PhD Proposal

Laser-induced transfer of nanoplasmonic materials on large surfaces for advanced plasmon-enhanced photoreactivity

Funding: 3-year project funded by the PEPR LUMA
Start date: Any time between 01/03/2025 and 01/10/2025
Gross salary: 2130 € / month

This PhD proposal is part of the SUNRISE project in the PEPR LUMA[1], financed for 6 years by France 2030. The work will be carried out in the Optics, Photonics and Surfaces Department of the Hubert Curien Laboratory (LabHC) located in Saint-Etienne, France, in collaboration with the Laboratoire de Chimie of the ENS Lyon, the Institut des Sciences Moléculaires in Bordeaux and the CEA in Saclay.

The SUNRISE project aims at exploiting plasmonic interactions to selectively modify the interaction between light and chromophores on a nanometric scale. In this context, the thesis aims to fabricate large-area functional surfaces with plasmon-enhanced photoreactivity and to integrate them in innovative photochemical flow reactors. These functional surfaces will be used to improve photoinduced synthesis and sensing.

In this PhD thesis, we aim to develop the laser-induced transfer (LIT)[2] process with various plasmonic nanomaterials of different sizes and shapes to functionalize microfluidic channels of flow devices to harness plasmonic interactions and enhance photochemical processes. This project will take advantage of LabHC's expertise in plasmonics and laser-matter interaction, which has led to the development of several applications to date.[3,4]

After a thorough understanding of the underlying mechanisms leading to the LIT of different materials reported in the literature, the PhD student will develop the LIT of metallic nano-objects, characterize the new mechanisms involved and optimize the process for the functionalization of large surfaces. The PhD student will then adapt the optical setup to functionalize the walls of microfluidic channels according to their specific designs. To characterize the LIT mechanisms, the PhD student will set up an experiment with an ultra high-speed camera. The functionalized surfaces will also be characterized post mortem by transmission and scanning electron microscopy, X-ray and spectroscopy to ensure that the transferred nanocatalysts have the expected properties.

This experimental PhD project is open to applicants holding a master degree's in physics with major in photonics. A B2 level of proficiency in English is required. The PhD candidate must demonstrate strong motivation to address key questions related to the fundamental laser-induced physics and chemistry of metallic nanoparticles. He or she should have a solid background in physics to conduct experimental research involving the use and development of ultrafast laser instrumentation, spectroscopy, microscopy, plasmonic system modelling, and data analysis. The ability to take initiative and work autonomously is essential for successfully completing this thesis, while also leveraging the expertise of the various collaborators involved in the project.

Applicants must send their CV to the contact persons, with a motivation letter, bachelor and master transcripts, and reference names or recommendation letters. Applications will be reviewed on a rolling basis, so we encourage you to submit your documents as soon as possible and no later than May 1, 2025.

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References : [1] https://www.pepr-luma.fr/; [2] P. Serra, et al., Adv. Mater. Technol., 1800099 (2018); [3] H. Ma, et al., J. Phys. Chem. C, 123, 25898-25907 (2019) ; [4] V. D. Le, et al., ACS Appl. Opt. Mater., 2, 3, 373-385 (2024)