ONSET OF SUPERCONDUCTIVITY AT 110 K in Y-Ba-Cu-O COMPOUND SYSTEM

E. V. SAMPATHKUMARAN, P. L. PAULOSE, A. K. GROVER, V. NAGARAJAN and S. K. DHAR
Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400005, India.

ABSTRACT

The existence of a superconducting phase transition well above 77 K in the multiphase compound, $Y_{1.2}Ba_{0.8}CuO_4$ as reported recently[1] was confirmed by our study. The observed superconducting onset temperature (~110 K) and the temperature at which the zero-resistance state is achieved (87 K) in our samples, to our knowledge, are the highest ever reported among the stable superconducting compounds. The transition width (~2 K) is also narrower compared to that reported by Wu *et al*[1].

FOLLOWING the report on the existence of a superconducting phase transition (T_c) at an unusually high temperature (~30 K) in a multiphase system $La_4BaCu_5O_{15-x}$ by Bednorz and Müller[2], there has been considerable interest currently among the scientific community to look for high temperature superconductivity in oxides. Chu *et al*[3] and Cava *et al*[4] from their investigations attributed the superconductivity to a A_2BO_4 type tetragonal phase in this multiphase compound. In fact, the compound $La_{1.8}Sr_{0.2}CuO_4$ has been shown by Cava *et al*[4] to exhibit a T_c of about 36 K. These studies were extended to various other substituents like Ca, Pb etc at the lanthanum site and T_c was found to decrease without any correlation to the ionic size of the substituent[5,6]. Very recently, Alabama and Texas based groups[1,7] (in USA) reported the existence of superconducting phase transition well above 77 K in a multiphase compound system corresponding to the formula, $Y_{1.2}Ba_{0.8}CuO_4$. These authors notice a linear decrease of resistance till 93 K, a sharp drop below 92 K and a zero-resistance state at 80 K in their sample and it is not clear which phase in the sample becomes superconducting. This is one of the greatest achievements of scientific research, in view of the fact that for the first time, a compound is identified to have T_c beyond the technological and psychological temperature barrier in the liquid nitrogen range. It should also be pointed out that there are many reports of such high T_c systems in the past and they were found to be irreproducible. In view of this, it would be of interest to synthesize new samples of $Y_{1.2}Ba_{0.8}CuO_4$ system in order to confirm its high T_c value and also to see whether T_c can be raised further in that system. Here, we report briefly the results of the investigation on our samples in support of the findings of Alabama and Texas groups.

The samples were prepared by a conventional solid-state reaction method starting with the stoichiometric amounts of Y_2O_3, $BaCO_3$ and CuO (by the prolonged heating at 900°C for a few days). The resistance measurements were carried out on the compacted and sintered pellets by the conventional four-probe method in the temperature interval 4–2–300 K.

The results of our resistance measurements are shown in figure 1. The resistivity at 300 K is of the order of 40 mohm.cm. There is a linear decrease in the electrical resistance till about 120 K and a deviation from linearity at about 110 K (T_{onset}). The resistance drops sharply at about 95 K and it goes to zero at 87 K (T_o). The width of the transition (defined as the difference of the temperature at 10–90% resistance values) and the midpoint of the transition are 2.5 K and 91 K respectively.

These results confirm the reproducibility of the high temperature superconductivity in Y-Ba-Cu-O system in support of the findings of Alabama and Texas groups. The points, however, we would like to stress are that (i) our observed values of T_{onset} and T_o are higher than those reported in Ref. 1 and, to our knowledge, the highest ever reported to date in any stable superconducting compound, and (ii) the width of the transition is also much narrower (~2 K) than that observed in Ref. 1. Meissner effect studies show the bulk nature of the superconductivity in the samples. It also appears that the resistive behaviour seems to be a sensitive function of the heat treatment given to the samples. A detailed report will appear elsewhere.

