Graphene in Neurotechnologies: Road Toward Clinical Applications

Matteo Donegà
Carolina Aguilar, Jose Garrido, Damià Viana and Inbrain team
INBRAIN Neuroelectronics, Verge Pilar 7, 08960 Sant Just Desvern, Barcelona, Spain
mdonega@inbrain-neuroelectronics.com

Abstract

INBRAIN Neuroelectronics is a start-up company based in Barcelona. INBRAIN was founded as a spin off from the Nanotechnology & Nanoscience Institute of Catalonia (ICN2, Barcelona), with proprietary technology from the collaborative efforts with Manchester University (UK). At INBRAIN we are developing a new generation of neuromodulation technologies to interface with the central and peripheral nervous system. Neural interfacing technology aims at restoring functionality lost in patients following disease or trauma, by stimulating and recording the electrical activity of the nervous system. Clinically available neural interfaces offer modest capabilities partly due to the limitations of the platinum-based electrode used causing inefficient signal detection capabilities, low spatial resolution and low charge injection capacities. Our aim is to create better neuromodulation systems enabled by our proprietary graphene technology, called Engineered Graphene for Neural Interface (EGNITE), which is based on reduced graphene oxide. EGNITE possess outstanding electrochemical characteristics for neurotechnology applications. EGNITE allows to fabricate very small electrodes to enable high-density neural probes, while maintaining relative low impedance levels to guarantee high signal detection sensitivity and ability to record a wideband frequency range of neural signals. Further, EGNITE allows high-charge injection capacity so that electrical stimulation can be safely applied with higher precision. These combined characteristics will provide neurologists with a novel tool able to record patient specific signal biomarkers necessary to drive responsive stimulation with a spatial and signal resolution never seen before. In the past 2 years INBRAIN has optimized fabrication processes of graphene-based interfaces to comply with good manufacturing processes and regulatory standards. We have performed pre-clinical validations of the technologies in both rodent (with ICN2) and large animal models demonstrating biocompatibility, functionality and translation into human-relevant models. Currently, we are refining design and fabrication of a number of neural interfaces carrying EGNITE contacts for early clinical feasibility studies.