Diamond and nanodiamond new obtaining method in its metastable region: autoepitaxial growth from liquid carbon

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The possibility of diamond and nanodiamond epitaxial growth on the diamond substrate from the liquid carbon in the isobaric gas-static conditions with 30 MPa pressure has been experimentally demonstrated for the first time. Liquid carbon was obtained as the result of the laser melting of the microdisperse graphite islands held by the adhesive on the substrate - the edge of natural diamond crystal. The diamond original surface was formed by pyramidal growth hillocks, with steps oriented along the edges of the octahedron (111), as well as the tetrahedral cavities – trigons. Trigons are known to be strictly oriented in the direction opposite to the octahedron edge and are formed as the result of the peculiar growth discordance. Remelted island surface is the well known cobble structure [1] consisting of graphite densely packed hexagonal crystals and strikingly different from the flaky structure of the islands before melting. In the solidified carbon from the contact area of the liquid carbon and the substrate transparent crystal particles and films were detected, protruding above the original diamond.

The surface of the particles also had the form of "cobble" due to the different types of instabilities in the growth process, but the "cobbles" was the flattened octahedral-faceted crystals having the characteristic lateral dimension of about 100 nm and thickness 100-200 nm. Raman spectrum of the particles contains diamond narrow line 1332 cm^{-1}, as well as graphite lines: *D*-line (1349 cm^{-1}) and shifted to the 1589 cm^{-1} *G*-line with intensity ratio $k = I_D/I_G \approx 0.8$. The *G*-line shift and the value of *k*, however, correspond to the strongly disordered nanographite with crystallite size ~ 5 nm [2]. Therefore, the particles are characterized by the line 1332 cm^{-1} and have the diamond structure. Orientation of the particles on the diamond substrate surface was similar to the trigon orientation, that indicates the autoepitaxial growth character.

The transparent films have a thickness of 10-20 nm. Nanodiamond structure was identified by the Raman line 1320 cm^{-1} and *G*-line shift to the 1576 cm^{-1}.

[1] Kawasaki M, Onuma K., Sunagawa I., *J. Crystal Growth* **285**, 188 (2003).
[2] Ferrari A.C., Robertson J., *Phys. Rev. B,* **61**, 14095 (2000).