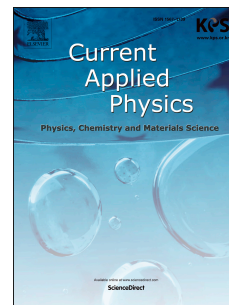


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Effect of vortex-vortex interactions on the critical current density of single-crystalline MgB₂ thin films

Duong Pham ^a, Soon-Gil Jung ^a, K. J. Song ^b, M. Ranot ^c, J. H. Lee ^a, N. H. Lee ^a, W. N. Kang ^{a*}

^aBK21 Physic Division and Department of Physic, Sungkyunkwan University, Suwon 440-746, Republic of Korea

^bDivision of Science Education (Physics) and Institute of Fusion Science, Chonbuk National University, Jeonju 561-756, Republic of Korea

^cMaterials Deformation Department, Korea Institute of Materials Science (KIMS), Changwon, Gyeongnam 51508, Republic of Korea

Abstract

We have investigated the influence of inter-vortex interactions on the critical current density (J_c) and flux pinning properties of single-crystalline MgB₂ thin films grown using a hybrid physical–chemical vapor deposition system. Magnetic field dependences of J_c were measured over a 5 to 35 K range of temperatures for fields applied parallel and perpendicular to the ab -plane of the film's surface. Two regions along the $J_c(H)$ curve, the low-field plateau region and the high-field slope region, which are respectively known as the single-vortex and collective pinning regimes, are clearly distinguishable. A ratio a_0/λ between the inter-vortex spacing a_0 and the penetration depth λ was calculated at each temperature, to investigate the effect of vortex-vortex interactions on the $J_c(H)$. We found that the a_0/λ dependences of the normalized $J_c(H,T)$ data tend to fall onto one curve irrespective of the temperature, if only we use a certain average value of λ . Furthermore, the flux pinning mechanism shows a crossover from δT_c -pinning to δl -pinning with increasing magnetic fields, indicating the coexistence of different pinning mechanisms in MgB₂.

PACS: 74.25.Sv, 74.25.Wx, 74.78.-w

Keywords: single-crystalline MgB₂ thin film, flux pinning, vortex-vortex interactions, HPCVD.

***Corresponding author:** Prof. Won Nam Kang

Postal address: Department of Physics, Sungkyunkwan University, Suwon 440-746, Republic of Korea

Phone: +82-31-290-5904, Fax: +82-31-290-7055

E-mail address: wnkan@skku.edu

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