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OBTAINING NANO-SIZED FUNCTIONAL MATERIALS IN PLASMA DISCHARGES IN LIQUIDS UNDER THE EFFECT OF INTENSIVE ULTRASOUND *)

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This work is devoted to the study of plasma-chemical processes determined by the combination of the effect of thermally nonequilibrium low-temperature plasma and intensive ultrasonic vibrations in the regime of intensive cavitation on liquid-phase media. This method for realization of plasma-chemical transformations has been proven to be of significant interest and advantages for the creation of new nano-sized materials with special properties, because it allows to vary the electrophysical and acoustic characteristics of the process when carrying out plasmachemical reactions. A practical consequence of solving this problem is the creation of a method for the targeted synthesis of significant substances. A distinctive feature and significant advantage of this method is that the simultaneous exposure of the reaction zone to thermally nonequilibrium plasma and ultrasonic cavitation leads to the creation of conditions that are unattainable in other cases and causes reactions to occur at high local concentrations of energy and active particles.

It was found that in such an acoustoplasma discharge it is possible to synthesize nanoparticles of metals and their oxides of various compositions, including nanoparticles of polymetallic oxides. In this case, the size of the primary nanoparticles was at the level of 2–50 nm depending on the material. With application of intensive ultrasound, it was possible to obtain narrow size fractions of nanoparticles. The experiments also revealed the possibility of synthesizing nanoscale core-shell materials.

Examination of the optical properties of synthesized nanomaterials allowed us to conclude that nanoparticles synthesized in a plasma discharge under the influence of ultrasonic cavitation have higher luminescence intensity compared to particles synthesized in a discharge without cavitation. In an aqueous suspension of nanoparticles synthesized in an acoustoplasma discharge, stimulated low-frequency Raman scattering was recorded, resulting from the interaction of laser pulses with acoustic vibrations of nanoparticles. The resulting suspensions of metal nanoparticles (including noble ones) and their oxides were used as alternative optical media for wavefront reversal, operating at laser pumping levels well below the threshold for stimulated Mandelstam-Brillouin scattering.

Further studies in this direction have shown that nanoparticles of various compositions synthesized under such conditions have an activated surface with a large number of uncompensated bonds and defects as a result of the action of intensive ultrasound and thus capable to effective interaction with organic and inorganic compounds, matrices, etc., allowing one to create new hybrid organic–inorganic composite materials.

*) abstracts of this report in Russian