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SIZE EFFECTS IN THE HEAT CAPACITY OF MODIFIED MWCNTs

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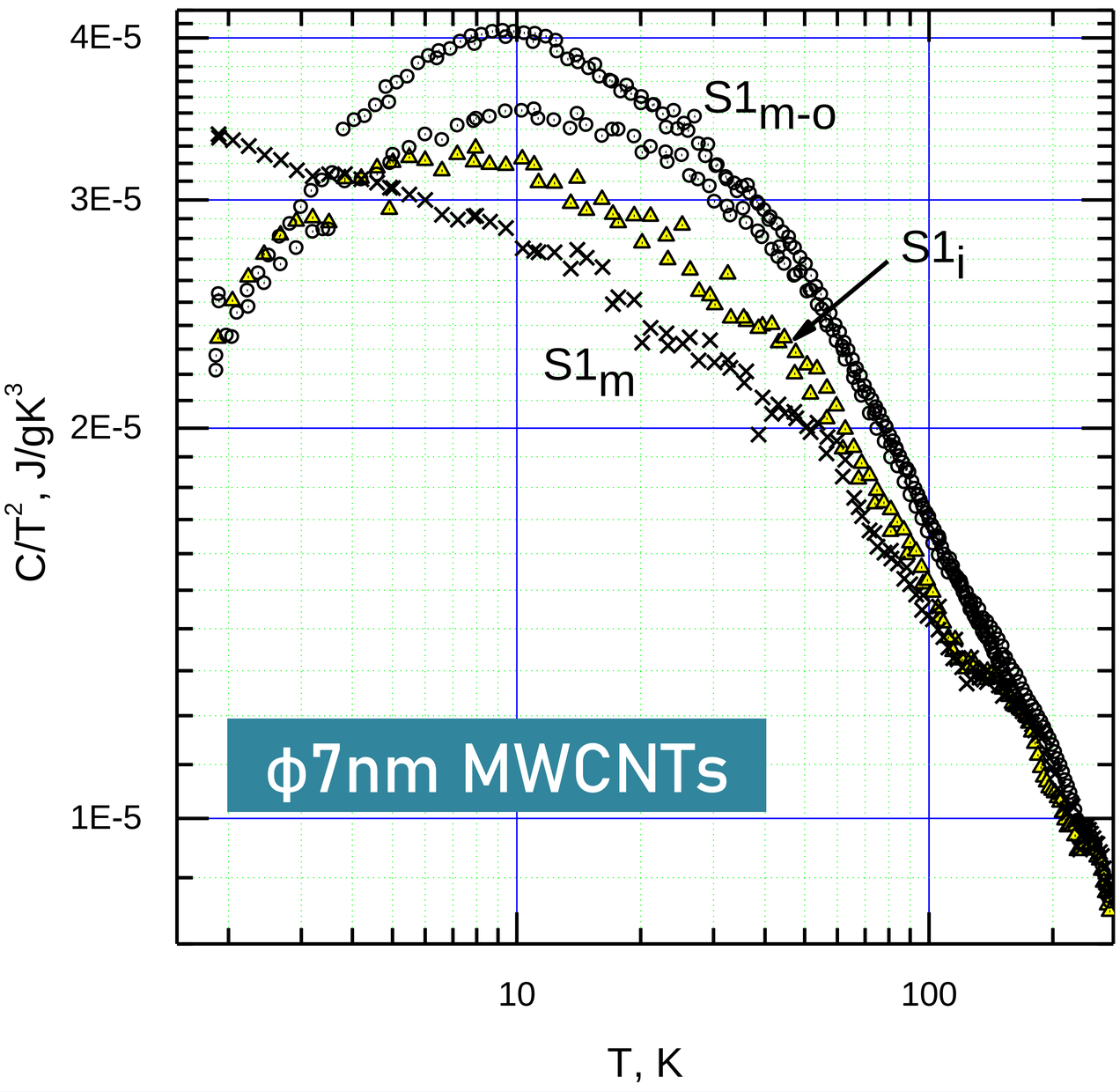


The effects of size and dimensionality were found.

The character of the temperature dependences of the specific heat of ground and ground-oxidized MWCNTs with various diameters fundamentally differs below ≈140 K

Grinding the Ø7.2 nm MWCNTs increases the number of topological defects thereby enhancing the probability of formation of quasi-bundles through surface areas. Both those effects can contribute to lowering the resultant heat capacity of nanotubes in respect to initial ones in the temperature range 4-50K.