The authors are grateful to Prof. R. Vijayaragha-

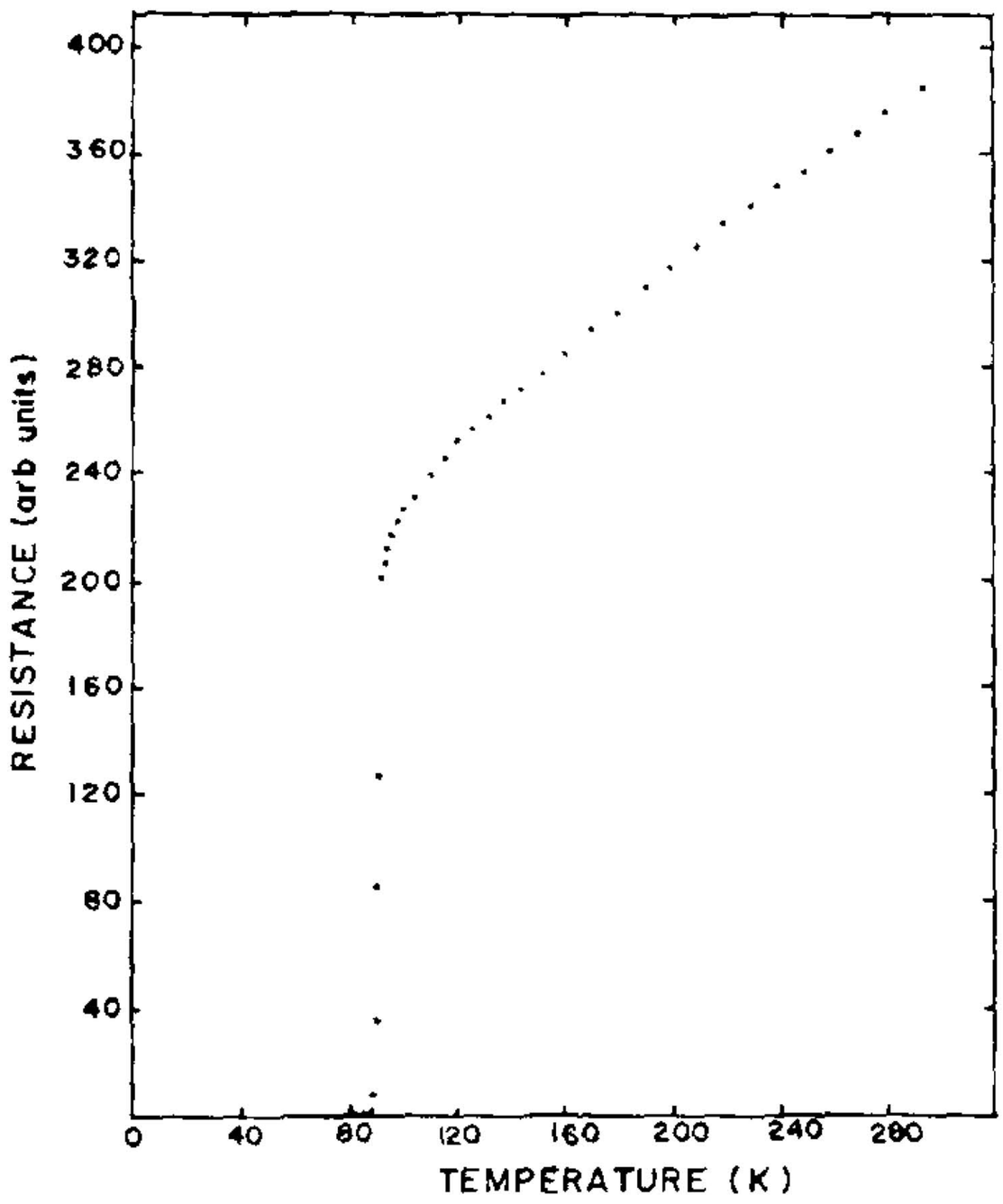

Figure 1. Resistance as a function of temperature (4.2–300 K) in multiphase sample with the starting composition $Y_{1.2}Ba_{0.8}CuO_4$.

van for his continued support and encouragement throughout all phases of this work. We also thank Prof. B. K. Basu and Dr R. G. Pillay for the facilities made available to us for preparing the samples.

9 March 1987

1. Wu, M. K., Ashburn, J. R., Torng, C. J., Hor, P. H., Meng, R. L., Gao, L., Huang, Z. J., Wang, Y. Q. and Chu, C. W., *Phys. Rev. Lett.*, 1987, **58,** 908.
2. Bednorz, J. G. and Müller, K. A., *Z. Phys.*, 1986, **B64,** 189.
3. Chu, C. W., Hor, P. A., Meng, R. L., Gao, L., Huang, Z. J. and Wang, Y. Q., *Phys. Rev. Lett.*, 1987, **58,** 405.
4. Cava, R. J., van Dover, R. B., Batlogg, B. and Rietman, E. A., *Phys. Rev. Lett.*, 1987, **58,** 408; Rao, C. N. R., private communication.
5. Gopalakrishnan, I. K., Umarji, A. M., Yakhmi, J. V., Gupta, L. C., Iyer, R. M. and Vijayaraghavan, R., *Mat. Lett.*, (communicated).
6. Sampathkumaran, E. V., Paulose, P. L., Grover, A. K., Nagarajan, V. and Dhar, S. K., *J. Phys.*, (communicated).
7. Hor, P. H., Gao, L., Meng, R. L., Huang, Z. J., Wang, Y. Q., Forster, K., Vassilious, J., Chu, C. W., Wu, M. K., Ashburn, J. R. and Torng, C. J., *Phys. Rev. Lett.*, 1987, **58,** 911.

Note added in proof:

We observe a clear deviation from linearity from the high temperature resistive behaviour in one of our samples (with slight excess of Ba concentration) at about 140 K, other features remaining the same as in figure 1.