Nanocomposites and nanomaterials
Film structures based on nonspherical gold nanoparticles for surface enhanced Raman spectroscopy (SERS)

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In the era of rapid development of nanotechnology various types of nanoparticles, including gold nanoparticles (Au NP), present considerable interest. Great attention is attracted to nonspherical Au NP due to the possibility of adjusting the plasmon resonance to a certain frequency. Due to the nonspherical morphology of Au NP, namely the presence of sharp ends, on which there is a significant electric field strength increasing caused by the excitation of delocalized valence electrons by the electromagnetic wave, films based on nonspherical Au NP can be used as SERS substrates. In this case, an important condition for the creation of film structures is to provide film surface cleanliness, uniformity in size and shape, the absence of Au NP aggregated fraction on the film surface.

The aim of the work was to develop techniques for obtaining film structures based on Au NP of different morphology and size for creating effective SERS substrates, studying their properties, establishing the relationship between Au NP morphology and their properties. One of the effective methods of films producing is template synthesis, which allows to control the filling density of the substrate by Au NP. Stable monolayer film structures based on Au nanoellipses and nanostars with an average NP size in the range of 20-70 nm and 20% size dispersion were obtained. Characterization of the obtaining films (structure, composition, size, optical properties) was carried out by electron microscopy, X-ray photoelectron spectroscopy and optical spectroscopy. It was shown that the Au NP shape significantly influences on the optical properties of the obtaining film structures. In the case of films based on Au nanoellipses, the surface plasmon resonance (SPR) maximum is in the region of 530 nm, for the Au nanostar based films, the SPR peak is in the region of 620 nm. It was shown that films based on Au nanoellipses and nanostars are effective SERS substrates: the enhancement factor of Rhodamine 6G Raman signal reaches 10^5-10^6, dye concentration is 10^{-5} M.