Proposal of PhD in the frame of the ANR project ULTRAZO

Laser-driven permanent material modifications induced in out of equilibrium doped zinc oxide deposited by magnetron sputtering

Context

Transparent conductive oxides (TCOs) are optically transparent thin films of metal oxides used as functional thin films in many applications such as photovoltaics, OLEDs, touch screens, insulating and smart glazing and are crucial for energy transition. High conductivity TCO films require an energetically costly baking step of the film/substrate system, which makes it difficult to decorrelate crystallization, diffusion, activation and defect formation processes that have different activation times and energies. The very large surfaces necessary to cover all these needs together with environmental concerns demand high yield fabrication processes with abundant non-toxic materials and with the lowest possible energy and raw material consumption.

Topics

This PhD is part of the ANR ULTRAZO project, whose goal is to intimately understand and master the local laser modification dynamics at different time scales in out-of-equilibrium inorganic metal oxides. The idea is to deliver precise amounts of energy with precise spatial and temporal widths to control the transformations and strongly reduce undesired processes.

Thesis objectives:

- Understand the impact of selected sputtering parameters on the metal oxide microstructure and dopant insertion. A large pool of characterization techniques, including advanced techniques to investigate the dopant local environment (ex. 2D NMR), photoluminescence spectroscopy and real time analysis (such as infrared thermography).
- Use laser processing to drive the modifications of the low temperature sputtered out-of-equilibrium films. Different kinds of lasers will be used (CW to ultrashort).
- The characterization of the laser process will be carried out both dynamically, using different techniques such as fast thermography and optical measurements (thermal modifications), and after the process. The effect of standard baking will be studied for comparison.
- Use finite element simulations to interpret the observed (thermally induced) modifications and real time data.

The student will interact with a second student (to be hired) studying real time modifications using pump probe experiments, but also with a postdoc (to be hired) carrying out atomistic simulations.

Partners

This thesis will take place between two main laboratories. “Institut Fresnel” in Marseille and “Surface du verre et interfaces”, a joint unit between Saint-Gobain and the CNRS within the Saint-Gobain Research center in Aubervilliers. Photoluminescence spectroscopy experiments will be carried out during specific campaigns at “Institut de physique et chimie des matériaux de Strasbourg” (IPCMS).

Student profile and starting date

Master 2 in research or engineering school with specialization in physics, optics or materials science. Knowledge of solid-state physics, non-linear optics and/or physical deposition methods would be an asset. The PhD work can start between January and October 2025 depending on the graduation date of the applicant.

Contacts

Konstantinos Iliopoulos (konstantinos.iliopoulos@fresnel.fr, PhD director), Matteo Balestrieri (matteo.balestrieri@saint-gobain.com) and Pierre Gilliot (pierre.gilliot@ipcms.unistra.fr)