GRAFIN: GRAphene-based Flexible neural Interfaces for the control of Neuroprosthetic devices

Main area: ARI09_GRM - based bioelectronic technologies
Keywords: Graphene microelectrode arrays, neuroprosthetics, artificial limb control, central nervous system, peripheral nervous system, neural interfaces, neural recording, neural stimulation, sensory feedback,
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Abstract

Loss of sensory and motor functions as a result of spinal cord injury, peripheral nerve injury or loss of a limb affects several million people worldwide, serving as a powerful motivation for the development of rehabilitation strategies that can partially restore or substitute the lost sensory - motor functions. A broad variety of electronic devices to bidirectionally interface the central and peripheral nervous system have been proposed and more are currently under development. However, given the stringent requirements for the materials and technologies to be used in these neural interfaces, progress in this field is rather slow. This project aims at exploring the potential of graphene-based technologies in neural interfaces for motor neuroprostheses. Taking advantage of intrinsic properties of graphene, such as biocompatibility, electronic performance, and easy integration within flexible substrates, we will develop graphene flexible devices to record and stimulate in the nervous system. Efficient stimulation will be based on novel highly porous reduced graphene thin films exhibiting extreme charge injection capacity. Recording with high signal-to-noise ratio will be provided by low noise CVD-grown single layer graphene field-effect transistors. Different designs will be developed to serve as extraneural and intraneural electrodes in peripheral nerve and in brain cortex. Biocompatibility and functionality will be extensively tested in chronic implants in animal models. The ability of these novel interfaces to record electrical signals from nerve and brain and to stimulate for providing sensory feedback will be determined in experimental models of nerve injury and of somatosensory cortex, in order to generate the proof of concept for the usability of interfaces for the control of neuroprostheses and for the neuromodulation of sensory dysfunctions (pain and touch) after nervous lesions. Multichannel stimulator will be developed and tailored for investigating the capability of the graphene based interface to provide sensory feedback. As a first trial in humans, surface devices with graphene electrodes will be tested on the stump of human amputees, to assess suitability for recording electromyographic signals with higher resolution than obtained with commercial electrodes, and for providing some sensory feedback. The results of the GRAFIN project will significantly push forward the forefront of graphene technology and innovation by increasing the TRL of graphene medical devices and by advancing towards clinical acceptance of graphene materials.

Consortium

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