for the conductive material, and protruding parts 1c, 11c, 11d of predominantly one-dimensional pattern, to guide the deposition of a second and possibly a third layer of electrically insulating polymeric material, following the deposition of the conductive traces, as will be seen shortly.

In a practical implementation of the method, referring again specifically to figure 1, the following operating steps are discernible.

CAD models are made of the first mold 1 and of the second mold 2 that are geometrically consistent with each other, and subsequently they are 3D printed, with relative finishing treatments to eliminate impurities, according to what is common practice in this printing technique.

Then deposition of a first electrically insulating polymeric layer 4 by manual or automated technique, using materials such as PDMS (polydimethylsiloxane), in the cavity 1a of the first mold 1, and relative polymerization through thermal or UV light treatments take place.

In parallel, or in immediate succession, with the second mold 2, stencil 3 (for example but not necessarily using the same material as the first insulating layer) is made for the deposition of the conductive material on the first insulating layer 4. Also in this case, the material is obviously deposited manually or automatically within the cavity 2a of the mold, and then polymerized with the known techniques. The stencil 3

has a geometric profile consistent, at least for part of its perimeter development, with that of the cavity 1a of the first mold 1.

At this point (arrow F1 in figure 1), the stencil 3 is superimposed on the first mold 1 inside which the first layer 4 has already been formed, aligning it precisely to the relative cavity 1a, exploiting the consistency of the geometric characteristics between the two profiles.

Therefore, the deposition of the pattern of electrically conductive material 5, for example polystyrene sulfonate compounds, (PEDOT:PSS), is carried out on the first layer of insulating material 4, through the perforations of the stencil 3, with screen printing modality.

The stencil 3 is then removed (arrow F2), and the solvent contained in the conductive material 5 is evaporated by heat treatment (25-80°C).

Then a connector element 6 is arranged, for example suitable and arranged to ensure the electrical connection of the conductive material pattern 5 to an external PCB, but which in general can provide any element with suitable electrical conductivity (even simple copper wiring) and directed to another mold of electrical/electronic component. The exemplary element provided herein is represented only partially with its terminal belonging to the body of the electrode itself. In a variant, the connector element 6 can

also be arranged on the first layer 4 and the deposition of the conductive pattern be carried out subsequently.

A second insulating layer 7 (again e.g. PDMS) is then deposited, always exploiting the cavity 1a of the first mold 1. Still, both manual and automatic/automated  
5 techniques can be used.

The polymerization step of the second layer 7 can advantageously be followed by an annealing treatment to improve the conductivity of the conductive material 5.

Finally, the now completed flexible main body of the electrode, indicated with 8, is detached from the first mold 1 (arrow F3).

10 As already mentioned, and again with particular reference to figure 4, on the first mold 1 appropriate distributions of protruding parts 1c, 11c, 11d favour the deposition of the second and possibly of a third layer of insulating material, because the surfaces of these parts act as a support and guide for the spatula that deposits and extends the insulating material in the aforesaid layers. In particular, what concerns the bi-layer mold  
15 of figure 4 a) the upper surfaces of the darker grey protruding elements 1c serve to guide the deposition step of the aforementioned second insulating layer 7. In the variant of figure 4 b), on the other hand, there is a tri-layer type mold 11 (with relative cavity 11a) (i.e. to obtain an insulating three-layer electrode, not represented). This variant modification makes it possible to arrange the conductive traces on two different levels,  
20 between the first and the second insulating layer and between the second and the third one, allowing to obtain a more intricate arrangement and/or a greater density of the active sites and of the traces themselves, without the risk of short-circuiting several traces. In this case, in addition to reliefs 11b for obtaining the exposure holes of the conductors, first protruding parts 11c (dark medium grey) for guiding the deposition of  
25 the second insulating layer, and second protruding parts 11d more elevated than the first protruding parts 11c for guiding the deposition of a third insulating layer are observed. For any further pattern of conductive material, the stencil 3 can also be used

or a different stencil obtained with steps similar to those already described, that is, through an own different specially configured mold.

