Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

****Field (cf. List of fields below):*** Chemistry, Physical Chemistry and Chemical Engineering,

Life Science and Engineering for Agriculture, Food and the Environment

Subfield: Electrochemistry, Bio analytical chemistry

*Title:***New biocompatible surface-attached hydrogel immobilization matrix for improved biosensors**

ParisTech School: Chimie ParisTech

Advisor(s) Name: FethiBediou, Cyrine Slim, Sophie Griveau
Advisor(s) Email:**fethi.bedioui@chimie-paristech.fr**
(Lab, website):http://www.upcgi.cnrs.fr/spip.php?rubrique9

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Electrochemical biosensors are integrated devices transducing the biological element-target recognition events into a detectable electrochemical signals. The development and interest for such sensors are their high selectivity towards the target analyte thanks to the biological sensing element. Biological sensing elements are of diverse nature: enzymes, aptamers, antibodies, cell…To get ergonomic and compact devices, the biological receptors are immobilized / integrate at the electrochemical interface. Upon target binding, the modification of the electrochemical signal of the redox reporter is directly related to the concentration of the target species. Electrochemical biosensors have attracted much attention owing to their simple configurations, low cost, multiplexed detection capabilities, high sensitivity and selectivity, as well as ease of miniaturization for portable point-of-care diagnostics and environmental monitoring. Engineering the bioelectrochemical sensing interface is crucial for improving the sensitivity and stability of electrochemical biosensors.

The immobilization procedure of the bioreceptor is one of the technological locks affecting the biosensors performance. It must assure both the preservation of its affinity towards the target and its stability. In this regard, several physical and chemical methods have been reported over the years to improve the bioreceptor immobilization. Hydrogels appear as attractive materials due to their three-dimensional hydrophilic networks and their high-water content. They present a lot of advantages thanks to their biocompatibility, highly deformability and adaptability while providing versatile, flexible and straightforward chemistry. This results in, promoting the bioreceptor long-term stability and providing suitable scaffold for trapping.The objectives of the project SATELIT is to combine electrochemistry and polymer expertise fields, to conceive tunable, sensitive and miniaturized electrochemical biosensors *via* the design of smart polymeric interfaces..

Surface-attached biocompatible hydrogel thin films with well-controlled chemistry and tailored architecture will be suitably used as immobilization matrix of biomolecules for molecular recognition of the target. From biomolecules, aptamers constitute an attractive alternative to antibodies due to their high affinity and their excellent specificity for a target or a family of selected targets. It is also possible to functionalize them with specific chemical functions and/or with tag to label the aptamers, for their further immobilization and/or for their analysis. They can be handled at room temperature, and are easily regenerated after denaturation, allowing their re-use which is interesting for the regeneration aspect of the biosensor. Immobilizing aptamers onto surface-attached hydrogel thin films notably by covalent attachment could provide a biocompatible shelter, while allowing the detection of small molecules. The density of immobilized aptamers that will affect the sensitivity of the sensor will be controlled thanks to hydrogel controlled chemistry which allow to developed sensor for trace and ultra-trace analytes detection. Incorporation of nanostructured metallic materials inside the hydrogel network and its role to improve biosensing characteristics will be explored. Within a constant

miniaturization effort, we will tend towards the transposition of this work, towards microfluidic electrochemical biosensors on real samples due to their miniature, portable and low-cost systems as well as high through put and automation. The integration of electrochemical sensors into microfluidic formats with the incorporation of unique materials for detection will be explored in this project. The development of these systems would lead to significant advantages compared to the current analytic systems, in terms of simplicity, speediness, cost, and automation.

Required background of the student: (Which should be the main field of study of the applicant before applying)

Physical chemistry, ideally background in basic electrochemistry

A list of 5(max.) representative publications of the group: (Related to the research topic)

Quinton, D., Girard, A., Thi Kim, L. T., Raimbault, V., Griscom, L., Razan, F., Bedioui, F. (2011).On-chip multi-electrochemical sensor array platform for simultaneous screening of nitric oxide and peroxynitrite. Lab on a Chip, 11(7), 1342–1350

Griveau, S., &Bedioui, F. (2013).Electroanalytical methodologies for the detection of S-nitrosothiols in biological fluids. The Analyst, 138(18), 5173–81

Ramirez-Garcia, G., Martinez-Alfaro, M., Gutierrez-Granados, S., Alatorre-Ordaz, A., Griveau, S., &Bedioui, F. (2015). Electrochemical assessment of possible melatonin effect on nitric oxide production from kidneys of sub-acute lead treated rats. ElectrochimicaActa, 166, 88–92

Slim, C., Ratajovà, E., Griveau, S., Kanoufi, F., Ferraro, D., Perrérard, C., Bedioui, F. (2015). Two-step local functionalization of fluoropolymerDyneon THV microfluidic materials by scanning electrochemical microscopy combined to click reaction. Electrochemistry Communications, 60, 5–8

P.M. Olmos Moya, M. Martínez Alfaro, R. Kazemi, M. A. Alpuche-Avilés, S.Griveau, F. Bedioui, and S. Gutiérrez Granados (2017) Simultaneous Electrochemical Speciation of Oxidized and Reduced Glutathione. Redox Profiling of Oxidative Stress in Biological Fluids with a Modified Carbon Electrode, Anal Chem 89, 10726-10733