Critical Current Characterization of >4μm thick Zr-Added $REBa_2Cu_3O_x$ Coated Conductors at 4 K and Very High Magnetic Fields

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Introduction

The University of Houston has developed an Advanced metal organic chemical vapor deposition (MOCVD) system which enables an excellent control of growth temperature that is important in the growth of thick film RE-Ba-Cu-O (REBCO, RE=rare earth) superconductor tapes [1]. Using this Advanced MOCVD tool, we have grown undoped REBCO films above 4 μm in thickness with I_c(77 K, sf) ≈ 1.6 kA/12mm-width corresponding to a J_c ≈ 3.0 MA/cm^2. We have also grown Zr-added 4+ μm thick REBCO films with high critical current density in high magnetic fields at lower temperatures.

Experimental

Several REBCO tapes with 4-5 μm thick films and different film compositions were tested at NHMFL using a 31.2 T resistive magnet fitted with a 38 mm bore liquid He cryostat. The films were patterned to bridges less than 1 mm in width for measurements at high currents. The tapes were first qualified by critical current measurements in a liquid nitrogen bath at self-field at UH prior to testing at NHMFL.

Results and Discussion

The magnetic field dependence of critical current density and the pinning force dependence on magnetic field of 10 thick film REBCO tapes tested in this work are shown in Figure 1. All tapes had 4.5 μm thick REBCO films and 15% Zr addition. Tapes A-F contained normal amount of Ba and tapes G through J contained slightly higher Ba. The magnetic field was applied perpendicular to the tape surface at 4.2 K. It is seen from the figures that tapes with normal Ba and 15%Zr exhibit critical current density as high as 18 MA/cm^2 at 6 T and 6.6 MA/cm^2 at 20 T. Tapes with slightly higher Ba and 15% Zr exhibit critical current density of 10.6 MA/cm^2 at 6 T and 4.3 MA/cm^2 at 20 T. All tapes with normal Ba perform better than all tapes with slightly higher Ba. The pinning force characteristics of all tapes show an extended plateau from 10 T to 31.2T. Pinning forces as high as 1.4 TN/m^3 were observed in these tapes. A variability in critical current density and pinning forces is seen even in tapes of same Ba composition. Detailed compositional and microstructural analyses are underway to determine the reasons for this variability.

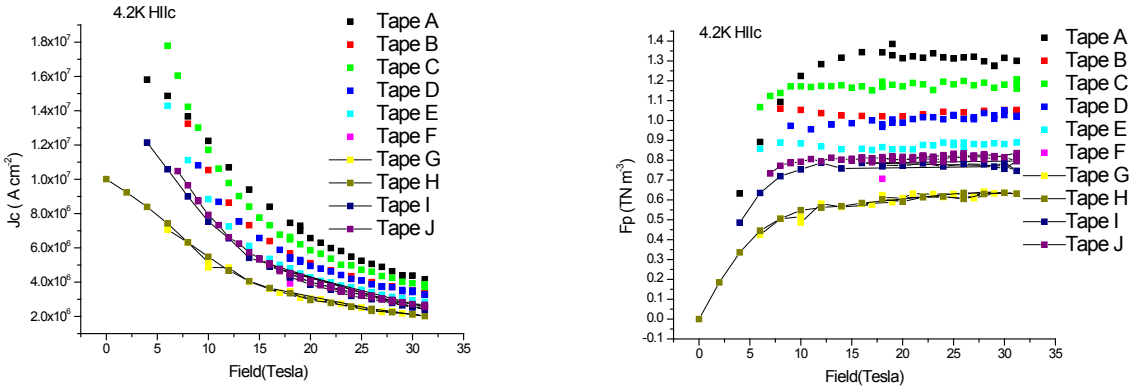

Figure 1 (left) Magnetic field dependence of critical current density of 4.5 μm thick film REBCO tape with 15%Zr with normal Ba composition (tapes A-F) and slightly higher Ba composition (tapes G-J) at 4.2 K. (right) Pinning force characteristics of these tapes.

Conclusions

Our results show that even thick film REBCO tapes made by Advanced MOCVD exhibit high critical current density and pinning forces at 4.2K in high magnetic fields up to 31T. The performance of these tapes appear to depend of the Ba composition of the films.

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References

[1] Majkic, G., *et al*., *IEEE Trans. Appl. Supercond.*, **25,** 6605304 (2015)