

High temperature superconductivity in bismuth-alkaline earth-copper-oxygen system

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Abstract. Electrical resistivity measurements of a series of compounds in the bismuth-alkaline earth-copper-oxygen system have been carried out. Several compositions ($\text{BiSrCaCu}_2\text{O}_x$, $\text{BiSrCaCu}_3\text{O}_x$, $\text{Bi}_2\text{Sr}_2\text{CaCu}_4\text{O}_x$ and $\text{Bi}_4\text{Sr}_3\text{Ca}_3\text{Cu}_8\text{O}_x$) showed superconducting onset temperatures in the range 90–130 K, though none of them showed $T_{c_f}(R=0)$ above 77 K. Extrapolated T_{c_f} of three compounds are in the range 72–75 K. All compounds are multiphasic.

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

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It is known that substitution of Y by a majority of lanthanide elements in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ superconductor only marginally affects the superconducting transition temperature T_c (Hor *et al* 1987) whereas replacement of Ba by Sr and Ca decreases T_c (Veal *et al* 1987; Kishio *et al* 1987). Recently Michel *et al* (1987) have reported T_c of 22 K in Bi-Sr-Cu-O system. However there has been no report of observation of high T_c in other oxide systems containing no rare earth elements. Recently technical newspaper reports (high T_c update, "Nature") from Japan and USA indicate that the onset of superconductivity at temperatures as high as 120 K has been observed in the Bi-Sr-Ca-Cu-O system. We have synthesized in the last few months a series of compounds in similar bismuth-alkaline earth-copper-oxygen system and measured their electrical resistivity as a function of temperature in an attempt to synthesize new class of high T_c oxide superconductors.

The compounds with nominal compositions as given in table 1 were prepared by reacting in appropriate ratio CuO , Bi_2O_3 , CaCO_3 , SrCO_3 and BaCO_3 . All compositions were initially calcined in air for 12 h, cooled, reground and reheated at 800°C for another 12 h. Reacted powders were then pressed into pellets and sintered at 850°C in air or flowing oxygen. Electrical resistivity measurements were then carried out from 300 K to 77 K on samples cut from the pellets by the standard four-probe technique.

Results are tabulated in table 1, and plotted in figure 1. Among ten compositions only four compositions showed T_c onset (T_{c0}) well above 77 K. However none of them showed $T_{c_f}(R=0)$ above 77 K. The extrapolated T_{c_f} values of the samples 1, 2, and 4 are ~ 75 K while T_c values (midpoint of 10 to 90% drop in resistance) of samples 1 to 4 are in the range 80–84 K. Particularly the sample 3 ($\text{Bi}_2\text{Sr}_2\text{CaCu}_4\text{O}_x$), though