PROPOSITION DE STAGE
INTERNSHIP PROPOSAL

2026

☐ Licence ☐ Master 1 ☑ Master 2 ☐ Fin d'études

Nom du laboratoire / Laboratory name: Laboratoire de Physique des Gaz et des Plasmas - L.P.G.P.

Code d'identification: *UMR 8578*

Organisme / Institution: CNRS - Université Paris-Saclay

Adresse/ Address: Bât. 210 rue Henri Becquerel, 91405 Orsay Cedex

Site internet / website: www.lpgp.universite-paris-saclay.fr

Lieu de stage / Internship place: L.P.G.P., Bât. 210, Campus Orsay Vallée

Responsable de stage / Internship supervisor

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Autres contacts / Other contacts:

Stage / Internship

Durée / Duration: 5-6 months

Prise en charge du transport / Payment for transport: Yes

Rémunération / Scholarship: Yes

Intitulé de stage / Subject: Deposition of Zirconium Oxide Thin Films by Magnetron Sputtering

Résumé / Summary: This internship focuses on studying how magnetron sputtering conditions control oxygen vacancies, stoichiometry, and magnetic behavior in ZrO_x films deposited by HiPIMS, MF, and RF techniques.
The student will gain hands-on experience in thin film deposition and data interpretation, contributing to a process-property map and potentially to a scientific publication.

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Sujet de stage / Description

Magnetic materials play a key role in modern technologies such as data storage, sensors, and emerging spintronic devices. In the search for new material systems compatible with these applications, increasing attention has been devoted to oxide-based materials in which functional properties can be tuned through defects rather than conventional magnetic dopants. Within this framework, zirconium oxide-based materials have attracted growing interest. While stoichiometric ZrO_2 is non-magnetic and electrically insulating, oxygen-deficient zirconium oxides (ZrO_x) can exhibit metallic or semiconducting behavior and, under certain conditions, measurable magnetic responses. These properties are widely attributed to oxygen vacancies and associated modifications in the local electronic structure. Importantly, the concentration and nature of such defects can be strongly influenced by thin film deposition conditions.

Magnetron sputtering is a versatile and industry-relevant *physical vapor deposition (PVD) technique* that enables precise control over film composition, microstructure, and defect density. By tuning key process parameters, such as oxygen partial pressure, sputtering power, working pressure, and substrate temperature, it is possible to tailor the oxygen vacancy concentration and, consequently, the physical properties of ZrO_x thin films.

The internship proposes an experimental study to investigate the relationships among deposition conditions, defect structure, and magnetic behavior in ZrO_x thin films. After an initial training phase and baseline depositions, the student will systematically vary selected process parameters, including sputtering power, working pressure, and gas composition. ZrO_x thin films will be deposited using *HiPIMS (High-power impulse magnetron sputtering), MF and RF magnetron sputtering* from a metallic zirconium target in an Ar/O_2 reactive atmosphere. Particular attention will be paid to the role of oxygen partial pressure and plasma conditions in determining film stoichiometry and defect formation.

The deposition and primary characterization of the thin films will be carried out at LPGP, while the morphological and structural characterizations will be provided by the Centre de Nanosciences et de Nanotechnologies (C2N). The student will analyze of the obtained results with guidance from experts in plasma physics and materials science at LPGP and C2N, respectively.

Throughout the project, the student will develop practical and analytical skills in thin film deposition techniques, data analysis and scientific interpretation, and scientific reporting and presentation.

By the end of the internship, the student is expected to:

- establish a process-property map for the reactive sputtering of ZrO_x thin films,
- gain a clear understanding of how non-stoichiometry and defects influence the physical properties of oxide thin films,
- identify correlations between deposition parameters and properties of the thin films,
- contribute to a dataset that may serve as a basis for a future scientific publication.

The internship will conclude with the preparation of a written report and an oral presentation summarizing the processing-structure-property relationships observed during the study, along with perspectives for further investigations.