MOLTECH-Anjou
UMR 6200 CNRS - Université d'Angers
Dr. Alexandre Abhervé, CR CNRS

PhD position | Spin-light-emitting diodes and spin-dependent field-effect transistors based on chiral halide perovskites

Contract	Fully funded 3-year PhD position
Starting date	October 2026
Institution	Laboratoire MOLTECH-Anjou (UMR CNRS 6200, Université d'Angers)
Contact	Dr. Alexandre Abhervé, email: alexandre.abherve@univ-angers.fr

A full-time 3-year PhD position is available in the CIMI group (*Chimie Inorganique, Matériaux et Interfaces*) at MOLTECH-Anjou laboratory (Angers, France) under the supervision of Dr. Alexandre Abhervé. The project is dedicated to the synthesis of chiral π-conjugated organic cations and their insertion in halide perovskite compounds, the characterization of their chiroptical properties, and the fabrication of spintronic devices based on these new materials.

Spintronic devices use, among the charge, the spin of the electron, leading to tremendous growth in data storage technologies. Combining electronic and spin properties in the same chiral material is the idea of the new field of « chiro-spintronics ». Chiro-spintronics may benefit from the spin selectivity of chiral molecules as a substitute for ferromagnetic materials. This spin-specific interaction between electrons and chiral molecules is called CISS ("chirality-induced spin selectivity") and was first reported on chiral organic molecules by R. Naaman *et al*. (*J. Phys. Chem. Lett.* **2012**, *3*, 2178-2187). Therefore, spintronic devices using chiral materials can operate at room temperature (*Nat. Rev. Chem.* **2019**, *3*, 250-260). To reveal this potential application, two types of devices are particularly promising: (i) spin-light-emitting-diodes (spin-LEDs), using a chiral layer as a spin filter in order to inject spin-polarized current into the emissive layer, hence resulting in increased quantum efficiency as well as polarized electroluminescence due to the spin selectivity; (ii) spin-dependent field-effect transistors (FETs), in which the electric current can be switched on and off depending on the selected enantiomer and the relative direction of an external magnetic field. A promising family of chiral materials are halide perovskites (HPs) due to their efficient charge carrier diffusion length and strong CISS effect (*Adv. Mater.* **2023**, *35*, 2305784). While spin-LEDs have been recently reported using lead-based chiral HPs (*Science* **2021**, *371*, 1129-1133; *Adv. Mater.* **2024**, *36*, 2309335), spin-dependent FETs have not been obtained with these materials. Thanks to our recent contribution on the synthesis of a large family of chiral HP compounds, especially lead-free "double halide perovskites" (DHPs, *Adv. Optical Mater.* **2025**, *13*, 2402949), a new generation of devices can be targeted. We also recently synthesized chiral electroactive cations which may allow to obtain the first example of chiral HP compounds in which the LUMO of the organic cation participate to the band gap of the hybrid material, an ideal case for charge separation. More π-conjugated organic cations can be targeted to expand this promising family of compounds. Therefore, the objectives of the projects are the synthesis of chiral electroactive organic cations and their use for the crystallization of chiral HPs, the characterization of their chiroptical and

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spin polarization properties (CISS effect), and the fabrication of spintronic devices such as spin-LEDs and spin-dependent FETs. Theoretical calculations will provide a rationale for the parameters influencing the spin splitting in chiral HPs and resulting spintronic properties.

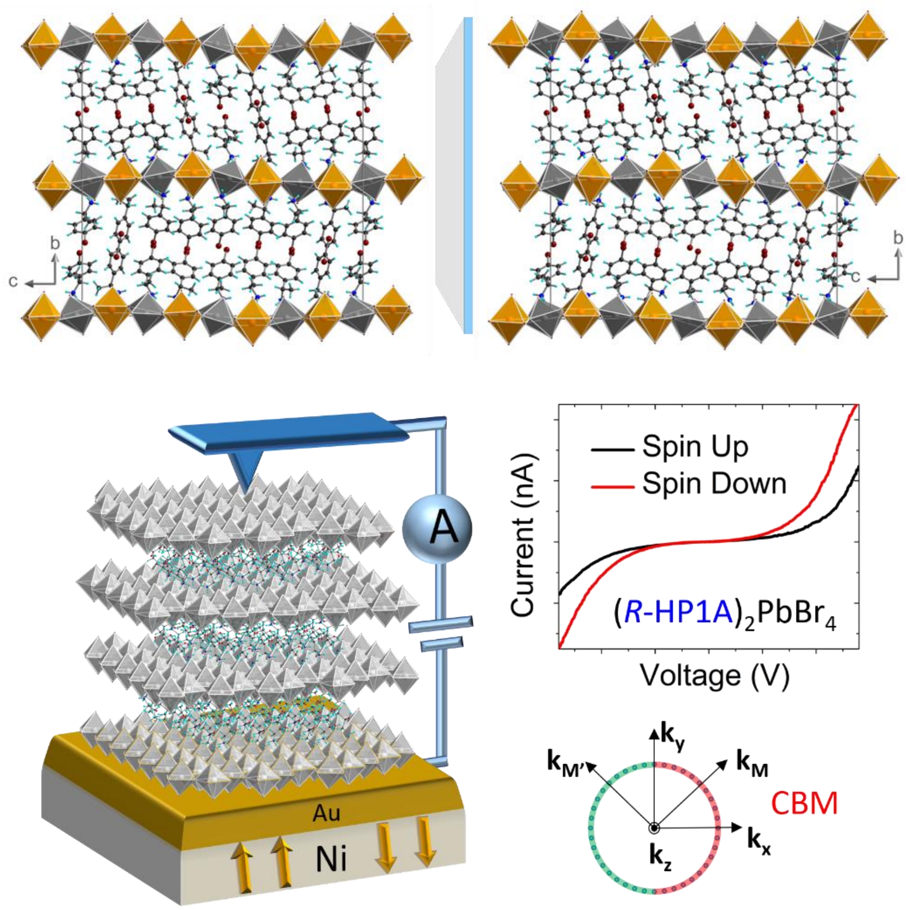

Figure | Top: Example of two enantiomers of 2D chiral HPs recently synthesized in the team. Bottom: Illustration of the CISS effect measurements, with an example of spin texture calculated in the conduction band maximum.

Profile of the candidate | The candidate will be responsible of the synthesis and characterization of chiral π-conjugated organic cations, the crystallization of chiral halide perovskite compounds based on these cations and the structural characterization by single-crystal and powder X-ray diffractions. Subsequently, the candidate will study the chiroptical properties on spin-coated thin films, while theoretical calculations will bring information about the band structure and spin texture of the new materials. Finally, the most promising materials will be inserted into devices. The candidate will be trained to prepare Spin-LEDs at MOLTECH-Anjou, as well as spin-dependent FET devices during two stays (of 4 months each) in the partner's laboratory at *Université Libre de Bruxelles* under the supervision of Dr. Guillaume Schweicher.

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