O 66: Plasmonics and Nanooptics VI

Time: Thursday 11:15–13:00 Location: WIL A317

O 66.1 Thu 11:15 WIL A317

Nano-plasmonics with single epitaxial quantum dots — •Markus Pfeiffer[1,2], Klas Lindfors[1,2], Christian Wolpert[1,2], Paola Atkinson[3], Armando Rastelli[3], Oliver G. Schmidt[3], Harald Giessen[2], and Markus Lippitz[1,2] — [1]Max Planck Institute for Solid State Research — [2]4. Physikalisches Intitut, Universität Stuttgart — [3]Institute for Integrative Nanosciences Dresden

Plasmon resonant metal structures are a particularly interesting choice to alter the emission properties of single quantum emitters since the electromagnetic field can be significantly modified close to the metal surface. This offers exciting possibilities in both fundamental light-matter studies as well as in applications.

We have experimentally investigated the influence of gold nanostructures on the photoluminescence properties of individual semiconductor quantum dots (QDs). The quantum dots are epitaxially grown GaAs/AlGaAs QDs which are buried a few nanometers beneath the semiconductor surface. The position of these emitters can be determined with high precision from a characteristic feature in the surface topography above each dot.

We have studied the enhancement of the excitation rate of single quantum dots using spherical gold nanoparticles. We observe enhancement factors up to 8 on resonance. We furthermore demonstrate significant differences between the enhancement spectrum and the far-field scattering spectrum of the antennas. We have also taken first steps towards incorporating single QDs in integrated plasmonic circuits.

O 66.2 Thu 11:30 WIL A317

Extraordinary Kerr effect in the transmission through ferromagnetic-plasmonic hybrid nanostructures — •M Pohl[1], V Belotelov[2], I Akimov[1,3], V Kotov[2,4], S Kasture[5], A Vengurlekar[5], A Gopal[5], D Yakovlev[3], A Zvezdin[2], and M Bayer[1] — [1]Experimentelle Physik E2, TU Dortmund, Germany — [2]A.M. Prokhorov General Physics Institute, Moscow, Russia — [3]A.F. Ioffe Physical-Technical Institute, St. Petersburg, Russia — [4]V.A. Kotelnikov Institute of Radio Engineering and Electronics, Moscow, Russia — [5]Tata Institute of Fundamental Research, Mumbai, India

The transverse magneto-optical Kerr effect (TMOKE) has been studied on a new magneto-optical heterostructure. The sample, consisting of a periodically nanostructured gold film on top of a ferromagnetic dielectric bismuth-iron-garnet film, allows the measurement of the TMOKE in transmission geometry via extraordinary optical transmission (EOT). It is shown that the effect is enhanced by up to three orders of magnitude exclusively near surface plasmon polariton resonances. The TMOKE signal is highly sensitive to the angle of light incidence, its polarization and the applied magnetic field strengths. Moreover, it changes sign for SPPs traveling in opposite directions. Thus, TMOKE can become an important tool for the complete characterization of plasmonic nanostructures. Additionally, the effect can be controlled by fields on the order of 100 Oe, which is very promising for ultra high sensitive devices and optical data processing.

O 66.3 Thu 11:45 WIL A317

Distinguishing between ultrafast optical harmonic generation and multi-photon-induced luminescence from ZnO thin films by interferometric frequency-resolved autocorrelation microscopy — •Slawa Schmidt[1], Manfred Mascheck[1], Martin Silies[1], Takashi Yatsui[2], Kokoro Kitamura[2], Motoichi Ohtsu[2], and Christoph Lienau[2] — [1]Carl-von-Ossietzky-Universität, Oldenburg — [2]University of Tokyo

The nonlinear optical properties of a thin ZnO film are studied using interferometric frequency-resolved autocorrelation (IFRAC) microscopy. By exciting the film with 6-fs, below-bandgap laser pulses at 800nm focused to a spot size of 1 μm two emission bands in the blue and blue-green spectral region with distinctly different coherence properties can be detected. We show that an analysis of the wavelength-dependence of the interference fringes in the IFRAC signal allows for an unambiguous assignment of these bands as coherent second harmonic emission and incoherent, multiphoton-induced photoluminescence, respectively. More generally our analysis shows that IFRAC allows for a complete characterization of the coherence properties of the nonlinear optical emission from nanostructures in a single-beam experiment. Since this technique combines a very high temporal and spatial resolution we anticipate broad applications in nonlinear nano-optics.

