Strong Reduction of the Field-Dependent Microwave Surface Resistance in YBCO with $BaZrO_3$ Inclusions

N. Pompeo[(1)], V. Galluzzi[(2)], A. Augieri[(2)], F. Fabbri[(2)], G. Celentano[(2)], T. Petrisor[(3)], R. Rogai[(1)] and E. Silva[(1,4)]

(1) Dipartimento di Fisica "E. Amaldi" and Unità CNISM, Università Roma Tre, Via della Vasca Navale 84, I-00146, Roma, Italy
(2) ENEA-Frascati, Via Enrico Fermi 45, 00044 Frascati, Roma, Italy
(3) Department of Physics, Technical University of Cluj, 400020 Cluj-Napoca (Romania)
(4) E-mail: silva@fis.uniroma3.it

Abstract - We present measurements of the magnetic-field-dependent microwave surface resistance in laser-ablated $YBa_2Cu_3O_{7-\delta}$ films on $SrTiO_3$ substrates. $BaZrO_3$ crystallites were included in the films using composite targets containing $BaZrO_3$ inclusions with mean grain size smaller than 1 μm. X-ray diffraction showed single epitaxial relationship between $BaZrO_3$ and $YBa_2Cu_3O_{7-\delta}$. The effective surface resistance was measured at 47.7 GHz for $60 < T < 90$ K and $0 < \mu_0 H < 0.8$ T. The magnetic field had a very different effect on pristine $YBa_2Cu_3O_{7-\delta}$ and $YBa_2Cu_3O7_{-\delta}/BaZrO_3$, while for $\mu_0 H = 0$ only a reduction of Tc in the $YBa_2Cu_3O7_{-\delta}/BaZrO_3$ film was observed, consistent with dc measurements. At low enough T and in moderate fields, $YBa_2Cu_3O_{7-\delta}/BaZrO_3$ exhibited an intrinsic thin-film resistance lower than that of the pure film. The results clearly indicate that $BaZrO_3$ inclusions cause a strong reduction of the field-dependent surface resistance. From the analysis of the data in the framework of simple models for the microwave surface impedance in the mixed state, we argue that $BaZrO_3$ inclusions result in very steep pinning potentials.

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