Strong Reduction of the Field-Dependent Microwave Surface Resistance in YBCO with BaZrO$_3$ Inclusions

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Abstract - We present measurements of the magnetic-field-dependent microwave surface resistance in laser-ablated YBa$_2$Cu$_3$O$_{7-δ}$ 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 $\mu$m. X-ray diffraction showed single epitaxial relationship between BaZrO$_3$ and YBa$_2$Cu$_3$O$_{7-δ}$. The effective surface resistance was measured at 47.7 GHz for $60 < T < 90$ K and $0 < \mu_0H < 0.8$ T. The magnetic field had a very different effect on pristine YBa$_2$Cu$_3$O$_{7-δ}$ and YBa$_2$Cu$_3$O$_{7-δ}$/BaZrO$_3$, while for $\mu_0H = 0$ only a reduction of $T_c$ in the YBa$_2$Cu$_3$O$_{7-δ}$/BaZrO$_3$ film was observed, consistent with dc measurements. At low enough $T$ and in moderate fields, YBa$_2$Cu$_3$O$_{7-δ}$/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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