MAR13-2012-020083

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Slow Abrikosov- to fast moving Josephson-vortex transition in iron-pnictide superconductors

PHILIP MOLL, Laboratory for Solid State Physics, ETH Zurich, Switzerland

We have observed a novel type of transition of vortex matter from well-pinned Abrikosov to highly mobile Josephson vortices in the iron pnictide high-T_c superconductor SmFeAs(O,F) ($T_c \sim 50K$). This A-to-J transition between the two regimes upon cooling through the temperature T^* is hallmarked by an extraordinary jump of vortex mobility and a pronounced peak in the critical current density. The dissipation below T^* reaches significant fractions of the normal state resistance at all temperatures and fields, far below $H_{c2} \| ab$, estimated well above $100T$ at low temperatures. We show the temperature T^* to coincide with the temperature at which the interlayer coherence length $\xi_c(T)$ equals the SmO layer thickness, hence leading to Josephson-like vortices below and Abrikosov-like vortices above T^*. This transition is surprising, as the material is an only moderately anisotropic superconductor ($\gamma \sim 5-7$), unlike strongly anisotropic, clearly two-dimensional cuprates. The observation of this A-to-J transition highlights the significance of structural layeredness and gives microscopic information about the order parameter in SmFeAs(O,F). This profound change in the nature of the vortex matter in these compounds has eluded discovery until now, as its detection poses two main experimental challenges: The Josephson nature of the vortex matter may only be observed (1) for fields precisely aligned with the FeAs layers(< 0.1deg). Even slightest field misalignments away from the FeAs planes (> 0.1deg) restore dissipation free current transport and very high critical current densities ($\sim 10^6 A/cm^2$) at low temperatures. Secondly (2), currents flowing perpendicular to the layers are essential for the observation, forcing the vortices to slide between the layers. To this end, thin ($< 10\mu m$) high quality single crystals of SmFeAs(O,F) were microstructured and contacted using a Focused Ion Beam.