LABORATOIRE DE CHIMIE ENS DE LYON

Université Claude Bernard Lyon 1

ENS DE LYON

UMR ENS-UCBL-CNRS 5182
46 allée d'Italie 69364 Lyon (France)
http://www.ens-lyon.fr/CHIMIE

Master 2 project in chemistry:
"Chirality and self-assembly of plasmonic nanoparticles"

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

▸ **Project:** If chemists traditionally deal with chirality for organic molecular compounds, the community is more and more interested in chiral inorganic nanostructures [1] and more particularly plasmonic chiral nanostructures. [2] 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 -ideally with an up-scalable, low cost, reproducible and versatile process- is currently a huge challenge. We want to address this challenge by developing the colloidal synthesis and self-assembly of a class of gold nanoparticles (AuNPs) with unusual chiral shape.

Recent efforts in the team have led to unprecedented improvement concerning the AuNPs colloidal synthesis: a large variety of pentatwinned AuNPs is now easily obtainable (like gold nanobipyramids - AuBPs), with high purity and monodispersity, and in high concentration. [3] We will take advantage of this by adapting this new versatile process for preparing chiral nanostructures. Previous results have been obtained following two approaches: (i) colloidal self-assembly of AuNPs via chiral ligands (L-arginine) and (ii) seed-mediated growth process with L-cysteine. Both methods have resulted in original gold and silver nanostructures with specific absorption and CD behaviors, like linear chains of self-assembled AuNPs (Fig.1a), or gold gnocchi-like (Fig.1b) and silver lemon-like (Fig.1c) chiral NPs grown from AuBPs seeds. [4] In the present M2 project we will pursue the study of both approaches and we could also combine them. The objectives are to control the preparation of new gold and silver nanostructures and to reach higher CD response. In later stages, the chiral nanoparticles will be incorporated into hybrid glasses using a sol-gel process, to produce a functional material keeping the chiroptical properties of the nano-objects.

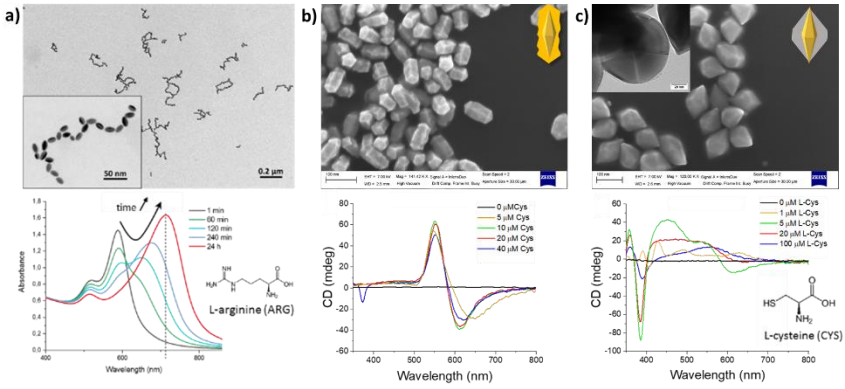

Fig.1 – Electron microscopy images and absorption or CD spectra of a) assemblies of AuNPs with arginine, b) gold gnocchi-like and c) silver lemon-like chiral NPs prepared with cysteine

▸ **Lab & context:** The study will be performed in the Chemistry Laboratory of ENS Lyon (UMR 5182) 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 (semiconductors, plasmonic nanostructures…) and the characterization of optical interactions and responses (absorption, emission, nonlinear responses…). This M2 work is part of the ANR PlaChiS project.

▸ **Skills/techniques:** Synthesis, surface modification and assembly of gold NPs - optical characterizations (UV-vis-NIR absorption, circular dichroism spectroscopy) - electron microscopy (SEM, TEM).

▸ **Profile:** The M2 candidate should have 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 and resources.

▸ **Contact:** **Prof. S. Parola** (stephane.parola@ens-lyon.fr) **Dr. A. Désert** (anthony.desert@ens-lyon.fr)
Laboratoire de Chimie-ENS Lyon-UCBL-CNRS, Équipe Matériaux Fonctionnels et Photonique

[1] W. Ma *et al.*, *Chem. Rev.* **2017**, 117, 8041.
[2] Y. Luo *et al.*, *Adv. Opt. Mater.* **2017**, 5, 1700040 ; X.-T. Kong *et al.*, *Adv. Mater.* **2018**, 0, 1801790 ; J. Kumar & L.M. Liz-Marzán, *BCSJ* **2019**, 92, 30 ; M. Hentschel *et al.*, *Sci. Adv.* **2017**, 3, e1602735.
[3] D. Chateau, A. Desert, F. Lerouge, G. Landaburu, S. Santucci, S. Parola, *ACS Appl. Mater. Interfaces* **2019**, 11, 39068.
[4] A. Carone, P. Mariani, A. Desert, M. Romanelli, J. Marcheselli, S. Corni, I. Rivalta, S. Parola, ACS Nano **2022**, 16, 1089.