Magnetic Torque Measurements on $(Ba_{1-x}K_x)Fe_2As_2$

T. Terashima, N. Kikugawa, S. Uji (Natl. Inst. Mat. Sci., Japan); A. Kiswandhi, E.S Choi, J.S. Brooks (FSU, NHMFL); K. Kihou, S. Ishida, C.-H. Lee, A. Iyo, H. Eisaki (AIST, Japan)

Introduction

We have performed magnetic torque measurements on $(Ba_{1-x}K_x)Fe_2As_2$ samples with several different compositions x. We have observed de Haas-van Alphen oscillations in some of the measured samples. In addition, as described below, we have found a sharp anomaly in magnetic hysteresis loops in the superconducting state for x = 0.76 compounds. It is probably related to an order-disorder transition of a vortex lattice.

Experimental

Single crystals of $(Ba_{1-x}K_x)Fe_2As_2$ were grown by a flux method at the National Institute of Advanced Industrial Science and Technology (AIST), Japan [1]. Magnetic torque measurements were performed with a top-loading He-3 refrigerator and the 45T Hybrid Magnet at the NHMFL. Piezoresistive microcantilevers were used.

Results and Discussion

Figure 1 shows magnetic torque hysteresis loops for an x = 0.76 sample. B_{c2} (or B_{irr}) is about 29 T. A strongly hysteretic region appears just below B_{c2}. It is what is usually called "peak effect". Below the peak effect region (B < ~22T), the torque is far more reversible. We note anomalously sharp variation in the torque occurring near low and high-field boundaries of the peak effect region. Especially, at the lower boundary, sometimes a vertical jump of the torque occurs (see the red arrow in the figure).

Although the origin of the peak effect is not completely determined yet, it is usually assumed that the peak effect is related to a first-order order-disorder transition of a vortex lattice [2]. We interpret the sharp jump of the torque as a direct manifestation of the underlying first-order transition.

Conclusions

We think that we have found a first-order order-disorder transition of a vortex lattice in $(Ba_{1-x}K_x)Fe_2As_2$ from magnetic torque measurements.

Acknowledgements

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References

[1] K. Kihou, *et al*., J. Phys. Soc. Jpn. **79**, 124713 (2010).
[2] For example, see T. Giamarchi and S. Bhattacharya, arXiv:cond-mat/0111052.

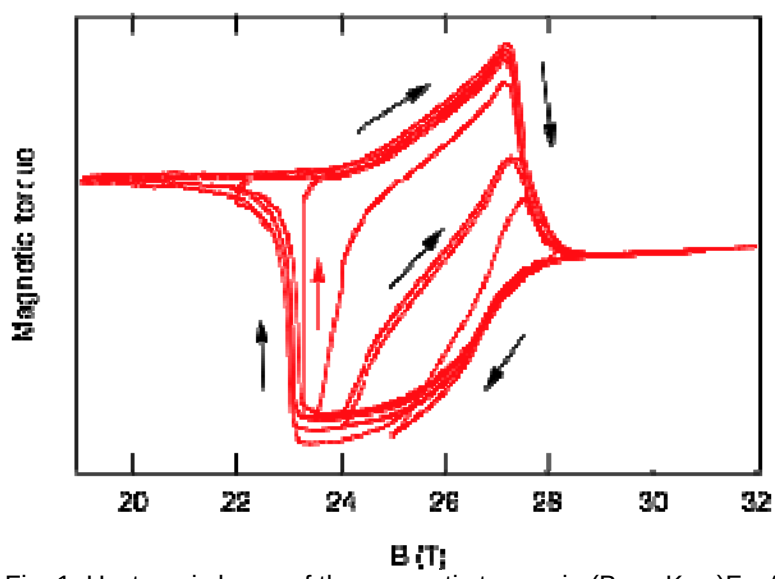

Fig. 1. Hysteresis loops of the magnetic torque in $(Ba_{0.24}K_{0.76})Fe_2As_2$. The field direction is ~10 degrees off the *ab* plane. T ~ 0.4 K.