

2024-2025 Internship proposal at LMGP Lab.

Criticality and Performance of Zinc Oxide Associated with the Energy Transition

Context

Low-carbon energy production technologies rely on an expanding range of materials. These materials face criticality constraints, which are currently studied in industry and public policy, but largely absent from research in materials science. This internship is part of an interdisciplinary effort to integrate criticality issues and the latest technological advancements in zinc oxide (ZnO) to facilitate deeper reflection on the materials of the future.

Project description

The goal of the internship is to develop scenarios for ZnO applications in solar energy recovery (e.g., photovoltaic devices) and mechanical energy recovery (e.g., piezoelectric devices), to integrate ZnO into an original biophysical model currently being developed at ISTerre. Three objectives can be identified:

- **Objective 1:** Build a database on the energy applications of ZnO through a state-of-the-art analysis, including laboratory measurements on calibrated layers fabricated by various vapor-phase and liquid-phase chemical deposition techniques (sol-gel, CBD, MOCVD, ALD, SALD) and advanced characterization of calibrated ZnO layers by SEM, AFM, TEM, Raman spectroscopy, and electrical measurements.
- **Objective 2:** Develop global energy transition scenarios incorporating ZnO energy applications.
- **Objective 3:** Analyze the evolution of raw material criticality in the modeling.

The student will conduct literature reviews, laboratory measurements, usage scenarios, and utilize a material consumption accounting model—MATER (Metabolic Analysis for Transdisciplinary Ecological Research).

Scientific environment

GAEL is a joint research unit of CNRS, INRAE, Université Grenoble Alpes (UGA), and Grenoble INP. The laboratory has been conducting prospective modeling of energy systems since the 1990s, and it currently hosts the POLES model (Prospective Outlook on Long-term Energy Systems), used for prospective studies by the European Commission and the third working group of the IPCC. The team enjoys high visibility at national, European, and international levels due to its participation in European research programs.

LMGP (Laboratory of Materials and Physical Engineering) is a joint research unit (UMR 5628) of CNRS and Grenoble INP within Université Grenoble Alpes, located at the Minatec site in the PHELMA (Physics, Electronics, Materials) engineering school buildings. It specializes in semiconductor materials science. The Nanowires & Semiconductor Nanostructures group at LMGP has developed expertise in the chemical synthesis of thin films and ZnO nanowires/nanostructures using liquid-phase and vapor-phase deposition techniques (CBD, ALD, MOCVD, etc.). We focus on controlling growth mechanisms and mastering the basic properties of these materials for applications in photovoltaics and piezoelectricity. The team benefits from numerous national and European research grants and has developed an extensive network of collaborations.

Laboratory websites: LMGP (<http://www.lmgp.grenoble-inp.fr/>) and GAEL (<https://gael.univ-grenoble-alpes.fr/accueil-gael>)

Profile & requested skills

- **Required**
 - Engineering background in materials science or equivalent
 - Knowledge of Python programming
 - Proficiency in English
 - Strong quantitative and analytical skills
- **Preferred**
 - Interest in materials growth and characterization, interdisciplinary approaches, modeling, and energy transition issues

Contacts

Interested candidates should contact Estelle Appert and cc Hugo Le Boulzec. Please include "ZnO Criticality Internship" in the email subject line. Application deadline: November 15, 2024.

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