ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Title: Chiral hybrid plasmonic nanostructures as enantioselective photocatalysts

Internship supervisor

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Laboratory	Institut Charles Sadron
Collaboration with a HiFunMat member (*please indicate their name*)	☒ No ☐ Yes :

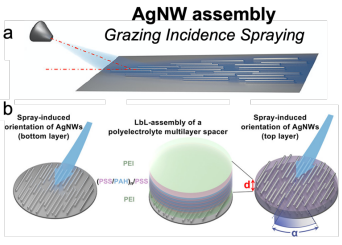
Student profile looked for

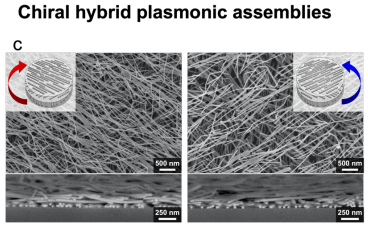
Master program (*more than one box can be ticked)*	☒ Material science and engineering ☒ Chemistry ☐ Physics
Other indications if necessary	

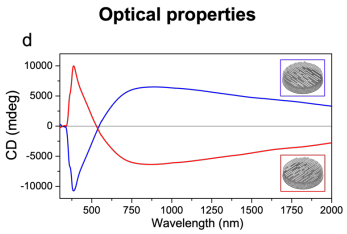
Internship description

With the increasing demand for chiral compounds in many industries such as pharmacology, the **synthesis of enantiopure chemicals** is of paramount importance. Chiral separation is nowadays the industrial strategy of choice, while asymmetric catalysis is the best approach leading to the formation of enantiopure molecules. Although the use of light as energy source is well established in photocatalysis, little is known about its implementation in heterogeneous asymmetric reactivity. Therefore, there is an urgent need to find new strategies to drive efficient asymmetric photochemical reactions with visible and near-infrared photons.

In this internship, which is part of an ambitious project recently funded by the ANR with partners in Paris and Bordeaux, we propose to combine the unique features of **plasmonic photocatalysis with asymmetric reactivity** in order to perform heterogeneous and asymmetric photocatalytic reactions driven by plasmons. To this end, **various molecular and nanoparticulate catalysts will be coupled to a chiral plasmonic metasurface prepared by self-assembly.** Grazing Incidence Spraying (GIS, Fig. 1a) will be used to assemble silver nanowires into oriented mono− and multilayer thin films with well-controlled orientation and spacing. GIS will be combined with the Layer-by-Layer (LbL) approach to build multilayer superstructures (Fig. 1b) embedding various catalysts. We have recently shown[1,2] that such chiral nanostructures (Fig. 1c) display a very high circular dichroism (Fig. 1d) over a broad wavelength range. The advantage of this approach is that multimaterial nanocomposites can be easily fabricated over large areas with a fine control over the nanoscale architecture. The polyelectrolyte multilayer matrix in which the nanowires are embedded will be used to host molecular catalysts that are chemically compatible with this hydrophilic environment, and inorganic nanoparticle catalysts.







The structure of the assembly will be systematically characterized using various microscopy techniques (AFM, SEM, TEM). The optical properties will be measured by combining different spectroscopic and polarimetric approaches (including UV-Vis-NIR polarized spectroscopy, ellipsometry, FTIR and CD spectroscopy).

Requirements & Application

This multidisciplinary internship, at the frontier between materials science, nanoscience and physical chemistry will involve both sample fabrication and physicochemical characterization. We are looking for a highly motivated student with a background in **physical chemistry, nanoscience and/or materials science**. Depending on the student's interest and progress during the internship, **this work can be continued with a doctoral thesis**, for which funding has already been secured (ANR 2023-2027).

IMPORTANT: Due to the internal security rules for access to the laboratories (ZRR), the recruitment process must start at least 10 weeks before the internship.

References

1. H. Hu; S. Sekar; W. Wu; Y. Battie; V. Lemaire; O. Arteaga; L. V. Poulikakos; D. J. Norris; H. Giessen; G. Decher; M. Pauly Nanoscale Bouligand Multilayers: Giant Circular Dichroism of Helical Assemblies of Plasmonic 1D Nano-Objects. *ACS Nano* **2021**, *15*, 13653-13661.
2. W. Wu; Y. Battie; V. Lemaire; G. Decher; M. Pauly Structure-Dependent Chiroptical Properties of Twisted Multilayered Silver Nanowire Assemblies. *Nano Lett.* **2021**, *21*, 8298-8303.