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High-temperature superconductivity in the 100 K region in perovskite-related oxides of the Ln-Ba-Cu-O (Ln = Y or La) system†

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Abstract. Oxides of the Y-Ba-Cu-O system are found to show onset of superconductivity in the 100–120 K region.

Keywords. High-temperature superconductivity; yttrium-barium copper oxides.

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In the wake of the sensational high T_c oxide superconductors discovered recently (Uchida *et al*; Cava *et al* 1987; Chu *et al* 1987; Rao and Ganguly 1987), we have been investigating several oxides in the Ln-Sr-(Ba)-Cu-O system where Ln is Pr, Nd or Y (Ganguly and Rao 1986; Ganguly *et al* 1987). This system has yielded many oxides where the onset of superconductivity, T_c°, is in the vicinity of 40 K. As part of this programme, we studied the oxide $La_4BaCu_5O_{13+\delta}$ (Michel *et al* 1985). A sample of this oxide showed a current-dependent resistivity behaviour around 160 K shown in figure 1(a), suggesting the possible presence of an oxide phase with a fairly high T_c. We have also studied several other related La-Ba-Cu oxides. Thus, $La_{3.75}Ba_{1.25}Cu_5O_{13+\delta}$ showed the onset of superconductivity, T_c°, at 20 K and current dependence of resistivity around 50 K as can be seen in figure 1(b). $La_3Ba_3Cu_6O_{14}$ however did not show any indication of superconductivity and remained semiconducting throughout.

We have been carrying out experiments on several lanthanide copper oxides analogous to the La-Ba-Cu oxides discussed above as indicated in an earlier communication (Rao and Ganguly 1987). Thus, we find that the oxide of nominal composition $Y_3Ba_3Cu_6O_{14}$ shows a T_c° at ~ 100 K (figure 2). An x-ray study of this oxide indicates the presence of two phases, the predominant one being a perovskite; the minor phase seems to be Y_2BaCuO_5 which is a green insulator. The Y-Ba-Cu oxide in which the high T_c superconductivity has just been reported by Wu *et al* (1987) is likely to contain these phases. However, no oxide phase of K_2NiF_4 structure seems to be present in any of these preparations.

What is specially significant in our study is that the oxide system $Y_{2.4}Ba_{3.6}Cu_6O_{14}$ shows a T_c° of around 115 K as shown in figure 2(a). Magnetic susceptibility measurements also show a similar T_c° (figure 2b). Zero resistivity is attained at ~ 85 K. This oxide composition mainly contains the perovskite phase, but no oxide of K_2NiF_4 structure; the Y_2BaCuO_5 phase is present only to a small extent.

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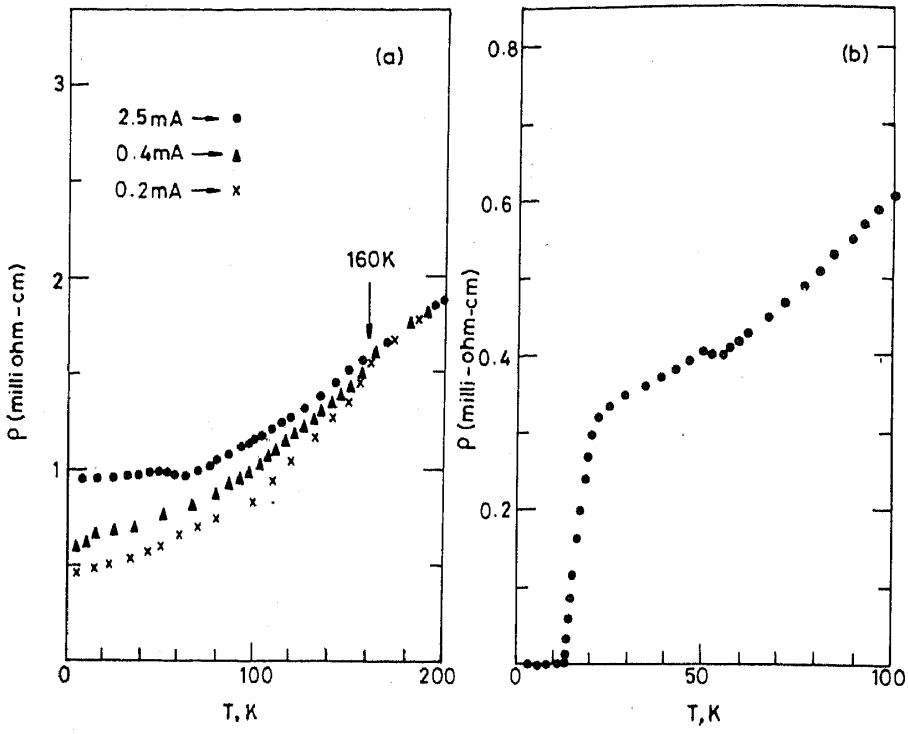

