Thermal Suppression of Strong Pinning

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Abstract

We study the pinning of vortices in layered type-II superconductors in the presence of uncorrelated quenched disorder, accounting for the electromagnetic interactions in the vortex system. Extending weak collective pinning theory to account for effects of strong pinning and introducing the new concept of variable range thermal smoothing of the pinning potential, we map out the pinning diagram and find the regimes of single pancake vortex (0D), single vortex (1D), pancake vortex bundle (2D) and vortex bundle (3D) pinning in the B-T-diagram for the case where the magnetic induction is perpendicular to the layering planes. The strong pinning in the 0D pancake vortex regime produces two distinct features in the current-voltage characteristic. The combination of layering and electromagnetic interactions leads to sharp crossovers between the 0D/1D and between the 2D/3D pinning regimes where the geometry of the pinned object changes discontinuously. As a consequence we find sharp jumps in the critical current for the onset of glassy response and in the activation barrier for creep as a function of temperature. Including the effect of finite Josephson coupling between the layers and varying the strength of the disorder potential, we discuss the evolution of the pinning diagram as a function of these material parameters.