

Indications of superconductivity in the 200–300 K range in the Bi-Ca-Sr-Cu-O system*

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Abstract. Some of the Bi-Ca-Sr-Cu-O compositions show indications of onset of superconductivity in the 200–300 K region, possibly due to the intergrowth of different layered sequences.

Keywords. High-temperature superconductivity; Bi-Ca-Sr-Cu-O system.

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In our recent communication on the high-temperature superconductivity in oxides of the Bi-Ca-Sr-Cu-O system (Rao *et al* 1988), we reported the occurrence of resistivity drops around 200 K in some of the samples. We felt that these may signify the presence of a small proportion of superconducting phases with T_c s around 200 K, possibly caused by the intergrowth of different layered sequences. Part of the reason for this hunch was based on our observation that $\text{Bi}_2\text{CaSrCuO}_{6+\delta}$ and $\text{Bi}_2\text{Ca}_{1.5}\text{Sr}_{1.5}\text{CuO}_{8+\delta}$ show onset of superconductivity around 85 and 100 K (with zero-resistance at 25 and 45 K) respectively; similarly, the T_c of the 2223 member of the Tl-Ca-Ba-Cu system seems to be higher than that of the 2122 member, suggesting that T_c increases with the number of CuO_2 layers. We therefore made up several Ba-Ca-Sr-Cu-O compositions corresponding to (1:1) intergrowth of two different phases (Rao 1985) and measured their resistivity. All of them indeed showed drops in resistivity around 200 K (figure 1). Onset of diamagnetic susceptibility was also seen around this temperature (figure 1). The resistivity drop around 200 K is more marked than that observed by Chu *et al* (1988) for the 110 K Bi-Ca-Sr-Cu-O phase. Some of these intergrowth compositions gave lattice images with considerable disorder and showed co-existence of fringes corresponding to different c -parameters (figure 2). It seems that intergrowth of different layered sequences may provide a means of increasing T_c .

Encouraged by the likely presence of a 200 K superconducting phase, we carried out electrical and magnetic measurements on different compositions of the Bi-Ca-Sr-Cu-O system. The composition $\text{Bi}_{2.25}\text{Ca}_{1.2}\text{Sr}_{1.55}\text{Cu}_2\text{O}_x$ showed onset of diamagnetism and a resistivity drop around 280 K (figure 3). This composition, although corresponding to a

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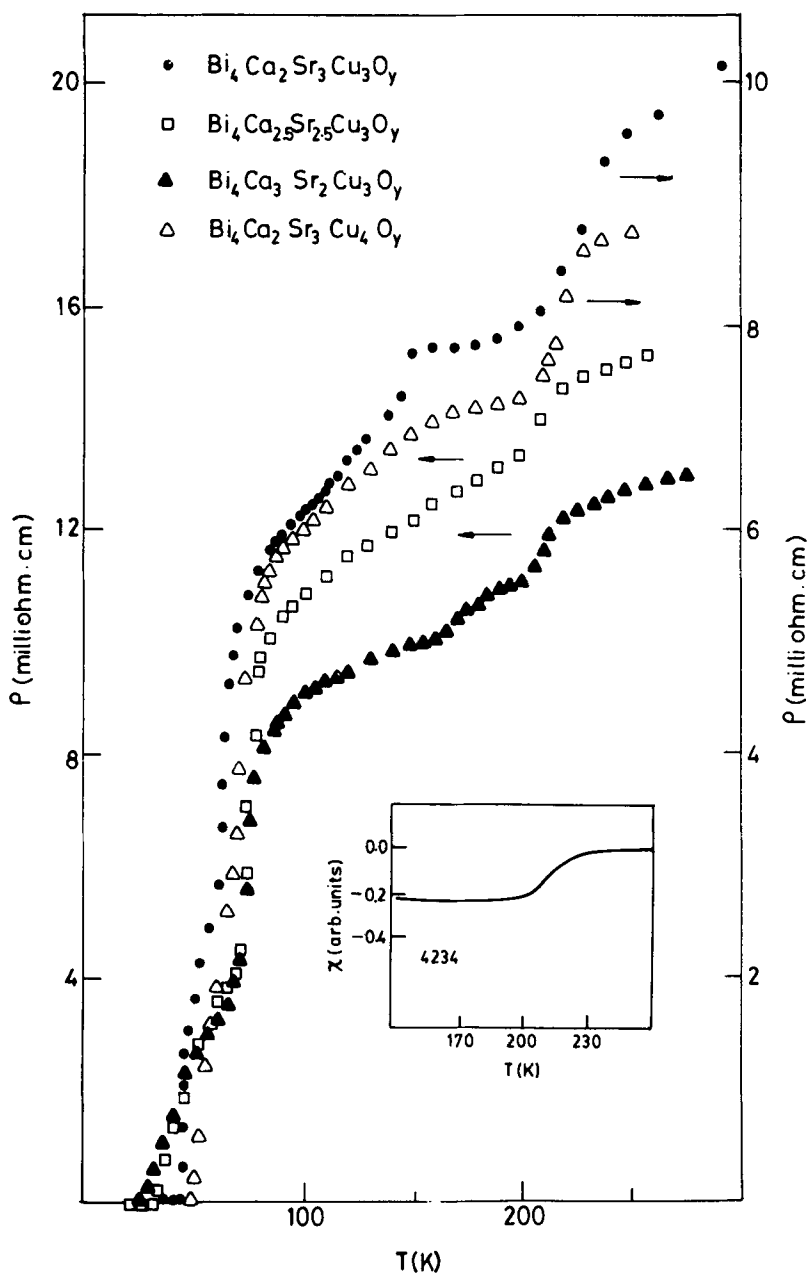


