EPIGRAPH: GRAPHene biomolecular and electrophysiological sensors integrated in an "all-in-one device" for the prediction and control of EPIleptic seizures (towards a general device for most brain disorders)

Main area: ARI09_GRM - based bioelectronic technologies
Keywords: bioelectronics; epilepsy; implant; neuromodulation; drug delivery; sensor; iontronics; therapy; medical technology
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Abstract

Brain function relies upon a complex, coordinated function of neurons, glial cells and blood vessels, which in neurological disorders such as epilepsy, Alzheimer's, and Parkinson's disease is disrupted. The EPIGRAPH project proposes the design and development of graphene biomolecular sensors, with graphene organic electronic ion pump (OEIP) neurotransmitter delivery, and electrophysiological electrodes integrated in an "all-in-one" or single device/platform for the prediction and control of epileptic seizures (towards a general intervention tool for wide range of brain disorders). Specifically the main objectives are to: i) develop a graphene-based biomolecular sensor for glucose and/or lactate detection using state-of-the-art laser processing techniques; ii) intervene pharmacologically to control brain activity via graphene-based OEIP electrophoretic drug delivery devices; iii) integrate the biomolecular sensor, the ion pump, and electrophysiological sensors into a single device that will enable combined electrophysiological and molecular measurements under in vitro/ex vivo (brain slice model) and in vivo environments (in situ animal model). The innovative function of this integrated single device is to provide treatment where and when it is needed. The "where" is provided by the local delivery made by the pump, and the "when" is provided by the molecular sensor using a predictive biomarker. EPIGRAPH will explore the potential of the device to provide local control of brain activity in vivo. A closed-loop system will be developed that predicts and stops seizures in an animal model. Graphene provides an optimal foundation for this lab-on-a-chip as it provides flexibility, high-performance, bio-compatibility, etc. The addition of organic electronics provides a unique opportunity to add ion (and charged biomolecule) signalling to the bio-tech interface. In this project, we will address the current limitations in technology for interfacing with neural signalling using "neuroelectronics" – bioelectronic tools developed specifically for precise neurochemical interfacing – and provide more profound understanding of neural dynamics and better therapies for neurological disorders. The main challenge of such technology is to be able to generalize this device to a variety of brain disorders, to measure and intervene on brain function where and when it is necessary.EPIGRAPH, a high-throughput medical device, will have a broad impact on different disciplines such as neuroscience, pharmaceutics, bioelectronics, and biomedical devices, and also on the rapidly developing fields of biosensors, bioelectronics and GRMs. EPIGRAPH directly addresses the Flagship topic of Graphene-Applied Research and Innovation and in particular the specific area of 9 GRM-based bioelectronics technologies. It is foreseen to fit with the scope of Work Package 5 (on Biomedical Technologies) and WP6 (on Biosensors) of the Graphene Flagship Core Project.

Consortium

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