Finally, in the molds 1, 11 represented here as an example and always inside the cavities 1a, 11a, second reliefs 1d, 11e functional for obtaining, on the flexible main body 8, a layer sandwich, obtained as described above, notches and slots that serve to close the electrode in the form of a nerve winding cuff to be treated can be noted. The reference in this case is in fact a cuff electrode, targeting a peripheral nerve, made with the method described above and of which figure 2 offers a more realistic representation. With the second reliefs just mentioned, a slot 8a was obtained, obtained centrally for the insertion of the connector 6 from the free end head, assisted by the deformation of the material of which the electrode is formed in particular in its flexible main body 8 (sandwich of insulating layers 4, 7 with the pattern of conductive material 5), so as to obtain the cuff 9 bending of said body, and of lateral stop notches 8b, which by elastic reaction of the material to the previous deformation engage with the ends of the slot 8a to stabilize the cylindrical shape of the cuff at a set diameter, in this case of about 2.7 mm. This closing mechanism is intended to be easily operated during a device implantation procedure, by fixing the electrode to the target tissue (peripheral nerve).

The fact that with the proposed method it is possible to obtain a high spatial resolution given by the precision of the mold, allowing the realization of active sites with a characteristic size of the order of hundreds/tens of  $\mu\text{m}$ , has been demonstrated by tests carried out and of which the representations in figure 3 give an account. The digital microscope analysis documented therein made it possible to identify the size of the active sites (in accordance with the nominal one as per CAD file), underlining the precision of the approach pursued. For the definition of the geometry of the insulating material (PDMS), molding has the advantage of exploiting the excellent infiltration characteristics of this material, allowing to obtain molds that replicate the negative of

the mold with very high fidelity. Accordingly, the resolution of the electrode (insulating part) depends on the printing resolution of the molds, which may reach the  $\mu\text{m}$ .

The use of a single mold for the realization of multiple layers of insulating material, and likewise the realization with the same geometric references of the deposition stencil  
5 of the conductive material, guarantees an excellent integration of the layers and streamlines and facilitates the production process, since there are no intermediate steps of detachment and consequent realignment of the layers from the mold. Moreover, the geometry of the outer layer can have characteristics and details (e.g. holes) that could not be obtained simply by pouring a layer of insulating material over  
10 the conductive tracks, as it is made by spin coating techniques, or at least it would require a significant step in post-processing (etching techniques, laser cutting). The number of the layers can moreover be increased by engineering in the structure of the mold details for the levelling of the insulating material at multiple heights, as discussed with reference to figure 4.

15 Obtaining comparable resolution using another approach, e.g. extrusion printing methods, is difficult, due to the low viscosity of the non-polymerized silicone. A further advantage is represented by the ease of execution of the steps of the process, which means that there is no need to use chemicals that could leave potentially harmful residues on the device. The geometry that can be conferred to the device guarantees  
20 its stable closure without the use of suture stitches or glues and without compromising the integrity of the electrode itself.

The method described ultimately makes it possible to make low-cost neural electrodes, with a very simple and at the same time extremely versatile technology, given the ease and low costs required to modify and fabricate the molds. Versatility is  
25 an essential requirement to allow the adaptation of the technology to the specifications of the patient, the anatomical district, or the pathology of interest. In addition, this method is suitable for the implementation of a wide range of devices, making it possible

to apply it to various sectors. Examples of feasible devices include cuff electrodes, regenerative electrodes, ECOG electrodes, and EMG electrodes/macroelectrodes.

The devices made with the method according to the invention, using exclusively polymeric materials, benefit from a significant improvement in performance in the framework of recording and stimulation of the neural signal, as demonstrated by the table below.

| #Active Site | Impedance @1kHz [kΩ] | Cathodic charge storage capacity (CSC) [mC/cm <sup>2</sup> ] |
|--------------|----------------------|--|
| 1            | 15.99                | 2203   |
| 2            | 17.03                | 1729   |
| 3            | 14.19                | 2642   |
| 4            | 12.37                | 2493   |
| Mean ± Std   | 14.89 ± 2.05         | 2266.75 ± 402.18   |

The electrochemical tests (electrical impedance spectroscopy and cyclic voltammetry) carried out on the prototype have in fact highlighted very low impedance values (calculated at 1 kHz) for the neural application; in addition, the signals obtained from the cyclic voltammetry tests (figure 5) do not show oxide-reduction peaks, indicating the electrochemical stability of the conductive compound.

The device made in the invention can be used in the field of the neural interfaces both to record the electrical signal coming from the nerve, and to modulate its activities by injecting electrical current. Since the design is highly customisable, this device can be made for extraneural applications, i.e. wrapping it around the nerve, or for intraneural applications, i.e. inserting the device inside the nerve, so as to reach the internal fascicles of the same, and greatly increase the selectivity of recording/stimulation.

