Nanocomposites and nanomaterials

Pump-probe spectroscopy studies of plasmonic structures

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After light induced excitation of collective oscillation of surface conduction electrons in nanoparticles, electron energy then decays through electron–electron interactions followed by a further relaxation via electron–phonon scattering. Influence of the media surrounding metal nanoparticle makes these processes even more complex. These processes are very important for a lot of the applications of the plasmonic nanomaterials such as photovoltaics, photosensors and biosensing. Therefore ultrafast dynamics of the excited plasmonic charge carriers remains under considerable interest.

Nanoparticles of the group IB metals such as copper, silver and gold received a significant interest as plasmonic nanomaterials. Localized surface plasmon resonance (LSPR) can be used in many areas like efficiency increase of solar cells, OLEDs, lasers, chemical and biochemical sensors or thermal effect that can be used in medicine. Silver nanoparticles as a plasmonic material have some advantages over Au or Cu nanoparticles such as higher intensity of the surface plasmon resonance, lower optical losses and larger solar energy conversion efficiencies.

In present study ultrafast dynamics of the Ag nanoparticles and Ag nanoparticles embedded into the diamond like carbon matrix were studied by transient absorption spectroscopy by using different excitation wavelengths. Structures of the investigated plasmonic nanocomposites were studied by Raman scattering spectroscopy, scanning electron microscopy and X-ray diffractometry. Chemical composition of the nanomaterials was investigated by Energy-dispersive X-ray spectroscopy. The dependence of the photovoltaic parameters of DLC:Ag and Si heterojunctions on the excitation wavelength was studied. We have found that the transient absorption spectra relaxation dynamics depends on the size distribution of nanoparticles and ultrafast energy transfer processes between the nanoparticles and host matrix are negligible. The results suggest that excitation at different wavelengths (350 – 800 nm) enables to follow dynamics of plasmon relaxation of Ag nanoparticles of different size.