PhD in Molecular Chemistry

University of Bordeaux (2022/2025)

Functional oligomeric helices as new tools for probing molecular and supramolecular chirality of chiral surfaces and interfaces

Scientific context: This PhD project is within the framework of the ANR project *NLOChiraMat* (2021-2025) which brings together two laboratories from the University of Bordeaux and a laboratory from the University of Namur in Belgium.

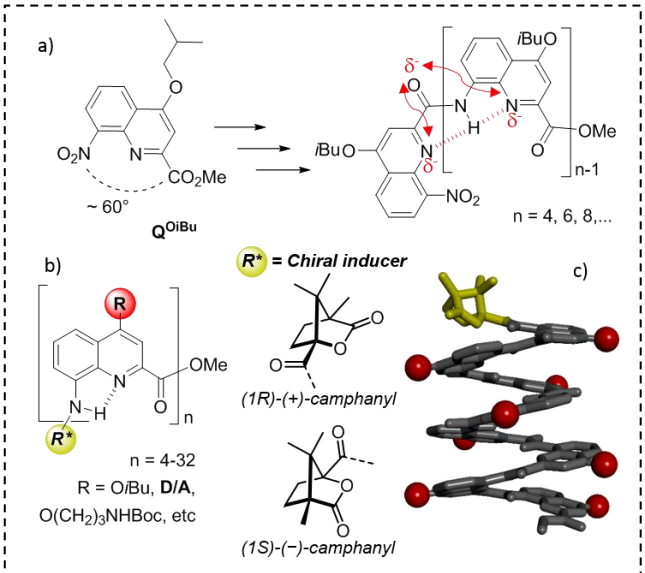
Summary of the ANR project NLOChiraMat: Chirality plays a crucial role at the molecular level in various fields such as biochemistry, biology, catalysis, pharmacology, etc. In order to probe chirality, well-established techniques such as electron circular dichroism (ECD) or circularly polarized luminescence (CPL) are employed. However, these techniques present some limitations in the direct detection of the chirality of supported monolayers of molecules or chiral surfaces, for which the development of an alternative chiroptical technique is desirable. Nonetheless, some nonlinear optical (NLO) techniques are particularly well suited to the characterization of surfaces and interfaces and offer higher sensitivity than their linear counterparts.

Recently, using aromatic oligoamide foldamers as a chiral molecular model, we have demonstrated that hyper-Rayleigh scattering (HRS), a 2nd-order NLO technique, can be a powerful complementary chiroptical method, well suited for the analysis of chiral molecular and supramolecular systems in solution.[1] We now wish to apply this technique to the detection of molecular chirality on surfaces.

Aromatic oligoamide foldamers are self-organizing molecular helices that possess intrinsic chirality, and their exceptional modularity allows for fine-tuning of their optoelectronic properties thus amplifying their chiroptical and NLO responses.

Thesis objectives : i) the synthesis of amino acid monomers to include them in oligoamide sequences; ii) the synthesis of functionalized aromatic oligoamide helices; iii) the grafting of these oligoamides on dedicated substrates to obtain chiral surfaces; iv) the characterization of these chiral surfaces by different spectroscopic techniques. Studies in nonlinear optics will be done in collaboration at ISM.

The different tasks will be carried out between two laboratories of the University of Bordeaux: the Institute of Molecular Sciences (ISM) and the Laboratory of Chemistry and Biology of Membranes and Nano-objects (CBMN).



a) Folding principle of quinoline oligoamides by hydrogen bonding, electronic repulsion and aromatic stacking; b) Formula of the functionalized quinoline oligomers and structure of the chiral camphanic inducer; c) Crystallographic structure of a helically folded quinoline octamer (Q8). The red balls indicate the positions available for substituents on the helix.

The thesis work will be co-supervised by Dr. Céline OLIVIER (CR CNRS), NEO group of ISM, and Dr. Yann FERRAND (DR CNRS), BISE group of CBMN located at IECB. The non-linear optics studies will be carried out in collaboration with Pr. Vincent RODRIGUEZ and his team, GSM group of ISM.

Required Skills: The candidate will hold a Master in Organic Chemistry (or equivalent).

The candidate is expected to own skills in organic synthesis primarily, as well as experience in the use of traditional characterization and analysis tools and methods (NMR spectroscopy, mass, etc.). An interest in synthetic chemistry and the study of supramolecular systems is essential for this project. In addition, an interest in the field of (supra)molecular chirality and the analysis of (chiro)optical properties will be appreciated.

Please send application (CV + cover letter) to :

Céline OLIVIER (celine.olivier@u-bordeaux.fr) et Yann FERRAND (yann.ferrand@u-bordeaux.fr)

Références :

[1] *«Hyper-Rayleigh Scattering as a New Chiroptical Method: Uncovering the Nonlinear Optical Activity of Aromatic Oligoamide Foldamers »* D. Verreault, K. Moreno, E. Merlet, F. Adamietz, B. Kauffmann, Y. Ferrand, C. Olivier and V. Rodriguez, *J. Am. Chem. Soc.* **2020**, *142*, 257.

Voir aussi :

« *Iterative evolution of an abiotic foldamer sequence for the recognition of guest molecules with atomic precision* » G. Lautrette, B. Wicher, B. Kauffmann, Y. Ferrand, I. Huc *J. Am. Chem. Soc.* **2016**, *138*, 10314.