Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Spatial resolution of MFM measurements of penetration depth

ERIC SPANTON, Stanford institute for materials and energy science, SLAC, LAN LUAN, Harvard, JOHN KIRTLEY, KATHRYN MOLER, Stanford institute for materials and energy science, SLAC — The penetration depth and its temperature dependence are key ways to characterize superconductors. Measurements of the local Meissner response of a superconductor can determine the local penetration depth. To quantify the spatial resolution of such measurements, we seek to characterize the point spread function of magnetic force microscope (MFM) measurements of the penetration depth both numerically and experimentally. Modeling various geometries of MFM tips (pyramid, dipole, and long thin cylinder) in the presence of various geometries of spatial variation in the penetration depth (point variation, columnar defects, and planar defects or twin boundaries) shows the importance of the MFM tip geometry to achieving both excellent spatial resolution and quantitatively interpretable results. We compare these models to experimental data on pnictides and cuprates to set upper limits on the sub-micron-scale variation of the penetration depth. These results demonstrate both the feasibility and the technical challenges of submicron penetration depth mapping.

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Date submitted: 11 Nov 2011 Electronic form version 1.4