Nanocomposite Coated Conductors: Towards Optimal Vortex Pinning for High Field Applications

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Abstract — Coated conductors (CC) are considered a revolution in materials engineering and materials device integration. This scientific success is attributed to two major breakthroughs of the last 20 years. The first one is associated to the development of long length flexible substrates, identification of proper epitaxial heterostructure growth methods and management of grain boundaries. The second is the smart conception of nanocomposites that boosted CC performance to unexpected values. Nowadays, the figure of merit for CC marketability is cost/performance. In this presentation, I want to revise the world-wide successful effort and future prospective of Nanocomposite Coated Conductors for ultra-high and high field applications, with special emphasis in the European cooperative action presently running. Superconducting Nanocomposites are based on the first principles of pinning Abrikosov vortices, however the community needed to address the high thermal instabilities of High Temperature Superconductors to devise novel routes to induce homogeneous dispersions of nanoscale defects acting as remarkable pinning centers using scalable fabrication methods. Several physical and chemical growth methods have victoriously achieved these goals and are nowadays integrated in fabrication lines in world-wide companies. Growth of nanocomposites from vapor phases, solid-gas reaction or even from liquids implies very different strategies and consequently the type of defects and temperature-magnetic field regions where they effectively pin vortices differ very much. The physical consequences of second phase composition, its shape, size, strain induced on the superconducting matrix, interaction with natural defects, evolution with film thickness, distinguish each growth method. Overall, this is a winning story owing to the joint efforts between materials engineering, chemistry, nanoscience, physics and electrical engineering, which testifies the richness of the superconducting community.

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