2020-2021

Master thesis proposal

CENTRE DE NANOSCIENCES ET DE NANOTECHNOLOGIES

Université Paris Saclay, C2N
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Director : Giancarlo Faini

Title: Study of ferroelectric and 2D materials heterostructures

Keywords: Functional oxides, ferroelectrics, 2D materials, surfaces & interfaces

Scientific description: Two-dimensional materials have emerged as a rich field of study with new solid-state physical properties and high potential value for applications. Moreover, because of the weak van-der-Waals interlayer interactions, it is possible to stack various 2D materials, or to couple them with other nanomaterials such as nanocrystals, to create 2D/2D or 2D/0D van der Waals heterostructures with novel properties and functionalities.
In the other end, ferroelectric materials are functional materials with remnant spontaneous electric polarization that can be reversed by an external electric field. This unique property makes them important for many applications, e.g., nonvolatile memories, field-effect transistors, and optoelectronic devices. Coupling 2D materials with ferroelectrics opens the doors to interesting and relatively little explored physical interfacial phenomena.

The purpose of this internship is to study how the ferroelectric polarization can modulate the electronic properties of a 2D semiconductor deposited on top of the ferroelectric material. Two types of ferroelectric materials will be investigated: epitaxial ferroelectric thin films and novel 2D ferroelectrics. The ferroelectric polarization will be studied and controlled by piezo force microscopy (see Figure). The 2D semiconductor will be deposited on top with special attention paid on the interface quality. The effect of the ferroelectric polarization on the 2D semiconductor will be studied by photoluminescence and Raman spectroscopy. This project will give valuable results on the potential of ferroelectric-2D heterostructures for novel non-volatile memories and field effect devices.

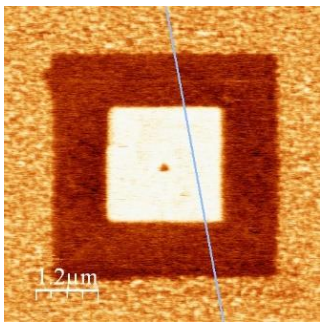

Figure: Piezo Force Microscopy image (phase) showing different orientations of the ferroelectric polarization in a PZT thin film, after electrical writing.

Techniques/methods in use: Epitaxial growth of oxide thin films by pulsed laser deposition (PLD), ferroelectric characterization by Piezo Force Microscopy (PFM), characterization of the 2D materials by photoluminescence and Raman spectroscopy mapping.
Applicant skills: Gifted and willing for experimental physics, well-disposed towards scanning probe microscopy, with a background in materials science and/or solid state physics.
Industrial partnership: N

Internship supervisor(s): Thomas Maroutian (thomas.maroutian@u-psud.fr , 01 70 27 04 89)
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Internship location: Centre for Nanoscience and Nanotechnology (C2N), Univ. Paris-Saclay

Possibility for a Doctoral thesis: Y