

CONTRATOS PREDOCTORALES 2022 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Nano-Engineered High-Temperature Superconductors for functional quantum devices

JOB POSITION RESEARCH LINE:

RL, General.- FUNCTIONAL OR MULTIFUNCTIONAL NANOSTRUCTURED MATERIALS

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

Emerging quantum technologies hold the promise to address standing society problems in a number of areas ranging from energy and information storage, transport, computing, communication, and sensing. Superconducting materials are prime candidates to develop quantum effects into functional devices. Dissipationless transport of current, generation of high magnetic fields, ultra-sensitive SQUID sensors, single-photon detectors or Qubits can be achieved by controlling superconducting parameters at the nanoscale.

The great challenge in view of superconducting technological applications is the use high temperature superconductors (HTS), with high operation temperatures with decrease cooling demands and unique functional properties associated to their correlated behaviour. In spite of great technological advancements in the recent years, functional devices based on HTS are still in the early stage with respect to those based on conventional low-temperature superconductors. An important drawback is their complexity and high sensitivity on nanometric defects and doping which imposes extreme demands on the micro-, nano-fabrication.

This research project aims to explore different nanostructures and hybrid systems based on high temperature superconductors, combined with other functional oxides, which may be used for the design of advanced energy-efficient devices with innovative quantum functionalities.

The project will be conducted at the "Superconducting Materials and large-scale nanostructures (SUMAN)" group at ICMAB-CSIC. SUMAN is a long-standing scientific group with more than 20 years in the research field of superconducting materials and development of their applications. A distinctive characteristic of the group is to keep a wise balance among fundamental properties and applied issues, including device development.

JOB POSITION DESCRIPTION:

The aim of this project is to design, fabricate and analyse hybrid nano-engineered systems, based on high temperature superconductors combined with other functional materials (ferroelectric, metallic, insulating) which could provide novel interactions and physical phenomena.

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

- **Design and nano-fabrication of hybrid systems based on HTS**
The aim is the creation of hybrid hetero-structures with superconducting nanostructured templates combined with other functional materials
- **Functional quantum properties of nano-engineered HTS systems**
Advanced physical characterization of fabricated micro-, nano-devices. Explore their unique functionalities arising from engineered nanostructures or hybrid systems through external perturbations such as electric-, magnetic-fields, temperature, or light.

The proposed project will give to the applicant a complete interdisciplinary knowledge on novel physical interactions, 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.

The training the student could acquire (which will depend on his/her background) include:

- Growth of thin films and multilayers (by different growing techniques)
- Fabrication of nano-structural hybrid superconducting-ferromagnet devices (micrometric and nanometric lithography techniques)
- Physical characterization (advanced electric transport and magnetic measurements) - Theoretical models (correlation between experimental results and simulations)
- Device implementation (evaluate the best designs to be integrated in a chip).

GROUP LEADER:

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