The materials for fabricating the insulating layers of the electrodes can be chosen from elastomeric polymers, in terms of silicone elastomers (the mentioned

PDMS), thermoplastic elastomers (polyurethane - PU), liquid crystal elastomers, polyesters and elastomeric carbonates (for example poly- $\epsilon$ -caprolactone - PCL). Alternatively, biodegradable elastomeric materials such as polyhydroxyalkanoates and polyurethanes (e.g. polyglycerol sebacate - PGS) can be used. As for the conductive component, it can be made with hydrogels and conductive polymers, such as polyaniline, polypyrrole, polythiophene or poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS). An alternative option consists in using electrically conductive hydrogels, obtained by combining an elastomer and a conductive component. The latter can be represented by one of the previously mentioned materials or by a solution of conductive metallic nanostructures (such as for example Au/Ag), with concentrations such as not to alter the rheological and mechanical properties of the material. The selected materials aim to reduce the inflammatory response of the implanted device [8], while improving the electrochemical properties in terms of neural signal recording [9].

15 The terms used in the present description are as generally understood by the person skilled in the art, unless otherwise indicated.

As used in the context of the present invention, the term "neural electrode" refers to an electrode intended to be electrically interfaced with the nervous system of a subject in need thereof, in particular the central nervous system, the peripheral nervous system, the autonomic nervous system and/or the enteric nervous system, in particular with one or more neural nerves and/or fibres. The term "nerve" may refer to one or more fibres of the nervous system that use electrical and chemical signals to transmit information. For example, in the peripheral nervous system a nerve may transmit motor, sensory, and/or enteric information from one part of the body to another.

25 In the context of the invention, the term "flexible" refers to the ability of the main body of an electrode according to any of the embodiments described herein to conform to the contours of the target nerve on or within which it is positioned. The flexibility and

elasticity of the main body of the electrode according to the invention is given by the materials of which it is substantially composed as illustrated in the detailed description.

The expression "electrically conductive" means, in the context of the invention, a material having a conductivity preferably at least higher than 15 S/cm. The expression  
5 "electrically insulating" means, in the context of the invention, a material(s) having a conductivity preferably not higher  $10^{-16}$  S/cm.

In the context of the present description, the expressions "active sites" or "sensitive sites" are used to identify the portions of the electrically conductive pattern of an electrode according to any of the variants described herein, which are configured  
10 to electrically contact a target nerve.

The present invention has been described hereto with reference to preferred embodiments thereof. It is intended that other embodiments may exist which relate to the same inventive core, all falling within the scope of protection of the claims indicated below.

References

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## CLAIMS

1. Process for fabricating an implantable neural electrode comprising a flexible main body (8) configured to be at least partially arranged around or inserted within a target nerve, said main body comprising at least two layers (4, 7) of insulating polymeric material and a pattern of electrically conductive material (5) arranged between said at least two layers (4, 7) of insulating polymeric material and at least partially exposed outwards through holes in one or more of said layers for contact with said target nerve, said process comprising the following steps:
- (i) Preparing a first mold (1) bearing a first molding cavity (1a) configured for molding said flexible main body (8):
  - (ii) Preparing a second mold (2) bearing a molding cavity (2a) having a geometric profile at least partially consistent with that of said first molding cavity (1a) of said first mold (1) and configured for molding a perforated stencil (3) with a perforation pattern consistent with said pattern of electrically conductive material (5) to be obtained in said flexible body (8);
  - (iii) Performing in said molding cavity (1a) of said first mold (1) the deposition of a first (4) of said layers of electrically insulating polymeric material;
  - (iv) Contextually, before or after step (iii), performing in said molding cavity (2a) of said second mold (2) the molding of said stencil (3);
  - (v) Placing said stencil (3) in said molding cavity (1a) of said first mold (1) above said first layer (4) of electrically insulating polymeric material;
  - (vi) Performing the deposition of said conductive material pattern (5), on said first layer (4) of insulating material, through the

