PHD STUDENT PHYSICS AND MATERIALS SCIENCE (H/F)

PhD PROJECT « Integration of oxide ferromagnets with high spin polarization onto ZnO-based 2D, 1D nanostructures: growth, structure, properties and first demonstrators »

Spin-based technology is viewed as a promising field on the “beyond-CMOS” roadmap as it offers a possible solution to reduce the heat of Information Technology devices as their dimensions shrink. Exploiting the spin instead of, or in addition to, the charge degree of freedom, could lead towards new multifunctional devices offering non-volatility, higher processing speeds, higher packing densities and reduced power consumption. While spintronics is a multi-disciplinary field, there is a worldwide effort to integrate semiconductors and magnetic materials, as, at the very fundamental level, an efficient spin injection and detection of spin in semiconductors is essential to the field, but remains an unsolved issue. The national research project “SPINOXIDE”, just selected by French National Research Agency in 2019, aims at taking advantage of the exceptional spin diffusion length and lifetime in ZnO wurtzite crystal structure, and ZnO compatibility for

the epitaxy of oxide ferromagnets with high spin polarization. This project, with convincing preliminary results (see figure), associates expert teams on: growth of ZnO-based 2D quantum wells and 1D nanowires, growth and properties of ferromagnetic oxides, advanced structural studies (X-ray diffraction, electron microscopies), spin photo-detectors and emitters, and magneto-optical studies of such materials and devices.

In the contractual frame, this PhD project aims at a thorough study, in sense of material science, of the epitaxy of two different ferromagnetic oxidests with a high spin polarization at room temperature onto 2D and 1D ZnO-based heterostructures. The FMO materials to be tested will be Fe_3O_4 with cubic spinel structure, and $Fe_{1.5}Ti_{0.5}O_3$ with corumdon structure with an hexagonal sublattice as that of the ZnO wurtzite. Both will be deposited by Pulsed Laser Deposition (PLD). ZnO-based nanostructures will be 2D quantum wells and 1D nanowires. The PhD student will be in charge of the PLD growth at GEMaC, then of the advanced structural studies by X-ray diffraction and by transmission electron microscopies for the interface studies, which will be performed at CRHEA during long stay periods. The investigation will be completed with magnetic properties performed at GEMaC, and with electrical study of FMO/ZnO interfaces (at CRHEA and GEMAC). The PhD project will define the more appropriate FMO material for the fabrication of spin photo-detector or emitter devices, as a next step. Participation to the spin photo-devices fabrication and testing could be considered. Time-resolved magneto-optic studies and optimization of such devices will be carried out by another PhD student in the SPINOXIDE project, with the expertise of research teams at LPCNO-Toulouse and IPCMS-Strasbourg.

General information: Paris-Saclay University PhD. Starting from 1st Nov. 2019. Duration 36 months

Education – skills: Master 2 in material science or condensed matter. Candidate should be motivated and interested in crystal growth and structural characterization in association with magnetic, and electrical properties. Skills for team working within projects. Experimental thoroughness.

Keywords: spintronics, optoelectronics, oxide ferromagnets, ZnO semiconductor, structural properties (X-ray diffraction, electron microscopy), magnetic and electric properties, spin-photodetector and spin-laser demonstrators.

Application on website : https://emploi.cnrs.fr/Offres/Doctorant/UMR8635-KARBRE-005/Default.aspx