

MAP-fis Essay Proposal, 2015-2016

(please write in English)

Supervisor

Name: Joao Oliveira Ventura & Paulo Castro Aguiar

e-mail: joventur@fc.up.pt

Title

Measuring neural activity using bio-compatible nano-electronics

Area

(Materials, Optics, Condensed Theory, High Energy Theory,...);

Materials, Nanotechnology

Summary of Proposal

The main aim of this project is to fabricate state-of-the-art arrays of gold mushroom-shaped micro-electrodes (gMuEs) for the recording of neural activity [1]. Neuro-electronic interfaces for activity recording and/or stimulation can be divided into intracellular (that give accurate and detailed readouts but are limited to a few hours of stable recording) and extracellular (which give incomplete and attenuated information, but allow long-term recording of both individual and large populations of neuron). With the recent advent of gMuEs, mimicking the shape and dimension of dendritic spines to improve the electrical coupling between neurons and micro-electronic devices, an experimental tool appeared that combines the advantages of both intracellular and extracellular techniques. In fact, gMuEs give close to intracellular readout levels although at an extracellular position, allowing the long-term stimulation of individual neurons at well-defined sites.

The fabrication of gMuE arrays will be performed using a combination of physical deposition, photo- or electron-beam lithographies, electrodeposition and lift-off, to create an array of sub-micrometer stalks terminated with gold protrusions.

Our approach will enable growing and accessing (record and stimulate) individual or sets of neurons in the same chip (to be performed at INEB-I3S). To establish well defined cell patterns with a limited number of connections, and thus an easier way to understand signal propagation, one also aims to guide cell growth on the gMuE. For this, we will lithograph different patterns and vary the distance between gMuEs (up to 20 μm) that is known to have an important influence on neuron growth guidance.



Universidade do Minho



References

(to allow students first look at topic)

[1] A. Hai, J. Shappir, and M. E. Spira, “Long-term, multisite, parallel, in-cell recording and stimulation by an array of extracellular microelectrodes,” *J. Neurophysiol.*, vol. 104, no. April 2010, pp. 559–568, 2010.