MINISTERIO
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AGENCIA ESTATAL DE INVESTIGACIÓN

ICMAB
INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA

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CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

CONTRATOS PREDOCTORALES – MATRANS24 (CEX2023-001263-S)

RESEARCH CHALLENGE:

Quantum Coherence for Devices

PROJECT TITLE / JOB POSITION TITLE:

Spin-Torque mechanisms in all-oxide devices for spintronic applications

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:
(Max. 2.000 characters – including spaces)

The main goal of the "Advanced Characterization and Nanostructured Materials" group at ICMAB is to generate both fundamental and applied knowledge for the implementation of functional oxide materials in novel technologies, such as spintronics. The research of the group focuses on the preparation and characterization of complex oxides thin films, heterostructures, and composite nanoparticles. For that purpose, sputtering and advanced characterization techniques, such as scanning probes and electron microscopies, synchrotron radiation, and advanced magneto transport techniques, are used. The group's research is both of basic and applied character as they own long-standing expertise in understanding the interplay between the microstructure and properties and its potential application for the design and fabrication of novel magnetoelectronic devices. In the last years, our research has been focused on investigating spin-orbit phenomena in complex oxides, particularly spin-orbit coupling (SOC) and spin-transfer torque (STT) to clarify the physical mechanisms governing spin current generation and transmission in ferromagnet (FM)/non-magnetic (NM) structures [1-3]. In particular, we are studying different strategies to enhance spin transmission, including interface engineering by adding antiferromagnetic (AF) materials in a wide range of oxide heterostructures.

1. Impact of Twin's Landscape on the Magnetic Damping of $La_{2/3}Sr_{1/3}MnO_3$ Thin Films
   S Chen, et. al., *Advanced Materials Interfaces* 11 (7), 2300882 (2024).
2. Spin-to-Charge Conversion in All-Oxide$La_{2/3}Sr_{1/3}MnO_3/SrIrO_3$ Heterostructures
   S Martin-Rio, et al., *ACS applied materials & interfaces* 15 (30), 37038-37046 (2023)
3. Spin to charge conversion in chemically deposited epitaxial $La_{0.9}MnO_3$ thin films capped with Pt; S Martin-Rio et al., *Journal of Materials Chemistry C* 10 (15), 5914-5921 (2022)

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JOB POSITION DESCRIPTION:
(Max. 2.000 characters – including spaces)
Include all the relevant information about the position, role, responsibilities and skills required within the project/group

A **magnon** is a quasiparticle that represents a collective excitation of the electron spins in a magnetic material. Essentially, it is a wave that propagates through a ferromagnetic or antiferromagnetic material. Unlike electrons, which carry an electric charge, magnons do not involve charge transport. This means they can carry information without the energy losses associated with electrical current, making them highly promising for applications in **spintronics** and other quantum technologies. Our goal is to investigate engineered heterostructures that combine functional materials in unconventional ways to develop a new generation devices based on the use of pure spin currents. We will focus on devices utilizing a synergetic combination of oxide ferromagnetic (FM), antiferromagnetic (AFM), and normal metal materials aimed to spintronic applications. Specifically, AFM in spin-orbit-torque architectures will enhance the density and speed of logic and memory applications, given its intrinsic resistance to interference from stray magnetic fields and compatibility with THz dynamics.

This project aims to investigate the fundamental physics of these materials, with an emphasis on experimental basic research while maintaining a view on their technological relevance. A new experimental setup will be developed to directly quantify the Spin-Hall angle and identify the key interfacial mechanisms controlling spin transmission. The experimental work will involve assembling a Vector Network Analyzer for signal generation and detection, combined with lock-in detection techniques. Additionally, the student will participate in the preparation and in-depth characterization of complex oxide thin films and heterostructures.

PhD CO-DIRECTORS:

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