Quantum Critical Points and Non-Fermi Liquid Behavior in CaRuO3

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Introduction

The extended nature of the 4-d transition elements compared to the 3-d counterparts makes the transition metal oxides which they constitute contain very delicately balanced ground states [1]. As a consequence these materials are excellent candidates for magnetic based quantum critical points as well as non-Fermi liquid behavior. Here we focus on transport measurements of $CaRuO_3$, the n = ∞ member of the Ruddelson-Popper series. Previous work [1] indicates that n = ∞ member of the Ca series, has similar characteristics to the n = 1 member of the Sr series, Sr_2RuO_4, in that it is located close to the boundary between dominant ferromagnetic and antiferromagnetic interactions.

Experimental

For pulsed magnetic field measurements it is necessary to increase the sample aspect ratio to achieve a measurable resistance. To this end the samples were cut using a focused ion beam (FIB). The FIB process cuts extremely small sections which is ideal for bring up resistance in low resistance samples to a measurable level. Wires were attached to the sample in a 4-point configuration and run down to ^{3}He temperatures in the Los Alamos NHMFL 65 T pulse magnet. The measurements were made using an AC-lockin technique.

Results and Discussion

The FIB process made the samples significantly more susceptible to damage when cooling. The $CaRuO_3$ sample survived cool down after several tires, producing insulating behavior unlike what has been seen in the literature.

Conclusions

The observed insulating behavior of the FIBed $CaRuO_3$ is at odds with the literature and is currently the subject of further investigation. To speculate, the insulating behavior may be due sample quality issues or arise from damage during the FIBing process. However, a less trivial and potentially more intriguing possibility is that the substrate may be applying a significant strain on the sample, effectively tuning a material which may already be close to a quantum critical point. Work is under way to determine the effect of strain on this material.

Acknowledgements

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References

[1] Cao, G. *et al.*, Solid State Communications, **148,** 305-309 (2008).

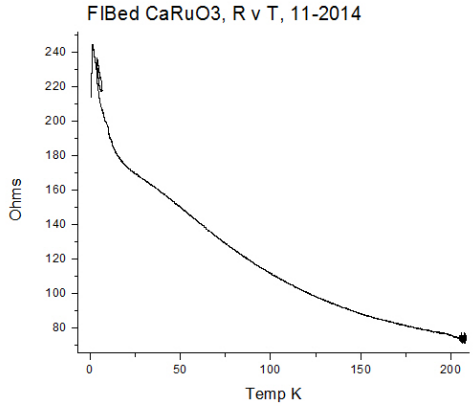

Fig. 1 Resistance vs. temperature plot for CaRuO3 showing the resistive upturn and drop at low temperatures not seen in the literature.

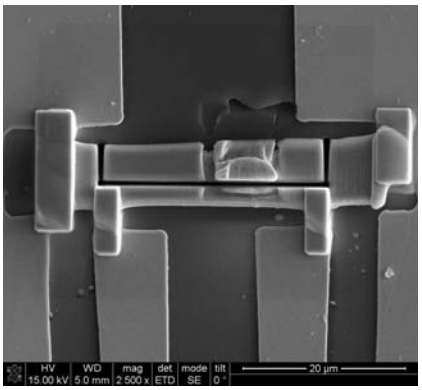

Fig. 2 SEM image of a FIB prepared sample