Post-doc opportunity at the Jean Lamour Institute, CNRS-University of Lorraine, Nancy.

2D oxide materials: synthesis, structure and properties.

Project description:

Ternary oxides with perovskite structures ABO_3 have two cationic species that can be selected among transition metals, lanthanides, simple metals, rare earths or even alkalis. So many possible associations result in a large class of materials exhibiting various properties, from superconductivity to giant magnetoresistance, from metal-insulator transitions to 2D electron gases. When synthesized in the form of thin layers, new phenomena may appear related to the 2D nature of the layers. In particular, when these ultrathin layers are supported on a metal, it becomes possible to more precisely control the stoichiometry of the films and their oxygen vacancy concentration compared to an all-oxide system, because interdiffusion phenomena at the interfaces are largely suppressed. The metallic substrate can also be used to modify the formation, structure and properties of the films, modifying the stress magnitude and the charge transfers at the interface. This is a rapidly growing field that has revealed the existence of new 2D oxide phases whose structures have no equivalent in bulk form.

From a structural point of view, these ultrathin reduced oxide phases can often be described from a few elementary tiles, such as MeO_4 squares (Me: a metal) or MeO_3 triangles. These tiles can be assembled together in different ways to pave the plane and form structures of various complexities, ranging from a simple hexagonal honeycomb structure to quasiperiodic structures with dodecagonal symmetry and their approximant. Such complex phases can be formed by reduction of perovskites thin films grown on hexagonal surfaces of transition or noble metals. This is a new class of 2D ternary oxides whose physicochemical properties are poorly understood. In addition, the number of systems investigated so far is still very limited compared to the vast landscape offered by the numerous possibility of ABO3/Me(111) combinations.

The project proposes **an original "all-thin film" approach** that is more versatile and more easily transferable for applications than using metal single crystals. We will use conventional and inexpensive substrates such as sapphire on which heterostructures will be fabricated by MBE (metal) and PLD (oxides). The general objective of the project is to achieve/control the synthesis of a whole range of new ultrathin oxides with flexible physicochemical properties and to gain a detailed understanding of the growth phenomena and of the chemical bonds and frustrations at interfaces. The work consists in understanding the interfacial interactions favoring the emergence of these new 2D phases and characterizeing their structural and electronic properties as well as their chemical reactivity and wetting properties in view of potential applications, for example in catalysis or electronics. The experimental work will be guided by a theoretical results obtained from numerical simulations based on density functional theory (DFT). The goal will be to study the geometric, electronic, magnetic and thermodynamic properties of ultrathin oxides derived from ABO_3/Me(111) interfaces.

Skills

We seek candidates with a strong background in surface science, ultra-high vacuum techniques, including surface preparation, low-energy electron diffraction, scanning tunneling microscopy and photoemission spectroscopy. Expertise in thin oxide layers would be a plus. We are looking for a young researcher willing to become a world expert in 2D materials, able to work in a collaborative environment, being able to interact with theoreticians, and self-determined to conduct this research project under the supervision of senior researchers.

Workplace:

The project will take place at the Jean Lamour Institute that is among the largest French laboratories for material sciences (https://ijl.univ-lorraine.fr/). The institute is part of the CNRS (http://www.cnrs.fr/index.php) and the Université de Lorraine (http://www.univ-lorraine.fr/). The project involves three different research groups and state of the art equipments for thin film growth and surface characterization in ultrahigh vacuum (UHV), including a 70-meter long UHV tube connecting more than 20 different chambers (MBE, PLD, XPS, ARPES, RHEED, LEED, SAM, SEM, STM, etc..) as well as 2 standalone UHV multi-technique platforms (STM, LEED, XPS, UPS, etc..).

The Jean Lamour Institute is located in Nancy, a dynamic mid-size city with a population of > 200 000, including about 48000 students and 3700 professors and researchers.

Contract:

Duration of contract: 18 months.
Salary: 2.663,79 €/month (gross) equivalent to 2.140,87 €/month (net).

Contact:

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