DIFFERENTIAL MAGNETO-OPTICAL IMAGING OF CURRENT FLOW IN $Bi_2Sr_2CaCu_2O_8$

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A differential magneto-optical (MO) technique was developed for two-dimensional imaging of the current distribution in type II superconductors [1]. By measuring the self-induced magnetic field generated by an ac current, we can map flow of currents as low as 100 μA with the field sensitivity of 20 mG. The MO indicator is based on 5 μm thick Bi-doped yttrium iron garnet film grown on gallium-gadolinium-garnet substrate that provides high sensitivity in a wide temperature range. The MO polarization rotation angle of 1^o-2^o at H_a = 100 Oe was achieved by using green line of Hg lamp at about 500 nm. Figure 1 shows the geometry of the mask and the irradiated $Bi_2Sr_2CaCu_2O_8$ crystal with density of columnar defects corresponding to matching field B_ϕ = 20 G. The images show the self-induced magnetic field generated by the applied current of 50 mA at dc field of 40 Oe at different temperatures. The corresponding current distribution obtained by inversion of the Biot Savart law is shown in the lower panel. The images reveal that the irradiated regions have a lower resistivity due to pinning of vortices by columnar defects, resulting in focusing of the current in the irradiated circular regions. At temperatures above 84K the vortices delocalize from the columnar defects by thermal fluctuations resulting in a uniform current flow at elevated temperatures.

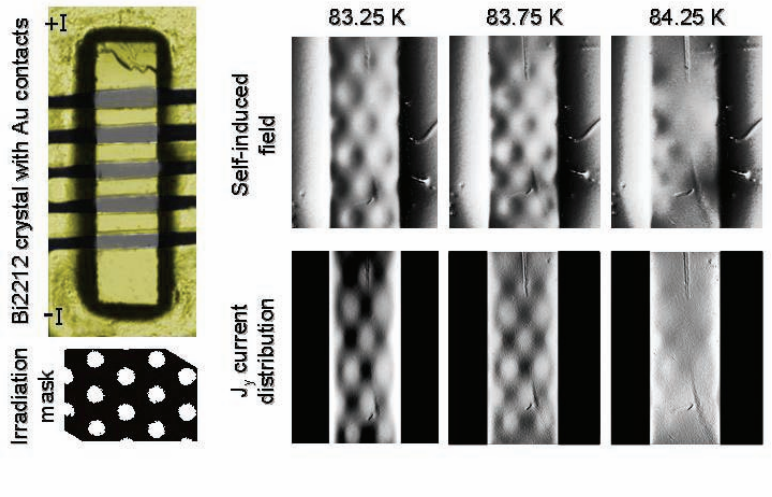

Fig. 1. Optical image of the sample and irradiation mask (left), and differential MO images of self-induced magnetic field (right) and corresponding current distribution at three temperatures. The diameter of the holes in the mask is 90 μm.

[1] Imaging the Vortex-Lattice Melting Process in the Presence of Disorder, A. Soibel, E. Zeldov, M. Rappaport, Y. Myasoedov, T. Tamegai, S. Ooi, M. Konczykowski, and V. B. Geshkenbein, *Nature* **406**, 282 (2000).