Characterization and in-vitro assessment of graphene-based microelectrode technology for use in neural prostheses

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Microelectrodes based on graphene-related materials (GRM) have been developed for neural stimulation and recording. GRM microelectrode arrays were fabricated with a three-dimensional architecture that elevates the effective surface area well beyond the geometrical surface area of the electrode. Performance of the electrodes was characterized with cyclic voltammetry, electrochemical impedance spectroscopy, and biphasic current pulses. Microelectrode functional performance was evaluated in vitro via electrical stimulation and recording from explanted mouse retina. GRM microelectrodes (25µm-diameter) have charge storage capacity over 20 mC/cm^2 and an impedance lower than 30 kΩ at 1 kHz. Charge injection capacity for the electrodes is measured at 4 mC/cm^2 for 1-ms cathodic pulses. In vitro retinal electrophysiology demonstrates the capability of the microelectrodes to electrically stimulate retinal ganglion cells and record single action potentials. Microelectrodes fabricated from the GRM have electrochemical properties that are competitive with state-of-the-art technology. The electrical performance of the electrodes in vitro is encouraging for the future integration of the GRM at the electrode-tissue interface in neural prosthesis technology. This work has been funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 696656 (Graphene Flagship) and Grant Agreement No. 732032 (BrainCom), and by the Whitaker International Program.

References

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