(H,T) Phase diagram of Ba_2CoTeO_6 from Dilatometry Studies

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Introduction

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 a Heisenberg-like antiferromagnet (AFM) on a triangular lattice and subsystem B is a J_1-J_2 Ising-like AFM on a honeycomb lattice. Magnetic phase transitions in zero field are observed at T_{N1} = 12 K and T_{N2}=3K for A and B respectively. The application of magnetic field induce plateaus in the magnetization that are typical for geometrical and bond-frustrated spin systems [1].

Experimental

We continue investigations in high DC and pulsed magnetic fields to unveil the rich phase diagram for different crystallographic directions in high quality single crystals. Magnetostriction and thermal expansion are measured with an optical fiber Bragg grating (FBG) technique at the DC-facility in Tallahassee up to 35T. Our experimental approach allows collecting simultaneously data of two different samples mounted on the same optical fiber for H ll c and H ⊥ c orientations. We use a commercial swept wavelength laser Hyperion® interrogator by Micron Optics, running at 5 KHz [2]. At NHMFL in Los Alamos, we measured specific heat up to 14 T using a Quantum Design PPMS® system. We furthermore complemented our set of data with magnetocaloric effect (MCE) experiments in pulsed magnetic fields at the ISSP in Tokyo by means of an AuGe-film thermometer deposited directly onto the sample subsequently magnetized adiabatically during a fast (50ms) field pulse.

Results and Discussion

Fig. 1 shows thermal expansion vs temperature measurements up to 35T for both field directions with distinct features at the 1st and 2nd order phase transitions as marked by arrows. Fig. 2 is a summary of all experimental data in the T - H Phase diagram for H ll c. Our study reveals a richer-than-expected phase diagram, which is likely a consequence of interlayer coupling between magnetic subsystem A and B. Most surprisingly, some of the anomalies are only observed in the crystal lattice and not in the magnetization data emphasizing the importance of dilatometric experiments for the understanding of 2-dimensional spin materials.

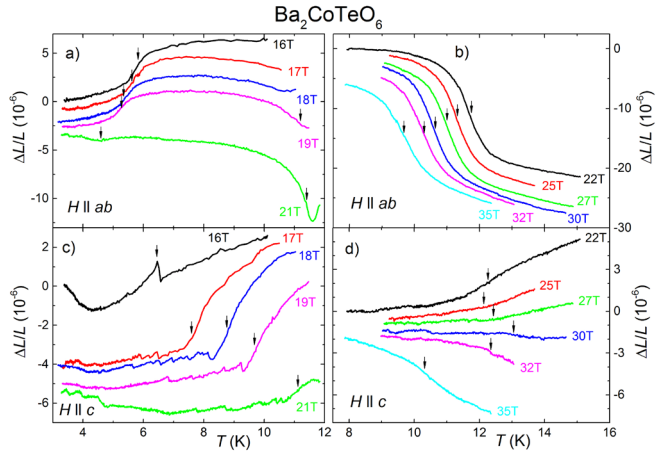

Fig.1 Thermal expansion ΔL/L (T) measurements in Ba_2CoTeO_6 single crystals obtained in a 35T DC-magnet at the NHMFL in Tallahassee. Arrows label anomalies of phase transitions that are used to construct the rich phase diagram as shown in Fig. 2.

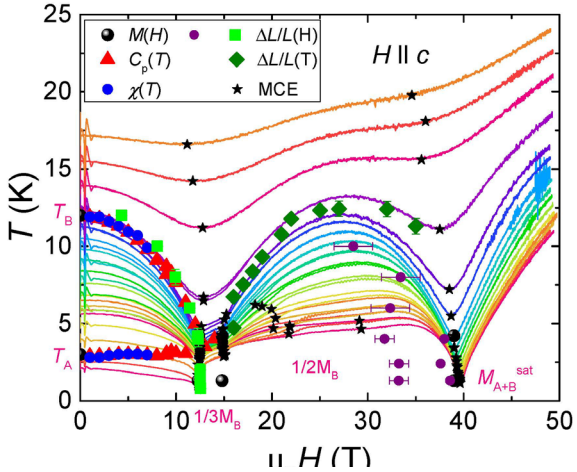

Fig.2 Phase diagram of Ba_2CoTeO_6 obtained by thermodynamic measurements in DC and pulsed magnetic fields, including magnetization, specific heat, thermal expansion, magnetostriction and magnetocaloric effect (MCE).

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[2] Jaime, M. *et al.,* Sensors **17**, 2572 (2017).
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