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Impact of the High Growth Rates on the Microstructure and Vortex Pinning of Transient Liquid Asssisted Growth (TLAG) Coated Conductors

T. Puig[1], X. Obradors[1], A. Kethamkuzhi[1], O. Mola[1], K. Gupta[1], R. Vlad[1], C. Torres[1], E. Pach[1,5], E. Guiara[1], L. Saltarelli[1], D. Garcia[1,2], V. Fuentes[1,5], C. Pop[1], D. Sanchez[3], S. Rasi[1], J. Banchewski[1], A. Queralto[1], S. Ricart[1], R. Yanez[2], J. Farjas[3], J. Gutierrez[1], C. Mocuta[4], E. Solano[5]

[1]Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus UAB; Bellaterra, Spain
[2]Departament de Química, Universitat Autonoma de Barcelona, Bellaterra, Spain
[3]GRMT, Department of Physics, University of Girona, Girona, Spain
[4]Diffabs beamline, Soleil Synchrotron, Paris, France
[5]NCD-Sweet beamline, ALBA Synchrotron, Bellaterra, Spain

E-mail: teresa@icmab.es

***Abstract*–High-temperature superconducting $REBa_2Cu_3O_7$ (RE = rare earth or yttrium) coated conductors are materials with exceptional superconducting properties, such as very high critical currents and irreversibility field. 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. In order to improve performance and reduce costs, faster growth strategies and methods are being explored, including vapour-solid, solid-solid, and liquid-solid growth methods, which pose new vortex physics scenarios [1]. 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) mechanism studied in my group, and the consequences of high growth rates on vortex pinning an electronic structure of coated conductors. TLAG is a kinetically controlled liquid-solid non-equilibrium ultrafast growth process capable of achieving growth rates of over 1000 nm/s with critical current densities of 3-5 MA/cm^2 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 for this study. 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)*– Coated conductors, liquid assisted growth, TLAG, flux pinning, critical currents**

[1] T. Puig et al, Nat Rev Phys (2023), doi.org/10.1038/s42254-023-00663-3
[2] A. Stangl et al, Sci Report 11, 8176 (2021)

[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)

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