Effect of Deposition Temperature on the Growth of Y1Ba2Cu3O7 Thin Film by Aerosol Assisted Chemical Vapor Deposition Using Liquid Solution Sources

Abstract:

We have investigated the effect of the deposition temperature on the growth of $Y_1Ba_2Cu_3O_{7-8}$ (YBCO) thin film using liquid solution sources on MgO (100) single crystalline substrate and have characterized the superconducting properties. The YBCO films were prepared by aerosol assisted chemical vapor deposition (CVD). Single solution source of Y, Ba, and Cu B-diketonates dissolved in tetrahydrofuran (THF) was used as precursor. This precursor was passed through an ultrasonic aerosol generator and transported into a hot-wall CVD reactor using Ar as reactant gas (400 sccm). The substrate was placed normal to the gas stream and the substrate temperature was varied from 760 to 860 °C. Deposition was carried out in oxygen atmosphere maintaining total pressure of 3.2 Torr inside the chamber. Deposition time was also varied from 10 to 30 min. The grown YBCO thin films were highly oriented to (001) orientation perpendicular to the substrate. The film deposited at 815 'C had a sharp transition to superconducting state about 87 K. The activation energy estimated from the Arrhenius plot is ~l9.l4 kJ/mol at the deposition temperature of 815 "C.

Temperature

Introduction:-

In order to obtain mgr quality epitaxial $Y_1Ba_2Cu_3O_{7-8}$, (YBCO) thin films which are suitable for electronic devices. it is important to understand details of the crystal growth mechanism of the films. Since the discovery of oxide superconductors, such investigations have been performed by growing HTS films using various deposition techniques. Chemical 'vapor deposition (CVD) and physical vapor deposition (PVD) techniques have been successfully applied to grow such films meeting most of the superconducting properties with critical current in excess of 10^6 A/cm: on single crystal substrate. Among these, CVD is a promising technique for the fabrication of HTS films, hating special merits, such as high deposition rate. The possibility of a long time deposition, no limitation of shape and the sale, and so on.

Although CVD technique possesses many kinds of merits, various problems still need to be addressed because of the lack of easy handling, stable precursors [Yoshida et al.,1996]. Particularly for alkaline earth metals such as barium, a relatively high processing temperature and a large number of parameters that must be controlled to maintain stoichiometry during the periodofdeposition. An important demand on the deposition prosess is avery good stability of growth rate and film stoichioinetry over long deposition periods.

Until now, hydrocarbon based B-dihetone chelate precursors such as $Ba(thd)_2$: (thd=22.6,6-tetramethlyl-3.5-heptanedionate) have hem used for fabrication of HTS films by CVD. The barium derivative.

$Ba(thd)_2$; has been found to have an irreproducible and variable transport rate because of gas phase and solid-state oligomerization and/or hydrolysis reaction Because of the long residence time in the sublimation vessel and plumbing, the stability of the precursor is critical in maintaining deposition rate and stoichiometry . An attempt is made to ease the problems associated with the thermal decomposition of the source material over a long time that the $Ba(thd)_2$ appears to have, by developing a new precursor with sufficient and stable volatility. We refer to as aerosol-assisted CVD

(AACVD), which uses a single liquid solution source for the fabrication of YBCO films. This technique the residence time at high temperature that any of the precursor must survive before deposition [Salazar et al., 1992: Kim et al., 2000]. In AACVD of YBCO, the precursors need to be dissolved in a suitable solvent without reacting with it and at the same time must have a sufficiently high vapor pressure to evaporate completely at the temperature of the preheating zone [Klippe and Wal1L 1997]. The solution is then introduced into an ultrasonic aerosol generator. The aerosol is transported into the preheated zone of the reactor and then it is held at temperature suficient to vaporize the compound.

In our earlier publication we reported a detailed procedure for the preparation of HTS YBCO thin film by AACVD using liquid solution source and presented the effect of various parameters. Viz oxygen pressure, substrate preheating temperature and distance between evaporating source (nozzle) and substrate [Kim et aL., 2000]. We now report the effect of deposition temperature on the film growth, superconducting properties and deposition rate using AAC-CVD and single source technique. The superconducting properties of the grown films are studied by using AC four point probe technique and structural and morphological studies are canted out by X-ray diffraction and scanning microscopic techniques. The results are compared and discussed with the reported work elsewhere.