Low temperature heat capacity measurements on $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$

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Abstract. Specific heats were measured on two samples of $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ in the temperature range 1.7 K to 10 K. In addition to the known Schottky behaviour, a peak in the specific heat curve was observed near 7.9 K in both the samples. This peak is probably due to impurity contribution and the specific heat measurements were undertaken in holmium oxide (Ho_2O_3), which was the suspected impurity. However, no peak was observed in the specific heat curve of holmium oxide.

Keywords. Specific heat; high T_c superconductors; low temperature; $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$.

1. Introduction

In compounds $\text{RBa}_2\text{Cu}_3\text{O}_7$ (R stands for rare earth ion except Ce, Pr, Pm and Tb), heat capacity measurements at low temperatures show sample-to-sample variations. The reason for this behaviour is not known. It is necessary to check if the amount of superconductivity in the materials has any effect on the low-temperature behaviour. Earlier Basu *et al* (1989) have carried out high precision heat capacity measurements on $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ near the superconducting transition temperature. In this report we present low temperature heat capacity measurement in two samples of $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ with different superconducting fractions.

2. Sample preparation

The preparation and processing of the samples were reported earlier (Basu *et al* 1988, 1989). Sample 1 had a T_c of 85 K and the specific heat jump $\Delta C_p/T_c \simeq 8 \text{ mJ/mol K}^2$ and sample 2 had a T_c of 90 K and the jump $\Delta C_p/T_c \simeq 22 \text{ mJ/mol K}^2$. The high temperature and low temperature measurements were done in these samples within a period of one month.

3. Measurements and discussion

The heat capacity was measured by the usual heat pulse technique. The accuracy of the measurement was about 3%. Figure 1 shows the results of low-temperature heat capacity measurements. In the holmium-based samples the low temperature heat capacity measurements were done by several experiments (Nakazawa *et al* 1987; Ferreira *et al* 1988; van der Meulen *et al* 1988), and our results are quite comparable with their results. The heat capacity in this compound is rather large at low temperatures and is attributed to Schottky anomaly (Ferreira *et al* 1988) arising from the interaction of the RE-ions with the crystalline electric field. Their assignment of

Figure 1. Specific heat of superconducting $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ vs temperature.

Figure 2. Specific heat of Ho_2O_3 vs temperature.

Schottky levels follows the experimental curve quite closely. The heat capacity curves, as reported by different authors, in general, agree. We, therefore, conclude that it is not possible to detect the effect of the amount of superconductivity in $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ in the low-temperature behaviour.

One of the features seen in the low temperature heat capacity curves of $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ (figure 1) is that there is a peak near 7.9 K in our measurements

although others did not report any peak at this temperature. We, therefore, felt that this peak may be due to some excess of one of the component compounds i.e. CuO_2 , Ba_2CO_3 and Ho_2O_3 . Eckert *et al* (1988) measured the low-temperature specific heats of CuO_2 and Ba_2CO_3 and no peak was observed at 7.9 K. We have, therefore, measured the low-temperature heat capacity of Ho_2O_3 and this is shown in figure 2. Ho_2O_3 is a good insulator and the pulse method of heat capacity measurement presented some problems. The accuracy of this measurement, we find, is not better than 5%. However, we do not see any peak near 7.9 K. If the excess Ho_2O_3 is responsible for the unusual peak in figure 1, it should show a large peak at 7.9 K in the specific heat curve of Ho_2O_3 (figure 2). However, the peak is absent.

4. Conclusion

We conclude that the amount of superconductivity in $\text{HoBa}_2\text{Cu}_3\text{O}_{7-\delta}$ is not detected in the low temperature behaviour. A peak near about 7.9 K has been observed in our measurement. The starting compounds i.e. Ba_2CO_3 , Ho_2O_3 and CuO_2 , for preparing HoBCO are not responsible for this peak. Further work is in progress.

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