ELECTROSPARK METHOD OF OBTAINING NANOPOWDERS*

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The development of energy-saving, environmentally-friendly methods for obtaining nanopowders of various substances is an urgent issue of modern science. This is due both to the practical need for the creation of nanomaterials, which are widely used nowadays due to their uniqueness, and the fundamental need to understand the processes that occur in the preparation and application of nanoparticles by various methods [1-2].

In work the electrospark method is used to synthesize metallic nanocomposite. The following components were included: an electrode system; movement system; system for measuring processing parameters (oscillograph and current sensor, high voltage voltage divider, manovacuum meter); source of current pulses; vacuum system (vacuum pump, gas cylinders with working gas, gas routes, gas cranes). The peculiarities of the installation are the application of the power supply circuit from two generators, working on one interelectrode gap. The generator consists of three main units: low-voltage part, high-voltage part, control system. The high-voltage part of the generator is designed to form the initial spark channel. The low-voltage part of the generator serves to transfer the energy of the capacitor to the spark channel. The generator control system is designed to synchronize the high-voltage and lowvoltage parts of the generator. The main parameters of the generator: a) high-voltage part: pulse duration 1 μs, pulse amplitude 18 kV, pulse energy 0.01 J; b) low-voltage part: duration of low-voltage pulse 5..100 μs, stored energy 0.1..0.6 J, frequency 0.1..5 Hz.

The essence of the electric spark method of obtaining nanoparticles is as follows: a metal plate (copper, zinc, iron), which is an electrode, will be located in the chamber. After the preliminary pumping, the gas cuvette is filled with gas (argon, nitrogen, air), depending on the type of compounds synthesized. At the end of this, the pulse generator is started, simultaneously with it the system of movement of the metal plate automatically turns on. The process of nanoparticle production begins. At the end of this process, the generator switches off automatically, and the movement system returns to the starting point. The method for obtaining nanoparticles is based on the use of the energy of an electric spark discharge, formed between the electrode and the target. When a voltage pulse is applied between the electrode and the target surface, a plasma channel of a spark breakdown is formed with an initial diameter RK ~ 0.1 mm. The current flowing through the channel heats it, the pressure in the channel rises, the channel expands. The plasma temperature reaches values of $3.8 \cdot 10^4$ °K, the energy flux density in this case is 10^6-10^9 J/m^2. As a result of the action of a concentrated energy flux on the target, a rapid local overheating of the surface leads to sublimation of the material. Under the influence of gas dynamic forces, the target material is removed from the discharge region where the nanopowder is condensed and formed, and due to the special design of the electrode system, the formed nanopowder is deposited in a special trap. As a result, the resulting nanopowder will obtain a composition identical to that of the target, or an oxide corresponding to the material of the electrode. Sedlating materials will be used as targets for the research: steel (st3), copper, zinc. The use of an electrode tool with an erosion coefficient smaller than that of the target will allow synthesizing a nanomaterial that has the chemical composition of both electrodes used. The energy in the plasma channel is sufficient for the plasmochemical process to proceed, as a result of which it is possible to form composite nanomaterials with a solid solution. An additional regulator of the properties of synthesized nanoparticles can be the composition of the gas phase used in the production process. The properties of the resulting nanomaterials evaluated by IR analysis, transmission electron microscopy, X-ray dif-fraction analysis, BET surface area analysis, TG/DSC/DTA thermoanalysis.

REFERENCES

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