Superconductivity in Oxypnictides: Upper Critical Fields of NdFeAs(O,F) Single Crystal

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Introduction

The newly discovered family of oxypnictide superconductors attracted much of attention since March 2008. However, despite ongoing intense experimental/theoretical studies, some fundamental questions about the nature of superconductivity on oxypnictides remain unanswered. Our early measurements [1] clearly showed that \( H_{c2}(T) \) was anomalous, suggesting at least 2 band superconductivity. Single crystal studies [2] confirmed many of the anomalies and suggest \( H_{c2}(0) > 100T \).

Experimental

Transport measurements were carried out in 35 T resistive, 45 T hybrid, and 60 T pulsed magnets. The single NdAsFe(O,F) crystal with dimensions of 10 x 15 x 1 \( \mu m^3 \) was grown by a high pressure technique. The electrical contacts to this very small sample were made by means of Focused Ion Beam Pt stripes.

![Fig. 1](image)

Fig. 1 \( H_{c2}(T) \) of a NdFeAs(O,F) single crystal. Measured points (symbols) and fits (solid lines) for different pairing scenarios in the framework of a two-band superconductivity model with paramagnetic limitation increase from (a) to (c).

Results and Discussion

We found \( H_{c2}(T) \) comparable to \(-100T\) of high \( T_c \) cuprates. As seen in Fig.1, \( H_{c2}(T) \) parallel to the c-axis exhibits a pronounced upward curvature similar to what was extracted from earlier measurements on polycrystalline samples [2]. Thus, this behavior is indeed an intrinsic feature of oxypnictides, rather than a manifestation of vortex lattice melting or electromagnetic granularity in polycrystals. The angular dependence of \( H_{c2} \) deviates from one-band Ginzburg-Landau scaling. The mass anisotropy decreases as \( T \) decreases. Spin-dependent magnetoresistance suggests contribution to the conductivity from disorder-modified electron-electron interactions.

Conclusions

Our study strongly supports multiband superconductivity in NdFeAs(O,F) with important paramagnetic limitation effects. Even with pulsed fields we explore only part of \( H_{c2} \) phase space and stronger fields are needed for final conclusions.

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References