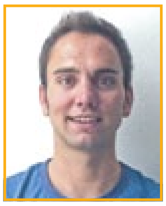
Bioactive brain interface with graphene nanoelectronics



Principal investigators

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In collaboration with EPFL labs we aim to achieve a long term high spatial resolution sampling of neural activity involved in motion control, in order to restore walking voluntary control for spinal cord injuries victims. Up to now, the actual brain implants have suffered from a lack of long-term reliability. However, this key feature might be overcome thanks to graphene outstanding properties and the large scale integration of highly sensitive nanodevices.

Description

High spatial resolution sampling of brain activity through the instrumentality of variable specific implants is a key technology in brain research projects like neuro-regenerative applications. However the current electrodes array based technologies present inconsistent performance in chronic signal recording, the lifetime of these implants being so far limited both by their bio-acceptance and by the sensitivity of their electronics. This lack of reliability might be overcome thanks to graphene outstanding properties which offer an ideal platform for sensing. The biocompatible, soft, and chemically inert nature of this atomically thin honeycomb carbon lattice offers novel perspectives for direct integration as biosensors. Moreover, the possibility to transfer it on transparent and flexible substrates opens the way to a new generation of chronic in-vivo implants.

During the past few years, graphene has indeed been shown to be an extremely promising material for neural tissue engineering, regenerative medicine and was successfully used to record electrical signals from electrogenic cells, hinting at the feasibility of a graphene-neuron interface and its possible neuroprosthetic applications.

Large graphene monolayers of high quality can be obtained by CVD growth and patterned with conventional nano&microfabrication processes, providing highly sensitive nanodevices array for non-invasive near field detection of neural electrical activity.

Graphene area can further be functionalized with natural biocompatible ultrathin polymer to prevent the graphene sensors from friction damages during the surgical implantation. This polymers can then receive bioactive hydrogels layers to reduce the immuno-inflammatory response of the tissue surrounding the implant, introducing a new generation of bioactive graphene biosensors for in vivo brain interfaces.

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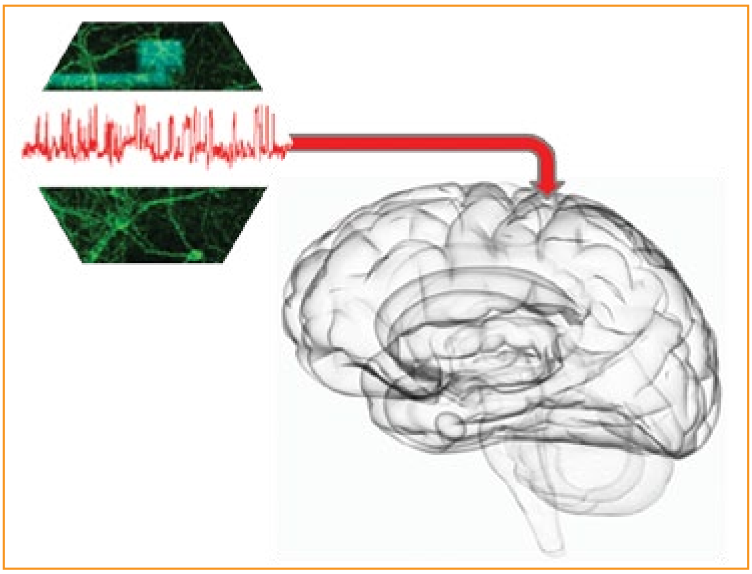
Collaborations: CERMAV, BioFab



Art picture of Graphene-Bioelectronics for in-vivo neural recording of the motor-cortex activity

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