New approaches in vortex pinning of high critical current YBCO nanocomposite films grown from chemical solutions: correlations with microstructure

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Vortex pinning is probably the most relevant physical property for large current applications of superconducting materials, especially at high magnetic fields. Therefore, artificial pinning centers engineering and design has always been a crucial subject for the community. After 20 years of intense research in $YBa_2Cu_3O_7$ coated conductors, they are now considered a mature technology for many potential applications at liquid nitrogen and also down to liquid helium temperatures where they can envisage ultrahigh magnetic fields. However, the cost is still an important issue, so Chemical solution deposition (CSD) methods arose as low cost, scalable methods which could compete in performance, while high growth rate methods have recently attracted much attention. In that direction, many efforts have been done to find scalable processes for artificial pinning centers engineering in CSD methods. The best strategy resulted in the so-called nanocomposites [1] where strain-associated vortex pinning mechanisms where proposed [2]. In this presentation, I will revise our latest understanding on vortex pinning of CSD nanocomposites. On one hand, special emphasis will be devoted to the use of colloidal solution of preformed nanoparticles were the nanoparticles size can be better controlled [3]. On the other, I will present a new approach to reach CSD nanocomposites through a transient-liquid assisted growth (TLAG) method, enabling ultrafast growth rates in the range of 100 nm/s, demonstrated by in-situ XRD synchrotron experiments [4], with new opportunities for vortex pinning and where nanoparticles behave differently. In all this study, deep analysis correlating vortex physics with defects microstructure and associated strains have been crucial. Atomic-scale aberration-corrected scanning transmission electron microscopy and angular dependent in-field transport measurements have enabled us to underpin the most favorable pinning centers for each temperature and magnetic field range.

References

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