Possible new vortex matter phases in $Bi_2Sr_2CaCu_2O_8$

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Abstract

The distribution of the transport current across a crystal is derived by a sensitive measurement of the self-induced magnetic field of the transport current using Hall sensor arrays. It is shown that in $Bi_2Sr_2CaCu_2O_8$ crystals both the vortex liquid and the vortex solid phases are affected by surface barriers. As a result, the standard transport measurements are dominated by the surface barrier rather than by the bulk vortex dynamics. [Fuchs *et al.*, Nature **391**, 373 (1998); cond-mat/9711284]. New ways to measure the true bulk dynamics are presented.

The vortex matter phase diagram is analyzed by investigating tansport-current driven vortex penetration through the surface barrier. The strength of the effective surface barrier and its nonlinearity and asymmetry are used to identify a possible new ordered phase above the first-order transition. This technique also allows sensitive determination of the depinning temperature. We find that the solid phase below the first-order transition is apparently subdivided into two phases by a vertical line extending from the multicritical point. [Fuchs *et al.*, Phys. Rev. Lett. **80**, 4971 (1998); cond-mat/9804205]