Comparison of current limiting defects in YBa$_2$Cu$_3$O$_{7-x}$ and Ba(Fe$_{1-x}$Co$_x$)$_2$As$_2$ films

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Introduction

- Current limiting defects in superconductors generate strong non-uniformities in local electric fields ($E$) due to the nonlinear $E(J)$ characteristics of the superconducting state.
- The Low Temperature Laser Scanning Microscope (LTLSM) can image $E(x,y)$ with about 2-3 um resolution over a wide range of $E$, $T$ and $H_{ext}$.
- We report the effects of current limiting defects in YBa$_2$Cu$_3$O$_{7-x}$ and Ba(Fe$_{1-x}$Co$_x$)$_2$As$_2$ films.

Visualization of transition from GB to IG behavior in Ba(Fe$_{1-x}$Co$_x$)$_2$As$_2$ on 5° bicrystal

Transition from GB limited to bulk limited regimes in MOD YBCO on RABITS

Texture characterization of BaF$_2$ YBCO film on older RABITS

Visualization of transition from GB to IG behavior in quasi-1D MOD YBa$_2$Cu$_3$O$_{7-x}$ link

Description of Samples

YBa$_2$Cu$_3$O$_{7-x}$

Coated conductors grown with s-beam BaF$_2$, ox, and SrTiO$_3$ substrates on RABITS

Critical angle

$\theta_c \approx 2.4 \degree$ for 2D GBs

$\theta_c \approx 1.2 \degree$ for 3D GBs

BaFe$_{1-x}$Co$_x$As$_2$ (x=0.08)

Granular films grown in situ on SrTiO$_3$ substrates by PLD processes to 300 nm thick

Critical angle

$\theta_c = 2.44 \pm 0.26$ nm wide, 700 nm long

GBs were used to define misorientation angles

$\delta$-scan of the 211 reflections were used to define misorientation angles

GBs have mixed misorientation

In-plane and out-of-plane misorientations reported

$\delta$-scan of the 112 reflections were used to define misorientation angles

$\delta$-scan of the 211 reflections were used to define misorientation angles

$\delta$-scan of the 112 reflections were used to define misorientation angles

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Summary

- We found that bias current dependencies and magnetic field dependence of $E(x,y)$ near GBs are qualitatively similar to that found in YBa$_2$Cu$_3$O$_{7-x}$ superconductors.
- Self field critical angle for BaFe$_{1-x}$Co$_x$As$_2$, GBs is similar to the in-plane misoriented MOD YBCO GBs.
- We found strong non-uniformity of the $E(x,y)$ response along BaFe$_{1-x}$Co$_x$As$_2$ GBs. To understand microscopic origins of these non-uniformities additional TEM and analysis is necessary.
- Meandering GBs of modern MOD film on RABITS have larger $J_c$ than PLD on RABITS and BaFe$_2$ on older RABITS.
- For MOD on modern RABITS in-plane component reduces $J_c$ more than out-of-plane component (between 1°-3°).