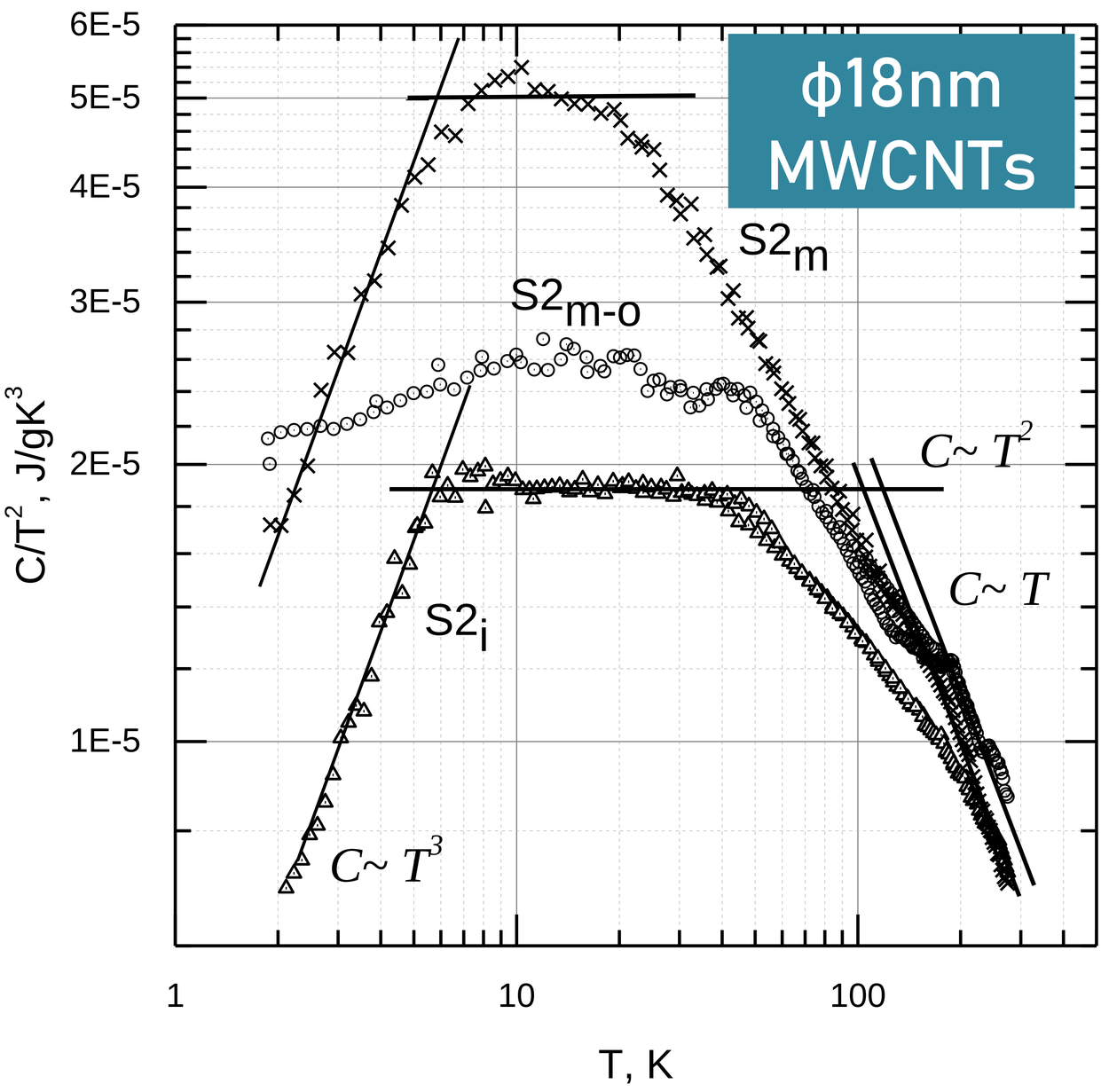
The case the Ø18 nm MWCNTs is contrary. Below 200 K the heat capacity value is significantly increased in comparison to the initial, non-ground sample. The number of walls in Ø18 nm MWCNTs is about 20 - 25 and they are more rigid than in the Ø7.2 nm MWCNTs case. Such nanotubes do not form bundles[2]. Grinding process of Ø18 nm MWCNTs increases the number of defects on the surface and the ends of the nanotubes. Thus, the observed significant increase in the specific heat of ground MWCNTs Ø18 nm may be due to an increase of the number of defects.

The heat capacity at constant pressure of MWCNTs modified by grinding and oxidation with average external diameter of Ø7.2 nm and Ø18 nm was measured in the temperature range from 1.8 to 275 K in C/T^2=f(T):

the initial nanotubes are referred as (S_i) [1],
the ground nanotubes as (S_m),
the ground-oxidized nanotubes as (S_{m-o})

The additional oxidation preceding the milling process leads to an increase of the specific heat of MWCNT in relation to the initial samples both in Ø7.2 and Ø18 nm nanotubes below ≈140 K. During the oxidation of the initial Ø7.2 nm MWCNTs in nitric acid, oxygen-containing groups are formed on the surface areas of the nanotubes with topological defects. Therefore, in ground-oxidized nanotubes, the number of formed quasi-bundles is small (formed only in the areas of nanotube contacting with surfaces with topological defects without oxygen-containing groups).

The parameters of defects change and their number increases during the grinding of oxidized MWCNTs Ø7.2 nm and Ø18 nm. As a result the increase of the phonon density of states in the low-energy part of the spectrum and, correspondingly, an increase of the heat capacity of nanotubes of Ø7.2 nm and Ø18 nm can occur.



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REFERENCES

1. V.V. Sumarokov, A. Jeżowski, D. Szewczyk, M.I. Bagatskii, M.S. Barabashko, A.N. Ponomarev, V.L. Kuznetsov, S.I. Moseenkov, "The low-temperature specific heat of MWCNTs", Low Temp. Phys. **45(3)**, 347–354, (2019).
2. A.V. Eletskii, "Mechanical properties of carbon nanostructures and related materials", Usp. Phys. Nauk. 177(3), 233–274 (1007)

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