A Low Temperature Separation of Nanodiamonds Hydrosols

Gubarevich T.M.

Institute of Physics of National Academy of Science, 220072 Minsk, Belarus

During working with nanocarbon particles, a task of concentrating and analyzing of highly stable hydrosols as well as a task of isolating from them the particles in pure state often arises. It is especially difficult to isolate quantitatively the particles of nanodiamonds, which are completely disaggregated and stabilized by surface-active substances (SAS). For such hydrosols with concentration of nanodiamonds lower than 0,1 g/l the methods of centrifuging or membrane filtrating (direct and tangential) are not effective. Concentrating by evaporation of part of the liquid, as well as precipitation with coagulants leads to undesirable contamination of nanomaterial. For these cases a simple and convenient method of freezing of hydrosols appears to be practical.

Behavior of nanodiamonds hydrosols and diamond-containing soot hydrosols during freezing under controlled conditions was studied. The range of nanoparticles concentrations was 0.001-0.1 g/l, pH values of hydrosols varied from 3.5 to 9.5. Non-ionic type of SAS was used.

Hydrosols of nanodiamond were put into plastic vessels and cooled with given speed till a complete crystallization of water. As known, during crystal growth a substance tends to seize foreign elements, both soluble and insoluble, and chemists have used this property for purification of substances by recrystallization. In our experiments on hydrosols freezing the segregation of the hydrosol's components (water, diamond particles, adsorbed gases and SAS) was observed as a result of water crystallization. At the same time characteristic volume structures were formed, namely radial tracks, formed by bubbles of gases (dissolved in water and adsorbed on particles surface), layered structures, formed by SAS, and "diamond kernel", where more than 95% of disperse phase of hydrosol were concentrated. Under optimal conditions of freezing, the most volume of water crystallizes in a pure state that allows, using consequent melting of an ice, to separate concentrate of nanoparticles from the excess of liquid and main amount of SAS. Macro- and micro-photos illustrate the process of hydrosols freezing and melting.

Particles of nanodiamonds after freezing are in aggregated state. Aggregation is caused by concentration reasons, namely by the fact that water as a liquid was almost removed from solvate shells of the particles. Freezing in this case is similar to drying, however strength of "frozen" aggregates is much lower comparing to dry powders. After the procedure of freezing, nanoparticles are easily and completely sediment, fall out on filters, and can be washed (if necessary) with water or other solvent without loses.