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HEAT CAPACITY MEASUREMENTS ON TaS_3

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Abstract - We have measured the heat capacity of TaS_3 in the temperature range 60-180K with a resolution better than 2% in order to investigate hysteresis effects around 100K. We observe hysteresis in heat capacity between 100K and 130K which corresponds to the resistivity hysteresis and to some anomalies in non linear properties associated with the motion of the CDW.

INTRODUCTION

Orthorhombic TaS_3 undergoes a Peierls transition at T=215K[1]. It was originally reported that the charge density wave (CDW) was commensurate with the underlying lattice with a periodicity of four lattice constants along the chain axis[2]. After observation of anomalies in the transport properties of orthorhombic TaS_3 more recent electron diffraction measurements[3] demonstrated that below 215K the wavelength of the Peierls transition is slightly incommensurate with the lattice and is temperature dependent, locking in to four lattice constants at $T_o^* \sim 130$K. This commensurate-incommensurate transition is observable in the temperature variation of the resistivity along the chain axis and also in the non linear properties like temperature variation of the electric threshold field and the ratio of the periodic noise frequency to the current carried by the CDW[3]. Furthermore recent investigation of the response to high field pulses[4] and accurate measurements of the ohmic conductivity[5,6] have shown the presence of metastable states in this system. In view of the intriguing transport properties of TaS_3, measurements of thermal properties are also of great interest.

In this paper we present new data for the heat capacity of orthorhombic TaS_3 and show the presence of thermal hysteresis.

HEAT CAPACITY

Heat capacity measurements were made using an improved heat pulse technique whose basic principles have been described previously[7]. The cooling and heating rates were both about 1K/hour and heating pulses of about 0,1K were applied to the sample.

As shown in Fig.1 there is a hysteresis of about 3-4% in the temperature region between 100K and 130K. The results represented the heat capacity of the whole sample (TaS_3, silicone grease, Cu container etc). The extra specific heat arising from the sample holder etc. has not yet been measured, we expect that the contribution of a parasitic specific heat will be about the half of the total heat capacity, i.e. the hysteresis in the specific heat of TaS_3 will be 6-8%.

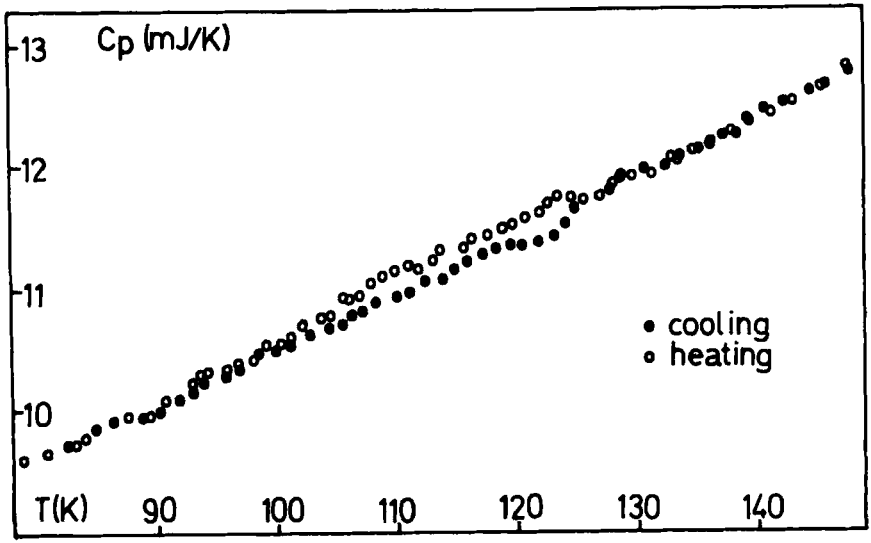

Fig.1 Total heat capacity of TaS_3 (sample + parasitic heat capacity) versus temperature

The hysteresis in heat capacity occurs in the range 100-130K and is probably the same origin as that in the resistivity. The heat capacity is directly related to the order parameter or the amplitude of the CDW. Thus the results reported here give further support for the suggestion that there is hysteresis in the amplitude of the CDW, associated with the presence of the metastable states[8].

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