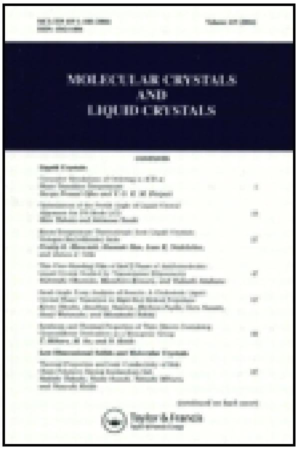

Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl16

Thermal Properties Of $ZrTe_5$

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Version of record first published: 20 Apr 2011.

To cite this article: Ana Smontara & Katica Biljaković (1985): Thermal Properties Of $ZrTe_5$, Molecular Crystals and Liquid Crystals, 121:1-4, 141-144

To link to this article: http://dx.doi.org/10.1080/00268948508074849

Mol. Cryst. Liq. Cryst. 1985, Vol. 121, pp. 141-144
0026-8941/85/1214-0141/$10.00/0

THERMAL PROPERTIES OF $ZrTe_5$

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Abstract - High resolution specific heat measurements have been performed in the temperature range 60-190K. Two very weak anomalies were found around 80K and 140K. Thermal conductivity measurements have also been performed and there was no detectable anomaly. The results are discussed in view of actual proposed interpretations.

INTRODUCTION

Recently, intensive investigation of several physical properties of transition-metal pentatelluride $ZrTe_5$ have been made searching for the mechanism of the resistivity anomaly[1] around 140K. Associated changes have been observed in the thermoelectric power[2] and the Hall coefficient[3]. At microwave frequencies the resistivity anomaly is nearly completely wiped out and the most likely explanation of this is, as in $NbSe_3$, the development of a collective made associated with a phase transition[4]. X-ray diffraction and magnetic measurements did not show the existence of charge or spin-density wave transitions respectively. In contrast to the first Raman scattering studies, a recent one suggests the possibility of a structural instability[5]. Band structure calculations[6] support the absence of one dimensional charge-density-wave instability and suggests that the electrical resistivity peak at 140K originates in the strong temperature dependence of the carrier density. Elastic measurements[7] revealed a new anomaly at 85K, where other properties are not singular, which is assigned to shear motion of neighboring sheets. Recently, structural investigations at room temperature as well as electrical resistivity and heat capacity measurements have been made[8] and the latter will be reported in this paper.

The samples used in this work were from the same baches as these an which structural, resistivity and elasticity measurements were reported earlier[1,7].

HEAT CAPACITY AND THERMAL RESISTIVITY

In order to clarify the problem of existence of the phase transition we performed heat capacity measurement in the temperature region between 60K and 190K. The measurements were carried out in two runs using 6.6 mg and 14.2 mg crystals respectively. The cooling rate was about 1K/hour. It was found that no indications of a latent heat were present, neither in the heating nor in the cooling run.

In the first experiment (No.1,Fig.1) there was no clear specific heat anomaly. However there were at least two marked changes in the slope, at 90K and around 140K.

In the second run we observed two broad anomalies. The first one is around 135K, which is also the temperature of the maximum in the resistivity measured on the same sample (Fig.2). There is a second anomaly at 90K. Both observed anomalies are rather smeared.

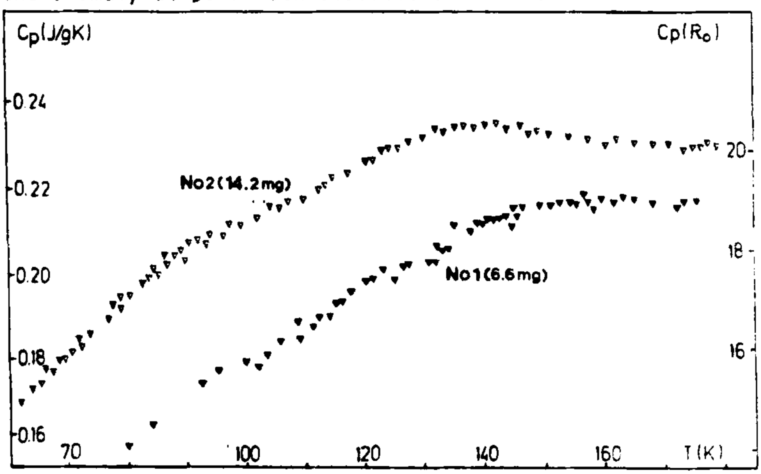

FIGURE 1 Specific heat of $ZrTe_5$ versus T measured during cooling in two separate runs on two different samples.

On the same samples we also performed electrical and thermal resistivity measurements (Fig.2). The latter was dane relative to constantan wire.

There is no indication of anomalies in thermal resistivity as there is in $NbSe_3$ except again two changes in the slope, the first one around 140K and the second one around 80K. The plot of the Lorentz number (kρ/T) shows a smoth variation with temperature.

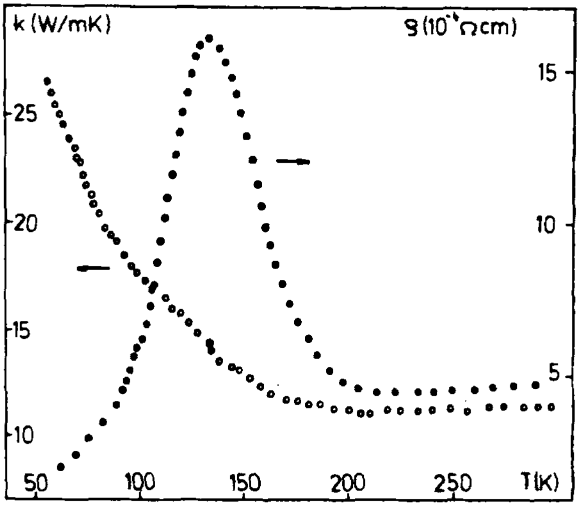

FIGURE 2 The electrical and thermal resistivity of $ZrTe_5$ as a function of temperature.

DISCUSSION

The high temperature peak in specific heat, at ~130K, corresponds to the transport anomalies in the orthorhombic polytype. As mentioned before two different approaches have been proposed to explain the transport anomalies. The present result could not ascertain the nature of proposed transition. A stepwise increase in the density of electronic states cannot reproduce the peak of the heat capacity. A sharp structure of electronic density of states curve around Fermi level qualitatively can reproduce the experimental results[8].

In the last paper of Sambongi et al[8] orthorhombic and monoclinic polytypes of $ZrTe_5$ are examined. Electrical resistivity was measured for monoclinic samples. They found a small hump near 85K.

The law temperature specific heat peak is associated with the elastic and resistivity anomalies of the monoclinic polytype. Though samples had been confirmed as orthorhombic by X-rays before measurement, both the elastic and heat capacity results are indicative of the presence of the monoclinic polytype.

ACKNOWLEDGEMENT

We are grateful to L.Forro for his help during electrical and thermal resistivity measurements and S.Barišić for helpful discussions. We especially wish to thank T.Sambongi for providing us with the samples and for many helpful discussions during the course of this work.

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