

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

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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,  $T_c^\circ$ , is in the vicinity of 40 K. As part of this programme, we studied the oxide  $\text{La}_4\text{BaCu}_5\text{O}_{13+\delta}$  (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,  $\text{La}_{3.75}\text{Ba}_{1.25}\text{Cu}_5\text{O}_{13+\delta}$  showed the onset of superconductivity,  $T_c^\circ$ , at 20 K and current dependence of resistivity around 50 K as can be seen in figure 1(b).  $\text{La}_3\text{Ba}_3\text{Cu}_6\text{O}_{14}$  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  $\text{Y}_3\text{Ba}_3\text{Cu}_6\text{O}_{14}$  shows a  $T_c^\circ$  at  $\sim 100$  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  $\text{Y}_2\text{BaCuO}_5$  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  $\text{K}_2\text{NiF}_4$  structure seems to be present in any of these preparations.

What is specially significant in our study is that the oxide system  $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$  shows a  $T_c^\circ$  of around 115 K as shown in figure 2(a). Magnetic susceptibility measurements also show a similar  $T_c^\circ$  (figure 2b). Zero resistivity is attained at  $\sim 85$  K. This oxide composition mainly contains the perovskite phase, but no oxide of  $\text{K}_2\text{NiF}_4$  structure; the  $\text{Y}_2\text{BaCuO}_5$  phase is present only to a small extent.

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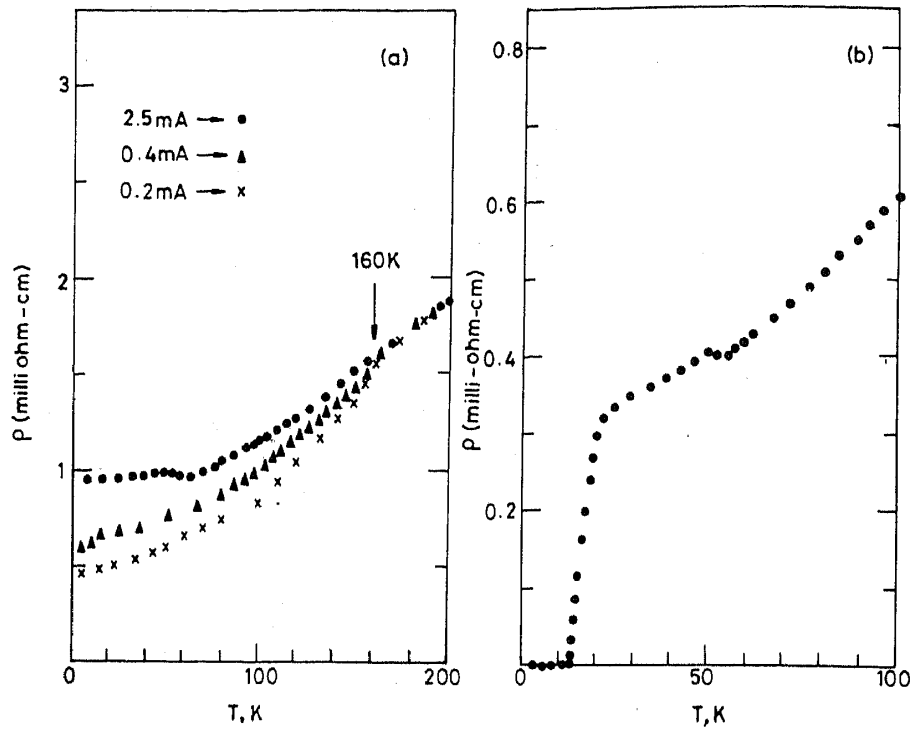


Figure 1. (a). Resistivity data on  $\text{La}_4\text{BaCu}_5\text{O}_{13+\delta}$  as a function of measuring current. Note that current-dependence starts at  $\sim 160$  K. (b) Resistivity data on  $\text{La}_{3.75}\text{Ba}_{1.25}\text{Cu}_5\text{O}_{13+\delta}$  showing superconducting transition at  $\sim 20$  K. Note an interesting anomaly around  $\sim 50$  K.

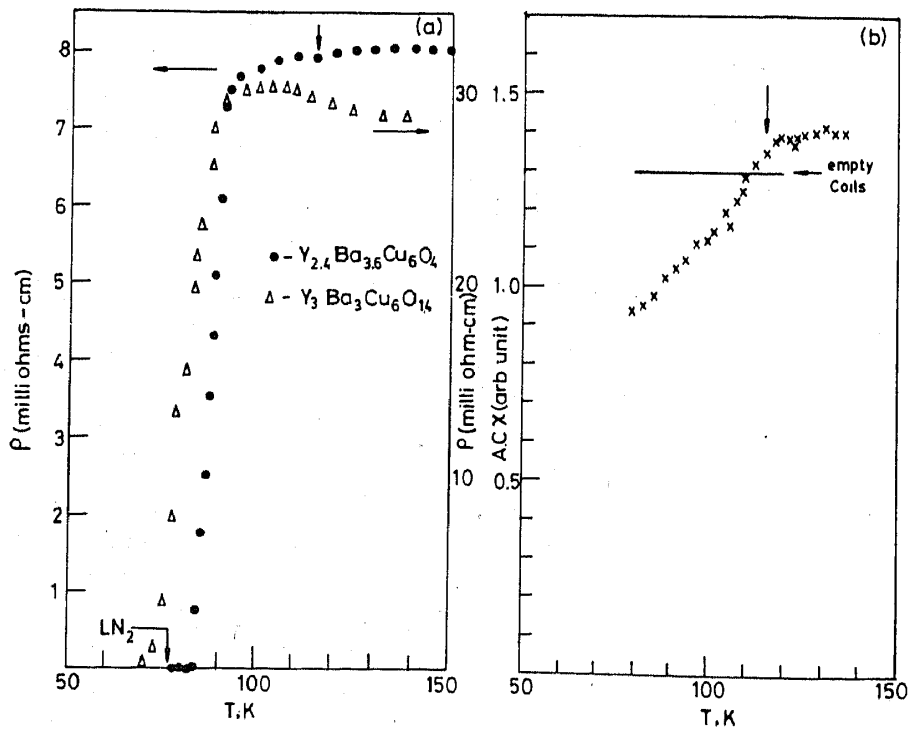


Figure 2. (a). Resistivity data on  $\text{Y}_3\text{Ba}_3\text{Cu}_6\text{O}_{14}$  and  $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$ . Note that  $T_c$  in the latter is  $\sim 115$  K. (b) Magnetic susceptibility data on  $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$ .

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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