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Substitutional effect on superconducting transition of Y-Ba-Cu-O

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Abstract. Superconducting Y-Ba-Cu-O system has been studied. The effect of changing compositions as well as the constituents on the superconducting transition temperature is reported.

Keywords. Superconducting Y-Ba-Cu-O system.

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The recently discovered (Wu *et al* 1987; Kadowaki *et al* 1987; Ganguly *et al* 1987; Umarji *et al* 1987) superconducting Y-Ba-Cu-O system is of particular interest as it

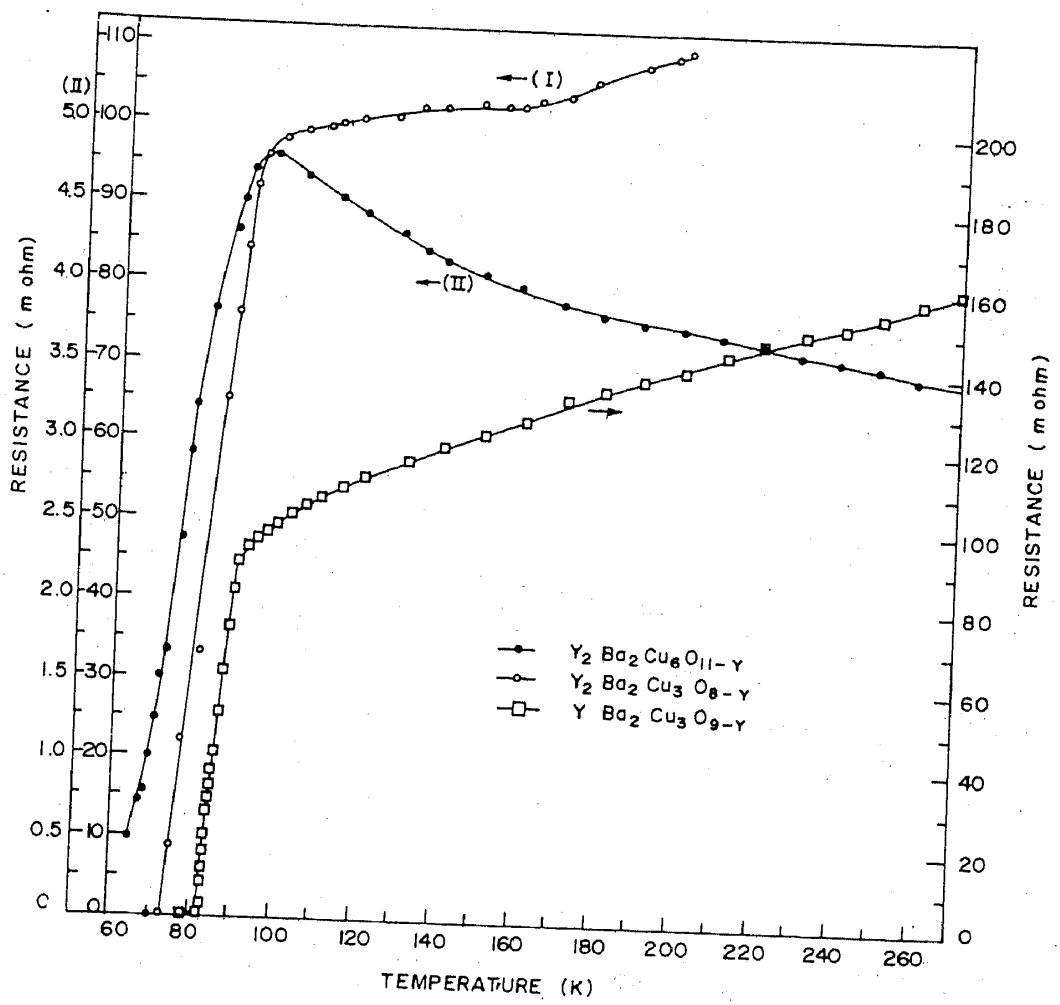

Figure 1. Resistance variation with temperature for different samples of Y-Ba-Cu-O of varying composition.

exhibits superconductivity in the liquid nitrogen temperature range. We have investigated various samples of this system prepared by the direct oxide mixing technique, described elsewhere (Jayaram *et al* 1987).

Figure 1 depicts the resistance variation with temperature of Y-Ba-Cu-O compounds with different compositions. As may be seen, the compound $YBa_2Cu_3O_{9-y}$ shows an onset temperature of 91 K and zero resistance at 83 K after 12 hr of solid state reaction at 950°C in air followed by 6 hr of sintering at the same temperature in oxygen environment. The sample was cooled to 200°C in the furnace before being taken out for low temperature characterization. With identical heat treatment the compound $Y_2Ba_2Cu_6O_{11-y}$ shows semiconducting like behaviour between 270 K and 90 K and below the latter a sharp drop of resistance by one order of magnitude is observed. This sample did not show zero resistance down to 63 K, however. Solid state reacted and sintered pellet of $Y_2Ba_2Cu_3O_{8-y}$ shows an onset T_c of 95 K with resistance zero at 73 K.