Figure 1. Resistivity data of some compositions of the Bi-Ca-Sr-Cu-O system. Inset shows susceptibility behaviour of the 4234 oxide. Repeated cycling does not affect the 200 K feature.

mixture, frequently showed unusual electron diffraction patterns due to supercell formation along the a and b directions; the corresponding lattice image showed 90° microdomains (figure 4). Similar patterns were also found in some of the "intergrowth" compositions (e.g. 4233).

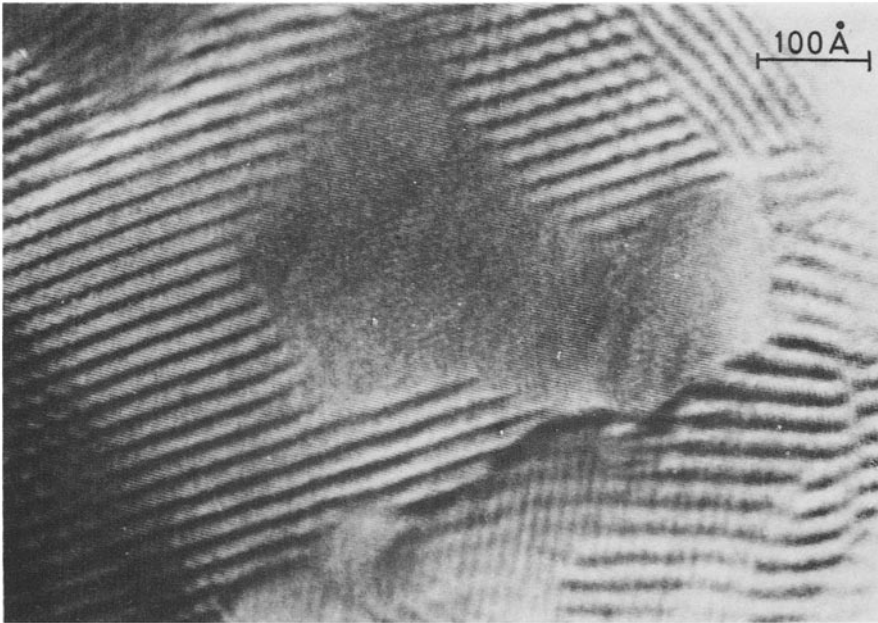


Figure 2. Lattice image of the 4234 oxide.

