Emerging isotropy as a generic feature of the iron-pnictide superconductors?

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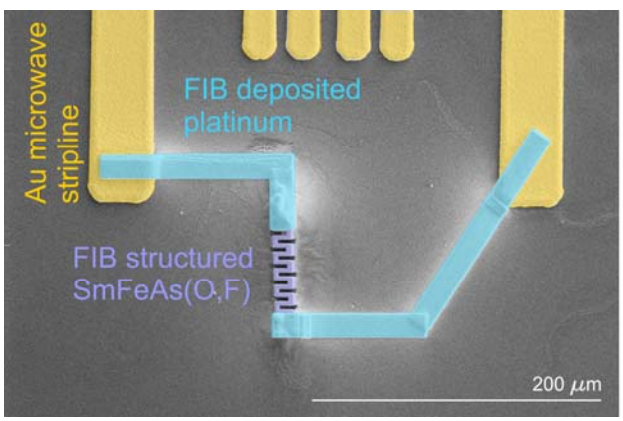
Introduction

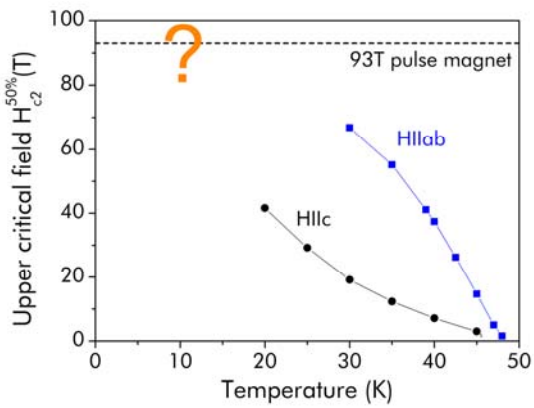
Since the discovery of multiband-superconductivity in MgB_2, the upper critical field (H_{c2}) anisotropy (γ_ξ) and London penetration depth anisotropy (γ_λ) are known to be temperature dependent as a result of the interplay of intra- and inter-band scattering. Similar temperature dependent anisotropies have been observed in the recently discovered iron-pnictide superconductors. The temperature dependence of γ_ξ thus provides valuable insights into the electronic structure associated with superconductivity and elucidates the materials multi-band nature. In this work, we aim to complete the H_{c2} phase diagram of SmFeAs(O,F) (T_c~50K) and thus obtain γ_ξ down to as low temperatures as possible.

Experimental

While the huge H_{c2}(0K) (>100T) in SmFeAs (O,F) is promising for the materials prospects in high field applications, its magnitude poses severe experimental obstacles. To extend these measurements to as low temperatures or conversely as high fields as possible, we approach the problem by combining measurements conducted in the most powerful magnet systems at NHMFL. The phase diagram up to 65T has been well studied using a short pulse magnet[1], and we are in the ongoing effort to explore lower temperatures in the 100T magnet. For the ultimately lowest temperatures, we are currently developing a direct transport setup measuring single crystals of SmFeAs(O,F) at GHz frequencies in the 300T single turn magnet system at LANL.

Results and Discussion





***(left)** SEM image of the active region of a GHz microstripline designed for transport measurements in the 300T single turn system. The single crystal of SmFeAs(O,F) (purple) has been microstructured by a Focused Ion Beam (FIB) to increase the signal from the superconductor and connected by FIB-deposited Pt (blue) to the Au leads of the stripline (gold).**(right)** Upper critical fields of SmFeAs(O,F) (T_c~50K) estimated from magnetotransport measurements at 50% ρ_n. The H_{c2} for both field orientations differ at higher temperatures, but clearly converge at lower temperatures indicating a reduction of anisotropy upon cooling.*

The data obtained so far strongly suggests the system to become more isotropic at lower temperatures, as the H_{c2} for both field orientations, HII*ab* and HII*c*, converge upon cooling. This situation is reminiscent of $(Ba,K)Fe_2As_2$, in which almost isotropic upper critical fields have been observed at lowest temperatures. The later material, however, is structurally and electronically more isotropic than the "1111" compound SmFeAs(O,F). While the anisotropy near T_c is 2-3 in $(Ba,K)Fe_2As_2$, it is 6-7 in SmFeAs(O,F) and here the reduction of anisotropy is more pronounced. This observation is surprising, given that the structural anisotropy of SmFeAs(O,F) is strong enough to support Josephson vortices[2].

Acknowledgements

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References

[1] P.J.W. Moll, *et al.*, Nature Materials **9**, 628-633 (2010)
[2] P.J.W. Moll, *et al.*, Nature Materials, published online (2012)