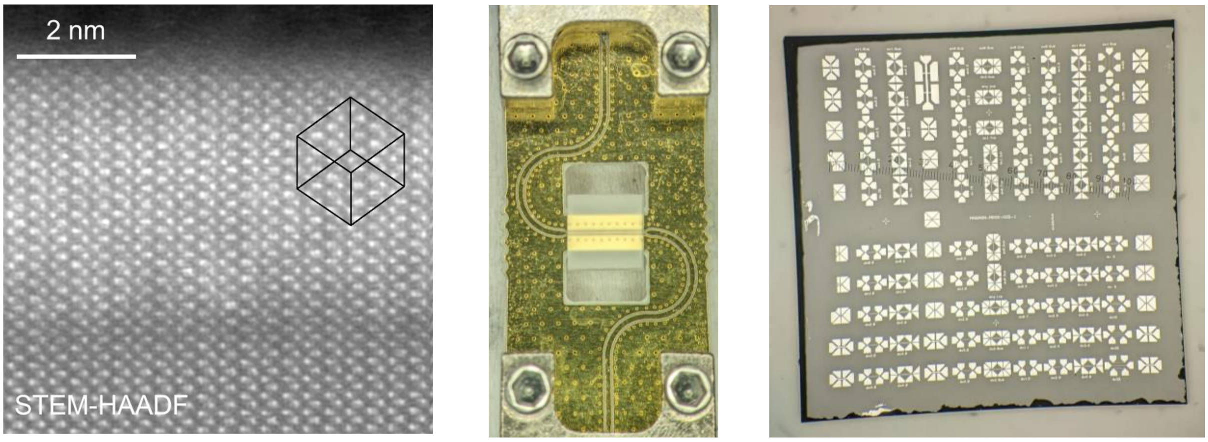
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2024-2025

Substituted iron garnets for low-temperature magnonics

General Scope: Magnonics is a thriving field in modern magnetism, whose aim is to investigate the behavior of magnetic excitations in nanostructures and use them to conceive novel electronic devices. This experimental approach is supported by the tremendous progress made over the recent years in the synthesis of ultrathin (<100 nm) epitaxial films of magnetic insulators. While applications to room-temperature common electronics are now thoroughly investigated, there remains a largely unexplored potential for turning them into compact cryogenic microwave devices, which are in high demand, for instance, in quantum technologies. A critical historical issue of low-temperature magnonics, related to the substrate compatibility in epitaxial synthesis, in on the verge of being overcome, relying on alternative compositions in garnet systems [1,2].



From left to right: Cross-sectional transmission electron microscope view of a 6 nm thick epitaxial film of Bi-doped iron garnet [Collab. U. Zaragoza]; Device for cryogenic microwave magnetization dynamic experiments on extended films; Nano-fabricated chip with several types of magnonic devices.

Research topic and facilities available: This M2 research internship is conceived as a follow up of our prior work dealing with epitaxial thin films of substituted iron garnets, addressing magnonic experiments at low temperatures [2]. Relying on magnetron sputtering deposition, X-ray diffraction tools, cryogenic SQUID magnetometry, optical (Brillouin) magnetic spectroscopy and magnetization dynamic experiments, you will participate to our quest of the best synthesis of magnetic insulators featuring unique properties at low temperatures. In a later stage, the goal is to couple these iron garnet nanomagnets to superconducting resonators, as a base brick to build integrated cryogenic microwave devices with highest figures of merit.

Possible collaboration and networking: We collaborate on this topic within a network of colleagues working at Spintec (Grenoble), UBO (Brest), ETH Zurich, and the University of Konstanz.

Possible extension as a PhD: Yes

Required skills: We are looking for a curious student, motivated by learning from mentors and colleagues to acquire a wide range of skills in experimental physics. This project requires a background and a strong interest in physics combined with materials science.

Starting date: ideally Feb-Mar 2025, contact us

Contact: William Legrand (william.legrand@neel.cnrs.fr), Laurent Ranno (laurent.ranno@neel.cnrs.fr)
MNM team; Institut Néel – CNRS

[1] Guo, S. et al. Strong on-Chip Microwave Photon–Magnon Coupling Using Ultralow-Damping Epitaxial $Y_3Fe_5O_{12}$ Films at 2 K. *Nano Lett.* **23**, 5055–5060 (2023).
[2] Legrand, W. et al. Lattice-tunable substituted iron garnets for low-temperature magnonics. *arXiv preprint arXiv:2407.06850* (2024).