Hierarchical & Functional Materials for health, environment & energy | HiFunMat

The Interdisciplinary thematic Institutes of the University of Strasbourg & Inserm

funded under the Excellence Initiative program

ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

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

Internship supervisor

Name, first name	CAPS Valérie
E-mail, Telephone	caps@unistra.fr 06 21 33 29 06
Laboratory	ICPEES
Collaboration with a HiFunMat member (*please indicate their name*)	☐ No ☒ Yes : CONSTANTIN Doru (ICS)

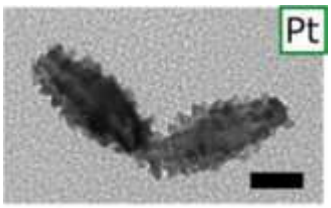
Student profile looked for

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, in particular of fossil fuel usage (CH_4 +2 O_2 → CO_2 + 2H_2O). It is so far continuously released in the atmosphere, where it accumulates, with life-threatening consequences on climate change. What if CO_2 could be recycled and become the next generation, renewable and sustainable energy resource? At ICPEES, we have found that methane can be selectively and continuously produced from a CO_2/water mixture (CO_2 + 2H_2O → CH_4 + 2O_2) using light as only energy source and plasmonic metal nanoparticles (M NPs) as catalyst. This appealing artificial photosynthesis process however critically depends on the composition of the M NPs. Segregated structures of bimetallic Au-Pt alloys in particular have appeared quite promising. So far, only Janus and core-shell NPs have been tested[1] and results suggest that structured NPs, with a large Au core covered by discrete smaller Pt NPs (rather than a full Pt shell, see Figure), could significantly boost the reaction rate.

This Master M2 internship will focus on the synthesis of such bimetallic nanostructures, according to previously established protocols,[2] on their purification, immobilization on relevant substrates and evaluation in the artificial photosynthesis of methane. The NPs will be characterized by scanning & transmission electron microscopy, X-ray photoelectron spectroscopy and UV-visible spectroscopy to correlate their photocatalytic performances, optical properties and nanostructures.



Work will take place in the Photocatalysis and Photoconversion (PHOTO) team of ICPEES. It will benefit from the experience of the team in artificial photosynthesis and from the experience of Doru Constantin in NPs synthesis and optical characterization. It will also benefit from the support of engineers and PhD researchers of the PHOTO 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 environment.

[1] L. Hammoud, C. Strebler, J. Toufaily, T. Hamieh, V. Keller, **V. Caps**, Faraday Discuss. 242 (2023) 443.

[2] X. Li, J. Lyu, C. Goldmann, M. Kociak, **D. Constantin**, C. Hamon, J. Phys. Chem. Lett. 10 (2019) 7093.