Interactive Approach towards Controllable Generation of Strong and Isotropic Artificial Pinning Centers in YBCO Films

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Abstract— **Raising critical current density J_c in high-temperature superconductors (HTS) is an important strategy towards performance-cost balanced HTS technology for commercialization. Development of strong nanoscale artificial pinning centers (APCs) in HTS, such as $YBa_2Cu_3O_7$ or RE-123 in general, represents one of the most exciting progress in HTS material research in the last decade. Significantly raised J_c has been demonstrated in APC/RE-123 nanocomposites by enhanced pinning on magnetic vortices in magnetic fields towards that demanded in practical applications. Among other processes, strain-mediated self-organization has been explored extensively for in situ formation of the APCs of a large variety of materials. The effort in controlling the morphology, dimension, orientation, and concentration of APCs has been prompted by its initial success and has led to a fundamental question on how strains interact at microscopic scales in determining the APCs at a macroscopic scale. Answering this question demands an interactive modeling-synthesis-characterization approach towards a thorough understanding of fundamental physics governing the strain-mediated self-organization of the APCs in the APC/RE-123 nanocomposites. Such an understanding is the key for a leap forward from the traditionally empirical method to materials-by-design to enable optimal APC landscape to be achieved in epitaxial APC/YBCO nanocomposites under a precise guidance of fundamental physics. The paper intends to provide a review on the progress made in controllable generation of APCs using the interactive modeling-synthesis-characterization approach. Emphasis will be given to the understanding so far achieved using such an approach on the collective effect of strain field on the morphology, dimension, and orientation of APCs in the epitaxial APC/RE-123 nanocomposite films.**

Keywords (Index Terms)— **REBCO, pinning, artificial pinning centers, elastic strain model, strain-mediated self-assembly.**

IEEE-CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), No. 41, July 2017.
Received July 26, 2017; Selected July 28, 2017. To be replaced by the annotated version in October 2017.
Reference STP593; Category 2, 5.
This invited presentation M3OrC-01 was given at CEC-ICMC 2017, July 09-13, 2017, Madison (USA).