

Ultrafast plasmon dynamics of heavily-doped semiconductor nanocrystals

by

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Abstract

Ultrafast electron-phonon coupling dominates the optical response of metallic nanostructures after intense excitation with femtosecond-laser pulses, offering the possibility to achieve optical modulation with unprecedented terahertz bandwidth [1]. In recent years, efforts have been made to synthesize heavily doped semiconductor nanocrystals that display plasmonic behaviour with spectrally tunable features [2]. A discussion on structural aspects, photo-physical properties, and theoretical and experimental analysis of the linear plasmonic response of colloidal nanocrystals will be illustrated. Colloidal Cu_{2-x}Se nanocrystals studied by ultrafast (~ 200 fs) pump-probe experiments in the near-infrared revealed the existence of strong nonlinearities in the plasmonic absorption. This is due to the lower carrier density of Cu_{2-x}Se compared to noble metals, which leads to ultrafast control of the probe signal with modulation depth exceeding 40% in transmission. A quantitative interpretation of these results based on a two-temperature model will be presented [3].

[1] Maier, S A "Plasmonics: Fundamentals and Applications"; Springer: New York, 2007; MacDonald K F et al, 2009 Nat. Photonics 3 55–58.

[2] Zhao Y X et al, J. Am. Chem. Soc. 131 4253–4261; Luther J M et al, 2011 Nat. Mater. 10 361–366.

[3] Sun C K et al, 1994 Phys. Rev. B 50 15337–15348; Scotognella F et al, 2011 Nano Lett. 11, 4711-4717; Scotognella F et al, 2013 EPJB 86, 154.

Short Biography



Francesco Scotognella studied at the Università di Parma and Università Milano-Bicocca (Italy), where he received his PhD in Materials Science in 2009. He was a visiting scientist at the University of Toronto in 2008, working with Prof. Geoffrey A. Ozin. He joined the Politecnico di Milano as a Postdoctoral Research Fellow within the framework of the European Project Photo-FET and then became an Assistant Professor in Experimental Physics in 2011. He is also affiliated to the Center of Nanoscience and Technology of the Italian Institute of Technology (IIT). His research interests focus on the science and technology of nanostructured and molecular materials (organic semiconductors, conjugated polymers, photonic crystals, semiconductor nanocrystals). He is actively involved in experimental work on photophysics, optoelectronics and photonics.

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