JOB DESCRIPTION

Job Title:

Polyurethane open cell foams coated by polydopamine as structured supports for nickel-photoredox dual catalysis.

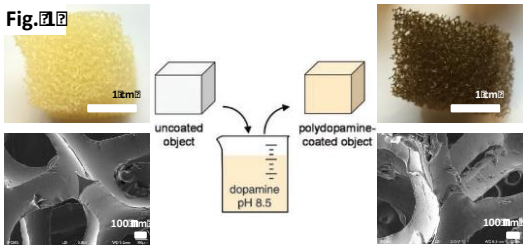
Job Summary :

Thanks to its advantageous properties, nickel's chemistry is currently experiencing a renewal. In particular visible-light mediated nickel-photoredox dual catalysis now allows challenging coupling reactions to take place under mild conditions. However the often high molar extinction coefficient of the photocatalyst (PC) hampers light penetration into the solution and thus causes dramatically reduced reaction rates when scaling-up reactions in traditional batch reactors. This constitutes an important drawback for its development on larger scales. Thus the aim of this PhD is to immobilize both the PC and the nickel catalyst on a support that is ideally structured to allow both their easy recovery and reuse, and their use under continuous flow conditions for challenging couplings.

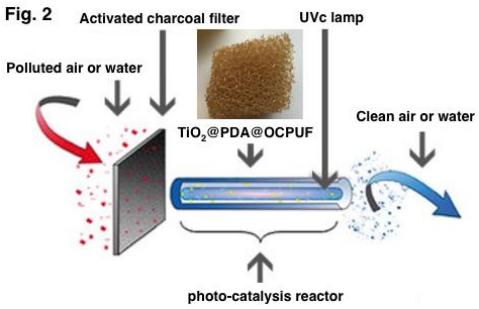
Job Description:

Continuous processes based on Structured Catalytic Supports (SCS) are widely used in industry. SCS allow important surface over volume ratio, small pressure loss, efficient mass transfers, intimate mixing of the reagents, and easy separation of the catalyst from the products.

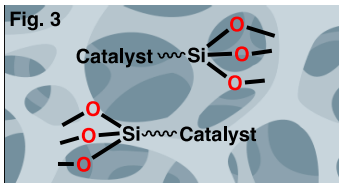
In this context, we have developed the use of polyurethane open cell foams (PUF) as SCS. These inexpensive foams present structural and transport properties of traditional SCS with the advantage of being easily engineered because of their lightweight and mechanical flexibility. Inspired by a biomimetic approach, we have shown that the surface of this polymeric material can be efficiently coated with an adhesive layer and further functionalized with either inorganic particles or molecular compounds. The process relies on catechol chemistry and consists in coating a PUF with a layer of polydopamine (PDA) by immersion in a buffered aqueous solution of dopamine (Fig. 1).



Thanks to the adherence properties of the catechols, nanoparticles (NPs) can be easily grafted all over the foam surface. In particular, a flexible structured-supported PC, PUF@PDA@TiO_2, has been designed to degrade a variety of air and water pollutants, under batch or flow conditions. Thanks to its easiness of engineering and to its large pores that let light and fluids go through, PUF@PDA@TiO_2 rolls have been used in a flow reactor equipped with a UVc lamp for 4 weeks for the degradation of water pollutants (Fig. 2).



Moreover, thanks to the presence of the catechols, the covalent grafting of molecular catalysts bearing a group that can form covalent bonds with them, such as an alkoxysilane, an amine or a thiol group has also been achieved (Fig. 3).



In this context, a first objective will be to establish a proof of concept in a model PC reaction with a covalently anchored polypyridyl Ir- or Ru-based PC on PUF@PDA. At this stage, it will be necessary to establish the robustness of the anchoring, the chemical resistance of the support and the reusability of the catalyst. Next the covalent grafting of both a PC and a Ni cross-coupling catalyst will be investigated. The resulting PUF@PDA@Ni-PC will be studied in model Ni-photoredox-catalyzed reactions. At this stage, it will be of main interest to establish whether the PC and the nickel catalyst are close enough to ensure efficient electron transfers. Further developments will involve optimisation and scale-up in continuous flow photoreactors, as well as extensions to original Ni catalysts and PCs.

The PhD will be conducted in the Laboratoire d'Innovation Moléculaire et Applications (UMR 7042 - http://lima.unistra.fr/) of the Université de Strasbourg under the guidance of Pr. Vincent Ritleng (https://orcid.org/0000-0002-8480-1491). Collaborations with the LAGEPP (UMR 5007) at the University of Lyon I, and the Institut Charles Sadron (UPR 022) in Strasbourg will allow the PhD candidate to develop additional competences in Chemical Engineering and Surface Sciences.

Main research field: Chemistry

Offer Requirements: The candidate should have an experience in ligand synthesis and in organometallic or coordination chemistry. Additional experience in photocatalysis would be appreciated. In addition, the candidate will need to have strong communication skills, as well as a strong motivation for working on a project involving surface science chemists, chemical engineers, and possibly industrial partners.

Eligibility criteria: The candidate should hold a Master degree from a foreign university or, after completion of a bachelor's degree abroad, should have enrolled in a Master program of a French University in order to apply to doctoral studies.

JOB DETAIL

Type of contract: 3-year PhD contract
Status: non-permanent
Company / Institute: Université de Strasbourg / LIMA-UMR 7042
Country: France
City: Strasbourg
Postal Code: 67087
Street: 25 rue Becquerel

APPLICATION DETAILS (mandatory)

Provisional start date: 01/09/2019
Application deadline: 01/06/2019
Application e-mail: vritleng@unistra.fr