Heat capacity measurements of a microgram Pb crystal using ac nanocalorimetry with good absolute accuracy

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Heat capacity measurements using the ac steady state method are often considered not able to provide absolute accuracy. By adjusting the working frequency to maintain a constant phase[1] and using the phase information to obtain the heat capacity, we have found that it is possible to achieve good absolute accuracy. We present a thermodynamic study of a $\sim 2.8\,\mu$g Pb superconducting crystal to demonstrate the newly opened capabilities. The sample is measured using a differential membrane-based custom-made calorimeter. The calorimetric cell is a pile of thin film Ti heater, insulation layer and GeAu thermometer fabricated in the center of two Si_3N_4 membranes. It has a background heat capacity $< 100\,$nJ/K at 300 K, decreasing to 9 pJ/K at 1 K. The sample is characterized at temperatures down to 0.5 K. The zero field transition at $T_c = 7.21\,$K has a width $< 20\,$mK and displays no upturn in C. The heat capacity jump at T_c and the extrapolation of the Sommerfeld term lead to $\Delta C/\gamma T_c = 3.69$. The deviations of the thermodynamic critical field from the empirical expression $H_c = H_c(0)\left[1-(T/T_c)^2\right]$ are discussed. Both analyses give results in good agreement with literature. To illustrate the possibility to probe latent heat using the ac method, an investigation of the phase transition in various magnetic fields is also carried out.

[1]S. Tagliati and A. Rydh, Thermochim. Acta, to be published.