

# Mechanical and structural features of catalytically polymerized three-dimensional C<sub>60</sub>

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We observed the effect of high (to 80 GPa) pressure, catalyst (CS<sub>2</sub>) [1] and laser irradiation [2] on the process of three-dimensional (3D) polymerization of fullerene C<sub>60</sub> and the mechanical properties of the 3D C<sub>60</sub> samples. The studies were carried out using resonant Raman spectroscopy and piezospectroscopy, high resolution transmission electron microscopy, x-ray diffraction, x-ray photoelectron spectroscopy. We have revealed that the 3D C<sub>60</sub> structure consists of at least two types of clusters formed by covalent bonds with a different set of force constants, while C<sub>60</sub>, as one of the elements of the 3D C<sub>60</sub> structure (clusters), are preserved at least up to a pressure of 80 GPa. The intensity of Raman scattering depends on the wavelength of the exciting radiation (resonance effect) and a set of force constants: the higher their values, the shorter-wavelength exiting radiation is required for Raman scattering observation by such clusters. Clusters with bulk moduli from 454 to 644 GPa are formed depending on methods of C<sub>60</sub> polymerization. According to the set of clusters, 3D C<sub>60</sub> samples with bulk moduli from 506 to 608 GPa were obtained.

[1] Popov M, Mordkovich V, Perfilov S, Kirichenko A, Kulnitskiy B, Perezhogin I and Blank V 2014 *Carbon* **76** 250–256

[2] Popov M, Churkin V, Kirichenko A, Denisov V, Ovsyannikov D, Kulnitskiy B and Blank V 2017 *Nanoscale Res. Lett.* **2** 561