Self-organization of detonation nanodiamonds after treatment by high-energy methods

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The use of achievements of nanotechnology in the real production is impossible without the development of processes for the production of nanomaterials in sufficient quantities. A successful example of such technology is the synthesis of detonation nanodiamonds (DND) with a particle size of 4 nm. Diamonds have a unique combination of high chemical, thermal and radiation resistance, the highest hardness and wearresistance among the known substances, low coefficient of thermal expansion and etc. [1].

In this paper, three effective methods of exposure to water suspension of nanodiamonds are considered: ultrasound (device UZDN-1 with the working frequency of 22 kHz and 44 kHz), cavitation (a rotating wedge with a frequency of 10-20 000 r/min) and laser radiation (femtosecond laser Tsunami, the wavelength of 800 nm, capacity 840-860 Mw). Time of exposure ranged from a few seconds to several minutes. Control of the size distribution was carried out by the "CPS Disc Centrifuge Model DC 24000".

After carrying out of experiments, in which intensity and exposure time each method are varied, the comparative analysis was made. This analysis showed that the most efficient and productive method of disintegration is the cavitation. The size of the primary diamond crystal is 4-5 nm.

After carrying out of works on the disintegration of nanodiamond agglomerates in water suspension by means of laser radiation it was found that the laser radiation promotes not only the destruction of aggregates, but also stimulates the formation of regular structures.

Laser treatment, in contrast to the other methods, leads to the growth of three-dimensional structures resembling the form of "baskets" from the primary DNA. The analysis of the AFM images shown, that at the deposition on a substrate of concentrated suspensions are formed aggregates (clusters) of a large number of nanodiamond particles, whose size is in the range from 20 up to 270 nm.

The further researches are conducted to specify the mechanism of the observed phenomena and the influence of external factors on the process of stimulation and self- organization processes control of DNA and properties of these structures.

[1] Lyamkin A.I., Petrov E.A., Ershov A.P., Sakovich G.V., Staver A.M., Titov V.M., *Dokl. Acad. Sci. USSR* **302**(3), 611 (1988) (in Russian).