High-field Transport Properties of Epitaxial SmFeAs(O,F) Thin Films

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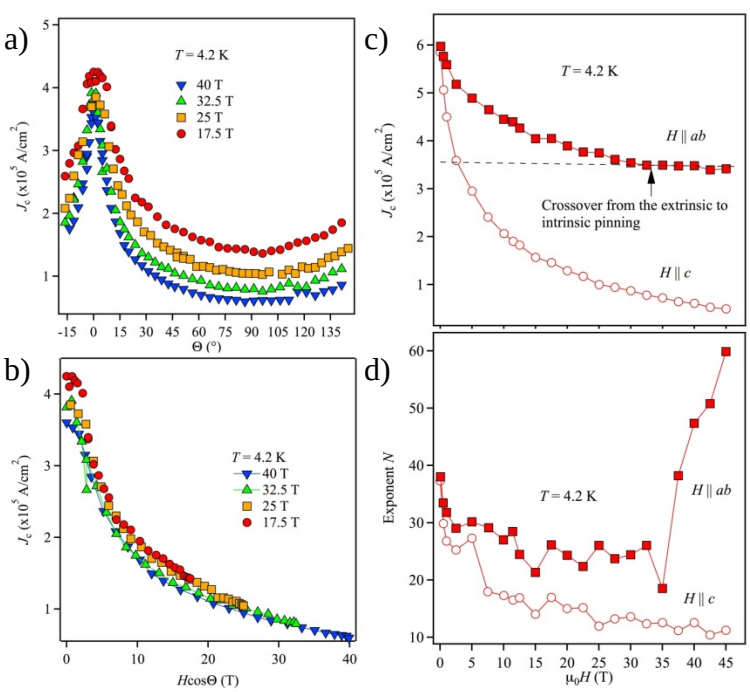
Introduction

SmFeAs(O,F) (Sm-1111) is the pnictide superconductor with so far the highest critical temperature. Due to its layered crystal structure and relatively large electronic anisotropy, it shares properties with cuprate high-T_c superconductors such as $YBa_2Cu_3O_7$. Here the transport properties, especially J_c scaling and possible intrinsic pinning, are investigated.

Experimental

The Sm-1111 film was grown by molecular beam epitaxy on CaF_2 single crystal substrate. The superconducting layer is phase pure, c-axis oriented epitaxial, and capped with a SmOF layer. A detailed description of the sample preparation can be found in Ref. [1]. A four-probe bridge of 70 µm width and 700 µm length was structured by laser cutting, and the critical current density J_c was defined by a criterion of 1 µV/cm in transport *V(I)* curves.



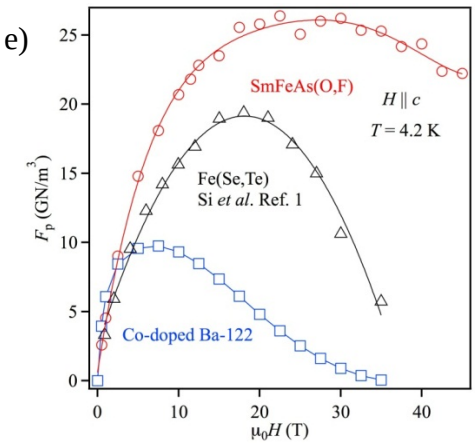


Figure 1: a) Anisotropy of J_c at 4.2 K for four different magnetic fields (a). J_c scales with the *c*-axis component of the applied magnetic field above 30 T. Field dependence of J_c (c) and *n*-value (d) at 4.2 K for H||c and H||ab reveal intrinsic pinning. Sm-1111 shows large pinning forces at low *T* (e).

Results and Discussion

The critical current density J_c shows a large anisotropy at low T with a sharp maximum at H||ab, as illustrated for high fields at 4.2 K in **Figure 1a**) and **b**). Above 30 T, only the c-axis component of the applied magnetic fields seems to govern the J_c, which means pinning and current flow are highly two-dimensional, i.e. the coherence length ξ_c is shorter than the interplanar distance d. This 2D behavior furthermore leads to the intrinsic pinning of flux lines at the planar structure for fields parallel *ab*. This is evidenced by a constant J_c and a steep increase of the power-law exponent *n* ($V \sim I^n$) due to lock-in of the flux lines, **Figure 1c**) and **d**). Due to its high T_c, Sm-1111 shows very large pinning forces at low *T* compared to the other pnictide families, **Figure 1e**).

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References

[1] Ueda, S., *et al.*, Japanese Journal of Applied Physics, **51**, 010103 (2012).