Magneto-Optical Imaging of Thermal Depinning of Abrikosov Vortices in Nb film

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Abstract

We report the magneto-optical (MO) imaging of vortices on the surface of a 450 nm-thick layer of Nb grown on SiO_2/Si substrate. High-resolution MO imaging was applied for direct observation of vortex motion under the influence of a temperature gradient, produced by heating with a tightly focused laser beam. For different initial flux density the radius of the thermally depinned area associated with the critical temperature gradient, and its dependence on the power of the laser beam P, initial temperature T_{in} and the size of the focused spot $2r_0$ was measured (Fig.1). The critical temperature gradient to unpin trapped vortices is proportional to the critical current density $J_c(T)$. We compared the data on the critical current density $J_c(T)$ deduced from experiments on thermal depinning with local heating by the focused laser beam with $J_c(T)$ obtained from transport measurements.
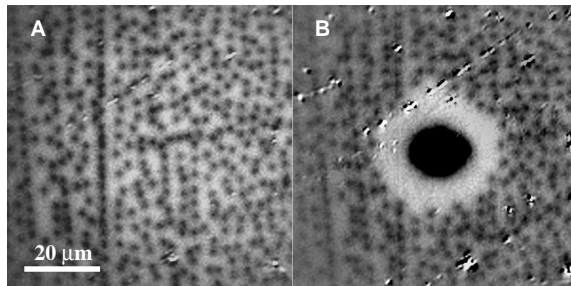
Figure 1: (A) Magneto-optical imaging of vortices FC (field cooling) in $\sim$ 2 Oe at $T_{in} = 6.5$ K and (B) the result of heating with the focused laser beam with $\lambda = 532$ nm, absorbed power $P_{abs} = 326$ μW duration of heating 0.5 sec. For chosen magnification 4 pixels/μm: area of view $\sim$ 75 x 75 μm^2. The radius of the focused spot $r_0 \sim 0.5$ μm.