PhD position

Fundamental mechanisms for self-powered hybrid perovskite-based optoelectronic devices

Context and objectives

This three-year PhD project aims to achieve a microscopic fundamental understanding of ferroelectric metal halide perovskites and optimize these properties for use in next-generation self-powered optoelectronic devices. The project will leverage the complementary and interdisciplinary expertise of two research groups: the HyMaD chemistry group at Hasselt University, and the CRISP physics group at Université de Lorraine. Throughout the program, the PhD candidate will synthesize and grow lead-free ferroelectric hybrid perovskite single-crystals within the HyMaD group, and subsequently investigate their structural and optoelectronic properties under external electric fields within the CRISP group in Nancy. The doctoral student will be registered at the Université de Lorraine, and co-supervised by Sébastien Pillet and Elodie Tailleur (Université de Lorraine), and Wouter Van Gompel (Hasselt University).

Research program

The research program will cover several aspects :

1. Crystal engineering for lead-free perovskites

New lead-free perovskites will be synthesized in the HyMaD group at UHasselt using strongly polar organic cations to enhance the overall electric polarization. The chemistry environment at HyMaD will allow the PhD student to acquire new knowledge and expertise on the synthesis of hybrid materials. We will follow a strategy to replace the toxic lead chemical element by alternative elements (such as Ge) while preserving and even enhancing the ferroelectric performance.

2. Structural and symmetry analysis as a function of temperature

In order to decipher the origin of the ferroelectric polarization, the crystal structure of the elaborated samples will be derived by single crystal X-ray diffraction methods. These results will be complemented by differential scanning calorimetry and second harmonic generation methods.

3. Dynamics of ferroelectric switching

The structural response of the synthesized ferroelectric hybrid perovskites will be investigated under varying electric fields, with the aim of identifying the key atomic-scale parameters that govern polar distortions. Additionally, polarized optical microscopy will be utilized to visualize ferroelectric domain configurations and track their dynamics under external field application.

4. Ferroelectricity induced optoelectronic properties on single crystal devices

The dynamics of charge carriers under external electric field will be monitored using time-resolved (TR) optical methods: TR-optical absorption, and TR-photoluminescence. Such experiments will be conducted as a function of temperature on the setup available at CRISP-CRM2 with nanosecond time resolution.

Candidate profile

Applicants must be graduated from a master's degree in physics or material science, and need to demonstrate a good understanding of crystallography and practical qualities as an experimentalist. The successful candidate is expected to have good ability for team work and dynamism on learning new skills. Applicants must be fluent in English and/or French with abilities in scientific writing.

How to apply

Applications should be submitted to Sébastien Pillet (sebastien.pillet@univ-lorraine.fr), Elodie Tailleur (elodie.tailleur@univ-lorraine.fr) and Wouter Van Gompel (wouter.vangompel@uhasselt.be) and should include the following information:

- CV including grade from master degree

Deadline for application is 09/06/2025. Start is autumn 2025.