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# Progress and Opportunities of the Transient Liquid Assisted Growth (TLAG) Method

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***Abstract*—The remarkable potential of $REBa_2Cu_3O_7$-coated conductors (REBCO CCs) has finally become a tangible reality by unlocking new technological opportunities like compact fusion, hybrid electric aviation, DC transmission lines or complex magnets in accelerator physics. However, the market perspectives advices to invest in high throughput manufacturing processes of reduced cost-to-performance ratio to compile with the large demands and foster initiatives to improve performance ensuring robustness. To address these challenges, in ICMAB we are developing a scalable, high throughput growth process known as Transient Liquid Assisted Growth (TLAG) [1]. This method achieves ultra-high growth rates exceeding 1000 nm/s while maintaining high critical current densities [2] by using nanocrystalline precursor films that can be prepared from chemical solution deposition (CSD) [3,4] or low temperature physical deposition (like Pulsed Laser Deposition) [5]. In the CSD case, the use of multifunctional colloidal inks enables the fabrication of nanocomposites CC for high-magnetic field applications.**

**TLAG is a highly non-equilibrium liquid-solid growth process in which nucleation and growth are kinetically controlled. For that reason, we have developed advanced in situ techniques to elucidate the underlying growth mechanisms and establish correlations between process parameters, epitaxy, growth rate and performance. This includes an in-situ growth installation at ALBA synchrotron with fast acquisition XRD and XAS coupled with mass spectrometry and in-situ electrical resistance. Results show that TLAG can operate at a very wide PO2-Temperature window, where nucleation density and growth rate can be tuned by liquid composition, RE ion and process parameters. Moreover, the CSD approach enables us to employ high-throughput experimentation by developing inkjet-printed combinatorial**

**compositional gradient films for fast process screening and data driving science. Besides, in order to improve performance in a robust manner, we are investigating the modification of the electronic structure by increasing the charge carrier density up to the overdoped state, where the vortex pinning centres improve their effectiveness by the increase of the condensation energy [6,7]. The combination of advanced transmission electron microscopy and high field angular transport measurements permits the understanding of the vortex physics of these complex materials grown at these high rates [8].**

**In this presentation, I will report on the progress of the above mentioned challenges with the aim of designing a robust, high throughput and flexible growth method for the manufacturing of CC at competitive cost-performance ratio.**

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