Master 2 internship

Tuning physico-chemical properties of new Transparent Conducting Oxides (TCO) for tomorrow transparent electronics

Dates: February-July 2024 (~5 months).
A funded doctoral position (ANR grant) is a perspective after the master 2 graduation.

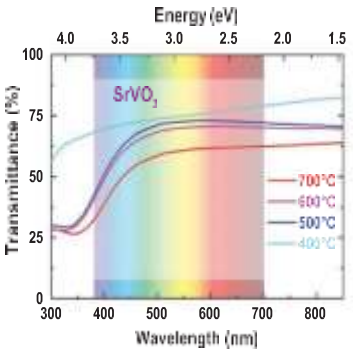
Employer: **Institut Lavoisier de Versailles (ILV, UMR 8180) CNRS / UVSQ – Université Paris Saclay**
45, Avenue des Etats-Unis, 78000 Versailles

Skill's area: Materials Science, Chemistry, Physics

Keywords: **Functional oxide perovskites, XPS spectroscopies, depth profiling, surface reactivity, structural optical electrical properties**

This internship project concerns the active domain of materials science and aim **to discover and validate new oxide materials suitable for breakthroughs in tomorrow's electronics** associated to societal needs of transparent active displays and photovoltaic panels. **In this field, transparent conducting oxides (TCO) are fundamental bricks [1]**, especially **perovskite oxides of chemical formula *ABO₃*** (with *"A"* an alkaline earth cation, here Ca, Sr, Ba, and *"B"* a transition metal cation, here V and Mo) [2]. Their integration as electrodes into visible transparent devices is facilitated by the iso-symmetry and ionicity with other functional oxide perovskites providing ferroelectricity, magnetism, etc.

The goal of this **Master2 experimental project** as part of a starting ANR larger project is to study new ABO_3 TCOs with enhanced electrical conductivity and wider optical transparency , with respect to actual TCO such as indium-tin oxide ITO or fluoride doped tin oxide FTO. For this, ultra-thin film (10-50 nm) will by grown by pulsed laser deposition (PLD) technique, structurally characterized by X-ray diffraction (XRD)and morphologically by atomic force microscopy (AFM). **Central part will be X-ray photoelectron emission spectroscopies (XPS, LEIS)** in order to conduct a fine physico-chemical study and an accurate **chemical state determination** of these new TCO **ultra-thin layers** (free and buried) to correlate with growth conditions and the physical properties such as the optical transmittance in near IR-visible-near UV range, and the electrical properties (resistivity and Hall effect).



Influence of growth temperature on optical transparency of SrVO3 thin films (from [2])

The internship will take place in the "Electrochemistry and Interfacial Physico-chemistry" (EPI) group at the Institut Lavoisier de Versailles (https://www.ilv.uvsq.fr/) in partnership with the "multiFunctional OXide" (FOX) team at the Groupe d'Etude de la MAtiere Condensée (GEMaC) laboratory (https://www.gemac.uvsq.fr/), both located on Versailles Sciences campus. These two groups have a fruitful cooperation on complementary themes: /i/ Advanced surface and interface characterizations, and /ii/ Materials science: from elaboration to physical electronic properties (optical, electrical,). Beside figure illustrates tuning of transparency of $SrVO_3$ thin films with PLD growth temperature.

A special focus on the cationic ratio and oxygen stoichiometry TCO layers will be done as they might be very sensitive to oxygen variation associated to growth conditions, and also to aging under ambient conditions, a crucial point for an applicative perspective. This was deeply studied for strontium-based perovskite oxides $SrTiO_3$ and $SrVO_3$ [3,4] by EPI and FOX teams involved in this internship. Fine analysis of chemical composition of free and buried TCO films will be done by profiling with several sputtering methods (Ar monoatomic and gas cluster ion beam). Thus, combined XPS and LEIS measurements will be performed and an advanced set up for oxide depth-profiling dedicated to the study of buried interface properties will be developed. Oxidizing or reducing treatments, and stability under several pH solutions will be performed and followed by AFM, and by XPS.

*[1] R. A. Afre, et al., REVIEWS ON ADVANCED MATERIALS SCIENCE 2018, **53**, 79.*
*[2] A. Boileau et al., Advanced Functional Materials 2022, **32**, 2108047.*
*[3] K. Ridier, D. Aureau, B. Bérini, Y. Dumont et al., Phys. Rev. B 2018, **97** 035146*
*[4] Y. Bourlier, M. Frégnaux, B. Bérini, Y. Dumont, D. Aureau, Appl. Surf. Sci. 2021 **553** 149536*

Candidates profile:

Candidates should have a particular interest in materials science in both chemistry and physics, and demonstrate knowledges in oxides materials, thin films, and chemical/physical spectroscopies. Scientific curiosity and appetence to experimental work will be appreciated. With your CV and motivation letter, don't wait to contact

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