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Elastic Constants of $TbAl_2$

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Abstract. The elastic constants of $TbAl_2$ single crystals have been determined by ultrasonic measurements. We find at room temperature $C_{11} = (1.44 \pm 0.3) \times 10^{11}$ N/m², $C_{12} = (0.33 \pm 0.1) \times 10^{11}$ N/m² and $C_{44} = (0.68 \pm 0.1) \times 10^{11}$ N/m². The Curie point is measured to be (108 ± 1)°K and large attenuation is observed below this temperature.

$REAl_2$ (RE = Rare Earth) intermetallic compounds crystallize in the cubic $MgCu_2$ Laves Phase [1] and most of them, in particular $TbAl_2$, order ferromagnetically at low temperature [2, 3]. Detailed magnetization [4] and inelastic neutron scattering

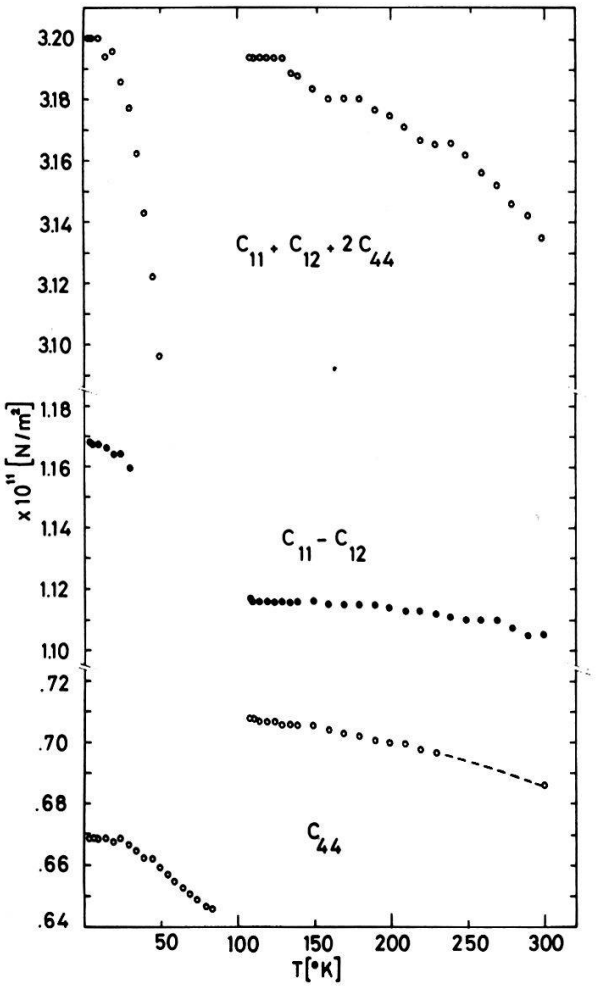

Figure 1
Elastic constants for $TbAl_2$ single crystal as a function of temperature.

experiments [5] on single crystals have been reported earlier. For detailed analysis of the magnetization, the magnetostriction and the magnon dispersion it is important to know the elastic constants of $TbAl_2$. It is the aim of this paper to report these parameters in single crystalline $TbAl_2$.

$TbAl_2$ has been prepared from 99.9% pure Tb and 99.999% pure Al. A single crystalline cylinder of 6 mm diameter and 17 mm length has been obtained by the Czochralski method [6]. The (110) direction was parallel to the axis of the cylinder. By spark cuttering and polishing we obtained two planes which were parallel within 1 μ. The measurement has been done by the usual ultrasonic method in the range from 4.2°K to 300°K.

The results are given in Figure 1. For calculating the elastic constants, we used the length of the crystal at room temperature and, at the same temperature, the density $\rho = (5.873 \pm 0.005)$ gr/cm^3 measured by the hydrostatic method. The absolute error for the elastic constants C_{11}, C_{12} and C_{44} is 2% and relative error is estimated to be 0.1%. We note that the ultrasonic attenuation in $TbAl_2$ is very strong in a large temperature range below the Curie point. The room temperature results are in agreement with recently performed phonon dispersion measurements which give $C_{11} = (1.7 \pm 0.3) \times 10^{11}$ N/m^2, $C_{12} = (0.5 \pm 0.2) \times 10^{11}$ N/m^2 and $C_{44} = (0.6 \pm 0.2) \times 10^{11}$ N/m^2 [7]. They are, within experimental error of the neutron measurement, the values of $C_{11} = (1.44 \pm 0.3) \times 10^{11}$ N/m^2, $C_{12} = (0.33 \pm 0.1) \times 10^{11}$ N/m^2 and $C_{44} = (0.68 \pm 0.1) \times 10^{11}$ N/m^2 determined in our measurements.

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