Fully funded PhD position available:

Design, preparation and chiroptical characterization of chiral molecules and monolayers for Chirality Induced Spin Selectivity studies

Host laboratory: Institut de Chimie de la Matière Condensée de Bordeaux (ICMCB)
Research group: Switchable Molecules and Materials
Host University: Université de Bordeaux, France
Contract duration: 36 months
Keywords: Molecular electronics, Chirality, Synthetic Chemistry, Surface Science, Physical Chemistry, Spintronics

Context of the research project

Molecular electronics is the discipline that studies nano-electronic devices in which the charge transport occurs across a single molecule or a single layer of molecules, to perform simple or complex electronic functions. In recent years, the advent of Big Data, Artificial Intelligence (AI) and the Internet of Things (IoT) comes at a tremendous energetic cost, making it extremely important to develop new energy-efficient electronic technologies. One possible avenue to design devices with ultra-low energy consumption is the development of spintronic devices that rely on the ability to generate currents presenting an asymmetric population of *spin up* and *spin down* electrons. It was recently shown that it is possible to observe **spin-dependent charge transport** in devices containing **chiral molecular spacers.** This exciting new phenomenon, named **Chirality Induced Spin-Selectivity** (CISS), allows to generate currents with very high spin polarizations at **room temperature**. However, to date, there is a very limited understanding as to how the different molecular properties affect the occurrence and/or the magnitude of the CISS effect, and this is the fundamental question that this project will address.

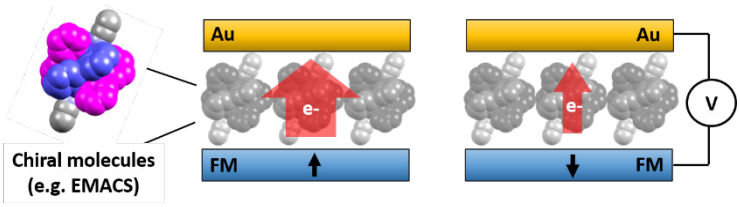

Fig.1. Magnetic field-dependent transport through chiral molecules

Objectives

The main goal of this project is to provide **systematic comparative studies to rationalize the occurrence and magnitude of the CISS effect in molecular nanodevices**. In order to reach those objectives, we will synthesize series of coordination compounds designed to present a range of stable chiroptical activities, that will be deposited as thin films or grafted as monolayers on metallic substrates while preserving both their structure and their enantiopurity. We will then thoroughly study the chiroptical properties of these thin films by a range of surface sensitive spectroscopies. Ultimately, the CISS effect induced by these chiral surfaces will be studied (partly in house, partly with the help of external collaborators) by integrating them into vertical charge transport devices to probe their spin dependent properties and analyze their CISS activity.

Candidate profile

We are looking for a candidate with a master's degree in chemistry with a strong interest in making functional molecular systems to study their physico-chemical properties. Knowledge of synthetic chemistry is a must, and knowledge of surface chemistry and chirality would be a clear advantage for this project.

Initially, the candidate will mainly be involved in the design and synthesis of the series of compounds:

- Organic synthesis, coordination chemistry, chemical characterizations (XRD, NMR, FT-IR, MS, Raman)

The candidate will then use these compounds to prepare and study chiral self-assembled monolayers:

- Preparation of the metallic substrates
- Preparation of monolayers, surface characterizations

The candidate will then benefit from the experience of the ISM team that will assist him/her in the study of the chiral properties of the compounds in solution and on surfaces. Depending on the advancement of the project, the charge transport measurements will either be performed partially by the candidate in house (with the assistance of current group members working on related topics) or exclusively by our external collaborators.

The candidate will learn to work independently and in a multidisciplinary setting in collaboration with spectroscopists and physicists. Good oral and written communication skills and English proficiency would be a plus for the dissemination of the results (publications, conferences…).

Working environment

The project will be funded by the GPR Light initiative for the salary of the PhD student with the support of the PEPR Spin research program. The work will take place in close collaboration between two teams on the Bordeaux/Pessac campus, at the Institut de Chime de la Matière Condensée de Bordeaux (ICMCB) for the synthesis and surface chemistry and at the Institut des Sciences Moléculaires (ISM) for the different spectroscopic techniques.

The student will be hosted mainly at ICMCB in the Switchable Molecule and Materials group. The team has fully equipped labs for chemical synthesis and chemical characterization of the compounds as well as full access to powder, single crystal and surface diffractometers, chemical characterization (NMR, FT-IT, CHNS microanalysis, ICP-OES). It has access to the PLACAMat platform for electron microscopies, XPS, and Tof-SIMS (among others) and free access to a mass spectrometer at a neighboring laboratory. It also has its own thermal evaporator (metals and organics), a spin coater, a table-top AFM, an EGaIn molecular junction setup, a polarimeter and a joint analytical-semipreparative HPLC chain. Additionally, the *Molecular Spectroscopy* team at ISM will provide the know-how and access to the characterization of the surfaces by PM-IRRAS and Vis-RAS, the characterization of the chiral molecular assemblies on nanoparticles by ROA, HROA and, and the surface chiroptical spectroscopies such as E-SHG and CPM-IRRAS.

Funding

Starting date: No later than October 2023
Contract duration: 36 months
Remuneration: ca. 2000 €/month gross (ca. 1600 €/month net)

To apply

Interested candidates are invited to send a CV, motivation letter and contact details of two referees to Mathieu Gonidec: mathieu.gonidec@icmcb.cnrs.fr