Electro-optic response in layered in-plane-polarized ferroelectric thin films

laboratoire Albert Fert

Scientific Context

Layered Carpy-Galy oxides (general formula $A_nB_nO_{3n+2}$, e.g. $La_2Ti_2O_7$) are a versatile family of ferroelectric materials consisting of perovskite blocks separated by additional oxygen planes. Their *uniaxial in-plane* polarization, arising from cooperative oxygen octahedral rotations, makes them fundamentally different from conventional ferroelectric perovskites and **potentially valuable for electro-optic applications (e.g. photonic integrated circuits).**

In our laboratory, through epitaxy we stabilized high-quality, single-crystalline thin films of these compounds, with nearly four-fold increase in ferroelectric polarization [1]. This opens the way to investigate their electro-optic properties, in particular, the Pockels effect, which describes the linear modulation of refractive index of a material under an applied electric field. **Studying this effect in layered ferroelectrics will provide insight into how their uniaxial in-plane polarization influence electro-optic coefficients, thus evaluating their potential for compact on-chip electro-optic modulators [2].**

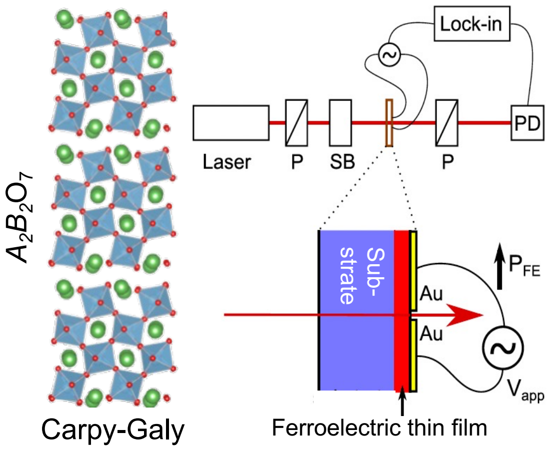

Fig. 1. The layered structure of the Carpy-Galy ferroelectric. Experimental set-up for transmission measurements of electro-optic properties.

Work program & skills acquired during internship

During the internship, the student will learn the basics of thin-film **structural characterization** (X-ray diffraction, atomic force microscopy) to determine film orientation and quality; perform **ellipsometry measurements** to extract the refractive indices and assess the material's birefringence; set up and carry out **electro-optic coefficient measurements** using a laser, Soleil-Babinet compensator, polarizer, and photodiode combined with lock-in amplifier detection [3] to quantify the effective electro-optic coefficients; compare results with theoretical predictions/canonical ferroelectric materials and uncover how the anisotropic layered structure and uniaxial in-plane polarization affect electro-optic properties.

The project will primarily focus on thin-film optical characterization and data interpretation, with a brief introduction to material properties. The **knowledge in optical measurements** (ellipsometry, birefringence, etc.) is a plus.

1. Gradauskaite, E. *et al. Adv. Mater.* **37** (12), 2416963 (2025).
2. Abel, S. *et al. Nat. Mater.* **18**, 42 (2019).
3. Sando, D. *et al. Phys. Rev. B* **89**, 195106 (2014).

Work environment

You will be working under the supervision of: **Elzbieta Gradauskaite (elzbieta.gradauskaite@cnrs-thales.fr , CNRS), Manuel Bibes (CNRS), Jérôme Bourderionnet (Thales), Gilles Feugnet (Thales).**

https://laboratoire-albert-fert.cnrs-thales.fr/
Laboratoire Albert Fert
Located in: Thales Research and Technology
1 avenue Augustin-Fresnel
91767 Palaiseau, France

Requested background : **Master 2**
Duration : **4-6 months**
Start period : **Feb 2026**
Possibility of the PhD thesis: **YES**

Contact : elzbieta.gradauskaite@cnrs-thales.fr ; https://oxitronics.cnrs.fr

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