GENERATION OF ZINC OXIDE NANOPARTICLES IN A GLOW DISCHARGE AT ATMOSPHERIC PRESSURE*

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Abstract: The paper presents a study of the features of discharge at atmospheric pressure in an inert gas jet generating plasma flows with a high content of metal particles in the context of obtaining aerosols with a high content of nanoparticles of zinc oxides, as applied to obtaining nanosized powders and coatings based on them. It is shown that the most suitable is the operation of a low-current discharge at atmospheric pressure in the glow discharge mode, which remains an insufficiently studied physical phenomenon to date. Emission of metal atoms from the surface of the molten zinc cathode insert occurs as a result of heat flux from the cathode layer of the discharge and gasdynamic interaction of the working gas jet with the molten metal. The main electrophysical and optical characteristics of the discharge included the following parameters: cathode material — zinc; discharge voltage 150–300 V; current 500–600 mA; pulse duration 9–12 μs with frequency 60–100 kHz in argon flow at a flow rate of 1 l/min. The presence of particles of cathode materials was confirmed by ionic and atomic lines of zinc, which were in the emission spectrum and were clearly distinguishable against the background of lines of argon atoms (Ar I). Based on the discharge with such parameters, the generation of powders of zinc oxide with particle sizes from 10 to 50 nm was carried out as a result of emission of combined gas–metal flows from discharge plasma through the anode orifice into the surrounding air. This led to their cooling, adhesion into nanosized agglomerates, and oxidation upon interaction with oxygen. Prospects for further development of this method of nanopowder synthesis and possibilities of increasing its productivity are discussed.

Keywords: glow discharge; atmospheric pressure; gas-discharge plasma; metal atoms; metal ions; radiation; nanoparticles

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Figure Captions

Figure 1 Sketch of nanopowders source based on glow discharge at atmospheric pressure

Figure 2 Optical emission spectrum of glow discharge plasma radiation at atmospheric pressure in an argon jet with a zinc cathode insert

Figure 3 Waveforms: discharge current (*a*) and anode currents of the photomultiplier initiated by radiation of zinc atoms Zn I with a wavelength 334.5 (*b*), 468.01 (*c*), and 636.23 nm (*d*), and argon Ar I at a wavelength 811.5 nm (*e*)

Figure 4 Specific erosion of zinc in a glow discharge at atmospheric pressure vs. the argon consumption at an average power of 70 W

Figure 5 Bright-field (*a* and *b*) and dark-field (*c* and *d*) transmission electron microscopy (TEM) images of the structure of zinc-based particles synthesized using a glow discharge at atmospheric pressure. The inset (*a*1) shows a high-resolution image

Figure 6 Microdiffraction patterns of zinc oxide ZnO nanoparticles agglomerates obtained by TEM of the nanoparticles

Figure 7 Nanodiffraction patterns of separated zinc oxide ZnO nanoparticles obtained by TEM

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