

산화물 초전도 선재의 기초물성

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Properties of Ceramics Superconducting Tapes

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Abstract

YBaCuO thick films were fabricated by plasma enhanced chemical vapor deposition, and the crystallinity and the superconducting properties were investigated. The growth temperature to obtain the thick films was decreased by around 150 °C due to plasma enhancement. The zero resistivity temperatures for films grown at 590 °C and 620°C were 55 and 80 K, resistively.

Keywords : YBaCuO, Chemical vapor deposition, Thick films, SrTiO₃

1. INTRODUCTION

Chemicalvapor deposition (CVD) is thought to be one of the most desirable methods for preparing superconducting thick films. However, high growth temperatures of over 750°C[1] have been required to grow superconducting YBaCuO thick films. Thus, a concerted effort has been made to decrease the growth temperature to enable CVD to be applied to electronic processes, because a reaction between the superconductor and the substrate proceeds at such a high temperature[2]. In this paper, we discuss the fabrication of YBaCuO thick films by using CVD, their crystallinity, and their superconducting properties.

2. EXPERIMENTAL PROCEDURE

A magneto microwave plasma

type apparatus was used for growing the superconducting thick films. The frequency of the microwave, which was generated by a magnetron, was 2.45 GHz. The tetramethylheptadione complexes of Y, Ba and Cu were employed as metal sources. They were sublimated and transferred to the growth chamber with Ar carrier gas. Oxygen gas was an oxidant. SrTiO₃ (100) single crystals polished with phosphonic acid at 90 °C were used as substrates. The substrate size was 10 mm × 5mm. The typical growth conditions were as follows: the sublimation temperatures and the Ar flow rates for the Y, Ba, and Cu complexes were 100 and 25 cm³/min, 250 °C and 25cm³/min, and 120C and 25 cm³/min, respectively. The O₂ flow rate was 10~50 cm³/min and the deposition pressure was 0.4 Torr. The crystallinity was investigated by X-ray diffraction (XRD). The chemical

composition of the films was determined by inductively coupled plasma (ICP) spectroscopy. The electrical properties were determined by the conventional four probe method.

3. RESULTS and DISCUSSION

The effect of the plasma enhancement on the composition of the prepared thick films is shown in Fig.1. The preparation temperature was 550 °C. The (Y+Ba)/Cu ratio decreased with increasing microwave power. These composition changes reflect a difference in the stability of organometallic compounds against plasmas.

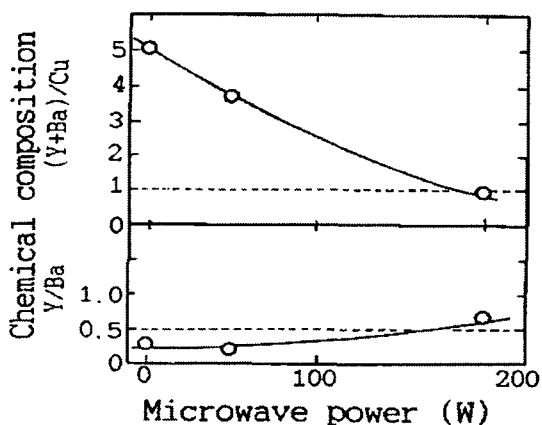


Fig. 1. The composition ratios plasma enhanced superconducting thick films, as measured by ICP spectroscopy.

The X-ray diffraction patterns of films grown under different plasma conditions are shown in Fig. 2. Not all the diffraction peaks detected for the film grown without plasma enhancement could be assigned to $Y_1Ba_2Cu_3O_{7-x}$.

The film grown at a microwave power of 100 W indicated weak $Y_1Ba_2Cu_3O_{7-x}$ peaks in

addition to the peaks detected for the film grown without plasma enhancement. All the diffraction peaks detected for the film grown at 200 W could be assigned to $Y_1Ba_2Cu_3O_{7-x}$. These results indicate that plasma enhancement promotes the formation of the $Y_1Ba_2Cu_3O_{7-x}$ structure.

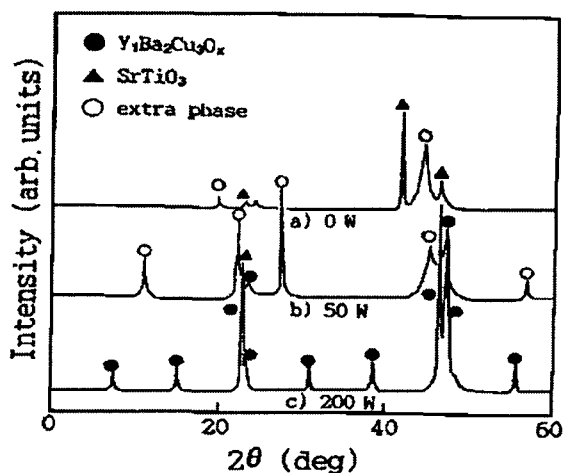


Fig. 2. The X-ray diffraction patterns for thick films grown by plasma enhanced CVD.

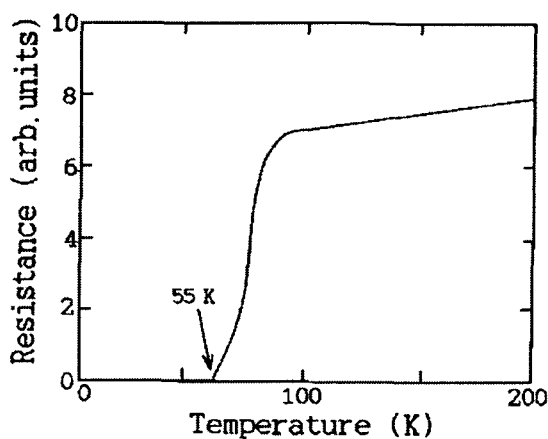


Fig. 3. The temperature dependence of the electrical resistivity for the film grown by plasma enhanced CVD at 550 °C and a microwave power of 200 W

4. CONCLUSION

Y1Ba2Cu3O7-X thick films grown by CVD were investigated. It was revealed that plasma enhancement could decrease the growth temperature for obtaining superconducting oxide films. By plasma enhancement, superconducting films could be grown above 590°C. A film grown by plasma enhancement at 620°C had a zero resistivity temperature of 80 K and a critical current density of 10^5 A/cm² at 77 K.

Acknowledgement

This research was supported by a grant from Center for Applied Superconductivity Technology of the 21st Century Frontier R&D Program funded by the Ministry of Science and Technology, Republic of Korea.

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