M2 Internship Proposal

Growth and characterization of LaCoO3 thin films for memristive device applications

Context

A memristor (memory + resistor) is an electronic device whose resistance depends on the history of the voltage or current applied to it. This property allows the device to retain information about its previous electrical state, making it a promising candidate for non-volatile memory technologies and neuromorphic computing, where hardware aims to reproduce the adaptive learning behavior of biological synapses. Memristive devices typically have a metal-oxide-metal structure, where the switching between different resistance states is driven by oxygen ion migration within the oxide layer. The specific physical mechanisms responsible for the switching depend strongly on the material system used.

Recently, the memristive devices based on the oxygen-driven topotactic phase transitions attracted attention for hardware neuromorphic architectures [1]. Among other materials, Lanthanum cobaltite ($LaCoO_3$) is a perovskite oxide known for its ability to undergo such transitions: the crystal structure changes while preserving the overall lattice framework [2,3]. These transformations are closely coupled to variations in electronic conductivity; therefore, understanding the oxygen diffusion kinetics and their coupling with electronic transport is crucial for the design of next-generation oxide-based electronic devices.

Objectives of the internship

In this project, we aim to investigate $LaCoO_3$ as a novel memristive material in which the resistive switching is governed by controlled oxygen migration and associated structural transitions. The student will participate in the synthesis of $LaCoO_3$ thin films followed by their structural, chemical, and electrical characterization. The objective is to establish the correlation between oxygen diffusion, topotactic phase transitions, and memristive behavior in this system. The work will involve the following main tasks:

1. **Thin film growth by Metal-Organic Chemical Vapor Deposition (MOCVD)**
    - Growth of $LaCoO_3$ on different substrates (STO, LAO, etc.)
2. **Structural and chemical characterization**
    - **X-ray Diffraction:** phase identification, texture, and crystallinity
    - **X-ray Photoelectron Spectroscopy:** composition and oxidation state analysis
    - **Scanning Electron Microscopy:** surface morphology
    - **Raman spectroscopy:** investigation of phonon modes and oxygen stoichiometry
3. **Electrical characterization of devices**
    - Measurements using a semiconductor parameter analyzer (Keithley 4200)
    - Investigation of resistive switching behavior, reliability and variability

Depending on progress, additional studies (temperature dependence, atmosphere effects, or operando Raman) may be considered to link the switching behavior with the oxygen dynamics.

Working environment

The intern will join the LMGP (Laboratoire des Matériaux et du Génie Physique), located at the MINATEC campus in Grenoble. LMGP provides access to advanced thin-film deposition tools and materials characterization instruments (XRD, SEM, AFM, Raman). Electrical measurements are performed with the device characterization platform, equipped with a probe station and a semiconductor parameter analyzer. The intern will work in a multidisciplinary and polyvalent team including PhD students and postdoctoral researchers.

Candidate profile

- Master 2 student in Materials Science, Physics, Nanotechnology, or Electrical Engineering
- Interest in experimental work on functional oxides and electronic devices
- Basic knowledge of thin film growth and characterization techniques (XRD, SEM, Raman, etc.)
- Motivation and good communication skills

Practical information

- **Location:** LMGP, Grenoble INP-UGA, 3 Parvis Louis Néel, 38000 Grenoble
- **Duration:** 6 months (full-time)
- **Start date:** February 2026 (flexible)
- **Allowance:** standard French M2 internship stipend (~700 €/month)

Contact

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References

[1] Nallagatla et al. Complementary Resistive Switching and Synaptic-Like Memory Behavior in an Epitaxial SrFeO2.5 Thin Film through Oriented Oxygen-Vacancy Channels, ACS Applied Materials & Interfaces 2020 12 (37), 41740-41748, 10.1021/acsami.0c10910

[2] Shin et al. Investigations on the Origin of Topotactic Phase Transition of LaCoO3 Thin Films with In Situ XRD and Ambient Pressure Hard X-ray Photoelectron Spectroscopy, ACS Applied Materials & Interfaces 2025 17 (1), 1499-1508, 10.1021/acsami.4c15505

[3] Huang et al. Topotactic transition between perovskite and brownmillerite phases for epitaxial $LaCoO_3$ films and effects thus resulted, 2020 J. Phys. D: Appl. Phys. 53 155003, 10.1088/1361-6463/ab6bef