Prof. Dr. F. Cichos

Sächsische Forschergruppe FOR877

Molecular Nanophotonics

MONA-/ FOR877- Seminar

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Nonlinear Spectroscopy of a Single Nanoobject

Nanoobjects with a size between 1 and 100 nanometers show fascinating properties that deviate strongly from those of bulk solids. The plasmon resonance of metal nanoparticles or the electron confinement in quantum dots are prominent examples. However, even in the best preparation methods, nanoobjects differ from each other in size, shape, or local environment. Experiments on the single particle level allow the experimenter to circumvent the ensemble heterogeneity. In this presentation I will demonstrate nonlinear optical spectroscopy of a single nanoobject.

Single nanoobjects, especially at room temperature, show only a weak interaction with light, as only a low number of electrons is involved. Nonlinear optical signals which are already weak for a bulk solid become difficult to detect. I will show how an optical nanoantenna is able to enhance the signal of a single nanoobject so that nonlinear spectroscopy becomes possible. We investigate the mechanical breathing mode of a single gold nanodisc by antenna-enhanced transient absorption spectroscopy [1].

Very large optical nonlinearities can be found on optical two-level systems such as semiconductor quantum dots. Their quantum-optical properties find use as single photon source or quantum bit. However, to be really used, a quantum bit needs to be connected to some kind of circuit. I will give an overview of our work on coherent reading and writing of quantum bits [2] and their coupling to plasmonic nanocircuits [3].

[1] T. Schumacher et al. , “Nanoantenna-enhanced ultrafast nonlinear spectroscopy of a single gold nanoparticle”, Nature Commun. 2 (2011) 333.

[2] C. Wolpert et al., “Transient reflection: A versatile technique for ultrafast spectroscopy of a single quantum dot in complex environments”, Nano Letters 12 (2012) 453.

[3] M. Pfeiffer et al. , “Enhancing the Optical Excitation Efficiency of a Single Self- Assembled Quantum Dot with a Plasmonic Nanoantenna”, Nano Letters 10 (2010) 4555.