IEEE-CSC, ESAS and CSSJ SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue No. 61, Nov. 2025

Understanding of Vortex Pinning in the Ultrafast Transient Liquid Assisted Growth (TLAG) Process of Coated Conductors

Teresa Puig[1], Xavier Obradors[2], Aiswarya Kethamkuzhi[1], Ona Mola[1], Kapil Gupta[1,3], Carla Torres[1], Roxana Vlad[1], Elzbieta Pach[1,4], Emma Ghiara[1], Mahel Voulhoux[1], Lavinia Saltarelli[1], Diana Garcia[5], Victor Fuentes[5,6], Cornelia Pop[5], Daniel Sanchez[7], Susagna Ricart[5], Ramon Yanez[8], Jordi Farjas[9], Eduardo Solano[6], Joffre Guiterrez[1]

[1]ICMAB-CSIC, Bellaterra, Spain
[2]ICMAB, Bellaterra, Spain
[3]ICN2, Bellaterra, Spain
[4]ALBA synchrotron, Bellaterra, Spain
[5]ICMAB-CSIC, Spain
[6]ALBA synchrotron, Spain
[7]Universitat de Girona, Physics Department, Girona, Spain
[8]Universitat Autonoma de Barcelona, Chemistry department, Spain
[9]Universitat de Girona, Physics Department, Spain

E-mail: teresa@icmab.es

***Abstract*—High-temperature superconducting REBa2Cu3O7 (RE = rare earth or yttrium) coated conductors are materials with exceptional superconducting properties, . Understanding the physics of vortices in these complex materials and controlling of the atomic structure of defects have made it possible to design their performance and achieve exceptional values of superconducting properties which enable their integration into devices. To improve performance and reduce costs, faster growth strategies and methods are being explored, which pose new vortex physics scenarios [1]. Recently, the implications of the electronic structure of the overdoped state for vortex physics have also been demonstrated [2]. In this contribution, I will report on the current understanding of the transient liquid-assisted growth (TLAG) process studied in my group, and the consequences of high growth rates on vortex pinning and electronic structure of coated conductors. TLAG is a kinetically controlled liquid-solid non-equilibrium ultrafast growth process capable of achieving growth rates over 1000 nm/s with critical current densities of 3-5 MA/cm2 at 77 K [2,3], which can utilise solution chemical deposition [4] for the fabrication of nanocomposite coated conductors. The use of fast-acquisition in situ XRD imaging (<100 ms/frame) under synchrotron radiation, transmission electron microscopy, in situ resistivity experiments and angular transport measurements have been crucial. Finally, our attempts to use high-throughput experimentation [5] to accelerate research on the study of the correlation between growth and superconducting properties will be discussed. The influence of using different rare earth will be reported by the investigation of**

films of graded composition with precise spatial control which have been fabricated by drop-on-demand combinatorial inkjet printing and analysed by rapid physical characterization methods.

***Keywords (Index Terms)*—Artificial Pinning Center, coated conductors, REBCO films, flux pinning, liquid assisted growth, microstructure**

Acknowledgements:
We acknowledge funding form ERC_AdG-2014-669504 ULTRASUPERTAPE, ERC-PoC-2020-IMPACT and ERC-PoC-SMS-INKS projects, the Excellence Program Severo Ochoa MATRANS42, and MICIU/AEI/FEDER for SUPERENERTECH (PID2021–127297OB-C21).

References:

[1] T. Puig et al, Nat Rev Phys (2024),
[2] A. Stangl et al, Sci Report 11, 8176 (2021), X. Obradors et al, Nat Mat N&V (2024)
[3] L. Soler et al, Nat Comm 11, 344 (2020)
[4] S. Rasi et al, Advanced Science 2022, 2203834 (2022)
[5] A. Queralto et al, ACS Appl. Mater. Interfaces 13, 9101 (2021)

IEEE-CSC, ESAS and CSSJ SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue No. 61, Nov. 2025. Presentation given at EUCAS 2025, Porto, Portugal, Sept. 2025.