HEAT CAPACITY AND TORQUE MAGNETOMETRIC STUDIES ON A Cr^{IV} BASED 2-D ANTIFERROMAGNET

N. Kaur (FSU), S. Nellutla (NHMFL), N. S. Dalal (FSU/NHMFL), Y.-J. Jo (NHMFL) and L. Balicas (NHMFL)

Introduction

Chromium in the rare oxidation state of +4 is found to have applications ranging from as an intermediate in Cr(VI) carcinogenesis [1] to magnetic recording medium in the form of CrO_2 to Cr(IV)-based lasers [2]. As versatile as Cr(IV) is, only few examples of stable Cr(IV) complexes are known. One exception is the class of Cr(IV)-diperoxoamine compounds which can be grown as large single crystals. This report presents the torque magnetometry and magnetic heat capacity measurements undertaken to search for a simple spin-gap system that could exhibit a Bose-Einstein type condensation (BEC) of magnons.

Experimental

Specific heat measurements of $Cr(dien)_2(O_2)_2$ single crystal in the temperature range 1.8-5 K under fields of 0-9 T were done on a Quantum Design Physical Property Measurement System (QD PPMS) at the Florida State University Department of Chemistry and Biochemistry. The superconducting magnet (SCM2) equipped with a ^{3}He insert (250 mK – 70 K) and a sample rotator at the National High Magnetic Field Laboratory was used to collect torque data.

Results and Discussion

Our earlier reported magnetization and specific heat (C_p) measurements had indicated that this compound is a 2-d antiferromagnet, with a T_N of 2.55 K in zero-field [3]. The C_p data have now been augmented by use of additional magnetic fields (*see* Fig. 1). Torque magnetometry has enabled measurements close to the $T \rightarrow 0$ K, B ~ 12 T region and as an example torque data at 300 mK is shown in Fig. 2. The *B*-*T* phase diagram (Fig. 3) is seen to be clearly parabolic and measurements in the dilution fridge are planned follow the transition temperature to 0 K around 12 T. The resultant phase boundary will be analyzed to extract the critical exponent (α) from the relation $k_b T_c \sim (B_c\text{-}B)^{\alpha}$. We surmise that this system is a promising simple new model for examining the BEC of magnons.

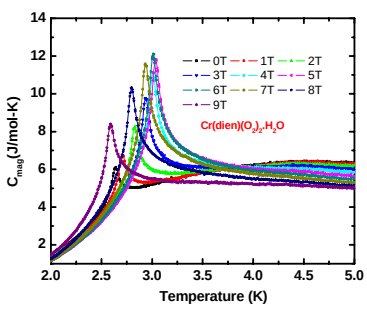

Fig. 1. C_p of $Cr(dien)_2(O_2)_2$ at various fields

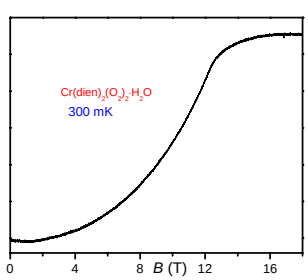

Fig. 2. Torque data on $Cr(dien)_2(O_2)_2$

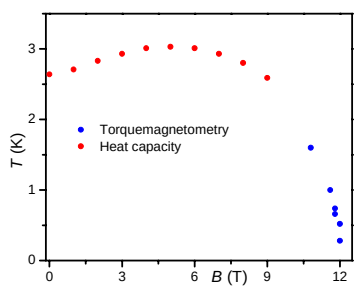

Fig. 3. *B* vs *T* phase diagram of $Cr(dien)_2(O_2)_2$

Acknowledgements

NK and ND thank NSF NIRT #0506946 for support. SN acknowledges NHMFL Diversity program and NSF DMR-0520481 for support. YJJ acknowledges the NHMFL-Schuller postdoctoral program while LB acknowledges the NHMFL in-house research program for partial support.

References

[1] Liu, K.J.; Shi, X.; Dalal N.S. *Biochem. Biophys. Res. Commun*. 235, 54 (1997).
[2] Soubbotin, K. A. et. al. *Opt. Mater*.**13**, 405 (2000).
[3] Ramsey, C. M., Cage, B.; Nguyen, P.; Abboud K.A.; Dalal, N.S.. *Chem. Mater.* **15**, 92 (2003).