O 66.4 Thu 12:00 WIL A317

Nanooptical control of hot-spot field superenhancement and long-lived coherences on a corrugated silver surface — Martin Aeschlimann[1], Tobias Brixner[2], Stefan Cunovic[3], Alexander Fischer[1], Christian Kramer[2], Pascal Melchior[1], Walter Pfeiffer[3], Christian Schneider[1], •Christian Strüber[3], Philip Tuchscherer[2], and Dmitri V. Voronine[3,4] — [1]TU Kaiserslautern, Germany — [2]Universität Würzburg, Germany — [3]Universität Bielefeld, Germany — [4]Texas A&M University, College Station, USA

Hot-spots on deterministically or randomly structured metal surfaces enable ultra-sensitive optical spectroscopy by increasing the optical signals. For example, Raman signals from molecules placed on Ag surfaces may be enhanced dramatically and single molecule sensitivity is reached. Here we combine photoemission photoelectron microscopy (PEEM) and polarization pulse shaping to investigate the multiphoton photoemission from hot-spots on a corrugated silver surface. The hot-spot related multiphoton photoemission is enhanced and manipulated with high contrast. Adaptive optimization reproducibly yield long complex pulse shapes for various optimization goals. This and results from pre-determined few-parameter control scans indicate the presence of long-lived coherences. The existence of such resonances with coherence lifetimes in the order of 100fs is proven in time-resolved local coherent spectroscopy. The high resolution of PEEM allows spatial mapping of these resonances across the surface. Spectral correlations between neighboring hot-spots indicate that weakly localized plasmon polariton states are responsible for the hot-spot emission.

O 66.5 Thu 12:15 WIL A317

Hotspot related plasmon assisted multiphoton photocurrents in metal-insulator-metal junctions — •Dominik Differt[1], Detlef Diesing[2], and Walter Pfeiffer[1] — [1]Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany — [2]Universität Duisburg-Essen, Universitätsstr. 5, 45117 Essen, Germany

Scanning photocurrent microscopy of metal-insulator-metal junctions (MIM) is used to investigate the mechanisms of femtosecond multiphoton photocurrent injection at liquid nitrogen temperature. The locally induced multiphoton photocurrent in a Ag-TaO-Ta MIM junction is measured in a scanning microscope cryostat under focused illumination (5μm focus diameter, 800nm, 30fs, 80MHz repetition rate). The intensity dependence reveals a mixture of two-photon and three-photon processes that are responsible for the photocurrent. Its lateral variation shows hotspot-like behaviour with significant magnitude variations on a 100 to 200nm length scale. Assuming an injection current duration of 40fs the peak injection current density of about 10^4 A cm^{-2} is estimated - 10^6 times higher than that for 400nm continuous wave illumination slightly below the damage threshold. The simultaneously measured extinction of the incident radiation reveals a 20 to 30% increased absorption at the hotspots. We attribute the local photocurrent enhancement to the defect-assisted excitation of surface plasmon polaritons at the silver electrode leading to an enhanced local excitation.

O 66.6 Thu 12:30 WIL A317

Controlling two-photon excited luminescence in gold nanostructures with polarization pulse shaping — •Giovanni Piredda[1], Zhimin Shi[2], Caroline Gollub[3], Regina de Vivie-Riedle[1], and Achim Hartschuh[1] — [1]Physikalische Chemie, Department Chemie und Biochemie, Ludwig-Maximilians-Universität München — [2]The Institute of Optics, University of Rochester, Rochester, NY 14620, USA — [3]Institute for Materials Science, TU Dresden

Ultrafast nanooptics is an emerging field that combines the concepts and tools of ultrafast spectroscopy and coherent control with those of near-field optics [1]. A simple demonstration of coherent control is the ability to maximize the yield of nonlinear optical processes; we choose for our demonstration two-photon excited luminescence from gold nanostructures [2]. We compare optimization results in different nanostructures showing that the pulse characteristics that result in the highest luminescence yield depend on the single structure; control has therefore a local character. We also provide numerical simulations to support our experimental findings [3].

[1] M.I. Stockman, S.V. Faleev, and D.J. Bergman; Phys. Rev. Lett., 88, 067402 (2002).

[2] M.R. Beversluis, A. Bouhelier, and L. Novotny; Phys. Rev. B 68, 115433 (2003).

[3] G. Piredda, C. Gollub, R. de Vivie-Riedle, and A. Hartschuh; Appl. Phys. B-Lasers O., 100, 195 (2010).

O 66.7 Thu 12:45 WIL A317

Investigation of polarization effects in reconstruction of highly focused vector beams using the knife-edge method — •Christian Huber[1,2], Pavel Marchenko[1,2], Sergejus Orlovas[1,2], Peter Banzer[1,2], Ulf Peschel[2], and Gerd Leuchs[1,2] — [1]Max Planck Institute for the Science of Light, Günther-Scharowsky-Str. 1, D-91058 Erlangen — [2]Institute of Optics, Information and Photonics, University Erlangen-Nuremberg, Staudtstr. 7/B2, D-91052 Erlangen

For experiments with highly focused vector beams the focal field distribution has to be known. The knife-edge method can be used to reconstruct the intensity distribution of the electric field in the focal plane of a high NA objective. For that purpose, a thin knife-edge fabricated on a photodiode is moved through the focal spot while the photocurrent is recorded. To calculate the beam profile by inverse Radon transform the measurements have to be performed for different angels from 0 to 180 degrees of the edge relative to the beam. As demonstrated previously [1] the focal spot can be experimentally characterized at a wavelength of 633 nm using a special mixture of Zink and Gold as knife-edge material. However for pure materials the reconstructed field distribution is modified by polarization dependent effects. To investigate these effects in detail we performed measurements for different edge materials, edge thicknesses and for different wavelengths. According to our experimental and theoretical results the observed polarization dependency for pure materials is caused by effects such as the excitation of plasmonic modes. [1] R. Dorn et al., Opt., 50 (12), 1917-1926 (2003)