

Superconducting Y-Ba-Cu-O Films with $T_c > 70$ K Prepared by Thermal Decomposition
Technique of Y-, Ba-, and Cu-2ethylhexanoates

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High T_c superconducting Y-Ba-Cu-O films with $T_c(\text{end}) > 70$ K were prepared on yttria stabilized zirconia substrates by the thermal decomposition technique using Y-, Ba-, and Cu-2ethylhexanoates. The observed $T_c(\text{onset})$ was 95 K and $T_c(\text{end})$ was 72 K, and they are currently the highest T_c values for films obtained from organic acid salts.

The recent development of high T_c superconducting oxides has stimulated a great deal of not only academic interests but the interests for the new applications of these new materials. To develop applications in electronic devices, the thin film preparation technique is indispensable and needs to be shortly established. Rf sputtering and screen printing techniques have been successfully applied to prepare superconducting thin films with $T_c(\text{end}) > 77$ K.^{1,2)} However, a vacuum chamber is necessary for rf sputtering technique. No vacuum equipment, on the other hand, is required in screen printing technique, but the thickness is limited by the size of powder ground after preheated. For thermal decomposition procedure, no such limitation for the film thickness exists. Kumagai et al.^{3,4)} have succeeded to prepare $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ films by the dipping-pyrolysis of organic acid salts. They used barium and copper naphthenates and yttrium stearate as the starting materials, and the observed $T_c(\text{onset})$ was 90 K and $T_c(\text{end})$ was 60 K. In this study, we used Y-, Ba-, and Cu-2ethylhexanoates as the starting materials, and obtained superconducting YBCO films with higher T_c .

Y-, Ba-, and Cu-2ethylhexanoates powders used were obtained from Matsushita Electronics Components Co. Each material was dissolved into the suitable solvents such as toluene, and the concentration of each solution is approximately 5 wt.%. These three kinds of solutions were mixed to contain Y:Ba:Cu=1:2:3 in molar ratio and stirred for several hours. This mixed solution was dripped on yttria stabilized zirconia (YSZ) substrates and dried in air. Then, the products were put into an electric furnace and heated at 500 °C for 30 min. This dripping, drying and heating processes were repeated ten times and finally heated at 800 °C for 80 h in pure oxygen. These drying and annealing procedures are basically the same way as first used by Kumagai et al.^{3,4)} The thickness of the obtained YBCO films was about 20 μm and their surface was very smooth and black in color.

The dc resistivity of this film was measured by the four probe method. Figure 1 shows dc resistivity as a function of temperature. The temperature dependence of dc resistivity above transition temperature was basically metallic, but a small dip was seen at near 230 K. $T_c(\text{onset})$ was 95 K and $T_c(\text{end})$ was 72 K, with an electric current of 0.1 mA. $T_c(\text{end})$ obtained in this study is 12 K higher than that reported by Kumagai et al.³⁾ Although $T_c(\text{end})$ is still lower than the liquid nitrogen temperature (77 K), a more careful annealing procedure seems to be effective to increase $T_c(\text{end})$ higher than 77 K.

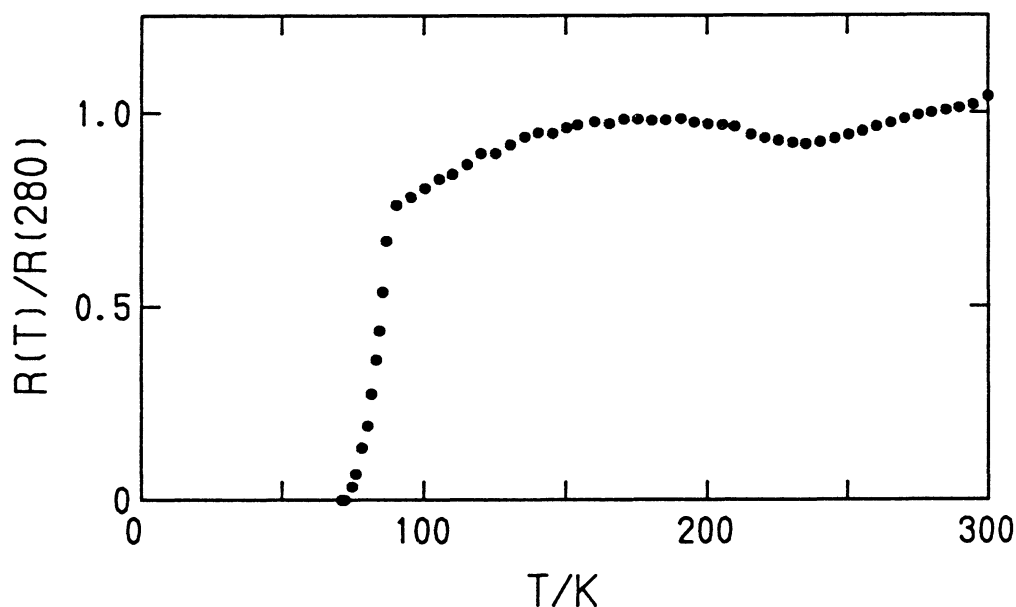


Fig.1. Temperature dependence of the relative resistance ($R(T)/R(280)$) for the present films, where $R(280)$ represents the resistance at 280 K and $R(T)$ represents the resistance obtained at each temperature (T). $R(280)$ was $1.2 \Omega \text{ cm}$.

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