Effect of Ba_2YTaO_6 Addition on the Irreversibility Line of $YBa_2Cu_3O_7$ films

V. Rouco, A. Palau, X. Obradors, T. Puig, (Institut de Ciència Materials de Barcelona, Spain), and F.F. Balakirev, M. Weigand, L. Civale, B. Maiorov (Materials Physics and Applications Division, Los Alamos National Laboratory)

Introduction

The irreversibility field (H_{irr}) marks the upper limit of the magnetic field(**H**) - Temperature(T) region where superconductors are useful for power applications; thus increasing H_{irr} is of great technological interest. The generation of non-superconducting second phases and defects was shown to be effective to push H_{irr} up. The size, density and nature of the nanoparticles is critical to achieve the desired effect.[1] In this work we investigate the effect of Ba_2YTaO_6 (BYTO) addition into $YBa_2Cu_3O_7$ (YBCO) films on H_{irr} at different field orientations up to 65T.

Experimental

Epitaxial c-axis oriented YBCO and YBCO+ 6wt% BYTO nanocomposite films were grown on single-crystalline $LaAlO_3$ substrates, with the film's thickness of 250nm. Samples were prepared from metalorganic solutions with stoichiometric quantities of Y, Ba and Cu anhydrous trifluoroacetate, where Zr, Ta or Y salts were added to achieve the desired composition of the nanocomposites.[2] The superconducting transition temperature T_c for YBCO was T_c=91.8K while for the 6wt% BYTO was T_c=91.3K. A low AC current corresponding to 100 A/cm^2 with a frequency of 100 kHz was applied along the bridge in order to measure the electrical resistivity (ρ) with **J**⊥**H**.[2] For DC field studies (up to 9T) a rotational stage was used to change the orientation of the applied field **H** with respect to the c-axis of the films (Θ). For pulsed field experiments, Θ was varied by mounting the sample on fixed wedges. This introduces an error that is particularly relevant near the *ab* plane direction. Comparison with DC data allowed us to determine the orientation of the YBCO sample (for nominal **H**||ab) to be 87° not 90°**.** Thus the H_{irr} at **H**||ab for YBCO should be higher in order to compare with the other sample as seen in **Figure 1a**. The H_{irr} were determined using a 0.01ρ*(95K)* criterion.

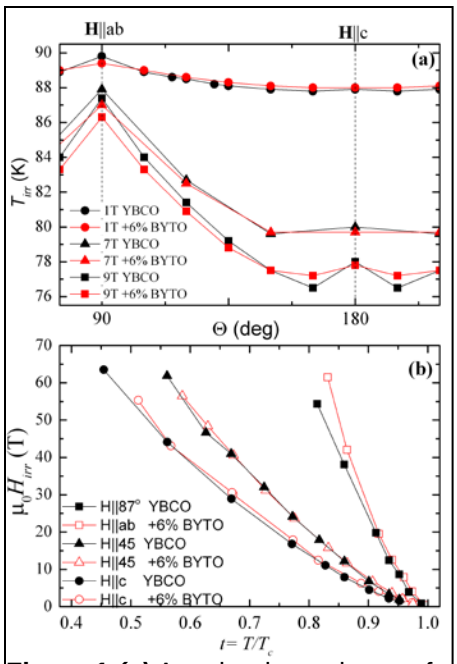

Figure 1.*(a)* Angular dependence of T_{irr} at different DC fields.***(b)*** H_{irr} for **H**||*c*, 45° and *ab*, for YBCO and YBCO+BYTO films.

Results and Discussion

Measurements in DC magnets were compared to the results from pulsed fields and showed very good agreement. We find that the addition of 6wt% BYTO nanoparticles enhances H_{irr} with respect to YBCO films only at low fields and high temperatures. Similarly to results for $BaZrO_3$ addition the effects are more important at intermediate angles.[3] The peak in $H_{irr}(\Theta)$ at **H**||c is also smaller, consistent with microscopy studies that show twin-boundaries being shorter and farther apart.[2] A decrease in H_{irr} was observed close to **H**||ab for YBCO+BYTO with respect to standard YBCO films most likely due to buckling of the *ab* planes.

Conclusions

We find that the addition of BYTO nanoparticles increases H_{irr} slightly in the high-temperature low-field region. Understanding the mixed pinning landscapes due to a combination of various dimensional disorders is critical to improve H_{irr}.

Acknowledgements

This work was supported by the US DOE, Office of Basic Energy Sciences, Materials Sciences and Engineering Division and by the SISGR, CECIT, Spain, MICINN (MAT2011-28874- C02-01), Consolider Nanoselect, Generalitat de Catalunya (Pla de Recerca SGR-770 and XaRMAE), EU (NESPA), Barcelona.

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