

# Optimizing a brain-on-chip technology with nanowire based-3D electrodes to record and stimulate the neuronal activity with high resolution.

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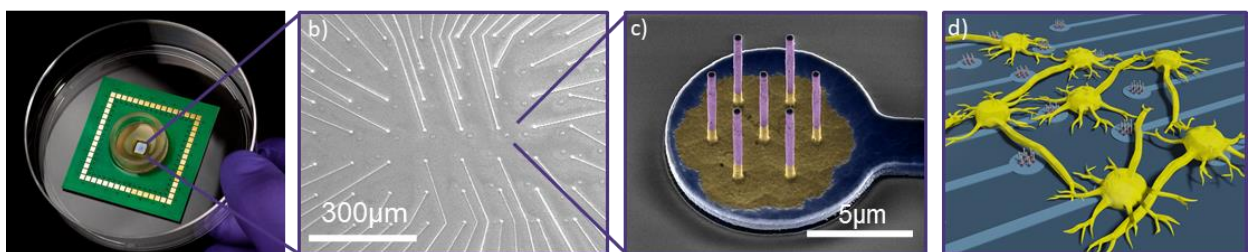
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Understanding the mechanisms involved in neurodegenerative diseases is one of the biggest scientific challenges yet to overcome. Within this field, remarkable advances were made, thanks to the development of new *in vitro* micro-electrode arrays technologies, in which the sensing elements are miniaturized and 3D-structured. Such devices, called Nanowire electrode arrays (NEA) offer real benefits, as they possess a high spatial resolution and an important surface-to-volume ratio leading to a higher affinity with cells. This configuration enables the recording and stimulation of neurons with subcellular accuracy<sup>1</sup>.

Our technology, a microfabricated NEA based on core-shell metallic nanowires<sup>1</sup>, aims to create hybrid synapses (bi-directional silico-bio interface) for driving neuronal networks. Our long-term vision is to propose a revolutionary drug-screening platform, whereby biological and simulated neuronal networks form a trainable and adaptive closed-loop system, to reproduce in-brain pathology. However, our nanoelectrodes possess a limited effective area, which leads to a low charge injection capacity, a key parameter for stimulation processes. Consequently, a detailed study has been conducted regarding nanoscale surface modification of the nanowires through coating engineering<sup>2</sup>. We will present a variety of suitable conductive materials and their associated deposition methods (electrodeposition, atomic layer deposition, etc.). All coated nanoelectrodes have been characterized electrochemically and morphologically, in order to establish a direct relationship between the materials synthesis conditions, the morphology and the conductive features.



**Figure 1:** a) Picture of the NEA device, mounted on PCB. b) SEM image of the nanoelectrodes array c) Colorized SEM image of a unitary 3D-nanoelectrode highlighting the conductive surface (purple) and insulation layers (yellow and blue). d) Illustration of a neuronal network on top of the electrodes

## References :

- (1) Casanova, A. et al., *J. Phys. Condens. Matter* **2018**, 30 (46), 464001.
- (2) Muguet, I. et al., *MRS fall meeting and exhibit, Boston Massachusetts, United States, 2021* [conference presentation].