Specific Heat and Magnetocaloric-effect Measurements on K_2NaCrO_8

S. Nellutla (NHMFL), Y. Yoshida (UF), Y.-J. Jo (NHMFL), M. Pati (FSU), Y. Takano (UF/NHMFL), L. Balicas (NHMFL) and N. S. Dalal (FSU/NHMFL)

Introduction

K_2NaCrO_8 belongs to a family of peroxychromates (M_3CrO_8, M = Na^+, K^+, Rb^+, Cs^+) in which chromium is in a rare oxidation state of +5 and is coordinated to four peroxy ligands, $(O_2)^{2-}$, in a dodecahedral geometry. These compounds are not only the simplest spin system available (S = ½, I = 0) but also have the advantage that they can be grown as large single crystals. Specific heat (C_p) measurements are an experimental choice since its magnetic contribution relies on an underlying magnetic phase. Earlier C_p measurements performed [1] at zero field and in the temperature range 1.8 – 20 K on single crystals of Na_3CrO_8 and K_2NaCrO_8 showed that these materials become antiferromagnets, respectively, at T_N = 2.35K and T_N ~ 1.7K. Brief field dependence of T_N (corresponding to the C_P peak maximum) showed that it decreases with increasing external field [1]. This work was thus undertaken to fully explore the K_2NaCrO_8 phase diagram and to understand the nature of the phase transition in this low-dimensional spin system with peculiar spin network.

Experimental

The superconducting magnet (SCM1) equipped with a dilution refrigerator (20 mK base temperature) at the National High Magnetic Field Laboratory was used to collect heat capacity and magnetocaloric data of K_2NaCrO_8 single crystal. The sample (~1.5mg) was mounted on the sapphire substrate of the calorimeter.

Results and Discussion

Figure 1 shows the *T* vs *B* phase diagram of K_2NaCrO_8. Black squares are collected from the heat capacity measurements and red dots are collected from the magnetocaloric measurements. The fact that the transition temperature is strongly suppressed around a saturation field of ~7.24 T suggests the possibility of a quantum phase transition. Data is currently being analyzed using "T-window" method to extract the critical exponent (α) from the relation $k_B T_c \sim (B_c - B)^{\alpha}$ and the magnon dispersion above B_c. Investigation of the complex spin structure of K_2NaCrO_8 is underway to understand the origin of the three dimensional antiferromagnetic ordering.

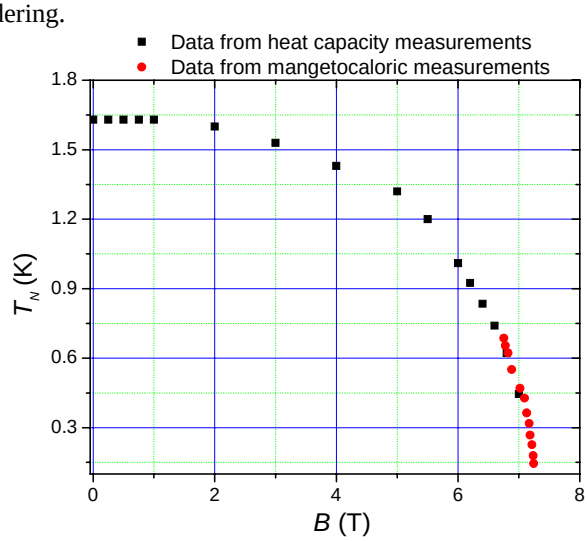

Figure 1. *B* vs *T* phase diagram of K_2NaCrO_8.

Acknowledgements

SN acknowledges NHMFL Diversity program and NSF DMR-0520481 and NSD thanks NSF NIRT-0506946 for partial support. YJJ acknowledges the NHMFL-Schuler postdoctoral program while LB acknowledges the NHMFL In-House Research Program for partial support.

References

[1] B. Cage, N. S. Dalal, *Chem. Mater.* **13**, 881 (2001).