Single-Crystal like MgB$_2$ Thin Films Grown by HPCVD System

Pham Van Duong, Mahipal Ranot and Won Nam Kang*

BK21 Physic Division and Department of Physic, Sungkyunkwan University, Suwon 440-746, Republic of Korea

Single-crystalline MgB$_2$ thin film was grown on (0001) Al$_2$O$_3$ substrate by using hybrid physical–chemical vapor deposition (HPCVD) system. Single crystal properties were studied by X-ray diffraction (XRD) and the full width at half maximum (FWHM) of the (0001) MgB$_2$ peak is 0.15°, which is very close to that has been reported for MgB$_2$ single-crystal. It indicates that the crystalline quality of thin film is good. The epitaxial growth was confirmed by performing ϕ-scan on the film. Resistivity dependence on temperature was investigated by physical property measurement system (PPMS) in various applied fields from 0 to 9 T. The upper critical fields were determined from PPMS data for the fields applied parallel and perpendicular to the a-b plane of the film. The anisotropy ratio $\gamma = \frac{H_{c2}^{ab}(0)}{H_{c2}^{ab}(0)}$ was estimated to be 2.5, which is very comparable with that of MgB$_2$ single-crystals [1]. The smooth surface was observed for the thin film by SEM analysis, which make sit well qualified for device applications. In addition, the thin film shows a high critical temperature ($T_c$) of 40.4 K with a sharp superconducting transition width of 0.2 K, and a high residual resistivity ratio (RRR=21), it reflects that MgB$_2$ thin film has a phase pure structure.

Keywords : MgB$_2$ thin film, Single-crystal, HPCVD


This work was supported by Mid-career Researcher Program through NRF grant funded by the Ministry of Education, Science & Technology (MEST) (No. 2010-0029136).