

CONTRATOS PREDOCTORALES 2021 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Control of superconducting-insulator transitions in functional nanostructured devices

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

Today advances to store and analyse massive information offer huge opportunities and unprecedented social benefits. The emergence of Internet of Things and Big-Data analysis result in major advantages in ICT but require to explore novel technologies for information storage and processing in a sustainable way. Multifunctional materials based on complex oxides offer unique opportunities to tune their magnetic or electric properties with multiple external inputs thus providing the basis for realizing emerging electronic devices. Among numerous outstanding properties of strongly correlated oxides, superconducting cuprates are of special interest due to their inherent energy efficiency.

In $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ (YBCO), one of the most studied superconducting cuprates, oxygen vacancies are prone to be created and annihilated by applying an electric field. At the same time, oxygen concentration determines the carrier density of the material and thus its superconducting properties. Small changes in the oxygen concentration may produce large changes in the electronic structure due to electric-field induced superconductor-insulator transitions (SIT) [1]. This makes YBCO an ideal candidate for energy-efficient logic and memory devices.

In this project we aim to demonstrate the potential of superconducting cuprates to device and implement gate-tuned devices based on field-induced SIT. The general objective is to reversibly control the concentration and profile of oxygen vacancies in YBCO nanostructures, through material and device engineering. The effect of natural or artificial defects, such as grain boundaries, twin boundaries, stacking faults, or patterned defects will be explored. Special attention will be paid on the integration of YBCO devices on silicon substrates.

The project will be carried out at the SUMAN department (RL2) under the supervision of Dr. A. Palau and Dr. N. Mestres.

1. Palau et al., ACS Appl. Mater. Interf. 2018, 10, 30522; Marinkovic et al., ACS Nano 2020, 14, 11765

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 aim of this project is to design, fabricate and fully characterize functional devices based on YBCO nanostructures with tunable superconductor-insulator transitions (SIT).

The scientific objectives that will be developed by the student are:

- Design and fabrication of nano-structured YBCO memristive devices, with natural or artificial defects, using field effect transistor concepts, and high-resolution lithography tools.
- Perform the electrical characterization of the devices. Current-voltage measurements will be carried out in sweep and pulse mode at different temperatures, to explore the field-induced modulation of SIT at nanometric scale.
- Understanding and control of oxygen doping profiles in nanostructured YBCO devices and associated functionalities.

The proposed project will give to the applicant a complete interdisciplinary knowledge on solid state devices, materials science and nanotechnology. The host institution has a wide experience in these disciplines and the required experimental techniques for a successful advance of the project.

The candidate should have an academic background in physics, nanoscience, nanotechnology or material science. A good level of English is also required. The candidate will perform the PhD in a very interdisciplinary environment, for this, she/he should have the ability to work in a team formed by researchers with different backgrounds and from different nationalities. In addition, the successful candidate might travel to other European countries to develop the project in the framework of established scientific collaborations or to present the results of his/her research in thematic conferences and schools.

GROUP LEADER:

Dr. Anna Palau, Dr. Narcís Mestres

Email: palau@icmab.es / narcis.mestres@icmab.es

Research project / Research Group website <https://departments.icmab.es/suman/>