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MATERIAL'S SCIENCE INSTITUT OF BARCELONA

LABORATORY OF MULTIFUNCTIONAL THIN FILMS AND COMPLEX STRUCTURES
INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA ICMAB-CSIC

http://www.icmab.es/mulfox/

Ferroelectric films on Silicon

Supervisor: Dr. F. Sánchez

The integration of ferroelectric oxides with Silicon is crucial for its use in microelectronics. The PhD thesis will address the fabrication of epitaxial $BaTiO_3$ films, a lead-free room temperature ferroelectric, on buffered Si(001) wafers and membranes using pulsed laser deposition. The project includes two main objectives. First, the influence of different epitaxial buffer layers (YSZ, $SrTiO_3$, etc), bottom electrode ($LaNiO_3$, $SrRuO_3$, etc) and its thickness on the structural and electrical properties of $BaTiO_3$ will be determined. Second, two specific functional heterostructures for novel devices will be fabricated and characterized: i) Metal-Ferroelectric-Insulator-Semiconductor (MFeIS) and ii) tunnel electroresistance structures. The fabrication of both is challenging, requiring ultrathin buffers the former and ultrathin $BaTiO_3$ the later. The PhD student will be trained in the use of advanced fabrication and characterization tools.

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Electric and Magnetic Control of Plasmons for Information Technologies

Supervisor: Dr. Gervasi Herranz

There is a huge interest to integrate light into integrated circuits. Light is interesting, because it offers remarkable properties, such as large bandwidth and fast operation speeds. However, overcoming diffraction limit is required to integrate light into circuits. Plasmons are a way around, since they confine the energy of light to the nanoscale, paving the way to the exploitation of light at small scales. Recently, we have demonstrated the microscopic mechanisms that underlying the enhanced magneto-optical responses boosted by plasmons [1]. In this project we aim at the study of plasmons in uncommon media, including magnetic and ferroelectric dielectrics. The objective is to exploit plasmons as conveyors of the information stored in magnetic/ferroelectric bits. The student will be trained in advanced optical characterization, including optical spectroscopy in the near IR -VIS and diffraction-limited optical imaging.

[1] M. Rubio-Roy et al., Langmuir, 28, 9010 (2012), O. Vlasin et al., Physical Review Applied 2, 054003 (2014)

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Magnetoresistance in non magnetic materials: a route towards new spin devices

Supervisor: Prof. Josep Fontcuberta

Electrons have charge and spin. Electronic industry exploits electron charge and magnetic sensors and magnetic memories exploit simultaneously the electron spin and charge. However, moving electrical charges implies energy dissipation. A better solution for efficient data storage and computing would be the use of pure spin currents. In this project the candidate will learn about these most advanced , technologies, the appropriate materials and the way we produce and test them. Particular emphasis will be devoted to the optical testing of magnetic properties.

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Light harvesting by ferroic materials and polar heterostructures

Supervisor: Prof. Josep Fontcuberta

Photovoltaic devices are used to capture visible light and transform it into electricity. This requires light absorption and the presence of an electric field to drive the light-generated photocarriers towards the electrodes. Polar fields in ferroelectric materials and other polar heterostructures can efficiently contribute to this effect thus allowing to obtain large photovoltaic effects. The project aims to build such nanomaterials by using most advanced preparation tools and intensive electrooptic and microstructural analysis. Some recent works can be found at our web site: http://www.icmab.es/mulfox/

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