- perforations of said stencil (3);
- (vii) Removing said stencil (3) from said first molding cavity (1a) of said first mold (1);
- (viii) Before, during or after steps (v) to (vii), arranging in said first mold  
5 suitable connector means (6) to ensure the electrical connection of said pattern of electrically conductive material (5) to the outside;
- (ix) Performing in said molding cavity (1a) of said first mold (1) the deposition of at least a second (7) of said layers of electrically insulating polymeric material;
- 10 (x) Extracting said flexible body (8) from said first cavity (1a) of said first mold (1).
2. Process according to claim 1, in which after the deposition of said second layer of electrically insulating material (7) steps of deposition of at least one additional pattern of electrically conductive material, using said stencil (3) or  
15 a different stencil obtained by steps alike steps (ii) and (iv), and steps of deposition of at least a third layer of insulating polymeric material are performed.
3. Process according to claim 1 or 2, wherein at least said steps (iii) and (ix) are performed in a manual or automated manner and include steps of  
20 polymerization of said electrically insulating polymeric material.
4. Process according to any of the preceding claims, in which said electrically conductive material is a hydrogel or conductive polymer.
5. Process according to claim 4, in which said conductive polymer is PEDOT:PSS.
- 25 6. Process according to claim 4 or 5, wherein said step (vi), performed in a manual or automated manner, includes a step of evaporation of solvent by heat treatment.
7. A process according to any of claims 4 to 6, wherein an annealing treatment

of said electrically conductive polymeric material is performed prior to said extraction step (x).

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8. Process according to any of the previous claims, in which said electrically insulating polymeric material is an elastomeric polymer selected from silicone elastomers, thermoplastic elastomers, liquid crystal elastomers, polyesters, and elastomeric polycarbonates, and mixtures thereof.
9. Process according to claim 8, in which said elastomeric polymer is PDMS.
10. Process according to any of the previous claims, in which the material of said stencil (3) is an elastomeric polymer, e.g., PDMS.
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11. Process according to any of the previous claims, in which said first (1) and said second (2) molds are obtained by 3D printing.
12. A process according to any one of the previous claims, wherein in said cavity (1a) of said first mold (1) a distribution of protruding parts (1c, 11c, 11d) comprising support and guide surfaces for deposition steps of at least said second layer (7) of electrically insulating polymeric material is obtained.
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13. Process according to claim 12, in which said protruding parts include first protruding parts (11c) for guiding the deposition of said second layer (7) of electrically insulating polymeric material, and at least second protruding parts (11d) more elevated than said first protruding parts (11c) for guiding the deposition of at least a third layer of electrically insulating polymeric material.
- 20
14. Process according to any of the previous claims, wherein in said cavity (1a) of said first mold (1) a distribution of first reliefs is created, for obtaining on said first layer of polymeric insulating material (4) one or more exposure holes of said pattern of electrically conductive material (5).
- 25
15. Process according to claim 14, wherein said electrode is a cuff-type electrode, in said cavity (1a) of said first mold (1) a distribution of second reliefs (1d, 11e) being created, for obtaining means of stable closure of said flexible body (8) in the form of a cylindrical cuff (9).

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16. Process according to claim 15, wherein said second reliefs (1d, 11e) are configured for obtaining, on said flexible body (8), a slot (8a) for inserting said connector means (6) from a free end thereof, and side stop notches (8b) suitable for engaging with the ends of said slot (8a) as a result of said insertion and by elastic reaction of said electrically insulating polymeric material to the previous deformation, to stabilize in cylindrical form said cuff (9).
17. Implantable neural electrode obtained with the process according to one or more of the previous claims.

