Chiral plasmonic metasurfaces for asymmetric photocatalysis

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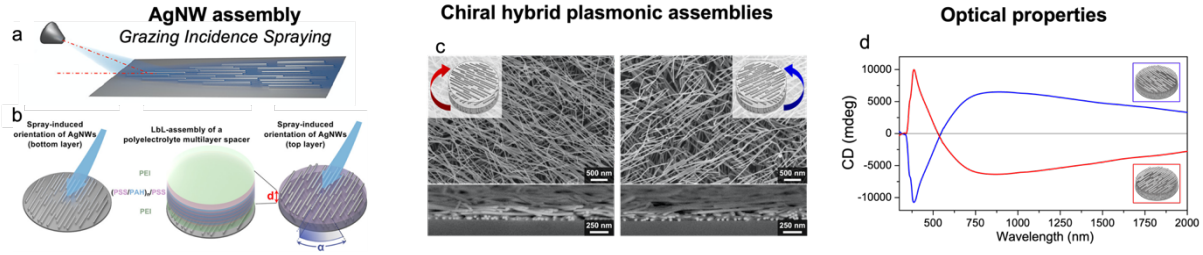
Although the use of light as an energy source in photocatalysis is well established, its implementation in heterogeneous asymmetric reactivity is still rare. Therefore, there is an urgent need to find new strategies to drive efficient asymmetric photochemical reactions with solar radiation. In this collaborative project (funded by the ANR) between our group in Strasbourg, the ITODYS laboratory in Paris and the CBMN laboratory in Bordeaux, we propose to combine the unique features of plasmonic metal nanoparticles as photocatalysts with asymmetric reactivity, aiming at the realization of heterogeneous and asymmetric photocatalytic reactions driven solely by plasmons.[1] Our ultimate goal is to understand the nature of the interaction between light, the heterogeneous photocatalyst, and the molecular species in order to induce stereocontrol of the photochemical reaction.

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.[2] GIS will be combined with the Layer-by-Layer (LbL) approach to build chiral multilayer superstructures (Fig. 1b). We have recently shown that such chiral nanostructures (Fig. 1c) exhibit a very high circular dichroism (Fig. 1d) over a broad wavelength range.[3, 4] 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 different 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). The catalytic efficiency will be characterized in collaboration with our project partners.



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2. H. Hu, M. Pauly, O. Felix and G. Decher, *Nanoscale*, 2017, **9**, 1307-1314.
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Information about the host institute

The Institut Charles Sadron (ICS) is an institute of the CNRS affiliated with the Université de Strasbourg (Unistra). It is a multidisciplinary research laboratory dedicated to fundamental research in the fields of Macromolecules and Soft Matter with applications in Materials Science. It is the largest research facility in this field in France (about 53 researchers and professors, 38 engineers, technicians and administrative staff and 100 temporary researchers, e.g., visiting scientists, post-docs, PhD students...). It provides all the infrastructures necessary for the complementary research of chemists, physico-chemists and physicists. The ICS has major central facilities for polymer research and materials science including home-built instrumentation for the synthesis and preparation of materials, their physicochemical and structural characterization, and the determination of their physical properties. They include a wide range of analytical, microscopic, spectroscopic, rheological and mechanical techniques as well as computer facilities. The scientific productivity of the ICS is about 120 articles, 3-5 patents and about 80 invited presentations per year.
The ICS is one of the founding members of the Interdisciplinary Thematic Institute (ITI) HiFunMat, a unique project devoted to materials science (research and education) involving a dense network of academic and industrial partners.
The ICS is located on the Cronenbourg campus in Strasbourg (France). Strasbourg is the largest city in the Grand-Est region and one of the four main capitals of the European Union. It is a tourist hot spot in the Upper Rhine Valley and is ranked highly not only for science, but also for quality of life.

The PECMAT group at ICS has a leading expertise in the study of multi-composite materials with nanoscale organization, which includes:
- the preparation of nanoscale building blocks
- the organization of these building blocks into (multi)functional (multi)composites
- the multiscale analysis of the structure and the dynamics of such systems
- the optimization of the materials properties.

Candidate profile

This multidisciplinary thesis work, at the frontier between chemistry, nanoscience, materials science and optics will include nanochemistry, structural characterization and physicochemical characterization. The thesis is intended for a candidate with a strong background in chemistry, physical chemistry, materials science or nanoscience.
The application should include a letter of motivation, a curriculum vitae, and a list of courses and grades taken at the master's level.
Interested candidates should apply at:
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