Critical Fields and Currents in SmFeAs(O,F) Microdevices

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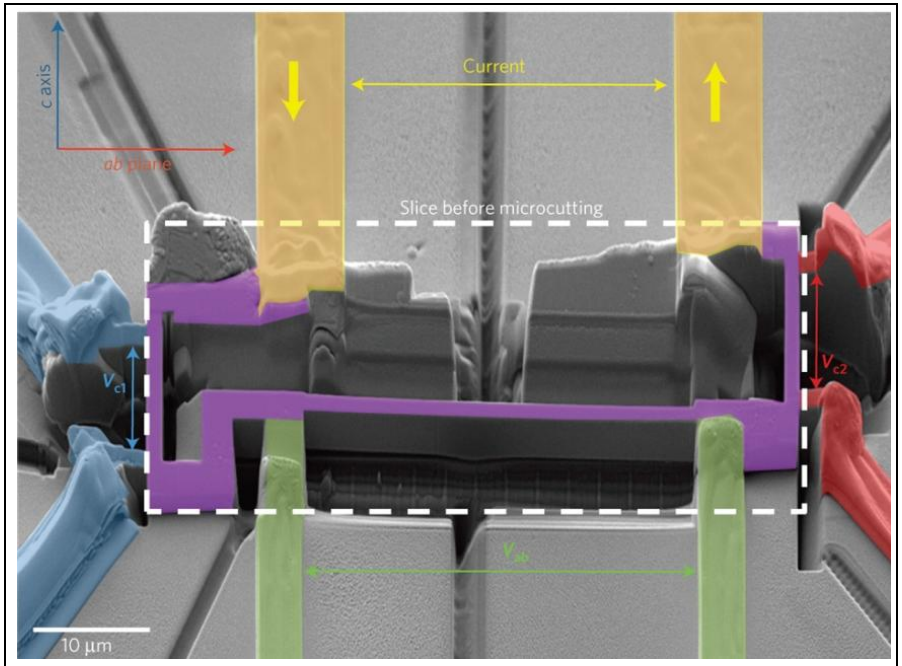
DMR-Award 0654118

Pulsed Field Facility User Program, LANL

Recent discovery of new high temperature superconducting materials, iron pnictides, made exploring their potential for applications one of the foremost research goals of a collaboration among researchers from the ETH in Zurich, Switzerland and the NHMFL Pulsed Field Facility. They have developed a new approach to determine critical magnetic fields and supercurrents in micron dimension pnictide single crystals, where superconductivity is the strongest and the limits of the material can be best observed.

By using focused ion beam (FIB) techniques, they shaped microscopic crystals few square microns in cross section and attached micron-sized contacts to successfully conduct transport measurements in pulsed magnets.

P. J. W. Moll, R. Puzniak, F. Balakirev, K. Rogacki, J. Karpinski, N. D. Zhigadlo, B. Batlogg, *Nature Materials* **9**, 628–633 (2010)



Focused ion beam etching was used to cut $SmFeAsO_{0.7}F_{0.25}$ crystals into micro bridges (purple) for transport measurements along several crystallographic directions at once. The electrical current enters and leaves the sample via the yellow contacts. Voltages are measured using the blue, green and red contacts. The dashed box is roughly 0.025mm x 0.055mm in size.

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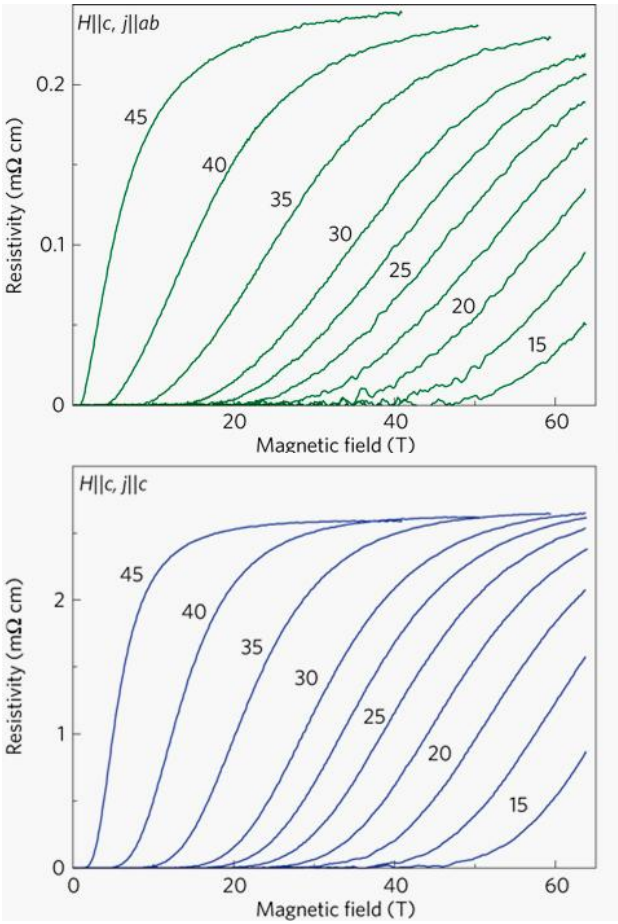

Magnetoresistance of $SmFeAsO_{0.7}F_{0.25}$ in pulsed fields up to 65 T at various temperatures for electrical currents perpendicular (top) and along (bottom) the *c* axis.

The exquisite control of the focus ion beam allows one to cut a sample structure that is optimized for the simultaneous measurement of *c*-axis and *ab*-plane resistivity. This enables researchers to address questions of electronic anisotropy in the so-called 1111 pnictides for the first time. Remarkably, the field scale of the resistive transition is found to be essentially independent of the current direction. This is an important prerequisite for possible practical application of these materials in superconducting wires, as the super-current in a polycrystalline wire is always limited by the least favorably oriented crystallites.

Another crucial parameter, the magnetic field up to which dissipation-free current transport can be maintained, is found to be extremely high at the relatively high temperature of 40K, exceeding 30T for magnetic field along the *c* axis and 50T for magnetic field perpendicular to the *c* axis.

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