

The features of the low temperature behavior of heat capacity and thermal expansion of bundles of single-walled carbon nanotubes

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The heat capacity of bundles of single-walled carbon nanotubes (SWNTs) has been investigated in a temperature interval of 2-120K using a compact adiabatic calorimeter [1]. A cylindrical sample (0.71602 g) was prepared from a SWNT powder (Cheap Tubes, USA).

The temperature dependence of the heat capacity $C(T)$ of the measured SWNT bundles has breaks near 36 K and 100 K. In the temperature intervals 2-34 K, 40-78 K, 86-100 K and 110-120 K the curve is described by different power functions with the exponents varying from 2 to 1. At $T=65-80$ K the curve $C(T)$ has a deflection.

The coefficient of the radial thermal expansion $\alpha_R(T)$ of SWNT bundles has been investigated at $T=2-120$ K [2]. The measurements were made using a dilatometer with the sensitivity $2 \cdot 10^{-9}$ cm. A cylindrical sample 7 mm high and 10 mm in diameter was prepared by compacting of a SWNT powder, which oriented the tubes in the bundles perpendicular to the sample axis. The sign of $\alpha_R(T)$ was observed to change below $T=5.5$ K. The heat capacity and the thermal expansion [2] were measured on samples obtained by the same preparation technique.

The temperature dependences of heat capacity and the coefficient of radial thermal expansion $\alpha_R(T)$ have features near $T=36$ K.

The Gruneisen coefficient ($\gamma = \alpha_r(T) \cdot V / (\chi \cdot C_v(T))$) was estimated for the SWNT bundles oriented perpendicular to the sample axis. It is found that γ is weakly dependent on temperature above 37 K.

The origin of the features observed is discussed.

- [1] M.I. Bagatskii, V.V. Sumarokov, A.V. Dolbin, CC2010: 8th Conference on Cryocrystals and Quantum Crystals CC-2010 (Chernogolovka, Russia, July 26-31, 2010).
- [2] A.V. Dolbin, V.B. Esel'son, V.G. Gavrilko, V.G. Manzhelii, N.A. Vinnikov, S.N. Popov, and B. Sundqvist, *Fiz. Nizk. Temp.* **34**, 860 (2008) [*Low Temp. Phys.* **34**, 678 (2008)].