

PhD Research Proposal Form China Scholarship Council (CSC) - ENS Group

FIELD: Organic Chemistry

Thesis subject title:

Synthesis and applications of highly preorganised rigid chiral platforms

Name of the French doctoral school: ED206 - Ecole Doctorale Chimie Lyon

Name of the Research team: Supramolecular Chemistry and Chemical Biology

Website :

http://www.ens-lyon.fr/CHIMIE/recherche/Teams/Chimie_Organique_et_Materiaux_Nanostructures/chimie-organique-et-materiaux-nanostructures?set_language=en&cl=en

Name of the Supervisor: Dr Philippe MAURIN, Associate Professor

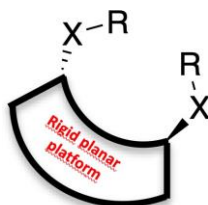
Email: philippe.maurin@ens-lyon.fr

Lab Language: English

Research Proposal Abstract :

Synthesis / characterisation of a new class of highly preorganised chiral compounds with chelating properties supported by a rigid planar platform with potential applications in various fields. The project will include development / evaluation of the performances of derivatives in domains such as

- New chiral catalysts
- « chiral building blocks » with axial chirality
- Helicoidal compounds or supramolecular arrangements



X = heteroatoms such as O or N

Project

This subject is part of a recently initiated project (article with preliminary results in preparation) on the synthesis of a family of enantiomerically pure chiral compounds based on an original planar rigid platform.

Our project is based on a very strong preorganised (elbow shaped) planar platform bearing two chiral centers with heteroatoms pointing in two different half-spaces. Once the access to the building blocks secured, the stereochemistry of the different stereoisomers assigned, their properties as precursors for the conception of compounds having

potential applications in asymmetric catalysis, materials for optic, chiral recognition and chiral helicoidal compounds, will be evaluated.

Workplan

1- The first months of the PhD will be dedicated to the development of the access route to the enantiomerically pure family of precursors that has already been explored. It will allow the selected PhD student to become familiar with the specific chemistry and characterization techniques involved in the project. The other objective will be to widen the variety of precursors by introducing specific functional groups or substituents (to adapt solubility in different solvents and prepare the grafting on materials)

2- The second part of the PhD will be dedicated to the evaluation of performances, in collaboration with other teams, in domains such as

- Chiral recognition / separation
- Asymmetric catalysis / synthesis
- Non-linear optics
- Chelating properties, chiral bidentate ligands
- Helicoidal compounds, supramolecular auto-assemblies
- foldamers
- material chemistry

We are very open to opportunities of cooperation or co-supervision/cotutelle of the PhD student with a Chinese partner for the characterization parts of the project and for evaluating the performances of our new class of derivatives in various application domains.

Presentation of ENS de Lyon

The Ecole Normale Supérieure de Lyon is an elite French public institution that trains professors, researchers, senior civil servants as well as business and political leaders. Students choose their courses and split their time between training and research in sciences and humanities. Built on the tradition of the ENS de Fontenay-Saint-Cloud, founded in 1880, the ENS de Lyon is a symbol of French Republican meritocracy and it remains committed today to disseminating knowledge to the widest audience and to promoting equal opportunity. The ENS de Lyon supports quality research that has earned it two Fields medal, many CNRS medals and several. It encourages interdisciplinary studies to foster a better understanding of complex contemporary issues.

Expertise and research of the institution are based on strong disciplinary competence (around 1100 publications/year in Humanities, Letters, Social Sciences, Mathematics, Physics, Biology and Chemistry), interdisciplinary and international cooperation (262 exchange partnerships with 26 countries) as well as partnerships with national research organizations (CNRS, INRA, INSERM, INRIA, Universities). ENS de Lyon supplies its laboratories with state-of-the-art equipment and facilities and provides support services to researchers in their initiative (Innovation and Technology Transfer Office, Office of International Affairs, HR ...). ENS de Lyon provides administrative and language resources for visiting students, postdocs and faculty members.

Key figures

ENS de Lyon is one of the leading French research and teaching institution (ranked 7th in the Times Higher Education « 2018 best world small university » ranking) with a very selective entrance examination at pre-Master level (less than 1/100 success rate) with a ratio of 2200 students for 800 researchers and teaching staff and 450 PhD students.

ENS de Lyon has extensive experience in Research and training programs. ENS de Lyon manages national, European and international funding (participation in 55 European H2020 projects) and administers a Research Fund, to finance high-level scientific projects.

Presentation of ENS de Lyon Laboratory of chemistry (<http://www.ens-lyon.fr/CHIMIE>)

The Chemistry Laboratory is a joint unit operated by the CNRS, the École Normale Supérieure of Lyon and Université Lyon 1.

The Chemistry Laboratory spans a range of specialties in chemistry and physical chemistry. It develops interdisciplinary research projects at the frontiers with biology, material sciences and physics. The research themes cover a wide spectrum of expertise in experimental chemistry (organic, inorganic and materials synthesis) together with characterization and modeling. The scientific interdisciplinary projects of the laboratory, which are partly related to

societal issues (environment, health, defense, information and communication technologies, textiles) are centered on three themes:

- systems for biology: imaging, diagnosis and therapy;
- systems with specific properties: properties for applications related to optics, magnetism, to supramolecular heterogeneous catalysis, to the detection of gaseous molecules, to chiral recognition or to the development of functional textiles;
- computational modeling: reactivity (exploration of reaction pathways in heterogeneous catalysis), spectroscopy (modeling of excited states for magnetic or optical systems), and development of models for enzymatic and biomolecular systems.

The laboratory has state of the art instrumentation and working spaces (new building since 2018).

▪ **Publications of the team in the field:**

This is a completely new project with an unprecedented chiral platform (never described) but the laboratory has extensive experience in organic synthesis and chirality. The PhD student will thus benefit of this experience and stimulating environment.

Examples of publications of the laboratory:

- « Synthesis of unnatural steroids, the « Bistro » strategy » Maurin, P.; Moraleda, D.; Pellissier, H.; Santelli, M., *Synlett*, **2015**, 26, 725
- "Magnetogenesis under physiological conditions with probes that report on (bio-)chemical stimuli." Touti, F.; Maurin, P.; Hasserodt, J. *Angew. Chem., Intl. Ed.* **2013**, 52, 4654
- "Synthesis of Cryptophane-223-Type Derivatives with Dual Functionalization" Baydoun, O.; De Rycke, N.; Leonce, E.; Boutin, C.; Berthault, P.; Jeanneau, E.; Brotin, T, *J. Org. Chem.* **2019**, 84 (14), 9127-9137
- "Chiroptical study of cryptophanes subjected to self-encapsulation". Baydoun, O.; Buffeteau, T.; Daugey, N.; Vanthuynne, N.; Chapellet, L.L.; De Rycke, N.; Brotin, T. *Chirality* **2019**, 31, 481

Type of PhD :

1. Full PhD

- Joint PhD/cotutelle (leading to a double diploma) : (Possible if co-director identified in China)
- Regular PhD (leading to a single French diploma) : YES

2. Visiting PhD (for students enrolled at a Chinese institution who will be invited to a French institution to carry out a mobility period) : NO