

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

P GANGULY, A K RAYCHAUDHURI*, K SREEDHAR and C N R RAO**

Solid State and Structural Chemistry Unit, *Department of Physics,
Indian Institute of Science, Bangalore 560 012, India

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.

PACS No. 74.70

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 $\text{La}_4\text{BaCu}_5\text{O}_{13+\delta}$ (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° , 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° 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 $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$ 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.

[†] Contribution No. 429 from the Solid State and Structural Chemistry Unit.

** To whom all correspondence should be addressed.

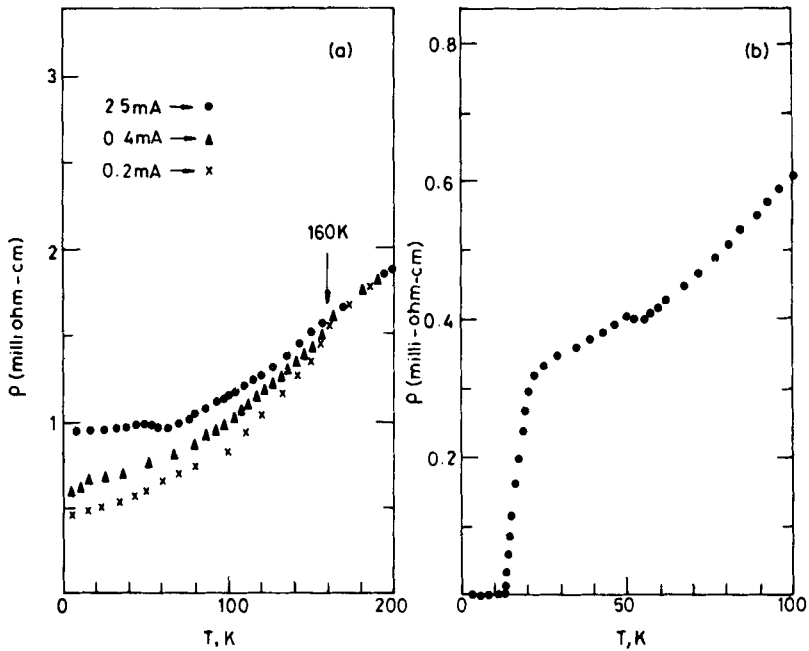


Figure 1. (a). Resistivity data on $\text{La}_4\text{BaCu}_5\text{O}_{13+\delta}$ as a function of measuring current. Note that current-dependence starts at ~ 160 K. (b) Resistivity data on $\text{La}_{3.75}\text{Ba}_{1.25}\text{Cu}_5\text{O}_{13+\delta}$ showing superconducting transition at ~ 20 K.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

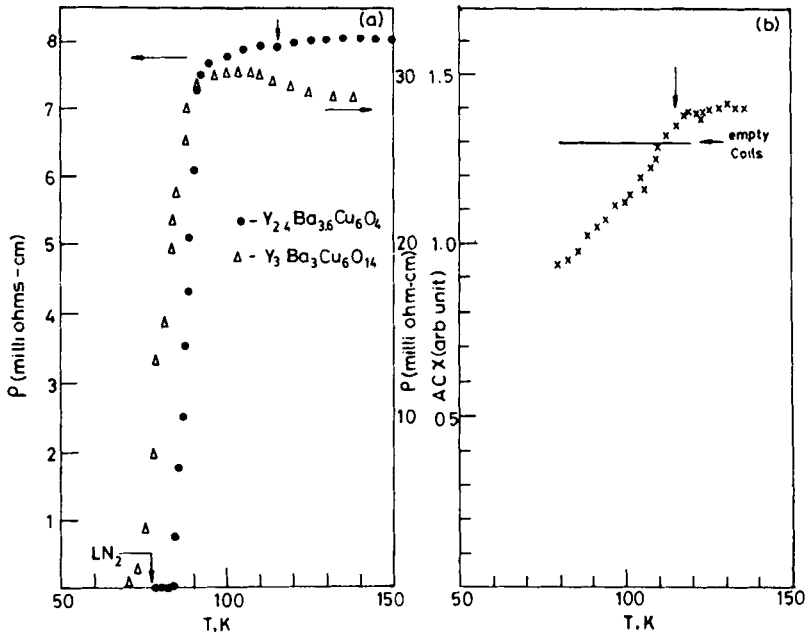


Figure 2. (a). Resistivity data on $\text{Y}_3\text{Ba}_3\text{Cu}_6\text{O}_{14}$ and $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$. Note that T_c^* in the latter is ~ 115 K. (b) Magnetic susceptibility data on $\text{Y}_{2.4}\text{Ba}_{3.6}\text{Cu}_6\text{O}_{14}$.

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.

The authors thank the University Grants Commission and the Department of Science and Technology, Government of India, for support of this research.

References

- Cava R J, van Dover R B, Batlogg B and Reitman E A 1987 *Phys. Rev. Lett.* **58** 408
Chu C W, Hor P H, Meng R L, Gao L, Huang Z J and Wang Y Q 1987 *Phys. Rev. Lett.* **58** 405
Ganguly P and Rao C N R 1986 *Proc. Indian Acad. Sci. (Chem. Sci.)* **97** 631
Ganguly P, Mohan Ram R A, Sreedhar K and Rao C N R 1987 *Solid State Commun.* (in print)
Michel C, Er-Rakho L and Raveau B 1985 *Mater. Res. Bull.* **20** 667
Rao C N R and Ganguly P 1987 *Curr. Sci.* **56** 47
Uchida S, Takagi H, Kitazawa K and Tanaka S 1987 *Jpn. J. Appl. Phys.* **26** L1
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
1987 *Phys. Rev. Lett.* **58** 908