

Oxygen stability in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$

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Abstract. The high T_c superconductor $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ has been found to lose appreciable amount of oxygen in a surprisingly low temperature range (~ 425 – 630 K), which drastically degrades the superconducting property. Accompanying this oxygen loss, the resistance behaviour has also been found to change from metallic to semiconducting.

Keywords. High temperature superconductivity; $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$; superconductivity; oxygen stability.

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Interest in studying the oxygen stability in the high T_c superconductor $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ stems primarily from the fact that the superconducting transition temperature (T_c) of this material is known to depend critically on its oxygen content (Cava *et al* 1987). For instance, T_c of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ decreases from above 90 K to below 30 K as x increases from $\lesssim 0.1$ to > 0.7 . $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ also loses oxygen reversibly above ~ 673 K, which is as large as $x \approx 0.7$ at 1173 K (Jorgensen *et al* 1987a). It is, therefore, important to study the oxygen stability in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$, both from the viewpoint of application as well as to understand the role of oxygen in superconductivity. In this work, the oxygen stability in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ has been studied. It has been found that $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ prepared by sintering below 1200 K, loses appreciable amount of oxygen in a surprisingly low temperature range (~ 425 – 630 K). The effect of this oxygen loss on the temperature dependence of electrical resistance of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ is reported and comments on its origin are made.

The sample was prepared by coprecipitating yttrium and barium as carbonates, followed by the addition of CuO to the dried carbonate precipitate. The carbonate-oxide mixture was calcinated at ~ 900 K for ~ 12 h and the resulting oxide mixture was pelletized under 4.7 kbar pressure. The pellets were sintered in flowing oxygen at ~ 1200 K for ~ 16 h, cooled to ~ 620 K and annealed for ~ 17 h at ~ 620 K. As some green insulating phase (Y_2BaCuO_5) was visible, the material was ground and repelletized under 4.7 kbar pressure. The pellets were then sintered in flowing oxygen at ~ 1200 K for ~ 14 h, cooled to ~ 800 K and annealed for ~ 18 h at ~ 800 K. The pellets were always furnace cooled (typical furnace cooling time constant ~ 1 h) in steps. It is noted that the temperature of the pellets during sintering and annealing is expected to be lower than the measured temperature due to the oxygen flow. X-ray diffraction study of the finally formed $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ showed that the sample is