Two-band Superconductivity in $LaFeAsO_{0.89}F_{0.11}$ at Very High Magnetic Fields

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Introduction

The new family of superconductors referred to as doped rare-earth iron oxyarsenides comprised of alternating layers of $REO_{1-x}F_x$ and FeAs has been the focus of research worldwide since early 2008. Our March 20-21 study[1] of $LaFeAsO_{0.89}F_{0.11}$ synthesized by David Mandrus' research group at ORNL showed remarkable enhancement of the upper critical fields B_{c2} particularly at low temperatures as compared to those expected from the already high slopes of $dB_{c2}/dT \approx 2$ T/K near T_c. The deduced $B_{c2}(0) \approx 63$-65 T exceeds the paramagnetic limit, consistent with strong coupling and important two-band effects[2].

Experimental

A polycrystalline $LaFeAsO_{0.89}F_{0.1}$ sample ~ 3 x 1 x 0.5 mm was used for our four probe transport measurements in the 45T Hybrid magnet at the NHMFL, supplemented by low field measurements in a Quantum Design 9T PPMS. The temperature range from 30K to 2.5K was explored using rotator probes with particular emphasis on the behavior of B_{c2} at low temperature (<10 K).

Results and Discussion

The dashed line at left in Fig. 1 is the Werthamer-Helfand-Hohenberg (WHH)[3] curve defined by the slope of B_{min}(T) at T_c. At right, B_{max}(T) (black) and B_{min}(T) (red) are plotted as functions of the reduced temperature T/T_c. At right, the lines are fits to the Gurevich 2-gap model[2] of B_{c2}. They are consistent with B_{c2} being determined by heavy, 3D-like carriers at low temperatures and lighter 2D carriers at higher T.

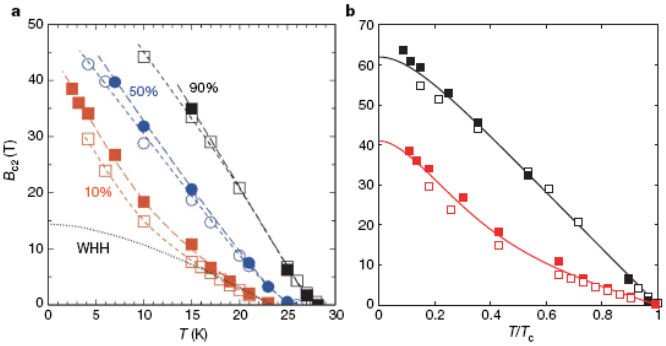

Fig. 1 B_{c2} of a $LaFeAsO_{0.89}F_{0.11}$ polycrystalline sample.

Conclusions

Our data show that the oxyarsenides are very high magnetic field superconductors and provide strong experimental support for recent models that deduce this family to be one in which two-band superconductivity plays a major role as with MgB_2 (ref 2).

Acknowledgements

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References

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