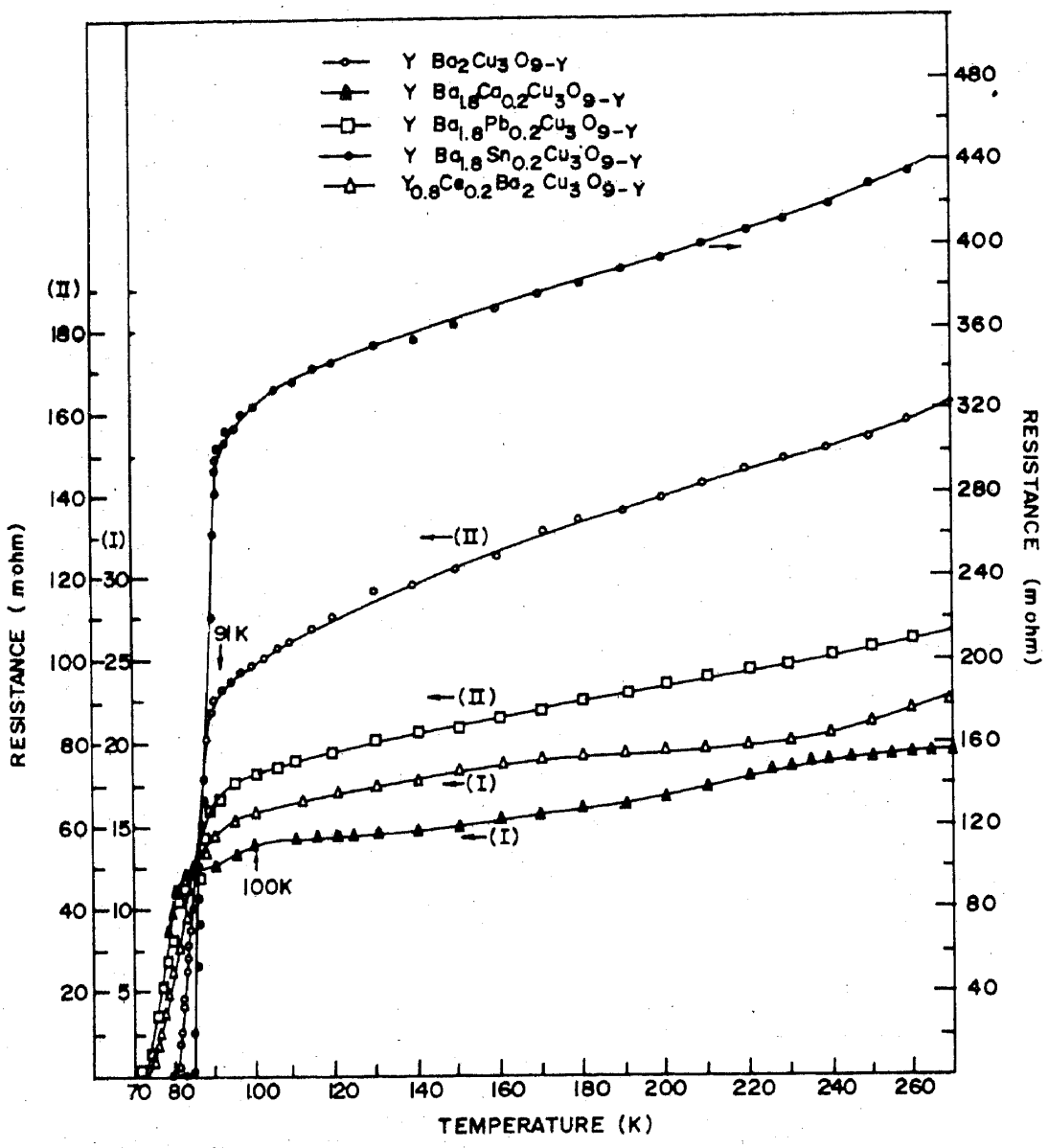

Figure 2. Effect of change in constituents on T_c behaviour of $YBa_2Cu_3O_{9-y}$ system.

The effect of replacing either yttrium or barium by divalent, trivalent and tetravalent impurities viz. Ca,Ce,Sn and Pb on superconducting transition of $YBa_2Cu_3O_{9-y}$ is studied. As shown in figure 2, nominal replacement of Ba by Ca in $YBa_2Cu_3O_{9-y}$ indicates the coexistence of two superconducting phases of 100 K and 82 K. The sample with tetravalent Pb impurity shows twin transitions, one at 95 K and the other at 85 K, whereas the replacement of Ba by Sn does not seem to disturb the superconducting transition at 95 K. When *Y* is replaced by trivalent Ce, superconducting transition gets broadened with the onset of T_c at 95 K and zero resistance at 74 K.

From the above observations it may be concluded that the compound $YBa_2Cu_3O_{9-y}$ yields the best superconducting characteristics. Existence of 100 K superconducting phase is indicated in the sample $YBa_{1.8}Ca_{0.2}Cu_3O_{9-y}$. Tetravalent Sn does not seem to disturb the $YBa_2Cu_3O_{9-y}$ lattice with the concentrations studied. However, at the same concentration Pb gives rise to a coexistence of a lower T_c phase with onset at 85 K. A systematic study of Ba replacement by Ca and Y replacement by Ce will be reported elsewhere.

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