

Project description

Tutor: Prof. Luca Selmi (luca.selmi@unimore.it)

Italian Co-tutor(s): Prof. Pierpaolo Palestri, Ing. Federico Leva, Dr. Ing. J.L. Mele

Title:

Ion-tronic sensors and actuators for the agrifood and neuroscience and sectors

Introduction:

In both the agrifood and the neuroscience sectors, it is of increasing importance to sense and modulate the concentration of ionic species and small molecules by means of innovative sensors and actuators. Ion Selective Membranes and conductive polymer technology integrated in Ion Sensitive Electrodes (ISE), ISFETs and OECD devices are promising candidates to achieve these goals. However, a clear understanding of their operating principles is not always backed by engineering-oriented models amenable to support the device design and optimization.

Proposed research activity and thesis objectives:

The objective of the thesis is to investigate the realization of new technology platforms incorporating efficient, low-power, electronically controlled ion emitters and ion sensors based on polymer technology and ion selective membranes suitable for integration in microelectronic technology. Potentiometric FET-based sensors and actuators will be privileged. Multiscale and multiphysics methods and models to simulate the ion emitters efficiency, the ion diffusion in electrolytes, the mass transfer across selective membranes, the distributed chemical reactions and the associated fixed and mobile charge distributions will be developed as well and extensively used to investigate the wide design space. The focus will be on the design of fully functional devices with a comprehensive approach expanding well beyond the methods and tools usually adopted in the electrochemistry community. Characterizations and model calibrations on data provided by international partners will be part of the endeavour. Both in-house developed (MATLAB, Python) and existing commercial simulation tools (COMSOL) 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: The research aims at developing and optimizing sensors and ion actuators integratable with commercial MEAs normally used for neuroscience studies, and new sensors for the agrifood and precision agriculture sectors deployable in the lab and possibly in the field.

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)

