High-temperature transitions of fullerite C_{60} at moderate pressures

V.V. Brazhkin[1], A.G. Lyapin[1], V.L. Solozhenko[2], V.I. Bugakov[1], S.N. Dub[3], O.O. Kurakevych[2], and M.V. Kondrin[1]

[1] *Institute for High Pressure Physics RAS, Sciences, 142190 Troitsk, Moscow region, Russia*
[2] *LPMTM-CNRS, Université Paris Nord, 93430 Villetaneuse, France*
[3] *Institute for Superhard Materials of the NAS of Ukraine, 04074 Kiev, Ukraine*

The transitional pressure-temperature phase diagram of fullerite C_{60} (who is the metastable phase with respect to diamond and graphite) is quite complicated, since it includes the transition to polymolecular, amorphous and nanocomposite phases [1, 2]. Although the transitions of C_{60} under pressure were studied during more than one decade, there are still grey areas on the transitional diagram of C_{60}, even at low pressures. By quenching experiments, we have study transitions of fullerite C_{60} at high temperatures (1000–1600K) and low/moderate pressures (0.1–1.5 GPa) attainable for large-volume high-pressure apparatus. Particularly we have prepared a new nanocarbon phases, whose structure is drastically differs from those of nanographite phases prepared from C_{60} at high temperatures at pressures 1.5-10 GPa. The study of the structure (x-ray diffraction and TEM), EELS spectra, Raman spectra, hardness and elastic moduli of the new phases provides a comprehensive identification of the obtained nanostructured carbon samples. It have been shown that these materials have a high (~90%) elastic recovery, fairly high hardness $H \approx$ 10-15 GPa and record high values of the hardness-to-Young modulus ratio $H/E \approx$ 0.17-0.22. The latter shows that the observed hardness value is close to the “ideal” limit of the H/E ratio. The nanostructure of the new carbon materials is thought to represent a combination of interlinked curved fragments of the C_{60} molecules and nanographite nuclei.

[1] B. Sundqvist, *Advances in Physics* **48**, 1 (1999).
[2] V.V. Brazhkin and A.G. Lyapin, *New Diamond and Frontier Carbon Technology* **14**, 259 (2004).