Nanocomposites and nanomaterials

Time-dependent absorption spectra of 1D, 2D plasmonic structures obtained by the ordering of Ag nanoparticles in polymer matrix.

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Spectral-kinetic characteristics of 1D, 2D periodic nanostructures based on polymer films with silver nanoparticles (Ag NPs) were studied in the spectral range near the surface-plasmon resonance absorption (SPRA) using a femtosecond spectrometer. The Ag NPs were synthesized in the polymer matrix from a metal precursor previously included into the initial photopolymer composite and ordered by a holographic method. 2D-periodic structures (square-2DS and hexagonal-2DH) were formed with photopolymerization of an initial mixture under interference pattern created by four or three recording beams respectively. The influence of the energy and polarization of initiating laser impulse and the symmetry of periodic structure on the transient SPRA spectra and relaxation dynamics of electron excitations was discussed. Characteristic times of relaxation were measured near the SPRA maximum (450-500 nm) for 1D, 2D ordered structures of different symmetry.

It was found that induced absorption in the spectral range 450-500 nm is enhanced with the structure complication. A change of structure symmetry in a sequence 1D-2DS-2DH affects considerably the decay constants of the induced changes in the SPRA-spectra resulting in the increase of relaxation times of electronic excitations determined by both thermalization of electrons (τ_1) and interaction with a matrix (τ_2). Relaxation times were measured to be $\tau_1 = 1.8$ ps, $\tau_2 = 16$ ps for 1D structure and $\tau_1 = 2.7$ ps, $\tau_2 = 141$ ps for 2DH structure. A conclusion was drawn, that the increase of the order of symmetry and reduction of period of Ag NPs location stimulate the manifestation of the collective effects under the excitation of electronic subsystem by a powerful laser radiation.

This work was supported by the grant of the Target Comprehensive Program of Fundamental Research of National Academy of Science of Ukraine "The Fundamental Problems of Creation of New Nanomaterials and Nanotechnologies" (Project 3/15-H).