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Multilayer BZO/YBCO Thick Films for High I_c in High Fields

Judy Wu[1], Victor Ogunjimi[1], Mary Ann Sebastian[2], Di Zhang[3], Bibek Gautam[1], Mohan Panth[1], Jie Jian[3], Jijie Huang[3], Yifan Zhang[3], Timothy Haugan[2], HaiyanWang[3]

[1]Department of Physics and Astronomy, University of Kansas, Lawrence, Kansas, USA
[2]U.S. Air Force Research Laboratory, Propulsion Directorate, WPAFB, Ohio, USA
[3]School of Materials Engineering, Purdue University, West Lafayette, Indiana, USA

Email: jwu@ku.edu

Abstract—A multilayer (ML) scheme was recently developed to facilitate diffusion of Ca from two thin ($Ca_{0.3}Y_{0.7}$)BCO layers sandwiched with three BZO/YBCO layers and the consequent dynamic Ca/Cu substitution on tensile strained YBCO lattice during the growth of c-axis aligned $BaZrO_3$ dimensional artificial pinning centers (BZO 1D-APCs) in BZO/YBCO nanocomposite films. The substitution of smaller Cu ions by larger Ca ones is found energetically preferable by inducing c-axis elongation of the YBCO lattice near the BZO 1D-APC/YBCO interface to enable a coherent interface via reducing the BZO/YBCO lattice mismatch from originally 7.7% to 1.4%, leading to significantly enhanced pinning efficiency of BZO 1D-APCs, especially at high magnetic fields. In this work, the ML scheme is applied to thick BZO/YBCO films with total thickness in the range from 150 nm to 750 nm. Remarkably, comparable J_c (B) was observed in these ML samples while at lower temperature and higher fields, the thicker BZO/YBCO ML films outperform their thinner counterparts in both higher value and less anisotropy of J_c (B). At 750 nm thickness, J_c (65K, 9T) is >1.2 MA/cm^2 and J_c (30K, 9T) reaches up to 12 MA/cm^2 with a variation of ~25% over the entire angular range of B field orientations. This result illustrates the critical role of the BZO 1D-APC/YBCO interface in the pinning efficiency of BZO 1D-APCs.

Keywords (Index Terms)—Multilayer, YBCO nanocomposite film, artificial pinning center, vortex pinning efficiency, interface engineering

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