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Elastic anomalies of TbB_4 in pulsed high magnetic fields

○Takahiro Fujita[1], Masato Yoshizawa[2], Ryosuke Kamiya[2], Hiroyuki Mitamura[3], Toshiro Sakakibara[3], Koichi. Kindo[3], Fumitoshi Iga[4], Isao Ishii[1] and Takashi Suzuki[1]

[1]Graduate School of Advanced Sciences of Matter, Hiroshima University

[2]Graduate School of Engineering, Iwate University

[3]Institute for Solid State Physics, University of Tokyo

[4]Faculty of Science, Ibaraki University

Rare earth tetraborides, RB_4 with a tetragonal structure, have attracted much attenuation in recent years because of their unique crystalline structure. The network of rare earth ions is equivalent to the so-called Shastry-Sutherland lattice. Therefore, they are expected to have a geometric frustration of spin and multipole.

TbB_4 undergoes two phase transitions at T_{N1}=42.1K and T_{N2}=21.7K. Magnetic susceptibilities both for the magnetic directions along *a* and *c* show a cusp at T_{N1}. The clear cusp suggests that the transition at T_{N1} should be an antiferromagnetic one. Elastic moduli show significant softening around T_{N2}. This softening suggests ferroquadrupolar ordering below T_{N2}. The macroscopic spontaneous strain due to the ferroquadrupolar ordering may lift the geometric frustration [1].

The magnetization curve for the magnetic direction along *c* revealed that there exist multiple metamagnetic transitions between 16T and 30T [2]. The multipolar interaction is expected to play an important role in ordering phases in magnetic fields. We measured elastic moduli in high magnetic fields up to 56 T by combining a pulse magnet at ISSP and an ultrasonic apparatus set up at Iwate University. Figure 1 shows the longitudinal elastic moduli C_{11}, C_{33} and transverse modulus C_{44} as a function of magnetic field for the field direction along *c* at 4.2 K. We found clear anomalies at most of transition fields. This is the first detection of metamagnetic transitions in TbB4 by an ultrasonic spectroscopy.

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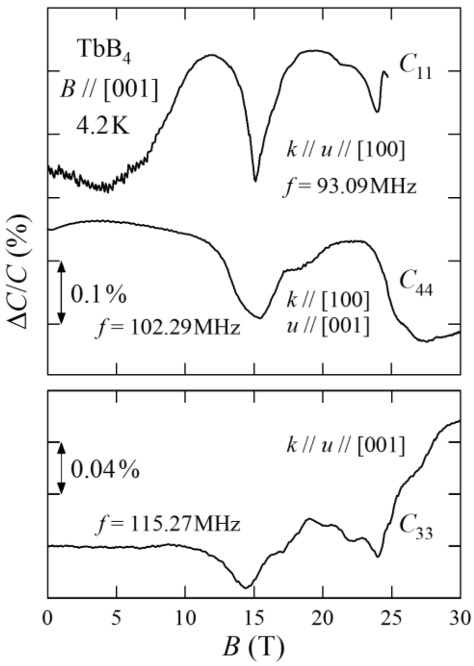

Figure 1. Relative change in elastic moduli as a function of magnetic field. Sound propagation and polarization directions are denoted by *k* and *u*, respectively.

[1] T. Suzuki *et al*., J. Phys: Conf. Ser. **150** (2009) 042194.

[2] S. Yoshii *et al*., J. Mag. Mag. Mater. **310** (2007) 1282.