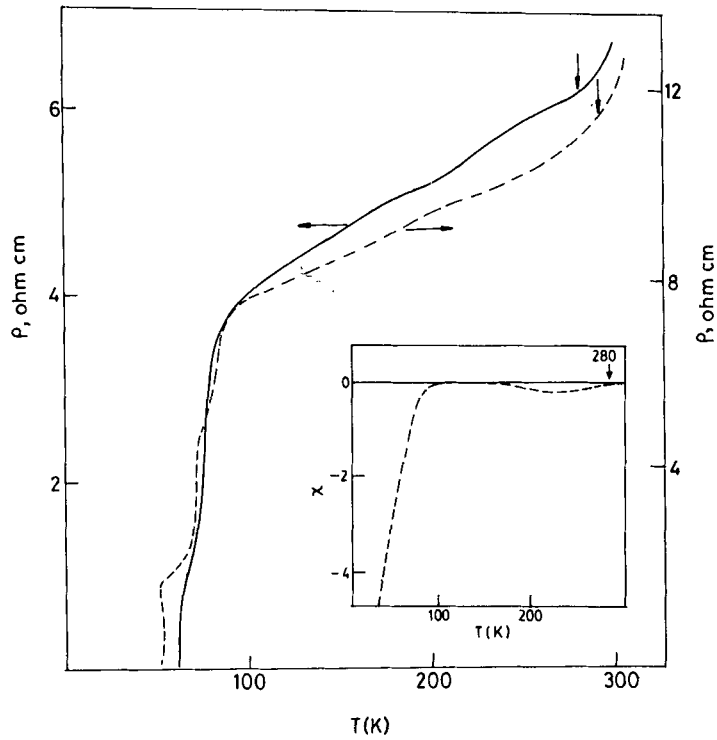


Figure 3. Resistivity data of two different samples of $\text{Bi}_{2.25}\text{Ca}_{1.2}\text{Sr}_{1.55}\text{Cu}_2\text{O}_x$. Inset shows susceptibility behaviour of one of the samples. Cycling had no effect on the 280 K feature.

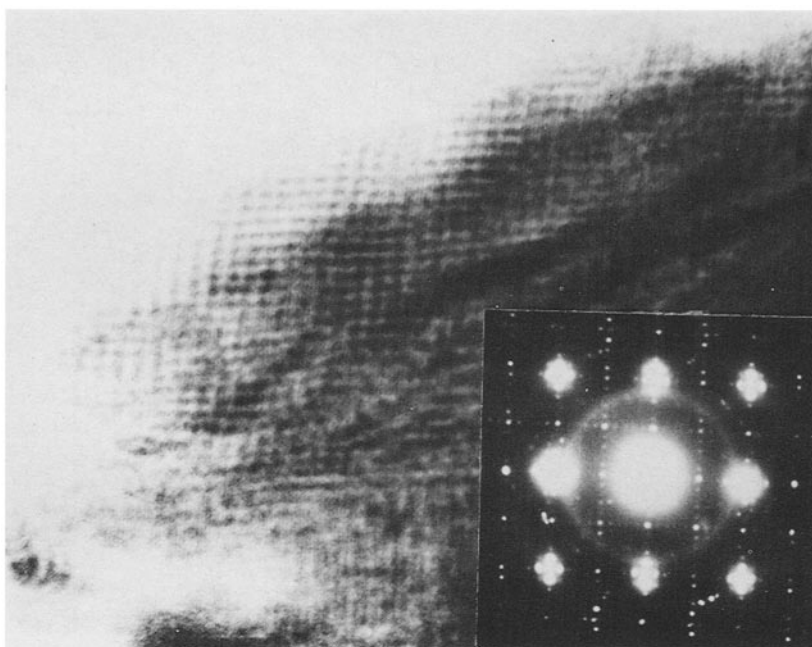


Figure 4. Electron diffraction pattern showing a supercell and lattice image showing 90 microdomains (electron beam along the *c*-axis).

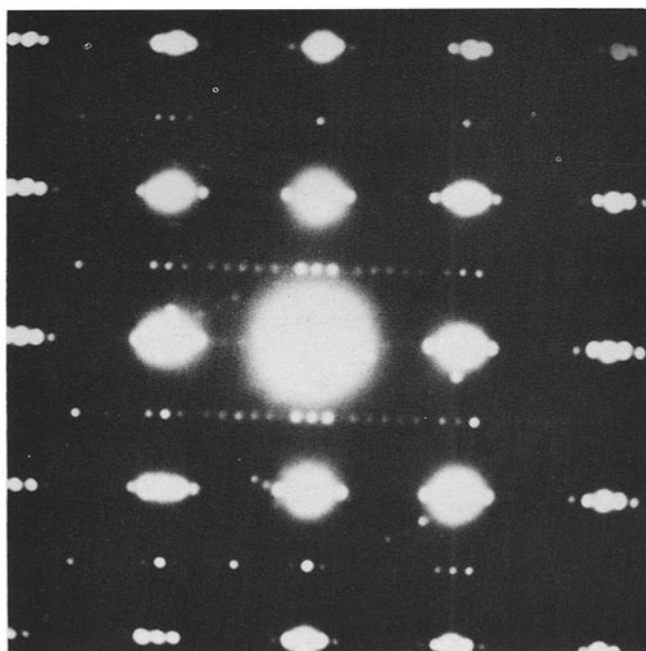


Figure 5. Electron diffraction pattern showing a supercell along the *b*-axis (electron beam along the *c*-axis).

Another interesting feature of the various Bi-Ca-Sr-Cu-O oxides is the presence of superstructure along the *b*-axis as shown in the electron diffraction pattern on figure 5. The *b*-axis here is a 10-fold superstructure of the cubic [110]. Such superstructure suggests presence of twins.

We are continuing these studies further to see if we can attain zero-resistance at 200 K or higher and will report detailed findings in the near future.

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