Synthesis of Superhard and Ultrahard Materials by 3D-polymerization of C_{60}, C_{70} Fullerenes Under High Pressure (15 GPa) and Temperatures up to 1820 K

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Solid fullerenes C_{60} and C_{70} have been treated at high pressure of 15 GPa and high temperatures of 520 – 1820 K for a time of exposure of 60 s and a quenching rate of 300 K s^{-1} using a toroid-type apparatus. X-ray diffraction and Raman spectra confirm the realization of 3D-polymerized phases in these solids at 15 GPa. The pressure/temperature maps of synthesis of metastable carbon phases on the basis of C_{60} and C_{70} have thus been extended to 15 GPa. The longitudinal and shear sound wave velocities were measured by acoustic microscopy techniques. A maximum sound wave velocity of $(21 \pm 1) \times 10^5$ m s^{-1} was observed in the sample synthesized from C_{60} at T = 1170 K. The elastic constants were calculated using experimental data. The acoustic microscopy images of experimental samples have been investigated.

Key words: Fullerenes, High Pressure, X-ray Diffraction, Raman Spectra, Elastic Properties, Superhard Materials