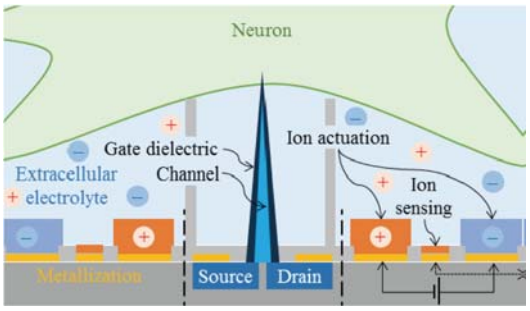
# PhD Project

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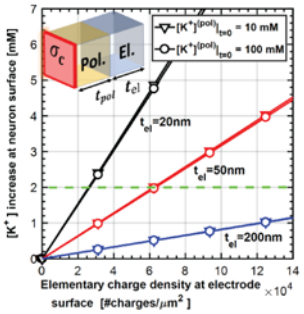
**Title:**
Ion-tronic device for neurostimulation in neuroscience studies

**Introduction:**
Neuroscience studies often rely on established Micro Electrode Array platforms for electrical neurostimulation and neuron signal recording. Usually these powerful platforms also implement electroporation to facilitate the electrode penetration into the neuron membrane and both intra- and extracellular potential recordings. In realistic electrolyte environments, however, the neuron interacts with its neighboring environment via ion exchange through the membrane as well. Neurostimulation by ionic, instead of electronic, signals, is only in its infancy, as it is the integrated implementation of micron-scale ionic actuation and electronic recording on the same platform. The use of doped polymers such as PEDOT:PSS and the increasing knowledge gained in the field of low-cost low-weight batteries suggest the possibility of entirely new pathways to ionic stimulation.




**Proposed research activity and PhD thesis objectives:**
The objective of the PhD thesis is to investigate the realization of a new technology platform incorporating efficient low power electronically controlled ion emitters based on polymer technology suitable for integration on smart microelectrode array substrates. Methods and models to simulate the ion emitters efficiency, the ion diffusion will be developed as well and extensively used to investigate the wide design space. Characterizations and model calibrations on data provided by project partners will be part of the endeavour. Both in-house developed and existing commercial simulation tools will be used. Activities will involve the research groups of the IUNET consortium, and of major European Universities involved in the H2020 IN-FET project, especially those of University of Sheffield and IBM Zurich.

**Vision goals of the activity:** An optimized electronically activated ion actuation array fabricated along the guidelines developed in this thesis could be combined with commercial MEAs or a novel vertical nanowire sensing platform to eventually deliver a complete actuation/sensing technology. The platform could then be used for closed-loop studies of neuron physiology, aimed at shedding new light on control of a number of neurophysiological diseases such as for instance epilepsy, which is estimated to affect as many as 50 million people worldwide.

**Supporting research projects (and Department)**
The activity will be carried out at the DIEF, Università degli Studi di Modena e Reggio Emilia and it is connected to the H2020 IN-FET project "Ionic Neuromodulation For Epilepsy Treatment"

**Possible connections with research groups, companies, universities involved in IN-FET.**
University of Sheffield (polymer-based iontronic device fabrication)
IBM Research Zurich (nanobattery research)
IUNET Research Consortium (www.iunet.info)

**Essential bibliography:**
[1] T.A. Sjöström et al., Advanced Material Technologies, DOI: 10.1002/admt.201700360