Deagglomeration of detonation nanodiamonds. Problem and its decision

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It is well known that a commercial powder of detonation nanodiamonds (DND) and their aqueous suspensions consist of 100-200 nm agglomerates of 4 - 5 nm crystalline diamond grains [1]. We have recently submitted a method for production of stable mono-disperse hydrosol of 4 nm isolated DND particles [2]. The method includes deep purification of initial industrial DND with ESR control of residual metal impurity, annealing of the purified DND in air, ultrasonic dispergation in water and centrifugation. We have also confirmed effect of DND deagglomeration after annealing in hydrogen atmosphere suggested last year in [3], however we revealed that zeta potential was negative in that case.

In all cases the annealing of nanodiamond and the chemical treatment of surface were needed for the deagglomeration. The size distribution of DND particles with maximum around 4 nm confirmed by DLS method as well as AFM of DND particles deposited from suspension on silicon substrate.

We have experimentally verified our idea suggested in [2] that penetration of water into nanopores of DND agglomerate during centrifugation generates a sizable capillary pressure and this pressure results in DND deagglomeration, however our attempt to get the deagglomeration of DND in water under high pressure did not confirm the idea.

Here we proposed two new possible explanations of deagglomeration of nanodiamonds. The first hypothesis is destruction of bonding chemical groups on the surface of the nanodiamond grains at the annealing. The second one is the destruction of interparticle bonds in agglomerates due to accumulation of defects at interfaces of grains. In the second case we believe that concentration of defects at the interfaces increases due to migration of defects from core to surface during the annealing.

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