ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Title : ZnO-M hierarchical nanostructures for green production of H_2 by photo-electrochemical water splitting

Internship supervisor

Name, first name	Cottineau Thomas
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Laboratory	ICPEES
Collaboration with a HiFunMat member (*please indicate their name*)	☐ No ☒ Yes :

Student profile looked for

Master program (*more than one box can be ticked*)	☒ Material science and engineering ☒ Chemistry ☒ Physics
Other indications if necessary	

Internship description

The large amount of energy brought to Earth by sunlight, and its availability across the planet, makes it an attractive source of energy. In addition to the conversion of photons into electricity in photovoltaic panels, new applications using semiconductor materials (SC) to convert light energy into chemical energy have emerged in recent times. These photo-electrochemical approaches utilize thin-film electrodes to convert solar energy into storable chemical energy (solar fuel, e.g., H_2). While different research teams have obtained promising results, it appears that a single material cannot combine all the required properties in terms of light harvesting, charge carrier mobility (e^-/h^+ pairs), stability in water, and catalysis of redox reactions. It is therefore necessary to create composite electrodes combining different materials to ensure the various functions of the reaction. Zinc oxide (ZnO) has driven a tremendous interest in the research field of renewable energies such as electrophotocatalysis. ZnO is a wide band gap (3.37 eV) semiconductor with excellent electronic and optical properties.

In this project, we aim to achieve such heterostructure based on ZnO nanorods modified by metallic nanoparticles deposited on their surface. The fabrication of hierarchical ZnO nanostructures will be achieved by aqueous solution chemistry, a simple and low-cost industrial process that fits with large-scale production and environmental respect. Nevertheless, the electrochemical properties of such ZnO nano-structures can be enhanced by metal nanoparticles which can be assembled or grown onto their surface. We will investigate the modifications of these structures by Au nanoparticles, which are expected to bring plasmonic visible light absorption and enhance the charge transfer at the semiconductor/electrolyte interface. In a second approach, the deposition of non-noble metal oxide nanoparticles, which can act as catalysts for water splitting reactions, will also be investigated (CoOx, FeCoOx).

The work will be done on the CNRS campus of Cronenbourg (ZRR) mainly at the IPCMS and ICPEES laboratory. The candidate will be trained to synthesis techniques in order to create

nanostructures through seed-mediated growth of zinc oxide nanorods covered by metal and metal oxide nanoparticles in a similar way as we reported (Azeredo et al. *J. Mater. Chem. C*, 6, **2018**, 10502). The characterization of such nanostructures will require a wide panel of techniques (X-ray diffraction, infrared and UV-visible spectroscopies, electron microscopies, XPS, granulometry …). The photoelectrochemical properties will be investigated at ICPEES. This research work will also give opportunities to interact with numerous researchers in Strasbourg. This project is for a Master 2 student in the field of Chemistry, Physico-Chemistry or Material Science. It requires a strong motivation for experimental work and an ability to work on the multidisciplinary aspects of the project such as materials synthesis and characterization, photoelectrochemistry, *etc*.

For more information and to apply please send a **CV and a motivation letter to Benoit Pichon (pichon@ipcms.unistra.fr) and Thomas Cottineau (cottineau@unistra.fr)**