Deposition of $BaZrO_3$-doped YBCO by a Fluorine-free MOD Process

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Introduction

In this study, both pure and $BaZrO_3$-doped superconducting YBCO films were fabricated on both single crystal and buffered RABiTS substrates by a fluorine-free metal organic deposition (MOD) process. We succeeded in introducing nanoscale $BaZrO_3$ (BZO) particles into YBCO films by adding extra Ba and Zr organic salts and were able to use multi-coating process to obtain high quality thick (up to ~ 1.1 μm) films. The pinning force density (F_p) in all BZO-doped YBCO samples is enhanced. The optimal $BaZrO_3$ doping content investigated in this work is x = 0.10 for YBCO + x BZO films. Maximum pinning force density (F_p^{max}) exceeding 10 GN/m^3 is obtained in ~ 200nm YBCO + 0.10 BZO film on $SrTiO_3$ substrates and 5 GN/m^3 in ~ 1.1μm YBCO + 0.10 BZO film on buffered RABiTS. The angular dependence of in-field critical current density (J_c) measurements shows J_c anisotropy is strongly reduced by BZO doping at 1 T and 4 T.

Experimental

Pure and BZO-doped YBCO films were prepared from metal-acetylacetonates solutions which were deposited by spin coating on different substrates. 0.2 - 1.1 μm-thick films were obtained by multi-coating process. The conversion heat treatment was carried out at the temperature of 775°C - 810°C in 200ppm O_2 in Ar. XRD was used to analyze the texture quality while HRSEM was used to analyze the film microstructure. The critical temperature (T_c) and critical current density (J_c) were determined from transport measurements in field applied parallel to the c-axis.

Results and Discussion

In field J_c and H^{irr} are enhanced for ~ 200 nm YBCO films due to BZO doping on STO substrates. The x = 0.10 sample has a champion F_p of ~ 10 GN/m^3. The F_p peak also shifts to higher field with BZO doping. For the coated conductor application, we deposited BZO-doped YBCO films on buffered RABiTS substrates. Fig. 1a and 1b show the field-dependence of J_c and F_p at 77K at applied fields parallel to YBCO c-axis. The strong enhancement of the field-dependence of J_c and F_p can be clearly seen in these thicker films on RABiTS substrates. We can also notice a general increase in the flat background of J_c in BZO-doped sample at the applied field, 4 T.

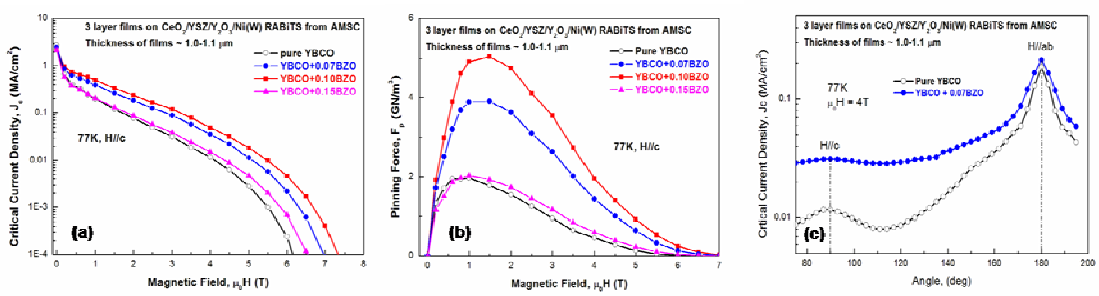

Fig. 1 (a) J_c as a function of H, (b) pinning force (F_p) as a function of H, and (c) angular dependence of J_c at 4 T, for pure and BZO-doped YBCO on RABiTS substrates.

Conclusions

We have proved an enhancement of F_p and isotropy of J_c in YBCO films by introducing BZO nanoparticles. It is suggested that the chemical doping of BZO in YBCO film using this fluorine-free MOD process is very promising for fabricating high performance YBCO conductors.

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