



UNIVERSITÉ
DE LORRAINE



Post-doctoral fellowship (one year position)

Metal halide perovskite nanocomposite thin films for X-ray photodetectors

Contacts :

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Context and objectives

X-ray detection is extensively used across various application areas, from medical diagnostics to industrial non-destructive testing. Current technologies rely on inorganic semiconductors (Si, α -Se, CdTe, HgI₂), which are costly to manufacture, especially for imaging applications. Hybrid organic-inorganic perovskites (HOIPs) are emerging as promising semiconductors due to their exceptional properties, including strong X-ray absorption, high charge carrier mobility, near-unity quantum yields, and ultrafast response times. Their preparation method via soft chemistry in aqueous solution offers a cost-effective alternative to traditional semiconductors. This project aims to establish a proof of concept for the development and use of hybrid perovskite nanocomposites in the form of thin films deposited on ITO electrodes (HOIP@SiO₂) as the foundation for next-generation X-ray photodetectors. This approach seeks to enhance the response time, sensitivity and spatial resolution of photodetectors, surpassing the capabilities of existing technologies.

Research program

The successful execution of this project involves several successive elaboration and characterization steps that will be carried out in different specialized laboratories in close collaboration : LCPME-Nancy, CRM2-Nancy, CEA-LETI-Grenoble.

1. Elaboration of HOIP@SiO₂ nanocomposite thin films

Nanoporous ordered silica thin films will be elaborated using electrochemical methods by the electro-assisted self-assembly technique developed by the ELAN team at LCPME. Nanoparticles of metal halide perovskite semiconductors will be confined by solution impregnation, while the growth process will be verified through in situ cyclic voltammetry.

2. Physico-chemical characterization of the elaborated films

The quality of the silica thin films and successful elaboration of nanocomposites will be verified using a combination of XPS, and infrared spectroscopy, while the long term stability to air and humidity will be assessed.

3. Electrochemical characterization

The response of the confined halide perovskite objects to charge injection and charge extraction will be investigated through cyclic voltammetry and spectro-electrochemistry performed on the nanocomposites on ITO electrodes.

4. Structural characterization

The structural properties of the elaborated nanocomposite thin films will be monitored using a combination of TEM, GISAXS and X-ray diffraction. Of crucial importance is the quality of the silica films with a perfect ordering of the nanoporosity characterized by a hexagonal pattern of nanochannels oriented perpendicular to the supporting electrode. The silica film will be analyzed by TEM and GISAXS. The exact crystal phase of the nanoconfined metal halide perovskite will be studied using standard X-ray diffraction methods.

5. Optical properties

Metal halide semi-conductors exhibit strong optical absorption, characterized by the optical band gap, and efficient photo-luminescence resulting from recombination of the charge-carriers. Optical absorption and photoluminescence properties of the elaborated nanocomposite will be investigated at CRM2.

6. Performance for X-ray photodetection

X-ray photodetection performance of the elaborated nanocomposite films will be evaluated in collaboration with CEA-LETI in Grenoble (France).

References

- [1] A. Goux et al. *Chem. Mater.* (2009), **21**, 731.
- [2] Z. Li et al., *Mater. Today*, (2021), **48**, 155

Salary : 2 700€ (Gross) / month

Starting date : July 1st 2025

Applicants must hold a PhD in Physics, Chemistry and or Material Science ; good skills in physico-chemical investigation methods (infra-red spectroscopy, X-ray diffraction) and electrochemistry is expected. Good track record of dissemination (papers, conferences, ...). Fluent in both written and spoken English.

Collaborations :

- CRM2-Université de Lorraine (CRISP team, <https://crm2.univ-lorraine.fr/en/research/teams/crisp/>)
- LCPME-CNRS (ELAN team, <https://www.lcpme.ul.cnrs.fr/en/elan/>)
- CEA-LETI (<https://www.leti-cea.fr/cea-tech/leti/Pages/Accueil.aspx>)

How to apply

Applications should be submitted to Sébastien Pillet (sebastien.pillet@univ-lorraine.fr) and Neus Vilà (neus.vila.cusco@uab.cat) and should include the following information:

- Curriculum Vitae - Your most recently updated C.V. including list of publications
- Motivation letter
- Persons who can be contacted for additional information / recommendation letters

Deadline for application is 30/04/2025