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ENS DE LYON

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Open PhD position in chemistry:
"Preparation of chiral hybrid materials with plasmonic nanoparticles"
"Préparation de matériaux hybrides chiraux avec des nanoparticules plasmoniques"

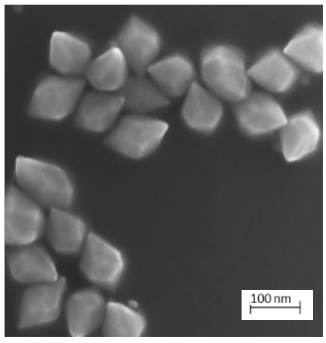
▸ **Key words:** **nanoparticle, seed-mediated growth process, colloidal assembly, sol-gel, plasmonics, chirality**

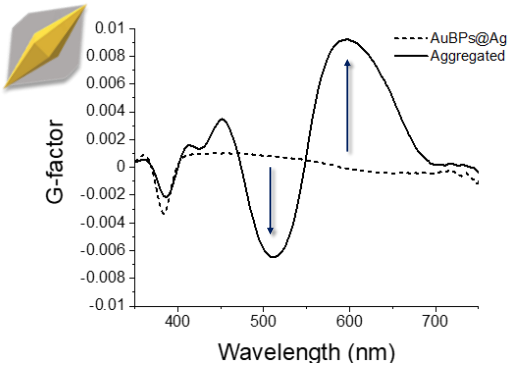
▸ **Project:** If chemists traditionally deals with chirality for organic molecular compounds, the community is more and more interested in chiral inorganic nanostructures and more particularly plasmonic chiral nanostructures.[1] Indeed, such nano-objects lead to unique properties of materials –e.g. high chiroptical activity like circular dichroism (CD) response– with concrete applications in the fields of catalysis, (bio)sensing, photonics… However, easily fabricating such nanostructures is currently a huge challenge.

Recently in the team, we have developed a colloidal synthesis of chiral plasmonic nanoparticles.[2] This synthesis is based on the controlled growth of gold or silver onto gold nanobipyramids (AuBP) in the presence of cysteine. The obtained AuBP@Au and AuBP@Ag nanoparticles exhibit circular dichroism response (see figure). Chiroptical properties can be tuned by nanoparticle size and shape, but also by aggregation. Indeed we have shown that new CD bands can emerge for aggregated AuBP@Ag NPs, while the CD response can disappear for chiral AuBP@Au system.[3] Current efforts are focused on understanding the origin of chirality in such systems, which is highly discussed in literature, but also on the preparation of chiral hybrid materials. For instance, we are able to incorporate plasmonic NPs into a hybrid glass using a sol-gel process, while preserving the optical properties.

In the present PhD project, we will pursue this strategy by combining (i) nanoparticles synthesis, (ii) colloidal assembly and (iii) sol-gel process. Playing with the nature of nanoparticles (shape, size and also handedness) and their interaction or aggregation state will enable us to control optical properties (wavelength region and g-factor values) and to appreciate the phenomena involved in chiral materials.

Figure - SEM image and CD spectra of AuBP@Ag nanoparticles (stable suspension and aggregated)





▸ **Lab & context:** The PhD work will be performed in the Chemistry Laboratory of ENS Lyon (UMR 5181) in the team « Functional Materials and Photonics ». The team develops research on hybrid materials devoted to optical applications. In particular the expertise lies in the design of original molecular systems coupled with inorganic materials and the characterization of optical interactions and responses (absorption, emission, nonlinear responses…). The applications are in the fields of optical protection, bioimaging, photocatalysis… The preparation of nanoparticles and materials, as well as routine characterizations, will be performed in the lab. Local collaborations with ILM Lyon are planned for advanced optical characterizations.

▸ **Skills/techniques:** Synthesis, surface modification and assembly of NPs – sol-gel process – Spectroscopy (UV-vis-NIR absorption, circular dichroism) – electron microscopy (SEM, TEM)

▸ **Candidate profile:** The candidate should have a Master's degree or equivalent for registration to a PhD program, with a high academic and scientific level in general chemistry, materials chemistry or physical chemistry of materials. In addition, he/she should be highly motivated by experimental work, curious and comfortable with bibliography.

▸ **Starting date:** **Sept. 2024**

▸ **Application deadline:** **March 2024**

▸ **Contact:** **Dr. A. Désert** (anthony.desert@ens-lyon.fr)

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▸ **References:**

[1] W. Wu, M. Pauly, *Mater. Adv.* **2022**, *3* (1), 186. doi: 10.1039/D1MA00915J
G. Zheng et al., *Chem. Soc. Rev.* **2021**, *50* (6), 3738. doi: 10.1039/C9CS00765B
[2] A. Carone et al., *ACS Nano* **2022**, *16* (1), 1089. doi: 10.1021/acsnano.1c08824
[3] A. Carone et al., *Advanced Optical Materials* **2023**, *11* (18), 2300119. doi: 10.1002/adom.202300119