Nanocomposites and nanomaterials

Dynamics of metal nanoparticle colloid production by femtosecond laser ablation

Y.V. Shynkarenko, A.M. Dmytruk

Department of photonic processes, Institute of Physics, National Academy of Sciences of Ukraine. Prospect Nauky, 46, Kyiv-03028, Ukraine.
E-mail: y.shynkarenko@gmail.com

Femtosecond laser ablation is known as chemically clean method of generation of nanoparticle colloids. In this paper, the results of production of water suspensions of Au and Ag nanoparticles by means of femtosecond laser ablation from corresponding solid targets in water are presented. Water with different pH and surfactant (SDS) concentrations was used as a solvent. The aim of this study was the investigation of not only the obtained suspensions properties, but also of the dynamics of mass transfer from solid target into the solution.

We used Ti:Sapphire laser with regenerative amplifier that produced laser pulses of 1 mJ at 800 nm with 1 kHz repetition rate. Pulse duration was varied between 150 fs and 2 ps by means of optical compressor after regenerative amplifier. Pure metal (99.9%) target was placed on the bottom of a glass cuvette, water level was 1 cm above the target. Laser irradiation was focused by the lens with focusing length of 15 cm. Peristaltic water pump was used to uniformly distribute produced nanoparticles among the solution. Optical absorption spectra were measured every 5 seconds with Acton SP-2500i CCD matrix spectrometer.

Stretching of the laser pulses leads to faster ablation of the material due to decreasing of laser pulse scattering in plasma. Laser pulses interact not only with solid target but also with colloidal solution, leading to fragmentation of already produced nanoparticles. Stability and mean size of nanoparticles strongly depend not only on surfactant but also on water pH level.

Measurements were performed at the Center for collective use of equipment “Femtosecond Laser Complex” of National Academy of Sciences of Ukraine.