LA-UR-17-21730
Approved for public release; distribution is unlimited.

Title: P13631-E002PF: Pulsed field magnetostriction of Ba2CoTeO6

Author(s): Tanaka, H.
Kurita, N.
Koike, M.
Jaime, Marcelo
Weickert, Dagmar Franziska

Intended for: NHMFL 2016 Annual Research Report
Report

Issued: 2017-03-01

P13631-E002PF: Pulsed field magnetostriction of Ba_2CoTeO_6

H. Tanaka (PI), N. Kurita, M. Koike (Tokyo Inst. Tech.), M. Jaime (NHMFL LANL), F. Weickert (NHMFL FSU)

Ba_2CoTeO_6 is an insulating material consisting of two magnetic subsystems referred as A and B build of S=1/2 spins. Subsystem A is considered to be a Heisenberg-like antiferromagnet (AFM) on a triangular lattice and subsystem B is a J_1-J_2 Ising-like AFM on a honey-comb lattice. The magnetic phase transitions are observed at T_{N1} = 12 K and T_{N2}=3K for A and B respectively. The application of magnetic fields unveils a rich phase diagram that varies depending on the direction of the applied field for either H ll c or H perp c. To date the phase diagram has been investigated by means of specific heat measurement up to 9T and susceptibility measurements with a SQUID magnetometer up to 7T. Magnetization measured in pulsed magnetic fields up to 60T at 1.3K and 4.2K reveal several steps and plateaux occurring at varying critical fields depending on the crystallographic direction. Common to the magnetization parallel c and perpendicular c is the saturation above 40T.

Experimental

We continued the study of multiple phase transitions in Ba_2CoTeO_6 single crystals with magnetostriction experiments based on the fiber-bragg grating (FBG) technique in pulsed magnetic fields up to 60T. This optical method allows obtaining simultaneously data of two different samples mounted on the same fibre for H ll c and H perp c. We focused on the temperature range below 20K down to 1.2K. The 60T short pulsed magnet at the NHMFL pulsed field facility at Los Alamos National Laboratory is energized during the experiment by a 16kV capacitor bank.

Results and Discussion

Fig. 1 shows the length change ΔL/L as a function of magnetic field at 1.3K for H ll c as an example measurement to demonstrate the occurrence of multiple anomalies up to 60T. We did measurements repeatedly at the same temperature to varying maximum fields to understand temperature changes due to the magnetocaloric effect (MCE) which originates in the field dependence of the internal entropy of the system. Figures 2 and 3 summarize the experimental results in phase diagrams for H ll c and H perp c respectively. We find 5 robust signatures up to 40T for H ll c and 4 distinctive features up to 50T for H perp c. All anomalies broaden with increasing temperature and show maximum hysteresis for measurements around 4K.

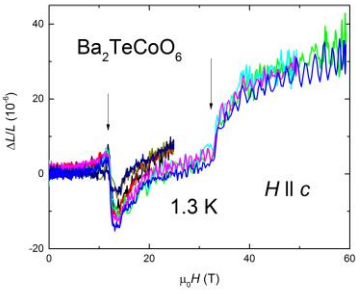

Fig. 1 Magnetostriction ΔL/L versus Magnetic field H measured at 1.3K for Ba_2CoTeO_6.

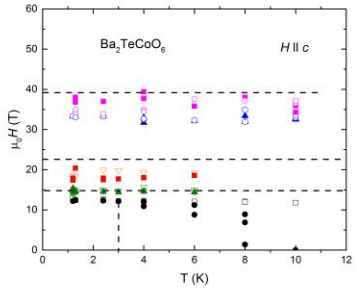

Fig. 2 H-T phase diagram of Ba_2CoTeO_6 for H ll c obtained by magnetostriction data.

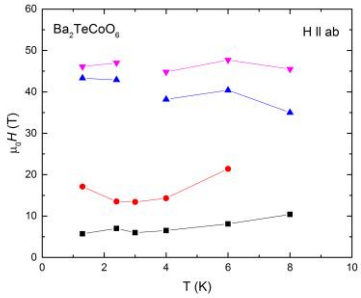

Fig. 3 H-T phase diagram of Ba_2CoTeO_6 for H perp c obtained by magnetostriction data.

Conclusions

By carrying out magnetostriction experiments in pulsed magnetic fields up to 60T we are able to obtain details of the H-T phase diagrams H ll c and H perp c in Ba_2CoTeO_6. We find anomalies in the sample length at similar critical fields as revealed by specific heat and susceptibility measurements at low fields. Most importantly, we extend with our magnetostriction data the phase diagram well above 9T. Multiple features at almost constant critical fields for both field directions are observed that show temperature broadening. The critical fields measured at 1.2K in the high field region coincide with anomalies of magnetization measurements in pulsed magnetic fields. Even though our magnetostriction experiments were carried out on small platelet samples with strong thermal coupling to the bath temperature, we observe significant hysteresis. This observation points to strong MCE and calls for a critical evaluation of the previous magnetization results. Further direct investigation of the MCE is highly recommended.