Fermi surface determination in USb single crystals (P14907-E006-PF)

Gofryk, K. (Idaho National Laboratory), Weickert, F., Jaime, M., Harrison, N., and Balakirev, F. (National High Magnetic Field Laboratory, Los Alamos)

Introduction

Magnetic and elastic behaviors that involve 5*f*-electrons in the actinide's materials exhibit a bewildering diversity that is difficult to fit within any conventional framework. Recently, we have performed detailed low temperature magnetostriction and magnetization measurements of USb in magnetic fields up to 65 T (NHMFL LANL) and discovered a sharp, first-order type transition at ~38 T [1]. This compound crystallizes in the cubic NaCl-type crystal structure and is known to order antiferromagnetically with a triple-k magnetic structure below T_N = 213 K [2, 3]. Our data strongly suggests that this transition is accompanied by a significant change in the Fermi surface topology. In order to unveil electronic structure of this materials and its change at the transition we plan to measure de Haas-van Alphen and Shubnikov-de Haas effect in pulsed magnetic fields up to 65 T.

Experimental

Our plan was to measure Shubnikov-de Haas effect on USb single crystals in pulsed magnetic fields up to 65 T (NHMFL pulse facility at Los Alamos). Our previous results have shown that USb undergoes a remarkably sharp first order-like transition at ~38 T. This transition is most probably accompanied by a significant change in the Fermi surface topology. The measurements were performed on crystals oriented along 100 crystallographic direction. The magnetic fields up to 65 T were used to induce quantum oscillations and study Fermi surface topology below and above the transition. The high-quality single crystals of uranium antimonide of the appropriate size were prepared and available for the proposed studies.

Results and Discussion

We have measured the electrical resistivity and magnetoresistivity of two oriented USb crystals having size of about 0.5 x 0.5 x 1 mm^3. Several experiments have been performed in temperatures above and below T_N. Unfortunately, due to large contact resistance to sample resistance ratio we were unable to obtain any meaningful data.

Conclusions

In order to overcome the challenges, we plan to reduce the sample dimensions in order to reduce the contact resistance and increase the measured electrical resistance of the sample. For the new experiments we plan to use a micro-size USb samples. In order to prepare such samples, we will use a plasma FIB setup at Idaho National Laboratory. The so-prepared samples will be then shipped to NHMFL LANL for high field measurements. The results obtained on the micro-size samples will help in understanding of our previous magnetostriction and magnetization measurements. These measurements will also be complemented by DFT calculations.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. K. G acknowledges support from DOE's Early Career Research Program.

References

[1] K. Gofryk *et al.*, in preparation.
[2] J Rossat-Mignod, *et al.*, Physica B, 102 (1980), p. 237
[3] K. Knöpfle and L. M. Sandratskii, Phys. Rev. B 63, 014411 (2000)