

Instability of diamond in the pressure range of 55-115 GPa

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Keywords: High Pressure, Carbon, Onions, Raman Spectroscopy

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In this study, we present results of experiments on transformations of the 25 nm diamond under high pressure conditions. On the basis of experimental data, we have recently proposed a new phase diagram of carbon with a region of diamond instability in the 55–115 GPa pressure range [1].

We used a diamond anvil cell (DAC) for our high-pressure study. Pressure was measured from the stress-induced shifts of the Raman spectra from the diamond anvil tip.

To study the diamond stability, we used a diamond with a mean crystal size of 25 nm produced at the Microdiamant AG (Lengwil, Switzerland). The mixture of 25 nm nanodiamond and 25 wt % of NaCl as a pressure-transmitting media was placed in the gasket hole. The Raman band of the diamond loaded in a NaCl medium to 52 GPa is located at 1483 cm⁻¹, which is appropriate to the known data. The stress tensor conditions in the diamond sample differ from the ones in the diamond anvils, so the Raman band of the diamond loaded between the anvils is separated from the Raman band of the diamond anvil. An increase in pressure from 52 GPa to 57 GPa leads to the disappearance of the diamond Raman band (Fig.1) under the influence of laser radiation.

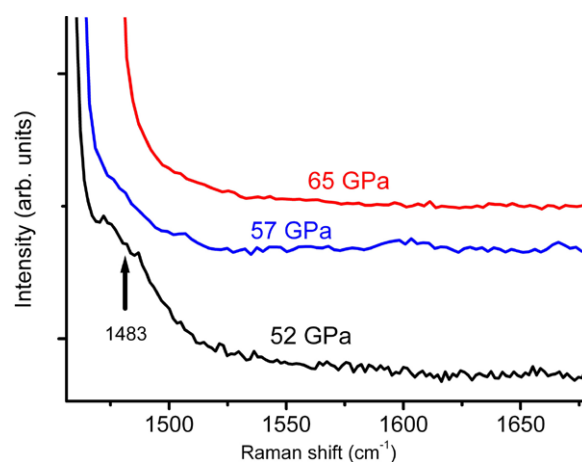


Figure 1. Raman spectra of the 25 nm diamond under a 52 GPa pressure, and the disappearance of the Raman band under 57 GPa [2]

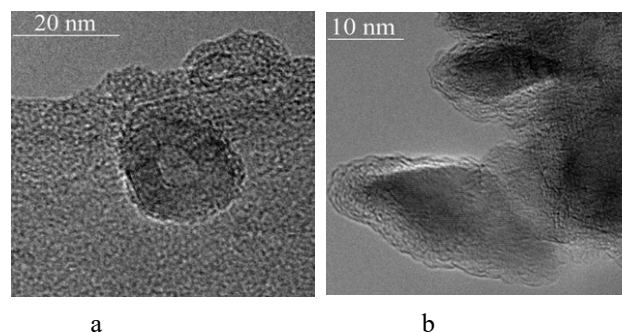


Figure 2. Onion created from 25 nm diamond under 57 GPa (a) Onion-like structures with nanodiamond nuclei (of around 5 nm) created from 25 nm diamond under a 70 GPa pressure (b) [2]

The diamonds irradiated at a pressure of 120 GPa are preserved without any noticeable changes in the phase composition. The diamonds irradiated at 57 and 70 GPa are transformed into onions. Figure 2(a) depicts onion created from diamond under 57 GPa, and the onion-like structures with nuclei of 5 nm nanodiamonds in the center obtained under laser radiation at a 70 GPa pressure (Fig. 2(b)). The latter structure could be also considered as 5 nm nanodiamonds covered by a few graphitized layers of carbon created from a 25 nm nanodiamond. Nevertheless, comparison of Figures 2 and 3 prompts consideration of the structures presented in Figure 3 as onion-like structures with nuclei of 5 nm nanodiamonds in the center.

Acknowledgments: This work was supported by the Ministry of Education and Science of the Russian Federation (project ID RFMEFI59317X0007; the agreement No. 14.593.21.0007); the work was done using the Shared-Use Equipment Center “Research of Nanostructured, Carbon and Superhard Materials” in FSBI TISNCM.

[1] Blank V., Churkin V., Kulnitskiy B. et al. Phase diagram of carbon and the factors limiting the quantity and size of natural diamonds // *Nanotechnology*. 2018. V. 29. P. 115603 (1-8)

[2] Blank V., Churkin V., Kulnitskiy B. et al. Pressure-Induced Transformation of Graphite and Diamond to Onions // *Crystals*. 2018. V. 8. P. 68 (1-8)