CORRELATION BETWEEN HEAT CAPACITY ANOMALY IN Tb AND MAGNETIC TRANSITION IN Tb_2O_3†

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Measurements on the heat capacity of Tb below 4°K by Kurti and Safrata[1] and Stanton, Jennings, and Spedding[2] yielded an anomaly which was attributed to an oxide impurity.[2] Subsequent measurements by Lounasmaa[3] on a sample of presumably higher purity than the first two confirmed this to the extent that no anomaly was found in the region in question. The fact that an oxide impurity can give rise to heat capacity anomalies in the He region was definitely established for the case of Gd by Crane.[4] In order to confirm the evidence for the anomaly in Tb found by Kurti and Safrata and Stanton et al. being caused by an oxide phase, the magnetic susceptibility of Tb_2O_3 was measured from 1.3 to 250°K. The lower stable form of the oxide was chosen for this measurement because presumably this is the form that would exist as an oxide phase in the metal.

As shown in Fig. 1, there exists a maximum in the susceptibility, characteristic of antiferromagnetic ordering, at 2.42°K. The transition in the heat capacity of Tb corresponds, to within 0.02°K, to the maximum in the susceptibility. The inverse of the susceptibility is not linear below 250°K, so it would be supposed that the crystal field splitting of the lowest J value for Tb ion in the oxide would be at least of the order of magnitude of 170 cm^{-1}. This is in accord with crystal field splittings found for other rare-earth oxides by Justice and Westrum.[5]

The susceptibility was measured using an ac bridge technique,[6] the field at the sample being roughly two Oe.

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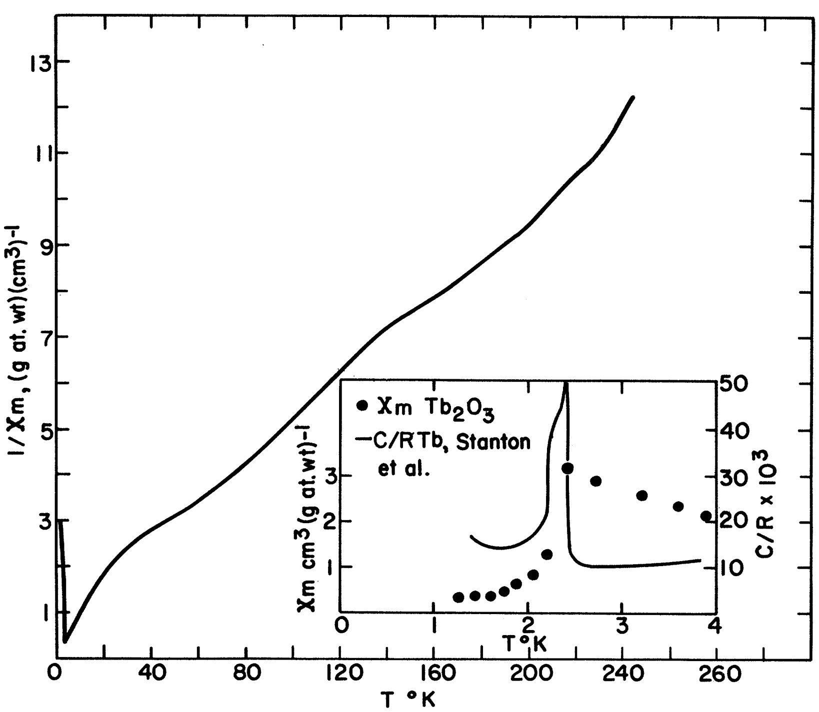

FIG. 1. Inverse molar susceptibility of Tb_2O_3. Insert: comparison between C_p of Tb and X_m of Tb_2O_3 in region of anomaly in C_p.