CONTRATOS PREDOCTORALES 2021 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Current-controlled ferroelectric devices for next generation nonvolatile data storage

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

To fulfill the future needs of information technologies, we are in a constant search for faster, denser, and more efficient memory elements. In this quest, ferroelectric devices (FEDs) play a crucial role as their permanent electric polarization can be used for nonvolatile data storage and processing. However, the only available means to dynamically control the electric polarization of FEDs is applying a gate voltage, which poses fundamental problems for technology applications. Problems include short circuit/leakage due to imperfect films, stress-induced fatigue, and permanent damage, which cause signal degradation and breakdown.

In this project, **we propose a radically new approach to control FEDs by using charge currents instead of electric fields**. Our strategy is to harness the current-induced electric fields generated by the anomalous Hall effect in ferromagnetic materials and its subsequent interaction with the ferroelectric material in the vicinity. This will allow us to dynamically control the FEDs' polarization at will (hence their binary data state) without needing a gate voltage. Additionally, such a combination of ferromagnetic and ferroelectric materials is expected to give rise to to novel interfacial transport phenomena not previously explored. Overall, this project will create a highly fertile ground for fundamental research and direct applications in memory cells based on ferrolectric/ferromagnetic multifunctional hybrid structures.

The PI's team (Spintronics & Magnetic Oxides) belongs the research group MULFOX in RL3. MULFOX consists of world-renown experts in ferroelectric materials such as Dr. Sanchez and Dr. Fina, with whom the PI made a preliminary collaboration agreement and discussed the feasibility and overarching impact of the project. The PI will bring in the 10+ years of spintronics expertise to achieve the ambitious project goals and develop a prototype memory device. The project will be mainly conducted in the PI's state-of-the-art laboratory, which readily accommodates all necessary tools. The material development will benefit from the shared PLD service and the newly acquired sputtering system by the PI. Other ICMAB shared facilities will be effectively used for the standard material characterization.

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

The successful candidate will

- Grow and optimize ferroelectric/ferromagnetic hybrid structures using pulsed laser and magnetron sputter deposition techniques.
- Coordinate the characterization of the above films in shared facilities and establish an efficient feedback loop to reach the desirable properties in the fastest possible timeframe.
- Screen and categorize the useful films.
- Fabricate micrometer-scale devices out of the selected films by standard lithography methods in the NANOQUIM platform.
- Conduct detailed magnetoelectrical and magneto-optical measurements to explore the feasibility of the current-induced control of FEDs and characterize other emerging interfacial phenomena.
- Design and demonstrate an all-electrical proof-of-concept memory device

The candidate is expected to work initially in collaboration with Dr. Florencio Sanchez and Dr. Ignasi Fina for the parts related to the growth and optimization of ferroelectric films. After optimizing films with suitable properties, the student will work independently under PI's direct supervision. The PI will monitor the scientific progress and the student's performance through weekly meetings and take all the necessary preventive actions to remain focused the project goals. The PI will organize evaluation meetings with the student every three months to discuss the contingency plans for potential problems and make/revise short- and long-term plans accordingly.

The suitable candidate should possess

- A BSc/MSc degree in physics, materials science, or a related discipline.
- A solid background in condensed matter physics.
- Knowledge of data analysis software (e.g., Matlab, Origin, etc.).
- Knowledge of ferroelectric and ferromagnetic materials and their transport properties.
- Writing and communications skills and ability to work in team.

Additionally, the following aspects would be beneficial:

- Knowledge of cleanroom processes.
- Knowledge of setup automation software (e.g., LabVIEW).
- Knowledge of basic laboratory electronics.
- Experience with device characterization.

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