Physical-chemical Properties of Detonation Synthesis Nanodiamond of Different Grades

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The technology of production of four grades of nanodiamond differing in the content of sp^3–phase from one detonation synthesis product has been developed. The results of comparative analysis of nanodiamond of ACUD-75 and ACUD-99 grades with content of sp^3–phase equal to 75% and 99% accordingly are presented in this report.

Phase composition and microstructure of these materials have been studied. The studies were carried out by transmission electron microscopy methods in combination with microdefraction, roentgen fluorescent electron spectroscopy and Auger spectroscopy.

It has been ascertained by electron microscopy method that powders of ACUD-75 and ACUD-99 grades consist of plate-like formations and it has three-level structure. For first level there is an independent single-crystalline particles with size from 3-5 nm to 10-15 nm. Next level is polycrystalline aggregations of particles with size range from 10-30 nm and higher. Third level is plate-like formations of various sizes which consist of structures of first and second levels. Studied powders are differed by proportion of elements of first and second level structures.

In ACUD-99 powder samples a content of polycrystalline aggregations increases, but for all that the sizes of monocrystalline particles are not changed.

It has been ascertained by microdiffraction studies that all powders have the same phase structure; nondiamond carbon has not been detected. Thus studied powders are differed in number of dense aggregations only. It is confirmed by granulometric composition of powders too. A distribution of aggregated particle of diamond is some wider than one of diamond-carbon material.

The following principal physical-chemical properties of these powders have been studied: specific surface, density, adsorption potential, porosity, electric resistance, oxidation stability (in the air).

The analysis of results has been shown that ACUD-75 powder in comparison with ACUD-99 powder has some higher values of adsorption-structural characteristics: specific surface – by 1.10 times, adsorption and specific adsorption potentials – by 1.3 times. Surface of ACUD-75 powder is more heterogeneous, this powder has lower electric resistance. Also the ACUD-75 powder has higher porosity. It has been ascertained that ACUD-75 powder has higher activity of chemical processes. It is confirmed by thermal desorption studies. There is considerable amount of physically adsorbed water on the surface of ACUD-75 powder. It is typical of ACUD-75 powder the presence of chemisorbed atomic oxygen and CO_2. Thermal stability of ACUD-75 powder is higher than one of ACUD-99 powder (temperature of oxidation of ACUD-75 powder is 400°C and temperature of oxidation of ACUD-99 powder is 420°C).

There are endo-exo–effects in oxidation processes of diamond-carbon product as well as nanodiamond powder. The first exo-effect for these materials is connected with desorption of water vapour. For ACUD-75 powder the second maximum of exo-effect is fixed at 480°C. We suppose that this maximum is connected with oxidation of materials before CO_2 generation. For ACUD-75 powder the another two maximums of exo-effect are fixed at 630°C and 770°C, these maximums are connected with CO_2 generation too.

It has been ascertained that ACUD-75 powder isn't mix of diamond and carbon but in fact it is composite material consist of as diamond as transition ("imperfect") forms of diamond. The ACUD-75 powder due to the fact that it has high adsorption activity and low cost price is very promising material in the near future.