4. Nano-electrodes fabrication to perform electric neuronal activity measurements

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Neural electrodes are devices that, directly in contact with neural tissue, can record the neural activity and trigger it through electrical stimulation. These neural electrodes can be used, for example, in the treatment of neural diseases as Parkinson, as spinal cord stimulators, cortical electrodes or retina implants, etc.

Nowadays, these electrode-based devices present size, morphology and rigidity issues that unleashes an immunologic response that inactivates them. In this work, we present metallic flexible electrodes composed by a flexible Au thin sheet with one of its faces covered by a network of metallic vertical nanowires (NWs) that we grow using template-assisted electrodeposition. To warranty a good neural electric response minimizing the damage to the surrounding tissue, a meticulous control of the geometry of the nanostructure is needed.

Using polycarbonate or anodic aluminium oxide (AAO) templates, we can tailor the nanostructure, varying the order, interdistance and diameter of the NWs. In the electrodeposition process, we can control their length and choose the material of these NWs. Also, we have developed a technique to produce core-shell NWs through pulsed electrodeposition, combining the properties of different metals.

We have obtained positive in vitro biocompatibility results of the nanostructured electrodes and the neural electric stimulation measurements performed show that our interfaces are able to trigger neural activity at low voltages. Simulations of electric field produced at an applied voltage, show that our nanostructured interfaces are expected to concentrate the electric field at the tip of de nanowires, what implies that less voltage is needed to trigger the neural electric stimulation comparing with plane electrodes. Our results support the potential of our nanostructured interfaces as flexible and compact functional electrodes.

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