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[Invited] Interactive approach towards controllable generation of strong and isotropic artificial pinning centers in RE-123 films

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Raising critical current density Jc in high temperature superconductors, such as YBa2Cu3O7 or RE-123 films, is important to performance-cost balanced conductor technology for commercialization. Development of strong nanoscale artificial pinning centers (APCs) in RE-123 films has led to significantly raised Jc in APC/RE-123 nanocomposites by enhanced pinning on magnetic vortices in moderate to high magnetic fields towards that demanded in practical applications. The effort in controlling the morphology, dimension, orientation, and concentration of APCs raises a fundamental question on how strains interact at microscopic scales in determining the APCs quantitatively. 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.
The paper reports our recent work in controllable generation of APCs towards strong and isotropic pinning using the interactive modeling-synthesis-characterization approach.1-7 Three specific methods were explored on 1D APC/RE-123 nanocomposites using: (1) lattice mismatch substrates to promote 1D APC splay; (2) impeded alignment of 1D APC of high-concentration using a secondary APC; and (3) low-temperature quench of long-length 1D APC growth. We show enhanced isotropic pining attributed to APC landscape of mixed morphologies that not only benefit pinning at different H orientations but also reduce the detrimental effect on superconductivity by the train on the RE-123 matrix.

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