LASER INDUCED AU-CU AND AU-AG NANOPARTICLES DEPOSITION

Anastasia Povolotskaya¹, Alexey Povolotskiy², Alina Manshina²

¹Department of Physics, St.-Petersburg State University, St.-Petersburg, Russia
²Department of Chemistry, St.-Petersburg State University, St.-Petersburg, Russia

The project is focused on extension of the Laser-induced chemical liquid phase deposition (LCLD) method for creation of more sophisticated structures with wider functional properties - Au-Cu, Au-Ag nanoparticles. In the LCLD method the laser initiates the chemical reducing reaction on the liquid-solid interface [1-3]. The laser focal volume determines the volume of this reaction what results in the localized submicron metal deposition. Also this method permits controlling width, morphology and resistance of metal structures as a result of variation laser power, temperature of solution and other parameters of deposition. The laser-assisted chemical reaction yields deposition of the structures on the substrate with high degree of adhesion. This method is characterized by technological efficiency, chemical safety and low-price equipment.

This metallization technology can be successfully used in the microelectronics industry for the creation of the electrodes the metal conductors on the microchips, in the display technologies for the production on flexible polymer monitors and keyboards, creation micro thermocouples and so on.

Up to now the LCLD method was successfully realized for precipitation of such metals as Cu, Ni, Pd, Ag on several kinds of semiconductors and insulators such as Si, Ge, GaAs, polymers and so on. It is worth stressing that directed variation of the metal phase composition is another degree of freedom in modification of the deposited metal phase properties, which substantially broaden both metal phase characteristics and potential areas of their applications. That is why deposition of heterometallic structures including nano-alloys is an extremely topical problem.

The interest of modern science and technology to metallic nanoparticles is stimulated by their multifaceted applications in different areas such as electronic industry, medicine, photonics, catalysis, sensing technology, etc. Unique physicochemical properties of metal nanoparticles make them promising objects for Surface Enhanced Raman Spectroscopy (SERS) and Localized Surface Plasmon Resonance spectroscopy (LSPR), at that special attention is paid to bimetallic gold-silver, gold-cupper nanoparticles. The interest to Au-Cu and Au-Ag nanoparticles is induced by their pronounced catalytic activity, luminescence and photovoltaic properties. Variation of the size, shape and spatial distribution of the nanoparticles allows regulating surface plasmon resonance (SPR) in wide energy range.

In the project the of problem of heterometallic structures creation is supposed to be solved on base of innovative approach: realization of the photo induced deposition process from liquid phase based on supramolecular complexes which designed and synthesized at Saint-Petersburg State University [4]. The supramolecular complexes consist of the central bimetallic cluster core (Au-Cu, Au-Ag) with direct metal-metal bonds, stabilized by the alkyln ligands acting as reducing agent. The complexes have unique properties such as pronounced photosensitivity, possibility of the bimetallic cluster variation (change of metals ratio and total volume) and modification of ligand fragments. The Au-Cu and Au-Ag ratio change allows directed control of the deposited phase composition, ligand modification results in change of photosensitive properties – complexes stability and spectral position of the absorption bands. It should be noted that the size of the central bimetal core is about 1-3 nm what tends to formation of deposits with nanostructured morphology.

The aim of this project is realization of photoinduced process of heterometallic nanoparticles deposition from solutions of supramolecular complexes under the laser radiation and investigation the precipitation mechanisms. It is supposed that the heterometallic nanoparticles (at different deposition parameters (dose of laser radiation) and chemical composition of liquid phase (type of supramolecular complexes and kind of solvent)) created at St. Petersburg State University, Russia.

References