Investigation of Magnetic Polaron Dynamics in the Magnetic Spinel $FeCr_2S_4$ in High Magnetic Fields

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Introduction

The spinel $FeCr_2S_4$ is a ferrimagnetic spinel with $T_C \approx 180$ K, at which the transport measurement reveals the colossal magnetoresistance effect (CMR) [1]. The double exchange model is ruled out because there is no mixed valence in $FeCr_2S_4$ [2] and magnetic polaron transport mechanism was proposed to explain such behavior [3]. The purpose of this experiment is to study the magnetic polarons behavior under pressure (and analogously magnetic field) in $FeCr_2S_4$. Moreover, magnetic polaron conductivity strongly depends on the magnetic polarization and so high fields should give similar result as highly polarized magnetic lattice. Hall effect measurement is important for sorting out the carrier and mobility effects, which should show up as changes in mobility of the carrier or density across T_C. However, there are only very few Hall effect measurement on $FeCr_2S_4$, and they were performed only at low field.

Experimental

The transport measurement was carried out by using the four-probe method in the Hall configuration with DC current source and nanovoltmeter in delta mode. The experiment was performed at cell 12 of the DC Field Facility at NHMFL using the top loading VTI system.

Results and Discussion

We measured the Hall signal at temperatures above and below T_C where the temperature stability is sufficient. The activated behavior of the sample limited the temperature range due to exponential behavior which is very sensitive to changes in temperature. Also, the Hall signal of the sample turned out to be very small compared to the magnetoresistance signal. Using several of the best results, we reconstructed the already reported behavior (figure 1 (b) and (c)) which indeed shows CMR behavior albeit only few points can be used. However, from the Hall effect result we can qualitatively observe that the carrier density increases with field at $T < 180$ K, which gives supporting evidence of the magnetic polaron transport mechanism.

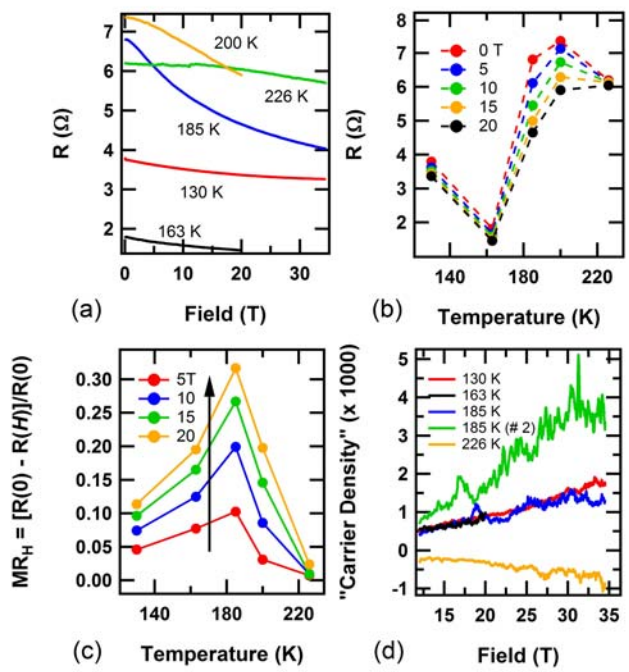

Figure 1. (a) the field dependence of the resistance, the reconstructed temperature dependence of (b) resistance and (c) relative change of the resistance and (d) the extracted carrier density (geometrical factors not considered).

Conclusions

The magnetic polaron transport is possible in FeCr2S4 as demonstrated by the data. More experiment is planned with a better sample contact orientation to minimize the magnetoresistance effect.

Acknowledgements

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References

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