Laser ablation and fragmentation of nanoparticles in liquid, electrostatic and magnetic fields for biomedical applications

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Abstract

Research in the direction of synthesis and application of spherical metal nanoparticles and compounds based on them is actively developing in biomedical applications. In this paper, we present the results of using various methods of laser ablation and fragmentation for the synthesis of nanoparticles. Laser ablation synthesis was carried out on the developed experimental equipment using liquid and gas media. At the end of the ablation process, the target was removed from the resulting solution. If necessary, fragmentation of the obtained material was carried out to achieve the necessary properties of the colloidal system in size, chemical and phase composition.

Materials obtained during ablation in a gas medium were deposited on the surface of the substrates under the action of an electrostatic or magnetic field. The obtained nanoparticles MoS2, WS2, ZnS, ZnSe, Al2O3, Ti, Fe, Fe2O3 were analyzed using electron microscopy, Raman spectroscopy, X-ray diffraction analysis and other methods. A complex of studies of the physicochemical properties of nanoparticles allowed us to evaluate their characteristics such as shape and size, morphology and surface composition. The optical properties of the obtained colloidal solutions were investigated by spectrophotometry.

The experiments were carried out on a laser robotic complex based on the Yb:KGW femtosecond laser system (Avesta Ltd.), generating pulses with a duration of 280 fs at a wavelength of 1030 nm with a repetition frequency of 10 kHz and a maximum pulse energy of 150 μJ. This complex has a modular structure, which allows the use of various additional nodes included in the optical schemes of exposure and processing of materials by femtosecond laser radiation.

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