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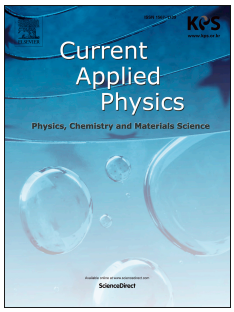

Effect of vortex-vortex interactions on the critical current density of single-crystalline MgB_2 thin films

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Abstract

We have investigated the influence of inter-vortex interactions on the critical current density (J_c) and flux pinning properties of single-crystalline MgB_2 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 MgB_2.

PACS: 74.25.Sv, 74.25.Wx, 74.78.-w
Keywords: single-crystalline MgB_2 thin film, flux pinning, vortex-vortex interactions, HPCVD.

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