SUPERCONDUCTING MATERIALS

and Functional Nanoengineered Structures Dept.

INSTITUT DE CIENCIA DE MATERIALS DE BARCELONA, ICMAB-CSIC

http://departments.icmab.es/suman/

PhD call offer:

"Ultrafast growth of ultrahigh performance superconducting tapes: Correlation between microstructure and properties"

The project aims to engage talent young students for a Materials Science doctorate in the field of High Temperature Superconducting (HTS) Materials by investigating the novel high-throughput growth process (Transient Liquid Assisted Growth, TLAG) [1,2] able to grow epitaxial superconducting films at even 1000 nm/s.

She/he will be integrated in a large group with different background expertise in the field of HTS materials developing cutting-edge research in the synthesis, microstructural and physical understanding of these materials. The goal is to unravel the growth mechanisms of TLAG and boost the superconducting properties at high magnetic fields by designing the material microstructure landscape. The research group is very international and interdisciplinary, with more than 25 years experience in superconductivity.

The PhD project is addressed towards the microstructural analysis of the material with special emphasis in Transmission Electron Microscopy (HRTEM, STEM), energy dispersive mode (EDX) and electron energy loss spectroscopy mode (EELS). Last generation aberration corrected microscopes will be used for that purpose.

RESEARCH FRAMEWORK:

Superconductivity is a macroscopic quantum phenomenon based on the formation of a condensate at the energy ground state by electron-pairing (Cooper pairs), with outstanding properties and impact in many applications. Since high temperature superconducting (HTS) cuprate materials were discovered 30 years ago, many additional applications were envisaged since large currents without losses could be expected at liquid nitrogen temperatures, however they had to face unknown

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science and new materials engineering complexities [3]. HTS are strongly correlated systems, showing unconventional superconductivity with a d-wave pairing symmetry and their microscopic theory is still unidentified. In addition, they need to be doped to be superconductors. Novel vortex phases and behaviour also appear, mainly associated to the higher thermal fluctuations, larger crystalline anisotropy and nanometric nature of the HTS superconducting parameters. Disorder is a strong enemy for the superconducting state of HTS, but if properly designed, it can be used as an outstanding source for vortex pinning, as we showed in [4,5]. Beyond the still unsolved questions about HTS, nowadays, the international community is able to fabricate HTS tapes for high current energy efficient applications (high power cables, wind generators, electrical aviation) and large scale infrastructures (fusion, circular colliders, NMR beyond 1 GHz), one of the remaining issues being the need to reduce the cost/performance ratio of the fabrication process. The TLAG process studied in this project and initiated with an ERC-Advanced grant and an ERC-Proof-of-Concept, addresses this topic. The PI now holds a second ERC-Proof-of Concept in this field.

[1] L. Soler et al, Nature Communications, 11, 344, (2020)
[2] S. Rasi et al, Advance Science (2022, in press)
[3] X. Obradors and T. Puig, Superconductor Science and Technology (SUST) 27, 044003 (2014)
[4] J. Gutierrez et al, Nat Mat 6, 367 (2007)
[5] A. Llordes et al, Nature Materials, 11, 329 (2012)

REQUIREMENTS and VALUABLE MERITS

PhD Students (4 years contract):

- Degree in Materials Science, Physics, Chemistry or Nanoscience
- High motivation to experimental research
- Working aptitudes in a collaborative group
- High level in written/spoken English
- Academic grades and research experience will be considered in the evaluation
- Experience and knowledge on superconductivity, superconducting materials and electron microscopy characterization techniques will be valuable

Candidates should send their CV, academic grades certificate and reference letters to:

erc-ultrasupertape@icmab.es

The recruitment process will be closed when a suitable candidate is found, but strong effort will be done to finish it before end of October 2022.

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