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

Vladimir D. Blank$^a$, Sergei G. Buga$^a$, Gennadi A. Dubitsky$^a$, Nadejda R. Serebryanaya$^{a,b}$, Vyatcheslav M. Prokhorov$^a$, Boris N. Mavrin$^b$, Victor N. Denisov$^b$, Leonid A. Chernoza-tonskii$^c$, Sofia Berezina$^d$, and Vadim M. Levin$^e$

$^a$ Technological Institute for Superhard and Novel Carbon Materials, Centralnaya St. 7 a, Troitsk, 142190 Russia
$^b$ Institute of Spectroscopy of the Russian Academy of Sciences, 142190 Troitsk, Moscow region, Russia
$^c$ Institute of Biochemical Physics of RAS, 117977, Moscow, Russia
$^d$ Department of Physics, University of Zilina, 010 26 Zilina, Slovakia
$^e$ Center for Acoustic Microscopy, Russian Academy of Sciences, Kosygin St. 4, Moscow, 117334 Russia

Reprint requests to Prof. Dr. S. G. Buga. E-mail: buga@ntcstm.troitsk.ru

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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