

**(Nanocomposites and nanomaterials)**  
**Properties of diamond nanopowders and carbon tubes modified  
by oxide iron**

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At present, the studies connected with application of diamond nanopowders and carbon tubes in medicine become wider. The opportunity to change the magnetic properties of carbon nanomaterials increases the ability of their application in medicine as carriers of medical products. In this connection obtaining of diamond powders and carbon tubes with different magnetic properties is an actual problem.

The research was carried out on nanodiamonds of marks ASUD-95 and ASUD-75 and on carbon tubes produced by firm "ALIT", received by method of sedimentation of hydrocarbons on the nickel - magnesium catalyst. The method of low temperature suspension processing of nanopowder diamond has been applied for additional surface clearing. The powders of carbon nanotubes have been additionally subjected to chemical processing to eliminate the rests of impurities of metal and graphite from the tubes surface. The fine-dispersed iron particles from water suspension of iron oxide have been coated on diamonds' nanopowders and carbon tubes.

While researching the magnetic properties on alteration of their specific magnetic susceptibility and the magnetic moment have been controlled in nanodiamonds. Measurements have been carried out on vibrating magnetometer «Vibrating Magnetometer 7404 VSM». The general content of impurities and inclusions presented as incombustible rests has been determined in the obtained nanopowders and carbon tubes. The element structure of impurities and inclusions of powders has been measured using method of X-ray fluorescence integral analysis with raster electronic microscope "BS-340" and a power dispersion analyzer of x-ray spectra "Link-860". Adsorption-structural and physical and chemical studies of the surface of powders have been carried out by a classical method of gases adsorption at low temperatures according to the BET principle with the help of gas-adsorption analyzer NOVA 2200 ("Quantachrome", USA). A hydrophilction degree has been estimated by the change of value of free energy saturation of powders' surface by water vapors.

It is shown, that pollution of surface of diamond nanopowders and carbon tubes after additional chemistry clearing is less in comparison with initial powders. It specifies lower values of the incombustible rest and the common content of impurities and inclusions. Presence of a lot of ferromagnetic impurities in initial

samples of diamond and carbon tubes specifies higher values of a specific magnetic susceptibility. These data are proved by the results of element composition of diamond nanopowders and carbon tubes.

Reduction of the impurities and inclusions content on the surface of nanodiamonds after low temperature processing promotes a specific surface of nanodiamonds marks ASUD-75 and slight reduction of a specific surface of nanodiamonds marks ASUD-95, as well as to increase the adsorption activity of nanodiamonds due to the increase of their adsorption potential. Thus, the saturation free energy of a surface by water vapors slightly increases causing the increase of hydrophilicity of powders. After chemical processing of initial carbon nanotubes the content of impurities reduces. It is testified by the reduction of the incombustible rest from 13,5 % up to 0,77 % bringing to increase of adsorption-structural characteristics and hydrophilicity of powders (saturation energy of surface of powders by water vapors). Additional chemical processing of the initial carbon nanotubes favors reduction of the content of impurities of metals - catalysts: nickel, magnesium, iron.

Surface modification of diamond nanopowders and carbon tubes has been carried out by adding of water solution of ferromagnetic powder of iron oxide ( $\text{Fe}_3\text{O}_4$ ) to water suspension of diamond and carbon tubes mixing constantly. By modification the particles of iron oxide are fixed on active parts of the surface of nanopowders due to unsaturated bonds that promotes amplification of magnetic properties of diamonds and carbon tubes.

As a result of the executed research the diamond nanopowders of marks ASUD-95 and ASUD-75 and carbon nanotubes modified by iron oxide with high magnetic characteristics have been obtained. It is shown, that after the surface modification of diamond nanopowders and carbon tubes their specific magnetic susceptibility and the magnetic moment are increased and coercive force is reduced. It is determined, that with increase of concentration of ferromagnetic powder the magnetic characteristics of nanopowder are amplified. After modification of the surface of diamond nanopowders and carbon tubes their adsorption-structural characteristics, as well as surface hydrophilicity, are reduced due to filling the surface of nanopowders with particles of ferromagnetic powder.

Thus, as a result of carrying out of modification the surface of diamond nanopowders of marks ASUD-95 and ASUD-75 and carbon nanotubes by a ferromagnetic powder as iron oxide ( $\text{Fe}_3\text{O}_4$ ) the diamond nanopowders and carbon tubes with high magnetic characteristics have been obtained which will be used by creation of magneto-sensitive compositions for application in oncology.