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Observation of inverse a. c. Josephson effect in bulk Y-Ba-Sr-Cu-O up to room temperature

A K GUPTA, B JAYARAM, S K AGARWAL, ANURAG GUPTA and A V NARLIKAR

National Physical Laboratory, Hillside Road, New Delhi 110012, India

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Abstract. Microwave induced d.c. voltage due to inverse a.c. Josephson effect has been observed across bulk samples of multiphase $Y_2BaSrCu_3O_8$. Results indicate that weakly coupled superconducting grains probably exist up to 26°C.

Keywords. Josephson effect; mixed metal oxides; high temperature superconductivity.

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Intense research activities have been started at many centres in the world after the discovery of high T_c superconductivity in mixed metal oxides (Bednorz and Muller 1986; Uchida *et al* 1987; Ganguly *et al* 1987; Umarji *et al* 1987). The superconducting onset temperature is generally determined by measurement of resistance as a function of temperature. However, if a high T_c phase coexist with lower temperature superconducting phase, the conventional resistance measurements cannot clearly establish superconductivity at the higher temperature. In our earlier publication (Gupta *et al* 1987a) we have shown that the high T_c superconducting material Y-Ba-Cu-O probably consists of a large number of weakly coupled superconducting grains and we have reported the observation of microwave induced d.c. voltage due to inverse a.c. Josephson effect across the bulk samples of Y-Ba-Cu-O. We have also shown that the superconducting grains are present in these samples up to 230 K which are not detected by usual resistance measurements. Hence the study of inverse a.c. Josephson effect in multiphase high T_c materials is found to be a more powerful technique than the conventional resistance measurements to establish probable superconducting phases at higher temperatures.

In this paper we report the study of inverse a.c. Josephson effect in multiphase samples of $Y_2BaSrCu_3O_8$. The samples were prepared by direct oxide·mixing technique described elsewhere (Jayaram *et al* 1987a,b). Typical resistance versus temperature curve is shown in figure 1. There is a sharp drop in resistance above 230 K followed by a gradual metal-like decrease of resistance with temperature. The sample shows the tendency of becoming fully superconducting (data not shown) below 60 K.

For the inverse a.c. Josephson effect studies the sample is mounted inside a X-band waveguide and is irradiated with highly stabilized phase-locked microwave radiations having a stability of one part in 10^9 over a period of 2 hr. The details of

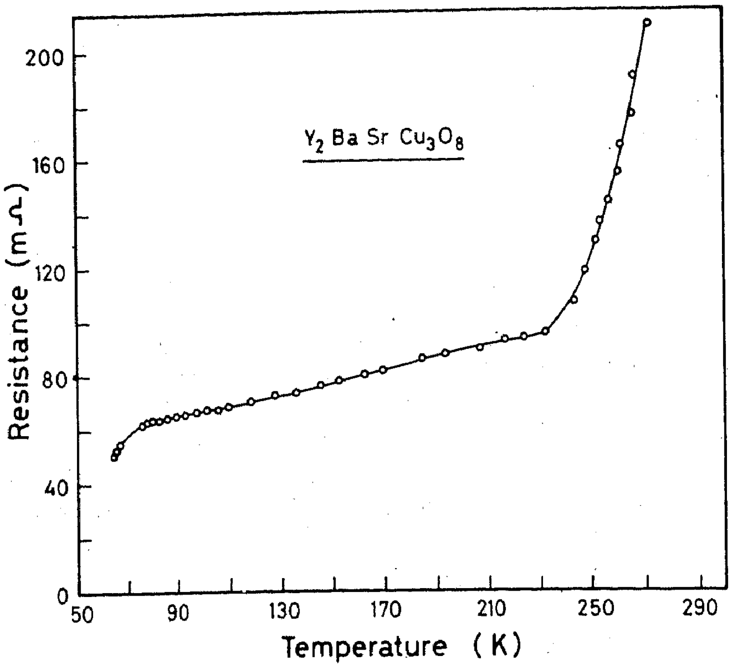

Figure 1. Resistive transition curve for the sample $Y_2BaSrCu_3O_8$.

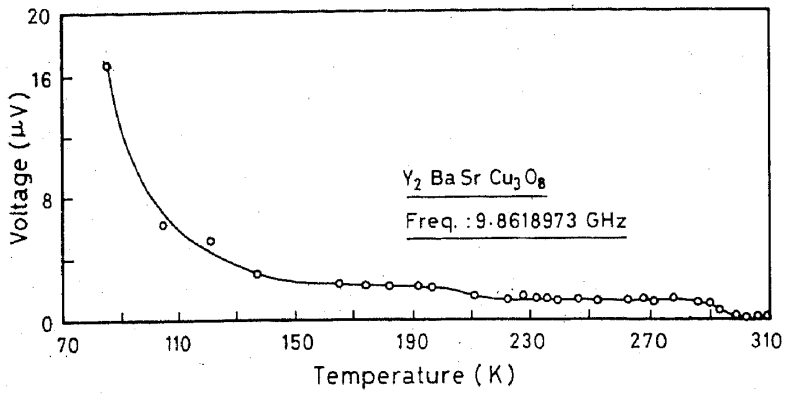

Figure 2. Temperature variation of the microwave induced voltage due to inverse a.c. Josephson effect.

microwave system are given elsewhere (Gupta *et al* 1987b). The d.c. voltage is measured using a high impedence nanovoltmeter. Correction for thermal e.m.f. is applied to each measurement. The overall uncertainty in the measurement of the induced voltage is $\pm$ 0·1 μV which is mainly due to variation in the thermal e.m.f.

Figure 2 shows the temperature variation of the microwave induced d.c. voltage for a fixed value of microwave power. It may be seen that the d.c. voltage is observed up to 299 K, that is +26°C. The simplest interpretation is that weakly coupled superconducting grains are present up to this temperature. As the sample has many phases the above studies have been repeated on several different samples and superconductivity in them is found to persist up to temperatures of +15 to 26°C. Efforts are being made to identify and isolate this phase which would lead to zero resistivity at room temperature.

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