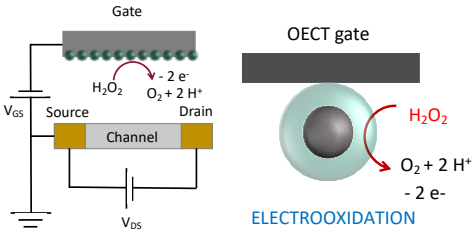
A new generation of printed biosensors for highly sensitive and quantitative biomarkers monitoring based on transistors and nanozymes

PhD position in Paris, Laboratory ITODYS, BiOSS team (Bioelectronics and Smart Surfaces). Open in Oct. 2024.

Monitoring biomarkers such as virus, biomolecules or hormones produced by the endocrine system holds paramount significance. Hormones, along with other biomarkers, serve as pivotal indicators of the body's physiological processes and functions. Even though optical transduction is nowadays the main detection modes used in biosensors, their replacement by electrochemical transduction would offer noteworthy advantages such as the possibility to operate in nontransparent or colored reaction mixtures and to directly produce an electronic signal that can be automatically treated and sent to the user.[i] **The PhD project aims to develop a generic printed biosensor for low cost, highly sensitive and quantitative hormones monitoring. To this end, a highly selective enzyme-linked aptamer assay (ELAA) will be combined to an Organic ElectroChemical Transistor (OECT) transducer functionalized with a new generation of hybrid electrocatalyst**. Organic ElectroChemical Transistor (**OECT**) devices[ii] are promising according to their ability to amplify interfacial events occurring onto the channel or gate electrodes.[iii,iv]



The objective of this PhD project is to modify the OECT gate with an **H_2O_2 ultrasensitive nanostructured interface, a key element of the final printed biosensor**. Highly selective nanocatalysts (nanozymes) for H_2O_2 oxidation encompassing a metal core and H_2O_2-responsive supramolecular shell will be synthesized and characterized by several physico-chemical techniques available in the laboratory (NMR, GC-MS, IR, electrochemistry, STM, AFM, XPS, SEM-EDX). The formulation and the printing of H_2O_2-sensitive nanozymes inks onto the gate electrodes will be optimized in order to obtain a highly active nanostructured interface. Finally, the fabrication of coplanar OECT biosensor on flexible substrate encompassing the smart H_2O_2 nanozyme will be performed by printing techniques within the PrintUp platform (https://printupinstitute.fr/en/research-development/) led by the BiOSS team. The performance of the modified OECT will be assessed as a function of both the architecture and the nanocatalysis triggered by H_2O_2. **This project will integrate supramolecular and molecular synthesis, electrochemistry, surface functionalization and printing fabrication techniques (namely inkjet-printing).**

Profile: The PhD candidate with a Master's degree in Chemistry should be a highly motivated student with a solid background in organic synthesis and supramolecular chemistry. The candidate should also have knowledge in molecular electrochemistry and/or spectroscopy.
Team-working abilities, organization and good communication and writing in English are required.

Location/supervision: The thesis will be conducted within the ITODYS Laboratory in Université Paris Cité. The PhD project will be co-supervised by Prof Benoît Piro and Dr Samia Zrig

How to apply? The applicant will attach a CV, a short (max 2 pages) research summary about previous experiences/internships (if any), a motivation letter and the contact of 2 references he/she worked with.

Emails: piro@u-paris.fr and samia.zrig@u-paris.fr

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[i] N. Wongkaew et al. Integrating high-performing electrochemical transducers in lateral flow assay Anal Bioanal Chem **2021**
[ii] J. Rivnay, G. Malliaras et al. Organic electrochemical transistors Nat. Rev. Mater. **2018**
[iii] B. Piro et al. Fabrication and use of organic electrochemical transistors for sensing of metabolites in aqueous media Appl. Sci. **2018**
[iv] F. Yan et al. Highly Sensitive Glucose Biosensors Based on Organic Electrochemical Transistors Using Platinum Gate Electrodes Modified with Enzyme and Nanomaterials Adv. Funct. Mater. **2011**