Contribution ID: **283** Type: **Poster Presentation (120m)**

Correlating growth rate with vortex pinning and defect microstructure in Transient Liquid Assisted Growth (TLAG) of superconducting REBCO film

Wednesday 24 July 2024 17:30 (15 minutes)

High costs have hindered the practical use of REBCO coated conductors, despite their promising properties for a wide range of applications. A potential way for lowering the costs is by increasing the growth rate of the superconducting material while keeping high critical current density values [1]. The novel high throughput growing method Transient Liquid Assisted Growth (TLAG) [2,3] is promising in this aspect, since it can achieve ultrahigh growth rates of up to 1000nm/s. In the TLAG process, a Ba-Cu-O transient liquid is formed where the rare earth (RE) is dissolved and fast diffused to the growth interface, enabling ultrahigh REBCO growth from the liquid phase. The use of different RE modify their solubility in the liquid and therefore their effect on the nucleation and growth rates. In this work, we aim to understand the effect of growth rate on the microstructural defects generation and superconducting properties of REBCO films (RE = Y, Gd) grown by the TLAG method. For that purpose, simultaneous in-situ resistivity and in -situ x-ray diffraction (XRD) at synchrotron facilities are being used during TLAG growth to provide insights into the nucleation and growth mechanisms and enable the determination of the growth rate dependence with the process parameters. In this respect, the oxygen pressure where the films are grown is seen as a very relevant parameter. Post-growth non-destructive analysis, such as magnetic granularity studies [4] are providing information on the percolative grain size, grain boundary and grain critical current densities. In particular, a clear dependence of the critical currents with the grain size is observed. Additionally, Transmission Electron Microscopy (TEM) is used to examine the defect microstructure at different growth rates, and angular dependent transport measurements has enabled to study the vortex pinning behaviour under different magnetic fields, temperatures and angles [5]. Preliminary results reveal a clear dependence of process parameters with microstructure and properties, expanding from a very defect to a very clean defect microstructure landscape. Overall, this presentation will summarise the understanding of the different observations to identify the key parameters that determine the growth rate and the corresponding vortex pinning landscape.

[1] T. Puig et al, *Nat. Rev. Phys.* (2023)

[2] L. Soler et al, *Nat. Commun.* (2020)

[3] S. Rasi et al, *J. Phys. Chem.* C (2020)

[4] A. Palau et al, *Phys. Rev. B* (2007)

[5] F. Vallès et al, *Commun. Mater.* (2022)

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Session Classification: Wed-Or12

Track Classification: Tracks ICMC Geneva 2024: ICMC 05: Thin films, multilayers, electronics, materials, processing and properties