

Intitulé du Sujet de Thèse : Light-Driven Hybrid Catalysts for Sustainable Oxidation

Laboratoire : iSm² Institut des Sciences Moléculaires de Marseille

Equipe : BiosCiences

Directeur de thèse HDR (50%) : Yasmina MEKMOUCHE

Codirecteur HDR (50%) : Thierry Tron

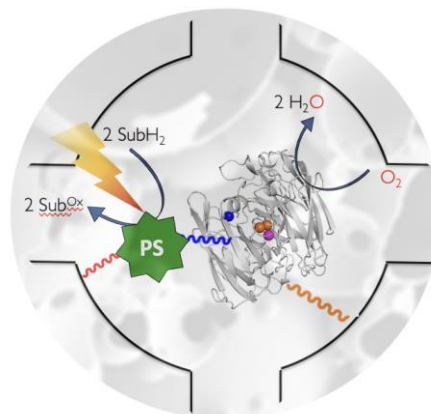
email : y.mekmouche@univ-amu.fr; thierry.tron@univ-amu.fr

Descriptif du projet

General Context. Developing sustainable oxidation processes is a major challenge for modern chemistry. Hybrid systems combining synthetic photocatalysts with oxidative enzymes offer new opportunities to perform selective reactions under mild conditions using molecular oxygen as a green oxidant. In particular, coupling a photocatalyst with a multicopper oxidase enables selective oxidation reactions while safely reducing dioxygen to water. Beyond synthetic applications, such systems may also contribute to the oxidative degradation of persistent micropollutants in water.

Description of the Work. This project aims to develop supported chemo-enzymatic photocatalysts for light-driven oxidation reactions. A photocatalyst and a multicopper oxidase will be immobilized on tailored materials (biobased materials, silica based, polymers...). Controlling the orientation and spatial organization of both catalysts on the support will allow the creation of efficient catalytic interfaces and optimized electron transfer.¹ Preliminary results suggest that the combination a multi-copper oxidase and different types of photocatalysts allows oxyfunctionalization of hydrocarbons with high yield of photoconversion;²

that the support does more than ensuring stability and reusability by playing a role in the catalytic process.³⁻⁵ The work will include the synthesis of photosensitizers, design of hybrid materials, oriented immobilization of catalysts, and spectroscopic characterization. Catalytic performance will be evaluated in selective oxyfunctionalization of organic substrates and in the photo-assisted degradation of micropollutants. This multidisciplinary approach aims to develop robust light-driven catalytic systems for sustainable synthesis and environmental remediation.



Schematic representation of photo-chemo-enzymatic system for sustainable oxidation.
PS = Photosensitizer

Références Bibliographiques

¹ V. Robert, *et al.* *ChemPlusChem*, **2017**, *82*, 607-614.

² (a) R. Farran, *et al.* *iScience*, **2021**, 102378 ; (b) C. Righetti, *et al.* *ChemCatChem* **2025**, *17*, e01086

³ F. Yang, *et al.* *Biotechnology Reports* **2021**, *31*, e00645.

⁴ F. Yang, *et al.* *ChemPlusChem* **2023**, *88*, e202300156.

⁵ F. Yang, *et al.* *ChemBioChem* **2024**, *25*, e202300781