Conductivity of carbon materials at pressures 20-50 GPa

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Conductivity of fullerite C_{60}, single-wall carbon nanotubes (SWNT) and graphite have been studied at pressures 20-50 GPa and temperatures 77-400K. The kinetics of resistivity of C_{60} at changing pressure was also studied. Transport phenomena were used as a tool for revelation and interpretation of phase transitions arisen under high pressure.

Resistivity peculiarities were identified with the known phase transitions of fullerite. Successive phase transitions of fullerite C_{60} appeared in the course of HPHT treatment were accompanied by changes in resistance, which can be of quite different magnitude (from hundreds Ohm to hundreds MOhm) and of different temperature dependence. Critical pressures for the transitions depended on conditions and duration of preliminary HPHT treatment. This fact, as well as smeared character of the transitions is connected with long relaxation time, which was found to be about 140 min.

Three types of SWNT samples were investigated: samples produced by the graphite thermal dispersion method (SWNT percentage is 70%), the chemical vapor deposition method (SWNT percentage is 80%) and HiPco method (SWNT percentage is 90%).

Electric properties of the samples under high pressure were dependent on SWNT percentage. The electric characteristics of SWNT samples remained of the same character with the increasing of SWNT percentage, but the additional features appeared. The irreversible changes of the electric properties of the SWNT samples observed in the pressure range 27-45 GPa can be connected with both the structure modification and partial destruction of the sample.

In the pressure range from ~ 16 to ~ 30 GPa, the sharp change in the termo EMF value of graphite was observed. Impedance measurements of graphite were carried out at room temperature in the frequency range of 1-200 kHz. The impedance features found for all samples at pressures of ~ 18 to ~ 32GPa confirm also the existence of the phase transition in this pressure range, which is confirmed by previous data obtained at d.c. conditions. The transition is irreversible.

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