Specific heat of rhombohedral C_{60} polymer in the temperature range of 2-300K

M. Gu, G. Cui, L. Wang ,and X. Chen

National Laboratory of Solid State Microstructures, Nanjing University, Nanjing 210093, People's Republic of China

Under high temperature of 700K and high pressure of 6 GPa, we have prepared a batch of C_{60} polymer. XRD data confirmed it is rhombohedral phase and solid ^{13}C NMR showed a formation of sp^3 bond between two neighbor C_{60} in (111) plane. We have measured the specific heat of C_{60} polymer and pristine C_{60} by means of PPMS, and the measurement proceeded in the temperature range from 2 to 300K. The experimental result of pristine C_{60} agreed well with previous report. For C_{60} polymer, above T=80K it is found that temperature dependence of the specific heat is similar to that of pristine C_{60} besides an anomaly from order-disorder phase transition at 260K, but in range from 2 to 80K the specific heat is much less than that of pristine C_{60}. Assuming three-dimensional (3D) and two-dimensional (2D) Debye phonon modes to contribute respectively to the specific heat in different temperature zone, the calculated values of specific heat have got a good agreement with the experimental data in the whole temperature range. These results show the 2D planar modes but not 3D modes are a dominator to the specific heat of C_{60} polymer, and the low-frequency intermolecular modes of C_{60} lattice are restrained in the case of C_{60} polymer by sp^3 bonds from 2+2 cycloaddition reaction.

This work was supported by grants from the MOST 973 Program of China (No. 2006CB705600), the NSF of China (No. 10674060) and the Jiangsu Province Foundation of Natural Science (No. BK2006109).