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THERMAL VACUUM PROCESS FOR OBTAINING NANO-DISPERSED MATERIALS

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An actual problem of physics is development of scientific and technical principles of creating nanostructured materials for the needs of modern technology.

On the basis of the performed theoretical and experimental studies, an energy-efficient pulse-shock thermal vacuum method for continuous production of nanodispersed materials had been developed. The method is based on the principle of combining high-speed processes of both evacuation and thermal heating to a predetermined temperature, which last occurs during direct contact of the initial powder material with the inner surface of a hollow heater [1].

For the closest contact with the starting powder material, the heater is made in the form of a helical spiral. The physical principle of this technique is that the decrease in pressure inside the heating element, produced by a vacuum pump, creates a gradient that stimulates an intense turbulent flow of powder and effective contact of particles with the inner surface of the heater.

A high temperature gradient in such a contact promotes creation of high stresses in them, which stimulates the process of their crushing.

Use of filters in this process makes it possible to better extracting the highly dispersed phase.

Thermal vacuum process was applied to obtain nanodispersed graphite [2]. The original C1 grade graphite powder with a particle size of 1...2 mm was subjected to thermal vacuum treatment, as a result of which the particle size decreased to a value from 2 to 40 nm.

A study of the structure of the obtained powder was carried out. For this, X-ray analysis and electron microscopy were used.

According to the results of X-ray diffraction studies, grade C1 graphite after processing in the thermal vacuum installation retains its original structure in the form of two known modifications: hexagonal one with lattice periods $a_o = 0.2461 \pm 0.0002$ nm, $c_o = 0.6705 \pm 0.0007$ nm, and about 30% rhombohedral one with periods $a = 0.2461 \pm 0.0001$ nm and $c = 1.003 \pm 0.0002$ nm. In addition, in small amounts, a superstructural rhombohedral phase with periods $a = 2a_o = 0.492 \pm 0.0001$ nm and $c = (3/2)c_o = 1.003 \pm 0.0002$ nm was found [2]. A phase with a monoclinic structure was also found with parameters $a = 0.6075 \pm 0.0001$ nm, $b = 0.4477 \pm 0.0002$ nm, $c = 0.4913 \pm 0.0003$ nm, and $\beta = 99.6 \pm 0.1°$ – presumably, with the presence of iron atoms in the structure.

The results of the analysis and calculations are generally consistent with TEM images of the reciprocal lattice of the processed graphite [2].

The continuous thermal vacuum process for obtaining a highly-dispersed powder of zirconium dioxide from zirconium hydroxide is also considered [3].

As a result, it can be noted that the described combination of physical processes makes it possible to obtain highly-dispersed powders in one cycle near 10...20 s. Use of filters makes it possible to extract fractions with a particle size of ~2 nm and a product yield of at least 50% [2, 3]. In this case, one can modify structure of material.

The described thermal vacuum method significantly reduces the technological process and its energy consumption, and it can be used for continuous and energy-efficient production of nanomaterials, as well as for drying dispersed materials.

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INFLUENCE OF DEUTERIUM PLASMA IONS ON $ZR_{57}CU_{15.4}AL_{10}NI_{12.6}NB_5$ AMORPHOUS ALLOY [1]

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The aim of this work is to study effects of an intense action on metal glasses – in this case, on the $Zr_{57}Cu_{15.4}Al_{10}Ni_{12.6}Nb_5$ alloy – of deuterium plasma particles of several tens of eV. The peculiarity of this approach reflects more closely some problems of thermonuclear energy than diffusion and even electrochemical saturation with hydrogen or deuterium.

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Blessed memory of Vladimir Sergeevich Voitsenya Doctor of Science, ideological leader of the work.