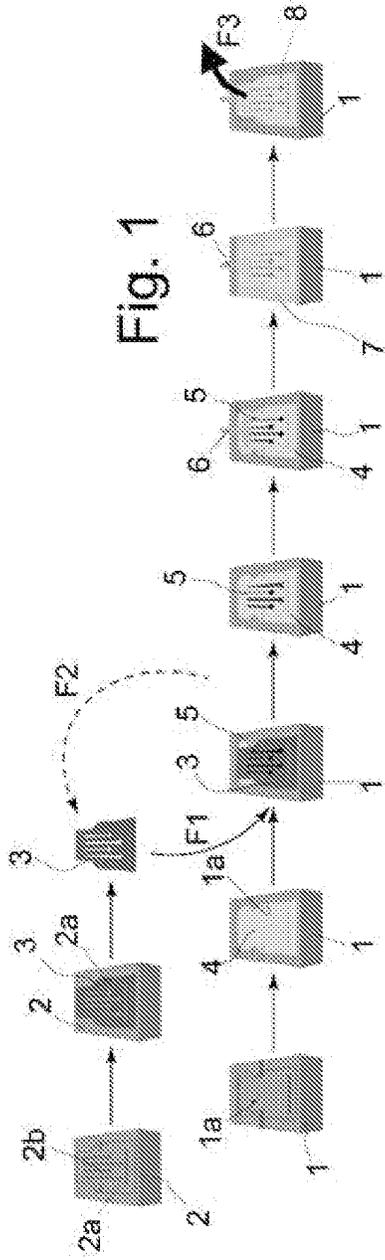


Fig. 1

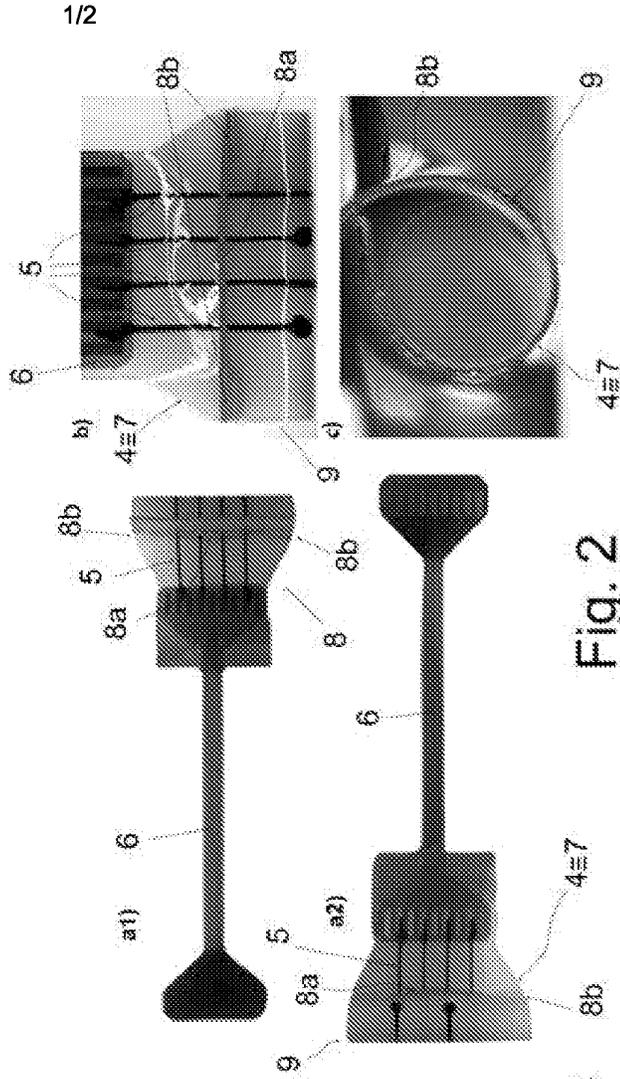


Fig. 2

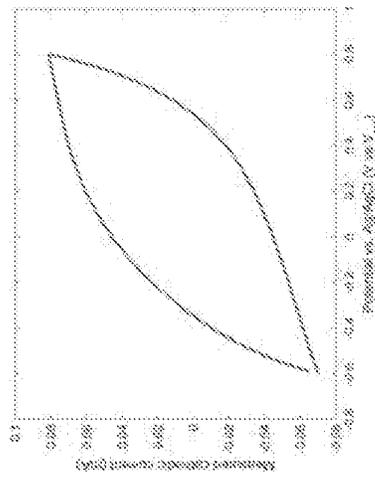


Fig. 5

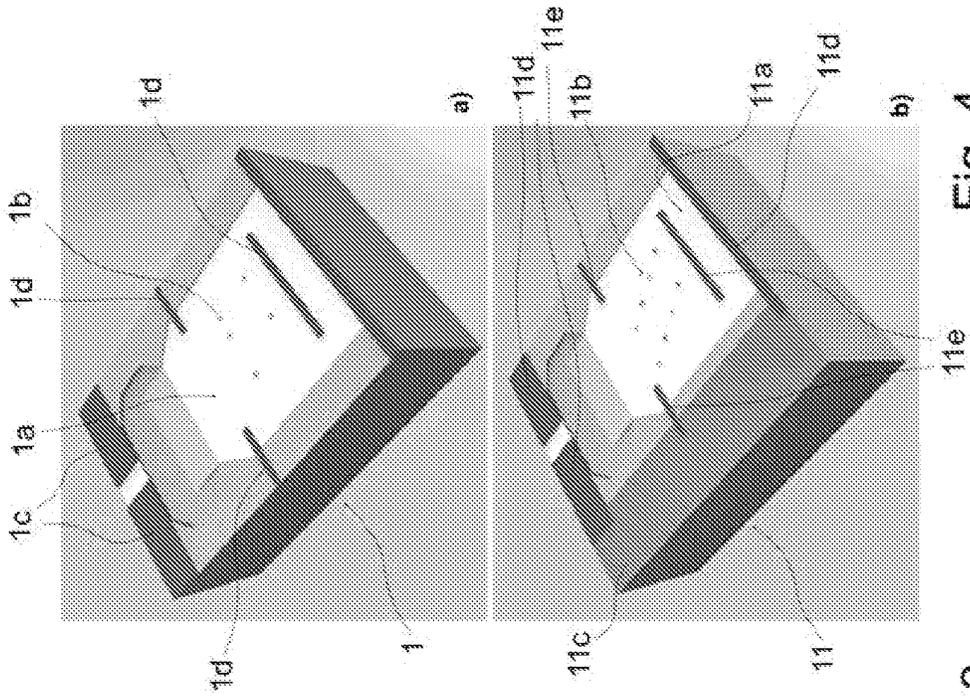
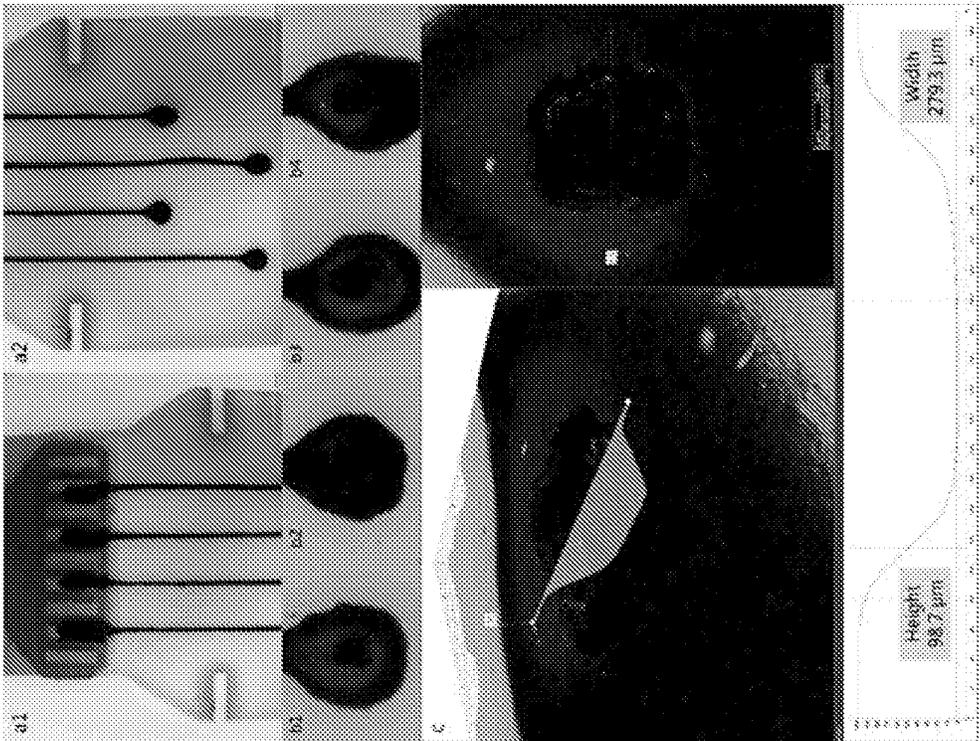


Fig. 4

Fig. 3



**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2025/053411

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. A61N1/05 A61B5/294 A61B5/388 C09D11/52 H05K1/09  
 H05K3/12  
**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)  
**A61N C09D H05K A61B A61L**

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)  
**EPO-Internal**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| A         | ZINNO CIRO ET AL: "Development of a 3D Printing Strategy for Completely Polymeric Neural Interfaces Fabrication", 2023 11TH INTERNATIONAL IEEE/EMBS CONFERENCE ON NEURAL ENGINEERING (NER), IEEE, 24 April 2023 (2023-04-24), pages 1-4, XP034345575, DOI: 10.1109/NER52421.2023.10123838 the whole document<br><p align="center">-----<br/>- / - -</p> | 1-17                  |

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

\* Special categories of cited documents :

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| "A" document defining the general state of the art which is not considered to be of particular relevance  | "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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| Date of the actual completion of the international search<br><b>13 June 2025</b> | Date of mailing of the international search report<br><b>30/06/2025</b> |
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| Name and mailing address of the ISA/<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Authorized officer<br><br><b>Smit, Josephus</b> |
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International application No

PCT/IB2025/053411

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