Figure 1. (a). Resistivity data on $La_4BaCu_5O_{13+\delta}$ as a function of measuring current. Note that current-dependence starts at ~ 160 K. **(b)** Resistivity data on $La_{3.75}Ba_{1.25}Cu_5O_{13+\delta}$ showing superconducting transition at ~ 20 K. Note an interesting anomaly around ~ 50 K.

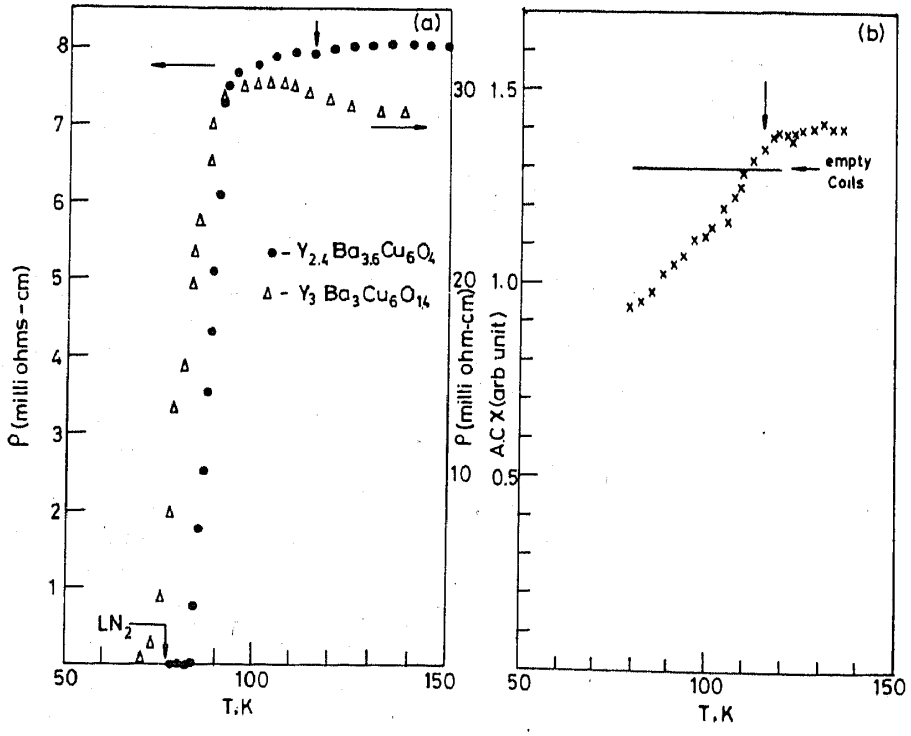

Figure 2. (a). Resistivity data on $Y_3Ba_3Cu_6O_{14}$ and $Y_{2.4}Ba_{3.6}Cu_6O_{14}$. Note that T_c° in the latter is ~ 115 K. (b) Magnetic susceptibility data on $Y_{2.4}Ba_{3.6}Cu_6O_{14}$.

We are at present measuring properties of a variety of oxides of the Y-Ba-Cu-O system wherein Y is substituted by Lu, Sc and other cations and Ba is partly substituted by Sr. In addition, measurements on certain oxide composites are also in progress.

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