ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Title: Design of supported bimetallic catalysts for plasmon-induced CO_2 recycling into methane

Internship supervisor

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

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

Carbon dioxide is one of the major pollutants of our world. It is produced on a large scale, as an inevitable by-product of human activity. It is so far continuously released in the atmosphere, where it accumulates, with life-threatening consequences on climate change. On the other hand, useful energy resources, such as oil, are running out. What if CO_2 could be recycled and become the next generation, renewable and sustainable energy resource? This is what we are currently investigating in the TOGETHER-FOR-CO2 ANR project. It is known that CO_2 can in principle be reduced into methane using light-activated catalysts and water as the reducing agent. What we found is that this could be achieved in a highly selective, continuous gas phase process, over extended period of times, using plasmonic metal nanoparticles (NPs). This true artificial photosynthesis process based on plasmon-induced chemical activity however critically depends on the composition of the plasmonic nanoparticle and the nature of the underlying inorganic support.

The general aim of this Master M2 internship is to improve reaction rates by material design. It will focus on various bi-metallic NPs (Ag, Au, Pt, Pd) supported on titania at a given M1/M2 ratio. It will include the inorganic chemical synthesis of titania-supported mono- and bi-metallic NPs, their characterization with UV-visible spectroscopy, X-ray photoelectron spectroscopy, scanning/transmission electron microscopy, temperature programmed reduction, and their photocatalytic evaluation. These data are expected to allow to identify the effect of the nature of the metals on the plasmon-induced performances of the bimetallic catalyst and identify the working mechanism of the functional couples of supported metal NPs.

Work will take place in the PhotoCatalysis and PhotoConversion (PCPC) team of ICPEES. It will benefit from the knowledge acquired within the CNRS-funded SelCO2PlasmonRed project (2021-2023) and the current ANR project (2023-2026), the experience of the team in this field, and the support of technicians and PhD researchers of the PCPC team. The candidate is expected to be able to work both autonomously and in a team, with shared equipment and schedule.

This topic relates to both energy and the environment.