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HEAT CAPACITY OF HIGH-TEMPERATURE SUPERCONDUCTOR $(Bi,Pb)_2\,Sr_2\,Ca_2\,Cu_3\,O_{10+x}$

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The heat capacity at constant pressure for high temperature superconductor $(Bi_{0.9}Pb_{0.13})_2\,Sr_2Ca_2Cu_3O_{1+x}$ was measured. The data have a peak at T_c = 107.6 K and the results are in agreement with measurements of other authors.

Heat capacity of high temperature superconductors (HT_cS) sample with starting composition $(Bi_{0.9}Pb_{0.13})_2Sr_2Ca_2Cu_3O_{1+x}$, prepared by National Research Institute for Materials, Prague [1] was measured in adiabatic calorimeter by steady state method. The mass ratio for HT_cS sample and parasitic mass (germanium resistance thermometer and electric wires) was approximately 40 : 1. The porosivity of this HT_cS is approximately 15% (the paper [1] gives density 5200 kg/m^3). For evaluation the folowing equation was used:

$$c_p = \frac{Qt}{m\Delta T} \tag{1}$$

where c_p is mean heat capacity for mean temperature $T = (T_1 + T_2)/2$ and $\Delta T = T_1 - T_2$. Each of the steps (for temperature growth from T_1 to T_2) was performed with $\Delta T = 1$ K. Heat capacity vs temperature for this sample, with critical current density [1] I_c at 77 K and zero magnetic field 1070 A/cm^2 is shown in Fig. 1.

The accuracy of the experiment has been estimated from mean-root-square error, which was evaluated from the relation

$$\delta_c = \frac{1}{m\Delta T}\{t^2\delta_Q^2 + Q^2\delta_t^2 + \left(\frac{Qt}{m}\right)^2 \delta_m^2 + \left(\frac{Gt}{\Delta T}\right)^2 \delta_{\Delta T}^2\}^{1/2} \tag{2}$$

Measured quantities $m, t, \Delta T, Q$, evaluated values for c_p and the mean-root-square error δc for six temperatures are shown in the Table 1.

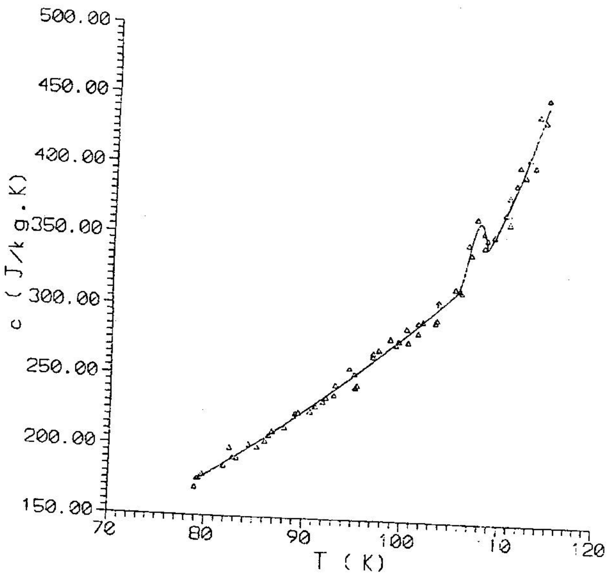

Fig. 1. The heat capacity vs. temperature

Table 1.Calculated value C (from (1)), σ_c (from (2) and measured values m, t, T, Q for HT_cS $\bar{T}$ - average value of measured temperature, T - choosen temperature.

T	85 K	95 K	106 K	108 K	110 K	113 K
$\bar{T}$	85.569	94.893	106.189	108.205	110.427	113.246
m[g]	12.050	12.050	12.050	12.050	12.050	12.050
σ_m	± 0.005	± 0.005	± 0.005	± 0.005	± 0.005	± 0.005
t[s]	32.500	35.250	30.830	22.500	21.700	22.500
σ_t	±0.100	±0.100	±0.100	±0.100	±0.100	±0.100
ΔT[K]	2.845	2.496	1.693	1.220	1.18	0.930
$\sigma\Delta T$	±0.022	±0.022	±0.022	±0.022	±0.022	±0.022
Q[mW]	222.133	221.984	225.931	232.583	232.299	212.843
σ_Q	±0.025	±0.025	±0.025	±0.025	±0.025	±0.025
σ_c	1.754	2.413	4.5777	6.613	7.694	10.288
c	202.679	253.722	325.598	359.628	367.580	421.053
$\bar{c}$[J/kg/K]	205.401	253.141	331.085	352.968	374.528	425.914

The fitting curves are:

$$c = 44.354 - 1.038T + .0034T^2 \quad (3)$$

for the temperature interval (79.2 - 105.8) K, as was determined from 43 measurements, and

$$c = 9.495 \times 10^6 - 2.676 \times 10^5 T + 2.515 \times 10^3 T^2 - 7.874T^3 \quad (4)$$

for temperature interval (105.5 - 108) K, determined from 9 measurements, and

$$c = 5.971 \times 10^3 - 1,179 \times 10^2 T + 0.061T^2 \quad (5)$$

for temperature interval (108 - 114.3) K, calculated from 14 measurements.

The heat capacity vs. temperature reaches its peak at $T = 107.6$ K (critical temperature T_c for this HT_cS is about 108 K [1]). Measurement attested that this sample of HT_cS has very similar change of the heat capacity vs temperature, like is shown for the polycrystaline sample [2] of BPSCCO (2223 phase) with peak at $T_c = 107$ K. The results entitle to use the same conclusions for fluctations like is described in Ref. 2. The heat capacity jump c at T_c (e.g. $\Delta c(T_c)/T_c$) is approximately 2.5 mJ/mol K^2 which is also in agreement with other measurements [2]. The authors prepare the solution for HT_cS characteristics introduction in which will be respected the theoretical debye function and temperature dependence R below T_c.

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