Creating a Bidirectional Bypass for Spinal Cord Injuries with Nanotechnology

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After a Spinal Cord Injury (SCI), the communications between the brain and the spinal circuits that dictate movement are interrupted. Innovative equipment has been developed to help patients regain control of limbs. The current strategies to remediate SCI based on computer-brain interfaces [1, 2], however, require the use of bulky devices, not implantable and without sensorial feedback.

We aim at developing a new generation of magnetic sensors and electrodes based on nanotechnology for neural interfacing with improved sensitivity and low tissue disturbance thanks to their nanostructure. The nanodevices are suitable for chronic implantation. It will be focused on restoring the transmission of electrical signals in the injured SC, acting as a bi-directional local bypass.

I will first describe the nanofabrication and performance of high-resolution magnetic field sensors working at room temperature, based on anisotropic magnetoresistive (AMR) LSMO films epitaxially grown on vicinal substrates. Then I will report on the production of nanowire-coated electrodes for neural excitation by template-assisted electrochemical growth (metallic) or nanoimprint technology (conductive polymer).

Finally I will show real-time measurements of both the pharmacologically induced activity of neural cord slices and the subsequent actuation on neural cord slices.

References

[1] E. Formento et al, Nature Neuroscience (2018)

[2] F. Wagner et al, Nature 563 (2018) 65

Figures

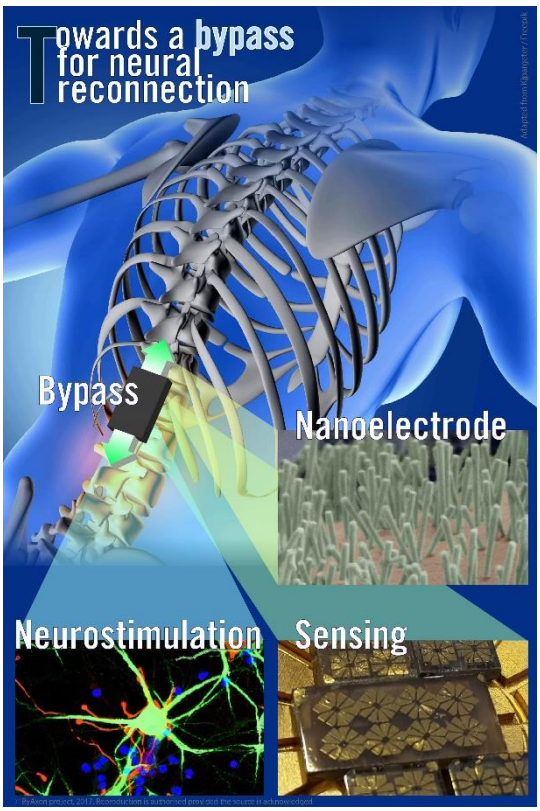

Figure 1. Scheme of the active By-pass for neural reconnection including magnetic sensing and nanoelectrodes for neurostimulation.

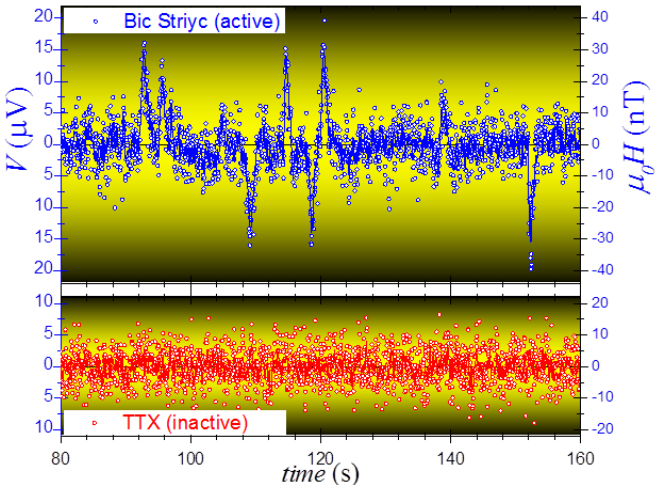

Figure 2. Real time measurements of the activity of a neural cord slice. The data have been taken at room temperature without any magnetic shielding.