Chemical solution deposition of Y$_1$Ba$_2$Cu$_3$O$_{7-x}$ thin films on SrTiO$_3$ substrates

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Abstract

Conventionally the fabrication of superconducting thin films is carried out by tedious processes and requires expensive equipment. Here we report the growth of YBa$_2$Cu$_3$O$_{7-x}$ (YBCO) thin films on SrTiO$_3$ substrates by the low-cost chemical solution deposition technique [1]. The preparation includes the precipitation of yttrium, barium and copper acetates in oxalic acid and directly dipping onto SrTiO$_3$[(100)] substrates. The epitaxial growth of the deposited layer was carried out by calcination and thermal treatments at 840 °C and 860 °C. The surface morphology was inspected by optical microscopy. X-ray diffraction (XRD) confirms the preferential epitaxial growth (002) of the YBCO crystallites, especially after thermal treatment at 860 °C. Both samples show a superconducting critical temperature of 90 K. The estimation of the critical current density ($J_c$) of the samples was measured indirectly from their respective hysteresis loops following the Bean equation [2] at 10 K. For the sample treated at 840 °C, $J_c$ was 19 x 10$^4$ A/cm$^2$, while for the sample obtained at 860 °C, $J_c$ was 17 x 10$^4$ A/cm$^2$, indicating that a thermal treatment of 840 °C is enough to obtain a stable YBCO thin film.

Methodology

A.1 Chemical solution

Preparation of the compound (precursor solution) YBa$_2$Cu$_3$O$_7$.

A.2 Deposition

Sample in furnace

A.3 Thermal treatments

Sample on Strate 840 °C x100

Analysis Result

Optical Microscopy

X-Ray Diffraction (XRD)

Magnetic susceptibility

Conclusions

We can manufacture superconducting films at low cost. The morphological characterization, optical microscopy, and XRD are the key methods for evaluating the quality of the films. The XRD gives the Coexisting with the secondary phases BaCu$_2$O$_y$, Cu$_2$O, and Y$_2$BaCuO$_4$ (green phase). Magnetic moment graphs Vs temperature, improve as the temperature increases. A thermal treatment of 840 °C is enough to obtain a stable YBCO thin film.

References


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