Size and temperature dependence of the surface plasmon resonance in silver nanoparticles

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The dependences of the surface plasmon energy were studied for silver nanoparticles in the size range 11–30 nm and in the temperature interval 293–650 K. The energy of SPR in silver nanoparticles embedded in silica glass host matrix depends on the size and the temperature of the nanoparticles. Our experiments exhibit the nonlinear red shift of the SPR as the size of the nanoparticles decreases. The increase of the surface scattering rate of the free electrons causes the red shift of the SPR energy as the particle size decreases. As the temperature of the sample increases, the SPR red shifts. The volume thermal expansion of the nanoparticles leads to red shift of the SPR. As the temperature of the particle increases, the volume of the nanoparticle increases and the density of the free electrons decreases. The lower electron density leads to the lower plasma frequency of the electrons and subsequently to the red shift of the SPR. The red shift of SPR with the increase of temperature is linear for large (25 nm and 30 nm) silver nanoparticles and becomes nonlinear (superlinear) for smaller nanoparticles (17 nm, 11 nm). The nonlinearity of the dependence of SPR energy on temperature becomes stronger for smaller nanoparticles (17 nm, 11 nm). These two effects can be rationalized by the dependence of the coefficient of the volume thermal expansion on the size and temperature of the nanoparticles, The coefficient of the volume thermal expansion increases when the nanoparticle size decreases and with the increase of the temperature of the nanoparticle.

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Modelling of a magnetic resonance in nanoparticles array

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Nanoparticles, possessing magnetic properties, represent appreciable interest for medicine. In our research we address to the solution of the following problems: development of the model, which describes magnetic field interaction with the magnetic nanoparticles array; and modeling of the magnetic resonance in the nanoparticles array. As a result of our calculations we have received 3D magnetization distributions, total energies and magnetic resonance spectra of separate nanoparticle and nanoparticles ensemble interacted by magnetodipole mechanism. It is established that separate nanoparticle in alternating and constant magnetic fields demonstrates the paramagnetic resonance appearing due to enhancement of magnetization oscillation. Characteristic reflexes of paramagnetic resonance for one nanoparticle in two directions are determined, as well as magnetization change along the direction of constant field. It is revealed that in system of interacting nanoparticles of variable and constant magnetic fields the dynamics of magnetization is characterized by the random process with the elements of stochastic resonance. It is shown that in the system of interacting nanoparticles with the characteristic size of 2 nm the ferromagnetic resonance (FMR) appearing at concentration of order 5e18 cm-3 upon the concentration decreases down to 5e16 cm-3 FMR is transformed into the paramagnetic resonance, characteristic for the noninteracting particles system.

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