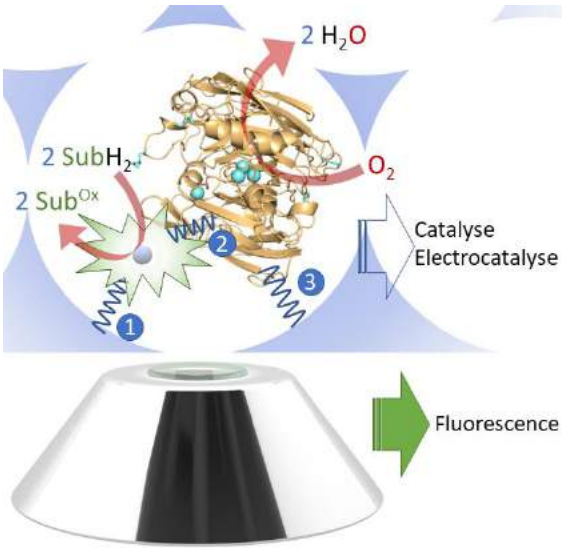
PhD proposal (Aix-Marseille University)
Institute of Molecular Sciences of Marseille (**iSm²**) & laboratory of Bioenergetics and Protein Engineering (**BIP**)

Heterogeneous chemo-enzymatic catalysis: an optimized immobilization strategy towards sustainability

Keywords**: enzyme oriented immobilization, tailored transition-metal-based catalysts, supported chemo-enzymatic (electro)catalysis, porous materials, *in operando* fluorescence microscopy**

PhD project summary



Scheme 1 Schematic representation of an organized hybrid material composed of a porous material (silica foam or conductive ITO GC electrode) functionalized with a chemoenzymatic catalyst for (electro)catalysis. Possible organization within the material ①②; ②③, ①③ or ①②③

The development of new processes for sustainable chemistry is at the heart of the great challenges of tomorrow. In this prospect, co-immobilizing a synthetic transition-metal-based catalyst and a robust multi-copper oxidase allows to couple a selective oxidation of organic compounds to a safe four-electron/four proton reduction of dioxygen to water. The aim of this project is to study *in situ* a new generation of supported chemo-enzymatic catalysts developed for sustainable oxidation of organic compounds. These systems will be confined in the pores of tailored 3D materials based on indium tin oxide (ITO) (ITO 3D-electrodes and macrocellular ITO-coated silica foams). A control of the orientation of the two catalysts (transition metal complex and enzyme) relative to each other and to the material surface will allow to define unique interfaces. Preliminary results suggest that the support does more than ensuring stability and reusability by playing a role in the catalytic process.[1] Therefore, controlling the organization of the components will allow to tune the reactivity. The multidisciplinary project will integrate various approaches to study the effect of different organizations on catalysis, ranging from materials synthesis and production of the tuned (bio)catalysts; to oriented immobilization of the catalysts into the material and characterization of catalysis via multiple methods (workflow catalysis, electrochemistry, *in operando* fluorescence microscopy during turnover[2]).

References: **1-** F. Yang et al., *Biotechnology Reports* **2021**, 31, e00645;
2- H. Man et al., *Analytical Chemistry* **2022,** *94* (45), 15604-15612.

Expected profile of the candidate

Candidates for the PhD position should have a Masters' degree in chemistry or chemical engineering, with major interest in physical chemistry or analytical chemistry. The successful applicant will have obtained excellent grades in his/her Bachelor and Master's degrees (or equivalent). He/she should be well-motivated, hardworking, willing, and able to work as part of a team. Background / experience in (bio)(electro)catalysis would be beneficial, interest for enzymes and particularly for metalloenzymes is welcome. Applicants are invited to send their CV, a cover letter, their transcripts of academic records, and the contact information for at least two references to Yasmina MEKMOUCHE (y.mekmouche@univ-amu.fr) and Anne de POULPIQUET (adepoulpiquet@imm.cnrs.fr).

The co-supervisors

S1.: Yasmina Mekmouche (**YM**), Institute of Molecular Sciences of Marseille (**iSm²**). HDR
S2. Anne de Poulpiquet (**AP**), laboratory of Bioenergetics and Protein Engineering (**BIP**).