Fully polymeric soft cuff electrode realized with additive manufacturing techniques

KEYWORDS

- NEURAL ELECTRODE
- CUFF ELECTRODE
- SOFT NEURAL INTERFACE
- 3D PRINTED ELECTRODE
- FULLY POLYMERIC ELECTRODE

AREA

- BIOMEDICAL

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Patent Type
Patent for invention

Co-Ownership
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Industrial & Commercial Reference
The sector deals with medical devices, for pathologies associated to the modulation of the nervous system's signal.

Time to Market
TRL2

Availability
Research, Development, Experimentation

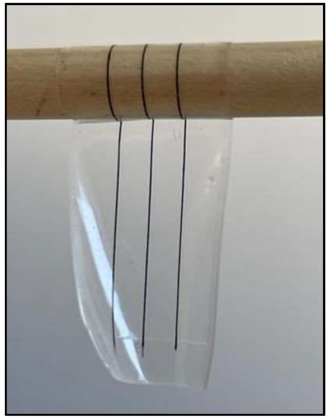
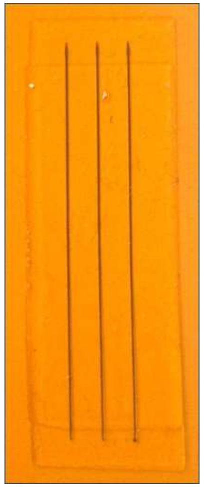


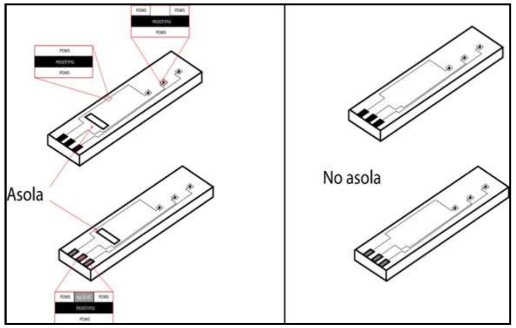
Fig. 1 Electrode wrapped to a cylindrical holder, to simulate an implantation.

Fig. 2 3D printed Electrode Prototype.



Abstract
Neural interfaces allow direct communication with the peripheral nervous system. A precise choice of the materials used needs to be performed in order to maximize the biocompatibility of the device, analysed by a surface and a structural point of view.
With this invention, an additive manufacturing method is presented, as a replacement for photolithography.
Owing to the issues related to the biocompatibility and the fabrication method of the implantable device, a fully polymeric neural interface is realized, by implementing a fabrication method that is more sustainable from both an economic ad executive points of view.

Fig. 3 Final design of the electrode.



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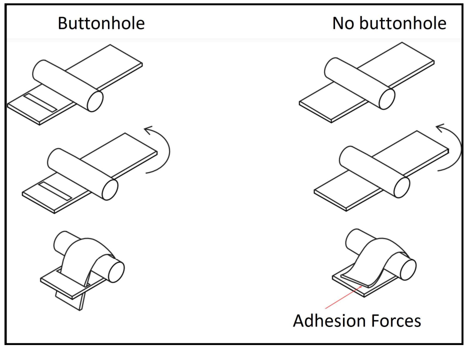
Technical Description

The insulating substrate can be realized using elastomeric polymers, such as polydimethylsiloxane or polyurethane; while the conductive traces be made from conductive hydrogels and polymers, such as polyaniline or poly(3,4-ethylenedioxythiophene) sulfonated polystyrene (PEDOT:PSS). The foreign body response that these materials may induced is definitely reduced. They guarantee a long-term stability in the biological environments, and they are characterized by low values of the Young's Modulus.

The implantable device was realized using a 3D printing method, which allows the customization of its final design.

The neural electrode can be used both in stimulating and recording activities, tailoring its design to the morphology of the nervous system / neural tissue.

Fig. 4 Possible ways for the electrode closure.



Technologies & Advantages

The neural interface proposed in this invention is designed to tackle two different challenges:

- Obtain a fully polymeric device, avoiding the presence of metals in the components (increase biocompatibility).
- Propose an alternative fabrication method based on simpler, versatile, and sustainable technologies.

The insulating substrate can be realized using polymeric materials. The conductive component can be realized using conductive polymers or hydrogels. The implantable device will be realized using 3D printing with a rapid process that allows design customization. The fabrication process is composed of a single step, the printing process of the digital file. No more steps are needed, and there is no need of other materials to be employed, as the use of the photoinitiator in the photolithographic process. The versatility of the proposed fabrication process gives advantages compared to the traditional approach, obtaining devices that are more biocompatible and customizable, reducing at the same time the cost and the fabrication time.

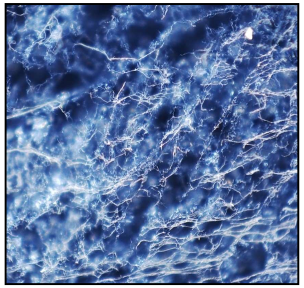
Applications

The proposed invention is presented as an implantable, conformable, flexible and elastic medical device capable of communicating with the peripheral nervous system in a reliable and minimally invasive manner due to its high biocompatibility. It can be employed for the treatment of many pathologies associated with neuromodulation, as examples:

- Epilepsy/Depression through cervical vagus nerve stimulation
- Heart failure through thoracic vagus nerve stimulation
- Ipoactive bladder through pudendal nerve stimulation

Taking into account the histology of the nerve that wants to be investigated, the size and distribution of the active sites will be varied so as to maximize the performance of the device, both in stimulation and recording applications.

Fig. 5 Internal structure of the conductive polymer.



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