Graphene based neuroelectronics

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2D materials such as graphene offer an ideal platform for recording and culturing neural networks, regarding its exceptional neuronal affinity and the presence of readily accessible surface charges which give the unprecedented possibility to realize a direct electrical coupling with cells. In addition, graphene is highly flexible, optically transparent and could be transferred on a wide range of substrate to be combined with multiple electrophysiological tools.

Here, we will present the cytocompatibility study of pristine monolayer graphene, and its significant advantage for neuroprostheses and *in-vitro* model networks. We will show that the ability to control the neuronal affinity of graphene based neural interface opens the way to a variety of applications such for patterning long-lasting *in-vitro* neural networks, and for brain interfaces to reduce immune response and the glial scars.

Moreover, the nano-structuration of large (mm^2) CVD-grown graphene monolayers allows the fabrication of dense arrays of highly sensitive field effect transistors (G-FETs). Among their successful bio-integrations, the detection of action potentials in numerous electrogenic cells including neurons has paved the road for the high spatio-temporal and wide-field mapping of neuronal activity. We will show that ultimate sensing could also be achieved such the field effect detection of ion channel activity, and will underline the significant contribution of grain boundaries - within the polycrystalline graphene FET channel - which provide highly sensitive sensing sites. Such ultra-sensitive and biocompatible neuroelectronics is highly versatile and should be useful for a wide range of fundamental and applied research areas, including brain-on-chip, pharmacology, and *in-vivo* monitoring or diagnosis.

References

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