LA-UR-17-22417
Approved for public release; distribution is unlimited.

Title:	Temperature Dependent Magnetoresistance of CeCu2Si2 up to 60 T [Proposal: P14728]
Author(s):	Stritzinger, Laurel Elaine Winter Lai, Y. Mcdonald, Ross David Baumbach, R. E.
Intended for:	NHMFL 2016 Annual Research Report Report
Issued:	2017-03-23

Temperature Dependent Magnetoresistance of $CeCu_2Si_2$ up to 60 T [Proposal: P14728]

Winter, L. E. (LANL); Lai, Y. (FSU, Physics); McDonald, R. D. (LANL); Baumbach, R. E. (FSU, Physics)

Introduction

We recently investigated the chemical substitution series $CeCu_2Si_{2-x}P_x$, for x = 0, 0.01, and 0.14, using a contactless tunnel diode oscillator technique. These measurements revealed previously unreported Shubnikov-de Haas oscillations above 45 T with an unusual temperature dependence that could potentially be explained by a high magnetic field transition. To investigate this possible transition, magnetoresistance measurements were desired. However, initial magnetoresistance measurements on $CeCu_2Si_2$ showed poor signal-to-noise due to the small value of the sample's resistivity. To overcome this obstacle, we performed micro-structuring of a single crystal specimen to increase the sample's resistance.

Experimental

Temperature dependence of the magnetoresistance of $CeCu_2Si_2$ in pulsed magnetic fields up to 60 T was obtained at the NHMFL Pulsed Field Facility. The sample was polished to approximately 18 μm and then cut using focused ion beam (FIB) lithography to increase the effective resistance of the sample (Fig 1a insert). Due to the difficulty and time it takes to prepare the samples, only $CeCu_2Si_2$ was measured.

Results and Discussion

Through the use of FIB microstructuring, the magnetoresistance of a crystal of $CeCu_2Si_2$ was increased by over a factor of 100, as shown by the before and after temperature dependence of the resistance in Figure 1. The sample was then measured up to 60 T for temperatures both above and below the Kondo coherence temperature T_{CO} = 17 K (Figure 1b). For temperatures 10 K and above the magnetoresistance continuously decreases as the field is increased. However, as the temperature is decreased towards 7 K we begin to see first an increase in the magnetoresistance before it decreases with increasing field. Not only does this trend continue as the temperature decreases further, the magnetic field at which the magnetoresistance switches from positive to negative also moves to higher field as highlighted by the difference between 7 K and 0.5 K. This behavior is similar to measurements reported by Rauchschwalbe *et al.* up to 30 T and suggests at very low temperatures the coherent state can be affected by the high magnetic fields [1]. Unfortunately though, no high magnetic field transitions or quantum oscillations were observed.

Acknowledgements

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490 and the State of Florida. RB acknowledges support from the NHMFL UCGP program.

References

[1] U. Rauchschwalbe *et al*., J. Magn. Magn. Mat., **63-64** 347-350 (1987).

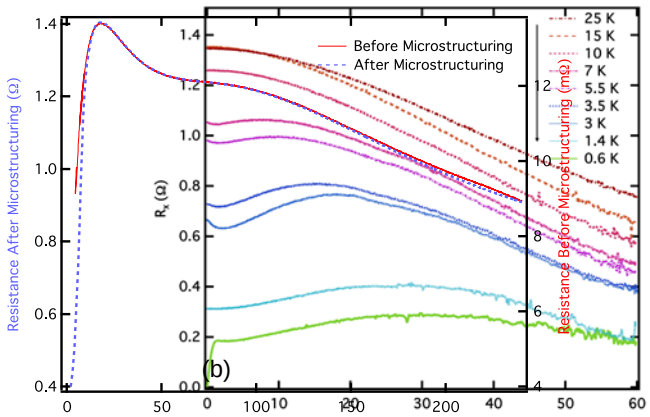

Fig.1 (a) The use of microstructuring via focused ion beam (FIB) lithography increased the resistance of $CeCu_2Si_2$ by a factor of ~100 as shown by the resistance both before the cutting (red solid line, right axis) and after (blue dotted line, left axis). (Insert) The roughly 1000 μm sample is ~18 μm thick and has three 10 μm wide cuts spaced 30 μm apart. (b) Magnetoresistance as a function of field for temperatures between 0.6 – 25 K that exhibits a sign change of the magnetoresistance below 10 K.