2ND INTERNATIONAL CONFERENCE ON CELL SCIENCE AND REGENERATIVE MEDICINE

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Flexible metallic nanostructured electrodes for implanted neural interfaces

Abstract: Neural interfaces have become essential tools for the diagnosis and treatment of many neurological disorders, offering new strategies when phamacological approaches are unsuficient or produce serious side effects. Despite their good results, the main challage of present implanted neural interfaces is their poor performance stability in the medium/long term that, in many cases, leads to the need of replacing the device or stopping the treatment. Broad research is taking place with the aim of developing new interfaces with softer materials that have a better mechanical compliance with the neural tissue, reducing foreign body responses. In addition, there is a need to improve the performance of the electrodes themselves, specially when their size is to be reduced for more spatial resolution when recording, or avoiding being unspecific when stimulating. To this aim, efforts have been made toward the use of new materials and coatings, as well as the modification of the electrode superficial structure.

In this work, we present our work in providing nanostructure to the surface of the neural electrodes with networks of vertical metallic nanowires prepared by template-assisted electrodeposition. These structural modifications lead to an increase of the electrode effective area and, hence an impedance decrease. In addition, the nanostructure favours the intimate neuron-electrode contact, reducing the foreign-body response. We compare different surfaces using electrochemical impedance spectroscopy and study their biocompatibility in rat embryonic cortical cells cultures. Our studies contribute to advance in the achivement of less invasive and more reliable implanted neural interfaces for a safer diagnosis and treatment of neurological disorders.

Keywords: Neural interfaces, nanostructured electrodes, templated-assisted electrodeposition, metallic nanowires, electrochemical impedance spectroscopy

Biography: M. Teresa González is an expert in the electrical properties of matter and has work in different fields including superconductivity, during is PhD research, molecular electronics, and the fabrication and caracterization of nanostructured electrodes for neural interfacing. Since 2016, she is head of the Neural Interfaces Laboratory at Fundación IMDEA Nanociencia. She has been PI of several national and European research projects focused on the development of neural interfaces. Presently, she is coordinator of the MSCA doctoral network NeuroNanotech (Grant Agreement number: 101169352).