Contribution ID: **167** Type: **Contributed Oral**

M2Or4B-04: Role of Ca diffusion in BaZrO3 nanorods/YBa2Cu3O7-x multilayer nanocomposite films

Tuesday 20 May 2025 17:15 (15 minutes)

In a recent study in probing the effect of the pinning efficiency of BaZrO3 (BZO) nanorods in BZO-doped YBa2Cu3O7-x (BZO/YBCO) nanocomposite films, Ca diffusion from two Ca0.3Y0.7Ba2Cu3O7-x spacers that form multilayers through alternative stacking with three BZO/YBCO layers was found to significantly enhance the pinning by approximately five folds at high fields up to 9.0 T. This raises a question on the role of Ca diffused into the multilayer BZO/YBCO nanocomposite films. In order to answer this question, this work investigates the Ca0.3Y0.7Ba2Cu3O7-x films of variable thickness in the range of 30-190 nm to understand whether the carrier over-doping induced by Ca substitution of Y would lead to enhanced pinning. In addition, the effect of the thicknesses of the constituent YBCO and Ca0.3Y0.7Ba2Cu3O7-x layers was also studied. By varying the YBCO thickness in the range of 50-330 nm, the effect of Ca diffusion from the two Ca0.3Y0.7Ba2Cu3O7-x spacers of 10 nm in thickness is investigated. Furthermore, the amount of Ca in Ca0.3Y0.7Ba2Cu3O7-x spacers may be controlled by varying their thickness ranging from 1 nm to 15 nm. Our result suggests the benefit of overdoping via Ca/Y substitution is minimal on pinning. In addition, the amount of Ca in the Ca0.3Y0.7Ba2Cu3O7-x spacers indeed affects the Ca diffusion and hence pinning enhancement dramatically, which reduce as the spacer thickness is below 5 nm threshold. Above this threshold, the Ca diffusion is highly effective through large BZO/YBCO thicknesses up to 330 nm (total film thickness ˜ 1 μm) and significantly enhanced pinning has been obtained in multilayer BZO/YBCO nanocomposites. At 20 K and 9.0 T, the Ic is up to 654 A/cm-width at B//c, which is close to 753 A/cm-width at B//ab due to the intrinsic pinning has been achieved.

Keywords: BZO/YBCO nanocomposite film, vortex pinning efficiency, multilayer, Ca diffusion, overdoping

Acknowledgements
This research was supported in part by NSF contracts Nos: NSF-DMR-2413044, the AFRL Aerospace Systems Directorate, the Air Force Office of Scientific Research (AFOSR LRIR # 24RQCOR004). J. S. and H.W. acknowledge the support from the U.S. Office of Naval Research (ONR, No. N00014-20-1-2600) and the U.S. National Science Foundation (No. DMR-2016453) for the TEM/STEM work.

Author: Dr WU, Judy (University of Kansas)

Co-authors: Dr SEBASTIAN, Mary Ann (US Air Force Research lab); Mr OGUNJIMI, Victor (University of Kansas); AAFIYA, Aafiya (University of Kansas); Mr SHEN, Jianan (Purdue University); HAUGAN, Timothy; Dr WANG, Haiyan (Purdue University)

Presenter: Dr WU, Judy (University of Kansas)

Session Classification: M2Or4B - Growth & Characterization of REBCO and Iron-based Superconductors