Enhanced Critical Current Density by Grain-Boundary Pinning in MgB_2 Films with Columnar Structure

H. S. Lee [a, *], T. J. Hwang [a], Y. J. Lee [a], D. H. Kim [a], W. K. Seong [b], W. N. Kang [b]

[a] *YeungnamUniversity, Gyeongsan, Korea*

[b] *Sungkyunkwan University, Suwon, Korea*

We studied the angular dependence of the transport properties of two MgB_2 films with columnar structure grown by using a hybrid physical chemical vapor deposition method. The thicknesses of the samples were 0.95 and 1.4 μm, respectively, and the X-ray diffraction patterns revealed that both films were *c*-axis oriented normal to the (0001) Al_2O_3 substrates. The angular dependence of the critical current density (J_c) and the resistivity (ρ) of both samples clearly showed the effect of enhanced flux pinning by grain boundaries: J_c for magnetic field (H) applied parallel to the *c* axis for a certain field range was more than twice larger than J_c for H parallel to the *ab* plane, and the corresponding ρ dip was observed when $H||c$. However, above specific magnetic field (H_{cr}), $J_c(H||c)$ decreased very rapidly with increasing H compared to $J_c(H||ab)$, indicating that effectiveness of the grain-boundary pinning is relatively small at $H > H_{cr}$ where the flux line density starts to outnumber the pinning site density provided by grain boundaries. The observed monotonic relationship between the flux-line spacing at H_{cr} and the magnetic penetration depth was found to be consistent with the rapid decrease of grain-boundary pinning effect above H_{cr}.

keywords : MgB_2 films, critical current density, grain-boundary pinning, columnar structure

Acknowledgement

This work was supported by Global Partnership Program through the Ministry of Science and Technology in Korea in 2007 .